Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Groundwater and Seeps Remedy 90% Design Submittal
Chemours Fayetteville Works

Prepared for

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EXECUTIVE SUMMARY

This 90% Design report, prepared by Geosyntec Consultants of NC, P.C. (Geosyntec) and GEOServices, LLC (GEOServices) for The Chemours Company FC, LLC (Chemours), describes the components of the remedial action being designed for implementation at the Fayetteville Works Site (the Site) pursuant to the requirements of paragraphs 2(c) and 3(b) of the Consent Order Addendum (COA) among Chemours, the North Carolina Department of Environmental Quality (NCDEQ), and Cape Fear River Watch (CFRW).

The Site is an active manufacturing facility and is located approximately 20 miles southeast of the City of Fayetteville along the Bladen-Cumberland County line in North Carolina. The Site is bounded by NC Highway 87 to the west, the Cape Fear River to the east, and on the north and south by forested areas, farmland and private residences. The Site's manufacturing areas are located on relatively flat ground and are separated from the Cape Fear River by a relatively steep bluff face which descends over 100 feet down to the Cape Fear River with multiple aquifer units intersecting along the bluff face (see Figure ES1). The Site is located within the North Carolina Coastal Plain Hydrogeologic region. Site hydrogeology consists of four water bearing units:

- The Perched Zone: Uppermost unconfined hydrostratigraphic unit in the vicinity of the Site. The Perched Zone is discontinuous and is spatially limited in its extents. Water from the perched zone migrates radially to the bluff face at the Site where it is expressed as groundwater fed seeps that migrate downwards to the surficial aquifer and also discharges to the Cape Fear River.
- The Surficial Aquifer: Directly underlies the Perched Zone, where it exists, and constitutes the surface water table. Surficial aquifer groundwater discharges both to the Black Creek Aquifer and to the bluff face at the Site as groundwater fed seeps and then enters the Cape Fear River.
- The Black Creek Aquifer: This zone is separated from the Surficial Aquifer by the Black Creek confining unit. The Black Creek Aquifer is a delta plain deposit with lateral variability in grain size and transmissivity with the northern areas at the Site having finer grain sizes and lower transmissivity. Black Creek Aquifer groundwater discharges as both groundwater fed seeps at the base or toe of the bluff face near the Cape Fear River and directly into the Cape Fear River.
- The Upper Cape Fear Formation: This unit consists of an overlying confining unit (the Upper Cape Fear Confining Unit, UCC) and the Upper Cape Fear Aquifer (UCFA) which consist of interbedded clays and sand. The clay beds are typically pale to medium gray which is consistent with clay beds identified in the base of most onsite borings (Geosyntec2021a).

The remedy design described in this report will intercept, capture and treat groundwater originating in the Perched, Surficial, and Black Creek Aquifers as well as the water that discharges at the bluff face as seeps.

The COA provides that Chemours shall proceed with the design and the installation of a barrier wall and groundwater extraction and treatment system to reduce per- and polyfluoroalkyl substances (PFAS) loading from groundwater flow from under the Facility to the Cape Fear River and Willis Creek. Similarly, the COA also outlines the objectives for a long-term seep remedy. The objective of the long-term seep remedy is to reduce the total annual mass loading of PFAS (as measured by the indicator parameters hexafluoropropylene oxide dimer acid [HFPO-DA], perfluoro-2-methoxypropanoic acid [PMPA] and perfluoro-1-methoxyacetic acid [PFMOAA]) to the Cape Fear River from Seeps A through D.

The remedy objectives outlined in the COA results in a remedy design with three components:

- The groundwater interception remedy
- The ex-situ capture remedy
- The groundwater treatment plant

The groundwater interception remedy consists of three key elements: (i) a subsurface barrier wall to create a vertical low permeability barrier to reduce the transmission of groundwater, (ii) a groundwater extraction system consisting of extraction wells in the Surficial and Black Creek aquifers, and (iii) a groundwater conveyance system to convey extracted groundwater to the treatment system (see Figure ES1). The ex-situ capture remedy design consists of capture locations where ex-situ flow intersects the barrier wall alignment at Seep A, Seep A-Tributary and Seep B to accommodate dry weather flows and stormwater flows from rainfall events up to 0.5 inches over 24 hours pursuant to COA paragraphs 2(c). In addition to seep capture, Chemours will also capture the dry weather flow crossing the remedy at the Willis Creek Tributary and at weep[1] locations to prevent groundwater migrating over the barrier wall / remedy pursuant to COA paragraph 3(b). The ex-situ capture design includes impoundment and pumping systems along with equalization basins, as needed, to control flows. The captured water is then conveyed to the groundwater treatment plant (GWTP) which is being designed to treat continuous maximum flow rates up to 1,500 gallons per minute (gpm) of water and to remove 99% of indicator PFAS parameters. A Performance Monitoring Plan (PMP) has been prepared to address long-term groundwater remedial action effectiveness.

The remedy design as described in this report will intercept, capture and treat groundwater pursuant to the requirements of paragraphs 2(c) and 3(b) of the COA.

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[1] Weeps are low flow or ephemeral groundwater reaching surface at or upgradient of the planned barrier wall alignment with anticipated flow rates of 10 gallons per minute or less.

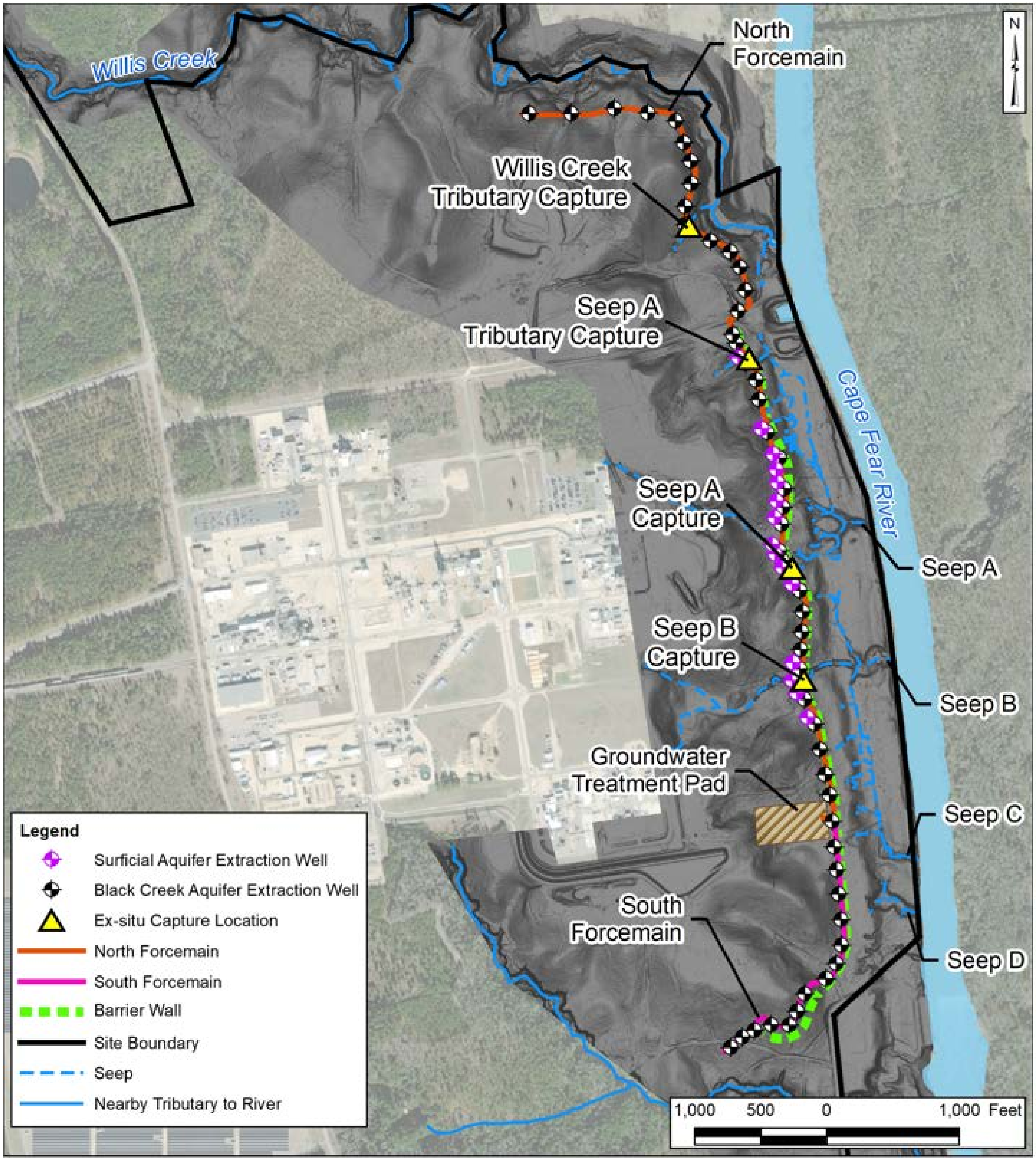

Figure ES1: Remedy Layout Overview

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

3D	three-dimensional
CAP	Corrective Action Plan
CFRW	Cape Fear River Watch
COA	Consent Order Addendum
cm/s	centimeters per second
CQA	Construction Quality Assurance
EBCT	Empty Bed Contact Time
E&SC	Erosion and Sediment Control
FEMA	Federal Emergency Management Agency
ft	feet
GAC	granular activated carbon
gpm	gallons per minute
GWTP	groundwater treatment plant
HFPO-DA	hexafluoropropylene oxide dimer acid
IXM	Ion Exchange Membranes
m	meter
mg/L	milligrams per liter
NC	North Carolina
NCDEQ	North Carolina Department of Environmental Quality
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
P_c	capillary pressure
PDI	Pre-Design Investigation
PFAS	per- and polyfluoroalkyl substances
PFM	Passive Flux Meter
PFMOAA	perfluoro-1-methoxyacetic acid
PMP	Project Monitoring Plan

ACRONYMS AND ABBREVIATIONS (CONT'D)

PMPA	perfluoro-2-methoxypropanoic acid
PPA	Polymers Processing Area
PVC	polyvinyl chloride
PVF	polyvinyl fluoride
S_w	wetting phase saturation
SMMP	Soil and Material Management Plan
UCC	Upper Cape Fear Confining Unit
UCFA	Upper Cape Fear Aquifer
USACE	United States Army Corps of Engineers

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DOCUMENT:

Barrier Wall Report 90% Design Submittal (Geotechnical Design: Seepage, Slope Stability, Soil Nail Wall)

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052287
25 MAR 2022
TAYLER J. DAY

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Barrier Wall Report 90% Design Submittal (Civil Design: Grading and Retaining Walls)

Ex-situ Capture Report 90% Design Submittal

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1. INTRODUCTION AND OBJECTIVES

Geosyntec Consultants of NC, P.C. (Geosyntec) and GEOServices, LLC (GEOServices) have prepared this 90% Design Report for The Chemours Company, FC, LLC (Chemours) Fayetteville Works facility in Bladen County, North Carolina (Figure 1, the Site). This report describes the components of the remedial action that is being designed for implementation at the Site. This report is submitted pursuant to the requirements of paragraph 3(b) of the Consent Order Addendum (COA). The COA requires Chemours to proceed with the design and installation of a barrier wall and groundwater extraction and treatment system to reduce per- and polyfluoroalkyl substances (PFAS) loading from groundwater flow from under the Facility to the Cape Fear River and Willis Creek. The objective of this report is to provide the 90% design of the remedy for North Carolina Department of Environmental Quality (NCDEQ) review and subsequent approval.

The design concepts presented are expected to remain consistent between this report and the constructed remedy. However, some elements may be refined in the final progression to 100% for construction design. The designs are also subject to change based on conditions encountered during installation.

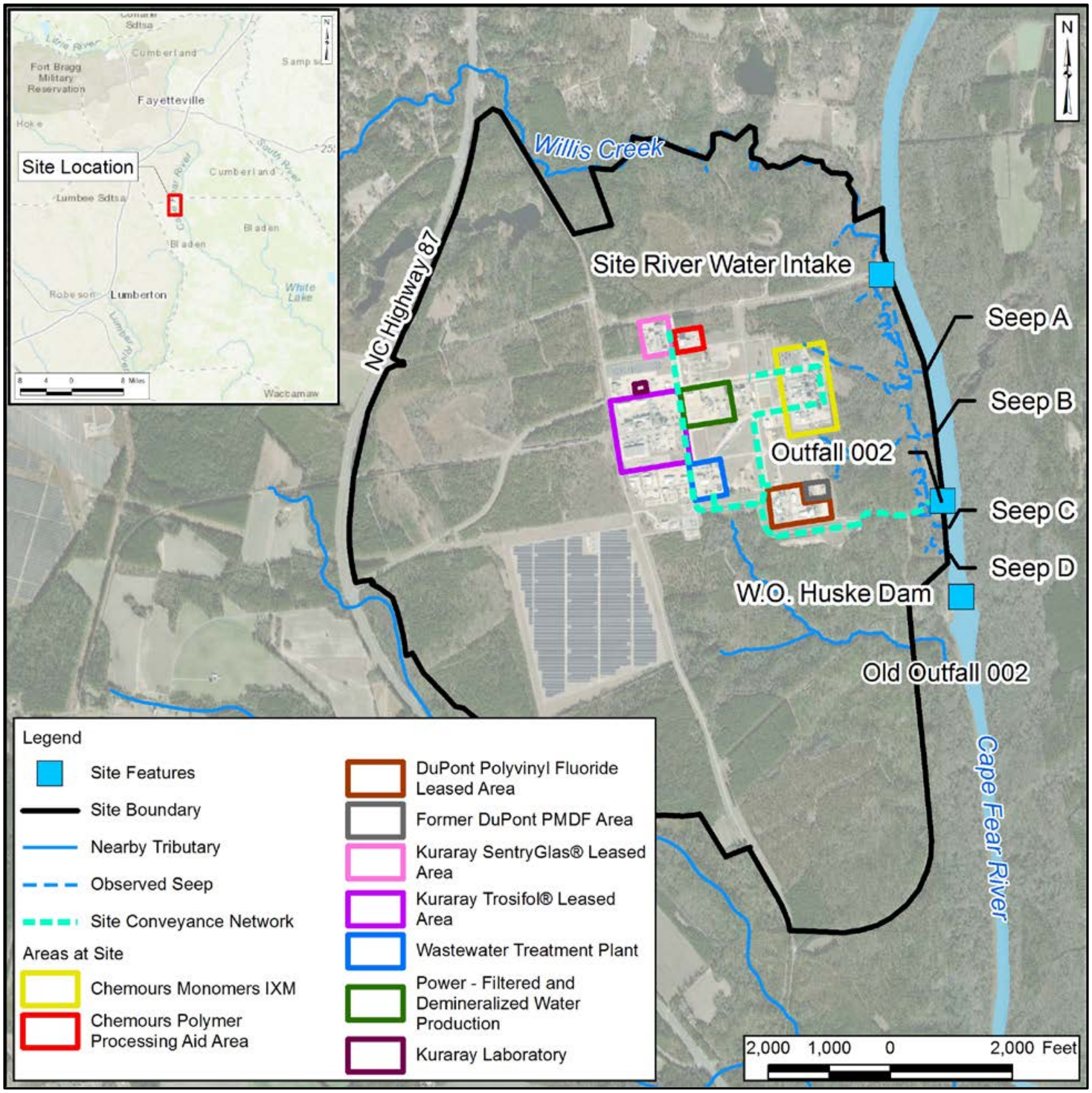

Figure 1: Site Location

1.1 Report Organization

The remainder of this document is organized as follows:

- **Section 2 – Background, Remedy Objectives and Overview** describes the overarching objectives of the remedy, a description of the Site, Site geology and an outline of the remedy design.
- **Section 3 – Groundwater Interception Remedy Design** describes the basis of design and 90% design for the groundwater interception remedy comprised of an underground barrier wall, groundwater extraction wells and conveyance system.
- **Section 4 –Ex-Situ Capture Remedy Design** describes the design of the seeps ex-situ capture systems.
- **Section 5 – Groundwater Treatment Design** describes the basis of design for the groundwater treatment plant as well as the specific components of the treatment train.
- **Section 6 – Permits** describes the permit submissions for National Pollutant Discharge Elimination System (NPDES), United States Army Corps of Engineers (USACE)/NCDEQ Clean Water Act Section 404 Permit and 401 Certification, well permits, extraction permits, and Bladen County permits for land disturbance and electrical connection.
- **Section 7 – Construction Quality Assurance (CQA)** provides a summary of the CQA practices that will be implemented to identify and rectify design nonconformance related to the Barrier Wall.
- **Section 8 – Operation and Maintenance** provides a summary of the operations and maintenance considerations for ongoing remedy operation.
- **Section 9 – Performance Monitoring** provides a summary of a performance monitoring plan which outlines the methods by which the remedy effectiveness will be monitored.
- **Section 10 – Adaptive Management** describes the contingencies incorporated as part of the design resiliency and flexibility.
- **Section 11 – Schedule** describes the timelines for the remedy design, installation and commissioning and COA milestone dates.
- **Section 12 – Summary and Closing** provides a summary of this design report.

1.2 Report Appendices

This report contains a series of appendices that support the 90% designs for the remedy components described in in Sections 2 through 5. These appendices are listed below in Table 1.

Table 1: Summary of Appendices

Attachment	Title	Content/Purpose
Appendix A	Groundwater Flow Model Report	Presents an update on the model development and the remedy modeled to prevent groundwater migration around, above or under the barrier wall.
Appendix B	Barrier Wall Design Report	Presents 90% design details on the barrier wall including contours, location, and structure of the wall.
Appendix C	Groundwater Extraction and Conveyance System Design Report	Presents 90% design details on the groundwater extraction and conveyance system to prevent groundwater migration around, above or under the barrier wall.
Appendix D	Seep Flow at Barrier Wall Memo	Presents the data and modeling relevant to the determination of seep dry weather flow and 0.5” rainfall stormwater volume estimates, in addition to Willis Creek Tributary dry weather flow.
Appendix E	Ex-Situ Capture Design Report	Presents 90% design details on the seep capture design for Seeps A, A-tributary and B flow upgradient of barrier wall and rain events up to 0.5 inches of rainfall in 24 hours, in addition to Willis Creek Tributary and ephemeral weep dry weather flow.
Appendix F	Groundwater Treatment Plant Process Narrative	Presents 90% design details on the groundwater treatment system required to achieve 99% removal efficiency.
Appendix G	Performance Monitoring Plan	Presents the performance monitoring plan for the groundwater interception remedy.

Attachment	Title	Content/Purpose
Appendix H	Barrier Wall Construction Quality Assurance (CQA) Plan	Presents the details for planned Quality Assurance during the construction of the Barrier Wall
Appendix I	Passive Flux Meter (PFM) Memo	Presents the relative differences in PFAS mass flux along northern and southern/ central sections of the remedy

In addition to the reports shown in Table above, there were additional basis of design documents transmitted previously in the 60% design submittal, including the Pre-Design Investigation Report (Geosyntec, 2021a) and the NPDES Engineering Report (Geosyntec, 2021b; Appendix G).

1.3 Design Progression from 90% to 100%

The objective of this 90% design report submittal and appendices (listed in Table 1) is to present the design basis, remedial concepts, and remedial designs to meet the requirements pursuant to COA paragraphs 2(c) and 3(b). This 90% design presents the remedy details and specifications for each design component. In progression to the 100% “Issued for Construction” design, some elements may be refined. The designs are also subject to change based conditions encountered during installation.

2. BACKGROUND, REMEDY OBJECTIVES AND OVERVIEW

This section provides a description of the Site location, remedy objectives and remedy overview and how remedy objectives will be fulfilled. Additional Site background details as well as Site and regional geography and geology are contained in the Corrective Action Plan (CAP; Geosyntec, 2019a), the On and Offsite Assessment Report (Geosyntec 2019b), and the Pre-Design Investigation (PDI) report (Geosyntec 2021a).

2.1 Site Background

The Site is located within a 2,177-acre property at 22828 North Carolina (NC) Highway 87, approximately 20 miles southeast of the city of Fayetteville along the Bladen-Cumberland County line in North Carolina. Figure 1 shown above presents the location of the Site.

The Site property was originally purchased by E.I. du Pont de Nemours and Company (DuPont) in 1970 for production of nylon strapping and elastomeric tape. DuPont sold its Butacite® and SentryGlas® manufacturing units to Kuraray America Inc. (Kuraray) in June 2014 and subsequently separated its specialty chemicals business, with Chemours becoming an independent operator in July 2015. The manufacturing area is approximately 312 acres, and the remaining areas are grassy areas, forests, and wetlands. Presently, the Site consists of five manufacturing areas (Figure 1): Chemours Monomers Ion Exchange Membranes (IXM); Chemours Polymer Processing Aid (PPA); Kuraray Trosifol®; Kuraray SentryGlas®; and DuPont Company polyvinyl fluoride (PVF) resin manufacturing unit. In addition to the manufacturing operations, Chemours operates two natural gas-fired boilers, a wastewater treatment plant for the treatment of sanitary wastewaters as well as process wastewaters from Kuraray and DuPont, and a thermal oxidizer for treatment of air emissions.

The Site is bounded by NC Highway 87 to the west, Cape Fear River to the east, and on the north and south by forested areas, farmland, and private residences. Cumberland and Bladen County zoning maps indicate that the surrounding areas are zoned as residential, agricultural, conservation, industrial or commercial.

2.1.1 Site Geology and Hydrogeology

The Site is located within the North Carolina Coastal Plain Hydrogeologic region. Site and regional geology consist of four primary units in stratigraphic order from bottom to top; the Cretaceous Cape Fear formation (the oldest formation), the Cretaceous Black Creek formation, the Surficial Aquifer, and younger sediments along the Cape Fear River, designated as floodplain deposits. This section summarizes the geology and hydrogeology of the Site. A more detailed discussion of the site-specific geology and hydrogeology is presented in the PDI report (Geosyntec 2021a) as well as the CAP (Geosyntec, 2019a).

Geology

The four primary units listed in order of age (oldest to youngest; deepest to most shallow) are described below.

The Upper Cape Fear formation consists of an overlying confining unit (the UCC), the Upper Cape Fear Aquifer (UCFA), the Lower Cape Fear Confining Unit, and the Lower Cape Fear Aquifer. The depositional environment is interpreted to have been either a marginal marine or deltaic consisting of interbedded clays and sand. The clay beds are typically pale to medium gray which is consistent with clay beds identified in the base of onsite borings along the groundwater remedy alignment. Clay strata are up to 8 feet (ft) in thickness. The sands are either massive or poorly cross-bedded and commonly contain clay clasts. Sands range from fine to very coarse grained (Sohl & Owens, 1991).

The Tar Heel formation of the Black Creek Group overlies the Cape Fear unconformably and consists of the Black Creek Aquifer and the Black Creek Confining Unit. In the area of the Site, the Tar Heel formation is interpreted to be a delta plain depositional environment. Horizontal beds of black carbonaceous clays are interbedded with sands. Wood is especially common in these facies, with silicified logs present (petrified wood). The deltaic sequences generally have a mixture of higher energy channel sands and lower energy mud flats typical of transgressive and regressive sequences of sea water levels.

The Varina Grove unit of early Pleistocene age unconformably overlies the Black Creek group and in previous Site reports was designated the Surficial Aquifer. The Varina Grove unit consists of sands, very fine to fine grained, silty and clayey, grading downward through fine to medium to medium to coarse to very coarse-grained sands. The sands and clay are generally dark grayish orange and/or dark yellow brown. They are interpreted as terrace deposits. As the uppermost unconfined unit, this will continue to be designated as the Surficial Aquifer. The overlying Perched Zone is interpreted to be the result of a topographically isolated clay unit (Perched Zone Clay) from this unit.

The flood plain deposits are observed in isolated areas at the site and are shown on the surficial geological map to be older alluvium of the late Pleistocene age. Deposits are described as gravel, with rounded to sub-rounded quartz clasts up to the 6 cm in diameter in a silty quartose. Color is typically dark grayish orange.

Hydrogeology

The sediments at Site give rise to four water bearing units from shallowest to deepest

- The Perched Zone: Uppermost unconfined hydrostratigraphic unit in the vicinity of the Site and is created by a topographically isolated clay bed associated with the Varina Grove unit. The Perched Zone is discontinuous and is spatially limited in extent. Water from the perched zone migrates radially including towards to the bluff face at the Site where it is expressed as groundwater fed seeps, and towards the western extent of the zone and then migrate downwards to the surficial aquifer and also discharges to the Cape Fear River.

- The Surficial Aquifer: directly underlies the Perched Zone, where it exists, and constitutes the surface water table and follows the surface topography where the perched clay is not laterally present. Surficial aquifer groundwater discharges both to the Black Creek Aquifer and to the bluff face at the Site as groundwater fed seeps and then enters the Cape Fear River.
- The Black Creek Aquifer is separated from the Surficial Aquifer by the Black Creek confining unit, which consists of dark gray to black organic-rich clay. The Black Creek Aquifer is associated with the Black Creek Formation. The Black Creek Aquifer is interpreted to have a delta plain depositional area. The lateral variability and changing energy conditions expected of a delta plain is supported by the varying yield and thickness observed during the PDI. Monitoring wells installed along Willis Creek showed a significant thinning of Black Creek Aquifer material (Geosyntec 2021a; Appendix A).
- The Upper Cape Fear formation of an overlying confining unit (the UCC) and the UCFA which consist of interbedded clays and sand. The clay beds are typically pale to medium gray which is consistent with clay beds identified in the base of most onsite borings (Geosyntec 2021a).

2.2 Remedy Objectives

The COA states in Paragraph 3(b) that “Chemours shall proceed with the design and the installation of a barrier wall and groundwater extraction and treatment system to reduce PFAS loading from groundwater flow from under the Facility to the Cape Fear River and Willis Creek”. The schedule associated with Paragraph 3(b) outlines a submission date of March 31, 2022 for the 90% design of the barrier wall and extraction system; and construction completion and commencement of operations by March 15, 2023.

In Paragraph 3(b)(i) and (ii) of the COA, objectives for the groundwater interception remedy are outlined:

- “Reduce PFAS loading from groundwater flow from under the Facility to the Cape Fear River and Willis Creek.”
- “Chemours shall construct a barrier wall located between the facility and the Cape Fear River and Willis Creek that is designed and constructed to intercept the groundwater flow under the Facility... It is understood that the precise contours, locations, and structure of the barrier wall will be determined as part of the design.”

- "Chemours shall construct an extraction system consisting of an adequate number of wells and/or interceptor trenches to pump groundwater at a rate and depth sufficient to prevent groundwater migration around, above, or under the barrier wall."
- "The system shall be designed so that extracted groundwater shall be treated through a treatment system that removes PFAS compounds (as measured by the three indicator parameters [HFPO-DA[2], PMPA[3], and PFMOAA[4]]) at a minimum removal efficiency of 99%."

Similarly, in Paragraph 2(c) of the COA, objectives for the long-term seep remedy are outlined. The primary objective of the long-term seep remedy is to reduce the total annual mass loading of PFAS (as measured by the indicator parameters) to the Cape Fear River from Seeps A through D as follows:

- During dry weather, reduce total mass loading by at least 99%.
- During dry weather and following rain events of 0.5 inches or less, reduce total mass loading by at least 95%.
- For seep water that daylights from Seeps A, B, C or D upgradient of the Barrier Wall, capture total dry weather flow plus rain events up to 0.5 inches in a 24-hour period upgradient of the Barrier Wall.

In order to address the groundwater and seep objectives, pre-design investigation and assessment activities were conducted as described in Section 3.1 and multiple design efforts are being advanced as described in Section 2.3.

2.3 Remedy Overview

The remedy objectives result in a remedy design with three components:

- The groundwater interception remedy
- The ex-situ capture remedy
- The groundwater treatment plant

The groundwater interception remedy contains three key elements: an underground barrier wall to create a vertical low permeability barrier to reduce the transmission of groundwater, a groundwater extraction system consisting of extraction wells in the Surficial and Black Creek aquifers, and a groundwater conveyance system to convey that groundwater to the treatment system. Figure 2 provides an overview of the groundwater interception remedy. The barrier wall design extends

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[2] HFPO-DA: hexafluoropropylene oxide dimer

[3] PMPA: perfluoro-2-methoxypropanoic acid

[4] PFMOAA: perfluoro-1-methoxyacetic acid

from the facility water intake access road at the northern barrier wall extent to the old Outfall Channel on the southern extent. The extraction system design consists of 69 wells: 54 in the black creek aquifer and 15 in the surficial aquifer. This extraction well network and conveyance system are designed to be installed upgradient of the barrier wall and extend from Willis Creek at the north to the old Outfall Channel at the south. As described later in Section 3, modeling results indicate this remedy will intercept groundwater migrating to both Willis Creek and the Cape Fear River along the length of the remedy

Additionally, the northern portion of the remedy alignment, where groundwater extraction is used to contain the PFAS mass flux without the barrier wall, has a much lower PFAS mass flux percentage than the southern portion where groundwater will be controlled by a barrier wall and extraction system. The northern sections mass flux is estimated to be only 3-5% of the mass flux in the Black Creek Aquifer along the remedy alignment reaching the river compared to the 95-97% from the southern section of the remedy.

The ex-situ capture remedy design consists of capture locations where the seep flow intersects the barrier wall alignment at Seep A, Seep A-Tributary and Seep B to accommodate dry weather flows and stormwater flows from rainfall events up to 0.5 inches over 24 hours pursuant to COA paragraphs 2(c). In addition to seep capture Chemours will also capture the groundwater dry weather flow crossing the remedy at the Willis Creek Tributary and at weep locations to prevent groundwater migrating over the barrier wall / remedy pursuant to COA paragraph 3(b). Weeps are low flow or ephemeral groundwater reaching surface at or upgradient of the planned remedy alignment with anticipated flow rates of 10 gallons per minute or less. The ex-situ capture designs include impoundment and pumping systems along with equalization basins, as needed, to control flows. The Ex-situ capture locations are shown in Figure 2 below. Soil waste including excess soils from site grading activities, preparation of ex-situ capture locations and ponds, drilling waste, and solids that may build up into ex-situ basins/ponds during operation and must be removed will be managed according to the Soils and Materials Management Plan (SMMP) submitted on February 8, 2022 (Chemours, 2022).

Captured water is then conveyed to the groundwater treatment plant (GWTP). The GWTP is being designed to treat maximum continuous flow rates up to 1,500 gallons per minute (gpm) of water from the ex-situ capture remedy and the groundwater remedy. Groundwater treatment will include pre-treatment followed by granular activated carbon (GAC) to remove a minimum of 99% of indicator parameters[5].

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[5] Indicator parameters are HFPO-DA, PMPA, and PFMOAA.

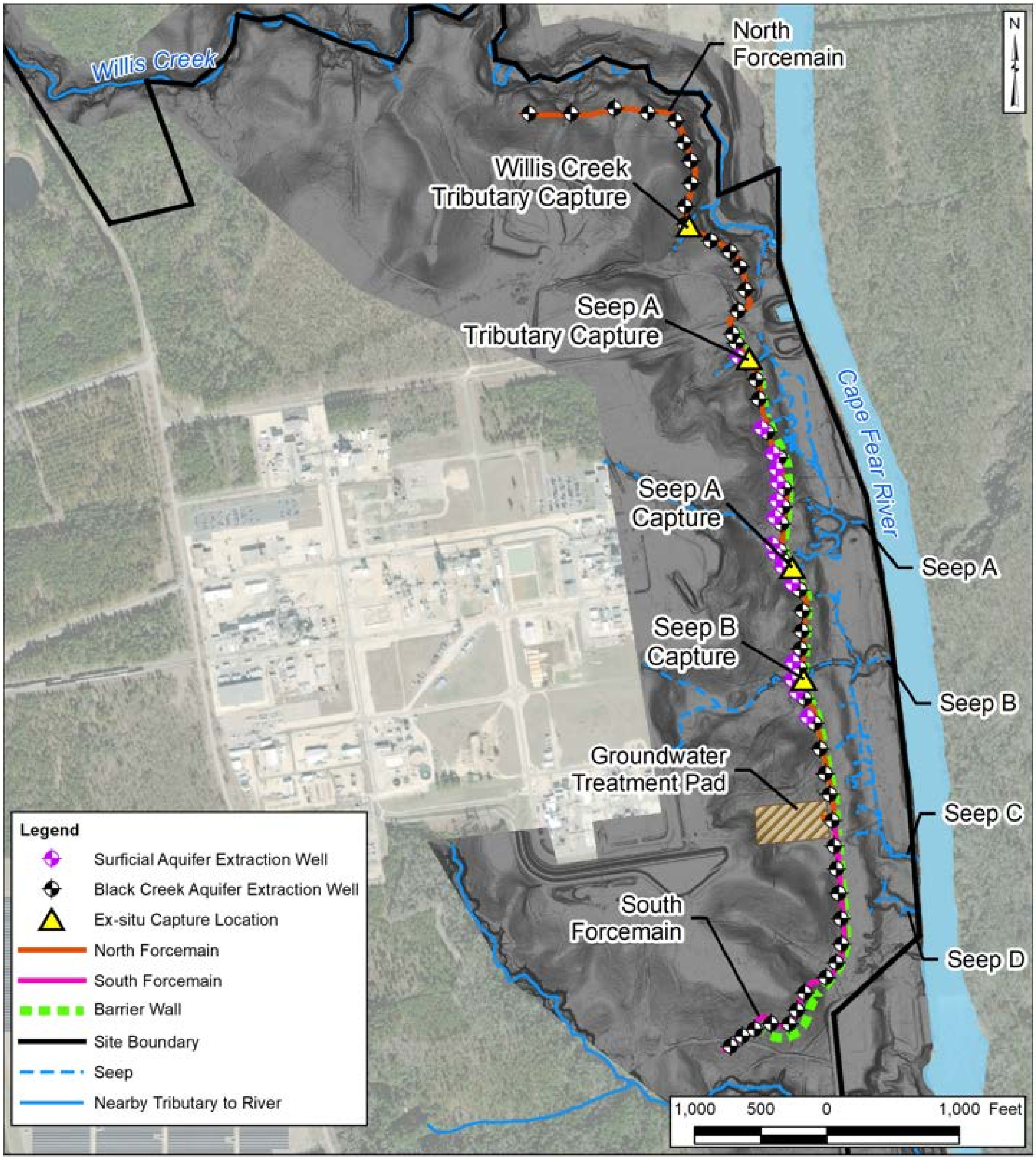

Figure 2: Remedy Layout Overview

3. GROUNDWATER INTERCEPTION REMEDY DESIGN

This section provides a summary of the basis of design elements which includes a summary of the PDI findings and of the groundwater flow model results. This is followed by a summary of the design elements of the groundwater interception remedy, including the groundwater extraction wells, the groundwater conveyance system, and the barrier wall.

3.1 Groundwater Interception Basis of Design

3.1.1 Summary of Pre-Design Investigation Report

PDI activities were conducted between the third quarter of 2020 through the second quarter of 2021. The objective of the PDI was to collect additional subsurface geological and hydrogeological data relevant to the design of the proposed barrier wall and groundwater extraction system, such that the remedies would be able to achieve the remedial objectives outlined in the COA and described above in Section 2.2. Version 1 of the PDI Report was submitted to NCDEQ on March 24, 2021 based on pre-design data collected in the third and fourth quarters of 2020. Version 2 of the PDI Report was submitted to NCDEQ on June 29, 2021 following additional investigations conducted in the first and second quarters of 2021 (Geosyntec, 2021a). The PDI report was also included as part of the 60% Design report submitted to DEQ and the CFRW on August 13, 2021. The main findings from the PDI that inform the design of the groundwater remedy are described below.

Site geology is highly variable along the groundwater remedy alignment. Consistent with the interpretation of a deltaic depositional environment, the Black Creek aquifer along the alignment is a mixture of high energy channel sands and lower energy mud flats. Geosyntec prepared a high-resolution cross section along the groundwater remedy alignment using a combination of data collected during the PDI and previous investigations (Figure 3). Three distinct sections of the groundwater remedy alignment are described as follows:

- The southern portion (0 to 3,000 ft on cross section) of the alignment where Black Creek aquifer soils have higher-energy channel sands but are also hydraulically influenced by the Old Outfall.
- The central portion (3,000 to 7,500 ft on cross section) of the alignment where Black Creek aquifer soils are dominated by higher-energy channel sands and correlates to the locations of a majority of the seeps.
- The northern portion (7,500 to 8,500 ft on cross section) of the alignment, adjacent to Willis Creek, where Black Creek aquifer soils are dominated by more fine-grained materials indicative of a transition to a low-energy depositional environment.

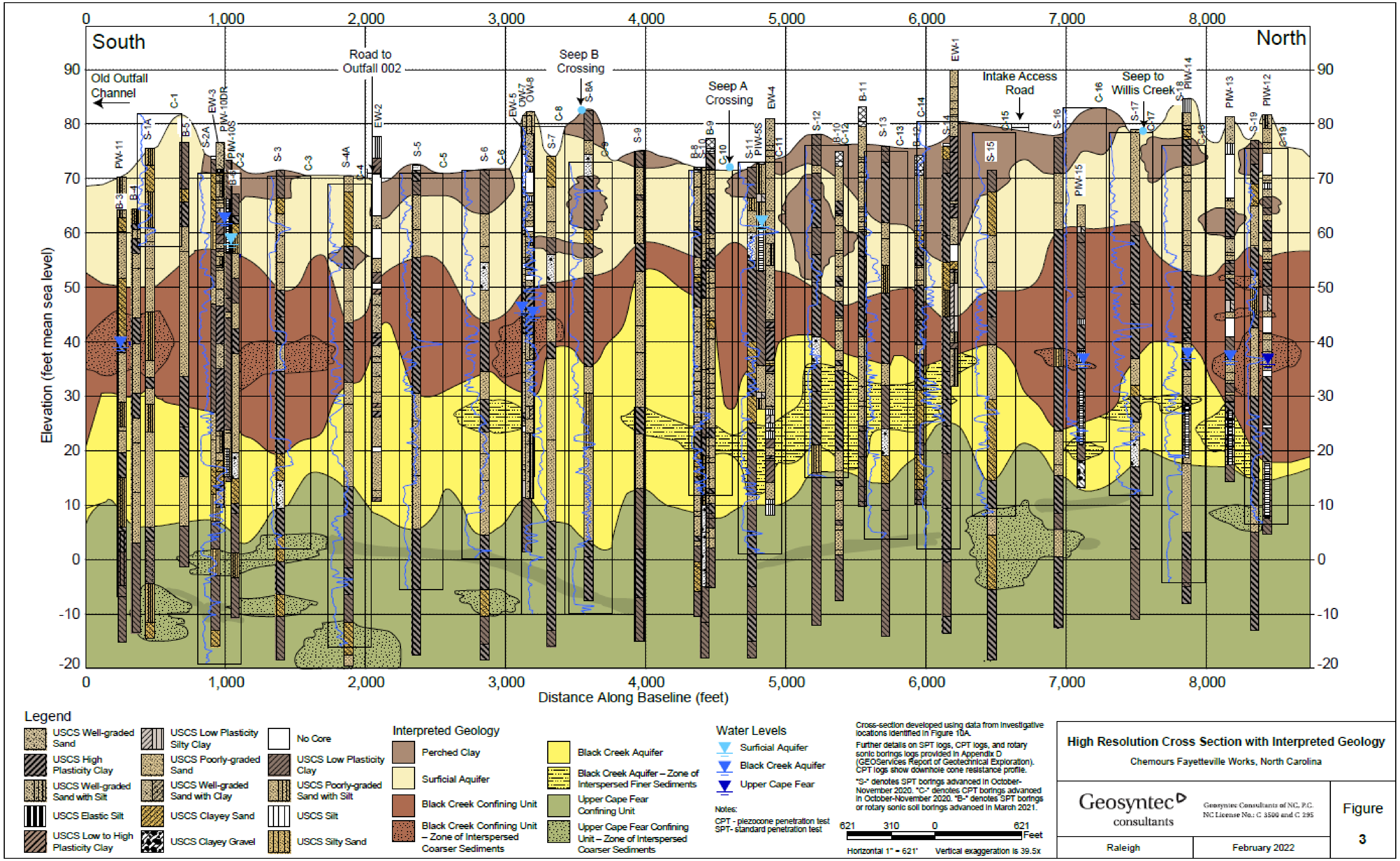

Figure 3: High Resolution Cross Section with Interpreted Geology

Analytical results from surface water samples in Willis Creek, adjacent groundwater samples from monitoring wells MW-11 through MW-15, and the Passive Flux Meter (PFM) results provide multiple lines of evidence that Table 3+ PFAS flux is considerably lower along Willis Creek than those locations along the Cape Fear River.

Aquifer properties are variable across the site. The northern portion of the proposed groundwater remedy alignment near Willis Creek is characterized by lower extraction yields compared to extraction wells further south. Extraction well EW-1, which is located adjacent to the road down to the river intake station, yields approximately 5 gpm during step testing relative to a range of 25-30 gpm at EW-5 near seep B. The variability in extraction rates is a function of finer aquifer materials and thinner transmissive units in the northern portion of the alignment.

The depth of the top of the UCC varies horizontally, present at shallower depths at the northern extent of the proposed barrier wall alignment as compared to the south. Seepage modeling indicates that a key-in depth of 5 ft is suitable to control groundwater migration beneath the wall.

The data collected as part of the PDI informed remedy design in several ways. The PDI increased resolution on Table 3+ PFAS concentrations and flux to inform loading in groundwater along the proposed alignment. It allowed for improved estimation of aquifer transmissivity and storativity, and zones of influence to inform extraction well design. The investigation also improved the characterization of soil properties to inform soil bearing capacity, design permeability performance criteria, and roadway stability. The investigations provided an assessment of the depth of the top of the UCC to establish barrier wall depths along the proposed alignment.

3.1.2 Groundwater Flow Model

A three-dimensional (3D) transient-state finite element numerical groundwater flow model was developed to simulate groundwater flow at the site and allow for testing the effectiveness of different remedial scenarios. The model has been refined from the original model developed during preparation of the CAP (Geosyntec, 2019a) to evaluate the groundwater flow pathways at the Site under current conditions. Refinements in the model incorporate modification of the layer characteristics to match field observations and the results of the step-drawdown and constant-rate tests from the PDI.

The model was constructed in FEFLOW® version 7.2 (DHI-WASY), which incorporates the Richards' equation, the conservation of mass, and nonlinear relationships between capillary pressure (P_c) and wetting phase saturation (S_w) and between S_w and K to solve for hydraulic heads. The model was constructed using field-observed parameters, which were interpolated to approximate aquifer conditions across the model domain and assumed to be representative in between measured locations.

The model domain covers an area approximately 72,690,473 square ft (2.61 square miles). The model uses 7 hydrostratigraphic units to represent, from surface downward, the Floodplain deposits, Perched Zone, Perched Clay, Surficial Aquifer, Black Creek Confining unit, Black Creek Aquifer, and Upper Cape Fear Confining (UCC) unit. The model varies in thickness from about 170 ft near the plant to 55 ft at the base of the bluff adjacent to the Cape Fear River.

Updates were applied to the 3D groundwater flow model to incorporate the PDI data collected at the Site in 2020. The new data including soil borings, hydraulic conductivity (i.e. from the aquifer tests), and groundwater velocities were incorporated into the groundwater flow model. The 3D groundwater model was calibrated to groundwater conditions and measurements observed from 2018 to 2020.

The 3D flow model was calibrated to 139 Site wells in the Perched zone, Surficial Aquifer, and the Black Creek Aquifer. The calibration results and statistics show the flow model is well calibrated, based on a reasonable agreement between the observed and calculated heads and flows. A model is considered to be well calibrated when the normalized root mean square (NRMS) is below 10%. The RMS for the Surficial aquifer was 5.65 ft; the NRMS was 6.4% and the RMS for the Black Creek Aquifer was 4.58 ft; the NRMS was 5.2%. At the conclusion of the PDI, the flow model was considered adequately calibrated and field verified to properly evaluate different remedial simulations. Detailed information regarding the model construction, and calibration (including detailed sensitivity analysis) is presented in Appendix A.

3.1.3 Groundwater Model – Remedy Development

In order to aid in designing the remedy as described in Paragraph 3 of the COA, the 3D numerical groundwater model developed in FEFLOW® was used to evaluate the hydraulic response to a barrier and changes to hydraulic gradients after the remedy is constructed. The groundwater model scenarios evaluated included:

- Scenario #1: Baseline condition calibration
- Scenario #2: Vertical Barrier Only
- Scenario #3: Hydraulic Barrier Only
- Scenario #4: Optimized Scenario

These model scenarios allowed for an evaluation of ambient conditions versus the groundwater interception remedy components in individual assessments then combined the remedy components in an optimized scenario. Two approaches were utilized to assess remedial alternatives. Particle tracking was used to assess the strengths and weaknesses along the remedy alignment. Particle tracking was incorporated to display flow direction between the Site and Cape Fear River under ambient conditions and after the addition of the vertical barrier and the groundwater extraction system. After assessing performance of each of the remedial components (detailed sensitivity analysis provided in Appendix A), an optimized remedial scenario was developed that supports the strengths of each approach. Figure 4 on the next page illustrates particle tracking without the remedy in place. A second illustration shows how the combination of a 30-inch-thick barrier wall from the river intake structure south to the Old Outfall along with a total of 69 extraction wells controls particle transport from reaching Willis Creek and the Cape Fear River. The independent use of groundwater extraction in the northern portion of the alignment controls particle transport while the central and southern portions, where aquifer transmissivity is higher, a barrier wall is needed in addition to groundwater extraction to control particle transport.

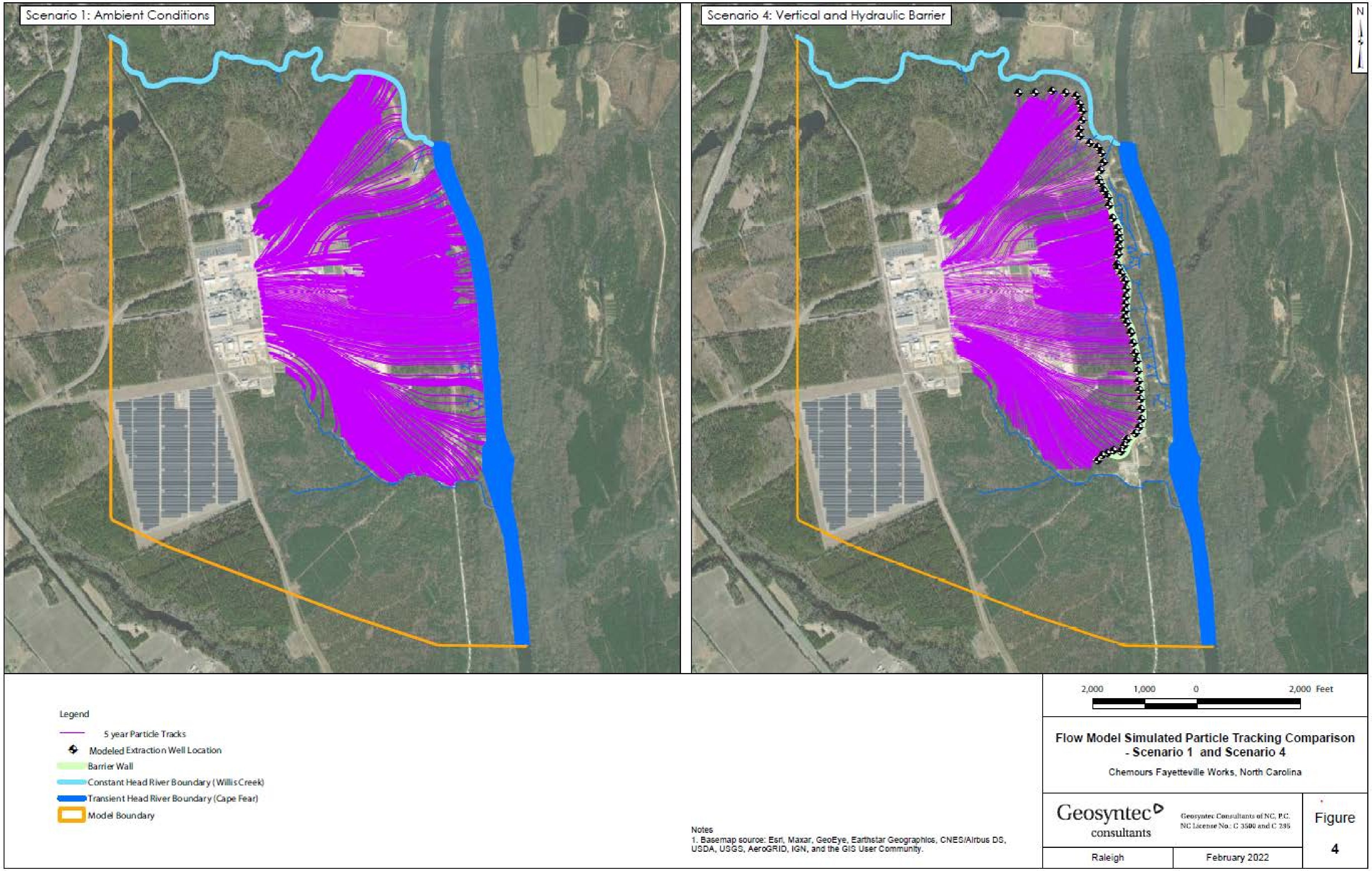

Figure 4: Flow Model Simulated Particle Tracking Comparison - Scenario 1 and Scenario 4

Based on the groundwater model results, Scenario 4 was selected as the best option for controlling groundwater discharge to the Cape Fear River. Scenario 4 includes 69 extraction wells (15 wells located in the surficial aquifer and 54 wells located in the Black Creek aquifer) installed in conjunction with a vertical barrier wall. The scenario modeled the wells operating continuously and extracting between 5 to 35 gpm over a period of 5 years. The simulated cumulative annualized flow rates for the extraction well network is approximately 1023 gpm. The basis of design for the extraction wells systems is based on results of this three-dimensional groundwater modeling analysis (see Appendix A).

3.2 Groundwater Interception Design Elements

The groundwater interception design is comprised of the following key components (Figure 2):

- Groundwater Extraction System
- Groundwater Conveyance System
- Barrier Wall

This section provides a brief description of each of these components and then discusses constructability considerations.

3.2.1 Groundwater Extraction System Design

The groundwater extraction system design consists of 69 extraction wells (i.e., EW-01 through EW-69) installed along the barrier wall. Associated appurtenances include well vaults, well head fixtures, submersible pumps, and instrumentation.

Extraction wells will be installed to extract groundwater from the Surficial and Black Creek aquifers upgradient of the barrier wall, the extraction wells are intended to be installed using sonic drilling techniques and the well construction design includes six-inch diameter stainless steel wire-wrapped well screens. Grain size sample data (Stations 5+00, 15+00, 20+00, 33+50, and 67+50) near the proposed extraction wells were evaluated to select an appropriately sized filter pack and well screen slot size. Based on the analysis using methods presented by Driscoll (2008), approximately 60% of the material in the Black Creek Aquifer at each location is coarser than 0.020 in, and 90% retention is achieved when using 20-40 sand and a 0.020 slot screen or equivalent. Approximately 60% of the material in the Surficial at each location is coarser than 0.010 in in the southern half of the barrier wall alignment, and 90% retention is achieved when using 20-40 sand and a 0.010 slot screen or equivalent. Fifteen (15) of the extraction wells in the current design are screened in the Surficial Aquifer and fifty-four (54) wells are screened in the Black Creek Aquifer. A 20-40 graded silica sand will be used for the filter pack material. The filter pack material will extend 2-3 feet above the screen.

The wells will be enclosed in order to protect the wellhead fixtures. The extraction wells are designed to consist of 6-inch diameter Schedule 40 Polyvinyl Chloride (PVC) riser pipe set above ground surface. To accommodate installation of a submersible well pump discharge pipe, a 1-inch Schedule 40 PVC stilling tube to house a pressure transducer, a pump power cable, a steel pump support cable, and air release valve discharge tubing. The discharge from the pump is then connected to a sequence of valving and instrumentation in order to monitor system parameters.

Refer to Appendix C for more details on well construction, well installation and development processes, as well as the design details on the well heads, pumps, and instrumentation.

3.2.2 Groundwater Conveyance System Design

The groundwater conveyance system design consists of two conveyance pipes, the North and South Forcemains, that connect the extraction wells to the GWTP.

The North Forcemain consists of a forcemain transitioning from 3-in to 10-in and conveys groundwater from EW-01 through EW-54 to the GWTP (Figure 2). The South Forcemain consists of a forcemain transitioning from 3-in to 8-in and conveys groundwater from EW-55 through EW-69 to the GWTP (Figure 2). Both forcemains will tie-in to each other prior to reaching an equalization tank located at the GWTP. The key design criteria used for the groundwater conveyance piping includes: (a) pipe flow velocity generally targeted in the range of 2 – 8 feet per second; (b) the design flow rate for the North Forcemain is 875 gpm; and (c) the design flow rate for the South Forcemain is 370 gpm. These design flow rates are the modeled maximum yield from the aquifer for the extraction system based on the results of the numerical groundwater model. The operating flow rates are expected to be lower than the design flow rates.

Material compatibility for components of the conveyance design in contact with the groundwater matrix at the Site has been incorporated into the design of the groundwater conveyance system. The design also includes details on pipe cleanouts, air release/vacuum breaker valves, associated fittings for the conveyance system, and the operations and control methodology. For relevant details on this design, refer to Appendix C.

3.2.3 Barrier Wall Design

The barrier wall will provide a low permeability hydraulic barrier, impeding the flow of groundwater towards the Cape Fear River. The barrier wall design extends for approximately 6050 linear feet to an average depth of 70-90 ft below ground surface with a minimum embedment of 5 ft into the Upper Cape Fear confining unit. The barrier wall extends from Outfall 003 in the southern portion of the alignment to the facility intake access road at the northern barrier wall extent. The designed alignment of the barrier wall roughly follows the contour for a 72-ft elevation between the facility and the Cape Fear River to allow construction and access above the 100-year flood level for the site.

The barrier wall will be installed using one-pass trencher installation method, specifically the DeWind One Pass MT3500 Trencher. This method continually mixes soil with binder along the entire wall depth to minimize joints in the wall. The barrier wall physical design includes a maximum hydraulic conductivity and minimum wall thickness of 1 x 10^{-6} centimeters per second (cm/s) and 30 inches thick, respectively. The vertical barrier will be constructed out of a low hydraulic conductivity mix which will include in-situ soils mixed with bentonite and cement in order to achieve a minimum compressive strength of 50 pounds per square inch (psi) for wall depths of less then 75 ft and 100 psi for wall depths of greater then 75ft. DeWind is performing a bench testing mix design study to determine the binder composition necessary to provide the minimum hydraulic conductivity (1x10^{-6} cm/s) and compressive strength (50-100 psi).

Steady-state seepage modeling indicates that a minimum embedment depth of 5 ft into the UCC is sufficient to control gradients below the toe of the barrier wall. The PDI results (Geosyntec, 2021a) presented the depths of the upper cape fear confining unit at 31 borings, and additional drilling will be performed on approximately 100 ft centers before wall construction to refine the UCC depth contour for installation.

Slope stability modeling of the barrier wall alignment indicates that graded slopes of 3H:1V with some 2H:1V sections and retaining walls, in areas with space and permitting constraints, satisfy long term stability requirements but will require surface water management and maintenance to reduce the effects of erosion on access to the hydraulic barrier system once operational. Refer to Appendix B for details on the barrier wall design.

3.2.4 Constructability Considerations

The design of the remedy considers resiliency needs related to severe weather/storm events. The 100-year flood plain described by the Federal Emergency Management Agency (FEMA) in this area for the Cape Fear River is at an elevation of approximately 68 ft above sea level (FEMA, 2007). The barrier wall and groundwater extraction and treatment components of the remedy will be situated above the 100-year flood plain to provide additional protection to the remedy components.

The barrier wall is planned to optimize remedy groundwater extraction rates and prevent Cape Fear River water extraction. The barrier wall is approximately following the 72-ft elevation line. This elevation features areas with relatively flat sections between the Old Outfall 002 and the water intake plant road and provide a natural layout location to construct a barrier wall (Figure 2). However, in the northern portion of the alignment adjacent to Willis Creek the topography has much steeper natural grades. These steep grades along with the sandy soils at surface have already resulted in observed stability maintenance issues with the preliminary clearing for roadway access. Consequently, this section of the alignment poses significant challenges for the constructability and maintenance of installing a suitable roadway.

Additionally, in this northern portion of the alignment adjacent to Willis Creek, confining layers thicken, and fine content increases in the Black Creek aquifer resulting in the lower transmissivity observed in the aquifer tests. Consequently, the modeling results indicate that the groundwater in this northern alignment portion can be intercepted using extraction wells alone and that a barrier wall, whose constructability would be significantly challenged, is not required. Groundwater extraction alone has shown through modeling to successfully address COA objectives (refer to Appendix A). Furthermore, results of PFAS mass flux deployments show that the PFAS mass flux from the northern section is only approximately 3-5% of the mass flux in the Black Creek Aquifer along the remedy alignment while the southern portion where groundwater will be controlled by a barrier wall and extraction system accounts for approximately 95-97% (refer to Appendix I).

4. EX-SITU CAPTURE REMEDY DESIGN

Groundwater Seeps A, B, C, and D (Figure 3) originate on the bluff at the facility and discharge into the Cape Fear River. Seeps C and D occur wholly down gradient of the proposed barrier wall location. Pursuant to COA paragraph 2(c) Chemours will capture and treat dry weather base flow plus rain events up to 0.5 inches in a 24-hours period for Seep A, Seep A-Tributary and Seep B which daylight upgradient of the Barrier Wall.

Chemours will also capture the groundwater dry weather flow crossing the remedy at the Willis Creek Tributary and at weep locations to prevent groundwater migrating over the barrier wall / remedy pursuant to COA paragraph 3(b). Weeps are low flow or ephemeral groundwater reaching surface at or upgradient of the planned barrier wall alignment with anticipated flow rates of 12 gallons per minute or less. The remainder of this section describes the basis of design and the design for the ex-situ capture remedies.

4.1 Seep Capture Basis of Design

Seep A and Seep B dry weather flow rates estimated by analysis of historical onsite flume data and the Stormwater flows and volumes from the drainage areas to Seep A and Seep B (upgradient of the barrier wall) were assessed based on North Carolina stormwater design guidance (NCDEQ, 2017), in addition to the development and execution of a long-term continuous hydrologic model.

Chemours had previously installed several flumes at Seeps A and B including locations at the end of each seep, as close as practicable to the Cape Fear River, to estimate total Seep flow rates. Additionally, several other flumes were installed at various tributaries that feed the main seep channels. For the purposes of characterizing the seep flows at the barrier wall, only a subset of the flume installations were applicable. The flume locations that were used for this estimation provide a conservative estimate as they are slightly downgradient from the barrier wall intersection resulting in a larger catchment.

The results of the flume data collection and analysis indicated dry period flow from Seeps A and B upgradient of the barrier wall that will require capture and treatment is about 161 gpm. Dry weather flow rates were measured at Seep A-Tributary and Willis Creek Tributary using steam gauging methods and volumetric collection of flow. The measured dry weather summer flowrates were 8 and 17 gpm for Seep A-Tributary and Willis Creek Tributary, respectively. An analysis was conducted to scale up these summer dry weather flow rates to be representative of a higher flow rate regime which can occur during the higher rainfall winter season. This results in an estimated dry weather flowrate during the winter season of 19 and 39 gpm for Seep A-Tributary and Willis Creek Tributary, respectively.

Stormwater runoff volumes were assessed for Seep A, A-Tributary and Seep B drainage areas upgradient of the barrier wall, for rain events up to 0.5 inches over a 24-hour period. Stormwater is defined as wet weather-driven flows that exclude dry weather flows (such as groundwater exfiltration or seeps).

Sizing a stormwater control measure involves calculating the volume and/or flowrate of runoff resulting from the specified design storm. Guidance from the NCDEQ Stormwater Design Manual (NCDEQ, 2017; Manual) was followed to estimate stormwater volumes using the Simple Method for Runoff Volume based on guidance from the Manual (NCDEQ 2017; Part B, Calculation Guidance, Simple Method for Runoff Volume). The Simple Method is a conservative estimation, and an uncalibrated hydrologic model was run to serve as a check on the static calculation. Model stormwater volume results were lower than the Simple Method results suggesting that the Simple Method results did provide a conservative design basis.

The Simple Method estimated volume of stormwater resulting from 0.5 inches of rainfall over 24 hours was 110,000 gallons for Seep A, 26,000 gallons for A-Tributary, and 46,000 gallons for Seep B. Since treatment of the captured seep flows incorporates temporary storage of captured stormwater for 24 hours (i.e., equalization), the volume is converted to a design flowrate is 126gpm metered to the GWTP.

Therefore, the total design flow rate for the seeps ex-situ capture design is a dry flowrate of 219 gpm and an additional 126 gpm of flow with equalization and storage for rainfall events. Refer to Appendix D of this report for the entire Seep Flow at Barrier Wall memo and relevant details of the flume data, volumetric measurements, and hydrologic calculations and modeling.

4.2 Ex-Situ Capture Design

Once the barrier wall and groundwater extraction and conveyance system are installed the ex-situ capture systems will be constructed. Ex-situ capture systems installed at Seep A, A-tributary, and Seep B will collect the dry weather flow and up to 0.5 inches of rainfall over 24 hours utilizing a gravity system flowing into a collection basin that will then enter a pump station and be pumped into a lined surge pond. The lined surge pond is included to provide flow equalization and some solids settling prior to the water being conveyed into the GWTP for treatment. The collection basins for Seep A, A-tributary, and Seep B are designed such that the dry weather flow will continuously be collected and the flow from the 0.5” rainfall events over 24 hours will be collected during rainfall events through an actuated sluice gate. The collection basins will then gravity drain through orifices into pump stations. The collection basins are designed to provide steady flow into the pump stations removing large variability in the flow from the 0.5” rainfall while still capturing the rainfall event volume. Willis Creek tributary and weeps capture designs collect baseflow through gravity drainage directly into a pump station that will be pumped to the lined surge pond. All captured flows from Seep A, A-tributary, Seep B, Willis Creek tributary, and the weeps will be conveyed from the respective collection points to the surge pond through a forcemain with pump stations.

General maintenance of the collection systems and forcemain is anticipated. Periodic inspections will be conducted to assess system components. These reoccurring inspections will include:

- Inspect trash rack system at Seep A
- Remove all material from pipe guard grates (debris, leaves, limbs, sticks, etc.)
- Inspect base flow collection structures at Willis Creek Tributary and weeps including inlet grates and remove any debris blocking the inlet grate
- Measure sediment in each pond and record depths. Remove sediment, as necessary and manage per the SMMP.
- Inspect pump stations, remove any collected solids, and test each pump

Refer to Appendix E of this report for details on the ex-situ capture design.

5. GROUNDWATER TREATMENT DESIGN

The groundwater and seep flow associated with the proposed groundwater remedy will be collected and treated to 99% removal efficiency (as measured by the three PFAS indicator parameters) by physical/chemical precipitation, filtration and carbon adsorption.

5.1 Groundwater Treatment Basis of Design

The source water to the GWTP will be the extracted groundwater and ex situ captured flows from the seeps, Willis Creek Tributary and weep water. The estimated hydraulic loading in gpm from the two aquifers and four seeps, post remedy construction, is shown in Table 2. The total flow value here of 1,368 gpm is higher than the 1,249 gpm flow listed in the 60% design report due to the addition of flows from Seep A-Tributary, Willis Creek Tributary and utilization of a barrier wall with a 30 inch thickness. This additional flow will be treated by the GWTP which has a design flow rate of 1,500 gpm and capability for expansion of flow rate if additional flows other than these predicted should be encountered.

Table 2: Hydraulic Loading of Representative Groundwater and Ex-Situ Sources

Water Source	Approximate Flow Rate
Ex Situ Captured Baseflow◊	219 gpm
Ex Situ Captured Stormflow*	126 gpm
Groundwater from Surficial Aquifer◊	142 gpm
Groundwater from Black Creek Aquifer	881 gpm
Total Flow	**1,368 gpm**

* Stormflow represents maximum increase over baseflow averaged over 24-hour period.
◊ Baseflow and Shallow Groundwater may include some double counting.

The projected concentrations in the combined influent to the GWTP were estimated from the flow-weighted concentrations groundwater and surface water groupings presented in the NPDES permit application. The design of the GWTP is based on the contaminant profile presented in Table 3.

Table 3: Influent Design Basis for the Groundwater Treatment System

Constituent	Units	Projected Concentrations			Influent Design Basis	
		Avg.	Min.	Max.	Min.	Max.
HFPO Dimer Acid	ug/L	12.2	8.22	18.9	4.11	28.3
PFMOAA	ug/L	64.3	17.5	192	8.73	288
PMPA	ug/L	13.2	8.38	22.5	4.19	33.8
Total table 3+ (20 compounds)	ug/L	139	54.9	352	27.4	528
Aluminum, total	mg/L	1.52	1.16	2.20	0.58	3.30
Bromide	mg/L	ND	ND	ND	ND	ND
Calcium, total	mg/L	4.07	3.74	4.55	1.87	6.82
Carbonate Alkalinity	mg/L	ND	ND	ND	ND	ND
Chloride, total[1]	mg/L	8.30	4.85	11.6	2.42	17.4
Fluoride, total	mg/L	0.11	0.11	0.11	0.06	0.17
Hardness	mg/L	ND	ND	ND	ND	ND
Iron, total	mg/L	4.86	2.28	8.56	1.14	12.8
Magnesium, total	mg/L	2.37	2.27	2.53	1.13	3.80
Manganese, total	mg/L	0.08	0.06	0.15	0.03	0.23
pH	Std units	6.61	6.50	6.80	6.5	8.5
Phosphate	mg/L	ND	ND	ND	ND	ND
Sulfate (as SO4)	mg/L	24.7	13.3	33.9	6.66	50.9
Total Dissolved Solids	mg/L	78.5	66.8	93.3	33.4	140
Total Organic Carbon	mg/L	1.11	0.57	2.01	0.29	3.01
TSS[2]	mg/L	59.2	38.4	120	19.2	180

[1] SEEP-A-WALL and SEEP-B-WALL each had one observation above 30,000 milligrams per liter (mg/L) chloride. Data has been excluded and can be considered an outlier for the basis of design.

[2] Potentially 250 mg/L during peak storm events (see below). This also does not include the total suspended solids (TSS) contribution from solids generated during pretreatment.

Pilot studies have been completed by vendors to verify the effectiveness of their proposed pre-treatment methods and confirm performance of their selected carbon media to remove the required constituents and loadings from representative feed water.

5.2 Groundwater Treatment Design

The water characteristics (flow rates and parameters) of the influent and required effluent quality have been presented as the basis of design (Section 5.1).

- The design basis values and underlying design data, as summarized in Table 3, were shared with prequalified water treatment vendors. Suez (www.suezwatertechnologies.com) was selected to furnish a complete water treatment system on a turnkey basis, subject to the design criteria listed above. The turnkey, or “build own operate maintain” model selected means the system will be fully engineered, constructed, commissioned, and operated by Suez subject to Chemours oversight.

As specified in this 90% design, the GWTP is to be comprised of the following series of treatment unit operations:

- Metals oxidation
    - Two 18,000 gallon influent oxidation retention tanks have been selected to allow for a hydraulic retention time of 30 minutes at the maximum design flow rate of 1,500 gpm. The two frac tanks are currently configured to both operate online concurrently, with the capability of adding up to 4 more oxidation tanks if the process flow increases beyond the capacity offered by the original 2 tanks.
- Filtration
    - Containerized UF membrane banks will be used to remove fine solids and turbidity which should prevent fouling and extend runtimes between GAC backwashes or reduce GAC replacement frequency. The UF system are designed as a series of five parallel containerized membrane systems, each comprised of a 500-gallon membrane tank containing a series of parallel banks of submerged membranes. The system will be configured such that up to three additional UF containers could be added in the future if capacity limits are reached with the original five containers. The filtered effluent from the UF process will be directed to a 21,000-gallon frac tank from which a portion the water will be sent to the GAC system and the remainder will be used as centrifuge wash water.
- Granular Activated Carbon (GAC) adsorption
    - PFAS removal will be accomplished using GAC adsorption. Filtered effluent will be pumped from the pH adjustment tank to the GAC system and will enter three GAC adsorption trains in parallel configuration, each designed to treat one third of the design flow (three trains of 500 gpm to treat up to 1,500 gpm). Each vessel will be configured as a down-flow process where water enters the top of the adsorber and exits through the bottom. A three-column, lead/middle/lag, configuration per train is proposed for the GWTP. This arrangement of 12-foot diameter vessels that can each hold 20,000 pounds of carbon will provide for the required hydraulic loading rate and Empty Bed Contact Time (EBCT) for PFAS removal. The system will be configured such that two additional 3-pass GAC skids could be added if additional treatment capacity is required.
- Solids Handling & Dewatering

  - The UF reject, GAC waste and clean-in-place (CIP) neutralized waste will be transferred to two, 17,500-gallon cone bottomed tanks in the solids handling system. The flow rate of this combined solids handling system influent will be monitored via a flow meter upstream of the cone-bottomed tanks. The system is configured for the potential future addition of 4 more cone bottomed tanks, if the capacity of the current system becomes insufficient. The thickened sludge from the cone bottomed tanks is then transferred via gravity to an 18,000-gallon sludge holding tank and the centrate is transferred to the influent oxidation tanks. The system will be configured to allow for the future addition of 5 additional sludge holding tanks if the capacity of the system requires expansion. The sludge from the sludge holding tank is then transferred to the centrifuge. The dewatered solids from the centrifuge will then be transferred via a distribution conveyor to a roll-off bin and the liquid centrate from the centrifuge will be transferred to a centrate tank.

- Ancillary processes for backwashing and residuals handling.

A design drawing package and process narrative is included in Appendix F. The design package attached in Appendix F includes details such as equipment layouts, process flow diagrams, single line diagrams, component specifications, and material schedules for each of these treatment units.

Treated water will be discharged to the same pipe which transmits the discharges from Chemours Fayetteville Site Outfall 002 to the Cape Fear River. This discharge will occur downgradient of the Outfall 002 discharge monitoring point (see Figure 5 below). Treated water from the GWTP will be discharged under a NPDES Permit. The NPDES and other relevant permits are described in the following section.

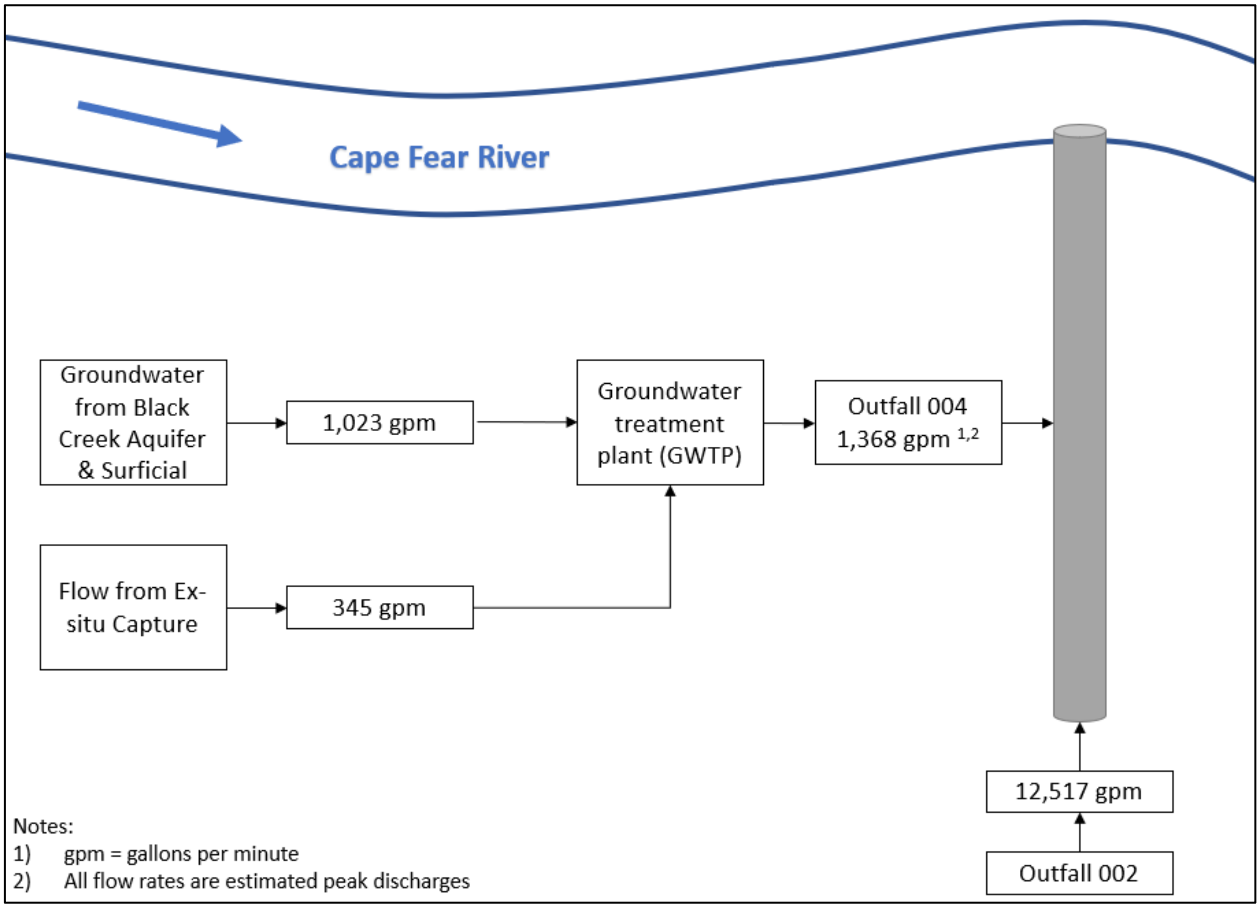

Figure 5: GWTP Water Balance[6]

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[6] The 345 gpm from the ex-situ capture shown in this figure is the total of baseflow and stormflow from up to 0.5-inch rainfall over 24 hours. This flow will be less in periods without rainfall or when rain of less than 0.5 inches over 24 hours occurs. Refer to Table 2 of this report or Appendix E for information on flowrates.

6. PERMITS

There are a range of permits necessary to construct and operate the groundwater remedy. The following subsections provide a summary of anticipated permits.

6.1 NPDES Permit

Chemours submitted a NPDES permit application on June 14, 2021 for discharges from a GWTP at Fayetteville Works. If approved, this NPDES would be Outfall 004. The GWTP is required under the COA between Chemours and the NCDEQ. The GWTP will discharge into the pipe that currently conveys effluent from Outfall 002 from the Site to the Cape Fear River. A Draft Permit and Draft Fact Sheet was issued to Chemours on November 3, 2021. Chemours responded to the issuance with comments on November 5, 2021. A new Draft Permit was issued to Chemours on February 11, 2022. Chemours responded to the issuance with comments on February 18, 2022. NCDEQ plans to post a draft Outfall 004 NPDES permit for public comment On March 27, 2022.

6.2 401/404 Permit

Chemours met with NCDEQ Water Resources Division and USACE on May 30, 2021, to perform a pre application walkdown of the Barrier Wall project. The site visit reviewed the current design and permit requirements. Based on conversations with NCDEQ and the USACE the proposed project will be a modification to the existing 401/404 permit (SAW-2019-00206) related to the interim seep remediation project. The USACE and NCDEQ requested additional information related to the groundwater and surface water drawdown/impacts.

On August 5, 2021, Chemours transmitted the groundwater and surface water drawdown/impact data to USACE along with our interpretation of the impacts related to the proposed project. Chemours submitted a permit modification application on August 13, 2021.

As design progressed and the ex-situ design changed based on the inclusion of the Willis Creek tributary and revised drawdown maps, the USACE was contacted and agreement was made that the modification application submitted on August 13, 2021 would be updated to account for these differences in design. The revised 404 permit modification application was submitted on February 9, 2022. Chemours is currently waiting on a review by USACE and NCDEQ.

6.3 Other Permits

Other permits will also be required to operate and construct the remedy. These include land disturbance permits, Erosion and sediment control (E&SC) plans, electrical permits, well permits, extraction permits, and building permits for any permanent structures. A Land Disturbance Permit under NCDEQ will be required to permit construction. Work will also be conducted in accordance with the Soil and Material Waste Management Plan prepared by Chemours on July 3, 2020 and updated and submitted on February 8, 2022 for work conducted in non-manufacturing areas of the Site. E&SC plans will be prepared in compliance with the latest 2013 updates to the Erosion and Sediment Control Planning and Design Manual and submitted to Bladen County representatives for review. A permit from Bladen County will be required for new electrical connections, which will also be subject to inspection by the electrical utility. A well permit for the installation of the system extraction wells will be obtained from the DEQ, as well as a permit for the extraction of water through these wells.

7. CONSTRUCTION QUALITY ASSURANCE (CQA)

The CQA plan includes general roles, responsibilities, and qualifications of parties involved; the preconstruction meeting; and general inspection and documentation procedures. Specific CQA requirements address construction procedures and observation, field and laboratory testing frequency and methods, and acceptance criteria for each component during the construction of the barrier wall.

The CQA plan consists of sampling and testing methods designed to evaluate specific performance criteria described in the barrier wall design submittals.

- Geometry
    - Alignment of the proposed barrier wall will be maintained in the field by surveying and physical staking. GPS monitoring of installation equipment will be required to further establish wall location.
    - Depth measurements will be collected by direct read of the excavation device mast or head above the ground surface. This measurement may be accomplished by establishing an elevation mark with a laser instrument or by using a machine mounted sensor. Penetration depth will be determined by observation of the barrier wall soil mixture returning to the surface and correlation with the estimated depth from pre-construction subsurface geotechnical information.
    - To verify barrier wall width, the width of the excavation tools will be checked at the beginning of each shift or as maintenance occurs on the equipment which effects the excavation tools.
    - Wall verticality will be evaluated with level indicators or sensors attached to the vertical sections of the excavation tools to monitor the verticality of the excavation mast. On-board monitors shall be calibrated and checked at the start of each shift.
- Wall Homogeneity
    - Integrated electronic seismic piezocone test (CPT) soundings will be advanced in the barrier wall mixture after a minimum of 7 days after each section of wall installation. Tip resistance, sleeve friction, and dynamic pore pressure will be recorded. Pore pressure dissipation testing will also be used to evaluate the homogeneity of the in-place barrier wall mixture.
- Wall Continuity
    - Continuity of the barrier wall will be evaluated by visual observation of the locations where wall construction has been temporarily terminated by any means such as end/beginning of shifts, maintenance, admixture supply interruption,

    construction around utility corridors, or other unforeseen work stoppage such as hazardous weather.

- Strength
    - Grab samples of the barrier wall mixture will be collected from shallow and deep locations. The grab samples will be sent to an independent laboratory to verify strength requirements using Unconfined Compressive Strength (UCS) tests.
- Wall Permeability
    - Grab samples of the barrier wall mixture will be collected from shallow and deep locations and undergo permeability testing.

Final Acceptance of the Barrier Wall System will be made by the Quality Consultant after review of the final construction data. If deficiencies in the construction of the Barrier Wall system are noted; repairs will be completed as requested prior to final acceptance documents.

The implementation of CQA monitoring during the construction is described in Appendix H of this report.

8. OPERATIONS AND MAINTENANCE

The remedy components will require routine operation and maintenance (O&M) to ensure operation as designed. Draft O&M Plans will be prepared for the remedy components prior to their startup and then refined based initial commissioning and operating conditions. The O&M Plans will describe routine preventative maintenance activities where appropriate, as well as conditions that may result in additional non-routine action. The O&M Plan will also include operating manuals and specifications of installed components for operator reference, checklists to support the routine inspection and logging remedy components, and checklists to track maintenance activities and instrument calibrations as needed.

The O&M Plans will include considerations for:

- System integration, functional checkouts and system startup
- System operating parameters, process control, and general operation guidance
- Routine inspection and maintenance
- Non- routine maintenance and alarm response

9. PERFORMANCE MONITORING

A Performance Monitoring Plan (PMP) for the Barrier Wall and Groundwater Extraction System has been prepared and is attached in Appendix G. Seep performance monitoring will be conducted pursuant to the *Onsite Seeps Long-Term Loading Calculation Plan* (Geosyntec, 2020) as required by COA paragraph 2(c)(ii).

The PMP provides a plan to evaluate the effectiveness of the System at reducing PFAS loading from groundwater to the Cape Fear River and Willis Creek. The PMP takes into account the numerous existing monitoring programs already performed at the site, including but not limited to annual groundwater monitoring; monthly groundwater sampling of a subset of wells; treatment efficiency as required by the NPDES permit; surface water monitoring; seeps long-term loading; and performance monitoring of the four seep flow-through cells.

As further detailed in Appendix G the effectiveness of the long-term groundwater remedial action will primarily be assessed through four main lines of evidence:

1. Hydraulic head both along the barrier wall alignment and downgradient of the barrier wall between the wall and the Cape Fear River, to assess groundwater capture and the reduction in hydraulic gradient downgradient of the remedy.
2. PFMs, to evaluate downgradient groundwater quality and reduction in PFAS flux.
3. Surface water samples at Willis Creek, to evaluate reduction in PFAS loading to Willis Creek.
4. Surface water samples at Tar Heel Ferry Road, to evaluate PFAS concentrations and mass loads in the well-mixed Cape Fear River downstream of the facility.

The following table summarizes the complementary programs that together with the PMP presented in Appendix G will satisfy the requirements of the COA:

Table 4: Performance Monitoring Lines of Evidence

Line of Evidence	Assesses	Sampling and Evaluation Program
Hydraulic head along the barrier wall and downgradient of the barrier wall.	Groundwater capture zones and evaluation of the prevention of groundwater migrating around, above or under the barrier wall.	Appendix G
PFMs in wells downgradient of barrier wall.	Downgradient groundwater and reduction in PFAS flux (i.e., reduced River PFAS loading)	Appendix G

Line of Evidence	Assesses	Sampling and Evaluation Program
Advective Groundwater Flux from gradients and concentrations measured in wells downgradient of barrier wall.	Downgradient groundwater and PFAS fluxes and flux reductions. (i.e., reduced River PFAS loading)	Mass Loading Program
Willis Creek Surface Water samples upstream of remedy and at Willis Creek mouth.	Reductions in PFAS loading to Willis Creek.	Appendix G
Cape Fear River Surface Water samples at Tar Heel Ferry Road.	Reductions in PFAS loading to the Cape Fear River.	Mass Loading Program
GWTP Influent and Effluent samples.	Removal efficiency of indicator PFAS by GWTP.	Future 004 NPDES permit requirements

10. ADAPTIVE MANAGEMENT

Given the scale of this remedy, implementation will likely encounter conditions not anticipated. In addition, considering the physical location of the Site, potential challenges, uncertainties, changed conditions may be encountered during remedial construction, operation, and maintenance. Accordingly, as best practice in any engineering design and to the extent reasonable and practicable, contingency elements have been factored into the design. These factors include elements such as;

- The GWTP unit operations have the capacity to treat additional groundwater or seeps water if needed.
- Groundwater extraction and conveyance components, including pumps with variable frequency drives and controls capacity, have built-in capacity to accommodate additional extraction wells if needed.
- Extra capacity in groundwater conveyance forcemain sizing.
- Assumption of minimum permeability and width criteria across the entire barrier wall.
- Conservative design basis for Ex-situ capture designs.
- Contingent capacity included in collection basins and surge ponds of ex-situ capture design.
- Extra capacity in the ex-situ capture piping and forcemains.
- Temporary backup power for the remedy design components to allow for capacity to operate in the event of power supply disruptions.

11. SCHEDULE

The present schedule of remedy elements; design, installation, and completion is shown in Figure 6. This schedule is subject to being updated as appropriate as the design progresses towards completion. The milestones provided by the COA requires a 90% design report to be submitted by March 31st, 2022, and for construction of the groundwater interception remedy pursuant to COA paragraph 3 be complete and commencing operations by March 15, 2023.

Activity													2023
		2Q			3Q			4Q			1Q		
	M	A	M	J	J	A	S	O	N	D	J	F	M
NPDES Permitting	🟦	🟦	🟦	🟦	🟦	🟦							
90% Submittal	🟦 *												
Extraction System and Conveyance Installation	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦					
Treatment Plant Design and Installation	🟦	🟦	🟦	🟦	🟦	🟦	🟦						
Barrier Wall Installation							🟦	🟦	🟦	🟦	🟦		
Ex-Situ Capture Installation			🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦		
Commissioning and Startup											🟦	🟦	🟦 ‡

Notes:

* - COA paragraph 3 Required 90% Design Submittal: March 31, 2022
‡ - COA paragraph 3 required groundwater interception remedy Startup: March 15, 2023

Figure 6: Proposed Project Schedule

12. SUMMARY AND CLOSING

Chemours is designing and implementing a remedy which will meet objectives set forth in COA paragraphs 3(b) and 2(c). This report summarizes the 90% design for the remedy which is further detailed in reports attached as appendices A through I to this report. The remedy for the site includes three important components: the groundwater interception remedy, the ex-situ capture remedy, and the water treatment system. Modeling informed by predesign investigations show that these three remedy components are expected to achieve remedial objectives outlined in the COA.

The objective of the groundwater interception remedy is to reduce PFAS mass loading to Willis Creek and the Cape Fear River by intercepting groundwater flowing to these water bodies. The interception remedy involves constructing an underground barrier wall to create a low permeability barrier to reduce groundwater transmission and installing a groundwater extraction system to intercept groundwater and control groundwater migration around, above, or under the barrier wall. The objective of the ex-situ seep capture remedy is to capture seeps A, A-tributary and B upgradient of the barrier wall dry weather seep flows as well as stormwater flows from rain events up to 0.5 inches in a 24-hour period. In addition, the ex-situ system will capture the groundwater dry weather flow crossing the remedy at the Willis Creek Tributary and at weep locations. Both the ex-situ capture remedy and the groundwater interception remedy convey PFAS containing water to a GWTP where the indicated parameter PFAS will be removed to a 99% efficiency.

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Geosyntec consultants

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GEOServices, LLC, Geotechnical and Materials Engineers

Appendix A
Groundwater Flow Modeling Report

Geosyntec consultants

engineers | scientists | innovators

3-Dimensional Groundwater Flow Model
Chemours Fayetteville Works

Prepared for

The Chemours Company FC, LLC
22828 NC Highway 87
Fayetteville, NC 28306

Prepared by

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3/25/2022

Geosyntec Project Number TR0795

March 2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

α	alpha
δ	delta
λ	lambda
θ	unsaturated-flow porosity
3D	three-dimensional
CAP	Corrective Action Plan
cm/s	centimeter per second
CO	Consent Order
COA	Addendum to Consent Order Paragraph 12
CPT	piezoCone Penetration Tests
ft	feet
ft/d	feet per day
ft^2	feet square
gpm	gallons per minute
HPT	hydraulic profiling tool
K	hydraulic conductivity
LiDAR	Light Detection and Ranging
NRMS	normalized root mean square
P_c	capillary pressure
PDI	Predesign Investigation
PFAS	per- and polyfluoroalkyl substances
ROI	radii of influence
RMS	root mean square
S_r	residual wetting phase saturation
S_s	specific storage
S_w	wetting phase saturation
USGS	United States Geological Survey

1. INTRODUCTION AND OBJECTIVES

This groundwater modeling report was prepared by Geosyntec Consultants of NC, P.C. (Geosyntec) for The Chemours Company FC, LLC (Chemours) to describe the numerical groundwater model used to develop the basis of design for the groundwater remedy to be implemented pursuant to Paragraph 3 of the Addendum to Consent Order Paragraph 12 (COA) among Chemours, the North Carolina Department of Environmental Quality, and Cape Fear River Watch. Geosyntec initially developed a three-dimensional (3D) numerical groundwater transient flow model in the Corrective Action Plan (Geosyntec, 2019). The model has been further refined to incorporate the results of the Pre-Design Investigation (PDI) efforts (Geosyntec, 2021) and the 60% Design Modeling Report (Geosyntec, 2021). The updated model incorporates refinements of the hydrostratigraphic units and aquifer properties that were completed in 2020. Modeling objectives included:

- Simulate capacity of a groundwater extraction system, upgradient of the vertical barrier to minimize mounding behind the barrier and control discharge of per- and polyfluoroalkyl substances (PFAS) containing groundwater to the River.
- Simulate a vertical physical barrier parallel to the Cape Fear River and evaluate its capacity to control/limit discharge of PFAS containing groundwater to the River.
- Utilize the model to evaluate various combinations of groundwater extraction and physical barrier scenarios that would sufficiently control discharge of groundwater to Cape Fear River.
- Select a preferred scenario which would inform the basis of design for the overall remedy, including estimates of extraction rates that will require treatment.

1.1 Scope of Work

The scope of work to achieve the above objectives included modifications to the 2019 Corrective Action Plan model and the incorporation of data acquired during the PDI. The majority of the changes to the model focused on the area surrounding the proposed vertical barrier and extraction well network. The scope of work to update and re-calibrate the model (current conditions model) included:

- Refining the grid cell spacing near the vertical barrier.
- Modifying the recharge zonation to better simulate site conditions.
- Modifying the hydraulic conductivity zonation based on data collected during the PDI.
- Examining and modifying the river stages in the various simulated surface water bodies in the model.

- Re-calibrating the modified model to October 2019 and March 2021 measured groundwater elevations.

The current conditions base model was calibrated using statistical analysis and used as the basis for several predictive scenarios. Remedial scenarios simulations included: 1) a barrier wall without pumping; 2) a pumping system without a barrier wall; and 3) a barrier wall combined with a pumping system. Each scenario was sequentially constructed to be able to assess the performance of the hydraulic containment required in accordance with the objectives set forth in COA Paragraph 3 (NCDEQ, 2020).

1.2 Report Organization

The remainder of this report includes the following subsections:

Section 2 – General Setting - describes the Site and surrounding areas, and geomorphological Site setting

Section 3 – Conceptual Model - describes the geology and hydrogeology of the Site and Site-specific hydrologic and hydraulic boundaries

Section 4 – Groundwater model software selection - describes the model selection process and the capabilities of the selected model

Section 5 – Groundwater model setup - describes the model mesh development, hydraulic parameters of hydrostratigraphic units, groundwater model boundary conditions based on available Site-specific data, and selected model calibration targets

Section 6 – Groundwater model calibration - presents the residual and sensitivity analysis results of the model calibration process

Section 7 – Remedial design simulations - presents the results of the predictive simulation suite performed to assess different groundwater barrier remedial strategies

Section 8 – Summary

Section 9 – References

2. GENERAL SETTING

2.1 Site Description and Surroundings

The Site is located within a 2,177 acre property at 22828 NC Highway 87, approximately 20 miles southeast of the city of Fayetteville along the Bladen-Cumberland county line in North Carolina. Figure A.01 presents an overview of the Site location. Figure A.02 presents a regional topographic map, and Figure A.03 presents a higher resolution, smaller scale topographic map of the Site.

The Site is bounded by NC Highway 87 to the west, Cape Fear River to the east, and on the north and south by forested areas, farmland, and private residences. Zoning maps indicate that the surrounding areas are zoned as residential, agricultural, conservation, industrial or commercial.

The manufacturing area of the Site covers approximately 312 acres (Figure A.03). The remaining areas are grassy areas, forests and wetlands. Chemours also operates a wastewater treatment plant (WWTP) at the Site.

2.2 Geomorphologic Site Setting

The Site is located in the Coastal Plain. In North Carolina, the Coastal Plain Physiographic Province extends from the present Atlantic Ocean inland to the Fall Line, an erosional contact boundary with the Piedmont Province. The Fall Line is approximately 40 miles northwest of the Site.

The manufacturing area sits on a flat-lying area at typical elevations ranging from 125 feet above mean sea level (ft MSL) to 150 ft above MSL (Figure A.03). The topography mildly slopes from the western boundary towards the north, east, and south. The slope then steepens abruptly in these directions as a result of incisions carved by surface watercourses. As shown on Figure A.03 these surface water features include:

- Towards the north, coinciding with the course of Willis Creek where the topography decreases to elevations ranging between 35 ft above MSL and 70 ft above MSL.
- Towards the east, coinciding with the course of the Cape Fear River where the elevation drops sharply to approximately 35 ft above MSL, forming a bluff face between the Site and the River.
- Towards the south and west, it coincides with the course of Georgia Branch Creek, where the topography decreases to elevations ranging between 35 ft above MSL and 110 ft above MSL.

A topographic incision also coincides with the Old Outfall 002, sloping more mildly in the southern central portion of the Site.

Willis Creek and Georgia Branch Creek are tributaries to the Cape Fear River. Willis Creek flows in an easterly direction and was observed to have flow rates around 2,900 gallons per minute (GPM) in dry weather and around 6,500 GPM following rainfall. Georgia Branch Creek, which is offsite for its entire course, is flowing in a southeasterly direction and was observed to have flow rates between 2,400 and 2,600 GPM in both wet and dry weather. Georgia Branch Creek runs northwest-southeast beside Highway 87 before turning east towards the Cape Fear River to the south of the Site. The median flow rate in the Cape Fear River is on the order of 750,000 GPM.

3. CONCEPTUAL MODEL

3.1 Aquifer System Framework

3.1.1 General

Multiple aquifer units occur underneath the Site, which are summarized in Table A.01 (from youngest to oldest) while their typical positions in the vertical profile are illustrated in Figure A.04.

Table A.01: Site Aquifer System

Unit	Description	Classification	Typical K-values*
Floodplain Deposits	Predominantly fine-grained deposits. Closely associated with the Cape Fear River course, typically 10 to 15 ft in thickness.	Aquitard (where fine-grained), local aquifer (where more sandy)	0.1 ft/day to 1 ft/day
Perched Zone	Predominantly loose silty sand, brown to reddish brown. Relatively thin in the eastern portion of the Site to a depth of about 20 ft below ground surface (bgs). In the western portion, an inferred erosional feature has likely resulted in the unit being thicker.	Unconfined perched groundwater body of local extent, porous medium	2 ft/day to 5 ft/day
Perched Clay	Predominantly stiff clay with minor silts, dark grey. Also spatially limited. Pinching out to the north. To the east and south, outcrops along the bluff face. To the west, terminates and becomes absent, presumably eroded by the erosional feature.	Aquitard of local extent, porous medium	< 1ft/day
Surficial Aquifer	Predominantly fine to medium-grained sand, white to light brown. Mostly continuous layer across Site area, typically 20 ft to 40 ft thick with a mild dip to the south. In the western portion, the absence of Perched Clay does not enable to differentiate the contact with the lithology representing the Perched Zone.	Unconfined, porous medium	2 ft/day to 5 ft/day

Unit	Description	Classification	Typical K-values*
Black Creek Confining Unit	Predominantly organic-rich clay, hard, dark grey to black. Regionally extensive layer, 20 ft to 40 ft thick with a mild dip to the south.	Aquitard of regional extent, porous medium	<1 ft/day
Black Creek Aquifer	Predominantly dense medium-grained sand, dark grey. Regionally extensive layer, typically 20 ft to 40 ft thick. Thins out in the Cape Fear River vicinity (up to less than 5 ft), likely due to erosion and emplacement of recent Floodplain Deposits.	Confined aquifer of regional extent, porous medium	5 ft/day to 80 ft/day
Cape Fear Confining Unit	Predominantly clay, hard. Regionally extensive layer.	Aquitard of regional extent, porous medium	<1 ft/day

Notes to Table: *Sourced from the On and Offsite Assessment Report (Geosyntec, 2019) and the Additional Site Investigation Report (Parsons, 2018). Aquifer values derived from aquifer testing (i.e. slug test and pumping test), aquitard values derived from grain-sized analysis.

In the western portion of the Site (Figure A.04), an erosional feature (i.e. paleochannel) is indicated. The erosional feature is interpreted to have completely eroded the Perched Clay, enabling direct hydraulic connection between the Perched Zone and the Surficial Aquifer. In parts (northwest), the erosional feature is also interpreted to have incised into the top of the Black Creek Aquifer.

3.1.2 EVS Model

A three-dimensional (3D) hydrostratigraphic model of the Site was constructed using CTech's Earth Volumetric Studio (EVS) software (https://www.ctech.com/products /earth-volumetric-studio/). The EVS model was developed to interpolate the hydrostratigraphic model, along the horizontal and vertical directions, and develop the model mesh for the numerical groundwater model.

A review of the available borehole logs, hydraulic profiling tool (HPT) logs and geological mapping observations indicated that the horizontal and vertical distribution of available data varied throughout the Site; with a dense distribution in some areas (e.g., onsite observations of the Perched Zone) and sparse in others (e.g., western portion of the Site, south of Old Outfall 002, and onsite observations below the Perched Clay). The EVS model was therefore constructed using an iterative process, by generating and incorporating control points which were guided by the cross-sections from the On and Offsite Assessment Report (Geosyntec, 2019), field observations and professional judgement.

A review of the available borehole logs also suggested that the hydrostratigraphic units within the Site vicinity are not continuous and not hierarchically layered (i.e., not “pancake” layered), especially in units above the Black Creek Aquifer. The “indicator kriging” method was therefore utilized to develop the EVS model. This approach involved computing the probability for each hydrostratigraphic unit at every cell within the model domain, and then assigning the unit with the highest probability to the cell.

Using this approach, the EVS model was constructed using the kriging interpolation method. Model input parameters were selected based on a review of the overall data distribution, visual comparisons of results with various input parameters, overall interpolating computing time and software limitations. A total of 98 boring locations, 28 HPT locations, 42 geological mapping observations, and 36 control points were incorporated to the EVS model.

The top of the model (i.e., ground surface) was determined based on the Light Detection and Ranging (LiDAR) data from NC Dept. of Public Safety published on 18 October 2015. The streambeds of Willis Creek and Old Outfall 002 were further refined based on surveyed data. The bottom of the model was set to -20 ft MSL, which is below the Black Creek Aquifer and intersects the Cape Fear Confining Unit. However, the bottom of the model does not represent the bottom of the Cape Fear Confining Unit.

The new data collected from 2018 to 2020 during the PDI was incorporated into the Conceptual Site Model (CSM) in 2020. The new data includes soil borings, hydraulic conductivity (i.e. from pump tests) and groundwater velocities. Additional data for seep flow rates was collected in 2021 and was incorporated into the CSM in 2021.

3.2 Groundwater Flow System

The groundwater flow system in the Perched Zone, Surficial Aquifer and Black Creek Aquifer and their relative interactions are briefly described in the following sections. Further description is available in the On and Offsite Assessment Report (Geosyntec, 2019).

3.2.1 Perched Zone

Groundwater levels in the Perched Zone are distributed according to a mound-like shape. Higher groundwater levels are indicated in the northeast of the manufacturing area, typically over 140 ft above MSL. Lower groundwater levels, at the edge of the mound, are less than 120 ft above MSL, coinciding with the edge of the Perched Clay or the bluff.

Groundwater from the Perched Zone is anticipated to be a manifestation of surface infiltration due to its localized nature, i.e., not in connection with regional flow.

Groundwater flow in the Perched Zone is radial i.e. outward from the top of the mound. Groundwater from the Perched Zone discharges along the bluff, above the contact between the Perched Zone and the Perched Clay. Groundwater from the Perched Zone is also anticipated to recharge the Surficial Aquifer, either via leakage through the Perched Clay or else via the erosional feature i.e. where the Perched Zone is directly connected to the Surficial Aquifer.

3.2.2 Surficial Aquifer

Groundwater levels in the Surficial Aquifer range from above 115 ft above MSL in the western area of the Site to about 90 ft above MSL in the northern and eastern areas. Groundwater in this aquifer unit is indicated to predominantly flow in a northeasterly and easterly direction, towards Willis Creek and the Cape Fear River, respectively. Groundwater from the Surficial Aquifer also discharges near the toe of the bluff, above the contact with the Black Creek confining unit. Discharge from the Surficial Aquifer into the Old Outfall 002 is also likely where it cuts across this unit.

Groundwater in the Surficial Aquifer is recharged by the regional flow and leakage from the above units.

3.2.3 Black Creek Aquifer

In the eastern part of the Site, groundwater levels in the Black Creek Aquifer range from 90 ft above MSL near the top of the bluff to about 35 ft above MSL near the Cape Fear River. There is limited information in the western part of the Site. Groundwater flow in the Black Creek Aquifer is predominantly in an easterly direction, towards the River although localized flow towards Willis Creek is anticipated where the creek is incised into this aquifer. While the Cape Fear River acts as a groundwater discharge zone for the Black Creek Aquifer, the steep gradient along the bluff (0.03 to 0.04 ft/ft) combined with the thin section of the aquifer (up to less than 5 ft) likely indicates resistance to flow.

3.3 Boundaries, Sources and Sinks

The dominant hydrologic boundary is the Cape Fear River, which acts as the regional groundwater discharge zone for the Black Creek Aquifer. The tributaries to the Cape Fear River are also indicated to act as more localized hydrologic boundaries, with groundwater from the Site variably interacting with these surface water bodies.

The bluff above the Cape Fear River acts as a seepage face. The steep slope results in groundwater discharge above the interface between the two shallow aquifer units (i.e. Perched Zone and Surficial Aquifer) and their underlying aquitard. The Cape Fear Confining Unit is considered to form the base of the Site aquifer system, providing a hydraulic barrier to the deeper hydrostratigraphic units (not included in the geologic or numerical models).

The main source of water in the Perched Zone is indicated to be derived from Site infiltration (both rainfall, stormwater recharge and infiltration from previously unlined sediment ponds and ditches). The source of water in the Surficial Aquifer and the Black Creek Aquifer are leakage from the shallower units and throughflow from the regional aquifer system.

Responses from rainfall were assessed by comparing rainfall events against changes in groundwater levels. Initial results from selected wells across the three aquifer units indicated an increase in groundwater level following a 0.08-inch rain event after a lag time typically ranging between 1.5 and 2 days.

3.4 Water Budget

Over the long term, the rate of water inflow to the Site is equal to the rate of water outflow from the Site. Water enters the groundwater system from regional flow, Site rainfall, stormwater recharge and infiltration from previously unlined sediment ponds and ditches. Water leaves the system through discharge primarily to the Cape Fear River via direct discharge and onsite groundwater seeps, and to a lesser extent discharge to Willis Creek, Georgia Branch Creek, and Old Outfall 002.

4. GROUNDWATER MODEL SOFTWARE SELECTION

The model is required to simulate variably saturated flow behaviors at the Site. The steep topography surrounding the Site is challenging to simulate, and therefore a finite element model was deemed to be more appropriate than a finite difference model (e.g. MODFLOW). Various commercially available finite element models were assessed based on their ability to meet the study objectives and their maturity and acceptance in the scientific and regulatory communities. FEFLOW (DHI-WASY) was the most suitable numerical model based on those criteria.

The model was constructed using field-measured data and parameters estimated from field measured data, which were interpolated to approximate aquifer conditions across the model domain and assumed to be representative in between measured locations.

4.1 Model Description

FEFLOW is a 3D finite element groundwater model widely recognized in industry, research, and government and considered to be an industry standard for finite element groundwater modeling. The code uses the Richards' equation, the conservation of mass, and nonlinear relationships between capillary pressure (P_c) and wetting phase saturation (S_w) and between S_w and hydraulic conductivity (K) to solve for hydraulic heads. FEFLOW simulates 3D transient groundwater flow in unsaturated and variably saturated, confined, and unconfined heterogeneous systems, and models the dynamic interaction with injection/extraction wells, recharge and surface water systems. This study used FEFLOW version 7.2 for the numerical groundwater flow model simulations. All groundwater models were simulated and post-processed within the built-in FEFLOW graphical user interface.

4.2 Model Limitations

Simulation of groundwater flow involves using specific measured data (e.g., groundwater elevation, hydraulic conductivity) and regional data (e.g., recharge) that are used to develop site-wide fields of hydraulic heads and aquifer parameters. By nature, the groundwater model is an approximation based on a limited number of data points, and thus in a complex environment, there are unavoidable uncertainties. Numerical groundwater flow models, therefore, are approximations of real-world hydrogeological systems. However, groundwater models are considered industry practice tools to integrate site data to represent groundwater systems and evaluate groundwater remedial design alternatives.

The model calibration was conducted for the purpose of simulating potential groundwater remedies pursuant to COA Paragraph 3. Therefore, the primary importance of calibration results was placed on the flow features salient to the simulation of groundwater flow within the vicinity between the bluff and the Cape Fear River and the groundwater discharge rates to the surface water features (Cape Fear River, Willis Creek, and Seeps), where the vertical barrier and extraction well network is proposed.

The validity and applicability of the model for purposes other than the stated objectives must be independently evaluated based on the professional judgment of the model user.

5. GROUNDWATER MODEL SETUP

The original groundwater flow model developed in 2019 as part of the Corrective Action Plan (CAP) was designed to represent the major physical and hydraulic features of the flow system in the Site Aquifers (Perched, Surficial, and Black Creek) in and around the Chemours Fayetteville Site discussed above in section 3.0. Construction and calibration of the original CAP groundwater model are described in Appendix H of the CAP report (Geosyntec, 2019).

Portions of the PDI focused on collecting data for further refining the groundwater model, including aquifer testing at five locations, additional borings/wells for geologic information to produce a high-resolution cross-section (shown in Figure A.04), and assessment of per- and polyfluoroalkyl substances (PFAS) chemistry in groundwater along the remedy alignment. This section describes the current version of the model developed for vertical barrier depth design and extraction well network evaluation, and where appropriate, how the model has been modified since inception.

5.1 Model Domain and Grid

The model domain covers an area of 72,690,473 feet square (ft^2) (2.61 square miles). The revised grid consists of 2,099,240 nodes and 4,154,656 elements, and 7 model hydrostratigraphic units. The number of nodes and elements were increased to refine the model domain from the edge of the bluff to Cape Fear River and Willis Creek. The model domain and grid location are presented in Figure A.05.

The model uses 7 hydrostratigraphic units to represent, from the surface downward, the Floodplain deposits, Perched Zone, Perched Clay, Surficial Aquifer, Black Creek Confining unit, Black Creek Aquifer, and Cape Fear Confining unit. The model varies in thickness from about 170 feet (ft) near the plant to 55 ft at the base of the bluff adjacent to the Cape Fear River.

The Light Detection and Ranging (LiDAR) elevation model prepared by the North Carolina Department of Public Safety was imported to represent ground surface topography (NC DPS, 2015), which was corrected with ground survey data, where available, in areas that could impact the performance of the model. The topography of the underlying model layers is based on lithostratigraphic data obtained from Site monitoring wells, soil borings, hydraulic profiling tool (HPT), and piezoCone Penetration Tests (CPT) which were integrated into the three-dimensional visualization model, EVS^{TM}.

5.2 Flow Boundary Conditions

Boundary conditions are used to simulate flow of water into and out of a model domain. Upgradient regional conditions, river and recharge boundaries are used in the updated model to simulate Site conditions. Figure A.06 presents the locations of the boundary conditions within the model domain. In evaluating the appropriateness of the groundwater flow model, the boundary conditions are essential because they determine where the water enters and leaves the system. If the boundary conditions are inappropriate, the model will poorly represent the actual groundwater flow system. The numerical model extent was closely tied to the boundary conditions chosen for the model:

Top Boundary: Established as the ground surface, taken from a combination of LiDAR data and topographic surveys performed along Willis Creek and the Outfall. Boundary conditions on the top boundary were either constant flux (to simulate rainfall recharge) or constant head equal to elevation (with a no inward flow constraint) to simulate seepage faces on the bluffs. Rainfall recharge values were selected with reference to the monthly precipitation from 2018 to 2020 and evapotranspiration estimates for the Mid-Atlantic Coastal Plain (United States Geological Survey [USGS], 2005). The two-year data cycle is repeated for the duration of the modeled simulation time to account for variations due to seasonality. The two-year cycle is considered more conservative than long-term historic conditions due to potential effects of climate change.

Bottom Boundary: Chosen as flat at an elevation of -20 ft above MSL, which is located within the Upper Cape Fear confining unit. This elevation is approximately 165 ft below the most upgradient (west) side of the model and 40 ft below the Cape Fear River at the downgradient end of the model. A no-flow hydraulic condition was applied to the entire bottom boundary of the model.

Northern Boundary: Willis Creek forms a hydraulic boundary north of the model domain. The creek is treated as a spatially-varying constant hydraulic head boundary from the northwest model corner to the outflow to the Cape Fear River located at the northeast model corner. The uppermost active nodes in the mesh along the Willis Creek boundary were linearly interpolated, from west to east along the creek, from a hydraulic head equal to the ground surface elevation at the westernmost part of Willis Creek to a hydraulic head equal to the constant hydraulic head boundary value of the Cape Fear River. Application of this constant head condition to only the upper nodes in the mesh forces all groundwater flowing towards the boundary to discharge into the creek (as all nodes below the upper nodes were assigned a no-flow condition). Sensitivity analysis discussed in Section 6.1 and Section 7.5 were conducted on the boundary condition and the extraction wells along Willis Creek.

Eastern Boundary: The Cape Fear River forms a hydraulic boundary east of the model domain. The River is treated as a constant hydraulic head boundary in the uppermost active nodes with an elevation representative of a daily median water elevation in the River, as measured at the W.O. Huske Dam (USGS, 2105500). The river stage elevations range from 32.05 ft to 36.78 ft over the simulation time period. The River wraps partially around the northeast and southeast corners of the model. Application of this constant head condition to only the uppermost nodes in the mesh forces groundwater flowing towards the boundary to discharge into the River.

Southern Boundary: The model domain southern extent was chosen to represent a flow line from the western boundary to the eastern boundary. A no-flow condition was applied to the southern boundary (that is, flow is from west to east along the boundary toward the Cape Fear River. The south side of the Old Outfall 002 catchment area has limited boring and monitoring well data to establish and verify data so the no flow boundary condition was approximated. This selection was based on the available measured hydraulic head data and professional judgment (Geosyntec, 2019).

Western Boundary: The western model boundary is not bounded by any clearly defined hydraulic features and its location was selected as an approximate flow divide beneath a topographic high. This boundary was chosen as parallel to the Cape Fear River as limited hydraulic information was available to make a more refined choice. This boundary is located more than a quarter mile from the manufacturing area of the Site. Spatially-varying constant hydraulic head boundary conditions were applied linearly ranging from 125 ft (in the shallower portion of the domain) or 122 ft (in the deeper portion of the domain) at the southern end of the boundary to the elevation of Willis Creek at the northern end of the boundary.

5.3 Hydraulic Parameters

The model parameters were chosen based on the available field data, such as CPT, HPT, and Aquifer test data collected from 2018 to 2020. Where ranges in data existed, geomean of the ranges were chosen as the initial set of parameters.

Hydraulic conductivity, specific storage (S_s), unsaturated-flow porosity (θ), residual wetting phase saturation (S_r), and Brooks-Corey-Burdine P_c-S_W-K constitutive parameters (alpha (α), lambda (λ), delta (δ)) are the main hydraulic parameters in the model. The distribution and assignment of these parameters are based on the conceptual model hydrostratigraphy. Hydraulic parameter distribution in the model was across individual hydrostratigraphic units. The parameter values for each hydrostratigraphic unit were determined during the flow model calibration process (Section 3) and presented in Table A.02.

Table A.02: Calibrated Model Hydraulic Parameters For Each Hydrostratigraphic Unit

Hydrostratigraphic Unit	K (ft/day)	S_s (m^{-1})	θ	S_r (-)	α (m^{-1})	λ (-)	δ (-)
Floodplain Deposits	1.4	1.0×10^{-8}	0.32	0.2	0.5	0.15	25
Perched Zone	2.6	1.0×10^{-3}	0.3	0.1	11.5	0.56	7.3
Perched Clay	0.0014	1.0×10^{-8}	0.5	0.2	0.5	0.15	25
Surficial Aquifer	25 to 72	1.0×10^{-3}	0.33	0.1	11.5	0.56	7.3
Black Creek Confining Unit	0.43	1.0×10^{-8}	0.55	0.2	0.5	0.15	25
Black Creek Aquifer	3.8 to 102	5.1×10^{-5}	0.34	0.1	11.5	0.56	7.3
Cape Fear Confining Unit	1.1	1.0×10^{-8}	0.28	0.2	0.5	0.15	25

S_r and the Brooks-Corey-Burdine (α, λ, δ) constitutive parameters for each hydrostratigraphic unit were selected based on the soil textural class and the estimated model parameters reviewed from Madi et al. (2018), Matlan et al. (2014), and Shao and Irannejad (1999). These parameter assignments were simplified for the model by separating the hydrostratigraphic units as either Aquifers or aquitards after performing the first set of flow model calibration runs where each hydrostratigraphic unit was assigned distinct parameter sets. Aquifer units were assigned S_r and Brooks-Corey-Burdine constitutive parameters representative of sands; aquitard units were assigned S_r and Brooks-Corey-Burdine constitutive parameters representative of sandy clay, silty clay, and clay soil types.

6. GROUNDWATER MODEL CALIBRATION

Model calibration is an iterative process where the initial parameters values (e.g., hydraulic conductivities, boundary conditions, recharge) are adjusted incrementally to produce a better match between simulated and observed water level elevations.

The site-wide synoptic water level rounds collected in July and March 2021 incorporated newly installed wells during the PDI.

A total of 139 monitoring well locations (60- Perched Zone, 32 – Surficial, and 47 – Black Creek Aquifer) were used as hydraulic head calibration targets. Table A.03 provides the wells, coordinates, hydrostratigraphic unit, observed and predicted hydraulic heads, and the residual heads. The residual head for each monitoring point is the calculated (model simulated) hydraulic head minus the observed hydraulic head ($X_{cal} – X_{obs}$). Monitoring well locations (hydraulic head targets) in the Perched Zone, Surficial Aquifer and Black Creek Aquifer are spatially illustrated on Figure A.07.

Figure A.08 presents the calibration statistics and a graph of the calculated heads versus observed heads. Calibration statistics presented include the range of residuals, residual mean, absolute residual mean, the standard error of the estimate, the root mean squared error, the normalized root mean squared error, and the flow mass balance.

The maximum residual (calculated minus observed head) occurs in the Perched zone at MW-27 (8.52 ft), Surficial Aquifer at SMW-09 (13.5 ft), and in the Black Creek at PW-10R (10.27 ft). Because the residual mean is a measure of the average residual head, it is possible that over-calculated and under-calculated values will negate each other thus producing a residual mean value closer to zero. This can be misleading as to the quality of the calibration and therefore it is more meaningful and preferable to use the absolute residual mean as an indicator of model calibration. The residual mean was -0.66 ft; the absolute residual mean was 2.94 ft.

The root mean square (RMS) is a statistical measure of the magnitude of the residual and is useful as an indicator of error where values are both positive and negative. The normalized root mean square (NRMS) is the RMS divided by the maximum difference in observed head values, expressed in percent (%). A model is considered to be well calibrated when the NRMS is below 10% (Spitz 1996) . The RMS for the Perched zone was 4.34 ft; the NRMS was 23.9%, the RMS for the Surficial Aquifer was 5.65 ft; the NRMS was 6.4% and the RMS for the Black Creek Aquifer was 4.58 ft; the NRMS was 5.2%. The Perched zone NRMS value exceeds 10%, but is unconfined and thin, and the perched zone can be significantly influenced by small scale local recharge patterns making calibration more difficult. The perched zone does not directly discharge to the Cape Fear River and the main transport pathways is either through an identified seep location or infiltration to the Black Creek Aquifer. The primary targets of the remedy are the Surficial and Black Creek Aquifers, not the perched, so calibration does not need to be as refined for this hydrostratigraphic unit.

The flow mass balance is a measure of the volume and rates of water entering and leaving the system through the flow boundaries and from aquifer storage at the end of each stress period (in the case of transient simulations). Ideally, the flow balance should be as close as practicable to a discrepancy of 0%. The flow mass balance in this model has a discrepancy of 0.78%.

Figure A.09 presents the simulated equipotential head contours for the Surficial Aquifer and Black Creek Aquifer layers in the calibrated base model. Field-measured (observed) groundwater elevation contours are also included for comparison. Although the focus during model calibration was the area where the vertical barrier and extraction wells will be installed, the model is adequately simulating the groundwater within the plant area.

6.1 Sensitivity Analysis for Model Calibration

Following model calibration, a sensitivity analysis was performed to key variables modified during the calibration process or selected based on literature values:

- Recharge due to rainfall;
- Hydraulic Conductivities for the Perched Zone, Perched Clay, Surficial Aquifer, and Black Creek Aquifer;
- Western boundary condition hydraulic head distribution; and
- Willis Creek boundary condition

The sensitivity of the model calibration to each variable is assessed qualitatively and quantitatively (where possible) in Table A.04 and more detailed results and a description of the sensitivity analysis is presented in Table A.05.

Table A.04: Calibrated Model Sensitivity Analysis

Sensitivity Variable	Change	Sensitivity	NRMS Error
Calibrated Model	N/A	N/A	12.2%
Rainfall Recharge	+/- 20%	Low	12.4% | 13.7%
Perched Zone K	+/- 50%	Low	11.3% | 13.2%
Surficial K	+/- 20%	Low	12.3% | 12.8%
Black Creek K	+/- 20%	Low	12.6% | 12.9%
Perched Clay K	Across three orders of magnitude	High	30.2% at reference hydraulic conductivity. Sensitivity limited to Perched Zone.
Western Boundary Condition	Change in spatial distribution of hydraulic heads and absolute values of hydraulic heads	Moderate	Wide range depending on changes. Sensitivity limited to Surficial and Black Creek, limited sensitivity in Perched Zone.
Willis Creek Boundary Condition	Change the nodes no flow nodes to flux nodes	Low	No significant difference for the rate of discharge from the aquifers to Willis creek.

The higher calibration assessment statistics (poorer fit) of the model in the Perched Zone are primarily due to the small range of observed hydraulic heads in the system (as compared to the Surficial and Black Creek Aquifers).

The results of the sensitivity runs indicate the horizontal conductivity zones with the highest sensitivity are the perched clay unit. The parameter sensitivities indicated that the calibration could be improved mildly by decreasing the conductivity in the perched aquifer. However, the selected conductivity is based on the computed values from slug test collected at the Site.

The western type I (i.e. constant head) boundary condition has was based on empirical head measurements and shows comparatively moderate sensitivity with the most sensitivity observed in the surficial and to a lesser extent, the Black Creek aquifer. By contrast, the boundary condition representing Willis Creek is less sensitive to changes in the construction from a type I to a type II boundary condition (i.e. constant head to fluid flux).

Recharge rate is low sensitivity parameter, with increases in rates showing a little higher sensitivity compared to a decrease in the recharge rate.

7. REMEDIAL DESIGN SIMULATIONS

The remedial design for Site groundwater includes the installation of a vertical barrier and a groundwater extraction and treatment system to control discharge of PFAS containing groundwater to the Cape Fear River.

The following describes a summary of the conclusions from the PDI and the model results for consideration into the vertical barrier design and groundwater extraction system remedy. The Site geology is highly variable along the groundwater remedy alignment. Consistent with the interpretation of a deltaic depositional environment, the Black Creek Aquifer along the alignment is a mixture of high-energy channel sands and lower-energy mud flats. Geosyntec prepared a high-resolution cross section along the groundwater remedy alignment using a combination of data collected during the PDI and previous investigations (Figure A.04). Three distinct sections of the groundwater remedy alignment are described as follows. Black Creek Aquifer soils in the northern portion of the groundwater remedy alignment are dominated by more fine-grained materials indicative of a transition to a low-energy deposition environment. The central portion of the alignment is characterized by higher-energy channel sands and correlates to the locations of a majority of the seeps. The southern portion is similar to the central portion of the alignment but is hydraulically influenced by the Old Outfall 002.

Particle tracking was incorporated to display flow direction between the Site and the Cape Fear River under baseline conditions and after the addition of the vertical barrier and the groundwater extraction network. Particle tracking starting locations were released from the Plant Area upgradient of the proposed remedy area.

Particle track and water budget analyses have been completed for various scenarios to quantify groundwater discharge between the Site and the Cape Fear River. This was accomplished using particle tracking and the rate budget analyzer within FEFLOW to assess the groundwater discharge to the Cape Fear River. Groundwater discharge was first estimated under baseline conditions (i.e., Scenario 1, the base case model). As the subsequent scenarios were developed, the particles discharged to Cape Fear River were compared to baseline conditions to evaluate the scenario's control of groundwater flow.

7.1 Scenario 1: Baseline Conditions

The base case model is equivalent to the model calibration conducted during the 60% design report where the model was adjusted to simulate current conditions prior to remedy implementation.

Figure A.10 presents particle-tracking results for Scenario 1 which uses a 5-year model run time and releases particles from the Plant Area. Under these conditions, particles released from the perimeter of the plant migrate horizontally, then eventually discharge to Cape Fear River.

7.2 Scenario 2: Vertical Barrier Alone

In this scenario, a five-year model simulation, the vertical barrier parallel to the Cape Fear River (shown by the green line in Figure A.11) is simulated from Surficial Aquifer to the top of the Upper Cape Fear Confining unit by creating a zone to represent the vertical boundary. The length of the barrier is approximately 9,000 ft, and the depth embeds five feet into the Upper Cape Fear Confining unit. Approximate depth of the barrier ranges from approximately 60 to 80 ft. The barrier is assigned a thickness of 30 inches and a hydraulic conductivity of 3.28×10^{-3} feet per day (ft/d) (1.0×10^{-6} centimeter per second [cm/s]). Figure A.12 presents the particle-tracking results for Scenario 2. In this five-year simulation, many of the particles released from the Site pass over, around, and through the vertical barrier, and eventually discharge to the Cape Fear River. Specifically, in the area near Seep A and B where there is high transmissivity, particles migrate over, around and through the barrier and discharge to Cape Fear River at a relatively high rate.

Results from the particle tracking and flow analysis indicated that the physical barrier wrap-around flow occurred at the barrier edges after 7 days, breakthrough occurs in multiple locations along the barrier, and groundwater discharges to surface. Specifically, in the areas near Seeps A and B, particles migrate over, around, and through the barrier and discharge to Cape Fear River.

7.3 Scenario 3: Hydraulic Barrier Alone

In Scenario 3, a hydraulic barrier alone was simulated using a groundwater extraction network between the bluff and the Cape Fear River (shown by the wells in Figure A.13). This simulation used 64 extraction wells (10 wells located in the Surficial Aquifer and 54 wells located in the Black Creek Aquifer) to mitigate groundwater discharge to the Cape Fear River.

The simulated extraction well flow rates ranged from 5 to 35 gallons per minute (gpm) depending on location, and the total cumulative flow rate for the extraction well network simulated was 1,023 gpm. Well spacing is generally 200 ft apart; well spacings are closer where there is higher groundwater flux, particularly in the vicinity of Seeps A and B, and along the southern end near the Old Outfall 002. Figure A.14 presents the particle-tracking results for Scenario 3. In this simulation, the particles are released from the Site in the plant area and many are contained by the extraction system. However, some particles are ultimately discharged to the Cape Fear River. Specifically, in the areas near Seeps A and B, particles migrate between some of the extraction wells and discharge to Cape Fear River. An evaluation of the extraction well network indicated insufficient overlap of the radii of influence (ROI) for the extraction wells in many areas of the hydraulic barrier remedy. This results in incomplete capture in the areas where there is increased groundwater flow due to the presence of highly transmissive material.

Additional extraction wells and increased pumping would allow for sufficient overlapping ROI, however, the resulting cone of depression is of sufficient size to begin drawing in Cape Fear River water with limited additional capture of groundwater, reducing overall efficiency. Sensitivity analysis was performed to optimize the well placement and well density along the proposed remedy route. In addition to the spacing specified in the above figures, simulations with a well spacing of 100 ft apart with tighter spacing of 25 feet apart (total of 135 wells) near Seep A, Seep B and near Outfall 003 (higher transmissible areas) were assessed. In the highly transmissive areas, particles from the plant area were still not fully captured by the groundwater extraction well network. Site conditions are such that groundwater from under the plant facility cannot maintain hydraulic control without also capturing some portion of Cape Fear River water. It was determined pumping alone could not match the performance of a combination pumping with a physical barrier, Scenario 4 below, with respect to capture.

Notably, in the northern area of the Site, where the overall hydraulic conductivity is lower, the ROI of the extraction wells in this area sufficiently overlap and allows for capture of groundwater over the area. Evaluation of the two stand-alone approaches demonstrate that the barrier wall only or pumping only is not sufficient to meet overall Consent Order (CO) objectives. However, the simulation also demonstrated that pumping alone near Willis Creek controls the discharge to surface water in the northern portion.

7.4 Scenario 4: Optimized Scenario

In scenario 4, the vertical barrier and a hydraulic barrier containing 69 extraction wells (15 wells located in the Surficial Aquifer and 54 wells located in the Black Creek Aquifer) were combined and simulated to assess the performance of the remedy (shown by the wells in Figure A.15).

Attachment 5 to the COA identified that the groundwater remedy would extend along Willis Creek in the northern alignment. Based on the favorable simulated performance of pumping only (see section 7.3 above) remedy along the northern Willis Creek section and the identified constructability considerations along the northern section (section 3.2.4 of the 90% Design Report), the northern section of the remedy could be successfully implemented with pumping only and the remainder of the remedy include the barrier wall of 6,000 ft long from near the intake road to near the Old Outfall. The depth of the barrier extends into the upper five ft of the Upper Cape Fear Confining unit, for a total depth of approximately 60 to 80 ft. The barrier is assigned a thickness of 30 inches and a hydraulic conductivity of 2.8 x 10^{-3} ft/d (1.0 x 10^{-6} cm/s).

The simulated extraction well flow rates range from 5 to 35 gpm depending on location, and the total cumulative flow rate for the extraction well network simulated was 1,023 gpm. The presence of the vertical barrier effectively reduces overall hydraulic conductivity over the alignment where the barrier wall is present. As a result, the effective ROI of the wells in a north-south direction is generally extended to allow sufficient overlap to capture groundwater flow. In those areas where a 200-ft spacing is not sufficient to capture released particles, spacing was tightened to provide adequate overlap of the ROI. Spacing is tighter at the northern and southern ends of the barrier wall and in the vicinity of the Seeps A and B where overall flow rates are higher as a result of increased transmissivity and to reduce the potential for wrap around.

Figure A.16 presents the particle-tracking results for Scenario 4. In this simulation, the particles released from the Site in the plant area are controlled by the combined vertical and hydraulic barrier. The effectiveness of the simulated remedy was largely equal for both the Surficial Aquifer above the barrier wall and the Black Creek Aquifer. Groundwater that is present downgradient of the remedy after startup becomes largely stagnant; over time, continuing rainwater recharge and fluctuation of the Cape Fear river slowly drives remaining water present downgradient of the wall toward the Cape Fear River.

7.5 Sensitivity Analysis for Remedial Design Scenarios

Following remedial design scenarios sensitivity analyses were performed to evaluate the sensitivity associated with the remedial design compared to the optimized remedial scenario (i.e. variations well locations, extraction rates and wall construction). Key assumptions that were evaluated include barrier wall thickness (30 inches), barrier wall hydraulic conductivity (1.0 x 10^{-6} cm/s), location of barrier wall relative to plant and river, and locations of extraction wells. Overall remedy performance, e.g., mitigating groundwater flow to surface water, is the combined function of the location of extraction wells and extraction rates paired with the hydraulic properties of the barrier wall – the presence of a barrier wall reduces the required rate of groundwater extraction.

The sensitivity analysis for the remedial design scenarios is assessed qualitatively and quantitatively (where possible) in Table A.06 and more detailed results and a description of the sensitivity analysis is presented in Table A.07

Table A.06: Remedial Design Sensitivity Analysis

Sensitivity Analysis	Change	Sensitivity	Result
Scenario 2: Barrier wall thickness	0.5 to 1.0 m	Moderate	An increase in barrier wall thickness from 30 inches to 39.4 inches (1.0 m) likely requires a 5% or more increase in pumping rate as greater volumes of water will be retained by the wall. A decrease in barrier wall thickness from 30 inches to 19.7 inches (0.5 m) likely requires an increase in pumping rate of 20% or more as some of the burden of capture will shift from the wall to extraction wells.
Scenario 2: Barrier hydraulic conductivity	1.0×10^{-7} to 1.0×10^{-5} cm/s	High	A reduction in hydraulic conductivity of the wall to 1.0 x 10-7 has minimal effect on the overall performance of the optimized remedy. However, an increase in hydraulic conductivity of the wall to 1.0 x 10-5 has a potentially material effect on the performance of the optimized remedy.
Scenario 2: Barrier Location	On the Bluff,and In the Flood Plain	Moderate	The barrier wall location had a modest correlation in the effectiveness of maintaining control over the discharge to the Cape Fear River. The barrier location along the bluff has higher wrap-around flow relative to the optimized location. In the flood plain, performance is similar to optimized location; however, the treatment area is more prone to floods (impacts to extraction and treatment system) and there are additional impacts to wetland areas.
Scenario 3: Hydraulic Control Extration Well Locations	On the Bluff,and In the Flood Plain	High	The extraction well locations had a strong correlation in the effectiveness of maintaining control over the discharge to the Cape Fear River and the hydraulic gradient of the Site. Extraction wells along the bluff requires an increase in pumping to maintain hydraulic control. Extraction wells in the flood plain require increase pumping due to intake of water from the Cape Fear River.
Scenario 4: Hydraulic Control Extration Well Locations at Willis Creek	Up to 1,000 ft from Willis Creek and, up to 500 ft from the creek	Low	The model is relatively insensitive to the distance of the line of extraction wells from Willis Creek. Moving the line of extraction wells closer to the plant does not improve performance.

The sensitivity analysis conducted for the remedial designs demonstrated which aspects of the remedy are most sensitive to change. The results of the sensitivity analysis were incorporated into developing contingency in the remedy.

8. SUMMARY

The original groundwater model developed during the CAP in 2019 was updated to include water level, hydraulic conductivity values, and hydrostratigraphic unit elevation data collected during the PDI in 2020/2021. The model was also further discretized vertically and horizontally to allow a more complex simulation of site conditions, simulate potential remedies, and help provide a basis for remedy design.

The model was calibrated to synoptic groundwater data collected from 2018 to 2020 by adjusting the hydraulic conductivity distribution, boundary conditions, and recharge. Model calibration statistics indicate a root mean square result of 5.65 ft and a normalized root mean square of 6.4% for the Surficial Aquifer and a root mean square result of 4.58 ft and a normalized root mean square of 5.2% for the Black Creek Aquifer, indicating a well calibrated model.

Several model scenarios were completed to assess basis of design for the remedy:

Scenario 1 simulates the current conditions base model updated with PDI data.

Scenario 2 simulates a vertical barrier only.

Scenario 3 simulates a hydraulic barrier via an extraction system only.

Scenario 4 simulates an optimized remedy that takes advantages of the strengths of both the vertical barrier and hydraulic barrier via an extraction system.

The modeling results indicate that the groundwater in the northern alignment portion can be intercepted using extraction wells alone and that a barrier wall is not required. Particle tracking results from Scenario 4 simulations indicate that discharge of the Surficial Aquifer to the seeps east of the barrier wall and the Black Creek Aquifer to the Cape Fear River controls groundwater and meets CO objectives.

Based on these model results, Scenario 4 was selected as a suitable option for limiting the groundwater discharge to the Cape Fear River and forms the basis of design for the groundwater remedy. Scenario 4 demonstrates that to provide adequate hydraulic containment, 69 extraction wells (15 wells located in the Surficial Aquifer, and 54 wells located in the Black Creek Aquifer) and a vertical barrier wall installed through the central and southern sections of the alignment successfully control groundwater discharging to the Cape Fear River. The estimated annualized cumulative flow rates for the extraction well network is about 1,023 gpm.

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Tables

Table A.03: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
BCA-01	Black Creek Aquifer	Oct-19	87.38	83.58	-3.80
BCA-02	Black Creek Aquifer	Oct-19	74.55	81.52	6.97
BCA-04	Black Creek Aquifer	Oct-19	121.55	114.41	-7.14
BCA-03R	Black Creek Aquifer	Oct-19	101.27	101.05	-0.22
PW-10R	Black Creek Aquifer	Oct-19	48.15	54.43	6.28
PW-12	Black Creek Aquifer	Oct-19	92.65	100.70	8.05
LTW-02	Black Creek Aquifer	Oct-19	42.19	39.36	-2.83
LTW-05	Black Creek Aquifer	Oct-19	42.35	42.42	0.07
PIW-2D	Black Creek Aquifer	Oct-19	64.55	64.30	-0.25
PIW-3D	Black Creek Aquifer	Oct-19	35.8	39.02	3.22
PIW-4D	Black Creek Aquifer	Oct-19	41.68	50.02	8.34
PIW-7D	Black Creek Aquifer	Oct-19	42.69	45.68	2.99
PIW-8D	Black Creek Aquifer	Oct-19	41.11	43.33	2.22
PIW-9D	Black Creek Aquifer	Oct-19	42.08	49.40	7.32
PW-09	Black Creek Aquifer	Oct-19	52.24	47.48	-4.76
PW-11	Black Creek Aquifer	Oct-19	39.6	40.57	0.97
PW-13	Black Creek Aquifer	Oct-19	119.79	117.30	-2.49
PW-14	Black Creek Aquifer	Oct-19	86.86	84.49	-2.37
PW-15R	Black Creek Aquifer	Oct-19	76.96	77.63	0.67
PZ-22	Black Creek Aquifer	Oct-19	44.06	43.02	-1.04
SMW-12	Black Creek Aquifer	Oct-19	33.44	38.88	5.44
LTW-01	Floodplain Deposits	Oct-19	37.3	40.33	3.03
LTW-03	Floodplain Deposits	Oct-19	39.71	39.06	-0.65
LTW-04	Floodplain Deposits	Oct-19	42.55	43.63	1.08
PIW-1S	Floodplain Deposits	Oct-19	32.59	35.56	2.97
PIW-6S	Floodplain Deposits	Oct-19	38.6	41.90	3.30
PIW-7S	Floodplain Deposits	Oct-19	42.51	50.33	7.82
PIW-7S	Floodplain Deposits	Oct-19	42.51	43.21	0.70
MW-13D	Surficial Aquifer	Oct-19	104.33	99.89	-4.44
MW-14D	Surficial Aquifer	Oct-19	109.67	107.09	-2.58
MW-16D	Surficial Aquifer	Oct-19	113.02	106.38	-6.64
MW-17D	Surficial Aquifer	Oct-19	117.09	114.11	-2.98
MW-18D	Surficial Aquifer	Oct-19	87.28	87.89	0.61
MW-19D	Surficial Aquifer	Oct-19	88.24	86.19	-2.05
MW-20D	Surficial Aquifer	Oct-19	89.51	85.37	-4.14
MW-21D	Surficial Aquifer	Oct-19	105.71	102.86	-2.85
MW-22D	Surficial Aquifer	Oct-19	113.82	110.93	-2.89
PIW-1D	Surficial Aquifer	Oct-19	32.81	32.17	-0.64
PIW-5S	Surficial Aquifer	Oct-19	60.46	48.36	-12.10
PW-02	Surficial Aquifer	Oct-19	90.05	82.82	-7.23
PW-05	Surficial Aquifer	Oct-19	121.25	121.37	0.12

Table A.03: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
MW-15DRR	Surficial Aquifer	Oct-19	103.37	101.34	-2.03
PW-03	Surficial Aquifer	Oct-19	105.57	95.39	-10.18
SMW-03B	Surficial Aquifer	Oct-19	93.4	100.72	7.32
SMW-05P	Surficial Aquifer	Oct-19	105.31	106.23	0.92
SMW-06B	Surficial Aquifer	Oct-19	103.15	102.07	-1.08
SMW-08B	Surficial Aquifer	Oct-19	108.29	106.71	-1.58
SMW-09	Surficial Aquifer	Oct-19	85.2	71.65	-13.55
SMW-10	Surficial Aquifer	Oct-19	46.69	53.70	7.01
SMW-11	Surficial Aquifer	Oct-19	57.87	54.34	-3.53
SMW-04B	Surficial Aquifer	Oct-19	102.94	100.42	-2.52
FTA-02	Perched Zone	Oct-19	133.61	131.69	-1.92
MW-1S	Perched Zone	Oct-19	132.9	130.81	-2.09
MW-2S	Perched Zone	Oct-19	130.69	129.30	-1.39
MW-9S	Perched Zone	Oct-19	130.36	124.57	-5.79
MW-11	Perched Zone	Oct-19	132.81	132.54	-0.27
MW-23	Perched Zone	Oct-19	131.61	128.04	-3.57
MW-24	Perched Zone	Oct-19	133.93	140.50	6.57
MW-26	Perched Zone	Oct-19	133.29	133.17	-0.12
MW-28	Perched Zone	Oct-19	131.99	123.47	-8.52
MW-31	Perched Zone	Oct-19	130.2	124.77	-5.43
MW-33	Perched Zone	Oct-19	132.36	128.58	-3.78
NAF-03	Perched Zone	Oct-19	139.43	139.36	-0.07
NAF-06	Perched Zone	Oct-19	139.99	139.05	-0.94
NAF-08A	Perched Zone	Oct-19	138.92	136.52	-2.40
NAF-09	Perched Zone	Oct-19	138.54	142.64	4.10
NAF-10	Perched Zone	Oct-19	136.38	141.43	5.05
NAF-11A	Perched Zone	Oct-19	135.76	132.42	-3.34
PZ-11	Perched Zone	Oct-19	133.55	126.63	-6.92
PZ-12	Perched Zone	Oct-19	137.02	130.84	-6.18
PZ-13	Perched Zone	Oct-19	130.74	131.00	0.26
PZ-20R	Perched Zone	Oct-19	135.54	131.57	-3.97
PZ-21R	Perched Zone	Oct-19	135.47	131.66	-3.81
PZ-24	Perched Zone	Oct-19	136.22	132.30	-3.92
PZ-25	Perched Zone	Oct-19	133.36	130.49	-2.87
PZ-27	Perched Zone	Oct-19	134.8	132.63	-2.17
PZ-28	Perched Zone	Oct-19	133.97	130.07	-3.90
PZ-29	Perched Zone	Oct-19	135.14	127.78	-7.36
PZ-32	Perched Zone	Oct-19	130.7	130.14	-0.56
PZ-34	Perched Zone	Oct-19	132.72	126.76	-5.96
SMW-03	Perched Zone	Oct-19	136.32	132.76	-3.56
NAF-13	Perched Zone	Oct-19	133.01	139.18	6.17

Table A.03: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
PZ-17	Perched Zone	Oct-19	135.12	141.51	6.39
SMW-02	Perched Zone	Oct-19	121.81	119.60	-2.21
PZ-12	Perched Zone	Dec-20	132	131.00	1.00
PZ-15	Perched Zone	Dec-20	135.85	141.51	-5.66
PZ-17	Perched Zone	Dec-20	121.85	119.60	2.25
PZ-19R	Perched Zone	Dec-20	137.14	131.57	5.57
PZ-20R	Perched Zone	Dec-20	137.07	131.66	5.41
PZ-21R	Perched Zone	Dec-20	138.62	132.30	6.32
PZ-35	Perched Zone	Dec-20	138.07	132.76	5.31
BCA-01	Black Creek Aquifer	Dec-20	84.43	83.58	0.85
BCA-02	Black Creek Aquifer	Dec-20	75.07	81.52	-6.45
BCA-03R	Black Creek Aquifer	Dec-20	101.29	101.05	0.24
BCA-04	Black Creek Aquifer	Dec-20	122.38	114.41	7.97
EW-1	Perched Zone	Dec-20	60.15	65.66	-5.51
EW-2	Perched Zone	Dec-20	43.35	44.10	-0.75
EW-3	Perched Zone	Dec-20	61.55	57.17	4.38
EW-4	Perched Zone	Dec-20	50.57	48.39	2.18
EW-5	Perched Zone	Dec-20	45.38	43.41	1.97
FTA-01	Perched Zone	Dec-20	134.14	131.69	2.45
FTA-02	Perched Zone	Dec-20	132.88	136.39	-3.51
FTA-03	Perched Zone	Dec-20	133.68	130.81	2.87
LTW-01	Floodplain Deposits	Dec-20	38.88	40.33	-1.45
LTW-02	Black Creek Aquifer	Dec-20	43.2	39.36	3.84
LTW-03	Floodplain Deposits	Dec-20	41.24	39.06	2.18
LTW-04	Floodplain Deposits	Dec-20	44.19	43.63	0.56
LTW-05	Black Creek Aquifer	Dec-20	42.78	42.42	0.36
MW-11	Perched Zone	Dec-20	125.15	125.90	-0.75
MW-12S	Perched Zone	Dec-20	132.56	128.04	4.52
MW-13D	Surficial Aquifer	Dec-20	104.75	99.89	4.86
MW-14D	Surficial Aquifer	Dec-20	110.29	107.09	3.20
MW-15DRR	Surficial Aquifer	Dec-20	103.21	101.34	1.87
MW-16D	Surficial Aquifer	Dec-20	112.89	106.38	6.51
MW-17D	Surficial Aquifer	Dec-20	117.74	114.11	3.63
MW-18D	Surficial Aquifer	Dec-20	88.79	87.89	0.90
MW-19D	Surficial Aquifer	Dec-20	90.03	86.19	3.84
MW-1S	Perched Zone	Dec-20	131.34	129.30	2.04
MW-20D	Surficial Aquifer	Dec-20	90.88	85.37	5.51
MW-21D	Surficial Aquifer	Dec-20	106.77	102.86	3.91
MW-22D	Surficial Aquifer	Dec-20	113.64	110.93	2.71
MW-23	Perched Zone	Dec-20	134.33	140.50	-6.17
MW-24	Perched Zone	Dec-20	128.92	134.53	-5.61

Table A.03: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
MW-25	Perched Zone	Dec-20	134.11	133.17	0.94
MW-26	Perched Zone	Dec-20	136.5	137.05	-0.55
MW-27	Perched Zone	Dec-20	132.44	123.47	8.97
MW-28	Perched Zone	Dec-20	131.29	124.77	6.52
MW-30	Perched Zone	Dec-20	135.1	139.18	-4.08
MW-31	Perched Zone	Dec-20	131.82	135.53	-3.71
MW-32	Perched Zone	Dec-20	132.24	128.58	3.66
MW-33	Perched Zone	Dec-20	132.47	129.72	2.75
MW-34	Perched Zone	Dec-20	132.13	136.43	-4.30
MW-35	Perched Zone	Dec-20	132.21	129.61	2.60
MW-36	Perched Zone	Dec-20	132.29	135.91	-3.62
MW-7S	Perched Zone	Dec-20	137.49	135.52	1.97
MW-8S	Perched Zone	Dec-20	141.94	147.54	-5.60
MW-9S	Perched Zone	Dec-20	133.39	132.54	0.85
NAF-01	Perched Zone	Dec-20	140.95	140.28	0.67
NAF-02	Perched Zone	Dec-20	141.05	139.36	1.69
NAF-03	Perched Zone	Dec-20	140.92	144.15	-3.23
NAF-06	Perched Zone	Dec-20	134.87	131.08	3.79
NAF-07	Perched Zone	Dec-20	140.6	136.52	4.08
NAF-08A	Perched Zone	Dec-20	140.73	142.64	-1.91
NAF-08B	Perched Zone	Dec-20	95.44	100.44	-5.00
NAF-09	Perched Zone	Dec-20	137.93	141.43	-3.50
NAF-10	Perched Zone	Dec-20	138.54	132.42	6.12
NAF-11A	Perched Zone	Dec-20	136.82	139.97	-3.15
NAF-11B	Perched Zone	Dec-20	94.13	99.26	-5.13
NAF-12	Perched Zone	Dec-20	140.15	136.79	3.36
OW-1	Perched Zone	Dec-20	59.78	62.67	-2.89
OW-1	Perched Zone	Dec-20	59.78	65.69	-5.91
OW-10	Perched Zone	Dec-20	59.82	60.49	-0.67
OW-2	Perched Zone	Dec-20	50.34	53.62	-3.28
OW-3	Perched Zone	Dec-20	50.14	48.81	1.33
OW-4	Perched Zone	Dec-20	61.57	62.16	-0.59
OW-5	Perched Zone	Dec-20	61.78	65.79	-4.01
OW-6	Perched Zone	Dec-20	42.8	42.55	0.25
OW-7	Perched Zone	Dec-20	45.35	44.40	0.95
OW-8	Perched Zone	Dec-20	44.6	45.95	-1.35
OW-9	Perched Zone	Dec-20	61.71	57.79	3.92
PIW-10DR	Perched Zone	Dec-20	61.16	60.94	0.22
PIW-10S	Perched Zone	Dec-20	57.93	53.29	4.64
PIW-11	Perched Zone	Dec-20	45.11	40.55	4.56
PIW-12	Perched Zone	Dec-20	35.53	34.75	0.78

Table A.03: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
PIW-13	Perched Zone	Dec-20	36.2	31.75	4.45
PIW-14	Perched Zone	Dec-20	37.01	38.24	-1.23
PIW-15	Perched Zone	Dec-20	35.58	33.96	1.62
PIW-16D	Perched Zone	Dec-20	131.11	135.13	-4.02
PIW-16S	Perched Zone	Dec-20	134.79	136.41	-1.62
PIW-1D	Surficial Aquifer	Dec-20	36.37	32.17	4.20
PIW-1S	Floodplain Deposits	Dec-20	35.35	35.56	-0.21
PIW-2D	Black Creek Aquifer	Dec-20	64.4	64.30	0.10
PIW-3D	Black Creek Aquifer	Dec-20	37.56	39.48	-1.92
PIW-4D	Black Creek Aquifer	Dec-20	42.67	47.23	-4.56
PIW-5S	Surficial Aquifer	Dec-20	61.17	48.36	12.81
PIW-6S	Floodplain Deposits	Dec-20	40.19	41.90	-1.71
PIW-7D	Black Creek Aquifer	Dec-20	43.35	45.96	-2.61
PIW-7S	Floodplain Deposits	Dec-20	43.42	50.33	-6.91
PIW-8D	Black Creek Aquifer	Dec-20	41.55	43.33	-1.78
PIW-9D	Black Creek Aquifer	Dec-20	42.49	49.40	-6.91
PIW-9S	Perched Zone	Dec-20	50.81	47.88	2.93
PW-01	Perched Zone	Dec-20	135.72	126.63	9.09
PW-02	Surficial Aquifer	Dec-20	89.99	82.82	7.17
PW-03	Surficial Aquifer	Dec-20	106.2	95.39	10.81
PW-04	Perched Zone	Dec-20	74.81	78.81	-4.00
PW-05	Surficial Aquifer	Dec-20	123.57	121.37	2.20
PW-06	Perched Zone	Dec-20	128.17	131.47	-3.30
PW-07	Perched Zone	Dec-20	118.6	123.45	-4.85
PW-09	Black Creek Aquifer	Dec-20	53.04	47.48	5.56
PW-10R	Black Creek Aquifer	Dec-20	47.18	54.43	-7.25
PW-11	Black Creek Aquifer	Dec-20	38.66	40.57	-1.91
PW-12	Black Creek Aquifer	Dec-20	93.77	100.70	-6.93
PW-13	Black Creek Aquifer	Dec-20	117.22	117.30	-0.08
PW-14	Black Creek Aquifer	Dec-20	86.49	84.49	2.00
PW-15R	Black Creek Aquifer	Dec-20	67.05	77.63	-10.58
PZ-11	Perched Zone	Dec-20	141.57	130.84	10.73
PZ-13	Perched Zone	Dec-20	138.5	134.75	3.75
PZ-14	Perched Zone	Dec-20	136.36	138.10	-1.74
PZ-22	Black Creek Aquifer	Dec-20	44.7	43.02	1.68
PZ-24	Perched Zone	Dec-20	134.15	130.49	3.66
PZ-26	Perched Zone	Dec-20	136.97	132.63	4.34
PZ-27	Perched Zone	Dec-20	133.16	130.07	3.09
PZ-28	Perched Zone	Dec-20	135.47	127.78	7.69
PZ-29	Perched Zone	Dec-20	133.18	133.94	-0.76
PZ-31	Perched Zone	Dec-20	130.16	130.14	0.02

Table A.03: Calibration Results: Observed vs Model Predicted Hydraulic Head Data

Chemours Fayetteville Works, North Carolina

Location Name	Aquifer	Observation Date	Observed Head (ft)	Calculated Head (ft)	Residual (Obs. - Calc.) (ft)
PZ-32	Perched Zone	Dec-20	132.92	138.25	-5.33
PZ-33	Perched Zone	Dec-20	132.67	126.76	5.91
PZ-34	Perched Zone	Dec-20	131.89	127.62	4.27
PZ-36	Perched Zone	Dec-20	132.64	130.52	2.12
PZ-37	Perched Zone	Dec-20	132.8	136.02	-3.22
PZ-38	Perched Zone	Dec-20	131.01	130.93	0.08
PZ-39	Perched Zone	Dec-20	134.26	135.43	-1.17
PZ-40	Perched Zone	Dec-20	134.5	137.68	-3.18
PZ-41	Perched Zone	Dec-20	134.86	132.79	2.07
PZ-42	Perched Zone	Dec-20	134.77	140.74	-5.97
PZ-43	Perched Zone	Dec-20	132.73	134.40	-1.67
PZ-44	Perched Zone	Dec-20	133.27	129.63	3.64
PZ-45	Perched Zone	Dec-20	133.19	135.67	-2.48
PZ-L	Perched Zone	Dec-20	117.82	115.81	2.01
SMW-01	Perched Zone	Dec-20	124.9	127.26	-2.36
SMW-02	Perched Zone	Dec-20	136.55	140.08	-3.53
SMW-02B	Perched Zone	Dec-20	89.2	89.69	-0.49
SMW-03B	Surficial Aquifer	Dec-20	93.84	100.72	-6.88
SMW-04B	Surficial Aquifer	Dec-20	103.26	100.42	2.84
SMW-05	Perched Zone	Dec-20	125.2	121.64	3.56
SMW-05P	Surficial Aquifer	Dec-20	105.5	106.23	-0.73
SMW-06	Perched Zone	Dec-20	125.92	126.41	-0.49
SMW-06B	Surficial Aquifer	Dec-20	103.22	102.07	1.15
SMW-07	Perched Zone	Dec-20	128.15	127.29	0.86
SMW-08	Perched Zone	Dec-20	116.82	119.40	-2.58
SMW-08B	Surficial Aquifer	Dec-20	108.26	106.71	1.55
SMW-09	Surficial Aquifer	Dec-20	85.91	71.65	14.26
SMW-10	Surficial Aquifer	Dec-20	47.37	53.70	-6.33
SMW-11	Surficial Aquifer	Dec-20	59.58	54.34	5.24
SMW-12	Black Creek Aquifer	Dec-20	36.01	38.88	-2.87

Notes:
ft - feet
Obs. - Observed
Calc. - Calculated

Table A05: Detialed Summary of Model Calibration

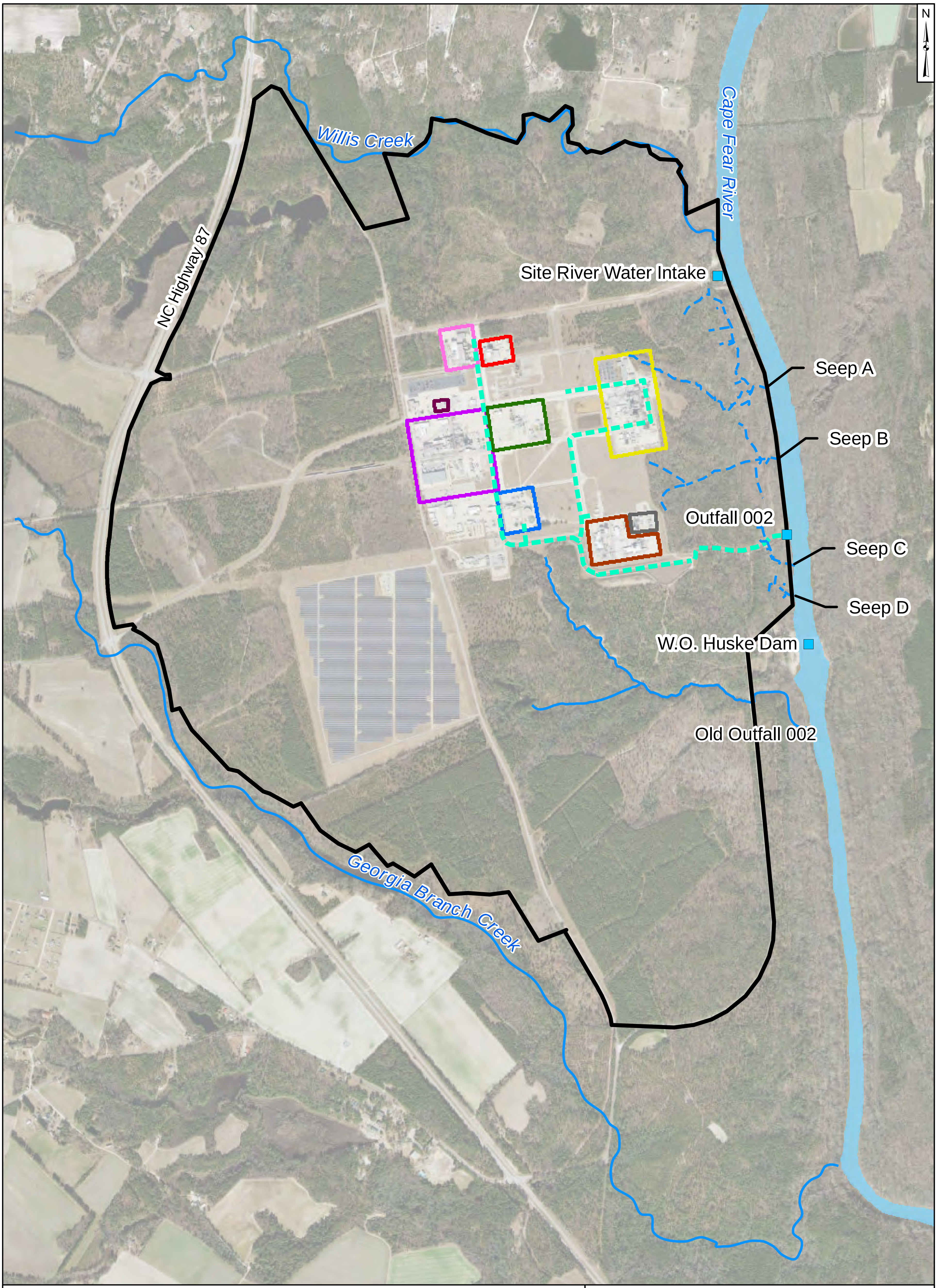
Sensitivity Variable	Change	Sensitivity	NRMS Error (%)	% Change in Discharge from the Site to Cape Fear River
Calibrated Model	N/A	N/A	12.2	--
Rainfall Recharge - increase	+ 20%	Low	12.4	+1.3%
Rainfall Recharge - decrease	- 20%	Low	13.7	-1.3%
Perched Zone K - increase	+ 50%	Low	11.3	+0.1%
Perched Zone K - decrease	- 50%	Low	13.2	-2.1%
Surficial K - increase	+ 20%	Low	12.3	+0.2%
Surficial K - decrease	- 20%	Low	12.8	-1.7%
Black Creek K - increase	+ 20%	Low	12.6	+0.1%
Black Creek K - decrease	- 20%	Low	12.9	-1.1%
Perched Clay K - increase	Across one orders of magnitude	High	30.2% at reference hydraulic conductivity. Sensitivity limited to Perched Zone.	-20.3%
Perched Clay K - increase	Across two orders of magnitude	High	36.4% at reference hydraulic conductivity. Sensitivity limited to Perched Zone.	-23.7%
Western Boundary Condition - increased	Change in spatial distribution of hydraulic heads and absolute values of hydraulic heads	Moderate	14.2% at reference hydraulic conductivity. Sensitivity limited to Surficial and Black Creek Aquifer.	13.1%
Western Boundary Condition - decrease	Change in spatial distribution of hydraulic heads and absolute values of hydraulic heads	Moderate	14.4% at reference hydraulic conductivity. Sensitivity limited to Surficial and Black Creek Aquifer.	-24.4%
Willis Creek Boundary Condition	Change the nodes no flow nodes to flux nodes	Low	12.3% No significant difference for the rate of discharge from the aquifers to Willis creek.	0.1%

Table A.07: Detailed Summary of Remedial Design Sensitivity Analysis

Sensitivity Analysis	Change	Sensitivity	Result	Percent Change from Optimal Scenario
Optimal Scenario (Barrier and hydraulic control) - 30 inch barrier thickness and 1.0 x10^{-6} cm/s barrier permeability - 69 Extractions wells	N/A	N/A	N/A	--
Barrier thickness - increase	1.0 m	Moderate	An increase in barrier wall thickness from 30 inches to 1.0 m (39.4") likely requires a minimum of 5% increase in pumping rate as greater volumes of water will be retained by the wall.	+4.6%
Barrier thickness - decrease	0.5 m	Moderate	A decrease in barrier wall thickness from 30 inches to 0.5 m (19.7") likely requires a pumping rate increase of 20% or more as some of the burden of capture will shift from the wall to extraction wells.	-18.4%
Barrier hydraulic conductivity - increase	1.0 x 10^{-7} cm/s	High	A reduction in hydraulic conductivity of the wall to 1.0 x 10^{-7} has minimal effect on the overall performance of the optimized remedy	+1.2%
Barrier hydraulic conductivity - decrease	1.0 x 10^{-5} cm/s	High	An increase in hydraulic conductivity of the wall to 1.0 x 10-5 has significant effect on the performance of the optimized remedy.	-58.1%
Barrier Location - On the Bluff	On the Bluff	Moderate	Relocating the remedy closer to the plant on the top of the bluff reduces performance of the remedy by over 30%.	-30.9%

Sensitivity Analysis	Change	Sensitivity	Result	Percent Change from Optimal Scenario
Barrier Location - In the Flood Plain	In the Flood Plain	Low	Moving the remedy into the flood plain closer to the Cape Fear River only modestly increases discharge reduction. Wetland impact would be far more significant.	+1.9%
Hydraulic Control Extraction Well Locations only	On the Bluff	High	The extraction well locations had a strong correlation in the effectiveness of maintaining hydraulic control over the total discharge to the Cape Fear River and the hydraulic gradient of the Site. Pumping along the bluff does not adequately capture groundwater. In order to match performance of the optimal scenario with wells located in the flood plain, higher pumping rates are required. A portion of the groundwater flow comes in to the treatment system from the Cape Fear River.	-80.1%
Hydraulic Control Extraction Well Locations only	In the Flood Plain	High		-30.8%
Hydraulic Control Extraction Well Locations	Up to 1,000 ft from Willis Creek	Low	The model is relatively insensitive to the distance of the line of extraction wells from Willis Creek. Moving the line of extraction wells closer to the plant does not materially improve performance.	+0.9%
Hydraulic Control Extraction Well Locations	Up to 500 ft from Willis creek	Low		+1.9%

Figures



Legend

- ■ Site Features
- ━ Site Boundary
- ─ Nearby Tributary
- ╌ Observed Seep (Natural Drainage)
- ╍ Site Drainage Network

Areas at Site

- 🟨 Chemours Monomers IXM
- 🟥 Chemours Polymer Processing Aid Area
- 🟫 DuPont Polyvinyl Fluoride Leased Area
- ⬜ Former DuPont PMDF Area
- ▢ Kuraray SentryGlas® Leased Area
- 🟪 Kuraray Trosifol® Leased Area
- 🟦 Wastewater Treatment Plant
- 🟩 Power - Filtered and Demineralized Water Production
- ▢ Kuraray Laboratory

Notes:
1. The outline of the Cape Fear River shown on this figure is approximate (River outline based on compilation of open data sources from ArcGIS online service and North Carolina Department of Environmental Quality Online GIS - Major Hydro shapefile).
2. Basemap sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

2,000 1,000 0 2,000 Feet

Site Location Map

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

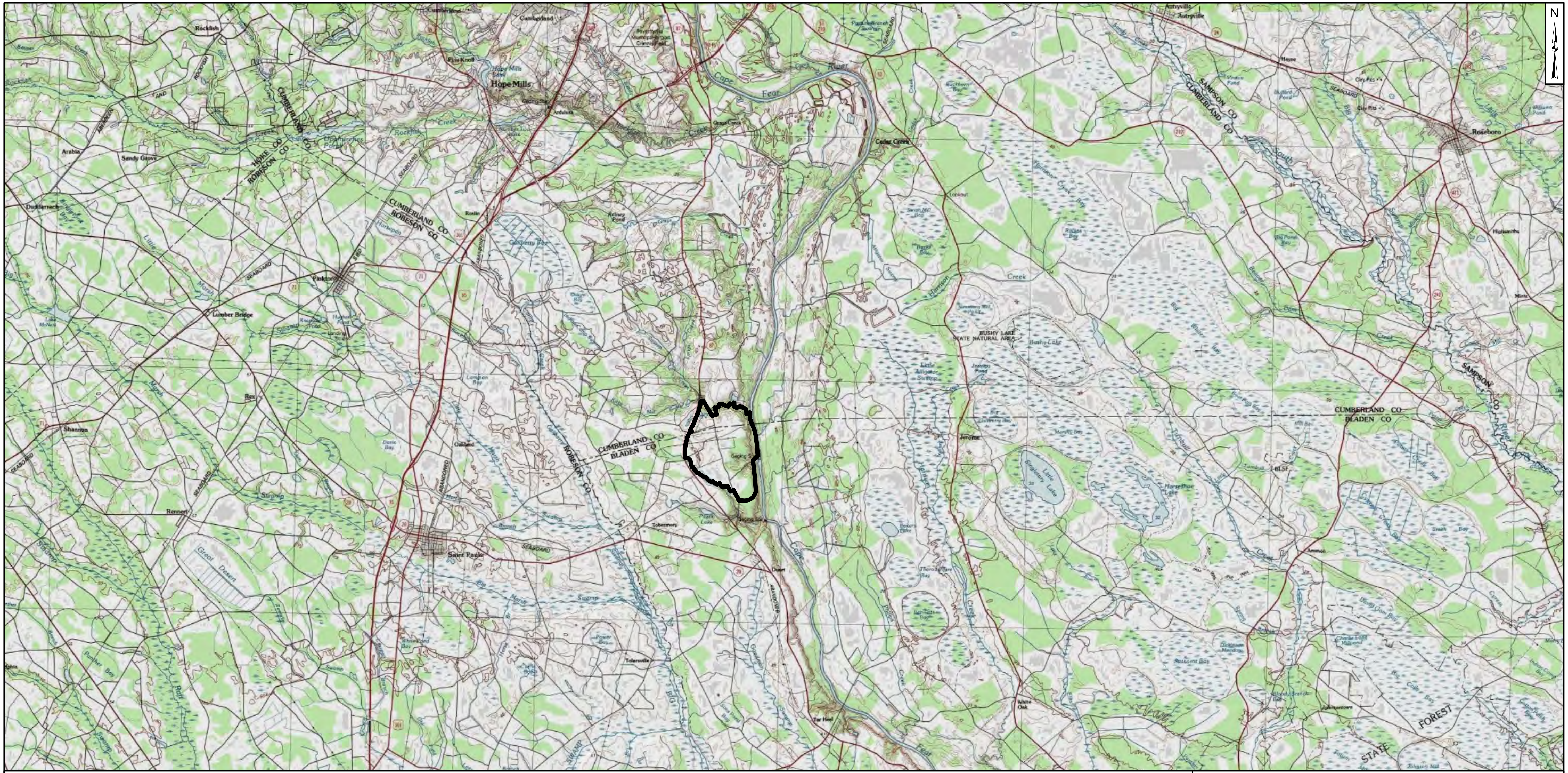
Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

Figure

A.01

Raleigh

February 2022



Legend

▬ Site Boundary

Notes:
1. For topographic map symbols, please refer to this document: https://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf
2. Basemap source: © 2013 National Geographic Society, i-cubed

2 1 0 2 Miles

Regional Topographic Map

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

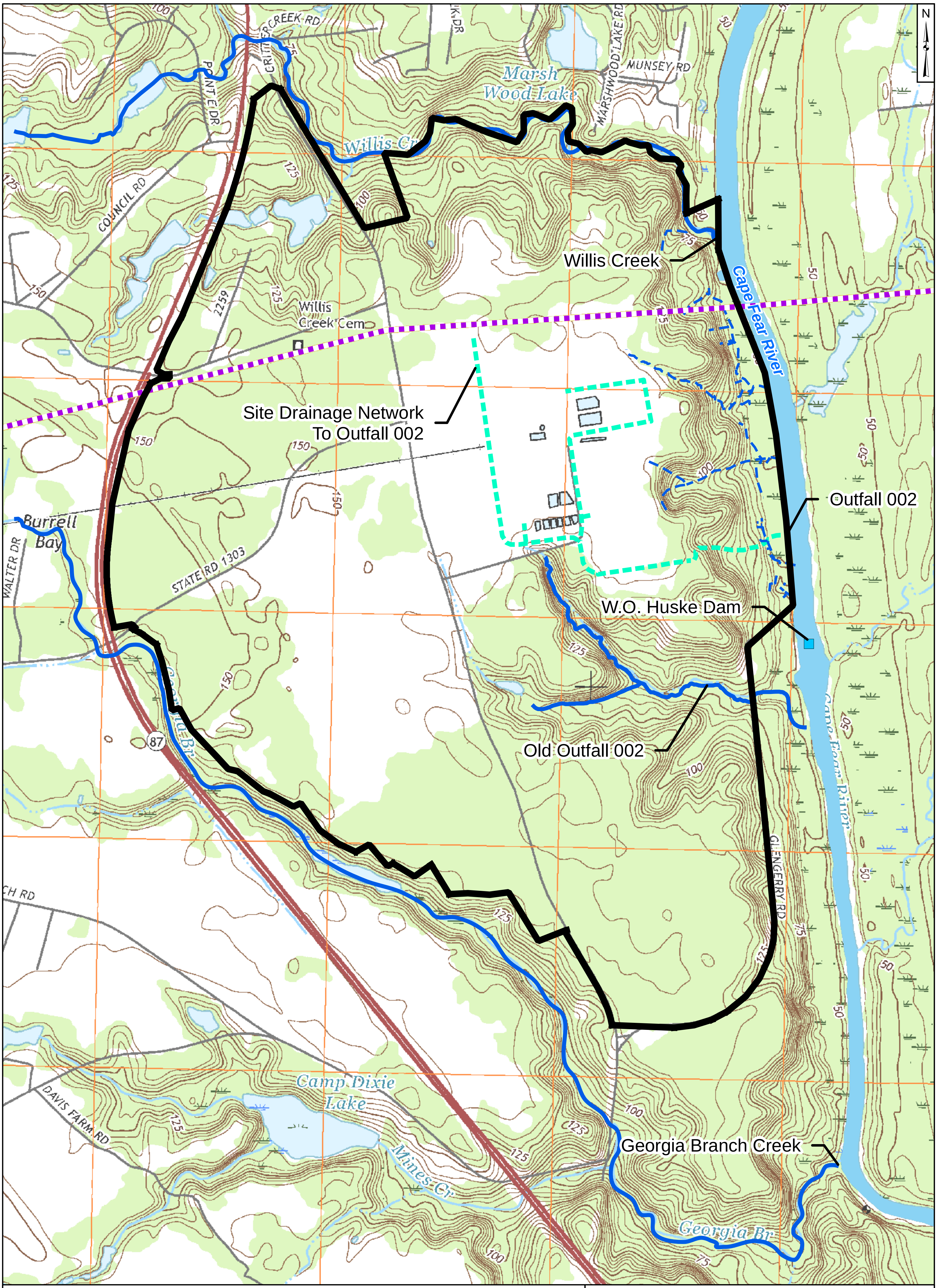
Raleigh

February 2022

Figure

A.02

Projection: NAD 1983 StatePlane North Carolina FIPS 3200 Feet; Units in Foot US



Legend

🟦 Site Features

Site Boundary

County Boundary

Observed Seep (Natural Drainage)

Nearby Tributary

Site Drainage Network

Notes:
Basemap sources: Esri, Garmin, USGS, NPS (World Terrain Reference); Esri, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community (World Hillshade)

2,000 1,000 0 2,000 Feet

Site Topographic Map

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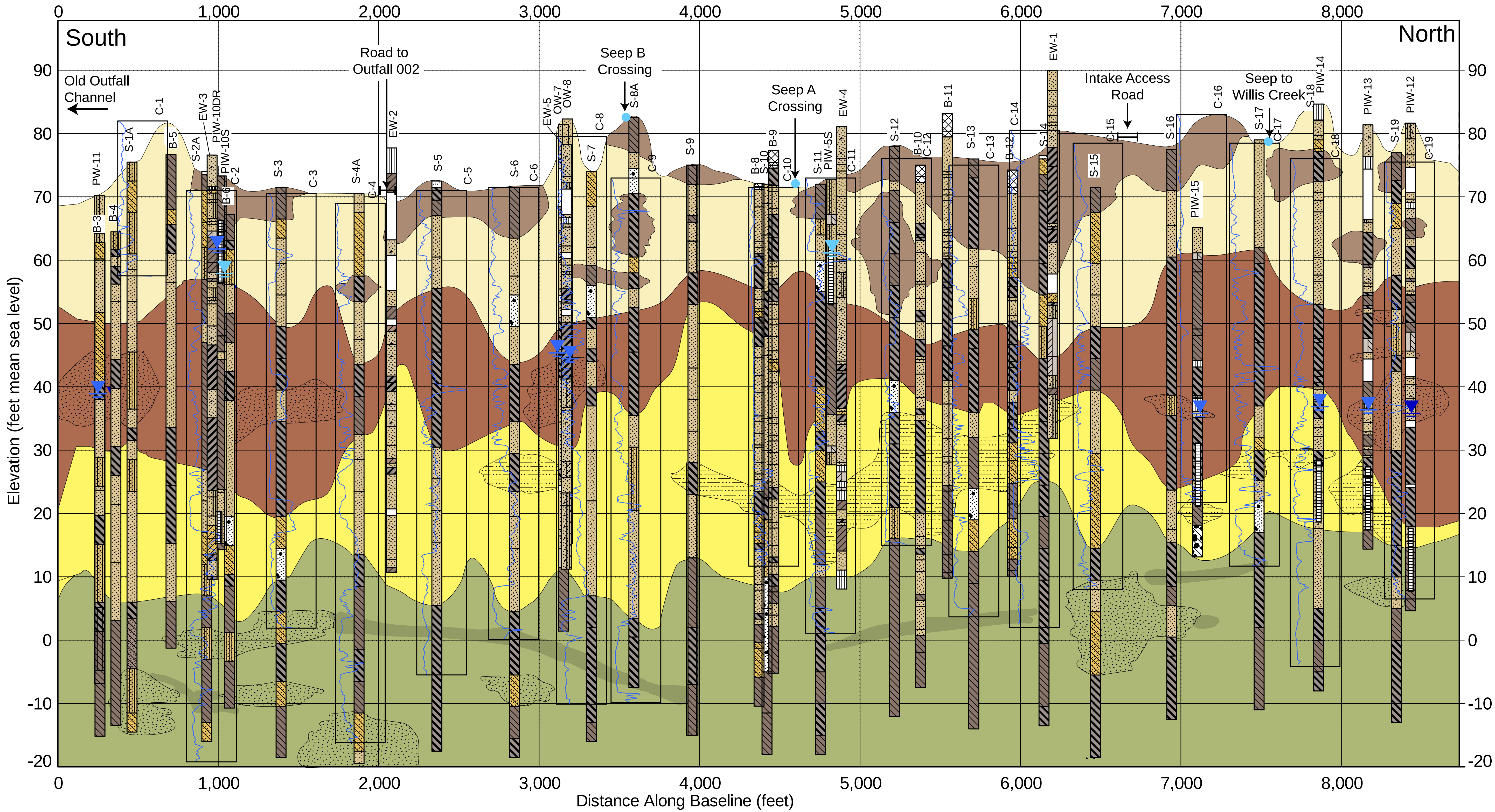
Figure

A.03



Legend

- ▨ USCS Well-graded Sand
- ▨ USCS High Plasticity Clay
- ▨ USCS Well-graded Sand with Silt
- ▨ USCS Elastic Silt
- ▨ USCS Low to High Plasticity Clay
- ▨ USCS Low Plasticity Silty Clay
- ▨ USCS Poorly-graded Sand
- ▨ USCS Well-graded Sand with Clay
- ▨ USCS Clayey Sand
- ▨ USCS Clayey Gravel
- ☐ No Core
- ▨ USCS Low Plasticity Clay
- ▨ USCS Poorly-graded Sand with Silt
- ▨ USCS Silt
- ▨ USCS Silty Sand

Interpreted Geology

- ▨ Perched Clay
- ▨ Surficial Aquifer
- ▨ Black Creek Confining Unit
- ▨ Black Creek Confining Unit – Zone of Interspersed Coarser Sediments
- ▨ Black Creek Aquifer
- ▨ Black Creek Aquifer – Zone of Interspersed Finer Sediments
- ▨ Upper Cape Fear Confining Unit
- ▨ Upper Cape Fear Confining Unit – Zone of Interspersed Coarser Sediments

Water Levels

- ▼ Surficial Aquifer
- ▼ Black Creek Aquifer
- ▼ Upper Cape Fear

Notes:

CPT - piezocone penetration test
SPT- standard penetration test

Cross-section developed using data from investigative locations identified in Figure 10A.

Further details on SPT logs, CPT logs, and rotary sonic borings logs provided in Appendix D (GEOServices Report of Geotechnical Exploration). CPT logs show downhole cone resistance profile.

"S-" denotes SPT borings advanced in October-November 2020. "C-" denotes CPT borings advanced in October-November 2020. "B-" denotes SPT borings or rotary sonic soil borings advanced in March 2021.

621 310 0 621 Feet

Horizontal 1" = 621' Vertical exaggeration is 39.5x

High Resolution Cross Section with Interpreted Geology

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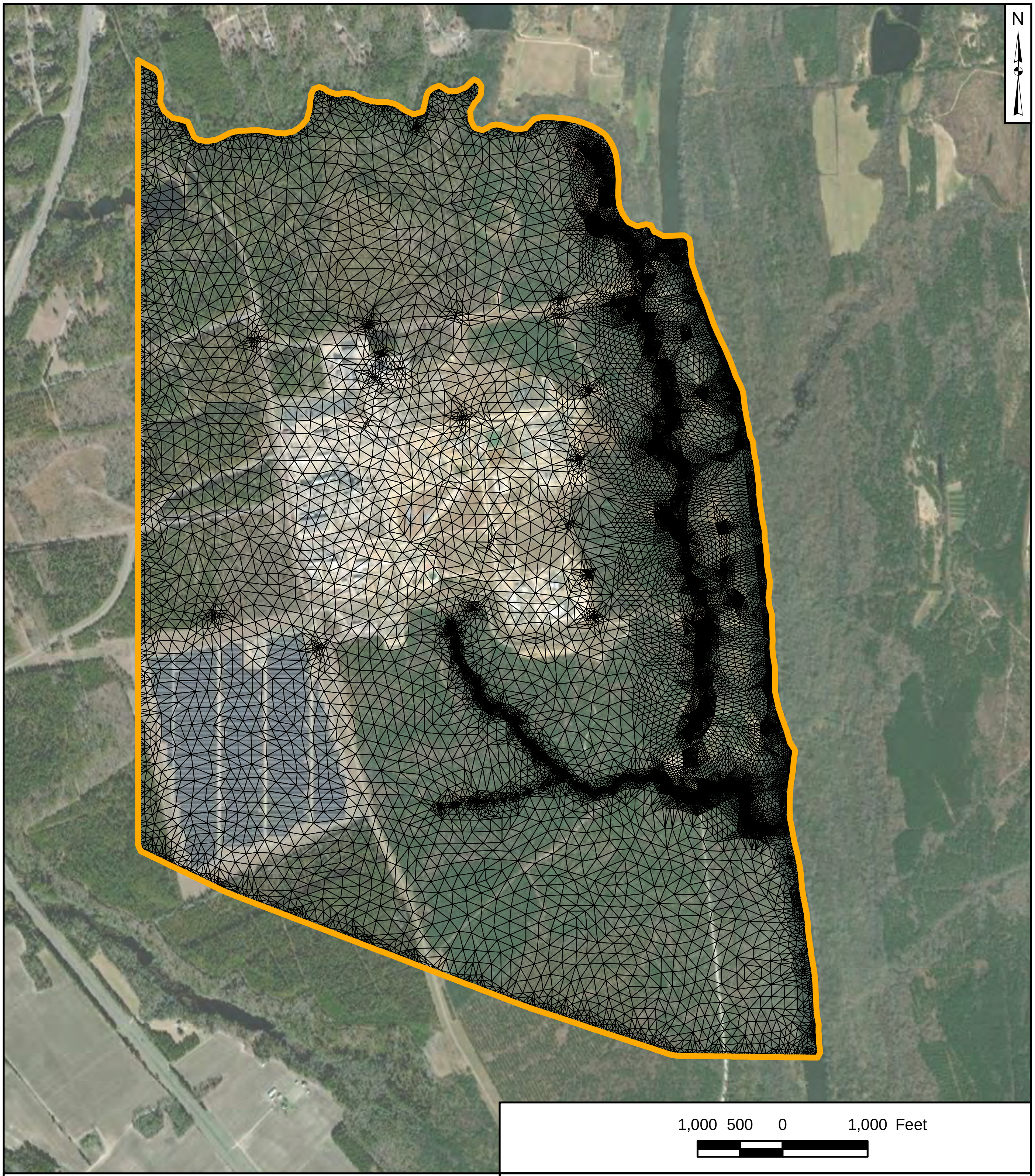
Figure
A04



Legend

▭ Model Boundary

▭ Model Grid

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Model Domain and Grid

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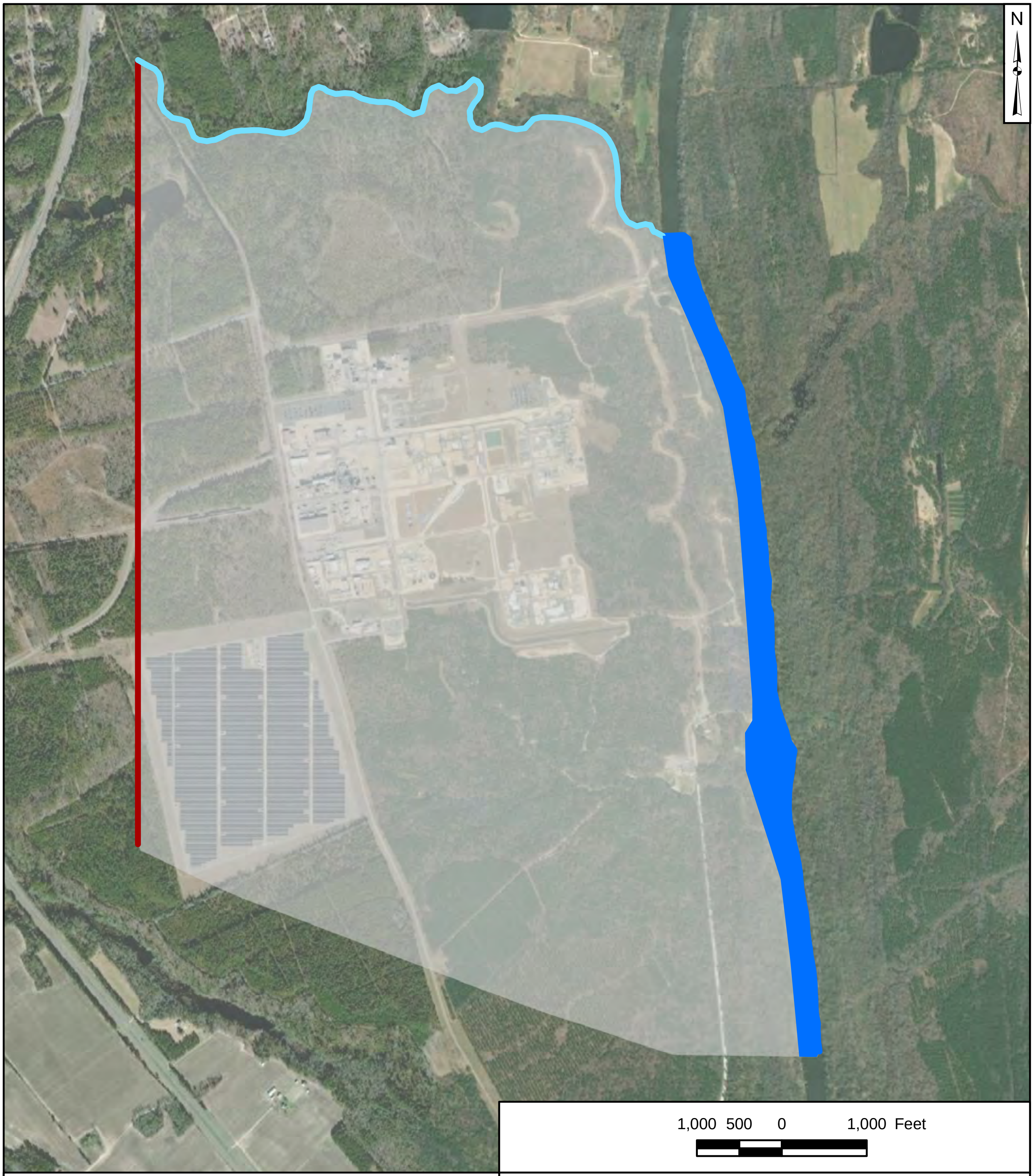
Figure

A.05



Legend

- Constant Head Boundary
- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- ▨ Recharge Area

Notes

1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Model Boundary Conditions

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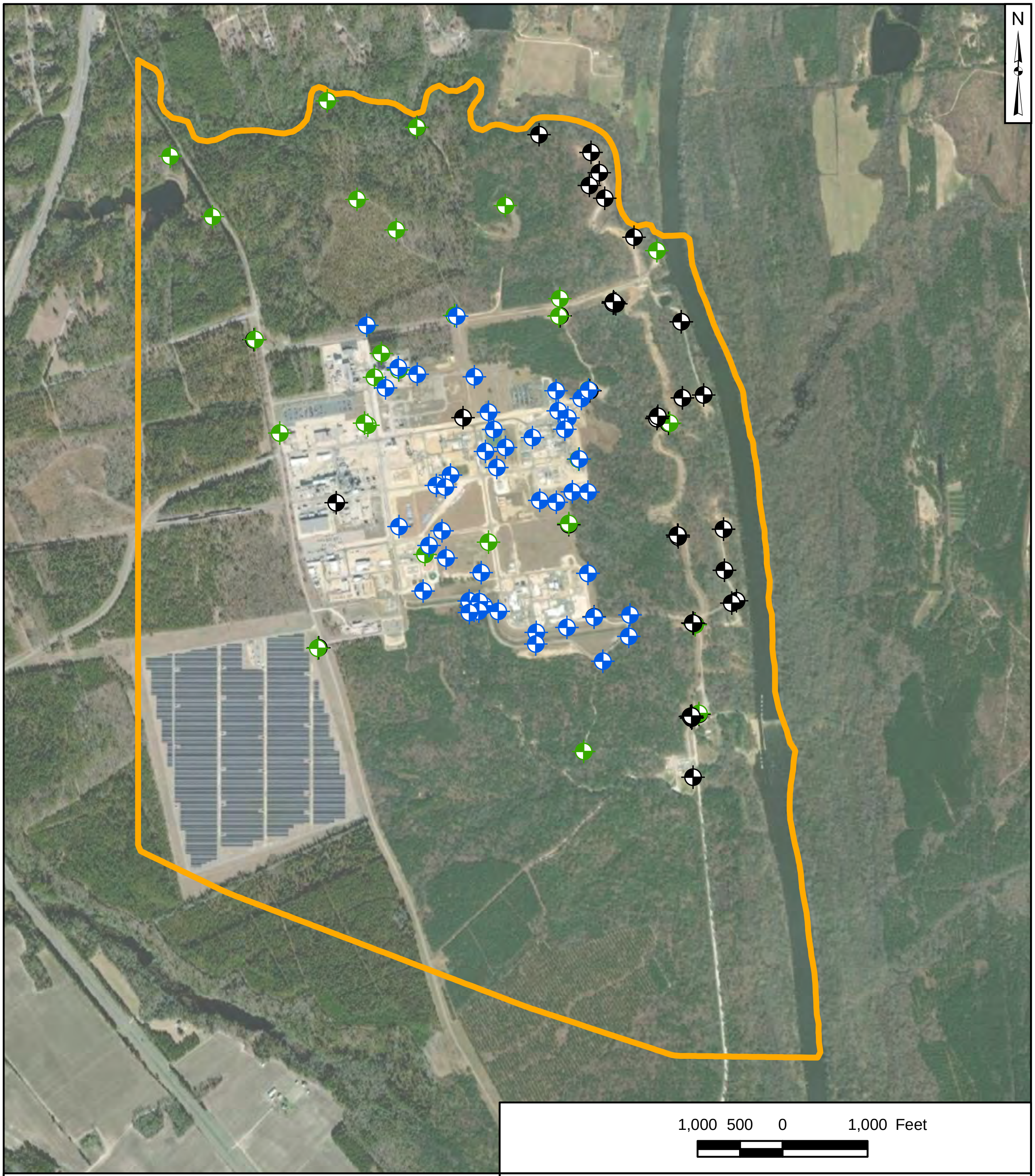
Figure

A.06



Legend

⌖ Perched Zone

⌖ Surficial Aquifer

⌖ Black Creek Aquifer

▭ Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Model Calibration Targets

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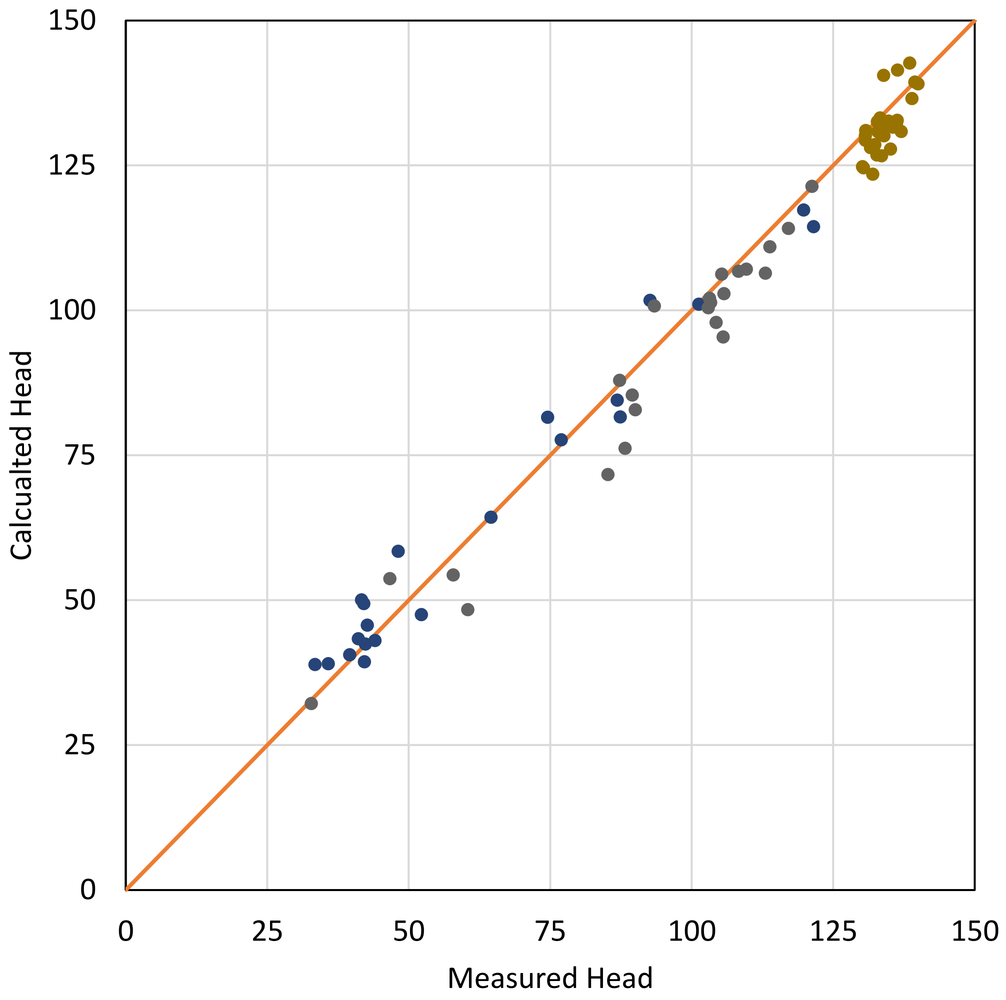
Figure

A.07



Calibration Results	
Correlation Coefficient	0.98
Flow Mass Balance	-0.78%
Normalized RMS	23.9% (Perched zone) 7.1% (Surficial Aquifer) 5.8% (Black Creek)
Maximum Residual	6.57 ft(Perched zone) 7.32 ft (Surficial Aquifer) 10.27 ft (Black Creek)
Minimum Residual	-8.52 ft(Perched zone) -13.54 ft (Surficial Aquifer) -0.007ft (Black Creek)
Residual Mean	-0.66 (ft)
Absolute Residual Mean	2.94 (ft)
Root Mean Square	4.34 ft(Perched zone) 6.24 ft (Surficial Aquifer) 5.08 ft (Black Creek)

Legend

● Black Creek Aquifer ● Surficial Aquifer ● Perched Zone

Flow Model Calibration Results

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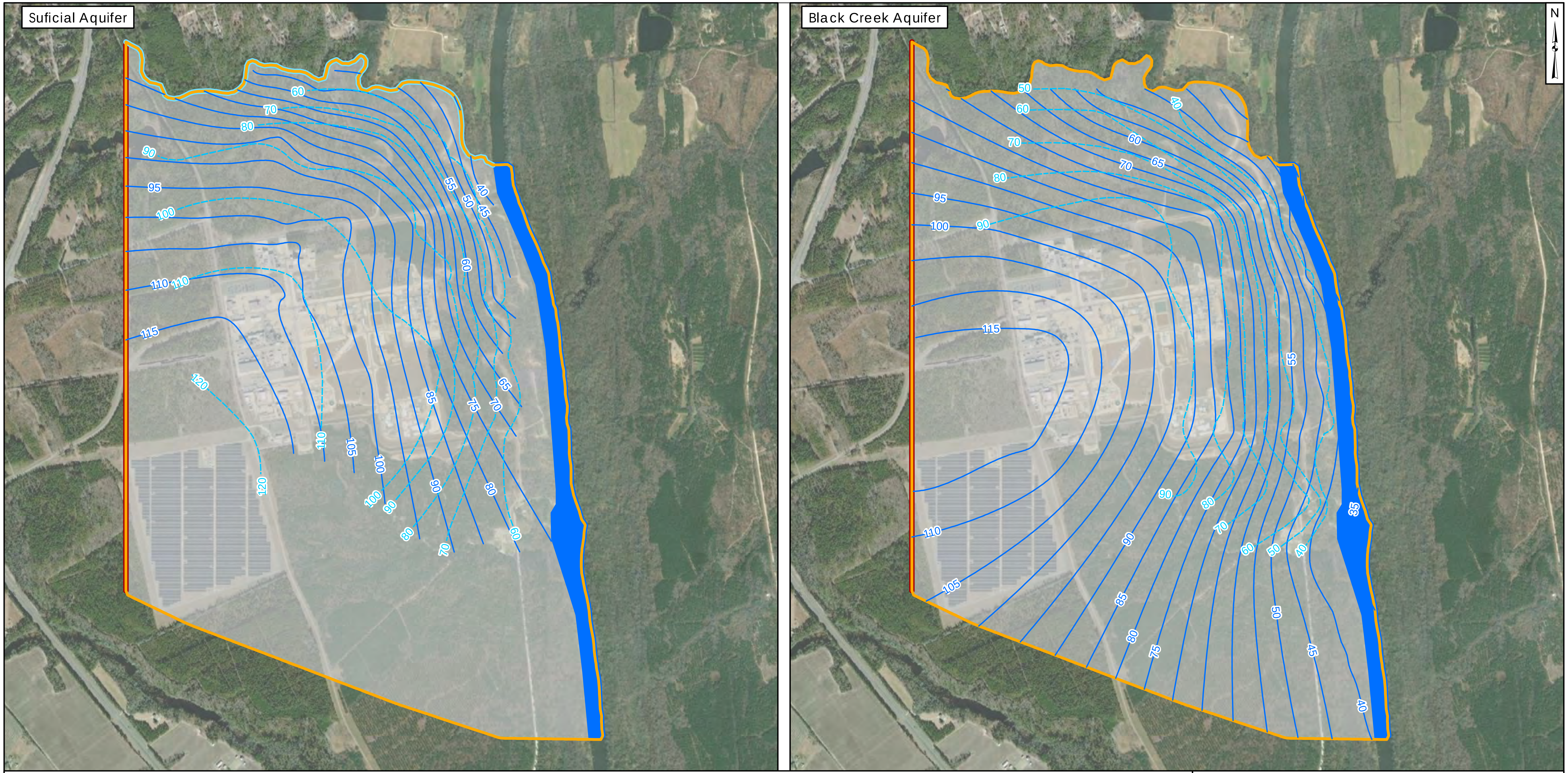
Figure

A.08



Legend

- Simulated Equipotentials (feet NAVD 88)
- Measured Equipotentials- July 2020 (feet NAVD88)
- Constant Head Boundary
- Constant Head River Boundary (Willis Creek)
- Transient Head River Boundary (Cape Fear)
- Recharge Area
- Model Boundary

2,000 1,000 0 2,000 Feet

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Flow Model Simulated Equipotentials - Base Model

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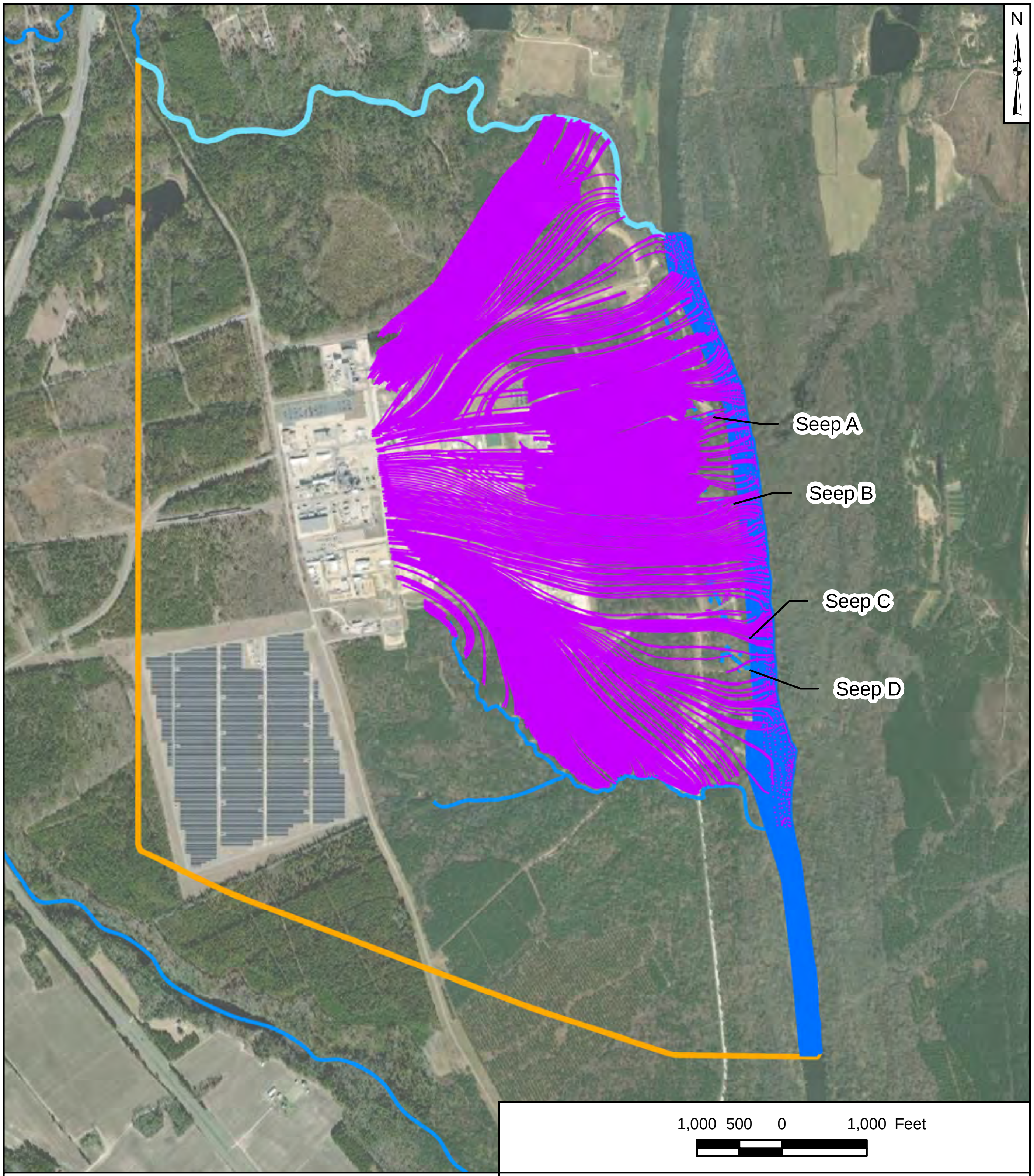
Figure
A.09



Legend

- 5 year Particle Tracks - No Remedy
- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 1 - Particle Tracking from Plant Area Ambient Conditions

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A.10

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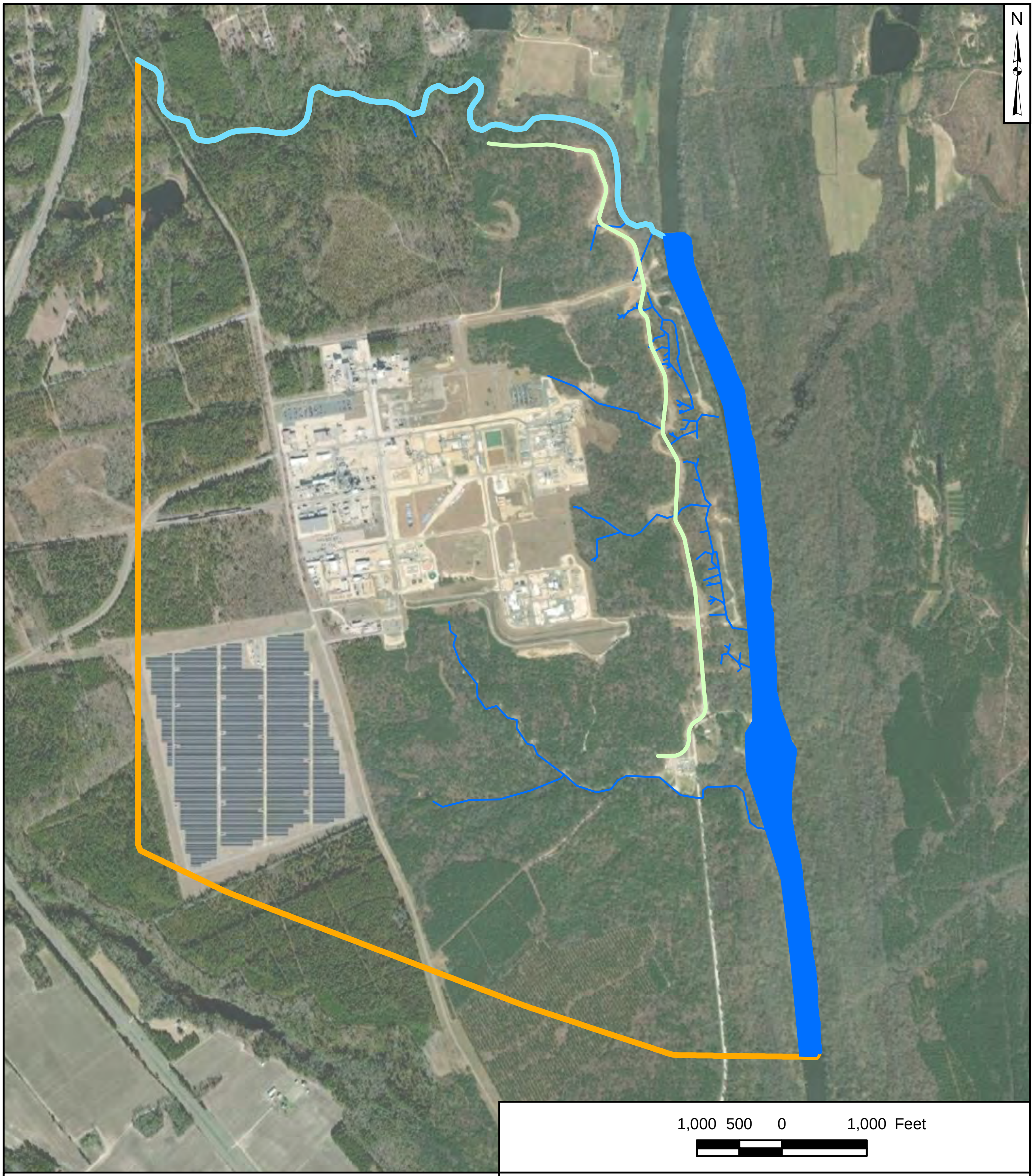

Legend

— Barrier Wall

— River Boundary (Willis Creek)

— River Boundary (Cape Fear)

▭ Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 2 – Vertical Barrier Remedial Design

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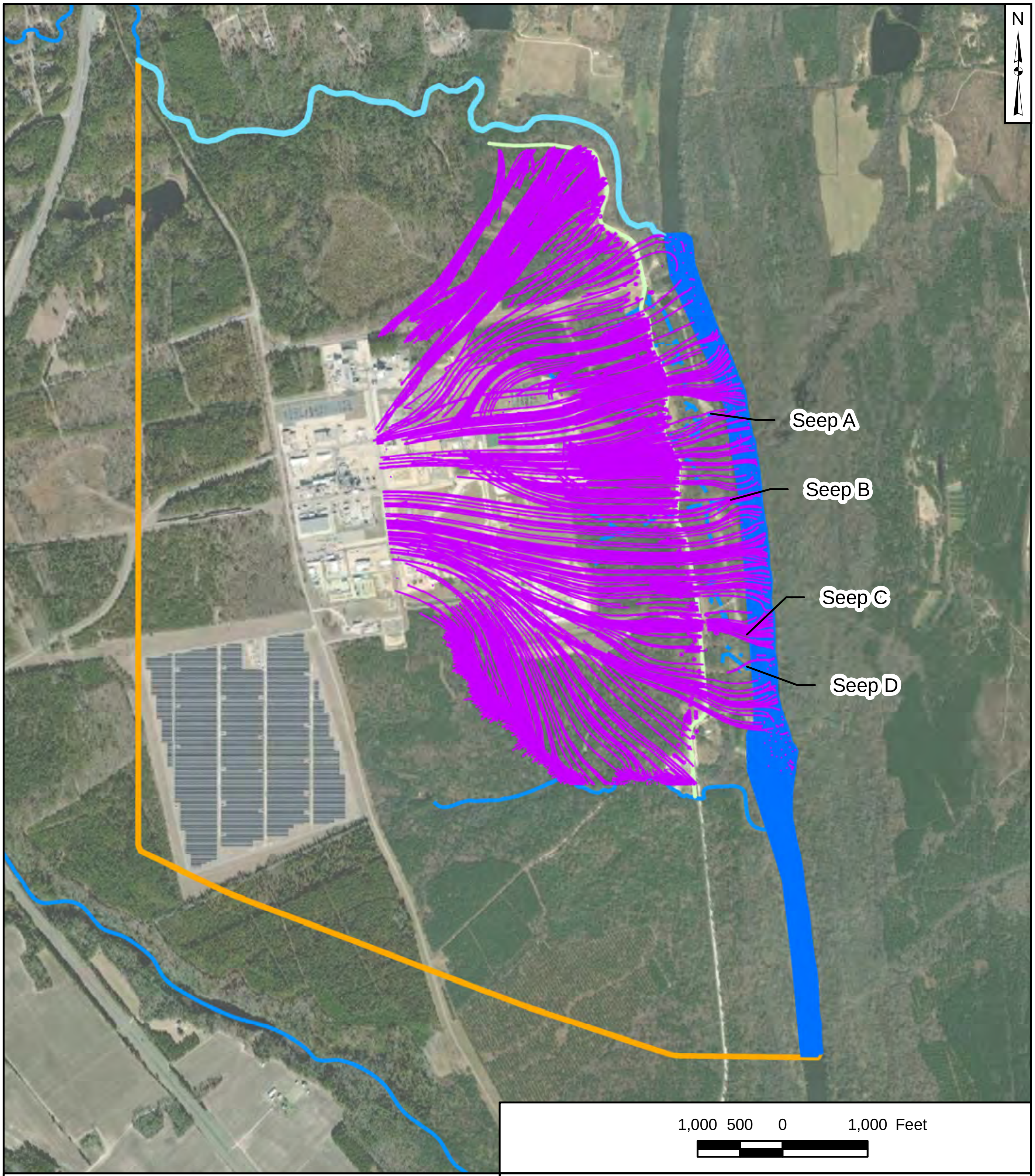
Figure

A.11



Legend

- 5 year Particle Tracks
- Barrier Wall
- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- Model Boundary

Notes

1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 2 - Particle Tracking from Plant Area - Vertical Barrier

Chemours Fayetteville Works, North Carolina

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Geosyntec Consultants of NC, P.C.
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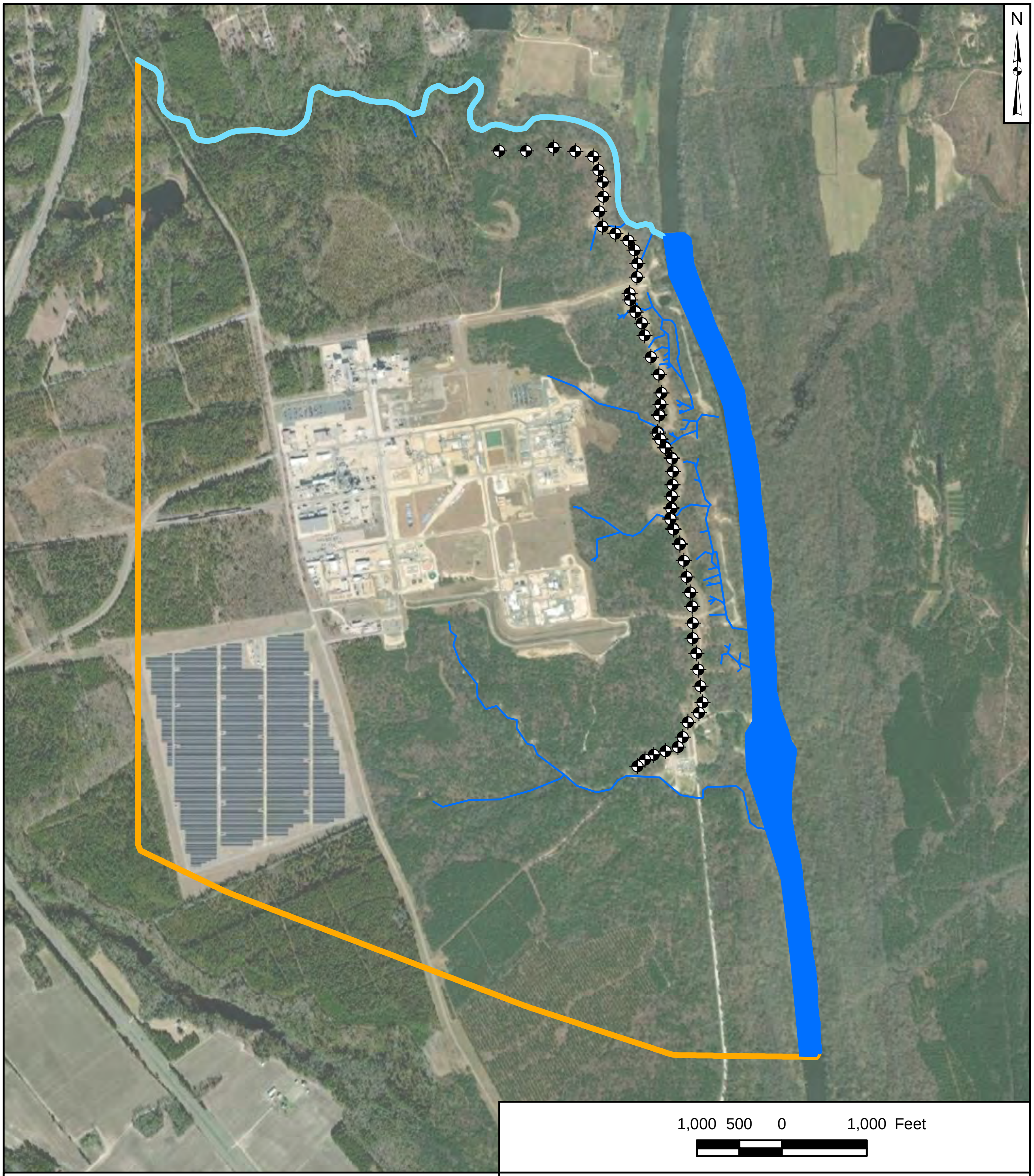
Raleigh	March 2022

Figure

A.12



Legend

⌖ Extraction Well Location

River Boundary (Willis Creek)

River Boundary (Cape Fear)

▭ Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 3 – Hydraulic Barrier Remedial Design

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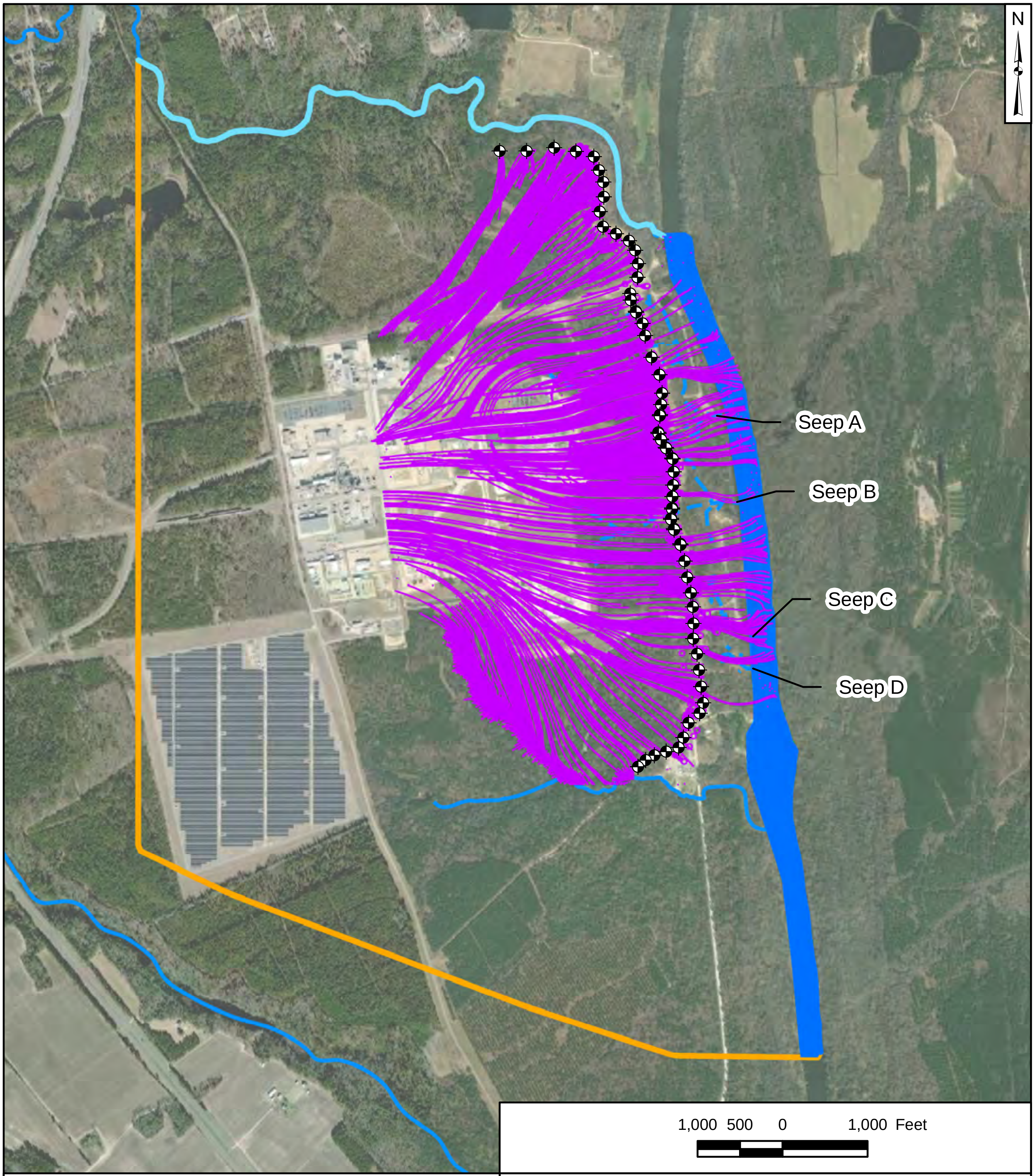
Figure

A.13



Legend

- River Boundary (Willis Creek)
- River Boundary (Cape Fear)
- Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 3 - Particle Tracking from Plant Area – Hydraulic Barrier

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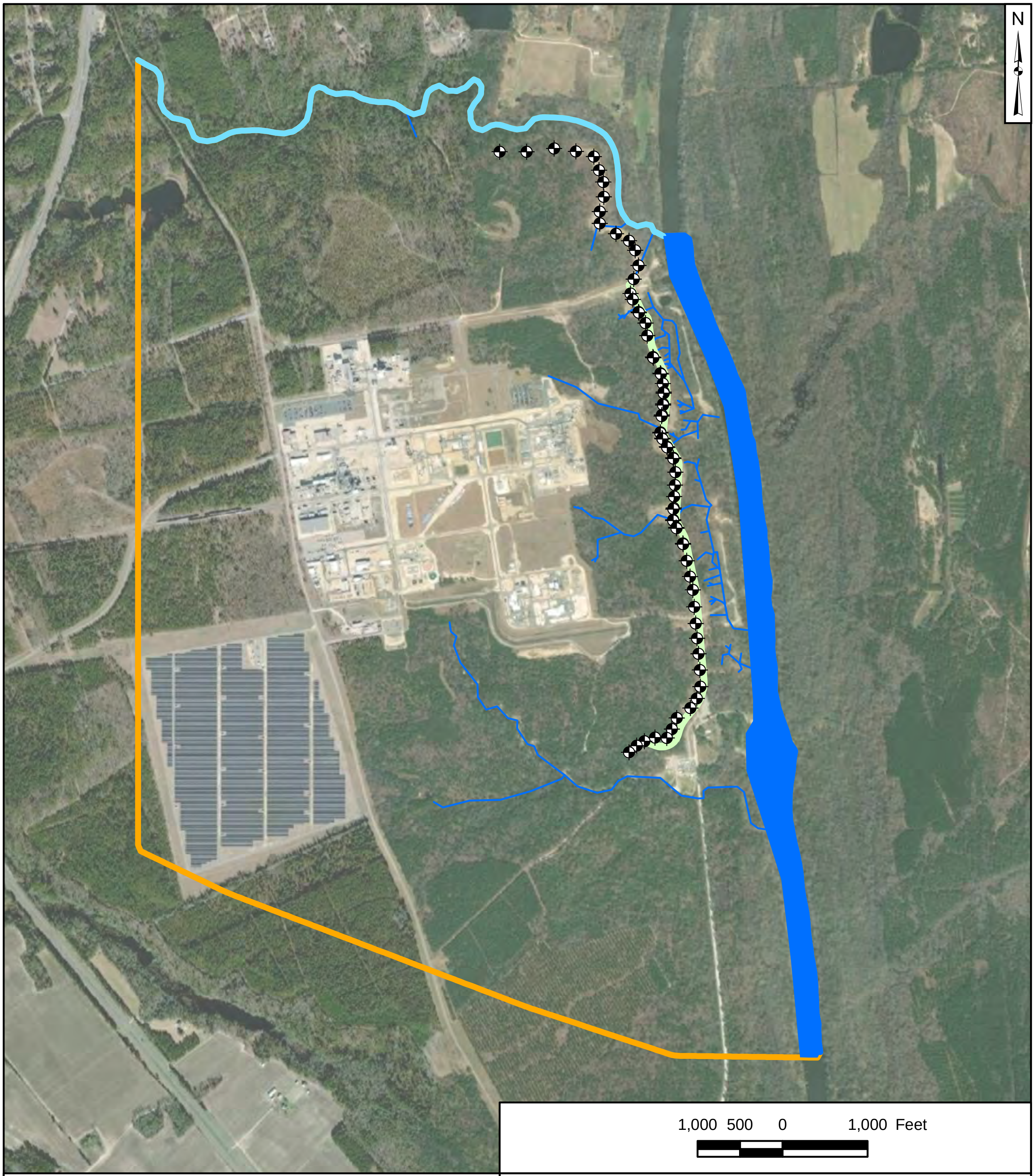
Figure

A.14



Legend

- ⊕ Extraction Well Location
- ▬ Barrier Wall
- ▬ River Boundary (Willis Creek)
- ▬ River Boundary (Cape Fear)
- ▭ Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 4 – Vertical and Hydraulic Remedial Design

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Geosyntec consultants

Geosyntec Consultants of NC, P.C.
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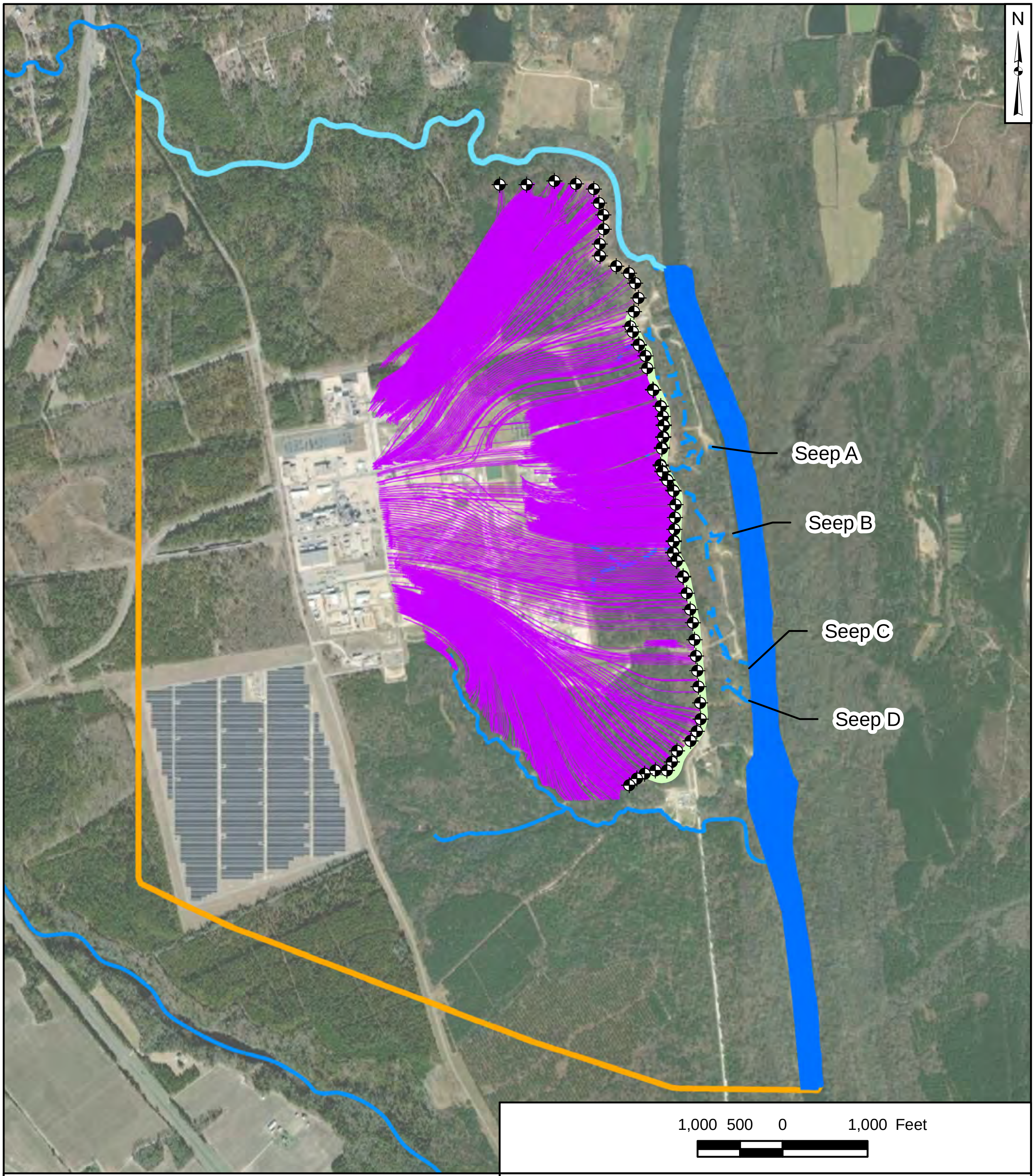
Figure

A.15



Legend

⌖ Extraction Well Location

🟩 Barrier Wall

― 5 year Particle Tracks

― River Boundary (Willis Creek)

― River Boundary (Cape Fear)

☐ Model Boundary

Notes
1. Basemap source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scenario 4 - Particle Tracking from Plant Area – Vertical and Hydraulic Barrier

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A.16

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Geosyntec consultants

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GEOS
GEOServices, LLC, Geotechnical and Materials Engineers

Appendix B
Barrier Wall Design Report

GEOS
GEOServices, LLC, Geotechnical and Materials Engineers

BARRIER WALL 90% DESIGN SUBMITTAL

Chemours Fayetteville Works

Prepared for

The Chemours Company FC, LLC
22828 NC Highway 87
Fayetteville, NC 28306

Prepared by

GEOServices, LLC
6607 Mountain View Road
Suite 139
Ooltewah, TN 37363

March 2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

Barrier Wall System 90% Plans

Seepage Models and Results

Redi Rock Wall Design Calculations

Soil Nail Wall Design Calculations

Slope Stability Models and Results

LIST OF ABBREVIATIONS

CAP	Corrective Action Plan
CFRW	Cape Fear River Watch
cm/s	centimeters per second
COA	Consent Order Addendum
SCPTU	seismic piezocone penetration tests
FOS	Factor of Safety
ft	feet
MSEW	Mechanically Stabilized Earth Wall
MSL	Mean Sea Level
NCDEQ	North Carolina Department of Environmental Quality
PDI	Pre-Design Investigation
PFAS	per- and polyfluoroalkyl substances
QA/QC	quality assurance/quality control

1 INTRODUCTION AND OBJECTIVES

GEOServices, LLC (GEOS) has prepared for The Chemours Company, FC, LLC (Chemours) this 90% Engineering Design Report for the Barrier Wall System planned to be installed at the Chemours Fayetteville Works facility in Bladen County, North Carolina. This report has been prepared pursuant to the Consent Order Paragraph 12 Addendum (COA) Paragraph 3 (North Carolina Department of Environmental Quality [NCDEQ], 2019) which requires a which requires a 90% design report for the Barrier Wall and Groundwater Extraction and Treatment System be submitted by March 31, 2022 to NCDEQ for approval. This report describes the basis of design for the Barrier Wall and presents a 90% level of design for the Barrier Wall System and its constituent components.

The Consent Order Paragraph 12 Addendum (COA) outlines that Chemours shall proceed with the design and the installation of a barrier wall and groundwater extraction and treatment system to reduce per- and polyfluoroalkyl substances (PFAS) loading from groundwater flow from under the Facility to the Cape Fear River and Willis Creek. Similarly, the COA also outlines the objectives for a long-term seep remedy. The primary objective of the long-term seep remedy is to reduce the total annual mass loading of PFAS (as measured by the indicator parameters HFPO-DA, PMPA and PFMOAA) to the Cape Fear River from Seeps A through D.

The remedy requirements outlined in the COA results in a remedy design with three components:

- The groundwater interception remedy
- Ex-situ capture remedy
- The groundwater treatment plant

The groundwater interception remedy contains three key elements: (i) an underground barrier wall to create a vertical low permeability barrier to reduce the transmission of groundwater, (ii) a groundwater extraction system consisting of extraction wells in the Surficial and Black Creek aquifers, and (iii) a groundwater conveyance system to convey that groundwater to the treatment system.

The design of the barrier wall is consistent with goals and remedies described in the Corrective Action Plan (CAP) (Geosyntec, 2019a). The COA requires Chemours to proceed with the design and installation of a barrier wall and groundwater extraction and treatment system to reduce PFAS loading from groundwater flow from under the Facility to the Cape Fear River and Willis Creek. The details and discussion of the groundwater extraction and conveyance design are presented in Appendix B of the 90% design document.

2 BARRIER WALL LOCATION AND ALIGNMENT

The design presented in this report has been developed based on the current understanding of Site conditions and is expected to generally remain consistent between this design stage and construction. Details of specific elements may be adjusted as the design of the other related components such as the barrier wall, the seeps and the GWTP are advanced towards remedy construction. The designs are also subject to change based on permitting input provided by the appropriate regulatory agencies or conditions encountered during installation. Barrier Wall Location and alignment

The barrier wall will extend from the intake structure access road north of the Fayetteville Works to the location of Old Outfall 002 on the south side of the property. Locations of these described features are shown on the site map in Figure 1. The wall will be west of the Cape Fear River and approximately parallel to the river course. The alignment of the proposed barrier wall is determined based on topographic constraints and iterative design with the groundwater model (Appendix B) that considers the physical barrier and extraction system in combination. A preliminary alignment roughly following the EL 72ft contour between the plant and the Cape Fear River was cleared for geotechnical investigation due to ease of access as the area is a natural bench. This elevation was also chosen as it is located above the 100-year flood elevation.

After preliminary investigation (discussed in subsequent sections) and consultation with the selected barrier wall installation contractor, the alignment has been revised to the current alignment (see attached plans). The alignment has been analyzed in the groundwater model to optimize the number of extraction wells.

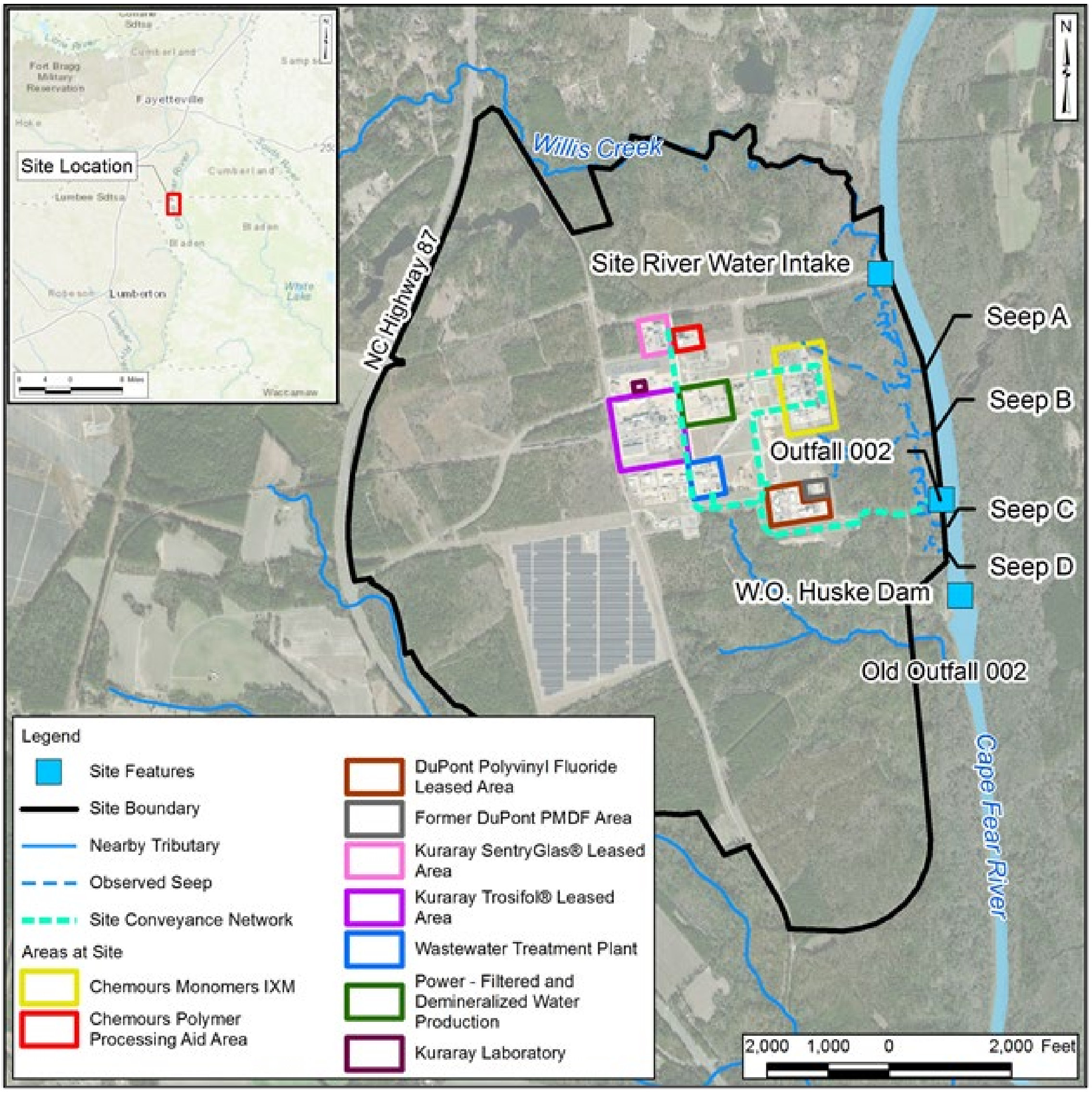


Figure 1: Site Location Features Used For Location Description

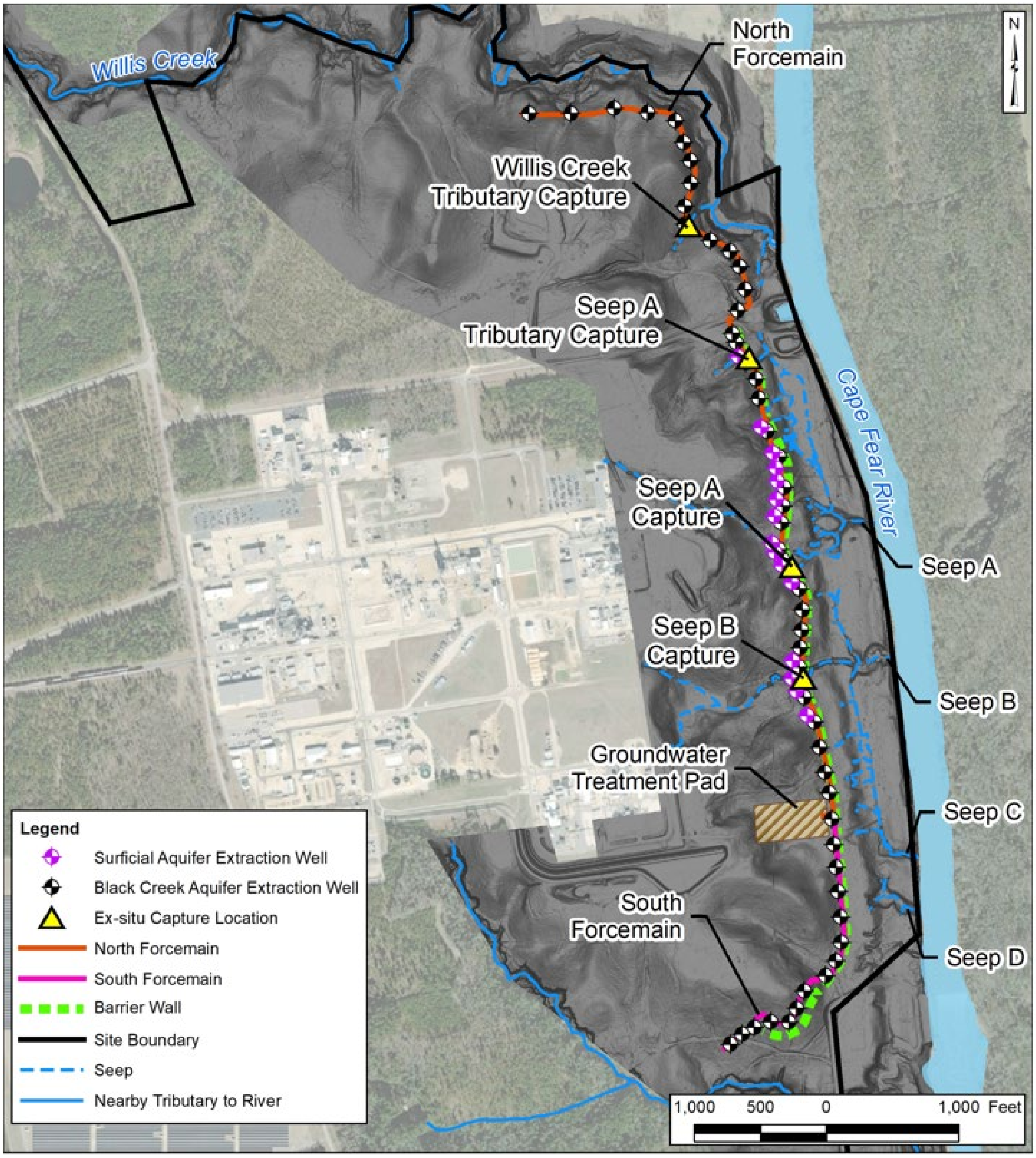


Figure 2: Remedy Layout Overview Including Barrier Wall Alignment

3 GEOTECHNICAL INFORMATION

The geotechnical basis of the barrier wall system was developed using information collected at the site and observations during interim seep capture construction. Geotechnical information has been collected and analyzed to characterize the expected soil conditions in the location of the proposed groundwater interception system.

3.1 Exploratory Borings and Soundings

The subsurface conditions along the proposed barrier wall alignment were explored with a series of integrated electronic seismic piezocone penetration tests (SCPTU), traditional mud rotary borings (standard penetration test [SPT] borings), and rotary sonic soil borings. The mud rotary borings and cone soundings were alternated and spaced at increments of 250 ft along the proposed alignment to generate adequate coverage. This resulted in a total of nineteen cone soundings and nineteen traditional mud rotary borings completed in 2020. To resolve several identified data gaps, seven additional mud rotary borings, and five rotary sonic soil borings were advanced in March 2021 and logged by GEOS personnel in the field. Individual logs for the SPT borings, the SCPTU soundings, and the rotary sonic soil borings are presented in the GEOS Geotechnical report and addendum included as attachments to this report. All current exploration locations are shown on the 90% barrier wall design plans attached to this Appendix.

Additional drilling is planned along the barrier wall alignment to refine the soil profile for barrier wall installation. Sonic borings will be performed on approximately 100 ft centers along the barrier wall alignment to supplement the existing geotechnical information.

3.1.1 Standard Penetration Testing

Two phases of geotechnical borings were advanced, the first phase occurred from October to November 2020, and the second phase occurred in March 2021. A total of 26 (19 in 2020, 7 in 2021) geotechnical borings advanced using open hole methods with NWJ (2-5/8 inch diameter) drill rods. The drill crew worked in general accordance with ASTM D 6151 (HSA Drilling) and ASTM D783 (Direct Rotary with Water-Based Drilling Fluid). The soil cuttings and drilling fluid were collected and placed in drums. The borings were then backfilled with grout. Detailed test boring records are presented in the full GEOServices geotechnical report and addendum previously submitted (Geosyntec, 2021a and 2021b).

SPT blow counts were measured using the split-spoon standard penetration test procedure (ASTM D 1586). In split–spoon sampling, a standard 2-inch O.D. split-spoon sampler is driven into the bottom of the boring with a 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the sampler the last 12 inches of the standard 18 inches of total penetration is recorded as the Standard Penetration Resistance (N-value). These N-values are indicated on the boring logs at the testing depth and provide an indication of the relative density of granular materials and strength of cohesive materials. Soil collected by the sampler during the SPT are used for material property tests. Less disturbed samples for hydraulic conductivity and strength testing were collected using thin-walled tube sampling test procedure (ASTM D 1587).

3.1.2 Cone Penetration Testing

An additional nineteen locations were explored using an integrated electronic seismic cone penetration test probe (piezocone) during the first phase of exploration between October and November 2020. The piezocone dimensions and the operating procedure were in accordance with ASTM D 5778. Since the SCPTU is a direct push technology, it allows data to be obtained continuously (approximately every 2 inches). A computer connected to the cone records tip resistance, sleeve friction, and dynamic pore pressure via instruments in the cone. Additionally, when the cone penetration is stopped, the piezocone essentially becomes a piezometer. While stopped, water is injected into a saturated porous material to generate excess pore pressures, then without advancing the cone, the pressure is then allowed to dissipate and pore water pressures are automatically recorded at five-second intervals and the readings are stored in a dissipation file. Pore pressure dissipation testing was performed in each of the nineteen SCPTU sounding locations. The pore pressure dissipation results are presented in the PDI report (Geosyntec, 2021a).

3.1.3 Rotary Sonic Soil Borings

In April 2021, a total of five geotechnical borings were advanced using sonic drilling methods along the preliminary barrier wall alignment. The drill crew worked in general accordance with ASTM D 6914 (Sonic Drilling for Site Characterization). Sonic drilling is a method in which the drill string is advanced, and the borehole is simultaneously cased by rotation and oscillation of the drill bit to collect a relatively continuous and undisturbed sample of the subsurface material. The sonic drilling method was selected for the supplementary excavation because a continuous sample of the layered strata is valuable for barrier wall mix design and identification of the presence of gravels and other non-soil materials identified in isolated borings during the preliminary exploration. The borings were backfilled with grout upon completion of each location. Detailed test boring records are presented in the addendum to the GEOS geotechnical report.

The PDI and subsequent 2021 soil investigation were primarily focused on soil layers that will be encountered by barrier wall construction, varying between 70 feet to 80 feet mean sea level (MSL). The investigations were performed from a cleared temporary roadway that approximately followed the EL 72ft (MSL) contour. For geotechnical purposes, this information is sufficient for geotechnical modeling of the barrier wall. However, none of the PDI geotechnical borings were performed above the proposed roadway elevation due to site constraints and the preliminary nature of the cleared alignment. An additional sonic drilling, in addition to those listed above, was performed during the Addendum investigation with the specific intention of characterizing layers above the roadway elevation and acquiring samples for laboratory testing for geotechnical parameters for use in slope stability calculations. The upslope boring encountered alluvial deposits (similar to all other collected borings) for the full penetration/boring depth. The sonic boring was extended to 60 feet below existing grade (ft bgs) near the top of the existing slope. Layers to be used for preliminary slope stability analyses were determined based on manual and visual classification (ASTM D2487) and laboratory tests. Slope stability analyses will be updated as additional exploration becomes available.

3.2 Geotechnical Laboratory Testing

Laboratory tests were performed as part of both the PDI Geotechnical Report and Addendum investigations (Geosyntec, 2021b). Results of laboratory testing are included in the PDI report (Geosyntec, 2021a). Moisture content determinations (ASTM D2216), Atterberg Limits (ASTM D4318) and particle size analyses (ASTM D6913 and ASTM D1140) were performed on bulk samples to assist in the USCS classification of the sampled soils in accordance with ASTM D2487.

Additional geotechnical laboratory testing was performed on trimmed intact samples to identify relevant design parameters for the barrier wall system. Hydraulic conductivity testing of various layers was determined using falling head permeability methods (ASTM D5084). Results of this testing can be found in Geosyntec (2021a). Consolidated undrained (CU) triaxial testing (ASTM D4767) was performed on specimens trimmed from 4-inch diameter intact sonic drilling sleeves. Triaxial strength testing is used in this context to evaluate the shear strength conditions of the underlying clayey soil. The strength of sandy soil layers in the slope above the roadway elevation was determined using the Direct Shear Test method (ASMD3080).

Results of all laboratory testing can be found in the PDI Geotechnical Report attached to Geosyntec (2021b).

3.3 Development of Barrier Wall Design Cross Sections

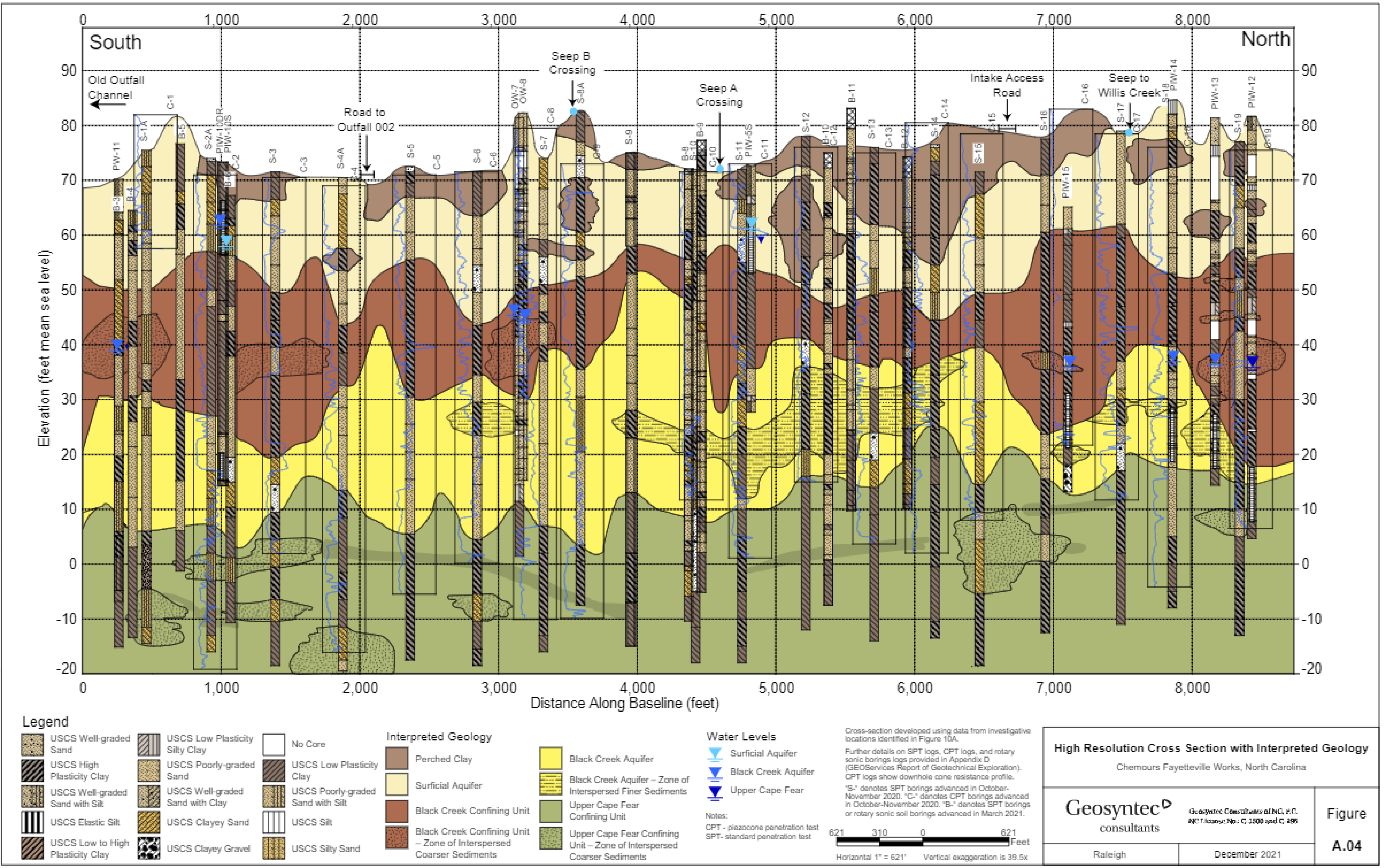
Borings and SCPTU soundings collected by GEOS and well log information collected by Geosyntec were used to develop a cross-section of the expected soil conditions along the preliminary barrier wall alignment. The developed cross section (Figure 3), plotted by Geosyntec, represents a view perpendicular to the centerline alignment of the barrier wall. The soil layers shown in Figure 3 were classified using overall site hydraulic modeling nomenclature and definitions of local geologic units including Perched Clay, Surficial Aquifer, Black Creek Confining Unit, Black Creek Aquifer and Upper Cape Fear Confining Unit.

It is important to note that the soil identification nomenclature of the geotechnical boring logs prepared by GEOS in the PDI Geotechnical Report (attached to Geosyntec, 2021b) do not directly match the geologic nomenclature of the Geosyntec well logs because the explorations were performed for distinct reasons. Geotechnical boring log soil classification follows standard geotechnical engineering practice (ASTM D2487) of identifying soils with United Soil Classification System (USCS) nomenclature to assist in assessing the geotechnical engineering properties of the soils. This is an important distinction because the groundwater interception design requires both styles of classifications to describe and evaluate various aspects of the overall remedy system.

All soils sampled in the PDI investigation were deposited by water and are therefore classified as alluvial deposits in typical geotechnical engineering nomenclature. At the subject site, the alluvial deposits can then be divided into two sub-classifications: fine and coarse grained. Fine-grained deposits consist of silts and clays while coarse-grained deposits consist primarily of sands. Transition zones between fine- and coarse-grained soil layers are typical in alluvial deposits and exist at this site.

Design 2-D cross-sections perpendicular to the barrier wall alignment are required for seepage and slope stability analyses Seepage modeling cross sections are most impacted by the hydraulic engineering properties of soil layers existing from the top of the barrier wall to the confining unit at depth. Slope stability cross-sections require layering and soil property information above and below the roadway bench that will be graded for the installation of the barrier wall. At the subject site the soils nearest the slope surface will tend to control slope stability due to the sandy soil profiles.

The geologic unit nomenclature and, where appropriate, layer elevations presented in Figure 3 were used when assigning soil layer names in cross-sections below the roadway elevation to remain consistent with the layering used in the hydraulic model in Appendix B. USCS nomenclature was used for elevations above the roadway based on the additional slope boring and engineering judgement. The geotechnical engineering properties (unit weights, shear strength, and seepage parameters) assigned to all layers for geotechnical modeling were primarily based on laboratory tests results presented in the PDI Geotechnical Report (attached to Geosyntec, 2021b) but also include some engineering judgement and correlation to field measurements collected during exploration. The layers and their geotechnical properties for both seepage and slope stability analyses are discussed in subsequent sections.



Cross-section developed using data from investigative locations identified in Figure 10A.

Further details on SPT logs, CPT logs, and rotary sonic borings logs provided in Appendix D (GEOServices Report of Geotechnical Exploration). CPT logs show downhole cone resistance profile.

"S-" denotes SPT borings advanced in October-November 2020. "C-" denotes CPT borings advanced in October-November 2020. "B-" denotes SPT borings or rotary sonic soil borings advanced in March 2021.

Notes:
CPT - piezocone penetration test
SPT- standard penetration test

High Resolution Cross Section with Interpreted Geology
Chemours Fayetteville Works, North Carolina

Geosyntec consultants
Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Raleigh
December 2021
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A.04

Figure 3 - Barrier Wall Soil Cross Section

4 90% BARRIER WALL DESIGN

The proposed barrier wall will enable more efficient control of groundwater flow from under the Chemours facility by the extraction wells. Therefore, groundwater analysis is required to determine the properties of the wall required to achieve the intended system performance. Characteristic properties of the barrier wall (discussed in detail in subsequent sections) are summarized as:

- Minimum wall thickness of 30-inches
- Maximum hydraulic conductivity of $1\text{x}10^{-6}$ cm/s for the barrier wall post-mixing
- Minimum compressive strength of 50psi for wall depths less than 75 feet and 100psi for wall depths exceeding 75 feet (based on soil and water pressures expected based on to-date exploration and modeling)
- Minimum embedment of 5 feet into the Upper Cape Fear Confining layer

Beyond determining the wall properties, the barrier wall system design process also considers necessary modifications of existing site conditions to accommodate barrier wall installation infrastructure. Site modification considerations are especially impactful at this site as the proposed barrier wall and the roadway are located on a large soil slope between the active plant and the river. The size and condition of the slope requires consideration of existing and planned topography in the design of the barrier wall system. In some areas, regrading of the natural slopes is possible while other areas will require retaining walls to achieve maintainable slopes above and below the roadway. Thus, in addition to the evaluation of the effectiveness of the barrier wall as part of the groundwater interception system, additional slope stability and retaining wall analyses are required to evaluate grading changes resulting from the new construction.

4.1 Barrier Wall Material, Width, and Material Properties

The PDI geotechnical report (attached to Geosyntec, 2021a) presents analysis and comparison of potential barrier wall installation methods. Based on the recommendations of the PDI Geotechnical Report, and interviews with potential contractors, Chemours selected DeWind One Pass (DeWind) as the barrier wall installation contractor. DeWind manufactures and uses proprietary one-pass trenching equipment to continually mix soil with binder along the entire wall height to minimize joints in the barrier wall. DeWind will provide the MT3500 trencher (Figure 4) to install a barrier wall with a minimum thickness of 30-inches. The trencher has a continuous width mast that extends full length during mixing which maintains trench width until the soil is mixed with the admixtures. The minimum width of the barrier wall is maintained because the trench is never open without either soil, mast, or soil mix support. The barrier wall extends into the Upper

Cape Fear Clay that underlies the Black Creek Aquifer in the subsurface model shown in Figure 3. The wall will consist of in-situ soil mixed with bentonite and cement.

Figure 4 - DeWind MT3500 Trencher

Seepage analyses in the current design package utilize a hydraulic conductivity value of 1.0×10^{-6} centimeters per second (cm/s). The hydraulic conductivity of the barrier wall is dependent on the proprietary contractor method of mixing and mix design parameters (percentage of bentonite and cement binders) applied to the in-situ soils. DeWind is currently performing a pre-installation bench testing mix design study to determine the binder composition necessary to provide the required design compressive strength (50psi for wall depths less than/equal to 75 feet and 100psi for wall depths exceeding 75 feet) and a hydraulic conductivity value of 1.0×10^{-6} cm/s. Seepage and groundwater modeling revisions will be performed if the values measured in bench mixing trials is significantly different from 1.0×10^{-6} cm/s. The hydraulic conductivity value used in modeling scenarios is considered a maximum allowable value and will be evaluated during construction as part of a quality monitoring program which has been submitted separately to DEQ

4.2 Barrier Wall Embedment (Seepage Modeling)

The PDI results (Geosyntec, 2021a) demonstrate that the Black Creek Aquifer is underlain by the Upper Cape Fear Confining Unit, a stiff clay layer of low permeability. Stiff clay is an ideal key-in layer to impede water flow under the wall. The elevation of the Upper Cape Fear Confining unit varies across the site. Elevations observed in each of the currently available borings along the alignment are presented in Table 1. Additional drilling performed on approximately 100ft centers before construction will be used to refine the Upper Cape Fear depth contour on the final construction plans.

The wall will extend into the stiff clays of the Upper Cape Fear Confining Unit. Key-in (or embedment) depth into a low permeability layer is determined considering the targeted performance criteria of the system and consideration of existing soil conditions. The subject site contains defined aquifers (Surficial and Black Creek) transporting PFAS containing water that is specifically targeted for interception, collection, and treatment. Therefore, that water needs to be contained in the aquifer long enough for the extraction system to collect the required volume.

The depth of barrier wall embedment required for this system is dependent on hydraulic interaction between the soil layers and the barrier wall. Primarily, the depth of embedment is determined based on the depth required to limit the hydraulic gradient (change in hydraulic head over a distance) at the bottom of the wall to drive the primary flow of the system into the wall instead of providing a preferential flow path under the wall. Soil-borne water interaction with the barrier wall requires a seepage analysis to determine the parameters used to evaluate embedment depth.

Table 1 - Elevation of Confining Layer At Each Boring

Boring Number	Northing	Easting	Elevation at Top of Confining Layer (ft)
B-1	394058.1353	2052259.3690	4.3
B-2	394257.1810	2052239.7265	-2.0
B-3	394356.6976	2052229.9053	4.3
B-4	394456.2141	2052220.0840	6.3
B-5	394804.5095	2052185.7098	3.3
B-6	395145.3787	2052374.4750	-5.1
B-7	395310.8989	2052361.5701	4.8
B-8	398085.9123	2052065.4609	-4.1
B-9	398155.3424	2051934.6273	8.2
B-10	399039.3653	2051907.7781	9.7
B-11	399231.4305	2051829.8464	10.4
B-12	399610.2113	2051709.9043	22.3
S-1A	394555.7181	2052210.2628	4.5
S-2A	395017.6623	2052276.9758	-3.0
S-3	395476.2209	2052340.4083	-0.5
S-4A	395962.0230	2052349.9385	13.5
S-5	396446.5351	2052343.2112	6.0
S-6	396900.2816	2052172.1302	4.0
S-7	397343.2830	2051993.1524	9.0
S-8A	397474.6952	2051762.8147	4.0
S-9	397670.4359	2052074.8044	6.5
S-10	398126.6934	2052003.8872	-5.5
S-11	398453.1470	2051931.4787	10.0
S-12	398914.4355	2051914.6132	15.5
S-13	399382.5730	2051759.5980	11.5
S-14	399785.1325	2051587.1342	25.0
S-15	400089.4998	2051687.6356	-5.5
S-16	400546.3983	2051554.8299	2.0
S-17	400792.9535	2051160.3674	16.5
S-18	401160.4833	2051194.3123	5.5
S-19	401637.1153	2051085.5536	6.0

4.2.1 Barrier Wall Seepage Modeling Scenarios

Two types of seepage analysis are considered in the design of geotechnical structures: transient and steady state. Transient systems do not have constant boundary conditions and the seepage conditions are therefore time dependent. Steady state systems develop long-term boundary conditions that are independent of time. The hydraulic barrier system is analyzed as both types of system to evaluate different performance parameters and time increments are of interest. Transient conditions are critical for particle migration analysis of the groundwater model system, but the transient conditions are dependent on hydraulic variables that are outside the geotechnical scope and can only be analyzed in the hydraulic model of the site that includes sources and well modeling (details in Appendix A). The steady state case considered in the geotechnical analysis of the barrier wall is based on long term normal operating conditions determined from the full-site transient hydraulic modeling. From a geotechnical design perspective, the critical performance case for the barrier wall occurs when the largest head difference between upslope (west) and downslope (east) develops in a steady state. The largest total head difference develops the maximum hydraulic gradients at interface layers, which dictates the embedment depth required for the barrier wall to minimize underflow and allow the groundwater extraction system to perform as intended. Hydraulic control and particle migration are considered in the hydraulic model in Appendix A.

Geotechnical seepage for the barrier wall design was computed using the finite element method in the commercially available two dimensional (2D) geotechnical finite element software RS2 from Rocscience. Preliminary seepage modeling designed to evaluate embedment depth of the wall into the Upper Cape Fear Confining unit is described in subsequent sections with modeling inputs and results attached to this Appendix.

Five seepage models were created and evaluated for the 90% design submittal. One cross-section (topography, soil layering, and hydraulic condition) is considered in each model. Four models represent seep locations (Seeps A through D), and one model represents an area south of Seep D. The locations of these models were chosen as points of interest in the overall hydraulic model for the site.

4.2.2 Seepage Model Input Properties

For steady state seepage analysis, identification of soil layering, water elevation and subsequent pressure (total head), and layer hydraulic conductivity is required at each location. Soil hydraulic conductivity testing was performed on clay and sand specimens collected and documented in the PDI Geotechnical Report. Hydraulic conductivities for each major geologic unit (Table 2) were utilized in the analyses.

Table 2 - Hydraulic Conductivity for Geologic Units Used in Seepage Models

Material Name	Porosity	Hydraulic conductivity (cm/s)	k2/k1
Surficial Aquifer	0.40	1×10^{-2}	0.01
Black Creek Confining Unit	0.40	2×10^{-6}	0.01
Black Creek Aquifer	0.38	1×10^{-5}	0.01
Black Creek Silty Sand	0.52	1×10^{-6}	0.01
Upper Cape Fear Clay	0.35	3×10^{-7}	0.01

The 2-D seepage models consider an anisotropy ratio of the horizontal to vertical hydraulic conductivities (k2/k1) in each layer. The anisotropy ratio values assigned to each layer are shown in Table **2**.

Layer boundary elevations were selected at each modeled cross section based on the site cross section presented in Figure 3. Layer boundaries are modeled as constant elevation perpendicular to the site cross section. This is a simplification as the layer boundaries vary in elevation; however, the purpose of this modeling is to evaluate the embedment depth of the barrier wall at discrete locations. Layer heterogeneity is best considered as part of the three-dimensional site hydraulic study.

In addition to the hydraulic conductivities of the material layers, external hydraulic boundary conditions are required to create a seepage flow condition for analysis. The boundary conditions in the model were applied as total heads based on output information from the hydraulic modeling (Appendix A). The total heads presented in Table 3 include baseline water level and the effects of the barrier wall and extraction wells on total head for the west side and east side of the wall (upstream and downstream). Baseline and differential total heads were modeled for cross-sections at each of the four Seep locations (Seeps A through D) and an additional location south of Seep D. Upstream total head in the models was computed by adding the average upstream water level increase in Table 3 to the baseline water level. The downstream total head was computed by subtracting the largest decrease in the water level from the baseline water level. The maximum difference between upstream (west) and downstream (east) is considered the worst-case seepage scenario as it creates the maximum head difference across the wall section resulting in maximum hydraulic gradients which are used to determine wall embedment.

Table 3 – Baseline Total Heads and 90% Pumping Scenario Water Level Change

Area	**Baseline Water Elevation (ft MSL)**	**Average Upstream (West-Side) Wall Water Level Increase (ft)**	**Range Downstream (East-Side) Wall Water Level Decrease (ft)**	**Maximum Head Difference Considered In Model (FT)**
Seep A	45	1.78	3.12 – 5.32	46.78ft-39.68ft=7.10ft
Seep B	50	2.22	3.05 – 5.18	52.22ft-44.82ft=7.40ft
Seep C	50	2.93	3.73 – 4.92	52.93ft-45.08ft=7.85ft
Seep D	60	3.43	3.20 – 4.71	63.43ft-55.29ft=8.14ft
South of Seep D	60	4.38	2.34 – 3.97	64.38ft-56.03ft=8.35ft

4.2.3 Seepage Modeling Results

Two primary outputs of the seepage models are of interest: the flow net conditions to confirm hydraulic behavior; and hydraulic gradient contours to determine if the barrier wall embedment is sufficient to limit gradients below the barrier wall below a critical hydraulic gradient. The critical gradient represents the hydraulic gradient condition at which soil particles can become unstable and begin to move.

An example seepage model cross section located at Seep A is shown in Figure 4. At this location, the Black Creek Aquifer (shown in yellow) is thickest (from EL 40FT to about EL 10FT) of the locations modeled in this document. The layout of the model is viewed from south to north on the plan, so the upstream (west) side of the wall is on the left of the model. The total head boundary conditions shown are directly from Table 3 and the layer elevations are from Figure 3.

The layout in Figure 4 represents the inputs for the seepage model with the finite element mesh shown over the barrier wall. All material inputs are included in the results attached to the Appendix. The post-processed outputs of the example model are the flow net (equipotential and flow lines) in Figure 5, and the hydraulic gradient contours in Figure 6. The scale on the total head contours in Figure 5 is relative to the original boundary conditions to illustrate the effect of the barrier wall on total head and flow.

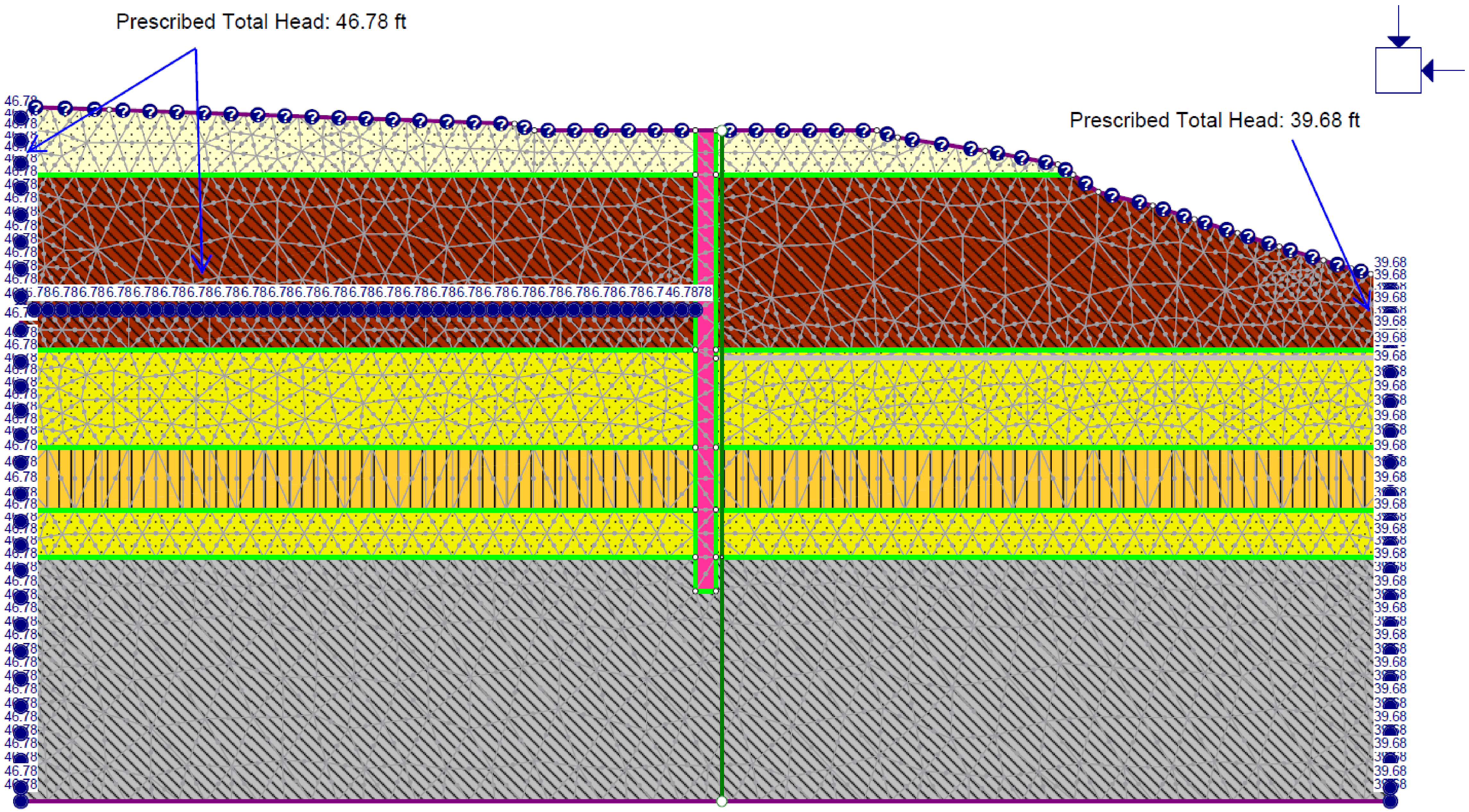
The equipotential lines in Figure 5 confirm that the barrier wall is concentrating the flow through the aquifer zone. The water in the Black Creek Aquifer layer with a hydraulic conductivity of 1×10^{-2} cm/s prefers to continue the flow path into the barrier wall (hydraulic conductivity of 1×10^{-6} cm/s) than into the confining unit clay (hydraulic conductivity of 1×10^{-7} cm/s or lower). The gradient results confirm this behavior with the contour of hydraulic gradients showing maximum values at the interface between the aquifer and the Upper Cape Fear Confining Unit nearest the barrier wall.

The important takeaway from the hydraulic gradient results in Figure 6 is that the zone around the bottom of the wall (embedded five feet into the Upper Cape Fear Confining Unit) is nearly zero. This indicates the wall is sufficiently embedded to maintain material stability and minimize flow under the barrier wall, as intended. The scale on hydraulic gradient in Figure 6 is from 0 to 1.0 as the critical hydraulic gradient is around 1.0 for most soils. There are zones of hydraulic gradient exceeding 1.0 located at the interface between the sands and clays illustrating the sharp contrast in hydraulic conductivity. However, as long as the barrier wall is properly embedded to limit the hydraulic gradient at the toe area, these interface soils are confined by the system. Thus, Figure 6 indicates that 5 feet of embedment into the Upper Cape Fear Confining Unit is sufficient to limit the hydraulic gradients of the system.

Preliminary seepage modeling results for the remaining four cases are attached to this Appendix. An embedment of five feet into the Upper Cape Fear Confining Unit was confirmed to meet performance expectations using the layering listed in **Table 3**; however, real layer boundaries are not typically as abrupt as those used in the numerical models. Alluvial soils typically transition from one soil type to another over a few feet such as when a sand becomes clayey as it transitions to a clay layer. Therefore, a parametric study was required to evaluate the effect of transitioning hydraulic conductivity in soils in the top two feet of the Upper Cape Fear Confining Unit. This is important because the wall embedment is designed to limit exit gradients which are heavily influenced by head loss across soil boundaries.

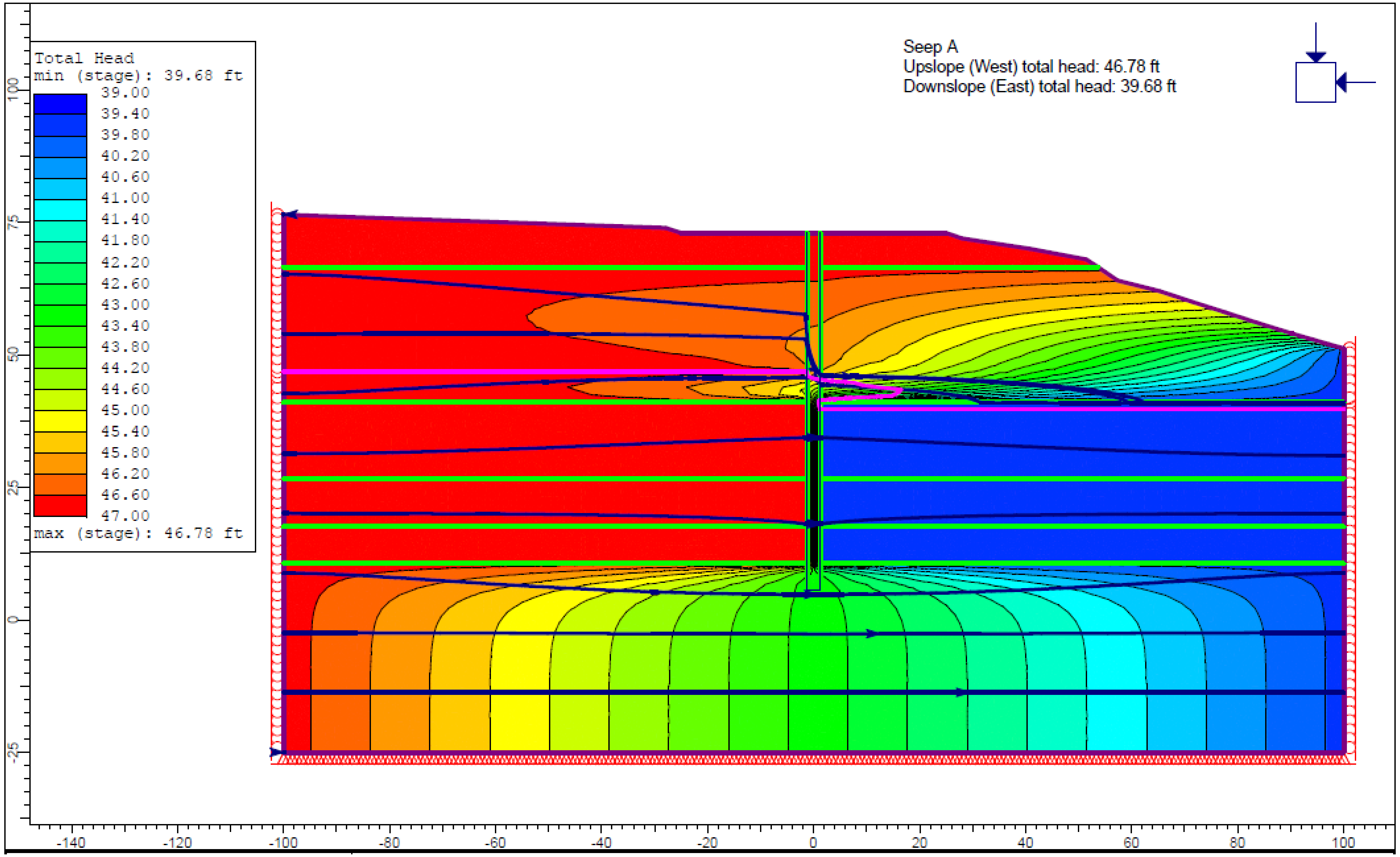
A preliminary parametric study was conducted by assigning varied hydraulic conductivities, two orders of magnitude larger (9.84×10^{-7} ft/s in model input represents 3×10^{-5} cm/s) and four orders of magnitude higher (9.84×10^{-5} ft/s in model input represents

$3\text{x}10^{-3}$ cm/s), to the soil over the top 2 feet of the Upper Cape Fear Confining Unit. These conditions represent a potential transition zone where the clay may have a higher sand content which would increase the hydraulic conductivity essentially lowering the interface between the aquifer and the confining layer. Parametric studies were conducted for the soil profile at Seep A because the overlying sand layer, Black Creek Aquifer, was thickest at this section, hence any adverse effects would be accentuated at this location. The results of the parametric study, shown in Figure 7 and Figure 8 preliminarily confirm an embedment depth of five feet (including 2 feet of transition material in the parametric study) is sufficient to manage exit gradients below critical levels providing resistance to material movement from fine grained layers at the bottom of the barrier wall.



Boundary Conditions

Figure 5 - Example Seepage Model Geometry for Seep A Cross-section



Seep A
Upslope (West) total head: 46.78 ft
Downslope (East) total head: 39.68 ft

Figure 6 - Total Head Contours (equipotential lines) with Flow Lines for Seep A Cross Section

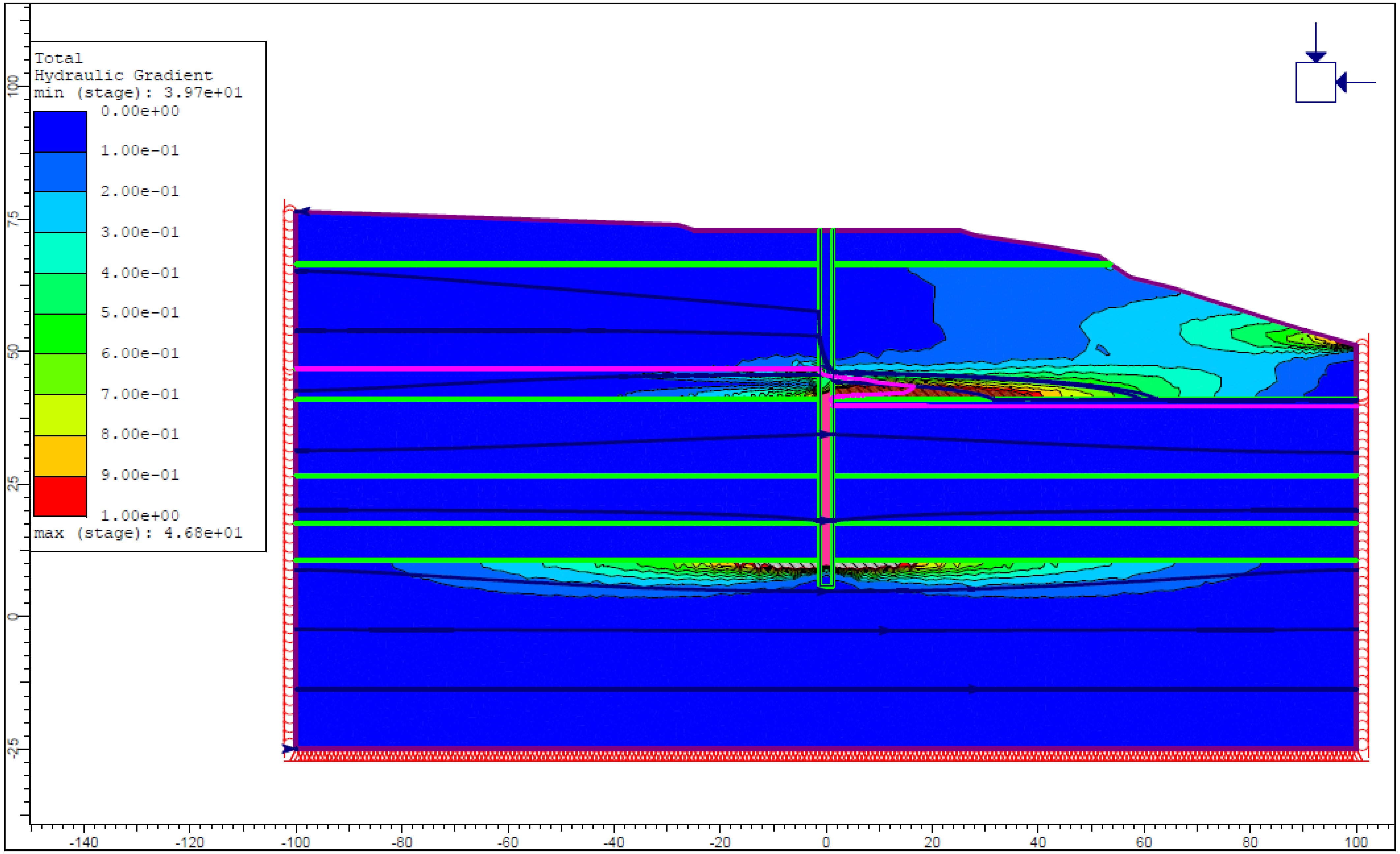


Figure 7 - Hydraulic Gradient Contours for Seep A Cross-Section

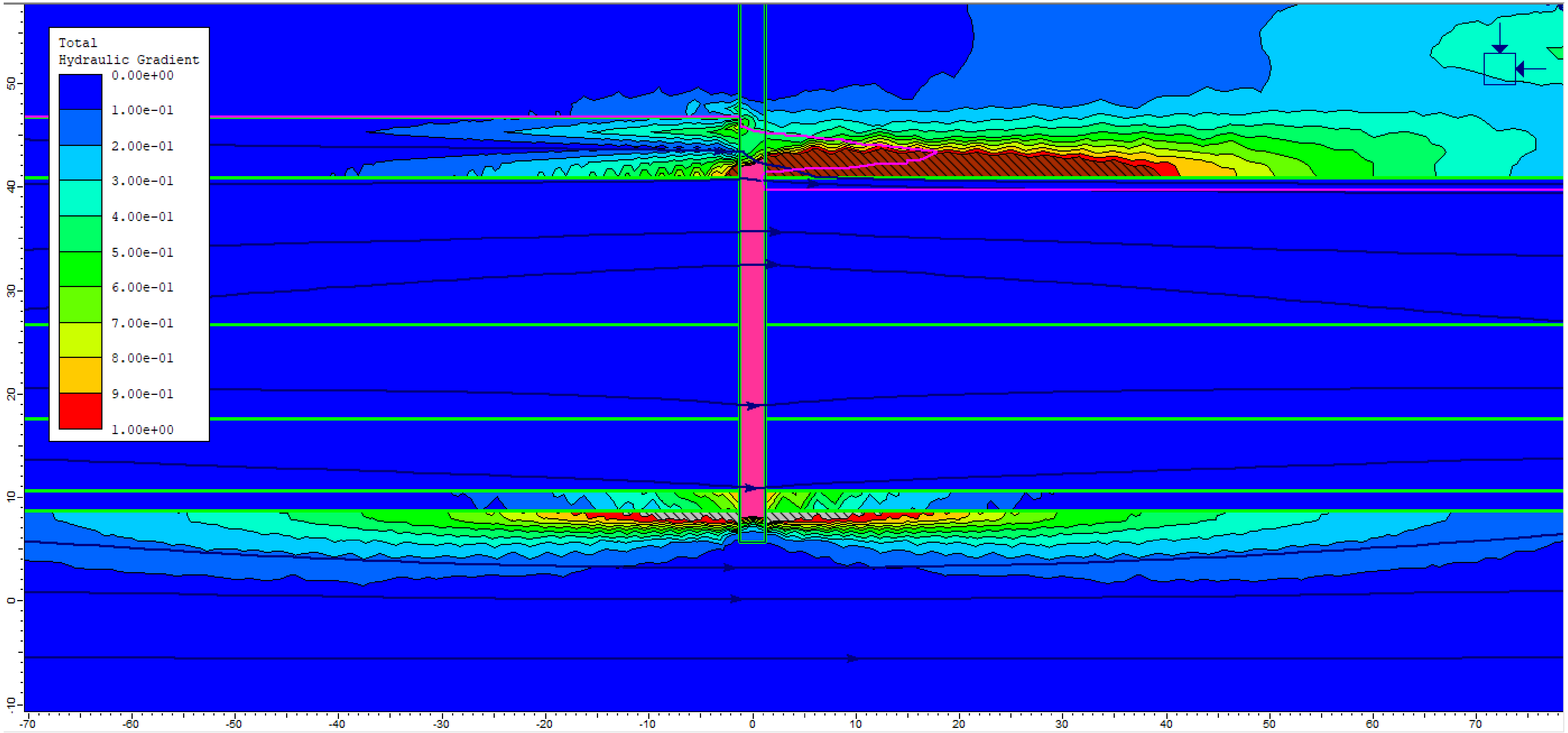


Figure 8 – Hydraulic Gradient for Parametric Study Case Seep A with 2ft Transition Zone of Higher Hydraulic Conductivity (2 orders of magnitude) in Upper Cape Fear Unit

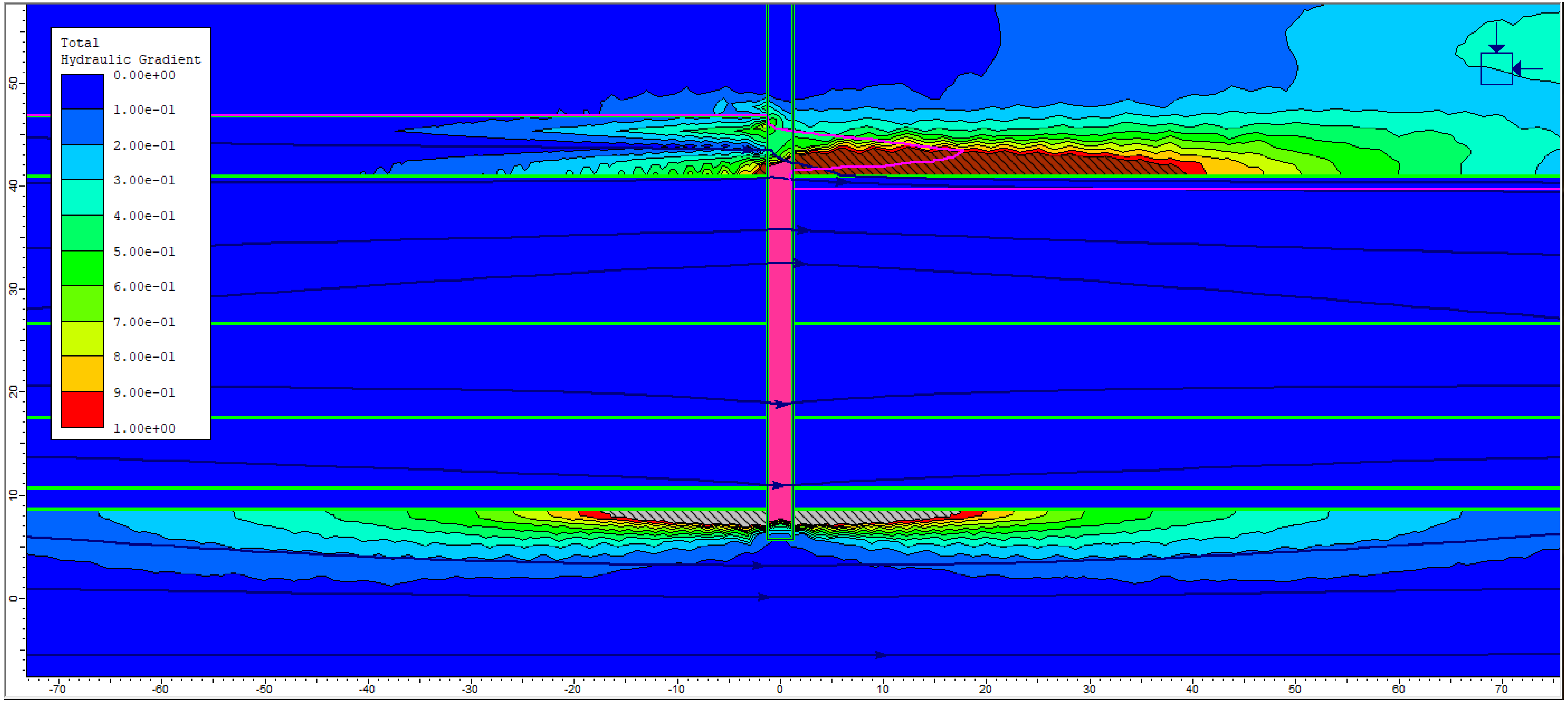


Figure 9 – Hydraulic Gradient for Parametric Study Seep A 2ft Layer of Higher Hydraulic Conductivity (4 orders of magnitude) in Upper Cape Fear Unit

4.3 Barrier Wall Roadway Analysis

The construction of the barrier wall will require access roadway to facilitate the movement of equipment and materials necessary for construction and for long-term maintenance of the extraction well system. Stability analyses for potential access road cross-sections before barrier wall construction was performed in the PDI Geotechnical Report (attached to Geosyntec, 2021a). One of the recommendations of the PDI analysis was grading of all slopes to 3H:1V. Design of the roadway alignment has proceeded with this recommendation in areas where space/permit constraints allow for slope grading. However, some sections along the alignment shown cannot be graded to 3H:1V within the topographic and permitted constraints of the property. Subsequent design calculations indicate that some sections with 2H:1V slopes are stable with erosion control measures while other steep sections of the alignment will require retaining walls to intercept natural grades and prevent additional permitting and clearing. Retaining wall systems and slope grading have been evaluated for stability during installation of the barrier wall through consideration of surcharge loading provided by DeWind.

4.3.1 Surcharge for Retaining Wall Design and Slope Stability Analysis

Objects that are on the top of the wall or slope apply additional (surcharge) loads that are added to the existing soil driving forces. To account for heavy construction and maintenance traffic, a typical surcharge of 250 pounds per square foot (psf) over the length of 20 feet was applied to roadway sections when evaluating the safety of slopes, and the retaining walls below (east side of) the roadway elevation. In addition to the normal construction traffic loading, the stability of the proposed grading and retaining walls were also checked for DeWind's trencher equipment surcharge of 3200 psf of dynamic pressure and 1600 psf of static pressure. The trencher, Dewind MT3500 is track mounted, so surcharge stresses are the result of the total equipment load being transferred to the ground through the two tracks. Thus, both the dynamic and static stresses from the trencher were modelled as two strip loadings corresponding to the dimensions and expected locations of the two tracks. Per DeWind, the track width is 6.5 feet and the clear distance between the tracks is 8.5 feet. Thus, the above stresses are applied to appropriate models as two strip loads of 6.5 feet width, 8.5 feet apart.

The equipment stress of 3200 psf and 1600 psf correspond to the stresses applied to the ground when the trencher is in operation, and when the trencher is parked, respectively. Based on the current construction schedule, trencher stresses are considered temporary because the trencher will not be stationary at given location for an extended period of time. In geotechnical engineering, a lower FOS may be considered for transient dynamic loading and short-term temporary loading such as the loading anticipated for this project.

4.3.2 Retaining Wall Design Considerations

The grading of the barrier wall road alignment shown in the attached plans is based on existing topography and maintaining serviceability of the roadway during hydraulic barrier system installation and operation. Some existing soil slopes are inclined at nearly 3H:1V making new grading difficult to match up with existing grade within the limits of the roadway construction area. To counteract this, mechanically stabilized earth walls (MSEW) will be installed above and/or below the road to assist in grading and reduce on-slope grading operations. In addition to the MSE walls, a soil nail wall is proposed to retain the hillslope starting approximately at station 83+60 to the end of the access road at 90+00 where approximately 20 ft of cut is required. Soil nail walls can be built with near vertical face, and the nails are installed into the cut face to support the excavation to minimize the volume of earthwork required for a large cut. Preliminary plans and calculations for retaining walls along the proposed alignment are attached to this Appendix.

4.3.3 Redi-Rock Retaining Wall Design

Retaining walls less than 15 feet tall were designed using Redi-Rock blocks. Redi-Rock walls are modular walls constructed of prefabricated block which are easy to construct and reduce backfill excavation. The use of Redi-Rock also offers the flexibility of designing the walls as gravity walls or MSE by adding reinforcement layers in the backfill. Due to their smaller height, and the limited backfill width, walls on the eastern (downslope) side of the roadway were designed as gravity walls with no reinforcement to reduce potential interference with barrier wall construction. Upslope walls as tall as 12 feet in height were designed as MSE walls (retained soil reinforced with geogrid) to reduce the excavation zone required. The design includes the use of on-site soils as backfill. Native soils along the alignment of retaining walls will be sampled and tested for grain-size distribution to determine applicability as fill per industry standards both for gravity walls and MSE walls.

There are 13 different retaining walls along the alignment of the barrier wall road. Wall section properties and loading conditions are summarized and shown in the attachments. Elevations for the retaining walls were determined using the existing survey and the grading plan. Multiple cross section were analyzed for each retaining wall. These sections were then analyzed using computer analysis software Redi-Rock Wall+ by Redi-Rock International and Fine Software. The software was used to evaluate internal, external, and global stability of all MSEW using calculations based on design concepts from Federal Highway Administration (FHWA) guidance (Berg, et al., 2009). Global stability analysis within the retaining wall calculations evaluates surfaces through the geogrid (if used) and surfaces immediately behind the retained sections. Global analysis of the slopes above and below the retaining walls was performed separately using Slide2 once the design criteria of the retaining walls were satisfied. Retaining wall minimum factors of safety used for appropriate limit states are summarized in Table **4**.

Table 4 – Factors of Safety for Retaining Wall Design

Limit States External Sliding	Minimum Factor of Safety
External Overturning	2.0
External Bearing Capacity	3.0
Internal Sliding Along Geogrid	1.5
Geogrid Tensile Strength	1.5
Geogrid Pullout	1.5
Geogrid/Block Connection Strength	1.5

4.3.4 Global Stability Factors of Safety for Redi-Rock Walls

Target factor of safety for each wall was determined based on location and surcharge conditions. Walls #1, #2, #4, and #8 were designed using a factor of safety of 1.50 for global stability as they are used to support the proposed roadway. Walls #4 and #8 were designed using a factor of safety of 1.30 to resist a transient surcharge condition and 1.10 for the dynamic surcharge condition. The transient condition factor of safety was utilized to account for a temporary loading condition above the wall which is not indicative of the permanent design loading after the completion of construction. The dynamic condition factor of safety was utilized for an extremely short-term loading condition (barrier wall installation) above the wall. Walls #3, #5 through #7, and #9 through #13 were designed using a factor of safety of 1.35 for global stability because they have no surcharges above the walls and are primarily used to facilitate grading of the barrier wall and roadways.

The minimum global factor of safety satisfied in the design of the individual retaining walls are shown in Table 7. Design plans and calculations for all retaining walls are attached to this Appendix.

Table 5 - Minimum Global Factor of Safety Satisfied in the Design of the Retaining Walls

Wall Number	Minimum FOS	Design Condition	Comments
1	1.50	Permanent	Final Design Condition
2	1.50	Permanent	Final Design Condition
3	1.35	Permanent	Final Design Condition
4	1.50	Permanent	Final Design Condition
	1.30	Transient	Static Trencher Condition
	1.10	Dynamic	Dynamic Trencher Condition
5	1.50	Permanent	Final Design Condition
6	1.35	Permanent	Final Design Condition
7	1.35	Permanent	Final Design Condition
8	1.50	Permanent	Final Design Condition
	1.30	Transient	Static Trencher Condition
	1.10	Dynamic	Dynamic Trencher Condition
9	1.35	Permanent	Final Design Condition
10	1.35	Permanent	Final Design Condition
11	1.35	Permanent	Final Design Condition
12	1.35	Permanent	Final Design Condition
13	1.35	Permanent	Final Design Condition

4.3.5 Soil Nail Wall

Soil nails are increasingly preferred in highway and road construction because they can be constructed with a relatively steep face without the need for backfill, thus reducing the volume of earthwork. Soil nail walls are constructed using the top-down construction method where 4 ft to 5 ft of excavation occurs in lifts. After each lift is exposed, soil nails and facing are installed before proceeding with the next lift. This is repeated until the excavation reaches the bottom of the wall. Thus, soil nail walls require a soil profile that can stand without support for approximately 5 feet of height. The facing consists of metal reinforcements and shotcrete and typically ranges between 4 inches to 14 inch in thickness.

Soil nails are commonly referred to as "passive" elements as they require some interaction with the surrounding soil, relative movement between the soil nails and the reinforced soil to develop strength. The reinforced zone (soil with soil nails) is strengthened by the tension resistance provided by the soil nails. The tensile strength developed in the rebars is transferred to the surrounding soil via the bond between the soil nails (grout) and the soil.

The cross-sections for the design of the soil nail wall were based on the grading plans. The design was performed using a commercial code SNAIL v 2.2.2 developed by California Department of Transportation in accordance with Soil Nail Wall Reference Manual published by the Federal Highway Administration (FHWA GEC 007, 2015). The Allowable Stress Design method was used for the design and the minimum factors of safety satisfied in the design are shown in Table **8**. In addition, SLIDE2 v.9.020, a 2D slope stability analysis program from Rocscience Inc was used to check the global stability of the soil nail walls including the hillslope. The design calculations along with global stability analysis is attached in the Appendix.

Table 6 – Factors of Safety for Soil Nail Wall Design

Limit States External Sliding	Minimum Factor of Safety
Overall Global Stability	1.5
Basal Heave	2.5
Pullout Resistance	2.0
Lateral Sliding	1.5
Tendon Tensile Strength	1.8
Facing - Flexural	1.5
Facing – Punching	1.5

4.3.6 Slope Stability Analysis

Once the retaining walls were inserted into the grading, ten representative cross-sections for preliminary slope stability analysis were identified by visual analysis of elevation contours along the alignment. The following slope conditions were considered:

- section supported by tallest retaining walls;
- section with large cut and fill with no retaining walls;
- section with largest quantity of fill below the roadway;
- section with retaining wall supported upslope with large fill on downslope side of road; and,
- section with steepest natural slope.

Slope analysis was performed using Slide2 (Rocscience version 9.020) limit equilibrium slope modeling software for efficient evaluation of potential failure surfaces. Spencer's complete equilibrium method (Spencer, 1967) was used to evaluate global stability Factor of Safety (FOS). When appropriate, the groundwater table is included based on the hydraulic conditions reported by the site groundwater modeling (Table 3). When the section of interest is located at considerable distance from the seeps, the water levels shown in Figure 3 were used.

It is common engineering practice to evaluate slopes for both short term and long-term stability. Short term, or undrained, analysis evaluates the slope immediately after construction when excess pore pressures have been generated but have not yet dissipated. Long term, or drained, analysis attempts to evaluate the slope over a considerably longer time frame (especially in clay layers) when pore pressure changes from construction activity have dissipated (positive for fill slopes and negative for cut slopes). The alignment currently has cuts and fills planned with and without retaining walls. All sections consider both long-term and short-term analyses.

Where the Dewind trencher dynamic loading of 3200 psf was applied, clayey soils were considered using an undrained analysis, as these high stresses occur and remove faster than generated pore pressure changes can dissipate. A drained analysis was performed to check the stability of these structures under the static 1600 psf stress. As the trencher will not be stationary at a location for more than a few days an undrained analysis is also appropriate for this loading; however, for completeness, a drained analysis was also performed in the unlikely event of the trencher being stationary at a location for extended period of time due to unforeseen reasons. All considered models satisfy factors of safety used in standard engineering practice. Models and results for all analyzed sections are included in the attachments.

4.3.6.1 Slope Stability Parameter Selection

Eight different soil materials are considered in the soil profile for slope stability analyses. These materials consist of the following: 1) Light Brown Sand, 2) Dark Gray Clay, 3) Light Gray Sand, 4) Perched Clay, 5) Surficial Aquifer, 6) Black Creek Confining Unit, 7) Black Creek Aquifer, and 8) Upper Cape Fear Confining Unit. Geologic unit analysis was not available on the upper soil layers collected in the sonic boring above the roadway so these upper soil layers are denominated by geotechnical classification (ASTM D2488) while the layers at and below the roadway are denominated using geologic classification to be consistent with the cross-section profile in Figure 3. In addition to these native soil layers, roadways and compacted fills were represented by Roadway Material and Compacted Fill layers with properties based on experience in materials testing. For the purposes of these analyses, the retaining wall block units are assigned infinite strength to analyze the stability of the slopes above and below the roadway without surfaces exiting the face of the retaining wall. Such a failure mechanism would be considered internal to the retaining wall and internal and external stability of the wall sections are considered explicitly in the retaining wall design.

For clayey layers, total stress (undrained) strength parameters were used for short term stability analysis and effective stress (drained) strength parameters were used for long term stability analysis. Sandy layers were assumed to be freely draining which significantly decreases excess pore pressure generation during construction activities. Therefore, the analyses consider effective stress strength parameters in sands for both short term and long-term stability analyses.

Unit weights and shear strength parameters utilized in the analyses were based primarily on existing soil borings and laboratory testing detailed in the PDI Geotechnical Report. These parameters were then adjusted to account for changes in soil consistency identified by SPT N-values as well as available SCPTU data. In some instances, adjustments considered published soil strength parameter standards. The material parameters used for stability analysis of the proposed roadway are summarized in Table 9.

Table 7 – Slope Stability Modeling Parameters

Layer Name	Unit Weight (pcf)	Total Stress (Short-term) Strength Parameters	Effective Stress (Long-term) Strength Parameters	
		Undrained Shear Strength (psf)	Cohesion (psf)	Friction Angle (degrees)
Light Brown Sand	110	-	75	32
Dark Gray Clay	120	1300	200	25
Light Gray Sand	115	-	50	32
Perched Clay	110	1100	200	24
Surficial Aquifer	115	-	75	32
Black Creek Confining Unit	120	900 - 2000	125	26
Black Creek Aquifer	120	-	0	33
Upper Cape Fear Confining Unit	120	2500	200	26
Compacted Fill	135	2000	0	35
Roadway Material	130	-	200	30

Upper soil layers were assigned constant strength over the entire thickness of the layers. However, due to the variation in the depth of the Black Creek Confining Unit at different sections, depth dependent shear strength is assigned with a minimum strength of 900 psf, increasing at 30 psf per foot of the layer, and a maximum strength of 2000 psf. Soil parameters assigned to slope stability analyses were also used for retaining wall design.

4.3.6.2 Slope Stability Analysis Results

The output of interest from slope stability analysis is the factor of safety (FOS) observed on the critical surface. Critical surface is defined as the slope search surface reporting the lowest FOS using a comprehensive search methodology. For permanent slopes, the critical surface FOS is compared to the target FOS of 1.5. For trencher loading, lower FOS of 1.1 and 1.3 are considered for temporary dynamic stress and temporary static stress respectively, as discussed in the retaining wall design methodology.

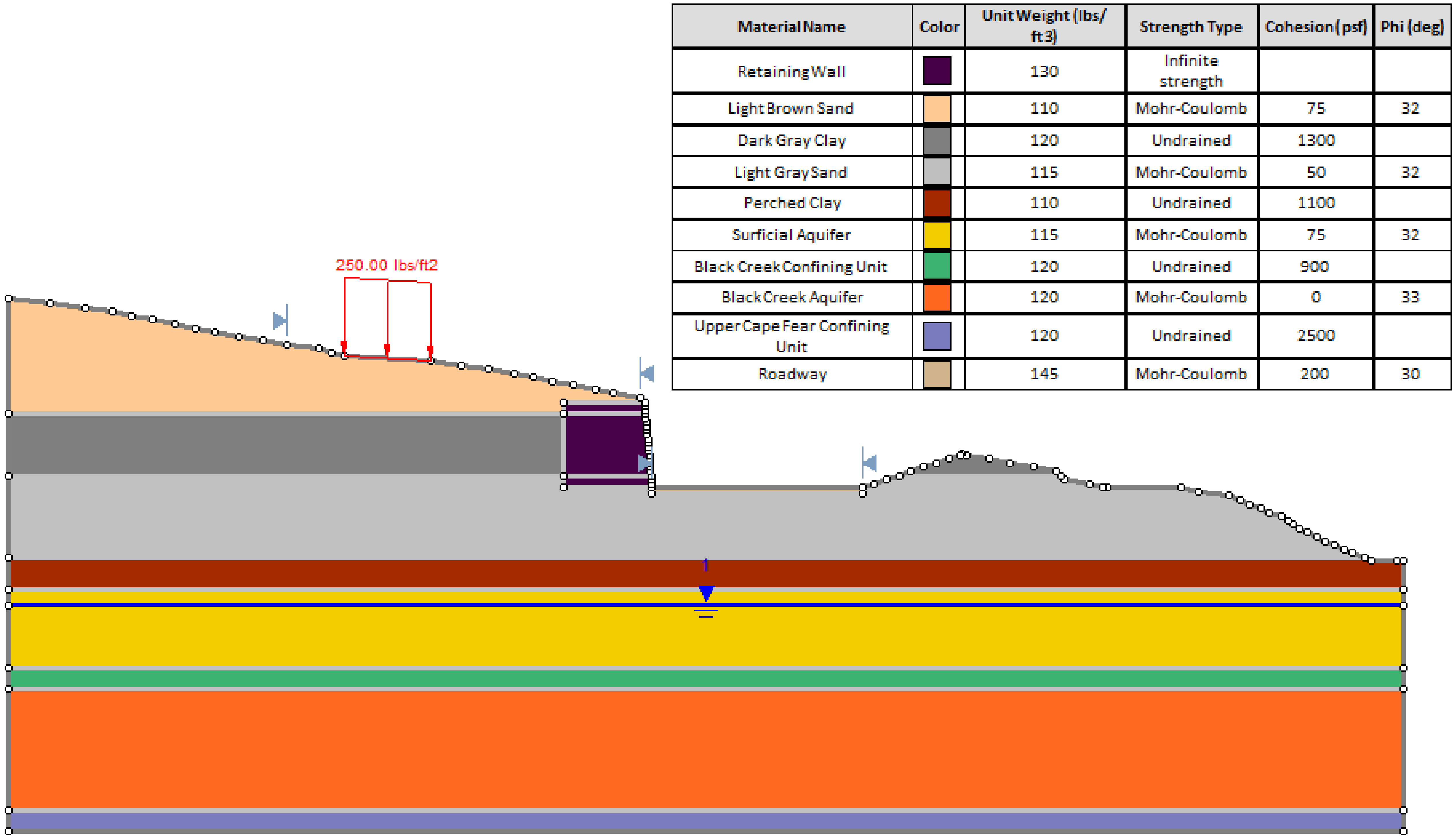
An example slope stability analysis is shown in Figures 10 - 12. Model geometry and material inputs are shown in Figure 10. The result of a short-term analysis with undrained soil strength parameters for clays and drained soil strength parameters for sands is shown as Figure 11. Long term analysis with drained soil strength parameters for all soils in the same model is shown as Figure 12. Also shown in Figure 11 and Figure 12 are the critical circular slip surfaces for the respective short term and long term analysis.

Results of all slope stability analyses are attached to this Appendix and the critical FOS are shown Table 10. The FOS in Table 7 are the smallest FOS for short term and long-term stability analysis. When there are multiple components, e.g., retaining walls, then the relevant component corresponding to the value reported is also noted. The analyses indicate that the proposed grading and the retaining walls provide adequate safety against global stability during and after construction.

The sandy nature of the surficial soils observed in interim seep capture construction will require careful compaction during construction, erosion control protocols, and maintenance of slopes post-construction to control surficial sloughing. Erosion from surface water during significant rain events is also a concern and has been addressed in slope construction and maintenance recommendations.

Table 8 Critical Global Stability FOS for the Slope Stability Analysis

Section	Approx. Station	Short Term FOS	Long Term FOS	Critical Component
1	3+00	2.49	2.36	-
2	10+00	2.66	2.47	-
3	15+30	1.82	1.55	-
4	22+60	1.67	1.50	Short Term: Overall slope Long Term: 12 ft High Upper Wall
5	36+80	1.76	1.70	Short Term: Upper Wall Long Term: Upper Wall
6	41+40	1.51	1.58	Short Term: Overall slope Long Term: Upper Wall
7	Wastewater Pond / 70+00	2.31	2.26	-
8	77+10	2.06	3.10	-
9	82+70	2.20	2.07	-
10	85+10	2.00	1.78	-



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Retaining Wall	🟪	130	Infinite strength		
Light Brown Sand	🟧	110	Mohr-Coulomb	75	32
Dark Gray Clay	⬛	120	Undrained	1300	
Light Gray Sand	⬜	115	Mohr-Coulomb	50	32
Perched Clay	🟥	110	Undrained	1100	
Surficial Aquifer	🟨	115	Mohr-Coulomb	75	32
Black Creek Confining Unit	🟩	120	Undrained	900	
Black Creek Aquifer	🟧	120	Mohr-Coulomb	0	33
Upper Cape Fear Confining Unit	🟦	120	Undrained	2500	
Roadway	🟫	145	Mohr-Coulomb	200	30

Figure 10 - Example Slope Stability Model with Parameters

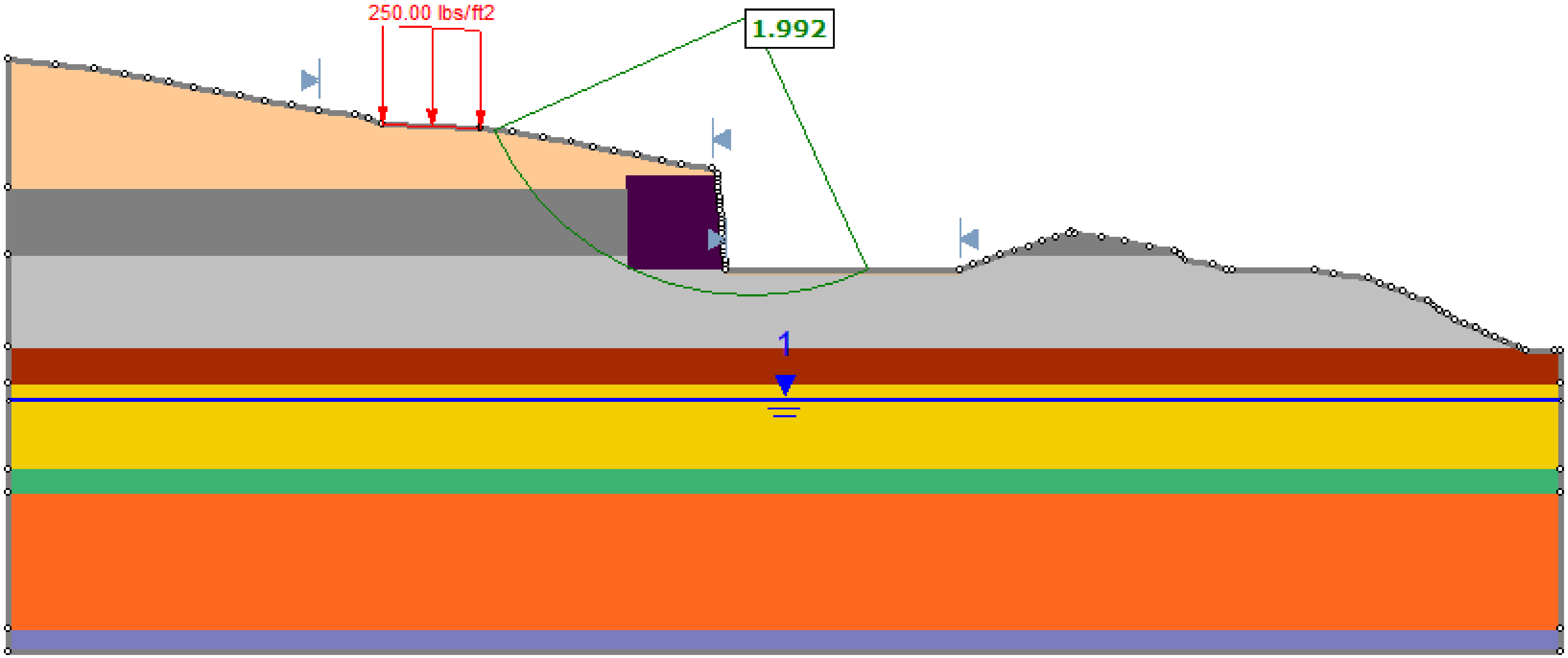


Figure 11 - Short-Term Slope Analysis of Example Case

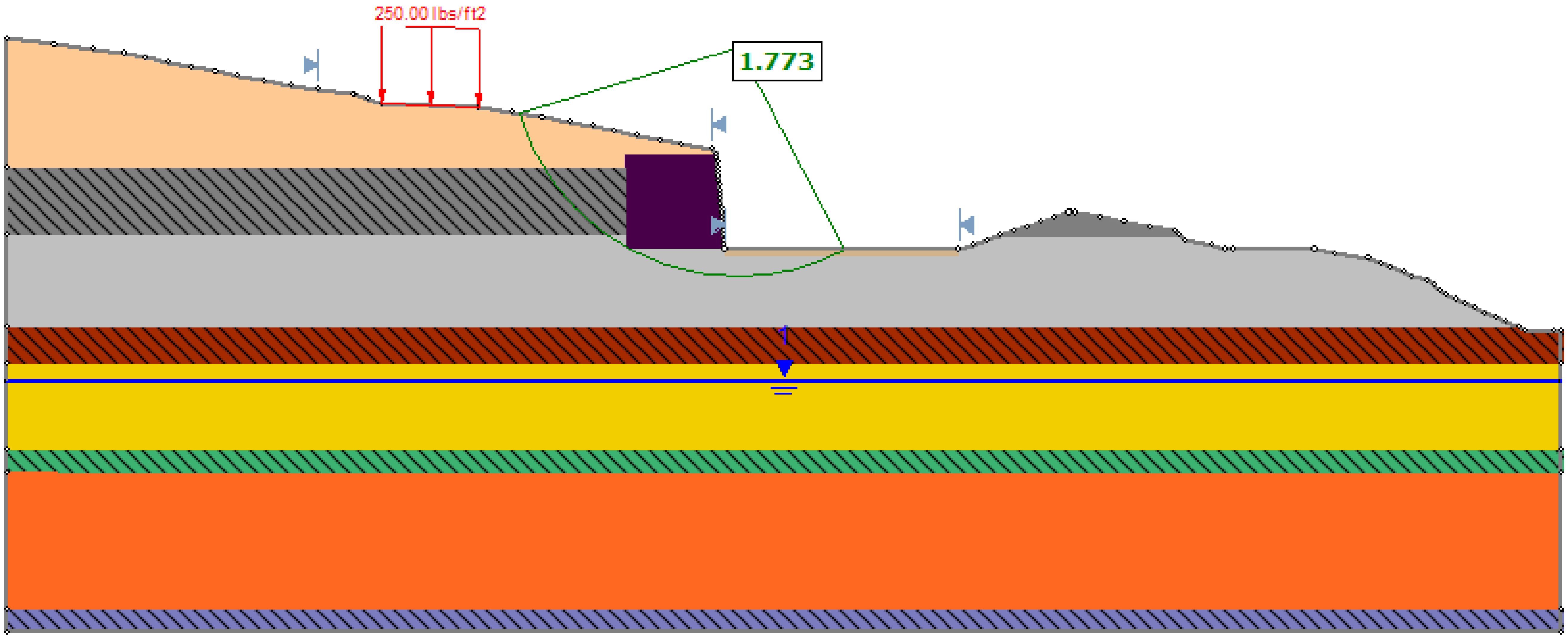


Figure 12 - Long-Term Slope Analysis of Example Case

5 SUMMARY AND CLOSING

The barrier wall system is part of the overall groundwater interception system design to accomplish the requirements of Paragraph 3(b)(i) and (ii) in the COA. Geotechnical and well drilling exploration of the site was utilized to develop a geologic cross-section of the area used in site groundwater and seepage models. Geotechnical laboratory testing (summarized in the PDI Geotechnical Report) is utilized in design parameters for both seepage modeling of the barrier wall and stability analyses of the roadway slopes and retaining walls.

Since the 60% design submittal, Chemours has selected DeWind One Pass Trenching as the barrier wall installation contractor. DeWind manufactures and operates trenching equipment (including the proposed MT3500 trencher) that continually mixes soil and binder along the full depth of the soil profile. DeWind is in the process of determining the binder quantities necessary to meet the design requirements.

Seepage modeling indicates that a 30-inch-wide barrier wall with a hydraulic conductivity of 1×10^{-6} cm/s requires a minimum embedment of 5 feet into the Upper Caper Fear Confining Unit to reduce seepage and facilitate well collection of PFAS loaded water on the upslope side of the barrier wall. Inputs, cross sections, and outputs of seepage models are attached.

Slope stability modeling of the barrier wall alignment indicates that slopes on the attached grading plans satisfy long term stability requirements but will require careful construction, surface water management, and maintenance to reduce the effects of erosion and maintain access to the groundwater interception system once operational. Additionally, some areas will require MSE retaining walls to achieve recommended grading within the project site limits.

6 REFERENCES

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Attachments

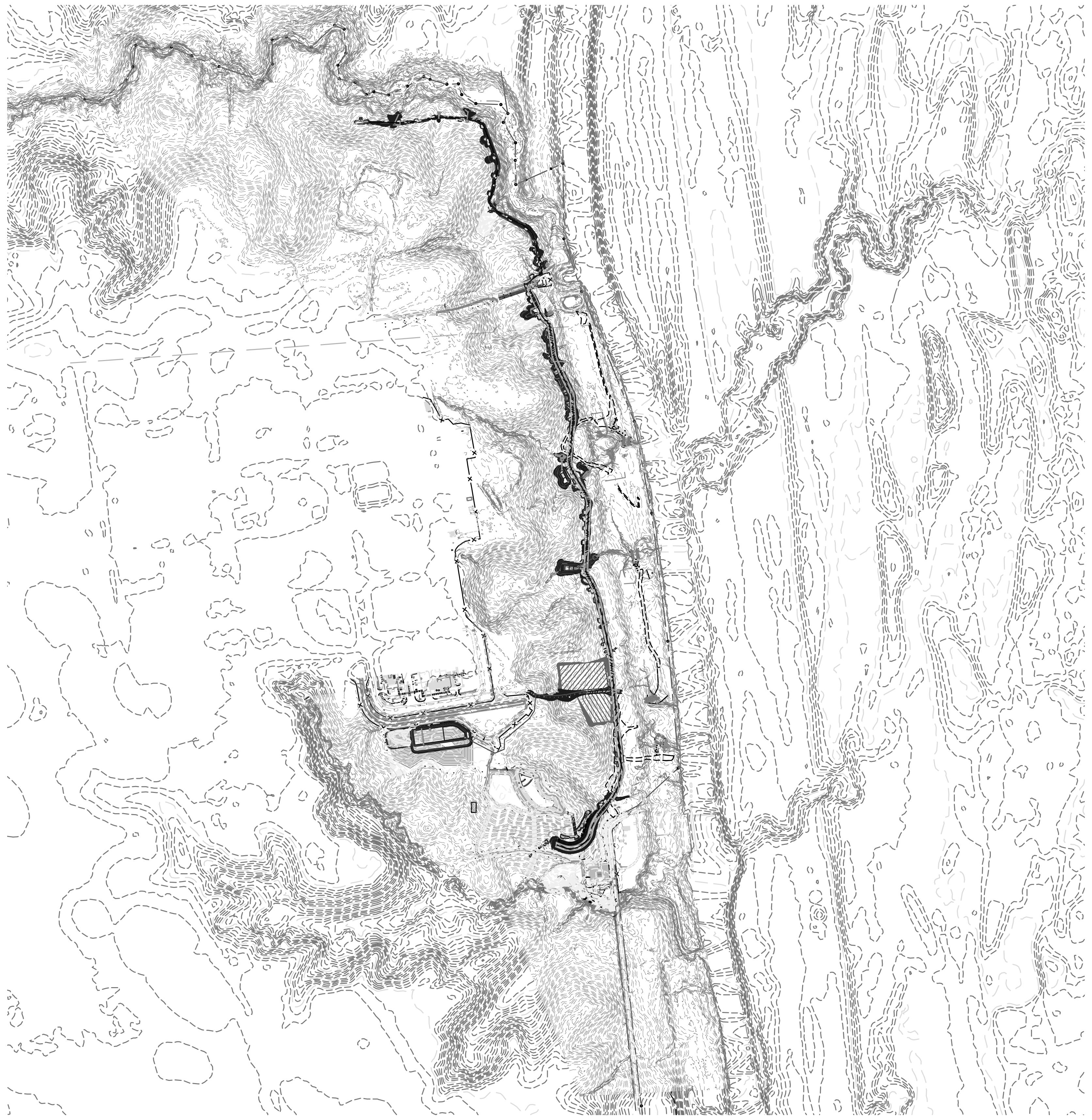
Barrier Wall System 90% Design Plans

The Chemours Company

Fayetteville, North Carolina

90% Barrier Wall Design Package

February 10, 2022



DRAWING INDEX

GENERAL

G-0.0	COVER SHEET

ACCESS ROAD CIVIL PLANS

G-0.1	OVERALL SITE PLAN
G-1.0	PLAN AND PROFILE STA 0+00 TO STA 12+50
G-2.0	PLAN AND PROFILE STA 12+50 TO STA 25+50
G-3.0	PLAN AND PROFILE STA 25+50 TO STA 38+50
G-4.0	PLAN AND PROFILE STA 38+50 TO STA 51+10
G-5.0	PLAN AND PROFILE STA 51+10 TO STA 64+50
G-6.0	PLAN AND PROFILE STA 64+50 TO STA 77+50
G-7.0	PLAN AND PROFILE STA 77+50 TO STA 90+00.91-END
G-8.0	ACCESS ROAD TYPICAL ROAD SECTION DETAILS
G-9.0	ACCESS ROAD SITE DETAILS
G-10.0	ENLARGED SITE PLANS - TURNAROUND AND EXISTING ROAD CONNECTIONS
G-11.0	WTP / CONTRACTOR LAYDOWN PAD ROADWAY PLAN AND PROFILE
G-12.0	DETAILS
G-13.0	DETAILS

RETAINING WALL PLANS

RW-0.1	NOTES
RW-0.2	DETAILS
RW-0.3	DETAILS
RW-0.4	SITE PLAN
RW-0.5	BLOCK QUANTITIES
RW-1.0	RETAINING WALL #1 PLAN AND PROFILE
RW-2.0	RETAINING WALL #2 PLAN AND PROFILE
RW-3.0	RETAINING WALL #3 PLAN AND PROFILE
RW-4.0	RETAINING WALL #4 & #5 PLAN AND PROFILE
RW-5.0	RETAINING WALL #6 PLAN AND PROFILE
RW-6.0	RETAINING WALL #7 PLAN AND PROFILE
RW-7.0	RETAINING WALL #8 PLAN AND PROFILE
RW-8.0	RETAINING WALL #9 PLAN AND PROFILE
RW-9.0	RETAINING WALL #10-13 PLAN AND PROFILE

SOIL NAIL WALL PLANS

SN-1.0	NOTES
SN-1.1	SITE PLAN AND DETAILS
SN-1.2	SOIL NAIL WALL PROFILE

BARRIER WALL PLANS

BW-1.0	BARRIER WALL PLAN AND PROFILE STA 30+49.6 TO STA 45+00
BW-2.0	BARRIER WALL PLAN AND PROFILE STA 45+00 TO STA 59+50
BW-3.0	BARRIER WALL PLAN AND PROFILE STA 59+50 TO STA 74+00
BW-4.0	BARRIER WALL PLAN AND PROFILE STA 74+00 TO STA 88+50
BW-5.0	BARRIER WALL PLAN AND PROFILE STA 88+50 TO STA 90+0.01

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90% Barrier Wall Design Package
Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

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ACCESS ROAD - SITE PLAN
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0' 300' 600'

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Access Road Civil Plans
Overall Site Plan

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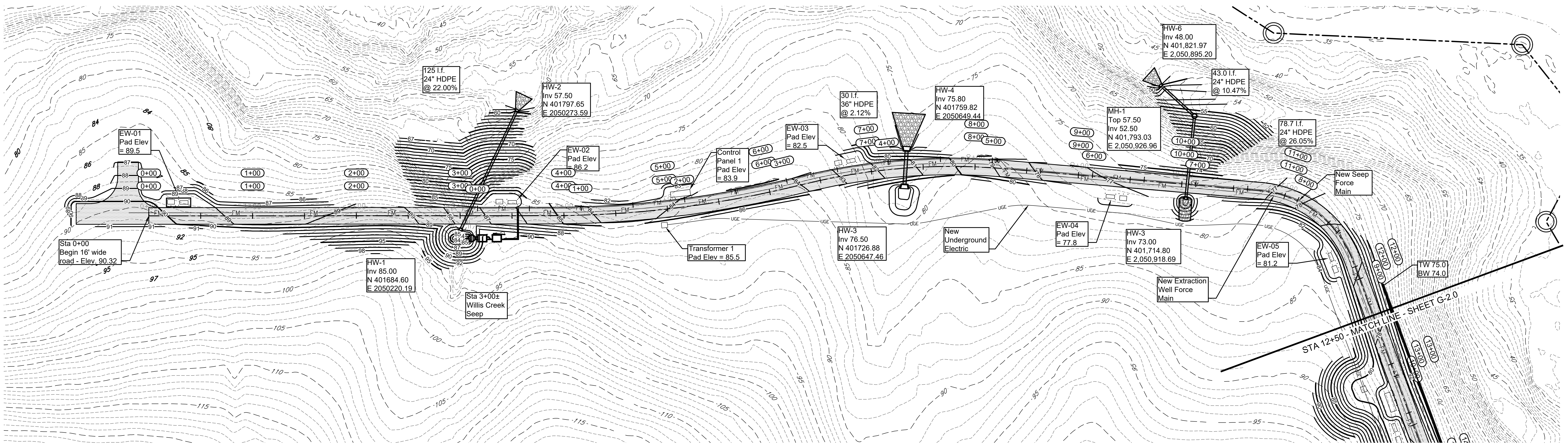

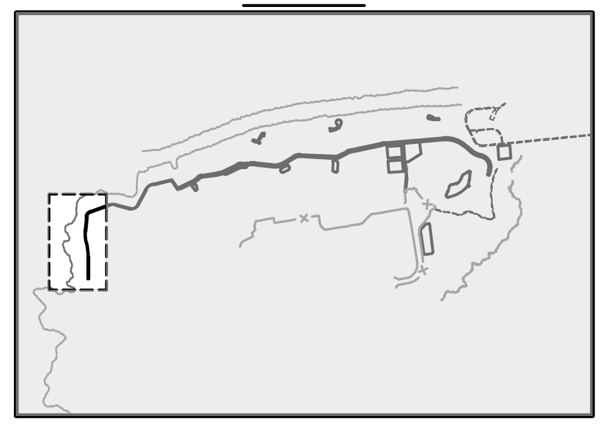

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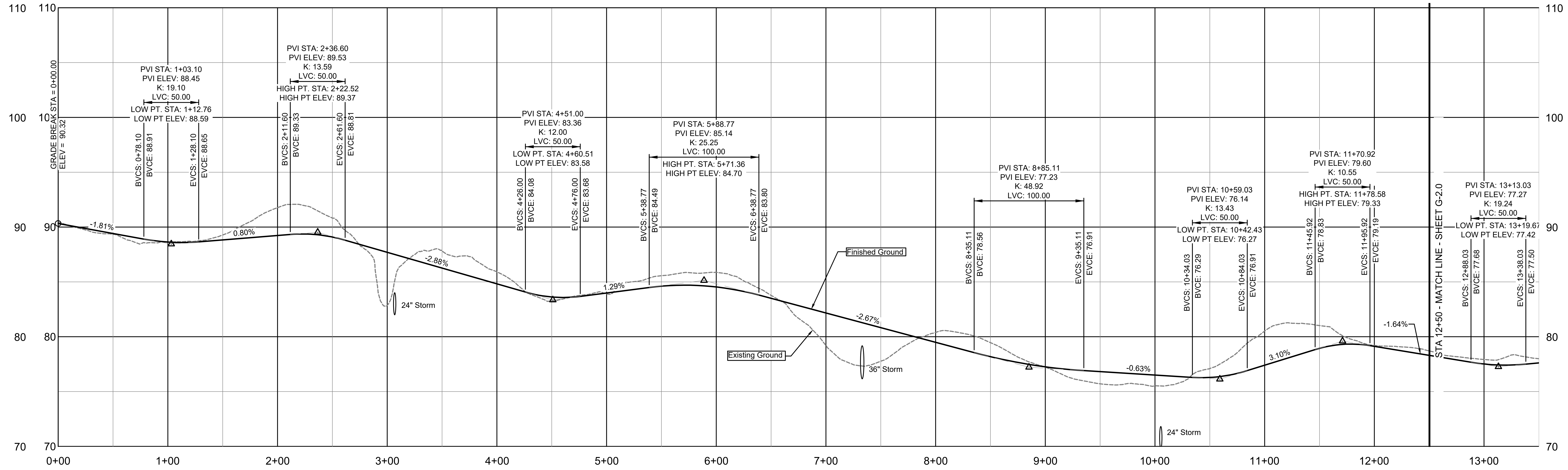

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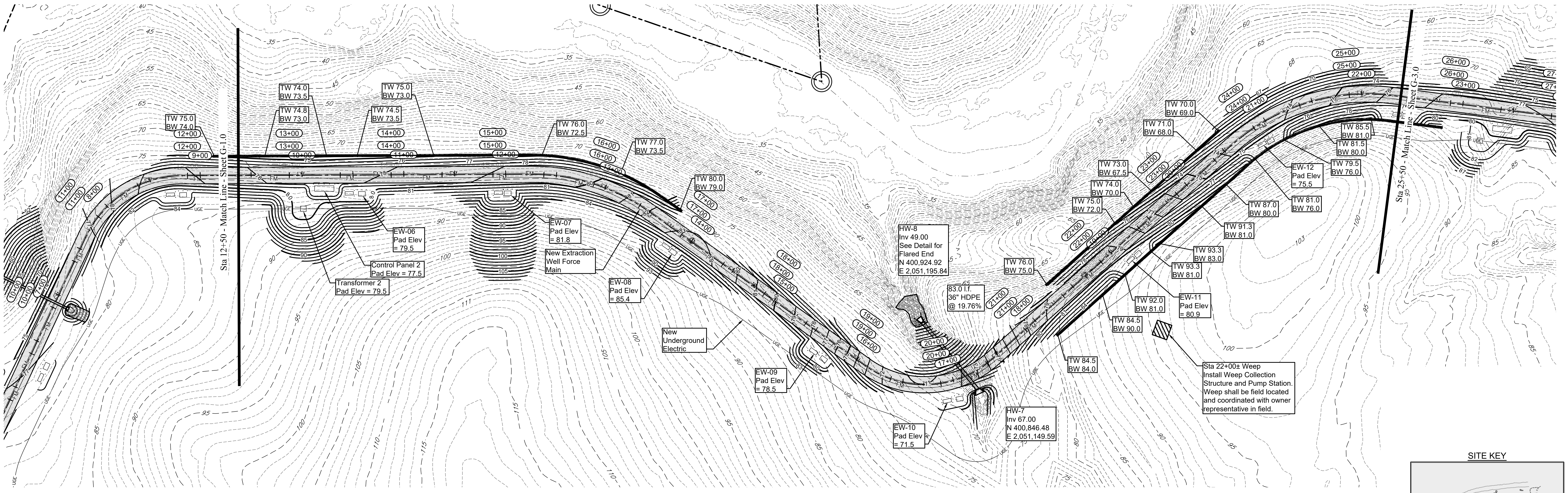

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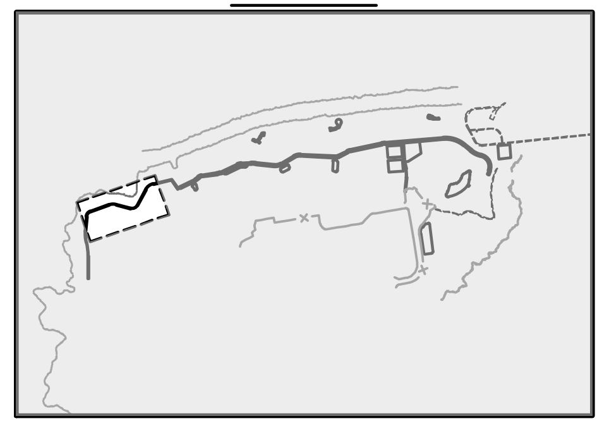

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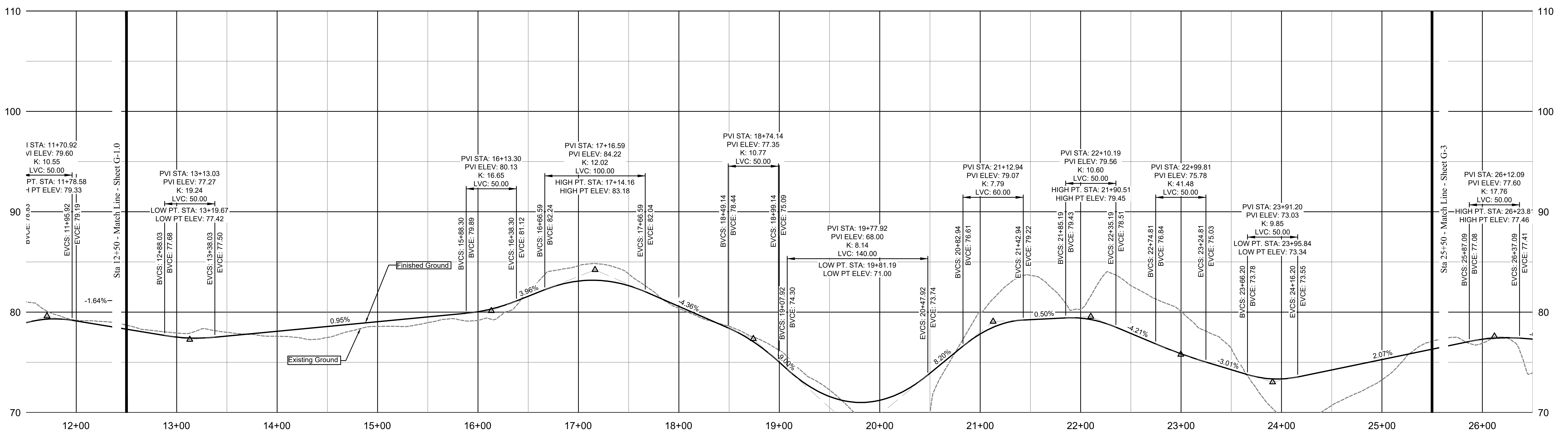

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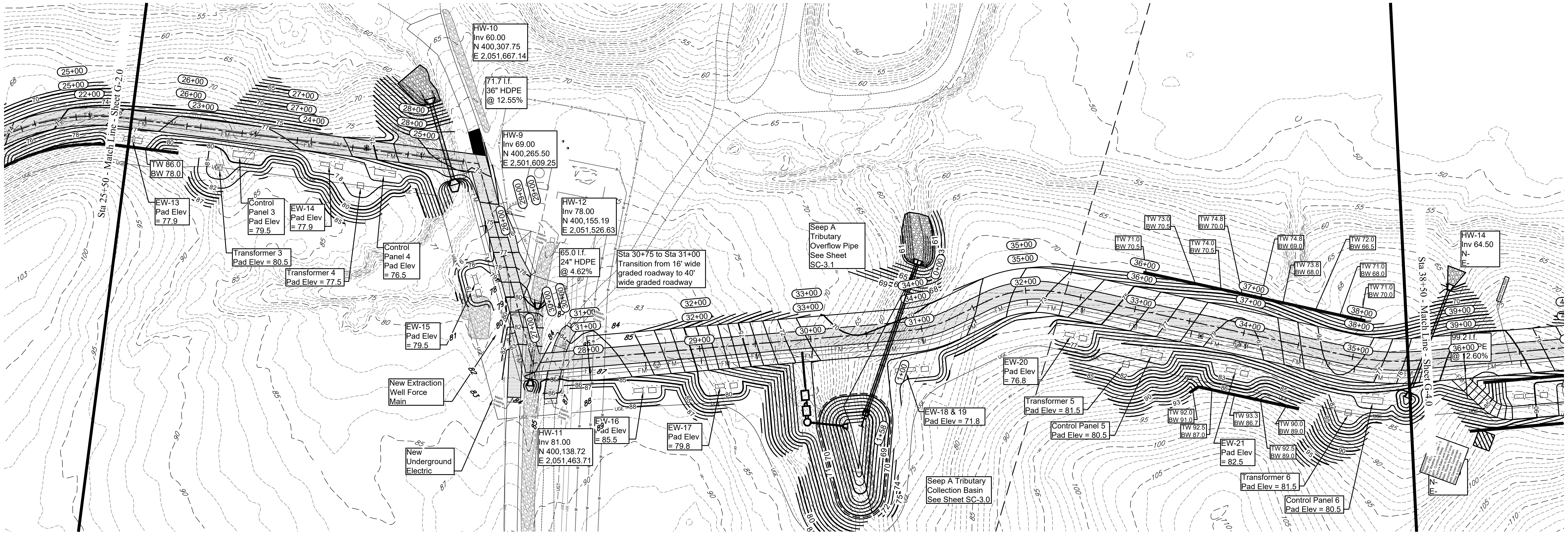

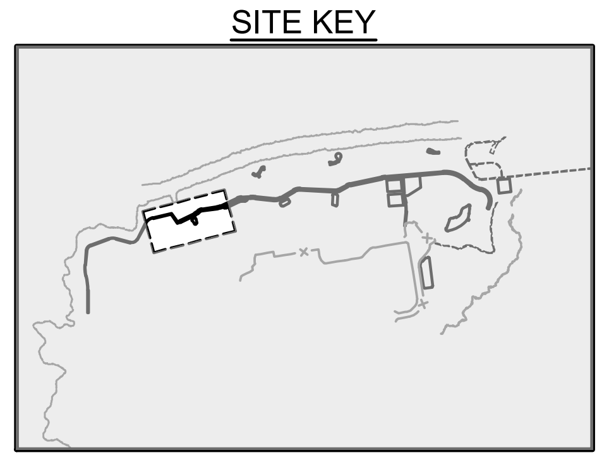

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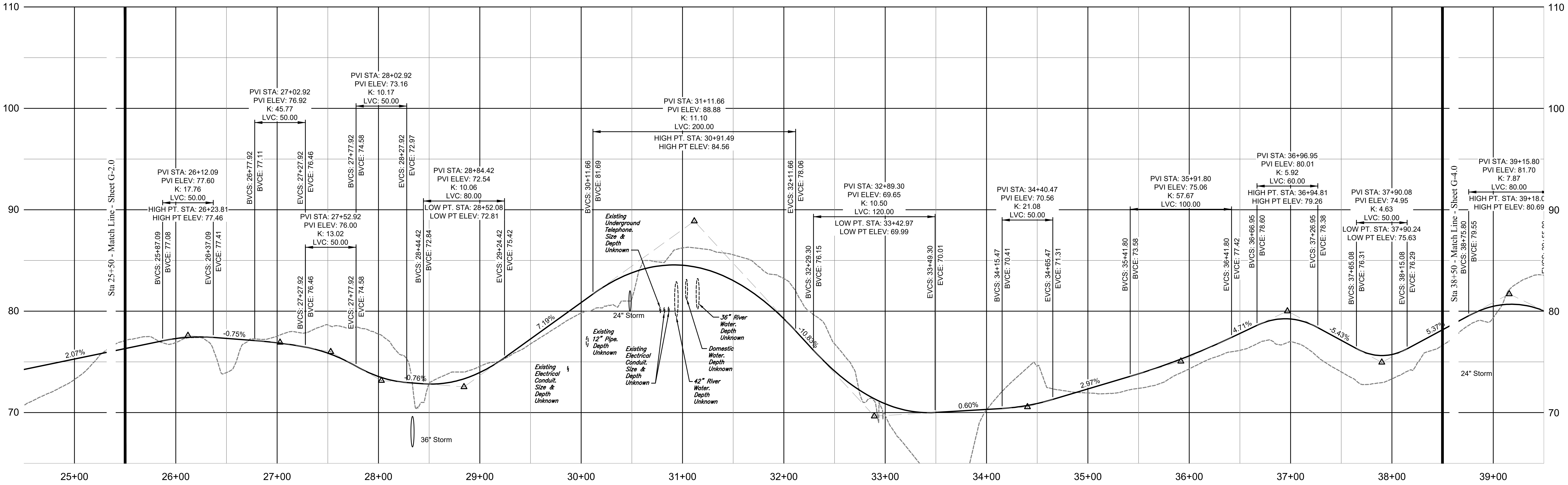

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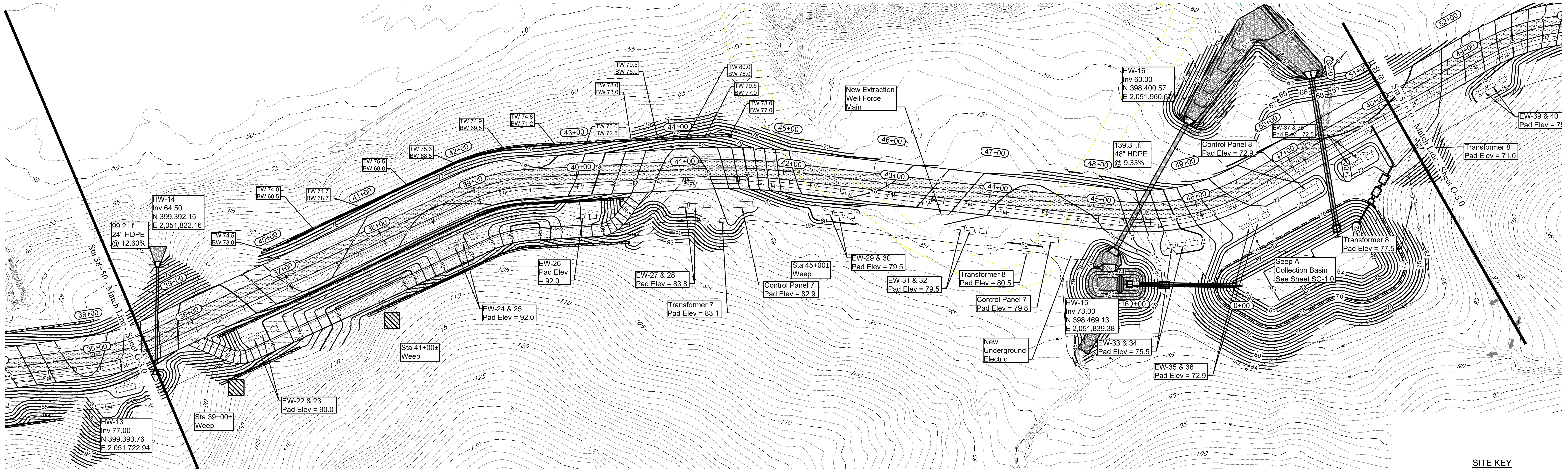

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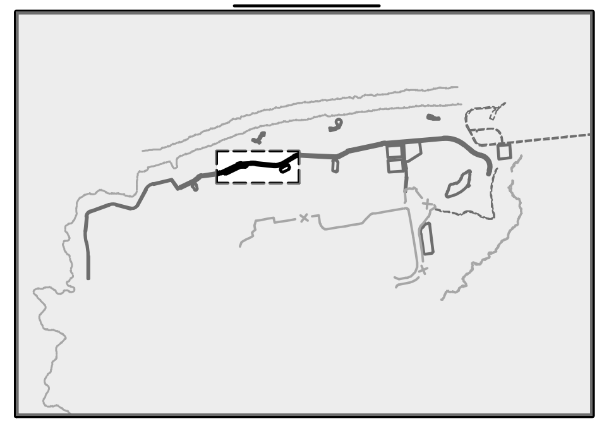

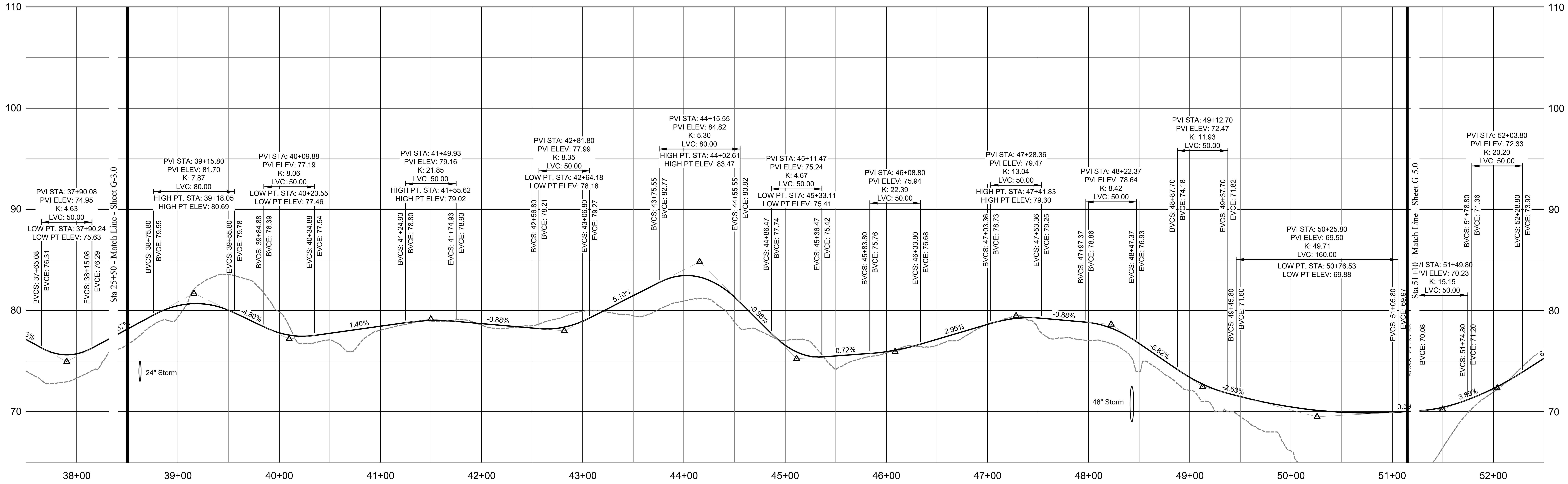

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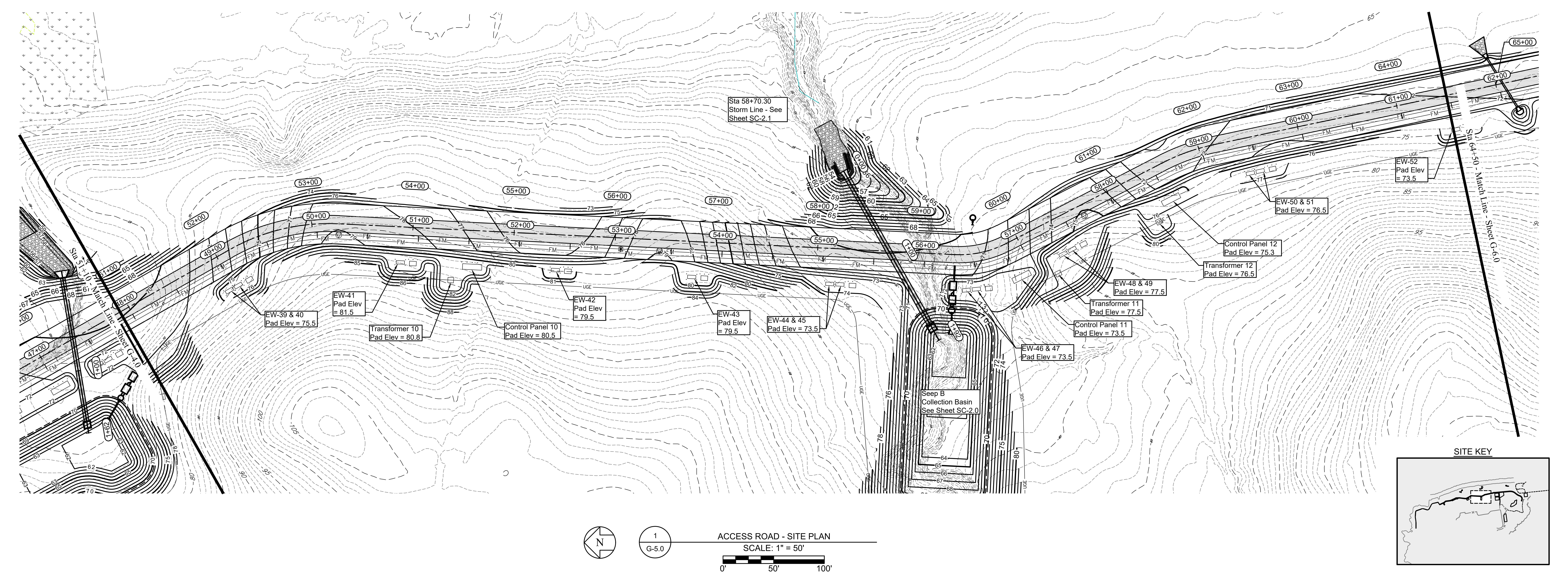

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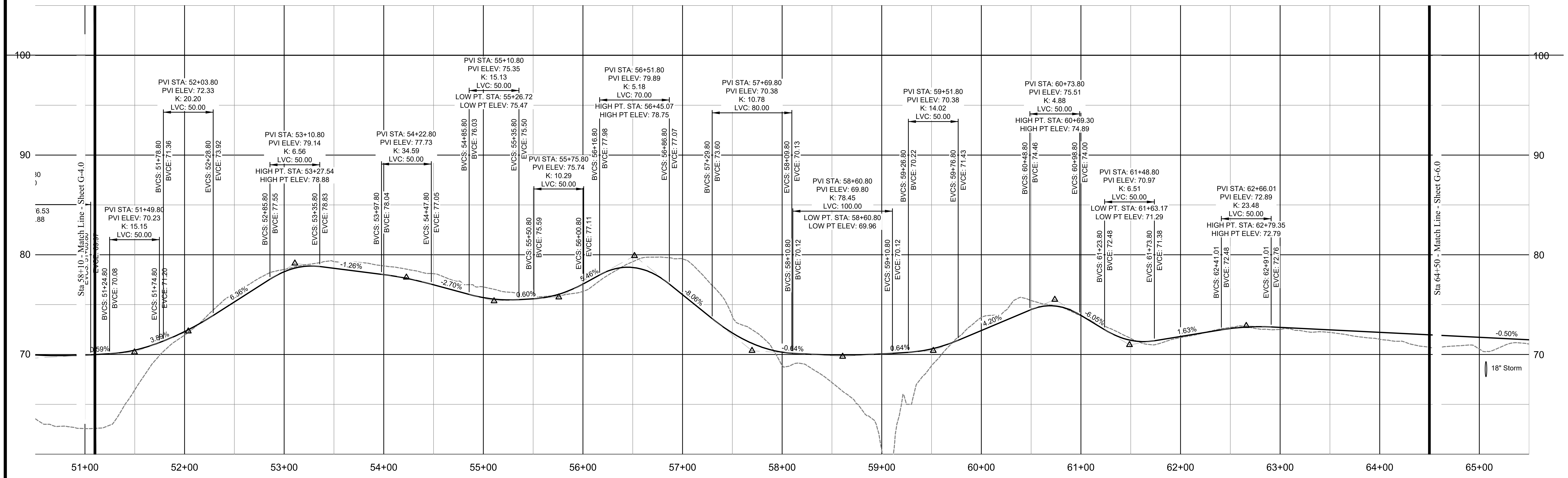

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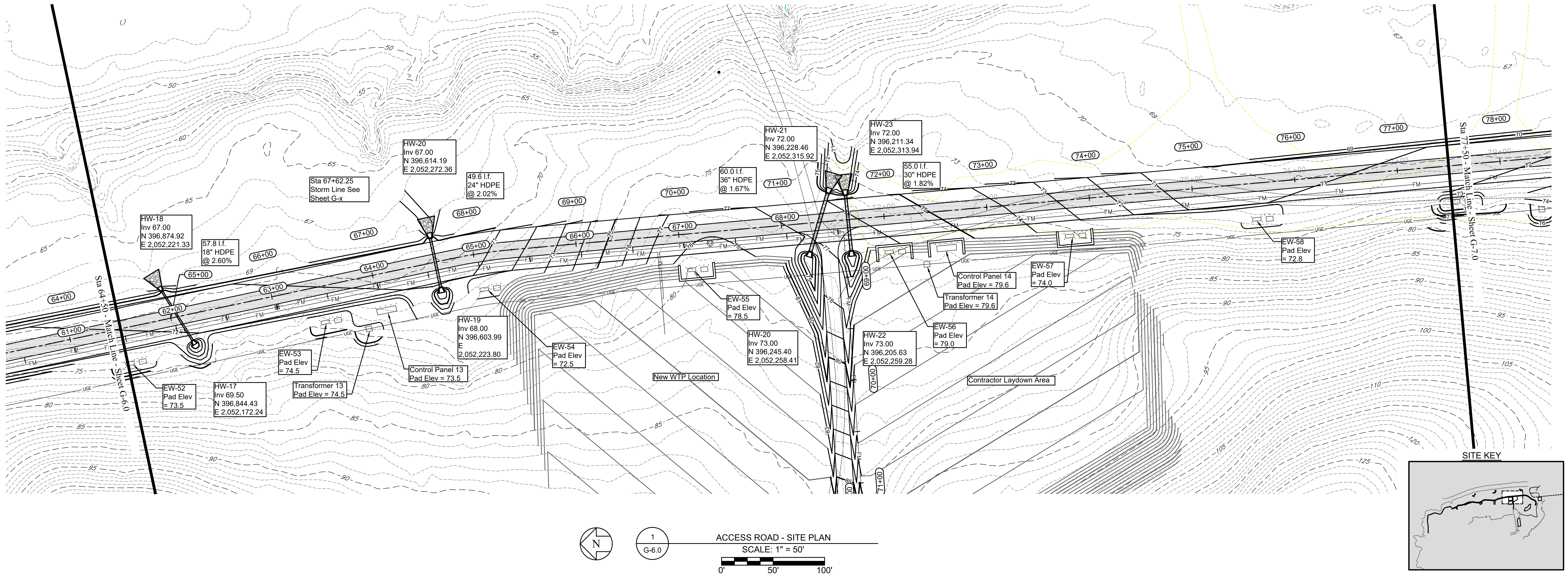

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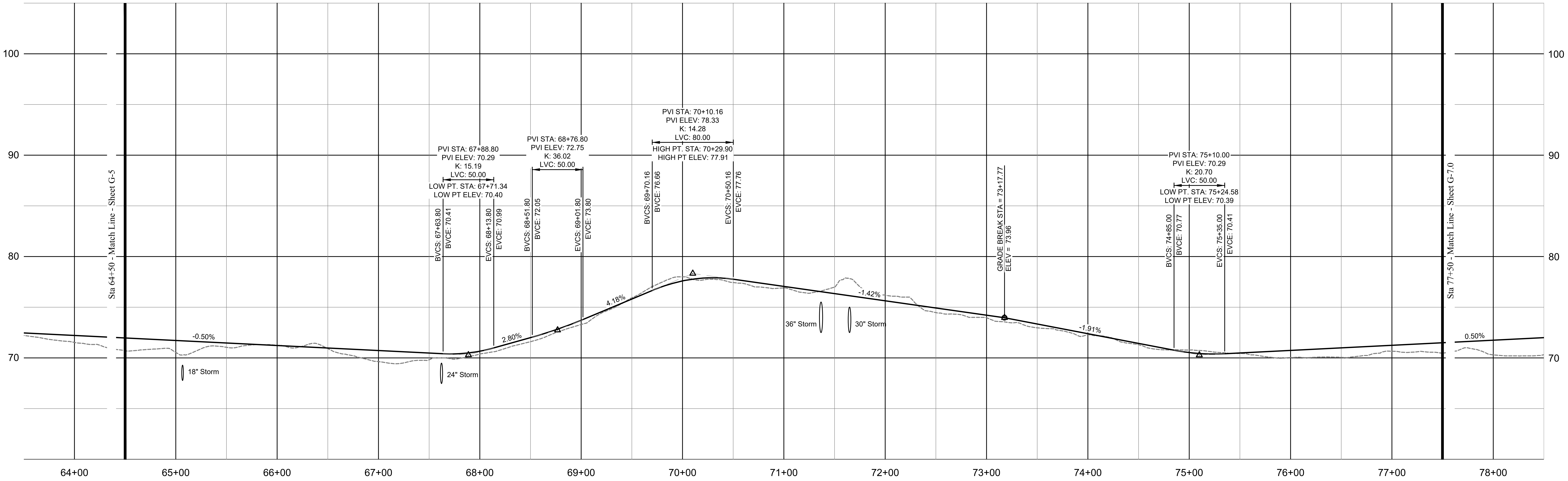

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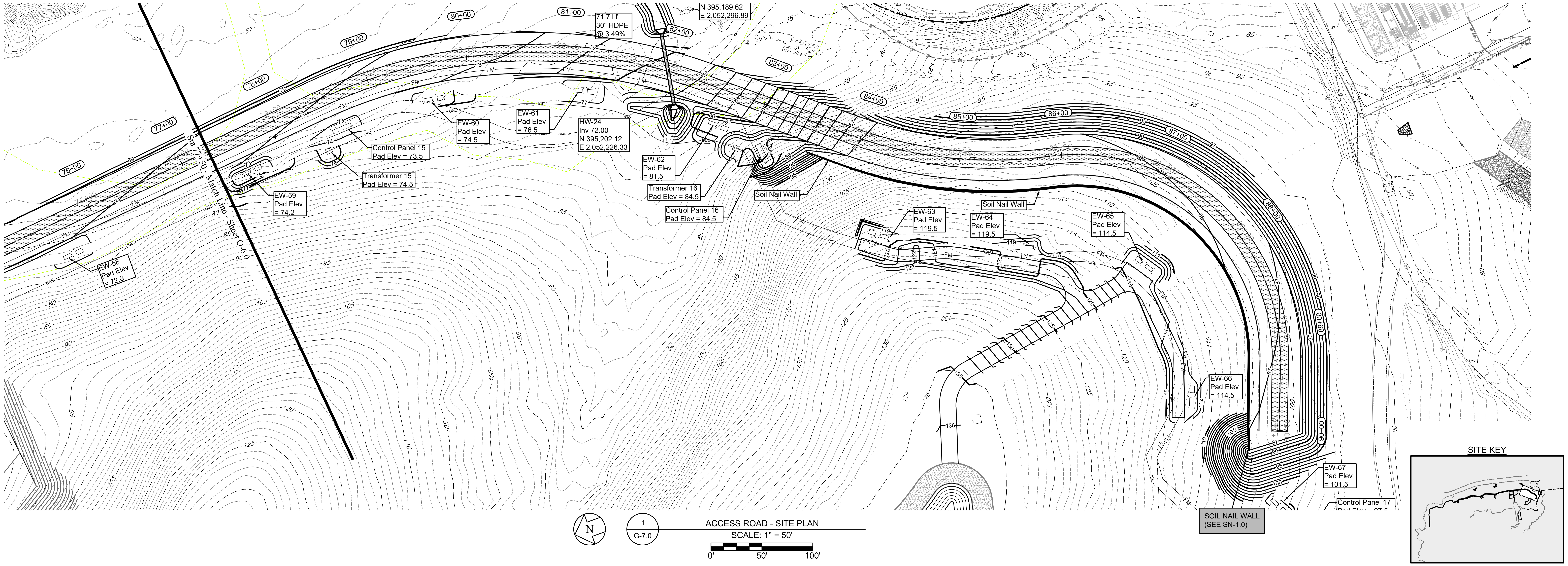

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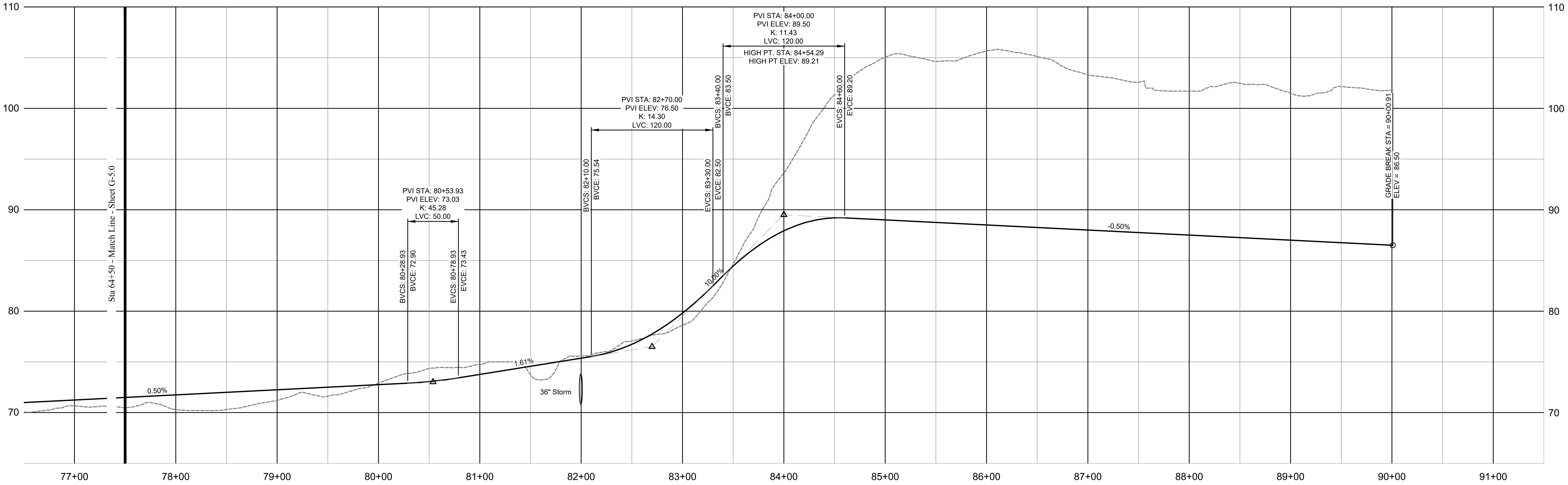

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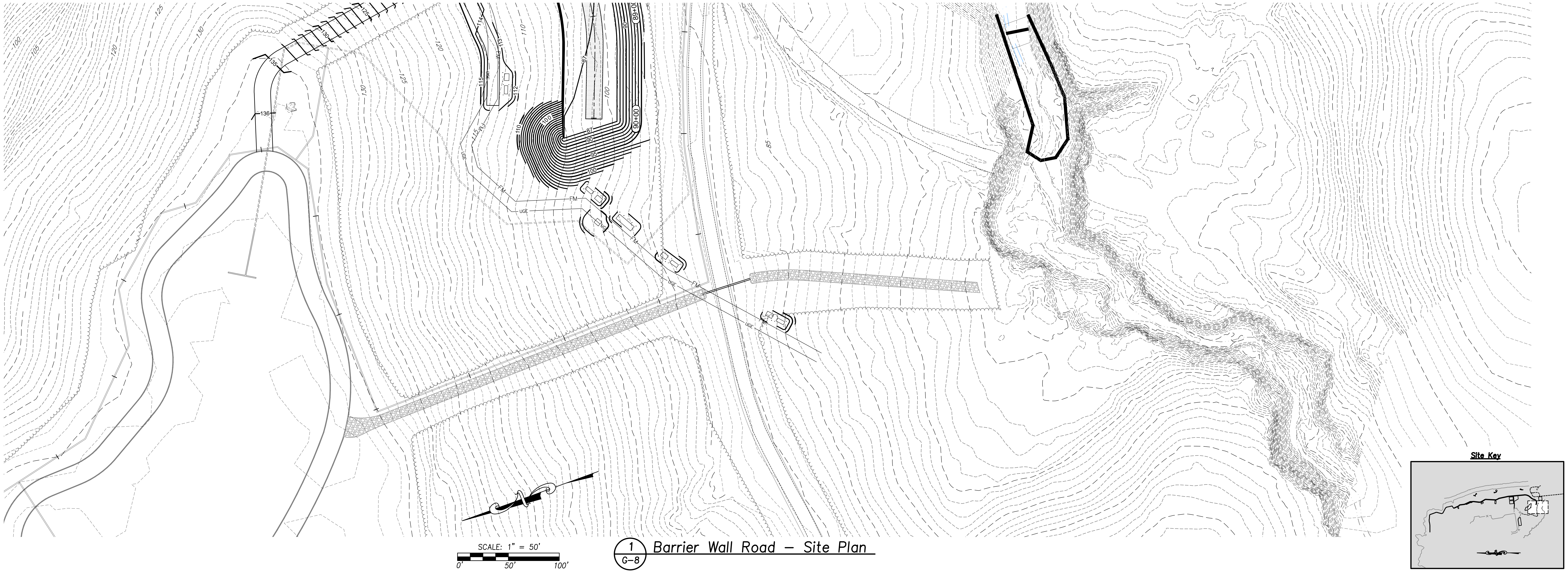

1
G-8
Barrier Wall Road – Site Plan

GEOS
Geotechnical, Environmental and Materials Engineers

Barrier Wall Road - Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY:	APPROVED BY:
BB	DAH

SCALE:
AS SHOWN

DATE:
February 10, 2022

Revisions

No.	Date	Description	By:
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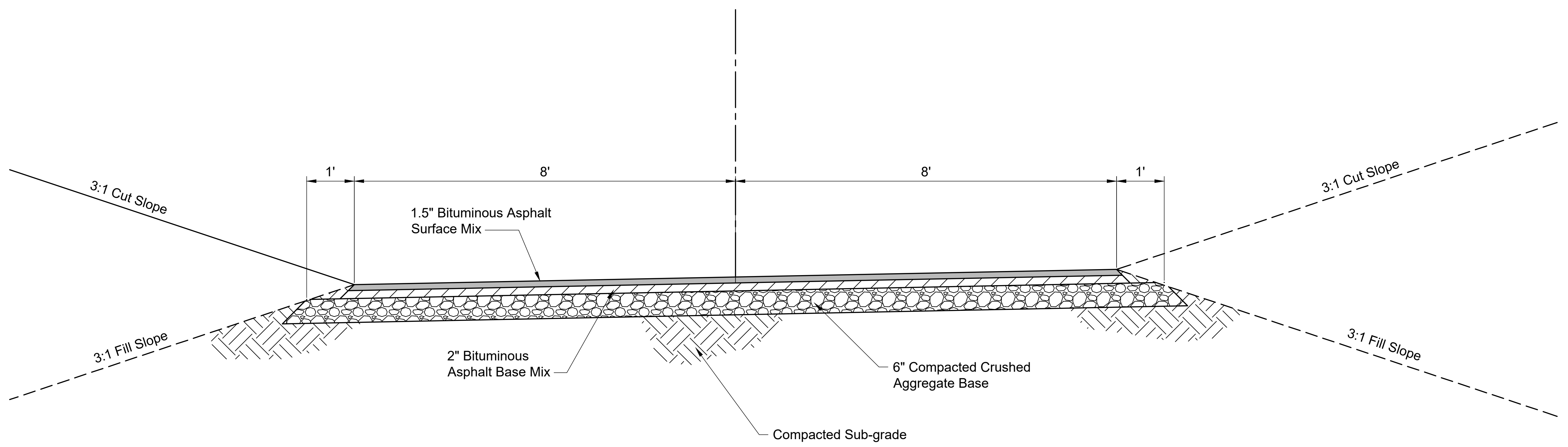
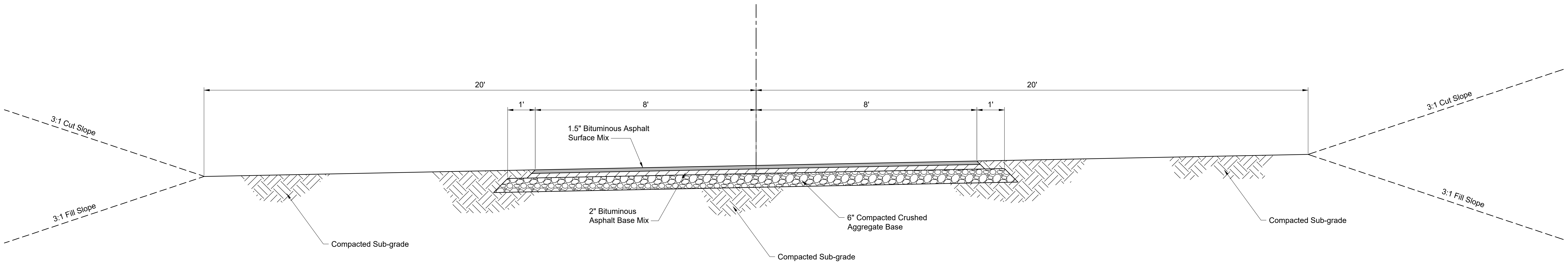
DRAWING:
G-8

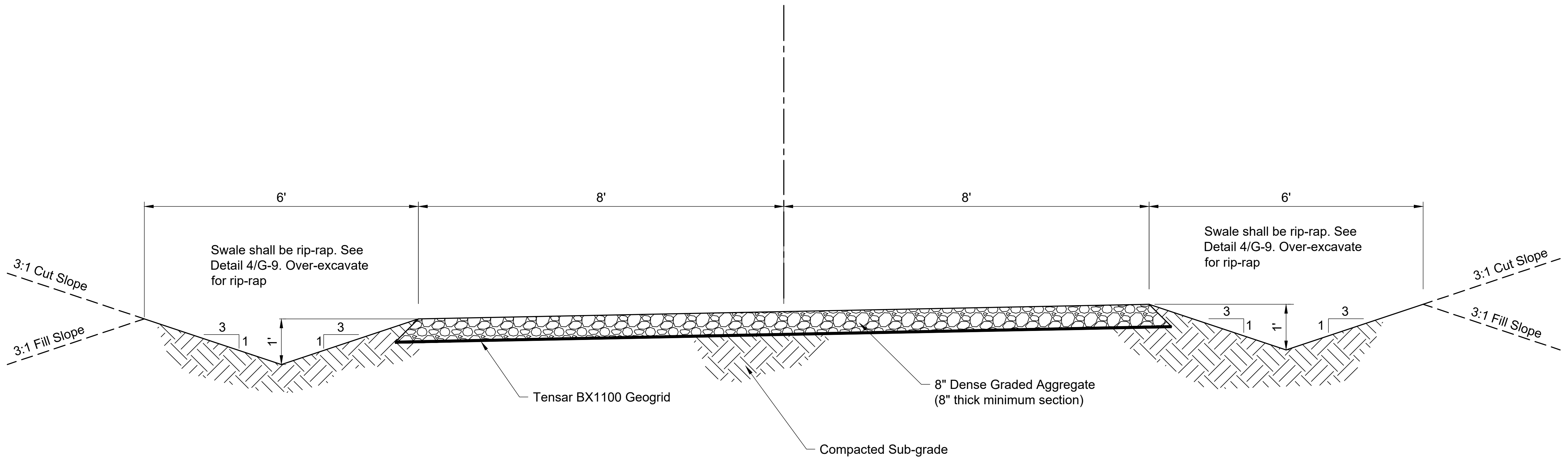
PROJECT NUMBER:
45-20803



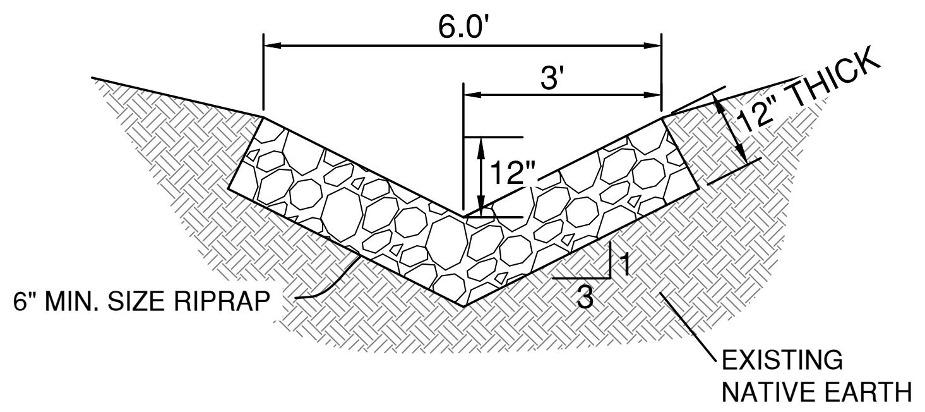
1 G-9 Barrier Wall Road – Typical Section – Sta 0+00 to Sta 30+75



2 G-9 Barrier Wall Road – Typical Section – Sta 31+00 to Sta 90+00.90 – End



3 G-9 Gravel Access Road – Typical Section



4 G-9 Roadside Rip-rap Swale

Geotechnical, Environmental and Materials Engineers

Typical Sections

Chemours Fayetteville Works
Fayetteville, North Carolina

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DESIGNED BY: BB	APPROVED BY: DAH

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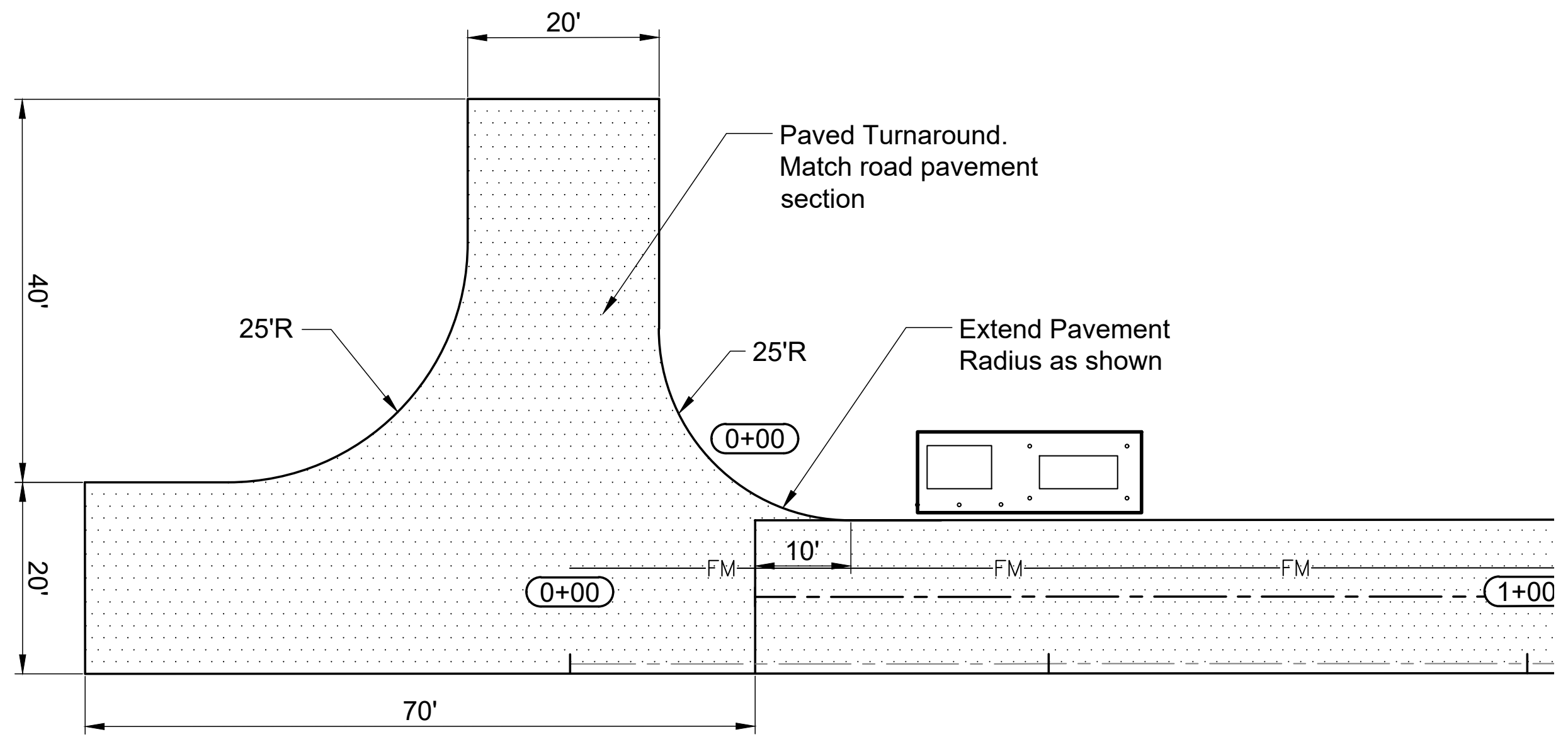
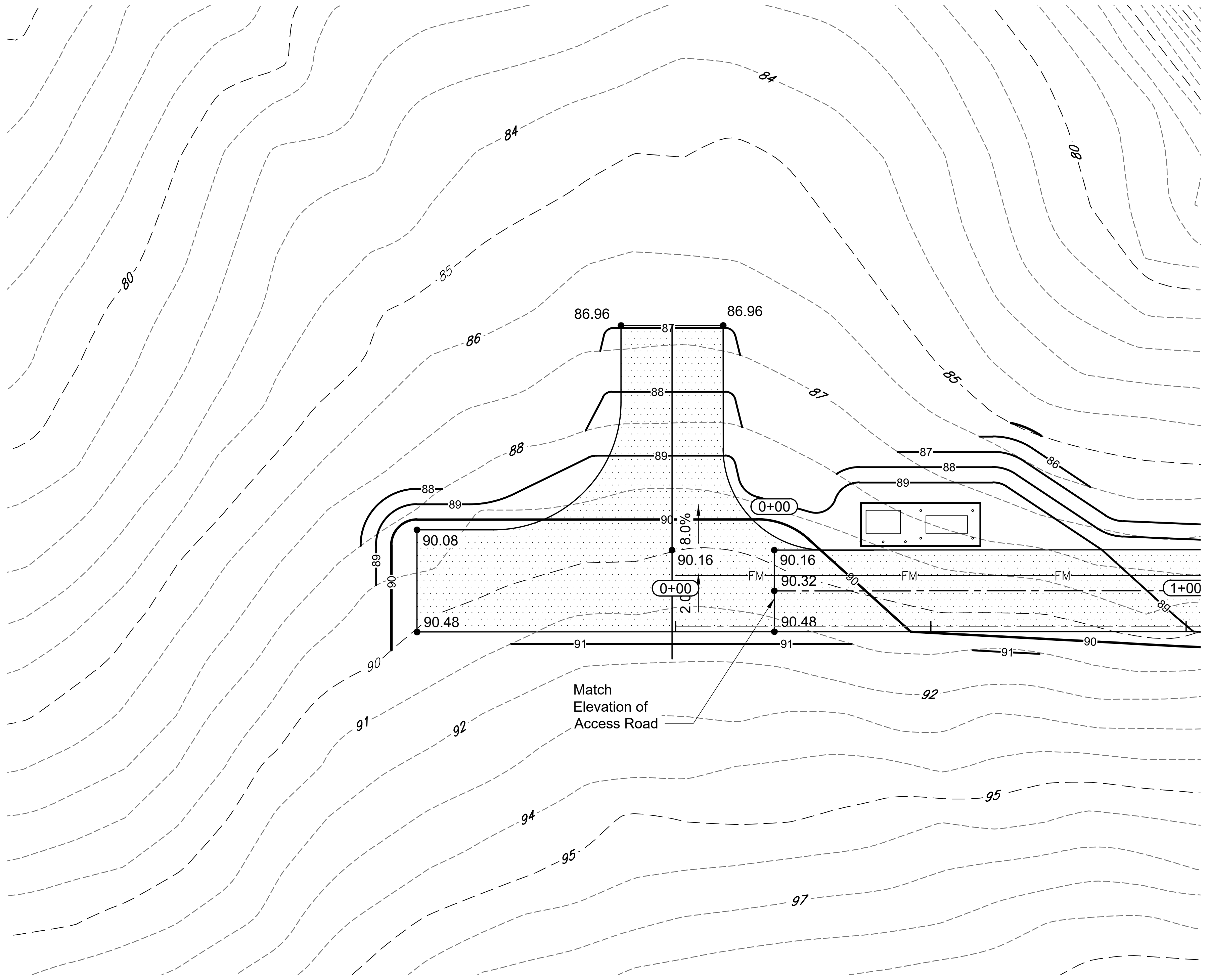
DRAWING: G-9

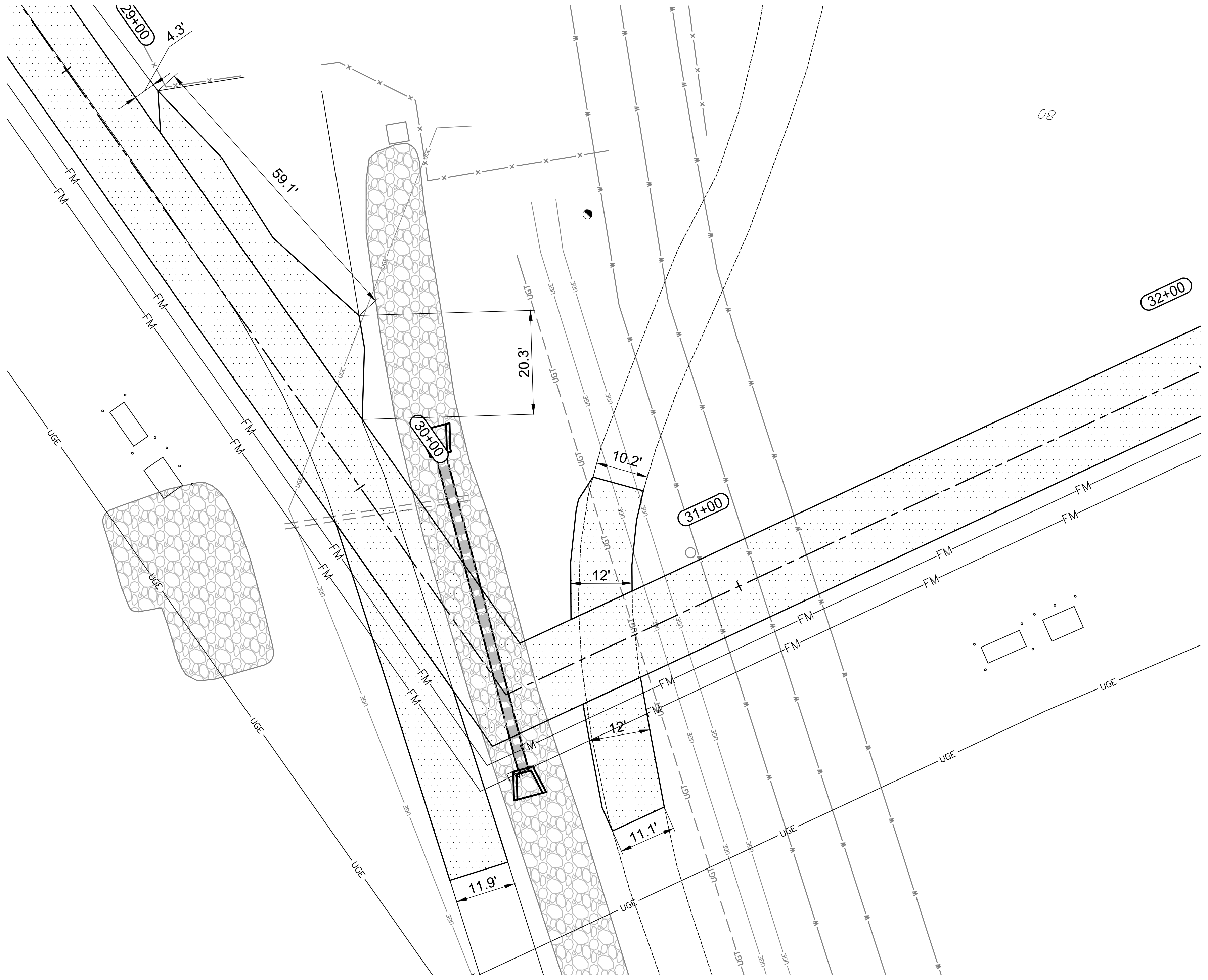
PROJECT NUMBER: 45-20803



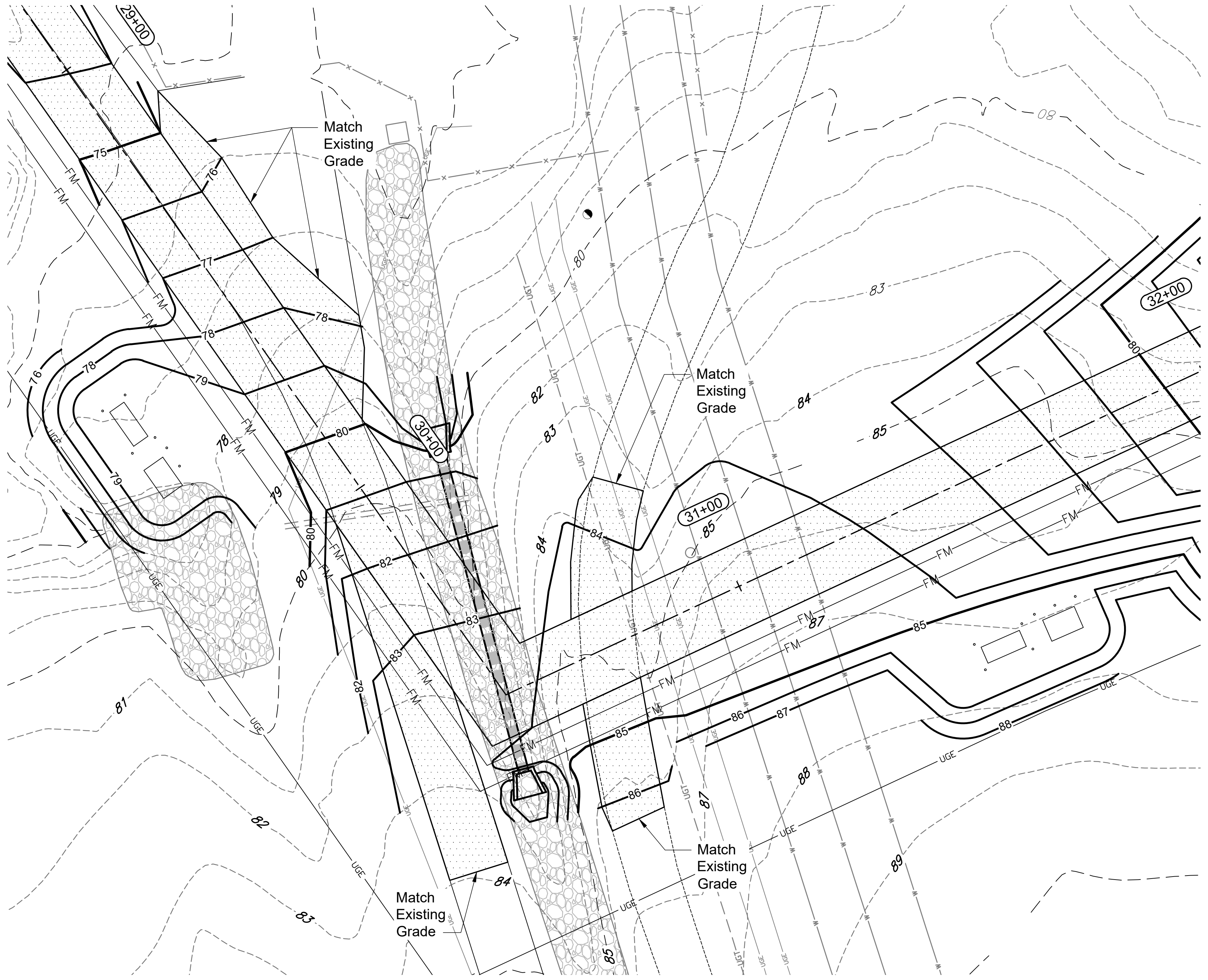
1 G-10 Barrier Wall Road Turnaround – Layout Plan



2 G-10 Barrier Wall Road Turnaround – Grading Plan



3 G-10 Barrier Wall Road Connection to Existing Road – Sta 31+75± Layout Plan



4 G-10 Barrier Wall Road Connection to Existing Road – Sta 31+75± Grading Plan

Geotechnical, Environmental and Materials Engineers

Enlarged Site Plans
Turnaround and Existing Road Connections

Chemours Fayetteville Works
Fayetteville, North Carolina

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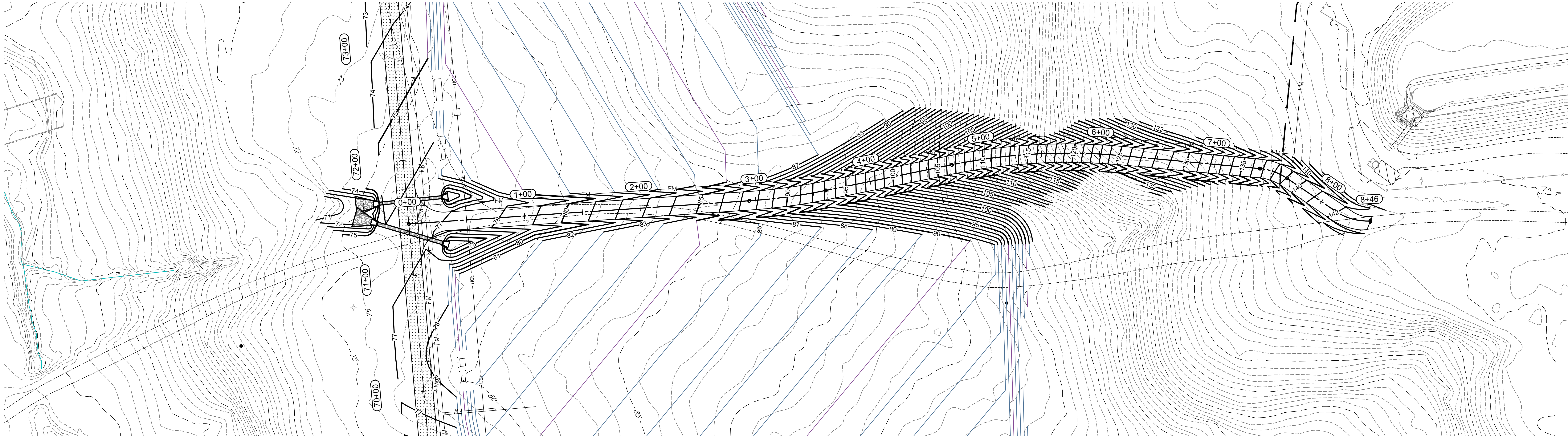
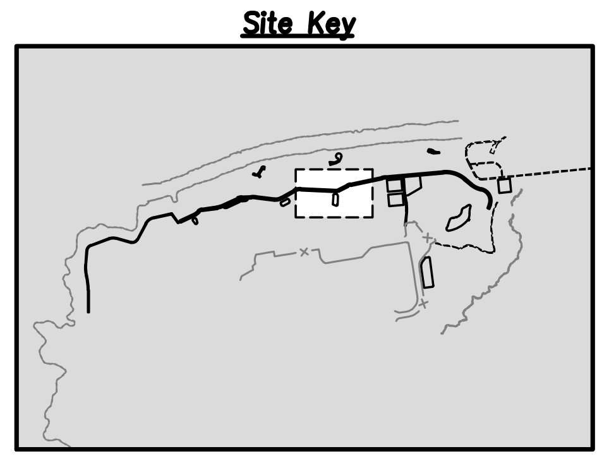
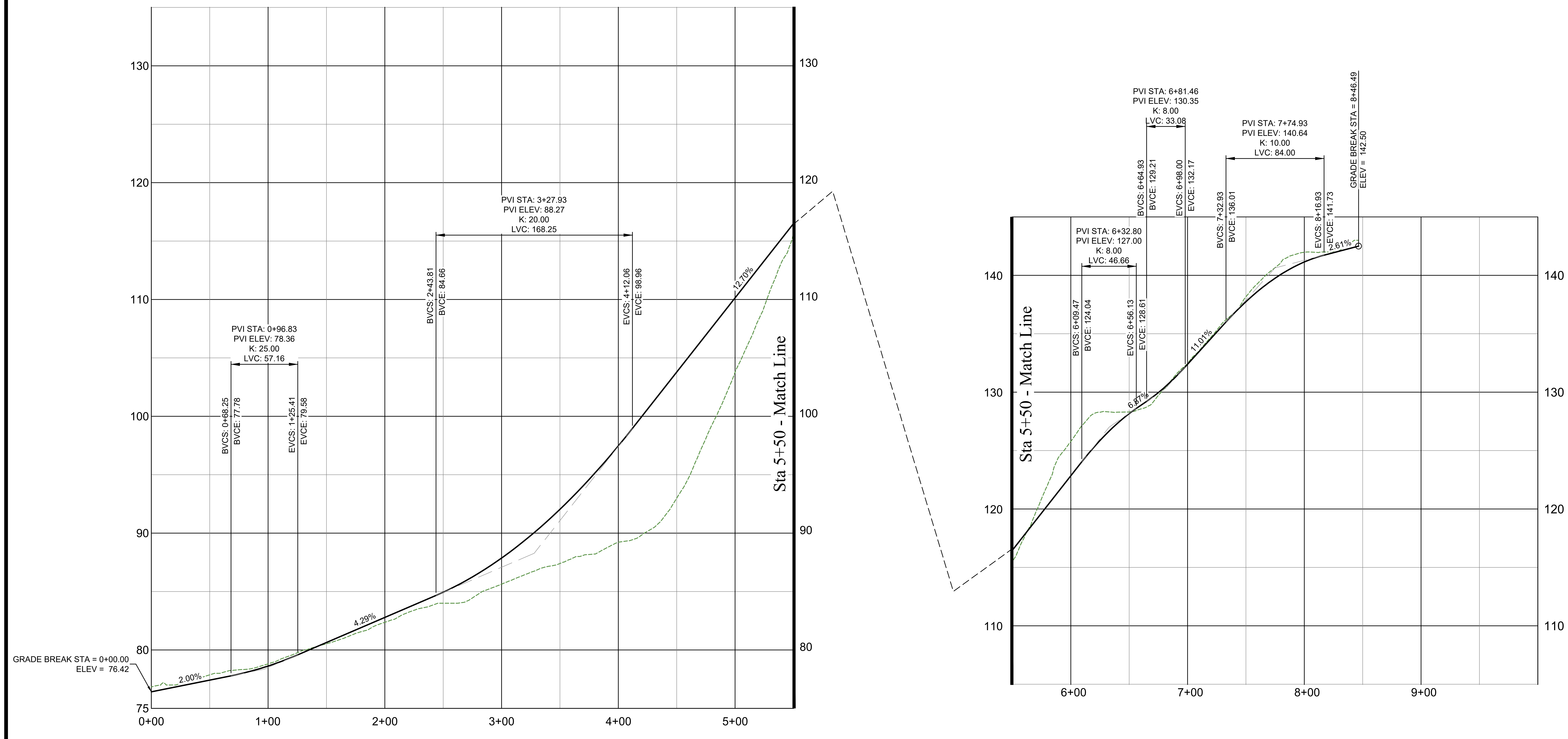
DRAWING: G-10

PROJECT NUMBER: 45-20803



1 G-10 *WTP Access Road – Site Plan*


Site Key



2 G-10 *WTP Access Road – Profile*

GEOS
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Access Road - Plan and Profile
Sta 51+10 to Sta 64+50

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY: DAH

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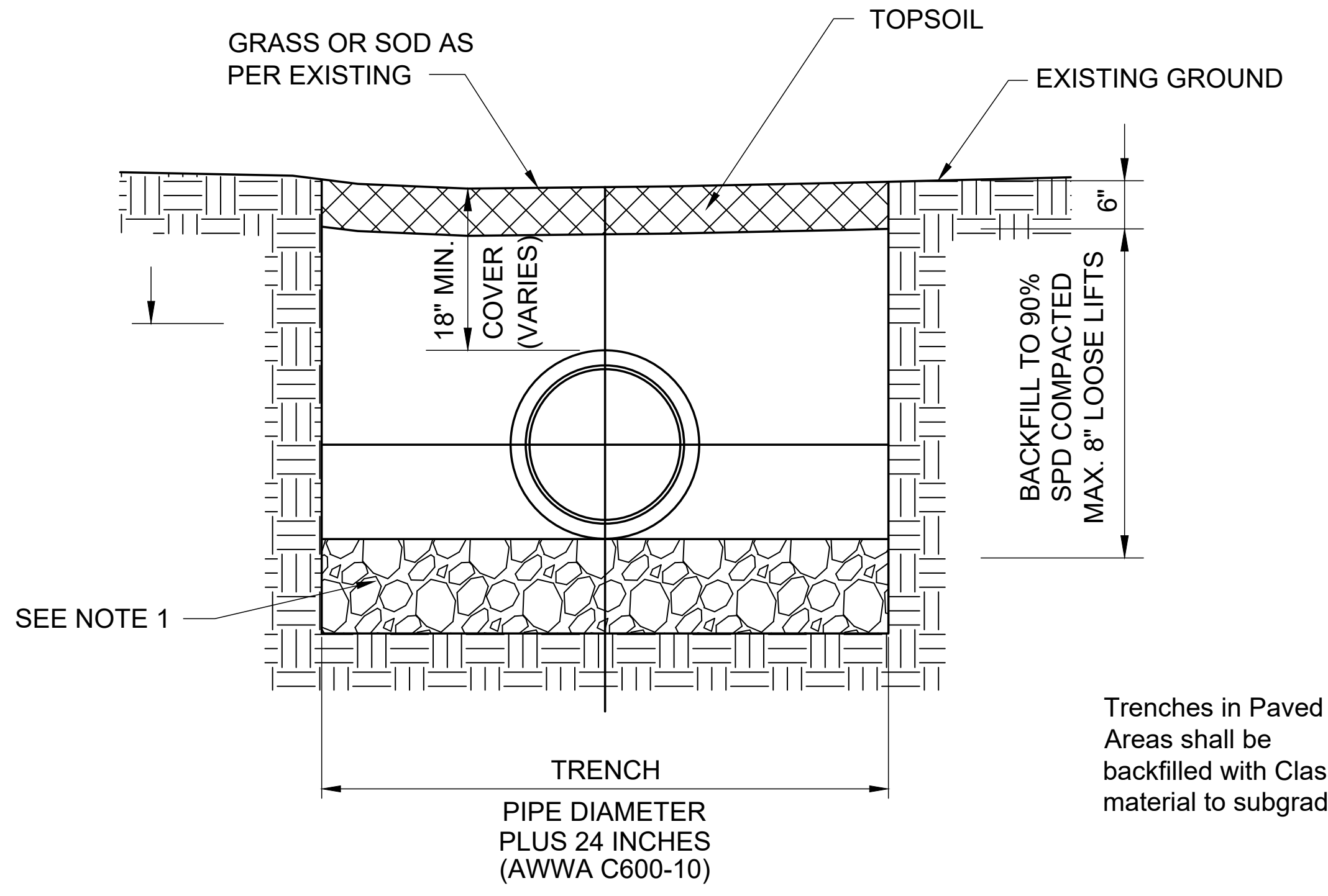
DRAWING:
G-11

PROJECT NUMBER:
45-20803

IMPROVED AREAS OR LAWNS, FROM CENTER LINE OF PIPE, MATERIAL SHALL BE PLACED IN 8" LAYERS. TOP 6" SHALL BE TOPSOIL FREE FROM ROCKS, ROOTS, ETC.

BACKFILL SHALL BE NATIVE MATERIAL FREE OF LARGE ROCKS OR HARD MATERIALS, SHALL BE COMPACTED TO 90% S.P.D. TO CL OF PIPE TO INSURE THAT NO VOID OR UNCOMPACTED AREAS OCCUR.

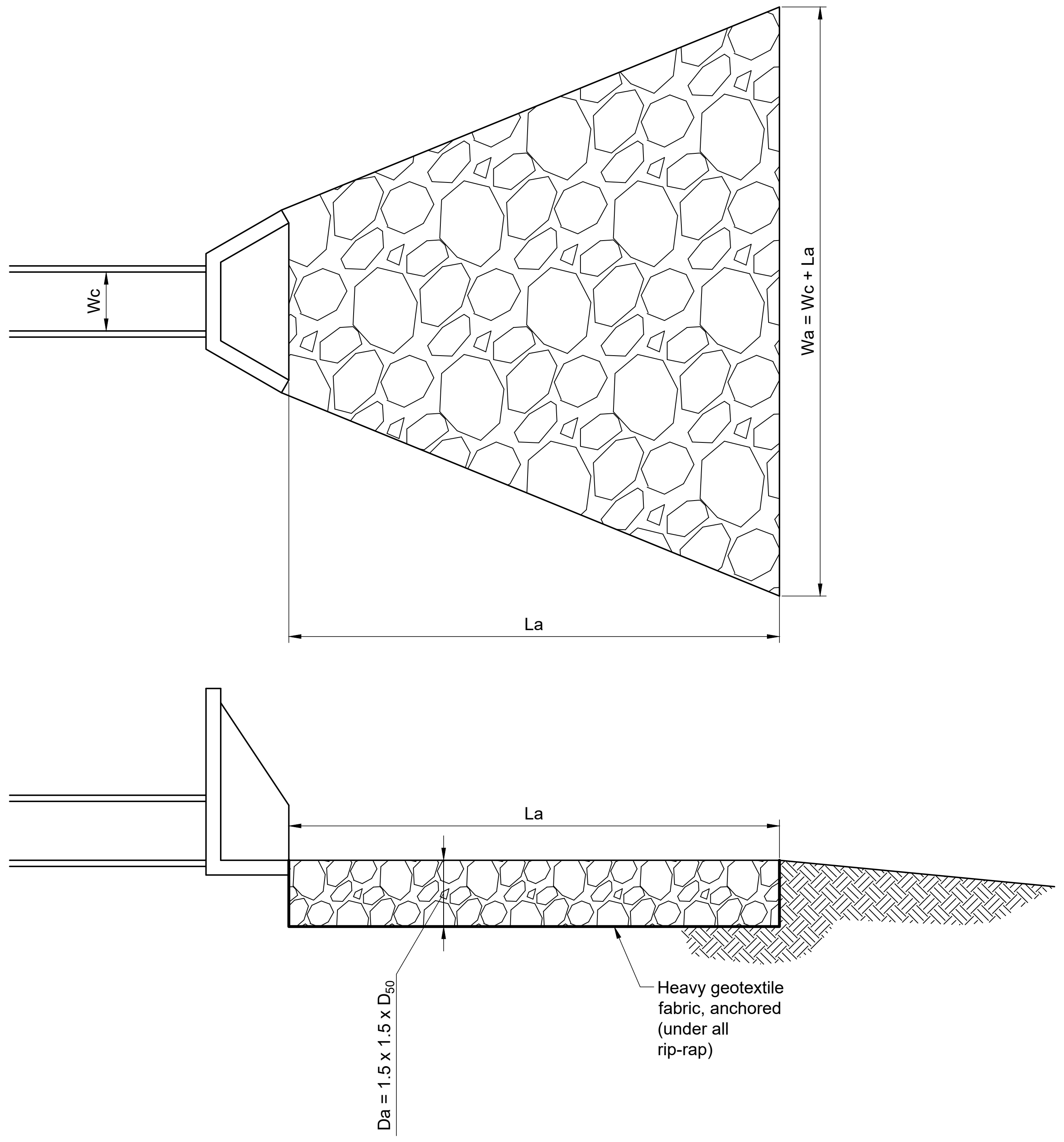


Trenches in Paved Areas shall be backfilled with Class 1 material to subgrade.

NOTES:

1. TRENCH FOUNDATION REQUIRED IF DIRECTED BY THE OWNER. DEPTH VARIES.
2. ALL SLOPES SHALL CONFORM TO OSHA REQUIREMENTS. ADDITIONAL PROTECTIVE MEASURES MAY BE REQUIRED ABOVE AND BEYOND OSHA DEPENDING ON SPECIFIC TRENCH CONDITIONS. CONTRACTOR IS SOLELY RESPONSIBLE FOR THE SAFETY OF WORKERS, THE GENERAL PUBLIC, AND OTHERS INVOLVED IN THE PROJECT AND SHALL PROVIDE SHEETING, BRACING, OR WHATEVER ACTION NECESSARY TO INSURE THE SAFETY OF ALL PEOPLE, PROPERTY AND STRUCTURES.
3. BEDDING:
   A. CLASS "1" SHALL BE No. 57 CRUSHED LIMESTONE.
   B. CLASS "2" SHALL BE REINFORCED CONCRETE 3,000 PSI DESIGN MIX
   C. CLASS "3" SHALL BE NATIVE SOIL

1 G-12 Pipe Bedding

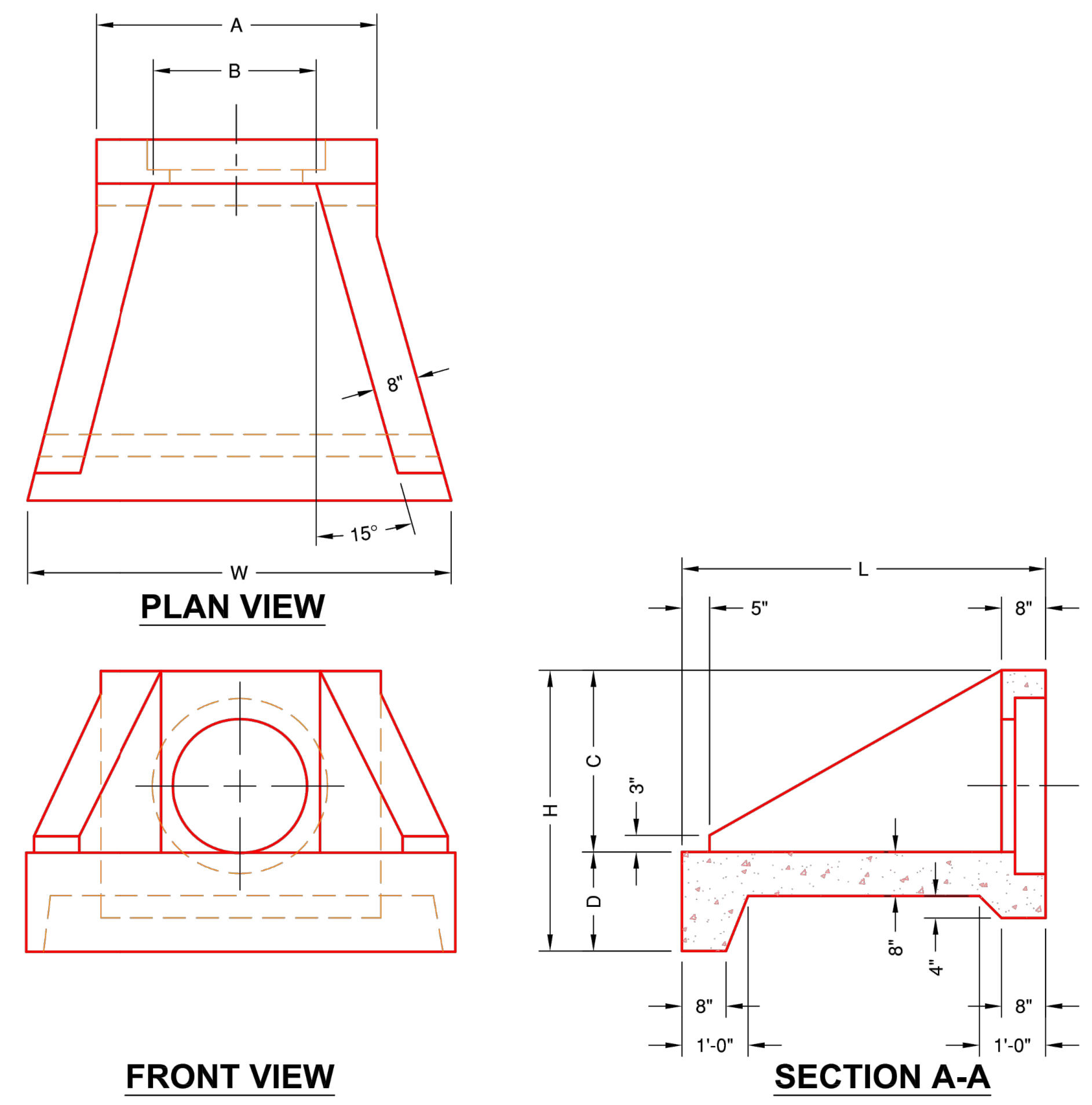


Heavy geotextile fabric, anchored (under all rip-rap)

Note: The dimensions are the minimum dimensions. Plans may indicate longer rip-rap aprons

Culvert Diameter	La (feet)	D_{50} (inches)
12"	10	3.5
15"	12	5.0
18"	14	5.5
21"	18	7.0
24"	20	8.5
27"	24	9.5
30"	25	9.5
36"	32	13.0
42"	32	13.0
48"	37	14.0
54"	40	15.0
60"	45	15.0
66"	50	18.0
72"	50	18.0

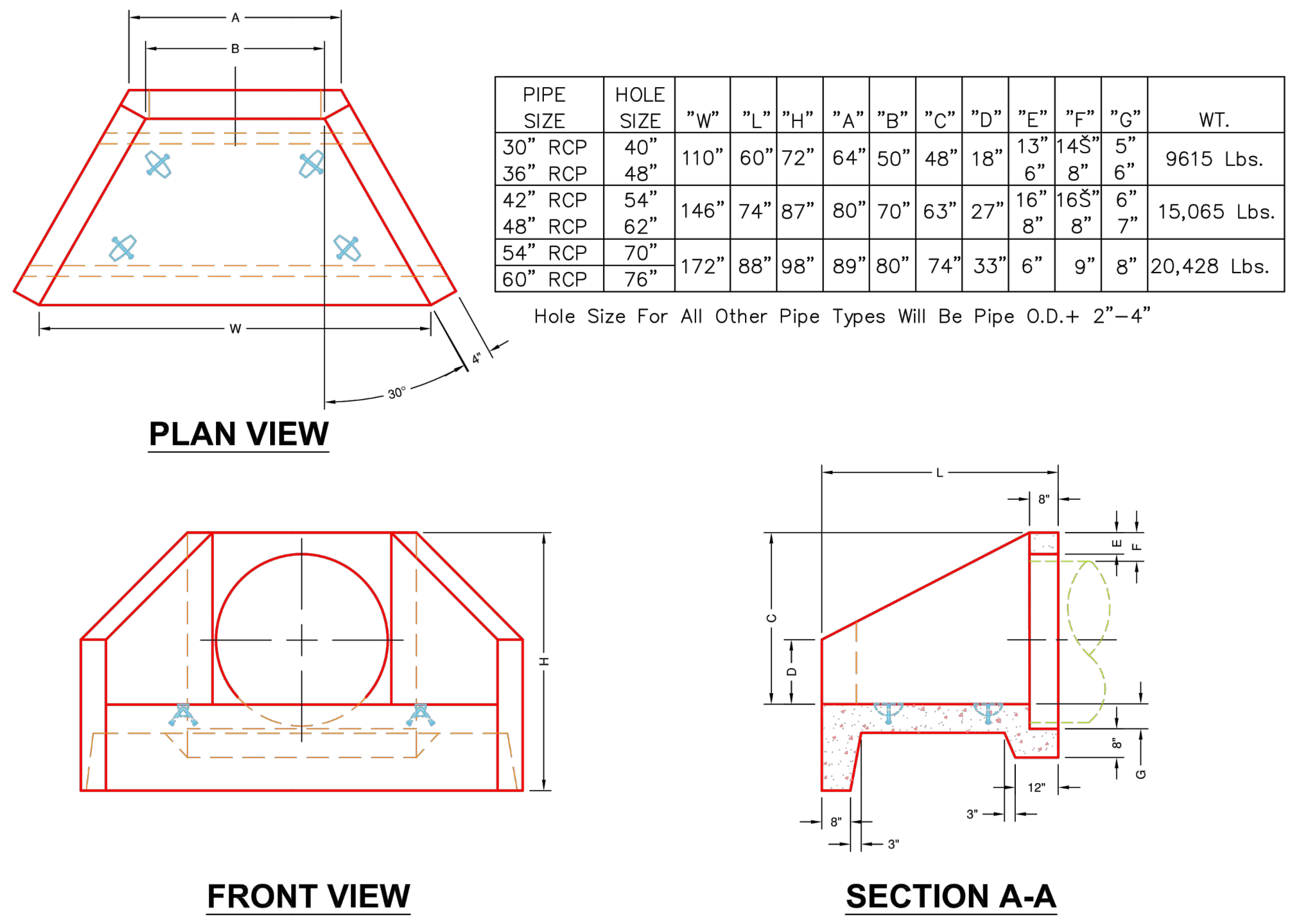
2 G-12 Rip-Rap Outlet Protection



Pipe Size	Hole Size	W	L	H	A	B	C	D	E	F	G	Weight
12" 15" 18"	12"Ø 15"Ø 18"Ø	63"	54"	43"	42"	24"	27"	16"	12' 8.5' 5"	13" 9.75' 6.5"	3" 3.5" 4"	3605 lbs.
24"	24"Ø	78"	66"	51"	51"	29"	33"	18"	5"	6"	4"	5468 lbs.

Concrete minimum compression strength : F'c=5,000 psi @ 28 days

Reinforcing Steel: ASTM A615, Fy=60,000 psi



PIPE SIZE	HOLE SIZE	"W"	"L"	"H"	"A"	"B"	"C"	"D"	"E"	"F"	"G"	WT.
30" RCP 36" RCP	40" 48"	110"	60"	72"	64"	50"	48"	18"	13" 6"	14Š" 8"	5" 6"	9615 Lbs.
42" RCP 48" RCP	54" 62"	146"	74"	87"	80"	70"	63"	27"	16" 8"	16Š" 8"	6" 7"	15,065 Lbs.
54" RCP 60" RCP	70" 76"	172"	88"	98"	89"	80"	74"	33"	6"	9"	8"	20,428 Lbs.

Hole Size For All Other Pipe Types Will Be Pipe O.D.+ 2"–4"

3 G-12 Cocnrete Headwall

GEOS
Geotechnical, Environmental and Materials Engineers

General Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY: DAH
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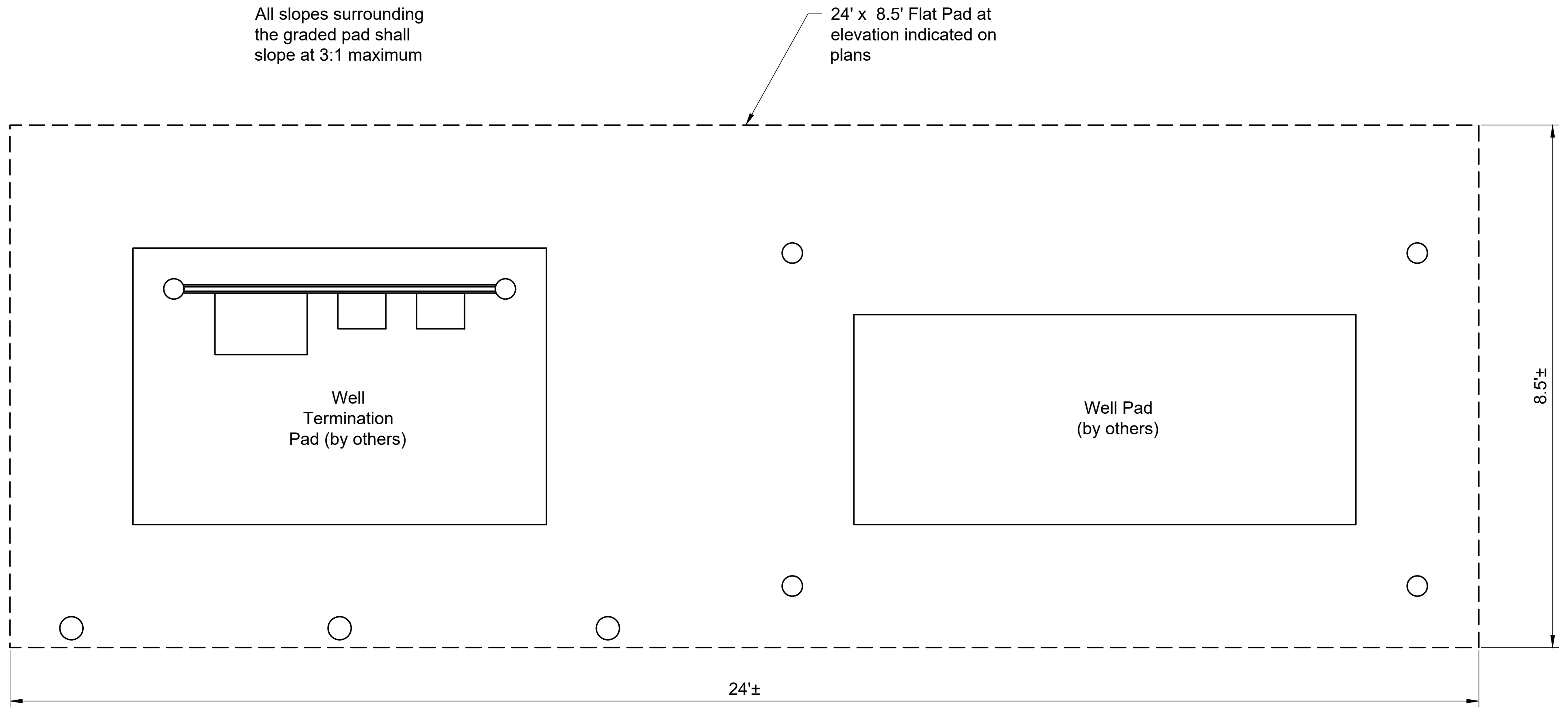
DRAWING:
G-12

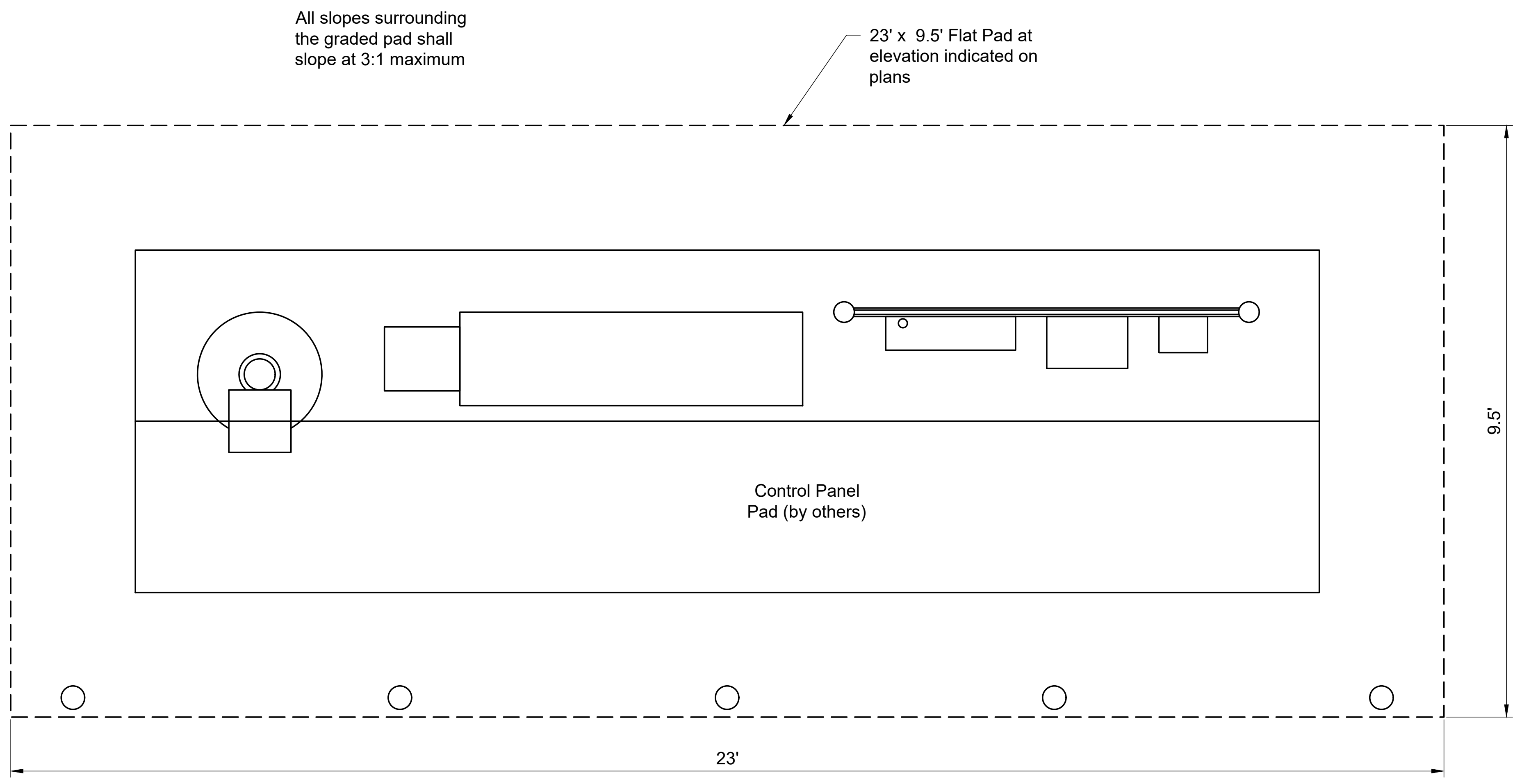
PROJECT NUMBER:
45-20803



All slopes surrounding the graded pad shall slope at 3:1 maximum

24' x 8.5' Flat Pad at elevation indicated on plans

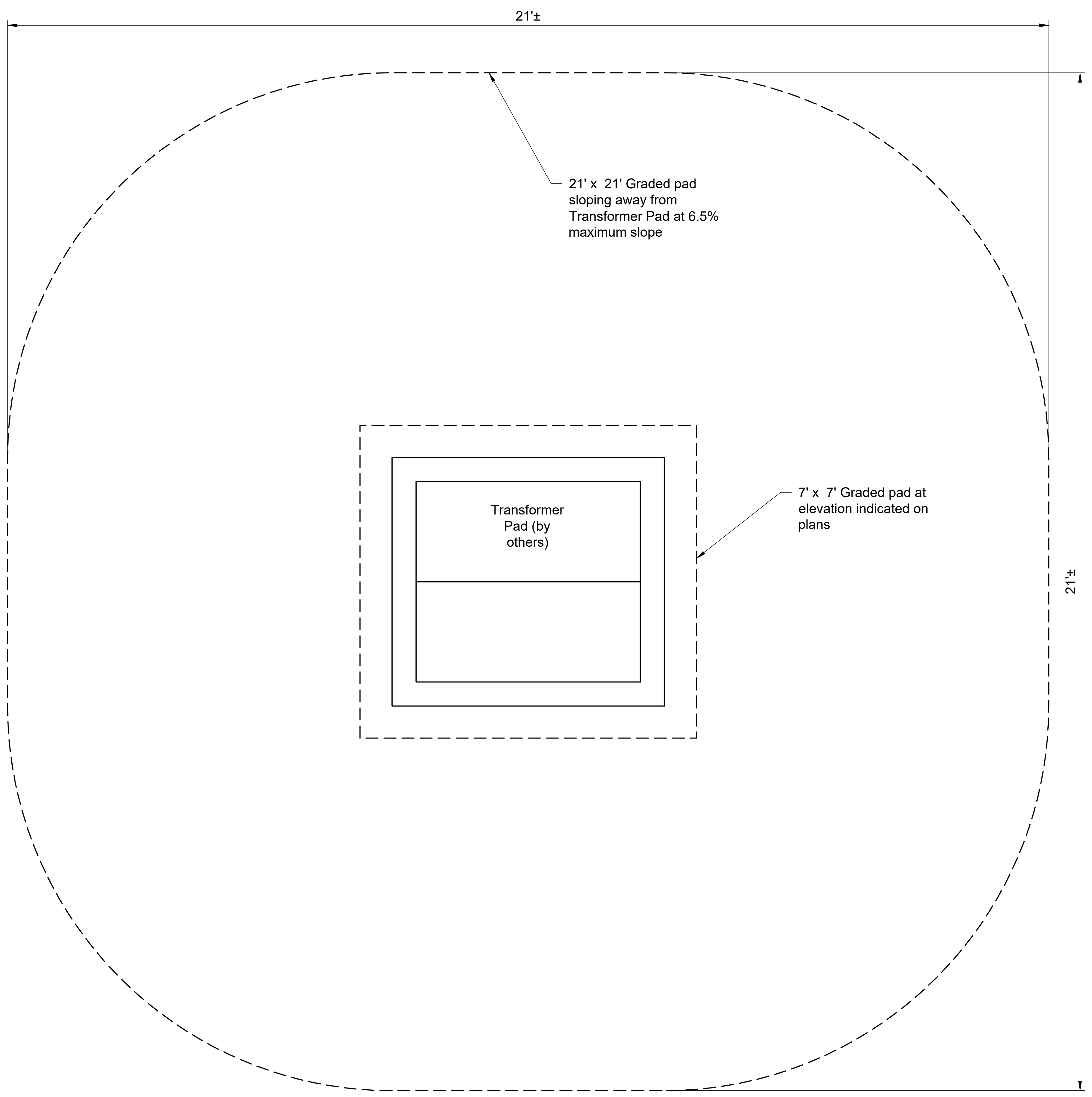
1 G-13 Well Pad Grading



All slopes surrounding the graded pad shall slope at 3:1 maximum

23' x 9.5' Flat Pad at elevation indicated on plans

1 G-13 Control Panel Pad Grading



21' x 21' Graded pad sloping away from Transformer Pad at 6.5% maximum slope

7' x 7' Graded pad at elevation indicated on plans

All slopes surrounding the graded pad (21'x21') shall slope at 3:1 maximum

3 G-13 Transformer Pad Grading

GEOS
Geotechnical, Environmental and Materials Engineers

General Details

Chemours Fayetteville Works
Fayetteville, North Carolina

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DRAWING: G-13

PROJECT NUMBER: 45-20803

The Chemours Company

Fayetteville, North Carolina

Redi-Rock Retaining Wall

February 10, 2022

1. GENERAL NOTES
    - a. THE DESIGN IS BASED ON SPECIFIC SEGMENTAL RETAINING WALL (SRW) UNIT PROPERTIES. THE USE OF ANY MATERIALS OTHER THAN THESE SPECIFIED HEREIN SHALL NOT BE ALLOWED WITHOUT PRIOR REVIEW AND APPROVAL.
    - b. THE WALL CONTRACTOR AND/OR CEI (CONSTRUCTION ENGINEER INSPECTION) STAFF SHALL VERIFY ALL CONDITIONS, GRADES, DIMENSION, AND TOPOGRAPHIC INFORMATION PRIOR TO CONSTRUCTION. IF THE WALL CONTRACTOR AND/OR CEI STAFF DISCOVERS ANY ERRORS, OMISSIONS, OR DISCREPANCIES, THEY SHALL CONTACT THE DESIGN PROFESSIONAL (GEOSERVICES, LLC). THE DESIGN PROFESSIONAL WILL THEN ISSUE INSTRUCTIONS AS TO HOW TO PROCEED.
    - c. THE CONTRACTOR/OWNER SHALL BE RESPONSIBLE FOR OBSERVING ALL APPLICABLE SAFETY LAWS AND REGULATIONS, INCLUDING BUT NOT LIMITED TO SHORING, GUARDRAILS AND/OR FENCING, TEMPORARY EXCAVATION, LOCAL BUILDING CODES AND REGULATIONS, ETC.
    - d. EXCAVATION FOR CURB AND GUTTER, FENCING, GUARDRAILS, UTILITIES, AND FOUNDATIONS SHALL BE COORDINATED WITH WALL CONSTRUCTION AND SHALL BE COMPLETED WITHOUT DAMAGE TO THE WALL SYSTEM.
    - e. THE OWNER/CEI ENGINEER SHALL PROVIDE TESTING IN ACCORDANCE WITH THE SPECIAL INSPECTIONS REQUIREMENTS OF IBC AND ITEMS LISTED HEREIN. THE CEI ENGINEER SHALL MAINTAIN RESPONSIBILITY FOR WALL CERTIFICATION (IF REQUIRED) TO THE PROVIDED PLANS AND SPECIFICATIONS.
    - f. DRAWINGS ARE SPECIFIC TO THE PROJECT. ANY PARTY ACCEPTING THESE DOCUMENTS DOES SO IN CONFIDENCE AND AGREES THAT IT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART, NOR DISCLOSED TO OTHERS WITHOUT THE CONSENT OF GEOSERVICES, LLC.
    - g. CONSTRUCTION AND INSPECTION OF THE SRW SHALL BE IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE BLOCK MANUFACTURER, THE ELEVATION VIEW, DETAIL(S), AND THE SPECIFICATIONS.
    - h. UTILITY INSTALLATION IN FRONT OF AND BEHIND THE WALL SHALL BE COORDINATED WITH WALL CONSTRUCTION.
2. DESIGN INFORMATION
    - a. DESIGN STANDARDS:
      NCMA DESIGN MANUAL FOR SEGMENTAL RETAINING WALLS
      IBC 2015
    - b. GEOTECHNICAL DATA:
      THE SOIL PROPERTIES UTILIZED IN THE DESIGN OF THE RETAINING WALLS WERE OBTAINED FROM THE GEOTECHNICAL EXPLORATIONS AND SLOPE STABILITY ANALYSES PERFORMED BY GEOSERVICES. THE GEOSERVICES CONSTRUCTION TESTING PERSONNEL ONSITE SHALL OBSERVE THE ACTUAL SOIL CONDITIONS PRESENT AT THE TIME OF CONSTRUCTION. IF DISCREPANCIES ARE NOTED, THESE SHALL BE BROUGHT TO THE ATTENTION OF THE DESIGN ENGINEER IMMEDIATELY TO DETERMINE IF MODIFICATIONS TO THE DESIGN ARE REQUIRED.
    - c. SURCHARGE & GEOMETRY: THE WALLS WERE DESIGNED WITH THE SLOPES AND SURCHARGES SHOWN IN TABLE 1 IN THIS PLAN SET
    - d. SOIL PROPERTIES: THE WALLS WERE DESIGNED WITH THE SOIL PROPERTIES SHOWN IN TABLE 2 IN THIS PLAN SET
    - e. ALLOWABLE BEARING PRESSURE: VARIES - SEE WALL PROFILES IN THIS PLAN SET
    - f. GEOGRID COVERAGE PERCENTAGE: 50 PERCENT (POSITIVE CONNECTION)
    - g. MINIMUM FACTORS OF SAFETY: THE WALLS WERE DESIGNED WITH THE MINIMUM FACTORS OF SAFETY SHOWN IN TABLE 3 OF THIS PLAN SET
    - h. WALL MATERIALS:
      BLOCK = REDI-ROCK GRAVITY OR POSITIVE CONNECTION (PC) UNITS (PER REDI-ROCK SPECIFICATIONS). SEE WALL PROFILES FOR SPECIFIC BLOCK TYPES AND LOCATIONS
      BLOCK SETBACK = 1.625" PER COURSE
      GEOGRID REINFORCEMENT = MIRAFI 8XT (12-INCH WIDE STRIPS PER REDI-ROCK SPECIFICATIONS) (ALL REINFORCED WALL SECTIONS)
      GEOTEXTILE FABRIC = 8-OZ. MIN. NON-WOVEN (GEOTEX OR APPROVED EQUAL)

Table 1 - Wall Slopes and Surcharges

Wall ID	Stations	Backslope (H:V)	Toe Slope (H:V)	Surcharge (PSF)	Surcharge Type	Design Condition
1	ALL	3:1	2.5:1	250	Heavy Traffic	Permanent
2	ALL	3:1	1.75:1	250	Heavy Traffic	Permanent
3	ALL	2:1	3.5:1	0	None	Permanent
4	ALL	3:1	5:1	250	Heavy Traffic	Permanent
				1600	Trencher - Static	Transient
				3200	Trencher - Dynamic	Accidental
5	ALL	4:1	3:1	0	None	Permanent
6	ALL	4:1	3:1	0	None	Permanent
7	ALL	3:1	Flat	125	Light Traffic	Permanent
8	ALL	3:1	3:1	250	Heavy Traffic	Permanent
				1600	Trencher - Static	Transient
				3200	Trencher - Dynamic	Accidental
9	ALL	5:1	3:1	0	None	Permanent
10	ALL	Flat	Flat	250	Heavy Traffic	Permanent
11	ALL	Flat	Flat	250	Heavy Traffic	Permanent
12	ALL	Flat	Flat	250	Heavy Traffic	Permanent
13	ALL	3:1	Flat	250	Heavy Traffic	Permanent

Table 2 - Soil Properties

Wall ID	Soil Location	Soil Type	Internal Friction Angle (Degrees)	Cohesion (PSF)	Unit Weight (PCF)
1	Retained	Perched Clay (Drained)	24	200	110
	Foundation	Surficial Aquifer	32	75	115
	Reinforced	Onsite Sands	32	0	115
2	Retained	Perched Clay (Drained)	24	200	110
	Foundation	Surficial Aquifer	32	75	115
	Reinforced	Onsite Sands	32	0	115
3	Retained #1	Light Gray Sand	32	50	115
	Retained #2	Dark Gray Clay (Drained)	25	200	120
	Foundation	Perched Clay (Drained)	24	200	110
	Reinforced	Onsite Sands	32	0	115
4	Retained	Perched Clay (Drained)	24	200	110
	Foundation	Perched Clay (Drained)	24	200	110
	Reinforced	Onsite Sands	32	0	115
5	Retained	Dark Gray Clay (Drained)	25	200	120
	Foundation	Light Gray Sand	32	50	115
	Reinforced	Onsite Sands	32	0	115
6	Retained	Dark Gray Clay (Drained)	25	200	120
	Foundation	Light Gray Sand	32	50	115
	Reinforced	Onsite Sands	32	0	115
7	Retained	Light Brown Sand	32	75	110
	Foundation	Dark Gray Clay (Drained)	25	200	120
	Reinforced	Onsite Sands	32	0	115
8	Retained	Black Creek Confining Layer	26	125	120
	Foundation	Black Creek Confining Layer	26	125	120
	Reinforced	Onsite Sands	32	0	115
9	Retained #1	Light Brown Sand	32	75	110
	Retained #2	Dark Gray Clay (Drained)	25	200	120
	Foundation	Light Gray Sand	32	50	115
	Reinforced	Onsite Sands	32	0	115
10	Retained	Dark Gray Clay (Drained)	25	200	120
	Foundation	Light Gray Sand	32	50	115
	Reinforced	N/A (Gravity Wall)	N/A	N/A	N/A
11	Retained	Dark Gray Clay (Drained)	25	200	120
	Foundation	Light Gray Sand	32	50	115
	Reinforced	N/A (Gravity Wall)	N/A	N/A	N/A
12	Retained	Dark Gray Clay (Drained)	25	200	120
	Foundation	Light Gray Sand	32	50	115
	Reinforced	N/A (Gravity Wall)	N/A	N/A	N/A
13	Retained	Dark Gray Clay (Drained)	25	200	120
	Foundation	Light Gray Sand	32	50	115
	Reinforced	N/A (Gravity Wall)	N/A	N/A	N/A

Table 3 - Factors of Safety

Wall ID	Design Condition	Internal Stability				External Stability			Global Stability
		Geogrid Sliding	Geogrid Strength	Geogrid Pullout	Connection Strength	Sliding	Overturning	Bearing	
1	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
2	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
3	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
4	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
	Transient	1.5	1.5	1.5	1.5	1.5	1.5	2.0	1.3
	Accidental	1.1	1.1	1.1	1.1	1.5	1.5	2.0	1.1
5	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
6	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
7	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
8	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
	Transient	1.5	1.5	1.5	1.5	1.5	1.5	2.0	1.3
	Accidental	1.1	1.1	1.1	1.1	1.5	1.5	2.0	1.1
9	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
10	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
11	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
12	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5
13	Permanent	1.5	1.5	1.5	1.5	1.5	2.0	3.0	1.5

3. BASE LEVELING PAD MATERIAL
    - a. LEVELING PAD MATERIAL SHALL CONSIST OF DENSE-GRADED LIMESTONE AGGREGATE OR LEAN CONCRETE PLACED TO THE LINES AND GRADES SHOWN ON THE CONSTRUCTION DRAWINGS, TO A MINIMUM THICKNESS OF 6 INCHES AND EXTEND LATERALLY A MINIMUM OF 6 INCHES IN FRONT OF AND BEHIND THE MODULAR WALL UNITS. LEVELING PAD SHALL BE PREPARED TO INSURE FULL CONTACT TO THE BASE SURFACE OF THE CONCRETE UNITS.
    - b. DENSE-GRADED AGGREGATE SHALL BE COMPACTED TO A MINIMUM OF 98% STANDARD PROCTOR MAXIMUM DRY DENSITY PER ASTM D-698 WITHIN 2% OF THE OPTIMUM MOISTURE CONTENT TO ENSURE A LEVEL HARD SURFACE ON WHICH TO PLACE THE FIRST COURSE OF BLOCKS.
4. DRAINAGE
    - a. A 4" PERFORATED DRAINAGE PIPE SHALL BE INSTALLED AT THE BASE OF THE RETAINING WALL AS SHOWN ON THE TYPICAL CROSS-SECTIONS AND SHALL BE SLOPED TO DRAIN AT 1% MINIMUM. CONTRACTOR SHALL BE RESPONSIBLE FOR KEEPING PIPE CONTINUOUS ALONG THE ENTIRE LENGTH OF THE WALL. THE PERFORATED DRAIN PIPE SHALL BE DAYLIGHTED AT EACH END OF THE WALL.
    - b. DENSE GRADED AGGREGATE SHALL BE BACKFILLED BEHIND THE INITIAL COURSE(S) OF WALL UNITS TO THE ELEVATION OF THE FINAL FINISHED GRADE AT THE BOTTOM OF THE WALL. THIS DENSE GRADED AGGREGATE BACKFILL SHALL BE COMPACTED TO A MINIMUM OF 98% STANDARD PROCTOR DENSITY PER ASTM D-698 WITHIN 2% OF THE OPTIMUM MOISTURE CONTENT. THE TOP SURFACE OF THE DENSE-GRADED AGGREGATE BACKFILL SHALL BE SLOPED TO DRAIN AT 1% MINIMUM TOWARDS THE WALL FACE AT ALL TIMES.
    - c. NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED BETWEEN THE SURFICIAL SOIL AND THE REINFORCED FILL AS SHOWN ON THE TYPICAL WALL CROSS-SECTIONS. GEOTEXTILE SHALL BE OVERLAPPED A MINIMUM OF 24 INCHES AT ALL SEAMS.
    - d. AT THE END OF EACH WORK DAY, THE CONTRACTOR SHALL GRADE THE SURFACE OF THE LAST LIFT OF RETAINED SOIL AWAY FROM THE FACE AND COMPACT TO PREVENT WATER FROM PONDING AND/OR FLOWING OVER THE WALL FACE.
    - e. THE CONTRACTOR SHALL INSTALL TEMPORARY SOIL BERMS AND DRAINAGE DITCHES AS NECESSARY TO DIVERT WATER AWAY FROM THE WALLS.
5. MODULAR UNIT INSTALLATION
    - a. FIRST COURSE OF WALL FACING UNITS SHALL BE PLACED ON THE LEVELING PAD AT THE APPROXIMATE LINE AND GRADE WITH THE AESTHETIC SURFACE FACING OUT AND THE FRONT EDGES TIGHT TOGETHER. ALIGNMENT AND LEVEL SHALL BE CHECKED IN ALL DIRECTIONS AND INSURE THAT ALL UNITS ARE IN FULL CONTACT WITH THE BASE AND PROPERLY SEATED.
    - b. PLACE THE FRONT OF UNITS SIDE BY SIDE. DO NOT LEAVE GAPS BETWEEN ADJACENT UNITS. LAYOUT OF CORNERS AND CURVES SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.
    - c. INSTALL SHEAR / CONNECTING DEVICES PER THE MANUFACTURER'S RECOMMENDATIONS.
    - d. THE BACKFILL IN FRONT AND IN BACK OF ENTIRE BASE ROW SHALL BE PLACED AND COMPACTED TO FIRMLY LOCK THEM IN PLACE. CHECK ALL UNITS AGAIN FOR LEVEL AND ALIGNMENT. ALL EXCESS MATERIAL SHALL BE SWEPT FROM TOP OF UNITS.
    - e. INSTALL NEXT COURSE OF WALL UNITS ON TOP OF BASE ROW. POSITION BLOCKS TO BE OFFSET FROM SEAMS OF BLOCKS BELOW IN A RUNNING BOND PATTERN. CHECK EACH BLOCK FOR PROPER ALIGNMENT AND LEVEL.
    - f. INSTALL EACH SUBSEQUENT COURSE IN LIKE MANNER. REPEAT PROCEDURE TO THE EXTENT OF THE WALL HEIGHT.
    - g. CAP UNITS SHALL BE GLUED TO THE UNDERLYING UNITS WITH AN ALL-WEATHER ADHESIVE RECOMMENDED BY THE MANUFACTURER.
6. BACKFILL PLACEMENT
    - a. THE BACKFILL MATERIAL USED SHALL BE #57 STONE, DENSE GRADED AGGREGATE, OR ONSITE SANDS MEETING THE CRITERIA OF THESE NOTES. THE BACKFILL TYPE SHALL BE AS SPECIFIED ON THE TYPICAL WALL CROSS-SECTIONS IN THIS PLAN SET. ANY CHANGES IN THE BACKFILL MATERIALS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO BACKFILL PLACEMENT.
    - b. BACKFILL MATERIALS SHALL BE PLACED, SPREAD, AND COMPACTED IN SUCH A MANNER THAT MINIMIZES THE DEVELOPMENT OF SLACK OR WRINKLES IN THE GEOGRID, INSTALLATION DAMAGE, AND WITHOUT DISPLACING THE GEOGRID OR WALL FACING UNITS.
    - c. BACKFILL MATERIALS SHALL BE PLACED AND COMPACTED IN LIFTS NOT TO EXCEED 6 INCHES WHERE HAND COMPACTION IS USED, OR 8 INCHES WHERE HEAVY COMPACTION EQUIPMENT IS USED. LIFT THICKNESS SHALL BE DECREASED TO ACHIEVE THE REQUIRED DENSITY AS NEEDED.
    - d. DENSE-GRADED BACKFILL MATERIALS SHALL BE COMPACTED TO 95% OF THE STANDARD PROCTOR MAXIMUM DRY DENSITY WITHIN 2% OF THE OPTIMUM MOISTURE CONTENT AS DETERMINED BY ASTM D698.
    - e. OPEN-GRADED BACKFILL MATERIALS SHALL BE CONSOLIDATED BY MAKING A MINIMUM OF 4 PASSES OVER THE AREA USING A VIBRATORY PLATE COMPACTOR OR UNTIL A NON-YIELDING SURFACE IS ACHIEVED.
    - f. ONLY LIGHTWEIGHT HAND-OPERATED EQUIPMENT SHALL BE ALLOWED WITHIN 3 FEET FROM THE TAIL OF THE FACING UNITS. COMPACTION EQUIPMENT BEYOND 3 FEET FROM THE FACE SHALL NOT EXCEED 8 TONS IN WEIGHT.
    - g. WALL SYSTEM SHALL NOT EXTEND MORE THAN 6 FEET ABOVE PROPOSED GRADE AT THE FRONT OF THE WALL WITHOUT BACKFILLING TO THE SPECIFIED GRADE AND INCLINATION AT THE TOE OF THE WALL. BACKFILL SHOULD BE PLACED AS SOON AS REASONABLY POSSIBLE.
7. GEOGRID INSTALLATION
    - a. GEOGRID SHALL BE PLACED WITH THE STRONGEST AXIS PERPENDICULAR TO THE WALL FACE. THE GEOGRID LAYERS SHALL BE PULLED TAUT PRIOR TO FILL PLACEMENT. THE GEOGRID LAYERS SHALL BE PLACED WITH AN ALLOWABLE TOLERANCE OF PLUS OR MINUS THREE INCHES FROM THE DESIGN ELEVATIONS.
    - b. THE MINIMUM LENGTHS OF THE REINFORCEMENT LAYERS (GEOGRID EMBEDMENT LENGTHS - L) ARE SHOWN IN THE REINFORCEMENT REQUIREMENTS TABLE.
    - c. WHERE OVERLAP IS NECESSARY, A MINIMUM OF THREE INCHES OF FILL SHOULD BE PLACED BETWEEN THE GEOGRID LAYERS.
    - d. GEOGRID REINFORCEMENTS SHALL BE CONTINUOUS THROUGH THEIR EMBEDMENT LENGTHS AND PLACED IN ACCORDANCE WITH THE REDI-ROCK SPECIFICATIONS TO PROVIDE 50% COVERAGE AT EACH LEVEL. ONLY CONTINUOUS LENGTHS OF GEOGRID SHALL BE USED TO DEVELOP THE REINFORCEMENT LENGTH. SPLICED CONNECTIONS BETWEEN SHORTER PIECES OF GEOGRID OR GAPS BETWEEN ADJACENT PIECES OF GEOGRID SHALL NOT BE PERMITTED.
    - e. MEASURES SHALL BE IMPLEMENTED TO PROTECT THE GEOGRID AT THE BACK EDGE OF THE FACING UNITS TO PREVENT DAMAGE TO THE GEOGRID BY ALL SHARP EDGES.
    - f. INSTALLED GEOGRIDS OR PORTIONS OF GEOGRIDS SHALL NOT BE CUT, DAMAGED, OR REMOVED DURING SUBSEQUENT CONSTRUCTION OPERATIONS. ANY EXCAVATION CONDUCTED IN THE REINFORCED ZONE MUST BE DONE WITHOUT DAMAGING THE GEOGRID LAYERS. UTILITIES TO BE PLACED WITHIN THE REINFORCED ZONE OF THE WALL SHALL BE COORDINATED BY THE CONTRACTOR. THE ENGINEER SHALL BE CONTACTED IF THERE ARE ANY QUESTIONS.
8. AS-BUILT CONSTRUCTION TOLERANCES
    - a. VERTICAL ALIGNMENT: +/- 1.5 INCHES OVER ANY 10 FOOT DISTANCE.
    - b. WALL BATTER: WITHIN 2 DEGREES OF DESIGN BATTER.
    - c. HORIZONTAL ALIGNMENT: +/- 1.5 INCHES OVER ANY 10 FOOT DISTANCE. CORNERS, BENDS, CURVES +/- 1 FOOT TO THEORETICAL LOCATION.
    - d. MAXIMUM HORIZONTAL GAP BETWEEN ERECTED UNITS SHALL BE 1/2 INCH.
9. STATEMENT OF SPECIAL INSPECTIONS
    - a. SPECIAL INSPECTION IS REQUIRED IN ACCORDANCE WITH IBC SECTION 1704.5.
    - b. THE SPECIAL INSPECTOR'S RESPONSIBILITIES INCLUDE VERIFYING THE FOLLOWING:

(I) WALL UNIT IDENTIFICATION AND COMPRESSIVE STRENGTH	ONCE PER WALL PRIOR TO CONSTRUCTION
(II) FOUNDATION PREPARATION AND BEARING CAPACITY	ONCE PER WALL PRIOR TO FILL
(III) LEVELING PAD COMPACTION TESTING	ONCE PER WALL MINIMUM
(IV) UNIT PLACEMENT INCLUDING ALIGNMENT, SIZE, AND INCLINATION	ONCE PER ROW OF BLOCK
(V) GEOSYNTHETIC REINFORCEMENT TYPE AND PLACEMENT	NOT APPLICABLE
(VI) BACKFILL PLACEMENT AND COMPACTION	CONTINUOUS (TESTING COMPANY SHALL OBSERVE PLACEMENT AND COMPACTION OF #57 STONE EVERY 20-40 YARDS. TESTING COMPANY SHALL OBSERVE COMPACTION PATTERN TO OBTAIN PATTERN FOR OPTIMAL COMPACTION)
(VII) DRAINAGE PROVISIONS	PERIODIC
(VIII) ANCHOR PROOF TEST OBSERVATIONS	CONTINUOUS (EACH PROOF TEST MUST BE OBSERVED)

    - c. CEI STAFFING MAY REQUIRE FURTHER TESTING FOR CERTIFICATION PURPOSES.

Geotechnical, Environmental and Materials Engineers

90% Barrier Wall Design Package
Retaining Wall Design Plans

Chemours Fayetteville Works
Fayetteville, North Carolina

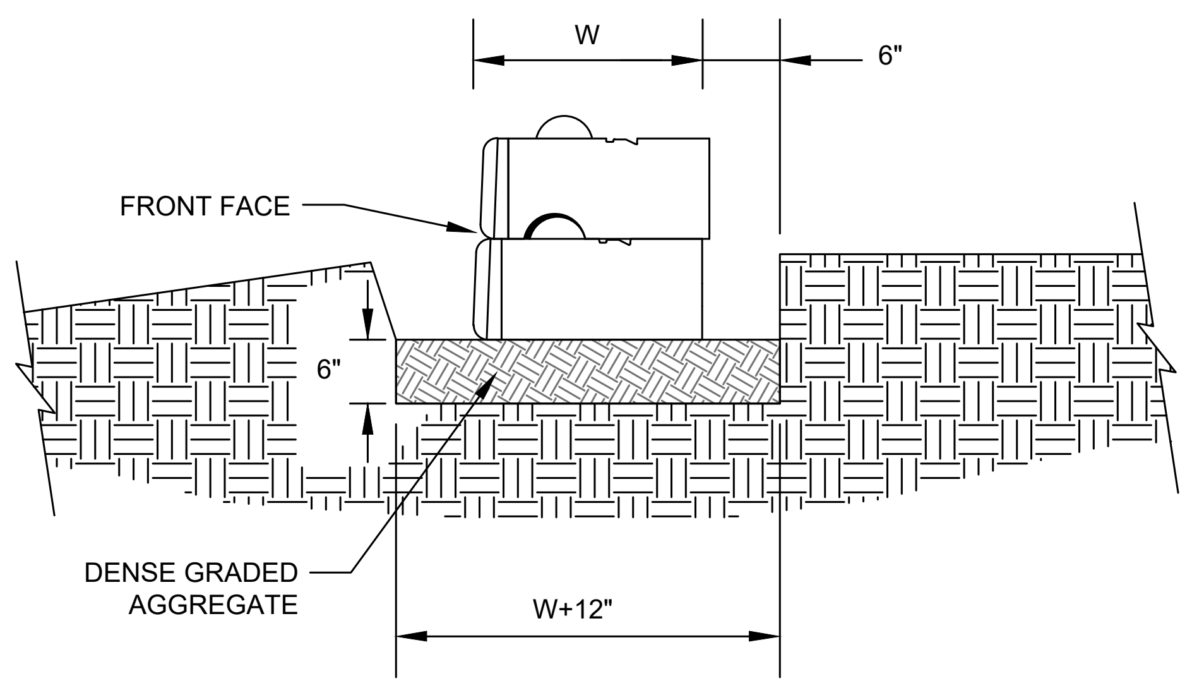
DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: JEE	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 10, 2022	

Revisions

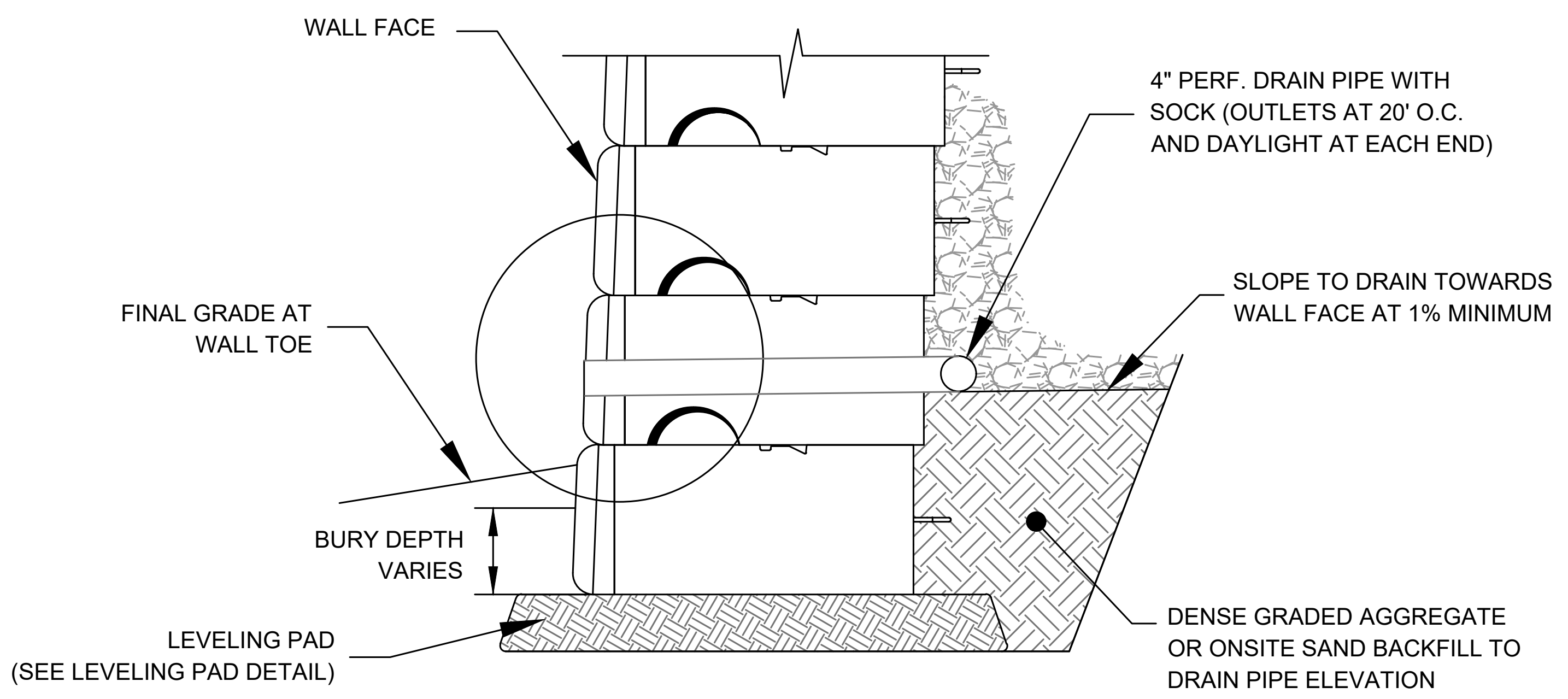
No.	Date	Description	By:
1			
2			
3			
4			
5			
6			

DRAWING:
RW-0.1

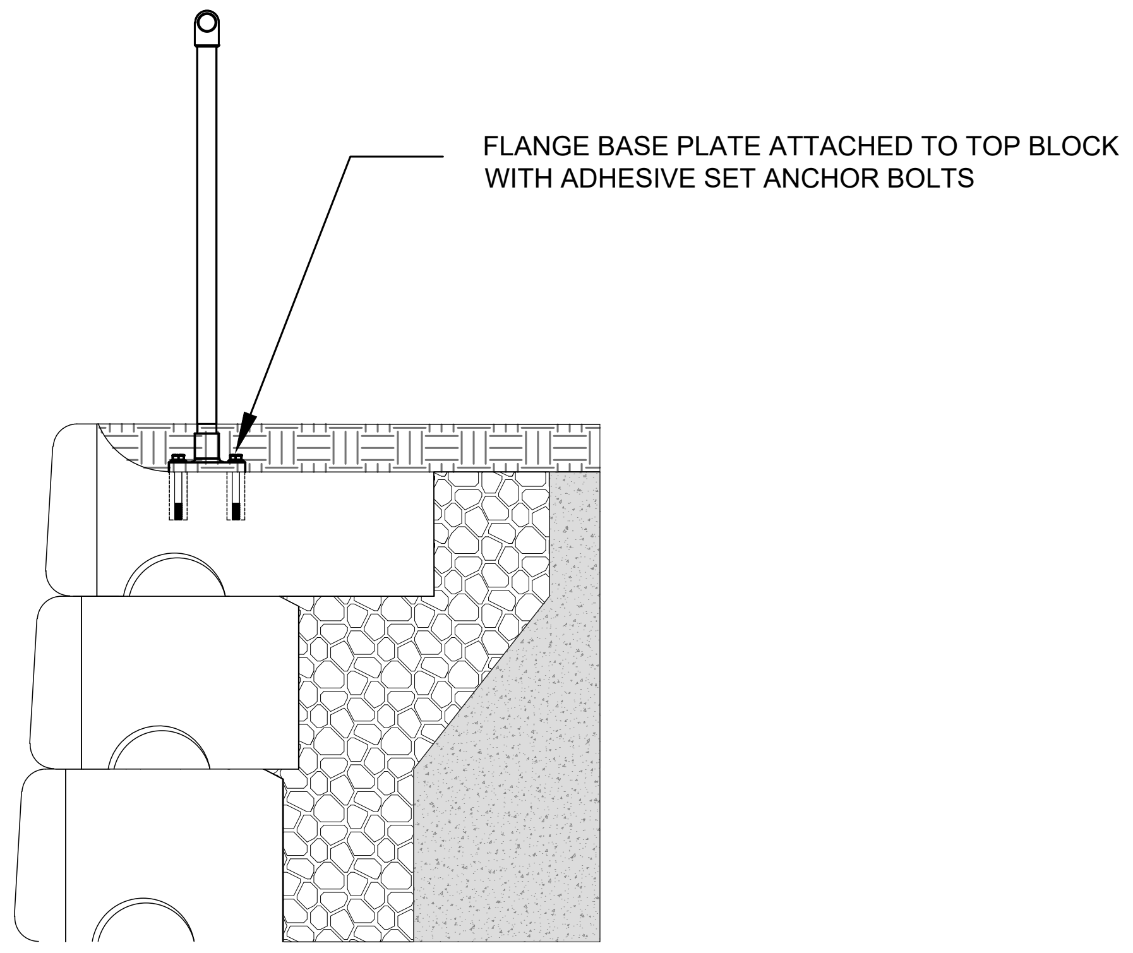
PROJECT NUMBER:
45-20803



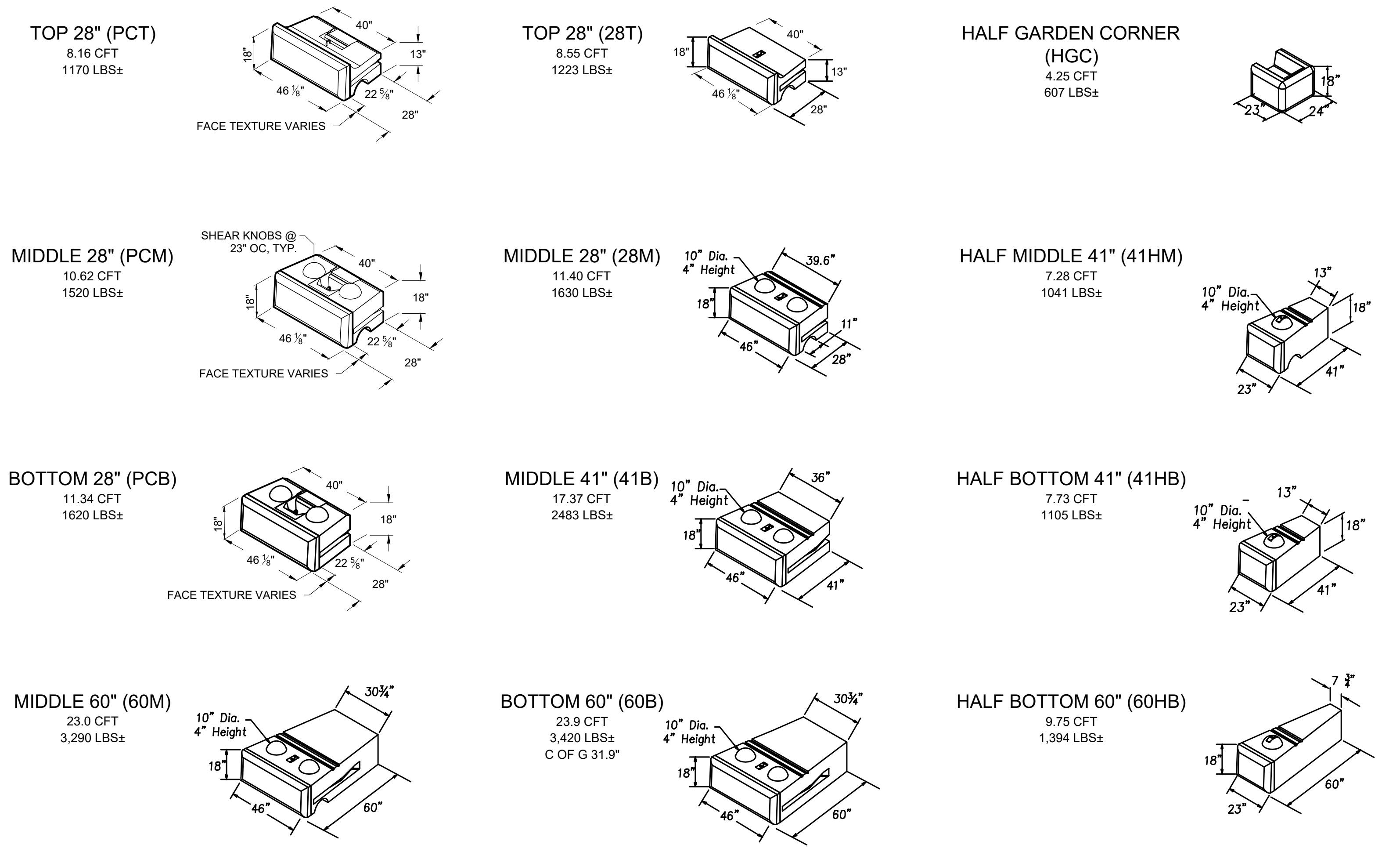
1 RW-0.2 TYPICAL LEVELING PAD DETAIL
SCALE: NTS



2 RW-0.2 TYPICAL DRAIN DETAILS
SCALE: NTS



3 RW-0.2 FENCE POST DETAILS - FLANGE BOLTED TO TOP BLOCK
SCALE: NTS


TOP 28" (PCT)
8.16 CFT
1170 LBS±

TOP 28" (28T)
8.55 CFT
1223 LBS±

HALF GARDEN CORNER (HGC)
4.25 CFT
607 LBS±

MIDDLE 28" (PCM)
10.62 CFT
1520 LBS±

MIDDLE 28" (28M)
11.40 CFT
1630 LBS±

HALF MIDDLE 41" (41HM)
7.28 CFT
1041 LBS±

BOTTOM 28" (PCB)
11.34 CFT
1620 LBS±

MIDDLE 41" (41B)
17.37 CFT
2483 LBS±

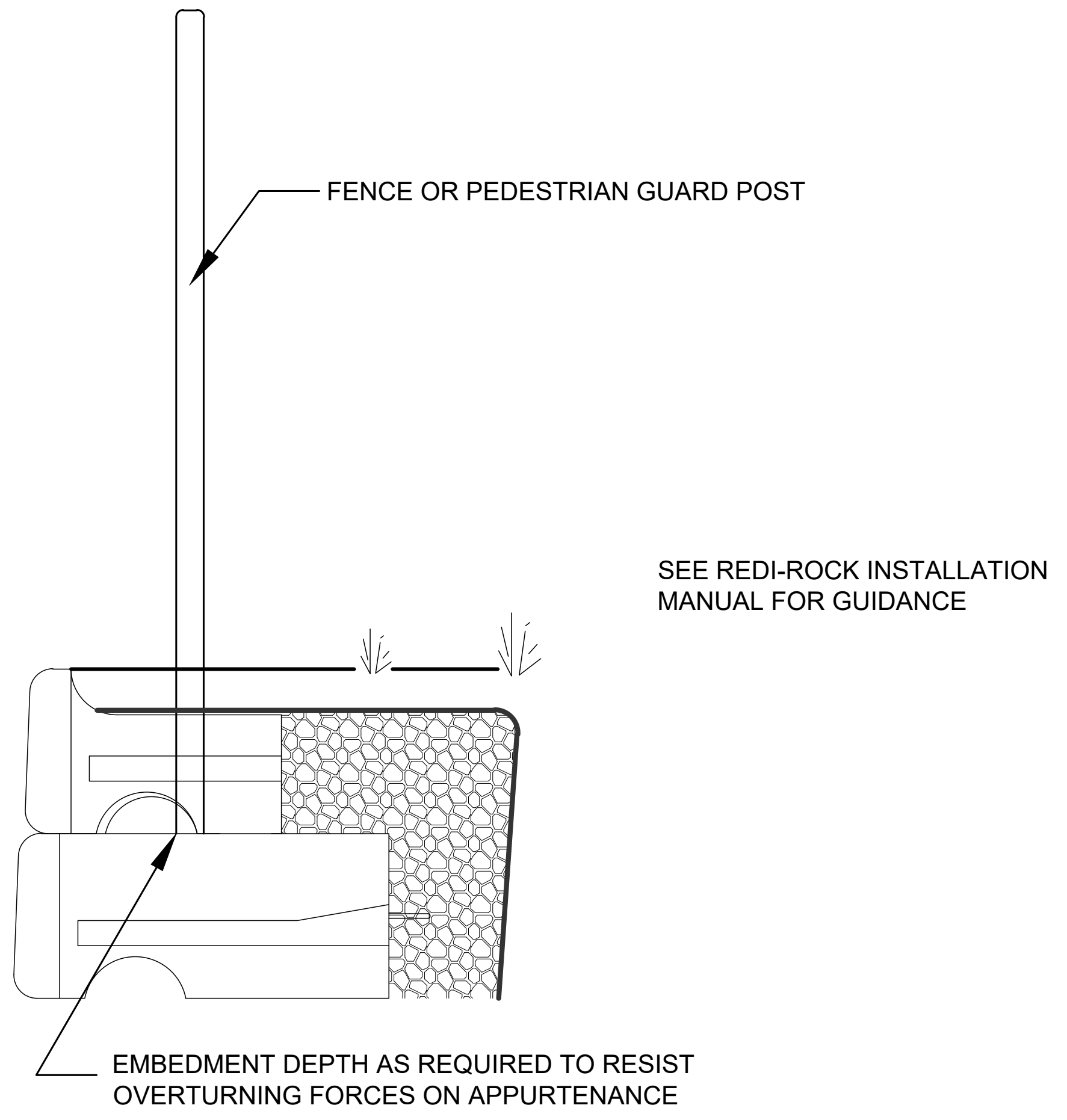
HALF BOTTOM 41" (41HB)
7.73 CFT
1105 LBS±

MIDDLE 60" (60M)
23.0 CFT
3,290 LBS±

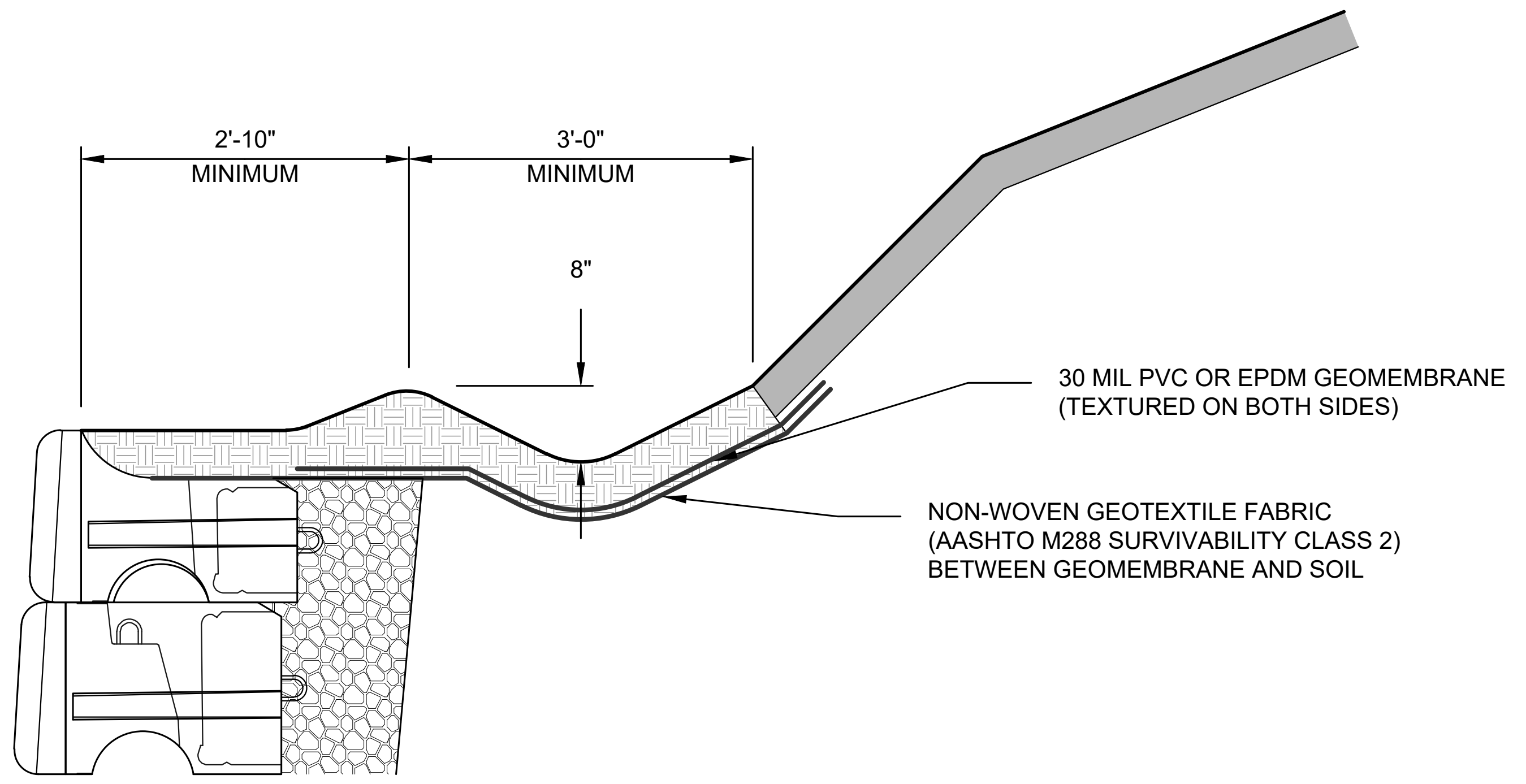
BOTTOM 60" (60B)
23.9 CFT
3,420 LBS±
C OF G 31.9"

HALF BOTTOM 60" (60HB)
9.75 CFT
1,394 LBS±

4 RW-0.2 TYPICAL REDI-ROCK UNIT DIMENSIONS
SCALE: NTS



5 RW-0.2 FENCE POST DETAILS - CORED INTO TOP BLOCK
SCALE: NTS



6 RW-0.2 TYPICAL DRAINAGE SWALE CONSTRUCTION DETAIL
SCALE: NTS

GEOS
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Retaining Wall Design Plans
Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: JEE	APPROVED BY:
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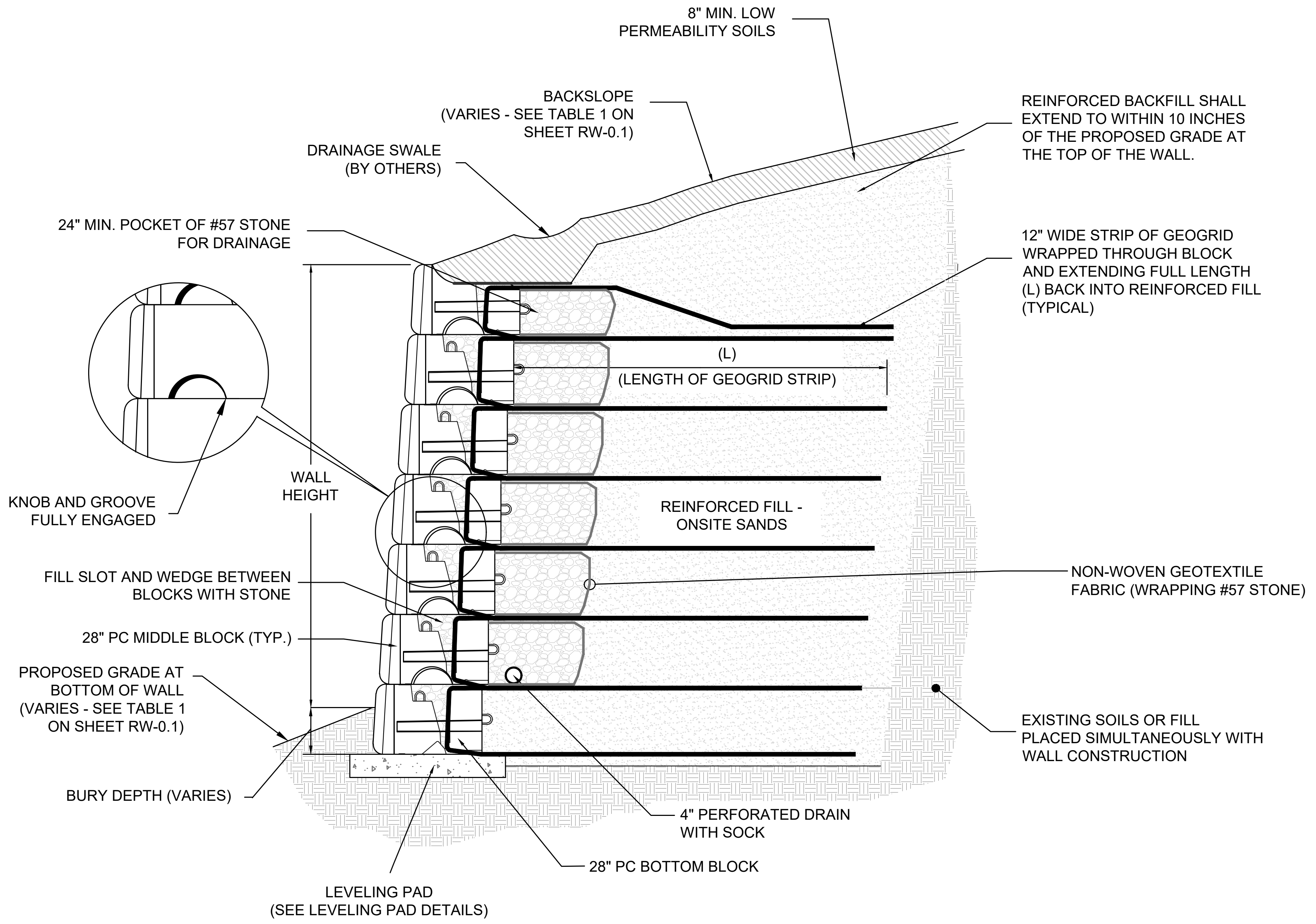
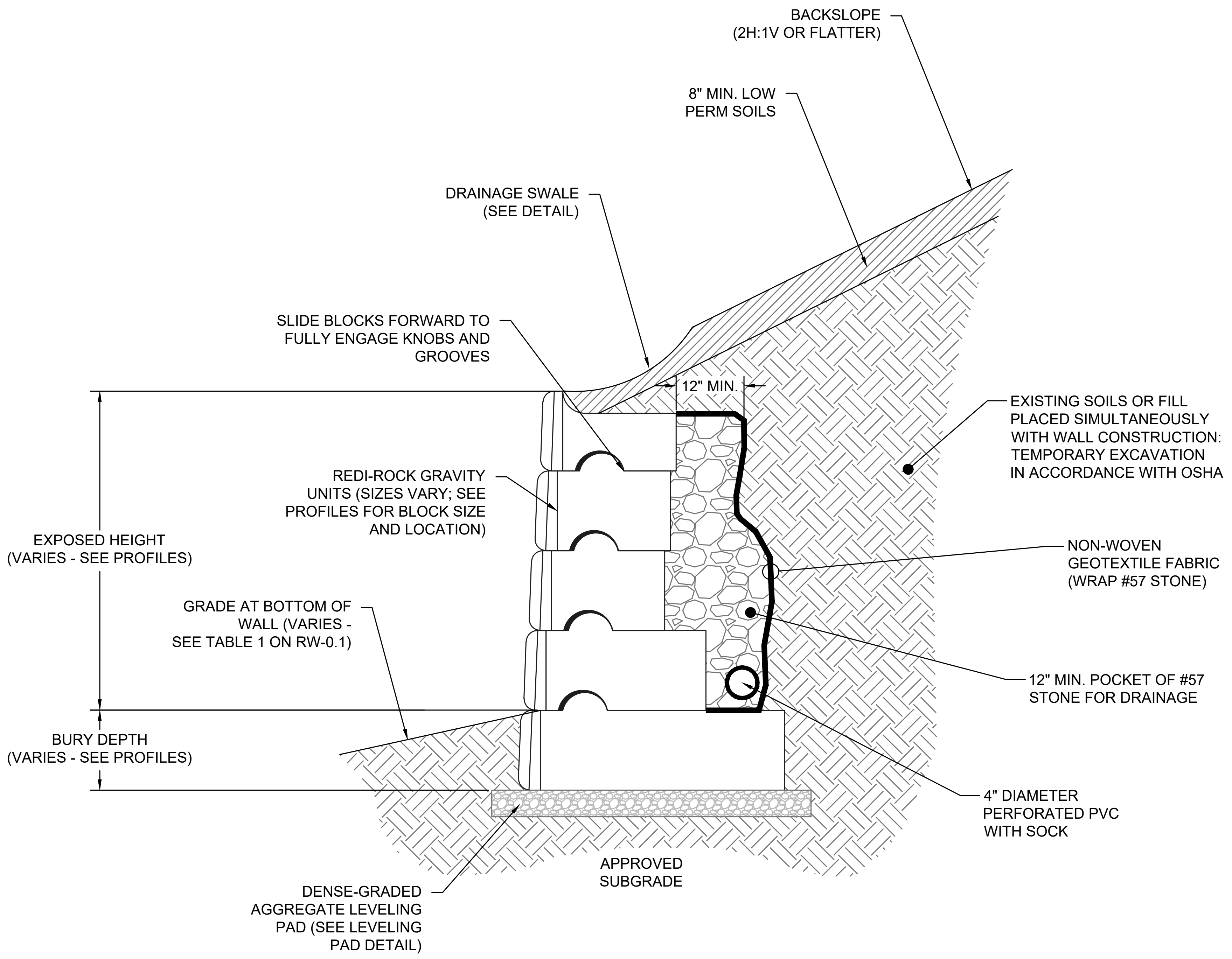
PROJECT NUMBER: 45-20803



1
RW-0.3
TYPICAL REINFORCED WALL CROSS-SECTION (SEE PROFILES FOR LOCATIONS)
SCALE: NTS



2
RW-0.3
TYPICAL GRAVITY WALL CROSS-SECTION (SEE PROFILES FOR LOCATIONS)
SCALE: NTS

GEOS
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Retaining Wall Design Plans
Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: JEE	APPROVED BY:
SCALE: AS SHOWN	
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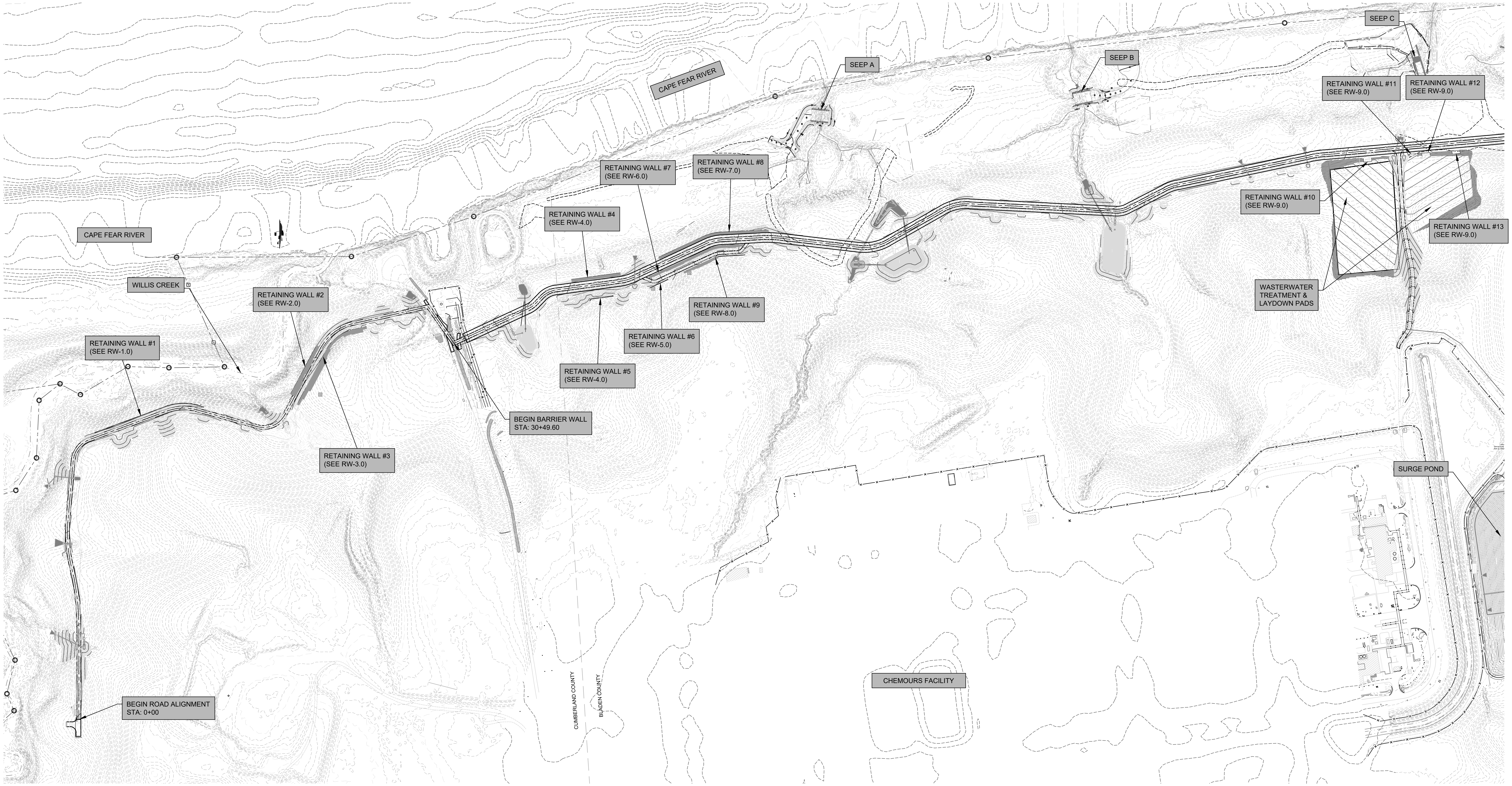
DRAWING:
RW-0.3

PROJECT NUMBER:
45-20803



N

1
RW-0.4

RETAINING WALL SITE PLAN
SCALE: 1" = 200'
0' 200' 400'

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Retaining Wall Design Plans
Retaining Wall Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
NSS	JEE
DESIGNED BY:	APPROVED BY:
JEE	
SCALE: AS SHOWN	
DATE: February 10, 2022	

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1			
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DRAWING:
RW-0.4

PROJECT NUMBER:
45-20803

ESTIMATED WALL #1 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	122	701.50	0.00
28"	Mid	5.75	0.00	167	960.25	0.00
28"	Bot	5.75	0.00	78	448.50	0.00
41"	Mid	5.75	0.00	16	92.00	0.00
41"	Bot	5.75	0.00	28	161.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	16	92.00	0.00
PC	Top	5.75	0.00	0	0.00	0.00
PC	Mid	5.75	0.00	0	0.00	0.00
PC	Bot	5.75	0.00	0	0.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	4	11.50	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	2	5.75	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	2	5.75	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	2	5.75	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	1782.50	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	99.03	CY
Total Stone Volume	99.03	CY

ESTIMATED WALL #2 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	0	0.00	0.00
28"	Mid	5.75	0.00	0	0.00	0.00
28"	Bot	5.75	0.00	0	0.00	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	0	0.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	57	327.75	0.00
PC	Mid	5.75	0.00	239	1374.25	0.00
PC	Bot	5.75	0.00	58	333.50	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	6	17.25	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	2	5.75	0.00
28"	Half Bot	2.875	0.00	9	25.88	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	0	0.00	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	2084.38	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	115.80	CY
Total Stone Volume	115.80	CY

ESTIMATED WALL #3 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	0	0.00	0.00
28"	Mid	5.75	0.00	0	0.00	0.00
28"	Bot	5.75	0.00	0	0.00	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	0	0.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	108	621.00	0.00
PC	Mid	5.75	0.00	500	2875.00	0.00
PC	Bot	5.75	0.00	112	644.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	22	63.25	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	14	40.25	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	0	0.00	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	4243.50	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	235.75	CY
Total Stone Volume	235.75	CY

ESTIMATED WALL #4 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	0	0.00	0.00
28"	Mid	5.75	0.00	0	0.00	0.00
28"	Bot	5.75	0.00	0	0.00	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	0	0.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	50	287.50	0.00
PC	Mid	5.75	0.00	121	695.75	0.00
PC	Bot	5.75	0.00	51	293.25	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	6	17.25	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	4	11.50	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	0	0.00	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	1305.25	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	72.51	CY
Total Stone Volume	72.51	CY

ESTIMATED WALL #5 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	25	143.75	0.00
28"	Mid	5.75	0.00	38	218.50	0.00
28"	Bot	5.75	0.00	11	63.25	0.00
41"	Mid	5.75	0.00	26	149.50	0.00
41"	Bot	5.75	0.00	3	17.25	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	11	63.25	0.00
PC	Top	5.75	0.00	0	0.00	0.00
PC	Mid	5.75	0.00	0	0.00	0.00
PC	Bot	5.75	0.00	0	0.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	4	11.50	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	2	5.75	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	1	2.88	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	2	5.75	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	537.63	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	29.87	CY
Total Stone Volume	29.87	CY

ESTIMATED WALL #6 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	20	115.00	0.00
28"	Mid	5.75	0.00	37	212.75	0.00
28"	Bot	5.75	0.00	4	23.00	0.00
41"	Mid	5.75	0.00	12	69.00	0.00
41"	Bot	5.75	0.00	16	92.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	11	63.25	0.00
PC	Top	5.75	0.00	0	0.00	0.00
PC	Mid	5.75	0.00	0	0.00	0.00
PC	Bot	5.75	0.00	0	0.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	4	11.50	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	2	5.75	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	2	5.75	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	483.00	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	26.83	CY
Total Stone Volume	26.83	CY

ESTIMATED WALL #7 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	0	0.00	0.00
28"	Mid	5.75	0.00	0	0.00	0.00
28"	Bot	5.75	0.00	0	0.00	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	0	0.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	104	598.00	0.00
PC	Mid	5.75	0.00	655	3766.25	0.00
PC	Bot	5.75	0.00	107	615.25	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	12	34.50	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	1	2.88	0.00
28"	Half Bot	2.875	0.00	5	14.38	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	0	0.00	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	5031.25	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	279.51	CY
Total Stone Volume	279.51	CY

ESTIMATED WALL #8 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	0	0.00	0.00
28"	Mid	5.75	0.00	0	0.00	0.00
28"	Bot	5.75	0.00	0	0.00	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	0	0.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	121	695.75	0.00
PC	Mid	5.75	0.00	393	2259.75	0.00
PC	Bot	5.75	0.00	120	690.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	5	14.38	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	1	2.88	0.00
28"	Half Bot	2.875	0.00	10	28.75	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	0	0.00	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	3691.50	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	205.08	CY
Total Stone Volume	205.08	CY

ESTIMATED WALL #9 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	26	149.50	0.00
28"	Mid	5.75	0.00	35	201.25	0.00
28"	Bot	5.75	0.00	0	0.00	0.00
41"	Mid	5.75	0.00	25	143.75	0.00
41"	Bot	5.75	0.00	27	155.25	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	36	207.00	0.00
PC	Mid	5.75	0.00	225	1293.75	0.00
PC	Bot	5.75	0.00	38	218.50	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	15	43.13	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	5	14.38	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	4	11.50	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	2288.50	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	127.14	CY
Total Stone Volume	127.14	CY

ESTIMATED WALL #10 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	16	92.00	0.00
28"	Mid	5.75	0.00	31	178.25	0.00
28"	Bot	5.75	0.00	18	103.50	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	0	0.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	0	0.00	0.00
PC	Mid	5.75	0.00	0	0.00	0.00
PC	Bot	5.75	0.00	0	0.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	5	14.38	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	1	2.88	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	0	0.00	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	299.00	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	16.61	CY
Total Stone Volume	16.61	CY

ESTIMATED WALL #11 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	18	103.50	0.00
28"	Mid	5.75	0.00	13	74.75	0.00
28"	Bot	5.75	0.00	16	92.00	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	0	0.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	0	0.00	0.00
PC	Mid	5.75	0.00	0	0.00	0.00
PC	Bot	5.75	0.00	0	0.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	1	2.88	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	4	11.50	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	0	0.00	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	181.13	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	10.06	CY
Total Stone Volume	10.06	CY

ESTIMATED WALL #12 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	18	103.50	0.00
28"	Mid	5.75	0.00	28	161.00	0.00
28"	Bot	5.75	0.00	16	92.00	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	0	0.00	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	0	0.00	0.00
PC	Mid	5.75	0.00	0	0.00	0.00
PC	Bot	5.75	0.00	0	0.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	1	2.88	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	5	14.38	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	0	0.00	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	270.25	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	15.01	CY
Total Stone Volume	15.01	CY

ESTIMATED WALL #13 QUANTITIES

Block Count		Face Area/Unit (SF)	Infill Volume/ Unit (CF)	Number of Units	Face Area (SF)	Infill Vol (CY)
Size	Type					
28"	Top	5.75	0.00	15	86.25	0.00
28"	Mid	5.75	0.00	42	241.50	0.00
28"	Bot	5.75	0.00	0	0.00	0.00
41"	Mid	5.75	0.00	0	0.00	0.00
41"	Bot	5.75	0.00	18	103.50	0.00
60"	Mid	5.75	0.00	0	0.00	0.00
60"	Bot	5.75	0.00	0	0.00	0.00
PC	Top	5.75	0.00	0	0.00	0.00
PC	Mid	5.75	0.00	0	0.00	0.00
PC	Bot	5.75	0.00	0	0.00	0.00
2-side	Cap	1.92	0.00	0	0.00	0.00
3-side	Cap	1.92	0.00	0	0.00	0.00
4-side	Cap	1.92	0.00	0	0.00	0.00
Corner	Half Gdn.	2.875	0.00	7	20.13	0.00
Corner	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Top	2.875	0.00	0	0.00	0.00
28"	Half Mid	2.875	0.00	0	0.00	0.00
28"	Half Bot	2.875	0.00	0	0.00	0.00
41"	Half Mid	2.875	0.00	0	0.00	0.00
41"	Half Bot	2.875	0.00	1	2.88	0.00
60"	Half Mid	2.875	0.00	0	0.00	0.00
60"	Half Bot	2.875	0.00	0	0.00	0.00
96"	XL	11.5	54.63	0	0.00	0.00
72"	XL	11.5	36.29	0	0.00	0.00
52"	XL	11.5	22.88	0	0.00	0.00

Summary of Quantities		
Total Face Area	368.00	SF
Total XL Infill Volume	0	CY
Total Drainage Stone Volume	20.44	CY
Total Stone Volume	20.44	CY

NOTE:
QUANTITIES SHOWN IN BLOCK TABLES ASSUME A NEAT EXCAVATION AND DO NOT ACCOUNT FOR THE FILL REQUIRED BETWEEN THE DRAINAGE STONE POCKET AND THE TEMPORARY EXCAVATION. THESE QUANTITIES SHALL NOT BE USED FOR BIDDING WITHOUT ACCOUNTING FOR OVERAGES.

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall Block Quantities

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: JEE	APPROVED BY:

SCALE: AS SHOWN

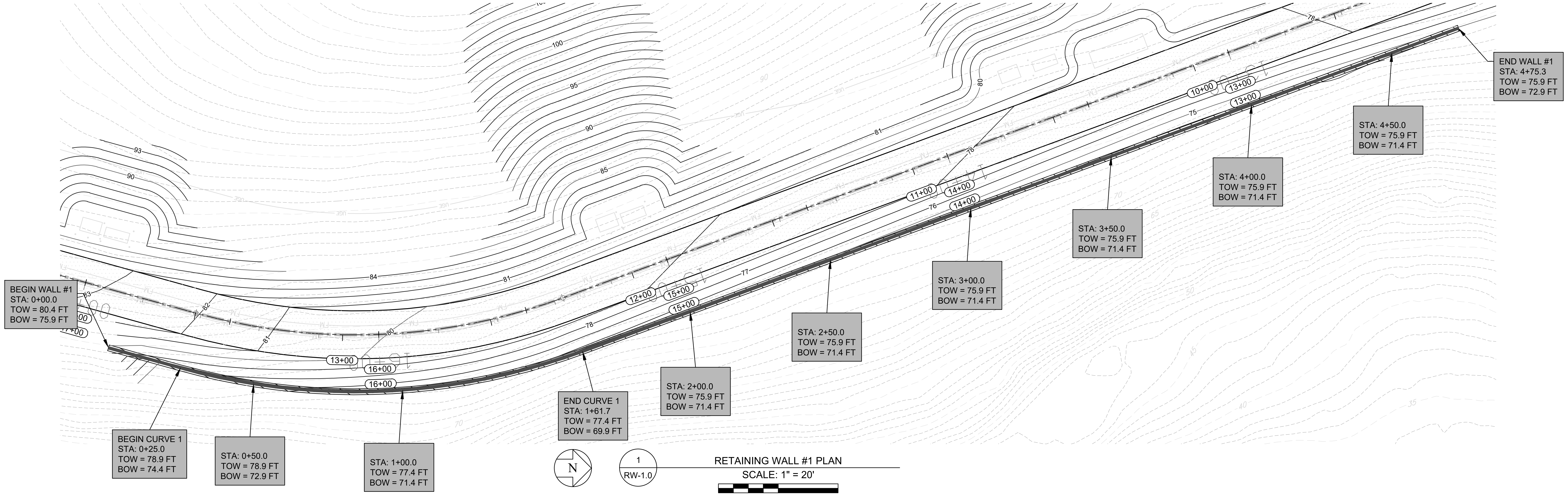
DATE: January 28, 2022

Revisions

No.	Date	Description	By:
1			
2			
3			
4			
5			
6			

DRAWING: RW-0.5

PROJECT NUMBER: 45-20803



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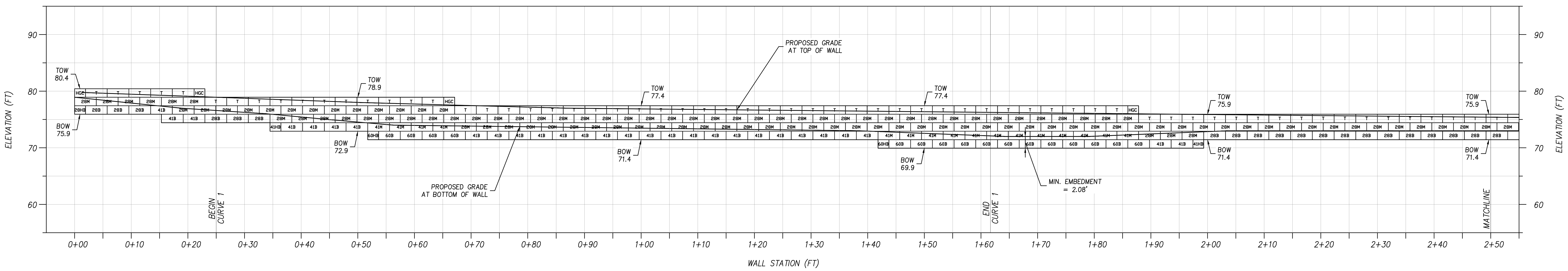
RW-1.0
RETAINING WALL #1 PLAN
SCALE: 1" = 20'
0' 20' 40'



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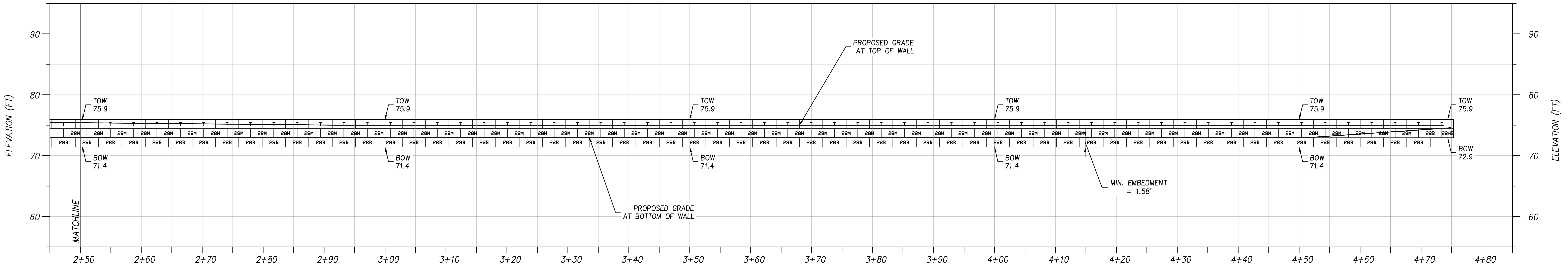
RW-1.0
RETAINING WALL #1 PROFILE
SCALE: 1" = 10'
0' 10' 20'



3
RW-1.0
RETAINING WALL #1 PROFILE
SCALE: 1" = 10'
0' 10' 20'

LEGEND:
- - - = GEOGRID REINFORCEMENT MIRAGRID 8XT (TYP.) OR APPROVED EQUAL

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall #1 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

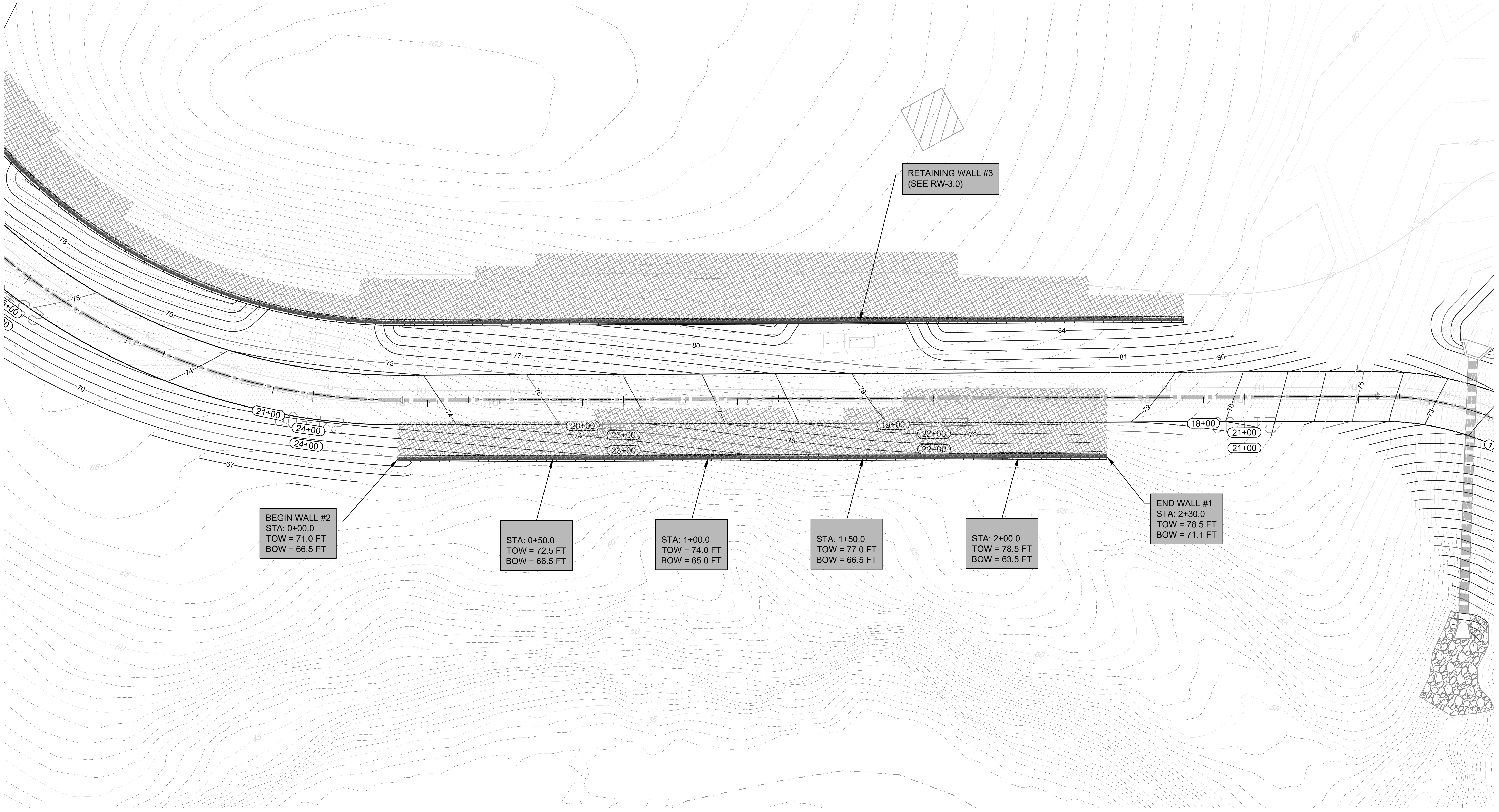
DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: JEE	APPROVED BY:
SCALE: AS SHOWN	
DATE: January 28, 2022	

Revisions

No.	Date	Description	By:
1			
2			
3			
4			
5			
6			

DRAWING:
RW-1.0

PROJECT NUMBER:
45-20803



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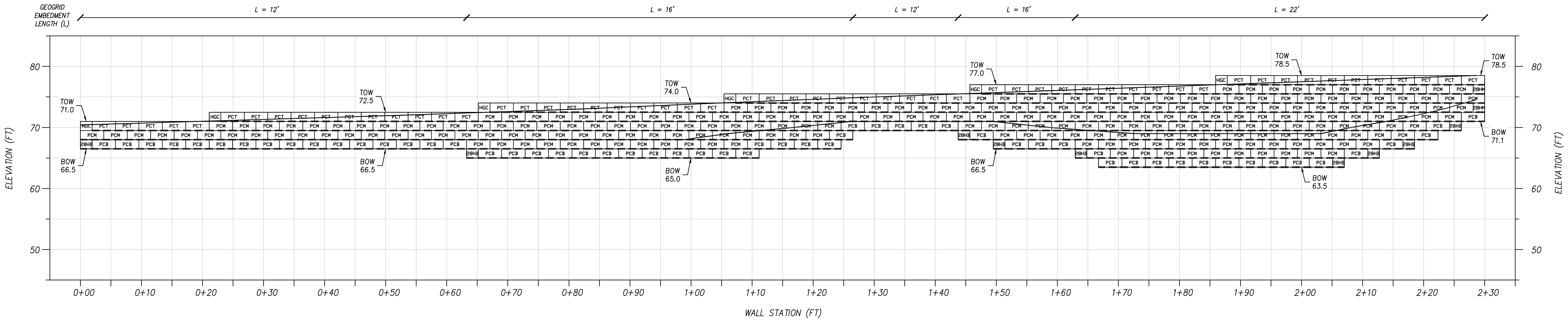
RW-2.0

RETAINING WALL #2 LOCATION PLAN

SCALE: 1" = 20'

0' 20' 40'



LEGEND:

- - - - = GEOGRID REINFORCEMENT MIRAGRID 8XT (TYP.) OR APPROVED EQUAL

2
RW-2.0

RETAINING WALL #2 PROFILE

SCALE: 1" = 10'

0' 10' 20'

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall #2 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
NSS	JEE
DESIGNED BY:	APPROVED BY:
JEE	

SCALE:
AS SHOWN

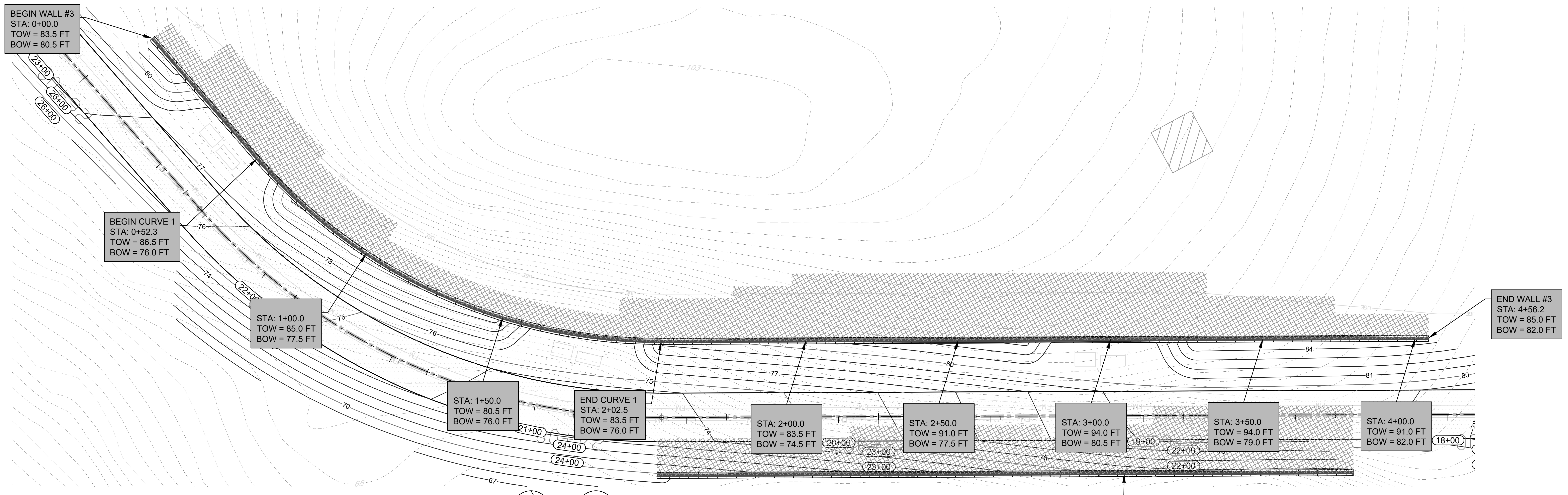
DATE:
January 28, 2022

Revisions

No.	Date	Description	By:
1			
2			
3			
4			
5			
6			

DRAWING:
RW-2.0

PROJECT NUMBER:
45-20803

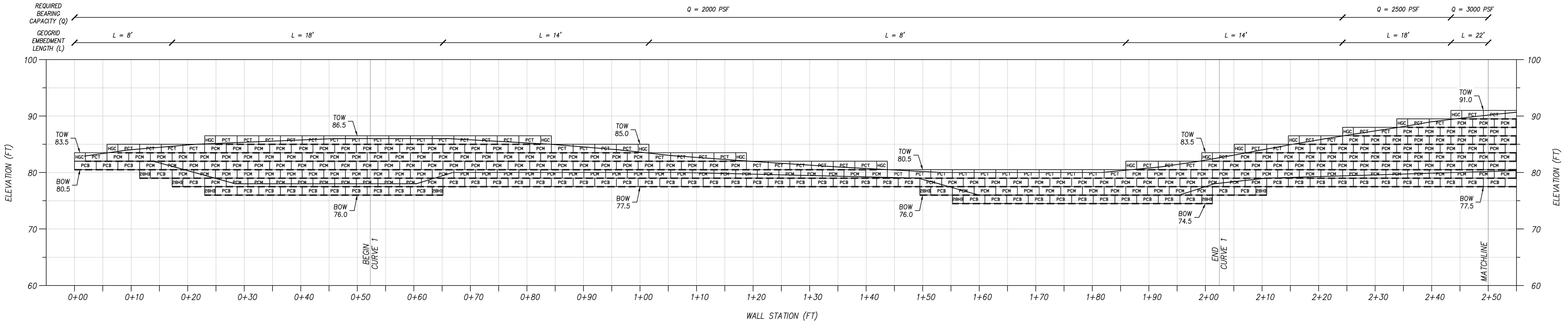


1
RW-3.0

RETAINING WALL #3 LOCATION PLAN

SCALE: 1" = 20'

0' 20' 40'

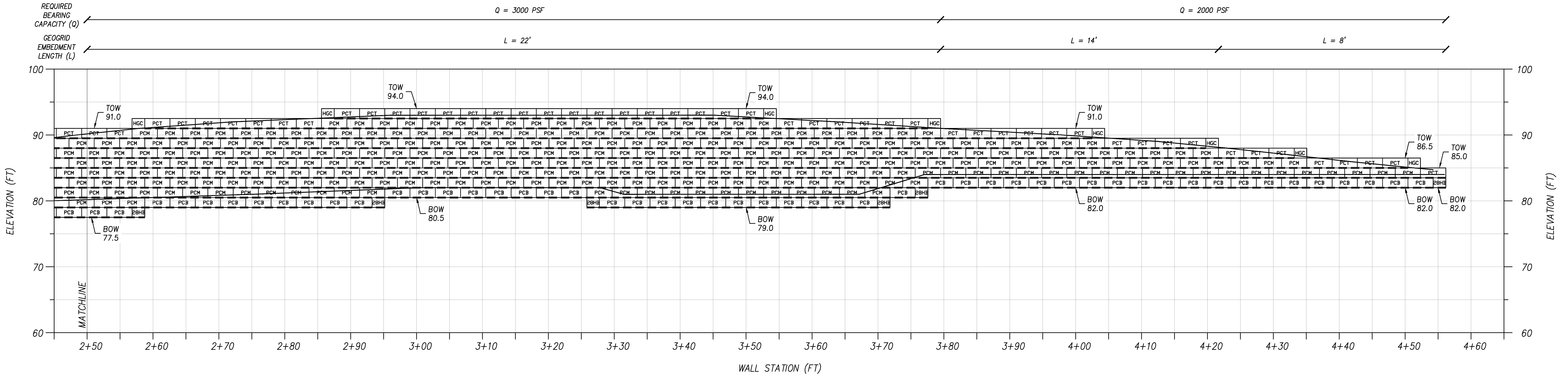


2
RW-3.0

RETAINING WALL #3 PROFILE

SCALE: 1" = 10'

0' 10' 20'



3
RW-3.0

RETAINING WALL #3 PROFILE

SCALE: 1" = 10'

0' 10' 20'

LEGEND:

– – – = GEOGRID REINFORCEMENT
MIRAGRID 8XT (TYP.)
OR APPROVED EQUAL

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall #3 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: JEE	APPROVED BY:

SCALE:
AS SHOWN

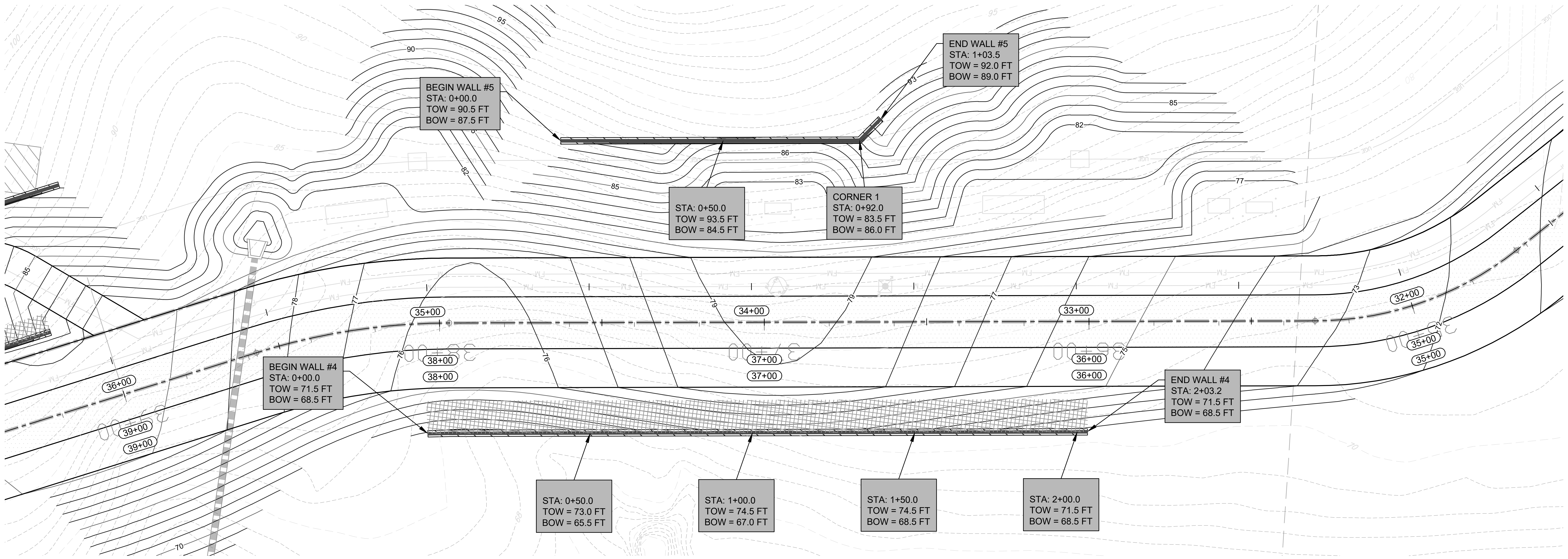
DATE:
January 28, 2022

Revisions

No.	Date	Description	By:
1			
2			
3			
4			
5			
6			

DRAWING:
RW-3.0

PROJECT NUMBER:
45-20803



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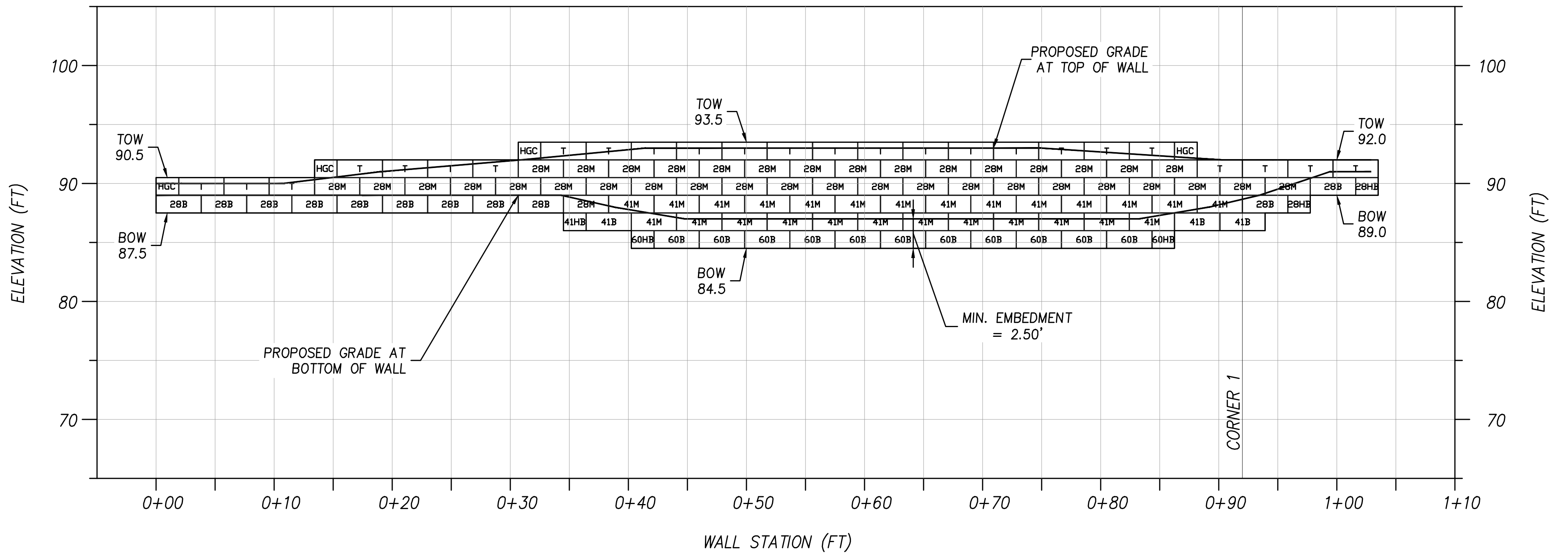
1
RW-4.0

RETAINING WALL #4 & #5 LOCATION PLAN

SCALE: 1" = 20'

0' 20' 40'



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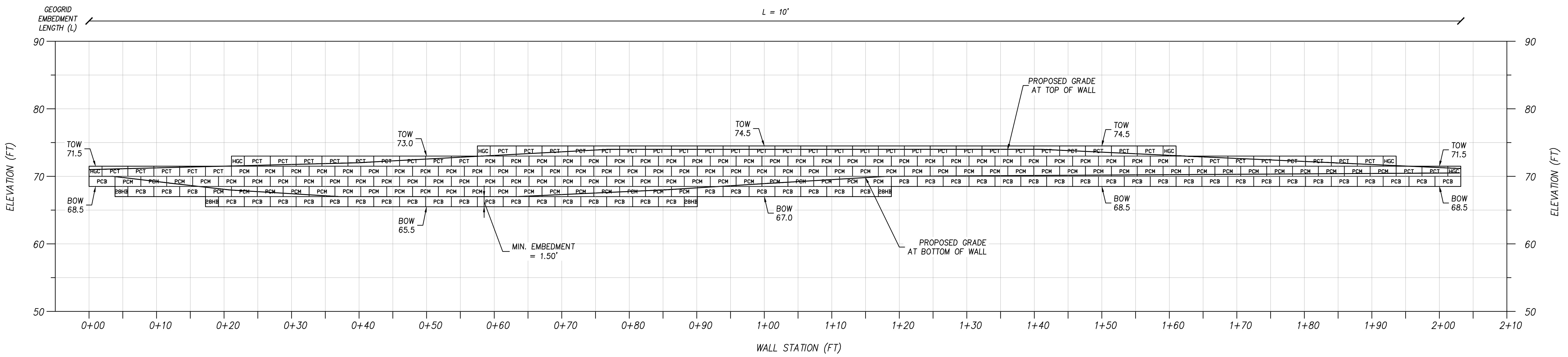
RW-4.0

RETAINING WALL #5 PROFILE

SCALE: 1" = 10'

0' 10' 20'



3
RW-4.0

RETAINING WALL #4 PROFILE

SCALE: 1" = 10'

0' 10' 20'

LEGEND:

- - - = GEOGRID REINFORCEMENT MIRAGRID 8XT (TYP.) OR APPROVED EQUAL

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall #4 & #5 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: JEE	APPROVED BY:
SCALE: AS SHOWN	
DATE: January 28, 2022	

Revisions

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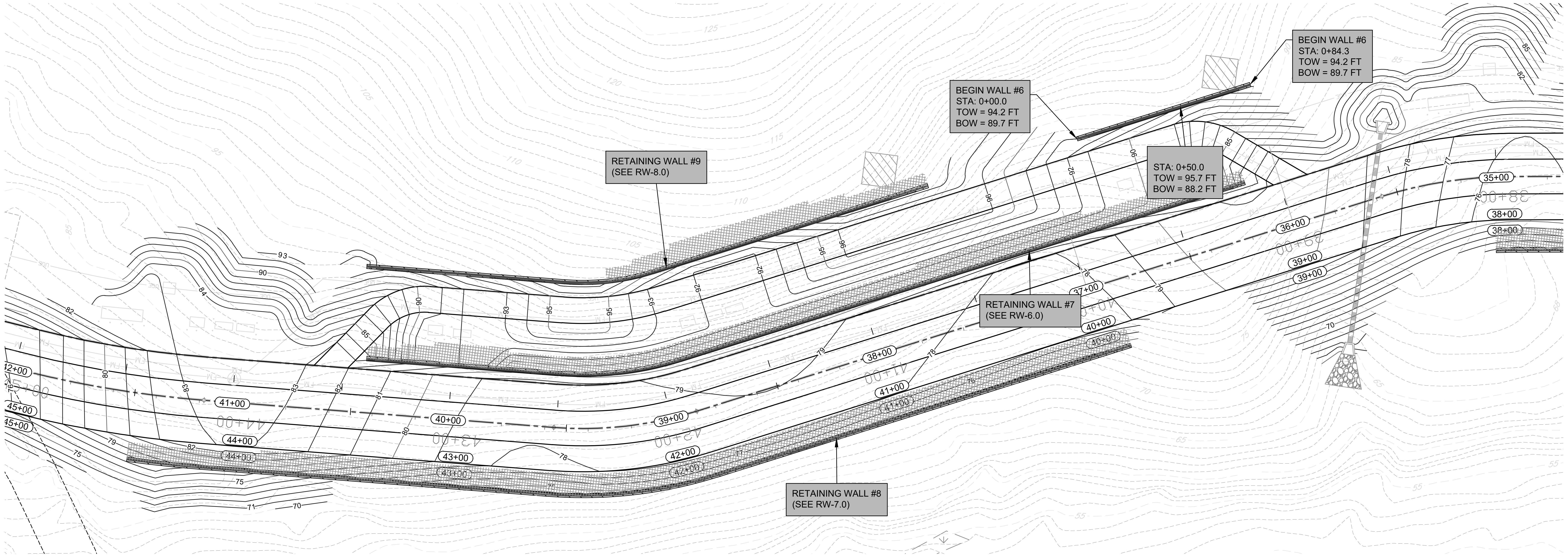
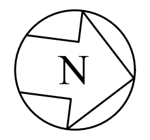
DRAWING:
RW-4.0

PROJECT NUMBER:
45-20803



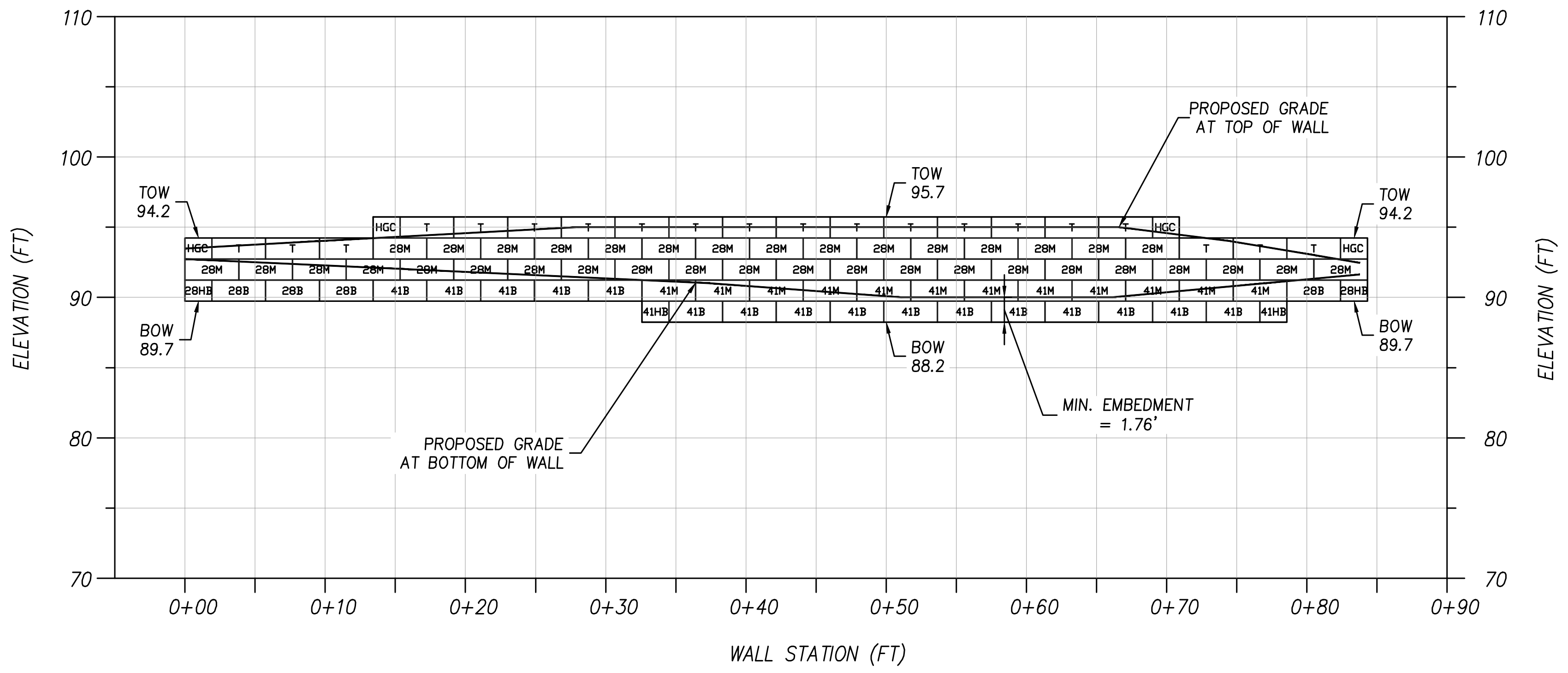


1
RW-5.0

RETAINING WALL #6 LOCATION PLAN

SCALE: 1" = 30'

0' 30' 60'



2
RW-5.0

RETAINING WALL #6 PROFILE

SCALE: 1" = 10'

0' 10' 20'

LEGEND:

- - - = GEOGRID REINFORCEMENT
MIRAGRID 8XT (TYP.)
OR APPROVED EQUAL

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall #6 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
NSS	JEE
DESIGNED BY:	APPROVED BY:
JEE	

SCALE:
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DATE:
January 28, 2022

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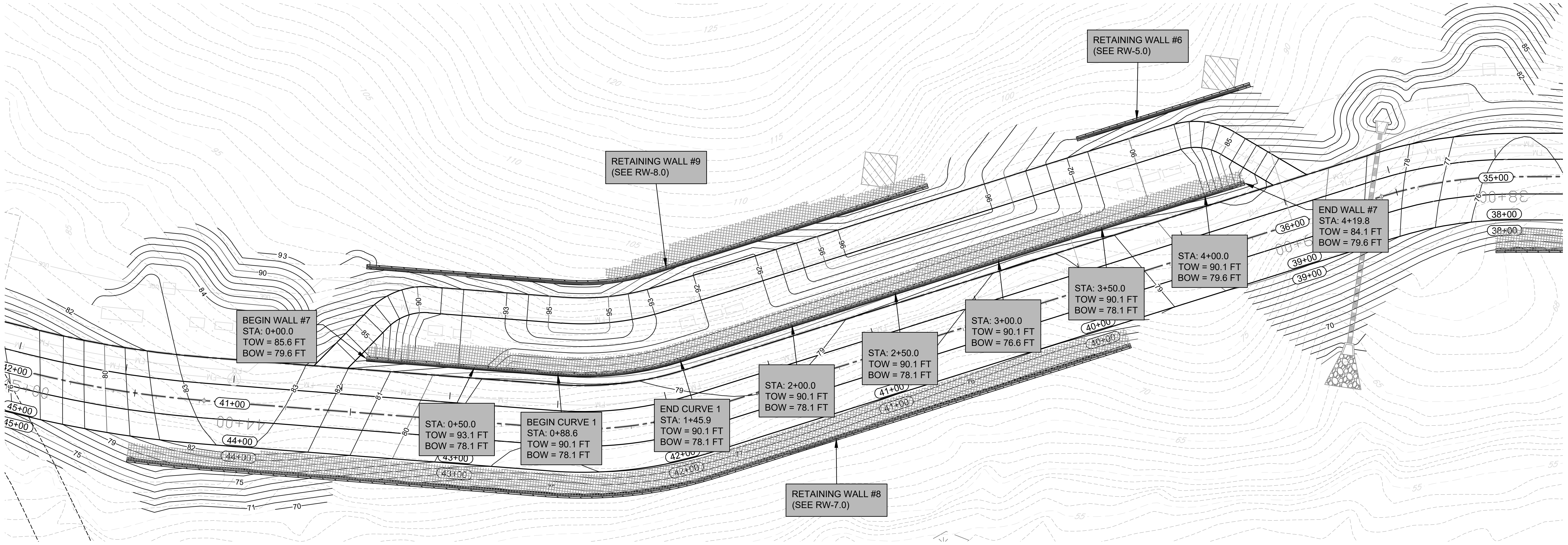
DRAWING:
RW-5.0

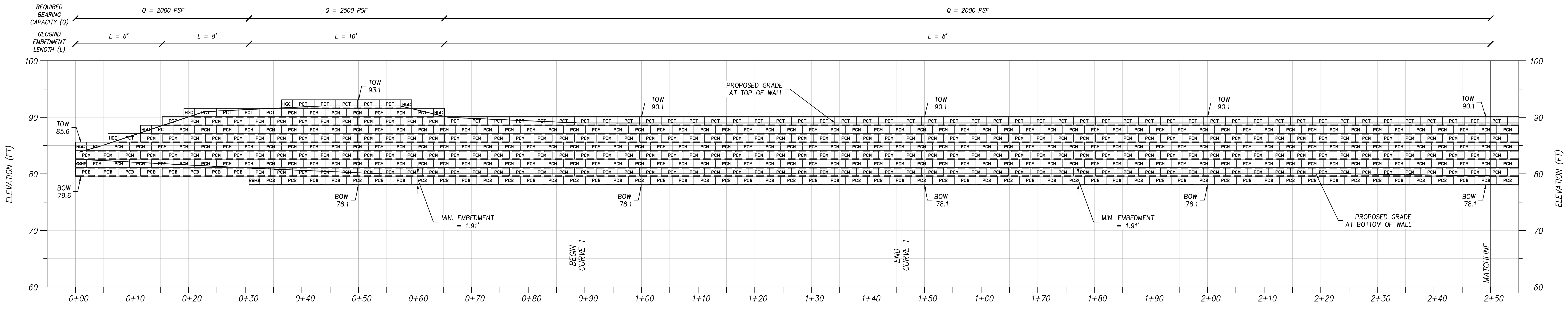
PROJECT NUMBER:
45-20803



1 RW-6.0 RETAINING WALL #7 LOCATION PLAN

SCALE: 1" = 30'

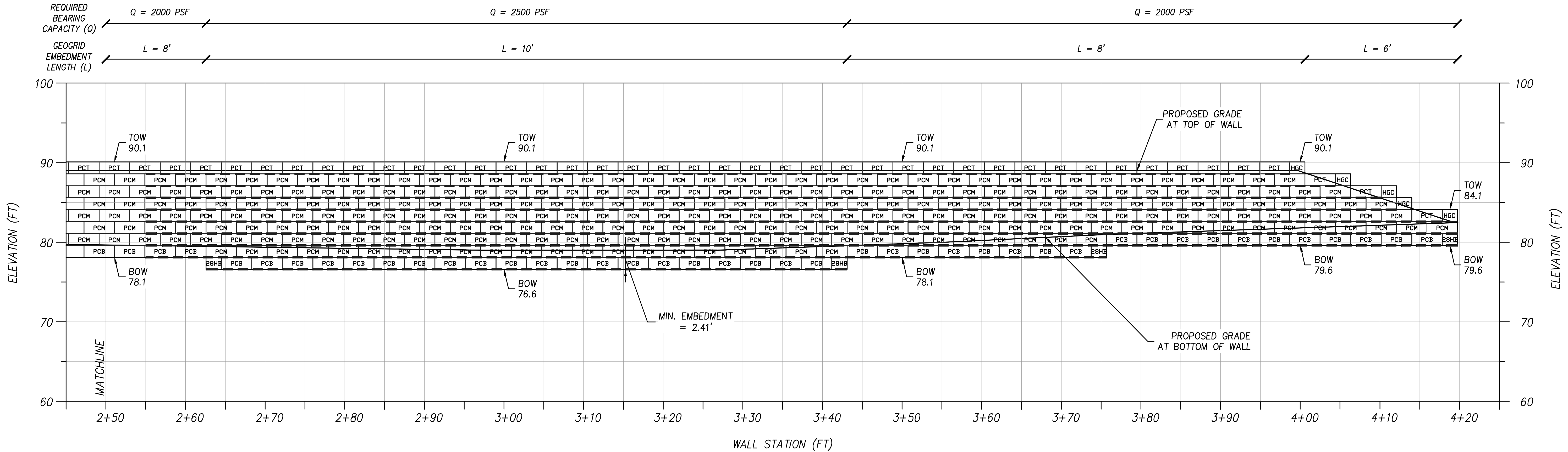
0' 30' 60'



2 RW-6.0 RETAINING WALL #7 PROFILE

SCALE: 1" = 10'

0' 10' 20'



3 RW-6.0 RETAINING WALL #7 PROFILE

SCALE: 1" = 10'

0' 10' 20'

LEGEND:
- - - = GEOGRID REINFORCEMENT MIRAGRID 8XT (TYP.) OR APPROVED EQUAL

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall #7 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS
REVIEWED BY: JEE
DESIGNED BY: JEE
APPROVED BY:
SCALE: AS SHOWN
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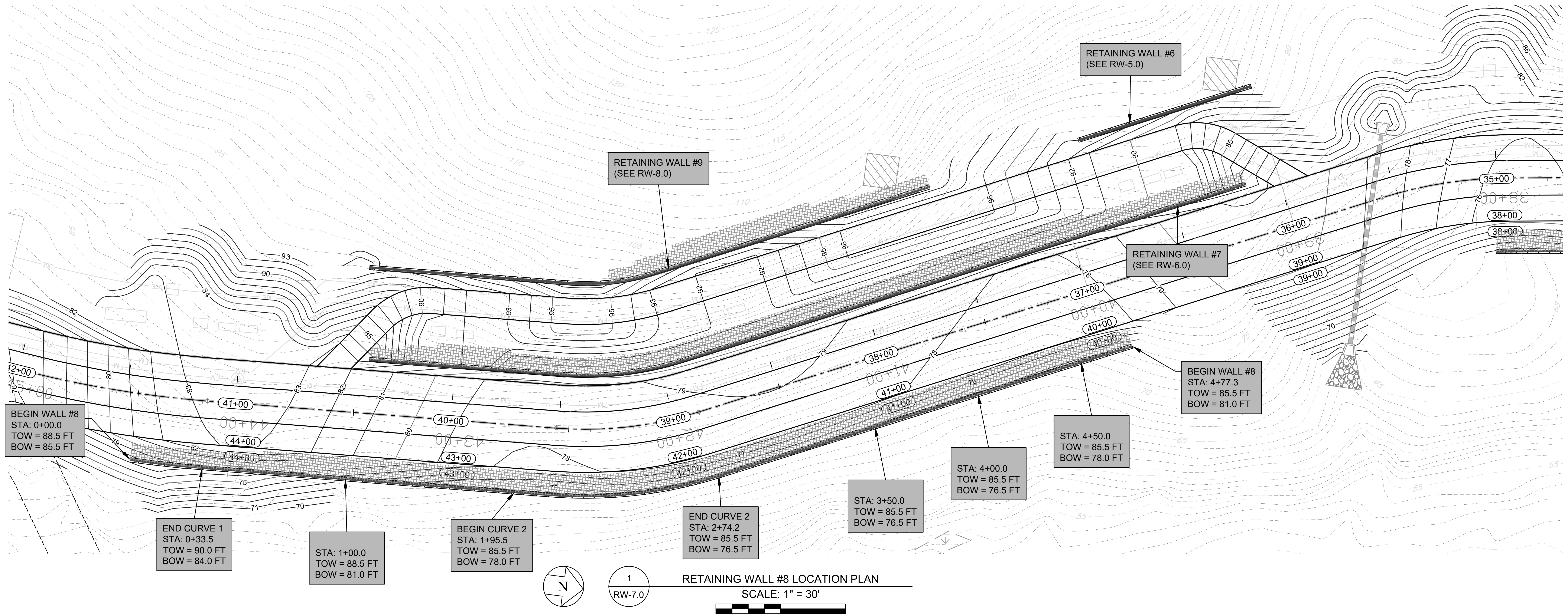
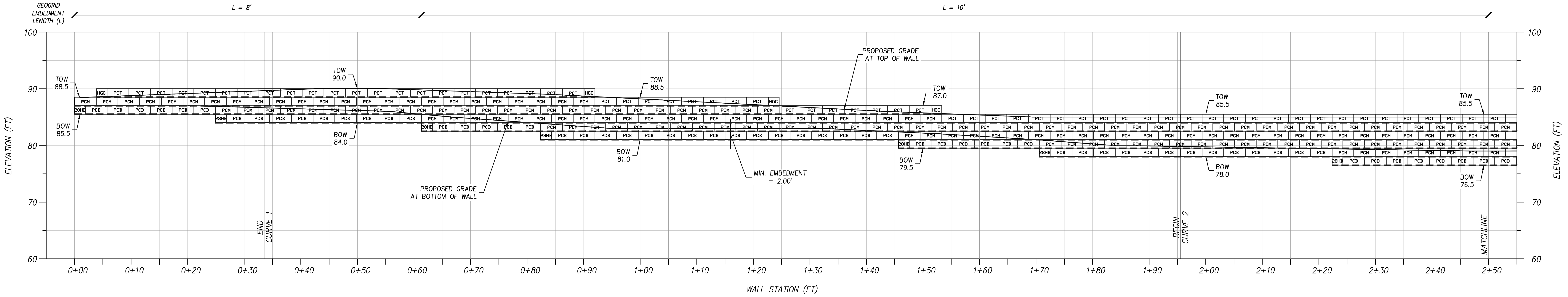
DRAWING: RW-6.0

PROJECT NUMBER: 45-20803



1
RW-7.0
RETAINING WALL #8 LOCATION PLAN
SCALE: 1" = 30'



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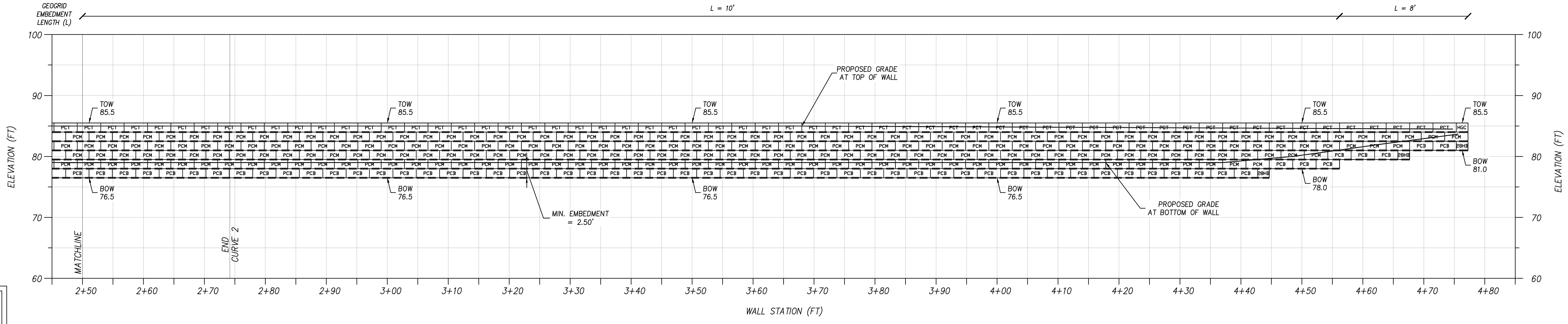
RW-7.0
RETAINING WALL #8 PROFILE
SCALE: 1" = 10'



3
RW-7.0
RETAINING WALL #8 PROFILE
SCALE: 1" = 10'

LEGEND:

- - - = GEOGRID REINFORCEMENT
MIRAGRID 8XT (TYP.)
OR APPROVED EQUAL

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall #8 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
NSS	JEE
DESIGNED BY:	APPROVED BY:
JEE	

SCALE: AS SHOWN

DATE: January 28, 2022

Revisions

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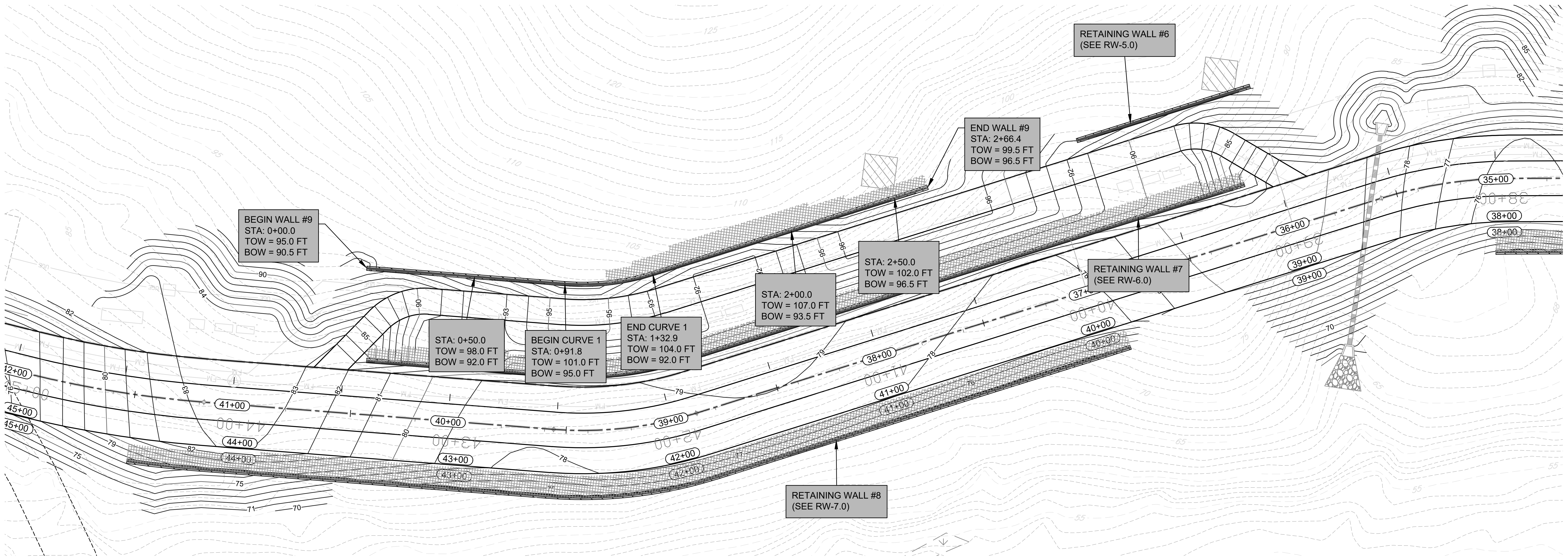
DRAWING: RW-7.0

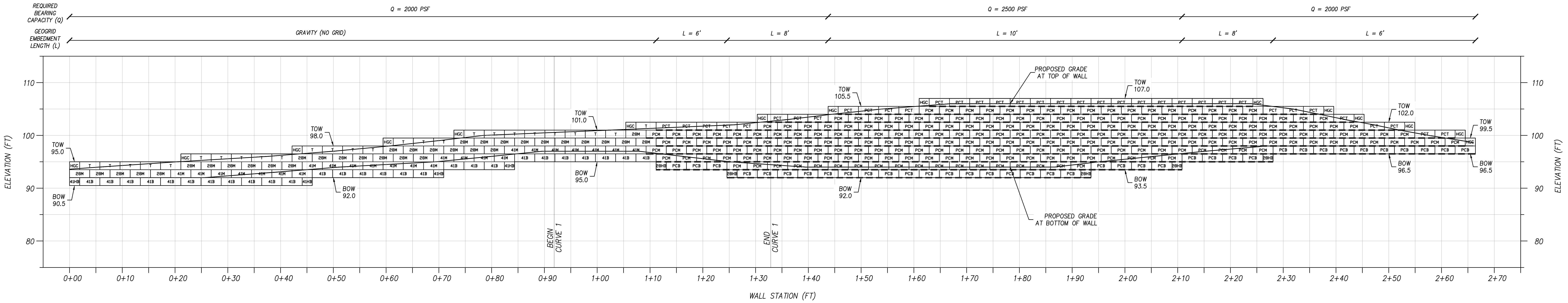
PROJECT NUMBER: 45-20803



1 RW-8.0 RETAINING WALL #9 LOCATION PLAN

SCALE: 1" = 30'

0' 30' 60'



2 RW-8.0 RETAINING WALL #9 PROFILE

SCALE: 1" = 10'

0' 10' 20'

LEGEND:

- - - = GEOGRID REINFORCEMENT MIRAGRID 8XT (TYP.) OR APPROVED EQUAL

GEOS

Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Wall #9 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS
REVIEWED BY: JEE
DESIGNED BY: JEE
APPROVED BY:
SCALE: AS SHOWN
DATE: January 28, 2022

Revisions

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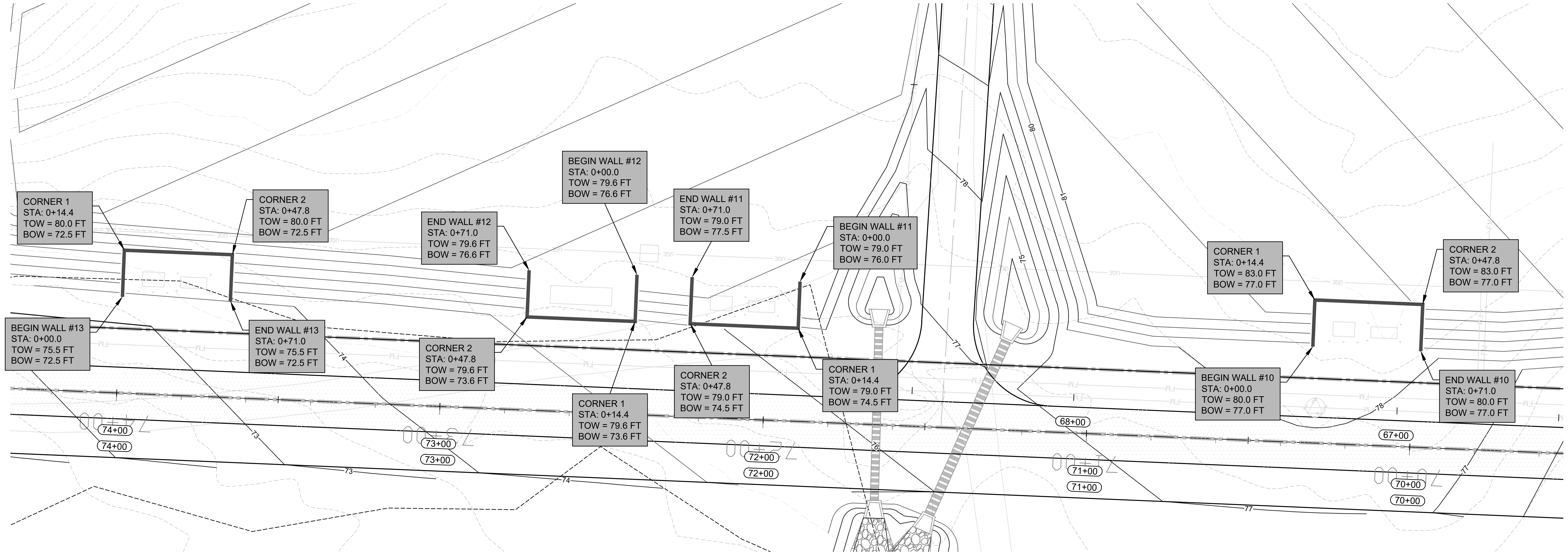
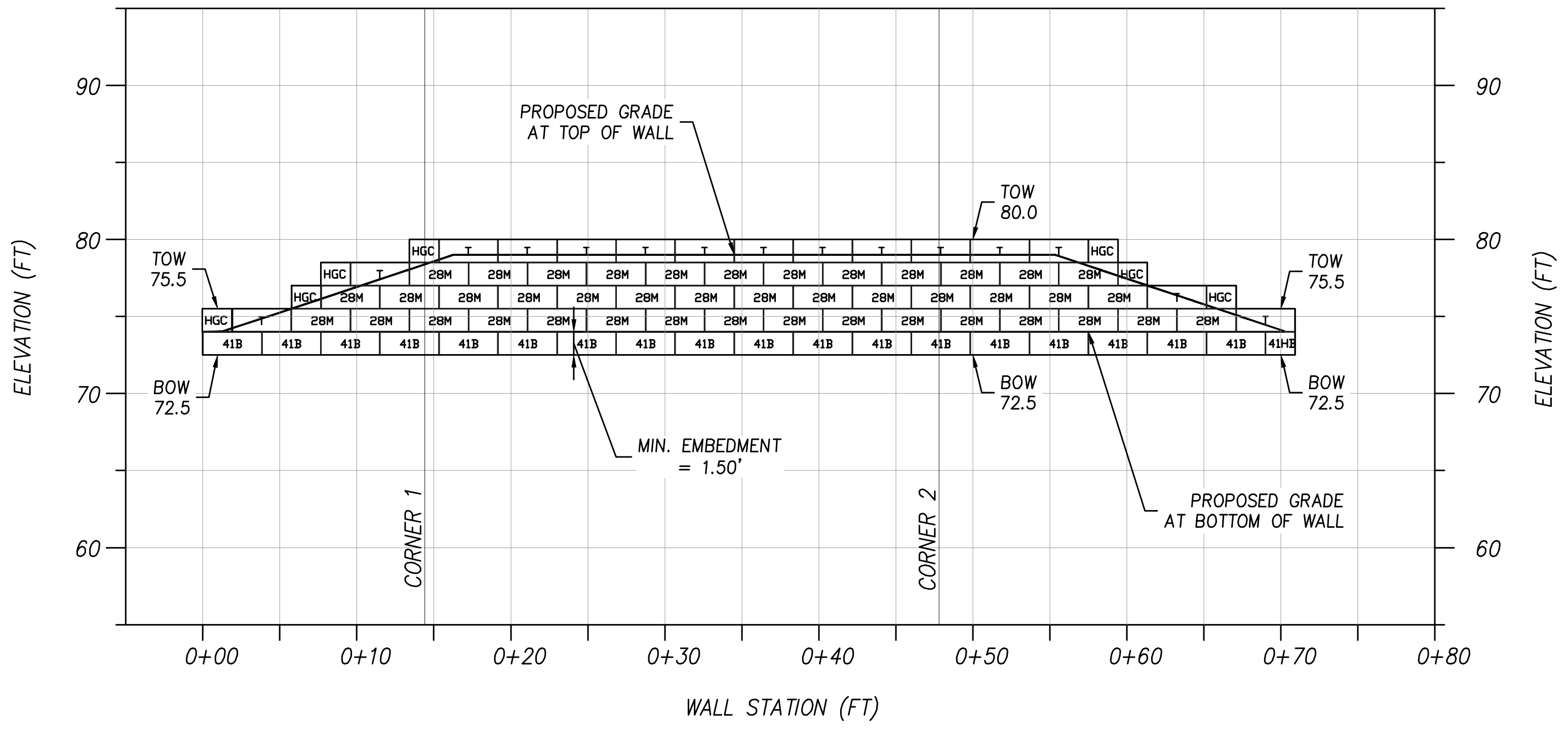
DRAWING: RW-8.0

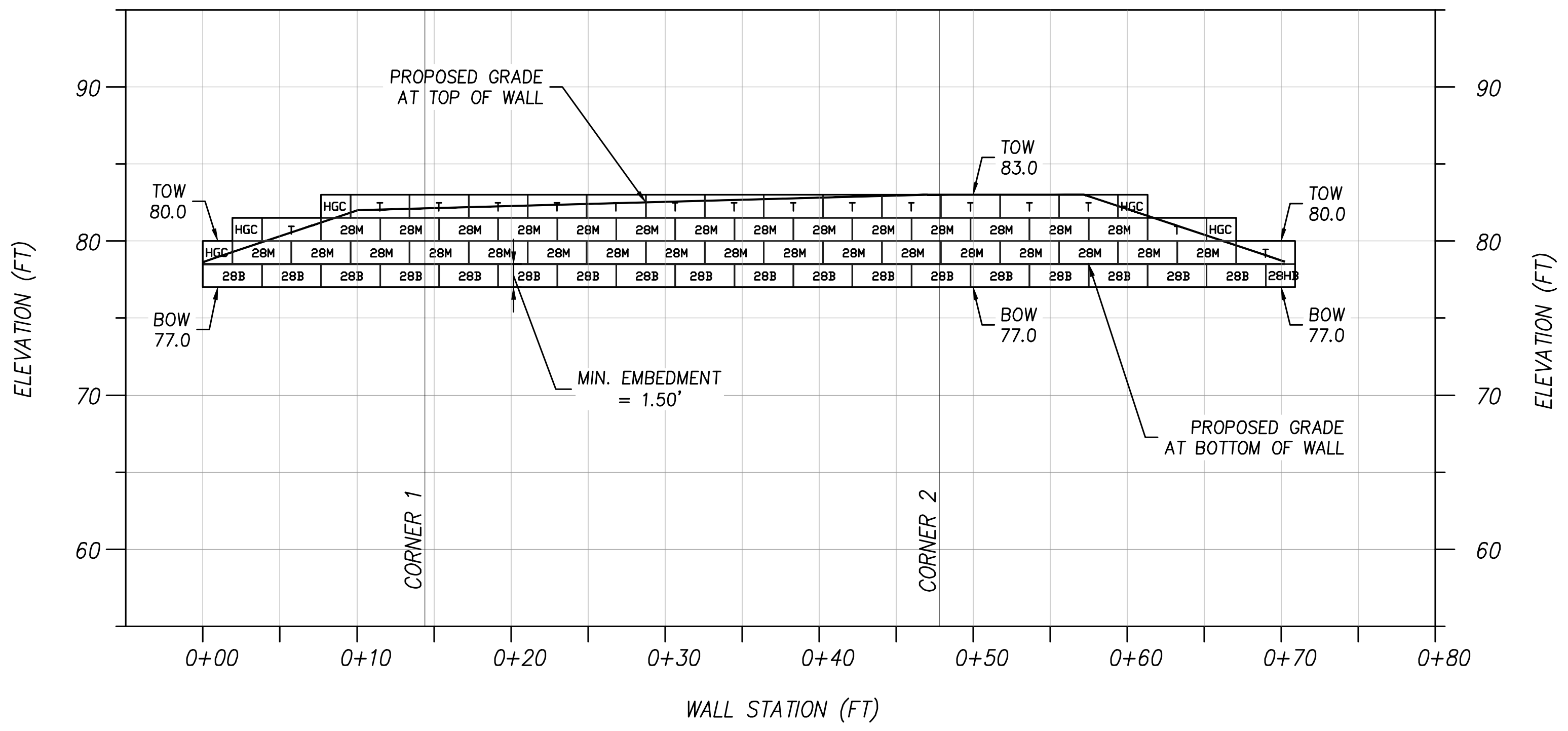
PROJECT NUMBER: 45-20803



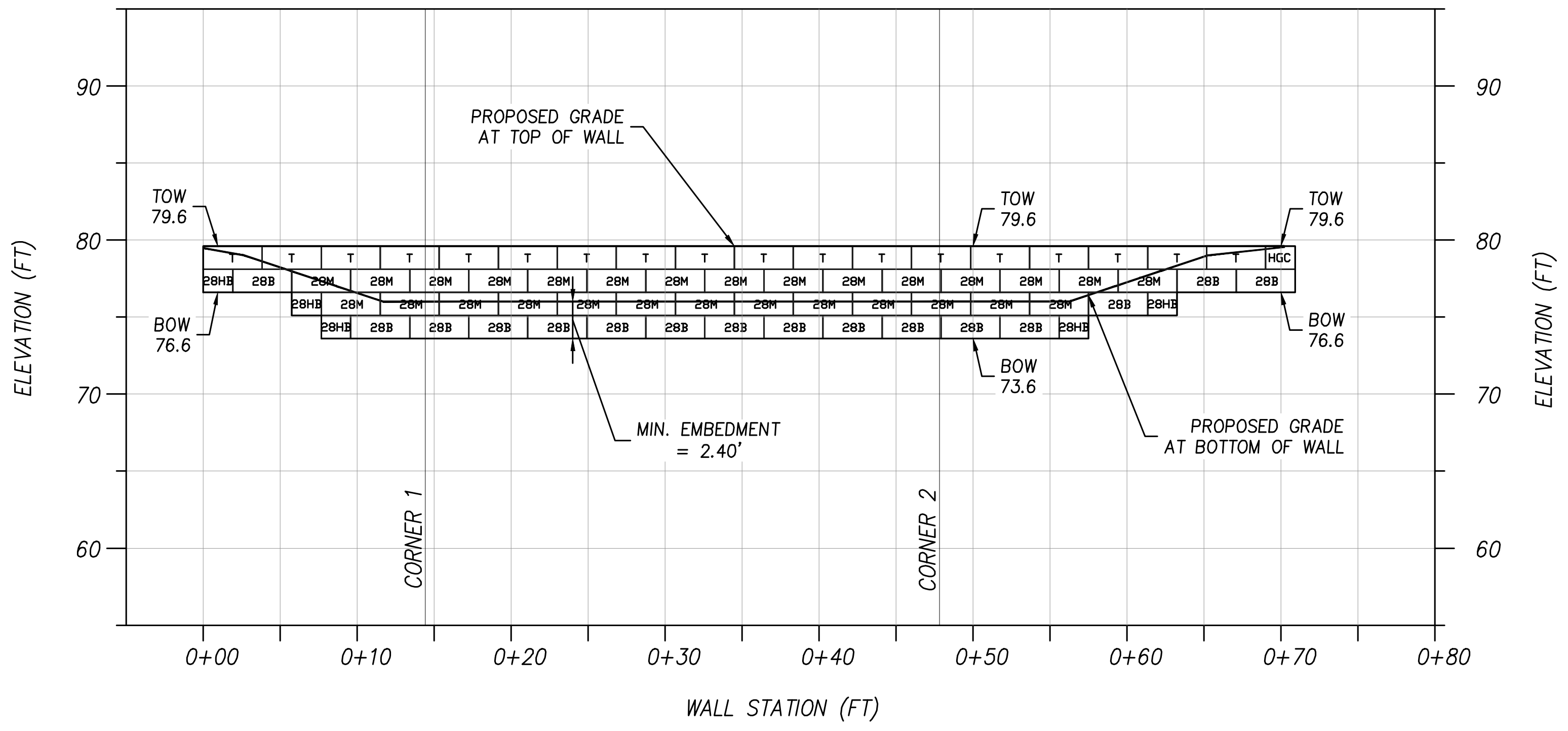
1 RW-9.0 RETAINING WALL #10 - #13 LOCATION PLAN
SCALE: 1" = 20'



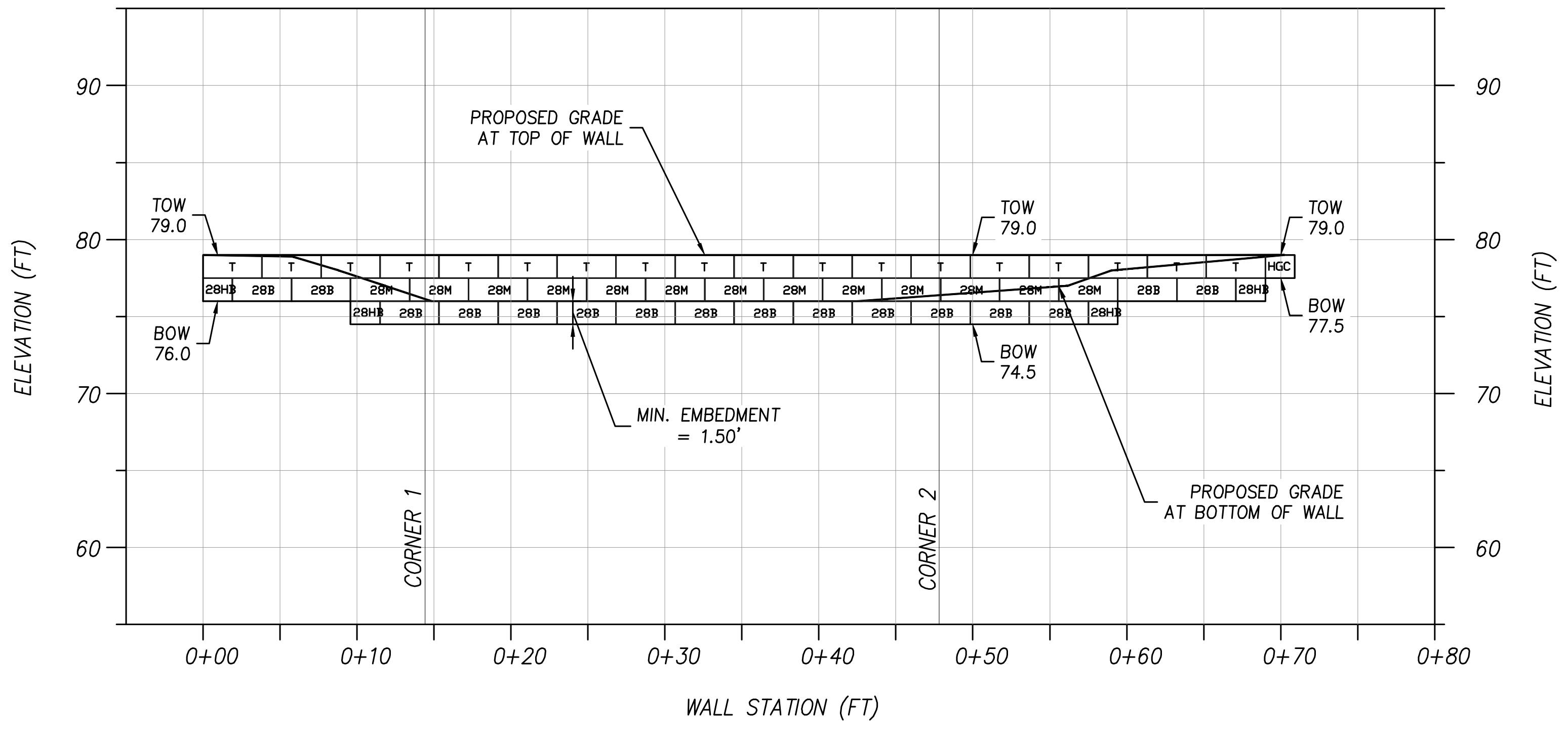
2 RW-9.0 RETAINING WALL #13 PROFILE
SCALE: 1" = 10'
0' 10' 20'



5 RW-9.0 RETAINING WALL #10 PROFILE
SCALE: 1" = 10'
0' 10' 20'



3 RW-9.0 RETAINING WALL #12 PROFILE
SCALE: 1" = 10'
0' 10' 20'



4 RW-9.0 RETAINING WALL #11 PROFILE
SCALE: 1" = 10'
0' 10' 20'

LEGEND:
- - - = GEOGRID REINFORCEMENT MIRAGRID 8XT (TYP.) OR APPROVED EQUAL

GEOS Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Retaining Walls #10 - #13 Plan & Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
NSS	JEE
DESIGNED BY:	APPROVED BY:
JEE	

SCALE:
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DATE:
January 28, 2022

Revisions

No.	Date	Description	By:
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DRAWING:
RW-9.0

PROJECT NUMBER:
45-20803

Chemours - Barrier Wall Access Road Soil Nail Wall

Fayetteville, North Carolina
Soil Nail Shoring Wall
February 10, 2022

Notes For The Construction Of Soil Nail Shoring Wall

1. GENERAL NOTES:

   A. CONSTRUCT SOIL NAIL RETAINING WALLS IN ACCORDANCE WITH THESE PLANS AND SPECIFICATIONS OR AS DIRECTED BY THE ENGINEER (GEOSERVICES, LLC.) DURING THE COURSE OF CONSTRUCTION.

   B. THE CONTRACTOR SHALL PROVIDE ALL LABOR, EQUIPMENT, AND MATERIALS TO CONSTRUCT THE PROJECT IN ACCORDANCE WITH THE LINES, ELEVATIONS, AND REQUIREMENTS OF THESE PLANS AND SPECIFICATIONS OR AS DIRECTED BY THE ENGINEER DURING THE COURSE OF THE CONSTRUCTION. ALTERNATIVES TO, OR CHANGES IN, THE PLANS AND SPECIFICATIONS MUST BE APPROVED BY THE ENGINEER PRIOR TO COMMENCEMENT OF WORK.

   C. THE CONTRACTOR SHALL BE RESPONSIBLE FOR INSTALLING ALL DRAINAGE FEATURES NECESSARY TO MINIMIZE INFILTRATION AND EXCESS RUNOFF IN THE AREAS OF THE WALLS, RETAINED MATERIAL, AND SOILS LOCATED DOWN SLOPE FROM THE SHORING BOTH DURING AND AFTER CONSTRUCTION. DRAINAGE FEATURES INCLUDE, BUT ARE NOT LIMITED TO, SURFACE DRAINS, SUBSURFACE DRAINS, AND DRAINAGE SWALES.

   D. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MEASURES TO PREVENT SURFACE WATER FROM PONDING AND/OR FLOWING AND/OR OVER THE WALL FACES.

   E. ALL UTILITY LOCATIONS SHALL BE FIELD VERIFIED AT THE TIME OF CONSTRUCTION. THE ENGINEER IS NOT RESPONSIBLE FOR FIELD VERIFYING THESE LOCATIONS AND DAMAGE TO IDENTIFIED AND UNIDENTIFIED UTILITIES AND FOUNDATIONS. THE CONTRACTOR SHALL FIELD VERIFY LOCATIONS AND ELEVATIONS OF ALL UTILITIES WITHIN 50 FEET BEHIND AND IN FRONT OF SOIL NAIL SHORING.

   F. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ACQUIRING PERMISSION AND ALL PERMITS FOR THE WALL CONSTRUCTION AREAS.

   G. WALL HEIGHTS SHOWN ARE BASED ON INFORMATION AVAILABLE AT THE TIME OF DESIGN. IF THE ACTUAL WALL HEIGHTS ARE MORE THAN ONE FOOT GREATER THAN THE WALL HEIGHTS SHOWN ON THE DRAWINGS, THE CONTRACTOR SHALL IMMEDIATELY INFORM THE ENGINEER OR HIS REPRESENTATIVE TO DETERMINE IF ANY MODIFICATIONS ARE REQUIRED.

   H. THE CONTRACTOR SHALL FIELD VERIFY ALL CONDITIONS, GRADES AND DIMENSIONS AT THE SITE PRIOR TO SHORING CONSTRUCTION. IF THE CONTRACTOR DISCOVERS ANY ERRORS, OMISSIONS OR DISCREPANCIES, HE SHALL CONTACT THE ENGINEER PRIOR TO CONTINUING WALL CONSTRUCTION. THE ENGINEER WILL THEN ISSUE INSTRUCTIONS AS HOW TO PROCEED.

   I. THE CONTRACTOR SHALL FIELD VERIFY ALL TOPOGRAPHIC AND GRADE INFORMATION SHOWN ON THESE PLANS AT THE TIME OF CONSTRUCTION FOR THE PROJECT AREAS.

   J. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBSERVING ALL APPLICABLE SAFETY LAWS AND REGULATIONS.

   K. MEASURES SHALL BE IMPLEMENTED TO MEET LOCAL, STATE AND FEDERAL REQUIREMENTS FOR FALL PROTECTION, TRAFFIC BARRIERS, AND ALL OTHER SAFETY CONDITIONS AT THE WALL LOCATIONS BOTH DURING AND AFTER WALL CONSTRUCTION. SAFETY MEASURES AND CONDITIONS SHALL BE THE RESPONSIBILITY OF THE OWNER. UNDER NO CIRCUMSTANCES SHALL THE ENGINEER BE RESPONSIBLE FOR PERFORMANCE OR IMPLEMENTATION OF THE SAFETY MEASURES OR ANY OTHER SAFETY CONDITIONS AT THE SITE BOTH DURING AND AFTER WALL CONSTRUCTION.

   L. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR SITE SAFETY AND UNDER NO CIRCUMSTANCES SHALL THE ENGINEER BE RESPONSIBLE FOR CONSTRUCTION SITE SAFETY.

   M. GRADING OPERATIONS BEHIND AND IN FRONT OF CONSTRUCTED PORTIONS OF THE SOIL NAIL WALLS SHALL BE RESTRICTED TO PREVENT DAMAGE TO CONSTRUCTED PORTIONS OF THE WALLS. ONLY LIGHT HAND-OPERATED EQUIPMENT SHALL BE USED WITHIN 15 FEET BEHIND THE WALLS TO PREVENT EXCESSIVE LATERAL STRESS ON CONSTRUCTED PORTIONS OF THE WALLS.

   N. THE ENGINEER SHALL BE RETAINED BY THE OWNER OR CONTRACTOR TO OBSERVE ALL WALL CONSTRUCTION ACTIVITIES TO CONFIRM THAT THE SITE CONDITIONS ARE CONSISTENT WITH THE DESIGN PARAMETERS AND TO ASSURE THAT THE CONTRACTOR'S METHODS ARE CAPABLE OF MEETING THE CONSTRUCTION CRITERIA.

2. DESIGN CRITERIA:

   A. GEOTECHNICAL PARAMETERS:
      SOIL: EXISTING MATERIALS
      UNIT WEIGHT: 120 PCF
      COHESION: 200 PSF
      EFFECTIVE FRICTION ANGLE: 25 DEGREES
      MIN. BOREHOLE NOMINAL DIAMETER: 6 INCHES MIN.
      NOMINAL DESIGN BOND STRESS: 9 PSI

   B. LOADING CONDITIONS:
      BACKSLOPE: VARIES (4H:1V OR FLATTER)
      TOE SLOPE: FLAT
      SURCHARGE: 250 PSF

   C. SHOTECRETE WALL FACING:
      F'C = 4000 PSI IN 28 DAYS
      THICKNESS = 6 INCHES
      WALL FACE BATTER: 5 DEGREES

   D. THE RETAINING WALL(S) SHALL NOT HAVE ANY ADDITIONAL SURCHARGES INCLUDING BUT NOT LIMITED TO CONSTRUCTION TRAFFIC, STRUCTURES, HEAVY EQUIPMENT, AND MATERIAL STOCKPILES PLACED ABOVE THE WALL AT ANY TIME DURING OR AFTER CONSTRUCTION.

   E. GROUNDWATER IS NOT EXPECTED WITHIN THE EXCAVATION FOR THE RETAINING STRUCTURE. HYDROSTATIC PRESSURE IS NOT CONSIDERED IN THE DESIGN. IF GROUNDWATER IT ENCOUNTERED, THE ENGINEER MUST BE NOTIFIED TO MODIFY THE DESIGN.

3. MATERIALS:

   A. TENDONS:
      TYPE: #9 BAR, GRADE 75 ALL-THREAD BAR, EPOXY COATED (OR APPROVED EQUAL)
      ACCESSORIES: ANCHOR BAR NUTS AND WASHERS SHALL BE OF THE MATERIAL TYPE AND SIZE COMPATIBLE WITH THE NAIL BAR PER THE MANUFACTURER'S SPECIFICATIONS. (EPOXY COATED)
      CENTRALIZERS SHALL BE PROVIDED AT INTERVALS OF 10 FEET WITH THE DEEPEST CENTRALIZER LOCATED TWO FEET FROM THE END OF THE NAIL BAR (MINIMUM OF 2 PER SOIL NAIL)

   B. BEARING PLATES:
      SPECIFICATION: ASTM A36 (EPOXY COATED)
      GRADE: 36 KSI
      SIZE: 6"X6"X1"

   C. FACING REINFORCEMENT:
      WALER BARS: #4 - GRADE 60
      PRIMARY STRUCTURAL REINFORCEMENT: 4X4XW4.0XW4.0 WELDED WIRE FABRIC (WWF)

   D. GROUT:
      TYPE: NEAT GROUT OR SAND/CEMENT MIXTURE
      COMPRESSIVE STRENGTH (28 DAY): 3000 PSI
      COMPRESSIVE STRENGTH (3 DAY): 1500 PSI
      SPECIFICATION: AASHTO T106/ASTM C109
      WATER: CLEAN, POTABLE

   F. DRAIN BOARDS: COMPOSITE DRAIN BOARD WITH FILTER FABRIC (AMERIDRAIN 500 OR EQUIVALENT AS APPROVED BY THE ENGINEER).

   G. SHOTCRETE:
      PORTLAND CEMENT: ASTM C150, TYPE I (MIN. 660 LB/CY)
      AGGREGATES: AASHTO M6/M80 STRENGTH AND DURABILITY
      GRADATION REQUIREMENTS:

SIEVE SIZE	% PASSING (BY WEIGHT)
½"	100
⅜"	90-100
NO. 4	70-85
NO. 8	50-70
NO. 16	35-55
NO. 30	20-35
NO. 50	8-20
NO. 100	1-2

      FINISH: NOZZLE OR SMOOTH (OWNER'S DISCRETION)
      WATER/CEMENT RATIO: 0.45 MAX.
      ENTRAINED AIR CONTENT: 7-10 PERCENT
      F'C AT 28 DAYS: 4000 PSI
      F'C AT 3 DAYS: 2000 PSI
      PLACEMENT TIME: WITHIN 90 MINUTES OF BATCHING.
      PROTECTION/CURING: IN ACCORDANCE WITH PROJECT SPECIFICATIONS.

4. CONSTRUCTION SEQUENCE

   A. EXCAVATION: SOIL AND/OR ROCK WILL BE ENCOUNTERED IN THE EXCAVATIONS. TRIM SLOPES FROM THE TOP DOWNWARD TO CREATE WORKING BENCHES FOR EACH SOIL NAIL ROW. VOIDS CREATED BY LOOSENED EARTH BEHIND NAIL HEAD PLATES SHALL BE FILLED WITH SHOTCRETE. EXCAVATION METHODS INCLUDING BLASTING SHALL NOT DISTURB OR DAMAGE IN ANY WAY PREVIOUSLY INSTALLED STRUCTURES OR PORTIONS OF THE RETAINING WALL. EXCAVATE AT MAXIMUM 2 FEET BENEATH NAIL ROW ELEVATION.

   B. DRAINAGE: IMMEDIATELY AFTER EXCAVATION TO FINAL SLOPE, INSTALL DRAINAGE BOARDS TO COVER AT LEAST 16" OF SPACE BETWEEN NAILS WITH FABRIC FACE AGAINST THE EXPOSED CONSTRUCTION FACE. ALLOW FOR 12 INCH LAP BETWEEN ADJOINING VERTICAL SECTIONS.

   C. REINFORCEMENT: INSTALL CONTINUOUS WELDED WIRE FABRIC WITH 8 INCH MINIMUM LAP HORIZONTALLY AND VERTICALLY. INSTALL NAIL HEAD REINFORCEMENT AS SHOWN.

   D. SHOTCRETING: PLACE SHOTCRETE LAYER AS SHOWN. EXCESS SHOTCRETE SHALL BE REQUIRED IN OVER EXCAVATED AREAS TO DEVELOP AN EVEN, UNIFORM SURFACE. THE SHOTCRETE VOLUME WILL DEPEND ON THE MATERIALS ENCOUNTERED IN THE EXCAVATION AND THE EXCAVATION TECHNIQUES USED.

   E. SHOTCRETE TO WITHIN 12 INCHES OF THE BOTTOM OF THE EXPOSED EXCAVATION. TEMPORARY SLOPES WHICH ARE NOT COVERED WITH SHOTCRETE SHALL BE PROTECTED AS DEEMED NECESSARY BY THE ENGINEER WITH PLASTIC NAILED AT THE TOP AND BOTTOM OF THE EXPOSED EXCAVATION.

   F. NAIL INSTALLATION: SOIL AND/OR ROCK WILL BE ENCOUNTERED AT NAIL LOCATIONS. THE MINIMUM NAIL LENGTHS SHALL BE INSTALLED AS DEFINED BY THE WALL PROFILES OR AS DIRECTED BY THE ENGINEER. IF ROCK IS ENCOUNTERED PRIOR TO REACHING THE REQUIRED NAIL LENGTH, THE ENGINEER SHALL BE CONTACTED FOR DIRECTION PRIOR TO PROCEEDING. IF DRILLING MEDIA OTHER THAN SOIL IS ENCOUNTERED, DRILLING SHALL BE TERMINATED IMMEDIATELY UNTIL OBSTRUCTION IS IDENTIFIED. THEN THE ENGINEER SHALL BE CONTACTED TO DETERMINE WHAT MODIFICATIONS TO THE DESIGN ARE REQUIRED. THE NAIL INCLINATIONS SHALL BE AS SHOWN ON THE TYPICAL CROSS SECTION DETAIL WITH A TOLERANCE OF 0 TO +3 DEGREES. THE MAXIMUM NAIL SPACING SHALL BE AS SHOWN IN THE TYPICAL SHORING CROSS-SECTIONS IN THESE PLANS. SPACING MAY BE ALTERED BY THE ENGINEER BASED ON THE ACTUAL SITE CONDITIONS. AFTER APPLYING INITIAL SHOTCRETE, INSTALL NAILS OF THE MINIMUM LENGTH AND INCLINATION. CARE SHALL BE TAKEN IN DRILLING NAIL HOLES TO PREVENT DRILLING INTO PREVIOUSLY INSTALLED NAILS. WHERE CAVING CONDITIONS ARE ENCOUNTERED, THE CONTRACTOR SHALL USE APPROVED HOLE CASING TECHNIQUES TO MAINTAIN THE MINIMUM NAIL DIAMETER AND LENGTH. ANY ALTERNATIVE DRILLING METHODS OR NAIL PRODUCTS SHALL BE REVIEWED BY THE ENGINEER FOR APPROVAL.

5. SHOTCRETE APPLICATION:

   A. SHOTCRETE SHALL NOT BE PLACED ON ANY SURFACE DETERMINED TO BE UNSUITABLE BY THE ENGINEER (I.E. FROZEN, SPONGY, OR HIGHLY DISTURBED MATERIALS OR WHERE THERE IS FREE WATER).

   B. SHOTCRETE SHALL NOT BE APPLIED WHEN AMBIENT AIR TEMPERATURE IS BELOW 40°F OR WHILE WEATHER CONDITIONS PRECLUDE ACHIEVING A SATISFACTORY PRODUCT.

   C. SHOTCRETE THICKNESS MEASURING PINS SHALL BE PLACED AT SUFFICIENT LOCATIONS TO CONTROL SHOTCRETE THICKNESS.

   D. PROVIDE ACCESS TO SHOTCRETE SURFACES FOR SHOTCRETING IN AN UNINTERRUPTED FASHION.

   E. PROVIDE FOR PLACEMENT IN CLOSE QUARTERS, EXTENDED DISTANCES, OR AROUND UNUSUAL OBSTRUCTIONS WHERE PLACEMENT VELOCITIES AND MIX CONSISTENCY MUST BE ADJUSTED.

   F. SHOTCRETE APPLICATION SHALL START AT BOTTOM OF THE LIFT.

   G. HOLD NOZZLE AS PERPENDICULAR TO SURFACE AS WORK WILL PERMIT, TO SECURE MAXIMUM COMPACTION WITH MINIMUM REBOUND.

   H. FOLLOW ROUTINE THAT WILL FIND AND COMPLETELY ENCASE REINFORCEMENT.

   I. BUILD UP LAYERS BY MAKING SEVERAL PASSES OF NOZZLE OVER WORK AREA. COMPLETELY ENCASE REINFORCEMENT.

   J. AFTER INITIAL SET, REMOVE EXCESS MATERIAL OUTSIDE ALIGNMENT LINES.

   K. ALLOW EACH LAYER OF SHOTCRETE TO TAKE INITIAL SET BEFORE APPLYING SUCCEEDING LAYERS. TOTAL FINISHED DEPTH OF SHOTCRETE SHALL BE IN ACCORDANCE WITH NOTE 2C. ADDITIONAL SHOTCRETE SHALL BE ADDED TO FILL UNDERCUTS OF FINISHED WALL SECTIONS.

   L. REMOVE REBOUND WHICH DOES NOT FALL CLEAR OF WORK. DISCARD SALVAGED REBOUND.

6. NAIL TENSIONING: TENSION AND LOCK-OFF ALL NAILS TO A SNUG-TIGHT CONDITION.

   A. REPEAT STEPS (A) THROUGH (L) ABOVE FOR THE REMAINING NAIL ROWS UNTIL COMPLETION OF THE WALL. THE TIME SPANS REQUIRED FOR THE FOLLOWING OPERATIONS FOR EACH LIFT ARE:

   B. SHOTCRETING: WITHIN 24 HOURS AFTER EXCAVATION UNLESS TEMPORARY BERM IS USED.

   C. NAIL INSTALLATION: WITHIN 24 HOURS AFTER EXCAVATION UNLESS TEMPORARY BERM IS USED OR INITIAL SHOTCRETE IS IN PLACE.

   D. NAIL TENSIONING: ONCE SHOTCRETE AND NAIL GROUT HAVE REACHED A MINIMUM COMPRESSIVE STRENGTH OF 3,000 PSI EACH.

7. VERIFICATION TESTING OF SACRIFICIAL NAILS:

   A. ONE (1) SACRIFICIAL TEST NAILS SHALL BE INSTALLED AND TESTED TO VERIFY THE GROUT-TO-SOIL BOND STRENGTH ASSUMED IN DESIGN. THE VERIFICATION TEST NAIL SHALL BE INSTALLED AT A REPRESENTATIVE LOCATION APPROVED BY THE ENGINEER. PRIOR TO EXCAVATING FOR THE NEXT LIFT, TEST NAIL SHALL BE INSTALLED AND TESTED. SHOULD TEST NAIL INDICATE THAT THE DESIGN SHEARING FORCE ACTUALLY BEING OBTAINED IN FIELD PRODUCTION IS LOWER THAN THAT ASSUMED IN DESIGN, THE CONTRACTOR SHALL INFORM THE ENGINEER WHO WILL MAKE NECESSARY DESIGN MODIFICATIONS. ADDITIONAL NAILS SHALL BE ADDED AS REQUIRED. DO NOT PROCEED TO NEXT LIFT UNTIL AUTHORIZED BY THE ENGINEER.

   B. SACRIFICIAL NAILS SHALL BE INSTALLED USING SIMILAR PROCEDURES AS PRODUCTION NAILS USING A GRADE 75, THREADED BAR WITH A TOTAL LENGTH OF 15 FEET CONSISTING OF A 10 FOOT BONDED LENGTH AND AN UNBONDED LENGTH OF 5 FEET AT THE NAIL HEAD. THE UNBONDED LENGTH SHALL BE A GREASED PVC PIPE PLACED OVER THE NAIL BAR TO PREVENT GROUT FROM BONDING TO THE NAIL BAR. THE BAR SIZE SHALL BE SELECTED SUCH THAT THE MAXIMUM TEST LOAD DOES NOT EXCEED 80% OF THE BAR YIELD STRENGTH.

   C. PERFORM PULL-OUT TEST ON TEST NAIL A MINIMUM OF 72 HOURS FOLLOWING INSTALLATION AS SHOWN AND DIRECTED.

   D. VERIFICATION TESTS SHALL BE INCREMENTALLY LOADED TO FAILURE IN ACCORDANCE WITH THE VERIFICATION TEST LOADING SCHEDULE.

      DESIGN TEST LOAD: BONDING SURFACE*DESIGN BOND STRESS

      VERIFICATION TEST LOADING SCHEDULE

LOAD	HOLD TIME
AL (0.05 DTL MAX.)	UNTIL STABLE
0.25 DTL	UNTIL STABLE
0.50 DTL	UNTIL STABLE
0.75 DTL	UNTIL STABLE
1.00 DTL	UNTIL STABLE
1.25 DTL	UNTIL STABLE
1.50 DTL (CREEP TEST)	10 MINUTES
1.75 DTL	UNTIL STABLE
2.00 DTL	UNTIL STABLE
2.50 DTL	UNTIL STABLE
FAILURE (DO NOT EXCEED 80% OF BAR YIELD STRESS)	

   E. TEST NAIL ELONGATION SHALL BE MEASURED AND RECORDED WITH A DIAL GAUGE CAPABLE OF MEASURING MOVEMENT OF 0.001 INCHES. HYDRAULIC JACK SHALL BE CAPABLE OF PRODUCING AND MAINTAINING A CONSTANT LOAD FOR AT LEAST EIGHT MINUTES OF EACH INCREMENT. ELONGATION READINGS SHALL BE TAKEN AND RECORDED AT PERIODS OF 0.5, 1, 2, 4, 8, AND 10 MINUTES AFTER EACH LOAD INCREMENT HAS BEEN APPLIED AND PERIODS OF 1, 2, 3, 5, 6, 10, 20, 30, 50, AND 60 MINUTES DURING THE CREEP PORTION OF THE TEST. RESULTS OF TEST NAIL ELONGATION SHALL BE GIVEN TO THE ENGINEER IMMEDIATELY UPON COMPLETION OF THE TEST. CARE SHALL BE TAKEN TO MAINTAIN A CONSTANT JACK LOAD.

   F. THE REACTION LOAD FOR TEST NAIL MAY BE SPREAD OVER THE SURFACE OF THE EXCAVATION BUT NO CLOSER THAN EIGHTEEN INCHES TO THE NAIL BEING TESTED. PRESSURE FROM THE REACTION SYSTEM AGAINST THE WALL SHALL NOT CRACK OR OTHERWISE DAMAGE PARTIALLY OR FULLY COMPLETED SECTIONS OF THE WALL.

   G. SACRIFICIAL TEST NAIL RESULTS SHALL BE SUBMITTED TO THE ENGINEER WITHIN 24 HOURS OF TESTING.

9. PROOF TESTING OF PRODUCTION NAILS:

   A. PROOF TESTING SHALL BE PERFORMED ON 5% OF THE PRODUCTION NAILS IN EACH ROW WITH A MINIMUM OF 1 TEST PER ROW.

   B. PRODUCTION PROOF TEST NAILS SHALL HAVE BOTH BONDED AND UNBONDED LENGTHS. THE BONDED LENGTH SHALL BE AS SHOWN ON THE PLANS WITH A MINIMUM UNBONDED LENGTH OF 5 FEET. THE UNBONDED LENGTH SHALL HAVE PVC PLACED OVER THE NAIL BAR TO PREVENT GROUT FROM BONDING TO THE ANCHOR BAR. THE BONDED LENGTH AFTER COMPLETION MUST BE AS SHOWN ON THE PLANS EITHER THROUGH PRIMARY OR SECONDARY GROUTING PROCEDURES.

   C. PROOF TESTS SHALL BE INCREMENTALLY LOADED TO A TEST LOAD OF 150% OF THE DESIGN TEST LOAD (DTL) IN ACCCORDANCE WITH THE PROOF TEST LOADING SCHEDULE.

      DESIGN TEST LOAD: BONDING SURFACE*DESIGN BOND STRESS

      PROOF TEST LOADING SCHEDULE

LOAD	HOLD TIME
AL (0.05 DTL MAX.)	UNTIL STABLE
0.25 DTL	UNTIL STABLE
0.50 DTL	UNTIL STABLE
0.75 DTL	UNTIL STABLE
1.00 DTL	UNTIL STABLE
1.25 DTL	UNTIL STABLE
1.50 DTL	10 MINUTES (SEE NOTE 5E)

      NOTE: DO NOT EXCEED 80% OF THE BAR YIELD STRESS. TEMPORARY UNBONDED LENGTHS MAY BE REQUIRED

   D. PROOFTESTING SHALL BE PERFORMED AT REPRESENTATIVE LOCATIONS AS APPROVED BY THE ENGINEER. THE WALL CONTRACTOR SHALL SUBMIT THESE PROOF TESTING LOCATIONS TO THE ENGINEER FOR APPROVAL PRIOR TO PROOF TESTING DURING THE INITIAL STAGES OF CONSTRUCTION.

   E. FOLLOWING PROOF TESTING, TEMPORARY PVC PIPES SHALL BE REMOVED AND THE PROOF TEST NAILS SHALL BE FULLY GROUTED AND COMPLETED IN ACCORDANCE WITH THE DESIGN PLANS.

   F. ADDITIONAL VERIFICATION TESTS MAY BE USED IN LEIU OF PROOF TESTS.

GEOS
Geotechnical, Environmental and Materials Engineers

90% Barrier Wall Design Package
Soil Nail Wall Design Plans

Chemours Fayetteville Works
Fayetteville, North Carolina

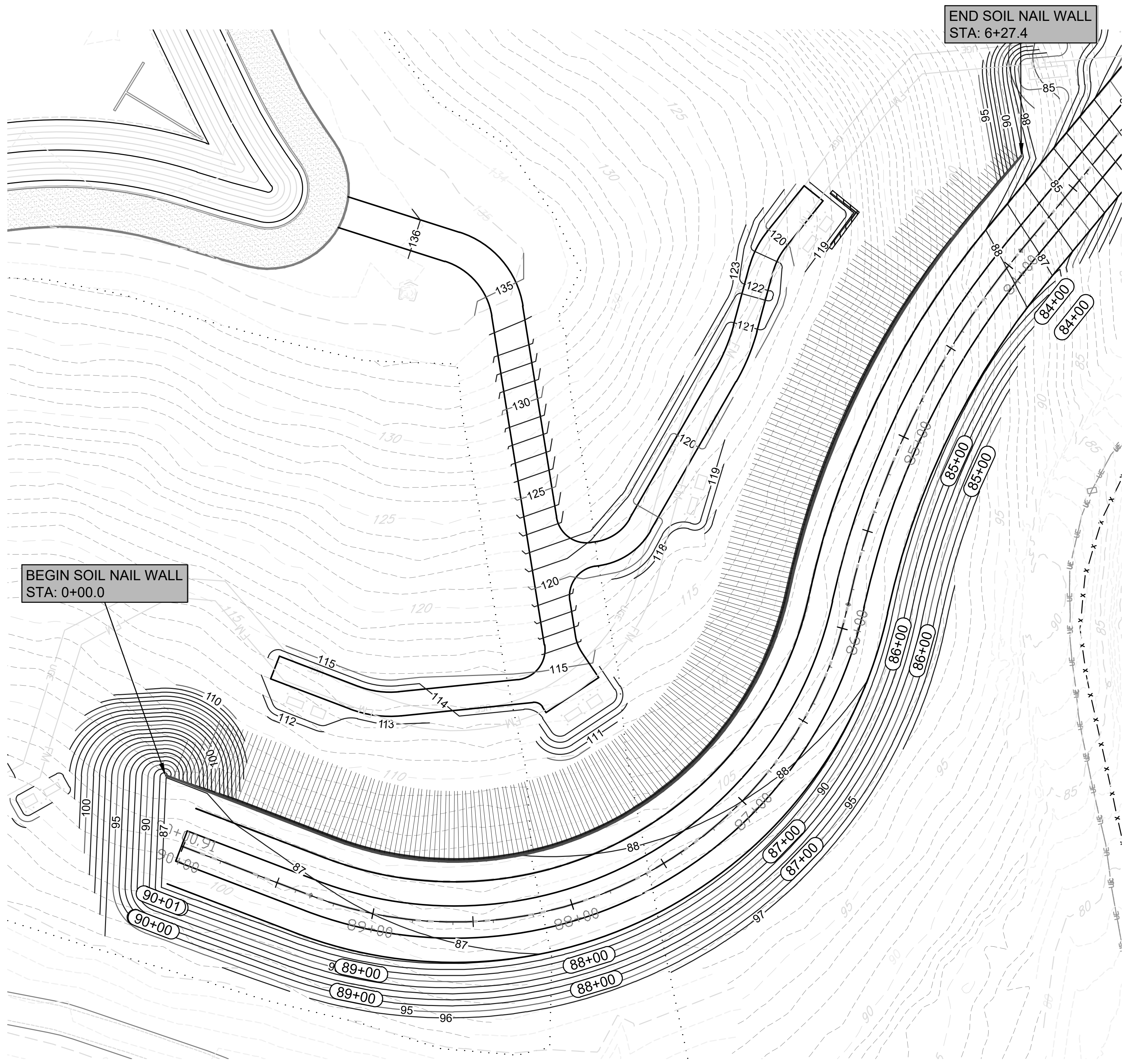
DRAWN BY: NSS
REVIEWED BY: JEE
DESIGNED BY: AS
APPROVED BY:
SCALE: AS SHOWN
DATE: February 10, 2022

Revisions

No.	Date	Description	By:
1			
2			
3			
4			
5			
6			

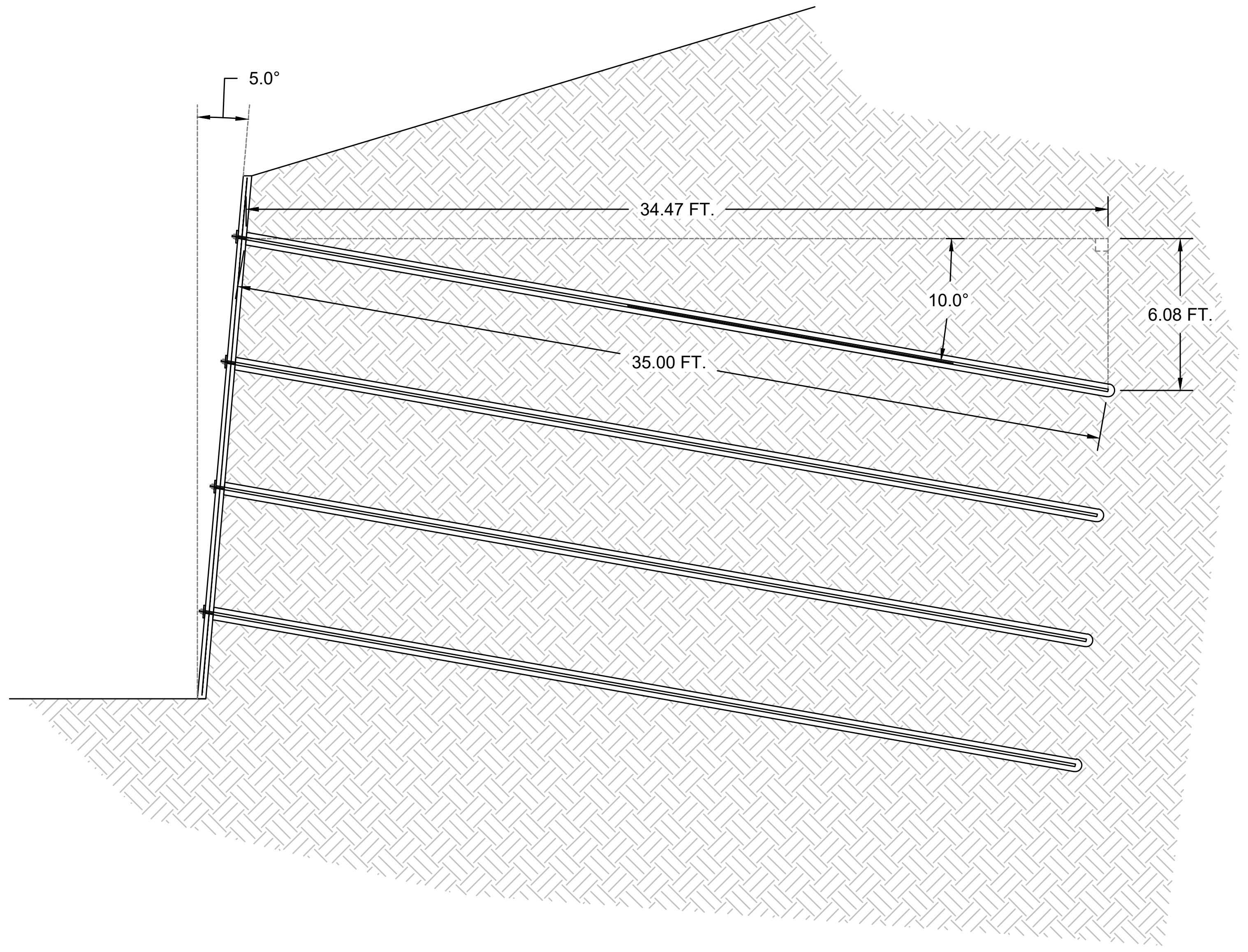
DRAWING: SN-1.0

PROJECT NUMBER: 45-20803

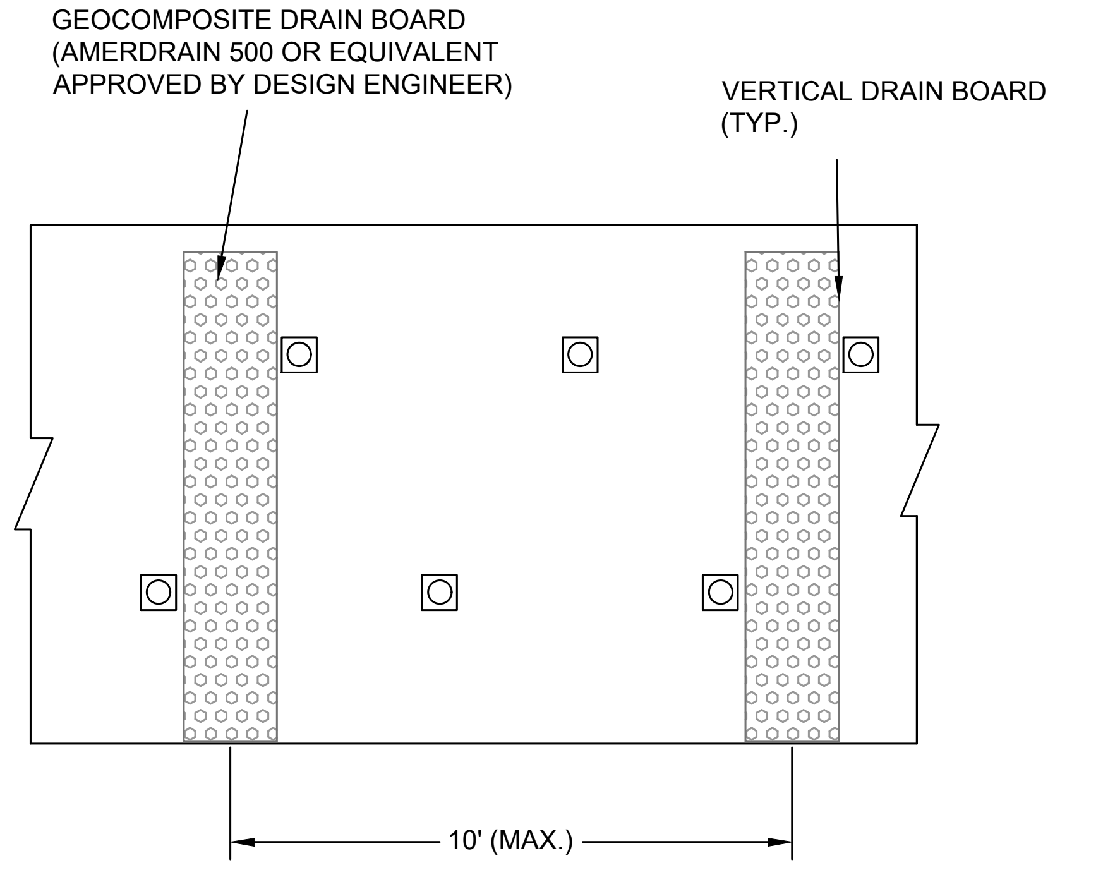


1
SN-1.1
SOIL NAIL WALL SITE PLAN
SCALE: 1" = 50'
0' 50' 100'

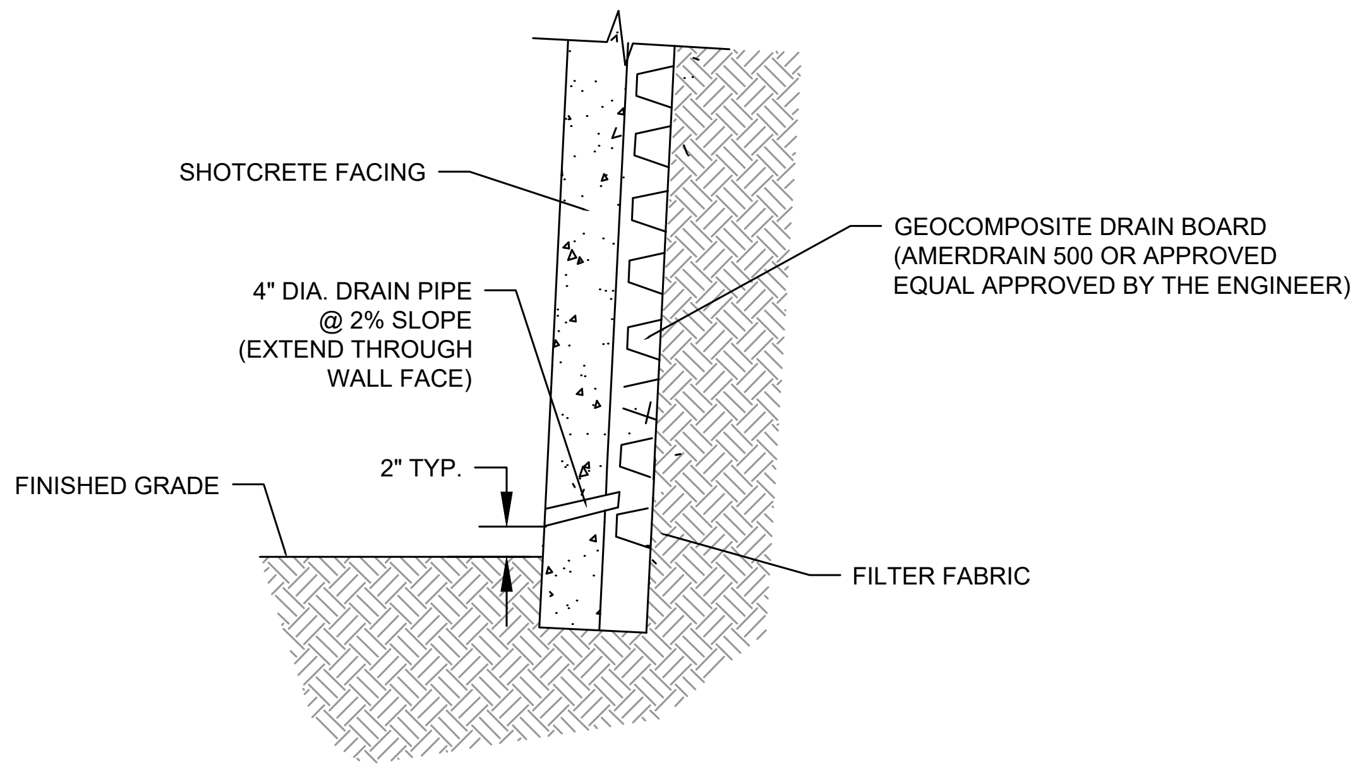
SOIL NAIL
NAIL: #9 BAR, GR. 75 MIN.
LENGTH: VARIES (SEE PROFILE)
ANGLE: 10°
WALL FACE BATTER = 5°
VERTICAL SPACING = 5 FT.
HORIZONTAL SPACING = 5 FT.
BACKSLOPE = VARIES, 4H:1V (MAX.)



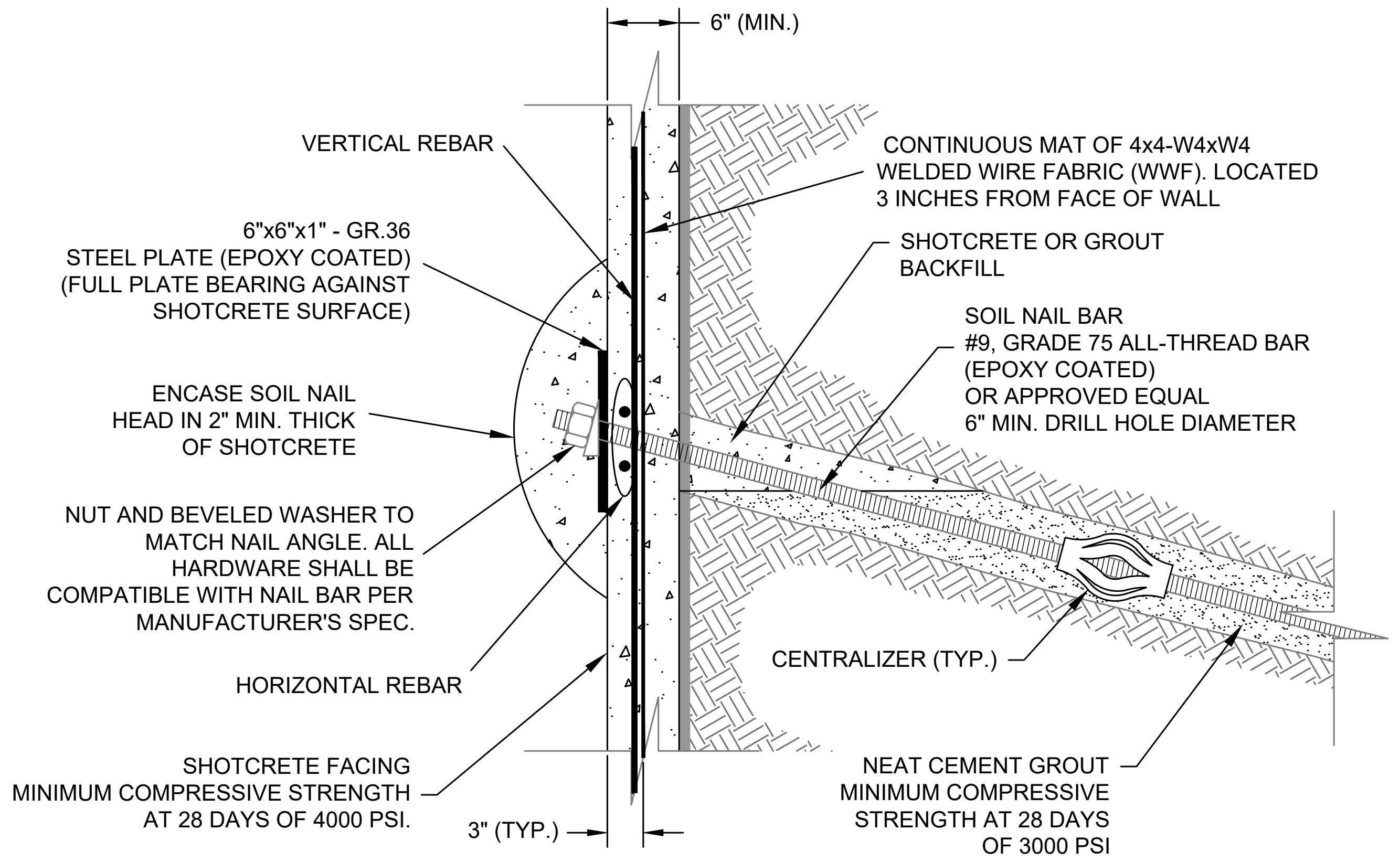
2
SN-1.1
SOIL NAIL WALL SECTION (TYP.)
SCALE: 1" = 5'
0' 5' 10'



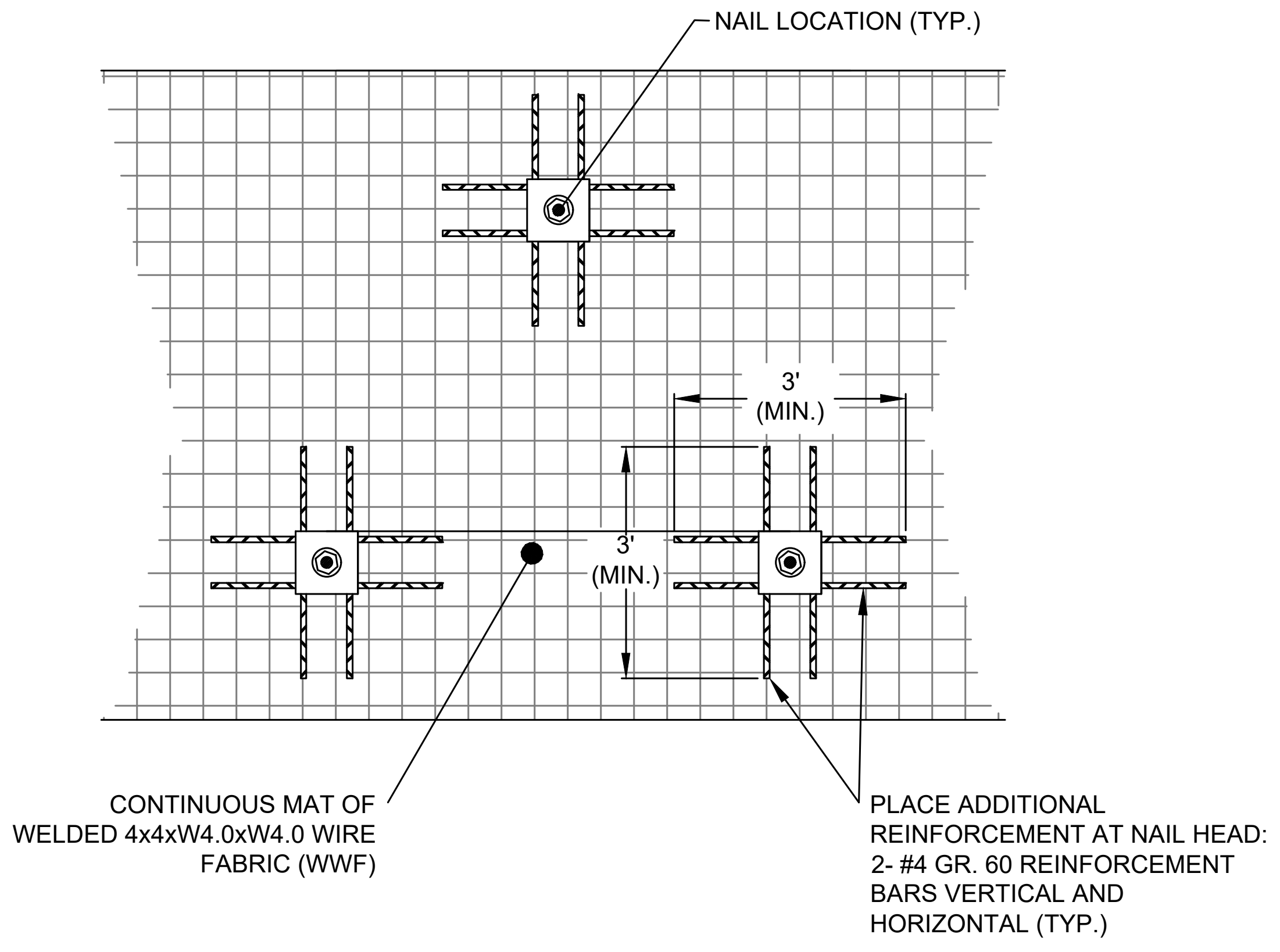
3
SN-1.1
TYPICAL DRAIN BOARD DETAIL (ELEV.)
SCALE: NTS



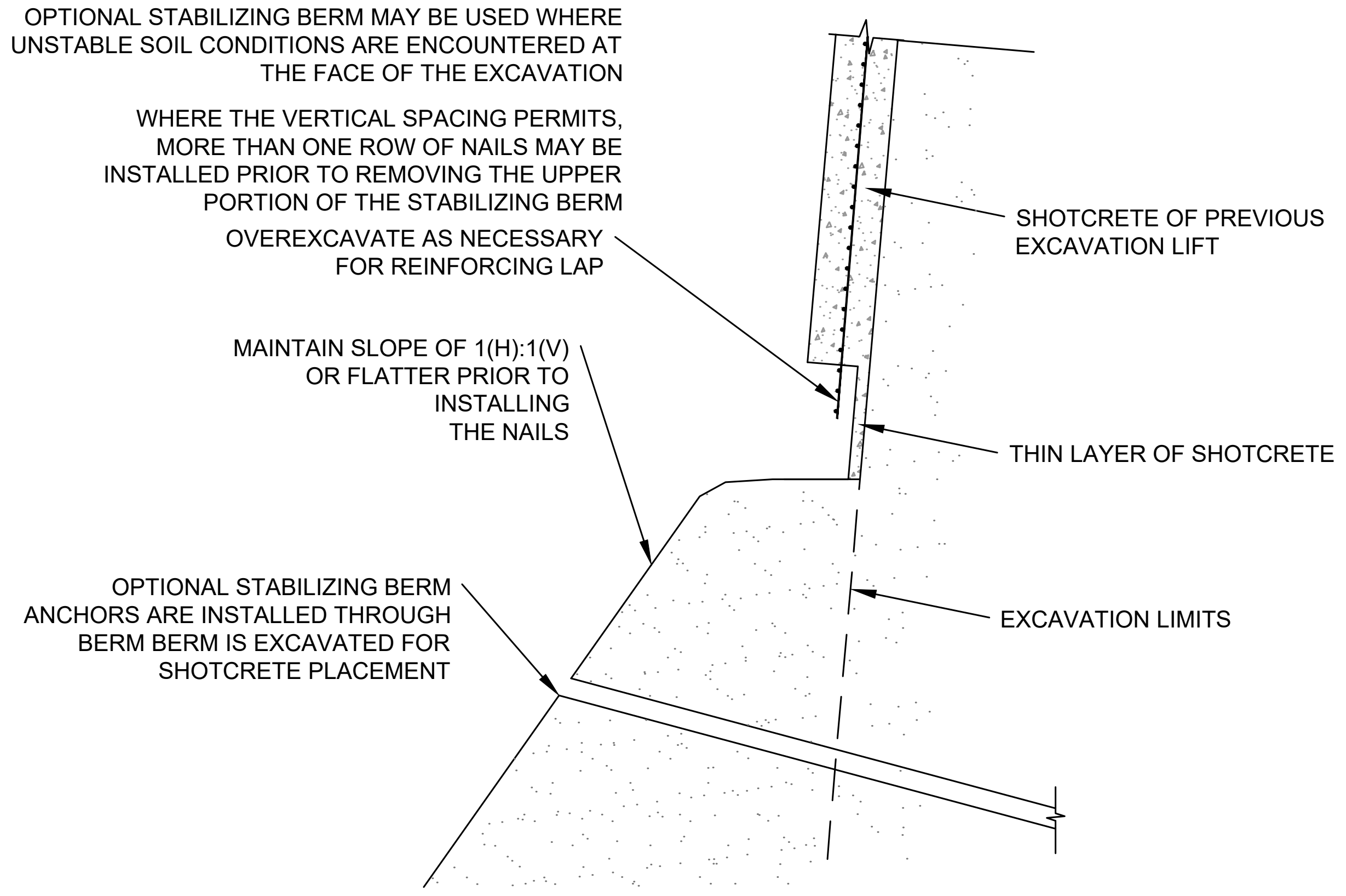
4
SN-1.1
TYPICAL DRAIN BOARD DETAIL (SECTION)
SCALE: NTS



5
SN-1.1
SOIL NAIL HEAD SECTION DETAIL (TYP.)
SCALE: NTS



6
SN-1.1
SOIL NAIL WALL FACING REINFORCEMENT DETAIL (TYP.)
SCALE: NTS



7
SN-1.1
TYPICAL TEMPORARY BERM DETAIL
SCALE: NTS

NOTES:

1. SOIL NAILS SHALL BE EPOXY-COATED, GRADE 75, #9 BARS WITH AN 6" DIAMETER HOLE..
2. BEARING PLATES TO BE 6"X6"X1", GRADE 36 STEEL PLATES (MIN.) INSTALLED SO THAT THE PLATE FULLY BEARS TO THE SHOTCRETE SURFACE.
3. ALL SHOTCRETE USED SHALL BE MINIMUM 4,000 PSI COMPRESSIVE STRENGTH. GROUT FILL SHALL BE 3,000 PSI COMPRESSIVE STRENGTH MIN.
4. ALL SHOTCRETE FACING SHALL HAVE A CONTINUOUS MAT OF WELDED WIRE FABRIC (WWF) INSTALLED AT THE MIDPOINT OF THE FACING. VERTICAL AND HORIZONTAL REBAR REINFORCEMENT (#4, GRADE 60, MIN., 3 FT MIN. LENGTH) SHALL BE PLACED BETWEEN SOIL NAIL HEADS AND THE CONTINUOUS WW AT EACH RESPECTIVE SOIL NAIL LOCATION.

GEOS
Geotechnical, Environmental and Materials Engineers

Soil Nail Wall Design Plans
Site Plan and Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: AS	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 10, 2022	

Revisions

No.	Date	Description	By:
1			
2			
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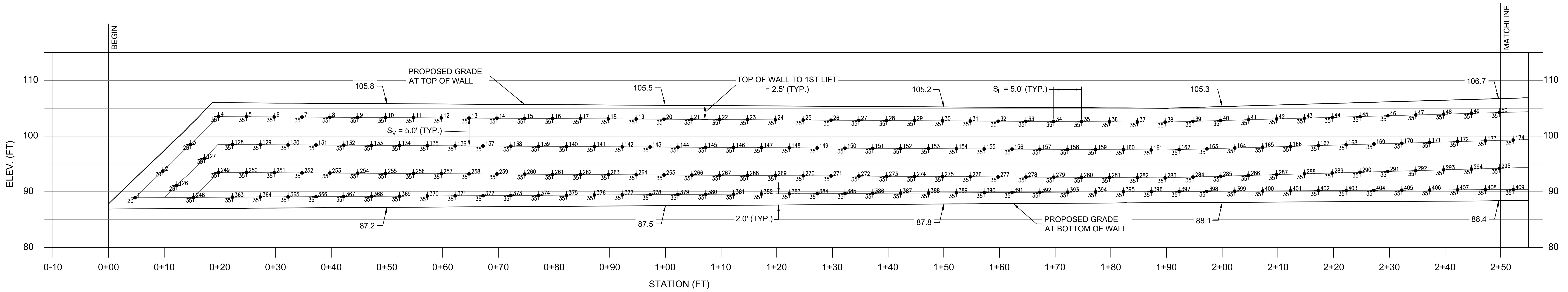
4			
5			
6			

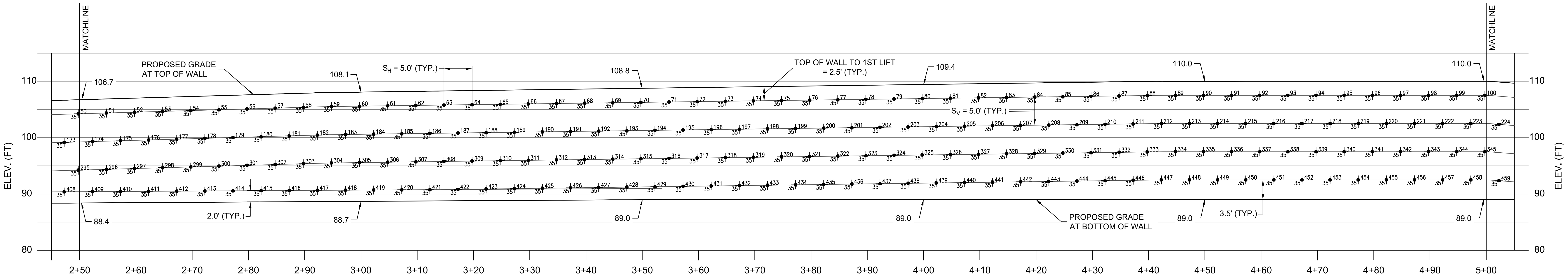
DRAWING:
SN-1.1

PROJECT NUMBER:
45-20803



1 SN-1.2

SOIL NAIL WALL PROFILE
SCALE: 1" = 10'
0' 10' 20'



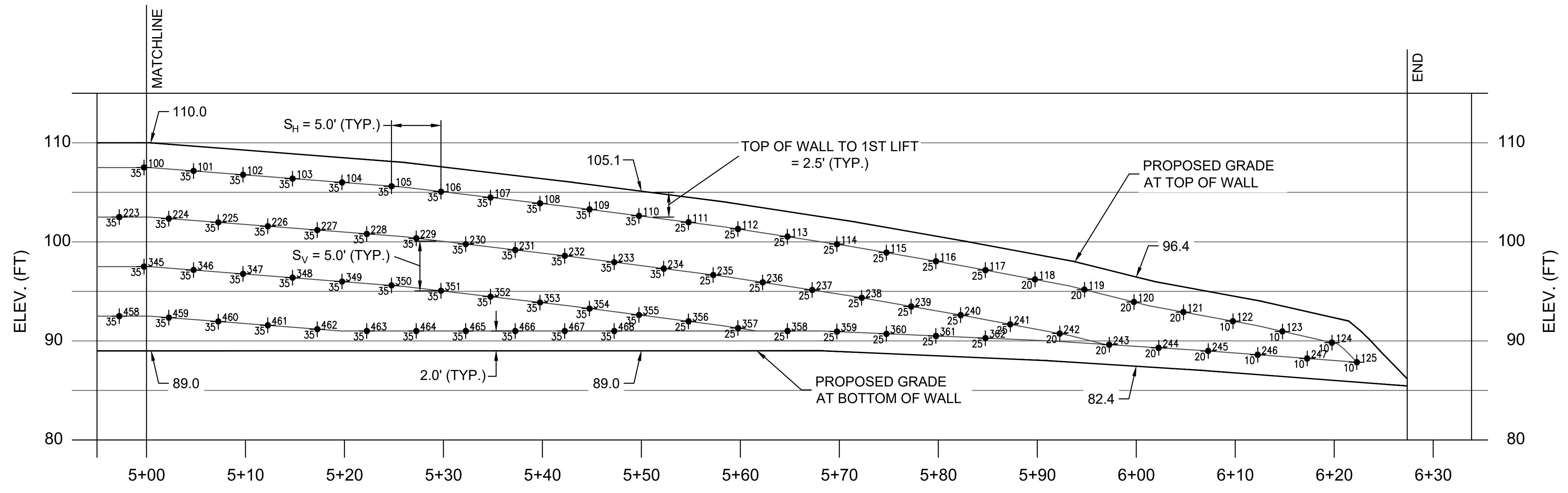
2 SN-1.2

SOIL NAIL WALL PROFILE
SCALE: 1" = 10'
0' 10' 20'

LEGEND

SOIL NAIL LOCATION
NAIL #
LENGTH (FT.)

ALL NAILS ARE INCLINED AT 10° FROM HORIZONTAL.



3 SN-1.2

SOIL NAIL WALL PROFILE
SCALE: 1" = 10'
0' 10' 20'

GEOS
Geotechnical, Environmental and Materials Engineers

Soil Nail Wall Design Plans
Soil Nail Wall Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: JEE
DESIGNED BY: AS	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 10, 2022	

Revisions

No.	Date	Description	By:
1			
2			
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4			
5			
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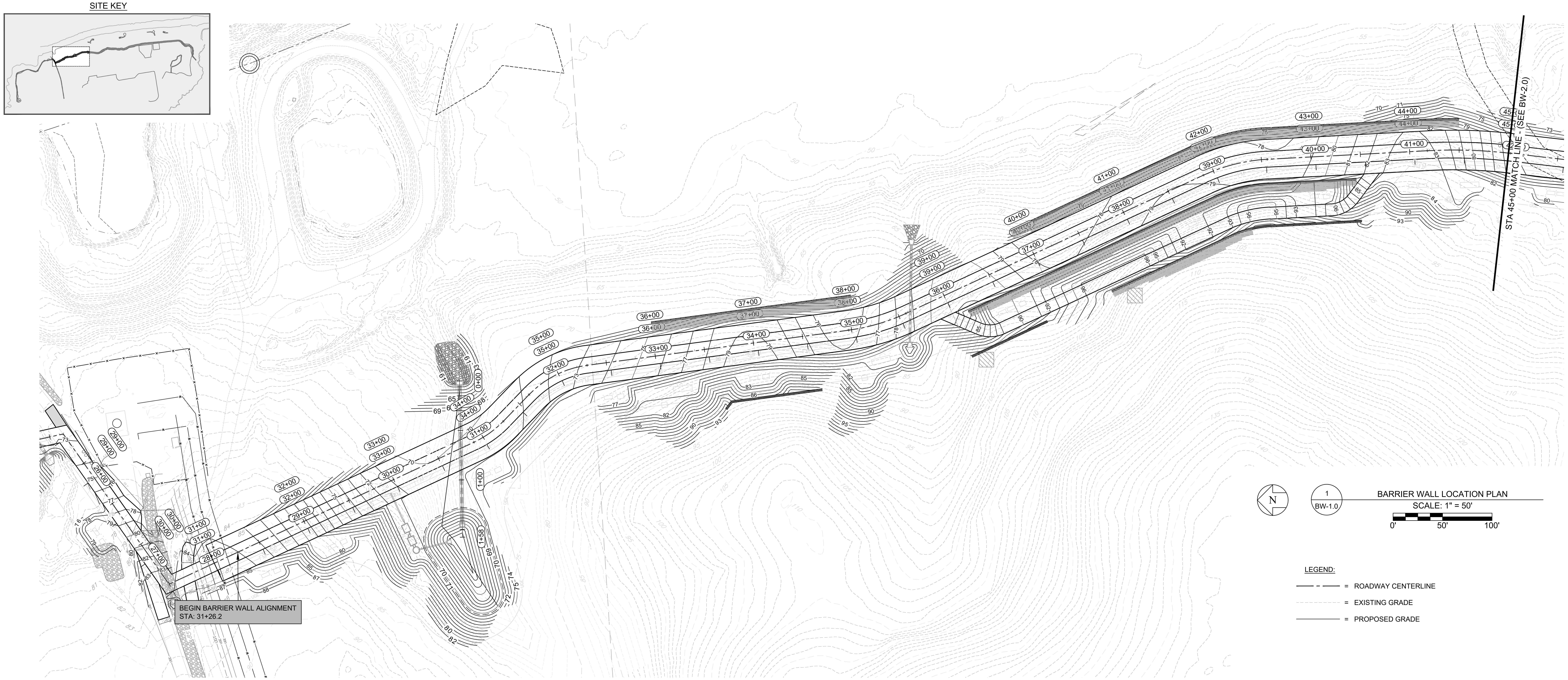
DRAWING:
SN-1.2

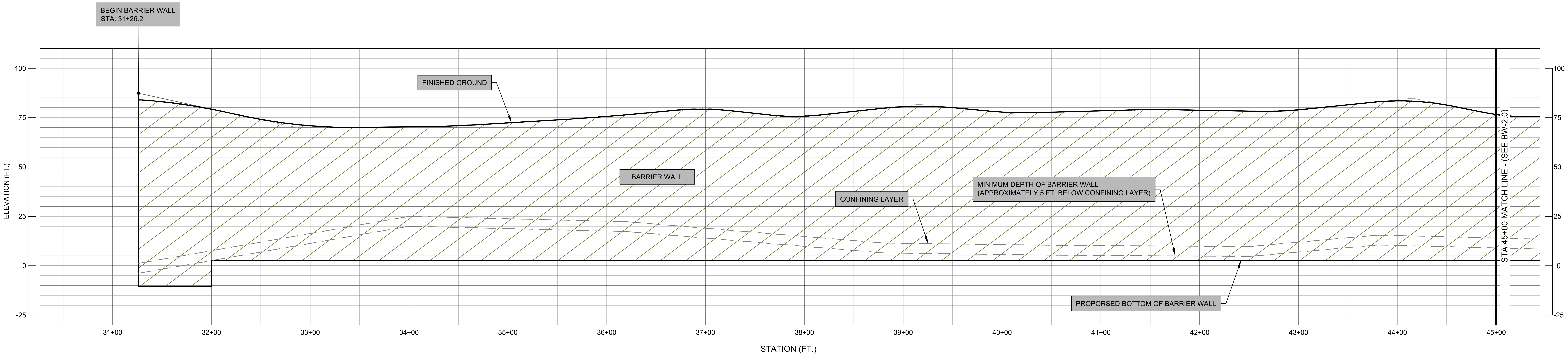
PROJECT NUMBER:
45-20803



1 / BW-1.0 **BARRIER WALL LOCATION PLAN**
SCALE: 1" = 50'

LEGEND:

- ROADWAY CENTERLINE
- EXISTING GRADE
- PROPOSED GRADE



2 / BW-1.0 **BARRIER WALL PROFILE**
SCALE: NTS

NOTE:
CONTRACTOR TO PROVIDE BARRIER WALL WITH MINIMUM THICKNESS OF 30 IN.
AND A MAXIMUM HYDRAULIC CONDUCTIVITY OF 1X10E-6 CM/S.

GEOS
Geotechnical, Environmental and Materials Engineers

Retaining Wall Design Plans
Barrier Wall Plan & Profile Sta 31+26.2 to Sta 45+00

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: TJD
DESIGNED BY: TJD	APPROVED BY:

SCALE: AS SHOWN

DATE: February 10, 2022

Revisions

No.	Date	Description	By:
1			
2			
3			
4			
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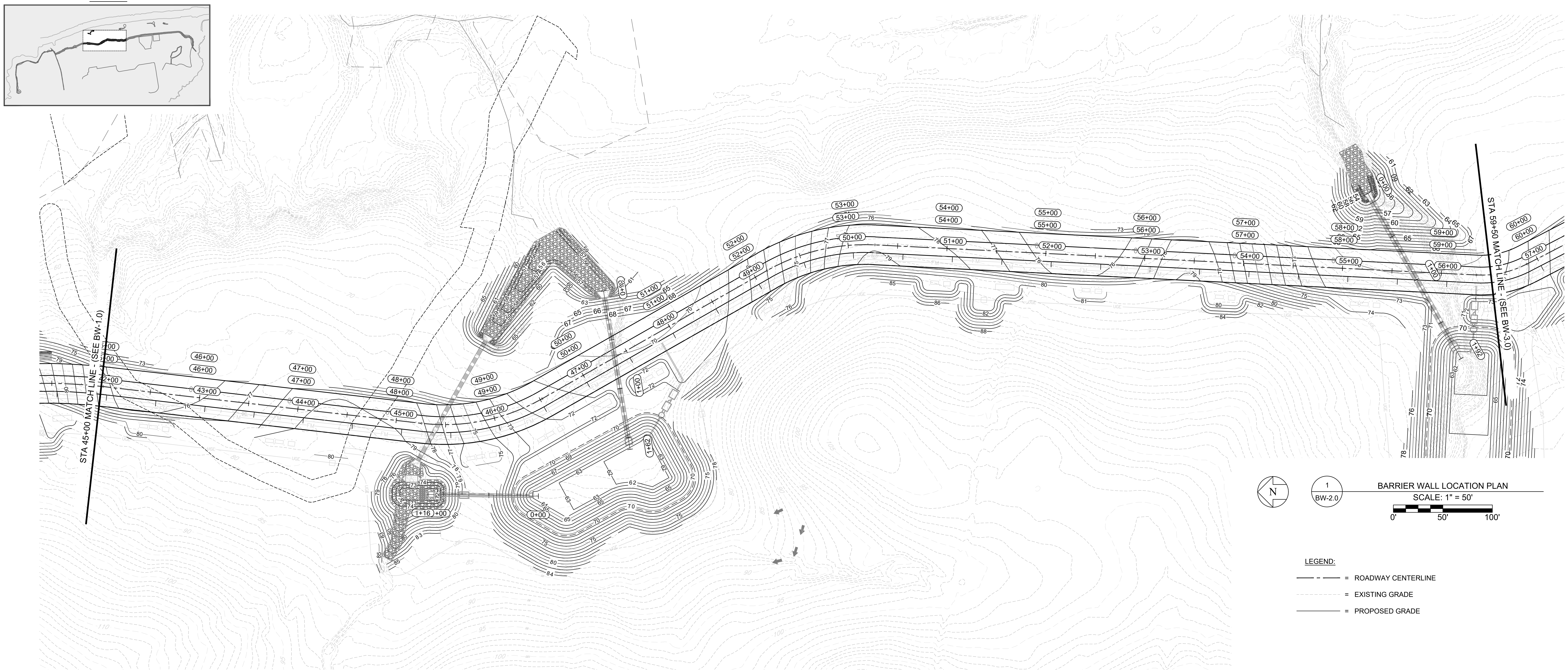
DRAWING: BW-1.0

PROJECT NUMBER: 45-20803

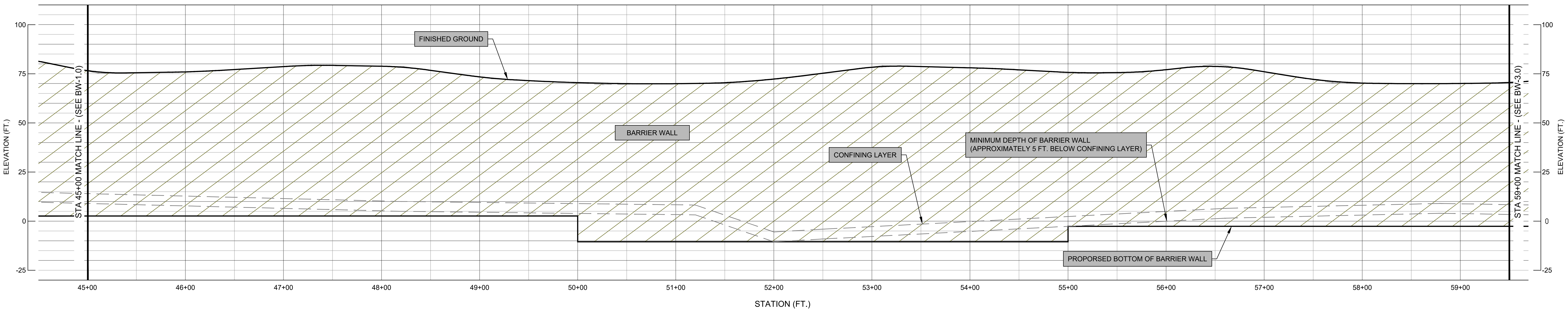
SITE KEY



1 BW-2.0 BARRIER WALL LOCATION PLAN
SCALE: 1" = 50'
0' 50' 100'

LEGEND:

——— - ———	= ROADWAY CENTERLINE
- - - - - -	= EXISTING GRADE
————	= PROPOSED GRADE



NOTE:
CONTRACTOR TO PROVIDE BARRIER WALL WITH MINIMUM THICKNESS OF 30 IN. AND A MAXIMUM HYDRAULIC CONDUCTIVITY OF 1X10E-6 CM/S.

2 BW-2.0 BARRIER WALL PROFILE
SCALE: NTS

Geotechnical, Environmental and Materials Engineers

Barrier Wall Design Plans
Barrier Wall Plan & Profile Sta 45+00 to Sta 59+50

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: TJD
DESIGNED BY: TJD	APPROVED BY:

SCALE: AS SHOWN

DATE: February 10, 2022

Revisions

No.	Date	Description	By:
1			
2			
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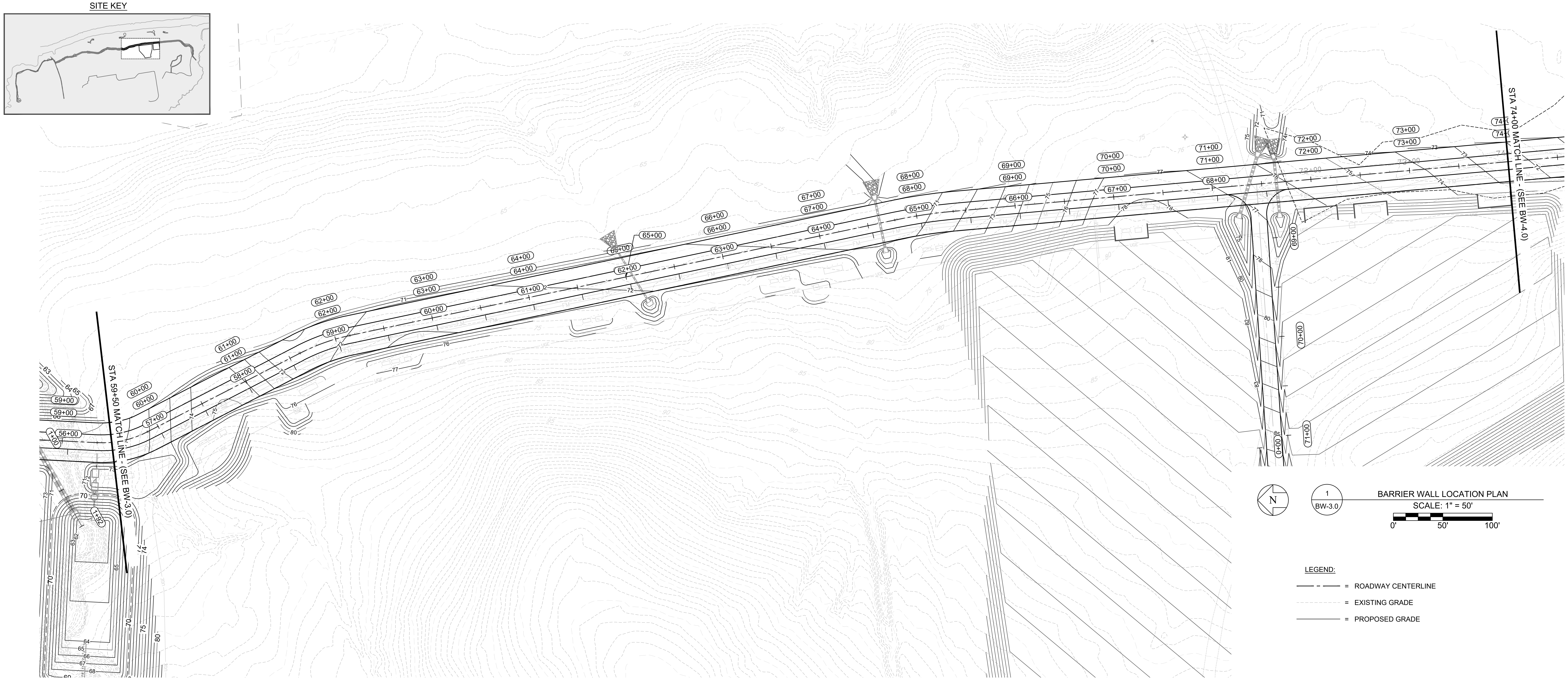
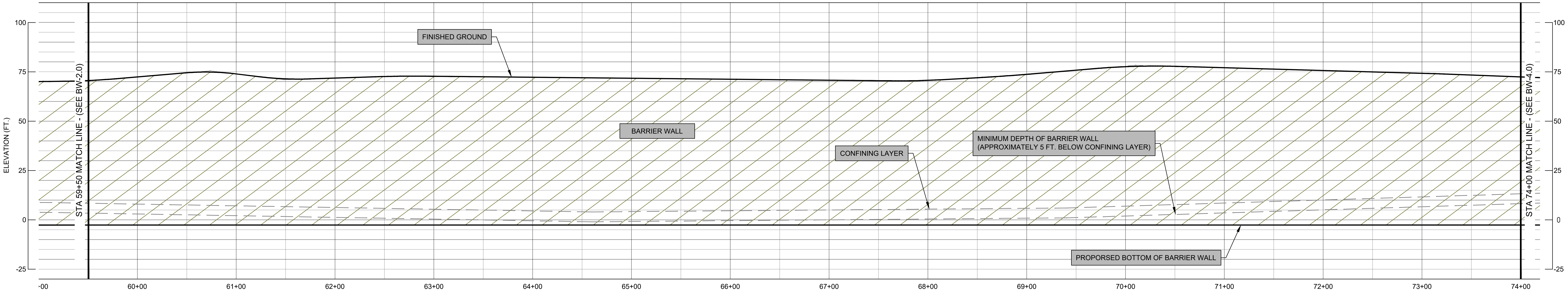
4			
5			
6			

DRAWING: BW-2.0

PROJECT NUMBER: 45-20803



1
BW-3.0
BARRIER WALL LOCATION PLAN
SCALE: 1" = 50'



2
BW-3.0
BARRIER WALL PROFILE
SCALE: NTS

NOTE:
CONTRACTOR TO PROVIDE BARRIER WALL WITH MINIMUM THICKNESS OF 30 IN. AND A MAXIMUM HYDRAULIC CONDUCTIVITY OF 1X10E-6 CM/S.

GEOS
Geotechnical, Environmental and Materials Engineers

Barrier Wall Design Plans
Barrier Wall Plan & Profile Sta 59+50 to Sta 74+00

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: TJD
DESIGNED BY: TJD	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 10, 2022	

Revisions

No.	Date	Description	By:
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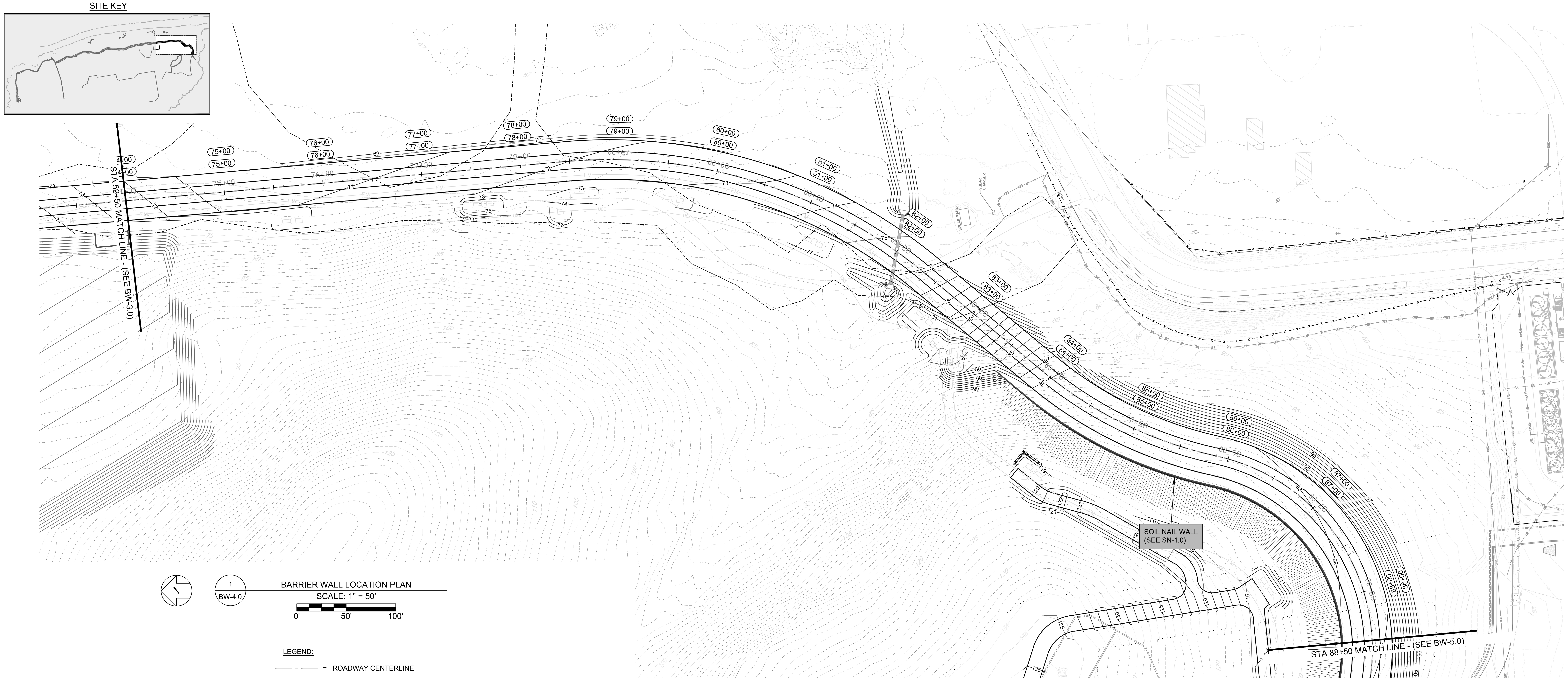
DRAWING:
BW-3.0

PROJECT NUMBER:
45-20803



1
BW-4.0

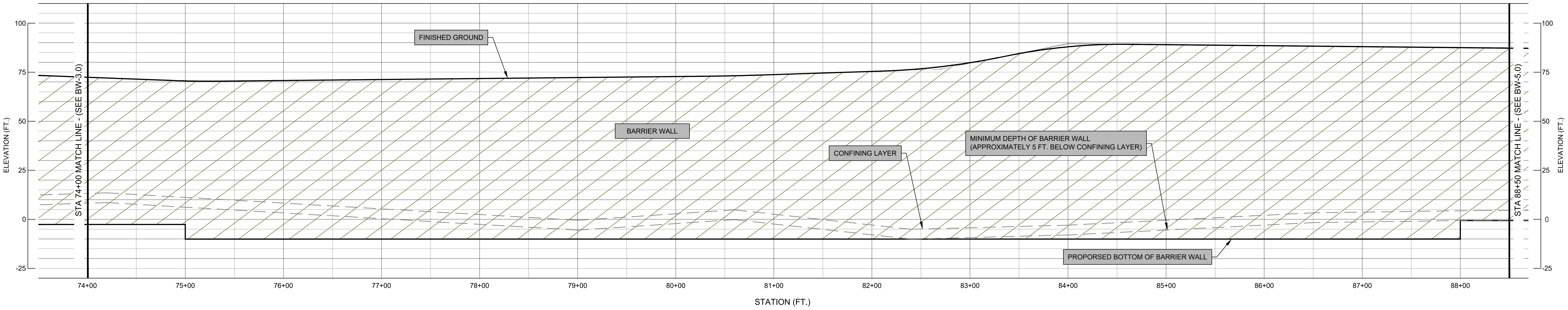
BARRIER WALL LOCATION PLAN

SCALE: 1" = 50'

0' 50' 100'

LEGEND:

- = ROADWAY CENTERLINE
- = EXISTING GRADE
- = PROPOSED GRADE



NOTE:
CONTRACTOR TO PROVIDE BARRIER WALL WITH MINIMUM THICKNESS OF 30 IN.
AND A MAXIMUM HYDRAULIC CONDUCTIVITY OF 1X10E-6 CM/S.

2
BW-4.0

BARRIER WALL PROFILE

SCALE: NTS

GEOS
Geotechnical, Environmental and Materials Engineers

Barrier Wall Design Plans
Barrier Wall Plan & Profile Sta 74+00 to Sta 88+50

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: TJD
DESIGNED BY: TJD	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 10, 2022	

Revisions

No.	Date	Description	By:
1			
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4			
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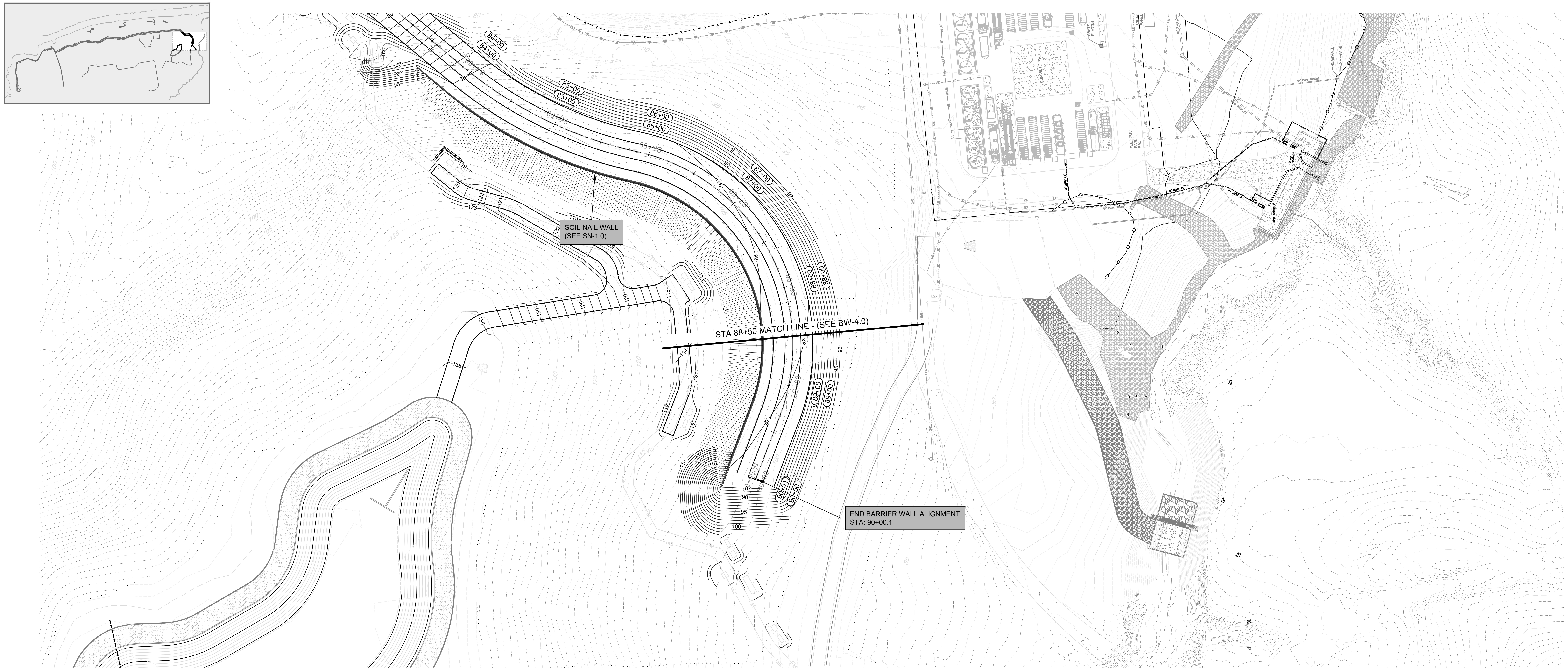
DRAWING:
BW-4.0

PROJECT NUMBER:
45-20803

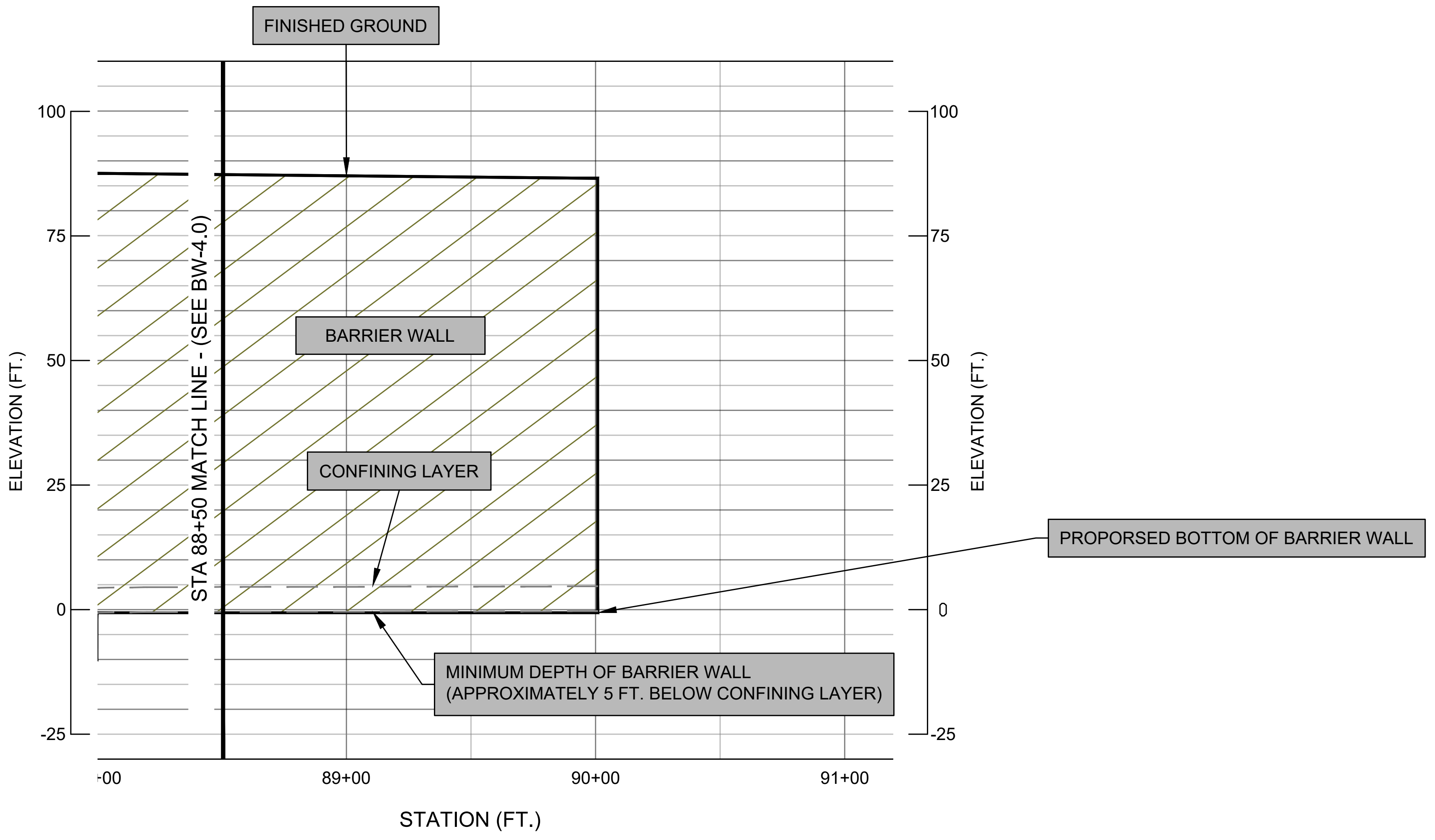
SITE KEY



1
BW-5.0
BARRIER WALL LOCATION PLAN
SCALE: 1" = 50'
0' 50' 100'

LEGEND:

- = ROADWAY CENTERLINE
- = EXISTING GRADE
- = PROPOSED GRADE



NOTE:
CONTRACTOR TO PROVIDE BARRIER WALL WITH MINIMUM THICKNESS OF 30 IN. AND A MAXIMUM HYDRAULIC CONDUCTIVITY OF 1X10E-6 CM/S.

2
BW-5.0
BARRIER WALL PROFILE
SCALE: NTS

GEOS
Geotechnical, Environmental and Materials Engineers

Barrier Wall Design Plans
Barrier Wall Plan & Profile Sta 88+50 to Sta 90+0.01

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: NSS	REVIEWED BY: TJD
DESIGNED BY: TJD	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 10, 2022	

Revisions

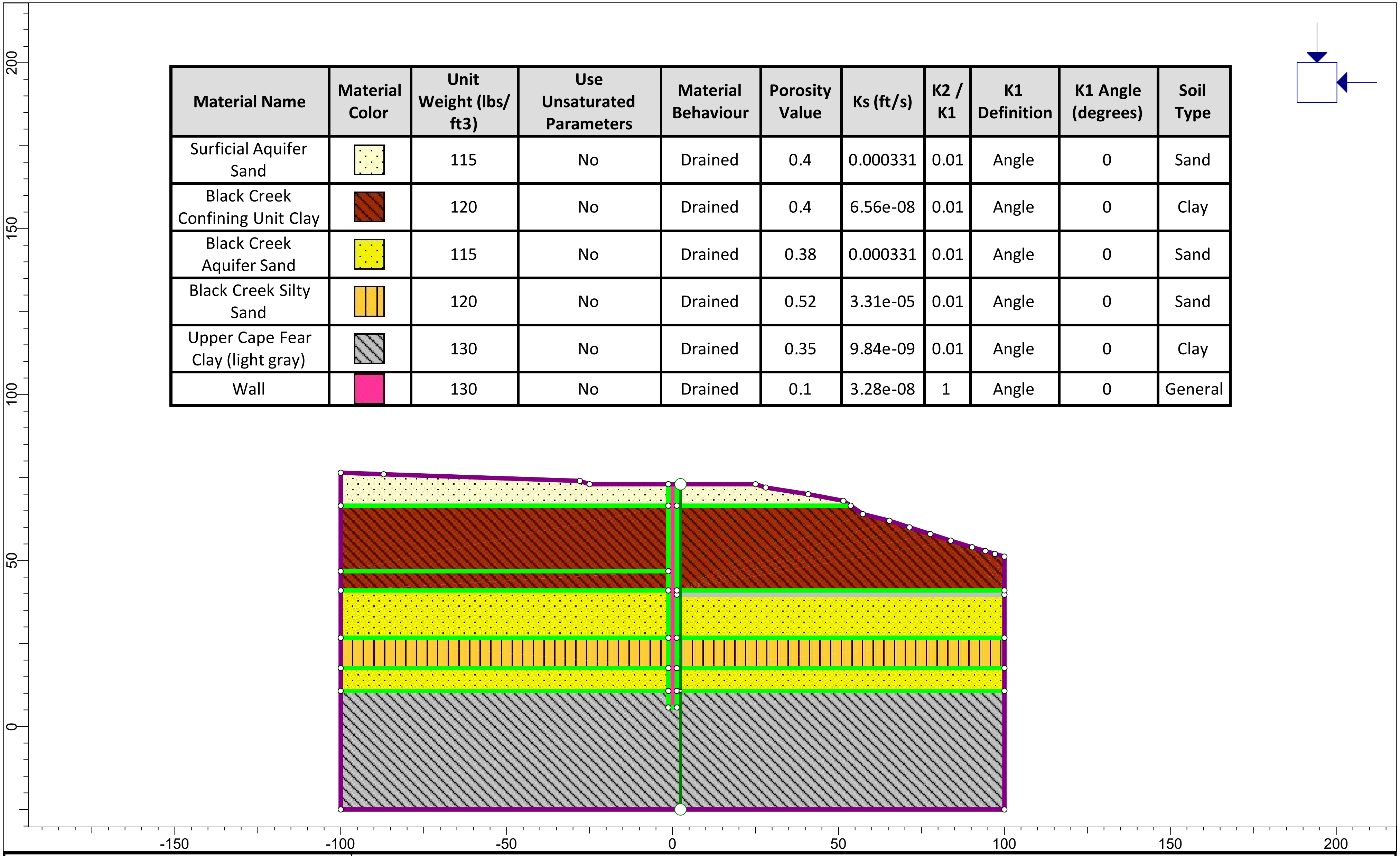
No.	Date	Description	By:
1			
2			
3			
4			
5			
6			

DRAWING:
BW-5.0

PROJECT NUMBER:
45-20803

Attachments

Seepage Models and Results



Material Name	Material Color	Unit Weight (lbs/ ft3)	Use Unsaturated Parameters	Material Behaviour	Porosity Value	Ks (ft/s)	K2 / K1	K1 Definition	K1 Angle (degrees)	Soil Type
Surficial Aquifer Sand	░	115	No	Drained	0.4	0.000331	0.01	Angle	0	Sand
Black Creek Confining Unit Clay	▨	120	No	Drained	0.4	6.56e-08	0.01	Angle	0	Clay
Black Creek Aquifer Sand	🟨	115	No	Drained	0.38	0.000331	0.01	Angle	0	Sand
Black Creek Silty Sand	▥	120	No	Drained	0.52	3.31e-05	0.01	Angle	0	Sand
Upper Cape Fear Clay (light gray)	▨	130	No	Drained	0.35	9.84e-09	0.01	Angle	0	Clay
Wall	■	130	No	Drained	0.1	3.28e-08	1	Angle	0	General

GEOS Universal Engineering Sciences

Geotechnical, Environmental and Materials Engineers

RS2 11.013

Project 45-20803 Barrier Wall Road Interim Design and Repair

Analysis Description Seep A: Seepage Through 2.5 Feet Barrier Wall

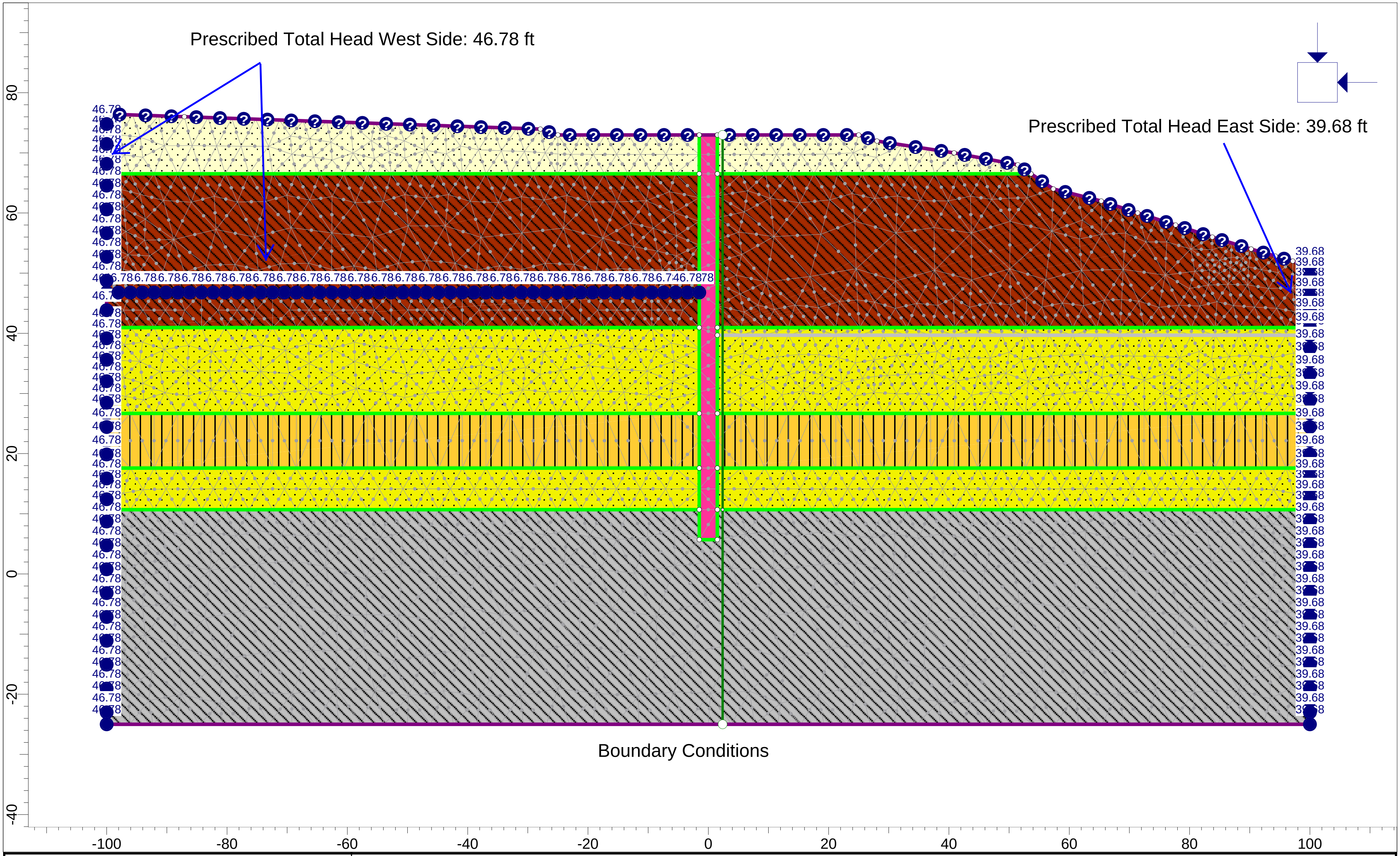
Drawn By

Scale 1:480

Company

Date

File Name Seep-A_2.5FT.fez

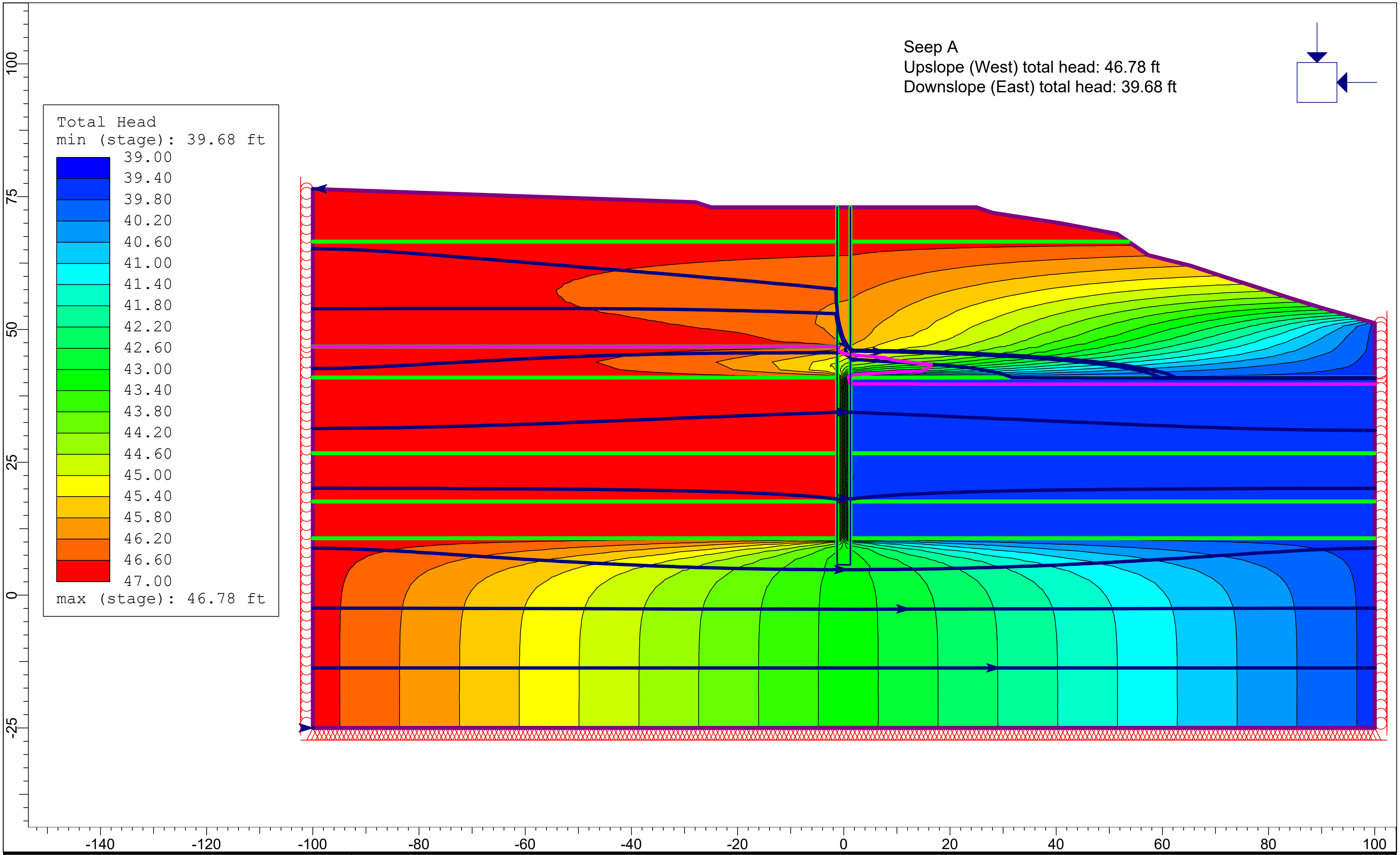


Boundary Conditions

GEOS Universal Engineering Sciences
Geotechnical, Environmental and Materials Engineers

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Description	Seep A, Example of Application of Boundary Conditions for Seepage Analysis
Drawn By	
Scale	1:265
Company	
Date	
File Name	Seep-A_3FT-saved.fez

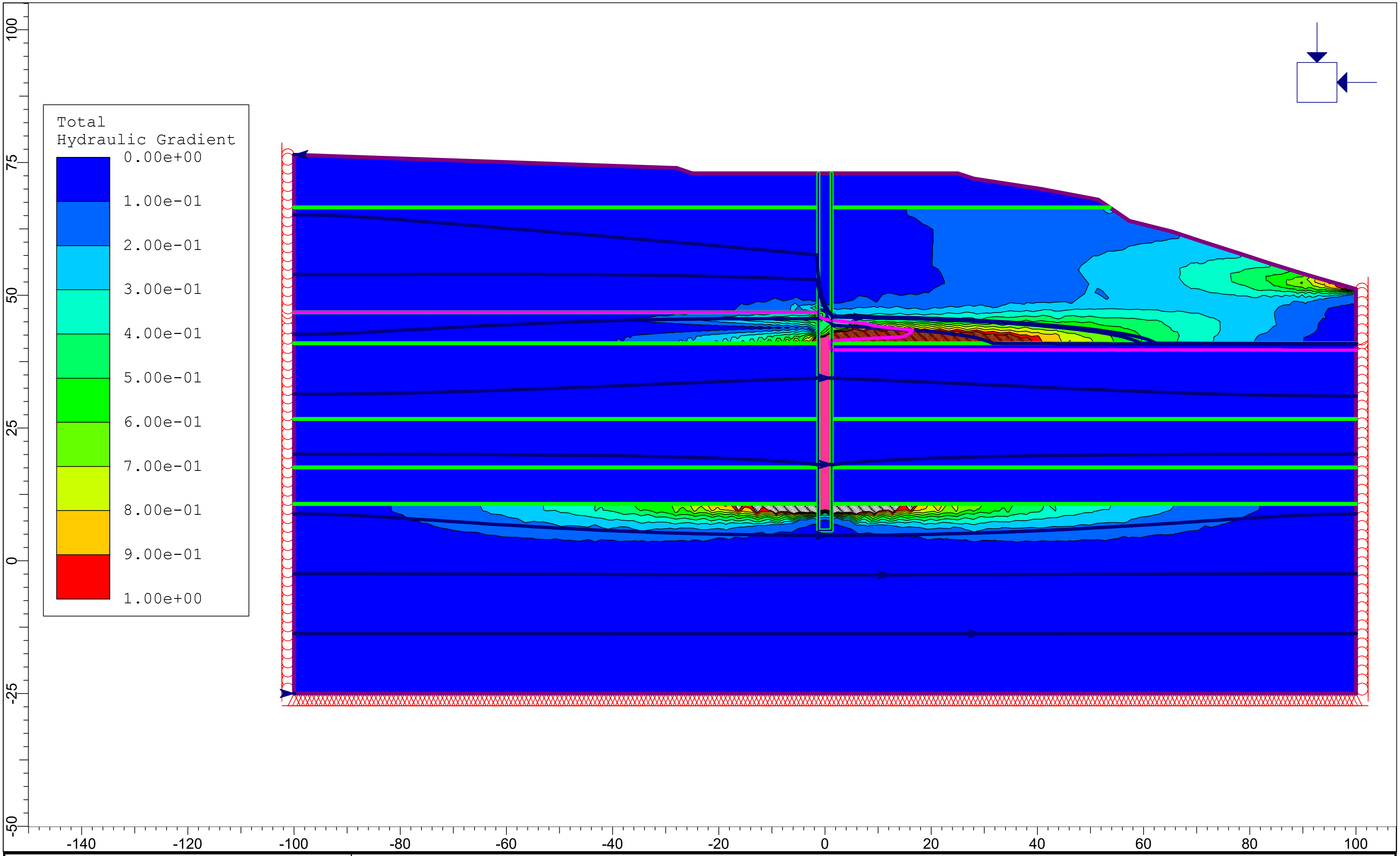
RS2 11.013


Seep A
Upslope (West) total head: 46.78 ft
Downslope (East) total head: 39.68 ft

GEOS Geotechnical, Environmental and Materials Engineers
Universal Engineering Sciences

INTERPRET 11.013

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Description	Seep A: Seepage Through 2.5 Feet Barrier Wall
Drawn By	
Scale	1:300
Company	
Date	
File Name	Seep-A_2.5FT.fez



GEOS Universal Engineering Sciences

Geotechnical, Environmental and Materials Engineers

Project
45-20803 Barrier Wall Road Interim Design and Repair

Analysis Description
Seep A: Seepage Through 2.5 Feet Barrier Wall

Drawn By

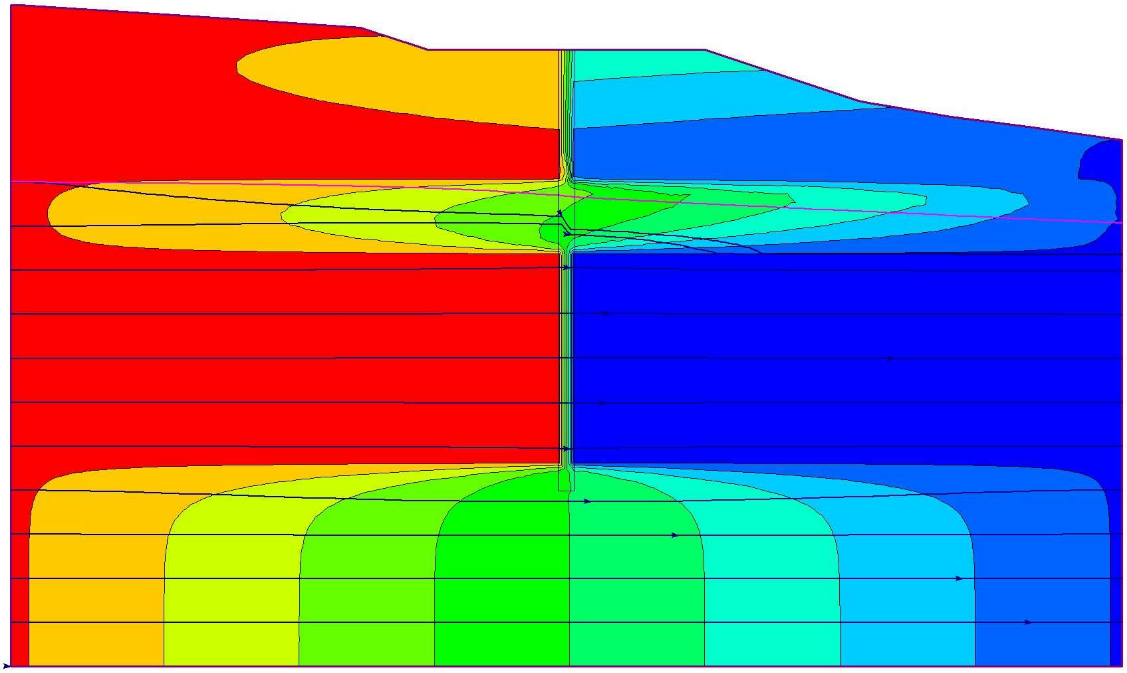
Scale 1:300

Company

Date

File Name Seep-A_2.5FT.fez

INTERPRET 11.013



Seep A
45-20803 Barrier Wall Road Interim Design and Repair
Barrier Wall Width: 2.5 Feet
Software Version: 11.013

Table of Contents

Seep-A_2.5FT.fez

RS2 Analysis Information

Project Summary

File Name:	Seep-A_2.5FT.fez
Last saved with RS2 version:	11.013
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Seep A: Seepage Through 2.5 Feet Barrier Wall

General Settings

Number of Stages:	2
Analysis Type:	Plane Strain
Solver Type:	Gaussian Elimination
Units:	Imperial, stress as psf
Permeability Units:	feet/second
Time Units:	seconds

Analysis Options

Maximum Number of Iterations:	500
Tolerance:	0.001
Number of Load Steps:	Automatic
Convergence Type:	Comprehensive
Tensile Failure:	Reduces Shear Strength

Joint tension reduces joint stiffness by a factor of 0.01

Groundwater Analysis

Method:	Steady State
Pore Fluid Unit Weight:	62.4 lbs/ft3
Maximum Number of Iterations:	500
Tolerance:	0.001
Use Fluid Potential:	Yes
Use Improved Seepage:	No
Probability:	None

Field Stress

Field stress:	Gravity
Using actual ground surface	
Effective stress ratio (horizontal/vertical in-plane):	1
Effective stress ratio (horizontal/vertical out-of-plane):	1
Locked-in horizontal stress (in-plane):	0
Locked-in horizontal stress (out-of-plane):	0

Mesh

Mesh type:	Graded	
Element type:	6 Noded triangles	
Stage Name	**# of Elements**	**# of Nodes**
1. Initial Conditions	6886	14123
2. Pumping	6886	14123

Mesh Quality

2 of 6886 Elements (0.0 % of elements) are poor quality elements
2 of 6886 Elements (0.0 % of elements) are poor quality elements because of the side length ratio
2 of 6886 Elements (0.0 % of elements) are poor quality elements because of the minimum interior angle
0 of 6886 Elements (0.0 % of elements) are poor quality elements because of the maximum interior angle
0 of 6886 Elements (0.0 % of elements) are poor quality elements because they are inverted
Note: Elements can be of poor quality for more than one reason

Poor quality elements defined as:

Side length ratio (maximum / minimum) > 30.00
Minimum interior angle < 2.0 degrees
Maximum interior angle > 175.0 degrees

Material Properties

Surficial Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	300000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Confining Unit Clay

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	400000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	26 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	6.56e-08 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Black Creek Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	600000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	34 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.38
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Silty Sand

Material Color	🟧
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	500000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	30 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.52
Ks	3.31e-05 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Upper Cape Fear Clay (light gray)

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-09 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Wall

Material Color	🟥
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	417709 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	0 degrees
Peak Cohesion	350 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.1
Ks	3.28e-08 ft/s
K2 / K1	1
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	General

Displacements

Displacement data is not available for 1. Initial Conditions until total displacement is viewed in a window
Displacement data is not available for 2. Pumping until total displacement is viewed in a window

Yielded Elements

List of All Coordinates

External boundary

X	Y
100	-25
100	10.69
100	17.59
100	26.69
100	39.68
100	40.95
100	51.18
97.1513	52.0039
94.2607	52.84
90.2502	54
90.2367	54.0039
83.7772	56.0039
77.6695	58.0039
71.363	60.0039
65.3217	62.0039
57.3492	64.0039
53.6405	66.52
51.4532	68.0039
40.8533	70.0039
28.0437	71.9548
25	72.9694
1.25	72.9694
-1.25	72.9694
-25	72.9694
-27.9168	73.9417
-87.0888	76.0039
-100	76.4539
-100	66.52
-100	46.78
-100	46.73
-100	40.95
-100	26.69
-100	17.59
-100	10.69
-100	-25

Material boundary

X	Y
-1.25	72.9694
-1.25	66.52
-1.25	46.78
-1.25	40.95
-1.25	26.69
-1.25	17.59
-1.25	10.69
-1.25	5.69
1.25	5.69
1.25	10.69
1.25	17.59
1.25	26.69
1.25	39.68
1.25	40.95
1.25	66.52
1.25	72.9694

Material boundary

X	Y
-100	66.52
-1.25	66.52

Material boundary

X	Y
1.25	66.52
53.6405	66.52

Material boundary

X	Y
-100	40.95
-1.25	40.95

Material boundary

X	Y
-100	26.69
-1.25	26.69

Material boundary

X	Y
-100	17.59
-1.25	17.59

Material boundary

X	Y
-100	10.69
-1.25	10.69

Material boundary

X	Y
1.25	40.95
100	40.95

Material boundary

X	Y
1.25	26.69
100	26.69

Material boundary

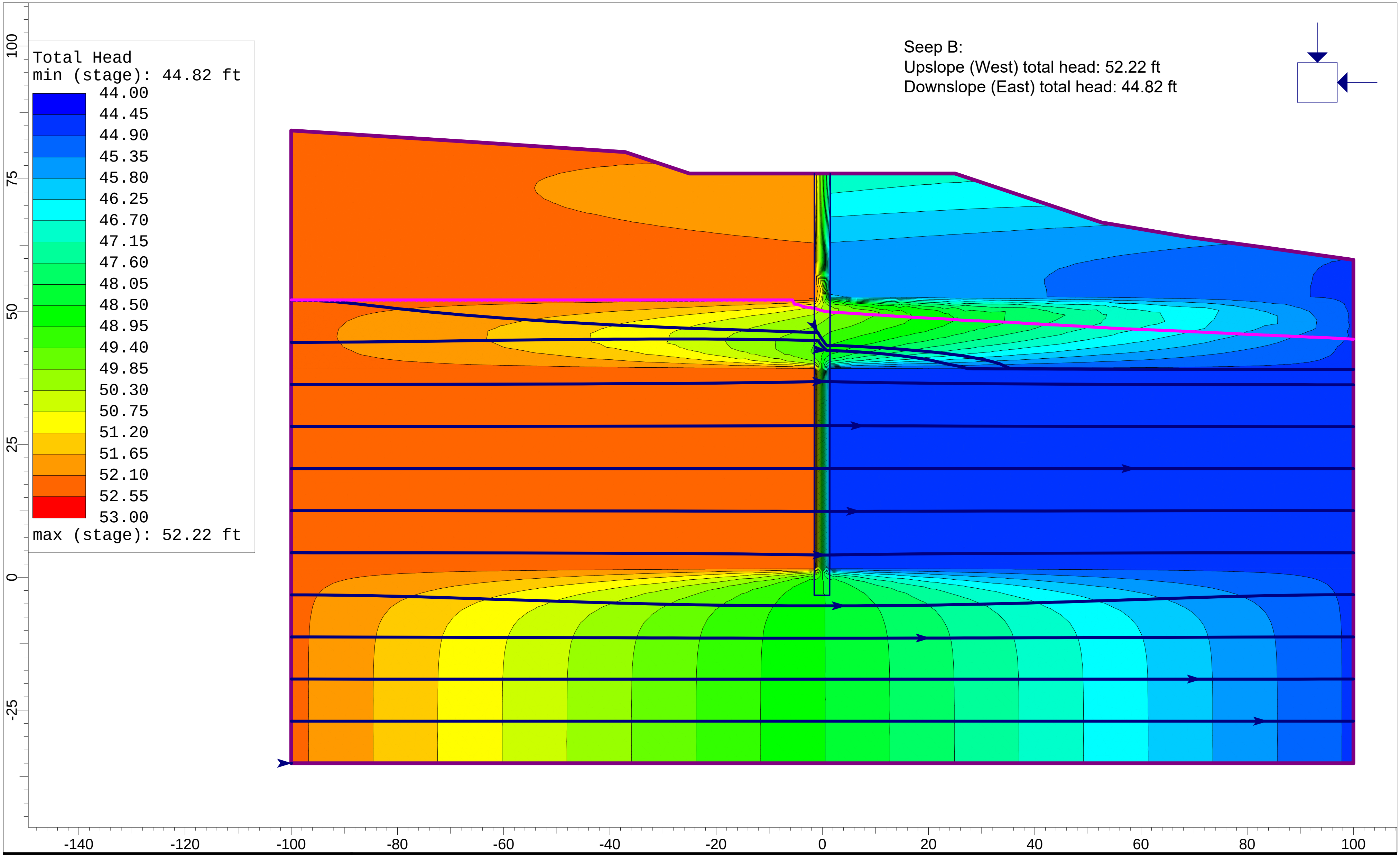
X	Y
1.25	17.59
100	17.59

Material boundary

X	Y
1.25	10.69
100	10.69

Material boundary

X	Y
-100	46.78
-1.25	46.78



Seep B:
Upslope (West) total head: 52.22 ft
Downslope (East) total head: 44.82 ft

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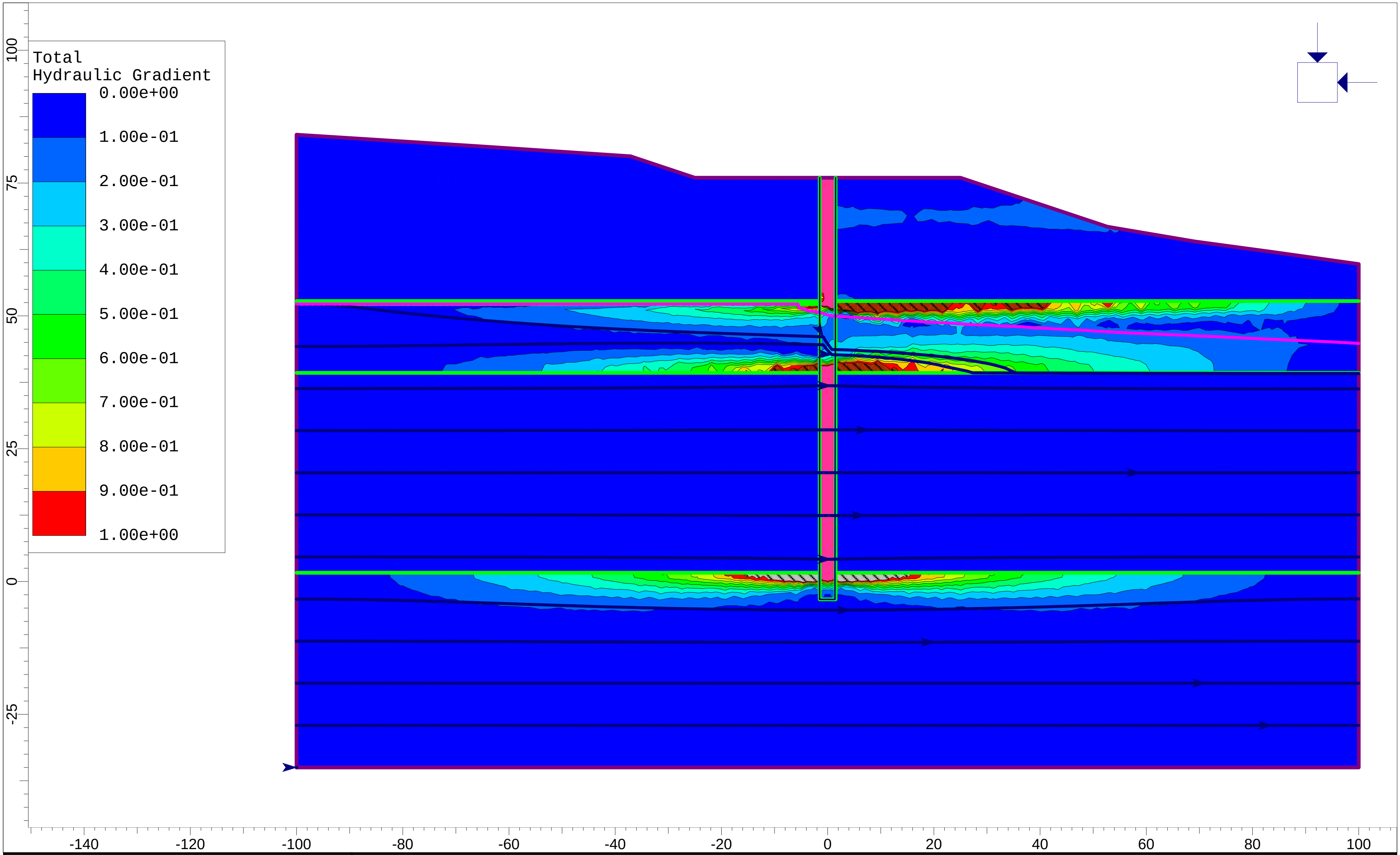
Project	45-20803 Barrier Wall Interim Design and Repair		
Analysis Description	Seep B: Seepage Through 3FT Barrier Wall		
Drawn By	*Scale* 1:300	*Company*	
Date		*File Name*	Seep-B_3FT.fez



GEOS Universal Engineering Sciences Geotechnical, Environmental and Materials Engineers	*Project* 45-20803 Barrier Wall Interim Design and Repair		
	Analysis Description Seep B: Seepage Through 3FT Barrier Wall		
	Drawn By	*Scale* 1:300	*Company*
INTERPRET 11.013	*Date*		*File Name* Seep-B_3FT.fez

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Seep B
45-20803 Barrier Wall Interim Design and Repair
Software Version: 11.013

Table of Contents

Seep-B_3FT.fez

RS2 Analysis Information

Project Summary

File Name:	Seep-B_3FT.fez
Last saved with RS2 version:	11.013
Project Title:	45-20803 Barrier Wall Interim Design and Repair
Analysis:	Seep B: Seepage Through 3FT Barrier Wall

General Settings

Number of Stages:	2
Analysis Type:	Plane Strain
Solver Type:	Gaussian Elimination
Units:	Imperial, stress as psf
Permeability Units:	feet/second
Time Units:	seconds

Analysis Options

Maximum Number of Iterations:	500
Tolerance:	0.001
Number of Load Steps:	Automatic
Convergence Type:	Comprehensive
Tensile Failure:	Reduces Shear Strength

Joint tension reduces joint stiffness by a factor of 0.01

Groundwater Analysis

Method:	Steady State
Pore Fluid Unit Weight:	62.4 lbs/ft3
Maximum Number of Iterations:	500
Tolerance:	0.001
Use Fluid Potential:	Yes
Use Improved Seepage:	No
Probability:	None

Field Stress

Field stress:	Gravity
Using actual ground surface	
Effective stress ratio (horizontal/vertical in-plane):	1
Effective stress ratio (horizontal/vertical out-of-plane):	1
Locked-in horizontal stress (in-plane):	0
Locked-in horizontal stress (out-of-plane):	0

Mesh

Mesh type:	Graded	
Element type:	6 Noded triangles	
Stage Name	**# of Elements**	**# of Nodes**
1. Initial condition	5938	12175
2. Pumping	5938	12175

Mesh Quality

2 of 5938 Elements (0.0 % of elements) are poor quality elements
2 of 5938 Elements (0.0 % of elements) are poor quality elements because of the side length ratio
2 of 5938 Elements (0.0 % of elements) are poor quality elements because of the minimum interior angle
0 of 5938 Elements (0.0 % of elements) are poor quality elements because of the maximum interior angle
0 of 5938 Elements (0.0 % of elements) are poor quality elements because they are inverted
Note: Elements can be of poor quality for more than one reason

Poor quality elements defined as:

Side length ratio (maximum / minimum) > 30.00
Minimum interior angle < 2.0 degrees
Maximum interior angle > 175.0 degrees

Material Properties

Surficial Aquifer Sand

Material Color	░
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	300000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	20 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Confining Unit Clay

Material Color	▧
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	400000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	26 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	6.56e-08 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Black Creek Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	600000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	34 degrees
Peak Cohesion	50 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.38
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Upper Cape Fear Clay (light gray)

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-09 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Wall

Material Color	🟥
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	417709 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	0 degrees
Peak Cohesion	350 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.1
Ks	3.28e-08 ft/s
K2 / K1	1
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	General

Displacements

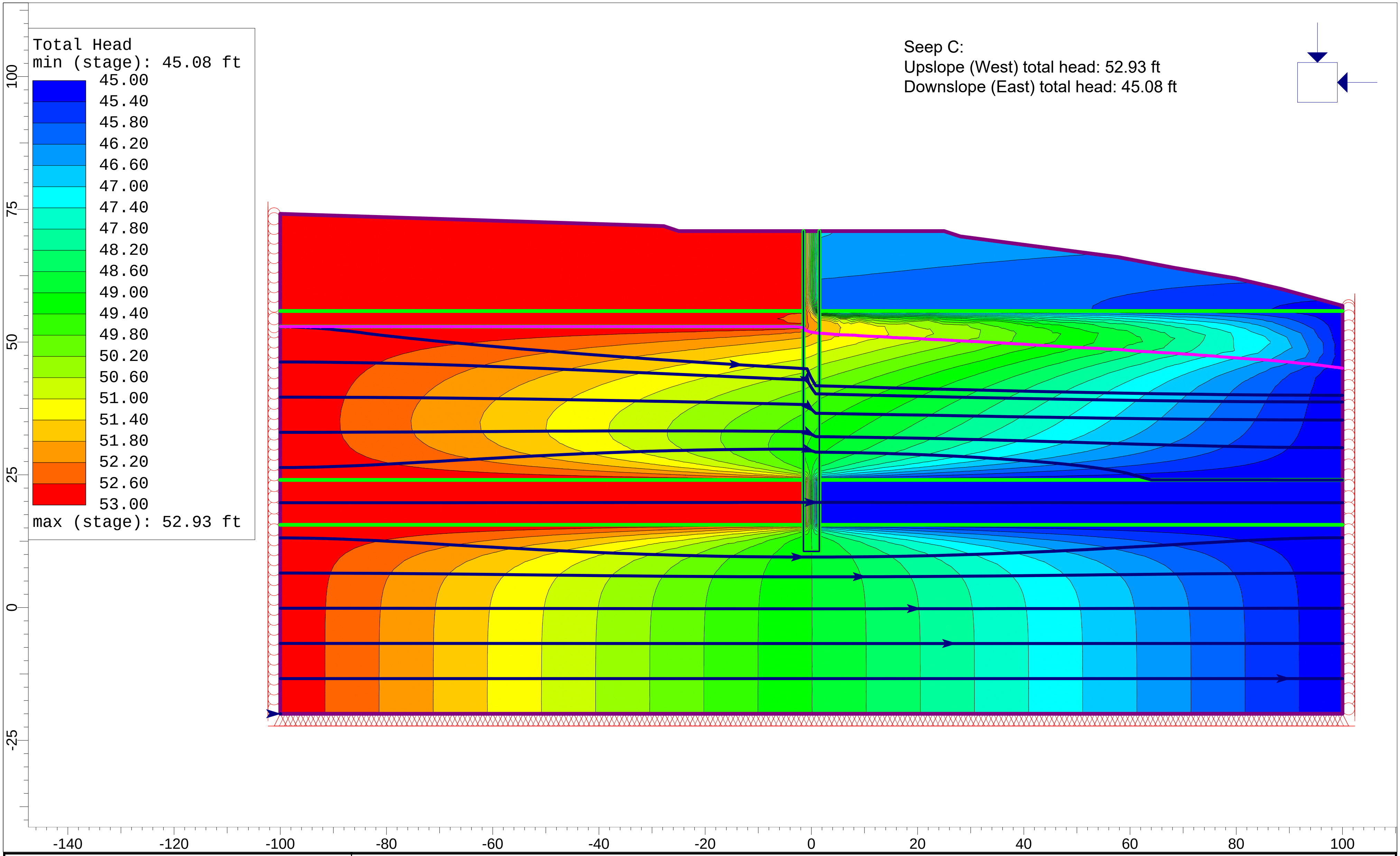
Displacement data is not available for 1. Initial condition until total displacement is viewed in a window
Displacement data is not available for 2. Pumping until total displacement is viewed in a window

Yielded Elements

List of All Coordinates

External boundary

X	Y
-100	-35
100	-35
100	1.65
100	39.27
100	52.8
100	59.75
98.1977	60.0027
83.9356	62.0027
69.1551	64.0027
57.298	66.0027
54.2087	66.52
52.6417	66.7824
25	76
1.5	76
-1.5	76
-25	76
-37.1327	80.0406
-66.7839	82.0027
-98.4462	84.0027
-100	84.1008
-100	52.8
-100	52.22
-100	52.16
-100	39.27
-100	1.65



Seep C:
Upslope (West) total head: 52.93 ft
Downslope (East) total head: 45.08 ft

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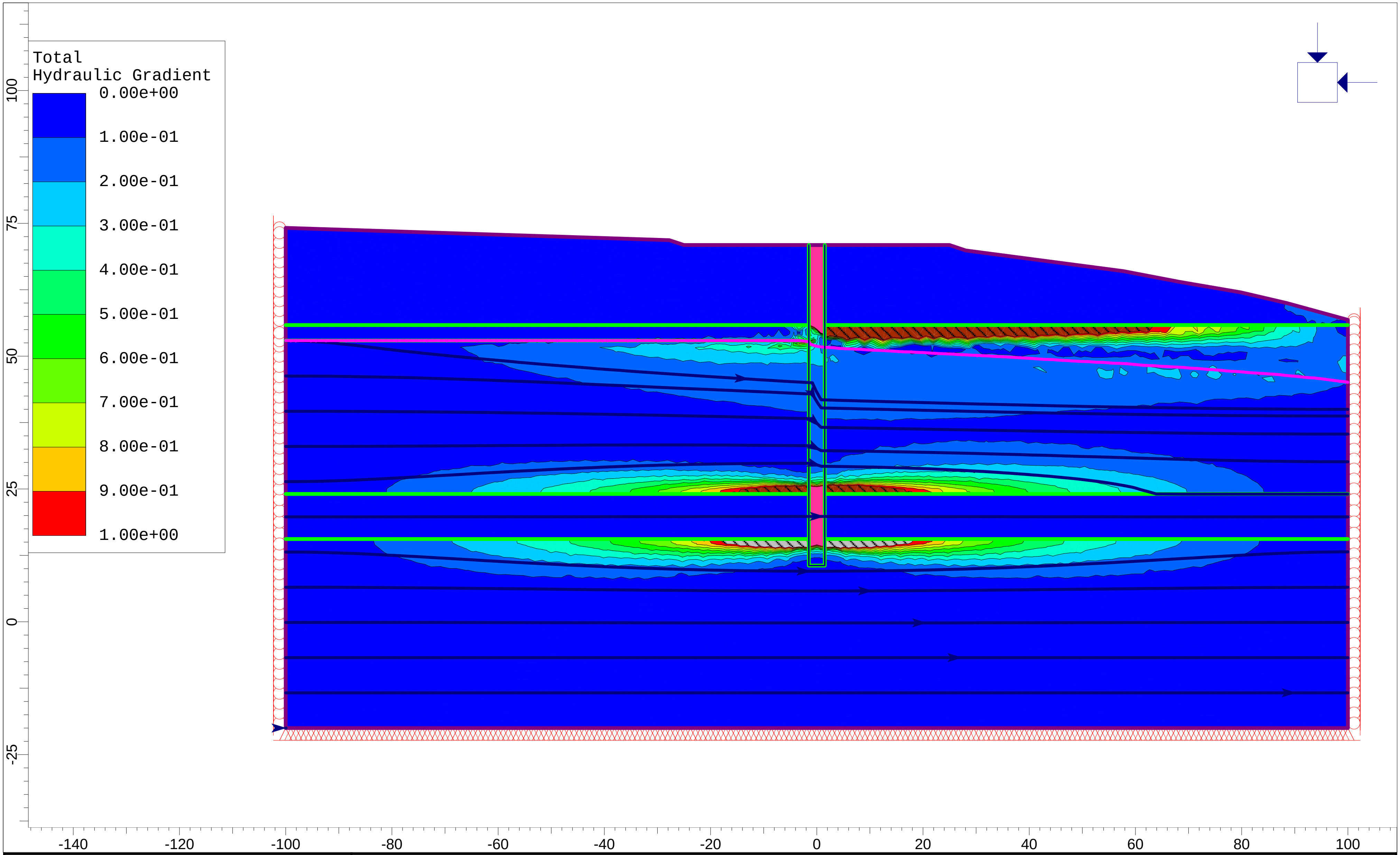
Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Description	Seep C: Seepage Through 3FT Barrier Wall
Drawn By	
Scale	1:300
Company	
Date	
File Name	Seep C 3FT.fez



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INTERPRET 11.013

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Description	Seep C: Seepage Through 3FT Barrier Wall
Drawn By	
Scale	1:300
Company	
Date	
File Name	Seep C 3FT.fez

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Seep C
45-20803 Barrier Wall Road Interim Design and Repair
Software Version: 11.013

Table of Contents

Seep C 3FT.fez

RS2 Analysis Information

Project Summary

File Name:	Seep C 3FT.fez
Last saved with RS2 version:	11.013
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Seep C: Seepage Through 3FT Barrier Wall

General Settings

Number of Stages:	2
Analysis Type:	Plane Strain
Solver Type:	Gaussian Elimination
Units:	Imperial, stress as psf
Permeability Units:	feet/second
Time Units:	seconds

Analysis Options

Maximum Number of Iterations:	500
Tolerance:	0.001
Number of Load Steps:	Automatic
Convergence Type:	Comprehensive
Tensile Failure:	Reduces Shear Strength

Joint tension reduces joint stiffness by a factor of 0.01

Groundwater Analysis

Method:	Steady State
Pore Fluid Unit Weight:	62.4 lbs/ft3
Maximum Number of Iterations:	500
Tolerance:	0.001
Use Fluid Potential:	Yes
Use Improved Seepage:	No
Probability:	None

Field Stress

Field stress:	Gravity
Using actual ground surface	
Effective stress ratio (horizontal/vertical in-plane):	1
Effective stress ratio (horizontal/vertical out-of-plane):	1
Locked-in horizontal stress (in-plane):	0
Locked-in horizontal stress (out-of-plane):	0

Mesh

Mesh type:	Graded
Element type:	6 Noded triangles

Stage Name	# of Elements	# of Nodes
1. Initial Conditions	5240	10783
2. Pumping	5240	10783

Mesh Quality

3 of 5240 Elements (0.1 % of elements) are poor quality elements
2 of 5240 Elements (0.0 % of elements) are poor quality elements because of the side length ratio
3 of 5240 Elements (0.1 % of elements) are poor quality elements because of the minimum interior angle
0 of 5240 Elements (0.0 % of elements) are poor quality elements because of the maximum interior angle
0 of 5240 Elements (0.0 % of elements) are poor quality elements because they are inverted
Note: Elements can be of poor quality for more than one reason

Poor quality elements defined as:

Side length ratio (maximum / minimum) > 30.00
Minimum interior angle < 2.0 degrees
Maximum interior angle > 175.0 degrees

Material Properties

Surficial Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	300000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Confining Unit Clay

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	400000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	26 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	6.56e-08 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Black Creek Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	600000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	34 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.38
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Upper Cape Fear Clay (light gray)

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-09 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Wall

Material Color	🟥
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	417709 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	0 degrees
Peak Cohesion	350 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.1
Ks	3.28e-08 ft/s
K2 / K1	1
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	General

Displacements

Displacement data is not available for 1. Initial Conditions until total displacement is viewed in a window
Displacement data is not available for 2. Pumping until total displacement is viewed in a window

Yielded Elements

List of All Coordinates

External boundary

X	Y
-100	-20
100	-20
100	15.58
100	24.05
100	55.85
100	56.83
95.7399	57.9989
88.4508	59.9989
79.8595	61.9989
68.191	63.9989
57.7369	65.9989
28.0331	69.894
25	70.905
1.5	70.905
-1.5	70.905
-25	70.905
-27.7721	71.829
-32.8761	71.9989
-95.5141	73.9989
-100	74.1421
-100	55.85
-100	52.93
-100	52.88
-100	24.05
-100	15.58

Material boundary

X	Y
-1.5	70.905
-1.5	55.85
-1.5	52.93
-1.5	52.88
-1.5	24.05
-1.5	15.58
-1.5	10.58
1.5	10.58
1.5	15.58
1.5	24.05
1.5	55.85
1.5	70.905

Material boundary

X	Y
-100	55.85
-1.5	55.85

Material boundary

X	Y
-100	24.05
-1.5	24.05

Material boundary

X	Y
-100	15.58
-1.5	15.58

Material boundary

X	Y
1.5	55.85
100	55.85

Material boundary

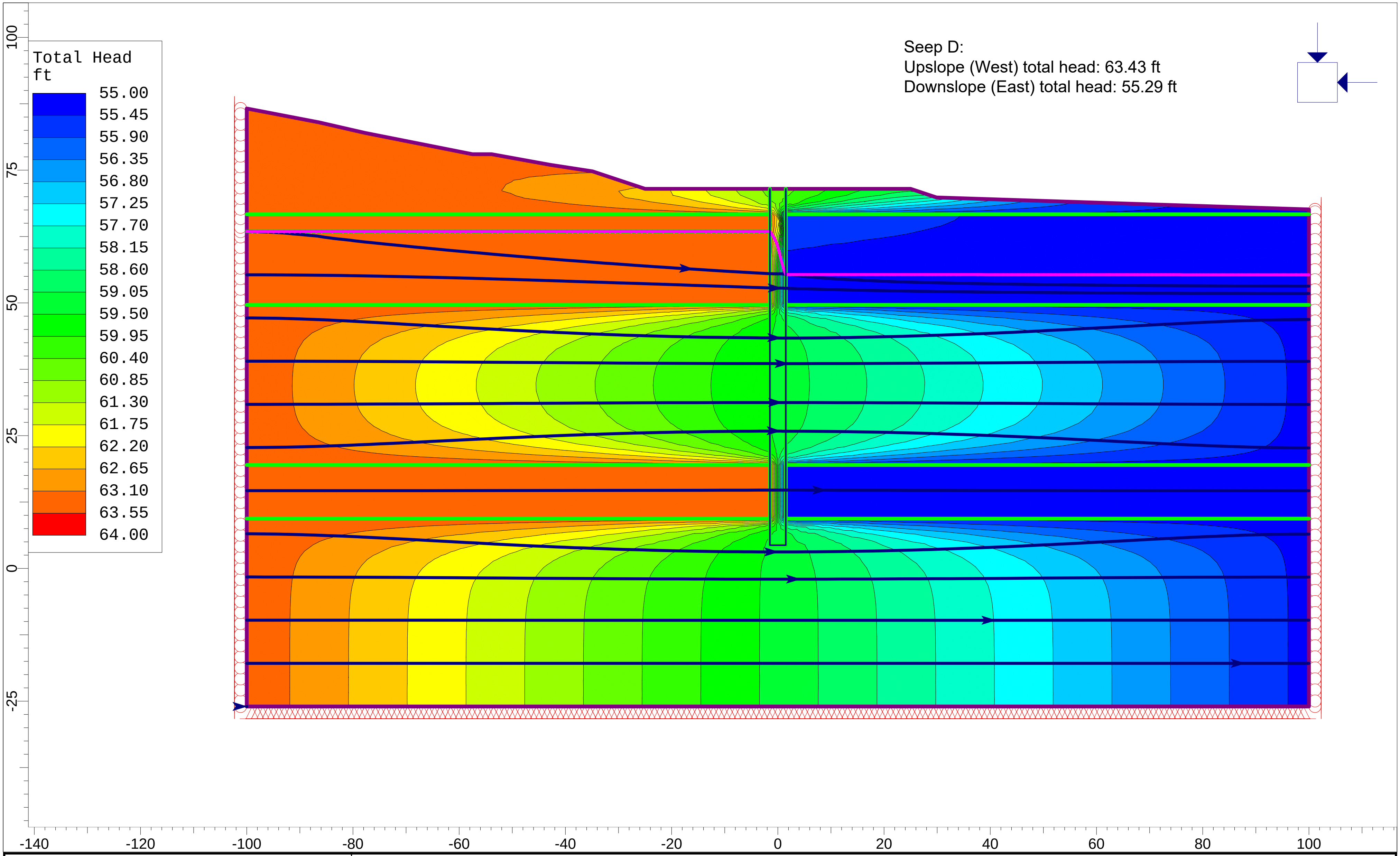
X	Y
1.5	24.05
100	24.05

Material boundary

X	Y
1.5	15.58
100	15.58

Material boundary

X	Y
-100	52.93
-1.5	52.93



Seep D:
Upslope (West) total head: 63.43 ft
Downslope (East) total head: 55.29 ft

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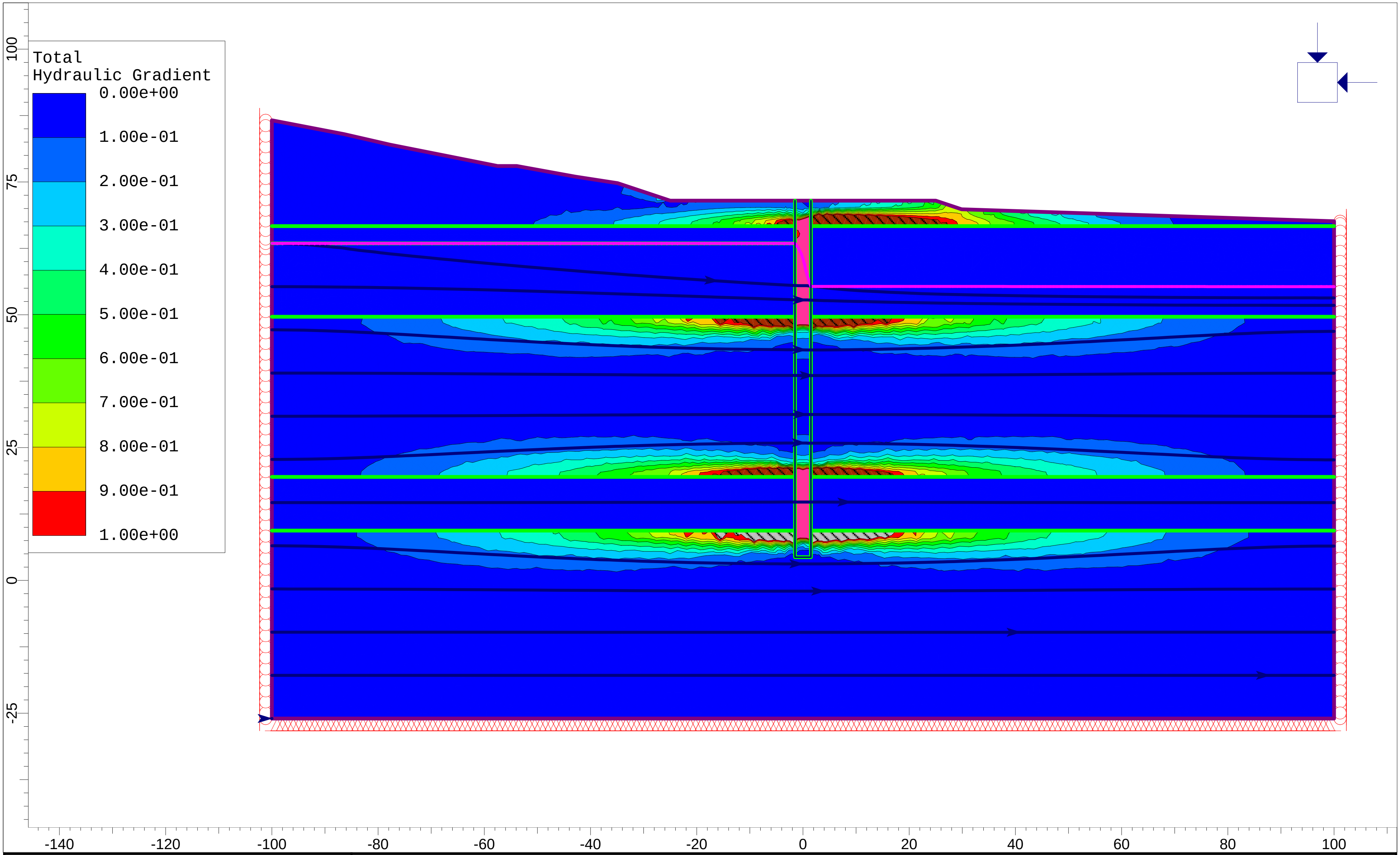
Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Description	Seep D: Seepage Through 3 FT Barrier Wall
Drawn By	
Scale	1:300
Company	
Date	
File Name	Seep D 3FT.fez



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Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis Description	Seep D: Seepage Through 3 FT Barrier Wall		
Drawn By	*Scale* 1:300	*Company*	
Date		*File Name*	Seep D 3FT.fez

INTERPRET 11.013

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Seep D
45-20803 Barrier Wall Road Interim Design and Repair
Software Version: 11.013

Table of Contents

Seep D 3FT.fez

RS2 Analysis Information

Project Summary

File Name:	Seep D 3FT.fez
Last saved with RS2 version:	11.013
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Seep D: Seepage Through 3 FT Barrier Wall

General Settings

Number of Stages:	2
Analysis Type:	Plane Strain
Solver Type:	Gaussian Elimination
Units:	Imperial, stress as psf
Permeability Units:	feet/second
Time Units:	seconds

Analysis Options

Maximum Number of Iterations:	500
Tolerance:	0.001
Number of Load Steps:	Automatic
Convergence Type:	Comprehensive
Tensile Failure:	Reduces Shear Strength

Joint tension reduces joint stiffness by a factor of 0.01

Groundwater Analysis

Method:	Steady State
Pore Fluid Unit Weight:	62.4 lbs/ft3
Maximum Number of Iterations:	500
Tolerance:	0.001
Use Fluid Potential:	Yes
Use Improved Seepage:	No
Probability:	None

Field Stress

Field stress:	Gravity
Using actual ground surface	
Effective stress ratio (horizontal/vertical in-plane):	1
Effective stress ratio (horizontal/vertical out-of-plane):	1
Locked-in horizontal stress (in-plane):	0
Locked-in horizontal stress (out-of-plane):	0

Mesh

Mesh type:	Graded	
Element type:	6 Noded triangles	
Stage Name	**# of Elements**	**# of Nodes**
1. Initial Conditions	5717	11736
2. Pumping	5717	11736

Mesh Quality

3 of 5717 Elements (0.1 % of elements) are poor quality elements
3 of 5717 Elements (0.1 % of elements) are poor quality elements because of the side length ratio
3 of 5717 Elements (0.1 % of elements) are poor quality elements because of the minimum interior angle
0 of 5717 Elements (0.0 % of elements) are poor quality elements because of the maximum interior angle
0 of 5717 Elements (0.0 % of elements) are poor quality elements because they are inverted
Note: Elements can be of poor quality for more than one reason

Poor quality elements defined as:

Side length ratio (maximum / minimum) > 30.00
Minimum interior angle < 2.0 degrees
Maximum interior angle > 175.0 degrees

Material Properties

Surficial Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	300000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Confining Unit Clay

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	400000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	26 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	6.56e-08 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Black Creek Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	600000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	34 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.38
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Upper Cape Fear Clay (light gray)

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-09 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Wall

Material Color	🟪
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	417709 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	0 degrees
Peak Cohesion	350 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.1
Ks	3.28e-08 ft/s
K2 / K1	1
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	General

Displacements

Displacement data is not available for 1. Initial Conditions until total displacement is viewed in a window
Displacement data is not available for 2. Pumping until total displacement is viewed in a window

Yielded Elements

List of All Coordinates

External boundary

X	Y
-100	-26
100	-26
100	9.37
100	19.48
100	49.63
100	61
100	66.68
100	67.6
87.4135	68.0038
29.8805	69.8493
25	71.4761
1.5	71.4761
-1.5	71.4761
-25	71.4761
-34.898	74.7754
-42.8674	76.0038
-53.891	78.0038
-57.4854	78.0038
-67.5761	80.0038
-77.6827	82.0038
-86.4033	84.0038
-96.8327	86.0038
-100	86.6111
-100	66.68
-100	63.43
-100	63.42
-100	49.63
-100	19.48
-100	9.37

Material boundary

X	Y
-1.5	71.4761
-1.5	66.68
-1.5	63.43
-1.5	63.42
-1.5	49.63
-1.5	19.48
-1.5	9.37
-1.5	4.37
1.5	4.37
1.5	9.37
1.5	19.48
1.5	49.63
1.5	66.68
1.5	71.4761

Material boundary

X	Y
-100	66.68
-1.5	66.68

Material boundary

X	Y
-100	49.63
-1.5	49.63

Material boundary

X	Y
-100	19.48
-1.5	19.48

Material boundary

X	Y
1.5	66.68
100	66.68

Material boundary

X	Y
1.5	49.63
100	49.63

Material boundary

X	Y
1.5	19.48
100	19.48

Material boundary

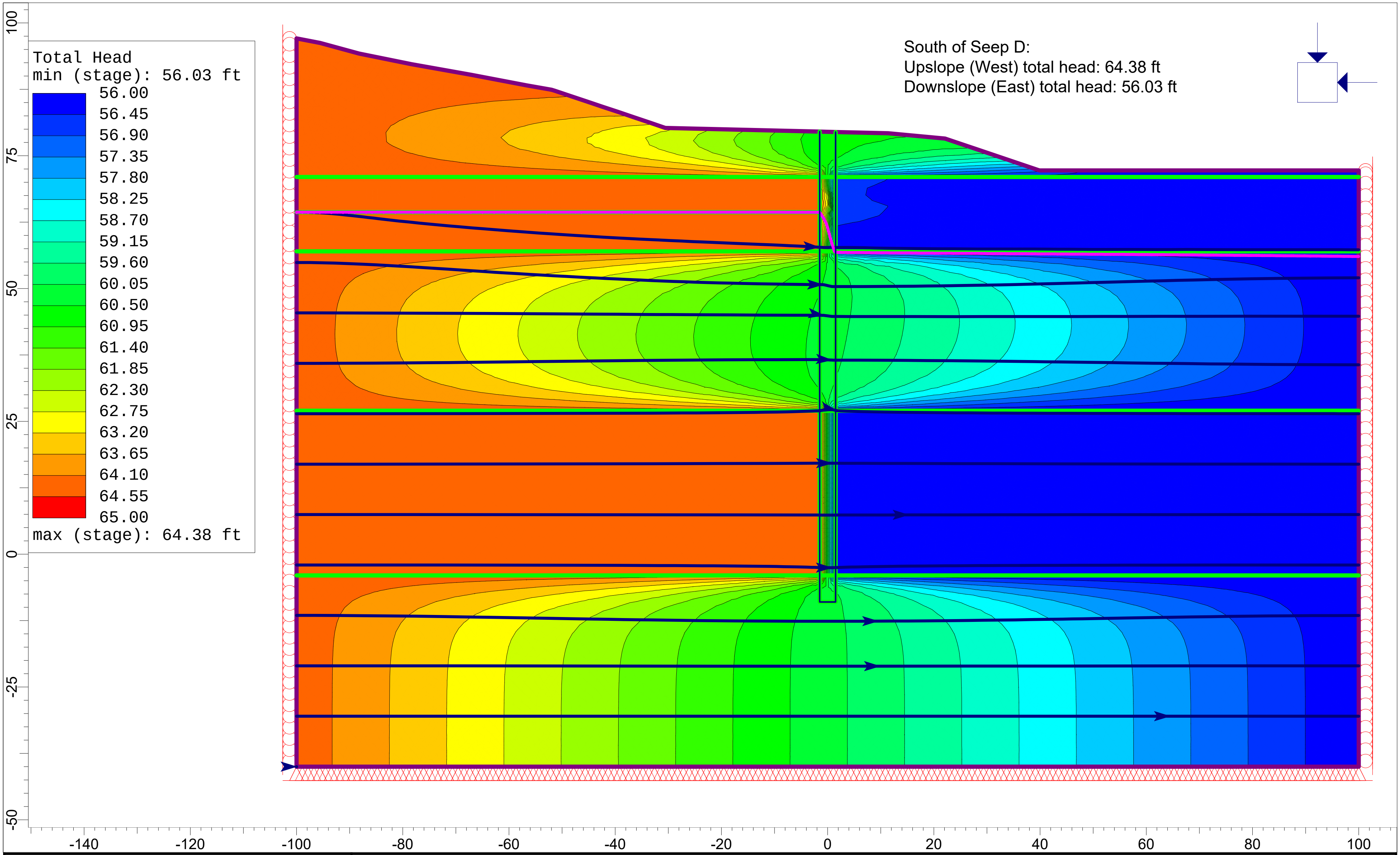
X	Y
-100	9.37
-1.5	9.37

Material boundary

X	Y
100	9.37
1.5	9.37

Material boundary

X	Y
-100	63.43
-1.5	63.43

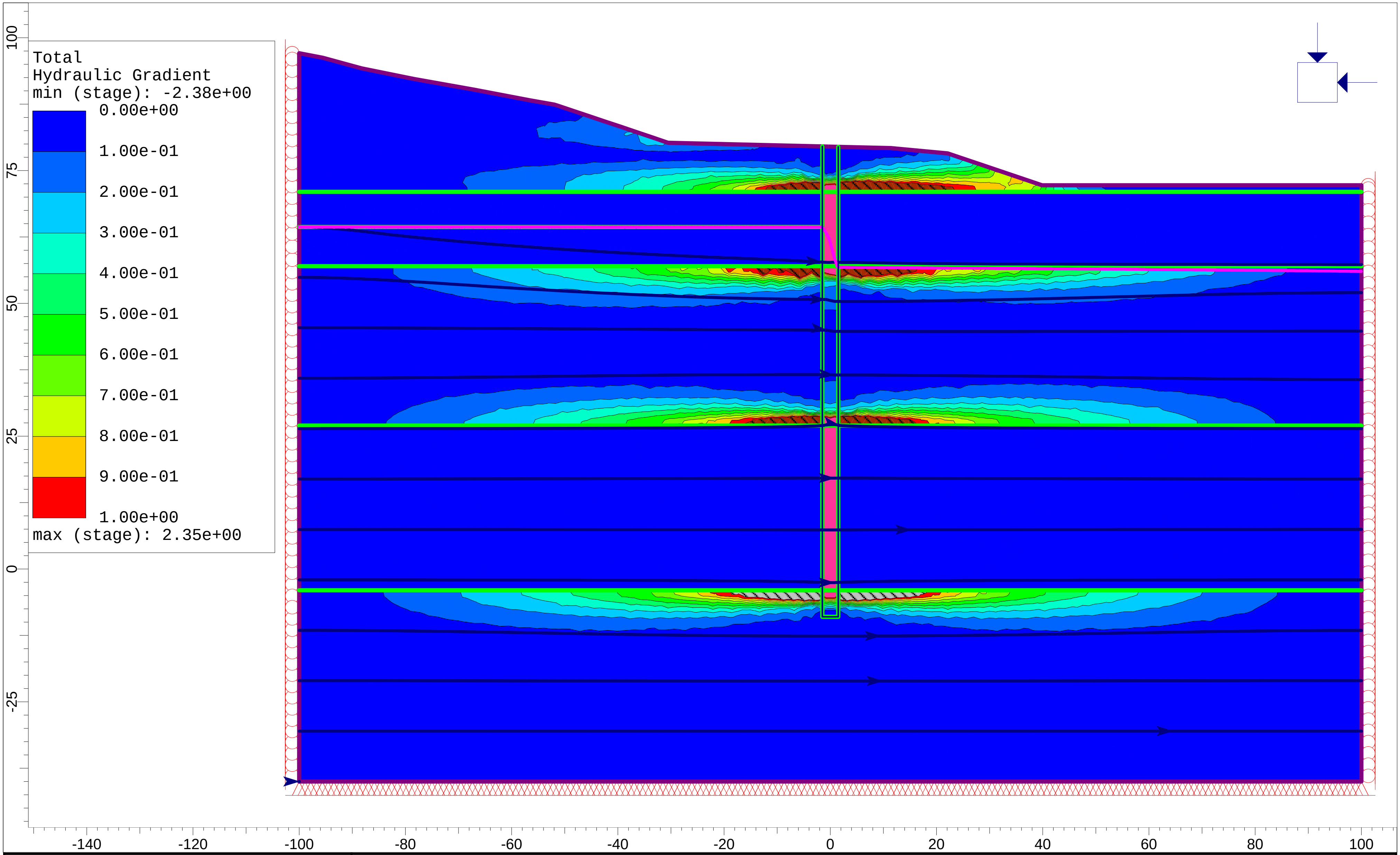


Universal Engineering Sciences

Geotechnical, Environmental and Materials Engineers

INTERPRET 11.013

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis Description	South of Seep D: Seepage Through 3FT Barrier Wall		
Drawn By	*Scale* 1:300	*Company*	
Date		*File Name*	south_seep D 6+00 3FT thick wall.fez



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Geotechnical, Environmental and Materials Engineers

INTERPRET 11.013

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Description	South of Seep D: Seepage Through 3FT Barrier Wall
Drawn By	
Scale	1:300
Company	
Date	
File Name	south_seep D 3FT thick wall.fez

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South of Seep D
45-20803 Barrier Wall Road Interim Design and Repair
Software Version: 11.013

Table of Contents

south_seep D 3FT thick wall.fez

RS2 Analysis Information

Project Summary

File Name:	south_seep D 3FT thick wall.fez
Last saved with RS2 version:	11.013
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	South of Seep D: Seepage Through 3FT Barrier Wall

General Settings

Number of Stages:	2
Analysis Type:	Plane Strain
Solver Type:	Gaussian Elimination
Units:	Imperial, stress as psf
Permeability Units:	feet/second
Time Units:	seconds

Analysis Options

Maximum Number of Iterations:	500
Tolerance:	0.001
Number of Load Steps:	Automatic
Convergence Type:	Comprehensive
Tensile Failure:	Reduces Shear Strength

Joint tension reduces joint stiffness by a factor of 0.01

Groundwater Analysis

Method:	Steady State
Pore Fluid Unit Weight:	62.4 lbs/ft3
Maximum Number of Iterations:	500
Tolerance:	0.001
Use Fluid Potential:	Yes
Use Improved Seepage:	No
Probability:	None

Field Stress

Field stress:	Gravity
Using actual ground surface	
Effective stress ratio (horizontal/vertical in-plane):	1
Effective stress ratio (horizontal/vertical out-of-plane):	1
Locked-in horizontal stress (in-plane):	0
Locked-in horizontal stress (out-of-plane):	0

Mesh

Mesh type:	Graded	
Element type:	6 Noded triangles	
Stage Name	**# of Elements**	**# of Nodes**
1. Initial Conditions	7013	14322
2. Pumping	7013	14322

Mesh Quality

All elements are of good quality

Poor quality elements defined as:

Side length ratio (maximum / minimum) > 30.00
Minimum interior angle < 2.0 degrees
Maximum interior angle > 175.0 degrees

Material Properties

Surficial Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	300000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Confining Unit Clay

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	400000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	26 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	6.56e-08 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Black Creek Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	600000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	34 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.38
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Upper Cape Fear Clay (light gray)

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-09 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Wall

Material Color	■
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	417709 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	0 degrees
Peak Cohesion	350 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.1
Ks	3.28e-08 ft/s
K2 / K1	1
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	General

Displacements

Displacement data is not available for 1. Initial Conditions until total displacement is viewed in a window
Displacement data is not available for 2. Pumping until total displacement is viewed in a window

Yielded Elements

List of All Coordinates

External boundary

X	Y
-100	-40
100	-40
100	-4
100	27
100	57
100	71
100	72.23
39.88	72.23
36.92	73.23
33.96	74.23
31	75.23
28.04	76.23
25.07	77.23
22.1	78.23
11.4	79.23
1.5	79.4645
-1.5	79.5361
-30.57	80.23
-33.48	81.23
-36.45	82.23
-39.4	83.23
-42.43	84.23
-45.4	85.23
-48.39	86.23
-51.38	87.23
-51.97	87.42
-56.61	88.23
-67.1	90.23
-78.36	92.23
-88.22	94.23
-95.57	96.23
-100	97.08
-100	71
-100	64.38
-100	57
-100	27
-100	-4

Material boundary

X	Y
-100	71
-1.5	71
1.5	71
100	71

Material boundary

X	Y
-100	57
-1.5	57
1.5	57
100	57

Material boundary

X	Y
-100	27
-1.5	27
1.5	27
100	27

Material boundary

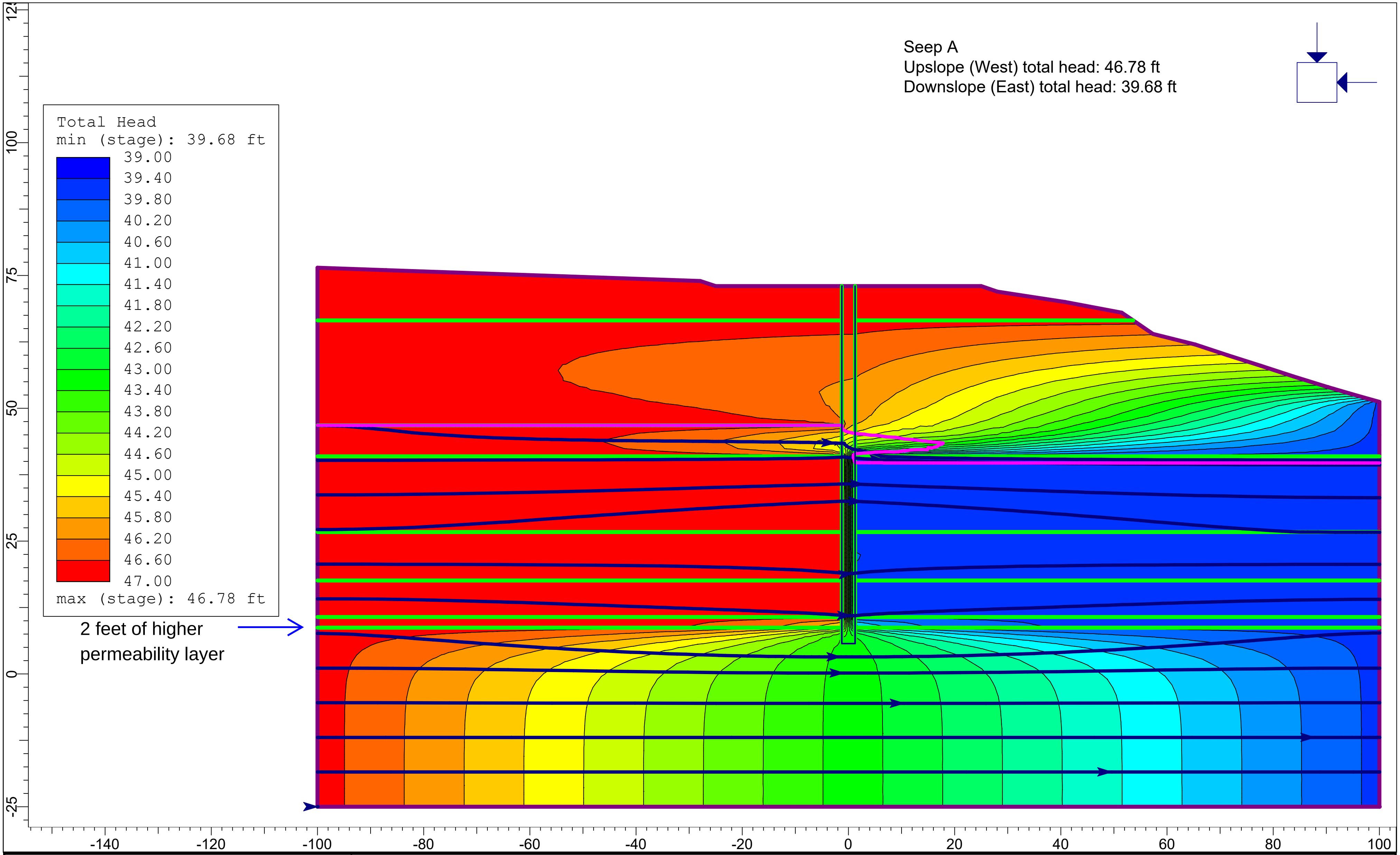
X	Y
-100	-4
-1.5	-4
1.5	-4
100	-4

Material boundary

X	Y
-1.5	79.5361
-1.5	71
-1.5	64.38
-1.5	57
-1.5	27
-1.5	-4
-1.5	-9
1.5	-9
1.5	-4
1.5	27
1.5	57
1.5	71
1.5	79.4645

Material boundary

X	Y
-100	64.38
-1.5	64.38



Seep A
Upslope (West) total head: 46.78 ft
Downslope (East) total head: 39.68 ft

2 feet of higher
permeability layer

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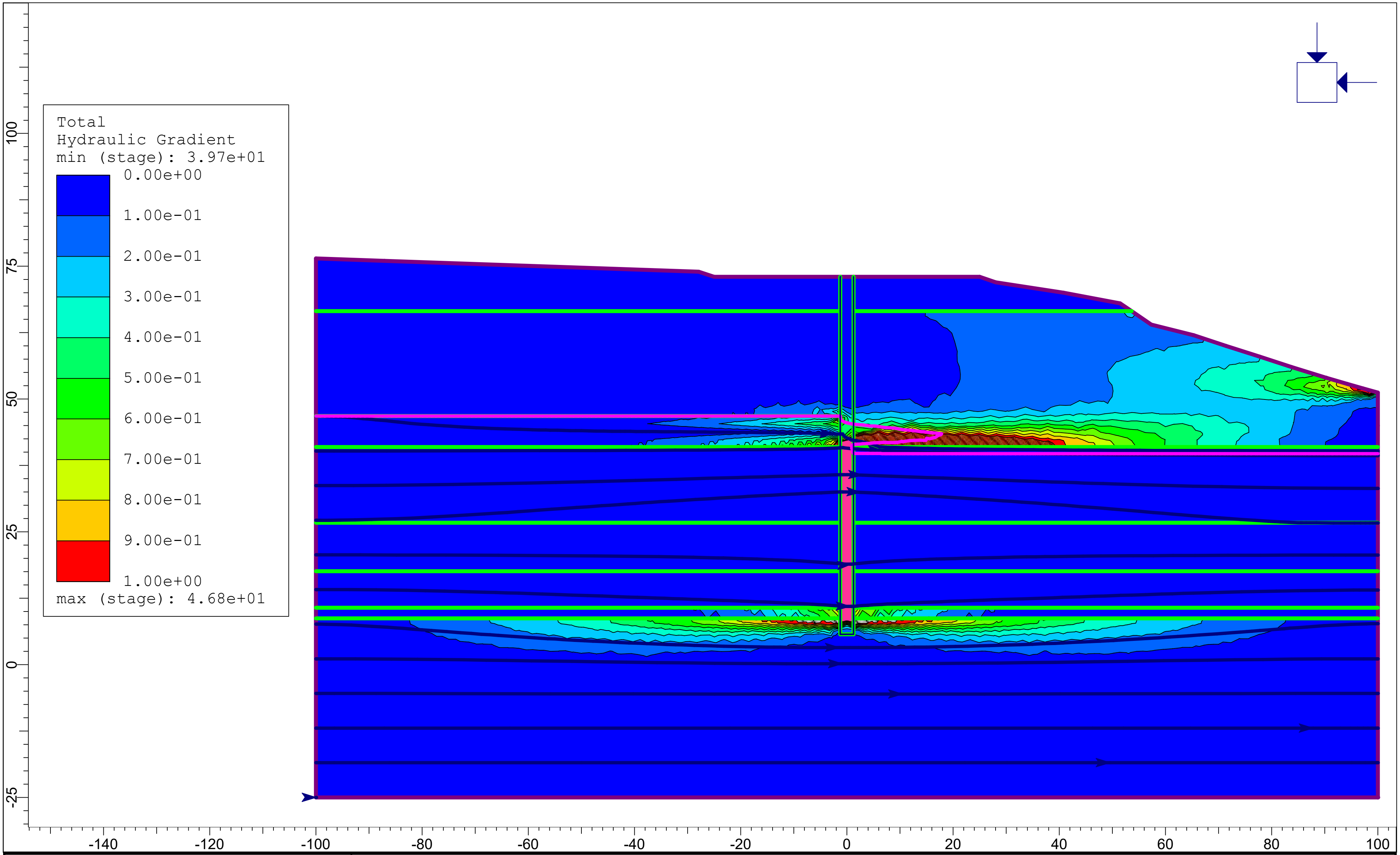
Project	45-20803 Barrier Wall Road Interim Design and Repair				
Analysis Description	Seep A: Parametric Study, 2 Orders Higher Permeability over 2ft				
Drawn By		*Scale*	1:300	*Company*	
Date				*File Name*	seep-A-Parametric-2orders_2.5FT.fez

INTERPRET 11.013



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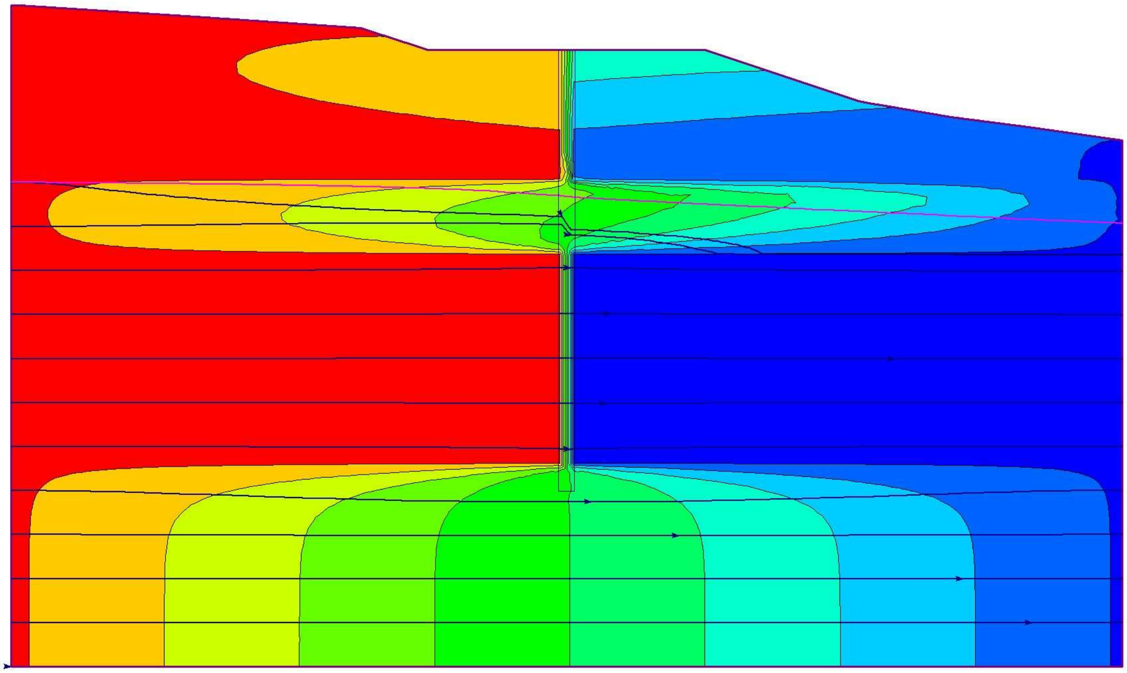
INTERPRET 11.013

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis Description	Seep A: Parametric Study, 2 Orders Higher Permeability over 2ft		
Drawn By	*Scale* 1:300	*Company*	
Date		*File Name*	seep-A-Parametric-2orders_2.5FT.fez



Seep A Parameteric Study 2 Orders of Magnitude Higher Permeability Over Top 2ft
45-20803 Barrier Wall Road Interim Design and Repair
Barrier Wall Width: 2.5 Feet
Software Version: 11.013

Table of Contents

seep-A-Parametric-2orders_2.5FT.fez

RS2 Analysis Information

Project Summary

File Name:	seep-A-Parametric-2orders_2.5FT.fez
Last saved with RS2 version:	11.013
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Seep A: Parametric Study, 2 Orders Higher Permeability over 2ft

General Settings

Number of Stages:	2
Analysis Type:	Plane Strain
Solver Type:	Gaussian Elimination
Units:	Imperial, stress as psf
Permeability Units:	feet/second
Time Units:	seconds

Analysis Options

Maximum Number of Iterations: 500
Tolerance: 0.001
Number of Load Steps: Automatic
Convergence Type: Comprehensive
Tensile Failure: Reduces Shear Strength
Joint tension reduces joint stiffness by a factor of 0.01

Groundwater Analysis

Method:	Steady State
Pore Fluid Unit Weight:	62.4 lbs/ft3
Maximum Number of Iterations:	500
Tolerance:	0.001
Use Fluid Potential:	Yes
Use Improved Seepage:	No
Probability:	None

Field Stress

Field stress:	Gravity
Using actual ground surface	
Effective stress ratio (horizontal/vertical in-plane):	1
Effective stress ratio (horizontal/vertical out-of-plane):	1
Locked-in horizontal stress (in-plane):	0
Locked-in horizontal stress (out-of-plane):	0

Mesh

Mesh type:	Graded	
Element type:	6 Noded triangles	
Stage Name	**# of Elements**	**# of Nodes**
1. Initial Conditions	7193	14736
2. Pumping	7193	14736

Mesh Quality

1 of 7193 Elements (0.0 % of elements) are poor quality elements
1 of 7193 Elements (0.0 % of elements) are poor quality elements because of the side length ratio
1 of 7193 Elements (0.0 % of elements) are poor quality elements because of the minimum interior angle
0 of 7193 Elements (0.0 % of elements) are poor quality elements because of the maximum interior angle
0 of 7193 Elements (0.0 % of elements) are poor quality elements because they are inverted
Note: Elements can be of poor quality for more than one reason

Poor quality elements defined as:

Side length ratio (maximum / minimum) > 30.00
Minimum interior angle < 2.0 degrees
Maximum interior angle > 175.0 degrees

Material Properties

Surficial Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	300000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Confining Unit Clay

Material Color	🟫
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	400000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	26 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	6.56e-08 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Black Creek Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	600000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	34 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.38
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Silty Sand

Material Color	▥
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	500000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	30 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.52
Ks	3.31e-05 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Upper Cape Fear Clay (light gray)

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-09 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Wall

Material Color	🟥
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	417709 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	0 degrees
Peak Cohesion	350 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.1
Ks	3.28e-08 ft/s
K2 / K1	1
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	General

Uncertain Boundary

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-07 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Displacements

Displacement data is not available for 1. Initial Conditions until total displacement is viewed in a window
Displacement data is not available for 2. Pumping until total displacement is viewed in a window

Yielded Elements

List of All Coordinates

External boundary

X	Y
100	-25
100	8.69
100	10.69
100	17.59
100	26.69
100	40.95
100	45
100	51.18
97.1513	52.0039
94.2607	52.84
90.2502	54
90.2367	54.0039
83.7772	56.0039
77.6695	58.0039
71.363	60.0039
65.3217	62.0039
57.3492	64.0039
53.6405	66.52
51.4532	68.0039
40.8533	70.0039
28.0437	71.9548
25	72.9694
1.25	72.9694
-1.25	72.9694
-25	72.9694
-27.9168	73.9417
-87.0888	76.0039
-100	76.4539
-100	66.52
-100	46.78
-100	40.95
-100	26.69
-100	17.59
-100	10.69
-100	8.69
-100	-25

Material boundary

X	Y
-1.25	72.9694
-1.25	66.52
-1.25	46.78
-1.25	40.95
-1.25	26.69
-1.25	17.59
-1.25	10.69
-1.25	8.69
-1.25	5.69
1.25	5.69
1.25	8.69
1.25	10.69
1.25	17.59
1.25	26.69
1.25	40.95
1.25	66.52
1.25	72.9694

Material boundary

X	Y
-100	66.52
-1.25	66.52

Material boundary

X	Y
1.25	66.52
53.6405	66.52

Material boundary

X	Y
-100	40.95
-1.25	40.95

Material boundary

X	Y
-100	26.69
-1.25	26.69

Material boundary

X	Y
-100	17.59
-1.25	17.59

Material boundary

X	Y
-100	10.69
-1.25	10.69

Material boundary

X	Y
1.25	40.95
100	40.95

Material boundary

X	Y
1.25	26.69
100	26.69

Material boundary

X	Y
1.25	17.59
100	17.59

Material boundary

X	Y
1.25	10.69
100	10.69

Material boundary

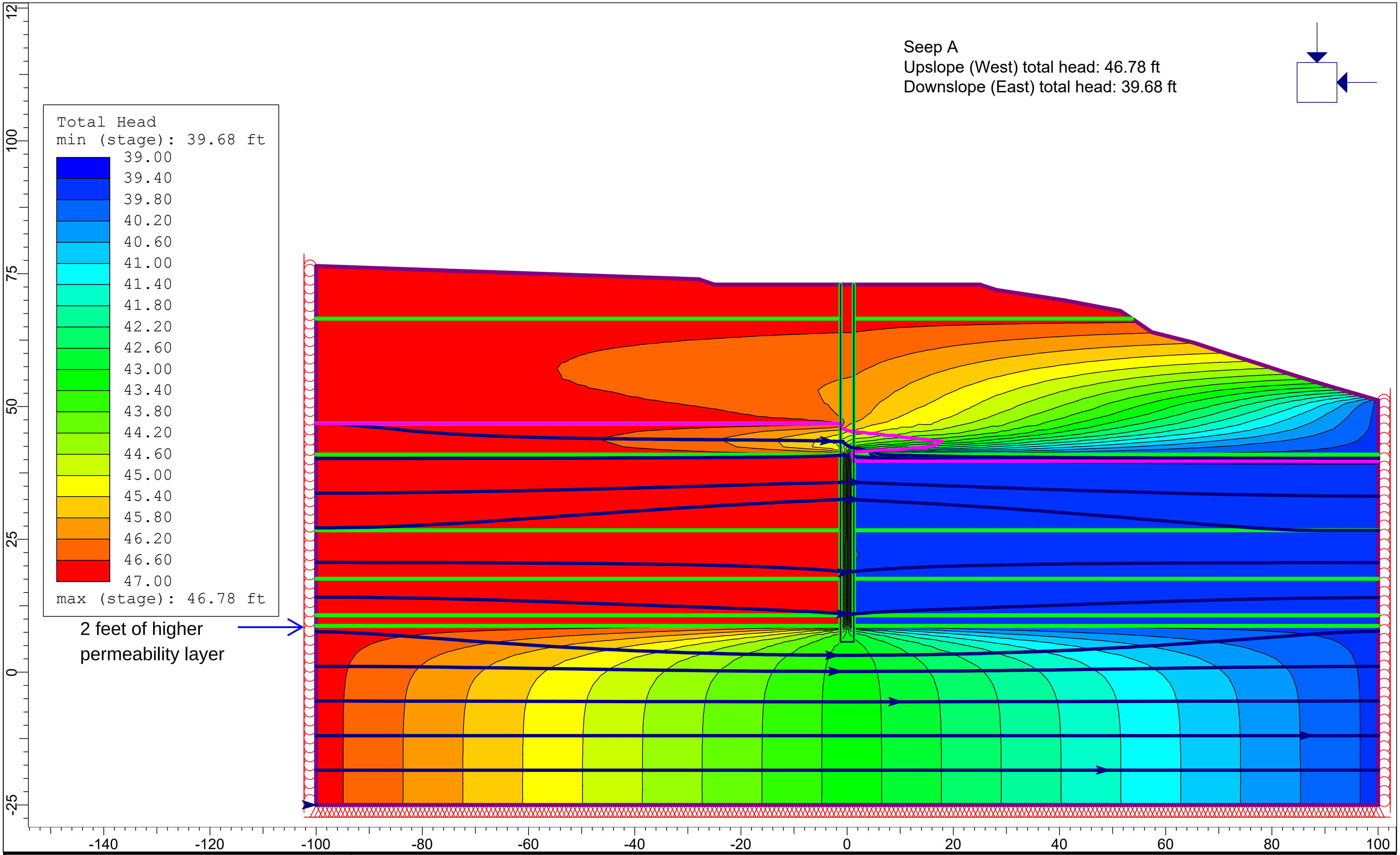
X	Y
-100	46.78
-1.25	46.78

Material boundary

X	Y
-100	8.69
-1.25	8.69

Material boundary

X	Y
100	8.69
1.25	8.69



Seep A
Upslope (West) total head: 46.78 ft
Downslope (East) total head: 39.68 ft

2 feet of higher
permeability layer

Universal
Engineering
Sciences
Geotechnical, Environmental and Materials Engineers

INTERPRET 11.013

Project
45-20803 Barrier Wall Road Interim Design and Repair

Analysis Description
Seep A: Parametric Study, 4 Orders Higher Permeability over 2ft

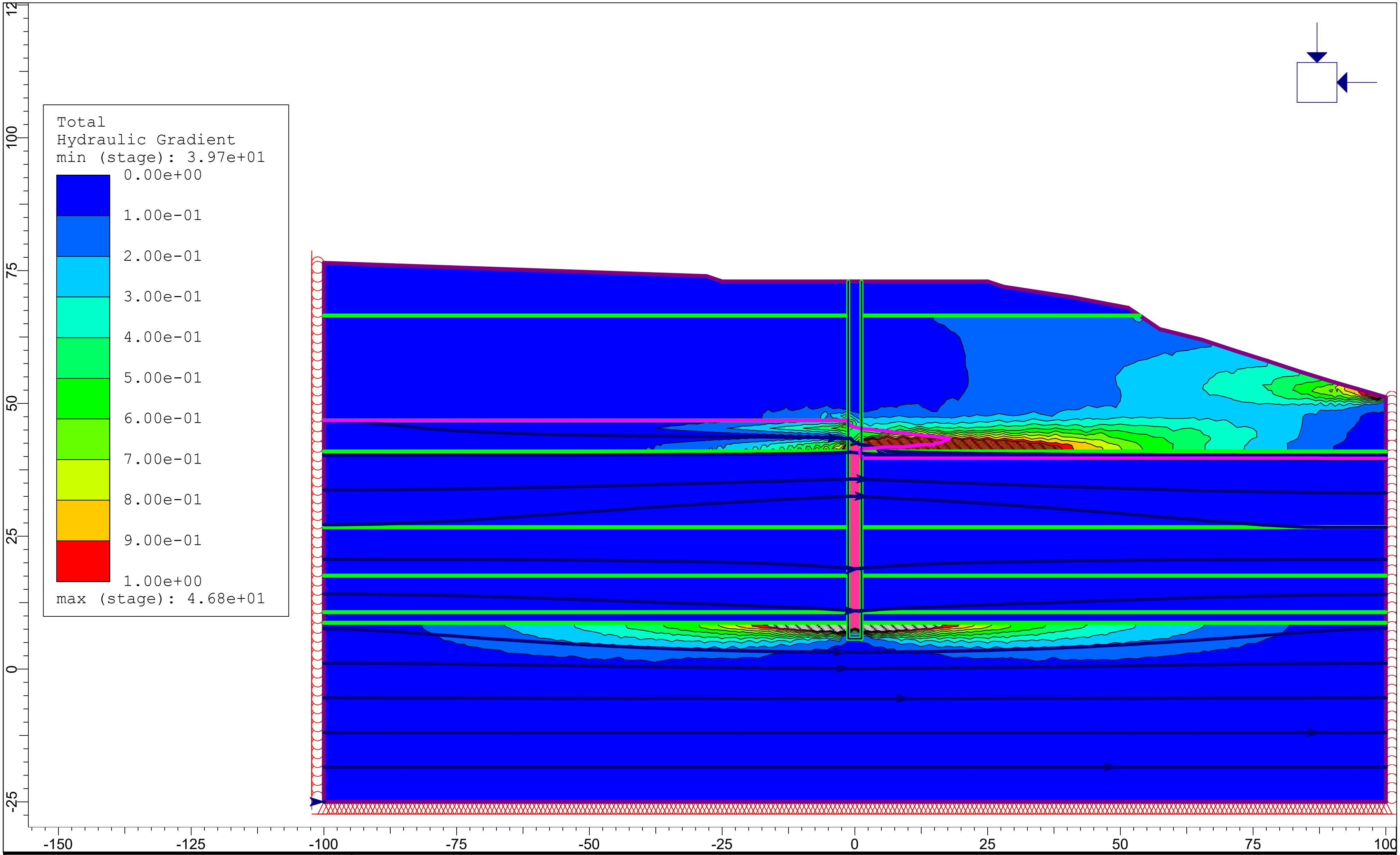
Drawn By

Scale 1:300

Company

Date

File Name seep-A-Parametric-4orders_2.5FT.fez



GEOS Universal Engineering Sciences
Geotechnical, Environmental and Materials Engineers

INTERPRET 11.013

Project
45-20803 Barrier Wall Road Interim Design and Repair

Analysis Description
Seep A: Parametric Study, 4 Orders Higher Permeability over 2ft

Drawn By

Scale 1:300

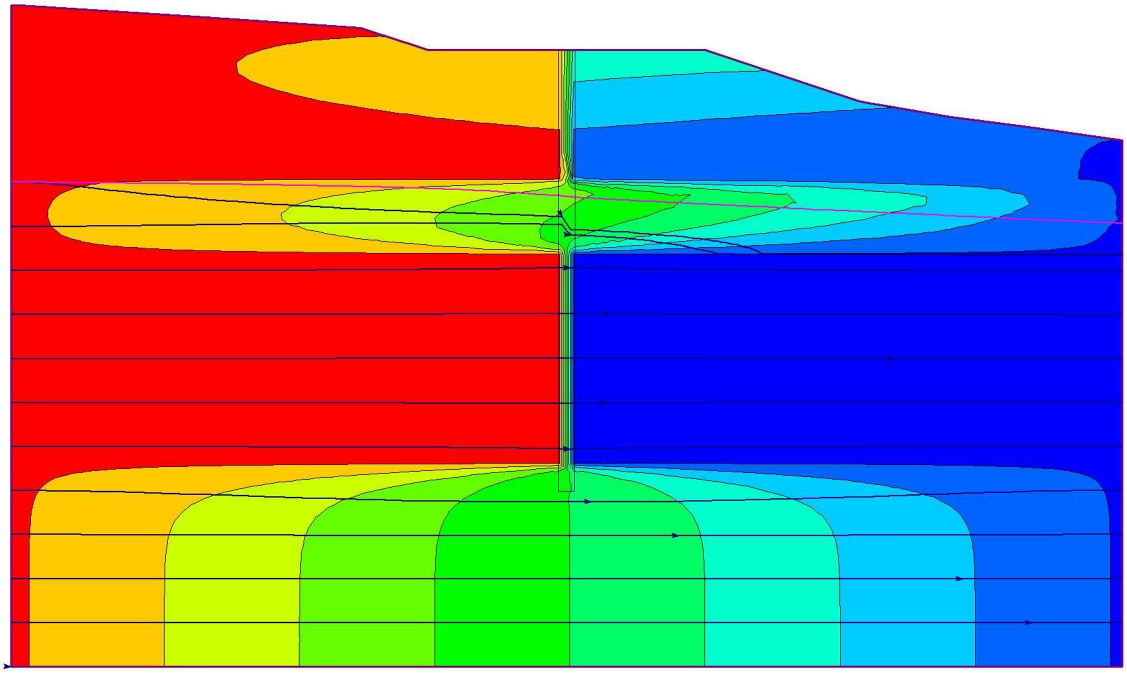
Company

Date

File Name seep-A-Parametric-4orders_2.5FT.fez

Geotechnical, Environmental and Materials Engineers

Universal
Engineering
Sciences



Seep A Parameteric Study 4 Orders of Magnitude Higher Permeability Over Top 2 ft
45-20803 Barrier Wall Road Interim Design and Repair
Barrier Wall Width: 2.5 Feet
Software Version: 11.013

Table of Contents

seep-A-Parametric-4orders_2.5FT.fez

RS2 Analysis Information

Project Summary

File Name:	seep-A-Parametric-4orders_2.5FT.fez
Last saved with RS2 version:	11.013
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Seep A: Parametric Study, 4 Orders Higher Permeability over 2ft

General Settings

Number of Stages:	2
Analysis Type:	Plane Strain
Solver Type:	Gaussian Elimination
Units:	Imperial, stress as psf
Permeability Units:	feet/second
Time Units:	seconds

Analysis Options

Maximum Number of Iterations: 500
Tolerance: 0.001
Number of Load Steps: Automatic
Convergence Type: Comprehensive
Tensile Failure: Reduces Shear Strength
Joint tension reduces joint stiffness by a factor of 0.01

Groundwater Analysis

Method:	Steady State
Pore Fluid Unit Weight:	62.4 lbs/ft3
Maximum Number of Iterations:	500
Tolerance:	0.001
Use Fluid Potential:	Yes
Use Improved Seepage:	No
Probability:	None

Field Stress

Field stress:	Gravity
Using actual ground surface	
Effective stress ratio (horizontal/vertical in-plane):	1
Effective stress ratio (horizontal/vertical out-of-plane):	1
Locked-in horizontal stress (in-plane):	0
Locked-in horizontal stress (out-of-plane):	0

Mesh

Mesh type: Graded

Element type: 6 Noded triangles

Stage Name	# of Elements	# of Nodes
1. Initial Conditions	7193	14736
2. Pumping	7193	14736

Mesh Quality

1 of 7193 Elements (0.0 % of elements) are poor quality elements
1 of 7193 Elements (0.0 % of elements) are poor quality elements because of the side length ratio
1 of 7193 Elements (0.0 % of elements) are poor quality elements because of the minimum interior angle
0 of 7193 Elements (0.0 % of elements) are poor quality elements because of the maximum interior angle
0 of 7193 Elements (0.0 % of elements) are poor quality elements because they are inverted
Note: Elements can be of poor quality for more than one reason

Poor quality elements defined as:

Side length ratio (maximum / minimum) > 30.00
Minimum interior angle < 2.0 degrees
Maximum interior angle > 175.0 degrees

Material Properties

Surficial Aquifer Sand

Material Color	░
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	300000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Confining Unit Clay

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	400000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	26 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.4
Ks	6.56e-08 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Black Creek Aquifer Sand

Material Color	🟨
Initial Element Loading	Field Stress and Body Force
Unit Weight	115 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	600000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	34 degrees
Peak Cohesion	0 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.38
Ks	0.000331 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Black Creek Silty Sand

Material Color	▥
Initial Element Loading	Field Stress and Body Force
Unit Weight	120 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	500000 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	30 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.52
Ks	3.31e-05 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Sand

Upper Cape Fear Clay (light gray)

Material Color	▨
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-09 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Wall

Material Color	🟥
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	417709 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	0 degrees
Peak Cohesion	350 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.1
Ks	3.28e-08 ft/s
K2 / K1	1
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	General

Uncertain Boundary

Material Color	▒
Initial Element Loading	Field Stress and Body Force
Unit Weight	130 lbs/ft3
Initial Water Condition	Interpolated
Elastic Type	Isotropic
Poisson's Ratio	0.3
Young's Modulus	1e+06 psf
Failure Criterion	Mohr-Coulomb
Material Type	Elastic
Peak Tensile Strength	0 psf
Peak Friction Angle	28 degrees
Peak Cohesion	100 psf
Use Unsaturated Parameters	No
Material Behaviour	Drained
Porosity Value	0.35
Ks	9.84e-05 ft/s
K2 / K1	0.01
K1 Definition	Angle
K1 Angle	0 degrees
Soil Type	Clay

Displacements

Displacement data is not available for 1. Initial Conditions until total displacement is viewed in a window
Displacement data is not available for 2. Pumping until total displacement is viewed in a window

Yielded Elements

List of All Coordinates

External boundary

X	Y
100	-25
100	8.69
100	10.69
100	17.59
100	26.69
100	40.95
100	45
100	51.18
97.1513	52.0039
94.2607	52.84
90.2502	54
90.2367	54.0039
83.7772	56.0039
77.6695	58.0039
71.363	60.0039
65.3217	62.0039
57.3492	64.0039
53.6405	66.52
51.4532	68.0039
40.8533	70.0039
28.0437	71.9548
25	72.9694
1.25	72.9694
-1.25	72.9694
-25	72.9694
-27.9168	73.9417
-87.0888	76.0039
-100	76.4539
-100	66.52
-100	46.78
-100	40.95
-100	26.69
-100	17.59
-100	10.69
-100	8.69
-100	-25

Material boundary

X	Y
-1.25	72.9694
-1.25	66.52
-1.25	46.78
-1.25	40.95
-1.25	26.69
-1.25	17.59
-1.25	10.69
-1.25	8.69
-1.25	5.69
1.25	5.69
1.25	8.69
1.25	10.69
1.25	17.59
1.25	26.69
1.25	40.95
1.25	66.52
1.25	72.9694

Material boundary

X	Y
-100	66.52
-1.25	66.52

Material boundary

X	Y
1.25	66.52
53.6405	66.52

Material boundary

X	Y
-100	40.95
-1.25	40.95

Material boundary

X	Y
-100	26.69
-1.25	26.69

Material boundary

X	Y
-100	17.59
-1.25	17.59

Material boundary

X	Y
-100	10.69
-1.25	10.69

Material boundary

X	Y
1.25	40.95
100	40.95

Material boundary

X	Y
1.25	26.69
100	26.69

Material boundary

X	Y
1.25	17.59
100	17.59

Material boundary

X	Y
1.25	10.69
100	10.69

Material boundary

X	Y
-100	46.78
-1.25	46.78

Material boundary

X	Y
-100	8.69
-1.25	8.69

Material boundary

X	Y
100	8.69
1.25	8.69

Attachments

Redi Rock Retaining Wall Calculations

Redi-Rock Wall Case Soil Conditions (cont)

Wall Number	Section Number	Soil Layer	Soil Type	Internal Friction Angle (°)	Cohesion (PSF)	Unit Weight (PCF)
1	3	1	Perched Clay (Drained)	24	200	110
		2	Surficial Aquifer	32	75	115
2	4	1	Perched Clay (Drained)	24	200	110
		2	Surficial Aquifer	32	75	115
3	4	1	Light Gray Sand	32	50	115
		2	Dark Gray Clay (Drained)	25	200	120
		3	Perched Clay (Drained)	24	200	110
4	5	1	Perched Clay (Drained)	24	200	110
5	5	1	Dark Gray Clay (Drained)	25	200	120
		2	Light Gray Sand	32	50	115
6	6	1	Dark Gray Clay (Drained)	25	200	120
		2	Light Gray Sand	32	50	115
7	6	1	Light Brown Sand	32	75	110
		2	Dark Gray Clay (Drained)	25	200	120

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Redi-Rock Wall Case Soil Conditions

Wall Number	Section Number	Soil Layer	Soil Type	Internal Friction Angle (°)	Cohesion (PSF)	Unit Weight (PCF)
8	6	1	Black Creek Confining Layer	26	125	120
9	6	1	Light Brown Sand	32	75	110
		2	Dark Gray Clay (Drained)	25	200	120
		3	Light Gray Sand	32	50	115
10	7	1	Dark Gray Clay (Drained)	25	200	120
		2	Light Gray Sand	32	50	115
11	7	1	Dark Gray Clay (Drained)	25	200	120
		2	Light Gray Sand	32	50	115
12	7	1	Dark Gray Clay (Drained)	25	200	120
		2	Light Gray Sand	32	50	115
13	7	1	Dark Gray Clay (Drained)	25	200	120
		2	Light Gray Sand	32	50	115

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Redi-Rock Wall Case Geometry Conditions

Wall Number	Backslope Condition	Toe Slope Condition	Loading Conditions	Loading Type
1	3H:1V	2.5H:1V	250 PSF	Traffic
2	3H:1V	1.75H:1V	250 PSF	Traffic
3	2H:1V	3.5H:1V	None	N/A
4	3H:1V	5H:1V	250 PSF	Traffic
			1600 PSF	Trencher (Static Loading)
			3200 PSF	Trencher (Dynamic Loading)
5	4H:1V	3H:1V	None	N/A
6	4H:1V	3H:1V	None	N/A
7	3H:1V	Flat	125 PSF	Light Traffic
8	3H:1V	3H:1V	250 PSF	Traffic
			1600 PSF	Trencher (Static Loading)
			3200 PSF	Trencher (Dynamic Loading)
9	5H:1V	3H:1V	None	N/A
10	Flat	Flat	250 PSF	Traffic
11	Flat	Flat	250 PSF	Traffic
12	Flat	Flat	250 PSF	Traffic
13	3H:1V	Flat	250 PSF	Traffic

WALL #1

MAX. WALL HEIGHT = 7.5 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #1
Description : H7.5
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

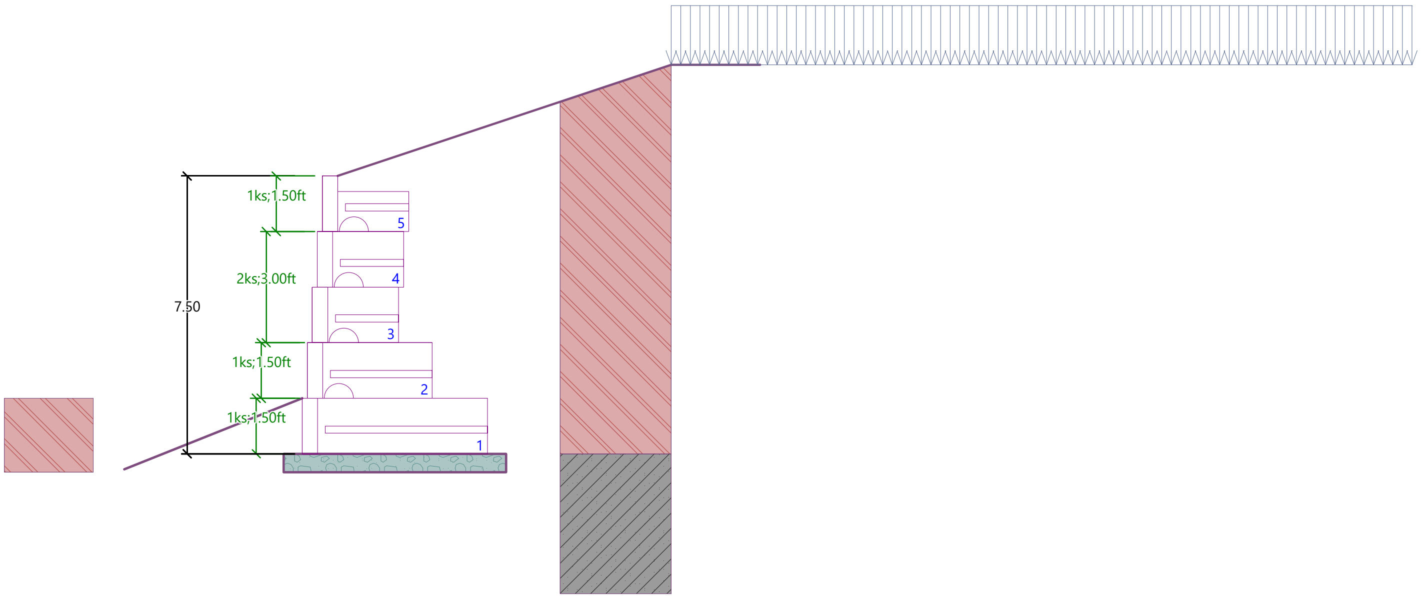
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 60	1	1.62
2	Block 41	1	1.62
3	Block 28	2	1.62
4	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 6.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	7.50	0.00 .. 7.50	Perched Clay (Drained)	▨
2	-	7.50 .. ∞	Surficial Aquifer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.00 ft, embankment length is 9.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [lbf/ft^2]	Mag.2 [lbf/ft^2]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
	new	change						
1	Yes		permanent	250.00		9.00	20.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -21.80 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.11	3065.6	2.51	1.000
FF resistance	-1515.3	-0.92	-606.1	0.35	1.000
Weight - earth wedge	0.0	-0.96	38.0	5.67	1.000
Weight - earth wedge	0.0	-5.11	892.4	3.82	1.000
Active pressure	1138.0	-2.28	966.6	5.38	1.000
Traffic	392.2	-3.34	357.8	4.96	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 18085.1 lbfft/ft
Overturning moment M_{ovr} = 2512.0 lbfft/ft

Safety factor = 7.20 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 3395.86 lbf/ft
Active horizontal force H_{act} = 14.97 lbf/ft

Safety factor = 226.82 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.65	1775.6	1.52	1.000
Weight - earth wedge	0.0	-2.27	115.7	2.84	1.000
Weight - earth wedge	0.0	-5.94	138.5	1.83	1.000
Active pressure	367.2	-1.71	238.0	3.16	1.000
Traffic	263.4	-1.76	183.0	3.05	1.000

Verification of most stressed block No. 2

Check for overturning stability

Resisting moment M_{res} = 4584.7 lbfft/ft
Overturning moment M_{ovr} = 1093.9 lbfft/ft

Safety factor = 4.19 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 8427.75 lbf/ft
Active horizontal force H_{act} = 630.62 lbf/ft

Safety factor = 13.36 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-1430.0	4714.36	14.97	0.000	785.7

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-1430.0	4714.36	14.97

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 785.7 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 7.64 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

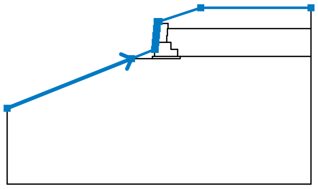
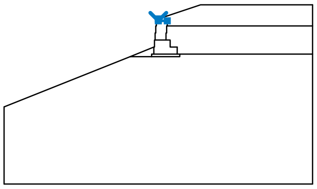
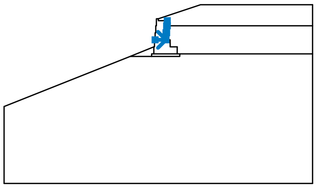
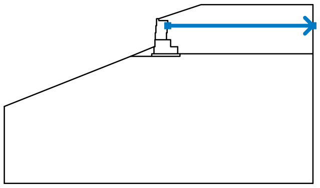
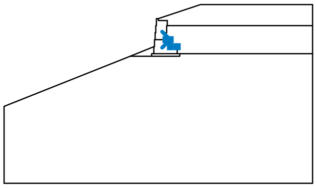
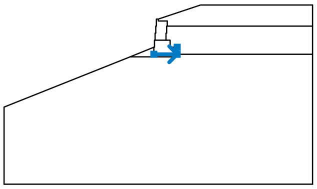
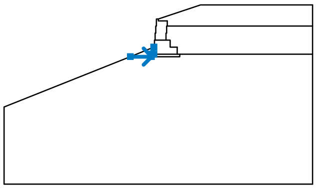
(input for current task)

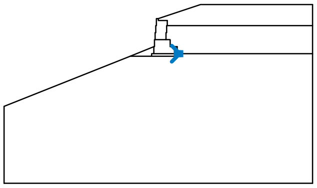
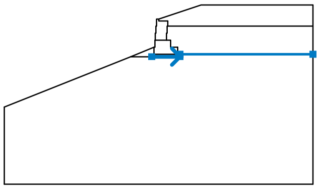
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-18.74	-5.96	-8.00	-0.96	-6.00
		-0.82	-6.00	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		9.00	3.00	32.80	3.00		
2		0.00	0.00	0.00	-0.42	1.92	-0.42
3		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
4		1.92	-1.50	32.80	-1.50		
5		1.65	-4.50	2.55	-4.50	2.55	-6.00
		4.04	-6.00				
6		-0.96	-7.50	4.04	-7.50	4.04	-6.00
7		-5.96	-8.00	-1.46	-8.00	-1.46	-7.50
		-0.96	-7.50	-0.96	-6.00		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
8		4.04	-7.50	4.54	-7.50		
9		-1.46	-8.00	4.54	-8.00	4.54	-7.50
		32.80	-7.50				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		
3	Surficial Aquifer	▨	120.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	Onsite Sands	▨	120.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

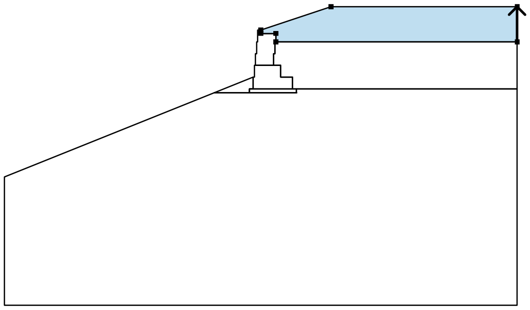
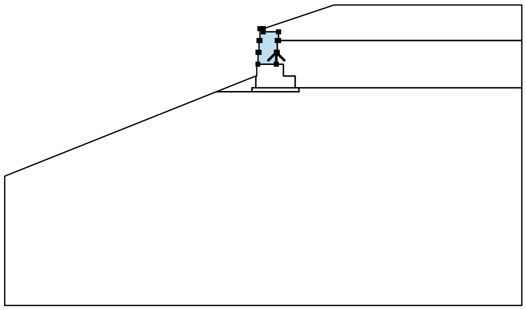
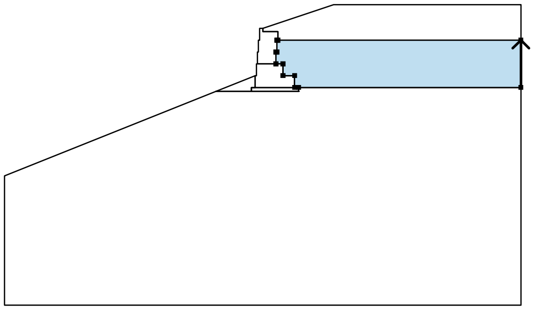
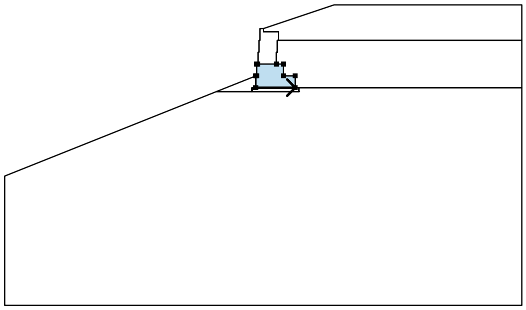
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

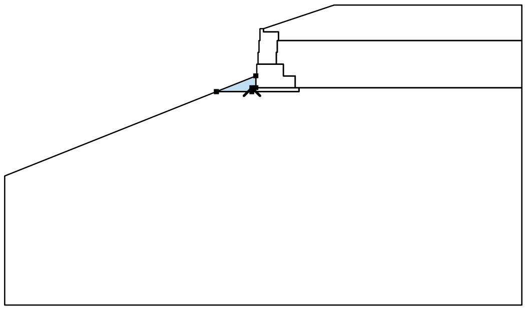
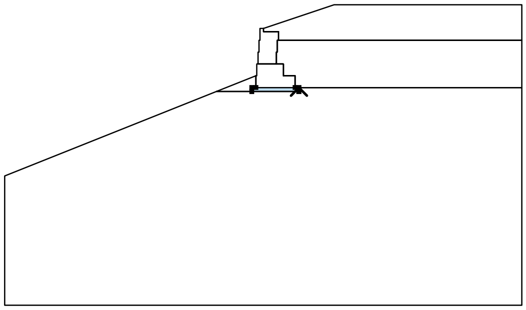
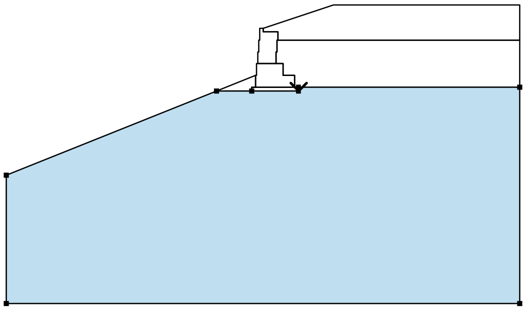
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		32.80	-1.50	32.80	3.00	Perched Clay (Drained)
		9.00	3.00	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		1.65	-4.50	1.65	-3.00	Material of structure
		1.78	-3.00	1.78	-1.50	▦
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	0.00	
		-0.42	0.00	-0.42	-1.50	
		-0.55	-1.50	-0.55	-3.00	
		-0.69	-3.00	-0.69	-4.50	
3		32.80	-7.50	32.80	-1.50	Perched Clay (Drained)
		1.92	-1.50	1.78	-1.50	▨
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	2.55	-4.50	
		2.55	-6.00	4.04	-6.00	
		4.04	-7.50	4.54	-7.50	
4		-0.96	-7.50	4.04	-7.50	Material of structure
		4.04	-6.00	2.55	-6.00	▦
		2.55	-4.50	1.65	-4.50	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
5		-1.46	-8.00	-1.46	-7.50	Perched Clay (Drained)
		-0.96	-7.50	-0.96	-6.00	▨
		-5.96	-8.00			
6		4.54	-8.00	4.54	-7.50	#57 Stone
		4.04	-7.50	-0.96	-7.50	▨
		-1.46	-7.50	-1.46	-8.00	
7		4.54	-7.50	4.54	-8.00	Surficial Aquifer
		-1.46	-8.00	-5.96	-8.00	▨
		-32.80	-18.74	-32.80	-35.14	
		32.80	-35.14	32.80	-7.50	

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 9.00	l = 20.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-10.27	[ft]	Angles :	α_1 =	-6.81	[°]
	z =	17.42	[ft]		α_2 =	59.85	[°]
Radius :	R =	28.71	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces :	F_a =	7941.6	lbf/ft
Sum of passive forces :	F_p =	12551.9	lbf/ft
Sliding moment :	M_a =	228004.3	lbfft/ft
Resisting moment :	M_p =	360364.5	lbfft/ft

Factor of safety = 1.58 > 1.50

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 6.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task	:	Chemours Barrier Wall Retaining Walls
Part	:	Wall #1
Description	:	H6
Author	:	GEOS
Date	:	1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

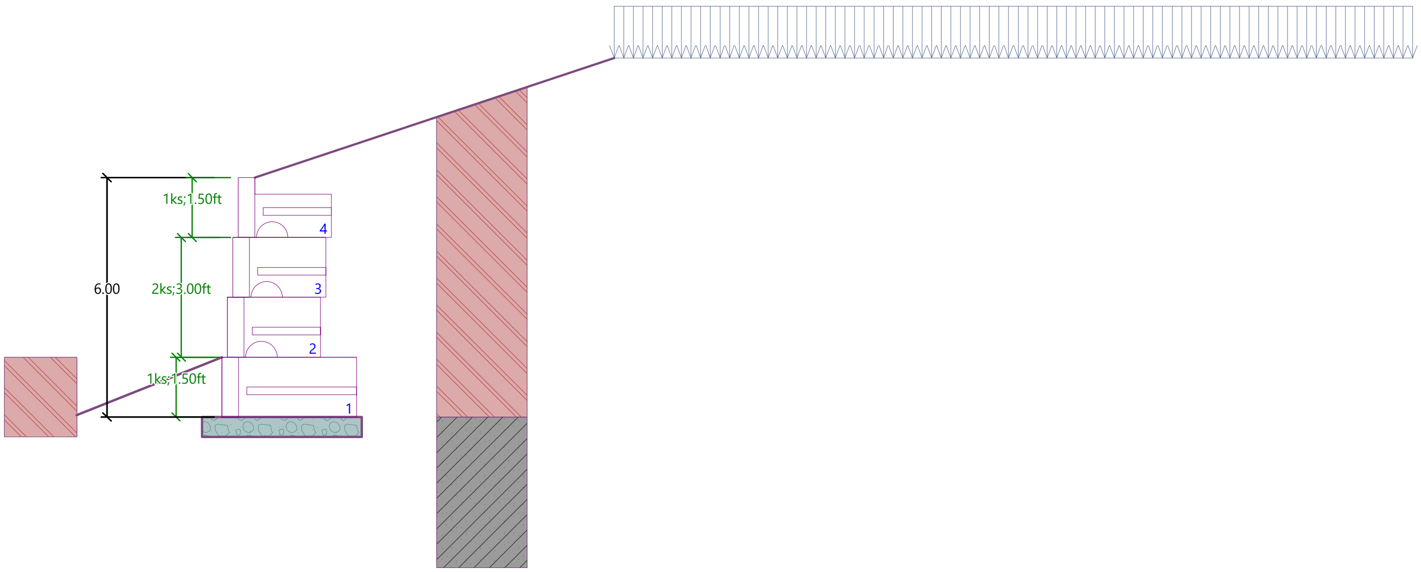
No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	1	1.62
2	Block 28	2	1.62
3	Top block 28	1	-

Name : Geometry

Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 4.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	6.00	0.00 .. 6.00	Perched Clay (Drained)	▨
2	-	6.00 .. ∞	Surficial Aquifer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.00 ft, embankment length is 9.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.00		9.00	20.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -21.80 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.84	1985.6	2.01	1.000
FF resistance	-1515.3	-0.92	-606.1	0.35	1.000
Weight - earth wedge	0.0	-0.64	2.9	3.92	1.000
Weight - earth wedge	0.0	-2.77	115.7	3.34	1.000
Weight - earth wedge	0.0	-6.44	138.5	2.33	1.000
Active pressure	503.9	-1.72	343.1	3.76	1.000
Traffic	282.9	-2.11	205.7	3.60	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 6535.5 lbfft/ft
Overturning moment M_{ovr} = 73.5 lbfft/ft

Safety factor = 88.92 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 1665.61 lbf/ft
Active horizontal force H_{act} = -728.45 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.65	1775.6	1.52	1.000
FF resistance	-666.2	-0.48	-266.5	0.00	1.000
Weight - earth wedge	0.0	-2.27	115.7	2.84	1.000
Weight - earth wedge	0.0	-5.94	138.5	1.83	1.000
Active pressure	367.2	-1.71	238.0	3.16	1.000
Traffic	263.4	-1.76	183.0	3.05	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 4584.7 lbfft/ft
Overturning moment M_{ovr} = 776.5 lbfft/ft

Safety factor = 5.90 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 1832.91 lbf/ft
Active horizontal force H_{act} = -35.58 lbf/ft

Safety factor = 1000.00 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-2091.2	2185.43	-728.45	0.000	546.4

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-2091.2	2185.43	-728.45

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 546.4 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 10.98 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

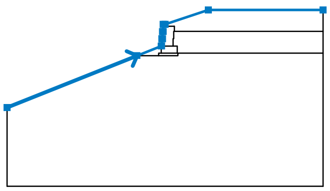
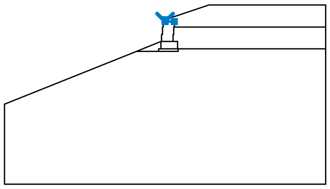
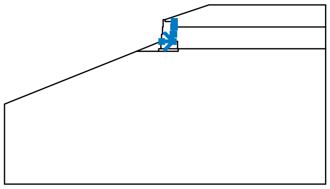
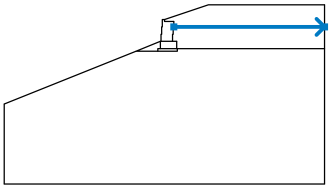
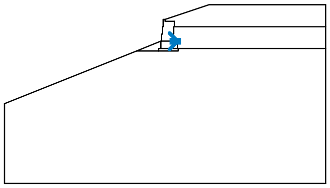
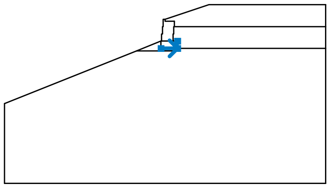
(input for current task)

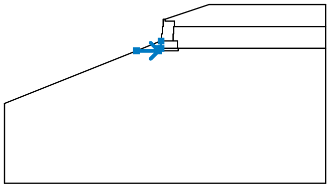
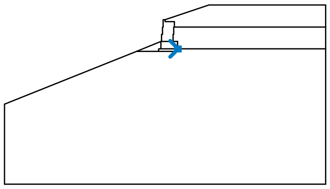
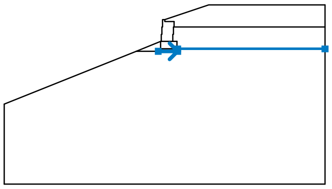
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-17.29	-5.82	-6.50	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	9.00	3.00	32.80	3.00
2		0.00	0.00	0.00	-0.42	1.92	-0.42
3		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
4		1.92	-1.50	32.80	-1.50		
5		1.65	-4.50	2.55	-4.50		
6		-0.82	-6.00	2.55	-6.00	2.55	-4.50

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
7		-5.82	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
8		2.55	-6.00	2.68	-6.00		
9		-1.32	-6.50	2.68	-6.50	2.68	-6.00
		32.80	-6.00				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	▩	120.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

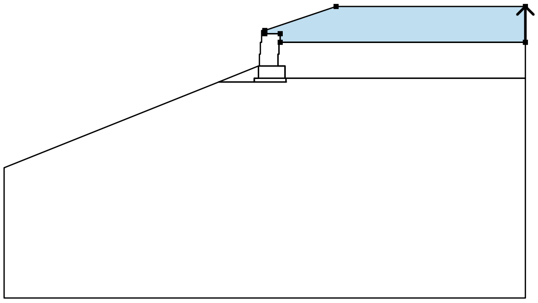
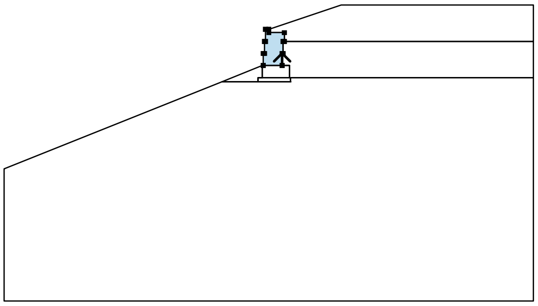
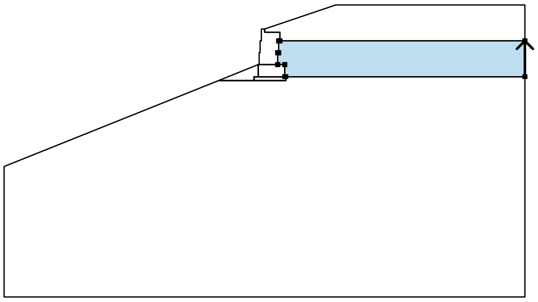
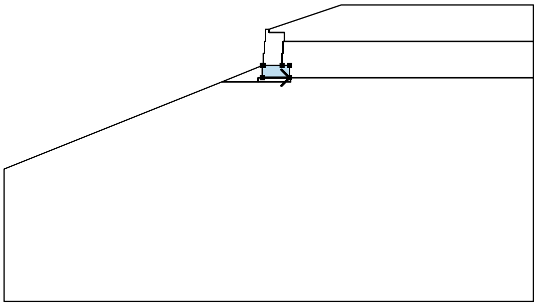
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

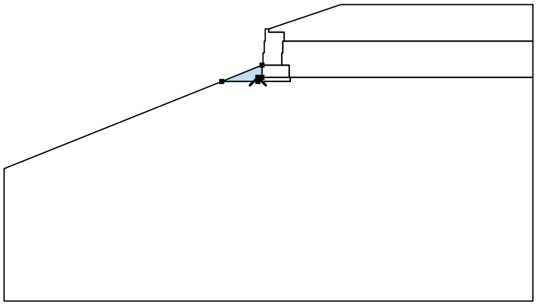
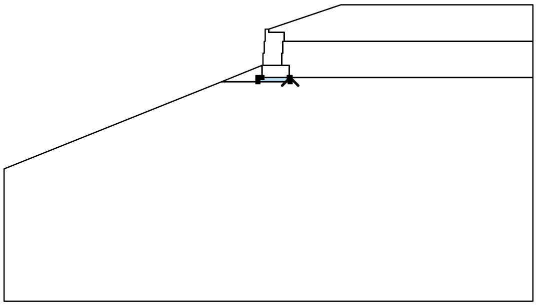
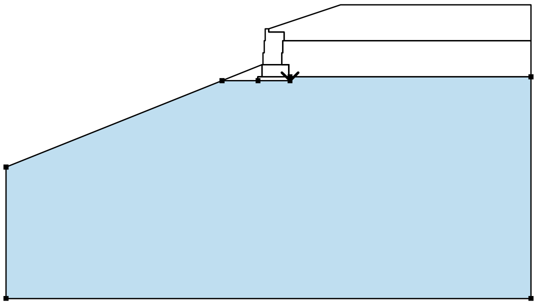
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		32.80	-1.50	32.80	3.00	Perched Clay (Drained)
		9.00	3.00	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		1.65	-4.50	1.65	-3.00	Material of structure
		1.78	-3.00	1.78	-1.50	▦
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	0.00	
		-0.42	0.00	-0.42	-1.50	
		-0.55	-1.50	-0.55	-3.00	
		-0.69	-3.00	-0.69	-4.50	
3		32.80	-6.00	32.80	-1.50	Perched Clay (Drained)
		1.92	-1.50	1.78	-1.50	▨
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	2.55	-4.50	
		2.55	-6.00	2.68	-6.00	
4		-0.82	-6.00	2.55	-6.00	Material of structure
		2.55	-4.50	1.65	-4.50	▦
		-0.69	-4.50	-0.82	-4.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
5		-1.32	-6.50	-1.32	-6.00	Perched Clay (Drained)
		-0.82	-6.00	-0.82	-4.50	▨
		-5.82	-6.50			
6		2.68	-6.50	2.68	-6.00	#57 Stone
		2.55	-6.00	-0.82	-6.00	▨
		-1.32	-6.00	-1.32	-6.50	
7		2.68	-6.00	2.68	-6.50	Surficial Aquifer
		-1.32	-6.50	-5.82	-6.50	▨
		-32.80	-17.29	-32.80	-33.69	
		32.80	-33.69	32.80	-6.00	

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 9.00	l = 20.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-11.07	[ft]	Angles :	α_1 =	-6.46	[°]
	z =	19.30	[ft]		α_2 =	56.34	[°]
Radius :	R =	29.41	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 6341.2 lbf/ft
Sum of passive forces : F_p = 11031.2 lbf/ft

Sliding moment : M_a = 186495.6 lbfft/ft
Resisting moment : M_p = 324428.0 lbfft/ft
Factor of safety = 1.74 > 1.50
Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 4.5 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #1
Description : H4.5
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

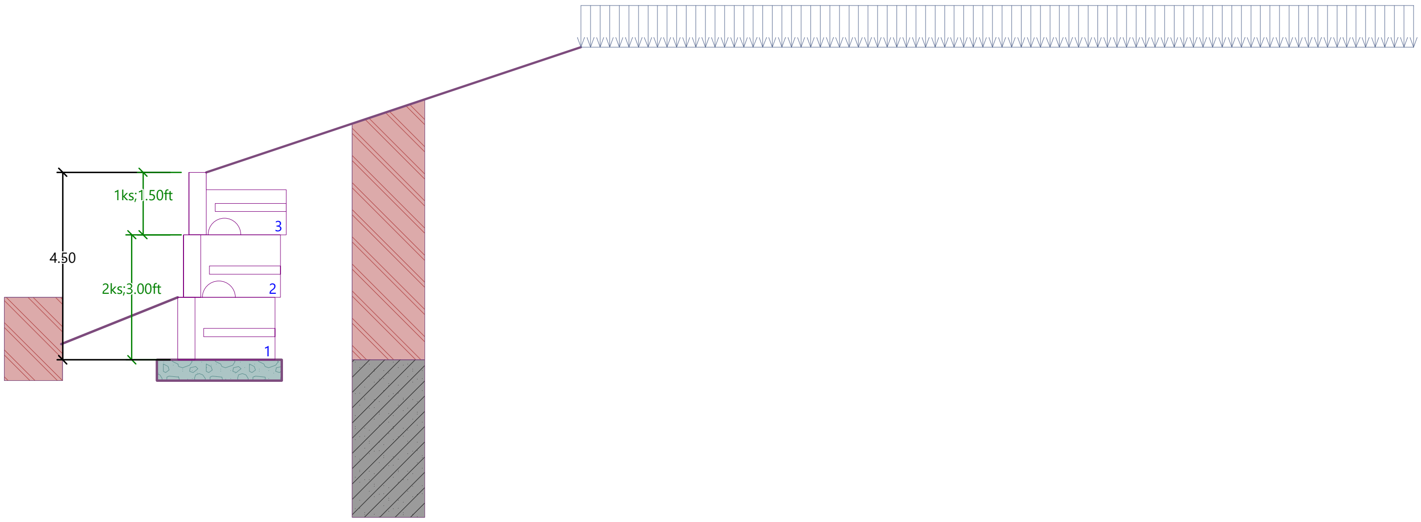
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28	2	1.62
2	Top block 28	1	-

Name : Geometry   Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	4.50	0.00 .. 4.50	Perched Clay (Drained)	▨
2	-	4.50 .. ∞	Surficial Aquifer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.00 ft, embankment length is 9.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.00		9.00	20.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -21.80 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.35	1325.6	1.76	1.000
FF resistance	-1515.3	-0.92	-606.1	0.35	1.000
Weight - earth wedge	0.0	-0.64	3.9	2.90	1.000
Weight - earth wedge	0.0	-4.94	138.5	2.20	1.000
Active pressure	131.5	-0.49	84.4	2.96	1.000
Traffic	105.4	-0.91	92.1	3.00	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 2956.4 lbfft/ft
Overturning moment M_{ovr} = -1231.1 lbfft/ft

Safety factor = 1000.00 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 873.89 lbf/ft
Active horizontal force H_{act} = -1278.37 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.13	1168.1	1.29	1.000
FF resistance	-666.2	-0.48	-266.5	0.00	1.000
Weight - earth wedge	0.0	-4.44	138.5	1.70	1.000
Active pressure	0.9	-0.06	0.2	2.34	1.000
Traffic	85.9	-0.62	66.1	2.50	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 1909.5 lbfft/ft
Overturning moment M_{ovr} = -264.5 lbfft/ft

Safety factor = 1000.00 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 928.44 lbf/ft
Active horizontal force H_{act} = -579.41 lbf/ft

Safety factor = 1000.00 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-2629.9	1038.44	-1278.37	0.000	346.1

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-2629.9	1038.44	-1278.37

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 346.1 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 17.33 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

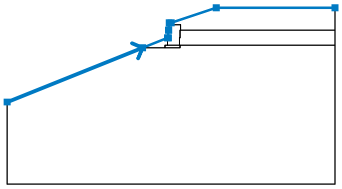
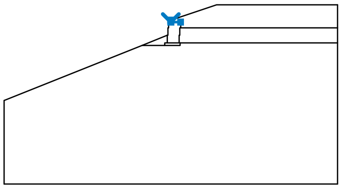
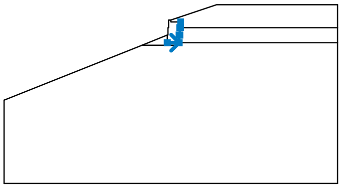
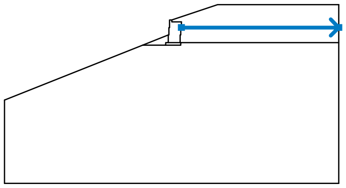
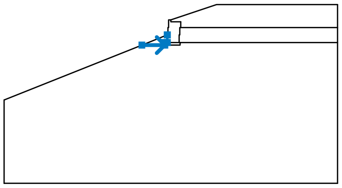
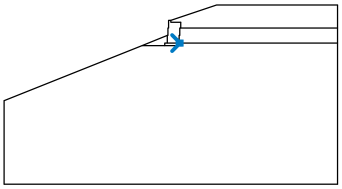
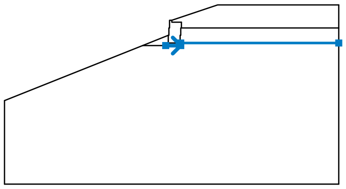
(input for current task)

Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF$_s$ =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-15.84	-5.69	-5.00	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	9.00	3.00
		32.80	3.00				
2		0.00	0.00	0.00	-0.42	1.92	-0.42
3		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
4		1.92	-1.50	32.80	-1.50		
5		-5.69	-5.00	-1.19	-5.00	-1.19	-4.50
		-0.69	-4.50	-0.69	-3.00		
6		1.65	-4.50	1.81	-4.50		
7		-1.19	-5.00	1.81	-5.00	1.81	-4.50
		32.80	-4.50				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▩	40.00	0.0	105.0
2	Perched Clay (Drained)	▧	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	◇	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▩	110.0		
2	Perched Clay (Drained)	▧	115.0		
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	◇	120.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

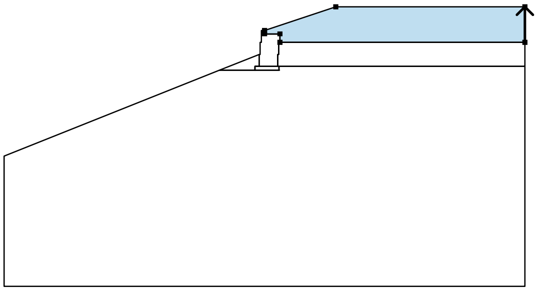
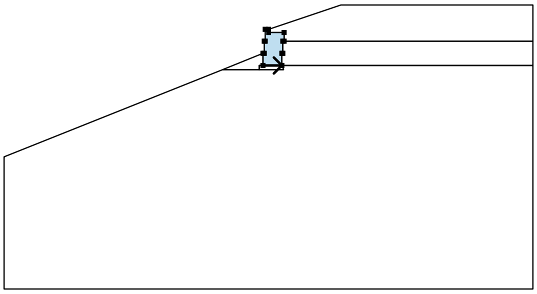
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

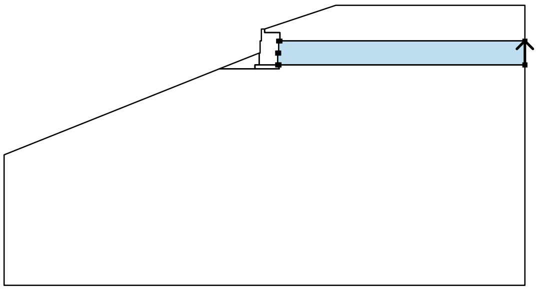
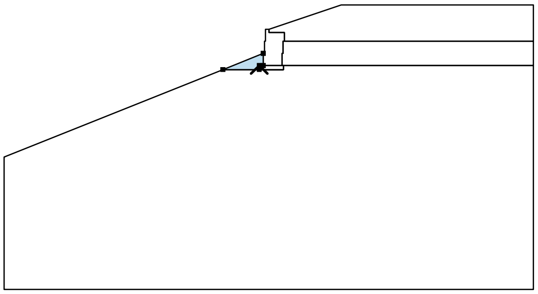
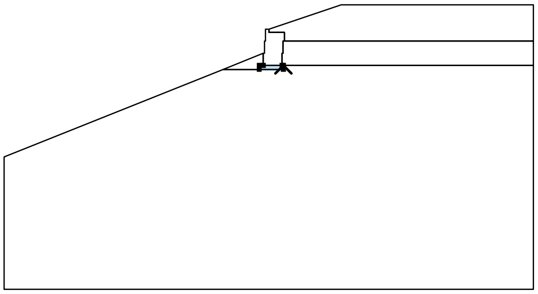
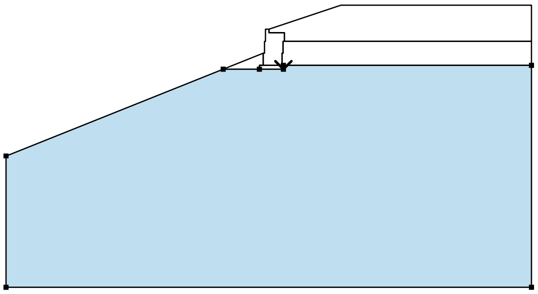
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		32.80	-1.50	32.80	3.00	Perched Clay (Drained)
		9.00	3.00	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-0.69	-4.50	1.65	-4.50	Material of structure
		1.65	-3.00	1.78	-3.00	▦
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		32.80	-4.50	32.80	-1.50	Perched Clay (Drained)
		1.92	-1.50	1.78	-1.50	▨
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.81	-4.50	
4		-1.19	-5.00	-1.19	-4.50	Perched Clay (Drained)
		-0.69	-4.50	-0.69	-3.00	▨
		-5.69	-5.00			
5		1.81	-5.00	1.81	-4.50	#57 Stone
		1.65	-4.50	-0.69	-4.50	▨
		-1.19	-4.50	-1.19	-5.00	
6		1.81	-4.50	1.81	-5.00	Surficial Aquifer
		-1.19	-5.00	-5.69	-5.00	▨
		-32.80	-15.84	-32.80	-32.24	
		32.80	-32.24	32.80	-4.50	

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 9.00	l = 20.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-27.22	[ft]	Angles :	α_1 =	-4.77	[°]
	z =	42.34	[ft]		α_2 =	47.36	[°]
Radius :	R =	58.08	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces :	F_a =	11304.7	lbf/ft
Sum of passive forces :	F_p =	21772.9	lbf/ft
Sliding moment :	M_a =	656577.7	lbfft/ft
Resisting moment :	M_p =	1264567.4	lbfft/ft

Factor of safety = 1.93 > 1.50

Slope stability ACCEPTABLE

WALL #2

MAX. WALL HEIGHT = 15.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #2
Description : H15
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

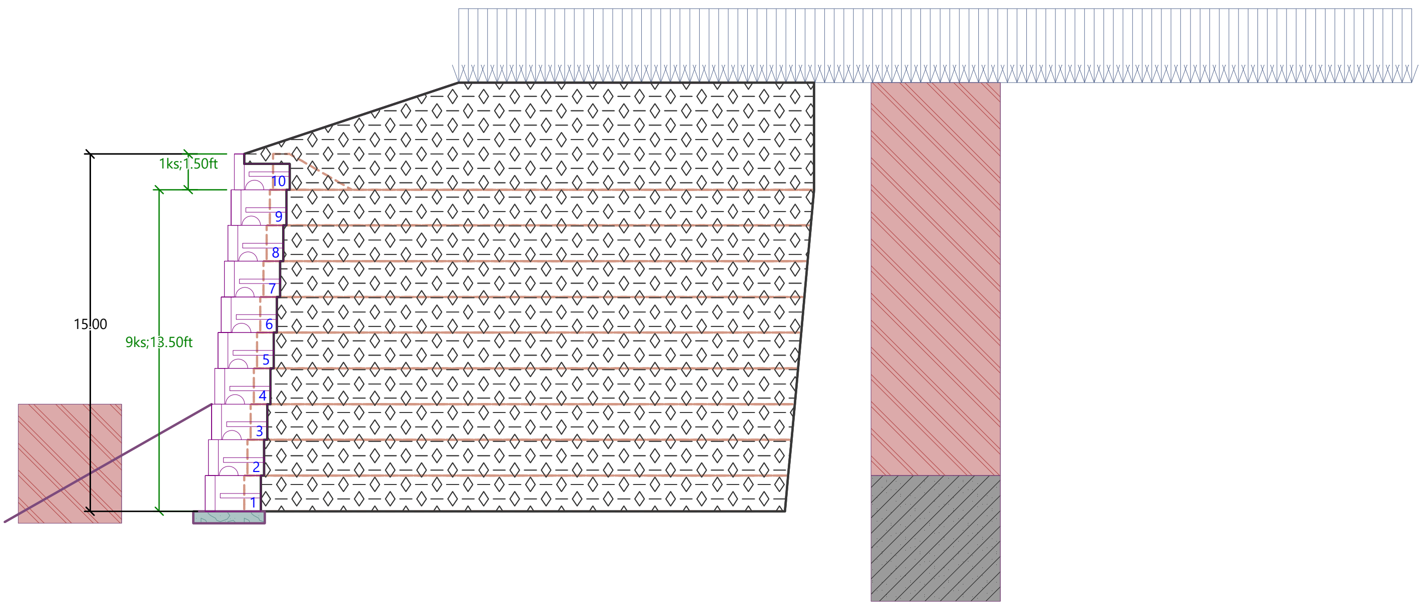
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	9	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	----------	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	=	7400.00	lbf/ft
Creep red. factor	RF_{CR}	=	1.58	
Durability red. factor	RF_D	=	1.15	
Installation damage red. factor	RF_{ID}	=	1.20	
Long-term design strength	R_t	=	3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	=	0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	=	0.67	
Scale correction factor	α	=	0.8	
Long-term strength reduction factor	CR_{cr}	=	0.532	
Calculation of long-term connection strength	R_{con}	=	3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 22.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	22.00	
2	Yes	Miragrid 8XT	22.00	
3	Yes	Miragrid 8XT	22.00	
4	Yes	Miragrid 8XT	22.00	
5	Yes	Miragrid 8XT	22.00	
6	Yes	Miragrid 8XT	22.00	
7	Yes	Miragrid 8XT	22.00	
8	Yes	Miragrid 8XT	22.00	
9	Yes	Miragrid 8XT	22.00	
10	Yes	Miragrid 8XT	22.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	13.50	0.00 .. 13.50	Perched Clay (Drained)	🟥
2	-	13.50 .. ∞	Surficial Aquifer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.00 ft, embankment length is 9.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		$[lbf/ft^2]$	$[lbf/ft^2]$	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.00		9.00	40.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 5.00 ft
Soil slope in front of structure β = -29.70 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-3676.9	-2.01	-2097.3	2.45	1.000
Weight - reinforced soil	0.0	-8.84	44845.7	14.20	1.000
Active pressure	2956.9	-4.38	1421.6	25.55	1.000
Traffic	1128.6	-7.19	666.8	25.55	1.000
Weight - wall	0.0	-7.33	4104.2	1.76	1.000
Traffic	0.0	-18.00	3729.2	18.09	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 759864.4 lbfft/ft
Overturning moment M_{ovr} = 13677.9 lbfft/ft

Safety factor = 55.55 > 2.00
Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 25980.80 lbf/ft
Active horizontal force H_{act} = 408.62 lbf/ft

Safety factor = 63.58 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-107984.4	4762.50	-14240.94	0.000	1587.5

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-107984.4	4762.50	-14240.94

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 1587.5 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 3.78 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-7.33	4082.8	-0.58	1.000
FF resistance	-3675.8	-2.01	-2096.7	-2.22	1.000
Active pressure	2869.5	-4.42	1562.8	22.00	1.000
Traffic	1052.2	-7.49	664.4	22.00	1.000
Weight - reinforced soil	0.0	-8.72	43205.6	11.52	1.000
Traffic	0.0	-18.00	3424.5	15.15	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 48857.33 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 28010.77 lbf/ft
Wall resistance = 3425.88 lbf/ft

Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:

Resisting horizontal force H_{res} = 35112.48 lbf/ft
Active horiz. force H_{act} = 3921.75 lbf/ft

Factor of safety = 8.95 > 1.50

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-444.83	15.00	848.47	78.64	7626.36	8.75	855.83	77.97
2	Miragrid 8XT	-812.72	13.50	1696.94	71.84	13481.72	9.04	1711.65	71.22
3	Miragrid 8XT	-724.40	12.00	1696.94	64.03	11801.62	9.21	1711.65	63.48
4	Miragrid 8XT	-665.47	10.50	1696.94	58.82	10212.42	9.77	1711.65	58.32
5	Miragrid 8XT	-606.55	9.00	1696.94	53.62	8714.12	10.44	1711.65	53.15
6	Miragrid 8XT	-547.63	7.50	1696.94	48.41	7306.72	11.24	1711.65	47.99
7	Miragrid 8XT	-462.86	6.00	1696.94	40.91	5990.21	11.59	1711.65	40.56
8	Miragrid 8XT	-325.61	4.50	1696.94	28.78	4764.60	10.25	1711.65	28.53
9	Miragrid 8XT	-265.94	3.00	1696.94	23.51	3629.88	10.99	1711.65	23.31
10	Miragrid 8XT	-287.04	1.50	1696.94	25.37	2586.07	16.65	855.83	50.31

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 444.83 lbf/ft

Safety factor = 1.91 > 1.50

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.10)

Pull out resistance T_p = 2586.07 lbf/ft
Force in reinforcement F_x = 287.04 lbf/ft

Safety factor = 9.01 > 1.50

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 444.83 lbf/ft

Safety factor = 1.92 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

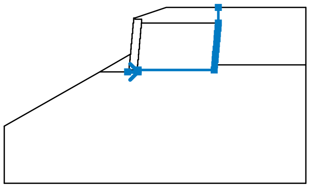
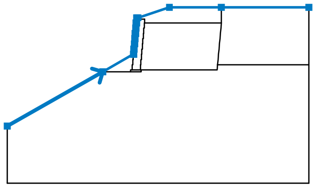
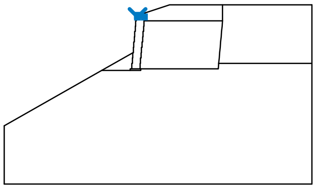
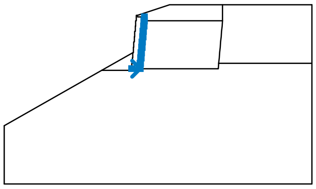
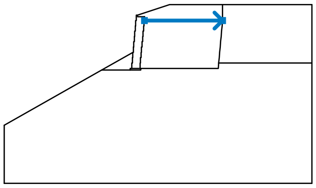
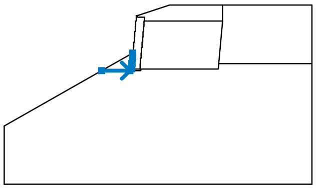
(input for current task)

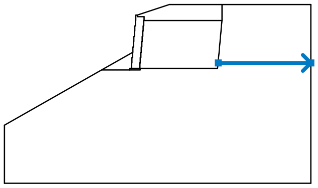
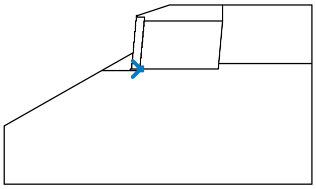
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-2.14	-15.50	0.86	-15.50	0.86	-15.00
		22.70	-15.00	22.83	-13.50	22.97	-12.00
		23.10	-10.50	23.24	-9.00	23.38	-7.50
		23.51	-6.00	23.65	-4.50	23.78	-3.00
		23.92	-1.50	23.92	3.00		
2		-37.50	-31.11	-10.13	-15.50	-1.36	-10.50
		-1.23	-10.50	-1.23	-9.00	-1.09	-9.00
		-1.09	-7.50	-0.96	-7.50	-0.96	-6.00
		-0.82	-6.00	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		9.00	3.00	23.92	3.00	49.00	3.00
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.64	-15.00	0.70	-15.00	0.70	-13.50
		0.83	-13.50	0.83	-12.00	0.97	-12.00
		0.97	-10.50	1.10	-10.50	1.10	-9.00
		1.24	-9.00	1.24	-7.50	1.38	-7.50
		1.38	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
5		1.92	-1.50	23.92	-1.50		
6		-10.13	-15.50	-2.14	-15.50	-2.14	-15.00
		-1.64	-15.00	-1.64	-13.50	-1.50	-13.50
		-1.50	-12.00	-1.36	-12.00	-1.36	-10.50

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
7		22.83	-13.50	49.00	-13.50		
8		0.70	-15.00	0.86	-15.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	🟩	40.00	0.0	105.0
2	Perched Clay (Drained)	🟥	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	🟩	110.0		
2	Perched Clay (Drained)	🟥	115.0		
3	Surficial Aquifer	▨	120.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	Onsite Sands	▨	120.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

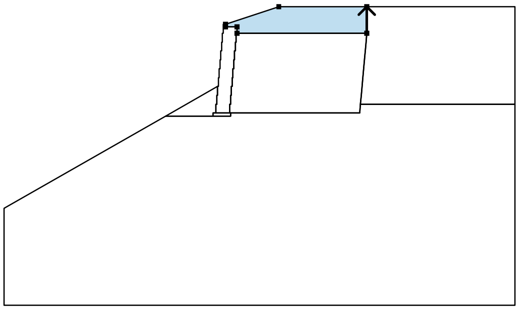
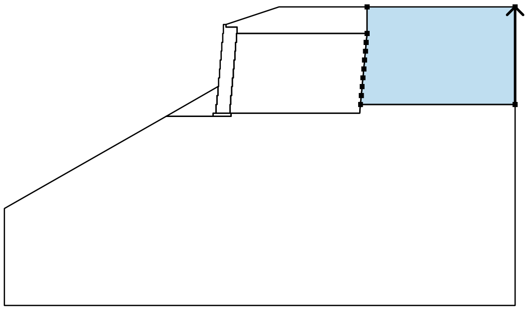
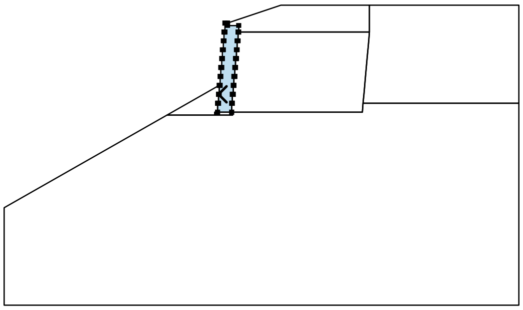
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

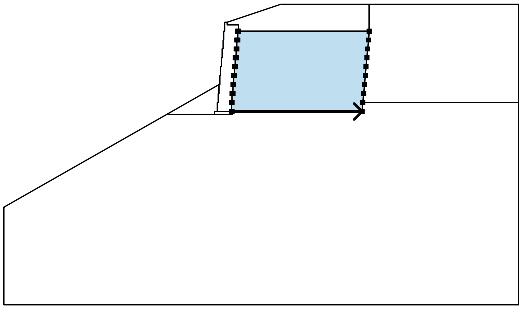
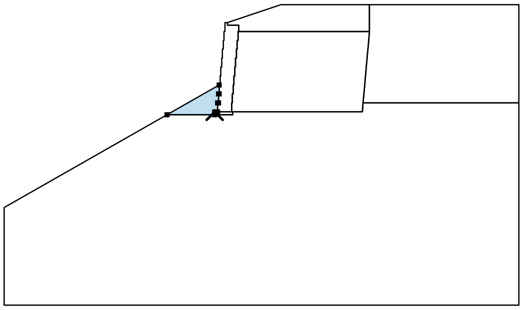
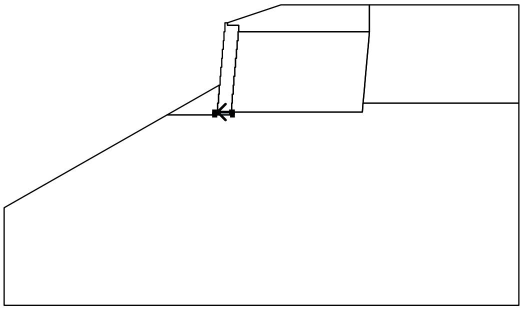
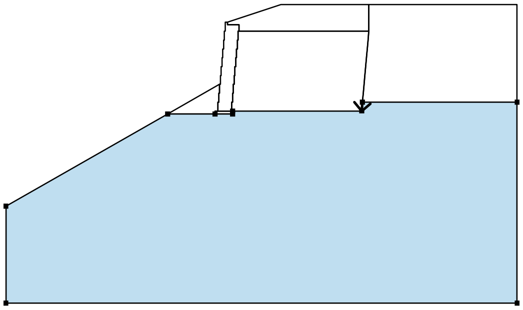
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		23.92	-1.50	23.92	3.00	Onsite Sands
		9.00	3.00	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		49.00	-13.50	49.00	3.00	Perched Clay (Drained)
		23.92	3.00	23.92	-1.50	▨
		23.78	-3.00	23.65	-4.50	
		23.51	-6.00	23.38	-7.50	
		23.24	-9.00	23.10	-10.50	
		22.97	-12.00	22.83	-13.50	
3		-1.36	-12.00	-1.50	-12.00	Material of structure
		-1.50	-13.50	-1.64	-13.50	▦
		-1.64	-15.00	0.70	-15.00	
		0.70	-13.50	0.83	-13.50	
		0.83	-12.00	0.97	-12.00	
		0.97	-10.50	1.10	-10.50	
		1.10	-9.00	1.24	-9.00	
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
		-1.09	-9.00	-1.23	-9.00	
		-1.23	-10.50	-1.36	-10.50	

No.	**Surface position**	**Coordinates of surface points [ft]**				**Assigned soil**
		x	**z**	**x**	**z**	
4		0.86	-15.00	22.70	-15.00	Onsite Sands ▨
		22.83	-13.50	22.97	-12.00	
		23.10	-10.50	23.24	-9.00	
		23.38	-7.50	23.51	-6.00	
		23.65	-4.50	23.78	-3.00	
		23.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
		1.10	-9.00	1.10	-10.50	
		0.97	-10.50	0.97	-12.00	
		0.83	-12.00	0.83	-13.50	
		0.70	-13.50	0.70	-15.00	
5		-2.14	-15.50	-2.14	-15.00	Perched Clay (Drained) ▨
		-1.64	-15.00	-1.64	-13.50	
		-1.50	-13.50	-1.50	-12.00	
		-1.36	-12.00	-1.36	-10.50	
		-10.13	-15.50			
6		0.70	-15.00	-1.64	-15.00	#57 Stone ▨
		-2.14	-15.00	-2.14	-15.50	
		0.86	-15.50	0.86	-15.00	
7		22.83	-13.50	22.70	-15.00	Surficial Aquifer ▨
		0.86	-15.00	0.86	-15.50	
		-2.14	-15.50	-10.13	-15.50	
		-37.50	-31.11	-37.50	-47.51	
		49.00	-47.51	49.00	-13.50	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	0.70	-15.00	22.70	-15.00	22.00	848.5	C = 0.67	Fixed
2	0.83	-13.50	22.83	-13.50	22.00	1696.9	C = 0.67	Fixed
3	0.97	-12.00	22.97	-12.00	22.00	1696.9	C = 0.67	Fixed
4	1.10	-10.50	23.10	-10.50	22.00	1696.9	C = 0.67	Fixed
5	1.24	-9.00	23.24	-9.00	22.00	1696.9	C = 0.67	Fixed
6	1.38	-7.50	23.38	-7.50	22.00	1696.9	C = 0.67	Fixed
7	1.51	-6.00	23.51	-6.00	22.00	1696.9	C = 0.67	Fixed
8	1.65	-4.50	23.65	-4.50	22.00	1696.9	C = 0.67	Fixed
9	1.78	-3.00	23.78	-3.00	22.00	1696.9	C = 0.67	Fixed
10	1.92	-1.50	23.92	-1.50	22.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 9.00	l = 40.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-29.40	[ft]	Angles :	α_1 =	-5.54	[°]
	z =	46.10	[ft]		α_2 =	56.06	[°]
Radius :	R =	77.20	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	1696.9
3	1696.9
4	52.0
5	0.0
6	0.0
7	0.0
8	0.0
9	0.0
10	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 48756.5 lbf/ft
Sum of passive forces : F_p = 75264.4 lbf/ft

Sliding moment : M_a = 3763999.5 lbfft/ft
Resisting moment : M_p = 5810414.3 lbfft/ft
Factor of safety = 1.54 > 1.50
Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 10.5 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #2
Description : H10.5
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

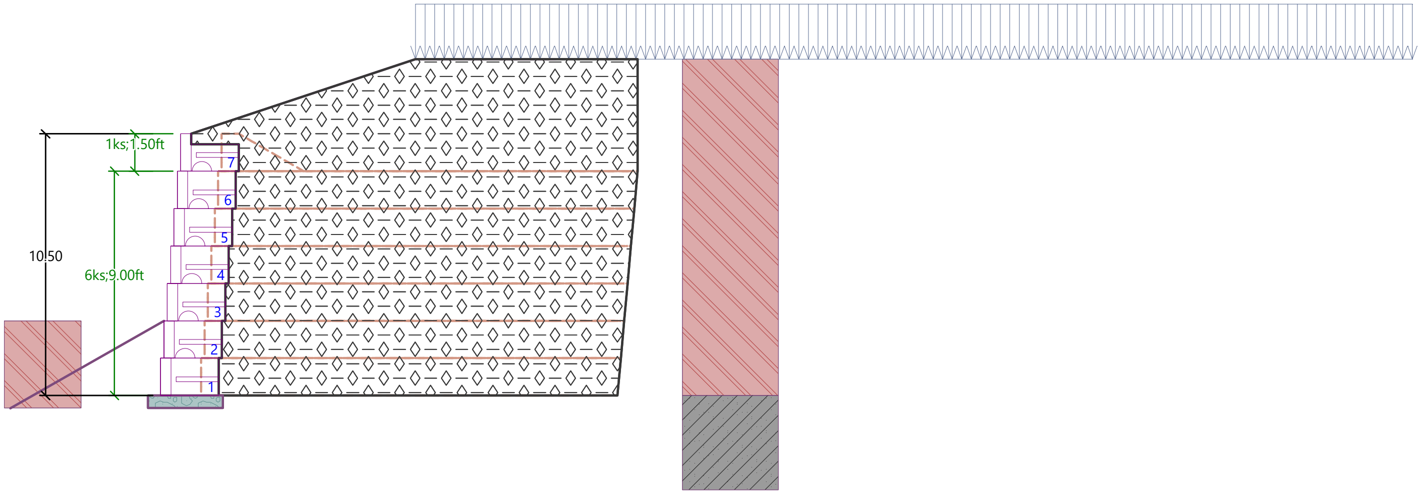
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	6	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength T_{ult} = 7400.00 lbf/ft
Creep red. factor RF_{CR} = 1.58
Durability red. factor RF_D = 1.15
Installation damage red. factor RF_{ID} = 1.20
Long-term design strength R_t = 3393.87 lbf/ft
Coefficient of direct slip along reinforcement C_{ds} = 0.67
Coefficient of interaction of soil and geo-reinforcement C_i = 0.67
Scale correction factor α = 0.8
Long-term strength reduction factor CR_{cr} = 0.532
Calculation of long-term connection strength R_{con} = 3423.30 lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 16.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	16.00	
2	Yes	Miragrid 8XT	16.00	
3	Yes	Miragrid 8XT	16.00	
4	Yes	Miragrid 8XT	16.00	
5	Yes	Miragrid 8XT	16.00	
6	Yes	Miragrid 8XT	16.00	
7	Yes	Miragrid 8XT	16.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Perched Clay (Drained)	🟥	24.00	200.0	110.00	52.50	16.00
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	◈	32.00	0.0	115.00	57.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight :	γ = 105.0 pcf
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 40.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Angle of friction struc.-soil :	δ = 26.67 °
Saturated unit weight :	γ_{sat} = 110.0 pcf

Perched Clay (Drained)

Unit weight :	γ = 110.0 pcf
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 24.00 °
Cohesion of soil :	c_{ef} = 200.0 psf
Angle of friction struc.-soil :	δ = 16.00 °
Saturated unit weight :	γ_{sat} = 115.0 pcf

Surficial Aquifer

Unit weight :	γ = 115.0 pcf
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 32.00 °
Cohesion of soil :	c_{ef} = 75.0 psf
Angle of friction struc.-soil :	δ = 21.30 °
Saturated unit weight :	γ_{sat} = 120.0 pcf

Onsite Sands

Unit weight :	γ = 115.0 pcf
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 32.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Angle of friction struc.-soil :	δ = 21.30 °
Saturated unit weight :	γ_{sat} = 120.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	10.50	0.00 .. 10.50	Perched Clay (Drained)	🟥
2	-	10.50 .. ∞	Surficial Aquifer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.00 ft, embankment length is 9.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.00		9.00	40.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 3.50 ft
Soil slope in front of structure β = -29.70 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-2191.1	-1.37	-1249.8	2.39	1.000
Weight - reinforced soil	0.0	-6.53	24110.7	11.01	1.000
Active pressure	1281.7	-2.77	570.6	19.15	1.000
Traffic	788.6	-4.74	499.6	19.15	1.000
Weight - wall	0.0	-5.08	2844.2	1.55	1.000
Traffic	0.0	-13.50	2229.2	14.69	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 320064.0 lbfft/ft
Overturning moment M_{ovr} = 4287.1 lbfft/ft

Safety factor = 74.66 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 15212.42 lbf/ft
Active horizontal force H_{act} = -120.88 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-54888.4	3331.65	-10113.07	0.000	1110.6

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-54888.4	3331.65	-10113.07

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force $e = 0.000$
Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom $\sigma = 1110.6$ psf
Bearing capacity of foundation soil $R_d = 6000.0$ psf

Safety factor = 5.40 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.08	2823.4	-0.78	1.000
FF resistance	-2190.2	-1.37	-1249.3	-2.27	1.000
Active pressure	1289.4	-2.78	711.5	16.00	1.000
Traffic	712.2	-5.08	497.2	16.00	1.000
Weight - reinforced soil	0.0	-6.43	23207.1	8.45	1.000
Traffic	0.0	-13.50	2026.0	11.95	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 26441.87 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 10801.43 lbf/ft
Wall resistance = 2369.10 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force $H_{res} = 15360.74$ lbf/ft
Active horiz. force $H_{act} = 2001.54$ lbf/ft

Factor of safety = 7.67 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-322.02	10.50	848.47	56.93	4159.83	11.61	855.83	56.44
2	Miragrid 8XT	-577.09	9.00	1696.94	51.01	7031.67	12.31	1711.65	50.57
3	Miragrid 8XT	-498.76	7.50	1696.94	44.09	5834.57	12.82	1711.65	43.71
4	Miragrid 8XT	-413.99	6.00	1696.94	36.59	4728.37	13.13	1711.65	36.28
5	Miragrid 8XT	-276.74	4.50	1696.94	24.46	3713.06	11.18	1711.65	24.25
6	Miragrid 8XT	-217.07	3.00	1696.94	19.19	2788.66	11.68	1711.65	19.02
7	Miragrid 8XT	-213.74	1.50	1696.94	18.89	1955.15	16.40	855.83	37.46

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 322.02 lbf/ft

Safety factor = 2.63 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.7)

Pull out resistance T_p = 1955.15 lbf/ft
Force in reinforcement F_x = 213.74 lbf/ft

Safety factor = 9.15 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 322.02 lbf/ft

Safety factor = 2.66 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

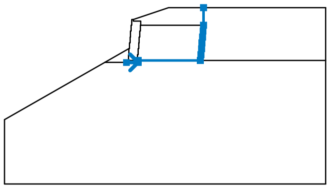
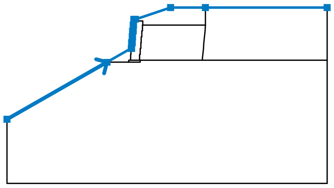
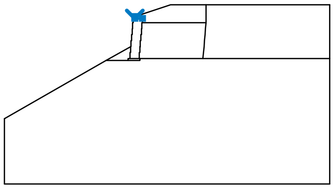
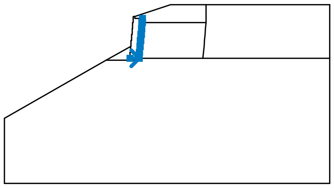
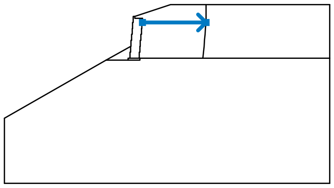
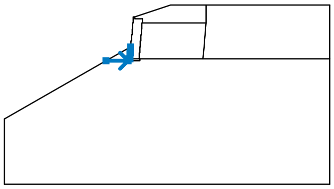
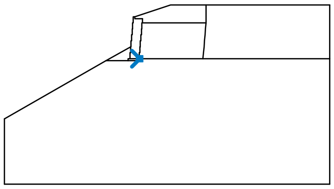
(input for current task)

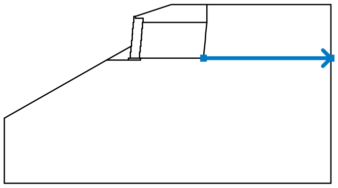
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.73	-11.00	1.27	-11.00	1.27	-10.50
		17.10	-10.50	17.24	-9.00	17.38	-7.50
		17.51	-6.00	17.65	-4.50	17.78	-3.00
		17.92	-1.50	17.92	3.00		
2		-32.80	-25.59	-7.23	-11.00	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	9.00	3.00
		17.92	3.00	49.00	3.00		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.23	-10.50	1.10	-10.50	1.10	-9.00
		1.24	-9.00	1.24	-7.50	1.38	-7.50
		1.38	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
5		1.92	-1.50	17.92	-1.50		
6		-7.23	-11.00	-1.73	-11.00	-1.73	-10.50
		-1.23	-10.50	-1.23	-9.00	-1.09	-9.00
		-1.09	-7.50				
7		1.10	-10.50	1.27	-10.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
8		17.10	-10.50	49.00	-10.50		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	▨	120.0		

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °

Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

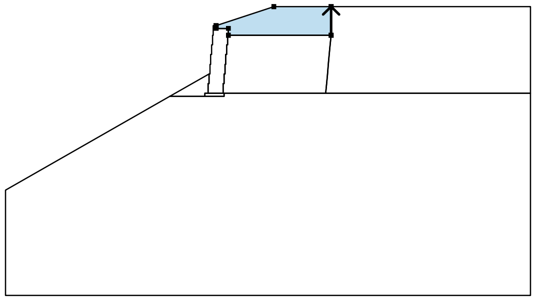
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

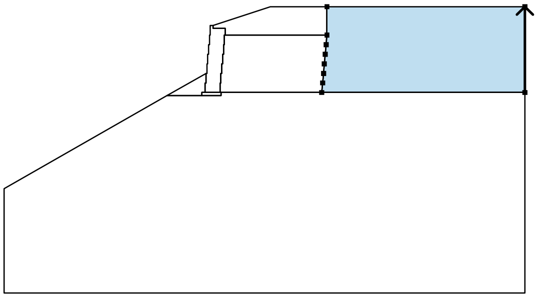
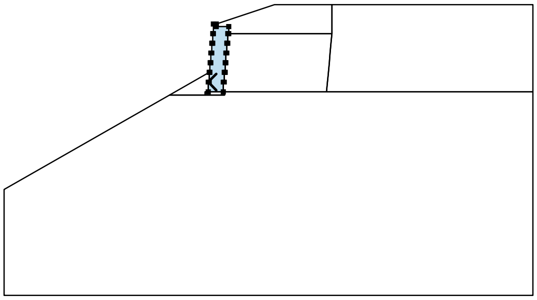
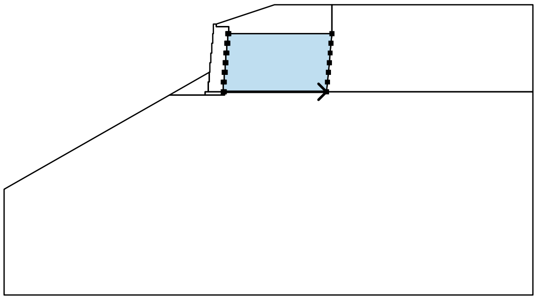
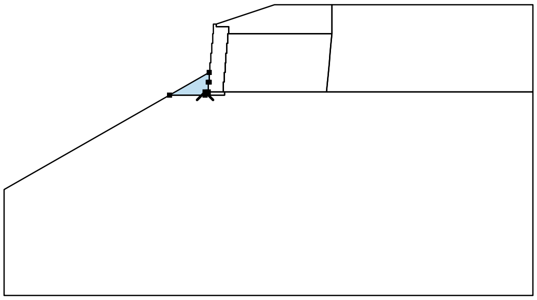
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

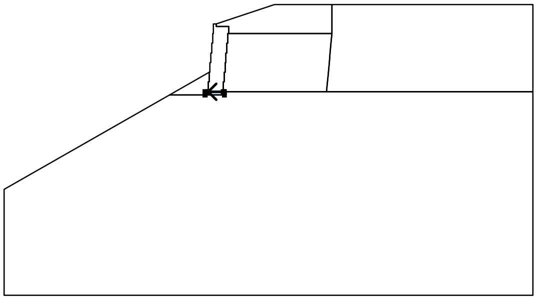
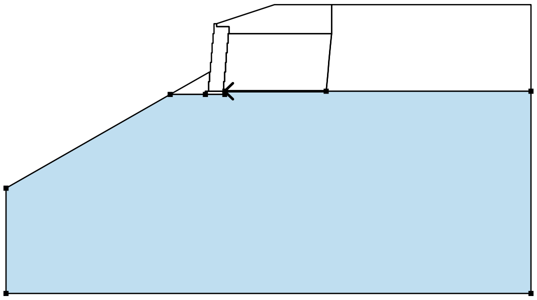
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		17.92	-1.50	17.92	3.00	Onsite Sands ▨
		9.00	3.00	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
2		49.00	-10.50	49.00	3.00	Perched Clay (Drained)
		17.92	3.00	17.92	-1.50	▨
		17.78	-3.00	17.65	-4.50	
		17.51	-6.00	17.38	-7.50	
		17.24	-9.00	17.10	-10.50	
3		-1.09	-9.00	-1.23	-9.00	Material of structure
		-1.23	-10.50	1.10	-10.50	▦
		1.10	-9.00	1.24	-9.00	
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
4		1.27	-10.50	17.10	-10.50	Onsite Sands
		17.24	-9.00	17.38	-7.50	◇
		17.51	-6.00	17.65	-4.50	
		17.78	-3.00	17.92	-1.50	
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.51	-4.50	
		1.51	-6.00	1.38	-6.00	
		1.38	-7.50	1.24	-7.50	
		1.24	-9.00	1.10	-9.00	
		1.10	-10.50			
5		-1.73	-11.00	-1.73	-10.50	Perched Clay (Drained)
		-1.23	-10.50	-1.23	-9.00	▨
		-1.09	-9.00	-1.09	-7.50	
		-7.23	-11.00			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		1.10 -1.73 1.27	-10.50 -10.50 -11.00	-1.23 -1.73 1.27	-10.50 -11.00 -10.50	#57 Stone ▨
7		17.10 1.27 -7.23 -32.80 49.00	-10.50 -11.00 -11.00 -41.99 -10.50	1.27 -1.73 -32.80 49.00	-10.50 -11.00 -25.59 -41.99	Surficial Aquifer ▨

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	1.10	-10.50	17.10	-10.50	16.00	848.5	C = 0.67	Fixed
2	1.24	-9.00	17.24	-9.00	16.00	1696.9	C = 0.67	Fixed
3	1.38	-7.50	17.38	-7.50	16.00	1696.9	C = 0.67	Fixed
4	1.51	-6.00	17.51	-6.00	16.00	1696.9	C = 0.67	Fixed
5	1.65	-4.50	17.65	-4.50	16.00	1696.9	C = 0.67	Fixed
6	1.78	-3.00	17.78	-3.00	16.00	1696.9	C = 0.67	Fixed
7	1.92	-1.50	17.92	-1.50	16.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 9.00	l = 40.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-26.47	[ft]	Angles :	α_1 =	-4.91	[°]
	z =	40.87	[ft]		α_2 =	55.18	[°]
Radius :	R =	66.33	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	24.3
3	0.0
4	0.0
5	0.0
6	0.0
7	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 33273.6 lbf/ft
Sum of passive forces : F_p = 50553.7 lbf/ft

Sliding moment : M_a = 2207037.7 lbfft/ft
Resisting moment : M_p = 3353227.9 lbfft/ft
Factor of safety = 1.52 > 1.50
Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 6.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #2
Description : H6
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

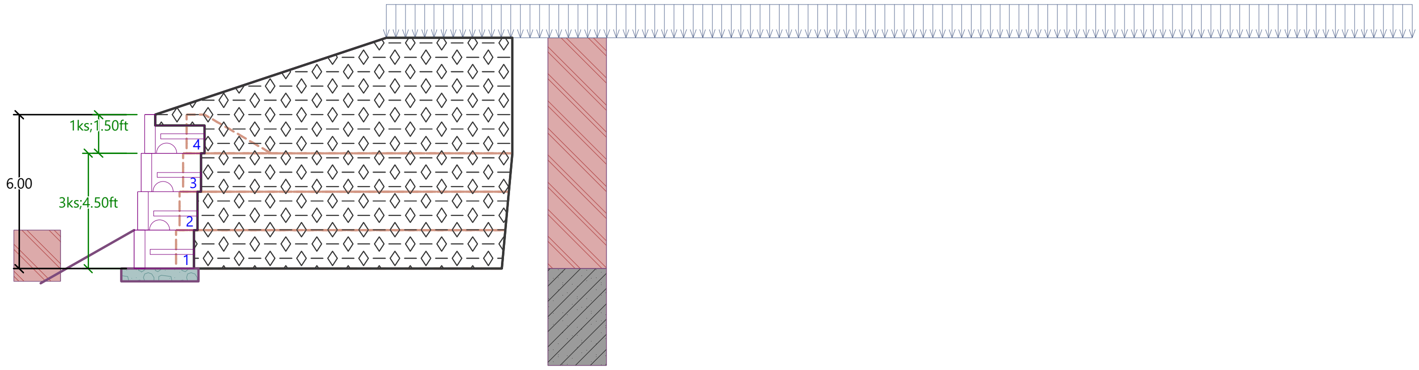
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	3	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength T_{ult} = 7400.00 lbf/ft
Creep red. factor RF_{CR} = 1.58
Durability red. factor RF_D = 1.15
Installation damage red. factor RF_{ID} = 1.20
Long-term design strength R_t = 3393.87 lbf/ft
Coefficient of direct slip along reinforcement C_{ds} = 0.67
Coefficient of interaction of soil and geo-reinforcement C_i = 0.67
Scale correction factor α = 0.8
Long-term strength reduction factor CR_{cr} = 0.532
Calculation of long-term connection strength R_{con} = 3423.30 lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 12.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	12.00	
2	Yes	Miragrid 8XT	12.00	
3	Yes	Miragrid 8XT	12.00	
4	Yes	Miragrid 8XT	12.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	🟩	40.00	0.0	105.00	47.50	26.67
2	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	◇	32.00	0.0	115.00	57.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	6.00	0.00 .. 6.00	Perched Clay (Drained)	🟥
2	-	6.00 .. ∞	Surficial Aquifer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.00 ft, embankment length is 9.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	250.00		9.00	40.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -29.70 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-954.1	-0.71	-544.2	2.33	1.000
Weight - reinforced soil	0.0	-4.21	11655.6	8.82	1.000
Active pressure	270.5	-1.27	120.4	14.74	1.000
Traffic	410.3	-2.51	331.2	14.74	1.000
Weight - wall	0.0	-2.83	1584.2	1.34	1.000
Traffic	0.0	-9.00	1229.2	12.28	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment M_{res} = 125392.2 lbfft/ft
Overturning moment M_{ovr} = 696.6 lbfft/ft

Safety factor = 180.01 > 2.00
Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 8502.89 lbf/ft
Active horizontal force H_{act} = -273.31 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-18283.7	1994.06	-5634.72	0.000	664.7

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-18283.7	1994.06	-5634.72

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force $e = 0.000$
Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom $\sigma = 664.7$ psf
Bearing capacity of foundation soil $R_d = 6000.0$ psf

Safety factor = 9.03 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.83	1564.7	-0.99	1.000
FF resistance	-953.4	-0.71	-543.8	-2.33	1.000
Active pressure	428.8	-1.41	265.7	0.25	1.000
Traffic	335.6	-2.73	329.5	8.00	1.000
Weight - reinforced soil	0.0	-4.15	11278.1	6.41	1.000
Traffic	0.0	-9.00	1127.6	9.74	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 13000.94 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 5310.85 lbf/ft
Wall resistance = 1312.96 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force $H_{res} = 7577.19$ lbf/ft
Active horiz. force $H_{act} = 764.44$ lbf/ft

Factor of safety = 9.91 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-174.00	6.00	848.47	30.76	1965.17	13.28	855.83	30.50
2	Miragrid 8XT	-238.65	4.50	1696.94	21.10	3100.95	11.54	1711.65	20.91
3	Miragrid 8XT	-168.20	3.00	1696.94	14.87	2351.79	10.73	1711.65	14.74
4	Miragrid 8XT	-140.43	1.50	1696.94	12.41	1670.88	12.61	855.83	24.61

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 174.00 lbf/ft

Safety factor = 4.88 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.1)

Pull out resistance T_p = 1965.17 lbf/ft
Force in reinforcement F_x = 174.00 lbf/ft

Safety factor = 11.29 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 174.00 lbf/ft

Safety factor = 4.92 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

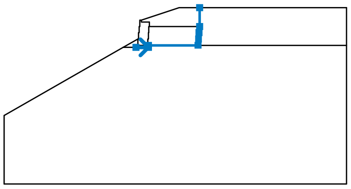
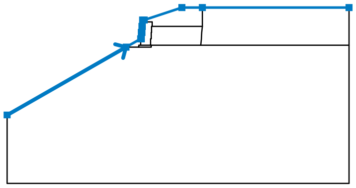
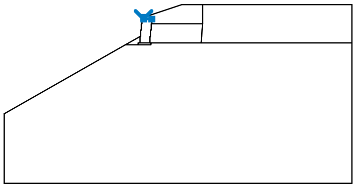
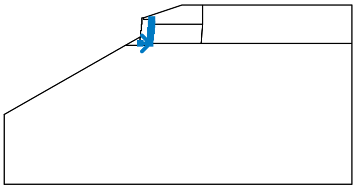
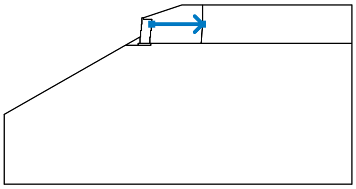
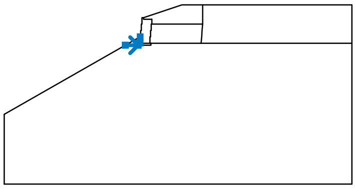
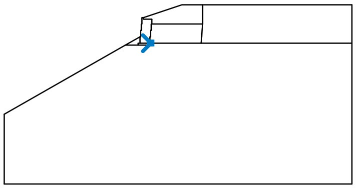
(input for current task)

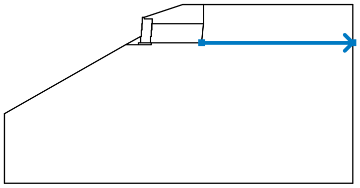
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.32	-6.50	1.68	-6.50	1.68	-6.00
		13.51	-6.00	13.65	-4.50	13.78	-3.00
		13.92	-1.50	13.92	3.00		
2		-32.80	-22.74	-4.33	-6.50	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	9.00	3.00	13.92	3.00
		49.00	3.00				
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-0.82	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
5		1.92	-1.50	13.92	-1.50		
6		-4.33	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
7		1.51	-6.00	1.68	-6.00		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
8		13.51	-6.00	49.00	-6.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	▨	120.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °

Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

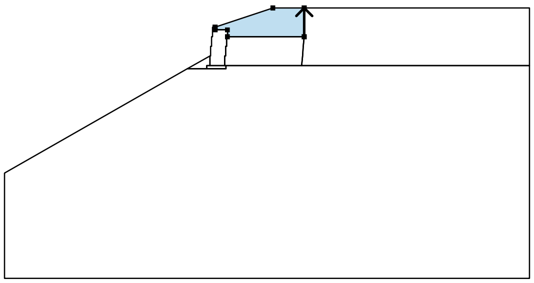
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

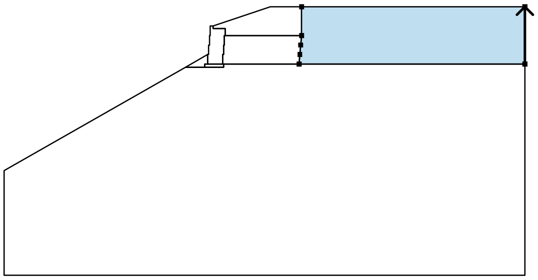
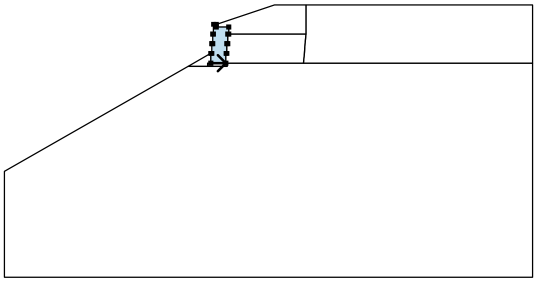
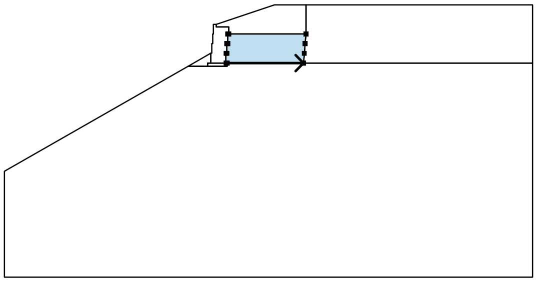
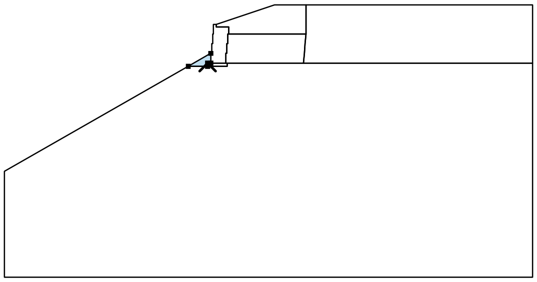
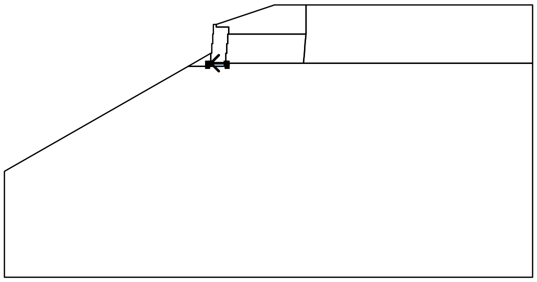
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

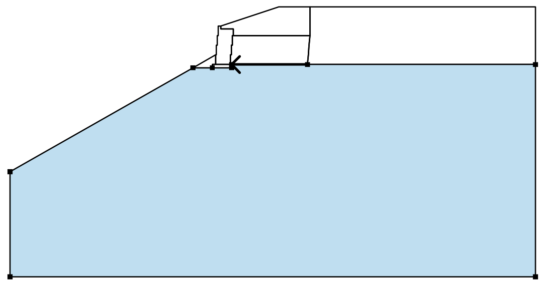
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		13.92	-1.50	13.92	3.00	Onsite Sands ▨
		9.00	3.00	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
2		49.00	-6.00	49.00	3.00	Perched Clay (Drained)
		13.92	3.00	13.92	-1.50	▨
		13.78	-3.00	13.65	-4.50	
		13.51	-6.00			
3		-0.82	-6.00	1.51	-6.00	Material of structure
		1.51	-4.50	1.65	-4.50	▦
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
4		1.68	-6.00	13.51	-6.00	Onsite Sands
		13.65	-4.50	13.78	-3.00	▩
		13.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
5		-1.32	-6.50	-1.32	-6.00	Perched Clay (Drained)
		-0.82	-6.00	-0.82	-4.50	▨
		-4.33	-6.50			
6		1.51	-6.00	-0.82	-6.00	#57 Stone
		-1.32	-6.00	-1.32	-6.50	▒
		1.68	-6.50	1.68	-6.00	

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
7		13.51	-6.00	1.68	-6.00	Surficial Aquifer
		1.68	-6.50	-1.32	-6.50	▨
		-4.33	-6.50	-32.80	-22.74	
		-32.80	-39.14	49.00	-39.14	
		49.00	-6.00			

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.51	-6.00	13.51	-6.00	12.00	848.5	C = 0.67	Fixed
2	1.65	-4.50	13.65	-4.50	12.00	1696.9	C = 0.67	Fixed
3	1.78	-3.00	13.78	-3.00	12.00	1696.9	C = 0.67	Fixed
4	1.92	-1.50	13.92	-1.50	12.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 9.00	l = 40.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-31.61	[ft]	Angles :	α_1 =	-0.46	[°]
	z =	43.95	[ft]		α_2 =	51.87	[°]
Radius :	R =	66.32	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	4.9
3	0.0
4	0.0

Slope stability verification (Bishop)

Sum of active forces :	F_a =	22227.4	lbf/ft
Sum of passive forces :	F_p =	33861.1	lbf/ft
Sliding moment :	M_a =	1474121.8	lbfft/ft
Resisting moment :	M_p =	2245667.6	lbfft/ft

Factor of safety = 1.52 > 1.50

Slope stability ACCEPTABLE

WALL #3

MAX. WALL HEIGHT = 15.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #3
Description : 15
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

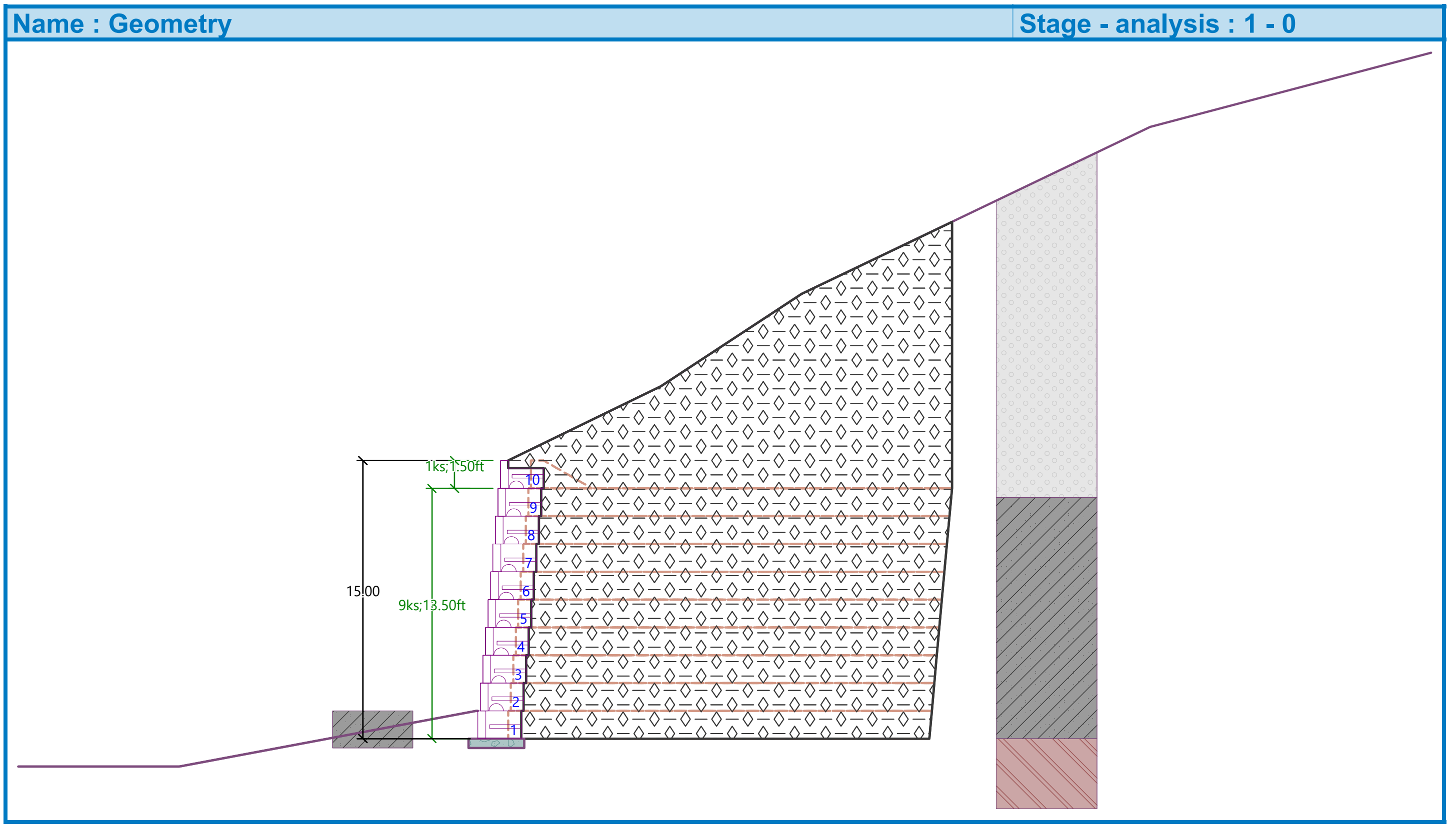
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	9	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength T_{ult} = 7400.00 lbf/ft
Creep red. factor RF_{CR} = 1.58
Durability red. factor RF_D = 1.15
Installation damage red. factor RF_{ID} = 1.20
Long-term design strength R_t = 3393.87 lbf/ft
Coefficient of direct slip along reinforcement C_{ds} = 0.67
Coefficient of interaction of soil and geo-reinforcement C_i = 0.67
Scale correction factor α = 0.8
Long-term strength reduction factor CR_{cr} = 0.532
Calculation of long-term connection strength R_{con} = 3423.30 lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 22.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	22.00	
2	Yes	Miragrid 8XT	22.00	
3	Yes	Miragrid 8XT	22.00	
4	Yes	Miragrid 8XT	22.00	
5	Yes	Miragrid 8XT	22.00	
6	Yes	Miragrid 8XT	22.00	
7	Yes	Miragrid 8XT	22.00	
8	Yes	Miragrid 8XT	22.00	
9	Yes	Miragrid 8XT	22.00	
10	Yes	Miragrid 8XT	22.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	2.00	0.00 .. 2.00	Light Gray Sand	░
2	13.00	2.00 .. 15.00	Dark Gray Clay (Drained)	▨
3	-	15.00 .. ∞	Perched Clay (Drained)	🟥

Terrain profile

No.	Coordinates x [ft]	Depth z [ft]
1	0.00	0.00
2	8.23	-4.00
3	15.81	-9.00
4	34.60	-18.00
5	49.75	-22.00
6	50.75	-22.00

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Dark Gray Clay (Drained)
Soil thickness in front of structure h = 2.00 ft

Terrain shape in front of structure

No.	Coordinate x[ft]	Depth z[ft]
1	0.00	0.00
2	0.00	-2.00
3	-0.10	-2.00
4	-16.10	1.00
5	-17.10	1.00

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1262.4	-0.69	0.0	2.33	1.000
Weight - reinforced soil	0.0	-11.29	55906.3	15.16	1.000
Active pressure	16129.9	-8.81	8159.2	25.55	1.000
Weight - wall	0.0	-7.33	4104.2	1.76	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 1063024.8 lbfft/ft
Overturning moment M_{ovr} = 141315.8 lbfft/ft

Safety factor = 7.52 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 33630.66 lbf/ft
Active horizontal force H_{act} = 14867.42 lbf/ft

Safety factor = 2.26 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-92370.2	7730.01	-10135.50	0.000	2576.7

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-92370.2	7730.01	-10135.50

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 2576.7 psf
Bearing capacity of foundation soil R_d = 9000.0 psf

Safety factor = 3.49 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-7.33	4082.8	-0.58	1.000
FF resistance	-1261.4	-0.69	0.0	-2.33	1.000
Active pressure	16809.8	-8.57	7582.0	22.00	1.000
Weight - reinforced soil	0.0	-10.98	52894.1	12.32	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 60476.03 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 25873.90 lbf/ft
Wall resistance = 3425.88 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 30561.18 lbf/ft
Active horiz. force H_{act} = 16809.85 lbf/ft

Factor of safety = 1.82 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-430.43	15.00	848.47	76.10	9019.24	7.16	855.83	75.44
2	Miragrid 8XT	-782.09	13.50	1696.94	69.13	16452.86	7.13	1711.65	68.54
3	Miragrid 8XT	-691.72	12.00	1696.94	61.14	14936.99	6.95	1711.65	60.62
4	Miragrid 8XT	-632.06	10.50	1696.94	55.87	13490.88	7.03	1711.65	55.39
5	Miragrid 8XT	-572.39	9.00	1696.94	50.60	12114.54	7.09	1711.65	50.16
6	Miragrid 8XT	-512.73	7.50	1696.94	45.32	10807.95	7.12	1711.65	44.93
7	Miragrid 8XT	-453.06	6.00	1696.94	40.05	9571.14	7.10	1711.65	39.70
8	Miragrid 8XT	-393.40	4.50	1696.94	34.77	8404.08	7.02	1711.65	34.48
9	Miragrid 8XT	-333.73	3.00	1696.94	29.50	7293.91	6.86	1711.65	29.25
10	Miragrid 8XT	-388.73	1.50	1696.94	34.36	6212.13	9.39	855.83	68.13

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 430.43 lbf/ft

Safety factor = 1.97 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.10)
Pull out resistance T_p = 6212.13 lbf/ft
Force in reinforcement F_x = 388.73 lbf/ft

Safety factor = 15.98 > 1.50

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 430.43 lbf/ft

Safety factor = 1.99 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

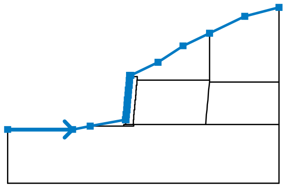
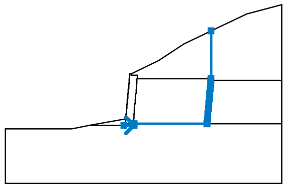
(input for current task)

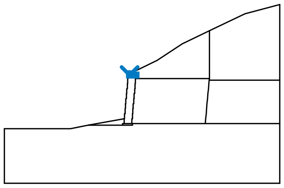
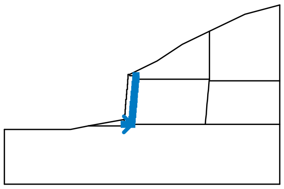
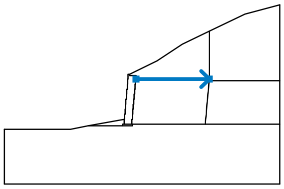
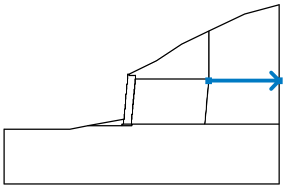
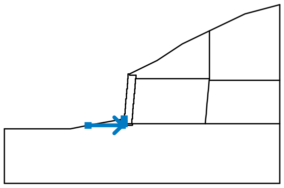
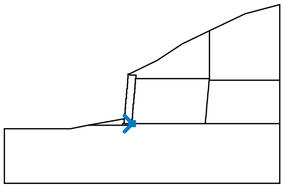
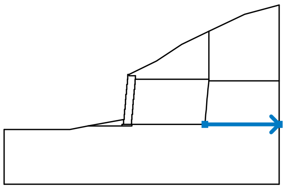
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-37.50	-16.50	-17.74	-16.50	-12.41	-15.50
		-1.74	-13.50	-1.64	-13.50	-1.50	-13.50
		-1.50	-12.00	-1.36	-12.00	-1.36	-10.50
		-1.23	-10.50	-1.23	-9.00	-1.09	-9.00
		-1.09	-7.50	-0.96	-7.50	-0.96	-6.00
		-0.82	-6.00	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		8.23	4.00	15.81	9.00	23.92	12.88
		34.60	18.00	45.00	20.75		
2		-2.14	-15.50	0.86	-15.50	0.86	-15.00
		22.70	-15.00	22.83	-13.50	22.97	-12.00
		23.10	-10.50	23.24	-9.00	23.38	-7.50
		23.51	-6.00	23.65	-4.50	23.78	-3.00
		23.87	-2.00	23.92	-1.50	23.92	12.88

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.64	-15.00	0.70	-15.00	0.70	-13.50
		0.83	-13.50	0.83	-12.00	0.97	-12.00
		0.97	-10.50	1.10	-10.50	1.10	-9.00
		1.24	-9.00	1.24	-7.50	1.38	-7.50
		1.38	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
5		1.92	-1.50	23.92	-1.50		
6		23.87	-2.00	45.00	-2.00		
7		-12.41	-15.50	-2.14	-15.50	-2.14	-15.00
		-1.64	-15.00	-1.64	-13.50		
8		0.70	-15.00	0.86	-15.00		
9		22.70	-15.00	45.00	-15.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Perched Clay (Drained)	▨	24.00	200.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Perched Clay (Drained)	▨	115.0		

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

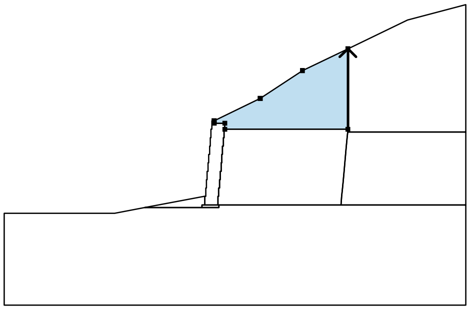
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

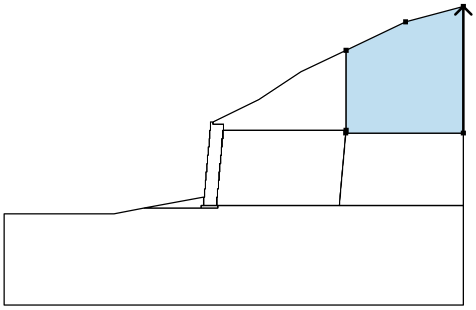
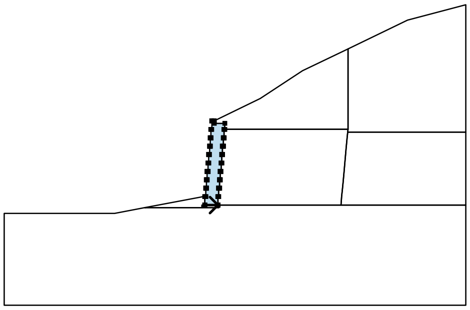
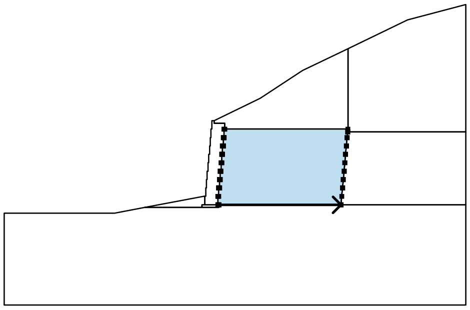
Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

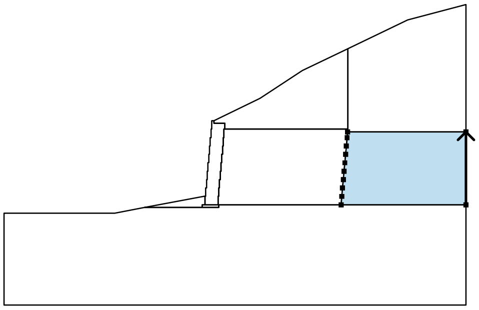
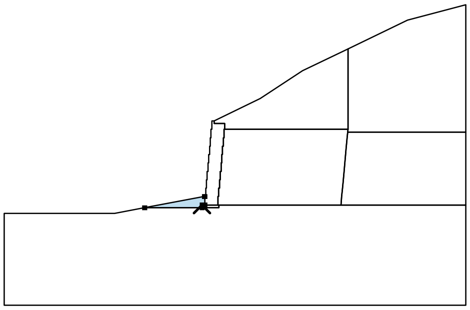
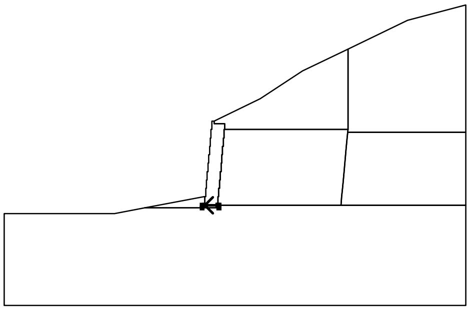
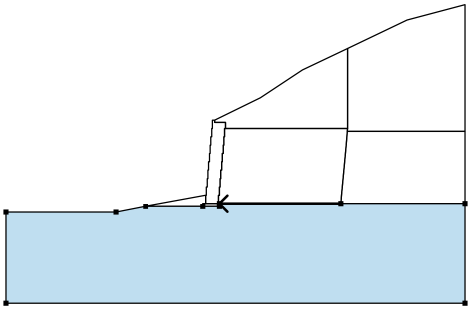
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		23.92	-1.50	23.92	12.88	Onsite Sands ▨
		15.81	9.00	8.23	4.00	
		0.00	0.00	0.00	-0.42	
		1.92	-0.42	1.92	-1.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
2		45.00	-2.00	45.00	20.75	Light Gray Sand
		34.60	18.00	23.92	12.88	▨
		23.92	-1.50	23.87	-2.00	
3		-1.64	-15.00	0.70	-15.00	Material of structure
		0.70	-13.50	0.83	-13.50	🟥
		0.83	-12.00	0.97	-12.00	
		0.97	-10.50	1.10	-10.50	
		1.10	-9.00	1.24	-9.00	
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
		-1.09	-9.00	-1.23	-9.00	
		-1.23	-10.50	-1.36	-10.50	
		-1.36	-12.00	-1.50	-12.00	
		-1.50	-13.50	-1.64	-13.50	
4		0.86	-15.00	22.70	-15.00	Onsite Sands
		22.83	-13.50	22.97	-12.00	▨
		23.10	-10.50	23.24	-9.00	
		23.38	-7.50	23.51	-6.00	
		23.65	-4.50	23.78	-3.00	
		23.87	-2.00	23.92	-1.50	
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.51	-4.50	
		1.51	-6.00	1.38	-6.00	
		1.38	-7.50	1.24	-7.50	
		1.24	-9.00	1.10	-9.00	
		1.10	-10.50	0.97	-10.50	
		0.97	-12.00	0.83	-12.00	
		0.83	-13.50	0.70	-13.50	
		0.70	-15.00			

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
5		45.00	-15.00	45.00	-2.00	Dark Gray Clay (Drained) ▨
		23.87	-2.00	23.78	-3.00	
		23.65	-4.50	23.51	-6.00	
		23.38	-7.50	23.24	-9.00	
		23.10	-10.50	22.97	-12.00	
		22.83	-13.50	22.70	-15.00	
6		-2.14	-15.50	-2.14	-15.00	Dark Gray Clay (Drained) ▨
		-1.64	-15.00	-1.64	-13.50	
		-1.74	-13.50	-12.41	-15.50	
7		0.70	-15.00	-1.64	-15.00	#57 Stone ▨
		-2.14	-15.00	-2.14	-15.50	
		0.86	-15.50	0.86	-15.00	
8		22.70	-15.00	0.86	-15.00	Perched Clay (Drained) ▨
		0.86	-15.50	-2.14	-15.50	
		-12.41	-15.50	-17.74	-16.50	
		-37.50	-16.50	-37.50	-32.90	
		45.00	-32.90	45.00	-15.00	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	0.70	-15.00	22.70	-15.00	22.00	848.5	C = 0.67	Fixed
2	0.83	-13.50	22.83	-13.50	22.00	1696.9	C = 0.67	Fixed
3	0.97	-12.00	22.97	-12.00	22.00	1696.9	C = 0.67	Fixed
4	1.10	-10.50	23.10	-10.50	22.00	1696.9	C = 0.67	Fixed

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		reinf.
5	1.24	-9.00	23.24	-9.00	22.00	1696.9	C = 0.67	Fixed
6	1.38	-7.50	23.38	-7.50	22.00	1696.9	C = 0.67	Fixed
7	1.51	-6.00	23.51	-6.00	22.00	1696.9	C = 0.67	Fixed
8	1.65	-4.50	23.65	-4.50	22.00	1696.9	C = 0.67	Fixed
9	1.78	-3.00	23.78	-3.00	22.00	1696.9	C = 0.67	Fixed
10	1.92	-1.50	23.92	-1.50	22.00	1696.9	C = 0.67	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.32	[ft]	Angles :	α_1 =	-24.82	[°]
	z =	26.15	[ft]		α_2 =	83.19	[°]
Radius :	R =	46.99	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	21.5
3	0.0
4	0.0
5	0.0
6	0.0
7	0.0
8	0.0
9	0.0
10	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 52181.9 lbf/ft
Sum of passive forces : F_p = 73016.3 lbf/ft

Sliding moment : M_a = 2452029.4 lbfft/ft
Resisting moment : M_p = 3431033.8 lbfft/ft
Factor of safety = 1.40 > 1.35

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 12.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #3
Description : H12
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

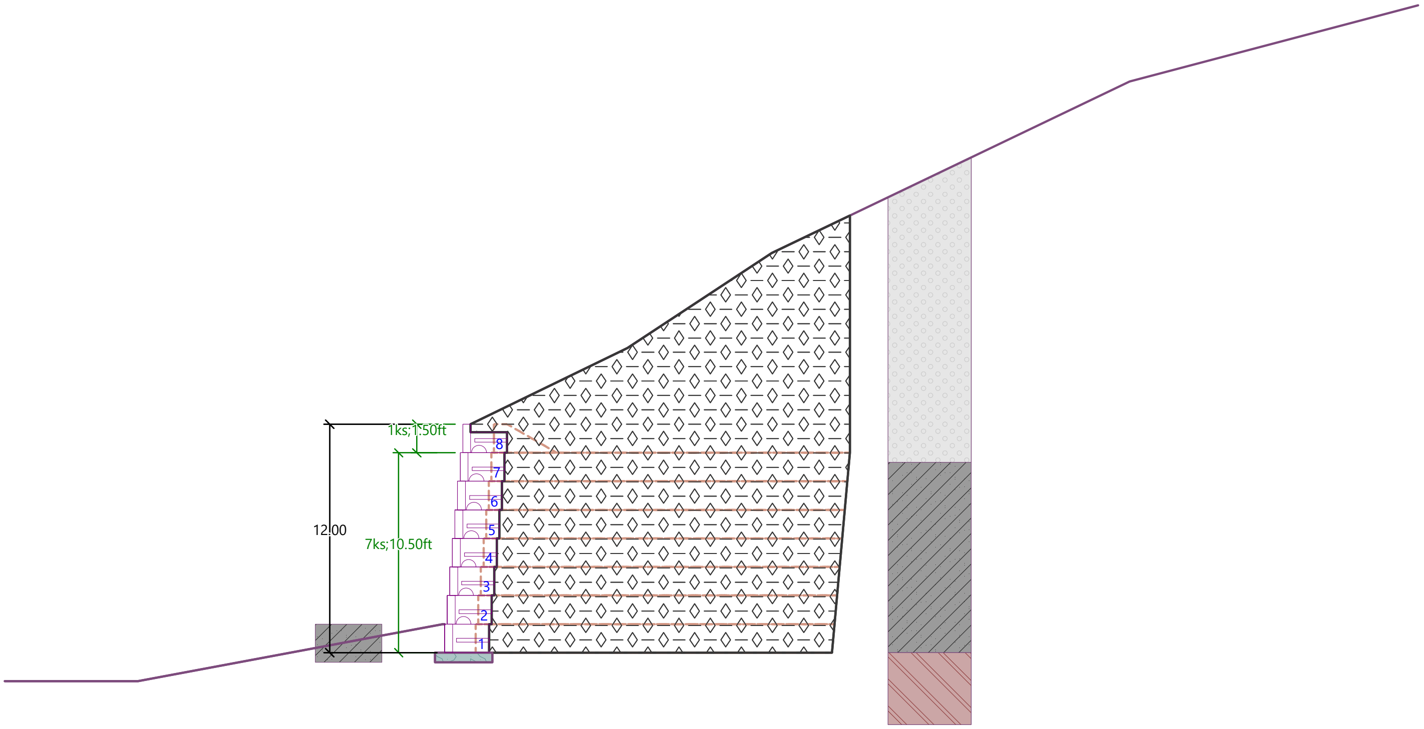
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	7	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback	a_1	=	0.50	ft
Lower setback	a_2	=	0.50	ft
Height	h	=	0.50	ft
Width	b	=	3.00	ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	=	7400.00	lbf/ft
Creep red. factor	RF_{CR}	=	1.58	
Durability red. factor	RF_D	=	1.15	
Installation damage red. factor	RF_{ID}	=	1.20	
Long-term design strength	R_t	=	3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	=	0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	=	0.67	
Scale correction factor	α	=	0.8	
Long-term strength reduction factor	CR_{cr}	=	0.532	
Calculation of long-term connection strength	R_{con}	=	3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 18.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	18.00	
2	Yes	Miragrid 8XT	18.00	
3	Yes	Miragrid 8XT	18.00	
4	Yes	Miragrid 8XT	18.00	
5	Yes	Miragrid 8XT	18.00	
6	Yes	Miragrid 8XT	18.00	
7	Yes	Miragrid 8XT	18.00	
8	Yes	Miragrid 8XT	18.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	2.00	0.00 .. 2.00	Light Gray Sand	░
2	10.00	2.00 .. 12.00	Dark Gray Clay (Drained)	▨
3	-	12.00 .. ∞	Perched Clay (Drained)	🟥

Terrain profile

No.	Coordinates x [ft]	Depth z [ft]
1	0.00	0.00
2	8.23	-4.00
3	15.81	-9.00
4	34.60	-18.00
5	49.75	-22.00
6	50.75	-22.00

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Dark Gray Clay (Drained)
Soil thickness in front of structure h = 2.00 ft

Terrain shape in front of structure

No.	Coordinate x[ft]	Depth z[ft]
1	0.00	0.00
2	0.00	-2.00
3	-0.10	-2.00
4	-16.10	1.00
5	-17.10	1.00

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1262.4	-0.69	0.0	2.33	1.000
Weight - reinforced soil	0.0	-9.21	37287.4	12.81	1.000
Active pressure	11400.5	-7.17	5821.5	21.28	1.000
Weight - wall	0.0	-5.83	3264.2	1.62	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 606918.6 lbfft/ft
Overturning moment M_{ovr} = 80900.2 lbfft/ft

Safety factor = 7.50 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 27519.29 lbf/ft
Active horizontal force H_{act} = 10138.06 lbf/ft

Safety factor = 2.71 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-62309.2	5907.29	-9042.90	0.000	1969.1

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-62309.2	5907.29	-9042.90

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 1969.1 psf
Bearing capacity of foundation soil R_d = 7500.0 psf

Safety factor = 3.81 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.83	3243.1	-0.71	1.000
FF resistance	-1261.4	-0.69	0.0	-2.33	1.000
Active pressure	12185.1	-6.98	5491.6	18.00	1.000
Weight - reinforced soil	0.0	-8.95	35290.1	10.10	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 40781.74 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 17447.95 lbf/ft
Wall resistance = 2721.32 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 21430.66 lbf/ft
Active horiz. force H_{act} = 12185.08 lbf/ft

Factor of safety = 1.76 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-340.06	12.00	848.47	60.12	5944.03	8.58	855.83	59.60
2	Miragrid 8XT	-607.99	10.50	1696.94	53.74	10605.25	8.60	1711.65	53.28
3	Miragrid 8XT	-524.26	9.00	1696.94	46.34	9392.20	8.37	1711.65	45.94
4	Miragrid 8XT	-464.59	7.50	1696.94	41.07	8248.92	8.45	1711.65	40.71
5	Miragrid 8XT	-404.93	6.00	1696.94	35.79	7175.40	8.46	1711.65	35.49
6	Miragrid 8XT	-345.26	4.50	1696.94	30.52	6171.64	8.39	1711.65	30.26
7	Miragrid 8XT	-285.60	3.00	1696.94	25.25	5237.65	8.18	1711.65	25.03
8	Miragrid 8XT	-316.53	1.50	1696.94	27.98	4373.41	10.86	855.83	55.48

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 340.06 lbf/ft

Safety factor = 2.50 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.8)
Pull out resistance T_p = 4373.41 lbf/ft
Force in reinforcement F_x = 316.53 lbf/ft

Safety factor = 13.82 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 340.06 lbf/ft

Safety factor = 2.52 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

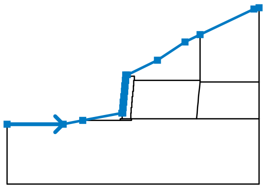
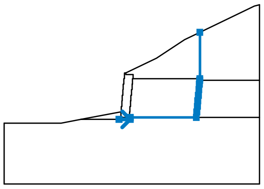
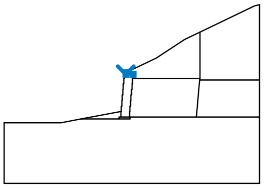
(input for current task)

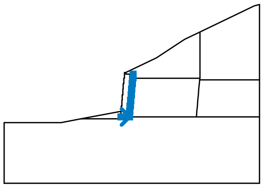
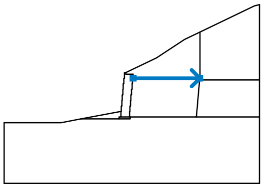
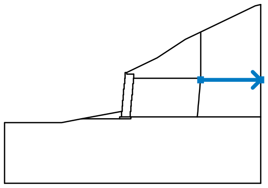
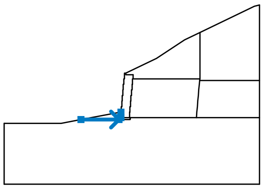
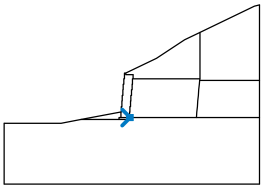
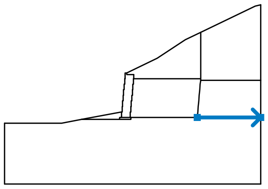
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-13.50	-17.46	-13.50	-12.13	-12.50
		-1.46	-10.50	-1.36	-10.50	-1.23	-10.50
		-1.23	-9.00	-1.09	-9.00	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	8.23	4.00
		15.81	9.00	19.92	10.97	34.60	18.00
		36.00	18.37				
2		-1.86	-12.50	1.14	-12.50	1.14	-12.00
		18.97	-12.00	19.10	-10.50	19.24	-9.00
		19.38	-7.50	19.51	-6.00	19.65	-4.50
		19.78	-3.00	19.87	-2.00	19.92	-1.50
		19.92	10.97				
3		0.00	0.00	0.00	-0.42	1.92	-0.42

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
4		-1.36	-12.00	0.97	-12.00	0.97	-10.50
		1.10	-10.50	1.10	-9.00	1.24	-9.00
		1.24	-7.50	1.38	-7.50	1.38	-6.00
		1.51	-6.00	1.51	-4.50	1.65	-4.50
		1.65	-3.00	1.78	-3.00	1.78	-1.50
		1.92	-1.50	1.92	-0.42		
5		1.92	-1.50	19.92	-1.50		
6		19.87	-2.00	36.00	-2.00		
7		-12.13	-12.50	-1.86	-12.50	-1.86	-12.00
		-1.36	-12.00	-1.36	-10.50		
8		0.97	-12.00	1.14	-12.00		
9		18.97	-12.00	36.00	-12.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Perched Clay (Drained)	▨	24.00	200.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Perched Clay (Drained)	▨	115.0		

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

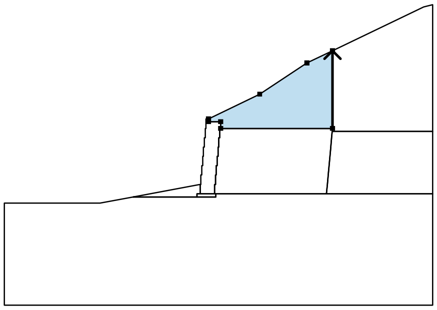
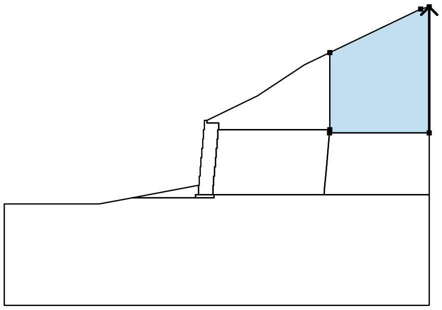
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

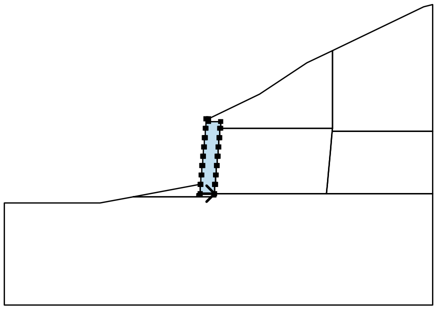
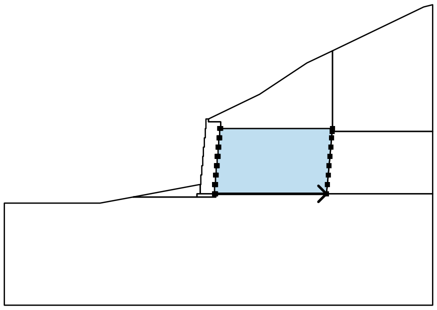
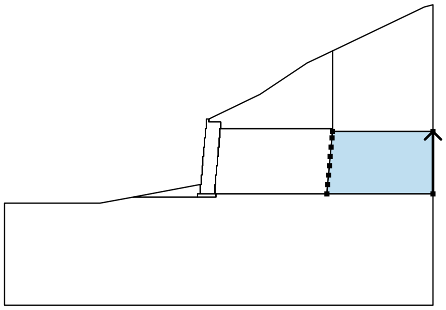
Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

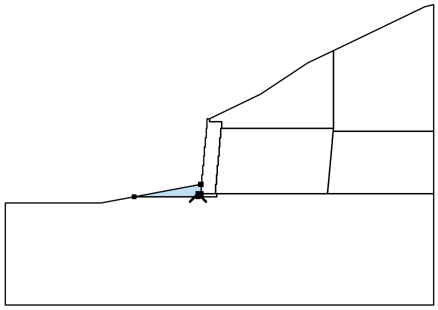
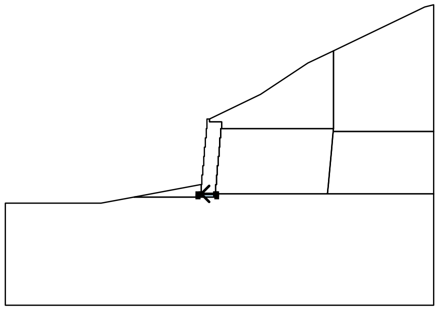
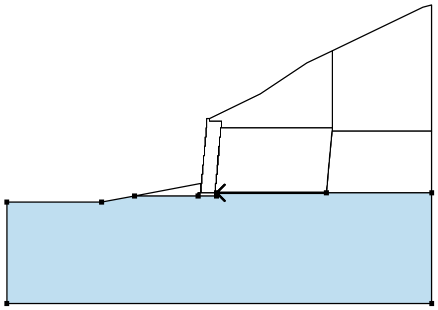
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		19.92	-1.50	19.92	10.97	Onsite Sands ▨
		15.81	9.00	8.23	4.00	
		0.00	0.00	0.00	-0.42	
		1.92	-0.42	1.92	-1.50	
2		36.00	-2.00	36.00	18.37	Light Gray Sand ▨
		34.60	18.00	19.92	10.97	
		19.92	-1.50	19.87	-2.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		-1.36	-12.00	0.97	-12.00	Material of structure
		0.97	-10.50	1.10	-10.50	▦
		1.10	-9.00	1.24	-9.00	
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
		-1.09	-9.00	-1.23	-9.00	
		-1.23	-10.50	-1.36	-10.50	
4		1.14	-12.00	18.97	-12.00	Onsite Sands
		19.10	-10.50	19.24	-9.00	◇
		19.38	-7.50	19.51	-6.00	
		19.65	-4.50	19.78	-3.00	
		19.87	-2.00	19.92	-1.50	
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.51	-4.50	
		1.51	-6.00	1.38	-6.00	
		1.38	-7.50	1.24	-7.50	
		1.24	-9.00	1.10	-9.00	
		1.10	-10.50	0.97	-10.50	
		0.97	-12.00			
5		36.00	-12.00	36.00	-2.00	Dark Gray Clay (Drained)
		19.87	-2.00	19.78	-3.00	▨
		19.65	-4.50	19.51	-6.00	
		19.38	-7.50	19.24	-9.00	
		19.10	-10.50	18.97	-12.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		-1.86	-12.50	-1.86	-12.00	Dark Gray Clay (Drained) ▨
		-1.36	-12.00	-1.36	-10.50	
		-1.46	-10.50	-12.13	-12.50	
7		0.97	-12.00	-1.36	-12.00	#57 Stone ▨
		-1.86	-12.00	-1.86	-12.50	
		1.14	-12.50	1.14	-12.00	
8		18.97	-12.00	1.14	-12.00	Perched Clay (Drained) ▨
		1.14	-12.50	-1.86	-12.50	
		-12.13	-12.50	-17.46	-13.50	
		-32.80	-13.50	-32.80	-29.90	
		36.00	-29.90	36.00	-12.00	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	0.97	-12.00	18.97	-12.00	18.00	848.5	C = 0.67	Fixed
2	1.10	-10.50	19.10	-10.50	18.00	1696.9	C = 0.67	Fixed
3	1.24	-9.00	19.24	-9.00	18.00	1696.9	C = 0.67	Fixed
4	1.38	-7.50	19.38	-7.50	18.00	1696.9	C = 0.67	Fixed
5	1.51	-6.00	19.51	-6.00	18.00	1696.9	C = 0.67	Fixed
6	1.65	-4.50	19.65	-4.50	18.00	1696.9	C = 0.67	Fixed
7	1.78	-3.00	19.78	-3.00	18.00	1696.9	C = 0.67	Fixed
8	1.92	-1.50	19.92	-1.50	18.00	1696.9	C = 0.67	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.00	[ft]	Angles :	α_1 =	-25.09	[°]
	z =	20.38	[ft]		α_2 =	86.66	[°]
Radius :	R =	37.41	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	11.5
3	0.0
4	0.0
5	0.0
6	0.0
7	0.0
8	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 34561.9 lbf/ft
Sum of passive forces : F_p = 51126.6 lbf/ft

Sliding moment : M_a = 1292960.6 lbfft/ft
Resisting moment : M_p = 1912646.3 lbfft/ft
Factor of safety = 1.48 > 1.35

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 9.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #3
Description : H9
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

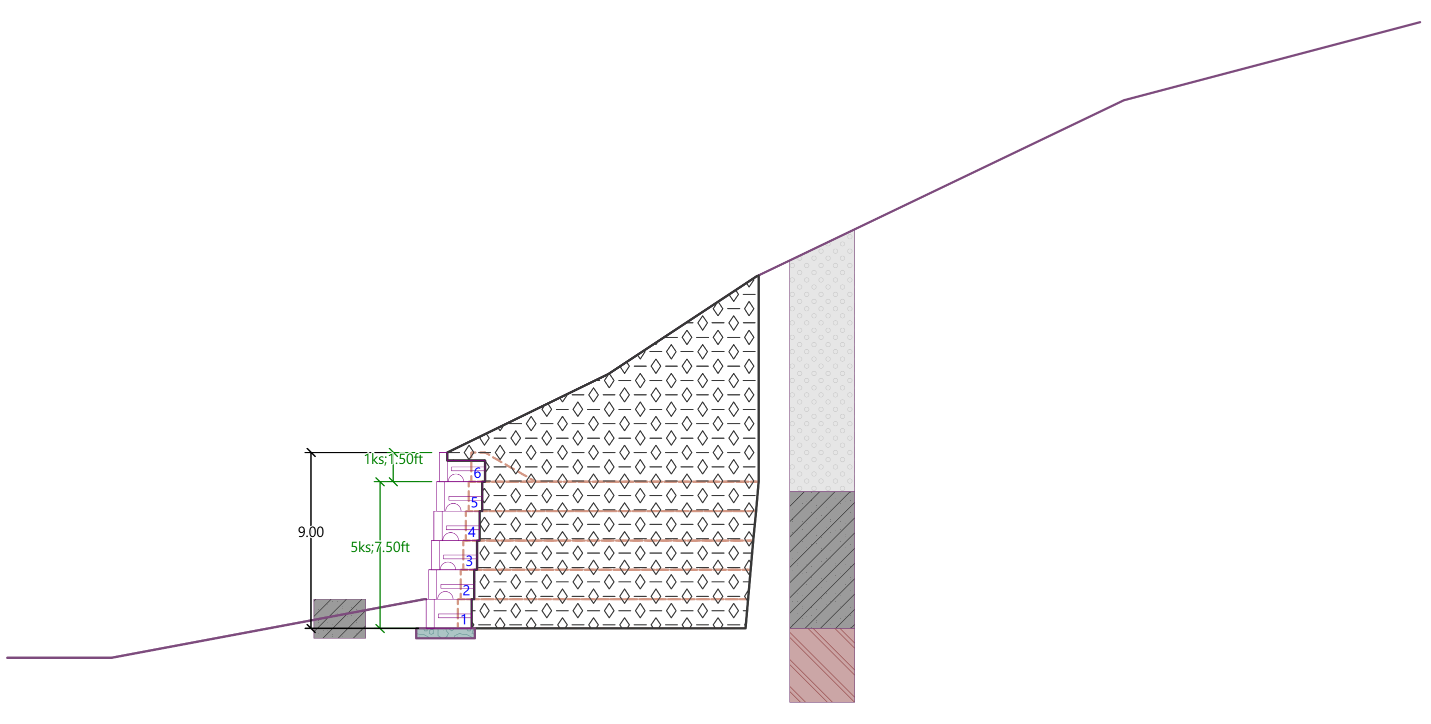
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	5	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	=	7400.00	lbf/ft
Creep red. factor	RF_{CR}	=	1.58	
Durability red. factor	RF_D	=	1.15	
Installation damage red. factor	RF_{ID}	=	1.20	
Long-term design strength	R_t	=	3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	=	0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	=	0.67	
Scale correction factor	α	=	0.8	
Long-term strength reduction factor	CR_{cr}	=	0.532	
Calculation of long-term connection strength	R_{con}	=	3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 14.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	14.00	
2	Yes	Miragrid 8XT	14.00	
3	Yes	Miragrid 8XT	14.00	
4	Yes	Miragrid 8XT	14.00	
5	Yes	Miragrid 8XT	14.00	
6	Yes	Miragrid 8XT	14.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	2.00	0.00 .. 2.00	Light Gray Sand	░
2	7.00	2.00 .. 9.00	Dark Gray Clay (Drained)	▨
3	-	9.00 .. ∞	Perched Clay (Drained)	🟥

Terrain profile

No.	Coordinates x [ft]	Depth z [ft]
1	0.00	0.00
2	8.23	-4.00
3	15.81	-9.00
4	34.60	-18.00
5	49.75	-22.00
6	50.75	-22.00

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Dark Gray Clay (Drained)
Soil thickness in front of structure h = 2.00 ft

Terrain shape in front of structure

No.	Coordinate x[ft]	Depth z[ft]
1	0.00	0.00
2	0.00	-2.00
3	-0.10	-2.00
4	-16.10	1.00
5	-17.10	1.00

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1262.4	-0.69	0.0	2.33	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - reinforced soil	0.0	-7.06	22309.9	10.43	1.000
Active pressure	7168.2	-5.51	3706.9	17.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment M_{res} = 299348.6 lbfft/ft
Overturning moment M_{ovr} = 38610.8 lbfft/ft

Safety factor = 7.75 > 2.00

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 17055.01 lbf/ft
Active horizontal force H_{act} = 5905.74 lbf/ft

Safety factor = 2.89 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-36864.9	4254.62	-7528.71	0.000	1418.2

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-36864.9	4254.62	-7528.71

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1418.2 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 4.23 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000
FF resistance	-1261.4	-0.69	0.0	-2.33	1.000
Active pressure	7872.6	-5.42	3546.1	14.00	1.000
Weight - reinforced soil	0.0	-6.86	21122.1	7.84	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 24668.15 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 10553.95 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 13832.28 lbf/ft
Active horiz. force H_{act} = 7872.59 lbf/ft

Factor of safety = 1.76 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-250.00	9.00	848.47	44.20	3506.75	10.69	855.83	43.82
2	Miragrid 8XT	-434.51	7.50	1696.94	38.41	6033.51	10.80	1711.65	38.08
3	Miragrid 8XT	-357.42	6.00	1696.94	31.59	5123.29	10.46	1711.65	31.32
4	Miragrid 8XT	-297.76	4.50	1696.94	26.32	4282.83	10.43	1711.65	26.09
5	Miragrid 8XT	-238.09	3.00	1696.94	21.05	3512.13	10.17	1711.65	20.87
6	Miragrid 8XT	-245.27	1.50	1696.94	21.68	2811.20	13.09	855.83	42.99

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 250.00 lbf/ft

Safety factor = 3.39 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.6)
Pull out resistance T_p = 2811.20 lbf/ft
Force in reinforcement F_x = 245.27 lbf/ft

Safety factor = 11.46 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)
Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 250.00 lbf/ft

Safety factor = 3.42 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

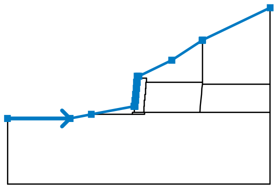
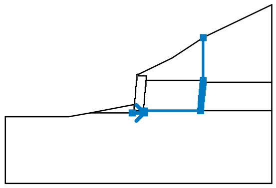
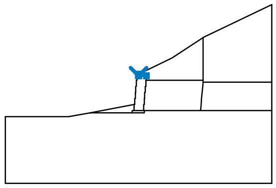
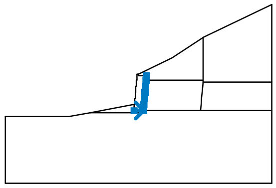
(input for current task)

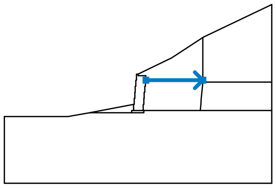
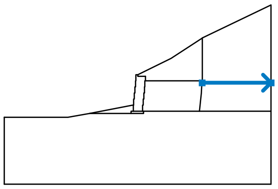
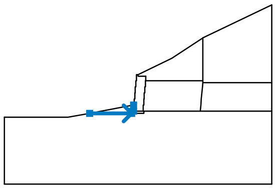
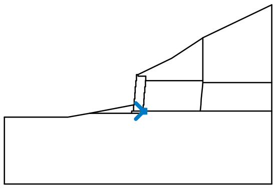
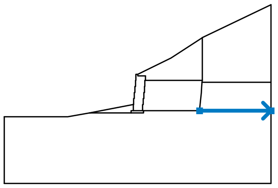
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-10.50	-17.19	-10.50	-11.86	-9.50
		-1.19	-7.50	-1.09	-7.50	-0.96	-7.50
		-0.96	-6.00	-0.82	-6.00	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	8.23	4.00	15.81	9.00
		15.92	9.05	32.80	17.14		
2		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		15.24	-9.00	15.38	-7.50	15.51	-6.00
		15.65	-4.50	15.78	-3.00	15.87	-2.00
		15.92	-1.50	15.92	9.05		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		1.92	-1.50	15.92	-1.50		
6		15.87	-2.00	32.80	-2.00		
7		-11.86	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		
8		1.24	-9.00	1.41	-9.00		
9		15.24	-9.00	32.80	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Perched Clay (Drained)	▨	24.00	200.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Perched Clay (Drained)	▨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °

Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

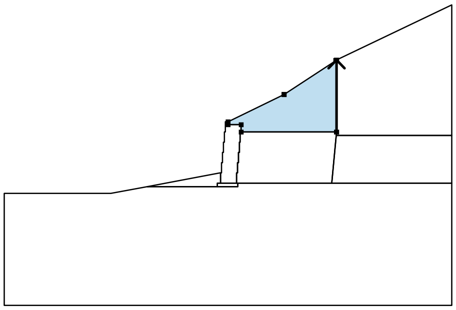
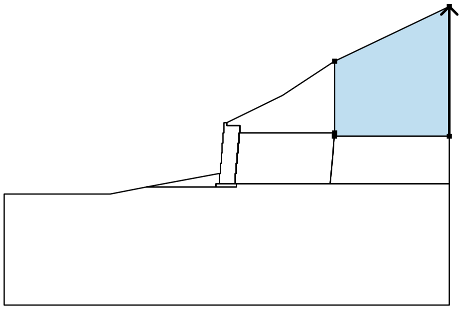
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

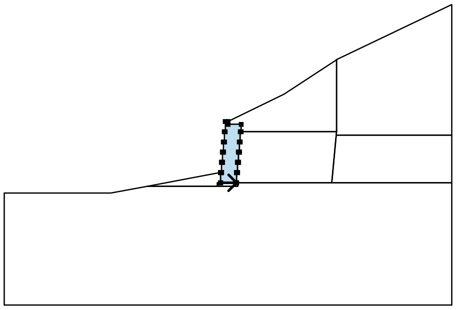
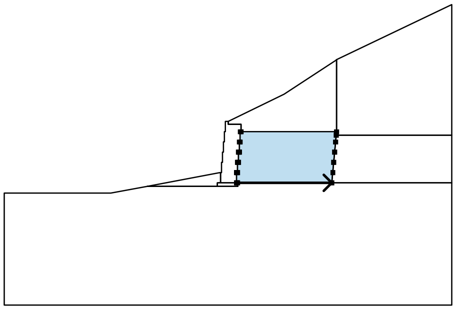
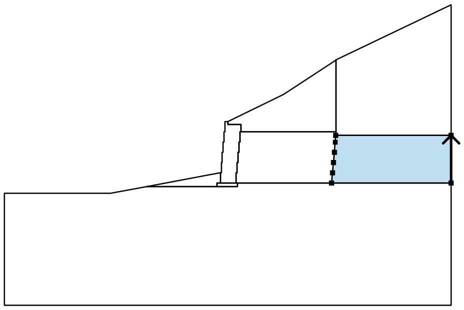
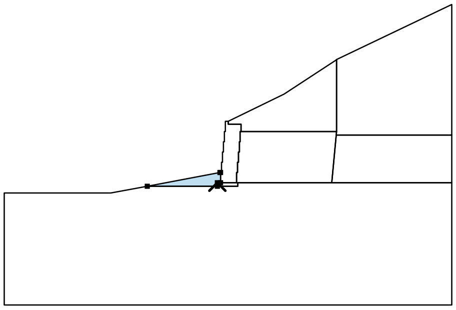
Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

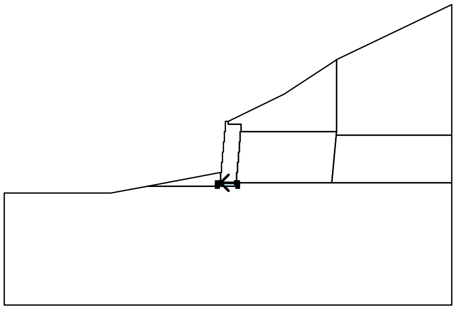
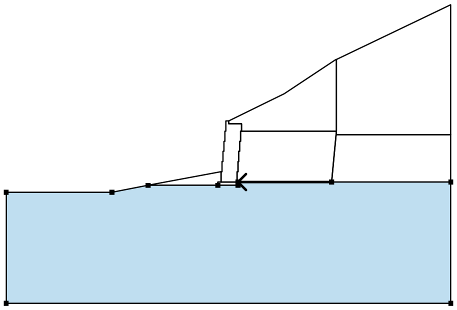
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		15.92	-1.50	15.92	9.05	Onsite Sands
		15.81	9.00	8.23	4.00	▩
		0.00	0.00	0.00	-0.42	
		1.92	-0.42	1.92	-1.50	
2		32.80	-2.00	32.80	17.14	Light Gray Sand
		15.92	9.05	15.92	-1.50	▒
		15.87	-2.00			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		-1.09	-9.00	1.24	-9.00	Material of structure
		1.24	-7.50	1.38	-7.50	▦
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
4		1.41	-9.00	15.24	-9.00	Onsite Sands
		15.38	-7.50	15.51	-6.00	▩
		15.65	-4.50	15.78	-3.00	
		15.87	-2.00	15.92	-1.50	
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.51	-4.50	
		1.51	-6.00	1.38	-6.00	
		1.38	-7.50	1.24	-7.50	
		1.24	-9.00			
5		32.80	-9.00	32.80	-2.00	Dark Gray Clay (Drained)
		15.87	-2.00	15.78	-3.00	▨
		15.65	-4.50	15.51	-6.00	
		15.38	-7.50	15.24	-9.00	
6		-1.59	-9.50	-1.59	-9.00	Dark Gray Clay (Drained)
		-1.09	-9.00	-1.09	-7.50	▨
		-1.19	-7.50	-11.86	-9.50	

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
7		1.24	-9.00	-1.09	-9.00	#57 Stone ▨
		-1.59	-9.00	-1.59	-9.50	
		1.41	-9.50	1.41	-9.00	
8		15.24	-9.00	1.41	-9.00	Perched Clay (Drained) ▨
		1.41	-9.50	-1.59	-9.50	
		-11.86	-9.50	-17.19	-10.50	
		-32.80	-10.50	-32.80	-26.90	
		32.80	-26.90	32.80	-9.00	

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.24	-9.00	15.24	-9.00	14.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	15.38	-7.50	14.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	15.51	-6.00	14.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	15.65	-4.50	14.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	15.78	-3.00	14.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	15.92	-1.50	14.00	1696.9	C = 0.67	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.92	[ft]	Angles :	α_1 =	-20.96	[°]
	z =	23.05	[ft]		α_2 =	79.94	[°]
Radius :	R =	35.62	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 23639.9 lbf/ft
Sum of passive forces : F_p = 36694.2 lbf/ft

Sliding moment : M_a = 842054.3 lbfft/ft
Resisting moment : M_p = 1307047.7 lbfft/ft
Factor of safety = 1.55 > 1.35

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 6.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #3
Description : H6
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

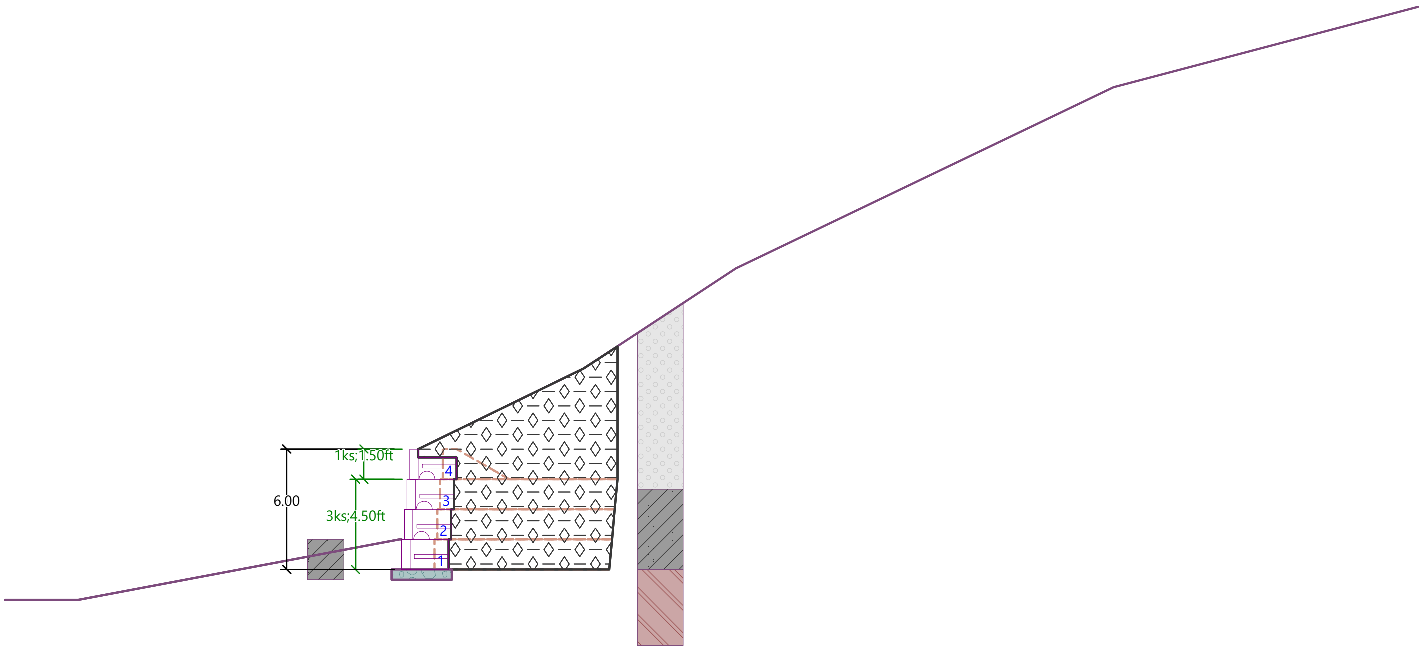
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	3	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	– – – – – – – – – –	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength T_{ult} = 7400.00 lbf/ft
Creep red. factor RF_{CR} = 1.58
Durability red. factor RF_D = 1.15
Installation damage red. factor RF_{ID} = 1.20
Long-term design strength R_t = 3393.87 lbf/ft
Coefficient of direct slip along reinforcement C_{ds} = 0.67
Coefficient of interaction of soil and geo-reinforcement C_i = 0.67
Scale correction factor α = 0.8
Long-term strength reduction factor CR_{cr} = 0.532
Calculation of long-term connection strength R_{con} = 3423.30 lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 8.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	8.00	
2	Yes	Miragrid 8XT	8.00	
3	Yes	Miragrid 8XT	8.00	
4	Yes	Miragrid 8XT	8.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	░	32.00	50.0	115.00	57.50	21.33
5	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	2.00	0.00 .. 2.00	Light Gray Sand	░
2	4.00	2.00 .. 6.00	Dark Gray Clay (Drained)	▨
3	-	6.00 .. ∞	Perched Clay (Drained)	🟥

Terrain profile

No.	Coordinates x [ft]	Depth z [ft]
1	0.00	0.00
2	8.23	-4.00
3	15.81	-9.00
4	34.60	-18.00
5	49.75	-22.00
6	50.75	-22.00

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Dark Gray Clay (Drained)
Soil thickness in front of structure h = 2.00 ft

Terrain shape in front of structure

No.	Coordinate x[ft]	Depth z[ft]
1	0.00	0.00
2	0.00	-2.00
3	-0.10	-2.00
4	-16.10	1.00
5	-17.10	1.00

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1262.4	-0.69	0.0	2.33	1.000
Weight - reinforced soil	0.0	-4.56	8423.5	6.81	1.000
Active pressure	3342.7	-3.44	1743.1	10.74	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.83	1584.2	1.34	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment M_{res} = 78184.2 lbfft/ft
Overturning moment M_{ovr} = 10623.3 lbfft/ft

Safety factor = 7.36 > 2.00

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7211.02 lbf/ft
Active horizontal force H_{act} = 2080.25 lbf/ft

Safety factor = 3.47 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-17259.6	2770.69	-5593.84	0.000	923.6

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-17259.6	2770.69	-5593.84

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 923.6 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 6.50 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.83	1564.7	-0.99	1.000
FF resistance	-1261.4	-0.69	0.0	-2.33	1.000
Active pressure	5835.3	-4.44	2598.0	6.10	1.000
Weight - reinforced soil	0.0	-6.57	14101.5	7.41	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 60.00 °
Overall normal force acting on reinforcement = 16699.54 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 7144.68 lbf/ft
Wall resistance = 1312.96 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:

Resisting horizontal force H_{res} = 9719.04 lbf/ft
Active horiz. force H_{act} = 5835.31 lbf/ft

Factor of safety = 1.67 > 1.50

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-159.95	6.00	848.47	28.28	1337.03	17.94	855.83	28.03
2	Miragrid 8XT	-261.04	4.50	1696.94	23.07	2065.77	18.95	1711.65	22.88
3	Miragrid 8XT	-190.59	3.00	1696.94	16.85	1532.79	18.65	1711.65	16.70
4	Miragrid 8XT	-174.01	1.50	1696.94	15.38	1075.15	24.28	855.83	30.50

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 159.95 lbf/ft

Safety factor = 5.30 > 1.50

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.4)

Pull out resistance T_p = 1075.15 lbf/ft
Force in reinforcement F_x = 174.01 lbf/ft

Safety factor = 6.18 > 1.50

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.4)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 174.01 lbf/ft

Safety factor = 4.92 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

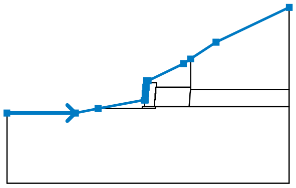
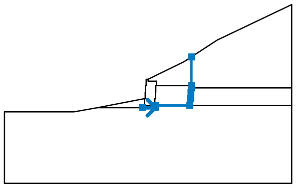
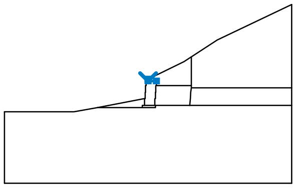
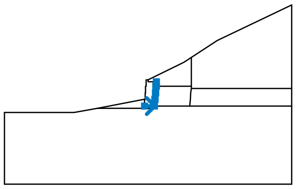
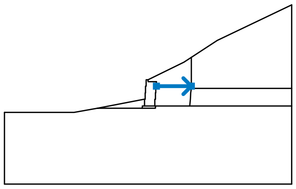
(input for current task)

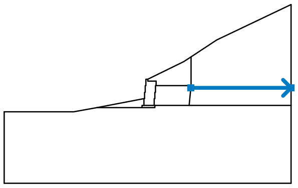
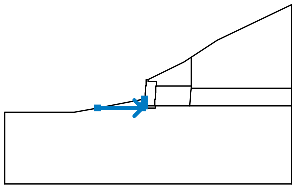
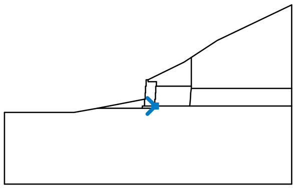
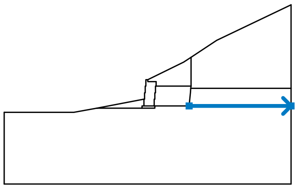
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-7.50	-16.92	-7.50	-11.59	-6.50
		-0.92	-4.50	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		8.23	4.00	9.92	5.11	15.81	9.00
		32.80	17.14				
2		-1.32	-6.50	1.68	-6.50	1.68	-6.00
		9.51	-6.00	9.65	-4.50	9.78	-3.00
		9.87	-2.00	9.92	-1.50	9.92	5.11
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-0.82	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
5		1.92	-1.50	9.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		9.87	-2.00	32.80	-2.00		
7		-11.59	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
8		1.51	-6.00	1.68	-6.00		
9		9.51	-6.00	32.80	-6.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Perched Clay (Drained)	▨	24.00	200.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Perched Clay (Drained)	▨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

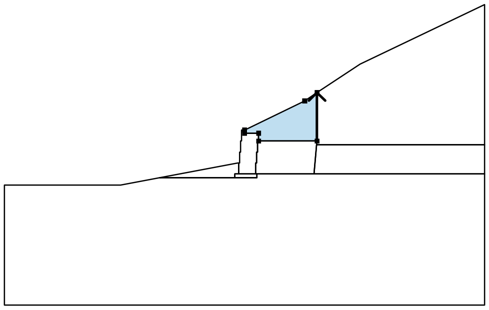
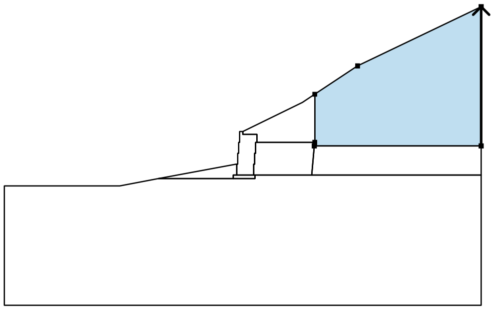
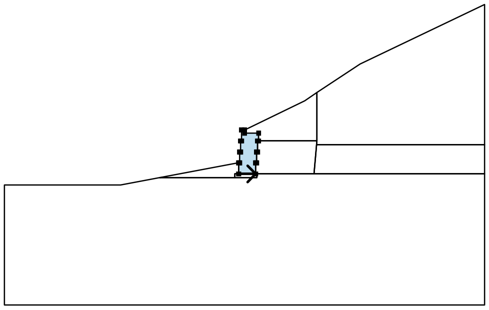
Perched Clay (Drained)

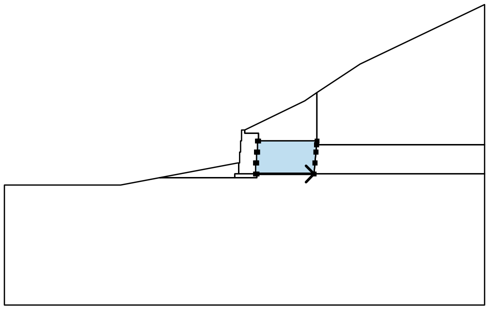
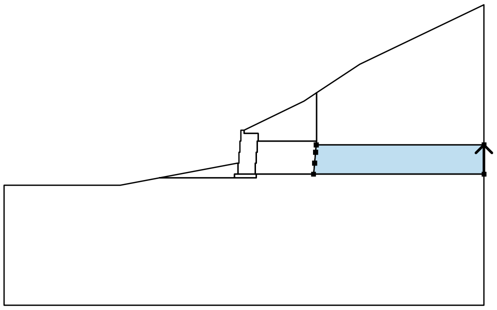
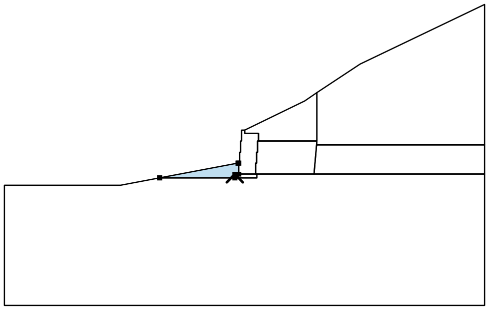
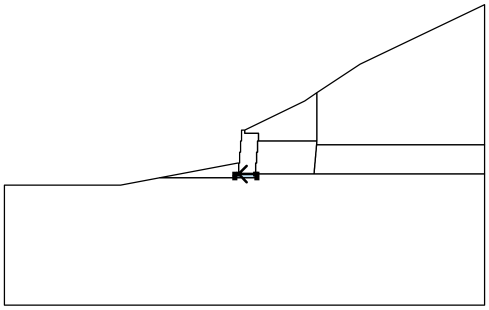
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

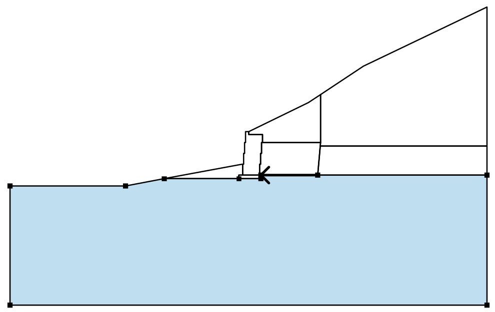
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		9.92	-1.50	9.92	5.11	Onsite Sands ▩
		8.23	4.00	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		32.80	-2.00	32.80	17.14	Light Gray Sand ░
		15.81	9.00	9.92	5.11	
		9.92	-1.50	9.87	-2.00	
3		-0.82	-6.00	1.51	-6.00	Material of structure 🟥
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
4		1.68	-6.00	9.51	-6.00	Onsite Sands
		9.65	-4.50	9.78	-3.00	▨
		9.87	-2.00	9.92	-1.50	
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.51	-4.50	
		1.51	-6.00			
5		32.80	-6.00	32.80	-2.00	Dark Gray Clay (Drained)
		9.87	-2.00	9.78	-3.00	▨
		9.65	-4.50	9.51	-6.00	
6		-1.32	-6.50	-1.32	-6.00	Dark Gray Clay (Drained)
		-0.82	-6.00	-0.82	-4.50	▨
		-0.92	-4.50	-11.59	-6.50	
7		1.51	-6.00	-0.82	-6.00	#57 Stone
		-1.32	-6.00	-1.32	-6.50	▨
		1.68	-6.50	1.68	-6.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
8		9.51	-6.00	1.68	-6.00	Perched Clay (Drained)
		1.68	-6.50	-1.32	-6.50	▨
		-11.59	-6.50	-16.92	-7.50	
		-32.80	-7.50	-32.80	-23.90	
		32.80	-23.90	32.80	-6.00	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	1.51	-6.00	9.51	-6.00	8.00	848.5	C = 0.67	Fixed
2	1.65	-4.50	9.65	-4.50	8.00	1696.9	C = 0.67	Fixed
3	1.78	-3.00	9.78	-3.00	8.00	1696.9	C = 0.67	Fixed
4	1.92	-1.50	9.92	-1.50	8.00	1696.9	C = 0.67	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.95	[ft]	Angles :	α_1 =	4.02	[°]
	z =	42.05	[ft]		α_2 =	51.51	[°]
Radius :	R =	42.15	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 4470.6 lbf/ft
Sum of passive forces : F_p = 6786.0 lbf/ft
Sliding moment : M_a = 188435.3 lbfft/ft
Resisting moment : M_p = 286029.0 lbfft/ft
Factor of safety = 1.52 > 1.35

Slope stability ACCEPTABLE

Geotechnical, Environmental and Materials Engineers

WALL #4

MAX. WALL HEIGHT = 9.0 FEET

Geotechnical, Environmental and Materials Engineers

INTERNAL/EXTERNAL STABILITY

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #4
Description : H6
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Post Construction - 250 PSF Traffic Surcharge

Safety factors Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

During Construction - 1600 PSF Static Trencher Surcharge

Safety factors Transient design situation			
Safety factor for overturning :	SF_o =	1.50	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients Transient design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Safety factors Accidental design situation			
Safety factor for overturning :	SF_o =	1.50	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.10	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.10	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.10	[–]
Safety factor for connection strength :	SF_{con} =	1.10	[–]

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Reduction coefficients Accidental design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

Setbacks

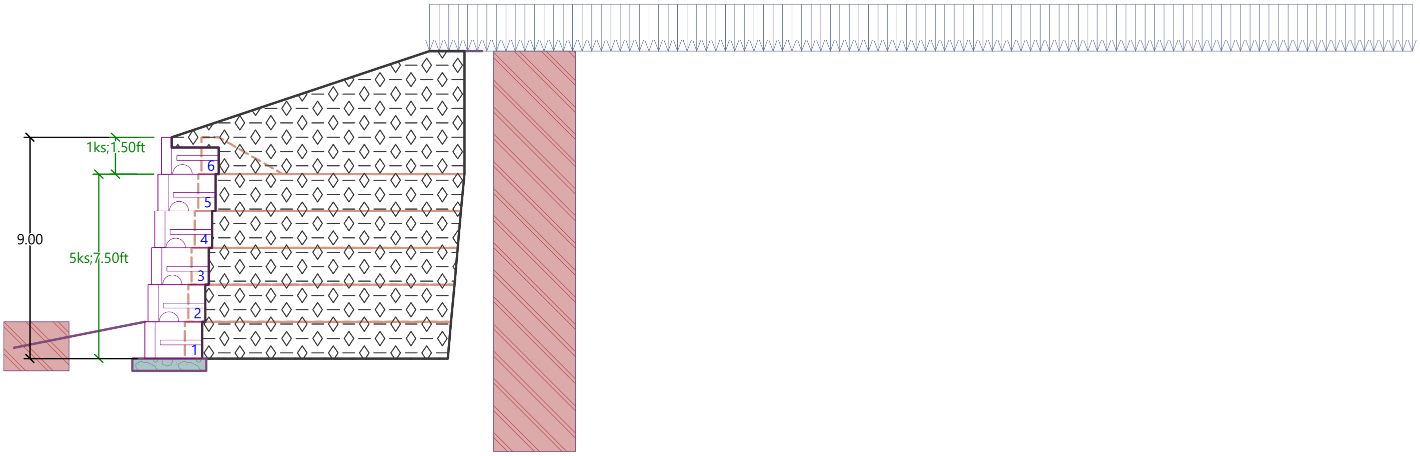
No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	5	1.62
2	Top block 28	1	-

Name : Geometry | **Stage - analysis : 1 - 0**

Post Construction - 250 PSF Traffic Surcharge



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	– – – – – – – – – –	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	=	7400.00	lbf/ft
Creep red. factor	RF_{CR}	=	1.58	
Durability red. factor	RF_D	=	1.15	
Installation damage red. factor	RF_{ID}	=	1.20	
Long-term design strength	R_t	=	3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	=	0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	=	0.67	
Scale correction factor	α	=	0.8	
Long-term strength reduction factor	CR_{cr}	=	0.532	
Calculation of long-term connection strength	R_{con}	=	3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 10.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	10.00	
2	Yes	Miragrid 8XT	10.00	
3	Yes	Miragrid 8XT	10.00	
4	Yes	Miragrid 8XT	10.00	
5	Yes	Miragrid 8XT	10.00	
6	Yes	Miragrid 8XT	10.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Perched Clay (Drained)	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.50 ft, embankment length is 10.50 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.00		10.50	40.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -11.31 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1 (Stage of construction 1)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1175.0	-0.69	-235.0	2.33	1.000
Weight - reinforced soil	0.0	-5.71	13183.6	7.92	1.000
Active pressure	992.2	-2.44	441.8	13.01	1.000
Traffic	704.6	-4.24	462.2	13.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000
Traffic	0.0	-12.50	354.2	12.30	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 123615.2 lbfft/ft
Overturning moment M_{ovr} = 4594.7 lbfft/ft

Safety factor = 26.90 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 9056.84 lbf/ft
Active horizontal force H_{act} = 521.77 lbf/ft

Safety factor = 17.36 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 1)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-38909.0	3644.22	-8089.98	0.000	1214.7

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-38909.0	3644.22	-8089.98

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 1214.7 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 4.94 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 1)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1174.0	-0.69	-234.8	-2.33	1.000
Active pressure	991.9	-2.44	441.6	10.00	1.000
Traffic	702.5	-4.24	461.3	10.00	1.000
Weight - reinforced soil	0.0	-5.55	12440.3	5.39	1.000
Traffic	0.0	-12.50	184.9	9.63	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 13528.13 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 5526.20 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 8717.15 lbf/ft
Active horiz. force H_{act} = 1694.41 lbf/ft

Factor of safety = 5.14 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 1)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-281.35	9.00	848.47	49.74	2133.81	19.78	855.83	49.31
2	Miragrid 8XT	-499.13	7.50	1696.94	44.12	3462.15	21.63	1711.65	43.74
3	Miragrid 8XT	-333.17	6.00	1696.94	29.45	2736.90	18.26	1711.65	29.20
4	Miragrid 8XT	-260.45	4.50	1696.94	23.02	2091.86	18.68	1711.65	22.82
5	Miragrid 8XT	-200.78	3.00	1696.94	17.75	1527.04	19.72	1711.65	17.60
6	Miragrid 8XT	-189.30	1.50	1696.94	16.73	1042.44	27.24	855.83	33.18

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 281.35 lbf/ft

Safety factor = 3.02 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.6)
Pull out resistance T_p = 1042.44 lbf/ft
Force in reinforcement F_x = 189.30 lbf/ft

Safety factor = 5.51 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)
Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 281.35 lbf/ft

Safety factor = 3.04 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Input data (Stage of construction 2)

During Construction - 1600 PSF
Static Trencher Surcharge

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Perched Clay (Drained)	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.50 ft, embankment length is 10.50 ft.

Water influence

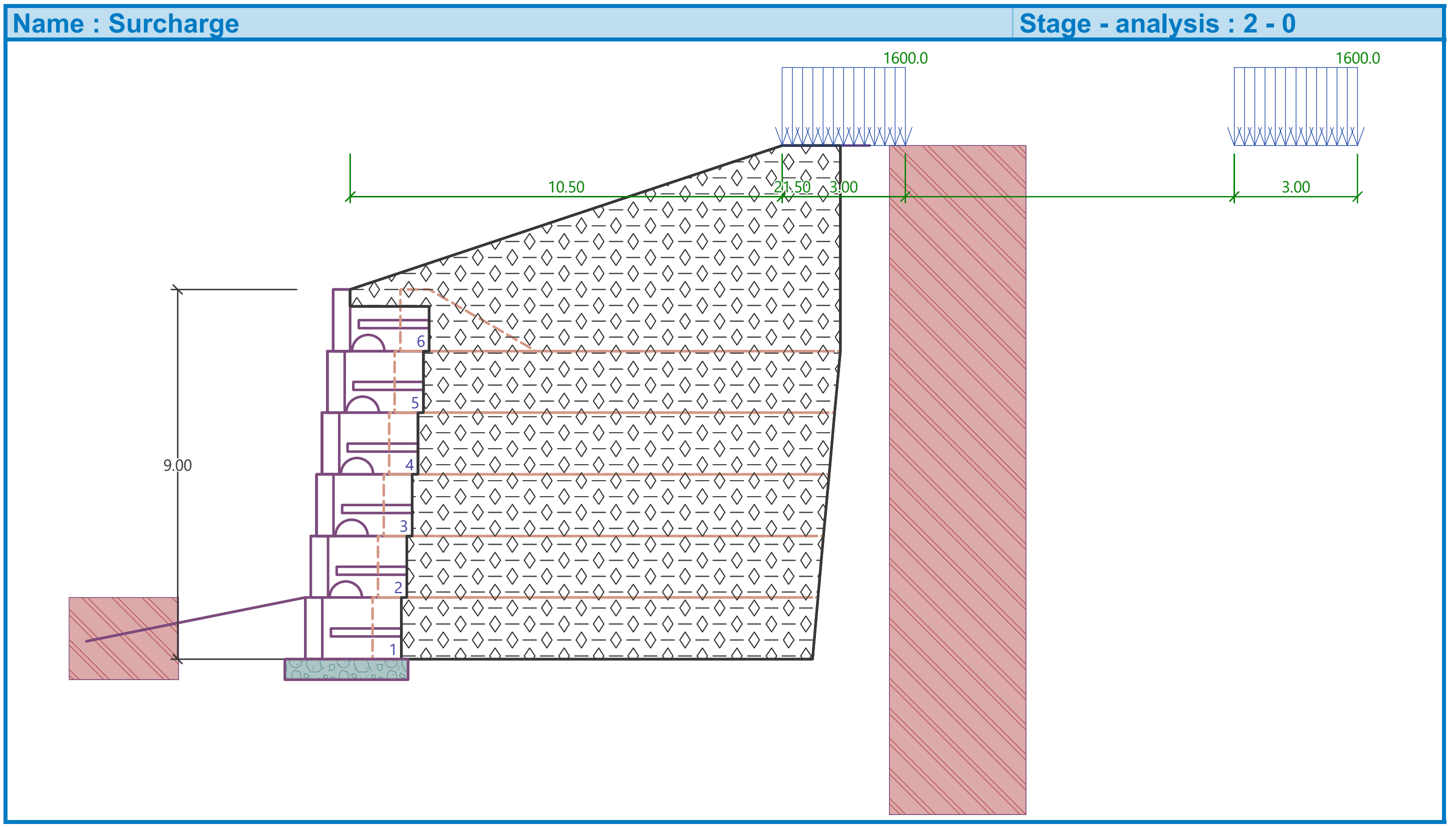
Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft^2]	Mag.2 [lbf/ft^2]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1600.00		10.50	3.00	on terrain
2	Yes		permanent	1600.00		21.50	3.00	on terrain

No.	Name
1	Trencher Track 1 - Static
2	Trencher Track 2 - Static

Name : Surcharge **Stage - analysis : 2 - 0**



Resistance on front face of the structure

Resistance on front face of the structure: passive

Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -11.31 °

Settings of the stage of construction

Design situation : transient

Verification No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1175.0	-0.69	-235.0	2.33	1.000
Weight - reinforced soil	0.0	-5.71	13183.6	7.92	1.000
Active pressure	992.2	-2.44	441.8	13.01	1.000
Trencher Track 1 - Static	854.4	-11.29	532.8	13.01	1.000
Trencher Track 2 - Static	1743.4	-4.59	783.0	13.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000
Trencher Track 1 - Static	0.0	-12.50	2266.7	12.30	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 158248.5 lbfft/ft
Overturning moment M_{ovr} = 19260.8 lbfft/ft

Safety factor = 8.22 > 1.50
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 10186.78 lbf/ft
Active horizontal force H_{act} = 2415.02 lbf/ft

Safety factor = 4.22 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 2)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-35986.0	4012.00	-7205.96	0.000	1337.3

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-35986.0	4012.00	-7205.96

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1337.3 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 4.49 > 2.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 2)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000
FF resistance	-1174.0	-0.69	-234.8	-2.33	1.000
Active pressure	991.9	-2.44	441.6	10.00	1.000
Trencher Track 1 - Static	1293.3	-10.75	766.5	10.00	1.000
Trencher Track 2 - Static	1671.7	-4.38	747.4	10.00	1.000
Weight - reinforced soil	0.0	-5.55	12440.3	5.39	1.000
Trencher Track 1 - Static	0.0	-12.50	1183.3	9.63	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 15579.14 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 6364.04 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:

Resisting horizontal force H_{res} = 9554.98 lbf/ft
Active horiz. force H_{act} = 3956.95 lbf/ft

Factor of safety = 2.41 > 1.50

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 2)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-389.98	9.00	848.47	68.94	2133.81	27.41	855.83	68.35
2	Miragrid 8XT	-745.59	7.50	1696.94	65.91	3462.15	32.30	1711.65	65.34
3	Miragrid 8XT	-367.22	6.00	1696.94	32.46	2736.90	20.13	1711.65	32.18
4	Miragrid 8XT	-260.45	4.50	1696.94	23.02	2091.86	18.68	1711.65	22.82
5	Miragrid 8XT	-200.78	3.00	1696.94	17.75	1527.04	19.72	1711.65	17.60
6	Miragrid 8XT	-189.30	1.50	1696.94	16.73	1042.44	27.24	855.83	33.18

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 389.98 lbf/ft

Safety factor = 2.18 > 1.50

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.2)

Pull out resistance T_p = 3462.15 lbf/ft
Force in reinforcement F_x = 745.59 lbf/ft

Safety factor = 4.64 > 1.50

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 389.98 lbf/ft

Safety factor = 2.19 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Input data (Stage of construction 3)

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Perched Clay (Drained)	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 3.50 ft, embankment length is 10.50 ft.

Water influence

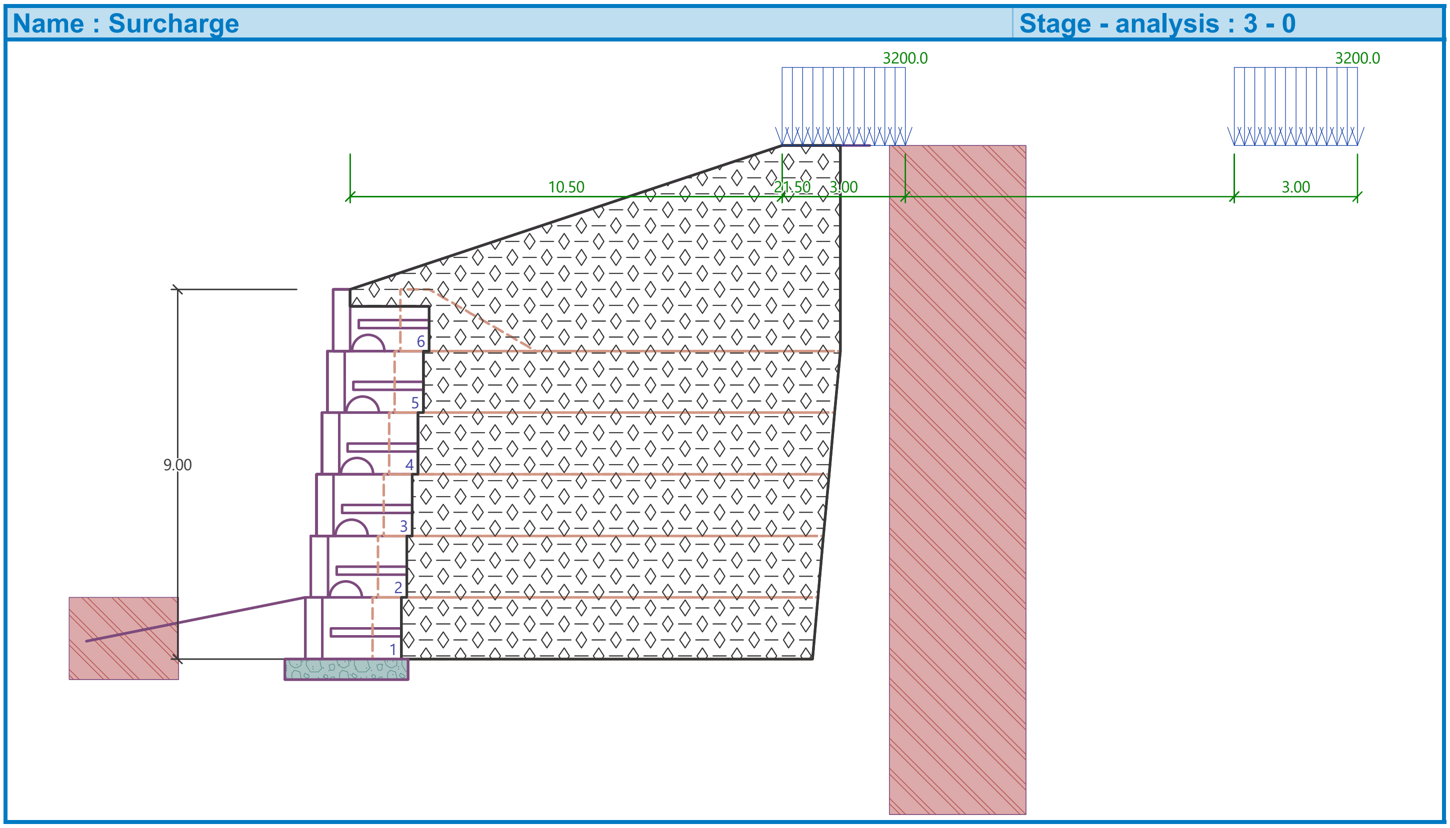
Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft^2]	Mag.2 [lbf/ft^2]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	3200.00		10.50	3.00	on terrain
2	Yes		permanent	3200.00		21.50	3.00	on terrain

No.	Name
1	Trencher Track 1 - Dynamic
2	Trencher Track 2 - Dynamic

Name : Surcharge | **Stage - analysis : 3 - 0**



Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Perched Clay (Drained)
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -11.31 °

Settings of the stage of construction

Design situation : accidental

Verification No. 1 (Stage of construction 3)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1175.0	-0.69	-235.0	2.33	1.000
Weight - reinforced soil	0.0	-5.71	13183.6	7.92	1.000
Active pressure	992.2	-2.44	441.8	13.01	1.000
Trencher Track 1 - Dynamic	2051.0	-11.32	1065.6	13.01	1.000
Trencher Track 2 - Dynamic	3502.1	-4.61	1566.1	13.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000
Trencher Track 1 - Dynamic	0.0	-12.50	4533.3	12.30	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 203252.6 lbfft/ft

Overturning moment M_{ovr} = 40947.8 lbfft/ft

Safety factor = 4.96 > 1.50

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 11650.22 lbf/ft
Active horizontal force H_{act} = 5370.39 lbf/ft

Safety factor = 2.17 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 3)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-31798.3	4569.06	-5880.63	0.000	1523.0

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-31798.3	4569.06	-5880.63

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1523.0 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 3.94 > 2.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 3)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000
FF resistance	-1174.0	-0.69	-234.8	-2.33	1.000
Active pressure	991.9	-2.44	441.6	10.00	1.000
Trencher Track 1 - Dynamic	3014.9	-10.80	1533.0	10.00	1.000
Trencher Track 2 - Dynamic	3350.3	-4.38	1494.7	10.00	1.000
Weight - reinforced soil	0.0	-5.55	12440.3	5.39	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Trencher Track 1 - Dynamic	0.0	-12.50	2366.7	9.63	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 18276.35 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 7465.84 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:

Resisting horizontal force H_{res} = 10656.79 lbf/ft
Active horiz. force H_{act} = 7357.17 lbf/ft

Factor of safety = 1.45 > 1.10

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 3)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-548.61	9.00	848.47	71.12	2133.81	28.28	855.83	70.51
2	Miragrid 8XT	-1093.98	7.50	1696.94	70.91	3462.15	34.76	1711.65	70.30
3	Miragrid 8XT	-414.34	6.00	1696.94	26.86	2736.90	16.65	1711.65	26.63
4	Miragrid 8XT	-260.45	4.50	1696.94	16.88	2091.86	13.70	1711.65	16.74
5	Miragrid 8XT	-200.78	3.00	1696.94	13.02	1527.04	14.46	1711.65	12.90
6	Miragrid 8XT	-189.30	1.50	1696.94	12.27	1042.44	19.98	855.83	24.33

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 548.61 lbf/ft

Safety factor = 1.55 > 1.10

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.2)

Pull out resistance T_p = 3462.15 lbf/ft
Force in reinforcement F_x = 1093.98 lbf/ft

Safety factor = 3.16 > 1.10

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 548.61 lbf/ft

Safety factor = 1.56 > 1.10

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

GLOBAL STABILITY

Slope stability analysis

Post Construction - 250 PSF Traffic Surcharge

Input data

Project

Settings

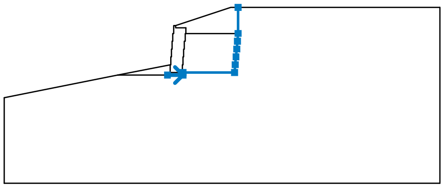
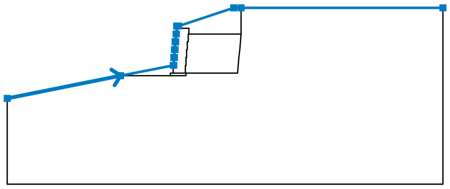
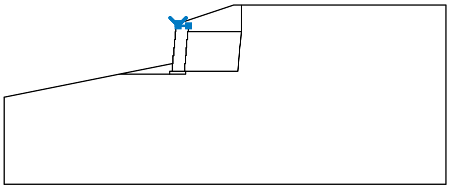
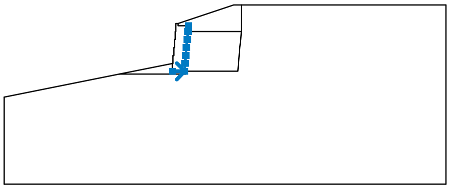
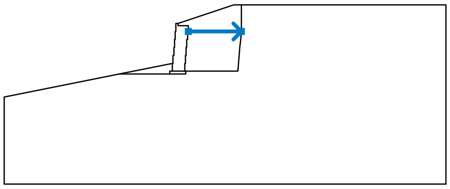
(input for current task)

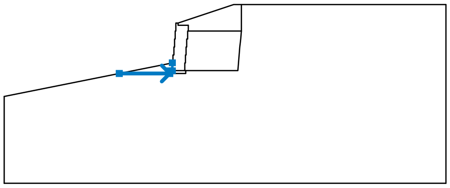
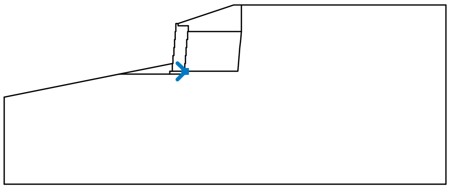
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		11.24	-9.00	11.38	-7.50	11.51	-6.00
		11.65	-4.50	11.78	-3.00	11.92	-1.50
		11.92	3.50				
2		-32.80	-13.84	-11.09	-9.50	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	10.50	3.50
		11.92	3.50	50.50	3.50		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	11.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-11.09	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		
7		1.24	-9.00	1.41	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		
3	Surficial Aquifer	▨	120.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	Onsite Sands	▨	120.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

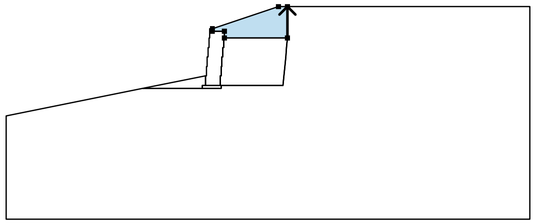
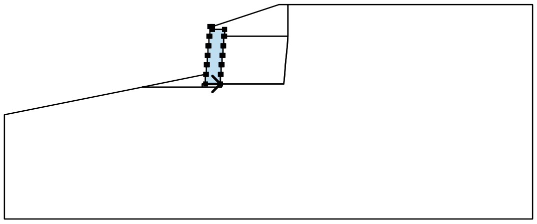
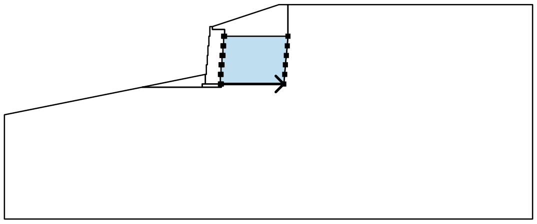
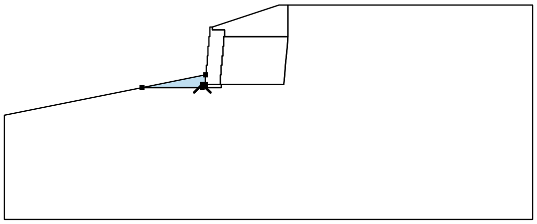
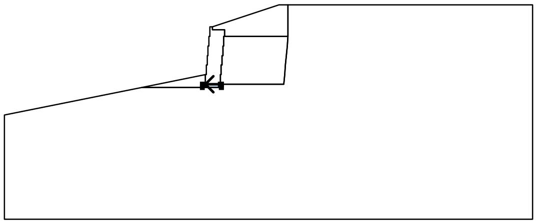
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

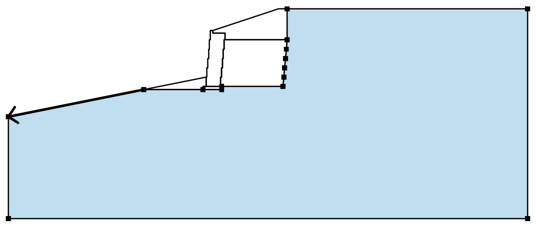
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		11.92	-1.50	11.92	3.50	Onsite Sands ▨
		10.50	3.50	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-1.09	-9.00	1.24	-9.00	Material of structure ▦
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
3		1.41	-9.00	11.24	-9.00	Onsite Sands ▨
		11.38	-7.50	11.51	-6.00	
		11.65	-4.50	11.78	-3.00	
		11.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
4		-1.59	-9.50	-1.59	-9.00	Perched Clay (Drained) ▧
		-1.09	-9.00	-1.09	-7.50	
		-11.09	-9.50			
5		1.24	-9.00	-1.09	-9.00	#57 Stone ▩
		-1.59	-9.00	-1.59	-9.50	
		1.41	-9.50	1.41	-9.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		-11.09	-9.50	-32.80	-13.84	Perched Clay (Drained)
		-32.80	-30.24	50.50	-30.24	▨
		50.50	3.50	11.92	3.50	
		11.92	-1.50	11.78	-3.00	
		11.65	-4.50	11.51	-6.00	
		11.38	-7.50	11.24	-9.00	
		1.41	-9.00	1.41	-9.50	
		-1.59	-9.50			

Reinforcements

No.	Point to the left x [ft]	Point to the left z [ft]	Point to the right x [ft]	Point to the right z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.24	-9.00	11.24	-9.00	10.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	11.38	-7.50	10.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	11.51	-6.00	10.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	11.65	-4.50	10.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	11.78	-3.00	10.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	11.92	-1.50	10.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude		
								q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 10.50	l = 40.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-4.86	[ft]	Angles :	α_1 =	-26.21	[°]
	z =	15.43	[ft]		α_2 =	65.96	[°]
Radius :	R =	29.28	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.2
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 13800.2 lbf/ft
Sum of passive forces : F_p = 26132.3 lbf/ft

Sliding moment : M_a = 404069.3 lbfft/ft
Resisting moment : M_p = 765154.3 lbfft/ft
Factor of safety = 1.89 > 1.50

Slope stability ACCEPTABLE

Slope stability analysis

During Construction - 1600 PSF
Static Trencher Surcharge

Input data

Project

Settings

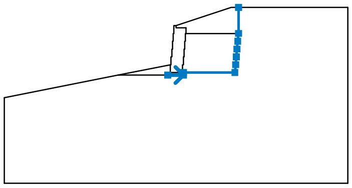
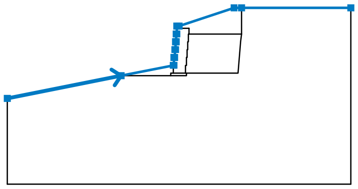
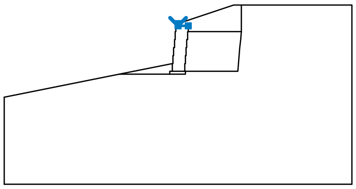
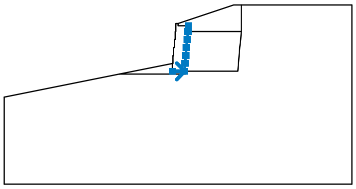
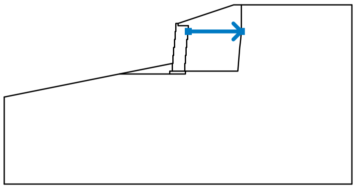
(input for current task)

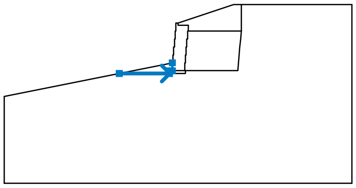
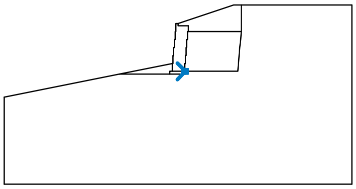
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Transient design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		11.24	-9.00	11.38	-7.50	11.51	-6.00
		11.65	-4.50	11.78	-3.00	11.92	-1.50
		11.92	3.50				
2		-32.80	-13.84	-11.09	-9.50	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	10.50	3.50
		11.92	3.50	32.80	3.50		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	11.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-11.09	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		
7		1.24	-9.00	1.41	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		
3	Surficial Aquifer	▨	120.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	Onsite Sands	▨	120.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

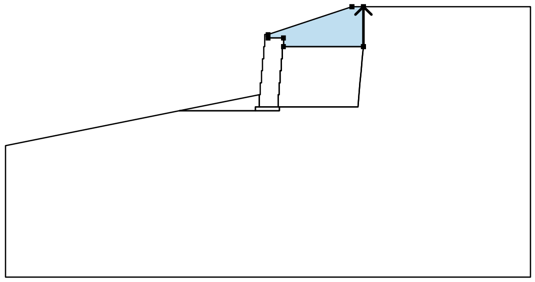
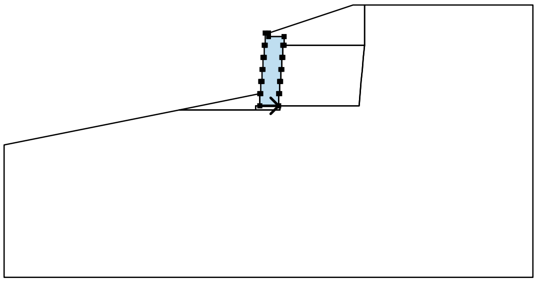
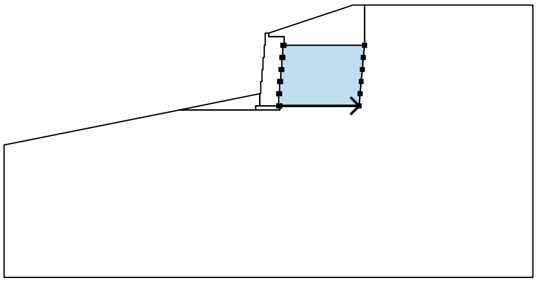
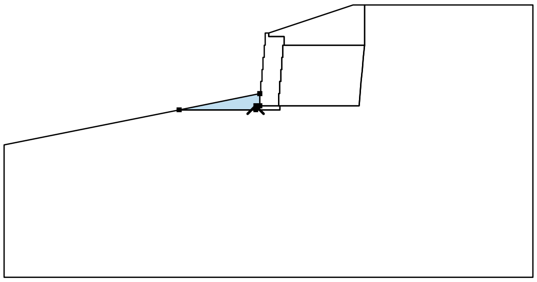
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

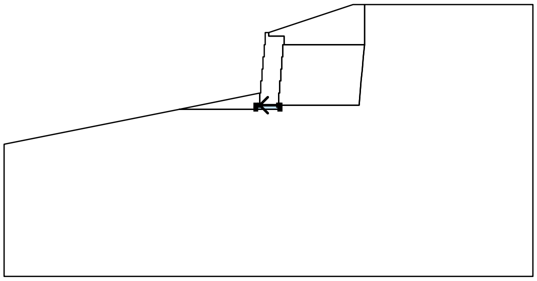
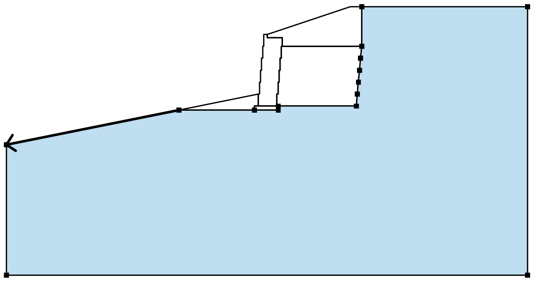
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		11.92	-1.50	11.92	3.50	Onsite Sands
		10.50	3.50	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-1.09	-9.00	1.24	-9.00	Material of structure
		1.24	-7.50	1.38	-7.50	▦
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
3		1.41	-9.00	11.24	-9.00	Onsite Sands
		11.38	-7.50	11.51	-6.00	▨
		11.65	-4.50	11.78	-3.00	
		11.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
4		-1.59	-9.50	-1.59	-9.00	Perched Clay (Drained)
		-1.09	-9.00	-1.09	-7.50	▧
		-11.09	-9.50			

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
5		1.24	-9.00	-1.09	-9.00	#57 Stone
		-1.59	-9.00	-1.59	-9.50	▨
		1.41	-9.50	1.41	-9.00	
6		-11.09	-9.50	-32.80	-13.84	Perched Clay (Drained)
		-32.80	-30.24	32.80	-30.24	▨
		32.80	3.50	11.92	3.50	
		11.92	-1.50	11.78	-3.00	
		11.65	-4.50	11.51	-6.00	
		11.38	-7.50	11.24	-9.00	
		1.41	-9.00	1.41	-9.50	
		-1.59	-9.50			

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.24	-9.00	11.24	-9.00	10.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	11.38	-7.50	10.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	11.51	-6.00	10.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	11.65	-4.50	10.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	11.78	-3.00	10.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	11.92	-1.50	10.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 10.50	l = 3.00		0.00	1600.0		lbf/ft^2
2	strip	permanent	on terrain	x = 21.50	l = 3.00		0.00	1600.0		lbf/ft^2

Surcharges

No.	Name
1	Trencher Track 1 - Static
2	Trencher Track 2 - Static

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : transient

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-3.90	[ft]	Angles :	α_1 =	-21.31	[°]
	z =	20.25	[ft]		α_2 =	59.46	[°]
Radius :	R =	32.96	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 17325.8 lbf/ft
Sum of passive forces : F_p = 28427.8 lbf/ft

Sliding moment : M_a = 571059.0 lbfft/ft
Resisting moment : M_p = 936979.3 lbfft/ft
Factor of safety = 1.64 > 1.30

Slope stability ACCEPTABLE

Slope stability analysis

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Input data

Project

Settings

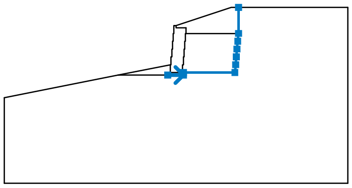
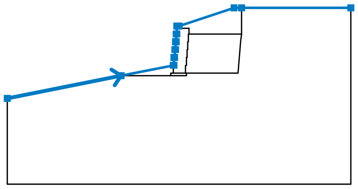
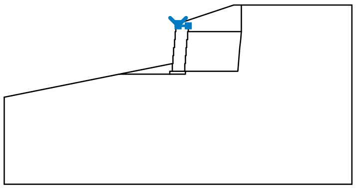
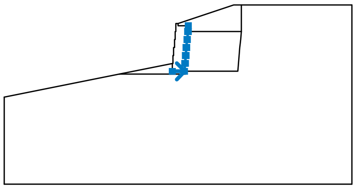
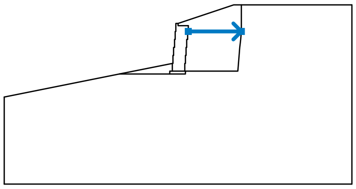
(input for current task)

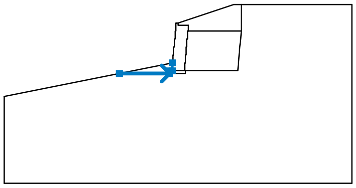
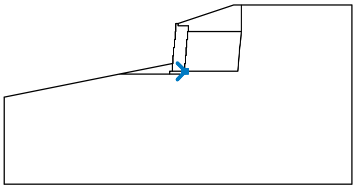
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Accidental design situation			
Safety factor :	SF_s =	1.10	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		11.24	-9.00	11.38	-7.50	11.51	-6.00
		11.65	-4.50	11.78	-3.00	11.92	-1.50
		11.92	3.50				
2		-32.80	-13.84	-11.09	-9.50	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	10.50	3.50
		11.92	3.50	32.80	3.50		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	11.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-11.09	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		
7		1.24	-9.00	1.41	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		
3	Surficial Aquifer	▨	120.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	Onsite Sands	▨	120.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

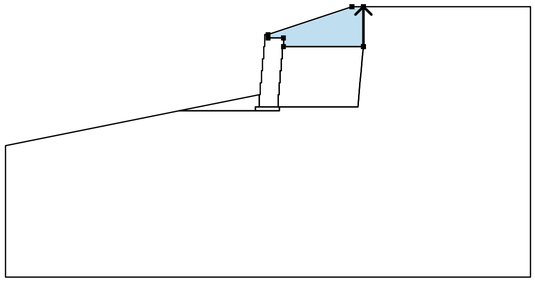
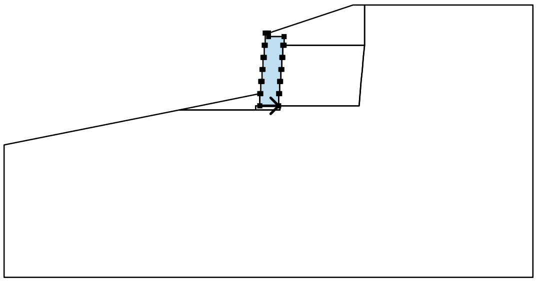
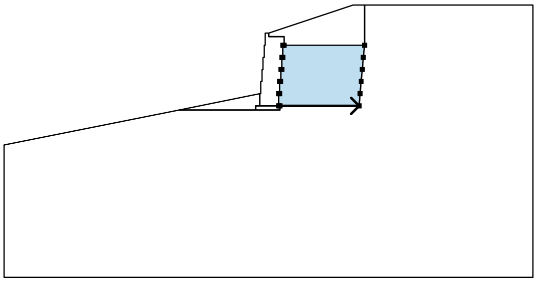
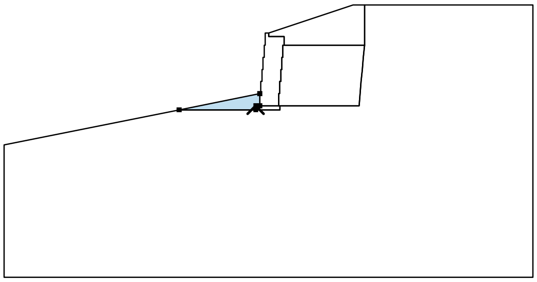
Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

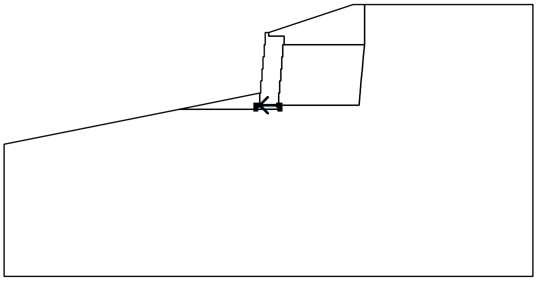
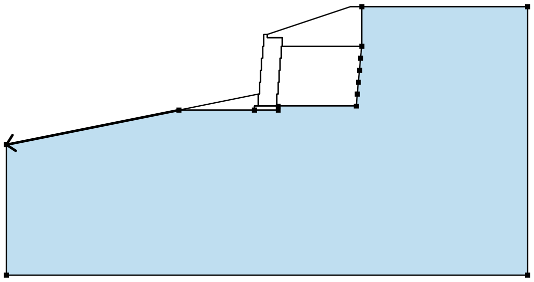
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		11.92	-1.50	11.92	3.50	Onsite Sands
		10.50	3.50	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-1.09	-9.00	1.24	-9.00	Material of structure
		1.24	-7.50	1.38	-7.50	▦
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
3		1.41	-9.00	11.24	-9.00	Onsite Sands
		11.38	-7.50	11.51	-6.00	▨
		11.65	-4.50	11.78	-3.00	
		11.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
4		-1.59	-9.50	-1.59	-9.00	Perched Clay (Drained)
		-1.09	-9.00	-1.09	-7.50	▨
		-11.09	-9.50			

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
5		1.24	-9.00	-1.09	-9.00	#57 Stone
		-1.59	-9.00	-1.59	-9.50	▨
		1.41	-9.50	1.41	-9.00	
6		-11.09	-9.50	-32.80	-13.84	Perched Clay (Drained)
		-32.80	-30.24	32.80	-30.24	▨
		32.80	3.50	11.92	3.50	
		11.92	-1.50	11.78	-3.00	
		11.65	-4.50	11.51	-6.00	
		11.38	-7.50	11.24	-9.00	
		1.41	-9.00	1.41	-9.50	
		-1.59	-9.50			

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.24	-9.00	11.24	-9.00	10.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	11.38	-7.50	10.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	11.51	-6.00	10.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	11.65	-4.50	10.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	11.78	-3.00	10.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	11.92	-1.50	10.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 10.50	l = 3.00		0.00	3200.0		lbf/ft^2
2	strip	permanent	on terrain	x = 21.50	l = 3.00		0.00	3200.0		lbf/ft^2

Surcharges

No.	Name
1	Trencher Track 1 - Dynamic
2	Trencher Track 2 - Dynamic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : accidental

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-5.25	[ft]	Angles :	α_1 =	-21.05	[°]
	z =	21.75	[ft]		α_2 =	58.49	[°]
Radius :	R =	34.92	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 24090.2 lbf/ft
Sum of passive forces : F_p = 33449.3 lbf/ft

Sliding moment : M_a = 841228.4 lbfft/ft
Resisting moment : M_p = 1168048.3 lbfft/ft
Factor of safety = 1.39 > 1.10
Slope stability ACCEPTABLE

WALL #5

MAX. WALL HEIGHT = 9.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #5
Description : H9
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

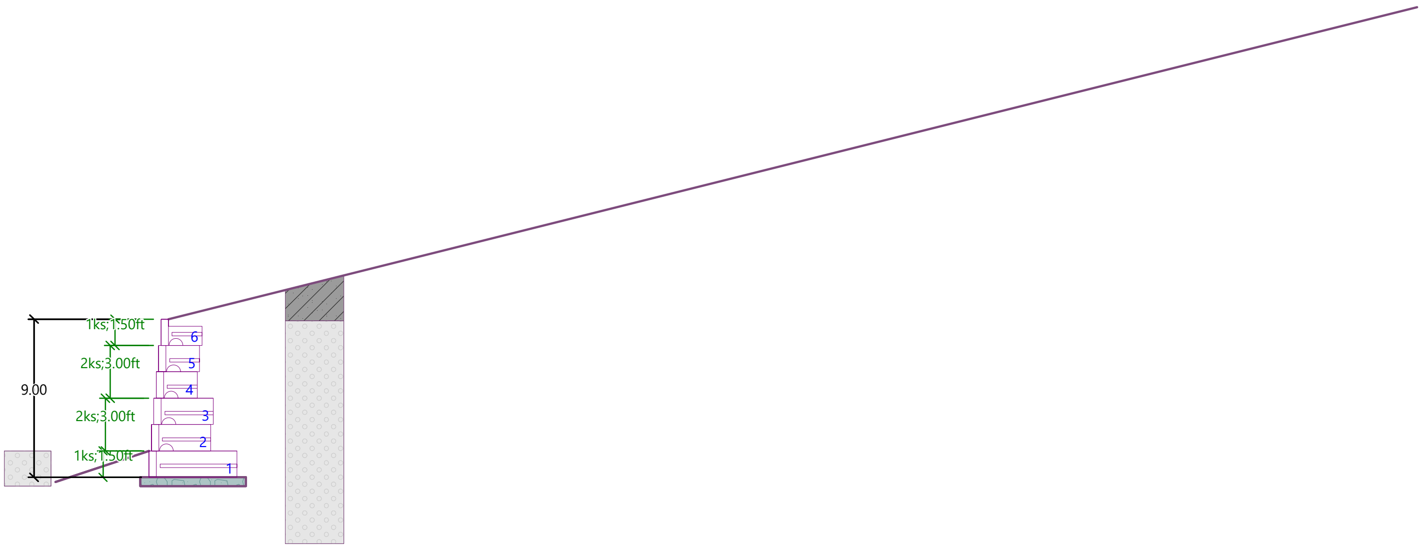
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 60	1	1.62
2	Block 41	2	1.62
3	Block 28	2	1.62
4	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 6.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Perched Clay (Drained)

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Dark Gray Clay (Drained)	▨
2	-	0.10 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 4.00 (slope angle is 14.04 °).
Embankment height is 17.75 ft, embankment length is 71.00 ft.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -18.43 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.78	3673.1	2.54	1.000
FF resistance	-930.9	-0.79	-310.2	0.32	1.000
Weight - earth wedge	0.0	-0.90	34.9	5.67	1.000
Weight - earth wedge	0.0	-3.86	397.3	4.28	1.000
Weight - earth wedge	0.0	-9.40	130.1	2.57	1.000
Active pressure	1836.1	-3.00	2306.8	4.99	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 22993.2 lbfft/ft
Overturning moment M_{ovr} = 4768.5 lbfft/ft

Safety factor = 4.82 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 4186.62 lbf/ft
Active horizontal force H_{act} = 905.13 lbf/ft

Safety factor = 4.63 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.28	2383.1	1.66	1.000
Weight - earth wedge	0.0	-3.60	94.0	2.96	1.000
Weight - earth wedge	0.0	-7.40	130.1	1.94	1.000
Active pressure	841.7	-2.41	587.8	3.24	1.000

Verification of most stressed block No. 2

Check for overturning stability

Resisting moment M_{res} = 6392.3 lbfft/ft
Overturning moment M_{ovr} = 2030.2 lbfft/ft

Safety factor = 3.15 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 9146.39 lbf/ft
Active horizontal force H_{act} = 841.72 lbf/ft

Safety factor = 10.87 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	471.3	6231.99	905.13	0.013	1065.5

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	471.3	6231.99	905.13

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.013
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1065.5 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 5.63 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

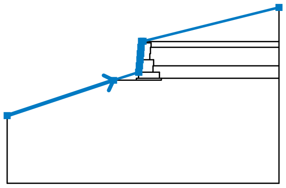
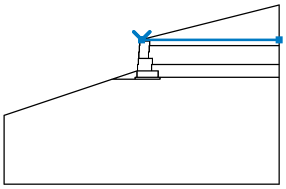
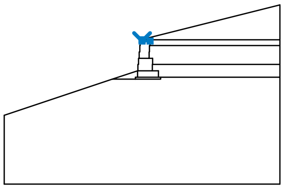
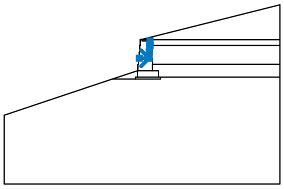
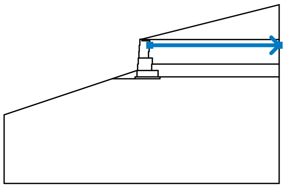
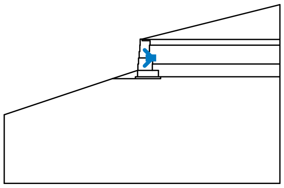
(input for current task)

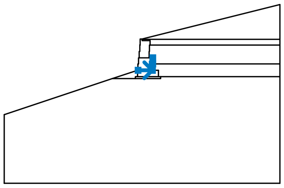
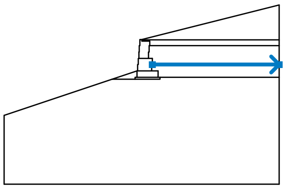
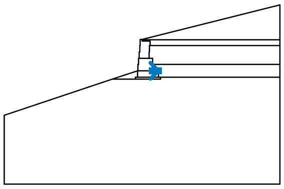
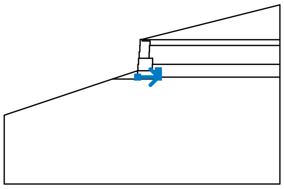
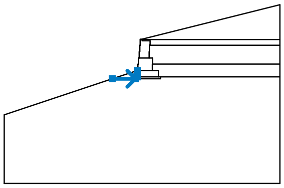
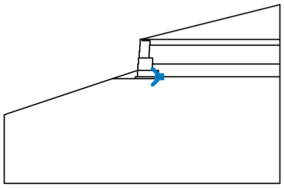
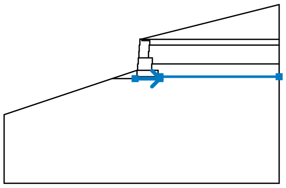
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-18.07	-7.09	-9.50	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	32.80	8.20
2		0.00	0.00	0.00	-0.10	32.80	-0.10
3		0.00	-0.10	0.00	-0.42	1.92	-0.42
4		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	32.80	-1.50		
6		1.65	-4.50	2.55	-4.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
7		-0.96	-7.50	2.42	-7.50	2.42	-6.00
		2.55	-6.00	2.55	-4.50		
8		2.55	-6.00	32.80	-6.00		
9		2.42	-7.50	3.91	-7.50		
10		-1.09	-9.00	3.91	-9.00	3.91	-7.50
11		-7.09	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		
12		3.91	-9.00	4.41	-9.00		
13		-1.59	-9.50	4.41	-9.50	4.41	-9.00
		32.80	-9.00				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Perched Clay (Drained)	▨	24.00	200.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Perched Clay (Drained)	▨	115.0		

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

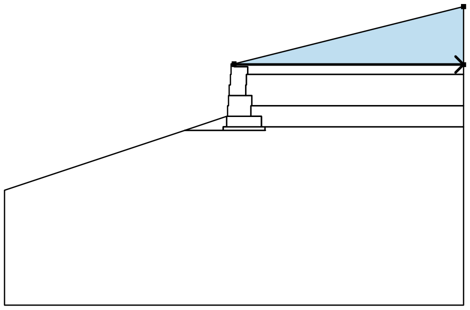
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

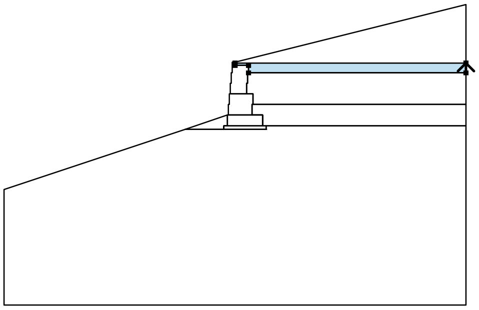
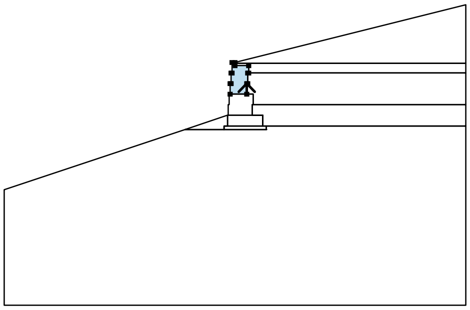
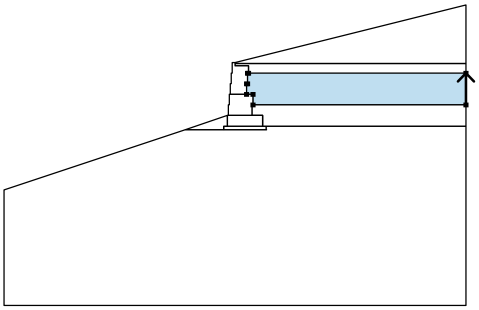
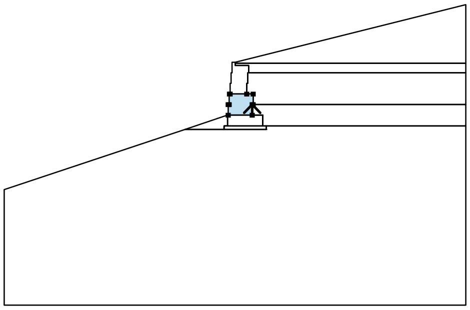
Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

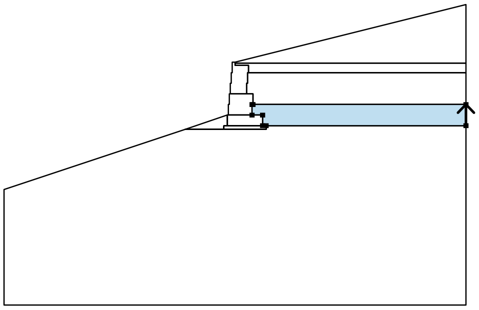
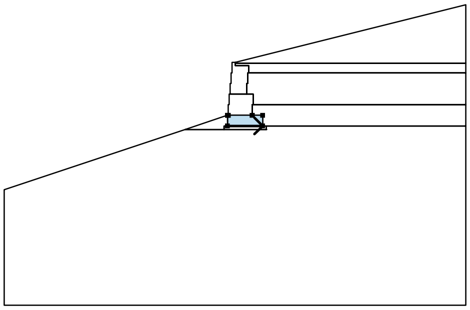
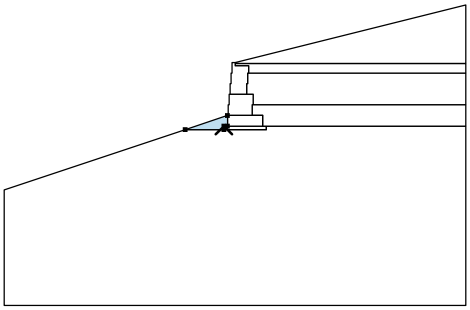
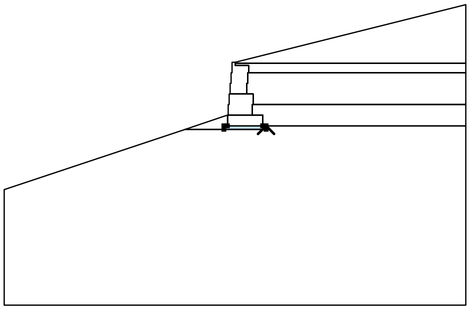
Rigid Bodies

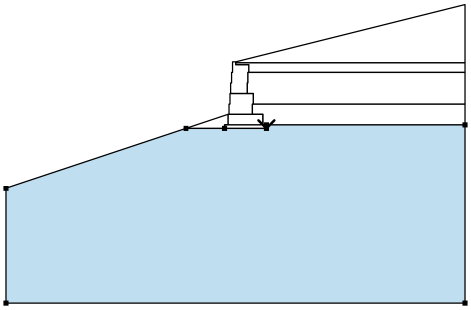
No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
1		0.00	-0.10	32.80	-0.10	Dark Gray Clay (Drained) ▨
		32.80	8.20	0.00	0.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
2		32.80	-1.50	32.80	-0.10	Light Gray Sand ▒
		0.00	-0.10	0.00	-0.42	
		1.92	-0.42	1.92	-1.50	
3		1.65	-4.50	1.65	-3.00	Material of structure ▦
		1.78	-3.00	1.78	-1.50	
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	-0.10	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50			
4		32.80	-6.00	32.80	-1.50	Light Gray Sand ▒
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	2.55	-4.50	
		2.55	-6.00			
5		2.42	-7.50	2.42	-6.00	Material of structure ▦
		2.55	-6.00	2.55	-4.50	
		1.65	-4.50	-0.69	-4.50	
		-0.82	-4.50	-0.82	-6.00	
		-0.96	-6.00	-0.96	-7.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		32.80	-9.00	32.80	-6.00	Light Gray Sand ▨
		2.55	-6.00	2.42	-6.00	
		2.42	-7.50	3.91	-7.50	
		3.91	-9.00	4.41	-9.00	
7		-1.09	-9.00	3.91	-9.00	Material of structure ▦
		3.91	-7.50	2.42	-7.50	
		-0.96	-7.50	-1.09	-7.50	
8		-1.59	-9.50	-1.59	-9.00	Light Gray Sand ▨
		-1.09	-9.00	-1.09	-7.50	
		-7.09	-9.50			
9		4.41	-9.50	4.41	-9.00	#57 Stone ▨
		3.91	-9.00	-1.09	-9.00	
		-1.59	-9.00	-1.59	-9.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
10		4.41	-9.00	4.41	-9.50	Light Gray Sand ▨
		-1.59	-9.50	-7.09	-9.50	
		-32.80	-18.07	-32.80	-34.47	
		32.80	-34.47	32.80	-9.00	

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-7.71	[ft]	Angles :	α_1 =	-16.32	[°]
	z =	8.36	[ft]		α_2 =	75.45	[°]
Radius :	R =	20.86	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 7598.7 lbf/ft
Sum of passive forces : F_p = 11617.7 lbf/ft

Sliding moment : M_a = 158509.4 lbfft/ft
Resisting moment : M_p = 242344.6 lbfft/ft
Factor of safety = 1.53 > 1.35

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 6.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #5
Description : H6
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

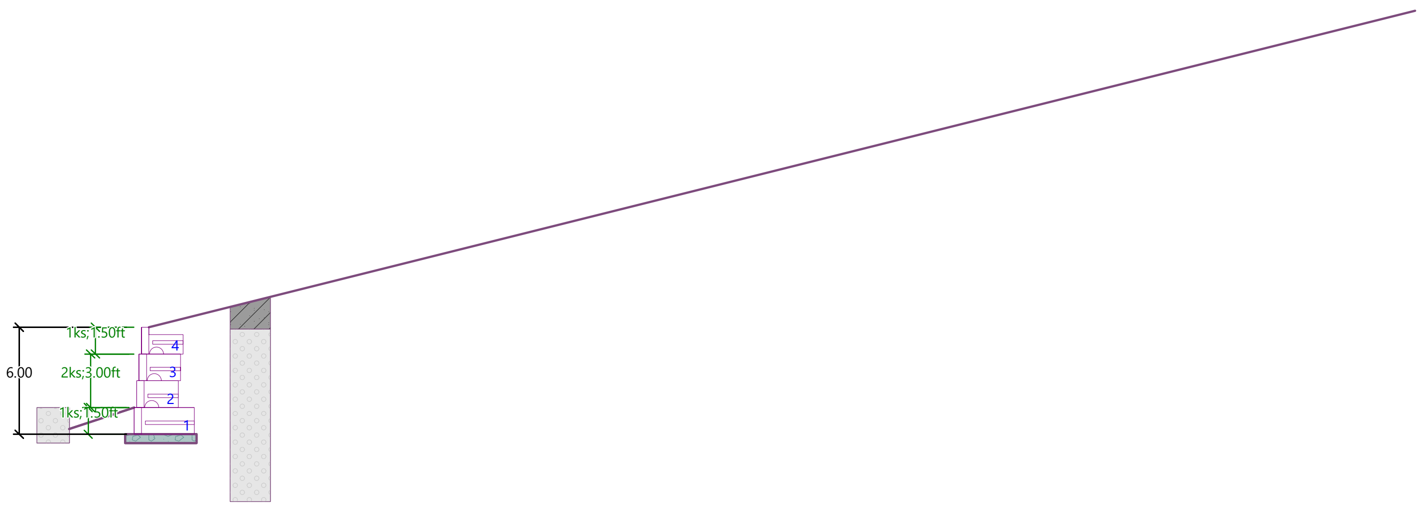
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	1	1.62
2	Block 28	2	1.62
3	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 4.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	🟩	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	⬜	32.00	50.0	115.00	57.50	21.33
5	Perched Clay (Drained)	🟥	24.00	200.0	110.00	52.50	16.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Dark Gray Clay (Drained)	▨
2	-	0.10 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 4.00 (slope angle is 14.04 °).
Embankment height is 17.75 ft, embankment length is 71.00 ft.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -18.43 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.84	1985.6	2.01	1.000
FF resistance	-930.9	-0.79	-310.2	0.32	1.000
Weight - earth wedge	0.0	-0.60	2.2	3.92	1.000
Weight - earth wedge	0.0	-2.60	94.0	3.33	1.000
Weight - earth wedge	0.0	-6.40	130.1	2.30	1.000
Active pressure	688.7	-1.94	634.2	3.66	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 6845.5 lbfft/ft
Overturning moment M_{ovr} = 599.4 lbfft/ft

Safety factor = 11.42 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 1784.62 lbf/ft
Active horizontal force H_{act} = -242.22 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.65	1775.6	1.52	1.000
FF resistance	-319.6	-0.42	-106.5	0.00	1.000
Weight - earth wedge	0.0	-2.10	94.0	2.83	1.000
Weight - earth wedge	0.0	-5.90	130.1	1.80	1.000
Active pressure	566.7	-1.78	506.5	3.09	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 4755.3 lbfft/ft
Overturning moment M_{ovr} = 875.7 lbfft/ft

Safety factor = 5.43 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 2013.63 lbf/ft
Active horizontal force H_{act} = 247.18 lbf/ft

Safety factor = 8.15 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-1174.3	2535.92	-242.22	0.000	634.0

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-1174.3	2535.92	-242.22

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 634.0 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 9.46 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

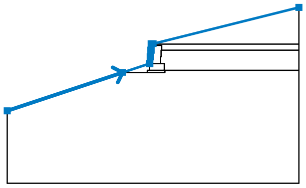
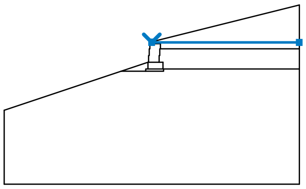
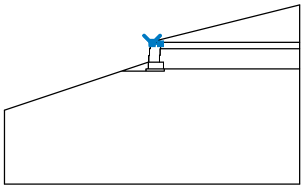
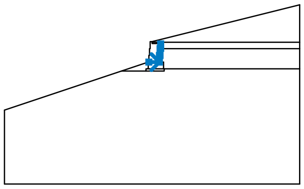
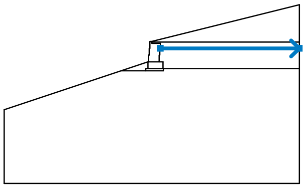
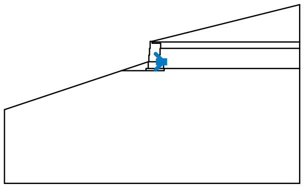
(input for current task)

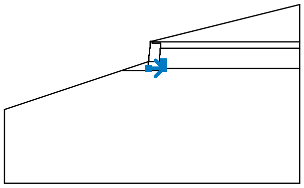
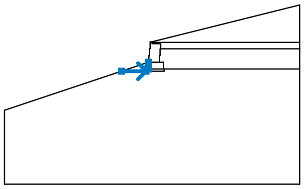
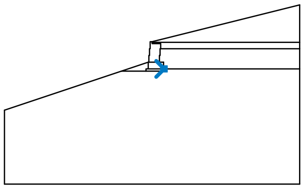
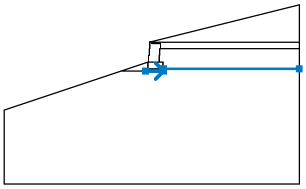
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-15.16	-6.82	-6.50	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	32.80	8.20		
2		0.00	0.00	0.00	-0.10	32.80	-0.10
3		0.00	-0.10	0.00	-0.42	1.92	-0.42
4		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	32.80	-1.50		
6		1.65	-4.50	2.55	-4.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
7		-0.82	-6.00	2.55	-6.00	2.55	-4.50
8		-6.82	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
9		2.55	-6.00	2.68	-6.00		
10		-1.32	-6.50	2.68	-6.50	2.68	-6.00
		32.80	-6.00				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	🟩	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	⬜	32.00	50.0	115.0
5	Perched Clay (Drained)	🟥	24.00	200.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Perched Clay (Drained)	▨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

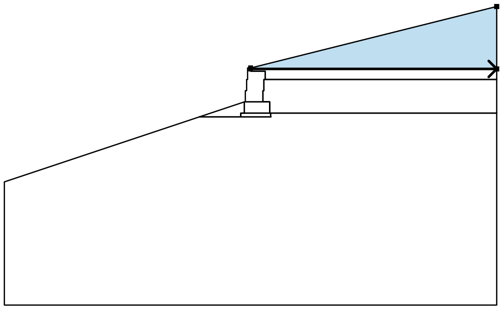
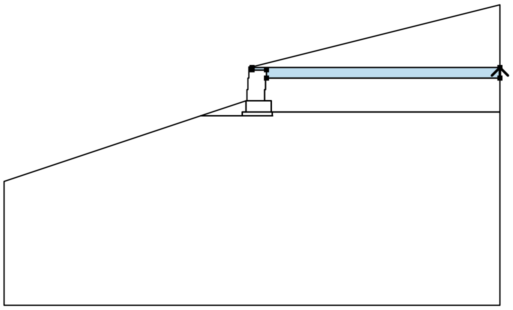
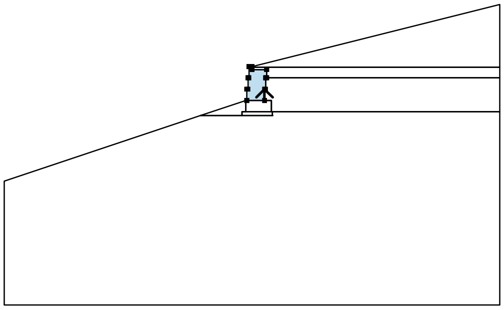
Perched Clay (Drained)

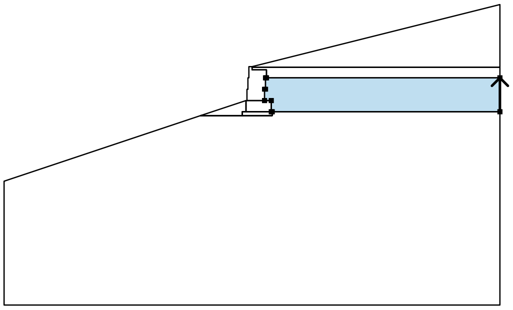
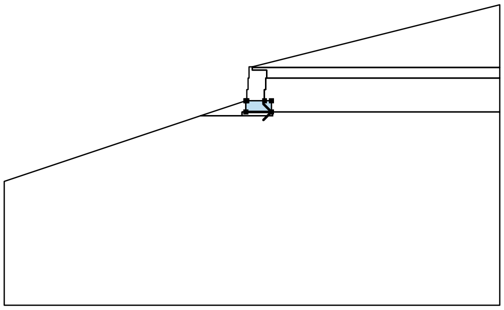
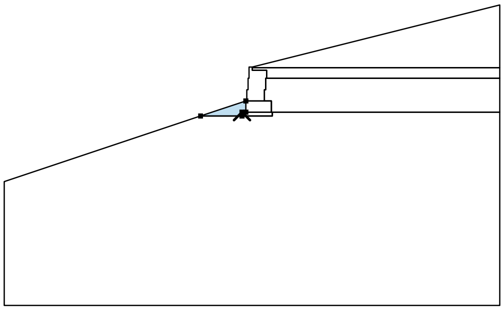
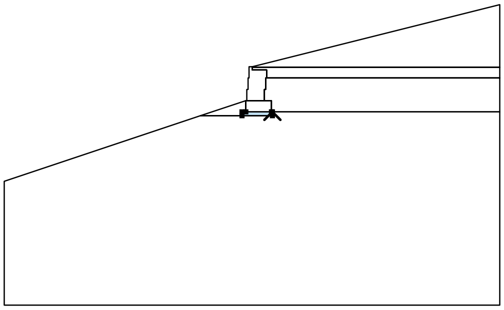
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

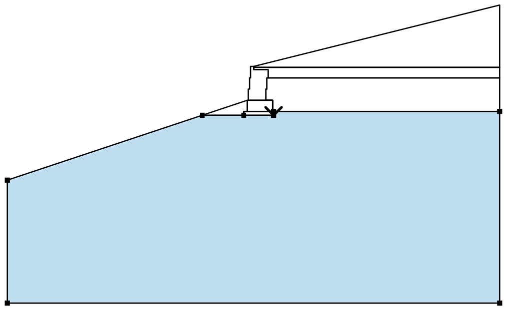
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
1		0.00	-0.10	32.80	-0.10	Dark Gray Clay (Drained) ▨
		32.80	8.20	0.00	0.00	
2		32.80	-1.50	32.80	-0.10	Light Gray Sand ▒
		0.00	-0.10	0.00	-0.42	
		1.92	-0.42	1.92	-1.50	
3		1.65	-4.50	1.65	-3.00	Material of structure 🟥
		1.78	-3.00	1.78	-1.50	
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	-0.10	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
4		32.80	-6.00	32.80	-1.50	Light Gray Sand ▨
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	2.55	-4.50	
		2.55	-6.00	2.68	-6.00	
5		-0.82	-6.00	2.55	-6.00	Material of structure 🟥
		2.55	-4.50	1.65	-4.50	
		-0.69	-4.50	-0.82	-4.50	
6		-1.32	-6.50	-1.32	-6.00	Light Gray Sand ▨
		-0.82	-6.00	-0.82	-4.50	
		-6.82	-6.50			
7		2.68	-6.50	2.68	-6.00	#57 Stone ▨
		2.55	-6.00	-0.82	-6.00	
		-1.32	-6.00	-1.32	-6.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
8		2.68	-6.00	2.68	-6.50	Light Gray Sand
		-1.32	-6.50	-6.82	-6.50	▨
		-32.80	-15.16	-32.80	-31.56	
		32.80	-31.56	32.80	-6.00	

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-5.64	[ft]	Angles :	α_1 =	-18.48	[°]
	z =	6.40	[ft]		α_2 =	73.33	[°]
Radius :	R =	14.84	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 3495.5 lbf/ft
Sum of passive forces : F_p = 6290.5 lbf/ft

Sliding moment : M_a = 51873.3 lbfft/ft
Resisting moment : M_p = 93351.5 lbfft/ft
Factor of safety = 1.80 > 1.35
Slope stability ACCEPTABLE

Geotechnical, Environmental and Materials Engineers

WALL #6

MAX. WALL HEIGHT = 7.5 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #6
Description : H7.5
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

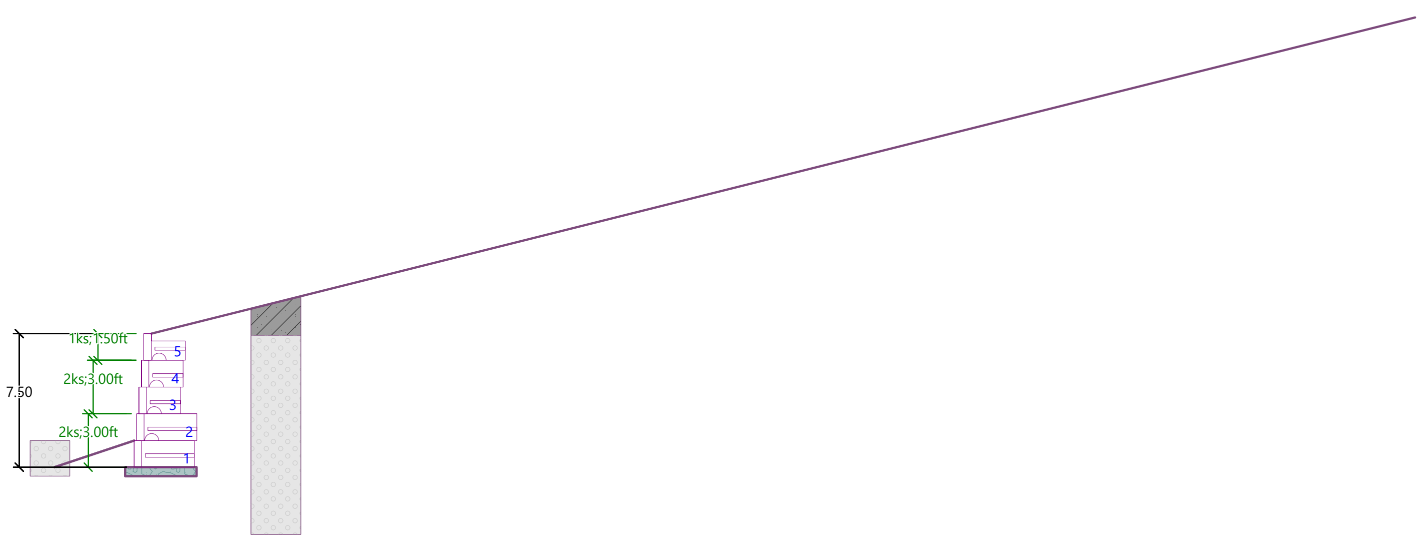
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	2	1.62
2	Block 28	2	1.62
3	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 4.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Perched Clay (Drained)	▨	24.00	200.0	110.00	52.50	16.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Perched Clay (Drained)

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Dark Gray Clay (Drained)	▨
2	-	0.10 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 4.00 (slope angle is 14.04 °).
Embankment height is 17.75 ft, embankment length is 71.00 ft.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -18.43 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.49	2593.1	2.15	1.000
FF resistance	-930.9	-0.79	-310.2	0.32	1.000
Weight - earth wedge	0.0	-0.59	2.0	3.92	1.000
Weight - earth wedge	0.0	-4.10	94.0	3.46	1.000
Weight - earth wedge	0.0	-7.90	130.1	2.44	1.000
Active pressure	996.9	-2.51	742.9	3.79	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 8935.0 lbfft/ft
Overturning moment M_{ovr} = 1766.6 lbfft/ft

Safety factor = 5.06 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2231.98 lbf/ft
Active horizontal force H_{act} = 66.00 lbf/ft

Safety factor = 33.82 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.28	2383.1	1.66	1.000
FF resistance	-319.6	-0.42	-106.5	0.00	1.000
Weight - earth wedge	0.0	-3.60	94.0	2.96	1.000
Weight - earth wedge	0.0	-7.40	130.1	1.94	1.000
Active pressure	841.7	-2.41	587.8	3.24	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 6392.3 lbfft/ft
Overturning moment M_{ovr} = 1895.1 lbfft/ft

Safety factor = 3.37 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 2591.58 lbf/ft
Active horizontal force H_{act} = 522.16 lbf/ft

Safety factor = 4.96 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-664.7	3251.84	66.00	0.000	813.0

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-664.7	3251.84	66.00

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 813.0 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 7.38 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

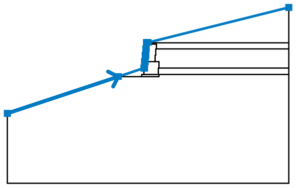
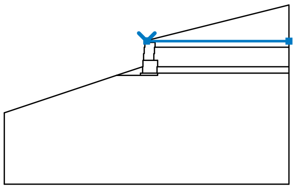
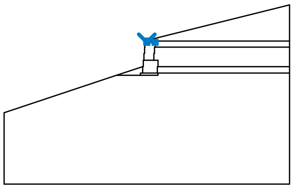
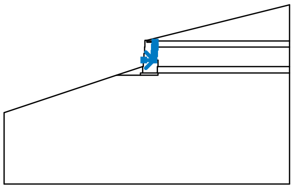
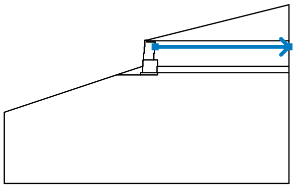
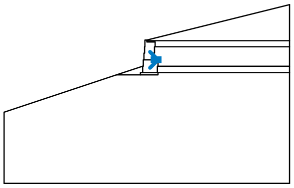
(input for current task)

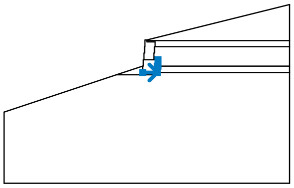
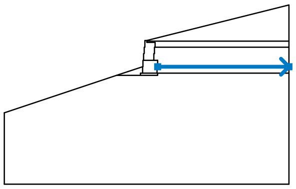
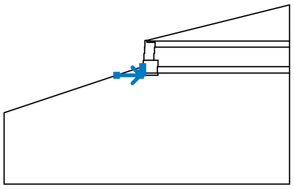
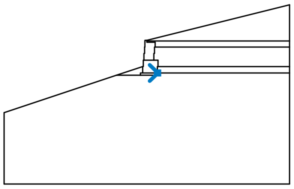
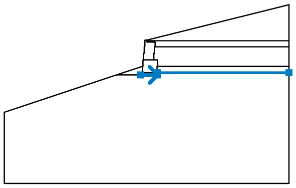
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-16.61	-6.96	-8.00	-0.96	-6.00
		-0.82	-6.00	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		32.80	8.20				
2		0.00	0.00	0.00	-0.10	32.80	-0.10
3		0.00	-0.10	0.00	-0.42	1.92	-0.42
4		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	32.80	-1.50		
6		1.65	-4.50	2.55	-4.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
7		-0.96	-7.50	2.42	-7.50	2.42	-6.00
		2.55	-6.00	2.55	-4.50		
8		2.55	-6.00	32.80	-6.00		
9		-6.96	-8.00	-1.46	-8.00	-1.46	-7.50
		-0.96	-7.50	-0.96	-6.00		
10		2.42	-7.50	2.54	-7.50		
11		-1.46	-8.00	2.54	-8.00	2.54	-7.50
		32.80	-7.50				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
4	Light Gray Sand	░	32.00	50.0	115.0
5	Perched Clay (Drained)	▨	24.00	200.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▒	110.0		
2	Onsite Sands	◇	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	░	120.0		
5	Perched Clay (Drained)	▨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °

Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

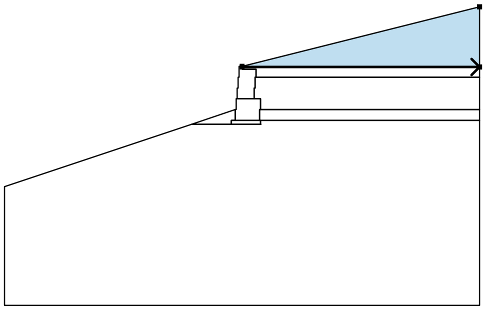
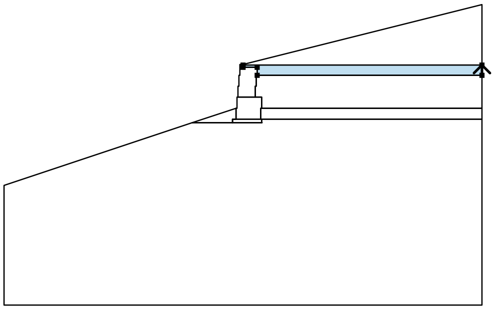
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

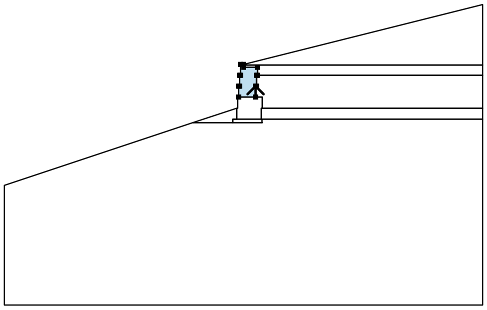
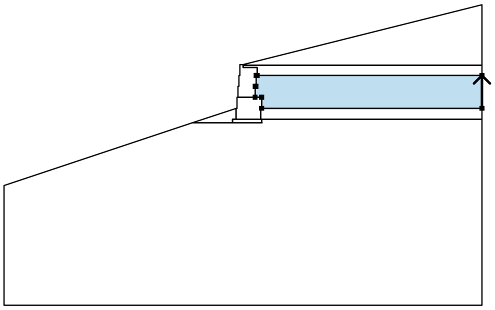
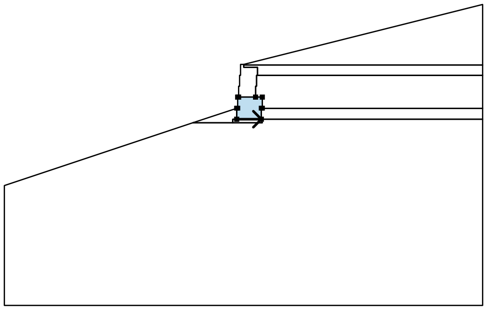
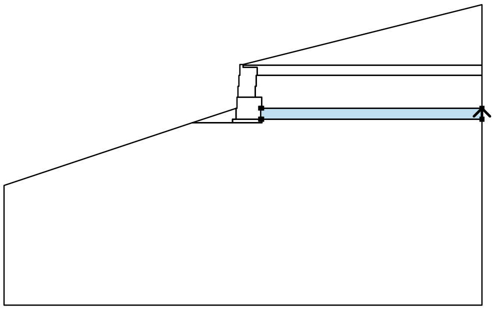
Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

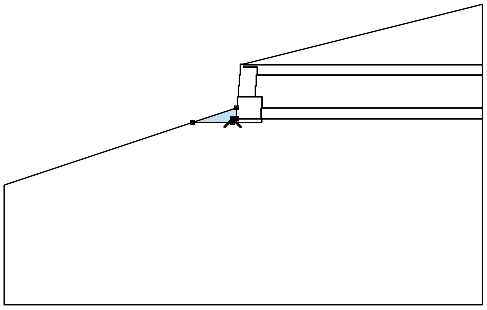
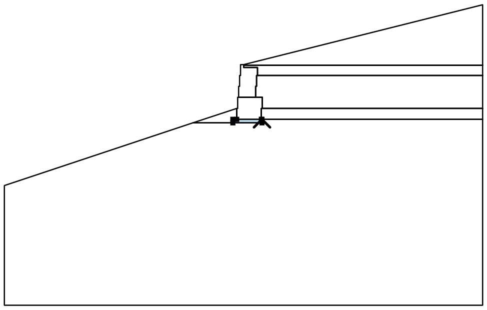
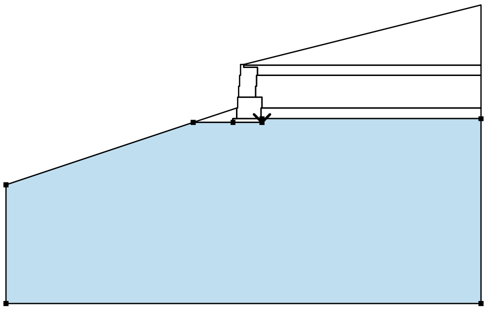
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
1		0.00 32.80	-0.10 8.20	32.80 0.00	-0.10 0.00	Dark Gray Clay (Drained) ▨
2		32.80 0.00 1.92	-1.50 -0.10 -0.42	32.80 0.00 1.92	-0.10 -0.42 -1.50	Light Gray Sand ▒

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		1.65	-4.50	1.65	-3.00	Material of structure 🟥
		1.78	-3.00	1.78	-1.50	
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	-0.10	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50			
4		32.80	-6.00	32.80	-1.50	Light Gray Sand ▨
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	2.55	-4.50	
		2.55	-6.00			
5		-0.96	-7.50	2.42	-7.50	Material of structure 🟥
		2.42	-6.00	2.55	-6.00	
		2.55	-4.50	1.65	-4.50	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
6		32.80	-7.50	32.80	-6.00	Light Gray Sand ▨
		2.55	-6.00	2.42	-6.00	
		2.42	-7.50	2.54	-7.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
7		-1.46	-8.00	-1.46	-7.50	Light Gray Sand ▨
		-0.96	-7.50	-0.96	-6.00	
		-6.96	-8.00			
8		2.54	-8.00	2.54	-7.50	#57 Stone ▨
		2.42	-7.50	-0.96	-7.50	
		-1.46	-7.50	-1.46	-8.00	
9		2.54	-7.50	2.54	-8.00	Light Gray Sand ▨
		-1.46	-8.00	-6.96	-8.00	
		-32.80	-16.61	-32.80	-33.01	
		32.80	-33.01	32.80	-7.50	

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-6.34	[ft]	Angles :	α_1 =	-17.01	[°]
	z =	5.99	[ft]		α_2 =	76.79	[°]
Radius :	R =	16.05	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 4695.5 lbf/ft
Sum of passive forces : F_p = 7486.7 lbf/ft

Sliding moment : M_a = 75363.4 lbfft/ft
Resisting moment : M_p = 120162.2 lbfft/ft
Factor of safety = 1.59 > 1.35

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 4.5 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #6
Description : H4.5
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

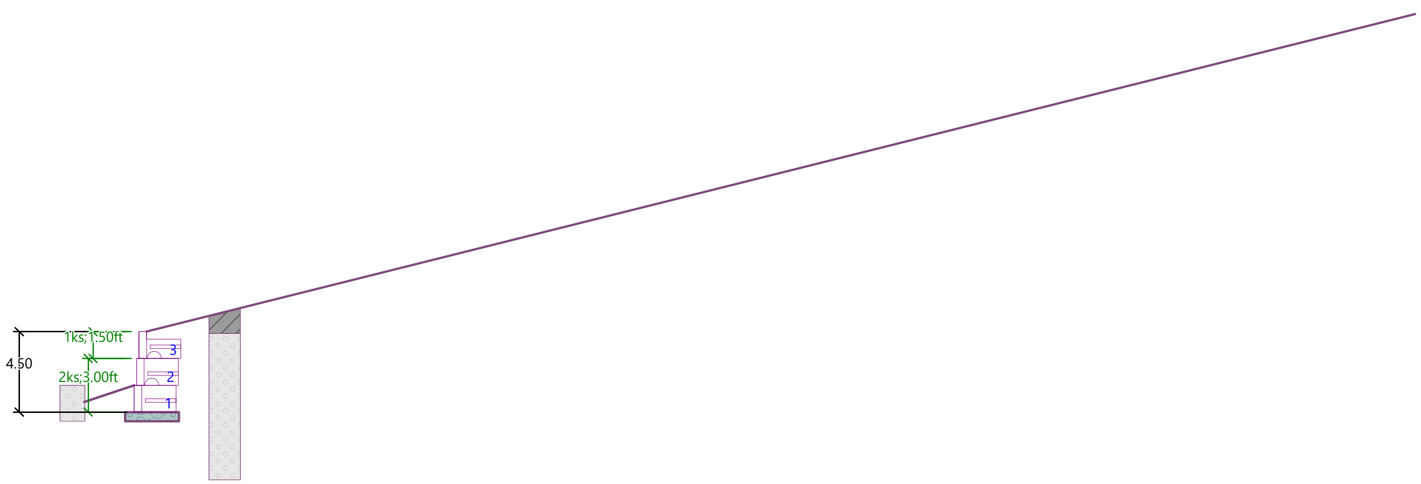
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28	2	1.62
2	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	🟩	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	⬜	32.00	50.0	115.00	57.50	21.33
5	Perched Clay (Drained)	🟥	24.00	200.0	110.00	52.50	16.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Perched Clay (Drained)

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Dark Gray Clay (Drained)	▨
2	-	0.10 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 4.00 (slope angle is 14.04 °).
Embankment height is 17.75 ft, embankment length is 71.00 ft.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -18.43 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.35	1325.6	1.76	1.000
FF resistance	-930.9	-0.79	-310.2	0.32	1.000
Weight - earth wedge	0.0	-0.61	3.2	2.90	1.000
Weight - earth wedge	0.0	-4.90	130.1	2.17	1.000
Active pressure	287.6	-1.24	163.3	2.95	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 3003.9 lbfft/ft
Overturning moment M_{ovr} = -378.5 lbfft/ft

Safety factor = 1000.00 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 969.80 lbf/ft
Active horizontal force H_{act} = -643.29 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.13	1168.1	1.29	1.000
FF resistance	-319.6	-0.42	-106.5	0.00	1.000
Weight - earth wedge	0.0	-4.40	130.1	1.67	1.000
Active pressure	188.4	-1.20	56.8	2.45	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 1864.2 lbfft/ft
Overturning moment M_{ovr} = 90.5 lbfft/ft

Safety factor = 20.59 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 1047.68 lbf/ft
Active horizontal force H_{act} = -131.15 lbf/ft

Safety factor = 1000.00 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-1414.5	1311.95	-643.29	0.000	437.3

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-1414.5	1311.95	-643.29

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 437.3 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 13.72 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

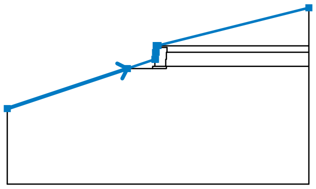
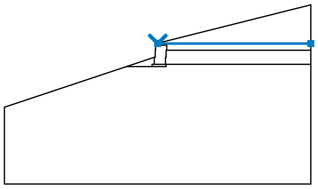
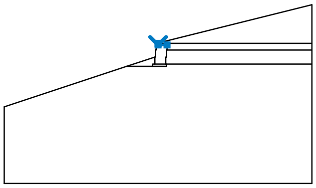
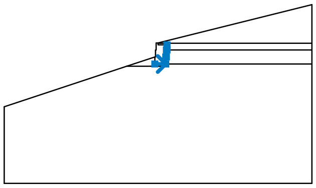
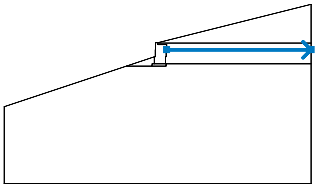
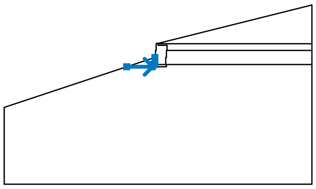
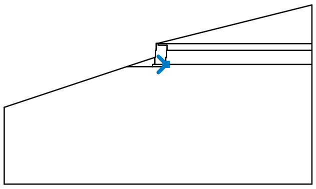
(input for current task)

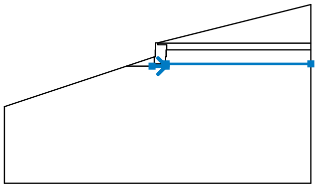
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-13.70	-6.69	-5.00	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	32.80	8.20
2		0.00	0.00	0.00	-0.10	32.80	-0.10
3		0.00	-0.10	0.00	-0.42	1.92	-0.42
4		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	32.80	-1.50		
6		-6.69	-5.00	-1.19	-5.00	-1.19	-4.50
		-0.69	-4.50	-0.69	-3.00		
7		1.65	-4.50	1.81	-4.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
8		-1.19	-5.00	1.81	-5.00	1.81	-4.50
		32.80	-4.50				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Perched Clay (Drained)	▨	24.00	200.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
5	Perched Clay (Drained)	▨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

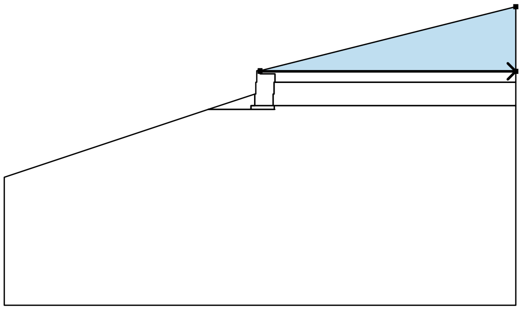
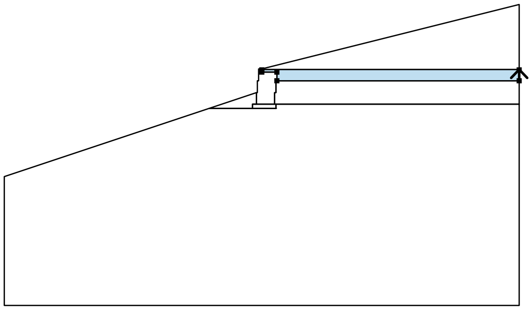
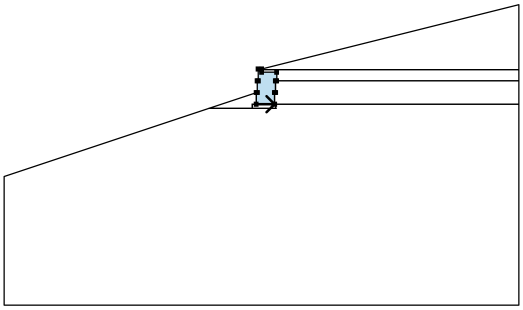
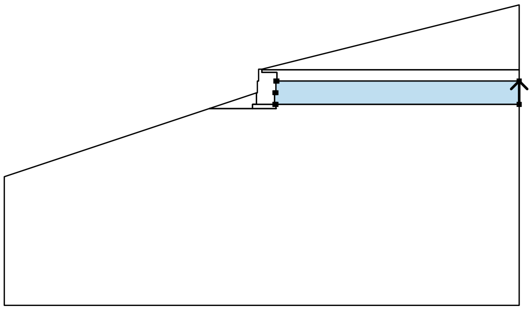
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

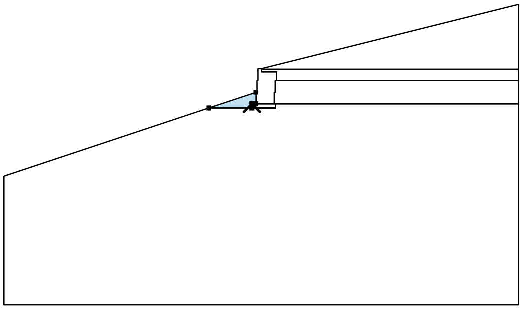
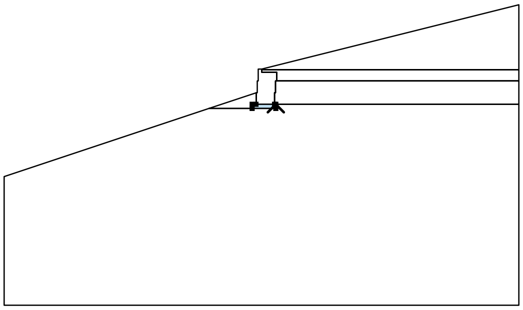
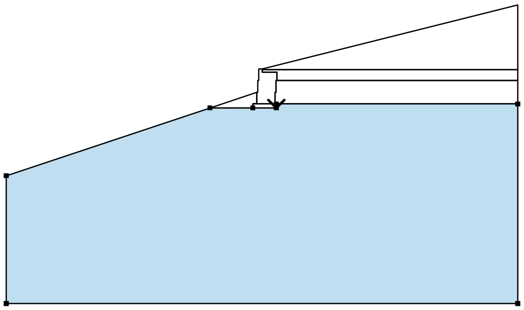
Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		0.00	-0.10	32.80	-0.10	Dark Gray Clay (Drained) ▨
		32.80	8.20	0.00	0.00	
2		32.80	-1.50	32.80	-0.10	Light Gray Sand ▨
		0.00	-0.10	0.00	-0.42	
		1.92	-0.42	1.92	-1.50	
3		-0.69	-4.50	1.65	-4.50	Material of structure ▦
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	-0.10	0.00	0.00	
		-0.42	0.00	-0.42	-1.50	
		-0.55	-1.50	-0.55	-3.00	
		-0.69	-3.00			
4		32.80	-4.50	32.80	-1.50	Light Gray Sand ▨
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.81	-4.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
5		-1.19	-5.00	-1.19	-4.50	Light Gray Sand ▨
		-0.69	-4.50	-0.69	-3.00	
		-6.69	-5.00			
6		1.81	-5.00	1.81	-4.50	#57 Stone ▨
		1.65	-4.50	-0.69	-4.50	
		-1.19	-4.50	-1.19	-5.00	
7		1.81	-4.50	1.81	-5.00	Light Gray Sand ▨
		-1.19	-5.00	-6.69	-5.00	
		-32.80	-13.70	-32.80	-30.10	
		32.80	-30.10	32.80	-4.50	

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-5.11	[ft]	Angles :	α_1 =	-17.81	[°]
	z =	6.51	[ft]		α_2 =	68.25	[°]
Radius :	R =	12.92	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces :	F_a =	2062.3	lbf/ft
Sum of passive forces :	F_p =	4280.7	lbf/ft
Sliding moment :	M_a =	26644.8	lbfft/ft
Resisting moment :	M_p =	55306.6	lbfft/ft

Factor of safety = 2.08 > 1.35

Slope stability ACCEPTABLE

WALL #7

MAX. WALL HEIGHT = 15.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #7
Description : H15
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

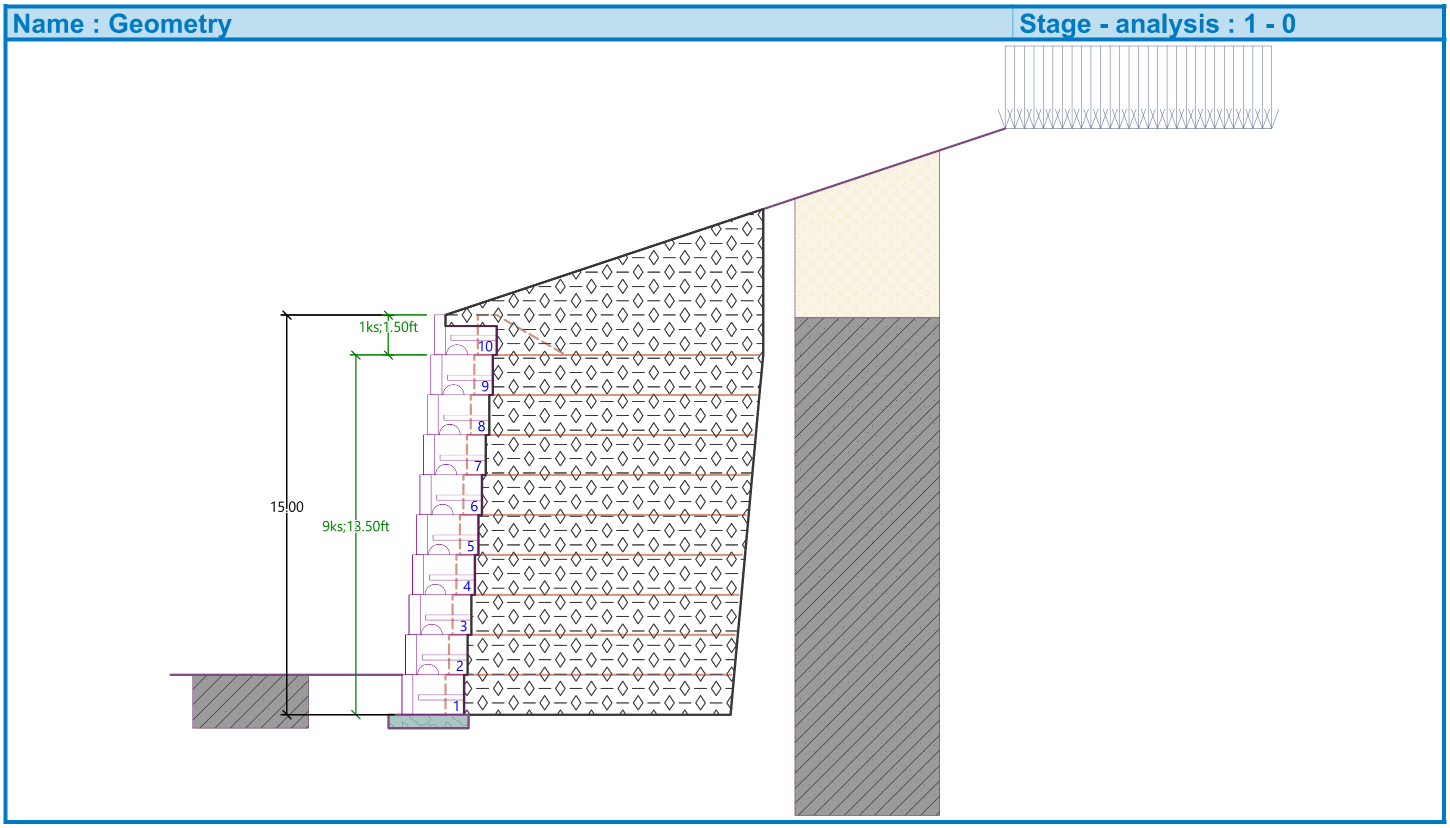
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	9	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength T_{ult} = 7400.00 lbf/ft
Creep red. factor RF_{CR} = 1.58
Durability red. factor RF_D = 1.15
Installation damage red. factor RF_{ID} = 1.20
Long-term design strength R_t = 3393.87 lbf/ft
Coefficient of direct slip along reinforcement C_{ds} = 0.67
Coefficient of interaction of soil and geo-reinforcement C_i = 0.67
Scale correction factor α = 0.8
Long-term strength reduction factor CR_{cr} = 0.532
Calculation of long-term connection strength R_{con} = 3423.30 lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 10.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	10.00	
2	Yes	Miragrid 8XT	10.00	
3	Yes	Miragrid 8XT	10.00	
4	Yes	Miragrid 8XT	10.00	
5	Yes	Miragrid 8XT	10.00	
6	Yes	Miragrid 8XT	10.00	
7	Yes	Miragrid 8XT	10.00	
8	Yes	Miragrid 8XT	10.00	
9	Yes	Miragrid 8XT	10.00	
10	Yes	Miragrid 8XT	10.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.33

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Light Brown Sand	▒
2	-	0.10 .. ∞	Dark Gray Clay (Drained)	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 7.00 ft, embankment length is 21.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	125.00		21.00	10.00	on terrain

No.	Name
1	Light Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Dark Gray Clay (Drained)
Soil thickness in front of structure h = 2.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1274.4	-0.68	0.0	2.33	1.000
Weight - reinforced soil	0.0	-8.72	20168.8	8.17	1.000
Active pressure	5208.2	-5.39	2443.8	13.55	1.000
Light Traffic	451.2	-8.81	216.4	13.55	1.000
Weight - wall	0.0	-7.33	4104.2	1.76	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 207944.1 lbfft/ft
Overturning moment M_{ovr} = 31165.9 lbfft/ft

Safety factor = 6.67 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 13786.14 lbf/ft

Active horizontal force H_{act} = 4384.96 lbf/ft

Safety factor = 3.14 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-96282.4	6785.33	-11656.86	0.000	2261.8

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-96282.4	6785.33	-11656.86

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 2261.8 psf
Bearing capacity of foundation soil R_d = 7500.0 psf

Safety factor = 3.32 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-7.33	4082.8	-0.58	1.000
FF resistance	-1273.4	-0.68	0.0	-2.33	1.000
Active pressure	5208.0	-5.17	2428.5	10.00	1.000
Light Traffic	390.4	-8.20	200.4	10.00	1.000
Weight - reinforced soil	0.0	-8.36	18422.2	5.44	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 21051.17 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 9006.47 lbf/ft
Wall resistance = 3425.88 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:

Resisting horizontal force H_{res} = 13705.72 lbf/ft
Active horiz. force H_{act} = 5598.34 lbf/ft

Factor of safety = 2.45 > 1.50

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-414.27	15.00	848.47	73.24	3254.55	19.09	855.83	72.61
2	Miragrid 8XT	-741.84	13.50	1696.94	65.57	5527.30	20.13	1711.65	65.01
3	Miragrid 8XT	-623.93	12.00	1696.94	55.15	4625.73	20.23	1711.65	54.68
4	Miragrid 8XT	-564.27	10.50	1696.94	49.88	3804.37	22.25	1711.65	49.45
5	Miragrid 8XT	-504.60	9.00	1696.94	44.60	3063.22	24.71	1711.65	44.22
6	Miragrid 8XT	-444.94	7.50	1696.94	39.33	2402.30	27.78	1711.65	38.99
7	Miragrid 8XT	-385.27	6.00	1696.94	34.06	1821.59	31.73	1711.65	33.76
8	Miragrid 8XT	-325.61	4.50	1696.94	28.78	1321.10	36.97	1711.65	28.53
9	Miragrid 8XT	-265.94	3.00	1696.94	23.51	900.82	44.28	1711.65	23.31
10	Miragrid 8XT	-287.04	1.50	1696.94	25.37	560.76	76.78	855.83	50.31

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 414.27 lbf/ft

Safety factor = 2.05 > 1.50

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.10)

Pull out resistance T_p = 560.76 lbf/ft
Force in reinforcement F_x = 287.04 lbf/ft

Safety factor = 1.95 > 1.50

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 414.27 lbf/ft

Safety factor = 2.07 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

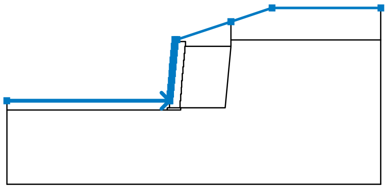
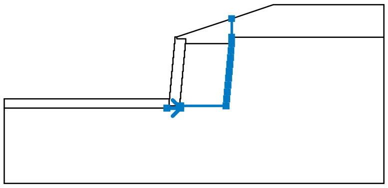
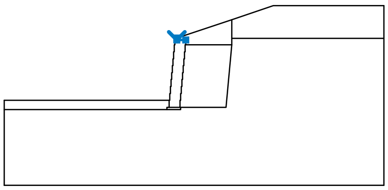
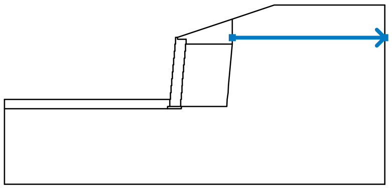
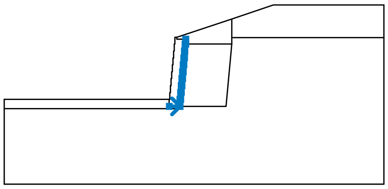
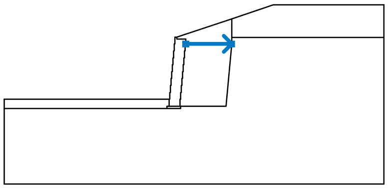
(input for current task)

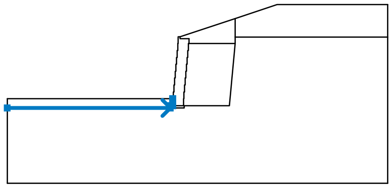
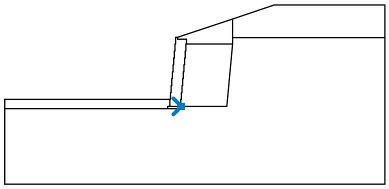
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-37.50	-13.50	-1.64	-13.50	-1.50	-13.50
		-1.50	-12.00	-1.36	-12.00	-1.36	-10.50
		-1.23	-10.50	-1.23	-9.00	-1.09	-9.00
		-1.09	-7.50	-0.96	-7.50	-0.96	-6.00
		-0.82	-6.00	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		11.92	3.97	21.00	7.00	45.00	7.00
2		-2.14	-15.50	0.86	-15.50	0.86	-15.00
		10.70	-15.00	10.83	-13.50	10.97	-12.00
		11.10	-10.50	11.24	-9.00	11.38	-7.50
		11.51	-6.00	11.65	-4.50	11.78	-3.00
		11.92	-1.50	11.92	-0.10	11.92	3.97
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		11.92	-0.10	45.00	-0.10		
5		-1.64	-15.00	0.70	-15.00	0.70	-13.50
		0.83	-13.50	0.83	-12.00	0.97	-12.00
		0.97	-10.50	1.10	-10.50	1.10	-9.00
		1.24	-9.00	1.24	-7.50	1.38	-7.50
		1.38	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
6		1.92	-1.50	11.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
7		-37.50	-15.50	-2.14	-15.50	-2.14	-15.00
		-1.64	-15.00	-1.64	-13.50		
8		0.70	-15.00	0.86	-15.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	Light Brown Sand	🟨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

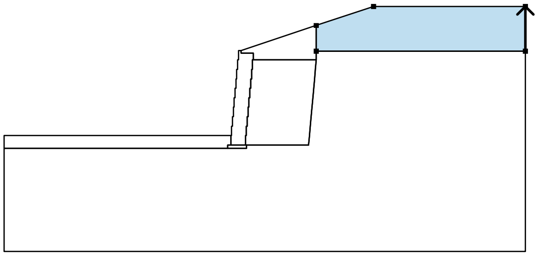
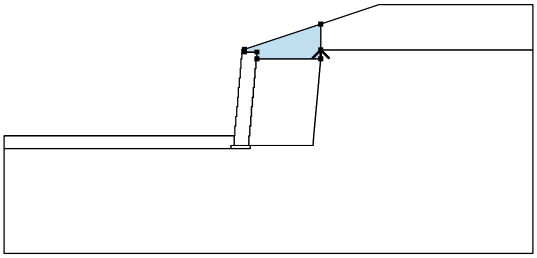
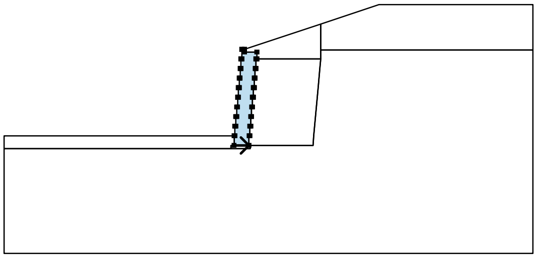
Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

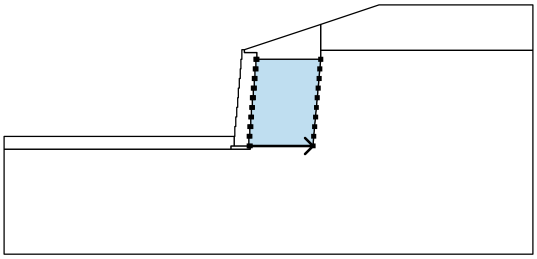
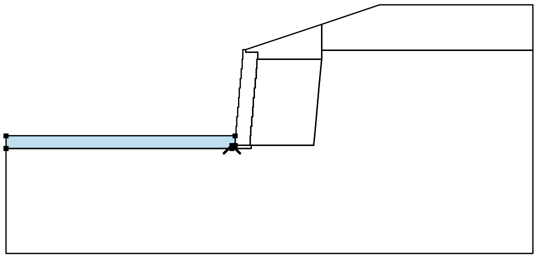
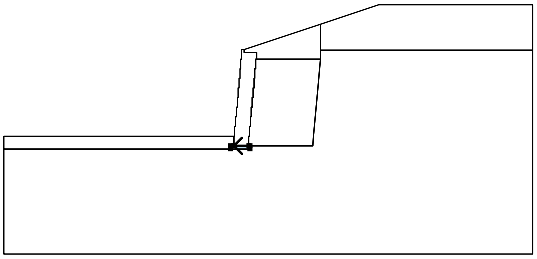
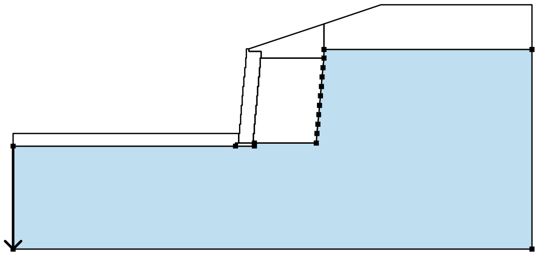
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		45.00	-0.10	45.00	7.00	Light Brown Sand ▨
		21.00	7.00	11.92	3.97	
		11.92	-0.10			
2		11.92	-1.50	11.92	-0.10	Onsite Sands ▨
		11.92	3.97	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
3		-1.64	-15.00	0.70	-15.00	Material of structure ▦
		0.70	-13.50	0.83	-13.50	
		0.83	-12.00	0.97	-12.00	
		0.97	-10.50	1.10	-10.50	
		1.10	-9.00	1.24	-9.00	
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
		-1.09	-9.00	-1.23	-9.00	
		-1.23	-10.50	-1.36	-10.50	
		-1.36	-12.00	-1.50	-12.00	
		-1.50	-13.50	-1.64	-13.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
4		0.86	-15.00	10.70	-15.00	Onsite Sands
		10.83	-13.50	10.97	-12.00	▨
		11.10	-10.50	11.24	-9.00	
		11.38	-7.50	11.51	-6.00	
		11.65	-4.50	11.78	-3.00	
		11.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
		1.10	-9.00	1.10	-10.50	
		0.97	-10.50	0.97	-12.00	
		0.83	-12.00	0.83	-13.50	
		0.70	-13.50	0.70	-15.00	
5		-2.14	-15.50	-2.14	-15.00	Dark Gray Clay (Drained)
		-1.64	-15.00	-1.64	-13.50	▨
		-37.50	-13.50	-37.50	-15.50	
6		0.70	-15.00	-1.64	-15.00	#57 Stone
		-2.14	-15.00	-2.14	-15.50	▨
		0.86	-15.50	0.86	-15.00	
7		-37.50	-15.50	-37.50	-31.90	Dark Gray Clay (Drained)
		45.00	-31.90	45.00	-0.10	▨
		11.92	-0.10	11.92	-1.50	
		11.78	-3.00	11.65	-4.50	
		11.51	-6.00	11.38	-7.50	
		11.24	-9.00	11.10	-10.50	
		10.97	-12.00	10.83	-13.50	
		10.70	-15.00	0.86	-15.00	
		0.86	-15.50	-2.14	-15.50	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	0.70	-15.00	10.70	-15.00	10.00	848.5	C = 0.67	Fixed
2	0.83	-13.50	10.83	-13.50	10.00	1696.9	C = 0.67	Fixed

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
3	0.97	-12.00	10.97	-12.00	10.00	1696.9	C = 0.67	Fixed
4	1.10	-10.50	11.10	-10.50	10.00	1696.9	C = 0.67	Fixed
5	1.24	-9.00	11.24	-9.00	10.00	1696.9	C = 0.67	Fixed
6	1.38	-7.50	11.38	-7.50	10.00	1696.9	C = 0.67	Fixed
7	1.51	-6.00	11.51	-6.00	10.00	1696.9	C = 0.67	Fixed
8	1.65	-4.50	11.65	-4.50	10.00	1696.9	C = 0.67	Fixed
9	1.78	-3.00	11.78	-3.00	10.00	1696.9	C = 0.67	Fixed
10	1.92	-1.50	11.92	-1.50	10.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 21.00	l = 10.00		0.00	125.0		lbf/ft^2

Surcharges

No.	Name
1	Light Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.64	[ft]	Angles :	α_1 =	-24.17	[°]
	z =	14.40	[ft]		α_2 =	76.00	[°]
Radius :	R =	30.58	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	0.0

3	0.0
4	0.0
5	0.0
6	0.0
7	0.0
8	0.0
9	0.0
10	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 20872.9 lbf/ft
Sum of passive forces : F_p = 34976.0 lbf/ft

Sliding moment : M_a = 638293.0 lbfft/ft
Resisting moment : M_p = 1069564.6 lbfft/ft
Factor of safety = 1.68 > 1.50

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 12.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #7
Description : H12
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

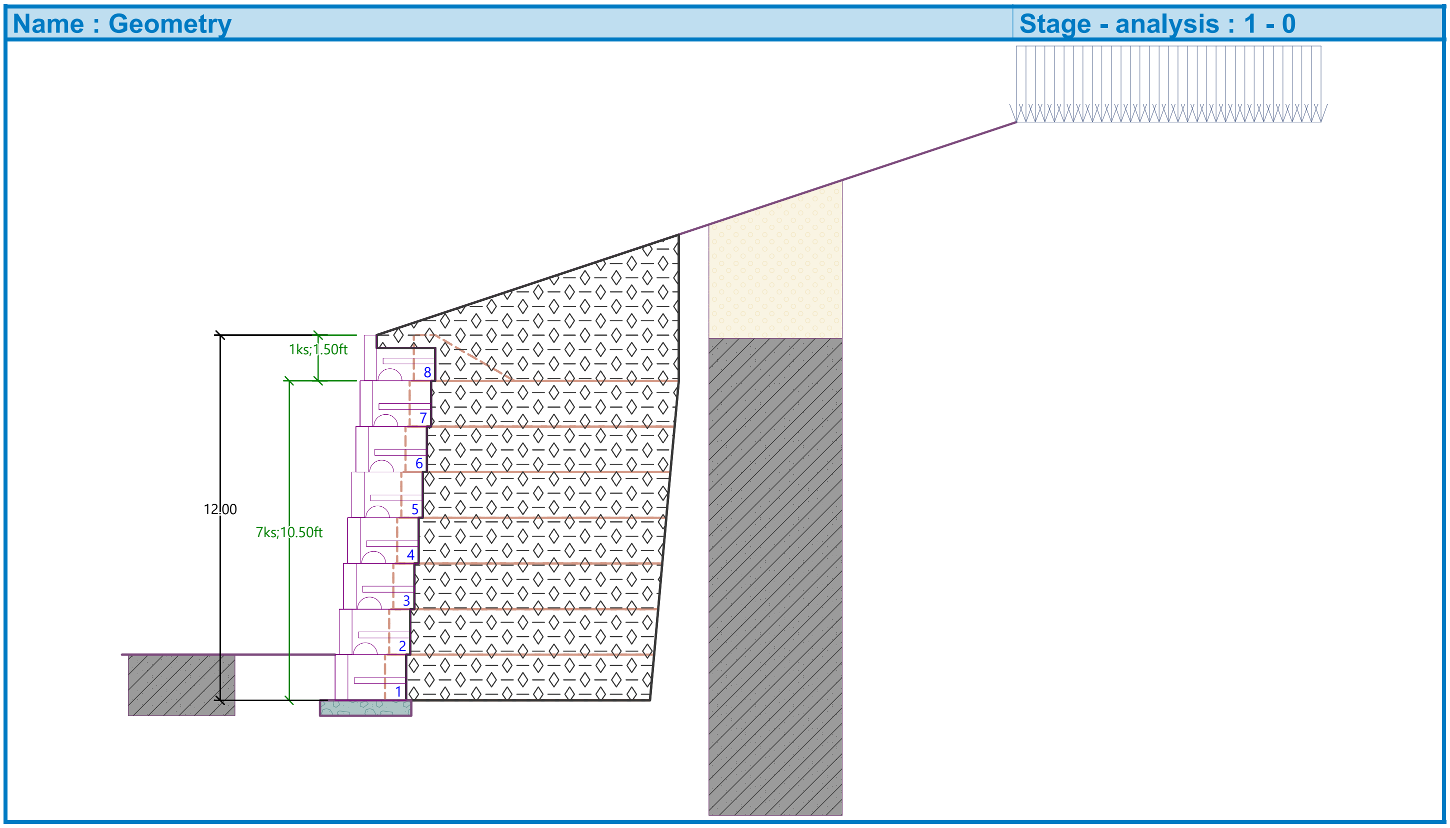
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	7	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength T_{ult} = 7400.00 lbf/ft
Creep red. factor RF_{CR} = 1.58
Durability red. factor RF_D = 1.15
Installation damage red. factor RF_{ID} = 1.20
Long-term design strength R_t = 3393.87 lbf/ft
Coefficient of direct slip along reinforcement C_{ds} = 0.67
Coefficient of interaction of soil and geo-reinforcement C_i = 0.67
Scale correction factor α = 0.8
Long-term strength reduction factor CR_{cr} = 0.532
Calculation of long-term connection strength R_{con} = 3423.30 lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 8.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	8.00	
2	Yes	Miragrid 8XT	8.00	
3	Yes	Miragrid 8XT	8.00	
4	Yes	Miragrid 8XT	8.00	
5	Yes	Miragrid 8XT	8.00	
6	Yes	Miragrid 8XT	8.00	
7	Yes	Miragrid 8XT	8.00	
8	Yes	Miragrid 8XT	8.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	🟦	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	◈	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Brown Sand	🟨	32.00	75.0	110.00	52.50	21.33

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Light Brown Sand	░
2	-	0.10 .. ∞	Dark Gray Clay (Drained)	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 7.00 ft, embankment length is 21.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	125.00		21.00	10.00	on terrain

No.	Name
1	Light Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Dark Gray Clay (Drained)
Soil thickness in front of structure h = 2.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1274.4	-0.68	0.0	2.33	1.000
Weight - reinforced soil	0.0	-7.06	13098.5	6.97	1.000
Active pressure	3245.6	-4.02	1521.2	11.28	1.000
Light Traffic	342.4	-6.25	165.6	11.28	1.000
Weight - wall	0.0	-5.83	3264.2	1.62	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 115600.0 lbfft/ft
Overturning moment M_{ovr} = 14306.6 lbfft/ft

Safety factor = 8.08 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 9618.39 lbf/ft

Active horizontal force H_{act} = 2313.61 lbf/ft

Safety factor = 4.16 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-58881.0	5205.89	-9615.83	0.000	1735.3

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-58881.0	5205.89	-9615.83

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1735.3 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 3.46 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.83	3243.1	-0.71	1.000
FF resistance	-1273.4	-0.68	0.0	-2.33	1.000
Active pressure	3230.9	-3.85	1506.6	8.00	1.000
Light Traffic	306.6	-6.10	155.3	8.00	1.000
Weight - reinforced soil	0.0	-6.76	11957.8	4.35	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 13619.63 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 5826.99 lbf/ft
Wall resistance = 2721.32 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:

Resisting horizontal force H_{res} = 9821.68 lbf/ft
Active horiz. force H_{act} = 3537.46 lbf/ft

Factor of safety = 2.78 > 1.50

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-313.94	12.00	848.47	55.50	2103.99	22.38	855.83	55.02
2	Miragrid 8XT	-555.75	10.50	1696.94	49.13	3426.42	24.33	1711.65	48.70
3	Miragrid 8XT	-472.02	9.00	1696.94	41.72	2725.08	25.98	1711.65	41.37
4	Miragrid 8XT	-412.36	7.50	1696.94	36.45	2103.95	29.40	1711.65	36.14
5	Miragrid 8XT	-352.69	6.00	1696.94	31.18	1563.04	33.85	1711.65	30.91
6	Miragrid 8XT	-293.03	4.50	1696.94	25.90	1102.35	39.87	1711.65	25.68
7	Miragrid 8XT	-233.36	3.00	1696.94	20.63	721.88	48.49	1711.65	20.45
8	Miragrid 8XT	-238.17	1.50	1696.94	21.05	421.62	84.73	855.83	41.74

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 313.94 lbf/ft

Safety factor = 2.70 > 1.50

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.8)

Pull out resistance T_p = 421.62 lbf/ft
Force in reinforcement F_x = 238.17 lbf/ft

Safety factor = 1.77 > 1.50

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 313.94 lbf/ft

Safety factor = 2.73 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

(input for current task)

Stability analysis

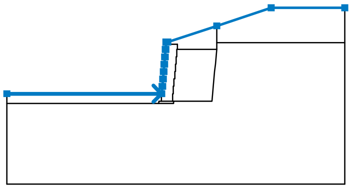
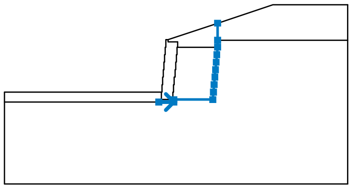
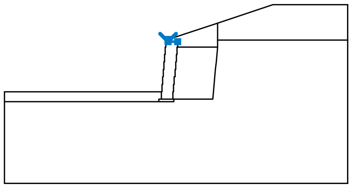
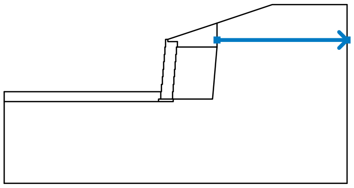
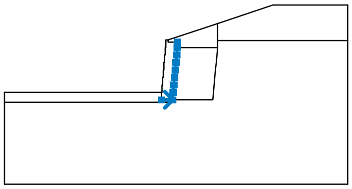
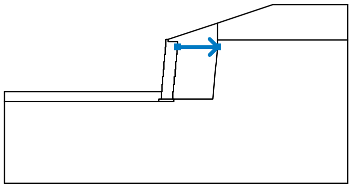
Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

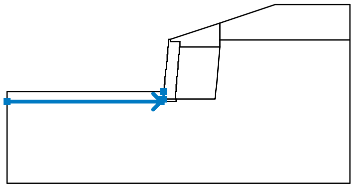
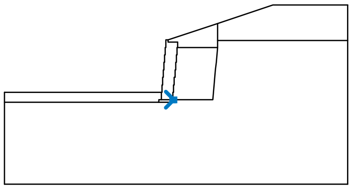
Safety factors

Permanent design situation

Safety factor :	SF_S =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-10.50	-1.36	-10.50	-1.23	-10.50
		-1.23	-9.00	-1.09	-9.00	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	9.92	3.31
		21.00	7.00	36.00	7.00		
2		-1.86	-12.50	1.14	-12.50	1.14	-12.00
		8.97	-12.00	9.10	-10.50	9.24	-9.00
		9.38	-7.50	9.51	-6.00	9.65	-4.50
		9.78	-3.00	9.92	-1.50	9.92	-0.10
		9.92	3.31				
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		9.92	-0.10	36.00	-0.10		
5		-1.36	-12.00	0.97	-12.00	0.97	-10.50
		1.10	-10.50	1.10	-9.00	1.24	-9.00
		1.24	-7.50	1.38	-7.50	1.38	-6.00
		1.51	-6.00	1.51	-4.50	1.65	-4.50
		1.65	-3.00	1.78	-3.00	1.78	-1.50
		1.92	-1.50	1.92	-0.42		
6		1.92	-1.50	9.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
7		-32.80	-12.50	-1.86	-12.50	-1.86	-12.00
		-1.36	-12.00	-1.36	-10.50		
8		0.97	-12.00	1.14	-12.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_{s} [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	Light Brown Sand	🟨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

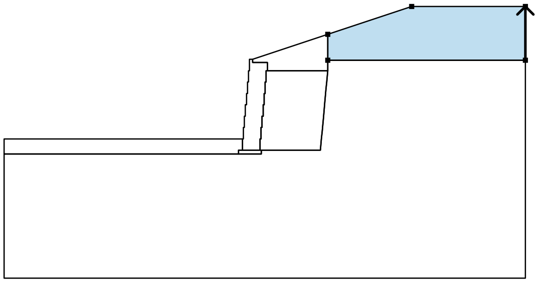
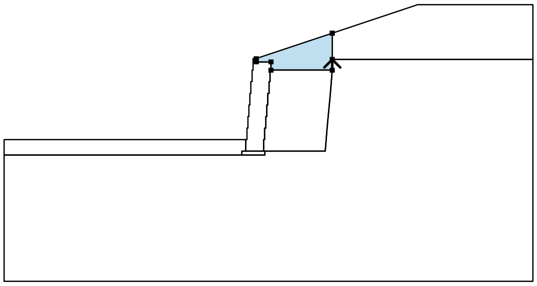
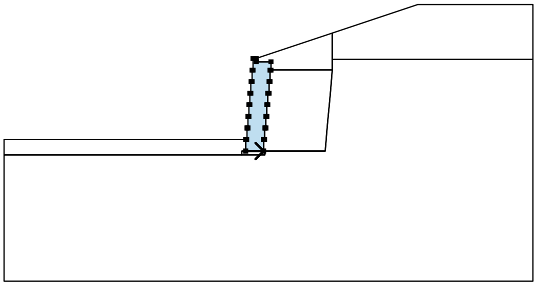
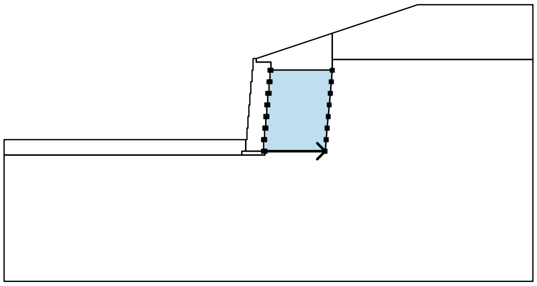
Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

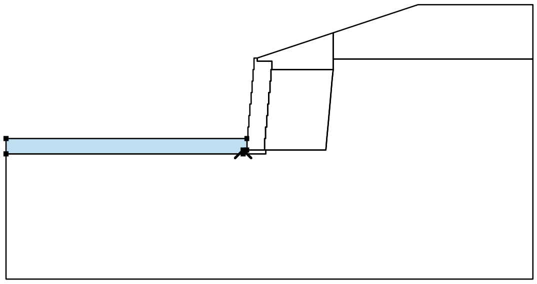
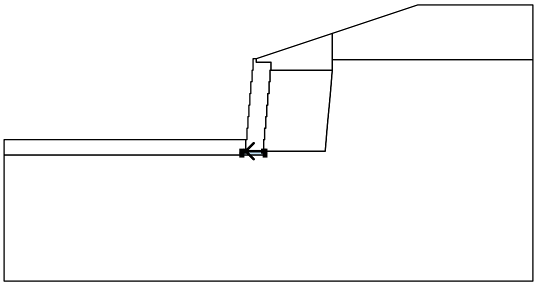
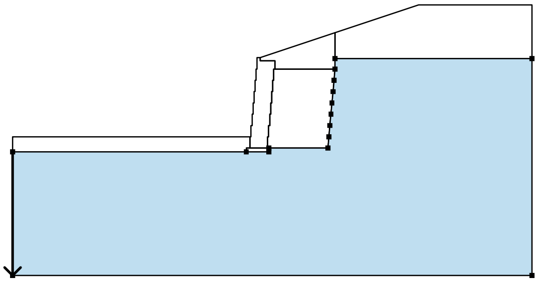
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		36.00	-0.10	36.00	7.00	Light Brown Sand
		21.00	7.00	9.92	3.31	🟨
		9.92	-0.10			
2		9.92	-1.50	9.92	-0.10	Onsite Sands
		9.92	3.31	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
3		-1.36	-12.00	0.97	-12.00	Material of structure
		0.97	-10.50	1.10	-10.50	🟥
		1.10	-9.00	1.24	-9.00	
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
		-1.09	-9.00	-1.23	-9.00	
		-1.23	-10.50	-1.36	-10.50	
4		1.14	-12.00	8.97	-12.00	Onsite Sands
		9.10	-10.50	9.24	-9.00	▨
		9.38	-7.50	9.51	-6.00	
		9.65	-4.50	9.78	-3.00	
		9.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
		1.10	-9.00	1.10	-10.50	
		0.97	-10.50	0.97	-12.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
5		-1.86	-12.50	-1.86	-12.00	Dark Gray Clay (Drained)
		-1.36	-12.00	-1.36	-10.50	▨
		-32.80	-10.50	-32.80	-12.50	
6		0.97	-12.00	-1.36	-12.00	#57 Stone
		-1.86	-12.00	-1.86	-12.50	▨
		1.14	-12.50	1.14	-12.00	
7		-32.80	-12.50	-32.80	-28.90	Dark Gray Clay (Drained)
		36.00	-28.90	36.00	-0.10	▨
		9.92	-0.10	9.92	-1.50	
		9.78	-3.00	9.65	-4.50	
		9.51	-6.00	9.38	-7.50	
		9.24	-9.00	9.10	-10.50	
		8.97	-12.00	1.14	-12.00	
		1.14	-12.50	-1.86	-12.50	

Reinforcements

No.	Point to the left x [ft]	Point to the left z [ft]	Point to the right x [ft]	Point to the right z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	0.97	-12.00	8.97	-12.00	8.00	848.5	C = 0.67	Fixed
2	1.10	-10.50	9.10	-10.50	8.00	1696.9	C = 0.67	Fixed
3	1.24	-9.00	9.24	-9.00	8.00	1696.9	C = 0.67	Fixed
4	1.38	-7.50	9.38	-7.50	8.00	1696.9	C = 0.67	Fixed
5	1.51	-6.00	9.51	-6.00	8.00	1696.9	C = 0.67	Fixed
6	1.65	-4.50	9.65	-4.50	8.00	1696.9	C = 0.67	Fixed
7	1.78	-3.00	9.78	-3.00	8.00	1696.9	C = 0.67	Fixed
8	1.92	-1.50	9.92	-1.50	8.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	permanent	on terrain	x = 21.00	l = 10.00		0.00	125.0		lbf/ft^2

Surcharges

No.	Name
1	Light Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.40	[ft]	Angles :	α_1 =	-22.56	[°]
	z =	15.09	[ft]		α_2 =	73.03	[°]
Radius :	R =	27.71	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0
7	0.0
8	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 14382.7 lbf/ft
Sum of passive forces : F_p = 26199.0 lbf/ft

Sliding moment : M_a = 398545.2 lbfft/ft
Resisting moment : M_p = 725975.0 lbfft/ft
Factor of safety = 1.82 > 1.50

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 9.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #7
Description : H9
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

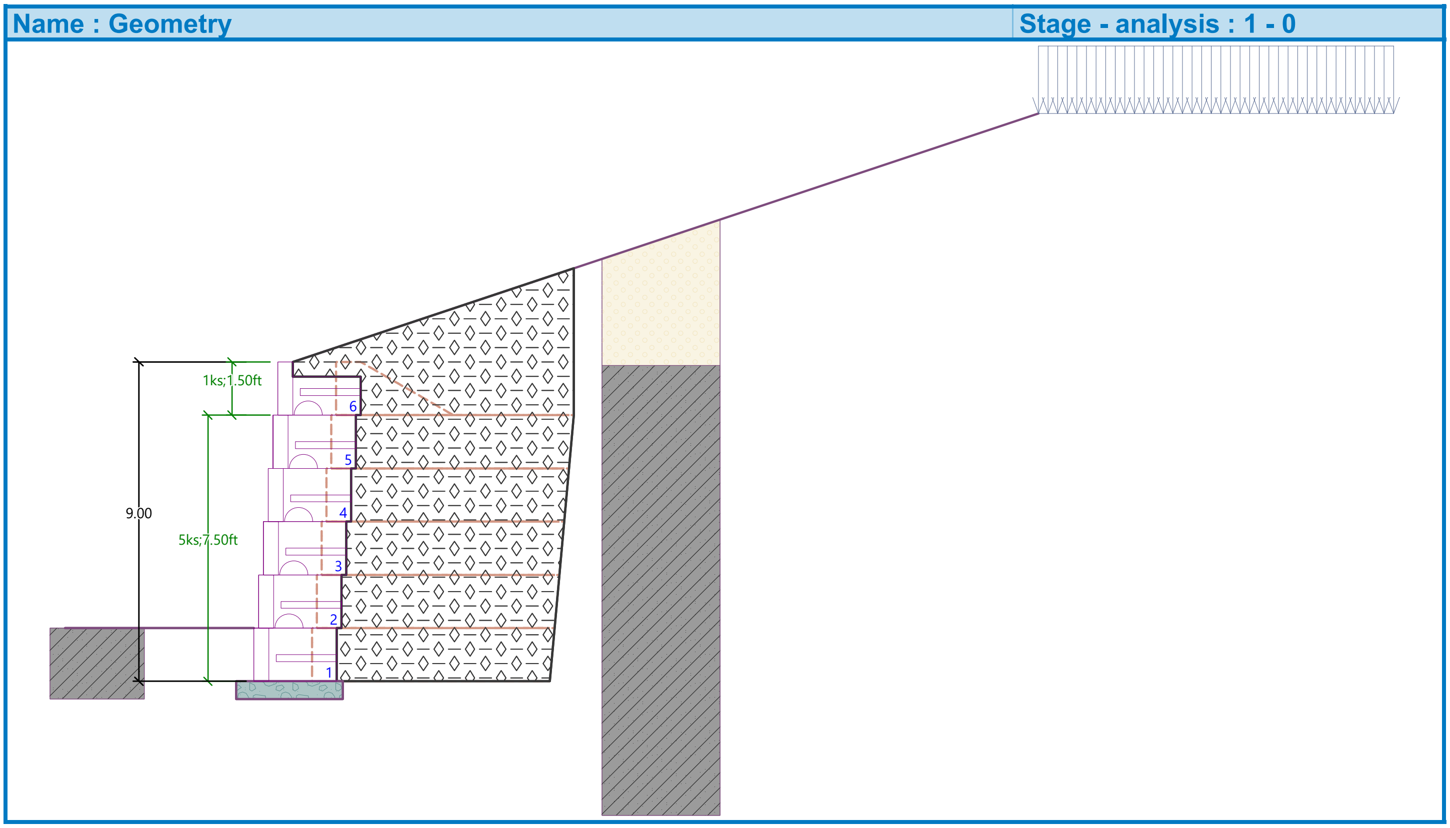
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	5	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback	a_1	=	0.50	ft
Lower setback	a_2	=	0.50	ft
Height	h	=	0.50	ft
Width	b	=	3.00	ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	– – – – – – – – – –	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	=	7400.00	lbf/ft
Creep red. factor	RF_{CR}	=	1.58	
Durability red. factor	RF_D	=	1.15	
Installation damage red. factor	RF_{ID}	=	1.20	
Long-term design strength	R_t	=	3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	=	0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	=	0.67	
Scale correction factor	α	=	0.8	
Long-term strength reduction factor	CR_{cr}	=	0.532	
Calculation of long-term connection strength	R_{con}	=	3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 6.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	6.00	
2	Yes	Miragrid 8XT	6.00	
3	Yes	Miragrid 8XT	6.00	
4	Yes	Miragrid 8XT	6.00	
5	Yes	Miragrid 8XT	6.00	
6	Yes	Miragrid 8XT	6.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Onsite Sands	◇	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Brown Sand	🟨	32.00	75.0	110.00	52.50	21.33

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Light Brown Sand	🟨
2	-	0.10 .. ∞	Dark Gray Clay (Drained)	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 7.00 ft, embankment length is 21.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	125.00		21.00	10.00	on terrain

No.	Name
1	Light Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Dark Gray Clay (Drained)
Soil thickness in front of structure h = 2.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-1274.4	-0.68	0.0	2.33	1.000
Weight - reinforced soil	0.0	-5.40	7561.5	5.76	1.000
Active pressure	1595.3	-2.62	746.7	9.01	1.000
Light Traffic	236.2	-4.13	112.7	9.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 54910.0 lbfft/ft
Overturning moment M_{ovr} = 4287.4 lbfft/ft

Safety factor = 12.81 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 6169.10 lbf/ft
Active horizontal force H_{act} = 557.03 lbf/ft

Safety factor = 11.07 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-28719.0	3753.25	-7046.49	0.000	1251.1

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-28719.0	3753.25	-7046.49

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force $e = 0.000$
Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom $\sigma = 1251.1$ psf
Bearing capacity of foundation soil $R_d = 6000.0$ psf

Safety factor = 4.80 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000
FF resistance	-1273.4	-0.68	0.0	-2.33	1.000
Active pressure	1575.2	-2.55	734.5	6.00	1.000
Light Traffic	215.9	-4.11	107.4	6.00	1.000
Weight - reinforced soil	0.0	-5.16	6894.5	3.25	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 7736.44 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 3309.94 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force $H_{res} = 6600.24$ lbf/ft
Active horiz. force $H_{act} = 1791.18$ lbf/ft

Factor of safety = 3.68 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-231.35	9.00	848.47	40.90	1203.25	28.84	855.83	40.55
2	Miragrid 8XT	-397.20	7.50	1696.94	35.11	1825.18	32.64	1711.65	34.81
3	Miragrid 8XT	-320.11	6.00	1696.94	28.30	1324.08	36.26	1711.65	28.05
4	Miragrid 8XT	-260.45	4.50	1696.94	23.02	903.19	43.25	1711.65	22.82
5	Miragrid 8XT	-200.78	3.00	1696.94	17.75	562.52	53.54	1711.65	17.60
6	Miragrid 8XT	-189.30	1.50	1696.94	16.73	302.06	94.00	855.83	33.18

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 231.35 lbf/ft

Safety factor = 3.67 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.6)

Pull out resistance T_p = 302.06 lbf/ft
Force in reinforcement F_x = 189.30 lbf/ft

Safety factor = 1.60 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 231.35 lbf/ft

Safety factor = 3.70 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

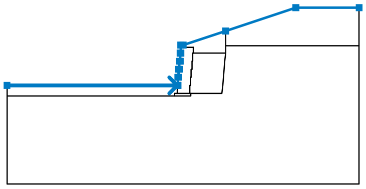
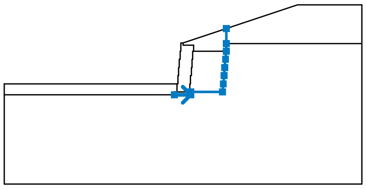
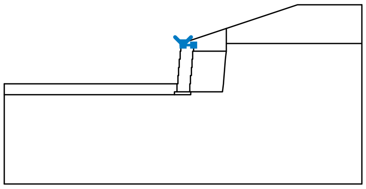
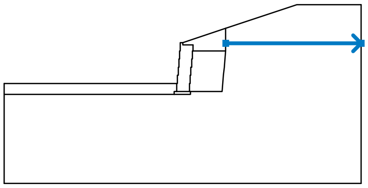
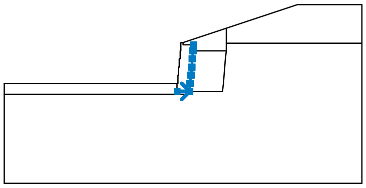
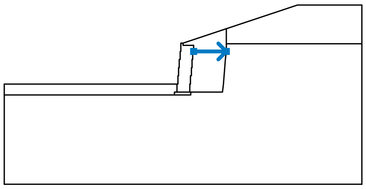
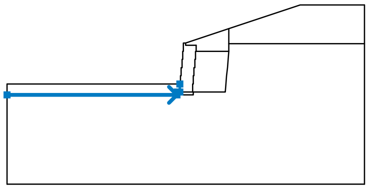
(input for current task)

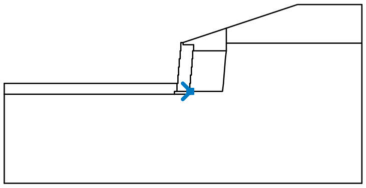
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-7.50	-1.09	-7.50	-0.96	-7.50
		-0.96	-6.00	-0.82	-6.00	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	7.92	2.64	21.00	7.00
		32.80	7.00				
2		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		7.24	-9.00	7.38	-7.50	7.51	-6.00
		7.65	-4.50	7.78	-3.00	7.92	-1.50
		7.92	-0.10	7.92	2.64		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		7.92	-0.10	32.80	-0.10		
5		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
6		1.92	-1.50	7.92	-1.50		
7		-32.80	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
8		1.24	-9.00	1.41	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Brown Sand	▨	115.0		

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °

Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

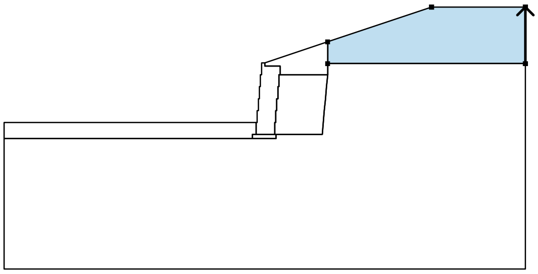
Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

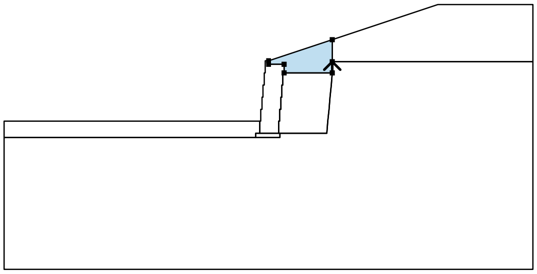
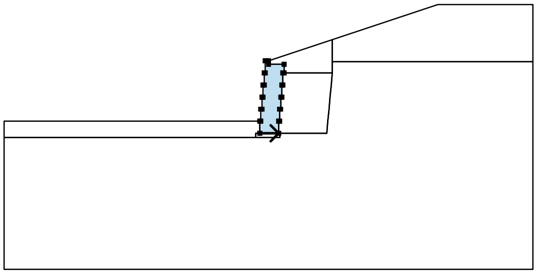
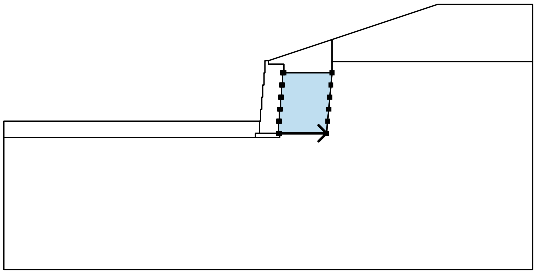
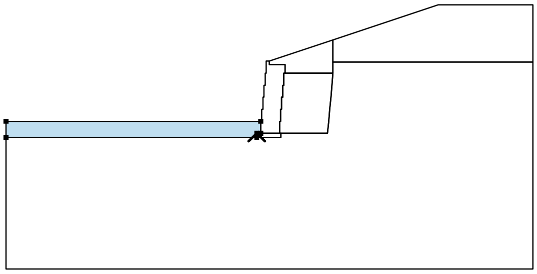
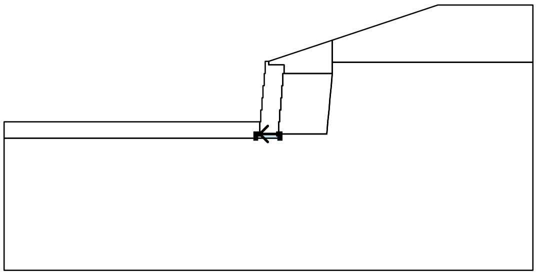
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

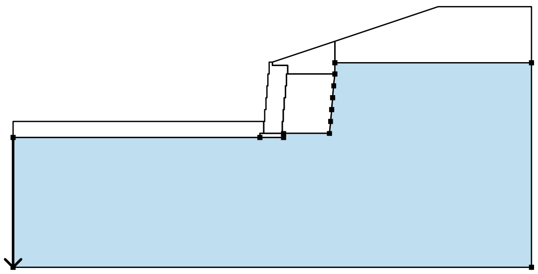
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		32.80	-0.10	32.80	7.00	Light Brown Sand ▨
		21.00	7.00	7.92	2.64	
		7.92	-0.10			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
2		7.92	-1.50	7.92	-0.10	Onsite Sands
		7.92	2.64	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
3		-1.09	-9.00	1.24	-9.00	Material of structure
		1.24	-7.50	1.38	-7.50	▦
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
4		1.41	-9.00	7.24	-9.00	Onsite Sands
		7.38	-7.50	7.51	-6.00	▨
		7.65	-4.50	7.78	-3.00	
		7.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
5		-1.59	-9.50	-1.59	-9.00	Dark Gray Clay (Drained)
		-1.09	-9.00	-1.09	-7.50	▨
		-32.80	-7.50	-32.80	-9.50	
6		1.24	-9.00	-1.09	-9.00	#57 Stone
		-1.59	-9.00	-1.59	-9.50	▨
		1.41	-9.50	1.41	-9.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
7		-32.80	-9.50	-32.80	-25.90	Dark Gray Clay (Drained)
		32.80	-25.90	32.80	-0.10	
		7.92	-0.10	7.92	-1.50	▨
		7.78	-3.00	7.65	-4.50	
		7.51	-6.00	7.38	-7.50	
		7.24	-9.00	1.41	-9.00	
		1.41	-9.50	-1.59	-9.50	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	1.24	-9.00	7.24	-9.00	6.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	7.38	-7.50	6.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	7.51	-6.00	6.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	7.65	-4.50	6.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	7.78	-3.00	6.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	7.92	-1.50	6.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 21.00	l = 10.00		0.00	125.0		lbf/ft^2

Surcharges

No.	Name
1	Light Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	0.31	[ft]	Angles :	α_1 =	-24.58	[°]
	z =	16.78	[ft]		α_2 =	68.51	[°]
Radius :	R =	26.70	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 10813.9 lbf/ft
Sum of passive forces : F_p = 22260.6 lbf/ft

Sliding moment : M_a = 288730.6 lbfft/ft
Resisting moment : M_p = 594356.9 lbfft/ft
Factor of safety = 2.06 > 1.50

Slope stability ACCEPTABLE

Geotechnical, Environmental and Materials Engineers

WALL #8

MAX. WALL HEIGHT = 9.0 FEET

INTERNAL/EXTERNAL STABILITY

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #8
Description : H9
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Post Construction - 250 PSF Traffic Surcharge

Safety factors Permanent design situation			
Safety factor for overturning :	$SF_o =$	2.00	[–]
Safety factor for sliding resistance :	$SF_s =$	1.50	[–]
Safety factor for bearing capacity :	$SF_b =$	3.00	[–]
Safety factor for sliding along geo-reinforcement :	$SF_{sr} =$	1.50	[–]
Safety factor for geo-reinforcement strength :	$SF_{st} =$	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	$SF_{po} =$	1.50	[–]
Safety factor for connection strength :	$SF_{con} =$	1.50	[–]

Reduction coefficients Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

During Construction - 1600 PSF Static Trencher Surcharge

Safety factors Transient design situation			
Safety factor for overturning :	$SF_o =$	1.50	[–]
Safety factor for sliding resistance :	$SF_s =$	1.50	[–]
Safety factor for bearing capacity :	$SF_b =$	2.00	[–]
Safety factor for sliding along geo-reinforcement :	$SF_{sr} =$	1.50	[–]
Safety factor for geo-reinforcement strength :	$SF_{st} =$	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	$SF_{po} =$	1.50	[–]
Safety factor for connection strength :	$SF_{con} =$	1.50	[–]

Reduction coefficients Transient design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Safety factors Accidental design situation			
Safety factor for overturning :	SF_o =	1.50	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.10	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.10	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.10	[–]
Safety factor for connection strength :	SF_{con} =	1.10	[–]

Reduction coefficients Accidental design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

Setbacks

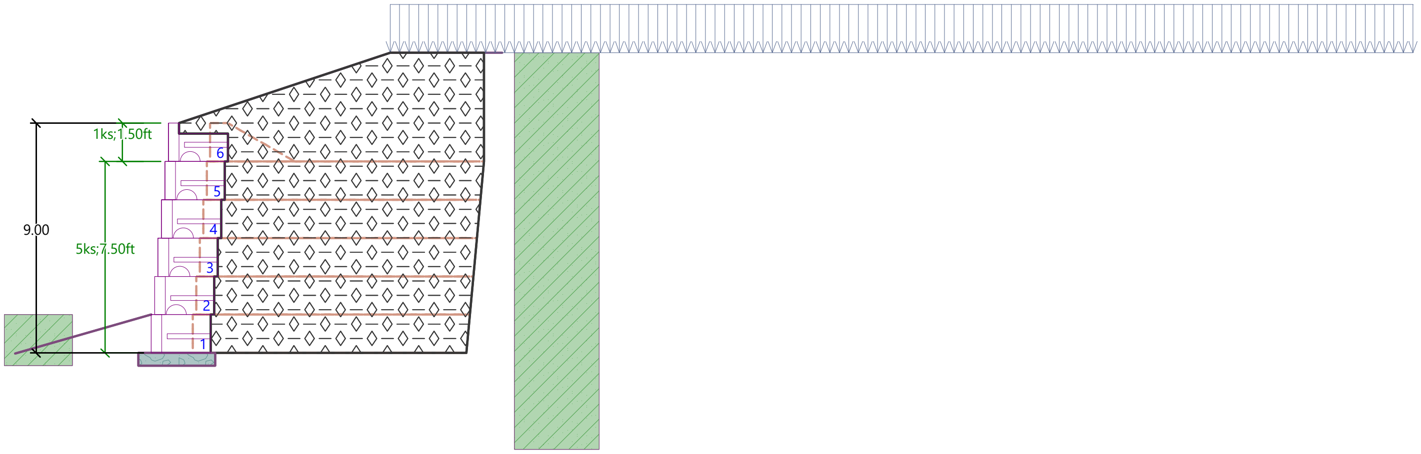
No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	5	1.62
2	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0

Post Construction - 250 PSF Traffic Surcharge



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	=	7400.00	lbf/ft
Creep red. factor	RF_{CR}	=	1.58	
Durability red. factor	RF_D	=	1.15	
Installation damage red. factor	RF_{ID}	=	1.20	
Long-term design strength	R_t	=	3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	=	0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	=	0.67	
Scale correction factor	α	=	0.8	
Long-term strength reduction factor	CR_{cr}	=	0.532	
Calculation of long-term connection strength	R_{con}	=	3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 10.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	10.00	
2	Yes	Miragrid 8XT	10.00	
3	Yes	Miragrid 8XT	10.00	
4	Yes	Miragrid 8XT	10.00	
5	Yes	Miragrid 8XT	10.00	
6	Yes	Miragrid 8XT	10.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	🟦	40.00	0.0	105.00	47.50	26.67
2	Perched Clay (Drained)	🟥	24.00	200.0	110.00	52.50	16.00
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
5	Black Creek Confining Layer	🟩	26.00	125.0	120.00	62.50	17.33

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Black Creek Confining Layer
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 125.0 psf
Angle of friction struc.-soil : δ = 17.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Black Creek Confining Layer	🟩

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 2.75 ft, embankment length is 8.25 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.00		8.25	40.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Black Creek Confining Layer
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -15.95 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1 (Stage of construction 1)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-865.6	-0.67	-247.4	2.33	1.000
Weight - reinforced soil	0.0	-5.60	12964.4	7.86	1.000
Active pressure	1395.5	-2.90	680.6	13.01	1.000
Traffic	744.8	-4.87	437.4	13.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000
Traffic	0.0	-11.75	916.7	11.18	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 129704.6 lbfft/ft
Overturning moment M_{ovr} = 7092.8 lbfft/ft

Safety factor = 18.29 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 9100.57 lbf/ft
Active horizontal force H_{act} = 1274.72 lbf/ft

Safety factor = 7.14 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 1)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-38416.8	3621.45	-7780.46	0.000	1207.2

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-38416.8	3621.45	-7780.46

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 1207.2 psf

Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 4.97 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 1)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000
FF resistance	-864.9	-0.67	-247.2	-2.33	1.000
Active pressure	1395.2	-2.90	680.5	10.00	1.000
Traffic	743.9	-4.87	436.9	10.00	1.000
Weight - reinforced soil	0.0	-5.47	12279.5	5.35	1.000
Traffic	0.0	-11.75	747.4	8.51	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 14144.27 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 6329.49 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 9211.28 lbf/ft
Active horiz. force H_{act} = 2139.04 lbf/ft

Factor of safety = 4.31 > 1.50

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 1)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-280.95	9.00	848.47	49.67	2133.81	19.75	855.83	49.24
2	Miragrid 8XT	-498.24	7.50	1696.94	44.04	3462.15	21.59	1711.65	43.66
3	Miragrid 8XT	-423.20	6.00	1696.94	37.41	2736.90	23.19	1711.65	37.09
4	Miragrid 8XT	-266.99	4.50	1696.94	23.60	2091.86	19.14	1711.65	23.40
5	Miragrid 8XT	-200.78	3.00	1696.94	17.75	1517.85	19.84	1711.65	17.60
6	Miragrid 8XT	-189.30	1.50	1696.94	16.73	993.12	28.59	855.83	33.18

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 280.95 lbf/ft

Safety factor = 3.02 > 1.50

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.6)
Pull out resistance T_p = 993.12 lbf/ft
Force in reinforcement F_x = 189.30 lbf/ft

Safety factor = 5.25 > 1.50

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 280.95 lbf/ft

Safety factor = 3.05 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Input data (Stage of construction 2)

During Construction - 1600 PSF
Static Trencher Surcharge

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Black Creek Confining Layer	🟩

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 2.75 ft, embankment length is 8.25 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft^2]	Mag.2 [lbf/ft^2]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1600.00		8.25	3.00	on terrain
2	Yes		permanent	1600.00		19.25	3.00	on terrain

No.	Name
1	Trencher Track 1 - Static
2	Trencher Track 2 - Static

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Black Creek Confining Layer
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -15.95 °

Settings of the stage of construction

Design situation : transient

Verification No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-865.6	-0.67	-247.4	2.33	1.000
Weight - reinforced soil	0.0	-5.60	12964.4	7.86	1.000
Active pressure	1395.5	-2.90	680.6	13.01	1.000
Trencher Track 2 - Static	1775.7	-4.71	866.1	13.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000
Trencher Track 1 - Static	0.0	-11.75	4800.0	10.84	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment M_{res} = 177086.2 lbfft/ft
Overturning moment M_{ovr} = 11836.1 lbfft/ft

Safety factor = 14.96 > 1.50

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 11030.17 lbf/ft
Active horizontal force H_{act} = 2305.61 lbf/ft

Safety factor = 4.78 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 2)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-34335.8	4118.53	-6604.68	0.000	1372.8

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-34335.8	4118.53	-6604.68

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1372.8 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 4.37 > 2.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 2)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-864.9	-0.67	-247.2	-2.33	1.000
Active pressure	1395.2	-2.90	680.5	10.00	1.000
Trencher Track 1 - Static	0.0	-11.75	0.0	10.00	1.000
Trencher Track 2 - Static	1698.9	-4.44	828.6	10.00	1.000
Weight - reinforced soil	0.0	-5.47	12279.5	5.35	1.000
Trencher Track 1 - Static	0.0	-11.75	4783.3	8.51	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 18571.90 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 8310.83 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 11192.62 lbf/ft
Active horiz. force H_{act} = 3094.11 lbf/ft

Factor of safety = 3.62 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 2)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-385.68	9.00	848.47	68.18	2133.81	27.11	855.83	67.60
2	Miragrid 8XT	-744.44	7.50	1696.94	65.80	3462.15	32.25	1711.65	65.24
3	Miragrid 8XT	-720.56	6.00	1696.94	63.69	2736.90	39.49	1711.65	63.15
4	Miragrid 8XT	-287.42	4.50	1696.94	25.41	2091.86	20.61	1711.65	25.19
5	Miragrid 8XT	-200.78	3.00	1696.94	17.75	1517.85	19.84	1711.65	17.60
6	Miragrid 8XT	-189.30	1.50	1696.94	16.73	993.12	28.59	855.83	33.18

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 385.68 lbf/ft

Safety factor = 2.20 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.3)
Pull out resistance T_p = 2736.90 lbf/ft
Force in reinforcement F_x = 720.56 lbf/ft

Safety factor = 3.80 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)
Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 385.68 lbf/ft

Safety factor = 2.22 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Input data (Stage of construction 3)

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Black Creek Confining Layer	🟩

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 2.75 ft, embankment length is 8.25 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	3200.00		8.25	3.00	on terrain
2	Yes		permanent	3200.00		19.25	3.00	on terrain

No.	Name
1	Trencher Track 1 - Dynamic
2	Trencher Track 2 - Dynamic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Black Creek Confining Layer
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -15.95 °

Settings of the stage of construction

Design situation : accidental

Verification No. 1 (Stage of construction 3)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-865.6	-0.67	-247.4	2.33	1.000
Weight - reinforced soil	0.0	-5.60	12964.4	7.86	1.000
Active pressure	1395.5	-2.90	680.6	13.01	1.000
Trencher Track 2 - Dynamic	3551.5	-4.71	1732.2	13.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000
Trencher Track 1 - Dynamic	0.0	-11.75	9600.0	10.84	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 240404.4 lbfft/ft
Overturning moment M_{ovr} = 20206.0 lbfft/ft

Safety factor = 11.90 > 1.50

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 13565.72 lbf/ft
Active horizontal force H_{act} = 4081.36 lbf/ft

Safety factor = 3.32 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 3)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-28712.7	4821.33	-4945.35	0.000	1607.1

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-28712.7	4821.33	-4945.35

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1607.1 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 3.73 > 2.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 3)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000
FF resistance	-864.9	-0.67	-247.2	-2.33	1.000
Active pressure	1173.1	-2.45	502.2	10.45	1.000
Trencher Track 2 - Dynamic	3886.5	-5.28	1374.7	10.74	1.000
Weight - reinforced soil	0.0	-5.66	13395.0	5.78	1.000
Trencher Track 1 - Dynamic	0.0	-11.75	9600.0	8.51	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 82.00 °

Overall normal force acting on reinforcement = 24871.80 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 11130.00 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 14011.80 lbf/ft
Active horiz. force H_{act} = 5059.57 lbf/ft

Factor of safety = 2.77 > 1.10

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 3)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-540.00	9.00	848.47	70.01	2133.81	27.84	855.83	69.41
2	Miragrid 8XT	-1091.68	7.50	1696.94	70.77	3462.15	34.68	1711.65	70.16
3	Miragrid 8XT	-1121.02	6.00	1696.94	72.67	2736.90	45.06	1711.65	72.04
4	Miragrid 8XT	-314.38	4.50	1696.94	20.38	2091.86	16.53	1711.65	20.20
5	Miragrid 8XT	-200.78	3.00	1696.94	13.02	1517.85	14.55	1711.65	12.90
6	Miragrid 8XT	-189.30	1.50	1696.94	12.27	993.12	20.97	855.83	24.33

Check for tensile strength (reinforcement No.3)
Tension strength R_t = 1696.94 lbf/ft
Force in reinforcement F_x = 1121.02 lbf/ft

Safety factor = 1.51 > 1.10

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.3)
Pull out resistance T_p = 2736.90 lbf/ft
Force in reinforcement F_x = 1121.02 lbf/ft

Safety factor = 2.44 > 1.10

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.3)
Connection strength R_{con} = 1711.65 lbf/ft
Force in reinforcement F_x = 1121.02 lbf/ft

Safety factor = 1.53 > 1.10

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Geotechnical, Environmental and Materials Engineers

GLOBAL STABILITY

Slope stability analysis

Post Construction - 250 PSF Traffic Surcharge

Input data

Project

Settings

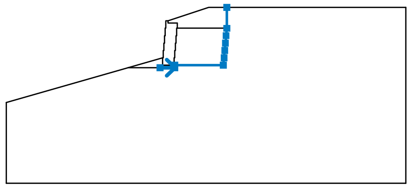
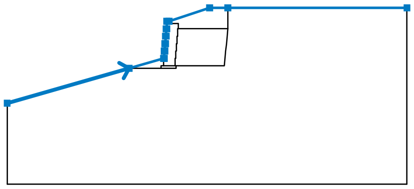
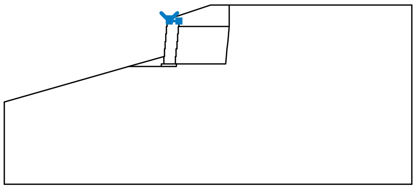
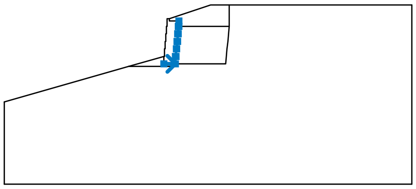
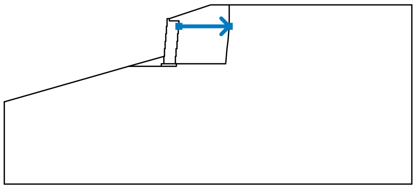
(input for current task)

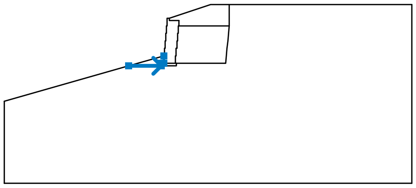
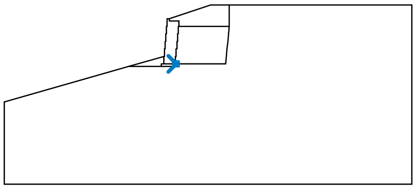
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		11.24	-9.00	11.38	-7.50	11.51	-6.00
		11.65	-4.50	11.78	-3.00	11.92	-1.50
		11.92	2.75				
2		-32.80	-16.56	-8.09	-9.50	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	8.25	2.75
		11.92	2.75	48.25	2.75		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	11.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-8.09	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		
7		1.24	-9.00	1.41	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	🟦	40.00	0.0	105.0
2	Perched Clay (Drained)	🟥	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▩	32.00	0.0	115.0
5	Black Creek Confining Layer	🟩	26.00	125.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	🟦	110.0		
2	Perched Clay (Drained)	🟥	115.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_{s} [pcf]	n [–]
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	◇	120.0		
5	Black Creek Confining Layer	🟩	125.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

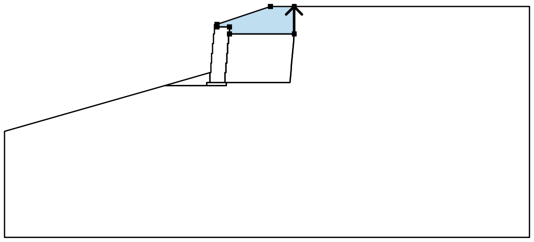
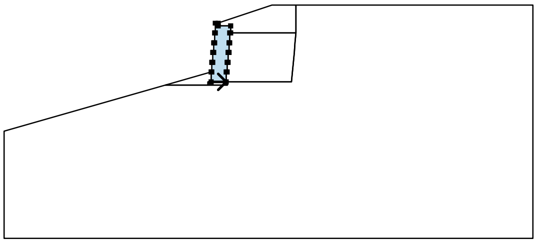
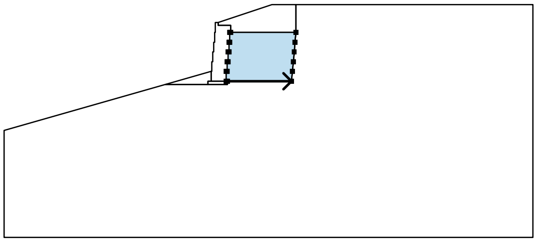
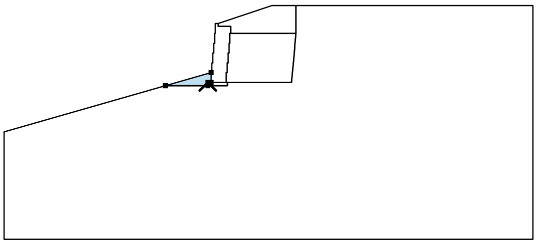
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

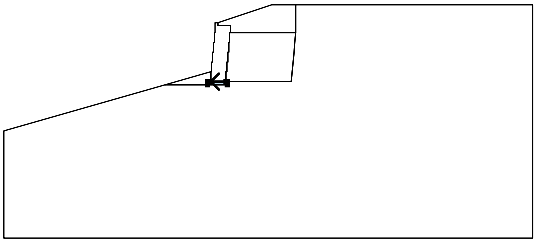
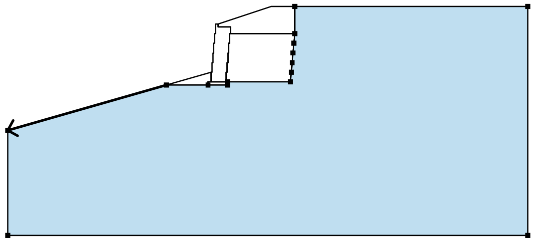
Black Creek Confining Layer
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 125.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		11.92	-1.50	11.92	2.75	Onsite Sands
		8.25	2.75	0.00	0.00	▩
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-1.09	-9.00	1.24	-9.00	Material of structure
		1.24	-7.50	1.38	-7.50	▦
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
3		1.41	-9.00	11.24	-9.00	Onsite Sands
		11.38	-7.50	11.51	-6.00	▩
		11.65	-4.50	11.78	-3.00	
		11.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
4		-1.59	-9.50	-1.59	-9.00	Black Creek Confining Layer
		-1.09	-9.00	-1.09	-7.50	▨
		-8.09	-9.50			

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
5		1.24	-9.00	-1.09	-9.00	#57 Stone ▨
		-1.59	-9.00	-1.59	-9.50	
		1.41	-9.50	1.41	-9.00	
6		-8.09	-9.50	-32.80	-16.56	Black Creek Confining Layer ▨
		-32.80	-32.96	48.25	-32.96	
		48.25	2.75	11.92	2.75	
		11.92	-1.50	11.78	-3.00	
		11.65	-4.50	11.51	-6.00	
		11.38	-7.50	11.24	-9.00	
		1.41	-9.00	1.41	-9.50	
		-1.59	-9.50			

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.24	-9.00	11.24	-9.00	10.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	11.38	-7.50	10.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	11.51	-6.00	10.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	11.65	-4.50	10.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	11.78	-3.00	10.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	11.92	-1.50	10.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 8.25	l = 40.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	$x =$	-10.38	[ft]	Angles :	$\alpha_1 =$	-20.49	[°]
	$z =$	20.41	[ft]		$\alpha_2 =$	61.09	[°]
Radius :	$R =$	36.53	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : $F_a =$ 16783.4 lbf/ft
Sum of passive forces : $F_p =$ 27814.1 lbf/ft

Sliding moment : $M_a =$ 613097.9 lbfft/ft
Resisting moment : $M_p =$ 1016049.7 lbfft/ft
Factor of safety = 1.66 > 1.50

Slope stability ACCEPTABLE

Slope stability analysis

During Construction - 1600 PSF
Static Trencher Surcharge

Input data

Project

Settings

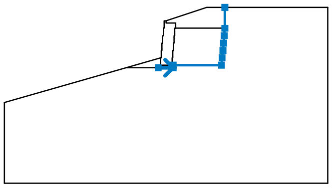
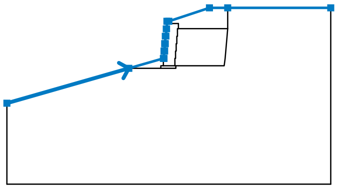
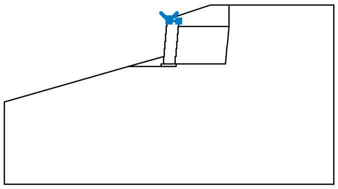
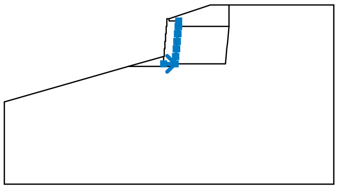
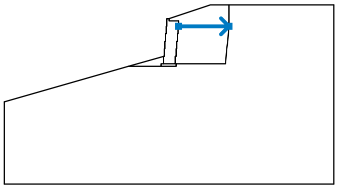
(input for current task)

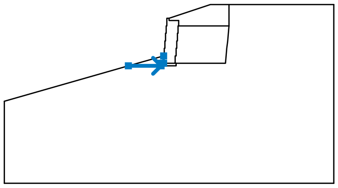
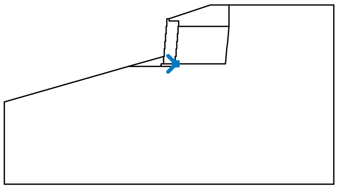
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Transient design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		11.24	-9.00	11.38	-7.50	11.51	-6.00
		11.65	-4.50	11.78	-3.00	11.92	-1.50
		11.92	2.75				
2		-32.80	-16.56	-8.09	-9.50	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	8.25	2.75
		11.92	2.75	32.80	2.75		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	11.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-8.09 -1.09	-9.50 -9.00	-1.59 -1.09	-9.50 -7.50	-1.59	-9.00
7		1.24	-9.00	1.41	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	🟦	40.00	0.0	105.0
2	Perched Clay (Drained)	🟥	24.00	200.0	110.0
3	Surficial Aquifer	⬛	32.00	75.0	115.0
4	Onsite Sands	⬛	32.00	0.0	115.0
5	Black Creek Confining Layer	🟩	26.00	125.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	🟦	110.0		
2	Perched Clay (Drained)	🟥	115.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	▨	120.0		
5	Black Creek Confining Layer	🟩	125.0		

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

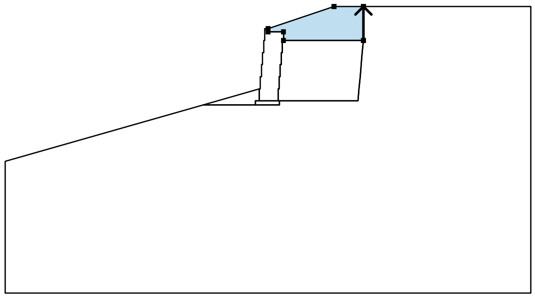
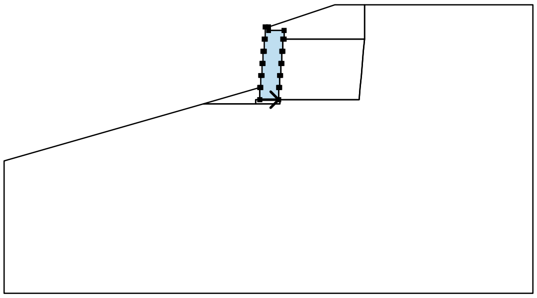
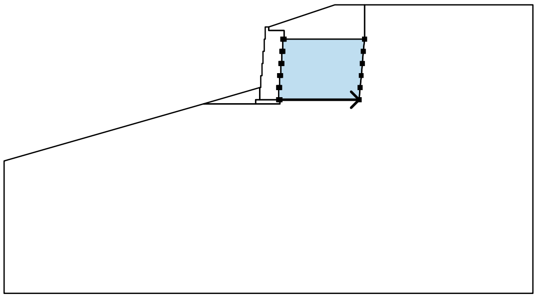
Black Creek Confining Layer

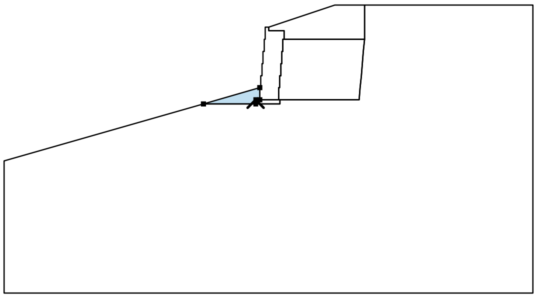
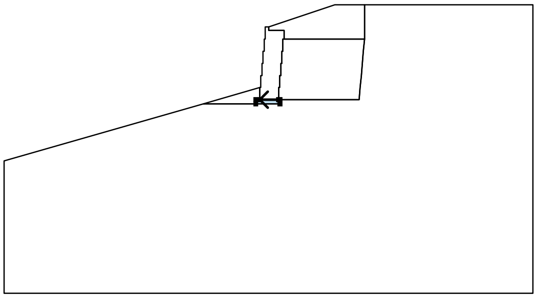
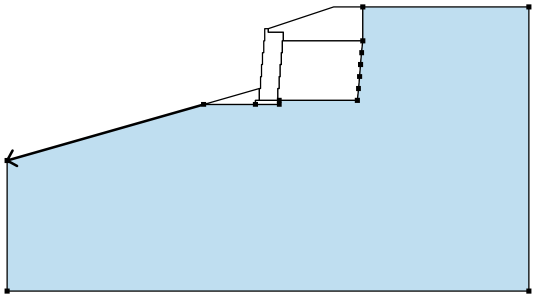
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 125.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
1		11.92	-1.50	11.92	2.75	Onsite Sands
		8.25	2.75	0.00	0.00	▩
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-1.09	-9.00	1.24	-9.00	Material of structure
		1.24	-7.50	1.38	-7.50	▦
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
3		1.41	-9.00	11.24	-9.00	Onsite Sands
		11.38	-7.50	11.51	-6.00	▩
		11.65	-4.50	11.78	-3.00	
		11.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
4		-1.59	-9.50	-1.59	-9.00	Black Creek Confining Layer ▨
		-1.09	-9.00	-1.09	-7.50	
		-8.09	-9.50			
5		1.24	-9.00	-1.09	-9.00	#57 Stone ▨
		-1.59	-9.00	-1.59	-9.50	
		1.41	-9.50	1.41	-9.00	
6		-8.09	-9.50	-32.80	-16.56	Black Creek Confining Layer ▨
		-32.80	-32.96	32.80	-32.96	
		32.80	2.75	11.92	2.75	
		11.92	-1.50	11.78	-3.00	
		11.65	-4.50	11.51	-6.00	
		11.38	-7.50	11.24	-9.00	
		1.41	-9.00	1.41	-9.50	
		-1.59	-9.50			

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.24	-9.00	11.24	-9.00	10.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	11.38	-7.50	10.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	11.51	-6.00	10.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	11.65	-4.50	10.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	11.78	-3.00	10.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	11.92	-1.50	10.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 8.25	l = 3.00		0.00	1600.0		lbf/ft^2

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
2	strip	permanent	on terrain	x = 19.25	l = 3.00		0.00	1600.0		lbf/ft^2

Surcharges

No.	Name
1	Trencher Track 1 - Static
2	Trencher Track 2 - Static

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : transient

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-6.72	[ft]	Angles :	α_1 =	-19.95	[°]
	z =	18.78	[ft]		α_2 =	61.03	[°]
Radius :	R =	33.10	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	3.3
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 18933.1 lbf/ft
Sum of passive forces : F_p = 27614.6 lbf/ft

Sliding moment : M_a = 626684.6 lbfft/ft
Resisting moment : M_p = 914043.9 lbfft/ft
Factor of safety = 1.46 > 1.30
Slope stability ACCEPTABLE

Slope stability analysis

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Input data

Project

Settings

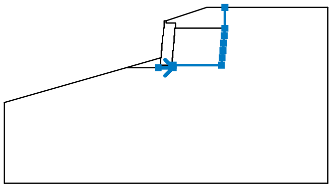
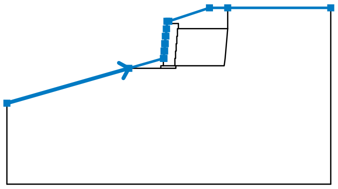
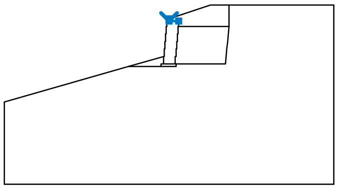
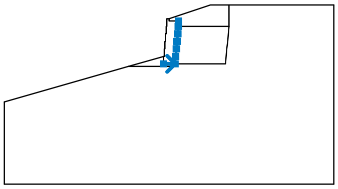
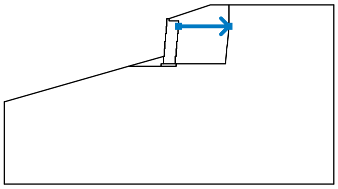
(input for current task)

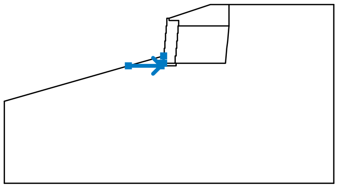
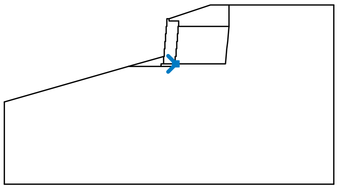
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Accidental design situation			
Safety factor :	SF_s =	1.10	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		11.24	-9.00	11.38	-7.50	11.51	-6.00
		11.65	-4.50	11.78	-3.00	11.92	-1.50
		11.92	2.75				
2		-32.80	-16.56	-8.09	-9.50	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	8.25	2.75
		11.92	2.75	32.80	2.75		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		1.92	-1.50	11.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-8.09	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		
7		1.24	-9.00	1.41	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0
5	Black Creek Confining Layer	▨	26.00	125.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	▨	120.0		
5	Black Creek Confining Layer	▨	125.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

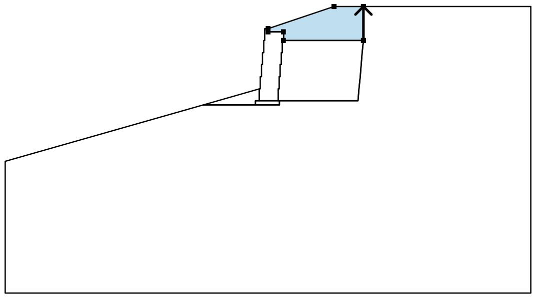
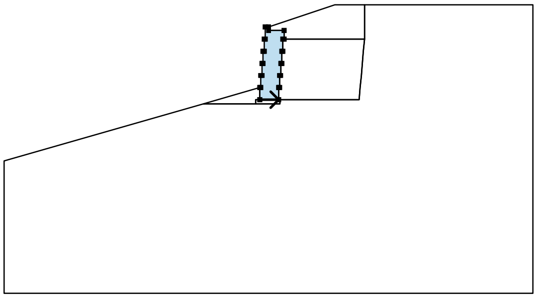
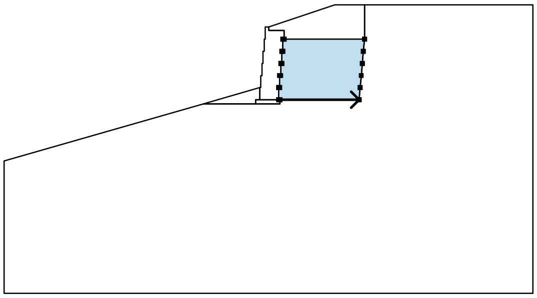
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

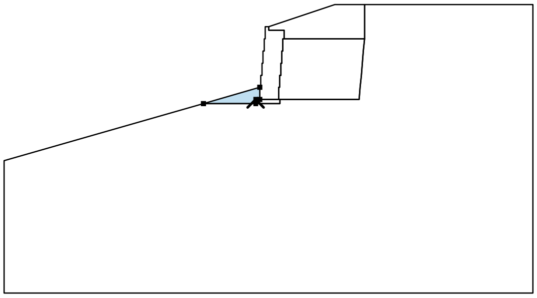
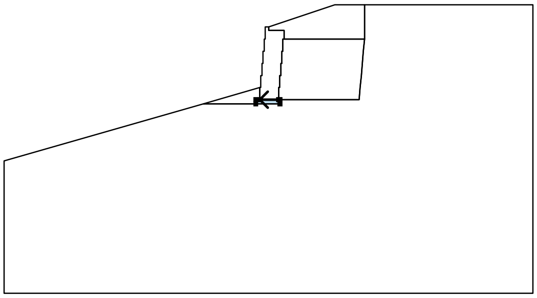
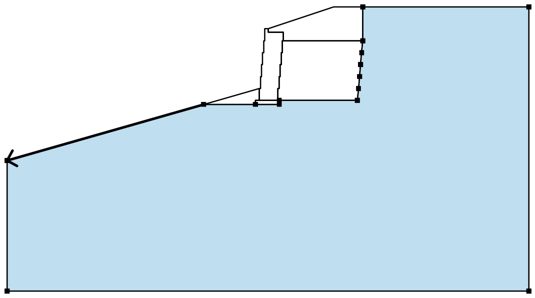
Black Creek Confining Layer
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 125.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		11.92	-1.50	11.92	2.75	Onsite Sands
		8.25	2.75	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-1.09	-9.00	1.24	-9.00	Material of structure
		1.24	-7.50	1.38	-7.50	▦
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
3		1.41	-9.00	11.24	-9.00	Onsite Sands
		11.38	-7.50	11.51	-6.00	▨
		11.65	-4.50	11.78	-3.00	
		11.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
4		-1.59	-9.50	-1.59	-9.00	Black Creek Confining Layer
		-1.09	-9.00	-1.09	-7.50	▨
		-8.09	-9.50			
5		1.24	-9.00	-1.09	-9.00	#57 Stone
		-1.59	-9.00	-1.59	-9.50	▨
		1.41	-9.50	1.41	-9.00	
6		-8.09	-9.50	-32.80	-16.56	Black Creek Confining Layer
		-32.80	-32.96	32.80	-32.96	▨
		32.80	2.75	11.92	2.75	
		11.92	-1.50	11.78	-3.00	
		11.65	-4.50	11.51	-6.00	
		11.38	-7.50	11.24	-9.00	
		1.41	-9.00	1.41	-9.50	
		-1.59	-9.50			

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.24	-9.00	11.24	-9.00	10.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	11.38	-7.50	10.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	11.51	-6.00	10.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	11.65	-4.50	10.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	11.78	-3.00	10.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	11.92	-1.50	10.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 8.25	l = 3.00		0.00	3200.0		$\mathrm{lbf/ft^2}$

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
2	strip	permanent	on terrain	x = 19.25	l = 3.00		0.00	3200.0		lbf/ft^2

Surcharges

No.	Name
1	Trencher Track 1 - Dynamic
2	Trencher Track 2 - Dynamic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : accidental

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-6.36	[ft]	Angles :	α_1 =	-20.02	[°]
	z =	18.47	[ft]		α_2 =	61.21	[°]
Radius :	R =	32.64	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	12.3
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 25101.0 lbf/ft
Sum of passive forces : F_p = 31663.8 lbf/ft

Sliding moment : M_a = 819298.2 lbfft/ft
Resisting moment : M_p = 1033506.6 lbfft/ft
Factor of safety = 1.26 > 1.10

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 6.0 FEET

INTERNAL/EXTERNAL STABILITY

Analysis of Redi Rock wall

Input data

Project

Task	:	Chemours Barrier Wall Retaining Walls
Part	:	Wall #8
Description	:	H6
Author	:	GEOS
Date	:	1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Post Construction - 250 PSF Traffic Surcharge

Safety factors Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

During Construction - 1600 PSF Static Trencher Surcharge

Safety factors Transient design situation			
Safety factor for overturning :	SF_o =	1.50	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients Transient design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Safety factors

Accidental design situation

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Safety factor for overturning :	SF_o =	1.50	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.10	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.10	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.10	[–]
Safety factor for connection strength :	SF_{con} =	1.10	[–]

Reduction coefficients

Accidental design situation

Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

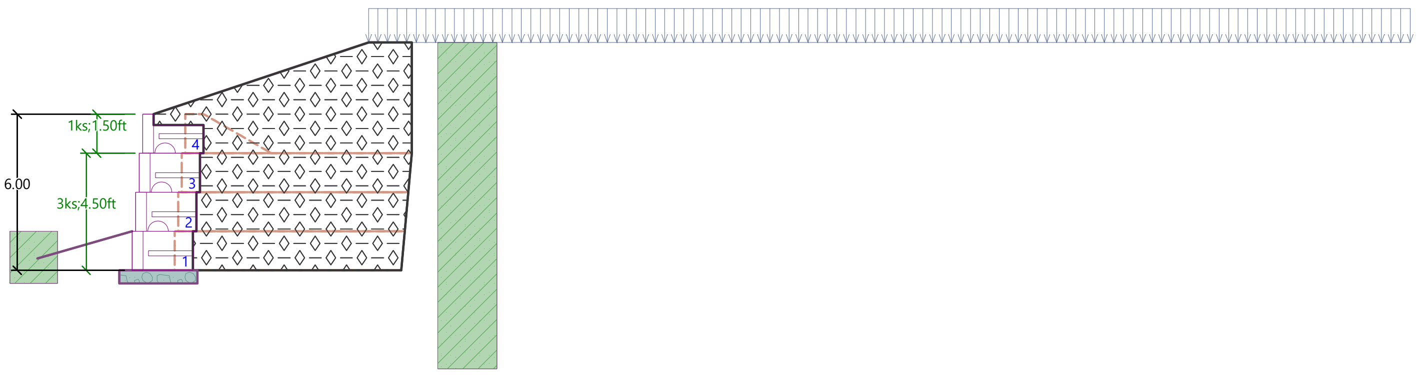
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	3	1.62
2	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	– – – – – – – – – –	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	= 7400.00	lbf/ft
Creep red. factor	RF_{CR}	= 1.58	
Durability red. factor	RF_D	= 1.15	
Installation damage red. factor	RF_{ID}	= 1.20	
Long-term design strength	R_t	= 3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	= 0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	= 0.67	
Scale correction factor	α	= 0.8	
Long-term strength reduction factor	CR_{cr}	= 0.532	
Calculation of long-term connection strength	R_{con}	= 3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 8.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	8.00	
2	Yes	Miragrid 8XT	8.00	
3	Yes	Miragrid 8XT	8.00	
4	Yes	Miragrid 8XT	8.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	🟦	40.00	0.0	105.00	47.50	26.67
2	Perched Clay (Drained)	🟥	24.00	200.0	110.00	52.50	16.00
3	Surficial Aquifer	▨	32.00	75.0	115.00	57.50	21.30
4	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
5	Black Creek Confining Layer	🟩	26.00	125.0	120.00	62.50	17.33

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.00 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Black Creek Confining Layer
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 125.0 psf
Angle of friction struc.-soil : δ = 17.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Black Creek Confining Layer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 2.75 ft, embankment length is 8.25 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [lbf/ft2]	Mag.2 [lbf/ft2]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
	new	change						
1	Yes		permanent	250.00		8.25	40.00	on terrain

No.	Name
1	Traffic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Black Creek Confining Layer
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -15.95 °

Settings of the stage of construction

Design situation : permanent

Verification No. 1 (Stage of construction 1)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-865.6	-0.67	-247.4	2.33	1.000
Weight - reinforced soil	0.0	-4.02	7478.5	6.70	1.000
Active pressure	598.5	-1.90	291.9	10.74	1.000
Traffic	513.7	-3.38	324.7	10.74	1.000
Weight - wall	0.0	-2.83	1584.2	1.34	1.000
Traffic	0.0	-8.75	416.7	9.91	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 62385.8 lbfft/ft
Overturning moment M_{ovr} = 2293.7 lbfft/ft

Safety factor = 27.20 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 5592.26 lbf/ft
Active horizontal force H_{act} = 246.57 lbf/ft

Safety factor = 22.68 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 1)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-17231.5	2292.49	-5426.00	0.000	764.2

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-17231.5	2292.49	-5426.00

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 764.2 psf

Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 7.85 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 1)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.83	1564.7	-0.99	1.000
FF resistance	-864.9	-0.67	-247.2	-2.33	1.000
Active pressure	598.2	-1.90	291.8	2.14	1.000
Traffic	512.4	-3.38	324.0	5.47	1.000
Weight - reinforced soil	0.0	-3.93	7113.1	4.29	1.000
Traffic	0.0	-8.75	315.1	7.37	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 8044.00 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 3599.65 lbf/ft
Wall resistance = 1312.96 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 5777.47 lbf/ft
Active horiz. force H_{act} = 1110.62 lbf/ft

Factor of safety = 5.20 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 1)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-199.00	6.00	848.47	35.18	1207.40	24.72	855.83	34.88
2	Miragrid 8XT	-245.02	4.50	1696.94	21.66	1809.56	20.31	1711.65	21.47
3	Miragrid 8XT	-168.20	3.00	1696.94	14.87	1284.55	19.64	1711.65	14.74
4	Miragrid 8XT	-140.43	1.50	1696.94	12.41	839.74	25.08	855.83	24.61

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 199.00 lbf/ft

Safety factor = 4.26 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.4)
Pull out resistance T_p = 839.74 lbf/ft
Force in reinforcement F_x = 140.43 lbf/ft

Safety factor = 5.98 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 199.00 lbf/ft

Safety factor = 4.30 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Black Creek Confining Layer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 2.75 ft, embankment length is 8.25 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft2]	Mag.2 [lbf/ft2]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1600.00		8.25	3.00	on terrain
2	Yes		permanent	1600.00		19.25	3.00	on terrain

No.	Name
1	Trencher Track 1 - Static
2	Trencher Track 2 - Static

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Black Creek Confining Layer
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -15.95 °

Settings of the stage of construction

Design situation : transient

Verification No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-865.6	-0.67	-247.4	2.33	1.000
Weight - reinforced soil	0.0	-4.02	7478.5	6.70	1.000
Active pressure	598.5	-1.90	291.9	10.74	1.000
Trencher Track 1 - Static	803.1	-7.70	465.4	10.74	1.000
Trencher Track 2 - Static	1007.7	-2.21	491.5	10.74	1.000
Weight - wall	0.0	-2.83	1584.2	1.34	1.000
Trencher Track 1 - Static	0.0	-8.75	2666.7	9.91	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 91464.3 lbfft/ft
Overturning moment M_{ovr} = 8970.3 lbfft/ft

Safety factor = 10.20 > 1.50
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 6882.02 lbf/ft
Active horizontal force H_{act} = 1543.58 lbf/ft

Safety factor = 4.46 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 2)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-15765.8	2633.44	-4649.42	0.000	877.8

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-15765.8	2633.44	-4649.42

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 877.8 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 6.84 > 2.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 2)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.83	1564.7	-0.99	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-864.9	-0.67	-247.2	-2.33	1.000
Active pressure	598.2	-1.90	291.8	2.14	1.000
Trencher Track 1 - Static	1086.8	-7.37	611.6	8.00	1.000
Trencher Track 2 - Static	945.3	-2.10	461.1	2.75	1.000
Weight - reinforced soil	0.0	-3.93	7113.1	4.29	1.000
Trencher Track 1 - Static	0.0	-8.75	2016.7	7.37	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 10494.19 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 4696.09 lbf/ft
Wall resistance = 1312.96 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 6873.92 lbf/ft
Active horiz. force H_{act} = 2630.35 lbf/ft

Factor of safety = 2.61 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 2)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-349.41	6.00	848.47	61.77	1207.40	43.41	855.83	61.24
2	Miragrid 8XT	-264.81	4.50	1696.94	23.41	1809.56	21.95	1711.65	23.21
3	Miragrid 8XT	-168.20	3.00	1696.94	14.87	1284.55	19.64	1711.65	14.74
4	Miragrid 8XT	-140.43	1.50	1696.94	12.41	839.74	25.08	855.83	24.61

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 349.41 lbf/ft

Safety factor = 2.43 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.1)
Pull out resistance T_p = 1207.40 lbf/ft
Force in reinforcement F_x = 349.41 lbf/ft

Safety factor = 3.46 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)
Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 349.41 lbf/ft

Safety factor = 2.45 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Input data (Stage of construction 3)

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Black Creek Confining Layer	▨

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 2.75 ft, embankment length is 8.25 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft^2]	Mag.2 [lbf/ft^2]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	3200.00		8.25	3.00	on terrain
2	Yes		permanent	3200.00		19.25	3.00	on terrain

No.	Name
1	Trencher Track 1 - Dynamic
2	Trencher Track 2 - Dynamic

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Black Creek Confining Layer
Soil thickness in front of structure h = 2.00 ft
Soil slope in front of structure β = -15.95 °

Settings of the stage of construction

Design situation : accidental

Verification No. 1 (Stage of construction 3)

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-865.6	-0.67	-247.4	2.33	1.000
Weight - reinforced soil	0.0	-4.02	7478.5	6.70	1.000
Active pressure	598.5	-1.90	291.9	10.74	1.000
Trencher Track 1 - Dynamic	1757.3	-7.71	930.8	10.74	1.000
Trencher Track 2 - Dynamic	2015.4	-2.21	983.0	10.74	1.000
Weight - wall	0.0	-2.83	1584.2	1.34	1.000
Trencher Track 1 - Dynamic	0.0	-8.75	5333.3	9.91	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 128157.6 lbfft/ft
Overturning moment M_{ovr} = 18573.6 lbfft/ft

Safety factor = 6.90 > 1.50

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 8503.55 lbf/ft
Active horizontal force H_{act} = 3505.49 lbf/ft

Safety factor = 2.43 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 3)

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-13814.3	3104.44	-3583.89	0.000	1034.8

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-13814.3	3104.44	-3583.89

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1034.8 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 5.80 > 2.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1 (Stage of construction 3)

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.83	1564.7	-0.99	1.000
FF resistance	-864.9	-0.67	-247.2	-2.33	1.000
Active pressure	598.2	-1.90	291.8	2.14	1.000
Trencher Track 1 - Dynamic	2340.8	-7.39	1223.2	8.00	1.000
Trencher Track 2 - Dynamic	1890.6	-2.10	922.1	2.75	1.000
Weight - reinforced soil	0.0	-3.93	7113.1	4.29	1.000
Trencher Track 1 - Dynamic	0.0	-8.75	4033.3	7.37	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °

Overall normal force acting on reinforcement = 13583.50 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 6078.54 lbf/ft
Wall resistance = 1312.96 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 8256.37 lbf/ft
Active horiz. force H_{act} = 4829.60 lbf/ft

Factor of safety = 1.71 > 1.10
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1 (Stage of construction 3)

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-550.06	6.00	848.47	71.31	1207.40	50.11	855.83	70.70
2	Miragrid 8XT	-290.96	4.50	1696.94	18.86	1809.56	17.69	1711.65	18.70
3	Miragrid 8XT	-168.20	3.00	1696.94	10.90	1284.55	14.40	1711.65	10.81
4	Miragrid 8XT	-140.43	1.50	1696.94	9.10	839.74	18.40	855.83	18.05

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 550.06 lbf/ft

Safety factor = 1.54 > 1.10
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.1)
Pull out resistance T_p = 1207.40 lbf/ft
Force in reinforcement F_x = 550.06 lbf/ft

Safety factor = 2.20 > 1.10
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)
Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 550.06 lbf/ft

Safety factor = 1.56 > 1.10
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

GLOBAL STABILITY

Slope stability analysis

Post Construction - 250 PSF Traffic Surcharge

Input data

Project

Settings

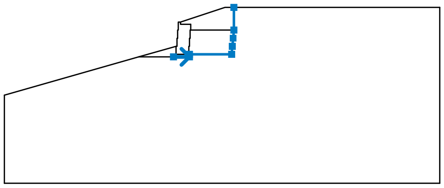
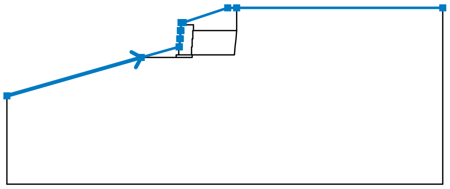
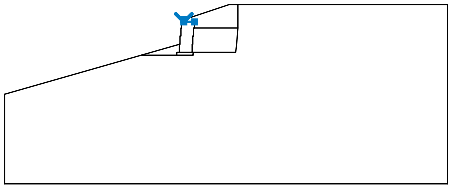
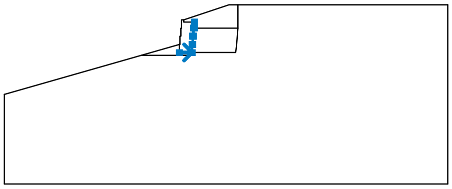
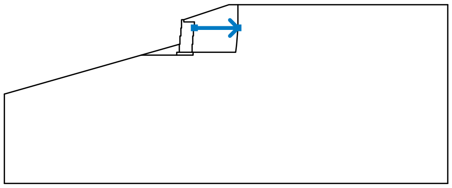
(input for current task)

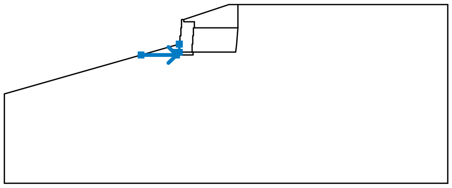
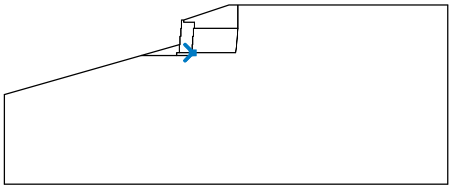
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.32	-6.50	1.68	-6.50	1.68	-6.00
		9.51	-6.00	9.65	-4.50	9.78	-3.00
		9.92	-1.50	9.92	2.75		
2		-32.80	-13.64	-7.82	-6.50	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	8.25	2.75	9.92	2.75
		48.25	2.75				
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-0.82	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
5		1.92	-1.50	9.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-7.82	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
7		1.51	-6.00	1.68	-6.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0
5	Black Creek Confining Layer	▨	26.00	125.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	▨	120.0		
5	Black Creek Confining Layer	▨	125.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

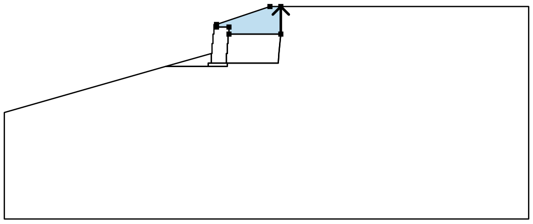
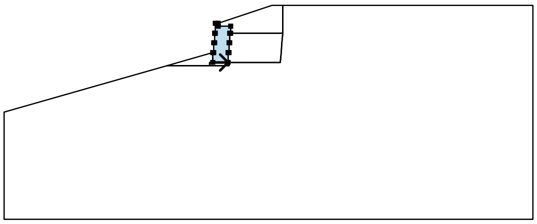
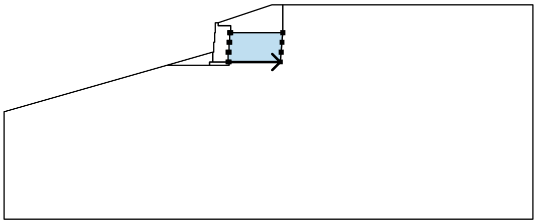
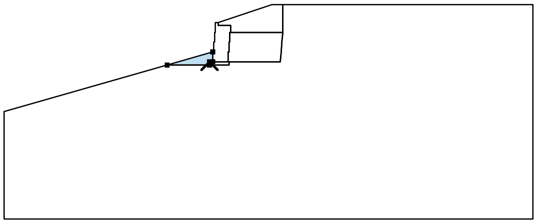
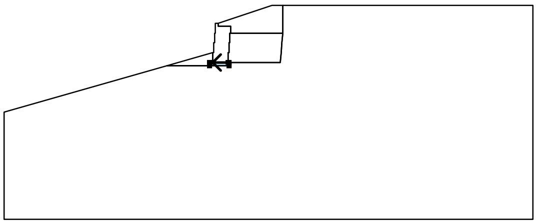
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

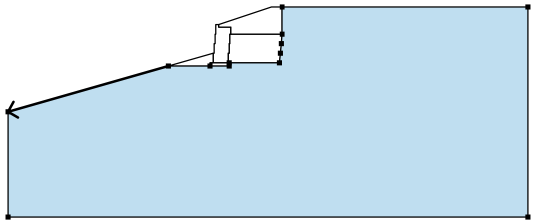
Black Creek Confining Layer
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 125.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		9.92	-1.50	9.92	2.75	Onsite Sands
		8.25	2.75	0.00	0.00	▩
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-0.82	-6.00	1.51	-6.00	Material of structure
		1.51	-4.50	1.65	-4.50	▦
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
3		1.68	-6.00	9.51	-6.00	Onsite Sands
		9.65	-4.50	9.78	-3.00	▩
		9.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
4		-1.32	-6.50	-1.32	-6.00	Black Creek Confining Layer
		-0.82	-6.00	-0.82	-4.50	
		-7.82	-6.50			▨
5		1.51	-6.00	-0.82	-6.00	#57 Stone
		-1.32	-6.00	-1.32	-6.50	▒
		1.68	-6.50	1.68	-6.00	

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
6		-7.82	-6.50	-32.80	-13.64	Black Creek Confining Layer
		-32.80	-30.04	48.25	-30.04	
		48.25	2.75	9.92	2.75	▨
		9.92	-1.50	9.78	-3.00	
		9.65	-4.50	9.51	-6.00	
		1.68	-6.00	1.68	-6.50	
		-1.32	-6.50			

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.51	-6.00	9.51	-6.00	8.00	848.5	C = 0.67	Fixed
2	1.65	-4.50	9.65	-4.50	8.00	1696.9	C = 0.67	Fixed
3	1.78	-3.00	9.78	-3.00	8.00	1696.9	C = 0.67	Fixed
4	1.92	-1.50	9.92	-1.50	8.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 8.25	l = 40.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-6.63	[ft]	Angles :	α_1 =	-20.79	[°]
	z =	17.85	[ft]		α_2 =	58.39	[°]
Radius :	R =	28.81	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 9461.0 lbf/ft
Sum of passive forces : F_p = 17785.7 lbf/ft

Sliding moment : M_a = 272571.4 lbfft/ft
Resisting moment : M_p = 512404.8 lbfft/ft
Factor of safety = 1.88 > 1.50

Slope stability ACCEPTABLE

Slope stability analysis

During Construction - 1600 PSF
Static Trencher Surcharge

Input data

Project

Settings

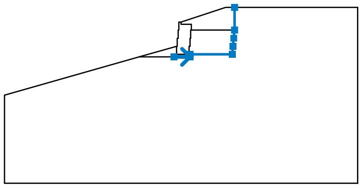
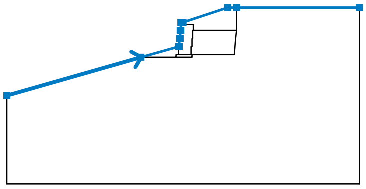
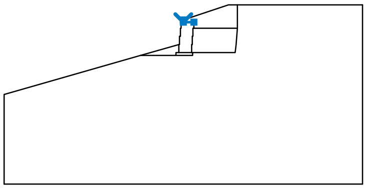
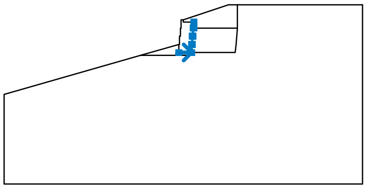
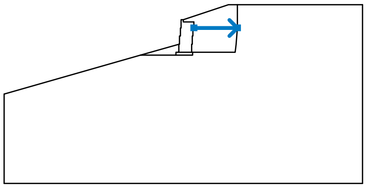
(input for current task)

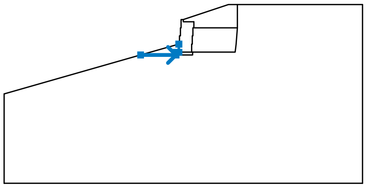
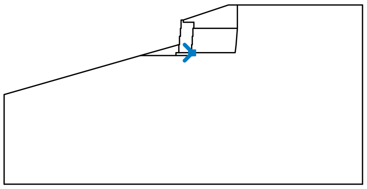
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Transient design situation			
Safety factor :	SF_s =	1.30	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.32	-6.50	1.68	-6.50	1.68	-6.00
		9.51	-6.00	9.65	-4.50	9.78	-3.00
		9.92	-1.50	9.92	2.75		
2		-32.80	-13.64	-7.82	-6.50	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	8.25	2.75	9.92	2.75
		32.80	2.75				
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-0.82	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
5		1.92	-1.50	9.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-7.82	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
7		1.51	-6.00	1.68	-6.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0
5	Black Creek Confining Layer	▨	26.00	125.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	▩	120.0		
5	Black Creek Confining Layer	🟩	125.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

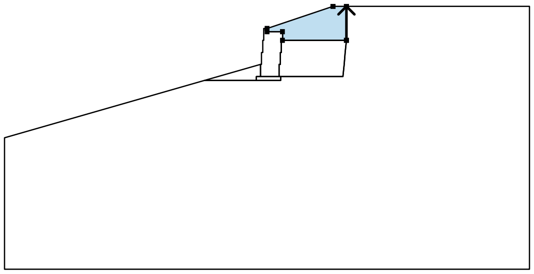
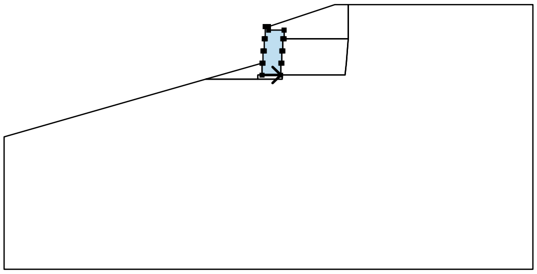
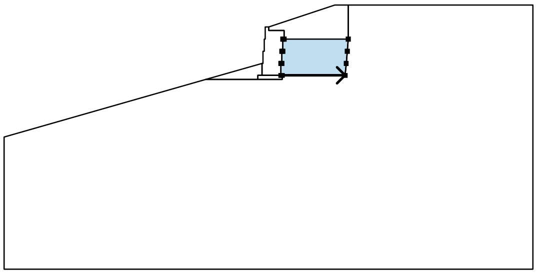
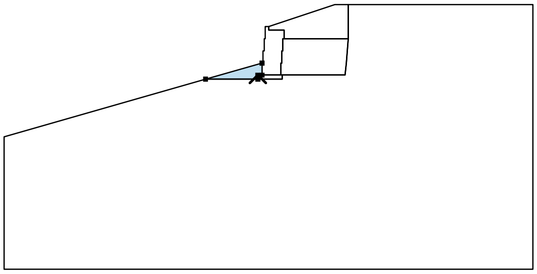
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

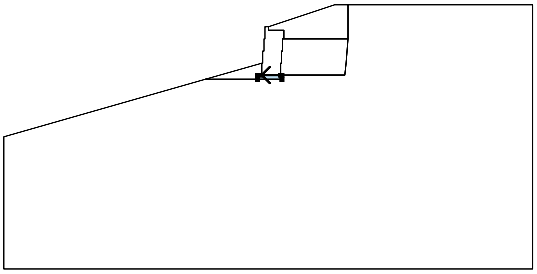
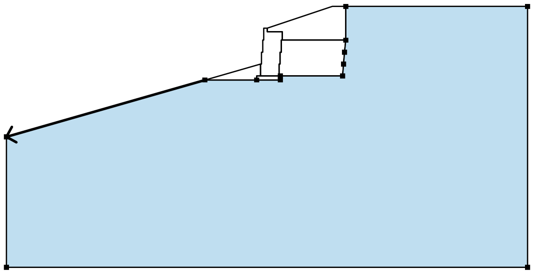
Black Creek Confining Layer
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 125.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		9.92	-1.50	9.92	2.75	Onsite Sands
		8.25	2.75	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-0.82	-6.00	1.51	-6.00	Material of structure
		1.51	-4.50	1.65	-4.50	🟥
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
3		1.68	-6.00	9.51	-6.00	Onsite Sands
		9.65	-4.50	9.78	-3.00	▨
		9.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
4		-1.32	-6.50	-1.32	-6.00	Black Creek Confining Layer
		-0.82	-6.00	-0.82	-4.50	🟩
		-7.82	-6.50			

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
5		1.51	-6.00	-0.82	-6.00	#57 Stone
		-1.32	-6.00	-1.32	-6.50	
		1.68	-6.50	1.68	-6.00	▨
6		-7.82	-6.50	-32.80	-13.64	Black Creek Confining Layer
		-32.80	-30.04	32.80	-30.04	
		32.80	2.75	9.92	2.75	▨
		9.92	-1.50	9.78	-3.00	
		9.65	-4.50	9.51	-6.00	
		1.68	-6.00	1.68	-6.50	
		-1.32	-6.50			

Reinforcements

No.	Point to the left x [ft]	z [ft]	Point to the right x [ft]	z [ft]	Length L [ft]	Strength R_t [lbf/ft]	Pull out resist.	End of reinf.
1	1.51	-6.00	9.51	-6.00	8.00	848.5	C = 0.67	Fixed
2	1.65	-4.50	9.65	-4.50	8.00	1696.9	C = 0.67	Fixed
3	1.78	-3.00	9.78	-3.00	8.00	1696.9	C = 0.67	Fixed
4	1.92	-1.50	9.92	-1.50	8.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 8.25	l = 3.00		0.00	1600.0		lbf/ft^2
2	strip	permanent	on terrain	x = 19.25	l = 3.00		0.00	1600.0		lbf/ft^2

Surcharges

No.	Name
1	Trencher Track 1 - Static
2	Trencher Track 2 - Static

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : transient

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.55	[ft]	Angles :	α_1 =	-30.35	[°]
	z =	5.46	[ft]		α_2 =	78.96	[°]
Radius :	R =	14.15	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	819.9
3	11.5
4	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 8540.0 lbf/ft
Sum of passive forces : F_p = 13988.6 lbf/ft

Sliding moment : M_a = 120841.1 lbfft/ft
Resisting moment : M_p = 197939.4 lbfft/ft
Factor of safety = 1.64 > 1.30

Slope stability ACCEPTABLE

During Construction - 3200 PSF
Dynamic Trencher Surcharge

Slope stability analysis

Input data

Project

Settings

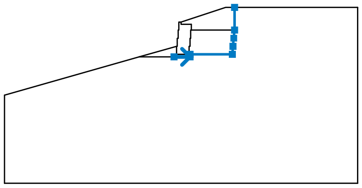
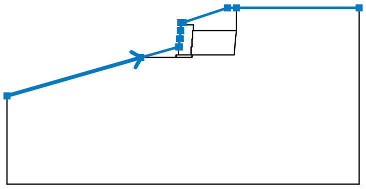
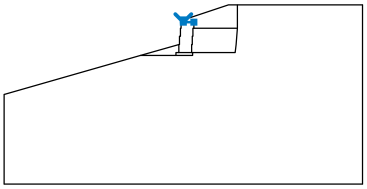
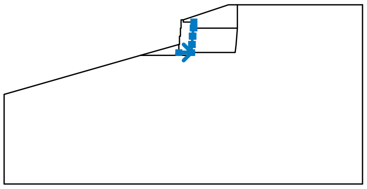
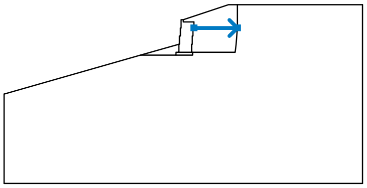
(input for current task)

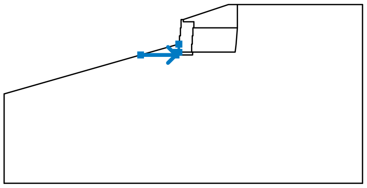
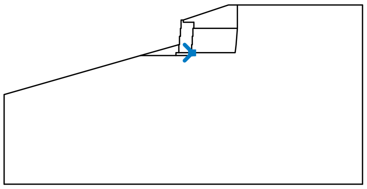
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Accidental design situation			
Safety factor :	SF_s =	1.10	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-1.32	-6.50	1.68	-6.50	1.68	-6.00
		9.51	-6.00	9.65	-4.50	9.78	-3.00
		9.92	-1.50	9.92	2.75		
2		-32.80	-13.64	-7.82	-6.50	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	8.25	2.75	9.92	2.75
		32.80	2.75				
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		-0.82	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
5		1.92	-1.50	9.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
6		-7.82	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
7		1.51	-6.00	1.68	-6.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Perched Clay (Drained)	▨	24.00	200.0	110.0
3	Surficial Aquifer	▨	32.00	75.0	115.0
4	Onsite Sands	▨	32.00	0.0	115.0
5	Black Creek Confining Layer	▨	26.00	125.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Perched Clay (Drained)	▨	115.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
3	Surficial Aquifer	▨	120.0		
4	Onsite Sands	◈	120.0		
5	Black Creek Confining Layer	🟩	125.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Perched Clay (Drained)
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Surficial Aquifer
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

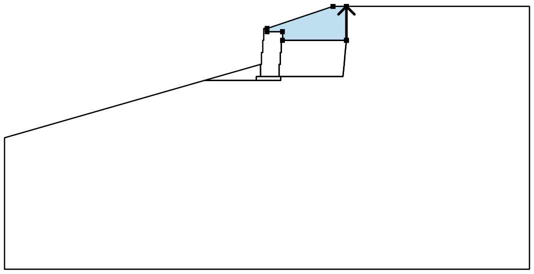
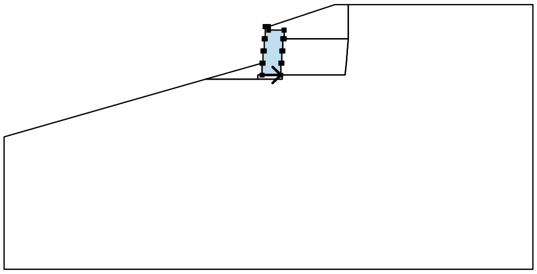
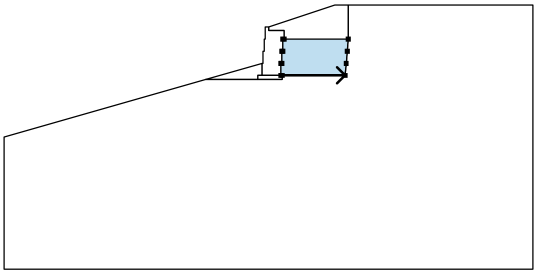
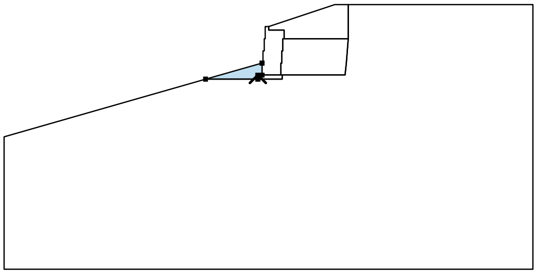
Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

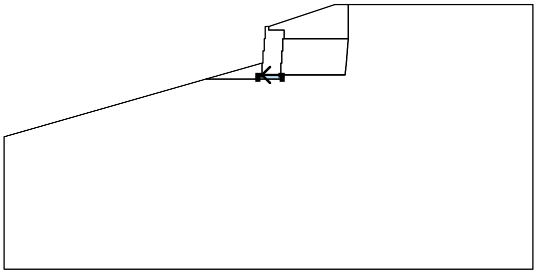
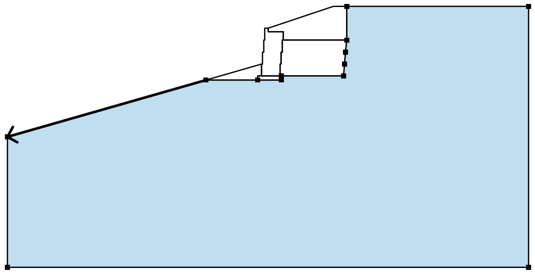
Black Creek Confining Layer
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 26.00 °
Cohesion of soil : c_{ef} = 125.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		9.92	-1.50	9.92	2.75	Onsite Sands
		8.25	2.75	0.00	0.00	▨
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		-0.82	-6.00	1.51	-6.00	Material of structure
		1.51	-4.50	1.65	-4.50	🟥
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
3		1.68	-6.00	9.51	-6.00	Onsite Sands
		9.65	-4.50	9.78	-3.00	▨
		9.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
4		-1.32	-6.50	-1.32	-6.00	Black Creek Confining Layer
		-0.82	-6.00	-0.82	-4.50	🟩
		-7.82	-6.50			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
5		1.51	-6.00	-0.82	-6.00	#57 Stone ▨
		-1.32	-6.00	-1.32	-6.50	
		1.68	-6.50	1.68	-6.00	
6		-7.82	-6.50	-32.80	-13.64	Black Creek Confining Layer ▨
		-32.80	-30.04	32.80	-30.04	
		32.80	2.75	9.92	2.75	
		9.92	-1.50	9.78	-3.00	
		9.65	-4.50	9.51	-6.00	
		1.68	-6.00	1.68	-6.50	
		-1.32	-6.50			

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	1.51	-6.00	9.51	-6.00	8.00	848.5	C = 0.67	Fixed
2	1.65	-4.50	9.65	-4.50	8.00	1696.9	C = 0.67	Fixed
3	1.78	-3.00	9.78	-3.00	8.00	1696.9	C = 0.67	Fixed
4	1.92	-1.50	9.92	-1.50	8.00	1696.9	C = 0.67	Fixed

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 8.25	l = 3.00		0.00	3200.0		lbf/ft^2
2	strip	permanent	on terrain	x = 19.25	l = 3.00		0.00	3200.0		lbf/ft^2

Surcharges

No.	Name
1	Trencher Track 1 - Dynamic
2	Trencher Track 2 - Dynamic

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : accidental

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-0.61	[ft]	Angles :	α_1 =	-30.63	[°]
	z =	4.79	[ft]		α_2 =	80.91	[°]
Radius :	R =	12.91	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	909.8
3	69.9
4	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 11949.2 lbf/ft
Sum of passive forces : F_p = 15789.4 lbf/ft

Sliding moment : M_a = 154264.8 lbfft/ft
Resisting moment : M_p = 203841.2 lbfft/ft
Factor of safety = 1.32 > 1.10
Slope stability ACCEPTABLE

WALL #9

MAX. WALL HEIGHT = 15.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #9
Description : H15
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

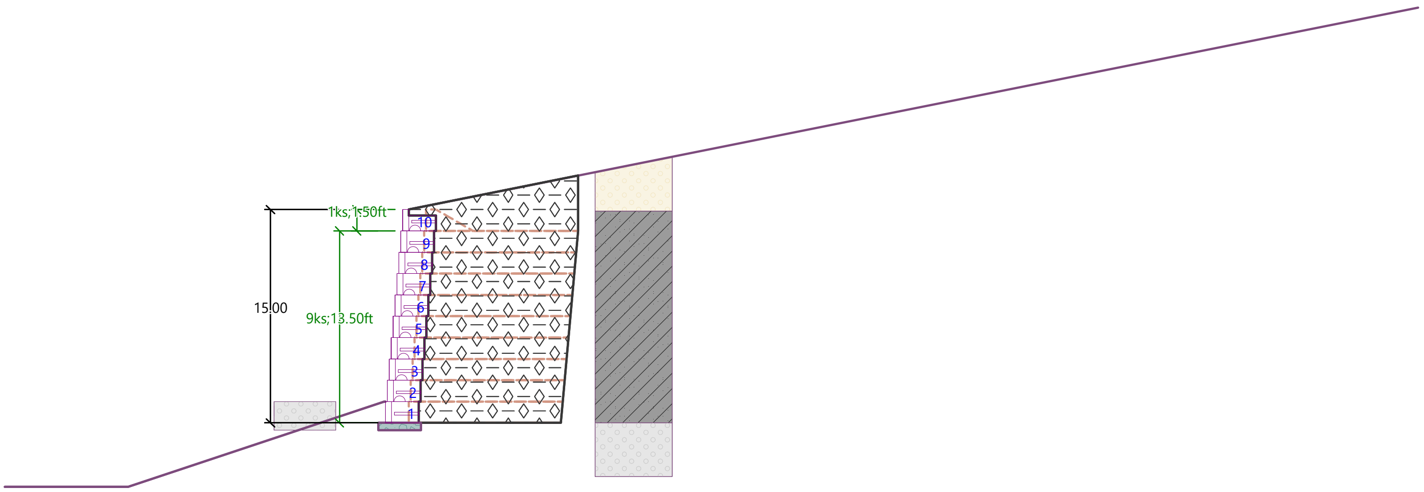
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	9	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback	a_1	=	0.50	ft
Lower setback	a_2	=	0.50	ft
Height	h	=	0.50	ft
Width	b	=	3.00	ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	– – – – – – – – – –	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	=	7400.00	lbf/ft
Creep red. factor	RF_{CR}	=	1.58	
Durability red. factor	RF_D	=	1.15	
Installation damage red. factor	RF_{ID}	=	1.20	
Long-term design strength	R_t	=	3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	=	0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	=	0.67	
Scale correction factor	α	=	0.8	
Long-term strength reduction factor	CR_{cr}	=	0.532	
Calculation of long-term connection strength	R_{con}	=	3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 10.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	10.00	
2	Yes	Miragrid 8XT	10.00	
3	Yes	Miragrid 8XT	10.00	
4	Yes	Miragrid 8XT	10.00	
5	Yes	Miragrid 8XT	10.00	
6	Yes	Miragrid 8XT	10.00	
7	Yes	Miragrid 8XT	10.00	
8	Yes	Miragrid 8XT	10.00	
9	Yes	Miragrid 8XT	10.00	
10	Yes	Miragrid 8XT	10.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand

Unit weight : γ = 110.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Light Brown Sand	🟨
2	14.90	0.10 .. 15.00	Dark Gray Clay (Drained)	▨
3	-	15.00 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 5.00 (slope angle is 11.31 °).
Embankment height is 14.20 ft, embankment length is 71.00 ft.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft

Terrain shape in front of structure

No.	Coordinate x[ft]	Depth z[ft]
1	0.00	0.00
2	0.00	-2.00
3	-0.10	-2.00
4	-18.10	4.00
5	-19.10	4.00

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-634.8	-0.61	0.0	2.33	1.000
Weight - reinforced soil	0.0	-8.24	19080.0	8.08	1.000
Active pressure	3808.1	-4.30	1776.4	13.55	1.000
Weight - wall	0.0	-7.33	4104.2	1.76	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment M_{res} = 185537.7 lbfft/ft

Overturning moment M_{ovr} = 16001.9 lbfft/ft

Safety factor = 11.59 > 2.00

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 12942.25 lbf/ft

Active horizontal force H_{act} = 3173.26 lbf/ft

Safety factor = 4.08 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-92066.7	6352.25	-11343.63	0.000	2117.4

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-92066.7	6352.25	-11343.63

Verification of foundation soil

Place of verification : bottom of leveling pad

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000

Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 2117.4 psf

Bearing capacity of foundation soil R_d = 7500.0 psf

Safety factor = 3.54 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-7.33	4082.8	-0.58	1.000
FF resistance	-634.2	-0.61	0.0	-2.33	1.000
Active pressure	3659.0	-4.38	1870.6	10.00	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - reinforced soil	0.0	-7.95	17569.2	5.39	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 19439.76 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 8317.05 lbf/ft
Wall resistance = 3425.88 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 12377.09 lbf/ft
Active horiz. force H_{act} = 3658.99 lbf/ft

Factor of safety = 3.38 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-367.21	15.00	848.47	64.92	3108.24	17.72	855.83	64.36
2	Miragrid 8XT	-655.66	13.50	1696.94	57.96	5232.68	18.80	1711.65	57.46
3	Miragrid 8XT	-565.29	12.00	1696.94	49.97	4333.38	19.57	1711.65	49.54
4	Miragrid 8XT	-505.62	10.50	1696.94	44.69	3518.56	21.56	1711.65	44.31
5	Miragrid 8XT	-445.96	9.00	1696.94	39.42	2788.24	23.99	1711.65	39.08
6	Miragrid 8XT	-386.29	7.50	1696.94	34.15	2142.40	27.05	1711.65	33.85
7	Miragrid 8XT	-326.63	6.00	1696.94	28.87	1581.05	30.99	1711.65	28.62
8	Miragrid 8XT	-266.96	4.50	1696.94	23.60	1104.19	36.27	1711.65	23.40
9	Miragrid 8XT	-207.30	3.00	1696.94	18.32	711.82	43.68	1711.65	18.17
10	Miragrid 8XT	-199.07	1.50	1696.94	17.60	403.94	73.92	855.83	34.89

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 367.21 lbf/ft

Safety factor = 2.31 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.10)
Pull out resistance T_p = 403.94 lbf/ft
Force in reinforcement F_x = 199.07 lbf/ft

Safety factor = 2.03 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)
Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 367.21 lbf/ft

Safety factor = 2.33 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

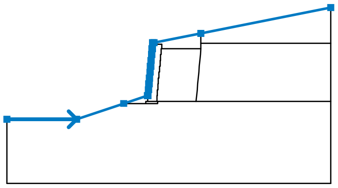
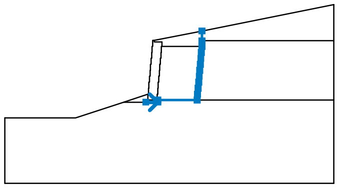
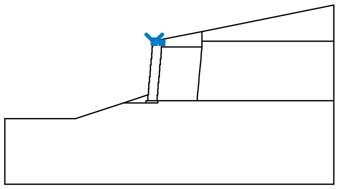
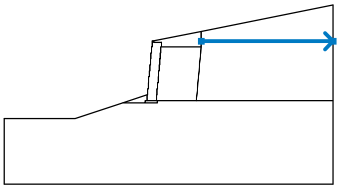
(input for current task)

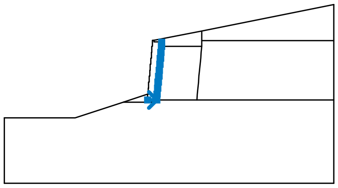
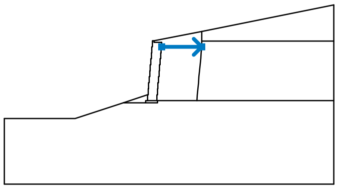
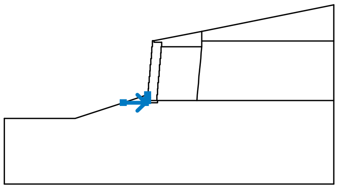
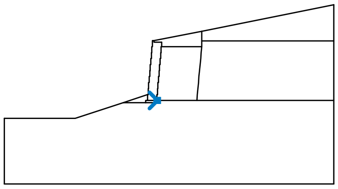
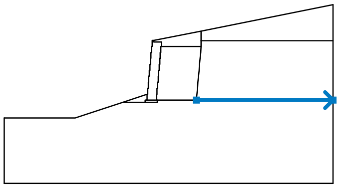
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-37.50	-19.50	-19.74	-19.50	-7.74	-15.50
		-1.74	-13.50	-1.64	-13.50	-1.50	-13.50
		-1.50	-12.00	-1.36	-12.00	-1.36	-10.50
		-1.23	-10.50	-1.23	-9.00	-1.09	-9.00
		-1.09	-7.50	-0.96	-7.50	-0.96	-6.00
		-0.82	-6.00	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		11.92	2.38	45.00	9.00		
2		-2.14	-15.50	0.86	-15.50	0.86	-15.00
		10.70	-15.00	10.83	-13.50	10.97	-12.00
		11.10	-10.50	11.24	-9.00	11.38	-7.50
		11.51	-6.00	11.65	-4.50	11.78	-3.00
		11.92	-1.50	11.92	-0.10	11.92	2.38
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		11.92	-0.10	45.00	-0.10		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		-1.64	-15.00	0.70	-15.00	0.70	-13.50
		0.83	-13.50	0.83	-12.00	0.97	-12.00
		0.97	-10.50	1.10	-10.50	1.10	-9.00
		1.24	-9.00	1.24	-7.50	1.38	-7.50
		1.38	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
6		1.92	-1.50	11.92	-1.50		
7		-7.74	-15.50	-2.14	-15.50	-2.14	-15.00
		-1.64	-15.00	-1.64	-13.50		
8		0.70	-15.00	0.86	-15.00		
9		10.70	-15.00	45.00	-15.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Light Brown Sand	▨	115.0		

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °

Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

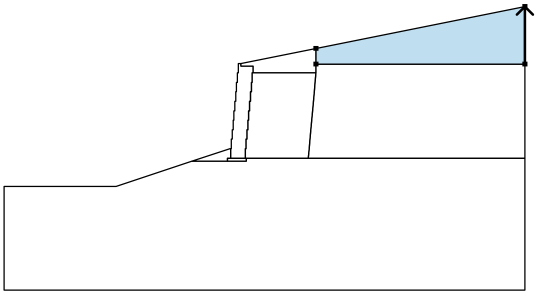
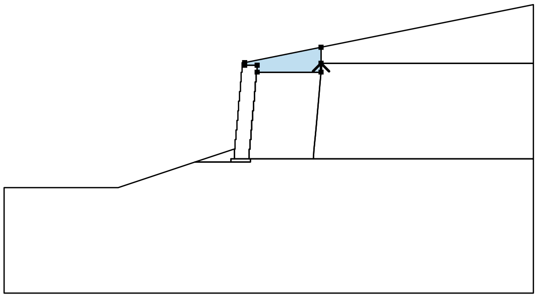
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

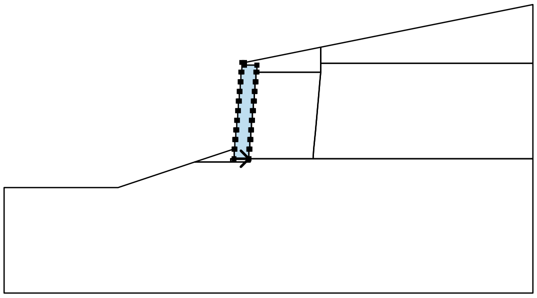
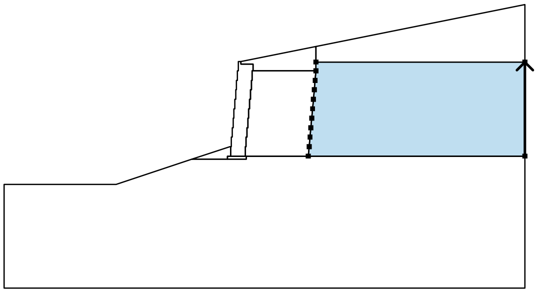
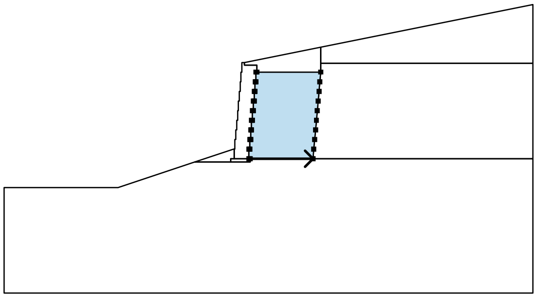
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

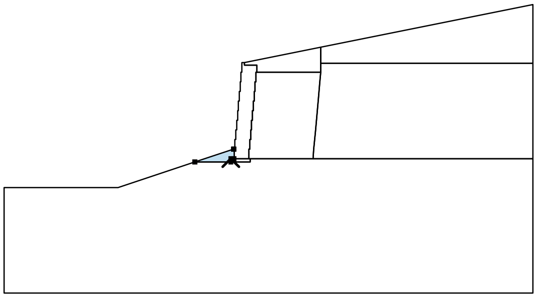
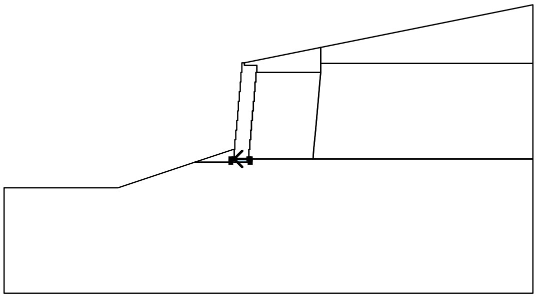
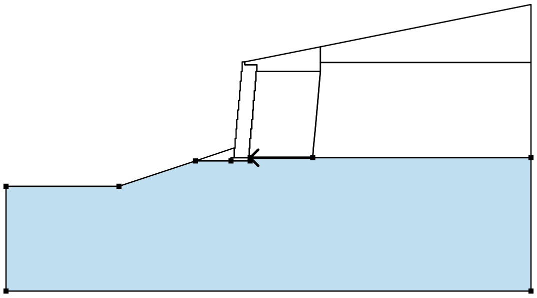
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		45.00	-0.10	45.00	9.00	Light Brown Sand ▨
		11.92	2.38	11.92	-0.10	
2		11.92	-1.50	11.92	-0.10	Onsite Sands ▨
		11.92	2.38	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		-1.64	-15.00	0.70	-15.00	Material of structure
		0.70	-13.50	0.83	-13.50	🟥
		0.83	-12.00	0.97	-12.00	
		0.97	-10.50	1.10	-10.50	
		1.10	-9.00	1.24	-9.00	
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
		-1.09	-9.00	-1.23	-9.00	
		-1.23	-10.50	-1.36	-10.50	
		-1.36	-12.00	-1.50	-12.00	
		-1.50	-13.50	-1.64	-13.50	
4		45.00	-15.00	45.00	-0.10	Dark Gray Clay (Drained)
		11.92	-0.10	11.92	-1.50	▨
		11.78	-3.00	11.65	-4.50	
		11.51	-6.00	11.38	-7.50	
		11.24	-9.00	11.10	-10.50	
		10.97	-12.00	10.83	-13.50	
		10.70	-15.00			
5		0.86	-15.00	10.70	-15.00	Onsite Sands
		10.83	-13.50	10.97	-12.00	▨
		11.10	-10.50	11.24	-9.00	
		11.38	-7.50	11.51	-6.00	
		11.65	-4.50	11.78	-3.00	
		11.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
		1.10	-9.00	1.10	-10.50	
		0.97	-10.50	0.97	-12.00	
		0.83	-12.00	0.83	-13.50	
		0.70	-13.50	0.70	-15.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		-2.14	-15.50	-2.14	-15.00	Light Gray Sand ▨
		-1.64	-15.00	-1.64	-13.50	
		-1.74	-13.50	-7.74	-15.50	
7		0.70	-15.00	-1.64	-15.00	#57 Stone ▨
		-2.14	-15.00	-2.14	-15.50	
		0.86	-15.50	0.86	-15.00	
8		10.70	-15.00	0.86	-15.00	Light Gray Sand ▨
		0.86	-15.50	-2.14	-15.50	
		-7.74	-15.50	-19.74	-19.50	
		-37.50	-19.50	-37.50	-35.90	
		45.00	-35.90	45.00	-15.00	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	0.70	-15.00	10.70	-15.00	10.00	848.5	C = 0.67	Fixed
2	0.83	-13.50	10.83	-13.50	10.00	1696.9	C = 0.67	Fixed
3	0.97	-12.00	10.97	-12.00	10.00	1696.9	C = 0.67	Fixed
4	1.10	-10.50	11.10	-10.50	10.00	1696.9	C = 0.67	Fixed
5	1.24	-9.00	11.24	-9.00	10.00	1696.9	C = 0.67	Fixed
6	1.38	-7.50	11.38	-7.50	10.00	1696.9	C = 0.67	Fixed
7	1.51	-6.00	11.51	-6.00	10.00	1696.9	C = 0.67	Fixed
8	1.65	-4.50	11.65	-4.50	10.00	1696.9	C = 0.67	Fixed
9	1.78	-3.00	11.78	-3.00	10.00	1696.9	C = 0.67	Fixed
10	1.92	-1.50	11.92	-1.50	10.00	1696.9	C = 0.67	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-11.79	[ft]	Angles :	α_1 =	-12.59	[°]
	z =	19.87	[ft]		α_2 =	68.60	[°]
Radius :	R =	40.34	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0
7	0.0
8	0.0
9	0.0
10	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 22384.6 lbf/ft
Sum of passive forces : F_p = 32437.5 lbf/ft

Sliding moment : M_a = 902996.3 lbfft/ft
Resisting moment : M_p = 1308528.1 lbfft/ft
Factor of safety = 1.45 > 1.35
Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 12.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #9
Description : H12
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

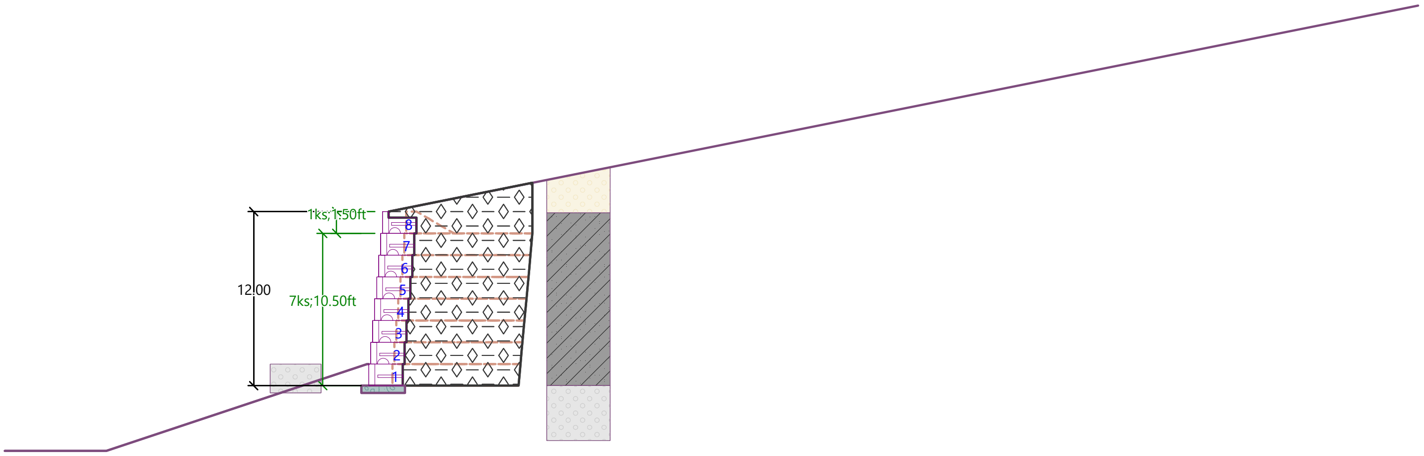
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	7	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	– – – – – – – – – –	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength T_{ult} = 7400.00 lbf/ft
Creep red. factor RF_{CR} = 1.58
Durability red. factor RF_D = 1.15
Installation damage red. factor RF_{ID} = 1.20
Long-term design strength R_t = 3393.87 lbf/ft
Coefficient of direct slip along reinforcement C_{ds} = 0.67
Coefficient of interaction of soil and geo-reinforcement C_i = 0.67
Scale correction factor α = 0.8
Long-term strength reduction factor CR_{cr} = 0.532
Calculation of long-term connection strength R_{con} = 3423.30 lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 8.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	8.00	
2	Yes	Miragrid 8XT	8.00	
3	Yes	Miragrid 8XT	8.00	
4	Yes	Miragrid 8XT	8.00	
5	Yes	Miragrid 8XT	8.00	
6	Yes	Miragrid 8XT	8.00	
7	Yes	Miragrid 8XT	8.00	
8	Yes	Miragrid 8XT	8.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective

Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Light Brown Sand	🟨
2	11.90	0.10 .. 12.00	Dark Gray Clay (Drained)	▨
3	-	12.00 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 5.00 (slope angle is 11.31 °).
Embankment height is 14.20 ft, embankment length is 71.00 ft.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft

Terrain shape in front of structure

No.	Coordinate x[ft]	Depth z[ft]
1	0.00	0.00
2	0.00	-2.00
3	-0.10	-2.00
4	-18.10	4.00
5	-19.10	4.00

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-634.8	-0.61	0.0	2.33	1.000
Weight - reinforced soil	0.0	-6.65	12344.5	6.91	1.000
Active pressure	2074.9	-3.17	967.6	11.28	1.000
Weight - wall	0.0	-5.83	3264.2	1.62	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 101472.9 lbfft/ft
Overturning moment M_{ovr} = 6190.9 lbfft/ft

Safety factor = 16.39 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 8988.11 lbf/ft
Active horizontal force H_{act} = 1440.11 lbf/ft

Safety factor = 6.24 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-54199.2	4883.55	-8987.34	0.000	1627.9

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-54199.2	4883.55	-8987.34

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification
Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 1627.9 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 3.69 > 3.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.83	3243.1	-0.71	1.000
FF resistance	-634.2	-0.61	0.0	-2.33	1.000
Active pressure	2040.5	-3.19	1059.8	8.00	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - reinforced soil	0.0	-6.40	11365.4	4.30	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 12425.26 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 5315.99 lbf/ft
Wall resistance = 2721.32 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:

Resisting horizontal force H_{res} = 8671.47 lbf/ft
Active horiz. force H_{act} = 2040.45 lbf/ft

Factor of safety = 4.25 > 1.50

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-291.14	12.00	848.47	51.47	2001.92	21.81	855.83	51.03
2	Miragrid 8XT	-510.14	10.50	1696.94	45.09	3222.76	23.74	1711.65	44.71
3	Miragrid 8XT	-426.41	9.00	1696.94	37.69	2526.18	25.32	1711.65	37.37
4	Miragrid 8XT	-366.74	7.50	1696.94	32.42	1914.09	28.74	1711.65	32.14
5	Miragrid 8XT	-307.08	6.00	1696.94	27.14	1386.48	33.22	1711.65	26.91
6	Miragrid 8XT	-247.41	4.50	1696.94	21.87	943.36	39.34	1711.65	21.68
7	Miragrid 8XT	-187.75	3.00	1696.94	16.60	584.74	48.16	1711.65	16.45
8	Miragrid 8XT	-169.75	1.50	1696.94	15.01	310.60	81.98	855.83	29.75

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 291.14 lbf/ft

Safety factor = 2.91 > 1.50

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.8)

Pull out resistance T_p = 310.60 lbf/ft
Force in reinforcement F_x = 169.75 lbf/ft

Safety factor = 1.83 > 1.50

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 291.14 lbf/ft

Safety factor = 2.94 > 1.50

Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

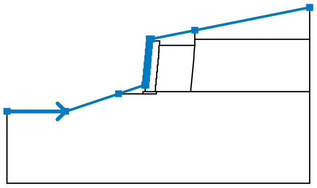
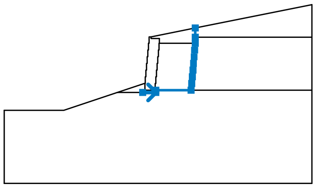
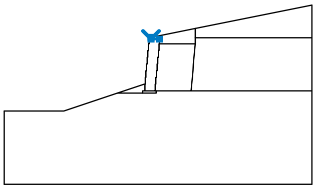
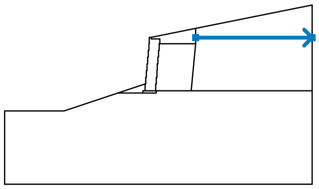
(input for current task)

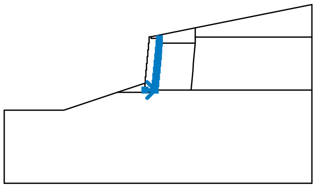
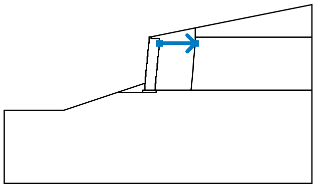
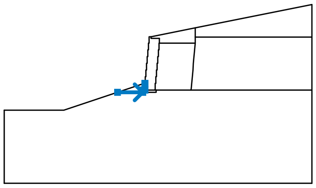
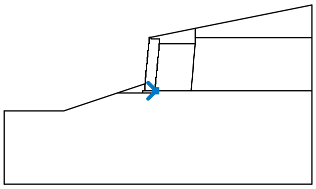
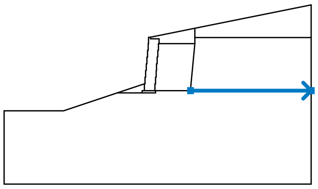
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-16.50	-19.46	-16.50	-7.46	-12.50
		-1.46	-10.50	-1.36	-10.50	-1.23	-10.50
		-1.23	-9.00	-1.09	-9.00	-1.09	-7.50
		-0.96	-7.50	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	9.92	1.98
		36.00	7.20				
2		-1.86	-12.50	1.14	-12.50	1.14	-12.00
		8.97	-12.00	9.10	-10.50	9.24	-9.00
		9.38	-7.50	9.51	-6.00	9.65	-4.50
		9.78	-3.00	9.92	-1.50	9.92	-0.10
		9.92	1.98				
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		9.92	-0.10	36.00	-0.10		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		-1.36	-12.00	0.97	-12.00	0.97	-10.50
		1.10	-10.50	1.10	-9.00	1.24	-9.00
		1.24	-7.50	1.38	-7.50	1.38	-6.00
		1.51	-6.00	1.51	-4.50	1.65	-4.50
		1.65	-3.00	1.78	-3.00	1.78	-1.50
		1.92	-1.50	1.92	-0.42		
6		1.92	-1.50	9.92	-1.50		
7		-7.46	-12.50	-1.86	-12.50	-1.86	-12.00
		-1.36	-12.00	-1.36	-10.50		
8		0.97	-12.00	1.14	-12.00		
9		8.97	-12.00	36.00	-12.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
4	Light Gray Sand	░	32.00	50.0	115.0
5	Light Brown Sand	░	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	░	120.0		
5	Light Brown Sand	░	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °

Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

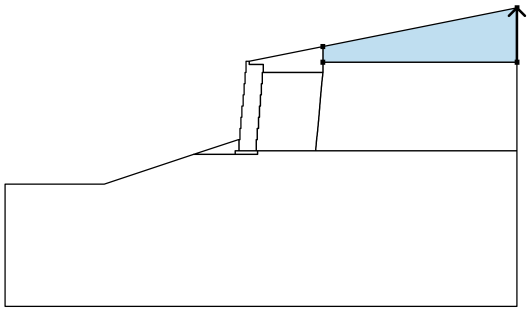
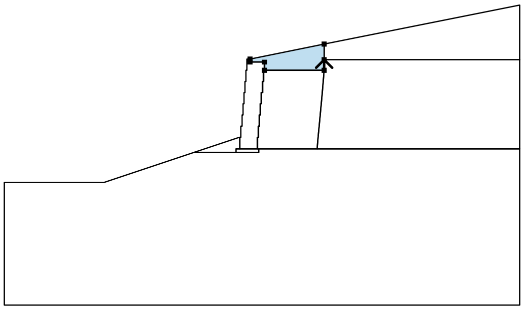
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

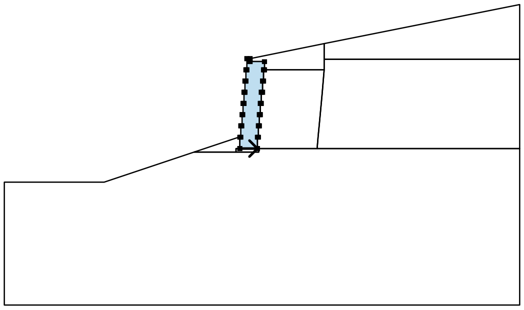
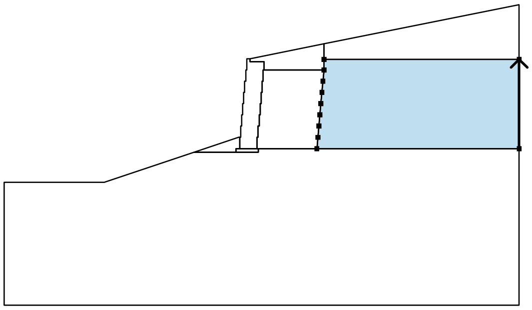
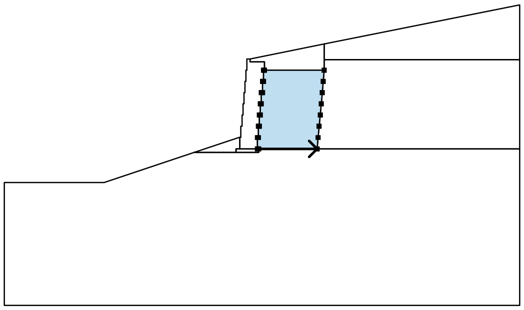
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

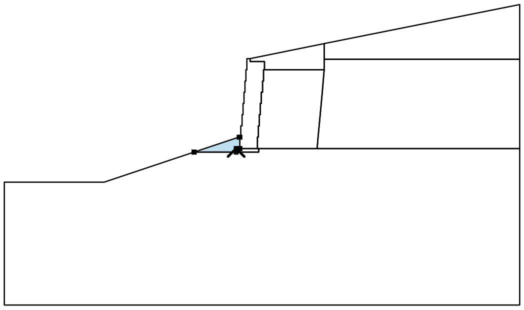
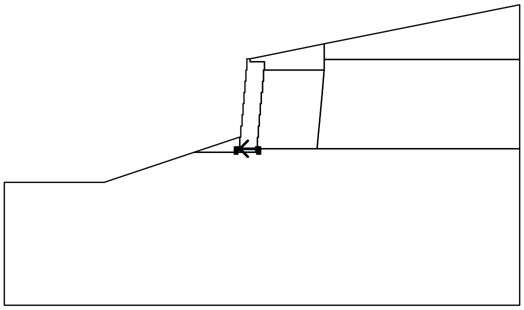
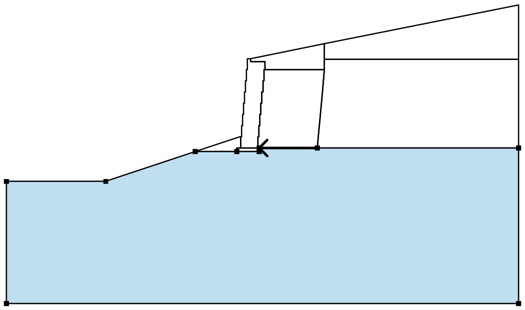
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		36.00	-0.10	36.00	7.20	Light Brown Sand 🟨
		9.92	1.98	9.92	-0.10	
2		9.92	-1.50	9.92	-0.10	Onsite Sands ▨
		9.92	1.98	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		-1.36	-12.00	0.97	-12.00	Material of structure
		0.97	-10.50	1.10	-10.50	🟥
		1.10	-9.00	1.24	-9.00	
		1.24	-7.50	1.38	-7.50	
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	
		-1.09	-9.00	-1.23	-9.00	
		-1.23	-10.50	-1.36	-10.50	
4		36.00	-12.00	36.00	-0.10	Dark Gray Clay (Drained)
		9.92	-0.10	9.92	-1.50	▨
		9.78	-3.00	9.65	-4.50	
		9.51	-6.00	9.38	-7.50	
		9.24	-9.00	9.10	-10.50	
		8.97	-12.00			
5		1.14	-12.00	8.97	-12.00	Onsite Sands
		9.10	-10.50	9.24	-9.00	▩
		9.38	-7.50	9.51	-6.00	
		9.65	-4.50	9.78	-3.00	
		9.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
		1.10	-9.00	1.10	-10.50	
		0.97	-10.50	0.97	-12.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		-1.86	-12.50	-1.86	-12.00	Light Gray Sand ▨
		-1.36	-12.00	-1.36	-10.50	
		-1.46	-10.50	-7.46	-12.50	
7		0.97	-12.00	-1.36	-12.00	#57 Stone ▨
		-1.86	-12.00	-1.86	-12.50	
		1.14	-12.50	1.14	-12.00	
8		8.97	-12.00	1.14	-12.00	Light Gray Sand ▨
		1.14	-12.50	-1.86	-12.50	
		-7.46	-12.50	-19.46	-16.50	
		-32.80	-16.50	-32.80	-32.90	
		36.00	-32.90	36.00	-12.00	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of reinf.
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		
1	0.97	-12.00	8.97	-12.00	8.00	848.5	C = 0.67	Fixed
2	1.10	-10.50	9.10	-10.50	8.00	1696.9	C = 0.67	Fixed
3	1.24	-9.00	9.24	-9.00	8.00	1696.9	C = 0.67	Fixed
4	1.38	-7.50	9.38	-7.50	8.00	1696.9	C = 0.67	Fixed
5	1.51	-6.00	9.51	-6.00	8.00	1696.9	C = 0.67	Fixed
6	1.65	-4.50	9.65	-4.50	8.00	1696.9	C = 0.67	Fixed
7	1.78	-3.00	9.78	-3.00	8.00	1696.9	C = 0.67	Fixed
8	1.92	-1.50	9.92	-1.50	8.00	1696.9	C = 0.67	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-11.90	[ft]	Angles :	α_1 =	-11.87	[°]
	z =	18.91	[ft]		α_2 =	66.02	[°]
Radius :	R =	36.14	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	848.5
2	5.2
3	0.0
4	0.0
5	0.0
6	0.0
7	0.0
8	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 15267.2 lbf/ft
Sum of passive forces : F_p = 23626.8 lbf/ft

Sliding moment : M_a = 551756.2 lbfft/ft
Resisting moment : M_p = 853872.3 lbfft/ft
Factor of safety = 1.55 > 1.35
Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 9.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #9
Description : H9
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Top block 24 straight	18.00	24.00	108.00
2	Block 28 PC	18.00	28.00	120.00
3	Block 41 PC	18.00	40.50	120.00
4	Top block 28	18.00	28.00	120.00
5	Top block 41	18.00	40.50	120.00
6	Top block 24 straight garden	18.00	24.00	80.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Top block 24 straight	6061.00	11276.00	44.00
2	Block 28 PC	6061.00	11276.00	44.00
3	Block 41 PC	6061.00	11276.00	44.00
4	Top block 28	6061.00	11276.00	44.00
5	Top block 41	6061.00	11276.00	44.00
6	Top block 24 straight garden	6061.00	11276.00	44.00

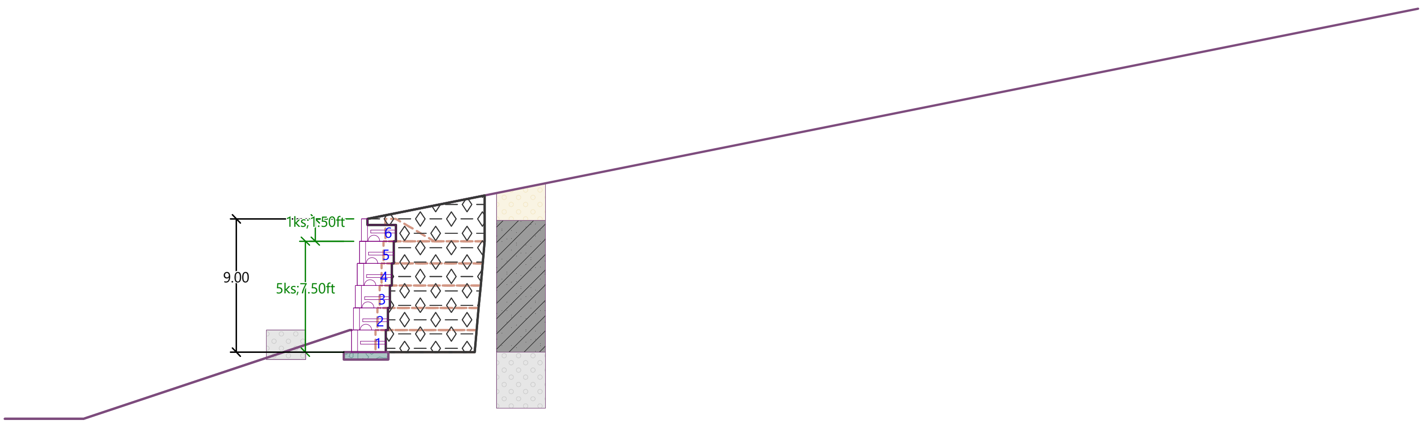
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
6	3.250

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	5	1.62
2	Top block 28	1	-

Name : Geometry **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength T_{ult} = 7400.00 lbf/ft
Creep red. factor RF_{CR} = 1.58
Durability red. factor RF_D = 1.15
Installation damage red. factor RF_{ID} = 1.20
Long-term design strength R_t = 3393.87 lbf/ft
Coefficient of direct slip along reinforcement C_{ds} = 0.67
Coefficient of interaction of soil and geo-reinforcement C_i = 0.67
Scale correction factor α = 0.8
Long-term strength reduction factor CR_{cr} = 0.532
Calculation of long-term connection strength R_{con} = 3423.30 lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : anchored tail
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 6.00 ft
Reinforced soil - Onsite Sands

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	6.00	
2	Yes	Miragrid 8XT	6.00	
3	Yes	Miragrid 8XT	6.00	
4	Yes	Miragrid 8XT	6.00	
5	Yes	Miragrid 8XT	6.00	
6	Yes	Miragrid 8XT	6.00	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Light Brown Sand	░
2	8.90	0.10 .. 9.00	Dark Gray Clay (Drained)	▨
3	-	9.00 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 5.00 (slope angle is 11.31 °).
Embankment height is 14.20 ft, embankment length is 71.00 ft.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft

Terrain shape in front of structure

No.	Coordinate x[ft]	Depth z[ft]
1	0.00	0.00
2	0.00	-2.00
3	-0.10	-2.00
4	-18.10	4.00
5	-19.10	4.00

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
FF resistance	-634.8	-0.61	0.0	2.33	1.000
Weight - reinforced soil	0.0	-5.06	7081.0	5.72	1.000
Active pressure	865.6	-2.05	403.7	9.01	1.000
Weight - wall	0.0	-4.33	2424.2	1.48	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment M_{res} = 47741.7 lbfft/ft
Overturning moment M_{ovr} = 1384.1 lbfft/ft

Safety factor = 34.49 > 2.00

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 5768.52 lbf/ft
Active horizontal force H_{act} = 230.83 lbf/ft

Safety factor = 24.99 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-25995.6	3534.66	-6361.46	0.000	1178.2

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-25995.6	3534.66	-6361.46

Verification of foundation soil

Place of verification : bottom of leveling pad
Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1178.2 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 5.09 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.33	2403.7	-0.85	1.000
FF resistance	-634.2	-0.61	0.0	-2.33	1.000
Active pressure	906.5	-1.99	486.4	6.00	1.000
Weight - reinforced soil	0.0	-4.86	6517.0	3.21	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 7003.44 lbf/ft

Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 2996.33 lbf/ft
Wall resistance = 2016.93 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 5647.42 lbf/ft
Active horiz. force H_{act} = 906.54 lbf/ft

Factor of safety = 6.23 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [lbf/ft]	Depth z[ft]	R_t [lbf/ft]	Utiliz. [%]	T_p [lbf/ft]	Utiliz. [%]	R_{con} [lbf/ft]	Utiliz. [%]
1	Miragrid 8XT	-215.06	9.00	848.47	38.02	1137.94	28.35	855.83	37.69
2	Miragrid 8XT	-364.62	7.50	1696.94	32.23	1697.52	32.22	1711.65	31.95
3	Miragrid 8XT	-287.53	6.00	1696.94	25.42	1203.66	35.83	1711.65	25.20
4	Miragrid 8XT	-227.87	4.50	1696.94	20.14	794.28	43.03	1711.65	19.97
5	Miragrid 8XT	-168.20	3.00	1696.94	14.87	469.40	53.75	1711.65	14.74
6	Miragrid 8XT	-140.43	1.50	1696.94	12.41	229.00	91.98	855.83	24.61

Check for tensile strength (reinforcement No.1)
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 215.06 lbf/ft

Safety factor = 3.95 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.6)
Pull out resistance T_p = 229.00 lbf/ft
Force in reinforcement F_x = 140.43 lbf/ft

Safety factor = 1.63 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)
Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 215.06 lbf/ft

Safety factor = 3.98 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

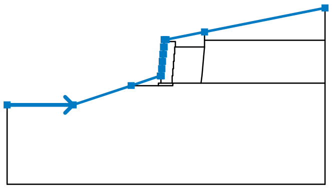
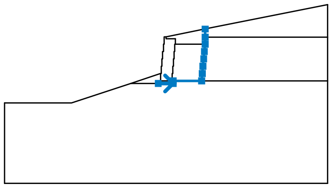
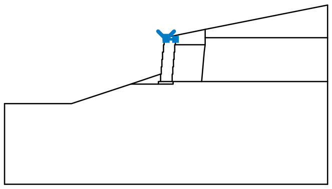
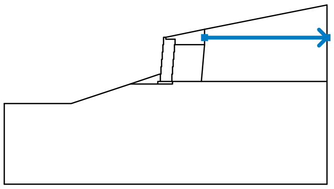
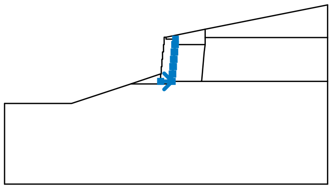
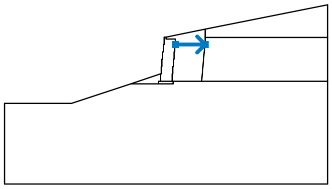
(input for current task)

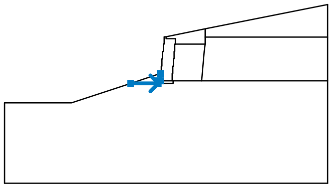
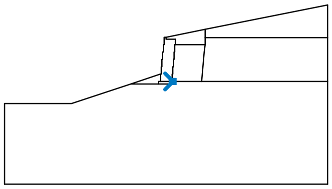
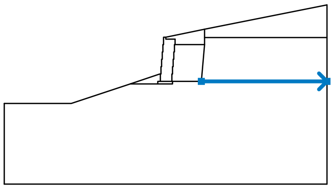
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-13.50	-19.19	-13.50	-7.19	-9.50
		-1.19	-7.50	-1.09	-7.50	-0.96	-7.50
		-0.96	-6.00	-0.82	-6.00	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	7.92	1.58	32.80	6.56
2		-1.59	-9.50	1.41	-9.50	1.41	-9.00
		7.24	-9.00	7.38	-7.50	7.51	-6.00
		7.65	-4.50	7.78	-3.00	7.92	-1.50
		7.92	-0.10	7.92	1.58		
3		0.00	0.00	0.00	-0.42	1.92	-0.42
4		7.92	-0.10	32.80	-0.10		
5		-1.09	-9.00	1.24	-9.00	1.24	-7.50
		1.38	-7.50	1.38	-6.00	1.51	-6.00
		1.51	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
6		1.92	-1.50	7.92	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
7		-7.19	-9.50	-1.59	-9.50	-1.59	-9.00
		-1.09	-9.00	-1.09	-7.50		
8		1.24	-9.00	1.41	-9.00		
9		7.24	-9.00	32.80	-9.00		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_{s} [pcf]	n [–]
1	#57 Stone	▨	110.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
2	Onsite Sands	▩	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	░	120.0		
5	Light Brown Sand	░	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

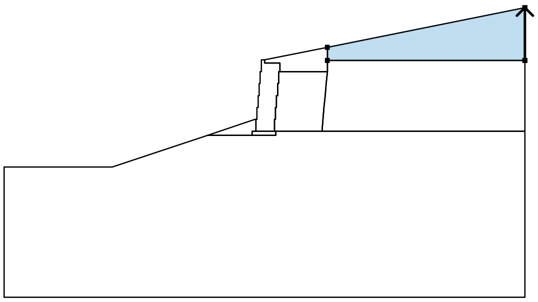
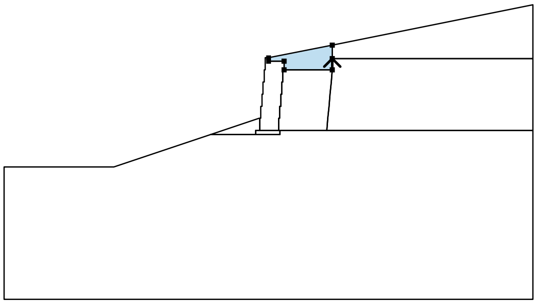
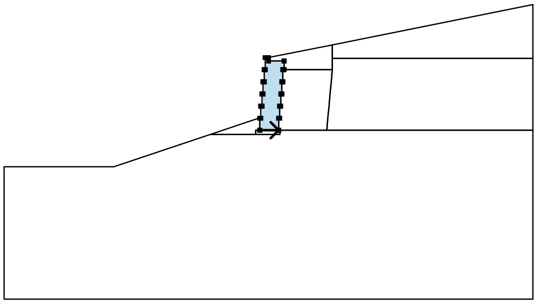
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

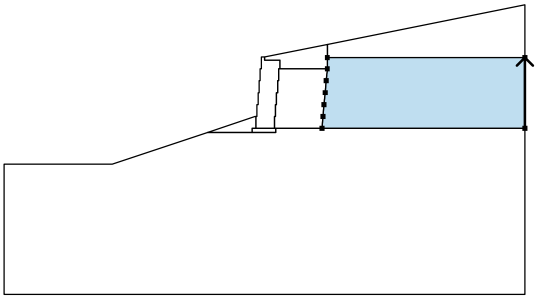
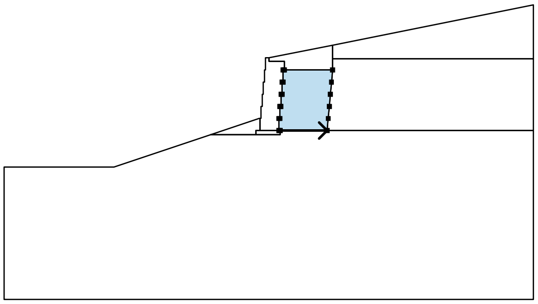
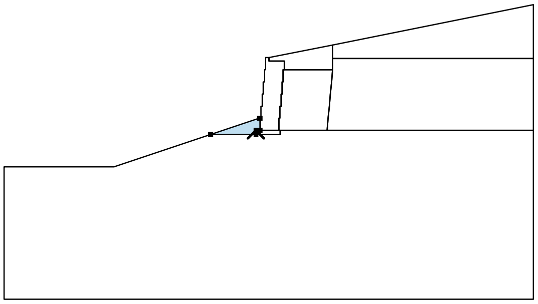
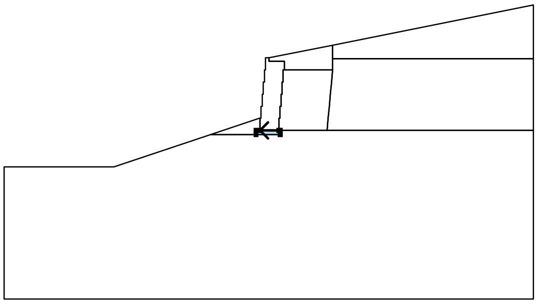
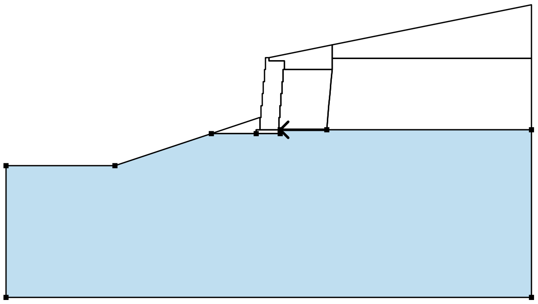
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		32.80	-0.10	32.80	6.56	Light Brown Sand
		7.92	1.58	7.92	-0.10	░
2		7.92	-1.50	7.92	-0.10	Onsite Sands
		7.92	1.58	0.00	0.00	▩
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
3		-1.09	-9.00	1.24	-9.00	Material of structure
		1.24	-7.50	1.38	-7.50	▦
		1.38	-6.00	1.51	-6.00	
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
		-0.96	-7.50	-1.09	-7.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
4		32.80	-9.00	32.80	-0.10	Dark Gray Clay (Drained) ▨
		7.92	-0.10	7.92	-1.50	
		7.78	-3.00	7.65	-4.50	
		7.51	-6.00	7.38	-7.50	
		7.24	-9.00			
5		1.41	-9.00	7.24	-9.00	Onsite Sands ▨
		7.38	-7.50	7.51	-6.00	
		7.65	-4.50	7.78	-3.00	
		7.92	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		1.51	-4.50	1.51	-6.00	
		1.38	-6.00	1.38	-7.50	
		1.24	-7.50	1.24	-9.00	
6		-1.59	-9.50	-1.59	-9.00	Light Gray Sand ▨
		-1.09	-9.00	-1.09	-7.50	
		-1.19	-7.50	-7.19	-9.50	
7		1.24	-9.00	-1.09	-9.00	#57 Stone ▨
		-1.59	-9.00	-1.59	-9.50	
		1.41	-9.50	1.41	-9.00	
8		7.24	-9.00	1.41	-9.00	Light Gray Sand ▨
		1.41	-9.50	-1.59	-9.50	
		-7.19	-9.50	-19.19	-13.50	
		-32.80	-13.50	-32.80	-29.90	
		32.80	-29.90	32.80	-9.00	

Reinforcements

No.	Point to the left		Point to the right		Length	Strength	Pull out resist.	End of
	x [ft]	z [ft]	x [ft]	z [ft]	L [ft]	R_t [lbf/ft]		reinf.
1	1.24	-9.00	7.24	-9.00	6.00	848.5	C = 0.67	Fixed
2	1.38	-7.50	7.38	-7.50	6.00	1696.9	C = 0.67	Fixed
3	1.51	-6.00	7.51	-6.00	6.00	1696.9	C = 0.67	Fixed
4	1.65	-4.50	7.65	-4.50	6.00	1696.9	C = 0.67	Fixed
5	1.78	-3.00	7.78	-3.00	6.00	1696.9	C = 0.67	Fixed
6	1.92	-1.50	7.92	-1.50	6.00	1696.9	C = 0.67	Fixed

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-10.14	[ft]	Angles :	α_1 =	-14.36	[°]
	z =	17.95	[ft]		α_2 =	63.68	[°]
Radius :	R =	32.09	[ft]				
The slip surface after optimization.							

Reinforcement bearing capacity

Reinforcement	Bearing capacity [lbf/ft]
1	0.0
2	0.0
3	0.0
4	0.0
5	0.0
6	0.0

Slope stability verification (Bishop)

Sum of active forces : F_a = 10749.1 lbf/ft
Sum of passive forces : F_p = 18504.6 lbf/ft

Sliding moment : M_a = 344939.0 lbfft/ft
Resisting moment : M_p = 593812.2 lbfft/ft
Factor of safety = 1.72 > 1.35

Slope stability ACCEPTABLE

MAX. WALL HEIGHT = 7.5 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #9
Description : H7.5
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

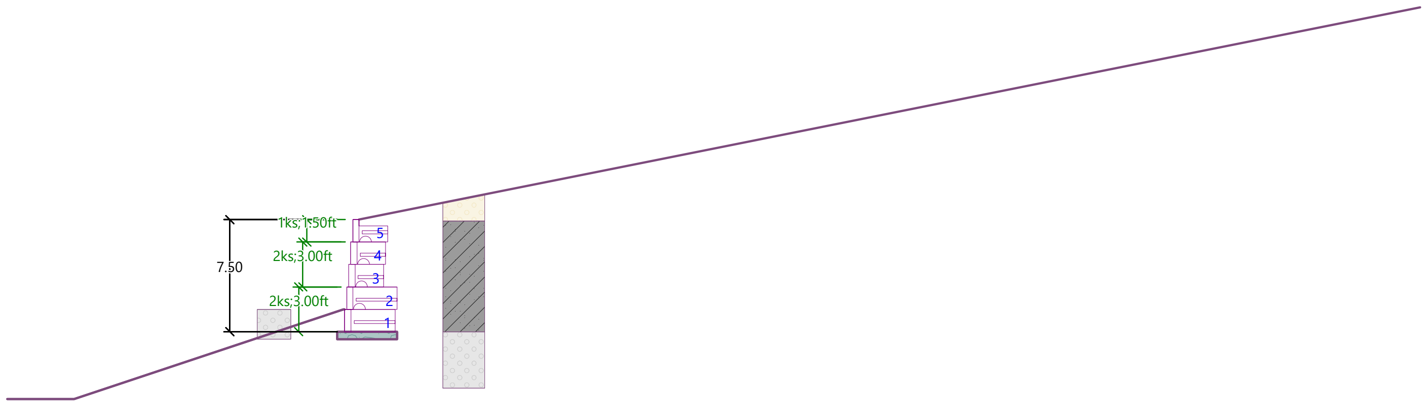
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	2	1.62
2	Block 28	2	1.62
3	Top block 28	1	-

Name : Geometry | **Stage - analysis : 1 - 0**



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 4.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	0.10	0.00 .. 0.10	Light Brown Sand	🟨
2	7.40	0.10 .. 7.50	Dark Gray Clay (Drained)	▨

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
3	-	7.50 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 5.00 (slope angle is 11.31 °).
Embankment height is 14.20 ft, embankment length is 71.00 ft.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft

Terrain shape in front of structure

No.	Coordinate x[ft]	Depth z[ft]
1	0.00	0.00
2	0.00	-2.00
3	-0.10	-2.00
4	-18.10	4.00
5	-19.10	4.00

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.49	2593.1	2.15	1.000
FF resistance	-1001.1	-0.79	0.0	0.50	1.000
Weight - earth wedge	0.0	-0.58	1.9	3.92	1.000
Weight - earth wedge	0.0	-4.06	90.8	3.46	1.000
Weight - earth wedge	0.0	-7.87	119.6	2.42	1.000
Active pressure	529.6	-2.00	383.0	3.82	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 7641.6 lbfft/ft
Overturning moment M_{ovr} = 266.5 lbfft/ft

Safety factor = 28.67 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2192.37 lbf/ft
Active horizontal force H_{act} = -471.47 lbf/ft

Safety factor = 1000.00 > 1.50

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.28	2383.1	1.66	1.000
FF resistance	-346.4	-0.42	0.0	0.00	1.000
Weight - earth wedge	0.0	-3.56	90.8	2.96	1.000
Weight - earth wedge	0.0	-7.37	119.6	1.92	1.000
Active pressure	360.7	-2.27	249.2	3.24	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 5261.9 lbfft/ft
Overturning moment M_{ovr} = 672.7 lbfft/ft

Safety factor = 7.82 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 2385.35 lbf/ft
Active horizontal force H_{act} = 14.33 lbf/ft

Safety factor = 166.46 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-998.2	3188.46	-471.47	0.000	797.1

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-998.2	3188.46	-471.47

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 797.1 psf

Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 7.53 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

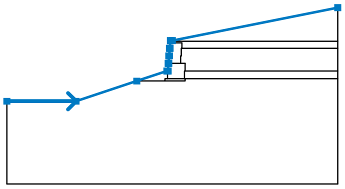
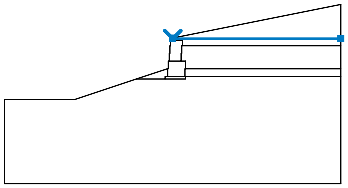
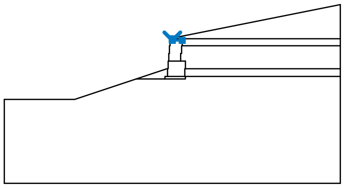
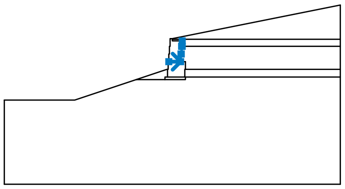
(input for current task)

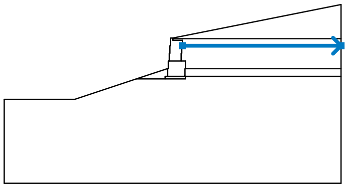
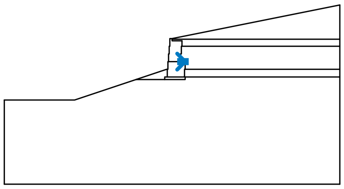
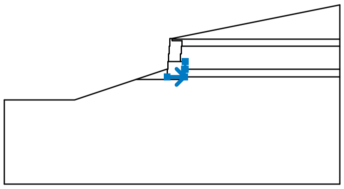
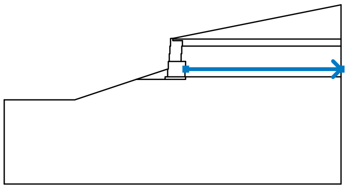
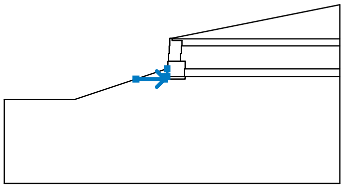
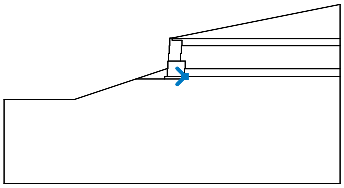
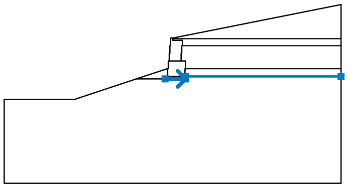
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-12.00	-19.06	-12.00	-7.06	-8.00
		-1.06	-6.00	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	32.80	6.56
2		0.00	0.00	0.00	-0.10	32.80	-0.10
3		0.00	-0.10	0.00	-0.42	1.92	-0.42
4		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		1.92	-1.50	32.80	-1.50		
6		1.65	-4.50	2.55	-4.50		
7		-0.96	-7.50	2.42	-7.50	2.42	-6.00
		2.55	-6.00	2.55	-4.50		
8		2.55	-6.00	32.80	-6.00		
9		-7.06	-8.00	-1.46	-8.00	-1.46	-7.50
		-0.96	-7.50	-0.96	-6.00		
10		2.42	-7.50	2.54	-7.50		
11		-1.46	-8.00	2.54	-8.00	2.54	-7.50
		32.80	-7.50				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Light Brown Sand	▨	115.0		

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

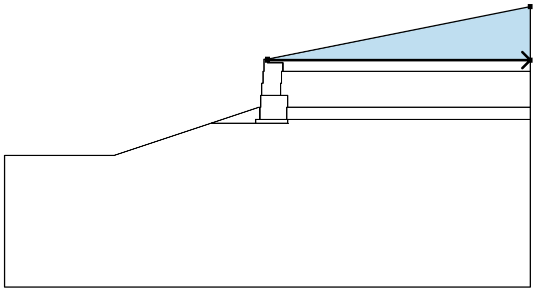
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

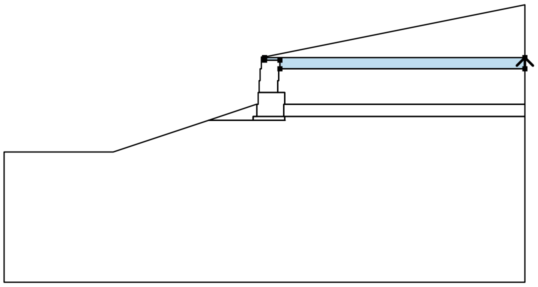
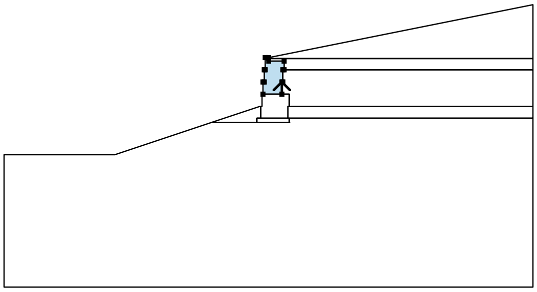
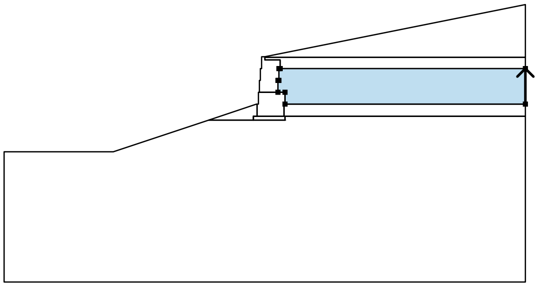
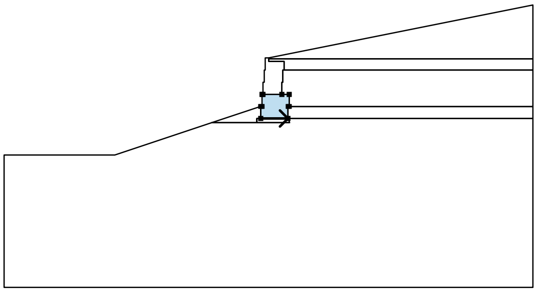
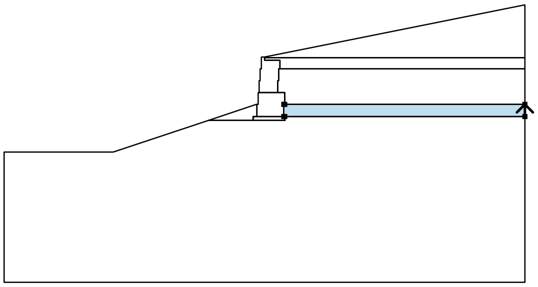
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

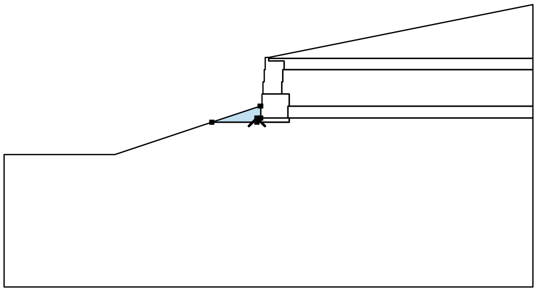
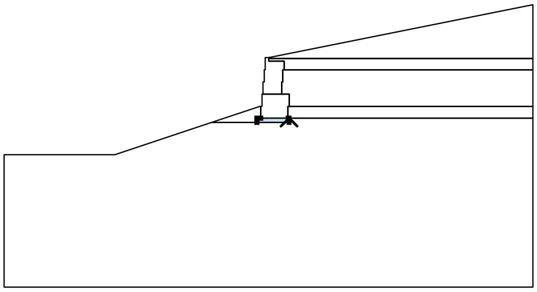
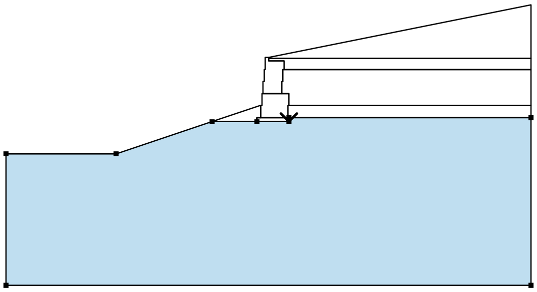
Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		0.00	-0.10	32.80	-0.10	Light Brown Sand ▒
		32.80	6.56	0.00	0.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
2		32.80	-1.50	32.80	-0.10	Dark Gray Clay (Drained)
		0.00	-0.10	0.00	-0.42	▨
		1.92	-0.42	1.92	-1.50	
3		1.65	-4.50	1.65	-3.00	Material of structure
		1.78	-3.00	1.78	-1.50	▦
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	-0.10	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50			
4		32.80	-6.00	32.80	-1.50	Dark Gray Clay (Drained)
		1.92	-1.50	1.78	-1.50	▨
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	2.55	-4.50	
		2.55	-6.00			
5		-0.96	-7.50	2.42	-7.50	Material of structure
		2.42	-6.00	2.55	-6.00	▦
		2.55	-4.50	1.65	-4.50	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.96	-6.00	
6		32.80	-7.50	32.80	-6.00	Dark Gray Clay (Drained)
		2.55	-6.00	2.42	-6.00	▨
		2.42	-7.50	2.54	-7.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
7		-1.46	-8.00	-1.46	-7.50	Light Gray Sand ▨
		-0.96	-7.50	-0.96	-6.00	
		-1.06	-6.00	-7.06	-8.00	
8		2.54	-8.00	2.54	-7.50	#57 Stone ▨
		2.42	-7.50	-0.96	-7.50	
		-1.46	-7.50	-1.46	-8.00	
9		2.54	-7.50	2.54	-8.00	Light Gray Sand ▨
		-1.46	-8.00	-7.06	-8.00	
		-19.06	-12.00	-32.80	-12.00	
		-32.80	-28.40	32.80	-28.40	
		32.80	-7.50			

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-8.07	[ft]	Angles :	α_1 =	-15.46	[°]
	z =	8.06	[ft]		α_2 =	70.90	[°]
Radius :	R =	18.74	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces :	F_a =	4933.4	lbf/ft
Sum of passive forces :	F_p =	8557.8	lbf/ft
Sliding moment :	M_a =	92452.6	lbfft/ft
Resisting moment :	M_p =	160372.4	lbfft/ft

Factor of safety = 1.73 > 1.35

Slope stability ACCEPTABLE

Geotechnical, Environmental and Materials Engineers

WALL #10

MAX. WALL HEIGHT = 6.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #10
Description : H6
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

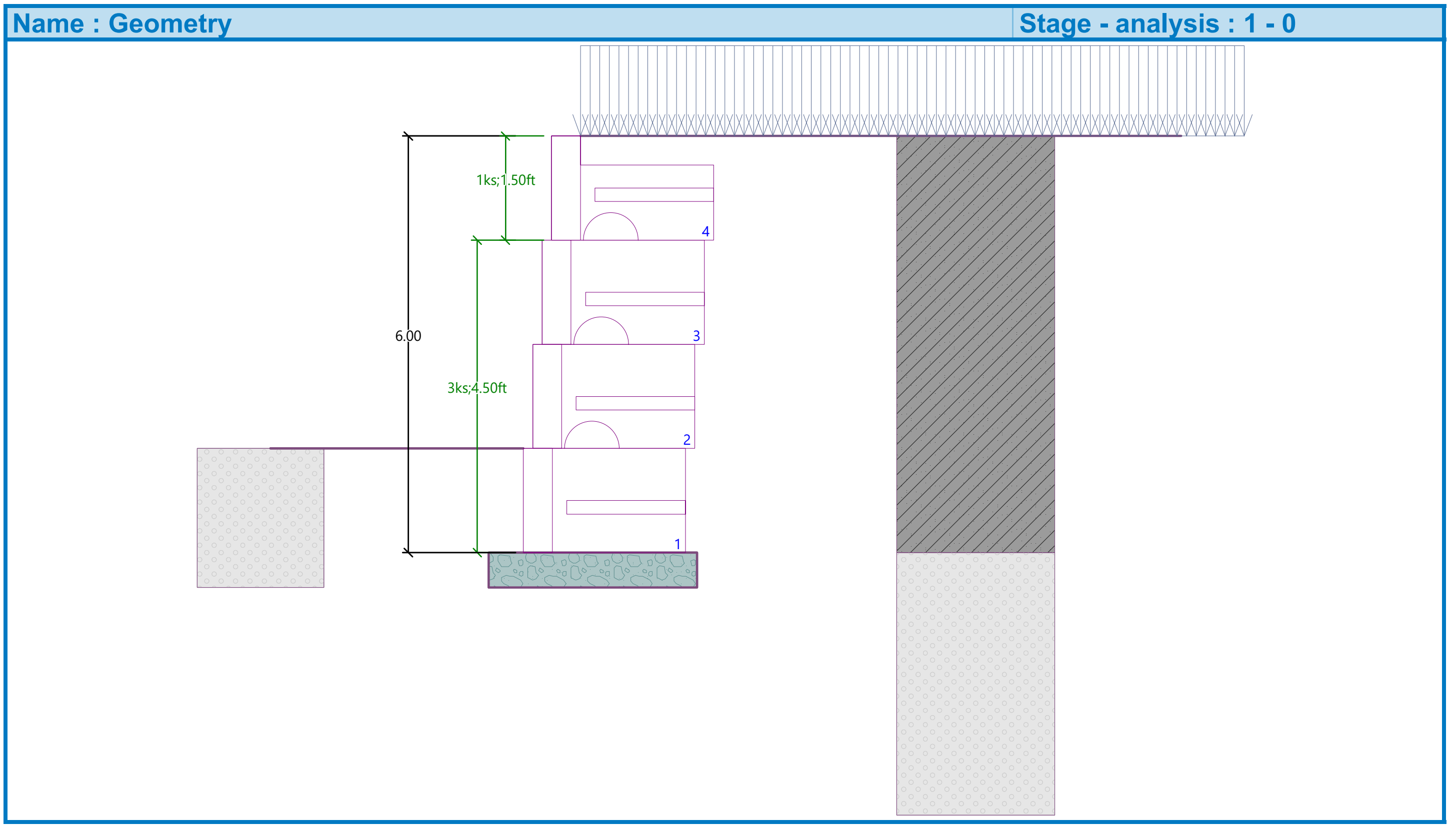
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28	3	1.62
2	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	6.00	0.00 .. 6.00	Dark Gray Clay (Drained)	▨
2	-	6.00 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft2]	[lbf/ft2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.0				on terrain

No.	Name
1	Traffic (Laydown Yard)

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.09	1745.6	1.83	1.000
FF resistance	-1109.4	-0.78	0.0	0.50	1.000
Weight - earth wedge	0.0	-0.58	2.3	2.90	1.000
Weight - earth wedge	0.0	-6.29	89.2	2.22	1.000
Active pressure	117.3	-0.38	96.8	2.95	1.000
Traffic (Laydown Yard)	140.7	-1.21	212.8	3.07	1.000
Traffic (Laydown Yard)	0.0	-6.50	412.8	2.15	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 5216.7 lbfft/ft
Overturning moment M_{ovr} = -644.6 lbfft/ft

Safety factor = 1000.00 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 1749.38 lbf/ft
Active horizontal force H_{act} = -851.37 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.13	1168.1	1.29	1.000
Weight - earth wedge	0.0	-4.29	89.2	1.58	1.000
Active pressure	0.0	-4.50	0.0	2.34	1.000
Traffic (Laydown Yard)	17.1	-1.60	143.1	2.50	1.000
Traffic (Laydown Yard)	0.0	-4.50	412.8	1.51	1.000

Verification of most stressed block No. 2

Check for overturning stability

Resisting moment M_{res} = 2631.6 lbfft/ft
Overturning moment M_{ovr} = 27.3 lbfft/ft

Safety factor = 96.46 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7812.07 lbf/ft
Active horizontal force H_{act} = 17.08 lbf/ft

Safety factor = 457.35 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-2022.0	2559.55	-851.37	0.000	853.2

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-2022.0	2559.55	-851.37

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 853.2 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 7.03 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

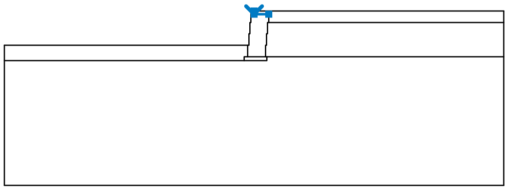
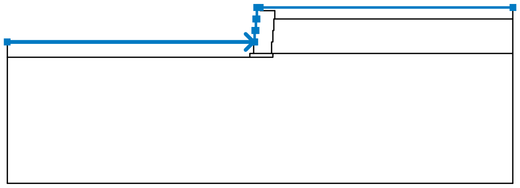
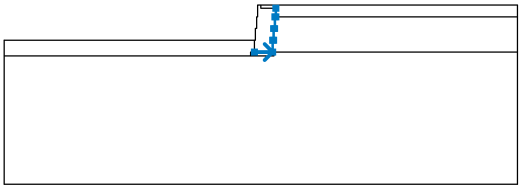
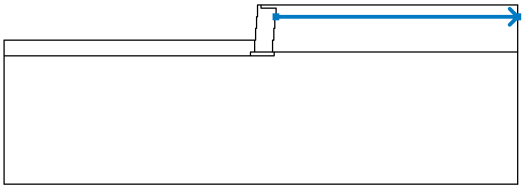
(input for current task)

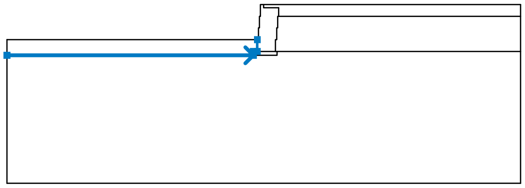
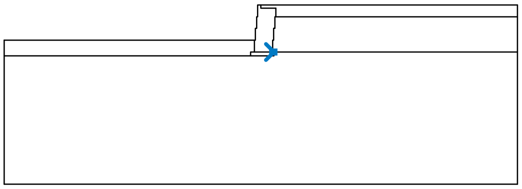
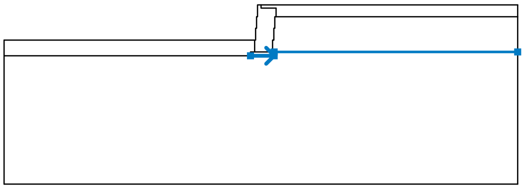
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_S =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		0.00	0.00	0.00	-0.42	1.92	-0.42
2		-32.80	-4.50	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		32.80	0.00				
3		-0.82	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
4		1.92	-1.50	32.80	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		-32.80	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
6		1.51	-6.00	1.68	-6.00		
7		-1.32	-6.50	1.68	-6.50	1.68	-6.00
		32.80	-6.00				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Light Brown Sand	▨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

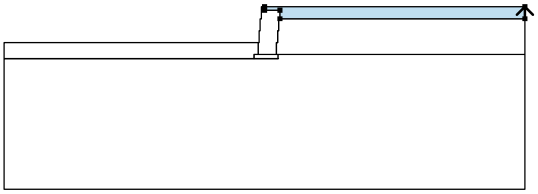
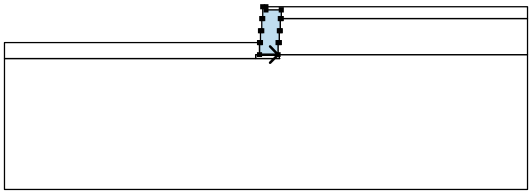
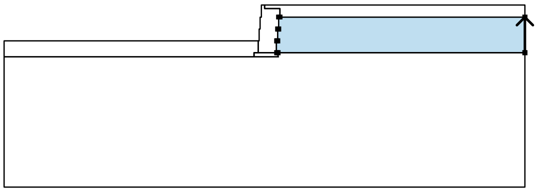
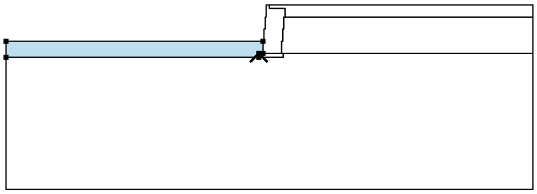
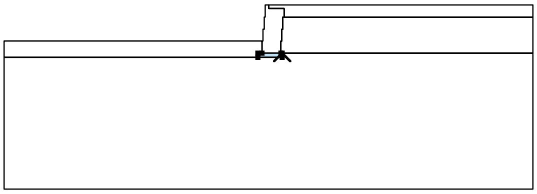
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

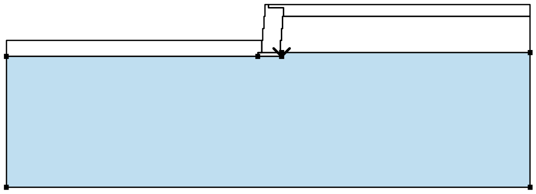
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
1		32.80	-1.50	32.80	0.00	Dark Gray Clay (Drained)
		0.00	0.00	0.00	-0.42	▨
		1.92	-0.42	1.92	-1.50	
2		-0.82	-6.00	1.51	-6.00	Material of structure
		1.51	-4.50	1.65	-4.50	▦
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
3		32.80	-6.00	32.80	-1.50	Dark Gray Clay (Drained)
		1.92	-1.50	1.78	-1.50	▨
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.51	-4.50	
		1.51	-6.00	1.68	-6.00	
4		-1.32	-6.50	-1.32	-6.00	Light Gray Sand
		-0.82	-6.00	-0.82	-4.50	░
		-32.80	-4.50	-32.80	-6.50	
5		1.68	-6.50	1.68	-6.00	#57 Stone
		1.51	-6.00	-0.82	-6.00	▒
		-1.32	-6.00	-1.32	-6.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		1.68	-6.00	1.68	-6.50	Light Gray Sand ▨
		-1.32	-6.50	-32.80	-6.50	
		-32.80	-22.90	32.80	-22.90	
		32.80	-6.00			

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 0.00	l = 32.80		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic (Laydown Yard)

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.91	[ft]	Angles :	α_1 =	-43.32	[°]
	z =	1.48	[ft]		α_2 =	79.63	[°]
Radius :	R =	8.22	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 2575.5 lbf/ft
Sum of passive forces : F_p = 5953.1 lbf/ft

Sliding moment : M_a = 21170.8 lbfft/ft
Resisting moment : M_p = 48934.5 lbfft/ft
Factor of safety = 2.31 > 1.35

Slope stability ACCEPTABLE

WALL #11

MAX. WALL HEIGHT = 4.5 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #11
Description : H4.5
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00
Verification methodology : Safety factors (ASD)
Reduce parameters of contact base - soil

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

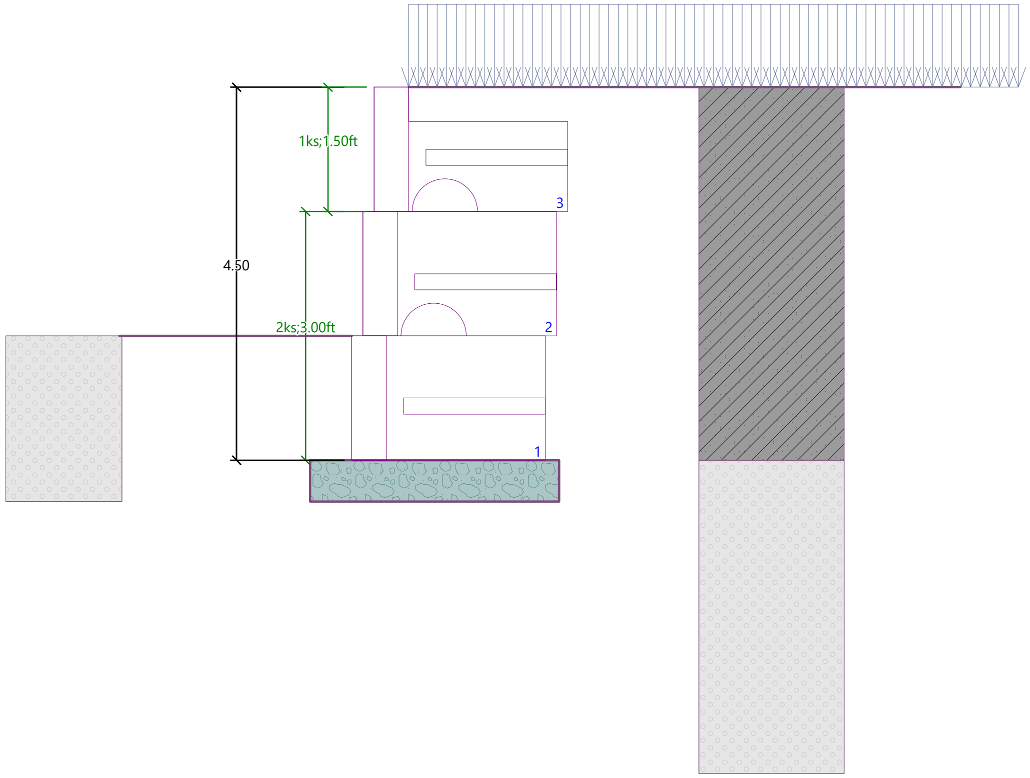
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28	2	1.62
2	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	4.50	0.00 .. 4.50	Dark Gray Clay (Drained)	▨
2	-	4.50 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft2]	[lbf/ft2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.0				on terrain

No.	Name
1	Traffic (Laydown Yard)

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.35	1325.6	1.76	1.000
FF resistance	-1109.4	-0.78	0.0	0.50	1.000
Weight - earth wedge	0.0	-0.58	2.3	2.90	1.000
Weight - earth wedge	0.0	-4.79	89.2	2.08	1.000
Active pressure	77.5	-0.37	61.5	2.95	1.000
Traffic (Laydown Yard)	66.6	-0.82	188.4	2.99	1.000
Traffic (Laydown Yard)	0.0	-5.00	412.8	2.01	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 4096.5 lbfft/ft
Overturning moment M_{ovr} = -776.5 lbfft/ft

Safety factor = 1000.00 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 1449.66 lbf/ft
Active horizontal force H_{act} = -965.30 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-1.41	748.1	1.23	1.000
Weight - earth wedge	0.0	-2.79	89.2	1.45	1.000
Active pressure	0.0	-3.00	0.0	2.20	1.000
Traffic (Laydown Yard)	5.7	-2.74	118.8	2.38	1.000
Traffic (Laydown Yard)	0.0	-3.00	412.8	1.38	1.000

Verification of most stressed block No. 2

Check for overturning stability

Resisting moment M_{res} = 1897.7 lbfft/ft

Overturning moment M_{ovr} = 15.8 lbfft/ft

Safety factor = 120.46 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7382.94 lbf/ft

Active horizontal force H_{act} = 5.75 lbf/ft

Safety factor = 1284.37 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-1753.2	2079.89	-965.30	0.000	693.3

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-1753.2	2079.89	-965.30

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000

Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 693.3 psf

Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 8.65 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

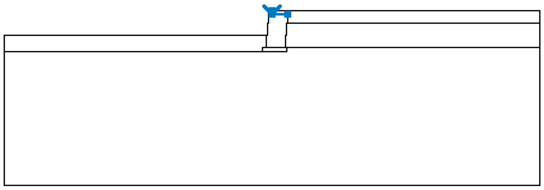
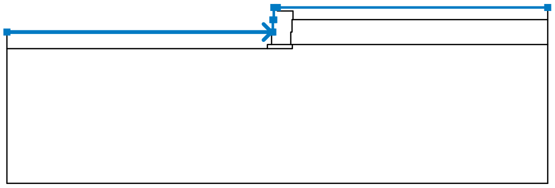
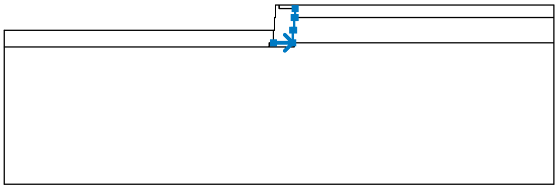
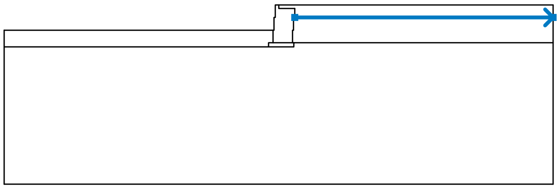
(input for current task)

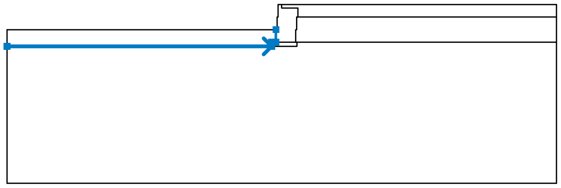
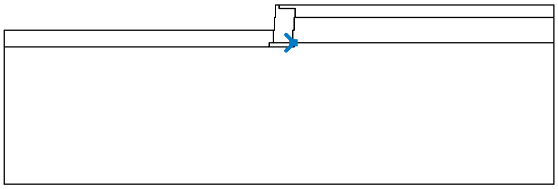
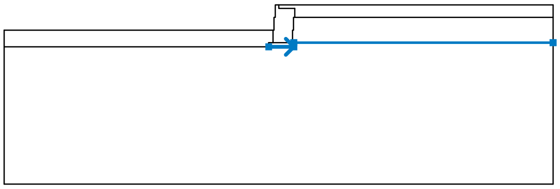
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_S =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		0.00	0.00	0.00	-0.42	1.92	-0.42
2		-32.80 -0.55 0.00	-3.00 -1.50 0.00	-0.69 -0.42 32.80	-3.00 -1.50 0.00	-0.55 -0.42	-3.00 0.00
3		-0.69 1.78 1.92	-4.50 -3.00 -0.42	1.65 1.78	-4.50 -1.50	1.65 1.92	-3.00 -1.50
4		1.92	-1.50	32.80	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		-32.80	-5.00	-1.19	-5.00	-1.19	-4.50
		-0.69	-4.50	-0.69	-3.00		
6		1.65	-4.50	1.81	-4.50		
7		-1.19	-5.00	1.81	-5.00	1.81	-4.50
		32.80	-4.50				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Light Brown Sand	▨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

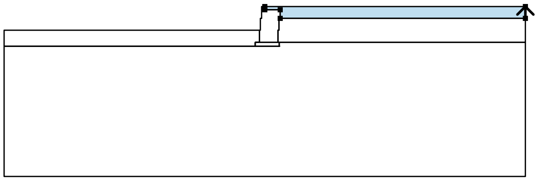
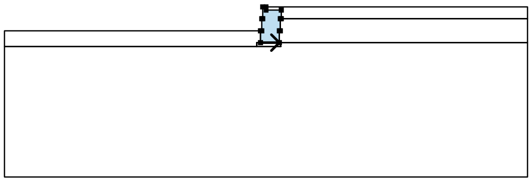
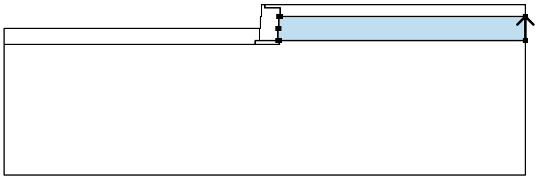
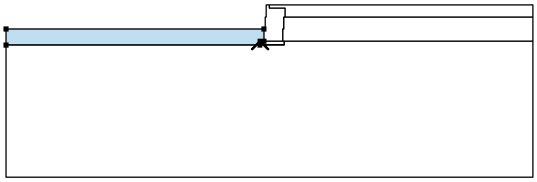
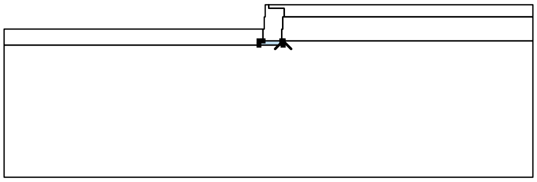
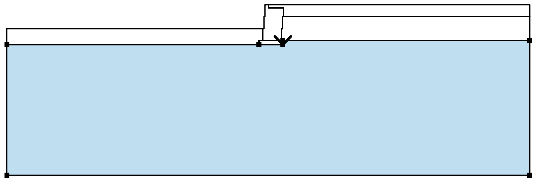
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	🟥	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft] x	z	x	z	Assigned soil
1		32.80	-1.50	32.80	0.00	Dark Gray Clay (Drained) ▨
		0.00	0.00	0.00	-0.42	
		1.92	-0.42	1.92	-1.50	
2		-0.69	-4.50	1.65	-4.50	Material of structure 🟥
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
3		32.80	-4.50	32.80	-1.50	Dark Gray Clay (Drained) ▨
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.81	-4.50	
4		-1.19	-5.00	-1.19	-4.50	Light Gray Sand ▒
		-0.69	-4.50	-0.69	-3.00	
		-32.80	-3.00	-32.80	-5.00	
5		1.81	-5.00	1.81	-4.50	#57 Stone ▒
		1.65	-4.50	-0.69	-4.50	
		-1.19	-4.50	-1.19	-5.00	
6		1.81	-4.50	1.81	-5.00	Light Gray Sand ▒
		-1.19	-5.00	-32.80	-5.00	
		-32.80	-21.40	32.80	-21.40	
		32.80	-4.50			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope α [°]	Magnitude q, q_1, f, F, x	 q_2, z	 unit
1	strip	permanent	on terrain	x = 0.00	l = 32.80		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic (Laydown Yard)

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters								
Center :	x =	-1.45	[ft]	Angles :	α_1 =	-46.22	[°]
	z =	1.94	[ft]		α_2 =	74.23	[°]
Radius :	R =	7.14	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 1733.3 lbf/ft
Sum of passive forces : F_p = 4706.5 lbf/ft

Sliding moment : M_a = 12375.4 lbfft/ft
Resisting moment : M_p = 33604.7 lbfft/ft
Factor of safety = 2.72 > 1.35
Slope stability ACCEPTABLE

WALL #12

MAX. WALL HEIGHT = 6.0 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #12
Description : H6.0
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

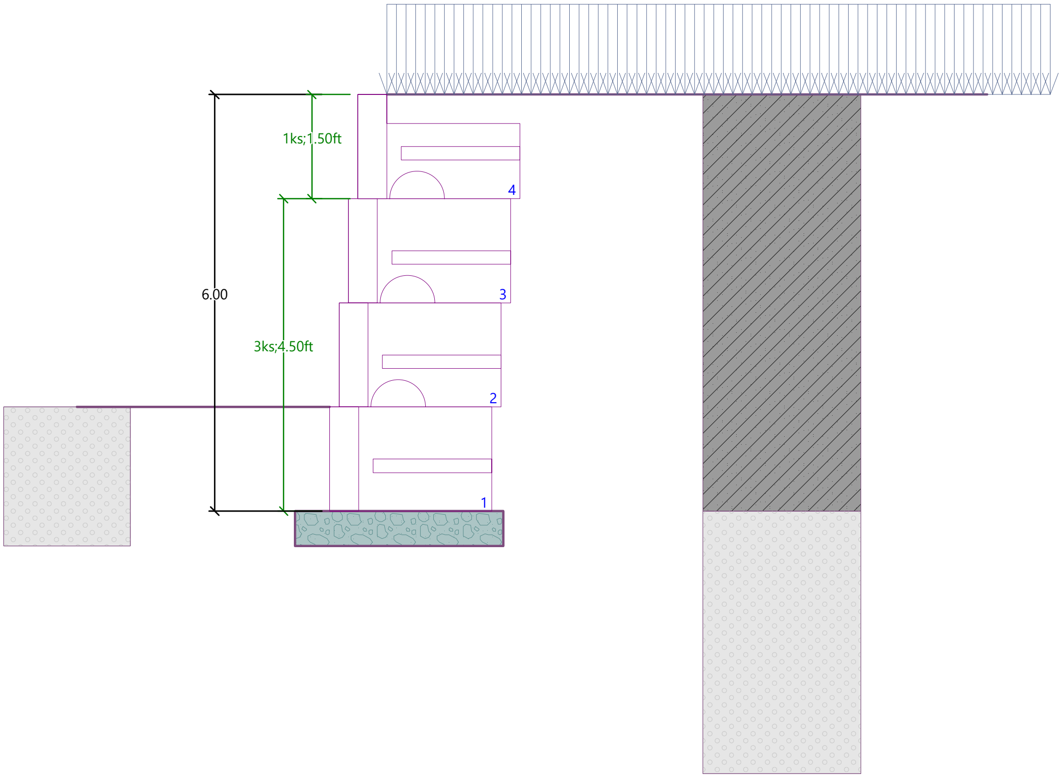
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28	3	1.62
2	Top block 28	1	-

Name : Geometry | Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 3.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone

Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand

Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	6.00	0.00 .. 6.00	Dark Gray Clay (Drained)	▨
2	-	6.00 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft²]	[lbf/ft²]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.0				on terrain

No.	Name
1	Traffic (Laydown Yard)

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.09	1745.6	1.83	1.000
FF resistance	-1109.4	-0.78	0.0	0.50	1.000
Weight - earth wedge	0.0	-0.58	2.3	2.90	1.000
Weight - earth wedge	0.0	-6.29	89.2	2.22	1.000
Active pressure	117.3	-0.38	96.8	2.95	1.000
Traffic (Laydown Yard)	140.7	-1.21	212.8	3.07	1.000
Traffic (Laydown Yard)	0.0	-6.50	412.8	2.15	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 5216.7 lbfft/ft
Overturning moment M_{ovr} = -644.6 lbfft/ft

Safety factor = 1000.00 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 1749.38 lbf/ft
Active horizontal force H_{act} = -851.37 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.13	1168.1	1.29	1.000
Weight - earth wedge	0.0	-4.29	89.2	1.58	1.000
Active pressure	0.0	-4.50	0.0	2.34	1.000
Traffic (Laydown Yard)	17.1	-1.60	143.1	2.50	1.000
Traffic (Laydown Yard)	0.0	-4.50	412.8	1.51	1.000

Verification of most stressed block No. 2

Check for overturning stability

Resisting moment M_{res} = 2631.6 lbfft/ft
Overturning moment M_{ovr} = 27.3 lbfft/ft

Safety factor = 96.46 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7812.07 lbf/ft
Active horizontal force H_{act} = 17.08 lbf/ft

Safety factor = 457.35 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-2022.0	2559.55	-851.37	0.000	853.2

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-2022.0	2559.55	-851.37

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 853.2 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 7.03 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

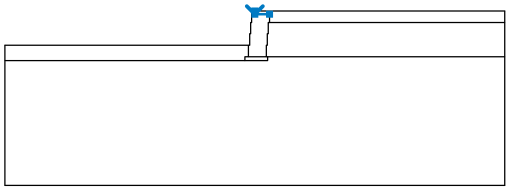
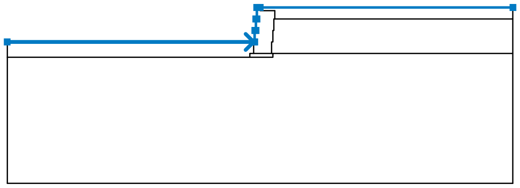
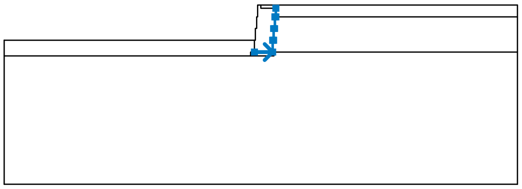
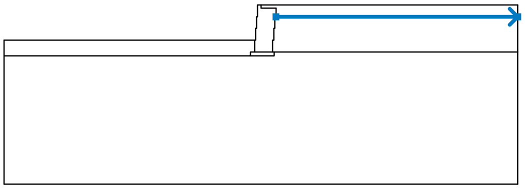
(input for current task)

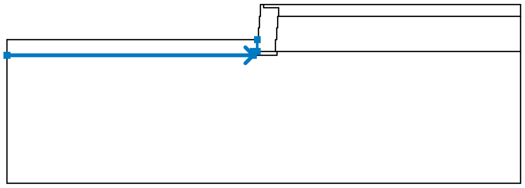
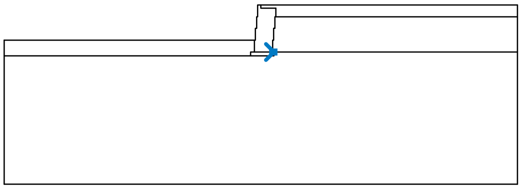
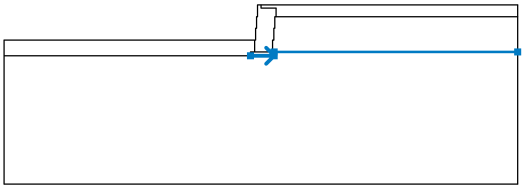
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_S =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		0.00	0.00	0.00	-0.42	1.92	-0.42
2		-32.80	-4.50	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		32.80	0.00				
3		-0.82	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
4		1.92	-1.50	32.80	-1.50		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		-32.80	-6.50	-1.32	-6.50	-1.32	-6.00
		-0.82	-6.00	-0.82	-4.50		
6		1.51	-6.00	1.68	-6.00		
7		-1.32	-6.50	1.68	-6.50	1.68	-6.00
		32.80	-6.00				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
2	Onsite Sands	▩	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	░	120.0		
5	Light Brown Sand	🟨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

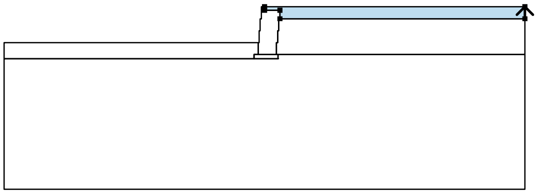
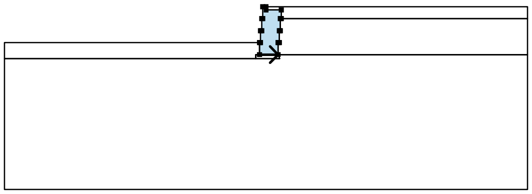
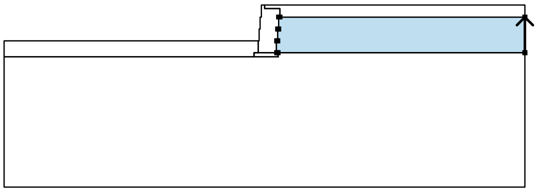
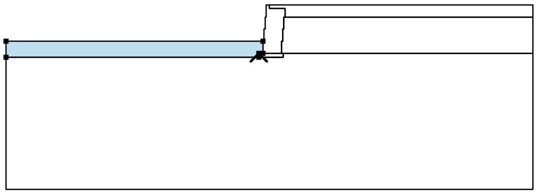
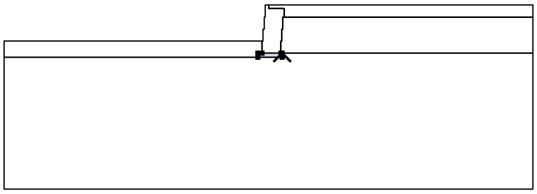
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

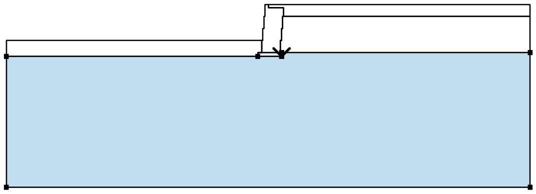
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		32.80	-1.50	32.80	0.00	Dark Gray Clay (Drained) ▨
		0.00	0.00	0.00	-0.42	
		1.92	-0.42	1.92	-1.50	
2		-0.82	-6.00	1.51	-6.00	Material of structure ▦
		1.51	-4.50	1.65	-4.50	
		1.65	-3.00	1.78	-3.00	
		1.78	-1.50	1.92	-1.50	
		1.92	-0.42	0.00	-0.42	
		0.00	0.00	-0.42	0.00	
		-0.42	-1.50	-0.55	-1.50	
		-0.55	-3.00	-0.69	-3.00	
		-0.69	-4.50	-0.82	-4.50	
3		32.80	-6.00	32.80	-1.50	Dark Gray Clay (Drained) ▨
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.51	-4.50	
		1.51	-6.00	1.68	-6.00	
4		-1.32	-6.50	-1.32	-6.00	Light Gray Sand ░
		-0.82	-6.00	-0.82	-4.50	
		-32.80	-4.50	-32.80	-6.50	
5		1.68	-6.50	1.68	-6.00	#57 Stone ▒
		1.51	-6.00	-0.82	-6.00	
		-1.32	-6.00	-1.32	-6.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		1.68	-6.00	1.68	-6.50	Light Gray Sand
		-1.32	-6.50	-32.80	-6.50	▨
		-32.80	-22.90	32.80	-22.90	
		32.80	-6.00			

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 0.00	l = 32.80		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic (Laydown Yard)

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.87	[ft]	Angles :	α_1 =	-42.58	[°]
	z =	1.67	[ft]		α_2 =	78.50	[°]
Radius :	R =	8.38	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 2600.1 lbf/ft
Sum of passive forces : F_p = 6011.9 lbf/ft

Sliding moment : M_a = 21788.6 lbfft/ft
Resisting moment : M_p = 50379.6 lbfft/ft
Factor of safety = 2.31 > 1.35

Slope stability ACCEPTABLE

GEOS
Geotechnical, Environmental and Materials Engineers

WALL #13

MAX. WALL HEIGHT = 7.5 FEET

Analysis of Redi Rock wall

Input data

Project

Task : Chemours Barrier Wall Retaining Walls
Part : Wall #13
Description : H7.5
Author : GEOS
Date : 1/10/2022

Settings

(input for current task)

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Mazindrani (Rankine)
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Allowable eccentricity :	0.333
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00
Verification methodology :	Safety factors (ASD)
Reduce parameters of contact base - soil	

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	3.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Reduction coefficients			
Permanent design situation			
Reduction coeff. of contact base - soil :	μ =	1.00	[–]

Blocks

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00

No.	Description	Height h [in]	Width w [in]	Unit weight γ [pcf]
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

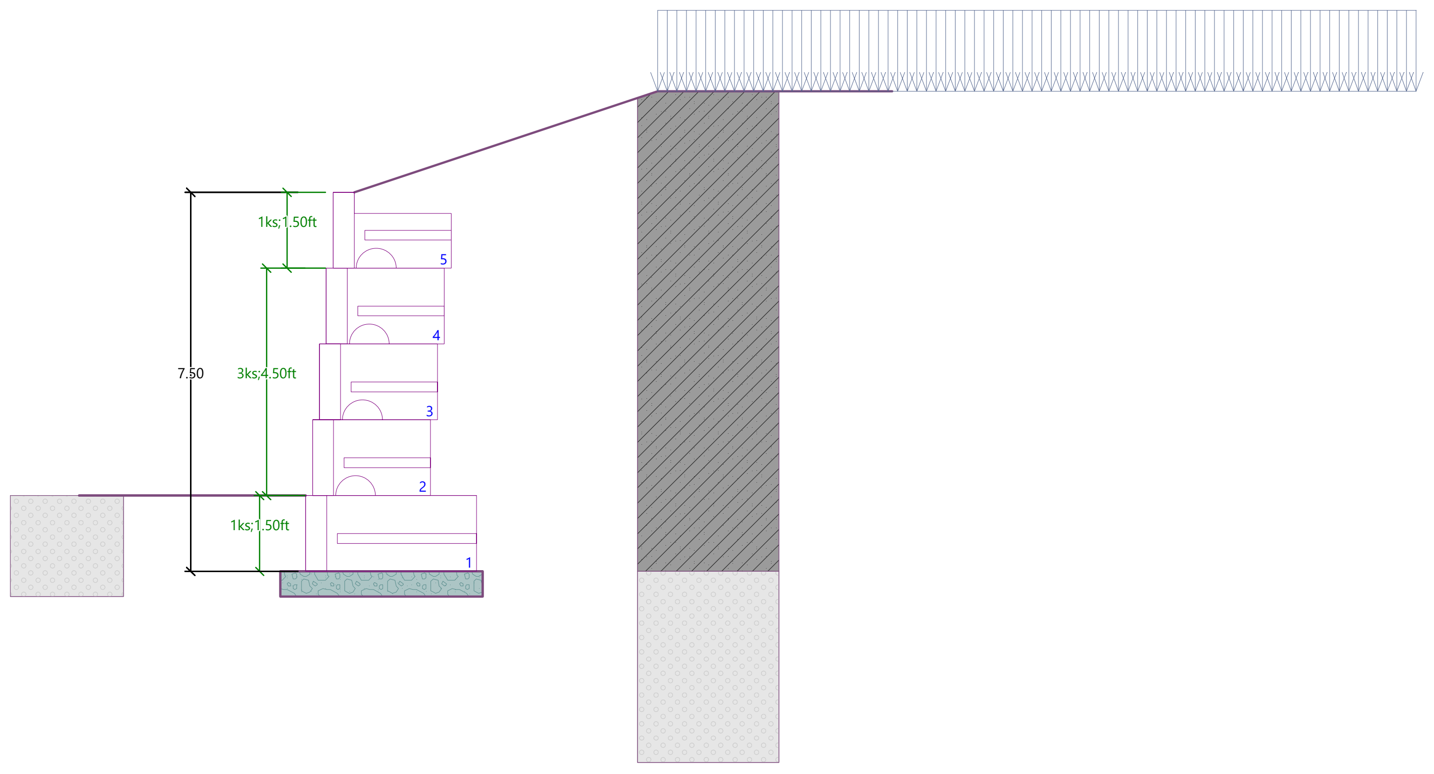
Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	1	1.62
2	Block 28	3	1.62
3	Top block 28	1	-

Name : Geometry — Stage - analysis : 1 - 0



Base

Geometry

Upper setback a_1 = 0.50 ft
Lower setback a_2 = 0.50 ft
Height h = 0.50 ft
Width b = 4.00 ft

Material

Soil creating foundation - #57 Stone

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	#57 Stone	▨	40.00	0.0	105.00	47.50	26.67
2	Onsite Sands	▨	32.00	0.0	115.00	57.50	21.30
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.00	62.50	16.67
4	Light Gray Sand	▨	32.00	50.0	115.00	57.50	21.33
5	Light Brown Sand	▨	32.00	75.0	110.00	52.50	21.30

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.67 °
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 200.0 psf
Angle of friction struc.-soil : δ = 16.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 120.0 pcf

Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Angle of friction struc.-soil : δ = 21.30 °
Saturated unit weight : γ_{sat} = 115.0 pcf

Backfill

Backfill is not considered.

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	7.50	0.00 .. 7.50	Dark Gray Clay (Drained)	▨
2	-	7.50 .. ∞	Light Gray Sand	░

Terrain profile

Terrain behind construction has the slope 1: 3.00 (slope angle is 18.43 °).
Embankment height is 2.00 ft, embankment length is 6.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[lbf/ft^2]	[lbf/ft^2]	x [ft]	l [ft]	z [ft]
1	Yes		permanent	250.00		6.00	15.00	on terrain

No.	Name
1	Traffic (Laydown Yard)

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - Light Gray Sand
Soil thickness in front of structure h = 2.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.55	2405.6	2.04	1.000
FF resistance	-1109.4	-0.78	0.0	0.50	1.000
Weight - earth wedge	0.0	-0.60	2.3	3.92	1.000
Weight - earth wedge	0.0	-2.66	107.2	3.33	1.000
Weight - earth wedge	0.0	-7.94	150.2	2.46	1.000
Active pressure	790.2	-1.86	599.9	3.68	1.000
Traffic (Laydown Yard)	303.0	-2.43	226.4	3.55	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 8660.0 lbfft/ft
Overturning moment M_{ovr} = 1344.2 lbfft/ft

Safety factor = 6.44 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2381.81 lbf/ft
Active horizontal force H_{act} = -16.19 lbf/ft

Safety factor = 1000.00 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.37	2195.6	1.55	1.000
FF resistance	-367.5	-0.42	0.0	0.00	1.000
Weight - earth wedge	0.0	-2.16	107.2	2.83	1.000
Weight - earth wedge	0.0	-7.44	150.2	1.96	1.000
Active pressure	620.3	-1.77	461.9	3.09	1.000
Traffic (Laydown Yard)	282.9	-2.10	205.9	3.00	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 6041.2 lbfft/ft
Overturning moment M_{ovr} = 1539.2 lbfft/ft

Safety factor = 3.92 > 2.00

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 2618.70 lbf/ft
Active horizontal force H_{act} = 535.61 lbf/ft

Safety factor = 4.89 > 1.50

Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-332.5	3491.63	-16.19	0.000	872.9

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-332.5	3491.63	-16.19

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.000
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 872.9 psf
Bearing capacity of foundation soil R_d = 6000.0 psf

Safety factor = 6.87 > 3.00

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Slope stability analysis

Input data

Project

Settings

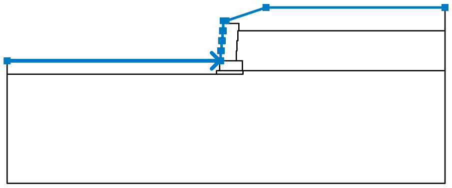
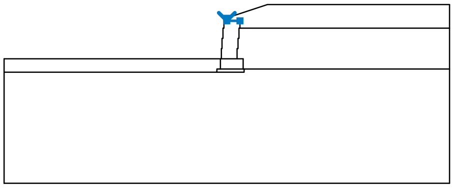
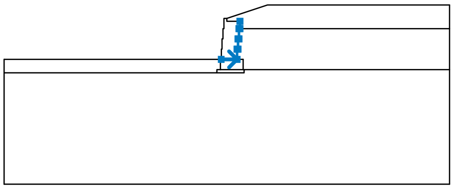
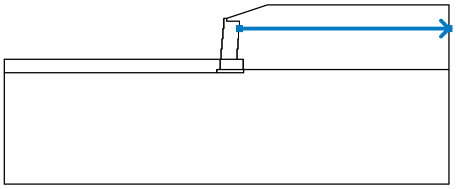
(input for current task)

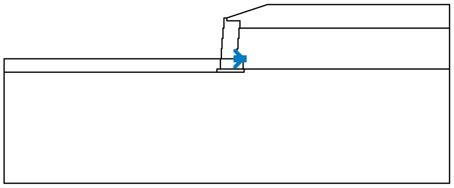
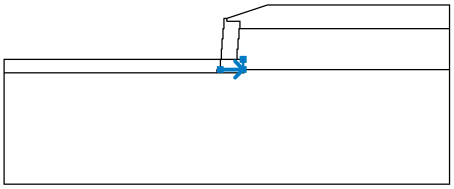
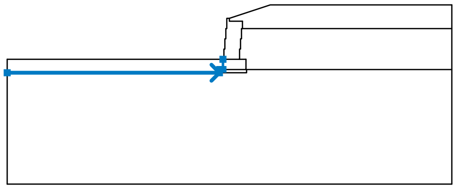
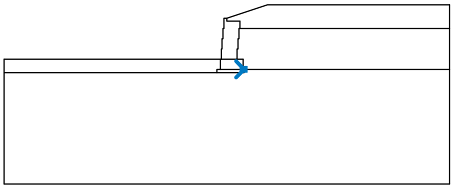
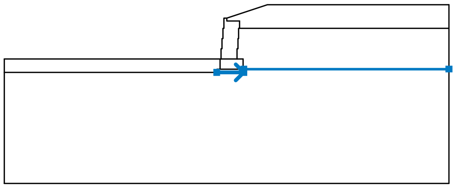
Stability analysis

Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.35	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-6.00	-0.96	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	6.00	2.00
		32.80	2.00				
2		0.00	0.00	0.00	-0.42	1.92	-0.42
3		-0.82	-6.00	1.51	-6.00	1.51	-4.50
		1.65	-4.50	1.65	-3.00	1.78	-3.00
		1.78	-1.50	1.92	-1.50	1.92	-0.42
4		1.92	-1.50	32.80	-1.50		

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Interface location</th><th colspan="6">Coordinates of interface points [ft]</th></tr>
<tr><th>x</th><th>z</th><th>x</th><th>z</th><th>x</th><th>z</th></tr>
<tr><td>5</td><td></td><td>1.51</td><td>-6.00</td><td>2.42</td><td>-6.00</td><td></td><td></td></tr>
<tr><td>6</td><td></td><td>-0.96</td><td>-7.50</td><td>2.42</td><td>-7.50</td><td>2.42</td><td>-6.00</td></tr>
<tr><td>7</td><td></td><td>-32.80
-0.96</td><td>-8.00
-7.50</td><td>-1.46
-0.96</td><td>-8.00
-6.00</td><td>-1.46</td><td>-7.50</td></tr>
<tr><td>8</td><td></td><td>2.42</td><td>-7.50</td><td>2.54</td><td>-7.50</td><td></td><td></td></tr>
<tr><td>9</td><td></td><td>-1.46
32.80</td><td>-8.00
-7.50</td><td>2.54</td><td>-8.00</td><td>2.54</td><td>-7.50</td></tr>
</table>

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	#57 Stone	▨	40.00	0.0	105.0
2	Onsite Sands	▨	32.00	0.0	115.0
3	Dark Gray Clay (Drained)	▨	25.00	200.0	120.0

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
4	Light Gray Sand	▨	32.00	50.0	115.0
5	Light Brown Sand	▨	32.00	75.0	110.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	#57 Stone	▨	110.0		
2	Onsite Sands	▨	120.0		
3	Dark Gray Clay (Drained)	▨	125.0		
4	Light Gray Sand	▨	120.0		
5	Light Brown Sand	▨	115.0		

Soil parameters

#57 Stone
Unit weight : γ = 105.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

Onsite Sands
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

Dark Gray Clay (Drained)
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °

Cohesion of soil : c_{ef} = 200.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

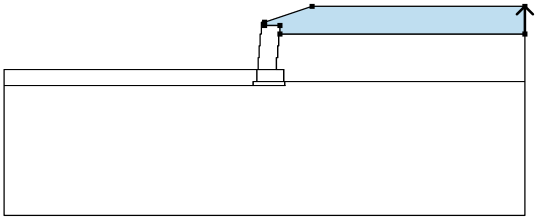
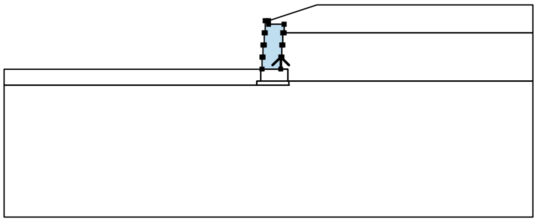
Light Gray Sand
Unit weight : γ = 115.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 50.0 psf
Saturated unit weight : γ_{sat} = 120.0 pcf

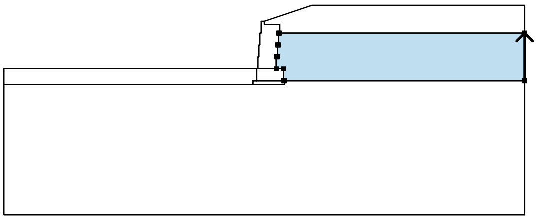
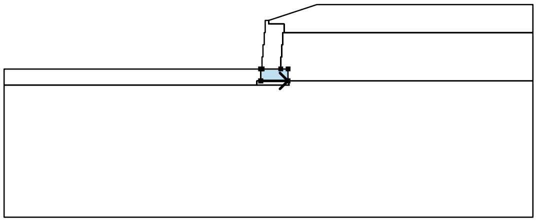
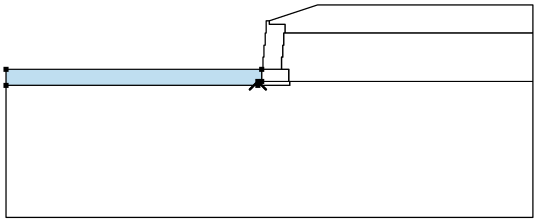
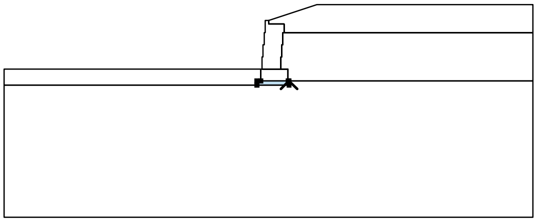
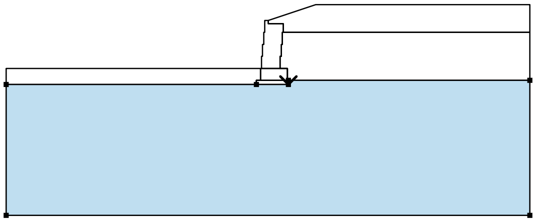
Light Brown Sand
Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 75.0 psf
Saturated unit weight : γ_{sat} = 115.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure	▦	120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		32.80	-1.50	32.80	2.00	Dark Gray Clay (Drained) ▨
		6.00	2.00	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
		1.92	-1.50			
2		1.51	-6.00	1.51	-4.50	Material of structure ▦
		1.65	-4.50	1.65	-3.00	
		1.78	-3.00	1.78	-1.50	
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	0.00	
		-0.42	0.00	-0.42	-1.50	
		-0.55	-1.50	-0.55	-3.00	
		-0.69	-3.00	-0.69	-4.50	
		-0.82	-4.50	-0.82	-6.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		32.80	-7.50	32.80	-1.50	Dark Gray Clay (Drained)
		1.92	-1.50	1.78	-1.50	▨
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	1.51	-4.50	
		1.51	-6.00	2.42	-6.00	
		2.42	-7.50	2.54	-7.50	
4		-0.96	-7.50	2.42	-7.50	Material of structure
		2.42	-6.00	1.51	-6.00	🟥
		-0.82	-6.00	-0.96	-6.00	
5		-1.46	-8.00	-1.46	-7.50	Light Gray Sand
		-0.96	-7.50	-0.96	-6.00	
		-32.80	-6.00	-32.80	-8.00	
6		2.54	-8.00	2.54	-7.50	#57 Stone
		2.42	-7.50	-0.96	-7.50	
		-1.46	-7.50	-1.46	-8.00	
7		2.54	-7.50	2.54	-8.00	Light Gray Sand
		-1.46	-8.00	-32.80	-8.00	
		-32.80	-24.40	32.80	-24.40	
		32.80	-7.50			

Surcharge

No.	Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
			z [ft]	x [ft]	l [ft]	b [ft]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	strip	permanent	on terrain	x = 6.00	l = 15.00		0.00	250.0		lbf/ft^2

Surcharges

No.	Name
1	Traffic (Laydown Yard)

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.10	[ft]	Angles :	α_1 =	-32.97	[°]
	z =	5.77	[ft]		α_2 =	74.41	[°]
Radius :	R =	14.03	[ft]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 5201.2 lbf/ft
Sum of passive forces : F_p = 10133.3 lbf/ft

Sliding moment : M_a = 72972.4 lbfft/ft
Resisting moment : M_p = 142170.6 lbfft/ft
Factor of safety = 1.95 > 1.35
Slope stability ACCEPTABLE

Attachments

Soil Nail Wall Calculations

Soil Nail Wall - Reinforced Facing Design ASD

ref: FHWA0-IF-03-017 Geotechnical Engineering Circular No. 7 Soil Nail Walls, March 2003

Design Factors and Coefficients

FoS Flexural Facing: $FS_{FF}=1.50$

FoS Punching Shear: $FS_{FP}=1.50$

FoS Nail Tension: $FS_{T}=1.80$

Nail Spacing

Vertical Nail Spacing: $S_V=5.00\ ft$

Horizontal Nail Spacing: $S_H=5.00\ ft$

Nail Loads

$T_0=21.00\ kip$ $T_{max}=29.41\ kip$

Soil Nail Tendon

Diameter: $D_{nail}=1.125\ in$

Yield Stress: $f_{y\_nail}=75.00\ ksi$

Use Grade 75, #9 Solid Bar

Epoxy-coated bars and sacrificial steel method
for corrosion projection.

Shotcrete:

Shotcrete Strength: $f_{c\_facing}=4.00\ ksi$

Shotcrete Thickness: (Facing) $h_i=6.00\ in$

Reinforcement Area: (No. 4, Walers) $A_{bar}=0.40\ in^2$

Reinforcement Yield Stress: $f_{y\_waler}=60.00\ ksi$

Welded Wire Mesh Area: $A_{WWF}=0.12\ \frac{in^2}{ft}$

Welded Wire Mesh Yield Stress: $f_{y\_steel\_mesh}=60.00\ ksi$

Bearing Plate

Length of Plate: $L_{BP}=6.00\ in$

Thickness of Plate: $t_P=1.00\ in$

Yield Stress of Plate: $f_{y\_bearing\_plate}=36.00\ ksi$

Diameter of Nut: (Washer) $D_{washer}=2.25\ in$

(4x4 W4.0xW4.0)

Min. Grout Strength: $f'_c=3\ ksi$ (Assumed)

Min. development length for epoxy-coated nails: $l_d=9.6\ ft$

MIN. Length of Nails

Nail Tensile Resistance

Use Grade 75, #9 Solid Bars

Use Epoxy-coated bars for corrosion protection, with additional protection from sacrificial steel method.

Effective Nail Diameter: $D_{nail} := 1.125\ in$

$$D_{net} := D_{nail} - 2 \cdot \frac{1}{16}\ in = 1\ in$$

Area: $A_{nail} := \frac{\pi}{4} \cdot \left(D_{net}^{2}\right) = 0.785\ in^{2}$

Yield Stress: $f_{y\_nail} := 75\ ksi$

SNAIL Output $T_0 := 21.0\ kip$

Vertical Nail Spacing: $S_V := 5\ ft$

$$T_{max} := \frac{T_0}{0.6 + 0.057 \cdot \left(\frac{S_V}{ft} - 3\right)} = 29.4\ kip$$

Horizontal Nail Spacing: $S_H := 5\ ft$

FoS Nail Tension: $FS_T := 1.8$

$$R_{T\_ALL} := \frac{f_{y\_nail} \cdot A_{nail}}{FS_T} = 32.7\ kip$$

$$Nail_{tens} := \text{if}\left(R_{T\_ALL} \ge T_{max}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

TEMPORARY/INITIAL FACING

Reinforcement Area per Unit Width:

Reinforcement Area (Walers): $A_{bar} := 2 \cdot 0.20\ in^{2} = 0.400\ in^{2}$ **Two #4 rebars**

Reinforcement Yield Stress: $f_{y\_waler} := 60\ ksi$

Welded Wire Mesh Area: $A_{WWF} := 0.12 \cdot \frac{in^{2}}{ft}$ **(4x4 W4.0xW4.0)**

Welded Wire Mesh Yield Stress: $f_{y\_steel\_mesh} := 60 \cdot ksi$

$f_{y\_steel} := min\left(f_{y\_waler}, f_{y\_steel\_mesh}\right)$ $f_{y\_steel} = 60.0\ ksi$

a_{vm} = Vertical reinforcement per unit width at midpoint. $a_{vm} := A_{WWF} = 0.120\ \frac{in^{2}}{ft}$

a_{vn} = Vertical reinforcement per unit width at nail. $a_{vn} := a_{vm} + \frac{A_{bar}}{S_H} = 0.200\ \frac{in^{2}}{ft}$ (Eq. 5.46)

a_{hm} = Horizontal reinforcement per unit width at midpoint. $a_{hm} := A_{WWF} = 0.120\ \frac{in^{2}}{ft}$

a_{hn} = Horizontal reinforcement per unit width at nail. $a_{hn} := a_{hm} + \frac{A_{bar}}{S_V} = 0.200\ \frac{in^{2}}{ft}$ (Eq. 5.46)

Facing Tensile Flexural Resistance

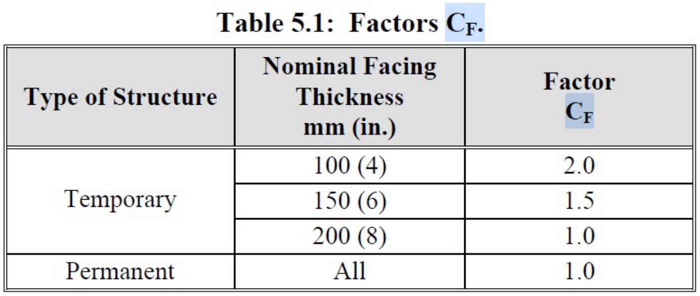


Table 5.1: Factors C_F.

Type of Structure	Nominal Facing Thickness mm (in.)	Factor C_F
Temporary	100 (4)	2.0
	150 (6)	1.5
	200 (8)	1.0
Permanent	All	1.0

Rigidity Factor: $C_F := 1.0$

Shotcrete Strength: $f_{c\_facing} := 4\ \textit{ksi}$

Initial facing thickness: $h_i := 6.0\ \textit{in}$

FoS Punching Shear: $FS_{FP} := 1.5$

FoS Flexural Facing: $FS_{FF} := 1.5$

$$R_{FF\_V} := 3.8 \cdot C_F \cdot \left(a_{vn} + a_{vm}\right) \cdot \frac{S_H \cdot h_i}{S_V} \cdot f_{y\_steel} = 36.480\ \textit{kip} \qquad \text{(Eq. 5.43a)}$$

$$R_{FF\_H} := 3.8 \cdot C_F \cdot \left(a_{hn} + a_{hm}\right) \cdot \frac{S_V \cdot h_i}{S_H} \cdot f_{y\_steel} = 36.480\ \textit{kip} \qquad \text{(Eq. 5.43b)}$$

Flexural Vertical:

$$Flex_V := \text{if}\left(\frac{R_{FF\_V}}{T_0} \geq FS_{FF}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”} \qquad \text{(Eq. 5.48)}$$

Flexural Horizontal:

$$Flex_H := \text{if}\left(\frac{R_{FF\_H}}{T_0} \geq FS_{FF}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”} \qquad \text{(Eq. 5.48)}$$

Check Minimum and Maximum Reinforcement ratios

$$\rho_{min} := 0.24 \cdot \frac{\sqrt{\left(\dfrac{f_{c\_facing}}{1 \cdot psi}\right)}}{\dfrac{f_{y\_steel}}{1 \cdot ksi}} = 0.253$$

(Eq. 5.51) $$a_{steel\_min} := \frac{\rho_{min}}{100} \cdot \frac{h_i}{2} = 0.091 \; \frac{in^2}{ft}$$

$$\rho_{max} := 0.05 \cdot \frac{\dfrac{f_{c\_facing}}{1 \cdot psi}}{\dfrac{f_{y\_steel}}{1 \cdot ksi}} \cdot \left(\frac{90}{90 + \dfrac{f_{y\_steel}}{1 \cdot ksi}}\right) = 2.000$$

(Eq. 5.53) $$a_{steel\_max} := \frac{\rho_{max}}{100} \cdot \frac{h_i}{2} = 0.720 \; \frac{in^2}{ft}$$

At midpoint region

Check for reinforcement in the vertical direction:

$$Check := \text{if}\left(a_{steel\_min} \le a_{vm} \le a_{steel\_max}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

Check for reinforcement in the horizontal direction:

$$Check := \text{if}\left(a_{steel\_min} \le a_{hm} \le a_{steel\_max}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

At nail region

Check for reinforcement in the vertical direction:

$$Check := \text{if}\left(a_{steel\_min} \le a_{vn} \le a_{steel\_max}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

Check for reinforcement in the horizontal direction:

$$Check := \text{if}\left(a_{steel\_min} \le a_{hn} \le a_{steel\_max}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

Ratio of the reinforcement in the nail and midspan zone

(Pg. 100)

$$Ratio_{vert} := \text{if}\left(\frac{a_{vn}}{a_{vm}} < 2.5, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

$$Ratio_{hor} := \text{if}\left(\frac{a_{hn}}{a_{hm}} < 2.5, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

Check Steel for Shrinkage and Temperature Requirements

For welded wire reinforcement per ACI 318R: $R_{required} := 0.0018$

$$a_{temp} := min\left(a_{hm}, a_{vm}\right) = 0.120 \ \frac{in^2}{ft}$$

$$R_{design} := \frac{a_{temp}}{\left(h_i - 1 \cdot in\right) \cdot 1 \cdot ft} \cdot 1 \cdot ft = 0.0020$$

$$Temp_{steel} := \text{if}\left(R_{design} \ge R_{required}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

Facing Punching Shear Resistance:

Bearing Plate

Length of Plate: $L_{BP} := 6 \ in$

$D'_c := L_{BP} + h_i = 12.00 \ in$ $C_p := 1.0$ (Ref: Pg. 102)

$$V_{facing} := 0.58 \cdot kip \cdot \sqrt{\left(\frac{f_{c\_facing}}{1 \cdot psi}\right)} \cdot \pi \cdot \frac{D'_c}{1 \cdot ft} \cdot \frac{h_i}{1 \cdot ft} = 57.621 \ kip$$ (Eq. 5.56)

$$R_{FP} := C_p \cdot V_{facing} = 57.621 \ kip$$

$$Check_{FP\_temporary} := \text{if}\left(\frac{R_{FP}}{T_0} \ge FS_{FP}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$ (Eq. 5.59)

Bearing of Plate to Shotcrete

Thickness of Plate: $t_P := 1.0\ in$

Load Factor (ACI Strength Design): $LF := 1.6$

Yield Stress of Plate: $f_{y\_bearing\_plate} := 36\ ksi$

Diameter of the hole:

$$d_{hole} := D_{nail} + 2 \cdot \frac{1}{16}\ in = 1.250\ in$$

$$A_{bearing\_plate} := L_{BP}^{\ 2} = 36\ in^2$$

$$A_{hole} := \frac{\pi}{4} \cdot d_{hole}^{\ 2} = 1.227\ in^2$$

$$A_{provided} := A_{bearing\_plate} - A_{hole} = 34.77\ in^2$$

$$\sigma_{all} := \frac{\left(0.65 \cdot 0.85 \cdot f_{c\_facing} \cdot 2\right)}{LF} = 2.763\ ksi$$

$$A_{min\_required} := \frac{T_0}{\sigma_{all}} = 7.602\ in^2$$

$$Check := \text{if}\left(A_{provided} \geq A_{min\_required}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

Check Plate Bending Moment Capacity

Plate Yield Strength: $f_{y\_bearing\_plate} = 36\ ksi$

Load $T_0 = 21\ kip$

Diameter of Washer: $D_{washer} := 2.25\ in$ From Williams Form

Washer Area: $A_{washer} := \frac{\pi}{4} \cdot D_{washer}^{\ 2} = 3.976\ in^2$

Plate Second Moment of Area: $I_{BP} := \frac{\left(L_{BP}\right) \cdot t_P^{\ 3}}{12} = 0.5\ in^4$

Allowable Bending Stress

$$f_{y\_all\_bearing\_plate} := 0.55 \cdot f_{y\_bearing\_plate} = 19.800\ \mathit{ksi}$$

$$M_{all\_bearing\_plate} := \frac{f_{y\_all\_bearing\_plate} \cdot I_{BP}}{\left(\frac{t_P}{2}\right)} = 19.8\ \mathit{kip} \cdot \mathit{in}$$

Actual Bending Stress

$$M_{actual\_bearing\_plate} := \left(\frac{T_0}{L_{BP} - d_{hole}}\right) \cdot \left(\frac{L_{BP} - D_{washer}}{2}\right) \cdot \left(\frac{L_{BP} - D_{washer}}{4}\right) = 7.77\ \mathit{kip} \cdot \mathit{in}$$

$$Check := \text{if}\left(M_{all\_bearing\_plate} \geq M_{actual\_bearing\_plate}, \text{“OK”}, \text{“Not OK”}\right) = \text{“OK”}$$

Use MIN. 6 inch x 6 inch x 1.0 inch thick bearing plate.

Embedment Depth for Epoxy-Coated Rebars

Ref: ACI 318-14

$\psi_t := 1.0$ Casting Position Modification Factor

$\psi_e := 1.5$ Modification factor for epoxy-coated or zinc and epoxy dual-coated reinforcement with clear cover less than $3 \cdot d_b$

$\lambda := 1.0$ Modification factor for lightweight concrete

$f'_c := 3000\ \mathit{psi}$ Grout strength - assumed

$$d_b := D_{nail} = 1.125\ \mathit{in}$$

$$l_d := \frac{\frac{f_{y\_nail}}{1 \cdot \mathit{psi}} \cdot \psi_t \cdot \psi_e}{20 \cdot \lambda \cdot \sqrt{\frac{f'_c}{1\ \mathit{psi}}}} \cdot d_b = 9.6\ \mathit{ft}$$

Provide Minimum Nail Length of 10 ft

Lateral Sliding: (Tallest Wall Section)

Soil Strength Parameter:

$S_u := 1300\ psf$ $\phi_u := 0\ deg$ For Total Stress Analysis, Short Term Stability

$c := 200\ psf$ $\phi := 25\ deg$ $\gamma := 120\ pcf$ For Drained Analysis, Long Term Stability

Wall parameters:

$\beta_{eq} := 10\ deg$ Equivalent back slope angle

$\beta := \beta_{eq} = 10\ deg$

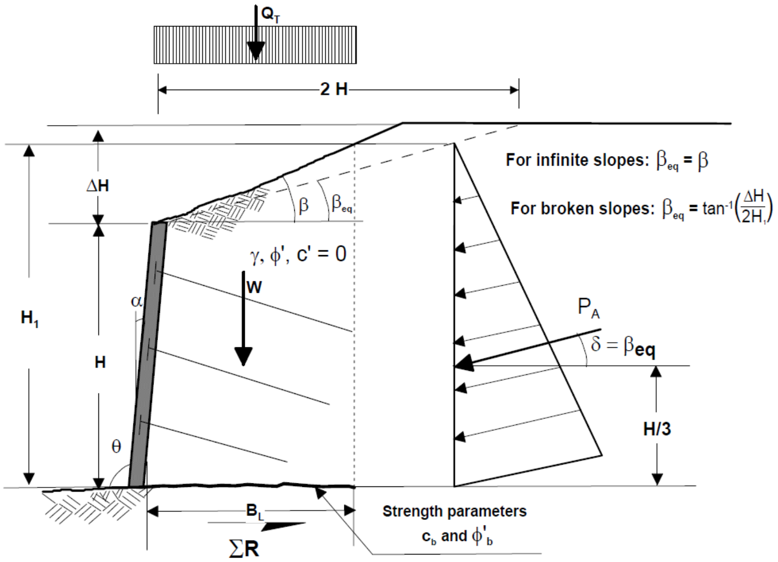
$\delta := \beta_{eq} = 10\ deg$ Wall soil friction angle

$B_L := 34.5\ ft$ Wall width

$\alpha := 5\ deg$ Wall batter

$H := 21.5\ ft$ Wall height

$q := 250\ psf$ Wall surcharge



Calculations

$$H_1 := H + \left(B_L + H \cdot \tan(\alpha)\right) \cdot \tan\left(\beta_{eq}\right) = 27.9\ ft$$

$$W := \left(B_L \cdot H + 0.5 \cdot B_L \cdot B_L \cdot \tan\left(\beta_{eq}\right)\right) \cdot \gamma = \left(1 \cdot 10^5\right) \frac{lbf}{ft}$$

$$Q_T := q \cdot B_L = \left(8.6 \cdot 10^3\right) \frac{lbf}{ft}$$

Short Term Stability

$$\sigma_h(z, \gamma, \phi, c) := \gamma \cdot z \cdot \tan\left(45\ deg - \frac{\phi}{2}\right)^2 - 2 \cdot c \cdot \tan\left(45\ deg - \frac{\phi}{2}\right)$$

At top of the wall:
$z := 0\ ft$

Use average Su for the top two layers, because the lower strength layer constitutes only small portion of the wall.

$\sigma_{h0} := \sigma_h\left(z, \gamma, \phi_u, S_u\right) + q = -2.4 \cdot 10^3\ psf$ Tension

At the base of the wall:

$$z := H_1 = 27.9\ ft$$

$$\sigma_{h1} := \sigma_h\left(z, \gamma, \phi_u, S_u\right) + q = 999.8\ psf$$

Depth to zero tensile stress from the top of H1

$$z_0 := \frac{-\sigma_{h0}}{\left(-\sigma_{h0} + \sigma_{h1}\right)} \cdot H_1 = 19.6\ ft$$

Lateral driving force

$$\Sigma D := \frac{\sigma_{h1} \cdot \left(H_1 - z_0\right)}{2} = \left(4.2 \cdot 10^3\right) \frac{lbf}{ft}$$

Resisting force

$$S_{ub} := S_u = \left(1.3 \cdot 10^3\right) psf$$

Shear strength of the layer at the base of the wall

$$\Sigma R := S_{ub} \cdot B_L = \left(4.5 \cdot 10^4\right) \frac{lbf}{ft}$$

$$FS_{SL} := \frac{\Sigma R}{\Sigma D} = 10.768$$

$$CheckFS_{SL} := \text{if}\left(FS_{SL} \geq 1.5, \text{“OK”}, \text{“NOT OK”}\right) = \text{“OK”}$$

Long Term Stability

$$c_b := c = 200\ psf \qquad \phi_b := \phi = 25\ deg$$

At the base, sliding occurs in the soil, therefore use shear strength of the layer.

$$K_a := \cos(\beta) \cdot \left(\frac{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}\right) = 0.43$$

Rankine earth pressure, Eq. 5-12

$$P_A := \frac{\gamma \cdot {H_1}^2}{2} \cdot K_a + K_a \cdot q \cdot H = \left(2.2 \cdot 10^4\right) \frac{lbf}{ft}$$

Eq. 5-10

$$\Sigma D := \cos\left(\delta\right) \cdot P_A = \left(2.2 \cdot 10^4\right) \frac{lbf}{ft}$$

Eq. 5-9

$$\Sigma R := c_b \cdot B_L + \left(W + Q_T + P_A \cdot \sin\left(\beta_{eq}\right)\right) \cdot \tan\left(\phi_b\right) = \left(6 \cdot 10^4\right) \frac{lbf}{ft}$$

Eq. 5-8

$$FS_{SL} := \frac{\Sigma R}{\Sigma D} = 2.718$$

Eq. 5-7

$$CheckFS_{SL} := \text{if}\left(FS_{SL} \geq 1.5, \text{“OK”}, \text{“NOT OK”}\right) = \text{“OK”}$$

Bearing Capacity

$S_u := 1300\ psf$ Average undrained shear strength

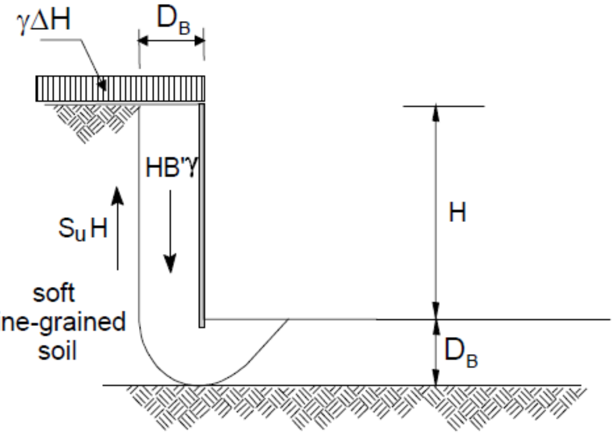
$H := 22\ ft$ Height of the wall

$\Delta H := 5.5\ ft$ Equivalent surcharge height of the back slope and construction surcharge

$D_B := 34.5\ ft$ Assume the clay layer extends well below the wall, conservative assumption

$B' := D_B = 34.5\ ft$

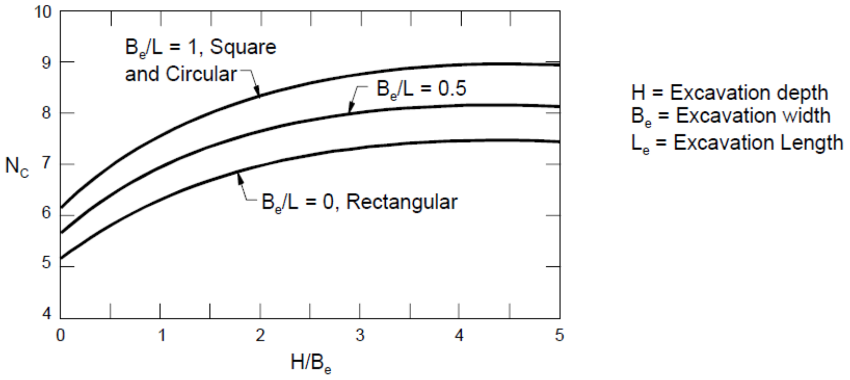
$N_c := 5.14$ Long wall and wide excavation, $\frac{B_e}{L_e}=0$, $\frac{H}{B_e}=0.$



Total pressure at the base of the soil block considering the shear strength of the soil behind the wall

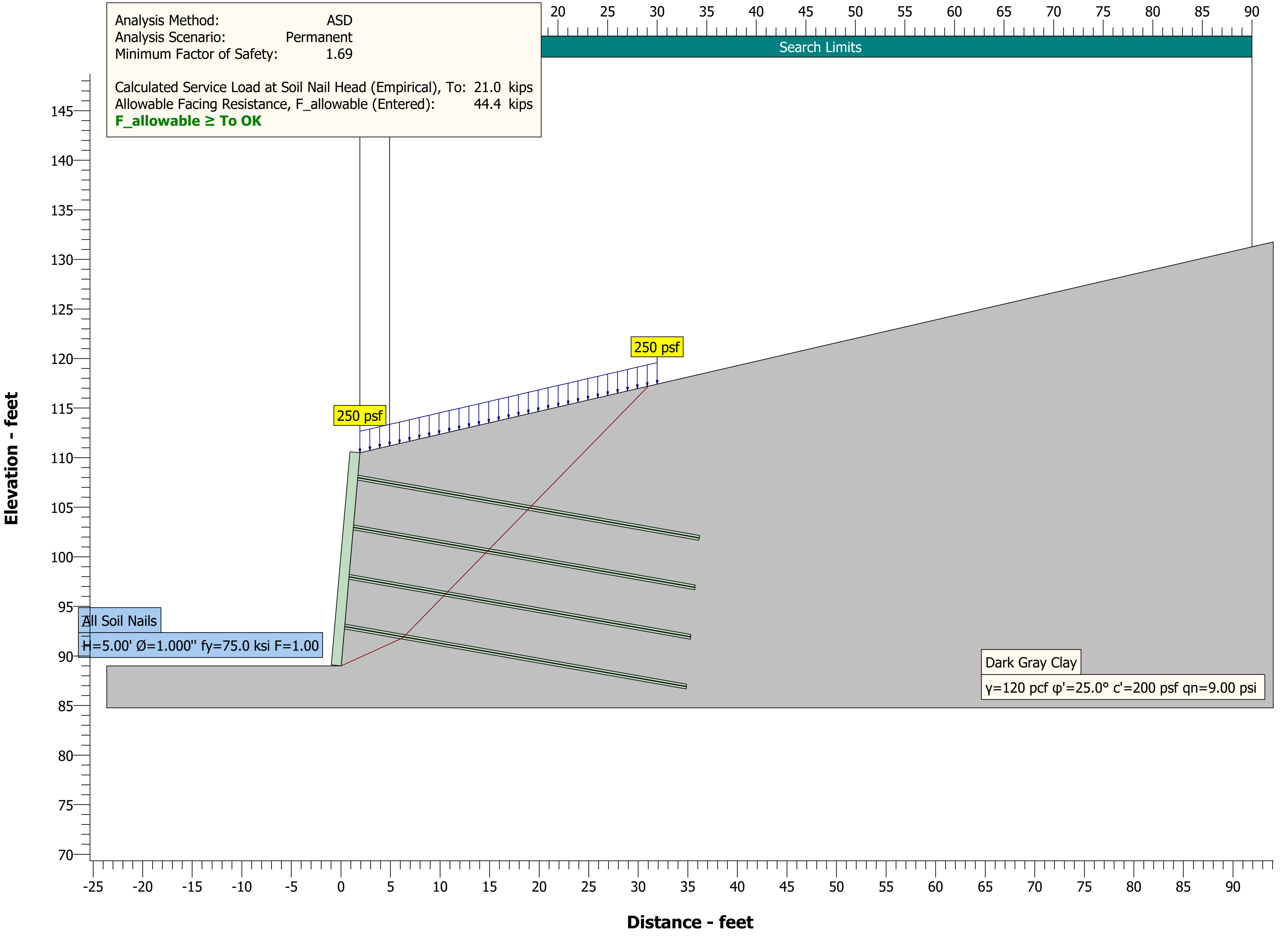
$$q := \frac{B' \cdot H \cdot \gamma + \gamma \cdot \Delta H \cdot B' - S_u \cdot H}{B'} = \left(2.5 \cdot 10^3\right)\ psf \qquad \text{(Eq. 5.14)}$$

$$FS_H := \frac{S_u \cdot N_c}{q} = 2.7$$



$CheckFS_{bearing} := \text{if}\left(FS_H \geq 2.5, \text{“OK”}, \text{“NOT OK”}\right) = \text{“OK”}$

Snail Version 2.2.2 - 45-20803 Soil Nail Wall 21ft 14:29:11 on 12/21/21



Analysis Method: ASD
Analysis Scenario: Permanent
Minimum Factor of Safety: 1.69

Calculated Service Load at Soil Nail Head (Empirical), To: 21.0 kips
Allowable Facing Resistance, F_allowable (Entered): 44.4 kips
F_allowable ≥ To OK

```
=======================================================================================================
                                               Snail

                                           Version: 2.2.2

                                  Copyright© State of California.
                                        All rights reserved.

=======================================================================================================
                                          File Information
=======================================================================================================

File Name: 45-20803 Soil Nail Wall 21ft.snz
Run Date:  12/21/21
Run Time:  14:29:11

=======================================================================================================
                                        Project Information
=======================================================================================================

Description:    20 FT Soil Nail Wall
Location:       Fayatteville, NC
EA:
Project ID:     45-20803
Wall No.:       1
Structure No.:
Station:        85+20
Engineer:       AS
                Designer

Comments:


=======================================================================================================
                                              Geometry
=======================================================================================================

Layout:

Reference Point:

At: Toe of Wall
Distance From Origin:        0.00 feet
Elevation Above Origin:     89.00 feet

Wall Dimensions:

Wall Height:       21.50 feet
Facing Angle:      85.00 degrees
Facing Batter:     1.050 :12 H:V

Ground Surface:

Number of lines that define the ground surface above the wall: 1

         Angle  Distance
No.    degrees      feet
------------------------
1           13

Number of lines that define the ground surface in front of the toe: 1

         Angle  Distance
No.    degrees      feet
------------------------
1            0

Soil Layers:

Number of Layers: 1

Ground Water:

Include Ground Water: No

=======================================================================================================
                                             Soil Nails
=======================================================================================================

Dimensions and Properties:

Maximum Vertical Spacing:               5.00 feet
Number of Soil Nail Rows:                  4
Soil Nail Design Parameters:               Uniform Throughout Cross-Section
```

```
Soil Nail Length:                      35.00 feet
Inclination From Horizontal:              10 degrees
Vertical Distance from Top of Wall
to First Row:                           2.50 feet
Vertical Spacing:                       5.00 feet
Horizontal Spacing H:                   5.00 feet
Nail Bar Diameter Ø:                   1.000 inches
Nail Bar Yield Strength fy:             75.0 ksi

Facing Resistance:

                                     Temporary   Permanent     Seismic
ASD Allowable Facing Resistance:          37.3        44.4        60.5 kips

======================================================================================================
                                          Soil Properties
======================================================================================================

                                        Unit Weight  Friction Angle        Cohesion
                                                  γ              φ'              c'
Layer  Description                              pcf         degrees             psf
-----------------------------------------------------------------------------------
1      Dark Gray Clay                           120            25.0             200

======================================================================================================
                                               Loads
======================================================================================================

Applied Loads:

Seismic:

Horizontal Seismic Coefficient Kh:

External Load:

Apply external load: No

Surcharges:

Apply surcharges:    Yes

           Distance from Top of Wall            Load            Load
               Begin             End           Begin             End
No.             feet            feet             psf             psf
--------------------------------------------------------------------
1               0.00           30.00             250             250

======================================================================================================
                                         Factors of Safety
======================================================================================================

                    Temporary   Permanent     Seismic
Pullout (Distal):        2.00        2.00        1.50
Pullout (Proximal):      2.00        2.00        1.50
Nail Bar Yield:          1.80        1.80        1.35

======================================================================================================
                                           Search Options
======================================================================================================

Search Limits:

Begin:      3.00 feet
End:       90.00 feet

Below Toe Searches (BTS):

Perform below Toe Search: No

Advanced Search Options:

Use Advanced Search Options: No

======================================================================================================
                                               Results
======================================================================================================

Analysis:

Method:          ASD
Scenario:  Permanent

Factor of Safety:
```

```
Minimum:                  1.69
Found at Search Point:       4
Found at Grid Point:        10
Found at Search Level:       Toe of the wall

Load at Soil Nail Head:

Calculated Service Load at Soil Nail Head (Empirical), To:    21.0 kips
Allowable Facing Resistance, F_allowable (Entered):           44.4 kips
F_allowable ≥ To OK

Nominal Pullout Resistance:

                    Nominal Pullout Resistance
Layer  Description                         klf
----------------------------------------------
    1  Dark Gray Clay                    2.036

Results by Search Level:

** Indicates Minimum Factor of Safety

Search Level: At the toe of the wall  Facing Design Force = 21.0 kips (Clouterre)
----------------------------------------------------------------------------------------------------------
|       |         |          |             Failure Planes               |       Reinforcement           |
|       |         |          |----------------------------------------|-------------------------------|
|       | Minimum | Distance |       Lower        |        Upper       |       |         |               |
|       | Factor  | From Toe |----------------------------------------|       |         | Controlling   |
|Search |   of    | of Wall  |  Angle  | Length   |  Angle  | Length   |       | Stress  | Resistance    |
|Point  | Safety  |   feet   | degrees |  feet    | degrees |  feet    | Level |  ksi    | Failure Mode  |
----------------------------------------------------------------------------------------------------------
      1      3.40       4.88     71.74     14.02     86.85      8.89        1     41.4   Pullout
                                                                            2     41.2   Pullout
                                                                            3     41.7   Bar Yield
                                                                            4     41.7   Bar Yield

      2      2.28      13.58     41.70     10.91     72.22     17.79        1     32.6   Pullout
                                                                            2     34.0   Pullout
                                                                            3     35.5   Pullout
                                                                            4     40.8   Pullout

      3      1.86      22.28     21.41      7.18     56.53     28.28        1     26.7   Pullout
                                                                            2     30.1   Pullout
                                                                            3     33.4   Pullout
                                                                            4     36.8   Pullout

   ** 4      1.69      30.98     24.49      6.81     45.70     35.49        1     22.5   Pullout
                                                                            2     27.5   Pullout
                                                                            3     32.5   Pullout
                                                                            4     37.5   Pullout

      5      1.71      39.68     26.92     13.35     41.04     36.83        1     17.9   Pullout
                                                                            2     23.7   Pullout
                                                                            3     29.5   Pullout
                                                                            4     38.0   Pullout

      6      1.72      48.38     23.95     15.88     37.29     42.57        1     14.0   Pullout
                                                                            2     20.6   Pullout
                                                                            3     27.1   Pullout
                                                                            4     37.2   Pullout

      7      1.77      57.08     21.80     18.44     34.44     48.45        1     10.6   Pullout
                                                                            2     17.8   Pullout
                                                                            3     25.5   Pullout
                                                                            4     36.5   Pullout

      8      1.79      65.78     20.17     21.02     32.20     54.42        1      7.6   Pullout
                                                                            2     15.3   Pullout
                                                                            3     24.3   Pullout
                                                                            4     36.0   Pullout

      9      1.81      74.48     14.41     15.38     30.02     68.82        1      5.5   Pullout
                                                                            2     13.8   Pullout
                                                                            3     22.1   Pullout
                                                                            4     33.5   Pullout

     10      1.83      83.18     13.61     17.12     28.57     75.77        1      3.1   Pullout
                                                                            2     11.8   Pullout
                                                                            3     20.5   Pullout
                                                                            4     33.0   Pullout

     11      1.85      91.88     12.96     18.86     27.37     82.77        1      0.9   Pullout
                                                                            2     10.0   Pullout
```

```
                                                                           3     19.0   Pullout
                                                                           4     32.7   Pullout


======================================================================================================
                                           END OF REPORT
======================================================================================================
```

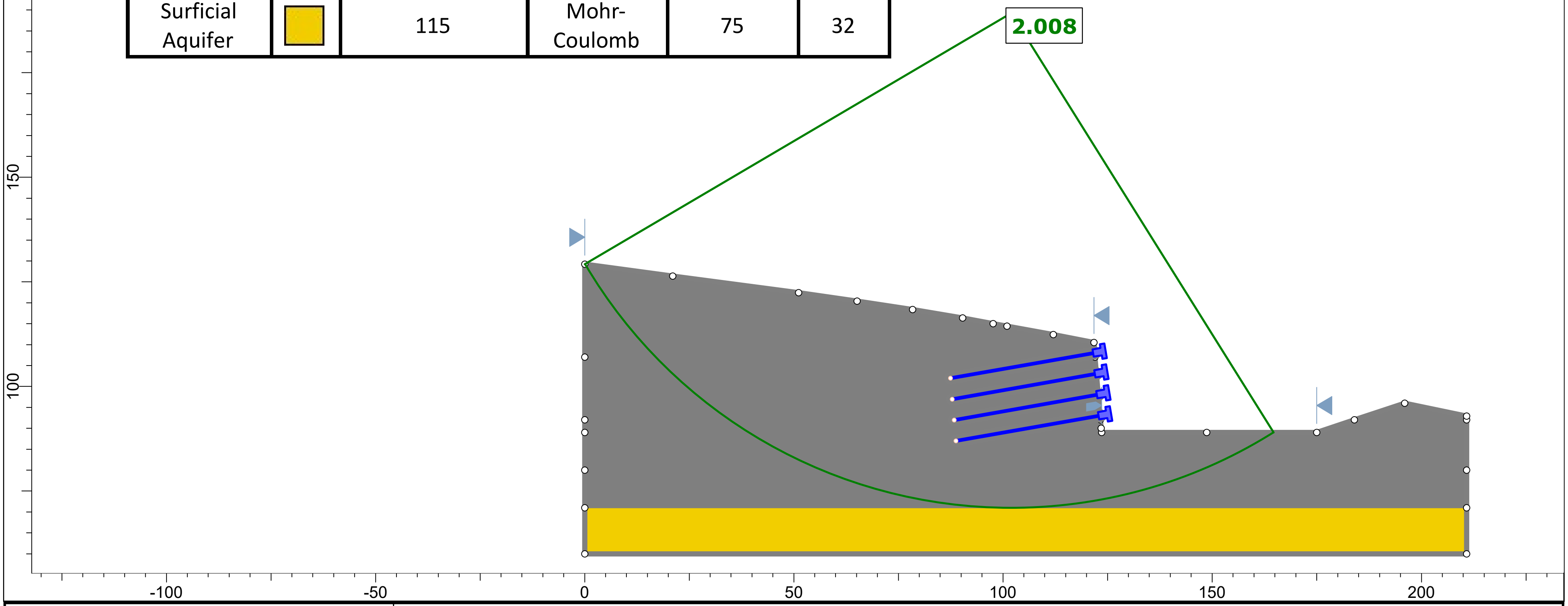
GLOBAL STABILITY

SOIL NAIL PARAMETERS

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Force Orientation
Soil Nail	🟦	Soil Nail	Active (Method A)	5	32725	32725	1018	Parallel to Reinforcement

MATERIAL PARAMETERS

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Dark Gray Clay	⬛	120	Undrained	1300	
Surficial Aquifer	🟨	115	Mohr-Coulomb	75	32



Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Analysis - Circular Slip Surface	*Scenario*	21 FT High Wall, After Construction
Drawn By		*Company*	
Date	12/21/2021 1:56:44 PM	*File Name*	Wall Height 21ft-after-const.slmd

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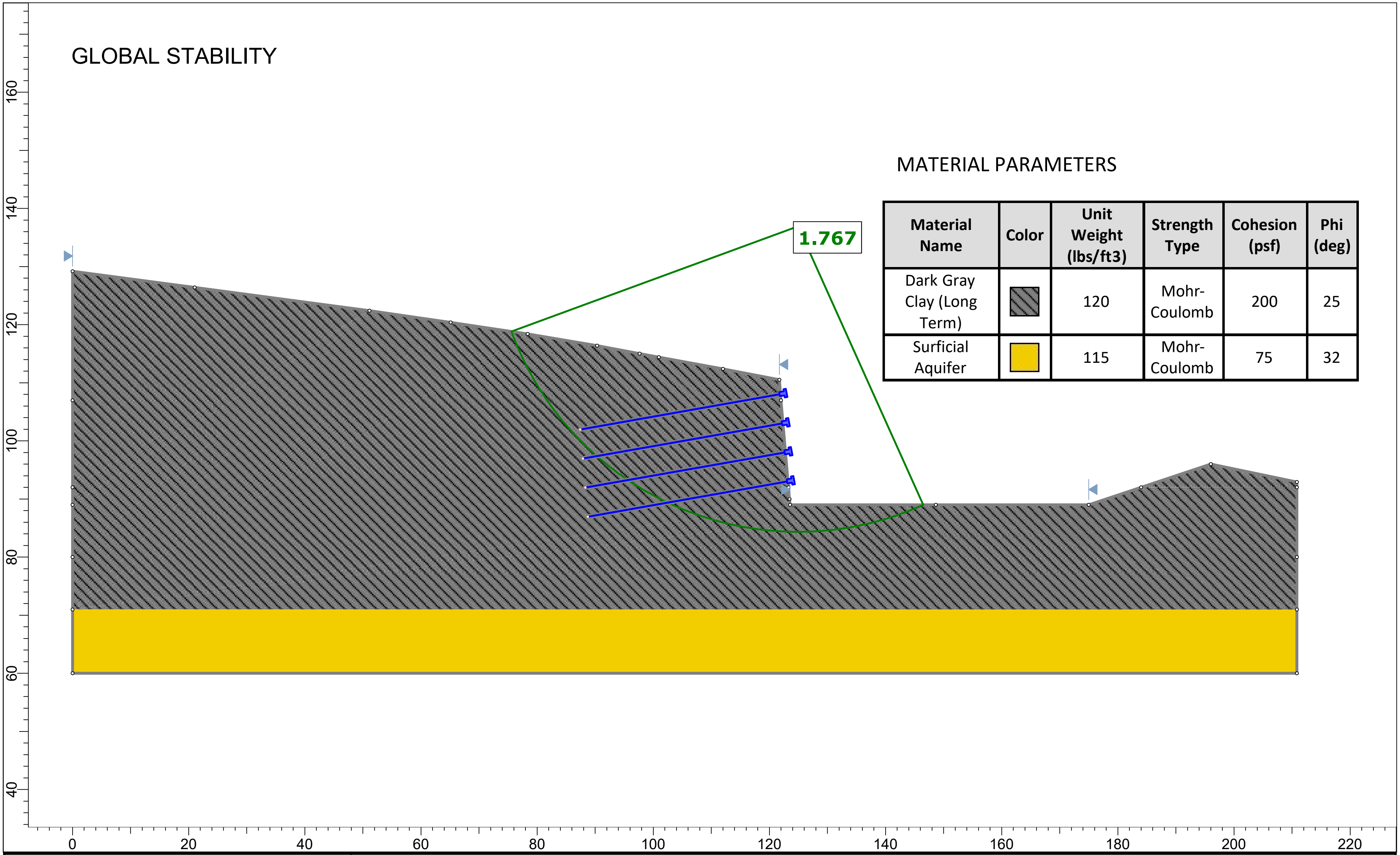
GLOBAL STABILITY



MATERIAL PARAMETERS

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Dark Gray Clay (Long Term)	▨	120	Mohr-Coulomb	200	25
Surficial Aquifer	🟨	115	Mohr-Coulomb	75	32

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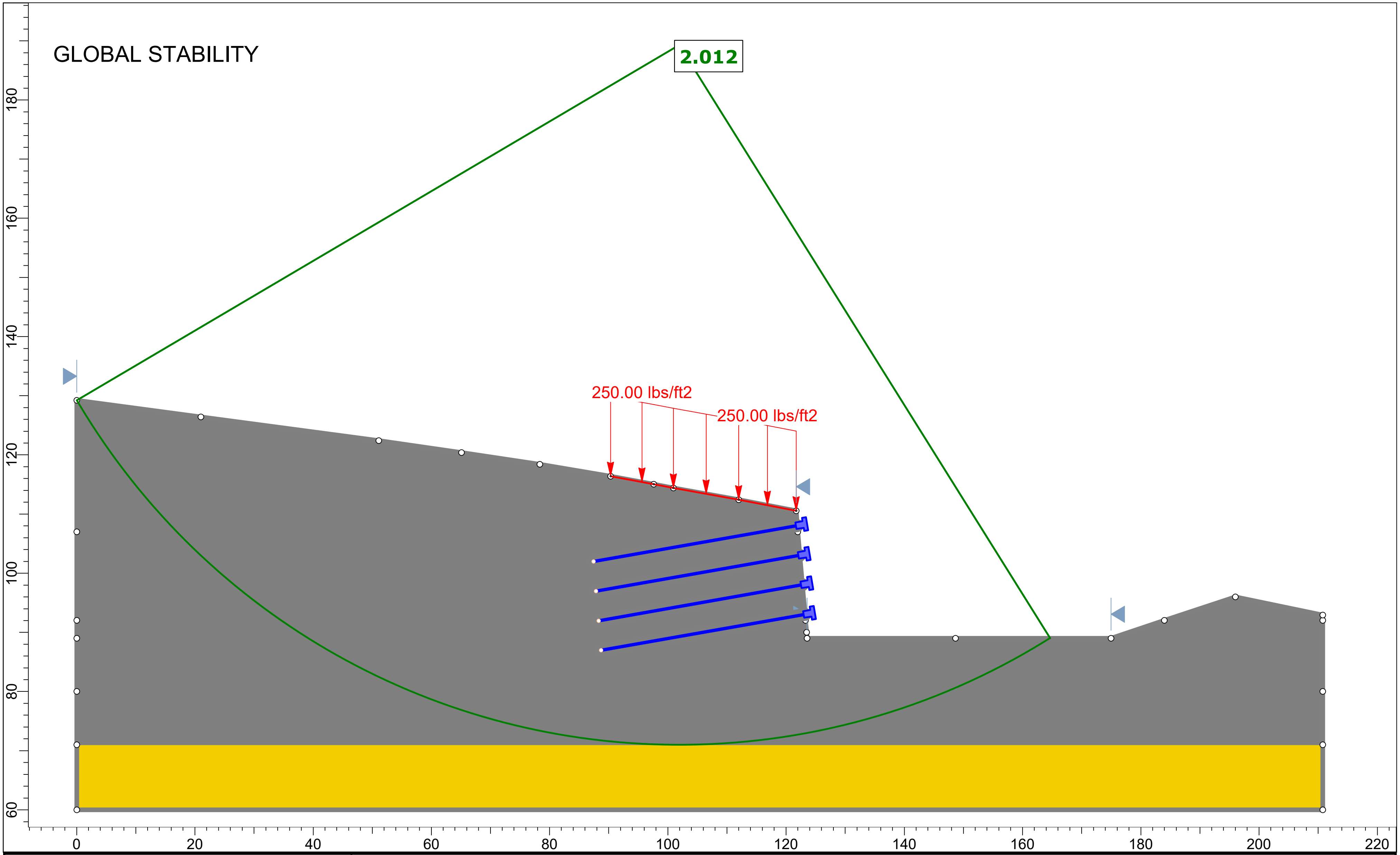
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Analysis - Circular Slip Surface	*Scenario*	21 FT High Wall, After Construction
Drawn By		*Company*	
Date	12/21/2021 1:56:45 PM	*File Name*	Wall Height 21ft-after-const.slmd



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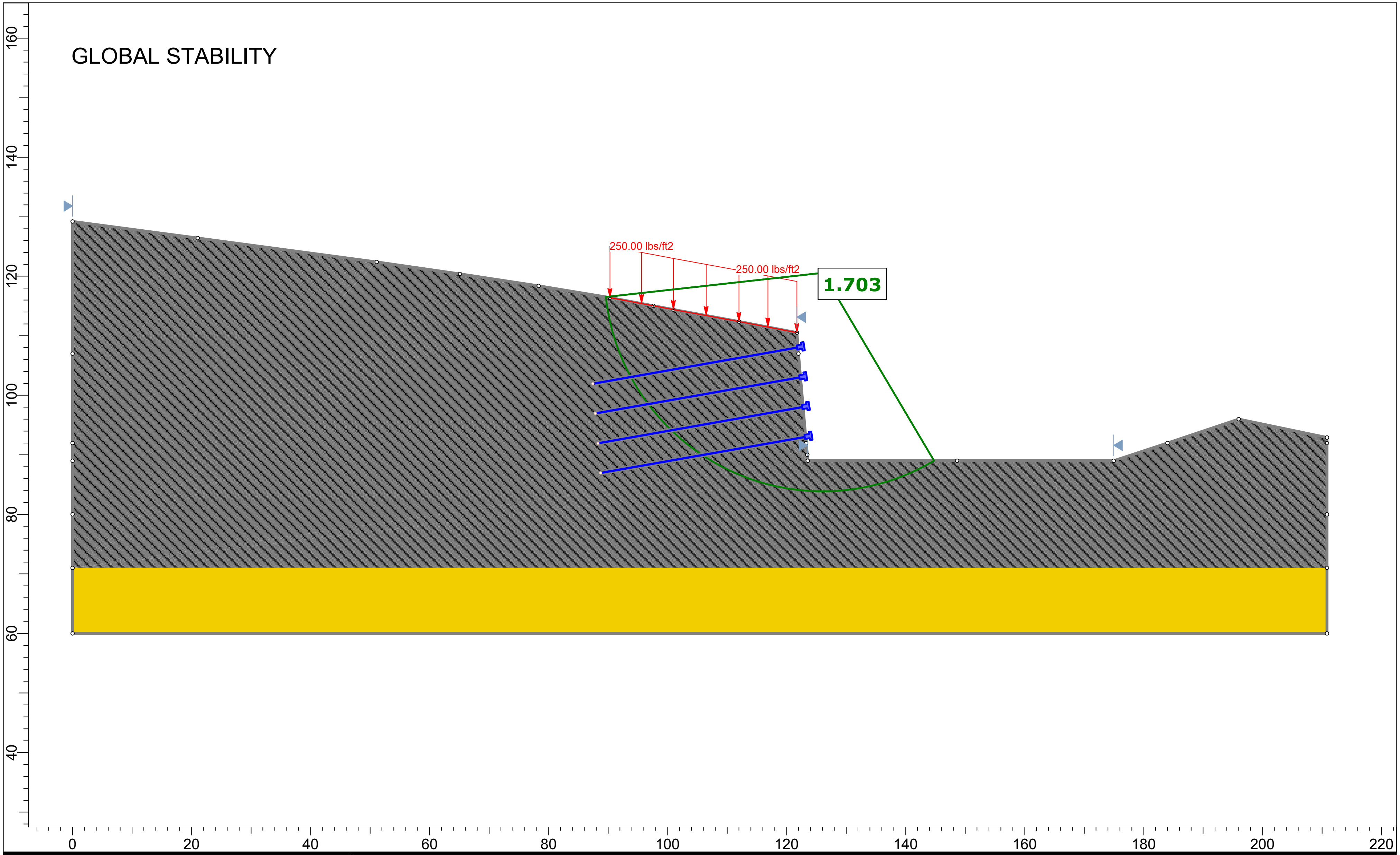
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Analysis - Circular Slip Surface	*Scenario*	21 FT High Wall, During Construction
Drawn By		*Company*	
Date	12/21/2021 2:00:15 PM	*File Name*	Wall Height 21ft-during const.slmd



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Project 45-20803 Barrier Wall Road Interim Design and Repair

Analysis Long Term Analysis - Circular Slip Surface

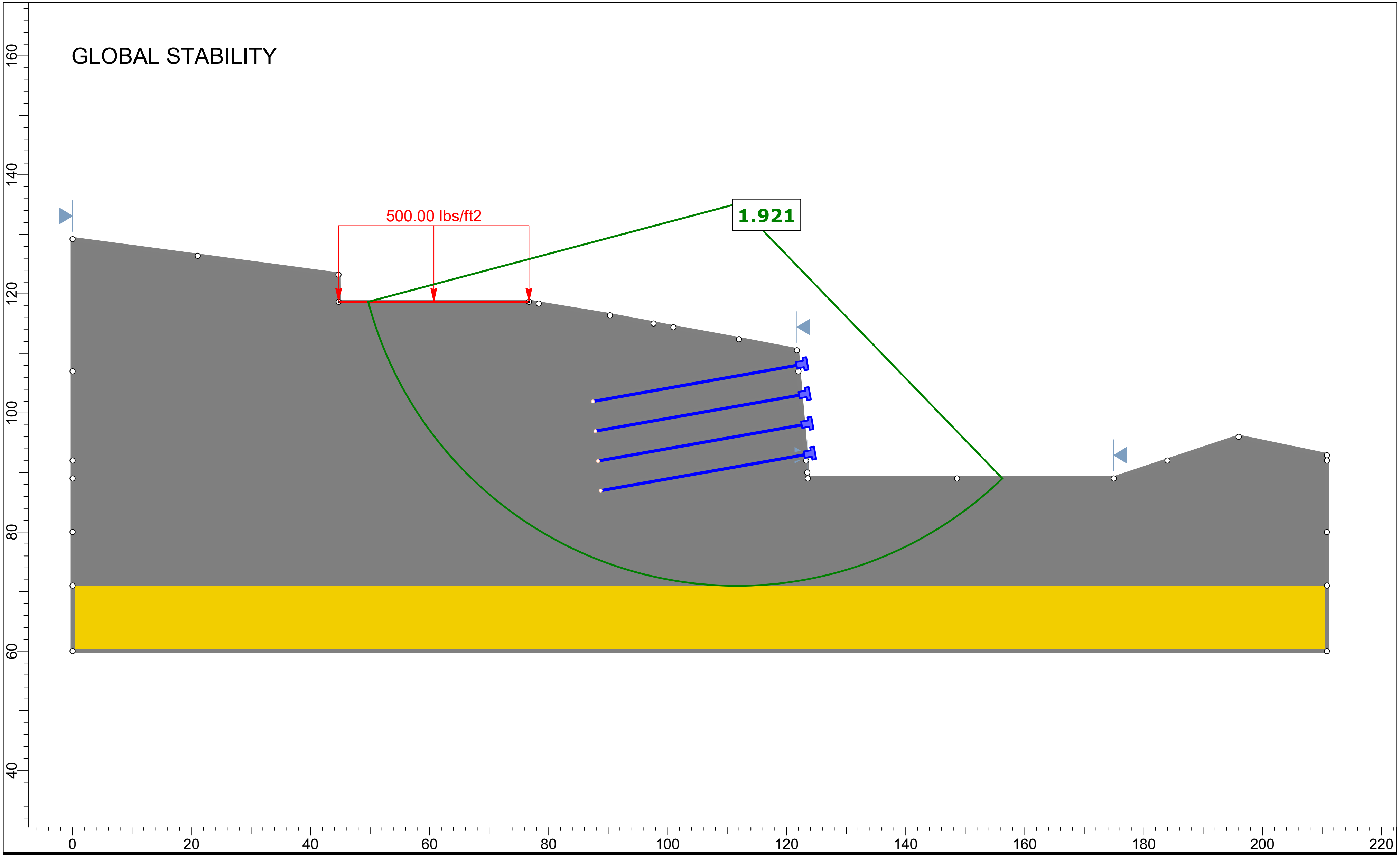
Scenario 21 FT High Wall, During Construction

Drawn By

Company

Date 12/21/2021 2:00:16 PM

File Name Wall Height 21ft-during const.slmd



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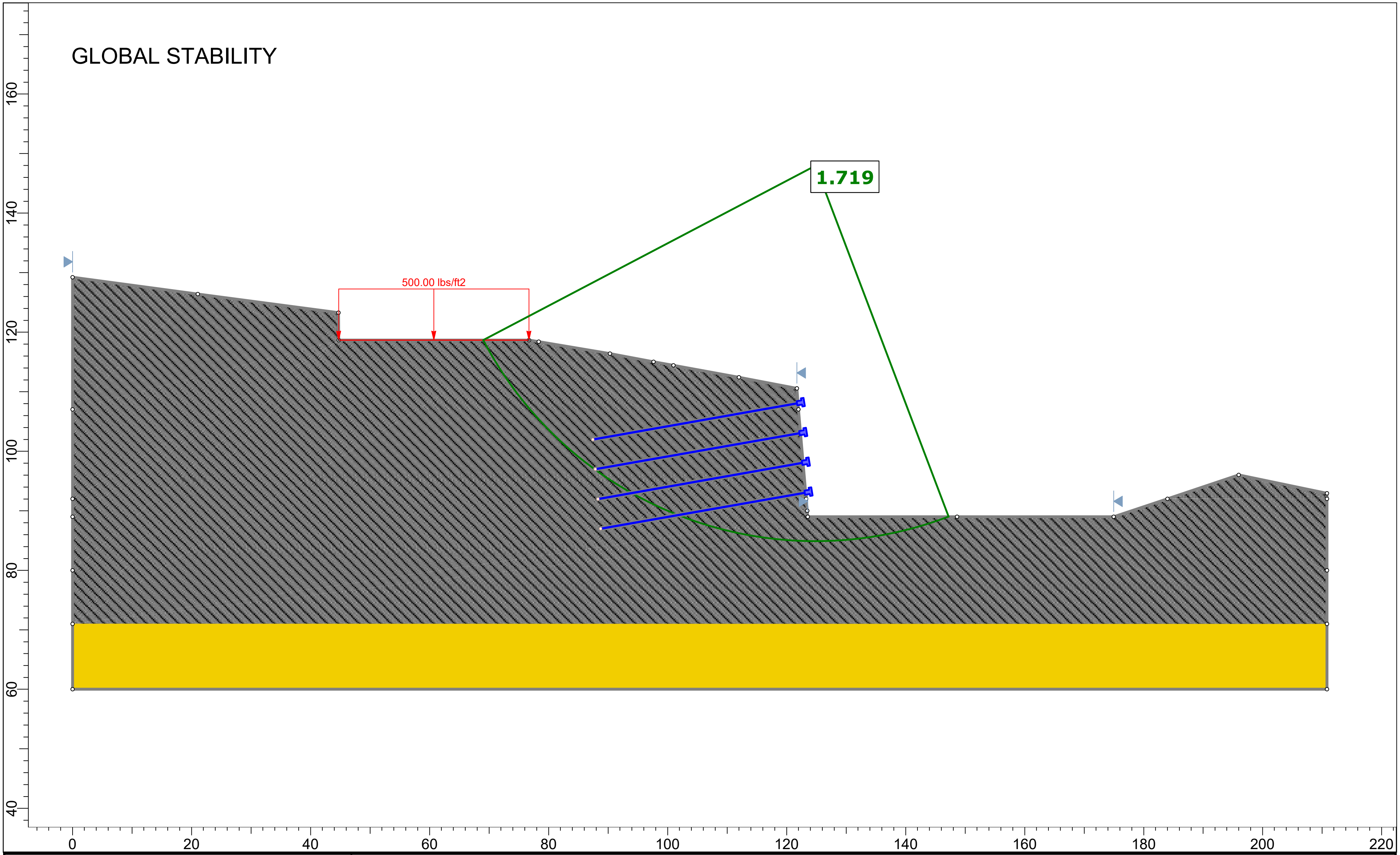
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Analysis - Circular Slip Surface	*Scenario*	21 FT High Wall, Well Pad Construction
Drawn By		*Company*	
Date	12/21/2021 1:51:22 PM	*File Name*	Wall Height 21ft-after-const-trload.slmd

GLOBAL STABILITY



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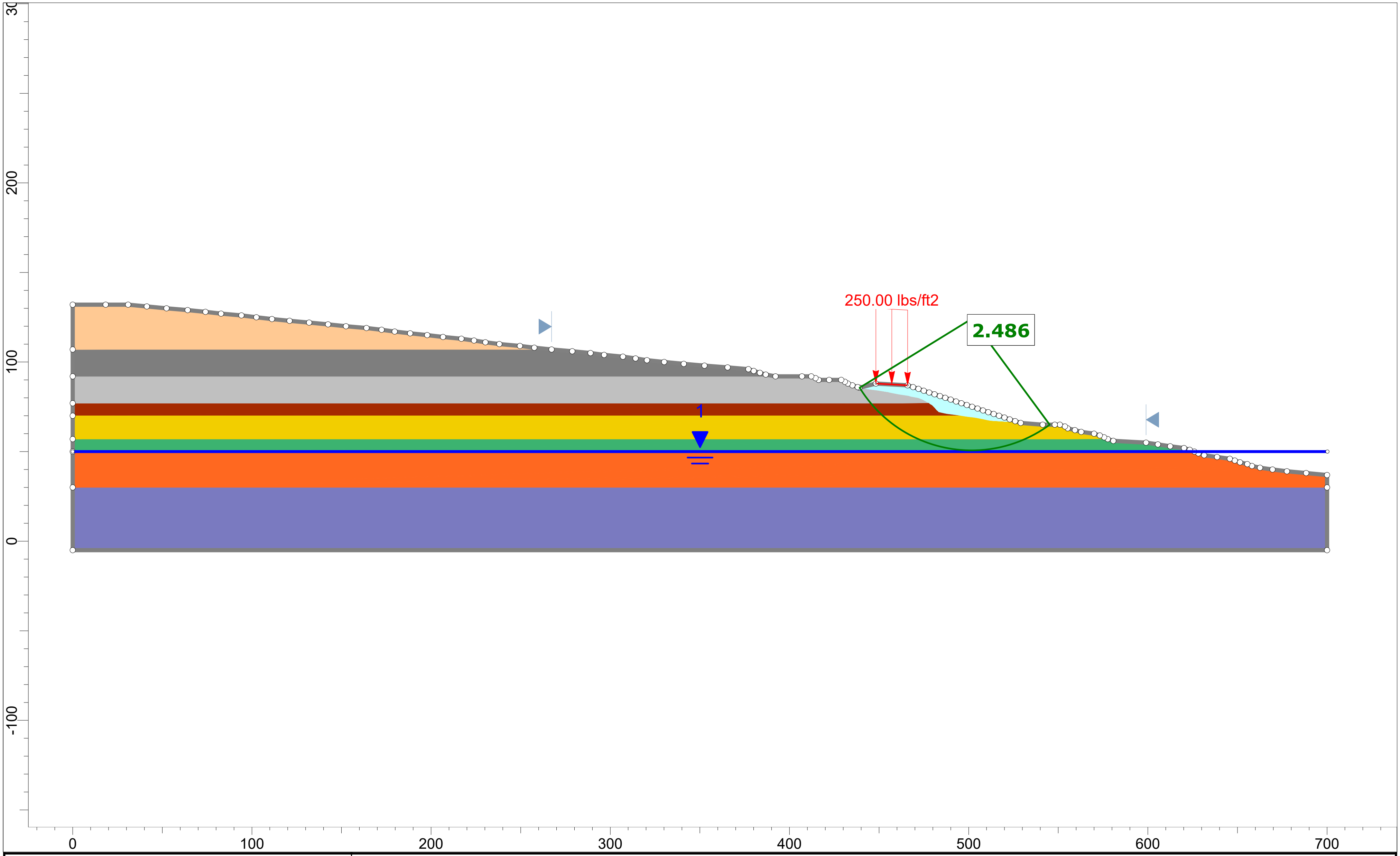
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Analysis - Circular Slip Surface	*Scenario*	21 FT High Wall, Well Pad Construction
Drawn By		*Company*	
Date	12/21/2021 1:51:23 PM	*File Name*	Wall Height 21ft-after-const-trload.slmd

Attachments

Slope Stability Models and Results



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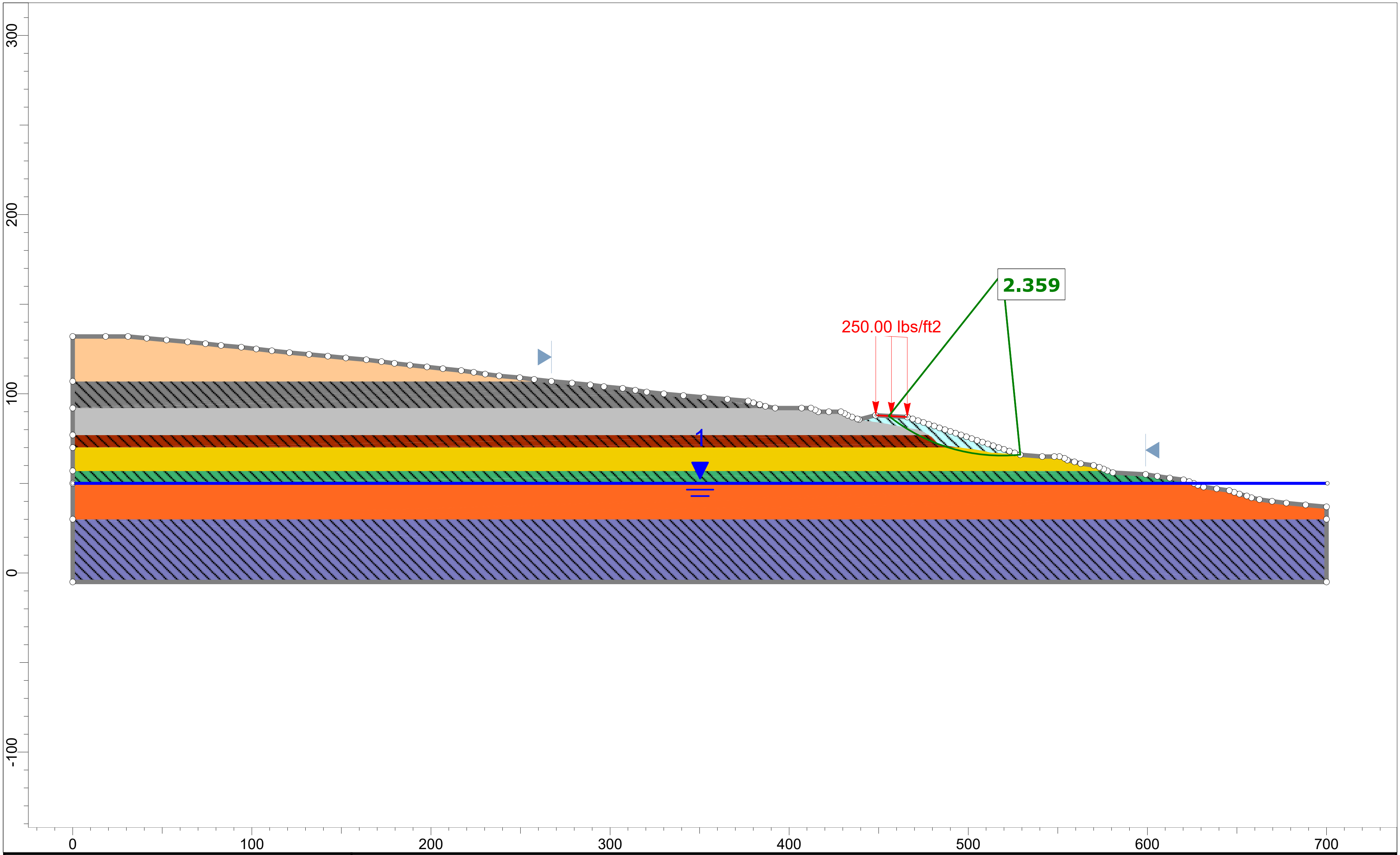
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 1
Drawn By		*Station*	Approx. 3+00
Date		*File Name*	section-1.slmd

SLIDEINTERPRET 9.020



Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 1
Drawn By		*Station*	Approx. 3+00
Date		*File Name*	section-1.slmd

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Section-1
45-20803 Barrier Wall Road Interim Design and Repair
Station: Approx. 3+00
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-1

Project Summary

File Name:	section-1.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Short Term Slope Stability
Comments	
	Section 1 Approx. 3+00

Currently Open Scenarios

Group Name		Scenario Name	Global Minimum	Compute Time
Short Term Stability	◆	Master Scenario	Spencer: 2.486320	00h:00m:12.617s
Long Term Stability	◆	Master Scenario	Spencer: 2.358960	00h:00m:11.653s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

All Open Scenarios

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Materials

Light Brown Sand	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	⬛
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	⬜
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay	
Color	🟥
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	1100
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	200

Friction Angle [deg]	24
Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Upper Cape Fear Confining Unit	
Color	🟪
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	2500
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Upper Cape Fear Confining Unit (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200

Friction Angle [deg]	26
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill	
Color	■
Strength Type	Undrained
Unit Weight [lbs/ft3]	125
Cohesion [psf]	2000
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material		Short Term Stability	Long Term Stability
Light Brown Sand	■	✓	✓
Dark Gray Clay	■	✓	✗
Dark Gray Clay (Drained)	▨	✗	✓
Light Gray Sand	■	✓	✓
Perched Clay	■	✓	✗
Perched Clay (Drained)	▨	✗	✓
Surficial Aquifer	■	✓	✓
Black Creek Confining Unit	■	✓	✗
Black Creek Confining Unit (Long Term)	▨	✗	✓
Black Creek Aquifer	■	✓	✓
Upper Cape Fear Confining Unit	■	✓	✗
Upper Cape Fear Confining Unit (Drained)	▨	✗	✓
Compacted Fill	■	✓	✗
Compacted Fill (Drained)	▨	✗	✓

Global Minimums

Short Term Stability

Method: spencer

FS	2.486320
Center:	501.674, 124.135
Radius:	73.451
Left Slip Surface Endpoint:	439.110, 85.653
Right Slip Surface Endpoint:	545.242, 65.000
Resisting Moment:	9.01111e+06 lb-ft
Driving Moment:	3.62428e+06 lb-ft
Resisting Horizontal Force:	109520 lb
Driving Horizontal Force:	44049.1 lb
Total Slice Area:	2006.1 ft2
Surface Horizontal Width:	106.131 ft
Surface Average Height:	18.902 ft

Long Term Stability

Method: spencer

FS	2.358960
Center:	518.960, 167.250
Radius:	101.772
Left Slip Surface Endpoint:	455.630, 87.582
Right Slip Surface Endpoint:	529.024, 65.977
Resisting Moment:	4.33131e+06 lb-ft
Driving Moment:	1.83611e+06 lb-ft
Resisting Horizontal Force:	39907.8 lb
Driving Horizontal Force:	16917.6 lb
Total Slice Area:	473.595 ft2
Surface Horizontal Width:	73.3931 ft
Surface Average Height:	6.45286 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Short Term Stability

Method: spencer

Number of Valid Surfaces: 54602
Number of Invalid Surfaces: 0

Long Term Stability

Method: spencer

Number of Valid Surfaces: 93859
Number of Invalid Surfaces: 0

Slice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.48632

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.07698	458.428	-56.9205	Light Gray Sand	50	32	50.7508	126.183	121.918	0	121.918	199.83	199.83
2	2.07698	1329.05	-54.0559	Light Gray Sand	50	32	121.907	303.1	405.045	0	405.045	573.181	573.181
3	2.07698	2125.68	-51.3778	Light Gray Sand	50	32	191.58	476.329	682.268	0	682.268	922.066	922.066
4	2.22971	3087.54	-48.7606	Perched Clay	1100	0	442.421	1100	805.868	0	805.868	1310.54	1310.54
5	2.22971	3801.43	-46.185	Perched Clay	1100	0	442.421	1100	1284.66	0	1284.66	1745.78	1745.78
6	2.22971	4328.81	-43.7253	Perched Clay	1100	0	442.421	1100	1602.59	0	1602.59	2025.75	2025.75
7	2.20496	4759.45	-41.3757	Surficial Aquifer	75	32	485.199	1206.36	1810.56	0	1810.56	2237.95	2237.95
8	2.20496	5207.38	-39.121	Surficial Aquifer	75	32	534.766	1329.6	2007.78	0	2007.78	2442.7	2442.7
9	2.20496	5620.94	-36.9365	Surficial Aquifer	75	32	582.27	1447.71	2196.79	0	2196.79	2634.56	2634.56
10	2.20496	6001.42	-34.813	Surficial Aquifer	75	32	627.642	1560.52	2377.33	0	2377.33	2813.76	2813.76
11	2.20496	6349.17	-32.7429	Surficial Aquifer	75	32	670.754	1667.71	2548.88	0	2548.88	2980.2	2980.2
12	2.20496	6668.19	-30.72	Surficial Aquifer	75	32	711.847	1769.88	2712.37	0	2712.37	3135.37	3135.37
13	2.20496	6921.65	-28.7387	Surficial Aquifer	75	32	710.95	1767.65	2708.81	0	2708.81	3098.67	3098.67
14	2.20496	7030.6	-26.7944	Surficial Aquifer	75	32	715.033	1777.8	2725.04	0	2725.04	3086.15	3086.15
15	2.20496	7107.64	-24.8829	Surficial Aquifer	75	32	732.902	1822.23	2796.15	0	2796.15	3136.08	3136.08
16	2.05511	6683.24	-23.0637	Black Creek Confining Unit	913.122	0	367.258	913.122	2958.39	0	2958.39	3114.76	3114.76
17	2.05511	6732.89	-21.3319	Black Creek Confining Unit	938.287	0	377.38	938.287	3006.17	0	3006.17	3153.55	3153.55
18	2.05511	6771.21	-19.6204	Black Creek Confining Unit	961.314	0	386.641	961.314	3049.1	0	3049.1	3186.93	3186.93
19	2.05511	6800.88	-17.9269	Black Creek Confining Unit	982.276	0	395.072	982.276	3088.32	0	3088.32	3216.13	3216.13
20	2.05511	6837.67	-16.2495	Black Creek Confining Unit	1001.23	0	402.696	1001.23	3131.11	0	3131.11	3248.48	3248.48
21	2.05511	6868.71	-14.5863	Black Creek Confining Unit	1018.24	0	409.537	1018.24	3171.49	0	3171.49	3278.06	3278.06
22	2.05511	6838.35	-12.9356	Black Creek Confining Unit	1033.34	0	415.61	1033.34	3183.26	0	3183.26	3278.71	3278.71

23	2.05511	6785.13	-11.2958	Black Creek Confining Unit	1046.58	0	420.935	1046.58	3184.21	0	3184.21	3268.29	3268.29
24	2.05511	6712.45	-9.66527	Black Creek Confining Unit	1057.99	0	425.524	1057.99	3175.82	0	3175.82	3248.29	3248.29
25	2.05511	6623.87	-8.04263	Black Creek Confining Unit	1067.59	0	429.386	1067.59	3159.67	0	3159.67	3220.34	3220.34
26	2.05511	6520.67	-6.42645	Black Creek Confining Unit	1075.42	0	432.535	1075.42	3136.27	0	3136.27	3184.99	3184.99
27	2.05511	6402.06	-4.8154	Black Creek Confining Unit	1081.49	0	434.976	1081.49	3105.16	0	3105.16	3141.8	3141.8
28	2.05511	6266.71	-3.20817	Black Creek Confining Unit	1085.82	0	436.718	1085.82	3065.58	0	3065.58	3090.06	3090.06
29	2.05511	6116.98	-1.60345	Black Creek Confining Unit	1088.41	0	437.759	1088.41	3018.59	0	3018.59	3030.85	3030.85
30	2.05511	5953.05	0	Black Creek Confining Unit	1089.27	0	438.105	1089.27	2964.18	0	2964.18	2964.18	2964.18
31	2.05511	5775.44	1.60345	Black Creek Confining Unit	1088.41	0	437.759	1088.41	2902.5	0	2902.5	2890.25	2890.25
32	2.05511	5585.73	3.20817	Black Creek Confining Unit	1085.82	0	436.718	1085.82	2834.23	0	2834.23	2809.75	2809.75
33	2.05511	5381.98	4.8154	Black Creek Confining Unit	1081.49	0	434.976	1081.49	2758.33	0	2758.33	2721.68	2721.68
34	2.05511	5165.33	6.42645	Black Creek Confining Unit	1075.42	0	432.535	1075.42	2675.24	0	2675.24	2626.52	2626.52
35	2.05511	4935.84	8.04263	Black Creek Confining Unit	1067.59	0	429.386	1067.59	2584.89	0	2584.89	2524.22	2524.22
36	2.05511	4687.06	9.66527	Black Creek Confining Unit	1057.99	0	425.524	1057.99	2483.94	0	2483.94	2411.47	2411.47
37	2.05511	4419.96	11.2958	Black Creek Confining Unit	1046.58	0	420.935	1046.58	2372.71	0	2372.71	2288.63	2288.63
38	2.05511	4137.8	12.9356	Black Creek Confining Unit	1033.34	0	415.61	1033.34	2252.66	0	2252.66	2157.2	2157.2
39	2.05511	3840.32	14.5863	Black Creek Confining Unit	1018.24	0	409.537	1018.24	2123.48	0	2123.48	2016.91	2016.91
40	2.05511	3527.19	16.2495	Black Creek Confining Unit	1001.23	0	402.696	1001.23	1984.82	0	1984.82	1867.45	1867.45
41	2.05511	3198.01	17.9269	Black Creek Confining Unit	982.276	0	395.072	982.276	1836.27	0	1836.27	1708.46	1708.46

42	2.05511	2852.36	19.6204	Black Creek Confining Unit	961.314	0	386.641	961.314	1677.38	0	1677.38	1539.54	1539.54
43	2.05511	2492.24	21.3319	Black Creek Confining Unit	938.287	0	377.38	938.287	1508.89	0	1508.89	1361.51	1361.51
44	2.05511	2202.85	23.0637	Black Creek Confining Unit	913.122	0	367.258	913.122	1374.87	0	1374.87	1218.5	1218.5
45	2.29475	2152.89	24.9218	Surficial Aquifer	75	32	340.891	847.564	1236.36	0	1236.36	1077.97	1077.97
46	2.29475	1810.32	26.9125	Surficial Aquifer	75	32	298.787	742.881	1068.83	0	1068.83	917.167	917.167
47	2.29475	1441.03	28.9391	Surficial Aquifer	75	32	251.065	624.228	878.947	0	878.947	740.129	740.129
48	2.29475	1043.45	31.0061	Surficial Aquifer	75	32	196.927	489.623	663.536	0	663.536	545.182	545.182
49	2.29475	628.029	33.1191	Surficial Aquifer	75	32	137.27	341.297	426.164	0	426.164	336.614	336.614
50	2.29475	214.261	35.2843	Surficial Aquifer	75	32	74.9296	186.299	178.116	0	178.116	125.094	125.094

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.35896

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.4725	98.0686	-37.9559	Compacted Fill (Drained)	200	28	131.207	309.513	205.965	0	205.965	308.313	308.313
2	1.4725	290.289	-36.9118	Compacted Fill (Drained)	200	28	154.439	364.316	309.034	0	309.034	425.04	425.04
3	1.4725	474.832	-35.8818	Compacted Fill (Drained)	200	28	177.23	418.079	410.147	0	410.147	538.355	538.355
4	1.4725	651.998	-34.8651	Compacted Fill (Drained)	200	28	199.579	470.798	509.298	0	509.298	648.345	648.345
5	1.4725	822.06	-33.8607	Compacted Fill (Drained)	200	28	221.484	522.471	606.48	0	606.48	755.091	755.091
6	1.4725	985.271	-32.8681	Compacted Fill (Drained)	200	28	242.944	573.094	701.687	0	701.687	858.662	858.662
7	1.49142	1152.28	-31.8802	Light Gray Sand	50	32	233.409	550.602	801.132	0	801.132	946.304	946.304
8	1.49142	1257.86	-30.8965	Light Gray Sand	50	32	197.897	466.832	667.069	0	667.069	785.492	785.492
9	1.49142	1319.31	-29.9229	Light Gray Sand	50	32	208.48	491.797	707.025	0	707.025	827.017	827.017
10	1.49142	1375.03	-28.9587	Light Gray Sand	50	32	218.491	515.412	744.813	0	744.813	865.719	865.719
11	1.49142	1425.16	-28.0034	Light Gray Sand	50	32	227.83	537.442	780.069	0	780.069	901.225	901.225
12	1.39832	1376.52	-27.0858	Perched Clay (Drained)	200	24	237.919	561.242	811.363	0	811.363	933.038	933.038
13	1.39832	1410.94	-26.205	Perched Clay (Drained)	200	24	243.302	573.94	839.886	0	839.886	959.631	959.631
14	1.39832	1443.09	-25.3308	Perched Clay (Drained)	200	24	248.475	586.142	867.29	0	867.29	984.906	984.906
15	1.39832	1473.14	-24.4628	Perched Clay (Drained)	200	24	253.452	597.883	893.66	0	893.66	1008.97	1008.97
16	1.39832	1501.8	-23.6009	Perched Clay (Drained)	200	24	258.311	609.346	919.407	0	919.407	1032.26	1032.26
17	1.39832	1530.28	-22.7445	Perched Clay (Drained)	200	24	263.192	620.859	945.265	0	945.265	1055.6	1055.6
18	1.39832	1565.49	-21.8935	Perched Clay (Drained)	200	24	268.915	634.36	975.592	0	975.592	1083.66	1083.66
19	1.39832	1603.27	-21.0475	Perched Clay (Drained)	200	24	275.001	648.716	1007.83	0	1007.83	1113.66	1113.66
20	1.4627	1699.39	-20.1871	Perched Clay (Drained)	200	24	279.204	658.631	1030.1	0	1030.1	1132.76	1132.76
21	1.4627	1702.04	-19.3121	Perched Clay (Drained)	200	24	281.203	663.346	1040.69	0	1040.69	1139.23	1139.23
22	1.4627	1700.66	-18.4418	Perched Clay (Drained)	200	24	282.734	666.958	1048.81	0	1048.81	1143.09	1143.09

23	1.4627	1693.83	-17.5759	Perched Clay (Drained)	200	24	283.621	669.051	1053.5	0	1053.5	1143.34	1143.34
24	1.48384	1707.4	-16.7079	Surficial Aquifer	75	32	311.407	734.596	1055.57	0	1055.57	1149.04	1149.04
25	1.48384	1693.97	-15.8376	Surficial Aquifer	75	32	311.691	735.266	1056.64	0	1056.64	1145.07	1145.07
26	1.48384	1676.39	-14.9711	Surficial Aquifer	75	32	311.257	734.242	1055.01	0	1055.01	1138.24	1138.24
27	1.48384	1654.72	-14.108	Surficial Aquifer	75	32	310.097	731.506	1050.63	0	1050.63	1128.57	1128.57
28	1.48384	1628.23	-13.2482	Surficial Aquifer	75	32	308.073	726.733	1042.99	0	1042.99	1115.52	1115.52
29	1.48384	1596.7	-12.3915	Surficial Aquifer	75	32	305.128	719.785	1031.87	0	1031.87	1098.91	1098.91
30	1.48384	1561.2	-11.5375	Surficial Aquifer	75	32	301.425	711.05	1017.89	0	1017.89	1079.42	1079.42
31	1.48384	1521.78	-10.6861	Surficial Aquifer	75	32	296.956	700.507	1001.02	0	1001.02	1057.06	1057.06
32	1.48384	1478.47	-9.83714	Surficial Aquifer	75	32	291.71	688.132	981.219	0	981.219	1031.8	1031.8
33	1.48384	1431.32	-8.99033	Surficial Aquifer	75	32	285.68	673.907	958.452	0	958.452	1003.65	1003.65
34	1.48384	1381.3	-8.1455	Surficial Aquifer	75	32	279.02	658.198	933.312	0	933.312	973.248	973.248
35	1.48384	1327.96	-7.30245	Surficial Aquifer	75	32	271.639	640.785	905.443	0	905.443	940.252	940.252
36	1.48384	1270.84	-6.46098	Surficial Aquifer	75	32	263.434	621.431	874.471	0	874.471	904.304	904.304
37	1.48384	1210.18	-5.62091	Surficial Aquifer	75	32	254.434	600.2	840.497	0	840.497	865.538	865.538
38	1.48384	1146.98	-4.78205	Surficial Aquifer	75	32	244.803	577.481	804.137	0	804.137	824.617	824.617
39	1.48384	1080.22	-3.94422	Surficial Aquifer	75	32	234.34	552.798	764.635	0	764.635	780.792	780.792
40	1.48384	1007.94	-3.10724	Surficial Aquifer	75	32	222.657	525.239	720.533	0	720.533	732.619	732.619
41	1.48384	929.488	-2.27091	Surficial Aquifer	75	32	209.602	494.442	671.248	0	671.248	679.56	679.56
42	1.48384	847.319	-1.43507	Surficial Aquifer	75	32	195.609	461.434	618.424	0	618.424	623.324	623.324
43	1.48384	761.454	-0.599537	Surficial Aquifer	75	32	180.66	426.17	561.989	0	561.989	563.879	563.879
44	1.48384	671.894	0.23587	Surficial Aquifer	75	32	164.731	388.595	501.856	0	501.856	501.178	501.178
45	1.48384	578.644	1.07133	Surficial Aquifer	75	32	147.799	348.652	437.935	0	437.935	435.171	435.171
46	1.48384	481.701	1.90701	Surficial Aquifer	75	32	129.837	306.281	370.128	0	370.128	365.805	365.805
47	1.48384	381.057	2.7431	Surficial Aquifer	75	32	110.817	261.414	298.325	0	298.325	293.016	293.016
48	1.48384	276.708	3.57978	Surficial Aquifer	75	32	90.7099	213.981	222.415	0	222.415	216.74	216.74
49	1.48384	168.646	4.41722	Surficial Aquifer	75	32	69.4828	163.907	142.281	0	142.281	136.914	136.914
50	1.48384	56.8145	5.27917	Surficial Aquifer	75	32	47.0701	111.036	57.6702	0	57.6702	53.3209	53.3209

Interslice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.48632

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	439.11	85.6529	0	0	0
2	441.187	82.4643	283.191	43.5735	8.74728
3	443.264	79.5997	1189.93	183.091	8.74733
4	445.341	77	2565.19	394.696	8.74728
5	447.571	74.4566	3627.05	558.081	8.74729
6	449.801	72.1326	5624.67	865.447	8.74729
7	452.03	70	8054.6	1239.33	8.74728
8	454.235	68.0577	10499.9	1615.58	8.74729
9	456.44	66.2645	12919.6	1987.89	8.74729
10	458.645	64.6067	15275.7	2350.41	8.74727
11	460.85	63.0735	17534.8	2698.02	8.74731
12	463.055	61.6556	19667.8	3026.22	8.74731
13	465.26	60.3454	21650	3331.21	8.7473
14	467.465	59.1362	23355.5	3593.63	8.7473
15	469.67	58.0227	24811.2	3817.6	8.74727
16	471.875	57	26052.6	4008.61	8.74727
17	473.93	56.125	27885.5	4290.64	8.74729
18	475.985	55.3224	29521.5	4542.37	8.7473
19	478.04	54.5898	30959.7	4763.65	8.74728
20	480.096	53.9249	32199.9	4954.48	8.74729
21	482.151	53.3259	33246.7	5115.55	8.7473
22	484.206	52.7911	34100	5246.84	8.74729
23	486.261	52.3191	34747.3	5346.44	8.74729
24	488.316	51.9086	35188.1	5414.27	8.7473
25	490.371	51.5586	35424	5450.56	8.74729
26	492.426	51.2682	35457.9	5455.77	8.74728
27	494.481	51.0367	35293.7	5430.52	8.7473
28	496.536	50.8636	34936.2	5375.5	8.74728
29	498.592	50.7484	34390.6	5291.55	8.74728
30	500.647	50.6909	33663.3	5179.66	8.74731
31	502.702	50.6909	32761.8	5040.93	8.74728
32	504.757	50.7484	31693.9	4876.63	8.7473
33	506.812	50.8636	30468.7	4688.11	8.7473
34	508.867	51.0367	29096	4476.9	8.7473
35	510.922	51.2682	27586.6	4244.65	8.74729
36	512.977	51.5586	25952.4	3993.2	8.74729
37	515.032	51.9086	24207.3	3724.69	8.7473
38	517.088	52.3191	22367	3441.53	8.7473
39	519.143	52.7911	20448.4	3146.32	8.74729
40	521.198	53.3259	18470	2841.91	8.74729
41	523.253	53.9249	16452.4	2531.47	8.74729
42	525.308	54.5898	14418.5	2218.53	8.74732
43	527.363	55.3224	12394	1907.01	8.74725
44	529.418	56.125	10406.4	1601.19	8.74727
45	531.473	57	8447.5	1299.79	8.74732
46	533.768	58.0663	6345.9	976.42	8.74729
47	536.063	59.2311	4414.31	679.214	8.7473
48	538.358	60.4999	2722.17	418.85	8.74729
49	540.652	61.8791	1354.53	208.417	8.74731
50	542.947	63.3761	401.122	61.7192	8.7473
51	545.242	64.9999	0	0	0

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.35896

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	455.63	87.5821	0	0	0
2	457.103	86.4335	43.3958	12.6268	16.2233
3	458.575	85.3274	157.821	45.921	16.2234
4	460.048	84.2622	333.771	97.1166	16.2233
5	461.52	83.2363	562.414	163.644	16.2233
6	462.993	82.2483	835.529	243.112	16.2233
7	464.465	81.2969	1145.45	333.29	16.2233
8	465.957	80.3693	1540.52	448.242	16.2233
9	467.448	79.4768	1840.75	535.6	16.2233
10	468.94	78.6184	2136.76	621.73	16.2233
11	470.431	77.7931	2425.64	705.783	16.2233
12	471.922	77	2704.58	786.944	16.2233
13	473.321	76.2849	2952.15	858.981	16.2233
14	474.719	75.5967	3189.99	928.185	16.2233
15	476.117	74.9348	3416.65	994.135	16.2233
16	477.516	74.2986	3630.79	1056.44	16.2233
17	478.914	73.6877	3831.33	1114.79	16.2232
18	480.312	73.1015	4017.47	1168.96	16.2234
19	481.711	72.5395	4189.71	1219.07	16.2233
20	483.109	72.0015	4347.53	1264.99	16.2233
21	484.572	71.4637	4493.17	1307.37	16.2233
22	486.034	70.9511	4615.34	1342.92	16.2233
23	487.497	70.4633	4713.41	1371.45	16.2233
24	488.96	70	4786.71	1392.78	16.2233
25	490.444	69.5546	4794.84	1395.14	16.2233
26	491.927	69.1337	4777.18	1390.01	16.2233
27	493.411	68.7369	4734	1377.44	16.2233
28	494.895	68.3639	4665.74	1357.58	16.2233
29	496.379	68.0146	4573.03	1330.61	16.2234
30	497.863	67.6886	4456.73	1296.76	16.2232
31	499.347	67.3857	4317.84	1256.35	16.2233
32	500.831	67.1057	4157.55	1209.71	16.2233
33	502.314	66.8484	3977.21	1157.24	16.2233
34	503.798	66.6136	3778.37	1099.38	16.2232
35	505.282	66.4012	3562.62	1036.61	16.2233
36	506.766	66.2111	3331.77	969.437	16.2233
37	508.25	66.043	3087.87	898.47	16.2233
38	509.734	65.897	2833.12	824.346	16.2233
39	511.217	65.7729	2569.74	747.71	16.2233
40	512.701	65.6706	2300.28	669.309	16.2233
41	514.185	65.59	2027.98	590.076	16.2233
42	515.669	65.5312	1756.5	511.084	16.2233
43	517.153	65.494	1489.27	433.33	16.2233
44	518.637	65.4785	1229.96	357.878	16.2233
45	520.12	65.4846	982.488	285.873	16.2233
46	521.604	65.5123	751.053	218.532	16.2233
47	523.088	65.5617	540.133	157.161	16.2233
48	524.572	65.6328	354.508	103.15	16.2232
49	526.056	65.7257	199.279	57.9838	16.2233
50	527.54	65.8403	79.8816	23.243	16.2233
51	529.024	65.9774	0	0	0

Discharge Sections

Entity Information

Short Term Stability

Shared Entities

Type	Coordinates (x,y)
	0, 132
	0, 107
	0, 92
	0, 77
	0, 70
	0, 57
	0, 50
	0, 30
	0, -5
	700, -5
	700, 30
	700, 36.9161
	688.344, 37.9998
	677.589, 38.9999
	669.61, 39.9999
	662.603, 40.9999
	658.123, 41.9999
	655.481, 42.9999
	651.43, 43.9999
	648.507, 44.9999
	645.731, 45.9999
	638.663, 46.9999
	631.405, 47.9999
	628.196, 48.9999
	625.968, 50
	623.373, 50.9999
	620.182, 51.9999
	612.468, 52.9999
	605.59, 53.9999
	598.992, 54.9999
	580.756, 55.9999
	577.657, 57
	575.578, 57.9999
	573.179, 58.9999
	570.003, 59.9999
	562.795, 60.9999
	559.314, 61.9999
	555.302, 62.9999
	553.733, 63.9999
	550.921, 64.9999
	548.038, 64.9999
	541.31, 64.9999
	529.024, 65.9774
	525.956, 66.9998

External Boundary	522.957, 67.9998 519.957, 68.9998 516.956, 70 513.957, 70.9998 510.957, 71.9998 507.957, 72.9998 504.957, 73.9998 501.958, 74.9998 498.958, 75.9998 495.957, 77 492.958, 77.9998 489.958, 78.9998 486.958, 79.9998 483.959, 80.9998 480.959, 81.9998 477.959, 82.9998 474.959, 83.9998 471.959, 84.9998 468.959, 85.9998 465.959, 86.9998 448.219, 87.9999 439.069, 85.6421 438.075, 85.9999 435.11, 86.9999 432.584, 87.9999 430.936, 89 428.872, 90 422.148, 90 416.315, 90 414.577, 91 412.175, 92 406.968, 92 392.197, 92 386.749, 93 383.515, 94 380.028, 95 377.099, 96 365.493, 97 352.547, 98 340.992, 99 330.074, 100 320.472, 101 314.119, 102 307.047, 103 296.584, 104 288.966, 105 278.777, 106 267.251, 107 257.619, 108 249.546, 109 238.056, 110 230.292, 111 223.923, 112 216.92, 113 206.661, 114 197.809, 115 188.279, 116 179.649, 117 172.402, 118

	163.913, 119 152.511, 120 142.46, 121 131.933, 122 120.974, 123 111.165, 124 102.488, 125 94.115, 126 82.8092, 127 74.0739, 128 64.1558, 129 52.333, 130 41.321, 131 30.8801, 132 18.3545, 132
Material Boundary	0, 77 477.736, 77 495.957, 77
Material Boundary	0, 70 495.013, 70 516.956, 70
Material Boundary	0, 57 577.657, 57
Material Boundary	0, 50 625.968, 50
Material Boundary	0, 30 700, 30
Material Boundary	0, 107 267.251, 107
Material Boundary	0, 92 392.197, 92
Material Boundary	439.069, 85.6421 440.852, 85.0002 449.298, 84.0002 455.214, 83.0002 459.84, 82.0002 466.417, 81.0002 471.95, 80.0002 474.424, 79.0002 476.261, 78.0002 477.736, 77 479.567, 76.0002 480.565, 75.0002 481.524, 74.0002 482.312, 73.0002 483.109, 72.0002 487.505, 71.0002 495.013, 70 503.52, 69.0002 508.941, 68.0002 512.825, 67.0002 528.736, 66.0002 529.024, 65.9774

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 50 700.186, 50	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	465.959, 86.9998 448.219, 87.9999	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Long Term Stability

Shared Entities

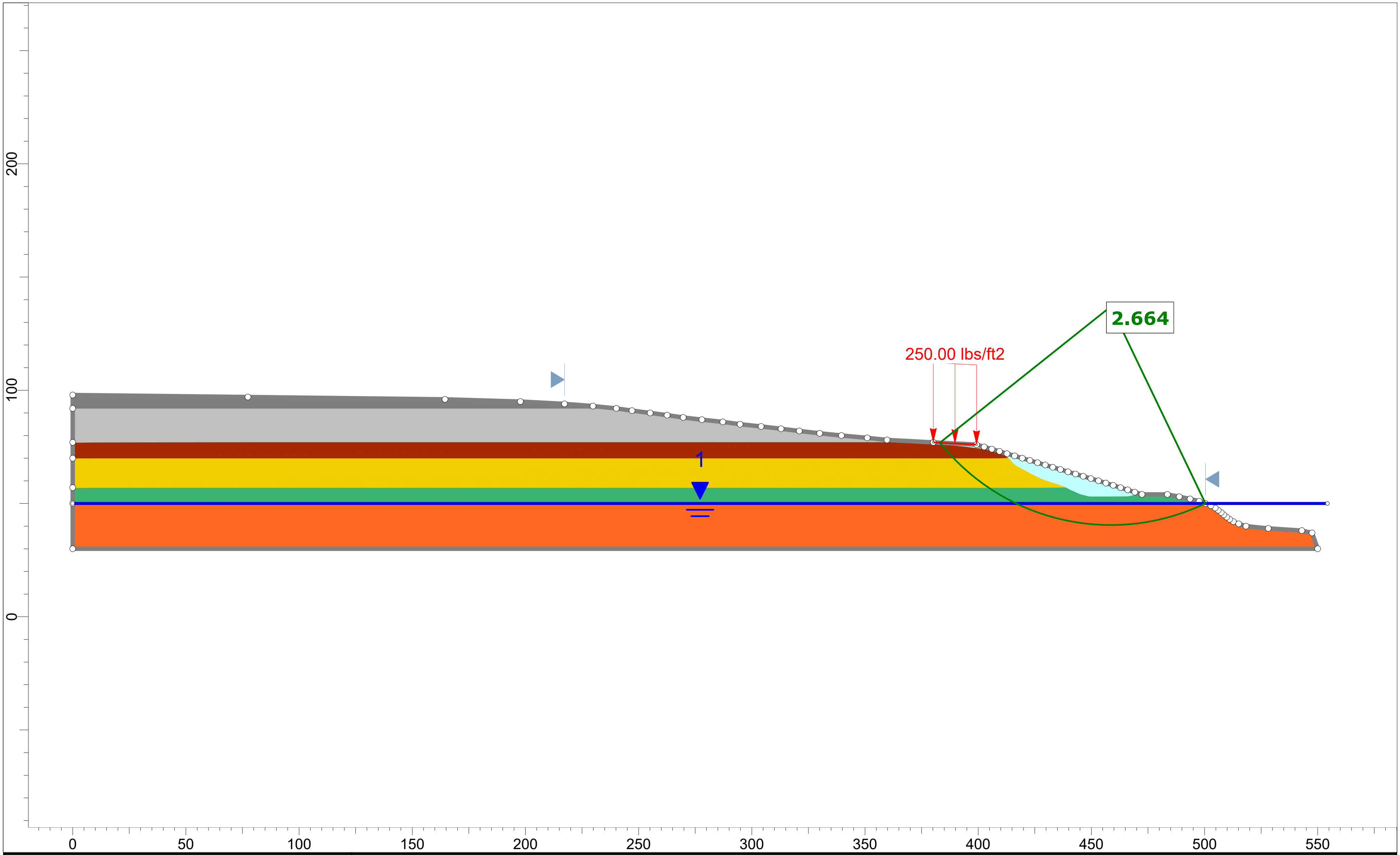
Type	Coordinates (x,y)
	0, 132 0, 107 0, 92 0, 77 0, 70 0, 57 0, 50 0, 30 0, -5 700, -5 700, 30 700, 36.9161 688.344, 37.9998 677.589, 38.9999 669.61, 39.9999 662.603, 40.9999 658.123, 41.9999 655.481, 42.9999 651.43, 43.9999 648.507, 44.9999 645.731, 45.9999 638.663, 46.9999 631.405, 47.9999 628.196, 48.9999 625.968, 50 623.373, 50.9999 620.182, 51.9999 612.468, 52.9999 605.59, 53.9999 598.992, 54.9999 580.756, 55.9999 577.657, 57 575.578, 57.9999 573.179, 58.9999 570.003, 59.9999 562.795, 60.9999 559.314, 61.9999 555.302, 62.9999 553.733, 63.9999 550.921, 64.9999 548.038, 64.9999 541.31, 64.9999 529.024, 65.9774 525.956, 66.9998

External Boundary	522.957, 67.9998 519.957, 68.9998 516.956, 70 513.957, 70.9998 510.957, 71.9998 507.957, 72.9998 504.957, 73.9998 501.958, 74.9998 498.958, 75.9998 495.957, 77 492.958, 77.9998 489.958, 78.9998 486.958, 79.9998 483.959, 80.9998 480.959, 81.9998 477.959, 82.9998 474.959, 83.9998 471.959, 84.9998 468.959, 85.9998 465.959, 86.9998 448.219, 87.9999 439.069, 85.6421 438.075, 85.9999 435.11, 86.9999 432.584, 87.9999 430.936, 89 428.872, 90 422.148, 90 416.315, 90 414.577, 91 412.175, 92 406.968, 92 392.197, 92 386.749, 93 383.515, 94 380.028, 95 377.099, 96 365.493, 97 352.547, 98 340.992, 99 330.074, 100 320.472, 101 314.119, 102 307.047, 103 296.584, 104 288.966, 105 278.777, 106 267.251, 107 257.619, 108 249.546, 109 238.056, 110 230.292, 111 223.923, 112 216.92, 113 206.661, 114 197.809, 115 188.279, 116 179.649, 117 172.402, 118	

	163.913, 119 152.511, 120 142.46, 121 131.933, 122 120.974, 123 111.165, 124 102.488, 125 94.115, 126 82.8092, 127 74.0739, 128 64.1558, 129 52.333, 130 41.321, 131 30.8801, 132 18.3545, 132
Material Boundary	0, 77 477.736, 77 495.957, 77
Material Boundary	0, 70 495.013, 70 516.956, 70
Material Boundary	0, 57 577.657, 57
Material Boundary	0, 50 625.968, 50
Material Boundary	0, 30 700, 30
Material Boundary	0, 107 267.251, 107
Material Boundary	0, 92 392.197, 92
Material Boundary	439.069, 85.6421 440.852, 85.0002 449.298, 84.0002 455.214, 83.0002 459.84, 82.0002 466.417, 81.0002 471.95, 80.0002 474.424, 79.0002 476.261, 78.0002 477.736, 77 479.567, 76.0002 480.565, 75.0002 481.524, 74.0002 482.312, 73.0002 483.109, 72.0002 487.505, 71.0002 495.013, 70 503.52, 69.0002 508.941, 68.0002 512.825, 67.0002 528.736, 66.0002 529.024, 65.9774

Scenario-based Entities

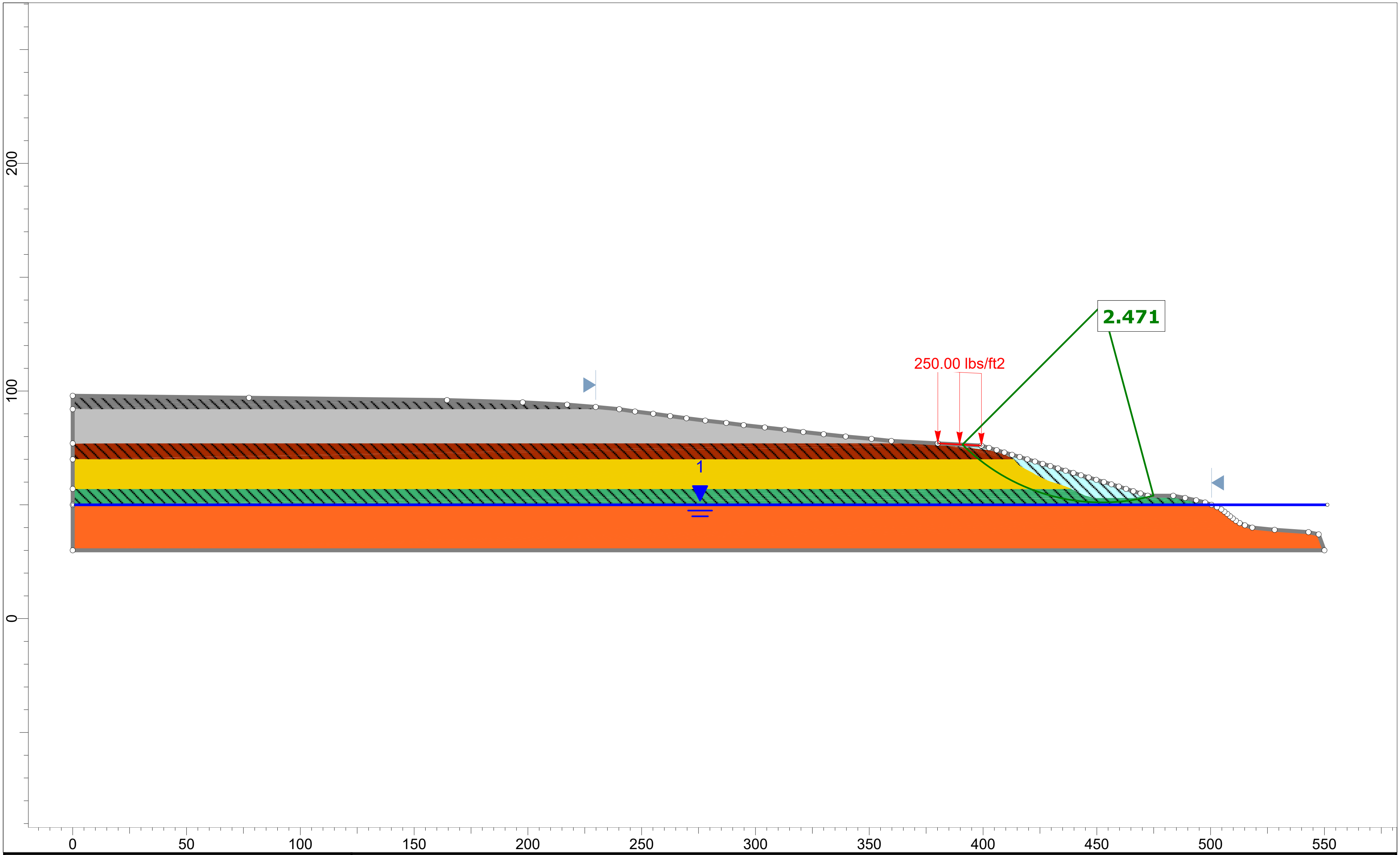
Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 50 700.492, 50	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)
Distributed Load	448.316, 87.9944 465.959, 86.9998	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No



GEOS Universal Engineering Sciences
Geotechnical, Environmental and Materials Engineers

SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 2
Drawn By		*Station*	Approx. STA 10+00
Date		*File Name*	section-2.slmd



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Date		*File Name*	section-2.slmd

Universal
Engineering
Sciences

Geotechnical, Environmental and Materials Engineers

Section-2
45-20803 Barrier Wall Road Interim Design and Repair
Approx STA 10+00
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-2

Project Summary

File Name:	section-2.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Long Term Slope Stability
Comments	
	Section 2 Approx. STA 10+00

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Short Term Stability 🔷	Master Scenario	Spencer: 2.664260	00h:00m:05.501s
Long Term Stability ♦	Master Scenario	Spencer: 2.470950	00h:00m:08.591s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

All Open Scenarios

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Materials

Dark Gray Clay	
Color	■
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	□
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay	
Color	🟥
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	1100
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	200
Friction Angle [deg]	24
Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75

Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Compacted Fill	
Color	🟦
Strength Type	Undrained
Unit Weight [lbs/ft3]	125
Cohesion [psf]	2000
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material		Short Term Stability	Long Term Stability
Dark Gray Clay	⬛	✓	✗
Dark Gray Clay (Drained)	▨	✗	✓
Light Gray Sand	⬜	✓	✓
Perched Clay	🟫	✓	✗
Perched Clay (Drained)	▨	✗	✓
Surficial Aquifer	🟨	✓	✓
Black Creek Confining Unit	🟩	✓	✗
Black Creek Confining Unit (Long Term)	▨	✗	✓
Black Creek Aquifer	🟧	✓	✓
Compacted Fill	🟦	✓	✗
Compacted Fill (Drained)	▨	✗	✓

Global Minimums

Short Term Stability

Method: spencer

FS	2.664260
Center:	458.607, 137.015
Radius:	96.539
Left Slip Surface Endpoint:	383.112, 76.846
Right Slip Surface Endpoint:	500.418, 50.001
Resisting Moment:	1.21807e+07 lb-ft
Driving Moment:	4.57189e+06 lb-ft
Resisting Horizontal Force:	114148 lb
Driving Horizontal Force:	42844.2 lb
Total Slice Area:	1767.87 ft2
Surface Horizontal Width:	117.306 ft
Surface Average Height:	15.0706 ft

Long Term Stability

Method: spencer

FS	2.470950
Center:	452.360, 137.828
Radius:	86.800
Left Slip Surface Endpoint:	391.001, 76.434
Right Slip Surface Endpoint:	474.883, 54.001
Resisting Moment:	5.04334e+06 lb-ft
Driving Moment:	2.04105e+06 lb-ft
Resisting Horizontal Force:	54175.8 lb
Driving Horizontal Force:	21925.1 lb
Total Slice Area:	738.159 ft2
Surface Horizontal Width:	83.8817 ft
Surface Average Height:	8.8 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Short Term Stability

Method: spencer

Number of Valid Surfaces:	42423
Number of Invalid Surfaces:	0

Long Term Stability

Method: spencer

Number of Valid Surfaces:	97052
Number of Invalid Surfaces:	0

Slice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.66426

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.675508	33.8854	-51.1257	Compacted Fill	2000	0	750.677	2000	-400.995	0	-400.995	530.183	530.183
2	2.66506	708.064	-49.5863	Perched Clay	1100	0	412.873	1100	88.0948	0	88.0948	572.983	572.983
3	2.66506	1552.58	-47.2022	Perched Clay	1100	0	412.873	1100	386.425	0	386.425	832.322	832.322
4	2.21097	1892.76	-45.1084	Surficial Aquifer	75	32	212.952	567.359	787.938	0	787.938	1001.7	1001.7
5	2.21097	2414.7	-43.2775	Surficial Aquifer	75	32	257.847	686.972	979.358	0	979.358	1222.15	1222.15
6	2.21097	2903.65	-41.5002	Surficial Aquifer	75	32	301.37	802.927	1164.93	0	1164.93	1431.56	1431.56
7	2.21097	3363.29	-39.7705	Surficial Aquifer	75	32	343.614	915.477	1345.04	0	1345.04	1631.03	1631.03
8	2.21097	3782.39	-38.0832	Surficial Aquifer	75	32	364.985	972.415	1436.16	0	1436.16	1722.18	1722.18
9	2.21097	4064.25	-36.4341	Surficial Aquifer	75	32	366.241	975.762	1441.52	0	1441.52	1711.87	1711.87
10	2.21097	4297.33	-34.8194	Surficial Aquifer	75	32	391.111	1042.02	1547.56	0	1547.56	1819.58	1819.58
11	2.44015	4997.22	-33.1552	Black Creek Confining Unit	923.908	0	346.778	923.908	1684.76	0	1684.76	1911.3	1911.3
12	2.44015	5251.88	-31.4415	Black Creek Confining Unit	970.198	0	364.153	970.198	1796.6	0	1796.6	2019.24	2019.24
13	2.44015	5496.5	-29.7586	Black Creek Confining Unit	1013.5	0	380.406	1013.5	1906.48	0	1906.48	2123.98	2123.98
14	2.44015	5722.75	-28.1035	Black Creek Confining Unit	1053.98	0	395.6	1053.98	2011.11	0	2011.11	2222.38	2222.38
15	2.44015	5931.6	-26.4736	Black Creek Confining Unit	1091.75	0	409.776	1091.75	2110.62	0	2110.62	2314.69	2314.69
16	2.38922	5965.37	-24.8831	Black Creek Aquifer	0	33	519.957	1385.3	2167.71	34.5337	2133.18	2408.88	2374.35
17	2.38922	6088.79	-23.3293	Black Creek Aquifer	0	33	521.972	1390.67	2242.7	101.258	2141.45	2467.82	2366.56
18	2.38922	6193.59	-21.7936	Black Creek Aquifer	0	33	523.399	1394.47	2310.51	163.212	2147.3	2519.79	2356.58
19	2.38922	6275.82	-20.2741	Black Creek Aquifer	0	33	523.815	1395.58	2369.56	220.554	2149.01	2563.06	2342.5
20	2.38922	6334.9	-18.7694	Black Creek Aquifer	0	33	523.102	1393.68	2419.49	273.423	2146.07	2597.26	2323.84
21	2.38922	6368.78	-17.2781	Black Creek Aquifer	0	33	520.993	1388.06	2459.36	321.941	2137.42	2621.41	2299.47

22	2.38922	6376.49	-15.7987	Black Creek Aquifer	0	33	517.329	1378.3	2488.61	366.22	2122.39	2634.99	2268.77
23	2.38922	6367.47	-14.33	Black Creek Aquifer	0	33	512.938	1366.6	2510.73	406.354	2104.38	2641.77	2235.41
24	2.38922	6343.77	-12.871	Black Creek Aquifer	0	33	507.983	1353.4	2526.48	442.43	2084.05	2642.55	2200.12
25	2.38922	6299.43	-11.4203	Black Creek Aquifer	0	33	501.839	1337.03	2533.36	474.521	2058.84	2634.74	2160.22
26	2.38922	6230.78	-9.97707	Black Creek Aquifer	0	33	494.092	1316.39	2529.76	502.692	2027.06	2616.67	2113.98
27	2.38922	6143.29	-8.54019	Black Creek Aquifer	0	33	485.227	1292.77	2517.7	527	1990.7	2590.56	2063.56
28	2.38922	6034.75	-7.10871	Black Creek Aquifer	0	33	474.976	1265.46	2496.13	547.49	1948.64	2555.36	2007.87
29	2.38922	5905.8	-5.68168	Black Creek Aquifer	0	33	463.348	1234.48	2465.14	564.203	1900.93	2511.24	1947.03
30	2.38922	5753.5	-4.25818	Black Creek Aquifer	0	33	449.99	1198.89	2423.3	577.17	1846.13	2456.8	1879.63
31	2.38922	5581.59	-2.83731	Black Creek Aquifer	0	33	435.228	1159.56	2371.98	586.414	1785.57	2393.55	1807.14
32	2.38922	5389.83	-1.41818	Black Creek Aquifer	0	33	418.991	1116.3	2310.9	591.954	1718.95	2321.28	1729.32
33	2.38922	5178.71	7.22456e-05	Black Creek Aquifer	0	33	401.271	1069.09	2240.06	593.8	1646.26	2240.06	1646.26
34	2.38922	4948.75	1.41833	Black Creek Aquifer	0	33	382.076	1017.95	2159.47	591.954	1567.51	2150.01	1558.05
35	2.38922	4700.21	2.83745	Black Creek Aquifer	0	33	361.385	962.824	2069.03	586.414	1482.62	2051.12	1464.71
36	2.38922	4432.6	4.25832	Black Creek Aquifer	0	33	339.081	903.401	1968.28	577.168	1391.12	1943.04	1365.87
37	2.38922	4142.36	5.68183	Black Creek Aquifer	0	33	314.713	838.477	1855.34	564.201	1291.14	1824.03	1259.83
38	2.38922	3834.06	7.10886	Black Creek Aquifer	0	33	288.717	769.217	1731.98	547.488	1184.49	1695.97	1148.48
39	2.38922	3575.73	8.54034	Black Creek Aquifer	0	33	268.809	716.176	1629.81	526.997	1102.81	1589.44	1062.45
40	2.38922	3456.82	9.97722	Black Creek Aquifer	0	33	265.563	707.528	1592.19	502.69	1089.5	1545.47	1042.78
41	2.38922	3327.35	11.4205	Black Creek Aquifer	0	33	262.03	698.116	1549.52	474.518	1075	1496.59	1022.07
42	2.38922	3179.88	12.8711	Black Creek Aquifer	0	33	257.318	685.561	1498.1	442.426	1055.67	1439.3	996.876
43	2.38922	3014.04	14.3302	Black Creek Aquifer	0	33	251.342	669.64	1437.51	406.35	1031.16	1373.3	966.948
44	2.38922	2759.8	15.7988	Black Creek Aquifer	0	33	235.51	627.459	1332.42	366.215	966.203	1265.78	899.566
45	2.38922	2424.62	17.2782	Black Creek Aquifer	0	33	210.326	560.364	1184.82	321.937	862.885	1119.4	797.463
46	2.38922	2066.2	18.7696	Black Creek Aquifer	0	33	182.618	486.541	1022.62	273.417	749.206	960.563	687.146

47	2.38922	1681.34	20.2743	Black Creek Aquifer	0	33	151.845	404.555	843.507	220.548	622.959	787.415	566.867
48	2.38922	1265.31	21.7937	Black Creek Aquifer	0	33	117.224	312.316	644.13	163.206	480.924	597.258	434.052
49	2.38922	807.859	23.3295	Black Creek Aquifer	0	33	77.1753	205.615	417.872	101.251	316.621	384.588	283.337
50	2.38922	281.364	24.8832	Black Creek Aquifer	0	33	28.485	75.8915	151.389	34.5266	116.863	138.177	103.65

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.47095

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.27025	93.4691	-44.3966	Compacted Fill (Drained)	200	28	121.514	300.254	188.55	0	188.55	307.531	307.531
2	1.48158	325.587	-43.1397	Perched Clay (Drained)	200	24	135.827	335.622	304.612	0	304.612	431.893	431.893
3	1.48158	535.751	-41.8135	Perched Clay (Drained)	200	24	156.075	385.653	416.983	0	416.983	556.596	556.596
4	1.48158	736.586	-40.5142	Perched Clay (Drained)	200	24	175.911	434.668	527.074	0	527.074	677.392	677.392
5	1.48158	928.075	-39.2396	Perched Clay (Drained)	200	24	195.288	482.547	634.608	0	634.608	794.106	794.106
6	1.73255	1315.36	-37.8837	Surficial Aquifer	75	32	201.143	497.015	675.366	0	675.366	831.86	831.86
7	1.73255	1489.12	-36.4483	Surficial Aquifer	75	32	193.188	477.357	643.904	0	643.904	786.585	786.585
8	1.73255	1632.32	-35.039	Surficial Aquifer	75	32	211.955	523.729	718.116	0	718.116	866.743	866.743
9	1.73255	1765.07	-33.6536	Surficial Aquifer	75	32	229.929	568.142	789.19	0	789.19	942.265	942.265
10	1.73255	1886.08	-32.2902	Surficial Aquifer	75	32	246.902	610.083	856.31	0	856.31	1012.34	1012.34
11	1.73255	1997.6	-30.9471	Surficial Aquifer	75	32	263.085	650.07	920.306	0	920.306	1078.05	1078.05
12	1.73255	2107.7	-29.6225	Surficial Aquifer	75	32	279.393	690.366	984.792	0	984.792	1143.65	1143.65
13	1.73255	2210.52	-28.3151	Surficial Aquifer	75	32	295.111	729.205	1046.95	0	1046.95	1205.95	1205.95
14	1.73255	2306.79	-27.0237	Surficial Aquifer	75	32	310.299	766.734	1107	0	1107	1265.27	1265.27
15	1.73255	2397.69	-25.7469	Surficial Aquifer	75	32	325.075	803.245	1165.43	0	1165.43	1322.21	1322.21
16	1.73255	2476.1	-24.4837	Surficial Aquifer	75	32	338.528	836.485	1218.63	0	1218.63	1372.79	1372.79
17	1.73255	2534.68	-23.2331	Surficial Aquifer	75	32	349.678	864.037	1262.72	0	1262.72	1412.84	1412.84
18	1.73255	2582.14	-21.9941	Surficial Aquifer	75	32	359.557	888.448	1301.79	0	1301.79	1447.02	1447.02
19	1.69256	2562.71	-20.7799	Black Creek Confining Unit (Long Term)	125	26	315.816	780.366	1343.7	0	1343.7	1463.54	1463.54
20	1.69256	2600.87	-19.5895	Black Creek Confining Unit (Long Term)	125	26	322.604	797.139	1378.09	0	1378.09	1492.9	1492.9
21	1.69256	2627.42	-18.4077	Black Creek Confining Unit (Long Term)	125	26	328.233	811.047	1406.61	0	1406.61	1515.84	1515.84
22	1.69256	2645.93	-17.2341	Black Creek Confining Unit (Long Term)	125	26	333.052	822.955	1431.02	0	1431.02	1534.34	1534.34
23	1.69256	2655.62	-16.0679	Black Creek Confining Unit (Long Term)	125	26	336.957	832.605	1450.81	0	1450.81	1547.86	1547.86

24	1.69256	2655.54	-14.9085	Black Creek Confining Unit (Long Term)	125	26	339.821	839.681	1465.32	0	1465.32	1555.79	1555.79
25	1.69256	2645.04	-13.7552	Black Creek Confining Unit (Long Term)	125	26	341.547	843.946	1474.06	0	1474.06	1557.67	1557.67
26	1.69256	2627.09	-12.6077	Black Creek Confining Unit (Long Term)	125	26	342.435	846.14	1478.56	0	1478.56	1555.15	1555.15
27	1.69256	2604.61	-11.4653	Black Creek Confining Unit (Long Term)	125	26	342.794	847.028	1480.37	0	1480.37	1549.9	1549.9
28	1.69256	2575.73	-10.3274	Black Creek Confining Unit (Long Term)	125	26	342.401	846.056	1478.38	0	1478.38	1540.78	1540.78
29	1.69256	2539.51	-9.1937	Black Creek Confining Unit (Long Term)	125	26	341.133	842.922	1471.96	0	1471.96	1527.17	1527.17
30	1.69256	2493.85	-8.0636	Black Creek Confining Unit (Long Term)	125	26	338.726	836.976	1459.77	0	1459.77	1507.76	1507.76
31	1.69256	2439.3	-6.93665	Black Creek Confining Unit (Long Term)	125	26	335.219	828.309	1441.99	0	1441.99	1482.78	1482.78
32	1.69256	2377.69	-5.81239	Black Creek Confining Unit (Long Term)	125	26	330.798	817.386	1419.6	0	1419.6	1453.28	1453.28
33	1.69256	2309.03	-4.69037	Black Creek Confining Unit (Long Term)	125	26	325.446	804.162	1392.49	0	1392.49	1419.19	1419.19
34	1.69256	2231.28	-3.57015	Black Creek Confining Unit (Long Term)	125	26	318.895	787.974	1359.3	0	1359.3	1379.2	1379.2
35	1.69256	2146.45	-2.45129	Black Creek Confining Unit (Long Term)	125	26	311.358	769.35	1321.11	0	1321.11	1334.44	1334.44
36	1.69256	2052.21	-1.33338	Black Creek Confining Unit (Long Term)	125	26	302.529	747.533	1276.38	0	1276.38	1283.42	1283.42
37	1.69256	1949.88	-0.215966	Black Creek Confining Unit (Long Term)	125	26	292.536	722.843	1225.76	0	1225.76	1226.86	1226.86
38	1.69256	1840.14	0.901363	Black Creek Confining Unit (Long Term)	125	26	281.434	695.409	1169.51	0	1169.51	1165.09	1165.09

39	1.69256	1722.48	2.01903	Black Creek Confining Unit (Long Term)	125	26	269.13	665.008	1107.18	0	1107.18	1097.69	1097.69
40	1.69256	1597.45	3.13747	Black Creek Confining Unit (Long Term)	125	26	255.66	631.724	1038.94	0	1038.94	1024.93	1024.93
41	1.69256	1464.77	4.25711	Black Creek Confining Unit (Long Term)	125	26	240.959	595.397	964.458	0	964.458	946.521	946.521
42	1.69256	1324.71	5.37839	Black Creek Confining Unit (Long Term)	125	26	225.024	556.024	883.729	0	883.729	862.544	862.544
43	1.69256	1177.24	6.50173	Black Creek Confining Unit (Long Term)	125	26	207.816	513.502	796.546	0	796.546	772.862	772.862
44	1.69256	1022.35	7.62759	Black Creek Confining Unit (Long Term)	125	26	189.292	467.732	702.706	0	702.706	677.356	677.356
45	1.69256	860.019	8.75642	Black Creek Confining Unit (Long Term)	125	26	169.412	418.608	601.984	0	601.984	575.889	575.889
46	1.69256	688.173	9.88868	Black Creek Confining Unit (Long Term)	125	26	147.848	365.326	492.742	0	492.742	466.968	466.968
47	1.69256	508.366	11.0249	Black Creek Confining Unit (Long Term)	125	26	124.756	308.267	375.752	0	375.752	351.446	351.446
48	1.69256	321.635	12.1655	Black Creek Confining Unit (Long Term)	125	26	100.222	247.644	251.458	0	251.458	229.852	229.852
49	1.69256	143.761	13.311	Black Creek Confining Unit (Long Term)	125	26	76.3777	188.726	130.656	0	130.656	112.586	112.586
50	1.69256	44.337	14.4619	Black Creek Confining Unit (Long Term)	125	26	62.9208	155.474	62.4813	0	62.4813	46.2535	46.2535

Interslice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.66426

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	383.112	76.8461	0	0	0
2	383.788	76.0081	-843.068	-152.485	10.2522
3	386.453	72.8782	-1667.61	-301.619	10.2522
4	389.118	70	-1655.66	-299.457	10.2522
5	391.329	67.7806	-377.744	-68.3221	10.2522
6	393.54	65.6988	1091.1	197.346	10.2522
7	395.751	63.7426	2703.55	488.989	10.2522
8	397.962	61.9025	4419.01	799.261	10.2522
9	400.173	60.1699	6100.35	1103.36	10.2522
10	402.384	58.5378	7643.36	1382.45	10.2522
11	404.595	57	9158.46	1656.48	10.2522
12	407.035	55.4059	10997.9	1989.19	10.2522
13	409.475	53.914	12789.7	2313.27	10.2522
14	411.915	52.5189	14521.4	2626.46	10.2522
15	414.355	51.2158	16176.8	2925.88	10.2522
16	416.796	50.0006	17741.8	3208.94	10.2522
17	419.185	48.8924	18901.8	3418.74	10.2522
18	421.574	47.862	19965.6	3611.16	10.2522
19	423.963	46.9067	20922.4	3784.22	10.2522
20	426.352	46.0241	21762.3	3936.12	10.2522
21	428.742	45.2122	22477	4065.4	10.2522
22	431.131	44.469	23060	4170.84	10.2522
23	433.52	43.793	23506.4	4251.59	10.2522
24	435.909	43.1827	23813.4	4307.1	10.2522
25	438.298	42.6367	23979.1	4337.07	10.2522
26	440.688	42.1541	24002.8	4341.36	10.2522
27	443.077	41.7338	23885.6	4320.17	10.2522
28	445.466	41.375	23629.7	4273.88	10.2522
29	447.855	41.0771	23238.7	4203.16	10.2522
30	450.245	40.8394	22717.7	4108.92	10.2522
31	452.634	40.6615	22073.7	3992.45	10.2522
32	455.023	40.543	21314.8	3855.18	10.2522
33	457.412	40.4839	20450.5	3698.85	10.2522
34	459.801	40.4839	19491.8	3525.46	10.2522
35	462.191	40.5431	18451.2	3337.25	10.2522
36	464.58	40.6615	17342.8	3136.78	10.2522
37	466.969	40.8394	16182.6	2926.93	10.2522
38	469.358	41.0771	14989.7	2711.17	10.2522
39	471.748	41.3751	13783.8	2493.07	10.2522
40	474.137	41.7338	12556.9	2271.14	10.2521
41	476.526	42.1541	11253.2	2035.35	10.2522
42	478.915	42.6368	9879.32	1786.86	10.2522
43	481.304	43.1827	8446.7	1527.75	10.2522
44	483.694	43.7931	6968.85	1260.45	10.2522
45	486.083	44.4691	5505.45	995.764	10.2522
46	488.472	45.2123	4122.44	745.622	10.2522
47	490.861	46.0242	2855.84	516.534	10.2522
48	493.251	46.9068	1748.61	316.269	10.2522
49	495.64	47.8621	853.202	154.318	10.2522
50	498.029	48.8925	238.241	43.0904	10.2522
51	500.418	50.0007	0	0	0

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.47095

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	391.001	76.4335	0	0	0
2	392.271	75.1897	80.2314	20.8602	14.5742
3	393.753	73.8014	301.997	78.5195	14.5743
4	395.234	72.4761	623.499	162.11	14.5742
5	396.716	71.2101	1030.28	267.873	14.5742
6	398.198	70	1508.99	392.338	14.5742
7	399.93	68.652	2071.03	538.468	14.5742
8	401.663	67.3724	2560.42	665.71	14.5742
9	403.395	66.1575	3065.81	797.111	14.5742
10	405.128	65.0041	3577.92	930.26	14.5742
11	406.86	63.9092	4087.89	1062.85	14.5742
12	408.593	62.8704	4588.34	1192.97	14.5742
13	410.326	61.8852	5074.64	1319.41	14.5743
14	412.058	60.9518	5540.88	1440.63	14.5742
15	413.791	60.0681	5981.76	1555.26	14.5742
16	415.523	59.2325	6392.61	1662.08	14.5742
17	417.256	58.4435	6767.83	1759.64	14.5742
18	418.988	57.6998	7101.44	1846.38	14.5743
19	420.721	57	7389.75	1921.34	14.5743
20	422.413	56.3577	7718.47	2006.81	14.5743
21	424.106	55.7554	8002.78	2080.73	14.5743
22	425.799	55.1921	8239.81	2142.35	14.5742
23	427.491	54.6671	8427.7	2191.21	14.5743
24	429.184	54.1796	8564.92	2226.88	14.5742
25	430.876	53.7289	8650.32	2249.09	14.5743
26	432.569	53.3146	8683.24	2257.65	14.5743
27	434.261	52.936	8663.65	2252.55	14.5742
28	435.954	52.5927	8591.91	2233.9	14.5742
29	437.646	52.2843	8468.62	2201.84	14.5742
30	439.339	52.0104	8294.73	2156.63	14.5742
31	441.032	51.7706	8071.72	2098.65	14.5742
32	442.724	51.5647	7801.54	2028.4	14.5742
33	444.417	51.3924	7486.49	1946.49	14.5742
34	446.109	51.2535	7129.27	1853.61	14.5742
35	447.802	51.1479	6733.32	1750.67	14.5743
36	449.494	51.0754	6302.29	1638.6	14.5743
37	451.187	51.036	5840.76	1518.6	14.5742
38	452.879	51.0297	5353.68	1391.96	14.5742
39	454.572	51.0563	4846.41	1260.07	14.5743
40	456.265	51.116	4325.03	1124.51	14.5742
41	457.957	51.2087	3796.12	986.994	14.5743
42	459.65	51.3347	3266.96	849.412	14.5743
43	461.342	51.4941	2745.45	713.817	14.5742
44	463.035	51.687	2240.22	582.458	14.5742
45	464.727	51.9136	1760.7	457.782	14.5742
46	466.42	52.1743	1317.15	342.46	14.5743
47	468.113	52.4694	921.637	239.626	14.5742
48	469.805	52.7992	586.667	152.534	14.5743
49	471.498	53.164	325.362	84.5942	14.5742
50	473.19	53.5645	143.826	37.3949	14.5743
51	474.883	54.001	0	0	0

Discharge Sections

Entity Information

Short Term Stability

Shared Entities

Type	Coordinates (x,y)
External Boundary	0, 30
	550, 30
	547.472, 37.0007
	543.005, 38.0007
	528.162, 39.0007
	518.319, 40.0007
	515.075, 41.0007
	512.754, 42.0007
	511.142, 43.0007
	509.774, 44.0007
	508.545, 45.0007
	507.336, 46.0007
	506.053, 47.0007
	504.699, 48.0007
	502.811, 49.0007
	500.418, 50.0007
	497.622, 51.0007
	493.643, 52.0007
	488.821, 53.0007
	483.621, 54.0007
	472.351, 54.0011
	469.197, 55.0006
	466.042, 56.0006
	462.864, 57.0006
	459.658, 58.0006
	456.416, 59.0006
	453.128, 60.0006
	449.781, 61.0006
	446.414, 62.0006
	443.048, 63.0006
	439.681, 64.0006
	436.314, 65.0006
	432.947, 66.0006
	429.58, 67.0006
	426.214, 68.0006
	422.847, 69.0006
	419.48, 70.0006
	416.113, 71.0006
	412.746, 72.0006
	409.379, 73.0006
	406.013, 74.0006
	402.646, 75.0006
	399.279, 76.0006
	380.169, 77

	380.158, 77.0006 359.728, 78.069 350.993, 79.0008 339.62, 80.0008 329.986, 81.0008 320.996, 82.0008 312.885, 83.0008 304.088, 84.0008 294.831, 85.0008 287.178, 86.0008 277.94, 87.0008 269.69, 88.0008 262.54, 89.0008 255.066, 90.0008 247.06, 91.0008 240.15, 92.0008 229.798, 93.0008 217.23, 94.0008 197.736, 95.0008 164.467, 96.0008 77.4121, 97.0008 0, 97.89 0, 92 0, 77 0, 70 0, 57 0, 50
Material Boundary	0, 77 372.948, 77 372.961, 77 380.169, 77
Material Boundary	0, 70 413.294, 70 419.48, 70.0006
Material Boundary	0, 57 438.745, 57 462.864, 57.0006
Material Boundary	0, 50 500.418, 50.0007
Material Boundary	0, 92 240.15, 92.0008
Material Boundary	359.728, 78.069 360.368, 78.0012 372.948, 77

Material Boundary	372.961, 77
	383.864, 76.0012
	394.225, 75.0012
	402.312, 74.0012
	407.631, 73.0012
	409.772, 72.0011
	411.678, 71.0011
	413.294, 70
	414.289, 69.0011
	415.094, 68.0011
	416.18, 67.0011
	417.955, 66.0011
	419.963, 65.0011
	421.999, 64.0011
	423.384, 63.0011
	425.538, 62.0011
	427.457, 61.0011
	429.915, 60.0011
	433.661, 59.0011
	436.186, 58.0011
	438.745, 57
	440.556, 56.0011
	442.914, 55.0011
	445.037, 54.0011
	449.053, 53.0011
	465.916, 53.0011
	470.916, 54.0011
	472.351, 54.0011

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 50 554.257, 50	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	399.279, 76.0006 380.169, 77	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Long Term Stability

Shared Entities

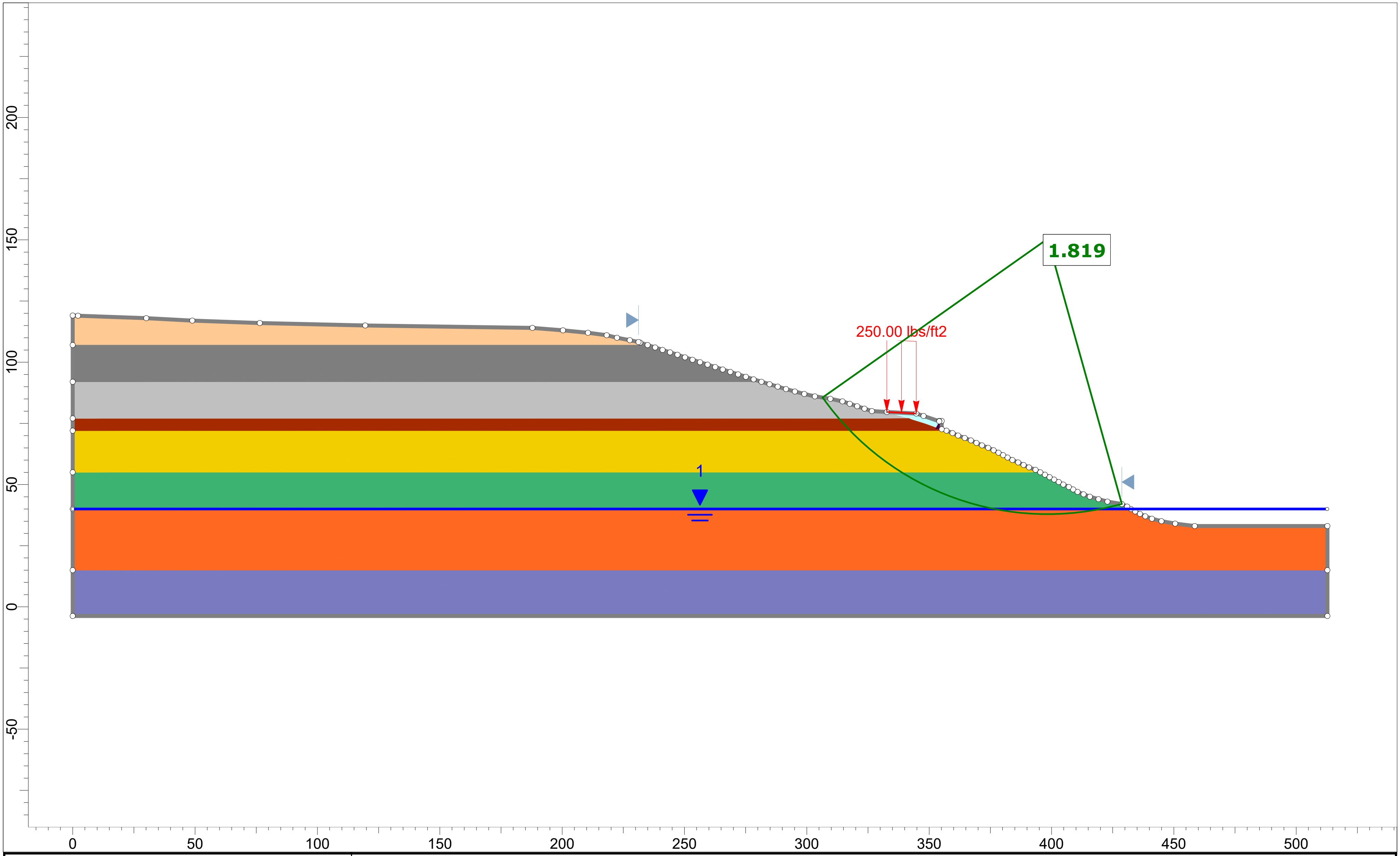
Type	Coordinates (x,y)
	0, 30
	550, 30
	547.472, 37.0007
	543.005, 38.0007
	528.162, 39.0007
	518.319, 40.0007
	515.075, 41.0007
	512.754, 42.0007
	511.142, 43.0007
	509.774, 44.0007
	508.545, 45.0007
	507.336, 46.0007
	506.053, 47.0007

External Boundary	504.699, 48.0007 502.811, 49.0007 500.418, 50.0007 497.622, 51.0007 493.643, 52.0007 488.821, 53.0007 483.621, 54.0007 472.351, 54.0011 469.197, 55.0006 466.042, 56.0006 462.864, 57.0006 459.658, 58.0006 456.416, 59.0006 453.128, 60.0006 449.781, 61.0006 446.414, 62.0006 443.048, 63.0006 439.681, 64.0006 436.314, 65.0006 432.947, 66.0006 429.58, 67.0006 426.214, 68.0006 422.847, 69.0006 419.48, 70.0006 416.113, 71.0006 412.746, 72.0006 409.379, 73.0006 406.013, 74.0006 402.646, 75.0006 399.279, 76.0006 380.169, 77 380.158, 77.0006 359.728, 78.069 350.993, 79.0008 339.62, 80.0008 329.986, 81.0008 320.996, 82.0008 312.885, 83.0008 304.088, 84.0008 294.831, 85.0008 287.178, 86.0008 277.94, 87.0008 269.69, 88.0008 262.54, 89.0008 255.066, 90.0008 247.06, 91.0008 240.15, 92.0008 229.798, 93.0008 217.23, 94.0008 197.736, 95.0008 164.467, 96.0008 77.4121, 97.0008 0, 97.89 0, 92 0, 77 0, 70 0, 57 0, 50

Material Boundary	0, 77 372.948, 77 372.961, 77 380.169, 77
Material Boundary	0, 70 413.294, 70 419.48, 70.0006
Material Boundary	0, 57 438.745, 57 462.864, 57.0006
Material Boundary	0, 50 500.418, 50.0007
Material Boundary	0, 92 240.15, 92.0008
Material Boundary	359.728, 78.069 360.368, 78.0012 372.948, 77
Material Boundary	372.961, 77 383.864, 76.0012 394.225, 75.0012 402.312, 74.0012 407.631, 73.0012 409.772, 72.0011 411.678, 71.0011 413.294, 70 414.289, 69.0011 415.094, 68.0011 416.18, 67.0011 417.955, 66.0011 419.963, 65.0011 421.999, 64.0011 423.384, 63.0011 425.538, 62.0011 427.457, 61.0011 429.915, 60.0011 433.661, 59.0011 436.186, 58.0011 438.745, 57 440.556, 56.0011 442.914, 55.0011 445.037, 54.0011 449.053, 53.0011 465.916, 53.0011 470.916, 54.0011 472.351, 54.0011

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 50 551.308, 50	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	380.158, 77.0006 380.169, 77 399.279, 76.0006	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

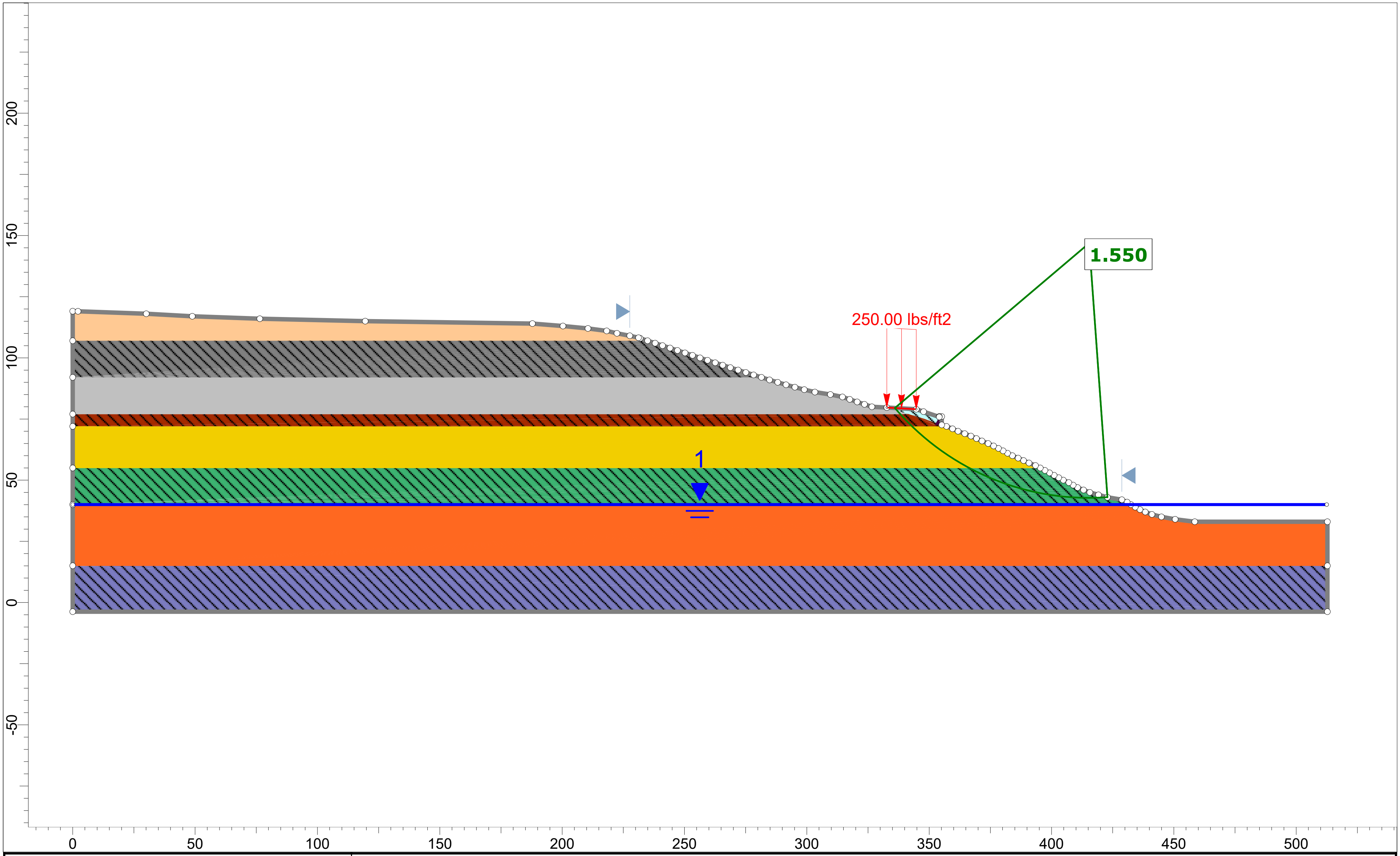


GEOS Universal Engineering Sciences

Geotechnical, Environmental and Materials Engineers

SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 3
Drawn By		*Station*	Approx. STA 15+30
Date		*File Name*	section-3.slmd



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Geotechnical, Environmental and Materials Engineers

SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis	Long Term Slope Stability
Section	Section 3
Drawn By	
Station	Approx. STA 15+30
Date	
File Name	section-3.slmd

GEOS Universal Engineering Sciences
Geotechnical, Environmental and Materials Engineers

Section-3
45-20803 Barrier Wall Road Interim Design and Repair
Approx. STA 15+30
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-3

Project Summary

File Name:	section-3.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Short Term Slope Stability
Comments	
	Section 3 Approx. STA 15+30

Currently Open Scenarios

Group Name		Scenario Name	Global Minimum	Compute Time
Short Term Stability	◆	Master Scenario	Spencer: 1.818970	00h:00m:11.262s
Long Term Stability	◆	Master Scenario	Spencer: 1.549800	00h:00m:01.839s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Short Term Stability

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Long Term Stability

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

All Open Scenarios

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Materials

Retaining Wall	
Color	🟪
Strength Type	Infinite strength
Unit Weight [lbs/ft3]	135
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Ru Value	0
Light Brown Sand	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	⬛
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	⬜
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay	
Color	🟥
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	1100
Cohesion Type	Constant

Water Surface	Assigned per scenario
Ru Value	0
Perched Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	200
Friction Angle [deg]	24
Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Upper Cape Fear Confining Unit	
Color	🟪
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	2500
Cohesion Type	Constant

Water Surface	Assigned per scenario
Ru Value	0
Upper Cape Fear Confining Unit (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill	
Color	🟦
Strength Type	Undrained
Unit Weight [lbs/ft3]	125
Cohesion [psf]	2000
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material	Short Term Stability	Long Term Stability
Retaining Wall 🟪	✓	✓
Light Brown Sand 🟧	✓	✓
Dark Gray Clay ◼	✓	✗
Dark Gray Clay (Drained) ▨	✗	✓
Light Gray Sand ◻	✓	✓
Perched Clay 🟥	✓	✗
Perched Clay (Drained) ▨	✗	✓
Surficial Aquifer 🟨	✓	✓
Black Creek Confining Unit 🟩	✓	✗
Black Creek Confining Unit (Long Term) ▨	✗	✓
Black Creek Aquifer 🟧	✓	✓
Upper Cape Fear Confining Unit 🟦	✓	✗
Upper Cape Fear Confining Unit (Drained) ▨	✗	✓
Compacted Fill ◻	✓	✗
Compacted Fill (Drained) ▨	✗	✓

Global Minimums

◆ Short Term Stability

Method: spencer

FS	1.818970
Center:	398.377, 150.428
Radius:	112.589
Left Slip Surface Endpoint:	306.387, 85.513
Right Slip Surface Endpoint:	428.709, 42.002
Resisting Moment:	1.61725e+07 lb-ft
Driving Moment:	8.89103e+06 lb-ft
Resisting Horizontal Force:	130766 lb
Driving Horizontal Force:	71890.1 lb
Total Slice Area:	2099.89 ft2
Surface Horizontal Width:	122.322 ft
Surface Average Height:	17.1668 ft

◆ Long Term Stability

Method: spencer

FS	1.549800
Center:	415.390, 146.881
Radius:	104.143
Left Slip Surface Endpoint:	335.996, 79.483
Right Slip Surface Endpoint:	422.834, 43.005
Resisting Moment:	6.11618e+06 lb-ft
Driving Moment:	3.94642e+06 lb-ft
Resisting Horizontal Force:	52630.2 lb
Driving Horizontal Force:	33959.3 lb
Total Slice Area:	798.348 ft2
Surface Horizontal Width:	86.8381 ft
Surface Average Height:	9.19352 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Short Term Stability

Method: spencer

Number of Valid Surfaces:	59330
Number of Invalid Surfaces:	0

Long Term Stability

Method: spencer

Number of Valid Surfaces:	11494
Number of Invalid Surfaces:	0

Slice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 1.81897

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.21374	340.835	-53.8358	Light Gray Sand	50	32	51.867	94.3445	70.966	0	70.966	141.926	141.926
2	2.21374	993.525	-51.9669	Light Gray Sand	50	32	113.294	206.079	249.779	0	249.779	394.617	394.617
3	2.21374	1579.9	-50.1731	Light Gray Sand	50	32	171.818	312.531	420.139	0	420.139	626.164	626.164
4	2.2842	2177.94	-48.4179	Perched Clay	1100	0	604.738	1100	320.11	0	320.11	1001.67	1001.67
5	2.2842	2623.65	-46.6947	Perched Clay	1100	0	604.738	1100	513.107	0	513.107	1154.72	1154.72
6	2.33679	3103.6	-45.0063	Surficial Aquifer	75	32	334.897	609.167	854.845	0	854.845	1189.82	1189.82
7	2.33679	3505.53	-43.3476	Surficial Aquifer	75	32	381.971	694.793	991.874	0	991.874	1352.42	1352.42
8	2.33679	3873.12	-41.7332	Surficial Aquifer	75	32	427.04	776.773	1123.07	0	1123.07	1503.99	1503.99
9	2.33679	4211.94	-40.1584	Surficial Aquifer	75	32	470.427	855.692	1249.37	0	1249.37	1646.32	1646.32
10	2.33679	4630.65	-38.6193	Surficial Aquifer	75	32	523.366	951.987	1403.47	0	1403.47	1821.56	1821.56
11	2.33679	5084.41	-37.1126	Surficial Aquifer	75	32	581.504	1057.74	1572.71	0	1572.71	2012.7	2012.7
12	2.33679	5514.53	-35.6354	Surficial Aquifer	75	32	672.611	1223.46	1837.92	0	1837.92	2320.09	2320.09
13	2.33679	5930.87	-34.185	Surficial Aquifer	75	32	760.623	1383.55	2094.12	0	2094.12	2610.75	2610.75
14	2.33679	6324.03	-32.7592	Surficial Aquifer	75	32	817.496	1487	2259.68	0	2259.68	2785.69	2785.69
15	2.51931	7242.92	-31.3018	Black Creek Confining Unit	922.976	0	507.417	922.976	2543.84	0	2543.84	2852.38	2852.38
16	2.51931	7670.58	-29.8128	Black Creek Confining Unit	967.608	0	531.954	967.608	2719.8	0	2719.8	3024.61	3024.61
17	2.51931	8041.35	-28.3456	Black Creek Confining Unit	1009.65	0	555.067	1009.65	2751.6	0	2751.6	3051.05	3051.05
18	2.51931	8223.74	-26.8984	Black Creek Confining Unit	1049.21	0	576.815	1049.21	2754.02	0	2754.02	3046.64	3046.64
19	2.51931	8363.6	-25.4695	Black Creek Confining Unit	1086.38	0	597.25	1086.38	2834.95	0	2834.95	3119.44	3119.44
20	2.51931	8510.89	-24.0574	Black Creek Confining Unit	1121.25	0	616.42	1121.25	2919.83	0	2919.83	3195.02	3195.02
21	2.51931	8253.76	-22.6607	Black Creek Confining Unit	1153.9	0	634.37	1153.9	2861.46	0	2861.46	3126.31	3126.31
22	2.51931	7734.39	-21.2781	Black Creek Confining Unit	1184.39	0	651.132	1184.39	2708.06	0	2708.06	2961.64	2961.64

23	2.51931	7722.97	-19.9084	Black Creek Confining Unit	1212.79	0	666.745	1212.79	2736.64	0	2736.64	2978.11	2978.11
24	2.51931	7685.12	-18.5504	Black Creek Confining Unit	1239.16	0	681.243	1239.16	2755.98	0	2755.98	2984.59	2984.59
25	2.51931	7654.01	-17.2031	Black Creek Confining Unit	1263.54	0	694.646	1263.54	2778.04	0	2778.04	2993.12	2993.12
26	2.51931	7583.33	-15.8656	Black Creek Confining Unit	1285.98	0	706.983	1285.98	2785.76	0	2785.76	2986.69	2986.69
27	2.51931	7470.6	-14.537	Black Creek Confining Unit	1306.52	0	718.275	1306.52	2777.89	0	2777.89	2964.15	2964.15
28	2.51931	7352.5	-13.2162	Black Creek Confining Unit	1325.2	0	728.544	1325.2	2767.86	0	2767.86	2938.95	2938.95
29	2.51931	7214.41	-11.9026	Black Creek Confining Unit	1342.04	0	737.802	1342.04	2750.08	0	2750.08	2905.59	2905.59
30	2.43943	6795.44	-10.616	Black Creek Aquifer	0	33	968.993	1762.57	2728.26	14.1304	2714.13	2909.88	2895.75
31	2.43943	6566.31	-9.35535	Black Creek Aquifer	0	33	939.449	1708.83	2672.31	40.9351	2631.37	2827.08	2786.15
32	2.43943	6307.02	-8.09929	Black Creek Aquifer	0	33	905.864	1647.74	2601.6	64.3053	2537.29	2730.51	2666.2
33	2.43943	6075.19	-6.84714	Black Creek Aquifer	0	33	876.672	1594.64	2539.81	84.2756	2455.53	2645.07	2560.8
34	2.43943	5854.79	-5.59827	Black Creek Aquifer	0	33	849.635	1545.46	2480.67	100.875	2379.8	2563.96	2463.08
35	2.43943	5609.16	-4.35206	Black Creek Aquifer	0	33	819.2	1490.1	2408.68	114.128	2294.55	2471.03	2356.9
36	2.43943	5378.39	-3.10791	Black Creek Aquifer	0	33	791.47	1439.66	2340.94	124.053	2216.88	2383.91	2259.86
37	2.43943	5102.92	-1.86523	Black Creek Aquifer	0	33	757.126	1377.19	2251.35	130.664	2120.69	2276.01	2145.35
38	2.43943	4749.32	-0.623429	Black Creek Aquifer	0	33	710.506	1292.39	2124.07	133.97	1990.1	2131.8	1997.83
39	2.43943	4371.29	0.618081	Black Creek Aquifer	0	33	659.802	1200.16	1982.05	133.978	1848.08	1974.94	1840.96
40	2.43943	3975.28	1.85988	Black Creek Aquifer	0	33	605.887	1102.09	1827.76	130.685	1697.07	1808.08	1677.4
41	2.43943	3566.31	3.10256	Black Creek Aquifer	0	33	549.455	999.442	1663.09	124.088	1539.01	1633.31	1509.22
42	2.43943	3182.81	4.3467	Black Creek Aquifer	0	33	496.939	903.917	1506.09	114.178	1391.91	1468.32	1354.14
43	2.43943	2734.7	5.5929	Black Creek Aquifer	0	33	432.881	787.398	1313.43	100.939	1212.49	1271.04	1170.1
44	2.43943	2307.86	6.84175	Black Creek Aquifer	0	33	371.847	676.378	1125.89	84.3543	1041.53	1081.27	996.916
45	2.43943	1929.14	8.09389	Black Creek Aquifer	0	33	318.774	579.841	957.273	64.3986	892.875	911.94	847.541

46	2.43943	1573.46	9.34993	Black Creek Aquifer	0	33	269.475	490.167	795.833	41.0431	754.79	751.463	710.42
47	2.43943	1247.37	10.6105	Black Creek Aquifer	0	33	225.335	409.878	645.409	14.2533	631.156	603.196	588.942
48	2.79407	1011.16	11.9688	Black Creek Confining Unit	990.428	0	544.499	990.428	661.801	0	661.801	546.374	546.374
49	2.79407	600.543	13.4265	Black Creek Confining Unit	953.731	0	524.325	953.731	514.388	0	514.388	389.22	389.22
50	2.79407	204.432	14.8931	Black Creek Confining Unit	918.289	0	504.84	918.289	369.802	0	369.802	235.54	235.54

◆ Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 1.5498

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.947213	62.0379	-49.2723	Compacted Fill (Drained)	200	28	171.88	266.38	124.842	0	124.842	324.476	324.476
2	1.22975	255.816	-48.3638	Light Gray Sand	50	32	134.028	207.716	252.398	0	252.398	403.165	403.165
3	1.61204	608.73	-47.202	Perched Clay (Drained)	200	24	225.231	349.063	334.802	0	334.802	578.046	578.046
4	1.61204	900.388	-45.9119	Perched Clay (Drained)	200	24	261.414	405.139	460.75	0	460.75	730.62	730.62
5	1.61204	1180.19	-44.6512	Perched Clay (Drained)	200	24	297.317	460.782	585.723	0	585.723	879.442	879.442
6	1.79613	1639.72	-43.3484	Surficial Aquifer	75	32	334.735	518.772	710.184	0	710.184	1026.16	1026.16
7	1.79613	1912.94	-42.004	Surficial Aquifer	75	32	318.893	494.22	670.891	0	670.891	958.063	958.063
8	1.79613	2119.77	-40.6875	Surficial Aquifer	75	32	355.579	551.076	761.881	0	761.881	1067.59	1067.59
9	1.79613	2312.06	-39.3965	Surficial Aquifer	75	32	391.192	606.27	850.211	0	850.211	1171.5	1171.5
10	1.79613	2491.3	-38.129	Surficial Aquifer	75	32	425.826	659.945	936.109	0	936.109	1270.35	1270.35
11	1.79613	2688.25	-36.8832	Surficial Aquifer	75	32	464.175	719.379	1031.22	0	1031.22	1379.52	1379.52
12	1.79613	2732.12	-35.6573	Surficial Aquifer	75	32	479.166	742.612	1068.41	0	1068.41	1412.18	1412.18
13	1.79613	2306.27	-34.4501	Surficial Aquifer	75	32	418.142	648.037	917.051	0	917.051	1203.9	1203.9
14	1.79613	2419.28	-33.26	Surficial Aquifer	75	32	443.602	687.494	980.194	0	980.194	1271.14	1271.14
15	1.79613	2502.87	-32.0859	Surficial Aquifer	75	32	464.718	720.22	1032.57	0	1032.57	1323.93	1323.93
16	1.79613	2571.32	-30.9268	Surficial Aquifer	75	32	483.688	749.619	1079.61	0	1079.61	1369.4	1369.4
17	1.79613	2648.03	-29.7815	Surficial Aquifer	75	32	504.447	781.792	1131.11	0	1131.11	1419.79	1419.79
18	1.79613	2712.98	-28.6492	Surficial Aquifer	75	32	523.55	811.398	1178.48	0	1178.48	1464.52	1464.52
19	1.76485	2716.69	-27.5387	Black Creek Confining Unit (Long Term)	125	26	467.56	724.624	1229.41	0	1229.41	1473.21	1473.21
20	1.76485	2750.35	-26.4489	Black Creek Confining Unit (Long Term)	125	26	478.192	741.102	1263.2	0	1263.2	1501.08	1501.08
21	1.76485	2775.08	-25.3694	Black Creek Confining Unit (Long Term)	125	26	487.636	755.738	1293.2	0	1293.2	1524.43	1524.43
22	1.76485	2799.52	-24.2994	Black Creek Confining Unit (Long Term)	125	26	497.135	770.46	1323.39	0	1323.39	1547.85	1547.85
23	1.76485	2818.48	-23.2384	Black Creek Confining Unit (Long Term)	125	26	505.91	784.06	1351.28	0	1351.28	1568.51	1568.51

24	1.76485	2811.46	-22.1857	Black Creek Confining Unit (Long Term)	125	26	510.794	791.629	1366.79	0	1366.79	1575.09	1575.09
25	1.76485	2783.43	-21.1409	Black Creek Confining Unit (Long Term)	125	26	512.412	794.136	1371.93	0	1371.93	1570.08	1570.08
26	1.76485	2739.47	-20.1034	Black Creek Confining Unit (Long Term)	125	26	511.443	792.635	1368.85	0	1368.85	1556.05	1556.05
27	1.76485	2677.55	-19.0727	Black Creek Confining Unit (Long Term)	125	26	507.475	786.484	1356.24	0	1356.24	1531.7	1531.7
28	1.76485	2615.04	-18.0484	Black Creek Confining Unit (Long Term)	125	26	503.202	779.862	1342.67	0	1342.67	1506.64	1506.64
29	1.76485	2566.66	-17.03	Black Creek Confining Unit (Long Term)	125	26	501.027	776.492	1335.75	0	1335.75	1489.22	1489.22
30	1.76485	2523.13	-16.0172	Black Creek Confining Unit (Long Term)	125	26	499.503	774.129	1330.91	0	1330.91	1474.3	1474.3
31	1.76485	2466.89	-15.0095	Black Creek Confining Unit (Long Term)	125	26	495.727	768.278	1318.92	0	1318.92	1451.83	1451.83
32	1.76485	2402.03	-14.0065	Black Creek Confining Unit (Long Term)	125	26	490.317	759.894	1301.72	0	1301.72	1424.03	1424.03
33	1.76485	2347.9	-13.0078	Black Creek Confining Unit (Long Term)	125	26	486.536	754.033	1289.71	0	1289.71	1402.1	1402.1
34	1.76485	2286.29	-12.0132	Black Creek Confining Unit (Long Term)	125	26	481.293	745.908	1273.05	0	1273.05	1375.47	1375.47
35	1.76485	2179.02	-11.0222	Black Creek Confining Unit (Long Term)	125	26	467.84	725.059	1230.3	0	1230.3	1321.43	1321.43
36	1.76485	2052.9	-10.0346	Black Creek Confining Unit (Long Term)	125	26	450.645	698.409	1175.66	0	1175.66	1255.4	1255.4
37	1.76485	1918.07	-9.04998	Black Creek Confining Unit (Long Term)	125	26	431.404	668.59	1114.53	0	1114.53	1183.24	1183.24
38	1.76485	1775.32	-8.06803	Black Creek Confining Unit (Long Term)	125	26	410.194	635.719	1047.13	0	1047.13	1105.27	1105.27

39	1.76485	1625.76	-7.08847	Black Creek Confining Unit (Long Term)	125	26	387.162	600.023	973.94	0	973.94	1022.08	1022.08
40	1.76485	1469.41	-6.11098	Black Creek Confining Unit (Long Term)	125	26	362.249	561.414	894.78	0	894.78	933.564	933.564
41	1.76485	1330.26	-5.13528	Black Creek Confining Unit (Long Term)	125	26	339.932	526.826	823.865	0	823.865	854.414	854.414
42	1.76485	1176.65	-4.16107	Black Creek Confining Unit (Long Term)	125	26	314.256	487.034	742.281	0	742.281	765.144	765.144
43	1.76485	991.419	-3.18806	Black Creek Confining Unit (Long Term)	125	26	281.776	436.696	639.068	0	639.068	654.763	654.763
44	1.76485	822.95	-2.21597	Black Creek Confining Unit (Long Term)	125	26	251.736	390.141	543.62	0	543.62	553.361	553.361
45	1.76485	682.916	-1.24452	Black Creek Confining Unit (Long Term)	125	26	226.563	351.128	463.631	0	463.631	468.553	468.553
46	1.76485	541.177	-0.273432	Black Creek Confining Unit (Long Term)	125	26	200.38	310.549	380.431	0	380.431	381.388	381.388
47	1.76485	417.067	0.697581	Black Creek Confining Unit (Long Term)	125	26	177.098	274.467	306.452	0	306.452	304.296	304.296
48	1.76485	304.366	1.66879	Black Creek Confining Unit (Long Term)	125	26	155.552	241.074	237.986	0	237.986	233.454	233.454
49	1.76485	186.497	2.64049	Black Creek Confining Unit (Long Term)	125	26	132.336	205.095	164.219	0	164.219	158.116	158.116
50	1.76485	63.2261	3.61294	Black Creek Confining Unit (Long Term)	125	26	107.926	167.264	86.6545	0	86.6545	79.8399	79.8399

Interslice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 1.81897

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	306.387	85.5132	0	0	0
2	308.6	82.4846	100.162	26.9315	15.0497
3	310.814	79.6545	556.361	149.595	15.0498
4	313.028	77	1291.41	347.236	15.0498
5	315.312	74.4256	734.751	197.56	15.0498
6	317.596	72.0021	597.513	160.66	15.0498
7	319.933	69.6648	1813.3	487.561	15.0498
8	322.27	67.4591	3108.93	835.929	15.0497
9	324.606	65.3747	4452.42	1197.17	15.0498
10	326.943	63.4028	5817.14	1564.12	15.0498
11	329.28	61.5361	7214.57	1939.86	15.0498
12	331.617	59.768	8637.03	2322.33	15.0498
13	333.954	58.0928	10144.8	2727.73	15.0497
14	336.29	56.5057	11691.9	3143.72	15.0498
15	338.627	55.0021	13180	3543.85	15.0498
16	341.147	53.4702	15799.1	4248.06	15.0497
17	343.666	52.0266	18385.7	4943.56	15.0498
18	346.185	50.6675	20727.6	5573.25	15.0498
19	348.704	49.3895	22794.8	6129.07	15.0498
20	351.224	48.1895	24692.7	6639.39	15.0498
21	353.743	47.0648	26424.4	7104.99	15.0497
22	356.262	46.013	27836.6	7484.72	15.0498
23	358.782	45.0319	28853.9	7758.24	15.0498
24	361.301	44.1195	29671.7	7978.15	15.0498
25	363.82	43.2741	30286.2	8143.36	15.0498
26	366.34	42.494	30703.8	8255.65	15.0498
27	368.859	41.778	30918.1	8313.26	15.0497
28	371.378	41.1248	30924	8314.86	15.0498
29	373.897	40.5331	30727	8261.88	15.0498
30	376.417	40.0021	30329.4	8154.98	15.0498
31	378.856	39.5449	29214	7855.09	15.0498
32	381.296	39.143	27997.3	7527.92	15.0498
33	383.735	38.7958	26691.6	7176.85	15.0498
34	386.175	38.5029	25297.9	6802.11	15.0498
35	388.614	38.2638	23819.3	6404.55	15.0498
36	391.053	38.0781	22269	5987.69	15.0498
37	393.493	37.9457	20649.1	5552.15	15.0498
38	395.932	37.8662	18981.8	5103.84	15.0498
39	398.372	37.8397	17305.7	4653.17	15.0498
40	400.811	37.866	15644.7	4206.56	15.0498
41	403.251	37.9452	14022.5	3770.39	15.0498
42	405.69	38.0774	12462.9	3351.02	15.0497
43	408.129	38.2629	10971.9	2950.12	15.0497
44	410.569	38.5017	9602.58	2581.95	15.0498
45	413.008	38.7944	8366.34	2249.55	15.0498
46	415.448	39.1414	7256.95	1951.25	15.0498
47	417.887	39.543	6280.22	1688.63	15.0498
48	420.327	40	5435.82	1461.59	15.0498
49	423.121	40.5923	3523.11	947.296	15.0498
50	425.915	41.2593	1715.64	461.303	15.0498
51	428.709	42.0024	0	0	0

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 1.5498

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	335.996	79.4835	0	0	0
2	336.944	78.3833	-25.3055	-9.61737	20.8093
3	338.173	77	159.183	60.4979	20.8094
4	339.785	75.259	379.326	144.163	20.8093
5	341.397	73.5948	725.093	275.572	20.8093
6	343.009	72.0023	1179.05	448.099	20.8093
7	344.806	70.3069	1782.48	677.433	20.8093
8	346.602	68.6894	2295.4	872.369	20.8093
9	348.398	67.1451	2833.86	1077.01	20.8093
10	350.194	65.67	3386.11	1286.9	20.8094
11	351.99	64.2602	3941.74	1498.06	20.8093
12	353.786	62.9124	4498.64	1709.71	20.8093
13	355.582	61.6238	5015.59	1906.18	20.8093
14	357.379	60.3916	5395.2	2050.45	20.8093
15	359.175	59.2136	5753.91	2186.78	20.8094
16	360.971	58.0875	6082.78	2311.77	20.8094
17	362.767	57.0114	6376.62	2423.44	20.8093
18	364.563	55.9835	6634.08	2521.29	20.8094
19	366.359	55.0022	6851.04	2603.75	20.8094
20	368.124	54.082	7158	2720.41	20.8094
21	369.889	53.204	7423.9	2821.46	20.8093
22	371.654	52.3672	7646.35	2906	20.8093
23	373.419	51.5703	7824.34	2973.65	20.8094
24	375.183	50.8125	7956.35	3023.82	20.8094
25	376.948	50.0928	8039.43	3055.39	20.8093
26	378.713	49.4104	8072.23	3067.86	20.8094
27	380.478	48.7644	8054.7	3061.2	20.8094
28	382.243	48.1542	7987.5	3035.66	20.8094
29	384.008	47.5791	7872.42	2991.92	20.8093
30	385.773	47.0385	7711.11	2930.62	20.8094
31	387.537	46.5319	7504.69	2852.17	20.8094
32	389.302	46.0587	7254.75	2757.18	20.8094
33	391.067	45.6185	6963.31	2646.42	20.8094
34	392.832	45.2108	6631.28	2520.23	20.8094
35	394.597	44.8352	6260.79	2379.42	20.8093
36	396.362	44.4914	5858.84	2226.66	20.8094
37	398.127	44.1791	5431.42	2064.22	20.8094
38	399.891	43.898	4984.08	1894.21	20.8094
39	401.656	43.6479	4522.8	1718.9	20.8094
40	403.421	43.4284	4053.91	1540.69	20.8093
41	405.186	43.2395	3584.27	1362.21	20.8094
42	406.951	43.0808	3115.59	1184.08	20.8093
43	408.716	42.9525	2656.81	1009.72	20.8093
44	410.481	42.8541	2222.81	844.781	20.8093
45	412.245	42.7859	1816.08	690.203	20.8093
46	414.01	42.7475	1434.39	545.14	20.8093
47	415.775	42.7391	1084.29	412.085	20.8093
48	417.54	42.7606	765.448	290.909	20.8093
49	419.305	42.812	478.947	182.024	20.8093
50	421.07	42.8934	232.25	88.2669	20.8094
51	422.834	43.0048	0	0	0

Discharge Sections

Entity Information

Short Term Stability

Shared Entities

Type	Coordinates (x,y)
	0, 119.08
	0, 107
	0, 92
	0, 77
	0, 72
	0, 55
	0, 40
	0, 15
	0, -3.759
	512.725, -3.759
	512.725, 15
	512.725, 33.0024
	458.538, 33.0024
	450.508, 34.0024
	444.906, 35.0024
	441.031, 36.0024
	438.308, 37.0024
	436.136, 38.0024
	434.215, 39.0024
	432.419, 40.0024
	430.921, 41.0024
	428.709, 42.0024
	422.843, 43.0024
	419.209, 44.0024
	415.649, 45.0024
	413.091, 46.0024
	410.631, 47.0024
	408.857, 48.0024
	407.063, 49.0024
	404.798, 50.0024
	402.938, 51.0024
	401.061, 52.0024
	399.186, 53.0024
	397.295, 54.0024
	395.395, 55.0024
	393.457, 56.0024
	390.783, 57.0024
	388.576, 58.0024
	386.34, 59.0024
	383.995, 60.0024
	382.013, 61.0024
	380.222, 62.0024
	378.302, 63.0024
	376.305, 64.0024

External Boundary	374.125, 65.0024 371.595, 66.0024 369.307, 67.0024 367.04, 68.0024 364.513, 69.0024 361.821, 70.0024 359.54, 71.0024 357.075, 72.0024 355.122, 72.5983 355.12, 76.0024 354.122, 76.0024 354.122, 75.8368 347.719, 78.0023 344.721, 79.0023 332.71, 79.6647 326.589, 80.0023 323.571, 81.0023 320.566, 82.0023 317.551, 83.0023 314.537, 84.0023 309.609, 85.0023 303.302, 86.0023 298.936, 87.0023 295.099, 88.0023 291.517, 89.0023 288.084, 90.0023 284.746, 91.0023 281.475, 92.0023 278.251, 93.0023 275.063, 94.0023 271.903, 95.0023 268.764, 96.0023 265.644, 97.0023 262.538, 98.0023 259.443, 99.0023 256.359, 100.002 253.283, 101.002 250.214, 102.002 247.152, 103.002 244.095, 104.002 241.043, 105.002 237.995, 106.002 234.951, 107.002 231.91, 108.002 231.233, 108.225 227.672, 109.002 222.401, 110.002 218.196, 111.002 210.563, 112.002 200.351, 113.002 187.864, 114.002 119.555, 115.002 76.4538, 116.002 48.8383, 117.002 30.0398, 118.002 2.1595, 119.002
Material Boundary	0, 77 341.696, 77

Material Boundary	0, 72 357.075, 72.0024
Material Boundary	0, 55 395.395, 55.0024
Material Boundary	0, 40 432.419, 40.0024
Material Boundary	0, 15 512.725, 15
Material Boundary	0, 92 281.475, 92.0023
Material Boundary	0, 107 234.951, 107.002
Material Boundary	332.71, 79.6647 334.752, 79.0001 338.305, 78.0001 341.696, 77 345.063, 76.0001 348.3, 75.0001 351.032, 74.0001 352.755, 73.3799 353.81, 73.0001 355.122, 72.5983
Material Boundary	352.32, 72.5983 352.755, 73.3799 354.122, 75.8368
Material Boundary	352.32, 72.5983 355.122, 72.5983

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 40 512.659, 40	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	332.71, 79.6647 344.721, 79.0023	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Long Term Stability

Shared Entities

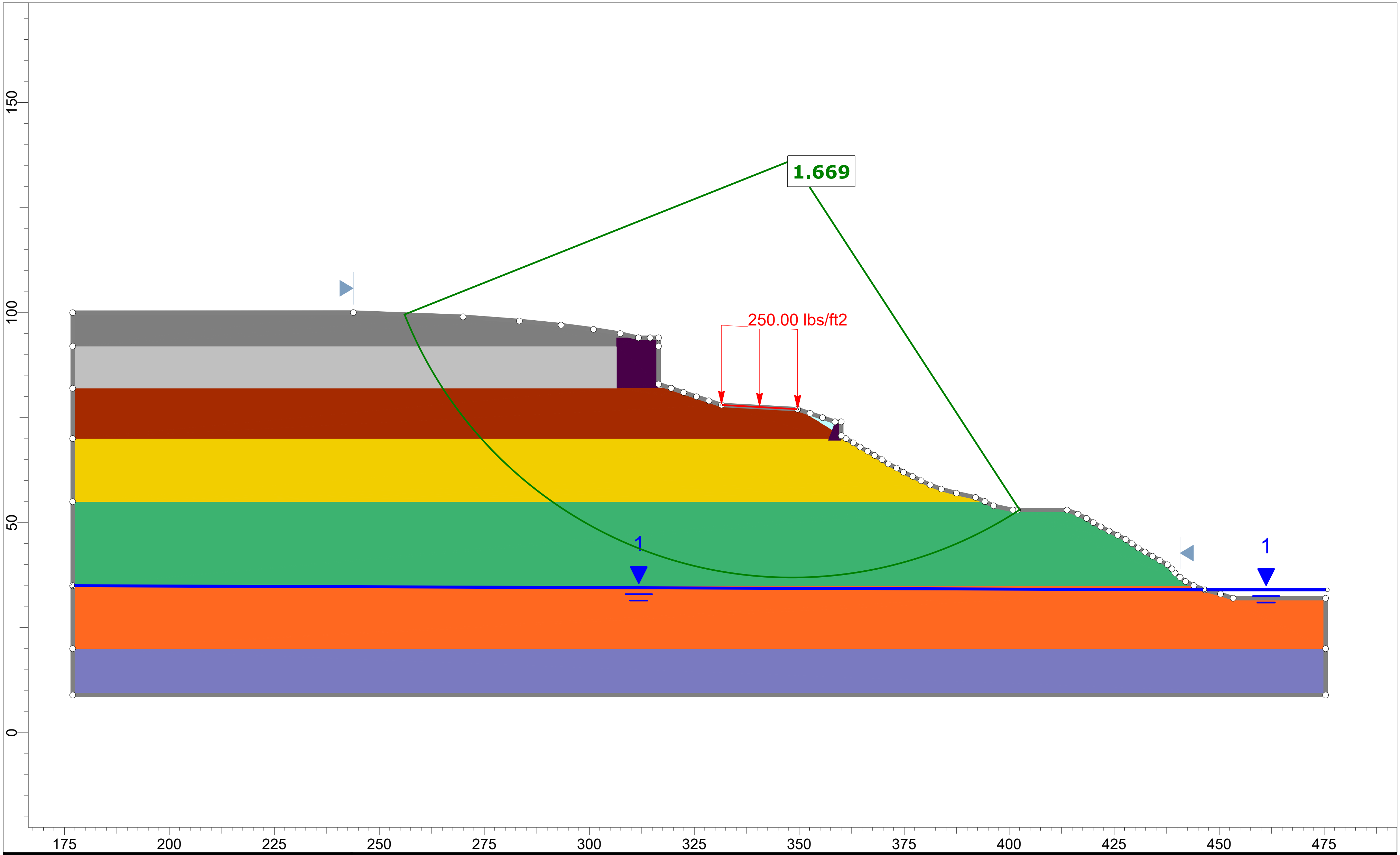
Type	Coordinates (x,y)
	0, 119.08 0, 107 0, 92 0, 77 0, 72 0, 55 0, 40 0, 15 0, -3.759 512.725, -3.759 512.725, 15 512.725, 33.0024 458.538, 33.0024

External Boundary	450.508, 34.0024
	444.906, 35.0024
	441.031, 36.0024
	438.308, 37.0024
	436.136, 38.0024
	434.215, 39.0024
	432.419, 40.0024
	430.921, 41.0024
	428.709, 42.0024
	422.843, 43.0024
	419.209, 44.0024
	415.649, 45.0024
	413.091, 46.0024
	410.631, 47.0024
	408.857, 48.0024
	407.063, 49.0024
	404.798, 50.0024
	402.938, 51.0024
	401.061, 52.0024
	399.186, 53.0024
	397.295, 54.0024
	395.395, 55.0024
	393.457, 56.0024
	390.783, 57.0024
	388.576, 58.0024
	386.34, 59.0024
	383.995, 60.0024
	382.013, 61.0024
	380.222, 62.0024
	378.302, 63.0024
	376.305, 64.0024
	374.125, 65.0024
	371.595, 66.0024
	369.307, 67.0024
	367.04, 68.0024
	364.513, 69.0024
	361.821, 70.0024
	359.54, 71.0024
	357.075, 72.0024
	355.122, 72.5983
	355.12, 76.0024
	354.122, 76.0024
	354.122, 75.8368
	347.719, 78.0023
	344.721, 79.0023
	332.71, 79.6647
	326.589, 80.0023
	323.571, 81.0023
	320.566, 82.0023
	317.551, 83.0023
	314.537, 84.0023
	309.609, 85.0023
	303.302, 86.0023
	298.936, 87.0023
	295.099, 88.0023
	291.517, 89.0023
	288.084, 90.0023
	284.746, 91.0023
	281.475, 92.0023

	278.251, 93.0023 275.063, 94.0023 271.903, 95.0023 268.764, 96.0023 265.644, 97.0023 262.538, 98.0023 259.443, 99.0023 256.359, 100.002 253.283, 101.002 250.214, 102.002 247.152, 103.002 244.095, 104.002 241.043, 105.002 237.995, 106.002 234.951, 107.002 231.91, 108.002 231.233, 108.225 227.672, 109.002 222.401, 110.002 218.196, 111.002 210.563, 112.002 200.351, 113.002 187.864, 114.002 119.555, 115.002 76.4538, 116.002 48.8383, 117.002 30.0398, 118.002 2.1595, 119.002
Material Boundary	0, 77 341.696, 77
Material Boundary	0, 72 357.075, 72.0024
Material Boundary	0, 55 395.395, 55.0024
Material Boundary	0, 40 432.419, 40.0024
Material Boundary	0, 15 512.725, 15
Material Boundary	0, 92 281.475, 92.0023
Material Boundary	0, 107 234.951, 107.002
Material Boundary	332.71, 79.6647 334.752, 79.0001 338.305, 78.0001 341.696, 77 345.063, 76.0001 348.3, 75.0001 351.032, 74.0001 352.755, 73.3799 353.81, 73.0001 355.122, 72.5983
Material Boundary	354.122, 75.8368 352.755, 73.3799 352.32, 72.5983 355.122, 72.5983

Scenario-based Entities

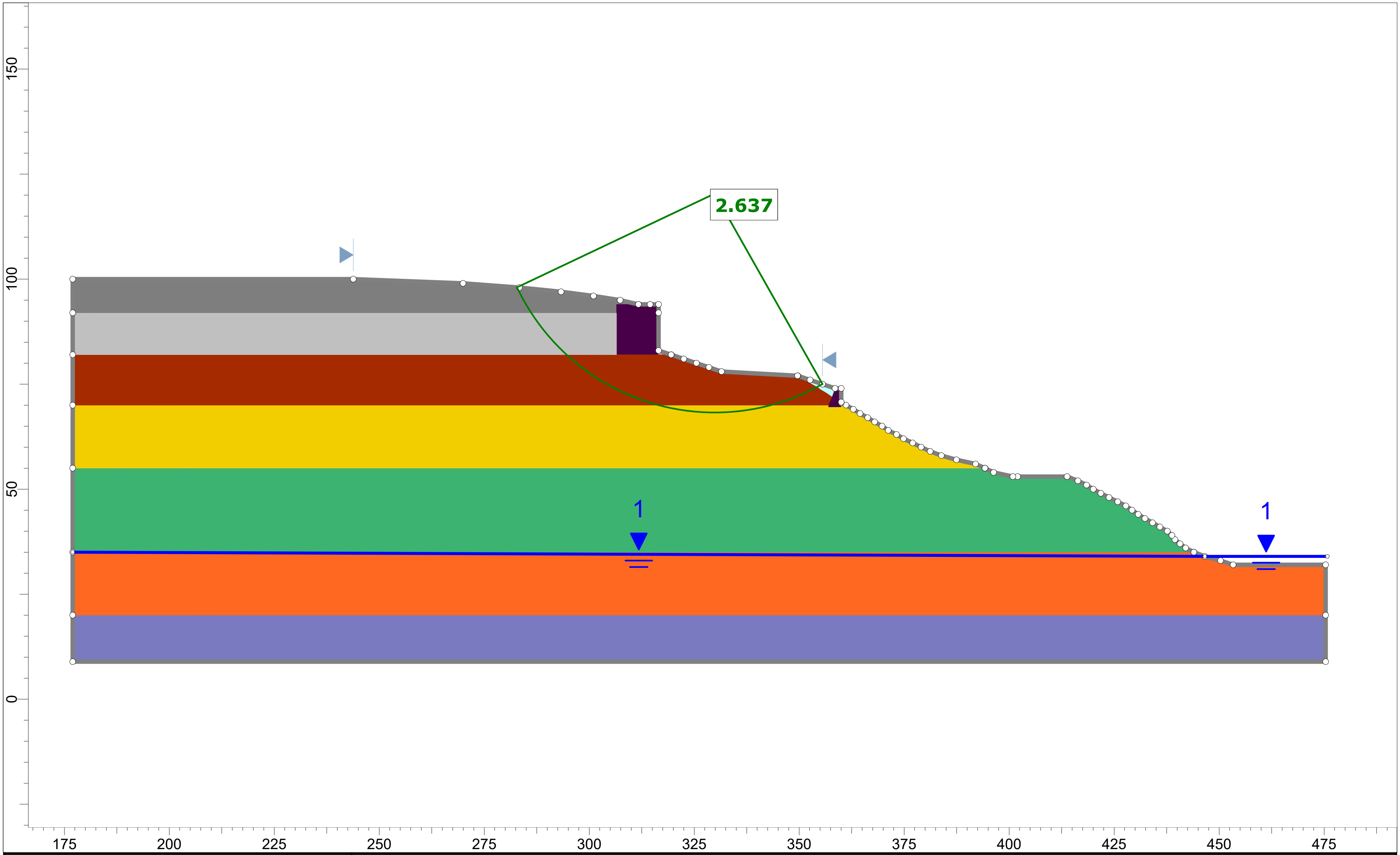
Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 40 512.471, 40	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)
Distributed Load	332.71, 79.6647 344.721, 79.0023	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No



GEOS Universal Engineering Sciences
Geotechnical, Environmental and Materials Engineers

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Short Term Slope Stability	*Section* Section 4
Drawn By	*Station* Approx STA 22+60
Date	*File Name* section-4.slmd

SLIDEINTERPRET 9.020

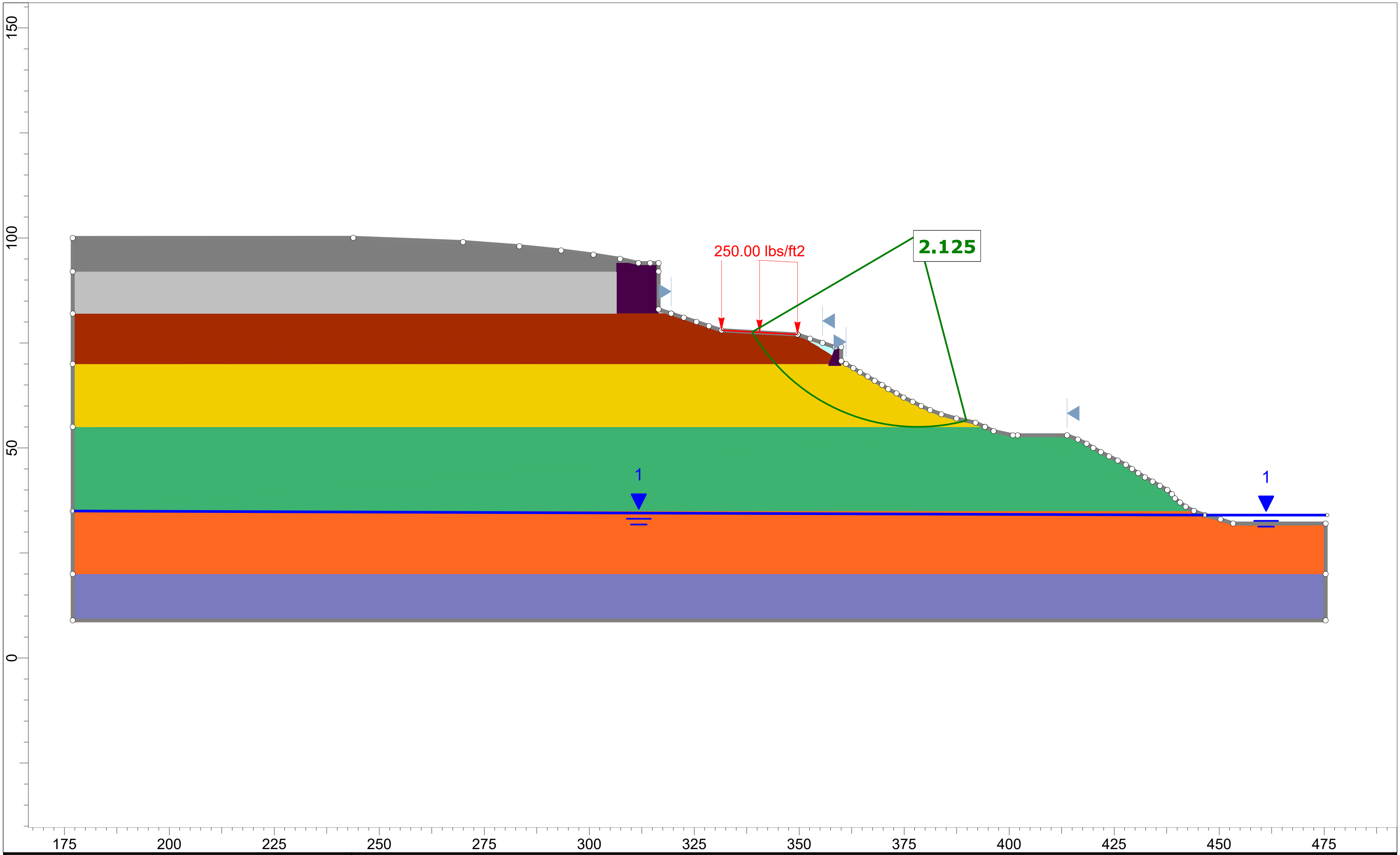


GEOS Universal Engineering Sciences

Geotechnical, Environmental and Materials Engineers

SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis	Short Term Slope Stability
Section	Section 4 - Upper Wall
Drawn By	
Station	Approx STA 22+60
Date	
File Name	section-4.slmd



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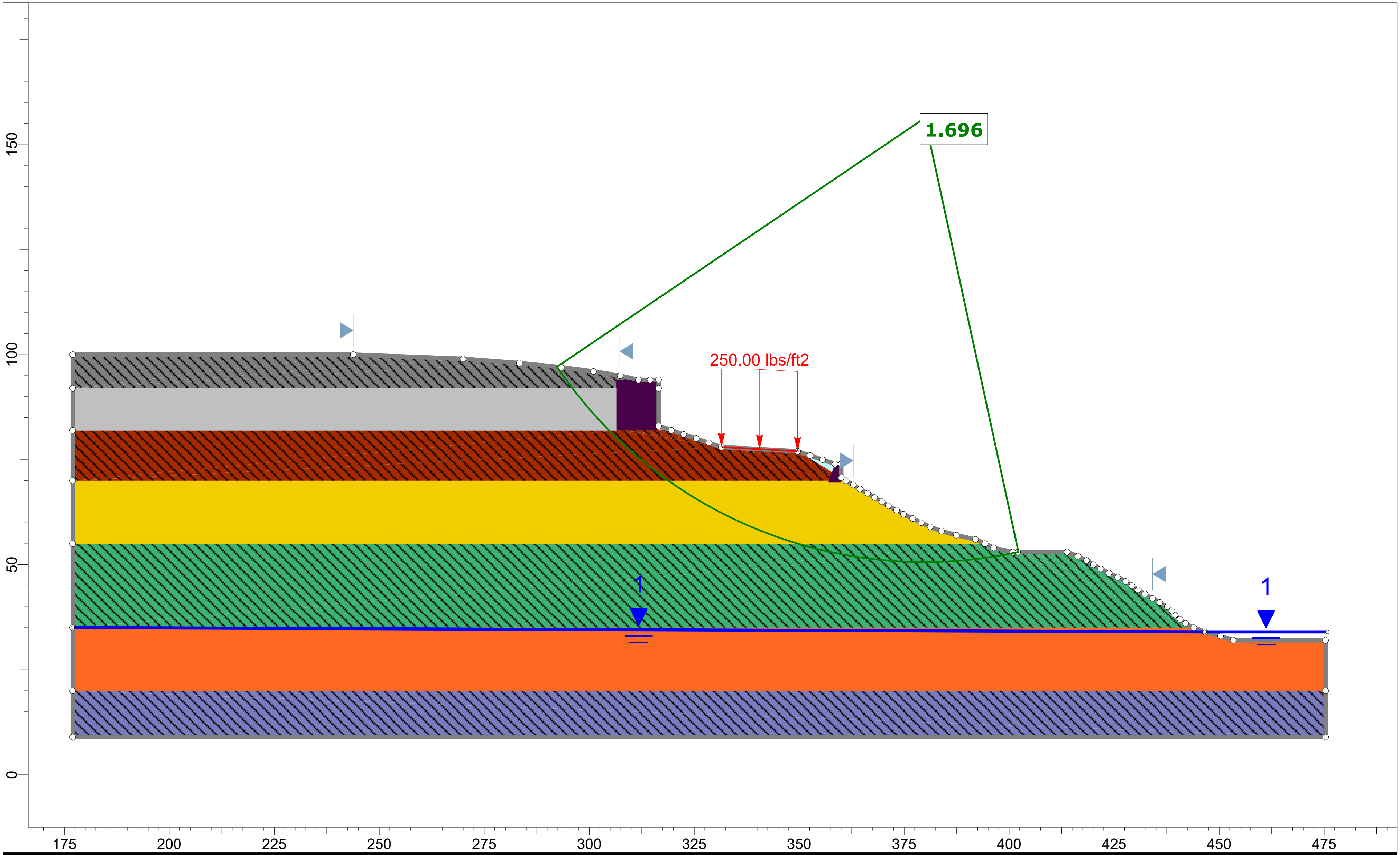
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 4 - Lower Wall
Drawn By		*Station*	Approx STA 22+60
Date		*File Name*	section-4.slmd

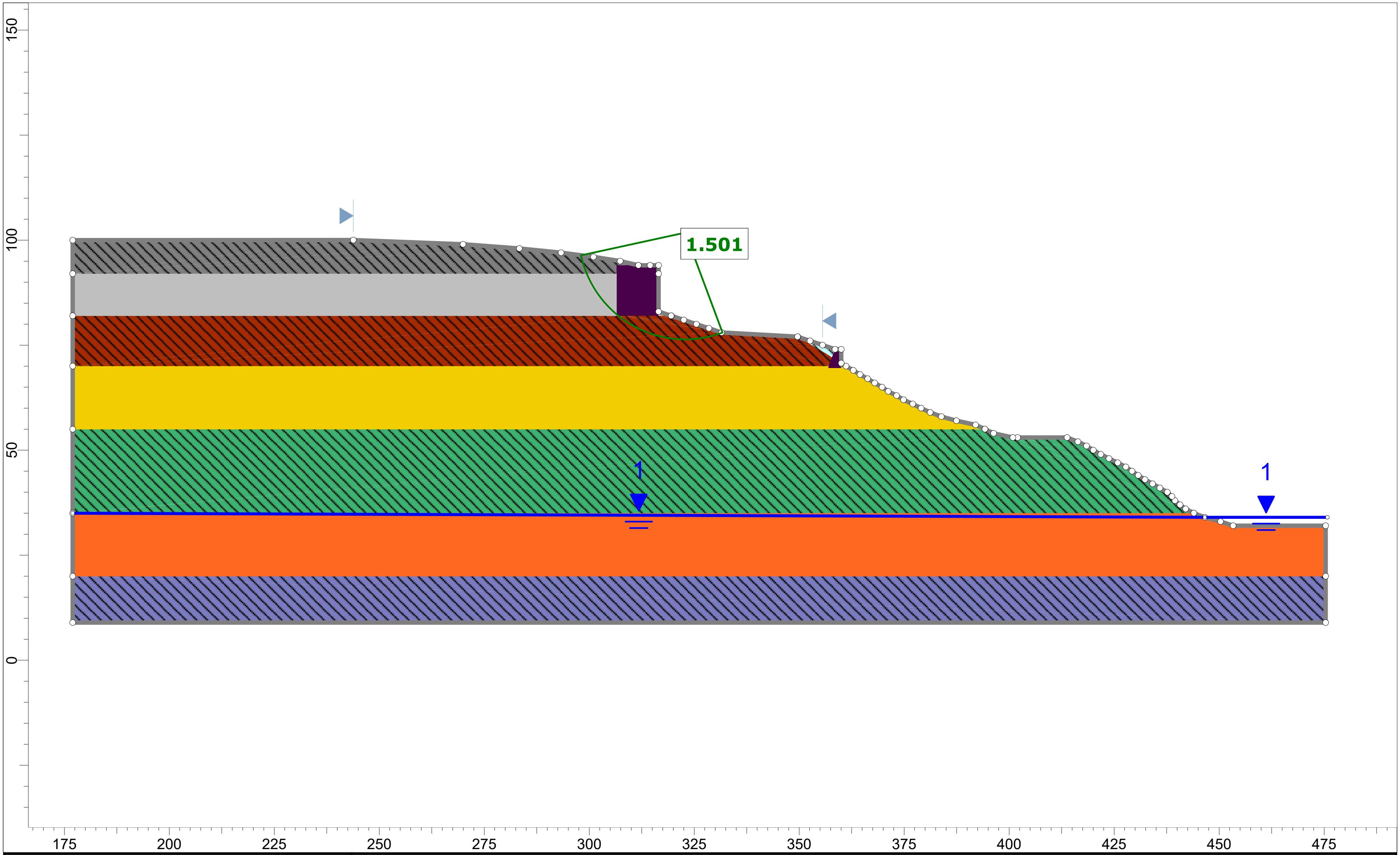


Universal Engineering Sciences

Geotechnical, Environmental and Materials Engineers

SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 4
Drawn By		*Station*	Approx STA 22+60
Date		*File Name*	section-4.slmd



Project	
45-20803 Barrier Wall Road Interim Design and Repair	

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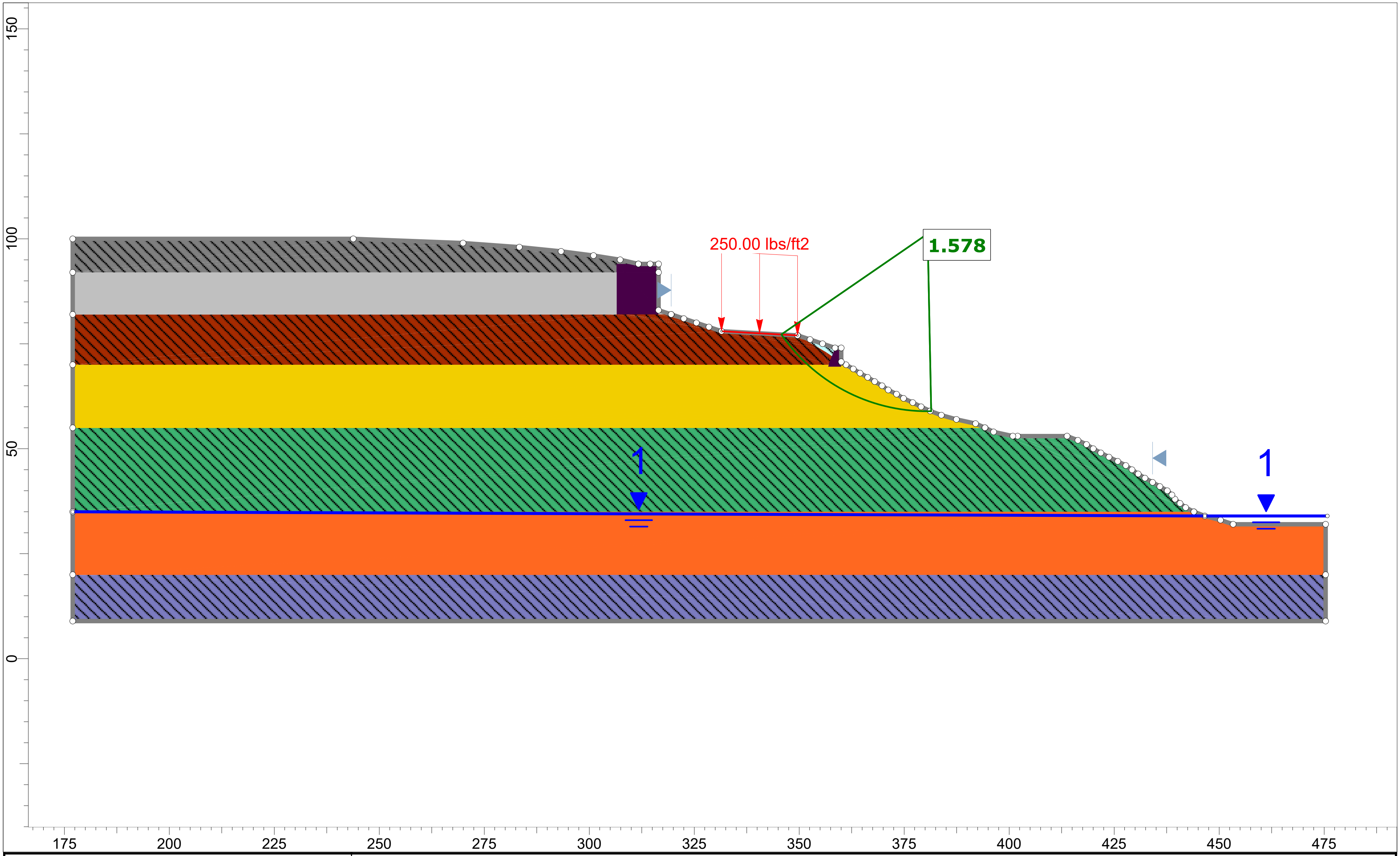
SLIDEINTERPRET 9.020

Analysis	Long Term Slope Stability	*Section*	Section 4 - Upper Wall
Drawn By		*Station*	Approx STA 22+60
Date		*File Name*	section-4.slmd



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SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 4 - Lower Wall
Drawn By		*Station*	Approx STA 22+60
Date		*File Name*	section-4.slmd

section-4

45-20803 Barrier Wall Road Interim Design and Repair

Approx. STA 22+60

Software Version: 9.02

Table of Contents

Slide Analysis Information

section-4

Project Summary

File Name:	section-4.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Short Term Slope Stability
Comments	
	Section 4 - Lower Wall Approx STA 22+60

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Short Term Stability ◆	Master Scenario	Spencer: 1.668780	00h:00m:09.100s
	Upper Wall	Spencer: 2.637440	00h:00m:06.713s
	Lower Wall	Spencer: 2.124980	00h:00m:28.367s
Long Term Sability ◆	Master Scenario	Spencer: 1.695770	00h:00m:07.275s
	Upper Wall	Spencer: 1.500620	00h:00m:05.866s
	Lower Wall	Spencer: 1.577570	00h:00m:10.308s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

Short Term Stability - Master Scenario

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Short Term Stability - Lower Wall

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Long Term Sability - Master Scenario

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Long Term Sability - Lower Wall

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Materials

Retaining Wall	
Color	🟪
Strength Type	Infinite strength
Unit Weight [lbs/ft3]	130
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	■
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	□
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay	
Color	🟥
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	1100
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	200
Friction Angle [deg]	24

Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Upper Cape Fear Confining Unit	
Color	🟪
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	2500
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Upper Cape Fear Confining Unit (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	26

Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill	
Color	🟦
Strength Type	Undrained
Unit Weight [lbs/ft3]	125
Cohesion [psf]	2000
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material	Short Term Stability	Upper Wall	Lower Wall	Long Term Sability	Upper Wall	Lower Wall
Retaining Wall	✓	✓	✓	✓	✓	✓
Dark Gray Clay	✓	✓	✓	✗	✗	✗
Dark Gray Clay (Drained)	✗	✗	✗	✓	✓	✓
Light Gray Sand	✓	✓	✓	✓	✓	✓
Perched Clay	✓	✓	✓	✓	✓	✓
Perched Clay (Drained)	✗	✗	✗	✓	✓	✓
Surficial Aquifer	✓	✓	✓	✓	✓	✓
Black Creek Confining Unit	✓	✓	✓	✗	✗	✗
Black Creek Confining Unit (Long Term)	✗	✗	✗	✓	✓	✓
Black Creek Aquifer	✓	✓	✓	✓	✓	✓
Upper Cape Fear Confining Unit	✓	✓	✓	✗	✗	✗
Upper Cape Fear Confining Unit (Drained)	✗	✗	✗	✓	✓	✓
Compacted Fill	✓	✓	✓	✓	✗	✗
Compacted Fill (Drained)	✗	✗	✗	✗	✓	✓

Global Minimums

Short Term Stability - Master Scenario

Method: spencer

FS	1.668780
Center:	348.308, 136.303
Radius:	99.370
Left Slip Surface Endpoint:	255.988, 99.539
Right Slip Surface Endpoint:	402.492, 53.005
Resisting Moment:	2.23563e+07 lb-ft
Driving Moment:	1.33968e+07 lb-ft
Resisting Horizontal Force:	191425 lb
Driving Horizontal Force:	114710 lb
Total Slice Area:	4550.74 ft2
Surface Horizontal Width:	146.504 ft
Surface Average Height:	31.0622 ft

Short Term Stability - Upper Wall

Method: spencer

FS	2.637440
Center:	329.897, 120.355
Radius:	52.107
Left Slip Surface Endpoint:	282.807, 98.046
Right Slip Surface Endpoint:	355.558, 75.005
Resisting Moment:	4.30557e+06 lb-ft
Driving Moment:	1.63248e+06 lb-ft
Resisting Horizontal Force:	70120.1 lb
Driving Horizontal Force:	26586.4 lb
Total Slice Area:	880.089 ft2
Surface Horizontal Width:	72.7508 ft
Surface Average Height:	12.0973 ft

Short Term Stability - Lower Wall

Method: spencer

FS	2.124980
Center:	378.231, 100.728
Radius:	45.728
Left Slip Surface Endpoint:	338.781, 77.602
Right Slip Surface Endpoint:	389.790, 56.485
Resisting Moment:	1.94871e+06 lb-ft
Driving Moment:	917048 lb-ft
Resisting Horizontal Force:	34915.3 lb
Driving Horizontal Force:	16430.9 lb
Total Slice Area:	411.858 ft2
Surface Horizontal Width:	51.0084 ft
Surface Average Height:	8.0743 ft

Long Term Sability - Master Scenario

Method: spencer

FS	1.695770
Center:	379.868, 156.317
Radius:	105.702
Left Slip Surface Endpoint:	292.308, 97.104
Right Slip Surface Endpoint:	402.217, 53.005
Resisting Moment:	1.10056e+07 lb-ft
Driving Moment:	6.49005e+06 lb-ft
Resisting Horizontal Force:	93969.4 lb
Driving Horizontal Force:	55414.1 lb
Total Slice Area:	1451.11 ft2
Surface Horizontal Width:	109.909 ft
Surface Average Height:	13.2028 ft

Long Term Sability - Upper Wall

Method: spencer

FS	1.500620
Center:	322.861, 101.786
Radius:	25.396
Left Slip Surface Endpoint:	298.046, 96.388
Right Slip Surface Endpoint:	331.736, 77.991
Resisting Moment:	562362 lb-ft
Driving Moment:	374754 lb-ft
Resisting Horizontal Force:	18635.7 lb
Driving Horizontal Force:	12418.7 lb
Total Slice Area:	274.718 ft2
Surface Horizontal Width:	33.69 ft
Surface Average Height:	8.15428 ft

Long Term Sability - Lower Wall

Method: spencer

FS	1.577570
Center:	380.588, 101.213
Radius:	42.300
Left Slip Surface Endpoint:	345.753, 77.217
Right Slip Surface Endpoint:	381.410, 58.921
Resisting Moment:	652720 lb-ft
Driving Moment:	413752 lb-ft
Resisting Horizontal Force:	13180.6 lb
Driving Horizontal Force:	8355 lb
Total Slice Area:	170.323 ft2
Surface Horizontal Width:	35.6572 ft
Surface Average Height:	4.77667 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Short Term Stability - Master Scenario

Method: spencer

Number of Valid Surfaces:	74005
Number of Invalid Surfaces:	0

Short Term Stability - Upper Wall

Method: spencer

Number of Valid Surfaces:	48277
Number of Invalid Surfaces:	0

Short Term Stability - Lower Wall

Method: spencer

Number of Valid Surfaces:	38824
Number of Invalid Surfaces:	0

Long Term Sability - Master Scenario

Method: spencer

Number of Valid Surfaces:	38898
Number of Invalid Surfaces:	0

Long Term Sability - Upper Wall

Method: spencer

Number of Valid Surfaces:	34570
Number of Invalid Surfaces:	0

Long Term Sability - Lower Wall

Method: spencer

Number of Valid Surfaces:	79097
Number of Invalid Surfaces:	0

Slice Data

Short Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 1.66878

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.37154	1498.97	-65.9049	Dark Gray Clay	1300	0	779.012	1300	-874.103	0	-874.103	867.8	867.8
2	2.86362	3406.02	-61.7773	Light Gray Sand	50	32	251.908	420.379	592.73	0	592.73	1062.09	1062.09
3	2.86362	5014.95	-58.4532	Light Gray Sand	50	32	385.619	643.513	949.818	0	949.818	1577.94	1577.94
4	3.06811	6902.44	-55.3203	Perched Clay	1100	0	659.164	1100	1146.02	0	1146.02	2098.7	2098.7
5	3.06811	8274.26	-52.3184	Perched Clay	1100	0	659.164	1100	1626.03	0	1626.03	2479.46	2479.46
6	3.06811	9473.73	-49.5089	Perched Clay	1100	0	659.164	1100	2054.21	0	2054.21	2826.24	2826.24
7	2.81365	9657.49	-46.9581	Surficial Aquifer	75	32	888.703	1483.05	2253.36	0	2253.36	3204.98	3204.98
8	2.81365	10523.4	-44.6296	Surficial Aquifer	75	32	993.828	1658.48	2534.1	0	2534.1	3515.17	3515.17
9	2.81365	11317.5	-42.3914	Surficial Aquifer	75	32	1094.96	1827.24	2804.16	0	2804.16	3803.69	3803.69
10	2.81365	12039.8	-40.2305	Surficial Aquifer	75	32	1191.55	1988.44	3062.14	0	3062.14	4070.17	4070.17
11	2.81365	12687.3	-38.1366	Surficial Aquifer	75	32	1282.82	2140.74	3305.87	0	3305.87	4313.05	4313.05
12	2.81365	13281	-36.1012	Surficial Aquifer	75	32	1370.4	2286.9	3539.78	0	3539.78	4539.14	4539.14
13	2.92945	14418.8	-34.0776	Black Creek Confining Unit	929.724	0	557.128	929.724	4205.43	0	4205.43	4582.32	4582.32
14	2.92945	14963.9	-32.0613	Black Creek Confining Unit	986.972	0	591.433	986.972	4414.88	0	4414.88	4785.33	4785.33
15	2.92945	15451	-30.0886	Black Creek Confining Unit	1039.96	0	623.186	1039.96	4609.32	0	4609.32	4970.41	4970.41
16	2.92945	15885.4	-28.1546	Black Creek Confining Unit	1088.93	0	652.531	1088.93	4789.77	0	4789.77	5138.99	5138.99
17	2.92945	16254.7	-26.2549	Black Creek Confining Unit	1134.12	0	679.61	1134.12	4951.8	0	4951.8	5287.02	5287.02
18	2.92945	16954.5	-24.3859	Black Creek Confining Unit	1175.72	0	704.539	1175.72	5221.44	0	5221.44	5540.82	5540.82
19	2.92945	17290	-22.5441	Black Creek Confining Unit	1213.88	0	727.406	1213.88	5376.78	0	5376.78	5678.74	5678.74
20	2.92945	17578.5	-20.7266	Black Creek Confining Unit	1248.75	0	748.301	1248.75	5518.49	0	5518.49	5801.65	5801.65
21	2.92945	16426.5	-18.9307	Black Creek Confining Unit	1280.45	0	767.297	1280.45	5193.49	0	5193.49	5456.65	5456.65

22	2.92945	13773.2	-17.154	Black Creek Confining Unit	1309.08	0	784.453	1309.08	4375.1	0	4375.1	4617.24	4617.24
23	2.92945	13755.9	-15.3941	Black Creek Confining Unit	1334.74	0	799.83	1334.74	4413.46	0	4413.46	4633.68	4633.68
24	2.92945	13707.4	-13.649	Black Creek Confining Unit	1357.51	0	813.475	1357.51	4441.88	0	4441.88	4639.42	4639.42
25	2.92945	13625.9	-11.9167	Black Creek Confining Unit	1377.46	0	825.429	1377.46	4459.53	0	4459.53	4633.73	4633.73
26	2.92945	13519.2	-10.1954	Black Creek Confining Unit	1394.63	0	835.718	1394.63	4526.47	0	4526.47	4676.77	4676.77
27	2.92945	13559.7	-8.48333	Black Creek Confining Unit	1409.09	0	844.383	1409.09	4772.39	0	4772.39	4898.33	4898.33
28	2.92945	13645.6	-6.7789	Black Creek Confining Unit	1420.87	0	851.442	1420.87	4847.55	0	4847.55	4948.76	4948.76
29	2.92945	13700.4	-5.08048	Black Creek Confining Unit	1430	0	856.913	1430	4912.78	0	4912.78	4988.97	4988.97
30	2.92945	13724.5	-3.38653	Black Creek Confining Unit	1436.5	0	860.808	1436.5	4968.02	0	4968.02	5018.96	5018.96
31	2.92945	13718.1	-1.69553	Black Creek Confining Unit	1440.4	0	863.146	1440.4	5013.12	0	5013.12	5038.67	5038.67
32	2.92945	13680.9	-0.00602115	Black Creek Confining Unit	1441.71	0	863.931	1441.71	5037.37	0	5037.37	5037.46	5037.46
33	2.92945	13486.5	1.68349	Black Creek Confining Unit	1440.42	0	863.158	1440.42	4777.44	0	4777.44	4752.07	4752.07
34	2.92945	13156.3	3.37446	Black Creek Confining Unit	1436.54	0	860.832	1436.54	4710.08	0	4710.08	4659.33	4659.33
35	2.92945	12858.4	5.06839	Black Creek Confining Unit	1430.05	0	856.943	1430.05	4653.1	0	4653.1	4577.09	4577.09
36	2.92945	11949.8	6.76677	Black Creek Confining Unit	1420.94	0	851.484	1420.94	4383.06	0	4383.06	4282.02	4282.02
37	2.92945	10664	8.47116	Black Creek Confining Unit	1409.18	0	844.437	1409.18	3978.62	0	3978.62	3852.85	3852.85
38	2.92945	9915.53	10.1831	Black Creek Confining Unit	1394.74	0	835.784	1394.74	3758.42	0	3758.42	3608.29	3608.29
39	2.92945	9140.5	11.9044	Black Creek Confining Unit	1377.59	0	825.507	1377.59	3526.38	0	3526.38	3352.35	3352.35
40	2.92945	8312	13.6366	Black Creek Confining Unit	1357.66	0	813.564	1357.66	3272.64	0	3272.64	3075.27	3075.27

41	2.92945	7504.42	15.3816	Black Creek Confining Unit	1334.91	0	799.932	1334.91	3023.25	0	3023.25	2803.19	2803.19
42	2.92945	6720.5	17.1414	Black Creek Confining Unit	1309.27	0	784.567	1309.27	2779.09	0	2779.09	2537.11	2537.11
43	2.92945	5916.06	18.918	Black Creek Confining Unit	1280.66	0	767.423	1280.66	2524.18	0	2524.18	2261.16	2261.16
44	2.92945	5157.13	20.7138	Black Creek Confining Unit	1248.98	0	748.439	1248.98	2282	0	2282	1998.99	1998.99
45	2.92945	4454.46	22.5311	Black Creek Confining Unit	1214.14	0	727.561	1214.14	2056.42	0	2056.42	1754.59	1754.59
46	2.92945	3769.85	24.3726	Black Creek Confining Unit	1176	0	704.706	1176	1833.47	0	1833.47	1514.2	1514.2
47	2.92945	3028.53	26.2415	Black Creek Confining Unit	1134.43	0	679.796	1134.43	1585.31	0	1585.31	1250.2	1250.2
48	2.92945	2060.46	28.1409	Black Creek Confining Unit	1075.76	0	644.639	1075.76	1242	0	1242	897.207	897.207
49	2.92945	1154.93	30.0747	Black Creek Confining Unit	998.56	0	598.377	998.56	907.203	0	907.203	560.689	560.689
50	2.92945	344.356	32.0471	Black Creek Confining Unit	927.506	0	555.799	927.506	604.138	0	604.138	256.201	256.201

Short Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 2.63744

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.68663	315.009	-62.6332	Dark Gray Clay	1300	0	492.902	1300	-582.112	0	-582.112	370.144	370.144
2	1.68663	892.972	-58.824	Dark Gray Clay	1300	0	492.902	1300	-193.15	0	-193.15	621.497	621.497
3	1.40759	1121.13	-55.6604	Light Gray Sand	50	32	142.123	374.84	519.852	0	519.852	727.887	727.887
4	1.40759	1415.15	-53.0023	Light Gray Sand	50	32	181.11	477.668	684.414	0	684.414	924.775	924.775
5	1.40759	1680.62	-50.4994	Light Gray Sand	50	32	218.107	575.243	840.566	0	840.566	1105.15	1105.15
6	1.40759	1921.96	-48.1233	Light Gray Sand	50	32	253.231	667.882	988.816	0	988.816	1271.28	1271.28
7	1.40759	2142.48	-45.8527	Light Gray Sand	50	32	286.598	755.884	1129.65	0	1129.65	1424.91	1424.91
8	1.40759	2341.58	-43.6716	Light Gray Sand	50	32	317.91	838.468	1261.81	0	1261.81	1565.31	1565.31
9	1.45815	2609.38	-41.5307	Perched Clay	1100	0	417.071	1100	1335.38	0	1335.38	1704.77	1704.77
10	1.45815	2775.97	-39.4219	Perched Clay	1100	0	417.071	1100	1473.01	0	1473.01	1815.86	1815.86
11	1.45815	2928.31	-37.3752	Perched Clay	1100	0	417.071	1100	1600.43	0	1600.43	1919.02	1919.02
12	1.45815	3067.57	-35.383	Perched Clay	1100	0	417.071	1100	1718.53	0	1718.53	2014.74	2014.74
13	1.45815	3193.35	-33.4389	Perched Clay	1100	0	417.071	1100	1827.12	0	1827.12	2102.53	2102.53
14	1.45815	3302.69	-31.5375	Perched Clay	1100	0	417.071	1100	1924.38	0	1924.38	2180.33	2180.33
15	1.45815	3400.95	-29.6741	Perched Clay	1100	0	417.071	1100	2013.8	0	2013.8	2251.44	2251.44
16	1.45815	3489.23	-27.8447	Perched Clay	1100	0	417.071	1100	2096.11	0	2096.11	2316.42	2316.42
17	1.45815	3780.1	-26.0457	Perched Clay	1100	0	417.071	1100	2309.66	0	2309.66	2513.5	2513.5
18	1.45815	3871.38	-24.2739	Perched Clay	1100	0	417.071	1100	2393.48	0	2393.48	2581.57	2581.57
19	1.45815	3913.82	-22.5265	Perched Clay	1100	0	417.071	1100	2444.93	0	2444.93	2617.91	2617.91
20	1.45815	3950.47	-20.801	Perched Clay	1100	0	417.071	1100	2492.08	0	2492.08	2650.52	2650.52
21	1.45815	4020.68	-19.095	Perched Clay	1100	0	417.071	1100	2560.95	0	2560.95	2705.33	2705.33
22	1.45815	4097.82	-17.4064	Perched Clay	1100	0	417.071	1100	2634.22	0	2634.22	2764.97	2764.97
23	1.45815	4167.35	-15.7334	Perched Clay	1100	0	417.071	1100	2702.32	0	2702.32	2819.81	2819.81
24	1.48875	2126.83	-14.0566	Surficial Aquifer	75	32	346.63	914.217	1343.03	0	1343.03	1429.81	1429.81
25	1.48875	2102.25	-12.3748	Surficial Aquifer	75	32	346.368	913.524	1341.92	0	1341.92	1417.91	1417.91
26	1.48875	2071.25	-10.7038	Surficial Aquifer	75	32	345.05	910.049	1336.35	0	1336.35	1401.58	1401.58
27	1.48875	2034.19	-9.04196	Surficial Aquifer	75	32	342.713	903.884	1326.49	0	1326.49	1381.03	1381.03
28	1.48875	1989.58	-7.38774	Surficial Aquifer	75	32	339.1	894.355	1311.25	0	1311.25	1355.21	1355.21
29	1.48875	1937.49	-5.73971	Surficial Aquifer	75	32	334.198	881.428	1290.56	0	1290.56	1324.15	1324.15
30	1.48875	1878.01	-4.09642	Surficial Aquifer	75	32	327.99	865.054	1264.35	0	1264.35	1287.84	1287.84
31	1.48875	1811.18	-2.45651	Surficial Aquifer	75	32	320.455	845.18	1232.54	0	1232.54	1246.29	1246.29
32	1.48875	1737.05	-0.818614	Surficial Aquifer	75	32	311.565	821.735	1195.03	0	1195.03	1199.48	1199.48

33	1.48875	1655.63	0.818614	Surficial Aquifer	75	32	301.293	794.641	1151.67	0	1151.67	1147.36	1147.36
34	1.48875	1596.15	2.45651	Surficial Aquifer	75	32	294.451	776.598	1122.79	0	1122.79	1110.16	1110.16
35	1.48875	1567.91	4.09642	Surficial Aquifer	75	32	292.718	772.027	1115.48	0	1115.48	1094.51	1094.51
36	1.48875	1532.5	5.73971	Surficial Aquifer	75	32	289.753	764.205	1102.96	0	1102.96	1073.84	1073.84
37	1.48875	1489.7	7.38774	Surficial Aquifer	75	32	285.481	752.939	1084.93	0	1084.93	1047.91	1047.91
38	1.48875	1439.43	9.04196	Surficial Aquifer	75	32	279.854	738.099	1061.18	0	1061.18	1016.64	1016.64
39	1.48875	1381.6	10.7038	Surficial Aquifer	75	32	272.816	719.537	1031.47	0	1031.47	979.906	979.906
40	1.48875	1316.08	12.3748	Surficial Aquifer	75	32	264.303	697.083	995.543	0	995.543	937.554	937.554
41	1.48875	1242.75	14.0566	Surficial Aquifer	75	32	254.24	670.542	953.068	0	953.068	889.412	889.412
42	1.36545	1069.93	15.6802	Perched Clay	1100	0	417.071	1100	977.276	0	977.276	860.198	860.198
43	1.36545	997.981	17.246	Perched Clay	1100	0	417.071	1100	938.863	0	938.863	809.391	809.391
44	1.36545	919.86	18.8253	Perched Clay	1100	0	417.071	1100	895.905	0	895.905	753.717	753.717
45	1.36545	835.397	20.4195	Perched Clay	1100	0	417.071	1100	848.262	0	848.262	692.993	692.993
46	1.36545	740.671	22.0305	Perched Clay	1100	0	417.071	1100	792.925	0	792.925	624.16	624.16
47	1.36545	602.65	23.66	Perched Clay	1100	0	417.071	1100	704.441	0	704.441	521.707	521.707
48	1.36545	447.939	25.31	Perched Clay	1100	0	417.071	1100	603.01	0	603.01	405.772	405.772
49	1.36545	285.21	26.9829	Perched Clay	1100	0	417.071	1100	495.259	0	495.259	282.907	282.907
50	1.33872	98.8881	28.6642	Compacted Fill	2000	0	758.311	2000	609.078	0	609.078	194.53	194.53

Short Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 2.12498

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.11685	107.243	-58.2889	Perched Clay	1100	0	517.652	1100	-491.397	0	-491.397	346.389	346.389
2	1.11685	311.325	-55.7154	Perched Clay	1100	0	517.652	1100	-230.168	0	-230.168	529.121	529.121
3	1.11685	496.423	-53.3023	Perched Clay	1100	0	517.652	1100	0.312416	0	0.312416	694.854	694.854
4	1.11685	665.67	-51.019	Perched Clay	1100	0	517.652	1100	206.713	0	206.713	846.394	846.394
5	1.11685	821.355	-48.8435	Perched Clay	1100	0	517.652	1100	393.576	0	393.576	985.791	985.791
6	1.02603	884.543	-46.8405	Surficial Aquifer	75	32	275.908	586.298	818.245	0	818.245	1112.47	1112.47
7	1.02603	1003.21	-44.9918	Surficial Aquifer	75	32	306.373	651.036	921.849	0	921.849	1228.13	1228.13
8	1.02603	1114.18	-43.201	Surficial Aquifer	75	32	335.573	713.086	1021.15	0	1021.15	1336.29	1336.29
9	1.02603	1218.11	-41.4614	Surficial Aquifer	75	32	363.57	772.578	1116.36	0	1116.36	1437.58	1437.58
10	1.02603	1315.57	-39.7674	Surficial Aquifer	75	32	390.418	829.631	1207.66	0	1207.66	1532.57	1532.57
11	1.02603	1395.59	-38.1141	Surficial Aquifer	75	32	359.697	764.348	1103.19	0	1103.19	1385.37	1385.37
12	1.02603	1453.61	-36.4974	Surficial Aquifer	75	32	371.145	788.675	1142.12	0	1142.12	1416.73	1416.73
13	1.02603	1506.01	-34.9139	Surficial Aquifer	75	32	387.402	823.221	1197.4	0	1197.4	1467.8	1467.8
14	1.02603	1553.23	-33.3604	Surficial Aquifer	75	32	402.515	855.337	1248.8	0	1248.8	1513.81	1513.81
15	1.02603	1595.37	-31.8341	Surficial Aquifer	75	32	416.487	885.026	1296.31	0	1296.31	1554.89	1554.89
16	1.02603	1633.15	-30.3328	Surficial Aquifer	75	32	429.458	912.59	1340.42	0	1340.42	1591.71	1591.71
17	1.02603	1666.88	-28.8541	Surficial Aquifer	75	32	441.487	938.15	1381.33	0	1381.33	1624.58	1624.58
18	1.02603	1716.82	-27.3961	Surficial Aquifer	75	32	457.593	972.377	1436.1	0	1436.1	1673.26	1673.26
19	1.02603	1776.85	-25.9572	Surficial Aquifer	75	32	476.346	1012.23	1499.88	0	1499.88	1731.77	1731.77
20	1.02603	1824.18	-24.5357	Surficial Aquifer	75	32	492.051	1045.6	1553.28	0	1553.28	1777.89	1777.89
21	1.02603	1491.23	-23.1301	Surficial Aquifer	75	32	411.046	873.464	1277.81	0	1277.81	1453.39	1453.39
22	1.02603	1375.19	-21.7391	Surficial Aquifer	75	32	384.355	816.746	1187.05	0	1187.05	1340.3	1340.3
23	1.02603	1352.37	-20.3614	Surficial Aquifer	75	32	381.269	810.19	1176.55	0	1176.55	1318.05	1318.05
24	1.02603	1323.16	-18.9959	Surficial Aquifer	75	32	376.404	799.852	1160	0	1160	1289.58	1289.58
25	1.02603	1288.95	-17.6416	Surficial Aquifer	75	32	370.094	786.443	1138.55	0	1138.55	1256.25	1256.25
26	1.02603	1257.33	-16.2973	Surficial Aquifer	75	32	364.321	774.175	1118.91	0	1118.91	1225.43	1225.43
27	1.02603	1222.94	-14.9622	Surficial Aquifer	75	32	357.677	760.056	1096.31	0	1096.31	1191.9	1191.9
28	1.02603	1181.41	-13.6354	Surficial Aquifer	75	32	348.988	741.593	1066.77	0	1066.77	1151.43	1151.43
29	1.02603	1138.92	-12.316	Surficial Aquifer	75	32	339.886	722.251	1035.82	0	1035.82	1110.03	1110.03
30	1.02603	1095.19	-11.0033	Surficial Aquifer	75	32	330.288	701.855	1003.18	0	1003.18	1067.4	1067.4
31	1.02603	1038.23	-9.6963	Surficial Aquifer	75	32	316.924	673.458	957.734	0	957.734	1011.89	1011.89
32	1.02603	982.588	-8.39441	Surficial Aquifer	75	32	303.722	645.404	912.836	0	912.836	957.656	957.656

33	1.02603	937.542	-7.09688	Surficial Aquifer	75	32	293.255	623.162	877.243	0	877.243	913.753	913.753
34	1.02603	885.108	-5.803	Surficial Aquifer	75	32	280.58	596.226	834.135	0	834.135	862.65	862.65
35	1.02603	824.48	-4.51209	Surficial Aquifer	75	32	265.429	564.032	782.615	0	782.615	803.561	803.561
36	1.02603	773.206	-3.22347	Surficial Aquifer	75	32	252.708	537	739.355	0	739.355	753.588	753.588
37	1.02603	723.261	-1.93647	Surficial Aquifer	75	32	240.191	510.402	696.789	0	696.789	704.91	704.91
38	1.02603	667.07	-0.65046	Surficial Aquifer	75	32	225.722	479.654	647.583	0	647.583	650.145	650.145
39	0.0121556	7.5465	0	Surficial Aquifer	75	32	217.854	462.936	620.827	0	620.827	620.827	620.827
40	1.05027	619.249	0.665646	Surficial Aquifer	75	32	209.39	444.95	592.043	0	592.043	589.61	589.61
41	1.05027	556.492	1.98206	Surficial Aquifer	75	32	193.069	410.267	536.539	0	536.539	529.857	529.857
42	1.05027	492.475	3.29952	Surficial Aquifer	75	32	176.166	374.35	479.06	0	479.06	468.904	468.904
43	1.05027	432.341	4.61873	Surficial Aquifer	75	32	160.148	340.311	424.586	0	424.586	411.648	411.648
44	1.05027	372.687	5.9404	Surficial Aquifer	75	32	144.049	306.101	369.839	0	369.839	354.85	354.85
45	1.05027	312.874	7.26525	Surficial Aquifer	75	32	127.681	271.32	314.177	0	314.177	297.9	297.9
46	1.05027	259.091	8.59402	Surficial Aquifer	75	32	112.851	239.807	263.746	0	263.746	246.691	246.691
47	1.05027	202.976	9.92747	Surficial Aquifer	75	32	97.1233	206.385	210.261	0	210.261	193.262	193.262
48	1.05027	144.071	11.2664	Surficial Aquifer	75	32	80.3385	170.718	153.181	0	153.181	137.177	137.177
49	1.05027	87.3836	12.6115	Surficial Aquifer	75	32	63.9693	135.933	97.5141	0	97.5141	83.2017	83.2017
50	1.05027	29.6547	13.9638	Surficial Aquifer	75	32	47.0367	99.952	39.9316	0	39.9316	28.2356	28.2356

Long Term Sability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 1.69577

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.83887	268.719	-55.0609	Dark Gray Clay (Drained)	200	25	121.405	205.874	12.5974	0	12.5974	186.374	186.374
2	1.83887	780.911	-53.3556	Dark Gray Clay (Drained)	200	25	166.255	281.93	175.7	0	175.7	399.201	399.201
3	2.17913	1524.57	-51.5703	Light Gray Sand	50	32	167.72	284.415	375.143	0	375.143	586.529	586.529
4	2.17913	2116.78	-49.7068	Light Gray Sand	50	32	230.766	391.326	546.237	0	546.237	818.412	818.412
5	2.17913	2663.35	-47.9124	Light Gray Sand	50	32	292.658	496.281	714.199	0	714.199	1038.23	1038.23
6	2.17913	3161.25	-46.1782	Light Gray Sand	50	32	352.477	597.72	876.535	0	876.535	1243.81	1243.81
7	2.35921	4025.33	-44.4298	Perched Clay (Drained)	200	24	399.682	677.769	1073.09	0	1073.09	1464.89	1464.89
8	2.35921	4789.24	-42.6648	Perched Clay (Drained)	200	24	465.232	788.927	1322.75	0	1322.75	1751.53	1751.53
9	2.35921	5183.56	-40.9486	Perched Clay (Drained)	200	24	504.844	856.1	1473.63	0	1473.63	1911.69	1911.69
10	2.35921	5627.9	-39.276	Perched Clay (Drained)	200	24	549.419	931.689	1643.4	0	1643.4	2092.71	2092.71
11	2.35921	6114.35	-37.6425	Perched Clay (Drained)	200	24	598.564	1015.03	1830.58	0	1830.58	2292.24	2292.24
12	2.35921	3057.91	-36.0442	Perched Clay (Drained)	200	24	359.605	609.807	920.442	0	920.442	1182.13	1182.13
13	2.2058	3069.6	-34.5277	Surficial Aquifer	75	32	414.48	702.863	1004.79	0	1004.79	1289.95	1289.95
14	2.2058	3265.32	-33.0885	Surficial Aquifer	75	32	446.627	757.376	1092.03	0	1092.03	1383.06	1383.06
15	2.2058	3441.49	-31.6724	Surficial Aquifer	75	32	477.158	809.15	1174.88	0	1174.88	1469.27	1469.27
16	2.2058	3598.69	-30.2777	Surficial Aquifer	75	32	506.019	858.092	1253.21	0	1253.21	1548.64	1548.64
17	2.2058	3737.75	-28.9025	Surficial Aquifer	75	32	533.193	904.173	1326.95	0	1326.95	1621.32	1621.32
18	2.2058	3864.87	-27.5454	Surficial Aquifer	75	32	579.447	982.609	1452.48	0	1452.48	1754.7	1754.7
19	2.2058	4079.32	-26.2048	Surficial Aquifer	75	32	673.287	1141.74	1707.14	0	1707.14	2038.51	2038.51
20	2.2058	4317.19	-24.8795	Surficial Aquifer	75	32	717.532	1216.77	1827.21	0	1827.21	2159.97	2159.97
21	2.2058	4539.42	-23.5682	Surficial Aquifer	75	32	760.722	1290.01	1944.43	0	1944.43	2276.28	2276.28
22	2.2058	4746.47	-22.2699	Surficial Aquifer	75	32	802.845	1361.44	2058.73	0	2058.73	2387.51	2387.51
23	2.2058	4938.78	-20.9836	Surficial Aquifer	75	32	843.876	1431.02	2170.09	0	2170.09	2493.75	2493.75
24	2.2058	5116.74	-19.7083	Surficial Aquifer	75	32	883.805	1498.73	2278.44	0	2278.44	2595.04	2595.04
25	2.2058	5280.7	-18.443	Surficial Aquifer	75	32	922.613	1564.54	2383.75	0	2383.75	2691.44	2691.44
26	2.2058	5430.69	-17.187	Surficial Aquifer	75	32	954.882	1619.26	2471.33	0	2471.33	2766.68	2766.68
27	2.18661	5450.24	-15.9449	Black Creek Confining Unit (Long Term)	125	26	738.249	1251.9	2310.49	0	2310.49	2521.41	2521.41

28	2.18661	5449.76	-14.7158	Black Creek Confining Unit (Long Term)	125	26	748.067	1268.55	2344.63	0	2344.63	2541.1	2541.1
29	2.18661	5434.07	-13.4936	Black Creek Confining Unit (Long Term)	125	26	756.093	1282.16	2372.53	0	2372.53	2553.96	2553.96
30	2.18661	5467.03	-12.2777	Black Creek Confining Unit (Long Term)	125	26	770.364	1306.36	2422.15	0	2422.15	2589.8	2589.8
31	2.18661	5229.31	-11.0673	Black Creek Confining Unit (Long Term)	125	26	750.072	1271.95	2351.6	0	2351.6	2498.31	2498.31
32	2.18661	4420.24	-9.86191	Black Creek Confining Unit (Long Term)	125	26	654.529	1109.93	2019.41	0	2019.41	2133.2	2133.2
33	2.18661	4186.74	-8.66092	Black Creek Confining Unit (Long Term)	125	26	632.329	1072.28	1942.22	0	1942.22	2038.54	2038.54
34	2.18661	3950.99	-7.46375	Black Creek Confining Unit (Long Term)	125	26	609.11	1032.91	1861.49	0	1861.49	1941.29	1941.29
35	2.18661	3698.48	-6.26985	Black Creek Confining Unit (Long Term)	125	26	582.872	988.417	1770.27	0	1770.27	1834.31	1834.31
36	2.18661	3422.02	-5.07868	Black Creek Confining Unit (Long Term)	125	26	552.511	936.932	1664.71	0	1664.71	1713.81	1713.81
37	2.18661	3155.14	-3.88971	Black Creek Confining Unit (Long Term)	125	26	522.563	886.147	1560.58	0	1560.58	1596.11	1596.11
38	2.18661	2882.84	-2.70241	Black Creek Confining Unit (Long Term)	125	26	490.93	832.504	1450.6	0	1450.6	1473.77	1473.77
39	2.18661	2640.5	-1.51628	Black Creek Confining Unit (Long Term)	125	26	462.654	784.554	1352.29	0	1352.29	1364.53	1364.53
40	2.18661	2380.75	-0.33079	Black Creek Confining Unit (Long Term)	125	26	430.96	730.809	1242.09	0	1242.09	1244.58	1244.58
41	2.18661	2132.04	0.854554	Black Creek Confining Unit (Long Term)	125	26	399.934	678.196	1134.22	0	1134.22	1128.25	1128.25
42	2.18661	1910.95	2.04026	Black Creek Confining Unit (Long Term)	125	26	372.118	631.026	1037.51	0	1037.51	1024.25	1024.25

43	2.18661	1721.46	3.22685	Black Creek Confining Unit (Long Term)	125	26	348.277	590.597	954.617	0	954.617	934.981	934.981
44	2.18661	1539.39	4.41482	Black Creek Confining Unit (Long Term)	125	26	324.841	550.855	873.131	0	873.131	848.052	848.052
45	2.18661	1367.85	5.6047	Black Creek Confining Unit (Long Term)	125	26	302.322	512.668	794.838	0	794.838	765.17	765.17
46	2.18661	1156.6	6.79701	Black Creek Confining Unit (Long Term)	125	26	272.672	462.389	691.748	0	691.748	659.248	659.248
47	2.18661	836.863	7.99229	Black Creek Confining Unit (Long Term)	125	26	224.254	380.283	523.406	0	523.406	491.92	491.92
48	2.18661	511.355	9.19108	Black Creek Confining Unit (Long Term)	125	26	173.196	293.701	345.889	0	345.889	317.865	317.865
49	2.18661	280.579	10.3939	Black Creek Confining Unit (Long Term)	125	26	136.403	231.308	217.963	0	217.963	192.943	192.943
50	2.18661	67.8822	11.6015	Black Creek Confining Unit (Long Term)	125	26	100.63	170.646	93.5882	0	93.5882	72.9291	72.9291

Long Term Sability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.50062

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.690498	101.307	-74.7625	Dark Gray Clay (Drained)	200	25	109.652	164.546	-76.0313	0	-76.0313	326.514	326.514
2	0.690498	275.685	-69.566	Dark Gray Clay (Drained)	200	25	144.293	216.529	35.4473	0	35.4473	422.736	422.736
3	0.673104	393.614	-65.5029	Light Gray Sand	50	32	118.604	177.979	204.808	0	204.808	465.095	465.095
4	0.673104	492.831	-62.0512	Light Gray Sand	50	32	156.128	234.289	294.924	0	294.924	589.192	589.192
5	0.673104	577.833	-58.9583	Light Gray Sand	50	32	192.332	288.617	381.867	0	381.867	701.434	701.434
6	0.673104	651.455	-56.1234	Light Gray Sand	50	32	226.995	340.633	465.109	0	465.109	803.211	803.211
7	0.673104	716.893	-53.4849	Light Gray Sand	50	32	260.456	390.845	545.466	0	545.466	897.258	897.258
8	0.673104	775.702	-51.0021	Light Gray Sand	50	32	292.821	439.413	623.191	0	623.191	984.821	984.821
9	0.673104	828.921	-48.6461	Light Gray Sand	50	32	324.165	486.449	698.465	0	698.465	1066.76	1066.76
10	0.673104	877.32	-46.3958	Light Gray Sand	50	32	354.558	532.057	771.451	0	771.451	1143.72	1143.72
11	0.673104	921.486	-44.235	Light Gray Sand	50	32	384.058	576.325	842.296	0	842.296	1216.23	1216.23
12	0.673104	961.881	-42.151	Light Gray Sand	50	32	412.719	619.334	911.126	0	911.126	1284.71	1284.71
13	0.673104	1054.28	-40.1336	Light Gray Sand	50	32	463.431	695.434	1032.91	0	1032.91	1423.62	1423.62
14	0.673104	1146.44	-38.1745	Perched Clay (Drained)	200	24	480.695	721.341	1170.96	0	1170.96	1548.88	1548.88
15	0.673104	1173.11	-36.2669	Perched Clay (Drained)	200	24	499.405	749.417	1234.01	0	1234.01	1600.42	1600.42
16	0.673104	1195.92	-34.4048	Perched Clay (Drained)	200	24	516.999	775.819	1293.32	0	1293.32	1647.37	1647.37
17	0.673104	1216.39	-32.5833	Perched Clay (Drained)	200	24	533.929	801.224	1350.37	0	1350.37	1691.61	1691.61
18	0.673104	1234.64	-30.7982	Perched Clay (Drained)	200	24	550.227	825.682	1405.3	0	1405.3	1733.28	1733.28
19	0.673104	1250.8	-29.0456	Perched Clay (Drained)	200	24	565.922	849.234	1458.2	0	1458.2	1772.48	1772.48
20	0.673104	1264.98	-27.3224	Perched Clay (Drained)	200	24	581.04	871.92	1509.16	0	1509.16	1809.34	1809.34
21	0.673104	1281	-25.6256	Perched Clay (Drained)	200	24	596.962	895.813	1562.82	0	1562.82	1849.17	1849.17
22	0.673104	1303.7	-23.9526	Perched Clay (Drained)	200	24	615.559	923.72	1625.51	0	1625.51	1898.96	1898.96
23	0.673104	1324.99	-22.301	Perched Clay (Drained)	200	24	633.936	951.297	1687.44	0	1687.44	1947.45	1947.45
24	0.673104	1344.61	-20.6688	Perched Clay (Drained)	200	24	651.989	978.387	1748.29	0	1748.29	1994.25	1994.25
25	0.673104	1362.62	-19.0539	Perched Clay (Drained)	200	24	669.733	1005.01	1808.09	0	1808.09	2039.41	2039.41

26	0.673104	1379.06	-17.4546	Perched Clay (Drained)	200	24	687.185	1031.2	1866.91	0	1866.91	2082.98	2082.98
27	0.673104	1393.98	-15.8692	Perched Clay (Drained)	200	24	704.36	1056.98	1924.79	0	1924.79	2125.03	2125.03
28	0.673104	783.794	-14.2963	Perched Clay (Drained)	200	24	462.278	693.703	1108.87	0	1108.87	1226.68	1226.68
29	0.673104	427.055	-12.7342	Perched Clay (Drained)	200	24	318.444	477.864	624.093	0	624.093	696.058	696.058
30	0.673104	420.349	-11.1818	Perched Clay (Drained)	200	24	319.956	480.133	629.189	0	629.189	692.436	692.436
31	0.673104	412.243	-9.63757	Perched Clay (Drained)	200	24	320.838	481.456	632.162	0	632.162	686.644	686.644
32	0.673104	402.764	-8.10042	Perched Clay (Drained)	200	24	321.077	481.815	632.968	0	632.968	678.666	678.666
33	0.673104	392.301	-6.56913	Perched Clay (Drained)	200	24	320.827	481.439	632.122	0	632.122	669.068	669.068
34	0.673104	380.725	-5.04254	Perched Clay (Drained)	200	24	320.009	480.212	629.368	0	629.368	657.604	657.604
35	0.673104	367.812	-3.51953	Perched Clay (Drained)	200	24	318.499	477.946	624.276	0	624.276	643.865	643.865
36	0.673104	353.57	-1.99901	Perched Clay (Drained)	200	24	316.271	474.602	616.765	0	616.765	627.804	627.804
37	0.673104	338.005	-0.479898	Perched Clay (Drained)	200	24	313.296	470.138	606.739	0	606.739	609.363	609.363
38	0.673104	321.118	1.03888	Perched Clay (Drained)	200	24	309.543	464.506	594.09	0	594.09	588.476	588.476
39	0.673104	302.909	2.55838	Perched Clay (Drained)	200	24	304.974	457.65	578.691	0	578.691	565.064	565.064
40	0.673104	283.375	4.07969	Perched Clay (Drained)	200	24	299.548	449.508	560.403	0	560.403	539.038	539.038
41	0.673104	262.509	5.60389	Perched Clay (Drained)	200	24	293.216	440.006	539.063	0	539.063	510.293	510.293
42	0.673104	240.302	7.13208	Perched Clay (Drained)	200	24	285.924	429.064	514.486	0	514.486	478.71	478.71
43	0.673104	216.743	8.66539	Perched Clay (Drained)	200	24	277.609	416.586	486.46	0	486.46	444.151	444.151
44	0.673104	191.816	10.205	Perched Clay (Drained)	200	24	268.198	402.463	454.738	0	454.738	406.457	406.457
45	0.673104	165.502	11.7521	Perched Clay (Drained)	200	24	257.606	386.568	419.038	0	419.038	365.446	365.446
46	0.673104	137.78	13.3079	Perched Clay (Drained)	200	24	245.734	368.754	379.028	0	379.028	320.903	320.903
47	0.673104	108.624	14.8738	Perched Clay (Drained)	200	24	232.47	348.849	334.321	0	334.321	272.579	272.579
48	0.673104	78.0032	16.4512	Perched Clay (Drained)	200	24	217.676	326.649	284.458	0	284.458	220.181	220.181
49	0.673104	45.8842	18.0415	Perched Clay (Drained)	200	24	201.193	301.914	228.903	0	228.903	163.371	163.371
50	0.673104	13.124	19.6463	Perched Clay (Drained)	200	24	189.954	285.049	191.023	0	191.023	123.21	123.21

Long Term Sability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 1.57757

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.69846	36.305	-54.6225	Perched Clay (Drained)	200	24	152.832	241.103	92.3184	0	92.3184	307.552	307.552
2	0.69846	106.759	-53.019	Perched Clay (Drained)	200	24	171.345	270.308	157.915	0	157.915	385.454	385.454
3	0.69846	173.126	-51.4731	Perched Clay (Drained)	200	24	189.532	299	222.358	0	222.358	460.403	460.403
4	0.69846	235.813	-49.9781	Perched Clay (Drained)	200	24	207.419	327.218	285.736	0	285.736	532.736	532.736
5	0.69846	295.158	-48.5281	Perched Clay (Drained)	200	24	225.025	354.992	348.118	0	348.118	602.714	602.714
6	0.69846	349.815	-47.1187	Perched Clay (Drained)	200	24	220.533	347.906	332.204	0	332.204	569.68	569.68
7	0.69846	391.927	-45.7456	Perched Clay (Drained)	200	24	211.887	334.267	301.567	0	301.567	519.042	519.042
8	0.69846	429.823	-44.4056	Perched Clay (Drained)	200	24	224.476	354.127	346.174	0	346.174	566.04	566.04
9	0.69846	465.183	-43.0956	Perched Clay (Drained)	200	24	236.693	373.4	389.463	0	389.463	610.922	610.922
10	0.716367	512.514	-41.797	Surficial Aquifer	75	32	222.407	350.862	441.472	0	441.472	640.306	640.306
11	0.716367	547.067	-40.508	Surficial Aquifer	75	32	238.998	377.036	483.359	0	483.359	687.54	687.54
12	0.716367	579.171	-39.2434	Surficial Aquifer	75	32	255.144	402.508	524.123	0	524.123	732.536	732.536
13	0.716367	609.115	-38.0013	Surficial Aquifer	75	32	270.903	427.368	563.907	0	563.907	775.569	775.569
14	0.716367	637.096	-36.7798	Surficial Aquifer	75	32	286.303	451.663	602.786	0	602.786	816.81	816.81
15	0.716367	663.162	-35.5775	Surficial Aquifer	75	32	301.325	475.362	640.713	0	640.713	856.262	856.262
16	0.716367	688.91	-34.393	Surficial Aquifer	75	32	316.565	499.404	679.189	0	679.189	895.889	895.889
17	0.716367	731.803	-33.2251	Surficial Aquifer	75	32	339.049	534.874	735.952	0	735.952	958.032	958.032
18	0.716367	768.09	-32.0725	Surficial Aquifer	75	32	359.418	567.007	787.376	0	787.376	1012.6	1012.6
19	0.716367	795.902	-30.9343	Surficial Aquifer	75	32	376.76	594.366	831.16	0	831.16	1056.95	1056.95
20	0.716367	830.461	-29.8095	Surficial Aquifer	75	32	397.352	626.85	883.144	0	883.144	1110.8	1110.8
21	0.716367	551.078	-28.6972	Surficial Aquifer	75	32	283.252	446.85	595.084	0	595.084	750.143	750.143
22	0.716367	522.575	-27.5966	Surficial Aquifer	75	32	275.021	433.865	574.303	0	574.303	718.06	718.06
23	0.716367	520.31	-26.507	Surficial Aquifer	75	32	278.068	438.672	581.997	0	581.997	720.679	720.679
24	0.716367	514.736	-25.4276	Surficial Aquifer	75	32	279.605	441.096	585.876	0	585.876	718.808	718.808
25	0.716367	506.945	-24.3578	Surficial Aquifer	75	32	280.064	441.821	587.038	0	587.038	713.832	713.832
26	0.716367	496.514	-23.297	Surficial Aquifer	75	32	279.207	440.468	584.871	0	584.871	705.099	705.099
27	0.716367	485.528	-22.2446	Surficial Aquifer	75	32	277.963	438.506	581.731	0	581.731	695.418	695.418
28	0.716367	476.056	-21.2	Surficial Aquifer	75	32	277.318	437.489	580.104	0	580.104	687.669	687.669

29	0.716367	465.593	-20.1628	Surficial Aquifer	75	32	276.085	435.544	576.991	0	576.991	678.367	678.367
30	0.716367	452.275	-19.1324	Surficial Aquifer	75	32	273.32	431.182	570.01	0	570.01	664.828	664.828
31	0.716367	436.69	-18.1084	Surficial Aquifer	75	32	269.255	424.769	559.747	0	559.747	647.797	647.797
32	0.716367	420.646	-17.0903	Surficial Aquifer	75	32	264.762	417.68	548.403	0	548.403	629.805	629.805
33	0.716367	404.96	-16.0778	Surficial Aquifer	75	32	260.253	410.568	537.021	0	537.021	612.03	612.03
34	0.716367	387.854	-15.0704	Surficial Aquifer	75	32	254.801	401.966	523.255	0	523.255	591.864	591.864
35	0.716367	364.511	-14.0678	Surficial Aquifer	75	32	245.795	387.759	500.52	0	500.52	562.112	562.112
36	0.716367	338.745	-13.0695	Surficial Aquifer	75	32	235.152	370.968	473.647	0	473.647	528.236	528.236
37	0.716367	319.225	-12.0753	Surficial Aquifer	75	32	227.578	359.021	454.528	0	454.528	503.214	503.214
38	0.716367	301.437	-11.0848	Surficial Aquifer	75	32	220.702	348.173	437.169	0	437.169	480.408	480.408
39	0.716367	281.882	-10.0975	Surficial Aquifer	75	32	212.576	335.354	416.654	0	416.654	454.51	454.51
40	0.716367	257.234	-9.11336	Surficial Aquifer	75	32	201.234	317.46	388.018	0	388.018	420.298	420.298
41	0.716367	231.04	-8.13188	Surficial Aquifer	75	32	188.608	297.542	356.141	0	356.141	383.091	383.091
42	0.716367	209.182	-7.1528	Surficial Aquifer	75	32	178.142	281.031	329.718	0	329.718	352.074	352.074
43	0.716367	189.111	-6.17581	Surficial Aquifer	75	32	168.405	265.67	305.135	0	305.135	323.358	323.358
44	0.716367	168.002	-5.20063	Surficial Aquifer	75	32	157.707	248.794	278.129	0	278.129	292.483	292.483
45	0.716367	144.253	-4.22695	Surficial Aquifer	75	32	145.013	228.768	246.081	0	246.081	256.798	256.798
46	0.716367	118.466	-3.25449	Surficial Aquifer	75	32	130.611	206.048	209.721	0	209.721	217.148	217.148
47	0.716367	91.822	-2.28297	Surficial Aquifer	75	32	115.184	181.711	170.772	0	170.772	175.364	175.364
48	0.716367	65.989	-1.31211	Surficial Aquifer	75	32	99.776	157.404	131.873	0	131.873	134.159	134.159
49	0.716367	39.6933	-0.341628	Surficial Aquifer	75	32	83.5477	131.802	90.9029	0	90.9029	91.401	91.401
50	0.716367	12.6298	0.628759	Surficial Aquifer	75	32	65.9955	104.112	46.5896	0	46.5896	45.8654	45.8654

Interslice Data

Short Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 1.66878

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	255.988	99.5389	0	0	0
2	259.36	92	-9219.5	-1364.29	8.41747
3	262.223	86.6644	-6779.23	-1003.18	8.41746
4	265.087	82	-3454.49	-511.191	8.41747
5	268.155	77.5657	-397.613	-58.8384	8.41749
6	271.223	73.5934	4036.57	597.328	8.41749
7	274.291	70	9393.32	1390.01	8.41746
8	277.105	66.9872	13678.7	2024.16	8.41748
9	279.918	64.2096	17917.4	2651.4	8.41749
10	282.732	61.6412	22035.1	3260.73	8.41748
11	285.546	59.2609	25967.1	3842.58	8.41747
12	288.359	57.0518	29656.2	4388.49	8.41748
13	291.173	55	33058.6	4891.98	8.41749
14	294.102	53.0183	39758.5	5883.42	8.41748
15	297.032	51.1834	46124.5	6825.46	8.41749
16	299.961	49.486	52120.4	7712.72	8.41748
17	302.891	47.9183	57715.7	8540.7	8.41747
18	305.82	46.4733	62877.5	9304.53	8.41747
19	308.75	45.1453	67745	10024.8	8.41745
20	311.679	43.9293	72149.9	10676.7	8.41751
21	314.609	42.8208	76072.3	11257.1	8.41748
22	317.538	41.816	79039.8	11696.2	8.41746
23	320.467	40.9118	80695.1	11941.2	8.4175
24	323.397	40.1052	81908.9	12120.8	8.41749
25	326.326	39.3939	82682.7	12235.3	8.41748
26	329.256	38.7757	83018.6	12285	8.41748
27	332.185	38.2488	82952.1	12275.2	8.41751
28	335.115	37.8119	82560.7	12217.2	8.41745
29	338.044	37.4636	81751.4	12097.5	8.41749
30	340.974	37.2032	80517.5	11914.9	8.41749
31	343.903	37.0299	78853.8	11668.7	8.41748
32	346.833	36.9431	76756.9	11358.4	8.41748
33	349.762	36.9428	74224.4	10983.6	8.41745
34	352.691	37.0289	71281.4	10548.1	8.41745
35	355.621	37.2017	67942.9	10054.1	8.41747
36	358.55	37.4615	64220.5	9503.27	8.41747
37	361.48	37.8091	60199.5	8908.25	8.41747
38	364.409	38.2454	55986.8	8284.86	8.41747
39	367.339	38.7716	51557.7	7629.44	8.41747
40	370.268	39.3891	46958.6	6948.88	8.41748
41	373.198	40.0998	42246.5	6251.59	8.41748
42	376.127	40.9057	37463.8	5543.86	8.41749
43	379.056	41.8092	32651.6	4831.75	8.41748
44	381.986	42.8133	27866.4	4123.64	8.41748
45	384.915	43.921	23143.3	3424.72	8.41748
46	387.845	45.1363	18510.2	2739.11	8.41745
47	390.774	46.4634	14009.9	2073.17	8.41748
48	393.704	47.9075	9726.61	1439.33	8.41746
49	396.633	49.4744	5889.77	871.561	8.41747
50	399.563	51.1708	2595.68	384.106	8.41748
51	402.492	53.0047	0	0	0

Short Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 2.63744

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	282.807	98.046	0	0	0
2	284.494	94.7876	-2726.97	-303.088	6.34209
3	286.18	92	-4095.58	-455.202	6.34209
4	287.588	89.9396	-3224.25	-358.358	6.34209
5	288.996	88.0715	-2200.28	-244.549	6.34208
6	290.403	86.364	-1071.58	-119.1	6.34207
7	291.811	84.7939	124.988	13.8918	6.34211
8	293.218	83.3438	1360.28	151.187	6.34205
9	294.626	82	2609.02	289.979	6.3421
10	296.084	80.7086	3726.29	414.158	6.3421
11	297.542	79.5099	4884.63	542.901	6.3421
12	299	78.396	6059.95	673.532	6.3421
13	300.459	77.3605	7232.35	803.838	6.3421
14	301.917	76.3976	8384.36	931.877	6.34209
15	303.375	75.5027	9499.11	1055.78	6.34212
16	304.833	74.6719	10564.9	1174.24	6.34213
17	306.291	73.9016	11572.2	1286.19	6.3421
18	307.749	73.189	12610.8	1401.62	6.34208
19	309.207	72.5314	13577.4	1509.05	6.34207
20	310.666	71.9266	14448.7	1605.9	6.34211
21	312.124	71.3727	15221.8	1691.83	6.34212
22	313.582	70.8679	15907.3	1768.01	6.34209
23	315.04	70.4108	16504.2	1834.35	6.34208
24	316.498	70	17006.9	1890.23	6.3421
25	317.987	69.6272	16992.2	1888.59	6.34208
26	319.476	69.3006	16915.6	1880.08	6.3421
27	320.964	69.0192	16778.7	1864.86	6.34208
28	322.453	68.7823	16583.4	1843.16	6.3421
29	323.942	68.5893	16332.4	1815.26	6.34209
30	325.431	68.4396	16028.7	1781.5	6.34207
31	326.919	68.333	15675.9	1742.29	6.34208
32	328.408	68.2691	15278.2	1698.09	6.34209
33	329.897	68.2479	14840.4	1649.43	6.34209
34	331.386	68.2691	14368	1596.92	6.34207
35	332.874	68.333	13858.5	1540.3	6.3421
36	334.363	68.4396	13304.4	1478.71	6.34208
37	335.852	68.5893	12708.6	1412.49	6.34208
38	337.341	68.7823	12074.7	1342.04	6.3421
39	338.829	69.0192	11407.3	1267.86	6.34209
40	340.318	69.3006	10711.4	1190.52	6.34212
41	341.807	69.6272	9993.29	1110.7	6.34209
42	343.296	70	9260.06	1029.21	6.34211
43	344.661	70.3833	8316.77	924.365	6.34209
44	346.027	70.8072	7350.11	816.926	6.34209
45	347.392	71.2727	6364.36	707.365	6.34209
46	348.757	71.781	5364.46	596.232	6.3421
47	350.123	72.3335	4357.65	484.33	6.3421
48	351.488	72.9318	3367.52	374.282	6.34209
49	352.854	73.5775	2409.44	267.796	6.34208
50	354.219	74.2728	1496.43	166.32	6.34208
51	355.558	75.0046	0	0	0

Short Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 2.12498

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	338.781	77.6021	0	0	0
2	339.898	75.7945	-1466.37	0	0
3	341.015	74.1564	-2421.58	0	0
4	342.132	72.6579	-2999.26	0	0
5	343.249	71.2777	-3292.12	0	0
6	344.365	70	-3367.39	0	0
7	345.391	68.9058	-2755.19	0	0
8	346.417	67.8801	-2123.96	0	0
9	347.443	66.9166	-1484.35	0	0
10	348.47	66.01	-845.387	0	0
11	349.496	65.1562	-214.79	0	0
12	350.522	64.3512	304.121	0	0
13	351.548	63.5921	790.351	0	0
14	352.574	62.8759	1250.37	0	0
15	353.6	62.2004	1680.96	0	0
16	354.626	61.5634	2079.4	0	0
17	355.652	60.963	2443.48	0	0
18	356.678	60.3977	2771.4	0	0
19	357.704	59.866	3065.54	0	0
20	358.73	59.3665	3325.95	0	0
21	359.756	58.8981	3548.57	0	0
22	360.782	58.4598	3686.86	0	0
23	361.808	58.0507	3778.13	0	0
24	362.834	57.6699	3834.95	0	0
25	363.86	57.3167	3858.46	0	0
26	364.886	56.9904	3850.23	0	0
27	365.912	56.6904	3812.07	0	0
28	366.938	56.4162	3745.69	0	0
29	367.964	56.1673	3653.12	0	0
30	368.99	55.9433	3536.42	0	0
31	370.016	55.7438	3397.66	0	0
32	371.042	55.5685	3240.39	0	0
33	372.068	55.4171	3066.96	0	0
34	373.094	55.2894	2878.13	0	0
35	374.12	55.1851	2677.22	0	0
36	375.146	55.1041	2468.24	0	0
37	376.172	55.0463	2251.68	0	0
38	377.198	55.0116	2029.4	0	0
39	378.224	55	1805.34	0	0
40	378.237	55	1802.69	0	0
41	379.287	55.0122	1575.55	0	0
42	380.337	55.0485	1353.27	0	0
43	381.387	55.1091	1139.24	0	0
44	382.438	55.1939	935.013	0	0
45	383.488	55.3032	743.304	0	0
46	384.538	55.4371	567.136	0	0
47	385.589	55.5959	406.746	0	0
48	386.639	55.7797	266.089	0	0
49	387.689	55.9889	149.661	0	0
50	388.739	56.2239	59.5611	0	0
51	389.79	56.485	0	0	0

Long Term Sability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 1.69577

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	292.308	97.1042	0	0	0
2	294.147	94.472	-190.257	-69.9177	20.1779
3	295.986	92	-61.8711	-22.737	20.1779
4	298.165	89.2535	602.681	221.479	20.1779
5	300.344	86.6834	1503.35	552.465	20.1778
6	302.523	84.2706	2588.3	951.175	20.1779
7	304.702	82	3809.93	1400.11	20.1779
8	307.061	79.6873	5348.03	1965.35	20.1779
9	309.42	77.5129	7125.73	2618.63	20.1778
10	311.78	75.4658	8950.49	3289.21	20.1778
11	314.139	73.5365	10824	3977.71	20.1779
12	316.498	71.7168	12741.8	4682.47	20.1778
13	318.857	70	13473	4951.19	20.1779
14	321.063	68.4824	14082.9	5175.33	20.1779
15	323.269	67.0451	14666.6	5389.82	20.1778
16	325.475	65.6842	15212.1	5590.31	20.1779
17	327.681	64.3964	15709	5772.91	20.1779
18	329.886	63.1786	16148	5934.22	20.1778
19	332.092	62.0281	16539.9	6078.25	20.1779
20	334.298	60.9425	16907	6213.14	20.1778
21	336.504	59.9196	17192.2	6317.95	20.1778
22	338.71	58.9573	17383.9	6388.4	20.1778
23	340.915	58.054	17471.3	6420.53	20.1779
24	343.121	57.208	17444.4	6410.64	20.1779
25	345.327	56.4179	17293.8	6355.28	20.1778
26	347.533	55.6823	17010.6	6251.24	20.1779
27	349.739	55	16588.9	6096.24	20.1778
28	351.925	54.3753	16416.8	6033.01	20.1779
29	354.112	53.801	16126.4	5926.27	20.1778
30	356.298	53.2763	15716.7	5775.73	20.1779
31	358.485	52.8004	15183.6	5579.8	20.1778
32	360.672	52.3727	14548	5346.24	20.1779
33	362.858	51.9926	13883.3	5101.98	20.1779
34	365.045	51.6595	13146.5	4831.22	20.1779
35	367.231	51.373	12346.9	4537.36	20.1779
36	369.418	51.1328	11496.7	4224.92	20.1779
37	371.605	50.9385	10611.2	3899.5	20.1778
38	373.791	50.7898	9699.69	3564.54	20.1779
39	375.978	50.6866	8775.13	3224.77	20.1779
40	378.165	50.6287	7840.99	2881.48	20.1778
41	380.351	50.6161	6913.62	2540.69	20.1779
42	382.538	50.6487	6001.47	2205.48	20.1779
43	384.724	50.7266	5106.36	1876.54	20.1779
44	386.911	50.8499	4226.56	1553.22	20.1779
45	389.098	51.0187	3368.32	1237.82	20.1778
46	391.284	51.2333	2536.21	932.031	20.1779
47	393.471	51.4939	1759.25	646.505	20.1778
48	395.657	51.8009	1107.83	407.117	20.1779
49	397.844	52.1547	606.457	222.867	20.1779
50	400.031	52.5558	220.552	81.0507	20.1779
51	402.217	53.0047	0	0	0

Long Term Sability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.50062

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	298.046	96.3882	0	0	0
2	298.736	93.8533	-268.223	-93.7708	19.2696
3	299.427	92	-301.869	-105.533	19.2696
4	300.1	90.5228	-78.9254	-27.5923	19.2696
5	300.773	89.2542	190.451	66.5816	19.2696
6	301.446	88.1358	488.448	170.761	19.2696
7	302.119	87.1332	802.41	280.522	19.2696
8	302.792	86.2241	1123.52	392.783	19.2696
9	303.465	85.3928	1445.05	505.187	19.2695
10	304.138	84.628	1761.63	615.864	19.2696
11	304.811	83.9213	2068.88	723.279	19.2696
12	305.484	83.266	2363.14	826.153	19.2696
13	306.158	82.6567	2641.29	923.394	19.2696
14	306.831	82.0892	2916.43	1019.58	19.2696
15	307.504	81.56	3213.49	1123.43	19.2695
16	308.177	81.0661	3487.73	1219.31	19.2696
17	308.85	80.6052	3736.94	1306.43	19.2696
18	309.523	80.175	3959.52	1384.25	19.2696
19	310.196	79.7738	4154.09	1452.27	19.2696
20	310.869	79.4	4319.38	1510.05	19.2696
21	311.542	79.0522	4454.23	1557.2	19.2696
22	312.215	78.7293	4558.18	1593.54	19.2696
23	312.889	78.4303	4631.12	1619.04	19.2696
24	313.562	78.1542	4671.53	1633.17	19.2697
25	314.235	77.9003	4677.9	1635.39	19.2696
26	314.908	77.6678	4648.77	1625.21	19.2696
27	315.581	77.4562	4582.7	1602.11	19.2696
28	316.254	77.2649	4478.29	1565.61	19.2696
29	316.927	77.0933	4358.25	1523.64	19.2696
30	317.6	76.9412	4239.46	1482.12	19.2697
31	318.273	76.8082	4108.45	1436.31	19.2696
32	318.947	76.6939	3965.39	1386.3	19.2696
33	319.62	76.5981	3810.54	1332.16	19.2696
34	320.293	76.5205	3644.23	1274.02	19.2696
35	320.966	76.4612	3466.84	1212.01	19.2697
36	321.639	76.4198	3278.93	1146.31	19.2696
37	322.312	76.3963	3081.17	1077.17	19.2695
38	322.985	76.3906	2874.33	1004.86	19.2695
39	323.658	76.4028	2659.33	929.702	19.2696
40	324.331	76.4329	2437.25	852.063	19.2696
41	325.004	76.4809	2209.32	772.376	19.2696
42	325.678	76.547	1976.93	691.134	19.2696
43	326.351	76.6312	1741.71	608.9	19.2696
44	327.024	76.7338	1505.49	526.32	19.2697
45	327.697	76.8549	1270.4	444.131	19.2696
46	328.37	76.995	1038.84	363.177	19.2696
47	329.043	77.1542	813.571	284.424	19.2696
48	329.716	77.3329	597.789	208.987	19.2696
49	330.389	77.5317	395.162	138.149	19.2697
50	331.062	77.7509	209.952	73.399	19.2696
51	331.736	77.9912	0	0	0

Long Term Sability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 1.57757

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	345.753	77.217	0	0	0
2	346.451	76.2334	-15.8809	-7.0205	23.8489
3	347.15	75.3059	10.9767	4.85248	23.8488
4	347.848	74.4286	73.7287	32.5934	23.8489
5	348.547	73.5969	166.593	73.6461	23.8489
6	349.245	72.8066	284.606	125.817	23.849
7	349.944	72.0545	380.514	168.215	23.8489
8	350.642	71.3376	448.787	198.397	23.849
9	351.34	70.6535	528.908	233.816	23.8489
10	352.039	70	618.193	273.286	23.8489
11	352.755	69.3596	741.69	327.881	23.8489
12	353.472	68.7476	866.392	383.009	23.849
13	354.188	68.1624	990.41	437.833	23.8489
14	354.904	67.6027	1112.08	491.618	23.8488
15	355.621	67.0672	1229.89	543.701	23.8489
16	356.337	66.5547	1342.48	593.473	23.8489
17	357.053	66.0643	1448.88	640.512	23.849
18	357.77	65.5951	1551.46	685.857	23.8489
19	358.486	65.1462	1647.57	728.347	23.849
20	359.203	64.7169	1734.65	766.843	23.849
21	359.919	64.3065	1812.62	801.311	23.8489
22	360.635	63.9143	1843.18	814.822	23.849
23	361.352	63.5399	1861.33	822.842	23.8489
24	362.068	63.1826	1870.17	826.751	23.8489
25	362.784	62.842	1869.52	826.462	23.8489
26	363.501	62.5177	1859.38	821.984	23.849
27	364.217	62.2092	1839.89	813.368	23.849
28	364.934	61.9162	1811.32	800.737	23.849
29	365.65	61.6384	1773.96	784.218	23.8489
30	366.366	61.3753	1728.06	763.928	23.8489
31	367.083	61.1268	1674.02	740.041	23.849
32	367.799	60.8925	1612.37	712.785	23.8489
33	368.515	60.6723	1543.59	682.38	23.8489
34	369.232	60.4658	1468.13	649.022	23.849
35	369.948	60.2729	1386.63	612.994	23.849
36	370.664	60.0934	1300.5	574.915	23.8489
37	371.381	59.9271	1210.9	535.308	23.849
38	372.097	59.7739	1117.62	494.07	23.8489
39	372.814	59.6335	1020.96	451.338	23.8489
40	373.53	59.5059	921.911	407.552	23.8489
41	374.246	59.391	822.421	363.57	23.8489
42	374.963	59.2887	723.837	319.989	23.8489
43	375.679	59.1988	625.933	276.708	23.8489
44	376.395	59.1212	529.011	233.862	23.849
45	377.112	59.056	434.231	191.962	23.8489
46	377.828	59.0031	343.434	151.823	23.8489
47	378.544	58.9624	258.462	114.259	23.8489
48	379.261	58.9338	180.869	79.9575	23.849
49	379.977	58.9174	111.596	49.3334	23.8489
50	380.694	58.9131	52.1655	23.0609	23.8489
51	381.41	58.921	0	0	0

Discharge Sections

Entity Information

Short Term Stability

Shared Entities

Type	Coordinates (x,y)
External Boundary	177, 100
	177, 92
	177, 82
	177, 70
	177, 55
	177, 35
	177, 20
	177, 8.954
	475.357, 8.954
	475.357, 20
	475.357, 32.0046
	453.323, 32.0046
	450.324, 33.0046
	446.579, 34.0047
	443.985, 35
	443.972, 35.0047
	442.01, 36.0047
	440.676, 37.0047
	439.468, 38.0047
	438.753, 39.0047
	437.642, 40.0047
	435.88, 41.0047
	434.144, 42.0047
	432.324, 43.0047
	430.725, 44.0047
	429.234, 45.0047
	427.774, 46.0047
	425.844, 47.0047
	423.768, 48.0047
	421.807, 49.0047
	420.022, 50.0047
	418.413, 51.0047
	416.363, 52.0047
	413.776, 53.0047
	402.01, 53.0047
	400.858, 53.0047
	396.283, 54.0047
	394.248, 55
	394.239, 55.0047
	391.984, 56.0047
	387.416, 57.0047
	383.835, 58.0047
	381.188, 59.0047
	379.014, 60.0047

	377.024, 61.0047 374.835, 62.0047 373.162, 63.0047 371.187, 64.0047 369.726, 65.0047 367.95, 66.0047 366.286, 67.0047 364.482, 68.0047 362.866, 69.0047 361.146, 70.0047 359.99, 70.554 359.99, 70.7179 359.99, 74.0047 358.532, 74.0047 355.558, 75.0046 352.583, 76.0046 349.636, 76.992 349.599, 77.0046 331.494, 78.0046 328.499, 79.0046 325.505, 80.0046 322.511, 81.0046 319.53, 82 319.516, 82.0046 316.498, 83.0046 316.498, 92 316.498, 94.0048 314.485, 94.0048 311.712, 94.0048 311.697, 94.0048 307.357, 95.0048 301, 96.0048 293.295, 97.0048 283.36, 98.0048 269.949, 99.0048 243.81, 100.005
Material Boundary	177, 82 306.498, 82 316.498, 82 319.53, 82
Material Boundary	177, 70 356.992, 70 359.99, 70 361.146, 70.0047
Material Boundary	177, 55 394.248, 55
Material Boundary	177, 35 443.985, 35
Material Boundary	177, 20 475.357, 20

Material Boundary	349.636, 76.992 351.274, 75.9831 352.961, 74.9831 354.732, 73.9831 356.456, 72.9831 357.791, 72.0776 357.93, 71.9831 359.431, 70.9831 359.99, 70.7179
Material Boundary	358.532, 74.0047 357.791, 72.0776 356.992, 70 356.8, 69.5 359.99, 69.5 359.99, 70 359.99, 70.554
Material Boundary	306.498, 82 306.498, 92 306.498, 94.0048 311.697, 94.0048
Material Boundary	316.498, 82 316.498, 83.0046
Material Boundary	177, 92 306.498, 92 316.498, 92

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario	Upper Wall	Lower Wall
Piezoline	177, 35 446.579, 34.0047 475.761, 34.0047	Assigned to: 🟧 Black Creek Aquifer	Assigned to: 🟧 Black Creek Aquifer	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	349.636, 76.992 349.599, 77.0046 331.494, 78.0046	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No		
Distributed Load	349.599, 77.0046 331.494, 78.0046			Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Long Term Sability

Shared Entities

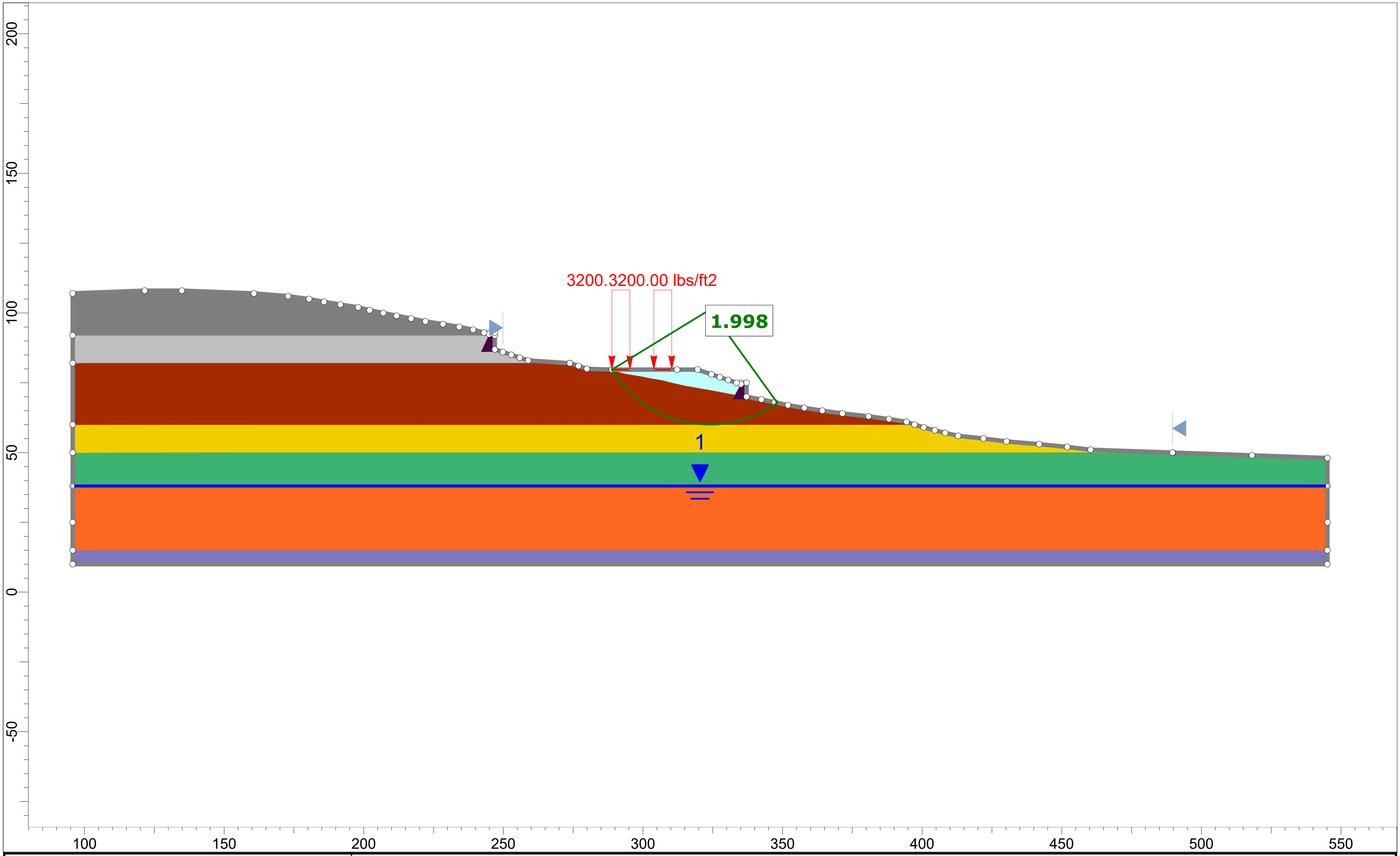
Type	Coordinates (x,y)
	177, 100 177, 92 177, 82 177, 70 177, 55

External Boundary	177, 35 177, 20 177, 8.954 475.357, 8.954 475.357, 20 475.357, 32.0046 453.323, 32.0046 450.324, 33.0046 446.579, 34.0047 443.985, 35 443.972, 35.0047 442.01, 36.0047 440.676, 37.0047 439.468, 38.0047 438.753, 39.0047 437.642, 40.0047 435.88, 41.0047 434.144, 42.0047 432.324, 43.0047 430.725, 44.0047 429.234, 45.0047 427.774, 46.0047 425.844, 47.0047 423.768, 48.0047 421.807, 49.0047 420.022, 50.0047 418.413, 51.0047 416.363, 52.0047 413.776, 53.0047 402.01, 53.0047 400.858, 53.0047 396.283, 54.0047 394.248, 55 394.239, 55.0047 391.984, 56.0047 387.416, 57.0047 383.835, 58.0047 381.188, 59.0047 379.014, 60.0047 377.024, 61.0047 374.835, 62.0047 373.162, 63.0047 371.187, 64.0047 369.726, 65.0047 367.95, 66.0047 366.286, 67.0047 364.482, 68.0047 362.866, 69.0047 361.146, 70.0047 359.99, 70.554 359.99, 70.7179 359.99, 74.0047 358.532, 74.0047 355.558, 75.0046 352.583, 76.0046 349.636, 76.992 349.599, 77.0046 331.494, 78.0046 328.499, 79.0046	

	325.505, 80.0046 322.511, 81.0046 319.53, 82 319.516, 82.0046 316.498, 83.0046 316.498, 92 316.498, 94.0048 314.485, 94.0048 311.712, 94.0048 311.697, 94.0048 307.357, 95.0048 301, 96.0048 293.295, 97.0048 283.36, 98.0048 269.949, 99.0048 243.81, 100.005
Material Boundary	177, 82 306.498, 82 308.498, 82 316.498, 82 319.53, 82
Material Boundary	177, 70 356.992, 70 359.99, 70 361.146, 70.0047
Material Boundary	177, 55 394.248, 55
Material Boundary	177, 35 443.985, 35
Material Boundary	177, 20 475.357, 20
Material Boundary	349.636, 76.992 351.274, 75.9831 352.961, 74.9831 354.732, 73.9831 356.456, 72.9831 357.791, 72.0776 357.93, 71.9831 359.431, 70.9831 359.99, 70.7179
Material Boundary	358.532, 74.0047 357.791, 72.0776 356.992, 70 356.8, 69.5 359.99, 69.5 359.99, 70 359.99, 70.554
Material Boundary	306.498, 82 306.498, 92 306.498, 94.0048 311.697, 94.0048
Material Boundary	316.498, 82 316.498, 83.0046
Material Boundary	177, 92 306.498, 92 308.498, 92 316.498, 92

Scenario-based Entities

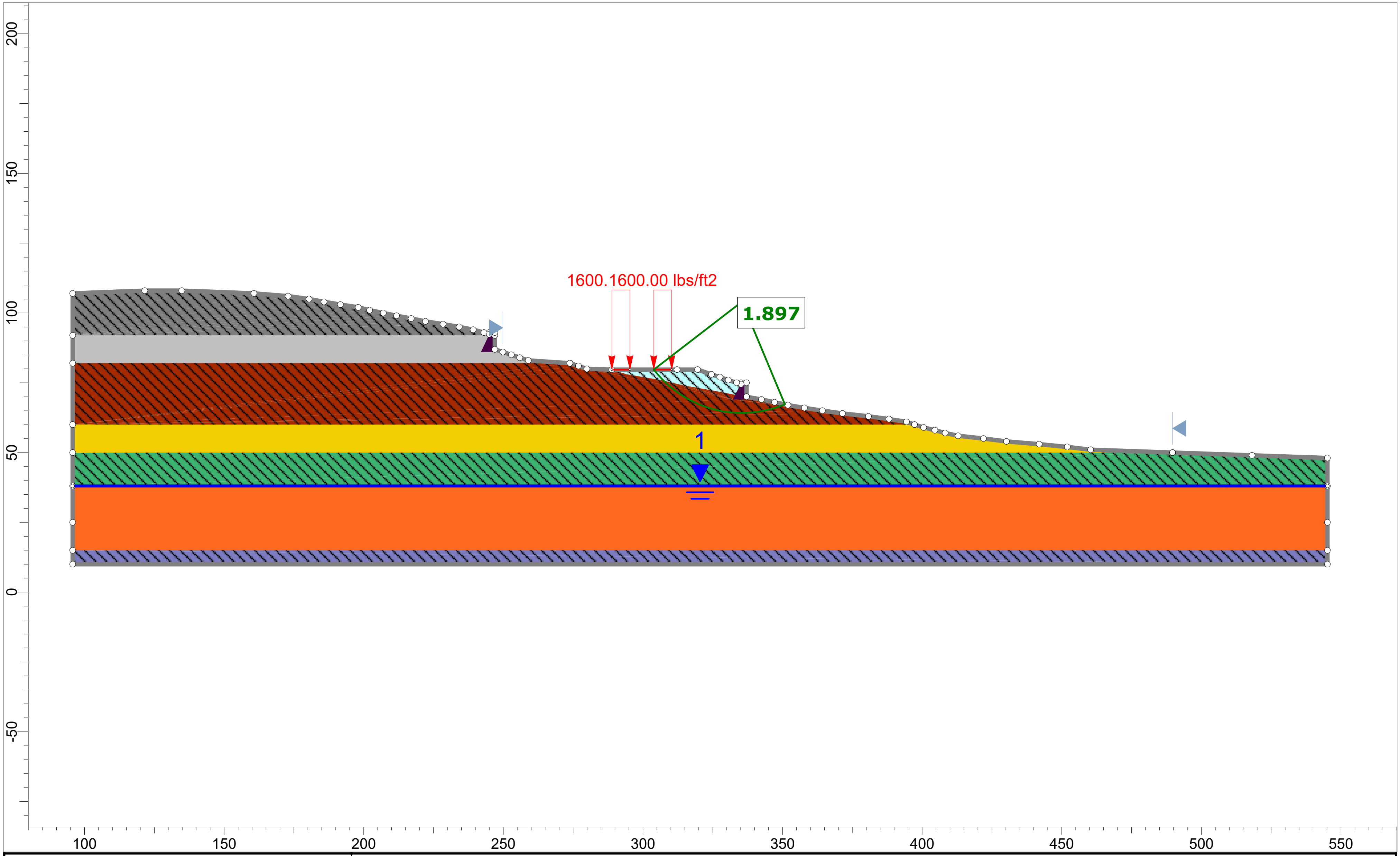
Type	Coordinates (x,y)	Master Scenario	Upper Wall	Lower Wall
Piezoline	177, 35 446.579, 34.0047 475.761, 34.0047	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)
Distributed Load	349.599, 77.0046 331.494, 78.0046	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No		
Distributed Load	349.599, 77.0046 331.494, 78.0046			Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No



GEOS Universal Engineering Sciences
Geotechnical, Environmental and Materials Engineers

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis	Short Term Slope Stability
Section	Section 5 - MT3500 Dynamic Pressure Stability - 3200 psf
Drawn By	
Station	Approx. STA 36+80
Date	
File Name	section-5.slmd

SLIDEINTERPRET 9.020



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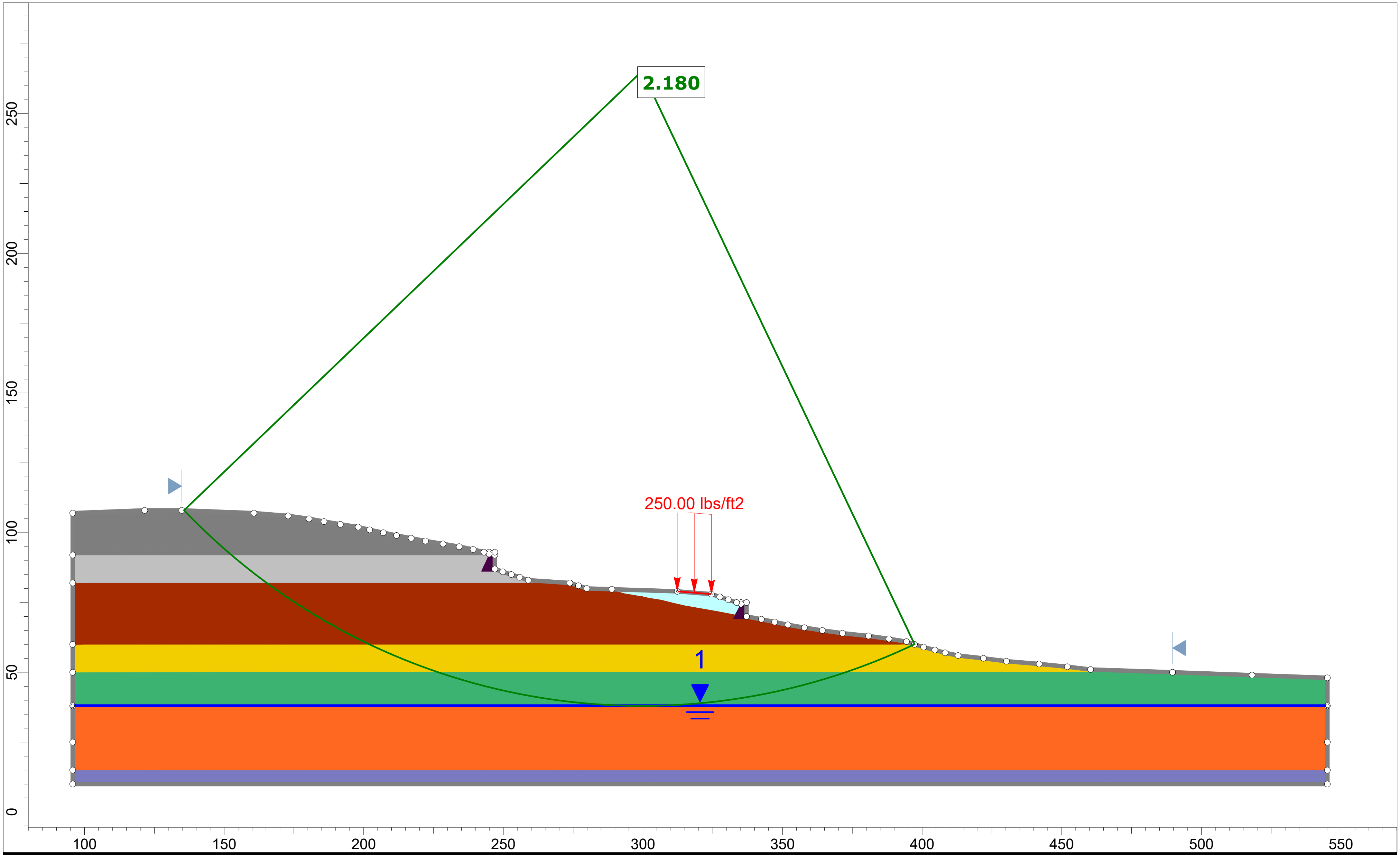
SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Long Term Slope Stability	*Section* Section 5 - MT3500 Static Pressure Stability - 1600 psf
Drawn By	*Station* Approx. STA 36+80
Date	*File Name* section-5.slmd



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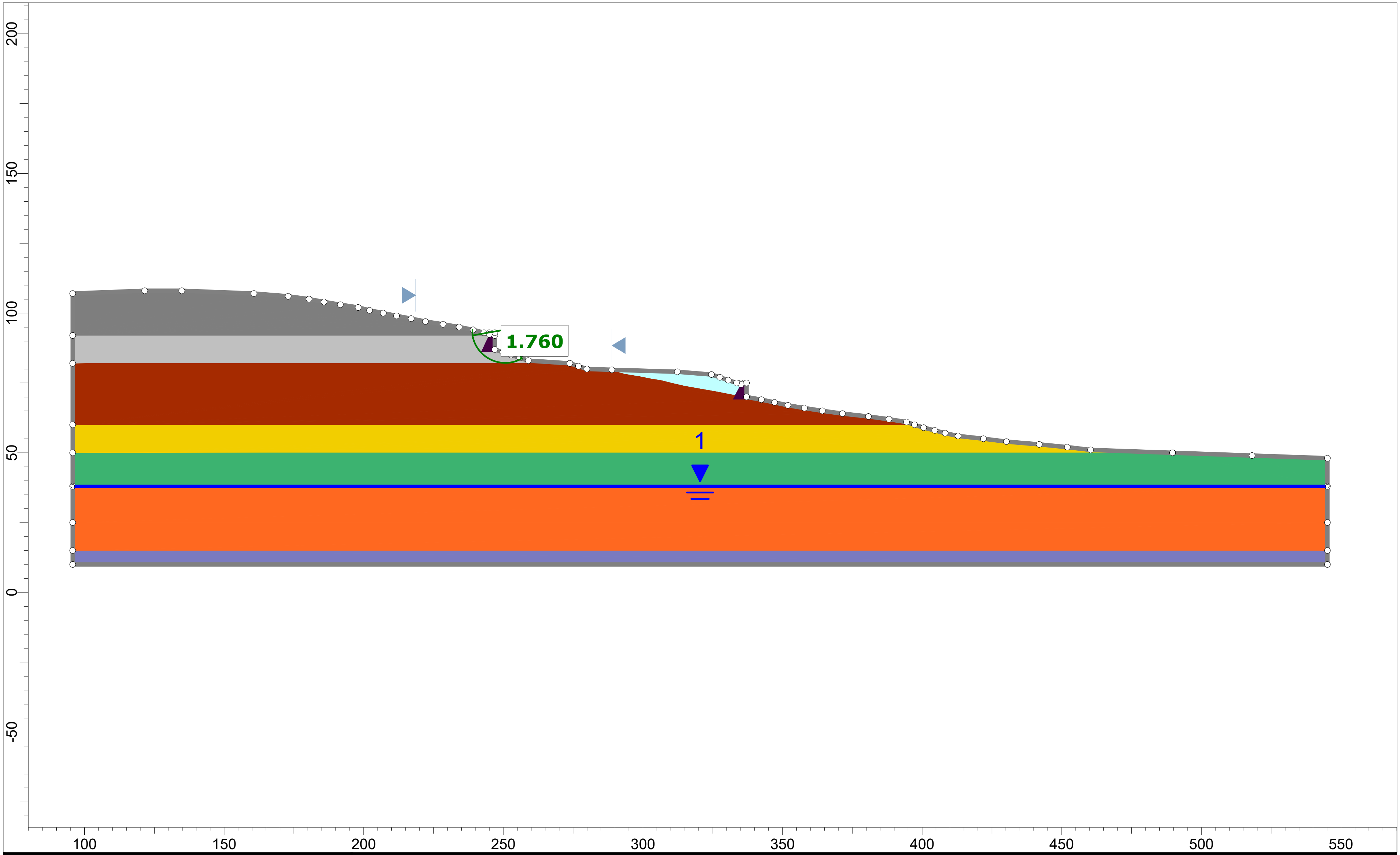
SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 5
Drawn By		*Station*	Approx. STA 36+80
Date		*File Name*	section-5.slmd



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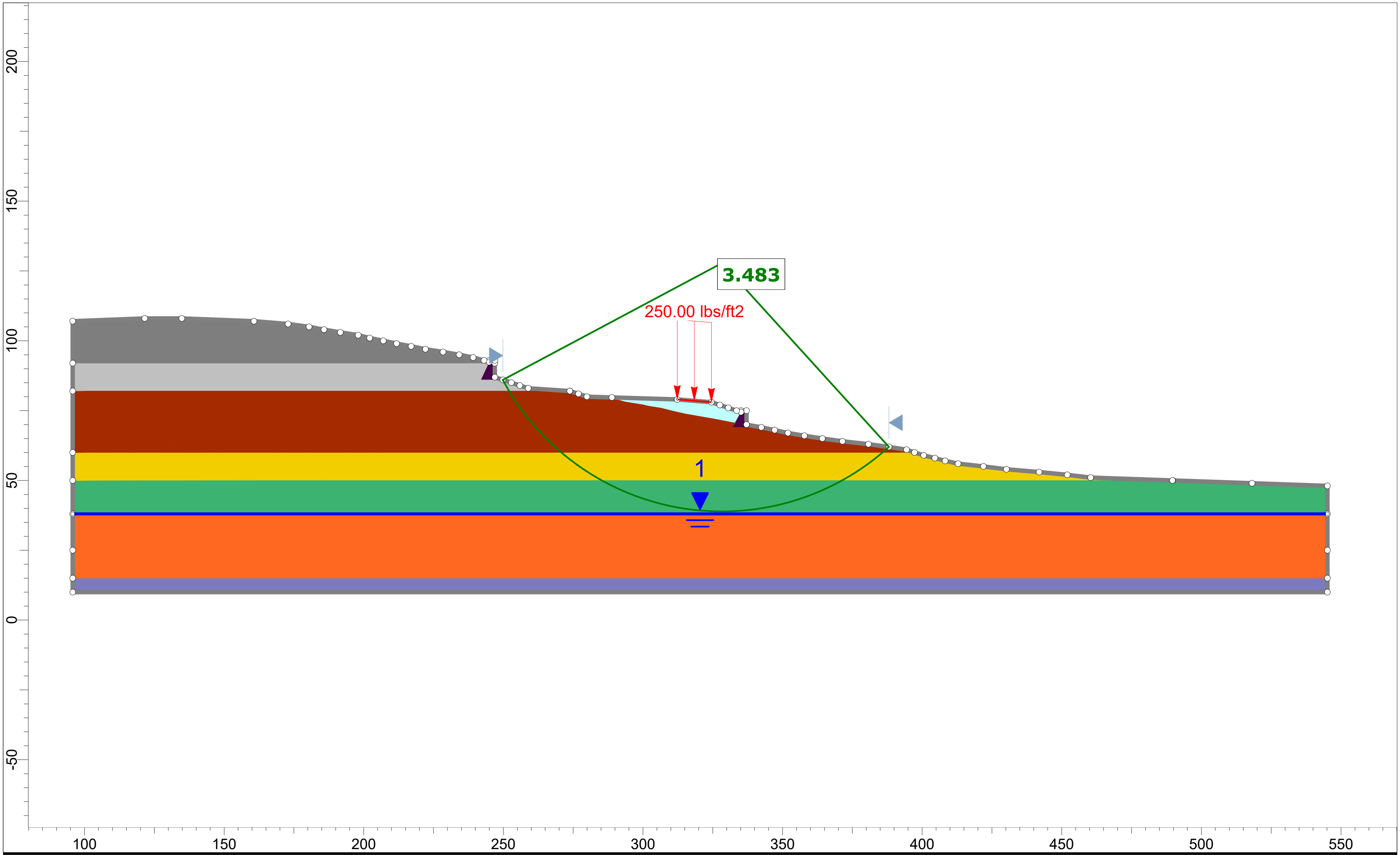
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 5 - Upper Wall
Drawn By		*Station*	Approx. STA 36+80
Date		*File Name*	section-5.slmd

SLIDEINTERPRET 9.020



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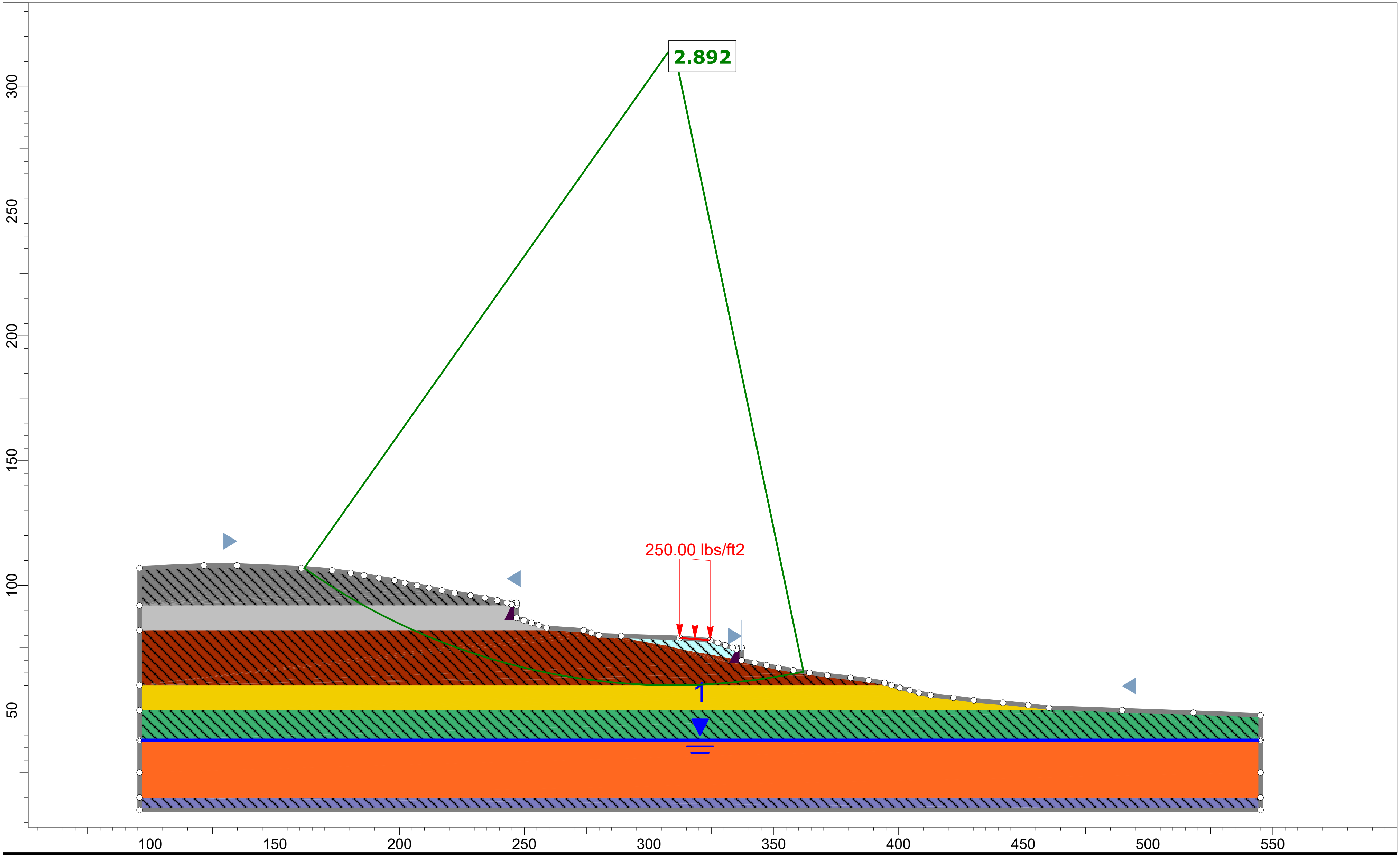
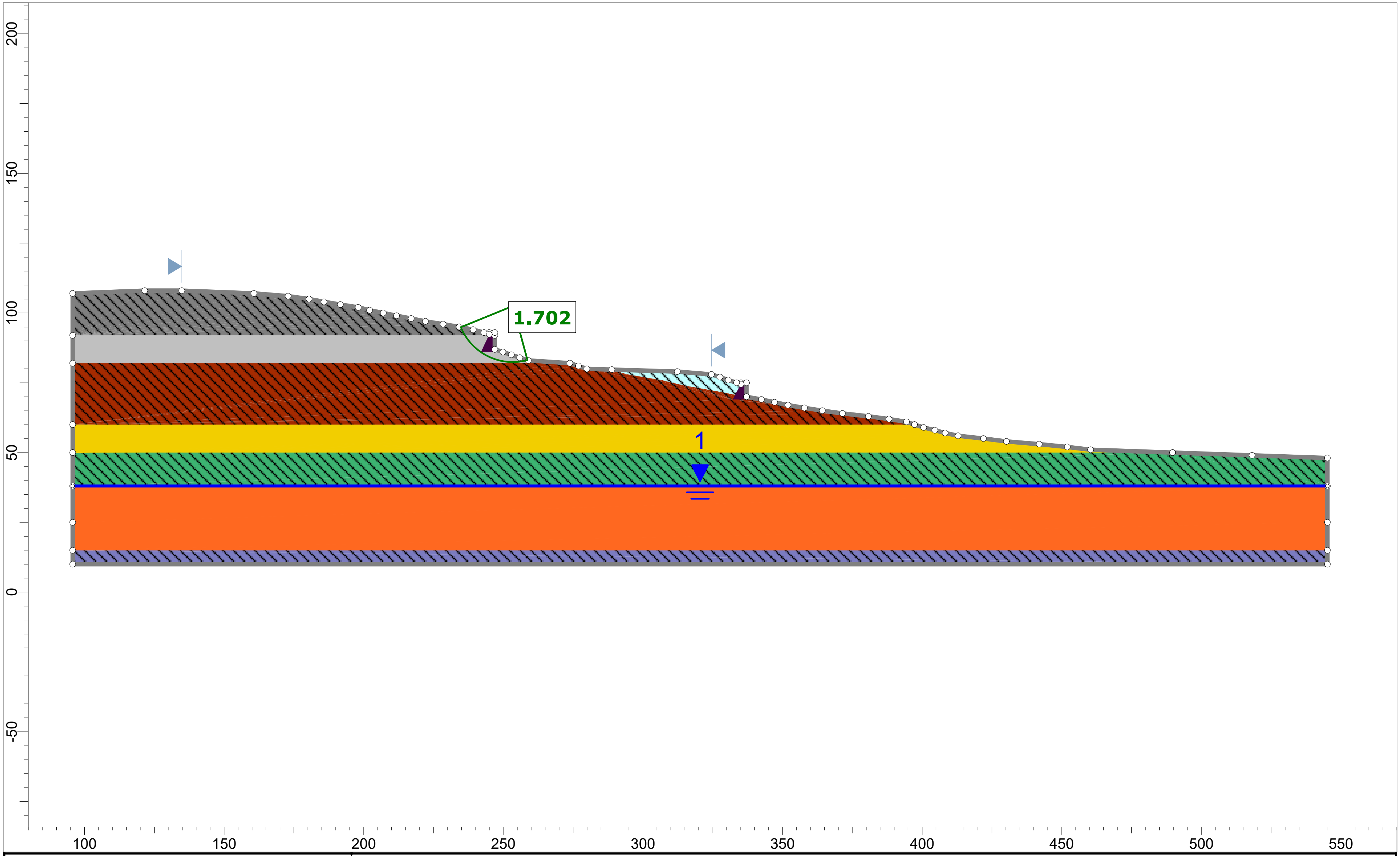
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 5 - Lower Wall
Drawn By		*Station*	Approx. STA 36+80
Date		*File Name*	section-5.slmd

SLIDEINTERPRET 9.020



	Project	45-20803 Barrier Wall Road Interim Design and Repair	
GEOS Universal Engineering Sciences Geotechnical, Environmental and Materials Engineers	*Analysis* Long Term Slope Stability	*Section* Section 5	
	Drawn By	*Station* Approx. STA 36+80	
SLIDEINTERPRET 9.020	*Date*	*File Name* section-5.slmd	



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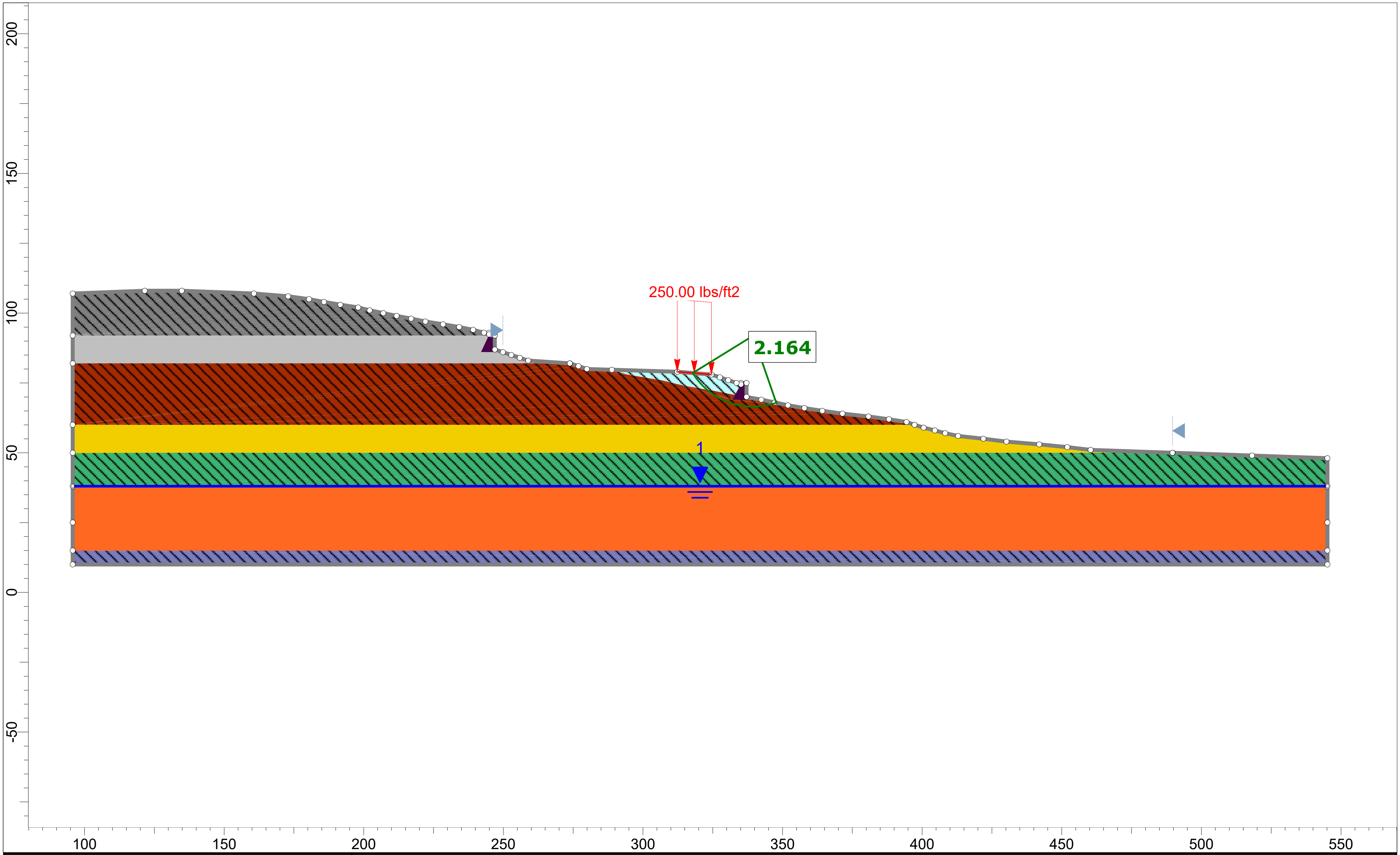
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 5 - Upper Wall
Drawn By		*Station*	Approx. STA 36+80
Date		*File Name*	section-5.slmd



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SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 5 - Lower Wall
Drawn By		*Station*	Approx. STA 36+80
Date		*File Name*	section-5.slmd

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Section-5
45-20803 Barrier Wall Road Interim Design and Repair
Approx. STA 36+80
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-5

Project Summary

File Name:	section-5.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Long Term Slope Stability

Comments

Section 5 - Lower Wall
Approx. STA 36+80

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
MT3500 Dynamic Pressure Stability - 3200 psf ◆	Master Scenario	Spencer: 1.997940	00h:00m:11.362s
MT3500 Static Pressure Stability - 1600 psf Drained ◆	Master Scenario	Spencer: 1.897270	00h:00m:07.807s
Short Term Stability ◆	Master Scenario	Spencer: 2.180020	00h:00m:09.946s
	Upper Wall	Spencer: 1.760470	00h:00m:10.353s
	Lower Wall	Spencer: 3.483150	00h:00m:09.154s
Long Term Stability ◆	Master Scenario	Spencer: 2.891880	00h:00m:06.553s
	Upper Wall	Spencer: 1.701650	00h:00m:06.376s
	Lower Wall	Spencer: 2.163780	00h:00m:07.157s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

MT3500 Dynamic Pressure Stability - 3200 psf

Distribution: Constant
Magnitude [psf]: 3200
Orientation: Vertical

Distribution: Constant
Magnitude [psf]: 3200
Orientation: Vertical

MT3500 Static Pressure Stability - 1600 psf Drained

Distribution: Constant
Magnitude [psf]: 1600
Orientation: Vertical

Distribution: Constant
Magnitude [psf]: 1600
Orientation: Vertical

Short Term Stability - Master Scenario

Distribution: Constant
Magnitude [psf]: 250
Orientation: Vertical

Short Term Stability - Lower Wall

Distribution: Constant
Magnitude [psf]: 250
Orientation: Vertical

Long Term Stability - Master Scenario

Distribution: Constant
Magnitude [psf]: 250
Orientation: Vertical

Long Term Stability - Lower Wall

Distribution: Constant
Magnitude [psf]: 250
Orientation: Vertical

Materials

Retaining Wall	
Color	🟪
Strength Type	Infinite strength
Unit Weight [lbs/ft3]	130
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	⬛
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	⬜
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay	
Color	🟥
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	1100
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	200
Friction Angle [deg]	24

Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Upper Cape Fear Confining Unit	
Color	🟪
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	2500
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Upper Cape Fear Confining Unit (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	26

Water Surface	Assigned per scenario
Hu Value	1
Compacted Fill	
Color	■
Strength Type	Undrained
Unit Weight [lbs/ft3]	125
Cohesion [psf]	2000
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material	MT3500 Dynamic Pressure Stability - 3200 psf	MT3500 Static Pressure Stability - 1600 psf Drained	Short Term Stability	Upper Wall	Lower Wall	Long Term Stability	Upper Wall	Lower Wall
Retaining W	✓	✓	✓	✓	✓	✓	✓	✓
Dark Gray C	✓	✗	✓	✓	✓	✗	✗	✗
Dark Gray C (Drained)	✗	✓	✗	✗	✗	✓	✓	✓
Light Gray Sand	✓	✓	✓	✓	✓	✓	✓	✓
Perched Cla	✓	✗	✓	✓	✓	✗	✗	✗
Perched Cla (Drained)	✗	✓	✗	✗	✗	✓	✓	✓
Surficial Aquifer	✓	✓	✓	✓	✓	✓	✓	✓
Black Creek Confining U	✓	✗	✓	✓	✓	✗	✗	✗
Black Creek Confining U (Long Term	✗	✓	✗	✗	✗	✓	✓	✓
Black Creek Aquifer	✓	✓	✓	✓	✓	✓	✓	✓
Upper Cape Fear Confin Unit	✓	✗	✓	✓	✓	✗	✗	✗
Upper Cape Fear Confin Unit (Draine	✗	✓	✗	✗	✗	✓	✓	✓
Compacted	✓	✗	✓	✓	✓	✗	✗	✗
Compacted (Drained)	✗	✓	✗	✗	✗	✓	✓	✓

Global Minimums

MT3500 Dynamic Pressure Stability - 3200 psf

Method: spencer

FS	1.997940
Center:	324.000, 101.216
Radius:	41.198
Left Slip Surface Endpoint:	288.852, 79.721
Right Slip Surface Endpoint:	348.098, 67.800
Resisting Moment:	3.07884e+06 lb-ft
Driving Moment:	1.54101e+06 lb-ft
Resisting Horizontal Force:	65170.2 lb
Driving Horizontal Force:	32618.7 lb
Total Slice Area:	734.843 ft2
Surface Horizontal Width:	59.2457 ft
Surface Average Height:	12.4033 ft

MT3500 Static Pressure Stability - 1600 psf Drained

Method: spencer

FS	1.897270
Center:	335.479, 104.017
Radius:	39.867
Left Slip Surface Endpoint:	303.871, 79.721
Right Slip Surface Endpoint:	350.827, 67.223
Resisting Moment:	1.38322e+06 lb-ft
Driving Moment:	729055 lb-ft
Resisting Horizontal Force:	30946.2 lb
Driving Horizontal Force:	16310.9 lb
Total Slice Area:	364.353 ft2
Surface Horizontal Width:	46.9568 ft
Surface Average Height:	7.75933 ft

Short Term Stability - Master Scenario

Method: spencer

FS	2.180020
Center:	299.663, 265.224
Radius:	227.258
Left Slip Surface Endpoint:	135.600, 107.967
Right Slip Surface Endpoint:	397.276, 59.998
Resisting Moment:	8.19153e+07 lb-ft
Driving Moment:	3.75754e+07 lb-ft
Resisting Horizontal Force:	332339 lb
Driving Horizontal Force:	152448 lb
Total Slice Area:	8298.78 ft2
Surface Horizontal Width:	261.676 ft
Surface Average Height:	31.714 ft

Short Term Stability - Upper Wall

Method: spencer

FS	1.760470
Center:	250.698, 94.076
Radius:	11.928
Left Slip Surface Endpoint:	238.951, 92.005
Right Slip Surface Endpoint:	256.656, 83.742
Left Slope Intercept:	238.951 94.039
Right Slope Intercept:	256.656 83.742
Resisting Moment:	92090.4 lb-ft
Driving Moment:	52310.2 lb-ft
Resisting Horizontal Force:	6462.83 lb
Driving Horizontal Force:	3671.08 lb
Total Slice Area:	87.5578 ft2
Surface Horizontal Width:	17.7047 ft
Surface Average Height:	4.94545 ft

Short Term Stability - Lower Wall

Method: spencer

FS	3.483150
Center:	328.316, 127.808
Radius:	88.907
Left Slip Surface Endpoint:	249.853, 85.997
Right Slip Surface Endpoint:	388.093, 61.997
Resisting Moment:	1.59589e+07 lb-ft
Driving Moment:	4.58174e+06 lb-ft
Resisting Horizontal Force:	155726 lb
Driving Horizontal Force:	44708.4 lb
Total Slice Area:	3447.17 ft2
Surface Horizontal Width:	138.24 ft
Surface Average Height:	24.9361 ft

Long Term Stability - Master Scenario

Method: spencer

FS	2.891880
Center:	309.651, 316.484
Radius:	256.502
Left Slip Surface Endpoint:	161.763, 106.908
Right Slip Surface Endpoint:	361.908, 65.362
Resisting Moment:	5.26059e+07 lb-ft
Driving Moment:	1.81909e+07 lb-ft
Resisting Horizontal Force:	196837 lb
Driving Horizontal Force:	68065.4 lb
Total Slice Area:	3134.97 ft2
Surface Horizontal Width:	200.145 ft
Surface Average Height:	15.6635 ft

Long Term Stability - Upper Wall

Method: spencer

FS	1.701650
Center:	253.388, 102.500
Radius:	20.096
Left Slip Surface Endpoint:	234.795, 94.877
Right Slip Surface Endpoint:	258.618, 83.096
Resisting Moment:	180165 lb-ft
Driving Moment:	105877 lb-ft
Resisting Horizontal Force:	7576 lb
Driving Horizontal Force:	4452.16 lb
Total Slice Area:	101.452 ft2
Surface Horizontal Width:	23.8237 ft
Surface Average Height:	4.25847 ft

Long Term Stability - Lower Wall

Method: spencer

FS	2.163780
Center:	339.450, 91.885
Radius:	25.409
Left Slip Surface Endpoint:	317.824, 78.544
Right Slip Surface Endpoint:	347.758, 67.872
Resisting Moment:	393230 lb-ft
Driving Moment:	181733 lb-ft
Resisting Horizontal Force:	13627.9 lb
Driving Horizontal Force:	6298.18 lb
Total Slice Area:	145.342 ft2
Surface Horizontal Width:	29.9336 ft
Surface Average Height:	4.85547 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

◆ MT3500 Dynamic Pressure Stability - 3200 psf

Method: spencer

Number of Valid Surfaces:	75062
Number of Invalid Surfaces:	0

◆ MT3500 Static Pressure Stability - 1600 psf Drained

Method: spencer

Number of Valid Surfaces:	52922
Number of Invalid Surfaces:	0

◆ Short Term Stability - Master Scenario

Method: spencer

Number of Valid Surfaces:	91470
Number of Invalid Surfaces:	0

◆ Short Term Stability - Upper Wall

Method: spencer

Number of Valid Surfaces:	19684
Number of Invalid Surfaces:	0

◆ Short Term Stability - Lower Wall

Method: spencer

Number of Valid Surfaces:	69142
Number of Invalid Surfaces:	0

◆ Long Term Stability - Master Scenario

Method: spencer

Number of Valid Surfaces:	74558
Number of Invalid Surfaces:	0

◆ Long Term Stability - Upper Wall

Method: spencer

Number of Valid Surfaces:	43556
Number of Invalid Surfaces:	0

◆ Long Term Stability - Lower Wall

Method: spencer

Number of Valid Surfaces:	69274
Number of Invalid Surfaces:	0

Slice Data

MT3500 Dynamic Pressure Stability - 3200 psf

Global Minimum Query (spencer) - Safety Factor: 1.99794

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.18491	122.376	-56.9917	Perched Clay	1100	0	550.567	1100	1914.08	0	1914.08	2761.61	2761.61
2	1.18491	355.001	-54.121	Perched Clay	1100	0	550.567	1100	2179.89	0	2179.89	2941.05	2941.05
3	1.18491	564.846	-51.3944	Perched Clay	1100	0	550.567	1100	2422.83	0	2422.83	3112.37	3112.37
4	1.18491	755.876	-48.8222	Perched Clay	1100	0	550.567	1100	2645.74	0	2645.74	3275.14	3275.14
5	1.18491	931.152	-46.3763	Perched Clay	1100	0	550.567	1100	2852.21	0	2852.21	3429.89	3429.89
6	1.18491	1091.16	-44.0357	Perched Clay	1100	0	550.567	1100	1656.86	0	1656.86	2189.2	2189.2
7	1.18491	1238.43	-41.7845	Perched Clay	1100	0	550.567	1100	562.671	0	562.671	1054.67	1054.67
8	1.18491	1374.94	-39.6098	Perched Clay	1100	0	550.567	1100	697.53	0	697.53	1153.16	1153.16
9	1.18491	1501.7	-37.5016	Perched Clay	1100	0	550.567	1100	825.083	0	825.083	1247.57	1247.57
10	1.18491	1619.53	-35.4514	Perched Clay	1100	0	550.567	1100	945.935	0	945.935	1337.95	1337.95
11	1.18491	1728.97	-33.4523	Perched Clay	1100	0	550.567	1100	1060.48	0	1060.48	1424.23	1424.23
12	1.18491	1830.7	-31.4983	Perched Clay	1100	0	550.567	1100	1169.19	0	1169.19	1506.56	1506.56
13	1.18491	1925.26	-29.5844	Perched Clay	1100	0	550.567	1100	2197.38	0	2197.38	2509.95	2509.95
14	1.18491	2013.04	-27.7062	Perched Clay	1100	0	550.567	1100	4228.89	0	4228.89	4518.02	4518.02
15	1.18491	2094.42	-25.8598	Perched Clay	1100	0	550.567	1100	4345.88	0	4345.88	4612.75	4612.75
16	1.18491	2170.66	-24.0419	Perched Clay	1100	0	550.567	1100	4458.28	0	4458.28	4703.89	4703.89
17	1.18491	2241.84	-22.2494	Perched Clay	1100	0	550.567	1100	4566.26	0	4566.26	4791.5	4791.5
18	1.18491	2307.42	-20.4795	Perched Clay	1100	0	550.567	1100	4669.5	0	4669.5	4875.12	4875.12
19	1.18491	2367.55	-18.7299	Perched Clay	1100	0	550.567	1100	2088.13	0	2088.13	2274.81	2274.81
20	1.18491	2422.25	-16.9982	Perched Clay	1100	0	550.567	1100	1870.69	0	1870.69	2038.99	2038.99
21	1.18491	2471.84	-15.2824	Perched Clay	1100	0	550.567	1100	1939.94	0	1939.94	2090.38	2090.38
22	1.18491	2516.49	-13.5805	Perched Clay	1100	0	550.567	1100	2005.46	0	2005.46	2138.46	2138.46
23	1.18491	2555.75	-11.8908	Perched Clay	1100	0	550.567	1100	2066.9	0	2066.9	2182.83	2182.83
24	1.18491	2589.66	-10.2115	Perched Clay	1100	0	550.567	1100	2124.25	0	2124.25	2223.42	2223.42
25	1.18491	2618.9	-8.54103	Perched Clay	1100	0	550.567	1100	2178.07	0	2178.07	2260.76	2260.76
26	1.18491	2643.41	-6.87786	Perched Clay	1100	0	550.567	1100	2228.32	0	2228.32	2294.73	2294.73
27	1.18491	2629.11	-5.22049	Perched Clay	1100	0	550.567	1100	2246.83	0	2246.83	2297.14	2297.14
28	1.18491	2583.56	-3.5675	Perched Clay	1100	0	550.567	1100	2239.33	0	2239.33	2273.65	2273.65
29	1.18491	2533.53	-1.91748	Perched Clay	1100	0	550.567	1100	2227.82	0	2227.82	2246.25	2246.25

30	1.18491	2479.05	-0.269044	Perched Clay	1100	0	550.567	1100	2212.31	0	2212.31	2214.89	2214.89
31	1.18491	2421.28	1.37916	Perched Clay	1100	0	550.567	1100	2193.79	0	2193.79	2180.53	2180.53
32	1.18491	2360.84	3.02852	Perched Clay	1100	0	550.567	1100	2172.81	0	2172.81	2143.68	2143.68
33	1.18491	2296.16	4.68039	Perched Clay	1100	0	550.567	1100	2148.04	0	2148.04	2102.97	2102.97
34	1.18491	2226.79	6.33617	Perched Clay	1100	0	550.567	1100	2119.11	0	2119.11	2057.97	2057.97
35	1.18491	2152.83	7.99729	Perched Clay	1100	0	550.567	1100	2086.06	0	2086.06	2008.7	2008.7
36	1.18491	2074.24	9.6652	Perched Clay	1100	0	550.567	1100	2048.87	0	2048.87	1955.1	1955.1
37	1.18491	1997.08	11.3414	Perched Clay	1100	0	550.567	1100	2012.9	0	2012.9	1902.47	1902.47
38	1.18491	1943.29	13.0276	Perched Clay	1100	0	550.567	1100	1997.78	0	1997.78	1870.39	1870.39
39	1.18491	1861.18	14.7253	Perched Clay	1100	0	550.567	1100	1957.7	0	1957.7	1813	1813
40	1.18491	1871.76	16.4364	Perched Clay	1100	0	550.567	1100	2001.65	0	2001.65	1839.23	1839.23
41	1.18491	1607.66	18.1626	Perched Clay	1100	0	550.567	1100	1796.72	0	1796.72	1616.1	1616.1
42	1.18491	953.714	19.9062	Perched Clay	1100	0	550.567	1100	1230.84	0	1230.84	1031.47	1031.47
43	1.18491	866.7	21.6692	Perched Clay	1100	0	550.567	1100	1182.26	0	1182.26	963.505	963.505
44	1.18491	774.147	23.454	Perched Clay	1100	0	550.567	1100	1128.82	0	1128.82	889.948	889.948
45	1.18491	675.834	25.2633	Perched Clay	1100	0	550.567	1100	1070.28	0	1070.28	810.458	810.458
46	1.18491	570.188	27.1001	Perched Clay	1100	0	550.567	1100	1005.15	0	1005.15	723.409	723.409
47	1.18491	455.583	28.9675	Perched Clay	1100	0	550.567	1100	931.776	0	931.776	627	627
48	1.18491	334.259	30.8693	Perched Clay	1100	0	550.567	1100	852.26	0	852.26	523.153	523.153
49	1.18491	205.898	32.8096	Perched Clay	1100	0	550.567	1100	766.236	0	766.236	411.289	411.289
50	1.18491	69.9714	34.7934	Perched Clay	1100	0	550.567	1100	687.523	0	687.523	304.963	304.963

MT3500 Static Pressure Stability - 1600 psf Drained

Global Minimum Query (spencer) - Safety Factor: 1.89727

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.855563	57.4429	-51.4651	Compacted Fill (Drained)	200	28	369.935	701.867	943.877	0	943.877	1408.37	1408.37
2	0.855563	168.51	-49.5309	Compacted Fill (Drained)	200	28	401.903	762.518	1057.94	0	1057.94	1529.02	1529.02
3	0.855563	272.36	-47.6706	Compacted Fill (Drained)	200	28	433.107	821.72	1169.29	0	1169.29	1644.77	1644.77
4	0.855563	369.753	-45.8745	Compacted Fill (Drained)	200	28	463.593	879.562	1278.07	0	1278.07	1756.03	1756.03
5	0.946403	510.476	-44.0452	Perched Clay (Drained)	200	24	437.793	830.611	1416.37	0	1416.37	1839.81	1839.81
6	0.946403	606.046	-42.1812	Perched Clay (Drained)	200	24	463.077	878.582	1524.12	0	1524.12	1943.74	1943.74
7	0.946403	695.851	-40.3707	Perched Clay (Drained)	200	24	487.746	925.386	1629.25	0	1629.25	2043.92	2043.92
8	0.946403	780.337	-38.6077	Perched Clay (Drained)	200	24	285.334	541.355	766.696	0	766.696	994.538	994.538
9	0.946403	859.788	-36.8871	Perched Clay (Drained)	200	24	255.957	485.62	641.512	0	641.512	833.6	833.6
10	0.946403	934.634	-35.2044	Perched Clay (Drained)	200	24	273.721	519.323	717.211	0	717.211	910.332	910.332
11	0.946403	1005.19	-33.556	Perched Clay (Drained)	200	24	291.089	552.274	791.22	0	791.22	984.297	984.297
12	0.946403	1071.69	-31.9385	Perched Clay (Drained)	200	24	308.065	584.482	863.56	0	863.56	1055.6	1055.6
13	0.946403	1134.07	-30.3489	Perched Clay (Drained)	200	24	324.595	615.844	934.003	0	934.003	1124.05	1124.05
14	0.946403	1192.36	-28.7849	Perched Clay (Drained)	200	24	340.652	646.309	1002.42	0	1002.42	1189.58	1189.58
15	0.946403	1247.17	-27.2439	Perched Clay (Drained)	200	24	356.324	676.043	1069.21	0	1069.21	1252.69	1252.69
16	0.946403	1298.65	-25.724	Perched Clay (Drained)	200	24	371.616	705.056	1134.38	0	1134.38	1313.42	1313.42
17	0.946403	1346.93	-24.2234	Perched Clay (Drained)	200	24	386.53	733.351	1197.93	0	1197.93	1371.83	1371.83
18	0.946403	1372.07	-22.7402	Perched Clay (Drained)	200	24	396.782	752.803	1241.62	0	1241.62	1407.92	1407.92
19	0.946403	1375.27	-21.2729	Perched Clay (Drained)	200	24	402.42	763.5	1265.64	0	1265.64	1422.32	1422.32
20	0.946403	1375.57	-19.8202	Perched Clay (Drained)	200	24	407.44	773.024	1287.03	0	1287.03	1433.88	1433.88
21	0.946403	1373.06	-18.3806	Perched Clay (Drained)	200	24	411.843	781.377	1305.79	0	1305.79	1442.64	1442.64

22	0.946403	1367.81	-16.953	Perched Clay (Drained)	200	24	415.628	788.558	1321.93	0	1321.93	1448.62	1448.62
23	0.946403	1360.46	-15.5361	Perched Clay (Drained)	200	24	418.924	794.812	1335.97	0	1335.97	1452.44	1452.44
24	0.946403	1351.74	-14.1289	Perched Clay (Drained)	200	24	421.89	800.44	1348.61	0	1348.61	1454.8	1454.8
25	0.946403	1340.59	-12.7303	Perched Clay (Drained)	200	24	424.27	804.955	1358.75	0	1358.75	1454.6	1454.6
26	0.946403	1326.98	-11.3395	Perched Clay (Drained)	200	24	426.044	808.32	1366.31	0	1366.31	1451.74	1451.74
27	0.946403	1310.73	-9.95533	Perched Clay (Drained)	200	24	427.147	810.414	1371.02	0	1371.02	1445.99	1445.99
28	0.946403	1292.01	-8.57705	Perched Clay (Drained)	200	24	427.606	811.284	1372.97	0	1372.97	1437.46	1437.46
29	0.946403	1270.86	-7.20376	Perched Clay (Drained)	200	24	427.412	810.916	1372.14	0	1372.14	1426.16	1426.16
30	0.946403	1247.25	-5.83462	Perched Clay (Drained)	200	24	426.537	809.255	1368.41	0	1368.41	1412	1412
31	0.946403	1231.08	-4.46881	Perched Clay (Drained)	200	24	427.5	811.083	1372.51	0	1372.51	1405.92	1405.92
32	0.946403	1226.27	-3.10555	Perched Clay (Drained)	200	24	431.41	818.502	1389.18	0	1389.18	1412.59	1412.59
33	0.946403	1201.81	-1.74404	Perched Clay (Drained)	200	24	430.222	816.247	1384.12	0	1384.12	1397.22	1397.22
34	0.946403	1219.5	-0.383521	Perched Clay (Drained)	200	24	440.252	835.277	1426.86	0	1426.86	1429.8	1429.8
35	0.946403	1241.9	0.976783	Perched Clay (Drained)	200	24	451.842	857.267	1476.25	0	1476.25	1468.55	1468.55
36	0.946403	921.879	2.33764	Perched Clay (Drained)	200	24	369.455	700.956	1125.17	0	1125.17	1110.09	1110.09
37	0.946403	578.84	3.69981	Perched Clay (Drained)	200	24	278.17	527.763	736.168	0	736.168	718.181	718.181
38	0.946403	553.192	5.06409	Perched Clay (Drained)	200	24	274.194	520.22	719.225	0	719.225	694.927	694.927
39	0.946403	525.176	6.43125	Perched Clay (Drained)	200	24	269.425	511.172	698.903	0	698.903	668.534	668.534
40	0.946403	494.776	7.8021	Perched Clay (Drained)	200	24	263.825	500.547	675.04	0	675.04	638.891	638.891
41	0.946403	461.97	9.17747	Perched Clay (Drained)	200	24	257.351	488.264	647.451	0	647.451	605.873	605.873
42	0.946403	425.678	10.5582	Perched Clay (Drained)	200	24	249.636	473.627	614.576	0	614.576	568.047	568.047
43	0.946403	385.407	11.9451	Perched Clay (Drained)	200	24	240.468	456.233	575.509	0	575.509	524.636	524.636
44	0.946403	342.624	13.3392	Perched Clay (Drained)	200	24	230.231	436.811	531.886	0	531.886	477.295	477.295
45	0.946403	297.301	14.7414	Perched Clay (Drained)	200	24	218.859	415.234	483.423	0	483.423	425.837	425.837
46	0.946403	249.391	16.1527	Perched Clay (Drained)	200	24	206.269	391.348	429.775	0	429.775	370.033	370.033

47	0.946403	198.787	17.5742	Perched Clay (Drained)	200	24	192.353	364.945	370.474	0	370.474	309.551	309.551
48	0.946403	145.395	19.0069	Perched Clay (Drained)	200	24	176.992	335.801	305.013	0	305.013	244.046	244.046
49	0.946403	89.2327	20.452	Perched Clay (Drained)	200	24	160.09	303.734	232.99	0	232.99	173.288	173.288
50	0.946403	30.2252	21.9109	Perched Clay (Drained)	200	24	141.258	268.004	152.74	0	152.74	95.923	95.923

Short Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 2.18002

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	5.65282	1856.62	-45.202	Dark Gray Clay	1300	0	596.325	1300	-179.227	0	-179.227	421.318	421.318
2	5.65282	5440.27	-43.2128	Dark Gray Clay	1300	0	596.325	1300	424.922	0	424.922	985.16	985.16
3	5.65282	8776.66	-41.2867	Dark Gray Clay	1300	0	596.325	1300	994.183	0	994.183	1517.82	1517.82
4	6.33015	13423.8	-39.307	Light Gray Sand	50	32	486.826	1061.29	1618.4	0	1618.4	2016.96	2016.96
5	6.33015	16824.2	-37.2728	Light Gray Sand	50	32	616.293	1343.53	2070.08	0	2070.08	2539.11	2539.11
6	5.26083	16231.8	-35.4558	Perched Clay	1100	0	504.583	1100	2563.69	0	2563.69	2923.02	2923.02
7	5.26083	18040.8	-33.8431	Perched Clay	1100	0	504.583	1100	2912.82	0	2912.82	3251.16	3251.16
8	5.26083	19595.6	-32.2604	Perched Clay	1100	0	504.583	1100	3218.48	0	3218.48	3536.98	3536.98
9	5.26083	20909.5	-30.7048	Perched Clay	1100	0	504.583	1100	3482.48	0	3482.48	3782.14	3782.14
10	5.26083	22075.6	-29.1739	Perched Clay	1100	0	504.583	1100	3720.86	0	3720.86	4002.57	4002.57
11	5.26083	23179.2	-27.6656	Perched Clay	1100	0	504.583	1100	3948.62	0	3948.62	4213.14	4213.14
12	5.26083	24119.5	-26.1778	Perched Clay	1100	0	504.583	1100	4147.6	0	4147.6	4395.64	4395.64
13	4.92937	23274.2	-24.7545	Surficial Aquifer	75	32	1204.46	2625.75	4082.06	0	4082.06	4637.44	4637.44
14	4.92937	23918.7	-23.3932	Surficial Aquifer	75	32	1249.51	2723.95	4239.21	0	4239.21	4779.74	4779.74
15	4.92937	24505.1	-22.0457	Surficial Aquifer	75	32	1292.1	2816.8	4387.79	0	4387.79	4911.03	4911.03
16	4.92937	25034.8	-20.7109	Surficial Aquifer	75	32	1332.23	2904.28	4527.8	0	4527.8	5031.5	5031.5
17	4.92937	25531.5	-19.3878	Surficial Aquifer	75	32	1371.08	2988.98	4663.34	0	4663.34	5145.84	5145.84
18	5.31123	28061.9	-18.025	Black Creek Confining Unit	925.922	0	424.731	925.922	4997.02	0	4997.02	5135.22	5135.22
19	5.31123	28518.7	-16.6221	Black Creek Confining Unit	975.63	0	447.533	975.63	5103.07	0	5103.07	5236.67	5236.67
20	5.31123	28779.2	-15.2295	Black Creek Confining Unit	1021.1	0	468.39	1021.1	5174.9	0	5174.9	5302.42	5302.42
21	5.31123	28701.3	-13.846	Black Creek Confining Unit	1062.43	0	487.349	1062.43	5186.06	0	5186.06	5306.18	5306.18
22	5.31123	25494.8	-12.4707	Black Creek Confining Unit	1099.68	0	504.436	1099.68	4624.54	0	4624.54	4736.1	4736.1
23	5.31123	25126.1	-11.1026	Black Creek Confining Unit	1132.94	0	519.692	1132.94	4581.83	0	4581.83	4683.81	4683.81
24	5.31123	25049.8	-9.74099	Black Creek Confining Unit	1162.25	0	533.137	1162.25	4593.25	0	4593.25	4684.77	4684.77
25	5.31123	25370.8	-8.38487	Black Creek Confining Unit	1187.67	0	544.798	1187.67	4678.56	0	4678.56	4758.86	4758.86

26	5.31123	25606.4	-7.03347	Black Creek Confining Unit	1209.24	0	554.692	1209.24	4748.83	0	4748.83	4817.27	4817.27
27	5.31123	25273.1	-5.686	Black Creek Confining Unit	1227	0	562.839	1227	4713.88	0	4713.88	4769.92	4769.92
28	5.31123	24989.6	-4.34168	Black Creek Confining Unit	1240.98	0	569.252	1240.98	4688.15	0	4688.15	4731.36	4731.36
29	5.31123	25116.2	-2.99974	Black Creek Confining Unit	1251.21	0	573.944	1251.21	4739.02	0	4739.02	4769.1	4769.1
30	5.31123	25245.2	-1.65946	Black Creek Confining Unit	1257.69	0	576.917	1257.69	4790.57	0	4790.57	4807.28	4807.28
31	7.85018	37339.2	0	Black Creek Confining Unit	1260	0	577.976	1260	4827.89	0	4827.89	4827.89	4827.89
32	4.93186	23375	1.6116	Black Creek Confining Unit	1257.92	0	577.022	1257.92	4843.96	0	4843.96	4827.73	4827.73
33	4.93186	23245.7	2.85605	Black Creek Confining Unit	1252.14	0	574.371	1252.14	4902.96	0	4902.96	4874.31	4874.31
34	4.93186	22945.2	4.10185	Black Creek Confining Unit	1243.15	0	570.247	1243.15	5059.47	0	5059.47	5018.58	5018.58
35	4.93186	22521.3	5.3496	Black Creek Confining Unit	1230.92	0	564.637	1230.92	4997.8	0	4997.8	4944.93	4944.93
36	4.93186	21816.6	6.5999	Black Creek Confining Unit	1215.43	0	557.532	1215.43	4685.84	0	4685.84	4621.34	4621.34
37	4.93186	20546.1	7.85337	Black Creek Confining Unit	1196.67	0	548.926	1196.67	4384.26	0	4384.26	4308.55	4308.55
38	4.93186	19061.5	9.11064	Black Creek Confining Unit	1174.6	0	538.802	1174.6	4099.18	0	4099.18	4012.78	4012.78
39	4.93186	15649.9	10.3723	Black Creek Confining Unit	1149.19	0	527.147	1149.19	3412.03	0	3412.03	3315.54	3315.54
40	4.93186	14547.1	11.6392	Black Creek Confining Unit	1120.42	0	513.949	1120.42	3200.42	0	3200.42	3094.56	3094.56
41	4.93186	13350.2	12.9118	Black Creek Confining Unit	1088.22	0	499.179	1088.22	2967.08	0	2967.08	2852.64	2852.64
42	4.93186	12159.1	14.1909	Black Creek Confining Unit	1052.55	0	482.817	1052.55	2732.52	0	2732.52	2610.43	2610.43
43	4.93186	10952.3	15.4773	Black Creek Confining Unit	1013.36	0	464.84	1013.36	2492.09	0	2492.09	2363.37	2363.37
44	4.93186	9702.97	16.7718	Black Creek Confining Unit	970.581	0	445.217	970.581	2239.97	0	2239.97	2105.79	2105.79

45	4.93186	8415.28	18.0751	Black Creek Confining Unit	924.142	0	423.914	924.142	1976.68	0	1976.68	1838.33	1838.33
46	4.92841	7130.79	19.3877	Surficial Aquifer	75	32	545.513	1189.23	1783.14	0	1783.14	1591.17	1591.17
47	4.92841	5819.95	20.7105	Surficial Aquifer	75	32	458.434	999.396	1479.34	0	1479.34	1306.02	1306.02
48	4.92841	4378.11	22.045	Surficial Aquifer	75	32	359.618	783.975	1134.6	0	1134.6	988.973	988.973
49	4.92841	2821.84	23.3923	Surficial Aquifer	75	32	249.706	544.364	751.139	0	751.139	643.121	643.121
50	4.92841	1065.06	24.7533	Surficial Aquifer	75	32	121.732	265.379	304.67	0	304.67	248.542	248.542

Short Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.76047

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.354094	114.648	-76.3849	Light Gray Sand	50	32	49.3062	86.8021	58.8957	0	58.8957	262.468	262.468
2	0.354094	160.784	-70.252	Light Gray Sand	50	32	77.3983	136.257	138.04	0	138.04	353.636	353.636
3	0.354094	192.957	-65.6696	Light Gray Sand	50	32	100.379	176.714	202.785	0	202.785	424.786	424.786
4	0.354094	218.496	-61.8048	Light Gray Sand	50	32	120.929	212.891	260.681	0	260.681	486.257	486.257
5	0.354094	239.801	-58.3821	Light Gray Sand	50	32	139.867	246.232	314.036	0	314.036	541.228	541.228
6	0.354094	258.057	-55.2669	Light Gray Sand	50	32	157.591	277.434	363.971	0	363.971	591.281	591.281
7	0.354094	273.957	-52.3808	Light Gray Sand	50	32	174.333	306.908	411.138	0	411.138	637.358	637.358
8	0.354094	287.951	-49.6732	Light Gray Sand	50	32	190.246	334.923	455.972	0	455.972	680.091	680.091
9	0.354094	301.076	-47.1093	Light Gray Sand	50	32	205.877	362.441	500.009	0	500.009	721.632	721.632
10	0.354094	315.804	-44.6639	Light Gray Sand	50	32	222.77	392.18	547.601	0	547.601	767.773	767.773
11	0.354094	329.655	-42.3179	Light Gray Sand	50	32	239.463	421.567	594.632	0	594.632	812.664	812.664
12	0.354094	342.365	-40.0566	Light Gray Sand	50	32	255.752	450.244	640.525	0	640.525	855.557	855.557
13	0.354094	353.354	-37.8681	Light Gray Sand	50	32	271.191	477.423	684.021	0	684.021	894.894	894.894
14	0.354094	363.276	-35.7429	Light Gray Sand	50	32	286.166	503.787	726.212	0	726.212	932.168	932.168
15	0.354094	372.395	-33.6731	Light Gray Sand	50	32	300.837	529.614	767.542	0	767.542	967.971	967.971
16	0.354094	380.77	-31.6521	Light Gray Sand	50	32	315.225	554.945	808.081	0	808.081	1002.4	1002.4
17	0.354094	392.074	-29.6741	Light Gray Sand	50	32	332.175	584.784	855.835	0	855.835	1045.11	1045.11
18	0.354094	423.122	-27.7344	Light Gray Sand	50	32	365.329	643.151	949.24	0	949.24	1141.32	1141.32
19	0.354094	430.402	-25.8287	Light Gray Sand	50	32	380.272	669.457	991.337	0	991.337	1175.4	1175.4
20	0.354094	437.094	-23.9532	Light Gray Sand	50	32	395.043	695.462	1032.96	0	1032.96	1208.45	1208.45
21	0.354094	443.225	-22.1047	Light Gray Sand	50	32	409.663	721.199	1074.14	0	1074.14	1240.53	1240.53
22	0.354094	448.818	-20.2801	Light Gray Sand	50	32	424.146	746.697	1114.95	0	1114.95	1271.68	1271.68
23	0.354094	317.563	-18.4767	Light Gray Sand	50	32	315.478	555.389	808.791	0	808.791	914.205	914.205
24	0.354094	171.141	-16.6921	Light Gray Sand	50	32	187.329	329.787	447.752	0	447.752	503.925	503.925
25	0.354094	170.434	-14.9241	Light Gray Sand	50	32	190.726	335.767	457.321	0	457.321	508.156	508.156
26	0.354094	169.252	-13.1705	Light Gray Sand	50	32	193.715	341.029	465.743	0	465.743	511.073	511.073
27	0.354094	167.607	-11.4294	Light Gray Sand	50	32	196.287	345.558	472.991	0	472.991	512.675	512.675
28	0.354094	165.507	-9.69892	Light Gray Sand	50	32	198.432	349.333	479.032	0	479.032	512.946	512.946
29	0.354094	162.959	-7.97735	Light Gray Sand	50	32	200.135	352.331	483.831	0	483.831	511.878	511.878
30	0.354094	159.97	-6.26301	Light Gray Sand	50	32	201.383	354.528	487.347	0	487.347	509.449	509.449
31	0.354094	156.546	-4.55428	Light Gray Sand	50	32	202.157	355.891	489.528	0	489.528	505.631	505.631
32	0.354094	152.689	-2.84961	Light Gray Sand	50	32	202.438	356.386	490.322	0	490.322	500.398	500.398

33	0.354094	148.402	-1.14746	Light Gray Sand	50	32	202.203	355.972	489.658	0	489.658	493.708	493.708
34	0.354094	143.686	0.55368	Light Gray Sand	50	32	201.425	354.602	487.466	0	487.466	485.52	485.52
35	0.354094	138.543	2.25531	Light Gray Sand	50	32	200.073	352.222	483.657	0	483.657	475.778	475.778
36	0.354094	132.97	3.95893	Light Gray Sand	50	32	198.112	348.77	478.133	0	478.133	464.422	464.422
37	0.354094	126.965	5.66606	Light Gray Sand	50	32	195.5	344.172	470.775	0	470.775	451.378	451.378
38	0.354094	120.526	7.37827	Light Gray Sand	50	32	192.19	338.345	461.45	0	461.45	436.563	436.563
39	0.354094	113.648	9.09713	Light Gray Sand	50	32	188.126	331.19	449.997	0	449.997	419.873	419.873
40	0.354094	106.328	10.8243	Light Gray Sand	50	32	183.245	322.598	436.248	0	436.248	401.211	401.211
41	0.354094	98.5643	12.5615	Light Gray Sand	50	32	177.479	312.446	420.001	0	420.001	380.455	380.455
42	0.354094	90.3406	14.3105	Light Gray Sand	50	32	170.723	300.553	400.968	0	400.968	357.418	357.418
43	0.354094	81.6461	16.0733	Light Gray Sand	50	32	162.866	286.721	378.834	0	378.834	331.907	331.907
44	0.354094	72.4688	17.8518	Light Gray Sand	50	32	153.773	270.713	353.215	0	353.215	303.691	303.691
45	0.354094	62.7947	19.6484	Light Gray Sand	50	32	143.28	252.241	323.653	0	323.653	272.496	272.496
46	0.354094	52.6076	21.4653	Light Gray Sand	50	32	131.183	230.944	289.573	0	289.573	237.99	237.99
47	0.354094	41.8889	23.3051	Light Gray Sand	50	32	117.228	206.377	250.255	0	250.255	199.756	199.756
48	0.354094	30.6177	25.1709	Light Gray Sand	50	32	101.093	177.972	204.797	0	204.797	157.289	157.289
49	0.354094	18.7904	27.0656	Light Gray Sand	50	32	82.4058	145.073	152.148	0	152.148	110.042	110.042
50	0.354094	6.36724	28.993	Light Gray Sand	50	32	64.5793	113.69	101.925	0	101.925	66.1387	66.1387

Short Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 3.48315

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.26566	422.667	-60.4543	Light Gray Sand	50	32	34.4326	119.934	111.918	0	111.918	172.664	172.664
2	2.67078	1473.61	-57.3895	Perched Clay	1100	0	315.806	1100	74.9667	0	74.9667	568.579	568.579
3	2.67078	2361.6	-54.3169	Perched Clay	1100	0	315.806	1100	421.294	0	421.294	861.058	861.058
4	2.67078	3152.45	-51.46	Perched Clay	1100	0	315.806	1100	732.406	0	732.406	1128.86	1128.86
5	2.67078	4005.66	-48.7727	Perched Clay	1100	0	315.806	1100	1062.96	0	1062.96	1423.36	1423.36
6	2.67078	4807.91	-46.2228	Perched Clay	1100	0	315.806	1100	1375.28	0	1375.28	1704.86	1704.86
7	2.67078	5538.49	-43.7867	Perched Clay	1100	0	315.806	1100	1662.28	0	1662.28	1964.99	1964.99
8	2.67078	6206.08	-41.4463	Perched Clay	1100	0	315.806	1100	1926.9	0	1926.9	2205.77	2205.77
9	2.89735	7438.54	-39.0951	Surficial Aquifer	75	32	403.118	1404.12	2127.04	0	2127.04	2454.59	2454.59
10	2.89735	8018.52	-36.7272	Surficial Aquifer	75	32	439.387	1530.45	2329.2	0	2329.2	2657.03	2657.03
11	2.89735	8405.02	-34.4303	Surficial Aquifer	75	32	465.857	1622.65	2476.75	0	2476.75	2796.09	2796.09
12	2.89735	8836.3	-32.1951	Surficial Aquifer	75	32	494.943	1723.96	2638.89	0	2638.89	2950.51	2950.51
13	2.89735	9387.66	-30.0136	Surficial Aquifer	75	32	530.847	1849.02	2839.03	0	2839.03	3145.68	3145.68
14	2.77517	9477	-27.9232	Black Creek Confining Unit	922.06	0	264.72	922.06	3154.95	0	3154.95	3295.25	3295.25
15	2.77517	9929.32	-25.9169	Black Creek Confining Unit	964.35	0	276.861	964.35	3329.34	0	3329.34	3463.87	3463.87
16	2.77517	10364	-23.9441	Black Creek Confining Unit	1003.06	0	287.975	1003.06	3499.05	0	3499.05	3626.92	3626.92
17	2.77517	10756.2	-22.0011	Black Creek Confining Unit	1038.37	0	298.112	1038.37	3655.19	0	3655.19	3775.64	3775.64
18	2.77517	11102.5	-20.0845	Black Creek Confining Unit	1070.41	0	307.311	1070.41	3796.39	0	3796.39	3908.75	3908.75
19	2.77517	11413.1	-18.191	Black Creek Confining Unit	1099.31	0	315.608	1099.31	3926	0	3926	4029.71	4029.71
20	2.77517	11689.2	-16.3179	Black Creek Confining Unit	1125.17	0	323.032	1125.17	4044.3	0	4044.3	4138.87	4138.87
21	2.77517	11933.1	-14.4625	Black Creek Confining Unit	1148.1	0	329.615	1148.1	4151.9	0	4151.9	4236.91	4236.91
22	2.77517	12152.1	-12.6226	Black Creek Confining Unit	1168.16	0	335.375	1168.16	4251.34	0	4251.34	4326.44	4326.44
23	2.77517	12339.8	-10.7958	Black Creek Confining Unit	1185.42	0	340.33	1185.42	4409.07	0	4409.07	4473.97	4473.97

24	2.77517	12461.6	-8.98008	Black Creek Confining Unit	1199.93	0	344.496	1199.93	4653.53	0	4653.53	4707.97	4707.97
25	2.77517	12536.2	-7.17341	Black Creek Confining Unit	1211.75	0	347.889	1211.75	4703.54	0	4703.54	4747.32	4747.32
26	2.77517	12579.7	-5.37388	Black Creek Confining Unit	1220.91	0	350.519	1220.91	4742.66	0	4742.66	4775.63	4775.63
27	2.77517	12593.9	-3.57966	Black Creek Confining Unit	1227.43	0	352.391	1227.43	4771.42	0	4771.42	4793.47	4793.47
28	2.77517	12489.3	-1.78896	Black Creek Confining Unit	1231.33	0	353.51	1231.33	4541.51	0	4541.51	4552.55	4552.55
29	2.77517	12207.6	0	Black Creek Confining Unit	1232.63	0	353.884	1232.63	4428.92	0	4428.92	4428.92	4428.92
30	2.77517	11896.3	1.78896	Black Creek Confining Unit	1231.33	0	353.51	1231.33	4339.28	0	4339.28	4328.23	4328.23
31	2.77517	11665.4	3.57966	Black Creek Confining Unit	1227.43	0	352.391	1227.43	4278.22	0	4278.22	4256.18	4256.18
32	2.77517	11037.7	5.37388	Black Creek Confining Unit	1220.91	0	350.519	1220.91	4072.62	0	4072.62	4039.64	4039.64
33	2.77517	9566.05	7.17341	Black Creek Confining Unit	1211.75	0	347.889	1211.75	3558.42	0	3558.42	3514.64	3514.64
34	2.77517	9277.26	8.98008	Black Creek Confining Unit	1199.93	0	344.496	1199.93	3473.31	0	3473.31	3418.87	3418.87
35	2.77517	8941.98	10.7958	Black Creek Confining Unit	1185.42	0	340.33	1185.42	3370.58	0	3370.58	3305.68	3305.68
36	2.77517	8572.26	12.6226	Black Creek Confining Unit	1168.16	0	335.375	1168.16	3254.46	0	3254.46	3179.36	3179.36
37	2.77517	8170.6	14.4625	Black Creek Confining Unit	1148.1	0	329.615	1148.1	3125.73	0	3125.73	3040.72	3040.72
38	2.77517	7755.25	16.3179	Black Creek Confining Unit	1125.17	0	323.032	1125.17	2990.96	0	2990.96	2896.39	2896.39
39	2.77517	7325.19	18.191	Black Creek Confining Unit	1099.31	0	315.608	1099.31	2849.68	0	2849.68	2745.96	2745.96
40	2.77517	6865.64	20.0845	Black Creek Confining Unit	1070.41	0	307.311	1070.41	2696.24	0	2696.24	2583.87	2583.87
41	2.77517	6378.11	22.0011	Black Creek Confining Unit	1038.37	0	298.112	1038.37	2530.99	0	2530.99	2410.54	2410.54
42	2.77517	5856.55	23.9441	Black Creek Confining Unit	1003.06	0	287.975	1003.06	2351.45	0	2351.45	2223.57	2223.57

43	2.77517	5307.59	25.9169	Black Creek Confining Unit	964.35	0	276.861	964.35	2159.81	0	2159.81	2025.27	2025.27
44	2.77517	4720.33	27.9232	Black Creek Confining Unit	922.06	0	264.72	922.06	1951.64	0	1951.64	1811.34	1811.34
45	2.89735	4281.49	30.0136	Surficial Aquifer	75	32	343.232	1195.53	1793.22	0	1793.22	1594.94	1594.94
46	2.89735	3599.69	32.1951	Surficial Aquifer	75	32	297.285	1035.49	1537.1	0	1537.1	1349.93	1349.93
47	2.89735	2865.87	34.4303	Surficial Aquifer	75	32	246.075	857.116	1251.65	0	1251.65	1082.96	1082.96
48	2.89735	2068.36	36.7272	Surficial Aquifer	75	32	188.235	655.652	929.238	0	929.238	788.792	788.792
49	2.89735	1190.81	39.0951	Surficial Aquifer	75	32	121.798	424.241	558.903	0	558.903	459.938	459.938
50	2.27547	288.838	41.2738	Perched Clay	1100	0	315.806	1100	467.468	0	467.468	190.281	190.281

Long Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 2.89188

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.96519	575.564	-34.6702	Dark Gray Clay (Drained)	200	25	83.8373	242.447	91.0284	0	91.0284	149.016	149.016
2	3.96519	1700.97	-33.6001	Dark Gray Clay (Drained)	200	25	122.279	353.616	329.43	0	329.43	410.672	410.672
3	3.96519	2774.19	-32.543	Dark Gray Clay (Drained)	200	25	159.517	461.303	560.366	0	560.366	662.158	662.158
4	3.96519	3734.57	-31.4983	Dark Gray Clay (Drained)	200	25	193.412	559.323	770.569	0	770.569	889.083	889.083
5	3.96519	4610.63	-30.4651	Dark Gray Clay (Drained)	200	25	224.852	650.246	965.556	0	965.556	1097.82	1097.82
6	3.96519	5370.23	-29.4427	Dark Gray Clay (Drained)	200	25	252.648	730.627	1137.93	0	1137.93	1280.54	1280.54
7	4.02481	6149.79	-28.423	Light Gray Sand	50	32	296.296	856.852	1291.23	0	1291.23	1451.59	1451.59
8	4.02481	6809	-27.4055	Light Gray Sand	50	32	328.829	950.933	1441.8	0	1441.8	1612.28	1612.28
9	4.02481	7445.69	-26.3973	Light Gray Sand	50	32	360.761	1043.28	1589.58	0	1589.58	1768.64	1768.64
10	4.02481	7976.13	-25.3979	Light Gray Sand	50	32	388.163	1122.52	1716.39	0	1716.39	1900.68	1900.68
11	4.02481	8398.5	-24.4066	Light Gray Sand	50	32	410.833	1188.08	1821.3	0	1821.3	2007.72	2007.72
12	3.88348	8491.4	-23.4402	Perched Clay (Drained)	200	24	367.456	1062.64	1937.52	0	1937.52	2096.84	2096.84
13	3.88348	8818.57	-22.498	Perched Clay (Drained)	200	24	381.077	1102.03	2025.99	0	2025.99	2183.82	2183.82
14	3.88348	9137.73	-21.5622	Perched Clay (Drained)	200	24	394.532	1140.94	2113.38	0	2113.38	2269.29	2269.29
15	3.88348	9426.68	-20.6323	Perched Clay (Drained)	200	24	407.017	1177.05	2194.48	0	2194.48	2347.73	2347.73
16	3.88348	9702.15	-19.7081	Perched Clay (Drained)	200	24	419.122	1212.05	2273.09	0	2273.09	2423.23	2423.23
17	3.88348	9992.99	-18.7892	Perched Clay (Drained)	200	24	431.885	1248.96	2356	0	2356	2502.94	2502.94
18	3.88348	10239.5	-17.8754	Perched Clay (Drained)	200	24	443.137	1281.5	2429.08	0	2429.08	2572	2572
19	3.88348	10436.2	-16.9661	Perched Clay (Drained)	200	24	452.64	1308.98	2490.79	0	2490.79	2628.89	2628.89
20	3.88348	10559.2	-16.0613	Perched Clay (Drained)	200	24	459.487	1328.78	2535.3	0	2535.3	2667.58	2667.58
21	3.88348	10676.8	-15.1606	Perched Clay (Drained)	200	24	466.178	1348.13	2578.74	0	2578.74	2705.05	2705.05
22	3.88348	10097	-14.2637	Perched Clay (Drained)	200	24	446.782	1292.04	2452.77	0	2452.77	2566.35	2566.35
23	3.88348	8145.54	-13.3703	Perched Clay (Drained)	200	24	375.488	1085.87	1989.69	0	1989.69	2078.94	2078.94

24	3.88348	7950.64	-12.4803	Perched Clay (Drained)	200	24	369.921	1069.77	1953.52	0	1953.52	2035.4	2035.4
25	3.88348	7751.11	-11.5932	Perched Clay (Drained)	200	24	364.098	1052.93	1915.71	0	1915.71	1990.4	1990.4
26	3.88348	7847.55	-10.709	Perched Clay (Drained)	200	24	369.526	1068.62	1950.96	0	1950.96	2020.84	2020.84
27	3.88348	8032.05	-9.82742	Perched Clay (Drained)	200	24	378.383	1094.24	2008.49	0	2008.49	2074.04	2074.04
28	3.88348	8190.28	-8.94815	Perched Clay (Drained)	200	24	386.305	1117.15	2059.95	0	2059.95	2120.77	2120.77
29	3.88348	8280.3	-8.07099	Perched Clay (Drained)	200	24	391.645	1132.59	2094.63	0	2094.63	2150.17	2150.17
30	3.88348	8022.17	-7.19573	Perched Clay (Drained)	200	24	383.42	1108.8	2041.21	0	2041.21	2089.62	2089.62
31	3.88348	7864.25	-6.32215	Perched Clay (Drained)	200	24	379.034	1096.12	2012.72	0	2012.72	2054.72	2054.72
32	3.88348	7980.57	-5.45005	Perched Clay (Drained)	200	24	385.427	1114.61	2054.25	0	2054.25	2091.02	2091.02
33	3.88348	8086.46	-4.57922	Perched Clay (Drained)	200	24	391.465	1132.07	2093.46	0	2093.46	2124.82	2124.82
34	3.88348	8212.06	-3.70944	Perched Clay (Drained)	200	24	398.347	1151.97	2138.17	0	2138.17	2163.99	2163.99
35	3.88348	8297.37	-2.84052	Perched Clay (Drained)	200	24	403.679	1167.39	2172.8	0	2172.8	2192.82	2192.82
36	3.88348	8347.04	-1.97226	Perched Clay (Drained)	200	24	407.625	1178.8	2198.43	0	2198.43	2212.46	2212.46
37	3.88348	8369.95	-1.10444	Perched Clay (Drained)	200	24	410.524	1187.19	2217.26	0	2217.26	2225.17	2225.17
38	6.00438	12945.2	0	Perched Clay (Drained)	200	24	415.66	1202.04	2250.62	0	2250.62	2250.62	2250.62
39	4.1046	8760.01	1.12915	Perched Clay (Drained)	200	24	452.394	1308.27	2489.21	0	2489.21	2480.3	2480.3
40	4.1046	8583.77	2.0464	Perched Clay (Drained)	200	24	447.875	1295.2	2459.86	0	2459.86	2443.86	2443.86
41	4.1046	8372.51	2.96418	Perched Clay (Drained)	200	24	437.632	1265.58	2393.33	0	2393.33	2370.67	2370.67
42	4.1046	7818.66	3.88271	Perched Clay (Drained)	200	24	381.595	1103.53	2029.35	0	2029.35	2003.46	2003.46
43	4.1046	7044.11	4.80225	Perched Clay (Drained)	200	24	352.77	1020.17	1842.13	0	1842.13	1812.49	1812.49
44	4.1046	6504.51	5.72303	Perched Clay (Drained)	200	24	333.021	963.057	1713.85	0	1713.85	1680.48	1680.48
45	4.1046	3542.92	6.6453	Perched Clay (Drained)	200	24	215.44	623.027	950.135	0	950.135	925.035	925.035
46	4.1046	2957.67	7.5693	Perched Clay (Drained)	200	24	192.787	557.517	802.996	0	802.996	777.378	777.378
47	4.1046	2308.15	8.49529	Perched Clay (Drained)	200	24	167.241	483.641	637.069	0	637.069	612.088	612.088
48	4.1046	1632.12	9.42351	Perched Clay (Drained)	200	24	140.296	405.718	462.049	0	462.049	438.764	438.764

49	4.1046	983.92	10.3542	Perched Clay (Drained)	200	24	114.166	330.153	292.33	0	292.33	271.471	271.471
50	4.1046	329.078	11.2877	Perched Clay (Drained)	200	24	87.4197	252.807	118.607	0	118.607	101.159	101.159

Long Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.70165

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.486449	29.0326	-66.0038	Dark Gray Clay (Drained)	200	25	98.5255	167.656	-69.3619	0	-69.3619	151.97	151.97
2	0.486449	82.8079	-62.782	Dark Gray Clay (Drained)	200	25	115.385	196.345	-7.83761	0	-7.83761	216.504	216.504
3	0.486449	129.165	-59.8834	Dark Gray Clay (Drained)	200	25	131.951	224.535	52.6148	0	52.6148	280.091	280.091
4	0.475837	164.99	-57.2473	Light Gray Sand	50	32	87.3654	148.665	157.897	0	157.897	293.708	293.708
5	0.475837	198.218	-54.816	Light Gray Sand	50	32	104.844	178.408	205.496	0	205.496	354.21	354.21
6	0.475837	228.189	-52.5237	Light Gray Sand	50	32	121.848	207.343	251.801	0	251.801	410.733	410.733
7	0.475837	255.4	-50.3456	Light Gray Sand	50	32	138.365	235.449	296.78	0	296.78	463.712	463.712
8	0.475837	280.224	-48.2636	Light Gray Sand	50	32	154.395	262.727	340.434	0	340.434	513.502	513.502
9	0.475837	302.946	-46.2633	Light Gray Sand	50	32	169.945	289.187	382.779	0	382.779	560.388	560.388
10	0.475837	323.202	-44.3336	Light Gray Sand	50	32	184.73	314.346	423.042	0	423.042	603.524	603.524
11	0.475837	340.886	-42.4656	Light Gray Sand	50	32	198.589	337.929	460.783	0	460.783	642.537	642.537
12	0.475837	357.021	-40.6519	Light Gray Sand	50	32	211.954	360.672	497.18	0	497.18	679.18	679.18
13	0.475837	371.741	-38.8862	Light Gray Sand	50	32	224.842	382.602	532.275	0	532.275	713.61	713.61
14	0.475837	385.15	-37.1635	Light Gray Sand	50	32	237.263	403.738	566.1	0	566.1	745.954	745.954
15	0.475837	397.363	-35.4792	Light Gray Sand	50	32	249.242	424.122	598.721	0	598.721	776.367	776.367
16	0.475837	412.602	-33.8295	Light Gray Sand	50	32	263.166	447.816	636.638	0	636.638	813.009	813.009
17	0.475837	429.821	-32.2112	Light Gray Sand	50	32	278.543	473.983	678.515	0	678.515	853.998	853.998
18	0.475837	445.576	-30.6211	Light Gray Sand	50	32	293.399	499.262	718.97	0	718.97	892.631	892.631
19	0.475837	459.029	-29.0568	Light Gray Sand	50	32	307.179	522.711	756.495	0	756.495	927.165	927.165
20	0.475837	471.468	-27.5159	Light Gray Sand	50	32	320.614	545.573	793.081	0	793.081	960.095	960.095
21	0.475837	482.986	-25.9962	Light Gray Sand	50	32	333.738	567.906	828.822	0	828.822	991.57	991.57
22	0.475837	522.672	-24.4961	Light Gray Sand	50	32	365.291	621.598	914.747	0	914.747	1081.19	1081.19
23	0.475837	542.041	-23.0136	Light Gray Sand	50	32	384.447	654.194	966.912	0	966.912	1130.21	1130.21
24	0.475837	552.712	-21.5472	Light Gray Sand	50	32	398.267	677.711	1004.55	0	1004.55	1161.81	1161.81
25	0.475837	562.616	-20.0955	Light Gray Sand	50	32	411.856	700.834	1041.55	0	1041.55	1192.23	1192.23
26	0.475837	352.331	-18.6572	Light Gray Sand	50	32	273.266	465.003	664.144	0	664.144	756.412	756.412
27	0.475837	191.123	-17.231	Light Gray Sand	50	32	164.225	279.454	367.202	0	367.202	418.135	418.135
28	0.475837	190.198	-15.8157	Light Gray Sand	50	32	166.178	282.777	372.521	0	372.521	419.594	419.594
29	0.475837	188.581	-14.4103	Light Gray Sand	50	32	167.638	285.261	376.497	0	376.497	419.572	419.572
30	0.475837	186.285	-13.0136	Light Gray Sand	50	32	168.595	286.89	379.102	0	379.102	418.067	418.067
31	0.475837	183.323	-11.6248	Light Gray Sand	50	32	169.037	287.641	380.305	0	380.305	415.08	415.08

32	0.475837	179.703	-10.2429	Light Gray Sand	50	32	168.948	287.491	380.065	0	380.065	410.594	410.594
33	0.475837	175.437	-8.86698	Light Gray Sand	50	32	168.315	286.414	378.342	0	378.342	404.6	404.6
34	0.475837	170.531	-7.49621	Light Gray Sand	50	32	167.121	284.382	375.089	0	375.089	397.08	397.08
35	0.475837	164.992	-6.12974	Light Gray Sand	50	32	165.347	281.362	370.257	0	370.257	388.014	388.014
36	0.475837	158.825	-4.76676	Light Gray Sand	50	32	162.97	277.318	363.784	0	363.784	377.374	377.374
37	0.475837	152.035	-3.40648	Light Gray Sand	50	32	159.968	272.21	355.61	0	355.61	365.132	365.132
38	0.475837	144.626	-2.04813	Light Gray Sand	50	32	156.315	265.993	345.66	0	345.66	351.25	351.25
39	0.475837	136.611	-0.690926	Light Gray Sand	50	32	151.991	258.635	333.886	0	333.886	335.719	335.719
40	0.475837	127.988	0.665889	Light Gray Sand	50	32	146.961	250.077	320.191	0	320.191	318.483	318.483
41	0.475837	118.748	2.02308	Light Gray Sand	50	32	141.182	240.243	304.452	0	304.452	299.465	299.465
42	0.475837	108.89	3.38141	Light Gray Sand	50	32	134.611	229.061	286.558	0	286.558	278.605	278.605
43	0.475837	98.4126	4.74164	Light Gray Sand	50	32	127.202	216.453	266.38	0	266.38	255.829	255.829
44	0.475837	87.3117	6.10456	Light Gray Sand	50	32	118.901	202.328	243.775	0	243.775	231.059	231.059
45	0.475837	75.6008	7.47095	Light Gray Sand	50	32	109.667	186.614	218.628	0	218.628	204.247	204.247
46	0.475837	63.2992	8.84164	Light Gray Sand	50	32	99.4564	169.24	190.823	0	190.823	175.352	175.352
47	0.475837	50.3602	10.2175	Light Gray Sand	50	32	88.1533	150.006	160.043	0	160.043	144.154	144.154
48	0.475837	36.7741	11.5992	Light Gray Sand	50	32	75.6679	128.76	126.043	0	126.043	110.511	110.511
49	0.475837	22.5317	12.9879	Light Gray Sand	50	32	61.897	105.327	88.5415	0	88.5415	74.2652	74.2652
50	0.475837	7.62262	14.3844	Light Gray Sand	50	32	49.3876	84.0404	54.4761	0	54.4761	41.8099	41.8099

Long Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 2.16378

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.636014	36.8874	-57.0131	Compacted Fill (Drained)	200	28	119.114	257.737	108.587	0	108.587	292.099	292.099
2	0.636014	107.106	-54.4622	Compacted Fill (Drained)	200	28	138.303	299.257	186.676	0	186.676	380.299	380.299
3	0.636014	170.807	-52.062	Compacted Fill (Drained)	200	28	156.807	339.295	261.976	0	261.976	463.128	463.128
4	0.636014	229.014	-49.7849	Compacted Fill (Drained)	200	28	174.68	377.97	334.713	0	334.713	541.309	541.309
5	0.636014	282.486	-47.6105	Compacted Fill (Drained)	200	28	191.967	415.374	405.061	0	405.061	615.368	615.368
6	0.636014	331.806	-45.5232	Compacted Fill (Drained)	200	28	208.701	451.583	473.158	0	473.158	685.706	685.706
7	0.636014	377.428	-43.5109	Compacted Fill (Drained)	200	28	224.91	486.656	539.122	0	539.122	752.635	752.635
8	0.636014	419.721	-41.5637	Compacted Fill (Drained)	200	28	240.62	520.648	603.052	0	603.052	816.412	816.412
9	0.59156	423.995	-39.7379	Perched Clay (Drained)	200	24	230.548	498.856	671.241	0	671.241	862.904	862.904
10	0.59156	452.402	-38.0239	Perched Clay (Drained)	200	24	241.192	521.887	722.97	0	722.97	911.572	911.572
11	0.59156	478.593	-36.3491	Perched Clay (Drained)	200	24	241.15	521.796	722.767	0	722.767	900.228	900.228
12	0.59156	495.476	-34.7096	Perched Clay (Drained)	200	24	219.577	475.116	617.92	0	617.92	770.017	770.017
13	0.59156	507.771	-33.1021	Perched Clay (Drained)	200	24	225.644	488.244	647.407	0	647.407	794.514	794.514
14	0.59156	518.543	-31.5234	Perched Clay (Drained)	200	24	231.346	500.582	675.118	0	675.118	817.017	817.017
15	0.59156	527.921	-29.9711	Perched Clay (Drained)	200	24	236.705	512.177	701.16	0	701.16	837.662	837.662
16	0.59156	535.936	-28.4426	Perched Clay (Drained)	200	24	241.716	523.021	725.518	0	725.518	856.445	856.445
17	0.59156	542.576	-26.9359	Perched Clay (Drained)	200	24	246.367	533.084	748.119	0	748.119	873.302	873.302
18	0.59156	547.921	-25.4491	Perched Clay (Drained)	200	24	250.667	542.389	769.019	0	769.019	888.308	888.308
19	0.59156	552.047	-23.9805	Perched Clay (Drained)	200	24	254.63	550.964	788.278	0	788.278	901.543	901.543

20	0.59156	554.997	-22.5285	Perched Clay (Drained)	200	24	258.259	558.815	805.911	0	805.911	913.035	913.035
21	0.59156	556.809	-21.0915	Perched Clay (Drained)	200	24	261.555	565.947	821.931	0	821.931	922.812	922.812
22	0.59156	557.498	-19.6684	Perched Clay (Drained)	200	24	264.514	572.351	836.314	0	836.314	930.86	930.86
23	0.59156	557.095	-18.2578	Perched Clay (Drained)	200	24	267.139	578.03	849.069	0	849.069	937.198	937.198
24	0.59156	556.927	-16.8585	Perched Clay (Drained)	200	24	269.841	583.876	862.2	0	862.2	943.97	943.97
25	0.59156	565.293	-15.4695	Perched Clay (Drained)	200	24	275.301	595.69	888.734	0	888.734	964.924	964.924
26	0.59156	570.663	-14.0898	Perched Clay (Drained)	200	24	279.868	605.573	910.932	0	910.932	981.178	981.178
27	0.59156	568.506	-12.7184	Perched Clay (Drained)	200	24	282.016	610.22	921.368	0	921.368	985.018	985.018
28	0.59156	565.281	-11.3544	Perched Clay (Drained)	200	24	283.813	614.109	930.104	0	930.104	987.096	987.096
29	0.59156	577.668	-9.99687	Perched Clay (Drained)	200	24	290.903	629.45	964.56	0	964.56	1015.84	1015.84
30	0.59156	606.617	-8.64498	Perched Clay (Drained)	200	24	303.818	657.395	1027.33	0	1027.33	1073.52	1073.52
31	0.59156	612.008	-7.29793	Perched Clay (Drained)	200	24	308.841	668.265	1051.74	0	1051.74	1091.29	1091.29
32	0.59156	616.48	-5.95493	Perched Clay (Drained)	200	24	313.64	678.647	1075.06	0	1075.06	1107.77	1107.77
33	0.59156	218.333	-4.6152	Perched Clay (Drained)	200	24	175.024	378.714	401.399	0	401.399	415.528	415.528
34	0.59156	213.918	-3.278	Perched Clay (Drained)	200	24	174.959	378.573	401.08	0	401.08	411.101	411.101
35	0.59156	208.602	-1.94259	Perched Clay (Drained)	200	24	174.554	377.697	399.115	0	399.115	405.035	405.035
36	0.59156	202.389	-0.608228	Perched Clay (Drained)	200	24	173.8	376.066	395.451	0	395.451	397.296	397.296
37	0.59156	195.279	0.725801	Perched Clay (Drained)	200	24	172.686	373.654	390.034	0	390.034	387.846	387.846
38	0.59156	187.272	2.06022	Perched Clay (Drained)	200	24	171.199	370.437	382.807	0	382.807	376.649	376.649
39	0.59156	178.367	3.39577	Perched Clay (Drained)	200	24	169.326	366.384	373.705	0	373.705	363.658	363.658
40	0.59156	168.56	4.73316	Perched Clay (Drained)	200	24	167.052	361.464	362.654	0	362.654	348.823	348.823
41	0.59156	157.847	6.07315	Perched Clay (Drained)	200	24	164.36	355.639	349.572	0	349.572	332.085	332.085
42	0.59156	145.665	7.41648	Perched Clay (Drained)	200	24	161.009	348.387	333.283	0	333.283	312.324	312.324
43	0.59156	132.112	8.76392	Perched Clay (Drained)	200	24	157.009	339.734	313.848	0	313.848	289.642	289.642
44	0.59156	117.631	10.1163	Perched Clay (Drained)	200	24	152.519	330.018	292.026	0	292.026	264.813	264.813

45	0.59156	102.211	11.4743	Perched Clay (Drained)	200	24	147.511	319.181	267.685	0	267.685	237.742	237.742
46	0.59156	85.8374	12.839	Perched Clay (Drained)	200	24	141.955	307.16	240.684	0	240.684	208.331	208.331
47	0.59156	68.4969	14.2111	Perched Clay (Drained)	200	24	135.819	293.882	210.862	0	210.862	176.466	176.466
48	0.59156	50.1721	15.5916	Perched Clay (Drained)	200	24	129.064	279.266	178.035	0	178.035	142.02	142.02
49	0.59156	30.844	16.9814	Perched Clay (Drained)	200	24	121.649	263.221	141.996	0	141.996	104.848	104.848
50	0.59156	10.4633	18.3816	Perched Clay (Drained)	200	24	113.739	246.107	103.558	0	103.558	65.7629	65.7629

Interslice Data

MT3500 Dynamic Pressure Stability - 3200 psf

Global Minimum Query (spencer) - Safety Factor: 1.99794

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	288.852	79.7211	0	0	0
2	290.037	77.8971	2839.04	646.581	12.8301
3	291.222	76.2589	5757.75	1311.31	12.8301
4	292.407	74.7749	8700.98	1981.62	12.8301
5	293.592	73.4203	11632.5	2649.27	12.8301
6	294.777	72.1771	14526.3	3308.3	12.83
7	295.961	71.0314	15772.2	3592.06	12.8301
8	297.146	69.9725	15715.7	3579.2	12.8301
9	298.331	68.9919	15747.4	3586.41	12.8301
10	299.516	68.0827	15845.3	3608.72	12.8301
11	300.701	67.239	15991.1	3641.92	12.8301
12	301.886	66.4561	16169	3682.43	12.8301
13	303.071	65.7301	16365.6	3727.21	12.8301
14	304.256	65.0574	17191.5	3915.31	12.8301
15	305.441	64.4351	19170.7	4366.05	12.83
16	306.626	63.8608	21014.4	4785.95	12.8301
17	307.811	63.3322	22718.7	5174.11	12.8301
18	308.996	62.8474	24279.9	5529.66	12.8301
19	310.18	62.4049	25694	5851.73	12.8301
20	311.365	62.0031	25880.7	5894.23	12.8301
21	312.55	61.6409	25906	5900	12.8301
22	313.735	61.3172	25881.8	5894.48	12.8301
23	314.92	61.0309	25803.5	5876.66	12.8301
24	316.105	60.7814	25666.9	5845.55	12.8301
25	317.29	60.568	25468	5800.25	12.8301
26	318.475	60.39	25203.3	5739.97	12.8301
27	319.66	60.2471	24869.5	5663.95	12.8301
28	320.845	60.1388	24460.5	5570.79	12.8301
29	322.03	60.065	23973.6	5459.91	12.8301
30	323.214	60.0253	23409.7	5331.48	12.8301
31	324.399	60.0197	22769.7	5185.72	12.8301
32	325.584	60.0483	22054.9	5022.91	12.83
33	326.769	60.1109	21266.3	4843.33	12.8301
34	327.954	60.2079	20405.7	4647.32	12.8301
35	329.139	60.3395	19474.6	4435.26	12.83
36	330.324	60.506	18475	4207.61	12.8301
37	331.509	60.7078	17409.2	3964.89	12.8301
38	332.694	60.9455	16278.6	3707.38	12.83
39	333.879	61.2196	15078.6	3434.09	12.83
40	335.064	61.531	13816.6	3146.68	12.8301
41	336.249	61.8806	12464.6	2838.77	12.8301
42	337.433	62.2693	11113.9	2531.15	12.8301
43	338.618	62.6984	9933.49	2262.32	12.8301
44	339.803	63.1692	8724.6	1987	12.8301
45	340.988	63.6833	7492	1706.28	12.8301
46	342.173	64.2424	6241.23	1421.42	12.8301
47	343.358	64.8488	4979.46	1134.05	12.83
48	344.543	65.5047	3715.99	846.303	12.8301
49	345.728	66.213	2460.05	560.267	12.8301
50	346.913	66.9769	1222.42	278.403	12.8301
51	348.098	67.8003	0	0	0

MT3500 Static Pressure Stability - 1600 psf Drained

Global Minimum Query (spencer) - Safety Factor: 1.89727

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	303.871	79.7211	0	0	0
2	304.726	78.6469	697.304	228.708	18.1589
3	305.582	77.644	1414.23	463.852	18.1589
4	306.437	76.7047	2141.8	702.486	18.1589
5	307.293	75.8227	2872.35	942.098	18.1589
6	308.239	74.9073	3754.34	1231.38	18.1589
7	309.186	74.0497	4622.94	1516.27	18.1589
8	310.132	73.2451	5472.04	1794.77	18.1589
9	311.079	72.4894	5781.28	1896.19	18.1589
10	312.025	71.7791	5994.56	1966.15	18.1589
11	312.971	71.1114	6214.28	2038.22	18.159
12	313.918	70.4837	6435.35	2110.72	18.1589
13	314.864	69.8937	6653.13	2182.15	18.1589
14	315.811	69.3396	6863.34	2251.1	18.1589
15	316.757	68.8196	7062.02	2316.27	18.159
16	317.703	68.3323	7245.67	2376.5	18.1589
17	318.65	67.8763	7411.04	2430.74	18.1589
18	319.596	67.4506	7555.13	2478	18.1589
19	320.543	67.0539	7671.95	2516.31	18.1589
20	321.489	66.6854	7757.27	2544.3	18.1589
21	322.435	66.3443	7810.5	2561.76	18.1589
22	323.382	66.0298	7831.18	2568.54	18.1589
23	324.328	65.7413	7819.02	2564.55	18.1589
24	325.275	65.4782	7773.86	2549.74	18.1589
25	326.221	65.24	7695.67	2524.1	18.159
26	327.167	65.0262	7584.47	2487.62	18.1589
27	328.114	64.8364	7440.38	2440.36	18.1589
28	329.06	64.6703	7263.69	2382.41	18.1589
29	330.007	64.5276	7054.79	2313.89	18.1589
30	330.953	64.4079	6814.24	2235	18.159
31	331.899	64.3112	6542.71	2145.94	18.1589
32	332.846	64.2373	6239.46	2046.47	18.1589
33	333.792	64.1859	5902.31	1935.89	18.1589
34	334.739	64.1571	5534.84	1815.37	18.159
35	335.685	64.1508	5127.04	1681.61	18.1589
36	336.631	64.1669	4675.39	1533.48	18.159
37	337.578	64.2055	4282.11	1404.48	18.1589
38	338.524	64.2667	3973.67	1303.32	18.1589
39	339.471	64.3506	3653.73	1198.38	18.1589
40	340.417	64.4573	3324.07	1090.26	18.1589
41	341.363	64.587	2986.74	979.617	18.1589
42	342.31	64.7399	2644.07	867.226	18.1589
43	343.256	64.9163	2299.29	754.143	18.1589
44	344.203	65.1165	1956.38	641.671	18.1589
45	345.149	65.3409	1619.03	531.024	18.1589
46	346.095	65.5899	1291.43	423.573	18.1588
47	347.042	65.864	978.316	320.877	18.1589
48	347.988	66.1638	685.14	224.718	18.1589
49	348.935	66.4898	418.123	137.14	18.159
50	349.881	66.8427	184.311	60.4519	18.1589
51	350.827	67.2234	0	0	0

◆ Short Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 2.18002

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	135.6	107.967	0	0	0
2	141.253	102.275	-4393.55	-542.483	7.03883
3	146.906	96.9638	-5510.14	-680.352	7.03884
4	152.559	92	-3948.46	-487.527	7.03884
5	158.889	86.8175	1355.03	167.309	7.03883
6	165.219	82	7423.81	916.638	7.03884
7	170.48	78.2536	14372	1774.55	7.03884
8	175.741	74.726	21990.8	2715.26	7.03883
9	181.002	71.4054	30022	3706.89	7.03882
10	186.263	68.2811	38245.7	4722.3	7.03884
11	191.523	65.3441	46517.7	5743.67	7.03884
12	196.784	62.5861	54751.5	6760.32	7.03884
13	202.045	60	62821.4	7756.73	7.03884
14	206.974	57.7271	66158.3	8168.75	7.03884
15	211.904	55.5946	69034.6	8523.89	7.03884
16	216.833	53.5985	71419.8	8818.39	7.03883
17	221.763	51.7347	73286.8	9048.92	7.03884
18	226.692	50	74613.2	9212.69	7.03884
19	232.003	48.2717	80992.1	10000.3	7.03883
20	237.314	46.6861	86704.8	10705.7	7.03885
21	242.626	45.2402	91698.1	11322.2	7.03883
22	247.937	43.9311	95896.9	11840.6	7.03881
23	253.248	42.7565	98647.9	12180.3	7.03883
24	258.559	41.7142	100661	12428.9	7.03885
25	263.871	40.8024	102016	12596.2	7.03884
26	269.182	40.0195	102783	12690.9	7.03884
27	274.493	39.3643	102947	12711.1	7.03881
28	279.804	38.8354	102448	12649.5	7.03882
29	285.115	38.4322	101313	12509.4	7.03884
30	290.427	38.1539	99581.5	12295.6	7.03884
31	295.738	38	97252.3	12008	7.03884
32	303.588	38	92712	11447.4	7.03884
33	308.52	38.1388	89192.1	11012.8	7.03885
34	313.452	38.3848	85151.1	10513.8	7.03881
35	318.384	38.7385	80547.3	9945.4	7.03884
36	323.316	39.2003	75452.6	9316.34	7.03884
37	328.247	39.7709	70027.2	8646.44	7.03883
38	333.179	40.4512	64335.6	7943.7	7.03885
39	338.111	41.2421	58434.5	7215.06	7.03883
40	343.043	42.1448	52752.8	6513.53	7.03884
41	347.975	43.1607	46965.1	5798.91	7.03884
42	352.907	44.2913	41146.9	5080.52	7.03884
43	357.839	45.5384	35356.3	4365.54	7.03884
44	362.77	46.904	29659	3662.07	7.03883
45	367.702	48.3904	24132.3	2979.68	7.03884
46	372.634	50	18858.5	2328.51	7.03884
47	377.563	51.7344	13075.5	1614.46	7.03881
48	382.491	53.5977	8058.06	994.951	7.03884
49	387.419	55.5934	4020.17	496.381	7.03884
50	392.348	57.7253	1187.29	146.598	7.03884
51	397.276	59.9977	0	0	0

Short Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.76047

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	238.951	92.0045	0	0	0
2	239.305	90.5426	68.676	26.6281	21.1931
3	239.659	89.5562	177.475	68.8135	21.1931
4	240.013	88.7731	300.802	116.632	21.1931
5	240.367	88.1126	430.243	166.821	21.1931
6	240.721	87.5374	561.432	217.687	21.1931
7	241.076	87.0267	691.629	268.169	21.1931
8	241.43	86.5672	818.922	317.525	21.1931
9	241.784	86.15	941.883	365.202	21.1931
10	242.138	85.7689	1059.71	410.886	21.193
11	242.492	85.4189	1172.61	454.663	21.1931
12	242.846	85.0965	1279.68	496.179	21.1931
13	243.2	84.7988	1379.98	535.069	21.1931
14	243.554	84.5234	1472.47	570.929	21.1931
15	243.908	84.2686	1556.39	603.47	21.1932
16	244.262	84.0327	1631.14	632.45	21.1931
17	244.616	83.8144	1696.11	657.643	21.1931
18	244.971	83.6126	1751.38	679.071	21.193
19	245.325	83.4265	1798.98	697.527	21.193
20	245.679	83.2551	1834.48	711.293	21.1931
21	246.033	83.0978	1857.34	720.158	21.1931
22	246.387	82.9539	1867.03	723.913	21.1931
23	246.741	82.8231	1863	722.35	21.193
24	247.095	82.7048	1847.19	716.22	21.193
25	247.449	82.5986	1828.52	708.982	21.1931
26	247.803	82.5042	1804.27	699.579	21.1931
27	248.157	82.4214	1774.39	687.994	21.1931
28	248.511	82.3498	1738.87	674.223	21.1931
29	248.866	82.2893	1697.73	658.27	21.1931
30	249.22	82.2396	1651	640.151	21.1931
31	249.574	82.2008	1598.76	619.896	21.1931
32	249.928	82.1726	1541.11	597.545	21.1931
33	250.282	82.1549	1478.2	573.153	21.1932
34	250.636	82.1479	1410.21	546.788	21.1931
35	250.99	82.1513	1337.35	518.537	21.193
36	251.344	82.1652	1259.89	488.503	21.193
37	251.698	82.1897	1178.15	456.81	21.1931
38	252.052	82.2249	1092.51	423.605	21.1931
39	252.407	82.2707	1003.42	389.062	21.1931
40	252.761	82.3274	911.414	353.388	21.1931
41	253.115	82.3951	817.111	316.823	21.1931
42	253.469	82.474	721.243	279.652	21.1931
43	253.823	82.5643	624.683	242.212	21.1931
44	254.177	82.6664	528.468	204.906	21.1931
45	254.531	82.7804	433.836	168.214	21.1931
46	254.885	82.9068	342.276	132.713	21.1931
47	255.239	83.0461	255.591	99.1019	21.1931
48	255.593	83.1986	175.985	68.2356	21.1931
49	255.947	83.365	106.174	41.1675	21.1931
50	256.302	83.5459	49.5195	19.2005	21.1931
51	256.656	83.7422	0	0	0

Short Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 3.48315

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	249.853	85.9971	0	0	0
2	252.119	82	369.307	31.3846	4.85746
3	254.789	77.8255	-161.485	-13.7234	4.85747
4	257.46	74.1064	561.61	47.727	4.85747
5	260.131	70.7536	2173.49	184.709	4.85748
6	262.802	67.7057	4569.53	388.33	4.85747
7	265.473	64.9184	7559.09	642.389	4.85746
8	268.143	62.3584	10970.8	932.323	4.85745
9	270.814	60	14671.5	1246.82	4.85746
10	273.711	57.6458	18510.6	1573.08	4.85748
11	276.609	55.484	22272.3	1892.75	4.85745
12	279.506	53.4979	25841.2	2196.05	4.85747
13	282.404	51.6737	29220.6	2483.24	4.85747
14	285.301	50	32433.7	2756.29	4.85746
15	288.076	48.5292	36339.1	3088.19	4.85747
16	290.851	47.1806	40060.4	3404.43	4.85746
17	293.626	45.9483	43572.9	3702.93	4.85746
18	296.402	44.827	46843.9	3980.91	4.85747
19	299.177	43.8123	49843	4235.78	4.85746
20	301.952	42.9003	52547.2	4465.58	4.85745
21	304.727	42.0879	54936.2	4668.61	4.85746
22	307.502	41.3721	56992.9	4843.4	4.85747
23	310.277	40.7506	58704	4988.81	4.85746
24	313.053	40.2214	60092.4	5106.8	4.85747
25	315.828	39.7829	61176.9	5198.96	4.85746
26	318.603	39.4336	61853.9	5256.49	4.85746
27	321.378	39.1725	62118.9	5279.01	4.85746
28	324.153	38.9989	61969	5266.27	4.85746
29	326.928	38.9123	61381.3	5216.33	4.85746
30	329.704	38.9123	60398.8	5132.84	4.85747
31	332.479	38.9989	59041.3	5017.47	4.85746
32	335.254	39.1725	57320.3	4871.22	4.85747
33	338.029	39.4336	55284	4698.17	4.85746
34	340.804	39.7829	53075.4	4510.47	4.85746
35	343.579	40.2214	50595.8	4299.75	4.85746
36	346.355	40.7506	47867.3	4067.88	4.85746
37	349.13	41.3721	44913.7	3816.88	4.85747
38	351.905	42.0879	41761.3	3548.98	4.85747
39	354.68	42.9003	38434.5	3266.26	4.85747
40	357.455	43.8123	34959.6	2970.95	4.85746
41	360.23	44.827	31370.6	2665.95	4.85746
42	363.006	45.9483	27705	2354.43	4.85745
43	365.781	47.1806	24007.7	2040.23	4.85746
44	368.556	48.5292	20326.5	1727.39	4.85745
45	371.331	50	16721.1	1421	4.85746
46	374.229	51.6737	12724.9	1081.4	4.8575
47	377.126	53.4979	9059.31	769.881	4.85746
48	380.023	55.484	5860.18	498.012	4.85746
49	382.921	57.6458	3305.82	280.936	4.85745
50	385.818	60	1637.03	139.119	4.85747
51	388.093	61.9972	0	0	0

Long Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 2.89188

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	161.763	106.908	0	0	0
2	165.728	104.165	-82.7689	-15.7272	10.7587
3	169.693	101.531	300.261	57.0536	10.7587
4	173.658	99.0003	1085.65	206.288	10.7587
5	177.624	96.5706	2191.02	416.322	10.7587
6	181.589	94.2382	3551.54	674.838	10.7587
7	185.554	92	5096.65	968.43	10.7587
8	189.579	89.8217	6716.84	1276.29	10.7587
9	193.604	87.7349	8402.08	1596.5	10.7587
10	197.628	85.7372	10125.6	1924	10.7587
11	201.653	83.8263	11843.3	2250.38	10.7587
12	205.678	82	13516.1	2568.23	10.7587
13	209.562	80.3162	15351.4	2916.97	10.7587
14	213.445	78.7078	17130.2	3254.97	10.7587
15	217.329	77.1732	18841.3	3580.1	10.7587
16	221.212	75.711	20469.5	3889.47	10.7587
17	225.095	74.3199	22004	4181.05	10.7587
18	228.979	72.9986	23439.7	4453.84	10.7587
19	232.862	71.7462	24761.2	4704.95	10.7587
20	236.746	70.5614	25954.5	4931.69	10.7587
21	240.629	69.4433	27004.8	5131.26	10.7587
22	244.513	68.391	27907.9	5302.86	10.7587
23	248.396	67.4038	28594.4	5433.31	10.7587
24	252.28	66.4807	28972.8	5505.21	10.7587
25	256.163	65.6212	29215.4	5551.31	10.7587
26	260.047	64.8245	29327.7	5572.65	10.7587
27	263.93	64.0901	29325.5	5572.23	10.7587
28	267.814	63.4174	29207.3	5549.76	10.7587
29	271.697	62.8059	28966.7	5504.05	10.7587
30	275.581	62.2552	28599.3	5434.24	10.7587
31	279.464	61.7649	28111.2	5341.49	10.7587
32	283.348	61.3346	27505.2	5226.35	10.7587
33	287.231	60.9641	26769.6	5086.57	10.7587
34	291.115	60.6531	25900.5	4921.44	10.7587
35	294.998	60.4013	24891.9	4729.79	10.7587
36	298.882	60.2086	23743	4511.47	10.7587
37	302.765	60.0749	22454	4266.55	10.7587
38	306.649	60	21025.8	3995.17	10.7587
39	312.653	60	18530.1	3520.95	10.7587
40	316.758	60.0809	16471.8	3129.86	10.7587
41	320.862	60.2276	14272.8	2712.01	10.7587
42	324.967	60.4401	11967.8	2274.04	10.7587
43	329.071	60.7187	9836.24	1869.01	10.7587
44	333.176	61.0635	7753.07	1473.18	10.7587
45	337.281	61.4749	5681.17	1079.5	10.7587
46	341.385	61.9531	4342.54	825.139	10.7587
47	345.49	62.4985	3113.27	591.561	10.7587
48	349.594	63.1116	2036.25	386.913	10.7587
49	353.699	63.7929	1145.64	217.686	10.7587
50	357.804	64.5428	457.814	86.9907	10.7587
51	361.908	65.3621	0	0	0

Long Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.70165

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	234.795	94.8772	0	0	0
2	235.281	93.7844	-123.665	-40.7679	18.2455
3	235.767	92.8386	-187.136	-61.6921	18.2456
4	236.254	92	-207.119	-68.28	18.2456
5	236.73	91.2603	-131.843	-43.464	18.2456
6	237.206	90.5854	-42.9711	-14.1661	18.2456
7	237.681	89.9647	55.4031	18.2645	18.2456
8	238.157	89.3906	160.022	52.7536	18.2456
9	238.633	88.8572	268.229	88.4259	18.2456
10	239.109	88.3599	377.82	124.554	18.2456
11	239.585	87.8951	486.699	160.448	18.2456
12	240.061	87.4596	592.993	195.489	18.2456
13	240.536	87.051	695.406	229.251	18.2456
14	241.012	86.6672	792.82	261.365	18.2456
15	241.488	86.3065	884.257	291.509	18.2456
16	241.964	85.9673	968.865	319.401	18.2456
17	242.44	85.6484	1046.82	345.101	18.2456
18	242.916	85.3487	1117.85	368.517	18.2456
19	243.391	85.067	1180.91	389.306	18.2456
20	243.867	84.8026	1234.93	407.114	18.2456
21	244.343	84.5548	1279.15	421.69	18.2455
22	244.819	84.3227	1312.86	432.805	18.2456
23	245.295	84.1059	1337.59	440.957	18.2456
24	245.771	83.9038	1350.31	445.151	18.2456
25	246.246	83.7159	1349.79	444.977	18.2455
26	246.722	83.5418	1335.38	440.228	18.2456
27	247.198	83.3812	1312.22	432.592	18.2455
28	247.674	83.2336	1288.36	424.728	18.2456
29	248.15	83.0988	1259.6	415.246	18.2456
30	248.626	82.9765	1225.96	404.158	18.2457
31	249.102	82.8665	1187.53	391.488	18.2456
32	249.577	82.7687	1144.43	377.278	18.2456
33	250.053	82.6827	1096.82	361.583	18.2456
34	250.529	82.6084	1044.91	344.471	18.2456
35	251.005	82.5458	988.976	326.031	18.2456
36	251.481	82.4947	929.318	306.364	18.2456
37	251.957	82.455	866.303	285.59	18.2456
38	252.432	82.4267	800.352	263.848	18.2456
39	252.908	82.4097	731.947	241.297	18.2456
40	253.384	82.404	661.631	218.117	18.2456
41	253.86	82.4095	590.018	194.508	18.2456
42	254.336	82.4263	517.806	170.702	18.2455
43	254.812	82.4544	445.777	146.957	18.2456
44	255.287	82.4939	374.811	123.562	18.2456
45	255.763	82.5448	305.899	100.844	18.2455
46	256.239	82.6072	240.139	79.1654	18.2456
47	256.715	82.6812	178.749	58.9273	18.2456
48	257.191	82.767	123.129	40.5912	18.2455
49	257.667	82.8646	74.8579	24.678	18.2456
50	258.142	82.9744	35.7246	11.7772	18.2457
51	258.618	83.0964	0	0	0

Long Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 2.16378

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	317.824	78.5445	0	0	0
2	318.46	77.5646	30.7678	10.0169	18.0334
3	319.096	76.6742	109.169	35.5416	18.0334
4	319.732	75.8583	223.343	72.7127	18.0334
5	320.368	75.1061	364.204	118.572	18.0334
6	321.004	74.4093	524.55	170.775	18.0334
7	321.64	73.7616	698.515	227.412	18.0334
8	322.276	73.1578	881.219	286.894	18.0334
9	322.912	72.5938	1068.53	347.876	18.0334
10	323.504	72.102	1262.48	411.019	18.0334
11	324.096	71.6395	1454.46	473.522	18.0335
12	324.687	71.2041	1626.68	529.591	18.0335
13	325.279	70.7944	1750.2	569.805	18.0335
14	325.87	70.4087	1866.62	607.707	18.0335
15	326.462	70.0459	1974.95	642.976	18.0335
16	327.053	69.7047	2074.35	675.337	18.0335
17	327.645	69.3843	2164.07	704.546	18.0334
18	328.236	69.0837	2243.44	730.387	18.0335
19	328.828	68.8022	2311.89	752.672	18.0335
20	329.42	68.5391	2368.94	771.244	18.0334
21	330.011	68.2937	2414.17	785.969	18.0334
22	330.603	68.0655	2447.23	796.733	18.0334
23	331.194	67.8541	2467.85	803.444	18.0334
24	331.786	67.6589	2475.78	806.027	18.0334
25	332.377	67.4797	2470.97	804.463	18.0335
26	332.969	67.3159	2453.89	798.899	18.0334
27	333.561	67.1675	2423.85	789.122	18.0335
28	334.152	67.034	2380.32	774.947	18.0334
29	334.744	66.9152	2323.19	756.348	18.0334
30	335.335	66.8109	2251.96	733.16	18.0335
31	335.927	66.7209	2164.93	704.826	18.0334
32	336.518	66.6452	2062.21	671.384	18.0335
33	337.11	66.5835	1943.32	632.677	18.0334
34	337.701	66.5357	1859.12	605.265	18.0335
35	338.293	66.5018	1769.38	576.049	18.0335
36	338.885	66.4818	1674.3	545.094	18.0335
37	339.476	66.4755	1574.14	512.485	18.0334
38	340.068	66.483	1469.23	478.33	18.0334
39	340.659	66.5043	1359.98	442.761	18.0334
40	341.251	66.5394	1246.86	405.934	18.0334
41	341.842	66.5884	1130.44	368.031	18.0334
42	342.434	66.6513	1011.37	329.266	18.0334
43	343.025	66.7283	890.615	289.953	18.0334
44	343.617	66.8195	769.266	250.446	18.0334
45	344.209	66.925	648.368	211.086	18.0334
46	344.8	67.0451	529.107	172.259	18.0335
47	345.392	67.1799	412.821	134.4	18.0334
48	345.983	67.3298	301.02	98.0014	18.0334
49	346.575	67.4948	195.408	63.6179	18.0334
50	347.166	67.6755	97.9127	31.8769	18.0334
51	347.758	67.8721	0	0	0

Discharge Sections

Entity Information

MT3500 Dynamic Pressure Stability - 3200 psf

Shared Entities

Type	Coordinates (x,y)
External Boundary	95.7847, 10
	545.12, 10
	545.12, 15
	545.12, 25
	545.12, 38
	545.12, 48.0485
	518.155, 48.9972
	489.731, 49.9972
	489.649, 50
	460.336, 50.9972
	451.972, 51.9972
	441.891, 52.9972
	430.186, 53.9972
	421.954, 54.9972
	412.876, 55.9972
	408.22, 56.9972
	404.553, 57.9972
	400.556, 58.9972
	397.269, 60
	394.408, 60.9972
	388.093, 61.9972
	380.77, 62.9972
	371.446, 63.9972
	364.254, 64.9972
	357.825, 65.9972
	351.898, 66.9972
	347.166, 67.9972
	342.402, 68.9972
	337.11, 69.9692
	337.11, 70
	337.11, 74.9973
	335.106, 74.9973
	335.106, 74.471
	333.533, 74.9971
	330.543, 75.9971
	327.546, 76.9971
	324.532, 77.9971
	319.583, 79.7211
	312.207, 79.7211
	288.852, 79.7211
	279.922, 79.9971
	276.893, 80.9971
	273.864, 81.9971
	273.821, 82

	258.92, 82.9971 255.881, 83.9971 252.863, 84.9971 249.853, 85.9971 246.925, 86.9698 246.925, 92 246.925, 92.9973 244.921, 92.9973 244.921, 92.3937 243.063, 92.9973 239.159, 93.9973 234.199, 94.9973 228.412, 95.9973 222.095, 96.9973 216.985, 97.9973 211.768, 98.9973 207, 99.9973 202.114, 100.997 198, 101.997 191.631, 102.997 185.756, 103.997 180.401, 104.997 172.926, 105.997 160.663, 106.997 134.827, 107.997 121.579, 107.997 95.7847, 106.997 95.7847, 92 95.7847, 82 95.7847, 60 95.7847, 50 95.7847, 38 95.7847, 25 95.7847, 15
Material Boundary	95.7847, 82 273.821, 82
Material Boundary	95.7847, 60 397.269, 60
Material Boundary	95.7847, 50 489.649, 50
Material Boundary	95.7847, 92 244.737, 92 246.925, 92
Material Boundary	288.852, 79.7211 291.019, 79.0001 294.506, 78.0001 300.362, 77.0001 306.567, 76.0001 310.659, 75.0001 314.965, 74.0001 320.608, 73.0001 326.28, 72.0001 331.517, 71.0001 333.051, 70.7173 337.11, 69.9692

Material Boundary	244.921, 92.3937 244.737, 92 241.925, 85.9973 246.925, 85.9973 246.925, 86.9698
Material Boundary	335.106, 74.471 333.051, 70.7173 332.11, 68.9973 337.11, 68.9973 337.11, 69.9692
Material Boundary	95.7847, 38 545.12, 38
Material Boundary	95.7847, 15 545.12, 15

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	95.7847, 38 545.12, 38	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	295.335, 79.7211 288.852, 79.7211	Constant DistributionOrientation: VerticalMagnitude: 3200 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	310.296, 79.7211 303.869, 79.7211	Constant DistributionOrientation: VerticalMagnitude: 3200 lbs/ft2Creates Excess Pore Pressure: No

MT3500 Static Pressure Stability - 1600 psf Drained

Shared Entities

Type	Coordinates (x,y)
	95.7847, 10 545.12, 10 545.12, 15 545.12, 25 545.12, 38 545.12, 48.0485 518.155, 48.9972 489.731, 49.9972 489.649, 50 460.336, 50.9972 451.972, 51.9972 441.891, 52.9972 430.186, 53.9972 421.954, 54.9972 412.876, 55.9972 408.22, 56.9972 404.553, 57.9972 400.556, 58.9972 397.269, 60 394.408, 60.9972 388.093, 61.9972

External Boundary	380.77, 62.9972
	371.446, 63.9972
	364.254, 64.9972
	357.825, 65.9972
	351.898, 66.9972
	347.166, 67.9972
	342.402, 68.9972
	337.11, 69.9692
	337.11, 70
	337.11, 74.9973
	335.106, 74.9973
	335.106, 74.471
	333.533, 74.9971
	330.543, 75.9971
	327.546, 76.9971
	324.532, 77.9971
	319.583, 79.7211
	312.207, 79.7211
	288.852, 79.7211
	279.922, 79.9971
	276.893, 80.9971
	273.864, 81.9971
	273.821, 82
	258.92, 82.9971
	255.881, 83.9971
	252.863, 84.9971
	249.853, 85.9971
	246.925, 86.9698
	246.925, 92
	246.925, 92.9973
	244.921, 92.9973
	244.921, 92.3937
	243.063, 92.9973
	239.159, 93.9973
	234.199, 94.9973
	228.412, 95.9973
	222.095, 96.9973
	216.985, 97.9973
	211.768, 98.9973
	207, 99.9973
	202.114, 100.997
	198, 101.997
	191.631, 102.997
	185.756, 103.997
	180.401, 104.997
	172.926, 105.997
	160.663, 106.997
	134.827, 107.997
	121.579, 107.997
	95.7847, 106.997
	95.7847, 92
	95.7847, 82
	95.7847, 60
	95.7847, 50
	95.7847, 38
	95.7847, 25
	95.7847, 15
Material Boundary	95.7847, 82
	273.821, 82

Material Boundary	95.7847, 60 397.269, 60
Material Boundary	95.7847, 50 489.649, 50
Material Boundary	95.7847, 92 244.737, 92 246.925, 92
Material Boundary	288.852, 79.7211 291.019, 79.0001 294.506, 78.0001 300.362, 77.0001 306.567, 76.0001 310.659, 75.0001 314.965, 74.0001 320.608, 73.0001 326.28, 72.0001 331.517, 71.0001 333.051, 70.7173 337.11, 69.9692
Material Boundary	244.921, 92.3937 244.737, 92 241.925, 85.9973 246.925, 85.9973 246.925, 86.9698
Material Boundary	335.106, 74.471 333.051, 70.7173 332.11, 68.9973 337.11, 68.9973 337.11, 69.9692
Material Boundary	95.7847, 38 545.12, 38
Material Boundary	95.7847, 15 545.12, 15

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	95.7847, 38 545.12, 38	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)
Distributed Load	295.335, 79.7211 288.852, 79.7211	Constant DistributionOrientation: VerticalMagnitude: 1600 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	310.296, 79.7211 303.869, 79.7211	Constant DistributionOrientation: VerticalMagnitude: 1600 lbs/ft2Creates Excess Pore Pressure: No

◆ Short Term Stability

Shared Entities

Type	Coordinates (x,y)
External Boundary	95.7847, 10
	545.12, 10
	545.12, 15
	545.12, 25
	545.12, 38
	545.12, 48.0485
	518.155, 48.9972
	489.731, 49.9972
	489.649, 50
	460.336, 50.9972
	451.972, 51.9972
	441.891, 52.9972
	430.186, 53.9972
	421.954, 54.9972
	412.876, 55.9972
	408.22, 56.9972
	404.553, 57.9972
	400.556, 58.9972
	397.269, 60
	394.408, 60.9972
	388.093, 61.9972
	380.77, 62.9972
	371.446, 63.9972
	364.254, 64.9972
	357.825, 65.9972
	351.898, 66.9972
	347.166, 67.9972
	342.402, 68.9972
	337.11, 69.9692
	337.11, 70
	337.11, 74.9973
	335.106, 74.9973
	335.106, 74.471
	333.533, 74.9971
	330.543, 75.9971
	327.546, 76.9971
	324.532, 77.9971
	312.278, 78.9971
	288.852, 79.7211
	279.922, 79.9971
	276.893, 80.9971
	273.864, 81.9971
	273.821, 82
	258.92, 82.9971
	255.881, 83.9971
	252.863, 84.9971
	249.853, 85.9971
	246.925, 86.9698
	246.925, 92
	246.925, 92.9973
	244.921, 92.9973
	244.921, 92.3937
	243.063, 92.9973
	239.159, 93.9973
	234.199, 94.9973
	228.412, 95.9973
	222.095, 96.9973
	216.985, 97.9973

	211.768, 98.9973 207, 99.9973 202.114, 100.997 198, 101.997 191.631, 102.997 185.756, 103.997 180.401, 104.997 172.926, 105.997 160.663, 106.997 134.827, 107.997 121.579, 107.997 95.7847, 106.997 95.7847, 92 95.7847, 82 95.7847, 60 95.7847, 50 95.7847, 38 95.7847, 25 95.7847, 15
Material Boundary	95.7847, 82 273.821, 82
Material Boundary	95.7847, 60 397.269, 60
Material Boundary	95.7847, 50 489.649, 50
Material Boundary	95.7847, 92 244.737, 92 246.925, 92
Material Boundary	288.852, 79.7211 291.019, 79.0001 294.506, 78.0001 300.362, 77.0001 306.567, 76.0001 310.659, 75.0001 314.965, 74.0001 320.608, 73.0001 326.28, 72.0001 331.517, 71.0001 333.051, 70.7173 337.11, 69.9692
Material Boundary	244.921, 92.3937 244.737, 92 241.925, 85.9973 246.925, 85.9973 246.925, 86.9698
Material Boundary	335.106, 74.471 333.051, 70.7173 332.11, 68.9973 337.11, 68.9973 337.11, 69.9692
Material Boundary	95.7847, 38 545.12, 38
Material Boundary	95.7847, 15 545.12, 15

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario	Upper Wall	Lower Wall
Piezoline	95.7847, 38 545.12, 38	Assigned to: 🟧 Black Creek Aquifer	Assigned to: 🟧 Black Creek Aquifer	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	312.278, 78.9971 324.532, 77.9971	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No		Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Long Term Stability

Shared Entities

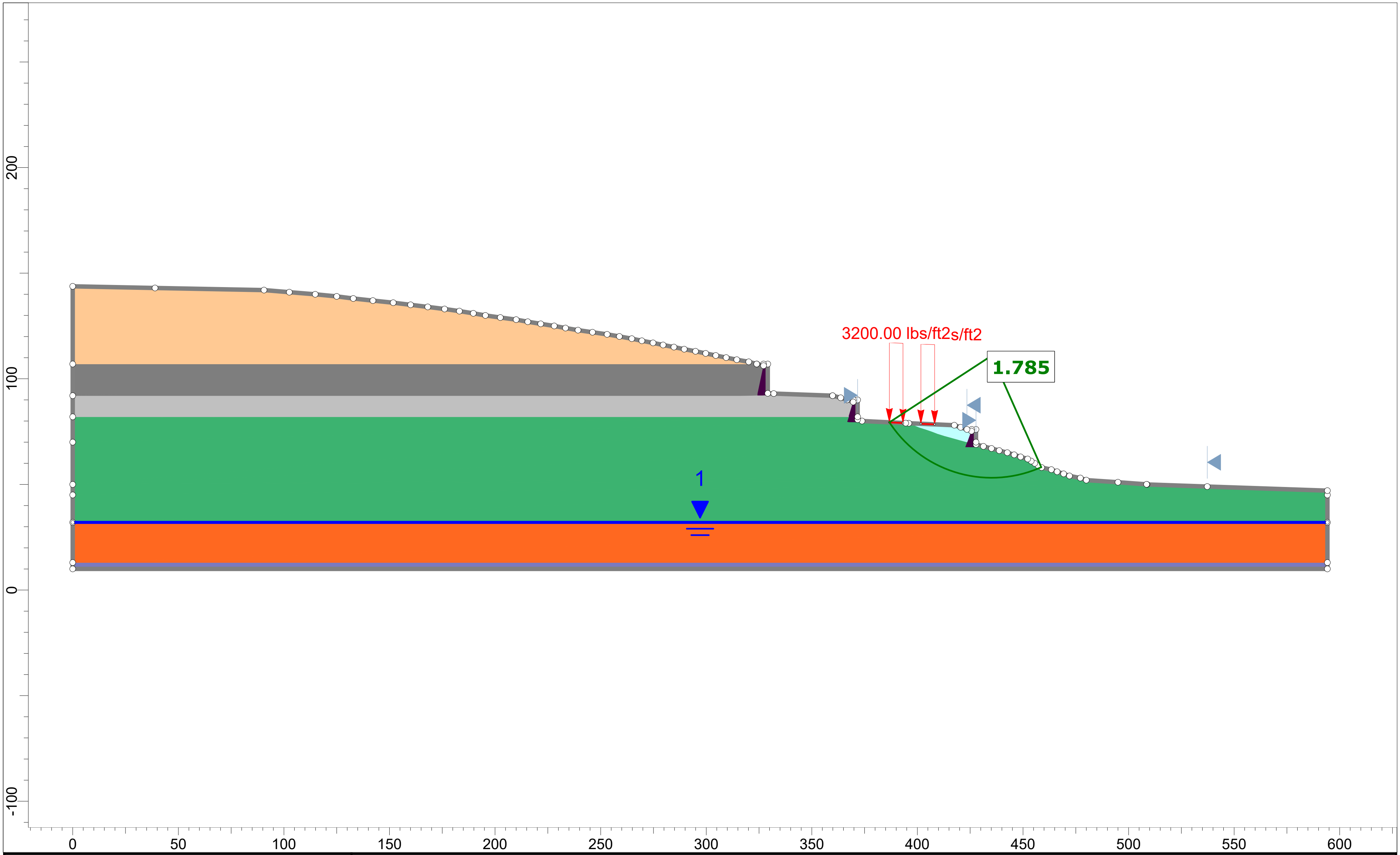
Type	Coordinates (x,y)
External Boundary	95.7847, 10 545.12, 10 545.12, 15 545.12, 25 545.12, 38 545.12, 48.0485 518.155, 48.9972 489.731, 49.9972 489.649, 50 460.336, 50.9972 451.972, 51.9972 441.891, 52.9972 430.186, 53.9972 421.954, 54.9972 412.876, 55.9972 408.22, 56.9972 404.553, 57.9972 400.556, 58.9972 397.269, 60 394.408, 60.9972 388.093, 61.9972 380.77, 62.9972 371.446, 63.9972 364.254, 64.9972 357.825, 65.9972 351.898, 66.9972 347.166, 67.9972 342.402, 68.9972 337.11, 69.9692 337.11, 70 337.11, 74.9973 335.106, 74.9973 335.106, 74.471 333.533, 74.9971 330.543, 75.9971 327.546, 76.9971 324.532, 77.9971 312.278, 78.9971 288.852, 79.7211 279.922, 79.9971 276.893, 80.9971

	273.864, 81.9971 273.821, 82 258.92, 82.9971 255.881, 83.9971 252.863, 84.9971 249.853, 85.9971 246.925, 86.9698 246.925, 92 246.925, 92.9973 244.921, 92.9973 244.921, 92.3937 243.063, 92.9973 239.159, 93.9973 234.199, 94.9973 228.412, 95.9973 222.095, 96.9973 216.985, 97.9973 211.768, 98.9973 207, 99.9973 202.114, 100.997 198, 101.997 191.631, 102.997 185.756, 103.997 180.401, 104.997 172.926, 105.997 160.663, 106.997 134.827, 107.997 121.579, 107.997 95.7847, 106.997 95.7847, 92 95.7847, 82 95.7847, 60 95.7847, 50 95.7847, 38 95.7847, 25 95.7847, 15
Material Boundary	95.7847, 82 273.821, 82
Material Boundary	95.7847, 60 397.269, 60
Material Boundary	95.7847, 50 489.649, 50
Material Boundary	95.7847, 92 244.737, 92 246.925, 92
Material Boundary	288.852, 79.7211 291.019, 79.0001 294.506, 78.0001 300.362, 77.0001 306.567, 76.0001 310.659, 75.0001 314.965, 74.0001 320.608, 73.0001 326.28, 72.0001 331.517, 71.0001 333.051, 70.7173 337.11, 69.9692

Material Boundary	244.921, 92.3937 244.737, 92 241.925, 85.9973 246.925, 85.9973 246.925, 86.9698
Material Boundary	335.106, 74.471 333.051, 70.7173 332.11, 68.9973 337.11, 68.9973 337.11, 69.9692
Material Boundary	95.7847, 38 545.12, 38
Material Boundary	95.7847, 15 545.12, 15

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario	Upper Wall	Lower Wall
Piezoline	95.7847, 38 545.12, 38	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)
Distributed Load	312.278, 78.9971 324.532, 77.9971	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No		Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No



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Project
45-20803 Barrier Wall Road Interim Design and Repair

Analysis
Short Term Slope Stability

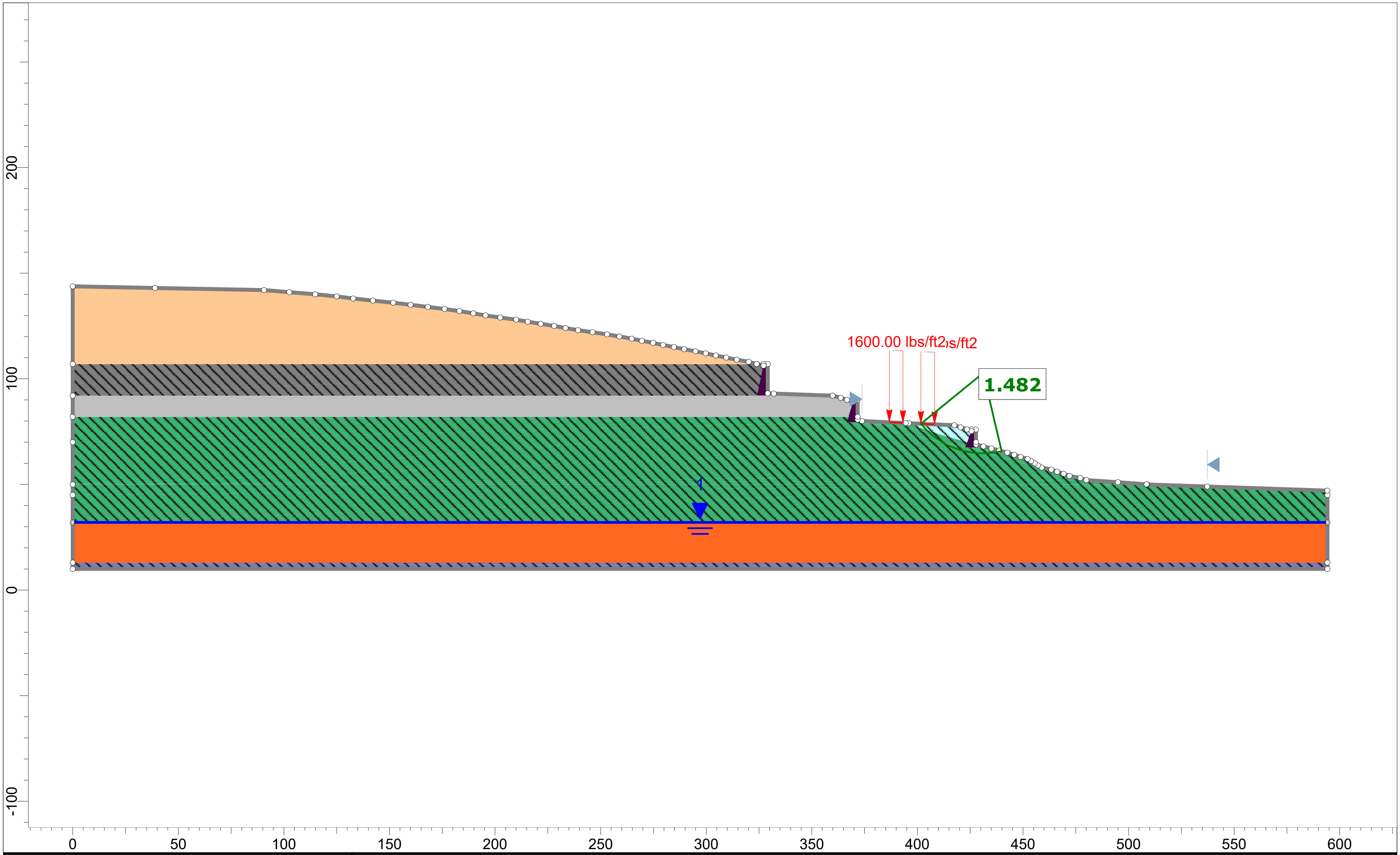
Section
Section 6 - MT3500 Dynamic Pressure Stability - 3200 psf

Drawn By

Station
Approx. STA 41+40

Date

File Name
section-6.slmd



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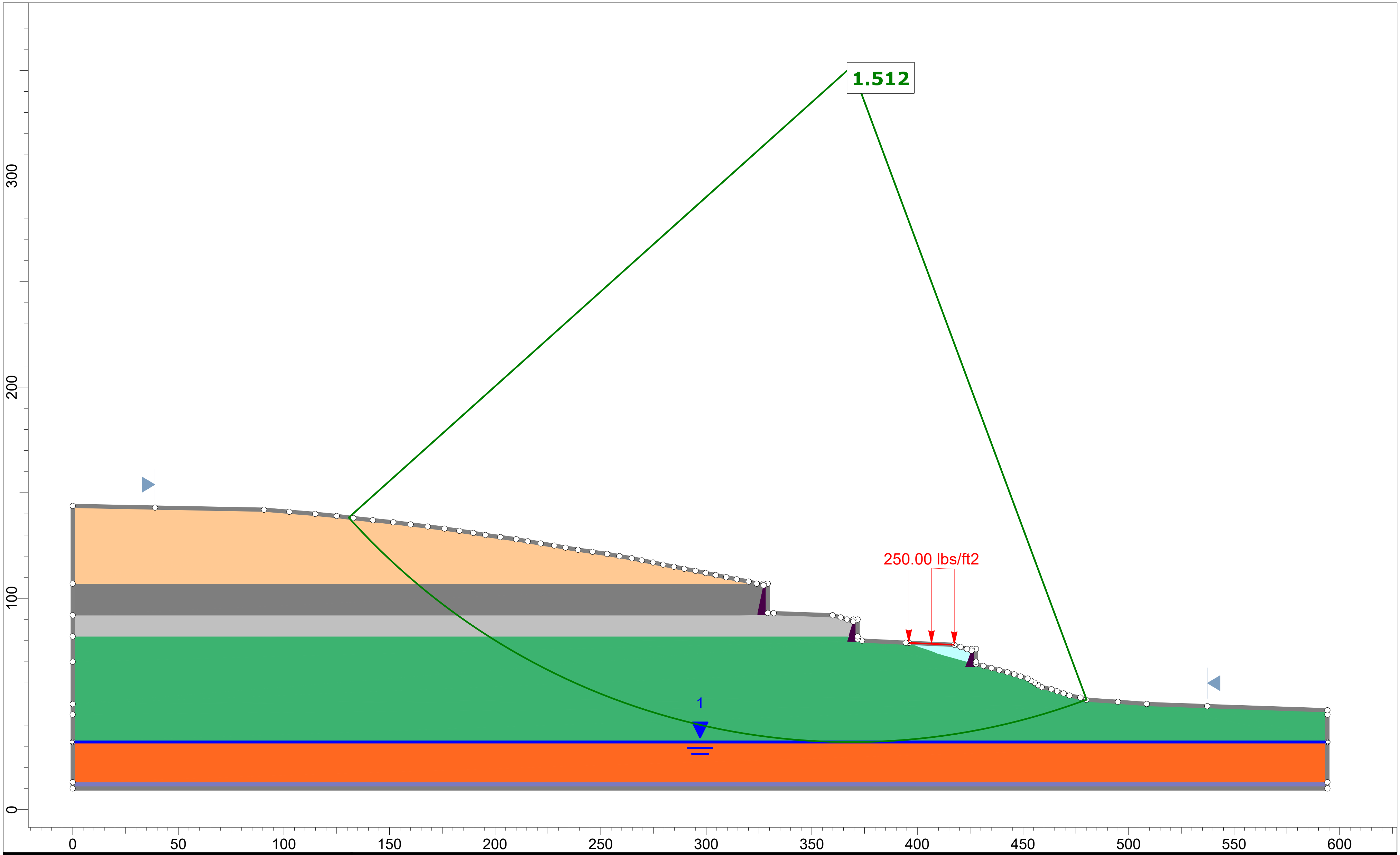
Project 45-20803 Barrier Wall Road Interim Design and Repair	
Analysis Long Term Slope Stability	*Section* Section 6 - MT3500 Static Pressure Stability - 1600 psf
Drawn By	*Station* Approx. STA 41+40
Date	*File Name* section-6.slmd



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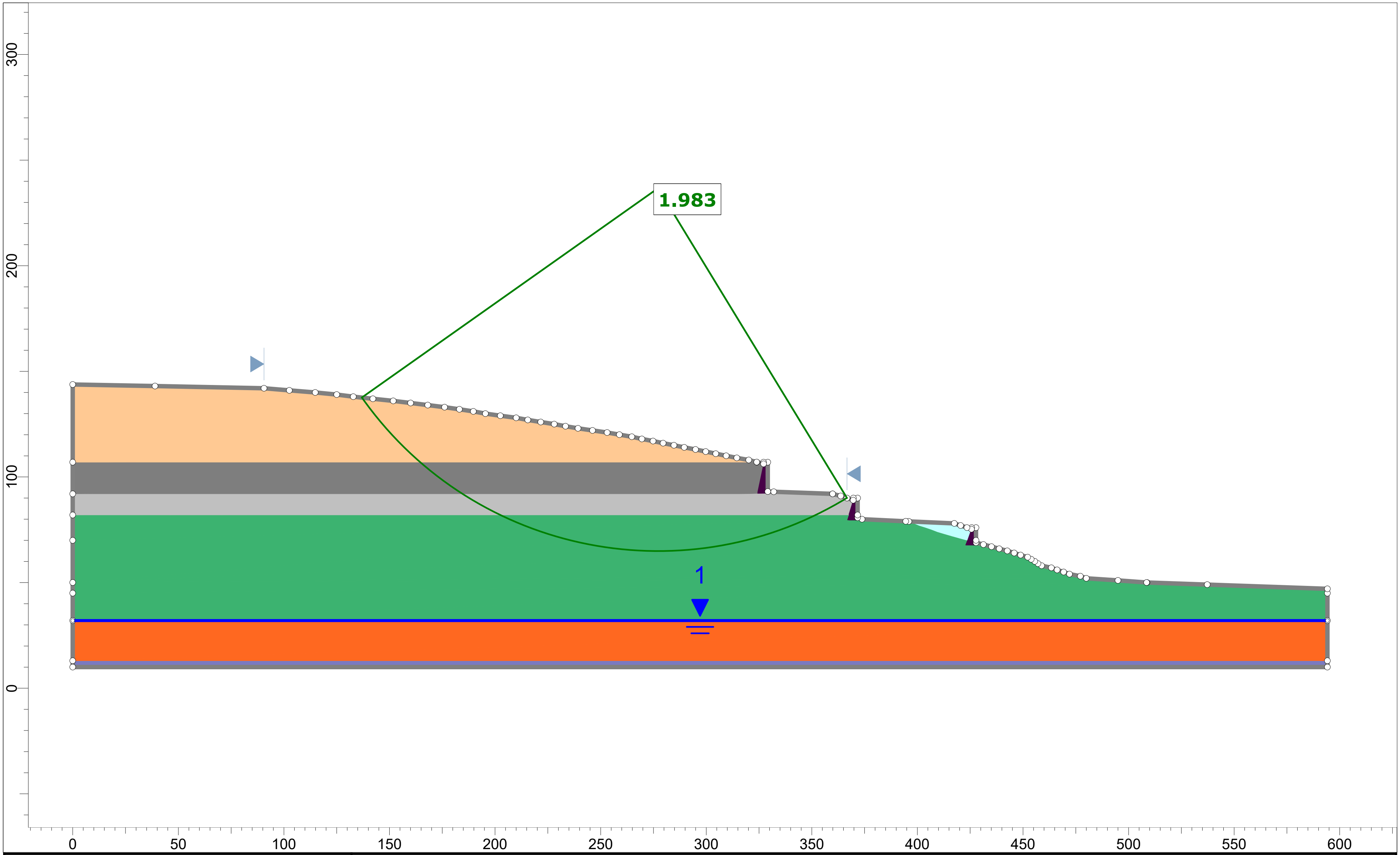
Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 6
Drawn By		*Station*	Approx. STA 41+40
Date		*File Name*	section-6.slmd



Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 6 - Upper Wall
Drawn By		*Station*	Approx. STA 41+40
Date		*File Name*	section-6.slmd

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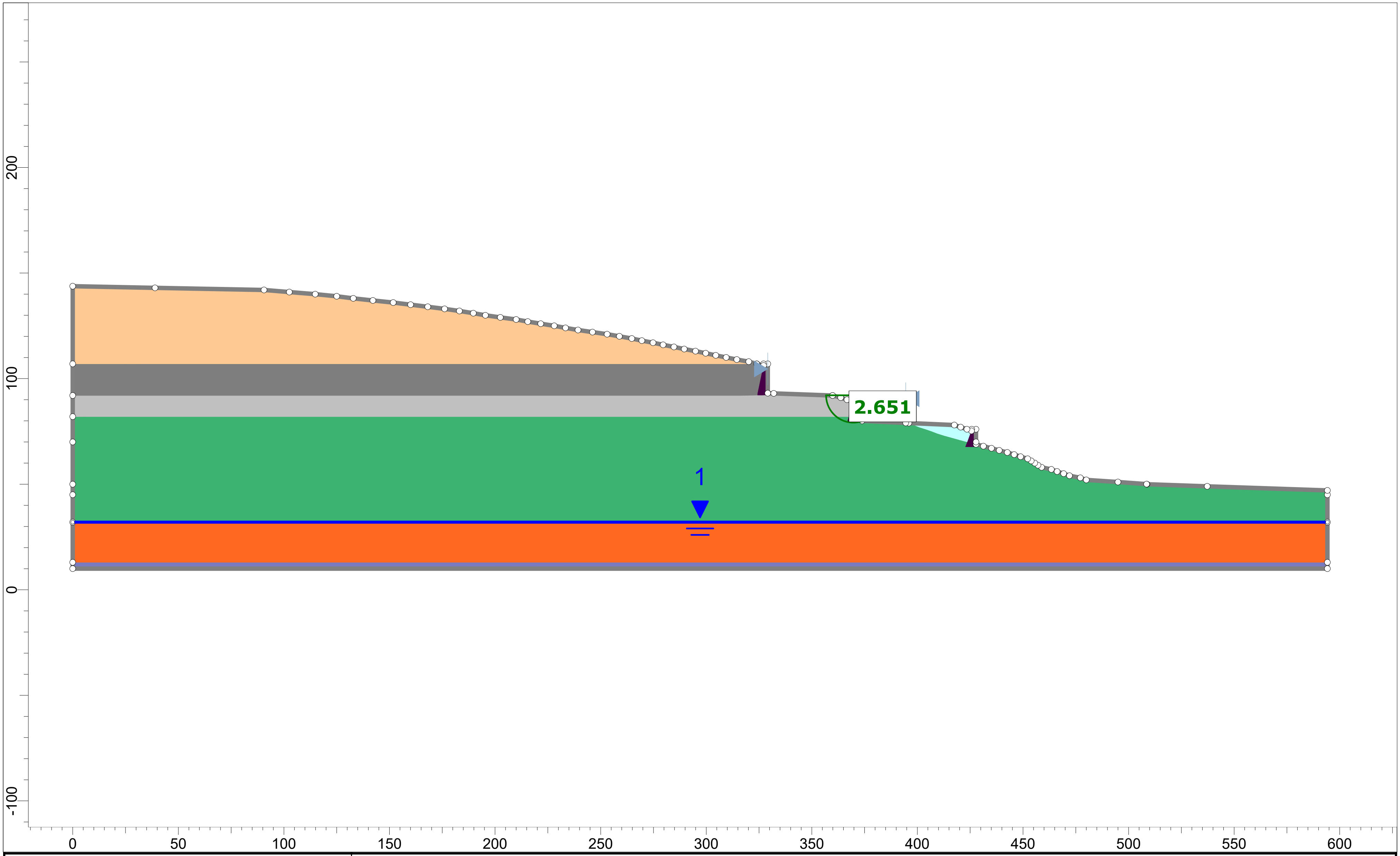
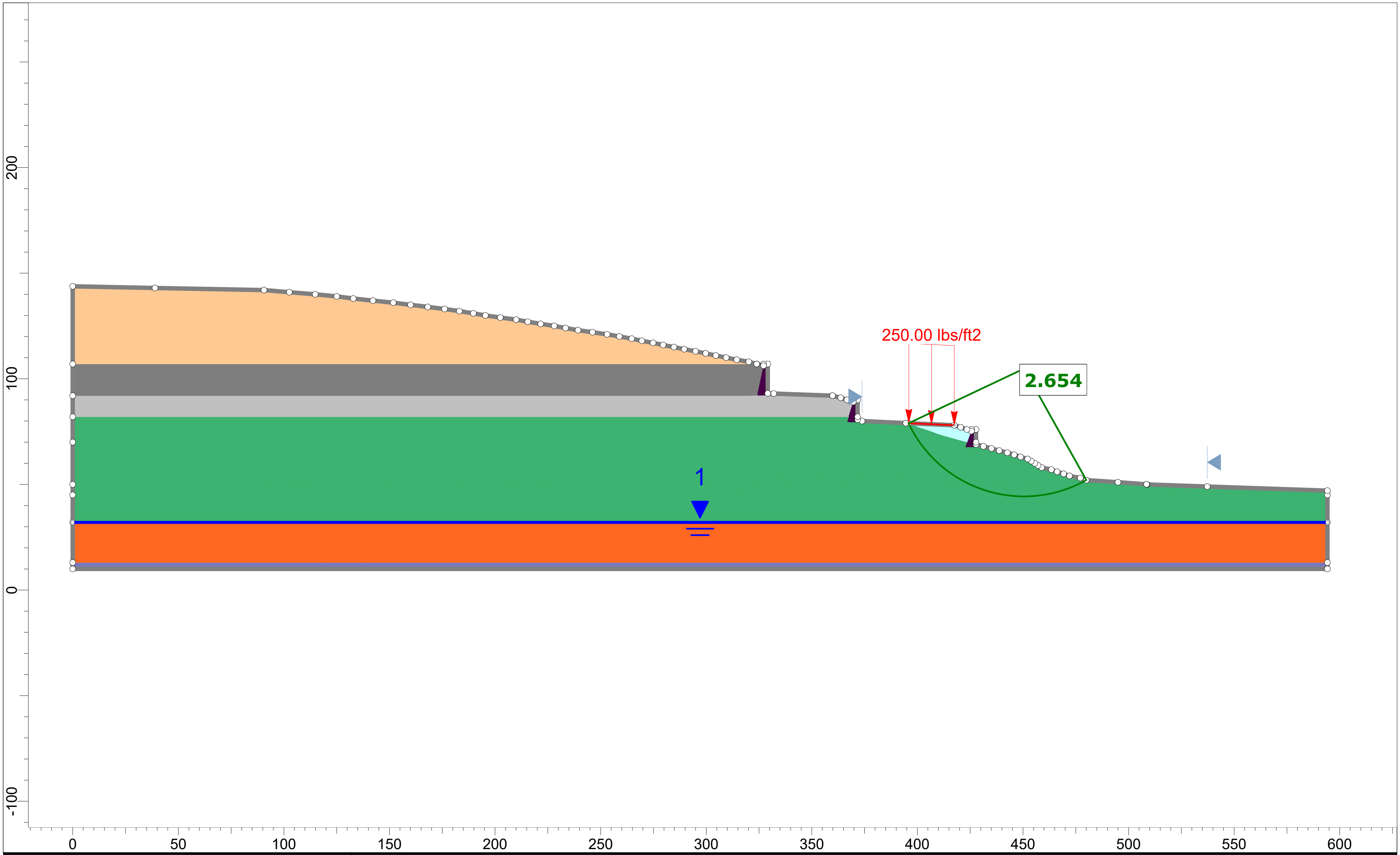


GEOS Universal Engineering Sciences Geotechnical, Environmental and Materials Engineers	*Project*	45-20803 Barrier Wall Road Interim Design and Repair	
	Analysis Short Term Slope Stability	*Section* Section 6 - Middle Wall	
	Drawn By	*Station* Approx. STA 41+40	
SLIDEINTERPRET 9.020	*Date*	*File Name* section-6.slmd	



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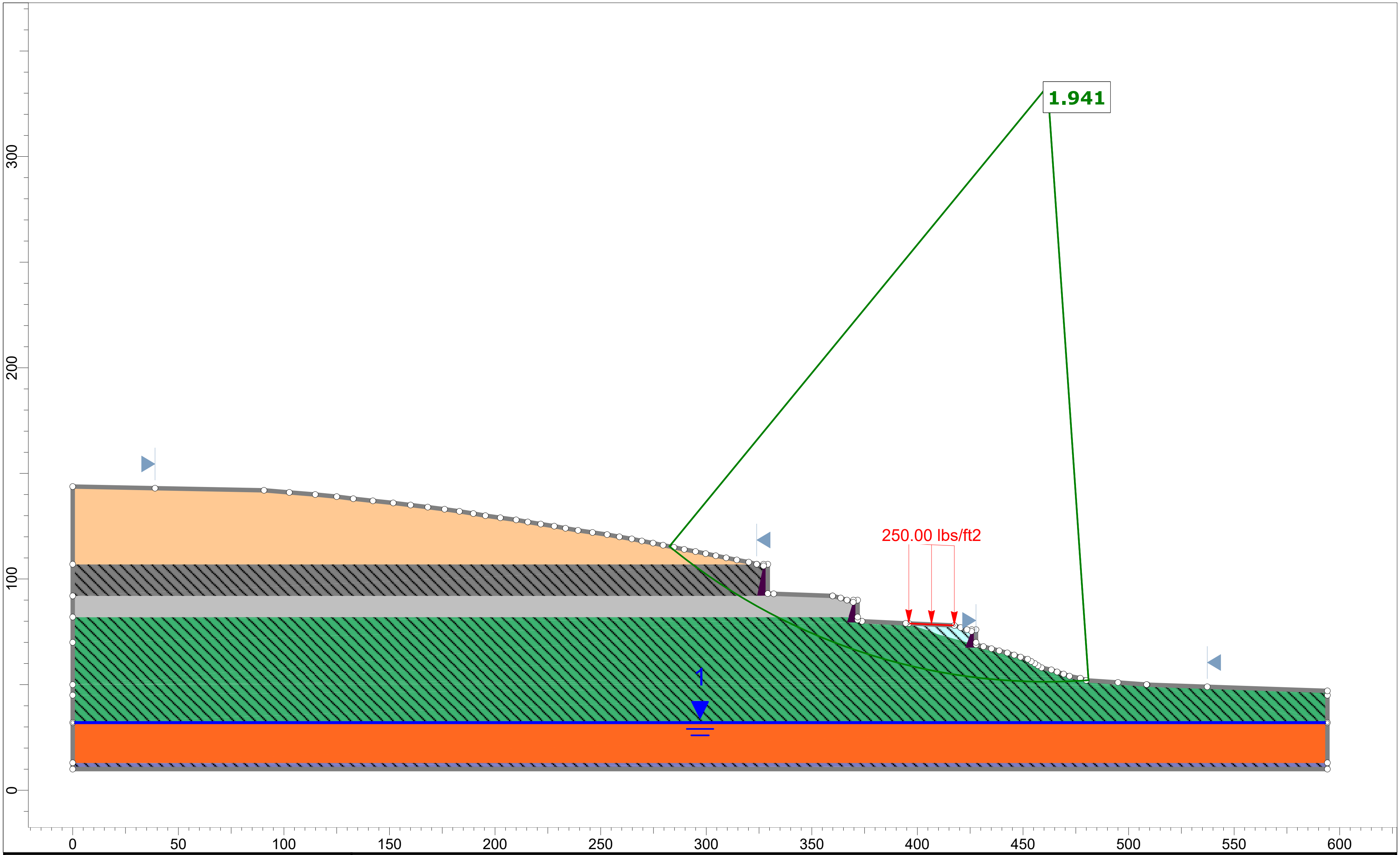
SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 6 - Lower Wall
Drawn By		*Station*	Approx. STA 41+40
Date		*File Name*	section-6.slmd



Universal Engineering Sciences

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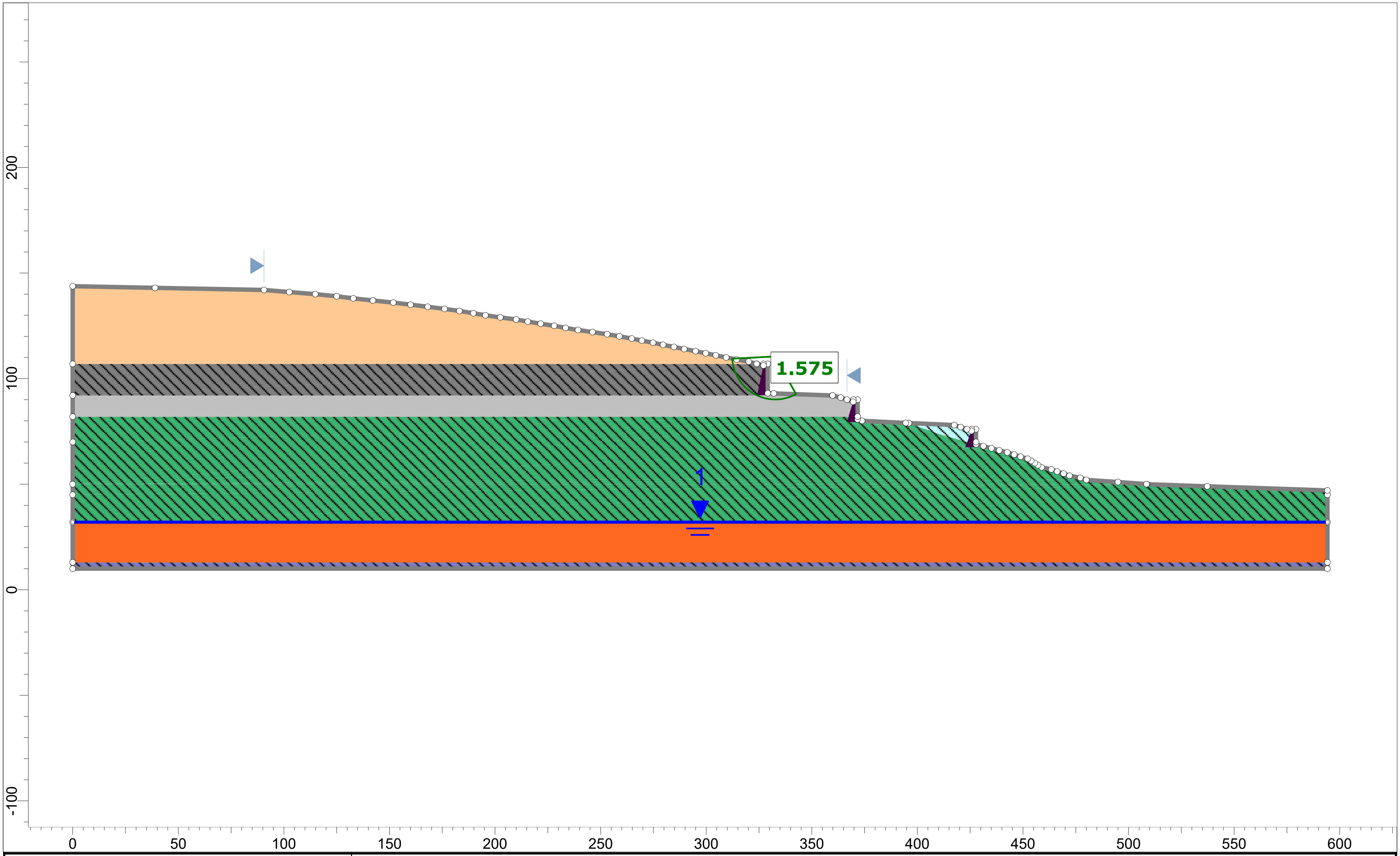
SLIDEINTERPRET 9.020

Project
45-20803 Barrier Wall Road Interim Design and Repair

Analysis	Long Term Slope Stability	*Section*	Section 6
Drawn By		*Station*	Approx. STA 41+40
Date		*File Name*	section-6.slmd



Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 6 - Upper Wall
Drawn By		*Station*	Approx. STA 41+40
Date		*File Name*	section-6.slmd

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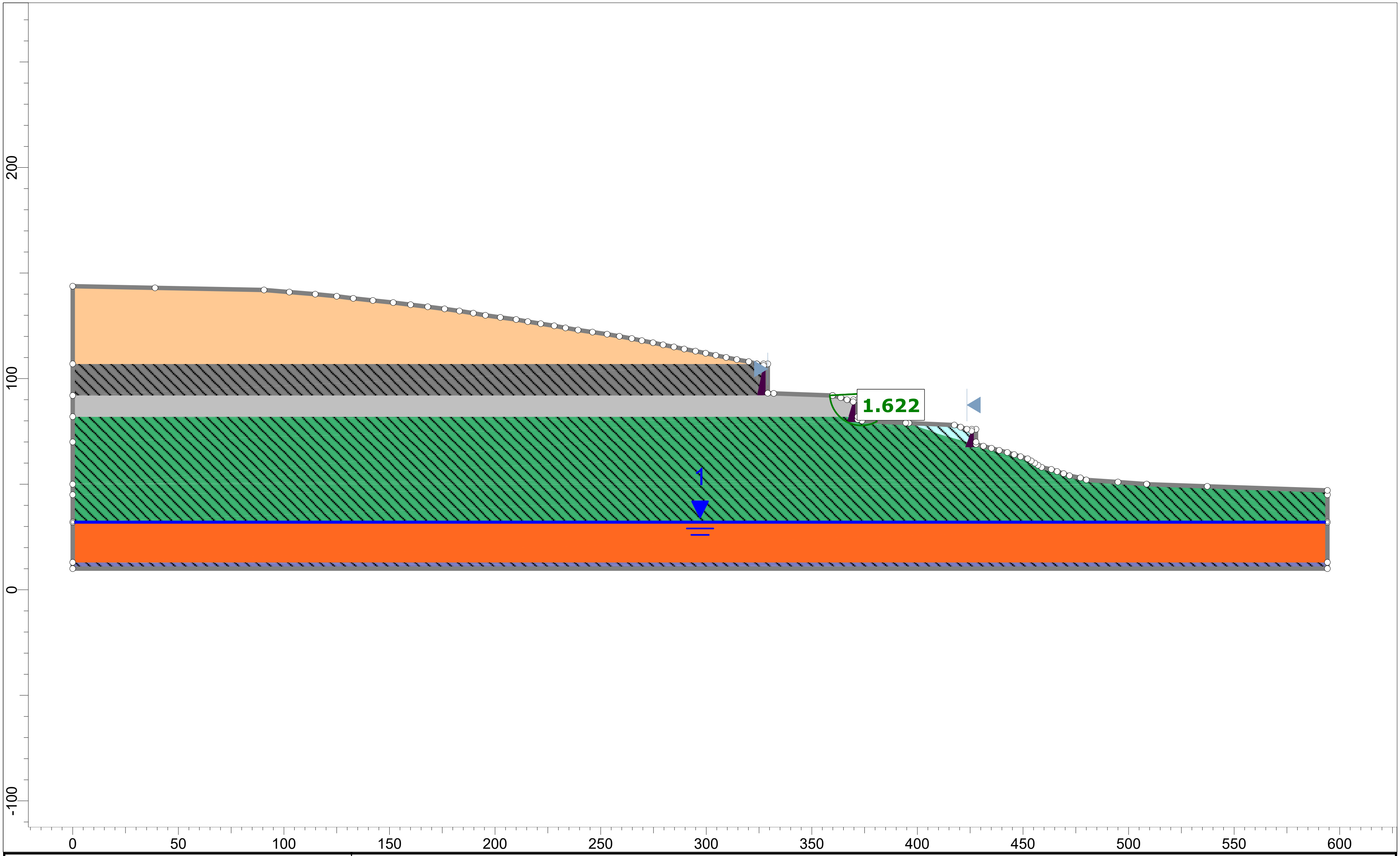
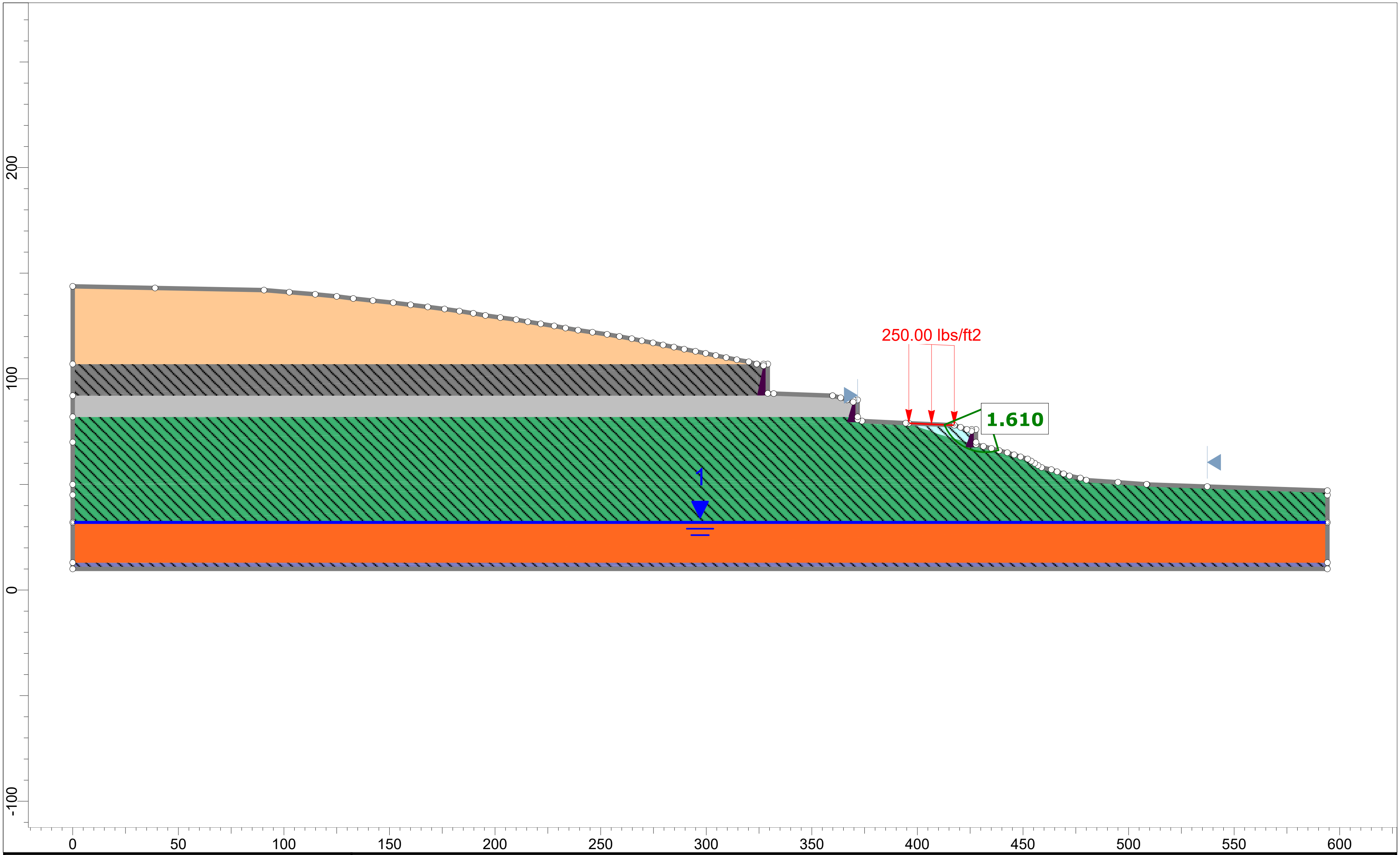


GEOS Universal Engineering Sciences Geotechnical, Environmental and Materials Engineers	*Project* 45-20803 Barrier Wall Road Interim Design and Repair		
	Analysis Long Term Slope Stability	*Section* Section 6 - Middle Wall	
	Drawn By	*Station* Approx. STA 41+40	
SLIDEINTERPRET 9.020	*Date*	*File Name* section-6.slmd	



GEOS Universal Engineering Sciences
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Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 6 - Lower Wall
Drawn By		*Station*	Approx. STA 41+40
Date		*File Name*	section-6.slmd

SLIDEINTERPRET 9.020

Section-6
45-20803 Barrier Wall Road Interim Design and Repair
Approx STA 41+40
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-6

Project Summary

File Name:	section-6.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Long Term Slope Stability

Comments

Section 6 - MT3500 Static Pressure Stability - 1600 psf
Approx. STA 41+40

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Dynamic Stability - 3200 psf ◆	Master Scenario	Spencer: 1.785370	00h:00m:14.103s
Static Stability - 1600 psf Drained ◆	Master Scenario	Spencer: 1.481980	00h:00m:07.269s
Short Term Stability ◆	Master Scenario	Spencer: 1.511630	00h:00m:12.124s
	Upper Wall	Spencer: 1.982820	00h:00m:07.154s
	Middle Wall	Spencer: 2.651190	00h:00m:05.43s
	Lower Wall	Spencer: 2.654230	00h:00m:12.73s
Long Term Stability ◆	Master Scenario	Spencer: 1.941440	00h:00m:06.136s
	Upper Wall	Spencer: 1.574920	00h:00m:05.491s
	Middle Wall	Spencer: 1.621990	00h:00m:04.451s
	Lower Wall	Spencer: 1.610410	00h:00m:06.414s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

◆ Dynamic Stability - 3200 psf

Distribution:	Constant
Magnitude [psf]:	3200
Orientation:	Vertical

Distribution:	Constant
Magnitude [psf]:	3200
Orientation:	Vertical

◆ Static Stability - 1600 psf Drained

Distribution:	Constant
Magnitude [psf]:	1600
Orientation:	Vertical

Distribution:	Constant
Magnitude [psf]:	1600
Orientation:	Vertical

◆ Short Term Stability - Master Scenario

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

◆ Short Term Stability - Lower Wall

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

◆ Long Term Stability - Master Scenario

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

◆ Long Term Stability - Lower Wall

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Materials

Retaining Wall	
Color	🟪
Strength Type	Infinite strength
Unit Weight [lbs/ft3]	130
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Ru Value	0
Light Brown Sand	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	◼
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	◻
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)

Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Upper Cape Fear Confining Unit	
Color	🟪
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	2500
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Upper Cape Fear Confining Unit (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Hu Value	1
Compacted Fill	
Color	🟦
Strength Type	Undrained
Unit Weight [lbs/ft3]	125
Cohesion [psf]	2000
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	28

Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material	Dynamic Stability - 3200 psf	Static Stability - 1600 psf Drained	Short Term Stability	Upper Wall	Middle Wall	Lower Wall	Long Term Stability	Upper Wall	Middle Wall	Lower Wall
Retaining	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Light Bro Sand	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dark Gray	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗
Dark Gray (Drained)	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓
Light Gra Sand	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Black Cre Confining	✓	✗	✓	✓	✓	✓	✗	✗	✗	✗
Black Cre Confining (Long Te	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓
Black Cre Aquifer	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Upper Ca Fear Con Unit	✓	✗	✓	✓	✓	✓	✗	✗	✗	✗
Upper Ca Fear Con Unit (Drai	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓
Compacte	✓	✗	✓	✓	✓	✓	✗	✗	✗	✗
Compacte (Drained)	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓

Global Minimums

Dynamic Stability - 3200 psf

Method: spencer

FS	1.785370
Center:	435.180, 110.967
Radius:	57.865
Left Slip Surface Endpoint:	386.696, 79.381
Right Slip Surface Endpoint:	458.673, 58.085
Resisting Moment:	5.80923e+06 lb-ft
Driving Moment:	3.25379e+06 lb-ft
Resisting Horizontal Force:	89232.6 lb
Driving Horizontal Force:	49979.8 lb
Total Slice Area:	962.567 ft2
Surface Horizontal Width:	71.9776 ft
Surface Average Height:	13.3731 ft

Static Stability - 1600 psf Drained

Method: spencer

FS	1.481980
Center:	431.164, 102.736
Radius:	38.060
Left Slip Surface Endpoint:	401.661, 78.692
Right Slip Surface Endpoint:	439.913, 65.695
Resisting Moment:	934524 lb-ft
Driving Moment:	630592 lb-ft
Resisting Horizontal Force:	21662.6 lb
Driving Horizontal Force:	14617.3 lb
Total Slice Area:	240.821 ft2
Surface Horizontal Width:	38.2524 ft
Surface Average Height:	6.2956 ft

Short Term Stability - Master Scenario

Method: spencer

FS	1.511630
Center:	368.762, 351.681
Radius:	319.718
Left Slip Surface Endpoint:	130.686, 138.282
Right Slip Surface Endpoint:	480.146, 51.992
Resisting Moment:	1.98008e+08 lb-ft
Driving Moment:	1.3099e+08 lb-ft
Resisting Horizontal Force:	579261 lb
Driving Horizontal Force:	383204 lb
Total Slice Area:	16393.2 ft2
Surface Horizontal Width:	349.459 ft
Surface Average Height:	46.9101 ft

Short Term Stability - Upper Wall

Method: spencer

FS	1.982820
Center:	277.223, 236.703
Radius:	171.817
Left Slip Surface Endpoint:	136.887, 137.572
Right Slip Surface Endpoint:	366.669, 90.004
Resisting Moment:	5.48336e+07 lb-ft
Driving Moment:	2.76544e+07 lb-ft
Resisting Horizontal Force:	290159 lb
Driving Horizontal Force:	146337 lb
Total Slice Area:	8513.59 ft2
Surface Horizontal Width:	229.782 ft
Surface Average Height:	37.0507 ft

Short Term Stability - Middle Wall

Method: spencer

FS	2.651190
Center:	369.681, 92.116
Radius:	12.968
Left Slip Surface Endpoint:	356.713, 92.116
Right Slip Surface Endpoint:	374.256, 79.982
Resisting Moment:	197297 lb-ft
Driving Moment:	74418.3 lb-ft
Resisting Horizontal Force:	13295.7 lb
Driving Horizontal Force:	5014.99 lb
Total Slice Area:	139.959 ft2
Surface Horizontal Width:	17.5431 ft
Surface Average Height:	7.97802 ft

Short Term Stability - Lower Wall

Method: spencer

FS	2.654230
Center:	450.485, 104.756
Radius:	60.430
Left Slip Surface Endpoint:	395.844, 78.945
Right Slip Surface Endpoint:	479.963, 52.005
Resisting Moment:	7.74387e+06 lb-ft
Driving Moment:	2.91756e+06 lb-ft
Resisting Horizontal Force:	110651 lb
Driving Horizontal Force:	41688.5 lb
Total Slice Area:	1311.33 ft2
Surface Horizontal Width:	84.1186 ft
Surface Average Height:	15.5891 ft

Long Term Stability - Master Scenario

Method: spencer

FS	1.941440
Center:	461.672, 333.337
Radius:	282.072
Left Slip Surface Endpoint:	282.569, 115.423
Right Slip Surface Endpoint:	481.056, 51.932
Resisting Moment:	5.53817e+07 lb-ft
Driving Moment:	2.85261e+07 lb-ft
Resisting Horizontal Force:	184682 lb
Driving Horizontal Force:	95126.5 lb
Total Slice Area:	2881.1 ft2
Surface Horizontal Width:	198.487 ft
Surface Average Height:	14.5153 ft

Long Term Stability - Upper Wall

Method: spencer

FS	1.574920
Center:	332.695, 110.510
Radius:	20.398
Left Slip Surface Endpoint:	312.327, 109.427
Right Slip Surface Endpoint:	342.506, 92.626
Resisting Moment:	412424 lb-ft
Driving Moment:	261870 lb-ft
Resisting Horizontal Force:	16524.3 lb
Driving Horizontal Force:	10492.1 lb
Total Slice Area:	237.638 ft2
Surface Horizontal Width:	30.1789 ft
Surface Average Height:	7.87433 ft

Long Term Stability - Middle Wall

Method: spencer

FS	1.621990
Center:	373.594, 92.848
Radius:	15.034
Left Slip Surface Endpoint:	358.581, 92.049
Right Slip Surface Endpoint:	380.820, 79.664
Resisting Moment:	166880 lb-ft
Driving Moment:	102886 lb-ft
Resisting Horizontal Force:	9351.19 lb
Driving Horizontal Force:	5765.25 lb
Total Slice Area:	134.695 ft2
Surface Horizontal Width:	22.2389 ft
Surface Average Height:	6.05673 ft

Long Term Stability - Lower Wall

Method: spencer

FS	**1.610410**
Center:	432.312, 86.345
Radius:	21.144
Left Slip Surface Endpoint:	412.797, 78.207
Right Slip Surface Endpoint:	438.394, 66.095
Resisting Moment:	262582 lb-ft
Driving Moment:	163052 lb-ft
Resisting Horizontal Force:	10377.3 lb
Driving Horizontal Force:	6443.86 lb
Total Slice Area:	128.668 ft2
Surface Horizontal Width:	25.5969 ft
Surface Average Height:	5.02671 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Dynamic Stability - 3200 psf

Method: spencer

Number of Valid Surfaces: 37285
Number of Invalid Surfaces: 0

Static Stability - 1600 psf Drained

Method: spencer

Number of Valid Surfaces: 41714
Number of Invalid Surfaces: 0

Short Term Stability - Master Scenario

Method: spencer

Number of Valid Surfaces: 105001
Number of Invalid Surfaces: 0

Short Term Stability - Upper Wall

Method: spencer

Number of Valid Surfaces: 56128
Number of Invalid Surfaces: 0

Short Term Stability - Middle Wall

Method: spencer

Number of Valid Surfaces: 10270
Number of Invalid Surfaces: 0

Short Term Stability - Lower Wall

Method: spencer

Number of Valid Surfaces: 65507
Number of Invalid Surfaces: 0

Long Term Stability - Master Scenario

Method: spencer

Number of Valid Surfaces: 64476
Number of Invalid Surfaces: 0

Long Term Stability - Upper Wall

Method: spencer

Number of Valid Surfaces: 30361
Number of Invalid Surfaces: 0

Long Term Stability - Middle Wall

Method: spencer

Number of Valid Surfaces:	20096
Number of Invalid Surfaces:	0

Long Term Stability - Lower Wall

Method: spencer

Number of Valid Surfaces:	43822
Number of Invalid Surfaces:	0

Slice Data

Dynamic Stability - 3200 psf

Global Minimum Query (spencer) - Safety Factor: 1.78537

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.43955	175.948	-55.6533	Black Creek Confining Unit	930.553	0	521.21	930.553	1890.79	0	1890.79	2653.52	2653.52
2	1.43955	512.096	-53.2001	Black Creek Confining Unit	988.931	0	553.908	988.931	2125.12	0	2125.12	2865.54	2865.54
3	1.43955	819.183	-50.8806	Black Creek Confining Unit	1042.26	0	583.778	1042.26	2349.54	0	2349.54	3067.38	3067.38
4	1.43955	1101.45	-48.6717	Black Creek Confining Unit	1091.28	0	611.235	1091.28	2564.63	0	2564.63	3259.7	3259.7
5	1.43955	1362.11	-46.5559	Black Creek Confining Unit	1136.55	0	636.591	1136.55	1557.74	0	1557.74	2229.88	2229.88
6	1.43955	1603.86	-44.5198	Black Creek Confining Unit	1178.51	0	660.093	1178.51	507.79	0	507.79	1156.91	1156.91
7	1.43955	1829.92	-42.5527	Black Creek Confining Unit	1216.66	0	681.461	1216.66	662.469	0	662.469	1288.07	1288.07
8	1.43955	2043.09	-40.6459	Black Creek Confining Unit	1238.9	0	693.918	1238.9	816.469	0	816.469	1412.19	1412.19
9	1.43955	2242.55	-38.7921	Black Creek Confining Unit	1257.94	0	704.582	1257.94	965.195	0	965.195	1531.53	1531.53
10	1.43955	2429.26	-36.9854	Black Creek Confining Unit	1273.14	0	713.096	1273.14	1108.91	0	1108.91	1645.99	1645.99
11	1.43955	2603.02	-35.2207	Black Creek Confining Unit	1289.67	0	722.354	1289.67	2837.1	0	2837.1	3347.05	3347.05
12	1.43955	2765.03	-33.4937	Black Creek Confining Unit	1305.74	0	731.355	1305.74	4036.47	0	4036.47	4520.43	4520.43
13	1.43955	2916.54	-31.8005	Black Creek Confining Unit	1319.21	0	738.9	1319.21	4192.07	0	4192.07	4650.22	4650.22
14	1.43955	3058.16	-30.1377	Black Creek Confining Unit	1330.06	0	744.977	1330.06	4342.25	0	4342.25	4774.76	4774.76
15	1.43955	3190.4	-28.5026	Black Creek Confining Unit	1338.47	0	749.688	1338.47	4229.02	0	4229.02	4636.11	4636.11

16	1.43955	3313.7	-26.8924	Black Creek Confining Unit	1344.43	0	753.026	1344.43	1859.03	0	1859.03	2240.94	2240.94
17	1.43955	3427.66	-25.305	Black Creek Confining Unit	1351.51	0	756.992	1351.51	1967.49	0	1967.49	2325.4	2325.4
18	1.43955	3532.94	-23.738	Black Creek Confining Unit	1358.37	0	760.834	1358.37	2071.28	0	2071.28	2405.86	2405.86
19	1.43955	3630.07	-22.1897	Black Creek Confining Unit	1364.1	0	764.043	1364.1	2170.71	0	2170.71	2482.35	2482.35
20	1.43955	3719.29	-20.6583	Black Creek Confining Unit	1368.99	0	766.782	1368.99	2265.83	0	2265.83	2554.93	2554.93
21	1.43955	3800.95	-19.1422	Black Creek Confining Unit	1372.56	0	768.782	1372.56	2356.77	0	2356.77	2623.62	2623.62
22	1.43955	3860.28	-17.6399	Black Creek Confining Unit	1374.79	0	770.031	1374.79	2434.12	0	2434.12	2678.98	2678.98
23	1.43955	3857.52	-16.15	Black Creek Confining Unit	1375.76	0	770.574	1375.76	2472.2	0	2472.2	2695.34	2695.34
24	1.43955	3842.67	-14.6713	Black Creek Confining Unit	1375.63	0	770.501	1375.63	2502.22	0	2502.22	2703.94	2703.94
25	1.43955	3820.94	-13.2025	Black Creek Confining Unit	1374.5	0	769.868	1374.5	2527.41	0	2527.41	2708.01	2708.01
26	1.43955	3816.11	-11.7425	Black Creek Confining Unit	1295.62	0	725.687	1295.62	2559.14	0	2559.14	2709.99	2709.99
27	1.43955	3809.73	-10.2902	Black Creek Confining Unit	1304.03	0	730.398	1304.03	2593.42	0	2593.42	2726.02	2726.02
28	1.43955	3948.63	-8.84453	Black Creek Confining Unit	1311.31	0	734.475	1311.31	2724.11	0	2724.11	2838.4	2838.4
29	1.43955	3311.5	-7.40454	Black Creek Confining Unit	1317.48	0	737.931	1317.48	2338.24	0	2338.24	2434.14	2434.14
30	1.43955	2610.82	-5.96924	Black Creek Confining Unit	1353.41	0	758.056	1353.41	1906.83	0	1906.83	1986.09	1986.09
31	1.43955	2571.44	-4.53769	Black Creek Confining Unit	1346.57	0	754.225	1346.57	1912.5	0	1912.5	1972.36	1972.36
32	1.43955	2523.97	-3.10898	Black Creek Confining Unit	1338.32	0	749.604	1338.32	1912.14	0	1912.14	1952.86	1952.86
33	1.43955	2468.65	-1.6822	Black Creek Confining Unit	1328.72	0	744.227	1328.72	1905.81	0	1905.81	1927.66	1927.66
34	1.43955	2406.97	-0.256469	Black Creek Confining Unit	1318.03	0	738.239	1318.03	1894.42	0	1894.42	1897.73	1897.73

35	1.43955	2337.55	1.16911	Black Creek Confining Unit	1305.95	0	731.473	1305.95	1876.89	0	1876.89	1861.96	1861.96
36	1.43955	2261.57	2.59541	Black Creek Confining Unit	1292.75	0	724.08	1292.75	1853.93	0	1853.93	1821.11	1821.11
37	1.43955	2180.48	4.02332	Black Creek Confining Unit	1278.67	0	716.193	1278.67	1826.52	0	1826.52	1776.15	1776.15
38	1.43955	2095.02	5.45374	Black Creek Confining Unit	1263.83	0	707.881	1263.83	1795.13	0	1795.13	1727.55	1727.55
39	1.43955	2003.09	6.88758	Black Creek Confining Unit	1247.9	0	698.959	1247.9	1758.1	0	1758.1	1673.67	1673.67
40	1.43955	1897	8.32578	Black Creek Confining Unit	1229.44	0	688.619	1229.44	1709.29	0	1709.29	1608.51	1608.51
41	1.43955	1780.59	9.76927	Black Creek Confining Unit	1209.22	0	677.294	1209.22	1651.4	0	1651.4	1534.78	1534.78
42	1.43955	1655.85	11.2191	Black Creek Confining Unit	1187.56	0	665.162	1187.56	1585.69	0	1585.69	1453.75	1453.75
43	1.43955	1522.19	12.6762	Black Creek Confining Unit	1164.35	0	652.162	1164.35	1511.48	0	1511.48	1364.79	1364.79
44	1.43955	1384.07	14.1417	Black Creek Confining Unit	1140.34	0	638.714	1140.34	1432.1	0	1432.1	1271.18	1271.18
45	1.43955	1243.57	15.6167	Black Creek Confining Unit	1115.96	0	625.058	1115.96	1349.13	0	1349.13	1174.42	1174.42
46	1.43955	1087.38	17.1024	Black Creek Confining Unit	1090.38	0	610.731	1090.38	1251.92	0	1251.92	1064	1064
47	1.43955	867.506	18.6001	Black Creek Confining Unit	1050.64	0	588.472	1050.64	1097.51	0	1097.51	899.47	899.47
48	1.43955	631.062	20.1111	Black Creek Confining Unit	1009.62	0	565.496	1009.62	925.758	0	925.758	718.692	718.692
49	1.43955	379.722	21.6368	Black Creek Confining Unit	965.929	0	541.025	965.929	736.625	0	736.625	522.016	522.016
50	1.43955	125.729	23.1788	Black Creek Confining Unit	921.832	0	516.325	921.832	540.152	0	540.152	319.08	319.08

Static Stability - 1600 psf Drained

Global Minimum Query (spencer) - Safety Factor: 1.48198

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.814612	47.3947	-49.8698	Compacted Fill (Drained)	200	28	453.126	671.523	886.809	0	886.809	1424.34	1424.34
2	0.814612	139.05	-48.0019	Compacted Fill (Drained)	200	28	489.386	725.261	987.872	0	987.872	1531.43	1531.43
3	0.814612	224.753	-46.1996	Compacted Fill (Drained)	200	28	525.017	778.064	1087.18	0	1087.18	1634.66	1634.66
4	0.761884	282.131	-44.5095	Black Creek Confining Unit (Long Term)	125	26	484.011	717.294	1214.38	0	1214.38	1690.18	1690.18
5	0.761884	346.612	-42.9222	Black Creek Confining Unit (Long Term)	125	26	512.617	759.688	1301.3	0	1301.3	1778.02	1778.02
6	0.761884	407.534	-41.3748	Black Creek Confining Unit (Long Term)	125	26	540.795	801.447	1386.92	0	1386.92	1863.27	1863.27
7	0.761884	465.156	-39.8634	Black Creek Confining Unit (Long Term)	125	26	568.564	842.601	1471.3	0	1471.3	1946.08	1946.08
8	0.761884	519.771	-38.3846	Black Creek Confining Unit (Long Term)	125	26	595.966	883.209	1554.56	0	1554.56	2026.66	2026.66
9	0.761884	571.509	-36.9355	Black Creek Confining Unit (Long Term)	125	26	368.195	545.657	862.475	0	862.475	1139.28	1139.28
10	0.761884	620.513	-35.5135	Black Creek Confining Unit (Long Term)	125	26	270.711	401.188	566.27	0	566.27	759.463	759.463
11	0.761884	666.808	-34.1163	Black Creek Confining Unit (Long Term)	125	26	289.717	429.355	624.02	0	624.02	820.293	820.293
12	0.761884	710.503	-32.7417	Black Creek Confining Unit (Long Term)	125	26	308.394	457.034	680.769	0	680.769	879.072	879.072
13	0.761884	751.852	-31.3881	Black Creek Confining Unit (Long Term)	125	26	326.783	484.286	736.645	0	736.645	936.021	936.021
14	0.761884	790.958	-30.0538	Black Creek Confining Unit (Long Term)	125	26	344.883	511.109	791.641	0	791.641	991.191	991.191

15	0.761884	827.904	-28.7372	Black Creek Confining Unit (Long Term)	125	26	362.688	537.496	845.743	0	845.743	1044.61	1044.61
16	0.761884	862.741	-27.437	Black Creek Confining Unit (Long Term)	125	26	380.187	563.429	898.912	0	898.912	1096.29	1096.29
17	0.761884	895.576	-26.1519	Black Creek Confining Unit (Long Term)	125	26	397.387	588.92	951.178	0	951.178	1146.3	1146.3
18	0.761884	926.482	-24.8809	Black Creek Confining Unit (Long Term)	125	26	414.291	613.971	1002.54	0	1002.54	1194.68	1194.68
19	0.761884	955.52	-23.6228	Black Creek Confining Unit (Long Term)	125	26	430.894	638.577	1052.99	0	1052.99	1241.45	1241.45
20	0.761884	982.746	-22.3767	Black Creek Confining Unit (Long Term)	125	26	447.197	662.737	1102.52	0	1102.52	1286.63	1286.63
21	0.761884	1005.83	-21.1416	Black Creek Confining Unit (Long Term)	125	26	462.302	685.123	1148.42	0	1148.42	1327.2	1327.2
22	0.761884	1011.44	-19.9168	Black Creek Confining Unit (Long Term)	125	26	471.068	698.113	1175.06	0	1175.06	1345.74	1345.74
23	0.761884	1012.49	-18.7014	Black Creek Confining Unit (Long Term)	125	26	478.191	708.669	1196.7	0	1196.7	1358.57	1358.57
24	0.761884	1011.91	-17.4946	Black Creek Confining Unit (Long Term)	125	26	484.745	718.382	1216.61	0	1216.61	1369.4	1369.4
25	0.761884	1009.7	-16.2958	Black Creek Confining Unit (Long Term)	125	26	490.716	727.232	1234.76	0	1234.76	1378.22	1378.22
26	0.761884	1005.9	-15.1044	Black Creek Confining Unit (Long Term)	125	26	496.1	735.211	1251.12	0	1251.12	1385.02	1385.02
27	0.761884	1000.56	-13.9195	Black Creek Confining Unit (Long Term)	125	26	500.89	742.309	1265.67	0	1265.67	1389.81	1389.81
28	0.761884	996.067	-12.7407	Black Creek Confining Unit (Long Term)	125	26	506.068	749.983	1281.41	0	1281.41	1395.83	1395.83
29	0.761884	1000.69	-11.5674	Black Creek Confining Unit (Long Term)	125	26	515.174	763.478	1309.08	0	1309.08	1414.52	1414.52

30	0.761884	998.813	-10.399	Black Creek Confining Unit (Long Term)	125	26	521.656	773.084	1328.76	0	1328.76	1424.5	1424.5
31	0.761884	993.467	-9.2349	Black Creek Confining Unit (Long Term)	125	26	526.726	780.597	1344.17	0	1344.17	1429.81	1429.81
32	0.761884	1043.39	-8.07466	Black Creek Confining Unit (Long Term)	125	26	556.476	824.687	1434.57	0	1434.57	1513.52	1513.52
33	0.761884	1074.97	-6.91775	Black Creek Confining Unit (Long Term)	125	26	578.786	857.749	1502.36	0	1502.36	1572.59	1572.59
34	0.761884	1082.71	-5.76367	Black Creek Confining Unit (Long Term)	125	26	590.774	875.515	1538.78	0	1538.78	1598.41	1598.41
35	0.761884	365.45	-4.61193	Black Creek Confining Unit (Long Term)	125	26	264.679	392.249	547.94	0	547.94	569.291	569.291
36	0.761884	352.93	-3.46205	Black Creek Confining Unit (Long Term)	125	26	262.248	388.646	540.555	0	540.555	556.42	556.42
37	0.761884	339.009	-2.31357	Black Creek Confining Unit (Long Term)	125	26	259.04	383.892	530.807	0	530.807	541.272	541.272
38	0.761884	323.689	-1.16603	Black Creek Confining Unit (Long Term)	125	26	255.022	377.938	518.6	0	518.6	523.791	523.791
39	0.761884	306.919	-0.0189443	Black Creek Confining Unit (Long Term)	125	26	250.134	370.693	503.745	0	503.745	503.827	503.827
40	0.761884	288.049	1.12813	Black Creek Confining Unit (Long Term)	125	26	244.005	361.611	485.124	0	485.124	480.319	480.319
41	0.761884	267.57	2.27566	Black Creek Confining Unit (Long Term)	125	26	236.83	350.977	463.322	0	463.322	453.911	453.911
42	0.761884	245.693	3.4241	Black Creek Confining Unit (Long Term)	125	26	228.668	338.882	438.524	0	438.524	424.842	424.842
43	0.761884	222.414	4.57392	Black Creek Confining Unit (Long Term)	125	26	219.47	325.25	410.574	0	410.574	393.016	393.016
44	0.761884	197.687	5.72559	Black Creek Confining Unit (Long Term)	125	26	209.156	309.965	379.235	0	379.235	358.265	358.265

45	0.761884	171.115	6.87958	Black Creek Confining Unit (Long Term)	125	26	197.449	292.616	343.664	0	343.664	319.842	319.842
46	0.761884	143.002	8.03639	Black Creek Confining Unit (Long Term)	125	26	184.444	273.343	304.148	0	304.148	278.107	278.107
47	0.761884	113.453	9.19651	Black Creek Confining Unit (Long Term)	125	26	170.127	252.125	260.645	0	260.645	233.101	233.101
48	0.761884	82.4534	10.3604	Black Creek Confining Unit (Long Term)	125	26	154.412	228.836	212.895	0	212.895	184.666	184.666
49	0.761884	50.119	11.5287	Black Creek Confining Unit (Long Term)	125	26	137.283	203.45	160.847	0	160.847	132.845	132.845
50	0.761884	16.9276	12.7019	Black Creek Confining Unit (Long Term)	125	26	120.764	178.969	110.653	0	110.653	83.434	83.434

Short Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 1.51163

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	6.45661	2211.02	-47.2758	Light Brown Sand	75	32	128.113	193.66	189.896	0	189.896	328.613	328.613
2	6.45661	6535.59	-45.5962	Light Brown Sand	75	32	311.648	471.096	633.886	0	633.886	952.089	952.089
3	6.45661	10606.9	-43.9656	Light Brown Sand	75	32	492.314	744.197	1070.94	0	1070.94	1545.79	1545.79
4	6.45661	14412.3	-42.3785	Light Brown Sand	75	32	668.451	1010.45	1497.03	0	1497.03	2106.95	2106.95
5	6.45661	17928.8	-40.8307	Light Brown Sand	75	32	838.003	1266.75	1907.19	0	1907.19	2631.32	2631.32
6	6.42892	21298	-39.3214	Dark Gray Clay	1300	0	859.999	1300	2410.45	0	2410.45	3114.89	3114.89
7	6.42892	24689.2	-37.8472	Dark Gray Clay	1300	0	859.999	1300	2921.44	0	2921.44	3589.66	3589.66
8	6.42892	27838.2	-36.402	Dark Gray Clay	1300	0	859.999	1300	3402.54	0	3402.54	4036.63	4036.63
9	7.38735	35454.4	-34.8793	Light Gray Sand	50	32	1509.31	2281.52	3571.17	0	3571.17	4623.27	4623.27
10	7.38735	38727	-33.2806	Light Gray Sand	50	32	1676.1	2533.64	3974.65	0	3974.65	5074.83	5074.83
11	6.95304	39351	-31.7561	Black Creek Confining Unit	964.553	0	638.088	964.553	4842.74	0	4842.74	5237.69	5237.69
12	6.95304	42117.4	-30.3017	Black Creek Confining Unit	1090.06	0	721.116	1090.06	5218.94	0	5218.94	5640.35	5640.35
13	6.95304	44549.4	-28.8686	Black Creek Confining Unit	1208.51	0	799.475	1208.51	5560.04	0	5560.04	6000.8	6000.8
14	6.95304	46771.3	-27.4551	Black Creek Confining Unit	1320.2	0	873.362	1320.2	5881.07	0	5881.07	6334.84	6334.84
15	6.95304	48833.7	-26.0594	Black Creek Confining Unit	1425.39	0	942.949	1425.39	6187.72	0	6187.72	6648.84	6648.84
16	6.95304	50633.8	-24.6802	Black Creek Confining Unit	1524.32	0	1008.39	1524.32	6465.56	0	6465.56	6928.95	6928.95
17	6.95304	52370.9	-23.3161	Black Creek Confining Unit	1617.19	0	1069.83	1617.19	6740.3	0	6740.3	7201.4	7201.4
18	6.95304	54019.1	-21.9659	Black Creek Confining Unit	1704.21	0	1127.4	1704.21	7007.95	0	7007.95	7462.66	7462.66
19	6.95304	55448	-20.6284	Black Creek Confining Unit	1785.54	0	1181.2	1785.54	7250.51	0	7250.51	7695.16	7695.16
20	6.95304	56640.6	-19.3025	Black Creek Confining Unit	1861.33	0	1231.34	1861.33	7464.97	0	7464.97	7896.24	7896.24

21	6.95304	57556.7	-17.9873	Black Creek Confining Unit	1931.72	0	1277.91	1931.72	7645.21	0	7645.21	8060.11	8060.11
22	6.95304	58316.9	-16.6819	Black Creek Confining Unit	1996.84	0	1320.98	1996.84	7807	0	7807	8202.86	8202.86
23	6.95304	58916.5	-15.3853	Black Creek Confining Unit	2000	0	1323.08	2000	7952.62	0	7952.62	8316.69	8316.69
24	6.95304	59382.3	-14.0967	Black Creek Confining Unit	2000	0	1323.08	2000	8080.14	0	8080.14	8412.39	8412.39
25	6.95304	59725.5	-12.8154	Black Creek Confining Unit	2000	0	1323.08	2000	8190.73	0	8190.73	8491.7	8491.7
26	6.95304	59872.1	-11.5406	Black Creek Confining Unit	2000	0	1323.08	2000	8274.02	0	8274.02	8544.18	8544.18
27	6.95304	59913.4	-10.2715	Black Creek Confining Unit	2000	0	1323.08	2000	8342.46	0	8342.46	8582.23	8582.23
28	6.95304	59893.9	-9.00752	Black Creek Confining Unit	2000	0	1323.08	2000	8402.24	0	8402.24	8611.97	8611.97
29	6.95304	60216.1	-7.74794	Black Creek Confining Unit	2000	0	1323.08	2000	8509.79	0	8509.79	8689.8	8689.8
30	6.95304	48837.5	-6.49212	Black Creek Confining Unit	2000	0	1323.08	2000	6968.78	0	6968.78	7119.34	7119.34
31	6.95304	49225.3	-5.23942	Black Creek Confining Unit	2000	0	1323.08	2000	7079.82	0	7079.82	7201.15	7201.15
32	6.95304	49485.3	-3.98924	Black Creek Confining Unit	2000	0	1323.08	2000	7173.26	0	7173.26	7265.53	7265.53
33	6.95304	49618.1	-2.74095	Black Creek Confining Unit	2000	0	1323.08	2000	7249.03	0	7249.03	7312.37	7312.37
34	6.95304	49410.9	-1.49396	Black Creek Confining Unit	2000	0	1323.08	2000	7276.55	0	7276.55	7311.05	7311.05
35	9.71709	65527.2	0	Black Creek Confining Unit	2000	0	1323.08	2000	6982.55	0	6982.55	6982.55	6982.55
36	7.10166	40690.6	1.50729	Black Creek Confining Unit	2000	0	1323.08	2000	6032.3	0	6032.3	5997.49	5997.49
37	7.10166	40171.2	2.78096	Black Creek Confining Unit	2000	0	1323.08	2000	6012.74	0	6012.74	5948.47	5948.47
38	7.10166	39517.3	4.056	Black Creek Confining Unit	2000	0	1323.08	2000	5973.99	0	5973.99	5880.17	5880.17
39	7.10166	38775.8	5.33307	Black Creek Confining Unit	2000	0	1323.08	2000	6140.51	0	6140.51	6017	6017

40	7.10166	37957.1	6.61279	Black Creek Confining Unit	2000	0	1323.08	2000	6115.64	0	6115.64	5962.26	5962.26
41	7.10166	36996.4	7.89584	Black Creek Confining Unit	2000	0	1323.08	2000	6033.53	0	6033.53	5850.03	5850.03
42	7.10166	35263.9	9.18289	Black Creek Confining Unit	1949.16	0	1289.44	1949.16	5614.08	0	5614.08	5405.63	5405.63
43	7.10166	30772.4	10.4746	Black Creek Confining Unit	1805.8	0	1194.6	1805.8	4934.51	0	4934.51	4713.65	4713.65
44	7.10166	24353	11.7718	Black Creek Confining Unit	1757.42	0	1162.6	1757.42	4033.12	0	4033.12	3790.84	3790.84
45	7.10166	21393.5	13.0751	Black Creek Confining Unit	1653.51	0	1093.86	1653.51	3615.48	0	3615.48	3361.43	3361.43
46	7.10166	18094.9	14.3853	Black Creek Confining Unit	1536.57	0	1016.5	1536.57	3137.27	0	3137.27	2876.56	2876.56
47	7.10166	13819.5	15.7033	Black Creek Confining Unit	1387.29	0	917.744	1387.29	2496.03	0	2496.03	2238	2238
48	7.10166	9513.1	17.0299	Black Creek Confining Unit	1236.92	0	818.269	1236.92	1839.21	0	1839.21	1588.57	1588.57
49	7.10166	5648.35	18.3659	Black Creek Confining Unit	1099.17	0	727.142	1099.17	1241.99	0	1241.99	1000.58	1000.58
50	7.10166	1956.95	19.7124	Black Creek Confining Unit	971.933	0	642.97	971.933	666.57	0	666.57	436.196	436.196

Short Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.98282

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	4.60819	1450.8	-53.472	Light Brown Sand	75	32	91.8006	182.024	171.275	0	171.275	295.21	295.21
2	4.60819	4219.49	-50.9611	Light Brown Sand	75	32	219.405	435.04	576.184	0	576.184	846.75	846.75
3	4.60819	6741.25	-48.5796	Light Brown Sand	75	32	342.958	680.023	968.239	0	968.239	1356.97	1356.97
4	4.60819	9032.64	-46.3059	Light Brown Sand	75	32	461.467	915.006	1344.29	0	1344.29	1827.29	1827.29
5	4.60819	11103.9	-44.1231	Light Brown Sand	75	32	574.051	1138.24	1701.54	0	1701.54	2258.29	2258.29
6	4.60819	13003.4	-42.0185	Light Brown Sand	75	32	682.019	1352.32	2044.15	0	2044.15	2658.64	2658.64
7	5.01223	16223.1	-39.8949	Dark Gray Clay	1300	0	655.632	1300	2489.55	0	2489.55	3037.64	3037.64
8	5.01223	18305	-37.7485	Dark Gray Clay	1300	0	655.632	1300	2920.22	0	2920.22	3427.84	3427.84
9	5.01223	20195.2	-35.6629	Dark Gray Clay	1300	0	655.632	1300	3317.57	0	3317.57	3788.04	3788.04
10	5.01223	21887.2	-33.6305	Dark Gray Clay	1300	0	655.632	1300	3679.94	0	3679.94	4116.04	4116.04
11	4.47102	20780.4	-31.75	Light Gray Sand	50	32	1205.43	2390.16	3745.03	0	3745.03	4490.98	4490.98
12	4.47102	21802.8	-30.0124	Light Gray Sand	50	32	1283	2543.95	3991.14	0	3991.14	4732.25	4732.25
13	4.47102	22715	-28.3047	Light Gray Sand	50	32	1355.44	2687.6	4221.04	0	4221.04	4951.02	4951.02
14	4.47102	23591.6	-26.624	Light Gray Sand	50	32	1426.96	2829.4	4447.98	0	4447.98	5163.29	5163.29
15	4.53051	24754.3	-24.9569	Black Creek Confining Unit	931.624	0	469.848	931.624	4985.71	0	4985.71	5204.38	5204.38
16	4.53051	25551.3	-23.3012	Black Creek Confining Unit	992.52	0	500.56	992.52	5181.29	0	5181.29	5396.88	5396.88
17	4.53051	26185.8	-21.6658	Black Creek Confining Unit	1048.79	0	528.939	1048.79	5345.8	0	5345.8	5555.92	5555.92
18	4.53051	26740.5	-20.0488	Black Creek Confining Unit	1100.58	0	555.058	1100.58	5495.93	0	5495.93	5698.49	5698.49
19	4.53051	27236.9	-18.4483	Black Creek Confining Unit	1148.05	0	578.999	1148.05	5635.8	0	5635.8	5828.95	5828.95
20	4.53051	27662.1	-16.8626	Black Creek Confining Unit	1191.32	0	600.821	1191.32	5762.43	0	5762.43	5944.54	5944.54
21	4.53051	27962.3	-15.2901	Black Creek Confining Unit	1230.5	0	620.581	1230.5	5864.06	0	5864.06	6033.71	6033.71
22	4.53051	28205.1	-13.7294	Black Creek Confining Unit	1265.68	0	638.323	1265.68	5954.67	0	5954.67	6110.62	6110.62

23	4.53051	28411.5	-12.1789	Black Creek Confining Unit	1296.95	0	654.094	1296.95	6038.5	0	6038.5	6179.67	6179.67
24	4.53051	28579.5	-10.6375	Black Creek Confining Unit	1324.38	0	667.927	1324.38	6115	0	6115	6240.45	6240.45
25	4.53051	28681.6	-9.10379	Black Creek Confining Unit	1348.04	0	679.86	1348.04	6178.02	0	6178.02	6286.97	6286.97
26	4.53051	28695.1	-7.57667	Black Creek Confining Unit	1367.96	0	689.906	1367.96	6222.43	0	6222.43	6314.2	6314.2
27	4.53051	28602.6	-6.05495	Black Creek Confining Unit	1384.21	0	698.102	1384.21	6244.17	0	6244.17	6318.22	6318.22
28	4.53051	28443.9	-4.5375	Black Creek Confining Unit	1396.81	0	704.456	1396.81	6251.57	0	6251.57	6307.48	6307.48
29	4.53051	28158.2	-3.02324	Black Creek Confining Unit	1405.8	0	708.99	1405.8	6231.14	0	6231.14	6268.58	6268.58
30	4.53051	27812.4	-1.51109	Black Creek Confining Unit	1411.18	0	711.704	1411.18	6197.18	0	6197.18	6215.96	6215.96
31	4.53051	27394.4	0	Black Creek Confining Unit	1412.97	0	712.606	1412.97	6146.85	0	6146.85	6146.85	6146.85
32	4.53051	26905.7	1.51109	Black Creek Confining Unit	1411.18	0	711.704	1411.18	6080.22	0	6080.22	6061.44	6061.44
33	4.53051	26358.1	3.02324	Black Creek Confining Unit	1405.8	0	708.99	1405.8	5999.65	0	5999.65	5962.21	5962.21
34	4.53051	25743.6	4.5375	Black Creek Confining Unit	1396.81	0	704.456	1396.81	5903.17	0	5903.17	5847.27	5847.27
35	4.53051	25084.1	6.05495	Black Creek Confining Unit	1384.21	0	698.102	1384.21	5795.43	0	5795.43	5721.38	5721.38
36	4.53051	24324.7	7.57667	Black Creek Confining Unit	1367.96	0	689.906	1367.96	5663.86	0	5663.86	5572.09	5572.09
37	4.53051	23492.6	9.10379	Black Creek Confining Unit	1348.04	0	679.86	1348.04	5514.29	0	5514.29	5405.35	5405.35
38	4.53051	22603.5	10.6375	Black Creek Confining Unit	1324.38	0	667.927	1324.38	5349.88	0	5349.88	5224.42	5224.42
39	4.53051	21657	12.1789	Black Creek Confining Unit	1296.95	0	654.094	1296.95	5170.31	0	5170.31	5029.14	5029.14
40	4.53051	20679.6	13.7294	Black Creek Confining Unit	1265.68	0	638.323	1265.68	4981.34	0	4981.34	4825.38	4825.38
41	4.53051	19549.2	15.2901	Black Creek Confining Unit	1230.5	0	620.581	1230.5	4754.61	0	4754.61	4584.95	4584.95

42	4.53051	18699.4	16.8626	Black Creek Confining Unit	1191.32	0	600.821	1191.32	4589.48	0	4589.48	4407.37	4407.37
43	4.53051	10259	18.4483	Black Creek Confining Unit	1148.05	0	578.999	1148.05	2663.85	0	2663.85	2470.7	2470.7
44	4.53051	9310.34	20.0488	Black Creek Confining Unit	1100.58	0	555.058	1100.58	2461.8	0	2461.8	2259.24	2259.24
45	4.53051	8283.24	21.6658	Black Creek Confining Unit	1048.79	0	528.939	1048.79	2237.6	0	2237.6	2027.47	2027.47
46	4.53051	7175.15	23.3012	Black Creek Confining Unit	992.52	0	500.56	992.52	1989.95	0	1989.95	1774.36	1774.36
47	4.53051	5983.16	24.9569	Black Creek Confining Unit	931.624	0	469.848	931.624	1717.44	0	1717.44	1498.77	1498.77
48	4.89763	5055.1	26.7043	Light Gray Sand	50	32	479.207	950.181	1440.59	0	1440.59	1199.53	1199.53
49	4.89763	3459.05	28.5481	Light Gray Sand	50	32	346.661	687.366	1020	0	1020	831.401	831.401
50	4.89763	1254.35	30.4248	Light Gray Sand	50	32	150.912	299.232	398.854	0	398.854	310.227	310.227

Short Term Stability - Middle Wall

Global Minimum Query (spencer) - Safety Factor: 2.65119

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.34673	59.3257	-83.3606	Light Gray Sand	50	32	15.9419	42.2649	-12.3787	0	-12.3787	124.577	124.577
2	0.34673	142.227	-73.9497	Light Gray Sand	50	32	48.6142	128.886	126.243	0	126.243	295.221	295.221
3	0.34673	183.78	-69.0369	Light Gray Sand	50	32	65.6811	174.133	198.653	0	198.653	370.088	370.088
4	0.34673	216.182	-65.0775	Light Gray Sand	50	32	81.202	215.282	264.506	0	264.506	439.261	439.261
5	0.34673	243.35	-61.6466	Light Gray Sand	50	32	95.7649	253.891	326.294	0	326.294	503.752	503.752
6	0.34673	266.951	-58.5647	Light Gray Sand	50	32	109.574	290.501	384.883	0	384.883	564.145	564.145
7	0.34673	287.89	-55.7354	Light Gray Sand	50	32	122.748	325.427	440.775	0	440.775	620.956	620.956
8	0.34673	306.725	-53.0991	Light Gray Sand	50	32	135.371	358.893	494.332	0	494.332	674.622	674.622
9	0.34673	323.834	-50.6161	Light Gray Sand	50	32	147.507	391.069	545.825	0	545.825	725.506	725.506
10	0.34673	337.879	-48.2583	Light Gray Sand	50	32	158.536	420.309	592.617	0	592.617	770.294	770.294
11	0.34673	349.185	-46.005	Light Gray Sand	50	32	168.485	446.687	634.832	0	634.832	809.334	809.334
12	0.34673	359.382	-43.8402	Light Gray Sand	50	32	177.995	471.898	675.176	0	675.176	846.107	846.107
13	0.34673	368.589	-41.7515	Light Gray Sand	50	32	187.099	496.034	713.804	0	713.804	880.805	880.805
14	0.34673	376.903	-39.7288	Light Gray Sand	50	32	195.827	519.174	750.835	0	750.835	913.58	913.58
15	0.352469	391.061	-37.7481	Black Creek Confining Unit	904.091	0	341.013	904.091	747.475	0	747.475	1011.5	1011.5
16	0.352469	398.488	-35.8033	Black Creek Confining Unit	911.998	0	343.996	911.998	789.584	0	789.584	1037.71	1037.71
17	0.352469	405.153	-33.905	Black Creek Confining Unit	919.365	0	346.774	919.365	829.687	0	829.687	1062.75	1062.75
18	0.352469	411.108	-32.0482	Black Creek Confining Unit	926.228	0	349.363	926.228	867.931	0	867.931	1086.65	1086.65
19	0.352469	416.397	-30.2283	Black Creek Confining Unit	932.618	0	351.773	932.618	904.435	0	904.435	1109.41	1109.41
20	0.352469	421.055	-28.4416	Black Creek Confining Unit	938.563	0	354.016	938.563	939.302	0	939.302	1131.05	1131.05
21	0.352469	424.555	-26.6846	Black Creek Confining Unit	944.084	0	356.098	944.084	971.296	0	971.296	1150.28	1150.28
22	0.352469	427.012	-24.9543	Black Creek Confining Unit	949.201	0	358.028	949.201	1000.66	0	1000.66	1167.26	1167.26
23	0.352469	428.925	-23.248	Black Creek Confining Unit	953.933	0	359.813	953.933	1028.56	0	1028.56	1183.14	1183.14

24	0.352469	430.315	-21.5633	Black Creek Confining Unit	958.293	0	361.458	958.293	1055.08	0	1055.08	1197.92	1197.92
25	0.352469	431.201	-19.898	Black Creek Confining Unit	962.296	0	362.968	962.296	1080.25	0	1080.25	1211.63	1211.63
26	0.352469	431.599	-18.25	Black Creek Confining Unit	965.954	0	364.347	965.954	1104.14	0	1104.14	1224.28	1224.28
27	0.352469	431.523	-16.6176	Black Creek Confining Unit	969.275	0	365.6	969.275	1126.78	0	1126.78	1235.89	1235.89
28	0.352469	430.987	-14.9989	Black Creek Confining Unit	972.269	0	366.729	972.269	1148.22	0	1148.22	1246.47	1246.47
29	0.352469	430.495	-13.3923	Black Creek Confining Unit	900.086	0	339.503	900.086	1165.5	0	1165.5	1246.33	1246.33
30	0.352469	432.392	-11.7965	Black Creek Confining Unit	902.449	0	340.394	902.449	1192.53	0	1192.53	1263.62	1263.62
31	0.352469	434.392	-10.2099	Black Creek Confining Unit	904.505	0	341.169	904.505	1220.06	0	1220.06	1281.51	1281.51
32	0.352469	437.543	-8.63114	Black Creek Confining Unit	906.26	0	341.831	906.26	1250.94	0	1250.94	1302.83	1302.83
33	0.352469	440.859	-7.05899	Black Creek Confining Unit	907.717	0	342.381	907.717	1282.66	0	1282.66	1325.05	1325.05
34	0.352469	443.761	-5.49217	Black Creek Confining Unit	908.88	0	342.82	908.88	1313.68	0	1313.68	1346.64	1346.64
35	0.352469	446.252	-3.92945	Black Creek Confining Unit	909.752	0	343.149	909.752	1344.05	0	1344.05	1367.62	1367.62
36	0.352469	448.335	-2.36967	Black Creek Confining Unit	910.333	0	343.368	910.333	1373.78	0	1373.78	1387.99	1387.99
37	0.352469	456.743	-0.811635	Black Creek Confining Unit	910.627	0	343.479	910.627	1421.89	0	1421.89	1426.75	1426.75
38	0.352469	496.115	0.745796	Black Creek Confining Unit	910.633	0	343.481	910.633	1559.31	0	1559.31	1554.84	1554.84
39	0.352469	495.718	2.30378	Black Creek Confining Unit	910.352	0	343.375	910.352	1585.08	0	1585.08	1571.27	1571.27
40	0.352469	494.915	3.86347	Black Creek Confining Unit	909.782	0	343.16	909.782	1610.28	0	1610.28	1587.11	1587.11
41	0.352469	493.703	5.42603	Black Creek Confining Unit	908.923	0	342.836	908.923	1634.95	0	1634.95	1602.38	1602.38
42	0.352469	492.081	6.99266	Black Creek Confining Unit	907.772	0	342.402	907.772	1659.11	0	1659.11	1617.11	1617.11

43	0.352469	349.097	8.56456	Black Creek Confining Unit	906.327	0	341.857	906.327	1257	0	1257	1205.52	1205.52
44	0.352469	53.0363	10.143	Black Creek Confining Unit	937.615	0	353.658	937.615	384.956	0	384.956	321.686	321.686
45	0.352469	45.2183	11.7292	Black Creek Confining Unit	932.07	0	351.567	932.07	375.338	0	375.338	302.344	302.344
46	0.352469	36.9684	13.3247	Black Creek Confining Unit	926.218	0	349.359	926.218	364.177	0	364.177	281.433	281.433
47	0.352469	28.2785	14.9307	Black Creek Confining Unit	920.055	0	347.035	920.055	351.41	0	351.41	258.872	258.872
48	0.352469	19.1391	16.5489	Black Creek Confining Unit	913.572	0	344.589	913.572	336.96	0	336.96	234.568	234.568
49	0.352469	9.79658	18.1807	Black Creek Confining Unit	906.763	0	342.021	906.763	321.581	0	321.581	209.257	209.257
50	0.352469	3.04785	19.828	Black Creek Confining Unit	902.159	0	340.285	902.159	315.457	0	315.457	192.759	192.759

Short Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 2.65423

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.68237	327.392	-62.9607	Black Creek Confining Unit	941.056	0	354.55	941.056	-121.692	0	-121.692	572.972	572.972
2	1.68237	939.856	-59.6284	Black Creek Confining Unit	1014.72	0	382.303	1014.72	178.73	0	178.73	831.09	831.09
3	1.68237	1477.72	-56.6017	Black Creek Confining Unit	1074.69	0	404.897	1074.69	455.835	0	455.835	1069.93	1069.93
4	1.68237	1957.09	-53.8021	Black Creek Confining Unit	1129.09	0	425.393	1129.09	716.138	0	716.138	1297.41	1297.41
5	1.68237	2389.22	-51.1791	Black Creek Confining Unit	1179.21	0	444.276	1179.21	960.573	0	960.573	1512.73	1512.73
6	1.68237	2782.91	-48.6983	Black Creek Confining Unit	1222.36	0	460.533	1222.36	1191.91	0	1191.91	1716.1	1716.1
7	1.68237	3143.73	-46.3346	Black Creek Confining Unit	1259.91	0	474.68	1259.91	1410.95	0	1410.95	1908.28	1908.28
8	1.68237	3476.04	-44.0693	Black Creek Confining Unit	1291.36	0	486.529	1291.36	1618.95	0	1618.95	2089.92	2089.92
9	1.68237	3782.3	-41.8878	Black Creek Confining Unit	1320.7	0	497.583	1320.7	1815.48	0	1815.48	2261.75	2261.75
10	1.68237	4064.81	-39.7786	Black Creek Confining Unit	1349.34	0	508.373	1349.34	2001.02	0	2001.02	2424.26	2424.26
11	1.68237	4326.31	-37.7323	Black Creek Confining Unit	1375.23	0	518.128	1375.23	2177.08	0	2177.08	2578	2578
12	1.68237	4568.48	-35.7411	Black Creek Confining Unit	1398.83	0	527.019	1398.83	2344.17	0	2344.17	2723.45	2723.45
13	1.68237	4791.72	-33.7987	Black Creek Confining Unit	1419.75	0	534.901	1419.75	2468.44	0	2468.44	2826.51	2826.51
14	1.68237	4933.87	-31.8994	Black Creek Confining Unit	1438.16	0	541.837	1438.16	2397.16	0	2397.16	2734.42	2734.42
15	1.68237	5023.87	-30.0386	Black Creek Confining Unit	1454.31	0	547.922	1454.31	2484.02	0	2484.02	2800.85	2800.85
16	1.68237	5099.23	-28.2122	Black Creek Confining Unit	1468.6	0	553.305	1468.6	2562.8	0	2562.8	2859.63	2859.63
17	1.68237	5194.06	-26.4165	Black Creek Confining Unit	1405.88	0	529.675	1405.88	2659.18	0	2659.18	2922.3	2922.3

18	1.68237	5326.2	-24.6483	Black Creek Confining Unit	1429.99	0	538.759	1429.99	2766.3	0	2766.3	3013.51	3013.51
19	1.68237	5494.17	-22.9049	Black Creek Confining Unit	1452.23	0	547.138	1452.23	2893.66	0	2893.66	3124.83	3124.83
20	1.68237	4087.43	-21.1837	Black Creek Confining Unit	1507.39	0	567.92	1507.39	2153.84	0	2153.84	2373.93	2373.93
21	1.68237	4128.3	-19.4823	Black Creek Confining Unit	1513.46	0	570.207	1513.46	2208.12	0	2208.12	2409.84	2409.84
22	1.68237	4155.79	-17.7986	Black Creek Confining Unit	1517.55	0	571.748	1517.55	2254.86	0	2254.86	2438.42	2438.42
23	1.68237	4169.67	-16.1307	Black Creek Confining Unit	1519.61	0	572.524	1519.61	2293.83	0	2293.83	2459.41	2459.41
24	1.68237	4172.19	-14.4767	Black Creek Confining Unit	1520	0	572.671	1520	2326.16	0	2326.16	2474.01	2474.01
25	1.68237	4162.25	-12.8349	Black Creek Confining Unit	1518.51	0	572.109	1518.51	2351.14	0	2351.14	2481.48	2481.48
26	1.68237	4142.5	-11.2038	Black Creek Confining Unit	1515.5	0	570.975	1515.5	2370.19	0	2370.19	2483.28	2483.28
27	1.68237	4115.79	-9.58186	Black Creek Confining Unit	1511.6	0	569.506	1511.6	2384.88	0	2384.88	2481.02	2481.02
28	1.68237	4079.27	-7.96764	Black Creek Confining Unit	1506.24	0	567.487	1506.24	2393.52	0	2393.52	2472.95	2472.95
29	1.68237	4021.92	-6.35977	Black Creek Confining Unit	1497.65	0	564.25	1497.65	2389.59	0	2389.59	2452.48	2452.48
30	1.68237	3949.81	-4.75691	Black Creek Confining Unit	1486.98	0	560.23	1486.98	2376.44	0	2376.44	2423.06	2423.06
31	1.68237	3864.03	-3.15778	Black Creek Confining Unit	1474.19	0	555.412	1474.19	2354.55	0	2354.55	2385.19	2385.19
32	1.68237	3768.42	-1.56111	Black Creek Confining Unit	1459.82	0	549.998	1459.82	2326.09	0	2326.09	2341.08	2341.08
33	1.68237	3670.24	0.0343448	Black Creek Confining Unit	1445.39	0	544.561	1445.39	2295.39	0	2295.39	2295.07	2295.07
34	1.68237	3551.34	1.62983	Black Creek Confining Unit	1429.58	0	538.604	1429.58	2251.53	0	2251.53	2236.21	2236.21
35	1.68237	3345.78	3.22658	Black Creek Confining Unit	1397.15	0	526.386	1397.15	2153.08	0	2153.08	2123.41	2123.41
36	1.68237	3116.51	4.82584	Black Creek Confining Unit	1363.4	0	513.671	1363.4	2038.41	0	2038.41	1995.04	1995.04

37	1.68237	2869.24	6.42888	Black Creek Confining Unit	1326.1	0	499.618	1326.1	1910.42	0	1910.42	1854.13	1854.13
38	1.68237	2646.74	8.037	Black Creek Confining Unit	1291.6	0	486.619	1291.6	1795.84	0	1795.84	1727.13	1727.13
39	1.68237	2509.25	9.65153	Black Creek Confining Unit	1272.87	0	479.563	1272.87	1734.1	0	1734.1	1652.54	1652.54
40	1.68237	2373.33	11.2738	Black Creek Confining Unit	1252.67	0	471.952	1252.67	1672.25	0	1672.25	1578.17	1578.17
41	1.68237	2209.96	12.9054	Black Creek Confining Unit	1228.53	0	462.857	1228.53	1591.74	0	1591.74	1485.68	1485.68
42	1.68237	2002.42	14.5476	Black Creek Confining Unit	1197.51	0	451.17	1197.51	1481.04	0	1481.04	1363.96	1363.96
43	1.68237	1793.61	16.2022	Black Creek Confining Unit	1166.53	0	439.498	1166.53	1367.83	0	1367.83	1240.13	1240.13
44	1.68237	1578.1	17.8708	Black Creek Confining Unit	1134.62	0	427.476	1134.62	1248.39	0	1248.39	1110.56	1110.56
45	1.68237	1344.1	19.5552	Black Creek Confining Unit	1099.73	0	414.331	1099.73	1114.5	0	1114.5	967.331	967.331
46	1.68237	1110.84	21.2574	Black Creek Confining Unit	1064.73	0	401.145	1064.73	978.824	0	978.824	822.768	822.768
47	1.68237	904.524	22.9795	Black Creek Confining Unit	1034.41	0	389.721	1034.41	859.594	0	859.594	694.331	694.331
48	1.68237	688.322	24.724	Black Creek Confining Unit	1002.28	0	377.616	1002.28	731.365	0	731.365	557.49	557.49
49	1.68237	447.482	26.4932	Black Creek Confining Unit	966.989	0	364.32	966.989	583.565	0	583.565	401.976	401.976
50	1.68237	152.587	28.3379	Black Creek Confining Unit	922.672	0	347.623	922.672	402.89	0	402.89	215.418	215.418

◆ Long Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 1.94144

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.58993	433.074	-38.9479	Light Brown Sand	75	32	61.7233	119.832	71.7464	0	71.7464	121.636	121.636
2	3.58993	1270.73	-38.0163	Light Brown Sand	75	32	116.254	225.701	241.172	0	241.172	332.053	332.053
3	3.58993	2083.77	-37.0964	Light Brown Sand	75	32	170.41	330.841	409.433	0	409.433	538.296	538.296
4	3.72007	3037.16	-36.1712	Dark Gray Clay (Drained)	200	25	243.127	472.017	583.341	0	583.341	761.096	761.096
5	3.72007	3917.93	-35.2406	Dark Gray Clay (Drained)	200	25	288.418	559.947	771.908	0	771.908	975.671	975.671
6	3.72007	4753.39	-34.3205	Dark Gray Clay (Drained)	200	25	332.278	645.097	954.513	0	954.513	1181.35	1181.35
7	3.72007	5553.63	-33.4104	Dark Gray Clay (Drained)	200	25	375.136	728.304	1132.95	0	1132.95	1380.41	1380.41
8	3.72007	6322.27	-32.5098	Dark Gray Clay (Drained)	200	25	417.117	809.808	1307.74	0	1307.74	1573.57	1573.57
9	3.72007	7060.94	-31.6181	Dark Gray Clay (Drained)	200	25	458.253	889.67	1479	0	1479	1761.12	1761.12
10	4.49321	9466.9	-30.644	Light Gray Sand	50	32	556.561	1080.53	1649.19	0	1649.19	1978.92	1978.92
11	4.49321	10329.8	-29.5888	Light Gray Sand	50	32	612.35	1188.84	1822.52	0	1822.52	2170.23	2170.23
12	4.49321	11778.6	-28.5445	Light Gray Sand	50	32	703.04	1364.91	2104.3	0	2104.3	2486.73	2486.73
13	4.49321	5115.68	-27.5105	Light Gray Sand	50	32	322.613	626.333	922.326	0	922.326	1090.34	1090.34
14	3.98444	5475.6	-26.5436	Black Creek Confining Unit (Long Term)	125	26	349.18	677.912	1133.64	0	1133.64	1308.06	1308.06
15	3.98444	6340.27	-25.6424	Black Creek Confining Unit (Long Term)	125	26	397.832	772.366	1327.3	0	1327.3	1518.27	1518.27
16	3.98444	7168.2	-24.7479	Black Creek Confining Unit (Long Term)	125	26	445.328	864.577	1516.36	0	1516.36	1721.64	1721.64
17	3.98444	7960.2	-23.8598	Black Creek Confining Unit (Long Term)	125	26	491.658	954.525	1700.78	0	1700.78	1918.24	1918.24
18	3.98444	8717	-22.9778	Black Creek Confining Unit (Long Term)	125	26	536.812	1042.19	1880.52	0	1880.52	2108.13	2108.13
19	3.98444	9439.31	-22.1014	Black Creek Confining Unit (Long Term)	125	26	580.78	1127.55	2055.53	0	2055.53	2291.38	2291.38

20	3.98444	10090.9	-21.2305	Black Creek Confining Unit (Long Term)	125	26	621.508	1206.62	2217.66	0	2217.66	2459.1	2459.1
21	3.98444	10391.9	-20.3647	Black Creek Confining Unit (Long Term)	125	26	643.291	1248.91	2304.36	0	2304.36	2543.15	2543.15
22	3.98444	10651.9	-19.5038	Black Creek Confining Unit (Long Term)	125	26	663.049	1287.27	2383	0	2383	2617.84	2617.84
23	3.98444	9574.37	-18.6474	Black Creek Confining Unit (Long Term)	125	26	607.163	1178.77	2160.55	0	2160.55	2365.44	2365.44
24	3.98444	7247.51	-17.7953	Black Creek Confining Unit (Long Term)	125	26	478.79	929.542	1649.55	0	1649.55	1803.23	1803.23
25	3.98444	7749.91	-16.9472	Black Creek Confining Unit (Long Term)	125	26	511.439	992.929	1779.52	0	1779.52	1935.37	1935.37
26	3.98444	8223.13	-16.103	Black Creek Confining Unit (Long Term)	125	26	542.88	1053.97	1904.67	0	1904.67	2061.39	2061.39
27	3.98444	8666	-15.2623	Black Creek Confining Unit (Long Term)	125	26	573.006	1112.46	2024.58	0	2024.58	2180.94	2180.94
28	3.98444	9078.89	-14.425	Black Creek Confining Unit (Long Term)	125	26	601.801	1168.36	2139.21	0	2139.21	2294	2294
29	3.98444	9466.27	-13.5908	Black Creek Confining Unit (Long Term)	125	26	650.883	1263.65	2334.57	0	2334.57	2491.93	2491.93
30	3.98444	9850.85	-12.7596	Black Creek Confining Unit (Long Term)	125	26	717.323	1392.64	2599.03	0	2599.03	2761.47	2761.47
31	3.98444	10209.6	-11.9311	Black Creek Confining Unit (Long Term)	125	26	744.571	1445.54	2707.51	0	2707.51	2864.84	2864.84
32	3.98444	10539.1	-11.1051	Black Creek Confining Unit (Long Term)	125	26	770.423	1495.73	2810.41	0	2810.41	2961.64	2961.64
33	3.98444	10839.6	-10.2814	Black Creek Confining Unit (Long Term)	125	26	794.858	1543.17	2907.69	0	2907.69	3051.88	3051.88
34	3.98444	11107.5	-9.45988	Black Creek Confining Unit (Long Term)	125	26	817.615	1587.35	2998.26	0	2998.26	3134.5	3134.5

35	3.98444	11080.7	-8.64031	Black Creek Confining Unit (Long Term)	125	26	762.259	1479.88	2777.92	0	2777.92	2893.75	2893.75
36	3.98444	10781.2	-7.82252	Black Creek Confining Unit (Long Term)	125	26	746.884	1450.03	2716.7	0	2716.7	2819.31	2819.31
37	3.98444	9643.73	-7.00633	Black Creek Confining Unit (Long Term)	125	26	680.346	1320.85	2451.85	0	2451.85	2535.46	2535.46
38	3.98444	7213.36	-6.19157	Black Creek Confining Unit (Long Term)	125	26	529.842	1028.66	1852.77	0	1852.77	1910.25	1910.25
39	3.98444	6903.93	-5.37806	Black Creek Confining Unit (Long Term)	125	26	513.881	997.669	1789.24	0	1789.24	1837.61	1837.61
40	3.98444	6556.32	-4.56564	Black Creek Confining Unit (Long Term)	125	26	495.153	961.31	1714.69	0	1714.69	1754.23	1754.23
41	3.98444	6176.68	-3.75414	Black Creek Confining Unit (Long Term)	125	26	473.998	920.238	1630.48	0	1630.48	1661.58	1661.58
42	3.98444	5693.58	-2.94339	Black Creek Confining Unit (Long Term)	125	26	445.63	865.164	1517.56	0	1517.56	1540.47	1540.47
43	3.98444	5170.92	-2.13323	Black Creek Confining Unit (Long Term)	125	26	414.14	804.028	1392.21	0	1392.21	1407.64	1407.64
44	3.98444	4244.15	-1.3235	Black Creek Confining Unit (Long Term)	125	26	354.914	689.045	1156.46	0	1156.46	1164.66	1164.66
45	3.98444	3240.61	-0.514029	Black Creek Confining Unit (Long Term)	125	26	289.476	562.001	895.984	0	895.984	898.581	898.581
46	3.98444	2746.97	0.295336	Black Creek Confining Unit (Long Term)	125	26	257.834	500.569	770.03	0	770.03	768.701	768.701
47	3.98444	2091.32	1.10476	Black Creek Confining Unit (Long Term)	125	26	214.465	416.371	597.398	0	597.398	593.262	593.262
48	3.98444	1401.45	1.91441	Black Creek Confining Unit (Long Term)	125	26	167.968	326.099	412.314	0	412.314	406.7	406.7
49	3.98444	870.981	2.72443	Black Creek Confining Unit (Long Term)	125	26	131.86	255.999	268.587	0	268.587	262.312	262.312

50	3.98444	268.897	3.53501	Black Creek Confining Unit (Long Term)	125	26	92.924	180.406	113.6	0	113.6	107.859	107.859

◆ Long Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.57492

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.275487	35.9362	-83.5231	Light Brown Sand	75	32	35.4701	55.8626	-30.6263	0	-30.6263	281.812	281.812
2	0.606804	245.953	-76.4509	Dark Gray Clay (Drained)	200	25	122.864	193.501	-13.9368	0	-13.9368	495.903	495.903
3	0.606804	391.208	-70.2837	Dark Gray Clay (Drained)	200	25	163.705	257.822	124.001	0	124.001	580.802	580.802
4	0.606804	493.685	-65.6864	Dark Gray Clay (Drained)	200	25	200.418	315.643	247.998	0	247.998	691.594	691.594
5	0.606804	576.177	-61.8115	Dark Gray Clay (Drained)	200	25	233.952	368.456	361.256	0	361.256	797.786	797.786
6	0.606804	646.161	-58.3813	Dark Gray Clay (Drained)	200	25	265.065	417.456	466.336	0	466.336	896.877	896.877
7	0.606804	706.781	-55.2597	Dark Gray Clay (Drained)	200	25	294.132	463.234	564.506	0	564.506	988.65	988.65
8	0.606804	760.171	-52.3681	Dark Gray Clay (Drained)	200	25	321.491	506.322	656.91	0	656.91	1073.89	1073.89
9	0.606804	807.713	-49.6557	Dark Gray Clay (Drained)	200	25	347.388	547.109	744.377	0	744.377	1153.36	1153.36
10	0.606804	850.364	-47.0873	Dark Gray Clay (Drained)	200	25	372.01	585.886	827.536	0	827.536	1227.69	1227.69
11	0.606804	888.82	-44.6378	Dark Gray Clay (Drained)	200	25	395.501	622.882	906.874	0	906.874	1297.41	1297.41
12	0.606804	923.606	-42.2879	Dark Gray Clay (Drained)	200	25	417.975	658.277	982.779	0	982.779	1362.94	1362.94
13	0.606804	955.13	-40.0228	Dark Gray Clay (Drained)	200	25	439.526	692.218	1055.57	0	1055.57	1424.67	1424.67
14	0.606804	983.084	-37.8307	Dark Gray Clay (Drained)	200	25	460.009	724.477	1124.74	0	1124.74	1481.96	1481.96
15	0.606804	1005.7	-35.7021	Dark Gray Clay (Drained)	200	25	478.737	753.973	1188	0	1188	1532.03	1532.03
16	0.606804	1025.55	-33.629	Dark Gray Clay (Drained)	200	25	496.569	782.056	1248.22	0	1248.22	1578.51	1578.51
17	0.606804	1043.13	-31.6047	Dark Gray Clay (Drained)	200	25	513.657	808.968	1305.94	0	1305.94	1622	1622
18	0.606804	1058.57	-29.6235	Dark Gray Clay (Drained)	200	25	530.043	834.775	1361.28	0	1361.28	1662.67	1662.67
19	0.606804	1072	-27.6807	Dark Gray Clay (Drained)	200	25	545.764	859.535	1414.38	0	1414.38	1700.68	1700.68
20	0.606804	1083.54	-25.7718	Dark Gray Clay (Drained)	200	25	560.852	883.297	1465.34	0	1465.34	1736.12	1736.12
21	0.611917	1110.69	-23.8855	Light Gray Sand	50	32	634.933	999.969	1520.26	0	1520.26	1801.44	1801.44
22	0.611917	1135.69	-22.0184	Light Gray Sand	50	32	663.801	1045.43	1593.02	0	1593.02	1861.46	1861.46
23	0.611917	1159.06	-20.1757	Light Gray Sand	50	32	692.524	1090.67	1665.42	0	1665.42	1919.89	1919.89

24	0.611917	1180.88	-18.3545	Light Gray Sand	50	32	721.135	1135.73	1737.52	0	1737.52	1976.78	1976.78
25	0.611917	1207.55	-16.5524	Light Gray Sand	50	32	753.467	1186.65	1819.02	0	1819.02	2042.96	2042.96
26	0.611917	1278.46	-14.767	Light Gray Sand	50	32	813.876	1281.79	1971.28	0	1971.28	2185.81	2185.81
27	0.611917	1289.03	-12.9961	Light Gray Sand	50	32	838.919	1321.23	2034.4	0	2034.4	2228.02	2228.02
28	0.611917	1298.22	-11.2378	Light Gray Sand	50	32	863.828	1360.46	2097.17	0	2097.17	2268.81	2268.81
29	0.611917	396.705	-9.49017	Light Gray Sand	50	32	293.47	462.192	659.645	0	659.645	708.703	708.703
30	0.611917	198.664	-7.75141	Light Gray Sand	50	32	167.341	263.548	341.748	0	341.748	364.527	364.527
31	0.611917	202.252	-6.01981	Light Gray Sand	50	32	173.412	273.11	357.051	0	357.051	375.338	375.338
32	0.611917	204.525	-4.29372	Light Gray Sand	50	32	178.815	281.62	370.669	0	370.669	384.095	384.095
33	0.611917	205.495	-2.57153	Light Gray Sand	50	32	183.515	289.022	382.516	0	382.516	390.758	390.758
34	0.611917	205.169	-0.851658	Light Gray Sand	50	32	187.475	295.258	392.495	0	392.495	395.282	395.282
35	0.611917	203.549	0.867442	Light Gray Sand	50	32	190.649	300.257	400.495	0	400.495	397.609	397.609
36	0.611917	200.637	2.58733	Light Gray Sand	50	32	192.988	303.941	406.391	0	406.391	397.67	397.67
37	0.611917	196.428	4.30955	Light Gray Sand	50	32	194.435	306.219	410.037	0	410.037	395.385	395.385
38	0.611917	190.916	6.03568	Light Gray Sand	50	32	194.922	306.986	411.264	0	411.264	390.654	390.654
39	0.611917	184.089	7.76734	Light Gray Sand	50	32	194.371	306.119	409.877	0	409.877	383.364	383.364
40	0.611917	175.934	9.50617	Light Gray Sand	50	32	192.692	303.475	405.643	0	405.643	373.376	373.376
41	0.611917	166.431	11.2539	Light Gray Sand	50	32	189.775	298.881	398.294	0	398.294	360.532	360.532
42	0.611917	155.558	13.0123	Light Gray Sand	50	32	185.493	292.137	387.5	0	387.5	344.634	344.634
43	0.611917	143.287	14.7833	Light Gray Sand	50	32	179.688	282.994	372.869	0	372.869	325.449	325.449
44	0.611917	129.586	16.5689	Light Gray Sand	50	32	172.171	271.156	353.924	0	353.924	302.699	302.699
45	0.611917	114.417	18.3712	Light Gray Sand	50	32	162.709	256.253	330.075	0	330.075	276.04	276.04
46	0.611917	97.7349	20.1925	Light Gray Sand	50	32	151.008	237.826	300.585	0	300.585	245.047	245.047
47	0.611917	79.4887	22.0354	Light Gray Sand	50	32	136.701	215.293	264.523	0	264.523	209.194	209.194
48	0.611917	59.6188	23.9027	Light Gray Sand	50	32	119.311	187.905	220.694	0	220.694	167.816	167.816
49	0.620208	37.9466	25.8104	Dark Gray Clay (Drained)	200	25	207.641	327.018	272.391	0	272.391	171.966	171.966
50	0.620208	12.9778	27.7625	Dark Gray Clay (Drained)	200	25	194.057	305.625	226.513	0	226.513	124.361	124.361

Long Term Stability - Middle Wall

Global Minimum Query (spencer) - Safety Factor: 1.62199

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.460374	78.4425	-81.2071	Light Gray Sand	50	32	27.6758	44.8899	-8.17791	0	-8.17791	170.744	170.744
2	0.460374	195.05	-72.5344	Light Gray Sand	50	32	72.5345	117.65	108.263	0	108.263	338.795	338.795
3	0.460374	261.813	-67.3331	Light Gray Sand	50	32	106.08	172.061	195.338	0	195.338	449.343	449.343
4	0.460374	310.032	-63.1157	Light Gray Sand	50	32	135.021	219.003	270.461	0	270.461	536.783	536.783
5	0.460374	348.368	-59.4491	Light Gray Sand	50	32	161.217	261.492	338.458	0	338.458	611.595	611.595
6	0.460374	380.836	-56.148	Light Gray Sand	50	32	185.705	301.211	402.02	0	402.02	678.878	678.878
7	0.460374	408.894	-53.1113	Light Gray Sand	50	32	208.821	338.706	462.026	0	462.026	740.264	740.264
8	0.460374	433.451	-50.2768	Light Gray Sand	50	32	230.784	374.33	519.035	0	519.035	796.787	796.787
9	0.460374	455.117	-47.6028	Light Gray Sand	50	32	251.745	408.328	573.445	0	573.445	849.168	849.168
10	0.460374	474.328	-45.0596	Light Gray Sand	50	32	271.817	440.884	625.545	0	625.545	897.927	897.927
11	0.440879	470.739	-42.6748	Black Creek Confining Unit (Long Term)	125	26	281.463	456.53	679.736	0	679.736	939.233	939.233
12	0.440879	484.936	-40.4283	Black Creek Confining Unit (Long Term)	125	26	295.66	479.557	726.948	0	726.948	978.826	978.826
13	0.440879	496.629	-38.2546	Black Creek Confining Unit (Long Term)	125	26	308.799	500.869	770.647	0	770.647	1014.12	1014.12
14	0.440879	506.899	-36.1443	Black Creek Confining Unit (Long Term)	125	26	321.35	521.226	812.383	0	812.383	1047.1	1047.1
15	0.440879	515.866	-34.0894	Black Creek Confining Unit (Long Term)	125	26	333.349	540.688	852.286	0	852.286	1077.89	1077.89
16	0.440879	523.625	-32.0833	Black Creek Confining Unit (Long Term)	125	26	344.825	559.302	890.451	0	890.451	1106.62	1106.62
17	0.440879	530.258	-30.1204	Black Creek Confining Unit (Long Term)	125	26	355.803	577.109	926.961	0	926.961	1133.38	1133.38
18	0.440879	535.854	-28.1958	Black Creek Confining Unit (Long Term)	125	26	366.317	594.162	961.925	0	961.925	1158.31	1158.31
19	0.440879	543.868	-26.3053	Black Creek Confining Unit (Long Term)	125	26	378.28	613.567	1001.71	0	1001.71	1188.71	1188.71

20	0.440879	553.552	-24.4452	Black Creek Confining Unit (Long Term)	125	26	391.383	634.819	1045.28	0	1045.28	1223.19	1223.19
21	0.440879	564.826	-22.6122	Black Creek Confining Unit (Long Term)	125	26	405.665	657.984	1092.78	0	1092.78	1261.74	1261.74
22	0.440879	576.089	-20.8033	Black Creek Confining Unit (Long Term)	125	26	420.257	681.652	1141.31	0	1141.31	1300.97	1300.97
23	0.440879	586.514	-19.0159	Black Creek Confining Unit (Long Term)	125	26	434.68	705.047	1189.27	0	1189.27	1339.08	1339.08
24	0.440879	596.129	-17.2476	Black Creek Confining Unit (Long Term)	125	26	448.947	728.188	1236.72	0	1236.72	1376.1	1376.1
25	0.440879	627.629	-15.496	Black Creek Confining Unit (Long Term)	125	26	477.46	774.435	1331.54	0	1331.54	1463.91	1463.91
26	0.440879	668.346	-13.7592	Black Creek Confining Unit (Long Term)	125	26	512.908	831.932	1449.43	0	1449.43	1575.02	1575.02
27	0.440879	673.688	-12.0352	Black Creek Confining Unit (Long Term)	125	26	526.22	853.523	1493.69	0	1493.69	1605.88	1605.88
28	0.440879	678.299	-10.3222	Black Creek Confining Unit (Long Term)	125	26	539.387	874.88	1537.48	0	1537.48	1635.72	1635.72
29	0.440879	682.191	-8.61847	Black Creek Confining Unit (Long Term)	125	26	552.424	896.026	1580.84	0	1580.84	1664.57	1664.57
30	0.440879	281.471	-6.9224	Black Creek Confining Unit (Long Term)	125	26	281.135	455.998	678.646	0	678.646	712.778	712.778
31	0.440879	139.787	-5.23242	Black Creek Confining Unit (Long Term)	125	26	184.369	299.045	356.845	0	356.845	373.729	373.729
32	0.440879	133.854	-3.54699	Black Creek Confining Unit (Long Term)	125	26	183.04	296.889	352.425	0	352.425	363.771	363.771
33	0.440879	127.232	-1.86463	Black Creek Confining Unit (Long Term)	125	26	181.111	293.76	346.009	0	346.009	351.905	351.905
34	0.440879	119.925	-0.183875	Black Creek Confining Unit (Long Term)	125	26	178.554	289.612	337.506	0	337.506	338.079	338.079

35	0.440879	115.02	1.49672	Black Creek Confining Unit (Long Term)	125	26	177.751	288.311	334.837	0	334.837	330.192	330.192
36	0.440879	112.938	3.1786	Black Creek Confining Unit (Long Term)	125	26	179.169	290.611	339.552	0	339.552	329.602	329.602
37	0.440879	110.171	4.86323	Black Creek Confining Unit (Long Term)	125	26	180.095	292.113	342.632	0	342.632	327.308	327.308
38	0.440879	106.712	6.55209	Black Creek Confining Unit (Long Term)	125	26	180.495	292.761	343.96	0	343.96	323.229	323.229
39	0.440879	102.555	8.2467	Black Creek Confining Unit (Long Term)	125	26	180.332	292.497	343.421	0	343.421	317.284	317.284
40	0.440879	97.6927	9.94861	Black Creek Confining Unit (Long Term)	125	26	179.566	291.254	340.873	0	340.873	309.376	309.376
41	0.440879	92.1137	11.6594	Black Creek Confining Unit (Long Term)	125	26	178.148	288.954	336.154	0	336.154	299.393	299.393
42	0.440879	85.806	13.3809	Black Creek Confining Unit (Long Term)	125	26	176.021	285.504	329.082	0	329.082	287.21	287.21
43	0.440879	78.7549	15.1147	Black Creek Confining Unit (Long Term)	125	26	173.119	280.798	319.433	0	319.433	272.674	272.674
44	0.440879	70.9429	16.8629	Black Creek Confining Unit (Long Term)	125	26	169.365	274.709	306.949	0	306.949	255.612	255.612
45	0.440879	62.3499	18.6274	Black Creek Confining Unit (Long Term)	125	26	164.665	267.085	291.318	0	291.318	235.814	235.814
46	0.440879	52.9524	20.4104	Black Creek Confining Unit (Long Term)	125	26	158.906	257.744	272.165	0	272.165	213.036	213.036
47	0.440879	42.7231	22.2144	Black Creek Confining Unit (Long Term)	125	26	151.951	246.463	249.035	0	249.035	186.98	186.98
48	0.440879	31.6308	24.0419	Black Creek Confining Unit (Long Term)	125	26	143.63	232.967	221.367	0	221.367	157.293	157.293
49	0.440879	19.6393	25.8958	Black Creek Confining Unit (Long Term)	125	26	133.735	216.917	188.457	0	188.457	123.531	123.531

50	0.440879	6.70697	27.7793	Black Creek Confining Unit (Long Term)	125	26	121.968	197.832	149.327	0	149.327	85.0762	85.0762

Long Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 1.61041

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.513958	35.7989	-65.6723	Compacted Fill (Drained)	200	28	135	217.406	32.736	0	32.736	331.344	331.344
2	0.513958	102.56	-62.4746	Compacted Fill (Drained)	200	28	161.925	260.766	114.283	0	114.283	425.002	425.002
3	0.513958	160.933	-59.5917	Compacted Fill (Drained)	200	28	187.51	301.968	191.775	0	191.775	511.272	511.272
4	0.513958	212.99	-56.9392	Compacted Fill (Drained)	200	28	212.071	341.522	266.164	0	266.164	591.967	591.967
5	0.513958	260.032	-54.4643	Compacted Fill (Drained)	200	28	235.795	379.726	338.016	0	338.016	668.153	668.153
6	0.513958	302.941	-52.1316	Compacted Fill (Drained)	200	28	258.803	416.779	407.701	0	407.701	740.527	740.527
7	0.513958	342.352	-49.9156	Compacted Fill (Drained)	200	28	281.182	452.819	475.483	0	475.483	809.582	809.582
8	0.513958	378.737	-47.7973	Compacted Fill (Drained)	200	28	302.997	487.949	541.553	0	541.553	875.681	875.681
9	0.511552	409.969	-45.767	Black Creek Confining Unit (Long Term)	125	26	269.115	433.385	632.283	0	632.283	908.702	908.702
10	0.511552	435.995	-43.8128	Black Creek Confining Unit (Long Term)	125	26	239.781	386.146	535.429	0	535.429	765.474	765.474
11	0.511552	454.65	-41.9207	Black Creek Confining Unit (Long Term)	125	26	249.074	401.112	566.114	0	566.114	789.758	789.758
12	0.511552	471.434	-40.0832	Black Creek Confining Unit (Long Term)	125	26	261.213	420.66	606.193	0	606.193	826.024	826.024
13	0.511552	486.516	-38.2941	Black Creek Confining Unit (Long Term)	125	26	272.847	439.396	644.606	0	644.606	860.043	860.043
14	0.511552	500.024	-36.5482	Black Creek Confining Unit (Long Term)	125	26	283.995	457.348	681.414	0	681.414	891.929	891.929
15	0.511552	512.058	-34.8408	Black Creek Confining Unit (Long Term)	125	26	294.668	474.537	716.656	0	716.656	921.767	921.767

16	0.511552	522.712	-33.1683	Black Creek Confining Unit (Long Term)	125	26	304.88	490.981	750.371	0	750.371	949.638	949.638
17	0.511552	532.068	-31.5271	Black Creek Confining Unit (Long Term)	125	26	314.641	506.701	782.602	0	782.602	975.619	975.619
18	0.511552	540.196	-29.9142	Black Creek Confining Unit (Long Term)	125	26	323.962	521.711	813.377	0	813.377	999.77	999.77
19	0.511552	547.156	-28.3271	Black Creek Confining Unit (Long Term)	125	26	332.848	536.021	842.718	0	842.718	1022.14	1022.14
20	0.511552	554.361	-26.7634	Black Creek Confining Unit (Long Term)	125	26	341.96	550.696	872.806	0	872.806	1045.27	1045.27
21	0.511552	565.436	-25.2209	Black Creek Confining Unit (Long Term)	125	26	353.095	568.628	909.572	0	909.572	1075.88	1075.88
22	0.511552	574.574	-23.6978	Black Creek Confining Unit (Long Term)	125	26	363.47	585.336	943.829	0	943.829	1103.36	1103.36
23	0.511552	580.128	-22.1923	Black Creek Confining Unit (Long Term)	125	26	372.21	599.41	972.683	0	972.683	1124.52	1124.52
24	0.511552	584.622	-20.7027	Black Creek Confining Unit (Long Term)	125	26	380.532	612.813	1000.16	0	1000.16	1143.98	1143.98
25	0.511552	588.188	-19.2277	Black Creek Confining Unit (Long Term)	125	26	388.491	625.629	1026.44	0	1026.44	1161.94	1161.94
26	0.511552	638.176	-17.7657	Black Creek Confining Unit (Long Term)	125	26	421.475	678.747	1135.35	0	1135.35	1270.39	1270.39
27	0.511552	654.268	-16.3157	Black Creek Confining Unit (Long Term)	125	26	436.968	703.698	1186.51	0	1186.51	1314.42	1314.42
28	0.511552	663.034	-14.8763	Black Creek Confining Unit (Long Term)	125	26	448.786	722.73	1225.53	0	1225.53	1344.74	1344.74
29	0.511552	670.959	-13.4465	Black Creek Confining Unit (Long Term)	125	26	460.399	741.431	1263.87	0	1263.87	1373.95	1373.95
30	0.511552	262.267	-12.0251	Black Creek Confining Unit (Long Term)	125	26	232.577	374.544	511.641	0	511.641	561.183	561.183

31	0.511552	193.665	-10.6113	Black Creek Confining Unit (Long Term)	125	26	195.732	315.209	389.986	0	389.986	426.656	426.656
32	0.511552	191.291	-9.20392	Black Creek Confining Unit (Long Term)	125	26	196.996	317.244	394.158	0	394.158	426.078	426.078
33	0.511552	188.126	-7.80215	Black Creek Confining Unit (Long Term)	125	26	197.788	318.519	396.772	0	396.772	423.873	423.873
34	0.511552	184.18	-6.40507	Black Creek Confining Unit (Long Term)	125	26	198.091	319.008	397.776	0	397.776	420.013	420.013
35	0.511552	179.459	-5.0118	Black Creek Confining Unit (Long Term)	125	26	197.891	318.686	397.114	0	397.114	414.468	414.468
36	0.511552	173.969	-3.6215	Black Creek Confining Unit (Long Term)	125	26	197.167	317.519	394.722	0	394.722	407.201	407.201
37	0.511552	167.531	-2.23333	Black Creek Confining Unit (Long Term)	125	26	195.777	315.282	390.135	0	390.135	397.77	397.77
38	0.511552	160.078	-0.846475	Black Creek Confining Unit (Long Term)	125	26	193.646	311.85	383.1	0	383.1	385.961	385.961
39	0.511552	151.863	0.539886	Black Creek Confining Unit (Long Term)	125	26	190.909	307.442	374.061	0	374.061	372.262	372.262
40	0.511552	142.887	1.92656	Black Creek Confining Unit (Long Term)	125	26	187.536	302.01	362.923	0	362.923	356.615	356.615
41	0.511552	133.151	3.31437	Black Creek Confining Unit (Long Term)	125	26	183.494	295.5	349.578	0	349.578	338.952	338.952
42	0.511552	122.65	4.70413	Black Creek Confining Unit (Long Term)	125	26	178.746	287.854	333.901	0	333.901	319.192	319.192
43	0.511552	111.382	6.09667	Black Creek Confining Unit (Long Term)	125	26	173.25	279.004	315.753	0	315.753	297.248	297.248
44	0.511552	99.3054	7.49283	Black Creek Confining Unit (Long Term)	125	26	166.933	268.831	294.898	0	294.898	272.942	272.942
45	0.511552	86.2513	8.89349	Black Creek Confining Unit (Long Term)	125	26	159.618	257.05	270.744	0	270.744	245.767	245.767

46	0.511552	72.3786	10.2995	Black Creek Confining Unit (Long Term)	125	26	151.364	243.758	243.49	0	243.49	215.984	215.984
47	0.511552	57.7078	11.7119	Black Creek Confining Unit (Long Term)	125	26	142.125	228.88	212.986	0	212.986	183.523	183.523
48	0.511552	42.2275	13.1315	Black Creek Confining Unit (Long Term)	125	26	131.824	212.29	178.971	0	178.971	148.218	148.218
49	0.511552	25.9241	14.5593	Black Creek Confining Unit (Long Term)	125	26	120.369	193.843	141.15	0	141.15	109.887	109.887
50	0.511552	8.78247	15.9965	Black Creek Confining Unit (Long Term)	125	26	106.841	172.058	96.482	0	96.482	65.853	65.853

Interslice Data

◆ Dynamic Stability - 3200 psf

Global Minimum Query (spencer) - Safety Factor: 1.78537

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	386.696	79.3806	0	0	0
2	388.135	77.2739	3232	1002.4	17.2312
3	389.575	75.3496	6523.07	2023.12	17.2312
4	391.014	73.5795	9840.77	3052.09	17.2311
5	392.454	71.9425	13158.1	4080.96	17.2312
6	393.893	70.4226	14608.3	4530.74	17.2312
7	395.333	69.007	14375.8	4458.64	17.2312
8	396.772	67.6854	14269.2	4425.56	17.2312
9	398.212	66.4496	14278.1	4428.34	17.2312
10	399.652	65.2925	14379.5	4459.79	17.2312
11	401.091	64.2083	14554.1	4513.93	17.2312
12	402.531	63.192	16396.3	5085.29	17.2312
13	403.97	62.2394	19187.4	5950.94	17.2312
14	405.41	61.3468	21864.3	6781.15	17.2311
15	406.849	60.5111	24419.6	7573.69	17.2312
16	408.289	59.7294	26645	8263.89	17.2312
17	409.728	58.9993	26917	8348.25	17.2312
18	411.168	58.3187	27165.1	8425.22	17.2312
19	412.607	57.6856	27379.9	8491.81	17.2312
20	414.047	57.0984	27553.3	8545.6	17.2312
21	415.487	56.5557	27678	8584.29	17.2312
22	416.926	56.056	27747.7	8605.89	17.2312
23	418.366	55.5982	27752.2	8607.28	17.2312
24	419.805	55.1814	27672.2	8582.48	17.2312
25	421.245	54.8045	27504.8	8530.56	17.2312
26	422.684	54.4668	27248.8	8451.17	17.2312
27	424.124	54.1675	26968.7	8364.3	17.2312
28	425.563	53.9062	26593.9	8248.04	17.2312
29	427.003	53.6822	26145.6	8109	17.2312
30	428.443	53.4951	25519.5	7914.83	17.2312
31	429.882	53.3446	24714	7665.01	17.2312
32	431.322	53.2303	23845.5	7395.65	17.2312
33	432.761	53.1521	22914.7	7106.96	17.2312
34	434.201	53.1099	21922.7	6799.29	17.2312
35	435.64	53.1034	20871	6473.09	17.2311
36	437.08	53.1328	19761.6	6129.04	17.2312
37	438.519	53.1981	18597.1	5767.86	17.2312
38	439.959	53.2993	17380	5390.38	17.2312
39	441.399	53.4367	16113.1	4997.45	17.2312
40	442.838	53.6106	14800	4590.21	17.2312
41	444.278	53.8213	13447.5	4170.72	17.2312
42	445.717	54.0692	12062.1	3741.03	17.2311
43	447.157	54.3547	10650.7	3303.29	17.2312
44	448.596	54.6785	9221.4	2860	17.2312
45	450.036	55.0412	7781.45	2413.4	17.2312
46	451.475	55.4436	6337.75	1965.64	17.2312
47	452.915	55.8865	4903.06	1520.67	17.2311
48	454.355	56.371	3523.25	1092.73	17.2312
49	455.794	56.8981	2220.27	688.613	17.2312
50	457.234	57.4691	1019.91	316.324	17.2312
51	458.673	58.0855	0	0	0

Static Stability - 1600 psf Drained

Global Minimum Query (spencer) - Safety Factor: 1.48198

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	401.661	78.692	0	0	0
2	402.475	77.7256	488.67	199.216	22.1792
3	403.29	76.8208	984.712	401.437	22.1792
4	404.104	75.9714	1481.5	603.964	22.1793
5	404.866	75.2224	2023.08	824.749	22.1792
6	405.628	74.5139	2555.42	1041.77	22.1793
7	406.39	73.8428	3075.08	1253.62	22.1793
8	407.152	73.2066	3578.92	1459.02	22.1793
9	407.914	72.6031	4064.11	1656.81	22.1792
10	408.676	72.0303	4278.22	1744.1	22.1792
11	409.438	71.4866	4380.32	1785.73	22.1793
12	410.199	70.9704	4482.18	1827.25	22.1792
13	410.961	70.4805	4581.26	1867.64	22.1792
14	411.723	70.0157	4675.26	1905.97	22.1793
15	412.485	69.5748	4762.07	1941.35	22.1792
16	413.247	69.1571	4839.68	1972.99	22.1792
17	414.009	68.7615	4906.24	2000.13	22.1793
18	414.771	68.3874	4959.99	2022.04	22.1793
19	415.533	68.0341	4999.3	2038.06	22.1792
20	416.295	67.7009	5022.62	2047.57	22.1792
21	417.056	67.3872	5028.49	2049.97	22.1793
22	417.818	67.0926	5015.41	2044.63	22.1792
23	418.58	66.8165	4981.7	2030.89	22.1793
24	419.342	66.5586	4926.82	2008.52	22.1793
25	420.104	66.3185	4850.49	1977.4	22.1793
26	420.866	66.0958	4752.48	1937.44	22.1792
27	421.628	65.8901	4632.63	1888.58	22.1792
28	422.39	65.7013	4490.85	1830.79	22.1793
29	423.151	65.529	4326.9	1763.95	22.1793
30	423.913	65.3731	4139.41	1687.51	22.1792
31	424.675	65.2333	3928.65	1601.59	22.1792
32	425.437	65.1094	3694.75	1506.24	22.1793
33	426.199	65.0013	3426.79	1397	22.1793
34	426.961	64.9089	3125.69	1274.25	22.1792
35	427.723	64.832	2794.93	1139.41	22.1793
36	428.485	64.7705	2627.41	1071.12	22.1793
37	429.247	64.7244	2452.97	1000	22.1792
38	430.008	64.6936	2272.39	926.386	22.1793
39	430.77	64.6781	2086.57	850.633	22.1793
40	431.532	64.6779	1896.55	773.169	22.1793
41	432.294	64.6929	1703.79	694.584	22.1792
42	433.056	64.7232	1509.73	615.472	22.1793
43	433.818	64.7687	1315.91	536.458	22.1793
44	434.58	64.8297	1124.05	458.242	22.1793
45	435.342	64.9061	936.087	381.615	22.1793
46	436.104	64.998	754.4	307.546	22.1792
47	436.865	65.1056	581.473	237.049	22.1792
48	437.627	65.2289	419.996	171.22	22.1793
49	438.389	65.3682	272.962	111.279	22.1794
50	439.151	65.5236	143.607	58.5443	22.1793
51	439.913	65.6953	0	0	0

◆ Short Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 1.51163

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	130.686	138.282	0	0	0
2	137.143	131.291	502.459	91.0102	10.2667
3	143.6	124.698	2674.14	484.366	10.2667
4	150.056	118.471	6172.76	1118.07	10.2667
5	156.513	112.579	10687	1935.74	10.2667
6	162.969	107	15930.6	2885.51	10.2667
7	169.398	101.734	23109	4185.74	10.2667
8	175.827	96.7387	32187.4	5830.1	10.2667
9	182.256	91.9985	42801	7752.53	10.2667
10	189.644	86.849	50068.9	9068.97	10.2667
11	197.031	82	56991	10322.8	10.2667
12	203.984	77.6963	73407.1	13296.2	10.2667
13	210.937	73.633	89611.8	16231.4	10.2667
14	217.89	69.7997	105380	19087.5	10.2667
15	224.843	66.1871	120569	21838.6	10.2666
16	231.796	62.7869	135068	24464.9	10.2667
17	238.749	59.5918	148733	26939.9	10.2666
18	245.702	56.595	161512	29254.6	10.2667
19	252.655	53.7906	173346	31398.1	10.2667
20	259.608	51.1732	184131	33351.6	10.2667
21	266.561	48.738	193770	35097.5	10.2667
22	273.514	46.4805	202166	36618.2	10.2666
23	280.467	44.3969	209270	37905.1	10.2667
24	287.42	42.4836	215310	38999	10.2666
25	294.373	40.7375	220242	39892.3	10.2666
26	301.326	39.1559	224020	40576.7	10.2667
27	308.279	37.7361	226591	41042.3	10.2666
28	315.232	36.4761	227926	41284.2	10.2667
29	322.186	35.3739	228010	41299.4	10.2667
30	329.139	34.4279	226884	41095.5	10.2667
31	336.092	33.6367	223222	40432.1	10.2666
32	343.045	32.9991	218559	39587.6	10.2667
33	349.998	32.5142	212861	38555.5	10.2667
34	356.951	32.1813	206098	37330.5	10.2667
35	363.904	32	198241	35907.4	10.2667
36	373.621	32	185417	33584.5	10.2666
37	380.722	32.1869	174917	31682.7	10.2667
38	387.824	32.5318	163470	29609.3	10.2667
39	394.926	33.0354	151089	27366.8	10.2667
40	402.027	33.6983	137646	24931.8	10.2667
41	409.129	34.5216	123238	22322.2	10.2667
42	416.231	35.5065	107923	19548.1	10.2667
43	423.332	36.6546	92343.9	16726.2	10.2666
44	430.434	37.9676	77402.6	14019.9	10.2667
45	437.536	39.4475	63197.9	11447	10.2666
46	444.637	41.0969	49485.9	8963.36	10.2667
47	451.739	42.9183	36570.7	6624.04	10.2667
48	458.841	44.915	25085.8	4543.78	10.2666
49	465.942	47.0902	15288.5	2769.21	10.2667
50	473.044	49.4479	7209.28	1305.82	10.2667
51	480.146	51.9924	0	0	0

Short Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.98282

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	136.887	137.572	0	0	0
2	141.495	131.35	642.519	90.3611	8.00533
3	146.103	125.668	2905.79	408.658	8.00533
4	150.712	120.444	6382.74	897.641	8.00533
5	155.32	115.621	10740	1510.43	8.00534
6	159.928	111.152	15699.4	2207.89	8.00531
7	164.536	107	21043.7	2959.5	8.00534
8	169.548	102.81	28189.1	3964.39	8.00532
9	174.561	98.9292	36235.4	5095.99	8.00533
10	179.573	95.3325	44881.7	6311.97	8.00533
11	184.585	91.9985	53864.4	7575.25	8.00532
12	189.056	89.2318	58836.6	8274.52	8.00532
13	193.527	86.6491	63408.1	8917.44	8.00533
14	197.998	84.2413	67511.8	9494.56	8.00532
15	202.469	82	71101.1	9999.35	8.00533
16	207	79.8915	79484.7	11178.4	8.00534
17	211.53	77.9403	87327	12281.3	8.00533
18	216.061	76.1405	94552	13297.4	8.00534
19	220.591	74.4872	101124	14221.6	8.00531
20	225.122	72.9758	107019	15050.6	8.00528
21	229.652	71.6026	112210	15780.7	8.00531
22	234.183	70.364	116661	16406.7	8.00533
23	238.713	69.2571	120361	16927	8.00531
24	243.244	68.2793	123302	17340.6	8.0053
25	247.774	67.4284	125479	17646.8	8.00532
26	252.305	66.7024	126884	17844.4	8.00532
27	256.835	66.0998	127508	17932.2	8.00534
28	261.366	65.6192	127346	17909.5	8.00538
29	265.896	65.2597	126403	17776.7	8.0053
30	270.427	65.0204	124682	17534.7	8.00531
31	274.957	64.9009	122198	17185.4	8.00533
32	279.488	64.9009	118970	16731.4	8.00532
33	284.018	65.0204	115019	16175.7	8.00529
34	288.549	65.2597	110371	15522.1	8.00533
35	293.079	65.6192	105057	14774.8	8.00535
36	297.61	66.0998	99109.4	13938.3	8.00532
37	302.14	66.7024	92570.7	13018.7	8.0053
38	306.671	67.4284	85487.4	12022.6	8.00534
39	311.201	68.2793	77909.1	10956.8	8.00533
40	315.732	69.2571	69890.3	9829.07	8.00533
41	320.263	70.364	61484.7	8646.94	8.00533
42	324.793	71.6026	52784.3	7423.36	8.00533
43	329.324	72.9758	43759.9	6154.2	8.00532
44	333.854	74.4872	37110.8	5219.1	8.00532
45	338.385	76.1405	30525.9	4293.03	8.00533
46	342.915	77.9403	24102.4	3389.66	8.00533
47	347.446	79.8915	17951.8	2524.66	8.00532
48	351.976	82	12202.1	1716.04	8.00528
49	356.874	84.4637	6305.94	886.84	8.00533
50	361.771	87.1282	1890.36	265.852	8.00533
51	366.669	90.0045	0	0	0

Short Term Stability - Middle Wall

Global Minimum Query (spencer) - Safety Factor: 2.65119

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	356.713	92.1163	0	0	0
2	357.06	89.1376	-42.4101	-17.1421	22.0085
3	357.406	87.9324	92.8529	37.531	22.0085
4	357.753	87.0274	249.822	100.978	22.0085
5	358.1	86.2812	418.993	169.356	22.0084
6	358.446	85.6387	595.379	240.651	22.0085
7	358.793	85.0714	775.645	313.515	22.0085
8	359.14	84.5625	957.349	386.959	22.0085
9	359.487	84.1007	1138.61	460.223	22.0084
10	359.833	83.6783	1317.91	532.696	22.0084
11	360.18	83.2897	1493.13	603.521	22.0085
12	360.527	82.9306	1662.59	672.015	22.0084
13	360.874	82.5976	1825.58	737.896	22.0085
14	361.22	82.2882	1981.5	800.921	22.0085
15	361.567	82	2129.84	860.88	22.0085
16	361.919	81.7271	2213.42	894.662	22.0085
17	362.272	81.4729	2292.71	926.709	22.0085
18	362.624	81.236	2366.82	956.664	22.0085
19	362.977	81.0153	2434.98	984.216	22.0085
20	363.329	80.8099	2496.53	1009.09	22.0084
21	363.682	80.619	2550.85	1031.05	22.0085
22	364.034	80.4419	2597.19	1049.78	22.0085
23	364.387	80.2779	2634.91	1065.03	22.0085
24	364.739	80.1264	2663.61	1076.63	22.0085
25	365.092	79.9872	2682.95	1084.44	22.0084
26	365.444	79.8596	2692.61	1088.35	22.0085
27	365.797	79.7433	2692.3	1088.22	22.0084
28	366.149	79.6382	2681.74	1083.96	22.0086
29	366.502	79.5437	2660.69	1075.45	22.0085
30	366.854	79.4598	2638.63	1066.53	22.0085
31	367.207	79.3862	2606.23	1053.43	22.0084
32	367.559	79.3227	2563.22	1036.05	22.0085
33	367.911	79.2692	2509.46	1014.32	22.0085
34	368.264	79.2256	2444.55	988.086	22.0085
35	368.616	79.1917	2368.03	957.156	22.0085
36	368.969	79.1675	2279.42	921.338	22.0085
37	369.321	79.1529	2178.22	880.434	22.0085
38	369.674	79.1479	2064.05	834.285	22.0085
39	370.026	79.1525	1935.62	782.374	22.0085
40	370.379	79.1666	1791.9	724.285	22.0085
41	370.731	79.1904	1632.41	659.819	22.0085
42	371.084	79.2239	1456.63	588.767	22.0085
43	371.436	79.2672	1264.01	510.91	22.0084
44	371.789	79.3202	1076.58	435.152	22.0085
45	372.141	79.3833	927.437	374.869	22.0085
46	372.494	79.4565	775.84	313.593	22.0085
47	372.846	79.54	622.087	251.447	22.0085
48	373.198	79.6339	466.53	188.571	22.0085
49	373.551	79.7387	309.572	125.129	22.0086
50	373.903	79.8544	151.588	61.2718	22.0085
51	374.256	79.9815	0	0	0

Short Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 2.65423

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	395.844	78.9451	0	0	0
2	397.526	75.6489	-996.519	-207.83	11.7805
3	399.209	72.7781	-1125.42	-234.713	11.7805
4	400.891	70.2265	-642.248	-133.945	11.7805
5	402.574	67.9276	289.682	60.4148	11.7805
6	404.256	65.8367	1552.06	323.691	11.7805
7	405.938	63.9218	3061.07	638.405	11.7805
8	407.621	62.1592	4750.93	990.836	11.7805
9	409.303	60.5306	6570.51	1370.32	11.7805
10	410.985	59.0217	8474.24	1767.35	11.7805
11	412.668	57.6211	10423.2	2173.83	11.7806
12	414.35	56.3193	12387.3	2583.44	11.7805
13	416.033	55.1086	14340.4	2990.79	11.7806
14	417.715	53.9824	16222.1	3383.22	11.7805
15	419.397	52.9352	17822.5	3716.98	11.7805
16	421.08	51.9624	19318.9	4029.06	11.7805
17	422.762	51.0598	20702.7	4317.68	11.7805
18	424.444	50.2241	22035.6	4595.66	11.7805
19	426.127	49.4521	23266.4	4852.35	11.7805
20	427.809	48.7413	24404.5	5089.7	11.7805
21	429.492	48.0893	24855.1	5183.68	11.7805
22	431.174	47.4941	25211.8	5258.07	11.7805
23	432.856	46.954	25469.5	5311.82	11.7805
24	434.539	46.4674	25624.2	5344.07	11.7805
25	436.221	46.0331	25672.9	5354.23	11.7805
26	437.903	45.6498	25613.3	5341.82	11.7805
27	439.586	45.3166	25444.3	5306.57	11.7805
28	441.268	45.0325	25165.3	5248.37	11.7805
29	442.95	44.7971	24775.9	5167.17	11.7805
30	444.633	44.6096	24276.4	5063	11.7805
31	446.315	44.4696	23668.4	4936.18	11.7805
32	447.998	44.3767	22954.2	4787.24	11.7805
33	449.68	44.3309	22137.2	4616.85	11.7805
34	451.362	44.3319	21220.4	4425.65	11.7805
35	453.045	44.3798	20208.2	4214.54	11.7805
36	454.727	44.4746	19120	3987.6	11.7805
37	456.409	44.6167	17967.9	3747.31	11.7805
38	458.092	44.8062	16766.7	3496.8	11.7805
39	459.774	45.0438	15523	3237.41	11.7805
40	461.457	45.3299	14221.5	2965.98	11.7805
41	463.139	45.6653	12868.1	2683.72	11.7805
42	464.821	46.0507	11477.3	2393.65	11.7805
43	466.504	46.4873	10073	2100.79	11.7805
44	468.186	46.9762	8666.31	1807.41	11.7805
45	469.868	47.5186	7271.27	1516.47	11.7805
46	471.551	48.1162	5909.48	1232.46	11.7805
47	473.233	48.7707	4595.21	958.359	11.7805
48	474.916	49.4841	3327.5	693.971	11.7805
49	476.598	50.2587	2126.82	443.56	11.7805
50	478.28	51.0973	1025.67	213.909	11.7805
51	479.963	52.0046	0	0	0

Long Term Stability - Master Scenario

Global Minimum Query (spencer) - Safety Factor: 1.94144

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	282.569	115.423	0	0	0
2	286.159	112.521	-13.3251	-4.05682	16.9328
3	289.749	109.715	246.293	74.9836	16.9328
4	293.338	107	746.212	227.184	16.9329
5	297.059	104.28	1428.64	434.948	16.9328
6	300.779	101.652	2384.76	726.038	16.9328
7	304.499	99.1124	3573.17	1087.85	16.9328
8	308.219	96.6585	4958.25	1509.54	16.9329
9	311.939	94.2877	6507.49	1981.2	16.9328
10	315.659	91.9975	8190.56	2493.61	16.9328
11	320.152	89.3355	10080.7	3069.05	16.9328
12	324.645	86.7842	11980	3647.31	16.9329
13	329.139	84.3401	13965.4	4251.74	16.9328
14	333.632	82	14674.6	4467.66	16.9328
15	337.616	80.0096	15540.1	4731.17	16.9328
16	341.601	78.097	16494.1	5021.62	16.9328
17	345.585	76.2603	17505.4	5329.5	16.9328
18	349.569	74.498	18544.4	5645.81	16.9328
19	353.554	72.8085	19583.2	5962.1	16.9329
20	357.538	71.1905	20595.8	6270.38	16.9328
21	361.523	69.6426	21553	6561.8	16.9328
22	365.507	68.1636	22398.9	6819.32	16.9328
23	369.492	66.7523	23120.9	7039.14	16.9328
24	373.476	65.4078	23607.6	7187.3	16.9328
25	377.461	64.1288	23810.1	7248.96	16.9328
26	381.445	62.9147	23933.6	7286.56	16.9328
27	385.429	61.7644	23962.1	7295.24	16.9328
28	389.414	60.6772	23880.9	7270.52	16.9328
29	393.398	59.6523	23676.3	7208.23	16.9328
30	397.383	58.6891	23332.6	7103.58	16.9328
31	401.367	57.7868	22820.5	6947.67	16.9328
32	405.352	56.9449	22134.2	6738.75	16.9329
33	409.336	56.1628	21263.5	6473.66	16.9328
34	413.321	55.44	20199.1	6149.58	16.9328
35	417.305	54.7761	18932.9	5764.12	16.9329
36	421.289	54.1707	17578.7	5351.81	16.9328
37	425.274	53.6233	16090.9	4898.85	16.9328
38	429.258	53.1336	14581.6	4439.35	16.9328
39	433.243	52.7013	13272	4040.66	16.9329
40	437.227	52.3262	11896.3	3621.83	16.9329
41	441.212	52.0081	10469.6	3187.47	16.9329
42	445.196	51.7466	9007.94	2742.46	16.9328
43	449.18	51.5418	7543.84	2296.71	16.9328
44	453.165	51.3933	6100.89	1857.41	16.9328
45	457.149	51.3013	4793.68	1459.43	16.9328
46	461.134	51.2655	3672.69	1118.15	16.9329
47	465.118	51.2861	2629.9	800.669	16.9328
48	469.103	51.3629	1729.75	526.622	16.9329
49	473.087	51.4961	1005.81	306.217	16.9328
50	477.072	51.6857	429.665	130.811	16.9328
51	481.056	51.9318	0	0	0

Long Term Stability - Upper Wall

Global Minimum Query (spencer) - Safety Factor: 1.57492

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	312.327	109.427	0	0	0
2	312.602	107	-84.1034	-27.8309	18.31
3	313.209	104.482	-193.853	-64.1483	18.31
4	313.816	102.789	-83.3658	-27.5867	18.31
5	314.423	101.446	127.932	42.3342	18.31
6	315.029	100.313	394.8	130.644	18.31
7	315.636	99.3278	693.37	229.444	18.31
8	316.243	98.4528	1008.6	333.758	18.31
9	316.85	97.6658	1330.27	440.203	18.31
10	317.457	96.9514	1650.97	546.325	18.31
11	318.063	96.2987	1965.06	650.263	18.31
12	318.67	95.6995	2268.12	750.549	18.31
13	319.277	95.1476	2556.56	845.995	18.31
14	319.884	94.638	2827.38	935.615	18.31
15	320.491	94.1668	3077.85	1018.5	18.31
16	321.097	93.7307	3305	1093.67	18.3101
17	321.704	93.3271	3507.06	1160.53	18.31
18	322.311	92.9537	3682.55	1218.6	18.31
19	322.918	92.6087	3830.17	1267.45	18.31
20	323.525	92.2904	3948.77	1306.7	18.3101
21	324.131	91.9974	4037.28	1335.99	18.3101
22	324.743	91.7264	4060.18	1343.56	18.31
23	325.355	91.479	4047.65	1339.42	18.3101
24	325.967	91.2541	3997.76	1322.91	18.31
25	326.579	91.0511	3908.64	1293.42	18.3101
26	327.191	90.8692	3777.77	1250.11	18.31
27	327.803	90.7079	3597.02	1190.3	18.31
28	328.415	90.5667	3370.29	1115.27	18.31
29	329.027	90.4451	3095.95	1024.49	18.31
30	329.639	90.3428	2983.6	987.311	18.31
31	330.251	90.2595	2909.53	962.799	18.31
32	330.863	90.195	2826.31	935.261	18.31
33	331.474	90.1491	2733.77	904.639	18.31
34	332.086	90.1216	2631.84	870.906	18.31
35	332.698	90.1125	2520.53	834.074	18.31
36	333.31	90.1218	2400	794.189	18.31
37	333.922	90.1494	2270.51	751.338	18.31
38	334.534	90.1955	2132.46	705.656	18.31
39	335.146	90.2602	1986.41	657.327	18.31
40	335.758	90.3437	1833.1	606.594	18.31
41	336.37	90.4461	1673.46	553.768	18.31
42	336.982	90.5679	1508.68	499.239	18.31
43	337.594	90.7093	1340.22	443.494	18.31
44	338.206	90.8708	1169.9	387.134	18.31
45	338.817	91.0529	999.968	330.901	18.31
46	339.429	91.2561	833.191	275.713	18.31
47	340.041	91.4811	673.013	222.708	18.31
48	340.653	91.7288	523.735	173.31	18.31
49	341.265	92	390.774	129.312	18.31
50	341.885	92.3	180.111	59.601	18.31
51	342.506	92.6264	0	0	0

Long Term Stability - Middle Wall

Global Minimum Query (spencer) - Safety Factor: 1.62199

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	358.581	92.0492	0	0	0
2	359.041	89.073	-37.1175	-13.7805	20.3683
3	359.502	87.6098	87.802	32.5979	20.3683
4	359.962	86.5074	254.156	94.3596	20.3683
5	360.423	85.5994	437.414	162.397	20.3683
6	360.883	84.8194	626.97	232.772	20.3682
7	361.343	84.133	817.158	303.383	20.3683
8	361.804	83.5196	1004.16	372.81	20.3682
9	362.264	82.9656	1185.19	440.02	20.3682
10	362.724	82.4613	1358.1	504.217	20.3683
11	363.185	82	1521.19	564.766	20.3682
12	363.626	81.5935	1673.04	621.142	20.3682
13	364.067	81.2179	1815.35	673.977	20.3682
14	364.507	80.8703	1946.71	722.746	20.3682
15	364.948	80.5483	2066.23	767.119	20.3682
16	365.389	80.2499	2173.14	806.813	20.3682
17	365.83	79.9735	2266.79	841.58	20.3682
18	366.271	79.7178	2346.57	871.2	20.3682
19	366.712	79.4814	2411.96	895.478	20.3682
20	367.153	79.2635	2463.02	914.437	20.3683
21	367.594	79.063	2499.46	927.965	20.3683
22	368.034	78.8794	2520.77	935.875	20.3682
23	368.475	78.7119	2526.13	937.865	20.3682
24	368.916	78.56	2514.64	933.6	20.3682
25	369.357	78.4231	2485.42	922.751	20.3682
26	369.798	78.3009	2437.07	904.801	20.3682
27	370.239	78.1929	2366.77	878.7	20.3682
28	370.68	78.0989	2274.5	844.445	20.3683
29	371.121	78.0186	2159.47	801.738	20.3683
30	371.561	77.9518	2020.85	750.274	20.3683
31	372.002	77.8983	1932.88	717.612	20.3682
32	372.443	77.8579	1865.77	692.696	20.3682
33	372.884	77.8306	1794.47	666.225	20.3682
34	373.325	77.8162	1719.36	638.339	20.3682
35	373.766	77.8148	1640.89	609.206	20.3682
36	374.207	77.8263	1558.44	578.596	20.3683
37	374.648	77.8508	1470.91	546.098	20.3682
38	375.089	77.8883	1378.43	511.763	20.3682
39	375.529	77.9389	1281.21	475.668	20.3682
40	375.97	78.0028	1179.53	437.919	20.3682
41	376.411	78.0802	1073.77	398.656	20.3683
42	376.852	78.1711	964.425	358.058	20.3682
43	377.293	78.276	852.085	316.35	20.3682
44	377.734	78.3951	737.503	273.81	20.3683
45	378.175	78.5287	621.599	230.779	20.3683
46	378.616	78.6773	505.501	187.675	20.3682
47	379.056	78.8414	390.593	145.014	20.3683
48	379.497	79.0214	278.57	103.424	20.3683
49	379.938	79.2181	171.527	63.682	20.3682
50	380.379	79.4322	72.0592	26.7531	20.3682
51	380.82	79.6644	0	0	0

Long Term Stability - Lower Wall

Global Minimum Query (spencer) - Safety Factor: 1.61041

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	412.797	78.2072	0	0	0
2	413.311	77.0704	-32.1085	-12.4916	21.2582
3	413.825	76.0842	-2.54731	-0.991015	21.2582
4	414.339	75.2085	69.1078	26.886	21.2582
5	414.853	74.4189	170.368	66.2806	21.2582
6	415.367	73.6993	292.521	113.803	21.2581
7	415.881	73.0383	429.098	166.938	21.2582
8	416.395	72.4276	575.078	223.73	21.2582
9	416.909	71.8609	726.42	282.609	21.2582
10	417.42	71.3354	921.099	358.348	21.2582
11	417.932	70.8447	1061.32	412.901	21.2583
12	418.443	70.3853	1194.05	464.538	21.2582
13	418.955	69.9548	1321.52	514.127	21.2581
14	419.466	69.5509	1442.43	561.168	21.2582
15	419.978	69.1717	1555.67	605.223	21.2582
16	420.49	68.8156	1660.25	645.909	21.2582
17	421.001	68.4813	1755.31	682.891	21.2582
18	421.513	68.1675	1840.08	715.873	21.2582
19	422.024	67.8731	1913.9	744.592	21.2582
20	422.536	67.5974	1976.17	768.815	21.2582
21	423.047	67.3394	2026.57	788.424	21.2582
22	423.559	67.0985	2065.26	803.476	21.2582
23	424.07	66.8739	2091.41	813.65	21.2582
24	424.582	66.6652	2104.15	818.607	21.2582
25	425.094	66.4719	2103.02	818.167	21.2582
26	425.605	66.2935	2087.6	812.167	21.2582
27	426.117	66.1296	2058.27	800.757	21.2582
28	426.628	65.9799	2012.6	782.99	21.2582
29	427.14	65.844	1949.76	758.542	21.2582
30	427.651	65.7217	1869.03	727.134	21.2582
31	428.163	65.6127	1805.91	702.579	21.2582
32	428.674	65.5168	1743.25	678.2	21.2582
33	429.186	65.434	1675.24	651.74	21.2582
34	429.697	65.3639	1601.96	623.231	21.2582
35	430.209	65.3064	1523.56	592.73	21.2582
36	430.721	65.2616	1440.23	560.312	21.2582
37	431.232	65.2292	1352.24	526.079	21.2582
38	431.744	65.2093	1259.96	490.178	21.2582
39	432.255	65.2017	1163.88	452.8	21.2582
40	432.767	65.2065	1064.5	414.138	21.2583
41	433.278	65.2237	962.407	374.418	21.2582
42	433.79	65.2533	858.267	333.903	21.2582
43	434.301	65.2954	752.854	292.893	21.2582
44	434.813	65.3501	647.053	251.732	21.2582
45	435.325	65.4174	541.892	210.819	21.2581
46	435.836	65.4974	438.638	170.649	21.2582
47	436.348	65.5904	338.641	131.746	21.2582
48	436.859	65.6964	243.414	94.6986	21.2582
49	437.371	65.8158	154.681	60.1775	21.2582
50	437.882	65.9486	74.4064	28.9473	21.2582
51	438.394	66.0953	0	0	0

Discharge Sections

Entity Information

Dynamic Stability - 3200 psf

Shared Entities

Type	Coordinates (x,y)
	0, 143.76
	0, 107
	0, 92
	0, 82
	0, 70
	0, 50
	0, 45
	0, 32
	0, 13
	0, 10
	594.137, 10
	594.137, 13
	594.137, 32
	594.137, 45
	594.137, 47.0244
	537.271, 49.0046
	508.685, 50
	508.553, 50.0046
	494.988, 51.0046
	479.963, 52.0046
	477.179, 53.0046
	472.032, 54.0046
	469.222, 55.0046
	466.152, 56.0046
	463.452, 57.0046
	458.812, 58.0046
	457.097, 59.0046
	455.55, 60.0046
	453.876, 61.0046
	452.217, 62.0046
	448.87, 63.0046
	445.801, 64.0046
	442.563, 65.0046
	438.726, 66.0046
	435.059, 67.0046
	431.275, 68.0046
	427.723, 68.8938
	427.723, 70
	427.723, 76.0046
	425.721, 76.0046
	425.621, 75.251
	423.459, 76.0045
	420.457, 77.0045
	417.455, 78.0045

External Boundary	395.949, 78.9406 394.48, 79.0045 373.78, 80.0045 371.673, 80.7022 371.673, 82 371.673, 90.0047 369.672, 90.0047 369.572, 89.0045 366.669, 90.0045 363.666, 91.0045 359.844, 92 359.827, 92.0045 331.976, 93.0045 329.139, 93.1064 329.139, 106.997 327.137, 107 327.12, 106.212 323.93, 107 323.911, 107.005 320.131, 108.005 314.445, 109.005 309.425, 110.005 304.51, 111.005 299.736, 112.005 294.912, 113.005 289.56, 114.005 284.706, 115.005 279.593, 116.005 274.784, 117.005 269.514, 118.005 264.762, 119.005 258.878, 120.005 253.066, 121.005 246.14, 122.005 239.276, 123.005 233.332, 124.005 228.019, 125.005 221.641, 126.005 215.507, 127.005 209.988, 128.005 202.468, 129.005 195.425, 130.005 189.683, 131.005 183.123, 132.005 176.094, 133.005 168.144, 134.005 159.977, 135.005 151.783, 136.005 142.141, 137.005 132.871, 138.005 124.978, 139.005 114.837, 140.005 102.575, 141.005 90.5561, 142.005 38.9643, 143.005
Material Boundary	0, 50 508.685, 50
Material Boundary	0, 32 594.137, 32

Material Boundary	0, 13 594.137, 13
Material Boundary	0, 92 324.139, 91.9974 329.139, 92 359.844, 92
Material Boundary	0, 107 323.93, 107
Material Boundary	369.572, 89.0045 367.461, 82 366.673, 79.5047 371.673, 79.5047 371.673, 80.7022
Material Boundary	425.621, 75.251 423.689, 70 423.682, 69.9815 422.723, 67.5046 427.723, 67.5046 427.723, 68.8938
Material Boundary	395.949, 78.9406 398.468, 78.0002 400.812, 77.0002 404.022, 76.0002 406.887, 75.0002 409.47, 74.0001 412.833, 73.0001 416.414, 72.0001 419.968, 71.0001 423.613, 70 423.682, 69.9815 427.723, 68.8938
Material Boundary	324.139, 91.9974 327.12, 106.212
Material Boundary	329.139, 92 329.139, 93.1064
Material Boundary	0, 82 367.461, 82 371.673, 82

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 32 594.137, 32	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	401.659, 78.692 408.153, 78.4094	Constant DistributionOrientation: VerticalMagnitude: 3200 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	393.172, 79.0677 386.696, 79.3806	Constant DistributionOrientation: VerticalMagnitude: 3200 lbs/ft2Creates Excess Pore Pressure: No

◆ **Static Stability - 1600 psf Drained**

Shared Entities

Type	Coordinates (x,y)
External Boundary	0, 143.76
	0, 107
	0, 92
	0, 82
	0, 70
	0, 50
	0, 45
	0, 32
	0, 13
	0, 10
	594.137, 10
	594.137, 13
	594.137, 32
	594.137, 45
	594.137, 47.0244
	537.271, 49.0046
	508.685, 50
	508.553, 50.0046
	494.988, 51.0046
	479.963, 52.0046
	477.179, 53.0046
	472.032, 54.0046
	469.222, 55.0046
	466.152, 56.0046
	463.452, 57.0046
	458.812, 58.0046
	457.097, 59.0046
	455.55, 60.0046
	453.876, 61.0046
	452.217, 62.0046
	448.87, 63.0046
	445.801, 64.0046
	442.563, 65.0046
	438.726, 66.0046
	435.059, 67.0046
	431.275, 68.0046
	427.723, 68.8938
	427.723, 70
	427.723, 76.0046
	425.721, 76.0046
	425.621, 75.251
	423.459, 76.0045
	420.457, 77.0045
	417.455, 78.0045
	395.949, 78.9406
	394.48, 79.0045
	373.78, 80.0045
	371.673, 80.7022
	371.673, 82
	371.673, 90.0047
	369.672, 90.0047
	369.572, 89.0045
	366.669, 90.0045
	363.666, 91.0045
	359.844, 92
	359.827, 92.0045

	331.976, 93.0045 329.139, 93.1064 329.139, 106.997 327.137, 107 327.12, 106.212 323.93, 107 323.911, 107.005 320.131, 108.005 314.445, 109.005 309.425, 110.005 304.51, 111.005 299.736, 112.005 294.912, 113.005 289.56, 114.005 284.706, 115.005 279.593, 116.005 274.784, 117.005 269.514, 118.005 264.762, 119.005 258.878, 120.005 253.066, 121.005 246.14, 122.005 239.276, 123.005 233.332, 124.005 228.019, 125.005 221.641, 126.005 215.507, 127.005 209.988, 128.005 202.468, 129.005 195.425, 130.005 189.683, 131.005 183.123, 132.005 176.094, 133.005 168.144, 134.005 159.977, 135.005 151.783, 136.005 142.141, 137.005 132.871, 138.005 124.978, 139.005 114.837, 140.005 102.575, 141.005 90.5561, 142.005 38.9643, 143.005
Material Boundary	0, 50 508.685, 50
Material Boundary	0, 32 594.137, 32
Material Boundary	0, 13 594.137, 13
Material Boundary	0, 92 324.139, 91.9974 329.139, 92 359.844, 92
Material Boundary	0, 107 323.93, 107

Material Boundary	369.572, 89.0045 367.461, 82 366.673, 79.5047 371.673, 79.5047 371.673, 80.7022
Material Boundary	425.621, 75.251 423.689, 70 423.682, 69.9815 422.723, 67.5046 427.723, 67.5046 427.723, 68.8938
Material Boundary	395.949, 78.9406 398.468, 78.0002 400.812, 77.0002 404.022, 76.0002 406.887, 75.0002 409.47, 74.0001 412.833, 73.0001 416.414, 72.0001 419.968, 71.0001 423.613, 70 423.682, 69.9815 427.723, 68.8938
Material Boundary	324.139, 91.9974 327.12, 106.212
Material Boundary	329.139, 92 329.139, 93.1064
Material Boundary	0, 82 367.461, 82 371.673, 82

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 32 594.137, 32	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)
Distributed Load	401.659, 78.692 408.153, 78.4094	Constant DistributionOrientation: VerticalMagnitude: 1600 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	393.172, 79.0677 386.696, 79.3806	Constant DistributionOrientation: VerticalMagnitude: 1600 lbs/ft2Creates Excess Pore Pressure: No

Short Term Stability

Shared Entities

Type	Coordinates (x,y)
	0, 143.76 0, 107

External Boundary	0, 92 0, 82 0, 70 0, 50 0, 45 0, 32 0, 13 0, 10 594.137, 10 594.137, 13 594.137, 32 594.137, 45 594.137, 47.0244 537.271, 49.0046 508.685, 50 508.553, 50.0046 494.988, 51.0046 479.963, 52.0046 477.179, 53.0046 472.032, 54.0046 469.222, 55.0046 466.152, 56.0046 463.452, 57.0046 458.812, 58.0046 457.097, 59.0046 455.55, 60.0046 453.876, 61.0046 452.217, 62.0046 448.87, 63.0046 445.801, 64.0046 442.563, 65.0046 438.726, 66.0046 435.059, 67.0046 431.275, 68.0046 427.723, 68.8938 427.723, 70 427.723, 76.0046 425.721, 76.0046 425.621, 75.251 423.459, 76.0045 420.457, 77.0045 417.455, 78.0045 395.949, 78.9406 394.48, 79.0045 373.78, 80.0045 371.673, 80.7022 371.673, 82 371.673, 90.0047 369.672, 90.0047 369.572, 89.0045 366.669, 90.0045 363.666, 91.0045 359.844, 92 359.827, 92.0045 331.976, 93.0045 329.139, 93.1064 329.139, 106.997 327.137, 107 327.12, 106.212

	323.93, 107 323.911, 107.005 320.131, 108.005 314.445, 109.005 309.425, 110.005 304.51, 111.005 299.736, 112.005 294.912, 113.005 289.56, 114.005 284.706, 115.005 279.593, 116.005 274.784, 117.005 269.514, 118.005 264.762, 119.005 258.878, 120.005 253.066, 121.005 246.14, 122.005 239.276, 123.005 233.332, 124.005 228.019, 125.005 221.641, 126.005 215.507, 127.005 209.988, 128.005 202.468, 129.005 195.425, 130.005 189.683, 131.005 183.123, 132.005 176.094, 133.005 168.144, 134.005 159.977, 135.005 151.783, 136.005 142.141, 137.005 132.871, 138.005 124.978, 139.005 114.837, 140.005 102.575, 141.005 90.5561, 142.005 38.9643, 143.005
Material Boundary	0, 50 508.685, 50
Material Boundary	0, 32 594.137, 32
Material Boundary	0, 13 594.137, 13
Material Boundary	0, 92 324.139, 91.9974 329.139, 92 359.844, 92
Material Boundary	0, 107 323.93, 107
Material Boundary	369.572, 89.0045 367.461, 82 366.673, 79.5047 371.673, 79.5047 371.673, 80.7022

Material Boundary	425.621, 75.251 423.689, 70 423.682, 69.9815 422.723, 67.5046 427.723, 67.5046 427.723, 68.8938
Material Boundary	395.949, 78.9406 398.468, 78.0002 400.812, 77.0002 404.022, 76.0002 406.887, 75.0002 409.47, 74.0001 412.833, 73.0001 416.414, 72.0001 419.968, 71.0001 423.613, 70 423.682, 69.9815 427.723, 68.8938
Material Boundary	324.139, 91.9974 327.12, 106.212
Material Boundary	329.139, 92 329.139, 93.1064
Material Boundary	0, 82 367.461, 82 371.673, 82

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario	Upper Wall	Middle Wall	Lower Wall
Piezoline	0, 32 594.137, 32	Assigned to: 🟧 Black Creek Aquifer	Assigned to: 🟧 Black Creek Aquifer	Assigned to: 🟧 Black Creek Aquifer	Assigned to: 🟧 Black Creek Aquifer
Distributed Load	395.949, 78.9406 417.455, 78.0045	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No			Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Long Term Stability

Shared Entities

Type	Coordinates (x,y)
	0, 143.76 0, 107 0, 92 0, 82 0, 70 0, 50 0, 45 0, 32 0, 13 0, 10 594.137, 10

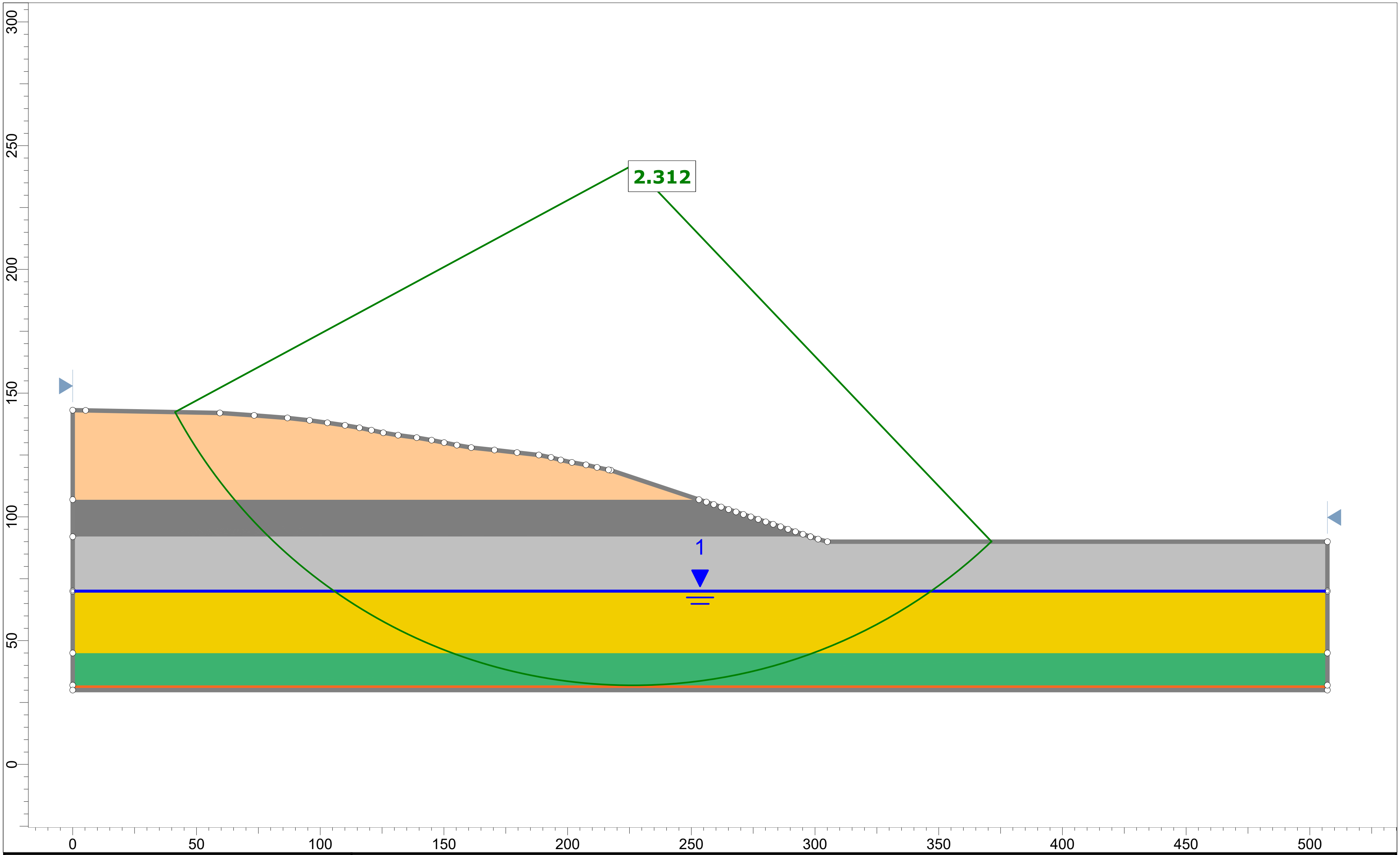
External Boundary	594.137, 13
	594.137, 32
	594.137, 45
	594.137, 47.0244
	537.271, 49.0046
	508.685, 50
	508.553, 50.0046
	494.988, 51.0046
	479.963, 52.0046
	477.179, 53.0046
	472.032, 54.0046
	469.222, 55.0046
	466.152, 56.0046
	463.452, 57.0046
	458.812, 58.0046
	457.097, 59.0046
	455.55, 60.0046
	453.876, 61.0046
	452.217, 62.0046
	448.87, 63.0046
	445.801, 64.0046
	442.563, 65.0046
	438.726, 66.0046
	435.059, 67.0046
	431.275, 68.0046
	427.723, 68.8938
	427.723, 70
	427.723, 76.0046
	425.721, 76.0046
	425.621, 75.251
	423.459, 76.0045
	420.457, 77.0045
	417.455, 78.0045
	395.949, 78.9406
	394.48, 79.0045
	373.78, 80.0045
	371.673, 80.7022
	371.673, 82
	371.673, 90.0047
	369.672, 90.0047
	369.572, 89.0045
	366.669, 90.0045
	363.666, 91.0045
	359.844, 92
	359.827, 92.0045
	331.976, 93.0045
	329.139, 93.1064
	329.139, 106.997
	327.137, 107
	327.12, 106.212
	323.93, 107
	323.911, 107.005
	320.131, 108.005
	314.445, 109.005
	309.425, 110.005
	304.51, 111.005
	299.736, 112.005
	294.912, 113.005
	289.56, 114.005

	284.706, 115.005 279.593, 116.005 274.784, 117.005 269.514, 118.005 264.762, 119.005 258.878, 120.005 253.066, 121.005 246.14, 122.005 239.276, 123.005 233.332, 124.005 228.019, 125.005 221.641, 126.005 215.507, 127.005 209.988, 128.005 202.468, 129.005 195.425, 130.005 189.683, 131.005 183.123, 132.005 176.094, 133.005 168.144, 134.005 159.977, 135.005 151.783, 136.005 142.141, 137.005 132.871, 138.005 124.978, 139.005 114.837, 140.005 102.575, 141.005 90.5561, 142.005 38.9643, 143.005
Material Boundary	0, 50 508.685, 50
Material Boundary	0, 32 594.137, 32
Material Boundary	0, 13 594.137, 13
Material Boundary	0, 92 324.139, 91.9974 329.139, 92 359.844, 92
Material Boundary	0, 107 323.93, 107
Material Boundary	369.572, 89.0045 367.461, 82 366.673, 79.5047 371.673, 79.5047 371.673, 80.7022
Material Boundary	425.621, 75.251 423.689, 70 423.682, 69.9815 422.723, 67.5046 427.723, 67.5046 427.723, 68.8938

Material Boundary	395.949, 78.9406 398.468, 78.0002 400.812, 77.0002 404.022, 76.0002 406.887, 75.0002 409.47, 74.0001 412.833, 73.0001 416.414, 72.0001 419.968, 71.0001 423.613, 70 423.682, 69.9815 427.723, 68.8938
Material Boundary	324.139, 91.9974 327.12, 106.212
Material Boundary	329.139, 92 329.139, 93.1064
Material Boundary	0, 82 367.461, 82 371.673, 82

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario	Upper Wall	Middle Wall	Lower Wall
Piezoline	0, 32 594.137, 32	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confin Unit (Draine	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confin Unit (Draine	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confin Unit (Draine	Assigned to: 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confin Unit (Draine
Distributed Load	395.949, 78.9406 417.455, 78.0045	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No			Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No



GEOS Universal Engineering Sciences
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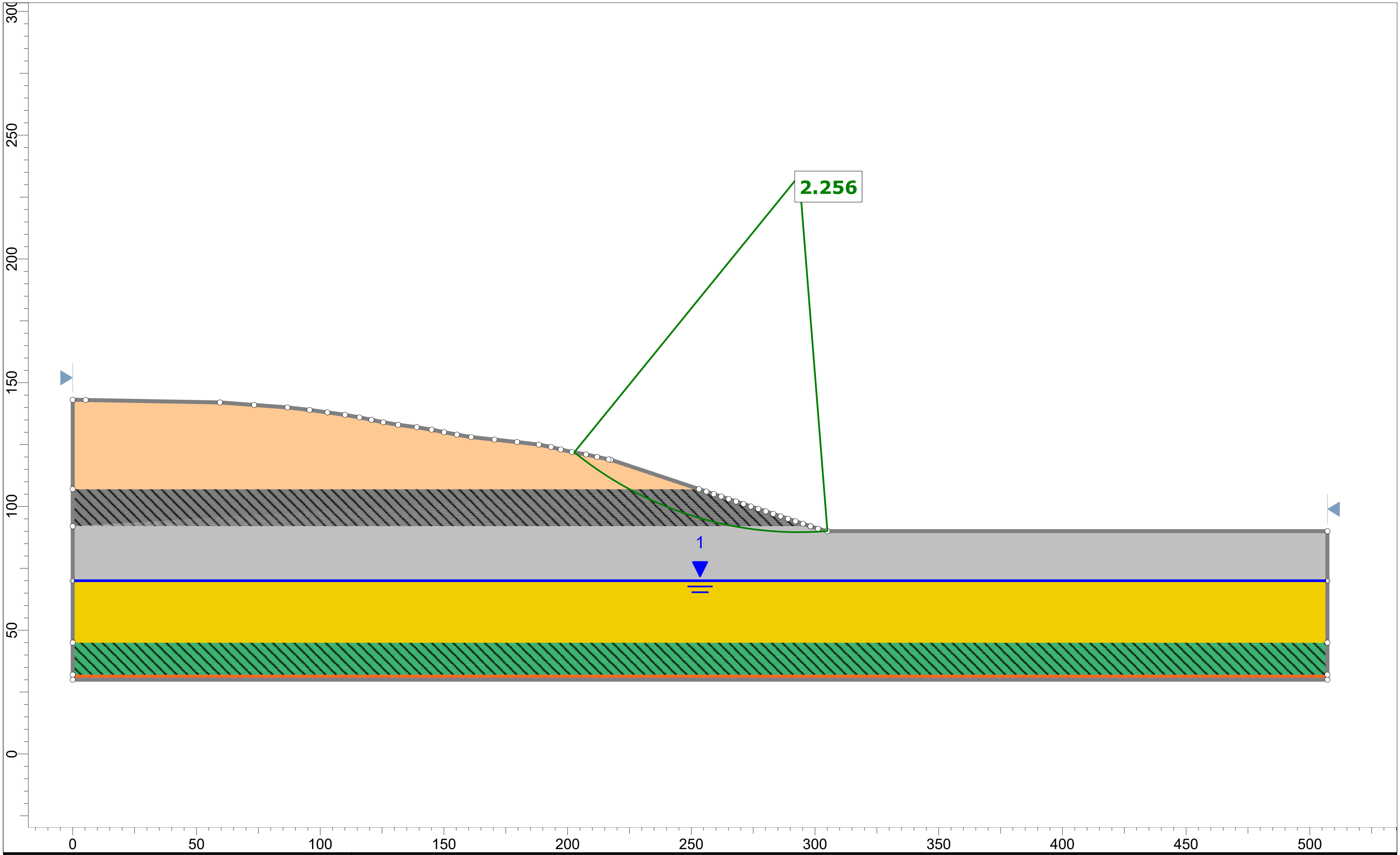
SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	*Section*	Section 7
Drawn By		*Station*	Wastewater Treatment Pond Approx. STA 70+00
Date		*File Name*	section-7.slmd



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Geotechnical, Environmental and Materials Engineers

SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 7
Drawn By		*Station*	Wastewater Treatment Pond Approx. STA 70+00
Date		*File Name*	section-7.slmd

GEOS
Geotechnical, Environmental and Materials Engineers
Universal
Engineering
Sciences

Section-7
45-20803 Barrier Wall Road Interim Design and Repair
Wastewater Treatment Pond Approx. STA 70+00
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-7

Project Summary

File Name:	section-7.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Long Term Slope Stability
Comments	
	Section 7 Wastewater Treatment Pond Approx. STA 70+00

Currently Open Scenarios

Group Name		Scenario Name	Global Minimum	Compute Time
Short Term Stability	◆	Master Scenario	Spencer: 2.311620	00h:00m:09.489s
Long Term Stability	◆	Master Scenario	Spencer: 2.255550	00h:00m:05.326s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Light Brown Sand	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	⬛
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	⬜
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Hu Value	1
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900

Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Hu Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1

Materials In Use

Material		Short Term Stability	Long Term Stability
Light Brown Sand	🟫	✓	✓
Dark Gray Clay	⬛	✓	✗
Dark Gray Clay (Drained)	▨	✗	✓
Light Gray Sand	⬜	✓	✓
Surficial Aquifer	🟨	✓	✓
Black Creek Confining Unit	🟩	✓	✗
Black Creek Confining Unit (Long Term)	▨	✗	✓
Black Creek Aquifer	🟧	✓	✓

Global Minimums

Short Term Stability

Method: spencer

FS	2.311620
Center:	226.332, 242.141
Radius:	210.199
Left Slip Surface Endpoint:	41.337, 142.338
Right Slip Surface Endpoint:	371.377, 90.004
Resisting Moment:	1.59208e+08 lb-ft
Driving Moment:	6.88731e+07 lb-ft
Resisting Horizontal Force:	653286 lb
Driving Horizontal Force:	282610 lb
Total Slice Area:	19451.4 ft2
Surface Horizontal Width:	330.04 ft
Surface Average Height:	58.9364 ft

Long Term Stability

Method: spencer

FS	2.255550
Center:	293.614, 233.699
Radius:	144.145
Left Slip Surface Endpoint:	202.706, 121.835
Right Slip Surface Endpoint:	304.995, 90.004
Resisting Moment:	8.95607e+06 lb-ft
Driving Moment:	3.97068e+06 lb-ft
Resisting Horizontal Force:	58512.8 lb
Driving Horizontal Force:	25941.7 lb
Total Slice Area:	813.668 ft2
Surface Horizontal Width:	102.289 ft
Surface Average Height:	7.9546 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Short Term Stability

Method: spencer

Number of Valid Surfaces: 95538
Number of Invalid Surfaces: 0

Long Term Stability

Method: spencer

Number of Valid Surfaces: 66981
Number of Invalid Surfaces: 0

Slice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.31162

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	5.99901	3394.24	-60.0173	Light Brown Sand	75	32	118.606	274.173	318.743	0	318.743	524.319	524.319
2	5.99901	9786.5	-56.8843	Light Brown Sand	75	32	311.51	720.092	1032.36	0	1032.36	1509.93	1509.93
3	5.99901	15472	-53.9966	Light Brown Sand	75	32	496.665	1148.1	1717.31	0	1717.31	2400.83	2400.83
4	5.99901	20491.3	-51.2979	Light Brown Sand	75	32	670.733	1550.48	2361.26	0	2361.26	3198.41	3198.41
5	6.94434	29501.3	-48.56	Dark Gray Clay	1300	0	562.376	1300	3307.41	0	3307.41	3944.41	3944.41
6	6.94434	35364.6	-45.7729	Dark Gray Clay	1300	0	562.376	1300	4160.78	0	4160.78	4738.53	4738.53
7	6.62045	38546.8	-43.1784	Light Gray Sand	50	32	1212.53	2802.92	4405.6	0	4405.6	5543.39	5543.39
8	6.62045	42657.7	-40.7498	Light Gray Sand	50	32	1368.98	3164.55	4984.32	0	4984.32	6163.9	6163.9
9	6.62045	46272.7	-38.4072	Light Gray Sand	50	32	1512.89	3497.22	5516.7	0	5516.7	6716.11	6716.11
10	6.62045	49458.1	-36.1383	Light Gray Sand	50	32	1645.44	3803.64	6007.08	0	6007.08	7208.64	7208.64
11	6.81368	53872.8	-33.9021	Surficial Aquifer	75	32	1746.42	4037.07	6483.5	142.859	6340.64	7657.14	7514.28
12	6.81368	56450.1	-31.6917	Surficial Aquifer	75	32	1795.35	4150.16	6938.58	416.977	6521.61	8047.05	7630.08
13	6.81368	58577.1	-29.5329	Surficial Aquifer	75	32	1834.68	4241.09	7335.8	668.668	6667.13	8375.21	7706.54
14	6.81368	60537.4	-27.4193	Surficial Aquifer	75	32	1873.37	4330.53	7709.66	899.391	6810.27	8681.53	7782.14
15	6.81368	62450.8	-25.3455	Surficial Aquifer	75	32	1915.3	4427.45	8075.75	1110.37	6965.38	8982.98	7872.61
16	6.81368	64078.5	-23.3068	Surficial Aquifer	75	32	1952.04	4512.38	8403.94	1302.65	7101.29	9244.89	7942.24
17	6.81368	65310.1	-21.2988	Surficial Aquifer	75	32	1979.29	4575.36	8679.2	1477.12	7202.08	9450.85	7973.73
18	6.79822	66211.3	-19.3202	Black Creek Confining Unit	935.749	0	404.802	935.749	9324.86	0	9324.86	9466.78	9466.78
19	6.79822	67300.8	-17.3675	Black Creek Confining Unit	1003.39	0	434.064	1003.39	9521.79	0	9521.79	9657.54	9657.54
20	6.79822	68386.6	-15.4354	Black Creek Confining Unit	1063.44	0	460.041	1063.44	9720.7	0	9720.7	9847.72	9847.72
21	6.79822	69265.3	-13.5212	Black Creek Confining Unit	1116.12	0	482.83	1116.12	9892.11	0	9892.11	10008.2	10008.2
22	6.79822	69933.5	-11.6223	Black Creek Confining Unit	1161.61	0	502.509	1161.61	10035	0	10035	10138.3	10138.3

23	6.79822	70234.3	-9.73619	Black Creek Confining Unit	1200.08	0	519.151	1200.08	10126.2	0	10126.2	10215.3	10215.3
24	6.79822	69925.6	-7.86073	Black Creek Confining Unit	1231.66	0	532.812	1231.66	10129.9	0	10129.9	10203.4	10203.4
25	6.79822	69547.8	-5.99372	Black Creek Confining Unit	1256.45	0	543.537	1256.45	10123.7	0	10123.7	10180.8	10180.8
26	6.79822	69014.6	-4.13308	Black Creek Confining Unit	1274.52	0	551.354	1274.52	10095	0	10095	10134.9	10134.9
27	6.79822	68151.9	-2.2768	Black Creek Confining Unit	1285.94	0	556.294	1285.94	10017.8	0	10017.8	10040	10040
28	9.90088	96489.2	0	Black Creek Confining Unit	1290	0	558.05	1290	9798.6	0	9798.6	9798.6	9798.6
29	6.1802	58320	2.19245	Black Creek Confining Unit	1286.45	0	556.514	1286.45	9545.62	0	9545.62	9524.32	9524.32
30	6.1802	56676.7	3.87965	Black Creek Confining Unit	1276.61	0	552.258	1276.61	9320.86	0	9320.86	9283.41	9283.41
31	6.1802	54897.7	5.57023	Black Creek Confining Unit	1261.29	0	545.63	1261.29	9072.19	0	9072.19	9018.98	9018.98
32	6.1802	52967.7	7.2657	Black Creek Confining Unit	1240.42	0	536.602	1240.42	8796.8	0	8796.8	8728.39	8728.39
33	6.1802	50804.3	8.96759	Black Creek Confining Unit	1213.98	0	525.164	1213.98	8480.75	0	8480.75	8397.87	8397.87
34	6.1802	48483.3	10.6775	Black Creek Confining Unit	1181.87	0	511.273	1181.87	8136.04	0	8136.04	8039.64	8039.64
35	6.1802	46020.5	12.3971	Black Creek Confining Unit	1144.01	0	494.895	1144.01	7764.8	0	7764.8	7656.02	7656.02
36	6.1802	43413.2	14.1281	Black Creek Confining Unit	1100.3	0	475.987	1100.3	7366.19	0	7366.19	7246.38	7246.38
37	6.1802	40658.8	15.8725	Black Creek Confining Unit	1050.61	0	454.491	1050.61	6939.2	0	6939.2	6809.97	6809.97
38	6.1802	37754.6	17.632	Black Creek Confining Unit	994.786	0	430.341	994.786	6482.85	0	6482.85	6346.07	6346.07
39	6.1802	34702	19.409	Black Creek Confining Unit	932.66	0	403.466	932.66	5996.74	0	5996.74	5854.58	5854.58
40	6.81368	34742.8	21.2988	Surficial Aquifer	75	32	1232.49	2849.06	5916.55	1477.12	4439.43	5436.05	3958.93
41	6.81368	32032.5	23.3068	Surficial Aquifer	75	32	1180.56	2729	5549.94	1302.65	4247.29	5041.35	3738.7
42	6.81368	29618	25.3455	Surficial Aquifer	75	32	1147.66	2652.95	5235.95	1110.37	4125.58	4692.34	3581.97
43	6.81368	26968.6	27.4193	Surficial Aquifer	75	32	1108.38	2562.15	4879.66	899.391	3980.27	4304.66	3405.26

44	6.81368	24071.4	29.5329	Surficial Aquifer	75	32	1061.93	2454.77	4477.1	668.668	3808.43	3875.48	3206.81
45	6.81368	20910.8	31.6917	Surficial Aquifer	75	32	1007.31	2328.52	4023.36	416.977	3606.38	3401.43	2984.45
46	6.81368	17468.7	33.9021	Surficial Aquifer	75	32	943.239	2180.41	3512.22	142.859	3369.36	2878.34	2735.48
47	6.10419	12483	36.05	Light Gray Sand	50	32	808.987	1870.07	2912.72	0	2912.72	2323.88	2323.88
48	6.10419	9241.36	38.1368	Light Gray Sand	50	32	624.562	1443.75	2230.47	0	2230.47	1740.1	1740.1
49	6.10419	5743.16	40.2853	Light Gray Sand	50	32	412.672	953.941	1446.6	0	1446.6	1096.82	1096.82
50	6.10419	1963.56	42.5045	Light Gray Sand	50	32	169.007	390.68	545.202	0	545.202	390.312	390.312

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.25555

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.01531	138.921	-38.5872	Light Brown Sand	75	32	43.7253	98.6247	37.8074	0	37.8074	72.6969	72.6969
2	2.01531	410.359	-37.5695	Light Brown Sand	75	32	71.5887	161.472	138.384	0	138.384	193.454	193.454
3	2.01531	664.722	-36.5654	Light Brown Sand	75	32	98.325	221.777	234.892	0	234.892	307.823	307.823
4	2.01531	891.858	-35.5743	Light Brown Sand	75	32	122.81	277.003	323.272	0	323.272	411.112	411.112
5	2.01531	1106.44	-34.5953	Light Brown Sand	75	32	146.479	330.39	408.711	0	408.711	509.742	509.742
6	2.01531	1312.17	-33.6277	Light Brown Sand	75	32	169.673	382.707	492.435	0	492.435	605.284	605.284
7	2.01531	1507.8	-32.6709	Light Brown Sand	75	32	192.227	433.577	573.844	0	573.844	697.113	697.113
8	2.01531	1692.28	-31.7242	Light Brown Sand	75	32	213.986	482.656	652.386	0	652.386	784.671	784.671
9	2.01531	1819.34	-30.787	Light Brown Sand	75	32	229.851	518.441	709.655	0	709.655	846.604	846.604
10	2.01531	1931.79	-29.859	Light Brown Sand	75	32	244.362	551.171	762.031	0	762.031	902.312	902.312
11	2.01531	2034.66	-28.9394	Light Brown Sand	75	32	258.03	582	811.37	0	811.37	954.042	954.042
12	2.01417	2137.79	-28.0283	Dark Gray Clay (Drained)	200	25	267.121	602.505	863.173	0	863.173	1005.37	1005.37
13	2.01417	2243.35	-27.125	Dark Gray Clay (Drained)	200	25	277.981	627	915.703	0	915.703	1058.11	1058.11
14	2.01417	2339.27	-26.229	Dark Gray Clay (Drained)	200	25	288.141	649.916	964.849	0	964.849	1106.81	1106.81
15	2.01417	2425.75	-25.3398	Dark Gray Clay (Drained)	200	25	297.6	671.252	1010.6	0	1010.6	1151.53	1151.53
16	2.01417	2503.02	-24.4571	Dark Gray Clay (Drained)	200	25	306.358	691.006	1052.97	0	1052.97	1192.31	1192.31
17	2.01417	2571.27	-23.5805	Dark Gray Clay (Drained)	200	25	314.414	709.177	1091.93	0	1091.93	1229.17	1229.17
18	2.01417	2630.67	-22.7098	Dark Gray Clay (Drained)	200	25	321.766	725.76	1127.49	0	1127.49	1262.16	1262.16
19	2.01417	2681.41	-21.8446	Dark Gray Clay (Drained)	200	25	328.413	740.753	1159.65	0	1159.65	1291.3	1291.3
20	2.01417	2723.64	-20.9846	Dark Gray Clay (Drained)	200	25	334.353	754.149	1188.38	0	1188.38	1316.62	1316.62
21	2.01417	2757.52	-20.1295	Dark Gray Clay (Drained)	200	25	339.582	765.945	1213.67	0	1213.67	1338.14	1338.14
22	2.01417	2783.17	-19.279	Dark Gray Clay (Drained)	200	25	344.098	776.131	1235.52	0	1235.52	1355.88	1355.88

23	2.01417	2800.73	-18.433	Dark Gray Clay (Drained)	200	25	347.898	784.702	1253.9	0	1253.9	1369.85	1369.85
24	2.01417	2810.32	-17.5911	Dark Gray Clay (Drained)	200	25	350.978	791.648	1268.79	0	1268.79	1380.07	1380.07
25	2.01417	2812.06	-16.7531	Dark Gray Clay (Drained)	200	25	353.333	796.96	1280.19	0	1280.19	1386.55	1386.55
26	2.01417	2799.34	-15.9188	Dark Gray Clay (Drained)	200	25	354.322	799.192	1284.97	0	1284.97	1386.03	1386.03
27	2.01417	2772.16	-15.0879	Dark Gray Clay (Drained)	200	25	353.917	798.278	1283.01	0	1283.01	1378.42	1378.42
28	2.01417	2737.42	-14.2603	Dark Gray Clay (Drained)	200	25	352.753	795.653	1277.38	0	1277.38	1367.04	1367.04
29	2.01417	2695.21	-13.4357	Dark Gray Clay (Drained)	200	25	350.825	791.303	1268.05	0	1268.05	1351.86	1351.86
30	2.01417	2645.61	-12.6139	Dark Gray Clay (Drained)	200	25	348.125	785.213	1254.99	0	1254.99	1332.89	1332.89
31	2.01417	2588.7	-11.7948	Dark Gray Clay (Drained)	200	25	344.646	777.366	1238.16	0	1238.16	1310.13	1310.13
32	2.01417	2524.54	-10.978	Dark Gray Clay (Drained)	200	25	340.381	767.746	1217.53	0	1217.53	1283.56	1283.56
33	2.10127	2555.53	-10.146	Light Gray Sand	50	32	352.799	795.755	1193.46	0	1193.46	1256.59	1256.59
34	2.10127	2466.01	-9.29859	Light Gray Sand	50	32	344.058	776.04	1161.91	0	1161.91	1218.24	1218.24
35	2.10127	2368.8	-8.45321	Light Gray Sand	50	32	334.135	753.659	1126.09	0	1126.09	1175.75	1175.75
36	2.10127	2263.95	-7.60968	Light Gray Sand	50	32	323.011	728.568	1085.94	0	1085.94	1129.09	1129.09
37	2.10127	2151.52	-6.7678	Light Gray Sand	50	32	310.665	700.721	1041.37	0	1041.37	1078.24	1078.24
38	2.10127	2031.56	-5.92739	Light Gray Sand	50	32	297.076	670.069	992.319	0	992.319	1023.16	1023.16
39	2.10127	1904.1	-5.08826	Light Gray Sand	50	32	282.22	636.561	938.691	0	938.691	963.82	963.82
40	2.10127	1769.19	-4.25023	Light Gray Sand	50	32	266.073	600.141	880.408	0	880.408	900.182	900.182
41	2.10127	1626.86	-3.4131	Light Gray Sand	50	32	248.61	560.753	817.375	0	817.375	832.202	832.202
42	2.10127	1477.16	-2.5767	Light Gray Sand	50	32	229.806	518.339	749.501	0	749.501	759.843	759.843
43	2.10127	1320.14	-1.74085	Light Gray Sand	50	32	209.634	472.839	676.682	0	676.682	683.053	683.053
44	2.10127	1155.86	-0.905369	Light Gray Sand	50	32	188.069	424.199	598.843	0	598.843	601.815	601.815
45	2.10127	984.441	-0.0700827	Light Gray Sand	50	32	165.095	372.379	515.916	0	515.916	516.117	516.117
46	2.10127	806.027	0.765189	Light Gray Sand	50	32	140.693	317.341	427.836	0	427.836	425.957	425.957
47	2.10127	621.295	1.60062	Light Gray Sand	50	32	114.928	259.225	334.829	0	334.829	331.618	331.618
48	2.10127	436.996	2.4364	Light Gray Sand	50	32	88.7531	200.187	240.349	0	240.349	236.573	236.573
49	2.10127	256.43	3.27269	Light Gray Sand	50	32	62.6493	141.309	146.125	0	146.125	142.542	142.542
50	2.10127	86.4913	4.11459	Light Gray Sand	50	32	39.3647	88.789	62.0752	0	62.0752	59.2434	59.2434

Interslice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.31162

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	41.337	142.338	0	0	0
2	47.336	131.94	2602.18	247.631	5.43606
3	53.335	122.743	10226.6	973.192	5.43606
4	59.334	114.487	21422.9	2038.65	5.43602
5	65.3331	107	35075.8	3337.91	5.43605
6	72.2774	99.1343	57182.7	5441.66	5.43605
7	79.2217	92	82958.4	7894.54	5.43605
8	85.8422	85.7877	102294	9734.55	5.43604
9	92.4626	80.0832	121657	11577.2	5.43605
10	99.0831	74.8345	140588	13378.8	5.43608
11	105.704	70	158728	15105	5.43606
12	112.517	65.421	176507	16796.9	5.43606
13	119.331	61.2142	193454	18409.6	5.43605
14	126.145	57.354	209261	19913.9	5.43607
15	132.958	53.8192	223739	21291.6	5.43605
16	139.772	50.5918	236743	22529.1	5.43605
17	146.586	47.6564	248101	23609.9	5.43604
18	153.399	45	257660	24519.6	5.43605
19	160.198	42.6166	277131	26372.5	5.43604
20	166.996	40.4904	294423	28018	5.43603
21	173.794	38.6133	309539	29456.6	5.43606
22	180.592	36.9786	322426	30682.9	5.43605
23	187.39	35.5803	333038	31692.8	5.43605
24	194.189	34.4139	341318	32480.7	5.43604
25	200.987	33.4753	347201	33040.5	5.43604
26	207.785	32.7615	350729	33376.3	5.43605
27	214.583	32.2703	351937	33491.2	5.43604
28	221.382	32	350860	33388.7	5.43604
29	231.282	32	345330	32862.5	5.43605
30	237.463	32.2366	339630	32320.1	5.43605
31	243.643	32.6557	332308	31623.3	5.43605
32	249.823	33.2585	323465	30781.8	5.43605
33	256.003	34.0464	313215	29806.3	5.43604
34	262.183	35.0217	301696	28710.1	5.43603
35	268.364	36.1869	289053	27507	5.43604
36	274.544	37.5454	275444	26211.9	5.43603
37	280.724	39.101	261041	24841.4	5.43606
38	286.904	40.8582	246036	23413.4	5.43604
39	293.084	42.8225	230640	21948.3	5.43604
40	299.265	45	215087	20468.3	5.43606
41	306.078	47.6564	190966	18172.9	5.43607
42	312.892	50.5918	166625	15856.5	5.43606
43	319.706	53.8192	141900	13503.6	5.43606
44	326.519	57.354	117094	11143	5.43606
45	333.333	61.2142	92570.4	8809.24	5.43605
46	340.147	65.421	68776	6544.9	5.43604
47	346.96	70	46261.8	4402.39	5.43604
48	353.065	74.4431	28378.3	2700.55	5.43604
49	359.169	79.2357	13873.1	1320.2	5.43604
50	365.273	84.4098	3867.36	368.029	5.43606
51	371.377	90.0041	0	0	0

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.25555

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	202.706	121.835	0	0	0
2	204.721	120.227	-27.3576	-7.96099	16.2249
3	206.736	118.677	42.8475	12.4685	16.2248
4	208.752	117.182	195.735	56.9585	16.2249
5	210.767	115.741	414.121	120.508	16.2248
6	212.782	114.351	686.922	199.893	16.2249
7	214.797	113.01	1004.89	292.42	16.2248
8	216.813	111.718	1358.95	395.452	16.2249
9	218.828	110.472	1740.31	506.427	16.2249
10	220.843	109.271	2129.03	619.541	16.2248
11	222.859	108.114	2517.99	732.728	16.2248
12	224.874	107	2901.9	844.446	16.2249
13	226.888	105.928	3289.19	957.144	16.2248
14	228.902	104.896	3673.9	1069.1	16.2249
15	230.916	103.904	4050.79	1178.77	16.2249
16	232.931	102.95	4415.06	1284.77	16.2248
17	234.945	102.034	4762.37	1385.84	16.2249
18	236.959	101.155	5088.82	1480.83	16.2248
19	238.973	100.312	5390.9	1568.74	16.2249
20	240.987	99.5042	5665.5	1648.64	16.2248
21	243.002	98.7316	5909.87	1719.76	16.2249
22	245.016	97.9934	6121.62	1781.38	16.2249
23	247.03	97.2888	6298.74	1832.92	16.2249
24	249.044	96.6175	6439.5	1873.88	16.2249
25	251.058	95.9789	6542.53	1903.86	16.2249
26	253.072	95.3726	6606.77	1922.55	16.2248
27	255.087	94.7981	6631	1929.6	16.2248
28	257.101	94.2551	6614.56	1924.82	16.2249
29	259.115	93.7432	6557.69	1908.27	16.2249
30	261.129	93.262	6460.95	1880.12	16.2249
31	263.143	92.8113	6325.16	1840.6	16.2248
32	265.157	92.3907	6151.47	1790.06	16.2248
33	267.172	92	5941.33	1728.91	16.2248
34	269.273	91.624	5648.49	1643.7	16.2249
35	271.374	91.2799	5325	1549.56	16.2248
36	273.475	90.9676	4974.27	1447.5	16.2249
37	275.577	90.6869	4600.13	1338.63	16.2249
38	277.678	90.4375	4206.77	1224.16	16.2249
39	279.779	90.2194	3798.77	1105.43	16.2248
40	281.881	90.0323	3381.15	983.905	16.2248
41	283.982	89.8761	2959.32	861.155	16.2249
42	286.083	89.7508	2539.15	738.887	16.2249
43	288.184	89.6562	2126.95	618.938	16.2249
44	290.286	89.5924	1729.5	503.281	16.2249
45	292.387	89.5592	1354.05	394.025	16.2249
46	294.488	89.5566	1008.33	293.422	16.2248
47	296.589	89.5847	700.574	203.865	16.2248
48	298.691	89.6434	439.326	127.843	16.2249
49	300.792	89.7328	231.27	67.299	16.2249
50	302.893	89.8529	82.0181	23.8671	16.2249
51	304.995	90.0041	0	0	0

Discharge Sections

Entity Information

Short Term Stability

Shared Entities

Type	Coordinates (x,y)

External Boundary	0, 143.1 0, 107 0, 92 0, 70 0, 45 0, 32 0, 30 507.079, 30 507.079, 32 507.079, 45 507.079, 70 507.079, 90.0041 304.995, 90.0041 301.273, 91.0041 298.175, 92 298.162, 92.0041 295.126, 93.0041 292.109, 94.0041 289.098, 95.0041 286.091, 96.0041 283.086, 97.0041 280.082, 98.0041 277.08, 99.0041 274.077, 100.004 271.075, 101.004 268.074, 102.004 265.072, 103.004 262.071, 104.004 259.07, 105.004 256.069, 106.004 253.081, 107 217.513, 118.853 216.548, 119.004 211.914, 120.004 207.426, 121.004 201.745, 122.004 197.226, 123.004 193.313, 124.004 188.403, 125.004 179.593, 126.004 170.433, 127.004 161.071, 128.004 155.225, 129.004 150.093, 130.004 145.028, 131.004 139.008, 132.004 131.517, 133.004 125.528, 134.004 120.738, 135.004 115.882, 136.004 110.034, 137.004 102.929, 138.004 95.7043, 139.004 86.772, 140.004 73.3252, 141.004 59.4448, 142.004 5.191, 143.004
Material Boundary	0, 70 507.079, 70

Material Boundary	0, 45 507.079, 45
Material Boundary	0, 92 298.175, 92
Material Boundary	0, 107 253.081, 107
Material Boundary	0, 32 507.079, 32

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 70 507.079, 70	Assigned to: 🟨 Surficial Aquifer

Long Term Stability

Shared Entities

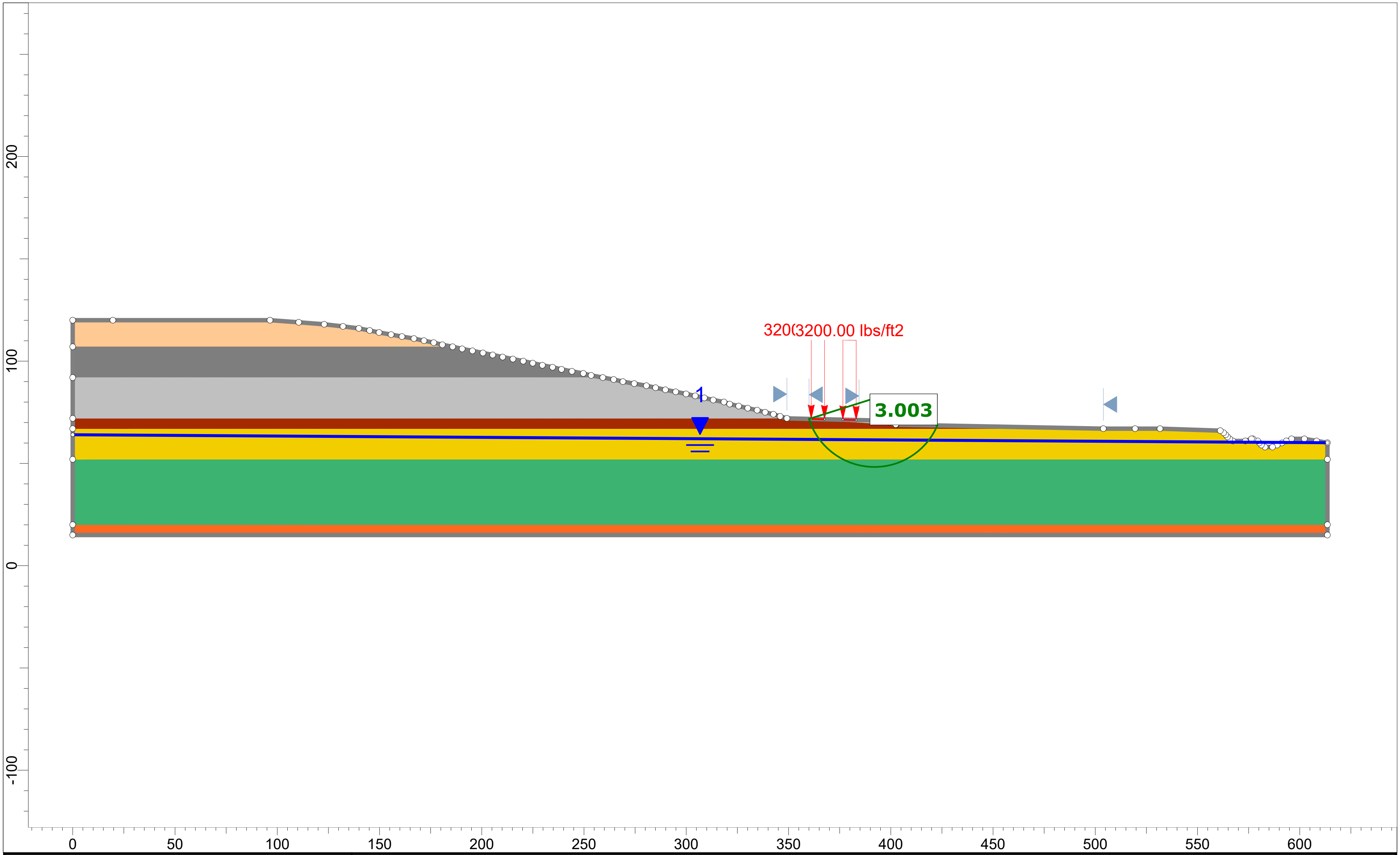
Type	Coordinates (x,y)

External Boundary	0, 143.1 0, 107 0, 92 0, 70 0, 45 0, 32 0, 30 507.079, 30 507.079, 32 507.079, 45 507.079, 70 507.079, 90.0041 304.995, 90.0041 301.273, 91.0041 298.175, 92 298.162, 92.0041 295.126, 93.0041 292.109, 94.0041 289.098, 95.0041 286.091, 96.0041 283.086, 97.0041 280.082, 98.0041 277.08, 99.0041 274.077, 100.004 271.075, 101.004 268.074, 102.004 265.072, 103.004 262.071, 104.004 259.07, 105.004 256.069, 106.004 253.081, 107 217.513, 118.853 216.548, 119.004 211.914, 120.004 207.426, 121.004 201.745, 122.004 197.226, 123.004 193.313, 124.004 188.403, 125.004 179.593, 126.004 170.433, 127.004 161.071, 128.004 155.225, 129.004 150.093, 130.004 145.028, 131.004 139.008, 132.004 131.517, 133.004 125.528, 134.004 120.738, 135.004 115.882, 136.004 110.034, 137.004 102.929, 138.004 95.7043, 139.004 86.772, 140.004 73.3252, 141.004 59.4448, 142.004 5.191, 143.004
Material Boundary	0, 70 507.079, 70

Material Boundary	0, 45 507.079, 45
Material Boundary	0, 92 298.175, 92
Material Boundary	0, 107 253.081, 107
Material Boundary	0, 32 507.079, 32

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 70 507.079, 70	Assigned to: 🟨 Surficial Aquifer ▨ Black Creek Confining Unit (Long Term) 🟧 Black Creek Aquifer



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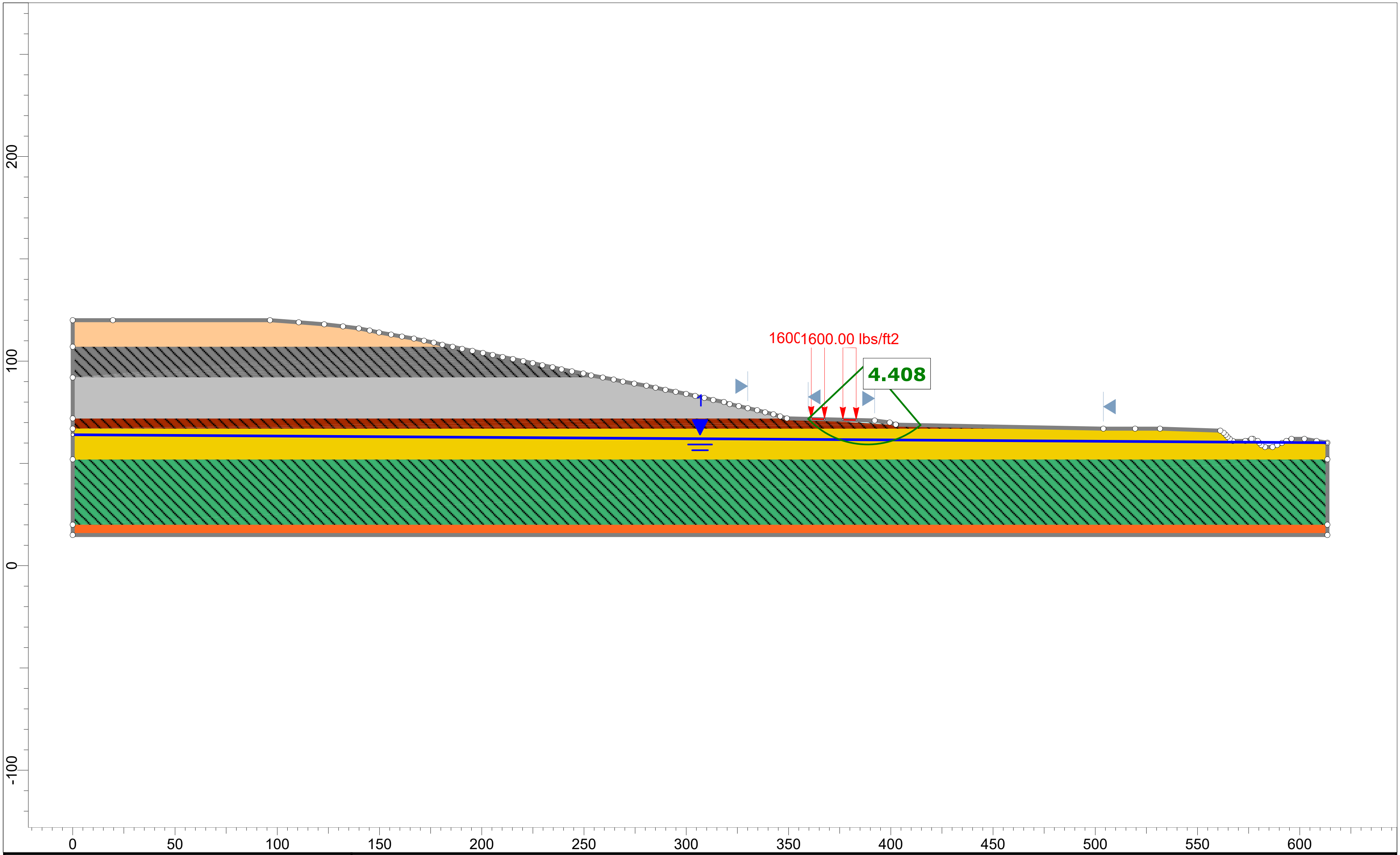
Geotechnical, Environmental and Materials Engineers

SLIDEINTERPRET 9.020

Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Short Term Slope Stability	*Section* Section 8 - MT3500 Dynamic Pressure Stability - 3200 psf
Drawn By	*Station* Approx. STA 77+10
Date	*File Name* section-8.slmd

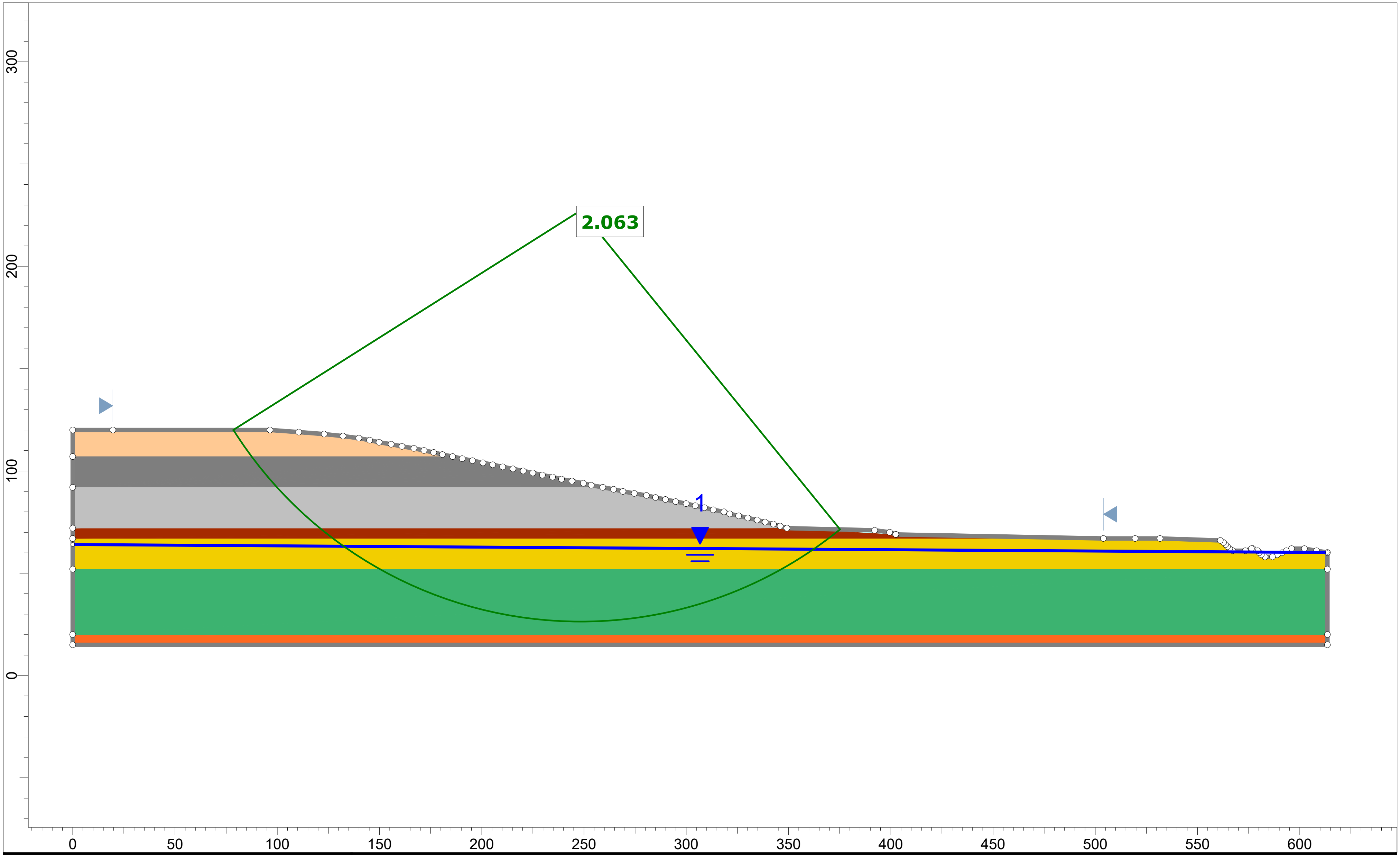


Universal Engineering Sciences

Geotechnical, Environmental and Materials Engineers

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 8 - MT3500 Static Pressure Stability - 1600 psf
Drawn By		*Station*	Approx. STA 77+10
Date		*File Name*	section-8.slmd

SLIDEINTERPRET 9.020



Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Short Term Slope Stability	Section	Section 8
Drawn By		Station	Approx. STA 77+10
Date		File Name	section-8.slmd

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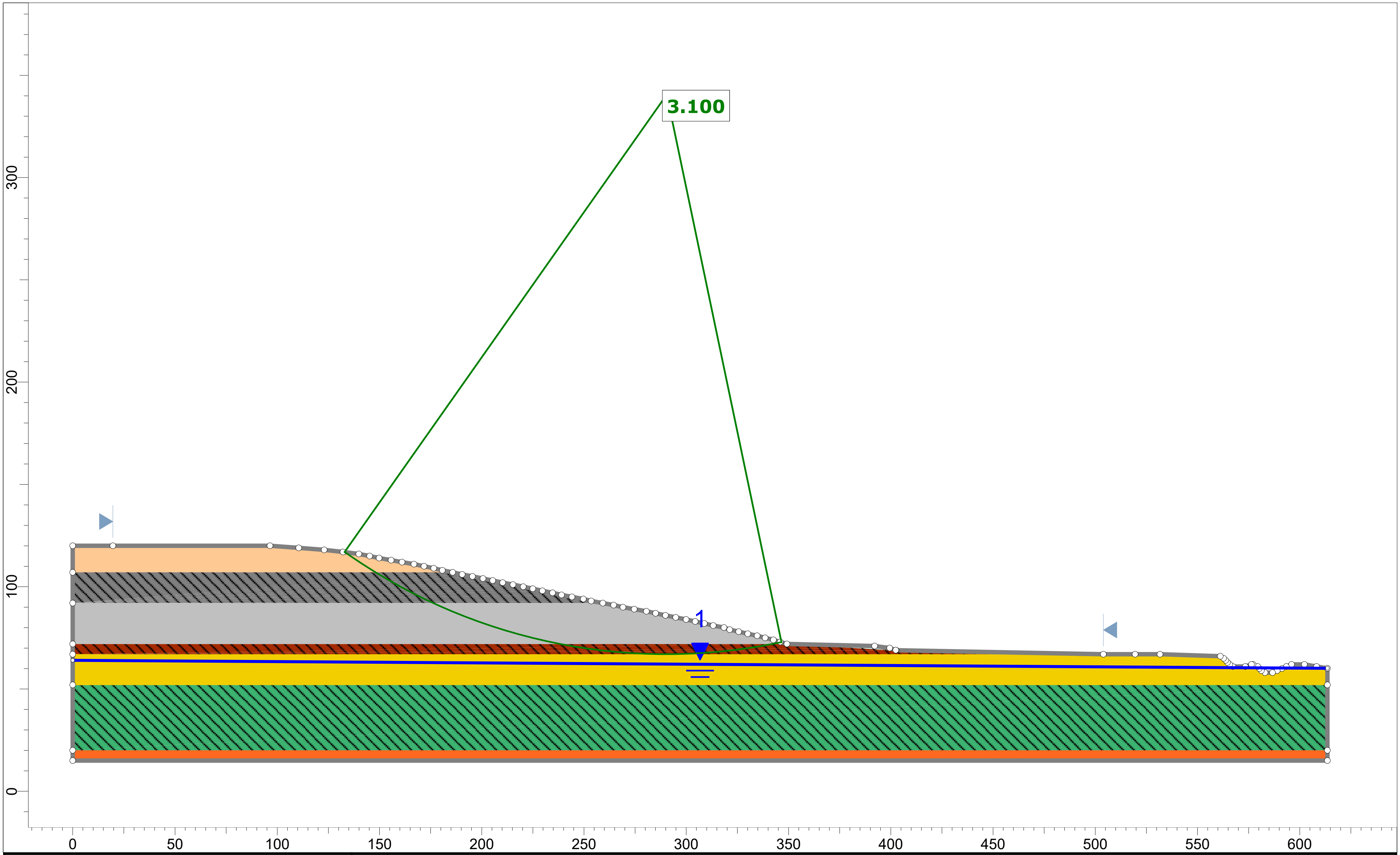

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Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 8
Drawn By		*Station*	Approx. STA 77+10
Date		*File Name*	section-8.slmd

SLIDEINTERPRET 9.020

Section-8
45-20803 Barrier Wall Road Interim Design and Repair
Approx. STA 77+10
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-8

Project Summary

File Name:	section-8.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Long Term Slope Stability

Comments

Section 8
Approx. STA 77+10

Currently Open Scenarios

Group Name		Scenario Name	Global Minimum	Compute Time
Dynamic Stability - 3200 psf	◆	Master Scenario	Spencer: 3.002520	00h:00m:07.487s
Static Stability - 1600 psf Drained	◆	Master Scenario	Spencer: 4.408300	00h:00m:07.492s
Short Term Stability	◆	Master Scenario	Spencer: 2.062620	00h:00m:10.146s
Long Term Stability	◆	Master Scenario	Spencer: 3.099890	00h:00m:07.187s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

Dynamic Stability - 3200 psf

Distribution: Constant
Magnitude [psf]: 3200
Orientation: Vertical

Distribution: Constant
Magnitude [psf]: 3200
Orientation: Vertical

Static Stability - 1600 psf Drained

Distribution: Constant
Magnitude [psf]: 1600
Orientation: Vertical

Distribution: Constant
Magnitude [psf]: 1600
Orientation: Vertical

Materials

Light Brown Sand	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	⬛
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	⬜
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay	
Color	🟥
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	1100
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	200

Friction Angle [deg]	24
Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Hu Value	1
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Hu Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Compacted Fill	
Color	🟦
Strength Type	Undrained
Unit Weight [lbs/ft3]	125
Cohesion [psf]	2000
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200

Friction Angle [deg]	28
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material		Dynamic Stability - 3200 psf	Static Stability - 1600 psf Drained	Short Term Stability	Long Term Stability
Light Brown Sand	🟧	✓	✓	✓	✓
Dark Gray Clay	⬛	✓	✗	✓	✗
Dark Gray Clay (Drained)	▨	✗	✓	✗	✓
Light Gray Sand	⬜	✓	✓	✓	✓
Perched Clay	🟥	✓	✗	✓	✗
Perched Clay (Drained)	▨	✗	✓	✗	✓
Surficial Aquifer	🟨	✓	✓	✓	✓
Black Creek Confining Unit	🟩	✓	✗	✓	✗
Black Creek Confining Unit (Long Term)	▨	✗	✓	✗	✓
Black Creek Aquifer	🟧	✓	✓	✓	✓
Compacted Fill	🟦	✓	✗	✓	✗
Compacted Fill (Drained)	▨	✗	✓	✗	✓

Global Minimums

Dynamic Stability - 3200 psf

Method: spencer

FS	3.002520
Center:	392.023, 81.792
Radius:	33.553
Left Slip Surface Endpoint:	360.009, 71.748
Right Slip Surface Endpoint:	422.855, 68.558
Resisting Moment:	2.93063e+06 lb-ft
Driving Moment:	976056 lb-ft
Resisting Horizontal Force:	65614.6 lb
Driving Horizontal Force:	21853.2 lb
Total Slice Area:	1012.75 ft2
Surface Horizontal Width:	62.8466 ft
Surface Average Height:	16.1147 ft

Static Stability - 1600 psf Drained

Method: spencer

FS	4.408300
Center:	388.691, 99.302
Radius:	40.075
Left Slip Surface Endpoint:	359.582, 71.758
Right Slip Surface Endpoint:	414.586, 68.717
Resisting Moment:	1.96878e+06 lb-ft
Driving Moment:	446607 lb-ft
Resisting Horizontal Force:	45391.9 lb
Driving Horizontal Force:	10296.9 lb
Total Slice Area:	434.818 ft2
Surface Horizontal Width:	55.0035 ft
Surface Average Height:	7.90528 ft

Short Term Stability

Method: spencer

FS	2.062620
Center:	248.397, 227.329
Radius:	200.977
Left Slip Surface Endpoint:	78.478, 120.000
Right Slip Surface Endpoint:	375.188, 71.394
Resisting Moment:	1.03817e+08 lb-ft
Driving Moment:	5.03325e+07 lb-ft
Resisting Horizontal Force:	456183 lb
Driving Horizontal Force:	221167 lb
Total Slice Area:	14702.2 ft2
Surface Horizontal Width:	296.709 ft
Surface Average Height:	49.551 ft

◆ Long Term Stability

Method: spencer

FS	3.099890
Center:	290.456, 340.525
Radius:	273.544
Left Slip Surface Endpoint:	132.915, 116.903
Right Slip Surface Endpoint:	346.569, 72.798
Resisting Moment:	6.67822e+07 lb-ft
Driving Moment:	2.15434e+07 lb-ft
Resisting Horizontal Force:	234978 lb
Driving Horizontal Force:	75802.2 lb
Total Slice Area:	3550.45 ft2
Surface Horizontal Width:	213.654 ft
Surface Average Height:	16.6178 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Dynamic Stability - 3200 psf

Method: spencer

Number of Valid Surfaces: 20917
Number of Invalid Surfaces: 0

Static Stability - 1600 psf Drained

Method: spencer

Number of Valid Surfaces: 24440
Number of Invalid Surfaces: 0

Short Term Stability

Method: spencer

Number of Valid Surfaces: 86097
Number of Invalid Surfaces: 0

Long Term Stability

Method: spencer

Number of Valid Surfaces: 82317
Number of Invalid Surfaces: 0

Slice Data

Dynamic Stability - 3200 psf

Global Minimum Query (spencer) - Safety Factor: 3.00252

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.0664763	0.863889	-72.3935	Compacted Fill	2000	0	666.107	2000	-1702.38	0	-1702.38	396.625	396.625
2	1.83153	500.968	-68.0234	Perched Clay	1100	0	366.359	1100	699.344	0	699.344	1607.18	1607.18
3	1.0838	689.757	-61.8774	Surficial Aquifer	75	32	553.199	1660.99	2538.12	0	2538.12	3573.18	3573.18
4	1.0838	922.214	-58.1595	Surficial Aquifer	75	32	611.743	1836.77	2819.42	0	2819.42	3804.51	3804.51
5	1.0838	1124.04	-54.7996	Surficial Aquifer	75	32	663.096	1990.96	3066.17	0	3066.17	4006.16	4006.16
6	1.27006	1542.43	-51.4536	Surficial Aquifer	75	32	704.345	2114.81	3313.86	49.4777	3264.38	4197.87	4148.39
7	1.27006	1758.5	-48.0895	Surficial Aquifer	75	32	692.768	2080.05	3351.6	142.858	3208.74	4123.42	3980.56
8	1.27006	1950.7	-44.9339	Surficial Aquifer	75	32	235.577	707.326	1237.97	226.039	1011.93	1473	1246.97
9	1.27006	2122.91	-41.9438	Surficial Aquifer	75	32	250.426	751.908	1383.96	300.682	1083.28	1609	1308.32
10	1.27006	2277.93	-39.0885	Surficial Aquifer	75	32	264.295	793.552	1517.9	367.98	1149.92	1732.6	1364.62
11	1.27006	2417.84	-36.3448	Surficial Aquifer	75	32	277.286	832.558	1641.17	428.824	1212.35	1845.19	1416.37
12	1.27006	2545.1	-33.6949	Surficial Aquifer	75	32	289.596	869.517	1755.39	483.901	1271.49	1948.49	1464.59
13	1.27006	2660.91	-31.1245	Surficial Aquifer	75	32	301.286	904.618	1861.41	533.749	1327.66	2043.34	1509.59
14	1.27006	2765.49	-28.6222	Surficial Aquifer	75	32	312.906	939.507	1962.3	578.8	1383.5	2133.06	1554.26
15	1.34209	3026.56	-26.1105	Black Creek Confining Unit	909.864	0	303.033	909.864	5167.33	0	5167.33	5315.86	5315.86
16	1.34209	3124.43	-23.5838	Black Creek Confining Unit	928.519	0	309.247	928.519	5268.78	0	5268.78	5403.78	5403.78
17	1.34209	3211.05	-21.105	Black Creek Confining Unit	945.078	0	314.762	945.078	5361.68	0	5361.68	5483.17	5483.17
18	1.34209	3286.99	-18.667	Black Creek Confining Unit	959.649	0	319.615	959.649	5446.49	0	5446.49	5554.47	5554.47
19	1.34209	3351.91	-16.2636	Black Creek Confining Unit	972.323	0	323.836	972.323	5056.27	0	5056.27	5150.74	5150.74
20	1.34209	3406.41	-13.8894	Black Creek Confining Unit	983.174	0	327.45	983.174	2439.8	0	2439.8	2520.77	2520.77
21	1.34209	3451.45	-11.5392	Black Creek Confining Unit	992.262	0	330.476	992.262	2492.98	0	2492.98	2560.45	2560.45

22	1.34209	3487.28	-9.20869	Black Creek Confining Unit	999.636	0	332.932	999.636	2539.46	0	2539.46	2593.43	2593.43
23	1.34209	3514.12	-6.89342	Black Creek Confining Unit	1005.33	0	334.829	1005.33	2579.34	0	2579.34	2619.82	2619.82
24	1.34209	3532.11	-4.58943	Black Creek Confining Unit	1009.38	0	336.178	1009.38	2612.75	0	2612.75	2639.74	2639.74
25	1.34209	3541.37	-2.29287	Black Creek Confining Unit	1011.81	0	336.987	1011.81	2639.73	0	2639.73	2653.22	2653.22
26	1.34209	3539.47	0	Black Creek Confining Unit	1012.61	0	337.253	1012.61	2658.48	0	2658.48	2658.48	2658.48
27	1.34209	3509.97	2.29287	Black Creek Confining Unit	1011.81	0	336.987	1011.81	2656.65	0	2656.65	2643.16	2643.16
28	1.34209	3467.83	4.58943	Black Creek Confining Unit	1009.38	0	336.178	1009.38	2645.36	0	2645.36	2618.38	2618.38
29	1.34209	3416.95	6.89342	Black Creek Confining Unit	1005.33	0	334.829	1005.33	2627.49	0	2627.49	2587.01	2587.01
30	1.34209	3357.23	9.20869	Black Creek Confining Unit	999.636	0	332.932	999.636	2602.92	0	2602.92	2548.95	2548.95
31	1.34209	3288.51	11.5392	Black Creek Confining Unit	992.262	0	330.476	992.262	2571.54	0	2571.54	2504.07	2504.07
32	1.34209	3189.68	13.8894	Black Creek Confining Unit	983.174	0	327.45	983.174	2517.35	0	2517.35	2436.38	2436.38
33	1.34209	3057.02	16.2636	Black Creek Confining Unit	972.323	0	323.836	972.323	2437.34	0	2437.34	2342.87	2342.87
34	1.34209	2927.7	18.667	Black Creek Confining Unit	959.649	0	319.615	959.649	2359.64	0	2359.64	2251.66	2251.66
35	1.34209	2840.34	21.105	Black Creek Confining Unit	945.078	0	314.762	945.078	2313.78	0	2313.78	2192.29	2192.29
36	1.34209	2747.64	23.5838	Black Creek Confining Unit	928.519	0	309.247	928.519	2263.87	0	2263.87	2128.87	2128.87
37	1.34209	2643.68	26.1105	Black Creek Confining Unit	909.864	0	303.033	909.864	2205.37	0	2205.37	2056.84	2056.84
38	1.24158	2344.98	28.5942	Surficial Aquifer	75	32	361.43	1085.2	2183.29	566.632	1616.66	1986.28	1419.65
39	1.24158	2240.07	31.0389	Surficial Aquifer	75	32	358.146	1075.34	2122.59	521.715	1600.88	1907.06	1385.35
40	1.24158	2124.69	33.5483	Surficial Aquifer	75	32	354.186	1063.45	2054.08	472.227	1581.86	1819.22	1347
41	1.24158	1997.95	36.133	Surficial Aquifer	75	32	349.507	1049.4	1977.14	417.769	1559.37	1721.96	1304.19
42	1.24158	1858.7	38.8062	Surficial Aquifer	75	32	344.053	1033.03	1891	357.845	1533.16	1614.32	1256.47
43	1.24158	1705.5	41.584	Surficial Aquifer	75	32	337.764	1014.14	1794.77	291.829	1502.94	1495.05	1203.23

44	1.24158	1536.53	44.4875	Surficial Aquifer	75	32	330.569	992.541	1687.29	218.916	1468.37	1362.58	1143.66
45	1.24158	1349.33	47.5443	Surficial Aquifer	75	32	322.401	968.015	1567.16	138.035	1429.12	1214.77	1076.74
46	1.24158	1140.54	50.7921	Surficial Aquifer	75	32	313.204	940.4	1432.65	47.7224	1384.93	1048.74	1001.01
47	1.16927	859.916	54.1753	Surficial Aquifer	75	32	287.562	863.412	1261.72	0	1261.72	863.369	863.369
48	1.16927	623.518	57.7526	Surficial Aquifer	75	32	239.412	718.84	1030.36	0	1030.36	650.877	650.877
49	1.16927	349.823	61.7325	Surficial Aquifer	75	32	174.49	523.909	718.407	0	718.407	393.904	393.904
50	0.716492	61.9447	65.3054	Perched Clay	1100	0	366.359	1100	1050.18	0	1050.18	253.459	253.459

Static Stability - 1600 psf Drained

Global Minimum Query (spencer) - Safety Factor: 4.4083

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.197144	2.49221	-46.3779	Compacted Fill (Drained)	200	28	42.4427	187.1	-24.2613	0	-24.2613	20.2736	20.2736
2	1.03859	84.6085	-45.1214	Perched Clay (Drained)	200	24	48.8025	215.136	33.9959	0	33.9959	83.0056	83.0056
3	1.03859	197.155	-43.053	Perched Clay (Drained)	200	24	157.999	696.506	1115.17	0	1115.17	1262.78	1262.78
4	1.03859	301.79	-41.0523	Perched Clay (Drained)	200	24	204.778	902.724	1578.34	0	1578.34	1756.68	1756.68
5	1.03859	399.232	-39.1108	Perched Clay (Drained)	200	24	214.85	947.123	1678.07	0	1678.07	1852.74	1852.74
6	1.03859	490.073	-37.2215	Perched Clay (Drained)	200	24	224.414	989.284	1772.76	0	1772.76	1943.23	1943.23
7	1.11731	623.802	-35.3103	Surficial Aquifer	75	32	278.291	1226.79	1843.25	0	1843.25	2040.37	2040.37
8	1.11731	719.089	-33.375	Surficial Aquifer	75	32	291.759	1286.16	1938.27	0	1938.27	2130.46	2130.46
9	1.11731	807.488	-31.4818	Surficial Aquifer	75	32	174.085	767.419	1108.1	0	1108.1	1214.71	1214.71
10	1.11731	889.422	-29.6263	Surficial Aquifer	75	32	115.912	510.973	697.702	0	697.702	763.62	763.62
11	1.11731	965.253	-27.8044	Surficial Aquifer	75	32	125.534	553.393	765.589	0	765.589	831.789	831.789
12	1.11731	1035.29	-26.0126	Surficial Aquifer	75	32	134.62	593.445	829.686	0	829.686	895.381	895.381
13	1.11731	1099.81	-24.2478	Surficial Aquifer	75	32	143.18	631.181	890.072	0	890.072	954.563	954.563
14	1.11731	1159.71	-22.5071	Surficial Aquifer	75	32	151.303	666.989	947.381	0	947.381	1010.07	1010.07
15	1.11731	1215.13	-20.7881	Surficial Aquifer	75	32	158.991	700.881	1001.62	0	1001.62	1061.98	1061.98
16	1.11866	1267.2	-19.0875	Surficial Aquifer	75	32	164.559	725.426	1052.75	11.851	1040.9	1109.7	1097.84
17	1.11866	1313.07	-17.4032	Surficial Aquifer	75	32	297.314	1310.65	2011.88	34.4268	1977.45	2105.07	2070.64
18	1.11866	1354.31	-15.7342	Surficial Aquifer	75	32	386.342	1703.11	2660.27	54.7583	2605.52	2769.12	2714.36
19	1.11866	1391.05	-14.0789	Surficial Aquifer	75	32	391.16	1724.35	2712.41	72.9031	2639.51	2810.51	2737.61
20	1.11866	1423.38	-12.4355	Surficial Aquifer	75	32	395.767	1744.66	2760.92	88.9112	2672.01	2848.19	2759.28
21	1.11866	1451.4	-10.8024	Surficial Aquifer	75	32	400.166	1764.05	2805.88	102.826	2703.05	2882.23	2779.41
22	1.11866	1474.75	-9.17816	Surficial Aquifer	75	32	404.312	1782.33	2846.98	114.683	2732.29	2912.3	2797.62
23	1.11866	1493.33	-7.56133	Surficial Aquifer	75	32	233.363	1028.74	1650.81	124.514	1526.3	1681.79	1557.27
24	1.11866	1507.78	-5.95055	Surficial Aquifer	75	32	187.33	825.807	1333.88	132.343	1201.54	1353.41	1221.07
25	1.11866	1518.14	-4.34448	Surficial Aquifer	75	32	189.169	833.912	1352.7	138.191	1214.51	1367.07	1228.88
26	1.11866	1524.45	-2.74182	Surficial Aquifer	75	32	190.796	841.087	1368.07	142.073	1225.99	1377.2	1235.13
27	1.11866	1526.72	-1.1413	Surficial Aquifer	75	32	192.209	847.317	1379.96	143.998	1235.97	1383.79	1239.79
28	1.11866	1524.98	0.458317	Surficial Aquifer	75	32	193.405	852.587	1388.37	143.973	1244.4	1386.82	1242.85
29	1.11866	1519.21	2.0583	Surficial Aquifer	75	32	194.379	856.879	1393.26	141.998	1251.27	1386.28	1244.28

30	1.11866	1509.42	3.65988	Surficial Aquifer	75	32	195.126	860.172	1394.6	138.069	1256.53	1382.12	1244.05
31	1.11866	1490.78	5.26434	Surficial Aquifer	75	32	195.007	859.649	1387.88	132.179	1255.7	1369.92	1237.74
32	1.11866	1455.84	6.87296	Surficial Aquifer	75	32	193.013	850.861	1365.95	124.315	1241.64	1342.69	1218.37
33	1.11866	1416.19	8.48704	Surficial Aquifer	75	32	190.658	840.477	1339.47	114.459	1225.01	1311.02	1196.56
34	1.11866	1372.38	10.1079	Surficial Aquifer	75	32	188.011	828.807	1308.93	102.587	1206.35	1275.42	1172.83
35	1.11866	1324.36	11.7371	Surficial Aquifer	75	32	185.061	815.804	1274.21	88.672	1185.54	1235.76	1147.09
36	1.11866	1272.06	13.3759	Surficial Aquifer	75	32	181.796	801.413	1235.18	72.6797	1162.5	1191.95	1119.27
37	1.11866	1214.96	15.0259	Surficial Aquifer	75	32	178.143	785.307	1191.3	54.5699	1136.73	1143.48	1088.91
38	1.11866	1133.44	16.6889	Surficial Aquifer	75	32	171.355	755.383	1123.14	34.2957	1088.84	1071.76	1037.47
39	1.11866	1036.24	18.3664	Surficial Aquifer	75	32	162.582	716.71	1038.75	11.8027	1026.95	984.772	972.97
40	1.17038	978.659	20.1	Surficial Aquifer	75	32	151.546	668.062	949.095	0	949.095	893.637	893.637
41	1.17038	904.722	21.8927	Surficial Aquifer	75	32	142.879	629.853	887.953	0	887.953	830.537	830.537
42	1.17038	835.589	23.7082	Surficial Aquifer	75	32	134.747	594.007	830.585	0	830.585	771.412	771.412
43	1.17038	760.455	25.5494	Surficial Aquifer	75	32	125.647	553.891	766.385	0	766.385	706.321	706.321
44	1.17038	679.049	27.4194	Surficial Aquifer	75	32	115.501	509.161	694.804	0	694.804	634.884	634.884
45	1.17038	591.055	29.3216	Surficial Aquifer	75	32	104.215	459.411	615.186	0	615.186	556.652	556.652
46	1.17038	496.109	31.2601	Surficial Aquifer	75	32	91.6784	404.146	526.744	0	526.744	471.09	471.09
47	1.17038	393.783	33.2393	Surficial Aquifer	75	32	77.7551	342.768	428.518	0	428.518	377.561	377.561
48	1.17038	283.577	35.2644	Surficial Aquifer	75	32	62.2766	274.534	319.32	0	319.32	275.284	275.284
49	1.08819	159.729	37.2667	Perched Clay (Drained)	200	24	68.2218	300.742	226.27	0	226.27	174.361	174.361
50	1.08819	54.4614	39.2488	Perched Clay (Drained)	200	24	56.886	250.771	114.033	0	114.033	67.5568	67.5568

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.06262

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	8.94418	6395.09	-55.4715	Light Brown Sand	75	32	165.973	342.339	427.831	0	427.831	669.066	669.066
2	6.19408	11782.2	-51.7939	Dark Gray Clay	1300	0	630.266	1300	1031.34	0	1031.34	1832.09	1832.09
3	6.19408	17313	-49.0198	Dark Gray Clay	1300	0	630.266	1300	1912.02	0	1912.02	2637.56	2637.56
4	7.01774	25246.4	-46.2272	Light Gray Sand	50	32	802.867	1656.01	2570.16	0	2570.16	3408.18	3408.18
5	7.01774	30489.4	-43.4041	Light Gray Sand	50	32	993.659	2049.54	3199.94	0	3199.94	4139.73	4139.73
6	7.01774	35176.1	-40.7073	Light Gray Sand	50	32	1173.14	2419.74	3792.38	0	3792.38	4801.7	4801.7
7	6.34563	35352.8	-38.2359	Perched Clay	1100	0	533.302	1100	4825.05	0	4825.05	5245.26	5245.26
8	5.25188	31503.6	-36.1571	Surficial Aquifer	75	32	1467.92	3027.76	4725.4	0	4725.4	5798.06	5798.06
9	5.89784	37602.3	-34.2132	Surficial Aquifer	75	32	1551.55	3200.25	5125.39	123.947	5001.44	6180.34	6056.39
10	5.89784	39664.3	-32.2029	Surficial Aquifer	75	32	1600.94	3302.14	5527.13	362.628	5164.5	6535.41	6172.78
11	5.89784	41340.3	-30.2362	Surficial Aquifer	75	32	1639.09	3380.83	5873.88	583.446	5290.43	6829.24	6245.79
12	5.95403	43316.8	-28.2991	Black Creek Confining Unit	948.084	0	459.65	948.084	6712.59	0	6712.59	6960.07	6960.07
13	5.95403	44813.2	-26.3877	Black Creek Confining Unit	1040.48	0	504.446	1040.48	6980.5	0	6980.5	7230.78	7230.78
14	5.95403	46146.1	-24.5074	Black Creek Confining Unit	1125.51	0	545.67	1125.51	7226.71	0	7226.71	7475.47	7475.47
15	5.95403	47249.2	-22.6549	Black Creek Confining Unit	1203.5	0	583.481	1203.5	7439.8	0	7439.8	7683.34	7683.34
16	5.95403	48116	-20.8272	Black Creek Confining Unit	1274.75	0	618.025	1274.75	7617.95	0	7617.95	7853.05	7853.05
17	5.95403	48801	-19.0213	Black Creek Confining Unit	1339.51	0	649.422	1339.51	7769.24	0	7769.24	7993.12	7993.12
18	5.95403	49345.5	-17.2349	Black Creek Confining Unit	1398.01	0	677.784	1398.01	7899.89	0	7899.89	8110.15	8110.15
19	5.95403	49729.6	-15.4656	Black Creek Confining Unit	1450.42	0	703.193	1450.42	8006.18	0	8006.18	8200.74	8200.74
20	5.95403	49996.1	-13.7114	Black Creek Confining Unit	1496.93	0	725.742	1496.93	8094.72	0	8094.72	8271.79	8271.79
21	5.95403	50085.6	-11.9701	Black Creek Confining Unit	1537.65	0	745.484	1537.65	8155.35	0	8155.35	8313.4	8313.4
22	5.95403	50058.5	-10.2401	Black Creek Confining Unit	1572.72	0	762.487	1572.72	8197.66	0	8197.66	8335.41	8335.41

23	5.95403	49912.8	-8.51938	Black Creek Confining Unit	1602.23	0	776.794	1602.23	8220.99	0	8220.99	8337.36	8337.36
24	5.95403	49594	-6.80641	Black Creek Confining Unit	1626.27	0	788.449	1626.27	8216.01	0	8216.01	8310.12	8310.12
25	5.95403	49141	-5.09953	Black Creek Confining Unit	1644.9	0	797.481	1644.9	8188.81	0	8188.81	8259.98	8259.98
26	5.95403	48562.4	-3.39719	Black Creek Confining Unit	1658.17	0	803.914	1658.17	8140.55	0	8140.55	8188.27	8188.27
27	5.95403	47862.2	-1.69785	Black Creek Confining Unit	1666.12	0	807.769	1666.12	8071.55	0	8071.55	8095.5	8095.5
28	5.95403	47124.5	0	Black Creek Confining Unit	1668.77	0	809.054	1668.77	7995.72	0	7995.72	7995.72	7995.72
29	5.95403	46115.6	1.69785	Black Creek Confining Unit	1666.12	0	807.769	1666.12	7873.49	0	7873.49	7849.54	7849.54
30	5.95403	45151.7	3.39719	Black Creek Confining Unit	1658.17	0	803.914	1658.17	7757.75	0	7757.75	7710.03	7710.03
31	5.95403	44025.8	5.09953	Black Creek Confining Unit	1644.9	0	797.481	1644.9	7613.4	0	7613.4	7542.24	7542.24
32	5.95403	42772	6.80641	Black Creek Confining Unit	1626.27	0	788.449	1626.27	7445.83	0	7445.83	7351.73	7351.73
33	5.95403	41494.1	8.51938	Black Creek Confining Unit	1602.23	0	776.794	1602.23	7272.4	0	7272.4	7156.04	7156.04
34	5.95403	39977.9	10.2401	Black Creek Confining Unit	1572.72	0	762.487	1572.72	7056.25	0	7056.25	6918.51	6918.51
35	5.95403	38283.5	11.9701	Black Creek Confining Unit	1537.65	0	745.484	1537.65	6807.14	0	6807.14	6649.09	6649.09
36	5.95403	36504.5	13.7114	Black Creek Confining Unit	1496.93	0	725.742	1496.93	6540.67	0	6540.67	6363.6	6363.6
37	5.95403	34553	15.4656	Black Creek Confining Unit	1450.42	0	703.193	1450.42	6241.25	0	6241.25	6046.69	6046.69
38	5.95403	32391.5	17.2349	Black Creek Confining Unit	1398.01	0	677.784	1398.01	5901.76	0	5901.76	5691.5	5691.5
39	5.95403	30097.3	19.0213	Black Creek Confining Unit	1339.51	0	649.422	1339.51	5534.94	0	5534.94	5311.06	5311.06
40	5.95403	27602.9	20.8272	Black Creek Confining Unit	1274.75	0	618.025	1274.75	5128.31	0	5128.31	4893.21	4893.21
41	5.95403	24857.2	22.6549	Black Creek Confining Unit	1203.5	0	583.481	1203.5	4672.01	0	4672.01	4428.47	4428.47

42	5.95403	22089.6	24.5074	Black Creek Confining Unit	1125.51	0	545.67	1125.51	4205.3	0	4205.3	3956.53	3956.53
43	5.95403	19098.1	26.3877	Black Creek Confining Unit	1040.48	0	504.446	1040.48	3691.64	0	3691.64	3441.37	3441.37
44	5.95403	15831.9	28.2991	Black Creek Confining Unit	948.084	0	459.65	948.084	3120.62	0	3120.62	2873.13	2873.13
45	5.20259	11039.8	30.1204	Surficial Aquifer	75	32	719.338	1483.72	2771.22	516.796	2254.42	2353.89	1837.1
46	5.20259	9001.04	31.8509	Surficial Aquifer	75	32	649.363	1339.39	2343.18	319.728	2023.45	1939.75	1620.03
47	5.20259	6937.88	33.6146	Surficial Aquifer	75	32	579.729	1195.76	1902.52	108.926	1793.59	1517.13	1408.21
48	7.33762	5988.69	35.7947	Surficial Aquifer	75	32	413.416	852.72	1244.61	0	1244.61	946.5	946.5
49	4.88519	1410.03	37.9676	Perched Clay	1100	0	533.302	1100	822.954	0	822.954	406.778	406.778
50	0.718902	26.8941	38.9828	Compacted Fill	2000	0	969.641	2000	1018.75	0	1018.75	234.033	234.033

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 3.09989

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.77258	440.113	-34.6841	Light Brown Sand	75	32	41.2816	127.968	84.767	0	84.767	113.335	113.335
2	3.77258	1300.15	-33.7286	Light Brown Sand	75	32	79.0889	245.167	272.323	0	272.323	325.126	325.126
3	3.77258	2065.63	-32.7836	Light Brown Sand	75	32	113.297	351.209	442.028	0	442.028	514.997	514.997
4	3.77258	2749.87	-31.8485	Light Brown Sand	75	32	144.393	447.601	596.286	0	596.286	685.982	685.982
5	4.02341	3672.26	-30.8923	Dark Gray Clay (Drained)	200	25	177.995	551.764	754.361	0	754.361	860.856	860.856
6	4.02341	4500.68	-29.9151	Dark Gray Clay (Drained)	200	25	205.478	636.958	937.061	0	937.061	1055.29	1055.29
7	4.02341	5274.06	-28.9475	Dark Gray Clay (Drained)	200	25	231.516	717.674	1110.16	0	1110.16	1238.21	1238.21
8	4.02341	6000.65	-27.9887	Dark Gray Clay (Drained)	200	25	256.337	794.616	1275.16	0	1275.16	1411.39	1411.39
9	4.02341	6704.77	-27.0385	Dark Gray Clay (Drained)	200	25	280.702	870.145	1437.13	0	1437.13	1580.39	1580.39
10	4.02341	7327.21	-26.0962	Dark Gray Clay (Drained)	200	25	302.648	938.176	1583.02	0	1583.02	1731.27	1731.27
11	4.02341	7890.24	-25.1614	Dark Gray Clay (Drained)	200	25	322.86	1000.83	1717.39	0	1717.39	1869.05	1869.05
12	4.14191	8624.78	-24.2202	Light Gray Sand	50	32	384.246	1191.12	1826.17	0	1826.17	1999.02	1999.02
13	4.14191	9075.44	-23.2724	Light Gray Sand	50	32	406.224	1259.25	1935.21	0	1935.21	2109.92	2109.92
14	4.14191	9513.83	-22.3312	Light Gray Sand	50	32	427.912	1326.48	2042.8	0	2042.8	2218.57	2218.57
15	4.14191	9869.53	-21.3964	Light Gray Sand	50	32	446.229	1383.26	2133.66	0	2133.66	2308.51	2308.51
16	4.14191	10213.3	-20.4675	Light Gray Sand	50	32	464.207	1438.99	2222.85	0	2222.85	2396.11	2396.11
17	4.14191	10528.5	-19.5442	Light Gray Sand	50	32	481.111	1491.39	2306.71	0	2306.71	2477.5	2477.5
18	4.14191	10791.5	-18.6261	Light Gray Sand	50	32	495.853	1537.09	2379.84	0	2379.84	2546.97	2546.97
19	4.14191	11011.3	-17.713	Light Gray Sand	50	32	508.802	1577.23	2444.07	0	2444.07	2606.58	2606.58
20	4.14191	11205.7	-16.8045	Light Gray Sand	50	32	520.725	1614.19	2503.22	0	2503.22	2660.48	2660.48
21	4.14191	11375.3	-15.9003	Light Gray Sand	50	32	531.622	1647.97	2557.28	0	2557.28	2708.72	2708.72
22	4.14191	11508.2	-15.0002	Light Gray Sand	50	32	540.945	1676.87	2603.53	0	2603.53	2748.48	2748.48
23	4.14191	11586.3	-14.1039	Light Gray Sand	50	32	547.826	1698.2	2637.66	0	2637.66	2775.3	2775.3
24	4.14191	11625.8	-13.211	Light Gray Sand	50	32	552.965	1714.13	2663.18	0	2663.18	2792.99	2792.99
25	4.14191	11649.6	-12.3214	Light Gray Sand	50	32	557.404	1727.89	2685.18	0	2685.18	2806.94	2806.94
26	4.14191	11629.4	-11.4349	Light Gray Sand	50	32	559.804	1735.33	2697.09	0	2697.09	2810.32	2810.32
27	4.44991	12413.7	-10.5183	Perched Clay (Drained)	200	24	451.787	1400.49	2696.34	0	2696.34	2780.22	2780.22

28	4.44991	12342.1	-9.57168	Perched Clay (Drained)	200	24	451.835	1400.64	2696.68	0	2696.68	2772.87	2772.87
29	4.44991	12242.3	-8.62769	Perched Clay (Drained)	200	24	450.981	1397.99	2690.72	0	2690.72	2759.15	2759.15
30	4.44991	11999.7	-7.68605	Perched Clay (Drained)	200	24	445.567	1381.21	2653.06	0	2653.06	2713.19	2713.19
31	4.44991	11841	-6.7465	Perched Clay (Drained)	200	24	442.758	1372.5	2633.47	0	2633.47	2685.84	2685.84
32	4.44991	11652.8	-5.80877	Perched Clay (Drained)	200	24	438.954	1360.71	2606.98	0	2606.98	2651.64	2651.64
33	4.44991	11383.5	-4.8726	Perched Clay (Drained)	200	24	432.483	1340.65	2561.95	0	2561.95	2598.82	2598.82
34	4.44991	11102	-3.93773	Perched Clay (Drained)	200	24	425.538	1319.12	2513.59	0	2513.59	2542.88	2542.88
35	4.44991	10832.8	-3.00391	Perched Clay (Drained)	200	24	418.908	1298.57	2467.44	0	2467.44	2489.43	2489.43
36	4.44991	10532.4	-2.07089	Perched Clay (Drained)	200	24	411.179	1274.61	2413.6	0	2413.6	2428.46	2428.46
37	4.44991	10105.2	-1.13841	Perched Clay (Drained)	200	24	399.175	1237.4	2330.04	0	2330.04	2337.97	2337.97
38	6.41914	13771.7	0	Perched Clay (Drained)	200	24	383.121	1187.63	2218.26	0	2218.26	2218.26	2218.26
39	4.44989	8973.54	1.13841	Perched Clay (Drained)	200	24	366.344	1135.63	2101.45	0	2101.45	2094.17	2094.17
40	4.44989	8453.51	2.07088	Perched Clay (Drained)	200	24	350.735	1087.24	1992.77	0	1992.77	1980.09	1980.09
41	4.44989	7848.87	3.0039	Perched Clay (Drained)	200	24	332.092	1029.45	1862.97	0	1862.97	1845.54	1845.54
42	4.44989	7206.88	3.93772	Perched Clay (Drained)	200	24	311.969	967.07	1722.87	0	1722.87	1701.39	1701.39
43	4.44989	6533	4.87259	Perched Clay (Drained)	200	24	290.529	900.608	1573.59	0	1573.59	1548.82	1548.82
44	4.44989	5854.35	5.80876	Perched Clay (Drained)	200	24	268.68	832.877	1421.46	0	1421.46	1394.13	1394.13
45	4.44989	4957.25	6.74648	Perched Clay (Drained)	200	24	239.024	740.948	1214.99	0	1214.99	1186.71	1186.71
46	4.44989	4157.12	7.68603	Perched Clay (Drained)	200	24	212.395	658.401	1029.59	0	1029.59	1000.92	1000.92
47	4.44989	3337.93	8.62767	Perched Clay (Drained)	200	24	184.784	572.811	837.347	0	837.347	809.309	809.309
48	4.44989	2464.98	9.57165	Perched Clay (Drained)	200	24	154.949	480.325	629.621	0	629.621	603.492	603.492
49	4.44989	1508.02	10.5183	Perched Clay (Drained)	200	24	121.774	377.486	398.642	0	398.642	376.032	376.032
50	3.95383	455.666	11.4147	Light Gray Sand	50	32	44.8539	139.042	142.497	0	142.497	133.441	133.441

Interslice Data

Dynamic Stability - 3200 psf

Global Minimum Query (spencer) - Safety Factor: 3.00252

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	360.009	71.748	0	0	0
2	360.075	71.5385	-400.91	-25.1848	3.59455
3	361.907	67	2101.78	132.032	3.59455
4	362.991	64.9721	6648.86	417.675	3.59454
5	364.074	63.2269	10906.1	685.112	3.59455
6	365.158	61.6906	14897.9	935.871	3.59454
7	366.428	60.0965	19285.3	1211.49	3.59456
8	367.698	58.6815	23147.5	1454.11	3.59456
9	368.968	57.4144	24416.9	1533.85	3.59455
10	370.238	56.2731	25678.2	1613.08	3.59454
11	371.508	55.2413	26908.5	1690.37	3.59455
12	372.779	54.3069	28089.8	1764.57	3.59453
13	374.049	53.46	29208.4	1834.84	3.59454
14	375.319	52.6931	30253.1	1900.47	3.59454
15	376.589	52	31215.5	1960.93	3.59455
16	377.931	51.3422	34207.7	2148.89	3.59453
17	379.273	50.7563	36879.4	2316.73	3.59454
18	380.615	50.2383	39234.1	2464.65	3.59454
19	381.957	49.7849	41274.5	2592.82	3.59454
20	383.299	49.3934	42819.3	2689.87	3.59455
21	384.641	49.0615	43189.4	2713.12	3.59455
22	385.983	48.7875	43428.7	2728.15	3.59454
23	387.325	48.5699	43534.2	2734.78	3.59455
24	388.668	48.4077	43503.2	2732.83	3.59454
25	390.01	48.2999	43333.3	2722.16	3.59455
26	391.352	48.2462	43022.6	2702.64	3.59454
27	392.694	48.2462	42569.8	2674.2	3.59455
28	394.036	48.2999	41974.6	2636.8	3.59454
29	395.378	48.4077	41238.2	2590.55	3.59455
30	396.72	48.5699	40362.3	2535.52	3.59454
31	398.062	48.7875	39348.9	2471.86	3.59454
32	399.404	49.0615	38200.5	2399.72	3.59454
33	400.746	49.3934	36925.4	2319.62	3.59455
34	402.088	49.7849	35536.3	2232.36	3.59455
35	403.431	50.2383	34037.3	2138.19	3.59454
36	404.773	50.7563	32416.1	2036.35	3.59455
37	406.115	51.3422	30674.5	1926.94	3.59454
38	407.457	52	28817	1810.26	3.59455
39	408.698	52.6768	26890.4	1689.23	3.59454
40	409.94	53.4239	24859.6	1561.66	3.59455
41	411.182	54.2472	22728.6	1427.79	3.59455
42	412.423	55.1537	20502.2	1287.93	3.59455
43	413.665	56.1522	18186.8	1142.48	3.59455
44	414.906	57.2539	15789.9	991.908	3.59455
45	416.148	58.4734	13321.5	836.847	3.59456
46	417.389	59.8305	10794.4	678.092	3.59453
47	418.631	61.3524	8224.97	516.685	3.59454
48	419.8	62.9721	5844.89	367.171	3.59455
49	420.97	64.8255	3655.2	229.616	3.59454
50	422.139	67	1888.89	118.659	3.59456
51	422.855	68.5582	0	0	0

Static Stability - 1600 psf Drained

Global Minimum Query (spencer) - Safety Factor: 4.4083

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	359.582	71.758	0	0	0
2	359.779	71.5511	-13.3902	-1.54352	6.5756
3	360.818	70.5081	-28.6435	-3.30181	6.57561
4	361.856	69.5378	889.225	102.503	6.57559
5	362.895	68.6333	2104.04	242.538	6.57561
6	363.934	67.7889	3297.69	380.133	6.57561
7	364.972	67	4463.11	514.474	6.57561
8	366.089	66.2086	5610.77	646.767	6.5756
9	367.207	65.4726	6711.24	773.621	6.5756
10	368.324	64.7884	7274.8	838.584	6.5756
11	369.441	64.153	7588.55	874.751	6.5756
12	370.559	63.5638	7899.3	910.572	6.5756
13	371.676	63.0185	8201.2	945.373	6.57561
14	372.793	62.5153	8489.09	978.558	6.5756
15	373.911	62.0523	8758.55	1009.62	6.57561
16	375.028	61.6281	9005.67	1038.11	6.57563
17	376.147	61.241	9229.01	1063.85	6.5756
18	377.265	60.8904	9601.69	1106.81	6.5756
19	378.384	60.5752	10007.7	1153.61	6.57559
20	379.503	60.2947	10330.9	1190.87	6.57561
21	380.621	60.048	10569	1218.31	6.57558
22	381.74	59.8346	10720	1235.72	6.5756
23	382.859	59.6538	10782.1	1242.88	6.57561
24	383.977	59.5053	10766	1241.03	6.57564
25	385.096	59.3887	10711.9	1234.79	6.57562
26	386.215	59.3037	10615.1	1223.63	6.57561
27	387.333	59.2502	10474.9	1207.47	6.57562
28	388.452	59.2279	10290.5	1186.21	6.5756
29	389.571	59.2368	10061.6	1159.83	6.57563
30	390.689	59.277	9788.07	1128.29	6.57557
31	391.808	59.3486	9469.89	1091.62	6.57562
32	392.927	59.4517	9108.58	1049.97	6.57561
33	394.045	59.5865	8708.37	1003.84	6.57563
34	395.164	59.7534	8271.39	953.464	6.57561
35	396.283	59.9528	7799.93	899.117	6.5756
36	397.401	60.1853	7296.66	841.104	6.5756
37	398.52	60.4513	6764.62	779.775	6.57561
38	399.639	60.7516	6207.51	715.555	6.5756
39	400.757	61.0869	5639.05	650.027	6.5756
40	401.876	61.4583	5071.29	584.58	6.5756
41	403.046	61.8866	4487.34	517.267	6.57561
42	404.217	62.3569	3902.42	449.841	6.57559
43	405.387	62.8709	3317.75	382.445	6.5756
44	406.557	63.4304	2741.84	316.059	6.57561
45	407.728	64.0376	2184.73	251.839	6.5756
46	408.898	64.6949	1658.3	191.156	6.57559
47	410.069	65.4054	1176.7	135.642	6.57565
48	411.239	66.1724	756.973	87.2582	6.57561
49	412.409	67	419.787	48.3898	6.57559
50	413.497	67.828	158.165	18.232	6.57558
51	414.586	68.717	0	0	0

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.06262

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	78.4784	120	0	0	0
2	87.4226	107	4074.85	407.485	5.71059
3	93.6166	99.1304	8280.68	828.068	5.71059
4	99.8107	92	18003.8	1800.38	5.71059
5	106.828	84.675	31186.5	3118.65	5.71059
6	113.846	78.0377	45440.6	4544.06	5.71059
7	120.864	72	60091.7	6009.17	5.71059
8	127.21	67	80827	8082.7	5.71059
9	132.461	63.1622	91239.8	9123.98	5.71059
10	138.359	59.1521	102627	10262.7	5.71059
11	144.257	55.4376	113700	11370	5.71059
12	150.155	52	124209	12420.9	5.71059
13	156.109	48.7942	142987	14298.7	5.71059
14	162.063	45.8402	160599	16059.9	5.71059
15	168.017	43.1258	176960	17696	5.71059
16	173.971	40.6407	191969	19196.9	5.71059
17	179.925	38.3758	205538	20553.8	5.71059
18	185.879	36.3232	217612	21761.2	5.71059
19	191.833	34.4761	228161	22816.1	5.71059
20	197.787	32.8287	237157	23715.7	5.71059
21	203.741	31.376	244588	24458.8	5.71059
22	209.695	30.1137	250436	25043.6	5.71059
23	215.649	29.0381	254706	25470.6	5.71059
24	221.603	28.1462	257406	25740.6	5.71059
25	227.557	27.4356	258542	25854.2	5.71059
26	233.511	26.9042	258137	25813.7	5.71059
27	239.465	26.5508	256220	25622	5.71059
28	245.419	26.3743	252827	25282.7	5.71059
29	251.374	26.3743	248002	24800.2	5.71059
30	257.328	26.5508	241795	24179.5	5.71059
31	263.282	26.9042	234258	23425.8	5.71059
32	269.236	27.4356	225457	22545.7	5.71059
33	275.19	28.1462	215463	21546.3	5.71059
34	281.144	29.0381	204344	20434.4	5.71059
35	287.098	30.1137	192207	19220.7	5.71059
36	293.052	31.376	179169	17916.9	5.71059
37	299.006	32.8287	165339	16533.9	5.71059
38	304.96	34.4761	150863	15086.3	5.71059
39	310.914	36.3232	135920	13592	5.71059
40	316.868	38.3758	120686	12068.6	5.71059
41	322.822	40.6407	105385	10538.5	5.71059
42	328.776	43.1258	90294.5	9029.45	5.71059
43	334.73	45.8402	75625.6	7562.56	5.71059
44	340.684	48.7942	61711.9	6171.19	5.71059
45	346.638	52	48966.6	4896.66	5.71059
46	351.841	55.0183	36853.5	3685.35	5.71059
47	357.043	58.2505	25896	2589.6	5.71059
48	362.246	61.709	16295.1	1629.51	5.71059
49	369.583	67	6671.3	667.13	5.71059
50	374.469	70.8123	924.354	92.4354	5.71059
51	375.188	71.3941	0	0	0

◆ Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 3.09989

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	132.915	116.903	0	0	0
2	136.688	114.292	65.5685	12.483	10.779
3	140.46	111.773	453.114	86.2645	10.7791
4	144.233	109.344	1099.71	209.364	10.779
5	148.005	107	1952.4	371.701	10.7791
6	152.029	104.593	3052.2	581.081	10.779
7	156.052	102.278	4394.77	836.682	10.7791
8	160.076	100.052	5933.84	1129.69	10.779
9	164.099	97.9141	7629.16	1452.45	10.7791
10	168.123	95.8607	9450.87	1799.27	10.7791
11	172.146	93.89	11352.9	2161.38	10.7791
12	176.169	92	13299.8	2532.03	10.779
13	180.311	90.1368	15110.8	2876.82	10.7791
14	184.453	88.3554	16875.7	3212.83	10.7791
15	188.595	86.654	18579	3537.09	10.779
16	192.737	85.0311	20193.5	3844.46	10.779
17	196.879	83.4852	21707.2	4132.64	10.779
18	201.021	82.0149	23106.1	4398.97	10.7791
19	205.163	80.6189	24374.7	4640.48	10.779
20	209.305	79.296	25500.5	4854.83	10.7791
21	213.446	78.0451	26475	5040.35	10.7791
22	217.588	76.8652	27290.4	5195.59	10.7791
23	221.73	75.7554	27939.5	5319.15	10.779
24	225.872	74.7147	28415.4	5409.77	10.7791
25	230.014	73.7424	28714.6	5466.72	10.779
26	234.156	72.8377	28835.3	5489.69	10.779
27	238.298	71.9999	28776.2	5478.46	10.7791
28	242.748	71.1737	28993.6	5519.84	10.7791
29	247.198	70.4233	29006.6	5522.31	10.779
30	251.648	69.7482	28816.6	5486.14	10.779
31	256.098	69.1476	28427.2	5412	10.779
32	260.547	68.6212	27843.3	5300.84	10.779
33	264.997	68.1685	27070.2	5153.66	10.7791
34	269.447	67.7892	26117.6	4972.3	10.779
35	273.897	67.4828	24994	4758.39	10.7791
36	278.347	67.2493	23706.1	4513.2	10.7791
37	282.797	67.0884	22264.8	4238.8	10.779
38	287.247	67	20694.6	3939.87	10.7791
39	293.666	67	18235.4	3471.67	10.779
40	298.116	67.0884	16419.4	3125.95	10.7791
41	302.566	67.2493	14538.1	2767.77	10.779
42	307.016	67.4828	12625.3	2403.62	10.779
43	311.466	67.7892	10709.4	2038.86	10.779
44	315.915	68.1685	8819.65	1679.1	10.7791
45	320.365	68.6212	6980.6	1328.98	10.7791
46	324.815	69.1476	5277.43	1004.72	10.779
47	329.265	69.7481	3714.01	707.077	10.779
48	333.715	70.4233	2326.4	442.903	10.779
49	338.165	71.1737	1164.45	221.69	10.7791
50	342.615	71.9999	293.226	55.8248	10.7791
51	346.569	72.7982	0	0	0

Discharge Sections

Entity Information

◆ Dynamic Stability - 3200 psf

Shared Entities

Type	Coordinates (x,y)
	0, 120 0, 107 0, 92 0, 72 0, 67 0, 52 0, 20 0, 15 613.486, 15 613.486, 20 613.486, 52 613.486, 60.12 608.222, 60.9999 602.24, 61.9999 595.957, 61.9999 593.448, 60.9999 591.252, 59.9999 588.927, 58.9999 586.694, 57.9999 583.005, 57.9999 581.202, 58.9999 580.227, 59.9999 579.424, 60.9999 577.096, 61.9999 576.405, 61.9999 573.372, 60.9999 567.244, 60.9999 565.719, 61.9999 564.653, 62.9999 563.776, 63.9999 562.786, 64.9999 561.15, 65.9999 531.634, 66.9999 519.46, 66.9999 503.959, 67 402.61, 68.9471 402.452, 68.9997 399.451, 69.9997 392.101, 70.9997 349.206, 71.9999 345.902, 72.9999 342.635, 73.9999 338.564, 74.9999 334.656, 75.9999

External Boundary	330.077, 76.9999 325.625, 77.9999 321.262, 78.9999 318.455, 79.9999 313.199, 80.9999 308.859, 81.9999 304.358, 82.9999 299.941, 83.9999 294.847, 84.9999 289.783, 85.9999 285.019, 86.9999 280.53, 87.9999 274.538, 88.9999 269.032, 89.9999 264.482, 90.9999 259.197, 92 253.493, 92.9999 249.649, 93.9999 244.094, 94.9999 238.993, 95.9999 234.627, 96.9999 229.626, 97.9999 224.946, 98.9999 220.27, 99.9999 215.258, 101 210.22, 102 205.351, 103 200.584, 104 195.458, 105 190.408, 106 185.789, 107 180.747, 108 176.52, 109 171.75, 110 166.839, 111 160.981, 112 155.691, 113 149.814, 114 145.207, 115 139.871, 116 132.165, 117 122.977, 118 110.516, 119 96.4627, 120 19.6198, 120
Material Boundary	0, 72 349.206, 71.9999
Material Boundary	0, 67 503.959, 67
Material Boundary	0, 52 613.486, 52
Material Boundary	0, 92 259.197, 92
Material Boundary	0, 107 185.789, 107
Material Boundary	0, 20 613.486, 20

Material Boundary	349.206, 71.9999 372.762, 71 381.852, 70 399.856, 69 402.61, 68.9471

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 613.486, 60.12	Assigned to: 🟨 Surficial Aquifer 🟧 Black Creek Aquifer
Distributed Load	367.591, 71.5712 361.094, 71.7227	Constant DistributionOrientation: VerticalMagnitude: 3200 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	376.587, 71.3614 383.1, 71.2096	Constant DistributionOrientation: VerticalMagnitude: 3200 lbs/ft2Creates Excess Pore Pressure: No

◆ Static Stability - 1600 psf Drained

Shared Entities

Type	Coordinates (x,y)
	0, 120 0, 107 0, 92 0, 72 0, 67 0, 52 0, 20 0, 15 613.486, 15 613.486, 20 613.486, 52 613.486, 60.12 608.222, 60.9999 602.24, 61.9999 595.957, 61.9999 593.448, 60.9999 591.252, 59.9999 588.927, 58.9999 586.694, 57.9999 583.005, 57.9999 581.202, 58.9999 580.227, 59.9999 579.424, 60.9999 577.096, 61.9999 576.405, 61.9999 573.372, 60.9999 567.244, 60.9999 565.719, 61.9999 564.653, 62.9999

External Boundary	563.776, 63.9999 562.786, 64.9999 561.15, 65.9999 531.634, 66.9999 519.46, 66.9999 503.959, 67 402.61, 68.9471 402.452, 68.9997 399.451, 69.9997 392.101, 70.9997 349.206, 71.9999 345.902, 72.9999 342.635, 73.9999 338.564, 74.9999 334.656, 75.9999 330.077, 76.9999 325.625, 77.9999 321.262, 78.9999 318.455, 79.9999 313.199, 80.9999 308.859, 81.9999 304.358, 82.9999 299.941, 83.9999 294.847, 84.9999 289.783, 85.9999 285.019, 86.9999 280.53, 87.9999 274.538, 88.9999 269.032, 89.9999 264.482, 90.9999 259.197, 92 253.493, 92.9999 249.649, 93.9999 244.094, 94.9999 238.993, 95.9999 234.627, 96.9999 229.626, 97.9999 224.946, 98.9999 220.27, 99.9999 215.258, 101 210.22, 102 205.351, 103 200.584, 104 195.458, 105 190.408, 106 185.789, 107 180.747, 108 176.52, 109 171.75, 110 166.839, 111 160.981, 112 155.691, 113 149.814, 114 145.207, 115 139.871, 116 132.165, 117 122.977, 118 110.516, 119 96.4627, 120

	19.6198, 120
Material Boundary	0, 72 349.206, 71.9999
Material Boundary	0, 67 503.959, 67
Material Boundary	0, 52 613.486, 52
Material Boundary	0, 92 259.197, 92
Material Boundary	0, 107 185.789, 107
Material Boundary	0, 20 613.486, 20
Material Boundary	349.206, 71.9999 372.762, 71 381.852, 70 399.856, 69 402.61, 68.9471

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 613.486, 60.12	Assigned to: 🟨 Surficial Aquifer ▨ Black Creek Confining Unit (Long Term) 🟧 Black Creek Aquifer
Distributed Load	367.591, 71.5712 361.094, 71.7227	Constant DistributionOrientation: VerticalMagnitude: 1600 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	376.587, 71.3614 383.1, 71.2096	Constant DistributionOrientation: VerticalMagnitude: 1600 lbs/ft2Creates Excess Pore Pressure: No

◆ **Short Term Stability**

Shared Entities

Type	Coordinates (x,y)
	0, 120 0, 107 0, 92 0, 72 0, 67 0, 52 0, 20 0, 15 613.486, 15 613.486, 20 613.486, 52

External Boundary	613.486, 60.12 608.222, 60.9999 602.24, 61.9999 595.957, 61.9999 593.448, 60.9999 591.252, 59.9999 588.927, 58.9999 586.694, 57.9999 583.005, 57.9999 581.202, 58.9999 580.227, 59.9999 579.424, 60.9999 577.096, 61.9999 576.405, 61.9999 573.372, 60.9999 567.244, 60.9999 565.719, 61.9999 564.653, 62.9999 563.776, 63.9999 562.786, 64.9999 561.15, 65.9999 531.634, 66.9999 519.46, 66.9999 503.959, 67 402.61, 68.9471 402.452, 68.9997 399.451, 69.9997 392.101, 70.9997 349.206, 71.9999 345.902, 72.9999 342.635, 73.9999 338.564, 74.9999 334.656, 75.9999 330.077, 76.9999 325.625, 77.9999 321.262, 78.9999 318.455, 79.9999 313.199, 80.9999 308.859, 81.9999 304.358, 82.9999 299.941, 83.9999 294.847, 84.9999 289.783, 85.9999 285.019, 86.9999 280.53, 87.9999 274.538, 88.9999 269.032, 89.9999 264.482, 90.9999 259.197, 92 253.493, 92.9999 249.649, 93.9999 244.094, 94.9999 238.993, 95.9999 234.627, 96.9999 229.626, 97.9999 224.946, 98.9999 220.27, 99.9999 215.258, 101 210.22, 102

	205.351, 103 200.584, 104 195.458, 105 190.408, 106 185.789, 107 180.747, 108 176.52, 109 171.75, 110 166.839, 111 160.981, 112 155.691, 113 149.814, 114 145.207, 115 139.871, 116 132.165, 117 122.977, 118 110.516, 119 96.4627, 120 19.6198, 120
Material Boundary	0, 72 349.206, 71.9999
Material Boundary	0, 67 503.959, 67
Material Boundary	0, 52 613.486, 52
Material Boundary	0, 92 259.197, 92
Material Boundary	0, 107 185.789, 107
Material Boundary	0, 20 613.486, 20
Material Boundary	349.206, 71.9999 372.762, 71 381.852, 70 399.856, 69 402.61, 68.9471

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 613.486, 60.12	Assigned to: 🟨 Surficial Aquifer 🟧 Black Creek Aquifer

Long Term Stability

Shared Entities

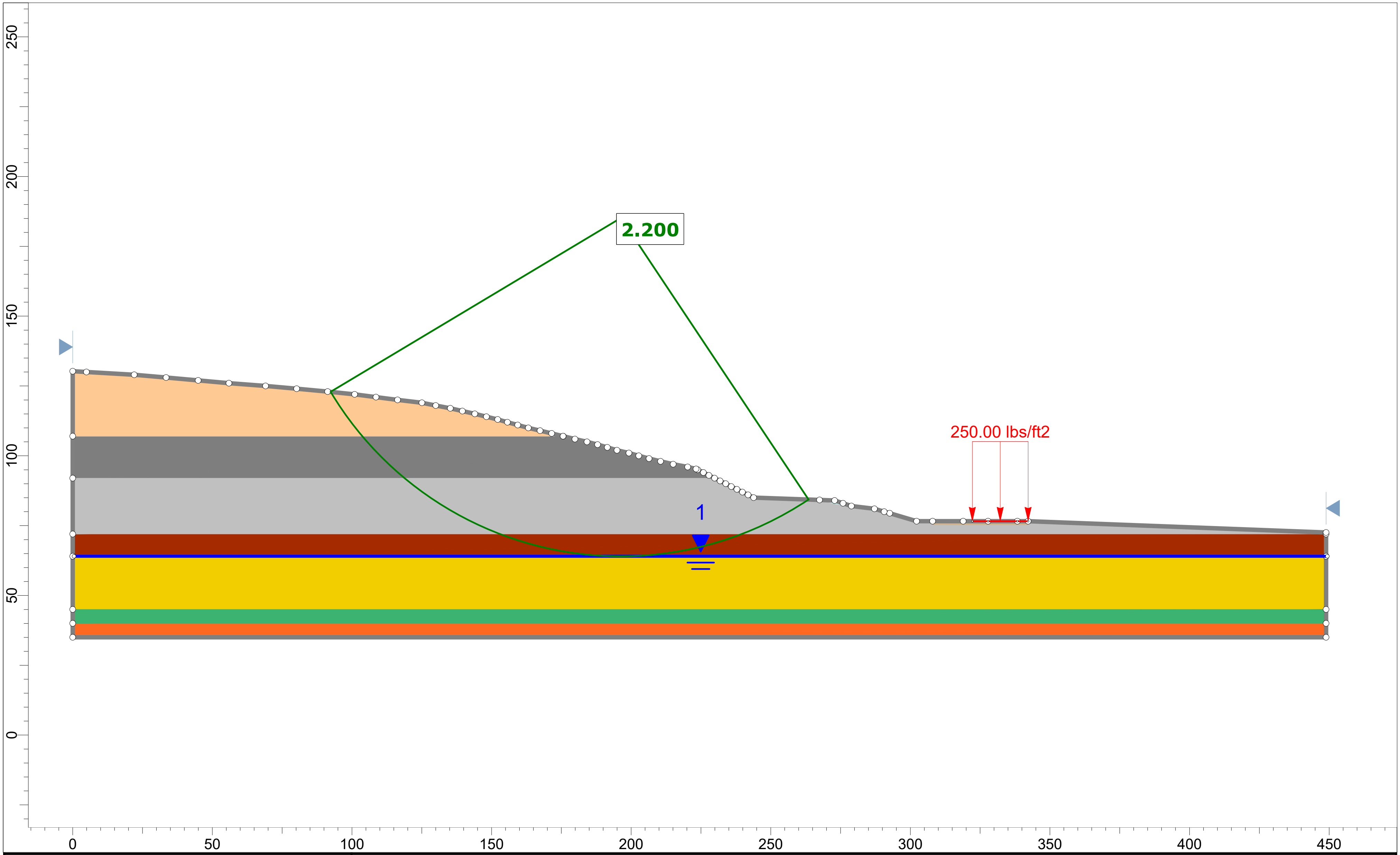
Type	Coordinates (x,y)
	0, 120 0, 107 0, 92 0, 72 0, 67 0, 52 0, 20

External Boundary	0, 15 613.486, 15 613.486, 20 613.486, 52 613.486, 60.12 608.222, 60.9999 602.24, 61.9999 595.957, 61.9999 593.448, 60.9999 591.252, 59.9999 588.927, 58.9999 586.694, 57.9999 583.005, 57.9999 581.202, 58.9999 580.227, 59.9999 579.424, 60.9999 577.096, 61.9999 576.405, 61.9999 573.372, 60.9999 567.244, 60.9999 565.719, 61.9999 564.653, 62.9999 563.776, 63.9999 562.786, 64.9999 561.15, 65.9999 531.634, 66.9999 519.46, 66.9999 503.959, 67 402.61, 68.9471 402.452, 68.9997 399.451, 69.9997 392.101, 70.9997 349.206, 71.9999 345.902, 72.9999 342.635, 73.9999 338.564, 74.9999 334.656, 75.9999 330.077, 76.9999 325.625, 77.9999 321.262, 78.9999 318.455, 79.9999 313.199, 80.9999 308.859, 81.9999 304.358, 82.9999 299.941, 83.9999 294.847, 84.9999 289.783, 85.9999 285.019, 86.9999 280.53, 87.9999 274.538, 88.9999 269.032, 89.9999 264.482, 90.9999 259.197, 92 253.493, 92.9999 249.649, 93.9999 244.094, 94.9999 238.993, 95.9999 234.627, 96.9999 229.626, 97.9999

	224.946, 98.9999 220.27, 99.9999 215.258, 101 210.22, 102 205.351, 103 200.584, 104 195.458, 105 190.408, 106 185.789, 107 180.747, 108 176.52, 109 171.75, 110 166.839, 111 160.981, 112 155.691, 113 149.814, 114 145.207, 115 139.871, 116 132.165, 117 122.977, 118 110.516, 119 96.4627, 120 19.6198, 120
Material Boundary	0, 72 349.206, 71.9999
Material Boundary	0, 67 503.959, 67
Material Boundary	0, 52 613.486, 52
Material Boundary	0, 92 259.197, 92
Material Boundary	0, 107 185.789, 107
Material Boundary	0, 20 613.486, 20
Material Boundary	349.206, 71.9999 372.762, 71 381.852, 70 399.856, 69 402.61, 68.9471

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 613.486, 60.12	Assigned to: 🟨 Surficial Aquifer ▨ Black Creek Confining Unit (Long Term) 🟧 Black Creek Aquifer



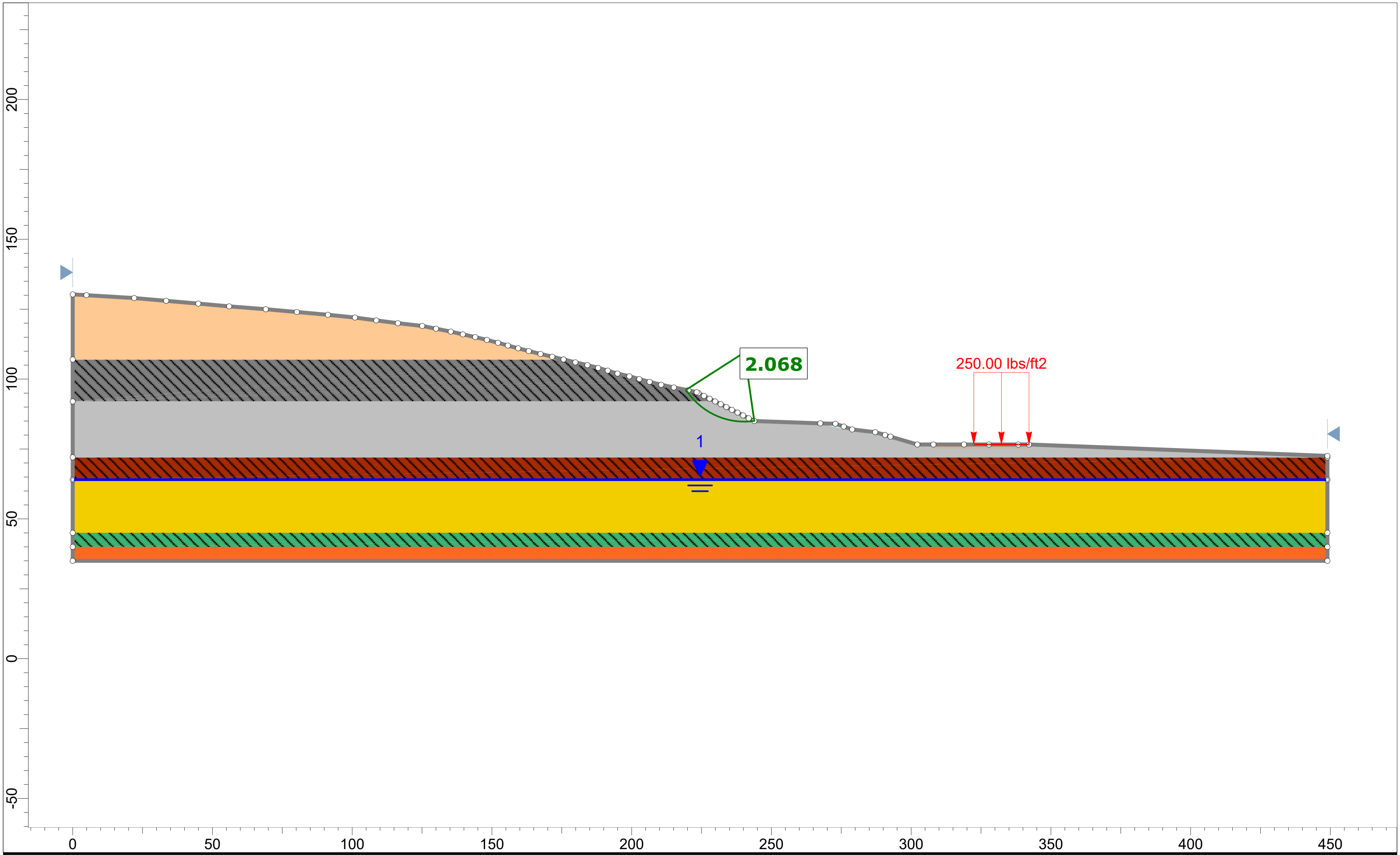
Universal Engineering Sciences

Geotechnical, Environmental and Materials Engineers

Project	45-20803 Barrier Wall Road Interim Design and Repair

Analysis	Short Term Slope Stability	*Section*	Section 9
Drawn By		*Station*	Approx STA 82+70
Date		*File Name*	section-9.slmd

SLIDEINTERPRET 9.020



GEOS Universal Engineering Sciences
Geotechnical, Environmental and Materials Engineers

Project	45-20803 Barrier Wall Road Interim Design and Repair		
Analysis	Long Term Slope Stability	*Section*	Section 9
Drawn By		*Station*	Approx STA 82+70
Date		*File Name*	section-9.slmd

SLIDEINTERPRET 9.020

Section-9
45-20803 Barrier Wall Road Interim Design and Repair
Approx. STA 82+70
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-9

Project Summary

File Name:	section-9.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Long Term Slope Stability

Comments

Section 9
Approx STA 82+70

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Short Term Stability ◆	Master Scenario	Spencer: 2.199770	00h:00m:10.160s
Long Term Stability ◆	Master Scenario	Spencer: 2.067910	00h:00m:08.22s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

All Open Scenarios

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Materials

Light Brown Sand	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	⬛
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	⬜
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay	
Color	🟥
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	1100
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	200

Friction Angle [deg]	24
Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Hu Value	1
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Hu Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Roadway	
Color	🟫
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	130
Cohesion [psf]	200
Friction Angle [deg]	30
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill	
Color	🟦
Strength Type	Undrained
Unit Weight [lbs/ft3]	125
Cohesion [psf]	2000

Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Compacted Fill (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material		Short Term Stability	Long Term Stability
Light Brown Sand	■	✓	✓
Dark Gray Clay	■	✓	✗
Dark Gray Clay (Drained)	▨	✗	✓
Light Gray Sand	■	✓	✓
Perched Clay	■	✓	✗
Perched Clay (Drained)	▨	✗	✓
Surficial Aquifer	■	✓	✓
Black Creek Confining Unit	■	✓	✗
Black Creek Confining Unit (Long Term)	▨	✗	✓
Black Creek Aquifer	■	✓	✓
Roadway	■	✓	✓
Compacted Fill	■	✓	✓

Global Minimums

◆ Short Term Stability

Method: spencer

FS	2.199770
Center:	196.337, 185.176
Radius:	121.203
Left Slip Surface Endpoint:	92.360, 122.894
Right Slip Surface Endpoint:	263.562, 84.324
Resisting Moment:	2.90417e+07 lb-ft
Driving Moment:	1.32021e+07 lb-ft
Resisting Horizontal Force:	212949 lb
Driving Horizontal Force:	96805.4 lb
Total Slice Area:	4833.45 ft2
Surface Horizontal Width:	171.202 ft
Surface Average Height:	28.2325 ft

◆ Long Term Stability

Method: spencer

FS	2.067910
Center:	240.352, 109.564
Radius:	24.812
Left Slip Surface Endpoint:	219.477, 96.152
Right Slip Surface Endpoint:	243.871, 85.003
Resisting Moment:	191554 lb-ft
Driving Moment:	92631.5 lb-ft
Resisting Horizontal Force:	6698.45 lb
Driving Horizontal Force:	3239.23 lb
Total Slice Area:	82.3518 ft2
Surface Horizontal Width:	24.3944 ft
Surface Average Height:	3.37585 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

Short Term Stability

Method: spencer

Number of Valid Surfaces:	110786
Number of Invalid Surfaces:	0

Long Term Stability

Method: spencer

Number of Valid Surfaces:	84083
Number of Invalid Surfaces:	0

Slice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.19977

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.78512	1151.42	-57.4169	Light Brown Sand	75	32	78.2713	172.179	155.519	0	155.519	277.988	277.988
2	3.78512	3314.9	-54.2248	Light Brown Sand	75	32	185.094	407.165	531.575	0	531.575	788.449	788.449
3	3.78512	5216.3	-51.2643	Light Brown Sand	75	32	286.954	631.233	890.158	0	890.158	1247.88	1247.88
4	3.77632	6946.76	-48.4875	Dark Gray Clay	1300	0	590.971	1300	1072.34	0	1072.34	1740.02	1740.02
5	3.77632	8590.24	-45.8589	Dark Gray Clay	1300	0	590.971	1300	1512.97	0	1512.97	2121.93	2121.93
6	3.77632	10076.5	-43.3496	Dark Gray Clay	1300	0	590.971	1300	1918.47	0	1918.47	2476.34	2476.34
7	3.77632	11428.5	-40.9404	Dark Gray Clay	1300	0	590.971	1300	2293.65	0	2293.65	2806.3	2806.3
8	3.4141	11384.9	-38.7243	Light Gray Sand	50	32	742.496	1633.32	2533.84	0	2533.84	3129.21	3129.21
9	3.4141	12273	-36.6836	Light Gray Sand	50	32	814.381	1791.45	2786.91	0	2786.91	3393.57	3393.57
10	3.4141	13015.1	-34.6957	Light Gray Sand	50	32	878.201	1931.84	3011.56	0	3011.56	3619.56	3619.56
11	3.4141	13654.8	-32.7546	Light Gray Sand	50	32	936.334	2059.72	3216.24	0	3216.24	3818.61	3818.61
12	3.4141	14240.7	-30.855	Light Gray Sand	50	32	991.781	2181.69	3411.42	0	3411.42	4003.93	4003.93
13	3.4141	14733.3	-28.9923	Light Gray Sand	50	32	1041.64	2291.37	3586.95	0	3586.95	4164.16	4164.16
14	3.4141	15155.4	-27.1627	Light Gray Sand	50	32	1087.25	2391.69	3747.48	0	3747.48	4305.35	4305.35
15	3.4141	15524	-25.3626	Light Gray Sand	50	32	1129.62	2484.9	3896.66	0	3896.66	4432.14	4432.14
16	3.4141	15825.6	-23.5889	Light Gray Sand	50	32	1167.66	2568.58	4030.56	0	4030.56	4540.43	4540.43
17	3.4141	16069	-21.8389	Light Gray Sand	50	32	1201.85	2643.79	4150.94	0	4150.94	4632.59	4632.59
18	3.40061	16157.5	-20.1135	Perched Clay	1100	0	500.052	1100	4392.27	0	4392.27	4575.4	4575.4
19	3.40061	16251.8	-18.4104	Perched Clay	1100	0	500.052	1100	4456.47	0	4456.47	4622.92	4622.92
20	3.40061	16314.9	-16.7239	Perched Clay	1100	0	500.052	1100	4511.43	0	4511.43	4661.68	4661.68
21	3.40061	16357.9	-15.0522	Perched Clay	1100	0	500.052	1100	4560.3	0	4560.3	4694.78	4694.78
22	3.40061	16377.6	-13.3936	Perched Clay	1100	0	500.052	1100	4602.21	0	4602.21	4721.28	4721.28
23	3.40061	16355.2	-11.7463	Perched Clay	1100	0	500.052	1100	4631.81	0	4631.81	4735.79	4735.79
24	3.40061	16288.7	-10.1088	Perched Clay	1100	0	500.052	1100	4648.41	0	4648.41	4737.56	4737.56
25	3.40061	16172.3	-8.47967	Perched Clay	1100	0	500.052	1100	4650.32	0	4650.32	4724.87	4724.87
26	3.40061	16019.6	-6.85739	Perched Clay	1100	0	500.052	1100	4641.34	0	4641.34	4701.47	4701.47
27	3.40061	15819.1	-5.24062	Perched Clay	1100	0	500.052	1100	4618.02	0	4618.02	4663.88	4663.88
28	3.40061	15545.7	-3.62803	Perched Clay	1100	0	500.052	1100	4573.05	0	4573.05	4604.76	4604.76

29	3.40061	15209.6	-2.01831	Perched Clay	1100	0	500.052	1100	4509.15	0	4509.15	4526.78	4526.78
30	5.13582	22297.7	0	Perched Clay	1100	0	500.052	1100	4421.04	0	4421.04	4421.04	4421.04
31	3.13903	13217.1	1.95641	Perched Clay	1100	0	500.052	1100	4330.67	0	4330.67	4313.58	4313.58
32	3.13903	12836.5	3.44212	Perched Clay	1100	0	500.052	1100	4239.42	0	4239.42	4209.34	4209.34
33	3.13903	12443.2	4.93015	Perched Clay	1100	0	500.052	1100	4143.48	0	4143.48	4100.35	4100.35
34	3.13903	12047.5	6.42152	Perched Clay	1100	0	500.052	1100	4046.13	0	4046.13	3989.85	3989.85
35	3.13903	11643.5	7.91729	Perched Clay	1100	0	500.052	1100	3945.53	0	3945.53	3875.98	3875.98
36	3.13903	11228.8	9.4185	Perched Clay	1100	0	500.052	1100	3840.86	0	3840.86	3757.91	3757.91
37	3.13903	10804.6	10.9263	Perched Clay	1100	0	500.052	1100	3732.52	0	3732.52	3635.99	3635.99
38	3.13903	10311	12.4418	Perched Clay	1100	0	500.052	1100	3600.82	0	3600.82	3490.5	3490.5
39	3.13903	9557.58	13.9661	Perched Clay	1100	0	500.052	1100	3382.22	0	3382.22	3257.86	3257.86
40	3.13903	8681.75	15.5007	Perched Clay	1100	0	500.052	1100	3121.37	0	3121.37	2982.69	2982.69
41	3.13903	7789.74	17.0467	Perched Clay	1100	0	500.052	1100	2853.29	0	2853.29	2699.96	2699.96
42	3.13903	6874.77	18.6057	Perched Clay	1100	0	500.052	1100	2575.54	0	2575.54	2407.2	2407.2
43	3.13903	5926.79	20.1791	Perched Clay	1100	0	500.052	1100	2284.6	0	2284.6	2100.82	2100.82
44	3.4071	5308.32	21.8371	Light Gray Sand	50	32	596.067	1311.21	2018.35	0	2018.35	1779.49	1779.49
45	3.4071	4270.83	23.5835	Light Gray Sand	50	32	494.706	1088.24	1661.54	0	1661.54	1445.57	1445.57
46	3.4071	3602.01	25.3534	Light Gray Sand	50	32	430.6	947.222	1435.86	0	1435.86	1231.82	1231.82
47	3.4071	2897.42	27.1496	Light Gray Sand	50	32	359.889	791.672	1186.92	0	1186.92	1002.36	1002.36
48	3.4071	2139.49	28.9753	Light Gray Sand	50	32	279.874	615.658	905.243	0	905.243	750.264	750.264
49	3.4071	1325.44	30.8338	Light Gray Sand	50	32	189.258	416.324	586.239	0	586.239	473.268	473.268
50	3.4071	451.999	32.729	Light Gray Sand	50	32	87.1091	191.62	226.64	0	226.64	170.655	170.655

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.06791

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.478039	17.9003	-56.2856	Dark Gray Clay (Drained)	200	25	86.7314	179.353	-44.2782	0	-44.2782	85.6993	85.6993
2	0.478039	52.1828	-54.3443	Dark Gray Clay (Drained)	200	25	97.345	201.301	2.78939	0	2.78939	138.48	138.48
3	0.478039	82.9713	-52.4908	Dark Gray Clay (Drained)	200	25	107.48	222.259	47.7342	0	47.7342	187.758	187.758
4	0.478039	111.201	-50.7126	Dark Gray Clay (Drained)	200	25	117.276	242.515	91.1743	0	91.1743	234.521	234.521
5	0.478039	137.341	-48.9996	Dark Gray Clay (Drained)	200	25	126.781	262.171	133.326	0	133.326	279.169	279.169
6	0.478039	161.603	-47.3437	Dark Gray Clay (Drained)	200	25	135.992	281.22	174.177	0	174.177	321.776	321.776
7	0.478039	184.162	-45.7383	Dark Gray Clay (Drained)	200	25	144.911	299.663	213.726	0	213.726	362.421	362.421
8	0.489491	209.71	-44.1596	Light Gray Sand	50	32	107.351	221.993	275.247	0	275.247	379.495	379.495
9	0.489491	224.639	-42.6039	Light Gray Sand	50	32	115.671	239.197	302.778	0	302.778	409.157	409.157
10	0.489491	234.954	-41.0862	Light Gray Sand	50	32	122.196	252.69	324.371	0	324.371	430.918	430.918
11	0.489491	243.994	-39.6028	Light Gray Sand	50	32	128.271	265.252	344.476	0	344.476	450.601	450.601
12	0.489491	251.844	-38.1506	Light Gray Sand	50	32	133.904	276.901	363.118	0	363.118	468.303	468.303
13	0.489491	258.574	-36.7267	Light Gray Sand	50	32	139.102	287.65	380.32	0	380.32	484.104	484.104
14	0.489491	264.247	-35.3288	Light Gray Sand	50	32	143.87	297.511	396.101	0	396.101	498.075	498.075
15	0.489491	268.919	-33.9547	Light Gray Sand	50	32	148.215	306.495	410.477	0	410.477	510.279	510.279
16	0.489491	272.637	-32.6024	Light Gray Sand	50	32	152.139	314.61	423.465	0	423.465	520.771	520.771
17	0.489491	275.445	-31.2703	Light Gray Sand	50	32	155.647	321.864	435.074	0	435.074	529.599	529.599
18	0.489491	277.382	-29.9568	Light Gray Sand	50	32	158.742	328.264	445.316	0	445.316	536.806	536.806
19	0.489491	278.482	-28.6603	Light Gray Sand	50	32	161.426	333.815	454.198	0	454.198	542.431	542.431
20	0.489491	278.778	-27.3798	Light Gray Sand	50	32	163.702	338.52	461.728	0	461.728	546.51	546.51
21	0.489491	278.296	-26.1139	Light Gray Sand	50	32	165.569	342.382	467.909	0	467.909	549.07	549.07
22	0.489491	277.175	-24.8615	Light Gray Sand	50	32	167.088	345.522	472.933	0	472.933	550.356	550.356
23	0.489491	275.767	-23.6218	Light Gray Sand	50	32	168.432	348.303	477.384	0	477.384	551.046	551.046
24	0.489491	273.696	-22.3936	Light Gray Sand	50	32	169.401	350.305	480.589	0	480.589	550.389	550.389
25	0.489491	270.938	-21.1763	Light Gray Sand	50	32	169.968	351.479	482.467	0	482.467	548.312	548.312
26	0.489491	267.509	-19.9688	Light Gray Sand	50	32	170.133	351.82	483.013	0	483.013	544.831	544.831
27	0.489491	263.426	-18.7706	Light Gray Sand	50	32	169.892	351.322	482.217	0	482.217	539.956	539.956
28	0.489491	258.702	-17.5808	Light Gray Sand	50	32	169.243	349.98	480.069	0	480.069	533.694	533.694
29	0.489491	253.35	-16.3988	Light Gray Sand	50	32	168.182	347.785	476.555	0	476.555	526.05	526.05

30	0.489491	247.382	-15.2239	Light Gray Sand	50	32	166.704	344.728	471.662	0	471.662	517.029	517.029
31	0.489491	240.809	-14.0555	Light Gray Sand	50	32	164.803	340.798	465.375	0	465.375	506.634	506.634
32	0.489491	233.64	-12.8931	Light Gray Sand	50	32	162.474	335.982	457.667	0	457.667	494.858	494.858
33	0.489491	225.884	-11.7361	Light Gray Sand	50	32	159.711	330.267	448.522	0	448.522	481.701	481.701
34	0.489491	217.549	-10.5839	Light Gray Sand	50	32	156.505	323.638	437.913	0	437.913	467.156	467.156
35	0.489491	208.641	-9.43602	Light Gray Sand	50	32	152.848	316.075	425.81	0	425.81	451.213	451.213
36	0.489491	199.166	-8.29195	Light Gray Sand	50	32	148.73	307.561	412.185	0	412.185	433.861	433.861
37	0.489491	189.131	-7.1512	Light Gray Sand	50	32	144.143	298.074	397.001	0	397.001	415.086	415.086
38	0.489491	178.538	-6.01329	Light Gray Sand	50	32	139.073	287.591	380.224	0	380.224	394.874	394.874
39	0.489491	167.393	-4.87776	Light Gray Sand	50	32	133.51	276.086	361.813	0	361.813	373.207	373.207
40	0.489491	155.699	-3.74415	Light Gray Sand	50	32	127.438	263.53	341.719	0	341.719	350.059	350.059
41	0.489491	143.458	-2.61201	Light Gray Sand	50	32	120.843	249.892	319.894	0	319.894	325.407	325.407
42	0.489491	130.671	-1.48088	Light Gray Sand	50	32	113.708	235.138	296.283	0	296.283	299.222	299.222
43	0.489491	117.34	-0.350332	Light Gray Sand	50	32	106.015	219.229	270.823	0	270.823	271.472	271.472
44	0.489491	103.465	0.78008	Light Gray Sand	50	32	97.7431	202.124	243.449	0	243.449	242.118	242.118
45	0.489491	89.0461	1.9108	Light Gray Sand	50	32	88.8709	183.777	214.087	0	214.087	211.122	211.122
46	0.489491	74.0827	3.04226	Light Gray Sand	50	32	79.3739	164.138	182.659	0	182.659	178.441	178.441
47	0.489491	58.5728	4.17491	Light Gray Sand	50	32	69.2254	143.152	149.074	0	149.074	144.021	144.021
48	0.489491	42.5146	5.30919	Light Gray Sand	50	32	58.3956	120.757	113.235	0	113.235	107.808	107.808
49	0.489491	25.9057	6.44557	Light Gray Sand	50	32	46.8524	96.8865	75.0342	0	75.0342	69.7412	69.7412
50	0.489491	8.73156	7.62936	Light Gray Sand	50	32	35.0485	72.4771	35.9709	0	35.9709	31.2762	31.2762

Interslice Data

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.19977

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	92.3599	122.894	0	0	0
2	96.145	116.972	624.294	99.0688	9.01704
3	99.9301	111.719	2714.88	430.822	9.01703
4	103.715	107	5827.19	924.713	9.01704
5	107.492	102.734	8166.9	1296	9.01704
6	111.268	98.8423	11818.8	1875.53	9.0171
7	115.044	95.2775	16422.4	2606.06	9.01704
8	118.821	92.0017	21700.5	3443.64	9.01705
9	122.235	89.2641	26097.9	4141.47	9.01707
10	125.649	86.7208	30400.7	4824.28	9.01707
11	129.063	84.3572	34515.8	5477.29	9.01704
12	132.477	82.1607	38377.9	6090.16	9.01704
13	135.891	80.1211	41944.3	6656.12	9.01705
14	139.305	78.2292	45168.1	7167.7	9.01705
15	142.719	76.4774	48014.8	7619.44	9.01704
16	146.133	74.859	50458.1	8007.16	9.01704
17	149.547	73.3682	52473.7	8327.02	9.01704
18	152.962	72	54043	8576.06	9.01705
19	156.362	70.7546	57809.7	9173.79	9.01705
20	159.763	69.6227	61150.7	9703.98	9.01706
21	163.163	68.6009	64057.1	10165.2	9.01706
22	166.564	67.6864	66524.3	10556.7	9.01704
23	169.965	66.8767	68547.5	10877.8	9.01708
24	173.365	66.1696	70119.4	11127.2	9.01704
25	176.766	65.5633	71234.3	11304.1	9.01702
26	180.166	65.0563	71888.6	11408	9.01708
27	183.567	64.6474	72083.4	11438.9	9.01707
28	186.968	64.3355	71820.5	11397.2	9.01708
29	190.368	64.1198	71103.2	11283.3	9.01703
30	193.769	64	69940.3	11098.8	9.01706
31	198.905	64	67367.8	10690.6	9.01708
32	202.044	64.1072	65331.1	10367.4	9.01708
33	205.183	64.296	62958.4	9990.84	9.01705
34	208.322	64.5668	60264.2	9563.29	9.01704
35	211.461	64.9201	57262.4	9086.94	9.01705
36	214.6	65.3566	53967.7	8564.11	9.01705
37	217.739	65.8773	50395.5	7997.23	9.01704
38	220.878	66.4833	46561.4	7388.8	9.01704
39	224.017	67.1759	42495.3	6743.56	9.01705
40	227.156	67.9566	38282.6	6075.04	9.01704
41	230.295	68.8271	33992.9	5394.32	9.01706
42	233.434	69.7896	29674.3	4709.01	9.01707
43	236.573	70.8464	25380.3	4027.59	9.01706
44	239.712	72	21172.5	3359.85	9.01704
45	243.119	73.3653	16382.6	2599.74	9.01703
46	246.526	74.8527	12222.9	1939.65	9.01707
47	249.933	76.4671	8435.31	1338.6	9.01708
48	253.34	78.2143	5133.27	814.595	9.01704
49	256.747	80.101	2470.23	392	9.01706
50	260.155	82.1347	632.061	100.301	9.01701
51	263.562	84.3245	0	0	0

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.06791

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	219.477	96.1522	0	0	0
2	219.955	95.4358	-73.1596	-22.2909	16.9454
3	220.433	94.7695	-117.811	-35.8955	16.9453
4	220.911	94.1467	-139.434	-42.484	16.9454
5	221.389	93.5624	-142.192	-43.3243	16.9454
6	221.867	93.0125	-129.448	-39.4412	16.9453
7	222.345	92.4936	-104.052	-31.7036	16.9455
8	222.823	92.0031	-68.4508	-20.8562	16.9454
9	223.313	91.5278	9.8651	3.00578	16.9454
10	223.802	91.0776	89.5779	27.2934	16.9454
11	224.292	90.6508	168.239	51.2604	16.9453
12	224.781	90.2458	244.992	74.6462	16.9454
13	225.271	89.8613	319.104	97.2273	16.9454
14	225.76	89.4961	389.948	118.813	16.9454
15	226.25	89.1491	456.99	139.239	16.9453
16	226.739	88.8195	519.773	158.369	16.9454
17	227.229	88.5065	577.918	176.085	16.9454
18	227.718	88.2092	631.104	192.29	16.9454
19	228.208	87.9271	679.074	206.906	16.9454
20	228.697	87.6595	721.62	219.869	16.9454
21	229.187	87.406	758.585	231.132	16.9454
22	229.676	87.1661	789.857	240.66	16.9454
23	230.166	86.9393	815.381	248.437	16.9454
24	230.655	86.7252	835.175	254.468	16.9454
25	231.145	86.5235	849.23	258.75	16.9453
26	231.634	86.3339	857.566	261.29	16.9453
27	232.124	86.156	860.24	262.105	16.9454
28	232.613	85.9897	857.344	261.223	16.9454
29	233.103	85.8346	849.001	258.681	16.9454
30	233.592	85.6905	835.372	254.528	16.9454
31	234.081	85.5573	816.647	248.823	16.9454
32	234.571	85.4348	793.051	241.633	16.9453
33	235.06	85.3227	764.844	233.039	16.9454
34	235.55	85.221	732.32	223.129	16.9453
35	236.039	85.1296	695.806	212.004	16.9454
36	236.529	85.0482	655.669	199.775	16.9454
37	237.018	84.9769	612.311	186.564	16.9454
38	237.508	84.9155	566.174	172.507	16.9454
39	237.997	84.8639	517.74	157.75	16.9454
40	238.487	84.8221	467.538	142.453	16.9453
41	238.976	84.7901	416.138	126.792	16.9453
42	239.466	84.7678	364.162	110.956	16.9454
43	239.955	84.7551	312.282	95.1487	16.9454
44	240.445	84.7521	261.227	79.593	16.9454
45	240.934	84.7588	211.786	64.5289	16.9454
46	241.424	84.7751	164.812	50.2164	16.9454
47	241.913	84.8011	121.229	36.9369	16.9453
48	242.403	84.8368	82.0352	24.9952	16.9454
49	242.892	84.8823	48.3157	14.7212	16.9453
50	243.382	84.9376	21.2449	6.47306	16.9453
51	243.871	85.0032	0	0	0

Discharge Sections

Entity Information

Short Term Stability

Shared Entities

Type	Coordinates (x,y)
External Boundary	0, 130.29 0, 107 0, 92 0, 72 0, 64 0, 45 0, 40 0, 35 448.923, 35 448.923, 40 448.923, 45 448.923, 64 448.923, 72 448.923, 72.5352 342.18, 76.6002 338.322, 76.6002 327.828, 76.6002 318.903, 76.6002 307.967, 76.6 302.235, 76.6 292.596, 79.4302 290.645, 80.0032 287.152, 81.0032 278.885, 82.0032 275.884, 83.0032 272.882, 84.0032 267.493, 84.189 243.871, 85.0032 241.871, 86.0032 239.87, 87.0032 237.869, 88.0032 235.868, 89.0032 233.868, 90.0032 231.867, 91.0032 229.866, 92.0032 227.865, 93.0032 225.864, 94.0032 223.864, 95.0032 223.274, 95.298 220.248, 96.0034 215.069, 97.0034 210.546, 98.0034 206.417, 99.0034 202.72, 100.003

	199.181, 101.003 194.935, 102.003 191.452, 103.003 187.993, 104.003 184.176, 105.003 179.854, 106.003 175.64, 107 175.626, 107.003 171.55, 108.003 167.381, 109.003 163.167, 110.003 159.386, 111.003 155.697, 112.003 152.183, 113.003 148.153, 114.003 144.01, 115.003 139.573, 116.003 135.247, 117.003 129.995, 118.003 125.057, 119.003 116.328, 120.003 108.601, 121.003 100.968, 122.003 91.3027, 123.003 80.1772, 124.003 69.053, 125.003 55.9588, 126.003 44.9316, 127.003 33.439, 128.003 22.0003, 129.003 4.9001, 130.003
Material Boundary	267.493, 84.189 268.156, 84.0001 272.211, 83.0001 277.507, 82.0001 282.87, 81.0001 287.691, 80.0001 292.596, 79.4302
Material Boundary	0, 72 448.923, 72
Material Boundary	0, 64 448.923, 64
Material Boundary	0, 45 448.923, 45
Material Boundary	0, 92 229.866, 92.0032
Material Boundary	0, 107 175.64, 107
Material Boundary	0, 40 448.923, 40
Material Boundary	307.967, 76.6 307.967, 75.1 342.18, 75.1 342.18, 76.6002

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0.439755, 64 449.363, 64	Assigned to: 🟨 Surficial Aquifer 🟧 Black Creek Aquifer
Distributed Load	342.18, 76.6002 338.322, 76.6002 327.828, 76.6002 322.221, 76.6002	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Long Term Stability

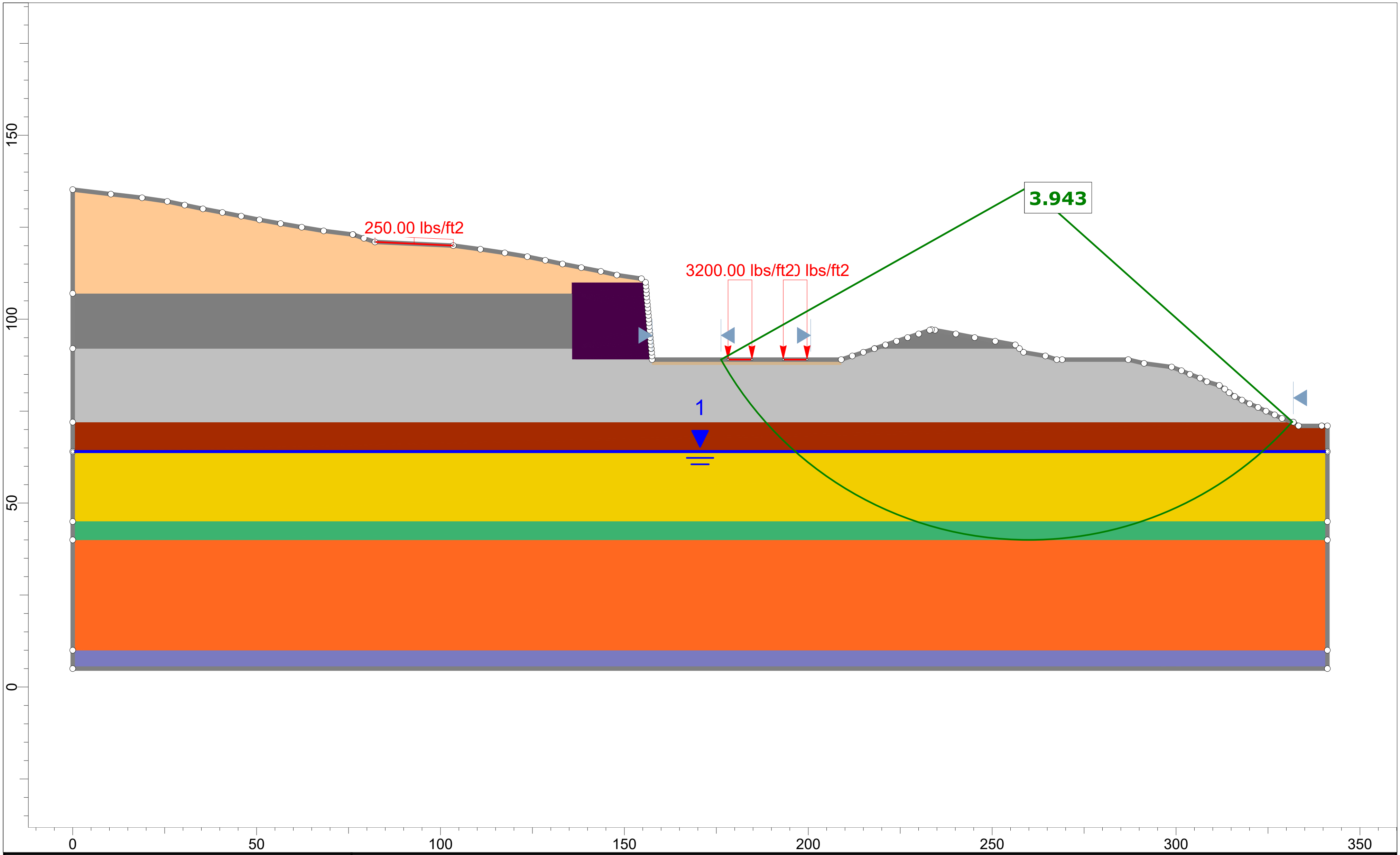
Shared Entities

Type	Coordinates (x,y)
External Boundary	0, 130.29 0, 107 0, 92 0, 72 0, 64 0, 45 0, 40 0, 35 448.923, 35 448.923, 40 448.923, 45 448.923, 64 448.923, 72 448.923, 72.5352 342.18, 76.6002 338.322, 76.6002 327.828, 76.6002 318.903, 76.6002 307.967, 76.6 302.235, 76.6 292.596, 79.4302 290.645, 80.0032 287.152, 81.0032 278.885, 82.0032 275.884, 83.0032 272.882, 84.0032 267.493, 84.189 243.871, 85.0032 241.871, 86.0032 239.87, 87.0032 237.869, 88.0032 235.868, 89.0032 233.868, 90.0032 231.867, 91.0032 229.866, 92.0032 227.865, 93.0032 225.864, 94.0032 223.864, 95.0032 223.274, 95.298 220.248, 96.0034 215.069, 97.0034 210.546, 98.0034

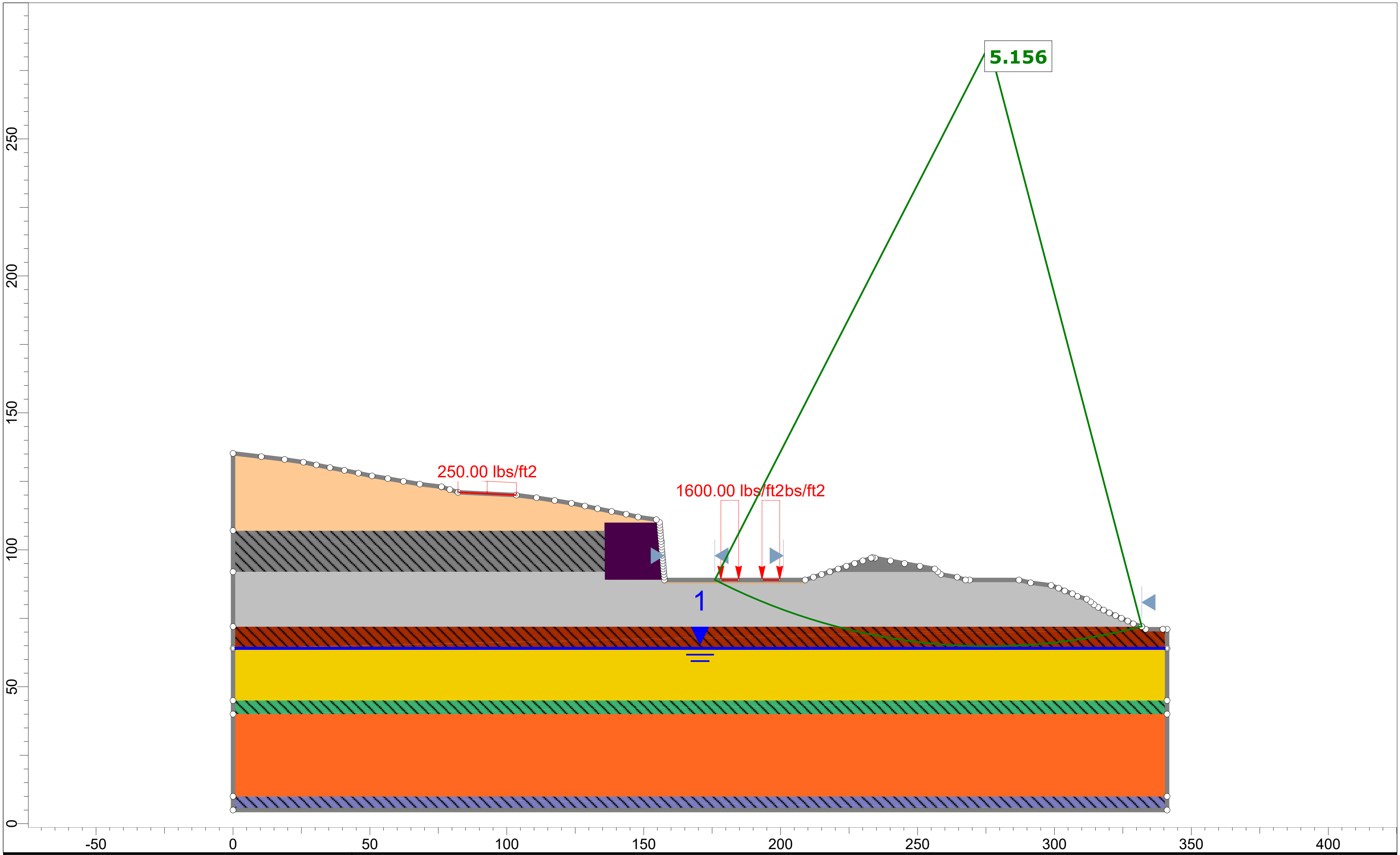
	206.417, 99.0034 202.72, 100.003 199.181, 101.003 194.935, 102.003 191.452, 103.003 187.993, 104.003 184.176, 105.003 179.854, 106.003 175.64, 107 175.626, 107.003 171.55, 108.003 167.381, 109.003 163.167, 110.003 159.386, 111.003 155.697, 112.003 152.183, 113.003 148.153, 114.003 144.01, 115.003 139.573, 116.003 135.247, 117.003 129.995, 118.003 125.057, 119.003 116.328, 120.003 108.601, 121.003 100.968, 122.003 91.3027, 123.003 80.1772, 124.003 69.053, 125.003 55.9588, 126.003 44.9316, 127.003 33.439, 128.003 22.0003, 129.003 4.9001, 130.003
Material Boundary	267.493, 84.189 268.156, 84.0001 272.211, 83.0001 277.507, 82.0001 282.87, 81.0001 287.691, 80.0001 292.596, 79.4302
Material Boundary	0, 72 448.923, 72
Material Boundary	0, 64 448.923, 64
Material Boundary	0, 45 448.923, 45
Material Boundary	0, 92 229.866, 92.0032
Material Boundary	0, 107 175.64, 107
Material Boundary	0, 40 448.923, 40
Material Boundary	307.967, 76.6 307.967, 75.1 342.18, 75.1 342.18, 76.6002

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 448.923, 64	Assigned to: 🟨 Surficial Aquifer ▨ Black Creek Confining Unit (Long Term) 🟧 Black Creek Aquifer
Distributed Load	342.18, 76.6002 338.322, 76.6002 327.828, 76.6002 322.4, 76.6002	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No



Universal Engineering Sciences Geotechnical, Environmental and Materials Engineers	*Project* 45-20803 Barrier Wall Road Interim Design and Repair		
	Analysis Short Term Slope Stability	*Section* Section 10 - MT3500 Dynamic Pressure Stability - 3200 psf	
	Drawn By	*Station* Approx. STA 85+10	
SLIDEINTERPRET 9.020	*Date*	*File Name* section-10.slmd	



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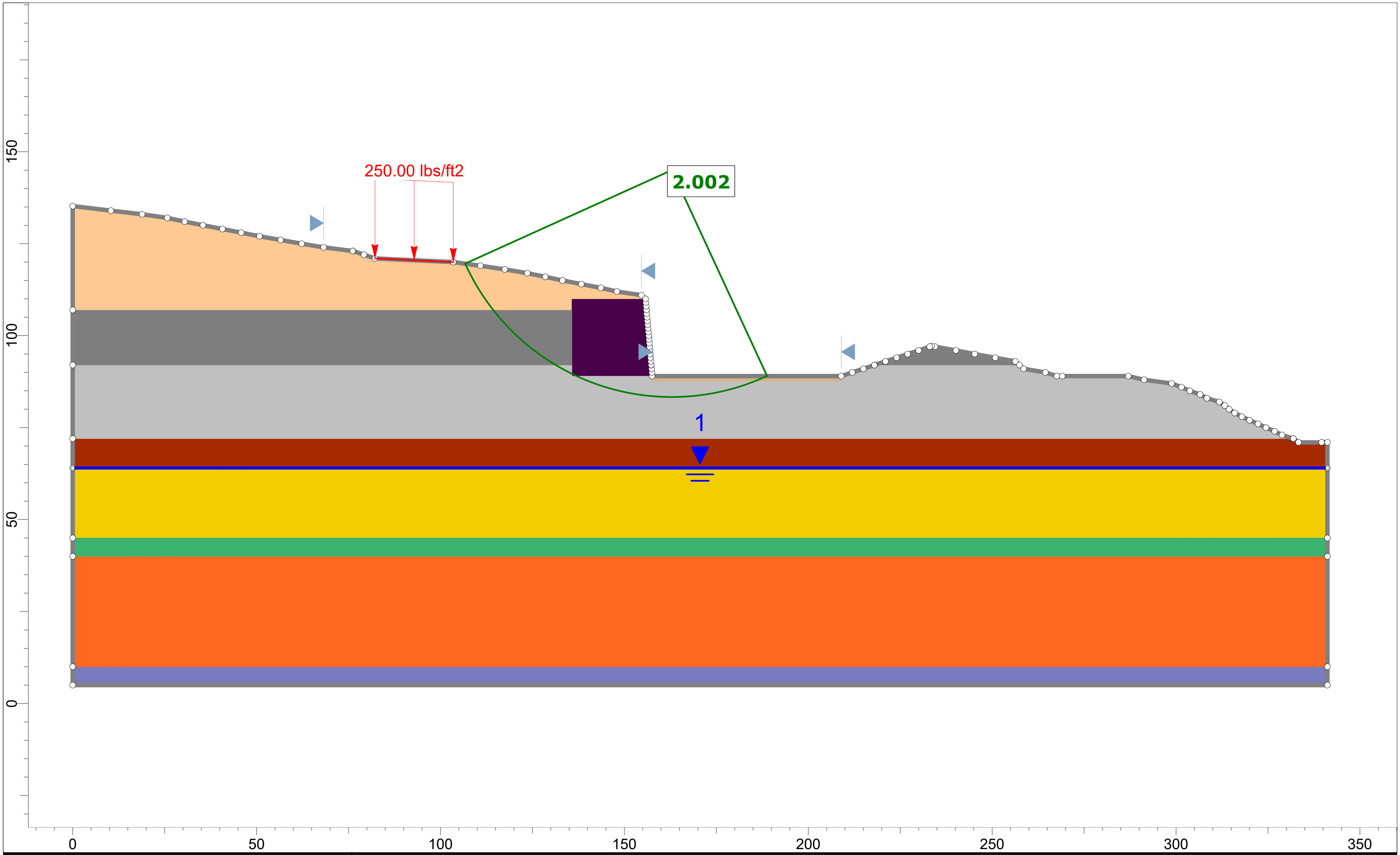
Geotechnical, Environmental and Materials Engineers

SLIDEINTERPRET 9.020

Project 45-20803 Barrier Wall Road Interim Design and Repair	
Analysis Long Term Slope Stability	*Section* Section 10 - MT3500 Static Pressure Stability - 1600 psf
Drawn By	*Station* Approx. STA 85+10
Date	*File Name* section-10.slmd



GEOS Universal Engineering Sciences Geotechnical, Environmental and Materials Engineers	*Project* 45-20803 Barrier Wall Road Interim Design and Repair	
	Analysis Short Term Slope Stability	*Section* Section 10
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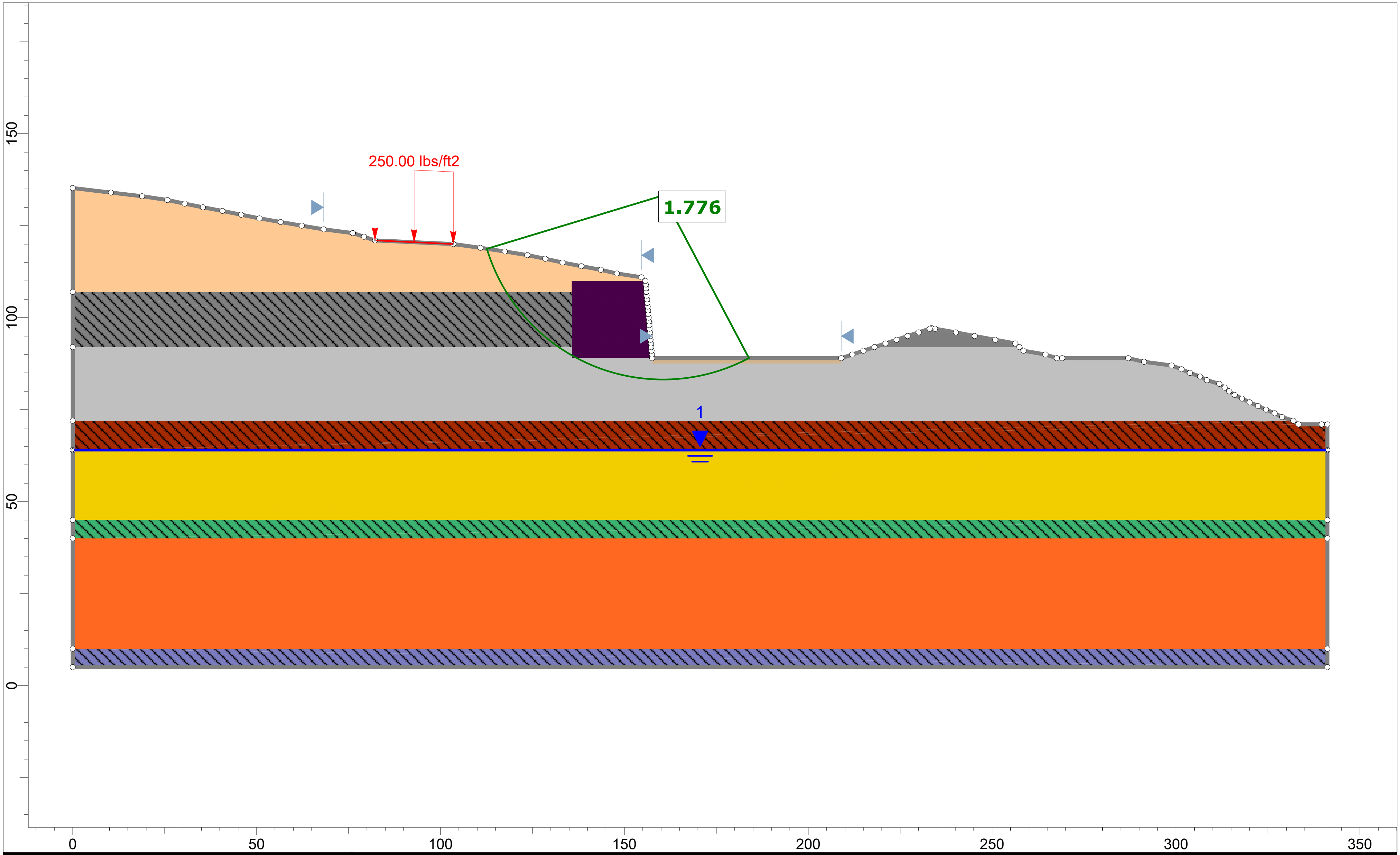
SLIDEINTERPRET 9.020	*Date*	*File Name* section-10.slmd



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Project	45-20803 Barrier Wall Road Interim Design and Repair
Analysis Short Term Slope Stability	*Section* Section 10
Drawn By	*Station* Approx. STA 85+10
Date	*File Name* section-10.slmd

Geotechnical, Environmental and Materials Engineers
Universal
Engineering
Sciences

Section-10
45-20803 Barrier Wall Road Interim Design and Repair
Approx. STA 85+10
Software Version: 9.02

Table of Contents

Slide Analysis Information

section-10

Project Summary

File Name:	section-10.slmd
Slide Modeler Version:	9.02
Project Title:	45-20803 Barrier Wall Road Interim Design and Repair
Analysis:	Short Term Slope Stability
Comments	
	Section 10 Approx. STA 85+10

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
MT3500 Dynamic Pressure Stability - 3200 psf ◆	Master Scenario	Spencer: 3.942840	00h:00m:08.522s
MT3500 Static Pressure Stability - 1600 psf ◆	Master Scenario	Spencer: 5.156120	00h:00m:07.639s
Short Term Stability ◆	Master Scenario	Spencer: 2.001830	00h:00m:04.356s
Long Term Stability ◆	Master Scenario	Spencer: 1.776190	00h:00m:03.779s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

All Open Scenarios

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	30
Circles per division:	20
Number of iterations:	20
Divisions to use in next iteration:	50%
Composite Surfaces:	Enabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

MT3500 Dynamic Pressure Stability - 3200 psf

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical
Distribution:	Constant
Magnitude [psf]:	3200
Orientation:	Vertical
Distribution:	Constant
Magnitude [psf]:	3200
Orientation:	Vertical

MT3500 Static Pressure Stability - 1600 psf

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical
Distribution:	Constant
Magnitude [psf]:	1600
Orientation:	Vertical
Distribution:	Constant
Magnitude [psf]:	1600
Orientation:	Vertical

Short Term Stability

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Long Term Stability

Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Vertical

Materials

Retaining Wall	
Color	🟪
Strength Type	Infinite strength
Unit Weight [lbs/ft3]	130
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Ru Value	0
Light Brown Sand	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay	
Color	⬛
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	1300
Cohesion Type	Constant
Water Surface	Assigned per scenario
Ru Value	0
Dark Gray Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	25
Water Surface	Assigned per scenario
Ru Value	0
Light Gray Sand	
Color	⬜
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	50
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Ru Value	0
Perched Clay	
Color	🟥
Strength Type	Undrained
Unit Weight [lbs/ft3]	110
Cohesion [psf]	1100
Cohesion Type	Constant

Water Surface	Assigned per scenario
Ru Value	0
Perched Clay (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	110
Cohesion [psf]	200
Friction Angle [deg]	24
Water Surface	Assigned per scenario
Ru Value	0
Surficial Aquifer	
Color	🟨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	75
Friction Angle [deg]	32
Water Surface	Assigned per scenario
Hu Value	1
Black Creek Confining Unit	
Color	🟩
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	900
Cohesion Type	F(Depth from Top of Layer)
Cohesion Change [psf/ft]	30
Cutoff [psf]	2000
Water Surface	Assigned per scenario
Ru Value	0
Black Creek Confining Unit (Long Term)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	125
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Hu Value	0
Black Creek Aquifer	
Color	🟧
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	0
Friction Angle [deg]	33
Water Surface	Assigned per scenario
Hu Value	1
Upper Cape Fear Confining Unit	
Color	🟪
Strength Type	Undrained
Unit Weight [lbs/ft3]	120
Cohesion [psf]	2500
Cohesion Type	Constant

Water Surface	Assigned per scenario
Ru Value	0
Upper Cape Fear Confining Unit (Drained)	
Color	▨
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	26
Water Surface	Assigned per scenario
Hu Value	1
Roadway	
Color	■
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	145
Cohesion [psf]	200
Friction Angle [deg]	30
Water Surface	Assigned per scenario
Ru Value	0

Materials In Use

Material		MT3500 Dynamic Pressure Stability - 3200 psf	MT3500 Static Pressure Stability - 1600 psf	Short Term Stability	Long Term Stability
Retaining Wall	■	✓	✓	✓	✓
Light Brown Sand	■	✓	✓	✓	✓
Dark Gray Clay	■	✓	✓	✓	✓
Dark Gray Clay (Drained)	▨	✗	✓	✗	✓
Light Gray Sand	■	✓	✓	✓	✓
Perched Clay	■	✓	✗	✓	✗
Perched Clay (Drained)	▨	✗	✓	✗	✓
Surficial Aquifer	■	✓	✓	✓	✓
Black Creek Confining Unit	■	✓	✗	✓	✗
Black Creek Confining Unit (Long Term)	▨	✗	✓	✗	✓
Black Creek Aquifer	■	✓	✓	✓	✓
Upper Cape Fear Confining Unit	■	✓	✗	✓	✗
Upper Cape Fear Confining Unit (Drained)	▨	✗	✓	✗	✓
Roadway	■	✓	✓	✓	✓

Global Minimums

MT3500 Dynamic Pressure Stability - 3200 psf

Method: spencer

FS	3.942840
Center:	260.000, 136.035
Radius:	96.045
Left Slip Surface Endpoint:	176.263, 88.995
Right Slip Surface Endpoint:	331.653, 72.078
Resisting Moment:	2.70246e+07 lb-ft
Driving Moment:	6.85409e+06 lb-ft
Resisting Horizontal Force:	239455 lb
Driving Horizontal Force:	60731.5 lb
Total Slice Area:	5650.55 ft2
Surface Horizontal Width:	155.39 ft
Surface Average Height:	36.3636 ft

MT3500 Static Pressure Stability - 1600 psf

Method: spencer

FS	5.156120
Center:	276.112, 284.227
Radius:	219.435
Left Slip Surface Endpoint:	175.931, 88.995
Right Slip Surface Endpoint:	331.893, 72.000
Resisting Moment:	4.18701e+07 lb-ft
Driving Moment:	8.12047e+06 lb-ft
Resisting Horizontal Force:	186517 lb
Driving Horizontal Force:	36173.8 lb
Total Slice Area:	2780.97 ft2
Surface Horizontal Width:	155.962 ft
Surface Average Height:	17.8311 ft

Short Term Stability

Method: spencer

FS	2.001830
Center:	162.917, 144.993
Radius:	61.689
Left Slip Surface Endpoint:	106.716, 119.556
Right Slip Surface Endpoint:	188.796, 88.995
Resisting Moment:	6.1915e+06 lb-ft
Driving Moment:	3.09292e+06 lb-ft
Resisting Horizontal Force:	87815.6 lb
Driving Horizontal Force:	43867.7 lb
Total Slice Area:	1156.01 ft2
Surface Horizontal Width:	82.0793 ft
Surface Average Height:	14.0841 ft

Long Term Stability

Method: spencer

FS	1.776190
Center:	160.496, 133.223
Radius:	50.032
Left Slip Surface Endpoint:	112.609, 118.729
Right Slip Surface Endpoint:	183.887, 88.995
Resisting Moment:	4.18376e+06 lb-ft
Driving Moment:	2.35547e+06 lb-ft
Resisting Horizontal Force:	73824.9 lb
Driving Horizontal Force:	41563.7 lb
Total Slice Area:	1050.29 ft2
Surface Horizontal Width:	71.2784 ft
Surface Average Height:	14.735 ft

Global Minimum Support Data

All Open Scenarios

No Supports Present

Valid and Invalid Surfaces

MT3500 Dynamic Pressure Stability - 3200 psf

Method: spencer

Number of Valid Surfaces: 72937
Number of Invalid Surfaces: 0

MT3500 Static Pressure Stability - 1600 psf

Method: spencer

Number of Valid Surfaces: 68195
Number of Invalid Surfaces: 0

Short Term Stability

Method: spencer

Number of Valid Surfaces: 34416
Number of Invalid Surfaces: 0

Long Term Stability

Method: spencer

Number of Valid Surfaces: 19843
Number of Invalid Surfaces: 0

Slice Data

MT3500 Dynamic Pressure Stability - 3200 psf

Global Minimum Query (spencer) - Safety Factor: 3.94284

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.860489	93.5781	-60.1589	Roadway	200	30	53.2961	210.138	17.5595	0	17.5595	110.465	110.465
2	3.76441	2100.24	-57.55	Light Gray Sand	50	32	335.71	1323.65	2038.28	0	2038.28	2566.25	2566.25
3	3.76441	4485.53	-53.5659	Light Gray Sand	50	32	532.515	2099.62	3280.09	0	3280.09	4001.48	4001.48
4	3.76441	6558.03	-49.9304	Light Gray Sand	50	32	227.235	895.95	1353.8	0	1353.8	1623.94	1623.94
5	2.6856	5795.25	-47.011	Perched Clay	1100	0	278.987	1100	1704.11	0	1704.11	2003.4	2003.4
6	2.6856	6613.48	-44.7089	Perched Clay	1100	0	278.987	1100	2660.82	0	2660.82	2936.99	2936.99
7	2.6856	7369.59	-42.4952	Perched Clay	1100	0	278.987	1100	5239.39	0	5239.39	5494.99	5494.99
8	3.2911	10001.4	-40.1248	Surficial Aquifer	75	32	815.176	3214.11	5110.17	86.5393	5023.63	5797.22	5710.68
9	3.2911	11006	-37.6017	Surficial Aquifer	75	32	428.818	1690.76	2837.93	252.163	2585.77	3168.19	2916.03
10	3.2911	11924.4	-35.1618	Surficial Aquifer	75	32	451.076	1778.52	3129.77	403.576	2726.19	3447.52	3043.94
11	3.2911	12744.6	-32.7931	Surficial Aquifer	75	32	471.422	1858.74	3396.65	542.064	2854.59	3700.38	3158.32
12	3.2911	13675.7	-30.486	Surficial Aquifer	75	32	498.468	1965.38	3693.9	668.672	3025.23	3987.36	3318.69
13	3.2911	14790.6	-28.2326	Surficial Aquifer	75	32	535.434	2111.13	4042.73	784.256	3258.48	4330.22	3545.96
14	3.2911	15844.9	-26.0258	Surficial Aquifer	75	32	571.918	2254.98	4378.22	889.527	3488.7	4657.49	3767.96
15	3.2911	16853.6	-23.8598	Surficial Aquifer	75	32	608.442	2398.99	4704.26	985.083	3719.18	4973.38	3988.3
16	3.2911	17809	-21.7296	Surficial Aquifer	75	32	644.561	2541.4	5018.47	1071.42	3947.05	5275.36	4203.94
17	3.2911	18711.2	-19.6305	Surficial Aquifer	75	32	680.165	2681.78	5320.69	1148.97	4171.72	5563.3	4414.33
18	3.24546	19293.7	-17.5727	Black Creek Confining Unit	915.416	0	232.172	915.416	5713.56	0	5713.56	5787.09	5787.09
19	3.24546	19923.5	-15.5524	Black Creek Confining Unit	944.382	0	239.518	944.382	5931.07	0	5931.07	5997.73	5997.73
20	3.24546	20054	-13.5517	Black Creek Confining Unit	969.664	0	245.93	969.664	5999.73	0	5999.73	6059.01	6059.01
21	3.24546	20106.2	-11.5677	Black Creek Confining Unit	991.363	0	251.434	991.363	6045.05	0	6045.05	6096.51	6096.51
22	3.24546	20097.5	-9.59774	Black Creek Confining Unit	1009.56	0	256.049	1009.56	6072.04	0	6072.04	6115.34	6115.34
23	3.24546	20055.1	-7.63916	Black Creek Confining Unit	1024.32	0	259.792	1024.32	6088.83	0	6088.83	6123.68	6123.68

24	3.24546	19976.4	-5.68953	Black Creek Confining Unit	1035.7	0	262.679	1035.7	6094.51	0	6094.51	6120.68	6120.68
25	3.24546	19849.4	-3.7465	Black Creek Confining Unit	1043.74	0	264.718	1043.74	6085.31	0	6085.31	6102.64	6102.64
26	3.24546	19457.3	-1.80777	Black Creek Confining Unit	1048.46	0	265.915	1048.46	5994.51	0	5994.51	6002.9	6002.9
27	2.81343	16377.7	0	Black Creek Confining Unit	1050	0	266.306	1050	5847.87	0	5847.87	5847.87	5847.87
28	3.24546	18682.3	1.80777	Black Creek Confining Unit	1048.46	0	265.915	1048.46	5809.79	0	5809.79	5801.39	5801.39
29	3.24546	18315	3.7465	Black Creek Confining Unit	1043.74	0	264.718	1043.74	5724.62	0	5724.62	5707.29	5707.29
30	3.24546	18052	5.68953	Black Creek Confining Unit	1035.7	0	262.679	1035.7	5671.25	0	5671.25	5645.07	5645.07
31	3.24546	17904.3	7.63916	Black Creek Confining Unit	1024.32	0	259.792	1024.32	5653.44	0	5653.44	5618.6	5618.6
32	3.24546	17712.7	9.59774	Black Creek Confining Unit	1009.56	0	256.049	1009.56	5621.73	0	5621.73	5578.44	5578.44
33	3.24546	17476.4	11.5677	Black Creek Confining Unit	991.363	0	251.434	991.363	5575.71	0	5575.71	5524.25	5524.25
34	3.24546	17194.8	13.5517	Black Creek Confining Unit	969.664	0	245.93	969.664	5514.98	0	5514.98	5455.7	5455.7
35	3.24546	16864.9	15.5524	Black Creek Confining Unit	944.382	0	239.518	944.382	5438.49	0	5438.49	5371.83	5371.83
36	3.24546	16318.9	17.5727	Black Creek Confining Unit	915.416	0	232.172	915.416	5292.6	0	5292.6	5219.07	5219.07
37	2.99191	14456.8	19.5352	Surficial Aquifer	75	32	681.273	2686.15	5331.19	1152.48	4178.71	5089.47	3936.99
38	2.99191	13931.7	21.441	Surficial Aquifer	75	32	670.047	2641.89	5190.58	1082.7	4107.88	4927.44	3844.74
39	2.99191	13360.7	23.372	Surficial Aquifer	75	32	657.262	2591.48	5032.92	1005.7	4027.22	4748.87	3743.17
40	2.99191	12572.8	25.3316	Surficial Aquifer	75	32	632.42	2493.53	4791.62	921.166	3870.45	4492.25	3571.08
41	2.99191	11640.3	27.3235	Surficial Aquifer	75	32	599.611	2364.17	4492.19	828.749	3663.44	4182.4	3353.65
42	2.99191	10667.2	29.352	Surficial Aquifer	75	32	565.151	2228.3	4174.02	728.025	3446	3856.2	3128.17
43	2.99191	9656.39	31.4217	Surficial Aquifer	75	32	529.19	2086.51	3837.58	618.501	3219.08	3514.29	2895.79
44	2.99191	8511.08	33.5383	Surficial Aquifer	75	32	485.406	1913.88	3442.43	499.598	2942.83	3120.68	2621.08
45	2.99191	7086.66	35.7081	Surficial Aquifer	75	32	423.847	1671.16	2925	370.626	2554.38	2620.35	2249.72
46	2.99191	5788.64	37.9388	Surficial Aquifer	75	32	370.905	1462.42	2451.09	230.758	2220.33	2161.94	1931.18
47	2.99191	4482.51	40.2395	Surficial Aquifer	75	32	317.773	1252.93	1964.08	78.9921	1885.09	1695.16	1616.17
48	4.02841	3884.5	43.0533	Perched Clay	1100	0	278.987	1100	1381.68	0	1381.68	1121.04	1121.04

49	4.02841	1303.13	46.4419	Perched Clay	1100	0	278.987	1100	720.812	0	720.812	427.418	427.418
50	0.0693502	0.399037	48.2169	Light Gray Sand	50	32	22.1747	87.4314	59.9029	0	59.9029	35.0871	35.0871

MT3500 Static Pressure Stability - 1600 psf

Global Minimum Query (spencer) - Safety Factor: 5.15612

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.97869	323.932	-26.7288	Roadway	200	30	87.7134	452.261	436.929	0	436.929	481.099	481.099
2	3.18629	975.615	-25.8312	Light Gray Sand	50	32	219.572	1132.14	1731.79	0	1731.79	1838.08	1838.08
3	3.18629	1529.32	-24.9104	Light Gray Sand	50	32	205.982	1062.07	1619.65	0	1619.65	1715.31	1715.31
4	3.18629	2060.29	-23.9964	Light Gray Sand	50	32	81.2532	418.951	590.443	0	590.443	626.614	626.614
5	3.18629	2569.02	-23.0889	Light Gray Sand	50	32	99.3899	512.466	740.1	0	740.1	782.471	782.471
6	3.18629	3055.96	-22.1874	Light Gray Sand	50	32	209.671	1081.09	1650.09	0	1650.09	1735.6	1735.6
7	3.18629	3521.55	-21.2917	Light Gray Sand	50	32	313.852	1618.26	2509.74	0	2509.74	2632.06	2632.06
8	3.18629	3966.17	-20.4014	Light Gray Sand	50	32	243.231	1254.13	1927	0	1927	2017.47	2017.47
9	3.18629	4390.19	-19.5163	Light Gray Sand	50	32	165.682	854.275	1287.11	0	1287.11	1345.83	1345.83
10	3.18629	4793.97	-18.6359	Light Gray Sand	50	32	180.708	931.753	1411.1	0	1411.1	1472.04	1472.04
11	3.18629	5160.73	-17.7601	Light Gray Sand	50	32	194.509	1002.91	1524.98	0	1524.98	1587.28	1587.28
12	3.18629	5812.65	-16.8886	Light Gray Sand	50	32	218.664	1127.46	1724.29	0	1724.29	1790.68	1790.68
13	3.18629	6545.45	-16.0211	Light Gray Sand	50	32	245.904	1267.91	1949.07	0	1949.07	2019.68	2019.68
14	3.18629	7263.62	-15.1573	Light Gray Sand	50	32	272.8	1406.59	2171	0	2171	2244.9	2244.9
15	3.09893	7740.62	-14.3088	Perched Clay (Drained)	200	24	245.592	1266.3	2394.95	0	2394.95	2457.59	2457.59
16	3.09893	8384.73	-13.4752	Perched Clay (Drained)	200	24	263.543	1358.86	2602.85	0	2602.85	2666	2666
17	3.09893	9012.6	-12.6445	Perched Clay (Drained)	200	24	281.155	1449.67	2806.81	0	2806.81	2869.89	2869.89
18	3.09893	9624.42	-11.8166	Perched Clay (Drained)	200	24	298.428	1538.73	3006.85	0	3006.85	3069.28	3069.28
19	3.09893	10061.2	-10.9911	Perched Clay (Drained)	200	24	311.052	1603.82	3153.03	0	3153.03	3213.45	3213.45
20	3.09893	10075.3	-10.1679	Perched Clay (Drained)	200	24	312.262	1610.06	3167.04	0	3167.04	3223.05	3223.05
21	3.09893	10048.8	-9.34687	Perched Clay (Drained)	200	24	312.361	1610.57	3168.2	0	3168.2	3219.62	3219.62
22	3.09893	9992.05	-8.52775	Perched Clay (Drained)	200	24	311.632	1606.81	3159.75	0	3159.75	3206.48	3206.48
23	3.09893	9926.76	-7.71037	Perched Clay (Drained)	200	24	310.658	1601.79	3148.48	0	3148.48	3190.54	3190.54
24	3.09893	9856.05	-6.89458	Perched Clay (Drained)	200	24	309.527	1595.96	3135.37	0	3135.37	3172.8	3172.8
25	3.09893	9766.3	-6.08019	Perched Clay (Drained)	200	24	307.859	1587.36	3116.06	0	3116.06	3148.85	3148.85
26	3.09893	9595.52	-5.26702	Perched Clay (Drained)	200	24	303.94	1567.15	3070.67	0	3070.67	3098.69	3098.69
27	3.09893	9010.6	-4.45493	Perched Clay (Drained)	200	24	288.523	1487.66	2892.13	0	2892.13	2914.61	2914.61

28	3.09893	8856.26	-3.64372	Perched Clay (Drained)	200	24	284.98	1469.39	2851.09	0	2851.09	2869.24	2869.24
29	3.09893	8681.54	-2.83325	Perched Clay (Drained)	200	24	280.847	1448.08	2803.23	0	2803.23	2817.12	2817.12
30	3.09893	8475.85	-2.02335	Perched Clay (Drained)	200	24	275.824	1422.18	2745.05	0	2745.05	2754.8	2754.8
31	3.09893	8495.16	-1.21385	Perched Clay (Drained)	200	24	277.075	1428.63	2759.54	0	2759.54	2765.41	2765.41
32	3.09893	8510.08	-0.404589	Perched Clay (Drained)	200	24	278.207	1434.47	2772.67	0	2772.67	2774.63	2774.63
33	3.09893	8510.08	0.404589	Perched Clay (Drained)	200	24	278.927	1438.18	2781	0	2781	2779.03	2779.03
34	3.09893	8495.16	1.21385	Perched Clay (Drained)	200	24	279.229	1439.74	2784.51	0	2784.51	2778.59	2778.59
35	3.09893	8465.31	2.02335	Perched Clay (Drained)	200	24	279.111	1439.13	2783.14	0	2783.14	2773.28	2773.28
36	3.09893	8390.88	2.83325	Perched Clay (Drained)	200	24	277.726	1431.99	2767.1	0	2767.1	2753.36	2753.36
37	3.09893	8108.9	3.64372	Perched Clay (Drained)	200	24	270.422	1394.33	2682.51	0	2682.51	2665.29	2665.29
38	3.09893	7841.57	4.45493	Perched Clay (Drained)	200	24	263.497	1358.62	2602.31	0	2602.31	2581.78	2581.78
39	3.09893	7604.09	5.26702	Perched Clay (Drained)	200	24	257.389	1327.13	2531.57	0	2531.57	2507.85	2507.85
40	3.09893	7290.34	6.08019	Perched Clay (Drained)	200	24	249.055	1284.16	2435.07	0	2435.07	2408.54	2408.54
41	3.09893	6748.48	6.89458	Perched Clay (Drained)	200	24	234.102	1207.06	2261.9	0	2261.9	2233.6	2233.6
42	3.09893	6177.6	7.71037	Perched Clay (Drained)	200	24	218.226	1125.2	2078.03	0	2078.03	2048.49	2048.49
43	3.09893	5543.28	8.52775	Perched Clay (Drained)	200	24	200.419	1033.38	1871.81	0	1871.81	1841.76	1841.76
44	3.09893	4974.68	9.34687	Perched Clay (Drained)	200	24	184.42	950.89	1686.53	0	1686.53	1656.17	1656.17
45	3.09893	4050.84	10.1679	Perched Clay (Drained)	200	24	157.965	814.487	1380.16	0	1380.16	1351.83	1351.83
46	3.09893	3223.01	10.9911	Perched Clay (Drained)	200	24	134.161	691.751	1104.49	0	1104.49	1078.43	1078.43
47	3.09893	2491.62	11.8166	Perched Clay (Drained)	200	24	113.044	582.866	859.93	0	859.93	836.279	836.279
48	3.09893	1763.3	12.6445	Perched Clay (Drained)	200	24	91.8869	473.78	614.92	0	614.92	594.305	594.305
49	3.09893	1024.7	13.4752	Perched Clay (Drained)	200	24	70.2953	362.451	364.871	0	364.871	348.027	348.027
50	3.09893	313.551	14.3088	Perched Clay (Drained)	200	24	49.3776	254.597	122.627	0	122.627	110.032	110.032

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.00183

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.51994	243.656	-64.0354	Light Brown Sand	75	32	50.9584	102.01	43.225	0	43.225	147.869	147.869
2	1.51994	698.971	-60.9683	Light Brown Sand	75	32	100.376	200.935	201.539	0	201.539	382.386	382.386
3	1.51994	1097.94	-58.175	Light Brown Sand	75	32	148.607	297.485	356.05	0	356.05	595.495	595.495
4	1.51994	1450.78	-55.5873	Light Brown Sand	75	32	195.248	390.854	505.473	0	505.473	790.491	790.491
5	1.51994	1767.52	-53.1609	Light Brown Sand	75	32	240.435	481.31	650.233	0	650.233	971.173	971.173
6	1.70218	2336.54	-50.7345	Dark Gray Clay	1300	0	649.406	1300	548.059	0	548.059	1342.45	1342.45
7	1.70218	2696.17	-48.2972	Dark Gray Clay	1300	0	649.406	1300	775.856	0	775.856	1504.66	1504.66
8	1.70218	3020.59	-45.9715	Dark Gray Clay	1300	0	649.406	1300	984.417	0	984.417	1656.23	1656.23
9	1.70218	3314.88	-43.7399	Dark Gray Clay	1300	0	649.406	1300	1177.31	0	1177.31	1798.76	1798.76
10	1.70218	3583.6	-41.5887	Dark Gray Clay	1300	0	649.406	1300	1357.33	0	1357.33	1933.67	1933.67
11	1.70218	3827.37	-39.5072	Dark Gray Clay	1300	0	649.406	1300	1525.09	0	1525.09	2060.55	2060.55
12	1.70218	4040.21	-37.4863	Dark Gray Clay	1300	0	649.406	1300	1677.86	0	1677.86	2175.92	2175.92
13	1.70218	4232.38	-35.5188	Dark Gray Clay	1300	0	649.406	1300	1820.53	0	1820.53	2284.07	2284.07
14	1.70218	4406.04	-33.5985	Dark Gray Clay	1300	0	649.406	1300	1954.14	0	1954.14	2385.58	2385.58
15	1.70218	4560.89	-31.7201	Dark Gray Clay	1300	0	649.406	1300	2078.52	0	2078.52	2479.92	2479.92
16	1.63418	4505.95	-29.9152	Light Gray Sand	50	32	704.316	1409.92	2176.32	0	2176.32	2581.57	2581.57
17	1.63418	4615.79	-28.1786	Light Gray Sand	50	32	735.212	1471.77	2275.3	0	2275.3	2669.17	2669.17
18	1.63418	4841.88	-26.4699	Light Gray Sand	50	32	784.942	1571.32	2434.62	0	2434.62	2825.47	2825.47
19	1.63418	5221.4	-24.7861	Light Gray Sand	50	32	860.553	1722.68	2676.85	0	2676.85	3074.23	3074.23
20	1.63418	5303.33	-23.125	Light Gray Sand	50	32	889.846	1781.32	2770.69	0	2770.69	3150.7	3150.7
21	1.63418	5373.88	-21.4842	Light Gray Sand	50	32	917.75	1837.18	2860.08	0	2860.08	3221.3	3221.3
22	1.63418	5434.38	-19.8616	Light Gray Sand	50	32	944.426	1890.58	2945.55	0	2945.55	3286.71	3286.71
23	1.63418	5483.57	-18.2556	Light Gray Sand	50	32	969.613	1941	3026.23	0	3026.23	3346.06	3346.06
24	1.63418	5514.3	-16.6642	Light Gray Sand	50	32	991.987	1985.79	3097.92	0	3097.92	3394.85	3394.85
25	1.63418	5534.32	-15.086	Light Gray Sand	50	32	1012.82	2027.49	3164.64	0	3164.64	3437.65	3437.65
26	1.63418	5553.48	-13.5195	Light Gray Sand	50	32	1033.82	2069.54	3231.93	0	3231.93	3480.51	3480.51
27	1.63418	5578.63	-11.9632	Light Gray Sand	50	32	1056.31	2114.56	3303.98	0	3303.98	3527.79	3527.79
28	1.63418	5595.39	-10.4157	Light Gray Sand	50	32	1077.68	2157.34	3372.45	0	3372.45	3570.55	3570.55
29	1.63418	5603.6	-8.87599	Light Gray Sand	50	32	1097.88	2197.76	3437.13	0	3437.13	3608.58	3608.58
30	1.63418	5532.81	-7.34267	Light Gray Sand	50	32	1103.14	2208.3	3454	0	3454	3596.15	3596.15

31	1.63418	3181.86	-5.81463	Light Gray Sand	50	32	656.829	1314.86	2024.2	0	2024.2	2091.09	2091.09
32	1.63418	1110.65	-4.29073	Light Gray Sand	50	32	250.833	502.125	723.549	0	723.549	742.369	742.369
33	1.63418	1128.42	-2.76987	Light Gray Sand	50	32	258.759	517.991	748.939	0	748.939	761.458	761.458
34	1.63418	1139.2	-1.25096	Light Gray Sand	50	32	265.487	531.459	770.498	0	770.498	776.296	776.296
35	1.63418	1141.84	0.267066	Light Gray Sand	50	32	270.711	541.918	787.232	0	787.232	785.97	785.97
36	1.63418	1136.34	1.78528	Light Gray Sand	50	32	274.358	549.219	798.92	0	798.92	790.369	790.369
37	1.63418	1122.69	3.30476	Light Gray Sand	50	32	276.343	553.192	805.273	0	805.273	789.316	789.316
38	1.63418	1100.85	4.82656	Light Gray Sand	50	32	276.571	553.649	806.004	0	806.004	782.651	782.651
39	1.63418	1070.79	6.35179	Light Gray Sand	50	32	274.938	550.379	800.775	0	800.775	770.17	770.17
40	1.63418	1032.44	7.88156	Light Gray Sand	50	32	271.324	543.144	789.193	0	789.193	751.633	751.633
41	1.63418	985.718	9.417	Light Gray Sand	50	32	265.593	531.672	770.836	0	770.836	726.787	726.787
42	1.63418	930.515	10.9593	Light Gray Sand	50	32	257.592	515.656	745.206	0	745.206	695.325	695.325
43	1.63418	866.711	12.5097	Light Gray Sand	50	32	247.145	494.742	711.738	0	711.738	656.904	656.904
44	1.63418	794.157	14.0695	Light Gray Sand	50	32	234.048	468.524	669.775	0	669.775	611.119	611.119
45	1.63418	712.685	15.64	Light Gray Sand	50	32	218.065	436.53	618.577	0	618.577	557.528	557.528
46	1.63418	622.096	17.2226	Light Gray Sand	50	32	198.924	398.213	557.256	0	557.256	495.593	495.593
47	1.63418	522.165	18.819	Light Gray Sand	50	32	176.301	352.924	484.78	0	484.78	424.698	424.698
48	1.63418	412.633	20.4306	Light Gray Sand	50	32	149.813	299.901	399.926	0	399.926	344.12	344.12
49	1.76501	292.063	22.1253	Roadway	200	30	201.924	404.217	353.715	0	353.715	271.618	271.618
50	1.76501	100.118	23.9068	Roadway	200	30	160.525	321.343	210.172	0	210.172	139.015	139.015

◆ Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 1.77619

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.31929	261.331	-70.8567	Light Brown Sand	75	32	52.7613	93.7141	29.9488	0	29.9488	181.943	181.943
2	1.31929	729.928	-66.6465	Light Brown Sand	75	32	109.708	194.863	191.822	0	191.822	445.909	445.909
3	1.31929	1111.22	-63.0722	Light Brown Sand	75	32	164.588	292.34	347.817	0	347.817	671.849	671.849
4	1.31929	1435.81	-59.8976	Light Brown Sand	75	32	217.502	386.324	498.22	0	498.22	873.394	873.394
5	1.42564	1882.55	-56.8965	Dark Gray Clay (Drained)	200	25	283.087	502.816	649.39	0	649.39	1083.59	1083.59
6	1.42564	2201.09	-54.0123	Dark Gray Clay (Drained)	200	25	328.145	582.848	821.022	0	821.022	1272.88	1272.88
7	1.42564	2484.89	-51.3168	Dark Gray Clay (Drained)	200	25	371.219	659.356	985.093	0	985.093	1448.73	1448.73
8	1.42564	2739.94	-48.772	Dark Gray Clay (Drained)	200	25	412.514	732.703	1142.39	0	1142.39	1613.13	1613.13
9	1.42564	2965.99	-46.3506	Dark Gray Clay (Drained)	200	25	451.644	802.205	1291.43	0	1291.43	1764.89	1764.89
10	1.42564	3165.95	-44.0324	Dark Gray Clay (Drained)	200	25	488.641	867.919	1432.36	0	1432.36	1904.77	1904.77
11	1.42564	3347.11	-41.8018	Dark Gray Clay (Drained)	200	25	524.161	931.009	1567.65	0	1567.65	2036.33	2036.33
12	1.42564	3511.1	-39.6465	Dark Gray Clay (Drained)	200	25	558.242	991.544	1697.47	0	1697.47	2160.05	2160.05
13	1.42564	3658.24	-37.5565	Dark Gray Clay (Drained)	200	25	590.784	1049.34	1821.42	0	1821.42	2275.67	2275.67
14	1.42564	3791.18	-35.5237	Dark Gray Clay (Drained)	200	25	622.015	1104.82	1940.39	0	1940.39	2384.45	2384.45
15	1.43108	3923.11	-33.5376	Light Gray Sand	50	32	742.257	1318.39	2029.85	0	2029.85	2521.84	2521.84
16	1.43108	4028.48	-31.5924	Light Gray Sand	50	32	780.846	1386.93	2139.54	0	2139.54	2619.78	2619.78
17	1.43108	4296.51	-29.6871	Light Gray Sand	50	32	851.474	1512.38	2340.31	0	2340.31	2825.73	2825.73
18	1.43108	4572.29	-27.8173	Light Gray Sand	50	32	926.01	1644.77	2552.16	0	2552.16	3040.75	3040.75
19	1.43108	4650.01	-25.9792	Light Gray Sand	50	32	963.174	1710.78	2657.8	0	2657.8	3127.14	3127.14
20	1.43108	4717.69	-24.1695	Light Gray Sand	50	32	998.998	1774.41	2759.63	0	2759.63	3207.96	3207.96
21	1.43108	4776.55	-22.3851	Light Gray Sand	50	32	1033.67	1836	2858.19	0	2858.19	3283.93	3283.93
22	1.43108	4826.89	-20.6233	Light Gray Sand	50	32	1067.2	1895.55	2953.5	0	2953.5	3355.13	3355.13
23	1.43108	4864.36	-18.8817	Light Gray Sand	50	32	1098.58	1951.29	3042.7	0	3042.7	3418.44	3418.44
24	1.43108	4889.36	-17.158	Light Gray Sand	50	32	1127.79	2003.17	3125.73	0	3125.73	3473.93	3473.93
25	1.43108	4906.63	-15.4502	Light Gray Sand	50	32	1155.81	2052.94	3205.37	0	3205.37	3524.82	3524.82
26	1.43108	4924.56	-13.7564	Light Gray Sand	50	32	1184.57	2104.02	3287.12	0	3287.12	3577.12	3577.12

27	1.43108	4944.82	-12.0747	Light Gray Sand	50	32	1214.55	2157.27	3372.33	0	3372.33	3632.15	3632.15
28	1.43108	4957.89	-10.4036	Light Gray Sand	50	32	1243.54	2208.76	3454.74	0	3454.74	3683.05	3683.05
29	1.43108	4963.88	-8.74139	Light Gray Sand	50	32	1271.54	2258.5	3534.33	0	3534.33	3729.85	3729.85
30	1.43108	4955.7	-7.08656	Light Gray Sand	50	32	1296.72	2303.22	3605.91	0	3605.91	3767.11	3767.11
31	1.43108	4433.89	-5.43765	Light Gray Sand	50	32	1188.54	2111.07	3298.4	0	3298.4	3411.53	3411.53
32	1.43108	1841.58	-3.79326	Light Gray Sand	50	32	522.722	928.453	1405.82	0	1405.82	1440.48	1440.48
33	1.43108	1013.06	-2.15198	Light Gray Sand	50	32	308.063	547.179	795.655	0	795.655	807.231	807.231
34	1.43108	1018.54	-0.512481	Light Gray Sand	50	32	316.285	561.782	819.019	0	819.019	821.848	821.848
35	1.43108	1017.27	1.1266	Light Gray Sand	50	32	322.934	573.592	837.925	0	837.925	831.574	831.574
36	1.43108	1009.27	2.76661	Light Gray Sand	50	32	327.91	582.431	852.067	0	852.067	836.221	836.221
37	1.43108	994.497	4.40889	Light Gray Sand	50	32	331.103	588.101	861.141	0	861.141	835.612	835.612
38	1.43108	972.926	6.05481	Light Gray Sand	50	32	332.383	590.375	864.778	0	864.778	829.522	829.522
39	1.43108	944.501	7.70577	Light Gray Sand	50	32	331.604	588.992	862.566	0	862.566	817.697	817.697
40	1.43108	909.15	9.3632	Light Gray Sand	50	32	328.599	583.655	854.024	0	854.024	799.841	799.841
41	1.43108	866.782	11.0286	Light Gray Sand	50	32	323.172	574.015	838.596	0	838.596	775.611	775.611
42	1.43108	817.285	12.7035	Light Gray Sand	50	32	315.096	559.67	815.642	0	815.642	744.612	744.612
43	1.43108	760.527	14.3895	Light Gray Sand	50	32	304.102	540.143	784.389	0	784.389	706.369	706.369
44	1.43108	696.351	16.0883	Light Gray Sand	50	32	289.874	514.872	743.951	0	743.951	660.347	660.347
45	1.43108	624.575	17.8018	Light Gray Sand	50	32	272.035	483.185	693.238	0	693.238	605.888	605.888
46	1.43108	544.988	19.5319	Light Gray Sand	50	32	250.125	444.269	630.962	0	630.962	542.231	542.231
47	1.43108	457.346	21.2808	Light Gray Sand	50	32	223.589	397.136	555.533	0	555.533	468.446	468.446
48	1.43108	361.369	23.0508	Light Gray Sand	50	32	191.74	340.566	465.003	0	465.003	383.414	383.414
49	1.54405	255.538	24.9162	Roadway	200	30	255.107	453.118	438.414	0	438.414	319.909	319.909
50	1.54405	87.6232	26.8824	Roadway	200	30	200.93	356.89	271.74	0	271.74	169.88	169.88

Interslice Data

◆ MT3500 Dynamic Pressure Stability - 3200 psf

Global Minimum Query (spencer) - Safety Factor: 3.94284

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	176.263	88.9951	0	0	0
2	177.123	87.4951	-19.5416	-1.95416	5.71059
3	180.888	81.5748	10783.4	1078.34	5.71059
4	184.652	76.4752	25504.9	2550.49	5.71059
5	188.417	72	30707.7	3070.77	5.71059
6	191.102	69.1189	34867.7	3486.77	5.71059
7	193.788	66.4605	41191.9	4119.19	5.71059
8	196.473	64	53333.7	5333.37	5.71059
9	199.764	61.2262	64824.3	6482.43	5.71059
10	203.056	58.6916	70605.5	7060.55	5.71059
11	206.347	56.3732	76376.2	7637.62	5.71059
12	209.638	54.2528	82026.3	8202.63	5.71059
13	212.929	52.3153	87542.1	8754.21	5.71059
14	216.22	50.5482	92923.1	9292.31	5.71059
15	219.511	48.9412	98075.9	9807.59	5.71059
16	222.802	47.4855	102920	10292	5.71059
17	226.093	46.1739	107381	10738.1	5.71059
18	229.384	45	111387	11138.7	5.71059
19	232.63	43.9722	116506	11650.6	5.71059
20	235.875	43.0689	121085	12108.5	5.71059
21	239.121	42.2867	124980	12498	5.71059
22	242.366	41.6224	128179	12817.9	5.71059
23	245.612	41.0736	130680	13068	5.71059
24	248.857	40.6383	132487	13248.7	5.71059
25	252.103	40.315	133605	13360.5	5.71059
26	255.348	40.1024	134039	13403.9	5.71059
27	258.594	40	133789	13378.9	5.71059
28	261.407	40	133040	13304	5.71059
29	264.652	40.1024	131581	13158.1	5.71059
30	267.898	40.315	129505	12950.5	5.71059
31	271.143	40.6383	126819	12681.9	5.71059
32	274.389	41.0736	123514	12351.4	5.71059
33	277.634	41.6224	119598	11959.8	5.71059
34	280.88	42.2867	115077	11507.7	5.71059
35	284.125	43.0689	109965	10996.5	5.71059
36	287.371	43.9722	104275	10427.5	5.71059
37	290.616	45	98081	9808.1	5.71059
38	293.608	46.0616	90382.4	9038.24	5.71059
39	296.6	47.2365	82278	8227.8	5.71059
40	299.592	48.5295	73803.2	7380.32	5.71059
41	302.584	49.9458	65123.9	6512.39	5.71059
42	305.576	51.4916	56385.1	5638.51	5.71059
43	308.568	53.1742	47670.5	4767.05	5.71059
44	311.559	55.002	39072.1	3907.21	5.71059
45	314.551	56.9852	30792.2	3079.22	5.71059
46	317.543	59.1357	23233.2	2323.32	5.71059
47	320.535	61.4681	16406.1	1640.61	5.71059
48	323.527	64	10482.1	1048.21	5.71059
49	327.555	67.7636	4157.66	415.766	5.71059
50	331.584	72	-20.3801	-2.03801	5.71059
51	331.653	72.0776	0	0	0

MT3500 Static Pressure Stability - 1600 psf

Global Minimum Query (spencer) - Safety Factor: 5.15612

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	175.931	88.9951	0	0	0
2	178.909	87.4951	394.119	43.4244	6.28754
3	182.096	85.9526	2365.7	260.655	6.28754
4	185.282	84.4729	4106.02	452.405	6.28754
5	188.468	83.0545	4684.6	516.154	6.28755
6	191.655	81.6962	5373.22	592.027	6.28755
7	194.841	80.3967	6849.4	754.674	6.28755
8	198.027	79.1549	8965.84	987.865	6.28754
9	201.214	77.9699	10474.4	1154.08	6.28755
10	204.4	76.8405	11400.1	1256.08	6.28757
11	207.586	75.766	12340.6	1359.7	6.28755
12	210.772	74.7454	13277.2	1462.89	6.28752
13	213.959	73.7781	14248.5	1569.91	6.28753
14	217.145	72.8631	15248.2	1680.06	6.28754
15	220.331	72	16252.8	1790.75	6.28755
16	223.43	71.2096	17384.7	1915.47	6.28757
17	226.529	70.467	18500.8	2038.44	6.28756
18	229.628	69.7718	19580.9	2157.44	6.28754
19	232.727	69.1235	20605.5	2270.33	6.28753
20	235.826	68.5216	21539.3	2373.22	6.28754
21	238.925	67.9658	22331.8	2460.54	6.28754
22	242.024	67.4557	22979.8	2531.94	6.28755
23	245.123	66.991	23482.4	2587.31	6.28753
24	248.222	66.5715	23840.6	2626.78	6.28754
25	251.321	66.1968	24056.3	2650.54	6.28753
26	254.42	65.8667	24130.8	2658.76	6.28755
27	257.518	65.581	24066.2	2651.63	6.28753
28	260.617	65.3395	23870.3	2630.05	6.28754
29	263.716	65.1422	23549.8	2594.74	6.28754
30	266.815	64.9888	23109.4	2546.21	6.28753
31	269.914	64.8794	22555.1	2485.15	6.28756
32	273.013	64.8137	21877.7	2410.51	6.28755
33	276.112	64.7918	21076.2	2322.2	6.28755
34	279.211	64.8137	20151	2220.25	6.28752
35	282.31	64.8794	19102.8	2104.76	6.28753
36	285.409	64.9888	17933.1	1975.89	6.28755
37	288.508	65.1422	16648.1	1834.3	6.28753
38	291.607	65.3395	15280.7	1683.64	6.28753
39	294.706	65.581	13835.8	1524.44	6.28754
40	297.805	65.8667	12315	1356.87	6.2875
41	300.904	66.1968	10739.3	1183.27	6.28756
42	304.002	66.5715	9166.27	1009.95	6.28755
43	307.101	66.991	7618.13	839.372	6.28754
44	310.2	67.4557	6127.25	675.107	6.28755
45	313.299	67.9658	4695.49	517.353	6.28754
46	316.398	68.5216	3438.87	378.898	6.28754
47	319.497	69.1235	2358.35	259.845	6.28754
48	322.596	69.7718	1450.51	159.818	6.28752
49	325.695	70.467	738.243	81.3404	6.28755
50	328.794	71.2096	249.459	27.4856	6.28754
51	331.893	72	0	0	0

Short Term Stability

Global Minimum Query (spencer) - Safety Factor: 2.00183

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	106.716	119.556	0	0	0
2	108.236	116.435	57.4123	18.2901	17.6706
3	109.756	113.697	456.658	145.48	17.6706
4	111.276	111.248	1102.62	351.266	17.6705
5	112.796	109.029	1927.19	613.952	17.6705
6	114.316	107	2880.73	917.729	17.6706
7	116.018	104.918	2915.81	928.902	17.6705
8	117.72	103.007	3291.82	1048.69	17.6706
9	119.423	101.247	3919.18	1248.55	17.6705
10	121.125	99.6177	4730.81	1507.12	17.6706
11	122.827	98.107	5675.18	1807.97	17.6706
12	124.529	96.7035	6709.58	2137.5	17.6705
13	126.231	95.398	7793.9	2482.94	17.6706
14	127.934	94.183	8899.74	2835.23	17.6706
15	129.636	93.0521	10003.5	3186.86	17.6706
16	131.338	92	11084.2	3531.16	17.6706
17	132.972	91.0597	11978.9	3816.17	17.6705
18	134.606	90.1843	12768.6	4067.74	17.6705
19	136.24	89.3706	13466.1	4289.95	17.6705
20	137.875	88.616	14078.9	4485.18	17.6706
21	139.509	87.9181	14557.4	4637.62	17.6706
22	141.143	87.2749	14896.3	4745.58	17.6705
23	142.777	86.6846	15090.8	4807.54	17.6705
24	144.411	86.1455	15136.6	4822.12	17.6705
25	146.045	85.6564	15029.8	4788.12	17.6706
26	147.68	85.2158	14767.7	4704.62	17.6706
27	149.314	84.8229	14347.1	4570.62	17.6706
28	150.948	84.4767	13763.8	4384.81	17.6706
29	152.582	84.1763	13014.6	4146.14	17.6706
30	154.216	83.9211	12096.6	3853.66	17.6705
31	155.851	83.7105	11020	3510.7	17.6706
32	157.485	83.5441	10282.8	3275.85	17.6706
33	159.119	83.4215	9961.39	3173.45	17.6706
34	160.753	83.3424	9597.48	3057.51	17.6705
35	162.387	83.3067	9190.85	2927.97	17.6706
36	164.021	83.3143	8742.19	2785.04	17.6706
37	165.656	83.3653	8252.86	2629.15	17.6705
38	167.29	83.4596	7724.99	2460.99	17.6706
39	168.924	83.5976	7161.52	2281.48	17.6706
40	170.558	83.7795	6566.27	2091.85	17.6706
41	172.192	84.0058	5944.07	1893.63	17.6706
42	173.826	84.2768	5300.84	1688.71	17.6705
43	175.461	84.5932	4643.81	1479.4	17.6706
44	177.095	84.9558	3981.62	1268.44	17.6705
45	178.729	85.3654	3324.59	1059.13	17.6706
46	180.363	85.8229	2685.01	855.375	17.6705
47	181.997	86.3294	2077.44	661.819	17.6705
48	183.632	86.8864	1519.16	483.967	17.6706
49	185.266	87.4951	1030.74	328.367	17.6705
50	187.031	88.2127	420.286	133.893	17.6706
51	188.796	88.9951	0	0	0

Long Term Stability

Global Minimum Query (spencer) - Safety Factor: 1.77619

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	112.609	118.729	0	0	0
2	113.928	114.929	44.1767	15.7977	19.6772
3	115.247	111.873	485.47	173.605	19.6771
4	116.567	109.276	1171.61	418.97	19.6771
5	117.886	107	2018.29	721.746	19.6772
6	119.312	104.813	3034.46	1085.13	19.6772
7	120.737	102.85	4178.14	1494.11	19.6771
8	122.163	101.07	5402.63	1931.99	19.6771
9	123.588	99.4428	6672.74	2386.19	19.6772
10	125.014	97.9483	7958.52	2845.99	19.6772
11	126.44	96.57	9235.69	3302.71	19.6772
12	127.865	95.2953	10486.4	3749.95	19.6771
13	129.291	94.114	11695.4	4182.29	19.6771
14	130.717	93.0178	12849.2	4594.92	19.6772
15	132.142	92	13936.9	4983.86	19.6771
16	133.573	91.0514	14799.5	5292.33	19.6771
17	135.004	90.1713	15564.5	5565.9	19.6772
18	136.436	89.3554	16254.6	5812.69	19.6772
19	137.867	88.6004	16855.7	6027.66	19.6772
20	139.298	87.903	17330	6197.25	19.6772
21	140.729	87.2608	17671.9	6319.51	19.6772
22	142.16	86.6714	17876.4	6392.66	19.6772
23	143.591	86.1328	17939	6415.03	19.6772
24	145.022	85.6433	17855.2	6385.07	19.6772
25	146.453	85.2015	17621.4	6301.47	19.6772
26	147.884	84.806	17234.3	6163.02	19.6772
27	149.315	84.4556	16689.7	5968.3	19.6772
28	150.746	84.1495	15983	5715.58	19.6772
29	152.177	83.8867	15110.2	5403.43	19.6771
30	153.609	83.6667	14067.2	5030.45	19.6771
31	155.04	83.4888	12851.9	4595.88	19.6772
32	156.471	83.3526	11599.4	4147.98	19.6772
33	157.902	83.2577	10984.3	3928.02	19.6772
34	159.333	83.2039	10586	3785.58	19.6772
35	160.764	83.1911	10143.6	3627.37	19.6771
36	162.195	83.2192	9657.6	3453.58	19.6772
37	163.626	83.2884	9129.14	3264.61	19.6772
38	165.057	83.3987	8560.02	3061.09	19.6772
39	166.488	83.5505	7952.82	2843.95	19.6772
40	167.919	83.7442	7310.97	2614.42	19.6772
41	169.35	83.9801	6638.93	2374.1	19.6772
42	170.782	84.2591	5942.29	2124.98	19.6772
43	172.213	84.5816	5227.98	1869.54	19.6772
44	173.644	84.9488	4504.54	1610.84	19.6772
45	175.075	85.3616	3782.41	1352.6	19.6772
46	176.506	85.8211	3074.34	1099.39	19.6771
47	177.937	86.3287	2395.86	856.767	19.6772
48	179.368	86.8861	1766.05	631.546	19.6772
49	180.799	87.4951	1208.34	432.105	19.6772
50	182.343	88.2124	499.763	178.717	19.6772
51	183.887	88.9951	0	0	0

Discharge Sections

Entity Information

◆ MT3500 Dynamic Pressure Stability - 3200 psf

Shared Entities

Type	Coordinates (x,y)
	0, 5 341.152, 5 341.152, 10 341.152, 40 341.152, 45 341.152, 64 341.152, 70.9951 339.618, 70.9951 339.612, 70.9951 333.323, 70.9951 331.908, 71.9951 331.893, 72 328.82, 72.9951 326.809, 73.9951 324.454, 74.9951 322.308, 75.9951 320.029, 76.9951 317.951, 77.9951 315.956, 78.9951 314.462, 79.9951 313.237, 80.9951 311.772, 81.9951 308.395, 82.9951 306.548, 83.9951 303.755, 84.9951 301.48, 85.9951 298.79, 86.9951 291.309, 87.9951 287.021, 88.9951 269.036, 88.9951 267.567, 88.9951 264.489, 89.9951 258.542, 90.9951 257.411, 92 256.291, 92.9953 250.858, 93.9953 245.263, 94.9953 240.127, 95.9953 234.492, 96.9953 233.526, 97.1547 233.045, 96.9951 230.035, 95.9951 227.025, 94.9951 224.014, 93.9951

External Boundary	221.004, 92.9951
	218.009, 92
	217.994, 91.9951
	214.984, 90.9951
	211.975, 89.9951
	208.965, 88.9951
	157.56, 88.9951
	157.479, 89.9951
	157.399, 90.9951
	157.296, 91.9951
	157.295, 92
	157.216, 92.9951
	157.13, 93.9951
	157.05, 94.9951
	156.944, 95.9951
	156.864, 96.9951
	156.768, 97.9951
	156.688, 98.9951
	156.604, 99.9951
	156.524, 100.995
	156.421, 101.995
	156.34, 102.995
	156.251, 103.995
	156.161, 104.995
	156.049, 105.995
	155.969, 106.995
	155.969, 107
	155.911, 107.995
	155.831, 108.995
	155.736, 109.995
	154.622, 110.995
	147.946, 111.995
	143.583, 112.995
	138.281, 113.995
	133.164, 114.995
	128.495, 115.995
	123.611, 116.995
	117.472, 117.995
	110.845, 118.995
	103.486, 119.995
	82.1792, 120.995
	79.1749, 121.995
	76.1895, 122.989
	76.1241, 122.995
	68.2083, 123.995
	62.2738, 124.995
	56.5322, 125.995
	50.7721, 126.995
	45.7988, 127.995
	40.7047, 128.995
	35.4024, 129.995
	30.4447, 130.995
	25.7039, 131.995
	18.8506, 132.995
	10.3771, 133.995
	0, 135.22
	0, 107
	0, 92
	0, 72

	0, 64 0, 45 0, 40 0, 10
Material Boundary	0, 64 341.152, 64
Material Boundary	0, 45 341.152, 45
Material Boundary	0, 40 341.152, 40
Material Boundary	0, 10 341.152, 10
Material Boundary	0, 72 331.893, 72
Material Boundary	0, 92 135.736, 92 157.295, 92
Material Boundary	218.009, 92 257.411, 92
Material Boundary	0, 107 135.736, 107 155.969, 107
Material Boundary	157.56, 88.9951 157.56, 87.4951 209.047, 87.4951 208.965, 88.9951
Material Boundary	155.736, 109.995 135.736, 109.995 135.736, 107 135.736, 92 135.736, 88.995 157.56, 88.9951

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 341.152, 64	Assigned to: 🟨 Surficial Aquifer 🟧 Black Creek Aquifer
Distributed Load	82.1792, 120.995 103.486, 119.995	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	199.67, 88.9951 193.193, 88.9951	Constant DistributionOrientation: VerticalMagnitude: 3200 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	184.676, 88.9951 178.189, 88.9951	Constant DistributionOrientation: VerticalMagnitude: 3200 lbs/ft2Creates Excess Pore Pressure: No

MT3500 Static Pressure Stability - 1600 psf

Shared Entities

Type	Coordinates (x,y)
External Boundary	0, 5
	341.152, 5
	341.152, 10
	341.152, 40
	341.152, 45
	341.152, 64
	341.152, 70.9951
	339.618, 70.9951
	339.612, 70.9951
	333.323, 70.9951
	331.908, 71.9951
	331.893, 72
	328.82, 72.9951
	326.809, 73.9951
	324.454, 74.9951
	322.308, 75.9951
	320.029, 76.9951
	317.951, 77.9951
	315.956, 78.9951
	314.462, 79.9951
	313.237, 80.9951
	311.772, 81.9951
	308.395, 82.9951
	306.548, 83.9951
	303.755, 84.9951
	301.48, 85.9951
	298.79, 86.9951
	291.309, 87.9951
	287.021, 88.9951
	269.036, 88.9951
	267.567, 88.9951
	264.489, 89.9951
	258.542, 90.9951
	257.411, 92
	256.291, 92.9953
	250.858, 93.9953
	245.263, 94.9953
	240.127, 95.9953
	234.492, 96.9953
	233.526, 97.1547
	233.045, 96.9951
	230.035, 95.9951
	227.025, 94.9951
	224.014, 93.9951
	221.004, 92.9951
	218.009, 92
	217.994, 91.9951
	214.984, 90.9951
	211.975, 89.9951
	208.965, 88.9951
	157.56, 88.9951
	157.479, 89.9951
	157.399, 90.9951
	157.296, 91.9951

	157.295, 92 157.216, 92.9951 157.13, 93.9951 157.05, 94.9951 156.944, 95.9951 156.864, 96.9951 156.768, 97.9951 156.688, 98.9951 156.604, 99.9951 156.524, 100.995 156.421, 101.995 156.34, 102.995 156.251, 103.995 156.161, 104.995 156.049, 105.995 155.969, 106.995 155.969, 107 155.911, 107.995 155.831, 108.995 155.736, 109.995 154.622, 110.995 147.946, 111.995 143.583, 112.995 138.281, 113.995 133.164, 114.995 128.495, 115.995 123.611, 116.995 117.472, 117.995 110.845, 118.995 103.486, 119.995 82.1792, 120.995 79.1749, 121.995 76.1895, 122.989 76.1241, 122.995 68.2083, 123.995 62.2738, 124.995 56.5322, 125.995 50.7721, 126.995 45.7988, 127.995 40.7047, 128.995 35.4024, 129.995 30.4447, 130.995 25.7039, 131.995 18.8506, 132.995 10.3771, 133.995 0, 135.22 0, 107 0, 92 0, 72 0, 64 0, 45 0, 40 0, 10
Material Boundary	0, 64 341.152, 64
Material Boundary	0, 45 341.152, 45

Material Boundary	0, 40 341.152, 40
Material Boundary	0, 10 341.152, 10
Material Boundary	0, 72 331.893, 72
Material Boundary	0, 92 135.736, 92 157.295, 92
Material Boundary	218.009, 92 257.411, 92
Material Boundary	0, 107 135.736, 107 155.969, 107
Material Boundary	157.56, 88.9951 157.56, 87.4951 209.047, 87.4951 208.965, 88.9951
Material Boundary	155.736, 109.995 135.736, 109.995 135.736, 107 135.736, 92 135.736, 88.995 157.56, 88.9951

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 341.152, 64	Assigned to: 🟨 Surficial Aquifer 🟧 Black Creek Aquifer
Distributed Load	82.1792, 120.995 103.486, 119.995	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	199.67, 88.9951 193.193, 88.9951	Constant DistributionOrientation: VerticalMagnitude: 1600 lbs/ft2Creates Excess Pore Pressure: No
Distributed Load	184.676, 88.9951 178.189, 88.9951	Constant DistributionOrientation: VerticalMagnitude: 1600 lbs/ft2Creates Excess Pore Pressure: No

Short Term Stability

Shared Entities

Type	Coordinates (x,y)
	0, 5 341.152, 5 341.152, 10

External Boundary	341.152, 40
	341.152, 45
	341.152, 64
	341.152, 70.9951
	339.618, 70.9951
	339.612, 70.9951
	333.323, 70.9951
	331.908, 71.9951
	331.893, 72
	328.82, 72.9951
	326.809, 73.9951
	324.454, 74.9951
	322.308, 75.9951
	320.029, 76.9951
	317.951, 77.9951
	315.956, 78.9951
	314.462, 79.9951
	313.237, 80.9951
	311.772, 81.9951
	308.395, 82.9951
	306.548, 83.9951
	303.755, 84.9951
	301.48, 85.9951
	298.79, 86.9951
	291.309, 87.9951
	287.021, 88.9951
	269.036, 88.9951
	267.567, 88.9951
	264.489, 89.9951
	258.542, 90.9951
	257.411, 92
	256.291, 92.9953
	250.858, 93.9953
	245.263, 94.9953
	240.127, 95.9953
	234.492, 96.9953
	233.526, 97.1547
	233.045, 96.9951
	230.035, 95.9951
	227.025, 94.9951
	224.014, 93.9951
	221.004, 92.9951
	218.009, 92
	217.994, 91.9951
	214.984, 90.9951
	211.975, 89.9951
	208.965, 88.9951
	157.56, 88.9951
	157.479, 89.9951
	157.399, 90.9951
	157.296, 91.9951
	157.295, 92
	157.216, 92.9951
	157.13, 93.9951
	157.05, 94.9951
	156.944, 95.9951
	156.864, 96.9951
	156.768, 97.9951
	156.688, 98.9951

	156.604, 99.9951 156.524, 100.995 156.421, 101.995 156.34, 102.995 156.251, 103.995 156.161, 104.995 156.049, 105.995 155.969, 106.995 155.969, 107 155.911, 107.995 155.831, 108.995 155.736, 109.995 154.622, 110.995 147.946, 111.995 143.583, 112.995 138.281, 113.995 133.164, 114.995 128.495, 115.995 123.611, 116.995 117.472, 117.995 110.845, 118.995 103.486, 119.995 82.1792, 120.995 79.1749, 121.995 76.1895, 122.989 76.1241, 122.995 68.2083, 123.995 62.2738, 124.995 56.5322, 125.995 50.7721, 126.995 45.7988, 127.995 40.7047, 128.995 35.4024, 129.995 30.4447, 130.995 25.7039, 131.995 18.8506, 132.995 10.3771, 133.995 0, 135.22 0, 107 0, 92 0, 72 0, 64 0, 45 0, 40 0, 10
Material Boundary	0, 64 341.152, 64
Material Boundary	0, 45 341.152, 45
Material Boundary	0, 40 341.152, 40
Material Boundary	0, 10 341.152, 10
Material Boundary	0, 72 331.893, 72
Material Boundary	0, 92 135.736, 92 157.295, 92

Material Boundary	218.009, 92 257.411, 92
Material Boundary	0, 107 135.736, 107 155.969, 107
Material Boundary	157.56, 88.9951 157.56, 87.4951 209.047, 87.4951 208.965, 88.9951
Material Boundary	155.736, 109.995 135.736, 109.995 135.736, 107 135.736, 92 135.736, 88.995 157.56, 88.9951

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 341.152, 64	Assigned to: 🟨 Surficial Aquifer 🟧 Black Creek Aquifer
Distributed Load	82.1792, 120.995 103.486, 119.995	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Long Term Stability

Shared Entities

Type	Coordinates (x,y)
	0, 5 341.152, 5 341.152, 10 341.152, 40 341.152, 45 341.152, 64 341.152, 70.9951 339.618, 70.9951 339.612, 70.9951 333.323, 70.9951 331.908, 71.9951 331.893, 72 328.82, 72.9951 326.809, 73.9951 324.454, 74.9951 322.308, 75.9951 320.029, 76.9951 317.951, 77.9951 315.956, 78.9951 314.462, 79.9951 313.237, 80.9951 311.772, 81.9951 308.395, 82.9951

External Boundary	306.548, 83.9951 303.755, 84.9951 301.48, 85.9951 298.79, 86.9951 291.309, 87.9951 287.021, 88.9951 269.036, 88.9951 267.567, 88.9951 264.489, 89.9951 258.542, 90.9951 257.411, 92 256.291, 92.9953 250.858, 93.9953 245.263, 94.9953 240.127, 95.9953 234.492, 96.9953 233.526, 97.1547 233.045, 96.9951 230.035, 95.9951 227.025, 94.9951 224.014, 93.9951 221.004, 92.9951 218.009, 92 217.994, 91.9951 214.984, 90.9951 211.975, 89.9951 208.965, 88.9951 157.56, 88.9951 157.479, 89.9951 157.399, 90.9951 157.296, 91.9951 157.295, 92 157.216, 92.9951 157.13, 93.9951 157.05, 94.9951 156.944, 95.9951 156.864, 96.9951 156.768, 97.9951 156.688, 98.9951 156.604, 99.9951 156.524, 100.995 156.421, 101.995 156.34, 102.995 156.251, 103.995 156.161, 104.995 156.049, 105.995 155.969, 106.995 155.969, 107 155.911, 107.995 155.831, 108.995 155.736, 109.995 154.622, 110.995 147.946, 111.995 143.583, 112.995 138.281, 113.995 133.164, 114.995 128.495, 115.995 123.611, 116.995 117.472, 117.995

	110.845, 118.995 103.486, 119.995 82.1792, 120.995 79.1749, 121.995 76.1895, 122.989 76.1241, 122.995 68.2083, 123.995 62.2738, 124.995 56.5322, 125.995 50.7721, 126.995 45.7988, 127.995 40.7047, 128.995 35.4024, 129.995 30.4447, 130.995 25.7039, 131.995 18.8506, 132.995 10.3771, 133.995 0, 135.22 0, 107 0, 92 0, 72 0, 64 0, 45 0, 40 0, 10
Material Boundary	0, 64 341.152, 64
Material Boundary	0, 45 341.152, 45
Material Boundary	0, 40 341.152, 40
Material Boundary	0, 10 341.152, 10
Material Boundary	0, 72 331.893, 72
Material Boundary	0, 92 135.736, 92 157.295, 92
Material Boundary	218.009, 92 257.411, 92
Material Boundary	0, 107 135.736, 107 155.969, 107
Material Boundary	157.56, 88.9951 157.56, 87.4951 209.047, 87.4951 208.965, 88.9951
Material Boundary	155.736, 109.995 135.736, 109.995 135.736, 107 135.736, 92 135.736, 88.995 157.56, 88.9951

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Piezoline	0, 64 341.152, 64	Assigned to: 🟨 Surficial Aquifer ▨ Black Creek Confining Unit (Long Term) 🟧 Black Creek Aquifer ▨ Upper Cape Fear Confining Unit (Drained)
Distributed Load	82.1792, 120.995 103.486, 119.995	Constant DistributionOrientation: VerticalMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

GEOS
GEOServices, LLC, Geotechnical and Materials Engineers

Appendix C
Groundwater Extraction and Conveyance System Design Report

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Groundwater Extraction and Conveyance System 90% Engineering Design Report

Chemours Fayetteville Works

Prepared for

The Chemours Company FC, LLC
22828 NC Highway 87
Fayetteville, NC 28306

Prepared by

Geosyntec Consultants of NC, P.C.
2501 Blue Ridge Road, Suite 430
Raleigh, NC 27607

Project Number TR0795A

March 2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

LIST OF ABBREVIATIONS

3D	three-dimensional
COA	Consent Order Addendum
ETM	Elapsed Time Meter
ft	feet
fps	feet per second
gal	gallon
gpm	gallon per minute
GWEC	Groundwater Extraction and Conveyance
GWTP	Groundwater Treatment Plant
HDPE	High Density Polyethylene
HMI	Human Machine Interface
kV	kilovolt
KVA	kilovolt ampere
MCP	Main Control Panel
NAVD88	North American Vertical Datum of 1988
NCDEQ	North Carolina Department of Environmental Quality
O&M	Operation and Maintenance
P&ID	Piping and Instrumentation Diagram
PDI	Pre-Design Investigation
PFAS	Per- and Polyfluoroalkyl Substances
PLC	Programmable Logic Controller
psi	pounds per square inch
PVC	Polyvinyl Chloride
SCADA	Supervisory Control and Data Acquisition
TOC	Top of Casing
V	volt
VFD	Variable Frequency Drive

1 INTRODUCTION

1.1 Overview and Background

Geosyntec Consultants of NC, P.C. (Geosyntec) has prepared for The Chemours Company, FC, LLC (Chemours) this 90% Engineering Design Report (report) for the Groundwater Extraction and Conveyance (GWEC) System planned to be installed at the Chemours Fayetteville Works facility in Bladen County, North Carolina (the Site; **Figure 1-1**). This report has been prepared pursuant to the Consent Order Addendum (COA) Paragraph 3 (North Carolina Department of Environmental Quality [NCDEQ], 2019) which requires a 90% design report for the Barrier Wall and Groundwater Extraction and Treatment System be submitted by March 31, 2022 to NCDEQ for approval. The groundwater interception remedy for the Site consists of three key elements: an underground low permeability barrier wall to reduce the transmission of groundwater downgradient, an extraction system for extracting and conveying groundwater from the Surficial and Black Creek Aquifers upgradient of the barrier wall, and a groundwater conveyance system to convey that groundwater to the groundwater treatment plant (GWTP). This report describes the basis of design and presents the 90% design level for the groundwater extraction and conveyance component of the remedy. The barrier wall design and GWTP design are presented in Appendices B and F of the Groundwater and Seeps Remedy 90% Design Report (Geosyntec, 2022a).

The design presented in this report has been developed based on the current understanding of Site conditions and is expected to generally remain consistent between this design stage and construction. Details of specific elements may be adjusted as the design of the other related components such as the barrier wall, the seeps and the GWTP are advanced towards remedy construction. The designs are also subject to change based on permitting input provided by the appropriate regulatory agencies or conditions encountered during installation.

1.2 GWEC System and Report Objectives

The extraction and conveyance components of the GWEC System are being designed such that in conjunction with the barrier wall and the GWTP, the per- and polyfluoroalkyl substance (PFAS) loading from groundwater flow under the facility to the Cape Fear River and Willis Creek is reduced, pursuant to COA Paragraph 3(b)(ii) (COA; NCDEQ, 2019). The objectives of this report are to:

- Describe the rationale and basis of design for the GWEC System components including, but not limited to, wells, the conveyance system, pumps, instrumentation, and electrical components.
- Provide 90% level engineering drawings consistent with the rationale and basis of design.

The design basis is formed in significant part based on the analysis and conclusions presented in the Groundwater Modeling report (Appendix A of the Groundwater and Seeps Remedy 90% Design; Geosyntec, 2022a).

1.3 Design Report Organization

The remainder of this report is divided into the following sections:

- **Section 2** – Key project drivers and constraints
- **Section 3 –** GWEC System Design Basis, including extraction system design flow rates
- **Section 4** – GWEC System infrastructure overview, including a description of the main system components, their design basis and rationale, and their anticipated operational conditions
- **Section 5** – GWEC System operations and maintenance
- **Section 6** – List of references cited in this report

2 KEY PROJECT DRIVERS AND CONSTRAINTS

This section details the key project drivers and constraints for the GWEC System.

Paragraph 3(b)(ii) of the COA states:

> *"Chemours shall construct an extraction system consisting of an adequate number of wells and/or interceptor trenches to pump groundwater at a rate and depth sufficient to prevent groundwater migration around, above, or under the barrier wall. The system shall be designed so that extracted groundwater shall be treated through a treatment system that removes PFAS compounds (as measured by concentrations of indicator parameters GenX, PMPA, and PFMOAA) at a minimum removal efficiency of 99%."*

Furthermore, the COA states that the complete installation and commencement of the operations of the barrier wall, the GWEC System, and the GWTP shall be completed by March 15, 2023.

Inherent in this requirement is the inclusion of an appropriately sized GWEC System to meet the remedial objectives stated in the COA. The design of a system to extract and convey groundwater to a GWTP on Site must account for several physical and logistical constraints and considerations.

- **Geographic/Geologic:** The Site geography, particularly the extremely steep and unstable slopes along certain parts of the remedy alignment, and the need for extensive clearing, slope stabilization, and erosion control present design and construction challenges that need to be considered. Further, the highly heterogenous nature of the hydrostratigraphy necessitates the inclusion of sufficient contingency into the 90% design to account for uncertainties in anticipated groundwater capture.
- **Schedule:** The COA schedule requires that the complete installation and commencement of the operations of the entire groundwater remedy be completed by March 15, 2023. However, for the entire remedial system to be installed effectively the GWEC System must be operable in advance of the barrier wall installation to reduce hydraulic head in the upgradient aquifer and thus avoid large hydraulic gradients across the barrier wall during construction. Therefore, the design and construction of the GWEC System must progress with a schedule offset from the COA completion date.
- **Global Supply Chain:** Project execution in accordance with the schedule is challenged further by the well-documented global shipping delays which are increasing lead-time volatility and resulting in an uncertain climate for procurement.
- **Technical:** Considerations for the design must include an understanding of existing site utilities and additional power requirements. The design must be technically compatible with other remedy components, including the GWTP, barrier wall, and seeps capture and conveyance. As such, the design must include contingency in the event that additional capacity is needed in the future. Operation and maintenance (O&M) requirements must be considered in the design in order to minimize effort and mitigate potential down time.

System automation and remote monitoring capabilities are included in the design to aide in minimizing O&M efforts.

3 GROUNDWATER EXTRACTION AND CONTAINMENT SYSTEM DESIGN BASIS

To aid in designing the barrier wall and groundwater extraction system, a three-dimensional (3D) numerical model was developed in FEFLOW version 7.2 (DHI-WASY). The model was used to evaluate the hydraulic response under various barrier wall extraction well configurations and expected changes to the hydraulic gradients after the barrier wall and extraction system is implemented. The model was updated and calibrated prior to the design simulations. Detailed information regarding the model construction, calibrations, and design simulations is presented in Appendix A of the Groundwater and Seeps Remedy 90% Design (Geosyntec, 2022a).

3.1 Extraction System Design Flow Rates

Numerical model simulations to assess well locations and associated pumping rate ranges were performed using flow data obtained from aquifer pumping tests (Groundwater Modeling Report, Appendix A of the Groundwater and Seeps Remedy 90% Design: Geosyntec, 2022a). Details of the lithological borings and pumping tests are included in the Pre-Design Investigation (PDI) Summary report (Geosyntec, 2021a). The PDI identified areas of increased transmissivity near Seep A, Seep B, and Seep D, and this information was incorporated into calibration and remedy design; details are presented in Appendix A of the Groundwater and Seeps Remedy 90% Design (Geosyntec, 2022a). The 3D numerical model simulations indicate that to provide hydraulic containment in accordance with the requirements set forth in the COA (Paragraph 3 of the COA), 69 extraction wells (15 wells in the Surficial Aquifer and 54 wells in the Black Creek Aquifer) will need to be installed in conjunction with the vertical barrier wall.

The modeled range of extraction well flow rates are provided in **Table 3-1**. The modeled maximum total flow rate for the extraction well network is 1,245 gallons per minute (gpm).

3.2 Material Compatibility

Material compatibility for components of the GWEC System directly in contact with the groundwater matrix at the Site is important for long-term reliability during operation and has been incorporated into the design of the various components. Details of the groundwater chemistry at the Site have been previously presented in the 2020 Annual Onsite and Offsite Groundwater Monitoring Report (Geosyntec, 2021b) and the Final RCRA Facility Investigation Report (Parsons, 2014).

4 GWEC SYSTEM DESIGN

This section provides a description of the components of the GWEC System, summarizes their design basis and rationale, and describes the overall operational logic of the system.

Figure 4-1 presents a plan view of the GWEC System layout, which is comprised of the following key components:

- **Groundwater Extraction System**: The groundwater extraction system, described in **Section 4.1.1**, consists of 69 extraction wells (i.e., EW-01 through EW-69) installed upgradient of the barrier wall. Associated appurtenances include well enclosures, well head fixtures, submersible pumps, and instrumentation.
- **Groundwater Conveyance System**: The groundwater conveyance system, described in **Section 4.1.2**, consists of two groundwater conveyance pipelines (i.e., North Forcemain and South Forcemain) that convey extracted groundwater to the GWTP.

4.1 System Description and Rationale

The GWEC System consists of 69 extraction wells screened at different depths within the transmissive zones of the Surficial and Black Creek Aquifers. Submersible pumps installed in each well will be used to extract and convey groundwater through individual lateral pipes into a single header pipe (i.e., North Forcemain and South Forcemain) that conveys extracted groundwater to the GWTP equalization tank.

Each wellhead will be equipped with flow, pressure, and water level measuring instrumentation for monitoring operational parameters and for system control. The extraction wells will be controlled by individual panels, with remote control access capabilities, designed to control operation of a specific set of extraction wells. These remote-control panels will be controlled using a primary Programmable Logic Controller (PLC) and Human Machine Interface (HMI) at a main control panel (MCP) within a control room. A Supervisory Control and Data Acquisition (SCADA) system will be used to record and log the operational data from the GWEC System.

4.1.1 Groundwater Extraction System

The main components of the groundwater extraction system are shown on Drawings C-01 through C-08 and M-01 through M-03 in **Attachment A**; the Piping and Instrumentation Diagrams (P&IDs) for the GWEC System are shown on Drawings D-01 through D-03 in **Attachment A**. Extraction wells and their associated components were sized based on the estimated extraction flow rates for each well. Current design elements have been conservatively estimated and/or sized to accommodate potential changes as the design is refined and for contingent capacity, should it be needed during operation.

The groundwater extraction system design consists of the following components:

- **Extraction Wells:** The GWEC System consists of 69 groundwater extraction wells with expected individual well flow rates ranging from 5 to 35 gpm, as shown on **Figure 4-1**. Typical well construction schematics for the 69 extraction wells are shown on Drawings M-01 through M-03 in **Attachment A**.

  Each extraction well will be constructed using 6-inch diameter Schedule 40 polyvinyl chloride (PVC) casing with 6-inch diameter stainless steel wire-wrapped, 0.020-inch slotted well screens. Both Schedule 40 PVC and stainless steel are compatible with the groundwater and aquifer matrix at the Site. Based on existing hydrostratigraphic data from the PDI (Geosyntec, 2021a), the screen intervals are expected to range between 20 and 40 feet (ft) in length within the transmissive zone of each aquifer. Consistent with best practices for extraction well design, each extraction well design includes a 5-ft sump below the bottom of the screened interval to allow for collection of silt or sediment that may accumulate over time (EPA, 2018).

  Of the proposed extraction wells, 15 wells will be screened in the Surficial Aquifer, while the remaining 54 wells will be screened in the Black Creek Aquifer. Based on previous sieve analyses (Geosyntec, 2020a), a 20-40 graded clean silica sand will be used for the filter pack material. The filter pack material will extend approximately 2-3 ft above the top of the screen.

  The extraction wells will be installed using sonic drilling to allow casing off the overlying aquifer and prevent vertical migration of groundwater between the aquifers during well installation. A combination of 6-inch, 8-inch, and 10-inch drill rods will be used to advance a minimum 10-inch borehole within which the extraction well casing, screen, and filter pack will be installed using centralizers.

  Each extraction well will be developed to remove residual sediment following installation and to establish hydraulic connectivity with the aquifer. During well development, measures such as continuous water level gauging to avoid drawdown below the top of the screen interval will be taken to minimize aeration of the groundwater to prevent iron fouling.

  Approximately 17 extraction wells will be selected for aquifer testing following development. Aquifer tests will be abbreviated step drawdown tests consisting of no fewer than three individual pumping rates. Pumping rates will coincide and exceed the design flowrates for each well location. During step drawdown tests, water levels inside the extraction well and in any nearby monitoring wells will be recorded continuously using pressure transducers and manual measurements. The final number of step drawdown tests may change based on the results of each test. Extraction wells not selected for a step drawdown test will be monitored during well development activities to confirm that well performance is consistent with the well design.

- **Well Enclosures:** The extraction wells and their associated wellhead fixtures are designed to be housed in lockable fiberglass Hot Box enclosures of appropriate dimensions, as shown on Drawings M-01 through M-03 (**Attachment A)**. Each enclosure design is set atop a 4-inch-thick concrete pad to allow water that enters the enclosure or condensation within the enclosure to drain through the opening at the bottom side and prevent submergence of equipment. Each well enclosure will be equipped with an entry sensor to alert the operator if the enclosure door is unintentionally left open or in the case of unauthorized entry. If opened, the sensor will be activated, and a signal will be sent to the local well control panel and the operator will be notified with an alarm. The sensor alarm will not affect system operations; it will be a notification alarm only. Well enclosures will be equipped with a heater to prevent pipe freezing.
- **Wellhead Fixtures:** As mentioned previously, each extraction well will consist of a 6-inch diameter Schedule 40 PVC riser casing terminating above the ground surface. Each riser well casing will terminate in a 6-inch well seal with five adequately sized holes bored through the seal plate to accommodate installation of the following: (i) high-density polyethylene (HDPE) submersible well pump discharge pipe; (ii) 1-inch Schedule 40 PVC stilling tube (i.e., transducer housing); (iii) pump power cable; (iv) steel pump support cable; and (v) the air release valve discharge tubing. The wellhead construction within each enclosure will sequentially comprise the following components:
    - Magnetic Flow Meter and Transmitter – A magnetic flow meter and transmitter will be installed on the vertical pipe segment after the HDPE pipe transitions to PVC at the well seal flange. The magnetic flow meter will be situated to provide a minimum of 5 pipe diameters of straight pipe upstream and 2 pipe diameters of straight pipe downstream of the flow sensor to avoid turbulence effects and provide accurate flow readings per manufacturer's recommendations.
    - Air Relief Valve – Downstream of the flow meter, an isolation ball valve and an air relief valve will be installed to prevent air entrainment or blocks due to air bubbles in the discharge line.
    - Pressure Transmitter and Sample Port Assembly – A pressure transmitter will be installed as illustrated on Drawings M-01 through M-03 (**Attachment A**). The pressure transmitter can be isolated from the pressurized line for maintenance via a 0.5-inch bronze isolation ball valve; the sample port will be comprised of a 0.5-inch bronze ball valve/sample port.
    - Check Valve – After the pressure transmitter, a check valve will be installed to prevent backflow through the piping system into the extraction well.
    - Ball Valve – After the check valve, a ball valve will be installed to provide isolation of the preceding valves and instrumentation from the remainder of the system.

  - Wellhead Cleanout – A wellhead cleanout consisting of a bronze ball valve and a quick connect fitting will be installed as illustrated on Drawings M-01 through M-03 (**Attachment A**). The wellhead cleanout will allow for lateral pipe cleaning in the event of solids buildup.

  Before exiting the enclosure, the Schedule 80 PVC pipe will transition to an HDPE pipe lateral that will connect to the conveyance forcemain. For collocated wells, the individual HDPE laterals will combine into a common lateral prior to connecting to the conveyance forcemain, as illustrated on Detail 32 on Drawing M-09 (**Attachment A**).

- **Submersible Pumps:** An electrical stainless-steel submersible pump will be installed in each extraction well. Pump specifications including flow ranges and total dynamic head losses are provided in **Table 4-1**. The pump impellers will be constructed of stainless-steel which is compatible with Site groundwater. The pumps were selected based on hydraulic modeling using WaterGEMS (SELECT Series 3), a water distribution system modeling and design software developed by Bentley Systems with modeled flow rate input from the Groundwater Modeling Report (Appendix A of Groundwater and Seeps Remedy 90% Design). Each extraction well pump will be equipped with a motor compatible for use with a Variable Frequency Drive (VFD) for controlling flow rates.

- **Water-Level Monitoring and Control:** Each extraction well will be equipped with a pressure transducer to monitor water levels in the well during operation to prevent extraction pump cavitation and to minimize fouling by drawing down water to the screen interval. The water level in the well will be used to control extraction pump operation. Flow control of the extraction wells is discussed further in **Section 4.1.4**.

4.1.2 Groundwater Conveyance System

Figure 4-1 presents the general layout of the GWEC System conveyance piping. Drawings C-01 through C-08 present the plans and profiles of the forcemains. The groundwater conveyance system will consist of the following components:

- Two subsurface conveyance pipes (i.e., North Forcemain and South Forcemain) that connect the extraction wells to the GWTP:
  - The North Forcemain consists of a telescoping forcemain transitioning from 3-inch SDR-11 HDPE to 10-inch SDR-11 HDPE and conveys groundwater from EW-01 through EW-54 to the GWTP.
  - The South Forcemain consists of a telescoping forcemain transitioning from 3-inch SDR-11 HDPE to 8-inch SDR-11 HDPE and conveys groundwater from EW-55 through EW-69 to the GWTP.
- Both forcemains will combine into a single forcemain and discharge into an equalization tank located at the GWTP.

- Pipe cleanouts to facilitate periodic cleaning of the pipes during operation.
- Air release/vacuum breaker valves.
- Subsurface trenches for installation of the forcemains prior to daylighting of the forcemains near the GWTP.
- Associated fittings.

The key design criteria used for the groundwater conveyance piping include: (i) structural integrity for subsurface use; (ii) pipe flow velocity generally targeted in the range of 2 – 8 feet per second (fps); (iii) the design flow rate for the North Forcemain of 875 gpm; and (iv) the design flow rate for the South Forcemain of 370 gpm.

Typically, a target flow velocity greater than 2 fps is selected to minimize particulate settling in pressurized pipes. For several sections of the GWEC System conveyance piping, nominal piping diameters 2 inches or less would be necessary to maintain flow velocities in excess of 2 fps. Conveyance piping less than 3 inches in diameter can be difficult to clean out should it become clogged due to particulate settling, biofouling, and/or chemical precipitation (e.g., scaling). Given the presence of dissolved iron in the extracted groundwater, scaling is considered to be a greater risk than settling of particulates. To facilitate conveyance piping cleaning should scaling occur, 3-inch conveyance piping was specified even where the 2 fps settling criterion was not satisfied. Both forcemains were designed to accommodate additional flow rates while maintaining the velocity constraints mentioned previously.

The conveyance pipeline will be constructed using SDR-11 HDPE pipe that is compatible with the Site groundwater, aquifer, and subsurface matrix. HDPE piping is also relatively flexible and is also considered suitable for subsurface installation. Butt-fusion welding will be used to assemble the HDPE conveyance piping to the extent possible. Alternative methods may include the use of compression fittings where butt-fusion welding may not be feasible. Transition from PVC piping to HDPE piping in the well enclosures will be facilitated using flanged connections. Prior to GWEC System startup, pressure testing of conveyance piping will be conducted following approved methods (ASTM, F 2164), to confirm the integrity of the conveyance piping and the integrity of the mechanical joints (i.e., there is no leakage).

In areas of high utility density, the conveyance pipeline will be installed via directional drilling in conjunction with intrusive utility surveying techniques (such as potholing or air-knifing) to avoid potential utility strikes. Directional drilling technology is typically accompanied with tracking mechanisms that allow tracking of the drill head as it advances in the subsurface. Different types of directional drill rigs have limitations on angle of entry and setback requirements which shall be determined as details on the conveyance layout are finalized with further design progress.

The conveyance piping shall be installed a minimum of 36 inches below grade with 4 inches of pipe bedding material below the conveyance piping as shown on Drawing M-08 in **Attachment A** and consistent with North Carolina guidance (Section 450 – Utility Trenches, 2021). Control conduits shall be installed in a similar manner in a separate trench. To the extent suitable, native soil will be used as backfill material, and the remainder will be substituted by appropriate imported clean fill. The trench will be designed to accommodate culvert crossings (as applicable) and accommodate stresses due to overburden materials. Because the pipeline will be installed prior to installation of the barrier wall, the trench shall be designed to withstand routine heavy vehicle loadings at locations where the pipeline will cross beneath or installed within the barrier wall roadway and other access roads. Surface completion of the trench will be made consistent with the surface of the surrounding roadway.

4.1.3 Electrical & Process Control Infrastructure

The power to the GWEC System will be distributed using an underground 13.2 kilovolt (kV) distribution feeder sourced from the power drop at the existing OF003 GWTP location. There will be 17 remote control panels installed along the barrier wall alignment to supply power and process control to the 69 extraction wells. At each of the 17 control panel locations, the 13.2 kV distribution feeder will be tapped to supply a 75-kilovolt ampere secondary transformer that will convert the power to single phase 120/240 volt (V). The secondary transformer will supply a fused disconnect switch to allow each location to be isolated for maintenance. The fused disconnect switch will feed a manual transfer switch to allow connection of a generator in the event of a power failure. The transfer switch will feed the distribution panel that will then power the remote-control panel, the area lighting, a convenience outlet, the well Hot Box enclosures, and a security camera.

The individual remote control panels system will be controlled by a PLC located in the MCP. The MCP will be installed in the control room near the GWTP and will be central to operations of the entire remedy. The PLC will be accessible/programmable via an HMI on a computer. The main control panel will also have a touch-screen HMI for redundancy if the computer is offline. The HMI will also be accessible remotely via a secure internet connection. The full range of GWEC System operations will be controllable both on- and off-Site to securely logged in operators.

The MCP will communicate with each of the 17 remote control panels via a fiber optic line network. The remote-control panels will contain input and output cards to relay the data from extraction wells to the remote PLCs for processing. Data transmitted from each well will include the extraction flow rate, well water level elevation, and discharge pressure at the well. Each remote-control panel will be equipped with a touch-screen HMI to facilitate local operations and maintenance activities.

Each remote-control panel is designed to allow control of up to six extraction wells to maintain a standard size. Each panel is designed to have at least one spare position to facilitate control of additional extraction wells should they be needed to achieve groundwater containment objectives. Additionally, the spare positions could be utilized for seep water control measures as contingency for the seep ex-situ capture design.

Each well pump will be controlled by appropriately rated VFDs that will convert the 240V single phase input to 240V three phase output to power the pump motor. The VFDs will be installed within the remote control panels. The VFDs will facilitate control of extraction well flow rates without the need for mechanical control using valves. The VFDs will be connected to a local disconnect switch near each well through buried conduits to allow servicing of the well pumps. A low voltage junction box will also be installed near the wells to allow termination of the instrumentation (i.e., flow meter, level transmitter, pressure transmitter, and intrusion alarm).

4.1.4 Process Control/Functional Description

The flow rates from individual extraction wells will be controlled by both localized setpoints (i.e., well level, enclosure pipeline flowrate/pressure) and level controls at the equalization tank at the GWTP that will shut off or prevent the extraction well pumps from operating if the level setpoint has been reached.

The system interlocks for the GWEC System operation are shown on the P&IDs (Drawing D-02 in **Attachment A**). The PLC will be programmed to execute the system operation logic depicted on Drawing D-02 in **Attachment A**. Overviews of the operation protocols and controls for the groundwater extraction well system are provided below.

4.1.4.1 Groundwater Extraction Well System Operation and Control

The HMI will include a general control interface window that displays and provides operational access to each of the 69 extraction wells. The general control interface window will display a graphical representation of the GWEC System. The well icons will display key well design details, including top of casing (ft North American Vertical Datum of 1988 [NAVD88]), transducer elevation (ft NAVD88), and pump elevation (ft NAVD88). The operational parameters and alarm status for the individual extraction wells will be displayed adjacent to the extraction well icons in a table. The operational parameters indicated on the HMI interface will include the following:

- **Well Status** – Indicates whether the extraction well is in OFF, HAND, or AUTO mode. In OFF, the pump will not be allowed to operate. In HAND, the pump will be turned on regardless of control interlocks. In AUTO, the pump will operate when required by the control system.
- **Pump Status** – Indicates whether the pump is ON or OFF.
- **Flow Rate** – Indicates the instantaneous flow rate of water pumped from well in gpm.
- **Total (gal)** – Indicates the total volume of flow in gallons (gal) pumped from the well since the totalizer was last reset. The total volume will be estimated by the PLC using the instantaneous flow rate from the flow meter and the reporting time steps. The total volume of flow as measured by the flow meter will be accessible at the device installed in the well enclosure.
- **Pressure** – Indicates the line pressures in pounds per square inch (psi) at the extraction well enclosures.

- **Well Level** – Indicates: (i) the height of the water column (in ft) above the well level transmitter; and (ii) the elevation of the water column with respect to ft NAVD88.
- **Flow Setpoint** – Indicates the flow to which the pump will attempt to maintain. The **Flow Setpoint** will be referenced in gpm.
- **Pump Speed (or Speed)** – Indicates the pump motor speed as a percentage.
- **Motor Current** – Indicates the motor current of the pump motor in amps.
- **Pump Starts (Daily)** – Indicates the number of pump starts at the well during the current calendar day.
- **Elapsed Time Meter (ETM) (Hours)** – Indicates the total elapsed time that the pump has operated since the meter was last reset.
- **Enclosure Status** – Indicates the extraction well enclosure door status (i.e., open or closed).

The alarm status for the extraction wells is displayed. The alarms listed include:

- **Panel Intrusion** – The well control panel is open; warning only.
- **Communication Failure** – There is a failure in communication between the well control panel and the MCP; this will shut down the pump(s) controlled through the well control panel.
- **High Motor Current** – The pump motor current exceeded the maximum allowable value; the pump will be shut down.
- **Low Level** – The water level in the well dropped below the Well Level set point; the pump will be shut down for a minimum of 5 minutes[1] to allow the well to recharge.
- **Low Flow** – The pump flow rate dropped below the minimum level; the pump will be shut down.
- **Pump Failure** – A pump failure occurred; pump is shut down.
- **Low Pressure** – The conveyance pipeline pressure is less than the minimum pressure setpoint within the well enclosure piping; the pump will shut off.
- **High Pressure** – The conveyance pipeline pressure is greater than the maximum pressure setpoint within the well enclosure piping; the pump will shut off.
- **Running in Hand at Well** – The pump is operating in Hand mode; control interlocks for pump are disabled.

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[1] A minimum shut down period of 5 minutes will be specified to prevent the number of pump motor starts per hour from exceeding manufacturer recommendations.

- **Enclosure Intrusion** – The well enclosure door is open, warning only.

In addition, the system will monitor the flow rates at each extraction well and compare it to the total incoming flow rate as measured at the inlet manifold. Accounting for accuracy range of the flowmeters, a predetermined setpoint for the discrepancy between the individual flow rates and the total flow rate will be used to trigger an alarm indicating a potential leak. Similarly, pressure readings outside of anticipated range and the accuracy of the instrument will trigger a pressure alarm and shut down the system. The system operator will be notified via text message or email when an alarm is triggered by an exceedance of the specified operational parameters.

The control interface window for an extraction well will be accessible by clicking on the extraction well information box on the HMI interface. The individual control interface window for an extraction well will provide the means to control pump extraction rate and other operational parameters. The operational variables[2] and their functionality are described below:

- **Flow Setpoint –** Sets the flow rate that the pump will attempt to maintain during routine operation.
- **Maximum Flow** – Sets the maximum flow at which the PLC will operate the extraction well pump. Given its function as one of the second-tier governing controls, the **Maximum Flow** set point can be used to set the operating flow rate of the extraction well. For example, if the **Maximum Flow** for EW-15 is set at 20 gpm and the **Target Water Level** is set at an elevation below which the water level in the well will not reach, the PLC will maintain the flow rate at 20 gpm (i.e., at the specified extraction rate, the water level in the well will not decrease to the **Target Well Level**). Therefore, the **Maximum Flow** set point acts as the operating flow rate control point.
- **Target Water Level** – Sets the level to which the pump will attempt to maintain the groundwater level in the well. The **Target Water Level** will be referenced to NAVD88 to the level at which the pressure transducer is installed. The **Target Water Level** will be the first-tier[3] governing control that is used to set the well extraction rate. The second-tier[3] governing control will be the **Minimum Flow** and **Maximum Flow** set points (see below) for the pump. Operationally, the PLC will attempt to maintain the **Target Water Level** by adjusting the pump rate within the specified flow range. The PLC will keep increasing flow up to the **Maximum Flow** set point in an attempt to draw the well water level down to the **Target Water Level**. If the well yield is less than the **Minimum Flow** set point the PLC will operate the well at **Minimum Flow** until the water level in the well drops to **Low Level (Pump Stop)**, as defined below, at which point the pump will be turned off.

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[2] Set points for the operational variables will be determined in the field during system installation, including functional checkout and startup activities.

[3] First- and second-tier governing controls are used for programming purposes only. The system can be operated either way depending on operator preference.

- **Low Level (Pump Stop)** - Sets the low-level interlock that shuts down the well pump should the water level in the well decrease to the specified level. The level set point will be referenced to NAVD88.
- **High Level (Pump Start)** – Sets the high-level interlock that starts the well pump should the water level in the well be above to the specified level. The level set point will be referenced to NAVD88.
- **Minimum Flow** – Sets the minimum flow at which the PLC will operate the extraction well pump. The minimum flow values for a well will be set no lower than the manufacturer's recommended flow rate.
- **Level Transmitter Depth from TOC** – Sets the depth below the top of casing (TOC) at which the level transmitter is installed in the well.
- **Low Pressure Alarm** – Sets the low pressure set point in the extraction well enclosure at which the PLC will transmit a signal to shut down the extraction well. The pressure transmitter is installed on the enclosure piping and a low-pressure alarm could be indicative of a potential pipe failure or leak within the enclosure.
- **High Pressure Alarm** – Sets the high pressure set point in the extraction well enclosure at which the PLC will transmit a signal to shut down the extraction well. The pressure transmitter is installed on the enclosure piping and a high-pressure alarm could be indicative of a potential pipe blockage or clogging within the enclosure.
- **Pump Motor High Current Alarm** – Sets the maximum allowable current (amps) set point for the pump motor. If exceeded, the PLC will transmit a signal to shut down the extraction well pump, thus protecting the motor from damage.
- **VFD Set Points** – These are set points that control the operation of the VFD controlling the extraction well pump motor. In general, after system start up, these set points will not be changed except by an operator with specialized training in VFD control optimization.
- **Total (gal) and ETM (hours) Resets** – These two control icons, if clicked, will reset the PLC estimated flow volume total and the elapsed time meter. The **Total (gal) Reset** does not reset the totalizer associated with the local device.
- **Communication Failure** – Sets whether a communication failure between the MCP and the well control panel shuts down the well (Enabled) or allows it to operate (Disabled). **Communication Failure** will only be set in the Disabled mode if maintenance is being performed at the well.
- **Panel Door Status** – Indicates whether the local well control panel is open or closed.

The control infrastructure and programming for the extraction wells provides an appropriate degree of operational flexibility to achieve the groundwater containment objectives.

4.1.4.2 Groundwater Treatment System Operation and Control

Extracted groundwater will be conveyed to an equalization tank at the GWTP (designed by others). The equalization tank will be equipped with a level transmitter and a high-high level switch. Overviews of the minimum operation protocols and controls are described below:

- **Equalization Tank Level High** – Sets the maximum water level setpoint for the level transmitter in the equalization tank at which the extraction well pumps will be shut off. The run permissive condition for the extraction wells is that the level in the tank is below the **Equalization Tank Level High**.
- **Equalization Tank Level High-High** – Sets the maximum water level setpoint for the high-high level switch in the equalization tank at which the extraction well pumps will be shut off. The **Equalization Tank Level High-High** setpoint shall be higher than the **Equalization Tank Level High** setpoint and acts as a redundant control in the event of level transmitter failure/malfunction.

4.2 Design Drawings

The design drawings incorporate the design elements of the groundwater extraction and conveyance components of the GWEC System as detailed in the preceding sections. The different design elements are presented in a manner that facilitates review of the principal design concepts. The drawings have been grouped into five categories, including:

- General (e.g., project notes, existing site conditions, etc.)
- Civil (e.g., site development plan, grading plan, piping plans and profiles, piping details, extraction well details, etc.)
- Process (e.g., piping & instrumentation diagrams)
- Mechanical (e.g., extraction well enclosure and piping plans, pipeline appurtenances, etc.)
- Electrical (e.g., electrical service drop, system architecture, control panels, conduit diagrams, PLC modules, well grounding, cable lists)

The 90% Design Drawings are provided in **Attachment A**.

4.3 Design Calculations

The basis for pump and pipe design of the GWEC System is presented in the Calculation Package (**Attachment C)** of this 90% Design Report. The Calculation Package documents engineering calculations and hydraulic modeling results performed using WaterGEMS (SELECT Series 3) to size and select: (i) the submersible pumps at the extraction wells; and (ii) the North and South conveyance forcemains. Design elements are based on the 90% Design Drawings (**Attachment A**) and have been conservatively estimated and/or sized to accommodate potential changes as the design is refined and for contingent capacity, should it be needed during operation

4.4 Technical Specifications

Technical Specifications prepared for the GWEC System 90% design are presented in Attachment B. The specifications include a Project Overview which summarizes the 90% design discussed in this report and provides additional detail on the project roles and scope definition for contractors. The specifications individually detail the scope, products, and execution for GWEC System components. The technical specifications may be adjusted as the GWEC System design and other related components progress towards construction. The Technical Specification package in **Attachment B** includes the following:

Division	Specification	Title
Division 01	--	Project Overview
	01 31 00	Project Management & Coordination
	01 33 00	Submittal Procedures
	01 35 29	Health, Safety, & Emergency Response Procedures
	01 57 20	Environmental Protection
	01 65 00	Product Delivery, Storage, & Handling
	01 66 00	Equipment Testing & Start-Up
Division 02	02 81 00	Soils Management
	02 21 00	Surveys
Division 03	03 40 00	Concrete
Division 22	22 10 00	Piping and Appurtenances
	22 11 00	HDPE Pipes and Fittings
	22 80 00	Valves and Gauges
	22 90 00	Mechanical Identification
	22 99 50	Mechanical Systems Commissioning
Division 26	26 05 00	Electrical
Division 31	31 10 00	Site Clearing
	31 23 00	Excavation and Fill

5 SYSTEM OPERATIONS AND MAINTENANCE

The GWEC System is designed to operate continuously with minimal operator attention. System automation and remote monitoring capabilities have been incorporated in the design to reduce O&M efforts, but operator attention will be required during system startup and optimization, routine inspection and maintenance, and response to alarm and system shut-down conditions. This section summarizes the procedures for these activities. A detailed system O&M Plan will be developed to assist the operator with conducting O&M activities and will include routine and non-routine operating procedures for the various components of the GWEC system.

5.1 System Integration, Functional Checkout, and Startup

The GWEC System will undergo functional checkout and startup processes after construction is complete. The mechanical, electrical, and instrumentation components comprising the GWEC System will be integrated into the process control network architecture to provide a fully functional and automated system. The system software that controls functionality of the individual extraction wells via the 17 remote control panels, the MCP, and associated instrumentation, communication, and power distribution subsystems will be programmed by the system integrator and executed by the PLC in the MCP.

Functional checkout activities will be performed prior to startup of the GWEC System. The purpose of the functional checkout is to verify that key system components have been installed correctly and are functioning in accordance with the design. Functional checkout activities will proceed according to the following sequence for each system:

- Verify installation and operation of electrical, mechanical, and instrumentation components consistent with the design
- Verify hydraulic performance (i.e., pipe filling and purging)
- Verify system interlocks by limited operation of the GWEC System
- Verify flow adjustments of the extraction well pumps
- Verify full system operation to confirm each system is operating consistent with design criteria

Once the system is confirmed to be fully functional, startup activities will commence. The startup of the extraction wells will be performed in a phased manner to minimize the volume of water generated initially so that the operating parameters can be optimized prior to running the system at higher capacities. Startup of the GWEC System will be considered substantially complete when the system is confirmed to be operating consistent with the design flow rates.

5.2 Routine Inspection and Maintenance

The components of the GWEC System will require inspection and maintenance to confirm operation in alignment with design objectives. Prior to startup, an O&M Plan will be prepared and then refined based on findings from construction, startup, and stable operation. The O&M Plan will describe routine preventative maintenance activities for the various components of the GWEC System and define the conditions that may prompt additional non-routine action. The O&M Plan will also include a compilation of operating manuals and specifications for the installed components for operator reference during O&M activities. The O&M Plan will include checklists to support the routine inspection and logging of GWEC System components and maintenance activities.

The expected O&M activities for the primary components of the GWEC system include:

- Routine inspections of the extraction wellheads and conveyance line during active operation with varying levels of scrutiny assigned to each inspection event.
- Regular calibration and cleaning of level, pressure, and flow instrumentation depending on routine monitoring of data collected from the instruments.
- Regular cleaning of pumps per manufacturer recommendations followed by replacement of pumps as necessary.
- Routine checking of valves, and air-release valves to confirm smooth operation and assess if cleaning or replacement is required.
- Routine thermal evaluation of the control panels to mitigate potential electrical health and safety hazards.
- Routine testing of system alarms and interlocks.
- Extraction well rehabilitation (chemical or physical) depending on well yield.
- Forcemain cleanout if fouling or scaling is occurring.
- Maintenance of vegetation around GWEC System infrastructure including wells, control panels, and transformers.

Over time, fouling or scaling of the well or groundwater conveyance pipes may occur due to particulate settling, biofouling, and/or chemical precipitation (e.g., scaling). Flow, pressure, and water level data from each well and the overall flow rate for the GWEC System will be routinely evaluated to determine the need for well or conveyance line maintenance. Well maintenance activities will include redevelopment to remove scaling/fouling and to maintain hydraulic connectivity of the screen interval with the aquifer. Depending on the level of scaling, additional well or conveyance line maintenance using chemical treatment may also be necessary. Additionally, the GWEC System extraction wells may be installed in groundwater that exhibits varying biogeochemical compositions, based on the aquifer (Surficial or Black Creek) and spatial variations across the entire length of the extraction well network. Although the O&M actions identified above will be generally applicable to the entire GWEC System, specific response actions may need to be developed for individual wells or conveyance pipeline sections depending on the frequency, extent, and type of fouling that is observed. Appropriate response actions will be incorporated into the O&M Plan once the cause and mitigation methods have been developed following commencement of GWEC System operation.

5.3 Non-Routine Maintenance and Emergency Response

In addition to routine O&M of the GWEC System, certain conditions may prompt the need for non-routine maintenance of the system. Non-routine maintenance and emergency response activities may include the following:

- Significant mechanical and electrical upgrades that require a long-term shutdown.
- Significant upgrades to address potential chronic fouling in addition to routine fouling mitigation activities.
- Leaks in the GWEC System or other remedy components that may result in modified operations.
- Long-term power outages requiring temporary power arrangements including generators to operate the GWEC System.
- Significant health and safety hazards not addressed during routine operation or arising from changed Site conditions.

Non-routine maintenance activities may be identified through the GWEC System alarms, routine inspections or a combination of both. The GWEC System or a portion of the system may be temporarily shut down to evaluate the conditions and repairs or upgrades may be required. Once the condition prompting non-routine maintenance has been resolved, the operator will restart the system and resume routine operation. Occasional short-term shutdowns of the pumps due to a power outage or pump failure is not expected to have a significant impact to the hydraulic containment system.

5.4 Performance Monitoring

Performance monitoring of the GWEC System will be performed to confirm that the system is providing hydraulic containment in accordance with COA Paragraph 3 (COA; NCDEQ, 2019). A Performance Monitoring Plan has been provided in Appendix G of the Groundwater and Seeps Remedy 90% Design Report (Geosyntec, 2022a). Optimization of the GWEC System may be conducted based on the performance monitoring data and O&M activities will be adapted accordingly, as required.

6 REFERENCES

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Tables

TABLE 3-1
EXTRACTION WELL SYSTEM DESIGN FLOW RATES
Chemours Fayetteville Works, North Carolina

Extraction Well No.	Design Flow Rate Range (gpm)
EW-01	5 - 10
EW-02	5 - 10
EW-03	5 - 10
EW-04	10 - 15
EW-05	15 - 20
EW-06	15 - 20
EW-07	15 - 20
EW-08	15 - 20
EW-09	10 - 15
EW-10	10 - 15
EW-11	10 - 15
EW-12	10 - 15
EW-13	10 - 15
EW-14	15 - 20
EW-15	15 - 20
EW-16	10 - 15
EW-17	15 - 20
EW-18	5 - 10
EW-19	15 - 15
EW-20	15 - 15
EW-21	15 - 20
EW-22	25 - 30
EW-23	5 - 5
EW-24	20 - 20
EW-25	5 - 10
EW-26	10 - 15
EW-27	10 - 20
EW-28	20 - 20
EW-29	20 - 20
EW-30	10 - 20
EW-31	10 - 20
EW-32	20 - 20
EW-33	10 - 20
EW-34	20 - 20
EW-35	10 - 20
EW-36	20 - 20
EW-37	10 - 20

TABLE 3-1
EXTRACTION WELL SYSTEM DESIGN FLOW RATES
Chemours Fayetteville Works, North Carolina

Extraction Well No.	Design Flow Rate Range (gpm)
EW-38	15 - 15
EW-39	10 - 20
EW-40	15 - 15
EW-41	15 - 15
EW-42	15 - 15
EW-43	10 - 15
EW-44	5 - 10
EW-45	10 - 15
EW-46	5 - 10
EW-47	15 - 15
EW-48	5 - 5
EW-49	15 - 15
EW-50	5 - 5
EW-51	15 - 15
EW-52	20 - 20
EW-53	20 - 20
EW-54	15 - 15
EW-55	15 - 15
EW-56	20 - 20
EW-57	20 - 20
EW-58	15 - 15
EW-59	20 - 20
EW-60	20 - 20
EW-61	20 - 20
EW-62	20 - 20
EW-63	20 - 25
EW-64	25 - 30
EW-65	25 - 30
EW-66	25 - 30
EW-67	30 - 35
EW-68	25 - 35
EW-69	25 - 35

Notes:

1) gpm - gallons per minute

TABLE 4-1
PUMP SPECIFICATIONS
Chemours Fayetteville Works, North Carolina

Extraction Well No.	Design Flow Rate Range (gpm)	Goulds GS Series Pump Model	Pump Flow Range (gpm)	Total Dynamic Head at Max Design Flow (ft)	Motor Horsepower (hp)
EW-01	5 - 10	10GS07	3 - 16	152.02	0.75
EW-02	5 - 10	10GS07	3 - 16	154.51	0.75
EW-03	5 - 10	10GS07	3 - 16	163.62	0.75
EW-04	10 - 15	13GS10	4 - 20	169.16	1.00
EW-05	15 - 20	18GS15	6 - 28	164.22	1.50
EW-06	15 - 20	18GS15	6 - 28	174.60	1.50
EW-07	15 - 20	18GS15	6 - 28	161.53	1.50
EW-08	15 - 20	18GS15	6 - 28	163.49	1.50
EW-09	10 - 15	13GS10	4 - 20	171.48	1.00
EW-10	10 - 15	13GS10	4 - 20	165.69	1.00
EW-11	10 - 15	13GS10	4 - 20	133.30	1.00
EW-12	10 - 15	13GS10	4 - 20	161.23	1.00
EW-13	10 - 15	13GS10	4 - 20	161.35	1.00
EW-14	15 - 20	18GS15	6 - 28	147.31	1.50
EW-15	15 - 20	18GS15	6 - 28	140.35	1.50
EW-16	10 - 15	13GS10	4 - 20	138.88	1.00
EW-17	15 - 20	18GS15	6 - 28	129.51	1.50
EW-18	5 - 10	10GS05	3 - 16	115.45	0.50
EW-19	15 - 15	13GS10	4 - 20	139.00	1.00
EW-20	15 - 15	13GS10	4 - 20	127.84	1.00
EW-21	15 - 20	18GS15	6 - 28	124.03	1.50
EW-22	25 - 30	25GS20	8 - 33	89.72	2.00
EW-23	5 - 5	5GS05R	1.5 - 7.5	75.72	0.50
EW-24	20 - 20	18GS15	6 - 28	80.20	1.50
EW-25	5 - 10	10GS05	3 - 16	67.83	0.50
EW-26	10 - 15	13GS10	4 - 20	69.55	1.00
EW-27	10 - 20	18GS10	6 - 28	68.25	1.00
EW-28	20 - 20	18GS15	6 - 28	127.55	1.50
EW-29	20 - 20	18GS15	6 - 28	73.16	1.50
EW-30	10 - 20	18GS10	6 - 28	107.53	1.00
EW-31	10 - 20	18GS10	6 - 28	89.02	1.00
EW-32	20 - 20	18GS15	6 - 28	111.05	1.50
EW-33	10 - 20	18GS10	6 - 28	84.79	1.00
EW-34	20 - 20	18GS15	6 - 28	123.91	1.50
EW-35	10 - 20	18GS10	6 - 28	88.38	1.00
EW-36	20 - 20	18GS15	6 - 28	127.36	1.50
EW-37	10 - 20	18GS10	6 - 28	88.56	1.00

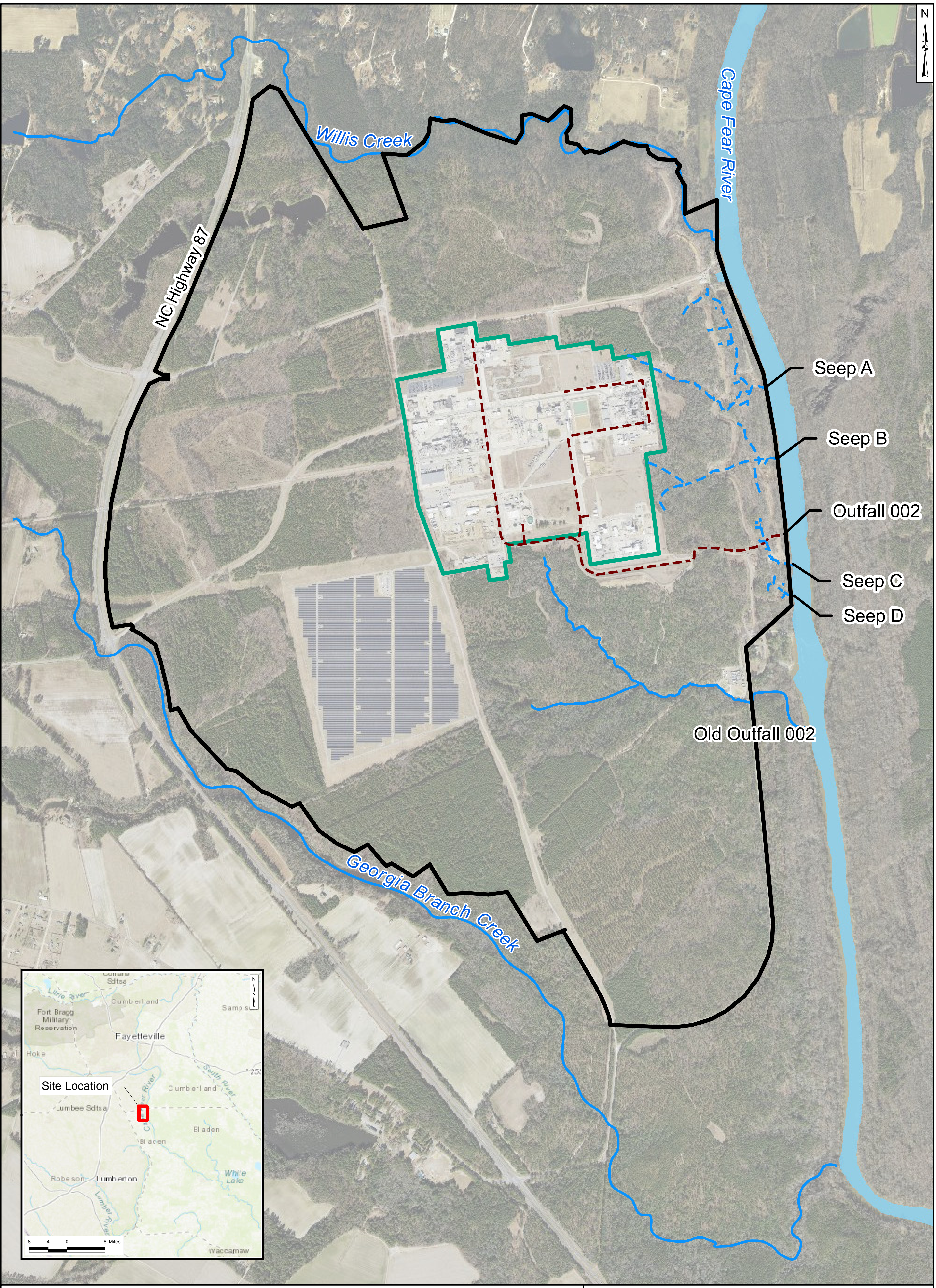
TABLE 4-1
PUMP SPECIFICATIONS
Chemours Fayetteville Works, North Carolina

Extraction Well No.	Design Flow Rate Range (gpm)	Goulds GS Series Pump Model	Pump Flow Range (gpm)	Total Dynamic Head at Max Design Flow (ft)	Motor Horsepower (hp)
EW-38	15 - 15	13GS10	4 - 20	133.82	1.00
EW-39	10 - 20	18GS10	6 - 28	78.84	1.00
EW-40	15 - 15	13GS10	4 - 20	124.64	1.00
EW-41	15 - 15	13GS10	4 - 20	122.86	1.00
EW-42	15 - 15	13GS10	4 - 20	125.07	1.00
EW-43	10 - 15	13GS10	4 - 20	121.42	1.00
EW-44	5 - 10	10GS05	3 - 16	71.53	0.50
EW-45	10 - 15	13GS10	4 - 20	123.42	1.00
EW-46	5 - 10	10GS05	3 - 16	85.19	0.50
EW-47	15 - 15	13GS10	4 - 20	127.05	1.00
EW-48	5 - 5	5GS05R	1.5 - 7.5	81.00	0.50
EW-49	15 - 15	13GS10	4 - 20	120.60	1.00
EW-50	5 - 5	5GS05R	1.5 - 7.5	76.66	0.50
EW-51	15 - 15	13GS10	4 - 20	117.34	1.00
EW-52	20 - 20	18GS15	6 - 28	111.23	1.50
EW-53	20 - 20	18GS15	6 - 28	102.42	1.50
EW-54	15 - 15	13GS10	4 - 20	102.36	1.00
EW-55	15 - 15	13GS10	4 - 20	97.46	1.00
EW-56	20 - 20	18GS15	6 - 28	99.23	1.50
EW-57	20 - 20	18GS15	6 - 28	104.45	1.50
EW-58	15 - 15	13GS10	4 - 20	114.04	1.00
EW-59	20 - 20	18GS15	6 - 28	117.95	1.50
EW-60	20 - 20	18GS15	6 - 28	119.37	1.50
EW-61	20 - 20	18GS15	6 - 28	118.88	1.50
EW-62	20 - 20	18GS15	6 - 28	118.77	1.50
EW-63	20 - 25	18GS15	6 - 28	88.72	1.50
EW-64	25 - 30	25GS20	8 - 33	88.94	2.00
EW-65	25 - 30	25GS20	8 - 33	99.67	2.00
EW-66	25 - 30	25GS20	8 - 33	101.88	2.00
EW-67	30 - 35	35GS20	10 - 50	118.81	2.00
EW-68	25 - 35	35GS20	10 - 50	129.36	2.00
EW-69	25 - 35	35GS20	10 - 50	132.23	2.00

Notes:

1) ft - feet; gpm - gallons per minute; hp - horsepower

Figures



Legend

🟩 Chemours Facility

Site Boundary

Nearby Tributary

Seep

Site Conveyance Network

Notes:
1. The outline of Cape Fear River is approximate and is based on open data from ArcGIS Online and North Carolina Department of Environmental Quality Online GIS (MajorHydro shapefile).
2. Basemap sources: NC OneMap (2019). North Carolina Department of Information Technology, Government Data Analytics Center, Center for Geographic Information and Analysis. Available at https://www.nconemap.gov.

1,000 500 0 1,000 Feet

Site Location Map

Chemours Fayetteville Works, North Carolina

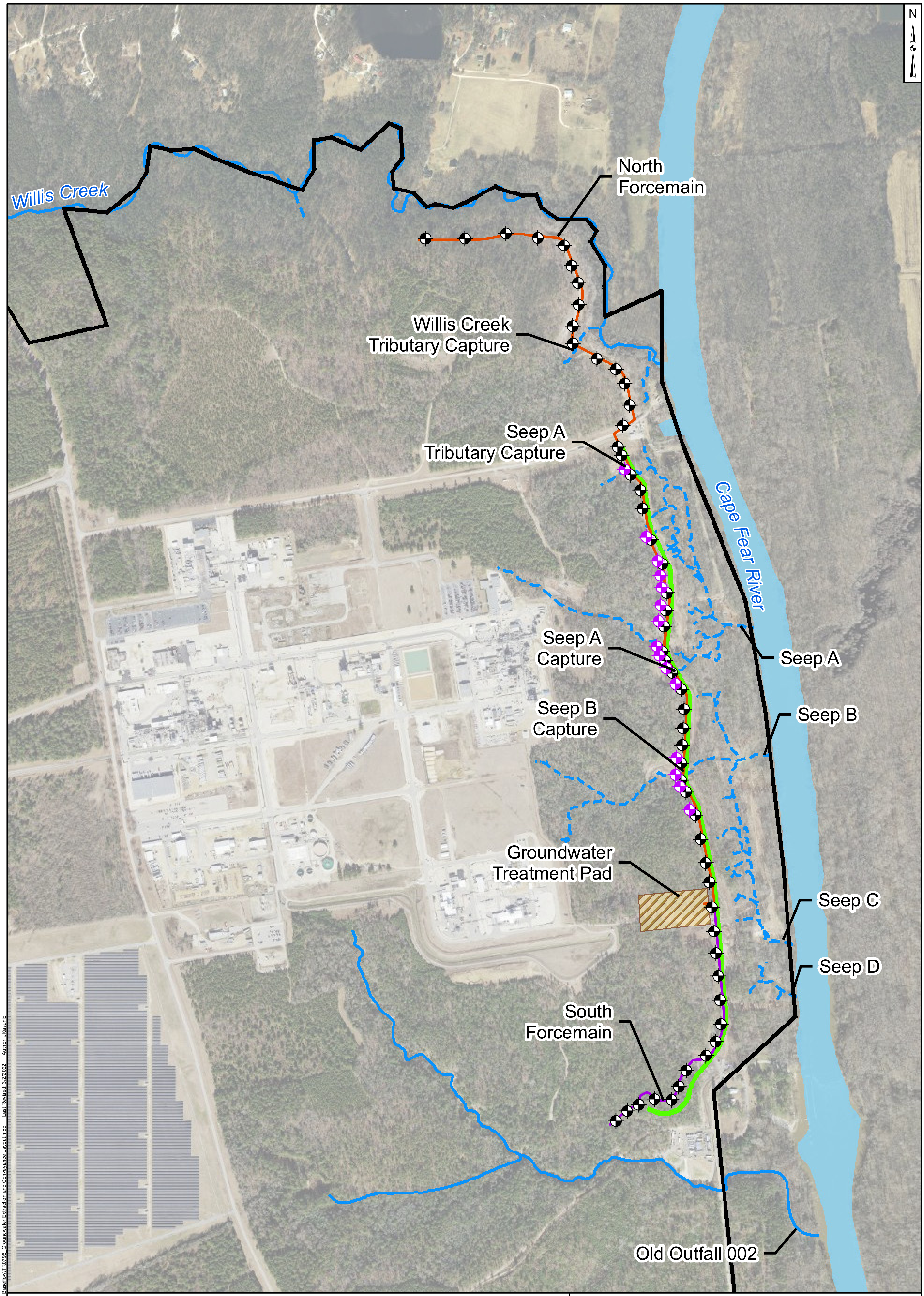
Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

Raleigh	March 2022	Figure 1-1

Path: P:\PRJ\Projects\TR0795\Database and GIS\GIS\Pre-design Investigation\Seeps PDI Baseflow\TR0795 Site Location.mxd Last Revised: 3/2/2022 Author: JKasunic

Projection: NAD 1983 StatePlane North Carolina FIPS 3200 Feet; Units in Foot US



Legend

⊕	Surficial Aquifer Extraction Well
⊕	Black Creek Aquifer Extraction Well
—	North Forcemain
—	South Forcemain
—	Barrier Wall; approximate surface elevation at 72 feet mean sea level
—	Site Boundary
- -	Seep
—	Nearby Tributary to River

Notes:

1. Surficial Aquifer extraction wells have been offset for visibility. Therefore, the placement of these wells on this map do not reflect their true geographic coordinates.
2. Conveyance forcemain alignment is preliminary and is subject to change in future submittals.
3. The outline of Cape Fear River is approximate and is based on open data from ArcGIS Online and North Carolina Department of Environmental Quality Online GIS (MajorHydro shapefile).
4. Basemap source: NC OneMap (2019). North Carolina Department of Information Technology, Government Data Analytics Center, Center for Geographic Information and Analysis. Available at https://www.nconemap.gov.

Groundwater Extraction and Conveyance System Layout

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

Figure

4-1

Raleigh

March 2022

Path: P:\PRJ\Projects\TR0795\Database and GIS\GIS\GIS\Pre-design Investigation\Seeps PDI Baseflow\TR0795_Groundwater Extraction and Conveyance Layout.mxd   Last Revised: 3/2/2022   Author: JKasunic

Projection: NAD 1983 StatePlane North Carolina FIPS 3200 Feet; Units in Foot US

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Attachment A
90% Design Drawings

THE CHEMOURS COMPANY
FAYETTEVILLE WORKS PROJECT
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM
90% DESIGN DRAWINGS

WILLIS CREEK AND CAPE FEAR RIVER CORRIDOR
FAYETTEVILLE, BLADEN AND CUMBERLAND COUNTIES
STATE OF NORTH CAROLINA
DECEMBER 2021

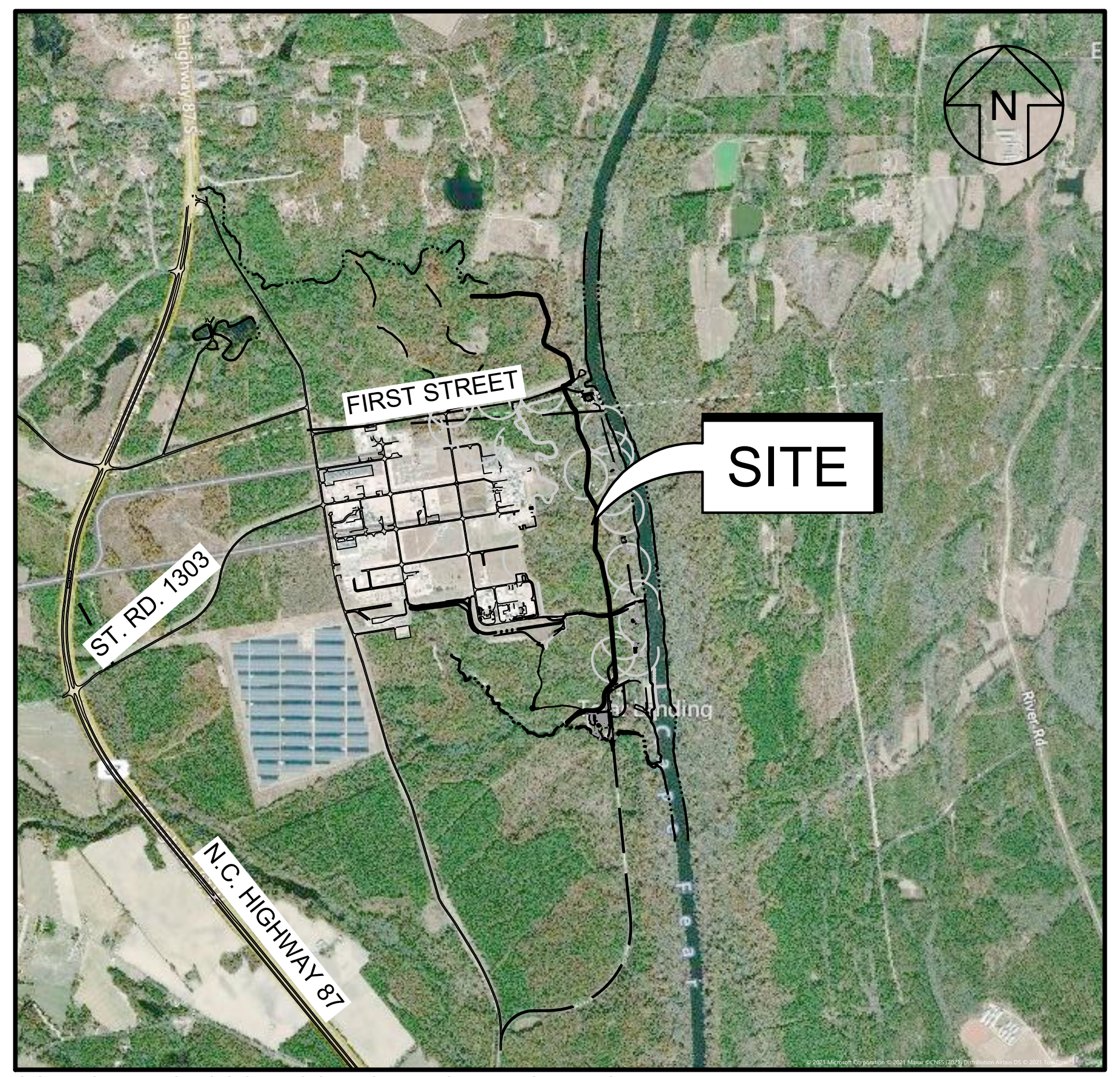
SOURCE: MICROSOFT CORPORATION BING MAPS 2021

VICINITY MAP

SCALE: 1" = 30 MILES

LIST OF DRAWINGS	
DRAWING NO.	DRAWING TITLE
GENERAL	
G-01	TITLE SHEET
G-02	GENERAL NOTES AND SYMBOLS
CIVIL	
C-01	SITE DEVELOPMENT PLAN
C-02	GROUNDWATER EXTRACTION SITE PLAN I
C-03	GROUNDWATER EXTRACTION SITE PLAN II
C-04	GROUNDWATER EXTRACTION SITE PLAN III
C-05	GROUNDWATER EXTRACTION SITE PLAN IV
C-06	GROUNDWATER EXTRACTION SITE PLAN V
C-07	GROUNDWATER EXTRACTION SITE PLAN VI
C-08	GROUNDWATER CONVEYANCE FORCEMAIN PROFILES
PROCESS	
D-01	PIPING AND INSTRUMENTATION DIAGRAM I
D-02	PIPING AND INSTRUMENTATION DIAGRAM II
D-03	EXTRACTION WELL P&ID SCHEDULES I
D-04	EXTRACTION WELL P&ID SCHEDULES II
MECHANICAL	
M-01	EXTRACTION WELL DETAILS I
M-02	EXTRACTION WELL DETAILS II
M-03	EXTRACTION WELL DETAILS III
M-04	EXTRACTION WELL DETAILS IV
M-05	EXTRACTION WELL DETAILS V
M-06	MECHANICAL DETAILS I
M-07	MECHANICAL DETAILS II
M-08	MECHANICAL DETAILS III
M-09	MECHANICAL DETAILS IV
ELECTRICAL	
E-01	OVERALL ELECTRICAL SITE PLAN
E-02	ELECTRICAL SITE PLAN I
E-03	ELECTRICAL SITE PLAN II
E-04	ELECTRICAL SITE PLAN III
E-05	ELECTRICAL SITE PLAN IV
E-06	ELECTRICAL SITE PLAN V
E-07	ELECTRICAL SITE PLAN VI
E-08	ELECTRICAL WELL SITE PLAN
E-09	ELECTRICAL DETAILS I
E-10	ELECTRICAL DETAILS II
E-11	ELECTRICAL DETAILS III
E-12	NETWORK ARCHITECTURE
E-13	PANELBOARD SCHEDULES AND JUNCTION BOX
E-14	SINGLE LINE DIAGRAM I
E-15	SINGLE LINE DIAGRAM II
E-16	SINGLE LINE DIAGRAM III

LIST OF DRAWINGS	
DRAWING NO.	DRAWING TITLE
ELECTRICAL (CONT.)	
E-17	SINGLE LINE DIAGRAM IV
E-18	SINGLE LINE DIAGRAM V
E-19	SINGLE LINE DIAGRAM VI
E-20	SINGLE LINE DIAGRAM VII
E-21	SINGLE LINE DIAGRAM VIII
E-22	SINGLE LINE DIAGRAM IX
E-23	CONTROL PANEL SCHEDULES
E-24	EW-01 CONTROL PANEL POWER DISTRIBUTION I
E-25	EW-01 CONTROL PANEL POWER DISTRIBUTION II
E-26	EW-02 CONTROL PANEL POWER DISTRIBUTION I
E-27	EW-02 CONTROL PANEL POWER DISTRIBUTION II
E-28	EW-03 CONTROL PANEL POWER DISTRIBUTION I
E-29	EW-03 CONTROL PANEL POWER DISTRIBUTION II
E-30	EW-04 CONTROL PANEL POWER DISTRIBUTION I
E-31	EW-04 CONTROL PANEL POWER DISTRIBUTION II
E-32	EW-05 CONTROL PANEL POWER DISTRIBUTION I
E-33	EW-05 CONTROL PANEL POWER DISTRIBUTION II
E-34	EW-06 CONTROL PANEL POWER DISTRIBUTION I
E-35	EW-06 CONTROL PANEL POWER DISTRIBUTION II
E-36	EW-07 CONTROL PANEL POWER DISTRIBUTION I
E-37	EW-07 CONTROL PANEL POWER DISTRIBUTION II
E-38	EW-08 CONTROL PANEL POWER DISTRIBUTION I
E-39	EW-08 CONTROL PANEL POWER DISTRIBUTION II
E-40	EW-09 CONTROL PANEL POWER DISTRIBUTION I
E-41	EW-09 CONTROL PANEL POWER DISTRIBUTION II
E-42	EW-10 CONTROL PANEL POWER DISTRIBUTION I
E-43	EW-10 CONTROL PANEL POWER DISTRIBUTION II
E-44	EW-11 CONTROL PANEL POWER DISTRIBUTION I
E-45	EW-11 CONTROL PANEL POWER DISTRIBUTION II
E-46	EW-12 CONTROL PANEL POWER DISTRIBUTION I
E-47	EW-12 CONTROL PANEL POWER DISTRIBUTION II
E-48	EW-13 CONTROL PANEL POWER DISTRIBUTION I
E-49	EW-13 CONTROL PANEL POWER DISTRIBUTION II
E-50	EW-14 CONTROL PANEL POWER DISTRIBUTION I
E-51	EW-14 CONTROL PANEL POWER DISTRIBUTION II
E-52	EW-15 CONTROL PANEL POWER DISTRIBUTION I
E-53	EW-15 CONTROL PANEL POWER DISTRIBUTION II
E-54	EW-16 CONTROL PANEL POWER DISTRIBUTION I
E-55	EW-16 CONTROL PANEL POWER DISTRIBUTION II
E-56	EW-17 CONTROL PANEL POWER DISTRIBUTION I
E-57	EW-17 CONTROL PANEL POWER DISTRIBUTION II
E-58	MAIN CONTROL PANEL (MCP) POWER DISTRIBUTION



SOURCE: MICROSOFT CORPORATION BING MAPS 2021

LOCATION MAP

SCALE: 1" = 3,000'

0 3,000

SCALE IN FEET

PREPARED FOR:

Chemours™

22828 NC-87
FAYETTEVILLE, NC 28306
910.483.4681

PREPARED BY:

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

90% DESIGN DRAWINGS

C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD
REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: TITLE SHEET

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-G01.DWG
REVIEWED BY:	SV	DRAWING NO.:	G-01
APPROVED BY:	JJD		

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-G01

LINETYPE LEGEND

———————	EDGE OF ROAD / EXISTING BUILDINGS
– – – – – – –	EXISTING GROUND (NOTE 1)
——FM——FM——	GROUNDWATER CONVEYANCE FORCEMAIN
—— P —— P ——	13.2 kV POWERLINE (BY OTHERS)
– – – – – – –	NON-WOVEN GEOTEXTILE SEPARATOR
—— – – ——	PROPERTY BOUNDARY (NOTE 2)
——→——	STORMWATER PIPE AND FLOW DIRECTION
∿∿∿∿∿∿	TREELINE
———————	BARRIER WALL
—··—··—··—	STREAM / RIVER

CONTOUR LEGEND

——— 410 ———	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
——— 410 ———	FINISHED GRADE SURFACE ELEVATION (FEET)

HATCH LEGEND

▨	ACCESS ROAD (EXISTING AND PROPOSED)
▨	CONCRETE
▨	PIPE EMBEDMENT FILL
▨	RIPRAP
■	STREAM (NOTE 1)
▨	SUBGRADE
▨	TRENCH BACKFILL / EARTHEN FILL
▨	WETLANDS (NOTE 1)

SYMBOL LEGEND

△	CONTROL MARKER (NOTE 2)
⌖	GROUNDWATER PIEZOMETER
⌒	HEADWALL
⅄	HISTORICAL WELL / PIEZOMETER
⌖	MONITORING NETWORK WELL
⊕	POWER POLE
▫	PRINCIPAL SPILLWAY RISER
⌖	RELIEF WELL
← 4%	SLOPE GRADE
▼ ▼ CREST TOE	SLOPE INDICATOR
3 1	SLOPE LABEL
▭	TRAILER OR BUILDING
ψ	VEGETATION
▼	WATER SURFACE
⌖	EXISTING INJECTION WELL
○	EXISTING EXTRACTION WELL
⌖	SURFICIAL AND BLACK CREEK AQUIFER EXTRACTION WELL
⊗	BLACK CREEK AQUIFER EXTRACTION WELL
▲	SURFICIAL AQUIFER EXTRACTION WELL
⊠	FORCEMAIN CLEANOUT
⊙	AIR RELEASE VALVE
◁	REDUCER

ABBREVIATIONS

AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
APP	APPROVED BY
ARV	AIR RELEASE VALVE
℄	CENTER LINE
DRN	DRAWN BY
DWG	DRAWING
E	EAST OR EASTING
EL	ELEVATION
EW	EXTRACTION WELL
FCO	FORCEMAIN CLEANOUT
FT	FEET
GWTP	GROUNDWATER TREATMENT PLANT
HDPE	HIGH DENSITY POLYETHYLENE
H:V	HORIZONTAL TO VERTICAL LENGTH RATIO FOR A SLOPE
HWY	HIGHWAY
IN	INCH
INV	INVERT
MAX	MAXIMUM
MIN	MINIMUM
MSL	MEAN SEA LEVEL
N	NORTH OR NORTHING
NAD	NORTH AMERICAN DATUM
NAVD88	NORTH AMERICAN VERTICAL DATUM OF 1988
NCDEQ	NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
NO.	NUMBER
NPDES	NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
N.S.A.	NATIONAL STONE ASSOCIATION
NTS	NOT TO SCALE
OC	ON CENTER
OZ	OUNCE
PFAS	PER- AND POLYFLUOROALKYL SUBSTANCES
PROJ	PROJECT
RCP	REINFORCED CONCRETE PIPE
RD	ROAD
REV	REVISION
S	SOUTH
SCH	SCHEDULE
SDR	STANDARD DIMENSIONAL RATIO
STA	STATION
SWP	STORMWATER PIPE
TYP	TYPICAL
U.S.	UNITED STATES
USEPA	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
W	WEST
W.S.	WATER SURFACE
%	PERCENT OR PERCENTILE

REFERENCE NOTES

1. THE BASIS OF BEARINGS FOR THIS SURVEY IS NAD83 NORTH CAROLINA STATE PLANES, US FOOT. THE BASIS OF ELEVATIONS FOR THIS SURVEY IS NAVD88 BASED ON AN OPUS SESSION PERFORMED ON NOVEMBER 16, 2019. THE TOPOGRAPHY OF THIS SURVEY HAS A CONTOUR INTERVAL OF ONE FOOT AND WAS PRODUCED FROM TWO LIDAR SCANS OF THE AREA. THE SCANS WERE PERFORMED ON DECEMBER 1, 2019 AND DECEMBER 19, 2019 BY SPECTRAL DATA CONSULTANTS, INC. PROJECT NO. 19085. THIS SURVEY WAS MADE IN ACCORDANCE WITH LAWS AND/OR MINIMUM STANDARDS OF THE STATE OF NORTH CAROLINA.
2. PROPERTY IS LOCATED WITHIN AN AREA HAVING A ZONE DESIGNATION "X" & "AE" BY THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA), ON FLOOD INSURANCE RATE MAP NO. 3720035900J, WITH A DATE OF IDENTIFICATION OF JANUARY 5, 2007, IN BLADEN COUNTY, STATE OF NORTH CAROLINA AND ON FLOOD INSURANCE RATE MAP NO. 3720044000J, WITH A DATE OF IDENTIFICATION OF JANUARY 5, 2007, IN CUMBERLAND COUNTY, STATE OF NORTH CAROLINA, WHICH ARE THE CURRENT FLOOD INSURANCE RATE MAP FOR THE COMMUNITY IN WHICH SAID PREMISES IS SITUATED. THE BASE FLOOD ELEVATION FOR THE AREA IS 68' MSL.
3. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.
4. COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.

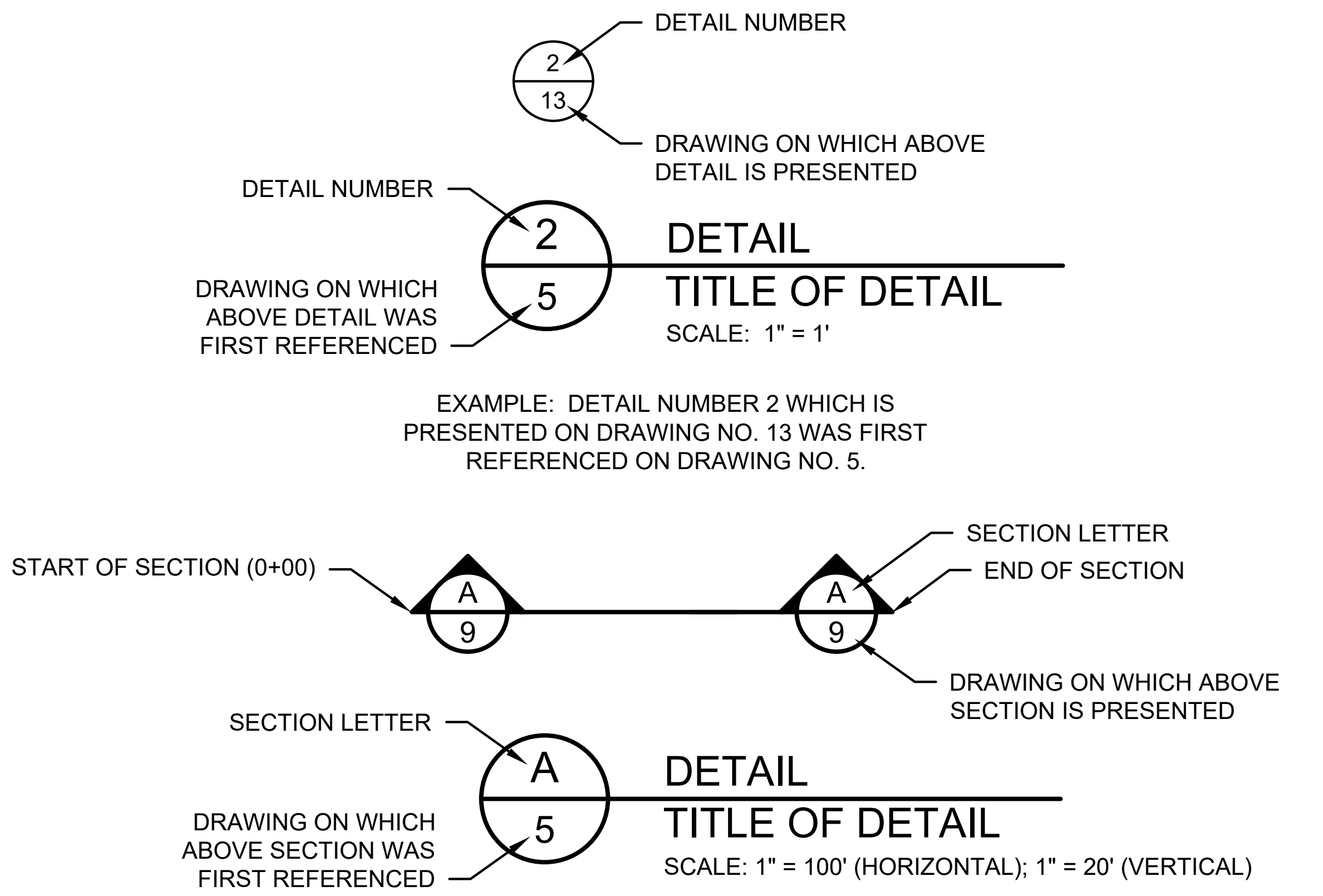
GENERAL EROSION AND SEDIMENT CONTROL (E&SC) NOTES

1. ALL EROSION CONTROL MEASURES SHALL BE IN CONFORMANCE WITH THE CURRENT EDITION OF THE “NC EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.” STORMWATER CONTROLS AND BEST MANAGEMENT PRACTICES SHALL BE DESIGNED, INSTALLED, AND MAINTAINED IN ACCORDANCE WITH THE APPLICABLE NPDES CONSTRUCTION STORMWATER DISCHARGE GENERAL PERMIT, NPDES INDUSTRIAL STORMWATER DISCHARGE GENERAL PERMIT, AND/OR THE FACILITY'S NPDES INDUSTRIAL WASTEWATER DISCHARGE INDIVIDUAL PERMIT.
2. STATE WATERS BUFFERS SHALL REMAIN UNDISTURBED, EXCEPT WHERE ENCROACHMENT IS REQUIRED TO FACILITATE PFAS REMEDIAL ACTIVITIES. UNLESS OTHERWISE EXEMPTED BY THE APPROPRIATE NPDES CONSTRUCTION STORMWATER GENERAL PERMIT, A STATE WATERS BUFFER VARIANCE SHALL BE OBTAINED FROM NORTH CAROLINA DEQ'S DIVISION OF WATER RESOURCES PRIOR TO BUFFER ENCROACHMENT.
3. PRIOR TO COMMENCING CONSTRUCTION ACTIVITIES FOR THIS PROJECT, THE LIMITS OF DISTURBANCE AND ALL WETLANDS AND STATE WATERS BUFFERS WITHIN 200 FEET OF THE LIMITS OF DISTURBANCE OR WITHIN THE PROPERTY BOUNDARY (WHICHEVER IS CLOSER) SHALL BE CLEARLY FLAGGED AND STAKED. THESE MARKINGS SHALL BE MAINTAINED UNTIL COMPLETION OF CONSTRUCTION / CLOSURE ACTIVITIES. SHOULD ANY OF THE MARKINGS BE DISTURBED, THE CONTRACTOR SHALL NOTIFY THE CHEMOURS COMPANY IMMEDIATELY. ALL CONSTRUCTION PERSONNEL SHALL BE SHOWN THE LOCATION OF THE LIMITS OF DISTURBANCE, STATE WATER BUFFERS, STATE WATERS AND WETLANDS OUTSIDE THE LIMITS OF DISTURBANCE TO PREVENT HEAVY EQUIPMENT ENCROACHMENT INTO THESE AREAS.

STEEL REINFORCING NOTES

1. CONTRACTOR SHALL FURNISH EMBEDMENT MATERIALS SUCH AS BOLTS AND FASTENERS FOR SECURING PIPE HANGERS, PIPE STANDS, AND OTHER EQUIPMENT THAT REQUIRES BOLTING TO CONCRETE.
2. CONTRACTOR SHALL FURNISH EPOXY RESIN FOR ANCHORING BOLTS AND FASTENERS TO CONCRETE. EPOXY RESIN SHALL CONFORM TO THE REQUIREMENTS OF ASTM C881.

DETAIL AND SECTION IDENTIFICATION LEGEND



EXAMPLE: DETAIL NUMBER 2 WHICH IS PRESENTED ON DRAWING NO. 13 WAS FIRST REFERENCED ON DRAWING NO. 5.

EXAMPLE: SECTION LETTER "A" WHICH IS PRESENTED ON DRAWING NO. 9 WAS FIRST REFERENCED ON DRAWING NO. 5.

CONCRETE NOTES

1. ALL CONCRETE WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE LATEST EDITION AND/OR ADDENDUM REFERENCED IN DESIGN STANDARDS ACI 318 AND ACI 301.
2. ADDITION OF WATER TO THE BATCH FOR MATERIAL WITH INSUFFICIENT SLUMP WILL NOT BE PERMITTED, UNLESS THE SUPPLIER HAS SPECIFICALLY WITHHELD WATER FROM THE BATCH AT THE PLANT. IN SUCH CASE, THE MIX DESIGN AND TRUCK TICKET MUST CLEARLY STATE THE MAXIMUM AMOUNT OF WATER THAT CAN BE ADDED TO THE BATCH ON SITE. IN NO CASE SHALL THE DESIGN WATER TO CEMENTITIOUS MATERIAL RATIO BE EXCEEDED.
3. MECHANICALLY VIBRATE ALL CONCRETE WHEN PLACED.
4. CHAMFER ALL EXPOSED EXTERNAL CORNERS OF CONCRETE WITH 3/4" X 45 DEGREE CHAMFER, UNLESS NOTED OTHERWISE.
5. CONTRACTOR TO REFER TO DRAWINGS OF OTHER TRADES AND VENDOR DRAWINGS FOR EMBEDDED ITEMS AND RECESSES NOT SHOWN ON THE STRUCTURAL DRAWINGS.
6. ALL CEMENT SHALL BE TYPE I/II, EXCEPT TYPE III MAY BE USED TO PROVIDE HIGH-EARLY STRENGTH FOR 4,000 PSI AT 14 DAYS. COMPLY WITH ACI 318 TESTING REQUIREMENTS FOR 14-DAY STRENGTH IN ACCORDANCE WITH ACI 318 CHAPTER 19.
7. THE STRUCTURAL DRAWINGS SHALL BE COORDINATED WITH MECHANICAL, ELECTRICAL, AND CIVIL DRAWINGS FOR THE SIZE AND LOCATION OF EMBEDDED ITEMS, OPENINGS, SLEEVES, INSERTS, DOWELS, DEPRESSIONS, ETC. DO NOT CUT REINFORCEMENT UNLESS INDICATED BY SECTION OR DETAIL. AT LOCATIONS OF CONFLICT, SPREAD THE REINFORCEMENT TO ACCOMMODATE PLACEMENT. ADD ADDITIONAL BARS IF NECESSARY, TO MAINTAIN SPACING REQUIREMENTS.
8. CONCRETE CONTAINING SUPERPLASTICIZING ADMIXTURE SHALL HAVE A SLUMP OF 4” ± 1”, TO BE FIELD VERIFIED, PRIOR TO ADDING ADMIXTURE, AND NOT EXCEEDING 8” AT PLACEMENT.
9. STRUCTURAL CONCRETE TO MEET THE REQUIREMENTS SHOWN IN THE FOLLOWING TABLE:

CONCRETE PROPERTIES				
CONCRETE USE	MIN 28 DAY COMPRESSIVE STRENGTH	SLUMP AT PLACEMENT	MAX W/C RATIO	REMARKS
ALL CONCRETE SHALL BE	4,000 PSI	4” ± 1”	0.45	AIR ENTRAINED TO 5% ± 1%

10. ALL AGGREGATES SHALL CONFORM TO ASTM C33.
11. FLY ASH WILL NOT BE PERMITTED.
12. CONCRETE MIX DESIGNS MUST COMPLY WITH THE REQUIREMENTS OF ACI 318 CHAPTER 9. FOLLOW SECTION 19.2 FOR AVERAGE COMPRESSIVE STRENGTHS WHEN TEST DATA ARE NOT AVAILABLE.
13. ADMIXTURES SHALL NOT CONTAIN MORE THAN 0.1% CHLORIDE IONS AND CONFORM TO THE FOLLOWING:
    A. AIR-ENTRAINING ADMIXTURES: ASTM C260
    B. WATER REDUCING ADMIXTURES: ASTM C494, TYPE A
    C. RETARDING ADMIXTURES: ASTM C494, TYPE D
14. CURE CONCRETE IN ACCORDANCE WITH ACI 301 USING WET CURE OR LIQUID CURING COMPOUND.
15. CURING COMPOUND SHALL CONFORM TO REQUIREMENTS OF ASTM C309 AND NOT IMPAIR NATURAL BONDING CHARACTERISTICS OF SUBSEQUENT COATINGS.
16. CONCRETE FORMWORK FOR VERTICAL LOADS AND LATERAL PRESSURES SHALL BE IN ACCORDANCE WITH ACI 347.
17. NONSHRINK GROUT SHALL BE USED FOR PIPE PENETRATIONS. MIX AND PLACE AS RECOMMENDED BY THE MANUFACTURER AND IN ACCORDANCE WITH ASTM C1107.
18. CONCRETE SLAB SURFACES SHALL BE COATED USING CARBOLINE PLASITE 9029, OR APPROVED EQUAL AS A PRIMER LAYER, AND PLASITE 9060, OR APPROVED EQUAL, AS A TOP COAT. THE PLASITE 9060 SHALL BE APPLIED IN A MINIMUM OF THREE COATINGS. EXTEND COATING TO THE TOP OF CHAMFERED EDGE.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
GENERAL NOTES AND SYMBOLS

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-G02.DWG
REVIEWED BY:	SV	DRAWING NO.:	G-02
APPROVED BY:	JJD		

NOTES:

1. GRID COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.
2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.
3. APPROXIMATE EXTENT OF IMPACTED WETLANDS DELINEATED BY PARSONS (AUGUST 2020 WOTUS REPORT, CHEMOURS FAYETTEVILLE WORKS, FLOW THROUGH CELLS, SEEP C PILOT STUDY). APPROXIMATE EXTENT OF UNIMPACTED WETLANDS IN UPLAND LOCATIONS DELINEATED BY GEOSYNTEC, SEPTEMBER 2020 (WOTUS REPORT PENDING FOR SEEPS A, B, AND D PERMIT MODIFICATION).
4. FORCEMAIN ALIGNMENT AND LOCATION OF FORCEMAIN CLEANOUTS, AIR RELEASE VALVES, AND REDUCERS IS PRELIMINARY AND ARE SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
5. CONTRACTOR SHALL VERIFY HIGH POINTS ALONG VERTICAL ALIGNMENT PRIOR TO FINALIZING AIR RELEASE VALVE LOCATIONS.
6. CONTRACTOR SHALL FIELD-VERIFY BENDS ALONG FORCEMAIN.
7. CONTRACTOR SHALL INSTALL THE FORCEMAIN PIPE CROSSING FROM STA 30+71 TO STA 31+65 VIA HORIZONTAL DIRECTIONAL DRILLING.

LEGEND

355	EXISTING GROUND MAJOR CONTOUR (5')	▨	WETLANDS
	EXISTING GROUND MINOR CONTOUR (1')	⌖	EXISTING INJECTION WELL
— —	PROPERTY BOUNDARY	○	EXISTING EXTRACTION WELL
—	BARRIER WALL ALIGNMENT	◪	SURFICIAL AND BLACK CREEK AQUIFER EXTRACTION WELL
═ ═	EXISTING GRAVEL ROAD	◉	BLACK CREEK AQUIFER EXTRACTION WELL
═	EXISTING PAVED ROAD	▲	SURFICIAL AQUIFER EXTRACTION WELL
—FM—	GROUND WATER CONVEYANCE FORCEMAIN	▣	FORCEMAIN CLEANOUT
—··—	STREAM	◎	AIR RELEASE VALVE
⊖—⊖	RELOCATED OUTFALL 002		

C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD
REV	DATE	DESCRIPTION	DRN	APP

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
SITE DEVELOPMENT PLAN

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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APPROVED BY:	JJD		

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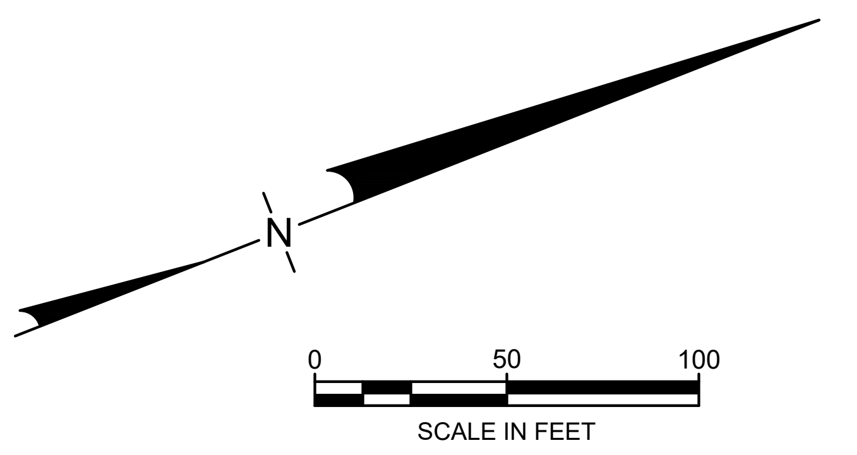

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
GROUNDWATER EXTRACTION SITE PLAN I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	C-02
APPROVED BY:	JJD		

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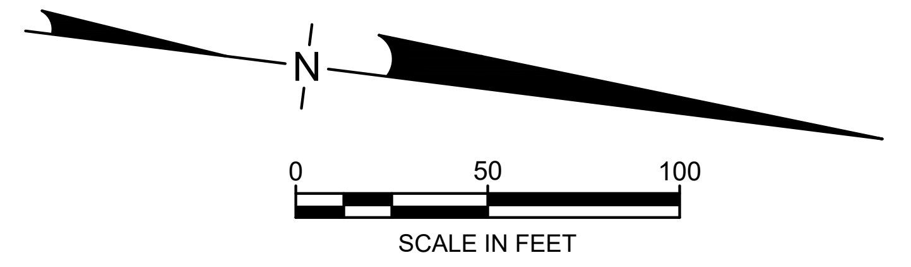

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2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
GROUNDWATER EXTRACTION SITE PLAN II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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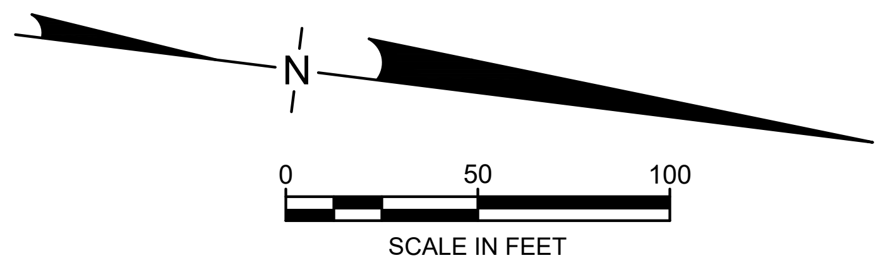
DATE: DECEMBER 2021
PROJECT NO.: TR0795A
FILE: TR0795A-C03.DWG
DRAWING NO.: C-03



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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
GROUNDWATER EXTRACTION SITE PLAN III

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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NOTES:

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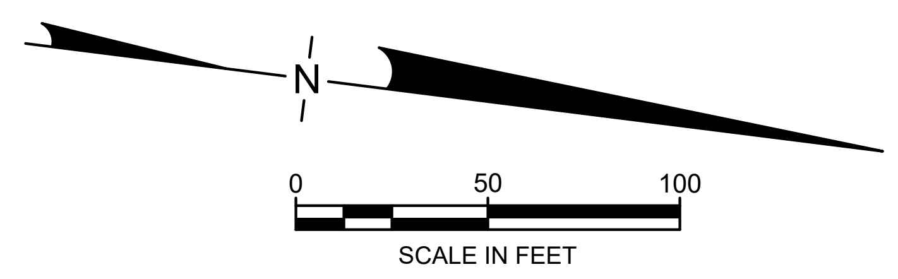

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
GROUNDWATER EXTRACTION SITE PLAN IV

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	C-05
APPROVED BY:	JJD		

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NOTES:

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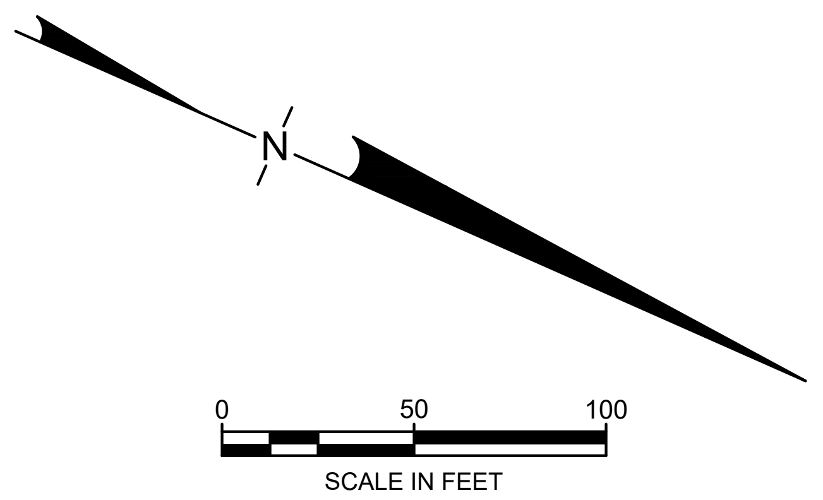

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
GROUNDWATER EXTRACTION SITE PLAN V

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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APPROVED BY:	JJD		

NOTES:

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
GROUNDWATER EXTRACTION SITE PLAN VI

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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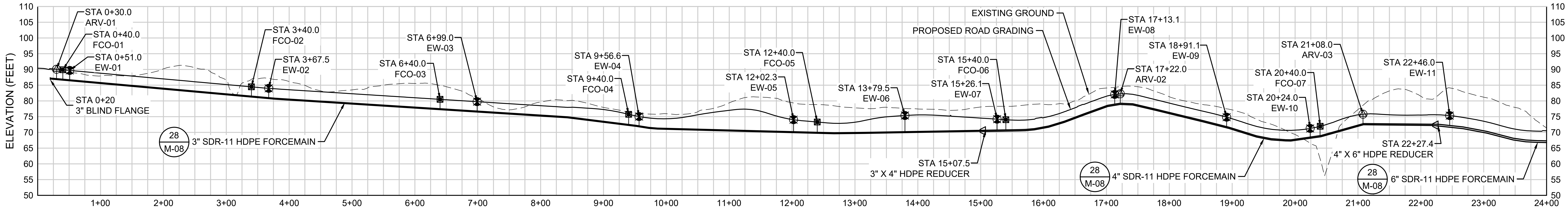
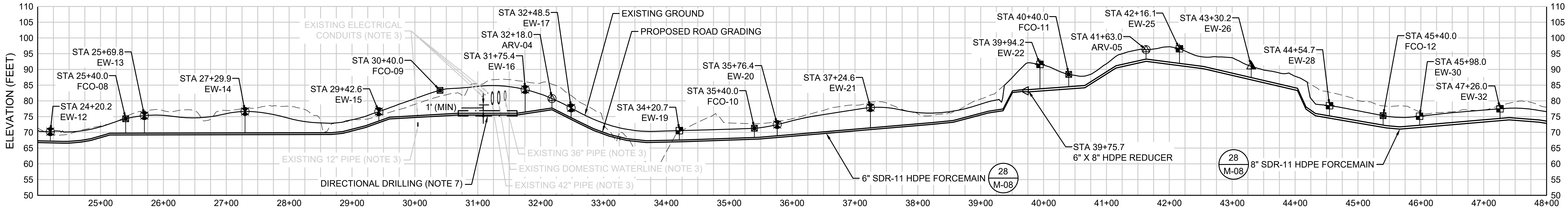
APPROVED BY:	JJD		



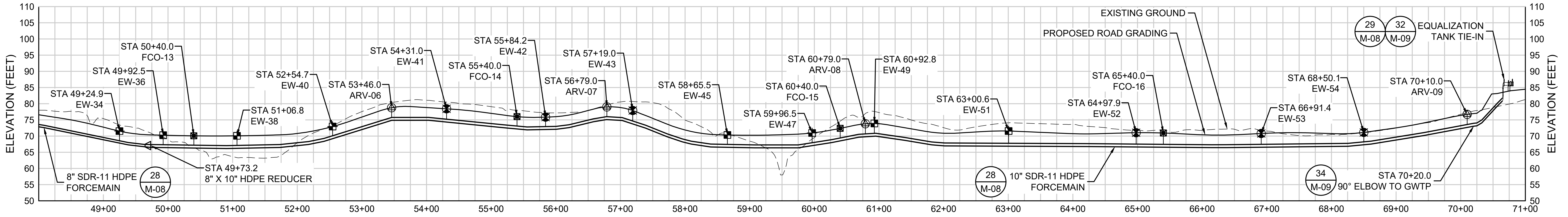
1 C-06 PROFILE

NORTH GROUNDWATER EXTRACTION FORCEMAIN
STA 0+00 TO 24+00
SCALE: 1" = 100' (HORIZONTAL); 1" = 20' (VERTICAL)



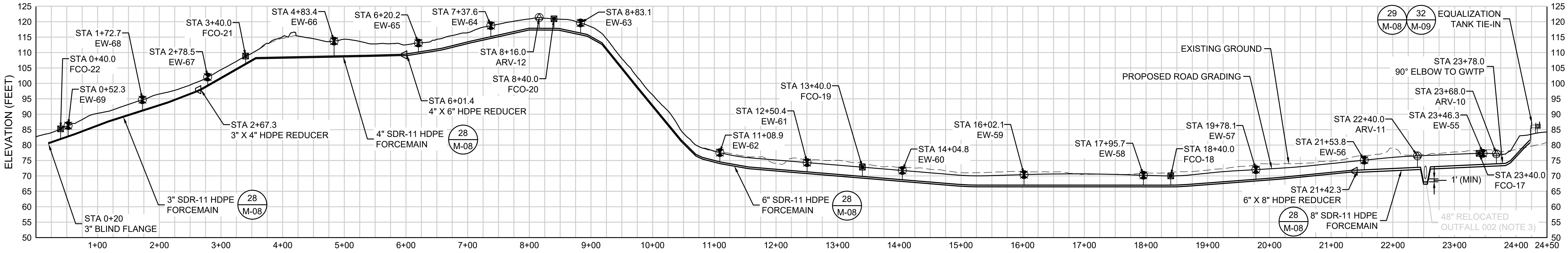
2 C-05 PROFILE

NORTH GROUNDWATER EXTRACTION FORCEMAIN
STA 24+00 TO 48+00
SCALE: 1" = 100' (HORIZONTAL); 1" = 20' (VERTICAL)



3 C-04 PROFILE

NORTH GROUNDWATER EXTRACTION FORCEMAIN
STA 48+00 TO 71+00
SCALE: 1" = 100' (HORIZONTAL); 1" = 20' (VERTICAL)



4 C-02 PROFILE

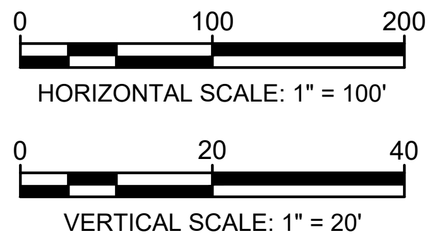
SOUTH GROUNDWATER EXTRACTION FORCEMAIN
STA 0+00 TO 24+00
SCALE: 1" = 100' (HORIZONTAL); 1" = 20' (VERTICAL)

NOTES:

1. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.
2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.
3. CONTRACTOR SHALL FIELD-VERIFY ELEVATION AND DIAMETER OF EXISTING PIPES PRIOR TO FORCEMAIN INSTALLATION.
4. FORCEMAIN ALIGNMENT AND LOCATION OF FORCEMAIN CLEANOUTS, AIR RELEASE VALVES, AND REDUCERS IS PRELIMINARY AND ARE SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
5. CONTRACTOR SHALL VERIFY HIGH POINTS ALONG VERTICAL ALIGNMENT PRIOR TO FINALIZING AIR RELEASE VALVE LOCATIONS.
6. CONTRACTOR SHALL FIELD-VERIFY BENDS ALONG FORCEMAIN.
7. CONTRACTOR SHALL INSTALL THE FORCEMAIN PIPE CROSSING FROM STA 30+71 TO STA 31+65 VIA HORIZONTAL DIRECTIONAL DRILLING. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PREPARATION OF THE INSTALLATION WORK PLAN.

LEGEND

- - -	EXISTING GROUND
—	PROPOSED ROAD GRADING (BY OTHERS)
═	PROPOSED FORCEMAIN
⊠	SURFICIAL AND BLACK CREEK AQUIFER EXTRACTION WELL
⧗	BLACK CREEK AQUIFER EXTRACTION WELL
▲	SURFICIAL AQUIFER EXTRACTION WELL
▣	FORCEMAIN CLEANOUT
⊛	AIR RELEASE VALVE
◁	REDUCER



REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
GROUNDWATER CONVEYANCE FORCEMAIN PROFILES

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

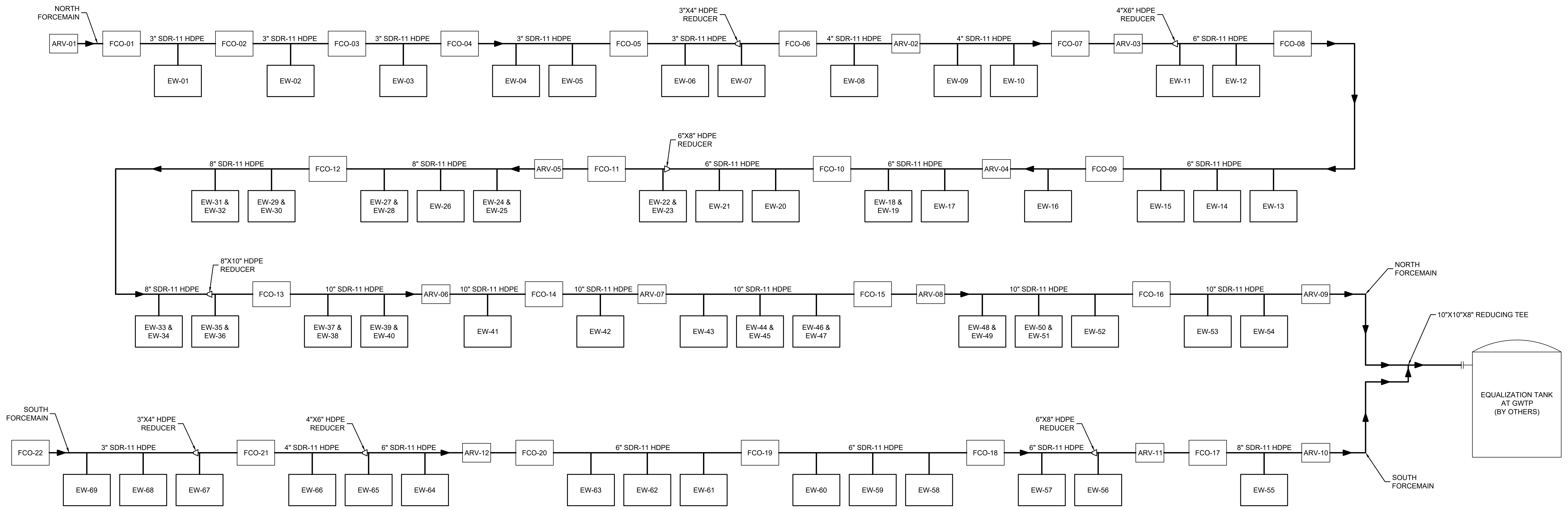
SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-C08.DWG
REVIEWED BY:	SV	DRAWING NO.:	C-08
APPROVED BY:	JJD		

90% DESIGN DRAWINGS

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\CHEMOURS\TR0795A - CHEMOURS\CAD\001 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-C08

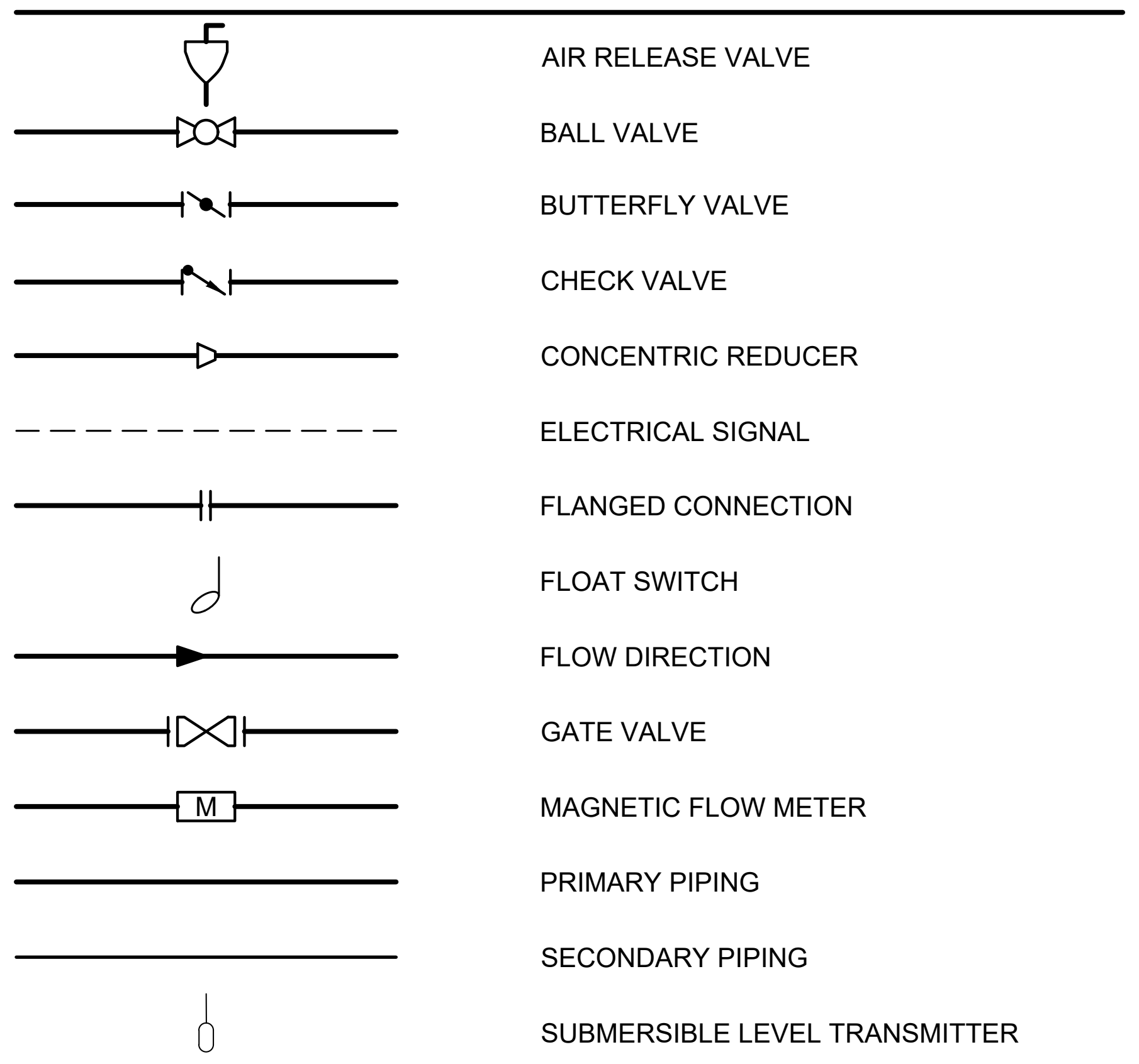


INSTRUMENT SOCIETY OF AMERICA TABLE

LETTER	FIRST LETTER(S)		SUCCEEDING LETTERS		
	PROCESS OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS (+)		ALARM		
B	BURNER FLAME		USER'S CHOICE (+)	USER'S CHOICE (+)	USER'S CHOICE (+)
C	CONDUCTIVITY			CONTROL	
D	DENSITY (S.G.)	DIFFERENTIAL			
E	VOLTAGE/EMF		PRIMARY ELEMENT		
F	FLOW RATE	RATIO/BIAS			
G	GAUGE		GLASS	GATE	
H	HAND (MANUAL)				HIGH
I	CURRENT		INDICATE		
J	POWER	SCAN			
K	TIME OR SCHEDULE			CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION				MIDDLE/INTERMEDIATE
N	USER'S CHOICE (+)		USER'S CHOICE (+)	USER'S CHOICE (+)	USER'S CHOICE (+)
O	USER'S CHOICE (+)		ORIFICE/RESTRICTION		
P	PRESSURE/VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY/EVENT (+)	INTEGRATE	INTEGRATE		
R	RADIOACTIVIT		RECORD/PRINT		
S	SPEED/FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTI-VARIABLE (+)		MULTIFUNCTION (+)	MULTIFUNCTION (+)	MULTIFUNCTION (+)
V	VISCOSITY			VALVE/DAMPER	
W	WEIGHT/FORCE		WELL		
X	UNCALSSIFIED (+)		UNCLASSIFIED (+)	UNCLASSIFIED (+)	UNCLASSIFIED
Y	USER'S CHOICE (+)			RELAY/COMPUTE (+)	
Z	POSITION			DRIVE, ACTUATE, OR UNCLASSIFIED FINAL CONTROL ELEMENT	

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS LIST.

PROCESS AND INSTRUMENTATION SYMBOLS



PUMP SYMBOLS

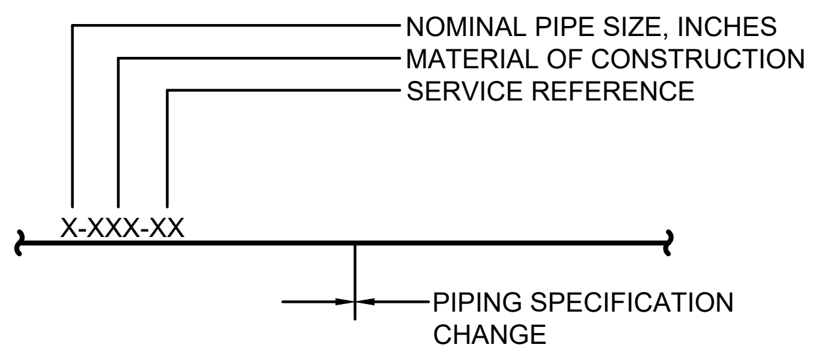
PIPING MATERIAL ABBREVIATIONS

PVC	POLYVINYL CHLORIDE
HDPE	HIGH DENSITY POLYETHYLENE

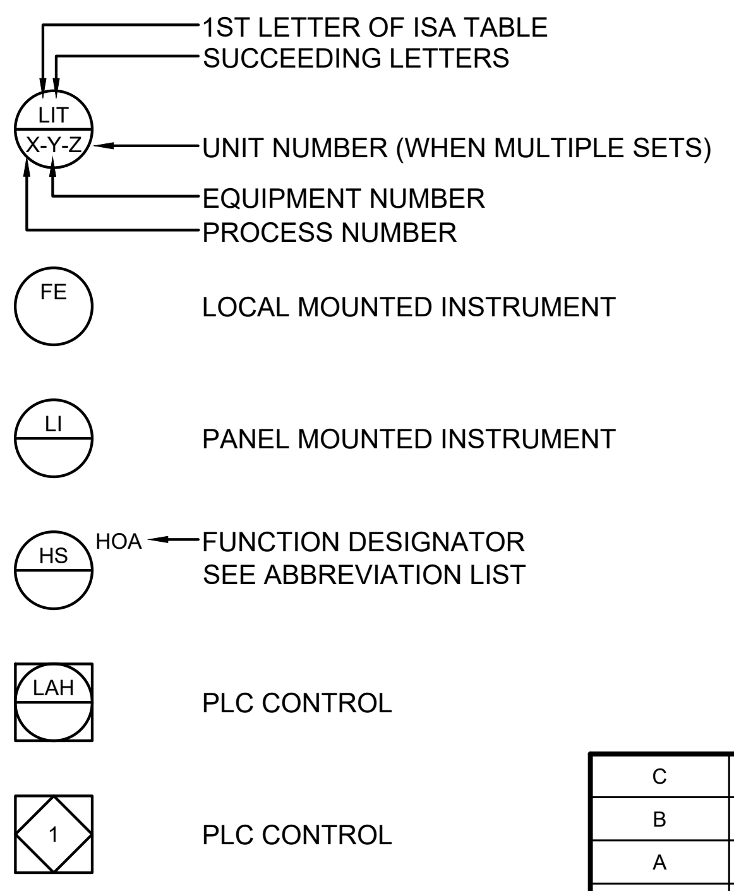
MISCELLANEOUS ABBREVIATIONS

ARV	AIR RELEASE VALVE
CV	CHECK VALVE
HOA	HAND-OFF-AUTO
HV	HAND VALVE
M	MOTOR
PLC	PROGRAMMABLE LOGIC CONTROLLER
SCH	SCHEDULE
VFD	VARIABLE FREQUENCY DRIVE
R	REDUCER
SC	SPEED CONTROL
SDR	STANDARD DIAMETER RATIO

PIPING IDENTIFICATION



INSTRUMENTATION SYMBOL IDENTIFICATION



90% DESIGN DRAWINGS

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TITLE:
PIPING AND INSTRUMENTATION DIAGRAM I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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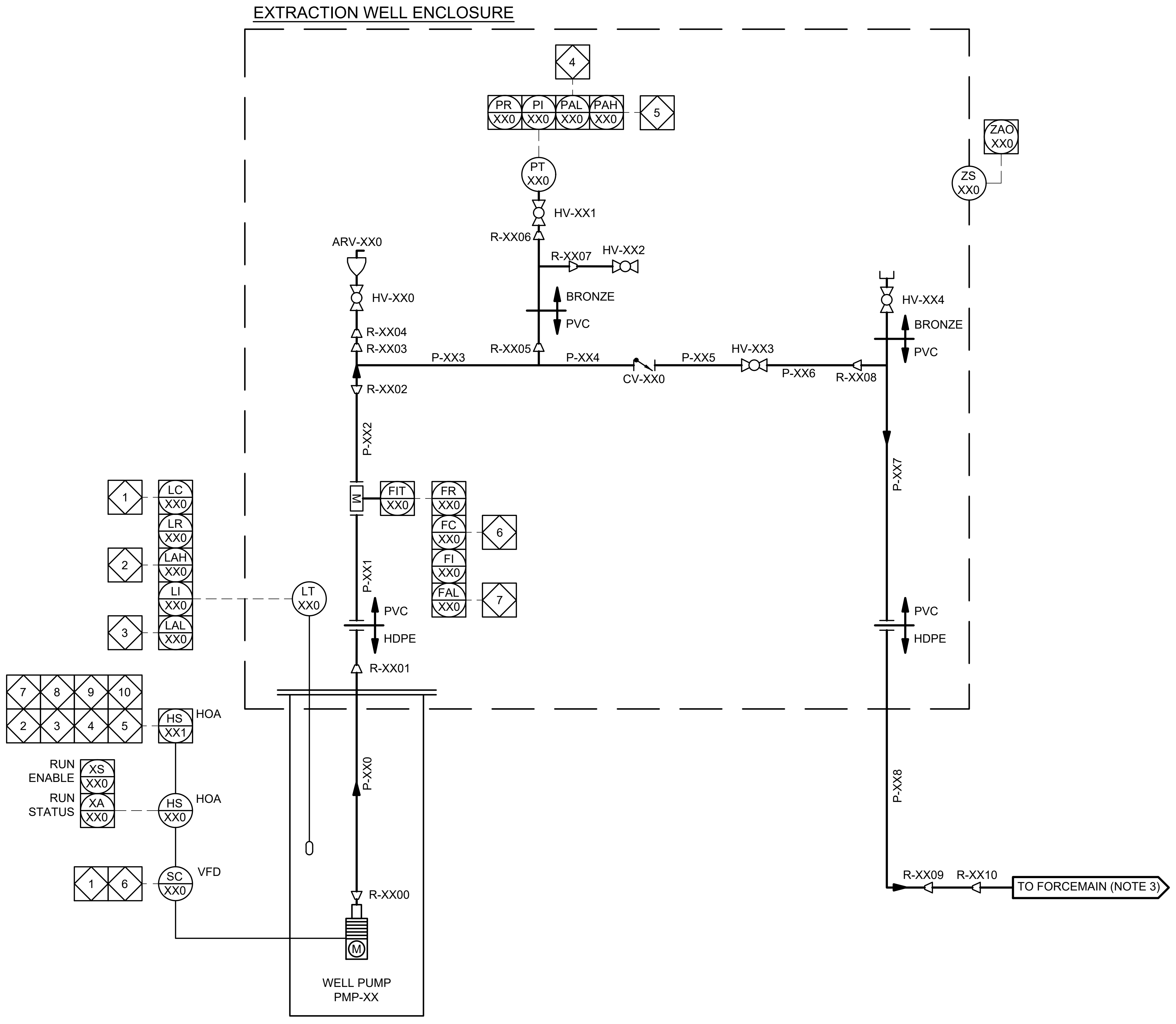
SIGNATURE

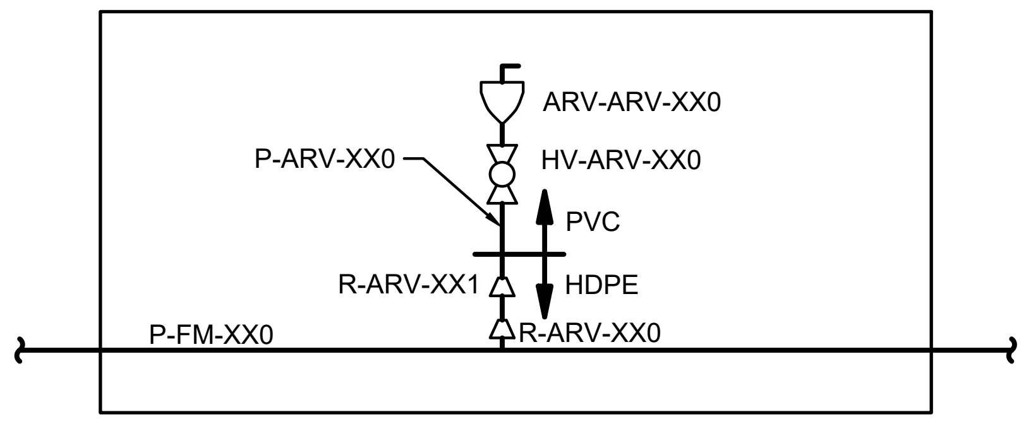
DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-D01.DWG
REVIEWED BY:	SV	DRAWING NO.:	D-01
APPROVED BY:	JJD		

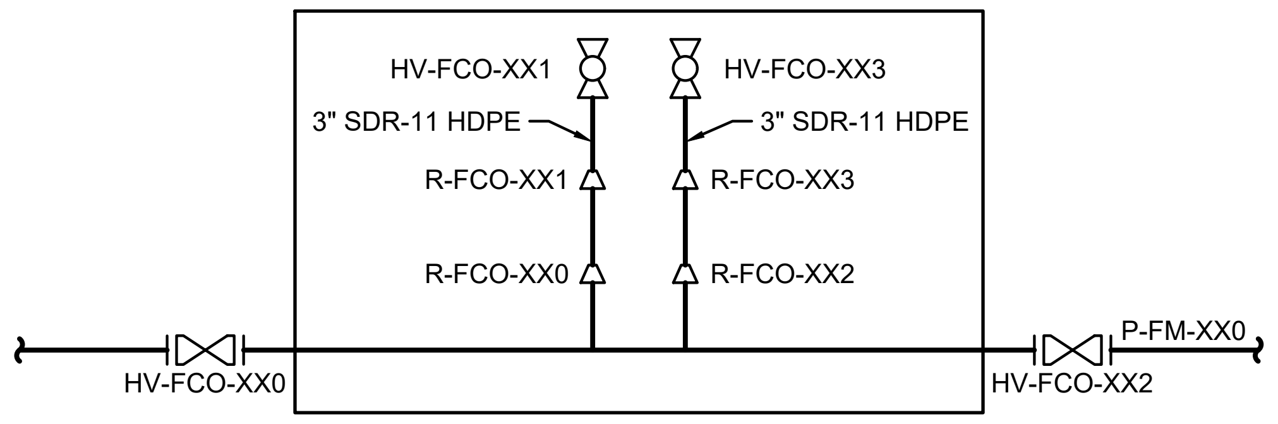
GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-D01



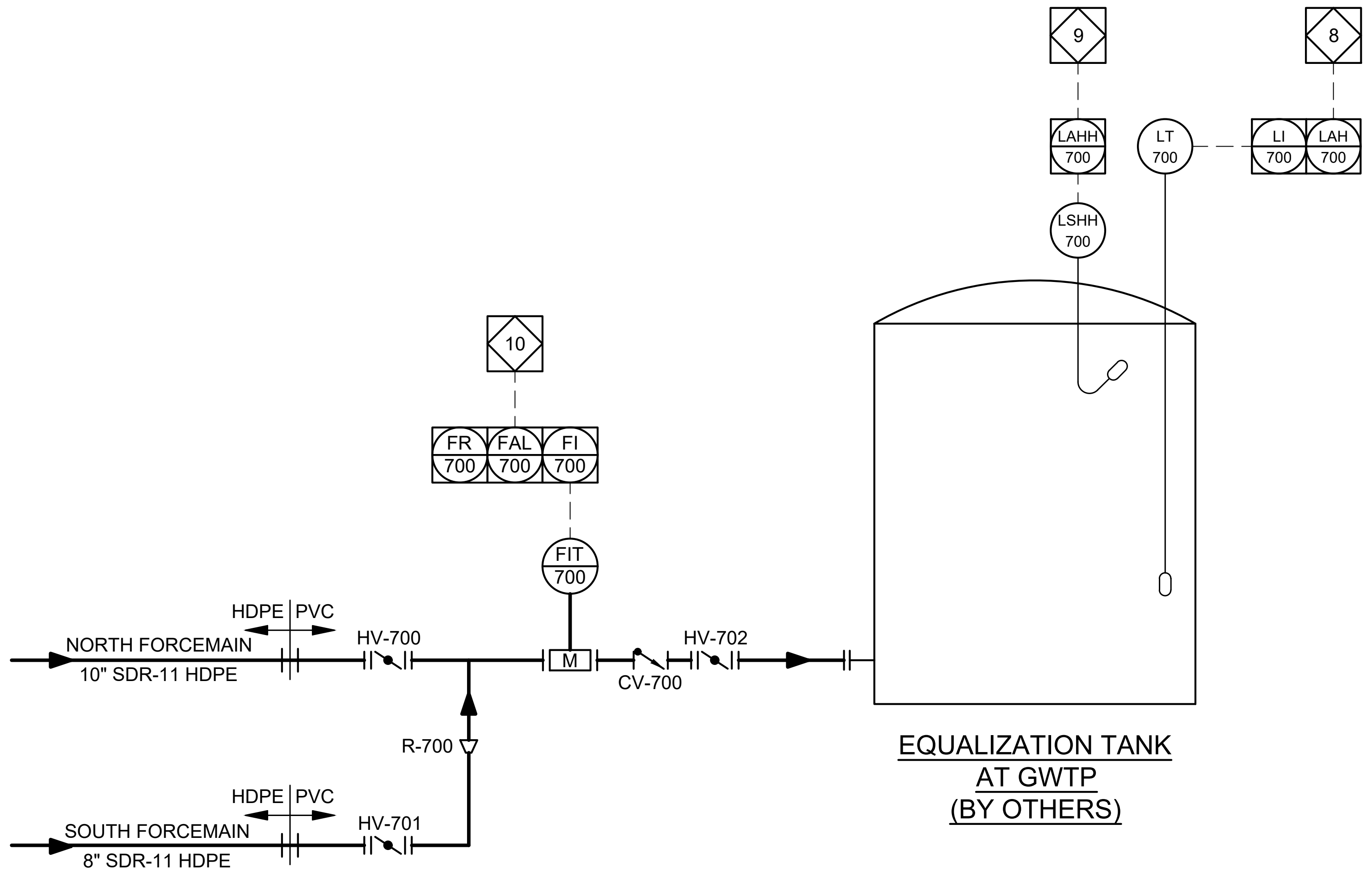
EXTRACTION WELL
(EW-XX)



FORCEMAIN
AIR RELEASE VALVE
(ARV-XX)



FORCEMAIN
CLEANOUT
(FCO-XX)



EQUALIZATION TANK
AT GWTP
(BY OTHERS)

INTERLOCK TABLE

INTERLOCK NUMBER	TRIGGERING DEVICE(S)	DESCRIPTION	ALARM TAG	ACTION REQUIRED BY PLC
1	LT-XX0	EXTRACTION WELL PUMP SPEED CONTROL	LC-XX0	SC-XX0 (VFD) OPERATE ON PID CONTROL LOOP AROUND USER-DEFINED LEVEL SET POINT LC-XX0
2	LT-XX0	EXTRACTION WELL LEVEL HIGH	LAH-XX0	START CORRESPONDING EXTRACTION WELL PUMP
3	LT-XX0	EXTRACTION WELL LEVEL LOW	LAL-XX0	SHUT OFF CORRESPONDING EXTRACTION WELL PUMP
4	PT-XX0	EXTRACTION WELL PIPE PRESSURE LOW	PAL-XX0	SHUT OFF CORRESPONDING EXTRACTION WELL PUMP
5	PT-XX0	EXTRACTION WELL PIPE PRESSURE HIGH	PAH-XX0	SHUT OFF CORRESPONDING EXTRACTION WELL PUMP
6	FIT-XX0	EXTRACTION WELL PUMP SPEED CONTROL	FC-XX0	SC-XX0 (VFD) OPERATE ON PID CONTROL LOOP AROUND USER-DEFINED FLOW SET POINT FC-XX0
7	FIT-XX0	EXTRACTION WELL PUMP FLOW LOW	FAL-XX0	RUN PERMISSIVE CONDITION FOR CORRESPONDING EXTRACTION WELL PUMP IS FIT-XX0 > FAL-XX0 SHUT OFF CORRESPONDING EXTRACTION WELL PUMP IF FAL-XX0 IS ENABLED
8	LT-700	EQUALIZATION TANK LEVEL HIGH	LAH-700	RUN PERMISSIVE CONDITION FOR EXTRACTION WELL PUMPS IS LT-700 < LAH-700 SHUT OFF EXTRACTION WELL PUMPS IF LAH-700 IS ENABLED
9	LSHH-700	EQUALIZATION TANK LEVEL HIGH-HIGH	LAHH-700	SHUT OFF EXTRACTION WELL PUMPS PMP-XX
10	FIT-700	INCOMING FLOW TO EQUALIZATION TANK	FAL-700	FAL-700 MINUS THE SUMMATION OF EXTRACTION WELL FLOW RATES FIT-XX0 IS MONITORED. A DIFFERENCE GREATER THAN __ GPM SHUTS OFF EXTRACTION WELL PUMPS.

NOTES:

1. TAGGING SCHEME SHOWN HEREIN IS GENERIC. XX SIGNIFIES THE EXTRACTION WELL NUMBER (I.E., EW-01 THROUGH EW-69), FORCEMAIN CLEANOUT NUMBER (I.E., FCO-01 THROUGH FCO-22) OR FORCEMAIN AIR RELEASE VALVE NUMBER (I.E., ARV-01 THROUGH ARV-12).
2. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
3. THE LATERALS FOR COLLOCATED WELLS (I.E., EW-18, EW-19, EW-22, EW-23, EW-24, EW-25, EW-27, EW-28, EW-29, EW-30, EW-31, EW-32, EW-33, EW-34, EW-35, EW-36, EW-37, EW-38, EW-39, EW-40, EW-44, EW-45, EW-46, EW-47, EW-48, EW-49, EW-50, AND EW-51) WILL COMBINE PRIOR TO REACHING THE FORCEMAIN.

90% DESIGN DRAWINGS

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RALEIGH, NC 27607
919.870.0576

TITLE:
PIPING AND INSTRUMENTATION DIAGRAM II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

DATE

DESIGN BY: BMT
DRAWN BY: JFH
CHECKED BY: CMDS
REVIEWED BY: SV
APPROVED BY: JJD

DATE: DECEMBER 2021
PROJECT NO.: TR0795A
FILE: TR0795A-D02.DWG
DRAWING NO.: D-02

EQUALIZATION TANK TAGGING SCHEME

	P&ID GENERIC LABEL	ELEMENT	MATERIAL	DESCRIPTION
INSTRUMENTATION	FIT-700	FLOW INDICATING TRANSMITTER	--	10"
	LT-700	LEVEL TRANSMITTER	--	BY OTHERS
	LSHH-700	LEVEL SWITCH	--	BY OTHERS
VALVES/FITTINGS	CV-700	CHECK VALVE	STAINLESS STEEL	10"
	HV-700	BUTTERFLY VALVE	STAINLESS STEEL	10"
	HV-702	BUTTERFLY VALVE	STAINLESS STEEL	10"
	HV-701	BUTTERFLY VALVE	STAINLESS STEEL	8"
	R-700	REDUCING TEE	SCH 80 PVC	10"X10"X8"

FORCEMAIN CLEANOUTS TAGGING SCHEME

	P&ID GENERIC LABEL	ELEMENT	MATERIAL	DESCRIPTION BASED ON FORCEMAIN CLEANOUT SIZE				
				3"	4"	6"	8"	10"
VALVES/FITTINGS	HV-FCO-XX0, HV-FCO-XX2	MJ GATE VALVE	STAINLESS STEEL	3"	4"	6"	8"	10"
	HV-FCO-XX1, HV-FCO-XX3	FULL-PORT BALL VALVE	PVC	3"	3"	3"	3"	3"
	R-FCO-XX0, R-FCO-XX2	REDUCER	SDR-11 HDPE	--	3"X4"	3"X6"	6"X8"	6"X10"
	R-FCO-XX1, R-FCO-XX3	REDUCER	SDR-11 HDPE	--	--	--	3"X6"	3"X6"

FORCEMAIN AIR RELEASE VALVES TAGGING SCHEME

	P&ID GENERIC LABEL	ELEMENT	MATERIAL	DESCRIPTION BASED ON FORCEMAIN AIR RELEASE VALVE SIZE				
				3"	4"	6"	8"	10"
VALVES	ARV-ARV-XX0	AIR RELEASE VALVE	PVC	1"	1"	1"	2"	2"
	HV-ARV-XX0	BALL VALVE	PVC	1"	1"	1"	2"	2"
FITTINGS	R-ARV-XX0	REDUCING TEE	SDR-11 HDPE	3"X3"X2"	4"X4"X2"	6"X6"X2"	8"X8"X2"	10"X10"X4"
	R-ARV-XX1	REDUCER	SDR-11 HDPE	2"X1"	2"X1"	2"X1"	--	2"X4"
PIPING	P-ARV-XX0	PIPE	SCH 80 PVC	1"	1"	1"	2"	2"

EXTRACTION WELL TAGGING SCHEME

	P&ID GENERIC LABEL	ELEMENT	MATERIAL	WELL TYPE (NOTE 2)			
				TYPE I	TYPE II	TYPE III	TYPE IV
PUMPS	PMP-XX	EXTRACTION WELL PUMP	--	SEE WELL DETAIL TABLE ON SHEET M-04			
VALVES	ARV-XX0	AIR RELEASE VALVE	PVC	3/4"	3/4"	3/4"	3/4"
	HV-XX0	BALL VALVE	PVC	3/4"	3/4"	3/4"	3/4"
	HV-XX1	BALL VALVE	BRONZE	1/4"	1/4"	1/4"	1/4"
	HV-XX2	BALL VALVE	BRONZE	1/4"	1/4"	1/4"	1/4"
	HV-XX3	BALL VALVE	PVC	1-1/2"	1-1/2"	2"	2"
	HV-XX4	BALL VALVE	BRONZE	2"	2"	2"	2"
	CV-XX0	CHECK VALVE	PVC	1-1/2"	1-1/2"	2"	2"
INSTRUMENTATION	FIT-XX0	FLOW INDICATING TRANSMITTER	--	1"	1-1/2"	1-1/2"	1-1/2"
	PT-XX0	PRESSURE TRANSMITTER	--	--	--	--	--
	LT-XX0	LEVEL TRANSMITTER	--	--	--	--	--
	ZS-XX0	POSITION SWITCH (WELL ENCLOSURE OPEN/CLOSED STATUS)	--	--	--	--	--
FITTINGS	R-XX00	REDUCER	STAINLESS STEEL	--	1-1/4" X 1-1/2"	1-1/4" X 1-1/2"	1-1/2" X 2"
	R-XX01	REDUCER	SDR-11 HDPE	1" X 1-1/4"	--	--	--
	R-XX02	REDUCER	SCH 80 PVC	1" X 1-1/2"	--	1-1/2" X 2"	1-1/2" X 2"
	R-XX03	REDUCER	SCH 80 PVC	1" X 1-1/2"	1" X 1-1/2"	1" X 2"	1" X 2"
	R-XX04	REDUCER	SCH 80 PVC	3/4" X 1"	3/4" X 1"	3/4" X 1"	3/4" X 1"
	R-XX05	REDUCING TEE	SCH 80 PVC	1/2" X 1-1/2" X 1-1/2"	1/2" X 1-1/2" X 1-1/2"	1/2" X 1-1/2" X 1-1/2"	1/2" X 1-1/2" X 1-1/2"
	R-XX06	REDUCER	BRONZE	1/4" X 1/2"	1/4" X 1/2"	1/4" X 1/2"	1/4" X 1/2"
	R-XX07	REDUCER	BRONZE	1/4" X 1/2"	1/4" X 1/2"	1/4" X 1/2"	1/4" X 1/2"
	R-XX08	REDUCING TEE	SCH 80 PVC	1-1/2" X 2" X 2"	1-1/2" X 2" X 2"	--	--
	R-XX09	REDUCER	SDR-11 HDPE	SEE NOTE 4			
	R-XX10	REDUCING TEE	SDR-11 HDPE				
PIPING	P-XX0	PIPE	SDR-11 HDPE	1-1/4"	1-1/2"	1-1/2"	1-1/2"
	P-XX1	PIPE	SCH 80 PVC	1"	1-1/2"	1-1/2"	1-1/2"
	P-XX2	PIPE	SCH 80 PVC	1"	1-1/2"	1-1/2"	1-1/2"
	P-XX3, P-XX4, P-XX5, P-XX6	PIPE	SCH 80 PVC	1-1/2"	1-1/2"	2"	2"
	P-XX7	PIPE	SCH 80 PVC	2"	2"	2"	2"
	P-XX8	PIPE	SDR-11 HDPE	2"	2"	2"	2"

INSTRUMENTATION SCHEDULE

P&ID LABEL	ELEMENT	SIZE	QUANTITIES	DESCRIPTION	MANUFACTURER/ MODEL	ITEM NUMBER
FIT-010, FIT-020, FIT-030, FIT-040, FIT-090, FIT-100, FIT-110, FIT-120, FIT-130, FIT-160, FIT-180, FIT-190, FIT-200, FIT-230, FIT-250, FIT-260, FIT-380, FIT-400, FIT-410, FIT-420, FIT-430, FIT-440, FIT-450, FIT-460, FIT-470, FIT-480, FIT-490, FIT-500, FIT-510, FIT-540, FIT-550, FIT-580	MAGNETIC FLOWMETER	1"	32	FLANGED CONNECTION, 4-20MA HART/DIGITAL HART, POLYURETHANE LINED, 316 L STAINLESS STEEL ELECTRODES	ROSEMOUNT 8705	SENSOR: 8705 P S A 010 H 1 W0 Q4 TRANSMITTER: 8732EM T 1 A 1 DA2 M5 Q4
FIT-050, FIT-060, FIT-070, FIT-080, FIT-140, FIT-150, FIT-170, FIT-210, FIT-220, FIT-240, FIT-270, FIT-280, FIT-290, FIT-300, FIT-310, FIT-320, FIT-330, FIT-340, FIT-350, FIT-360, FIT-370, FIT-390, FIT-520, FIT-530, FIT-560, FIT-570, FIT-590, FIT-600, FIT-610, FIT-620, FIT-630, FIT-640, FIT-650, FIT-660, FIT-670, FIT-680, FIT-690	MAGNETIC FLOWMETER	1-1/2"	37	FLANGED CONNECTION, 4-20MA HART/DIGITAL HART, POLYURETHANE LINED, 316 L STAINLESS STEEL ELECTRODES	ROSEMOUNT 8705	SENSOR: 8705 P S A 015 H 1 W0 Q4 TRANSMITTER: 8732EM T 1 A 1 DA2 M5 Q4
FIT-700	MAGNETIC FLOWMETER	10"	1	FLANGED CONNECTION, 4-20MA HART/DIGITAL HART, POLYURETHANE LINED, 316 L STAINLESS STEEL ELECTRODES	ROSEMOUNT 8705	SENSOR: 8705 P S A 100 H 1 W0 Q4 TRANSMITTER: 8732EM T 1 A 1 DA2 M5 Q4
PT-010, PT-020, PT-030, PT-040, PT-050, PT-060, PT-070, PT-080, PT-090, PT-100, PT-110, PT-120, PT-130, PT-140, PT-150, PT-160, PT-170, PT-180, PT-190, PT-200, PT-210, PT-220, PT-230, PT-240, PT-250, PT-260, PT-270, PT-280, PT-290, PT-300, PT-310, PT-320, PT-330, PT-340, PT-350, PT-360, PT-370, PT-380, PT-390, PT-400, PT-410, PT-420, PT-430, PT-440, PT-450, PT-460, PT-470, PT-480, PT-490, PT-500, PT-510, PT-520, PT-530, PT-540, PT-550, PT-560, PT-570, PT-580, PT-590, PT-600, PT-610, PT-620, PT-630, PT-640, PT-650, PT-660, PT-670, PT-680, PT-690	PRESSURE TRANSMITTER	1/4"	69	4 TO 20 MA OUTPUT, 316 L STAINLESS STEEL BODY, -14.7 TO 150 PSIG RATED, GAUGE PRESSURE TRANSMITTER	ROSEMOUNT 2088	2088 G 2 S 22 A 1 S1 T1 Q4
LT-180, LT-230, LT-250, LT-260, LT-270, LT-290, LT-310, LT-330, LT-350, LT-370, LT-390, LT-440, LT-460, LT-480, LT-500	LEVEL TRANSMITTER (SURFICIAL WELLS)	--	15	SUBMERSIBLE, 316 L STAINLESS STEEL BODY, POLYURETHANE CABLE, 4 TO 20 MA OUTPUT	DWYER MBLT	MBLT-2SC-IVPF-50-50-NIST
LT-010, LT-020, LT-030, LT-040, LT-050, LT-060, LT-070, LT-080, LT-090, LT-100, LT-110, LT-120, LT-130, LT-140, LT-150, LT-160, LT-170, LT-190, LT-200, LT-210, LT-220, LT-240, LT-280, LT-300, LT-320, LT-340, LT-360, LT-380, LT-400, LT-410, LT-420, LT-430, LT-450, LT-470, LT-490, LT-510, LT-520, LT-530, LT-540, LT-550, LT-560, LT-570, LT-580, LT-590, LT-600, LT-610, LT-620, LT-630, LT-640, LT-650, LT-660, LT-670, LT-680, LT-690	LEVEL TRANSMITTER (BCA WELLS)	--	54	SUBMERSIBLE, 316 L STAINLESS STEEL BODY, POLYURETHANE CABLE, 4 TO 20 MA OUTPUT	DWYER MBLT	MBLT-2SC-IVPF-100-100-NIST
ZS-010, ZS-020, ZS-030, ZS-040, ZS-050, ZS-060, ZS-070, ZS-080, ZS-090, ZS-100, ZS-110, ZS-120, ZS-130, ZS-140, ZS-150, ZS-160, ZS-170, ZS-180, ZS-190, ZS-200, ZS-210, ZS-220, ZS-230, ZS-240, ZS-250, ZS-260, ZS-270, ZS-280, ZS-290, ZS-300, ZS-310, ZS-320, ZS-330, ZS-340, ZS-350, ZS-360, ZS-370, ZS-380, ZS-390, ZS-400, ZS-410, ZS-420, ZS-430, ZS-440, ZS-450, ZS-460, ZS-470, ZS-480, ZS-490, ZS-500, ZS-510, ZS-520, ZS-530, ZS-540, ZS-550, ZS-560, ZS-570, ZS-580, ZS-590, ZS-600, ZS-610, ZS-620, ZS-630, ZS-640, ZS-650, ZS-660, ZS-670, ZS-680, ZS-690	POSITION SWITCH	--	69	WELL ENCLOSURE OPEN/CLOSED STATUS	IDEM SERIES MPC	MPC-114114
LT-700	LEVEL TRANSMITTER	--	BY OTHERS			
LSHH-700	LEVEL SWITCH	--	BY OTHERS			

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS
2. SEE WELL DETAIL TABLE ON SHEET M-04 FOR CORRESPONDING EXTRACTION WELL TYPE.
3. "--" INDICATES THAT ITEM IS NOT APPLICABLE.
4. DIMENSIONS VARY AND ARE DEPENDENT ON INDIVIDUAL EXTRACTION WELL CONNECTION TO THE FORCEMAIN. CONTRACTOR SHALL VERIFY SIZE PRIOR TO INSTALLATION.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants
Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EXTRACTION WELL P&ID SCHEDULES I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-D03.DWG
REVIEWED BY:	SV	DRAWING NO.:	D-03
APPROVED BY:	JJD		

VALVE SCHEDULE

P&ID LABEL	ELEMENT	MATERIAL	QUANTITIES	SIZE	DESCRIPTION	MANUFACTURER/MODEL
ARV-010, ARV-020, ARV-030, ARV-040, ARV-050, ARV-060, ARV-070, ARV-080, ARV-090, ARV-100, ARV-110, ARV-120, ARV-130, ARV-140, ARV-150, ARV-160, ARV-170, ARV-180, ARV-190, ARV-200, ARV-210, ARV-220, ARV-230, ARV-240, ARV-250, ARV-260, ARV-270, ARV-280, ARV-290, ARV-300, ARV-310, ARV-320, ARV-330, ARV-340, ARV-350, ARV-360, ARV-370, ARV-380, ARV-390, ARV-400, ARV-410, ARV-420, ARV-430, ARV-440, ARV-450, ARV-460, ARV-470, ARV-480, ARV-490, ARV-500, ARV-510, ARV-520, ARV-530, ARV-540, ARV-550, ARV-560, ARV-570, ARV-580, ARV-590, ARV-600, ARV-610, ARV-620, ARV-630, ARV-640, ARV-650, ARV-660, ARV-670, ARV-680, ARV-690	AIR RELEASE VALVE	PVC	69	3/4"	--	PLAST-O-MATIC OR APPROVED EQUAL
ARV-ARV-010, ARV-ARV-020, ARV-ARV-030, ARV-ARV-040, ARV-ARV-120	AIR RELEASE VALVE	PVC	5	1"	--	PLAST-O-MATIC OR APPROVED EQUAL
ARV-ARV-050, ARV-ARV-060, ARV-ARV-070, ARV-ARV-080, ARV-ARV-090, ARV-ARV-100, ARV-ARV-110	AIR RELEASE VALVE	PVC	7	2"	--	PLAST-O-MATIC OR APPROVED EQUAL
CV-010, CV-020, CV-030, CV-040, CV-050, CV-060, CV-070, CV-080, CV-090, CV-100, CV-110, CV-120, CV-130, CV-140, CV-150, CV-160, CV-170, CV-180, CV-190, CV-200, CV-210, CV-230, CV-240, CV-250, CV-260, CV-270, CV-280, CV-290, CV-300, CV-310, CV-320, CV-330, CV-340, CV-350, CV-360, CV-370, CV-380, CV-390, CV-400, CV-410, CV-420, CV-430, CV-440, CV-450, CV-460, CV-470, CV-480, CV-490, CV-500, CV-510, CV-520, CV-530, CV-540, CV-550, CV-560, CV-570, CV-580, CV-590, CV-600, CV-610, CV-620, CV-630	CHECK VALVE	PVC	62	1-1/2"	--	ASAHI/PLAST-O-MATIC OR APPROVED EQUAL
CV-220, CV-640, CV-650, CV-660, CV-670, CV-680, CV-690	CHECK VALVE	PVC	7	2"	--	ASAHI/PLAST-O-MATIC OR APPROVED EQUAL
HV-010, HV-020, HV-030, HV-040, HV-050, HV-060, HV-070, HV-080, HV-090, HV-100, HV-110, HV-120, HV-130, HV-140, HV-150, HV-160, HV-170, HV-180, HV-190, HV-200, HV-210, HV-220, HV-230, HV-240, HV-250, HV-260, HV-270, HV-280, HV-290, HV-300, HV-310, HV-320, HV-330, HV-340, HV-350, HV-360, HV-370, HV-380, HV-390, HV-400, HV-410, HV-420, HV-430, HV-440, HV-450, HV-460, HV-470, HV-480, HV-490, HV-500, HV-510, HV-520, HV-530, HV-540, HV-550, HV-560, HV-570, HV-580, HV-590, HV-600, HV-610, HV-620, HV-630, HV-640, HV-650, HV-660, HV-670, HV-680, HV-690	BALL VALVE	PVC	69	3/4"	--	ASAHI/PLAST-O-MATIC OR APPROVED EQUAL
HV-011, HV-021, HV-031, HV-041, HV-051, HV-061, HV-071, HV-081, HV-091, HV-101, HV-111, HV-121, HV-131, HV-141, HV-151, HV-161, HV-171, HV-181, HV-191, HV-201, HV-211, HV-221, HV-231, HV-241, HV-251, HV-261, HV-271, HV-281, HV-291, HV-301, HV-311, HV-321, HV-331, HV-341, HV-351, HV-361, HV-371, HV-381, HV-391, HV-401, HV-411, HV-421, HV-431, HV-441, HV-451, HV-461, HV-471, HV-481, HV-491, HV-501, HV-511, HV-521, HV-531, HV-541, HV-551, HV-561, HV-571, HV-581, HV-591, HV-601, HV-611, HV-621, HV-631, HV-641, HV-651, HV-661, HV-671, HV-681, HV-691, HV-012, HV-022, HV-032, HV-042, HV-052, HV-062, HV-072, HV-082, HV-092, HV-102, HV-112, HV-122, HV-132, HV-142, HV-152, HV-162, HV-172, HV-182, HV-192, HV-202, HV-212, HV-222, HV-232, HV-242, HV-252, HV-262, HV-272, HV-282, HV-292, HV-302, HV-312, HV-322, HV-332, HV-342, HV-352, HV-362, HV-372, HV-382, HV-392, HV-402, HV-412, HV-422, HV-432, HV-442, HV-452, HV-462, HV-472, HV-482, HV-492, HV-502, HV-512, HV-522, HV-532, HV-542, HV-552, HV-562, HV-572, HV-582, HV-592, HV-602, HV-612, HV-622, HV-632, HV-642, HV-652, HV-662, HV-672, HV-682, HV-692	BALL VALVE	BRONZE	138	1/4"	--	APOLLO OR APPROVED EQUAL
HV-014, HV-024, HV-034, HV-044, HV-054, HV-064, HV-074, HV-084, HV-094, HV-104, HV-114, HV-124, HV-134, HV-144, HV-154, HV-164, HV-174, HV-184, HV-194, HV-204, HV-214, HV-224, HV-234, HV-244, HV-254, HV-264, HV-274, HV-284, HV-294, HV-304, HV-314, HV-324, HV-334, HV-344, HV-354, HV-364, HV-374, HV-384, HV-394, HV-404, HV-414, HV-424, HV-434, HV-444, HV-454, HV-464, HV-474, HV-484, HV-494, HV-504, HV-514, HV-524, HV-534, HV-544, HV-554, HV-564, HV-574, HV-584, HV-594, HV-604, HV-614, HV-624, HV-634, HV-644, HV-654, HV-664, HV-674, HV-684, HV-694	BALL VALVE	BRONZE	69	2"	--	APOLLO OR APPROVED EQUAL
HV-013, HV-023, HV-033, HV-043, HV-053, HV-063, HV-073, HV-083, HV-093, HV-103, HV-113, HV-123, HV-133, HV-143, HV-153, HV-163, HV-173, HV-183, HV-193, HV-203, HV-213, HV-233, HV-243, HV-253, HV-263, HV-273, HV-283, HV-293, HV-303, HV-313, HV-323, HV-333, HV-343, HV-353, HV-363, HV-373, HV-383, HV-393, HV-403, HV-413, HV-423, HV-433, HV-443, HV-453, HV-463, HV-473, HV-483, HV-493, HV-503, HV-513, HV-523, HV-533, HV-543, HV-553, HV-563, HV-573, HV-583, HV-593, HV-603, HV-613, HV-623, HV-633	BALL VALVE	PVC	62	1-1/2"	--	ASAHI/PLAST-O-MATIC OR APPROVED EQUAL
HV-223, HV-643, HV-653, HV-663, HV-673, HV-683, HV-693, HV-ARV-050, HV-ARV-060, HV-ARV-070, HV-ARV-080, HV-ARV-090, HV-ARV-100, HV-ARV-110	BALL VALVE	PVC	14	2"		ASAHI/PLAST-O-MATIC OR APPROVED EQUAL
HV-ARV-010, HV-ARV-020, HV-ARV-030, HV-ARV-040, HV-ARV-120	BALL VALVE	PVC	5	1"	--	ASAHI/PLAST-O-MATIC OR APPROVED EQUAL
HV-FCO-010, HV-FCO-020, HV-FCO-030, HV-FCO-040, HV-FCO-050, HV-FCO-220, HV-FCO-012, HV-FCO-022, HV-FCO-032, HV-FCO-042, HV-FCO-052, HV-FCO-222	GATE VALVE	STAINLESS STEEL	12	3"	MECHANICAL JOINT CONNECTION	U.S. PIPE OR APPROVED EQUAL
HV-FCO-060, HV-FCO-070, HV-FCO-210, HV-FCO-062, HV-FCO-072, HV-FCO-212	GATE VALVE	STAINLESS STEEL	6	4"	MECHANICAL JOINT CONNECTION	U.S. PIPE OR APPROVED EQUAL
HV-FCO-080, HV-FCO-090, HV-FCO-100, HV-FCO-180, HV-FCO-190, HV-FCO-200, HV-FCO-082, HV-FCO-092, HV-FCO-102, HV-FCO-182, HV-FCO-192, HV-FCO-202	GATE VALVE	STAINLESS STEEL	12	6"	MECHANICAL JOINT CONNECTION	U.S. PIPE OR APPROVED EQUAL
HV-FCO-110, HV-FCO-120, HV-FCO-170, HV-FCO-112, HV-FCO-122, HV-FCO-172	GATE VALVE	STAINLESS STEEL	6	8"	MECHANICAL JOINT CONNECTION	U.S. PIPE OR APPROVED EQUAL
HV-FCO-130, HV-FCO-140, HV-FCO-150, HV-FCO-160, HV-FCO-132, HV-FCO-142, HV-FCO-152, HV-FCO-162	GATE VALVE	STAINLESS STEEL	8	10"	MECHANICAL JOINT CONNECTION	U.S. PIPE OR APPROVED EQUAL
HV-FCO-011, HV-FCO-021, HV-FCO-031, HV-FCO-041, HV-FCO-051, HV-FCO-061, HV-FCO-071, HV-FCO-081, HV-FCO-091, HV-FCO-101, HV-FCO-111, HV-FCO-121, HV-FCO-131, HV-FCO-141, HV-FCO-151, HV-FCO-161, HV-FCO-171, HV-FCO-181, HV-FCO-191, HV-FCO-201, HV-FCO-211, HV-FCO-221, HV-FCO-013, HV-FCO-023, HV-FCO-033, HV-FCO-043, HV-FCO-053, HV-FCO-063, HV-FCO-073, HV-FCO-083, HV-FCO-093, HV-FCO-103, HV-FCO-113, HV-FCO-123, HV-FCO-133, HV-FCO-143, HV-FCO-153, HV-FCO-163, HV-FCO-173, HV-FCO-183, HV-FCO-193, HV-FCO-203, HV-FCO-213, HV-FCO-223	FULL-PORT BALL VALVE	PVC	44	3"	PVC FULL-PORT BALL VALVE	HAYWARD OR APPROVED EQUAL
CV-700	CHECK VALVE	STAINLESS STEEL	1	10"	--	
HV-700, HV-702	BUTTERFLY VALVE	STAINLESS STEEL	2	10"	--	
HV-701	BUTTERFLY VALVE	STAINLESS STEEL	1	8"	--	

PUMP SCHEDULE

P&ID LABEL	ELEMENT	MANUFACTURER/MODEL	QUANTITIES	MECHANICAL INFORMATION	MOTOR
PMP-23, PMP-48, PMP-50	EXTRACTION WELL PUMP	GOULDS 5GS05R SERIES OR APPROVED EQUAL	3	1-1/4" OUTLET, STAINLESS STEEL CONSTRUCTION	0.5 HP, 240 V, 3 PH
PMP-18, PMP-25, PMP-44, PMP-46	EXTRACTION WELL PUMP	GOULDS 10GS05 SERIES OR APPROVED EQUAL	4	1-1/4" OUTLET, STAINLESS STEEL CONSTRUCTION	0.5 HP, 240 V, 3 PH
PMP-01, PMP-02, PMP-03	EXTRACTION WELL PUMP	GOULDS 10GS07 SERIES OR APPROVED EQUAL	3	1-1/4" OUTLET, STAINLESS STEEL CONSTRUCTION	0.75 HP, 240 V, 3 PH
PMP-04, PMP-09, PMP-10, PMP-11, PMP-12, PMP-13, PMP-16, PMP-19, PMP-20, PMP-26, PMP-38, PMP-40, PMP-41, PMP-42, PMP-43, PMP-45, PMP-47, PMP-49, PMP-51, PMP-54, PMP-55, PMP-58	EXTRACTION WELL PUMP	GOULDS 13GS10 SERIES OR APPROVED EQUAL	22	1-1/4" OUTLET, STAINLESS STEEL CONSTRUCTION	1 HP, 240 V, 3 PH
PMP-27, PMP-30, PMP-31, PMP-33, PMP-35, PMP-37, PMP-39	EXTRACTION WELL PUMP	GOULDS 18GS10 SERIES OR APPROVED EQUAL	7	1-1/4" OUTLET, STAINLESS STEEL CONSTRUCTION	1 HP, 240 V, 3 PH
PMP-05, PMP-06, PMP-07, PMP-08, PMP-14, PMP-15, PMP-17, PMP-21, PMP-24, PMP-28, PMP-29, PMP-32, PMP-34, PMP-36, PMP-52, PMP-53, PMP-56, PMP-57, PMP-59, PMP-60, PMP-61, PMP-62, PMP-63	EXTRACTION WELL PUMP	GOULDS 18GS15 SERIES OR APPROVED EQUAL	23	1-1/4" OUTLET, STAINLESS STEEL CONSTRUCTION	1.5 HP, 240 V, 3 PH
PMP-22, PMP-64, PMP-65, PMP-66	EXTRACTION WELL PUMP	GOULDS 25GS20 SERIES OR APPROVED EQUAL	4	1-1/4" OUTLET, STAINLESS STEEL CONSTRUCTION	2 HP, 240 V, 3 PH
PMP-67, PMP-68, PMP-69	EXTRACTION WELL PUMP	GOULDS 35GS20 SERIES OR APPROVED EQUAL	3	2" OUTLET, STAINLESS STEEL CONSTRUCTION	2 HP, 240 V, 3 PH

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
2. "--" INDICATES THAT ITEM IS NOT APPLICABLE.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EXTRACTION WELL P&ID SCHEDULES II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

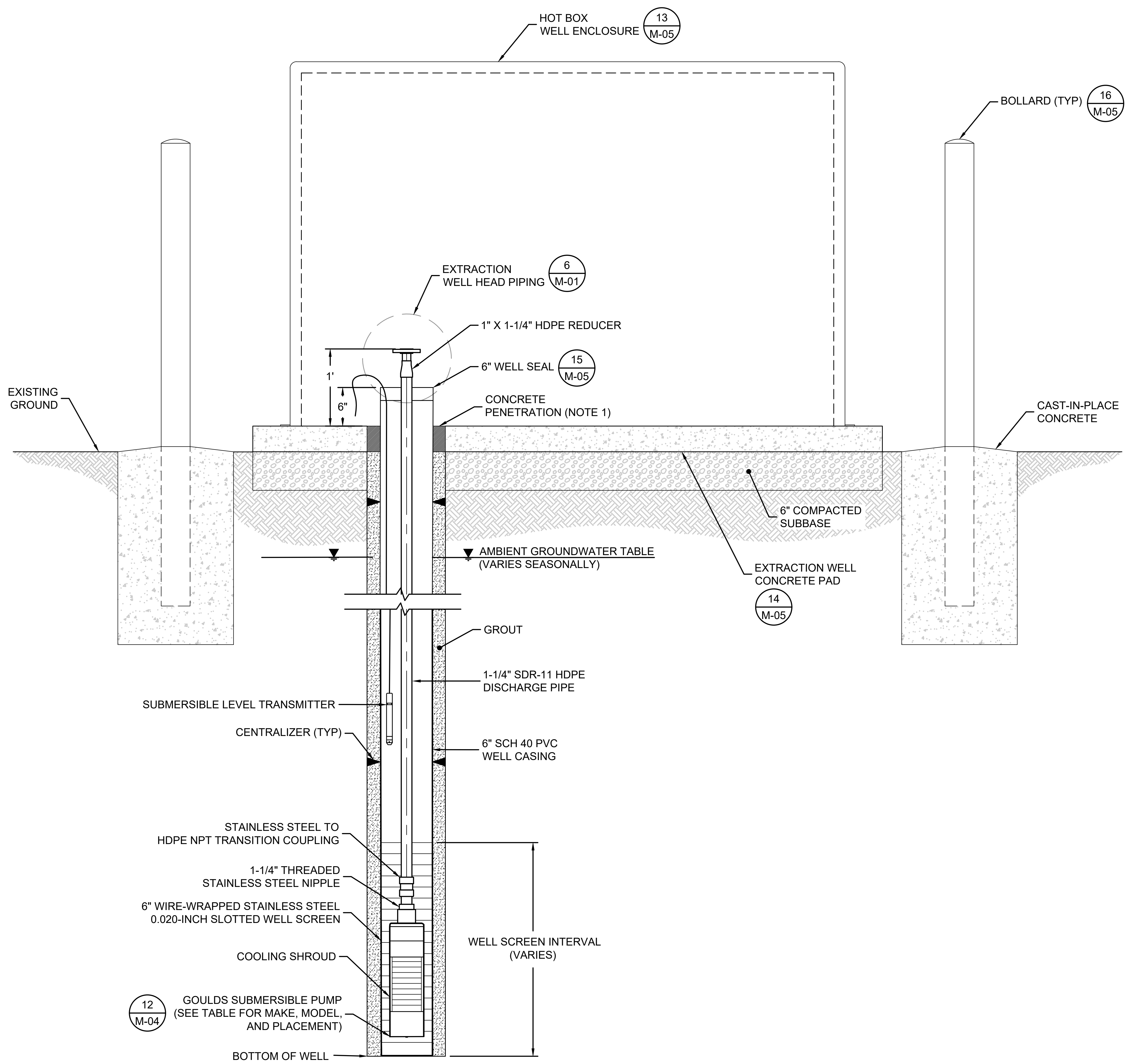
SITE:
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

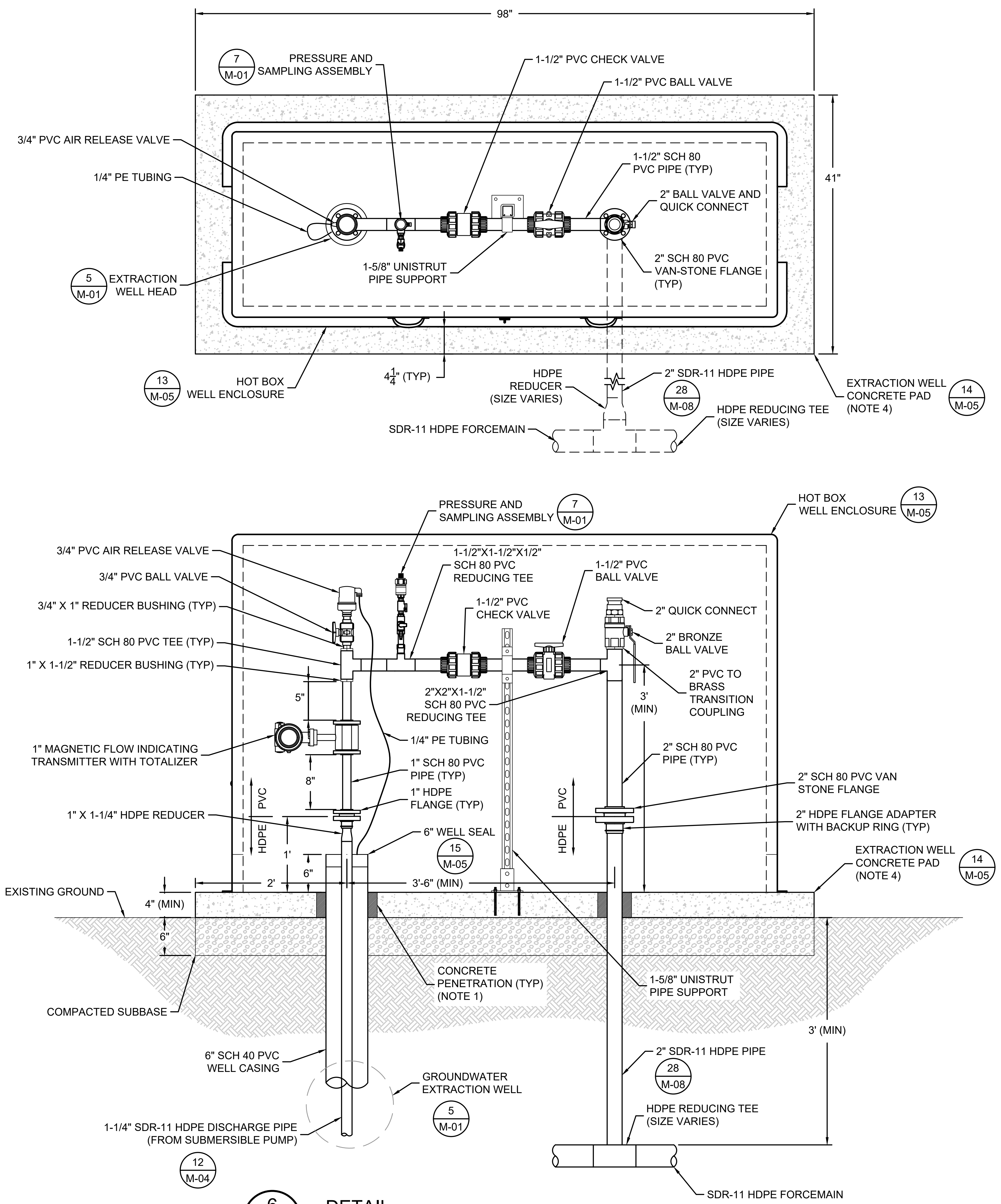
SIGNATURE

DATE

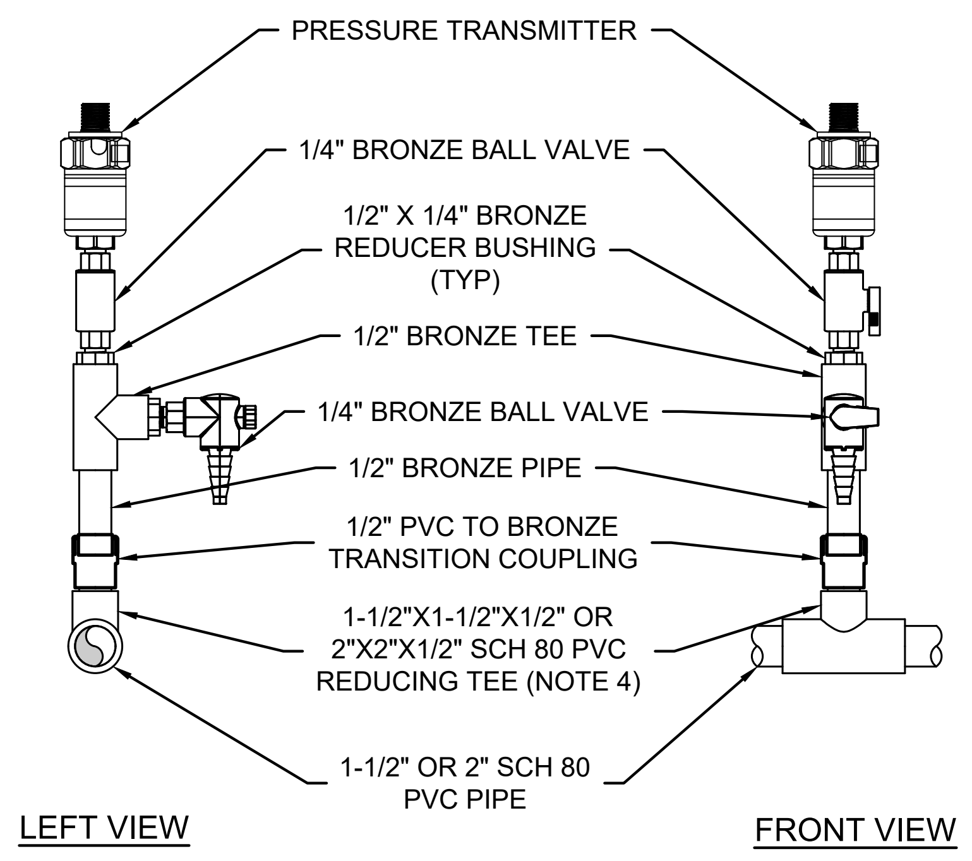
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-D04.DWG
REVIEWED BY:	SV	DRAWING NO.:	D-04
APPROVED BY:	JJD		



5 C-01 DETAIL
GROUNDWATER EXTRACTION WELL - TYPE I
SCALE: 1" = 1'



6 M-01 DETAIL
WELL HEAD PIPING - TYPE I
SCALE: 1" = 1'



7 M-01 DETAIL
PRESSURE AND SAMPLING ASSEMBLY
SCALE: 1" = 5'

NOTES:

1. PENETRATIONS SHALL BE SEALED WITH GROUT TO PREVENT WATER INFILTRATION.
2. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
3. INDIVIDUAL CONCRETE PAD ORIENTATIONS SHALL BE DETERMINED IN FIELD TO FACILITATE CONNECTION TO LATERAL PIPE.
4. 1/2" BRONZE PIPE SHALL BE CONNECTED TO THE MAIN PIPE VIA A REDUCING TEE SELECTED TO MATCH THE NECESSARY TRANSITION FROM THE MAIN PIPE TO THE PRESSURE AND SAMPLING ASSEMBLY.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EXTRACTION WELL DETAILS I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

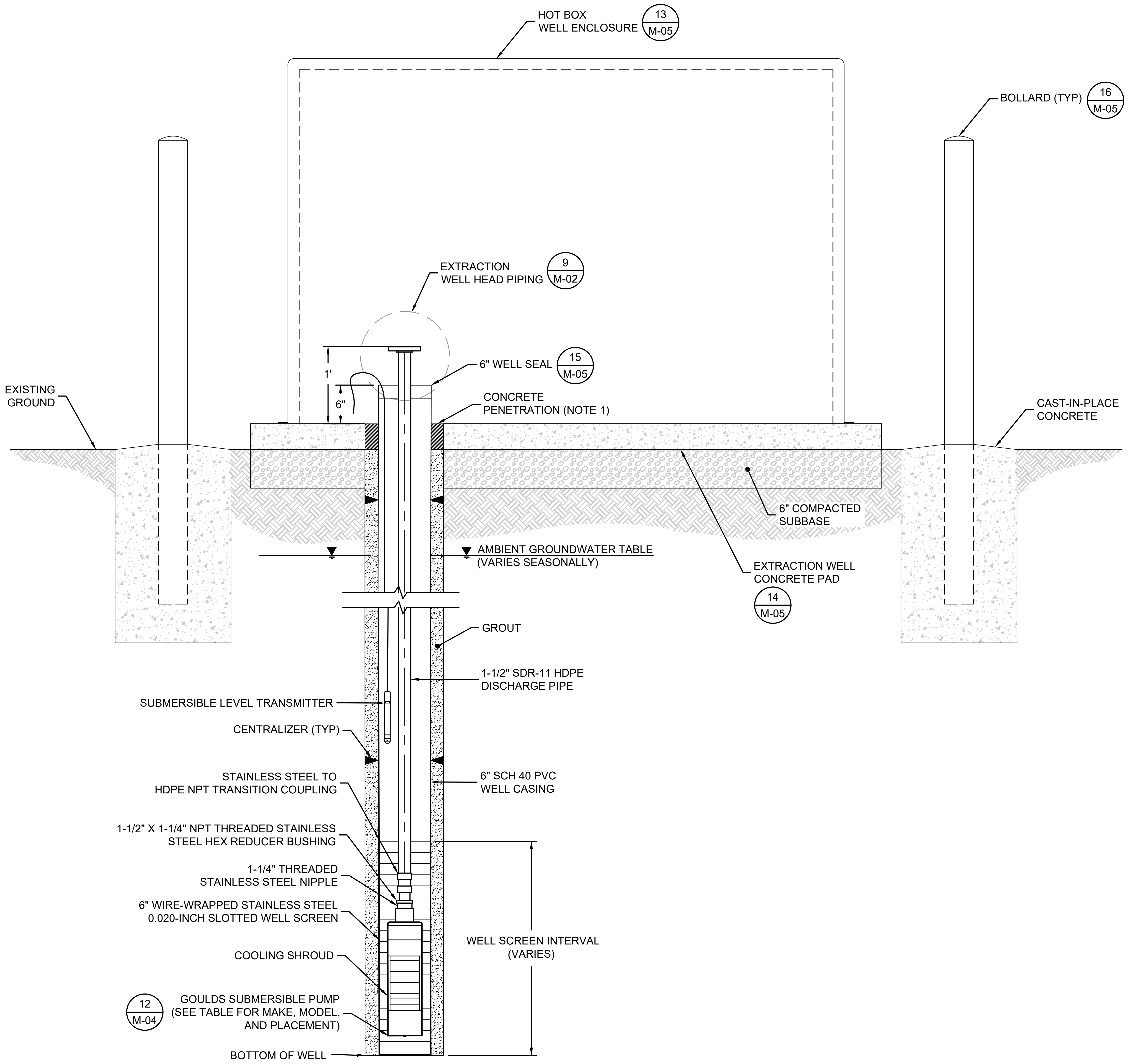
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M01.DWG
REVIEWED BY:	SV	DRAWING NO.:	M-01
APPROVED BY:	JJD		

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-M01

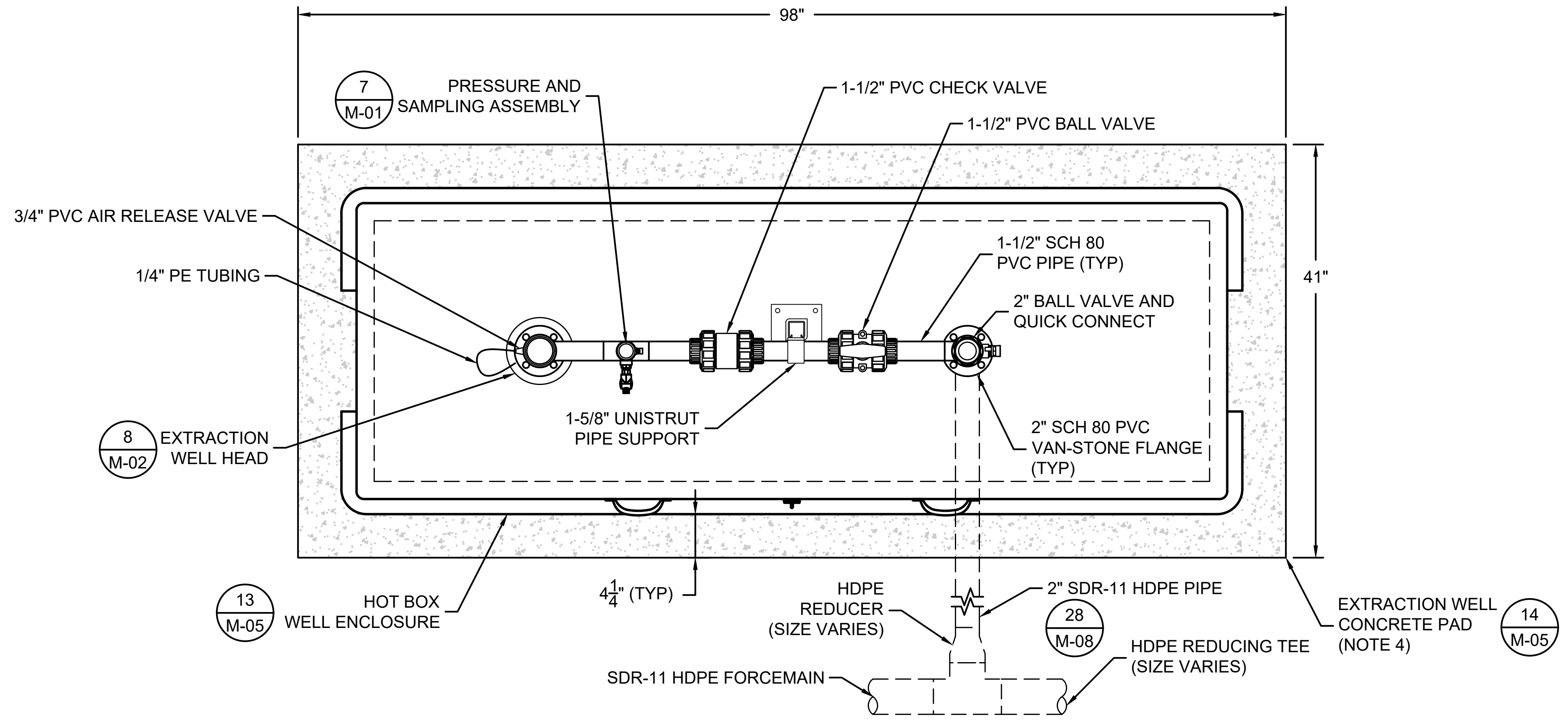


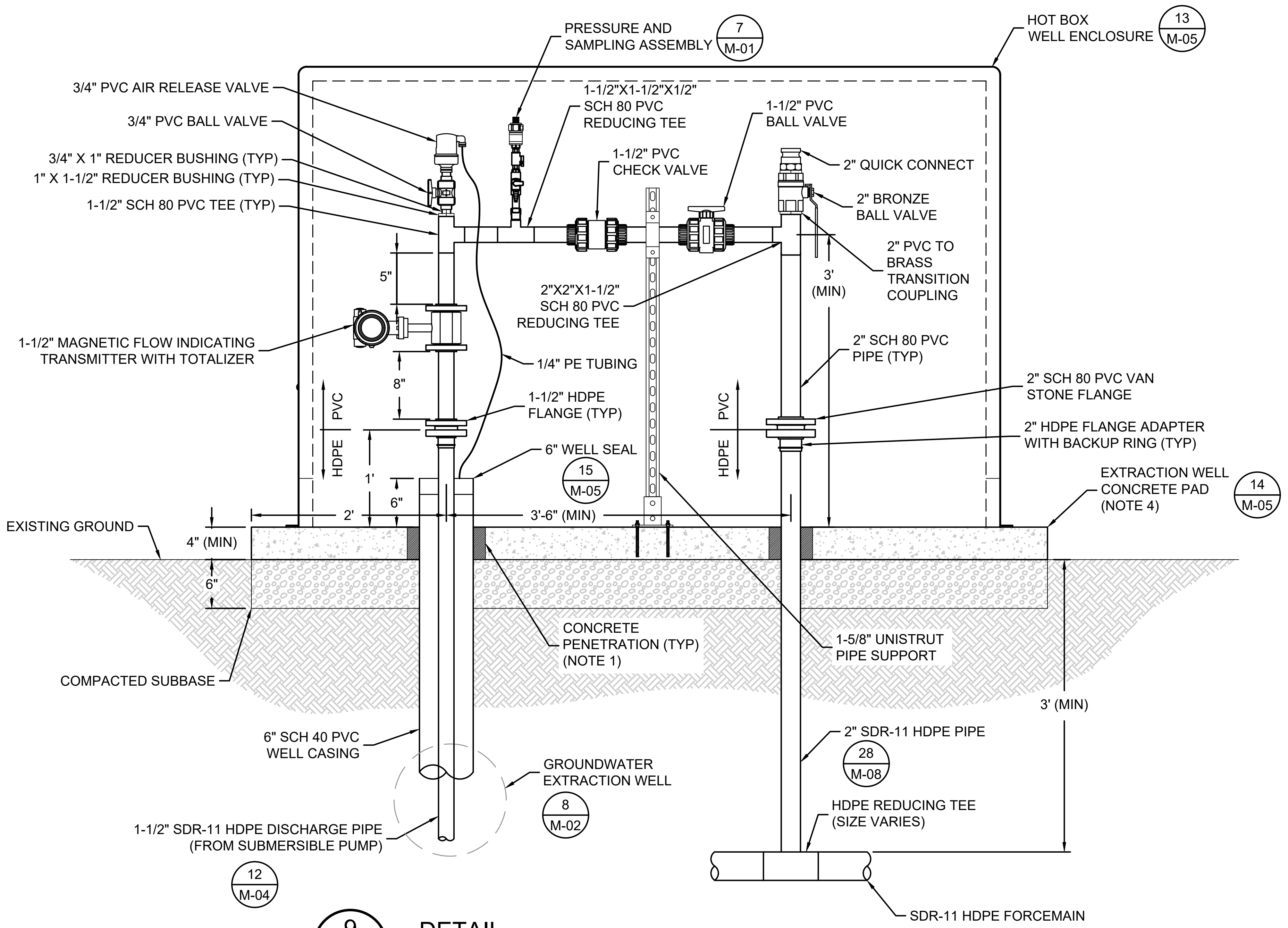
8 / C-01

DETAIL

GROUNDWATER EXTRACTION WELL - TYPE II

SCALE: 1" = 1'





9 / M-02

DETAIL

WELL HEAD PIPING - TYPE II

SCALE: 1" = 1'

NOTES:

1. PENETRATIONS SHALL BE SEALED WITH GROUT TO PREVENT WATER INFILTRATION.
2. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
3. INDIVIDUAL CONCRETE PAD ORIENTATIONS SHALL BE DETERMINED IN FIELD TO FACILITATE CONNECTION TO LATERAL PIPE.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
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919.870.0576

TITLE:
EXTRACTION WELL DETAILS II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

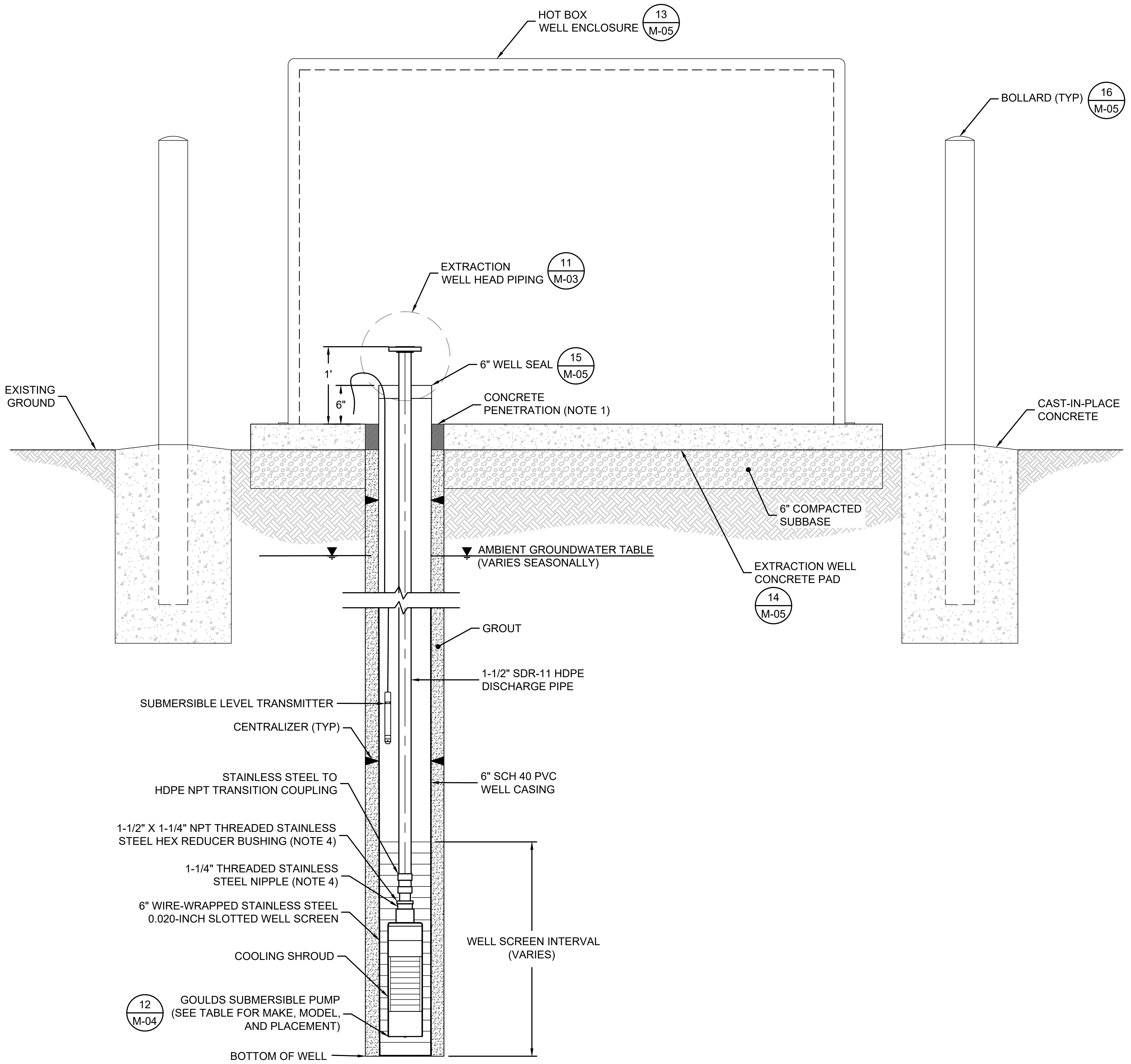
SITE:
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

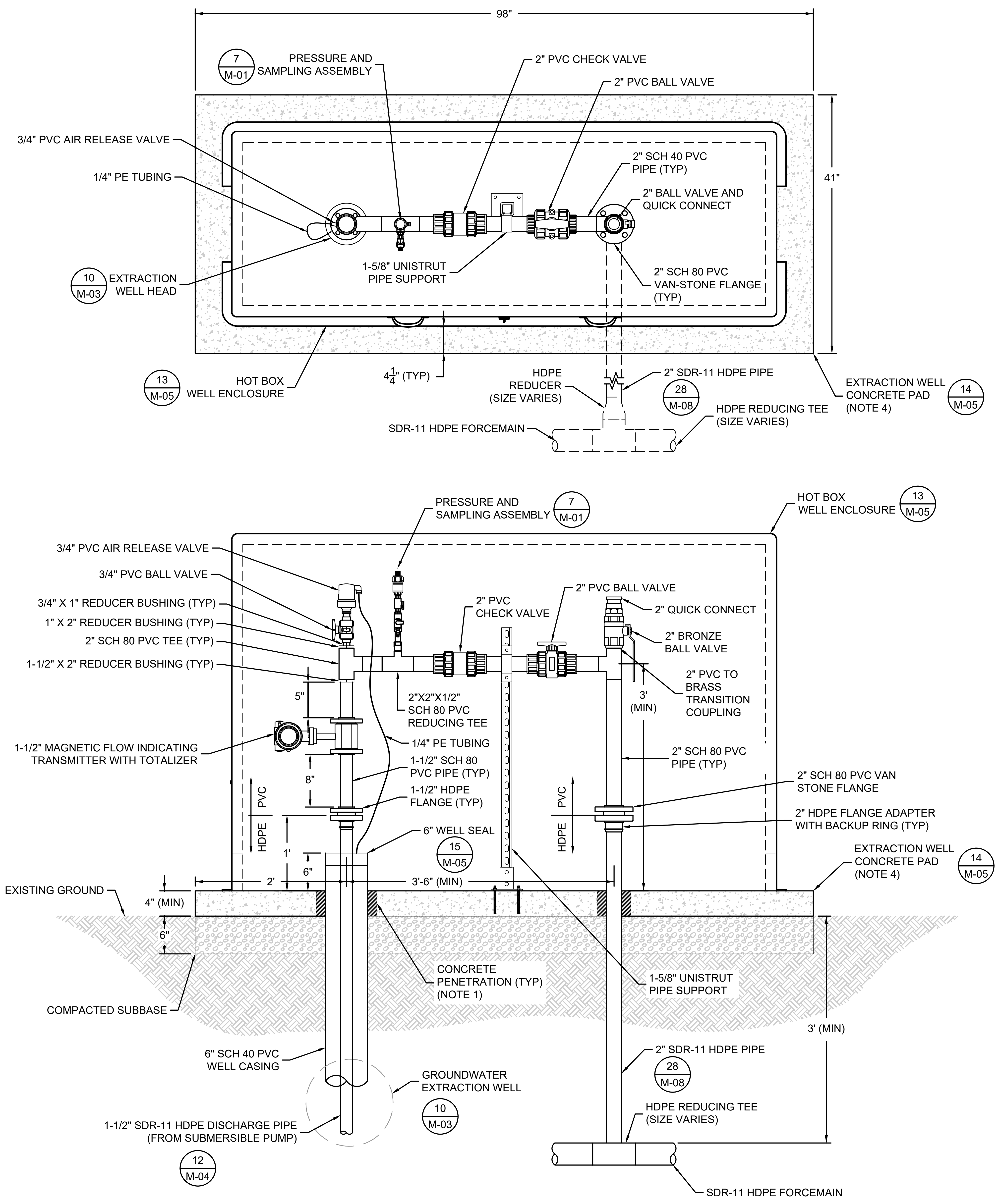
DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M02.DWG
REVIEWED BY:	SV	DRAWING NO.:	M-02
APPROVED BY:	JJD		



10 C-01 DETAIL
GROUNDWATER EXTRACTION WELL - TYPE III AND TYPE IV

SCALE: 1" = 1'



11 M-03 DETAIL
WELL HEAD PIPING - TYPE III AND TYPE IV

SCALE: 1" = 1'

NOTES:

1. PENETRATIONS SHALL BE SEALED WITH GROUT TO PREVENT WATER INFILTRATION.
2. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
3. INDIVIDUAL CONCRETE PAD ORIENTATIONS SHALL BE DETERMINED IN FIELD TO FACILITATE CONNECTION TO LATERAL PIPE.
4. FOR TYPE IV WELLS, THE 1-1/4" THREADED STAINLESS STEEL NIPPLE IS NOT NEEDED, AND THE 1-1/2" X 1-1/4" NPT THREADED STAINLESS STEEL HEX REDUCER BUSHING SHALL BE 2" X 1-1/2" NPT THREADED STAINLESS STEEL HEX REDUCER BUSHING.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EXTRACTION WELL DETAILS III

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M03.DWG
REVIEWED BY:	SV	DRAWING NO.:	
APPROVED BY:	JJD		M-03

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-M03

WELL ID	NORTHING (NAD83)	EASTING (NAD83)	WELL DIAMETER (IN)	WELL MATERIAL	GROUND SURFACE (FT NAVD88)	SCREEN DIAMETER (IN)	PUMP PLACEMENT (FT NAVD88)	GOULDS GS SERIES PUMP MODEL	WELL TYPE
EW-01	401709.79	2049950.94	6	PVC	88.03	6	38.03	10GS07	TYPE I
EW-02	401709.98	2050267.38	6	PVC	85.33	6	35.33	10GS07	TYPE I
EW-03	401749.49	2050593.83	6	PVC	80.55	6	25.55	10GS07	TYPE I
EW-04	401715.27	2050847.89	6	PVC	77.48	6	22.48	13GS10	TYPE I
EW-05	401655.21	2051059.13	6	PVC	77.42	6	22.42	18GS15	TYPE II
EW-06	401490.69	2051120.35	6	PVC	78.80	6	8.80	18GS15	TYPE II
EW-07	401353.13	2051171.07	6	PVC	82.10	6	17.10	18GS15	TYPE II
EW-08	401180.48	2051176.69	6	PVC	87.49	6	12.49	18GS15	TYPE II
EW-09	401008.94	2051129.06	6	PVC	78.28	6	3.28	13GS10	TYPE I
EW-10	400869.20	2051129.91	6	PVC	69.93	6	4.93	13GS10	TYPE I
EW-11	400748.01	2051322.46	6	PVC	90.11	6	30.11	13GS10	TYPE I
EW-12	400665.15	2051473.17	6	PVC	76.89	6	1.89	13GS10	TYPE I
EW-13	400550.03	2051544.78	6	PVC	80.84	6	0.84	13GS10	TYPE I
EW-14	400376.33	2051583.79	6	PVC	80.71	6	10.71	18GS15	TYPE II
EW-15	400214.89	2051530.20	6	PVC	75.22	6	15.22	18GS15	TYPE II
EW-16	400042.88	2051489.32	6	PVC	86.79	6	16.79	13GS10	TYPE I
EW-17	399975.56	2051517.92	6	PVC	82.30	6	22.30	18GS15	TYPE II
EW-18	399828.57	2051586.37	6	PVC	72.39	6	42.39	10GS05	TYPE I
EW-19	399819.51	2051590.59	6	PVC	73.24	6	13.24	13GS10	TYPE I
EW-20	399696.27	2051667.98	6	PVC	75.87	6	20.87	13GS10	TYPE I
EW-21	399549.40	2051687.69	6	PVC	85.08	6	20.08	18GS15	TYPE II
EW-22	399298.56	2051754.41	6	PVC	90.00	6	55.00	25GS20	TYPE III
EW-23	399289.50	2051758.62	6	PVC	89.38	6	69.38	5GS05R	TYPE I
EW-24	399106.44	2051843.78	6	PVC	92.44	6	57.44	18GS15	TYPE II
EW-25	399097.37	2051847.99	6	PVC	92.07	6	77.07	10GS05	TYPE I
EW-26	398983.07	2051870.84	6	PVC	88.67	6	76.67	13GS10	TYPE I
EW-27	398883.50	2051881.22	6	PVC	86.94	6	76.39	18GS10	TYPE II
EW-28	398873.51	2051881.75	6	PVC	86.39	6	11.94	18GS15	TYPE II
EW-29	398744.04	2051874.16	6	PVC	79.72	6	69.72	18GS15	TYPE II
EW-30	398734.11	2051873.02	6	PVC	79.40	6	28.40	18GS10	TYPE II
EW-31	398616.91	2051859.50	6	PVC	78.56	6	53.56	18GS10	TYPE II
EW-32	398606.98	2051858.35	6	PVC	78.72	6	23.72	18GS15	TYPE II
EW-33	398413.44	2051842.72	6	PVC	74.75	6	54.75	18GS10	TYPE II
EW-34	398403.55	2051844.18	6	PVC	74.00	6	9.00	18GS15	TYPE II
EW-35	398342.78	2051863.13	6	PVC	70.27	6	50.27	18GS10	TYPE II
EW-36	398333.75	2051867.42	6	PVC	69.65	6	4.65	18GS15	TYPE II
EW-37	398242.51	2051919.37	6	PVC	65.67	6	48.67	18GS10	TYPE II
EW-38	398233.82	2051924.32	6	PVC	65.01	6	-2.99	13GS10	TYPE I
EW-39	398113.98	2051992.55	6	PVC	74.43	6	57.43	18GS10	TYPE II
EW-40	398105.29	2051997.49	6	PVC	75.32	6	5.32	13GS10	TYPE I
EW-41	397945.05	2052019.22	6	PVC	83.33	6	5.33	13GS10	TYPE I
EW-42	397792.07	2052011.56	6	PVC	79.66	6	1.66	13GS10	TYPE I
EW-43	397657.44	2052004.82	6	PVC	82.15	6	4.15	13GS10	TYPE I
EW-44	397521.13	2051998.00	6	PVC	72.62	6	57.62	10GS05	TYPE I
EW-45	397511.14	2051997.50	6	PVC	73.01	6	1.01	13GS10	TYPE I
EW-46	397386.53	2051992.11	6	PVC	69.00	6	43.00	10GS05	TYPE I
EW-47	397376.57	2051993.09	6	PVC	69.22	6	-3.78	13GS10	TYPE I
EW-48	397291.07	2052028.48	6	PVC	79.81	6	43.81	5GS05R	TYPE I
EW-49	397282.18	2052033.07	6	PVC	79.32	6	1.32	13GS10	TYPE I
EW-50	397106.09	2052107.74	6	PVC	76.14	6	46.14	5GS05R	TYPE I
EW-51	397096.31	2052109.81	6	PVC	76.42	6	2.42	13GS10	TYPE I
EW-52	396903.30	2052150.70	6	PVC	73.74	6	3.74	18GS15	TYPE II
EW-53	396713.95	2052190.81	6	PVC	73.85	6	9.85	18GS15	TYPE II
EW-54	396559.71	2052222.63	6	PVC	72.49	6	10.49	13GS10	TYPE I
EW-55	396358.59	2052241.44	6	PVC	80.39	6	13.39	13GS10	TYPE I
EW-56	396166.80	2052258.59	6	PVC	78.66	6	10.66	18GS15	TYPE II
EW-57	395991.82	2052274.23	6	PVC	75.58	6	8.58	18GS15	TYPE II
EW-58	395810.19	2052290.46	6	PVC	72.05	6	5.05	13GS10	TYPE I
EW-59	395617.32	2052307.70	6	PVC	72.93	6	1.93	18GS15	TYPE II
EW-60	395425.07	2052313.48	6	PVC	74.28	6	3.28	18GS15	TYPE II
EW-61	395283.84	2052271.08	6	PVC	75.92	6	5.92	18GS15	TYPE II
EW-62	395170.93	2052194.92	6	PVC	78.59	6	7.59	18GS15	TYPE II
EW-63	395053.93	2052035.52	6	PVC	118.59	6	42.59	18GS15	TYPE II
EW-64	394924.13	2051976.49	6	PVC	117.97	6	45.97	25GS20	TYPE III
EW-65	394819.75	2051918.20	6	PVC	112.24	6	36.24	25GS20	TYPE III
EW-66	394823.77	2051780.47	6	PVC	111.87	6	36.87	25GS20	TYPE III
EW-67	394780.51	2051655.80	6	PVC	101.88	6	26.88	35GS20	TYPE IV
EW-68	394728.96	2051563.22	6	PVC	93.79	6	18.79	35GS20	TYPE IV
EW-69	394650.50	2051474.16	6	PVC	86.12	6	16.12	35GS20	TYPE IV

12
M-01

TABLE

WELL DETAIL TABLE

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EXTRACTION WELL DETAILS IV

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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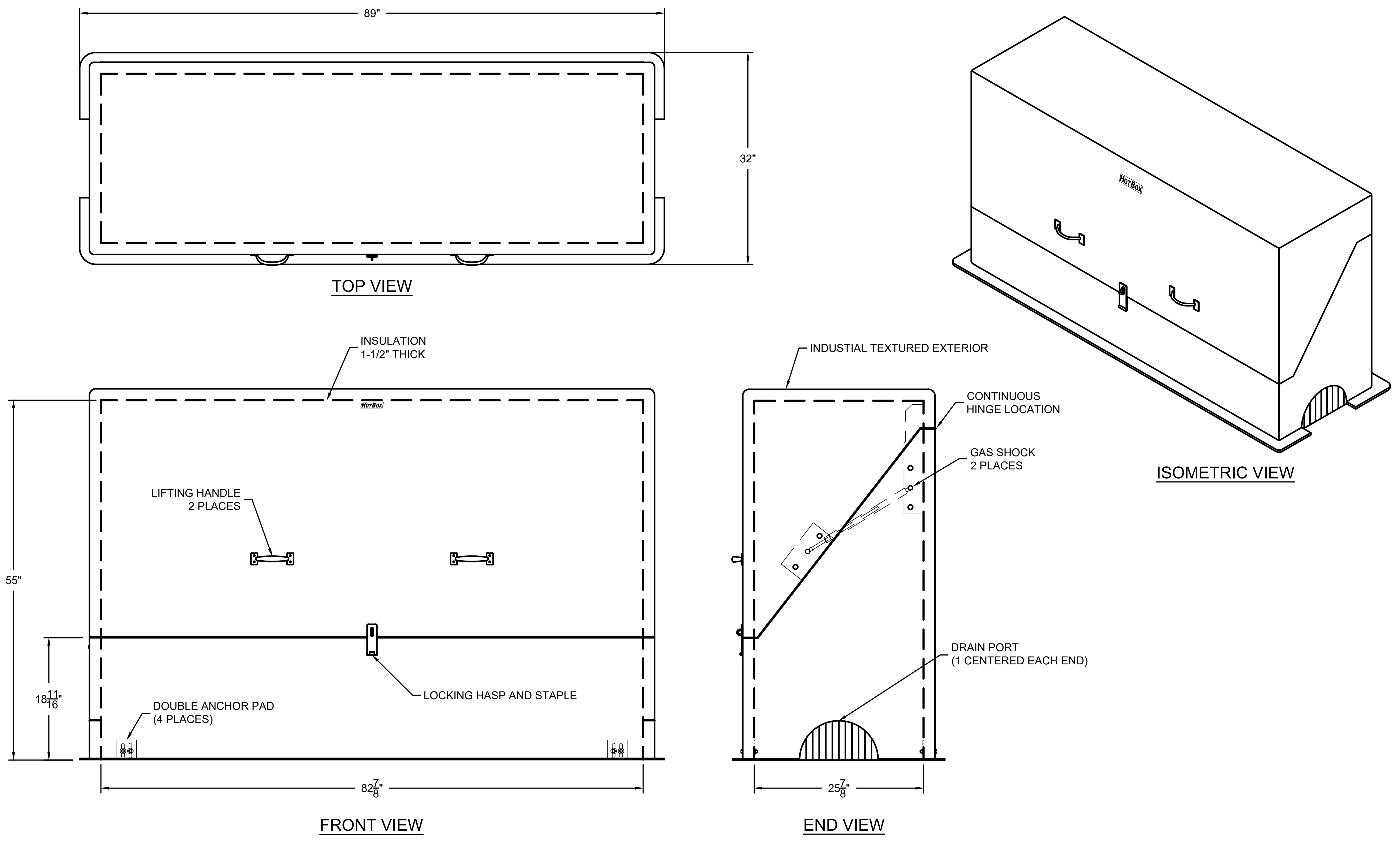
SIGNATURE

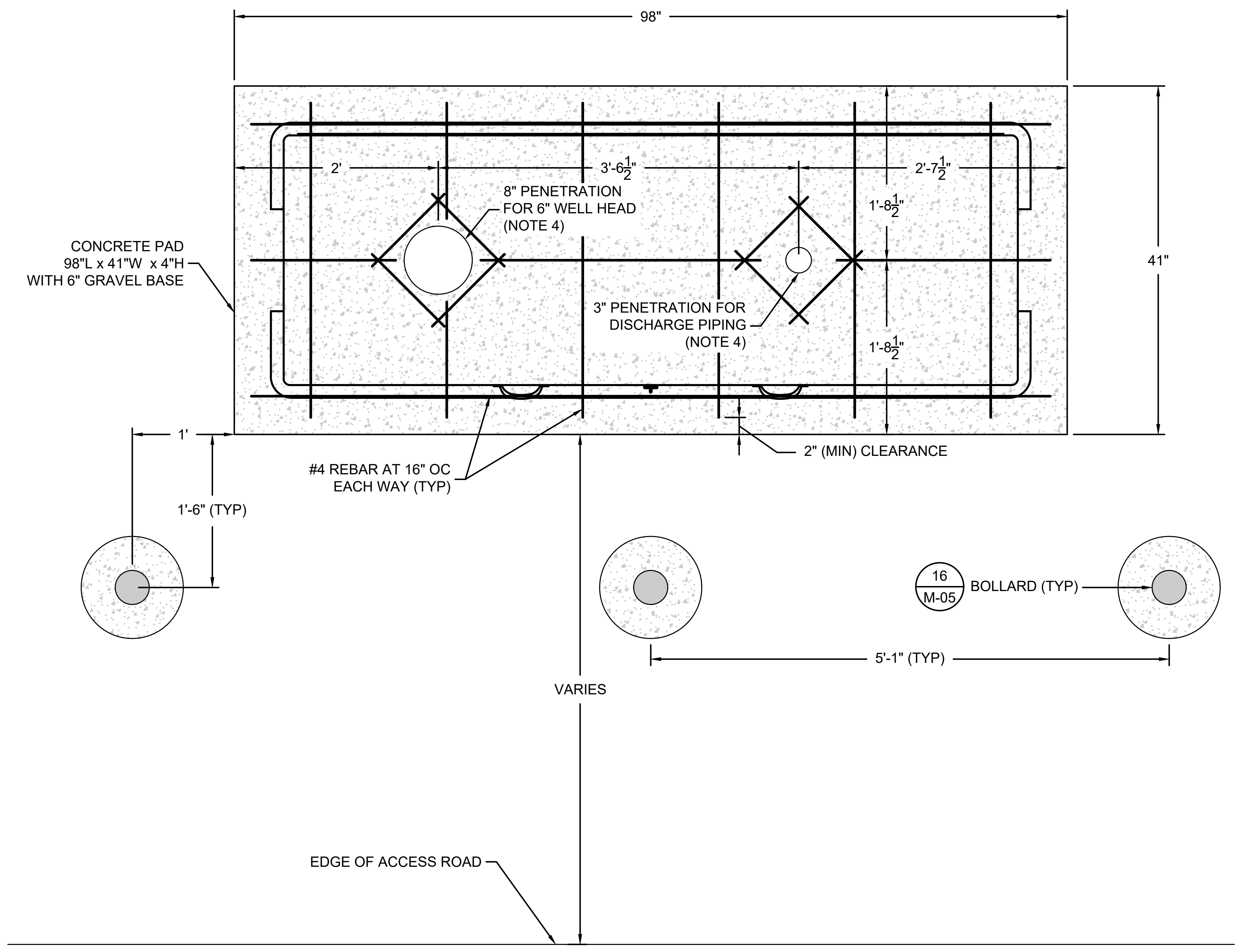
DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M04.DWG
REVIEWED BY:	SV	DRAWING NO.:	M-04
APPROVED BY:	JJD		

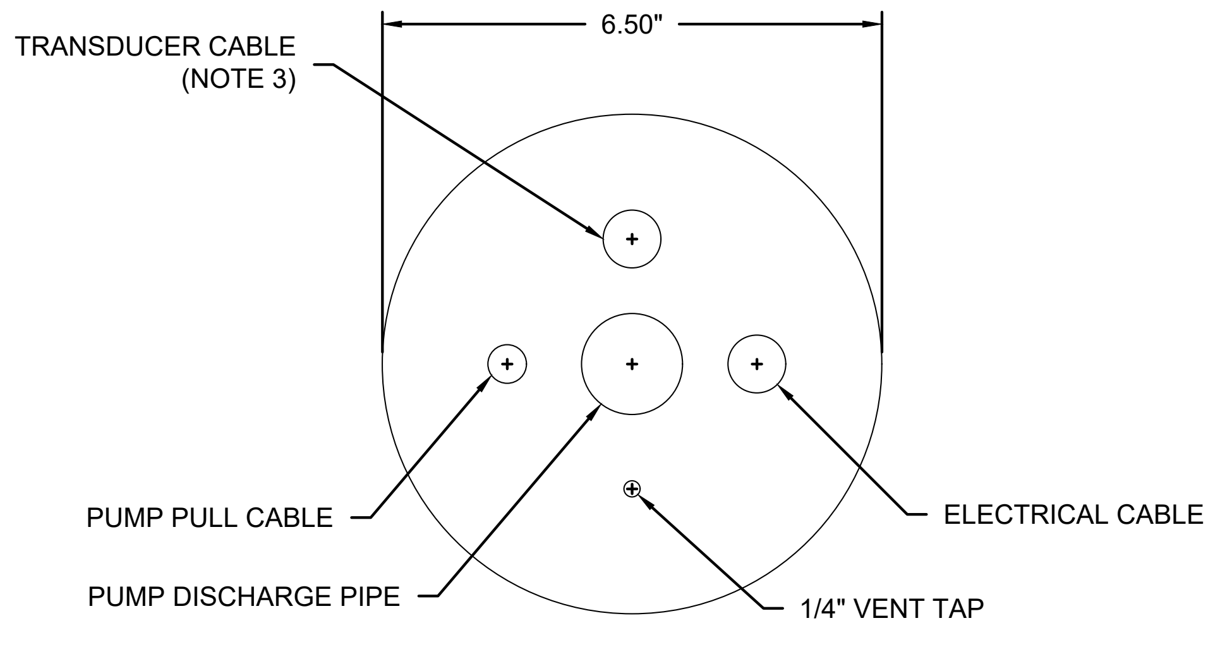
GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-M04



13
M-01
DETAIL
HOT BOX WELL ENCLOSURE
(NOTE 1)
SCALE: 1" = 1'

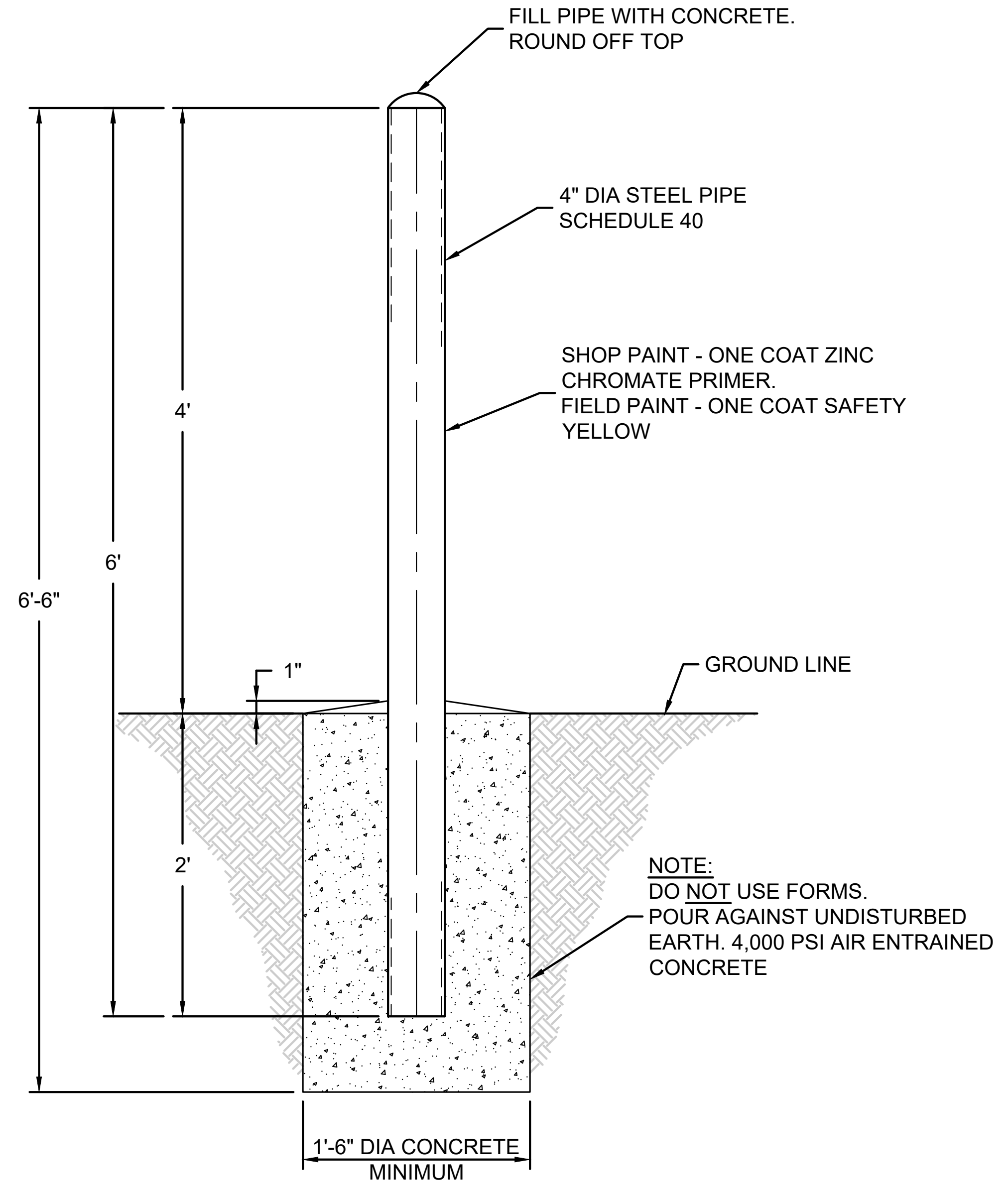


14
M-01
DETAIL
EXTRACTION WELL CONCRETE PAD
(NOTE 5)
SCALE: 1" = 1'



6" CAMPBELL CAST IRON WELL SEAL PART NO. SUB6X1S

15
M-01
DETAIL
WELL SEAL
(NOTE 2)
SCALE: 1" = 1'



16
M-01
DETAIL
BOLLARD
SCALE: 1" = 1'

NOTES:

1. HOT BOX ENCLOSURE MODEL HB3ES. HEAT IS PROVIDED BY (1) 1500 WATT, 240V SINGLE PHASE HEATER (MODEL ACI1500-208/240). FOUR INTERNAL BRACKETS AND CONCRETE ANCHORS ARE SUPPLIED WITH THE ENCLOSURE.
2. WELL SEAL OPENING DIMENSIONS
   - 6-IN WELL SEAL WITH 2 OR 3-IN HOLE IN CENTER
   - TWO 3/4-IN NPT HOLES ON COLLAR
   - ONE 1/4-IN VENT TAP
3. 0.75-INCH HOLE SHALL BE DRILLED IN THE FIELD TO ACCOMMODATE TRANSDUCER DEPLOYMENT.
4. PENETRATIONS SHALL BE SEALED WITH GROUT TO PREVENT WATER INFILTRATION.
5. INDIVIDUAL CONCRETE PAD ORIENTATIONS SHALL BE DETERMINED IN FIELD TO FACILITATE CONNECTION TO LATERAL PIPE.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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Geosyntec consultants
Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295
ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EXTRACTION WELL DETAILS V

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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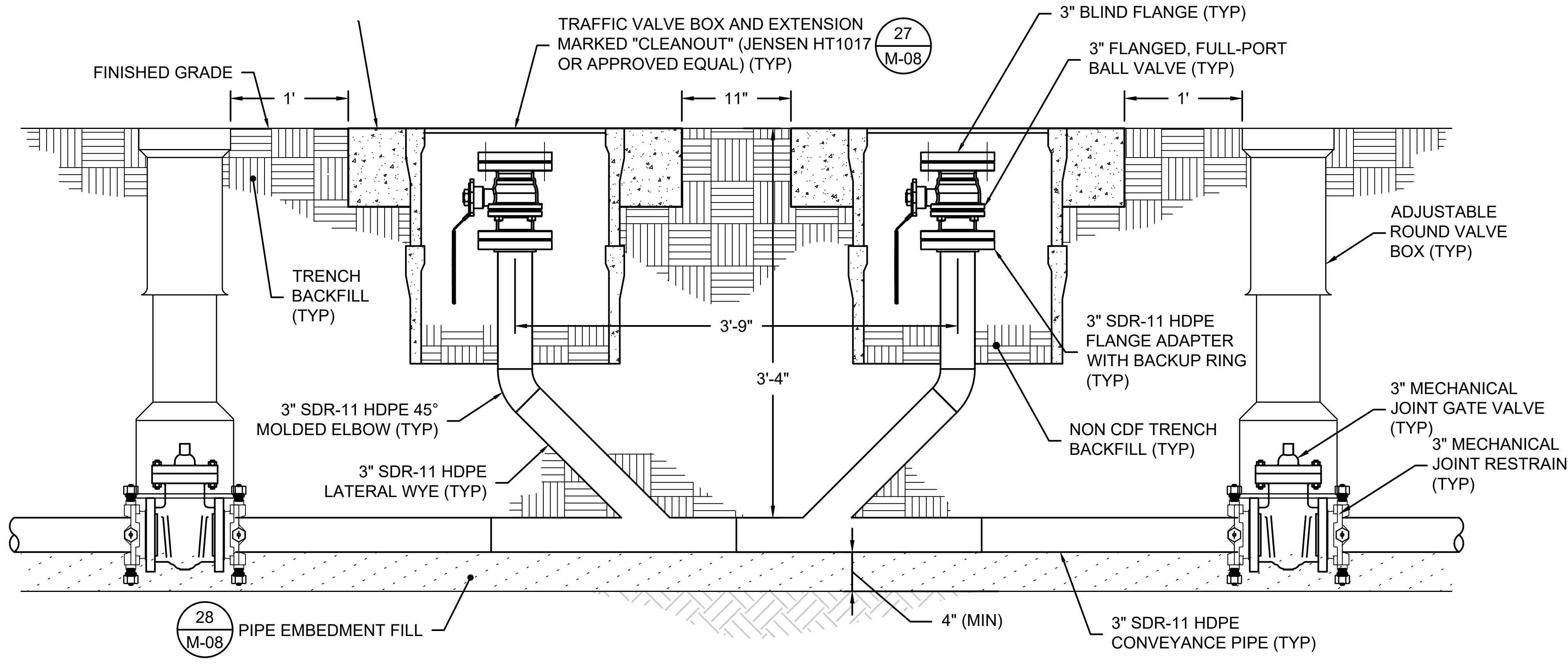
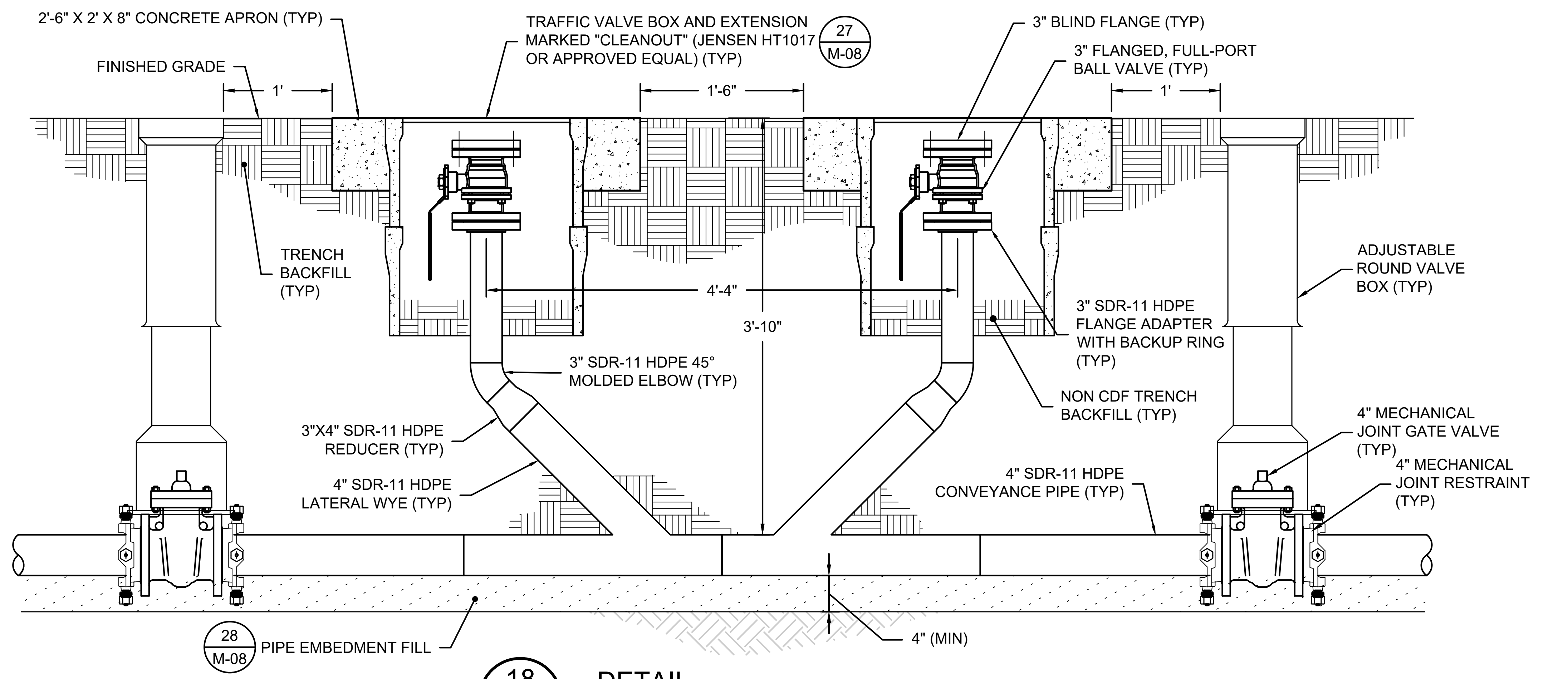
DATE

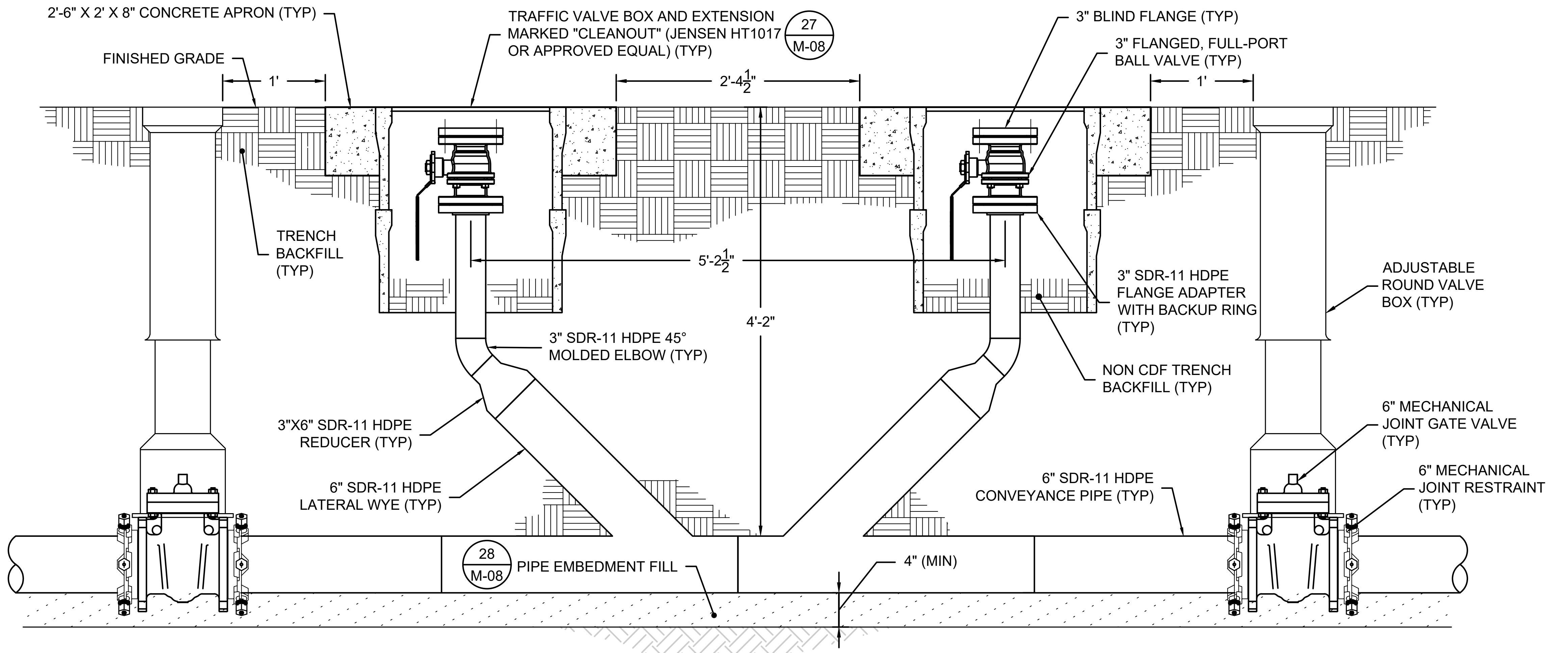
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M05.DWG
REVIEWED BY:	SV	DRAWING NO.:	
APPROVED BY:	JJD		M-05



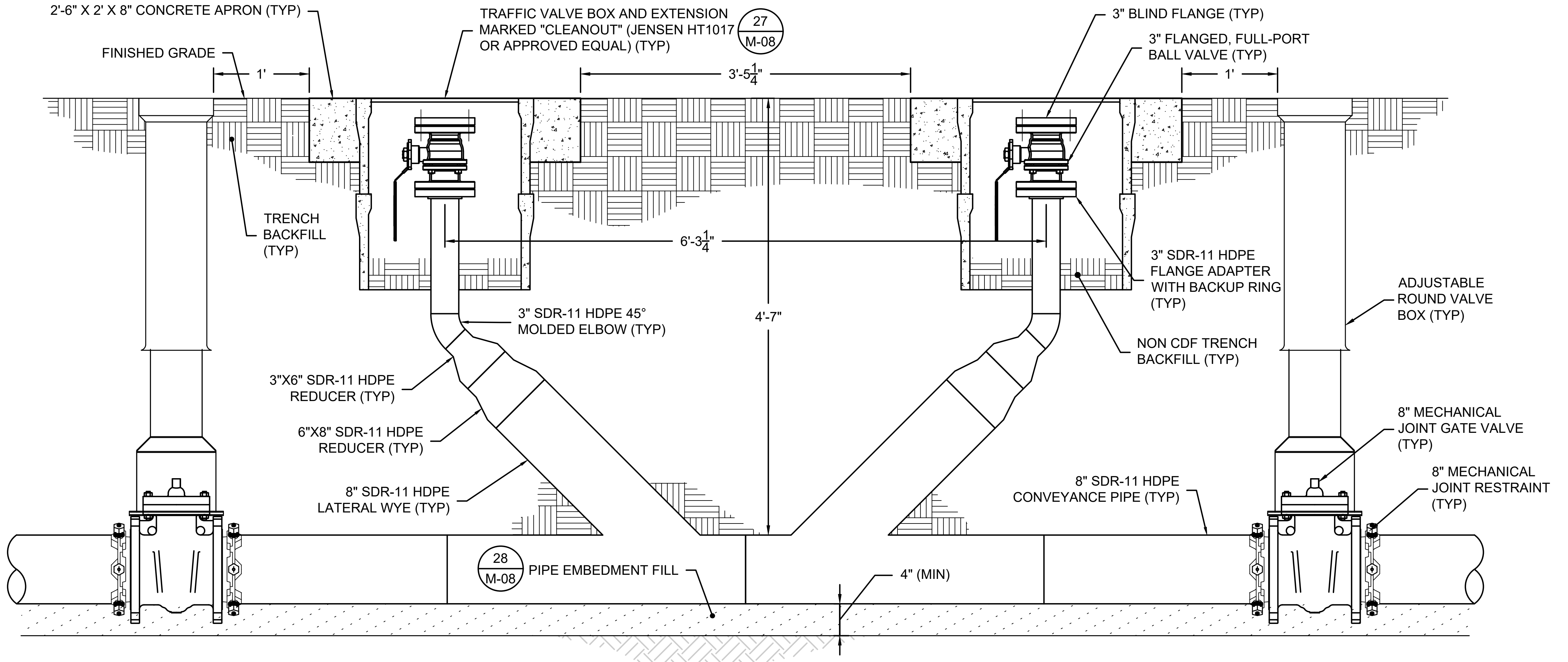
17 C-02 DETAIL
3 INCH FORCEMAIN CLEANOUT
SCALE: 1" = 1'



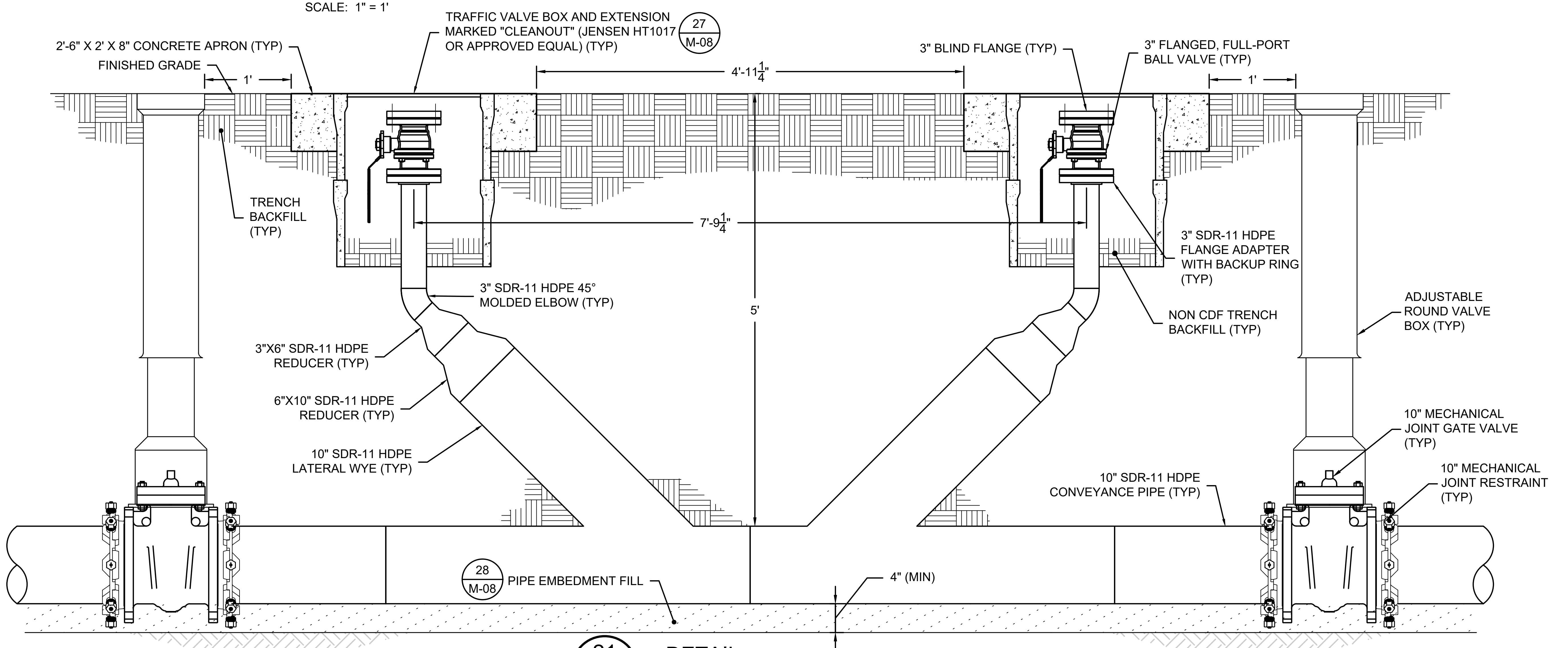
18 C-02 DETAIL
4 INCH FORCEMAIN CLEANOUT
SCALE: 1" = 1'



19 C-03 DETAIL
6 INCH FORCEMAIN CLEANOUT
SCALE: 1" = 1'



20 C-03 DETAIL
8 INCH FORCEMAIN CLEANOUT
SCALE: 1" = 1'



21 C-03 DETAIL
10 INCH FORCEMAIN CLEANOUT
SCALE: 1" = 1'

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
MECHANICAL DETAILS I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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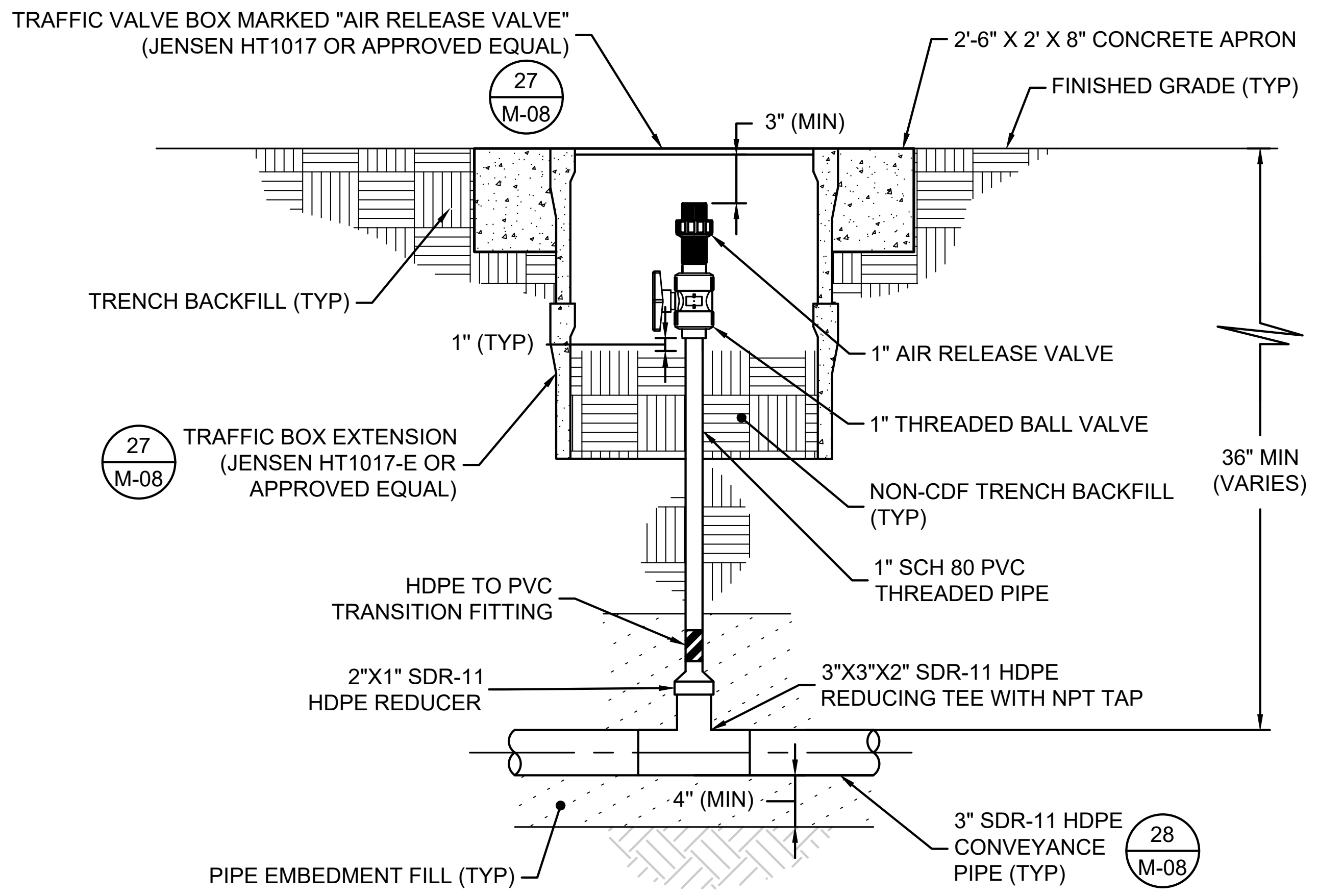
SIGNATURE

DATE

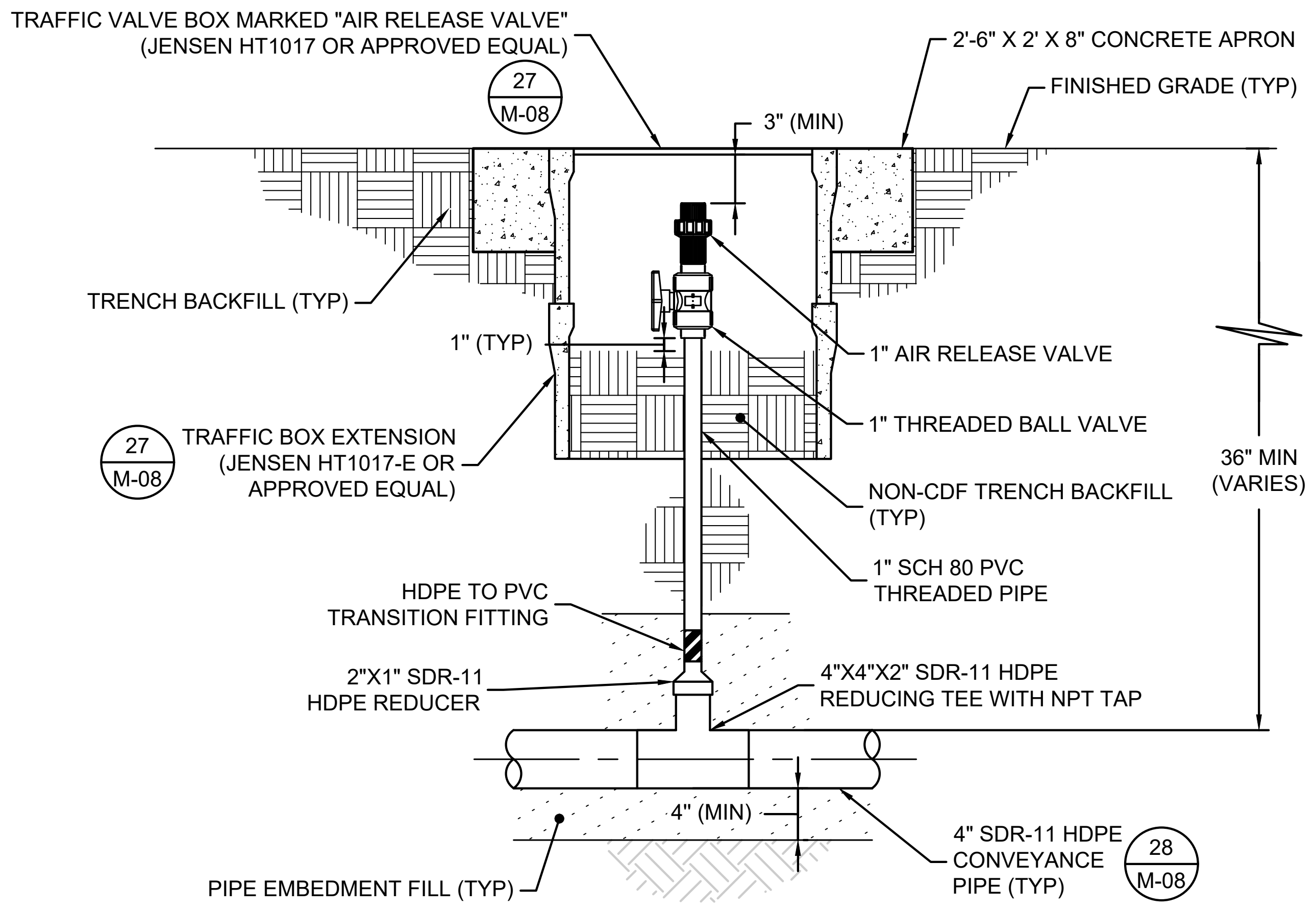
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M06.DWG
REVIEWED BY:	SV	DRAWING NO.:	M-06
APPROVED BY:	JJD		

90% DESIGN DRAWINGS



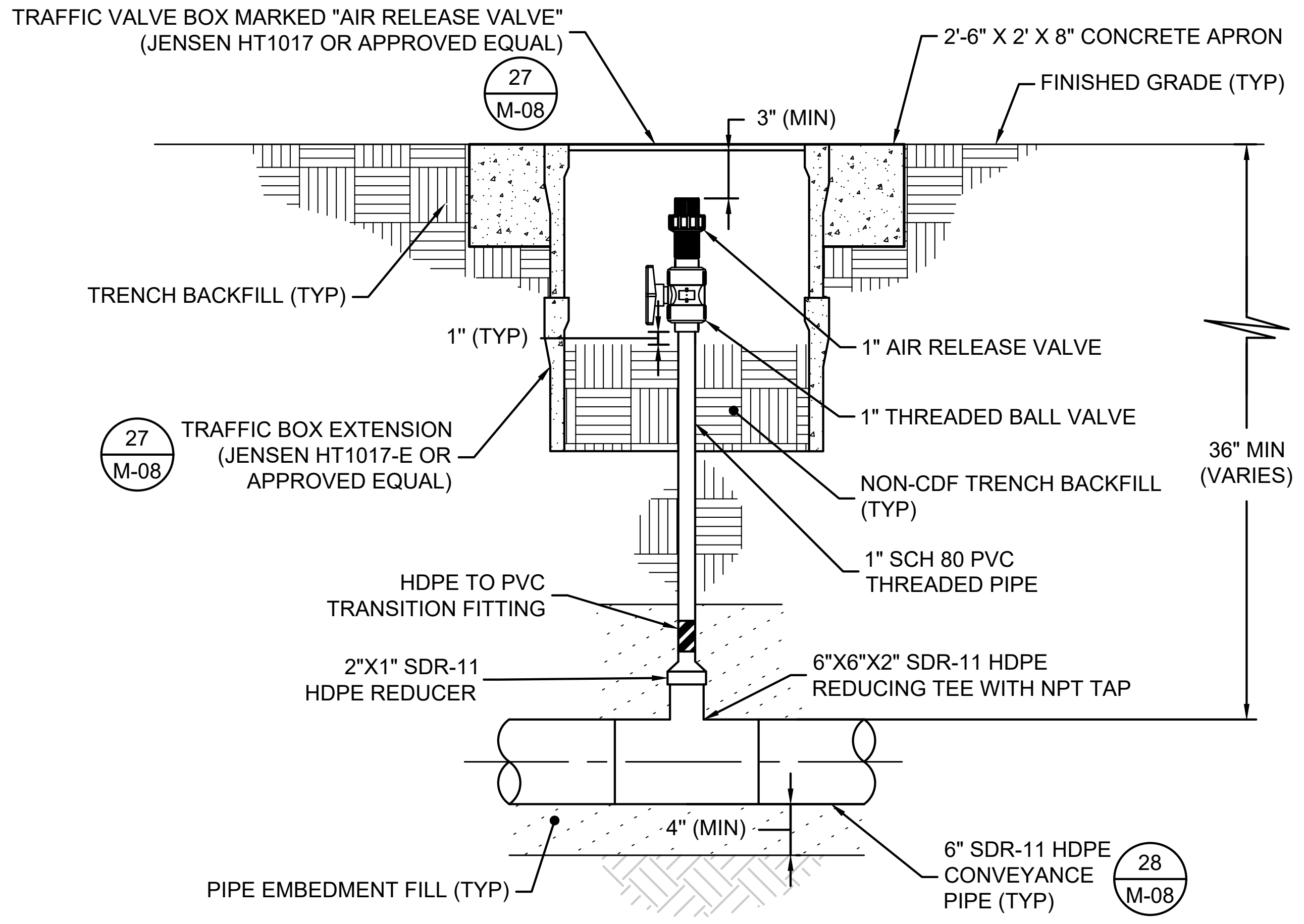
22
C-07

DETAIL
3 INCH FORCEMAIN AIR RELEASE VALVE
SCALE: 1" = 1'



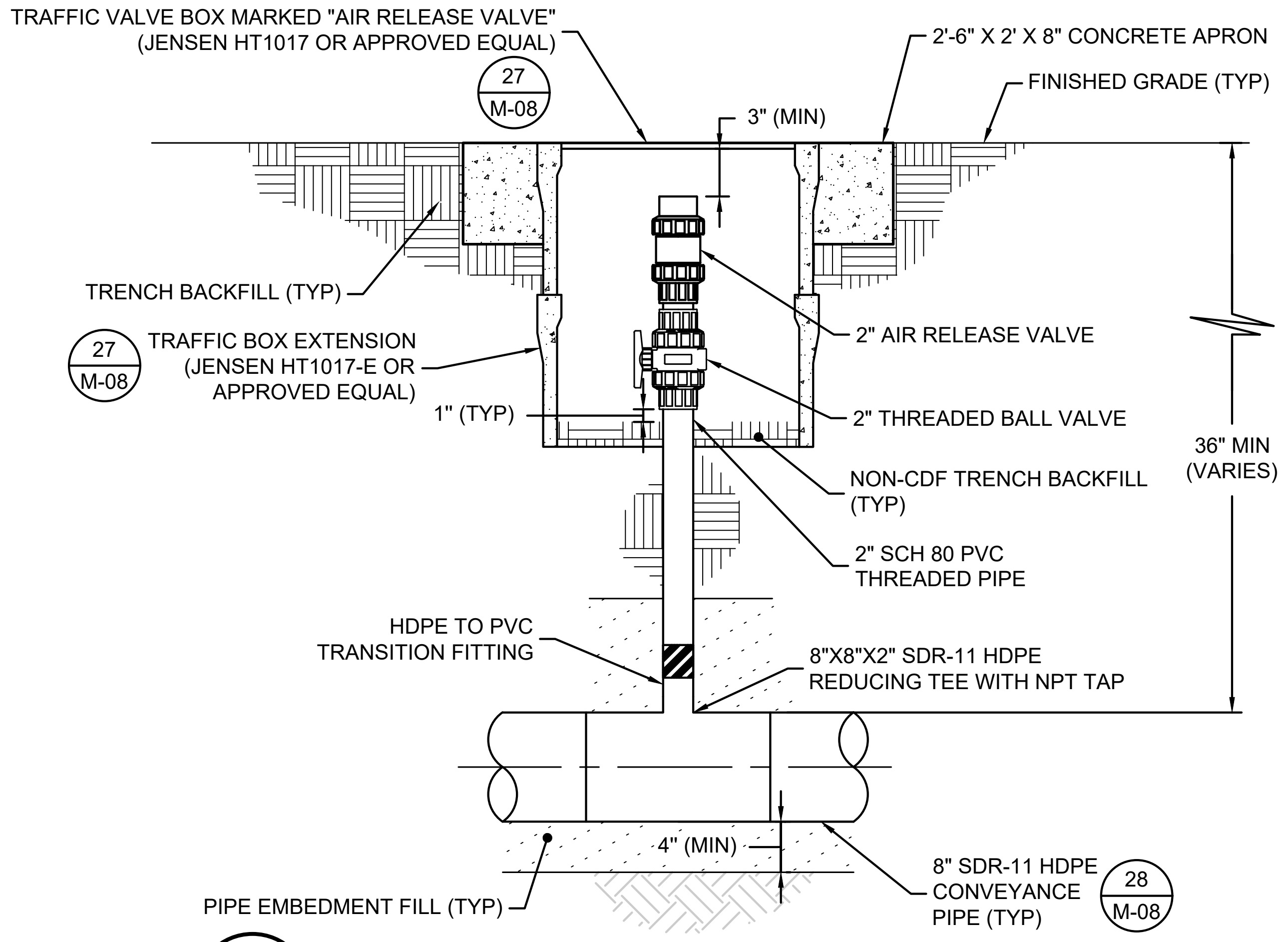
23
C-06

DETAIL
4 INCH FORCEMAIN AIR RELEASE VALVE
SCALE: 1" = 1'



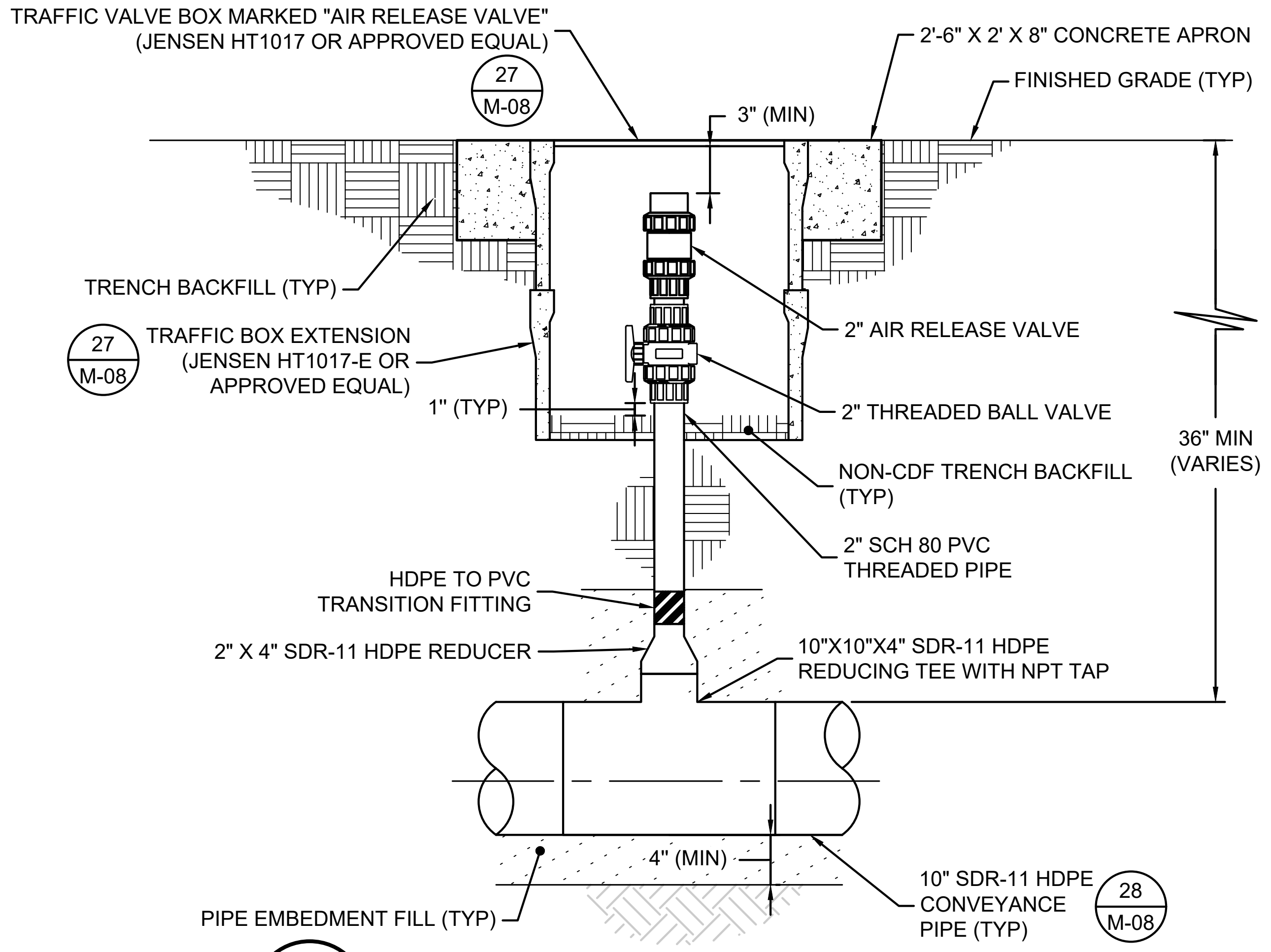
24
C-03

DETAIL
6 INCH FORCEMAIN AIR RELEASE VALVE
SCALE: 1" = 1'



25
C-03

DETAIL
8 INCH FORCEMAIN AIR RELEASE VALVE
SCALE: 1" = 1'



26
C-03

DETAIL
10 INCH FORCEMAIN AIR RELEASE VALVE
SCALE: 1" = 1'

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
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Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
MECHANICAL DETAILS II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M07.DWG
REVIEWED BY:	SV	DRAWING NO.:	M-07
APPROVED BY:	JJD		

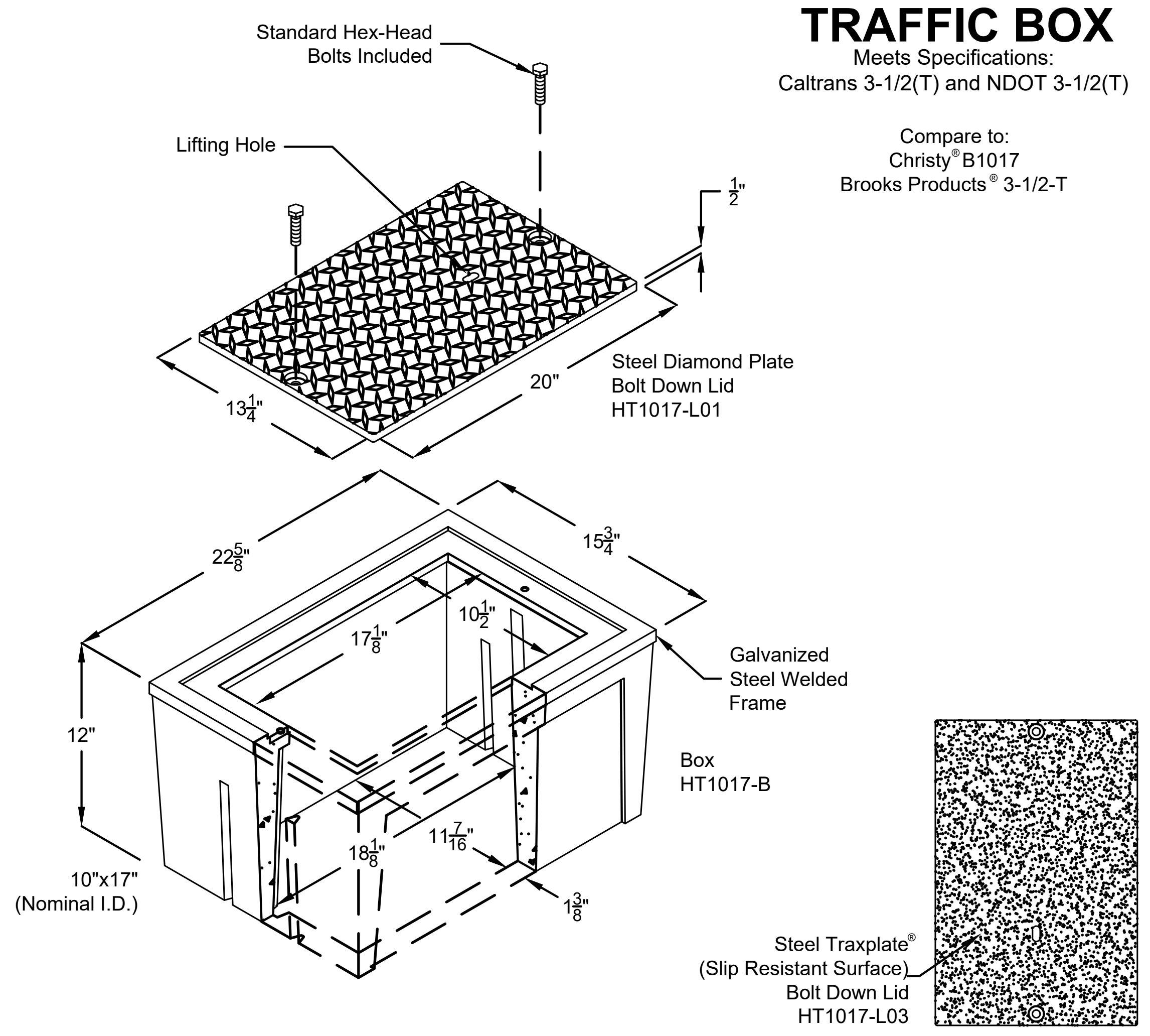
90% DESIGN DRAWINGS

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-M07

HT1017
TRAFFIC BOX

Meets Specifications:
Caltrans 3-1/2(T) and NDOT 3-1/2(T)

Compare to:
Christy® B1017
Brooks Products® 3-1/2-T



PART NO.	PRODUCT	DESCRIPTION	APPROX. WEIGHT	QTY. PER PALLET
HT1017-B	BOX	10"x17"x12" Concrete Traffic Rated Box (Comes Standard With Hex Bolts)	125	20
HT1017-E	EXTENSION	10"x17"x12" Concrete Extension	126	20
HT1017-L01	LID	Steel Diamond Plate Bolt Down Lid	38	
HT1017-L03	LID	Steel Traxplate® Bolt Down Slip Resistant Cover	38	
GALVANIZING AVAILABLE ON ALL STEEL LIDS				

For penta head and other bolt options, see security hardware sheet.

Design load: Traffic rated when installed per Caltrans ES-8B

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Please contact Jensen Precast whenever necessary for confirmation or advice on product design.

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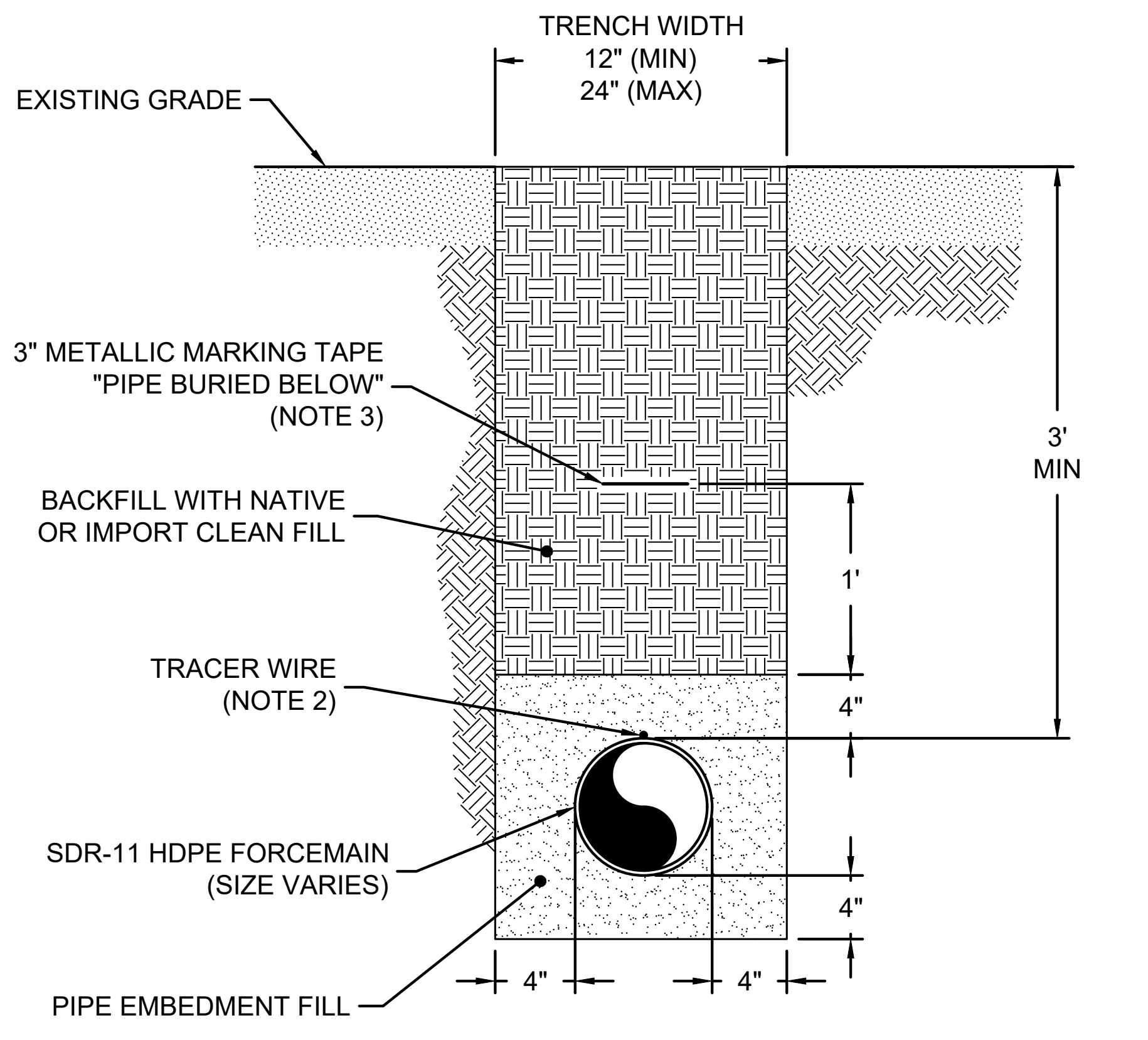
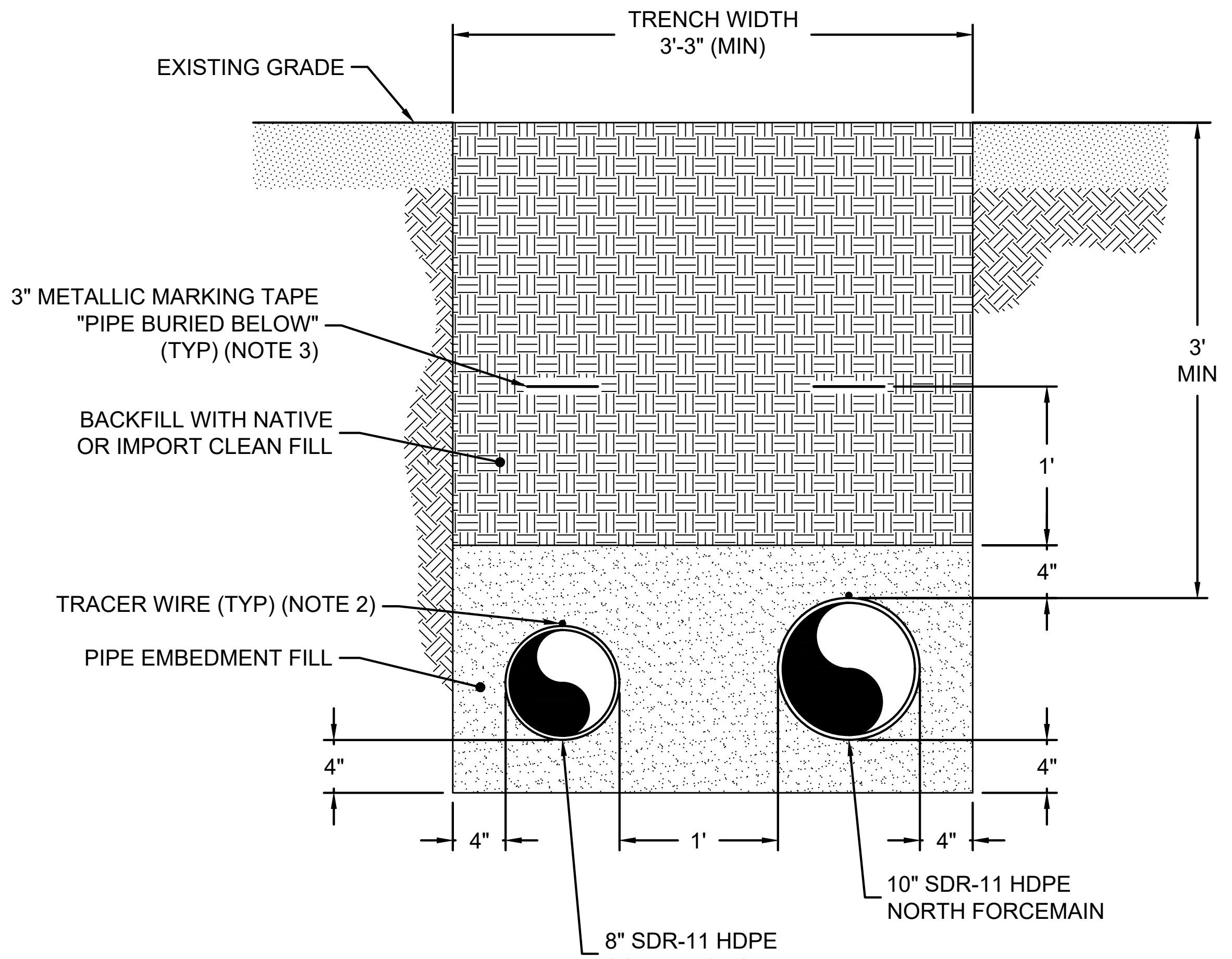
JENSEN PRECAST
JENSENPRECAST.COM

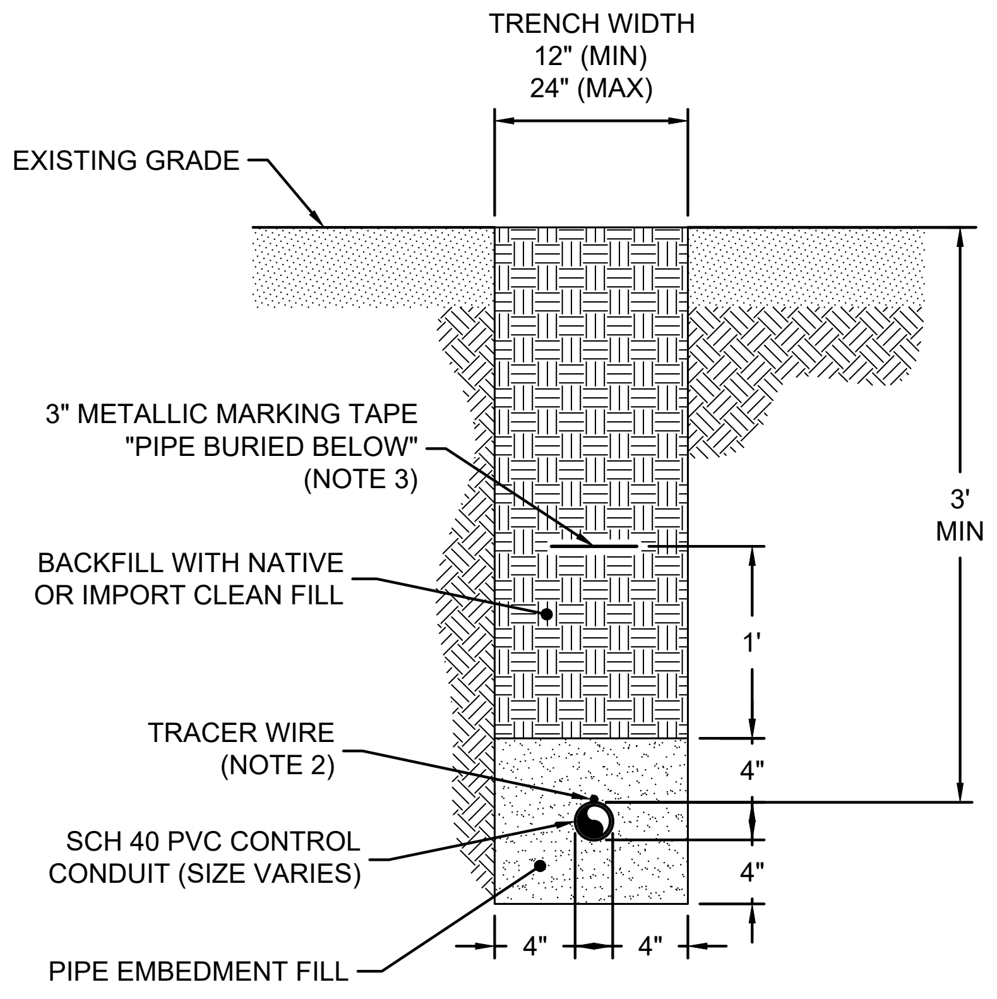
27
M-06
DETAIL
TRAFFIC BOX
SCALE: 1" = 1'



28
C-01
DETAIL
TYPICAL FORCEMAIN AND LATERAL PIPE BEDDING
SCALE: 1" = 1'



29
C-01
DETAIL
TIE-IN FORCEMAIN PIPE BEDDING
SCALE: 1" = 1'



30
C-01
DETAIL
CONTROL CONDUIT PIPE BEDDING
SCALE: 1" = 1'

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
2. TRACER WIRE SHALL BE 10 AWG PRO-TRACE HDD-CCS PE45 OR ENGINEER APPROVED EQUAL.
3. MARKING TAPE SHALL BE PRO-LINE, 5.0 MIL, 3-INCH WIDE DETECTABLE MARKING TAPE OR ENGINEER APPROVED EQUAL.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
MECHANICAL DETAILS III

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

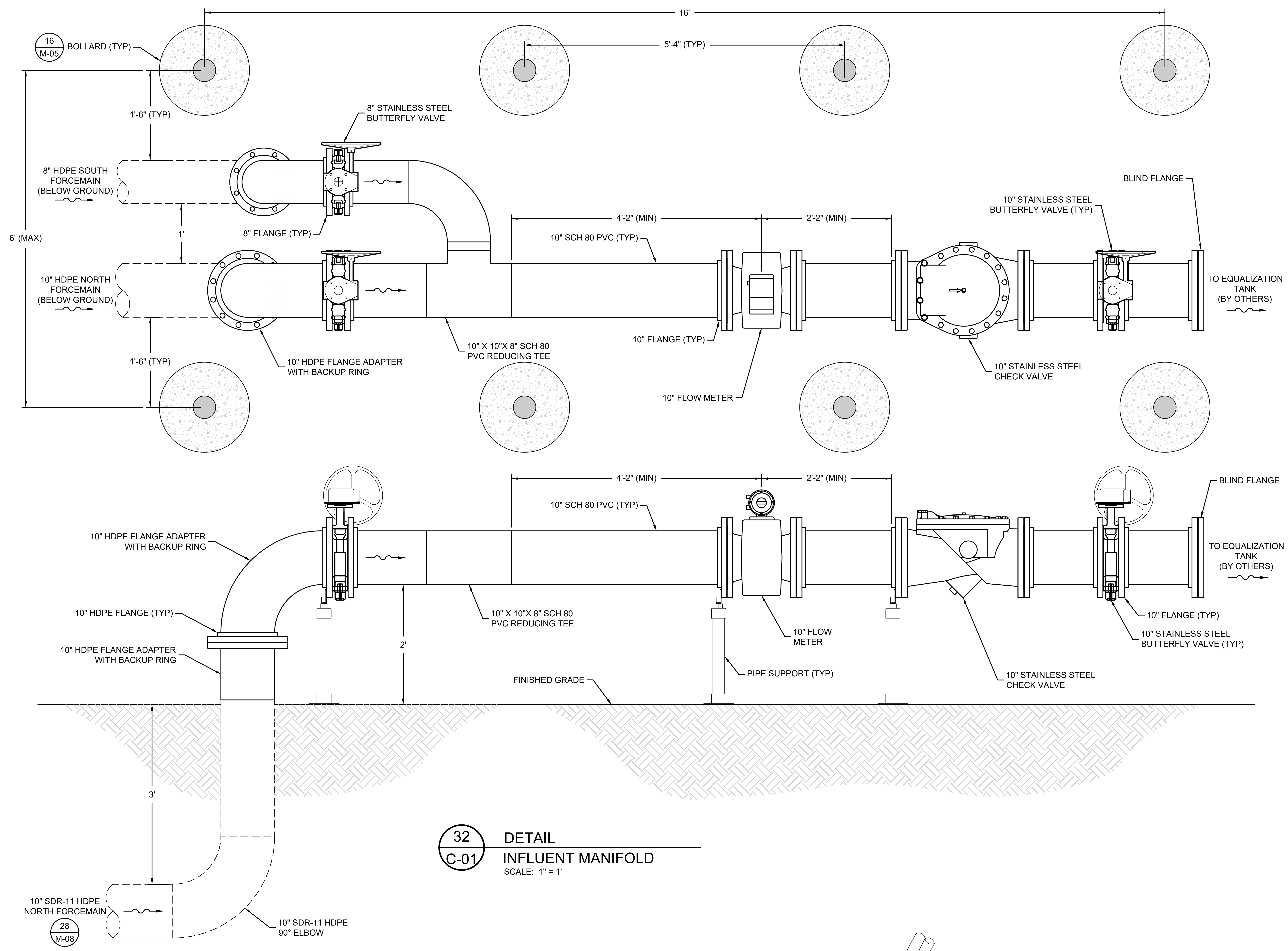
SIGNATURE

DATE

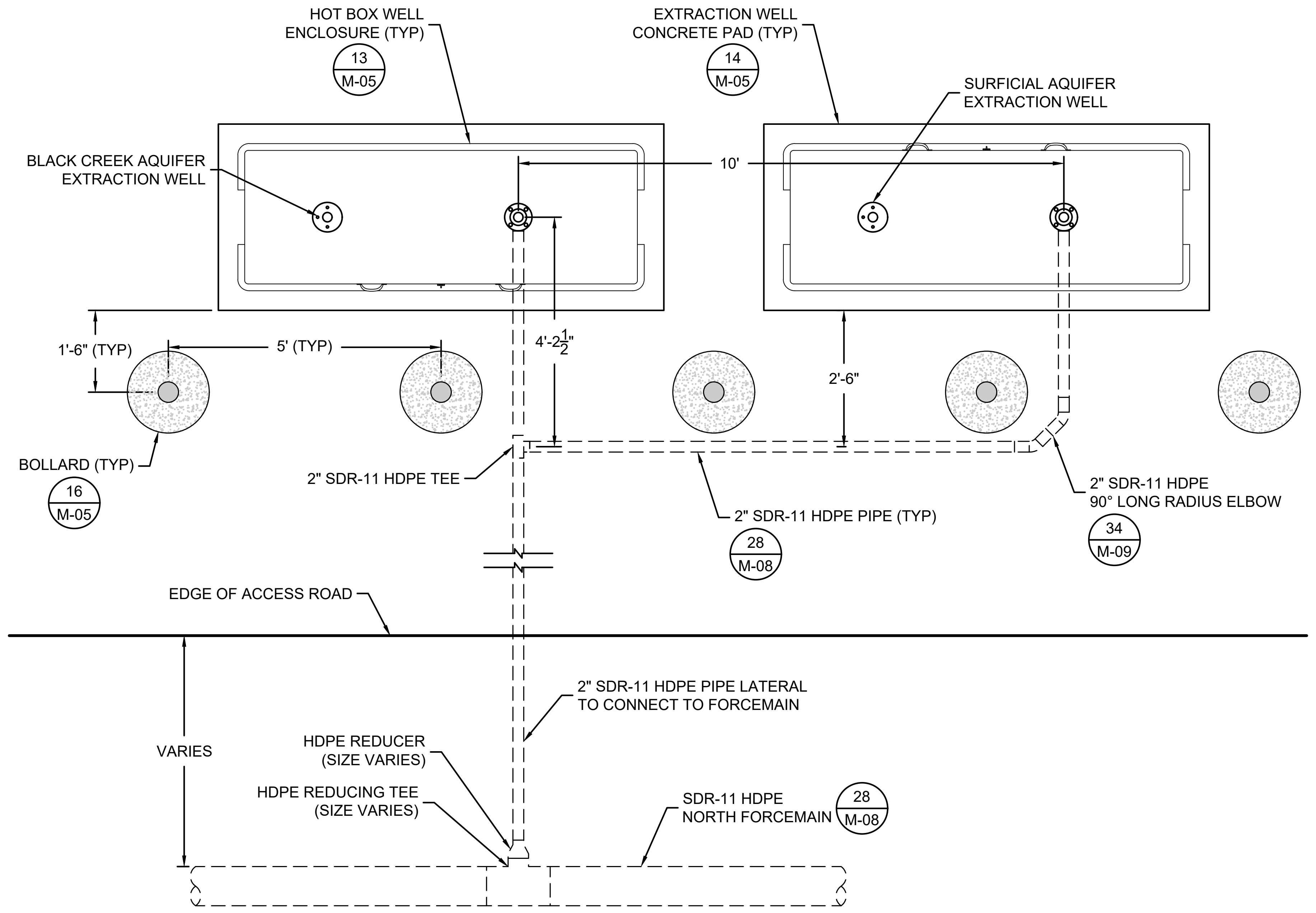
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M08.DWG
REVIEWED BY:	SV	DRAWING NO.:	M-08
APPROVED BY:	JJD		

90% DESIGN DRAWINGS

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-M08



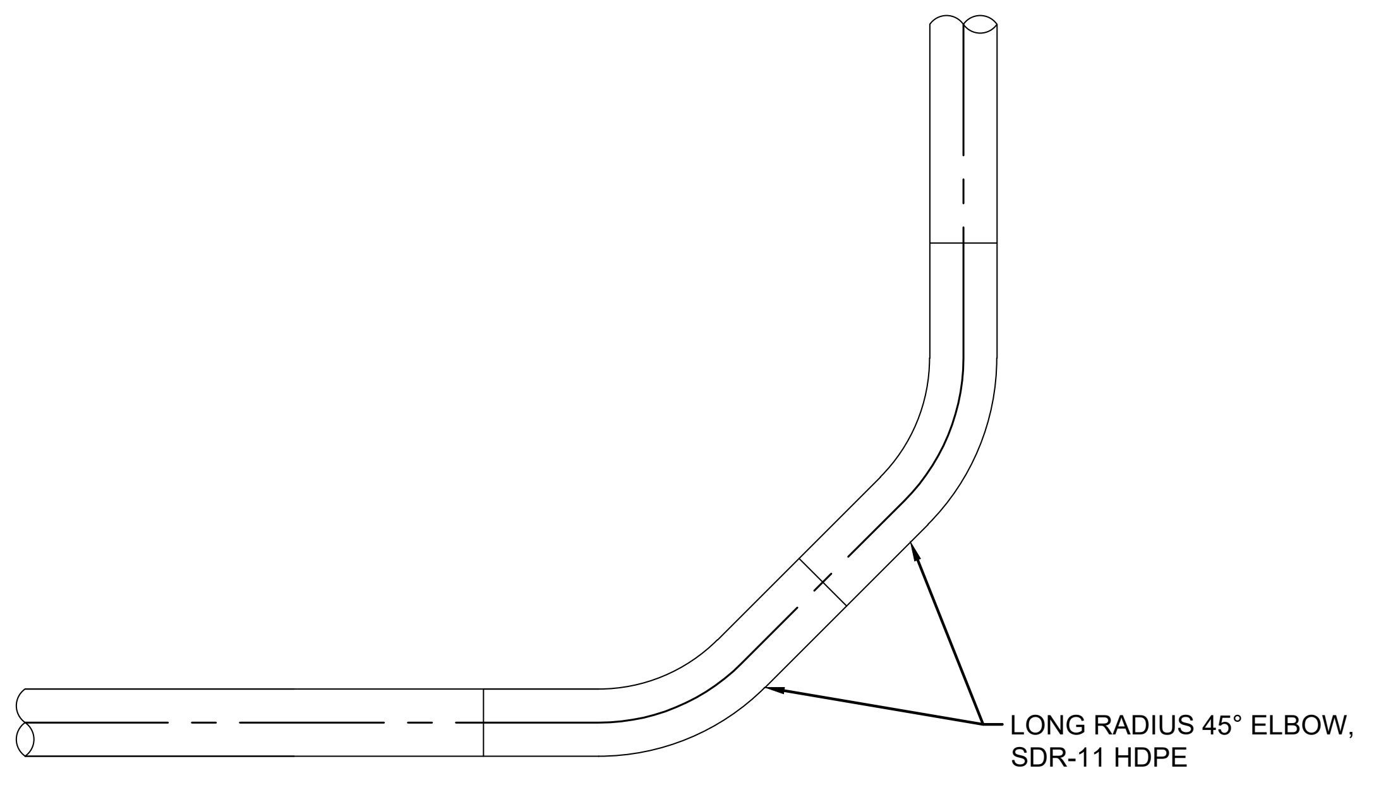
32
C-01
DETAIL
INFLUENT MANIFOLD
SCALE: 1" = 1'



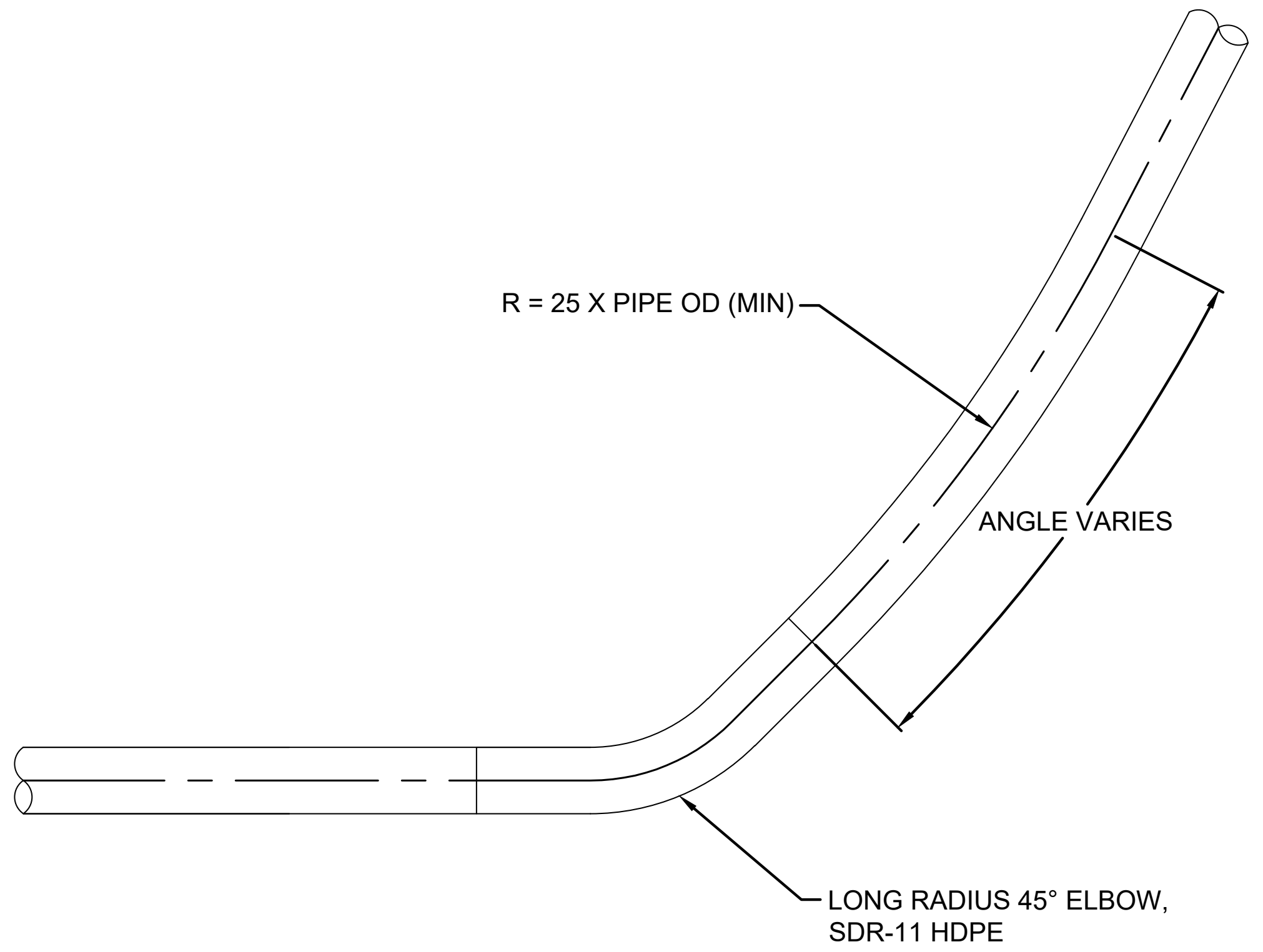
33
C-03
DETAIL
ADJACENT WELL PIPING
(NOTE 2)
SCALE: 1" = 2'

NOTES:

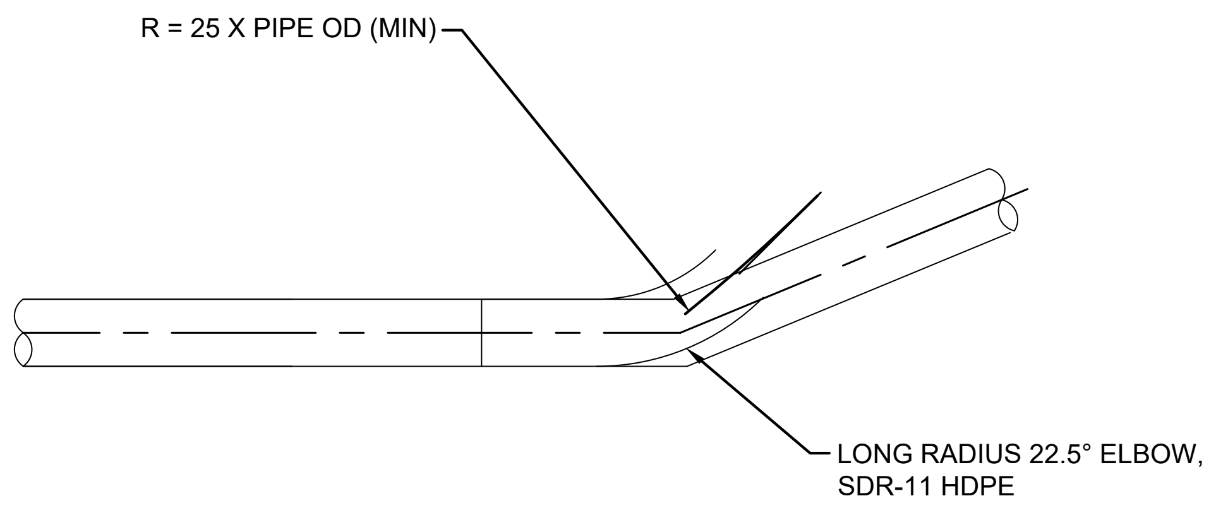
1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
2. INDIVIDUAL CONCRETE PAD ORIENTATIONS SHALL BE DETERMINED IN FIELD TO FACILITATE CONNECTION TO LATERAL PIPE.



34
C-03
DETAIL
90º LONG RADIUS ELBOW
SCALE: 1" = 1'



35
C-02
DETAIL
45º LONG RADIUS ELBOW AND PIPE BEND
SCALE: 1" = 1'



36
C-05
DETAIL
22.5º LONG RADIUS ELBOW
SCALE: 1" = 1'

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants
Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
MECHANICAL DETAILS IV

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-M09.DWG
REVIEWED BY:	SV	DRAWING NO.:	M-09
APPROVED BY:	JJD		

90% DESIGN DRAWINGS

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-M09

NOTES:

1. GRID COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.

2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.

3. APPROXIMATE EXTENT OF IMPACTED WETLANDS DELINEATED BY PARSONS (AUGUST 2020 WOTUS REPORT, CHEMOURS FAYETTEVILLE WORKS, FLOW THROUGH CELLS, SEEP C PILOT STUDY). APPROXIMATE EXTENT OF UNIMPACTED WETLANDS IN UPLAND LOCATIONS DELINEATED BY GEOSYNTEC, SEPTEMBER 2020 (WOTUS REPORT PENDING FOR SEEPS A, B, AND D PERMIT MODIFICATION).

4. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

5. MECHANICAL DETAILS NOT SHOWN FOR CLARITY.

6. THE ALIGNMENT FOR THE 13.2 kV LINE IS APPROXIMATE BASED ON REQUIRED OFFSETS FROM THE FORCEMAIN AND THE EXTRACTION WELLS. THE INSTALLED 13.2 kV LINE SHALL BE INSTALLED WITHIN A CORRIDOR THAT EXTENDS +/- 10 FT ALONG THE DEPICTED ALIGNMENT. THE INSTALLATION CONTRACTOR SHALL BE RESPONSIBLE FOR THE FINAL 13.2 kV ALIGNMENT SO THAT THE 13.2 kV LINE CAN BE CONNECTED TO THE 17 TRANSFORMERS AS SHOWN ON SHEETS E-02 THROUGH E-07.

LEGEND

355	EXISTING GROUND MAJOR CONTOUR (5')	⌖	EXISTING INJECTION WELL
	EXISTING GROUND MINOR CONTOUR (1')	○	EXISTING EXTRACTION WELL
— — —	PROPERTY BOUNDARY	◩	SURFICIAL AND BLACK CREEK AQUIFER EXTRACTION WELL
━━━	BARRIER WALL ALIGNMENT	⧗	BLACK CREEK AQUIFER EXTRACTION WELL
═ ═ ═	EXISTING GRAVEL ROAD	▲	SURFICIAL AQUIFER EXTRACTION WELL
═══	EXISTING PAVED ROAD	▣	FORCEMAIN CLEANOUT
—FM—	GROUND WATER CONVEYANCE FORCEMAIN	⊛	AIR RELEASE VALVE
— · —	STREAM	▮	CONTROL PANEL
o━━━o	RELOCATED OUTFALL 002	◆	FUTURE CONTROL PANEL (IF NEEDED)
▨	WETLANDS	▭	WELL TERMINATION

REV	DATE	DESCRIPTION	DRN	APP
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
OVERALL ELECTRICAL SITE PLAN

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

DATE

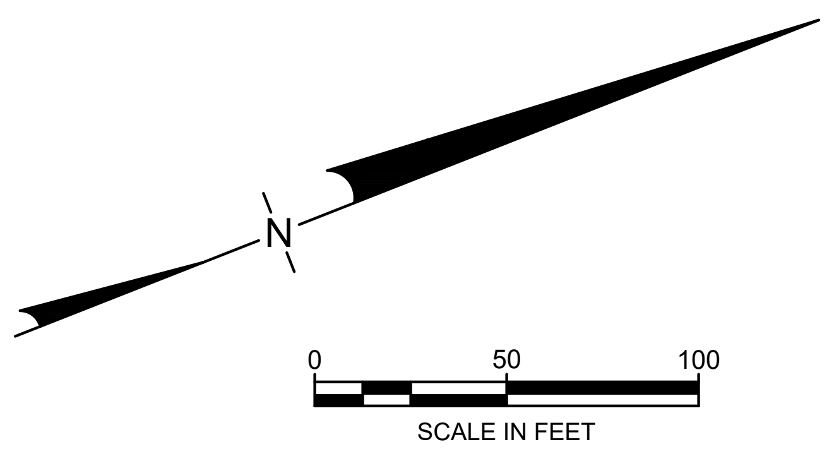
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E01.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-01
APPROVED BY:	JJD		

90% DESIGN DRAWINGS

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\CHEMOURS\TR0795A - CHEMOURS\CAD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-E01

NOTES:

1. GRID COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.
2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.
3. APPROXIMATE EXTENT OF IMPACTED WETLANDS DELINEATED BY PARSONS (AUGUST 2020 WOTUS REPORT, CHEMOURS FAYETTEVILLE WORKS, FLOW THROUGH CELLS, SEEP C PILOT STUDY). APPROXIMATE EXTENT OF UNIMPACTED WETLANDS IN UPLAND LOCATIONS DELINEATED BY GEOSYNTEC, SEPTEMBER 2020 (WOTUS REPORT PENDING FOR SEEPS A, B, AND D PERMIT MODIFICATION).
4. FORCEMAIN ALIGNMENT AND LOCATION OF FORCEMAIN CLEANOUTS, AIR RELEASE VALVES, AND REDUCERS IS PRELIMINARY AND ARE SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
5. CONTRACTOR SHALL VERIFY HIGH POINTS ALONG VERTICAL ALIGNMENT PRIOR TO FINALIZING AIR RELEASE VALVE LOCATIONS.
6. CONTRACTOR SHALL FIELD-VERIFY BENDS ALONG FORCEMAIN.
7. THE ALIGNMENT FOR THE 13.2 kV LINE IS APPROXIMATE BASED ON REQUIRED OFFSETS FROM THE FORCEMAIN AND THE EXTRACTION WELLS. THE INSTALLED 13.2 kV LINE SHALL BE INSTALLED WITHIN A CORRIDOR THAT EXTENDS +/- 10 FT ALONG THE DEPICTED ALIGNMENT. THE INSTALLATION CONTRACTOR SHALL BE RESPONSIBLE FOR THE FINAL 13.2 kV ALIGNMENT SO THAT THE 13.2 kV LINE CAN BE CONNECTED TO THE 17 TRANSFORMERS AS SHOWN ON SHEETS E-02 THROUGH E-07.



90% DESIGN DRAWINGS

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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:

ELECTRICAL SITE PLAN I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E02.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-02
APPROVED BY:	JJD		

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-E02

NOTES:

1. GRID COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.

2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.

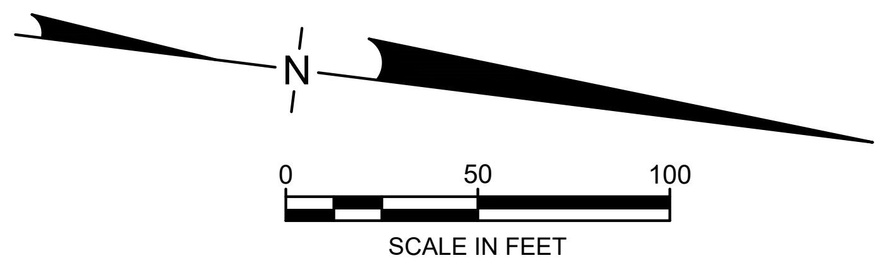
3. APPROXIMATE EXTENT OF IMPACTED WETLANDS DELINEATED BY PARSONS (AUGUST 2020 WOTUS REPORT, CHEMOURS FAYETTEVILLE WORKS, FLOW THROUGH CELLS, SEEP C PILOT STUDY). APPROXIMATE EXTENT OF UNIMPACTED WETLANDS IN UPLAND LOCATIONS DELINEATED BY GEOSYNTEC, SEPTEMBER 2020 (WOTUS REPORT PENDING FOR SEEPS A, B, AND D PERMIT MODIFICATION).

4. FORCEMAIN ALIGNMENT AND LOCATION OF FORCEMAIN CLEANOUTS, AIR RELEASE VALVES, AND REDUCERS IS PRELIMINARY AND ARE SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

5. CONTRACTOR SHALL VERIFY HIGH POINTS ALONG VERTICAL ALIGNMENT PRIOR TO FINALIZING AIR RELEASE VALVE LOCATIONS.

6. CONTRACTOR SHALL FIELD-VERIFY BENDS ALONG FORCEMAIN.

7. THE ALIGNMENT FOR THE 13.2 kV LINE IS APPROXIMATE BASED ON REQUIRED OFFSETS FROM THE FORCEMAIN AND THE EXTRACTION WELLS. THE INSTALLED 13.2 kV LINE SHALL BE INSTALLED WITHIN A CORRIDOR THAT EXTENDS +/- 10 FT ALONG THE DEPICTED ALIGNMENT. THE INSTALLATION CONTRACTOR SHALL BE RESPONSIBLE FOR THE FINAL 13.2 kV ALIGNMENT SO THAT THE 13.2 kV LINE CAN BE CONNECTED TO THE 17 TRANSFORMERS AS SHOWN ON SHEETS E-02 THROUGH E-07.



90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
ELECTRICAL SITE PLAN II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

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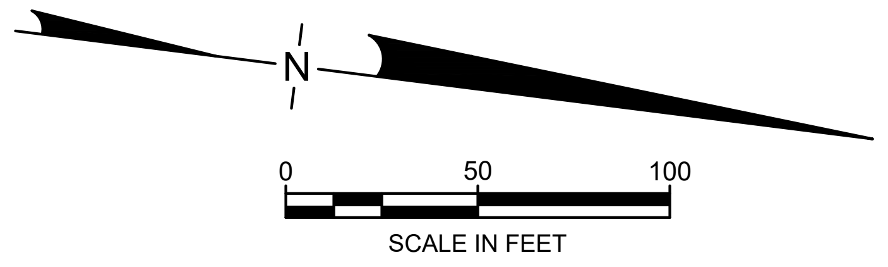
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E03.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-03
APPROVED BY:	JJD		

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-E03

NOTES:

1. GRID COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.
2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.
3. APPROXIMATE EXTENT OF IMPACTED WETLANDS DELINEATED BY PARSONS (AUGUST 2020 WOTUS REPORT, CHEMOURS FAYETTEVILLE WORKS, FLOW THROUGH CELLS, SEEP C PILOT STUDY). APPROXIMATE EXTENT OF UNIMPACTED WETLANDS IN UPLAND LOCATIONS DELINEATED BY GEOSYNTEC, SEPTEMBER 2020 (WOTUS REPORT PENDING FOR SEEPS A, B, AND D PERMIT MODIFICATION).
4. FORCEMAIN ALIGNMENT AND LOCATION OF FORCEMAIN CLEANOUTS, AIR RELEASE VALVES, AND REDUCERS IS PRELIMINARY AND ARE SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
5. CONTRACTOR SHALL VERIFY HIGH POINTS ALONG VERTICAL ALIGNMENT PRIOR TO FINALIZING AIR RELEASE VALVE LOCATIONS.
6. CONTRACTOR SHALL FIELD-VERIFY BENDS ALONG FORCEMAIN.
7. THE ALIGNMENT FOR THE 13.2 kV LINE IS APPROXIMATE BASED ON REQUIRED OFFSETS FROM THE FORCEMAIN AND THE EXTRACTION WELLS. THE INSTALLED 13.2 kV LINE SHALL BE INSTALLED WITHIN A CORRIDOR THAT EXTENDS +/- 10 FT ALONG THE DEPICTED ALIGNMENT. THE INSTALLATION CONTRACTOR SHALL BE RESPONSIBLE FOR THE FINAL 13.2 kV ALIGNMENT SO THAT THE 13.2 kV LINE CAN BE CONNECTED TO THE 17 TRANSFORMERS AS SHOWN ON SHEETS E-02 THROUGH E-07.



90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
ELECTRICAL SITE PLAN III

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E04.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-04
APPROVED BY:	JJD		

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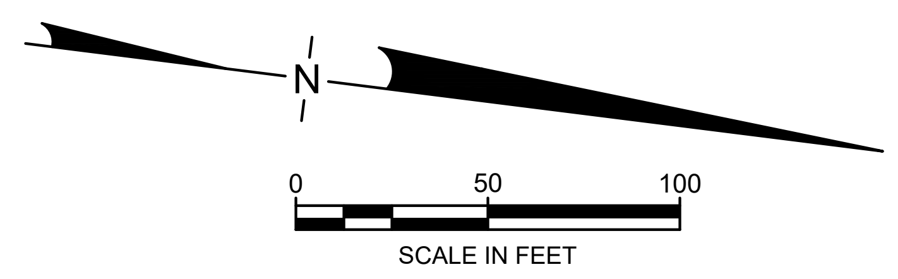

NOTES:

1. GRID COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.
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3. APPROXIMATE EXTENT OF IMPACTED WETLANDS DELINEATED BY PARSONS (AUGUST 2020 WOTUS REPORT, CHEMOURS FAYETTEVILLE WORKS, FLOW THROUGH CELLS, SEEP C PILOT STUDY). APPROXIMATE EXTENT OF UNIMPACTED WETLANDS IN UPLAND LOCATIONS DELINEATED BY GEOSYNTEC, SEPTEMBER 2020 (WOTUS REPORT PENDING FOR SEEPS A, B, AND D PERMIT MODIFICATION).
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5. CONTRACTOR SHALL VERIFY HIGH POINTS ALONG VERTICAL ALIGNMENT PRIOR TO FINALIZING AIR RELEASE VALVE LOCATIONS.
6. CONTRACTOR SHALL FIELD-VERIFY BENDS ALONG FORCEMAIN.
7. CONTRACTOR SHALL INSTALL THE FORCEMAIN PIPE CROSSING FROM STA 30+71 TO STA 31+65 VIA HORIZONTAL DIRECTIONAL DRILLING.
8. THE ALIGNMENT FOR THE 13.2 kV LINE IS APPROXIMATE BASED ON REQUIRED OFFSETS FROM THE FORCEMAIN AND THE EXTRACTION WELLS. THE INSTALLED 13.2 kV LINE SHALL BE INSTALLED WITHIN A CORRIDOR THAT EXTENDS +/- 10 FT ALONG THE DEPICTED ALIGNMENT. THE INSTALLATION CONTRACTOR SHALL BE RESPONSIBLE FOR THE FINAL 13.2 kV ALIGNMENT SO THAT THE 13.2 kV LINE CAN BE CONNECTED TO THE 17 TRANSFORMERS AS SHOWN ON SHEETS E-02 THROUGH E-07.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:

ELECTRICAL SITE PLAN IV

PROJECT:

THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:

FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E05.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-05
APPROVED BY:	JJD		

NOTES:

1. GRID COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.
2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.
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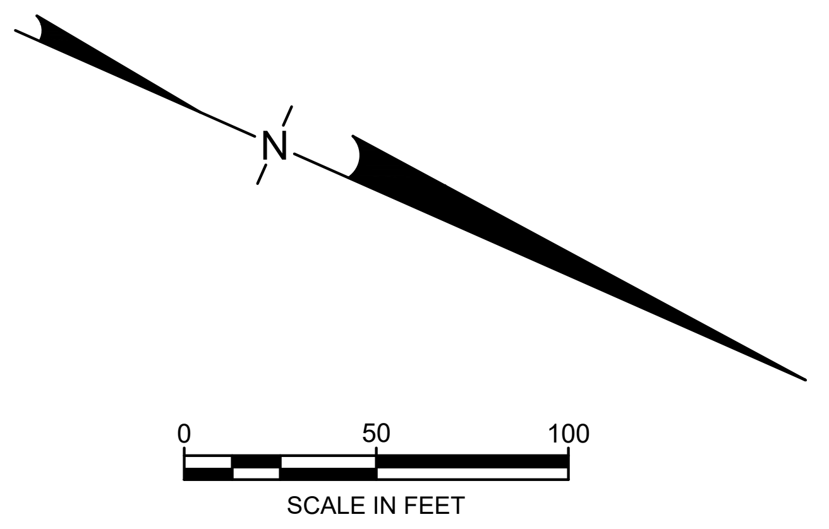

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants
Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
ELECTRICAL SITE PLAN V

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

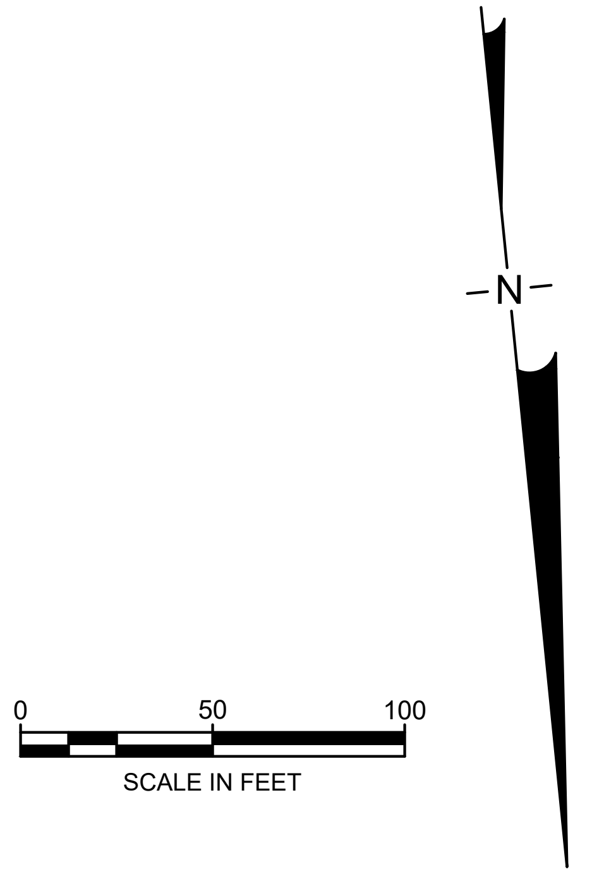
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E06.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-06
APPROVED BY:	JJD		

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-E06



NOTES:

1. GRID COORDINATE SYSTEM CORRESPONDS TO NAD83, NORTH CAROLINA. ELEVATIONS PRESENTED ARE IN FEET, NAVD 88.
2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.
3. APPROXIMATE EXTENT OF IMPACTED WETLANDS DELINEATED BY PARSONS (AUGUST 2020 WOTUS REPORT, CHEMOURS FAYETTEVILLE WORKS, FLOW THROUGH CELLS, SEEP C PILOT STUDY). APPROXIMATE EXTENT OF UNIMPACTED WETLANDS IN UPLAND LOCATIONS DELINEATED BY GEOSYNTEC, SEPTEMBER 2020 (WOTUS REPORT PENDING FOR SEEPS A, B, AND D PERMIT MODIFICATION).
4. FORCEMAIN ALIGNMENT AND LOCATION OF FORCEMAIN CLEANOUTS, AIR RELEASE VALVES, AND REDUCERS IS PRELIMINARY AND ARE SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
5. CONTRACTOR SHALL VERIFY HIGH POINTS ALONG VERTICAL ALIGNMENT PRIOR TO FINALIZING AIR RELEASE VALVE LOCATIONS.
6. CONTRACTOR SHALL FIELD-VERIFY BENDS ALONG FORCEMAIN.
7. THE ALIGNMENT FOR THE 13.2 kV LINE IS APPROXIMATE BASED ON REQUIRED OFFSETS FROM THE FORCEMAIN AND THE EXTRACTION WELLS. THE INSTALLED 13.2 kV LINE SHALL BE INSTALLED WITHIN A CORRIDOR THAT EXTENDS +/- 10 FT ALONG THE DEPICTED ALIGNMENT. THE INSTALLATION CONTRACTOR SHALL BE RESPONSIBLE FOR THE FINAL 13.2 kV ALIGNMENT SO THAT THE 13.2 kV LINE CAN BE CONNECTED TO THE 17 TRANSFORMERS AS SHOWN ON SHEETS E-02 THROUGH E-07.

90% DESIGN DRAWINGS

C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD
REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
ELECTRICAL SITE PLAN VI

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

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DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E07.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-07
APPROVED BY:	JJD		

GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-E07

NOTES:

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2. TOPOGRAPHIC, ROADS, BUILDINGS, AND PROPERTY LINE INFORMATION OBTAINED FROM FREELAND-CLINK SCALES & ASSOCIATES, INC. OF NC. SURVEY OF THE CHEMOURS FAYETTEVILLE WORKS SITE DATE 7 JANUARY 2019.
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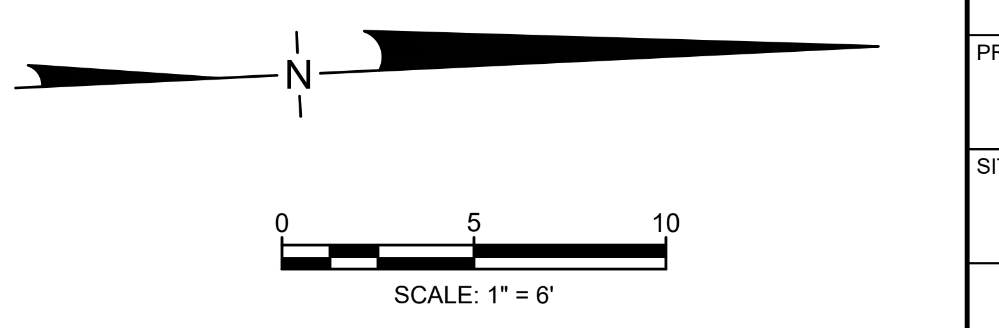
5. CONTRACTOR SHALL VERIFY HIGH POINTS ALONG VERTICAL ALIGNMENT PRIOR TO FINALIZING AIR RELEASE VALVE LOCATIONS.
6. CONTRACTOR SHALL FIELD-VERIFY BENDS ALONG FORCEMAIN.
7. SEEP FORCEMAIN LOCATION AND DESIGN BY OTHERS.
8. THE ALIGNMENT FOR THE 13.2 kV LINE IS APPROXIMATE BASED ON REQUIRED OFFSETS FROM THE FORCEMAIN AND THE EXTRACTION WELLS. THE INSTALLED 13.2 kV LINE SHALL BE INSTALLED WITHIN A CORRIDOR THAT EXTENDS +/- 10 FT ALONG THE DEPICTED ALIGNMENT. THE INSTALLATION CONTRACTOR SHALL BE RESPONSIBLE FOR THE FINAL 13.2 kV ALIGNMENT SO THAT THE 13.2 kV LINE CAN BE CONNECTED TO THE 17 TRANSFORMERS AS SHOWN ON SHEETS E-02 THROUGH E-07.



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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
ELECTRICAL WELL SITE PLAN

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	E-08
APPROVED BY:	JJD		

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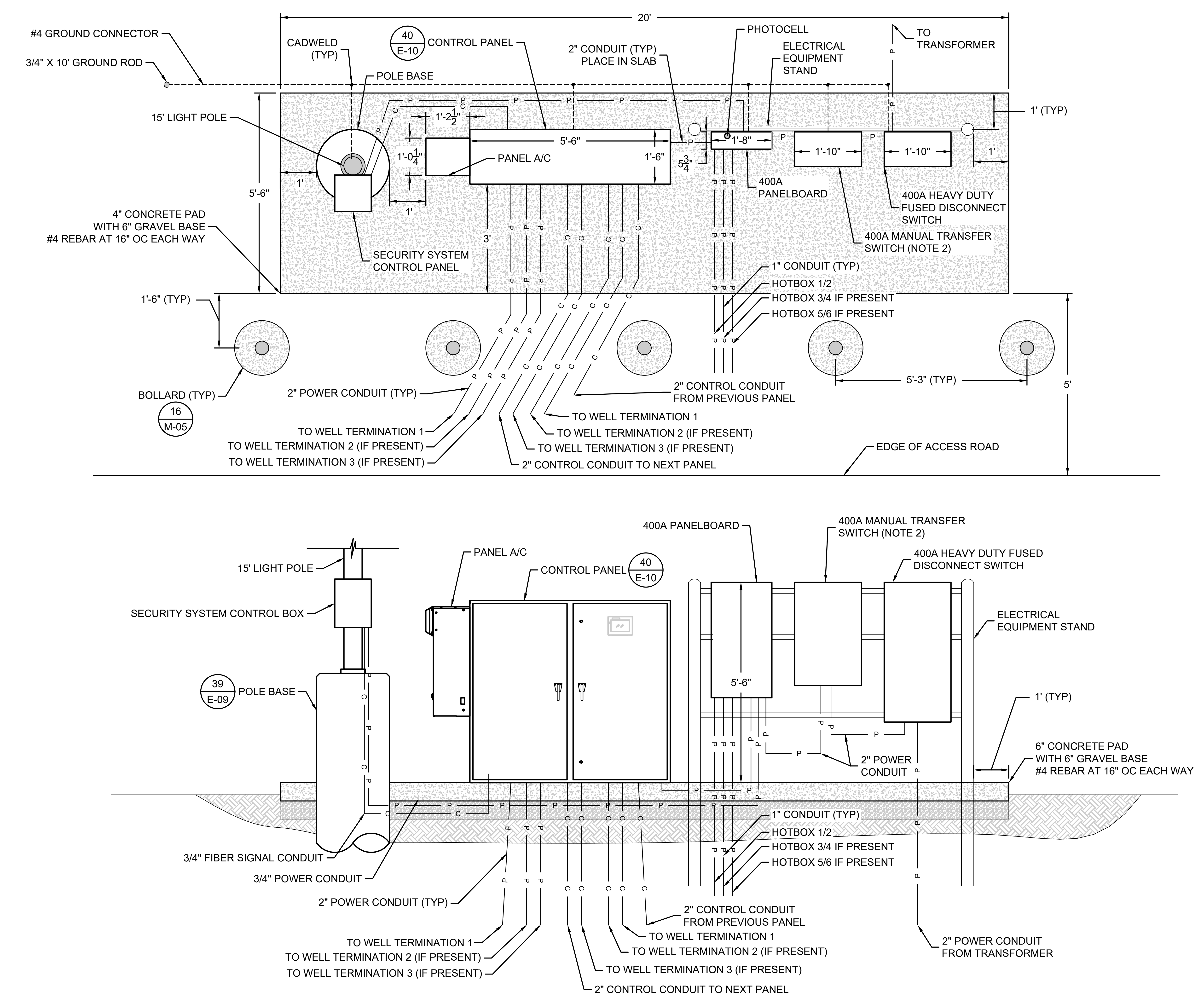
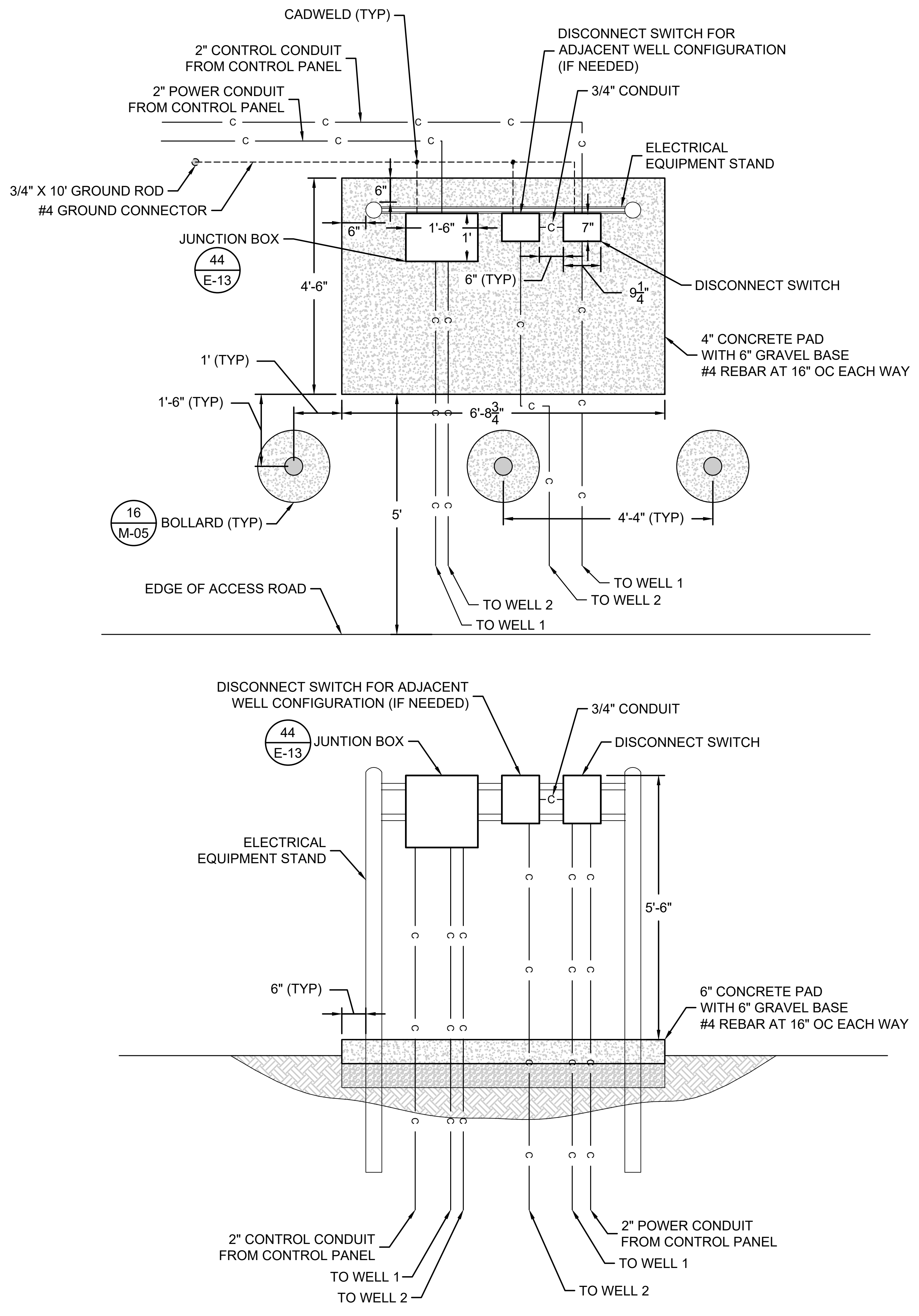


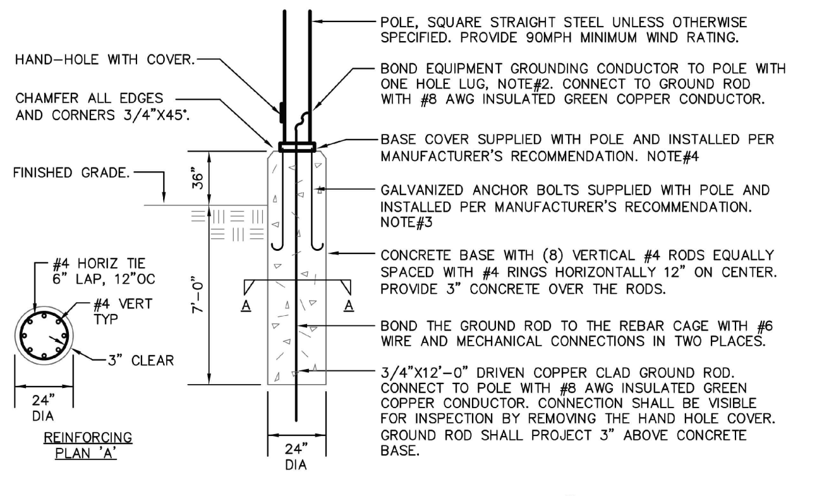
37 / E-01 DETAIL
CONTROL PANEL GENERAL ARRANGEMENT

SCALE: 1" = 2'



38 / E-01 DETAIL
WELL TERMINATION

SCALE: 1" = 2'



POLE BASE DETAIL – 24"ø

N.T.S.

NOTES:

1. BASE SHALL BE HAND RUBBED FINISH UNLESS OTHERWISE SPECIFIED.
2. EQUIPMENT GROUNDING LUGS TO BE FACTORY INSTALLED.
3. TOP OF ANCHOR BOLTS SHALL EXTEND FULLY THROUGH THE TOP MOST NUT TO PROVIDE FULL STRUCTURAL STRENGTH AND POSITIVE DRAINAGE OF RAINWATER.
4. POLE BASE COVER SHALL TOUCH THE TOP OF THE CONCRETE BASE. THERE SHALL BE NO VISIBLE AIR GAP BETWEEN THE BASE COVER AND THE TOP OF THE CONCRETE BASE.
5. CENTER POINT OF BASE SHALL BE SET BACK FROM PAVEMENT AS INDICATED BELOW:
   EDGE OF PAVEMENT, NO CURB: 36" FROM EDGE OF PAVEMENT
   EDGE OF PAVEMENT, WITH CURB: 24" FROM BACK OF CURB
   PARKING ISLAND: CENTER BETWEEN BACK OF CURBS
   NOTE: THE ENTIRE POLE BASE ASSEMBLY SHALL BE ENTIRELY LOCATED WITHIN THE OWNER'S PROPERTY BOUNDARY.

SEAL 043533 EDWARD C. HENDERSON 8/5/20

ENGINEERING SERVICES GROUP, INC.
NORTH CAROLINA, P.C.
CONSULTING ENGINEERS
900 EAST HILL AVE. SUITE 350
KNOXVILLE, TENNESSEE 37915
(865) 522-0393
FIRM NO. C-2229 PROJECT NO. 24337

Chemours
Fayetteville, North Carolina

DATE: 8-5-20
SCALE: NONE
E1.1

POLE BASE DETAIL PROVIDED BY OWNER.

39 / E-09 DETAIL
POLE BASE

THE CHEMOURS COMPANY
FENCE GATE AREA LIGHTING
LIGHT FIXTURE SCHEDULE

SYM	CATALOG NUMBER	QTY	FIXTURE WATTS	FIXTURE TYPE	FIXTURE VOLTS	MOUNTING	DESCRIPTION
A	LIGHT UNIT HOLOPHANE MGLEDM P8 40K MVOLT AG VH GRSD PCSS PR7	1	280	LED	120	POLE	MONGOOSE LED MEDIUM, 38,000 LUMENS, 4000K CCT,AUTO-SENSING VOLTAGE (120-277), AREA w/REFRACTOR (TYPE 5), VERTICAL TENON/HORIZONTAL ARM, VITRACOAT SDCR GRAY
A POLE	ONE LIGHT PER POLE RTA3910G P2 ND GR 2	1	N/A	N/A	N/A	N/A	ROUND TAPERED ALUMINUM POLE 15FT, 10.0 X 6.0 .188 WALL, TENON – 2.38 OD X 4" LG, GRAY PAINT, ANCHOR BOLTS, BASE COVER

ELECTRICAL NOTES

1. WIRE AND CABLE REQUIREMENTS
   1.1. ALL CONDUCTORS SHALL BE #12 AWG MINIMUM UNLESS OTHERWISE SPECIFIED.
   1.2. WIRES AND CABLES SHALL MEET APPLICABLE REQUIREMENTS OF THE 2017 NATIONAL ELECTRICAL CODE AND UL FOR THE TYPE OF INSULATION, JACKET, AND CONDUCTOR SPECIFIED OR INDICATED.
   1.3. ALL CONDUCTORS SHALL BE COPPER WITH 600 VOLT INSULATION UNLESS OTHERWISE INDICATED.
   1.4. WIRE AND CABLE SHALL BE MANUFACTURED BY BELDEN, GENERAL CABLE, ESSEX, ENCORE, ROME CABLE, SOUTHWIRE, OR APPROVED ALTERNATIVE.
   1.5. USE STRANDED COPPER TYPE THHN/THWN FOR WIRING #10 AWG AND SMALLER. USE STRANDED COPPER TYPE THWN-2 FOR WIRING #8 AND LARGER.
   1.6. PROVIDE COLOR CODED WIRE AND WITH A DIFFERENT COLOR FOR EACH PHASE AND NEUTRAL AND GROUND AS FOLLOWS: 208/120 VOLT CIRCUITS - PHASES A, B, AND C: BLACK, RED, AND BLUE RESPECTIVELY; NEUTRAL: WHITE; GROUND: GREEN.
   1.7. PROVIDE WIRE LABELS AND DESCRIPTION AS-BUILTS.

2. CONDUIT REQUIREMENTS
   2.1. ALL CONDUITS SHALL BE 1 INCH THICK MINIMUM.
   2.2. ALL CONDUITS SHALL BE SCHEDULE 40 PVC BELOW GRADE AND TRANSITIONS. USE RGS CONDUIT ABOVE GRADE.
   2.3. USE PROPER SIZED TOOLS FOR BENDING. DO NOT HEAT METAL CONDUIT. DENTS AND FLAT SPOTS WILL BE REJECTED. CUT AND THREAD CONDUIT SO ENDS WILL BUTT IN COUPLINGS. MAKE ENDS NO LONGER THAN NECESSARY AND REAM PIPE FREE OF BURRS.
   2.4. PROVIDE BUSHINGS ON THE OPEN ENDS OF CONDUIT CONTAINING CONDUCTORS. INSULATED BUSHINGS SHALL BE PROVIDED FOR CONDUITS CONTAINING CONDUCTORS #4 AWG OR LARGER WITH AN INSULATING RING AN INTEGRAL PART OF THE BUSHING.
   2.5. LEAVE ONE #10 AWG OR EQUIVALENT NYLON PULL WIRE IN EMPTY CONDUITS.
   2.6. JUNCTION BOXES
      2.6.1. PULL AND JUNCTION BOXES SHALL NOT BE LOCATED BELOW 100 YEAR FLOOD ELEVATION.
      2.6.2. PULL AND JUNCTION BOXES SHALL BE SIZED IN ACCORDANCE WITH THE 2017 NATIONAL ELECTRICAL CODE ACCORDING TO NUMBER OF CONDUCTORS IN BOX SHALL OR TYPE OF SERVICE TO BE PROVIDED. MINIMUM SIZE IS 4-11/16" SQUARE AND 2-1/2" DEEP.
      2.6.3. PULL BOXES SHALL BE PROVIDED WHERE NECESSARY IN THE CONDUIT SYSTEM TO FACILITATE CONDUCTOR INSTALLATION. CONDUIT RUNS LONGER THAN 100 FEET OR WITH BENDS EXCEEDING 270 DEGREES SHALL HAVE A PULL BOX INSTALLED AT A CONVENIENT INTERMEDIATE LOCATION.
      2.6.4. INSTALL IN LOCATIONS AS SHOWN ON DRAWINGS AND AS REQUIRED FOR SPLICES, TAPS, WIRE PULLING, EQUIPMENT CONNECTIONS, AND COMPLIANCE WITH REGULATORY REQUIREMENTS.
      2.6.5. INSTALL PULL AND JUNCTION BOXES IN ACCESSIBLE AREAS ONLY.
      2.6.6. INSTALL KNOCKOUT CLOSURES IN UNUSED BOX OPENINGS.
3. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT EDITION OF THE NATIONAL ELECTRIC CODE, NFPA 70. SHOULD THE PLANS AND CODES CONFLICT, THE CODE TAKES PRECEDENCE. MAKE NO CHANGES EVEN IN THE CASE OF CONFLICT WITHOUT FIRST OBTAINING APPROVAL OF THE ENGINEER.
4. MATERIAL SHALL BE LISTED AND LABELED BY UNDERWRITER'S LABORATORIES, INC. OR OTHER RECOGNIZED TEST FACILITIES. EQUIPMENT SHALL BE IDENTIFIED FOR USE.
5. INSTALL SPECIFIED EQUIPMENT AS NOTED ON THE DRAWINGS OR APPROVED ALTERNATIVE.

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
2. FURNISH TRANSFER SWITCH WITH INTERNAL TERMINAL BLOCK FOR LANDING GENERATOR PIGTAIL

90% DESIGN DRAWINGS

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
ELECTRICAL DETAILS I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

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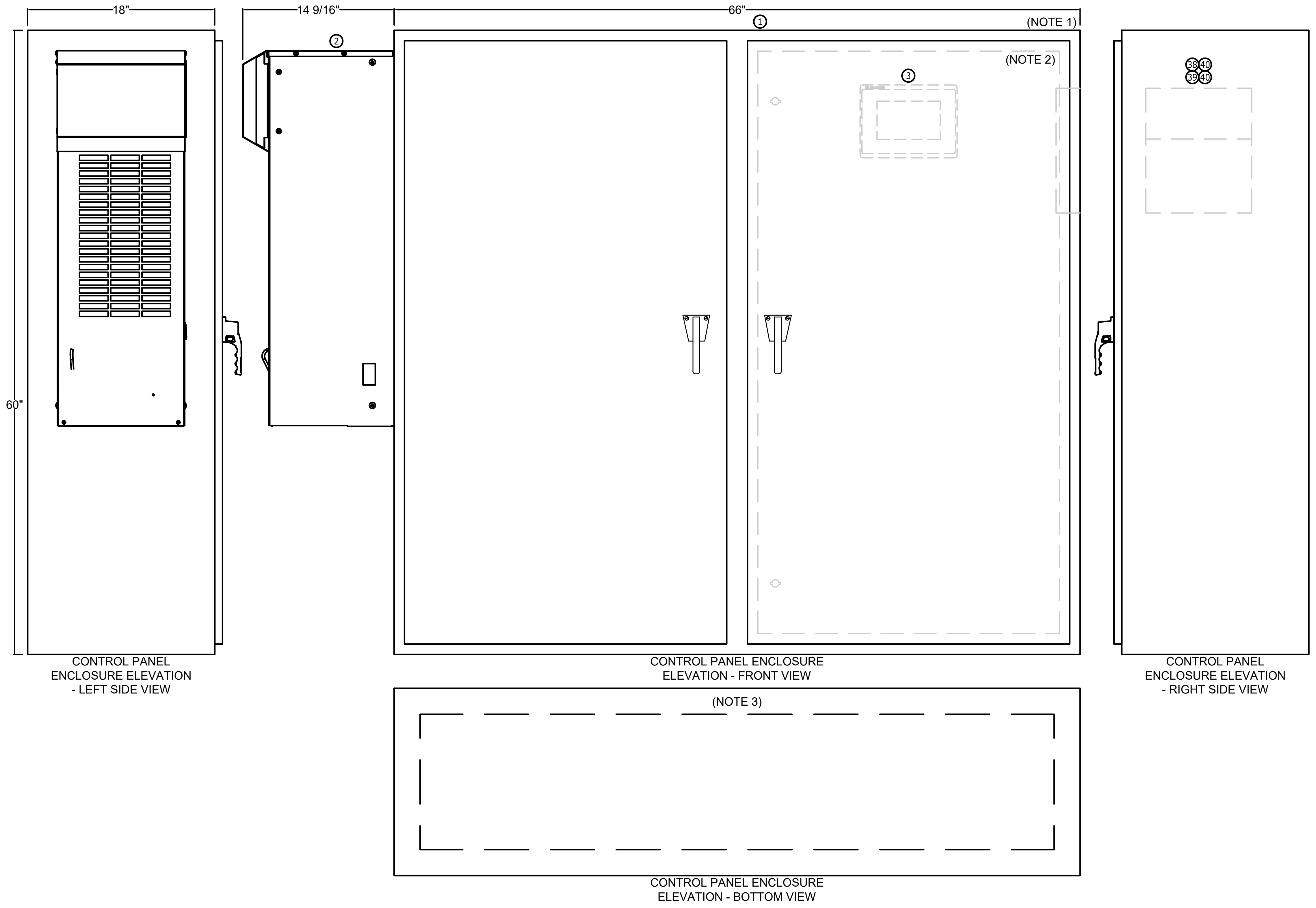
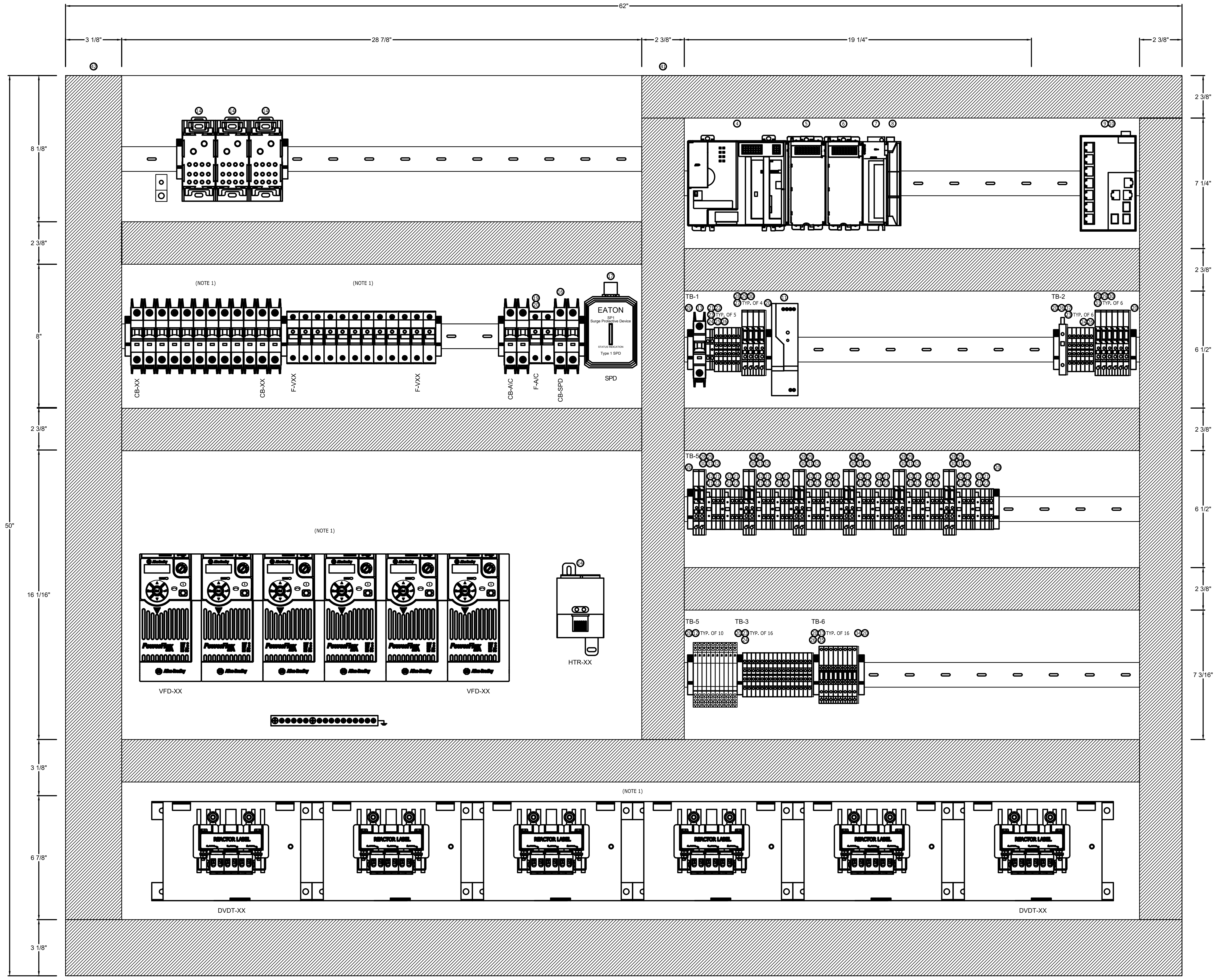
DESIGN BY: BMT
DRAWN BY: JFH
CHECKED BY: CMDS
REVIEWED BY: SV
APPROVED BY: JJD
DATE: DECEMBER 2021
PROJECT NO.: TR0795A
FILE: TR0795A-E09.DWG
DRAWING NO.: E-09



40 E-09 DETAIL
ELECTRICAL CONTROL PANEL ENCLOSURE
SCALE: NTS



41 E-10 DETAIL
ELECTRICAL CONTROL PANEL BACKPLATE
SCALE: NTS

BILL OF MATERIALS				
ITEM #	QTY	PART NO.	MANUFACTURER	DESCRIPTION
1	1	FS486018N4X	GAYLORD MANUFACTURING	FREE STANDING ENCLOSURE, 48"(H) x 60" (W) x 18"(D), NEMA 4X, 304SST
2	1	13383441158	PFANNENBERG	ENCLOSURE AIR CONDITIONER, DTS3181 SL, NEMA 4X, 4,100 BTU/h, 230VAC, 50/60 Hz,
3	1	2713P-T7WD1	ALLEN-BRADLEY	HMI, 7" COLOR, PANELVIEW 5310, 24VDC
4	1	1769-L24ER-QB1B	ALLEN-BRADLEY	PLC, COMPACTLOGIX, 5370 L2 CONTROLLER, 24VDC INPUT PWR, 16 DC INPUTS, 16 DC OUTPUTS
5	1	1769-IF16C	ALLEN-BRADLEY	16-CH ANALOG CURRENT INPUT MODULE
6	1	1769-IF8	ALLEN-BRADLEY	8-CH ANALOG CURRENT INPUT MODULE
7	1	1769-OF8C	ALLEN-BRADLEY	8-CH ANALOG CURRENT OUTPUT MODULE
8	1	1769-ECR	ALLEN-BRADLEY	END CAP RIGHT
9	1	EDS-510A-3SFP	MOXA	FIBER/ETHERNET SWITCH, (7) 10/100BASE T(X) PORTS, (3) 100/1000BASE SFP, MANAGED, 24VDC
10	3	SFP-1GLXLC	MOXA	SFP MODULE W/ (1) 1000 BASE LX PORT WITH LC CONNECTOR FOR 10 km TRANSMISSION
11	1	2904376	PHOENIX CONTACT	24VDC POWER SUPPLY, 6.25A OUTPUT, 120VAC INPUT
12	10	38.51.7.024.0050	FINDER	RELAY, 38 SERIES, SPDT, 24VDC COIL, 6.3A
13	1	FAZ-C15-1-NA-SP	EATON	CIRCUIT BREAKER, 1-POLE, 15A, TRIP CURVE C, UL489
14	1	032029-01	STEGO	ENCLOSURE HEATER, 1,000W, 100-120VAC
15	3	EPDB512	EDISON	DISTRIBUTION BLOCK, 1-POLE, 570A, LINE SIDE: (2) 300MCM TO 4AWG, LOAD SIDE: (12) 4AWG TO 14AWG
16	2	FAZ-C15-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 15A, TRIP CURVE C, UL489
17	1	SP1-240S	EATON	SURGE PROTECTIVE DEVICE, 120/240VAC SINGLE PHASE, 50kA
18	1	EHCC2DU	EDISON	FUSE HOLDER, CLASS CC FUSES, 30A, 600V, 2-POLE
19	2	KLDR008	LITTELFUSE	CC FUSE, TIME DELAY, 600VAC
20	17	1061200000	WEIDMULLER	END BRACKET, WEW 35/2, BG
21	25	1020100000	WEIDMULLER	WDU 4, FEED-THRU TERMINAL, SINGLE LEVEL, RATED CROSS SECTION: 6 MM^2, SCREW CONNECTION, DIN RAIL MOUNT
22	13	1010100000	WEIDMULLER	WPE 4, PE TERMINAL, SINGLE LEVEL, RATED CROSS SECTION: 6 MM^2, SCREW CONNECTION, DIN RAIL MOUNT
23	27	1041900000	WEIDMULLER	WDK 4N, FEED-THRU TERMINAL, DOUBLE LEVEL, RATED CROSS SECTION: 6 MM^2, SCREW CONNECTION, DIN RAIL MOUNT
24	LOT	1758270000	WEIDMULLER	ZQV 4V/41, CROSS-CONNECTOR, 41 POLE, USED WITH WDK 4N

BILL OF MATERIALS (CONT'D)				
25	1	1041910000	WEIDMULLER	WDK 4N PE, GROUND TERMINAL BLOCK, DOUBLE LEVEL, GRN/YEL
26	3	1084000000	WEIDMULLER	WDK 4N, TERMINAL END PLATE
27	4	1518370000	WEIDMULLER	KDKS 1PE/LLC, FUSE TERMINAL, 100-250V AC/DC, BLOWN FUSE INDICATION, RATED CROSS SECT: 4 MM^2, SCREW CONN.
28	LOT	0545400000	WEIDMULLER	SAK SERIES, QB 58/8/15, CROSS-CONNECTOR, 58-POLE
29	LOT	0546000000	WEIDMULLER	SAK SERIES, QB 58/8/15, CROSS-CONNECTOR INSULATION, 58-POLE
30	8	9503330000	WEIDMULLER	END PLATE, KDKS 1
31	18	1518300000	WEIDMULLER	KDKS 1PE/LLC, FUSE TERMINAL, 10-36V AC/DC, BLOWN FUSE INDICATION, RATED CROSS SECT: 4 MM^2, SCREW CONN.
32	12	1011300000	WEIDMULLER	WSI 6/LD, FUSE TERMINAL, 10-36V AC/DC, BLOWN FUSE INDICATION, RATED CROSS SECTION: 6 MM^2, SCREW CONNECTION
33	8	1247420000	WEIDMULLER	DISCONNECT TERMINAL BLOCK, WDK 2.5 TR-DU-PE, BG
34	1	1839850000	WEIDMULLER	END PLATE, WDK 2.5 TR-DU-PE, BG
35	LOT	1577600000	WEIDMULLER	WQV SERIES, 2.5/32, CROSS-CONNECTOR, 32-POLE
36	1	1880410000	WEIDMULLER	WSI 4/2, FUSE BLOCK, 10-36VAC/DC LED INDICATOR
37	1	1880450000	WEIDMULLER	WQV SERIES, 2.5/32, CROSS-CONNECTOR, 32-POLE
38	1	FWME2	PANDUIT	FIBER PATCH PANEL ENCLOSURE
39	1	FAP6WBUDLCZ	PANDUIT	LC FIBER ADAPTER PANEL, OS1/OS2, LC DUPLEX
40	2	F92ERLNLNSNM002	PANDUIT	FIBER PATCH CORD, OS1/OS2, LC DUPLEX, 2M
41	LOT	T1E-2240W	IBOCO	WIREWAY, 2.25"(W) x 4.00"(D), WHITE
42	LOT	T1E-3040W	IBOCO	WIREWAY, 3.00"(W) x 4.00"(D), WHITE

NOTES:

1. FREE-STANDING ENCLOSURE, 304SST.
2. ENCLOSURE TO HAVE INTERNAL DEADFRONT WITH HMI.
3. ENCLOSURE TO HAVE CUTOUT ON BOTTOM OF ENCLOSURE.
4. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
5. MODEL NUMBERS AND QUANTITIES FOR THE CIRCUIT BREAKERS, FUSE BLOCKS, FUSE BLOCK COVERS, FUSES, VARIABLE FREQUENCY DRIVES AND DVDT FILTER ARE LISTED BY THEIR ASSOCIATED CONTROL PANEL NUMBER WITH THEIR EQUIPMENT IDENTIFICATION NUMBER ON DRAWING E-23. I.E. CB-##, F-V##, VFD-## AND DVDT-##.

90% DESIGN DRAWINGS

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RALEIGH, NC 27607
919.870.0576

TITLE:
ELECTRICAL DETAILS II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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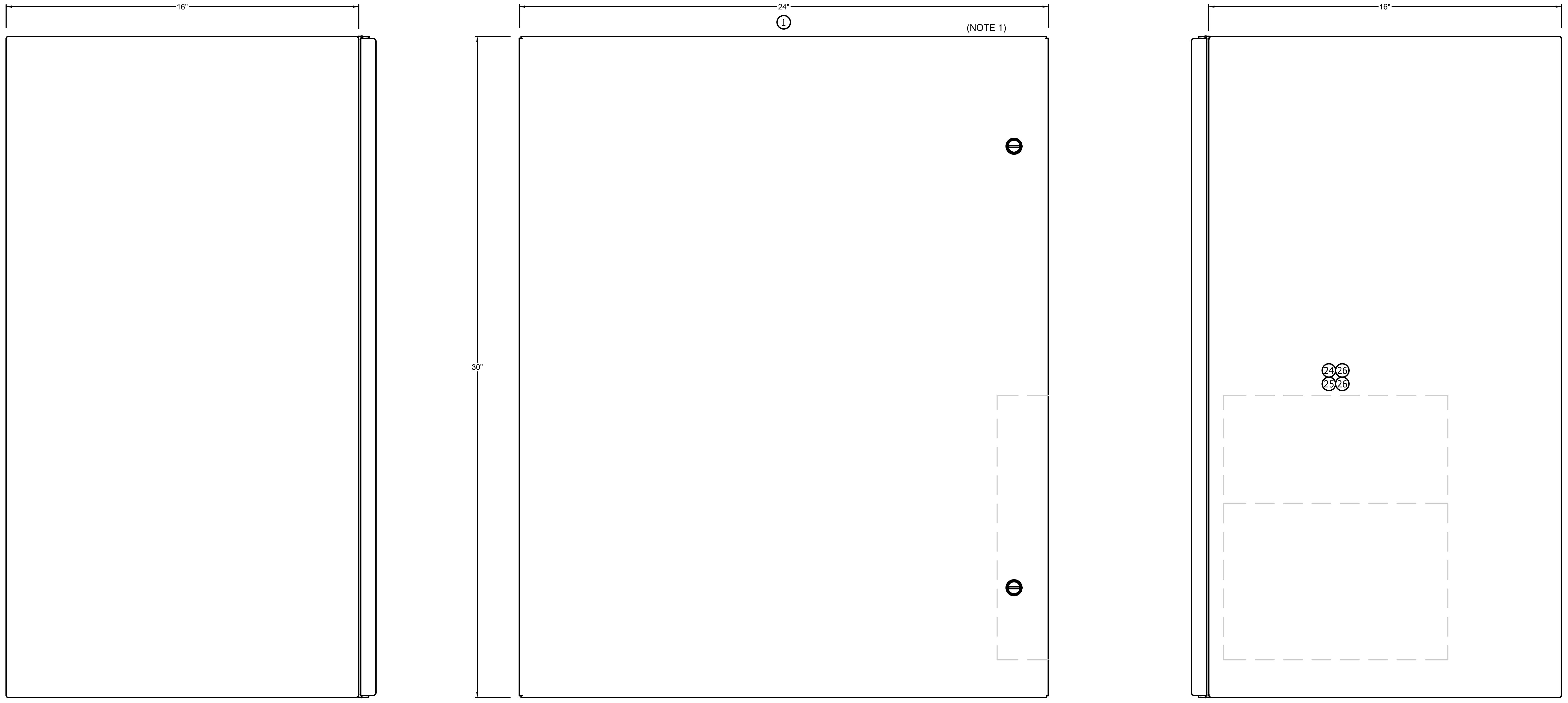
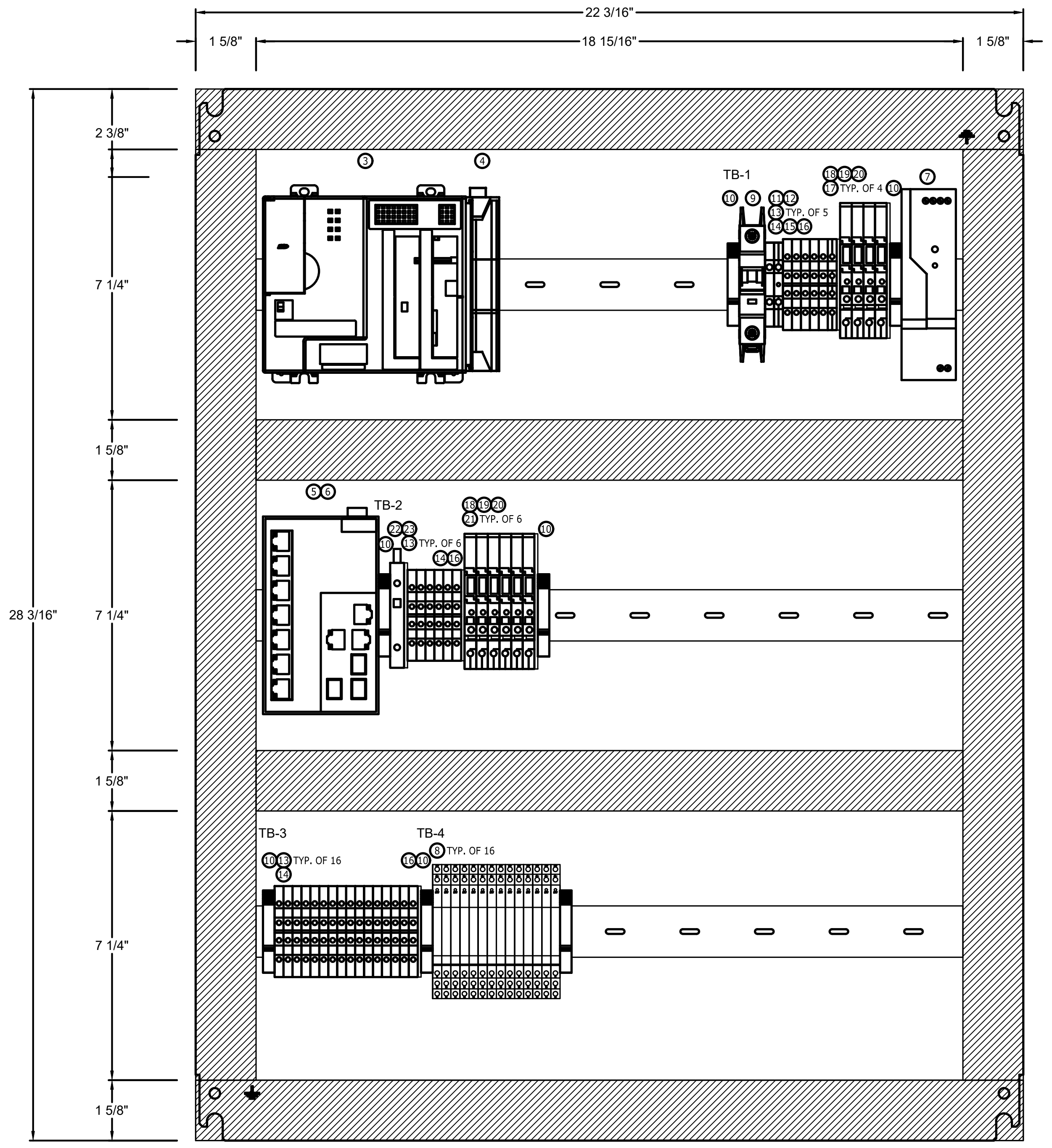
REVIEWED BY:	SV	DRAWING NO.:	E-10
APPROVED BY:	JJD		



42 / E-11 DETAIL
MAIN CONTROL PANEL ENCLOSURE
SCALE: NTS



43 / E-11 DETAIL
MAIN CONTROL PANEL BACKPLATE
SCALE: NTS

BILL OF MATERIALS

ITEM #	QTY	PART NO.	MANUFACTURER	DESCRIPTION
1	1	CSD302416	HOFFMAN	ENCLOSURE, WALL MOUNT, 30"(H) x 24"(W) x 16"(D), NEMA 4/12, ANSI 61 GREY
2	1	CP3024	HOFFMAN	BACKPLATE, 28.2"(H) x 22.2"(W), WHITE
3	1	1769-L24ER-QB1B	ALLEN-BRADLEY	PLC, COMPACTLOGIX, 5370 L2 CONTROLLER, 24VDC INPUT PWR, 16 DC INPUTS, 16 DC OUTPUTS
4	1	1769-ECR	ALLEN-BRADLEY	END CAP RIGHT
5	1	EDS-510E-3GTXSFP	MOXA	FIBER/ETHERNET SWITCH, (7) 10/100BASE T(X) PORTS, (3) 1000BASE SFP+, MANAGED, 24VDC
6	3	SFP-1GLXLC	MOXA	SFP MODULE W/ (1) 1000 BASE LX PORT WITH LC CONNECTOR FOR 10 km TRANSMISSION
7	1	2904376	PHOENIX CONTACT	24VDC POWER SUPPLY, 6.25A OUTPUT, 120VAC INPUT
8	16	38.51.7.024.0050	FINDER	RELAY, 38 SERIES, SPDT, 24VDC COIL, 6.3A
9	1	FAZ-C15-1-NA-SP	EATON	CIRCUIT BREAKER, 1-POLE, 15A, TRIP CURVE C, UL489
10	7	1061200000	WEIDMULLER	END BRACKET, WEW 35/2, BG
11	1	1020100000	WEIDMULLER	WDU 4, FEED-THRU TERMINAL, SINGLE LEVEL, RATED CROSS SECTION: 6 MM^2, SCREW CONNECTION, DIN RAIL MOUNT
12	1	1010100000	WEIDMULLER	WPE 4, PE TERMINAL, SINGLE LEVEL, RATED CROSS SECTION: 6 MM^2, SCREW CONNECTION, DIN RAIL MOUNT
13	27	1041900000	WEIDMULLER	WDK 4N, FEED-THRU TERMINAL, DOUBLE LEVEL, RATED CROSS SECTION: 6 MM^2, SCREW CONNECTION, DIN RAIL MOUNT
14	LOT	1758270000	WEIDMULLER	ZQV 4V/41, CROSS-CONNECTOR, 41 POLE, USED WITH WDK 4N
15	1	1041910000	WEIDMULLER	WDK 4N PE, GROUND TERMINAL BLOCK, DOUBLE LEVEL, GRN/YEL
16	3	1084000000	WEIDMULLER	WDK 4N, TERMINAL END PLATE
17	4	1518370000	WEIDMULLER	KDKS 1PE/LLC, FUSE TERMINAL, 100-250V AC/DC, BLOWN FUSE INDICATION, RATED CROSS SECT: 4 MM^2, SCREW CONN.
18	LOT	0545400000	WEIDMULLER	SAK SERIES, QB 58/8/15, CROSS-CONNECTOR, 58-POLE
19	LOT	0546000000	WEIDMULLER	SAK SERIES, QB 58/8/15, CROSS-CONNECTOR INSULATION, 58-POLE
20	2	9503330000	WEIDMULLER	END PLATE, KDKS 1
21	6	1518300000	WEIDMULLER	KDKS 1PE/LLC, FUSE TERMINAL, 10-36V AC/DC, BLOWN FUSE INDICATION, RATED CROSS SECT: 4 MM^2, SCREW CONN.
22	1	1880410000	WEIDMULLER	WSI 4/2, FUSE BLOCK, 10-36VAC/DC LED INDICATOR
23	1	1880450000	WEIDMULLER	WQV SERIES, 2.5/32, CROSS-CONNECTOR, 32-POLE
24	1	FWME2	PANDUIT	FIBER PATCH PANEL ENCLOSURE
25	1	FAP6WBUDLCZ	PANDUIT	LC FIBER ADAPTER PANEL, OS1/OS2, LC DUPLEX
26	2	F92ERLNLNSNM002	PANDUIT	FIBER PATCH CORD, OS1/OS2, LC DUPLEX, 2M
27	LOT	T1E-2230W	IBOCO	WIREWAY, 2.25"(W) x 3.00"(D), WHITE
28	LOT	T1E-3030W	IBOCO	WIREWAY, 3.00"(W) x 3.00"(D), WHITE

NOTES:

1. WALL MOUNT ENCLOSURE, NEMA 4/12, ANSI 61 GREY.
2. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
3. MODEL NUMBERS AND QUANTITIES FOR THE CIRCUIT BREAKERS, FUSE BLOCKS, FUSE BLOCK COVERS, FUSES, VARIABLE FREQUENCY DRIVES AND DVDT FILTER ARE LISTED BY THEIR ASSOCIATED CONTROL PANEL NUMBER WITH THEIR EQUIPMENT IDENTIFICATION NUMBER ON DRAWING E-23. I.E. CB-##, F-V##, VFD-## AND DVDT-##.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
ELECTRICAL DETAILS III

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

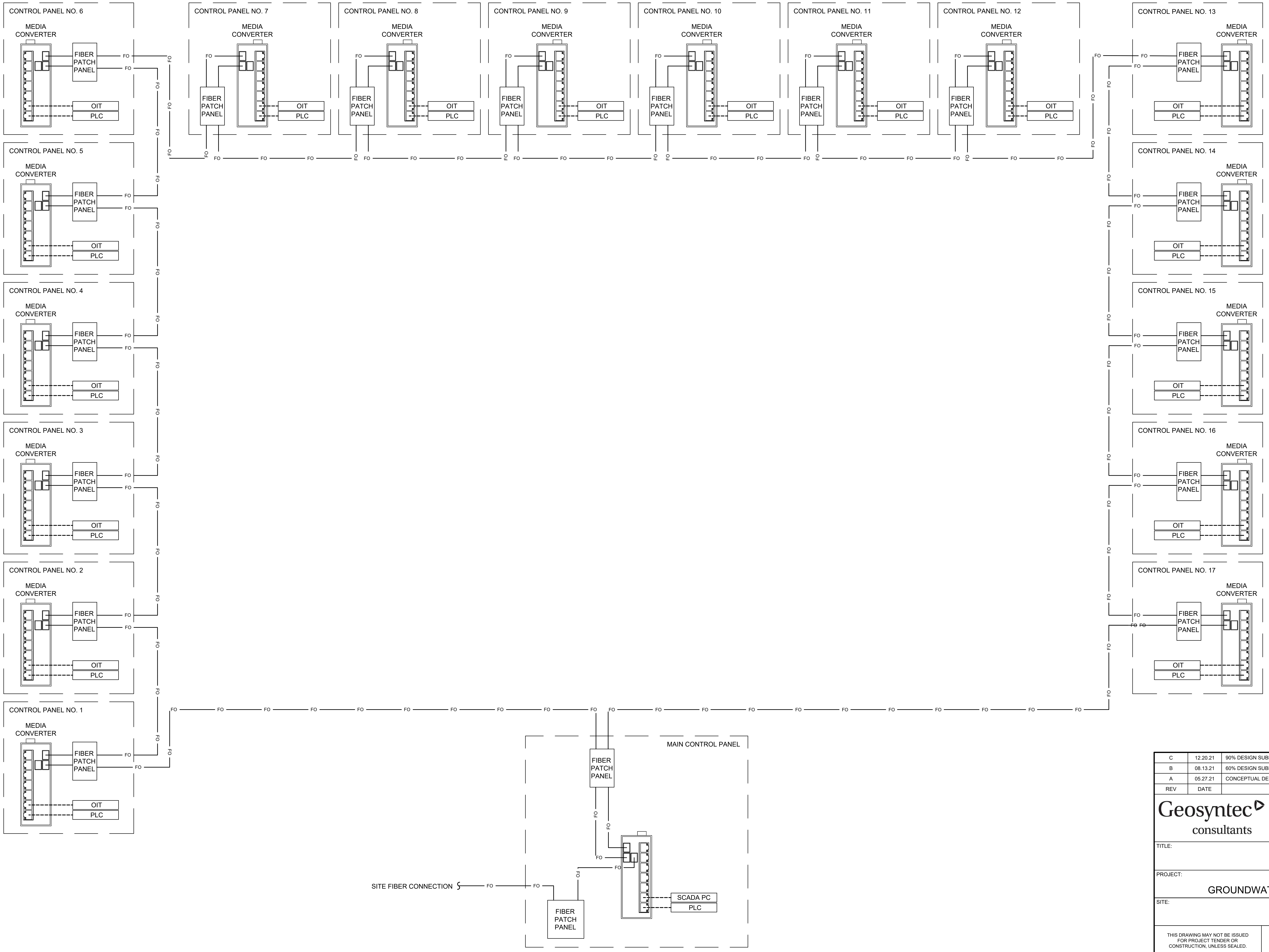
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E11.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-11
APPROVED BY:	JJD		

90% DESIGN DRAWINGS



LEGEND

- - - - - - - - CAT6 ETHERNET CABLE
——— FO ——— FIBER

NOTES:

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90% DESIGN DRAWINGS

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
NETWORK ARCHITECTURE

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DESIGN BY: BMT
DRAWN BY: JFH
CHECKED BY: CMDS
REVIEWED BY: SV
APPROVED BY: JJD
DATE: DECEMBER 2021
PROJECT NO.: TR0795A
FILE: TR0795A-E12.DWG
DRAWING NO.: E-12

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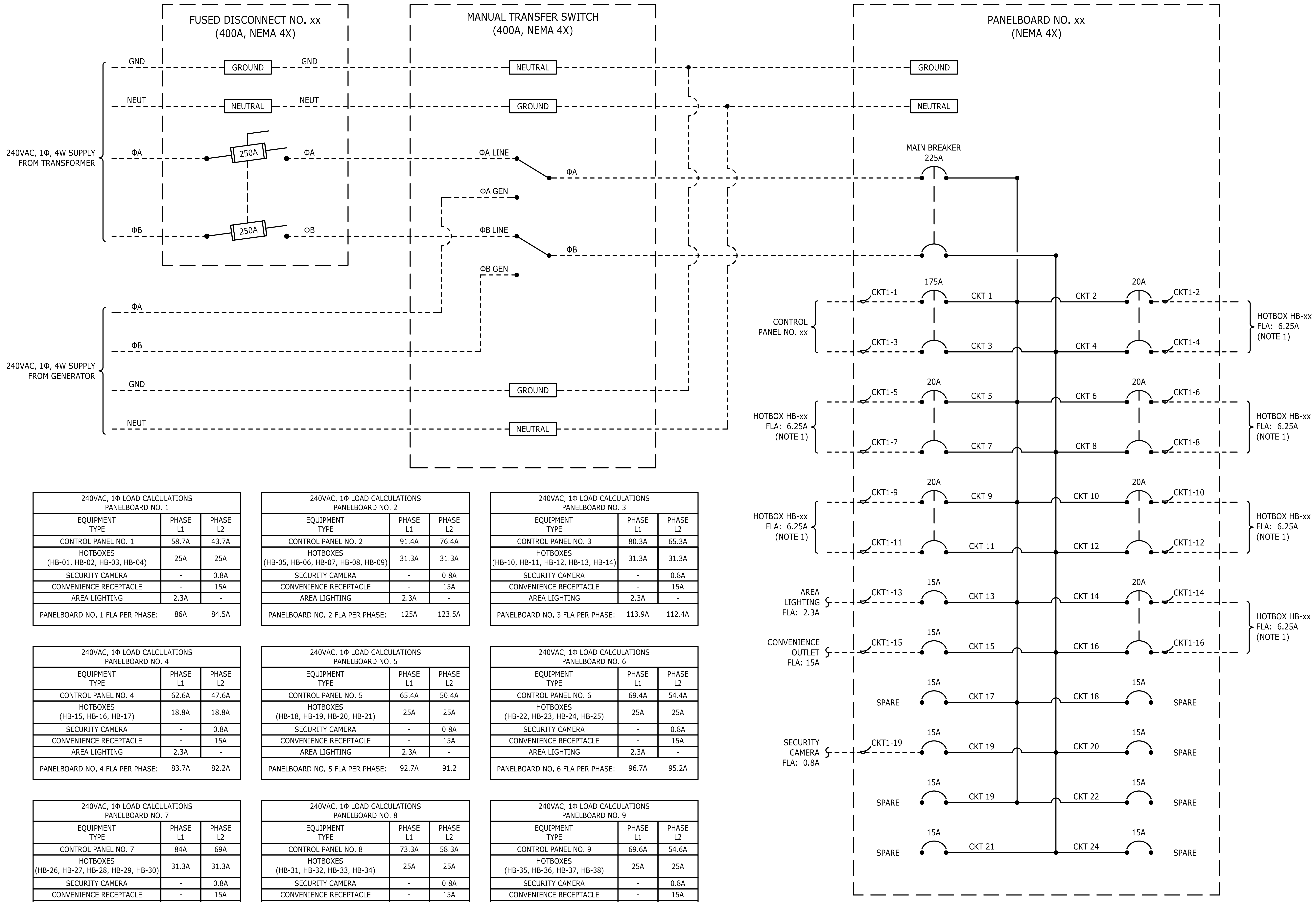

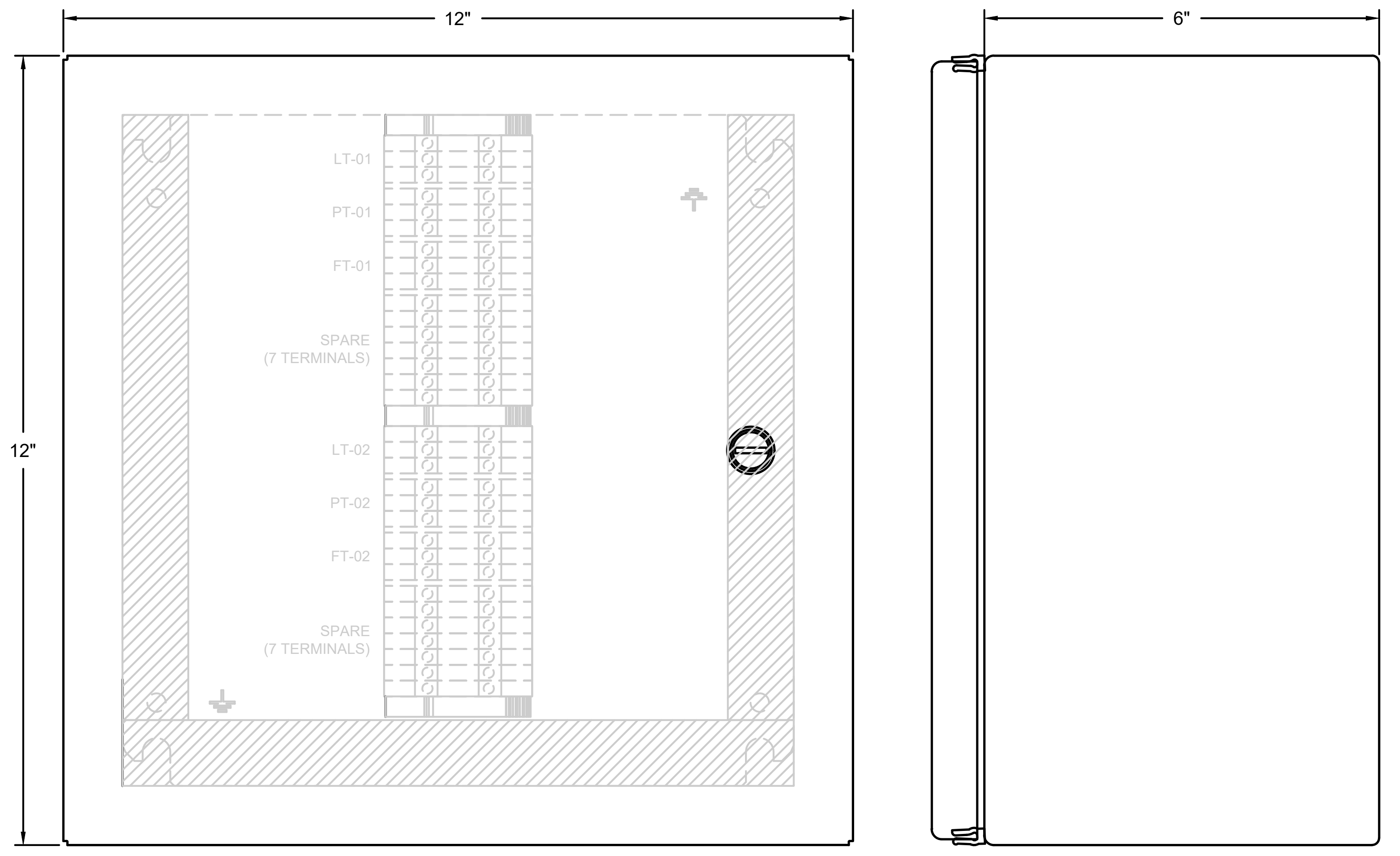

44
E-09

DETAIL
JUNCTION BOX

SCALE: 1" = 2"

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 1

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 1	58.7A	43.7A
HOTBOXES (HB-01, HB-02, HB-03, HB-04)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 1 FLA PER PHASE:	86A	84.5A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 2

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 2	91.4A	76.4A
HOTBOXES (HB-05, HB-06, HB-07, HB-08, HB-09)	31.3A	31.3A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 2 FLA PER PHASE:	125A	123.5A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 3

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 3	80.3A	65.3A
HOTBOXES (HB-10, HB-11, HB-12, HB-13, HB-14)	31.3A	31.3A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 3 FLA PER PHASE:	113.9A	112.4A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 4

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 4	62.6A	47.6A
HOTBOXES (HB-15, HB-16, HB-17)	18.8A	18.8A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 4 FLA PER PHASE:	83.7A	82.2A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 5

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 5	65.4A	50.4A
HOTBOXES (HB-18, HB-19, HB-20, HB-21)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 5 FLA PER PHASE:	92.7A	91.2

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 6

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 6	69.4A	54.4A
HOTBOXES (HB-22, HB-23, HB-24, HB-25)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 6 FLA PER PHASE:	96.7A	95.2A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 7

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 7	84A	69A
HOTBOXES (HB-26, HB-27, HB-28, HB-29, HB-30)	31.3A	31.3A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 7 FLA PER PHASE:	117.6A	116.1A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 8

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 8	73.3A	58.3A
HOTBOXES (HB-31, HB-32, HB-33, HB-34)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 8 FLA PER PHASE:	100.6A	99.1A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 9

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 9	69.6A	54.6A
HOTBOXES (HB-35, HB-36, HB-37, HB-38)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 9 FLA PER PHASE:	96.9A	95.4A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 10

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 10	75.7A	60.7A
HOTBOXES (HB-39, HB-40, HB-41, HB-42, HB-43)	31.3A	31.3A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 10 FLA PER PHASE:	109.3A	107.8A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 11

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 11	56.6A	41.6A
HOTBOXES (HB-44, HB-45, HB-46, HB-47)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 11 FLA PER PHASE:	83.9A	82.4A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 12

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 12	51.3A	36.3A
HOTBOXES (HB-48, HB-49, HB-50, HB-51)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 12 FLA PER PHASE:	83.9A	82.4A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 13

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 13	62.6A	47.6A
HOTBOXES (HB-52, HB-53, HB-54)	18.8A	18.8A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 13 FLA PER PHASE:	83.7A	82.2A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 14

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 14	58.9A	43.9A
HOTBOXES (HB-55, HB-56, HB-57)	18.8A	18.8A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 14 FLA PER PHASE:	80A	78.5A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 15

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 15	77A	62A
HOTBOXES (HB-58, HB-59, HB-60, HB-61)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 15 FLA PER PHASE:	104.3A	102.8A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 16

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 16	88.8A	73.8A
HOTBOXES (HB-62, HB-63, HB-64, HB-65)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 16 FLA PER PHASE:	116.1A	114.6A

240VAC, 1Φ LOAD CALCULATIONS
PANELBOARD NO. 17

EQUIPMENT TYPE	PHASE L1	PHASE L2
CONTROL PANEL NO. 17	96A	81A
HOTBOXES (HB-66, HB-67, HB-68, HB-69)	25A	25A
SECURITY CAMERA	-	0.8A
CONVENIENCE RECEPTACLE	-	15A
AREA LIGHTING	2.3A	-
PANELBOARD NO. 17 FLA PER PHASE:	123.3A	121.8A

NOTES:

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
PANELBOARD SCHEDULES AND JUNCTION BOX

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E13.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-13
APPROVED BY:	JJD		

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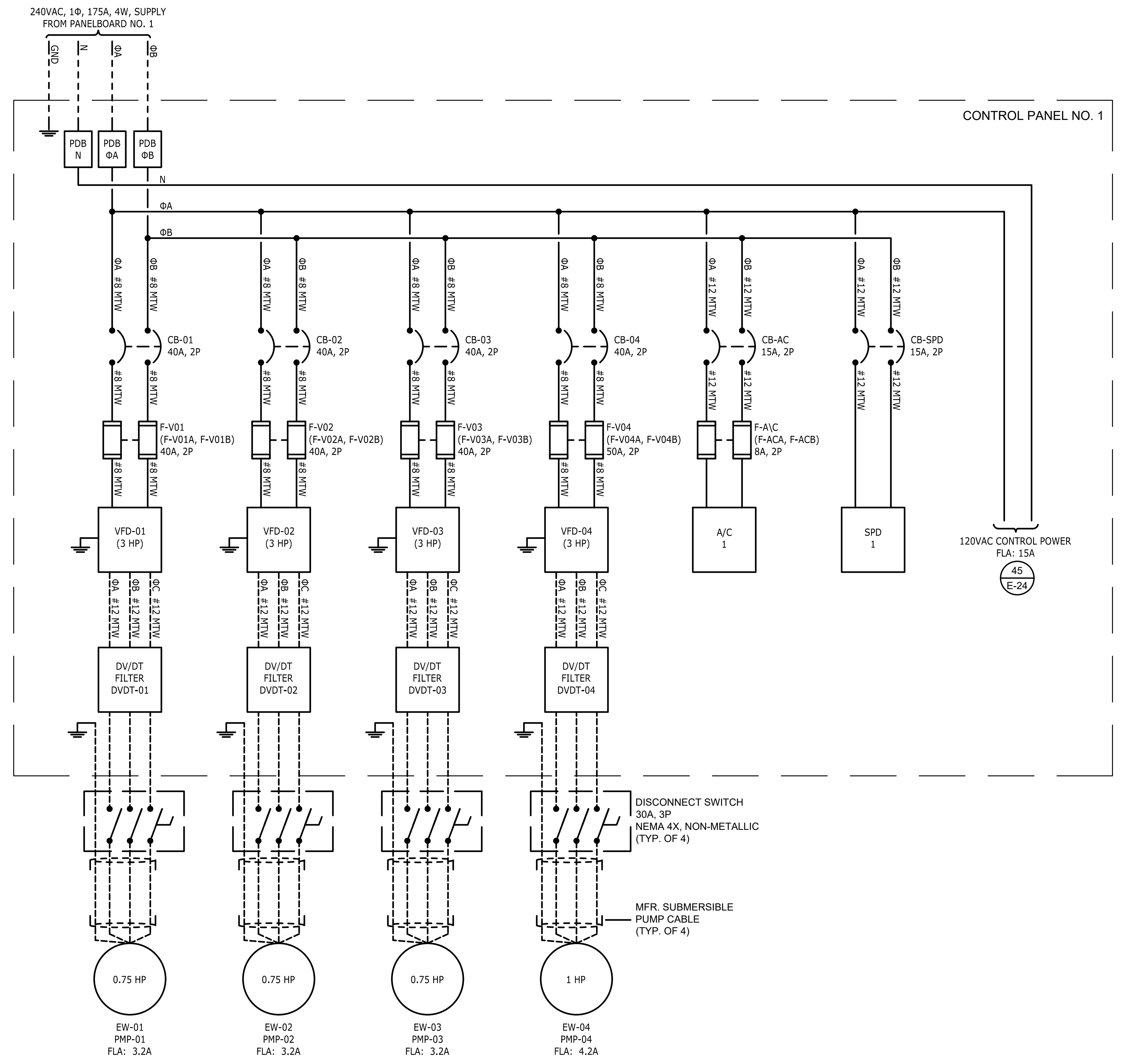

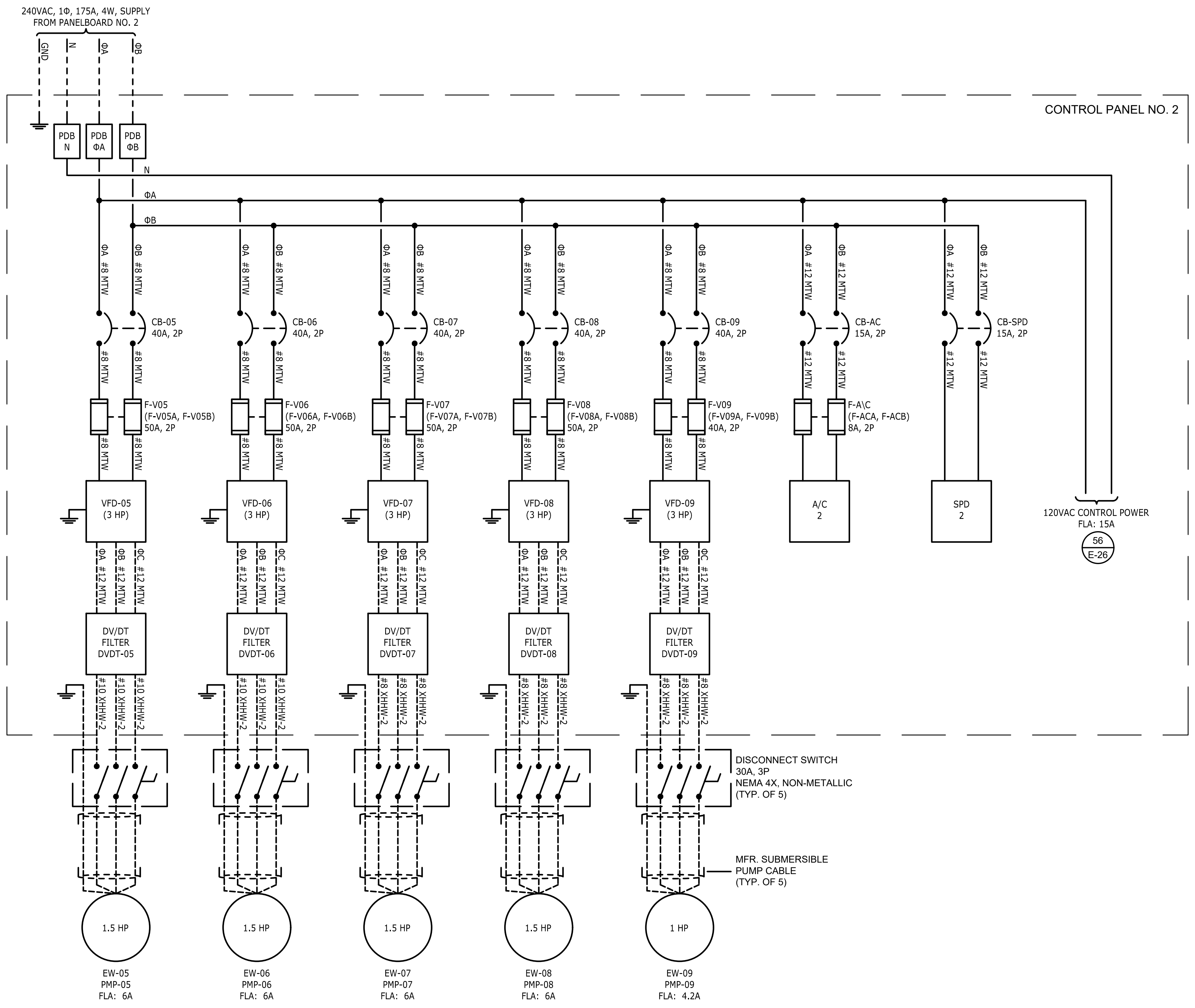

240VAC, 1Ø LOAD CALCULATIONS
CONTROL PANEL NO. 1

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-01 VFD (0.75 HP)	8.6A	8.6A
PUMP PMP-02 VFD (0.75 HP)	8.6A	8.6A
PUMP PMP-03 VFD (0.75 HP)	8.6A	8.6A
PUMP PMP-04 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-1	4.5A	4.5A
CONTROLS	15A	--
CONTROL PANEL NO. 1 FLA PER PHASE:	56	41 A
125% OF LARGEST MOTOR: 1.25 x 10.7 = 13.4A 13.4 - 10.7 = 2.7A		2.7A
CONTROL PANEL NO. 1 FLA:		58.7A

240VAC, 1Ø LOAD CALCULATIONS
CONTROL PANEL NO. 2

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-05 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-06 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-07 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-08 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-09 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-2	4.5A	4.5A
CONTROLS	15A	--
CONTROL PANEL NO. 2 FLA PER PHASE:	87.8A	72.8A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18.8A 18.8 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 2 FLA:		91.4A

NOTES:

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2. CONTROL PANELS HAVE BEEN DESIGNED TO ACCOMMODATE UP TO 6 EXTRACTION WELLS. EACH PANEL SHALL HAVE 1-2 SPARES TO ACCOMMODATE FUTURE EXPANSION IF NECESSARY.

90% DESIGN DRAWINGS

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
SINGLE LINE DIAGRAM I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	E-14
APPROVED BY:	JJD		

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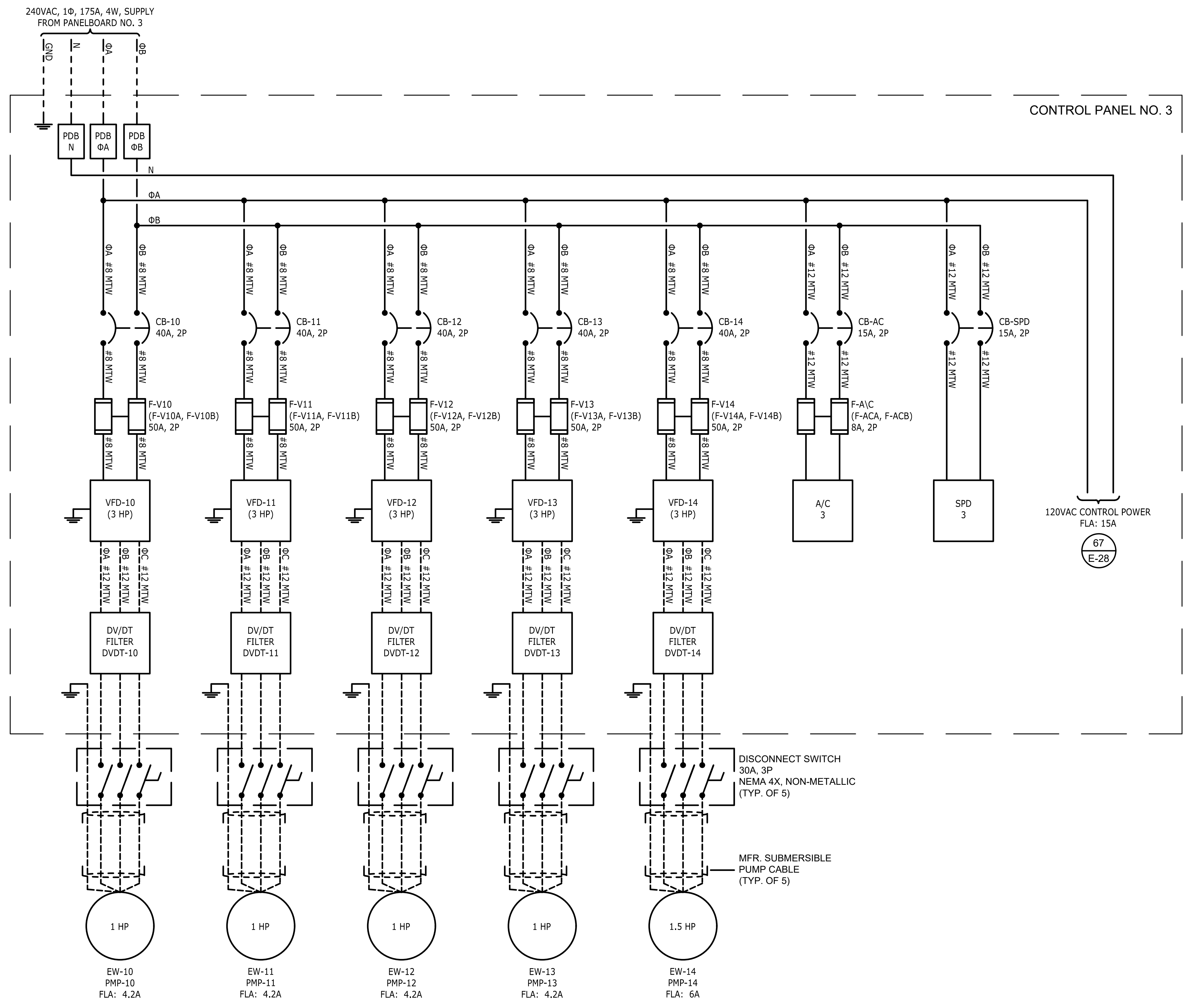

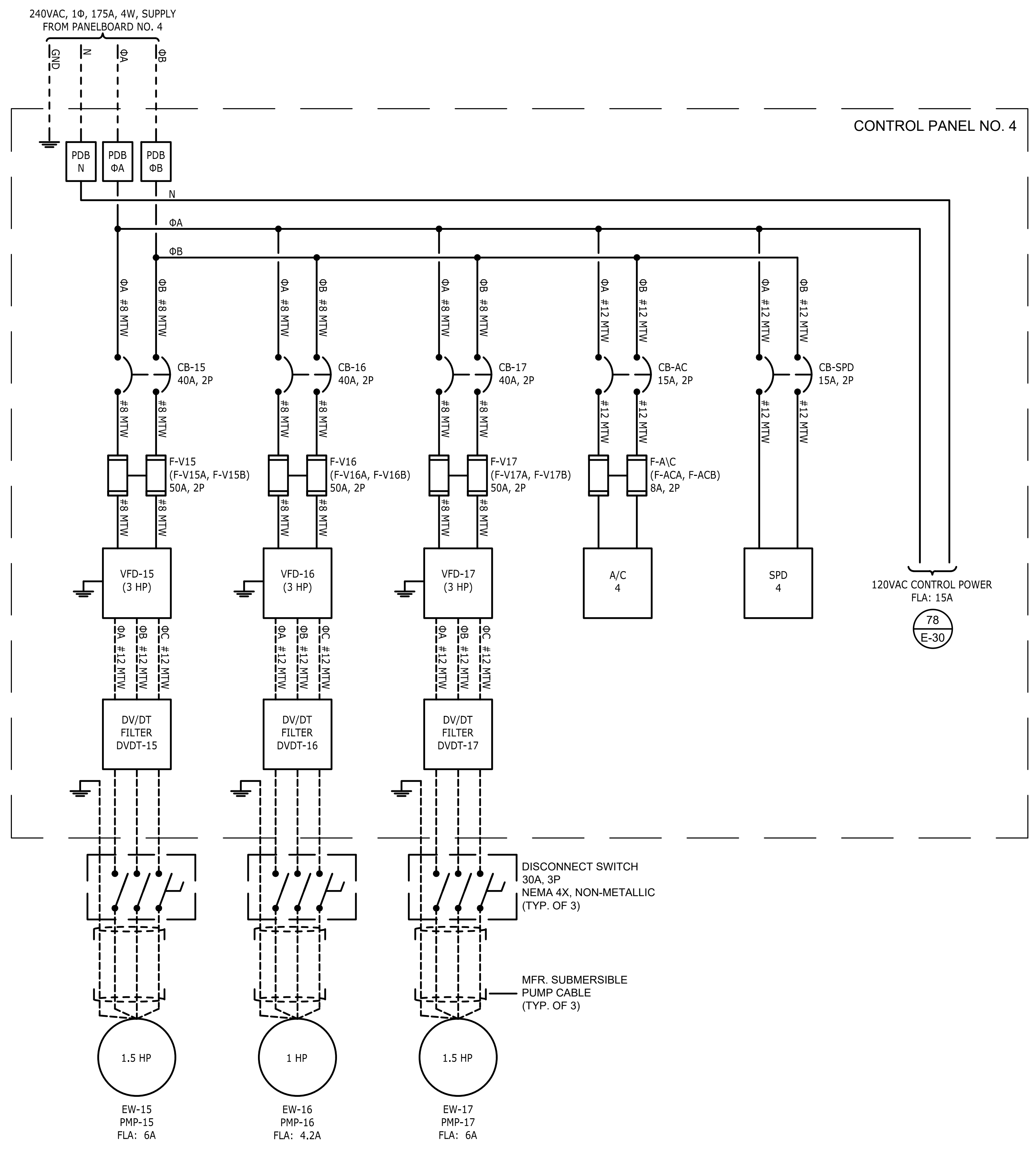

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 3		
EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-10 VFD (1 HP)	10.7A	10.7A
PUMP PMP-11 VFD (1 HP)	10.7A	10.7A
PUMP PMP-12 VFD (1 HP)	10.7A	10.7A
PUMP PMP-13 VFD (1 HP)	10.7A	10.7A
PUMP PMP-14 VFD (1.5 HP)	14.4A	14.4A
AIR CONDITIONER AC-3	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 3 FLA PER PHASE:	76.7A	61.7
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 3 FLA:		80.3A

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 4		
EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-15 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-16 VFD (1 HP)	10.7A	10.7A
PUMP PMP-17 VFD (1.5 HP)	14.4A	14.4A
AIR CONDITIONER AC-4	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 3 FLA PER PHASE:	59A	44A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 4 FLA:		62.6A

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
SINGLE LINE DIAGRAM II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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CHECKED BY:	CMDS	FILE:	TR0795A-E15.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-15
APPROVED BY:	JJD		

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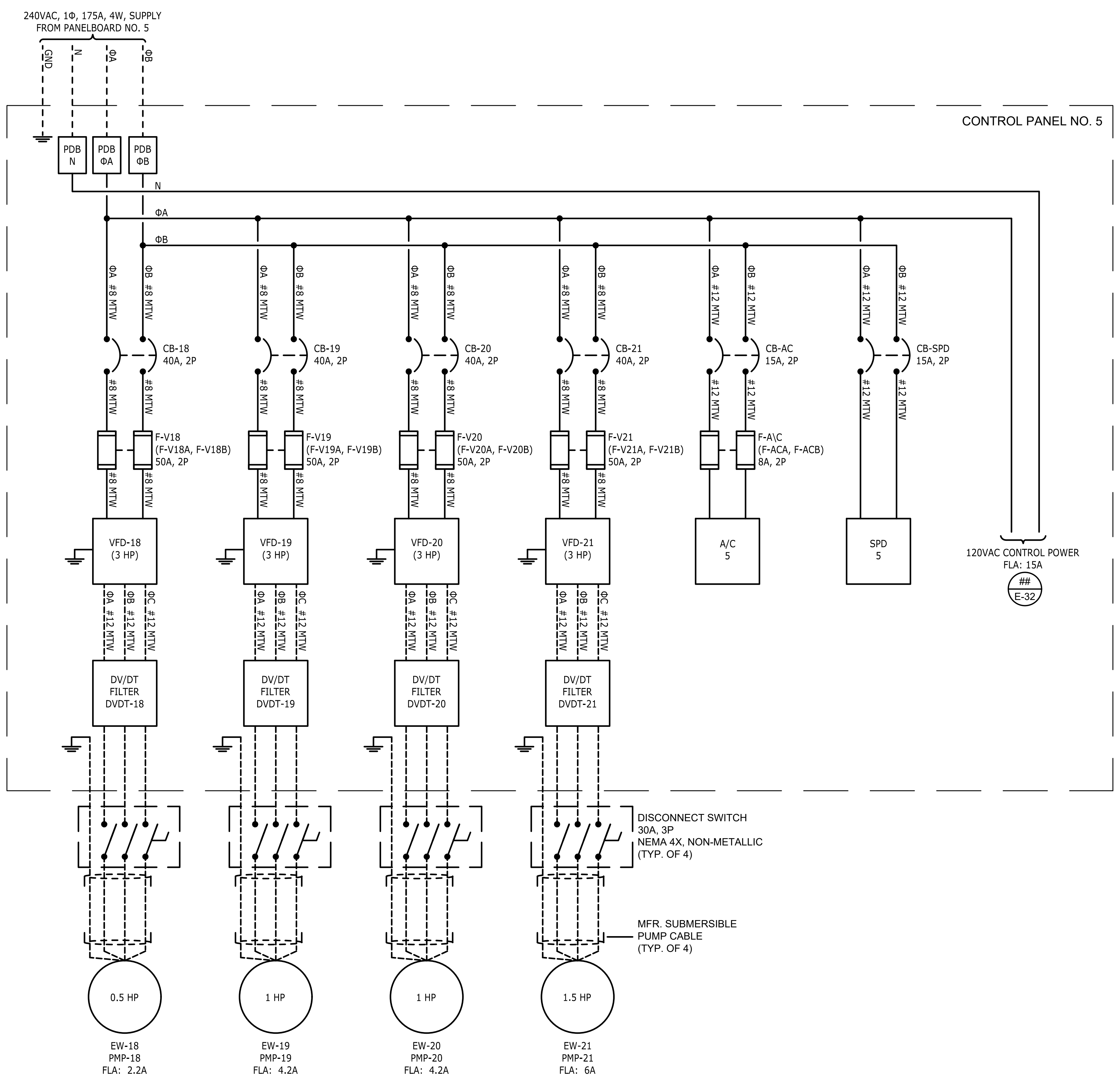

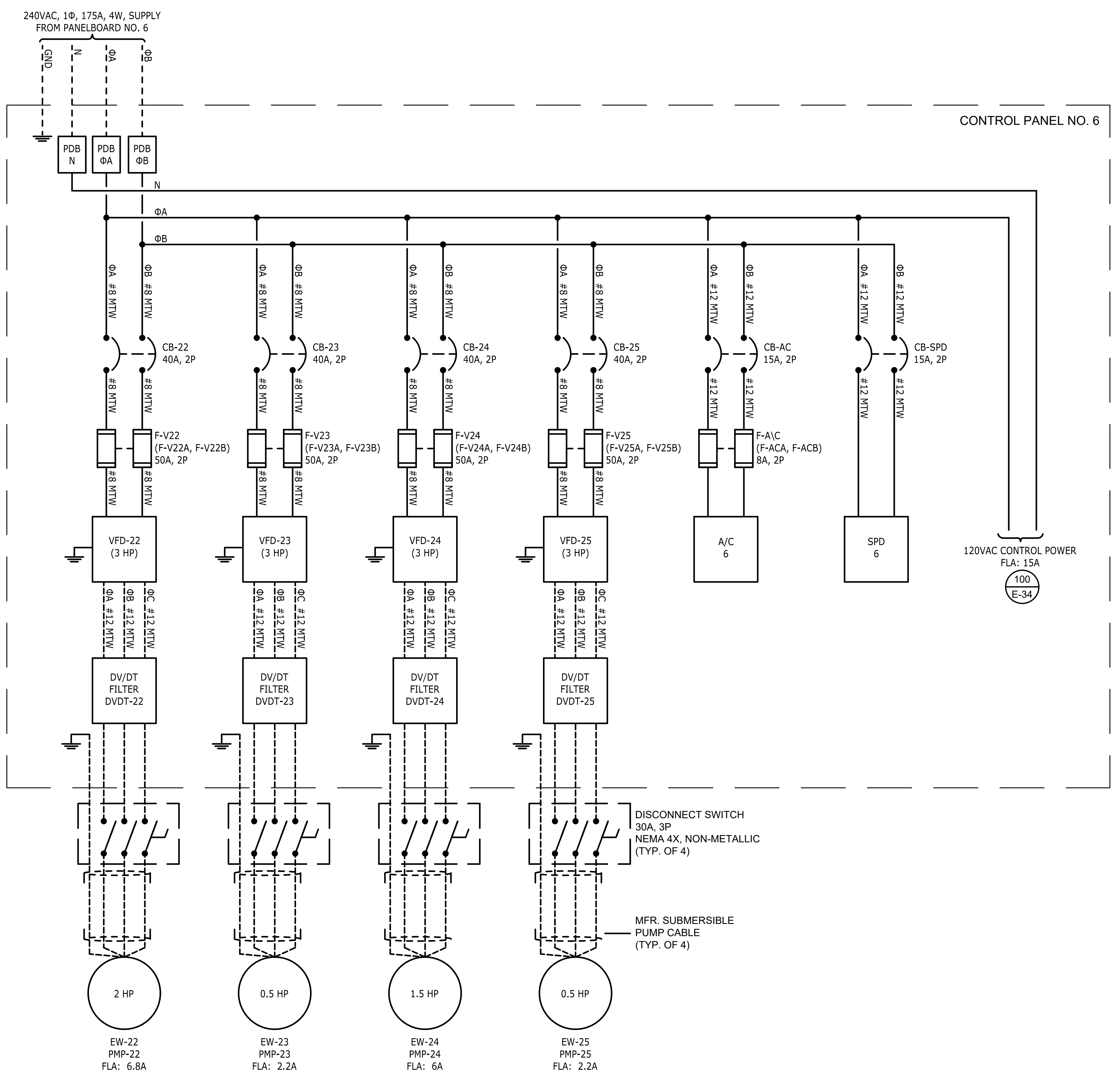

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 5

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-18 VFD (0.5 HP)	6.5A	6.5A
PUMP PMP-19 VFD (1 HP)	10.7A	10.7A
PUMP PMP-20 VFD (1 HP)	10.7A	10.7A
PUMP PMP-21 VFD (1.5 HP)	14.4A	14.4A
AIR CONDITIONER AC-5	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 5 FLA PER PHASE:	61.8A	46.8A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 5 FLA:		65.4A

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 6

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-22 VFD (2 HP)	18A	18A
PUMP PMP-23 VFD (0.5 HP)	6.5A	6.5A
PUMP PMP-24 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-25 VFD (0.5 HP)	6.5A	6.5A
AIR CONDITIONER AC-6	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 6 FLA PER PHASE:	64.9A	49.9A
125% OF LARGEST MOTOR: 1.25 x 18 = 22.5A 22.5 - 18 = 4.5A		4.5A
CONTROL PANEL NO. 6 FLA:		69.4A

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.
2. CONTROL PANELS HAVE BEEN DESIGNED TO ACCOMMODATE UP TO 6 EXTRACTION WELLS. EACH PANEL SHALL HAVE 1-2 SPARES TO ACCOMMODATE FUTURE EXPANSION IF NECESSARY.

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90% DESIGN DRAWINGS

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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
SINGLE LINE DIAGRAM III

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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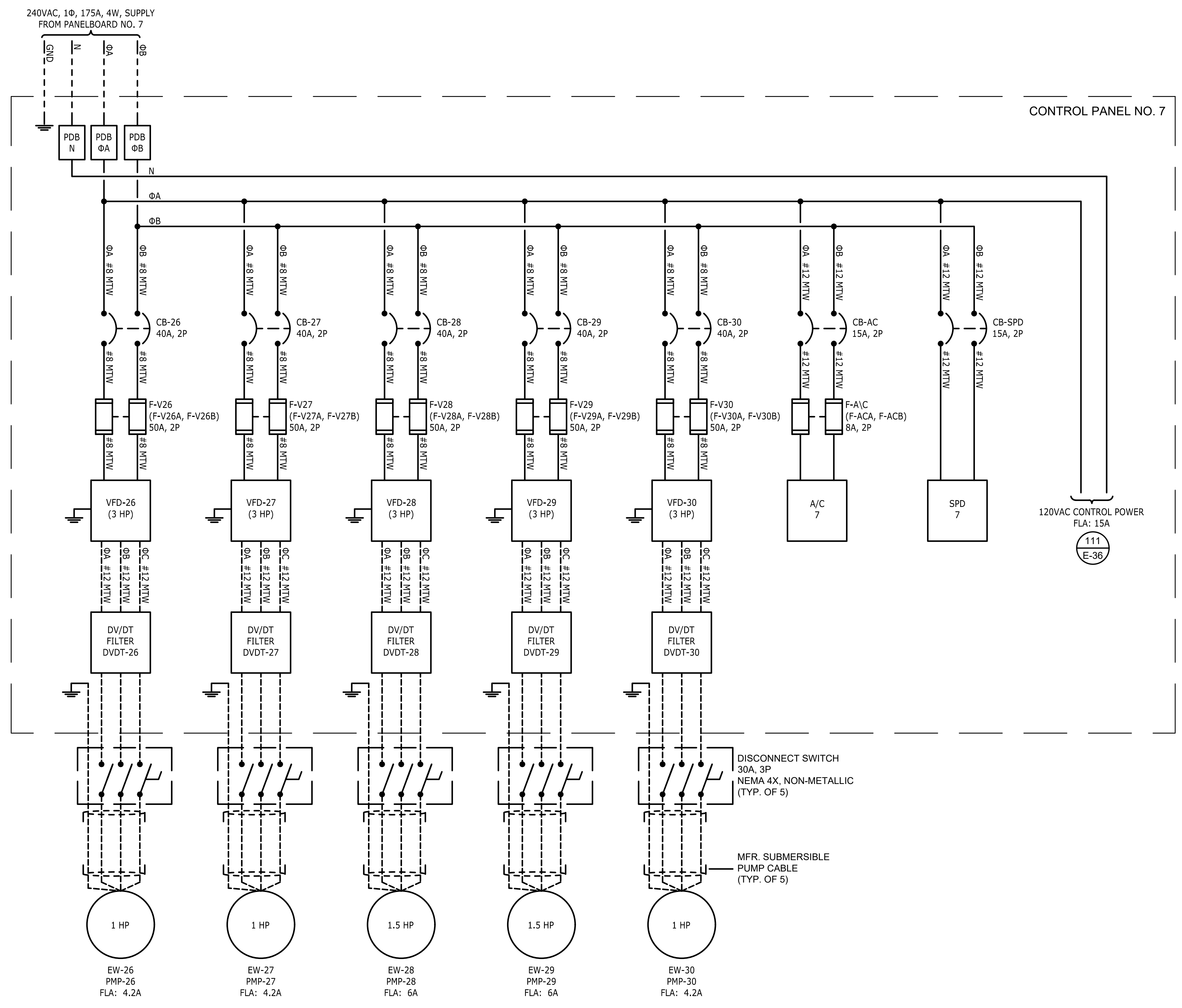

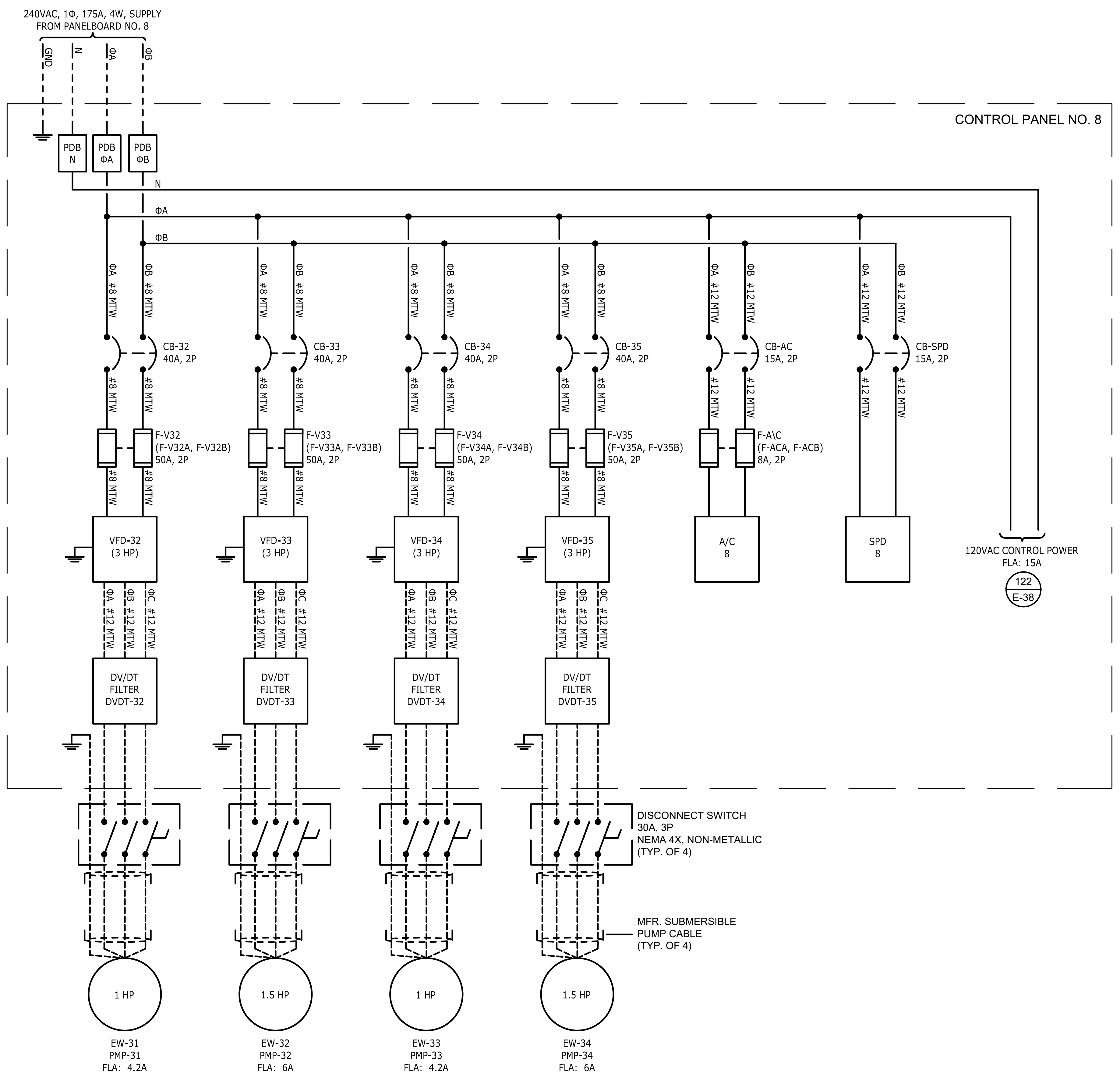

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 7

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-26 VFD (1 HP)	10.7A	10.7A
PUMP PMP-27 VFD (1 HP)	10.7A	10.7A
PUMP PMP-28 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-29 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-30 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-7	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 7 FLA PER PHASE:	80.4	65.4A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 7 FLA:		84A

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 8

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-31 VFD (1 HP)	10.7A	10.7A
PUMP PMP-32 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-33 VFD (1 HP)	10.7A	10.7A
PUMP PMP-34 VFD (1.5 HP)	14.4A	14.4A
AIR CONDITIONER AC-8	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 8 FLA PER PHASE:	69.7A	54.7A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 8 FLA:	73.3A	

NOTES:

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90% DESIGN DRAWINGS

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C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
SINGLE LINE DIAGRAM IV

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	E-17
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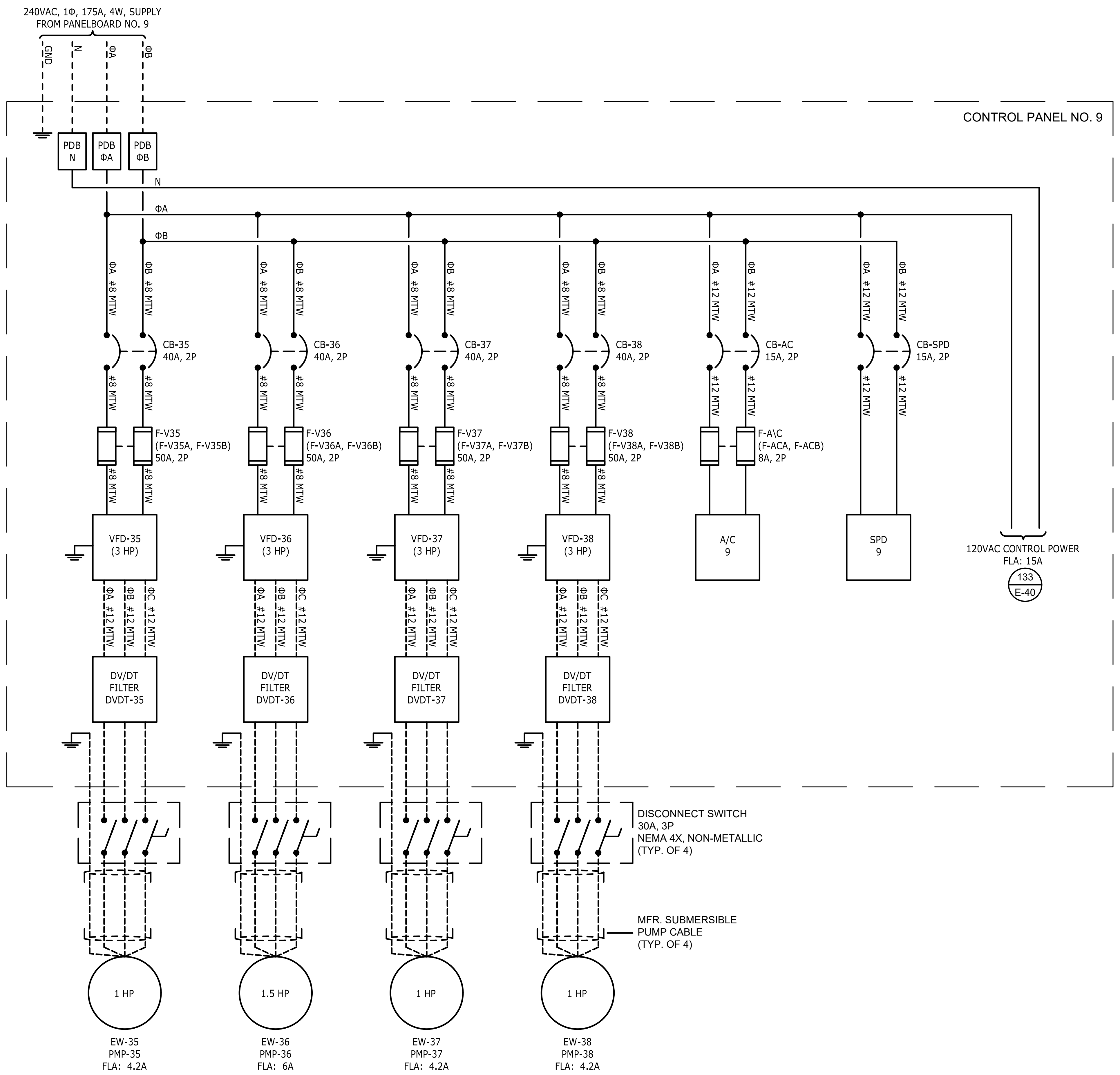

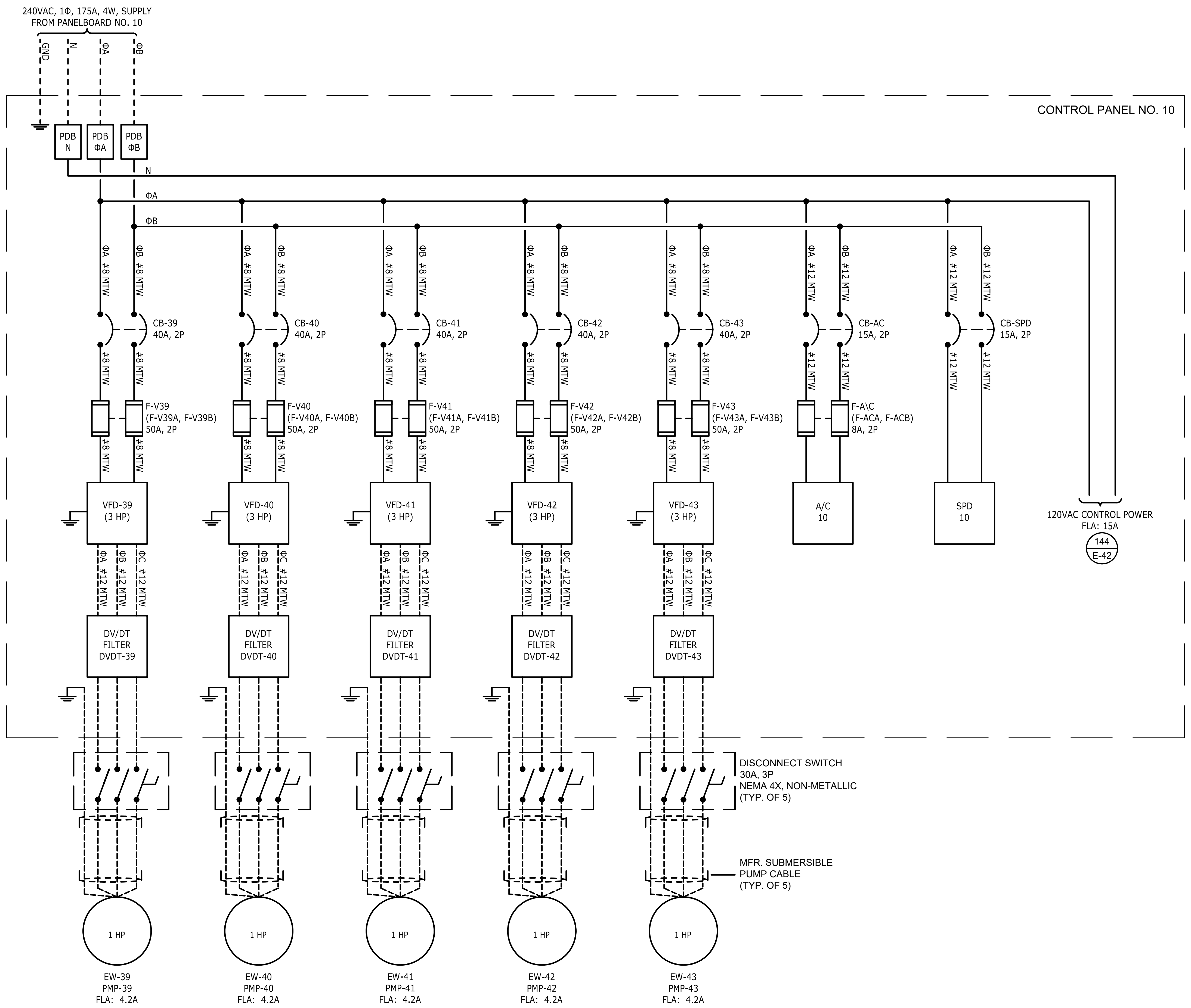

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 9

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-35 VFD (1 HP)	10.7A	10.7A
PUMP PMP-36 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-37 VFD (1 HP)	10.7A	10.7A
PUMP PMP-38 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-9	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 9 FLA PER PHASE:	66A	51A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 9 FLA:		69.6A

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 10

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-39 VFD (1 HP)	10.7A	10.7A
PUMP PMP-40 VFD (1 HP)	10.7A	10.7A
PUMP PMP-41 VFD (1 HP)	10.7A	10.7A
PUMP PMP-42 VFD (1 HP)	10.7A	10.7A
PUMP PMP-43 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-10	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 10 FLA PER PHASE:	73A	58A
125% OF LARGEST MOTOR: 1.25 x 10.7 = 13.4A 13.4 - 10.7 = 2.7A		2.7A
CONTROL PANEL NO. 10 FLA:		75.7A

NOTES:

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90% DESIGN DRAWINGS

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TITLE:
SINGLE LINE DIAGRAM V

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DATE: DECEMBER 2021
PROJECT NO.: TR0795A
FILE: TR0795A-E18.DWG
DRAWING NO.: E-18

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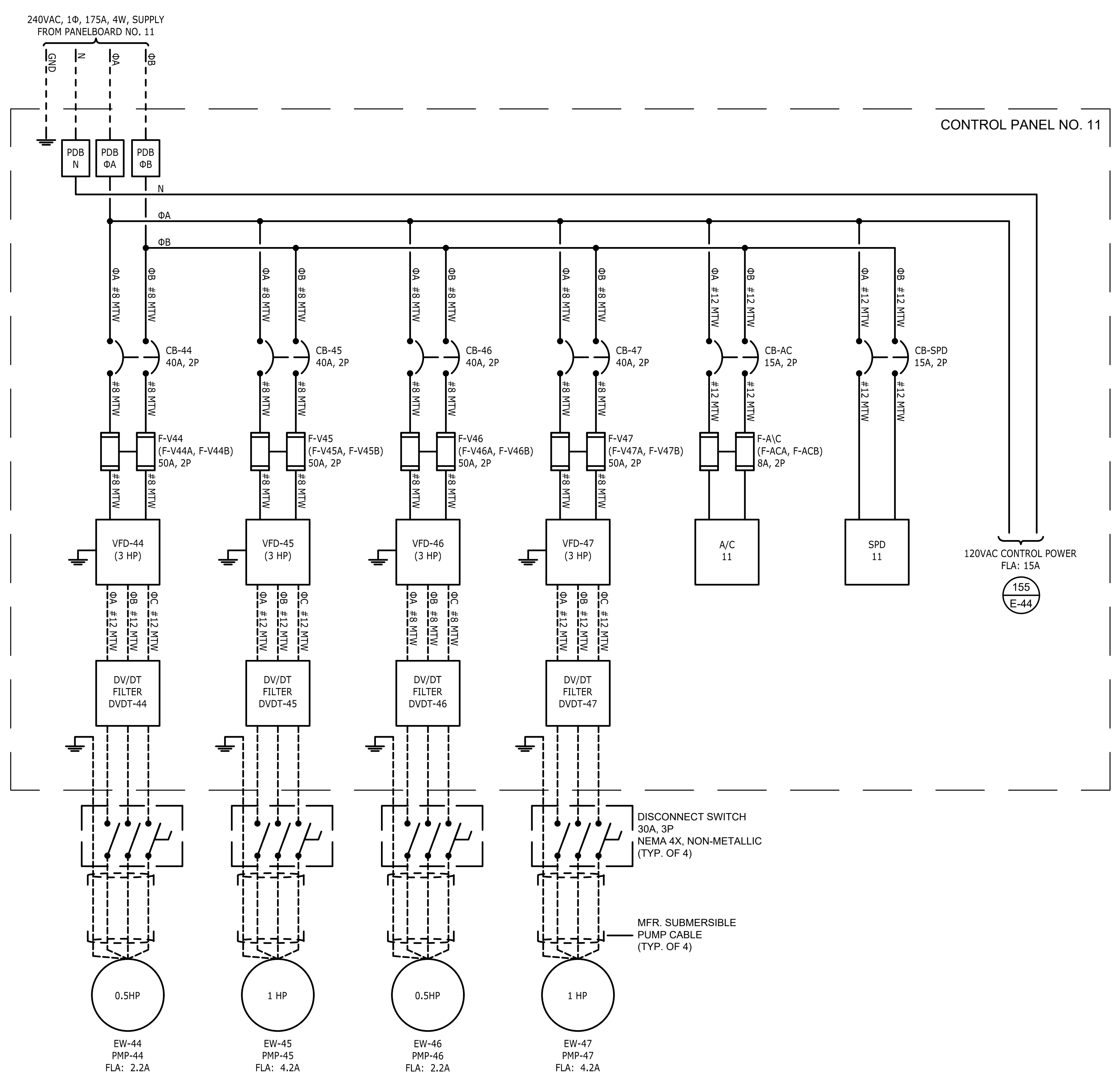

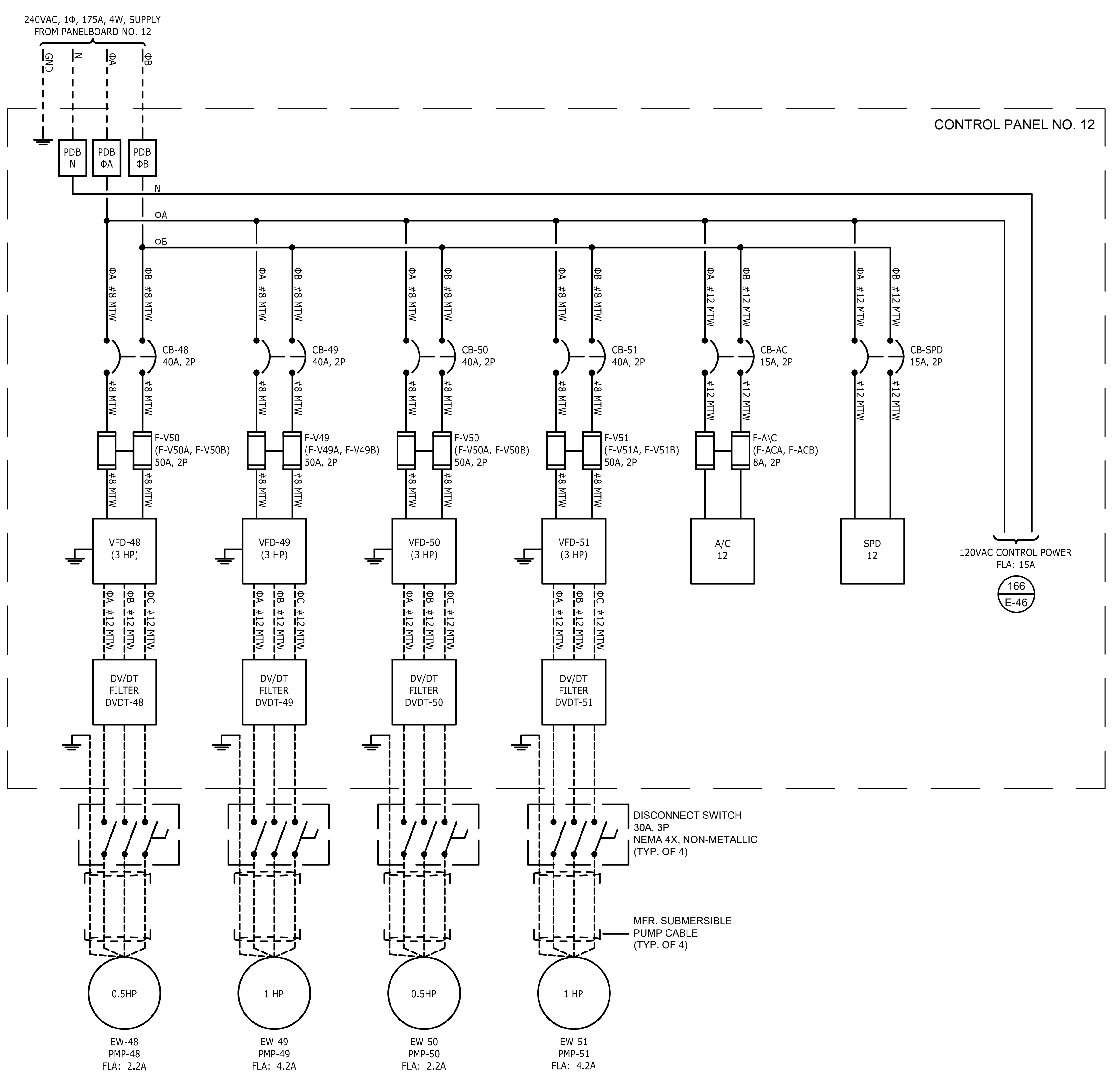

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 11

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-44 VFD (0.5 HP)	6.5A	6.5A
PUMP PMP-45 VFD (1 HP)	10.7A	10.7A
PUMP PMP-46 VFD (0.5 HP)	6.5A	6.5A
PUMP PMP-47 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-11	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 11 FLA PER PHASE:	53.9A	38.9A
125% OF LARGEST MOTOR: 1.25 x 10.7 = 13.4A 13.4 - 10.7 = 2.7A		2.7A
CONTROL PANEL NO. 11 FLA:		56.6A

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 12

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-48 VFD (0.5 HP)	6.5A	6.5A
PUMP PMP-49 VFD (1 HP)	10.7A	10.7A
PUMP PMP-50 VFD (0.5 HP)	6.5A	6.5A
PUMP PMP-51 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-12	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 12 FLA PER PHASE:	53.9A	38.9A
125% OF LARGEST MOTOR: 1.25 x 10.7 = 13.4A 13.4 - 10.7 = 2.7A		2.7A
CONTROL PANEL NO. 12 FLA:		56.6A

NOTES:

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919.870.0576

TITLE:
SINGLE LINE DIAGRAM VI

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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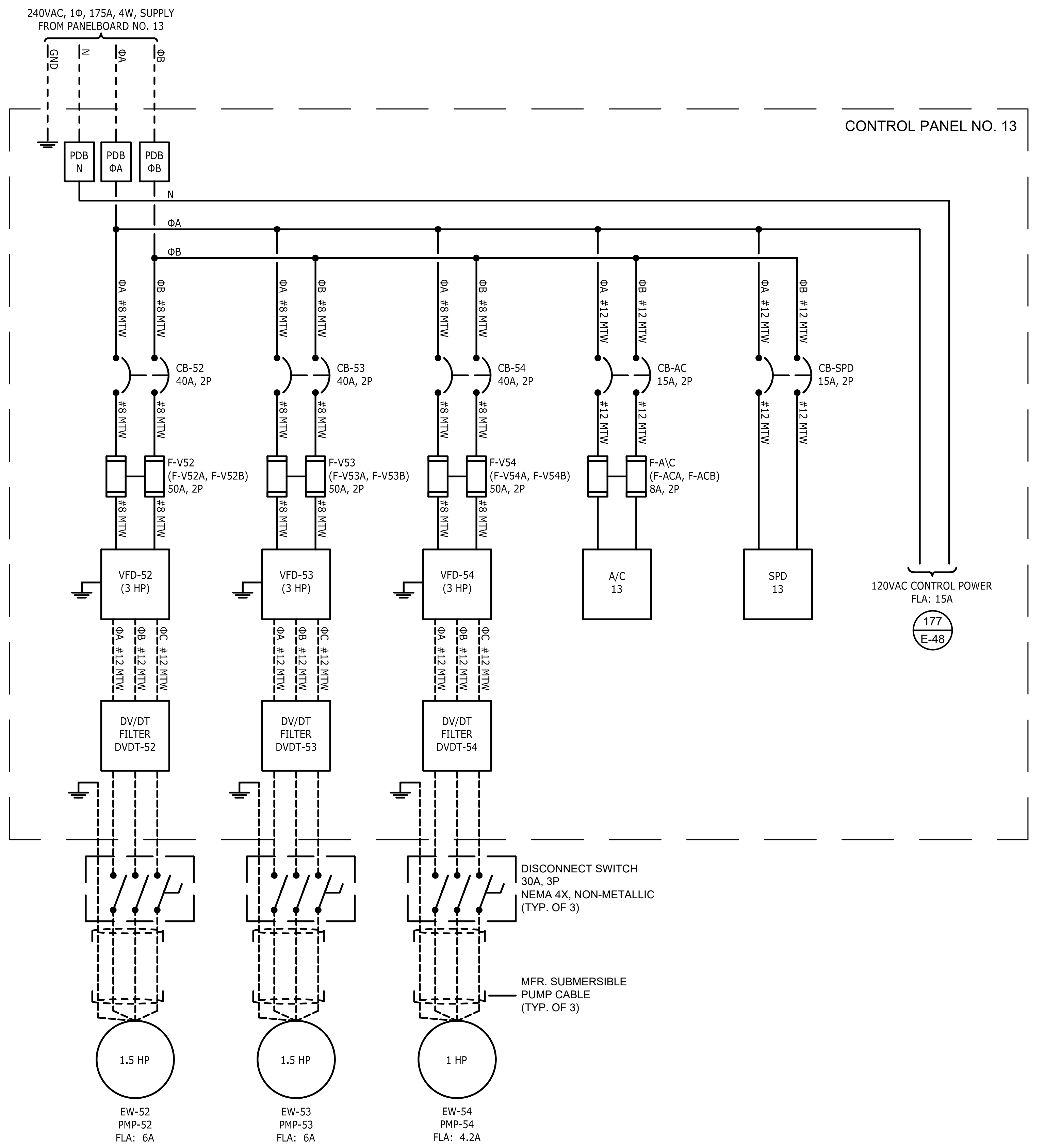

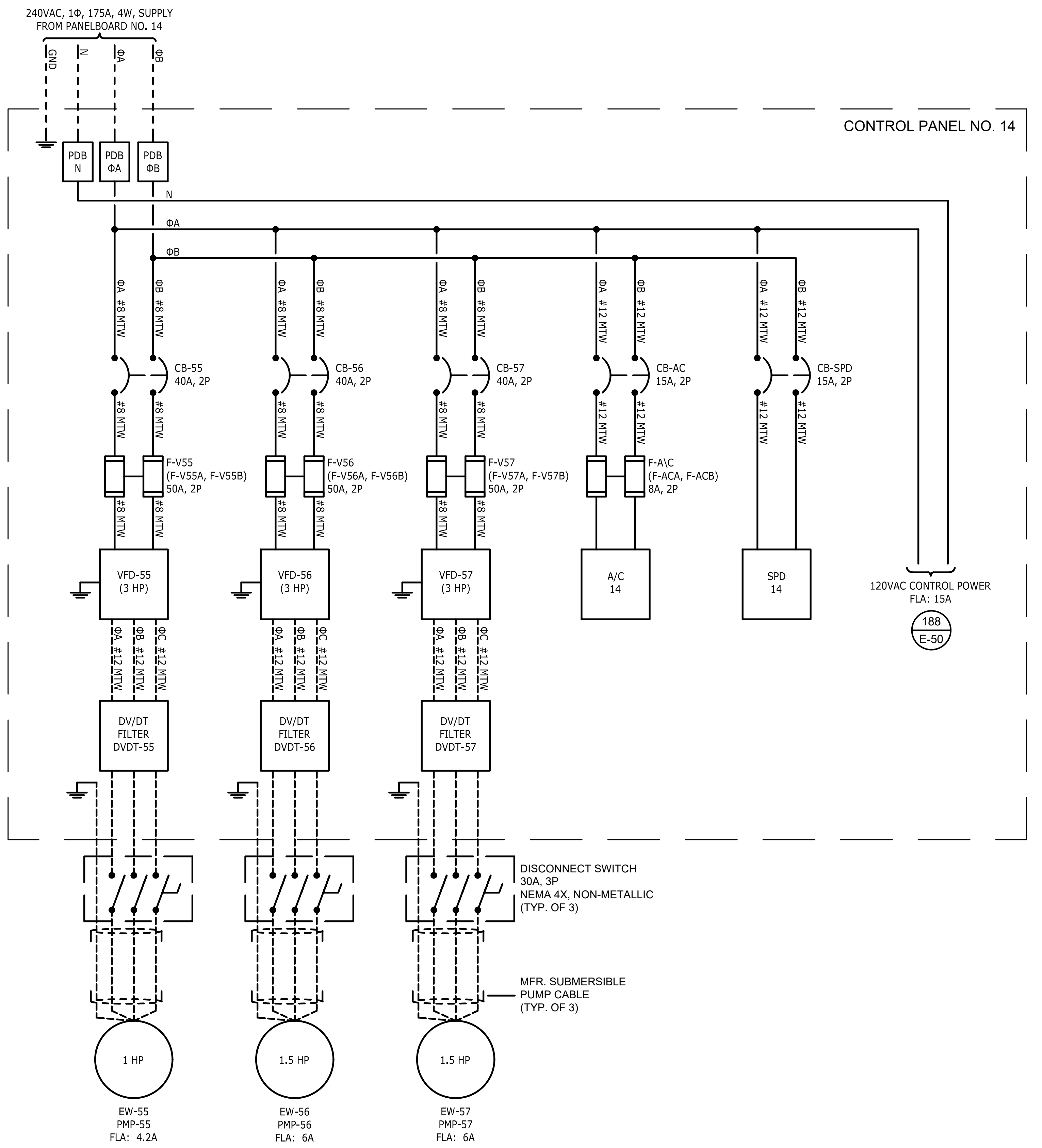

240VAC, 1Ø LOAD CALCULATIONS
CONTROL PANEL NO. 13

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-52 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-53 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-54 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-13	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 13 FLA PER PHASE:	59A	44A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 13 FLA:		62.6A

240VAC, 1Ø LOAD CALCULATIONS
CONTROL PANEL NO. 14

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-55 VFD (1 HP)	10.7A	10.7A
PUMP PMP-56 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-57 VFD (1 HP)	10.7A	10.7A
AIR CONDITIONER AC-14	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 14 FLA PER PHASE:	55.3A	40.3A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 14 FLA:		58.9A

NOTES:

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919.870.0576

TITLE:
SINGLE LINE DIAGRAM VII

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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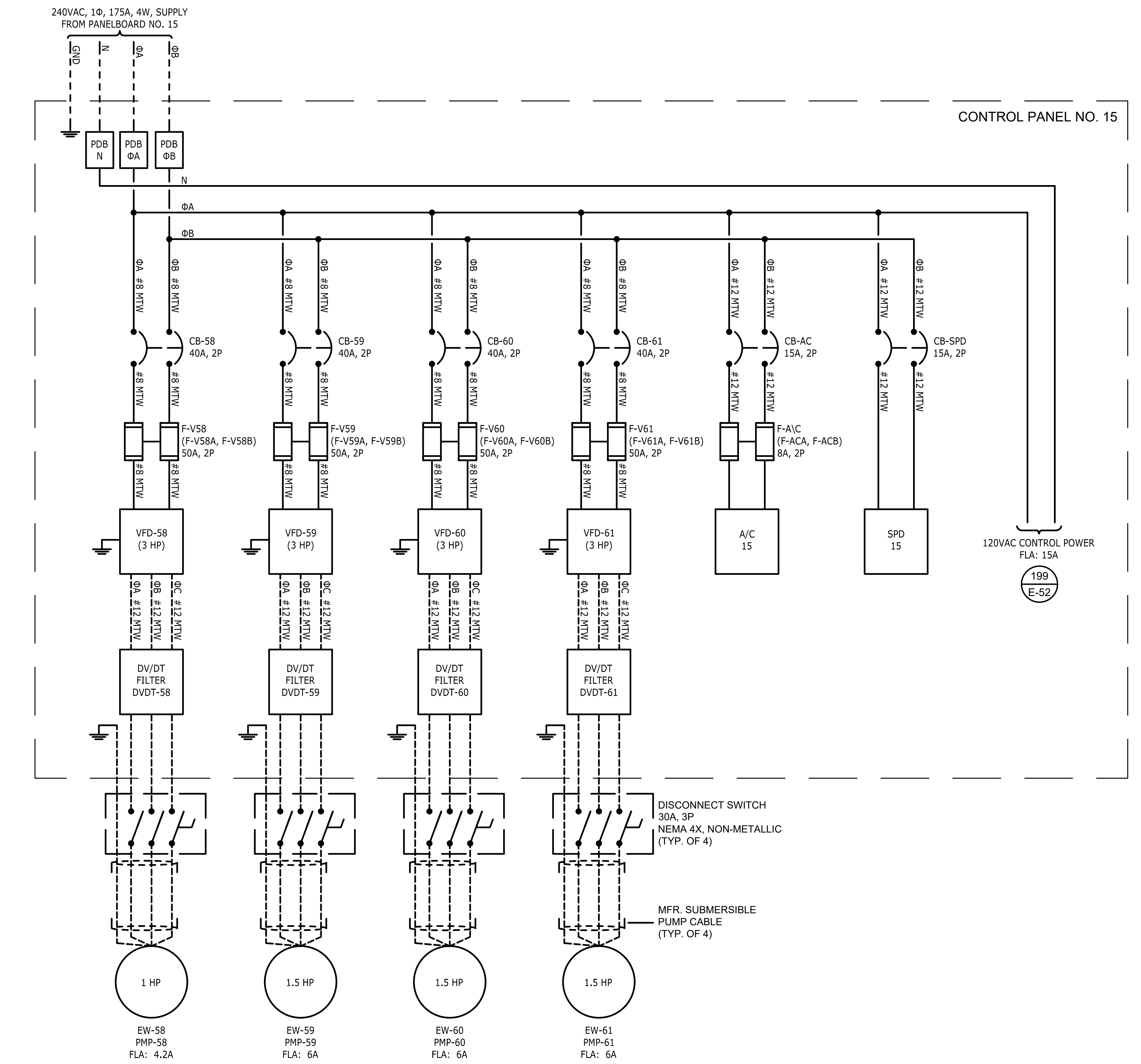

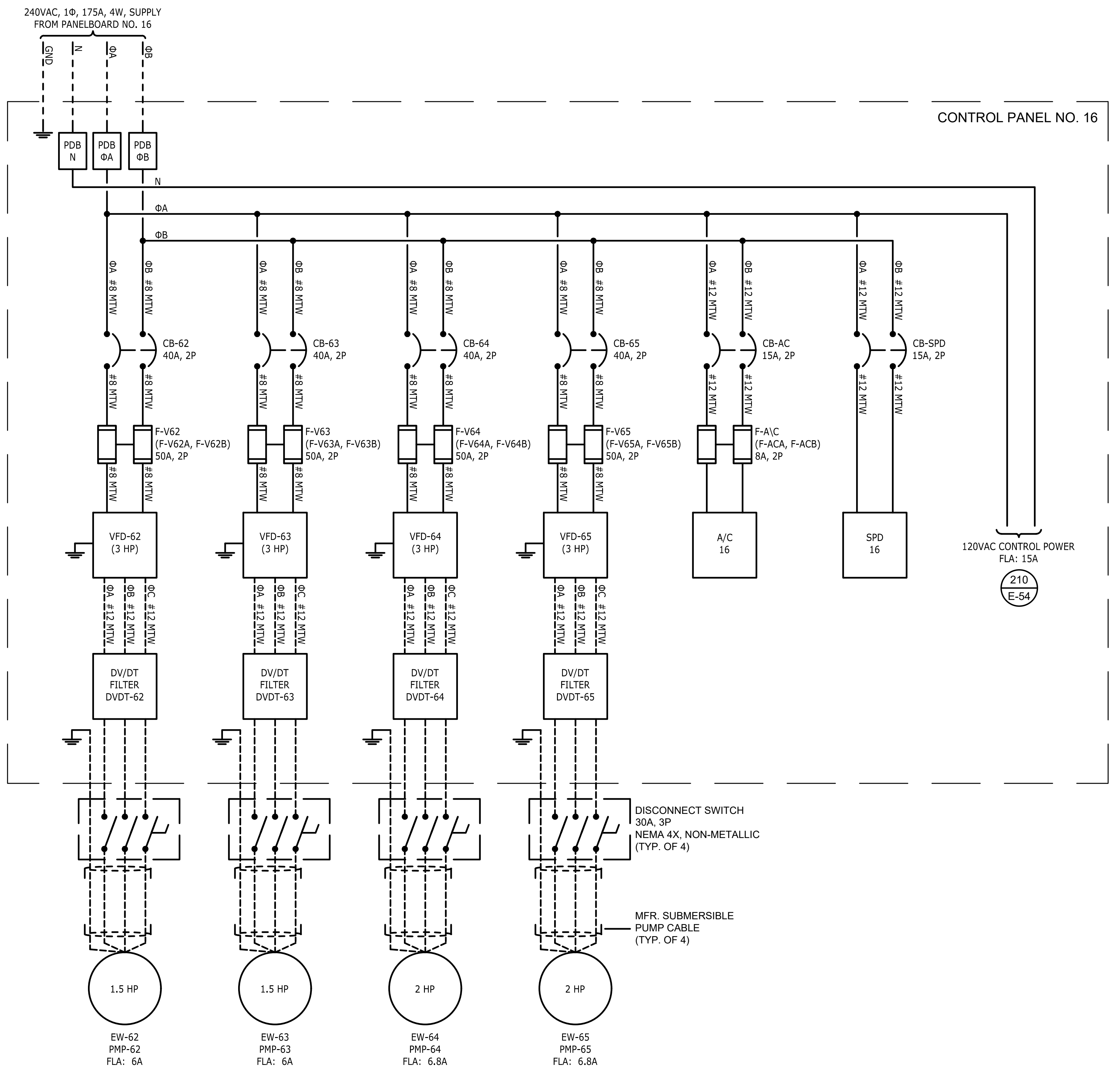

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 15

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-58 VFD (1 HP)	10.7	10.7
PUMP PMP-59 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-60 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-61 VFD (1.5 HP)	14.4A	14.4A
AIR CONDITIONER AC-13	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 15 FLA PER PHASE:	73.4A	58.4A
125% OF LARGEST MOTOR: 1.25 x 14.4 = 18A 18 - 14.4 = 3.6A		3.6A
CONTROL PANEL NO. 15 FLA:		77A

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 16

EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-62 VFD (1.5HP)	14.4A	14.4A
PUMP PMP-63 VFD (1.5 HP)	14.4A	14.4A
PUMP PMP-64 VFD (2 HP)	18A	18A
PUMP PMP-65 VFD (2 HP)	18A	18A
AIR CONDITIONER AC-14	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 16 FLA PER PHASE:	84.3A	69.3A
125% OF LARGEST MOTOR: 1.25 x 18 = 22.5A 22.5 - 18 = 4.5A		4.5A
CONTROL PANEL NO. 16 FLA:		88.8A

NOTES:

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919.870.0576

TITLE:
SINGLE LINE DIAGRAM VIII

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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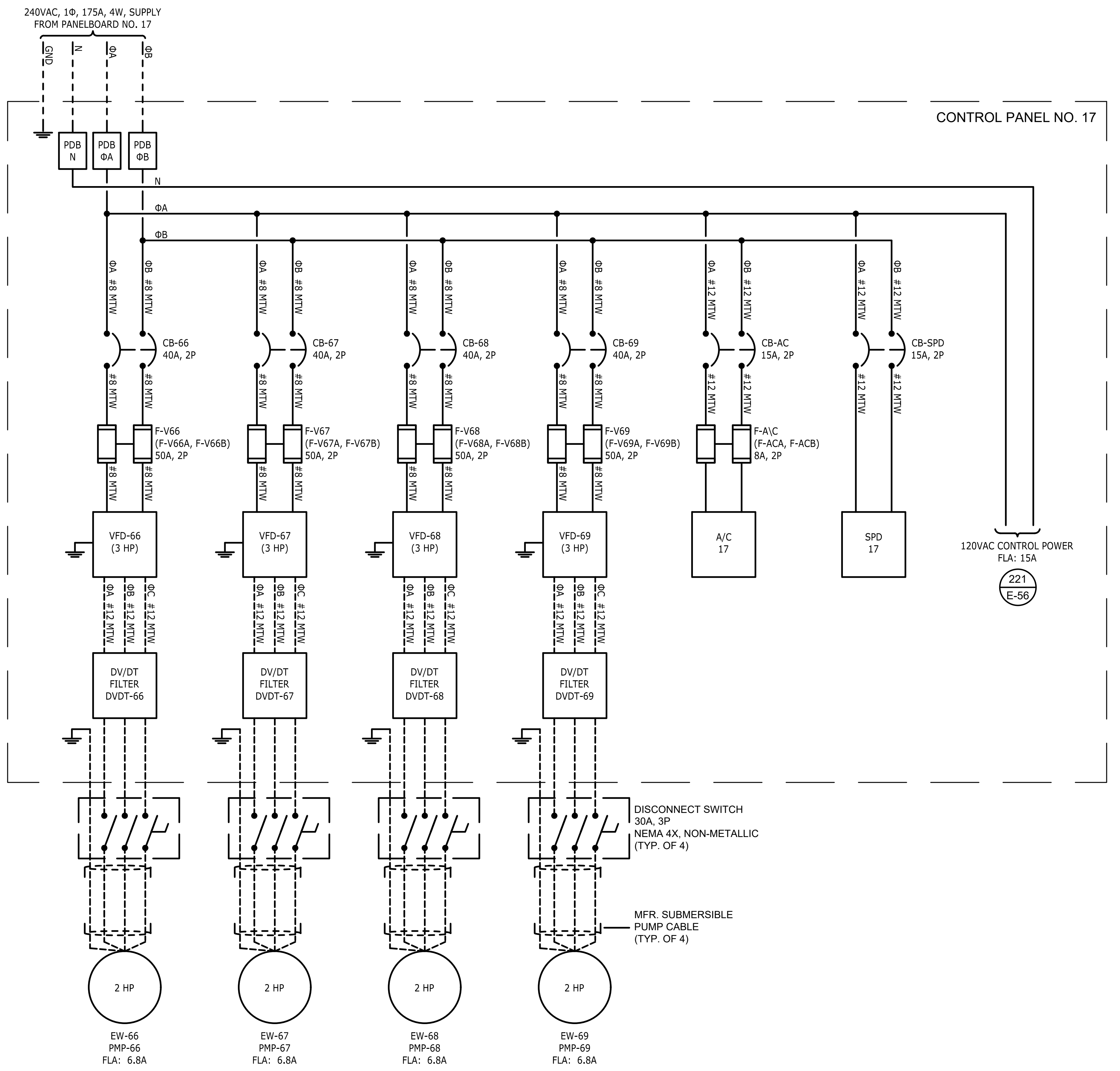

240VAC, 1Ø LOAD CALCULATIONS CONTROL PANEL NO. 17		
EQUIPMENT TYPE	PHASE L1	PHASE L2
PUMP PMP-66 VFD (2 HP)	18A	18A
PUMP PMP-67 VFD (2 HP)	18A	18A
PUMP PMP-68 VFD (2 HP)	18A	18A
PUMP PMP-69 VFD (2 HP)	18A	18A
AIR CONDITIONER AC-13	4.5A	4.5A
CONTROLS	15A	-
CONTROL PANEL NO. 17 FLA PER PHASE:	91.5A	76.5A
125% OF LARGEST MOTOR: 1.25 x 18 = 22.5A 22.5 - 18 = 4.5A		4.5A
CONTROL PANEL NO. 17 FLA:		96A

NOTES:

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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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RALEIGH, NC 27607
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TITLE:
SINGLE LINE DIAGRAM IX

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
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PROJECT NO.: TR0795A
FILE: TR0795A-E22.DWG
DRAWING NO.: E-22

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CONTROL PANEL NO. 1				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-01, CB-02, CB-03, CB-04	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V01, F-V02, F-V03, F-V04	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-01, VFD-02, VFD-03, VFD-04	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-01, DVDT-02, DVDT-03	3	V1K4A00EX	TCI	DV/DT FILTER, 4A, 3-PHASE, OPEN
DVDT-04	1	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 2				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-05, CB-06, CB-07, CB-08, CB-09	5	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V05, F-V06, F-V07, F-V08, F-V09	5	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	10	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	10	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-05, VFD-06, VFD-07, VFD-08, VFD-09	5	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-05, DVDT-06, DVDT-07, DVDT-08, DVDT-09	5	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 3				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-10, CB-11, CB-12, CB-13, CB-14	5	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V10, F-V11, F-V12, F-V13, F-V14	5	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	10	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	10	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-10, VFD-11, VFD-12, VFD-13, VFD-14	5	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-10, DVDT-11, DVDT-12, DVDT-13, DVDT-14	5	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 4				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-15, CB-16, CB-17	3	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V15, F-V16, F-V17	3	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	6	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	6	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-15, VFD-16, VFD-17	3	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-15, DVDT-16, DVDT-17	3	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 5				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-18, CB-19, CB-20, CB-21	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V18, F-V19, F-V20, F-V21	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-18, VFD-19, VFD-20, VFD-21	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-18	1	V1K3A00EX	TCI	DV/DT FILTER, 3A, 3-PHASE, OPEN
DVDT-19, DVDT-20, DVDT-21	3	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 6				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-22, CB-23, CB-24, CB-25	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V22, F-V23, F-V24, F-V25	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-22, VFD-23, VFD-24, VFD-25	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-22	1	V1K8A00EX	TCI	DV/DT FILTER, 8A, 3-PHASE, OPEN
DVDT-23, DVDT-25	2	V1K3A00EX	TCI	DV/DT FILTER, 3A, 3-PHASE, OPEN
DVDT-24	1	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 7				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-26, CB-27, CB-28, CB-29, CB-30	5	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V26, F-V27, F-V28, F-V29, F-V30	5	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	10	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	10	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-26, VFD-27, VFD-28, VFD-29, VFD-30	5	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-26, DVDT-27, DVDT-28, DVDT-29, DVDT-30	5	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 8				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-31, CB-32, CB-33, CB-34	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V31, F-V32, F-V33, F-V34	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-31, VFD-32, VFD-33, VFD-34	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-31, DVDT-32, DVDT-33, DVDT-34	4	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 9				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-35, CB-36, CB-37, CB-38	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V35, F-V36, F-V37, F-V38	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-35, VFD-36, VFD-37, VFD-38	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-35, DVDT-36, DVDT-37, DVDT-38	4	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 10				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-39, CB-40, CB-41, CB-42, CB-43	5	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V39, F-V40, F-V41, F-V42, F-V43	5	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	10	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	10	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-39, VFD-40, VFD-41, VFD-42, VFD-43	5	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-39, DVDT-40, DVDT-41, DVDT-42, DVDT-43	5	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 11				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-44, CB-45, CB-46, CB-47	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V44, F-V45, F-V46, F-V47	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-44, VFD-45, VFD-46, VFD-47	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-44, DVDT-46	2	V1K3A00EX	TCI	DV/DT FILTER, 3A, 3-PHASE, OPEN
DVDT-45, DVDT-47	2	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 12				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-48, CB-49, CB-50, CB-51	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V48, F-V49, F-V50, F-V51	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-48, VFD-49, VFD-50, VFD-51	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-48, DVDT-50	2	V1K3A00EX	TCI	DV/DT FILTER, 3A, 3-PHASE, OPEN
DVDT-49, DVDT-51	2	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 13				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-52, CB-53, CB-54	3	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V52, F-V53, F-V54	3	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	6	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	6	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-52, VFD-53, VFD-54	3	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
VFD-52, VFD-53, DVDT-54	1	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 14				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-55, CB-56, CB-57	3	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V55, F-V56, F-V57	3	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	6	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	6	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-55, VFD-56, VFD-57	3	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-55, DVDT-56, DVDT-57	3	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 15				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-58, CB-59, CB-60 CB-61	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V58, F-V59, F-V60 F-V61	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-58, VFD-59, VFD-60 VFD-61	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-58, DVDT-59, DVDT-60 DVDT-61	4	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN

CONTROL PANEL NO. 16				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-62, CB-63, CB-64, CB-65	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V62, F-V63, F-V64, F-V65	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-62, VFD-63, VFD-64, VFD-65	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-62, DVDT-63	2	V1K6A00EX	TCI	DV/DT FILTER, 6A, 3-PHASE, OPEN
DVDT-64, DVDT-65	2	V1K8A00EX	TCI	DV/DT FILTER, 8A, 3-PHASE, OPEN

CONTROL PANEL NO. 17				
EQUIPMENT ID NO.	QTY	PART NO.	MANUFACTURER	DESCRIPTION
CB-66, CB-67, CB-68, CB-69	4	FAZ-D40-2-NA	EATON	CIRCUIT BREAKER, 2-POLE, 40A, TRIP CURVE D, UL489
F-V66, F-V67, F-V68, F-V69	4	LFT300602C	LITTELFUSE	FUSE BLOCK, CLASS T, 2-POLE, 60A, 600VAC, #2-4, 6-14 CU
	8	LFT30060FBC	LITTELFUSE	FUSE BLOCK COVER, 60A, CLASS T
	8	JLLN040	LITTELFUSE	FUSE, CLASS T, 50A, 300VAC
VFD-66, VFD-67, VFD-68, VFD-69	4	25A-A011N104	ALLEN-BRADLEY	POWERFLEX 523 AC DRIVE, 240VAC, 1-PHASE, 11A, 3HP, FRAME B, IP20
DVDT-66, DVDT-67, DVDT-68, DVDT-69	4	V1K8A00EX	TCI	DV/DT FILTER, 8A, 3-PHASE, OPEN

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:

CONTROL PANEL EQUIPMENT SCHEDULES

PROJECT:

THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:

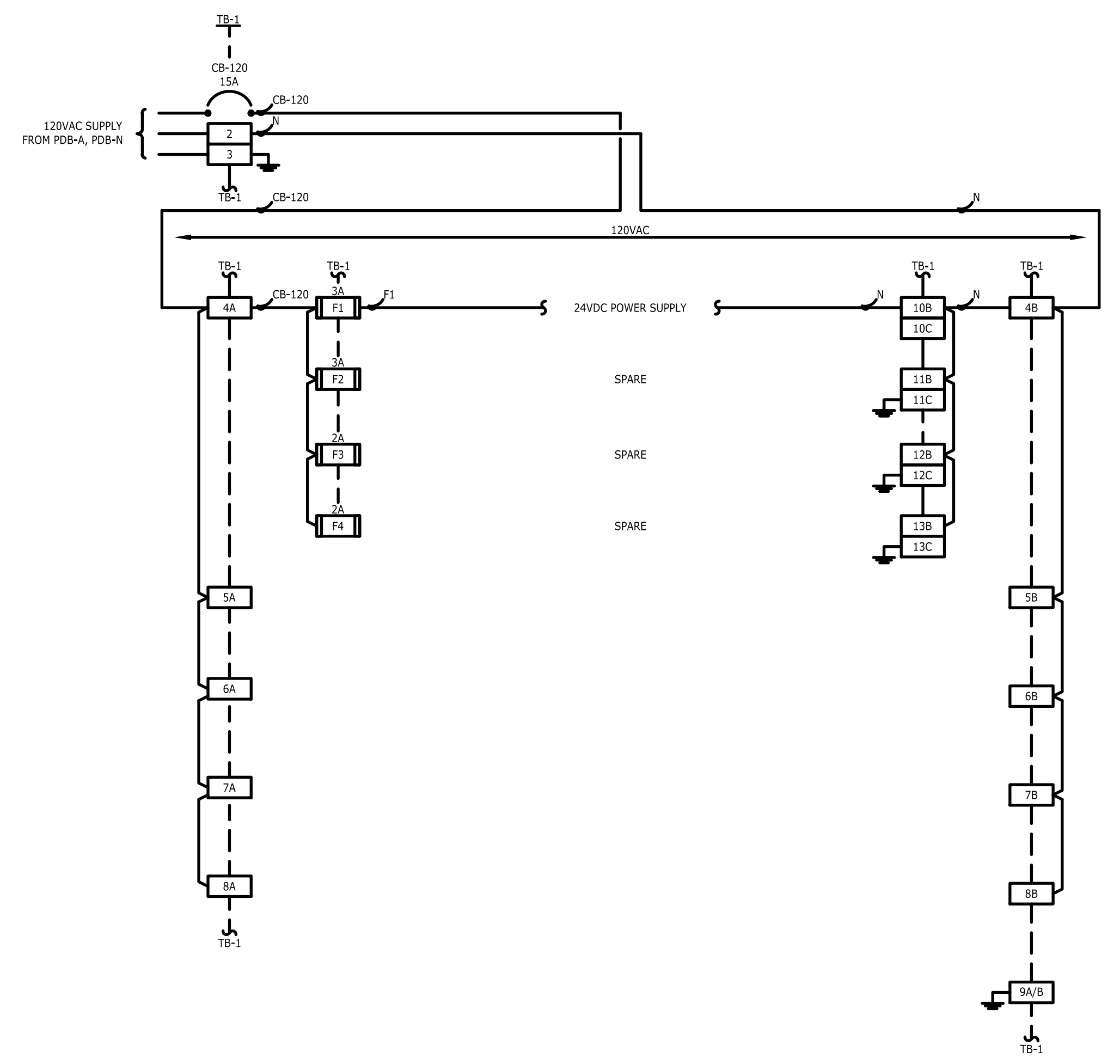
FAYETTEVILLE WORKS SITE

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

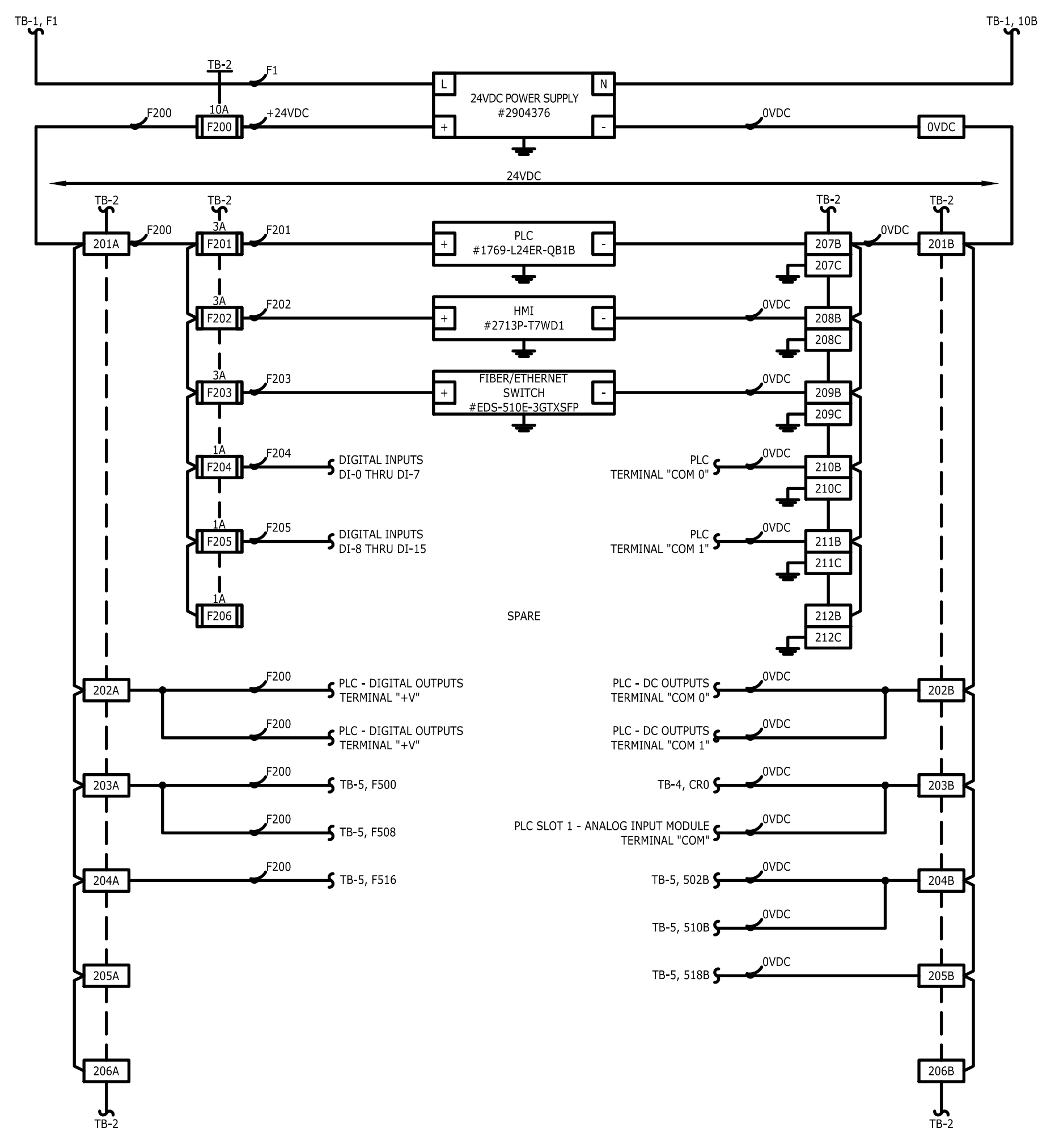
SIGNATURE

DATE

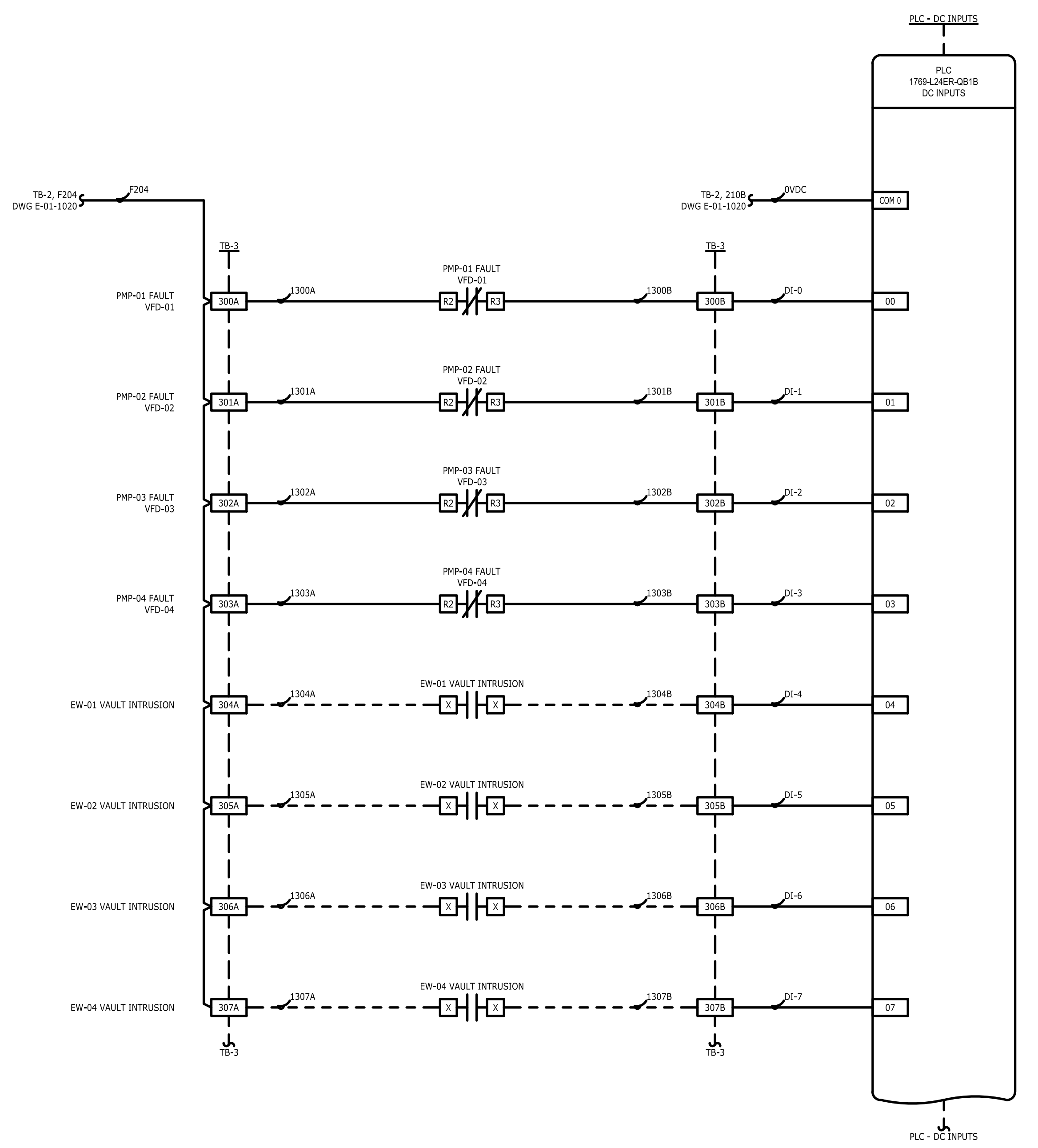
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E23.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-23
APPROVED BY:	JJD		



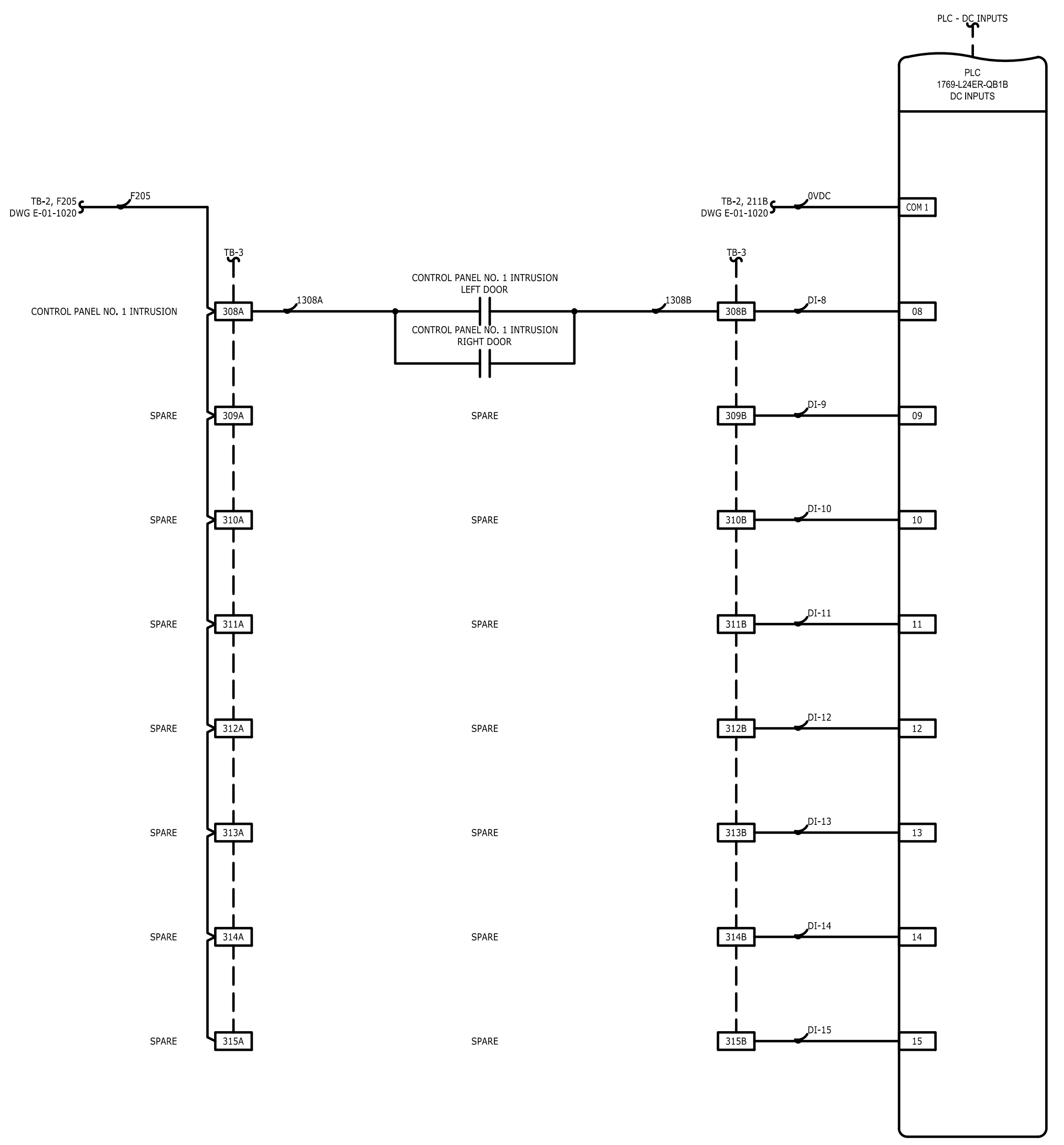
45 DETAIL
E-24 CONTROL PANEL NO. 1 120VAC POWER DISTRIBUTION



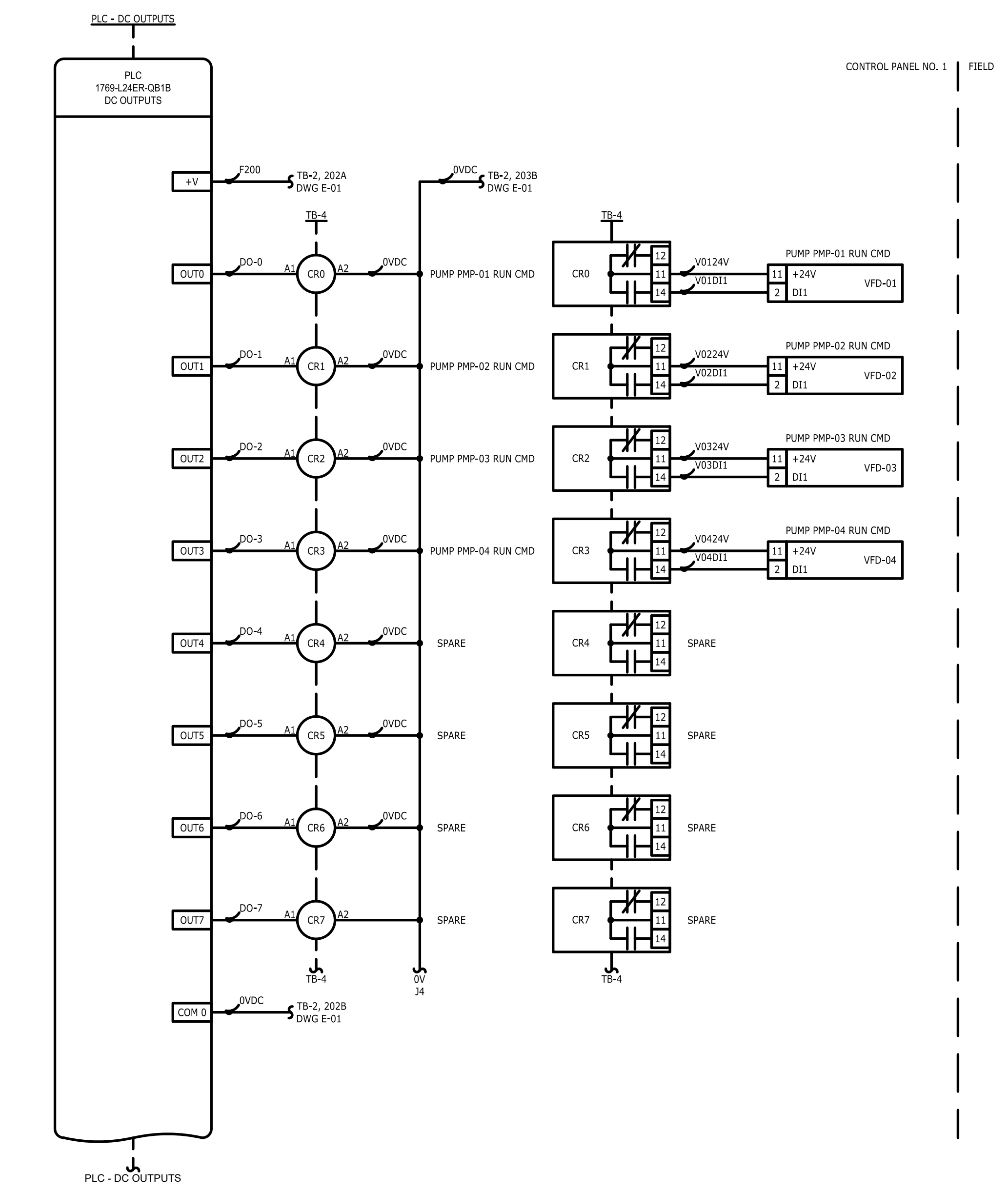
46 DETAIL
E-24 CONTROL PANEL NO. 1 24VDC POWER DISTRIBUTION



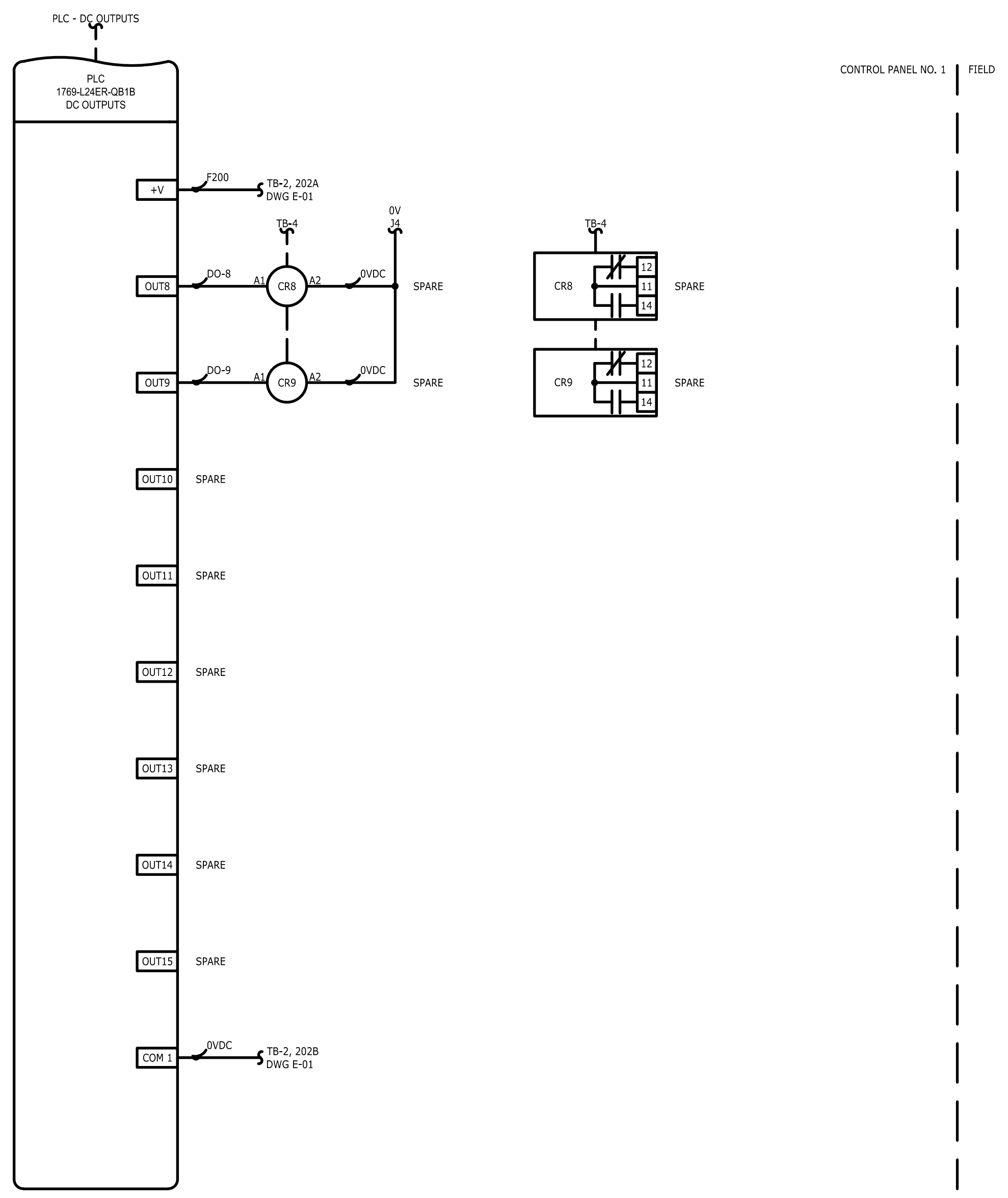
47 DETAIL
E-24 CONTROL PANEL NO. 1 PLC DIGITAL WIRING DIAGRAM I



48 DETAIL
E-24 CONTROL PANEL NO. 1 PLC DIGITAL WIRING DIAGRAM II



49 DETAIL
E-24 CONTROL PANEL NO. 1 PLC RELAY OUTPUTS WIRING DIAGRAM I



50 DETAIL
E-24 CONTROL PANEL NO. 1 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-01 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

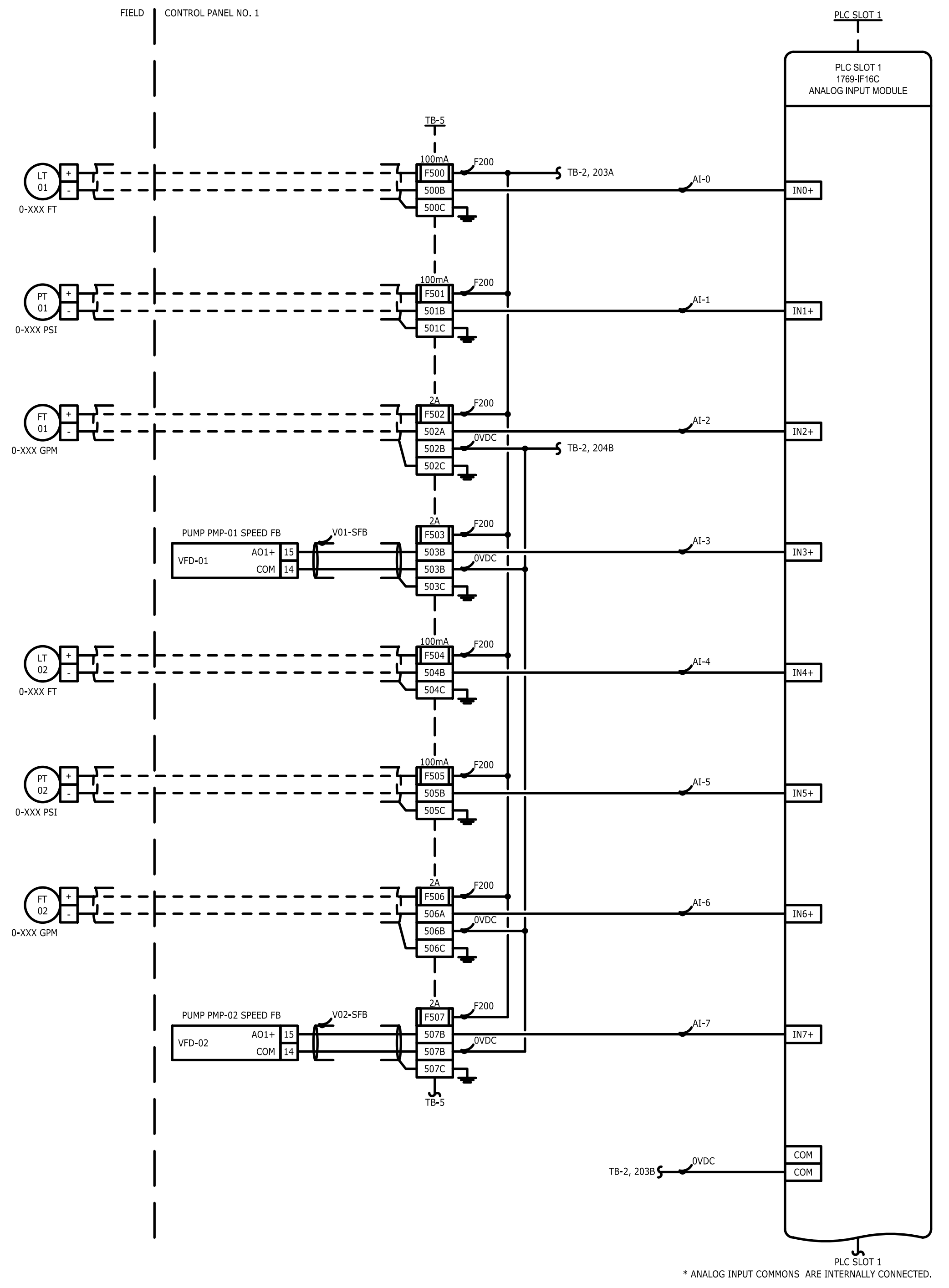
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E24.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-24
APPROVED BY:	JJD		

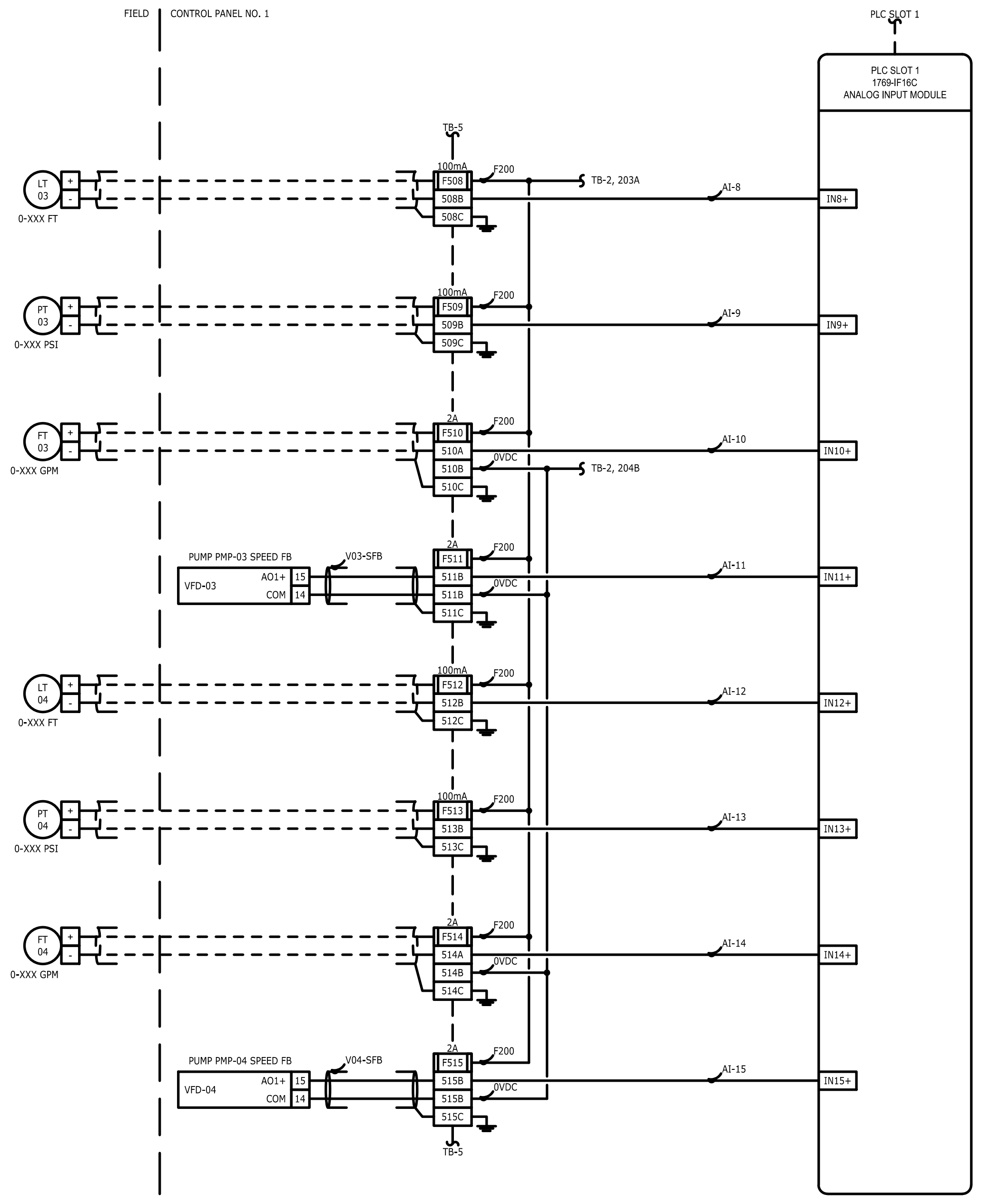
90% DESIGN DRAWINGS



51
E-25

DETAIL

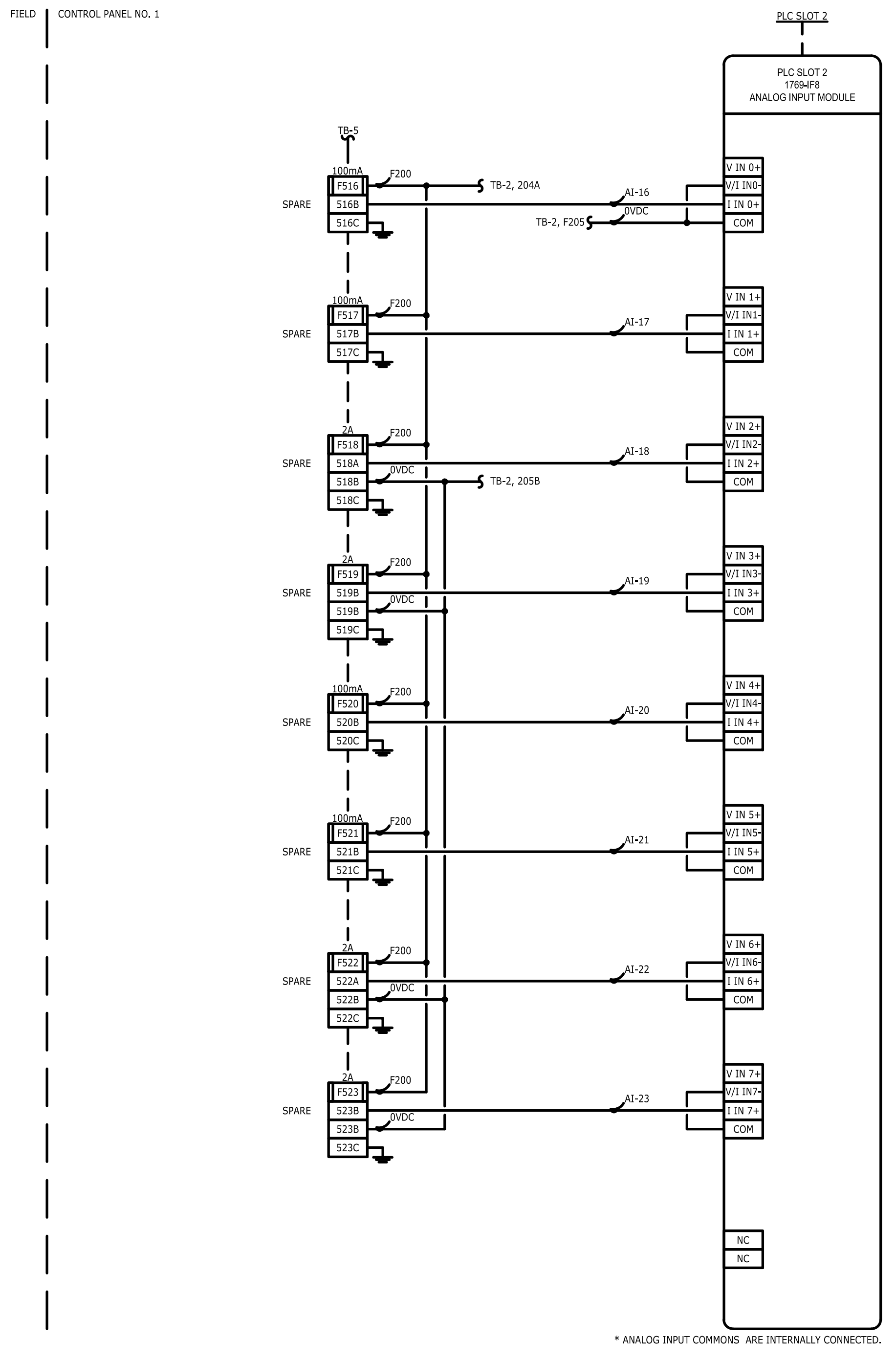
CONTROL PANEL NO. 1 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



52
E-25

DETAIL

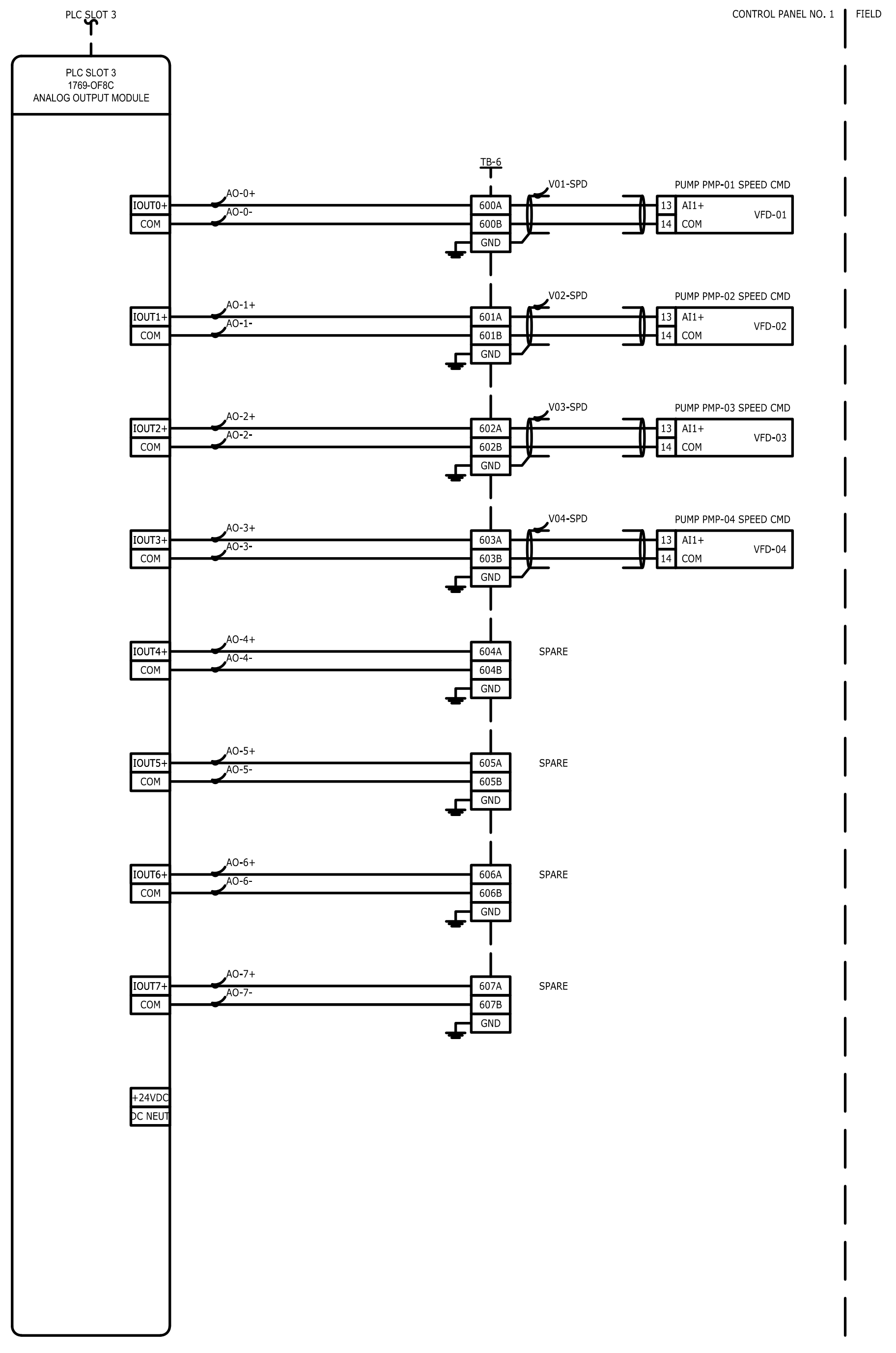
CONTROL PANEL NO. 1 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



53
E-25

DETAIL

CONTROL PANEL NO. 1 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



54
E-25

DETAIL

CONTROL PANEL NO. 1 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-01 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

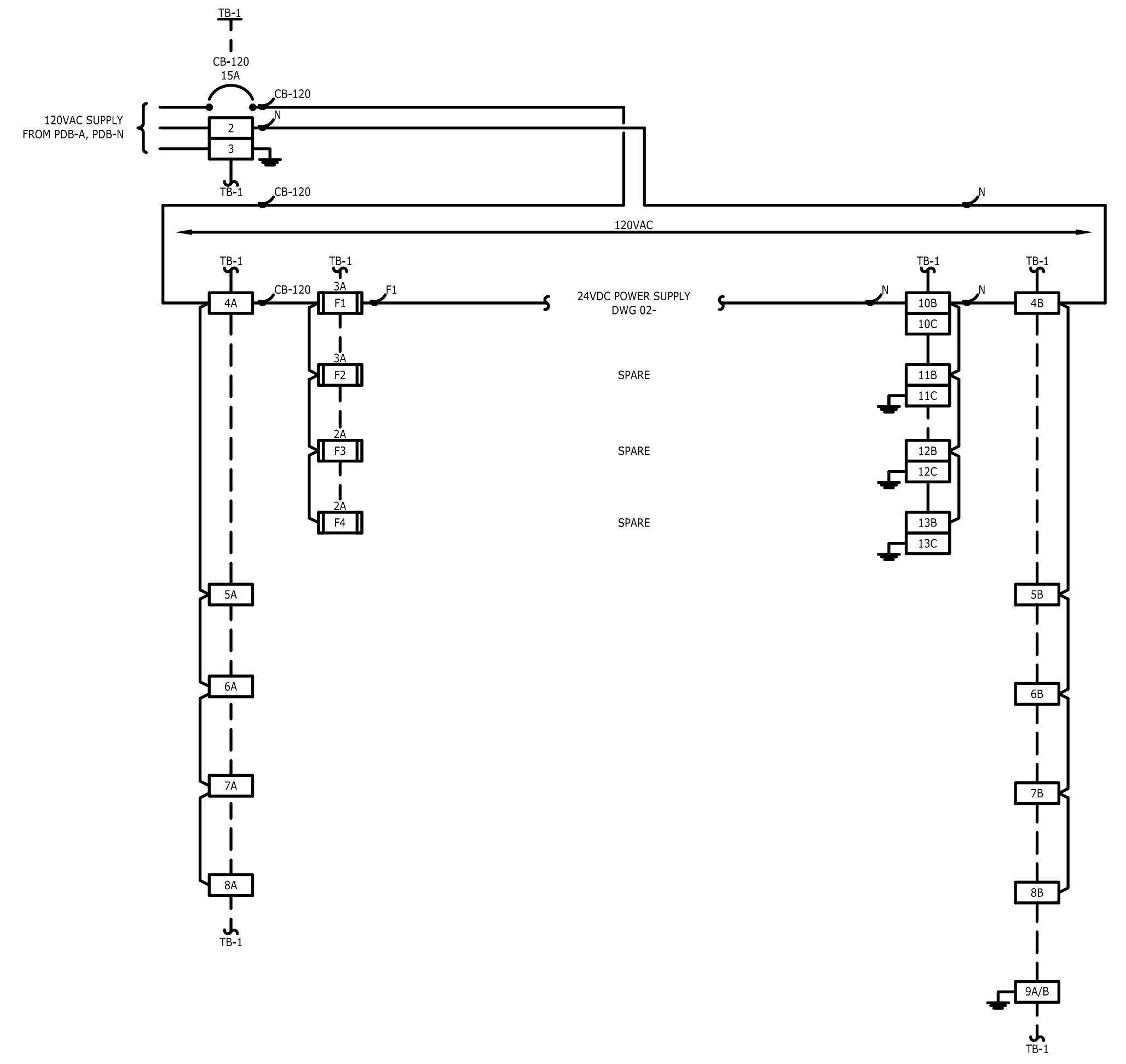
THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

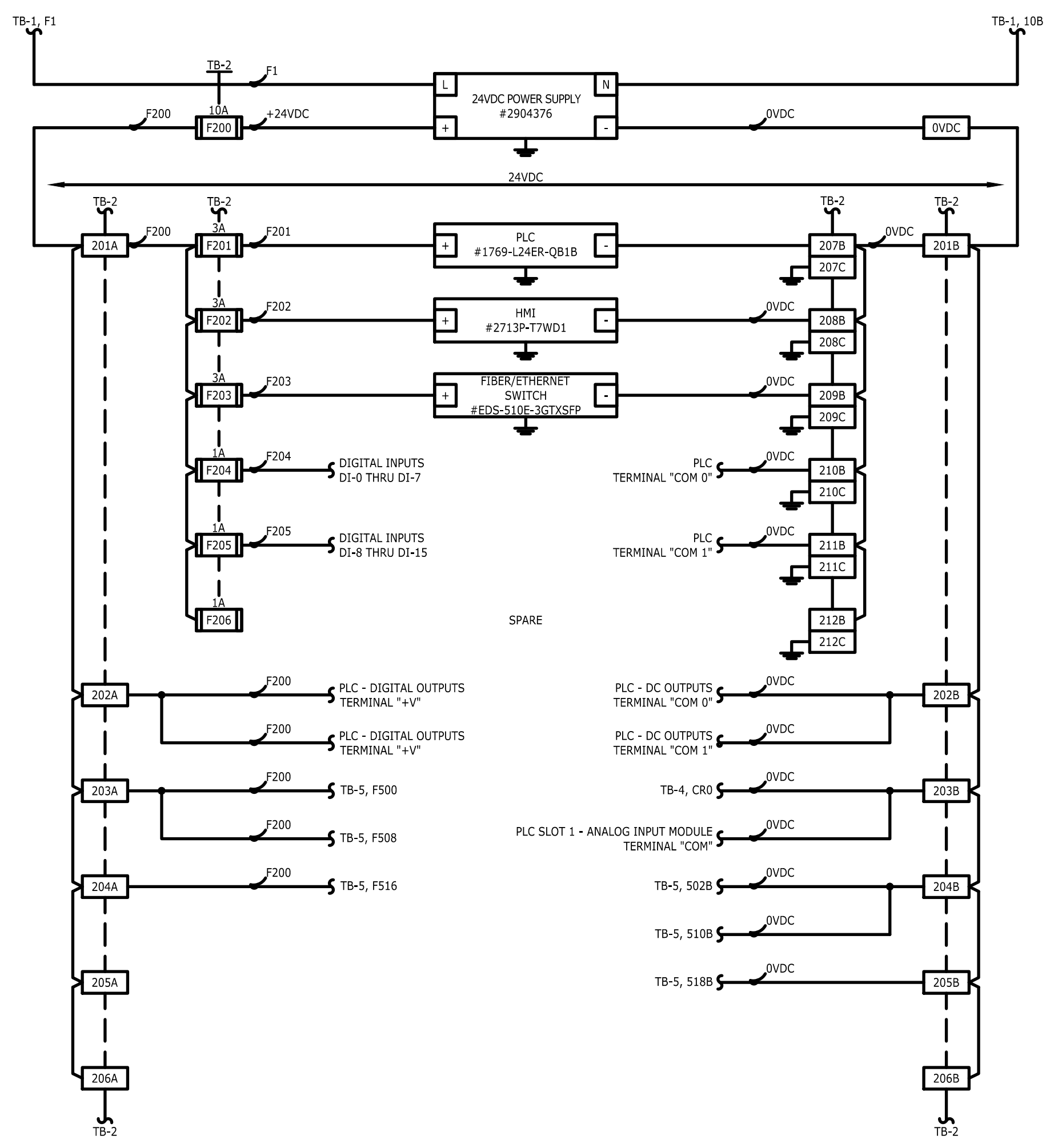
DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E25.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-25
APPROVED BY:	JJD		

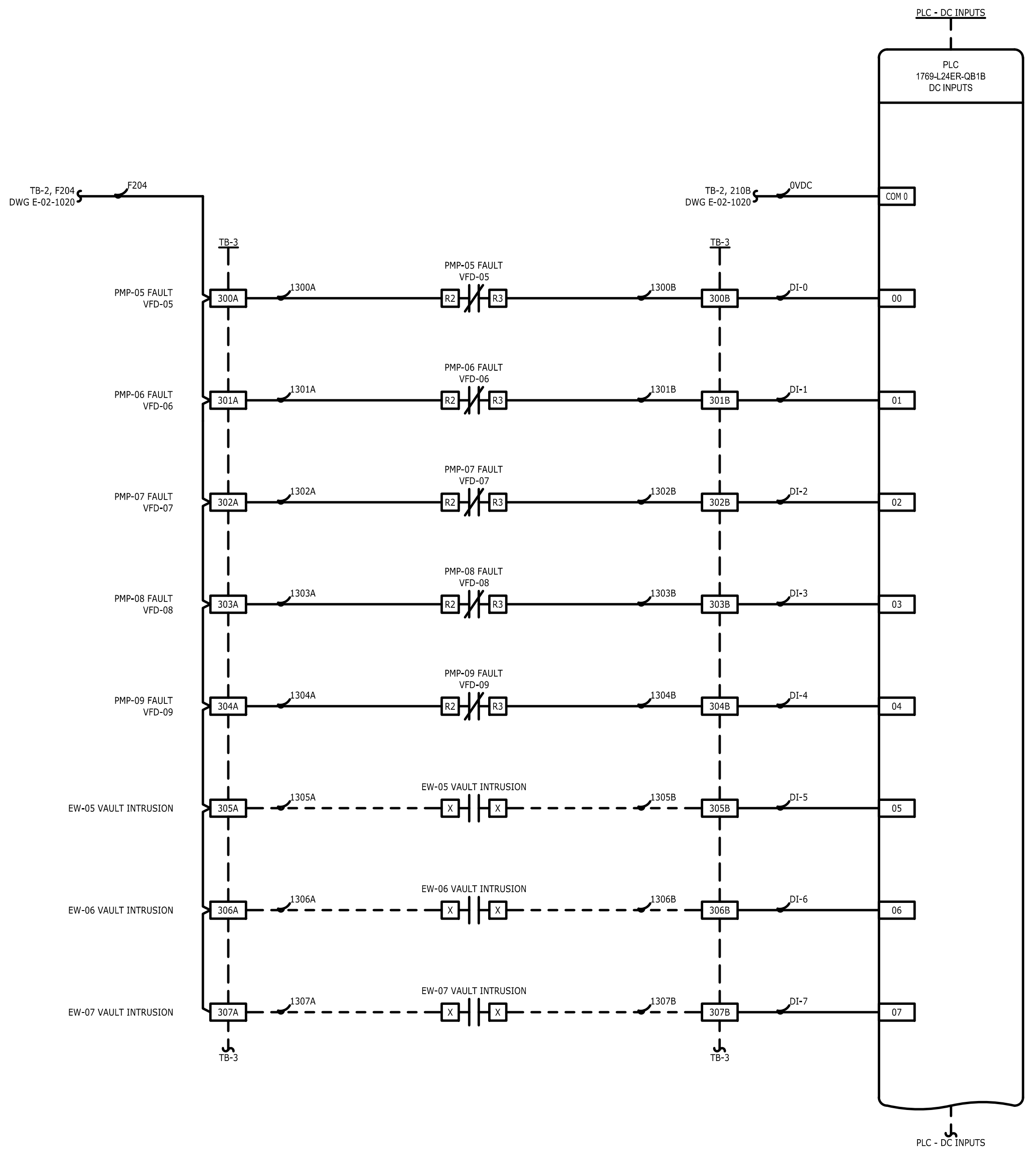
GEOSYNTEC-PW-01\DOCUMENTS\CLIENTS\C\CHEMOURS\TR0795A - CHEMOURS\CADD\01 - GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM\DRAWINGS\SHEETS\TR0795A-E25



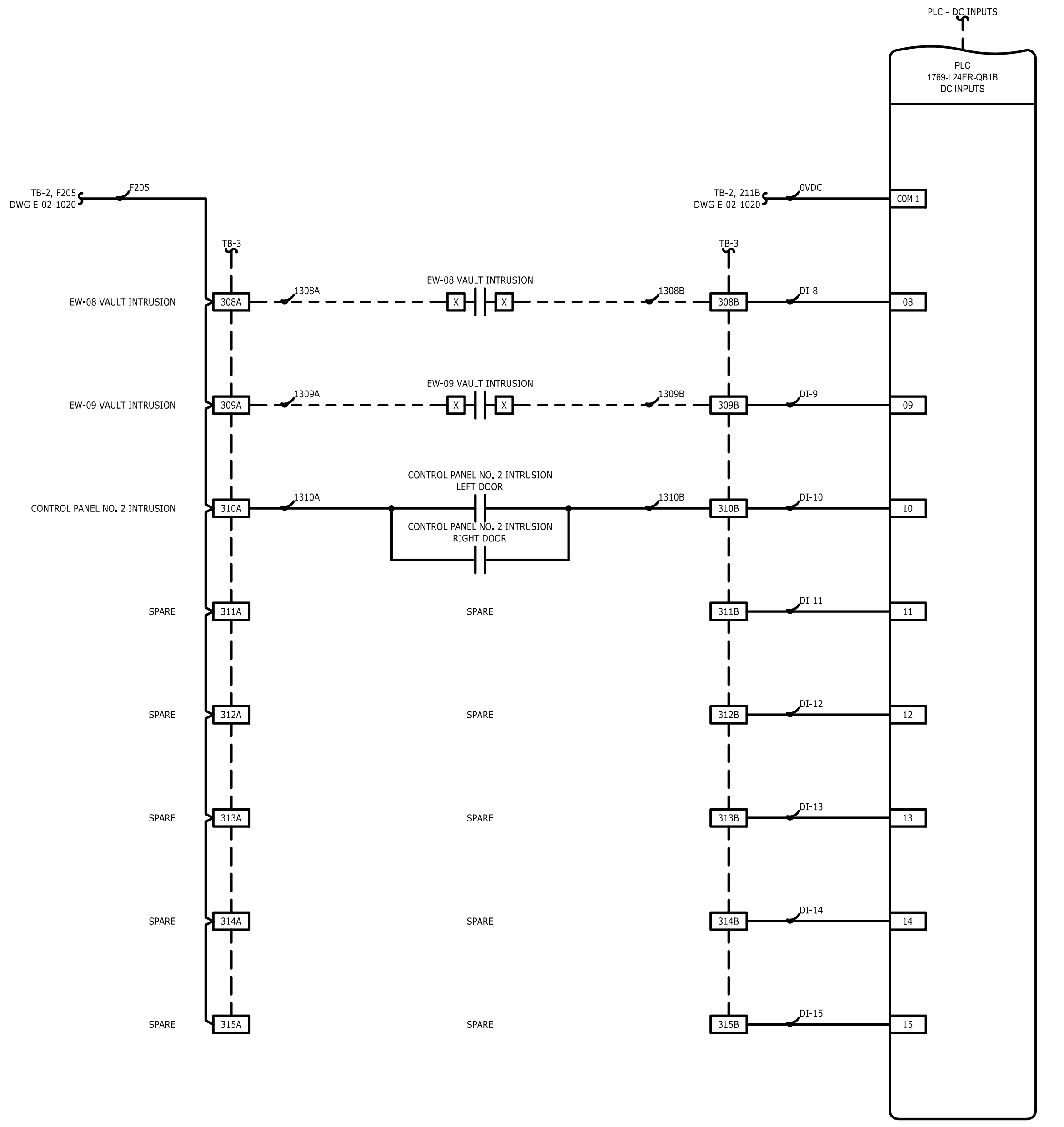
56 E-26
DETAIL
CONTROL PANEL NO. 2 120VAC POWER DISTRIBUTION



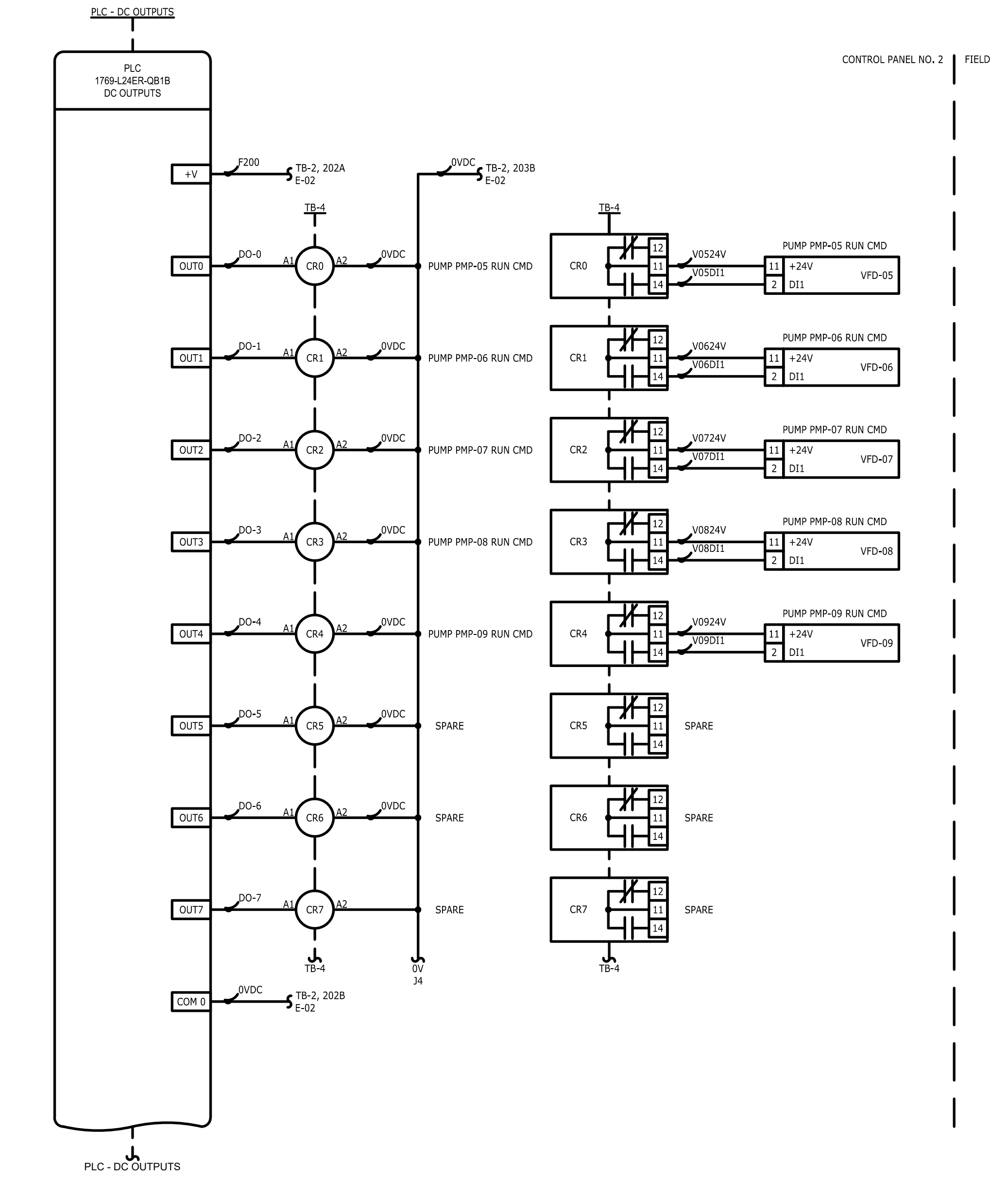
57 E-26
DETAIL
CONTROL PANEL NO. 2 24VDC POWER DISTRIBUTION



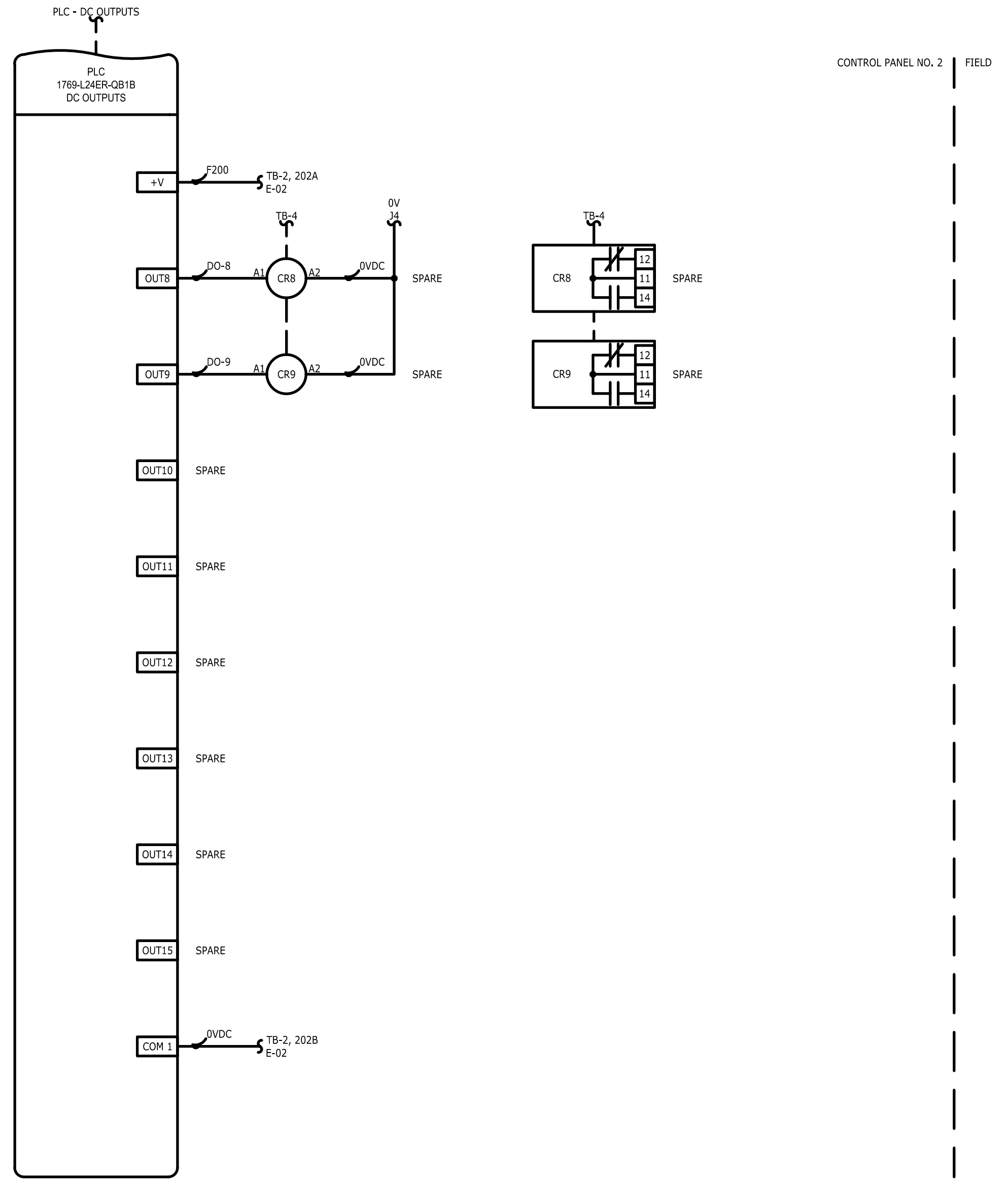
58 E-26
DETAIL
CONTROL PANEL NO. 2 PLC DIGITAL WIRING DIAGRAM I



59 E-26
DETAIL
CONTROL PANEL NO. 2 PLC DIGITAL WIRING DIAGRAM II



60 E-26
DETAIL
CONTROL PANEL NO. 2 PLC RELAY OUTPUTS WIRING DIAGRAM I



61 E-26
DETAIL
CONTROL PANEL NO. 2 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD
REV	DATE	DESCRIPTION	DRN	APP

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-02 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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CHECKED BY:	CMDS	FILE:	TR0795A-E26.DWG
REVIEWED BY:	SV	DRAWING NO.:	
APPROVED BY:	JJD		E-26

90% DESIGN DRAWINGS

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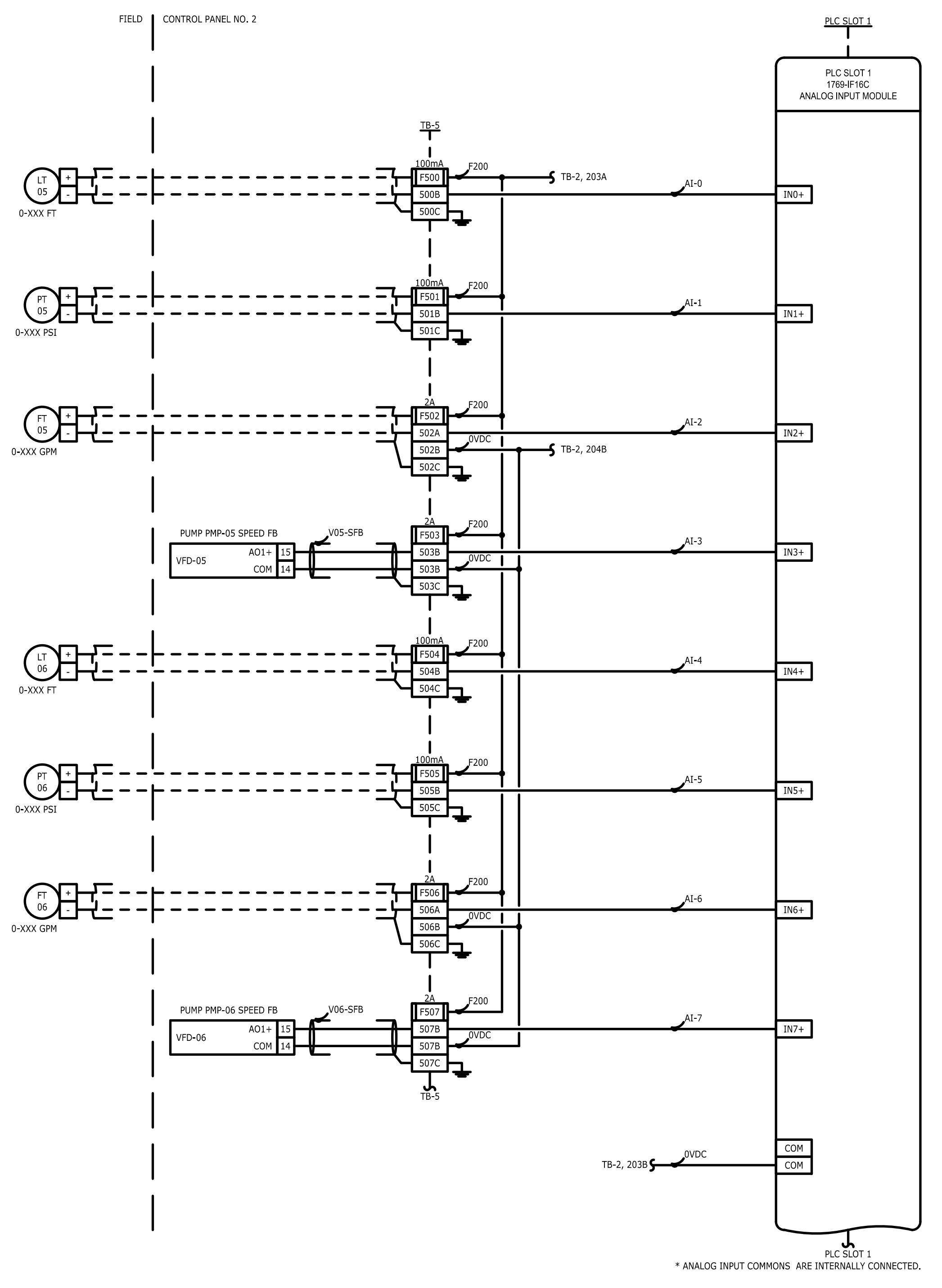
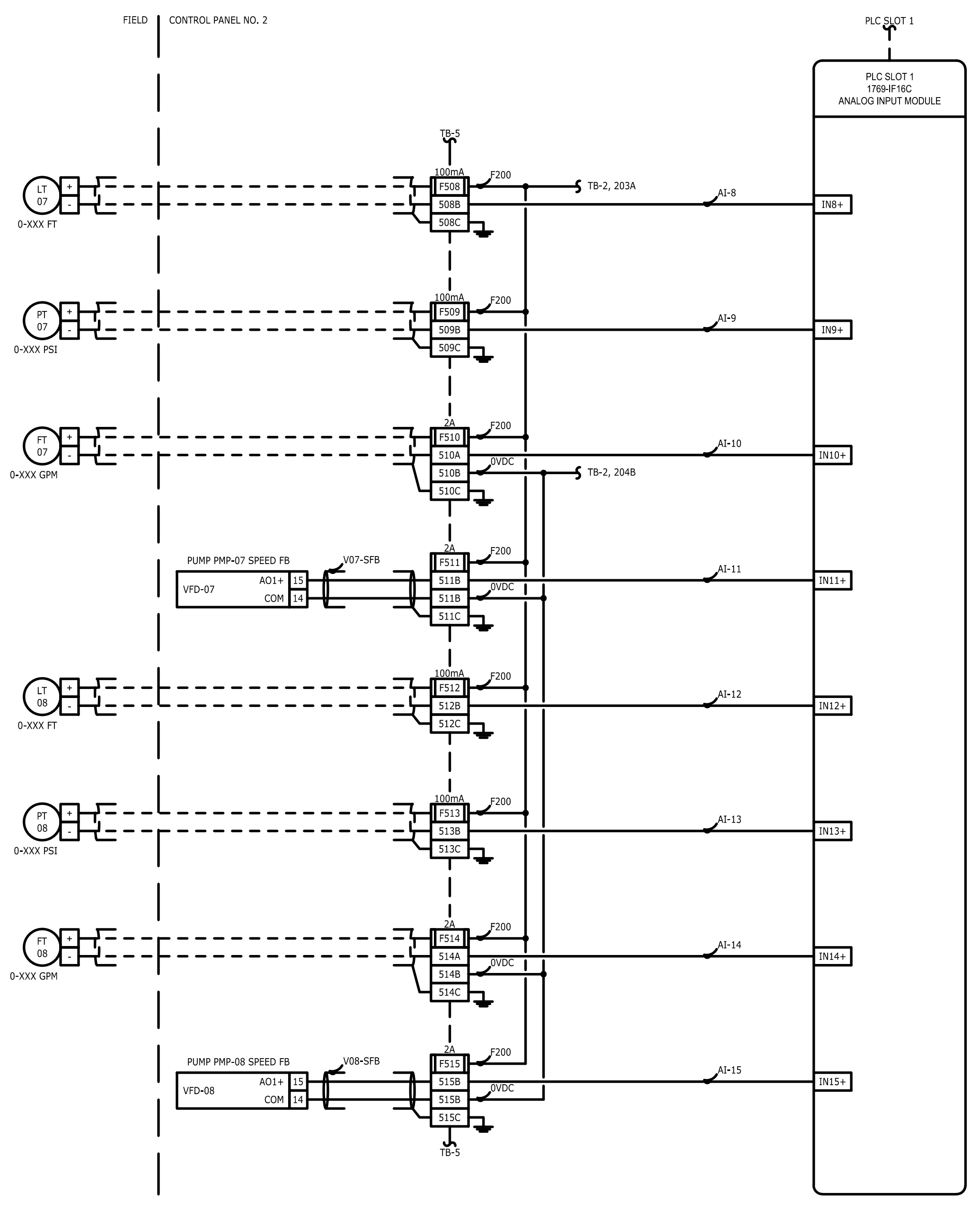
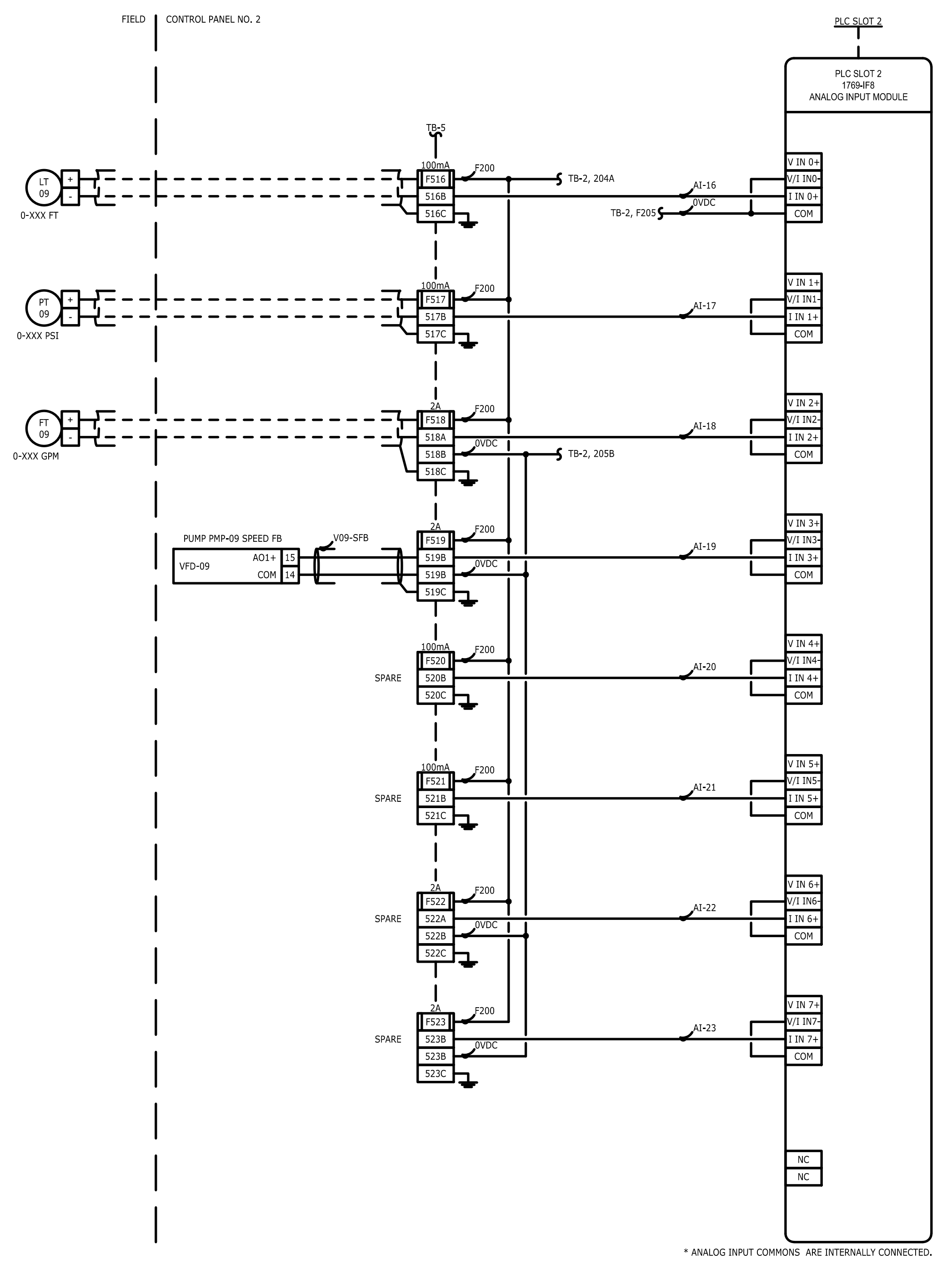


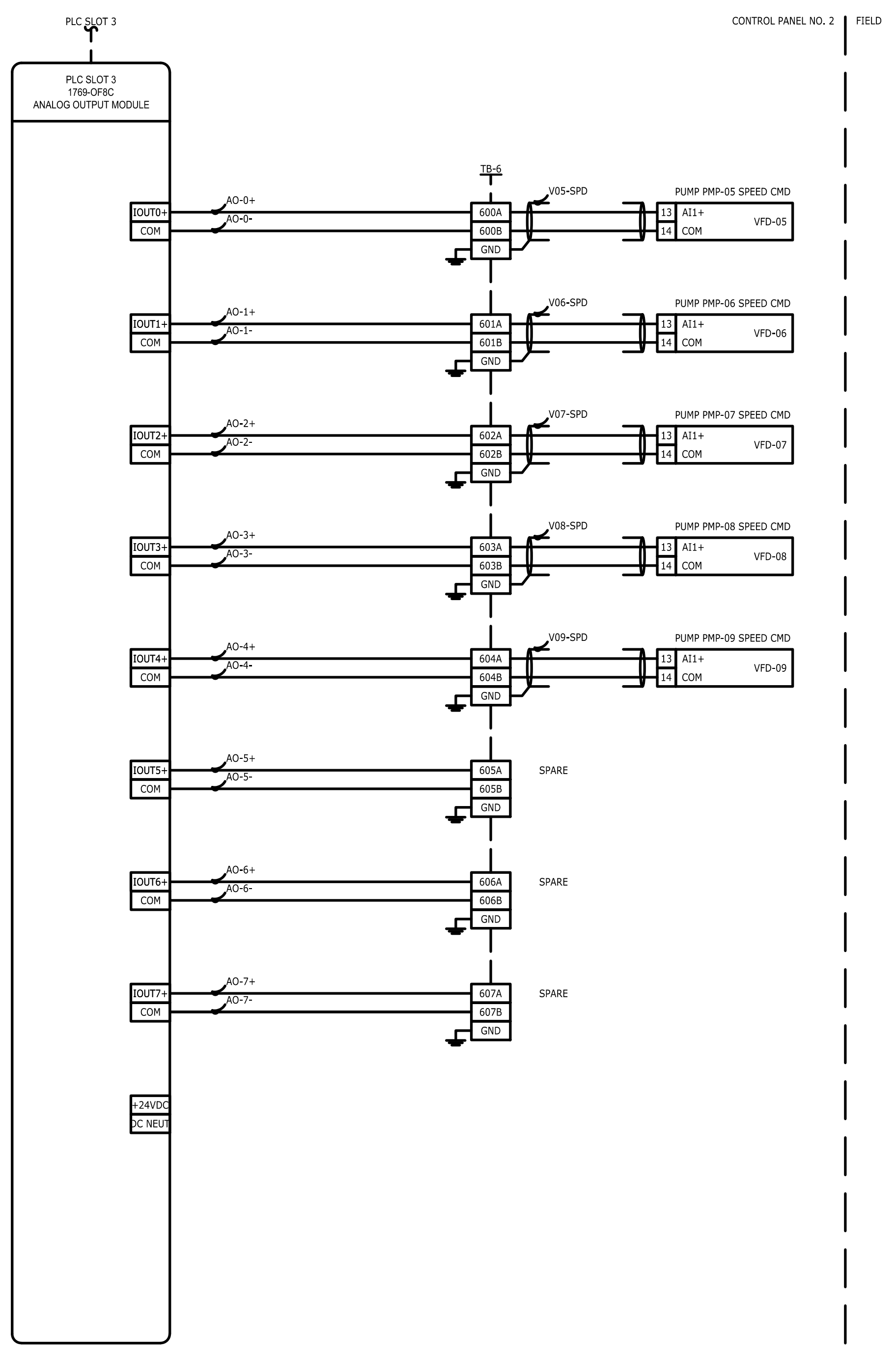
62 / E-27 DETAIL
CONTROL PANEL NO. 2 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



63 / E-27 DETAIL
CONTROL PANEL NO. 2 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



64 / E-27 DETAIL
CONTROL PANEL NO. 2 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



65 / E-27 DETAIL
CONTROL PANEL NO. 2 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

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90% DESIGN DRAWINGS

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C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-02 CONTROL PANEL POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E27.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-27
APPROVED BY:	JJD		

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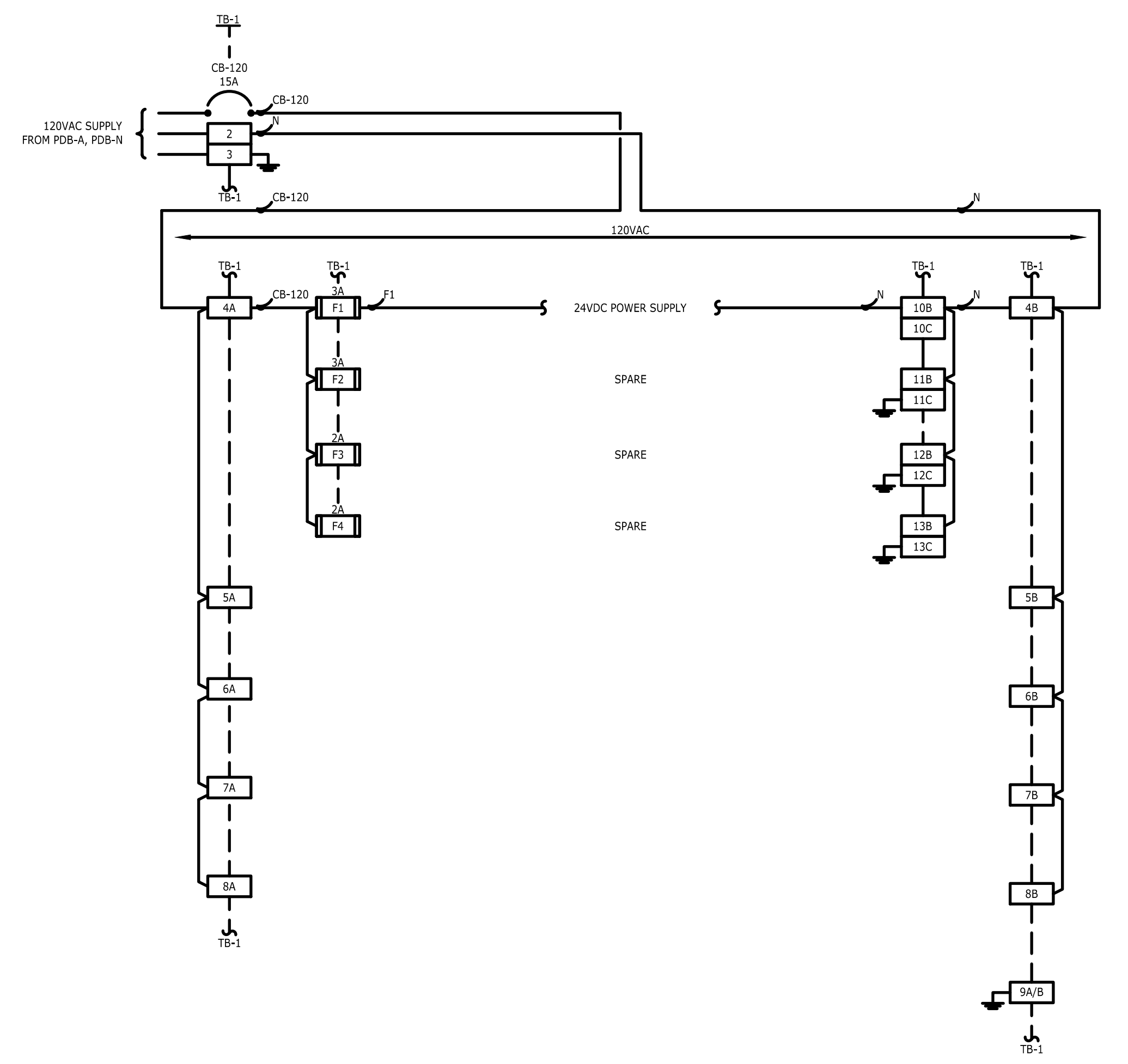
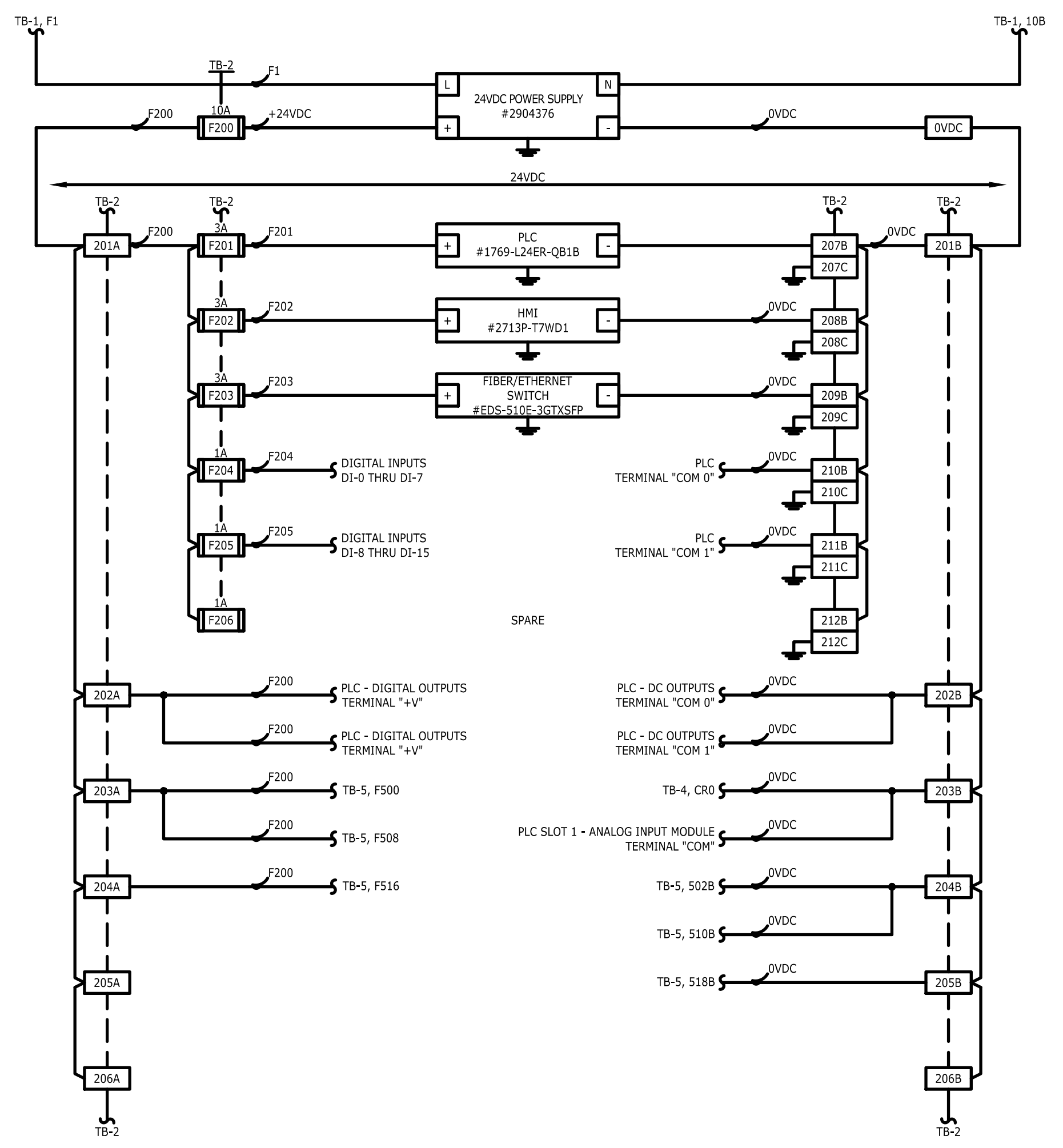
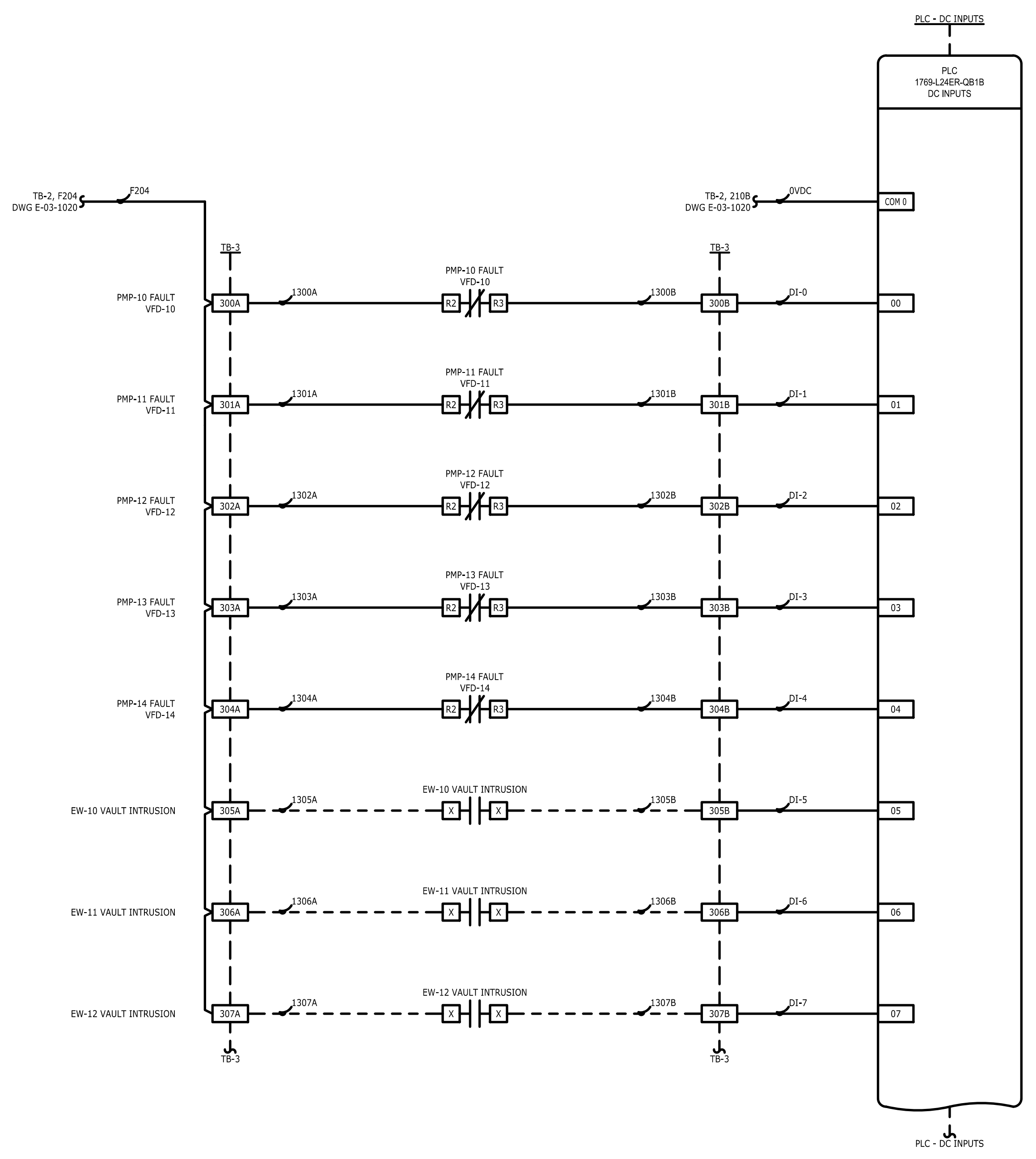


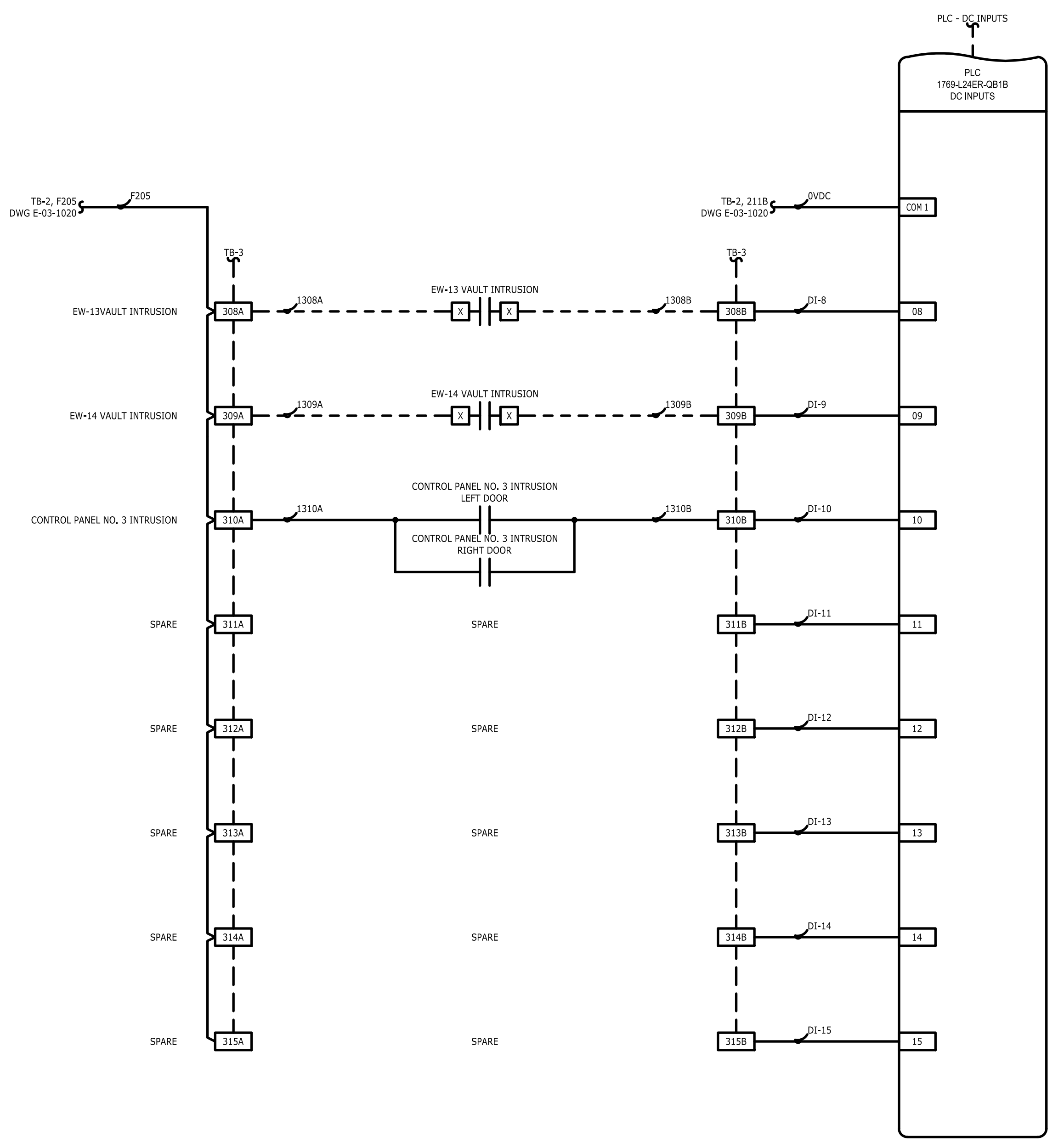
67 DETAIL
E-28
CONTROL PANEL NO. 3 120VAC POWER DISTRIBUTION



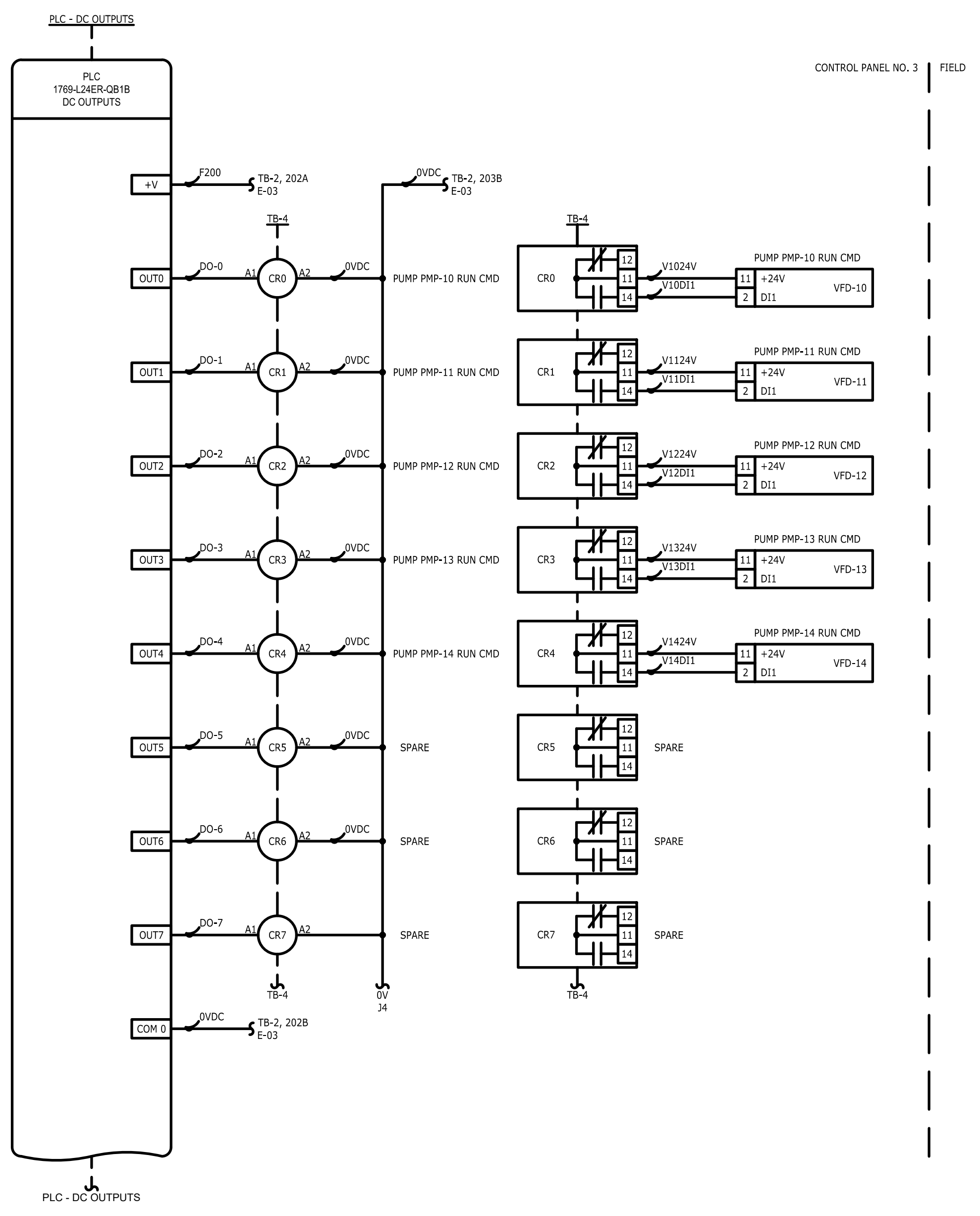
68 DETAIL
E-28
CONTROL PANEL NO. 3 24VDC POWER DISTRIBUTION



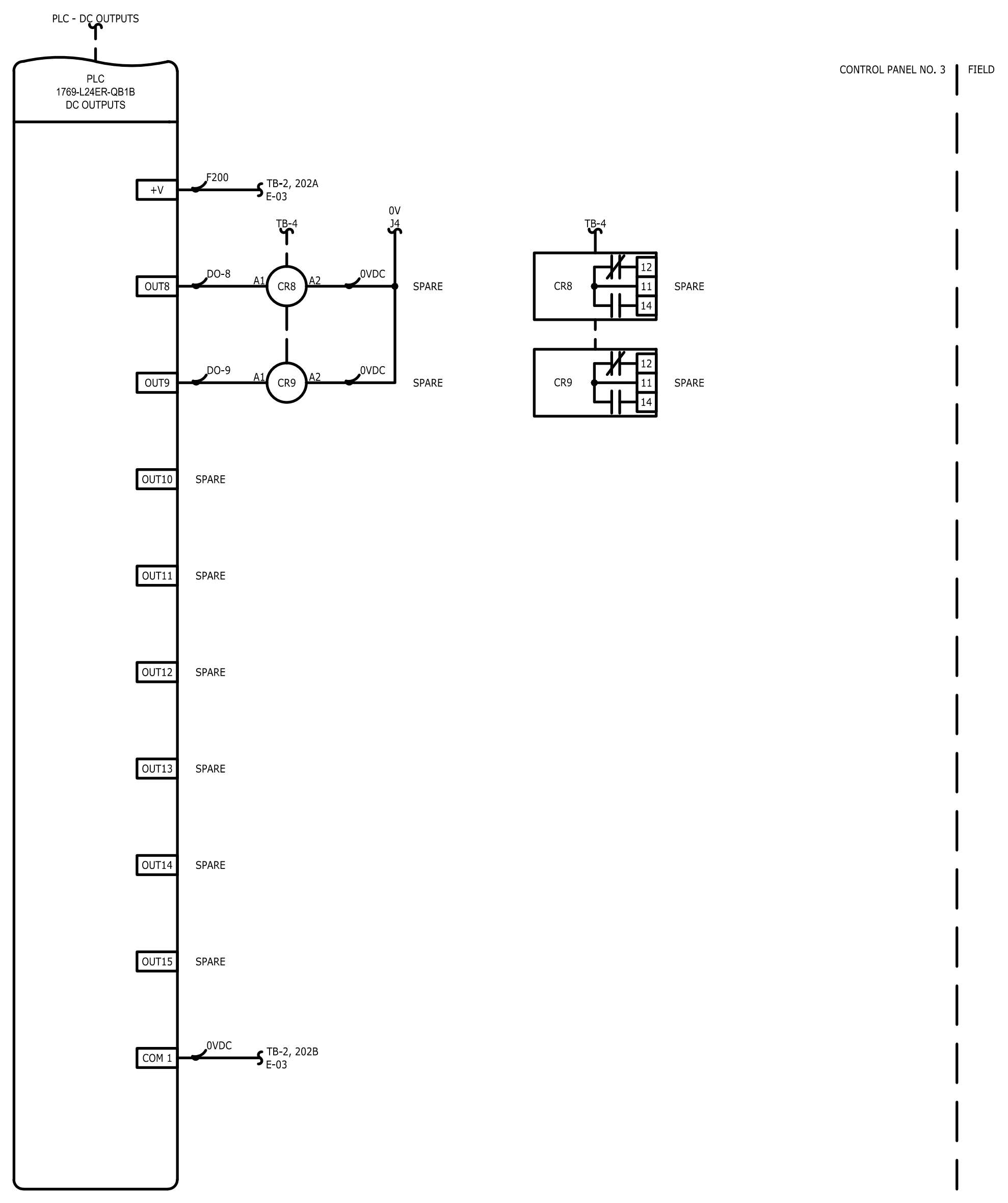
69 DETAIL
E-28
CONTROL PANEL NO. 3 PLC DIGITAL WIRING DIAGRAM I



70 DETAIL
E-28
CONTROL PANEL NO. 3 PLC DIGITAL WIRING DIAGRAM II



71 DETAIL
E-28
CONTROL PANEL NO. 3 PLC RELAY OUTPUTS WIRING DIAGRAM I



72 DETAIL
E-28
CONTROL PANEL NO. 3 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-03 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E28.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-28
APPROVED BY:	JJD		

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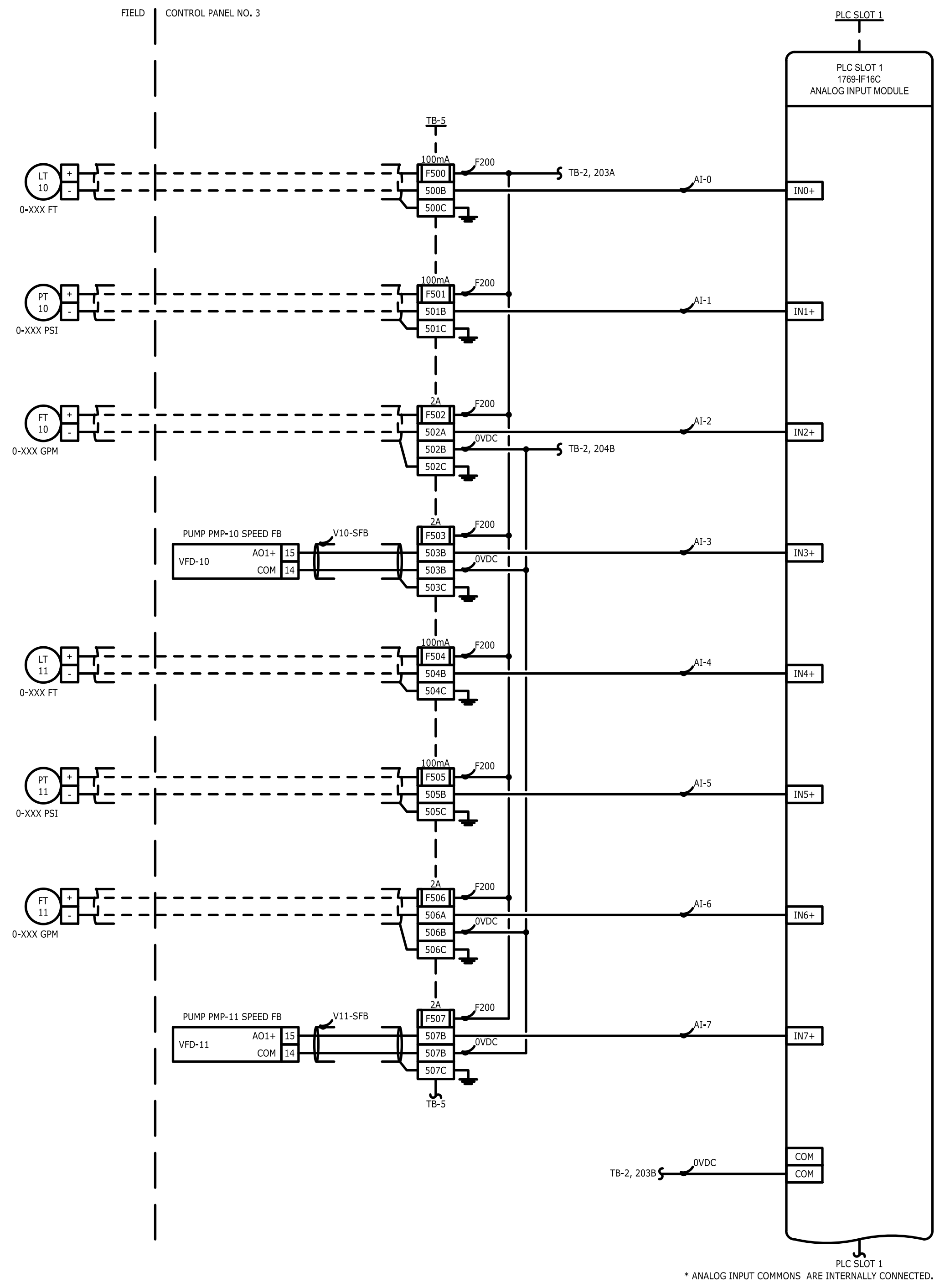
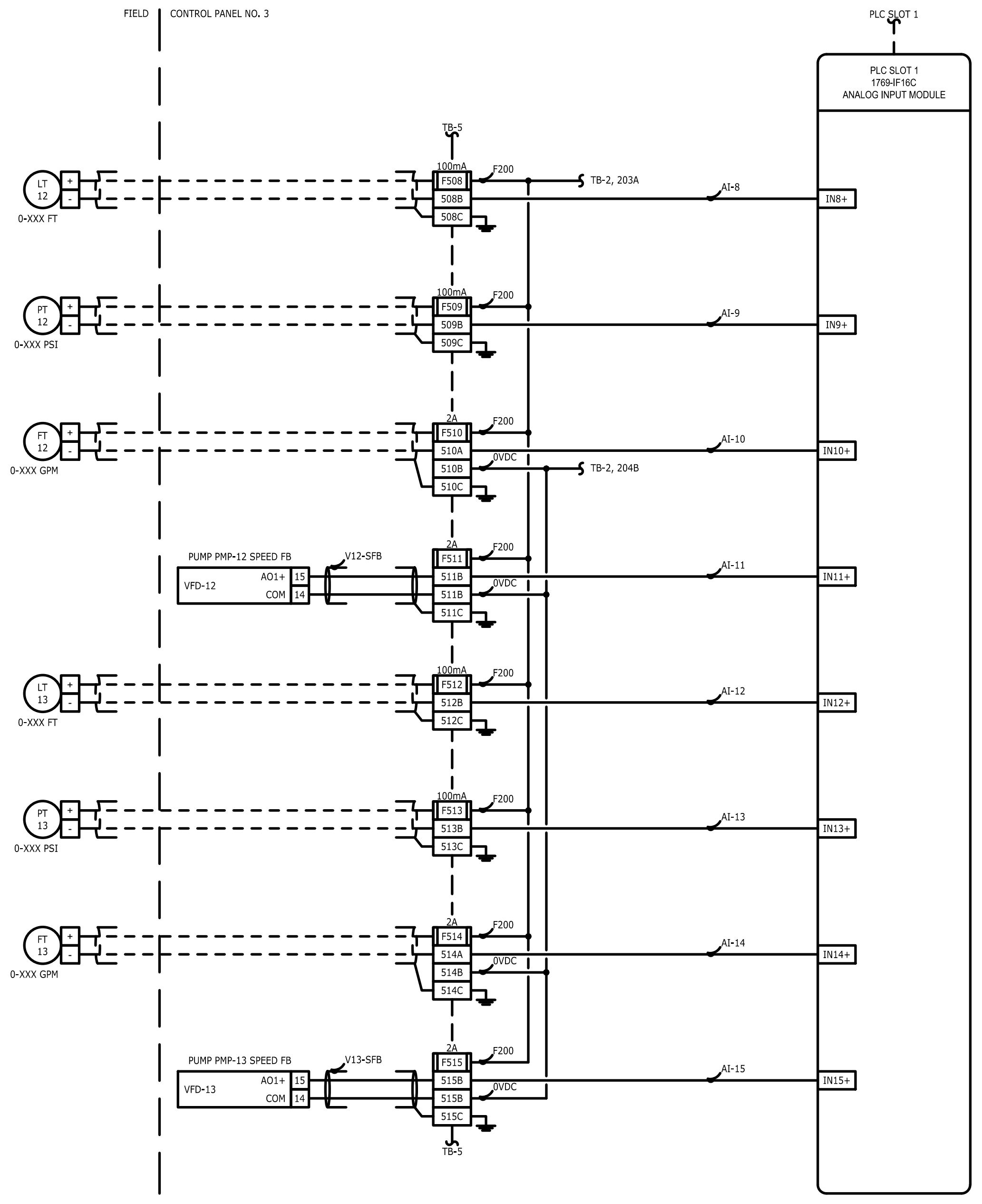


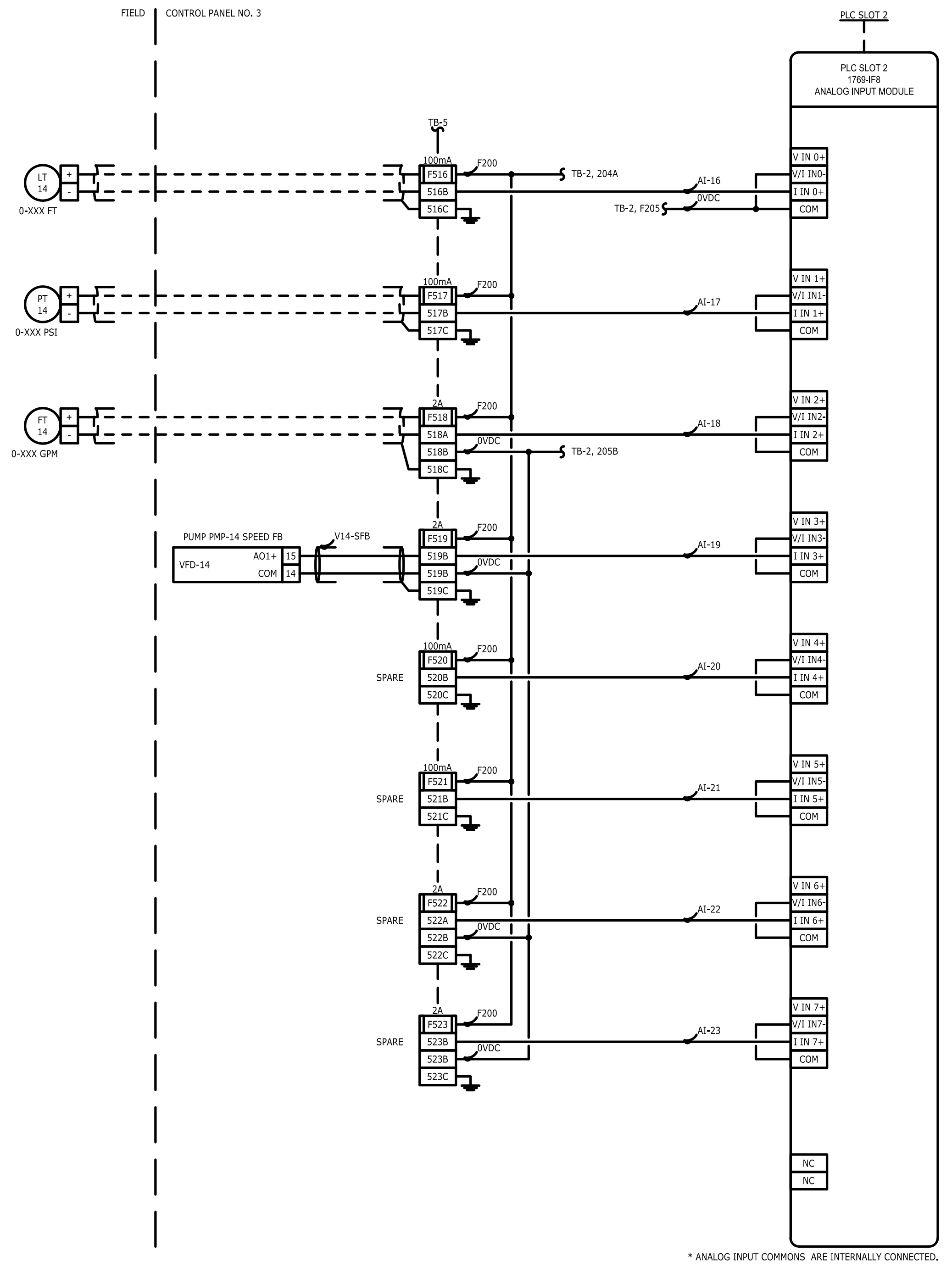
73
E-29

DETAIL
CONTROL PANEL NO. 3 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



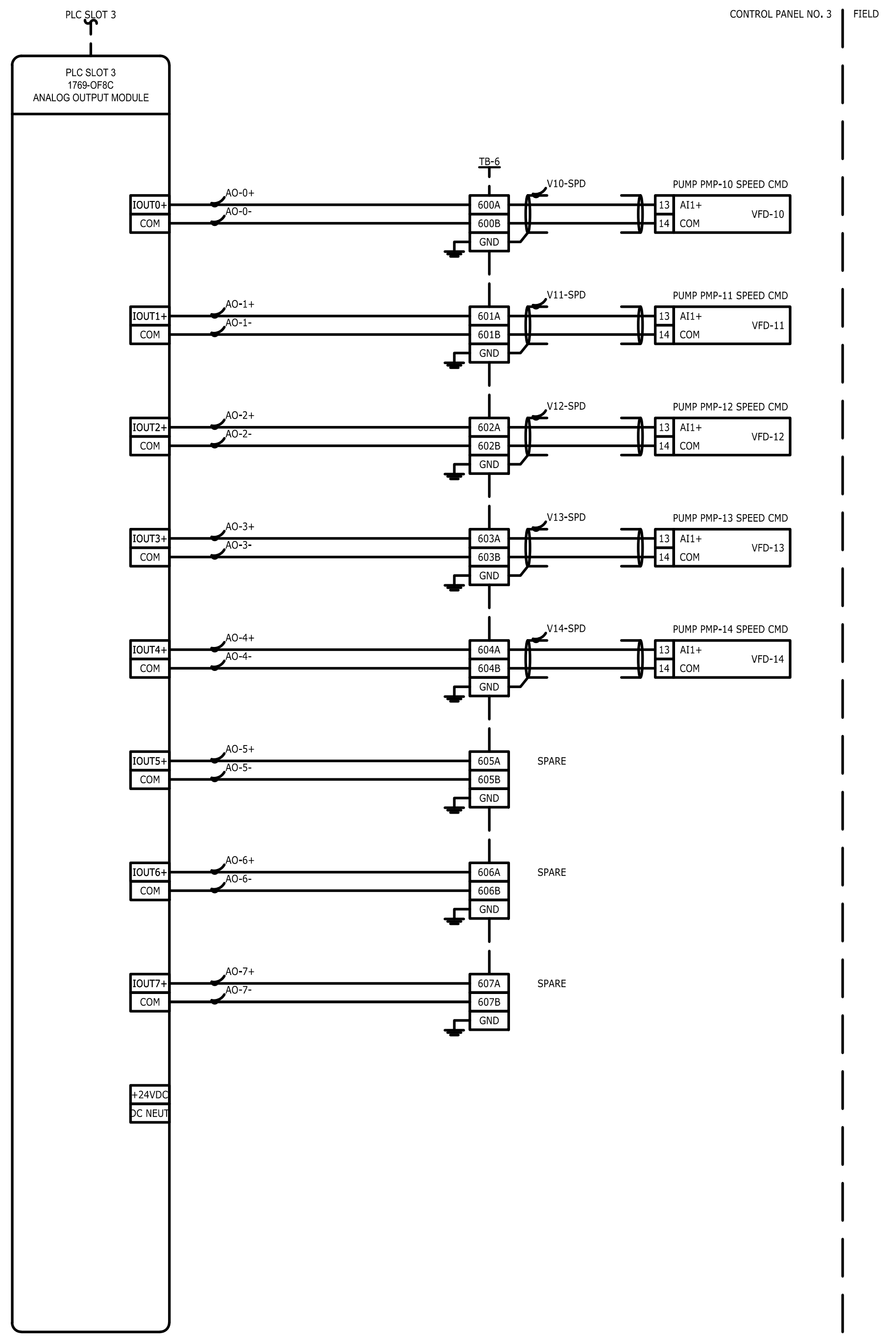
74
E-29

DETAIL
CONTROL PANEL NO. 3 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



75
E-29

DETAIL
CONTROL PANEL NO. 3 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



76
E-29

DETAIL
CONTROL PANEL NO. 3 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

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90% DESIGN DRAWINGS

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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-03 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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CHECKED BY:	CMDS	FILE:	TR0795A-E29.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-29
APPROVED BY:	JJD		

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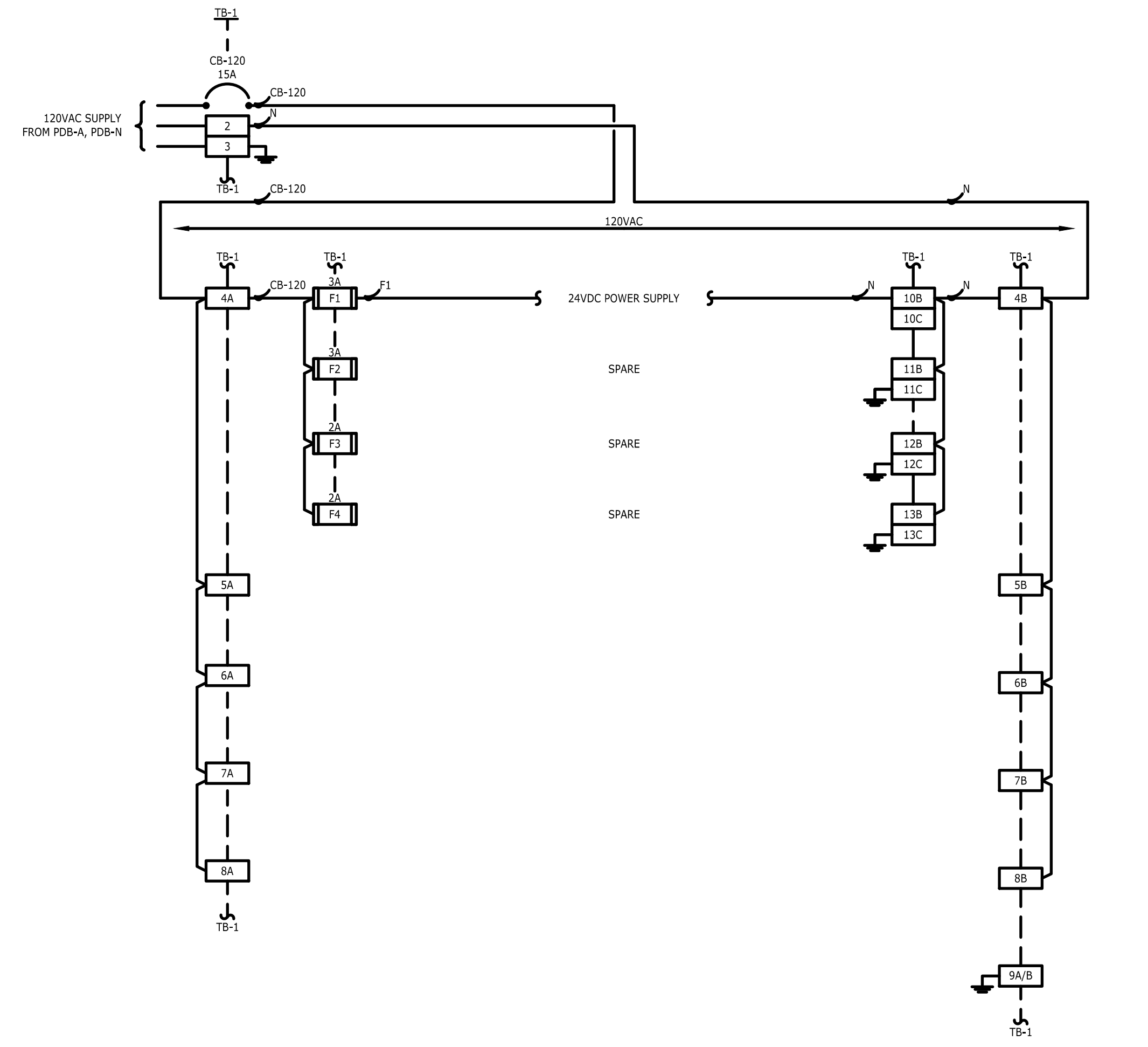
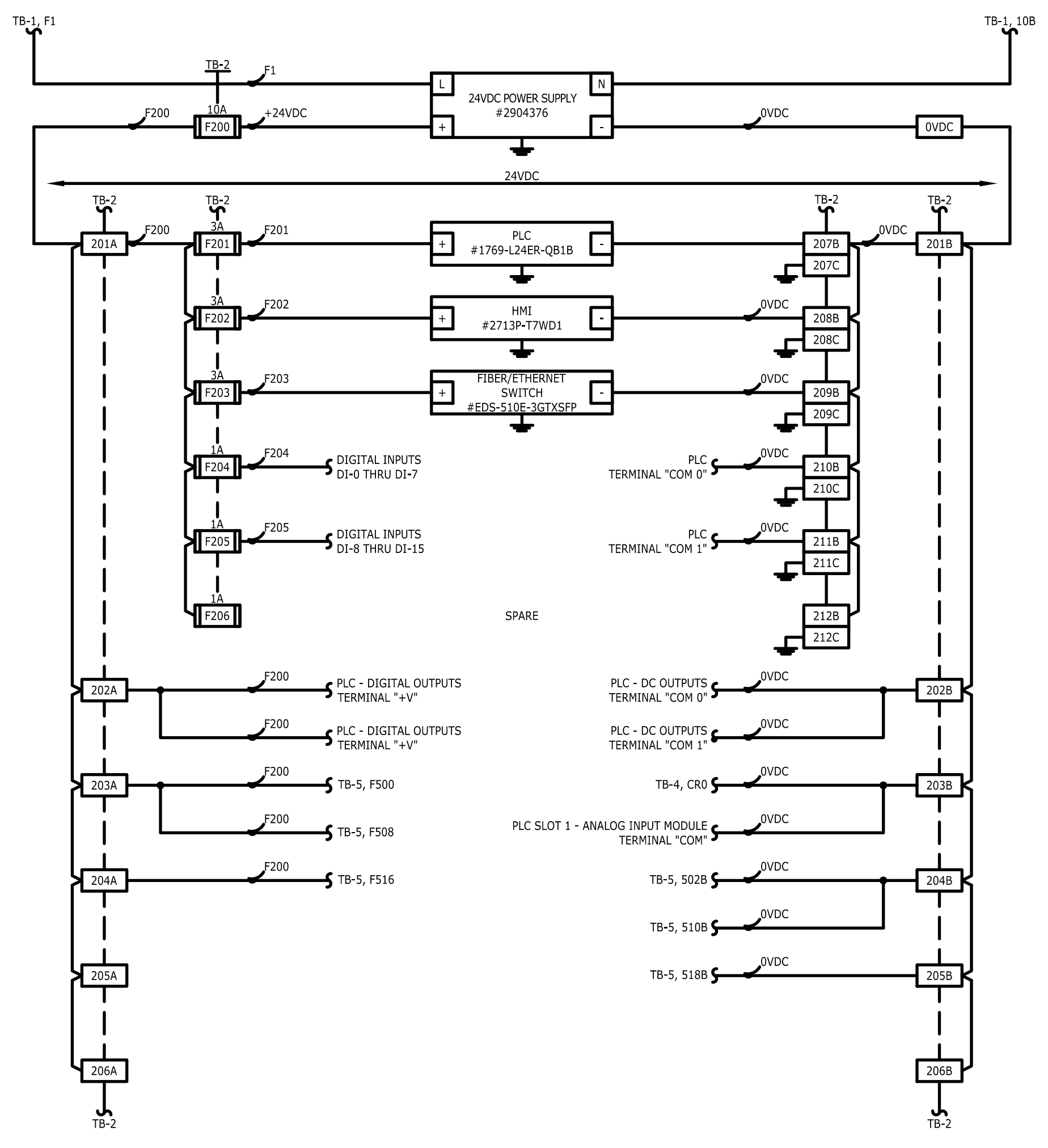
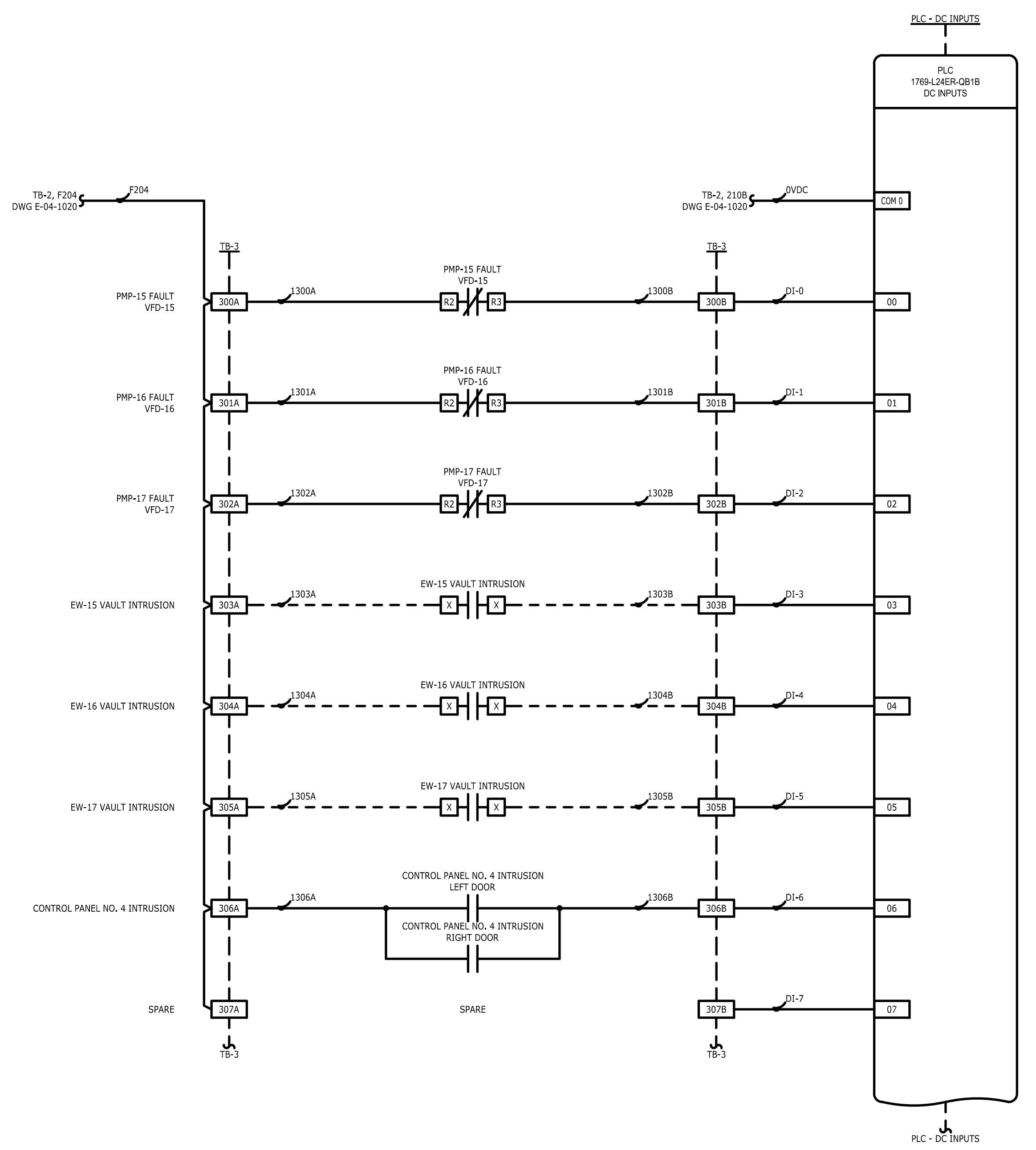


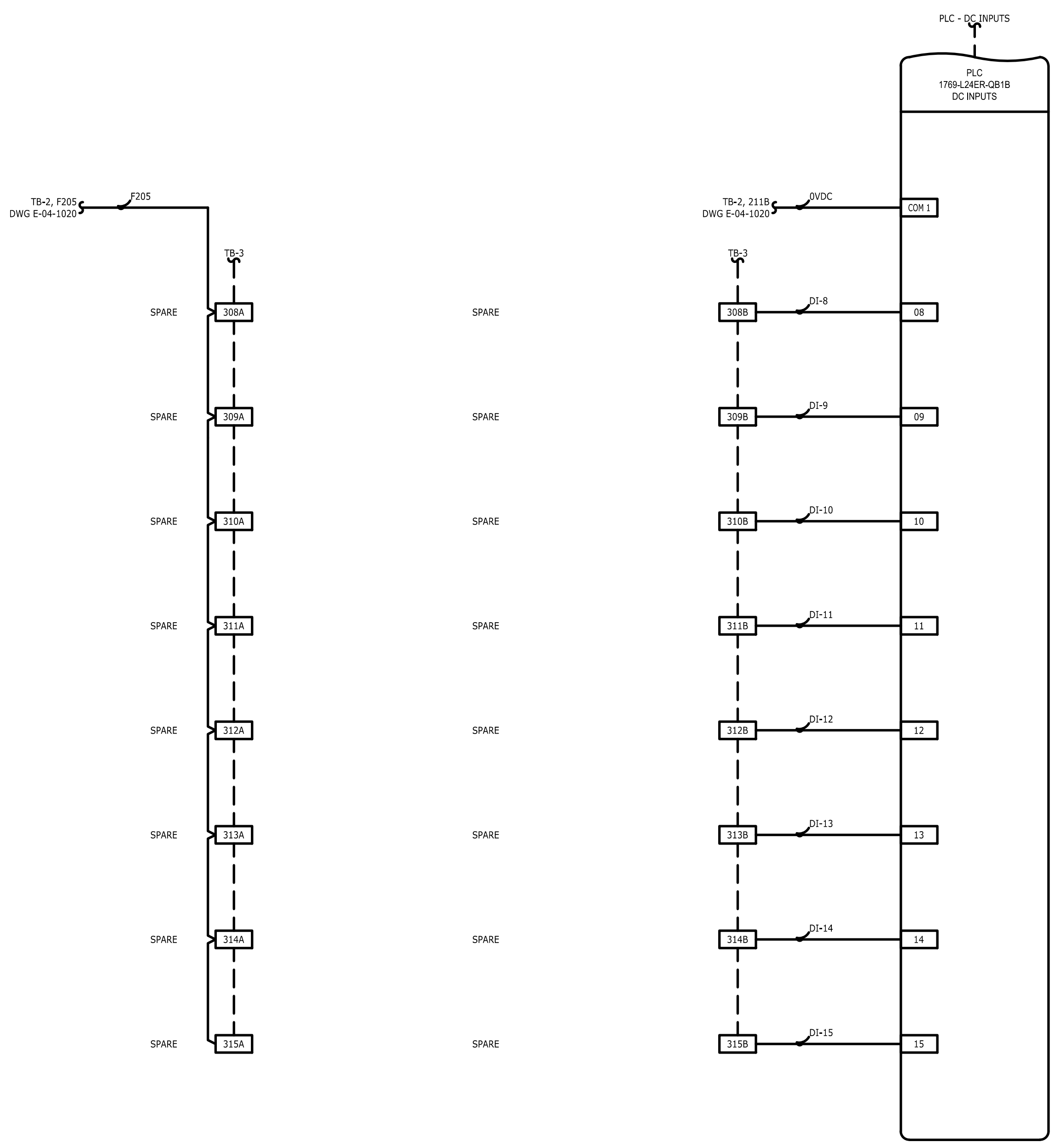
78 DETAIL
E-30 CONTROL PANEL NO. 4 120VAC POWER DISTRIBUTION



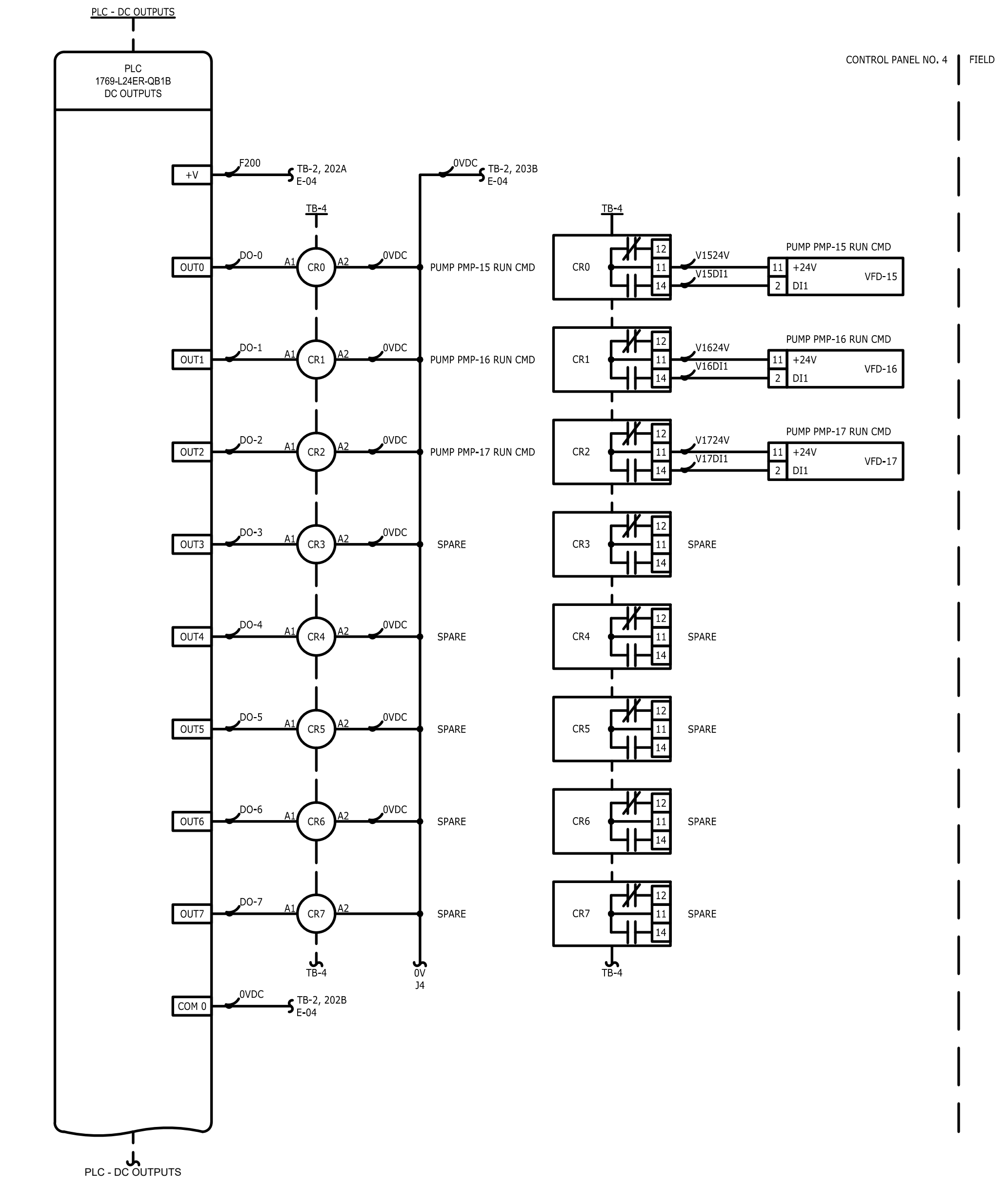
79 DETAIL
E-30 CONTROL PANEL NO. 4 24VDC POWER DISTRIBUTION



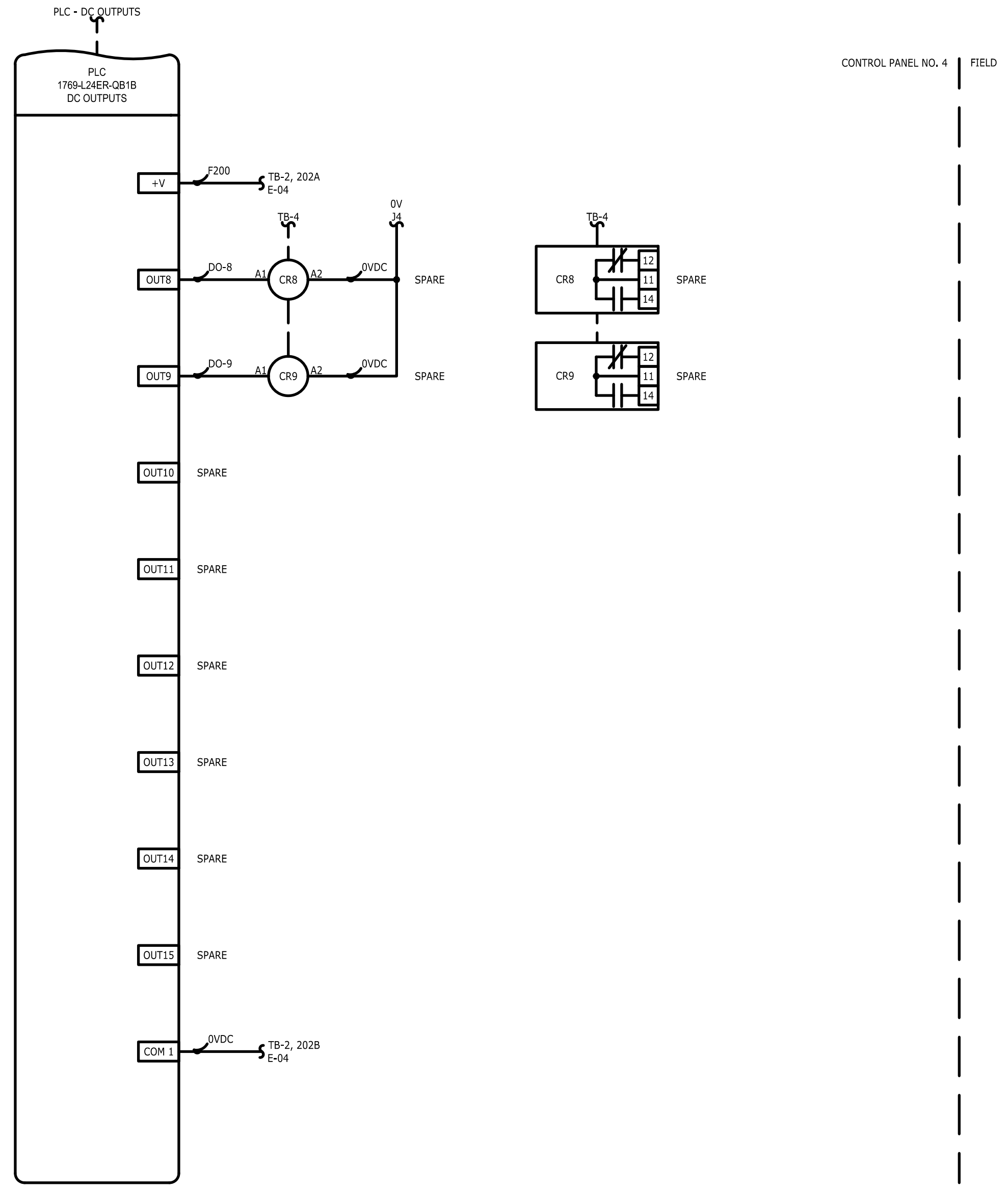
80 DETAIL
E-30 CONTROL PANEL NO. 4 PLC DIGITAL WIRING DIAGRAM I



81 DETAIL
E-30 CONTROL PANEL NO. 4 PLC DIGITAL WIRING DIAGRAM II



82 DETAIL
E-30 CONTROL PANEL NO. 4 PLC RELAY OUTPUTS WIRING DIAGRAM I



83 DETAIL
E-30 CONTROL PANEL NO. 4 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-04 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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APPROVED BY:	JJD		

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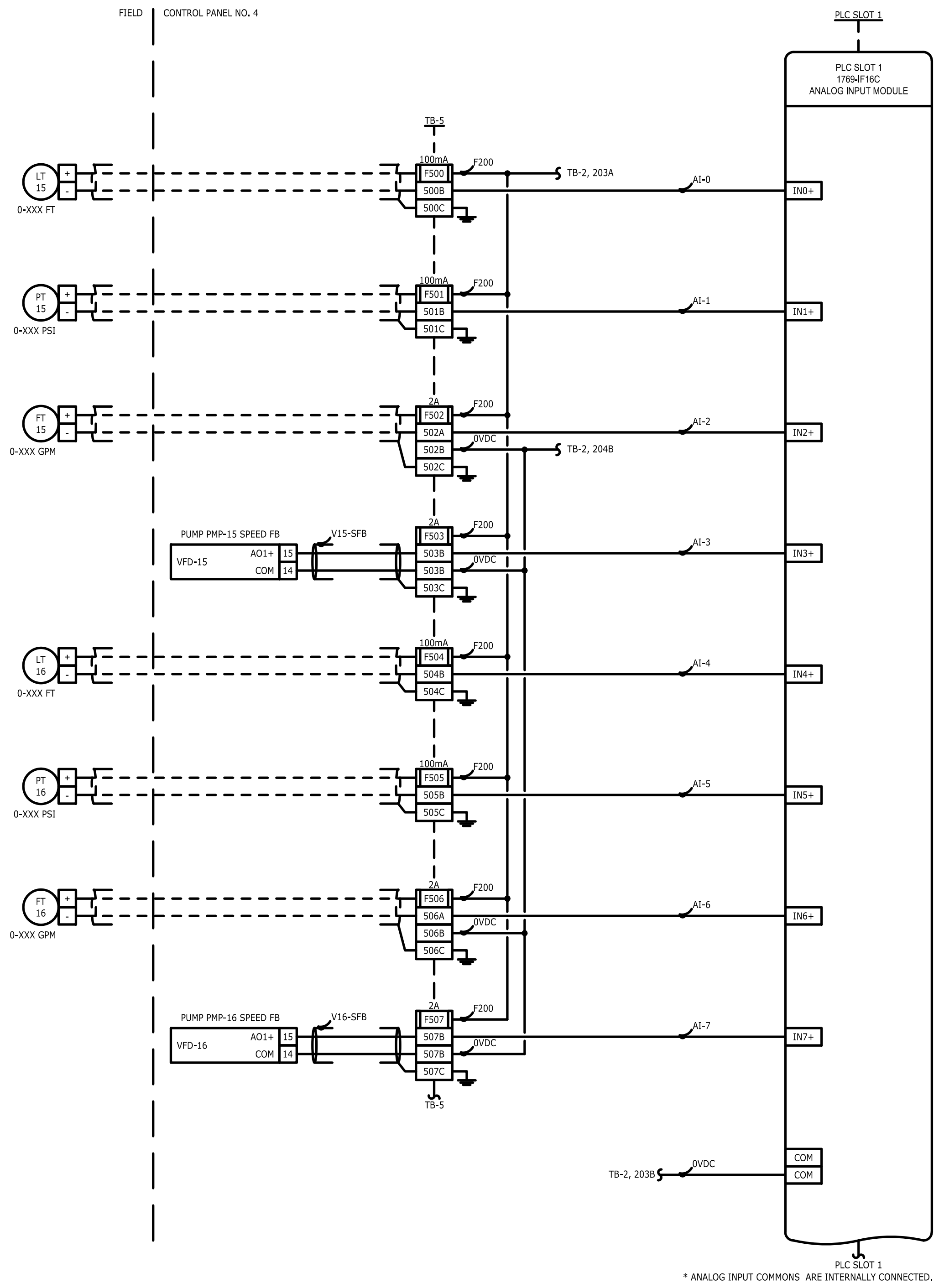
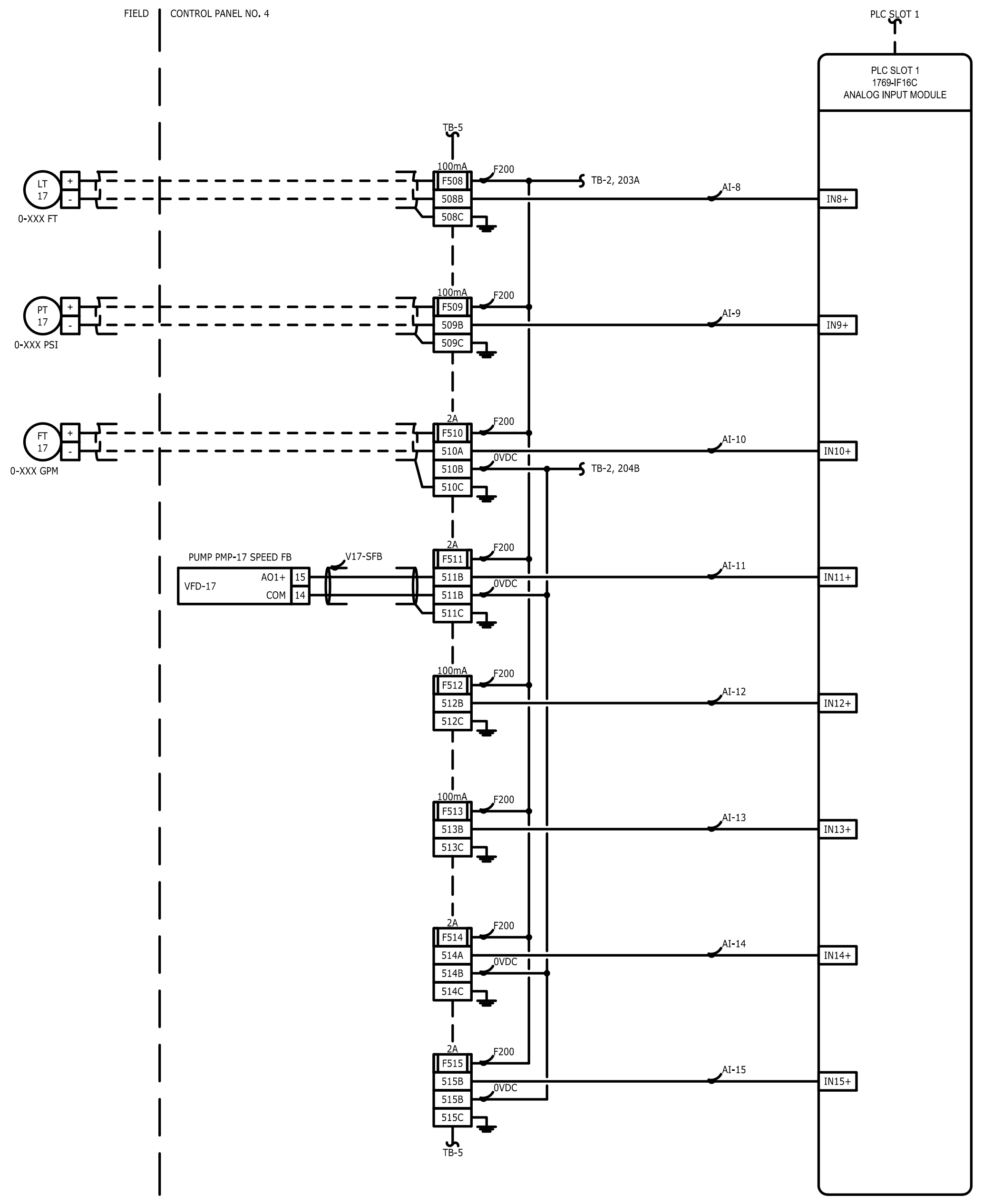
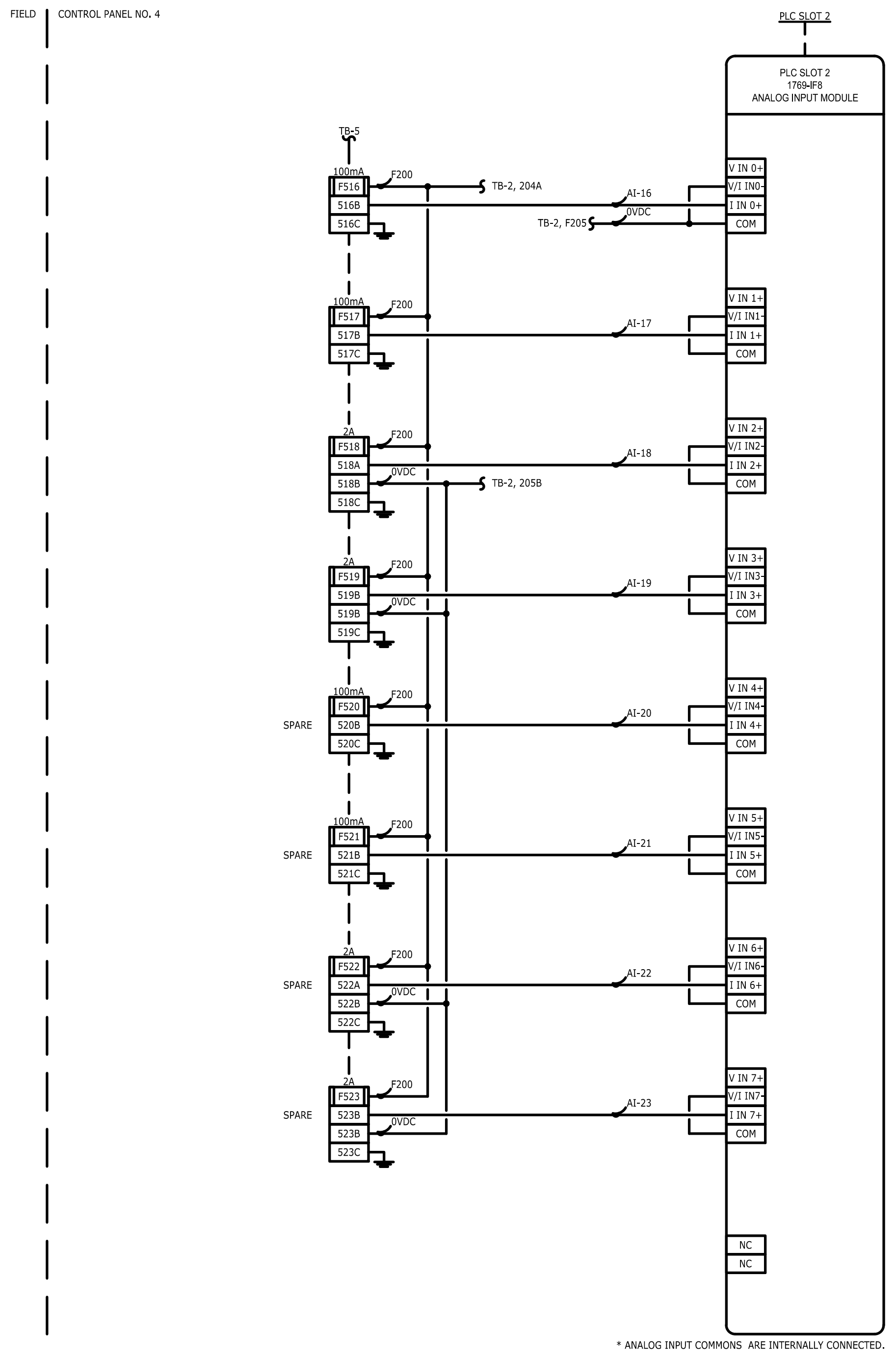


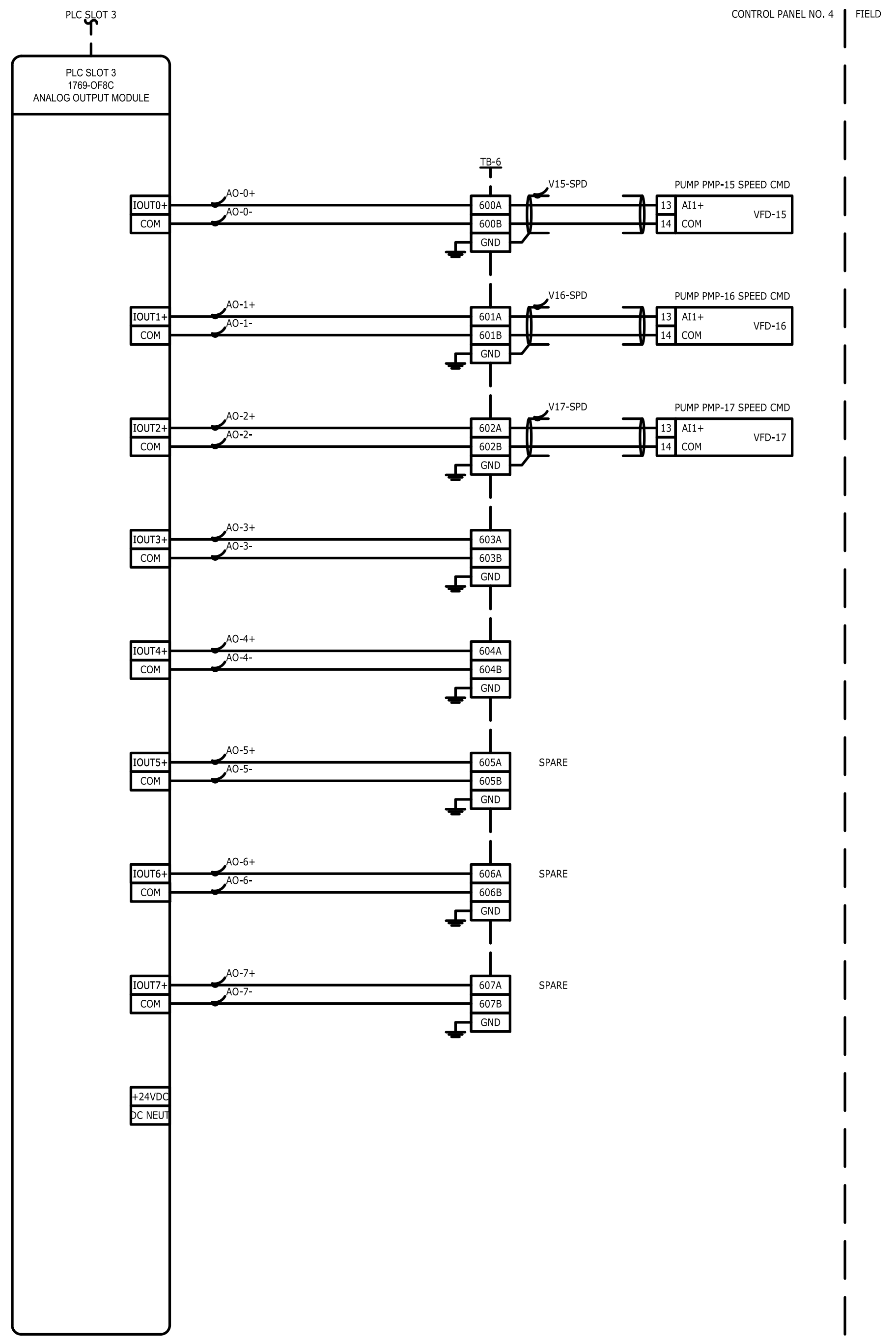
84 E-31 DETAIL
CONTROL PANEL NO. 4 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



85 E-31 DETAIL
CONTROL PANEL NO. 4 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



86 E-31 DETAIL
CONTROL PANEL NO. 4 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



87 E-31 DETAIL
CONTROL PANEL NO. 4 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

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RALEIGH, NC 27607
919.870.0576

TITLE: EW-04 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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APPROVED BY:	JJD		

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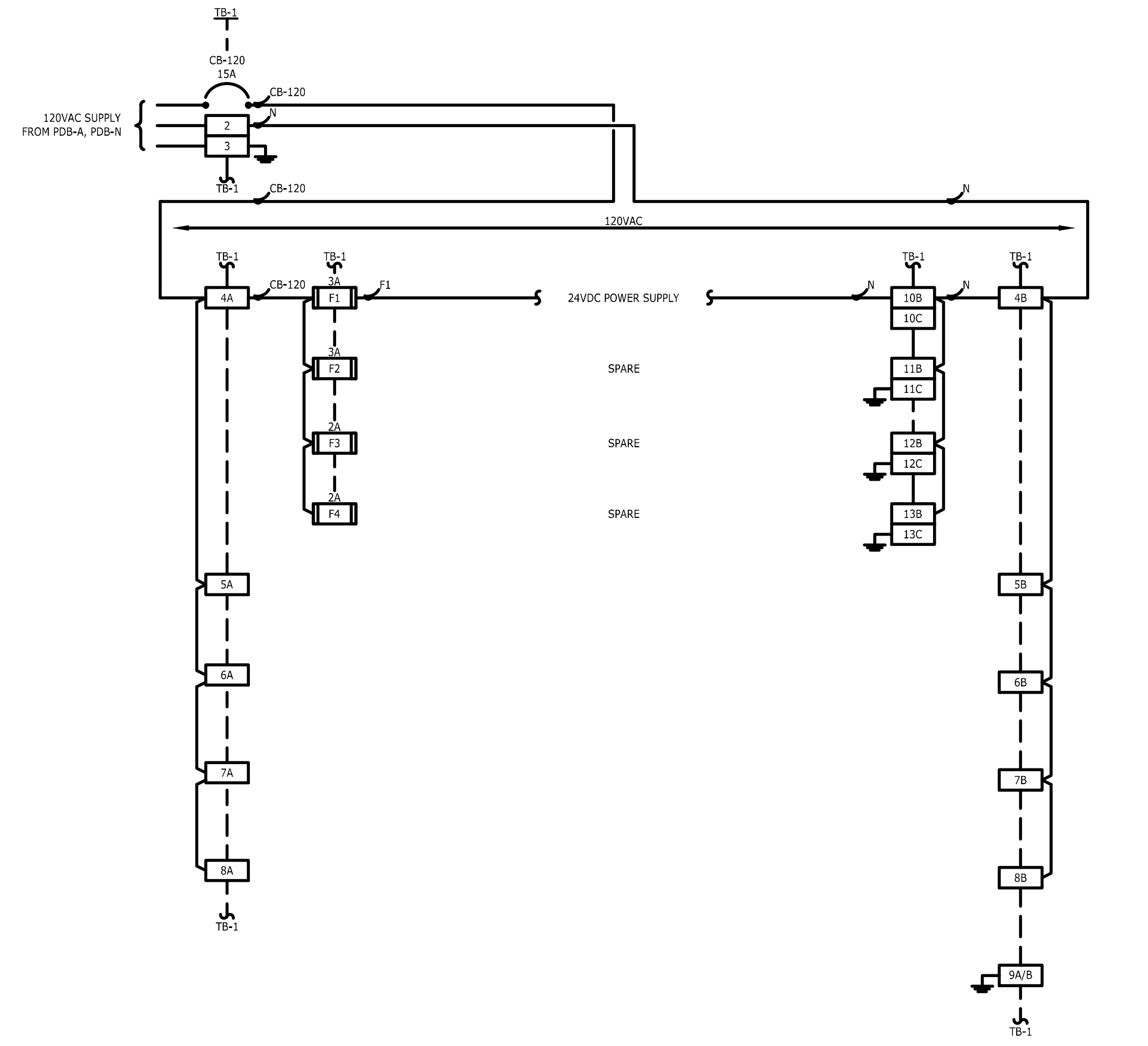
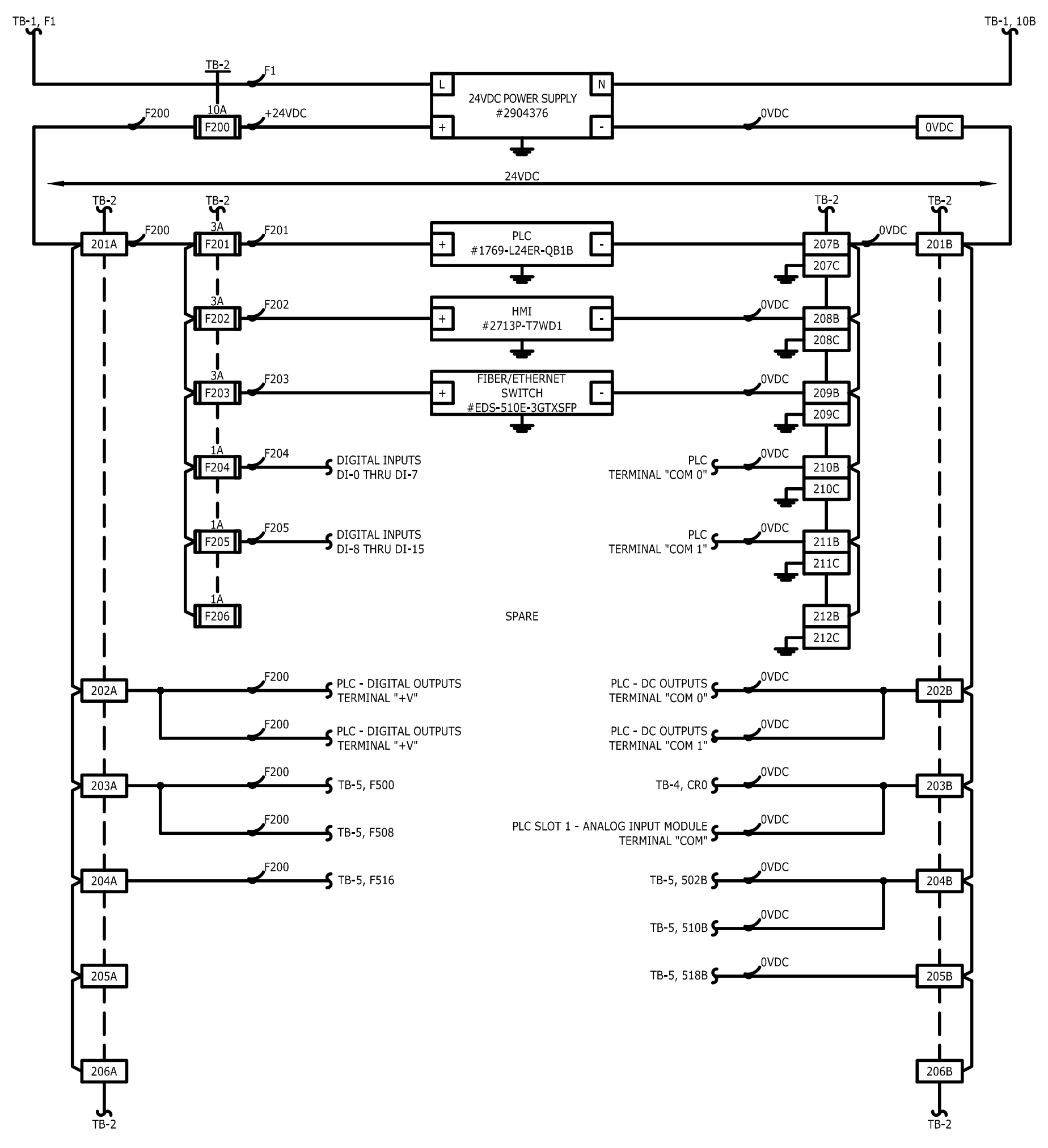
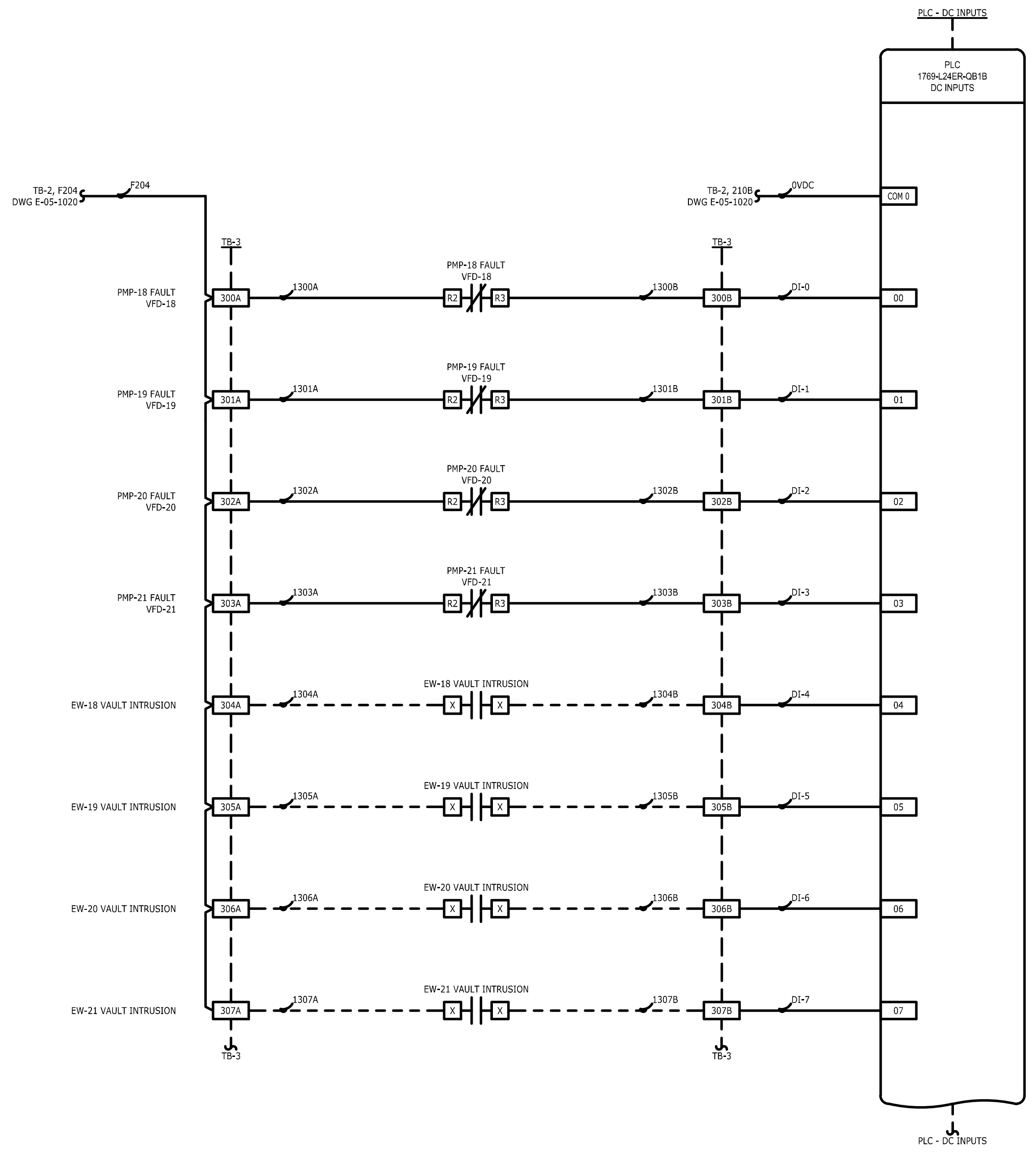


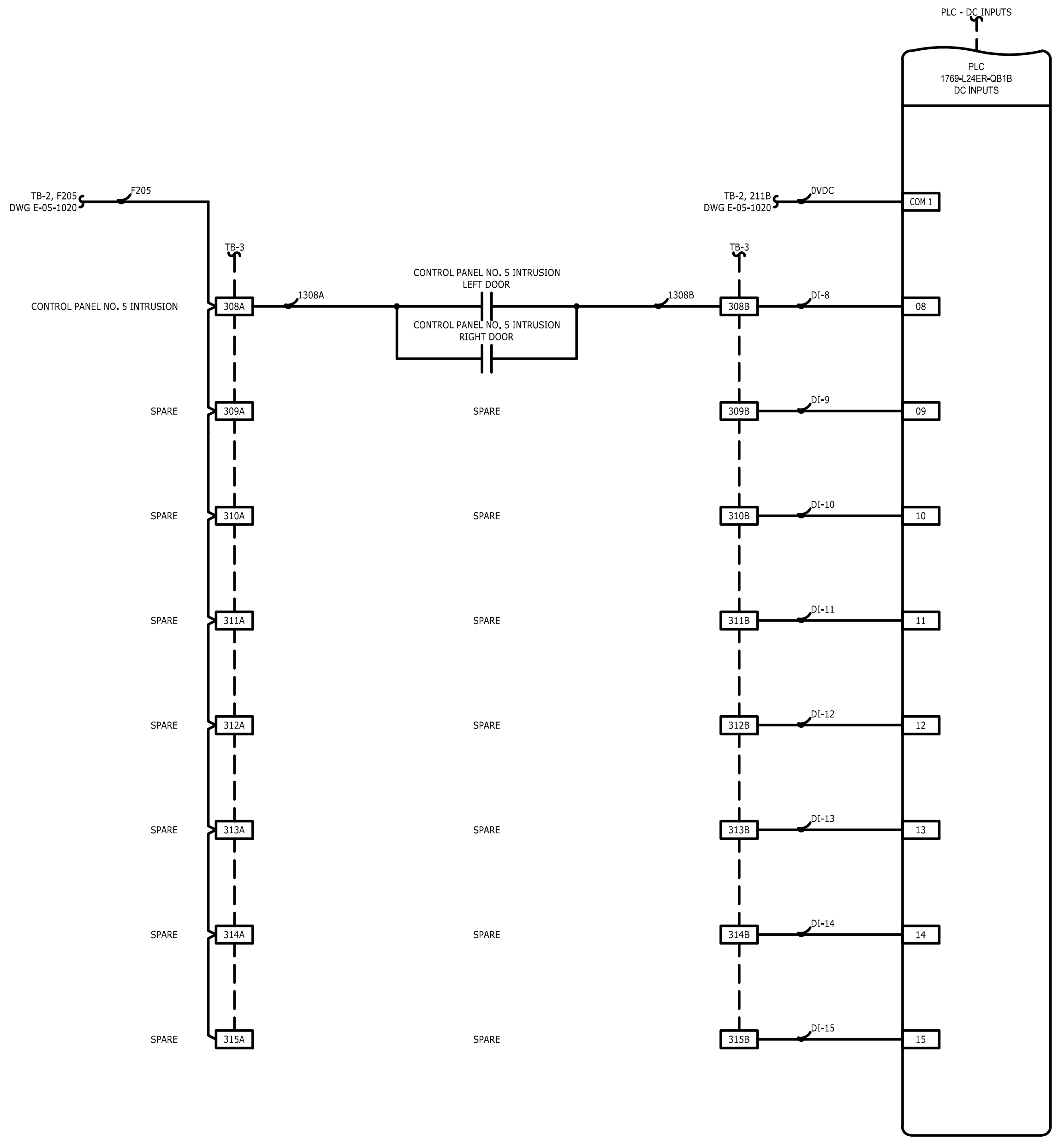
84
E-32
DETAIL
EW-05 120VAC POWER DISTRIBUTION



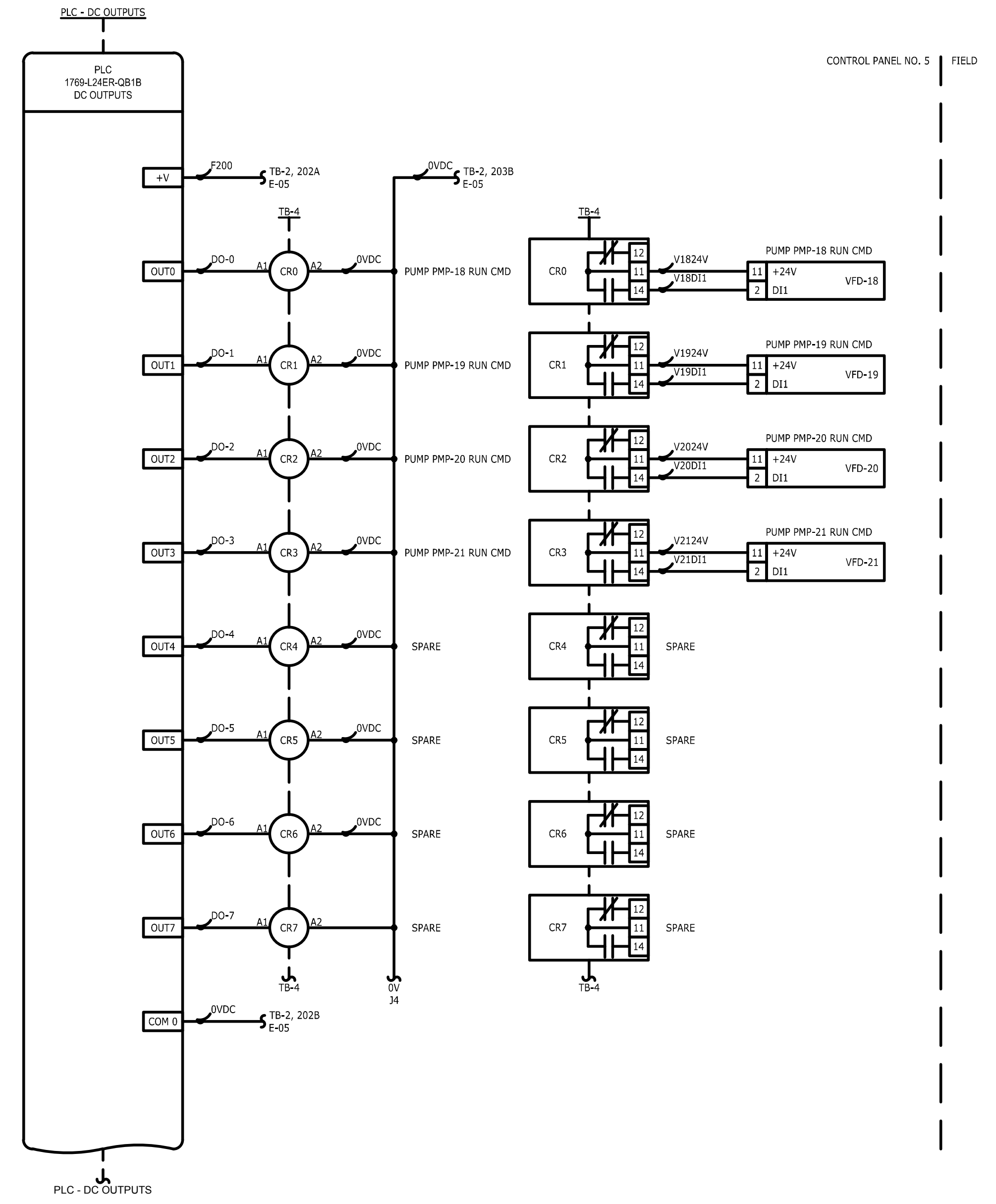
85
E-32
DETAIL
EW-05 24VDC POWER DISTRIBUTION



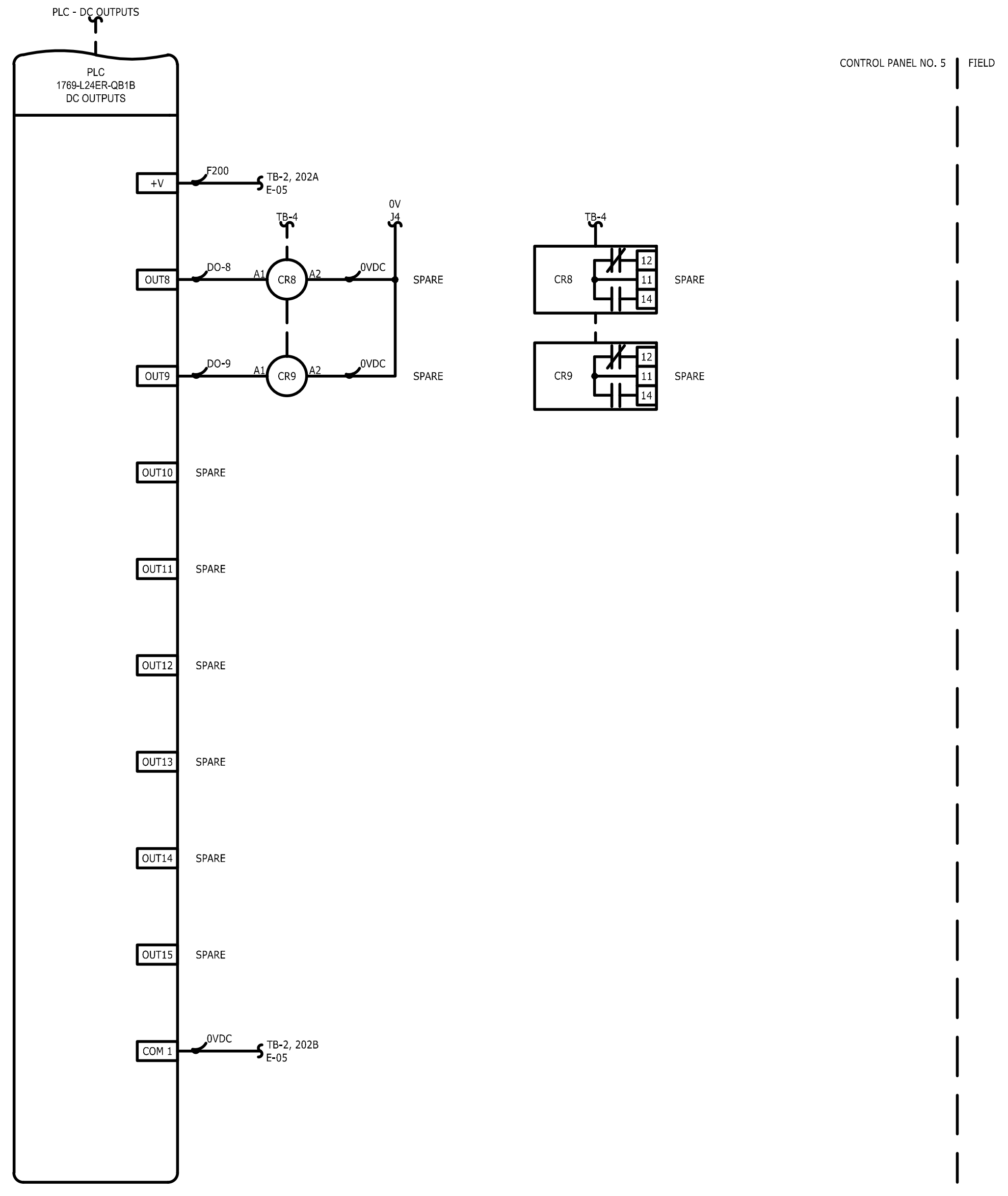
86
E-32
DETAIL
EW-05 PLC DIGITAL WIRING DIAGRAM I



87
E-32
DETAIL
EW-05 PLC DIGITAL WIRING DIAGRAM II



88
E-32
DETAIL
EW-05 PLC RELAY OUTPUTS WIRING DIAGRAM I



89
E-32
DETAIL
EW-05 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

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Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-05 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E32.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-32
APPROVED BY:	JJD		

90% DESIGN DRAWINGS

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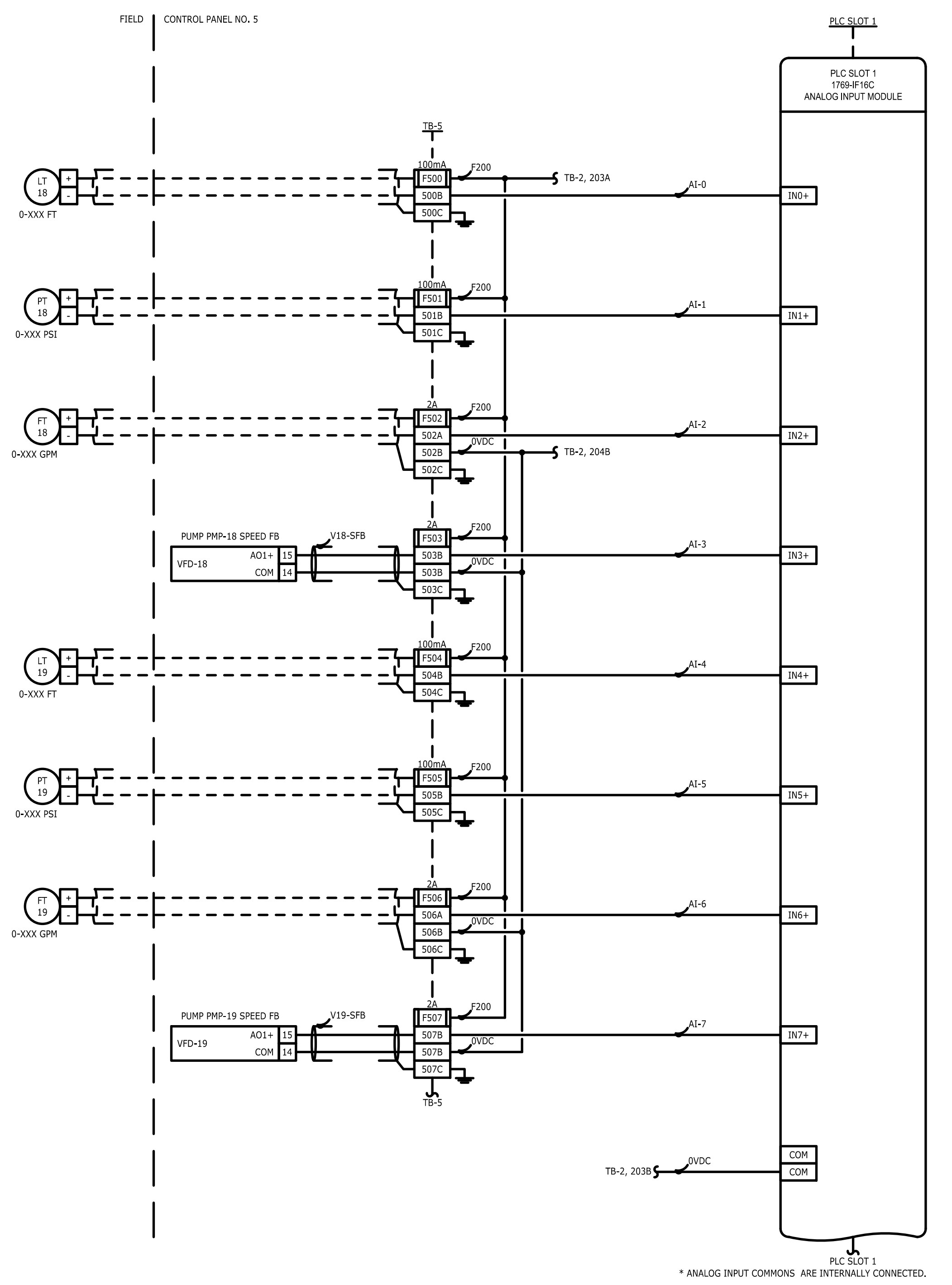
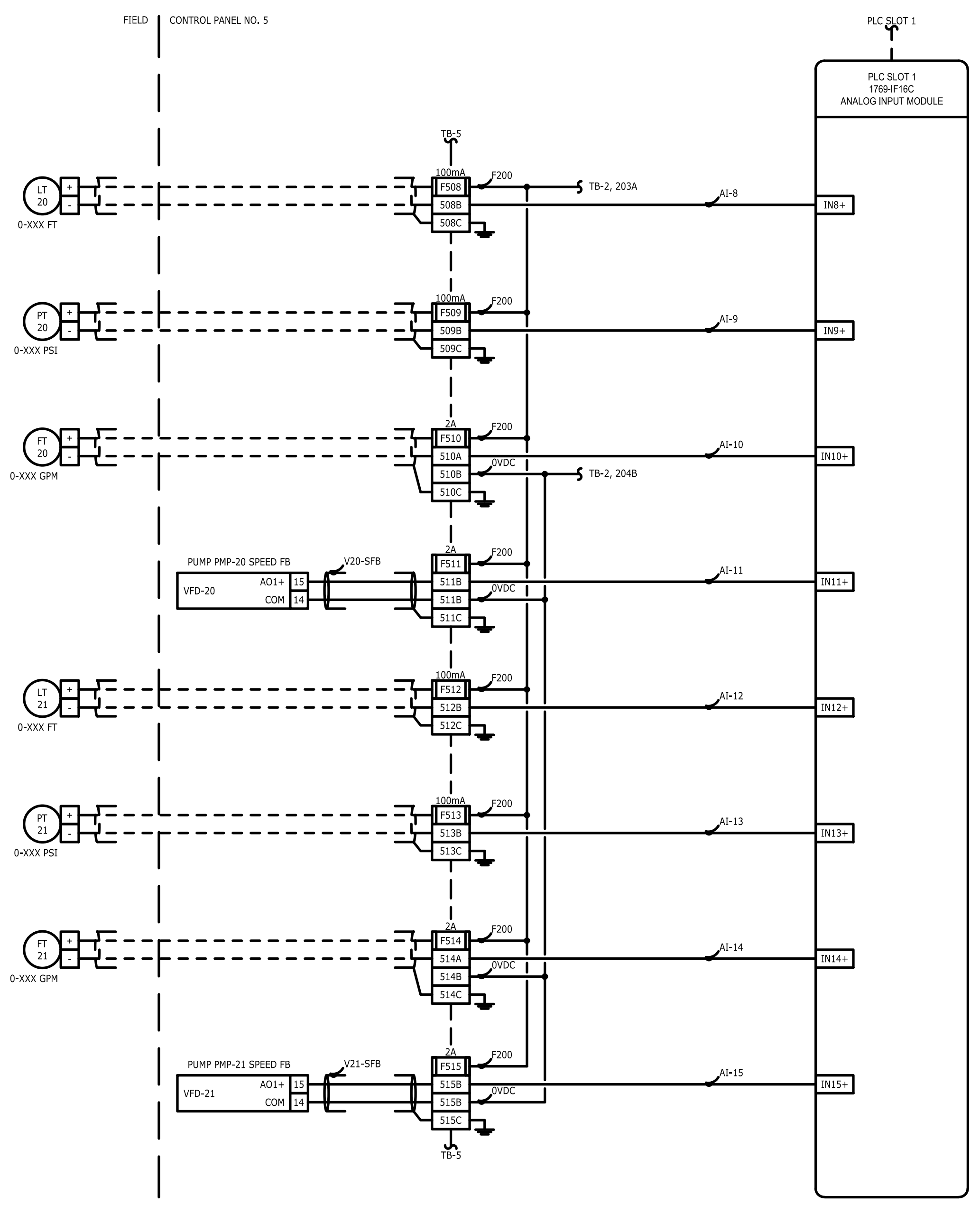


95
E-33

DETAIL
CONTROL PANEL NO. 5 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM I



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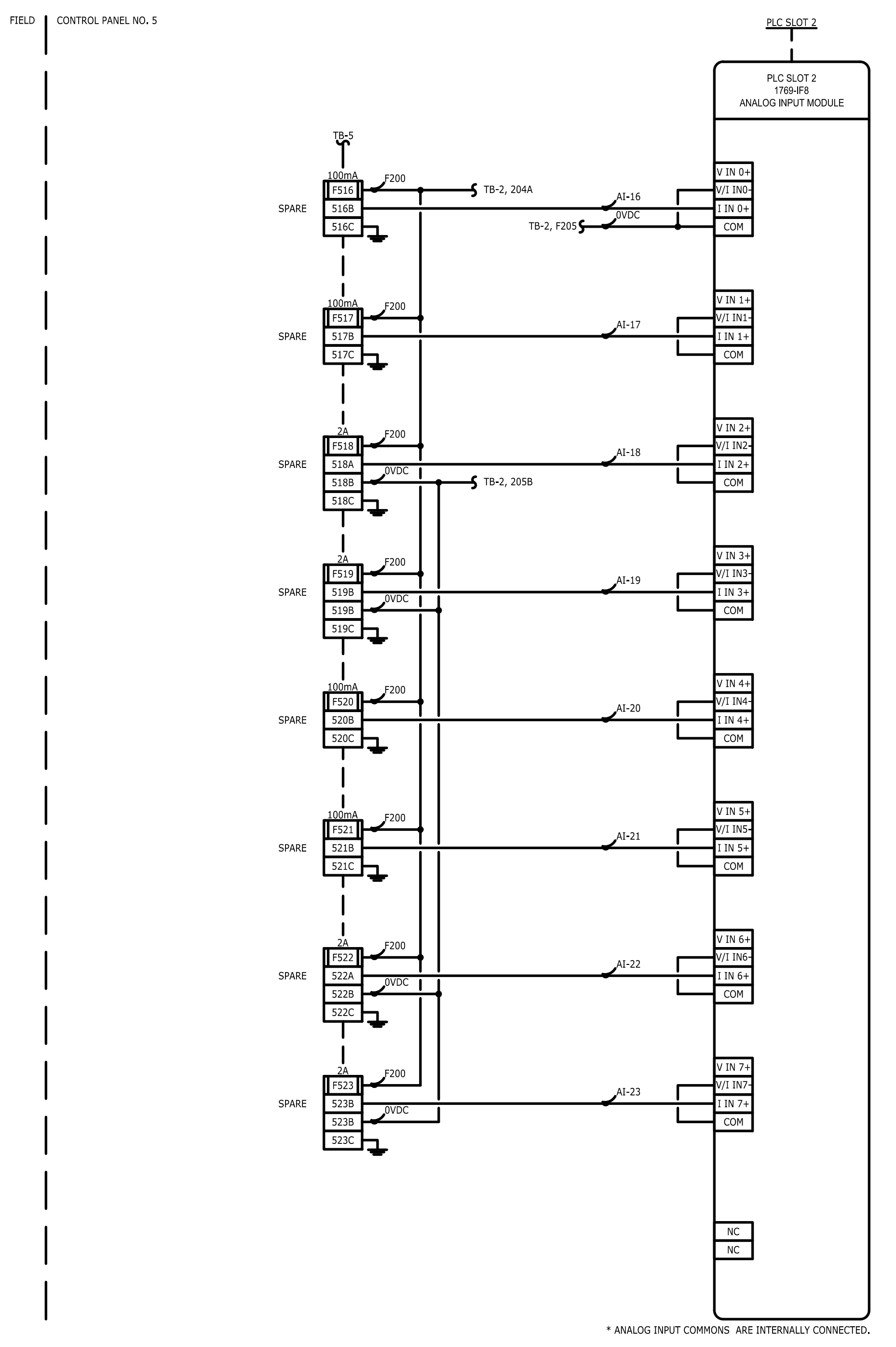
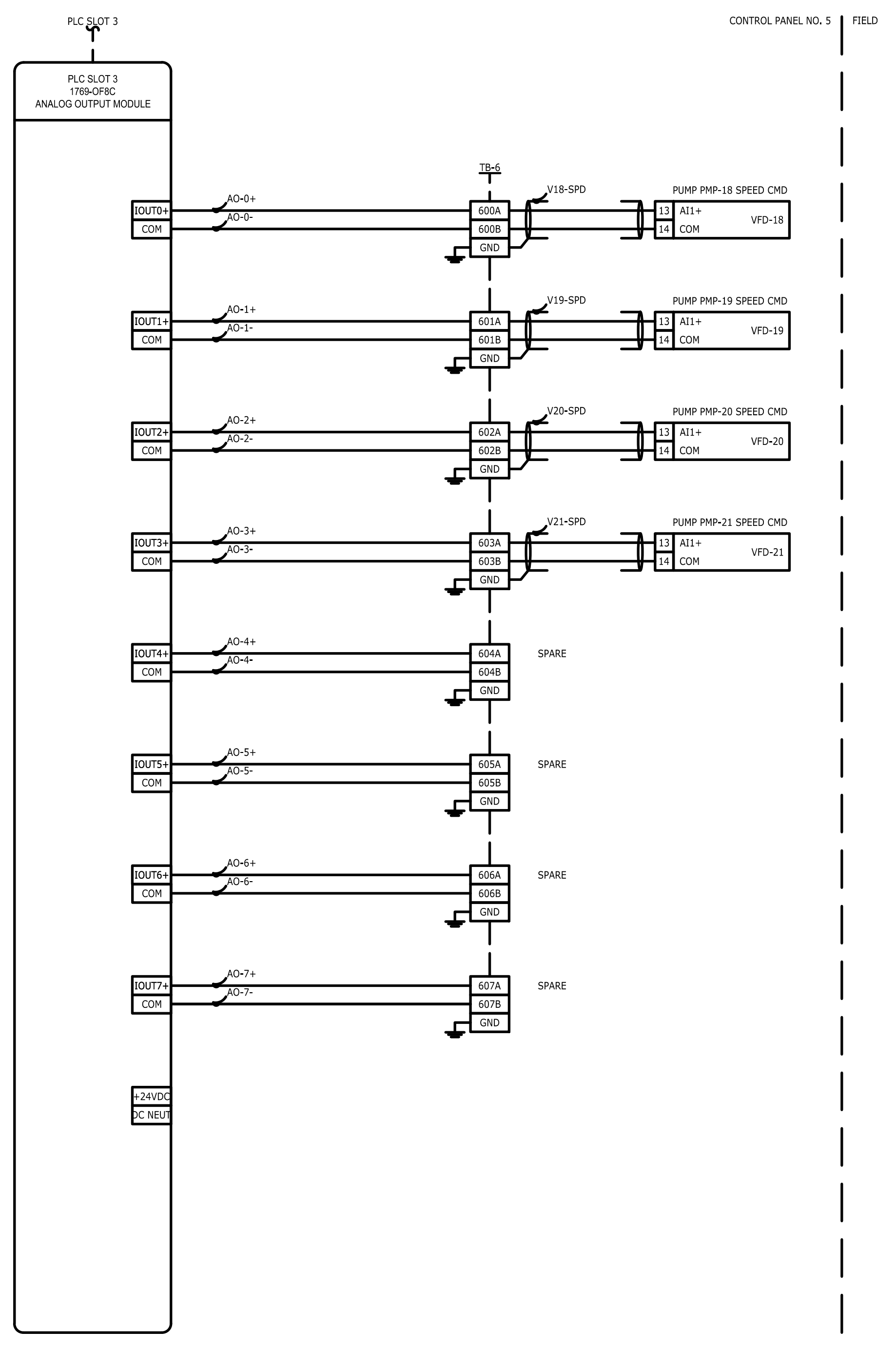
E-33

DETAIL
CONTROL PANEL NO. 5 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM II



97
E-33

DETAIL
CONTROL PANEL NO. 5 PLC SLOT
2 ANALOG INPUT WIRING DIAGRAM



98
E-33

DETAIL
CONTROL PANEL NO. 5 PLC SLOT 3
ANALOG INPUT WIRING DIAGRAM

NOTES:

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C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-05 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E33.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-33
APPROVED BY:	JJD		

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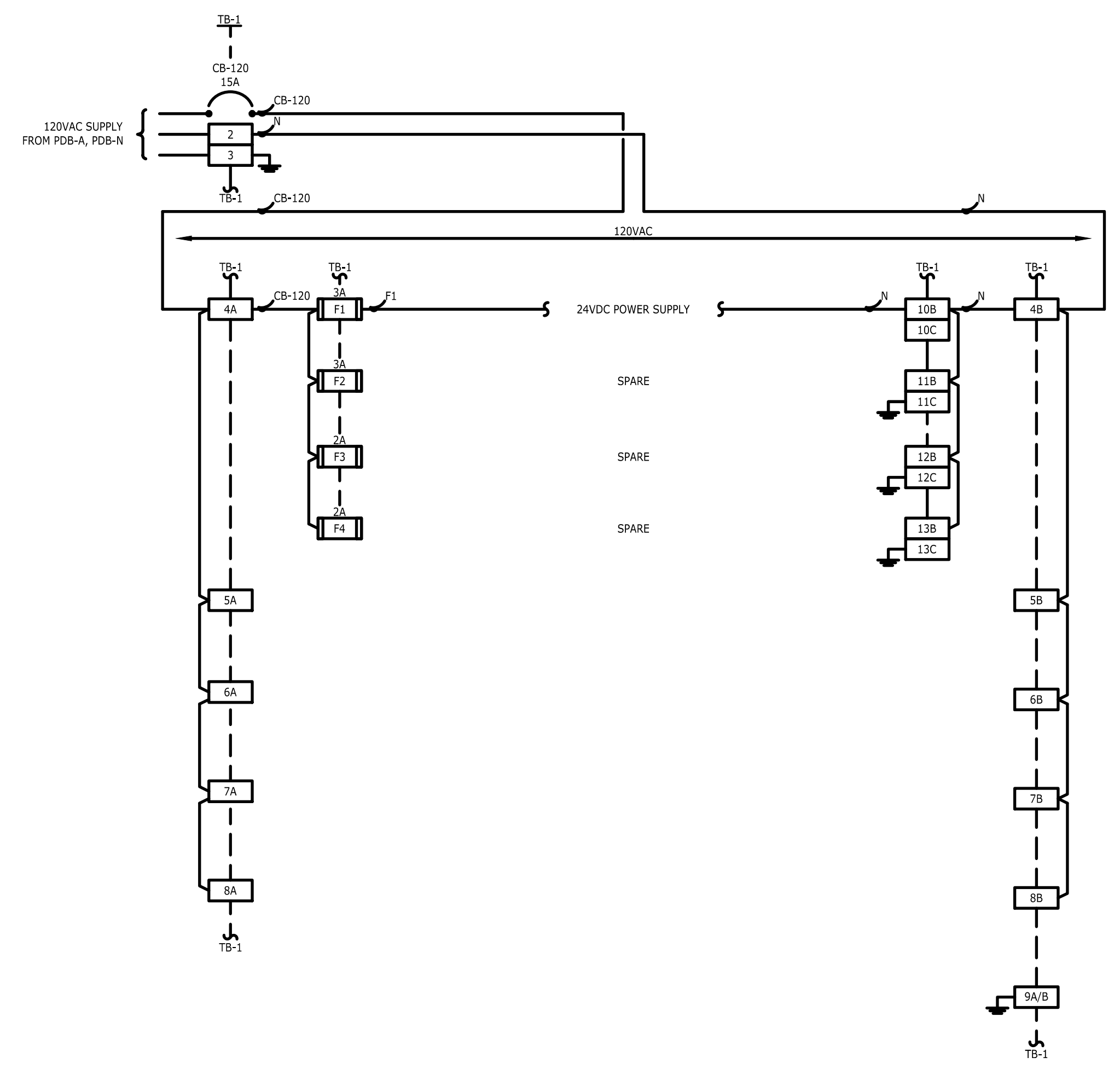

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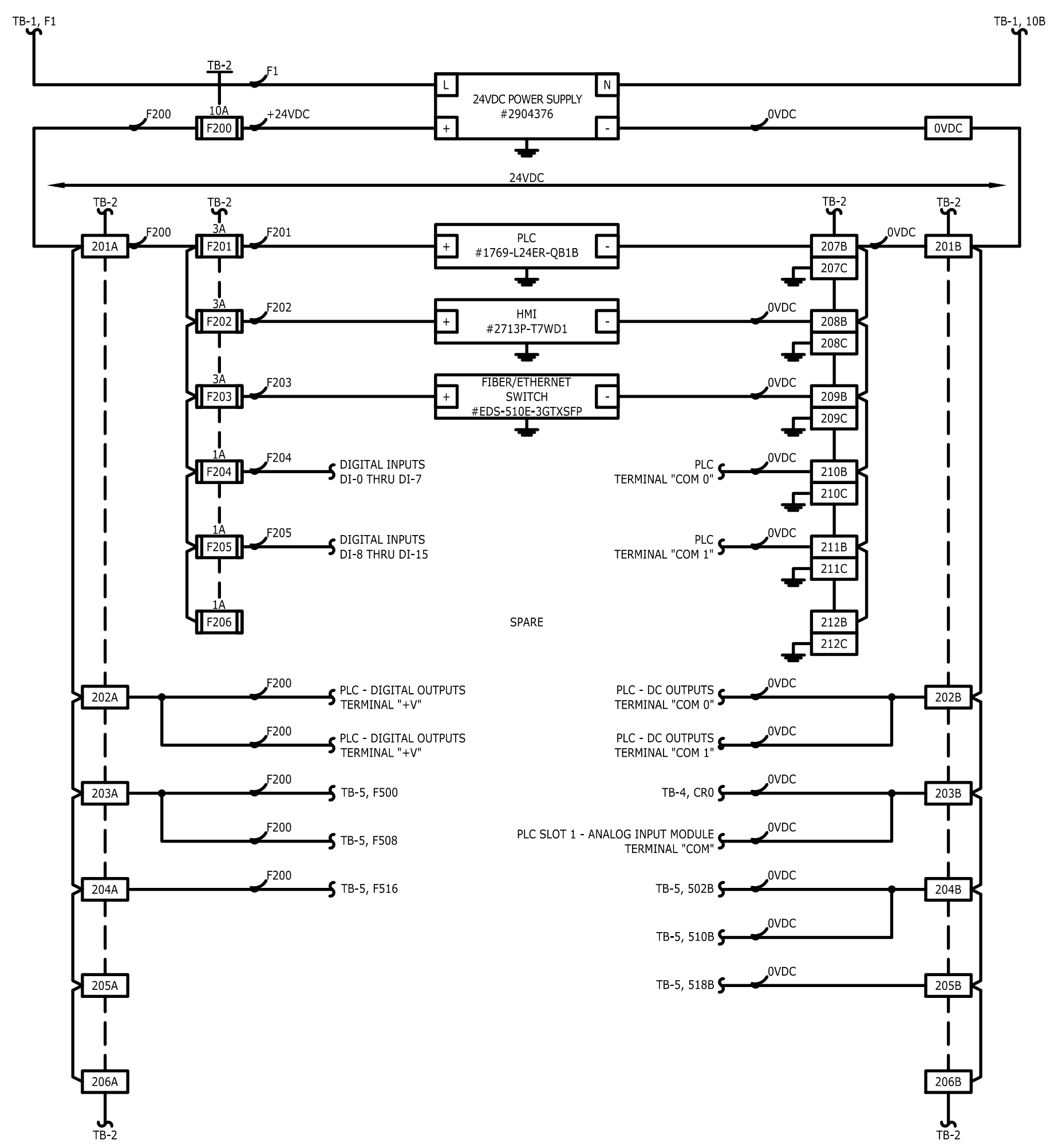
E-34
DETAIL
CONTROL PANEL NO. 6 120VAC POWER DISTRIBUTION



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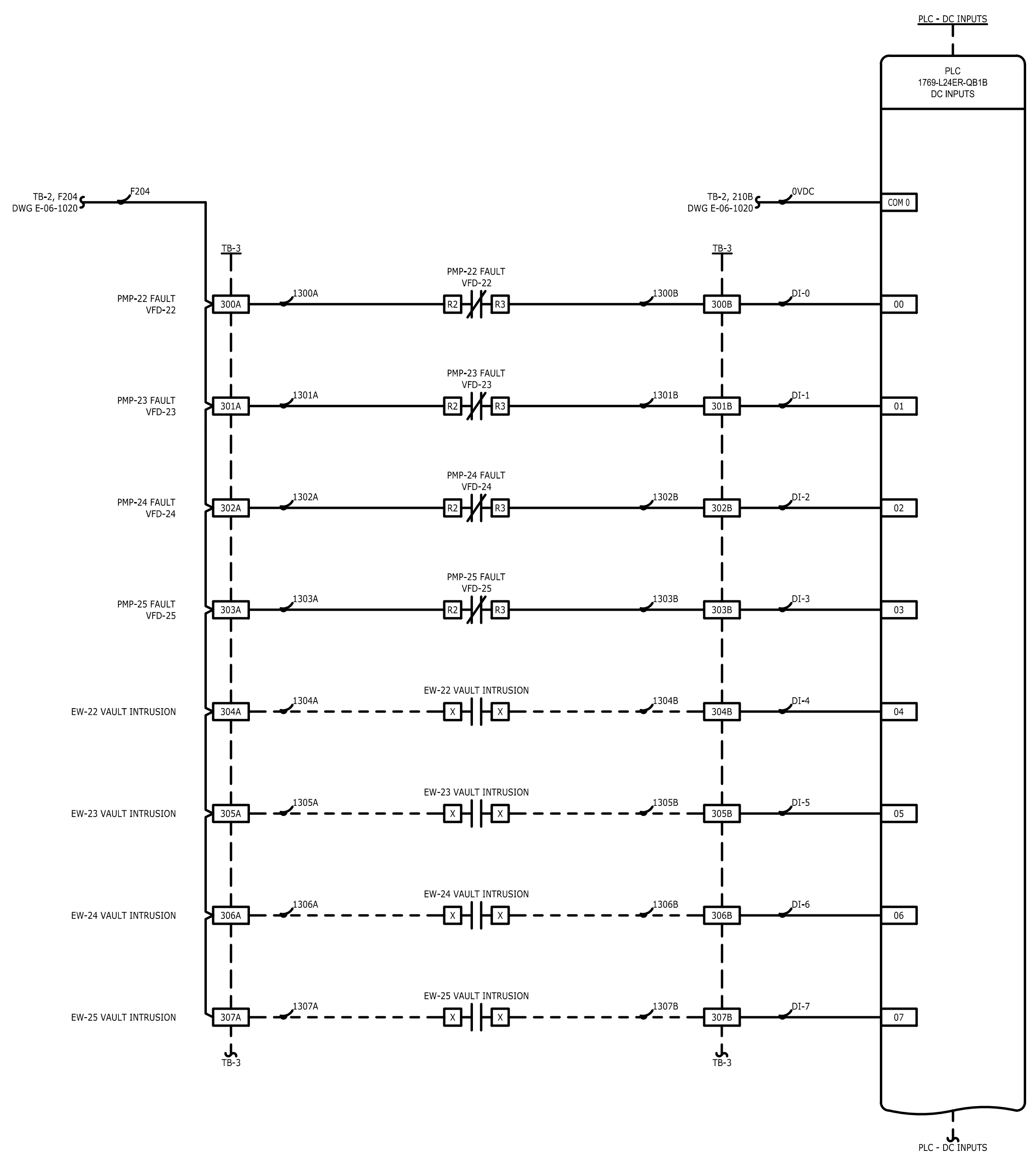
E-34
DETAIL
CONTROL PANEL NO. 6 24VDC POWER DISTRIBUTION



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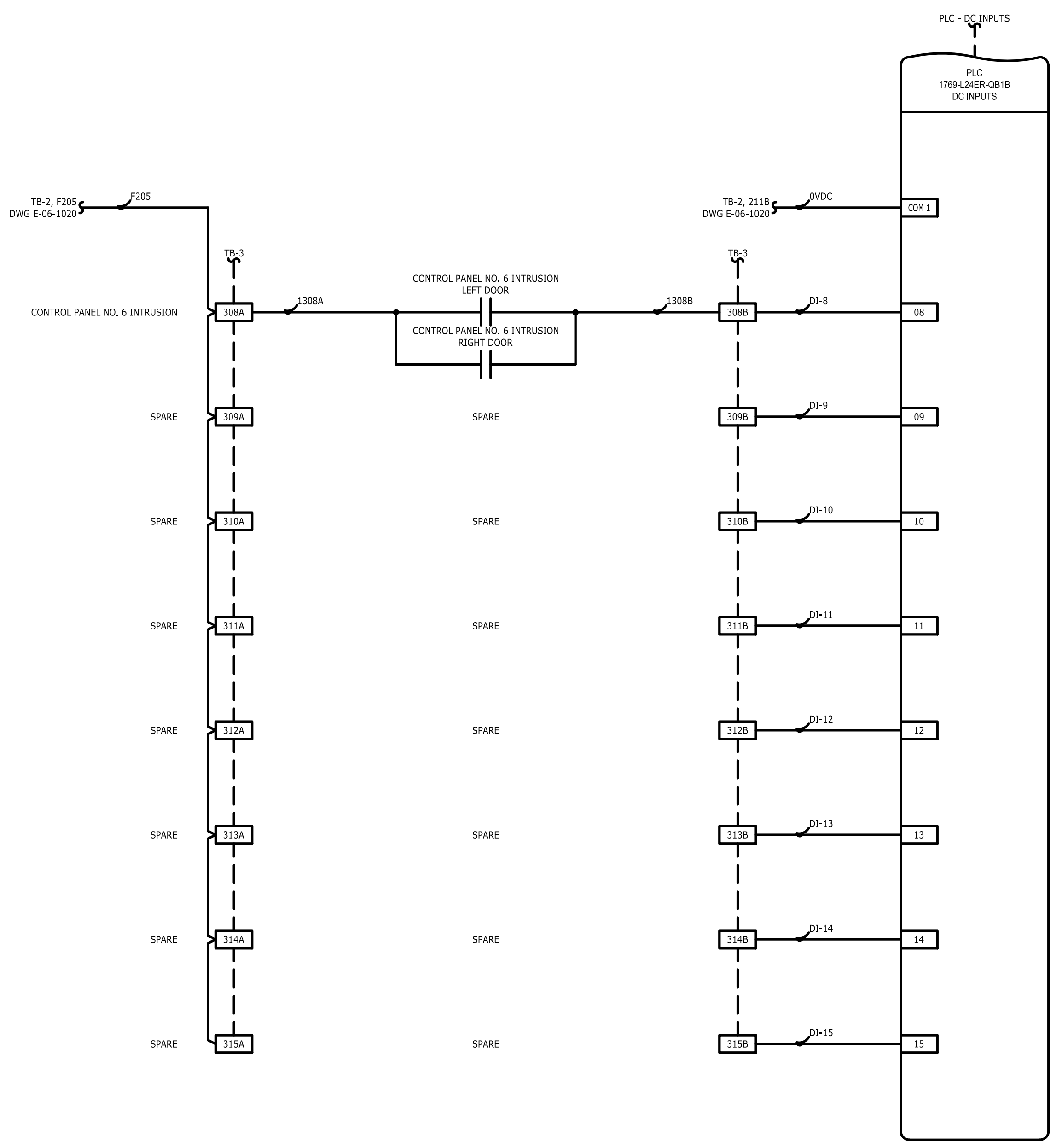
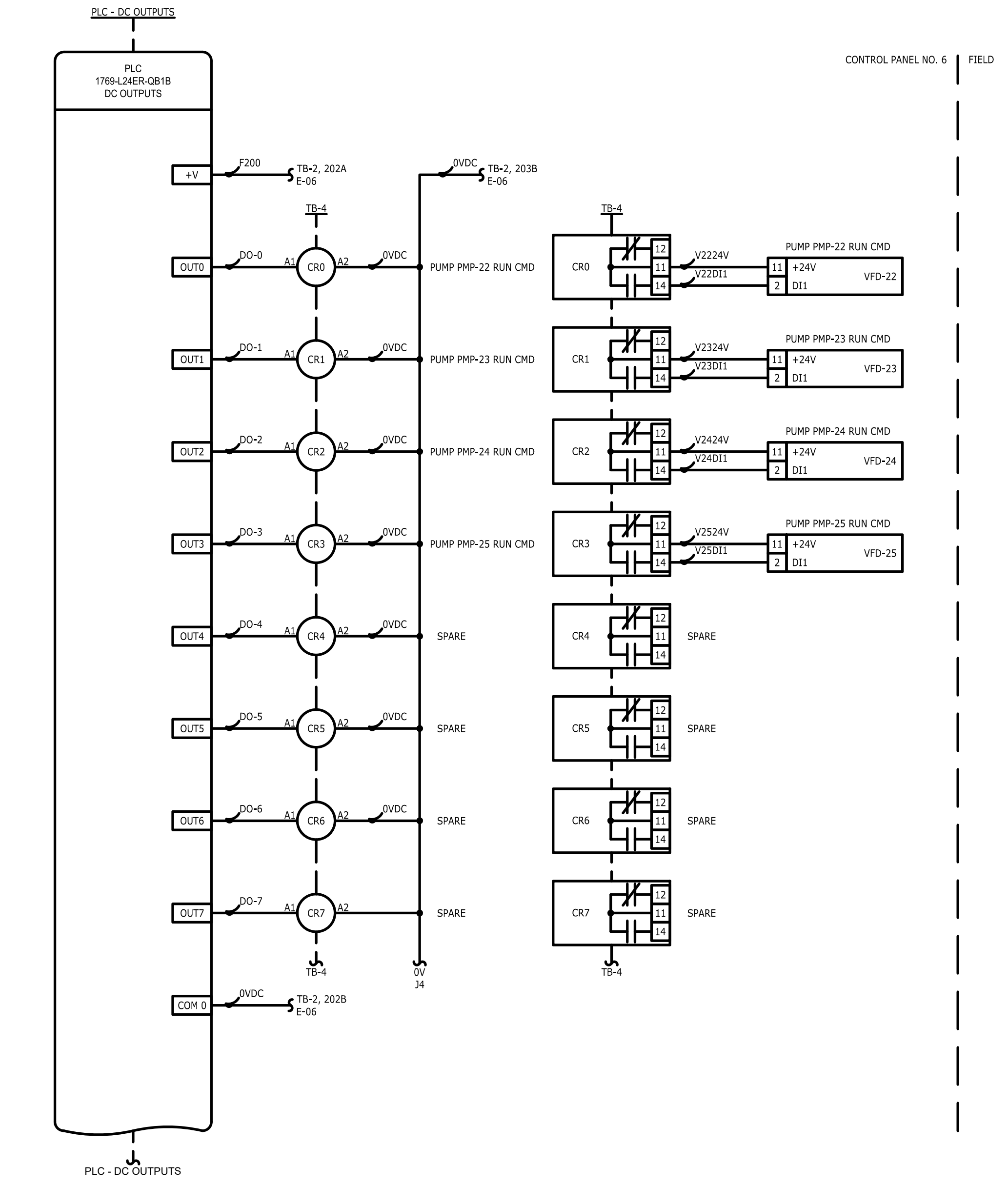
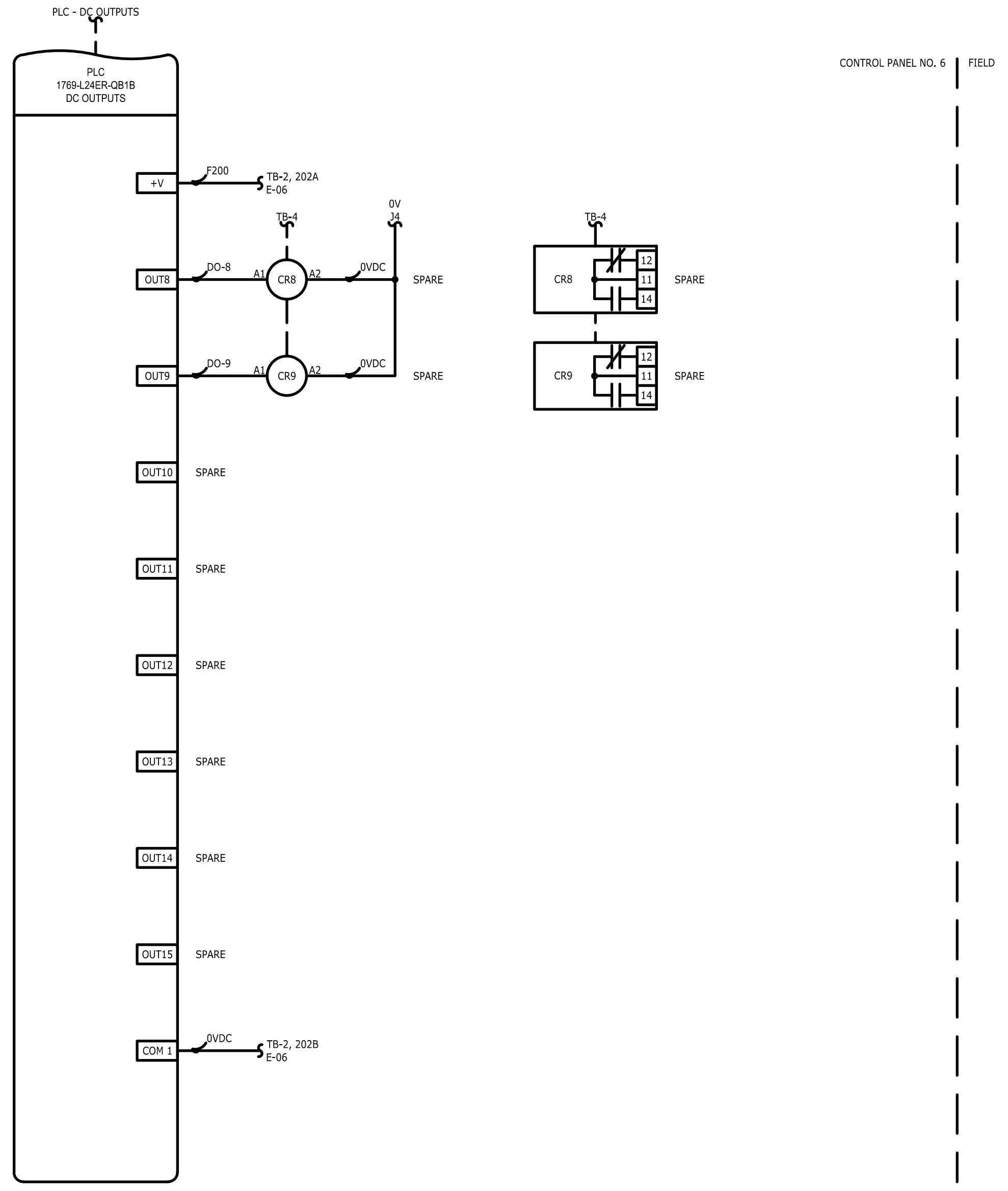
DETAIL
CONTROL PANEL NO. 6 PLC DIGITAL WIRING DIAGRAM I



103
E-34
DETAIL
CONTROL PANEL NO. 6 PLC DIGITAL WIRING DIAGRAM II



104
E-34
DETAIL
CONTROL PANEL NO. 6 PLC RELAY OUTPUTS WIRING DIAGRAM I



105
E-34
DETAIL
CONTROL PANEL NO. 6 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-06 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E34.DWG
REVIEWED BY:	SV	DRAWING NO.:	
APPROVED BY:	JJD		E-34

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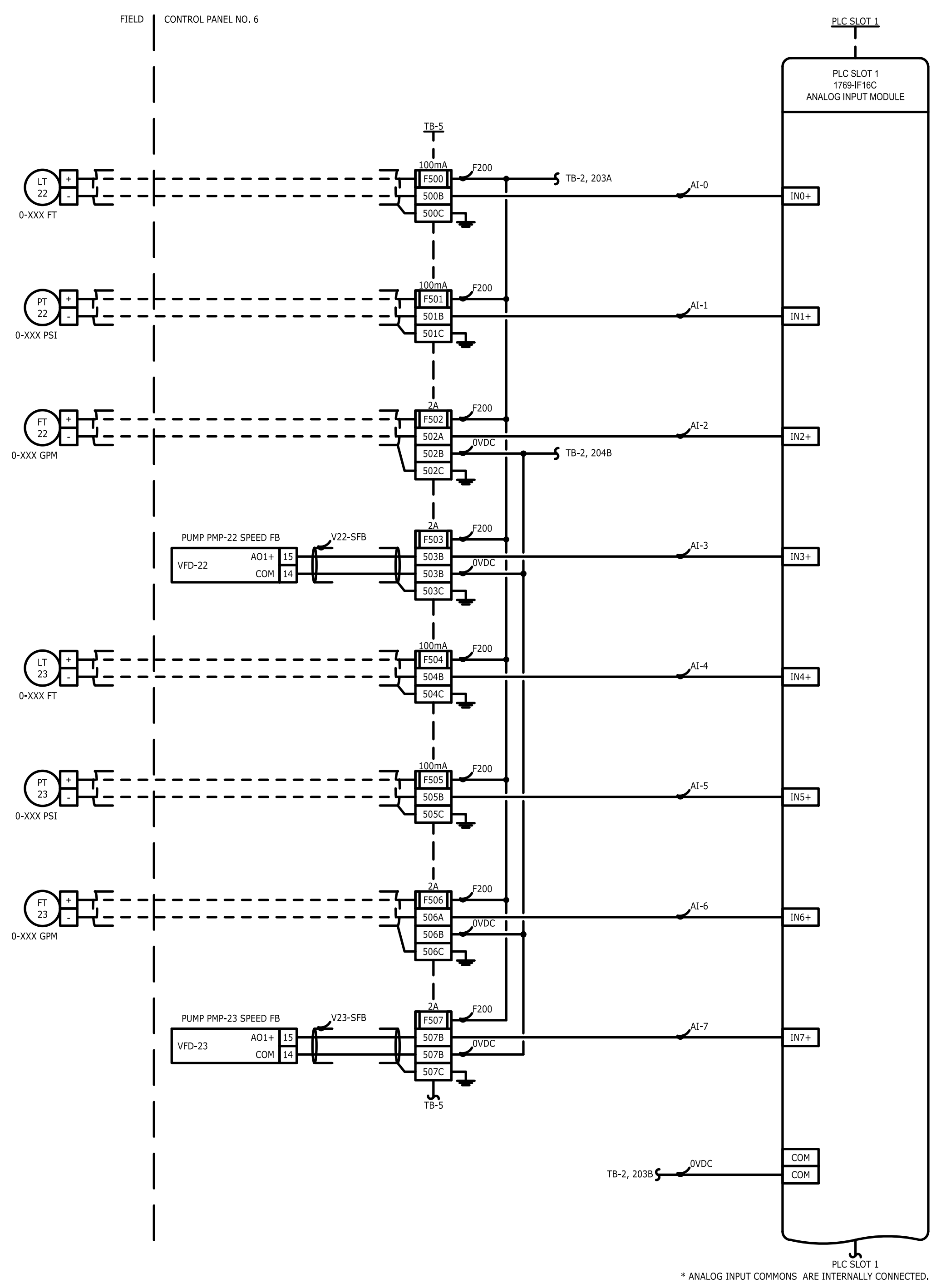
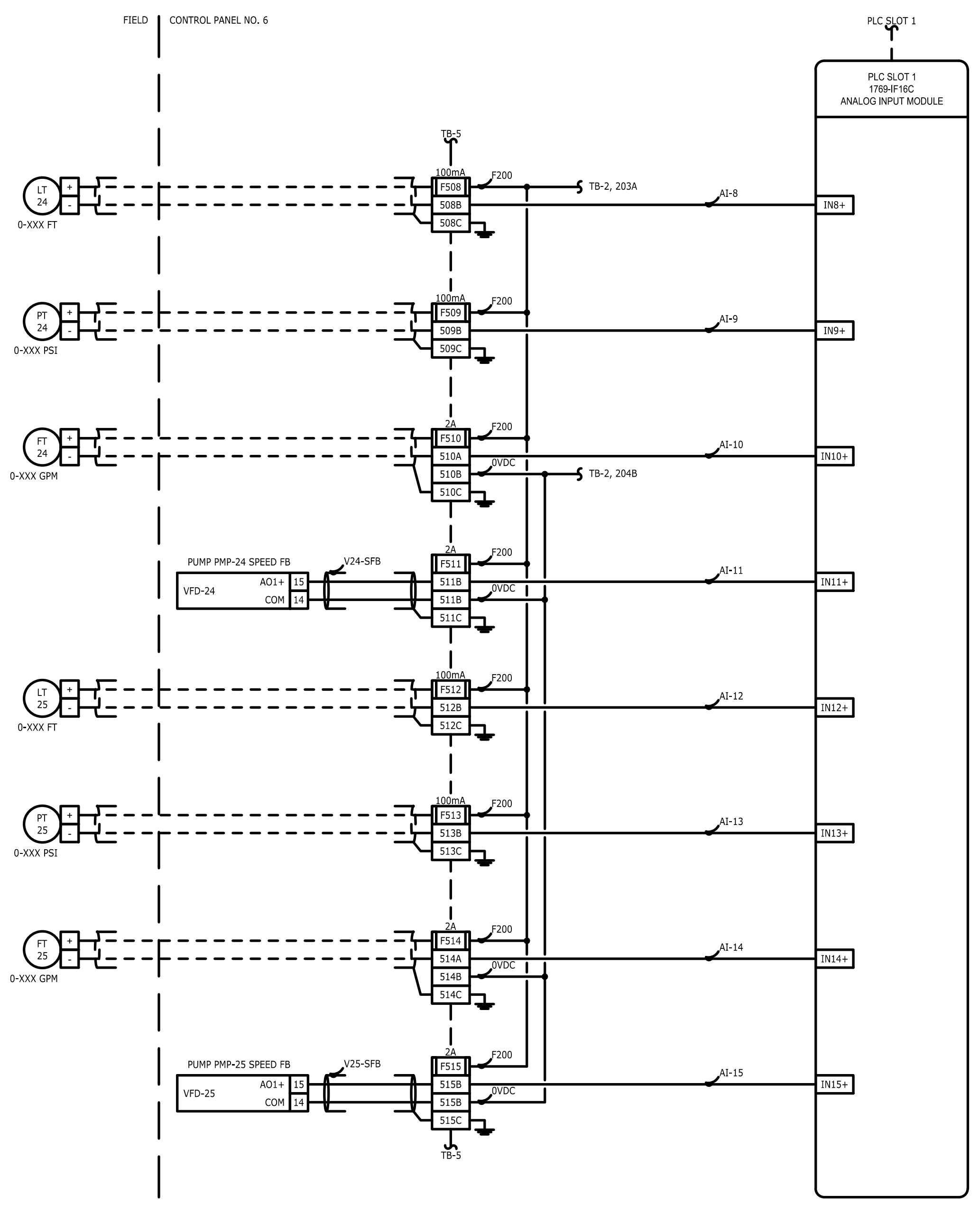


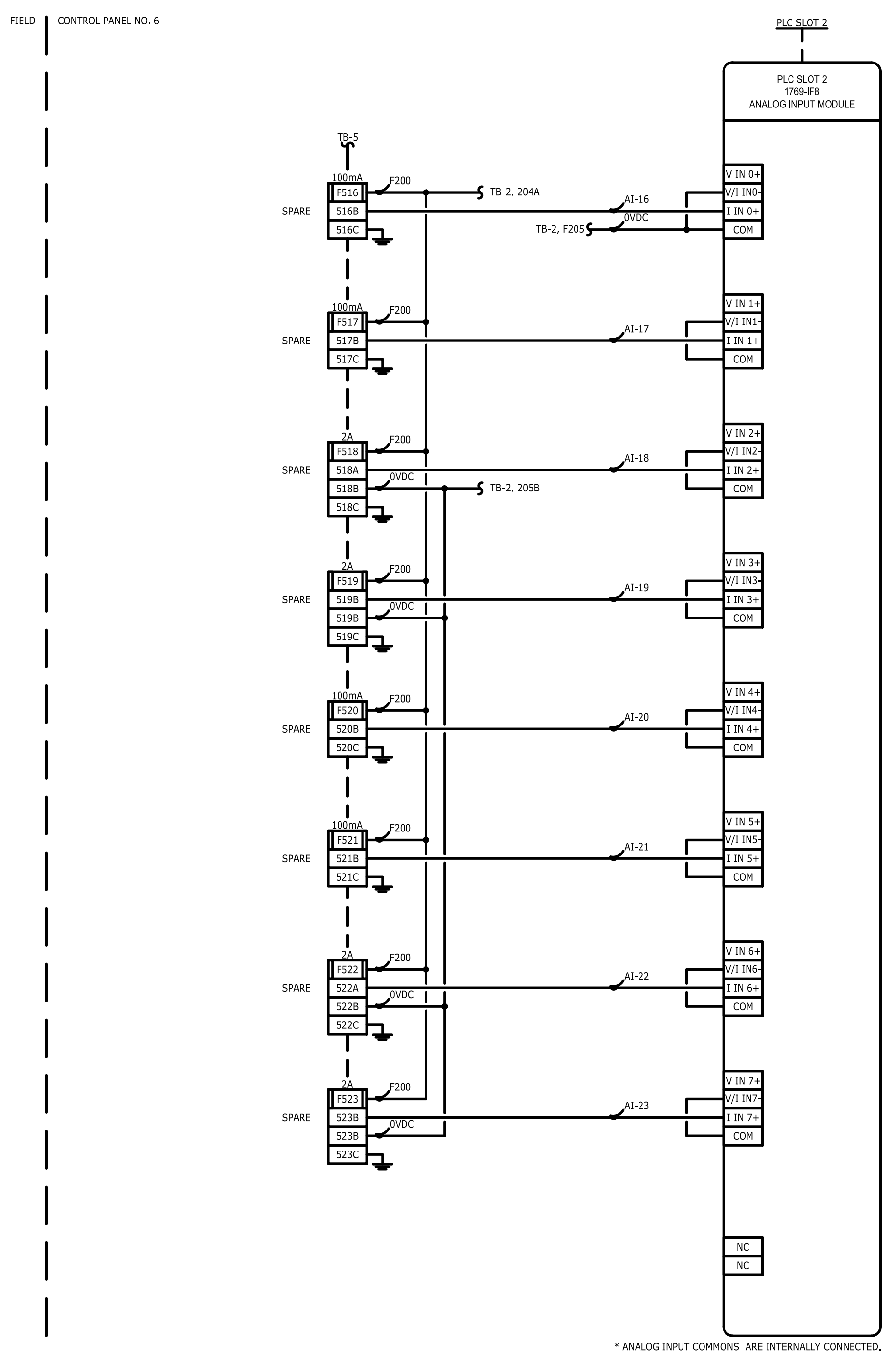
106 E-35 DETAIL

CONTROL PANEL NO. 6 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



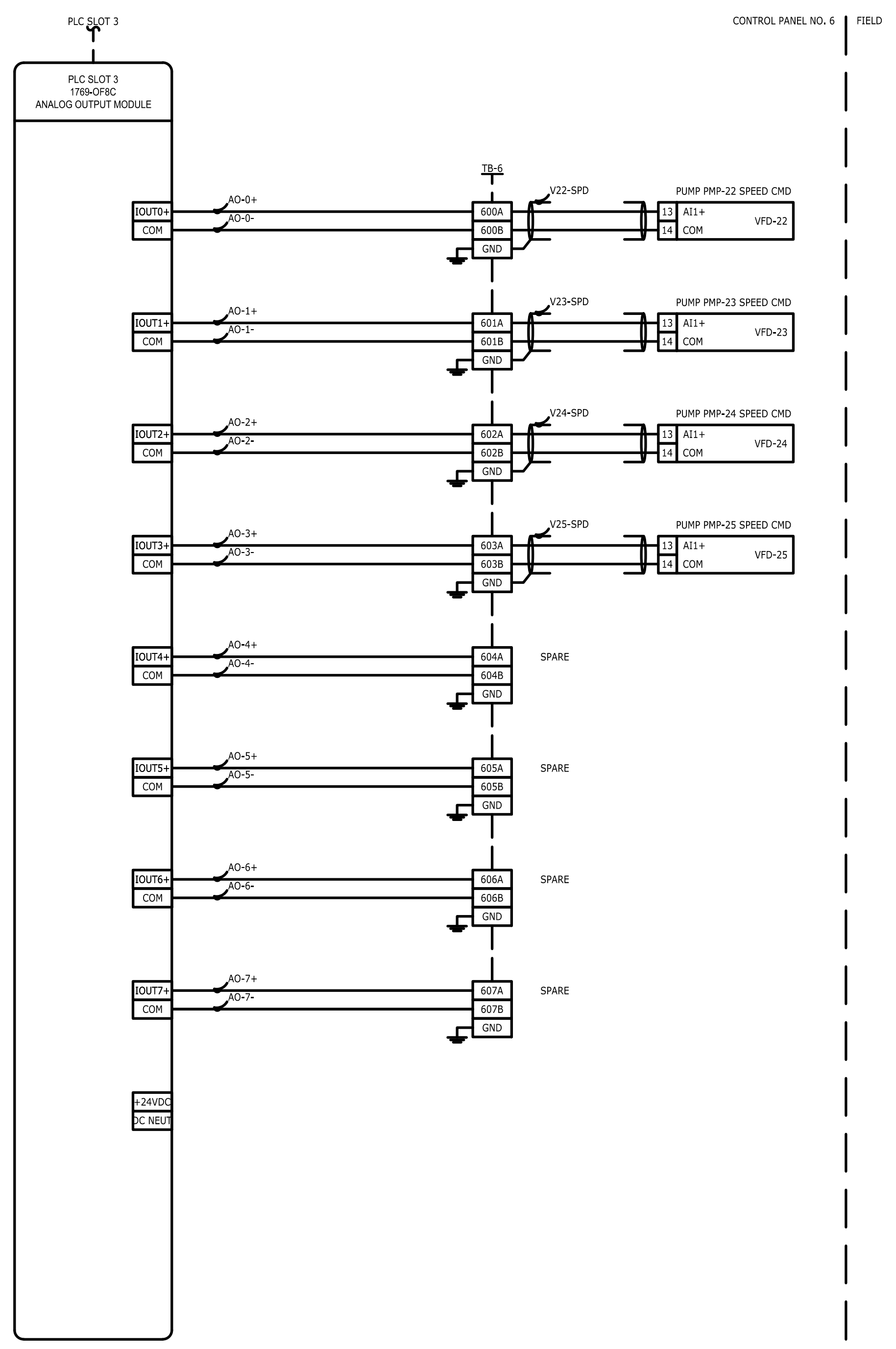
107 E-35 DETAIL

CONTROL PANEL NO. 6 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



108 E-35 DETAIL

CONTROL PANEL NO. 6 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



109 E-35 DETAIL

CONTROL PANEL NO. 6 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

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90% DESIGN DRAWINGS

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C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-06 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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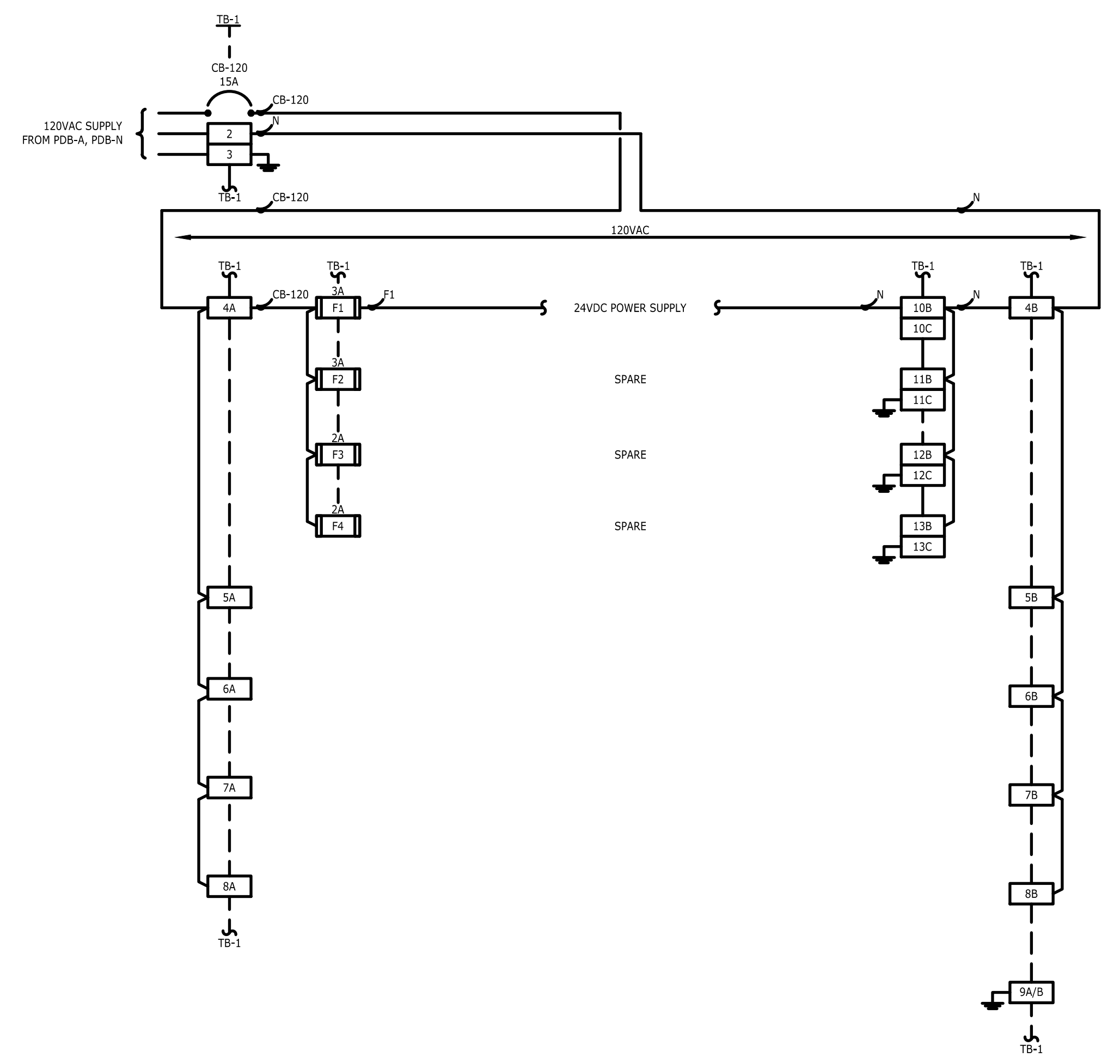
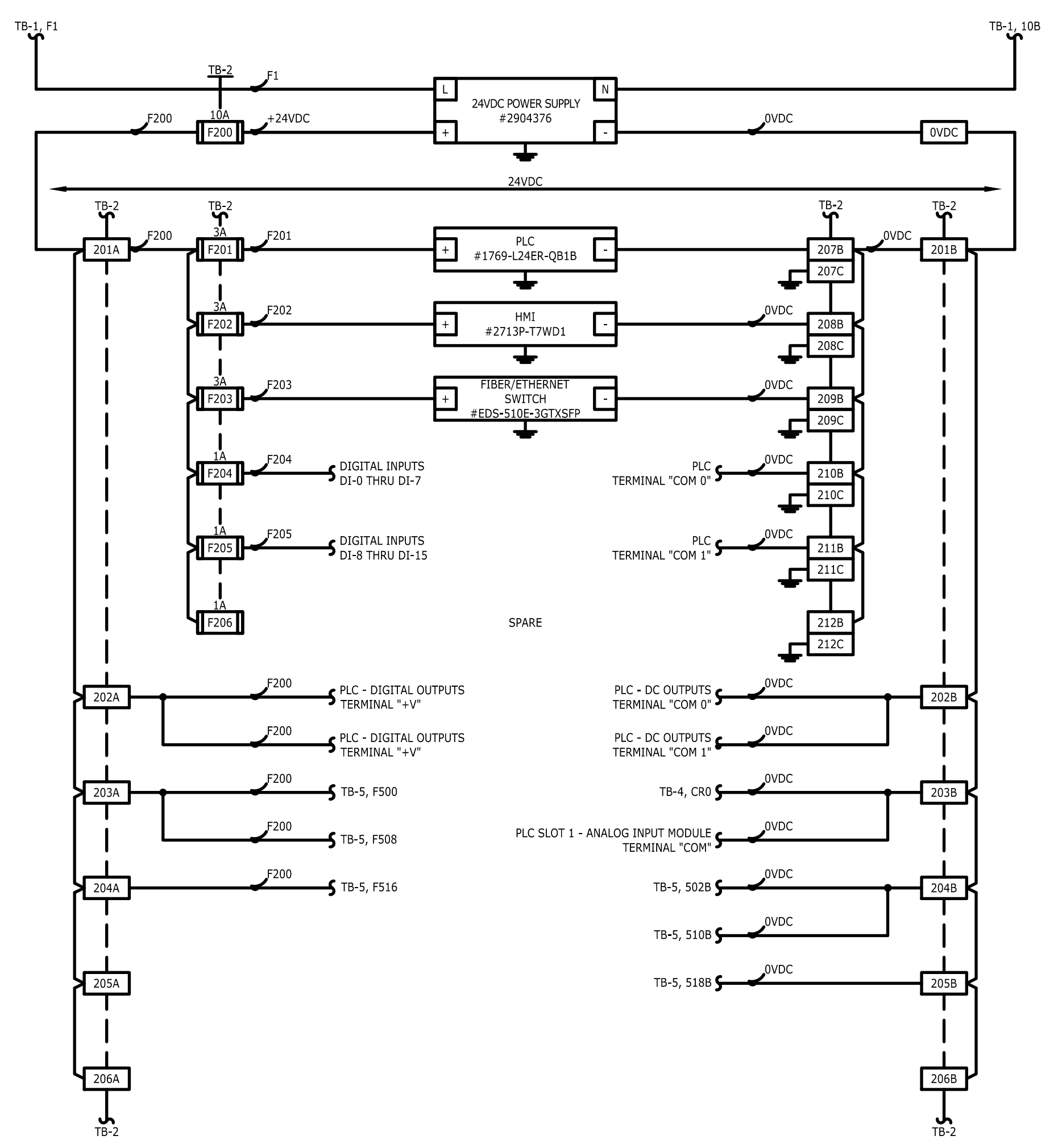
SIGNATURE

DATE

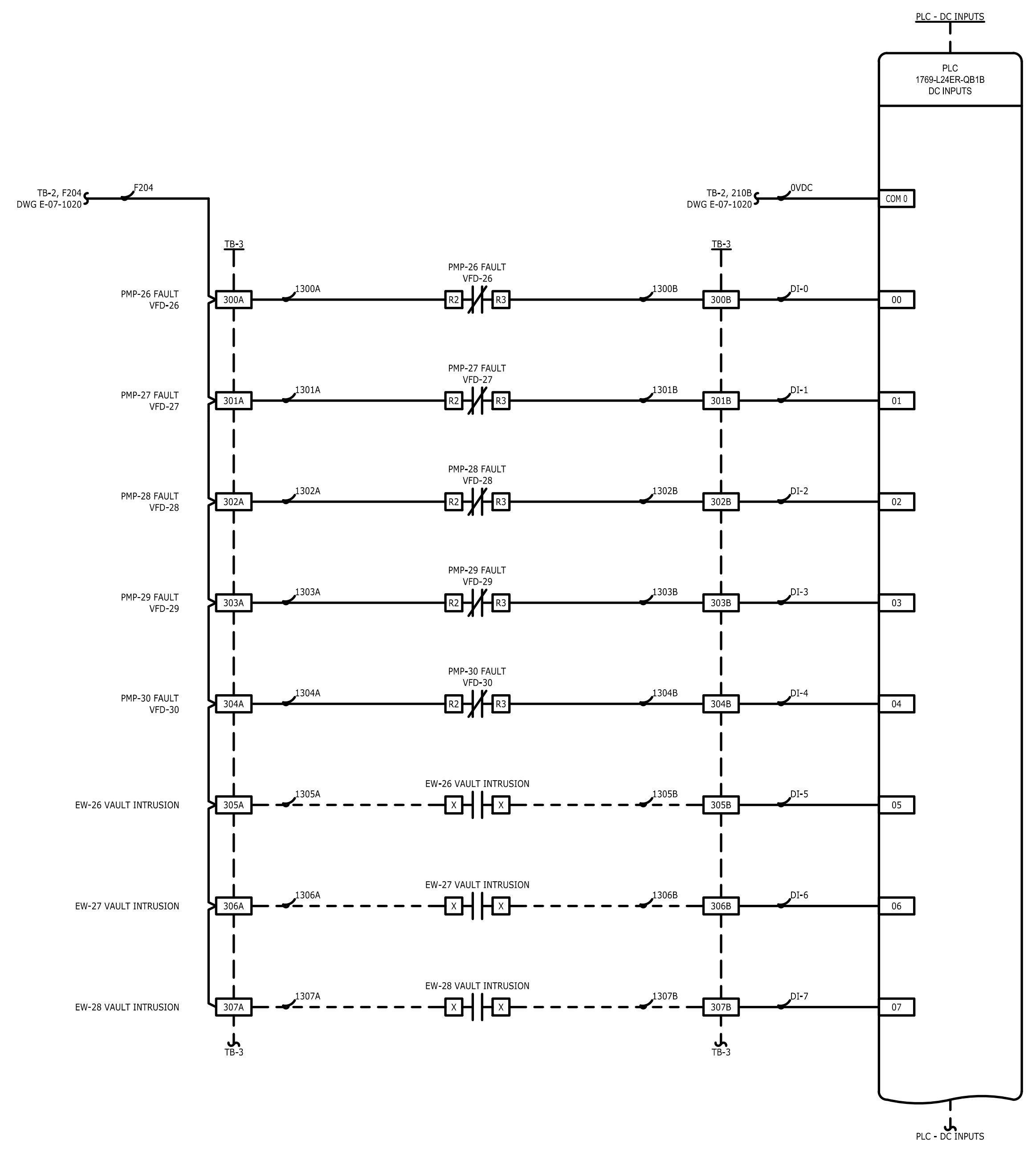
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E35.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-35
APPROVED BY:	JJD		



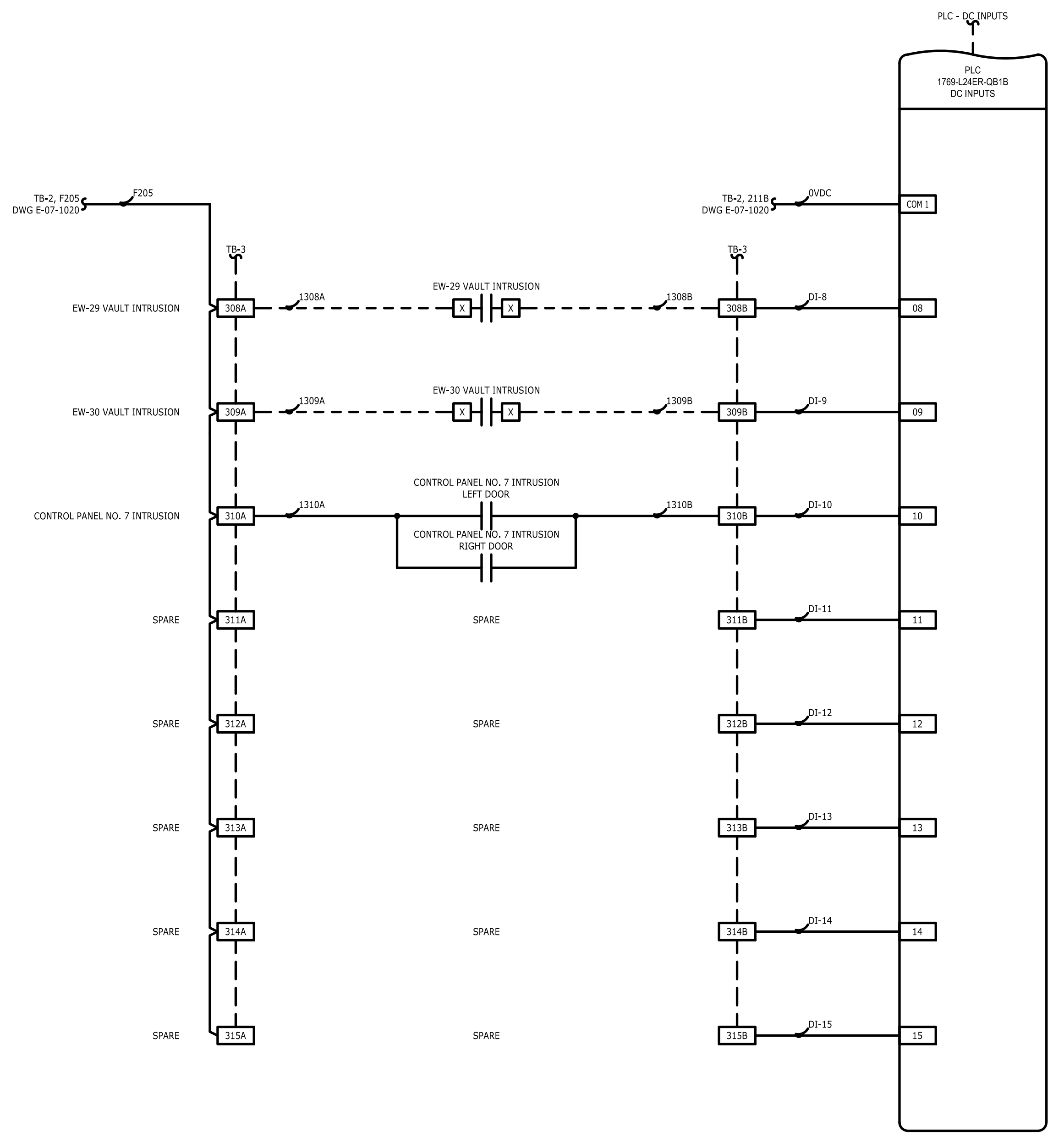
111
E-36
DETAIL
CONTROL PANEL NO. 7 120VAC POWER DISTRIBUTION



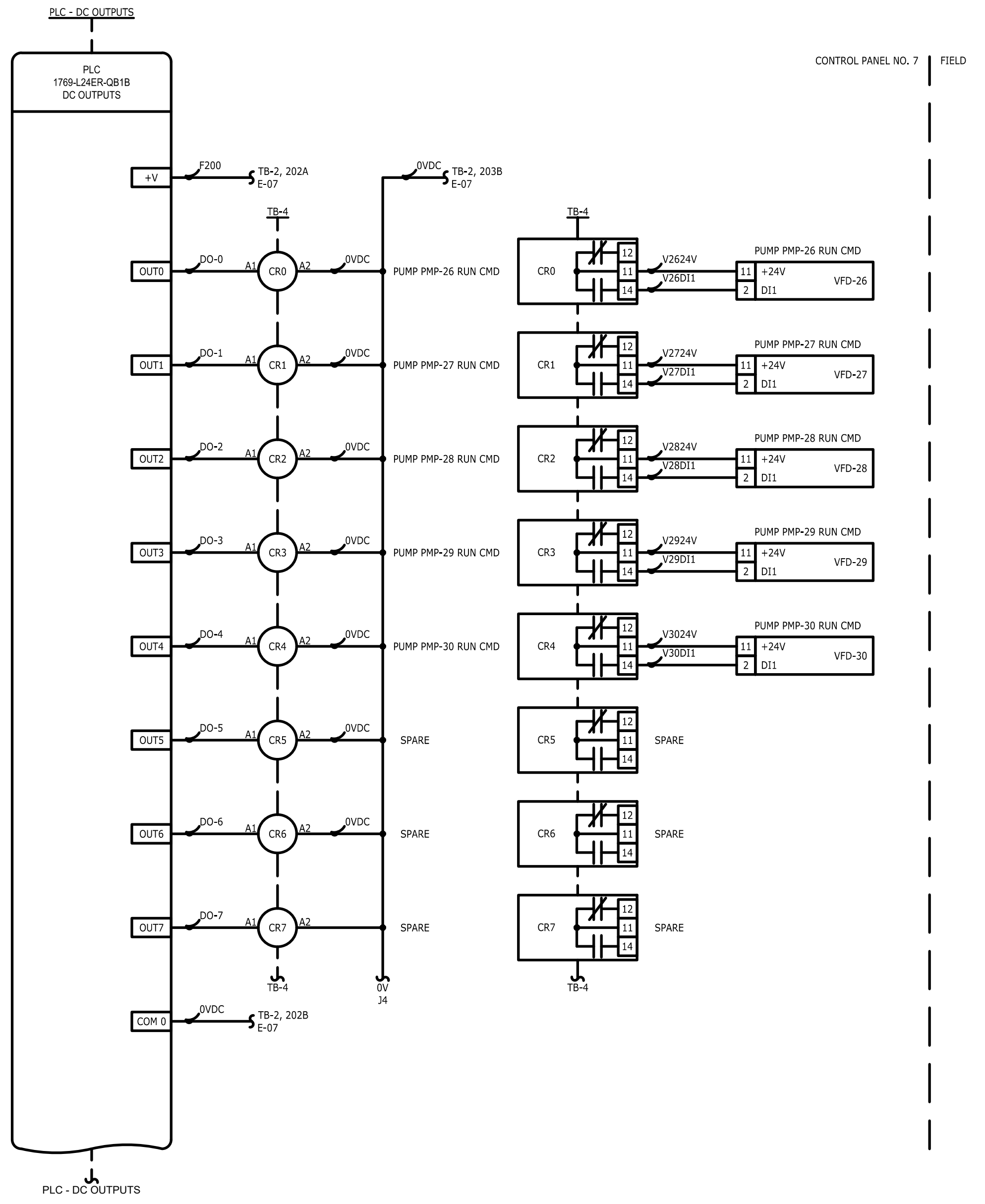
112
E-36
DETAIL
CONTROL PANEL NO. 7 24VDC POWER DISTRIBUTION



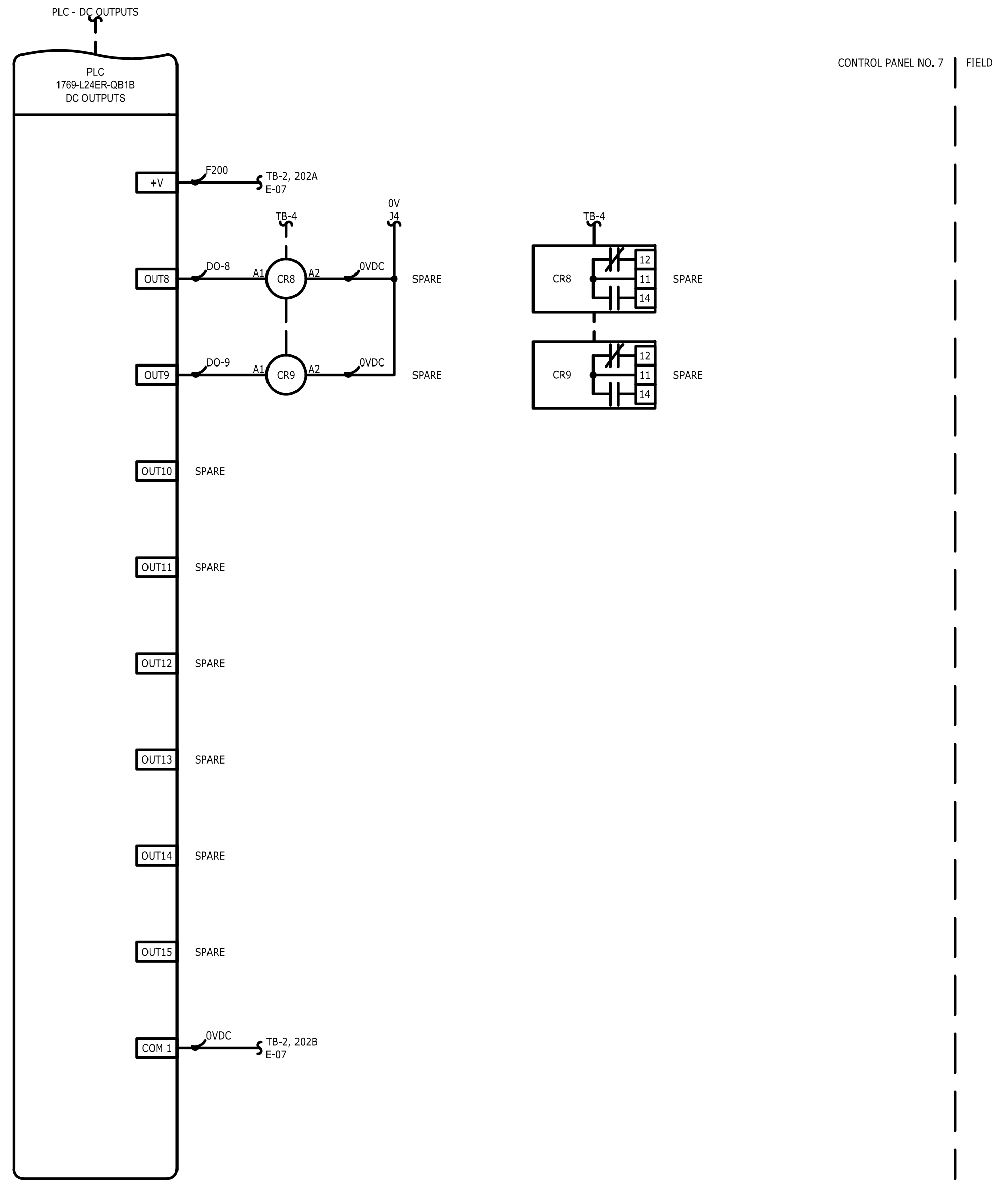
113
E-36
DETAIL
CONTROL PANEL NO. 7 PLC DIGITAL WIRING DIAGRAM I



114
E-36
DETAIL
CONTROL PANEL NO. 7 PLC DIGITAL WIRING DIAGRAM II



115
E-36
DETAIL
CONTROL PANEL NO. 7 PLC RELAY OUTPUTS WIRING DIAGRAM I



116
E-36
DETAIL
CONTROL PANEL NO. 7 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

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REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-07 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	E-36
APPROVED BY:	JJD		

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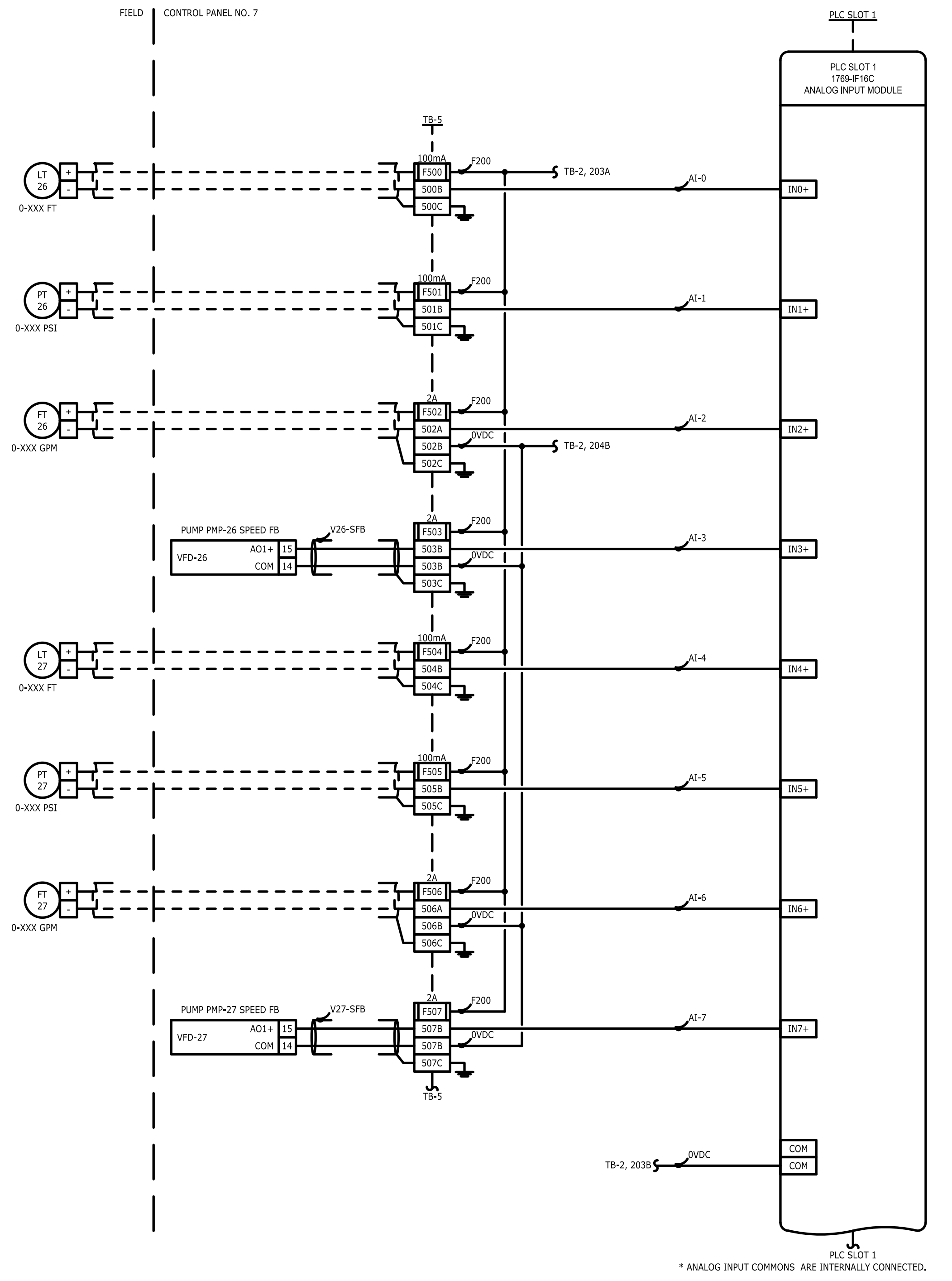
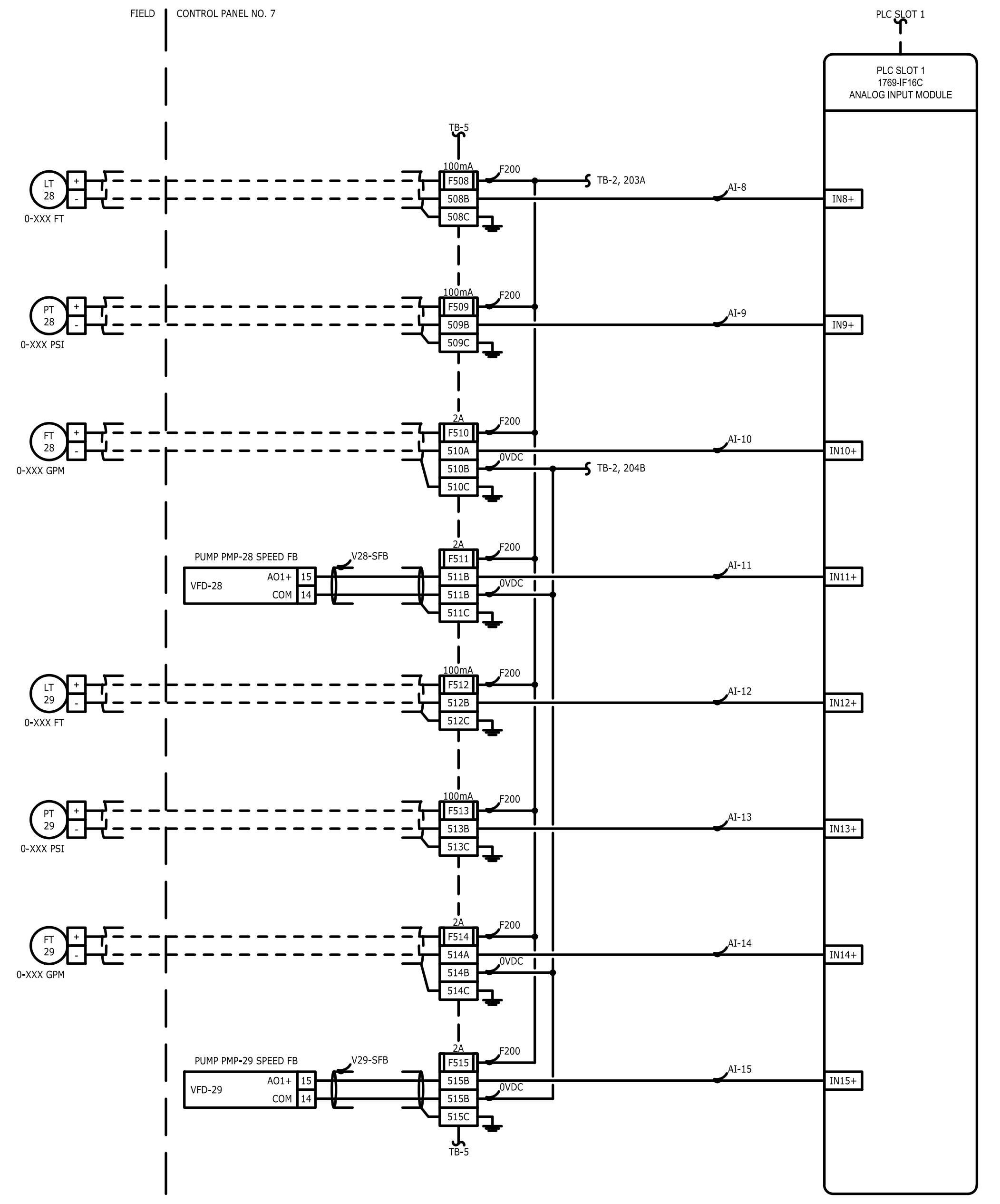
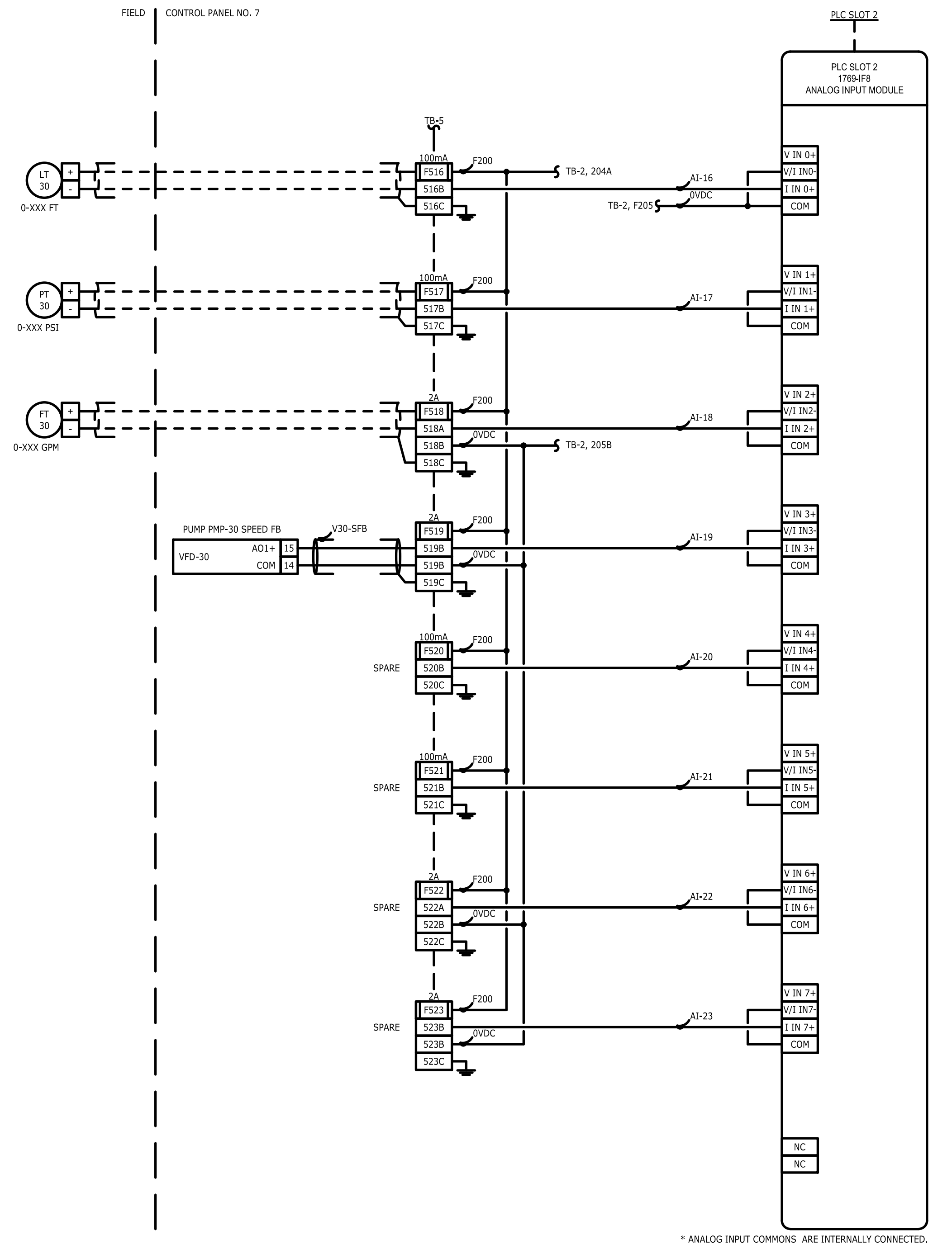


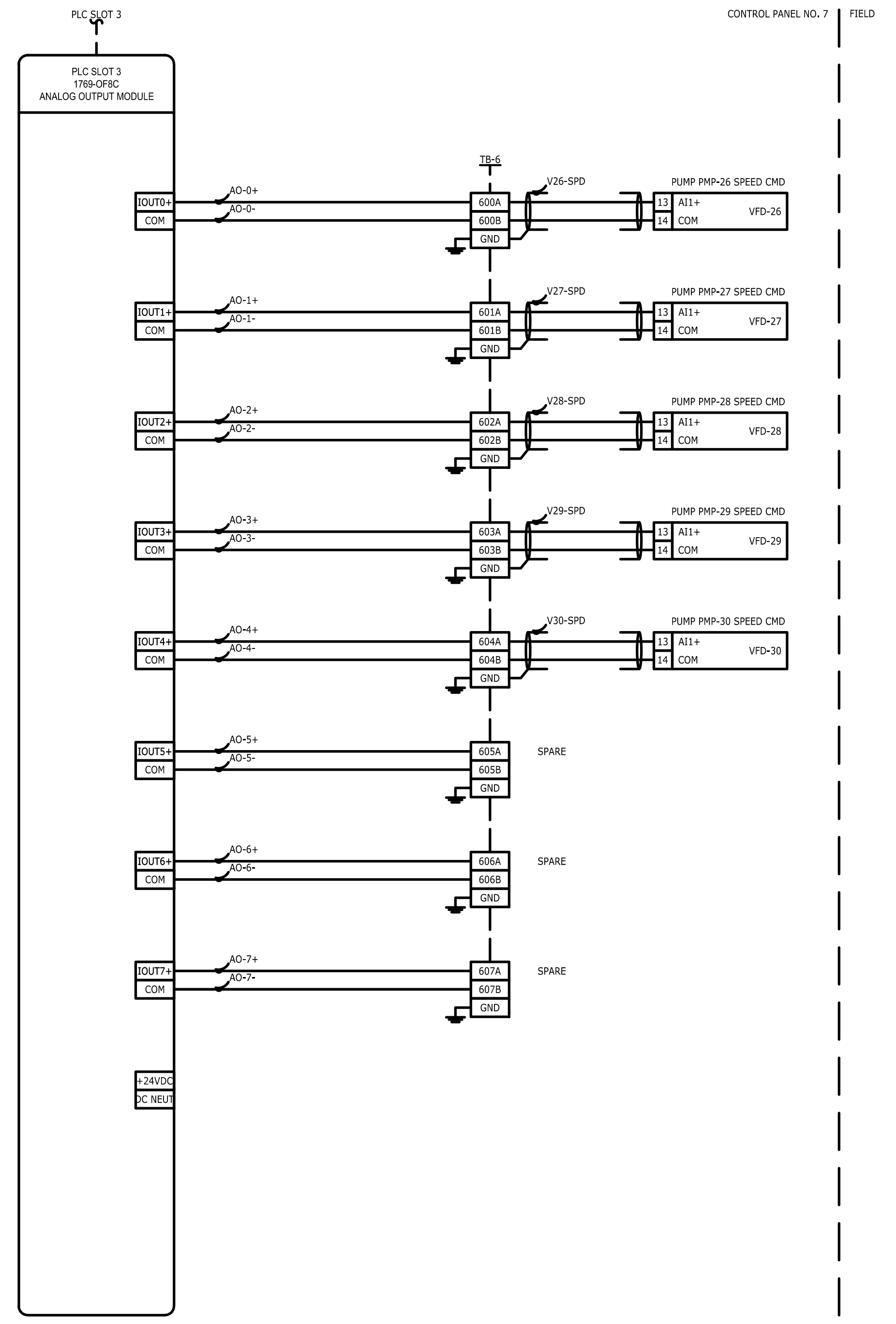
117 E-37 DETAIL
CONTROL PANEL NO. 7 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



118 E-37 DETAIL
CONTROL PANEL NO. 7 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



119 E-37 DETAIL
CONTROL PANEL NO. 7 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



120 E-37 DETAIL
CONTROL PANEL NO. 7 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

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C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-07 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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CHECKED BY:	CMDS	FILE:	TR0795A-E37.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-37
APPROVED BY:	JJD		

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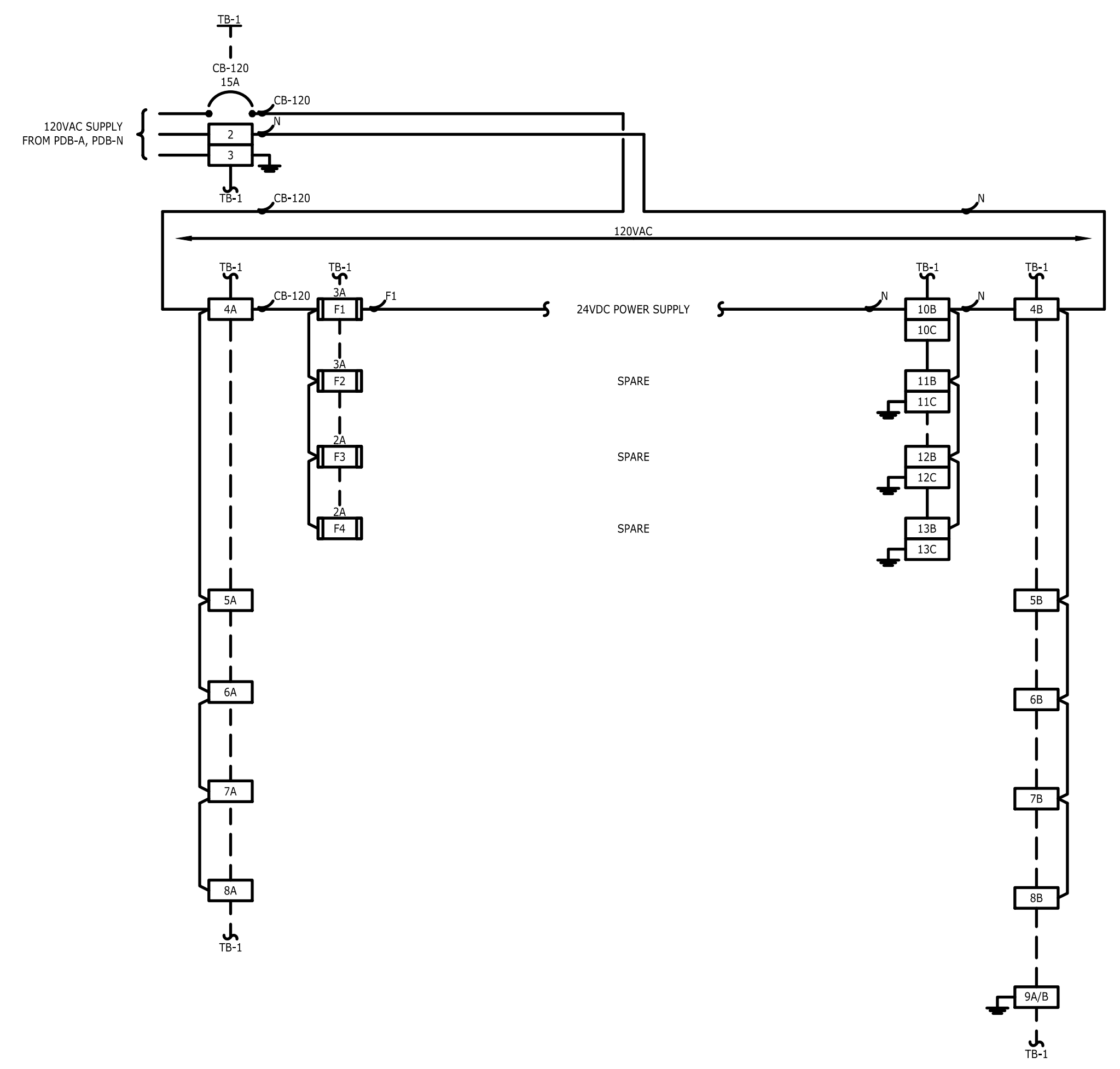
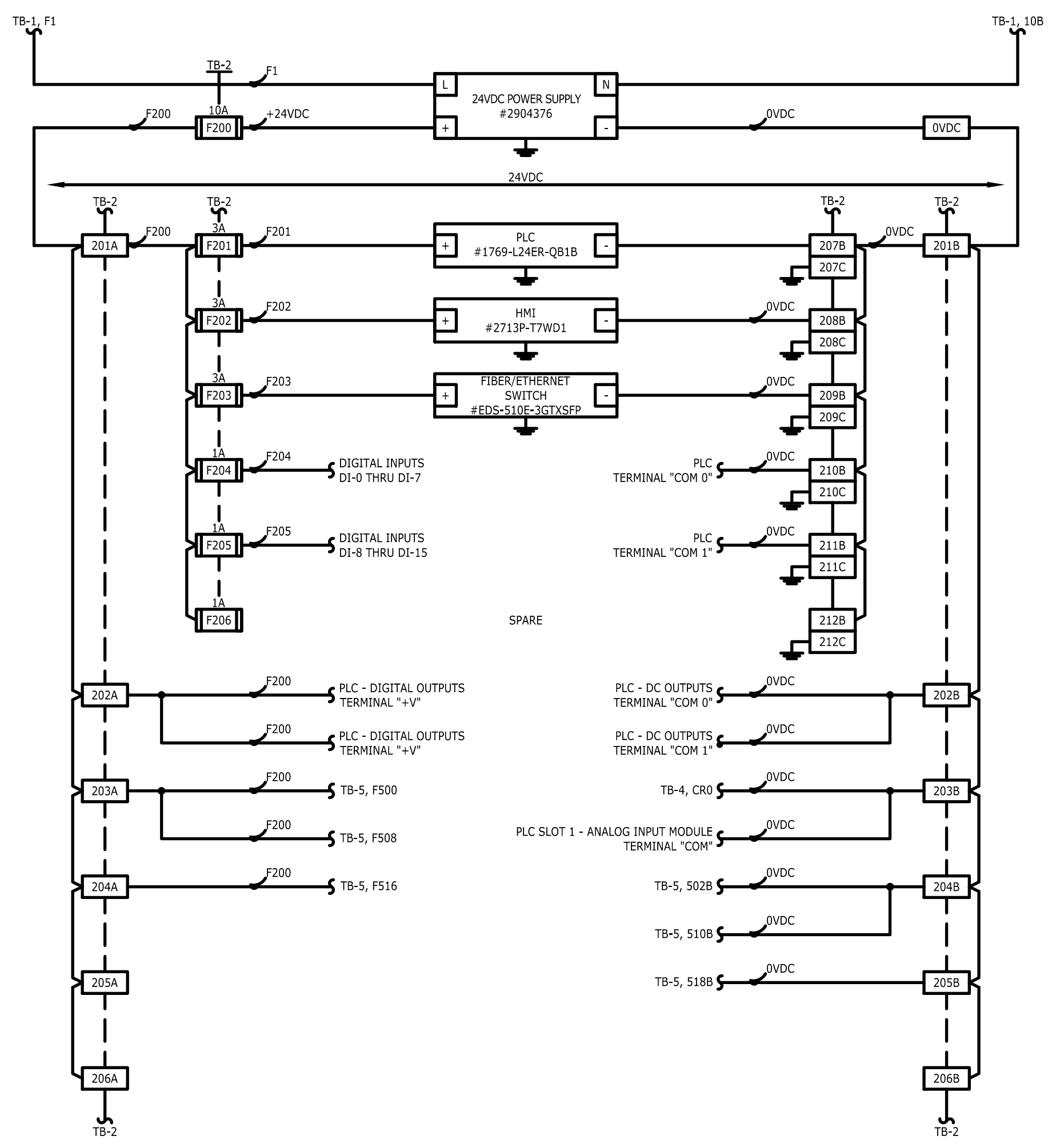


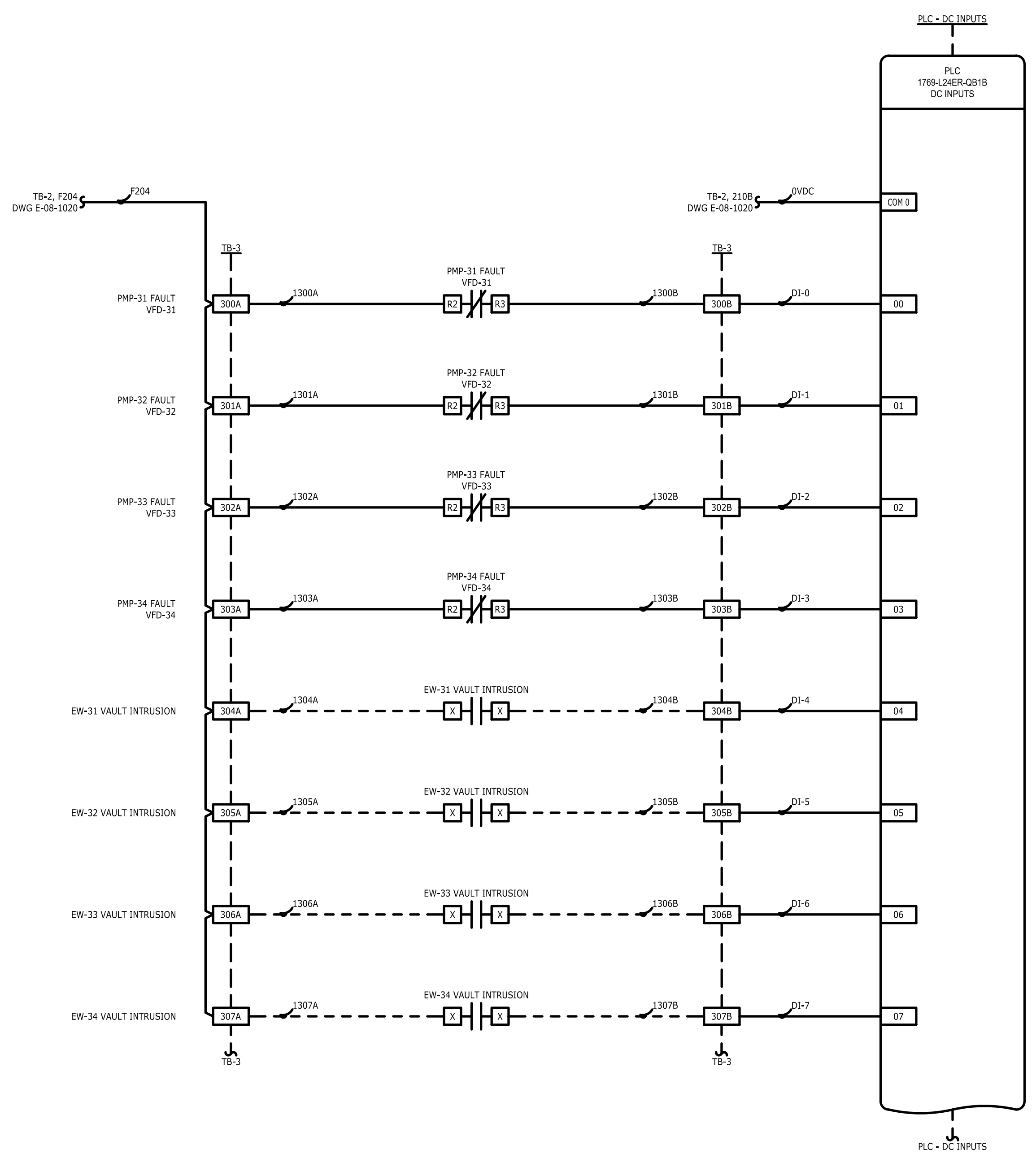
122 DETAIL E-38

CONTROL PANEL NO. 8 120VAC POWER DISTRIBUTION



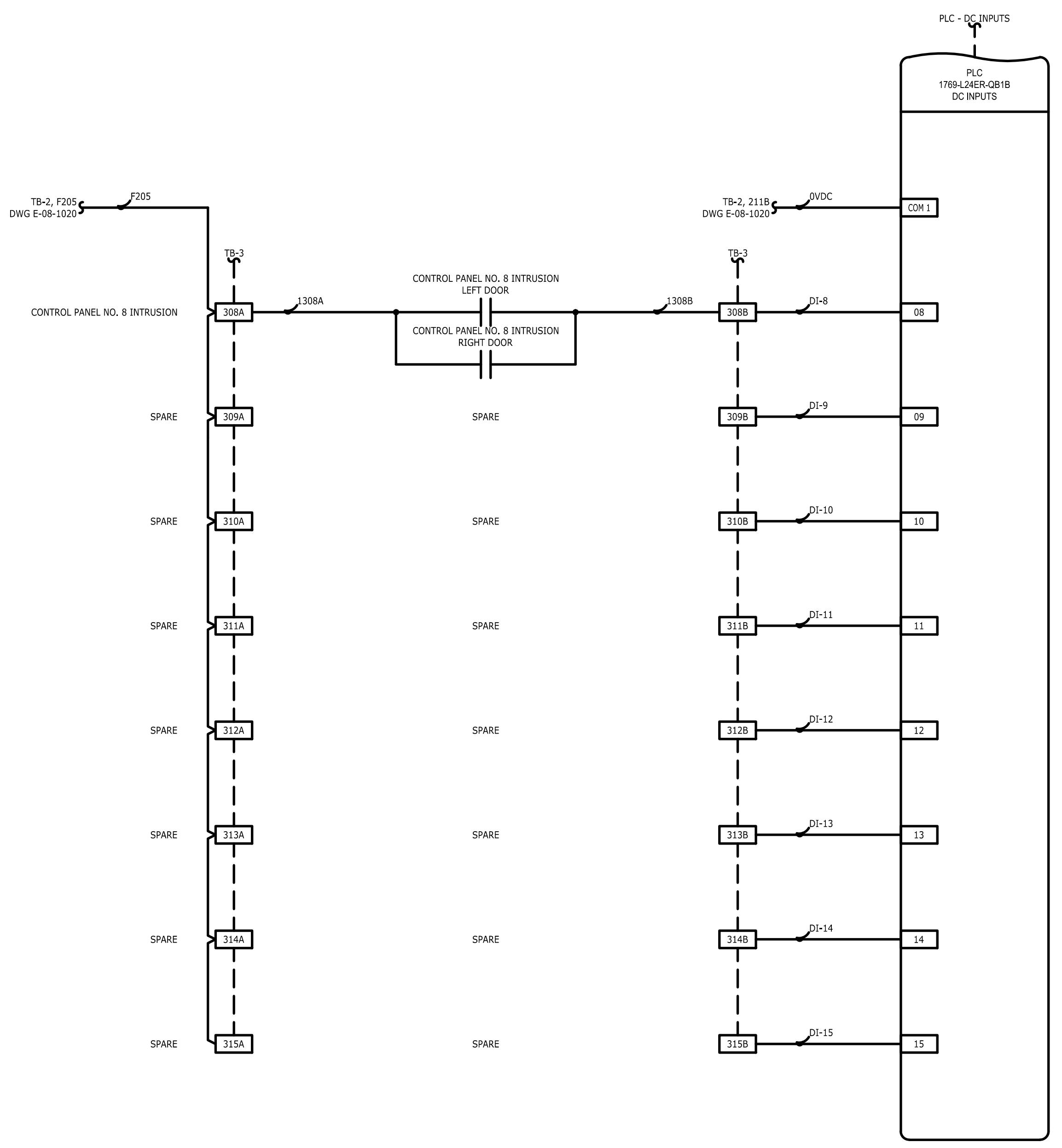
123 DETAIL E-38

CONTROL PANEL NO. 8 24VDC POWER DISTRIBUTION



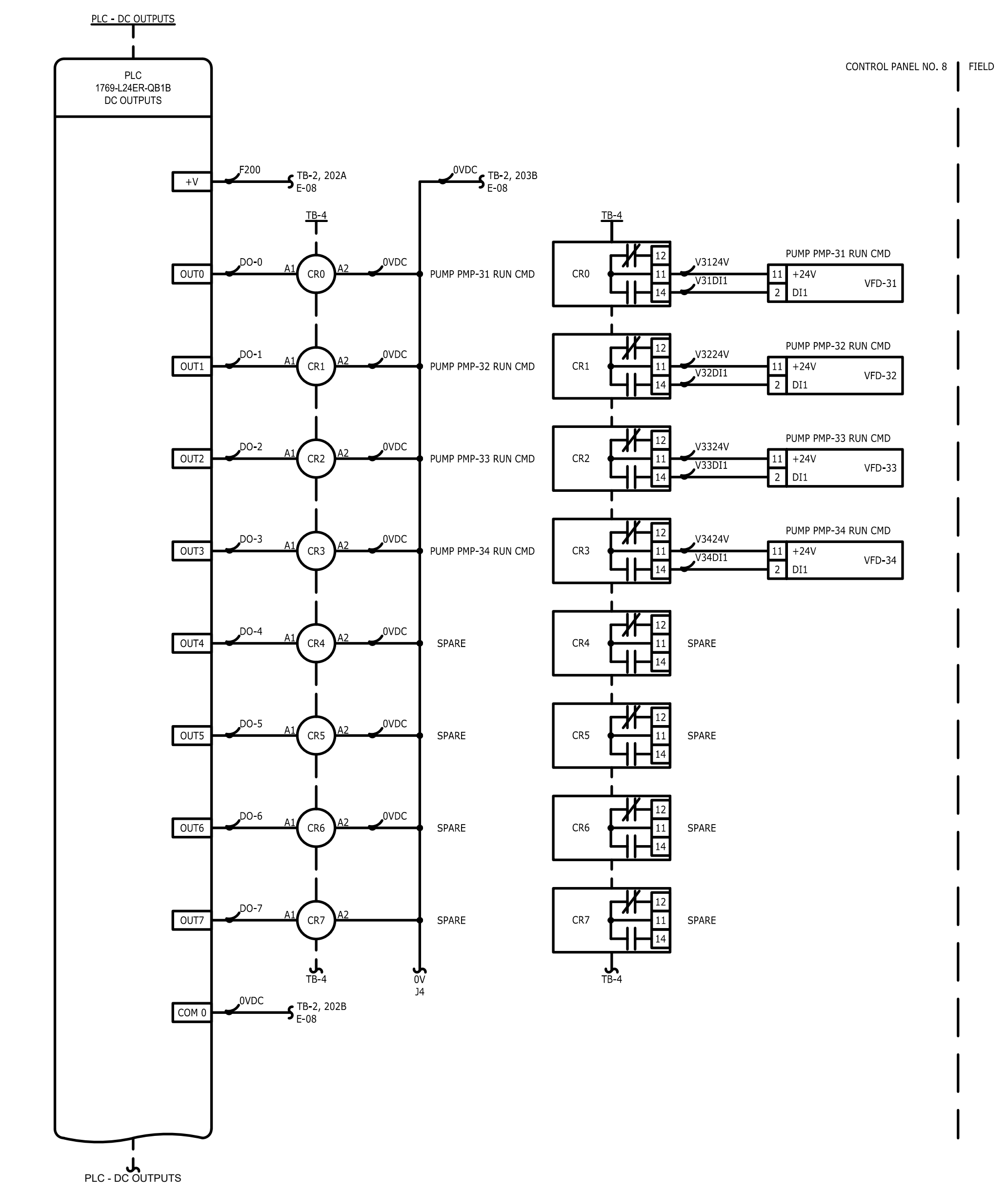
124 DETAIL E-38

CONTROL PANEL NO. 8 PLC DIGITAL WIRING DIAGRAM I



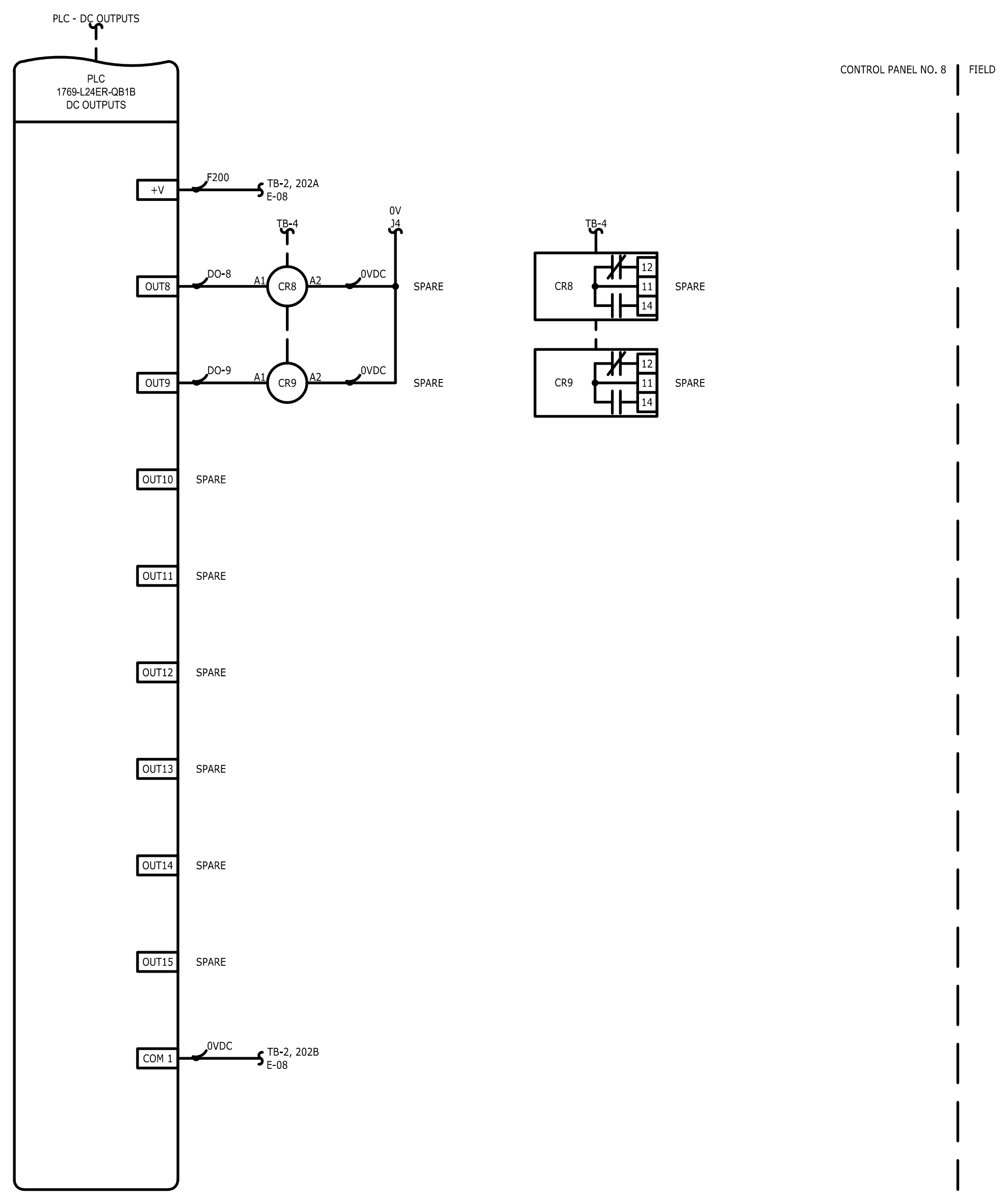
125 DETAIL E-38

CONTROL PANEL NO. 8 PLC DIGITAL WIRING DIAGRAM II



126 DETAIL E-38

CONTROL PANEL NO. 8 PLC RELAY OUTPUTS WIRING DIAGRAM I



127 DETAIL E-38

CONTROL PANEL NO. 8 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-08 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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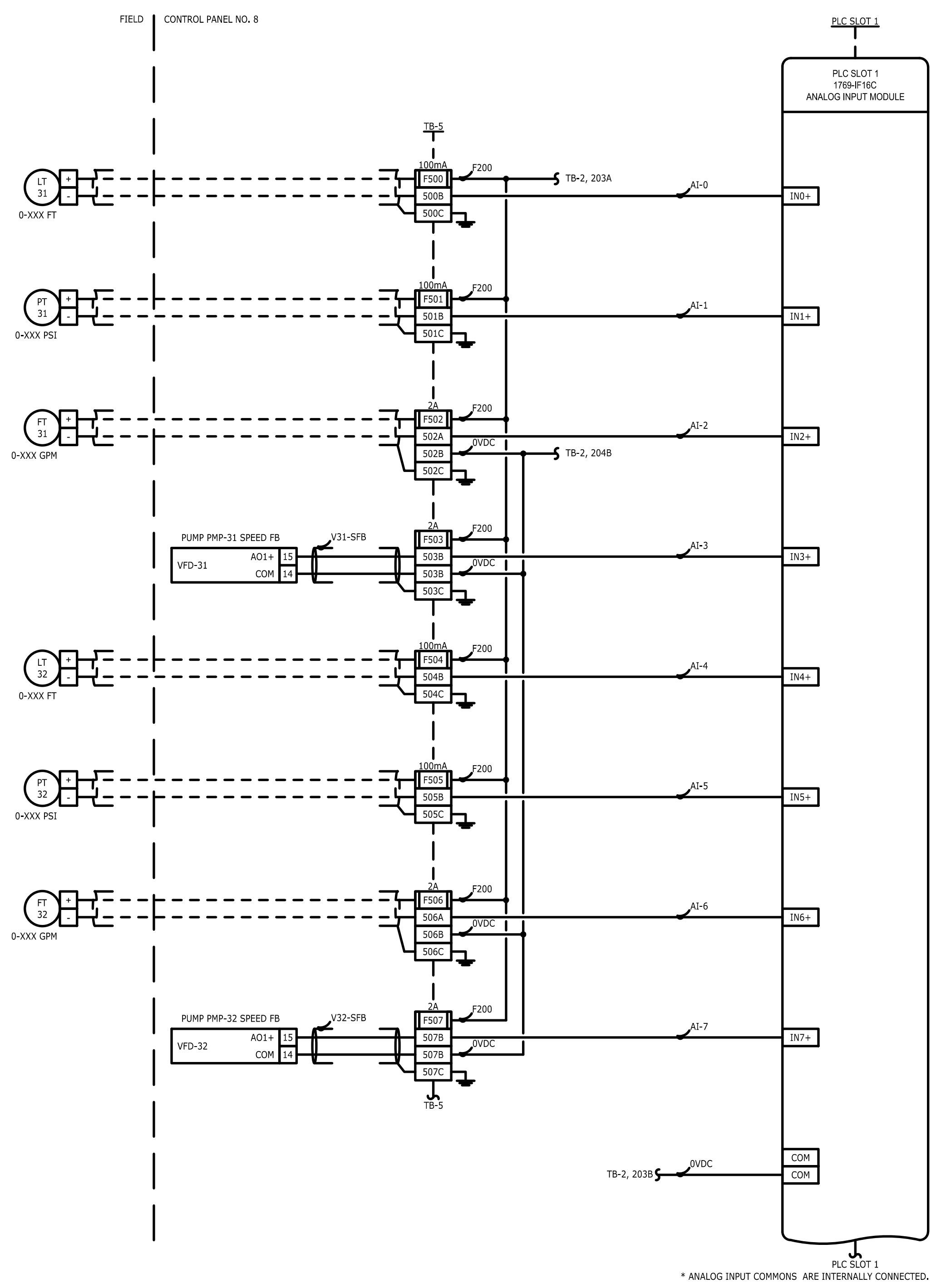
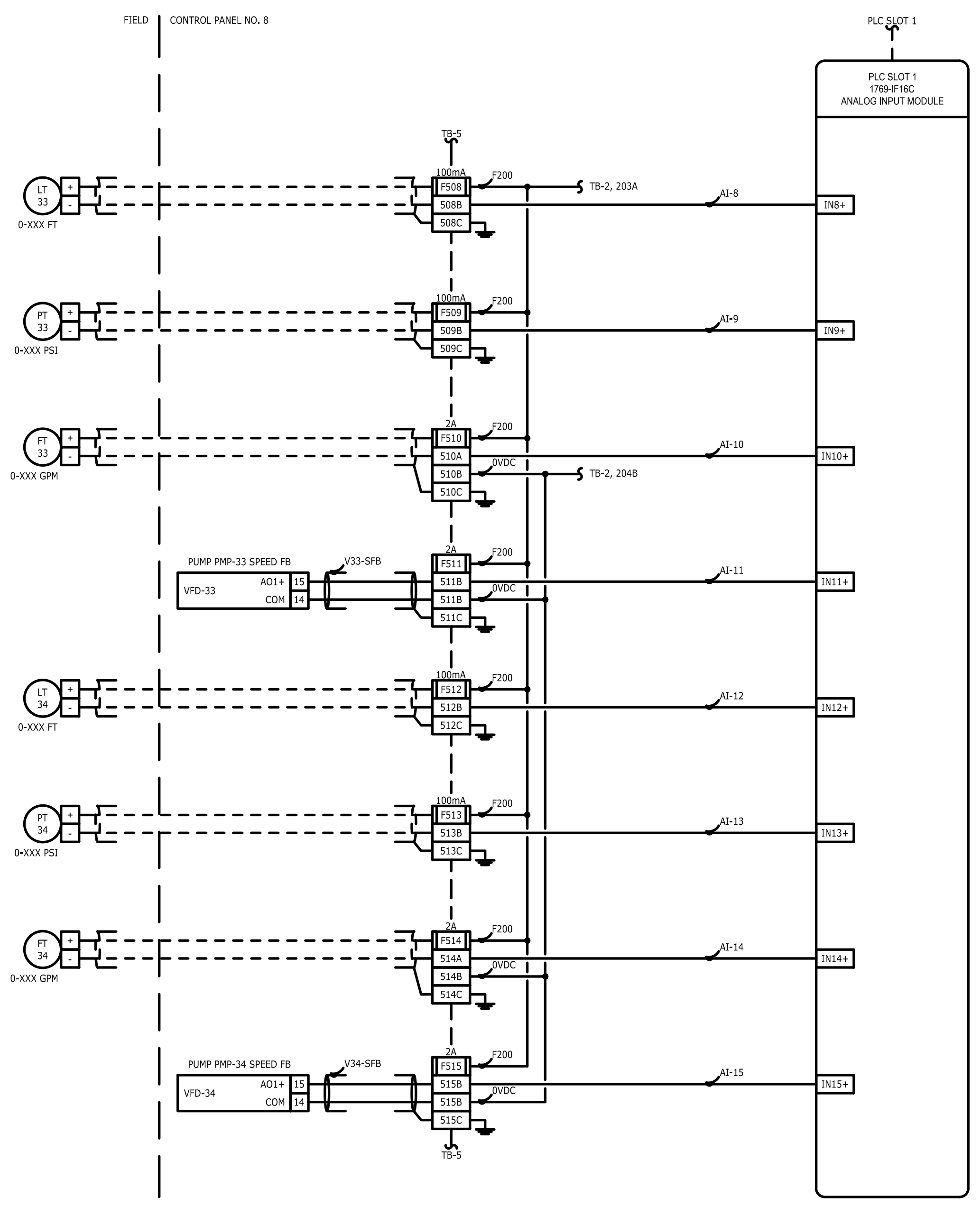
REVIEWED BY:	SV	DRAWING NO.:	E-38
APPROVED BY:	JJD		

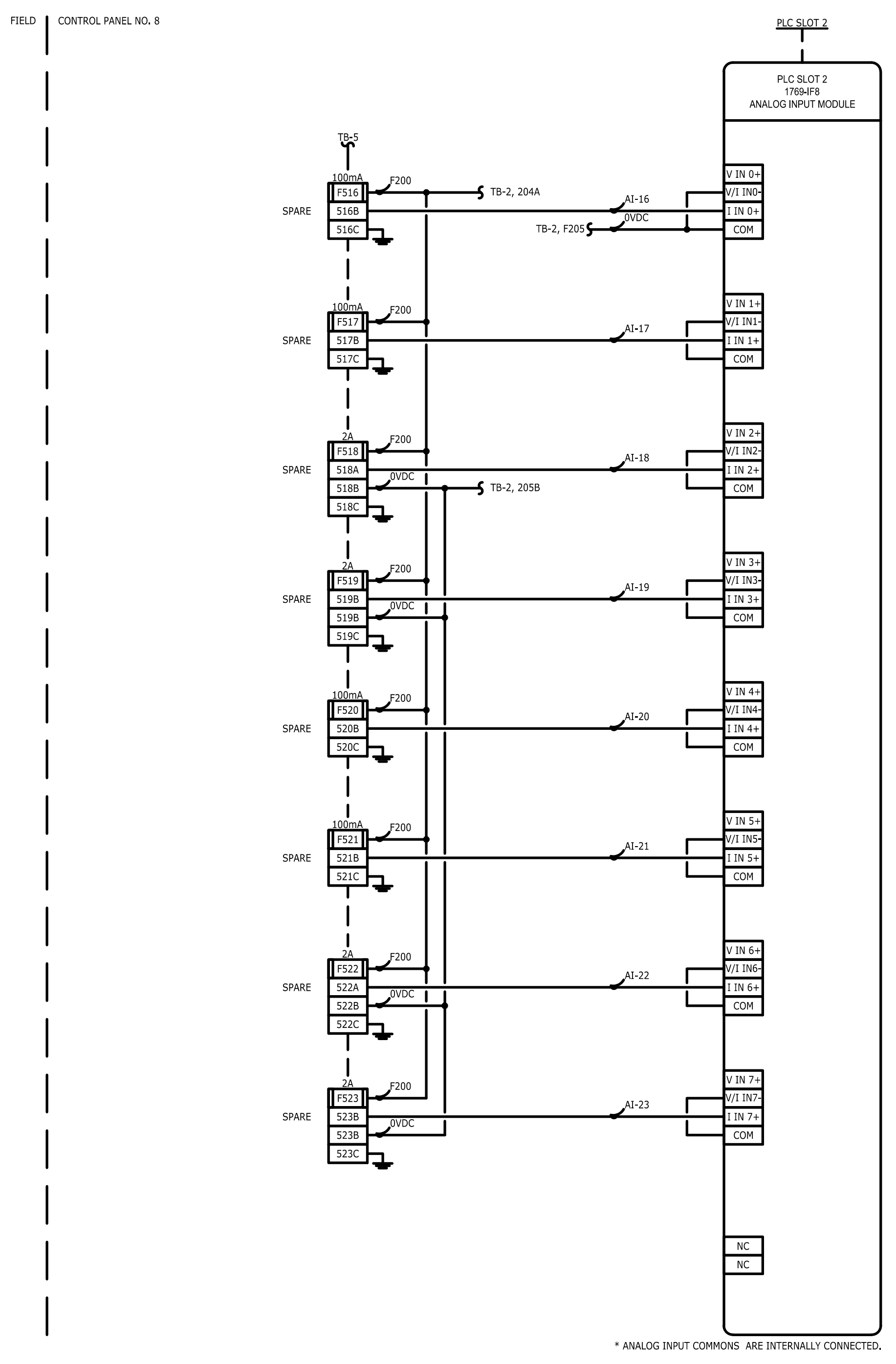
90% DESIGN DRAWINGS



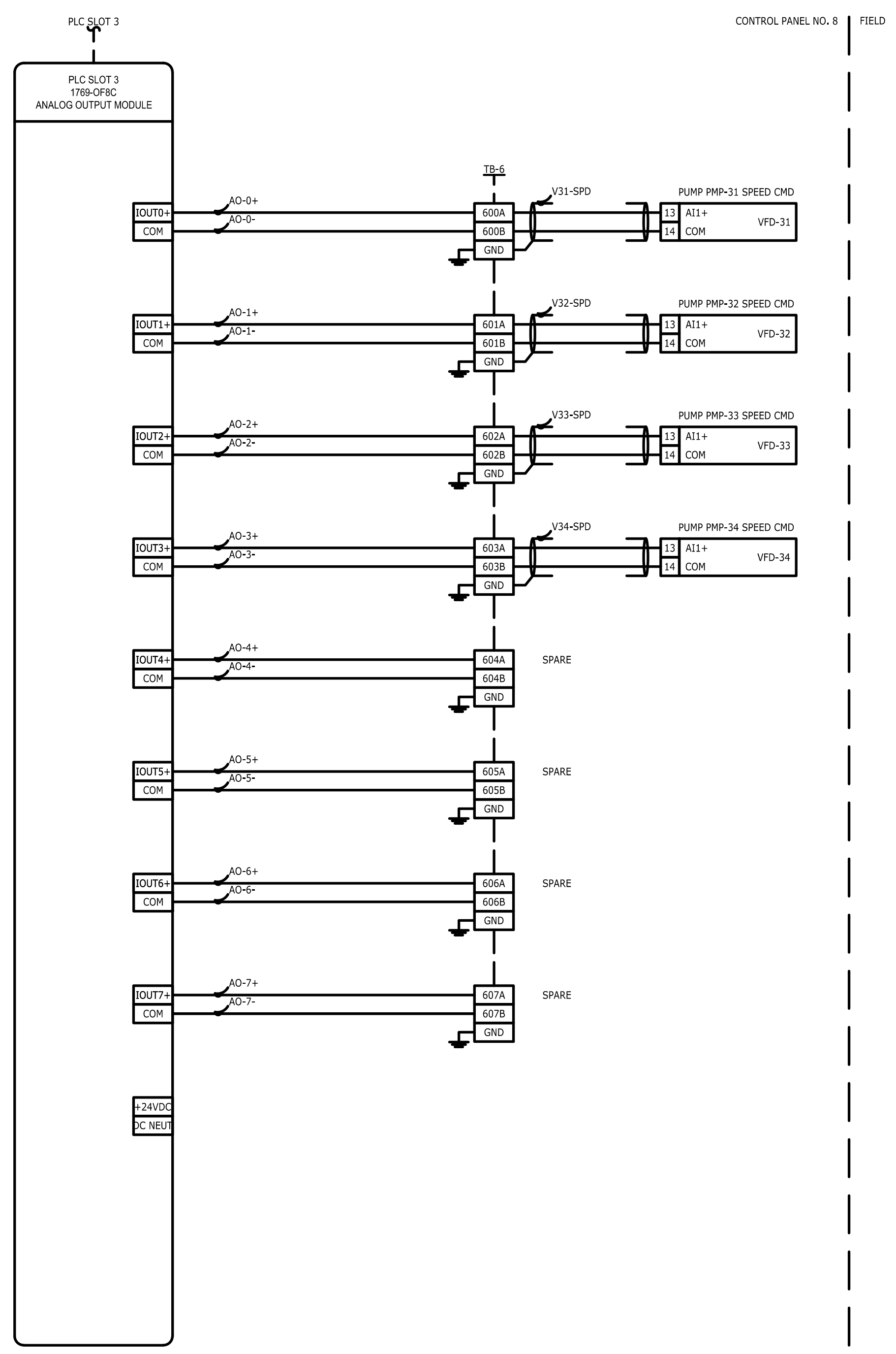
128
E-39
DETAIL
CONTROL PANEL NO. 8 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM I



129
E-39
DETAIL
CONTROL PANEL NO. 8 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM II



130
E-39
DETAIL
CONTROL PANEL NO. 8 PLC SLOT 2
ANALOG INPUT WIRING DIAGRAM



131
E-39
DETAIL
CONTROL PANEL NO. 8 PLC SLOT 3
ANALOG INPUT WIRING DIAGRAM

NOTES:

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90% DESIGN DRAWINGS

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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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consultants

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-08 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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SIGNATURE

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CHECKED BY:	CMDS	FILE:	TR0795A-E39.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-39
APPROVED BY:	JJD		

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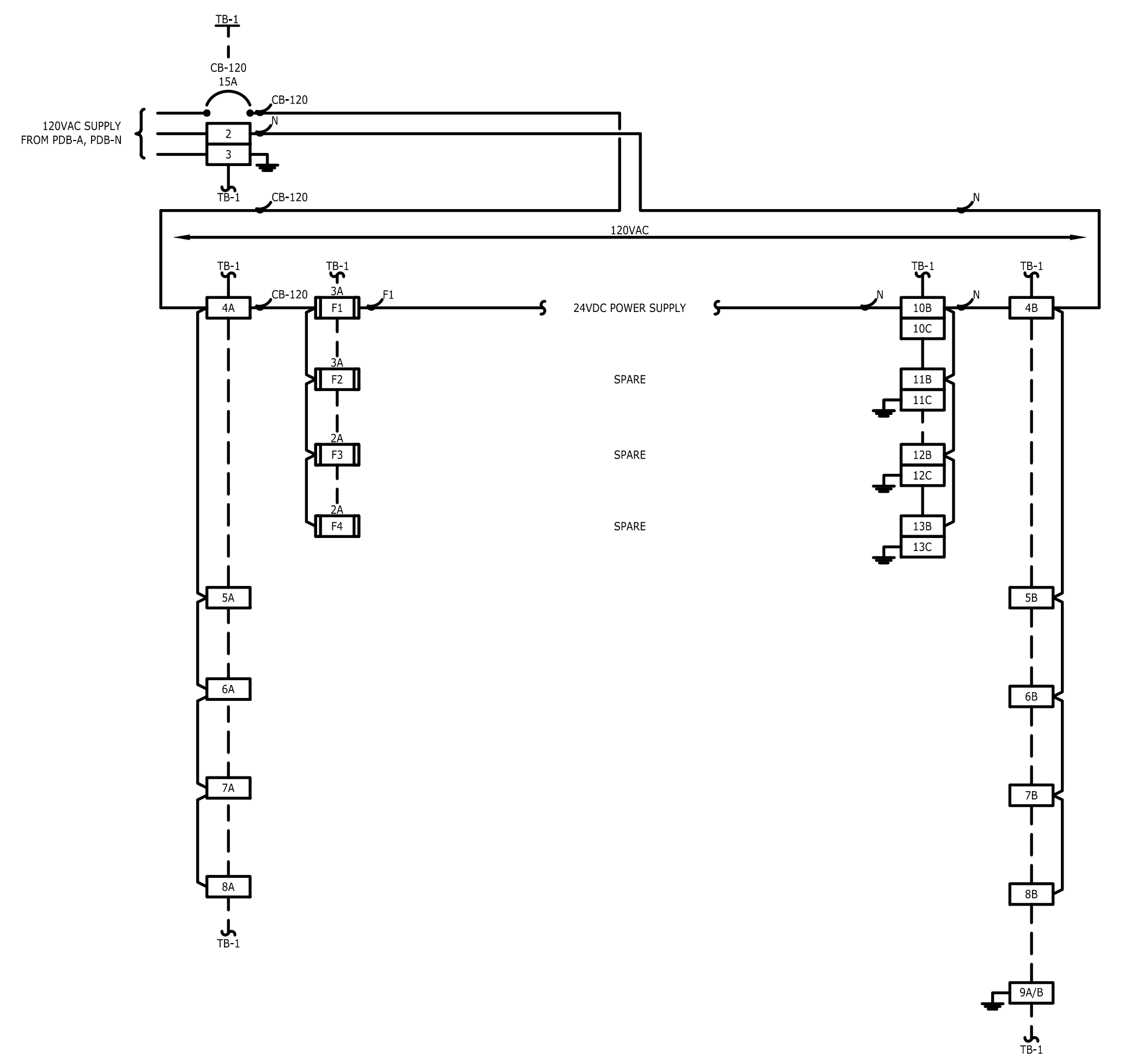
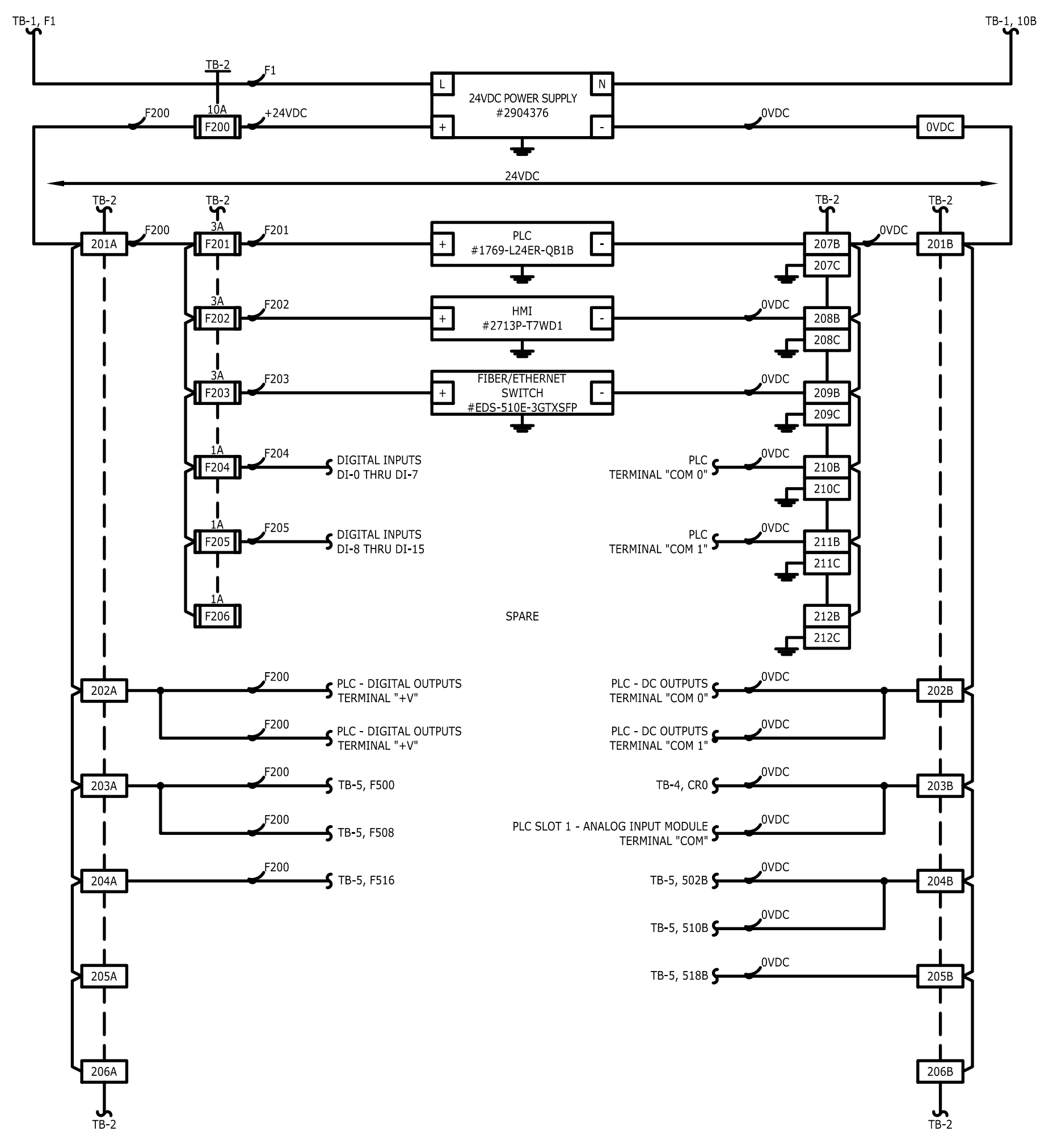
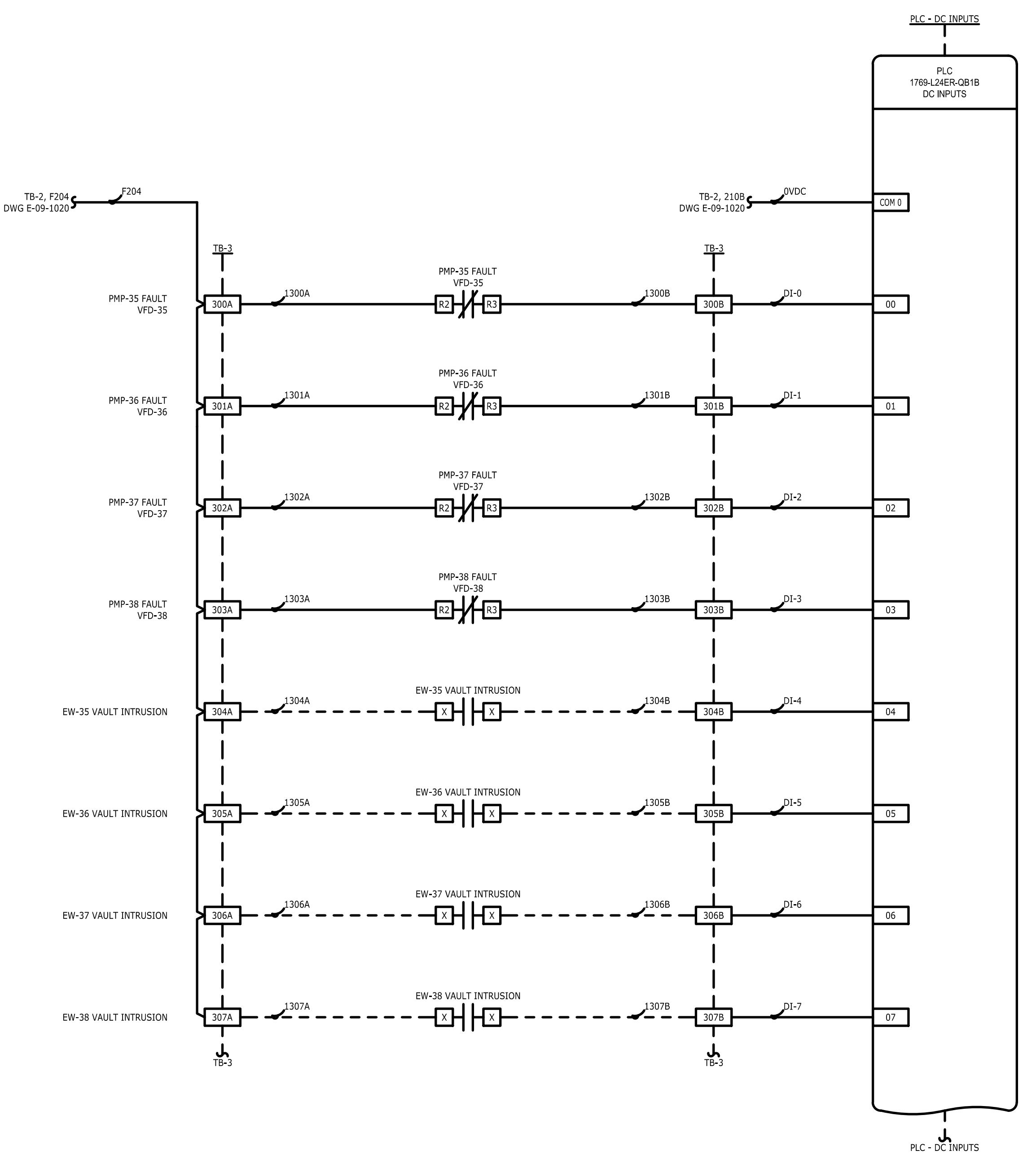


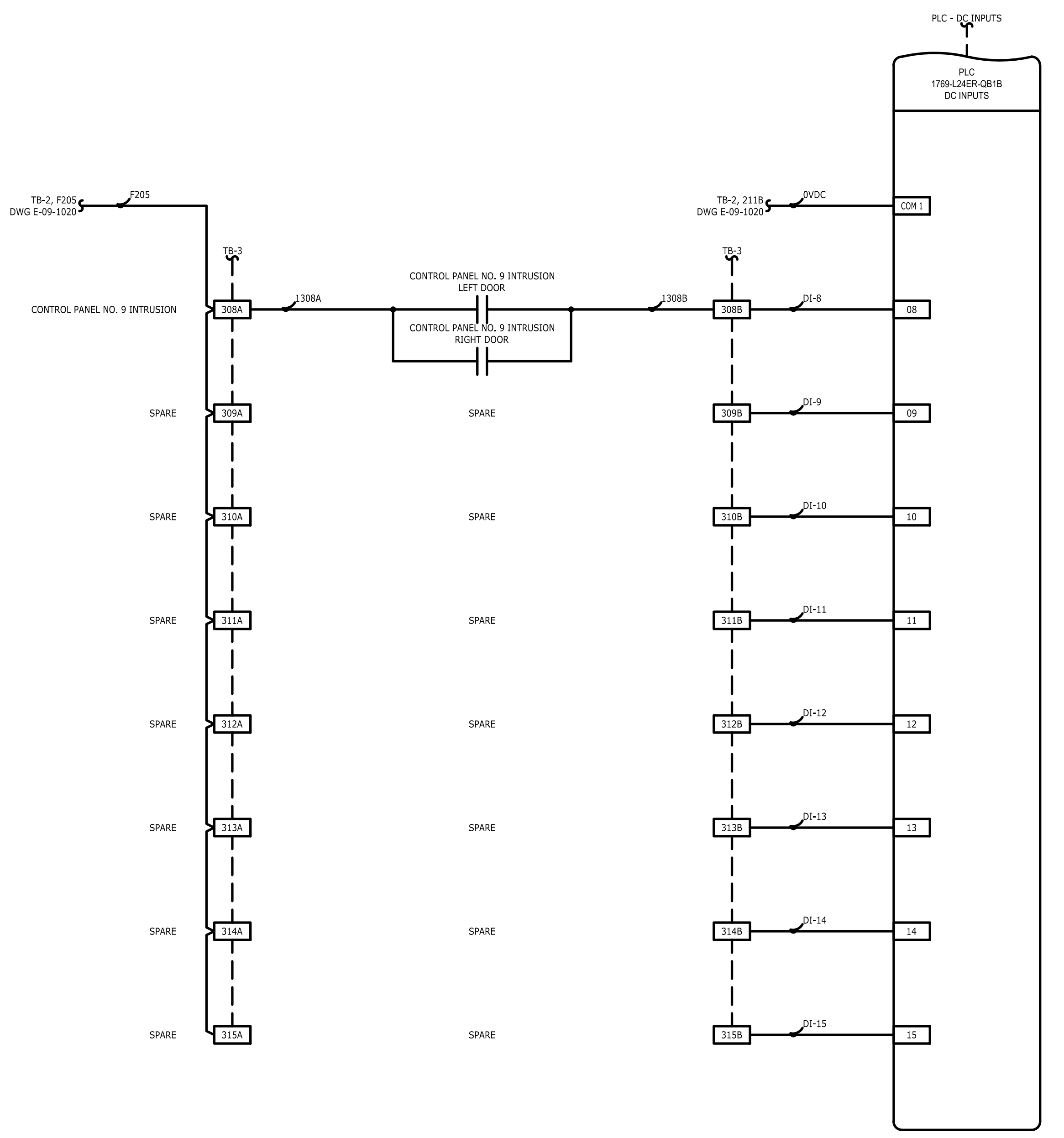
133 E-40 DETAIL
CONTROL PANEL NO. 9 120VAC POWER DISTRIBUTION



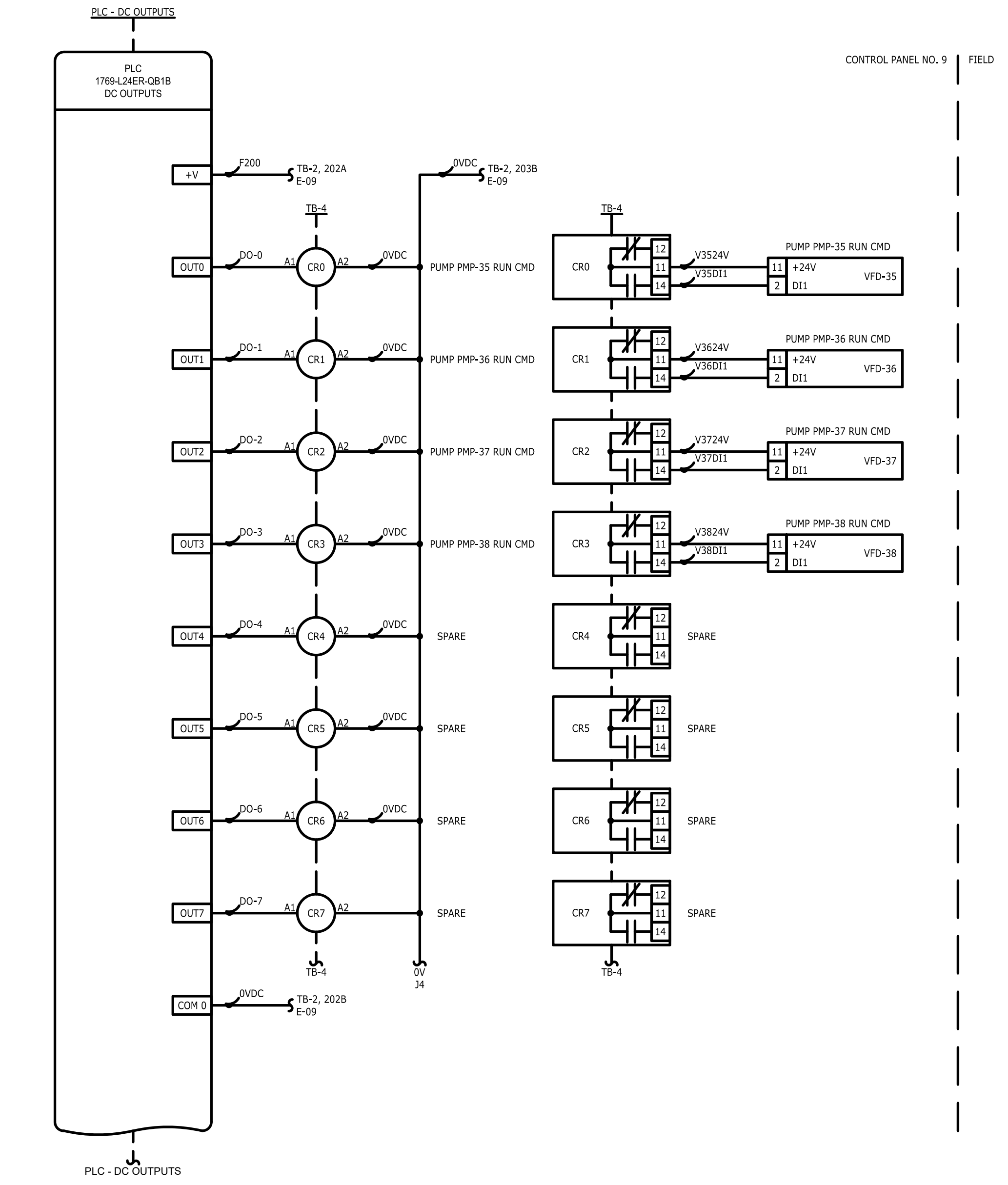
134 E-40 DETAIL
CONTROL PANEL NO. 9 24VDC POWER DISTRIBUTION



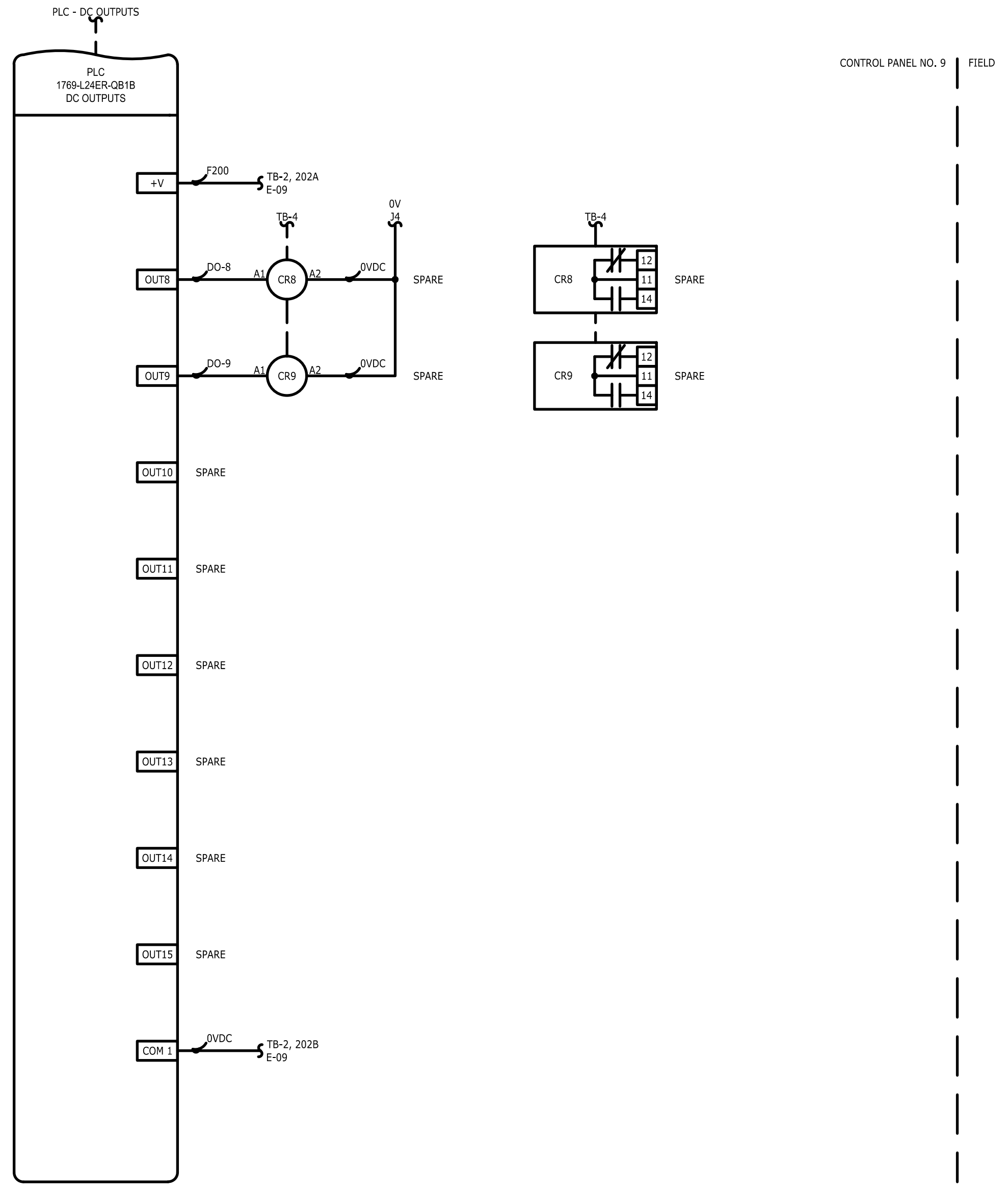
135 E-40 DETAIL
CONTROL PANEL NO. 9 PLC DIGITAL WIRING DIAGRAM I



136 E-40 DETAIL
CONTROL PANEL NO. 9 PLC DIGITAL WIRING DIAGRAM II



137 E-40 DETAIL
CONTROL PANEL NO. 9 PLC RELAY OUTPUTS WIRING DIAGRAM I



138 E-40 DETAIL
CONTROL PANEL NO. 9 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-09 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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SIGNATURE

DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E40.DWG
REVIEWED BY:	SV	DRAWING NO.:	
APPROVED BY:	JJD		E-40

90% DESIGN DRAWINGS

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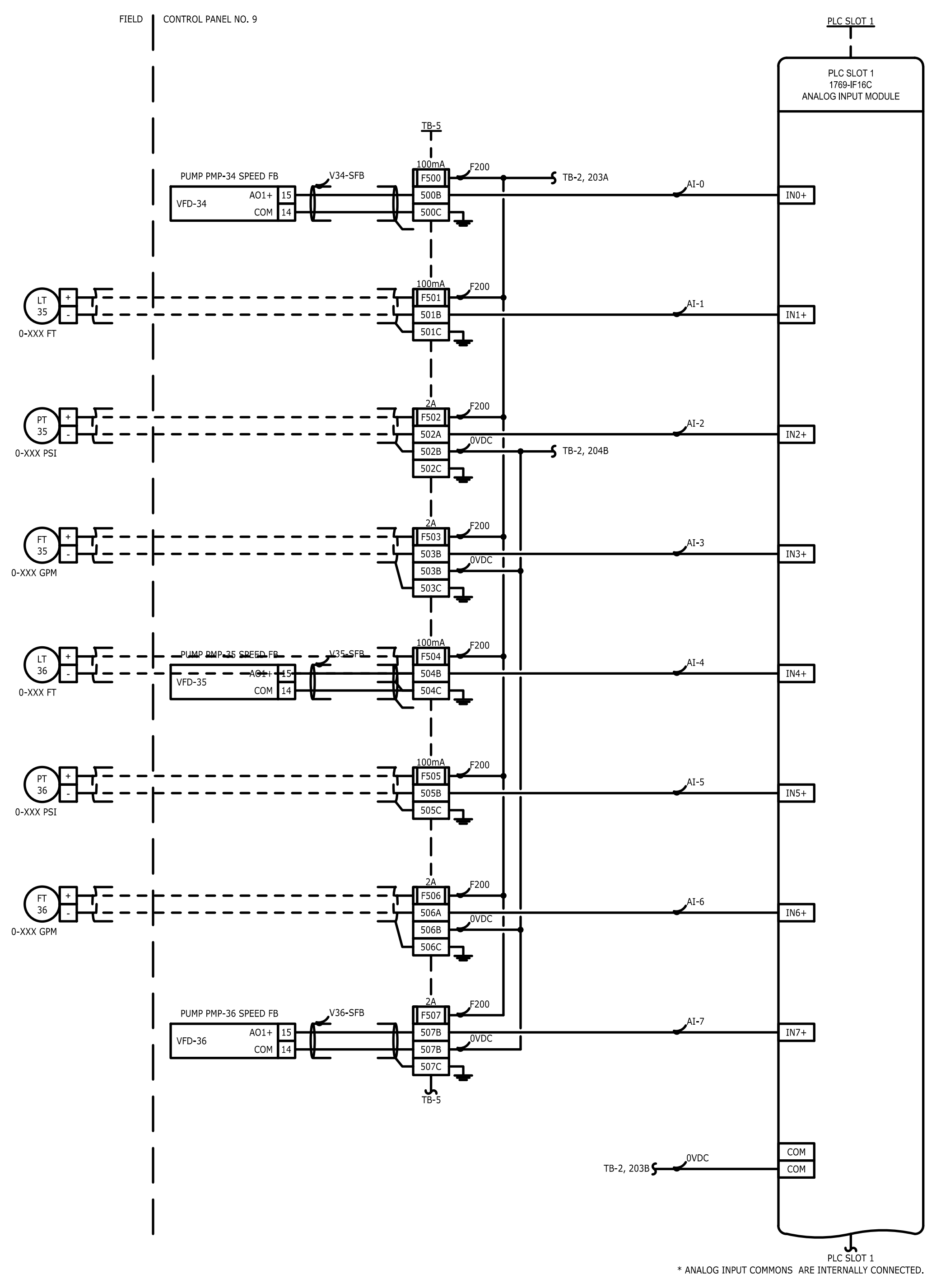
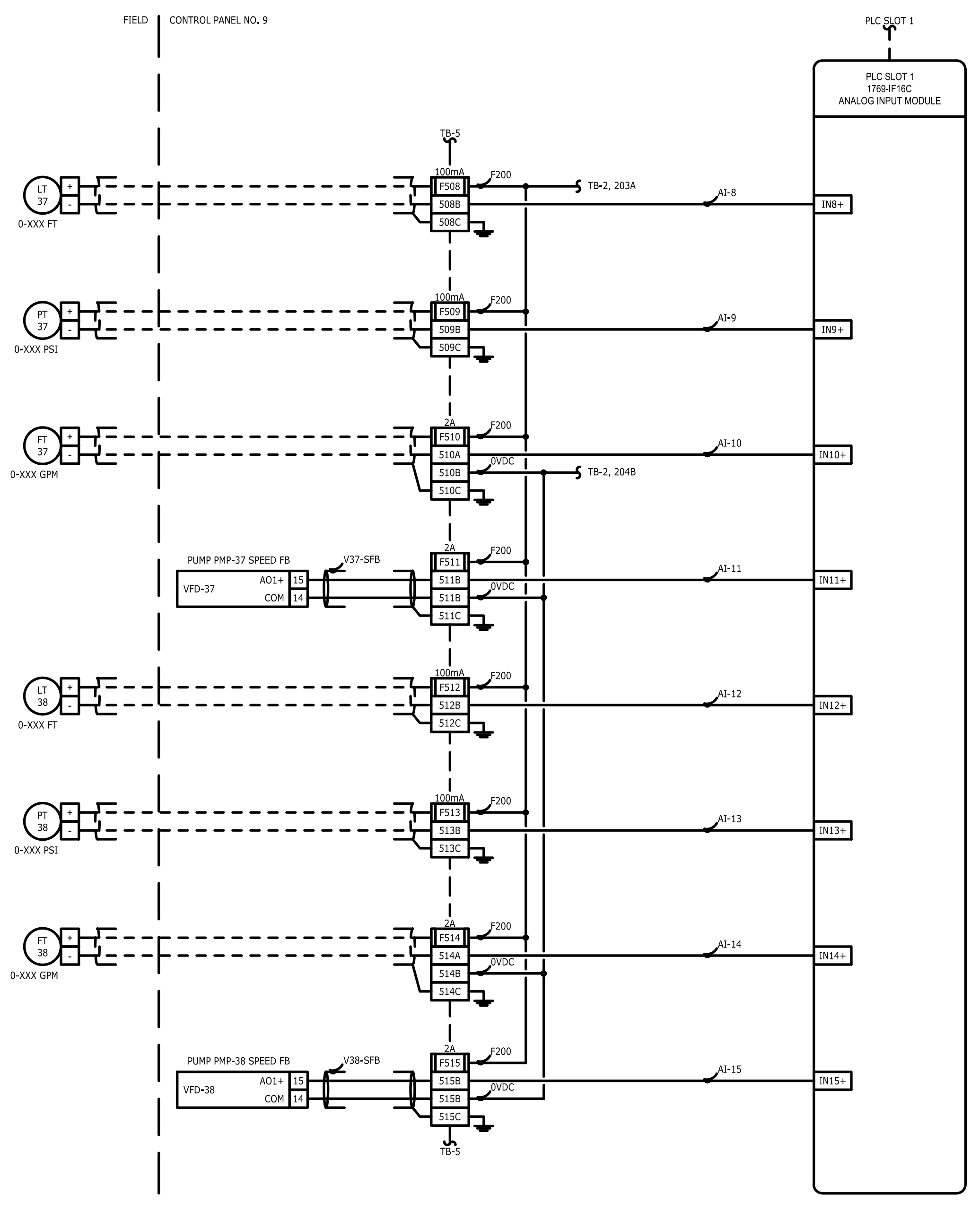
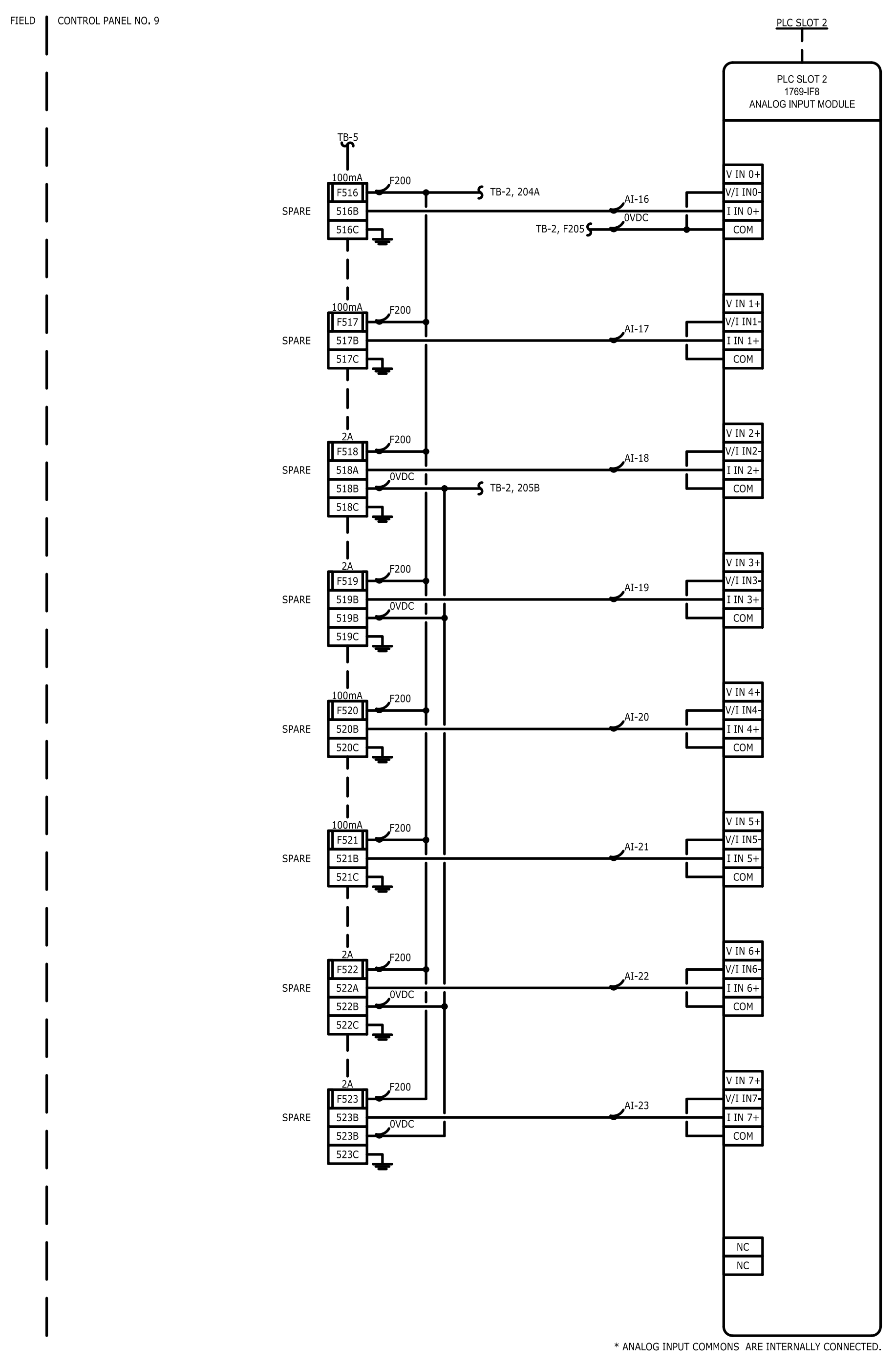


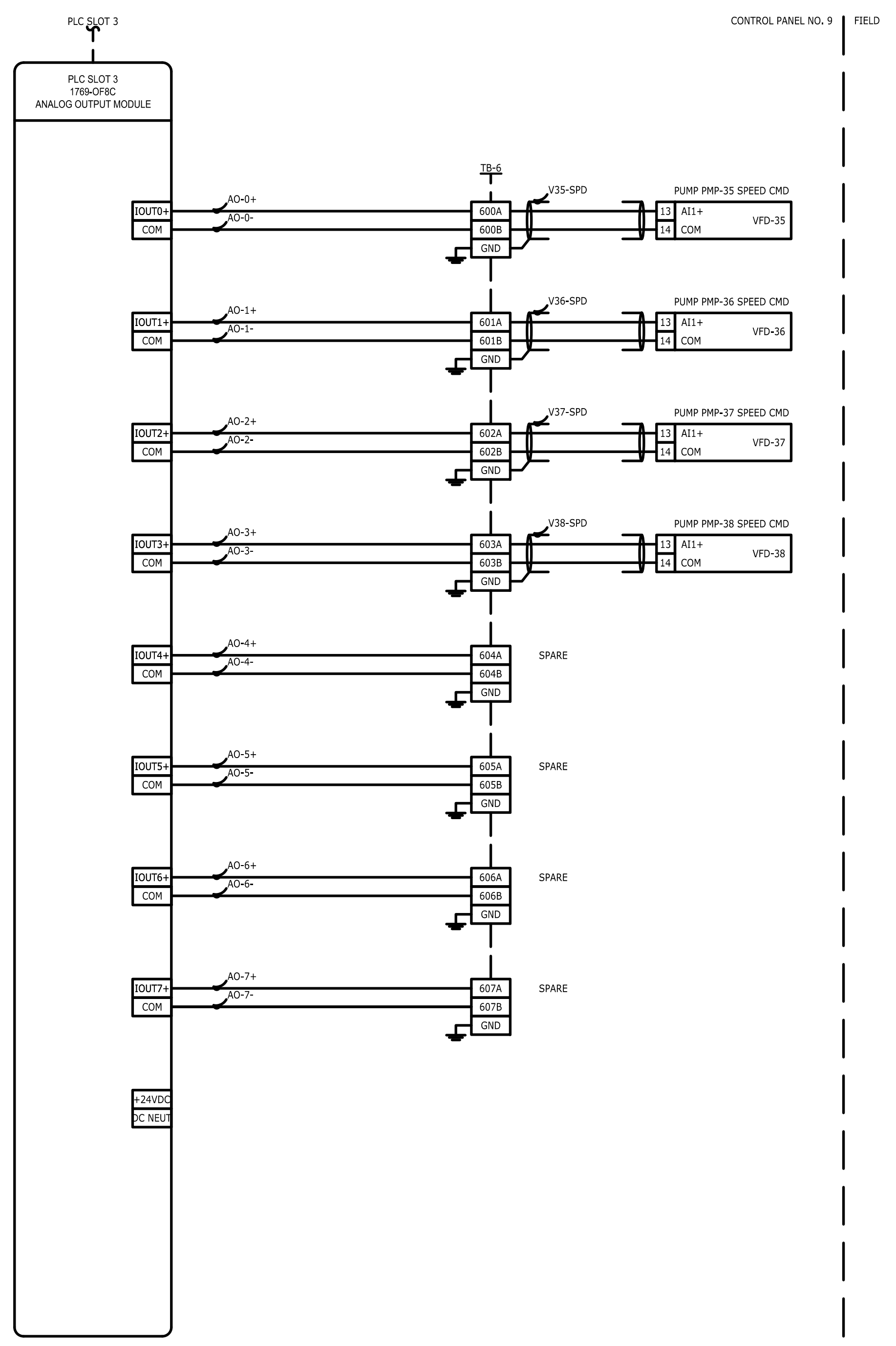
139 E-41 DETAIL
CONTROL PANEL NO. 9 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM I



140 E-41 DETAIL
CONTROL PANEL NO. 9 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM II



141 E-41 DETAIL
CONTROL PANEL NO. 9 PLC SLOT 2
ANALOG INPUT WIRING DIAGRAM



142 E-41 DETAIL
CONTROL PANEL NO. 9 PLC SLOT 3
ANALOG INPUT WIRING DIAGRAM

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-09 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E41.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-41
APPROVED BY:	JJD		

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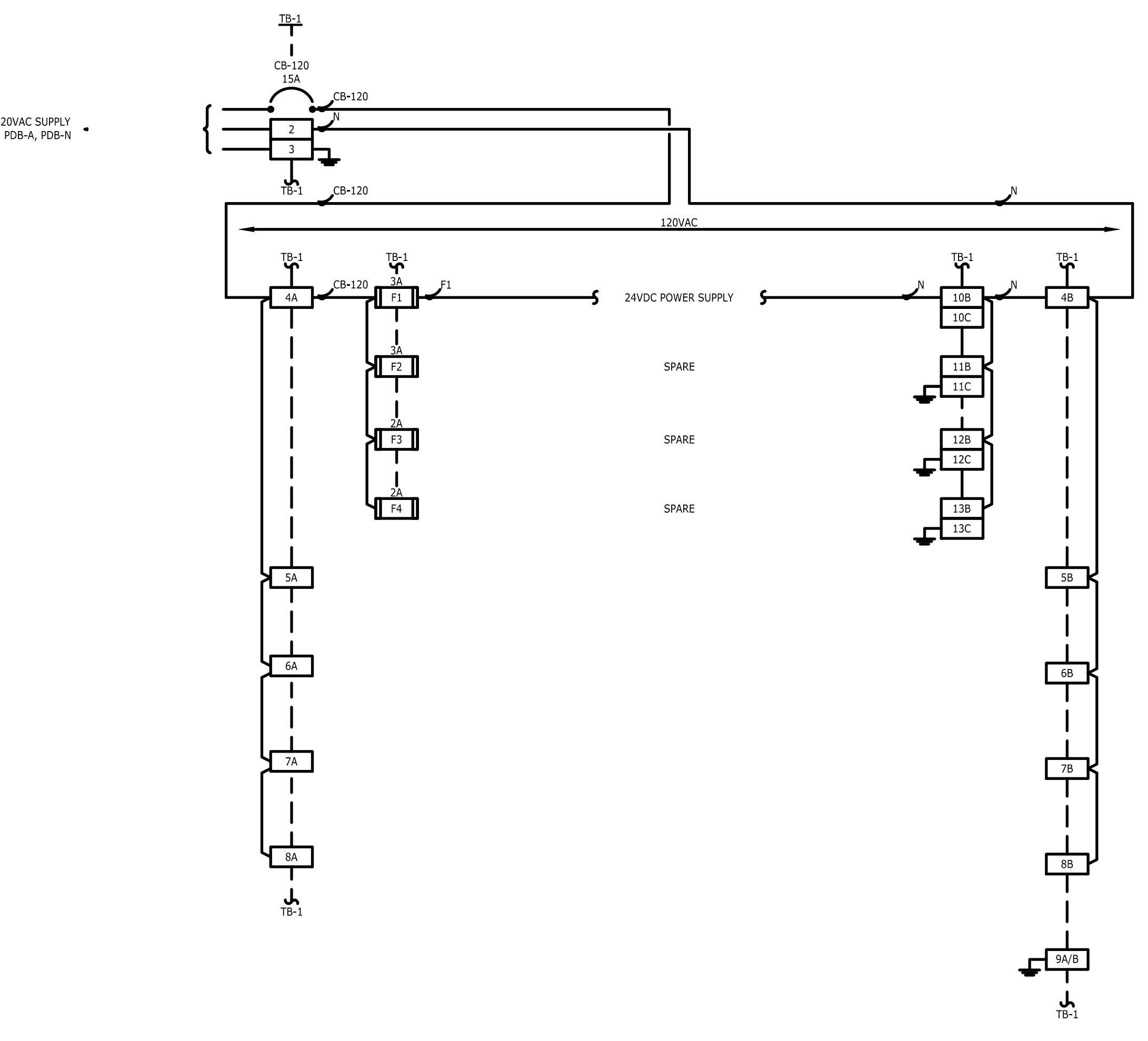
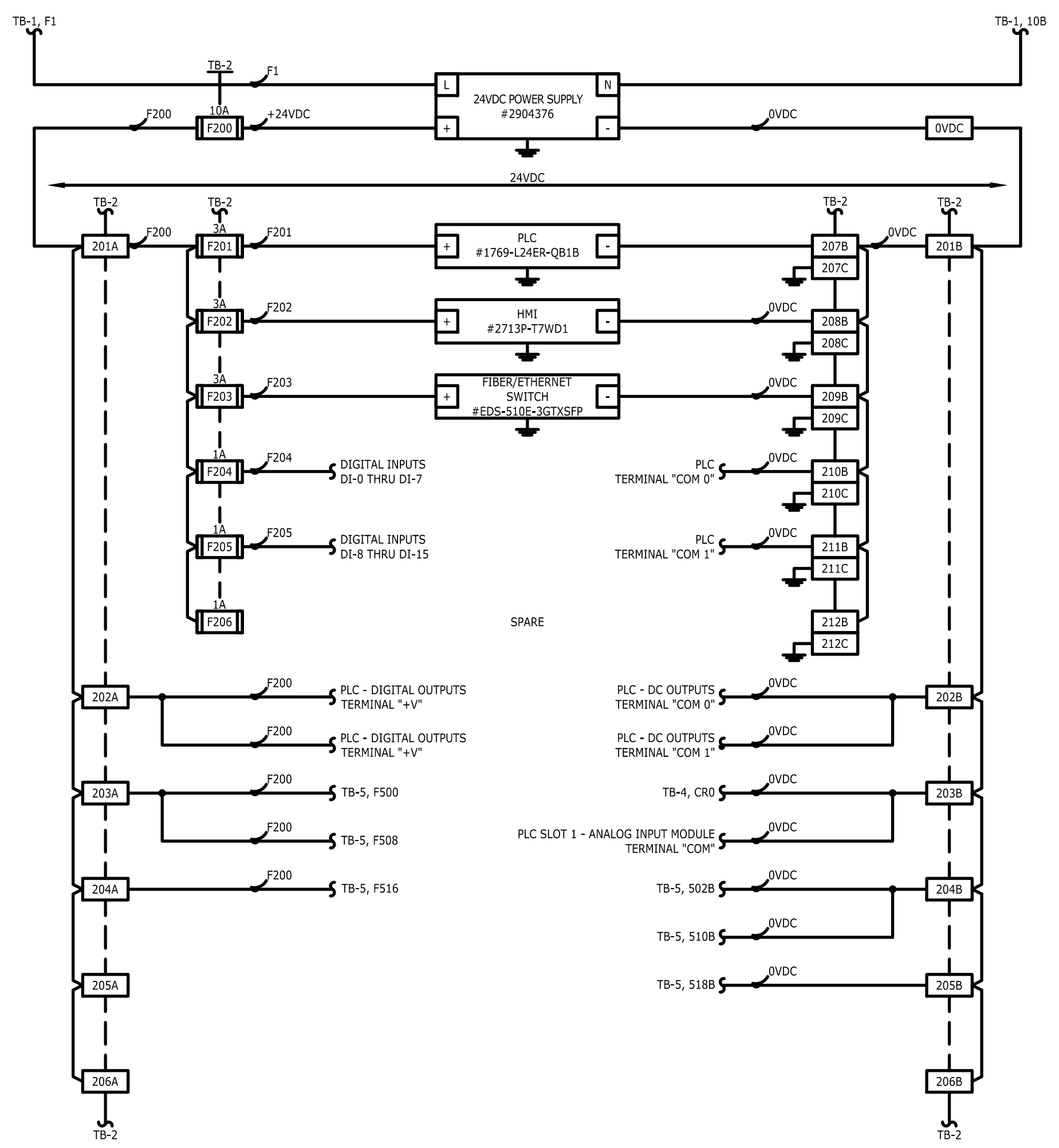
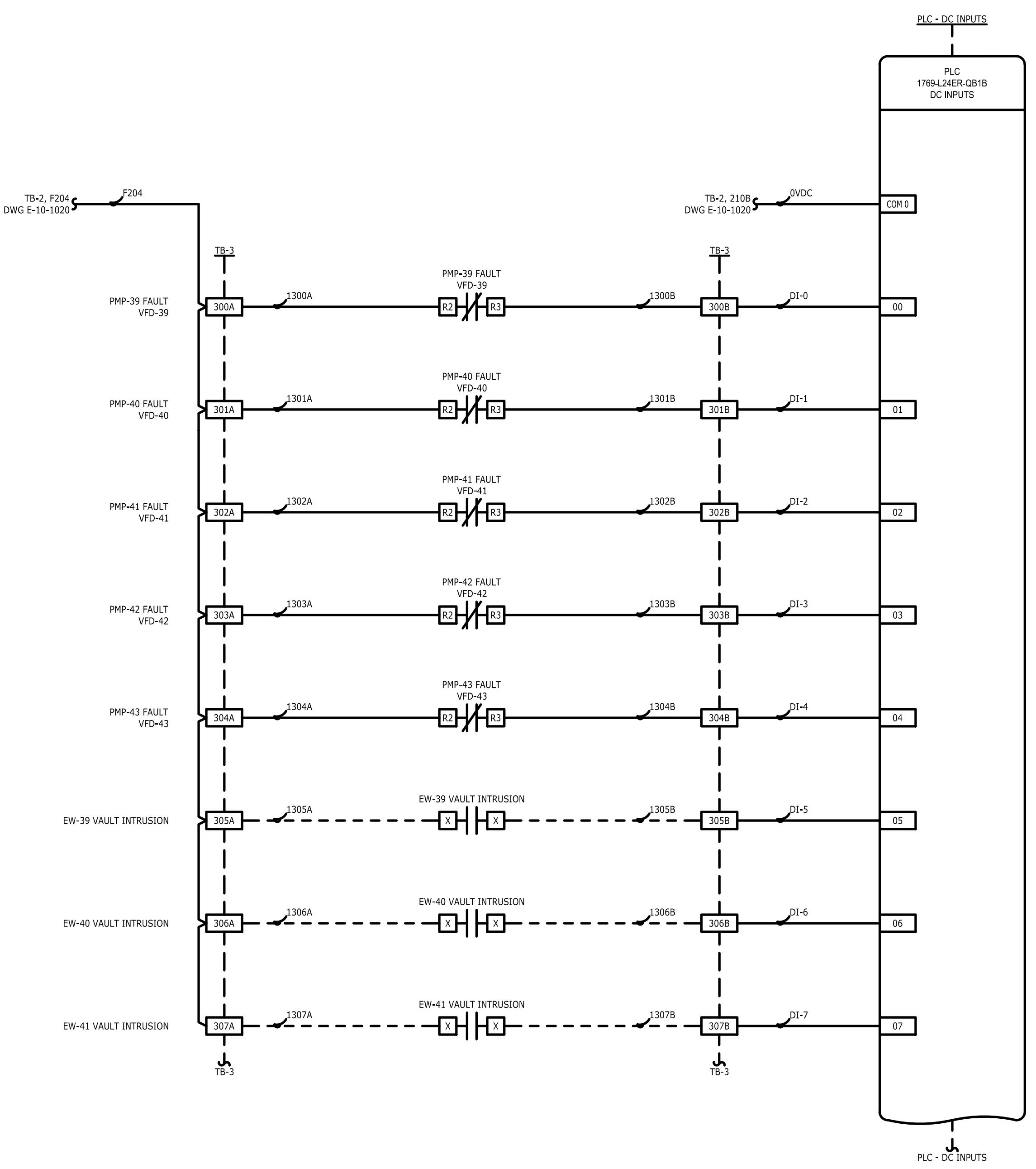


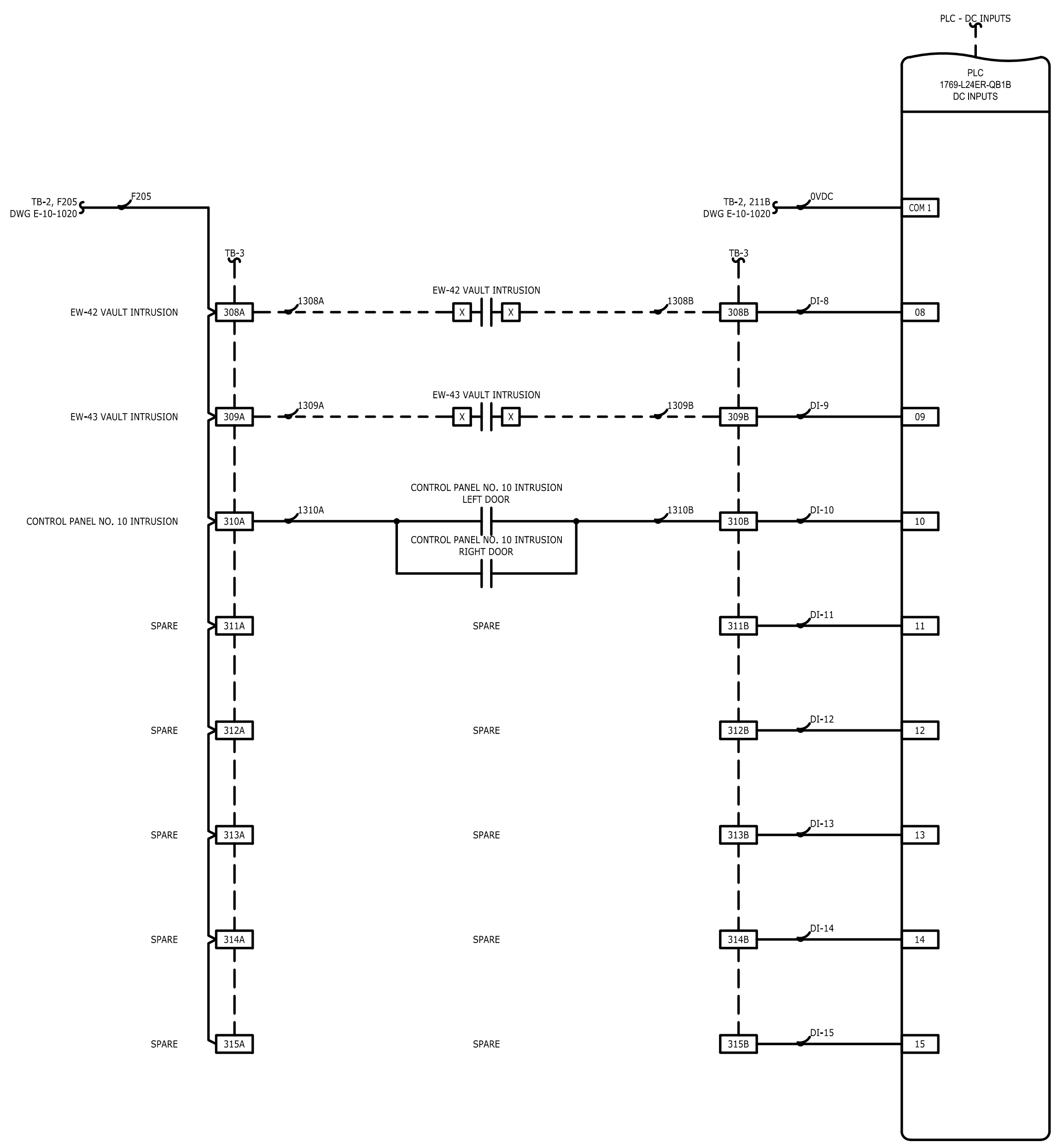
144 DETAIL
E-42 CONTROL PANEL NO. 10 120VAC POWER DISTRIBUTION



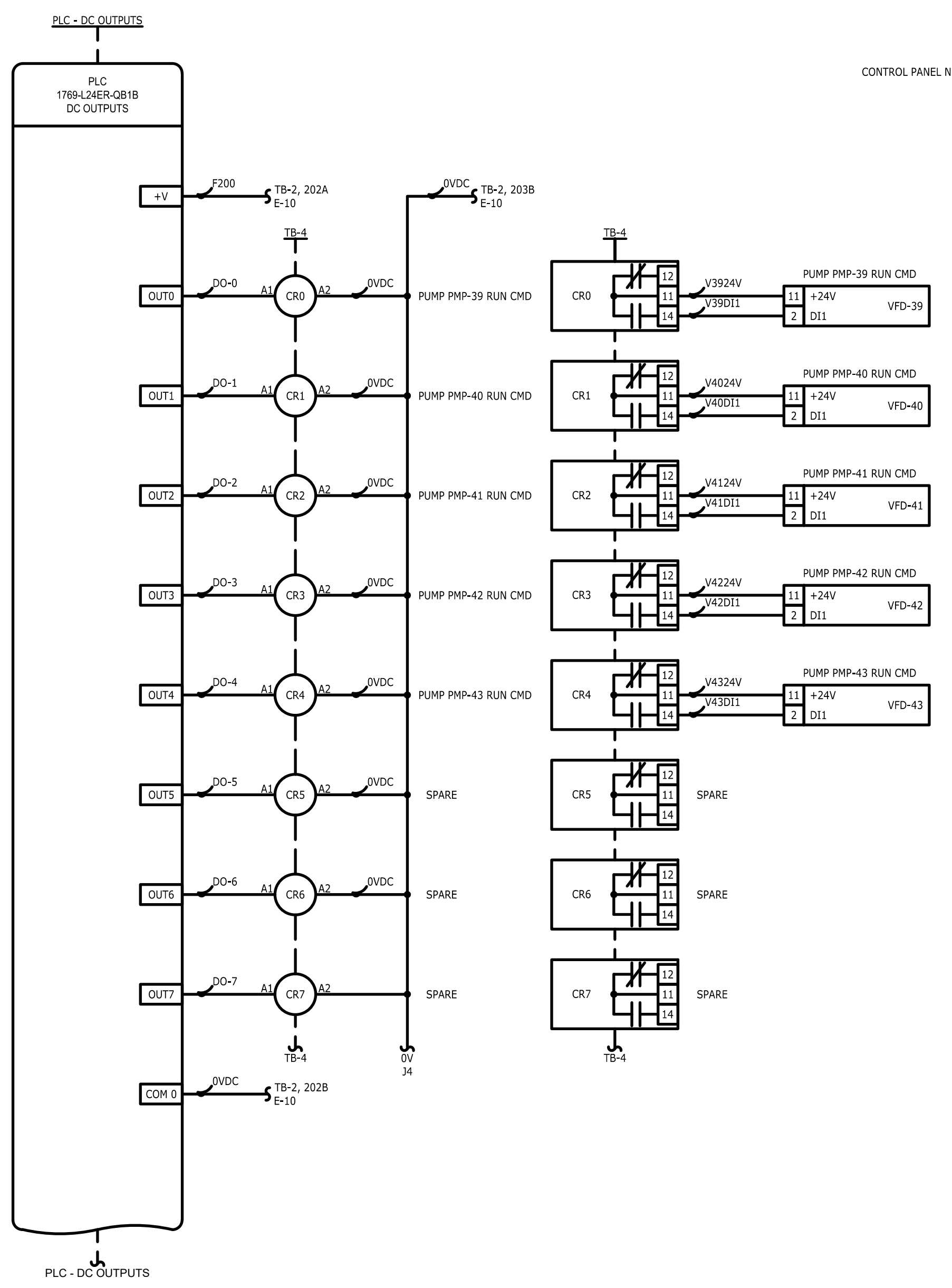
145 DETAIL
E-42 CONTROL PANEL NO. 10 24VDC POWER DISTRIBUTION



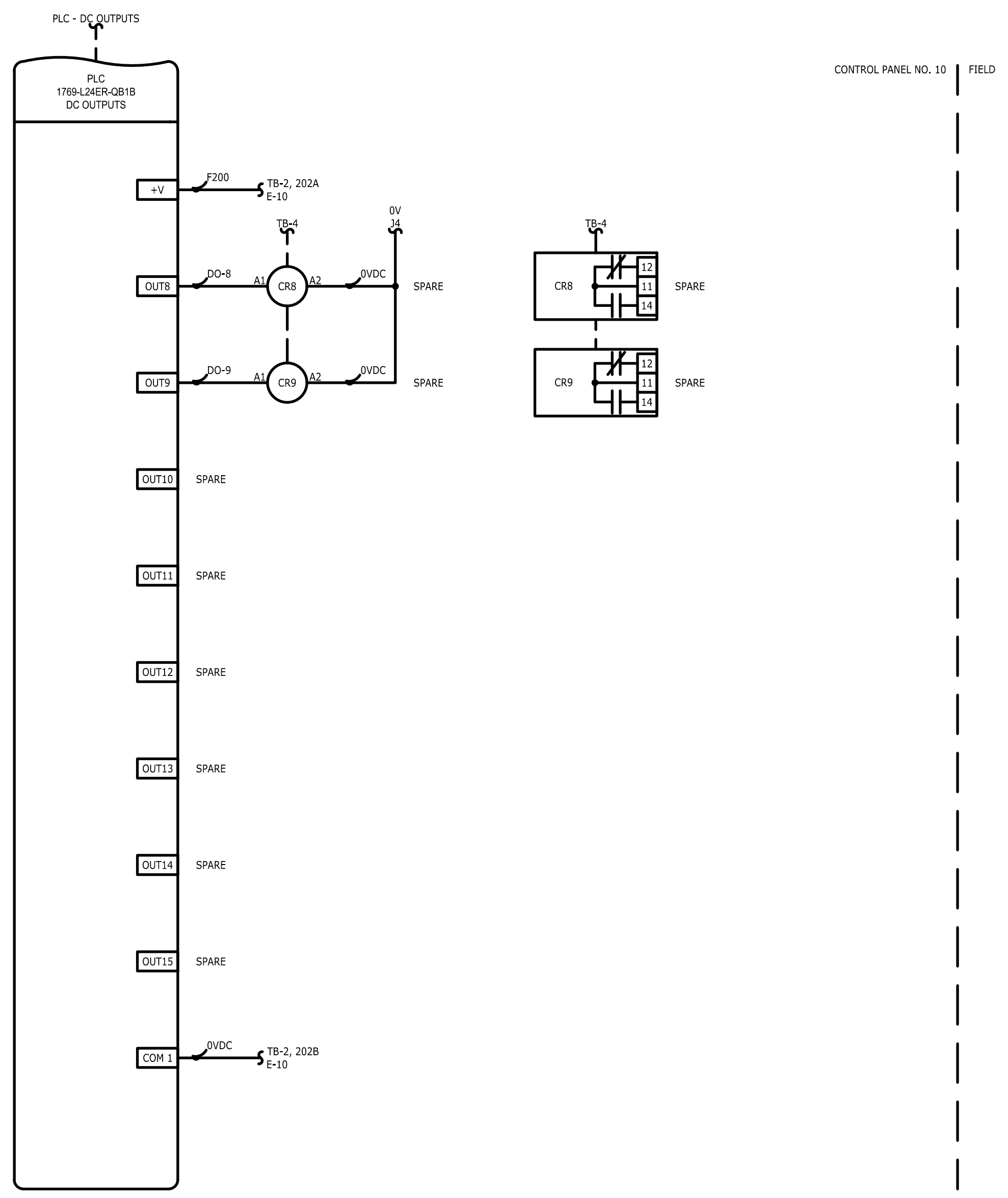
146 DETAIL
E-42 CONTROL PANEL NO. 10 PLC DIGITAL WIRING DIAGRAM I



147 DETAIL
E-42 CONTROL PANEL NO. 10 PLC DIGITAL WIRING DIAGRAM II



148 DETAIL
E-42 CONTROL PANEL NO. 10 PLC RELAY OUTPUTS WIRING DIAGRAM I



149 DETAIL
E-42 CONTROL PANEL NO. 10 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-10 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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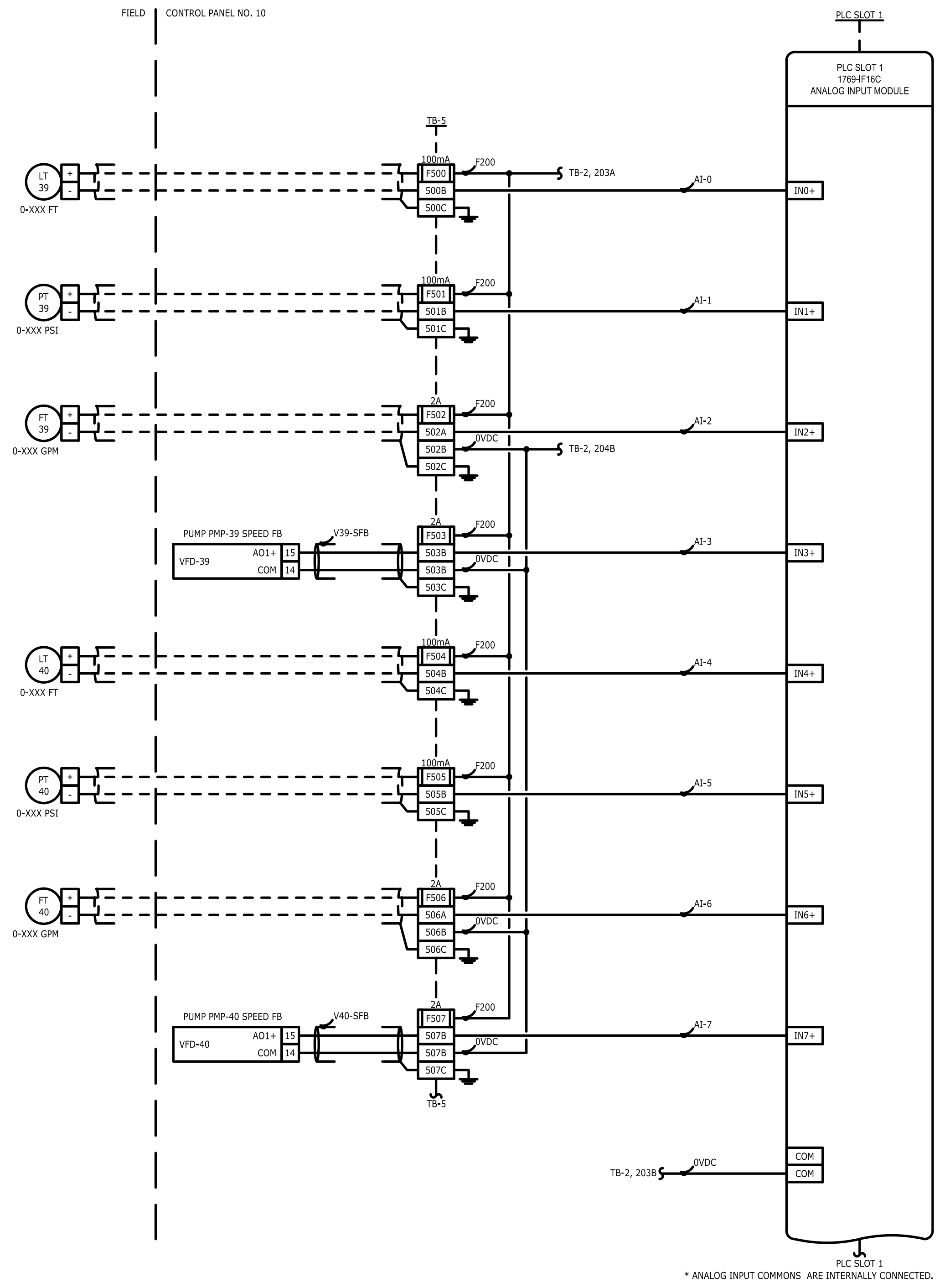
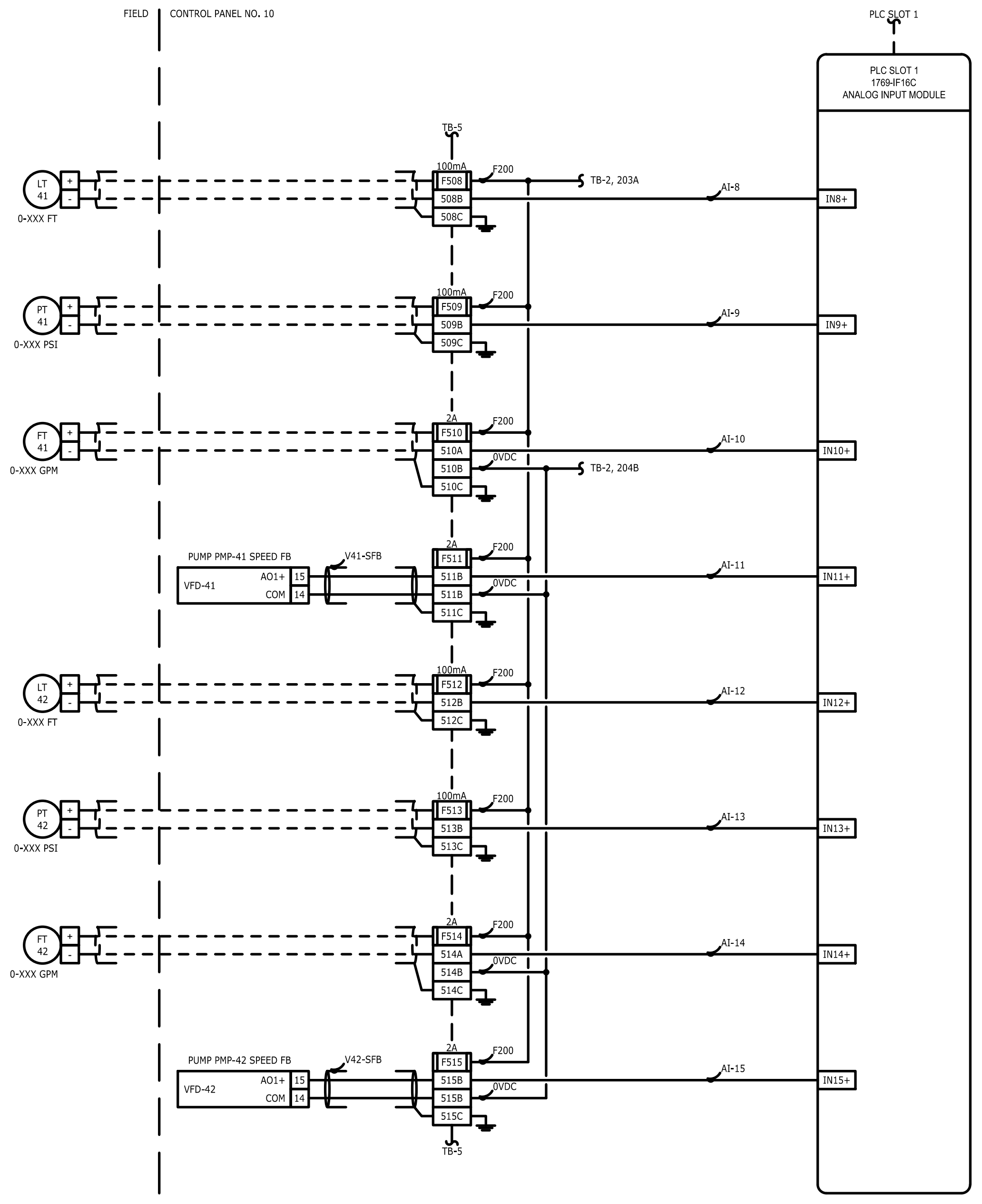
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E42.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-42
APPROVED BY:	JJD		

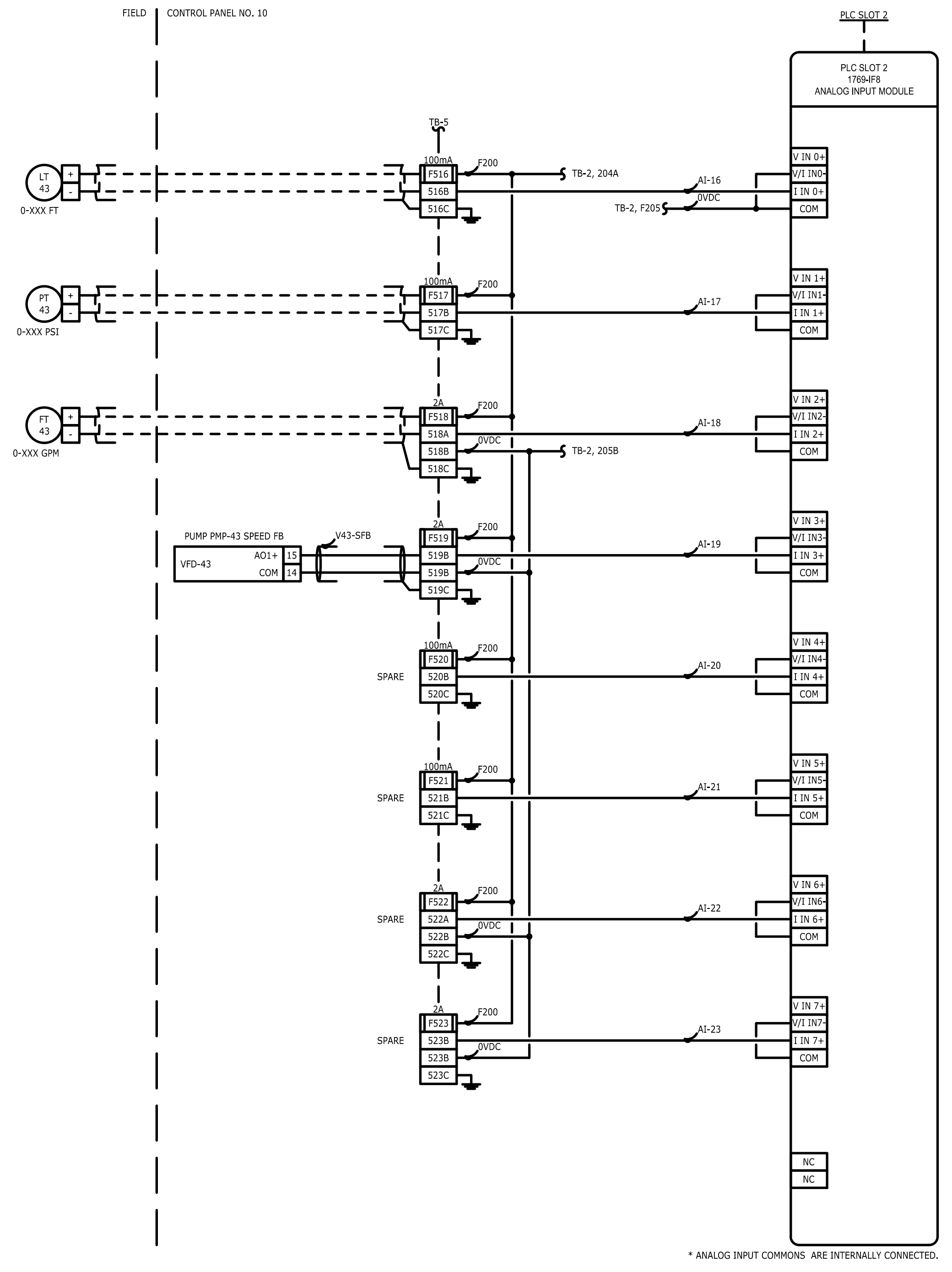
90% DESIGN DRAWINGS



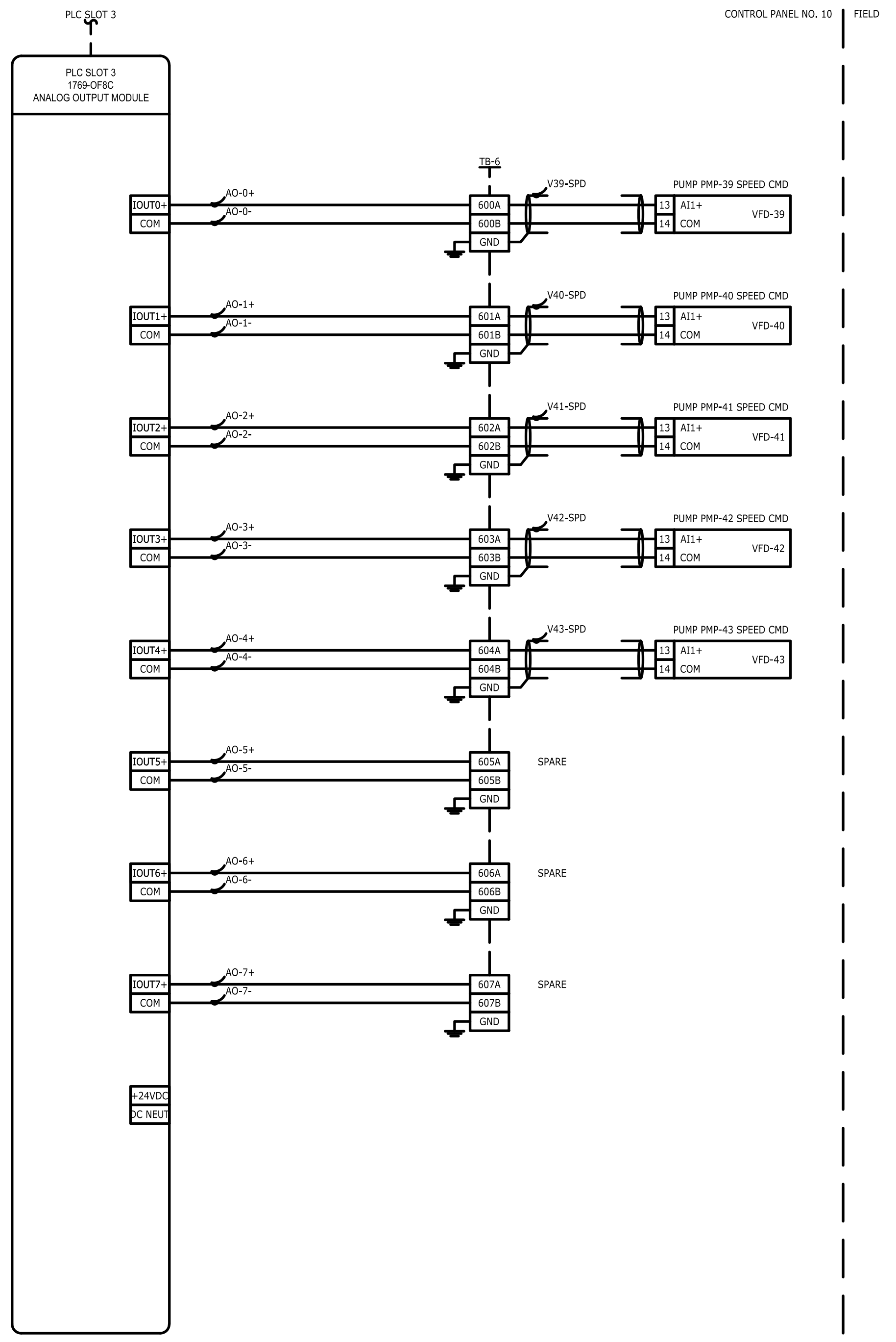
150 E-43 DETAIL
CONTROL PANEL NO. 10 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



151 E-43 DETAIL
CONTROL PANEL NO. 10 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



152 E-43 DETAIL
CONTROL PANEL NO. 10 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



153 E-43 DETAIL
CONTROL PANEL NO. 10 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-10 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E43.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-43
APPROVED BY:	JJD		

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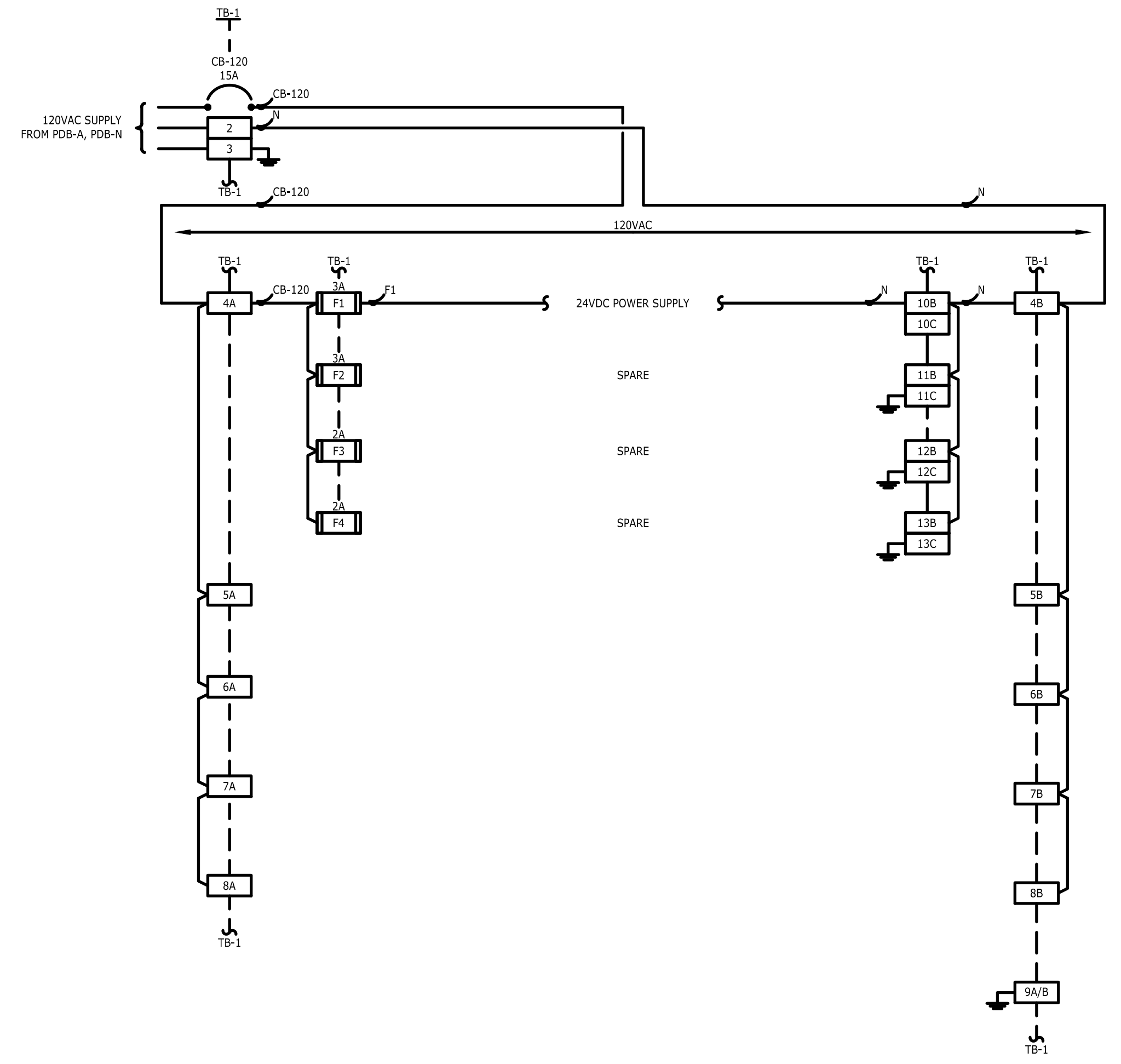
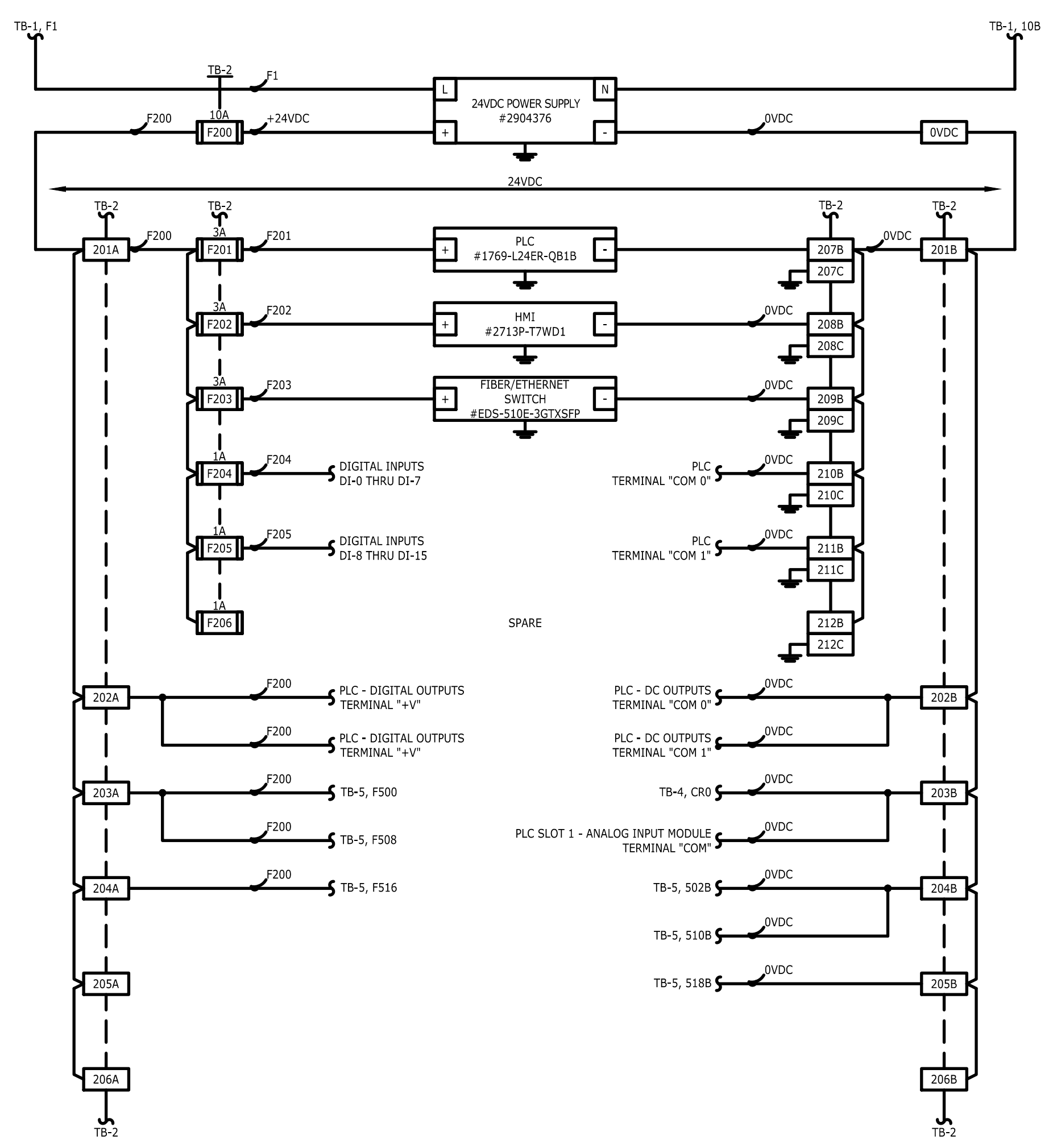


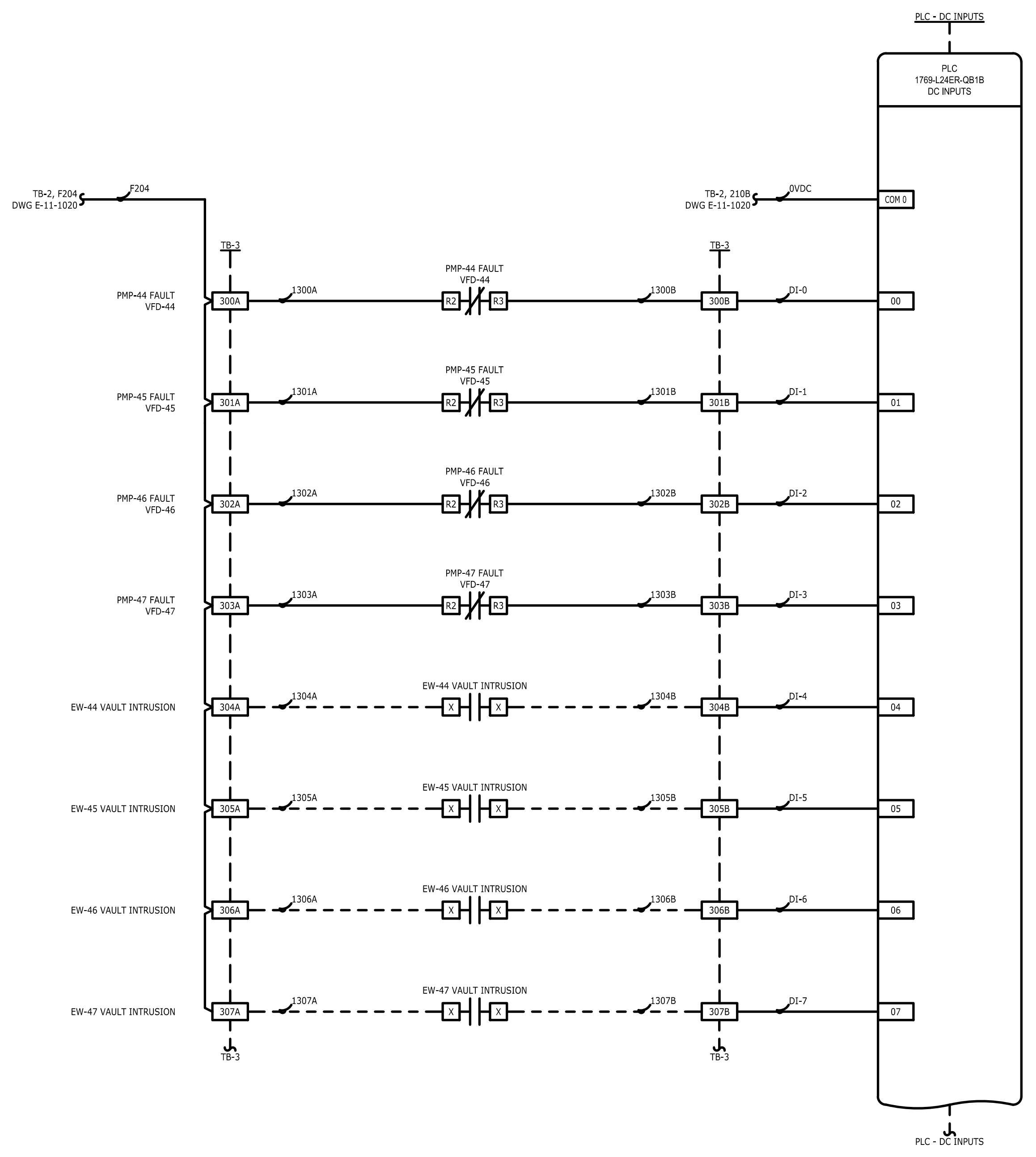
155 E-44 DETAIL

CONTROL PANEL NO. 11 120VAC POWER DISTRIBUTION



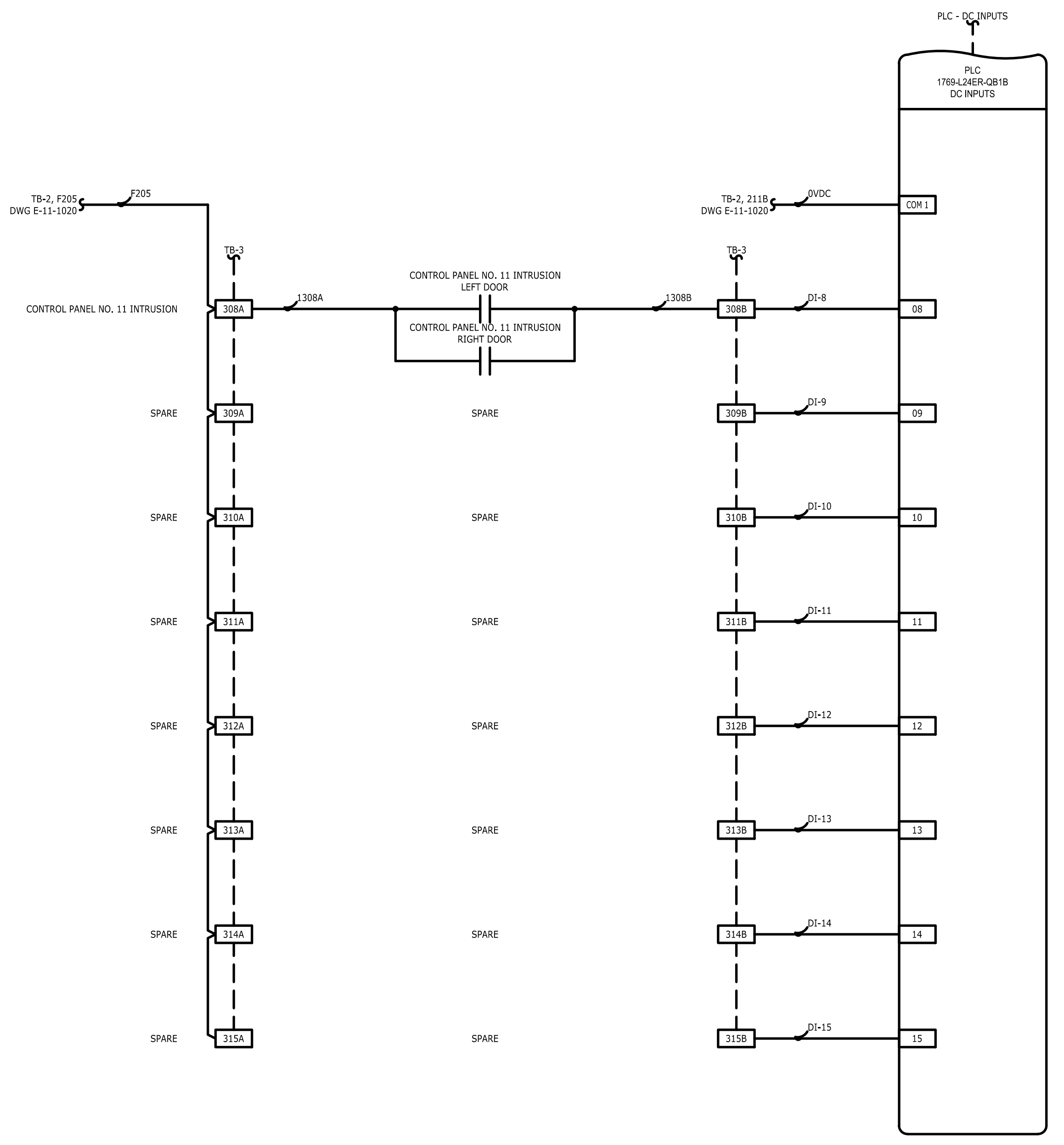
156 E-44 DETAIL

CONTROL PANEL NO. 11 24VDC POWER DISTRIBUTION



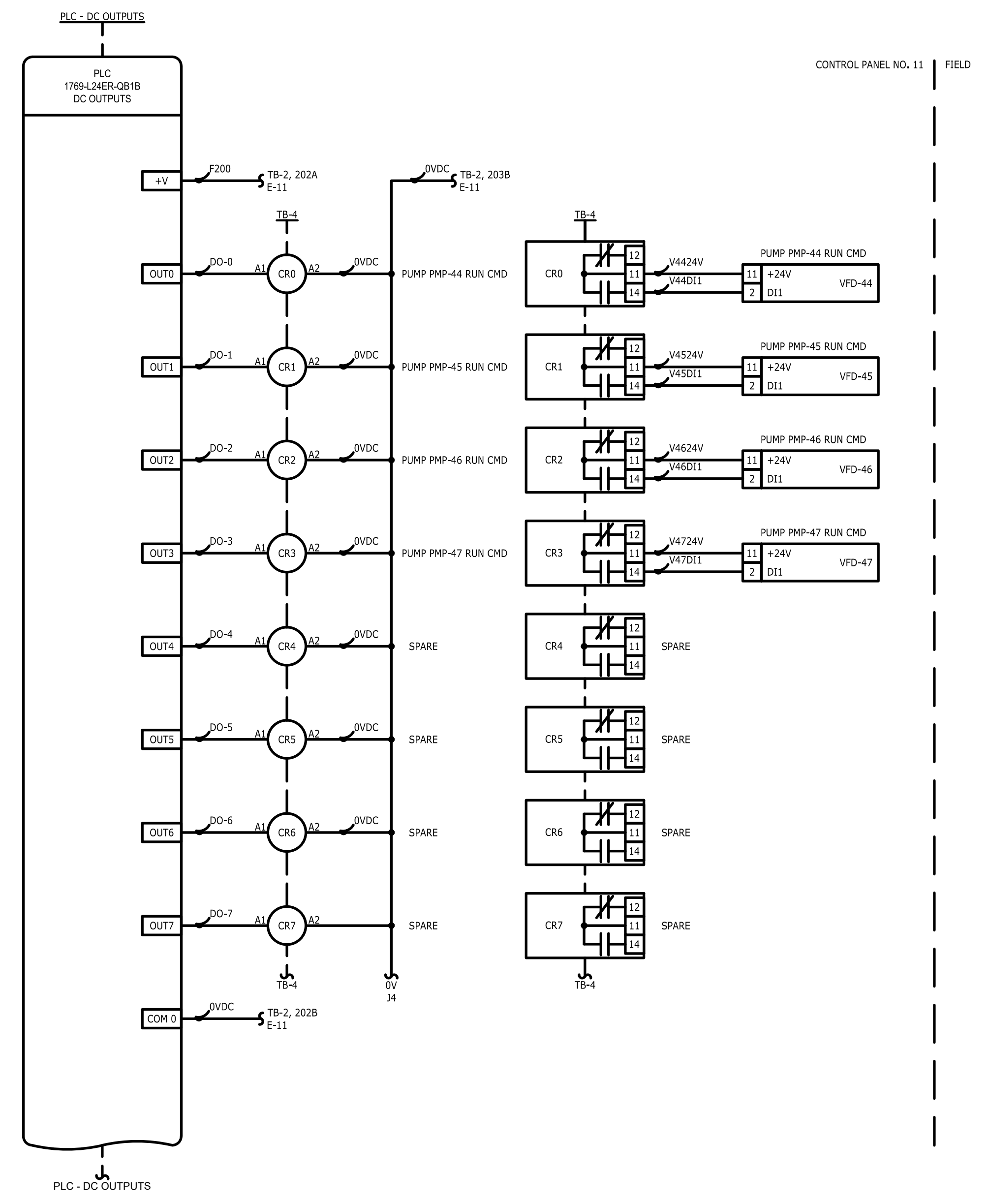
157 E-44 DETAIL

CONTROL PANEL NO. 11 PLC DIGITAL WIRING DIAGRAM I



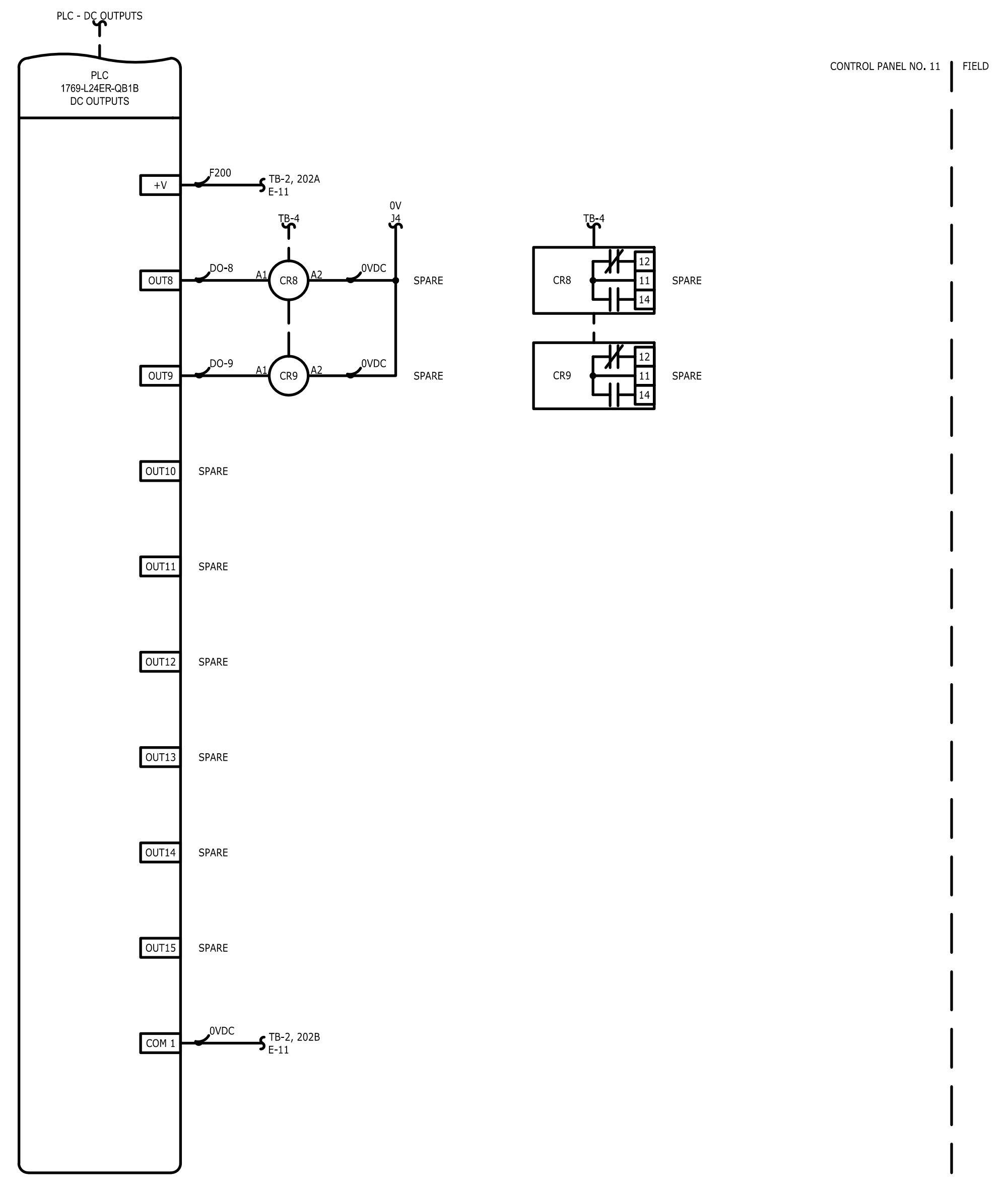
158 E-44 DETAIL

CONTROL PANEL NO. 11 PLC DIGITAL WIRING DIAGRAM II



159 E-44 DETAIL

CONTROL PANEL NO. 11 PLC RELAY OUTPUTS WIRING DIAGRAM I



160 E-44 DETAIL

CONTROL PANEL NO. 11 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-11 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E44.DWG
REVIEWED BY:	SV	DRAWING NO.:	
APPROVED BY:	JJD		E-44

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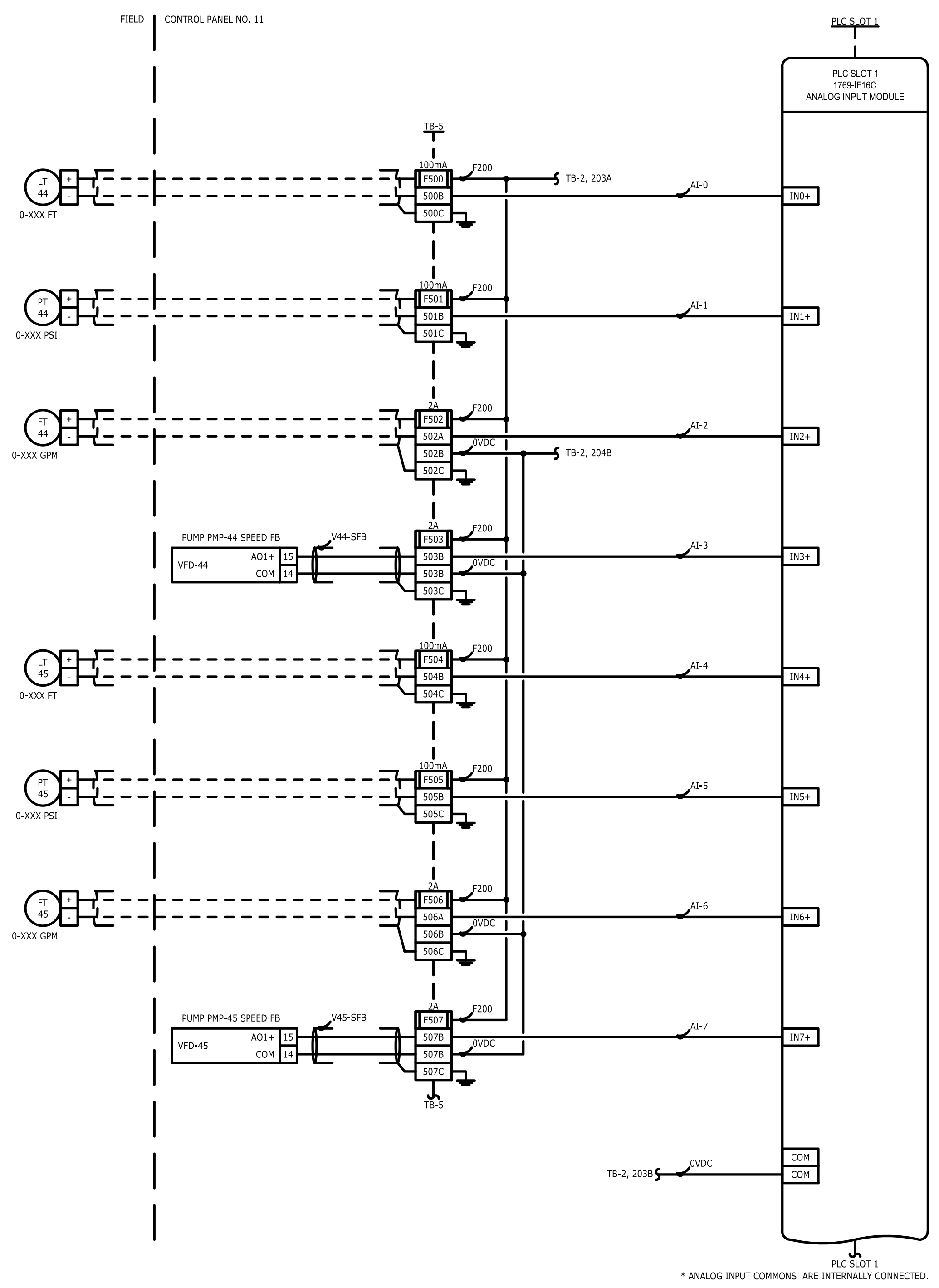
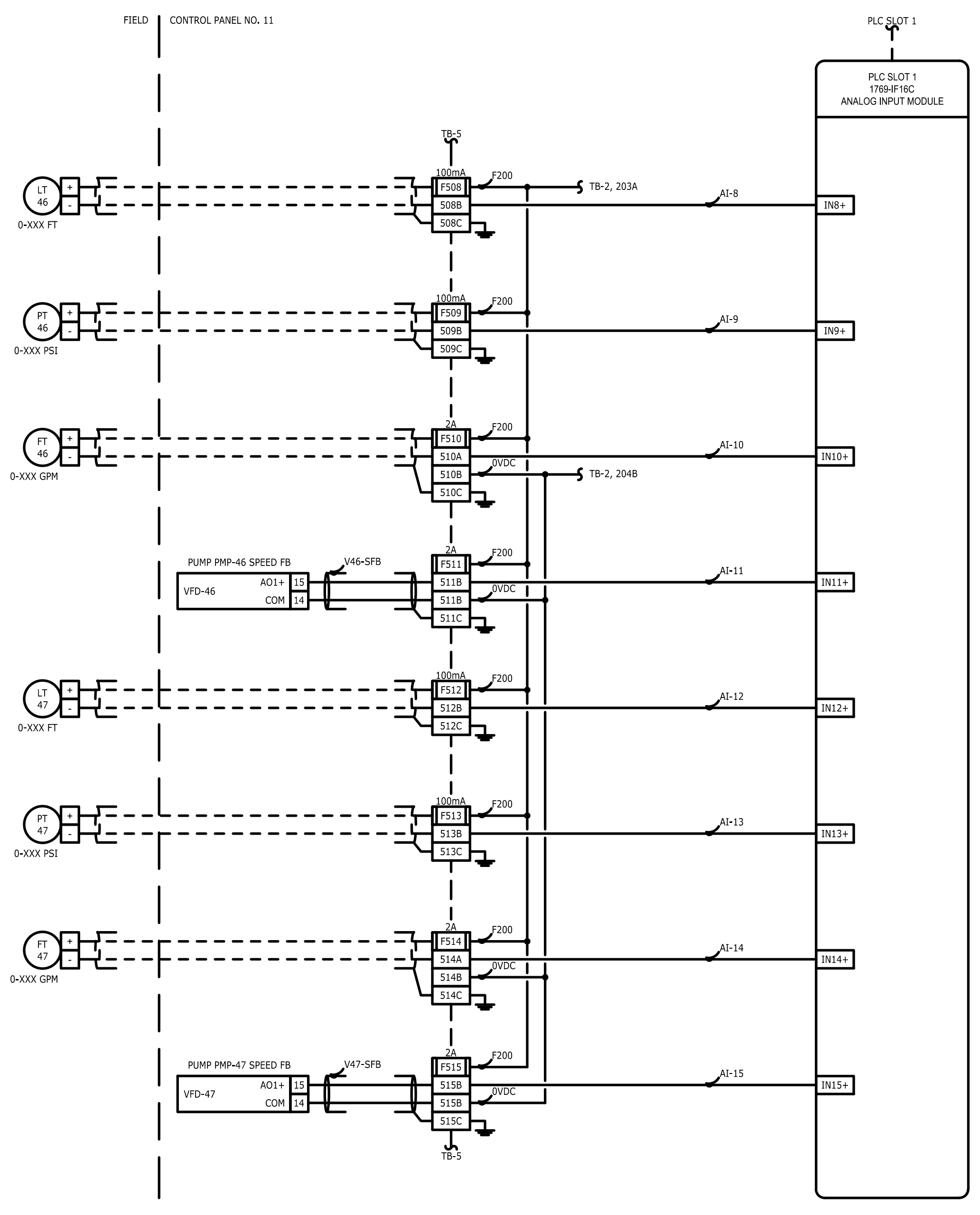


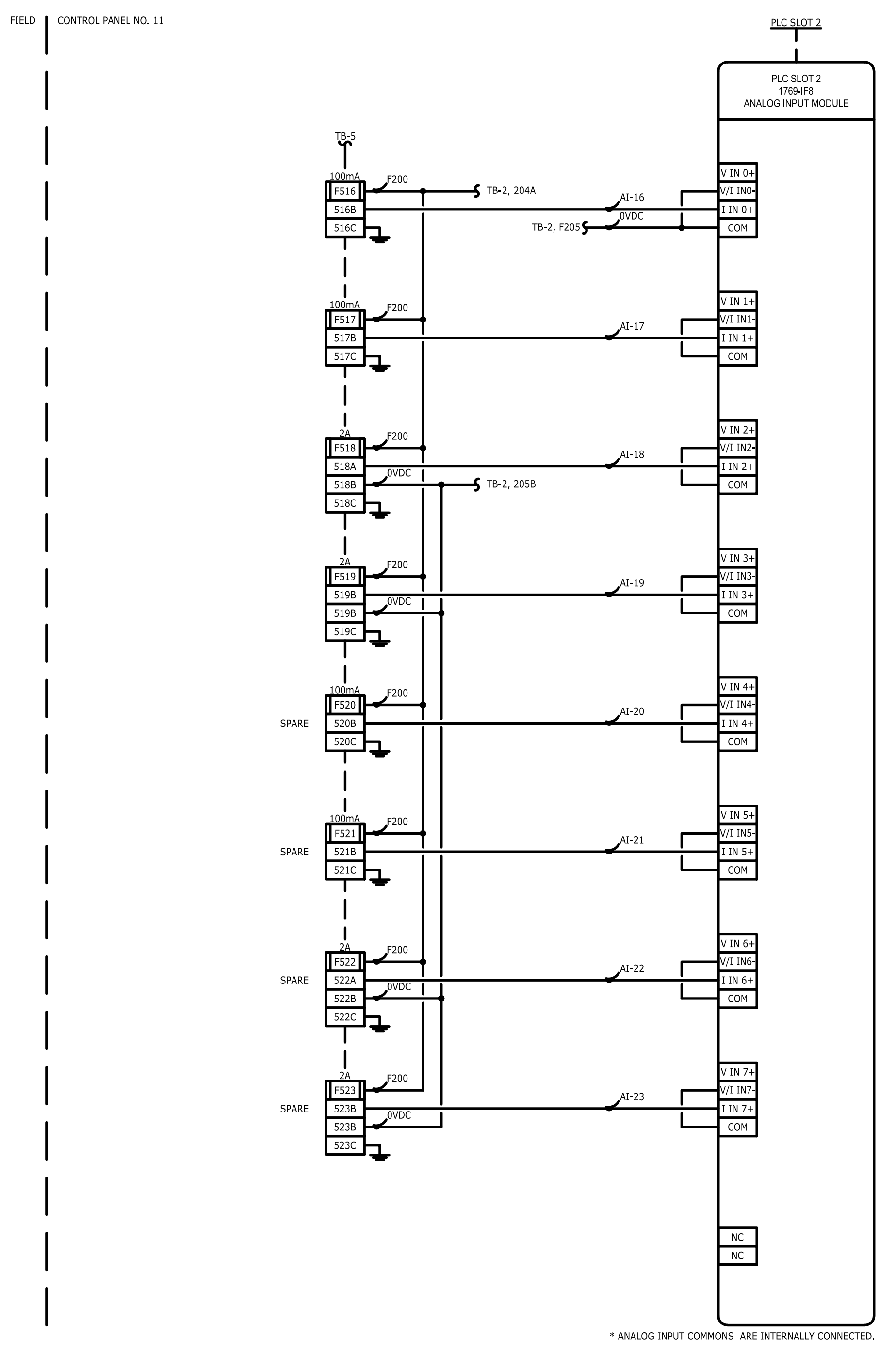
161
E-45

DETAIL
CONTROL PANEL NO. 11 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



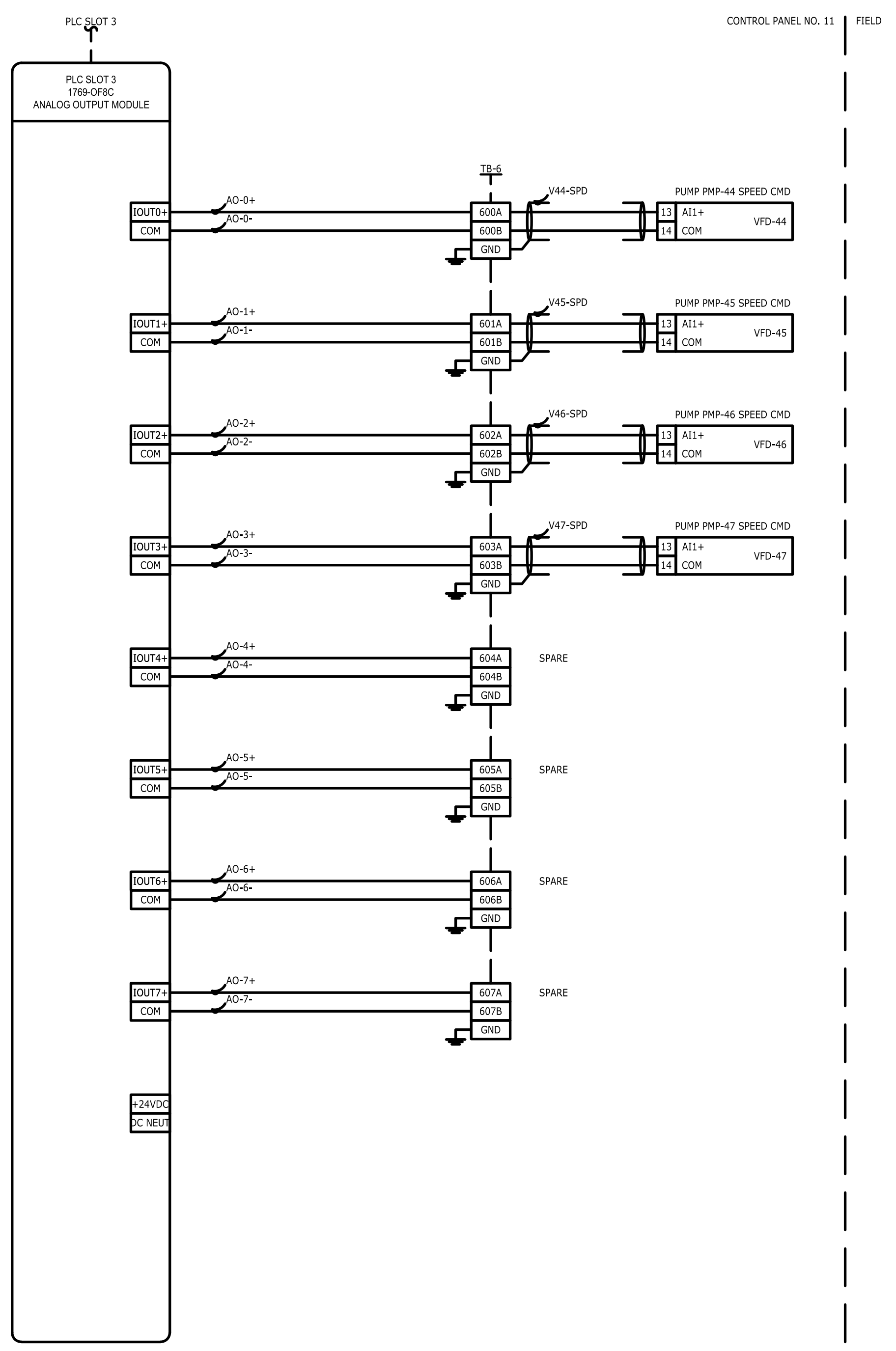
162
E-45

DETAIL
CONTROL PANEL NO. 11 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



163
E-45

DETAIL
CONTROL PANEL NO. 11 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



164
E-45

DETAIL
CONTROL PANEL NO. 11 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-11 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E45.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-45
APPROVED BY:	JJD		

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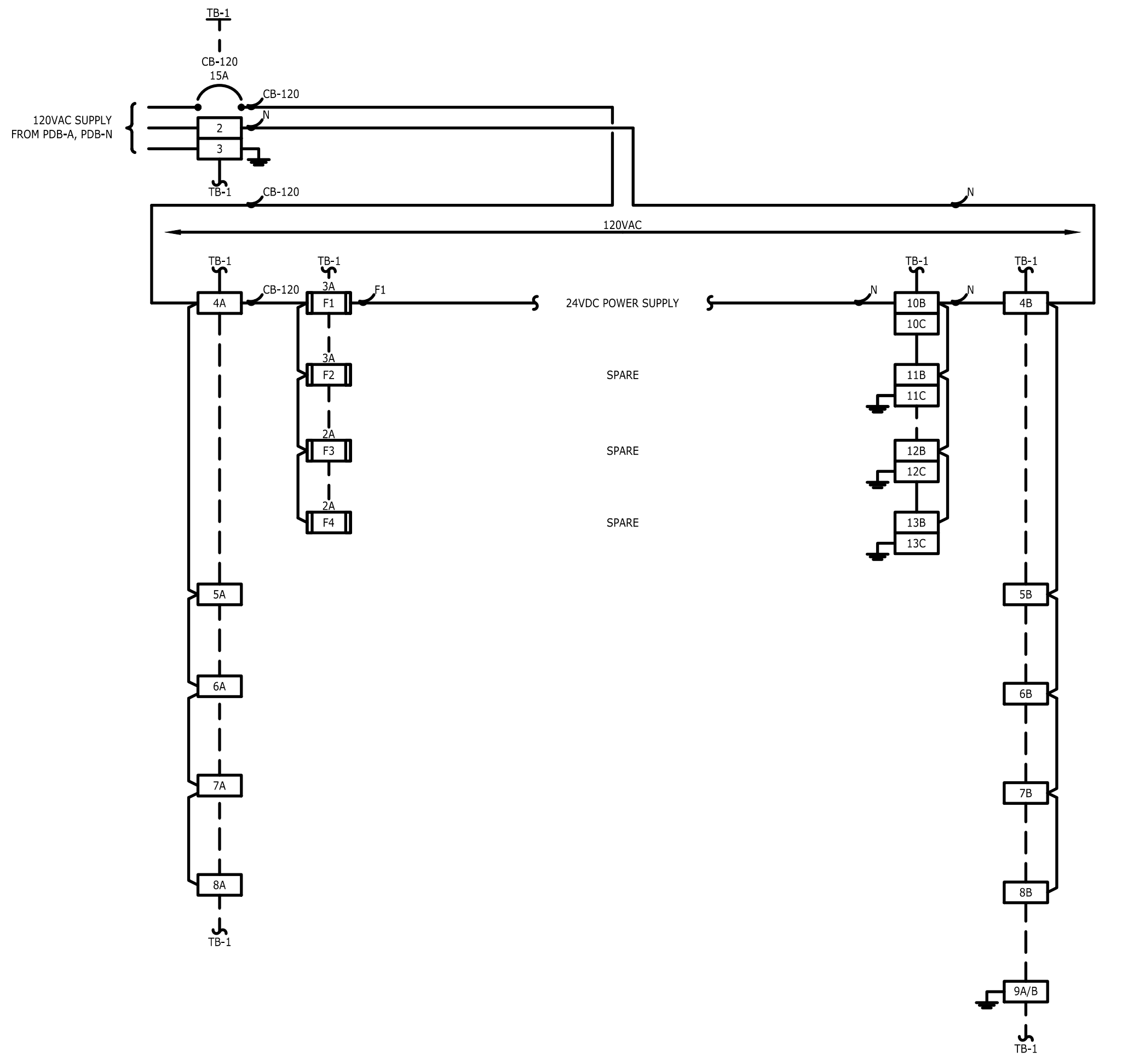
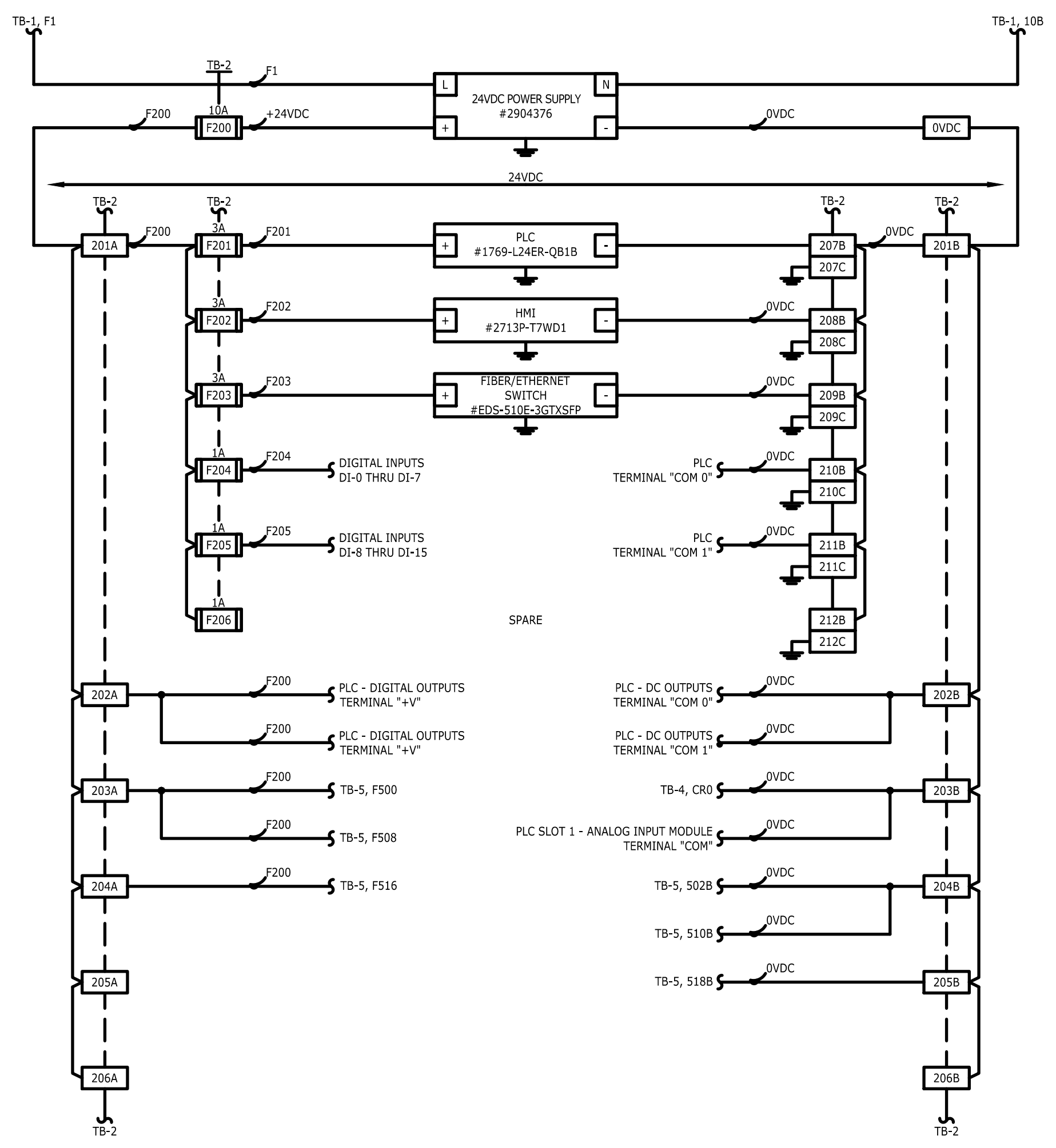
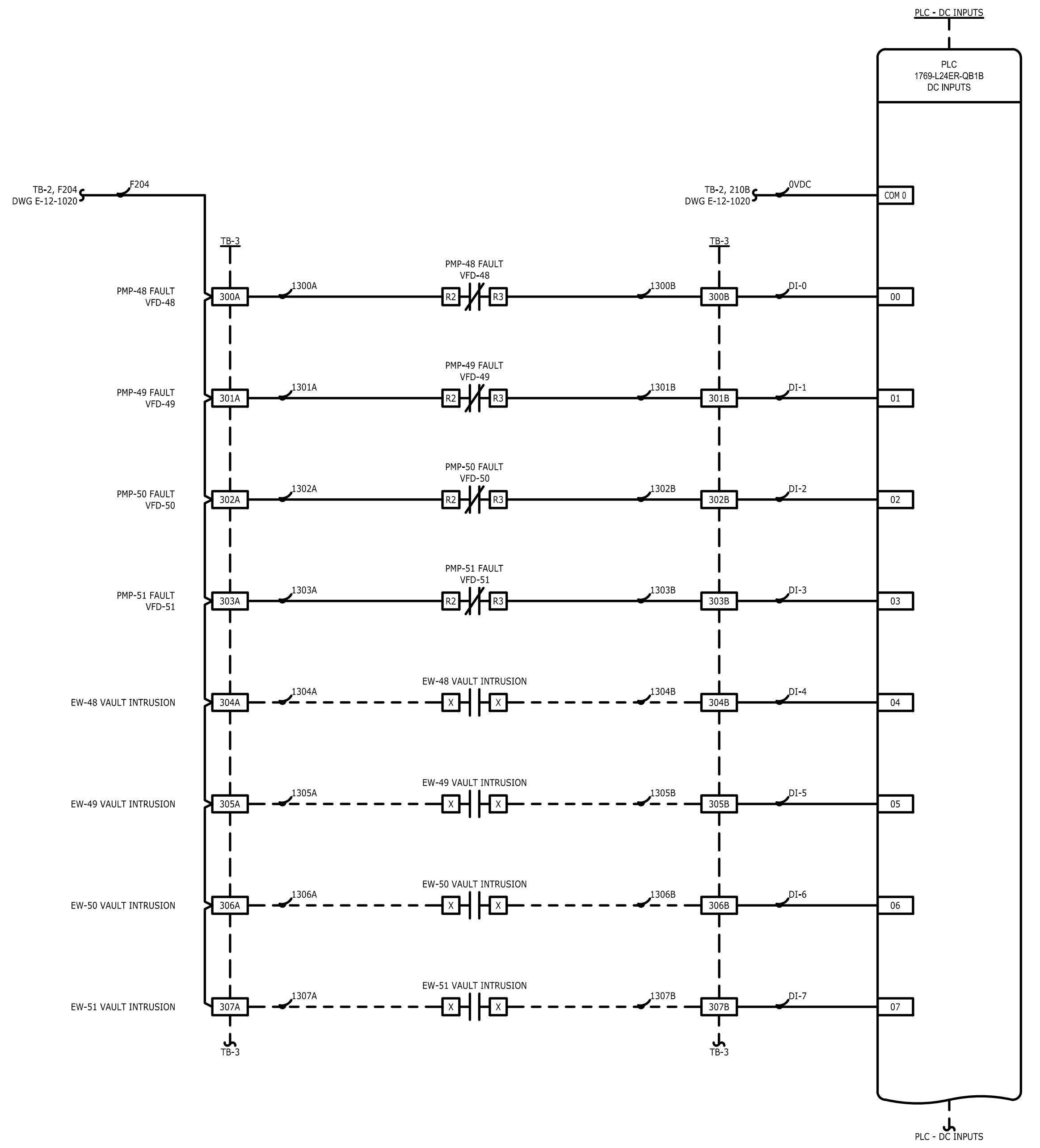


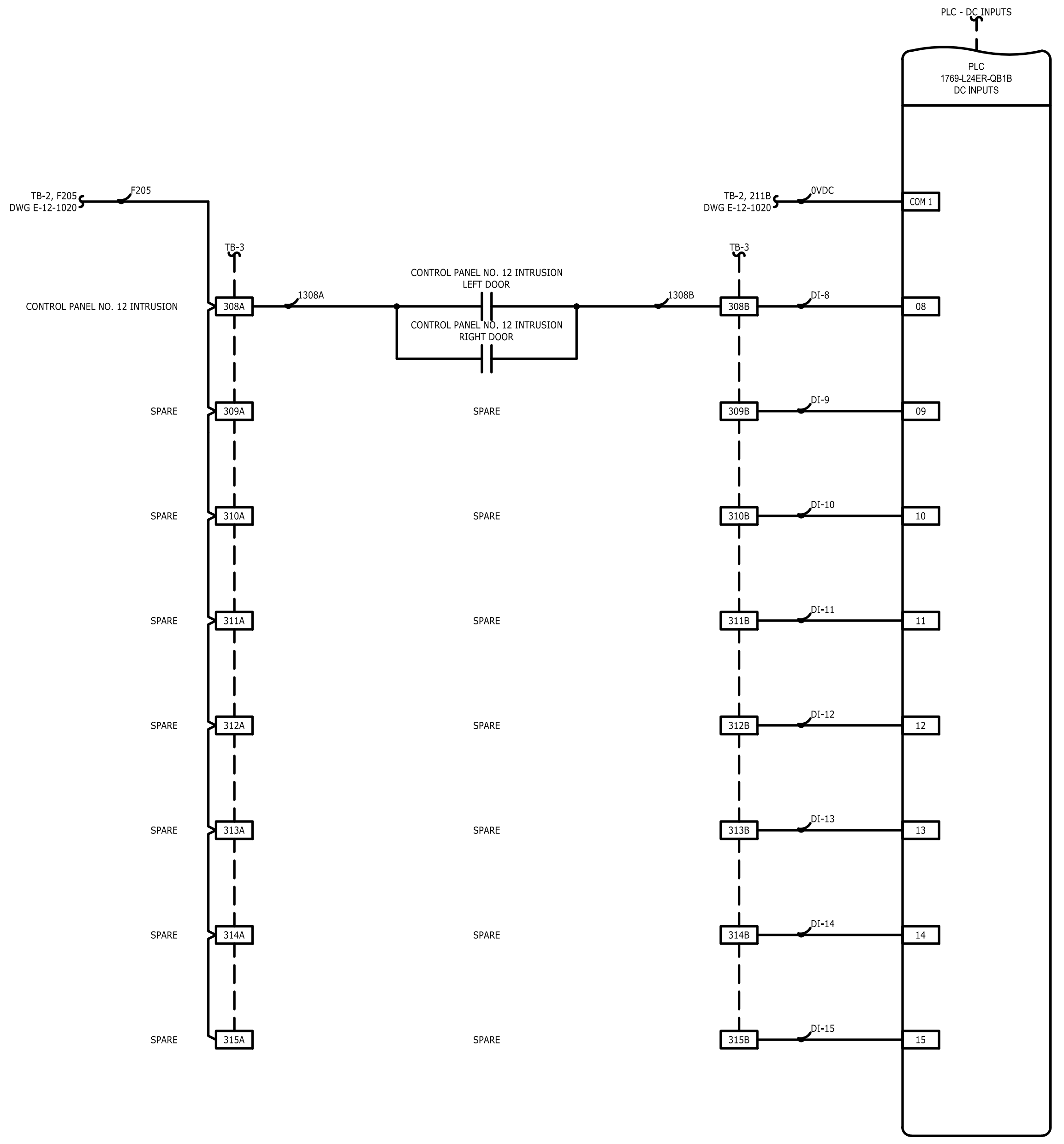
166 E-46 DETAIL
CONTROL PANEL NO. 12 120VAC POWER DISTRIBUTION



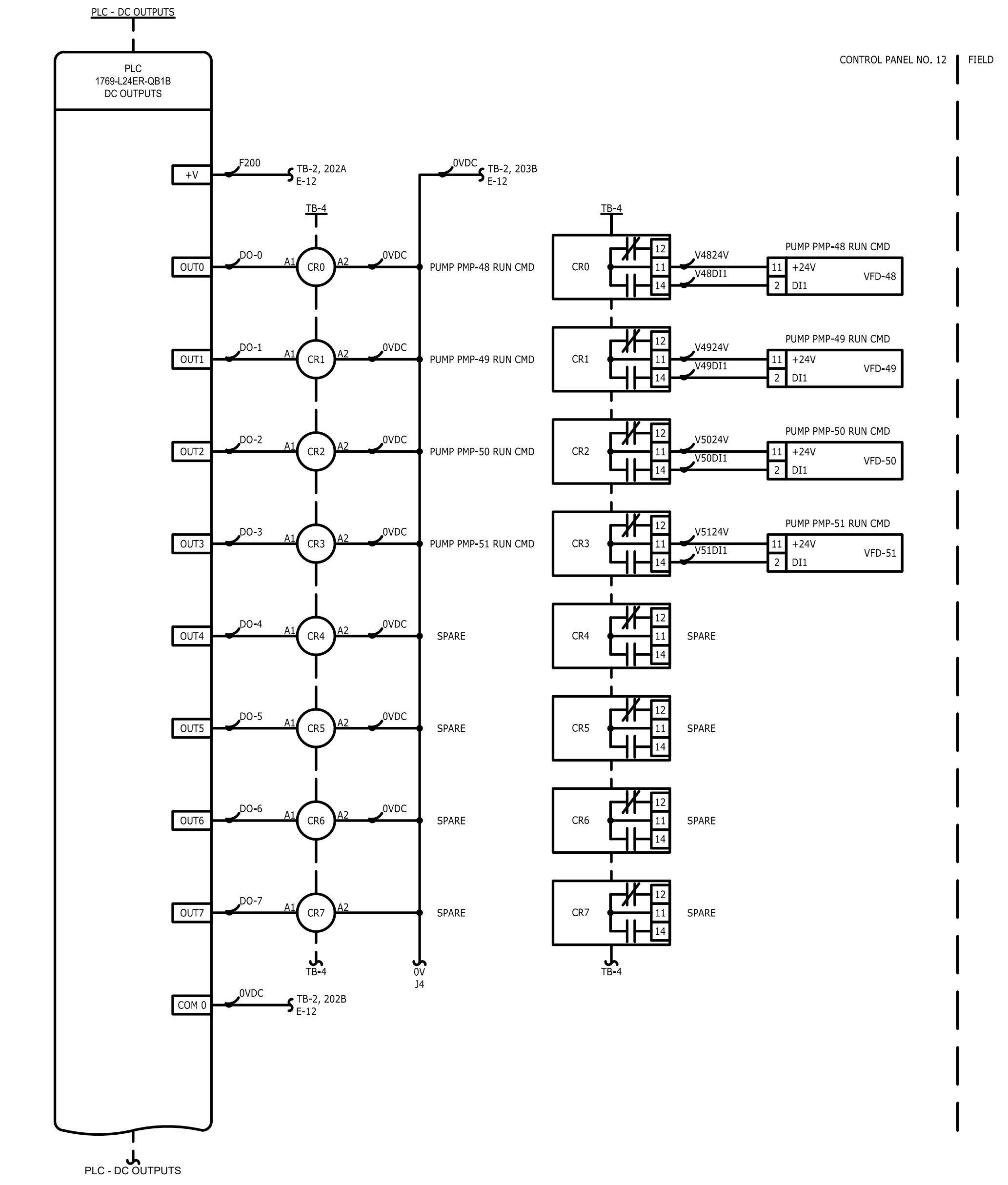
167 E-46 DETAIL
CONTROL PANEL NO. 12 24VDC POWER DISTRIBUTION



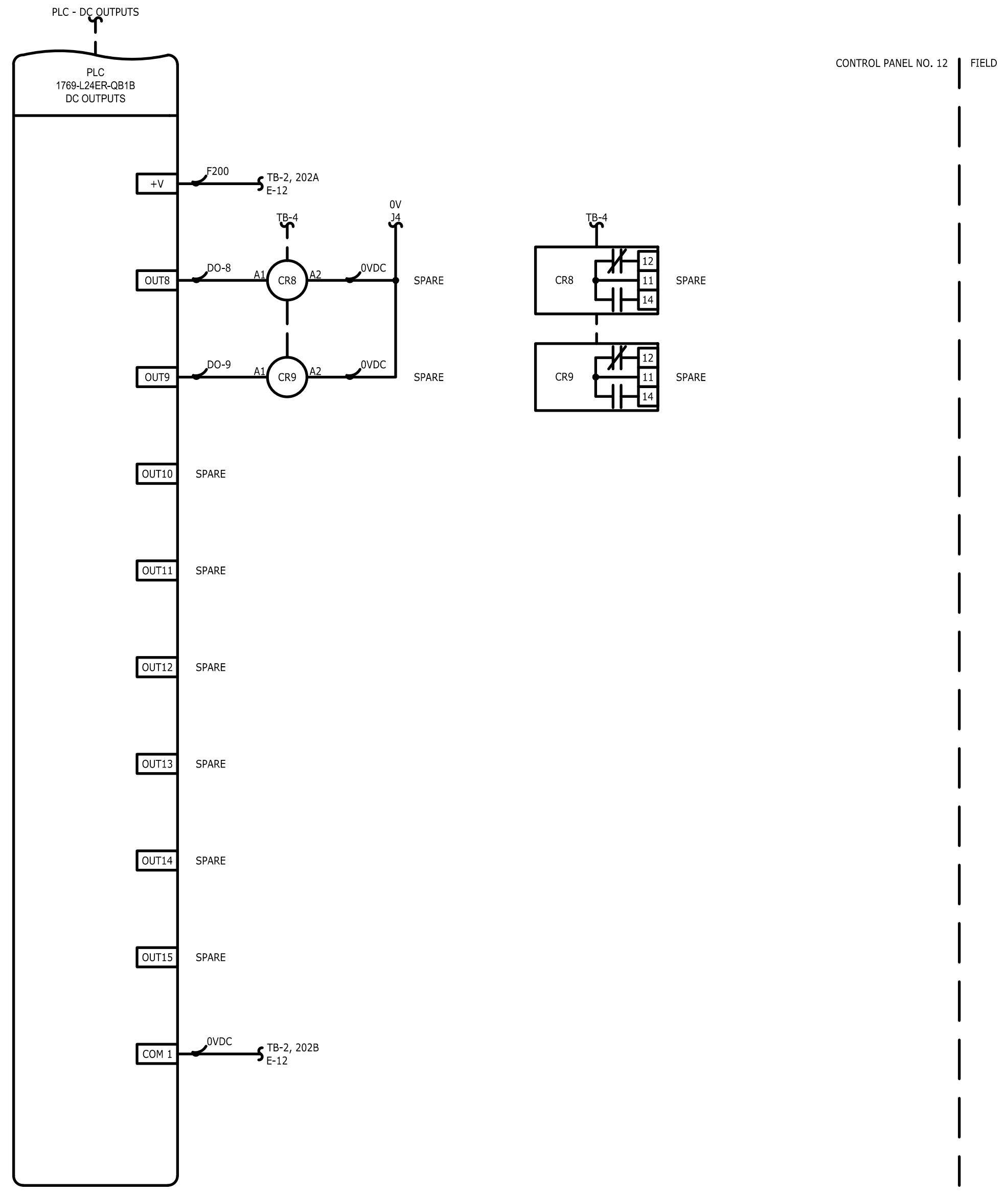
168 E-46 DETAIL
CONTROL PANEL NO. 12 PLC DIGITAL WIRING DIAGRAM I



169 E-46 DETAIL
CONTROL PANEL NO. 12 PLC DIGITAL WIRING DIAGRAM II



170 E-46 DETAIL
CONTROL PANEL NO. 12 PLC RELAY OUTPUTS WIRING DIAGRAM I



171 E-46 DETAIL
CONTROL PANEL NO. 12 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-12 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E46.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-46
APPROVED BY:	JJD		

90% DESIGN DRAWINGS

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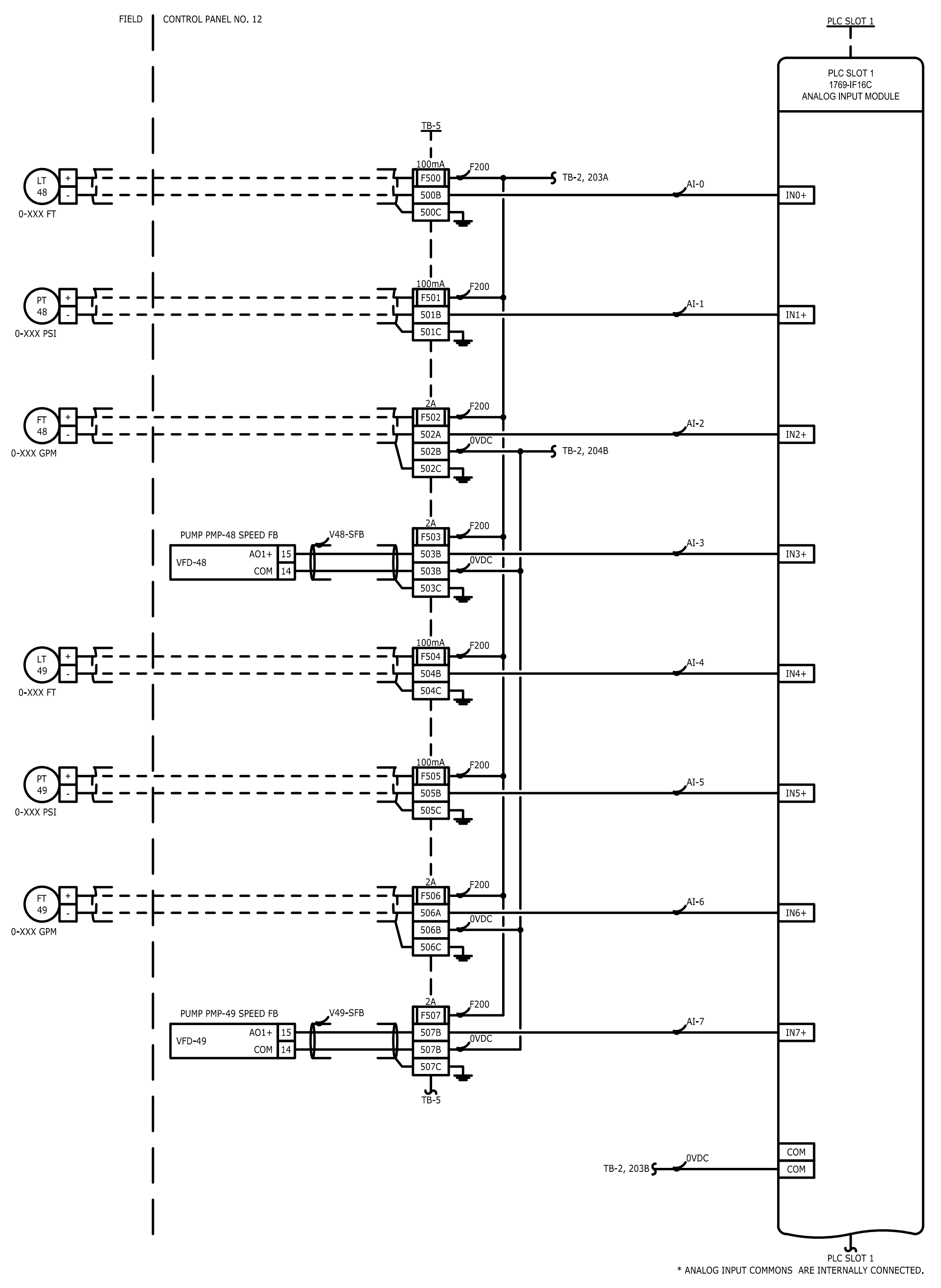
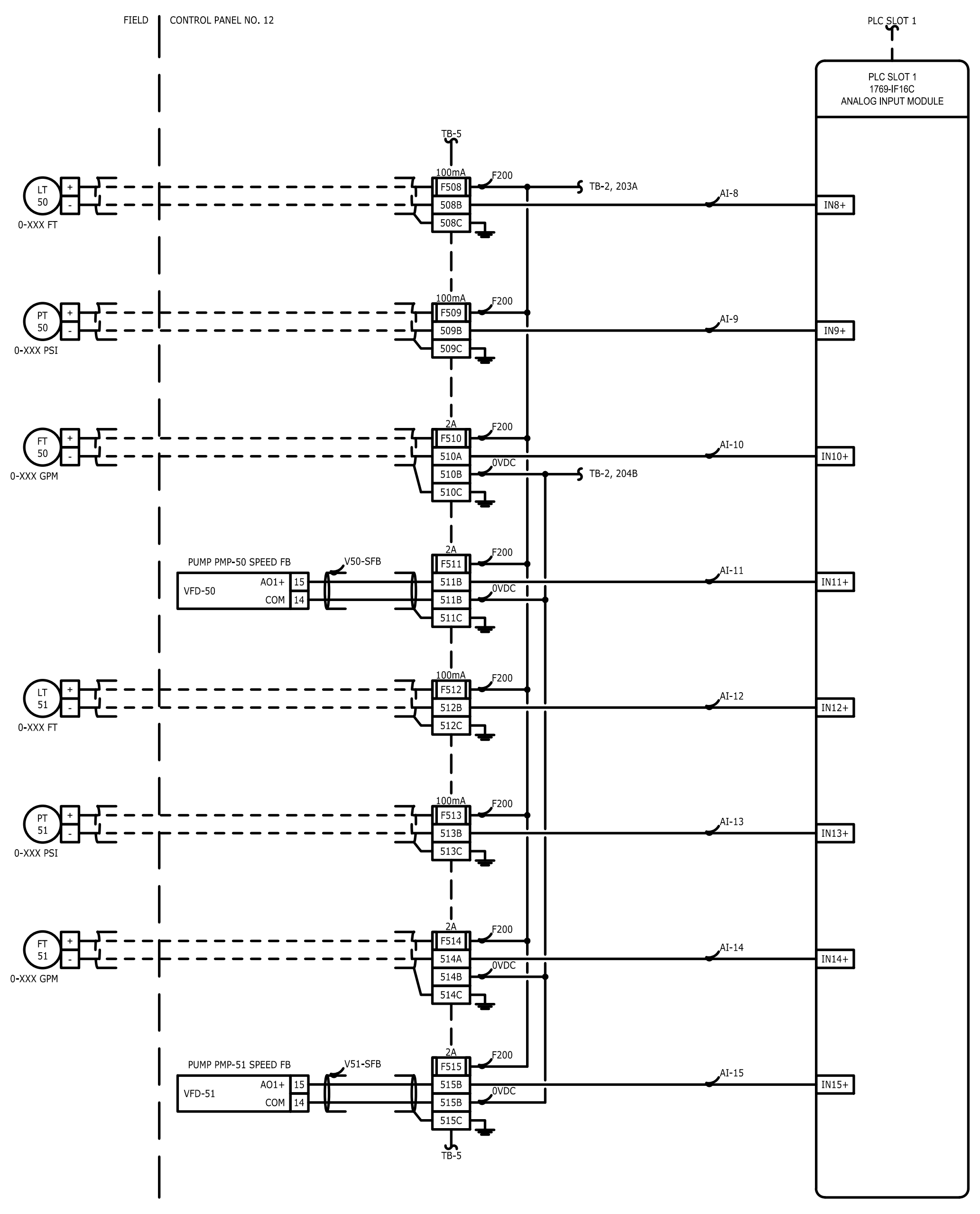


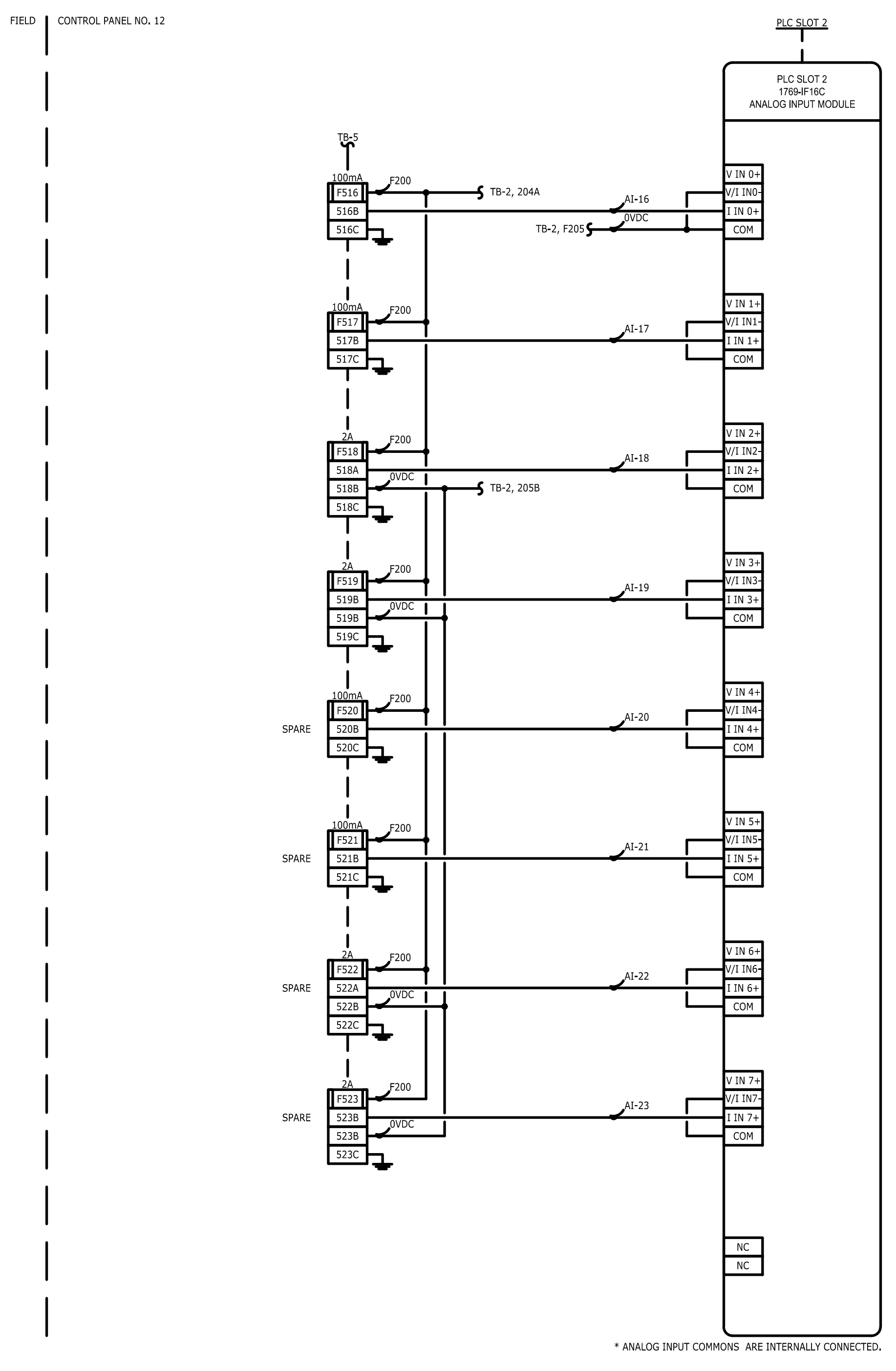
172 E-47 DETAIL

CONTROL PANEL NO. 12 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



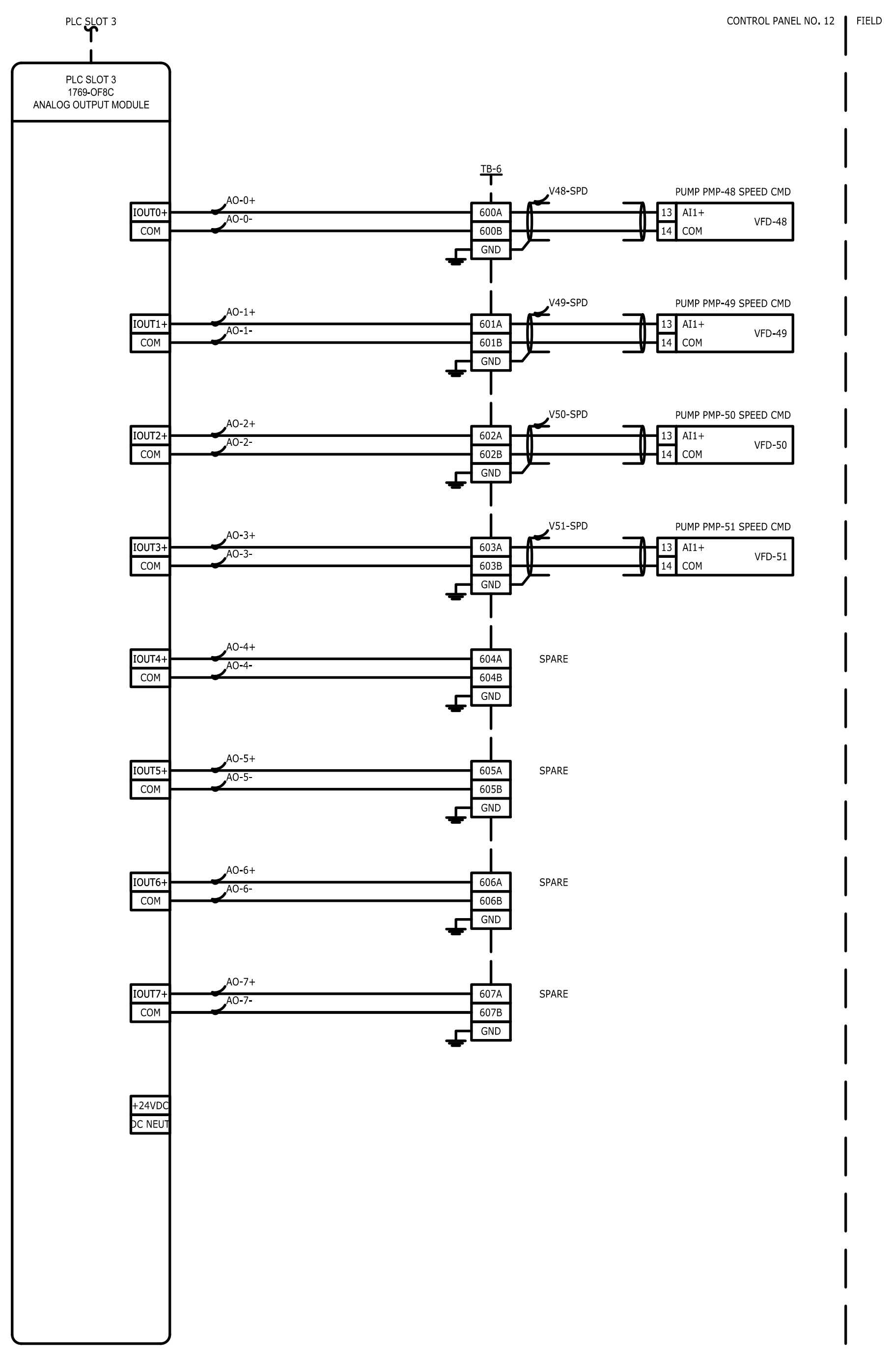
173 E-47 DETAIL

CONTROL PANEL NO. 12 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



174 E-47 DETAIL

CONTROL PANEL NO. 12 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



175 E-47 DETAIL

CONTROL PANEL NO. 12 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-12 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E47.DWG
REVIEWED BY:	SV	DRAWING NO.:	
APPROVED BY:	JJD		E-47

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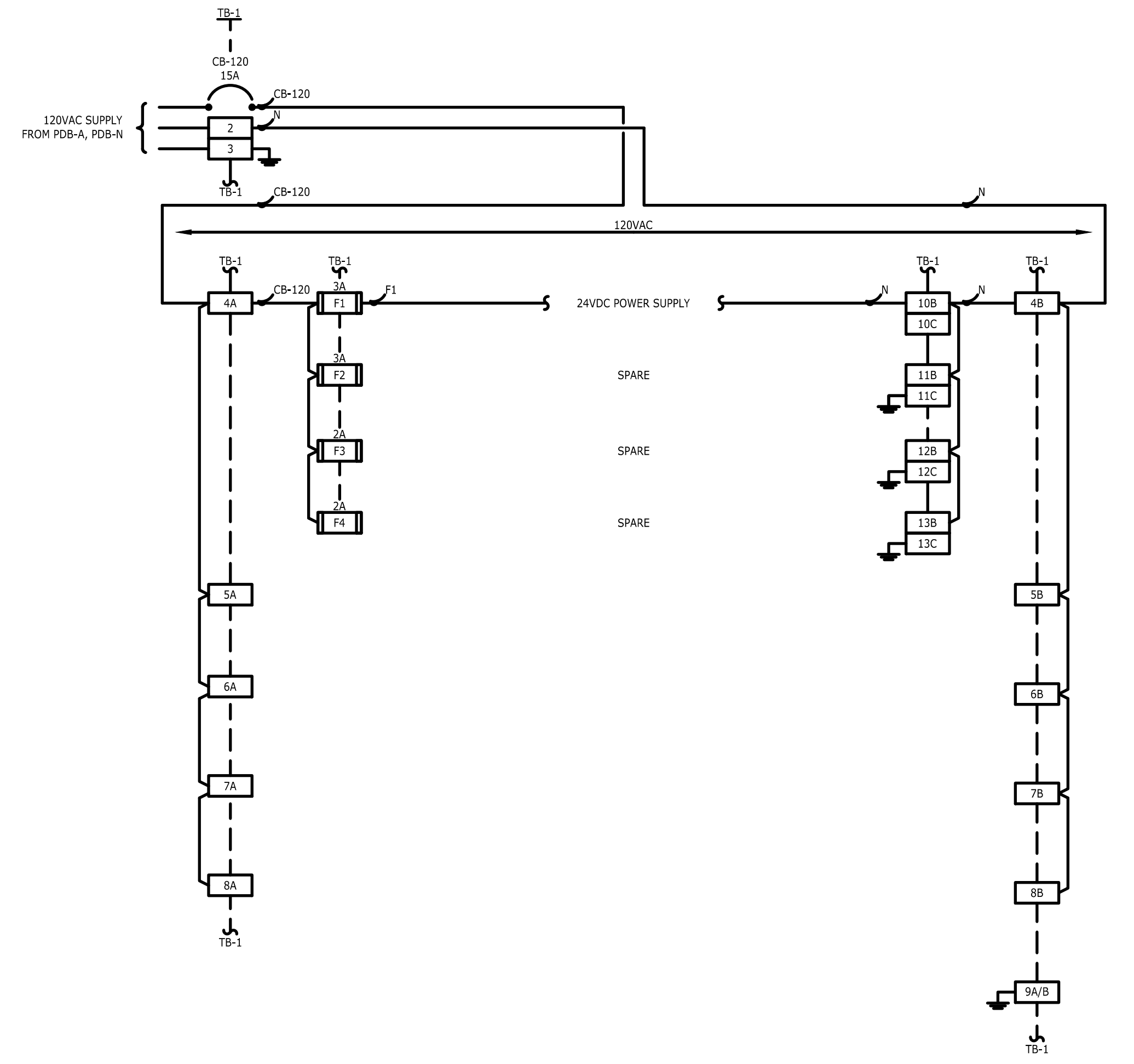
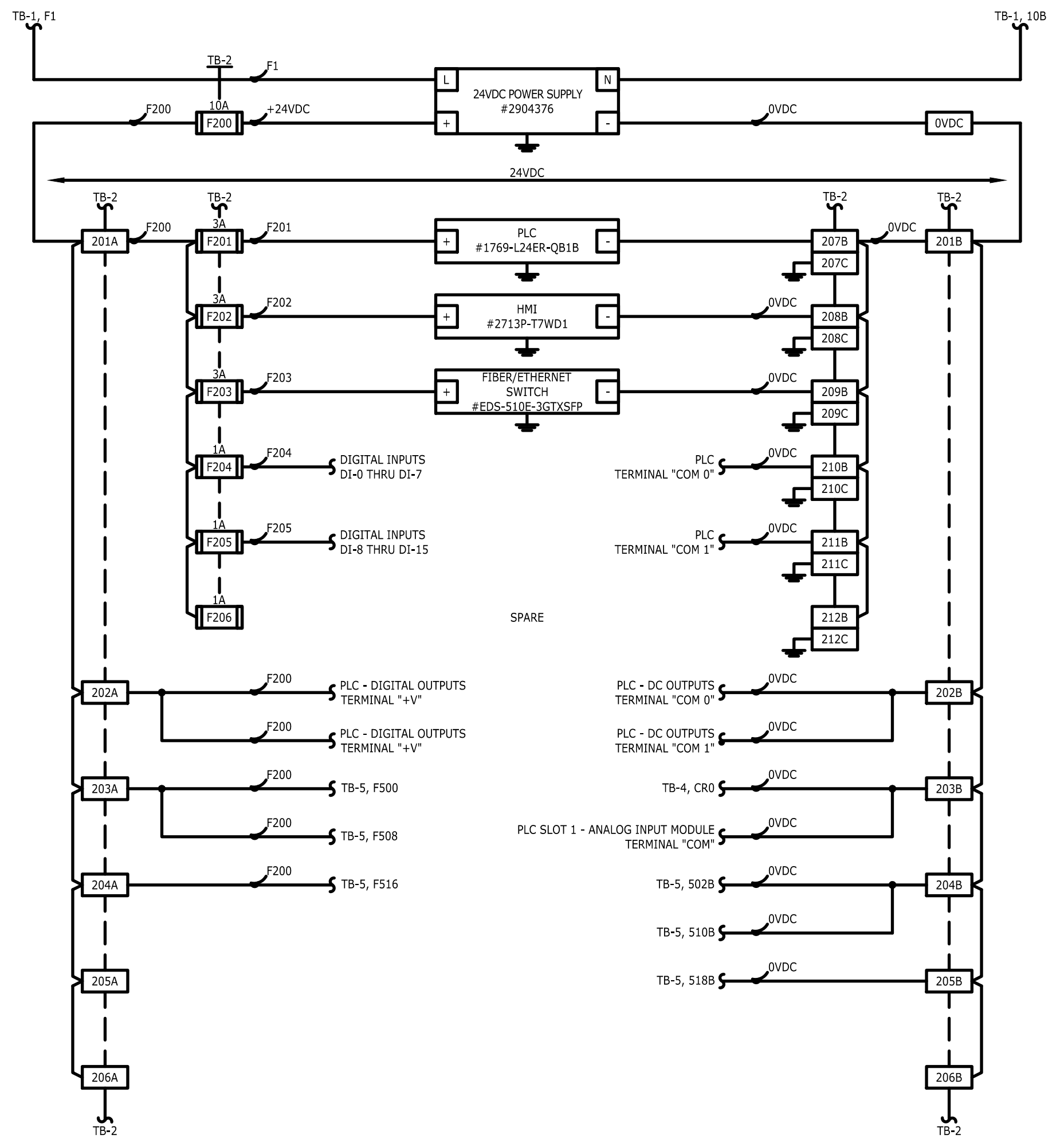
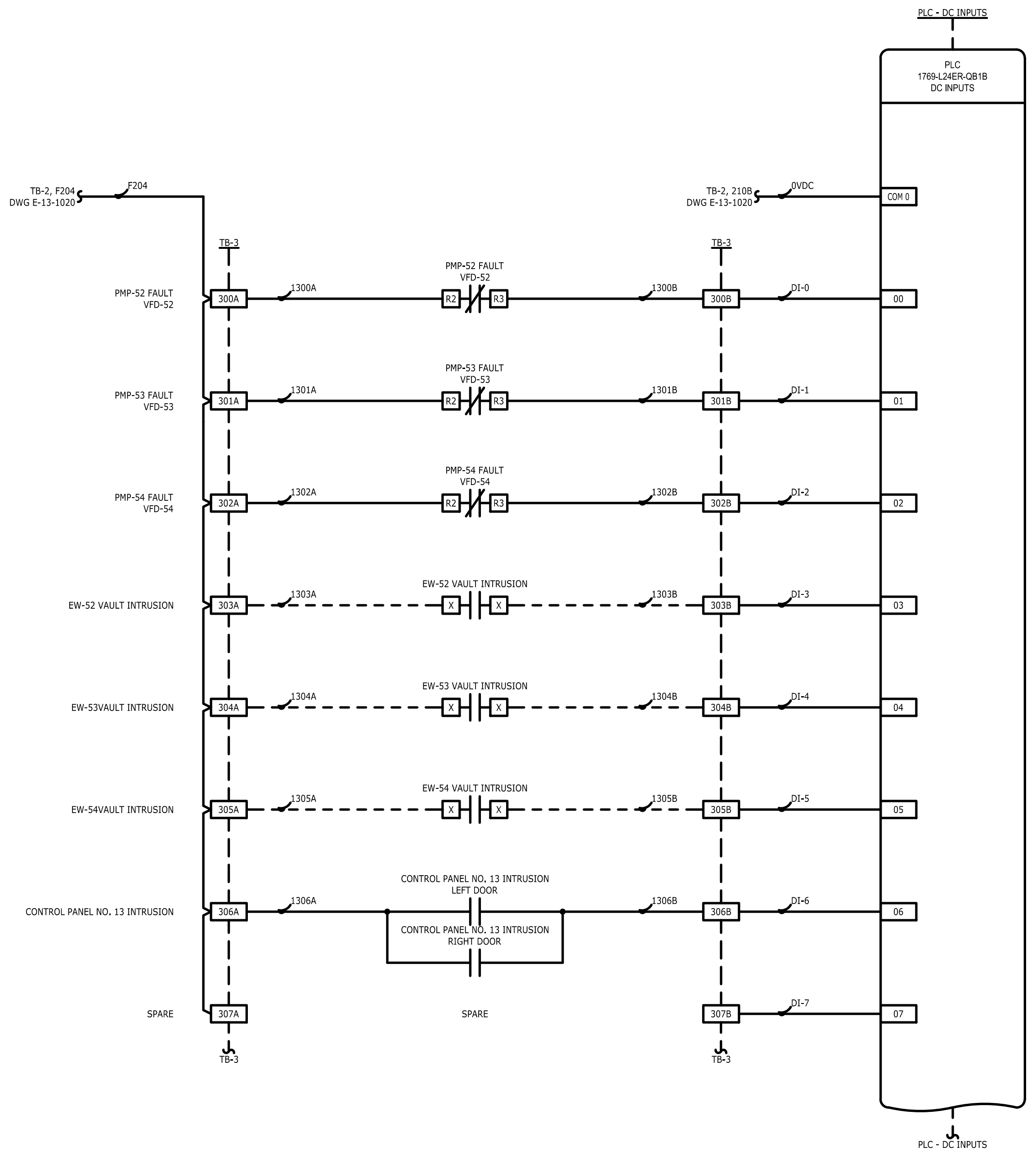


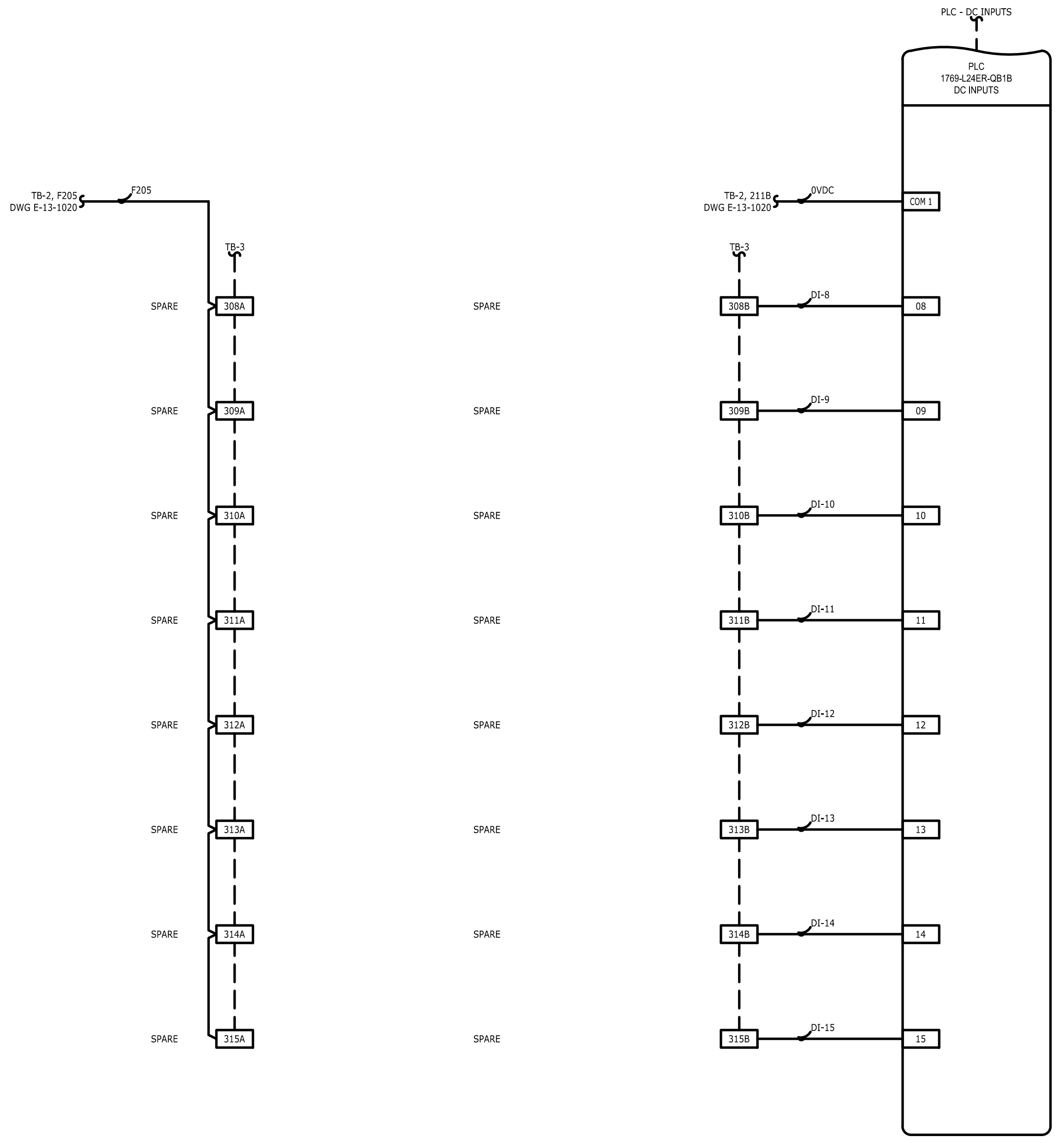
177 DETAIL
E-48
CONTROL PANEL NO. 13 120VAC POWER DISTRIBUTION



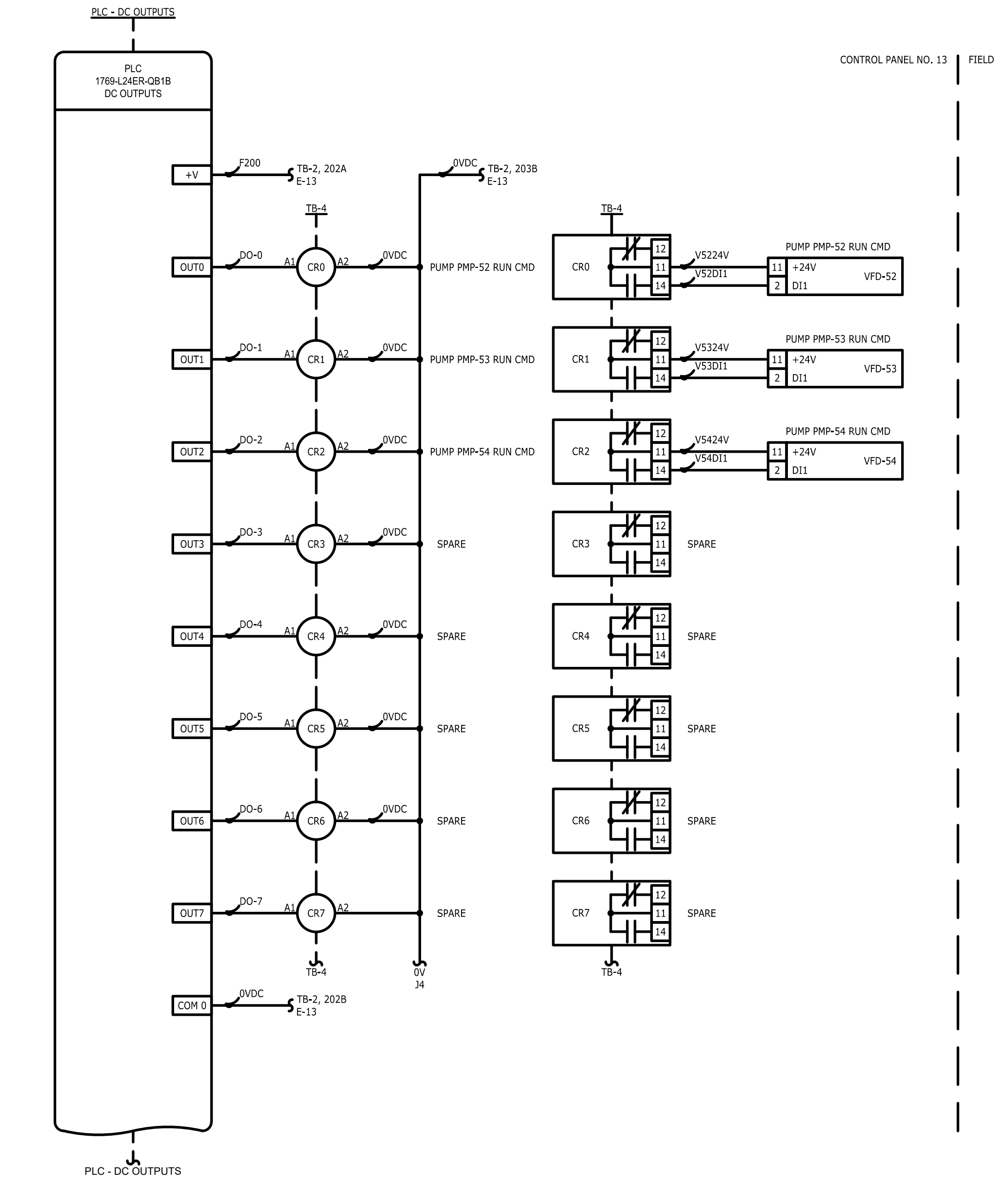
178 DETAIL
E-48
CONTROL PANEL NO. 13 24VDC POWER DISTRIBUTION



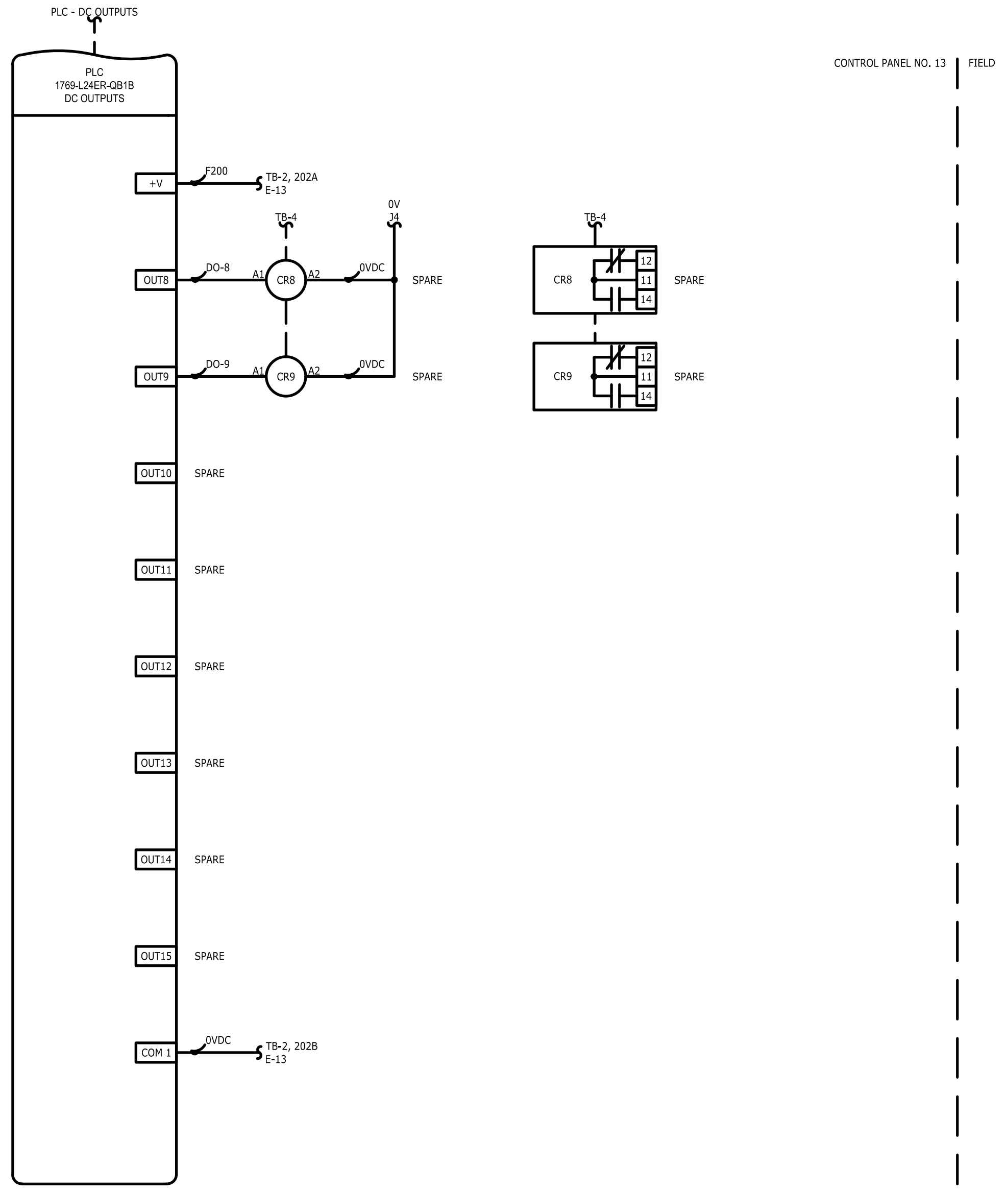
179 DETAIL
E-48
CONTROL PANEL NO. 13 PLC DIGITAL WIRING DIAGRAM I



180 DETAIL
E-48
CONTROL PANEL NO. 13 PLC DIGITAL WIRING DIAGRAM II



181 DETAIL
E-48
CONTROL PANEL NO. 13 PLC RELAY OUTPUTS WIRING DIAGRAM I



182 DETAIL
E-48
CONTROL PANEL NO. 13 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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NC License No.: C-3500 and C-295

ATRIUM AT BLUE RIDGE
2501 BLUE RIDGE ROAD, SUITE 430
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919.870.0576

TITLE:
EW-13 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E48.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-48
APPROVED BY:	JJD		

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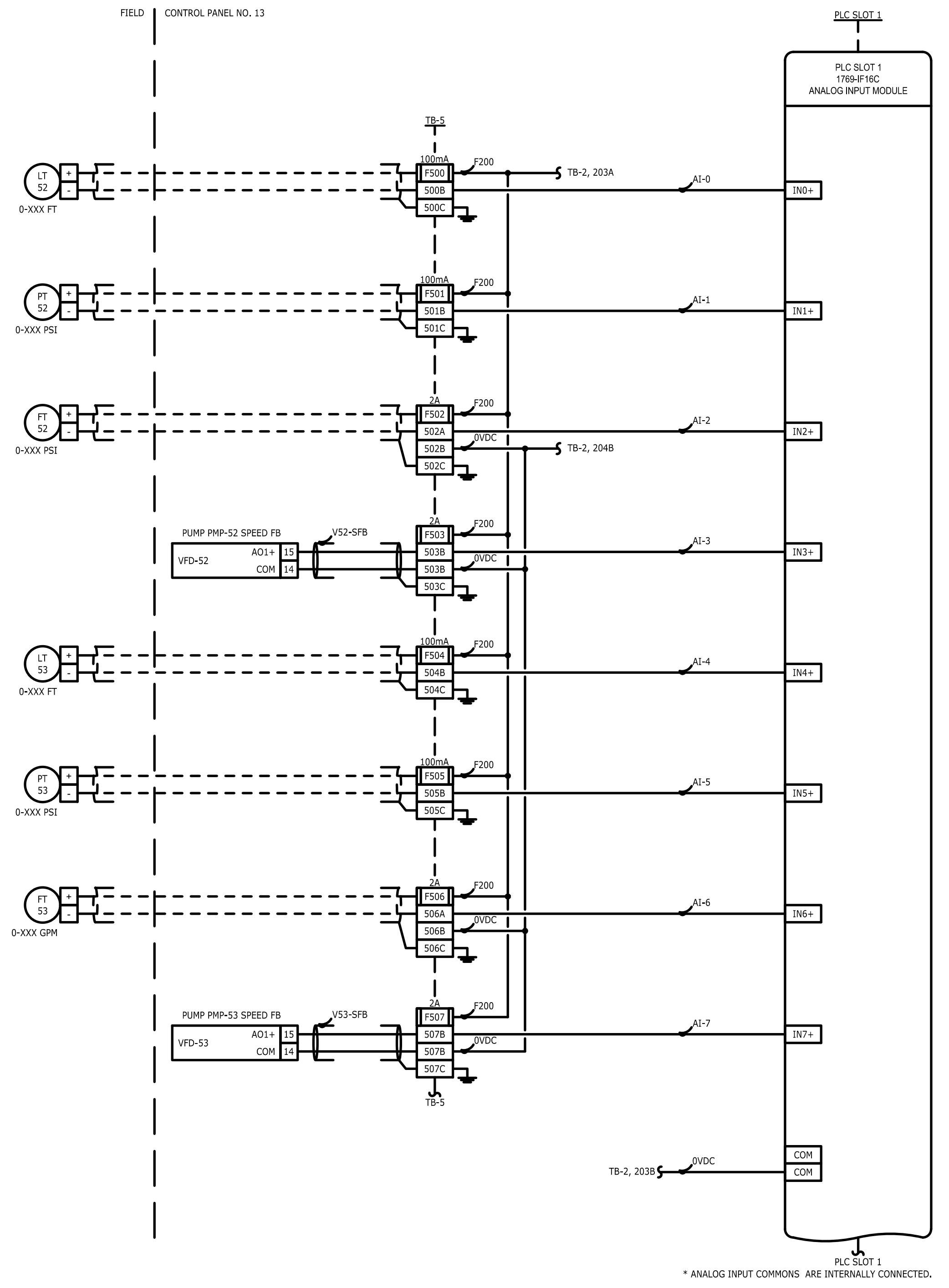
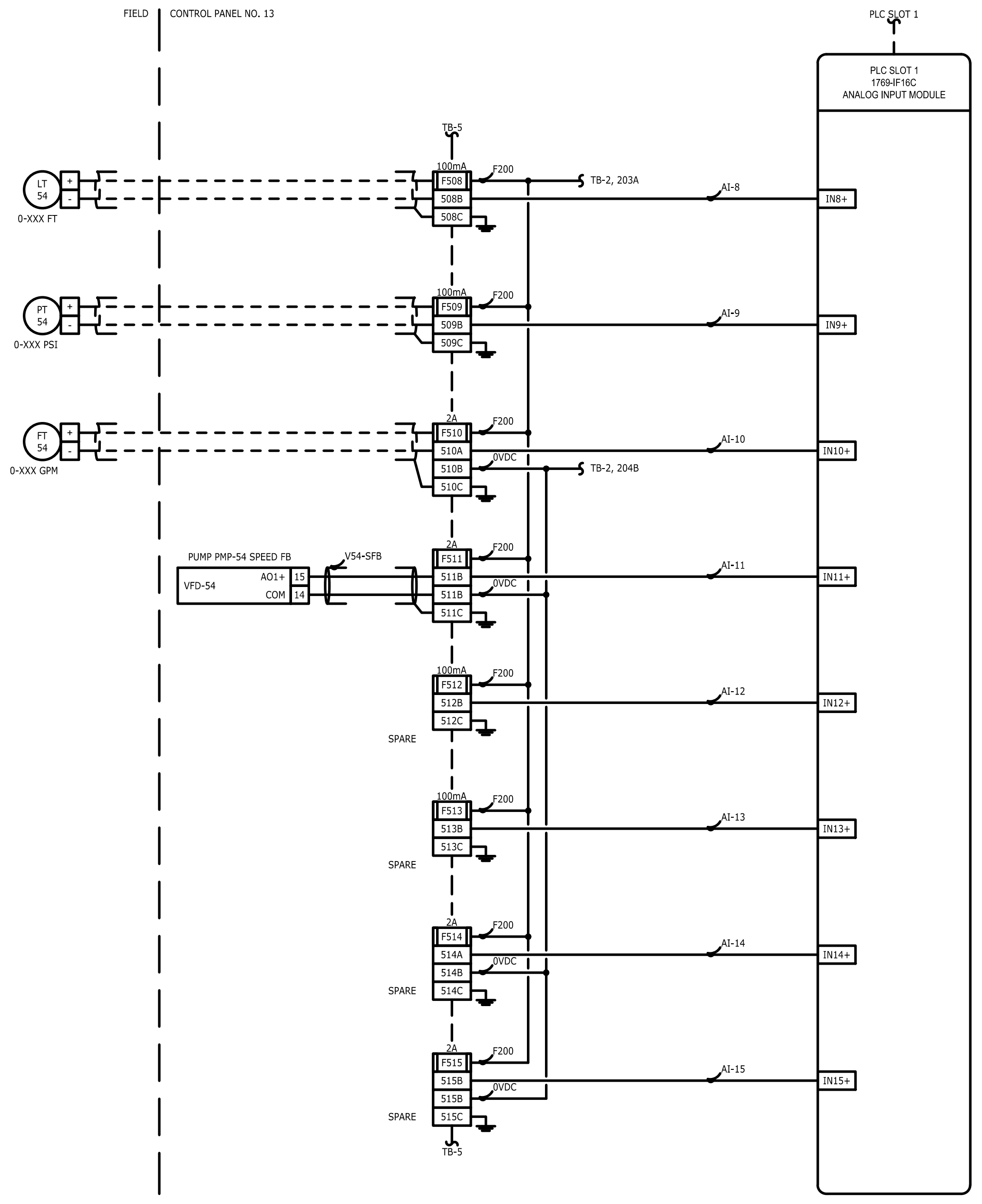
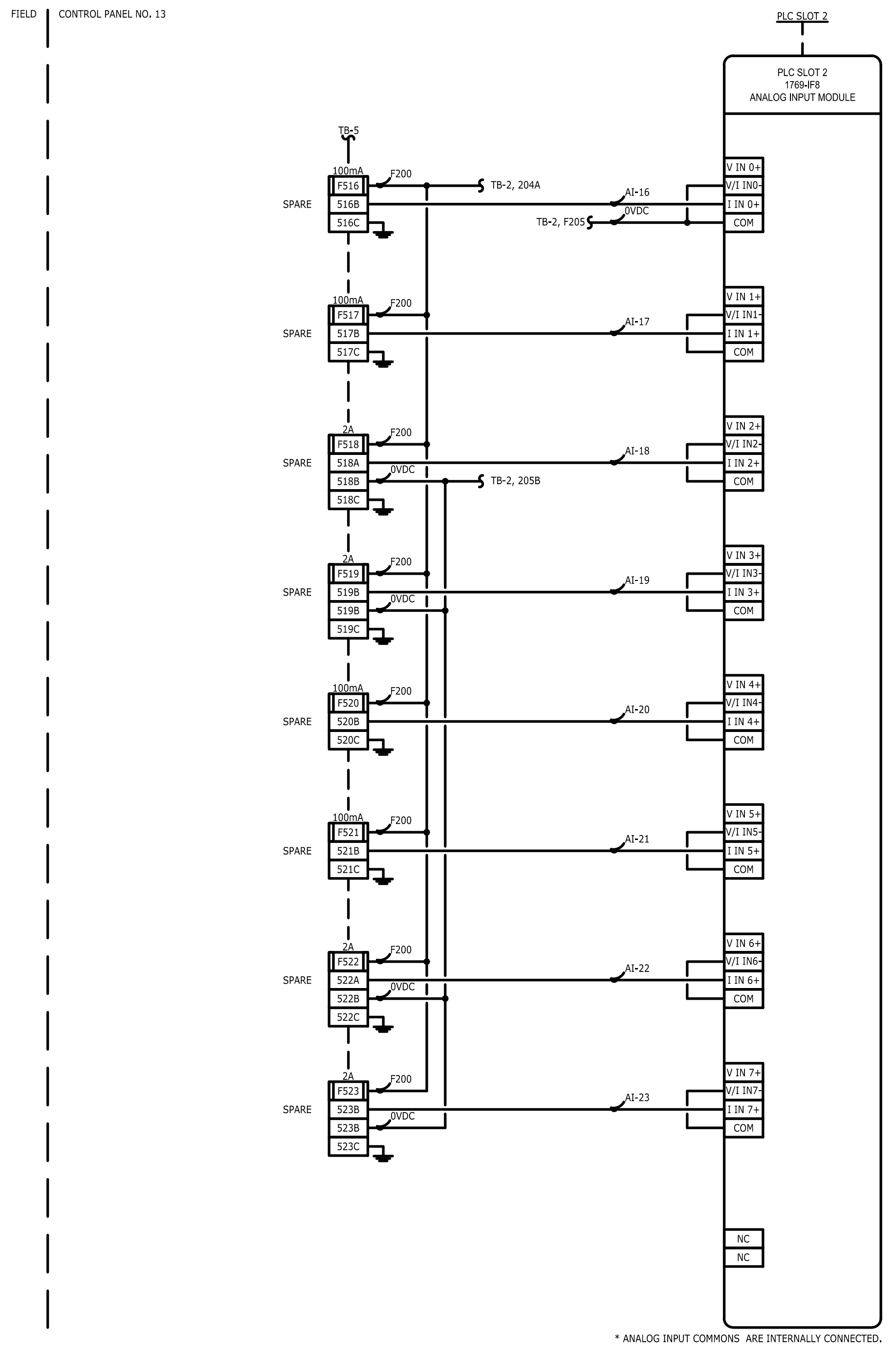


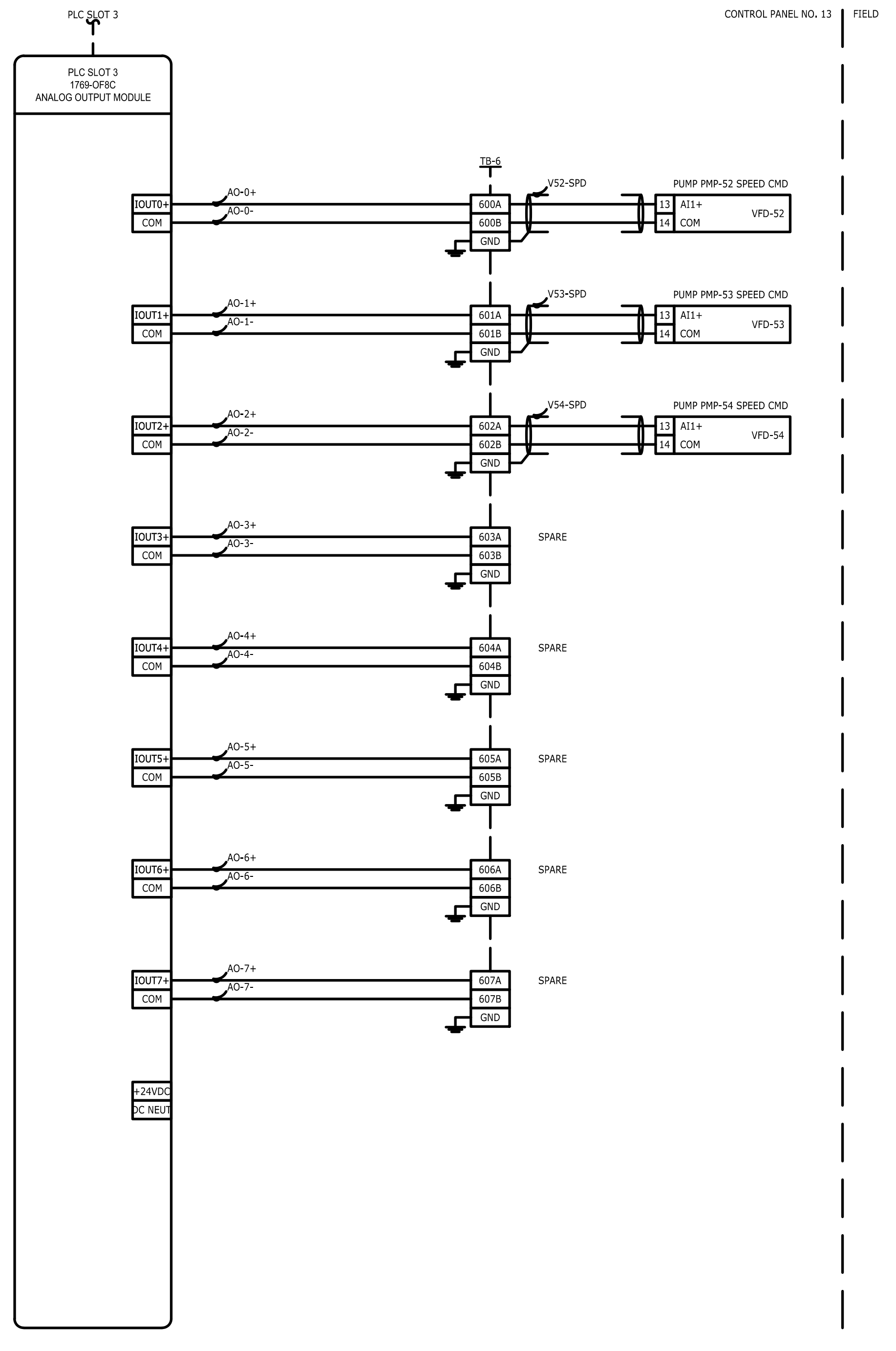
183 E-49 DETAIL
CONTROL PANEL NO. 13 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM I



184 E-49 DETAIL
CONTROL PANEL NO. 13 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM II



185 E-49 DETAIL
CONTROL PANEL NO. 13 PLC SLOT 2
ANALOG INPUT WIRING DIAGRAM



186 E-49 DETAIL
CONTROL PANEL NO. 13 PLC SLOT 3
ANALOG INPUT WIRING DIAGRAM

NOTES:

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C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE: EW-13 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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DATE

DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E49.DWG
REVIEWED BY:	SV	DRAWING NO.:	
APPROVED BY:	JJD		E-49

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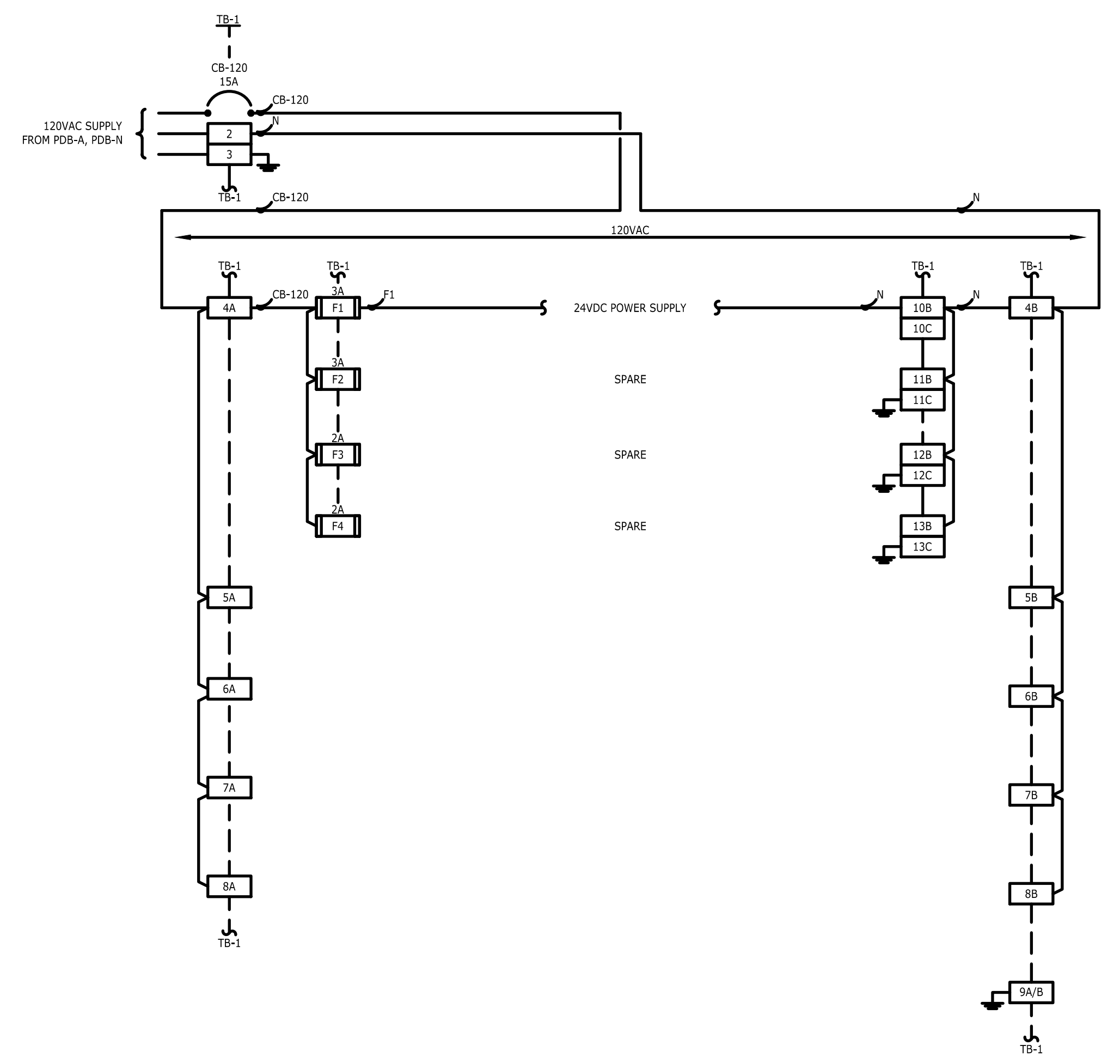
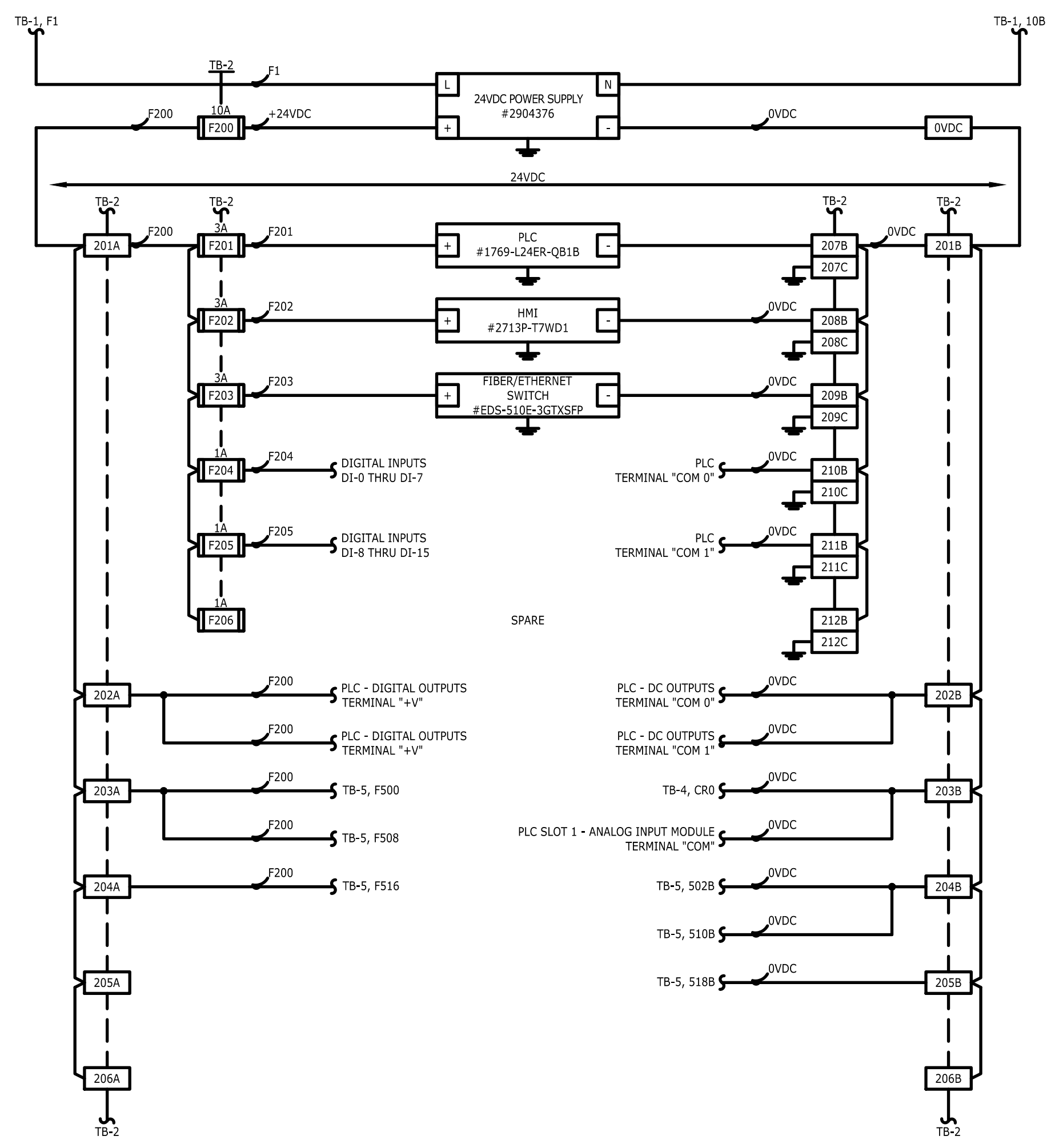
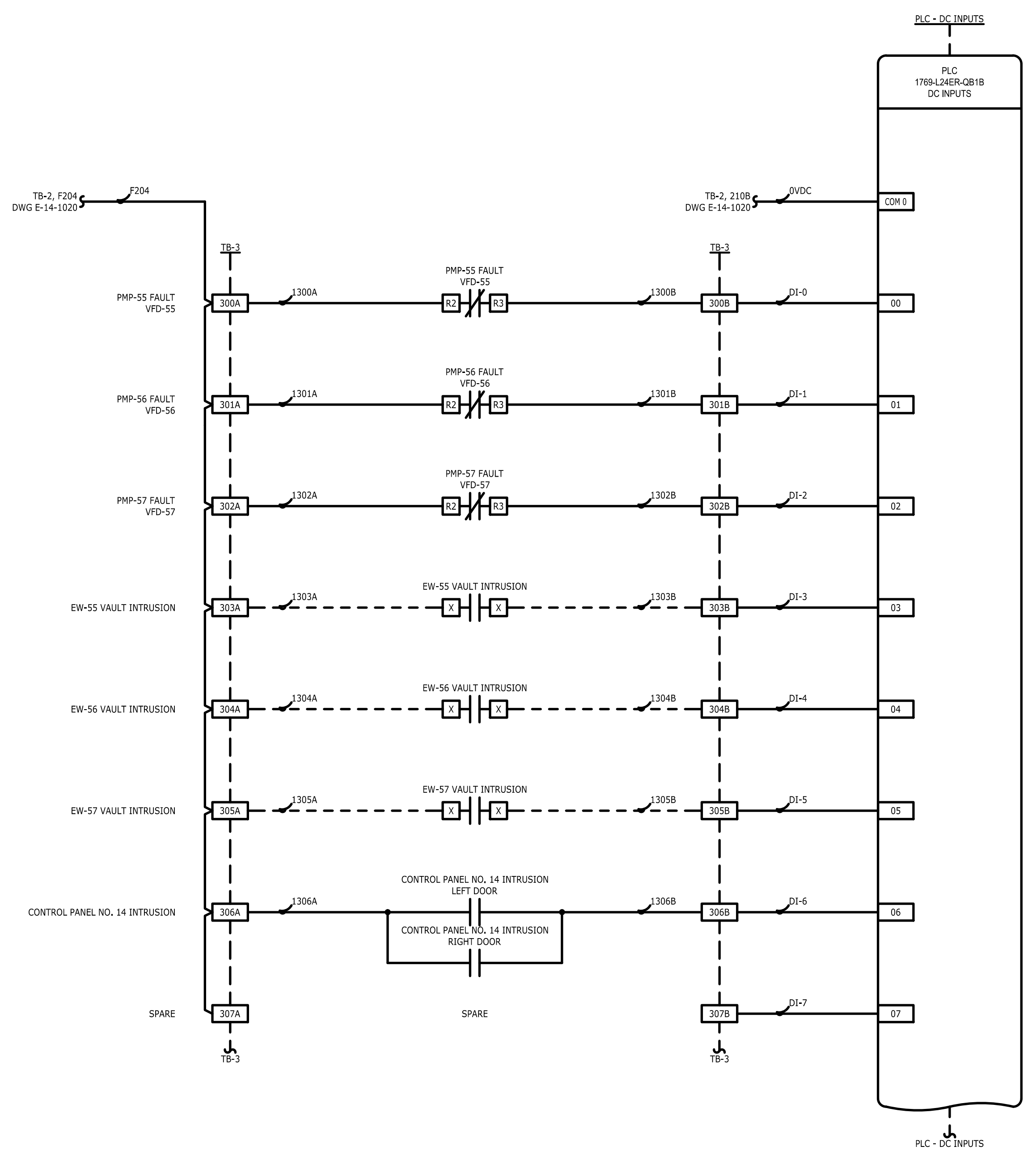


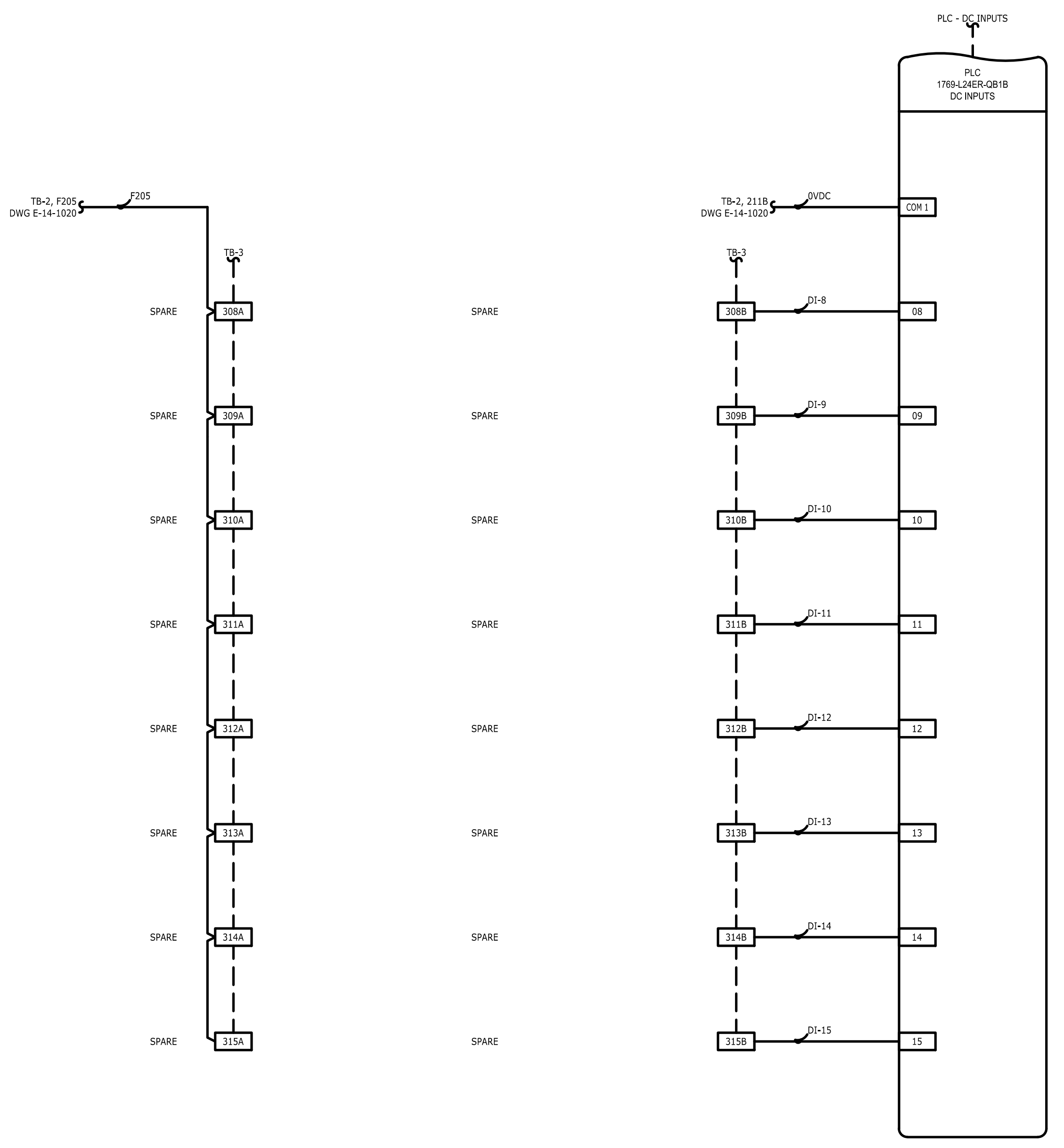
188 DETAIL
E-50 CONTROL PANEL NO. 14 120VAC POWER DISTRIBUTION



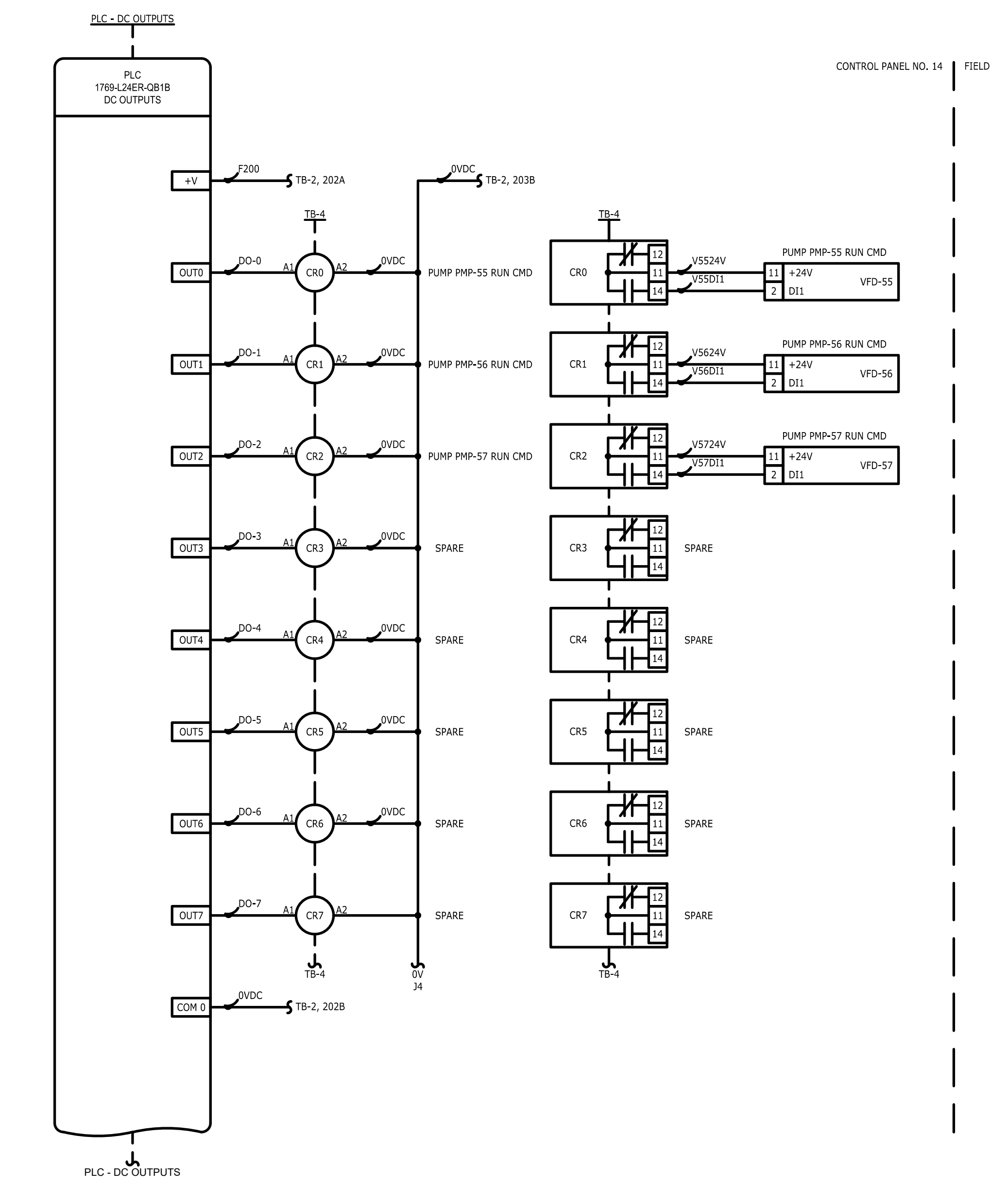
189 DETAIL
E-50 CONTROL PANEL NO. 14 24VDC POWER DISTRIBUTION



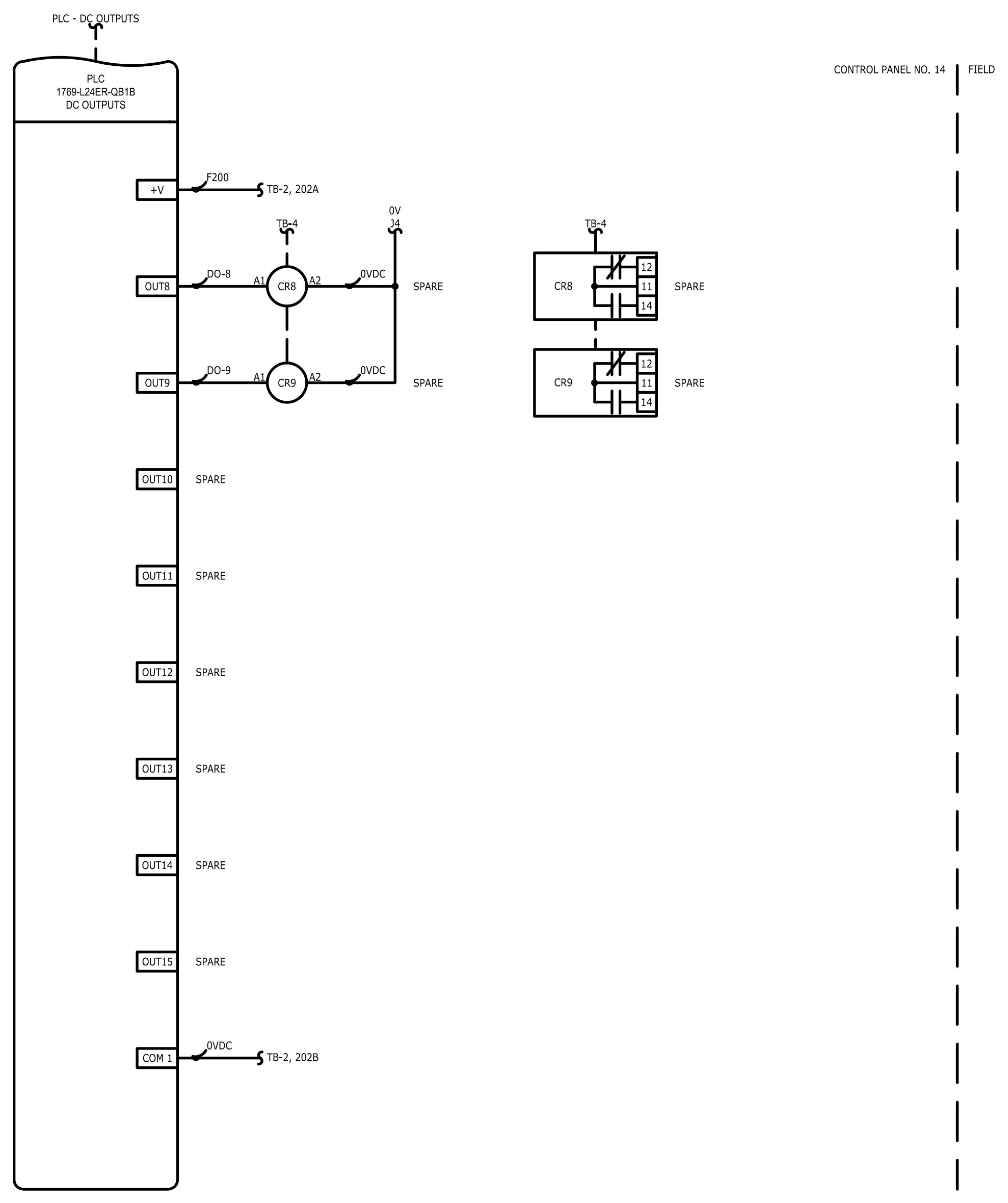
190 DETAIL
E-50 CONTROL PANEL NO. 14 PLC DIGITAL WIRING DIAGRAM I



191 DETAIL
E-50 CONTROL PANEL NO. 14 PLC DIGITAL WIRING DIAGRAM II



192 DETAIL
E-50 CONTROL PANEL NO. 14 PLC RELAY OUTPUTS WIRING DIAGRAM I



193 DETAIL
E-50 CONTROL PANEL NO. 14 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

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REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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RALEIGH, NC 27607
919.870.0576

TITLE:
EW-14 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E50.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-50
APPROVED BY:	JJD		

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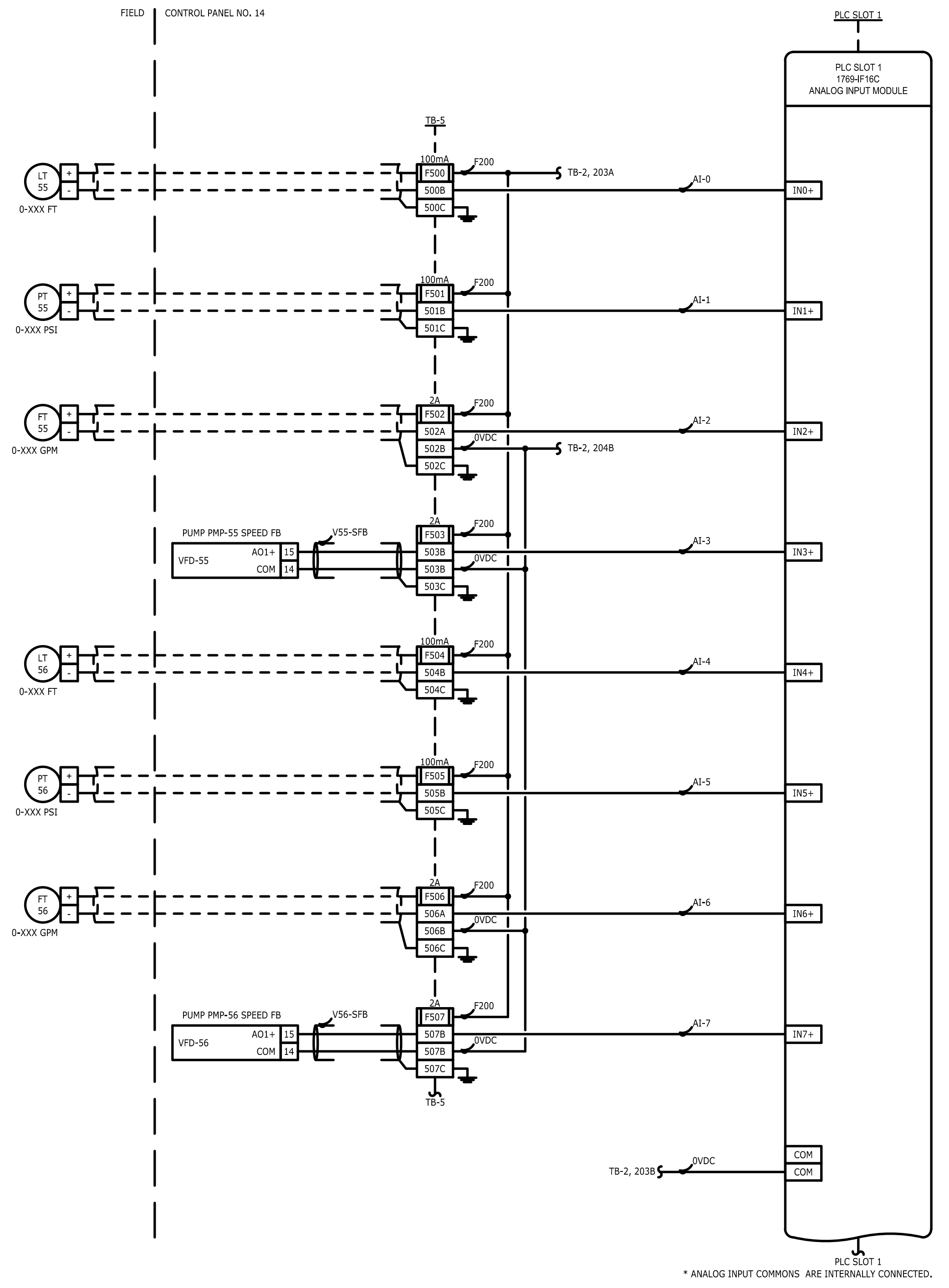
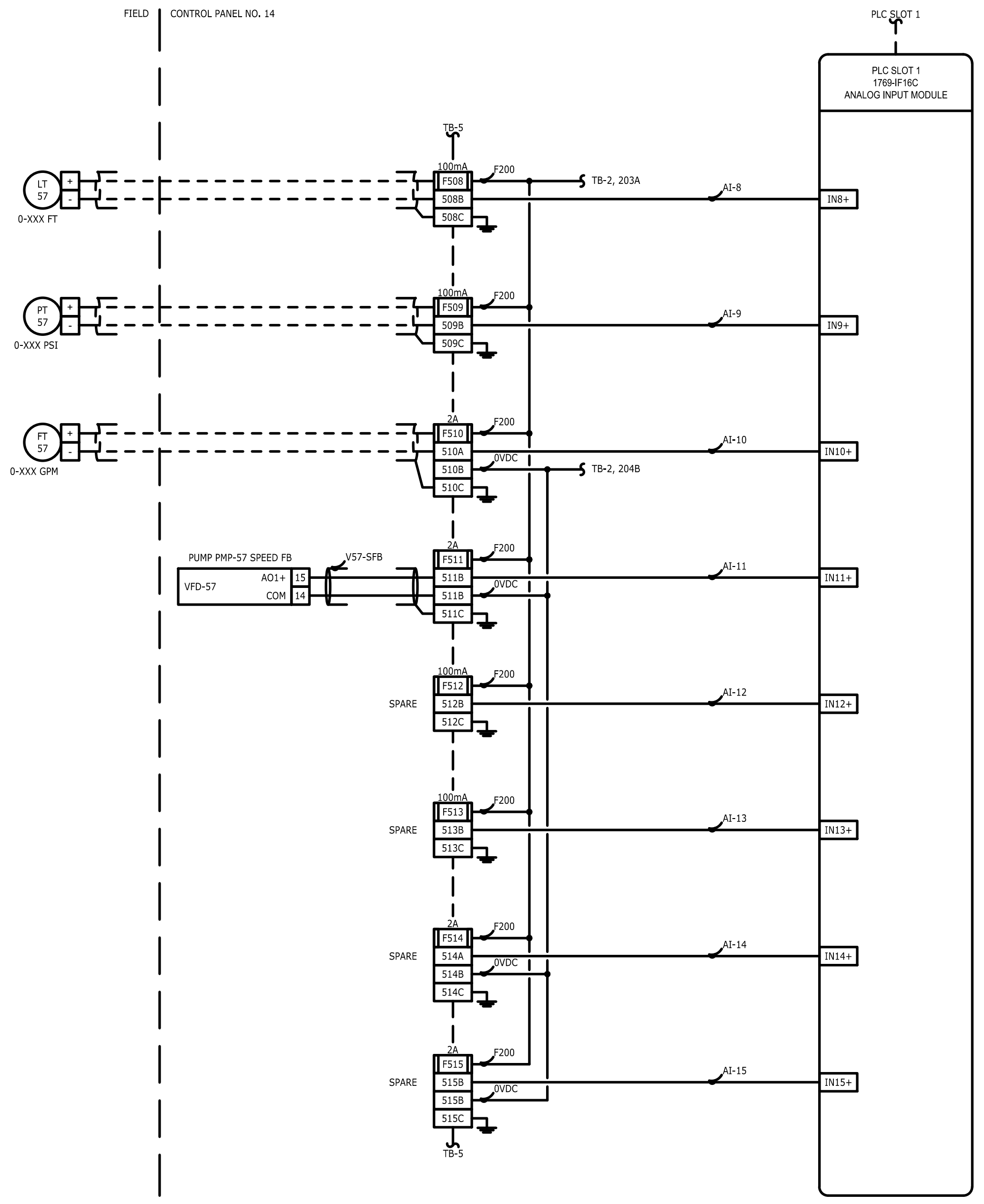
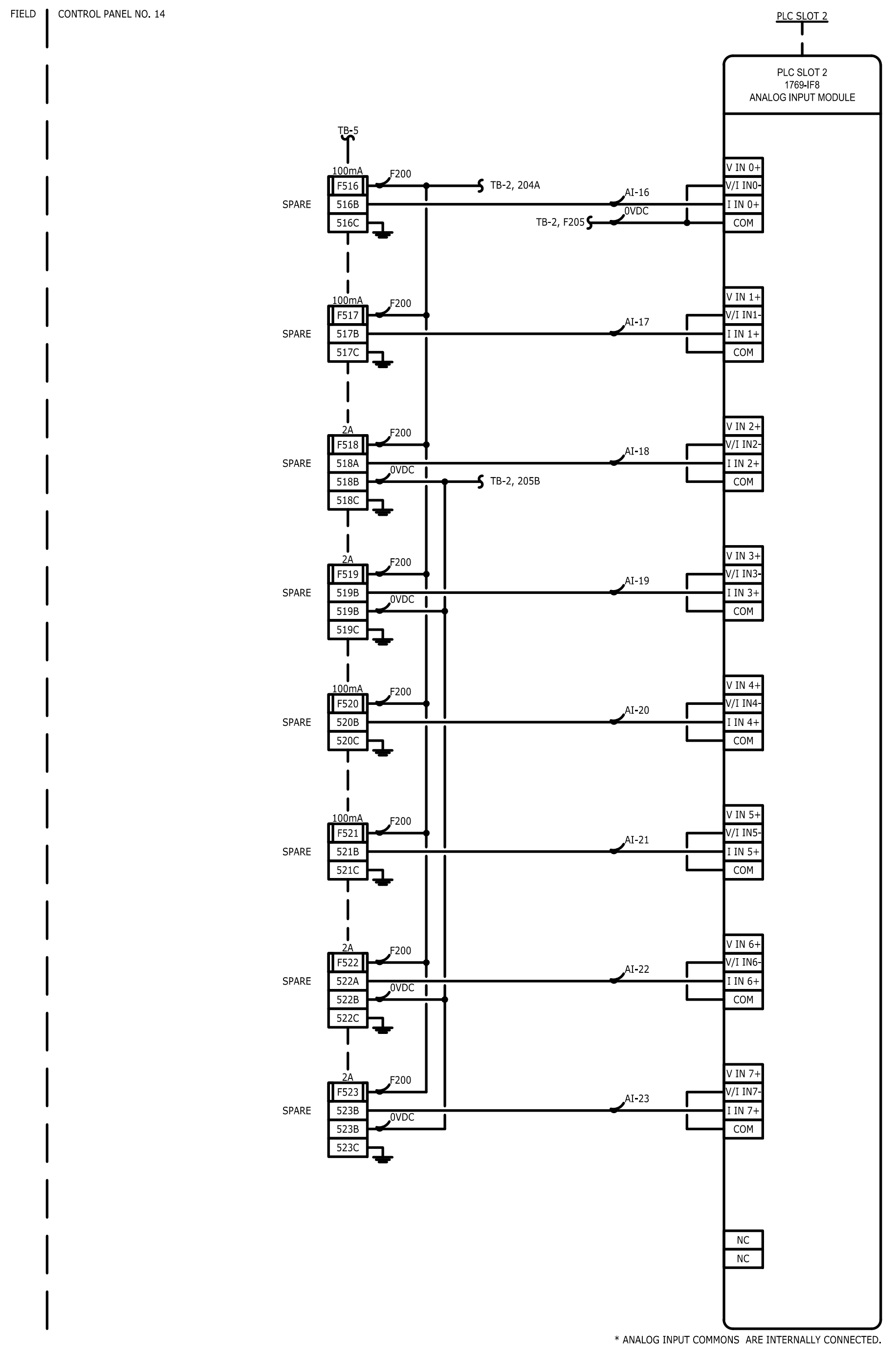


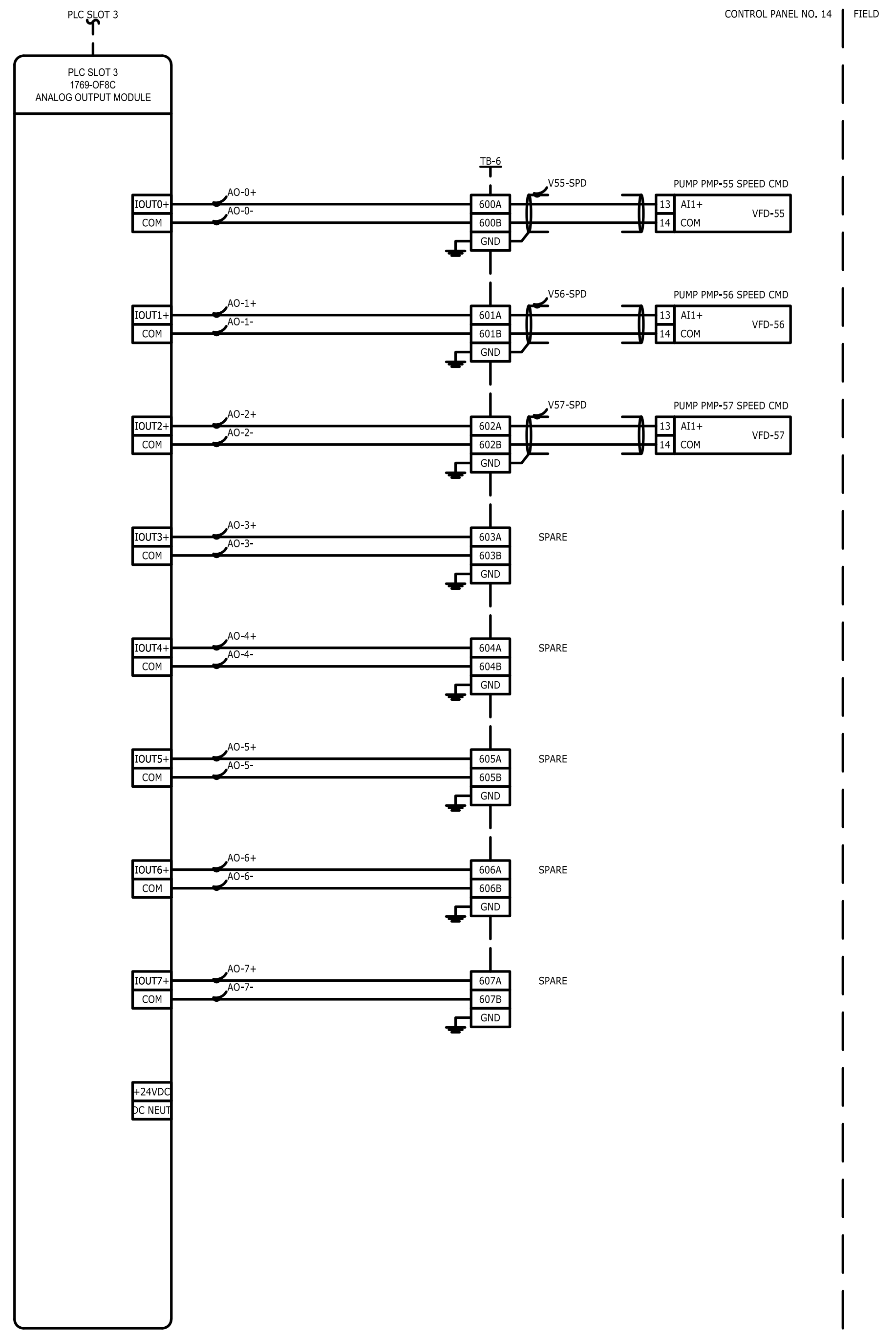
194
E-51
DETAIL
CONTROL PANEL NO. 14 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM I



195
E-51
DETAIL
CONTROL PANEL NO. 14 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM II



196
E-51
DETAIL
CONTROL PANEL NO. 14 PLC SLOT 2
ANALOG INPUT WIRING DIAGRAM



197
E-51
DETAIL
CONTROL PANEL NO. 14 PLC SLOT
3 ANALOG INPUT WIRING DIAGRAM

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

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B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-14 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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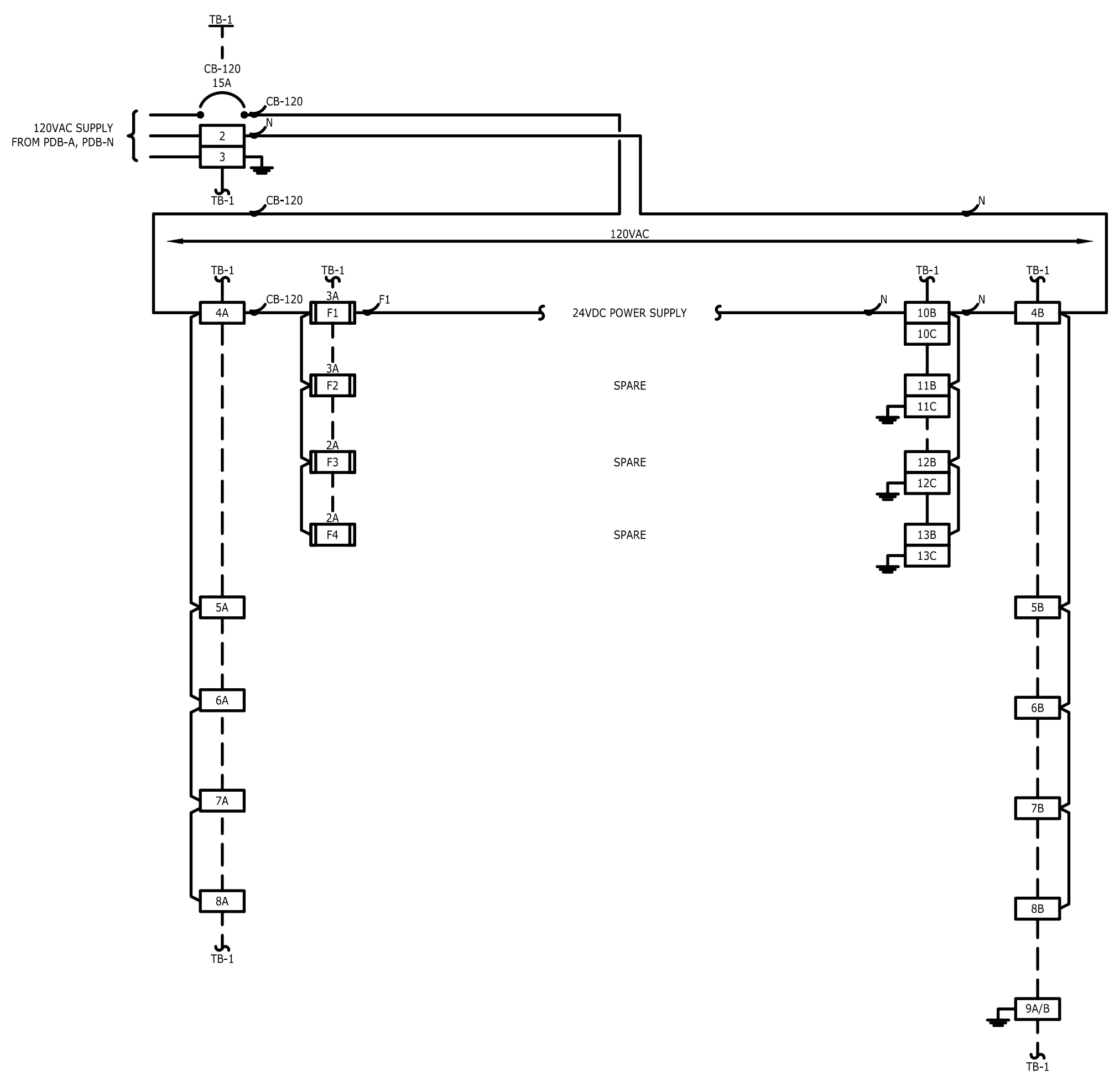
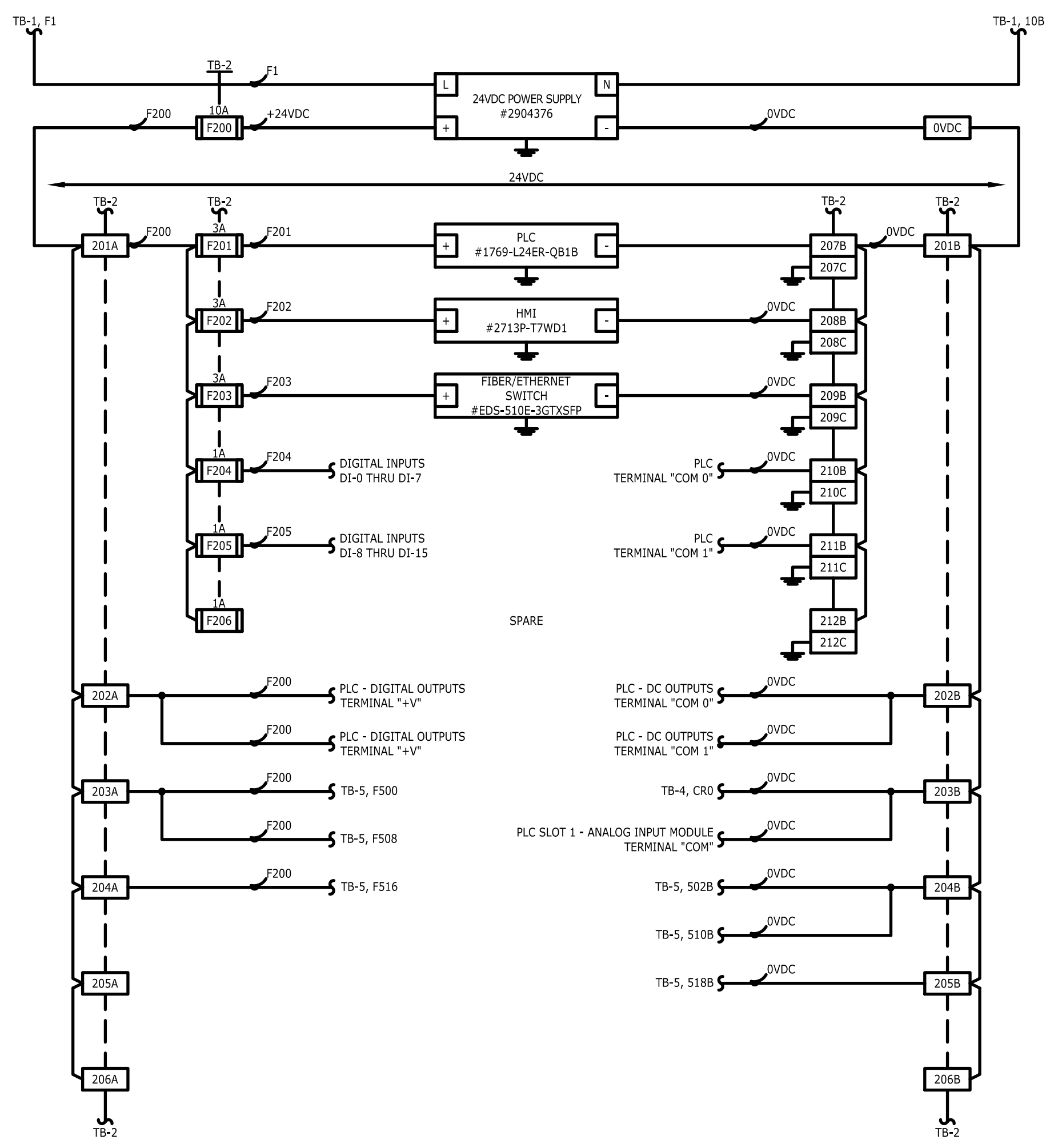
DATE

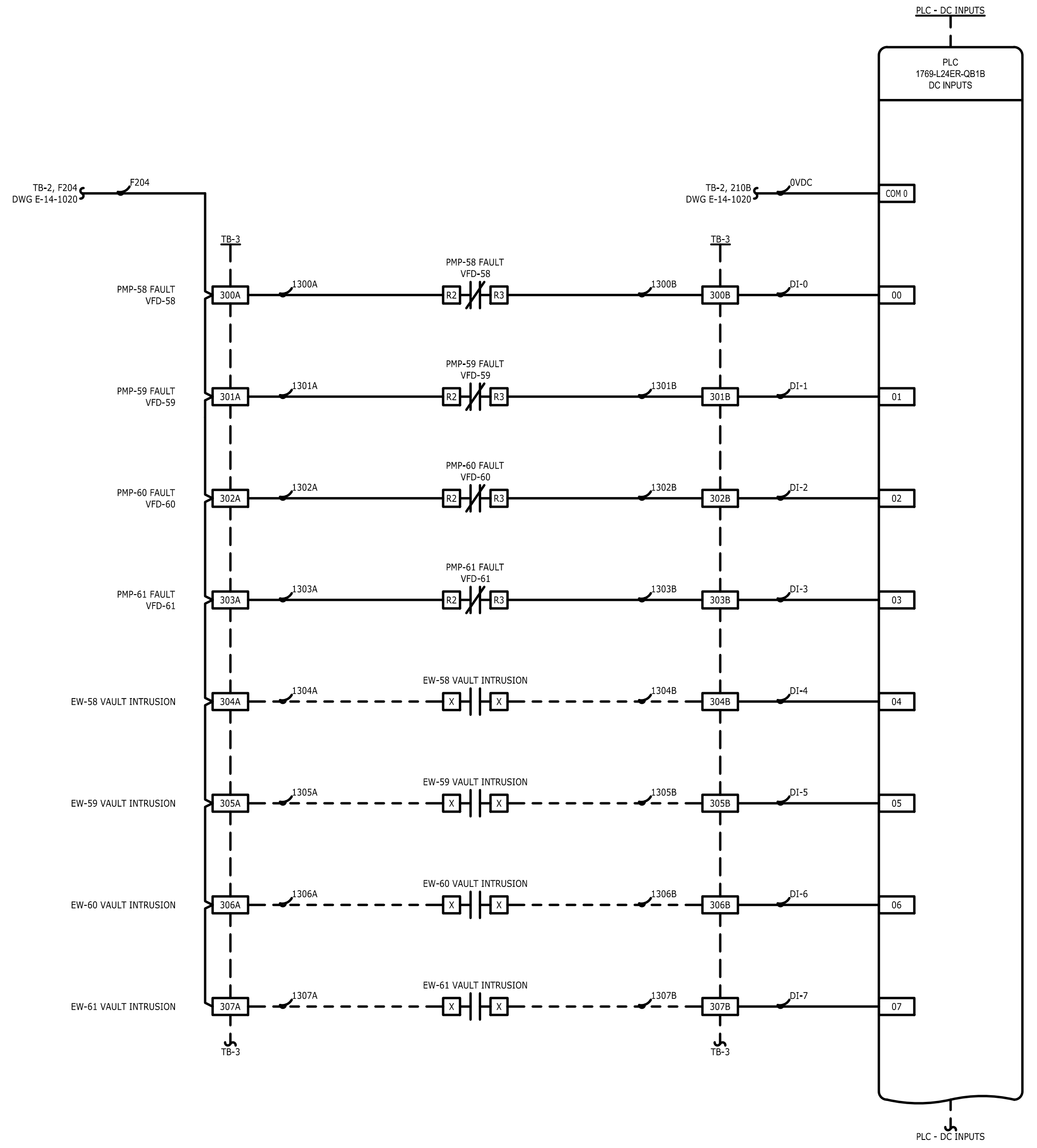
DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E51.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-51
APPROVED BY:	JJD		



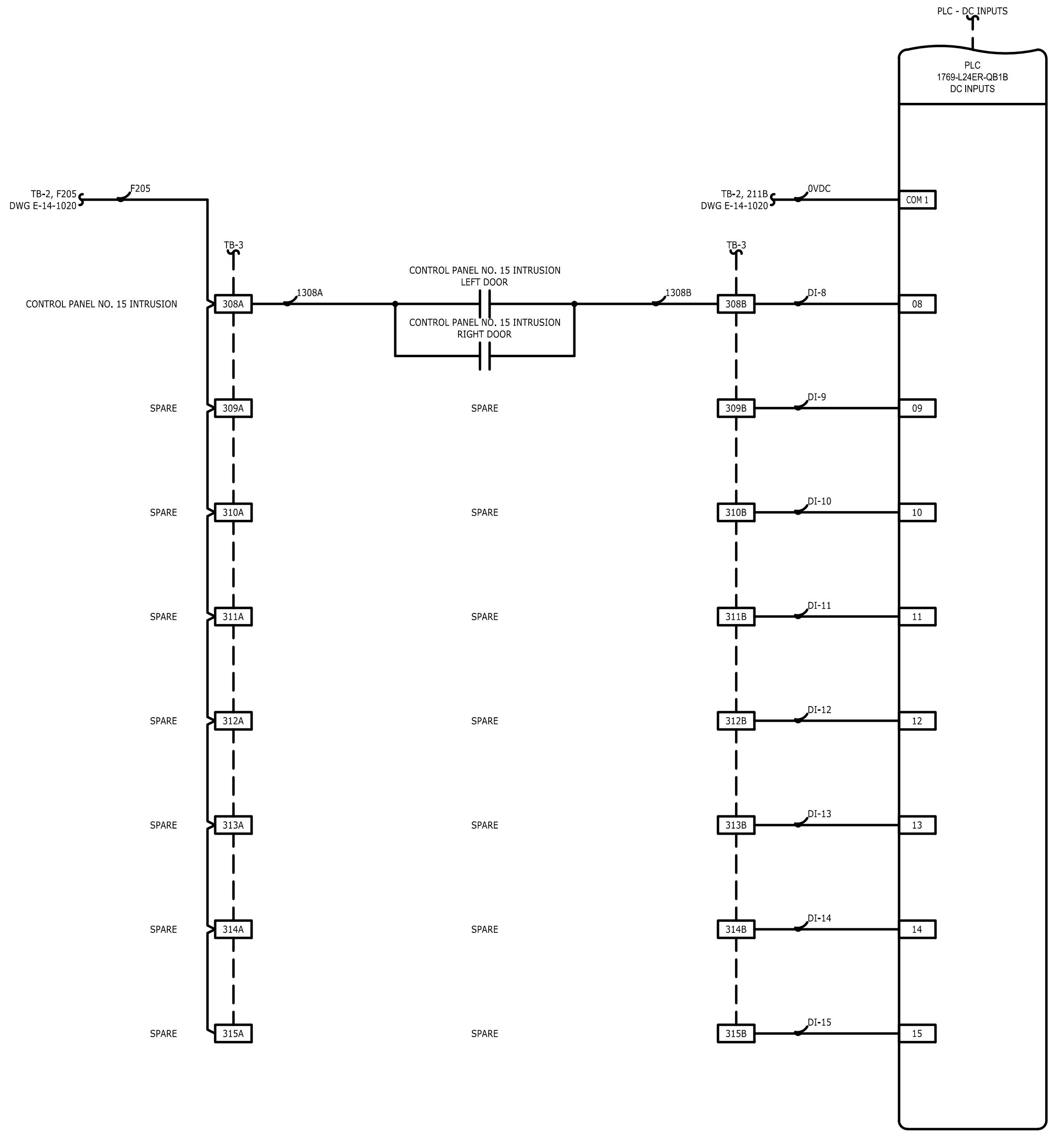
199 DETAIL
E-52 CONTROL PANEL NO. 15 120VAC POWER DISTRIBUTION



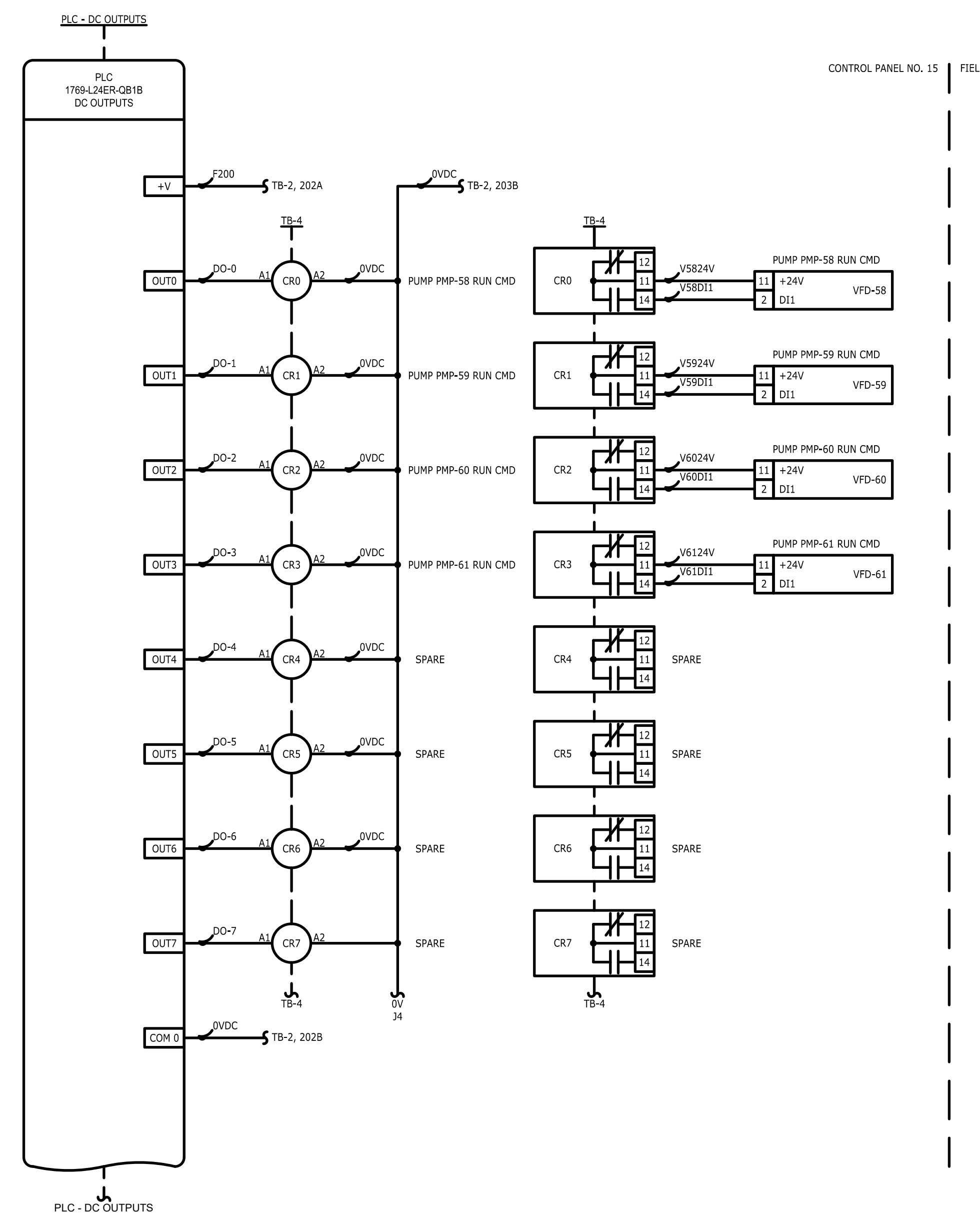
200 DETAIL
E-52 CONTROL PANEL NO. 15 24VDC POWER DISTRIBUTION



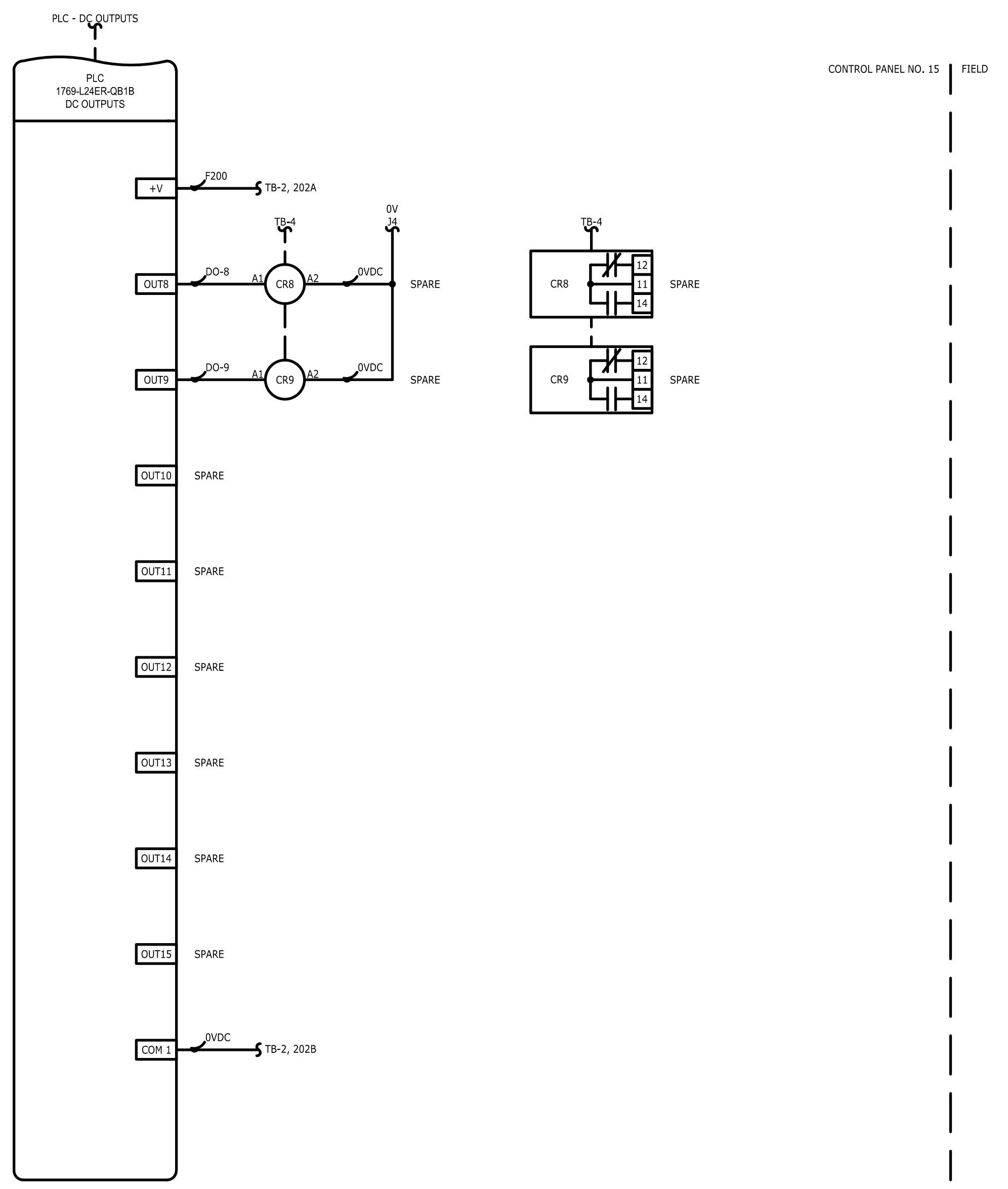
201 DETAIL
E-52 CONTROL PANEL NO. 15 PLC DIGITAL WIRING DIAGRAM I



202 DETAIL
E-52 CONTROL PANEL NO. 15 PLC DIGITAL WIRING DIAGRAM II



203 DETAIL
E-52 CONTROL PANEL NO. 15 PLC RELAY OUTPUTS WIRING DIAGRAM I



204 DETAIL
E-52 CONTROL PANEL NO. 15 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

1. DESIGN PROVIDED HEREIN IS SUBJECT TO CHANGE IN FUTURE SUBMITTALS.

REV	DATE	DESCRIPTION	DRN	APP
C	12.20.21	90% DESIGN SUBMITTAL	JFH	JJD
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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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2501 BLUE RIDGE ROAD, SUITE 430
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919.870.0576

TITLE:
EW-15 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	E-52
APPROVED BY:	JJD		

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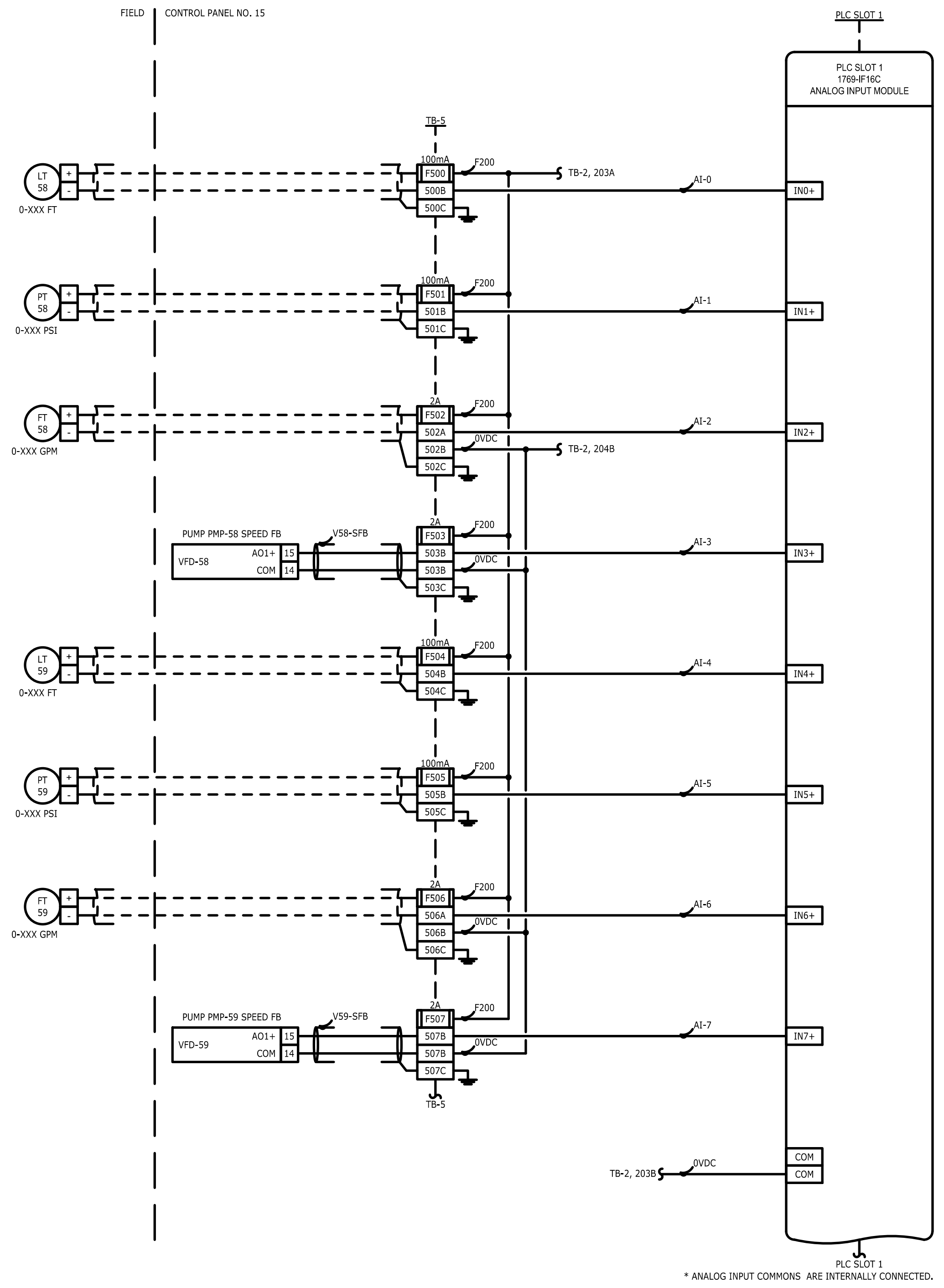
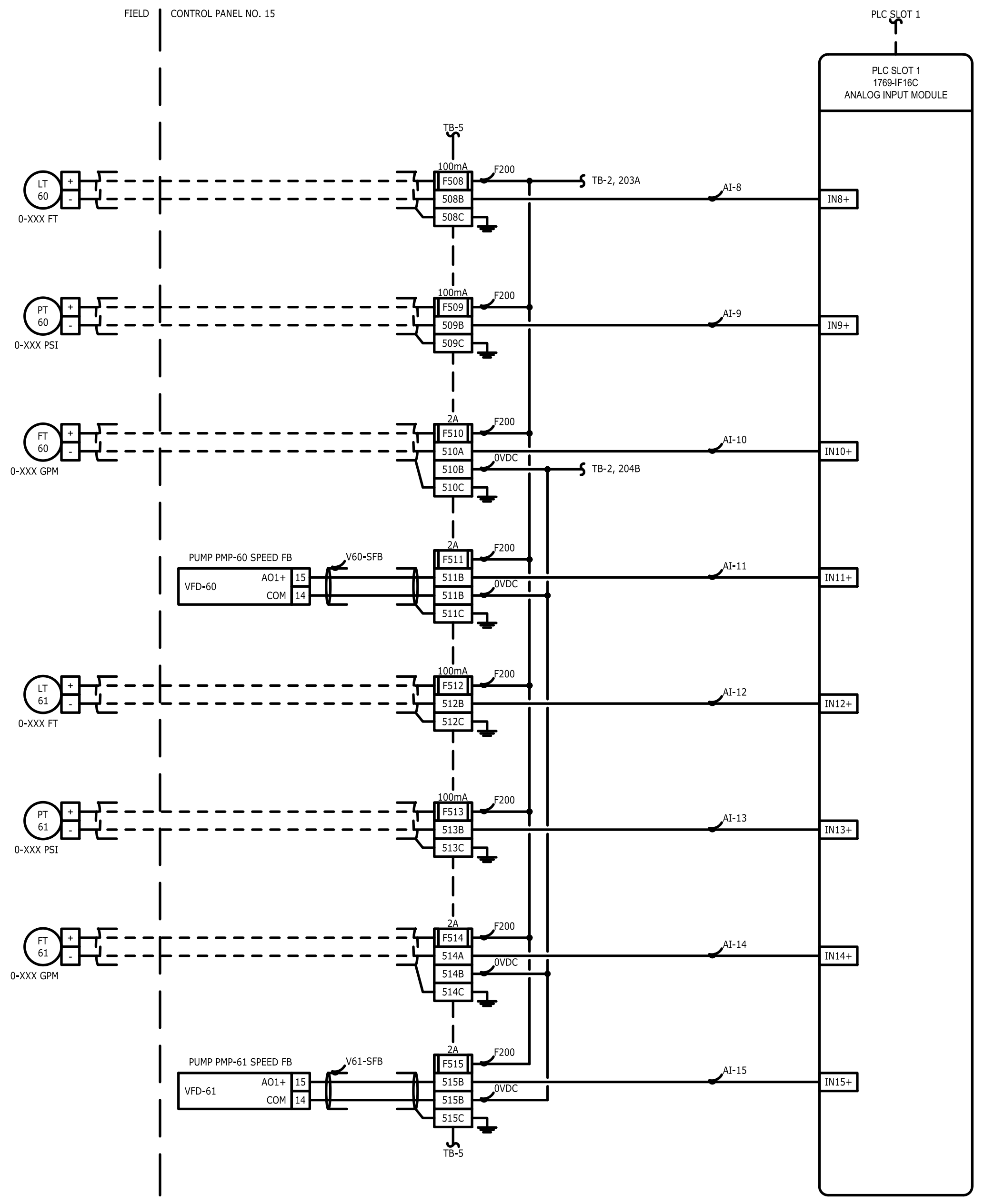


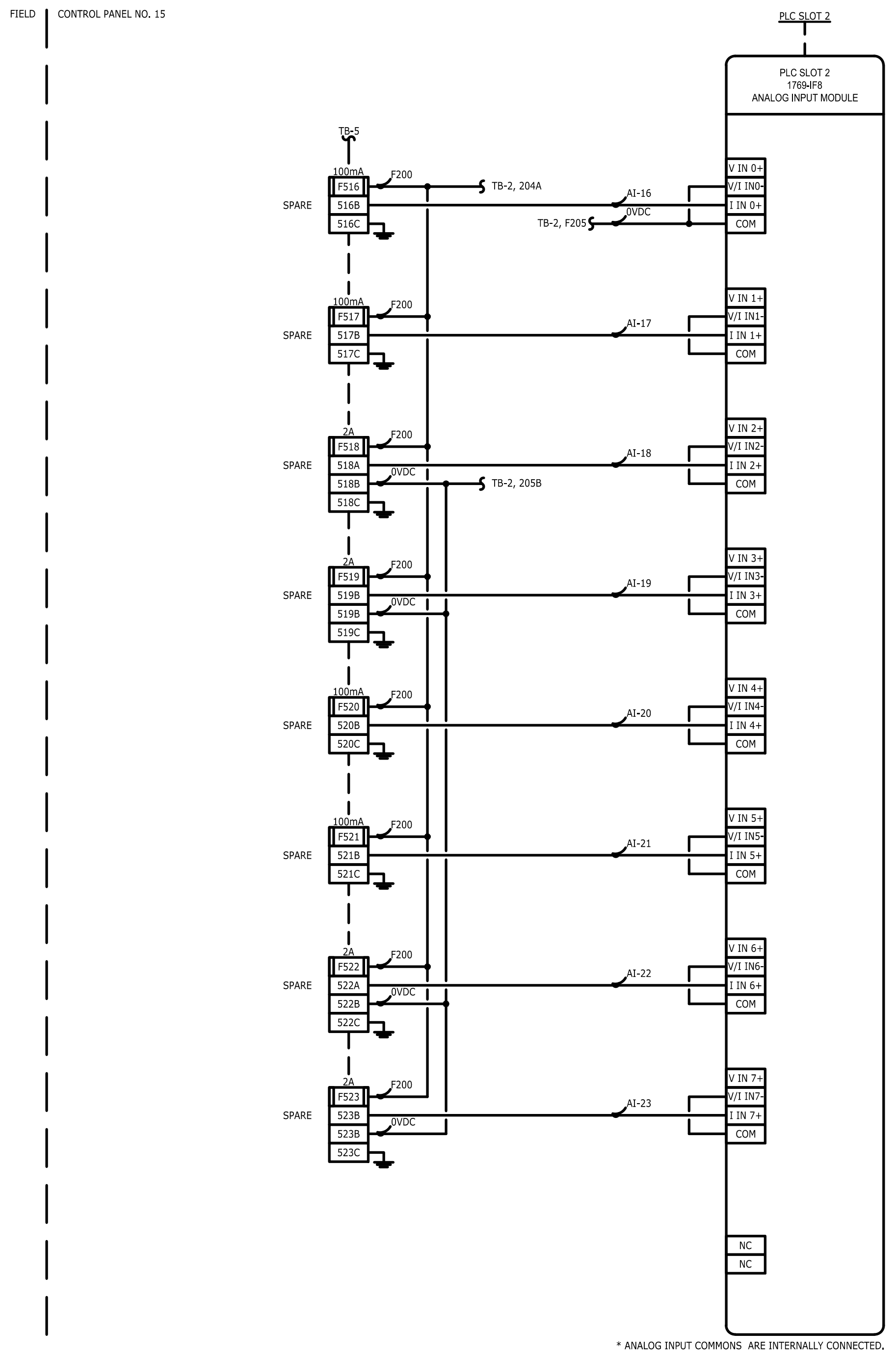
205
E-53

DETAIL
CONTROL PANEL NO. 15 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM I



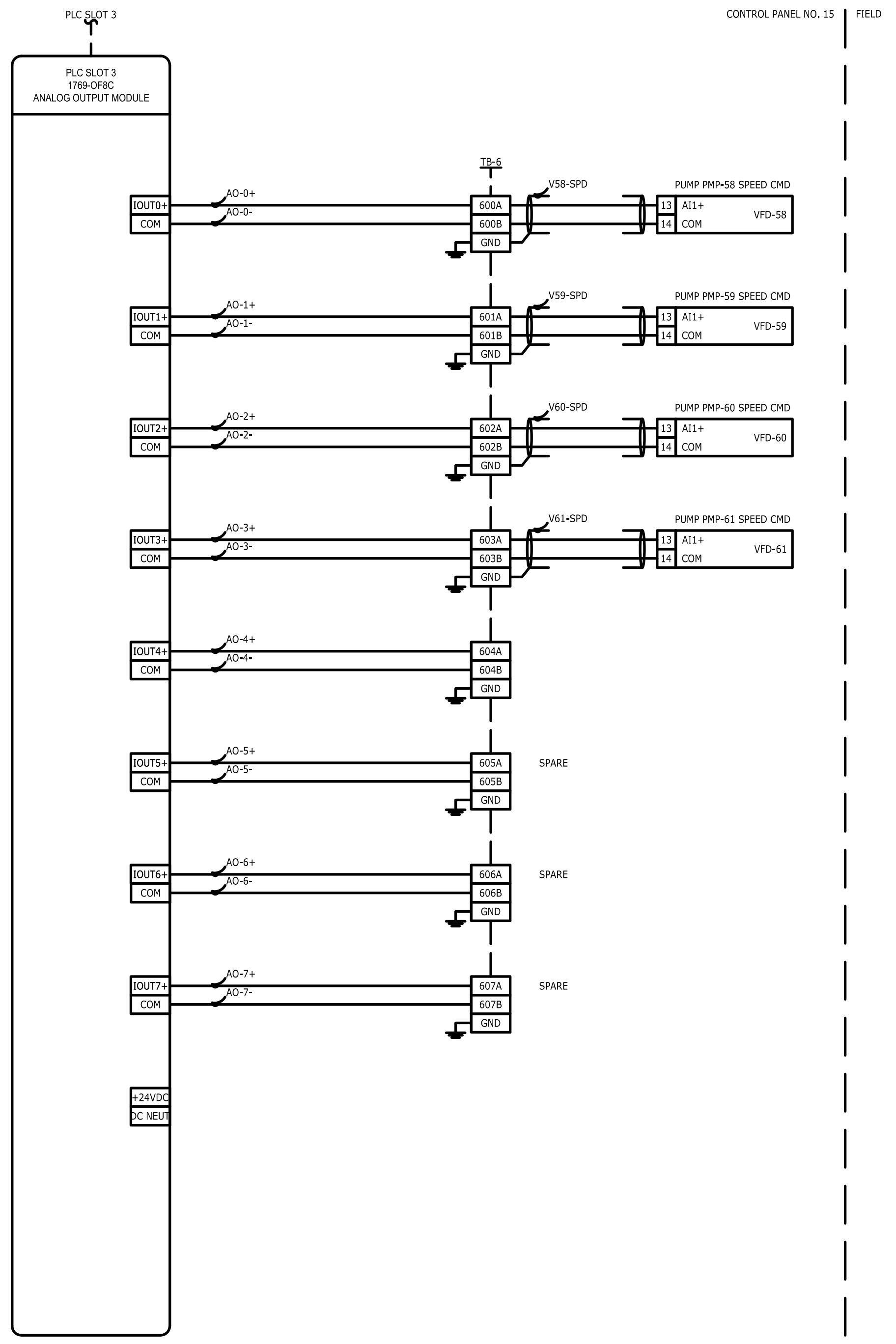
206
E-53

DETAIL
CONTROL PANEL NO. 15 PLC SLOT 1 ANALOG INPUT WIRING DIAGRAM II



207
E-53

DETAIL
CONTROL PANEL NO. 15 PLC SLOT 2 ANALOG INPUT WIRING DIAGRAM



208
E-53

DETAIL
CONTROL PANEL NO. 15 PLC SLOT 3 ANALOG INPUT WIRING DIAGRAM

NOTES:

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90% DESIGN DRAWINGS

REV	DATE	DESCRIPTION	DRN	APP
B	08.13.21	60% DESIGN SUBMITTAL	JFH	JJD
A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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consultants

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NC License No.: C-3500 and C-295

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2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-15 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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DESIGN BY:	BMT	DATE:	DECEMBER 2021
DRAWN BY:	JFH	PROJECT NO.:	TR0795A
CHECKED BY:	CMDS	FILE:	TR0795A-E53.DWG
REVIEWED BY:	SV	DRAWING NO.:	E-53
APPROVED BY:	JJD		

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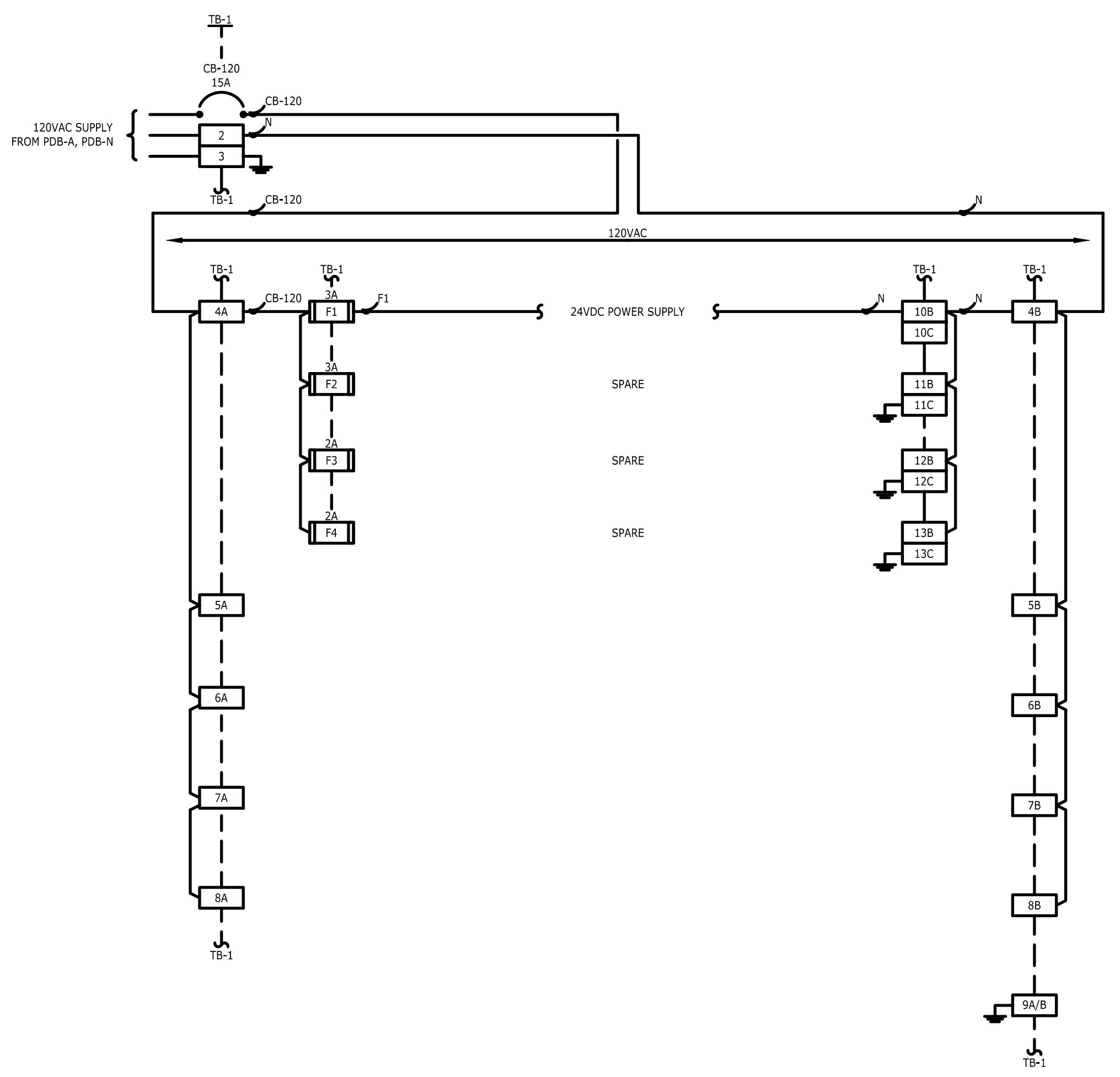
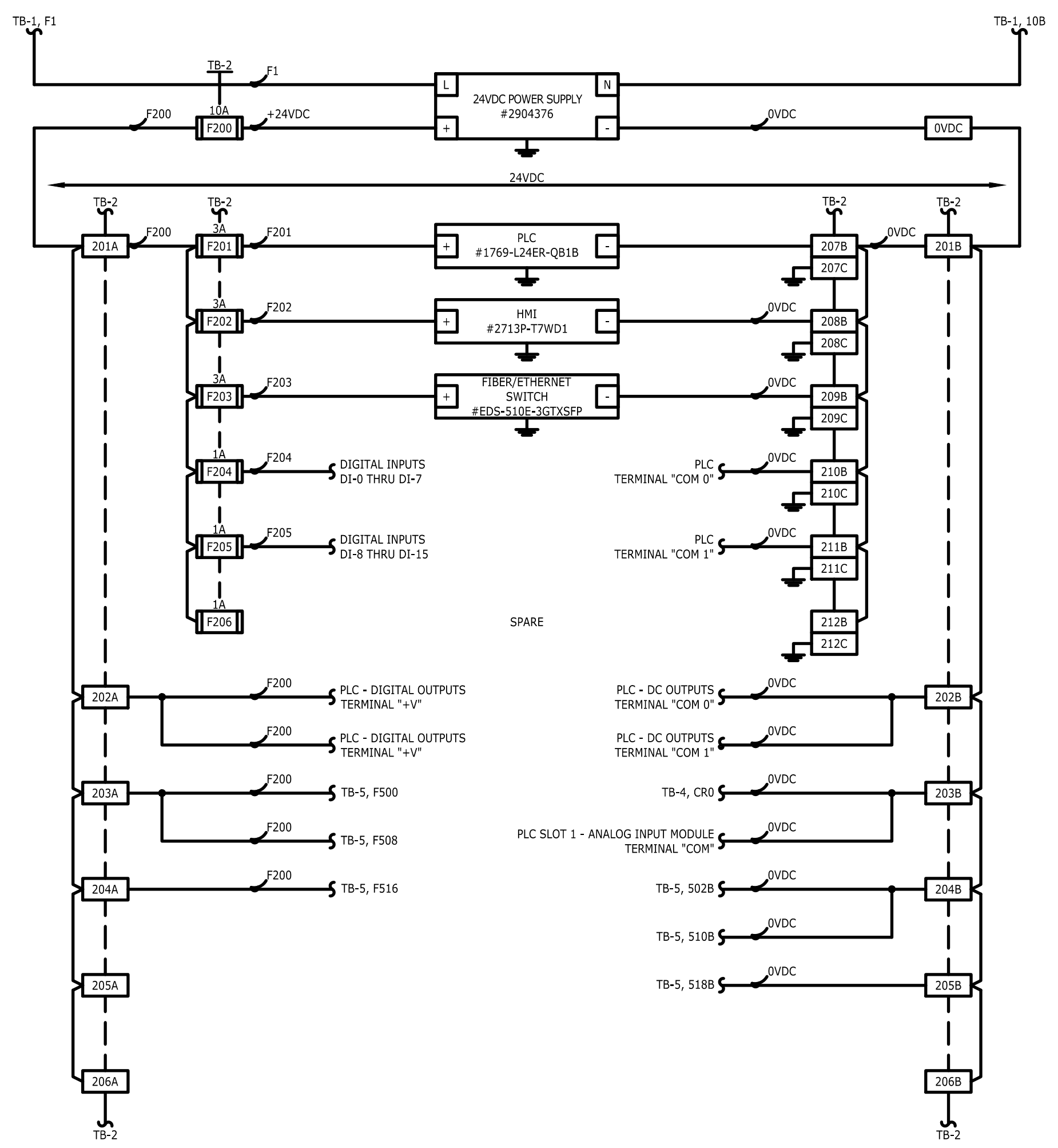
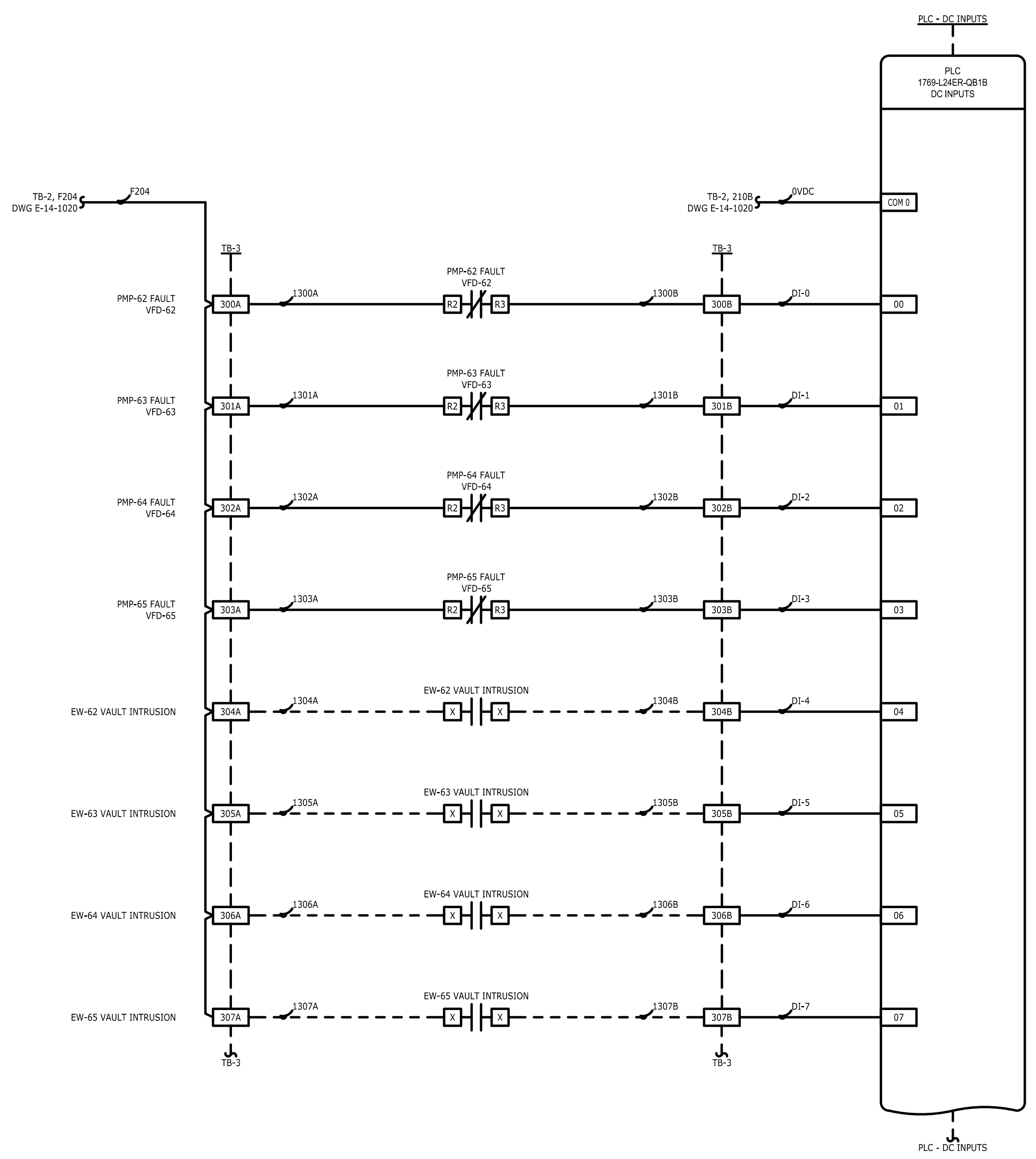


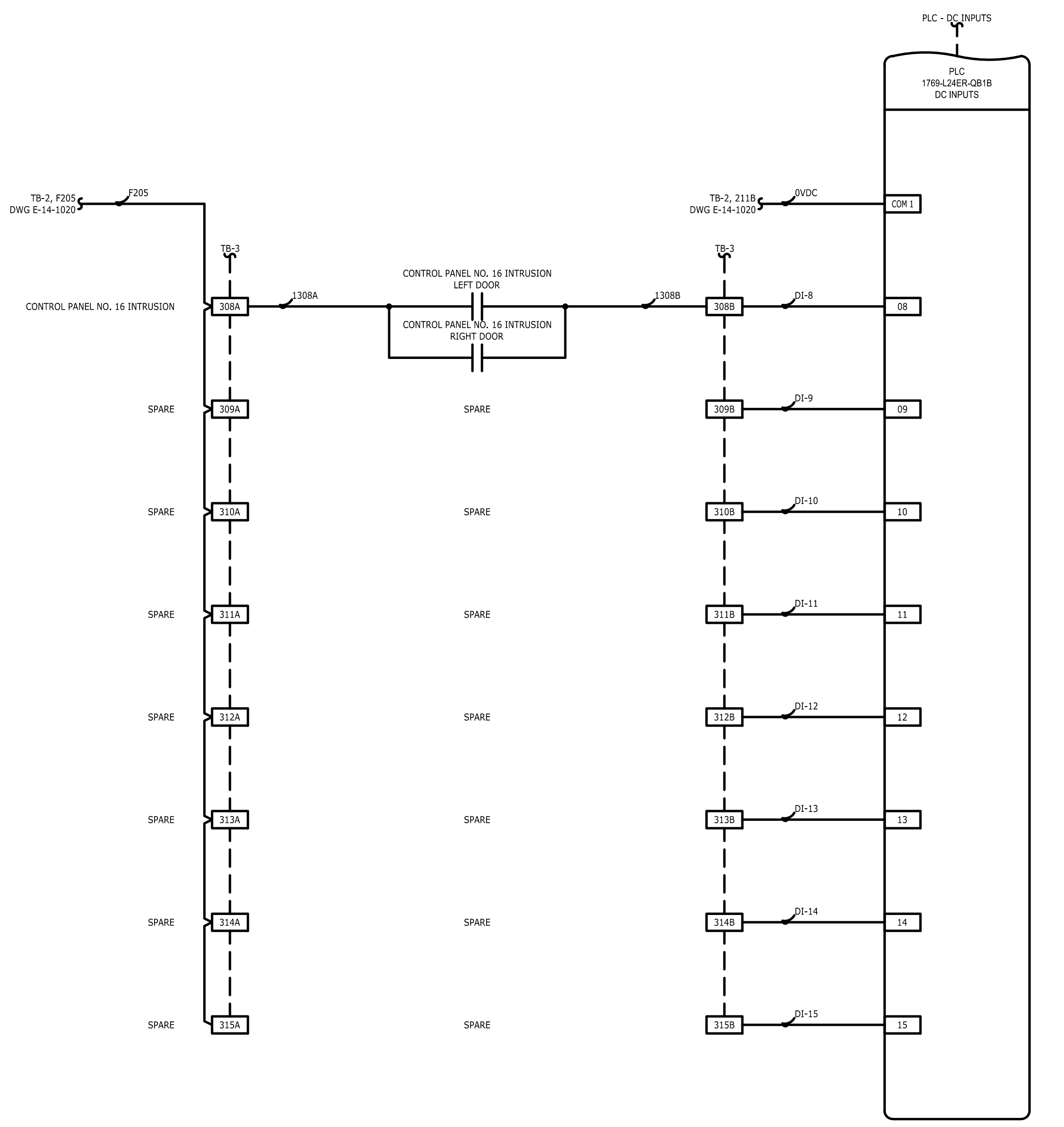
210 DETAIL
E-54
CONTROL PANEL NO. 16 120VAC POWER DISTRIBUTION



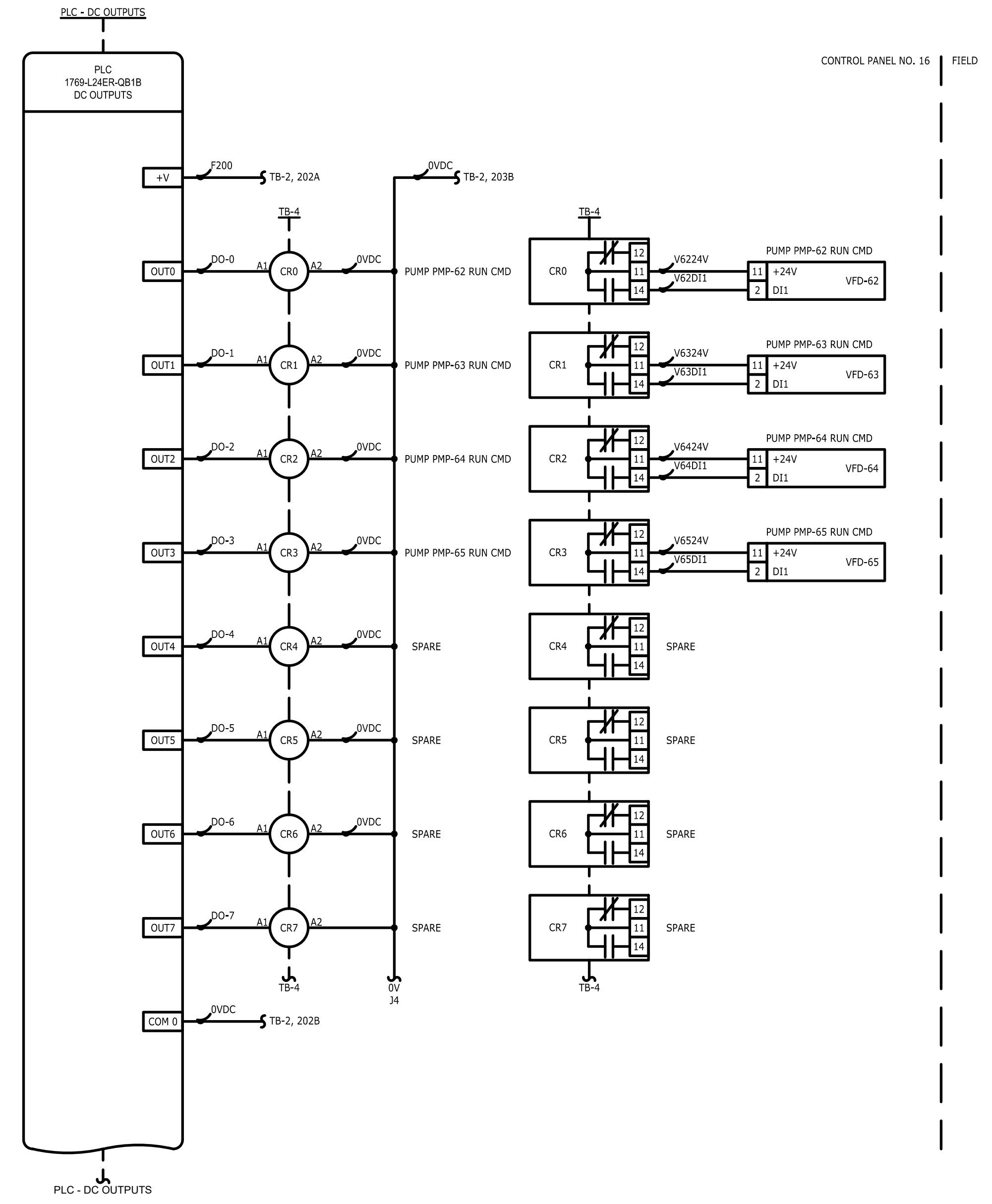
211 DETAIL
E-54
CONTROL PANEL NO. 16 24VDC POWER DISTRIBUTION



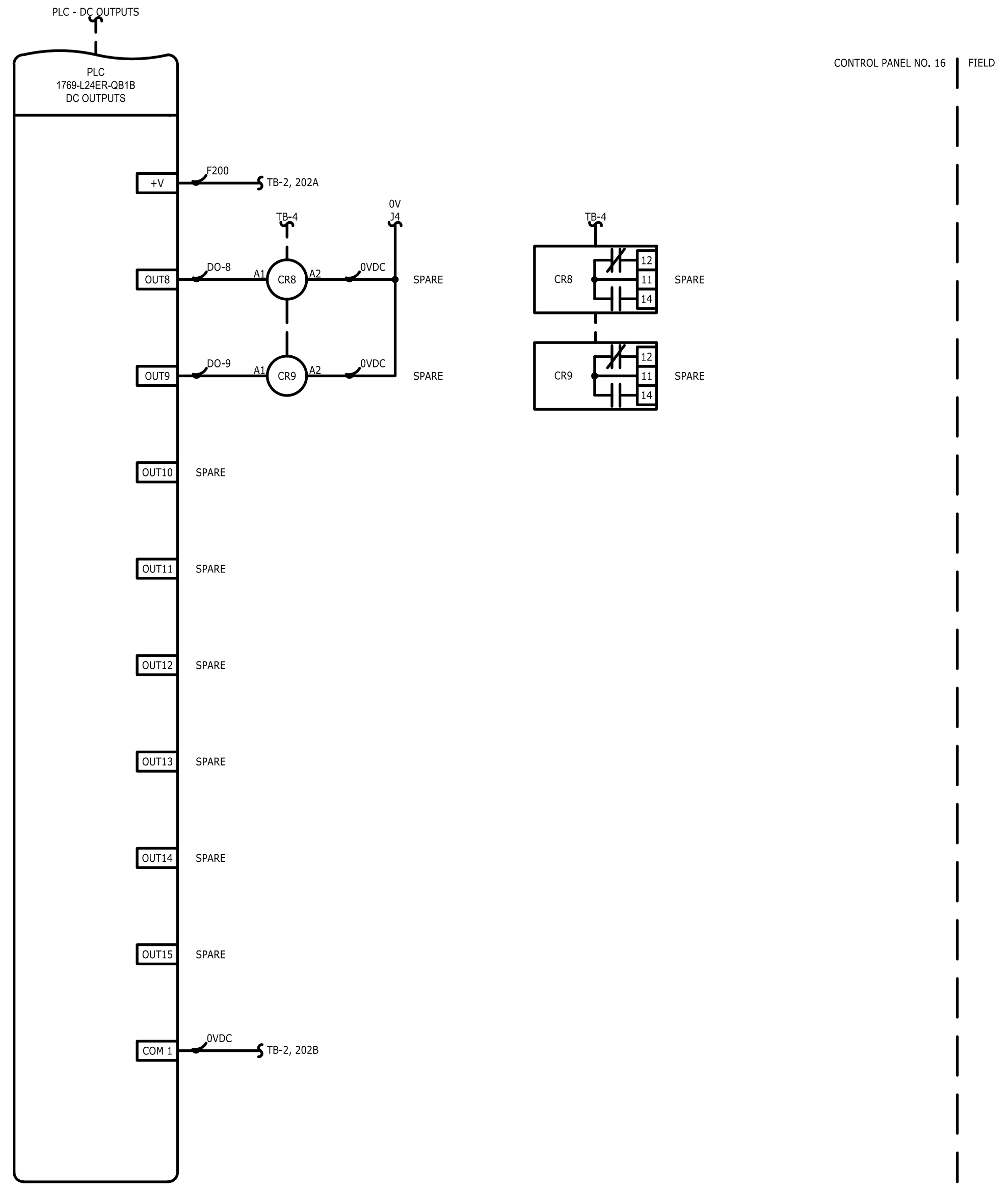
212 DETAIL
E-54
CONTROL PANEL NO. 16 PLC DIGITAL WIRING DIAGRAM I



213 DETAIL
E-54
CONTROL PANEL NO. 16 PLC DIGITAL WIRING DIAGRAM II



214 DETAIL
E-54
CONTROL PANEL NO. 16 PLC RELAY OUTPUTS WIRING DIAGRAM I



215 DETAIL
E-54
CONTROL PANEL NO. 16 PLC RELAY OUTPUTS WIRING DIAGRAM II

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A	05.27.21	CONCEPTUAL DESIGN SUBMITTAL	JFH	JJD

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RALEIGH, NC 27607
919.870.0576

TITLE: EW-16 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	E-54
APPROVED BY:	JJD		

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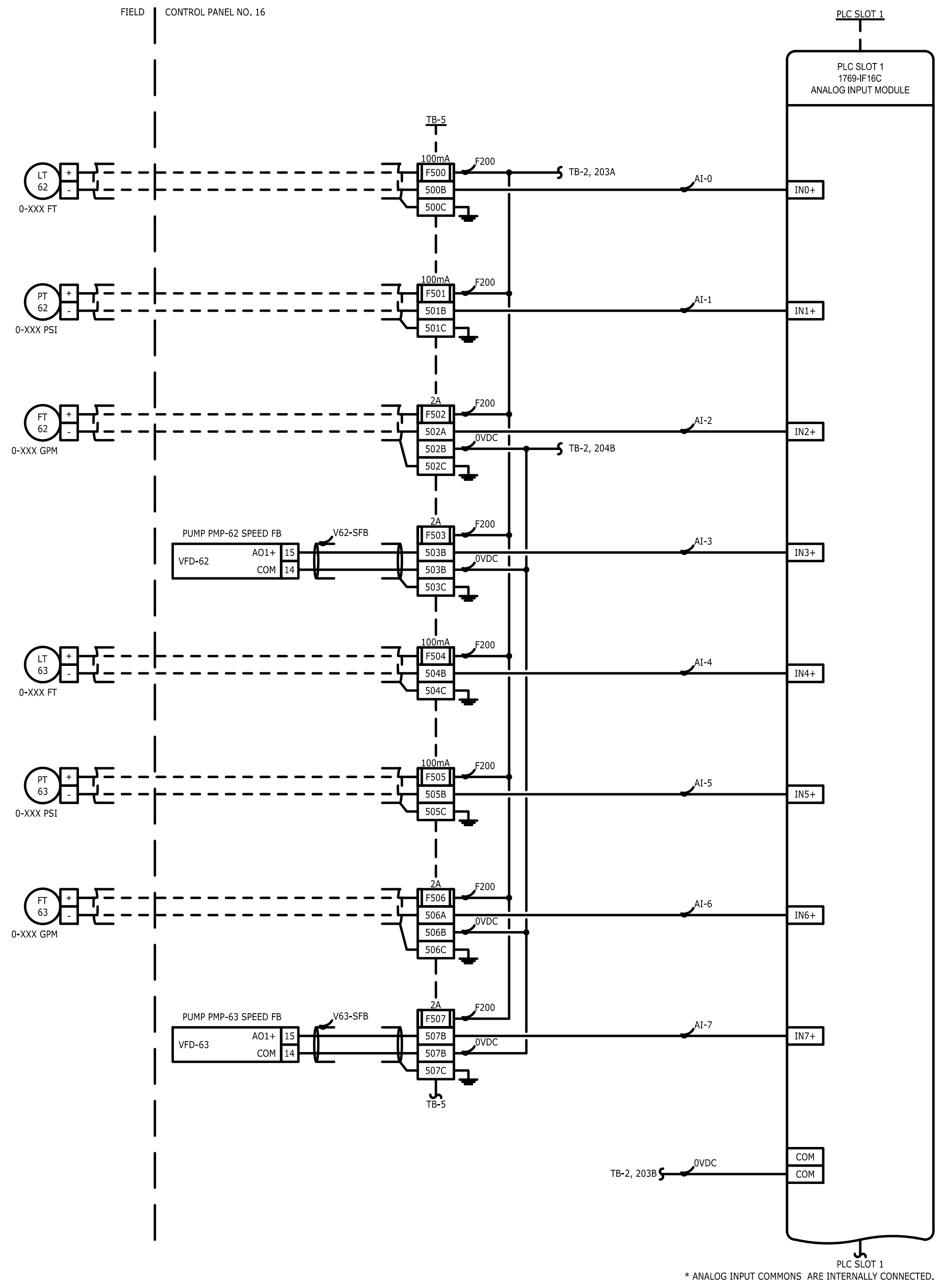
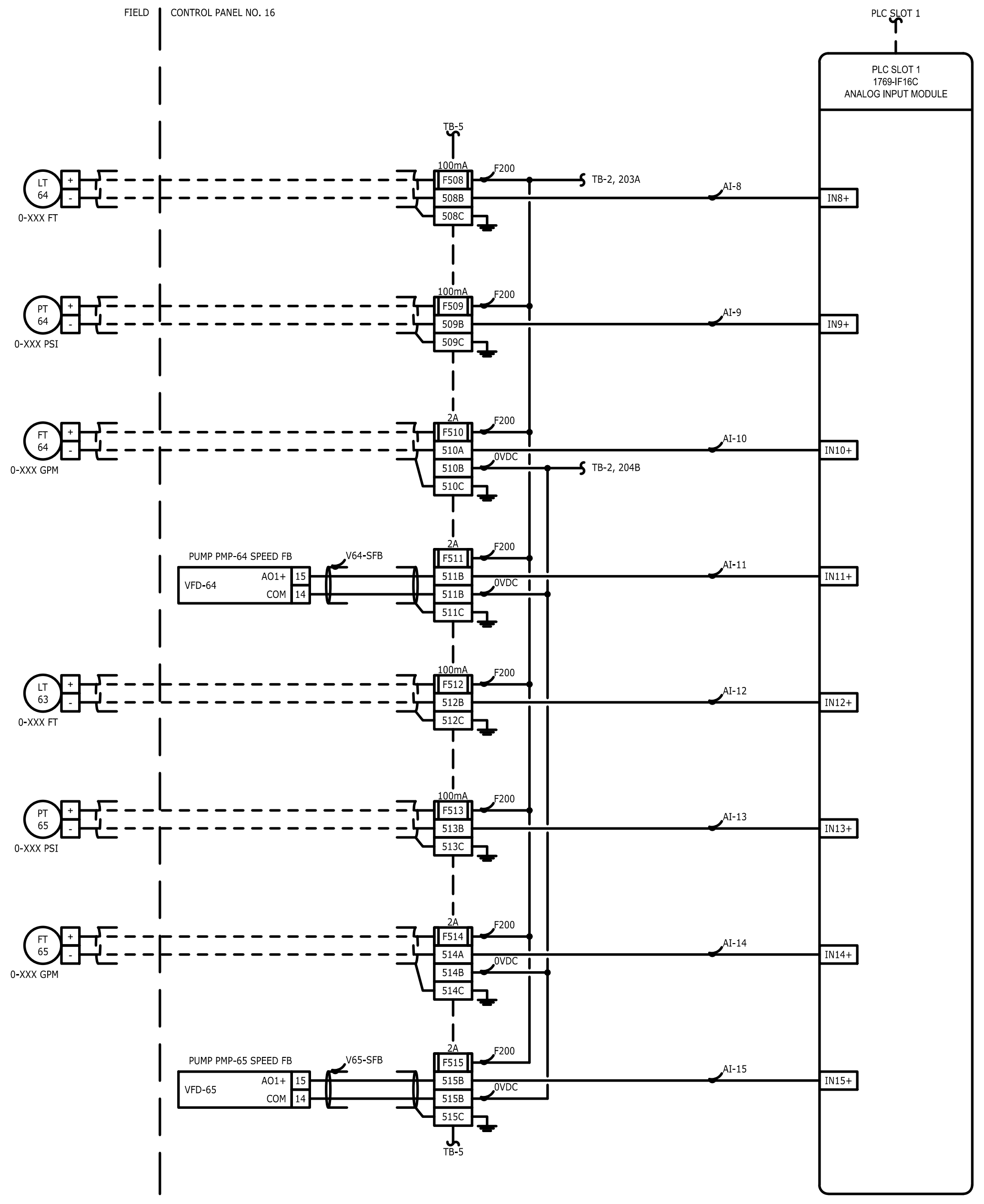


216
E-55

DETAIL

CONTROL PANEL NO. 16 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM I



217
E-55

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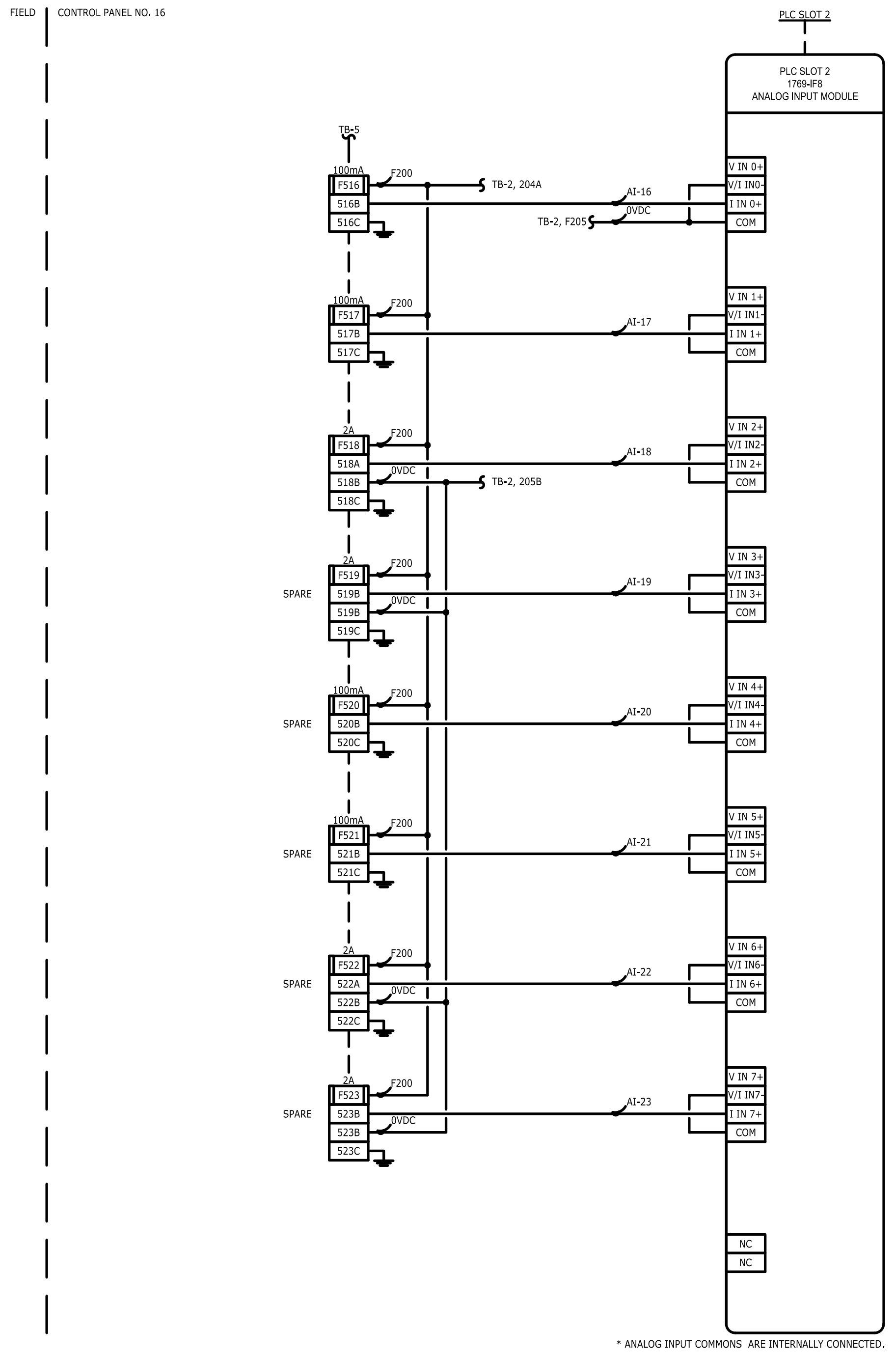
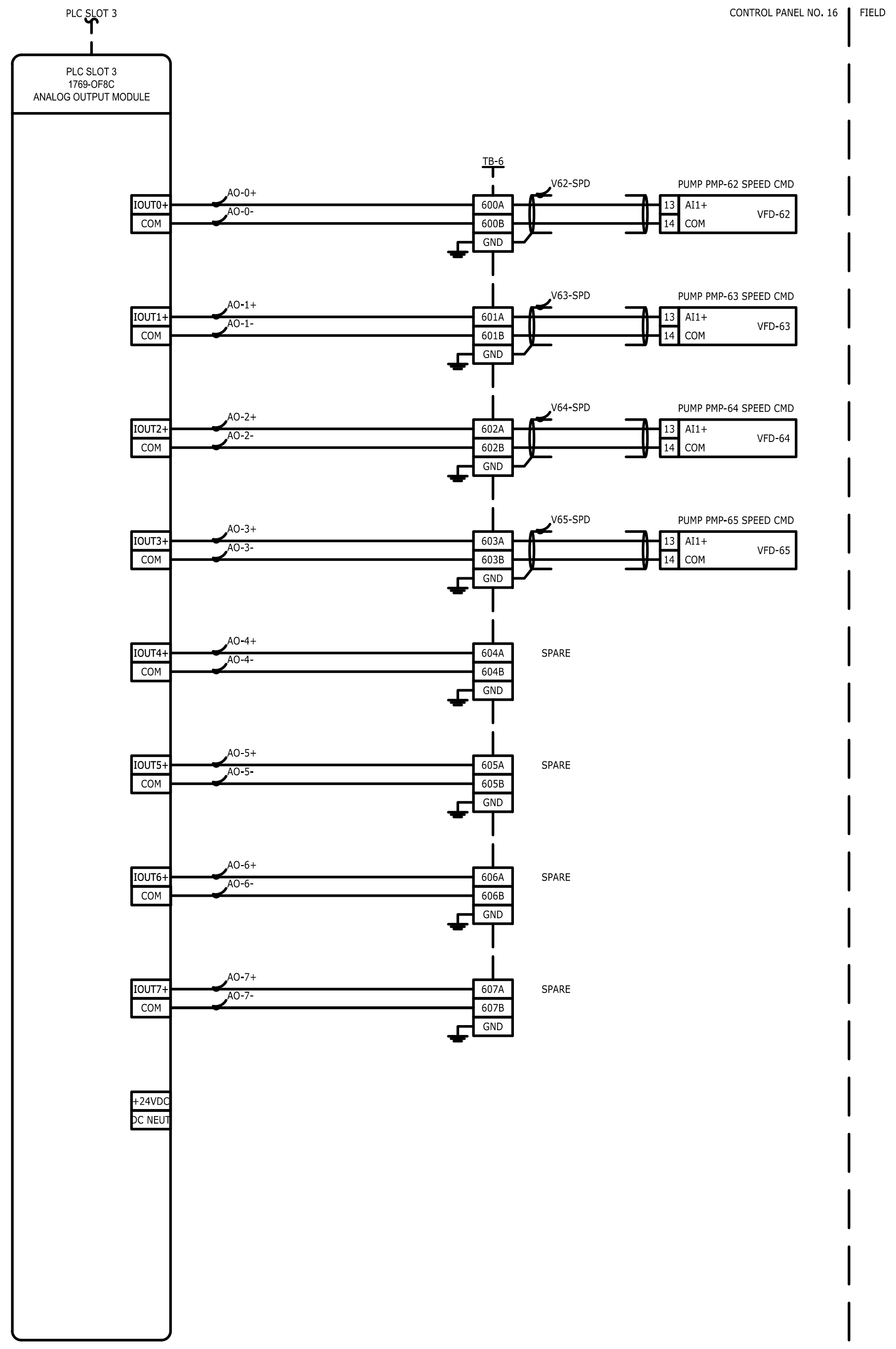


218
E-55

DETAIL

CONTROL PANEL NO. 16 PLC SLOT 2
ANALOG INPUT WIRING DIAGRAM



219
E-55

DETAIL

CONTROL PANEL NO. 16 PLC SLOT
3 ANALOG INPUT WIRING DIAGRAM

NOTES:

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2501 BLUE RIDGE ROAD, SUITE 430
RALEIGH, NC 27607
919.870.0576

TITLE:
EW-16 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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REVIEWED BY:	SV	DRAWING NO.:	E-55
APPROVED BY:	JJD		

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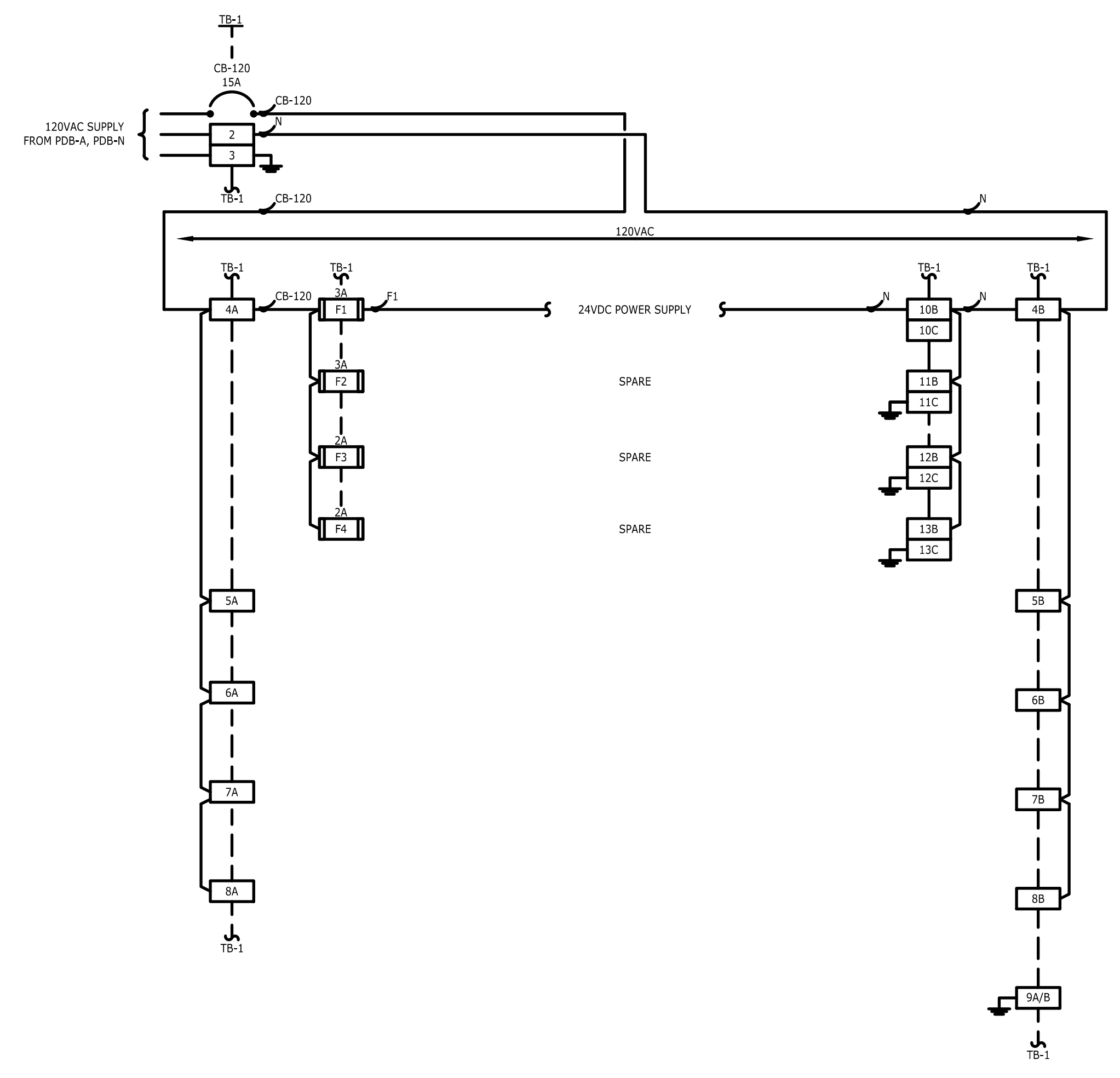
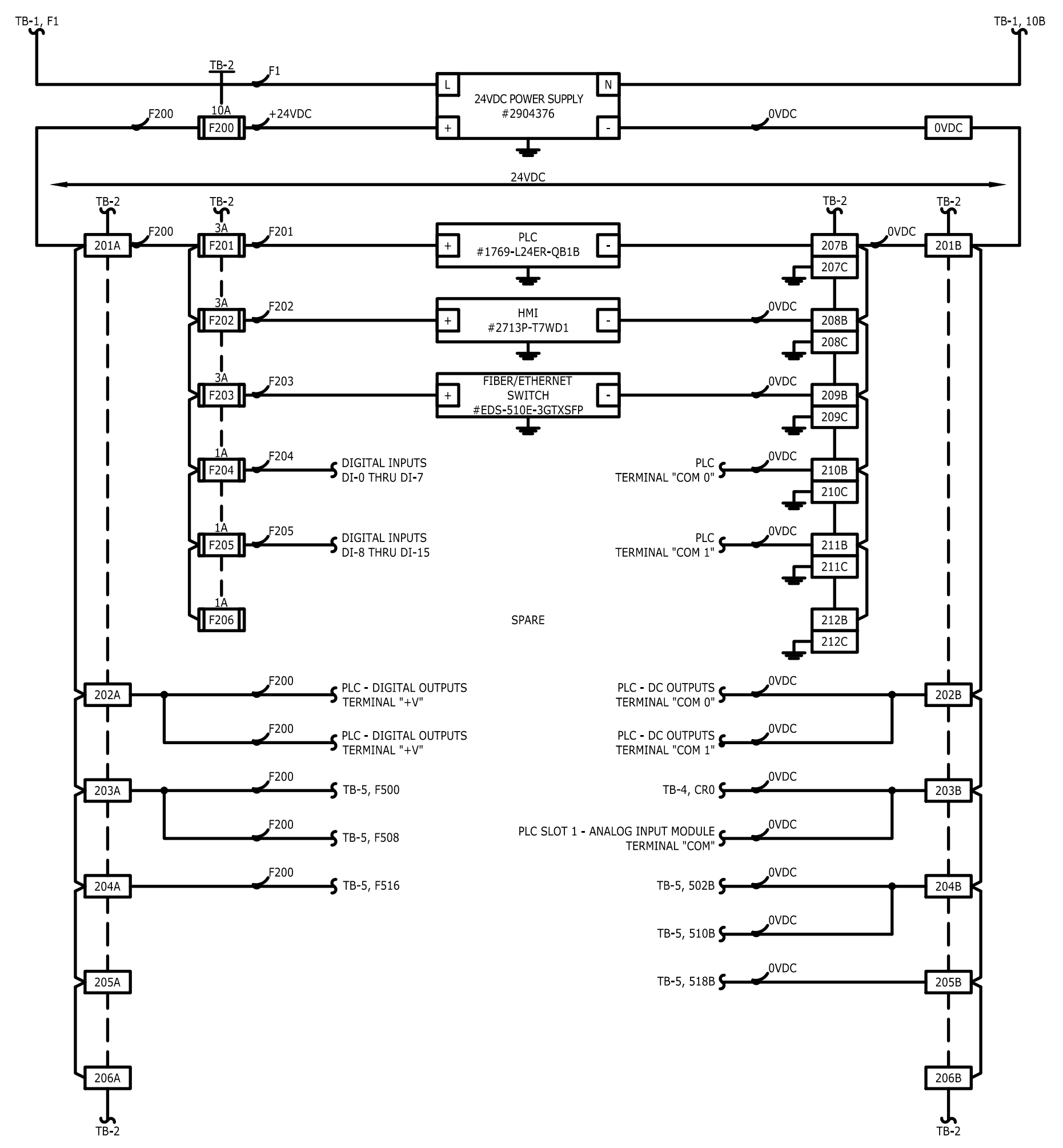
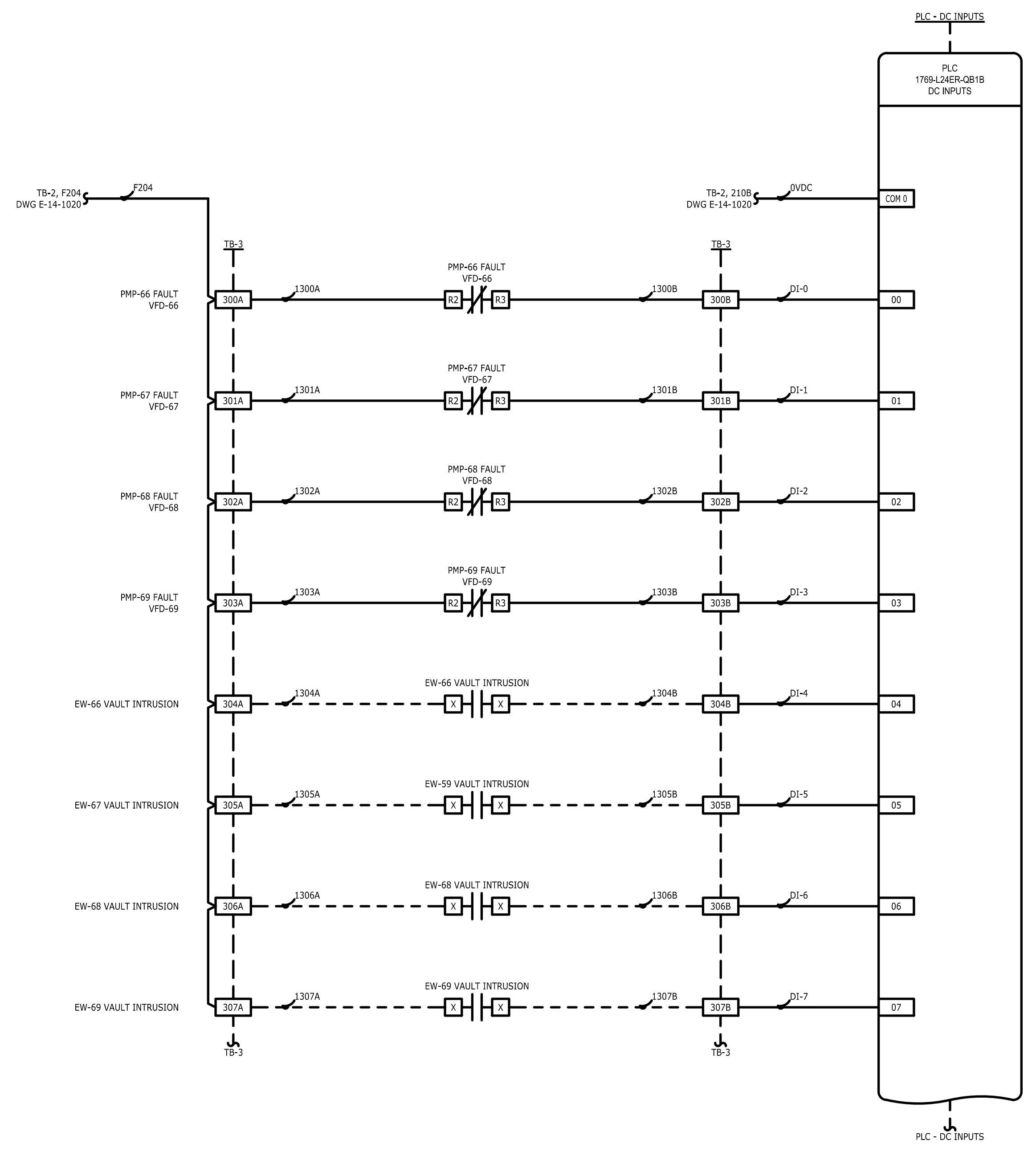


221 E-56 DETAIL
CONTROL PANEL NO. 17 120VAC POWER DISTRIBUTION



222 E-56 DETAIL
CONTROL PANEL NO. 17 24VDC POWER DISTRIBUTION



223 E-56 DETAIL
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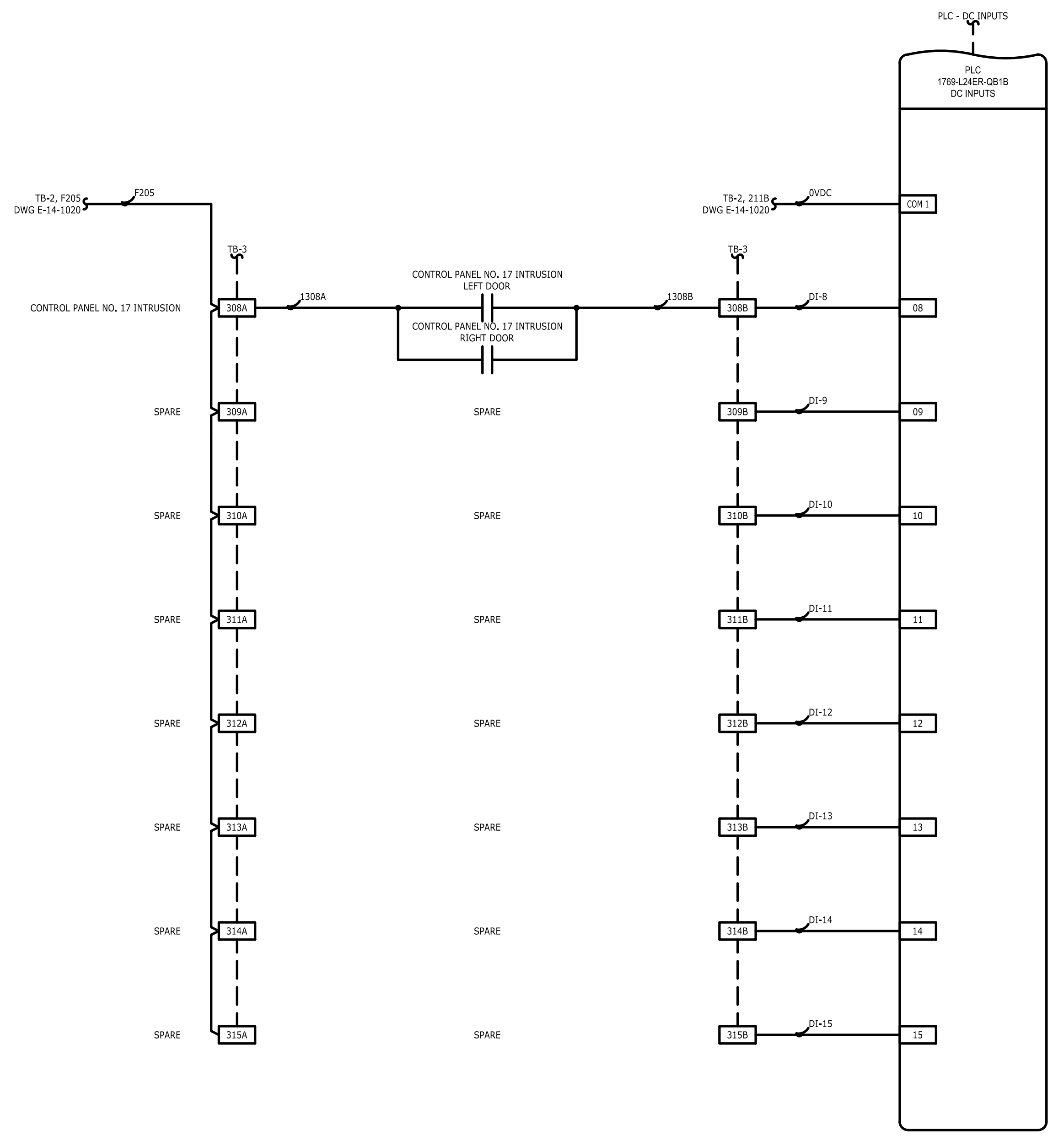
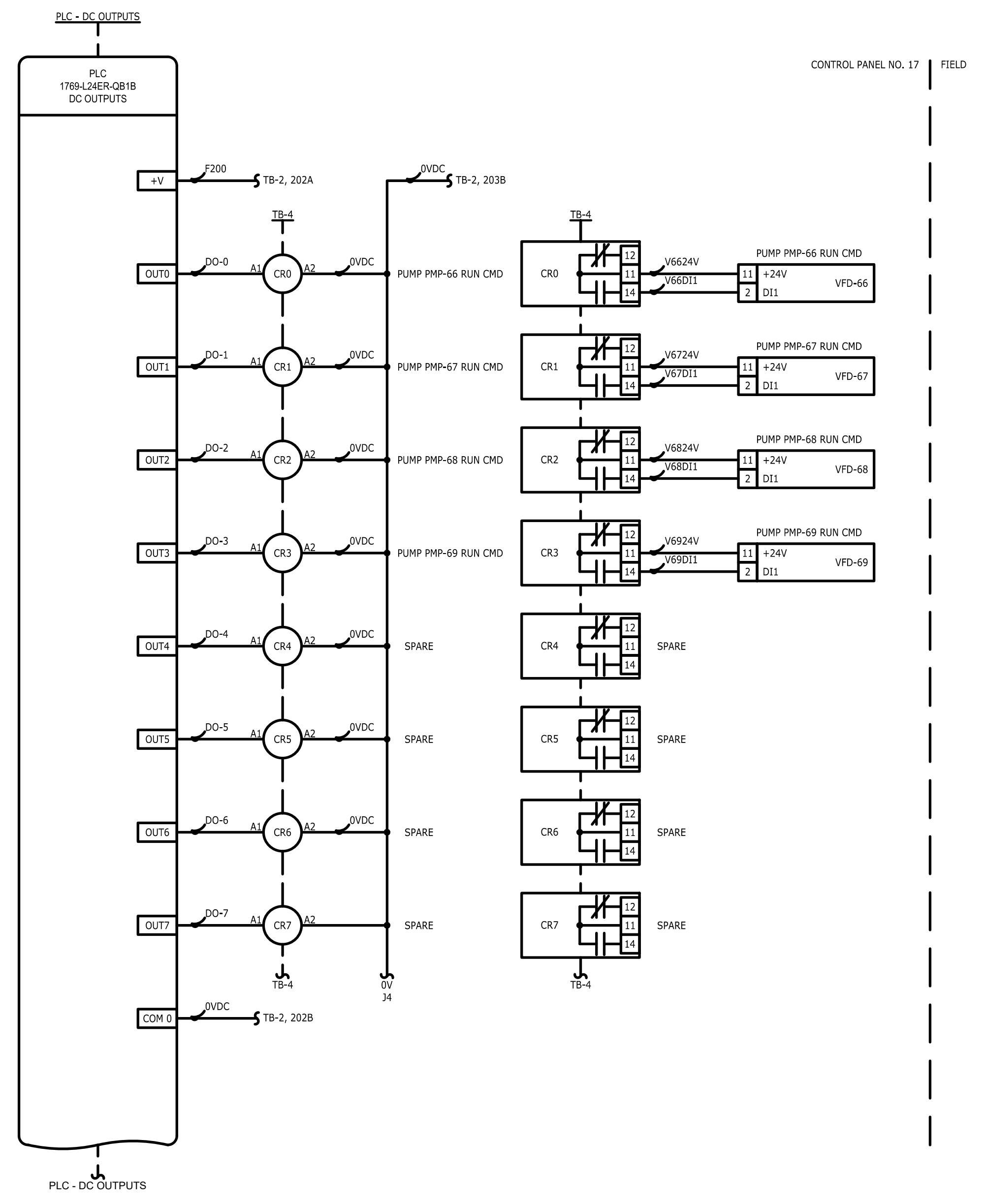
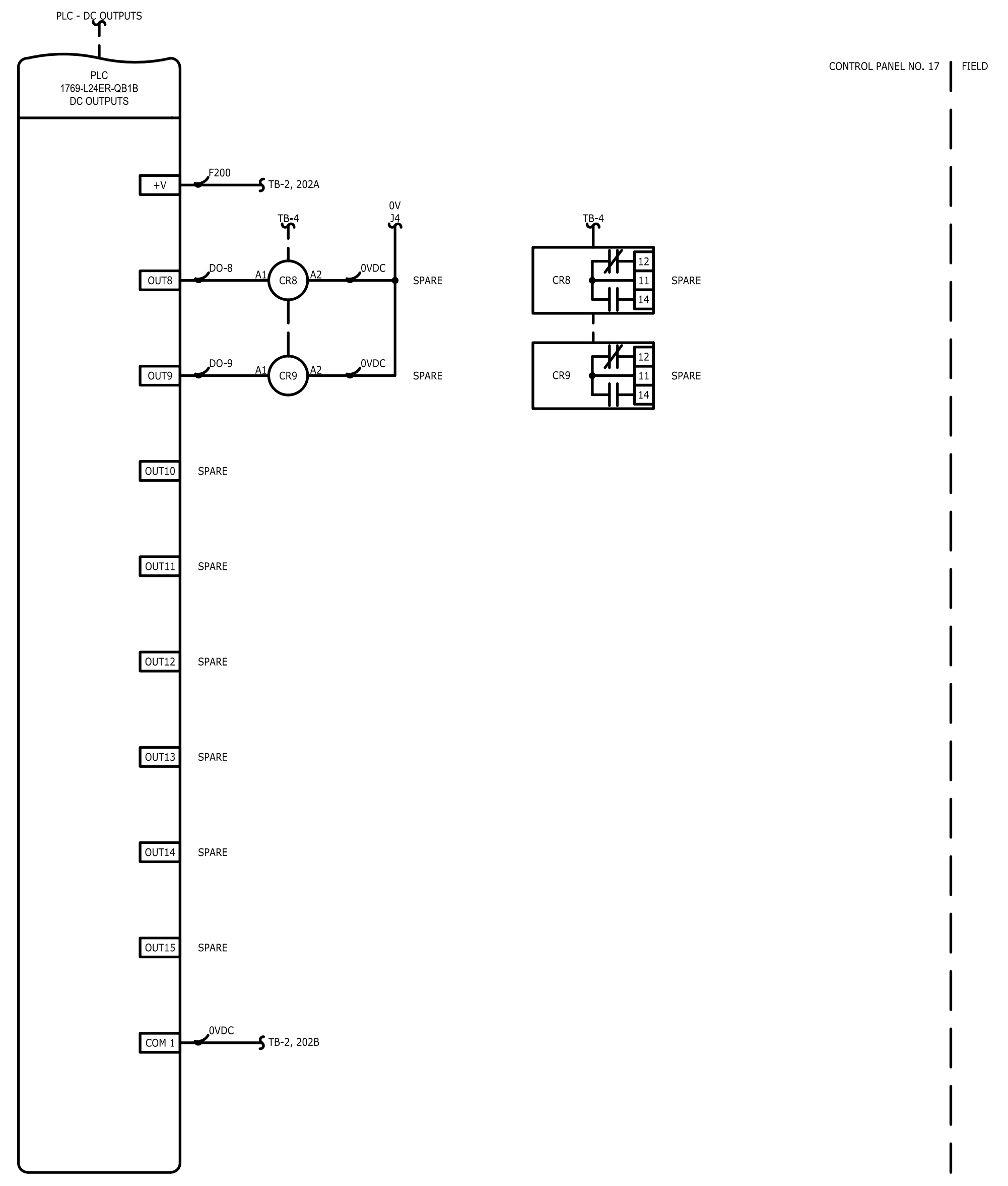


224 E-56 DETAIL
CONTROL PANEL NO. 17 PLC DIGITAL WIRING DIAGRAM II



225 E-56 DETAIL
CONTROL PANEL NO. 17 PLC RELAY OUTPUTS WIRING DIAGRAM I



226 E-56 DETAIL
CONTROL PANEL NO. 17 PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

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919.870.0576

TITLE:
EW-17 CONTROL PANEL
POWER DISTRIBUTION I

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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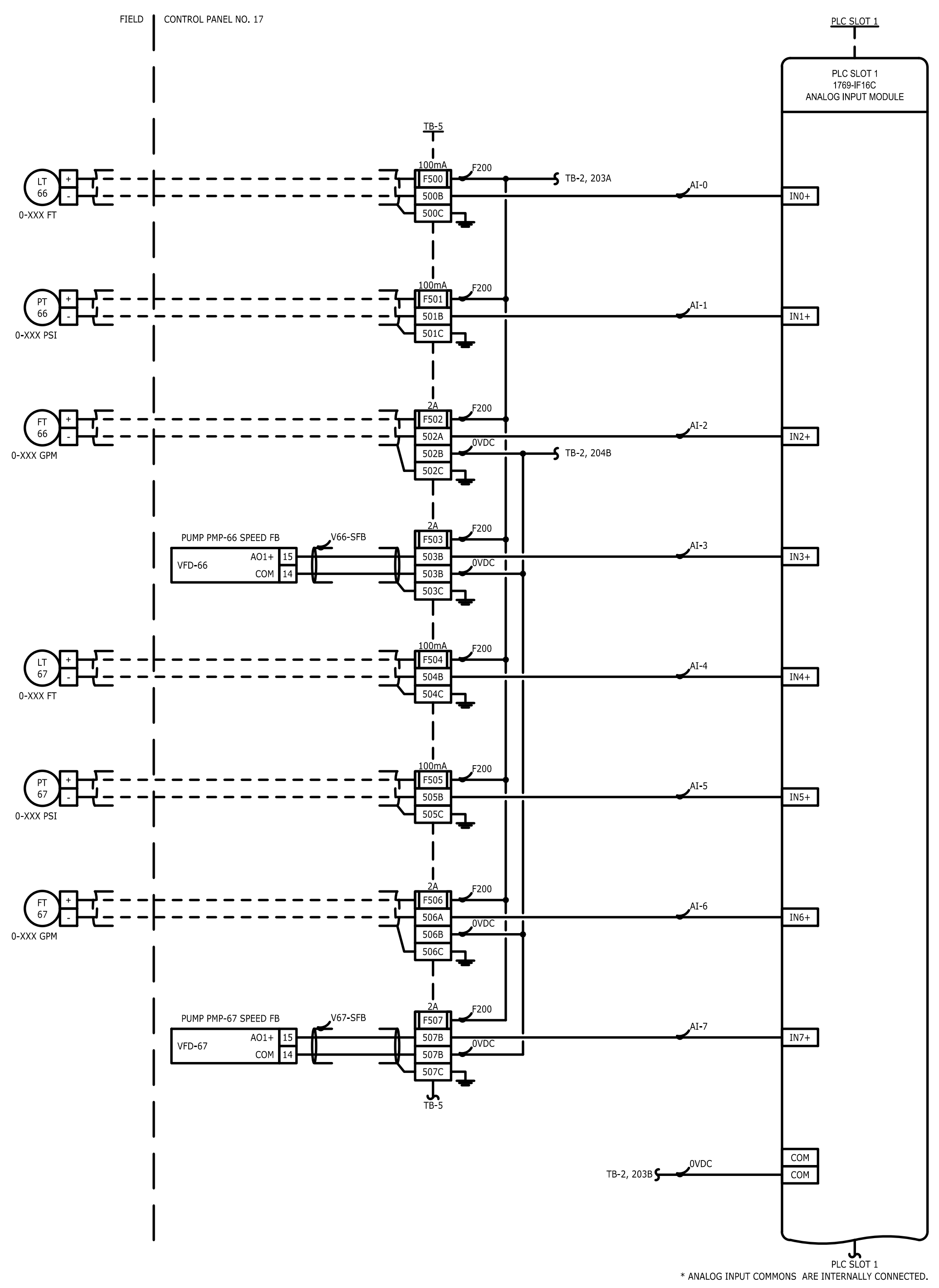
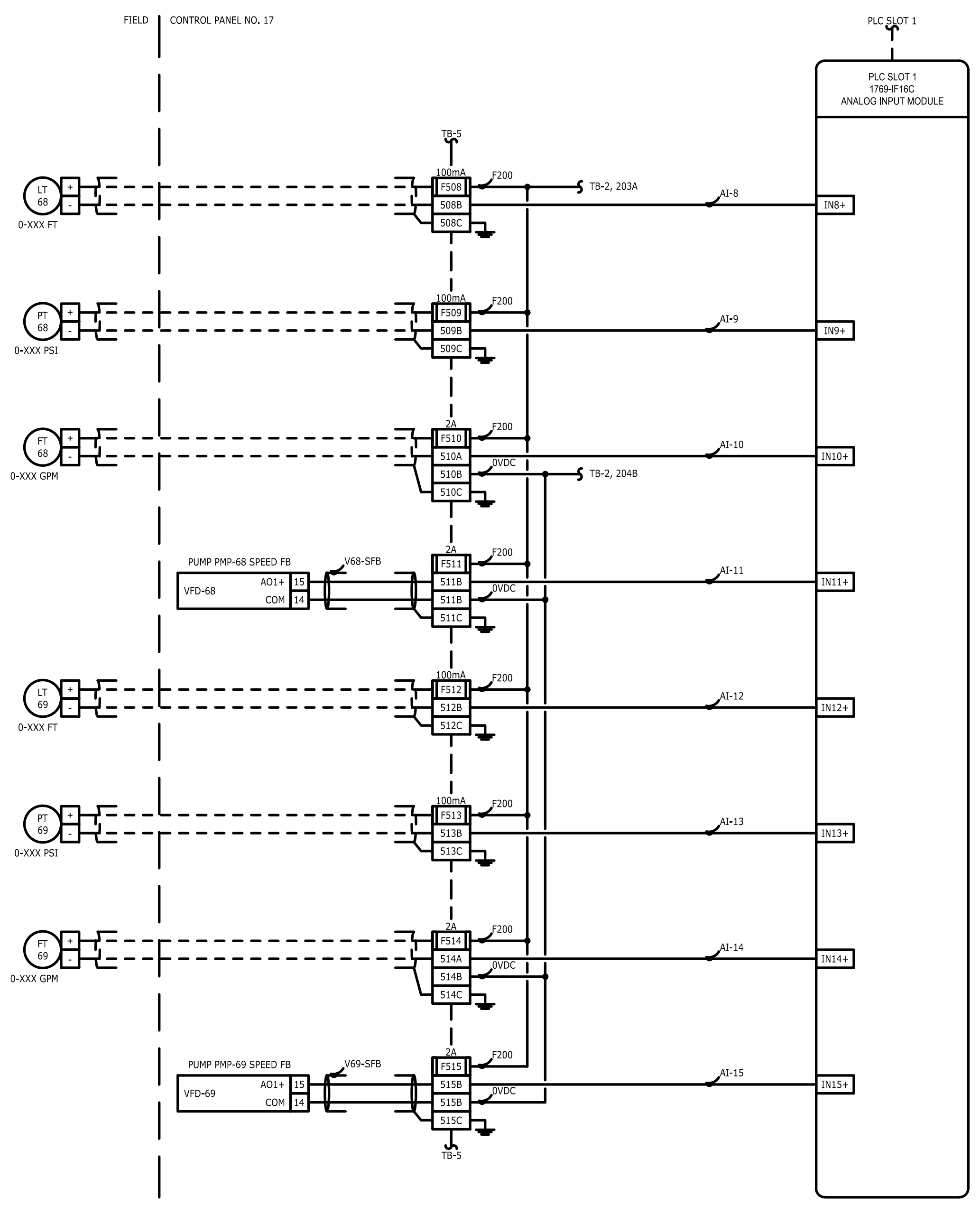
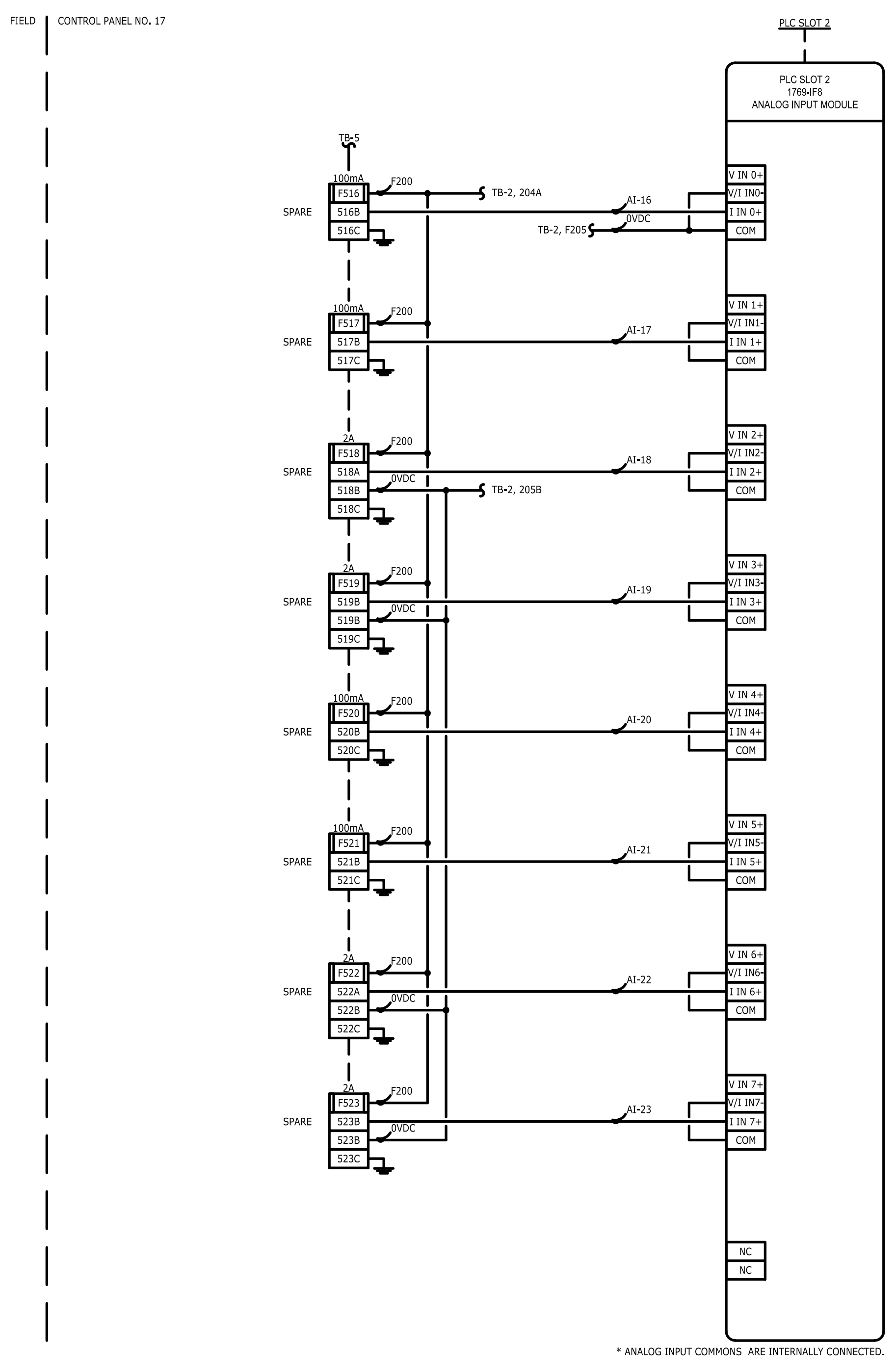


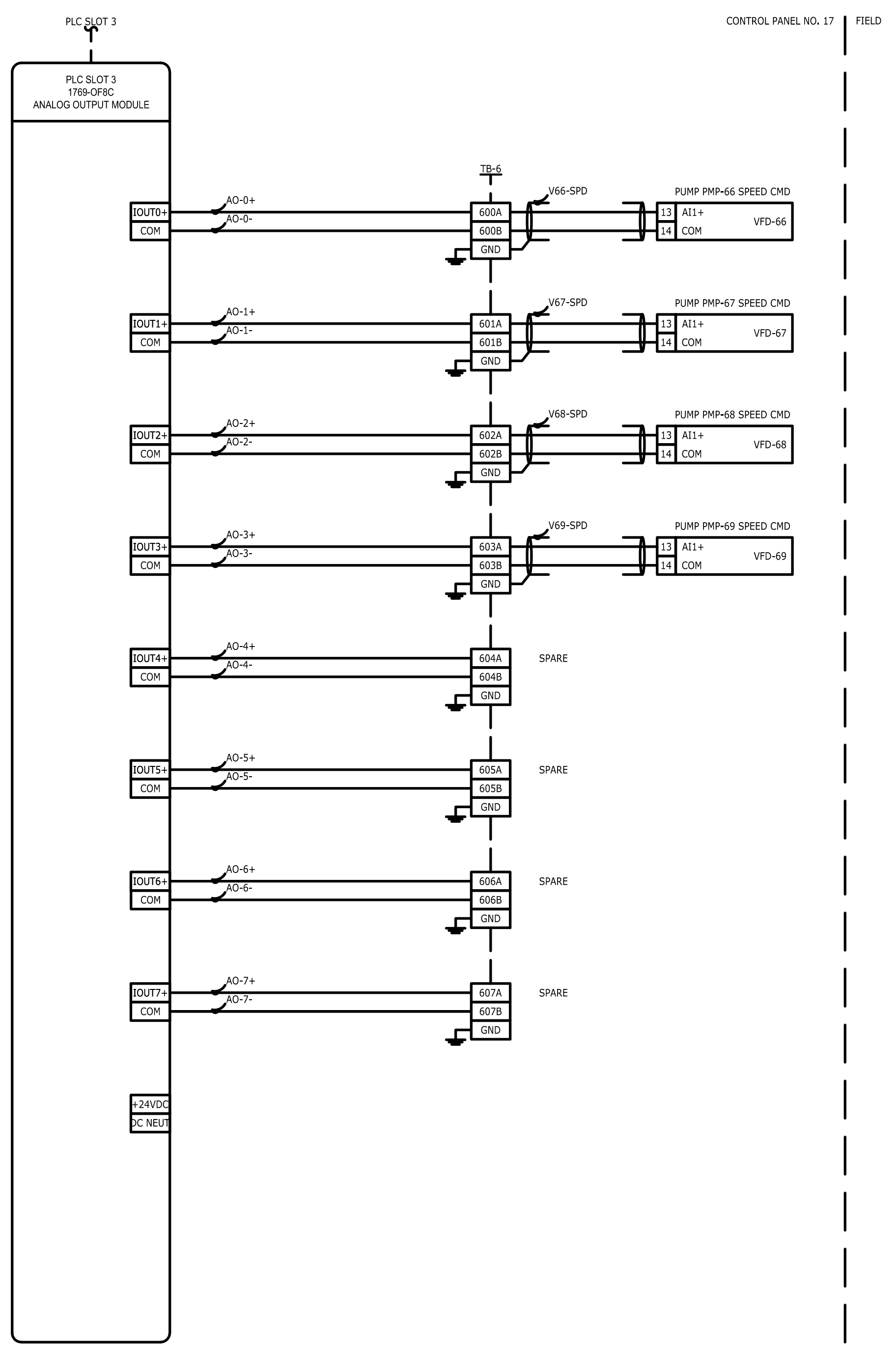
227 E-57 DETAIL
CONTROL PANEL NO. 17 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM I



228 E-57 DETAIL
CONTROL PANEL NO. 17 PLC SLOT 1
ANALOG INPUT WIRING DIAGRAM II



229 E-57 DETAIL
CONTROL PANEL NO. 17 PLC SLOT 2
ANALOG INPUT WIRING DIAGRAM



230 E-57 DETAIL
CONTROL PANEL NO. 17 PLC SLOT 3
ANALOG INPUT WIRING DIAGRAM

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RALEIGH, NC 27607
919.870.0576

TITLE:
EW-17 CONTROL PANEL
POWER DISTRIBUTION II

PROJECT:
THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE:
FAYETTEVILLE WORKS SITE

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APPROVED BY:	JJD		

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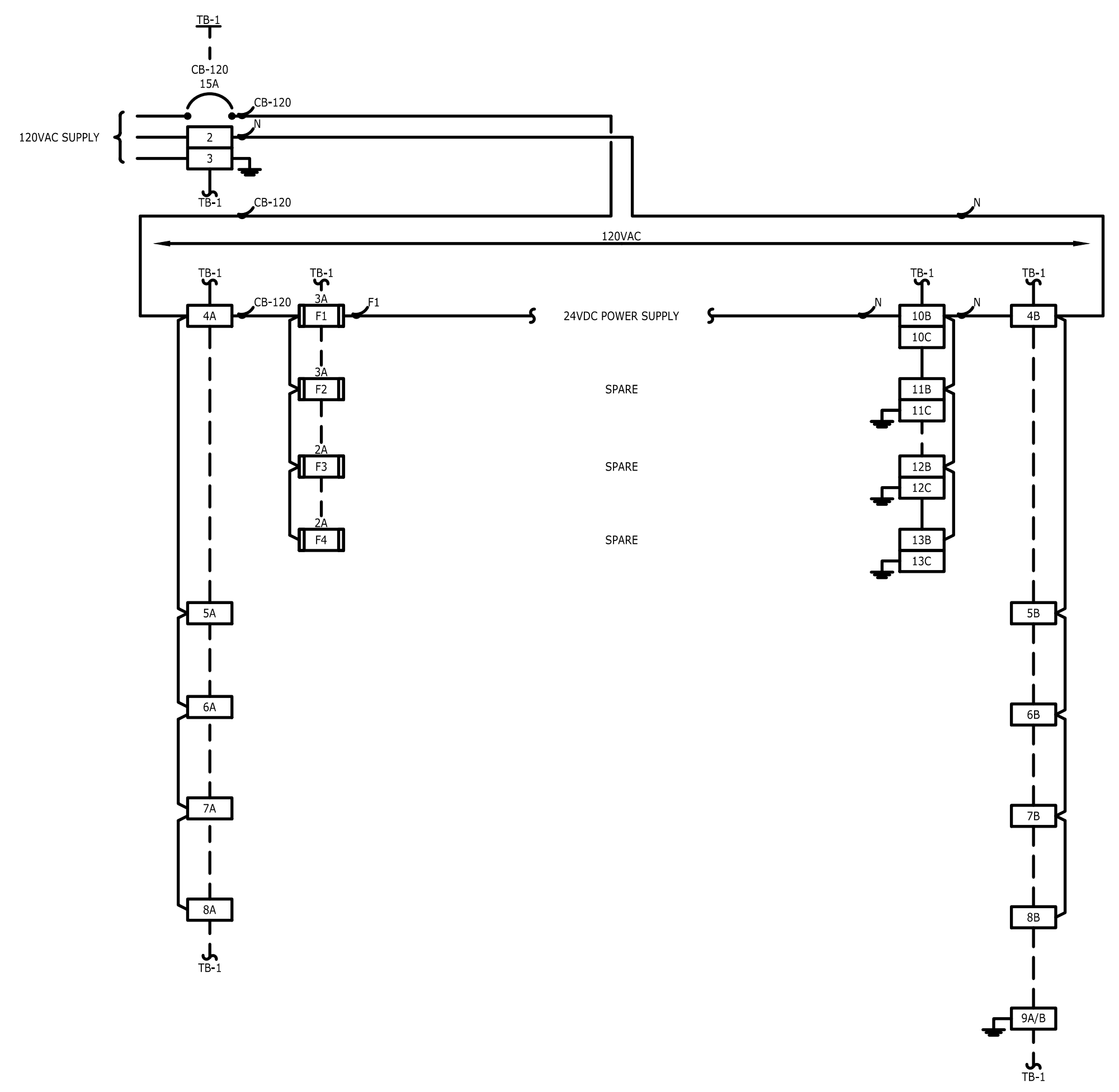
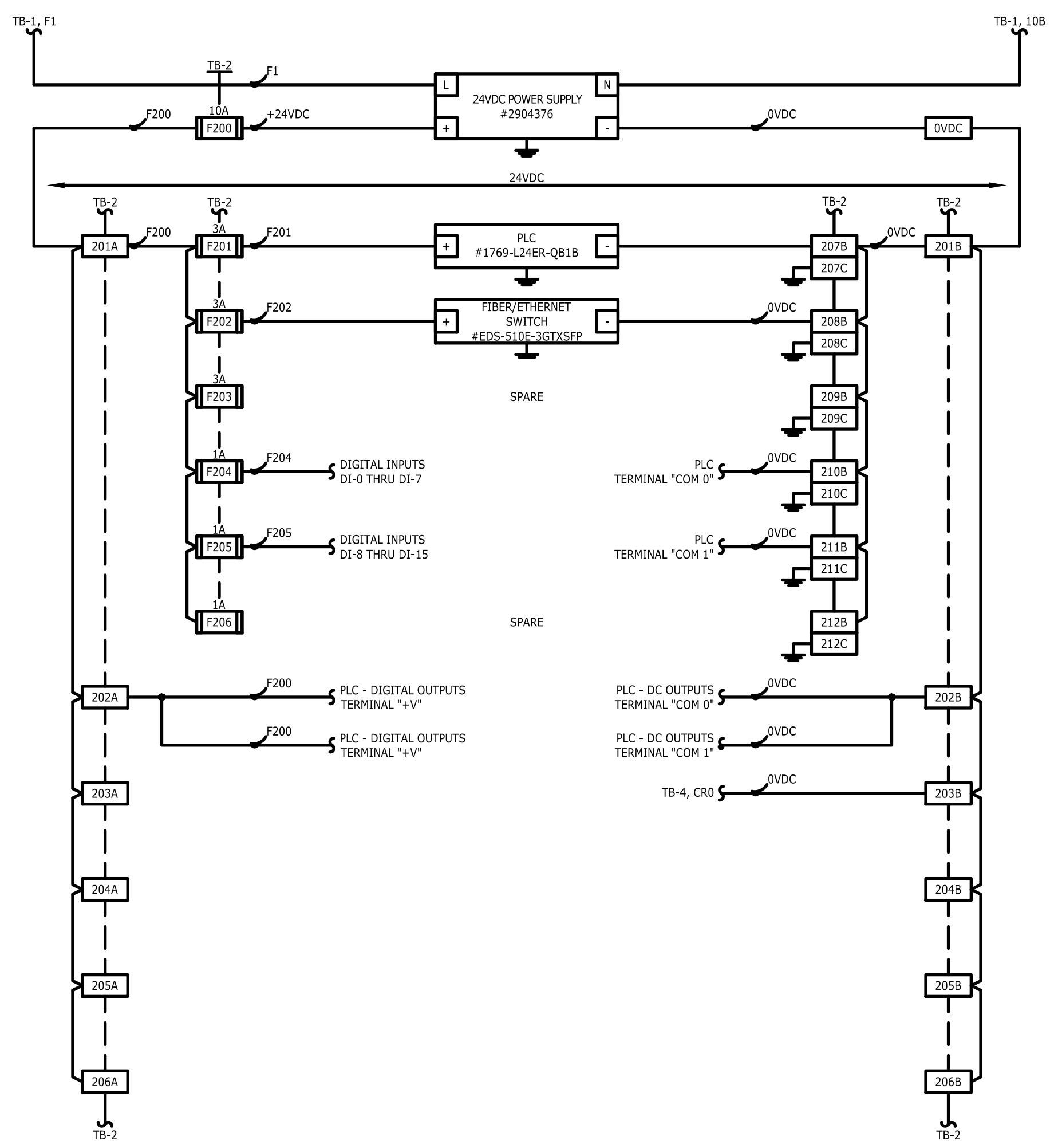
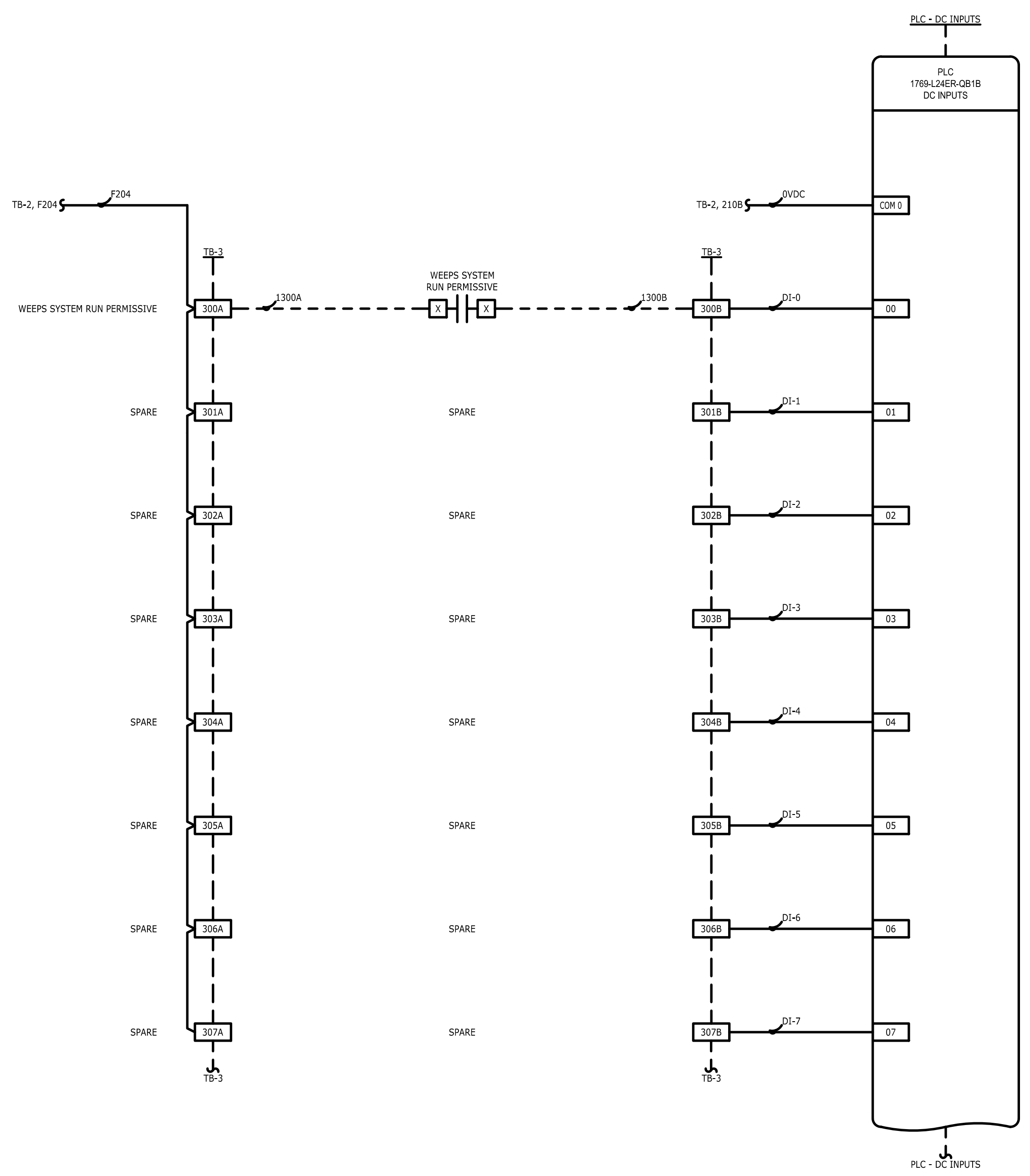


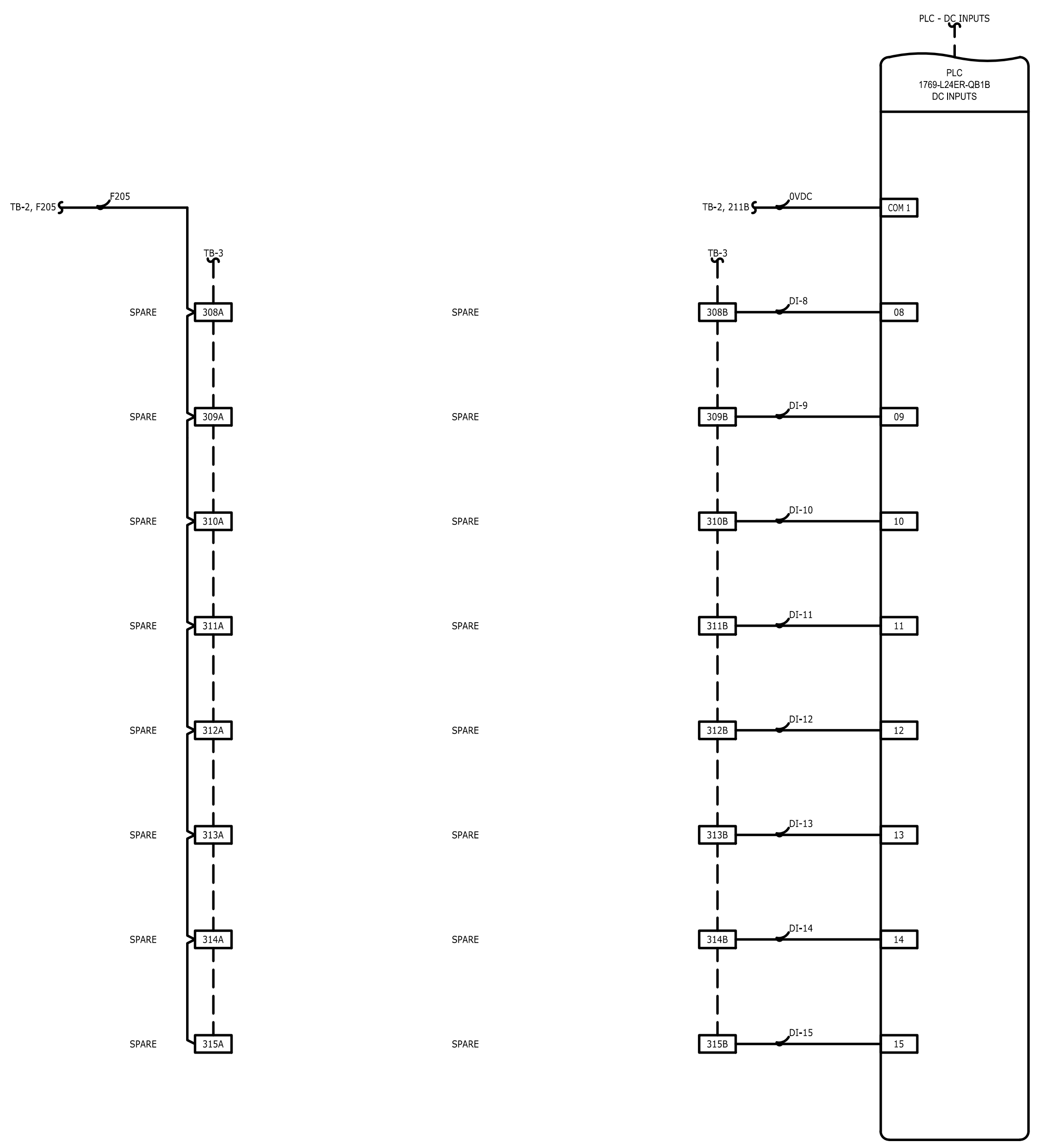
232 DETAIL
E-58 MCP 120VAC POWER DISTRIBUTION



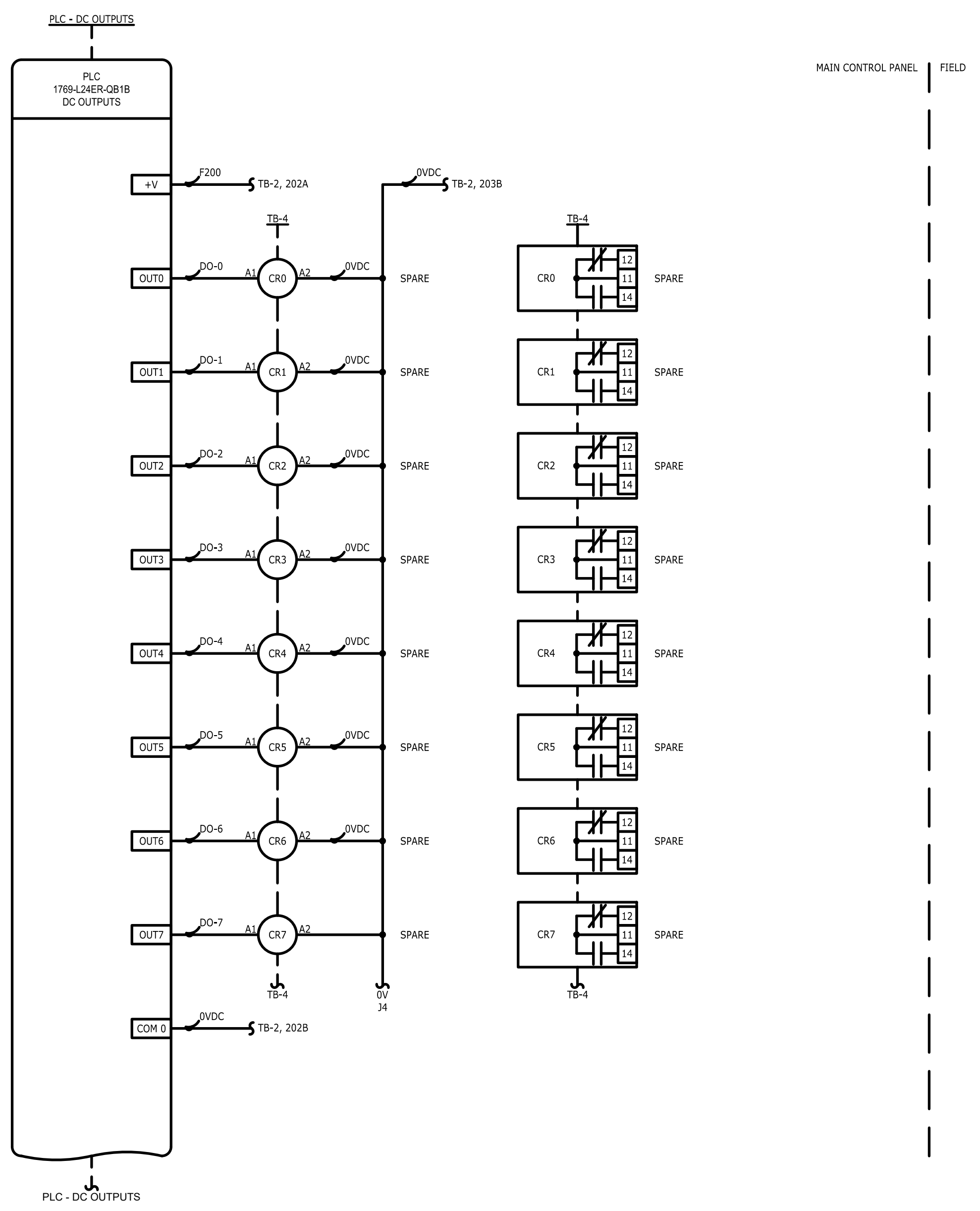
233 DETAIL
E-58 MCP 24VDC POWER DISTRIBUTION



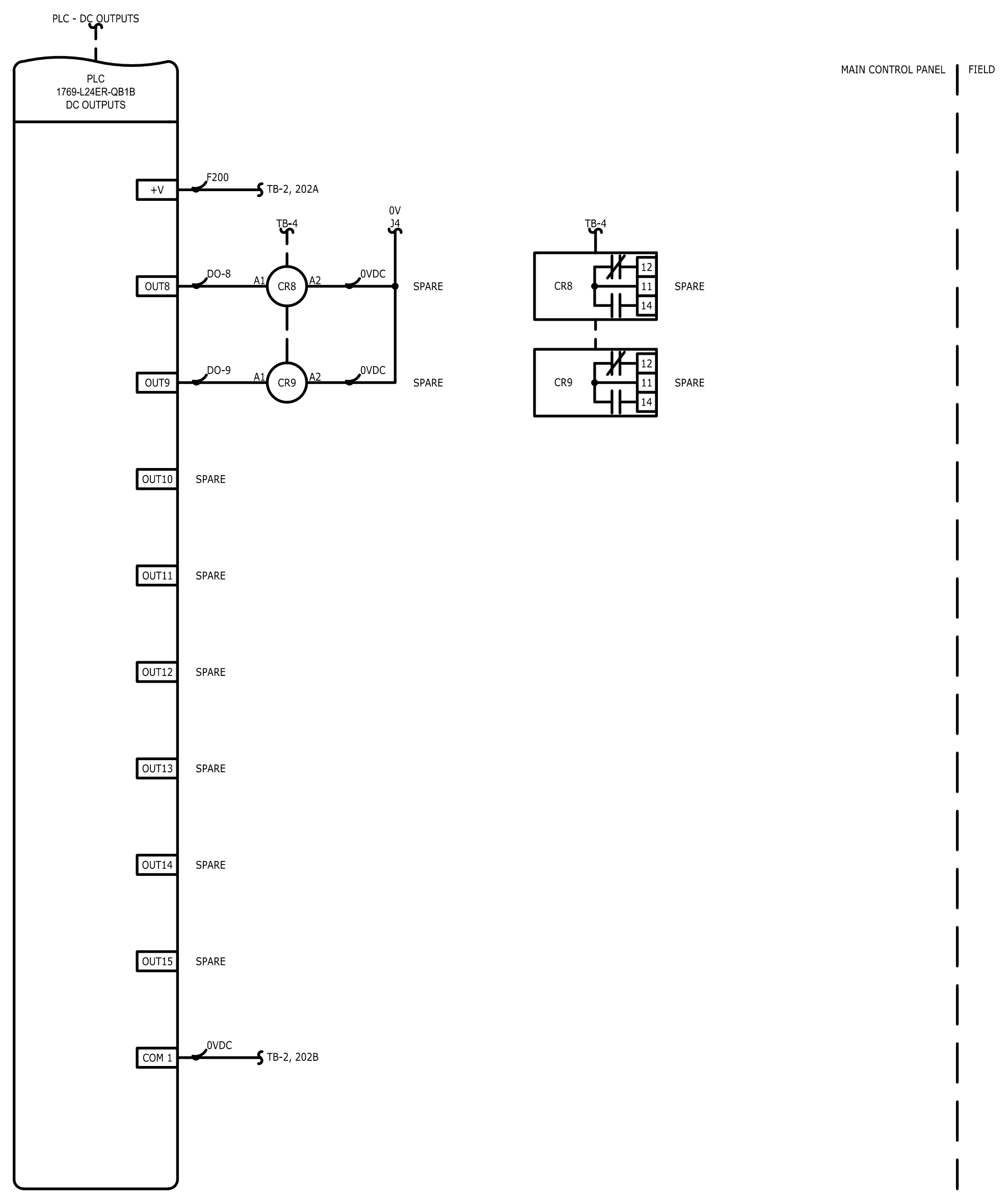
234 DETAIL
E-58 MCP PLC DIGITAL WIRING DIAGRAM I



235 DETAIL
E-58 MCP PLC DIGITAL WIRING DIAGRAM II



236 DETAIL
E-58 MCP PLC RELAY OUTPUTS WIRING DIAGRAM I



237 DETAIL
E-58 MCP PLC RELAY OUTPUTS WIRING DIAGRAM II

NOTES:

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RALEIGH, NC 27607
919.870.0576

TITLE: MAIN CONTROL PANEL (MCP)
POWER DISTRIBUTION

PROJECT: THE CHEMOURS COMPANY
GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM

SITE: FAYETTEVILLE WORKS SITE

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APPROVED BY:	JJD		

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Attachment B
Technical Specifications

SECTION 01 31 00

PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SCOPE

A. This Section includes administrative and supervisory requirements necessary for coordinating construction operations including, but not necessarily limited to, the following:

1. General project coordination procedures.
2. Project Roles.
3. Coordination Drawings, including Site Logistics Plans.
4. Cleaning and protection.

B. **Related Sections:** The following Sections contain requirements that relate to this Section:

1. Project Overview.
2. Section 01 33 00 – Submittal Procedures for description of the submittal process.

1.2 PROJECT ROLES

A. **Owner**

1. Ultimate decision authority and responsibility for project success.
2. Facilitate construction adherence to corporate H&S practices, procurement practices, site access and site security.

B. **Design Engineer & Construction Observation (CO) Engineer**

1. The Design Engineer shall
    a. Respond to Requests for Information (RFIs) and submissions from contractors and CM.
    b. Be responsible for the approval of proposed products to be furnished.
    c. Review any non-conformance and corrective actions identified by the Construction Oversite and Quality Assurance Engineer.
    d. Review and approve changes to the design, as necessary.
2. The CO Engineer shall be a representative of the Design Engineer.
3. The CO Engineer shall be responsible for observing whether the installation of the system meets design intent.

C. Construction Quality Assurance (CQA) Engineer

1. The CQA Engineer is responsible for providing managerial oversight during the completion of the Work.
2. The CQA Engineer shall:
    a. Ensure general conformance to design and schedule of the Work.
    b. Report construction nonconformance and corrective actions to the Design Engineer.
    c. Facilitate RFI and Submittals process from subcontractors during construction.
    d. Conduct appropriate inspection and testing of installed systems.
    e. Maintain thorough documentation of constructed systems (daily summaries, photologs, test reports, checklists etc.).

D. Construction Manager:

1. The Construction Manager is the responsible party for the Construction portion of the Work, as identified in the Project Overview.
2. The Construction Manager shall:
    a. Coordinate acquisition of necessary permits.
    b. Ensure overall conformance to Health and Safety requirements.
    c. Be responsible for overall management of construction subcontractors onsite.
    d. Manage schedule and construction project controls.
    e. Be responsible for RFI and Submittal coordination.
    f. Communicate with the Design Engineer on engineering design related aspects.
    g. Ensure general adherence to quality construction standards and proper techniques.
    h. Oversee general adherence to governing project documents such as Site-Specific HASP and Erosion and Sediment Control Plan.

E. Earthwork Contractor

1. The Earthwork Manager is responsible for:
    a. Clearing and grading of the conveyance alignment, extraction well locations, and associated GWEC infrastructure.
    b. Trenching, backfill, and erosion and sediment control for subsurface lines.
    c. Procurement and installation of concrete pads for the extraction well locations.
    d. Adherence to erosion and sediment control practices.

F. Mechanical Contractor

1. The Mechanical Contract Manager is the responsible party for the installation of forcemain piping and appurtenances.
2. The Mechanical Contract Manager shall:
    a. Complete installation of forcemain piping
    b. Complete installation of pipe fittings, valving and fasteners for wellhead fixtures and forcemains.
    c. Installation of instrumentation provided by the Instrumentation Contractor.
    d. Storage and appropriate use of spare instrumentation as provided by the Instrumentation Contractor.
    e. Testing of all components installed and final assembled product.
    f. Install instrumentation provided by the instrumentation contractor, including:
        i) Submersible Pumps
        ii) Flowmeters
        iii) Level Sensors
        iv) Pressure Transmitters
        v) Wellhead Box Position Switches
3. Procurement and installation of:
    a. Valves, piping, fittings, and fasteners
    b. Well enclosures
    c. Bollards for extraction wells

G. Drilling Contractor

1. The Drilling Manager is the responsible party for the drilling activities related to the installation of extraction and monitoring wells, as described in the Project Overview
2. The Drilling Manager shall oversee:
    a. Mobilization and demobilization of between two and four rigs.
    b. Installation of extraction wells using sonic drilling methods.
    c. Installation of monitoring wells.
    d. Procurement of all necessary materials for well installation (i.e., well casing, bentonite, well screens, etc.).
    e. Well development and hydraulic step testing.
    f. Management of investigation derived waste (IDW) from well installation activities.
    g. Adherence to local, state, and federal regulations on environmental drilling and well completion.

H. Electrical Contractor

1. The Electrical Manager will be the responsible party for installation activities related to the electrical design of the GWEC system, as described in the Project Overview
2. The Electrical Manager shall oversee:
    a. Acquisition of relevant permits and inspections.
    b. Installation of high voltage lines and 120/240 transformers in coordination with Four County EMC.
    c. Procurement and installation of:
        i) Wires
        ii) Panel boards and main disconnects
        iii) Termination boxes
        iv) Light poles
        v) Transfer Switches
        vi) Fiber Optic and ethernet Cables
        vii) Conduits
    d. Connection of electrical service to control panels.
    e. Procurement and installation of GFI outlets at panels.
    f. Procurement of necessary materials and installation of concrete pads for panels and light poles.
    g. Procurement and installation of fiber optic and ethernet cable for communications.
    h. Procurement and installation of power infrastructure for instrumentation and pumps.
    i. Procurement and installation of area lighting.
    j. Procurement and installation of materials necessary for grounding all components, as appropriate.
    k. Installation of remote-control panels and MCP provided by others.
    l. Wiring of instrumentation installed by the mechanical contractor, including;
        i) Submersible Pumps
        ii) Flowmeters
        iii) Level Sensors
        iv) Pressure Transmitters
        v) Wellhead Box Position Switches
    m. Testing of all components installed and final assembled product.

I. Instrumentation, Communications, and Control Panel Contractor

1. The Instrumentation Manager shall be responsible for the installation of the instrumentation, communications, and control panel design of the GWEC system, as described in the Project Overview
2. The Instrumentation Manager shall oversee:
    - a. Procurement, fabrication, and assembly of 17 remote panels, 1 MCP, and the operator workstation.
    - b. Provision of operators for programming support and network configuration.
    - c. Field connection of instrumentation to MCP terminal strips.
    - d. Instrumentation and communication loop checks.
    - e. Start-up and Shakedown of panels and communications.
    - f. Procurement and assembly of panel components, including:
        - i) Panel enclosures
        - ii) Position switches
        - iii) Variable Frequency Drives (VFDs)
        - iv) Human-Machine Interfaces (HMIs)
        - v) Programable Logic Controllers (PLCs)
        - vi) Input/Output modules
        - vii) Fuses
        - viii) Panel mounted disconnects
        - ix) Uninterrupted Power Supply (UPS)
        - x) Cooling unit, breakers, surge protection, 24 VDC power supply, Ethernet switches, MODBUS etc…
    - g. Procurement and transfer to the mechanical contractor of:
        - i) Submersible pumps
        - ii) Flowmeters
        - iii) Level sensors
        - iv) Pressure transmitters
        - v) Wellhead box position switches
    - h. Procurement of an appropriate number of spares to be stored onsite by the Construction Manager and Mechanical Contract Manager to be utilized as needed.

1.3 COORDINATION

A. The Construction Manager shall coordinate construction activities included in the various Sections of these Specifications to assure efficient and orderly installation of each part of the Work.

1. Schedule construction operations in the sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
3. Make provisions to accommodate items scheduled for later installation.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

PART 2 PRODUCTS

Not Applicable.

PART 3 EXECUTION

3.1 GENERAL COORDINATION PROVISIONS

A. Construction Mobilization**:**

1. Cooperate with the Construction Manager and CQA Engineer in the allocation of mobilization areas of the site, for field offices and sheds, for agency facility access, traffic, and parking facilities.
2. During Construction, coordinate use of site and facilities through the Construction Manager and CQA Engineer.
3. Comply with Construction Manager and CQA Engineer procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
4. Comply with instructions of the Construction Manager and CQA Engineer for use of temporary utilities and construction facilities.

B. The Construction Manager and CQA Engineer will meet with the Contractor(s) on all major items of coordination.

1. If the coordination meeting fails to resolve coordination conflicts, the Contractor shall indicate the nature of such conflicts in a detailed RFI, proposing the most economical solution.
2. The Contractor shall not permit work by trades to proceed in a given bay or area until all trade foremen agree on the exact arrangements for each area. If a given trade proceeds prior to trades approval, then if necessary, that trade shall revise their work, if necessary, at no extra cost, in order to permit other trades to proceed.

C. The Contractor shall coordinate required inspections and tests.

D. Construction Demobilization:

- Coordinate demobilization from site through the Construction Manager and CQA Engineer.
- Comply with Construction Manager and CQA Engineer procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- Comply with instructions of the Construction Manager and CQA Engineer for decommissioning of temporary utilities and deconstruction of temporary facilities.

3.2 CLEANING AND PROTECTION

A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering, where required, to assure protection from damage or deterioration.

B. Clean and provide maintenance on completed construction as construction per manufacturers requirements through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.

C. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURE

PART 1 GENERAL

1.1 SCOPE

A. Section Includes:
   1. Contractor’s Responsibilities.
   2. Transmittal Procedure.
   3. Review Procedure.
   4. Liability.

1.2 CONTRACTOR'S RESPONSIBILITIES

A. Where required by the specifications, the Contractor shall submit descriptive information which will enable the Construction Manager and Design Engineer to advise the Owner whether the Contractor's proposed materials, equipment or methods of work are in general conformance with the design concept and are in compliance with the drawings and specifications. The information to be submitted shall consist of drawings, specifications, descriptive data, certificates, samples, test results, project controls requirements and other such information, all as specifically required in the specifications and in the contract.

B. The Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall ensure that the material, equipment, or method of work shall be as described in the submittal. Submittals shall contain all required information, including satisfactory identification of items, units, and assemblies in relation to the contract drawings and specifications. The Contractor shall verify that the material and equipment described in each submittal conforms to the requirements of the specifications and drawings. Unless otherwise approved by the Construction Manager or Design Engineer, submittals shall be made only by the Contractor, who shall indicate by a signed stamp on the submittals that the Contractor has checked the submittals and that the work shown conforms to contract requirements and has been checked for dimensions and relationship with work of all other trades involved. If the information shows deviations from the specifications or drawings, the Contractor, by statement in writing accompanying the information, shall identify the deviations and state the reason(s) therefore. The Contractor shall ensure coordination of submittals among the related crafts and subcontractors.

C. The Contractor may authorize a material or equipment supplier to deal directly with the Engineer with regard to a submittal. The Contractor, however, shall be responsible for the accuracy and completeness of information contained in all submittals.

D. Types of Submittals: Submittals are listed in individual sections and including but not limited to those detailed below.

   1. Shop drawings, reviewed and annotated by the Contractor
   2. Product data sheets

E. Submit applicable manufacturer’s literature describing the product manufacturer’s recommendations and instructions for installation, monitoring, operation and maintenance procedures for the products required on the Design Drawings and outlined in other specifications. Provide manufacturer’s product data sheets and brochures on each product and all related equipment and accessories.

F. It is the Contractor’s responsibility to provide the necessary information about the products to the Design Engineer, obtain the approval for, and to procure the approved products – all in a timely manner so as not to delay the overall schedule.

   1. Physical samples, as needed for testing.
   2. Work Plan

G. Work Plan shall demonstrate compliance with the requirements outlined in the in related Sections and Design Drawings. The Work Plan shall include a detailed narrative description; proposed sequencing, details, and means and methods of all related operations; shop drawings; manufacturer's cut, data, and specification sheets, and all other supporting data for proposed effort including, but not limited to, the following:

   1. Means and Methods, including equipment and machinery, stage, and sequence of work.
   2. Methods of monitoring work progress.
   3. Plans and details for methods of protecting existing utilities and structures to remain in place including, but not limited to, restrictions on use of equipment over or adjacent to existing structures and utilities.
   4. Plans and means and methods for protecting the existing/installed wells, wellheads, forcemains and instrumentation from damages during the construction.
   5. Anticipated difficulties and proposed resolutions.

H. Quality Control (QC) Plan

   1. Provide the testing and documentation procedures to be performed.

2. Include a general description of the Work, focusing on the components addressed in the QC Plan.
3. Description of the organization completing the Work. Include tables and charts showing the project organization lines of authority and communication matrix. Key individuals from the organization should be identified.
4. Describe the QC procedures that will be used for inspection, testing, and management of data. At a minimum, procedures should be provided for the evaluation of the following:
    a. Pressure testing
    b. Electrical permitting and testing
    c. Trench compaction testing
    d. Instrumentation scaling
5. Forms referenced in the document should be included in an appendix to the plan.
6. Inspection and test reports
7. Warranties
8. Survey data
9. Schedule, procurement, Work Breakdown Structure and Project Controls required submittals
10. As-built Drawings, Surveys, and Report
    a. Includes installation logs, location plan, surveyed coordinates of the final installed products, photographic logs of installation, instrument serial numbers, factory calibration records, instrument calibration factors, and Baseline Readings.
11. Closeout submittals
12. Daily Construction Reports and Project photographs
    a. To be prepared by the Construction Manager and provided to the Design Engineer with 48 hours of the completed workday.
    b. Brief description of materials placed, including forcemains, wellhead assemblies, panels.
    c. QC testing record logs with test location and method used, test results and conformance of results with requirements listed in the specifications, and description on resolution of non-compliant test results.
    d. A list of deviations from the Design Drawings or Specifications.
    e. Details of any delays that may impact the project schedule, areas that need improvement, and proposed solutions.

1.3 TRANSMITTAL PROCEDURE

A. General: Submittals regarding material and equipment shall be accompanied by a transmittal form from the Contractor. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete specification sections for which a submittal is required. However, submittals for various items shall be made with a single form only when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.

B. Submittal Identification: Each set of submittals or samples shall be attached to the submittal transmittal form. The submittal number shall be made up of two parts: GW Design – Title -YYYYMMDD - ZZ. The Title shall be a descriptive title identifying what the content of the submittal is. The ZZ shall be the sequential number of a specific submittal or resubmittal (01 for the first submittal, 02 for the first resubmittal, etc.). The yyyymmdd should indicate the year, month, and day that the document was transmitted. All submittals shall show the contract title, shall indicate the name of the vendor, and shall indicate when the equipment and/or material will be required by the construction schedule. The submittal must be adequate to permit a comprehensive review without further reference to the Contractor. The documents submitted must be separately identifiable on the Contractor's submittal transmittal form.

C. Deviation from Contract: If the Contractor proposes to provide material or equipment which does not conform to the specifications and drawings, this shall be indicated under a "deviations" section on the submittal transmittal form accompanying the submittal copies.

  1. Where the phrase "or equal" or "or equivalent" occurs in the Contract Documents, Design Drawings, or Specifications, do not assume that materials, equipment, or methods will be approved as equal unless the item has been specifically approved for this work by the Construction Manager or Design Engineer.

D. Submittal Completeness: Submittals which do not have all the information required to be submitted, including deviations, shall be considered (at the discretion of the Construction Manager or Design Engineer) as not complying with the intent of the contract and are not acceptable and will be returned requesting resubmittal with relevant information.

1.4 REVIEW PROCEDURE

A. When the Contract requires a submittal, the Contractor shall submit the specified information as follows to the Construction Manager or Design Engineer for review:

1. One (1) legible copy (either electronic or hard copy) of all the submitted information.

2. One (1) set of sample materials need to be submitted.

B. Within 10 calendar days after receipt of the submittal by the Design Engineer, the submittal will be reviewed, and a marked-up copy will be returned to the Contractor. On complex drawings and equipment, the Design Engineer shall acknowledge receipt within 10 days and advise the Contractor when the submittal will be returned. The returned submittal shall indicate one of the following actions.

1. If the review indicates that the material, equipment or work method is in general conformance with the design concept and complies with the drawings and specifications, submittal copies will be marked "REVIEWED". In this event, the Contractor may begin to implement the work method or incorporate the material or equipment covered by the submittal.

2. If the review indicates limited corrections are required, copies will be marked "REVIEWED AS NOTED". The Contractor may begin implementing the work method or incorporating the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in operation and maintenance data, a corrected copy shall be provided. Otherwise, no resubmittal will be required.

3. If the review reveals that the submittal is deficient or contains incorrect data, copies will be marked "REVISE AND RESUBMIT". The Contractor shall not undertake work covered by this submittal until the submittal has been revised, resubmitted and returned marked either REVIEWED" or "REVIEWED AS NOTED ".

4. If the review indicates that the material, equipment, or work method is not in general conformance with the design concept or in compliance with the drawings and specifications, copies of the submittal will be marked "REJECTED". Submittal with deviations which have not been identified clearly may be rejected. The Contractor shall not undertake work covered

by such submittal until a new submittal is made and returned marked either "REVIEWED" or "REVIEWED AS NOTED".

5. If it is determined that the submittal does not require review or is not for Design Engineer review, copies of the submittal will be marked “NOT REVIEWED”.

C. Resubmittals shall include the entire submittal package. No changes shall be made by the Contractor on resubmittals other than those changes indicated on the reviewed submittal, unless such changes are clearly described in a letter or the transmittal form accompanying the resubmittal. Changes shall be clearly indicated and use revision clouds where applicable.

1.5 LIABILITY

A. Review of drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide shall not relieve the Contractor of responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the Design Engineer, the Construction Manager or the Owner, or by any officer, employee or subcontractor thereof, and the Contractor shall have no claim under the contract on account of the failure or partial failure of the method of work, material, or equipment so reviewed. A mark of "REVIEWED" or "REVIEWED AS NOTED" shall mean that the Owner has no objection to the Contractor, upon its own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

[END OF SECTION]

SECTION 01 35 29

HEALTH, SAFETY, AND EMERGENCY RESPONSE REQUIREMENTS

PART 1 GENERAL

1.1 SCOPE

A. Section Includes:

  1. General Requirements.
  2. References.
  3. Submittals.
  4. Health and Safety Plan.
  5. Medical Surveillance Requirements.
  6. Training Requirements.
  7. Responsibilities.

1.2 GENERAL REQUIREMENTS

A. Site activities in conjunction with this Work may pose unique safety and chemical and physical exposure hazards, which require specialized expertise to effectively address and eliminate. The Contractor shall be responsible for preparing and implementing a detailed, effective Site-Specific Health & Safety Plan (HASP). At a minimum this HASP shall meet the requirements, procedures and protocols set forth in this section. The Contractor shall amend this HASP as necessary to reflect proposed operations and activities associated with the Work. The HASP will be subject to review and comment by the Owner and/or the Construction Manager, and any review comments must be addressed prior to the initiation of any on-site activities.

Due to the nature of this work and safety hazards associated with this type of operation, a thorough evaluation of the site and implementation of safety procedures is necessary to reduce the potential for accidents and to minimize risks to workers and visitors.

All health and safety procedures, precautions, and personal protective equipment (PPE) to be employed during construction shall be specified in detail in the Contractor HASP. The HASP must contain adequate details to address the potential health and safety concerns that may be encountered for each task and operation, as required by OSHA standards 29 CFR 1910.120 and 1926.65. Careful attention is necessary in the preparation of this document to ensure that all requirements of these regulations pertaining to HASPs are adequately addressed. No field work shall begin until the HASP and Exhibits 1-3 have been submitted. Additionally, the Contractor shall ensure that safety and health provisions are followed by all their employees and any lower tiered subcontractors, suppliers and support personnel.

B. Contractor shall conduct a preconstruction safety conference (point of action discussion – POAD) prior to the start of site activities and after submission of the HASP. The objective of the meeting will be to discuss health and safety concerns related to the impending work, discuss health and safety organization and expectations, review and answer comments and concerns regarding the HASP or other health and safety concerns the Contractor may have. Contractor shall ensure that those individuals responsible for health and safety for the Work are available and attend this meeting.

C. Contractor shall comply with safety requirements as directed by the Owner including POAD and Project Safety Analysis (PSA) processes.

D. The Contractor shall also provide morning safety briefings to discuss elements of that day's planned activities and items that may be the focus of near miss or actual incidents.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

A. CODE OF FEDERAL REGULATIONS

29 CFR 1910	Occupational Safety and Health Standards for General Industry – all applicable sections, with emphasis on, but not limited to, the following:
29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
29 CFR 1910.95	Occupational Noise Exposure
29 CRF 1910 Subpart I	Personal Protective Equipment
29 CFR 1910 Subpart P	Hand and Portable Powered Tools and other Hand-Held Equipment
29 CFR 1910.1200	Hazard Communication
29 CFR 1926	Safety and Health Regulations for Construction – all applicable sections, with emphasis on, but not limited to, the following:
29 CFR 1926 Subpart C	General Safety and Health Provisions

29 CFR 1926 Subpart D	Occupation Health and Environmental Controls – Including the following specific parts:
29 CFR 1926.52	Occupational Noise Exposure
29 CFR 1926.59	Hazard Communication
29 CFR 1926.65	Hazardous Waste Operations and Emergency Response
29 CFR 1926.103	Respiratory Protection
29 CFR 1926 Subpart E	Personal Protective and Life Saving Equipment
40 CFR 260-270	Environmental Protection Agency (EPA) Hazardous Waste Requirements

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) PUBLICATIONS

Z88-2 American National Standard for Respiratory Protection

C. U.S. ENVIRONMENTAL PROTECTION AGENCY PUBLICATIONS

600/4-84/075 Characterization of Hazardous Waste Sites - A Methods Manual, Volume I - Site Investigations

D. OWSER Directive

9234.1-02 CERCLA Compliance with other Laws Manual

9285.1-03 EPA 1992 Standard Operating Safety Guidelines (SOSG)

E. NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

DHHS (NIOSH) NIOSH/EPA/USCG/ EPA Occupational Safety and Pub. # 85-115 Health Guidance manual for Hazardous Site Activities

DHHS (NIOSH) NIOSH Guide to Industrial Respiratory Protection Pub. # 85-116

DHHS (NIOSH) NIOSH Certified Equipment Pub. # 90-102

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 Submittal Procedures:

A. Site-Specific Health and Safety Plan (HASP)

B. Health and Safety Certificates

1. OSHA Compliance Training
2. Training Documentation, 40-hour HAZWOPER, and current 8-hour Refresher
3. Medical Clearance letter

1.4 HEALTH AND SAFETY PLAN

A. Site-specific health and safety procedures are required due to the hazardous conditions potentially present onsite during remedial and construction activities. The Contractor shall develop and maintain on site at all times during performance of the work, a HASP detailing the safety and health procedures at this site and shall obtain acceptance of the plan by the Owner and/or the Construction Manager prior to the initiation of the work. Contractor shall implement, maintain, and enforce these procedures prior to and during all phases of the Work. Should any unforeseen or site-specific safety factors, health hazards, or conditions become evident during the performance of the work, the Contractor shall notify the Owner and/or the Construction Manager verbally and in writing as soon as possible for resolution. Contractor shall take prudent action to establish and maintain safe working conditions and to safeguard employees, the surrounding community, and the environment.

B. The HASP shall comply with all federal, state, and local, and site-specific health and safety requirements (including but not limited to those referenced in this Section).

1.5 MEDICAL SURVEILLANCE REQUIREMENTS

A. All Contractor and subcontractor personnel entering contaminated areas of the site must have completed a medical examination by a licensed, board-certified physician specializing in occupational medicine complying with the requirements of 29 CFR 1910.120 and 1926.65 within 12 months prior to entering the site. Written certification, signed by the physician, of fitness for work and ability to wear required respiratory protection shall be provided to the Owner and/or the Construction Manager prior to assigning personnel onsite.

B. Non-scheduled medical examinations shall be conducted under one or more of the following circumstances:

    1. After acute exposure to any toxic or hazardous material;
    2. At the discretion of the Contractor Site Safety Officer and the occupational physician when an employee has been exposed to dangerous levels of toxic or hazardous materials;
    3. At the discretion of the Contractor Site Safety Officer and the occupational physician, and at the request of an employee with demonstrated symptoms of overexposure to toxic or hazardous materials.

C. Medical Records (29 CFR 1910.120)

The Contractor shall maintain complete and accurate records of employee's medical examinations and exposure data for at least 30 years (or longer, if required by federal, state, or local requirements) after termination of employment. And shall make records of the required medical examination and exposure data available for inspection and copying to appropriate local, state, and/or federal regulatory agencies, or authorized representative of them, and an employee's physician upon the request of the employee or former employee. Medical records are not to be submitted to the Owner or the Construction Manager.

1.6 TRAINING REQUIREMENTS

A. Qualified personnel shall certify that all Contractor personnel (including visitors) entering the Exclusion or Contamination Reduction Zones have received appropriate health and safety training in accordance with 29 CFR 1910.120 and 29 CFR 1926.65. Initial training shall consist of a minimum of 40 hours offsite and 3 days of actual field experience under the direct supervision of a trained experienced supervisor. This training will be updated annually with a minimum of 8 hours of training. In addition, Contractor’s supervisory personnel shall have a minimum of 8 hours of additional specialized training on recognizing and managing health and safety concerns in hazardous waste operations. This supervisory training also carries an annual refresher training requirement that must be satisfied. The Contractor may request to reduce the initial training requirement to 24 hours upon providing documentation that workers who are selected for the 24-hour training are in compliance with 1910.120 and 1926.65 paragraphs (e)(3)(ii.) or (iii.).

B. In addition to the above training, prior to entering contaminated areas, all personnel (including visitors) shall be provided site-specific training and shall read the HASP and be familiar with the use of safety, respiratory, and protective equipment, and with the health, safety, and security procedures. The Contractor shall maintain documentation of site-specific training on site and must make all training and medical surveillance documentation available to the Owner and/or the Construction Manager upon request. The site-specific briefing shall also include a review of the hazard communication program in accordance with 29 CFR 1910.1200.

C. The Contractor shall have at least one personnel certified in First Aid and CPR on site during all site activities, who must be certified by the American Red Cross or other approved agency in First Aid and CPR. The Contractor shall provide the names(s) of all first aid/CPR certified personnel and copies of the current first aid and CPR certification(s) prior to setup of work operations.

1.7 RESPONSIBILITIES

A. Site Safety and Health Officer

The Contractor shall designate one (1) person to function as the Site Safety and Health Officer (SSHO). The SSHO shall be at the Work site at all times the work is being conducted by the Contractor, unless otherwise approved by Owner and/or the Construction Manager, to perform safety and occupational health management, surveillance, inspections, and safety enforcement for the Contractor. The SSHO’s training, experience, and qualifications shall be submitted for approval prior to the start of construction. Responsibilities of the SSHO include:

1. Conduct daily safety and health inspections and maintain a written log, which includes area/operation inspected, date of inspection, identified hazards, recommended corrective actions, estimated and actual dates of corrections.
2. Conduct incident/mishap investigations and complete required reports.
3. Maintain applicable safety reference material on the job site.
4. Ensure subcontractor compliance with safety and health requirements.
5. Maintain a list of hazardous chemicals on site and their safety data sheets (SDS).
6. Conduct equipment, tools, and supplies inspections and remove or lock out defective equipment or tools to prevent further usage.

B. Safety and Health Compliance

In addition to the requirements detailed in this specification, the Contractor shall comply with the laws, ordinances, criteria, rules, and regulations of federal, state, regional, and local authorities regarding handling, sampling, and storing of hazardous wastes. Any disregard for the provision of these Specifications shall be deemed just and sufficient cause of termination of this contract. The Contractor shall also provide morning safety briefings to discuss elements of that day's planned activities and items that may be the focus of near miss or actual incidents.

C. Hazard Communication Program

The Contractor and Subcontractor shall establish a Hazard Communication Program as required by 29 CFR 1910.1200 and 29 CFR 1926.59.

D. Site Equipment

The Contractor shall provide well-maintained equipment suitable to carry out the Work. All equipment brought on-site will be subjected to an equipment inspection prior to commencement of on-site activities. All repairs to be made will be completed prior to the commencement of Work. Should the required repairs cause a delay the Contractor will be fully responsible for any impact on schedule and associated costs.

E. Permits

No Health and Safety permits are required, but substantive requirement of all applicable regulations must be met.

F. Requirements and Restrictions for Heavy Equipment

Any heavy equipment (e.g., bulldozers, forklift trucks, front-end loaders, etc.) brought to the site must be in proper and safe working order, and have all manufacturer's provided guarding devices and safety belts securely in place. Each piece of equipment shall have an approved and inspected fire extinguisher.

All vehicle operators must be properly trained and licensed and must be able to provide proof of such training prior to being permitted to operate the machinery.

If any maintenance is required on elevated surfaces, appropriate fall protection devices (fall arrest devices such as belts, lanyards, fall protection slide rail, or ladders that meet the requirements of applicable OSHA and ANSI standards) must be provided by the Contractor, and properly used.

Only equipment approved by the equipment manufacturer may be used in conjunction with heavy equipment. Additional requirements and restrictions may be specified in the Contractor HASP, or other site documents.

PART 2 PRODUCTS

Not Applicable.

PART 3 EXECUTION

3.1 SITE-SPECIFIC HEALTH AND SAFETY PLAN

In addition to the direction on HASP preparation specified in Part 1 of this Section, the following additional direction is also relevant for the HASP.

A. The Contractor shall prepare a site-specific HASP that will govern their activities throughout this Work. The following standards from 40 CFR 1926 are a partial listing of requirements that must be considered and addressed (as applicable) to the planned Scope of Work. The Contractor is responsible for identifying any other requirements that may apply to the planned scope of work and addressing them in their HASP:

- General Safety and Health Provisions
- Occupational Health and Environmental Controls
  - ⇒ 1926.50 - Medical services and first aid
  - ⇒ 1926.52 - Occupational noise exposure
  - ⇒ 1926.55 - Gases, vapors, fumes, dusts, and mists
  - ⇒ 1926.59 - Hazard communication
  - ⇒ 1926.64 - Process safety management of highly hazardous chemicals
  - ⇒ 1926.65 - Hazardous Waste Operations and Emergency Response
- Personal Protective Equipment and Life Saving Equipment (1926.95- .103)
  - ⇒ 1926.95 - Criteria for personal protective equipment
  - ⇒ 1926.96 - Occupational foot protection
  - ⇒ 1926.100 - Head protection
  - ⇒ 1926.101 - Hearing protection
  - ⇒ 1926.102 - Eye and face protection
- Fire Protection and Prevention
  - ⇒ 1926.150 - Fire protection
  - ⇒ 1926.151 - Fire prevention
  - ⇒ 1926.152 - Flammable and combustible liquids

- Materials Handling, Storage, Use, and Disposal
  - ⇒ 1926.251 - Rigging equipment for material handling
- Tools - Hand and Power
  - ⇒ 1926.300 - General requirements
  - ⇒ 1926.301 - Hand tools
  - ⇒ 1926.302 - Power operated hand tools
- Motor Vehicles and Mechanized Equipment
  - ⇒ 1926.600 - Equipment
  - ⇒ 1926.601 - Motor vehicles
  - ⇒ 1926.604 - Site Clearing

B. The HASP must include, at a minimum, the following required elements:

1. Site overview and site control measures, including a site map showing the limits of work and staging areas.
2. Names, telephone numbers, and organizations of key personnel and alternates responsible for site safety and health,
3. A safety and health (chemical, electrical, and physical) risk or hazard analysis for each site task and work operation.
4. Employee training requirements and records.
5. Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used.
6. Emergency Response Plan and contingency procedures, including onsite first aid and emergency equipment.
7. Spill containment procedures.
8. Site postings, logs, reports, and record keeping.
9. Map, telephone number, and directions to nearest hospital.

C. The HASP shall also address how and where the inventory of hazardous chemical substances supplied by the Contractor and lower tier subcontractors will be prepared and maintained, and also shall address the collection and maintenance of SDSs at the work site. Include in the HASP provisions related to initial site preparation prior to implementation of the remedial activities described in the contract. It shall be the responsibility of the Contractor to conduct whatever testing and monitoring is necessary to assure safe operations during the initial site preparation work.

D. Should the Contractor seek relief from, or substitution for, any portion or provision of the HASP, the Contractor shall submit such requests to Owner and/or the Construction Manager and Engineer in writing. If approved, authorization will be provided in writing.

E. Establish Procedures for Weather-Related Problems

Weather conditions can affect site work and impact personnel safety. Work practices shall be written to account for extremes in weather conditions and the potential impact of these conditions on work safety onsite and public safety offsite. Procedures shall be specified to suspend or halt work under given environmental conditions.

F. Unforeseen Conditions

Should any unforeseen potentially hazardous condition become evident during the performance of work at the site, it shall be the Contractor's responsibility to bring such to the attention of the Owner and/or Construction Manager for resolution. In the interim, the Contractor shall implement all necessary prudent action to establish and maintain safe working conditions and to safeguard employees, the public, and the environment.

3.2 SITE CONTROL

A. Daily Activities Log

The Contractor and the Construction Manager will control and document expenditures of resources, equipment, and manpower, such as through the completion of a Daily Activities Log. The format used will be mutually agreeable to both parties. The daily activities logs will be utilized to show expenditures, activities conducted, and H&S records. This document and either the field logbook entries or the Safe Work Permits will be used to document health and safety measures instituted during the daily execution of specific tasks.

B. Engineer Inspections

Inspections of work performed, materials employed, equipment, and ongoing operations will be conducted routinely by the Quality Assurance Engineer and/or Construction Manager. The inspections will focus on determining compliance with the elements specified in the HASP, or other site guidance documents as applicable (e.g., Safe Work Permits).

C. Regulatory Agency Inspections

Inspections may be conducted periodically by North Carolina Department of Environment Quality (NCDEQ) or other agencies to ensure the acceptability of all work, materials, and equipment in support of elements as defined within these specifications.

3.3 EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

A. Emergency Response and Contingency Plan

1. The Contractor shall develop site-specific emergency response and contingency plans as required by 29 CFR 1910.120 for chemical exposures, personal injury, potential or actual fire or explosion, and environmental accidents, as part of the HASP.
2. These plans shall include line of authority, evacuation procedures and routes to places of refuge or safe distances from the danger area. Instructions for possible mobilization/evacuation of the surrounding community shall also be included.

3. Contingency planning should include written spill and discharge containment/control procedures. It should address Work relevant hazardous materials or wastes with potential of spills like hydraulic oils and petroleum products used during the remedial action. Describe prevention measures, such as building berms or dikes; spill control measures and material to be used (e.g. booms, vermiculite); location of the spill control material; personal protective equipment required to clean up spills; disposal of contaminated material; and who is responsible to report the spill. Storage of contaminated material or hazardous materials must be appropriately bermed, diked and/or contained to prevent any spillage of material on uncontaminated soil. If the spill or discharge is reportable, and/or human health or the environment is threatened, the National Response Center, the state, and the Owner and/or the Construction Manager must be notified as soon as possible.

B. In Case of Emergency

The Contractor shall take diligent action to remove or reduce the cause of the emergency, to alert the Owner and/or the Construction Manager, and institute measures necessary to prevent any repetition of the conditions or actions leading to, or resulting in, the emergency. Contractor shall provide written notification of emergencies within 24 hours.

C. Emergency Medical Care

Contractor shall pre-arrange for emergency medical care services at a nearby medical facility and establish emergency routes. Additionally, the Contractor shall arrange with or notify attending medical staff of the potential for contact with contaminated skin and/or clothing.

3.4 PERSONAL PROTECTIVE EQUIPMENT (PPE) REQUIREMENTS

A. Personal Protective Equipment Procedures

The appropriate level of PPE and procedures to be followed shall be initially determined by the Contractor CIH/CSP and periodically evaluated by the SSHO based on a review of existing data, personal observation, and an air-monitoring program.

B. Personal Protective Equipment

Contractor shall provide all onsite personnel with appropriate PPE and ensure that all safety equipment and protective clothing is kept clean and well maintained. The Contractor shall establish "action levels" for airborne contaminants in the HASP. These levels shall be used in conjunction with air monitoring results and direct contact potential to determine upgrading or downgrading of PPE levels to be worn.

3.5 PERSONAL HYGIENE AND DECONTAMINATION

A. Personal Hygiene

Contractor shall specify personal hygiene concerns and requirements for this site in the HASP. Contractor shall provide and require that personnel use appropriate storage containers for used disposable clothing.

B. Decontamination Procedures

Contractor shall specify required decontamination procedures for both personnel and equipment, including procedures for removing contaminated clothing, cleaning personnel and equipment, disposing of disposable clothing, and laundering of re-useable clothing.

C. Vehicle Decontamination

Personnel engaged in vehicle decontamination shall wear PPE including disposable clothing and respiratory protection consistent with the requirements of this Specification and the HASP.

D. Eye Protection

The Contractor shall provide safety glasses, goggles, or face shields for eye protection and mandate their use by personnel engaged in remediation operations.

E. Caution Signs and Labels

The Contractor shall locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before encountering a hazard. The Contractor shall provide labels to all contaminated materials, scrap, waste, debris, and other products.

F. PPE and Decontamination Fluids

The Contractor will package used PPE and decontamination fluids in appropriate containers.

3.6 ONSITE MEDICAL MONITORING

A. Contractor shall include procedures for monitoring personnel for physical conditions (e.g., heart rate, body temperature, and body water loss) in the HASP. When necessary, monitoring shall be performed by a person with a current first aid/CPR certification who is trained to recognize the symptoms of various physical conditions and shall comply with the NIOSH/OSHA/USCG/EPA Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.

3.7 WORK PROCEDURE

A. The Contractor shall perform the scope of work in accordance with all pertinent local, state and federal regulatory guidance specified herein. Personnel shall wear and utilize all protective clothing, appropriate personnel monitoring devices, and equipment as specified in the approved HASP.

B. Contaminated Materials Handling Procedures

All contaminated materials, waste, debris, clothing, and water shall be properly handled in accordance with the regulations stipulated in 40 CFR 761 and 40 CFR parts 262-264.

C. Site Inspection

While performing this work the Contractor shall be subject to onsite inspection by Owner and/or the Construction Manager who may be assisted by or represented by safety personnel. If the work is found to be in violation of these Specifications, a stop work order to be in effect immediately and until the violation is resolved. Stand by time required during resolution of the violation shall be at the Contractor's expense.

EXHIBIT 1

TRAINING AND MEDICAL MONITORING - OSHA COMPLIANCE LETTER

The following statements must be typed on company letterhead and signed by an officer of the company to accompany certificates or other acceptable means of certification attesting to the following:

Subject: Health and Safety Training and Medical Monitoring - OSHA Compliance

Dear _________,

As an officer of [Company Name], I hereby state that I am aware of the potentially hazardous nature of the subject Work. I also understand that it is our responsibility to comply with all applicable occupational safety and health regulations, including those stipulated in Title 29 of the Code of Federal Regulations (CFR) Parts 1926 (OSHA Construction Industry Standards) and 1904 (injury and illness recordkeeping and reporting requirements).

I also understand that many of the applicable regulations require an appropriate level of training and medical monitoring for certain employees engaged in those operations. In this regard, I hereby state that all [Company Name] employees who will be assigned to work on this Site will have satisfied appropriate health and safety training and medical monitoring requirements for the planned site activities. Copies of training certificates and proof of medical monitoring for these employees are attached.

Sincerely,

(Name of Company Officer)

Enclosed - Copies of Training Certificates and Proof of Medical Monitoring

EXHIBIT 2

TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potentially hazardous nature of performing remediation activities at the Fayetteville Works Site, and that I have received site-specific training that included the elements presented below:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- The contents of the Site-Specific Health and Safety Plan, and other applicable site guidance documents
- Use of the Safe Work Permit System (when used as stipulated in the Health and Safety Plan)
- Emergency action procedures (evacuation and assembly points)
- Spill response procedures
- Review the contents of relevant Material Safety Data Sheets
- Associated hazards and restrictions within the facility
- Other topics: ________________________________
____
____
____
____

I further state that I have been given the opportunity to ask questions and that all of my questions have been answered to my satisfaction.

Name	Signature	Training Date

END OF SECTION

SECTION 01 57 20

ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 SCOPE

A. This section includes site-specific requirements for environmental protection during the course of the Work.

1.2 DESCRIPTION OF WORK

A. The Contractor shall adhere to all applicable and relevant environmental protection plans prepared by Construction Manager, Design Engineer or Owner and not limited to:

1. A Traffic Control Plan;
2. A Work Area Plan;
3. A Spill Control Plan;
4. A Solid Waste Disposal Plan (both hazardous and non-hazardous);
5. A Recycling and Solid Waste Minimization Plan;
6. A Sediment and Erosion Control Plan;
7. A Dust Control Plan;
8. An Air Pollution Control Plan;
9. A Stormwater Management Plan; and
10. A Waste Water Management Plan.

B. The Contractor shall furnish all labor, materials, and equipment and perform all Work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as a result of construction operations under this contract. For the purpose of this Section, environmental pollution is defined as the presence of chemical, physical or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.

C. The control of environmental pollution requires consideration of air, water, and land, and involves management of noises and solid waste, as well as other pollutants. The Contractor shall provide and maintain methods, equipment, and temporary construction as necessary to mitigate environmental impacts within the work footprint and related areas under the Contractor’s control. Remove temporary facilities at completion of the Work.

1.3 APPLICABLE REGULATIONS

A. The Contractor shall comply with all applicable federal, state, and local laws and regulations concerning environmental pollution control and abatement.

1.4 ENVIRONMENTAL MANAGEMENT

A. The Construction Manager shall be the person responsible for overseeing the environmental goals for the project and implementing procedures for environmental protection. This responsibility includes:

   1. Compliance with applicable federal, state, and local environmental regulations, including maintaining required documentation.

   2. Environmental training for Contractor personnel in accordance with their position requirements.

   3. Monitoring and documentation of environmental procedures.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

3.01 EROSION CONTROL

A. Plan and execute construction and earthwork by methods that control surface drainage and to prevent erosion and sedimentation as prescribed in the site erosion and sediment control plan.

   1. Minimize areas of bare soil.
   2. Provide temporary control measures such as berms and drains.

B. Periodically inspect disturbed areas to detect any evidence of the start of erosion. Apply corrective measures as required to control erosion.

C. Construct diversion ditches, silt fencing, hay bale dikes or such other erosion control devices to control runoff from any area subject to erosion during construction.

D. Comply with all local, state and federal permits and requirements.

3.02 PROTECTION OF LAND RESOURCES

A. Land resources within the limits of work shall be protected against erosion. Confine all construction activities to areas shown on the Drawings.

B. Do not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. Snow fence or other approved equal shall be wrapped around tree trunks if heavy equipment has the potential to damage the tree bark, to prevent damage to trees.

C. The locations of storage, decontamination pad, and other facilities, required in the performance of the work, shall be on cleared portions of the job site.

D. Remove all signs of temporary construction facilities such as work areas, structures, stockpiles, decontamination pads, or any other vestiges of construction at the completion of work.

3.03 PROTECTION OF AIR QUALITY

A. The use of burning at the project site for the disposal of refuse and debris will not be permitted.

B. Maintain all work areas free from dust, which could cause the standards for air pollution to be exceeded, and which would cause a hazard or nuisance to others.

C. Provide and apply dust control material such as water to minimize raising dust from construction operations and provide positive means to prevent dust from dispersing into the atmosphere. Monitor dust levels and maintain adequate documentation.

3.04 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

A. During the life of this project, maintain all facilities constructed for pollution, erosion, and siltation control as long as the operations creating the particular pollutant are being carried out.

B. All pollution control facilities shall be inspected by the Contractor once per week and after storm events of ½ inch of rain or more. Accumulated material shall be removed from behind erosion and sediment control barriers when it reaches one-third (1/3) the height of the barrier. A stockpile of sufficient replacement silt fence and straw bales shall be maintained on the site, under protective cover, for routine maintenance and emergency repair.

3.05 NOISE CONTROL

A. Make every effort to minimize noises caused by the work of this contract. Equipment shall be equipped with silencers, or mufflers designed to operate with the least possible noise in compliance with federal and state regulations.

3.06 SURFACE WATER PROTECTION

A. Provide methods to control surface water within the Work footprint to prevent damage to adjacent water bodies. Control fill, grading and ditching to direct surface drainage away from construction areas and to direct drainage to proper disposal.

B. Dispose of drainage water in a manner to prevent flooding, erosion or other damage to any portion of the site or to adjoining areas in accordance with local, state and federal regulations.

C. Tracking of construction debris outside of the Work footprint should be avoided. Institute proper sediment and erosion control systems (e.g. rock beds) at the egress of work areas to prevent sediment from migrating. Establish equipment wash stations to remove construction sediment/debris before leaving the site. Capture wash water for proper disposal.

D. See Section 3.01 of this specification for additional details regarding erosion control in relation to protection of surface water.

3.07 DEBRIS CONTROL

A. Maintain all areas under Contractor’s control free of debris.

B. Initiate and maintain a specific program to prevent accumulation of debris at construction site, storage and parking areas or along access roads and haul routes.

   1. Provide containers for deposit of debris.
   2. Prohibit overloading of trucks to prevent spillages on access and haul routes. Provide periodic inspection of traffic areas and enforce requirements.
   3. Schedule periodic collection and disposal of debris to prevent accumulation.

3.08 POLLUTION CONTROL

A. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of hazardous or noxious substances from construction operations.

B. Provide equipment and personnel to perform emergency measures required to contain any spillages and to remove contaminated soils or liquids. Excavate and dispose of any contaminated soil in accordance with local, state and federal regulations and replace with suitable compacted fill and topsoil.

C. Take all appropriate measures to prevent harmful substances from entering surface waters and groundwater. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams or in sanitary or storm sewers.

D. Provide systems to prevent dispersal of harmful pollutants into the atmosphere.

[END OF SECTION]

SECTION 01 65 00

PRODUCT DELIVERY, STORAGE, AND HANDLING

PART 1 GENERAL

1.1 SCOPE

A. Section Includes:

1. Products.
2. Product delivery requirements.
3. Product storage and handling requirements.
4. Product options.
5. Product List.

1.2 PRODUCTS

A. Products include material, equipment, and systems.

B. At a minimum, products shall comply with specified requirements, drawings and referenced standards.

C. Specified products define standard of quality, type, function, dimension, appearance, performance, and quantity required.

D. Products are to be furnished by qualified manufacturers and shall be suitable for intended use.

E. Products are to be supplied by the specified manufacturer unless specified otherwise. The manufacturer's production capacity shall provide sufficient product quantity, and delivery, to meet Work requirements and schedule.

1.3 PRODUCT DELIVERY AND HANDLING REQUIREMENTS

A. Product lead times are to be clearly communicated with the Owner and/or Design Engineer and/or Construction Manager on a weekly basis. If supply chain issues occur for a product, the Contractor must notify the Owner and/or Design Engineer and/or Construction Manager within two (2) days and provide potential alternative products to the Owner and/or Design Engineer and/or Construction Manager within five (5) days.

B. Products are to be transported and handled according to manufacturer's instructions.

C. Shipments are to be promptly inspected to confirm products comply with requirements, quantities are correct, and products are undamaged. Products and materials that are damaged or unsatisfactory for Work use shall be rejected.

D. The responsible Contractor shall provide qualified personnel and suitable equipment to handle products; use methods to prevent soiling, disfigurement, or damage. Offloading and storage of equipment shall be performed in accordance with the manufacturer’s recommendations.

1.4 PRODUCT STORAGE REQUIREMENTS

A. Products shall be stored and protected according to manufacturer's instructions.

B. Products shall be stored with seals and labels intact and legible.

C. Sensitive products shall be stored in weather-tight, climate-controlled enclosures in an environment suitable for product.

D. For exterior storage of fabricated products, place products on sloped supports above ground in such a manner that surface water will not pond around the stored equipment materials.

E. Provide local off-Site storage and protection, to the extent reasonable when Site does not permit on-Site storage or protection.

F. Products subject to deterioration shall be covered with impervious sheet covering and ventilated to prevent condensation and degradation of products.

G. Equipment and personnel shall be provided to store products; use methods to prevent soiling, disfigurement, or damage.

H. Storage of products shall be arranged to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

A. Products specified by referenced standards or by description shall comply with the specified reference standards or description.

B. Products specified by naming one or more manufacturers shall be from one of the listed manufacturers, no substitutions allowed unless approved by the Design Engineer.

C. There shall be no options or substitutions for products specified by named manufacturers that comply with specifications.

D. Where the phrase "or equal" or "or equivalent" is used in a Products specification, any substitution or option shall be approved by the Construction Manager or Design Engineer.

1.6 PRODUCT LIST

A. A complete list of major products proposed for use on the Work shall be submitted, with name of manufacturer, trade name, and model number of each product following receipt of Notice to Proceed in accordance with submittal requirements identified in the technical specifications. Additional information related to Procurement status of the products shall be submitted when requested by Owner, Construction Manager, or Design Engineer.

PART 2 PRODUCTS

A. Not used

PART 3 EXECUTION

A. Not used

END OF SECTION

SECTION 01 66 00

EQUIPMENT TESTING AND START-UP

PART 1 GENERAL

1.1 SCOPE

A. Equipment testing and start-up are required for satisfactory completion of the contract and, therefore, shall be completed within the contract time.

1.2 RELATED SECTIONS AND PLANS

A. Project Overview

B. Section 22 05 19 – Valves and Gauges

C. Section 22 10 00 – Piping and Appurtenances

D. Section 22 11 00 – High Density Polyethylene (HDPE) Pipes and Fittings

E. Section 26 05 00 –Electrical

F. Design Drawings – The Contractor shall refer to material schedules in the Design Drawings.

1.3 EQUIPMENT TESTING

A. Groundwater Extraction and Conveyance System testing shall include:

1. Coordination of the Contractor, Quality Assurance Engineer, and Owner for the successful equipment and facilities start-up.

2. Contractor is responsible for the complete test, check out, start-up, and commissioning of all elements of the Work. Verify these activities through daily inspection reports, test records, on-site vendor certifications, and by other appropriate means.

B. All test, check out, and start-up requirements shall be conducted as indicated in the Contract Documents and documentation of same shall be provided to the Quality Assurance Engineer prior to commissioning.

C. It is not the intent of the Quality Assurance Engineer to instruct the Contractor in the equipment start-up; however, the Quality Assurance Engineer shall be available prior to and during testing to provide technical support to the Contractor.

D. The Contractor shall be required to start-up the GWEC system under direction of the Quality Assurance Engineer, operate it, and pass any acceptance tests as outlined in the Contract Documents prior to acceptance.

E. Not less than three weeks prior to start-up, a detailed start-up test plan and schedule shall be submitted to the Quality Assurance Engineer for review.

F. The Contractor shall furnish equipment operation and maintenance manuals and provide them to the Quality Assurance Engineer and the Owner’s operating personal prior to start-up testing.

G. The Contractor shall furnish operating personnel, connections, and consumables as required to complete the testing and start-up.

H. The start-up testing shall not be commenced until all required leakage tests and equipment tests have been completed to the satisfaction of the Quality Assurance Engineer.

I. All defects in materials or workmanship which appear during the test period shall be immediately corrected by the Contractor. Time lost for equipment repairs, wiring corrections, control point settings, or other reasons which interrupt the testing period may, at the discretion of the Quality Assurance Engineer, be justifiable cause for extending the test duration.

J. During the start-up, the Contractor shall keep records of the operations in accordance with the instructions of the Quality Assurance Engineer.

K. The GWEC System start-up testing procedures shall be divided into the following five distinct stages performed by the Contractor or as otherwise specified in Contract documents: (1) system pressure and/or leakage tests; (2) installation inspection and pre-operation checkout; (3) initial operation and testing; (4) functional acceptance testing; and (5) Performance Warranty Testing. Testing procedures shall be designed to simulate as nearly as possible all conditions of operation, both normal and emergency, and shall be carefully selected to ensure that the equipment is not damaged. Once the testing procedures have been accepted by the Owner, the Contractor shall produce check-out, alignment, adjustment, and calibration sign-off forms for each item of equipment and system, to be used in the field by the Contractor and the Quality Assurance Engineer jointly so that each item of electrical, mechanical, and instrumentation equipment and system has been properly installed, equipment/system piping is cleaned, devices serviced, calibrated, and tested. The Contractor is advised that failure to observe these precautions may place the acceptability of the subject equipment in question and the Contractor may be required to either demonstrate that the equipment has not been damaged or replace it as determined by the Owner.

PART 2 PRODUCTS

A. Not Used.

PART 3 EXECUTION

3.1 GENERAL

A. General tests shall conform to testing requirements of the applicable technical Specifications.

B. No tests shall be conducted by the Contractor until submission, receipt, and acceptance of the Contractors detailed test plan and schedule.

C. All equipment, materials, electrical devices, pumps, pipes, and workmanship included in the Work shall be tested by the Contractor to the satisfaction of the Quality Assurance Engineer before any portion is put into operation.

D. Inspections and tests, unless otherwise specified or accepted, shall be adequate to demonstrate compliance with specified performance requirements.

E. Testing equipment shall be calibrated and/or certified by an approved agency, as often as necessary to ensure its proper operation in accordance with the Specifications.

F. Where, in the case of an otherwise satisfactory test, any doubt, dispute, or difference should arise between the Owner and the Contractor regarding the test results, the methods, or equipment used in carrying out of such test(s) by the Contractor, then the Owner may order the test(s) to be repeated.

3.2 INSPECTIONS AND OPERATIONAL TESTING

A. System pressure and leak tests:

1. System pressure and leak tests shall be carried out in accordance with Sections 22 20 00 and 22 11 00.

B. Inspection and Pre-operation Checkout:

1. Before any pre-operation checkout procedures are performed, the Contractor shall furnish a certificate, certifying that the equipment has been installed, equipment/system piping is cleaned, devices serviced, adjusted, calibrated, and aligned to their satisfaction.

2. The Contractor shall perform pre-operation checkout procedures to ensure that all equipment has been properly serviced, aligned, connected, calibrated, and adjusted prior to operation. The Contractor shall provide personnel as required

to observe and conduct pre-operation and checkout activities. Pre-operation checkout procedures include, but not necessarily be limited to, the following:

a. Ring-out of all power, control, and monitoring and control circuits prior to connection.
b. Voltage check of all circuits.
c. Phase sequence check.
d. Pre-connection alignment check of all connecting pipelines and machines.
e. Calibration of all equipment provided by others, including fuses, temperature, pressure, level, vibration, flow switches, analyzers, alarms, etc., and all visual monitors including gauges, thermometers, etc.
f. Complete checkout, through simulated operating conditions, of all safety circuits and devices.
g. Manual rotation and/or movement of all moving parts to ensure freedom of movement and correct direction of rotation.
h. Check that all valves are correctly oriented and in their correct operating mode.

C. Initial Operation and Testing:

1. Once the required pre- operational checkout procedures have been completed and witnessed by the Quality Assurance Engineer, individual systems and subsystems may be started. Initial testing of equipment shall be operated for a sufficient period of time to determine equipment operating characteristics meet and satisfy the performance requirements of the contract.

2. The Contractor shall be responsible for the operation and performance of all equipment in accordance with the Specifications.

3. Once initial operational tests have been satisfactorily completed, all equipment shall be rechecked by the Contractor for any indications of improper operating characteristics. Any deficiencies shall be corrected to the complete satisfaction of the Quality Assurance Engineer.

D. Functional Acceptance Testing

1. Functional testing shall be carried out to evaluate the compliance of each component with its specific functional requirement.

2. Each instrument, piece of equipment or system shall be tested, cycled, or manipulated manually and/or using the corresponding control system as applicable and according to the manufactures documentation to confirm functional acceptance.

3. Functional acceptance testing shall be carried out by the Contractor as directed by the Quality Assurance Engineer.

4. A checklist containing each instrument, equipment, and system shall be used and signed off by the Quality Assurance Engineer confirming acceptance.

E. Performance Warranty Testing:

1. Complete any performance warranty testing to validate any vendor or Contractor warranty or performance guaranty provided in Contract Documents.

2. Performance testing shall be conducted under the conditions outlined in the vendor or Contractor's performance warranty documents.

[END OF SECTION]

SECTION 02 21 00

SURVEYS

PART 1 GENERAL

1.1 SCOPE

A. This Section covers record and construction surveys. Surveys shall be performed at the beginning and completion of the work and at intermediate points as necessary to perform work and record as-built-information for final Record Drawings.

B. Surveyor, refers to a North Carolina-licensed Surveyor who is completing a survey on behalf of the Owner and/or the Construction Manager and/or a Contractor.

1.2 RELATED SECTIONS AND PLANS

A. Section 03 00 00 – Concrete

B. Section 22 10 00 – Piping and Appurtenances

C. Section 31 10 00 – Site Clearing

D. Section 31 23 00 – Excavation and Fill

1.3 SUBMITTALS

A. Submittals shall be made as survey work is performed. Submittals of drawings and sketches shall include two printed sets and one electronic copy, if applicable. Submittals under this Section, include, but are not limited to:

1. Surveyor’s notes.
2. Calibration documentation for surveying equipment, survey controls, and benchmarks.
3. Survey sketches and notes for initial system layout, to be submitted to the Design Engineer prior to the beginning of each construction activity at the site.
4. Survey sketches and notes for final system layout, to be submitted to the Design Engineer as soon as is practicable after the survey is performed.
5. Final sketches and notes depicting as-built conditions, to be submitted to the Design Engineer at or before the Post-Construction Conference.

6. The Contractor shall submit a full set of red-line drawings depicting as-built conditions at or before the Post-Construction Conference.

PART 2 PRODUCTS

2.1 SURVEY CONTROL

A. The Surveyor shall survey and establish any additional survey control required for performance of the Work, conduct all measurements, and check all dimensions necessary for proper execution of the Work. The Surveyor shall be responsible to re- establish existing survey control lost during the course of work. Work survey control shall be tied into the existing survey control shown on the Design Drawings.

   1. Survey control shall be set and measurements taken using standard accepted surveying methods and equipment.

   2. Surveyors shall be land surveyors registered in the State of North Carolina. Surveyor’s field notes shall be included with project record documents for submission to the Design Engineer. The Surveyor’s signature shall be included on all field notes and survey record documents.

   3. Surveying instruments shall be calibrated prior to the start of the survey work. Documentation attesting to instrument calibration shall be submitted to the Design Engineer prior to performing survey work.

   4. Survey instruments and equipment shall provide precision of 0.1 foot for horizontal control and 0.02 foot for elevation.

B. The Surveyor shall provide all materials as required to properly perform the surveys, including, but not limited to, instruments, tapes, rods, measures, mounts and tripods, stakes and hubs, nails, ribbons, other reference markers, and all else as required. All material shall be of good professional quality and in first-class condition.

C. All lasers, transits, and other instruments shall be calibrated and maintained in accurate calibration throughout the execution of the work. Calibration certificates shall be submitted to the Design Engineer upon request.

2.2 RECORD SURVEY

A. All survey sketches and notes shall be tied to the existing survey control shown on the Design Drawings. Other requirements are given below. Survey sketches and notes shall be labeled with the name of the project, the name of the Surveyor, the date of the survey, and the survey location and purpose.

   1. <u>Initial/Control Surveys:</u> Control surveys shall include surveys for the establishment of benchmarks and control points. The Initial Survey shall provide for layout of the construction and shall confirm locations and layouts

of the extraction wells and trenching for piping systems and utilities. This Initial Survey shall be used to verify initial site conditions are consistent with design intent. All initial/control surveys for elevation shall be + or - .01 feet and for horizontal, control angles shall be to the nearest twenty (20) seconds + or - 10 seconds and measured distances shall be to + or - .01 feet.

2. Intermediate Survey: The Intermediate Survey shall clearly show work in progress and shall record as-built conditions as work progresses. Spot elevations shall be accurate to the nearest tenth of a foot. Red-line Drawings shall be maintained by the Contractor to include as-built conditions as work progresses. Red-line mark-ups shall include but not be limited to:

   a. Locations of the extraction well enclosures; air release valve vaults; pipe clean-out vaults; and electrical pull boxes;
   b. Layouts and profiles of piping distribution systems and utilities at regular intervals (recommended to be not more than fifty (50) foot intervals);
   c. Locations of well electrical termination and control panel assemblies.

3. Final (i.e., As-Built) Survey: Final survey shall document the final condition of the site to include as-built construction to the lines and grades shown on the Design Drawings. All significant features of the groundwater Extraction and Conveyance shall be surveyed, including but not limited to the piping systems, and locations of the extraction well enclosures, air release valve vaults, pipe clean-out vaults, electrical pull boxes, and electrical termination/control panel assemblies. All surveys for elevation shall be to the nearest 0.01 feet (+ or - 0.005) feet and for horizontal distances shall be + or - 0.1 feet). Document the permanent survey control information on the record drawings.

2.3 PROFESSIONAL STAMP

A. Final survey sketches and notes shall bear the stamp and signature of the Surveyor registered in the State of North Carolina responsible for the survey work.

PART 3 EXECUTION

3.1 MEASUREMENTS

A. The Contractor shall check all survey measurements and check all dimensions necessary for the proper execution of the work called for by the Design Drawings and Specifications.

B. Where the dimensions and locations of existing structures or utilities affect the installation or connection of new work, the Contractor shall verify such dimensions and locations in the field before conducting the Work.

C. The Surveyor shall establish the horizontal and vertical control benchmarks from the existing survey control shown on the Design Drawings.

D. The Contractor shall maintain a set of red-line drawings to indicate as-built conditions as work progresses.

3.2 INITIAL/CONTROL SURVEY

A. Prior to performing work at the site, the Contractor shall schedule an initial layout survey of the site to be conducted by the Surveyor to include locations of existing underground utilities and other features affecting the Work.

B. The Contractor shall verify with the Design Engineer and Construction Manager the locations of Site reference and survey control points prior to starting work. The Contractor shall promptly notify the Design Engineer of any discrepancies discovered. The Contractor shall also verify layouts periodically during construction.

3.3 INTERMEDIATE SURVEYS

A. The Surveyor shall perform surveys as needed throughout the progress of the Work to document work that has been performed and to record as-built conditions.

3.4 FINAL RECORD SURVEY

A. At the conclusion of the Work, the Contractor shall schedule the Surveyor perform a final survey of the site to confirm as-built conditions. The survey shall accurately locate features that are to be shown on the final Record Drawings. The Final Survey will be used by the Design Engineer to produce final Record Drawings as required by the Owner.

[END OF SECTION]

SECTION 03 00 00

CONCRETE

PART 1 GENERAL

1.1 SCOPE

A. This Section includes all labor, materials and services required for placement of concrete, concrete reinforcement, concrete forms, cast-in-place concrete, and precast concrete structures.

1.2 RELATED SECTIONS AND PLANS

A. Section 01 33 00 – Submittal Procedure

B. Section 02 21 00 – Surveys

C. Section 31 23 00 – Excavation and Fill

D. Section 31 10 00 – Site Clearing

1.3 REFERENCES

A. Latest version of American Concrete Institute (ACI) Standards:

1.	ACI 301.	Specifications for Structural Concrete.
2.	ACI 304.	Guide for Measuring, Mixing, Transporting, and Placing Concrete.
3.	ACI 305.	Guide to Hot-Weather Concreting.
4.	ACI 306.	Guide to Cold Weather Concreting.
5.	ACI 315.	Details and Detailing of Concrete Reinforcement.
6.	ACI 318.	Building Code Requirements for Structural Concrete.
7.	ACI 347.	Guide to Formwork for Concrete.

B. Latest version of American Society for Testing Materials (ASTM) Standards:

1.	ASTM A 185.	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

2.	ASTM A 615.	Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
3.	ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
4.	ASTM C 33.	Standard Specification for Concrete Aggregates.
5.	ASTM C 39.	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
6.	ASTM C 94.	Standard Specification for Ready-Mixed Concrete.
7.	ASTM C 143.	Standard Test Method for Slump of Hydraulic Cement Concrete.
8.	ASTM C 150.	Standard Specification for Portland Cement.
9.	ASTM C 172	Standard Test Method for Sampling Freshly Mixed Concrete.
10.	ASTM C 231.	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
11.	ASTM C 260.	Standard Specification for Air-Entraining Admixtures for Concrete.
12.	ASTM C 309.	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
13.	ASTM C 494.	Standard Specification for Chemical Admixtures for Concrete.
14.	ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
15.	ASTM C 1107.	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink).
16.	ASTM C 1240.	Standard Specification for Silica Fume Used in Cementitious Mixtures.

1.4 SUBMITTALS

A. The Contractor shall submit the following to the Construction Manager and Design Engineer for review fourteen (14) calendar days prior to concrete placement:

1. Concrete mix designs. Mix designs shall comply with the requirements of ACI 318 Chapter 19. Follow Section 19.2 for average compressive strengths when test data is not available.

2. Certification from the supplier that concrete materials and concrete mix meet the material requirements of this Section.

3. Shop drawings for cast-in-place concrete structures.

4. Procedures for concrete placement during hot weather (ACI 305) and cold weather (ACI 306).

5. Sample of preformed expansion joint sealer for concrete.

PART 2 PRODUCTS

2.1 MATERIALS

A. Forms

1. The Contractor shall furnish all formwork and materials to complete concrete structures as indicated in the Design Drawings.

2. Concrete formwork shall be designed in accordance with the Design Drawings.

B. Concrete Reinforcement

1. The Contractor shall furnish concrete reinforcement as shown on the Design Drawings.

C. Concrete

1. The Contractor shall furnish all cast-in-place concrete, precast concrete, curing compounds, and grout as per the Design Drawings.

2. Concrete, curing compounds, and grout shall conform to the requirements specified in the Design Drawings.

3. Refer to the Drilling Scope of Work for details on grout for the extraction wells.

PART 3 EXECUTION

3.1 PREPARATION

A. Forms shall be used to confine and shape concrete to required dimensions. Forms shall have sufficient strength to withstand forces from placement and vibration of the concrete and sufficient rigidity to maintain specified tolerances.

B. Design, engineering, and construction of the formwork shall be the responsibility of the Contractor.

C. Erect formwork and bracing to achieve design requirements in accordance with requirements of ACI 301 and ACI 347.

   1. Provide bracing to ensure stability of formwork.

   2. Align joints and make watertight. Keep number of form joints to a minimum.

   3. Provide chamfer strips on external corners of permanently exposed edges with ¾” x 45 degree chamfer, unless noted otherwise.

   4. Shore or strengthen formwork subject to overstressing by construction loads.

D. Form Release Agent:

   1. Apply form release agent on formwork in accordance with manufacturer's instructions.

   2. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

   3. Keep surfaces coated prior to placement of concrete.

E. Form Cleaning:

   1. Clean and remove foreign matter within forms as erection proceeds.

   2. Clean formed cavities of debris prior to placing concrete.

   3. Flush with water or vacuum to remove remaining foreign matter.

   4. Ensure that water and debris drain to exterior.

F. Form Removal:

1. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
2. Loosen forms carefully.
3. Do not wedge with pry bars, hammers, or tools directly in contact with finished concrete surfaces.

3.2 PLACING AND FASTENING

A. Arrange and place reinforcing steel as shown on the Design Drawings and in accordance with the requirements of ACI 304 and ACI 318.

B. Secure reinforcement against displacement during placing of concrete. Do not deviate from required position.

3.3 ERECTION/INSTALLATION/APPLICATION

A. Maintain concrete cover around reinforcement according to the requirements of ACI 301, ACI 318, and as shown on the Design Drawings.

B. Provide formed openings where required for Work to be embedded in concrete members.

C. Design drawings shall be coordinated with forming and setting openings, slots, recesses, sleeves, bolts, anchors, and other inserts with mechanical, electrical, civil drawings and other concrete activities.

D. Install concrete accessories straight, level, and plumb, or as called out on the Design Drawings.

E. Place concrete continuously between forms or other limits indicated on the Design Drawings. Place concrete in accordance with ACI 301 and ACI 318, and ensure that reinforcement and forms are not disturbed during concrete placement.

F. Install precast concrete structures as shown on the Design Drawings.

G. Trowel grout into void spaces at pipe penetrations and concrete joints in accordance with manufacturer’s recommendations.

3.4 CONCRETE PLACEMENT

A. Notify the Construction Manager at least 24 hours in advance of concrete placement.

B. Do not place concrete until foundations, forms, vapor barrier, reinforcing steel, pipes, conduits, sleeves, hangers, anchors, inserts and other Work required to be built into concrete have been inspected by the Quality Assurance Engineer and approved by the Construction Manager.

C. Place concrete in accordance with the Design Drawings, the requirements of the local building code, and in compliance with practices and recommendations of ACI-304. Place the concrete in a continuous operation to prevent the formation of seams.

D. Mechanically vibrate the concrete in place without dislocation or damage to the reinforcement and built-in items.

E. Mix and place concrete only when the temperature is within the limits of ACI 305 and ACI 306, unless otherwise approved by the Construction Manager.

F. Prepare construction joints by roughening, brushing clean, and maintaining moisture for 24 hours (or apply bonding agent on clean prepared concrete joint in accordance with manufacturer's instructions) prior to placement of concrete against construction joint. Join the concrete fully around pipes.

3.5 PROTECTION

A. Provide concrete curing and protection in accordance with the Design Drawings and ACI 301. Apply curing compound, in accordance with the approved manufacturer's recommendations.

B. Provide broom finish on all exposed slabs.

3.6 PRECAST CONCRETE INSTALLATION

A. Place and position the precast concrete structure on prepared subgrade as shown on the Design Drawings.

B. Repair minor damage to the precast concrete, such as spalls or chips, using an epoxy bonding agent and grout, as specified in this Section. Major damage that occurs during installation, as determined by the Construction Manager, is cause for rejection.

C. After installation, cut off the lifting devices and seal openings with grout that is specified in this Section.

D. Install the precast concrete structures to the limits and grades indicated on the Design Drawings.

3.7 CONSTRUCTION QUALITY REQUIREMENTS

A. Quality Assurance Engineer will perform inspection of prepared subgrade, formwork, reinforcing steel layout, and other scheduled structures specified in this Section and shown on Design Drawings prior to concrete placement.

B. The Contractor or a third-party concrete testing service shall perform conformance testing on concrete samples during concrete placement.

1. Samples shall be taken in accordance with ASTM C 172 for temperature (ASTM C 1064), slump (ASTM C 143), air entrainment (ASTM C 231), and three test cylinders shall be made (ASTM C31) and tested for compressive strength (ASTM C 39).

2. Samples shall be taken at a minimum frequency of one for each 100 cubic yards (yd^3) of each concrete mix design placed in any one day.

3. Samples shall be tested against the concrete mix properties as indicated on the Design Drawings.

4. Lightweight aggregate concrete shall not be used without prior approval of the Design Engineer.

3.8 TESTING AND INSPECTION

A. Materials and operations shall be tested and inspected as Work progresses. Failure to detect defective Work shall not prevent rejection when defect is discovered, nor shall it obligate the Design Engineer for final acceptance.

B. Testing agencies shall meet the requirements of "Practice for Use in the Evaluation of Testing and Inspection Agencies as Used in Construction" ASTM E 329-90.

C. The following tests shall be performed by the Contractor or the designated agency:

1. Secure composite samples in accordance with "Standard Method of Sampling Freshly Mixed Concrete" ASTM C 172-90.

2. Mold and cure five specimens from each sample in accordance with "Test Methods of Making and Curing Concrete Test Specimens in the Field" ASTM C 31-90.

3. Compressive tests shall be in accordance with "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens" ASTM C 39-86. Three specimens shall be tested at 28 days for acceptance, one shall be tested at 7 days for information and one shall be held for testing at 56 days should the samples tested at 28 days not meet the design strength.

4. Make one sample for each 100 yd^3 or fraction thereof, of each mix design of concrete placed in any one day. A sample is defined as a minimum of 5 test cylinders.

5. Determine slump for each sample and whenever consistency of concrete appears to vary, using "Standard Test Method for Slump of Portland Cement Concrete" ASTM C 143-90.

6. Determine total air content of normal-weight concrete sample for each sample in accordance with "Standard Test Method for Air Content of Freshly Mixed concrete by the Pressure Method" ASTM C 231-89a.

7. Determine temperature of concrete sample for each strength test.

8. Determine unit weight, yield and air content for each strength test in accordance with "Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete" ASTM C 138-81.

3.9 SURVEY

A. Survey the location and elevations of the concrete structures in accordance with Section 02 21 00.

3.10 TOLERANCE

A. Install concrete structures to within ± 0.02 feet of the elevations indicated on the Design Drawings.

[END OF SECTION]

SECTION 22 05 19

VALVES AND GAUGES

PART 1 GENERAL

1.1 SCOPE

A. This section includes all labor, materials, equipment, tools, supervision, transportation, and incidentals necessary to fabricate and install valves and gauges for the system. The work shall be carried out as specified herein and in accordance with the Design Drawings.

1.2 RELATED SECTION

A. Section 22 10 0 – Process Piping and Appurtenances

B. Design Drawings – The Mechanical Contractor shall refer to material schedules on Drawings D-03 and D-04.

1.3 REFERENCES

A. Not Used.

1.4 SUBMITTALS

A. Submit proposed manufacturer specifications to Construction Manager and Design Engineer for approval in accordance with design.

B. Submit Manufacturer's operations and maintenance manual for each valve and gauge.

C. Submit to the Construction Manager, Quality Assurance Engineer, Construction Observation Engineer and Design Engineer for review testing results from leak testing, flow testing and visual inspection within 14 days after completion of work.

PART 2 PRODUCTS

2.1 GENERAL

A. Purchase all equipment and materials from suppliers that have been in business for a minimum of five years.

B. The Mechanical Contractor shall refer to material schedules on Drawings D-03 and D-04.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install valves and gauges at locations shown on Design Drawings.

B. Connect all piping, valves and fittings as shown on Design Drawings and in strict conformance with Manufacturer’s requirements.

3.2 START UP AND TESTING

A. Leak test all pipes, valves and fittings prior to operation.

B. Visually inspect all pipes, valves and fittings for leaks during start-up and rectify as needed until a leak-free system is provided.

C. Using the flow meter and pressure indicator, verify that liquid flows and discharge pressures are in accordance with Manufacturer’s guidelines.

[END OF SECTION]

SECTION 22 05 53

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SCOPE

A. This Section includes valve, equipment, and piping identification and label material requirements.

1.2 REFERENCES

A. Latest version of the American Society of Mechanical Engineers (ASME) Standard:

1. ASME A 13.1. Scheme for the Identification of Piping Systems

B. Design Drawings – The Mechanical Contractor shall refer to material schedules on Drawings D-03 and D-04.

PART 2 PRODUCTS

2.1 VALVE AND EQUIPMENT IDENTIFICATION

A. Each valve and equipment shall be identified with the unique valve number and description, as shown the Design Drawings.

B. Label size shall be 1 ½-inch x 3-inch valve tag with 3/8-inch lettering on line 1 and 3/16-inch lettering on subsequent lines.

C. Labels shall be constructed of nonreflective materials. Black characters on a white background.

D. Labels, including adhesives and other means of attachment, shall be made from corrosion-resistant materials that are compatible with the component and environment where they are used.

E. Valve tags on insulated valves shall be located outside the insulation jacketing and be easily accessible for inspection.

F. Tags shall be secured using heavy-duty chain fasteners, or 0.025-inch stainless steel aircraft cable with locking clasps permanently fixed closed with a crimp.

2.2 PIPING IDENTIFICATION

A. Identify the flow medium and the flow direction for all piping systems including insulated pipe by labeling on: (i) interior wall where pipe passes through wall; and (ii) on pipe sections within valve and control valve houses. Pipes shall be labeled as indicated on the Design Drawings and in accordance with ASME A 13.1.

B. Refer to the Design Drawings for details on Piping and Instrumentation Diagram (P&ID) symbols and legend for the flowing medium, medium code, and material code relationship.

2.3 PRODUCT MARKING

A. All piping materials shall be marked and identified in accordance with the applicable ASTM specification as indicated on the piping material data sheets.

PART 3 EXECUTION

3.1 ITEMS TO BE IDENTIFIED

A. All piping, valves, and equipment except that which is installed in inaccessible locations such as partitions, walls and floors, and that which is buried underground, shall be identified with labels hereinafter specified. All labels shall show direction of fluid flow. Labels shall be applied to piping at the following locations:

1. adjacent to each valve;
2. each branch and riser at take-off;
3. at each pipe passage through wall or floor;
4. at not more than 40 feet spacing on straight pipe runs; and
5. at each change in direction.

B. Each valve and piece of equipment shall be labeled according to its identification number shown on the P&ID.

[END OF SECTION]

SECTION 22 08 00

MECHANICAL SYSTEMS COMMISSIONING

PART 1 GENERAL

1.1 SCOPE

A. The scope of this Section covers the procedures and requirements for the commissioning of mechanical systems.

1.2 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 66 00 – Equipment Testing and Start-up

1.3 SUBMITTALS

A. The Contractor shall submit documentation related to commissioning activities as required in this Section.

1.4 RESPONSIBILITIES

A. Mechanical, Instrumentation/Panel and Electrical Contractors. The commissioning responsibilities applicable to each of the Mechanical, Instrumentation/Panel and Electrical Contractors of this Section are as follows (all references apply to commissioned equipment only):

Construction and Acceptance Phases

B. Contractors shall attend a commissioning scoping meeting and other meetings necessary to facilitate the commissioning process.

C. Contractors shall provide the Construction Manager, Quality Assurance Engineer and Construction Observation Engineer with normal cut sheets and shop drawing submittals of commissioned equipment.

1. Provide additional requested documentation to the Construction Manager, Quality Assurance Engineer and Construction Observation Engineer for development of start-up and functional testing procedures.

    a. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Construction Manager, Quality Assurance Engineer and Construction Observation Engineer.

b. The Construction Manager, Quality Assurance Engineer or Construction Observation Engineer may request further documentation necessary for the commissioning process.

c. This data request may be made prior to normal submittals.

2. Provide a copy of any O&M manuals and submittals of commissioned equipment, through normal channels, to the Construction Manager, Quality Assurance Engineer or Construction Observation Engineer for review and approval.

3. Contractors shall assist (along with the Design Engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications or equipment documentation is not sufficient for writing detailed testing procedures.

4. Where applicable, the Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

5. Develop a full start-up and initial checkout plan using manufacturers' start-up procedures and the pre-functional checklists from the Quality Assurance Engineer for all commissioned equipment. Submit to Quality Assurance Engineer for review and approval prior to startup.

6. During the startup and initial checkout process, execute the mechanical-related portions of the pre-functional checklists for all commissioned equipment.

7. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Quality Assurance Engineer.

8. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

9. Perform functional performance testing under the direction of the Quality Assurance Engineer for specified equipment. Assist the Quality Assurance Engineer in interpreting the monitoring data, as necessary.

10. Correct deficiencies (differences between specified and observed performance) as interpreted by the Quality Assurance Engineer and retest the equipment.

11. Prepare redline as-built drawings for all drawings and final as-builds for Contractor-generated coordination drawings.

12. Provide training of the Owner's operating personnel as specified.

13. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

Warranty Period

14. Execute seasonal or deferred functional performance testing, witnessed by the Quality Assurance Engineer and Construction Observation Engineer, according to the specifications.

15. Correct deficiencies and make necessary adjustments for applicable issues identified in any seasonal testing.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. Contractors shall provide all test equipment necessary to fulfill the testing requirements of this Section.

B. Refer to Section 01 66 00 for additional testing requirements.

PART 3 EXECUTION

3.1 STARTUP

A. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the Quality Assurance Engineer. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre-functional checklists as soon as possible.

3.2 FUNCTIONAL PERFORMANCE TESTS

A. Functional performance tests shall be carried out as specified in Section 01 66 00 and in accordance with the manufacture's procedures.

3.3 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. Refer to Section 01 66 00 for specific details on non-conformance issues relating to pre- functional checklists and tests.

B. Refer to Section 01 66 00 for issues relating to functional performance tests.

3.4 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

B. Contractors shall compile and prepare documentation for all equipment and systems and deliver this documentation to the Design Engineer for inclusion in the GWEC O&M manual. Equipment O&M manuals shall be prepared according to this section and completed prior to the training of Owner personnel.

C. The Design Engineer shall receive a copy of the Equipment O&M manuals for review and approval.

3.5 TRAINING OF OWNER PERSONNEL

A. The Contractor shall be responsible for coordination, scheduling, and completion of owner personnel training, and shall provide all necessary materials.

B. The Quality Assurance Engineer shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment or systems.

3.6 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the start-up and initial checkout plan described in Section 01 66 00 and the completed start-up, initial checkout and pre- functional checklists.

[END OF SECTION]

SECTION 22 10 00

PIPING AND APPURTENANCES

PART 1 GENERAL

1.1 SCOPE

A. This Section includes all labor, materials, equipment, and services necessary to install process piping and appurtenances. The work shall be carried out as specified herein and in accordance with the Design Drawings.

1.2 RELATED SECTIONS AND PLANS

A. Section 01 33 00 – Submittal Procedures

B. Section 02 21 00 – Surveys

C. Section 31 23 00 – Excavation and Fill

D. Section 22 11 00 – High Density Polyethylene (HDPE) Pipes and Fittings

E. Design Drawings – The Mechanical Contractor shall refer to material schedules on Drawings.

1.3 REFERENCES

A. Latest version of American National Standards Institute (ANSI) Standard:

1. ANSI A13.1 Standard Specification for Piping and Piping Systems.

B. Latest version of American Society of Mechanical Engineers (ASME) Standards:

1. ASME B 2.1. Standard Specification for Pipe Threads.
2. ASME B 16.5. Standard Specification for Steel Pipe Flanges and Flanged Fittings.
3. ASME B 31.3. Standard Specification for Category D Piping.
4. ASME B 31.9. Building Services Piping.

C. Latest version of American Society for Testing Materials (ASTM) Standards:

1. ASTM F 477. Standard Test Method for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

2. ASTM D 1784. Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds;
3. ASTM D 1785. Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120;
4. ASTM D 2241. Poly (Vinyl Chloride) (PVC) Pressure-Related Pipe (SDR Series);
5. ASTM D 2466. Standard specifications for socket-type poly (vinyl chloride) (PVC) plastic pipe fittings, Schedule 40.
6. ASTM D 2467. Standard specifications for socket-type poly (vinyl chloride) (PVC) plastic pipe fittings, Schedule 80.
7. ASTM D 2564. Standard Specification for Solvent Cements for PVC Plastic Piping Systems
8. ASTM D 2855. Standard Practice for Making Solvent - Cemented Joints with PVC Pipe & Fittings

D. Latest version of National Electrical Manufacturers' Association (NEMA) Standard:

1. NEMA ICS 6 Industrial Control and Systems-Enclosures.

E. Latest version of American Institute of Steel Construction (AISC) Manual of Steel Construction (AISC Manual of Steel Construction).

1.4 SUBMITTALS

A. Submit to the Construction Manager and Design Engineer for review shop drawings with the type of construction materials, manufacturer and catalog or model number, electrical characteristics, etc. for products specified in this Section or on the Design Drawings within 45 calendar days from notice to proceed.

B. Submit to the Construction Manager and Design Engineer for review shop drawings with dimensions, ratings, mounting requirements, clearances, components interface, wiring diagrams and other information required for complete installation within 45 calendar days from notice to proceed.

C. Submit to the Construction Manager and Design Engineer for review a list of materials, to be furnished with the names of the suppliers and the delivery dates of the materials to the sites.

D. Submit to the Design Engineer for review and approval at least 21 calendar days prior to hydrostatic pressure testing; procedures to be used for hydrostatic testing of installed process piping and appurtenances specified in this Section.

E. Submit “Record” copies of all shop drawings to the Engineer before final inspection and acceptance.

F. Submit to the Construction Manager and Design Engineer copies of complete operating instructions, installation and maintenance instructions, and spare parts bulletins upon completion of the Work.

G. Submit to Construction Manager, Quality Assurance Engineer, Construction Observation Engineer and Design Engineer for review test results and inspection documentation specified in this Section within 14 days after completion of the Work.

PART 2 PRODUCTS

2.1 PROCESS PIPING AND APPURTENANCES

A. The Mechanical Contractor shall furnish process pipe and tube of type, joint type, grade, size and weight (wall thickness or class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined for installation requirements, and comply with governing regulations and industry standards.

B. Process piping and fittings shall be of Schedule 80 PVC construction at the extraction wellhead, unless otherwise shown on the Design Drawings.

C. Process piping diameters at the extraction wellheads shall be as shown on the Design Drawings, or approved by the Design Engineer.

D. Piping, fittings, gaskets and other wetted parts shall be compatible with the materials being handled.

E. Schedule 40 PVC pipe and fittings shall comply with ASTM D-2466.

F. Schedule 80 PVC pipe and fittings shall comply with ASTM D-2467.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

A. Pipe hangers, inserts and supports shall conform to MSS SP-58 and SP-69. Provide support at spacings not exceeding manufacturer's recommendations or as shown on Design Drawings.

B. Pipe supports shall be as shown in the Design Drawings or an approved equal.

2.3 FLANGE GASKETS

A. The Mechanical Contractor shall furnish all ring and full-face flange gaskets. Gaskets shall be low torque type and in accordance with ASTM F 477.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Provide factory applied plastic end caps on each length of pipe and tube. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

B. Exercise care in transporting and handling to avoid damage to pipe and fittings.

C. Materials shall be identified, inspected, controlled, and protected in a manner that will ensure conformance with the codes and standards specified in this Section.

D. Care shall be taken in the storage and handling of all material so that contamination by grease, moisture, or other foreign matter does not occur. Materials shall be stored off the ground, protected from the weather, and handled so that physical damage to the material does not occur.

3.2 GENERAL

A. Install pipe groups parallel to surface and so as not to interfere with other trades such as duct work or electrical wiring.

B. Space pipe supports, arrange reducers, and pitch piping to allow air to be vented at system high points and to allow the system to be drained at the low points as required.

C. Plug all ends of piping and equipment, except when work is being performed, to minimize entrance of dirt and debris.

D. Pipe shall not be supported by adjoining equipment. Piping shall not exert strain on or cause misalignment of equipment.

E. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of PVC pipe.

F. Remove scale, slag, dirt and debris for both inside and outside of piping and fitting before assembly.

G. Install piping so as not to interfere with equipment.

H. Install piping free of sags or bends.

3.3 JOINTS

A. PVC, HDPE and Metal Pipe connections: Make joints between PVC, HDPE, and metal pipe with flanges or with adapters as specified on the Design Drawings.

B. Screwed Joints: Do not mar or damage threaded surfaces of pipe and fittings. Apply thread sealant or Teflon tape suitable for the service to male threads only.

3.4 PIPE FITTINGS

A. Install process pipe fittings as shown on the Design Drawings.

B. Thoroughly purge existing pipe of all hazardous material prior to cutting.

3.5 CONNECTIONS

A. Install unions, flanges and adapters as shown on the Design Drawings.

3.6 PIPE SUPPORT HANGERS, SUPPORTS, ANCHORS, AND GUIDES

A. Pipe supports shall be installed in accordance with Design Drawings.

B. Use generally accepted stock or production parts wherever possible.

C. Where not specified in the Design Drawings, support vertical risers by riser clamps preferably installed below pipe hubs or by resting clamps on the floor slabs or pipe sleeve.

D. Where not specified in the Design Drawings, horizontal support spacing for continuous pipe shall be a maximum of 8 feet or approved by Design Engineer.

E. Piping located within 2 feet of the floor shall be supported on stands, piers or standard pipe supports in accordance with Design Drawings.

3.7 CLEANING AND TESTING

A. Flushing and Cleaning:

1. Prior to operations, all piping systems shall be flushed cleaned.

B. Pressure Testing for Piping:

1. Notify Quality Assurance Engineer and Construction Observation Engineer of date and time at least 48 hours prior to pipe pressure testing.
2. Perform tests in the presence of the Quality Assurance Engineer and Construction Observation Engineer and in accordance with the approved hydrostatic testing procedure submitted by the Mechanical Contractor in accordance with this Section.

3. Pressure tests shall be applied to piping only before connection of fixtures, equipment and appurtenances. In no case shall any piping, fixtures, equipment or appurtenances be subjected to pressures exceeding their rating.

4. Blank off or remove diaphragm valves, relief valves, pumps, traps, instruments and automatic valves, which may be damaged by test pressure. Open, but do not back- seat all valves.

5. All defective work shall be repaired or replaced, and the tests shall be repeated.

6. Pressure test pipe at 150 psi internal pressure. Test pipes in accordance with approved test procedure conforming to the requirements of ASME B 31.9.

7. The use of caulking or other temporary fixers, etc., to stop leaks is not permitted.

3.8 FIELD QUALITY CONTROL

A. Pipe solvent welds shall be made in accordance to and inspected per ASME D 2855.

B. A minimum of 20 percent of all solvent welds will be evaluated by an inspector qualified and certified or otherwise approved by the Quality Assurance Engineer.

C. Verify valves and appurtenances that are directional/flow sensitive are installed correctly.

D. For hydrostatic testing, the PVC piping shall be isolated from other pipe and equipment being tested. Verify hydrostatic pressure test on PVC pipe maintains 150 psi for a period of 3 hours. The test gauge shall be calibrated to N.I.S.T. Standards within 6 months of the test date.

3.9 CONSTRUCTION QUALITY REQUIREMENTS

A. Quality Assurance Engineer and Construction Observation Engineer will be present during pressure testing of process piping and appurtenances specified in this Section to evaluate compliance with this Section.

[END OF SECTION]

SECTION 22 11 00

HIGH-DENSITY POLYETHYLENE (HDPE) PIPES AND FITTINGS

PART 1 GENERAL

1.1 SCOPE

A. This Section includes all labor, materials, equipment, and services necessary to install high-density polyethylene (HDPE) pipes, fittings, and appurtenances. The Work shall be carried out as specified herein and in accordance with the Design Drawings.

1.2 RELATED SECTIONS AND PLANS

A. Section 01 33 00 – Submittal Procedures

B. Section 02 21 00 – Surveys

C. Section 31 23 00 – Excavation and Fill

D. Section 22 10 00 – Piping and Appurtenances

E. Design Drawings – The Mechanical Contractor shall refer to material schedules on Drawings.

1.3 REFERENCES

A. Latest version of the American Society for Testing and Materials (ASTM) Standards:

1. ASTM D 638. Standard Test Method for Tensile Properties of Plastics.
2. ASTM D 790. Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
3. ASTM D 1238. Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
4. ASTM D 1248. Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
5. ASTM D 1505. Standard Test Method for Density of Plastics by the Density-Gradient Technique.
6. ASTM D 1603. Standard Test Method for Carbon Black in Olefin Plastics.

7. ASTM D 1693. Standard Test Method for Environmental Stress- Cracking of Ethylene Plastics.

8. ASTM D 2657. Standard Practice for Heat Joining Polyolefin Pipe and Fittings.

9. ASTM D 2837. Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

10. ASTM D 3350. Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

11. ASTM F 714. Standard Specification for Polyethylene (PE) Plastic Pipe (SDR- PR) Based on Outside Diameter.

12. ASTM F 1055. Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

B. Latest version of the American National Standards Institute (ANSI) Standards:

1. ANSI B16.5. Standard Specifications for Steel Pipe Flanges and Flange Fittings.

C. “Committee Report: Design and Installation of PE Pipe”, Journal of American Water Works Association (AWWA), Vol 91, Issue 2, 1999, pp. 92-100 [AWWA, 1999].

1.4 SUBMITTALS

A. Submit the following to the Construction Manager and Design Engineer for review at least 14 calendar days prior to delivery of HDPE materials to the Site:

1. a list of materials to be furnished with the names of the suppliers and delivery dates of the materials to the Site;

2. origin (resin supplier's name, resin production plant) and identification (brand name, number) of the polyethylene resin used;

3. minimum Manufacturers' certifiable values and the corresponding test procedures for HDPE material properties listed in Table 22 11 00-1;

4. submit values that are specific to the resin used in manufacture; and

5. pipe joining equipment identification and procedures for butt-fusion welding (including recommended plate temperatures and fusion pressures) and electrofusion couplings, if used.

B. Submit to the Construction Manager and Design Engineer for review at least 14 calendar days prior to installation, the following documentation on the HDPE pipes, fittings, supports, and appurtenances:

   1. copies of quality control certificates issued by the resin supplier including the production dates and origin of the resin used to manufacture the HDPE products for the Work and to include certification that no reclaimed polymer is added to the resin during the manufacturing of the HDPE products to be used for the Work; and

   2. results of tests specified in Table 22 11 00-1 conducted by the Manufacturer to verify the quality of the resin used to manufacture the HDPE products.

C. Submit to the Design Engineer for review at least 7 calendar days prior to installation; documentation of training and certification of personnel qualified for performing HDPE pipe joining operations as specified in this Section.

D. Submit to the Design Engineer for review at least 21 calendar days prior to hydrostatic pressure testing; procedures to be used for hydrostatic testing of installed HDPE pipe and fittings or confirmation that the Mechanical Contractor will use the procedures in Part 3.5 of the Section.

E. Submit to the Construction Manager, Quality Assurance Engineer, Construction Observation Engineer and Design Engineer within one week after performance of the Work, results of performance tests specified in this Section.

F. Provide a list of equipment and other required information to install HDPE pipes and fittings.

G. Submit to the Construction Manager, Quality Assurance Engineer, Construction Observation Engineer and Design Engineer within 14 calendar days prior to HDPE pipe testing, a certificate of calibration that is less than 12 months old for pressure gauges used for hydrostatic pressure testing.

1.5 HEALTH AND SAFETY REQUIREMENTS

A. The Mechanical Contractor shall comply with Occupational Health and Safety Administration (OSHA) Construction Standards and standards imposed by the City of Fayetteville and the State of North Carolina, in addition to and standards outlined by the Owner.

PART 2 PRODUCTS

2.1 HDPE COMPOUND

A. HDPE pipe and fittings shall be manufactured from new, high performance, high molecular weight, HDPE resin conforming to ASTM D 1248 (Type III, Class C, Category 5, Grade P34), ASTM D 3350 (minimum cell classification as shown in

Table 22 11 00-1), and having a PPI Rating of PE 3408. Furnish material having at least the minimum specified property values listed in Table 22 11 00-1.

2.2 HDPE PIPES AND FITTINGS

A. Unless otherwise shown on the Drawings, HDPE pipe and fittings shall have a maximum Standard Dimension Ratio (SDR) of 11 and conform to ASTM F 714.

B. HDPE pipes shall be furnished in standard laying lengths of nominal 40 feet or greater unless otherwise approved in advance by the Design Engineer.

C. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and are uniform in color, density, melt index, and other physical properties.

D. HDPE end caps at the end of pipes shall be furnished as shown on the Drawings.

E. Electrofusion couplings, if used, shall meet the requirements of ASTM F 1055 and as recommended by the electrofusion coupling Manufacturer. Electrofusion couplings shall be used only with prior written approval of the Engineer.

2.3 IDENTIFICATION

A. Continuously indent print on the HDPE pipe, or space at regular intervals (recommended not to exceed 5 feet), with the following:

1. name and/or trademark of the HDPE pipe Manufacturer;
2. nominal HDPE pipe size;
3. standard dimension ratio;
4. the letters PE followed by the polyethylene grade per ASTM D 1248, followed by the Hydrostatic Design Stress in 100's of psi;
5. manufacturing Standard Reference; and
6. a production code from which the date and place of manufacture can be determined.

2.4 TRACER WIRE

A. Tracer wire shall be 10 AWG Pro-trace HDD-CCS PE45 or Design Engineer approved equal.

2.5 EMBEDMENT FILL AND BACKFILL MATERIALS

A. Pipe embedment fill and backfill materials shall be furnished in accordance with Section 31 23 00.

2.6 EQUIPMENT

A. The Mechanical Contractor shall furnish equipment to install HDPE pipe, electrofusion couplings, fittings, and appurtenances.

PART 3 EXECUTION

3.1 GENERAL

A. HDPE pipe joining operations shall be performed with trained and certified personnel. Training and certification shall be provided by pipe Manufacturer or other entity approved in writing by the Design Engineer.

3.2 HANDLING OF HDPE PIPE, FITTINGS AND APPURTENANCES

A. Deliver HDPE pipe, fittings, and appurtenances to the Site at least 10 calendar days prior to the planned installation date.

B. Provide proper handling and storage of the HDPE pipe, fittings, and appurtenances at the Site. Protect materials from excessive heat or cold, dirt, moisture, cutting, or other damaging or deleterious conditions. Provide any additional storage procedures required by the Manufacturer.

C. Exercise care when transporting, handling, and placing HDPE pipe and fittings. Use fabric or nylon slings and straps when handling HDPE pipe. Do not position slings, straps, etc., at butt-fusion joints or at fittings.

D. The maximum allowable depth of cuts, gouges, or scratches on the exterior surface of HDPE pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges, and scratches. Replace any HDPE pipe and fittings that become gouged, twisted, or crimped. Remove damaged pipes and fittings from the Site.

E. Whenever pipe laying is not actively in progress, close the open ends of all installed pipes using watertight plugs.

3.3 HDPE PIPE, FITTINGS AND APPURTENANCE INSTALLATION

A. General:

1. Examine HDPE pipe and fittings for cracks, damage, or defects before installation. Do not use cracked, damaged, or defective material.

2. Inspect the interior of all pipe and fittings and remove any foreign material from the pipe interior before the pipe is moved into final position.

3. Perform field-cutting of pipes, where required, with a machine specifically designed for cutting pipe. Make cuts without damage to pipe, so as to leave a smooth end at right angles to the axis of pipe. Taper cut ends and smooth sharp edges. Flame cutting is not allowed.

4. Perform trenching and backfilling in accordance with Section 31 23 00.

5. Do not lay pipe until the Quality Assurance Engineer has approved the bedding conditions.

6. Install HDPE pipe and fittings in accordance with the Manufacturer's recommendations and the requirements of this Section.

7. Provide necessary adapters and/or fittings required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

8. Install pipe and fittings to the lines and grades shown on the Design Drawings.

9. Install tracer wire on pipes as shown on the Design Drawings.

10. Place and compact embedment fill and trench backfill material as shown on the Design Drawings and in accordance with Section 31 23 00.

B. Install marker tape in accordance with Section 31 23 00 and as shown on the Design Drawings.

C. Perform testing of installed pipe, fittings, and appurtenances in accordance with this Section.

3.4 HDPE PIPE JOINTS, FITTINGS, AND APPURTENANCES CONNECTIONS

A. Qualify personnel performing pipe joining as specified in this Section. Training shall be conducted on the specific type of equipment that will be used during production joining operations. Electrofusion couplings (if used) shall be installed by personnel using procedures provided by the electrofusion coupling Manufacturer and approved by the Design Engineer.

B. Notify the Construction Manager at least one day prior to any pipe joining to allow scheduling of monitoring by Quality Assurance Engineer and Construction Observation Engineer.

C. Install electrofusion couplings only with prior written approval of the Design Engineer.

D. Weather Conditions for Joining:

   1. Do not join HDPE pipes and fittings at ambient temperatures below 40° Fahrenheit (F) or above 104°F, unless authorized in writing by the Design Engineer. For cold (below 40°F) or hot (above 104°F) weather joining, use the additional methods authorized in writing by the Design Engineer.

   2. Measure ambient temperatures at fusion machine.

   3. Do not join HDPE pipe and fittings during any precipitation, in the presence of heavy fog, dew, or areas of ponded water.

E. Prior to joining, clean the joint area to be free of moisture, dust, dirt, debris of any kind, and foreign material.

F. Fusion joining equipment shall be approved for the applicable field joining processes which are thermal butt-fusion and electrofusion. Electrofusion joining should only be used with specific prior written approval of the Design Engineer. Fusion apparatus shall be automated devices equipped with gauges giving the applicable temperatures and pressures.

G. Make trial butt-fusion joints on spool pieces of HDPE pipe to verify that joining conditions are adequate. Conduct trial joints on the same material to be installed and under similar field conditions as production joints. Conduct trial joining at the beginning of each day for each fusion apparatus used that day. Also, each joiner shall make at least one trial joint each day. Conduct trial joining under the same conditions as the actual joining. Prepare trial joints that are at least 2 feet long (after joining) with the joint at the midpoint. Quality Assurance Engineer and Construction Observation Engineer will monitor trial joining and visually check joining integrity including bead height, and that thermal fusion equipment meets conditions recommended by the pipe Manufacturer including, but not limited to, temperature, alignment, and interfacial pressure.

H. The Mechanical Contractor shall destructively test the trial butt-fusion joints made each day to confirm joint integrity, operator procedure, and fusion machine set-up. A field performed “Bent Strap” Test is to be performed as follows: The bent strap test specimen is prepared from the trial butt fusion spool after it has been allowed to cool to ambient temperature. A test strap that is at least 6” or 15 pipe wall thicknesses long on each side of the fusion, and about 1” or 1.5 wall thicknesses wide is cut out of the trial fusion pipe. The strap is then bent so the ends of the strap touch. Any disbondment at the fusion is unacceptable, and indicates poor fusion quality. If failure occurs, fusion procedures and/or machine set-up shall be changed, and a new trial fusion and bent strap test specimen shall be prepared and tested. Field fusion shall not proceed until a trial test joint has passed the bent strap test.

I. Join HDPE pipe sections using butt-fusion joining procedures. Fabricate joints in strict compliance with ASTM D 2657, ASTM F 1055, and the Manufacturer's recommendations, and the requirements of this Section.

J. Install flanged connections of HDPE pipe and fittings as shown on the Design Drawings and as follows:

1. Thermal butt-fuse HDPE flange connection (flange adapter) to HDPE pipe.

2. Use Type Schedule 40 carbon steel lap joint flange, except as noted on Design Drawings or approved by the Design Engineer. Outside diameter and drillings shall comply with ANSI B 16.5.

3. Gasket materials and installation shall be in accordance with Specification for Underground Equipment and Vault Equipment, Attachment A to this Section or as approved by the Design Engineer.

4. Use Bolts, nuts, and washers as shown in Specification for Underground Equipment and Vault Equipment, Attachment A to this Section. Lubricate bolt threads prior to attaching nuts. Install bolts using the HDPE Manufacturer’s bolt tightening procedures. Retighten bolts 1 and 4 hours after initial tightening.

K. PVC Materials used in vaults and underground shall be as shown in Specification for Underground Equipment and Vault Equipment, Attachment A to this Section or as approved by the Design Engineer.

3.5 FIELD TESTING AND INSPECTION

A. Notify the Construction Manager a minimum of 24 hours in advance of any pipe, including fitting and appurtenance, testing or pipe inspection. The Quality Assurance Engineer and Construction Observation Engineer will monitor pipe testing.

B. Provide testing apparatus, including pumps, hoses, gauges with pressure relief valves, taps, plugs, drains, temporary connections, and fittings to perform testing in accordance with this Section.

C. Test gauges shall be calibrated within one year of date of test. Calibration shall be traceable to national or industry standards where possible.

D. Conduct HDPE Pipe and Fittings Hydrostatic Testing in accordance with the Mechanical Contractor’s approved procedure as submitted in accordance with Part 1.4 of this Section or as follows:

1. Pressure test installed HDPE solid wall, carrier, and containment pipe with a minimum 6 inches of initial backfill placed over the containment pipe. Leave

joints, fittings, and flanged connections of containment pipe uncovered so that they can be visually inspected for any leaks.

2. Perform tests in the presence of the Quality Assurance Engineer and Construction Observation Engineer and in accordance with the approved Mechanical Contractor testing procedure specified in this Section.

3. Test pipe in accordance with the approved testing procedure and as specified in this Section. Test HDPE solid wall pipe at internal pressures as specified below:

   a. all HDPE underground piping shall be tested at 150 psi.

4. Initial expansion phase: Pipe expansion-stabilization shall be conducted for a period of four (4) hours. This phase begins when the pipe is filled with water to the specified pressure. If necessary, water is added to the pipe four times at one-hour intervals, to return the pipe to the specified pressure. Stabilization is achieved if there is no further reduction in pressure during the final one-hour period; this phase shall not exceed four (4) hours. The actual test may begin at this time even if stabilization has not been achieved; or, the pipe may be inspected for leaks, repaired if necessary, and the expansion-stabilization phase restarted.

5. Actual test phase: Start the test at the end of the fourth hour of the expansion stabilization phase, by adding water in order to return to the specified pressure if necessary. Perform the hydrostatic test for up to three (3) hours: At the end of each hour, add make-up water to return the pipe to the test pressure, if necessary. A passing test is considered to require less than the cumulative make- up water listed in Table 22 11 00-2 (with no visible leaks), after either hour 1, 2, or 3. If the added volume exceeds the cumulative table value after the third and final addition of make-up water, the test has failed. Inspect for evidence of leaking, repair as necessary, or take actions to minimize ambient temperature fluctuations, prior to repeating the expansion and test phases. Optionally, at the discretion of the technician, pipe pressure may be monitored during a 1-, 2-, or 3-hour period; water is added once as necessary at the end of the selected hour. If make-up water at the end of the selected hour is less than shown in Table 22 11 00-2, the test passes; if make-up water is greater, the test may be continued to the next hour. However, the test shall not exceed three (3) hours; pass/fail criteria is based on the volume of make-up water shown in Table 22 11 00-2.

E. HDPE Pipe Inspection:

1. Inspect fusion joints for evidence of excess or insufficient bead size, contamination, offset, or any other evidence of inadequate joining. The surface of the HDPE pipe shall be clean at the time of inspection. Wipe or wash the HDPE pipe surface if surface contamination inhibits inspection.

F. Defects and Repairs:

1. Repair Procedures: Repair any portion of the HDPE pipe exhibiting a flaw, or poor-quality fusion joint by removing bad joint or pipe section and replacing with a new pipe section.

    a. When making repairs, satisfy the following:
        i. clean and dry all pipe surfaces immediately prior to repair;
        ii. only use approved fusion equipment; and
        iii. extend repairs at least 12 inches in all direction beyond the extent of the defect.
2. Repair Verification:

    a. Inspect each repair using the methods described in this Section.

3.6 CONSTRUCTION QUALITY REQUIREMENTS

A. Quality Assurance Engineer and Construction Observation Engineer will monitor HDPE pipe joining and performance testing to establish compliance with this Section.

B. If the performance testing and confirmation of compliance indicates that any portion of the work does not meet the requirements of this Section, Quality Assurance Engineer will delineate the extent of the non-conforming work.

3.7 SURVEY CONTROL

A. Survey location and elevation of the HDPE pipe and appurtenances in accordance with Section 02 21 00.

B. Survey the top of HDPE pipe on no greater than 200-foot centers in accordance with Section 02 21 00 or at changes in horizontal or vertical alignment.

C. Provide a redline drawing showing location of electrofusion couplings if used.

3.8 TOLERANCES

A. Install HDPE pipes to within 0 to 0.2 foot of bottom of pipe elevations as indicated on the Design Drawings.

TABLE 22 11 00-1

REQUIRED PROPERTIES AND RANGES HDPE PIPE AND FITTINGS

Properties	Cell Classification	Qualifiers	Units	Specified Property Values	Test Method	
Density	3	Minimum	g/cm3	0.941	ASTM D 1505	
Melt Flow Index	4	Maximum	g/10 min	0.15	ASTM D 1238	
					(Condition 190/2.16)	E
Or	5	Range	g/10 min	0.15 to 4.0	ASTM D1238	
					(Condition 190/21.6)	F
Flexural Modulus	5	Minimum	Lb/in2	110,000	ASTM D 790	
Tensile Strength	4	Minimum	Lb/in2	3,000	ASTM D 638	
Hydrostatic Design Basis at 73ºF	4	Minimum	Lb/in2	1,600	ASSTM D 2837	
UV Stabilizer	C	Minimum	% Carbon Black	2	ASTM D 1603	

TABLE 22 11 00-2

ALLOWANCE* FOR EXPANSION UNDER TEST PRESSURE FOR AMBIENT CONDITIONS+

Allowance for Expansion (U.S. Gallons / 100 Feet of Pipe)

Nominal Pipe Size (Inches)	1 Hour Test	2 Hour Test	3 Hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.30	2.10
11	1.0	2.0	3.0
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	8.9	13.3
28	5.5	11.1	16.8
32	7.0	14.3	21.5
36	9.0	18.0	27.0
40	11.0	22.0	33.0
48	15.0	27.0	43.0

*These allowances only apply to the actual test phase and not to the initial expansion phase. They also assume pipe is being tested at a maximum design pressure equal to 1.5 times the pressure rating. If the pipe is being tested at a lower system design pressure, the allowance should be reduced by the ratio of the system design pressure to the maximum design pressure.

+When testing at temperatures below ambient (approximately 75°F), less pipe expansion takes place, resulting in lower requirements for make-up water. For a test temperature of about 68°F, the values in this table should be multiplied by a reduction factor of 0.75. For 50°F, this factor is 0.50.

ATTACHMENT A

SPECIFICATION FOR UNDERGROUND EQUIPMENT AND VAULT EQUIPMENT

ACRONYMS

AISI – American Iron and Steel Institute

ANSI – American National Standards Institute

ASME – American Society of Mechanical Engineers

ASTM – American Standard for Testing and Materials

BHN – Brinell Hardness Number (metallurgy)

HDPE – High Density Polyethylene

min – Minimum

Pmax – Maximum Pressure

PVC – Polyvinyl Chloride

Tmax – Maximum Temperature

Vault – Below Grade Pre-Cast Concrete Vault Enclosure

PVC PIPE

A. 8” and Smaller

1. Type 1, Grade 1 PVC, Schedule 80, socket type, ASTM D-1784, with PVC cell classification 12454; manufactured in strict accordance with ASTM D-1785 for physical dimensions and tolerances.

PVC FITTINGS

A. 8” and Smaller

1. Type 1, Grade 1 PVC, Schedule 80, socket type, ASTM D-1784, with PVC cell classification 12454; manufactured in strict accordance with ASTM D2467.

FLANGES

A. 8” and Smaller

1. Type 1, Grade 1 PVC, 150 lb., ANSI/ASME B16.5 standard, flat face, Schedule 80, socket and blind flanges, ASTM D1784, with PVC cell classification 12454; manufactured in strict accordance with ASTM D2467.

FASTENER HARDWARE – UNDERGROUND

A. Hex-Head Machine, ASTM A193, Grade B8M Class 1 Stainless steel, ANSI 316, carbide solution treated Bolts (75 ksi min. tensile strength; 30 ksi min. yield strength; 30 percent min. elongation)

B. Hex-Nut, ASTM A194, Grade 8M Class 1 Stainless AISI 316 heavy hex nut (80 ksi proof load, 126-300 hardness, BHN)

C. Washers, AISI SS 316 washer

FASTENER HARDWARE - VAULTS

A. American Standard Machine Bolts, ASTM A307 Grade B heavy hex bolts with zinc coating (60-100 ksi tensile strength, 18 percent min. elongation) coated with min. 1-mil thick pipe primer)

B. Hex-Nut, ASTM A563 Grade A Heavy Hex, coated as above Washers, F844, coated as above

GASKETING

A. 1/16-inch thick Garlock® Blue-Gard Style 3000, ASME B16.5 Class 150-lb., aramid fiber/nitrile binder, Pmax 1000 psig, Tmax 400°F, as required for HDPE piping used in non-low pressure systems.

GENERAL NOTES

A. Installer shall strictly adhere to manufacturer’s instructions and recommendations and Part 3 of this Section for connection and joint assembly of pipe and fittings.

B. Bolting torque, bolt tightening, gasketing and installation practices shall be in accordance with manufacturer’s instructions and recommendations and Part 3 of this Section.

C. When matching different piping material types such as HDPE to PVC or metallic piping, the connection shall be flanged, and a gasket shall be used to ensure a competent connection or with adapters as specified on the Design Drawings.

D. PVC pipe and PVC fittings shall be produced by the same manufacturer.

E. Application of PVC primer and solvent cement shall be in accordance with the PVC pipe and fitting manufacturer’s instructions and recommendations, and in good construction practices.

[END OF SECTION]

SECTION 26 05 00

ELECTRICAL

PART 1 GENERAL

1.1 SCOPE

A. Work in this Section includes materials, installation, testing, operation, maintenance, inspections, and recordkeeping for the Groundwater Extraction and Conveyance (GWEC) system electrical components, instrumentation, control panels, and controls systems.

1.2 RELATED SECTIONS, PLANS, AND DOCUMENTS

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 – Submittal Procedures
2. Section 02 21 00 – Surveys
3. Section 03 00 00 – Concrete
4. Section 22 10 00 – Piping and Appurtenances

B. Related Work specified in other Plans includes, but is not limited to:

1. Project Overview
2. Design Drawings

1.3 REFERENCES

A. Materials and equipment under this Section shall comply with the latest versions of applicable standards of the organizations listed in below:

1. American National Standards Institute (ANSI)
2. ASTM International (ASTM)
3. American Wire Gauge (AWG)
4. Electrical Testing Laboratories, Inc. (ETL)
5. Factory Mutual (FM)
6. Insulated Cable Engineers Association (ICEA)
7. Institute of Electrical and Electronic Engineers (IEEE)
8. National Electrical Code (NEC)(NFPA-70)
9. National Electrical Manufacturers Association (NEMA)
10. National Electrical Safety Code (NESC)(ANSI-C2)

11. International Electrical Testing Association Acceptance Testing Specifications (NETA ATS)
12. National Fire Protection Association (NFPA)
13. National Institute of Standards and Technology (NIST)
14. Nationally Recognized Testing Laboratories (NRTL)
15. Underwriters Laboratories, Inc. (UL)
16. OSHA – Federal Occupational and Safety Administration Standards, Part 1518 and 1910

B. Latest version of American National Standards Institute (ANSI) Standards:

1. ANSI A13.1 Scheme for the Identification of Piping Systems
2. ANSI B31.3 Process Piping

C. Latest version of American Society of Mechanical Engineers (ASME) Standards:

1. ASME B1.2 Pipe Threads, General Purpose, Inch

D. Construction Quality Assurance (CQA) Plan.

1.4 GENERAL REQUIREMENTS

A. Codes and Standards

1. These codes and standards set forth minimum requirements which may be exceeded by the Contractor if, in the Contractor's judgment and with the Owner’s review and approval, superior or more economical designs or materials are available for successful completion of the Contractor's Work as required by this specification.
2. In addition to the above codes and standards, the Contractor shall comply with all applicable federal, state, and local laws, codes, and regulations.
3. In the event of any conflict among standards, codes, or this specification, the Contractor shall refer the conflict to the Design Engineer for written resolution.

B. Construction

1. The Contractors shall be responsible for all installation as required by the Design Drawings, these specifications, and the equipment manufacturer’s procedures. The Work shall be performed in accordance with all applicable installation notes and details provided with the Design Drawings.
2. Competent and qualified supervisory personnel and workmen of all crafts required (skilled and unskilled) shall be provided in sufficient numbers by the Contractor to complete the Work as specified and scheduled.

3. The Contractor shall be responsible for following the Owner’s clearance, lock-out/tag-out, and start-up procedures.
4. The Contractor shall not disconnect or reenergize any plant electrical or mechanical equipment or wiring without the Owner’s approval. The Owner’s designated representative shall obtain and hold clearance on all electrical and mechanical equipment involved.
5. The Contractor shall properly install electrical equipment in compliance with all applicable Occupational Safety and Health Administration (OSHA) regulations relating to each specific item or installation.
6. The Contractor shall understand they will be working in the same areas and in conjunction with other contractors. The Contractor shall coordinate their Work with these contractors. The Contractor shall advise the Construction Manager in the event of any conflict with another contractor.
7. The Contractor shall not remove, alter, drill, load, or connect to existing steel structures except where approved by the Owner. The Contractor shall not cut openings in walls, floors, or in erected structures, except as required by Design.
8. The Contractor shall furnish, fabricate, and install temporary steel supports, scaffolding, brackets, guys, anchors, and so forth as required for erection purposes. The Contractor shall remove them to the satisfaction of the Owner when the Work is complete. Proper and adequate handling of equipment and rigging shall be demonstrated at all times. Equipment and rigging shall be examined and checked at frequent intervals.
9. The Contractor shall not work within 10 feet of any power lines. The Owner shall be contacted before any Work begins that requires an exception to the 10 foot approach.
10. Installed equipment shall in no way interfere with the installation, access to, or the operation of other equipment. Interference problems encountered during installation shall be resolved in consultation with the Construction Manager.
11. Where space heaters are provided with equipment, the space heaters shall be energized immediately upon completion of the equipment installation. The Contractor shall maintain the space heaters in operation during the construction period until the system is turned over to the Owner. A temporary power supply shall be used if permanent power is not available.
12. Field changes to conduit routings, outside an agreed upon tolerance, from those shown on drawings may be allowed only with the Design Engineers approval. Any change requests shall be submitted in accordance with applicable change request procedures.
13. When the Scope of Work applies to existing plants or facilities or includes Work already turned over to the Owner, the following requirements shall be included:

        a. The Contractor shall understand that they will be working in and around existing operating equipment and shall have to share areas with operating plant personnel. Debris and safety hazard free access to all existing operating equipment must be provided for plant operations personnel at all times.
        b. The Contractor personnel shall not, under any circumstances, operate or tamper with any plant equipment or components unless included under this contract. The Contractor personnel shall not enter the plant or plant offices/facilities except to perform the work required by this contract.
        c. The Contractor shall get approval from the Owner before disconnecting any cable or instrument.
        d. Existing structures, pipes, ducts, panelboards, cabinets, conduits, trays, cables, and all other equipment not in the Scope of Work shall remain in place. Contractor shall work around and protect these in-place items as required to perform Work. Any items damaged must be reported to the Owner and returned to previous operating and physical condition.
        e. Where necessary, the Contractor shall excavate carefully around existing equipment and other similar items. If the buried grounding grid cable is exposed and damaged, the Contractor shall notify the Owner before initiating repairs.

1.5 SUBMITTALS

A. Submit to the Owner and/or Design Engineer for review and approval, at least 30 calendar days prior to commencement of Work described in this Section and in the Contractor's GWEC System Work plans for the respective scopes outlined in the Project Overview; Mechanical, Electrical, and Instrumentation & Process Control Work Plans. The Contractor's GWEC System Mechanical, Electrical, and Instrumentation and Process Control Work Plans shall include, at a minimum:

    1. list of the type of material, manufacturer, and catalog or model number for all materials necessary for the installation of items described in this Section;
    2. drawings and sketches including control panel layout, assembly diagrams, and wiring diagrams;
    3. control panel installation instructions, including calibration requirements and installation details:
        a. calibration required at the time of system installation and at regular intervals thereafter; and
        b. certification of test equipment (calibration records) to be used to complete the testing in accordance with this Section.
    4. drawings and sketches of panel boards, electrical panels, and cabinets;

5. drawings and sketches shall detail type of construction materials, manufacturer and catalog or model number, characteristics, sizes, ratings, mounting requirements, clearances, component interface, wiring diagrams, connections, instructions, and other information required for proper evaluation and complete installation for products in this Section;

6. Manufacturer's published product literature including certificates of compliance, test reports, maintenance recommendations, and replacement parts procurement information;

7. Step-by-step procedures for initial startup and functional checkout testing;

8. Step-by-step procedures for a startup plan, and for operation of the system;

9. Procedures for checking and resolving alarm conditions, and for general troubleshooting;

10. Procedures and frequencies for maintenance and inspections of pumps and electrical equipment;

11. Copies of the inspection logs that will be used for inspection and maintenance;

12. Manufacturer's make, model number, and specifications of hardware and software for all instrumentation and controls system components including operator's interface terminals, human machine interfaces, and programmable logic controller; and

13. The Contractor's GWEC System Construction Quality Control (CQC) Work Plan, addressing the actions that will be taken by the Contractor to verify that the materials and the workmanship of the GWEC system meet the requirements of this Section. The CQC Work Plan shall include but not be limited to, the CQC monitoring, testing, and documentation that the Contractor shall perform for pump, electrical, and instrumentation materials and installations.

B. Instrumentation & Process Control Contractor: Submit a controls narrative for the proposed controls system to the Design Engineer for review and approval at most 14 calendar days after notice to proceed. The controls narrative shall include a diagram of controls system architecture, a functional narrative of controls systems including details on human machine interface graphics displays.

C. Do not order materials or start shop Work until the Design Engineer and Owner's review and approval of drawings and sketches is completed.

D. If changes to the Contractor's approved Plans become necessary or are otherwise requested by the Contractor during the Work, submit updated Work Plans at least 21 calendar days prior to the start of any activities affected by the change. The revised Plan must be approved by the Design Engineer, Construction Manager, and/or Owner prior to implementing the proposed change.

E. Submit a list of all measuring and test equipment (M&TE) for approval before use. M&TE shall be calibrated to NIST standards or ANSI Z540.1.C. Submit a certificate of calibration less than 12 months old for M&TE. M&TE shall be calibrated within 12 months of date of use. Calibration shall be traceable to national or industry recognized standards where possible.

F. Submit the following to the Design Engineer for review and approval within 14 calendar days after completion of the specified Work:

1. two complete electrical equipment Systems Manuals. Include in each manual one copy of approved drawings and sketches, catalog pages, instruction sheets, operating instructions, installation and maintenance instructions, spare parts bulletins, and a wiring diagram for each system;
2. four copies of complete operating instructions, installation and maintenance instructions, and spare parts bulletins;
3. Manufacturer's certification that the pumps were manufactured, tested, and supplied in accordance with this Section;
4. verification that installation is complete, free of leaks, and ready for operation;
5. test reports listing equipment used, persons performing the tests, date tested, device or circuit tested, and results of testing;
6. calibration reports; and
7. operation and maintenance (O&M) manuals including programming instructions for the operator's interface terminal, and human machine interface.

1.6 WORK AND SITE CONDITIONS

A. Prior to implementing any Work of this Section, the Contractor shall become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this Section.

B. Prior to implementing any Work of this Section, the Contractor shall carefully inspect the installed Work of all other Sections and verify that all such Work is complete to the point where the installation of this Section may properly commence without adverse impact.

PART 2 PRODUCTS

2.1 GENERAL

A. When the following terms are used in relation to the Work for this and related Sections, they shall have the following meanings:

TERM	MEANING
Boxes	Outlets, junctions, or pull boxes
Code	Codes currently enforced at the Work Site
Compression	Compressed using a leverage-powered (hydraulic or approved equal) crimping tool
Connection	Materials and labor required for equipment to be fully operational
Wiring	Raceways, conductors, and connections

B. Where electrical equipment is identified by the manufacturer and catalog number, the equipment shall be considered the basis of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval and authorization similar equipment of other manufacturers as substitution. It is the Contractor's responsibility to prove that proposed equipment is equal to that specified. The decision of the Design Engineer as to whether the submitted equipment is acceptable is final and binding.

C. Changes necessary to accommodate the substituted equipment shall be made at the Contractor's expense and shall be as authorized by the Owner and/or Design Engineer. Detailed drawings and sketches indicating the required changes shall be submitted for approval at the time the substitution is requested.

D. Installation of equipment, distribution panels, and transformers shall be in accordance with the Design Drawings. Materials and equipment necessary for the proper installation and operation of the Work included under this Section shall be purchased, procured, installed, wired, and tested as required by this and related Sections. Materials and equipment shall include, but not be limited to: single phase 13.2 kVAC distribution to the control panel pads, transformers, 1 phase 4-wire 240 VAC and 1 phase 3-wire system 120 VAC wiring to electrical equipment such as fused disconnect switches, manual transfer switches, distribution panels, pumps, and control devices; lights, fans, unit heaters, AC units, and lightning/surge protection systems; and other components required for a complete electrical system. The wiring shall include raceways, cables, junction and pull boxes, wireways, and other components required for a complete installation.

E. Materials and equipment installed shall be tested and listed by UL or other NRTL and shall be so labeled.

F. Materials and equipment shall be new and shall conform to or exceed the applicable standards in accordance with this and related Sections. Materials and equipment shall have a date of manufacture of less than 1 year prior to use on the Work.

G. The use of materials containing polyvinyl chloride (PVC) above grade shall be prohibited unless specifically instructed in the design documentation accompanying these specifications, or unless prior approval has been obtained from the Design Engineer and/or Owner.

H. Materials and equipment shall be provided by manufacturers whose products have been in service for at least 3 years.

I. Include brackets, attachments, mounting, hardware, touch-up paint, and other accessories needed for complete installation.

2.2 GROUNDING CONDUCTORS AND CONNECTORS

A. Grounding conductors shall be copper only, sized per code; bare or green insulated in sizes No. 4 American Wire Gauge (AWG) or larger.

2.3 GROUND RODS

A. In accordance with the Design Drawings, furnish ¾-inch diameter by 10-foot long copper clad steel ground rods.

2.4 CONDUITS, FITTINGS, AND WIREWAYS

A. Acceptable types of conduits and raceways are as follows.

1. Non-metallic conduit (i.e., PVC), underground only;2.Liquid-tight flexible metal conduit;
3. Rigid heavy wall galvanized steel (RGS);
4. Rigid aluminum; and
5. Conduits shall be provided as follows:
    a. Metal conduit, tubing, and fittings of required types, grades, sizes, and weights (wall thicknesses) shall be provided for each service shown on the Design Drawings. Where types and grades are not shown, select to comply with applicable portions of NEC. Minimum size shall be ¾-inch diameter. All conduit types shall be UL or other NRTL labeled.
    b. RGS conduit shall be zinc-coated, threaded type, hot-dip galvanized inside and outside and after cutting. RGS shall be used on outdoor exposed conduit runs. RGS conduits shall be Allied, Republic Steel, Triangle-PWC, Wheatland, or approved equal.
    c. Liquid-tight flexible metal conduit shall be constructed of single strip, continuous, interlocked, and double-wrapped steel; hot-dip galvanized; and coated with liquid-tight jacket. This conduit shall be used for connections to pumps, valves, instruments. Liquid-tight

flexible metal conduit shall be Anaconda type UA sealtight, Electri-Flex type LA, or approved equal.

B. Provide metal conduit fittings in accordance with the following.

1. Rigid metal conduit fittings shall be cast malleable iron, galvanized, or cadmium plated.
2. RGS fittings shall be of the threaded type. Bushings shall be of the insulated type. Use Myer's hub connectors on outdoor or damp locations.
3. Conduit fittings and bodies shall be Appleton, O.Z., Steel City, Raco, Crouse-Hinds, Efcor, Thomas and Betts, or approved equal conforming to UL 6.
4. Liquid-tight flexible metal conduit fittings shall be insulated throat cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, ¾ inch minimum, conforming to UL 360.

C. Provide non-metallic conduit in accordance with the following.

1. Provide non-metallic conduit, ducts, and fittings of required types, sizes, and weights for each service shown on the Design Drawings.
2. Electrical plastic heavy wall conduit shall be Schedule 40, 90 degree C, constructed of PVC, 1 inch minimum size, for direct burial.

D. Provide non-metallic conduit fittings and accessories in accordance with the following.

1. PVC conduit and tubing fittings shall be manufactured to mate and match to conduit or tubing type and materials as required.
2. PVC conduit shall be Carlon, Triangle-PWC, or approved equal.
3. PVC conduits shall not be supported using metallic encirclements. Break encirclements using nylon nuts and bolts.

E. Provide galvanized cast-metal conduit bodies of required types, shapes, and sizes. Conduit bodies shall be constructed with threaded-conduit-entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.

F. Provide electrical raceways for each type of service shown on the Design Drawings. Provide and assemble couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other components and accessories as required.

G. Provide underground sweeps constructed of PVC conduit for connection to above ground stub-ups.

H. All required field bends in metallic conduit must be uniform long radius sweeps, bent on a suitable power bender or another suitable bending tool.

I. When PVC conduits are directly buried, the trench bottom must be level and free of pockets. Line trench bottom with 4-inches of stone-free soil or sand. After installation, cover the conduits with a 4-inch layer of stone-free soil or sand. For conduits in force main trenches, follow conduit burial details as shown on the Design Drawings.

J. Provide marker tape for conduit in trenches as shown on the Design Drawings.

2.5 CONDUCTORS

A. Unless otherwise noted, all conductors shall be annealed copper with minimum 98% conductivity and shall conform with the applicable standards of UL, ANSI, and ICEA.

B. Branch circuit conductors shall not be smaller than No. 12 AWG copper wire.

C. All conductors No. 8 and larger shall be stranded.

D. The use of solid or stranded wire shall meet the equipment manufacturer installation requirements.

E. Unless otherwise specified, all conductor insulation shall be type THHN/THWN for wiring #10 AWG and smaller. Use stranded copper type THWN-2 for WIRING #8 and larger for 600V and below. Other types of conductors shall be installed where shown on Design Drawings.

F. Cable sizes shall be in accordance with the Design Drawings.

2.6 NAME PLATES

A. Provide permanently attached equipment nameplates constructed of three-layer plastic laminated material engraved through white surface material to black sub-layer. Lettering shall be ½-inch bold style. Nameplates shall indicate the equipment, maximum voltage, number of phases, and the name of the piece of equipment that provides the source of power as shown on the Design Drawings.

2.7 LIGHTING

A. Furnish lighting fixtures and light poles as shown on the Design Drawings.

B. Luminaries, receptacles, switches, and controls are considered lighting system assemblies made up of components. Install them as required by Design Drawings.

C. Install luminaries complete with lamps so each completed lighting branch circuit can be energized separately from the whole lighting system.

D. Alternative materials shall not be installed without prior approval from the Design Engineer.

2.8 PUMPS

A. Pumps shall be as shown on the Design Drawings or as otherwise approved by the Design Engineer.

B. Pumps shall be of stainless-steel construction and wetted parts shall be corrosion resistant and groundwater compatible.

C. Instrumentation Contractor shall furnish extraction well pumps, motor ends, and variable frequency drives (VFDs) as shown on the Design Drawings.

2.9 INSTRUMENTATION

A. Instrumentation shall be as shown on the Design Drawings or as otherwise approved by the Design Engineer.

B. Wetted parts shall be groundwater compatible plastic (e.g., PVC, polypropylene, polyethylene, etc.), 316 stainless steel, or other metals with better corrosion resistance.

C. Instrumentation exposed to the elements shall be NEMA 4 rated or higher.

D. Furnish flow meters as shown on the Design Drawings.

E. Furnish pressure transmitters/gauges as shown on the Design Drawings.

F. Furnish level transmitters/switches as shown on the Design Drawings.

G. Furnish position switches as shown on the Design Drawings.

2.10 CONTROL PANELS

A. Furnish electrical control panels to operate pumps and associated instrumentation, as shown on the Design Drawings and to satisfy the requirements of this Section.

B. Furnish typical control panel arrangements at locations shown on the Design Drawings. Furnish well termination arrangements at each extraction well location as per the Design Drawings.

C. Control panel enclosures and boxes shall be stainless steel and NEMA 4X rated.

PART 3 EXECUTION

3.1 GENERAL

A. The Work shall include, but not be limited to:

1. connection to existing utility services;
2. power distribution;
3. controls and instrumentation in accordance with this Section, Drawings, and Project Overview;
4. testing, start-up of electric motors, operation, maintenance, inspections, and recordkeeping in accordance with the approved Contractor's GWEC System Mechanical, Electrical, Instrumentation, and Process Control Work Plan;
5. testing and start-up of electrical equipment in accordance with Contractor's GWEC System Mechanical, Electrical, Instrumentation, and Process Control Work Plan approved by the Owner; and
6. an electrical system fully tested and operating to the approval of the Owner.

B. Make connections to equipment in accordance with approved drawings and sketches. The Design Drawings are diagrammatic and show the arrangement and location of fixtures, equipment, and conduit. Carefully investigate the structural and finish conditions affecting the Work and arrange the Work accordingly.

C. Furnish and install connections in accordance with codes, including but not limited to:

1. raceway system;
2. panelboards;
3. service neutral;
4. "separately derived service" (transformer or emergency power supply);
5. electrically-operated equipment and devices; and
6. surge arrestors.

D. Do not connect for electrical service a device or piece of equipment that has a neutral conductor connected to a grounding conductor or to the frame within the device or equipment.

E. Test instrumentation shall conform to NETA ATS.

3.2 GROUNDING

A. Provide grounding for electrical systems and equipment as required by the National Electrical Code (NEC) and National Electrical Safety Code (NESC) and as shown on the Design Drawings.

B. In conduit runs requiring an expansion fitting, install a bonding jumper around the fitting to maintain continuous ground continuity.

C. Where exposed to potential physical damage, protect ground wire with rigid non-ferrous conduit as permitted by applicable NESC standards.

D. Provide grounding conductor in all conduit runs except for control circuits 24 V and less.

E. Measure the system's resistance to ground. Perform testing in accordance with the instrument Manufacturer's recommendations using the fall-of-potential method. Provide to the Quality Assurance Engineer and/or Design Engineer, within 2 calendar days of completion of testing, test reports indicating overall resistance to ground and resistance of each electrode to ground.

F. Perform resistance to ground testing on each ground rod installed. Resistance shall be 5 ohms or less. If resistance is greater than 5 ohms, install a second ground rod of equal size a minimum of 6 feet from the original and connect with a minimum No. 2 AWG wire. Test the new ground rod and record results. Notify the Quality Assurance Engineer and/or the Design Engineer if the second ground rod test results are above 25 ohms.

G. Inspect grounding and bonding system conductors and connections for tightness and proper installation in accordance with the Manufacturer's instructions. Accurately record as-built locations of grounding electrodes and submit to the Construction Manager and Design Engineer.

3.3 DELIVERY AND STORAGE

A. Deliver materials in original, unbroken pallets or packages bearing the label of the Manufacturer. Handle materials carefully to prevent damage. Store items in an enclosed area free from contact with soil and water.

3.4 CUTTING CONSTRUCTION

A. Repair or replace construction materials that are damaged or cut with materials of like kind and quality as original materials.

3.5 EQUIPMENT CONNECTION

A. Provide complete electrical connections necessary to serve equipment of this and related Sections. Provide required control connections to equipment so that the equipment is fully operational upon completion of the Work. Where the Design Drawings show an equipment connection, provide the code-required disconnect switch.

B. Install materials and equipment in conformance with the Manufacturer's installation instructions and UL requirements.

3.6 WIRE NUMBERING

A. Number field wiring, external to pre-manufactured panels and equipment, in a manner that is uniquely identified with the associated field equipment. The numbering shall be sequential, beginning with 1 and continuing to 999. If a panel requires more than 999 wire numbers, start again at 1 preceded by an alpha character starting with A.

B. Submit a finished wire number schedule with conduit numbers and a functional description of the wires within 14 calendar days after completion of the specified Work.

3.7 EQUIPMENT SUPPORTS

A. Complete installation of structural steel framing and reinforced concrete before installing supporting devices.

B. Fasten hanger rods, conduit clamps, and outlet and junction boxes to structures in accordance with the Manufacturer's recommendations.

C. Use expansion anchors for support on concrete surfaces.

D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

E. Fabricate supports from structural steel or steel channel. Rigidly bolt to structural steel to present a neat appearance. Use hexagon head bolts with spring lock washers under nuts.

3.8 TESTING DURING ELECTRICAL INSTALLATION

A. Test wires installed on-site for point-to-point continuity for a minimum of 10 seconds and document on Contractor’s testing data sheet or equivalent record document.

B. Wire insulation shall be Megger tested between each conductor and ground. Use a 1,000 V Megger for insulation rated 600 V, and 500 V Megger for insulation rated

300 V. Minimum resistance shall be 100 megohms. Perform Megger test for at least 60 seconds or until resistance is stable.

C. Measure and record resistance readings between shield and ground for shielded cables in accordance with the Manufacturer's recommendations. Transfer the readings to the as-built drawings.

D. Provide test results to the Quality Assurance Engineer and Design Engineer.

E. Exothermic and mechanical-type connections shall be visually inspected to ensure good connections.

F. Exothermic connections shall be tested by hitting the weld with a hammer.

3.10 PUMP INSTALLATION

A. Install pumps, pump motors, and VFDs in accordance with the Manufacturer’s installation instructions and recommendations.

B. Install well pumps at the well depth as shown on the Design Drawings.

C. After installation and connection Work is completed, check the installation for correctness, verifying that connections are free of leaks and the system is operational per the standard pump curve based on flow and pressure readings. Installation personnel shall correct discrepancies.

3.11 INSTRUMENTATION AND CONTROLS

A. Flow meters:

1. Install flow meters as shown on the Design Drawings and in accordance with Manufacturer’s instructions, with readout in the upright position. Readout should display gpm. Connect rate totalizer to readout device and local control panel HMI.
2. Install flow meters with appropriate lengths of straight pipe runs per Manufacturer’s recommendations.
3. Flow meters shall provide adequate protection to associated pumps under low-flow conditions.
4. Flow meter pump control shall be in accordance with the Design Drawings. Flow meter set points shall be approved by the Design Engineer.

B. Level transmitters and switches:

1. Install level transmitters and switches as shown on the Design Drawings.

2. Level transmitters shall provide adequate protection to associated pumps under low level conditions.
3. Level switches shall provide redundant equalization tank overflow protection under high level conditions.
3. Level transmitter/switch pump control shall be in accordance with Design Drawings. Set points for pump control shall be approved by the Design Engineer.

C. Pressure transmitters:

1. Install pressure transmitters as shown on the Design Drawings.
2. Pressure transmitter pump control shall be in accordance with Design Drawings. Set points for pump control shall be approved by the Design Engineer.

D. Position switches:

1. Install position switches on well enclosure hot box as per the manufacture's recommendation and.

2. Position switches shall provide well enclosure hot box door open/close status.

3.12 CONSTRUCTION QUALITY REQUIREMENTS

A. The Contractor shall implement their CQC program as set forth in their approved Contractor's GWEC System Mechanical, Electrical, Instrumentation, and Process Control CQC Work Plan and correct all deficiencies and non-conformances at no additional cost to the Owner.

B. The Contractor shall be aware that there will be a Quality Assurance Engineer retained by the Owner under a separate contract, who will have an independent role to observe and perform monitoring, testing, and documentation in accordance with the CQA Plan. The Contractor shall provide equipment and labor to assist the Owner's Quality Assurance Engineer in obtaining material samples.

C. The Contractor shall be aware of the activities required of the Owner's Quality Assurance Engineer by the CQA Plan and this Section and shall account for these activities in the construction schedule.

D. The Owner's Quality Assurance Engineer will indicate any portion of the electrical materials or installations that do not meet the requirements of this Section and delineate the extent of the non-conformance. The Contractor shall correct all deficiencies and non-conformances identified by the Owner's Quality Assurance Engineer at no additional cost to the Owner.

3.13 SURVEY CONTROL

A. Conduct surveying as needed to layout, control, and document the Work, in accordance with Section 02 21 00.

B. Survey the locations, limits, and elevations of excavations, fill, installed Work, and additional constructed Site features in accordance with Section 02 21 00.

3.14 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all Work, including prior Work and all materials and completed Work of other Sections.

B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, as directed and approved by the Owner, at no additional cost to the Owner.

[END OF SECTION]

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.1 SCOPE

A. This section included activities associated with site preparation, including, but not limited to clearing and grubbing.

B. Procedures for land disturbance outlined in the land disturbance permit shall be adhered too. Any additional necessary required permits shall be obtained by the Contractor.

1.2 RELATED SECTIONS AND PLANS

A. Section 02 21 00 – Surveys

B. Section 31 23 00 – Excavation and Fill

1.3 DEFINITIONS

A. Clearing: Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas indicated to be cleared.

B. Grubbing: Grubbing shall consist of the removal and disposal of stumps and roots larger than 3 inches in diameter.

C. Stripping: Stripping consists of the removal and stockpiling of topsoil and organics present on the surface prior to earthwork.

1.4 REFERENCES

A. Technical Specifications, City of Fayetteville, North Carolina (Fayetteville Technical Specifications).

PART 2 PRODUCTS

A. (Not Used)

PART 3 EXECUTION

3.1 EXISTING TREES AND VEGETATION

A. Notify the Construction Manager at least 24 hours in advance of execution of work.

B. The Contractor shall remove and dispose of all vegetation in areas designated for construction in accordance with the Fayetteville, Technical Specifications.

C. Avoid cutting or injuring trees and vegetation outside areas to be cleared as indicated on the Design Drawings. Trees and areas to be protected shall be clearly marked or flagged and the Contractor shall be responsible for any damages within these areas.

3.2 CLEARING

A. Remove brush and other vegetation from areas designated for construction.

3.3 GRUBBING

A. Material to be grubbed, together with other organic or metallic debris which is not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas designated for construction. Depression made by grubbing shall be filled with suitable material and compacted to make the surface consistent with the original adjacent surface of the ground.

3.4 STRIPPING

A. Remove topsoil and other organic soils from the surface of the construction area to expose suitable soil. Stockpile topsoil material for later reuse.

3.5 REMOVAL AND DISPOSAL OF MATERIALS

A. Non-Hazardous Soil

1. Excavated soil identified as contaminated/impacted will be stockpiled within the designated location and covered with a polyethylene tarp to prevent contact with precipitation and resulting run-off.

2. Any soil designated for off-site disposal will be transferred into an appropriate, designated non-hazardous waste storage container: (1) a covered and lined roll-off box; or (2) a 55-gallon steel drum approved by North Carolina DOT for transport of the material.

3. Waste storage containers must remain closed and secured unless waste is actively being added or removed.

4. Do not completely fill containers. Roll-off boxes should not be filled to more

than about 2/3 of full capacity and 55-gallon drums should not be filled more than about 90% of their capacity.

B. Vegetative material shall be disposed of at a landfill facility approved by the Owner and Construction Manager.

C. No burning of vegetative materials will be permitted.

[END OF SECTION]

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 GENERAL

1.1 SCOPE

A. This section includes earthwork and associated activities, including but not limited to, removal and reuse of excavation soils, surface water management and erosion control, excavation, trenching, dewatering, stockpiling, subgrade preparation, and compacted fill.

B. Procedures for land disturbance outlined in the land disturbance permit shall be adhered too. Any additional necessary permits required shall be obtained by the Contractor.

1.2 RELATED SECTIONS AND PLANS

A. Section 01 33 00 – Submittal Procedures

B. Section 02 11 00 – Surveys

C. Section 22 11 00 – HDPE Pipes and Fittings

D. Section 26 05 00 –Electrical

E. Section 31 10 00 – Site Clearing

1.3 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. The most recent version of each standard shall be utilized.

1. American Society for Testing and Materials (ASTM):

ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM D 422	Particle-Size Analysis of Soils
ASTM D 1140	Amount of Material in Soils Finer than the No. 200 Sieve
ASTM D 1556	Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort
ASTM D 2167	Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2922	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

2. Latest version of Occupational Safety and Health Administration (OSHA) Construction Standards.

3. Technical Specifications, City of Fayetteville, North Carolina (Fayetteville Technical Specifications)

4. North Carolina Erosion and Sediment Control Planning and Design Manual.

1.4 DEFINITIONS

A. Degree of Compaction: “degree of compaction” required is expressed as a percentage of the maximum dry density obtained by ASTM D 1557.

B. Optimum Moisture Content: "optimum moisture content" shall be determined by ASTM D 1557.

C. Prepared Subgrade: the "prepared subgrade" is defined as the ground surface after clearing, grubbing, stripping, excavation, scarification and/or compaction and proofrolling. Subgrade requirements apply to soils beneath roads and structures, including pre-cast and cast-in-place concrete structures.

D. Clean Soil: “clean soil” is the term used for soil that is free of waste products and organic materials. Clean soil shall be excavated, stockpiled, and reused.

E. Import Fill: “import fill” shall be borrow soil material obtained by the Contractor from off-site sources.

F. Waste Material: “waste material” shall consist of vegetation, organic material, debris, other deleterious material, chemically impacted soil, and other non-conforming material encountered as part of the Work.

1.5 SUBMITTALS

A. The following shall be submitted to the Design Engineer:

1. Results of all field and laboratory soil tests used to verify compliance with conformance and performance requirements of this Section.

2. Analytical test results for and potential proposed off-site borrow sources.

B. For each source of pipe embedment fill material, submit the following to the Design Engineer for review at least 14 days prior to intended delivery to site:

1. The source of the pipe embedment fill material;

2. Test results conducted in accordance with ASTM C 136; and

3. Written certification that material meets requirements of this Section.

C. For proposed imported bedding/backfill materials, submit gradation reports to the Design Engineer for review at least 14 days prior to intended delivery to site.

D. For proposed imported topsoil materials, submit gradation and agricultural reports to the Design Engineer for review at least 14 days prior to intended delivery to site.

1.6 WORK RECORD DOCUMENTS

A. Contractor shall maintain logs of all soils excavated, reused and staged soil management areas (including but not limited to manifests, disposal tickets and volumes).

B. Contractor's quality control requirements shall meet applicable local and state requirements. The Contractor shall provide test results to confirm conformance and performance requirements of this Section

1.7 CLASSIFICATION OF EXCAVATION

A. Trench Excavation: trench excavation is the excavation of trenches for the placement and construction of piping and/or utilities.

B. Clean soil excavation: clean soil excavation is the excavation of soil to be stockpiled in an approved area for re-use.

1.8 BLASTING

A. Blasting will not be permitted.

1.9 UTILIZATION OF EXCAVATED MATERIALS

A. Clean soil material removed from excavations shall be used, insofar as practicable in the construction of fills, subgrades, trench bedding and backfill, and for similar purposes. Excavated materials shall be stockpiled in approved designated areas with appropriate erosion and sedimentation control features until utilization.

B. Waste material, if encountered, shall be removed from excavations and disposed of in designated waste disposal or spoil areas.

C. No excavated material shall be disposed of in such a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed Work in any way.

D. Contractor shall be responsible for removing all unused stockpiled soils and waste materials from site after completing the Work.

1.10 SHORING, SHEETING, BRACING, AND SLOPING

A. The contractor shall install and maintain shoring, sheeting, bracing, and sloping necessary to support the sides of any excavation, to keep and to prevent any movement which may damage adjacent pavements, utilities, or structures, damage or delay the Work, or endanger life and health. Install and maintain shoring, sheeting, bracing, and sloping as required by the Occupational Safety and Health Administration (OSHA) and other applicable government regulations and agencies.

1.11 EXCAVATION SAFETY

A. The Contractor shall be solely responsible for making all excavations in a safe manner. The contractor shall also provide appropriate measures to retain excavation sideslopes and ensure that persons working in or near the excavations are protected.

1.12 CODES, ORDINANCES, AND STATUTES

A. The contractor shall be familiar with, and comply with, all local, state and federal codes, ordinances, statutes, instructions, and regulations.

1.13 TOLERANCES

A. Material limits shall be constructed within a tolerance of 0.1 foot except:

1. under existing roadways which require a tolerance of 0.03 foot; and

2. where dimensions or grades are shown on the Drawings or specified as minimum. All grading shall be performed to maintain slopes and drainage as shown on the Drawings. No reverse slopes shall be permitted.

1.14 WATER CONTROL

A. Contractor shall provide barriers to prevent surface water run-on into excavations.

B. Contractor shall provide and operate equipment adequate to remove all surface or ground water from excavations. Water shall be disposed in a manner that will not damage adjacent properties.

C. When removing water in open excavations, discharge the water outside the excavation limits and at a point below the bottom of the elevation of the excavation when possible.

D. Design water removal systems to minimize removal of fine soil particles from the excavation area.

PART 2 PRODUCTS

2.1 STRUCTURAL FILL

A. Material to be reused from on-site excavations and imported from off-site for use as structural fill shall be classified as GC, SP, SW, SC, SM, ML, or CL in accordance with ASTM D 2487.

2.2 AGGREGATE

A. Base aggregate shall conform to ASTM C 33-90. Local aggregates not complying with this standard may be used providing it can be shown by special test or a record or past performance that these aggregates produce concrete of adequate strength and durability.

1. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances, within allowable standards.

2. Coarse Aggregate: Clean, uncoated, graded aggregate (i.e., gravel or crushed rock) containing no clay, mud, loam or foreign/organic matter.

B. Aggregate shall be imported gravel or crushed rock, free from dirt, clay clods, and organic material.

2.3 SAND

A. Natural sand (bar sand or concrete sand) pipe embedment fill material for underground pipe and utilities shall meet the gradation listed in Table 31 23 00-1. Gradation testing shall be in accordance with ASTM C 136.

TABLE 31 23 00-1

Pipe Bedding Sand Gradation

Sieve Size	Percent Passing
No. 4	100
No. 200	<10

2.4 BACKFILL

A. Furnish trench backfill material for underground pipe and electrical conduit that meets the fill material requirements for structural fill specified within this Section and meets the gradation listed in Table 31 23 00-2. Obtain and reuse uncontaminated excavated soils from on-site excavation, trenching, and impacted fill material stockpiles.

TABLE 21 23 00-2

Quarry Process Aggregate Backfill Material

Sieve Size	Percent Passing
1 inch	100
No. 200	<10

B. Furnish topsoil for backfill material. Topsoil must be a sandy or silty loam material with sufficient organic content to be capable of supporting vegetative growth.

2.5 IDENTIFICATION TAPE AND TRACER WIRE

A. The Contractor shall furnish a minimum 3-inch wide underground metallic marker tape with suitable warning legend to mark underground pipes and electrical conduits.

B. Marking tape shall be Pro-line, 5.0 mil, 3-inch wide detectable marking tape or Design Engineer approved equal.

C. Tapes shall be placed in trenches continuously as shown on the Construction Drawings.

D. The Contractor shall furnish tracer wire on pipes as shown on the Construction Drawings and installed in accordance with Section 22 11 00.

2.6 EROSION AND SEDIMENTATION CONTROL FEATURES

A. Silt fence and other erosion and sedimentation control features shall be utilized meeting all material, quantity, and frequency requirements specified in the Erosion and Sediment Control Plan.

2.7 EQUIPMENT

A. The Contractor shall furnish equipment to perform the work specified in this Section.

B. The Contractor shall furnish hand compaction equipment such as walk-behind pad-foot compactor, hand tamper, or vibratory plate compactors for compaction in areas inaccessible to large compaction equipment.

PART 3 EXECUTION

3.1 EXCAVATION

A. The Contractor shall perform excavation within the limits of the Work, to the lines, grades, and elevations indicated on the Drawings and as specified herein.

B. Grading shall conform to the typical sections shown on the Drawings.

C. Soil materials shall be transported to the stockpile or the fill area within the limits of the Work.

D. Nonconforming materials encountered within the limits of the Work shall be excavated below grade and replaced with conforming materials.

E. Surplus excavated material suitable for use on the Work shall be stockpiled in areas approved for surplus material storage.

F. Nonconforming excavated material shall be disposed of in designated waste or spoil areas.

G. During construction, excavation and fill operations shall be performed in a manner and sequence that will provide proper drainage.

H. Material required for fill in excess of that produced by excavation within the grading limits shall be imported from off-site.

I. Except as otherwise permitted, excavation shall be performed in such a manner as will provide adequate drainage.

J. The Contractor shall ensure that excavation of any area or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.2 TRENCHING

A. Trench support methods shall satisfy applicable local, state, and federal requirements, including requirements of the OSHA Construction Standards. Provide trench support materials on site prior to the start of trenching. Maintain the safety and stability of slopes and trenches and protect adjacent utilities and structures.

B. Trench for placement of pipes shall be to the depths and dimensions shown on the Construction Drawings. Stockpile excess excavated material from trenching in stockpile areas so not to impede other construction or access.

C. For any trenches greater than 4 feet in depth. Install adequate trench protection (sheeting, shoring, and bracing) to prevent ground movement or damage to adjacent structures, pipelines, and utilities.

D. Move trench boxes, if used, carefully to avoid disturbing pipe, bedding, or trench wall.

E. Alternately trench slopes may be sloped or benched, if space allows, in accordance with the applicable OSHA Standard.

F. Protect and maintain the trench bottom. Remove rock fragments or raveled materials that collect on the trench bottom. Backfill over-excavation with compacted fill in accordance with this Section. Excavate soft subgrade encountered at the trench bottom and backfill to trench bottom elevation with compacted fill in accordance with this Section.

G. Where trenches will be excavated in compacted fill areas, perform trenching only after compacted fill has reached at least 12 inches above top of the pipe.

H. For pipe installation limit the maximum length of open trench to 500 feet or the length of trench to support one day installation, whichever is greater, unless otherwise approved by the Design Engineer.

I. Continuously dewater trenches. Perform dewatering in accordance with this Section.

3.3 SELECTION OF IMPORT FILL

A. Import fill shall be obtained from off-site borrow areas selected by the Contractor and approved in writing by the Design Engineer.

B. The Contractor shall procure material, pay all royalties and other charges involved, and bear all expenses for importing borrow fill material.

C. No borrow soil shall be obtained within the limits of the Site without prior written approval from the Design Engineer.

D. Off-site borrow sources shall be analytically tested for contaminates prior to importation of fill.

3.4 SUBGRADE PREPARATION

A. Construction:

1. Subgrade shall be constructed to lines, grades, and cross sections as shown on the drawings, and shall be compacted as specified in this Section. This operation shall include plowing, disking, and any moistening or aerating required for achieving the specified moisture content and compaction requirements.

2. Soft or otherwise nonconforming material, as determined from laboratory testing, shall be removed, replaced with structural fill material, and recompacted.

3. Low areas resulting from removal of nonconforming material shall be filled, and the entire subgrade shall be shaped to lines, grades, and cross sections in the Drawings and compacted as specified in this Section.

B. Compaction: Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment suited to the type of material being compacted.

3.5 GENERAL FILL

A. Fill under and adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum dry density as determined by ASTM D 1557 for cohesive materials or 95 percent laboratory maximum dry density for cohesionless materials.

B. Fill areas under footings, foundation slabs, or floor slabs, lifts shall be placed in 6 to 8- inch thick loose lifts and compacted as specified in this Section. For other areas loose lifts shall be 12-inch thick maximum.

C. Surfaces on which backfill is to be placed shall be prepared as specified in Part 3.3 of this Section.

D. Trench backfill and bedding material shall be compacted as specified in this Section.

E. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well-suited to the material being compacted.

3.6 BACKFILLING PIPE TRENCHES

A. General:

1. Do not backfill with frozen or saturated material.

2. Do not backfill over frozen, wet, or soft trench bottom or side slopes. Remove materials that are frozen, wet, or soft as specified in this Section.

3. Do not disturb or damage piping or geosynthetics in trench during backfilling.

4. Do not use compaction equipment which exerts greater than 10 pounds per square inch ground pressure over piping that is covered by less than 12 inches of backfill material.

B. Placement of pipe embedment fill for pipes:

1. Place pipe embedment fill in one lift to the bottom of pipe elevation.

2. Compact pipe embedment fill with a minimum of 4 passes of a vibratory plate compactor prior to placing pipe.

3. Place pipe on top of the compacted pipe embedment fill.

For pipes 12 inches in diameter or less, place additional pipe embedment fill on the sides and hand tamp the fill around the sides as needed, such that intimate contact between the pipe and the pipe embedment fill is maintained below the spring line of the pipe. Continue placing pipe embedment fill until it is even with the top of the pipe. Compact the pipe embedment fill with a minimum of 4 passes of a walk- behind smooth drum compactor, hand tamper, or vibratory plate compactor, as appropriate. Place pipe embedment fill above the top of pipe to a minimum thickness of 4 inches as shown on the Construction Drawings in maximum 7-inch thick loose lifts. Compact each lift of pipe embedment fill with a minimum of 4 passes of a walk-behind smooth drum compactor, hand tamper, or vibratory plate compactor, as appropriate.

C. Placement of trench backfill material for pipes:

1. Trenches Outside Roadways and Roadway Right-of-Ways

   a. After placement and compaction of pipe embedment fill to the limits shown on the Construction Drawings, permitted excavated trench soils or import fill shall be utilized as backfill for the remainder of the trench. Soils and Quarry Process aggregate backfill shall be placed and compacted in maximum 6-inch lifts and each lift shall be compacted to not less than 95% of the materials maximum dry density as determined by ASTM D698 –Standard Proctor

   b. Trench backfill will be placed in lifts to the original grades.

D. Place underground metallic marker tape in trench backfill below finished grade 12 inches above top of piping and electrical conduits. Trench delineator stakes shall be placed in 50 feet intervals along the trench centerline.

E. Contractor shall complete trench up to grade and restore to existing conditions.

F. Certifications of imported clean fill shall be submitted to the Design Engineer for approval 14 days prior to utilizing. The certificates shall indicate the material is from a clean/virgin source.

G. All trenches shall not settle greater than 1/2-inch within 12 months of final resurfacing.

H. After pipe installation, Contractor shall place remaining bedding material and immediately place backfill in trench being careful to not damage piping.

I. Adjust the moisture content of excessively wet, but otherwise suitable, backfill material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.

J. Adjust the moisture content of excessively dry, but otherwise suitable, backfill material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.

3.7 PERFORATIONS

A. Perforations in the trench backfill resulting from survey stakes or other activities shall be backfilled with trench backfill material. Perforations resulting from nuclear density tests and sand-cone or drive cylinder density tests will be filled with trench backfill material.

3.8 MOISTURE CONTROLS

A. Materials shall be compacted at a moisture content within plus or minus 4 percentage points of the modified proctor optimum moisture content as determined by ASTM D 1557 or the maximum range at which the required compaction is achievable, whichever is more stringent.

B. Do not attempt to compact fill material that contains excessive moisture. Condition material by blading, discing, harrowing, or other methods, to aerate the soil and expedite drying.

C. Moisture shall be added to soils drier than the specified range. The added moisture shall be homogenized within the lift by discing or other suitable manner.

D. Lifts shall be sealed with a smooth drum roller prior to precipitation.

3.9 FINISHING

A. The final subgrade surfaces under all pavements shall be finished by compaction with a smooth drum roller. Final elevations should be in accordance with the lines, grades, cross sections, and elevations shown on the Drawings.

B. Gutters and ditches shall be finished in a manner that will result in effective drainage.

3.10 GEOTECHNICAL TESTING

A. Geotechnical testing shall be the responsibility of a third party testing service. Testing shall be performed by a commercial testing laboratory approved by the State ofNorth Carolina.

B. In-place soil density shall be tested in accordance with ASTM D 1556 (Sand Cone), ASTM D 2167 (Rubber Balloon), ASTM D 2937 (Drive Cylinder), or ASTM D 6938 (Nuclear Gauge).

1. When ASTM D 6938 (nuclear gauge method) is used to test density, the density and moisture calibration curves shall be checked and adjusted using the sand cone method as described in ASTM D 1556 or ASTM D 2937 or other method approved in advance by the Design Engineer.

2. In-place nuclear moisture-density testing shall only be performed by personnel certified as qualified to operate the nuclear gauges. All standard nuclear gauge safety procedures pertaining to usage, transportation, and storage and operational procedures pertaining to daily standard counts and applicable correction curves shall be implemented.

C. When test results indicate that density requirements are not met, the material not meeting requirements shall be reworked and recompacted, or removed, replaced, and recompacted to meet requirements of this Section, at no additional expense to the Owner.

D. Tests shall be performed on recompacted areas to assess conformance with the requirements of this Section.

E. Inspections and test results shall be certified by a Professional Engineer registered in the State of North Carolina. These certifications shall state that the tests and observations were performed by or under the direct supervision of the Quality Assurance Engineer and that the results are representative of the materials or conditions being certified by the tests.

F. The minimum acceptable test frequencies are as follows:

1. Gradation: One test per 500 cubic yards stockpiled or in-place source material to be utilized. Gradation of fill material shall be determined in accordance with ASTM D 422.

2. Optimum Moisture and Maximum Density: Tests shall be performed per ASTM D 1557 for each type material or source of material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill shall be performed, or when any

change in material occurs that may affect the optimum moisture content or maximum density.

3. In-Place Densities:

   a. One test per 5000 square feet, or fraction thereof, of each lift of fill compacted by other than hand-operated machines.
   b. One test per 1000 square feet, or fraction thereof, of each lift of fill compacted by hand-operated machinery.
   c. One test per 100 linear feet, or fraction thereof, of each lift of fill for roads.

4. Check Tests on In-Place Densities: If ASTM D 6938 is used to test density, density results shall be periodically verified by ASTM D 1556, ASTM D 2937, or alternate method approved in advance by the Design Engineer, as follows:

   a. One check test per day for each nuclear gauge used that day or one check test per twenty-five nuclear gauge test reading for each nuclear gauge used, whichever results in the most check tests.

3.11 PLACING GEOTEXTILE

A. Any surface to receive geotextile shall be smooth, free from obstructions, depressions, and sharp objects.

B. Do not operate machinery directly on the geotextile. When placing material over joints, place in the direction from the overlying geotextile to the underlying geotextile. Prevent puncture, tear, or displacement of geotextile and protect from damage. Replace torn areas and holes by placing an overlay of geotextile having dimensions at least 2 feet greater than the tear or hole.

3.12 SUBGRADE PROTECTION

A. During construction, excavations shall be kept shaped and drained. Ditches and drains along subgrades shall be maintained in such a manner as to drain effectively.

B. Finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until concrete, fill, base, or pavement is placed.

C. The storage or stockpiling of materials on finished subgrades shall not be permitted.

3.13 EROSION AND SEDIMENTATION CONTROL

A. Contractor shall meet or exceed all requirements as specified in the Fayetteville Technical Specifications and North Carolina Erosion and Sediment Control Planning and Design Manual pertaining to erosion and sedimentation control while performing all Work.

3.14 SEEDING

A. All grass areas disturbed by construction shall be sodded or permanently seeded with compatible grass at completion of construction unless otherwise approved by the Design Engineer.

3.15 CONSTRUCTION QUALITY REQUIREMENTS

A. The Contractor shall be responsible for all construction quality control testing and shall comply with the City of Fayetteville and North Carolina requirements for and independent quality control/quality assurance testing. Results approved by the independent testing organization shall be submitted to the Quality Assurance Engineer for approval of the Design Engineer.

B. The Quality Assurance Engineer shall review and approve pipe installation as-built elevations prior to backfilling.

[END OF SECTION]

Attachment C
WaterGEMS Calculation Package

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

CALCULATION PACKAGE COVER SHEET

Client: Chemours Company **Project:** 90% Design FW Groundwater Remedy Project **Project #:** TR0795A

TITLE OF PACKAGE: **GROUNDWATER EXTRACTION AND CONVEYANCE SYSTEM – PUMP AND PIPING DESIGN**

PREPARATION	**CALCULATION PREPARED BY:** (Calculation Preparer, CP)	Signature	Ding Hsiang Lin	12/15/21
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APPROVAL	**APPROVED BY:** (Calculation Approver, CA)	Signature	James J Deitsch	12/20/21
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REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
A	90% GWEC System Design	12/20/21	DHL	SV	BMT	JJD

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

HYDRAULIC CONTROL SYSTEM - PUMP AND PIPING DESIGN

PURPOSE

This calculation package was prepared in support of the Chemours Company 90% Design Drawings for the Groundwater Extraction and Conveyance System (GWEC; Geosyntec Consultants, 2021). This calculation package (herein referred as “Package”) presents preliminary engineering calculations for the design of the GWEC System.

The GWEC System consists of 69 extraction wells (i.e., EW-1 through EW-69), two groundwater conveyance pipelines (i.e., North Forcemain and South Forcemain), and a groundwater treatment plant (GWTP). The GWEC System layout is depicted schematically in **Figure 1**. Each extraction well is equipped with a submersible pump. Piping connected to the pump outlet ties into a common forcemain “header” pipe, which delivers the extracted groundwater to the GWTP. There are two header pipes: North Forcemain, which conveys groundwater from EW-1 through EW-54, and South Forcemain, which conveys groundwater from EW-55 through EW-69. The conveyance pipelines combine at the GWTP pad via a manifold and discharge into a single equalization tank.

This Package documents engineering calculations to size and select: (i) the submersible pumps at the extraction wells; (ii) the North Forcemain, the conveyance pipeline that conveys extracted groundwater from 54 extraction wells (i.e., EW-1 through EW-54) to the GWTP equalization tank; (iii) the South Forcemain, the conveyance pipeline that conveys extracted groundwater from 15 extraction wells (i.e., EW-55 through EW-69) to the GWTP equalization tank; and (iv) the combined conveyance pipeline leading to the GWTP. Current design elements are based on the 90% Design Drawings and have been conservatively estimated and/or sized to accommodate potential changes as the design is refined and for contingent capacity, should it be needed during operation.

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

DESIGN CRITERIA AND CONSTRAINTS

Design criteria used for the groundwater conveyance and the discharge system are outlined below:

- Pipe flow velocity is generally targeted in the range of 2 – 8 feet per second (fps).
- Extraction well pump sizes are based on the maximum design flow rates from each well. The expected and maximum design flow rates are shown in **Table 1**.
- Extraction well pumps are selected to operate at relative speed factors below 95 percent to allow for higher extraction rates in the event that it is required.
- Extraction well pumps are estimated to be placed immediately above the corresponding extraction well screen. The groundwater level elevation at each pump inlet location is estimated to be 5 ft above each Surficial aquifer well pump inlet and 15 ft above each Black Creek Aquifer well pump inlet.
- The North Forcemain, which carries extracted groundwater from EW-1 through EW-54, is sized based on a maximum design flow rate of 875 gallons per minute (gpm). This is a pressurized conveyance pipeline.
- The South Forcemain, which carries extracted groundwater from EW-55 through EW-69, is sized based on a maximum design flow rate of 370 gpm. This is a pressurized conveyance pipeline.
- The selected submersible pumps are assumed to be operating at variable flow rates with variable frequency drives (VFDs).
- Standard dimension ratios (SDRs) of the extraction well pipeline and the conveyance pipelines are based on design flow rates.

METHOD

Flow Velocity and Pipe Sizing

Flow Velocity in Full, Pressurized Pipes

Under their respective design flow rates, the extraction well piping and the North and South Forcemains were sized to accommodate the design criterion of velocities ranging from 2 to 8 fps. Flow velocities were calculated using the following equation:

$$V = {}^{Q}\!/_{A_p} \tag{1}$$

where:

V = average velocity of the liquid (fps);

Q = flow rate (cubic feet per second; ft^3/s);

A_p = area of pipe = $\frac{\pi}{4}(D^2)$ (square feet; ft^2); and

D = inside diameter of pipe (feet; ft).

Pump and Pipe Selection for Pressurized System

The conservation of energy equation (Bernoulli’s Equation) states that the total energy of a fluid flowing within a pipe excluding friction losses is constant. The extended Bernoulli’s Equation accounts for the frictional loss encountered by a fluid as it flows from one point to the next. The total frictional head loss is defined as the sum of major losses due to frictional effects in fully developed pipe flow and minor losses due to friction incurred from fittings in the pipeline, changes in flow direction, and changes in flow cross-sectional area. Combined, major losses and minor losses are referred to as “dynamic frictional losses” and represent the energy lost from the system as a result of fluid flow from one point to the next. The equation for pump head calculation can be given by:

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

$$H_P = (Z_2 - Z_1) + \frac{V_2^2 - V_1^2}{2g} + \sum h_{L1-2} \tag{2}$$

where:

Z_1 = elevation at point 1 (ft);

Z_2 = elevation at point 2 (ft);

P_1 = pressure at point 1 (lbs/ft^2);

P_2 = pressure at point 2 (lbs/ft^2);

γ = unit weight of water (lbs/ft^3);

V_1 = velocity at point 1 (fps);

V_2 = velocity at point 2 (fps);

g = acceleration due to gravity, (ft/s^2);

H_p = pressure head provided by the pump at point 1 (ft); and

Σh_{L1-2} = summation of dynamic frictional head losses between points 1 and 2 (ft).

Based on Equation (2), the pump must add sufficient energy to the water in the extraction well to overcome: (i) elevation change between the liquid level at the pump suction and the pipeline discharge point ($Z_2 - Z_1$), (ii) the increase in the velocity head at the discharge point ($\frac{V_2^2 - V_1^2}{2g}$), and (iii) the dynamic frictional losses caused by components of the piping system (Σh_{L1-2}). Among these factors of total dynamic head (TDH) required of the pump, elevation head is typically the largest contributor for groundwater systems.

Extraction well pump curves were initially selected based on the approximate elevation head at the maximum flow rate at each extraction well. Pump discharge piping sizes were selected based on the flow velocity target range and the maximum flow rate. The extraction well and lateral and conveyance pipelines were selected based on the highest anticipated combined flow rate from the extraction wells.

Dynamic Frictional Losses

Several well-established equations are routinely used to calculate frictional losses for pipe network components such as fittings, valves, and pipe lengths. The total frictional losses (i.e., Σh_{L1-2}) are estimated by summing the contributions of the individual pipe network components.

Frictional losses in individual fittings and valves are calculated using the minor loss equation [Lindeburg, 2001] as shown below:

$$h_{L,fitting} = k_{fitting}\left(\frac{V^2}{2g}\right) \tag{3}$$

where:

$h_{L,fitting}$ = head loss across a fitting or valve (ft);

$k_{fitting}$ = loss coefficient for each type of fitting or valve (dimensionless); and

V = average velocity of flow in fitting or valve based on flow rate (fps).

Frictional losses within a pipe or flexible hose are calculated using the Darcy-Weisbach equation as shown below:

$$h_{L,pipe} = \left(\frac{fL}{D}\right)\left(\frac{V^2}{2g}\right) \tag{4}$$

where:

$h_{L,pipe}$ = friction head loss in pipe (ft);

L = length of pipe (ft);

D = inside diameter of pipe (ft); and

f = Darcy friction factor (dimensionless).

The friction factor can be calculated as follows:

$$f = \frac{0.25}{\left(\log\left(\frac{\left(\frac{\varepsilon}{D}\right)}{3.7} + \frac{5.74}{Re^{0.9}}\right)\right)^2} \qquad (5)$$

where;

R_e = Reynolds number = D×V/ν (dimensionless);

ν = kinematic viscosity of water (ft^2/s); and

ε = absolute roughness (ft).

Hence,

$$\Sigma h_{L1\text{-}2} = h_{L,fitting} + h_{L,pipe} \qquad (6)$$

WaterGEMS Analysis – Extraction Well Pumps and Piping

WaterGEMS (SELECT series 3) is a water distribution modeling and design software developed by Bentley Systems. With inputs of an initial pump curve, pipe diameters, pipe fittings, and valving, the WaterGEMS model calculated preliminary results such as headloss, flow velocity, and flow rate for each pump, etc. If the simulated flow rates did not meet the required design flow rates, different pump curves with more capacity were added to re-run the model and generate updated results. This manual iteration process was repeated until the calculated flow rates were within required ranges.

Hydraulic Pipe Structural Analysis

Hydraulic pipe structural analysis was performed for HDPE pipelines only given that the pressure rating of the PVC pipes specified in the design are approximately of a factor of three or higher than the HDPE pipes specified. For example, SDR-11 HDPE pipe has a maximum working pressure of 160 pounds per square inch (psi) for each diameter whereas the working pressures for the PVC pipes specified in the design range from 470 to 630 psi. Confirmation of HDPE pipe integrity indicates concurrent PVC pipe integrity for this design.

Hydraulic Rupture Analysis (Long-Term Strength)

The resistance of the pump discharge pipe, extraction well laterals, and conveyance pipeline (at locations with the highest expected pressure calculated by the WaterGEMS model) against hydraulic rupture was evaluated using the following equation:

$$\mathrm{FS_{hr}} = \frac{\mathrm{P_{rating}}}{\mathrm{P_h}} \tag{7}$$

where:

FS_{hr} = factor of safety against hydraulic rupture (dimensionless);

P_{rating} = pressure rating of the pipe material (which includes an integral factor of safety of 2); and

P_h = hydraulic pressure in the pipe

An $FS_{hr} > 1.0$ is considered sufficient given that the pressure rating of the pipe includes an intrinsic factor of safety of 2.

Surge (Water Hammer) Analysis (Short-Term Strength)

Surge pressures (commonly termed “water-hammer”) result from changes in fluid velocity within pipe systems. Surge pressure can be caused by, for example, opening/closing valves and starting/stopping of pumps. Excessive surge pressures can result in pipe failure. The pipe material used for groundwater conveyance pipelines is high density polyethylene (HDPE) (PE4710).

Surge pressures for HDPE pipes were calculated as follows [PPI, 2008]:

$$\mathrm{P_s} = \mathrm{a}\left(\frac{\mathrm{V_{max}} - \mathrm{V_{min}}}{2.31\mathrm{g}}\right) \tag{8}$$

where:

P_s = surge pressure (psi);

a = wave velocity (fps);

V_{max} = maximum fluid velocity (fps);

V_{min} = minimum fluid velocity (fps);

g = acceleration due to gravity (ft/s^2).

The wave velocity was estimated as following:

$$a = \frac{4660}{\sqrt{1 + \frac{k}{E}(SDR - 2)}} \tag{9}$$

where:

k = bulk modulus of the fluid (psi);

E = modulus of elasticity for HDPE (psi); and

SDR = standard dimension ration (unitless).

Surge pressure analysis was performed on the pump discharge pipe, extraction well laterals, and conveyance pipelines (at locations with the highest expected pressure calculated by the WaterGEMS model). Maximum velocity was also obtained from model results.

Total pressure (P_{total}) within each section of the pipe system is the sum of the normal operating pressure (i.e., working pressure [P_w] in that pipe section) plus the transient surge pressure:

$$P_{total} = P_w + P_s \tag{10}$$

The total pressure for each pipeline section should remain below the Short-Term Pressure Rating (STR) of the proposed pipe, which is listed for various SDR HDPE pipes in **Table 2** [PPI, 2008]. If total pressure exceeds the STR of the selected pipe, then a pipe with a higher STR should be selected.

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date: **12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

DESIGN PARAMETERS

Well Extraction Pipe, North Forcemain, and South Forcemain Selection

Design parameters selected to evaluate extraction well and conveyance pipelines are presented below:

- Maximum design flow rates:
    - Maximum design flow rates from each well are shown in **Table 1**.
    - North Forcemain, which conveys extracted groundwater from EW-1 through EW-54, has a maximum design flow rate of 875 gpm.
    - South Forcemain, which conveys extracted groundwater from EW-55 through EW-69, has a maximum design flow rate of 370 gpm.
- Pipe materials:
    - SDR-11 HDPE was selected for the conveyance pipelines and the pump discharge pipe material due to its light weight, strength, durability, rot-resistance, and weather-resistance. Dimensions of HDPE piping are as shown in **Table 3**.
    - Schedule 80 PVC was selected for well head pipe material due to its light weight, versatility, strength, easy installation, durability, and low cost. Dimensions of PVC piping are as shown in **Table 4**.
- Pipe length:
    - Lengths of HDPE pipeline segments were measured from the 90% Groundwater Extraction and Conveyance System drawings (Drawing C-1 [Geosyntec Consultants, 2021]) including a factor of safety of 10% to account for expansion and elevation changes.
- For extraction well piping, the pipe diameter, and material are shown on the 90% Groundwater Extraction and Conveyance System drawings (Drawing M-1

through M-3 [Geosyntec Consultants, 2021]). The well type of each extraction well is summarized in **Table 1.**

- Forcemain cleanouts were placed every 300 – 500 ft along the conveyance pipelines to allow for periodical flushing of the lines in case of solid deposition due to low fluid velocities. Each forcemain cleanout was modeled as two (2) wyes.

- HDPE pipe friction loss was modeled as polyvinyl chloride (PVC) pipe because HDPE material is not available in the WaterGEMS library and the friction properties of HDPE and PVC are similar. Minor loss coefficients along the extraction well and conveyance pipelines were selected from the WaterGEMS database and are not listed herein.

- Pipe material, pipe diameters, and pipe lengths used as model inputs to WaterGEMS for the well extraction and conveyance pipelines are provided in **Table 5**.

Extraction Well Pump Selection

Design parameters selected to evaluate the extraction well submersible pumps are presented below:

- Expected and maximum design flow rates of each extraction well are summarized in **Table 1**.

- Elevation estimates measured in ft North American Vertical Datum of 1988 (NAVD 88):
    - The groundwater level elevation at each pump inlet location, Z_1, was estimated to be 5 ft above each Surficial aquifer well pump inlet and 15 ft above each Black Creek Aquifer well pump inlet. The elevation Z_1 varies by well and is summarized in **Table 6**.
    - Elevation at the discharge point at the GWTP (foundation estimated to be 90 ft NAVD88 at existing grade + 20 ft, a conservative estimate of the height of the discharge point to the aeration tank), Z_2 = 110 ft NAVD88.

- Pump elevations, groundwater elevations, pump curve definitions, expected and maximum design flow rates, and head losses for each pump selected are provided in **Table 6** and **Figures 2a through 2f**. Pump elevations, pump curves, and flow rates were input based on the design criteria. Pumps were selected based on the best fit of flow rates and pump head calculated in WaterGEMS.

- Pumps have minimum submergence requirements specified by the pump manufacturer and thus an analysis of net positive suction head (NPSH) is not necessary.

Pipe Structural Analysis

Hydraulic Rupture Analysis (Long-Term Strength)

The pressure rating of SDR-11 HDPE pipe (PE4710) is 200 psi (**Table 2**).

Surge (Water Hammer) Analysis (Short-Term Strength)

The data used in the surge pressure analysis are:

- Bulk modulus of fluid (assume water at 73ºF), k = 300,000 psi [PPI, 2008];
- Modulus of elasticity (assume HDPE at 73ºF), E = 150,000 psi [PPI, 2008];
- Standard dimension ratio, SDR = 11 (unitless);
- Minimum fluid velocity, V_{min} = 0 fps;
- Short-term pressure rating of pipe, STR = 200 psi (**Table 2**) [PPI, 2008].

Maximum flow velocities, surge pressure, maximum working pressure and total pressure results were calculated by the WaterGEMS model and presented in the Computations and Results section.

COMPUTATIONS AND RESULTS

The subsections below detail the pump and pipe sizing results and pipe structural analysis for extraction well and conveyance system.

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

WaterGEMS Model Results – Pump Discharge Piping, Well Head Piping, and Conveyance Pipeline Sizing

The layout of the GWEC System in WaterGEMS is shown in **Figure 3 and 3a through 3j.** Various pipe diameters were evaluated in WaterGEMS to achieve the desired design criteria. 1-1/4-in. diameter SDR-11 HDPE pipe was selected for Type I pump discharge piping, and 1-1/2 in diameter SDR-11 HDPE pipe was selected for Type II, III, and IV pump discharge piping. For the piping inside the well heads, the pipe diameter and material of each well type are shown on the 90% Groundwater Extraction and Conveyance System drawings (Drawing M-1 through M-3 [Geosyntec Consultants, 2021]). The conveyance pipelines were designed as telescoping pipelines with the North Forcemain transitioning from 3-inch SDR-11 HDPE to 10-inch SDR-11 HDPE and the South Forcemain transitioning from 3-inch SDR-11 HDPE to 8-inch SDR-11 HDPE through the use of expansion fittings.

The pump discharge piping, extraction well piping, extraction well laterals, and conveyance pipelines using these selected diameters and materials met the design flow rate for groundwater conveyance to the GWTP without exceeding the pipes' structural design limits (see the following section for pipe structural analysis). Pipe specifications such as diameters and lengths are presented in the WaterGEMS pipe input table (**Table 5**). Minor losses were also modeled for each pipe segment and based on the 90% mechanical detail drawings (Drawings M-1 through M-3 [Geosyntec Consultants, 2021]). The pipe outputs for flow, velocity, and pressure loss are shown in **Table 7**.

Through the iterative analysis and based on current availability and lead times to meet project needs, Goulds GS submersible pumps were selected for groundwater extraction based on their ability to provide satisfactory performance for the range of operating conditions considered.

- For extraction wells EW-23, EW-48, and EW-50, the Goulds 5GS05R series submersible pumps are estimated to provide adequate capacity to meet target flow rates. **Figure 2a** presents pump curves for the Goulds 5GS05R series submersible pump.

- For extraction wells EW-18, EW-25, EW-44, and EW-46, the Goulds 10GS05 series submersible pumps are estimated to provide adequate capacity to meet target flow rates. **Figure 2b** presents pump curves for the Goulds 10GS05 series submersible pump.

- For extraction wells EW-01, EW-02, and EW-03, the Goulds 10GS07 series submersible pumps are estimated to provide adequate capacity to meet target flow rates. **Figure 2b** presents pump curves for the Goulds 10GS07 series submersible pump.

- For extraction wells EW-04, EW-09 through EW-13, EW-16, EW-19, EW-20, EW-26, EW-38, EW-40 through EW-43, EW-45, EW-47, EW-49, EW-51, EW-54, EW-55, and EW-58, the Goulds 13GS10 series submersible pumps are estimated to provide adequate capacity to meet target flow rates. **Figure 2c** presents pump curves for the Goulds 13GS10 series submersible pump.

- For extraction wells EW-27, EW-30, EW-31, EW-33, EW-35, EW-37, and EW-39, the Goulds 18GS10 series submersible pumps are estimated to provide adequate capacity to meet target flow rates. **Figure 2d** presents pump curves for the Goulds 18GS10 series submersible pump.

- For extraction wells EW-05 through EW-08, EW-14, EW-15, EW-17, EW-21, EW-24, EW-28, EW-29, EW-32, EW-34, EW-36, EW-52, EW-53, EW-56, EW-57, and EW-59 through EW-63, the Goulds 18GS15 series submersible pumps are estimated to provide adequate capacity to meet target flow rates. **Figure 2d** presents pump curves for the Goulds 18GS15 series submersible pump.

- For extraction wells EW-22, EW-64, EW-65, and EW-66, the Goulds 25GS20 series submersible pumps are estimated to provide adequate capacity to meet target flow rates. **Figure 2e** presents pump curves for the Goulds 25GS20 series submersible pump.

- For extraction wells EW-67, EW68, and EW-69, the Goulds 35GS20 series submersible pumps are estimated to provide adequate capacity to meet target flow rates. **Figure 2f** presents pump curves for the Goulds 35GS20 series submersible pump.

The pump results from the model simulations are presented in **Table 6**.

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Structural Analysis

Hydraulic Rupture Analysis (Long-Term Strength)

The pressure rating of SDR-11 HDPE pipe (P_{rating}) is 200 psi and includes a factor of safety of 2.0. The hydraulic pressure in the conveyance pipelines is estimated as the highest observed pressure at the junctions during design flow conditions (**Table 8**). The maximum pressure along the conveyance pipelines under maximum design flow rate conditions was estimated to be 55.2 psi at J-EW-04 and FCO-04.

$$FS_{hr} = \frac{P_{rating}}{P_h} = \frac{200}{55.2} = 3.62\ (OK)$$

Surge (Water Hammer) Analysis (Short-Term Strength)

The surge pressure analysis was conducted using the maximum calculated flow velocity within the conveyance pipelines. The velocity was calculated by WaterGEMS to be 6.75 fps in pipes P-GWTP-1 through P-GWTP-4, which is the section of the pipeline that follows the merge of the North and South Forcemains, and conveys the cumulative extracted groundwater to the equalization tank at the GWTP. The wave velocity was estimated using previously defined parameters:

$$a = \frac{4660}{\sqrt{1 + \frac{k}{E}(SDR - 2)}} = \frac{4660}{\sqrt{1 + \frac{300000}{150000}(11 - 2)}} = 1{,}069.1\ \text{fps}$$

$$P_s = a\left(\frac{V_{max} - V_{min}}{2.31g}\right) = 1{,}069.1\left(\frac{6.75 - 0}{(2.31)(32.174)}\right) = 97.1\ \text{psi}$$

The maximum working pressure for pipes P-GWTP-1 through P-GWTP-4 is 13.3 psi. Therefore,

$$P_{total} = P_w + P_s = 13.3 + 97.1 = 110.4\ \text{psi}$$

$$P_{total} < STR = 200\ \text{psi}$$

The total pressure is less than the short-term strength of the extraction well SDR-11 HDPE Pipe.

SUMMARY AND CONCLUSIONS

The proposed hydraulic design satisfies the design criteria for the pump discharge piping, extraction well piping, extraction well lateral piping, and conveyance pipeline. The North Forcemain, which conveys extracted groundwater from EW-1 through EW-54 to the GWTP, ranges from 3-in to 10-in diameter SDR-11 HDPE pipes. The South Forcemain, which conveys extracted groundwater from EW-55 through EW-59 to the GWTP, ranges from 3-in to 8-in diameter SDR-11 HDPE pipes.

Goulds GS Series 5GS, 10GS, 13S, 18GS, 25GS, and 35GS series submersible pumps were selected for the extraction wells and provided adequate flow and TDH capacity to convey the extracted groundwater to the GWTP equalization tank. The pumps were selected to operate at relative speed factors below 95 percent to allow for higher extraction rates in the event that it is required.

A summary of the selected pump models and expected/maximum design flow rates is presented below:

Pump Label	Goulds Pump Model	Motor Horsepower (HP)	Expected Design Flow Rate (gpm)	Maximum Design Flow Rate (gpm)
PMP-01	10GS07	0.75	5	10
PMP-02	10GS07	0.75	5	10
PMP-03	10GS07	0.75	5	10
PMP-04	13GS10	1.00	10	15
PMP-05	18GS15	1.50	15	20
PMP-06	18GS15	1.50	15	20
PMP-07	18GS15	1.50	15	20
PMP-08	18GS15	1.50	15	20
PMP-09	13GS10	1.00	10	15
PMP-10	13GS10	1.00	10	15
PMP-11	13GS10	1.00	10	15
PMP-12	13GS10	1.00	10	15

Pump Label	Goulds Pump Model	Motor Horsepower (HP)	Expected Design Flow Rate (gpm)	Maximum Design Flow Rate (gpm)
PMP-13	13GS10	1.00	10	15
PMP-14	18GS15	1.50	15	20
PMP-15	18GS15	1.50	15	20
PMP-16	13GS10	1.00	10	15
PMP-17	18GS15	1.50	15	20
PMP-18	10GS05	0.50	5	10
PMP-19	13GS10	1.00	15	15
PMP-20	13GS10	1.00	15	15
PMP-21	18GS15	1.50	15	20
PMP-22	25GS20	2.00	25	30
PMP-23	5GS05R	0.50	5	5
PMP-24	18GS15	1.50	20	20
PMP-25	10GS05	0.50	5	10
PMP-26	13GS10	1.00	10	15
PMP-27	18GS10	1.00	10	20
PMP-28	18GS15	1.50	20	20
PMP-29	18GS15	1.50	20	20
PMP-30	18GS10	1.00	10	20
PMP-31	18GS10	1.00	10	20
PMP-32	18GS15	1.50	20	20
PMP-33	18GS10	1.00	10	20
PMP-34	18GS15	1.50	20	20
PMP-35	18GS10	1.00	10	20
PMP-36	18GS15	1.50	20	20
PMP-37	18GS10	1.00	10	20
PMP-38	13GS10	1.00	15	15
PMP-39	18GS10	1.00	10	20
PMP-40	13GS10	1.00	15	15
PMP-41	13GS10	1.00	15	15
PMP-42	13GS10	1.00	15	15
PMP-43	13GS10	1.00	10	15

Pump Label	Goulds Pump Model	Motor Horsepower (HP)	Expected Design Flow Rate (gpm)	Maximum Design Flow Rate (gpm)
PMP-44	10GS05	0.50	5	10
PMP-45	13GS10	1.00	10	15
PMP-46	10GS05	0.50	5	10
PMP-47	13GS10	1.00	15	15
PMP-48	5GS05R	0.50	5	5
PMP-49	13GS10	1.00	15	15
PMP-50	5GS05R	0.50	5	5
PMP-51	13GS10	1.00	15	15
PMP-52	18GS15	1.50	20	20
PMP-53	18GS15	1.50	20	20
PMP-54	13GS10	1.00	15	15
PMP-55	13GS10	1.00	15	15
PMP-56	18GS15	1.50	20	20
PMP-57	18GS15	1.50	20	20
PMP-58	13GS10	1.00	15	15
PMP-59	18GS15	1.50	20	20
PMP-60	18GS15	1.50	20	20
PMP-61	18GS15	1.50	20	20
PMP-62	18GS15	1.50	20	20
PMP-63	18GS15	1.50	20	25
PMP-64	25GS20	2.00	25	30
PMP-65	25GS20	2.00	25	30
PMP-66	25GS20	2.00	25	30
PMP-67	35GS20	2.00	30	35
PMP-68	35GS20	2.00	25	35
PMP-69	35GS20	2.00	25	35

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TABLES

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Table 1. Extraction Well Pump Design Parameters

Extraction Well No.	Pump Label	Expected Design Flow Rate (gpm)	Maximum Design Flow Rate (gpm)	Well Type	Aquifer
EW-01	PMP-01	5	10	Type I	Black Creek
EW-02	PMP-02	5	10	Type I	Black Creek
EW-03	PMP-03	5	10	Type I	Black Creek
EW-04	PMP-04	10	15	Type I	Black Creek
EW-05	PMP-05	15	20	Type II	Black Creek
EW-06	PMP-06	15	20	Type II	Black Creek
EW-07	PMP-07	15	20	Type II	Black Creek
EW-08	PMP-08	15	20	Type II	Black Creek
EW-09	PMP-09	10	15	Type I	Black Creek
EW-10	PMP-10	10	15	Type I	Black Creek
EW-11	PMP-11	10	15	Type I	Black Creek
EW-12	PMP-12	10	15	Type I	Black Creek
EW-13	PMP-13	10	15	Type I	Black Creek
EW-14	PMP-14	15	20	Type II	Black Creek
EW-15	PMP-15	15	20	Type II	Black Creek
EW-16	PMP-16	10	15	Type I	Black Creek
EW-17	PMP-17	15	20	Type II	Black Creek
EW-18	PMP-18	5	10	Type I	Surficial
EW-19	PMP-19	15	15	Type I	Black Creek
EW-20	PMP-20	15	15	Type I	Black Creek
EW-21	PMP-21	15	20	Type II	Black Creek
EW-22	PMP-22	25	30	Type III	Black Creek
EW-23	PMP-23	5	5	Type I	Surficial
EW-24	PMP-24	20	20	Type II	Black Creek
EW-25	PMP-25	5	10	Type I	Surficial
EW-26	PMP-26	10	15	Type I	Surficial
EW-27	PMP-27	10	20	Type II	Surficial
EW-28	PMP-28	20	20	Type II	Black Creek
EW-29	PMP-29	20	20	Type II	Surficial

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

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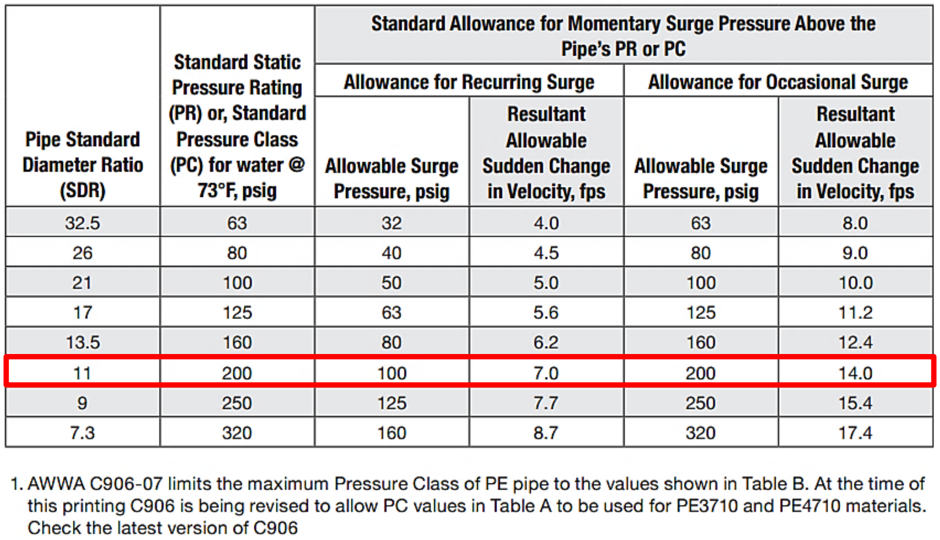
Extraction Well No.	Pump Label	Expected Design Flow Rate (gpm)	Maximum Design Flow Rate (gpm)	Well Type	Aquifer
EW-30	PMP-30	10	20	Type II	Black Creek
EW-31	PMP-31	10	20	Type II	Surficial
EW-32	PMP-32	20	20	Type II	Black Creek
EW-33	PMP-33	10	20	Type II	Surficial
EW-34	PMP-34	20	20	Type II	Black Creek
EW-35	PMP-35	10	20	Type II	Surficial
EW-36	PMP-36	20	20	Type II	Black Creek
EW-37	PMP-37	10	20	Type II	Surficial
EW-38	PMP-38	15	15	Type I	Black Creek
EW-39	PMP-39	10	20	Type II	Surficial
EW-40	PMP-40	15	15	Type I	Black Creek
EW-41	PMP-41	15	15	Type I	Black Creek
EW-42	PMP-42	15	15	Type I	Black Creek
EW-43	PMP-43	10	15	Type I	Black Creek
EW-44	PMP-44	5	10	Type I	Surficial
EW-45	PMP-45	10	15	Type I	Black Creek
EW-46	PMP-46	5	10	Type I	Surficial
EW-47	PMP-47	15	15	Type I	Black Creek
EW-48	PMP-48	5	5	Type I	Surficial
EW-49	PMP-49	15	15	Type I	Black Creek
EW-50	PMP-50	5	5	Type I	Surficial
EW-51	PMP-51	15	15	Type I	Black Creek
EW-52	PMP-52	20	20	Type II	Black Creek
EW-53	PMP-53	20	20	Type II	Black Creek
EW-54	PMP-54	15	15	Type I	Black Creek
EW-55	PMP-55	15	15	Type I	Black Creek
EW-56	PMP-56	20	20	Type II	Black Creek
EW-57	PMP-57	20	20	Type II	Black Creek
EW-58	PMP-58	15	15	Type I	Black Creek
EW-59	PMP-59	20	20	Type II	Black Creek
EW-60	PMP-60	20	20	Type II	Black Creek

Extraction Well No.	Pump Label	Expected Design Flow Rate (gpm)	Maximum Design Flow Rate (gpm)	Well Type	Aquifer
EW-61	PMP-61	20	20	Type II	Black Creek
EW-62	PMP-62	20	20	Type II	Black Creek
EW-63	PMP-63	20	25	Type II	Black Creek
EW-64	PMP-64	25	30	Type III	Black Creek
EW-65	PMP-65	25	30	Type III	Black Creek
EW-66	PMP-66	25	30	Type III	Black Creek
EW-67	PMP-67	30	35	Type IV	Black Creek
EW-68	PMP-68	25	35	Type IV	Black Creek
EW-69	PMP-69	25	35	Type IV	Black Creek

Notes:

1. gpm - gallons per minute
2. EW- extraction well
3. PMP - pump

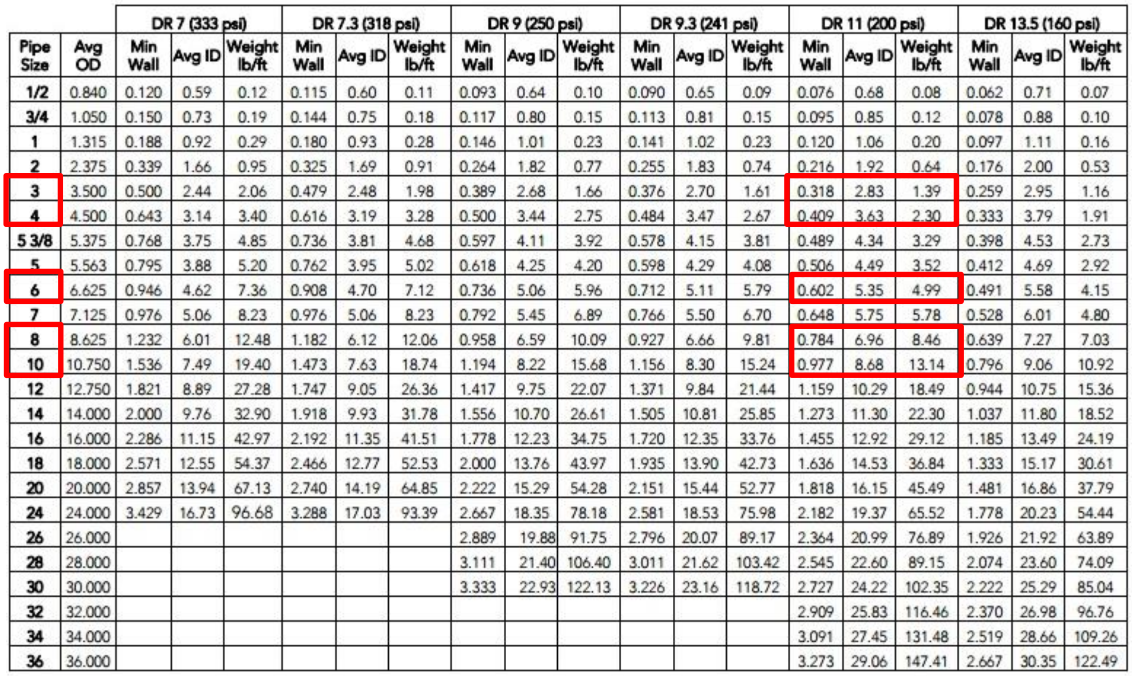
Table 2. Allowances for Momentary Surge Pressures for PE4710 HDPE Pipes [PPI, 2008]



Pipe Standard Diameter Ratio (SDR)	Standard Static Pressure Rating (PR) or, Standard Pressure Class (PC) for water @ 73°F, psig	Standard Allowance for Momentary Surge Pressure Above the Pipe's PR or PC			
		Allowance for Recurring Surge		Allowance for Occasional Surge	
		Allowable Surge Pressure, psig	Resultant Allowable Sudden Change in Velocity, fps	Allowable Surge Pressure, psig	Resultant Allowable Sudden Change in Velocity, fps
32.5	63	32	4.0	63	8.0
26	80	40	4.5	80	9.0
21	100	50	5.0	100	10.0
17	125	63	5.6	125	11.2
13.5	160	80	6.2	160	12.4
11	200	100	7.0	200	14.0
9	250	125	7.7	250	15.4
7.3	320	160	8.7	320	17.4

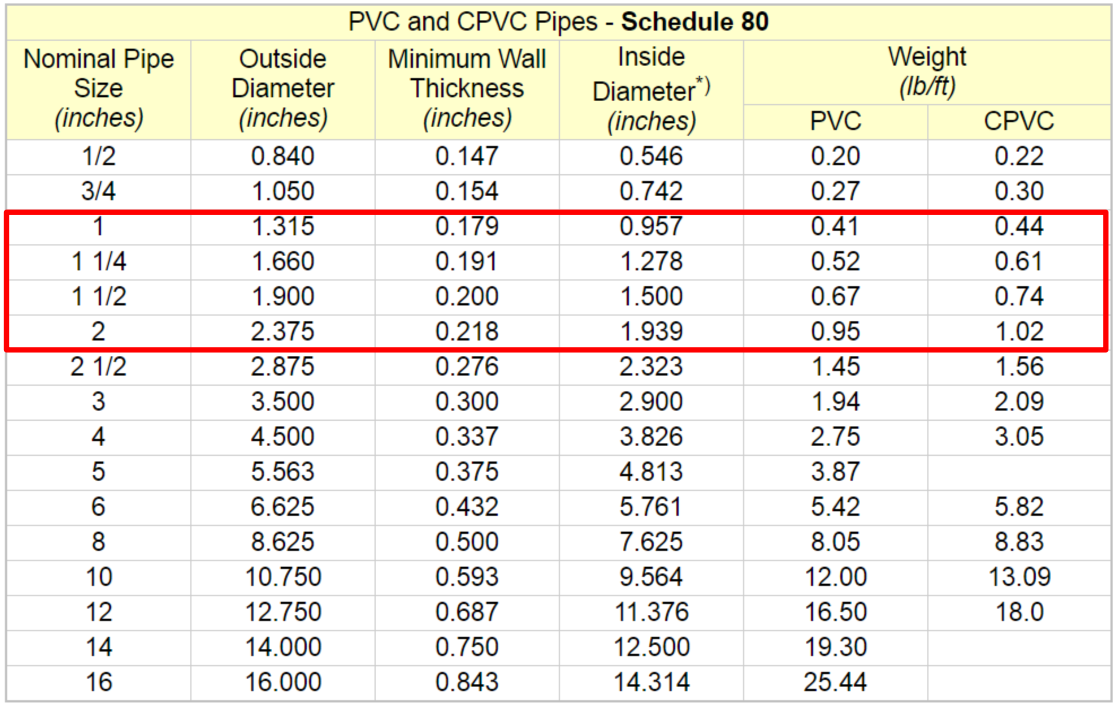
1. AWWA C906-07 limits the maximum Pressure Class of PE pipe to the values shown in Table B. At the time of this printing C906 is being revised to allow PC values in Table A to be used for PE3710 and PE4710 materials. Check the latest version of C906

Table 3. HDPE Iron Pipe Size (IPS) PE4710 Pipe Properties [J.M. Eagle, 2013]



		DR 7 (333 psi)			DR 7.3 (318 psi)			DR 9 (250 psi)			DR 9.3 (241 psi)			DR 11 (200 psi)			DR 13.5 (160 psi)		
Pipe Size	**Avg OD**	**Min Wall**	**Avg ID**	**Weight lb/ft**	**Min Wall**	**Avg ID**	**Weight lb/ft**	**Min Wall**	**Avg ID**	**Weight lb/ft**	**Min Wall**	**Avg ID**	**Weight lb/ft**	**Min Wall**	**Avg ID**	**Weight lb/ft**	**Min Wall**	**Avg ID**	**Weight lb/ft**
1/2	0.840	0.120	0.59	0.12	0.115	0.60	0.11	0.093	0.64	0.10	0.090	0.65	0.09	0.076	0.68	0.08	0.062	0.71	0.07
3/4	1.050	0.150	0.73	0.19	0.144	0.75	0.18	0.117	0.80	0.15	0.113	0.81	0.15	0.095	0.85	0.12	0.078	0.88	0.10
1	1.315	0.188	0.92	0.29	0.180	0.93	0.28	0.146	1.01	0.23	0.141	1.02	0.23	0.120	1.06	0.20	0.097	1.11	0.16
2	2.375	0.339	1.66	0.95	0.325	1.69	0.91	0.264	1.82	0.77	0.255	1.83	0.74	0.216	1.92	0.64	0.176	2.00	0.53
3	3.500	0.500	2.44	2.06	0.479	2.48	1.98	0.389	2.68	1.66	0.376	2.70	1.61	0.318	2.83	1.39	0.259	2.95	1.16
4	4.500	0.643	3.14	3.40	0.616	3.19	3.28	0.500	3.44	2.75	0.484	3.47	2.67	0.409	3.63	2.30	0.333	3.79	1.91
5 3/8	5.375	0.768	3.75	4.85	0.736	3.81	4.68	0.597	4.11	3.92	0.578	4.15	3.81	0.489	4.34	3.29	0.398	4.53	2.73
5	5.563	0.795	3.88	5.20	0.762	3.95	5.02	0.618	4.25	4.20	0.598	4.29	4.08	0.506	4.49	3.52	0.412	4.69	2.92
6	6.625	0.946	4.62	7.36	0.908	4.70	7.12	0.736	5.06	5.96	0.712	5.11	5.79	0.602	5.35	4.99	0.491	5.58	4.15
7	7.125	0.976	5.06	8.23	0.976	5.06	8.23	0.792	5.45	6.89	0.766	5.50	6.70	0.648	5.75	5.78	0.528	6.01	4.80
8	8.625	1.232	6.01	12.48	1.182	6.12	12.06	0.958	6.59	10.09	0.927	6.66	9.81	0.784	6.96	8.46	0.639	7.27	7.03
10	10.750	1.536	7.49	19.40	1.473	7.63	18.74	1.194	8.22	15.68	1.156	8.30	15.24	0.977	8.68	13.14	0.796	9.06	10.92
12	12.750	1.821	8.89	27.28	1.747	9.05	26.36	1.417	9.75	22.07	1.371	9.84	21.44	1.159	10.29	18.49	0.944	10.75	15.36
14	14.000	2.000	9.76	32.90	1.918	9.93	31.78	1.556	10.70	26.61	1.505	10.81	25.85	1.273	11.30	22.30	1.037	11.80	18.52
16	16.000	2.286	11.15	42.97	2.192	11.35	41.51	1.778	12.23	34.75	1.720	12.35	33.76	1.455	12.92	29.12	1.185	13.49	24.19
18	18.000	2.571	12.55	54.37	2.466	12.77	52.53	2.000	13.76	43.97	1.935	13.90	42.73	1.636	14.53	36.84	1.333	15.17	30.61
20	20.000	2.857	13.94	67.13	2.740	14.19	64.85	2.222	15.29	54.28	2.151	15.44	52.77	1.818	16.15	45.49	1.481	16.86	37.79
24	24.000	3.429	16.73	96.68	3.288	17.03	93.39	2.667	18.35	78.18	2.581	18.53	75.98	2.182	19.37	65.52	1.778	20.23	54.44
26	26.000							2.889	19.88	91.75	2.796	20.07	89.17	2.364	20.99	76.89	1.926	21.92	63.89
28	28.000							3.111	21.40	106.40	3.011	21.62	103.42	2.545	22.60	89.15	2.074	23.60	74.09
30	30.000							3.333	22.93	122.13	3.226	23.16	118.72	2.727	24.22	102.35	2.222	25.29	85.04
32	32.000													2.909	25.83	116.46	2.370	26.98	96.76
34	34.000													3.091	27.45	131.48	2.519	28.66	109.26
36	36.000													3.273	29.06	147.41	2.667	30.35	122.49

Table 4. Typical PVC and CPVC Pipe Properties [Engineering Toolbox, 2004]



PVC and CPVC Pipes - **Schedule 80**

Nominal Pipe Size *(inches)*	Outside Diameter *(inches)*	Minimum Wall Thickness *(inches)*	Inside Diameter*) *(inches)*	Weight *(lb/ft)* PVC	Weight *(lb/ft)* CPVC
1/2	0.840	0.147	0.546	0.20	0.22
3/4	1.050	0.154	0.742	0.27	0.30
1	1.315	0.179	0.957	0.41	0.44
1 1/4	1.660	0.191	1.278	0.52	0.61
1 1/2	1.900	0.200	1.500	0.67	0.74
2	2.375	0.218	1.939	0.95	1.02
2 1/2	2.875	0.276	2.323	1.45	1.56
3	3.500	0.300	2.900	1.94	2.09
4	4.500	0.337	3.826	2.75	3.05
5	5.563	0.375	4.813	3.87	
6	6.625	0.432	5.761	5.42	5.82
8	8.625	0.500	7.625	8.05	8.83
10	10.750	0.593	9.564	12.00	13.09
12	12.750	0.687	11.376	16.50	18.0
14	14.000	0.750	12.500	19.30	
16	16.000	0.843	14.314	25.44	

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Table 5. WaterGEMS Inputs – Pipes

Pipe Label	Material	Diameter (in)	Length (ft)
P-N-3"-01	SDR-11 HDPE	2.83	11
P-N-3"-02	SDR-11 HDPE	2.83	17
P-N-3"-03	SDR-11 HDPE	2.83	314
P-N-3"-04	SDR-11 HDPE	2.83	35
P-N-3"-05	SDR-11 HDPE	2.83	296
P-N-3"-06	SDR-11 HDPE	2.83	70
P-N-3"-07	SDR-11 HDPE	2.83	261
P-N-3"-08	SDR-11 HDPE	2.83	15
P-N-3"-09	SDR-11 HDPE	2.83	272
P-N-3"-10	SDR-11 HDPE	2.83	45
P-N-3"-11	SDR-11 HDPE	2.83	150
P-N-3"-12	SDR-11 HDPE	2.83	145
P-N-4"-01	SDR-11 HDPE	3.63	17
P-N-4"-02	SDR-11 HDPE	3.63	20
P-N-4"-03	SDR-11 HDPE	3.63	66
P-N-4"-04	SDR-11 HDPE	3.63	121
P-N-4"-05	SDR-11 HDPE	3.63	14
P-N-4"-06	SDR-11 HDPE	3.63	183
P-N-4"-07	SDR-11 HDPE	3.63	97
P-N-4"-08	SDR-11 HDPE	3.63	51
P-N-4"-09	SDR-11 HDPE	3.63	22
P-N-4"-10	SDR-11 HDPE	3.63	75
P-N-4"-11	SDR-11 HDPE	3.63	132
P-N-6"-01	SDR-11 HDPE	5.35	17
P-N-6"-02	SDR-11 HDPE	5.35	194
P-N-6"-03	SDR-11 HDPE	5.35	91
P-N-6"-04	SDR-11 HDPE	5.35	44
P-N-6"-05	SDR-11 HDPE	5.35	29
P-N-6"-06	SDR-11 HDPE	5.35	177
P-N-6"-07	SDR-11 HDPE	5.35	156
P-N-6"-08	SDR-11 HDPE	5.35	80
P-N-6"-09	SDR-11 HDPE	5.35	112

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
P-N-6"-10	SDR-11 HDPE	5.35	37
P-N-6"-11	SDR-11 HDPE	5.35	109
P-N-6"-12	SDR-11 HDPE	5.35	51
P-N-6"-13	SDR-11 HDPE	5.35	30
P-N-6"-14	SDR-11 HDPE	5.35	116
P-N-6"-15	SDR-11 HDPE	5.35	74
P-N-6"-16	SDR-11 HDPE	5.35	37
P-N-6"-17	SDR-11 HDPE	5.35	55
P-N-6"-18	SDR-11 HDPE	5.35	44
P-N-6"-19	SDR-11 HDPE	5.35	37
P-N-6"-20	SDR-11 HDPE	5.35	164
P-N-6"-21	SDR-11 HDPE	5.35	222
P-N-6"-22	SDR-11 HDPE	5.35	15
P-N-6"-23	SDR-11 HDPE	5.35	17
P-N-6"-24	SDR-11 HDPE	5.35	24
P-N-6"-25	SDR-11 HDPE	5.35	5
P-N-8"-01	SDR-11 HDPE	6.96	17
P-N-8"-02	SDR-11 HDPE	6.96	55
P-N-8"-03	SDR-11 HDPE	6.96	136
P-N-8"-04	SDR-11 HDPE	6.96	55
P-N-8"-05	SDR-11 HDPE	6.96	126
P-N-8"-06	SDR-11 HDPE	6.96	70
P-N-8"-07	SDR-11 HDPE	6.96	15
P-N-8"-08	SDR-11 HDPE	6.96	16
P-N-8"-09	SDR-11 HDPE	6.96	25
P-N-8"-10	SDR-11 HDPE	6.96	12
P-N-8"-11	SDR-11 HDPE	6.96	98
P-N-8"-12	SDR-11 HDPE	6.96	60
P-N-8"-13	SDR-11 HDPE	6.96	141
P-N-8"-14	SDR-11 HDPE	6.96	219
P-N-8"-15	SDR-11 HDPE	6.96	57
P-N-10"-01	SDR-11 HDPE	8.68	17
P-N-10"-02	SDR-11 HDPE	8.68	57
P-N-10"-03	SDR-11 HDPE	8.68	70

Pipe Label	Material	Diameter (in)	Length (ft)
P-N-10"-04	SDR-11 HDPE	8.68	163
P-N-10"-05	SDR-11 HDPE	8.68	54
P-N-10"-06	SDR-11 HDPE	8.68	51
P-N-10"-07	SDR-11 HDPE	8.68	90
P-N-10"-08	SDR-11 HDPE	8.68	124
P-N-10"-09	SDR-11 HDPE	8.68	45
P-N-10"-10	SDR-11 HDPE	8.68	109
P-N-10"-11	SDR-11 HDPE	8.68	41
P-N-10"-12	SDR-11 HDPE	8.68	162
P-N-10"-13	SDR-11 HDPE	8.68	145
P-N-10"-14	SDR-11 HDPE	8.68	52
P-N-10"-15	SDR-11 HDPE	8.68	43
P-N-10"-16	SDR-11 HDPE	8.68	12
P-N-10"-17	SDR-11 HDPE	8.68	229
P-N-10"-18	SDR-11 HDPE	8.68	218
P-N-10"-19	SDR-11 HDPE	8.68	51
P-N-10"-20	SDR-11 HDPE	8.68	163
P-N-10"-21	SDR-11 HDPE	8.68	175
P-N-10"-22	SDR-11 HDPE	8.68	180
P-N-10"-23	SDR-11 HDPE	8.68	11
P-N-10"-24	SDR-11 HDPE	8.68	49
P-N-10"-25	SDR-11 HDPE	8.68	6
P-N-10"-26	SDR-11 HDPE	8.68	2
P-N-10"-27	SDR-11 HDPE	8.68	2
P-S-3"-01	SDR-11 HDPE	2.83	10
P-S-3"-02	SDR-11 HDPE	2.83	131
P-S-3"-03	SDR-11 HDPE	2.83	110
P-S-4"-01	SDR-11 HDPE	3.63	16
P-S-4"-02	SDR-11 HDPE	3.63	65
P-S-4"-03	SDR-11 HDPE	3.63	65
P-S-4"-04	SDR-11 HDPE	3.63	24
P-S-4"-05	SDR-11 HDPE	3.63	66
P-S-4"-06	SDR-11 HDPE	3.63	134
P-S-6"-01	SDR-11 HDPE	5.35	17

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC: **BMT** Date: **12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
P-S-6"-02	SDR-11 HDPE	5.35	130
P-S-6"-03	SDR-11 HDPE	5.35	91
P-S-6"-04	SDR-11 HDPE	5.35	27
P-S-6"-05	SDR-11 HDPE	5.35	45
P-S-6"-06	SDR-11 HDPE	5.35	41
P-S-6"-07	SDR-11 HDPE	5.35	73
P-S-6"-08	SDR-11 HDPE	5.35	95
P-S-6"-09	SDR-11 HDPE	5.35	27
P-S-6"-10	SDR-11 HDPE	5.35	21
P-S-6"-11	SDR-11 HDPE	5.35	157
P-S-6"-12	SDR-11 HDPE	5.35	94
P-S-6"-13	SDR-11 HDPE	5.35	75
P-S-6"-14	SDR-11 HDPE	5.35	218
P-S-6"-15	SDR-11 HDPE	5.35	214
P-S-6"-16	SDR-11 HDPE	5.35	45
P-S-6"-17	SDR-11 HDPE	5.35	156
P-S-6"-18	SDR-11 HDPE	5.35	177
P-S-8"-01	SDR-11 HDPE	6.96	17
P-S-8"-02	SDR-11 HDPE	6.96	91
P-S-8"-03	SDR-11 HDPE	6.96	7
P-S-8"-04	SDR-11 HDPE	6.96	5
P-S-8"-05	SDR-11 HDPE	6.96	7
P-S-8"-06	SDR-11 HDPE	6.96	6
P-S-8"-07	SDR-11 HDPE	6.96	87
P-S-8"-08	SDR-11 HDPE	6.96	11
P-S-8"-09	SDR-11 HDPE	6.96	20
P-S-8"-10	SDR-11 HDPE	6.96	11
P-S-8"-11	SDR-11 HDPE	6.96	49
P-S-8"-12	SDR-11 HDPE	6.96	6
P-S-8"-13	SDR-11 HDPE	6.96	2
P-S-8"-14	SDR-11 HDPE	6.96	2
P-S-8"-15	SDR-11 HDPE	6.96	2
P-GWTP-10"-1	SDR-11 HDPE	8.68	12
P-GWTP-10"-2	SDR-11 HDPE	8.68	2

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
P-GWTP-10"-3	SDR-11 HDPE	8.68	200
P-GWTP-10"-4	SDR-11 HDPE	8.68	20
WHP-EW-1-1	SDR-11 HDPE	1.34	0.10
WHP-EW-1-2	SDR-11 HDPE	1.34	51
WHP-EW-1-3	SCH 80 PVC	0.96	2.00
WHP-EW-1-4	SCH 80 PVC	1.50	2.66
WHP-EW-1-5	SCH 80 PVC	1.50	0.84
WHP-EW-1-6	SCH 80 PVC	1.94	2.00
WHP-EW-1-7	SDR-11 HDPE	1.92	4.33
WHP-EW-1-8	SDR-11 HDPE	1.92	12
WHP-EW-2-1	SDR-11 HDPE	1.34	0.10
WHP-EW-2-2	SDR-11 HDPE	1.34	51
WHP-EW-2-3	SCH 80 PVC	0.96	2.00
WHP-EW-2-4	SCH 80 PVC	1.50	2.66
WHP-EW-2-5	SCH 80 PVC	1.50	0.84
WHP-EW-2-6	SCH 80 PVC	1.94	2.00
WHP-EW-2-7	SDR-11 HDPE	1.92	4.33
WHP-EW-2-8	SDR-11 HDPE	1.92	12
WHP-EW-3-1	SDR-11 HDPE	1.34	0.10
WHP-EW-3-2	SDR-11 HDPE	1.34	56
WHP-EW-3-3	SCH 80 PVC	0.96	2.00
WHP-EW-3-4	SCH 80 PVC	1.50	2.66
WHP-EW-3-5	SCH 80 PVC	1.50	0.84
WHP-EW-3-6	SCH 80 PVC	1.94	2.00
WHP-EW-3-7	SDR-11 HDPE	1.92	4.33
WHP-EW-3-8	SDR-11 HDPE	1.92	12
WHP-EW-4-1	SDR-11 HDPE	1.34	0.10
WHP-EW-4-2	SDR-11 HDPE	1.34	56
WHP-EW-4-3	SCH 80 PVC	0.96	2.00
WHP-EW-4-4	SCH 80 PVC	1.50	2.66
WHP-EW-4-5	SCH 80 PVC	1.50	0.84
WHP-EW-4-6	SCH 80 PVC	1.94	2.00
WHP-EW-4-7	SDR-11 HDPE	1.92	4.33
WHP-EW-4-8	SDR-11 HDPE	1.92	17

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-5-1	SDR-11 HDPE	1.53	0.10
WHP-EW-5-2	SDR-11 HDPE	1.53	56
WHP-EW-5-3	SCH 80 PVC	1.50	2.00
WHP-EW-5-4	SCH 80 PVC	1.50	2.66
WHP-EW-5-5	SCH 80 PVC	1.50	0.84
WHP-EW-5-6	SCH 80 PVC	1.94	2.00
WHP-EW-5-7	SDR-11 HDPE	1.92	4.33
WHP-EW-5-8	SDR-11 HDPE	1.92	17
WHP-EW-6-1	SDR-11 HDPE	1.53	0.10
WHP-EW-6-2	SDR-11 HDPE	1.53	71
WHP-EW-6-3	SCH 80 PVC	1.50	2.00
WHP-EW-6-4	SCH 80 PVC	1.50	2.66
WHP-EW-6-5	SCH 80 PVC	1.50	0.84
WHP-EW-6-6	SCH 80 PVC	1.94	2.00
WHP-EW-6-7	SDR-11 HDPE	1.92	4.33
WHP-EW-6-8	SDR-11 HDPE	1.92	17
WHP-EW-7-1	SDR-11 HDPE	1.53	0.10
WHP-EW-7-2	SDR-11 HDPE	1.53	66
WHP-EW-7-3	SCH 80 PVC	1.50	2.00
WHP-EW-7-4	SCH 80 PVC	1.50	2.66
WHP-EW-7-5	SCH 80 PVC	1.50	0.84
WHP-EW-7-6	SCH 80 PVC	1.94	2.00
WHP-EW-7-7	SDR-11 HDPE	1.92	4.33
WHP-EW-7-8	SDR-11 HDPE	1.92	17
WHP-EW-8-1	SDR-11 HDPE	1.53	0.10
WHP-EW-8-2	SDR-11 HDPE	1.53	76
WHP-EW-8-3	SCH 80 PVC	1.50	2.00
WHP-EW-8-4	SCH 80 PVC	1.50	2.66
WHP-EW-8-5	SCH 80 PVC	1.50	0.84
WHP-EW-8-6	SCH 80 PVC	1.94	2.00
WHP-EW-8-7	SDR-11 HDPE	1.92	4.33
WHP-EW-8-8	SDR-11 HDPE	1.92	17
WHP-EW-9-1	SDR-11 HDPE	1.34	0.10
WHP-EW-9-2	SDR-11 HDPE	1.34	76

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-9-3	SCH 80 PVC	0.96	2.00
WHP-EW-9-4	SCH 80 PVC	1.50	2.66
WHP-EW-9-5	SCH 80 PVC	1.50	0.84
WHP-EW-9-6	SCH 80 PVC	1.94	2.00
WHP-EW-9-7	SDR-11 HDPE	1.92	4.33
WHP-EW-9-8	SDR-11 HDPE	1.92	17
WHP-EW-10-1	SDR-11 HDPE	1.34	0.10
WHP-EW-10-2	SDR-11 HDPE	1.34	66
WHP-EW-10-3	SCH 80 PVC	0.96	2.00
WHP-EW-10-4	SCH 80 PVC	1.50	2.66
WHP-EW-10-5	SCH 80 PVC	1.50	0.84
WHP-EW-10-6	SCH 80 PVC	1.94	2.00
WHP-EW-10-7	SDR-11 HDPE	1.92	4.33
WHP-EW-10-8	SDR-11 HDPE	1.92	17
WHP-EW-11-1	SDR-11 HDPE	1.34	0.10
WHP-EW-11-2	SDR-11 HDPE	1.34	61
WHP-EW-11-3	SCH 80 PVC	0.96	2.00
WHP-EW-11-4	SCH 80 PVC	1.50	2.66
WHP-EW-11-5	SCH 80 PVC	1.50	0.84
WHP-EW-11-6	SCH 80 PVC	1.94	2.00
WHP-EW-11-7	SDR-11 HDPE	1.92	4.33
WHP-EW-11-8	SDR-11 HDPE	1.92	17
WHP-EW-12-1	SDR-11 HDPE	1.34	0.10
WHP-EW-12-2	SDR-11 HDPE	1.34	76
WHP-EW-12-3	SCH 80 PVC	0.96	2.00
WHP-EW-12-4	SCH 80 PVC	1.50	2.66
WHP-EW-12-5	SCH 80 PVC	1.50	0.84
WHP-EW-12-6	SCH 80 PVC	1.94	2.00
WHP-EW-12-7	SDR-11 HDPE	1.92	4.33
WHP-EW-12-8	SDR-11 HDPE	1.92	17
WHP-EW-13-1	SDR-11 HDPE	1.34	0.10
WHP-EW-13-2	SDR-11 HDPE	1.34	81
WHP-EW-13-3	SCH 80 PVC	0.96	2.00
WHP-EW-13-4	SCH 80 PVC	1.50	2.66

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-13-5	SCH 80 PVC	1.50	0.84
WHP-EW-13-6	SCH 80 PVC	1.94	2.00
WHP-EW-13-7	SDR-11 HDPE	1.92	4.33
WHP-EW-13-8	SDR-11 HDPE	1.92	17
WHP-EW-14-1	SDR-11 HDPE	1.53	0.10
WHP-EW-14-2	SDR-11 HDPE	1.53	71
WHP-EW-14-3	SCH 80 PVC	1.50	2.00
WHP-EW-14-4	SCH 80 PVC	1.50	2.66
WHP-EW-14-5	SCH 80 PVC	1.50	0.84
WHP-EW-14-6	SCH 80 PVC	1.94	2.00
WHP-EW-14-7	SDR-11 HDPE	1.92	4.33
WHP-EW-14-8	SDR-11 HDPE	1.92	17
WHP-EW-15-1	SDR-11 HDPE	1.53	0.10
WHP-EW-15-2	SDR-11 HDPE	1.53	61
WHP-EW-15-3	SCH 80 PVC	1.50	2.00
WHP-EW-15-4	SCH 80 PVC	1.50	2.66
WHP-EW-15-5	SCH 80 PVC	1.50	0.84
WHP-EW-15-6	SCH 80 PVC	1.94	2.00
WHP-EW-15-7	SDR-11 HDPE	1.92	4.33
WHP-EW-15-8	SDR-11 HDPE	1.92	16
WHP-EW-16-1	SDR-11 HDPE	1.34	0.10
WHP-EW-16-2	SDR-11 HDPE	1.34	71
WHP-EW-16-3	SCH 80 PVC	0.96	2.00
WHP-EW-16-4	SCH 80 PVC	1.50	2.66
WHP-EW-16-5	SCH 80 PVC	1.50	0.84
WHP-EW-16-6	SCH 80 PVC	1.94	2.00
WHP-EW-16-7	SDR-11 HDPE	1.92	4.33
WHP-EW-16-8	SDR-11 HDPE	1.92	20
WHP-EW-17-1	SDR-11 HDPE	1.53	0.10
WHP-EW-17-2	SDR-11 HDPE	1.53	61
WHP-EW-17-3	SCH 80 PVC	1.50	2.00
WHP-EW-17-5	SCH 80 PVC	1.50	2.66
WHP-EW-17-6	SCH 80 PVC	1.50	0.84
WHP-EW-17-6	SCH 80 PVC	1.94	2.00

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-17-7	SDR-11 HDPE	1.92	4.33
WHP-EW-17-8	SDR-11 HDPE	1.92	23
WHP-EW-18-1	SDR-11 HDPE	1.34	0.10
WHP-EW-18-2	SDR-11 HDPE	1.34	31
WHP-EW-18-3	SCH 80 PVC	0.96	2.00
WHP-EW-18-4	SCH 80 PVC	1.50	2.66
WHP-EW-18-5	SCH 80 PVC	1.50	0.84
WHP-EW-18-6	SCH 80 PVC	1.94	2.00
WHP-EW-18-7	SDR-11 HDPE	1.92	4.33
WHP-EW-18-8	SDR-11 HDPE	1.92	4.21
WHP-EW-18-9	SDR-11 HDPE	1.92	10
WHP-EW-19-1	SDR-11 HDPE	1.34	0.10
WHP-EW-19-2	SDR-11 HDPE	1.34	61
WHP-EW-19-3	SCH 80 PVC	0.96	2.00
WHP-EW-19-4	SCH 80 PVC	1.50	2.66
WHP-EW-19-5	SCH 80 PVC	1.50	0.84
WHP-EW-19-6	SCH 80 PVC	1.94	2.00
WHP-EW-19-7	SDR-11 HDPE	1.92	4.33
WHP-EW-19-8	SDR-11 HDPE	1.92	4.21
WHP-EW-19-9	SDR-11 HDPE	1.92	19
WHP-EW-20-1	SDR-11 HDPE	1.34	0.10
WHP-EW-20-2	SDR-11 HDPE	1.34	56
WHP-EW-20-3	SCH 80 PVC	0.96	2.00
WHP-EW-20-4	SCH 80 PVC	1.50	2.66
WHP-EW-20-5	SCH 80 PVC	1.50	0.84
WHP-EW-20-6	SCH 80 PVC	1.94	2.00
WHP-EW-20-7	SDR-11 HDPE	1.92	4.33
WHP-EW-20-8	SDR-11 HDPE	1.92	23
WHP-EW-21-1	SDR-11 HDPE	1.53	0.10
WHP-EW-21-2	SDR-11 HDPE	1.53	66
WHP-EW-21-3	SCH 80 PVC	1.50	2.00
WHP-EW-21-4	SCH 80 PVC	1.50	2.66
WHP-EW-21-5	SCH 80 PVC	1.50	0.84
WHP-EW-21-6	SCH 80 PVC	1.94	2.00

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-21-7	SDR-11 HDPE	1.92	4.33
WHP-EW-21-8	SDR-11 HDPE	1.92	23
WHP-EW-22-1	SDR-11 HDPE	1.53	0.10
WHP-EW-22-2	SDR-11 HDPE	1.53	36
WHP-EW-22-3	SCH 80 PVC	1.50	2.00
WHP-EW-22-4	SCH 80 PVC	1.94	2.66
WHP-EW-22-5	SCH 80 PVC	1.94	0.84
WHP-EW-22-6	SCH 80 PVC	1.94	2.00
WHP-EW-22-7	SDR-11 HDPE	1.92	4.33
WHP-EW-22-8	SDR-11 HDPE	1.92	4.21
WHP-EW-22-9	SDR-11 HDPE	1.92	19
WHP-EW-23-1	SDR-11 HDPE	1.34	0.10
WHP-EW-23-2	SDR-11 HDPE	1.34	21
WHP-EW-23-3	SCH 80 PVC	0.96	2.00
WHP-EW-23-4	SCH 80 PVC	1.50	2.66
WHP-EW-23-5	SCH 80 PVC	1.50	0.84
WHP-EW-23-6	SCH 80 PVC	1.94	2.00
WHP-EW-23-7	SDR-11 HDPE	1.92	4.33
WHP-EW-23-8	SDR-11 HDPE	1.92	4.21
WHP-EW-23-9	SDR-11 HDPE	1.92	10
WHP-EW-24-1	SDR-11 HDPE	1.53	0.10
WHP-EW-24-2	SDR-11 HDPE	1.53	36
WHP-EW-24-3	SCH 80 PVC	1.50	2.00
WHP-EW-24-4	SCH 80 PVC	1.50	2.66
WHP-EW-24-5	SCH 80 PVC	1.50	0.84
WHP-EW-24-6	SCH 80 PVC	1.94	2.00
WHP-EW-24-7	SDR-11 HDPE	1.92	4.33
WHP-EW-24-8	SDR-11 HDPE	1.92	4.21
WHP-EW-24-9	SDR-11 HDPE	1.92	19
WHP-EW-25-1	SDR-11 HDPE	1.34	0.10
WHP-EW-25-2	SDR-11 HDPE	1.34	16
WHP-EW-25-3	SCH 80 PVC	0.96	2.00
WHP-EW-25-4	SCH 80 PVC	1.50	2.66
WHP-EW-25-5	SCH 80 PVC	1.50	0.84

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-25-6	SCH 80 PVC	1.94	2.00
WHP-EW-25-7	SDR-11 HDPE	1.92	4.33
WHP-EW-25-8	SDR-11 HDPE	1.92	4.21
WHP-EW-25-9	SDR-11 HDPE	1.92	10
WHP-EW-26-1	SDR-11 HDPE	1.34	0.10
WHP-EW-26-2	SDR-11 HDPE	1.34	13
WHP-EW-26-3	SCH 80 PVC	0.96	2.00
WHP-EW-26-4	SCH 80 PVC	1.50	2.66
WHP-EW-26-5	SCH 80 PVC	1.50	0.84
WHP-EW-26-6	SCH 80 PVC	1.94	2.00
WHP-EW-26-7	SDR-11 HDPE	1.92	4.33
WHP-EW-26-8	SDR-11 HDPE	1.92	12
WHP-EW-27-1	SDR-11 HDPE	1.53	0.10
WHP-EW-27-2	SDR-11 HDPE	1.53	12
WHP-EW-27-3	SCH 80 PVC	1.50	2.00
WHP-EW-27-4	SCH 80 PVC	1.50	2.66
WHP-EW-27-5	SCH 80 PVC	1.50	0.84
WHP-EW-27-6	SCH 80 PVC	1.94	2.00
WHP-EW-27-7	SDR-11 HDPE	1.92	4.33
WHP-EW-27-8	SDR-11 HDPE	1.92	4.21
WHP-EW-27-9	SDR-11 HDPE	1.92	10
WHP-EW-28-1	SDR-11 HDPE	1.53	0.10
WHP-EW-28-2	SDR-11 HDPE	1.53	76
WHP-EW-28-3	SCH 80 PVC	1.50	2.00
WHP-EW-28-4	SCH 80 PVC	1.50	2.66
WHP-EW-28-5	SCH 80 PVC	1.50	0.84
WHP-EW-28-6	SCH 80 PVC	1.94	2.00
WHP-EW-28-7	SDR-11 HDPE	1.92	4.33
WHP-EW-28-8	SDR-11 HDPE	1.92	4.21
WHP-EW-28-9	SDR-11 HDPE	1.92	19
WHP-EW-29-1	SDR-11 HDPE	1.53	0.10
WHP-EW-29-2	SDR-11 HDPE	1.53	11
WHP-EW-29-3	SCH 80 PVC	1.50	2.00
WHP-EW-29-4	SCH 80 PVC	1.50	2.66

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-29-5	SCH 80 PVC	1.50	0.84
WHP-EW-29-6	SCH 80 PVC	1.94	2.00
WHP-EW-29-7	SDR-11 HDPE	1.92	4.33
WHP-EW-29-8	SDR-11 HDPE	1.92	4.21
WHP-EW-29-9	SDR-11 HDPE	1.92	10
WHP-EW-30-1	SDR-11 HDPE	1.53	0.10
WHP-EW-30-2	SDR-11 HDPE	1.53	52
WHP-EW-30-3	SCH 80 PVC	1.50	2.00
WHP-EW-30-4	SCH 80 PVC	1.50	2.66
WHP-EW-30-5	SCH 80 PVC	1.50	0.84
WHP-EW-30-6	SCH 80 PVC	1.94	2.00
WHP-EW-30-7	SDR-11 HDPE	1.92	4.33
WHP-EW-30-8	SDR-11 HDPE	1.92	4.21
WHP-EW-30-9	SDR-11 HDPE	1.92	19
WHP-EW-31-1	SDR-11 HDPE	1.53	0.10
WHP-EW-31-2	SDR-11 HDPE	1.53	26
WHP-EW-31-3	SCH 80 PVC	1.50	2.00
WHP-EW-31-4	SCH 80 PVC	1.50	2.66
WHP-EW-31-5	SCH 80 PVC	1.50	0.84
WHP-EW-31-6	SCH 80 PVC	1.94	2.00
WHP-EW-31-7	SDR-11 HDPE	1.92	4.33
WHP-EW-31-8	SDR-11 HDPE	1.92	4.21
WHP-EW-31-9	SDR-11 HDPE	1.92	10
WHP-EW-32-1	SDR-11 HDPE	1.53	0.10
WHP-EW-32-2	SDR-11 HDPE	1.53	56
WHP-EW-32-3	SCH 80 PVC	1.50	2.00
WHP-EW-32-4	SCH 80 PVC	1.50	2.66
WHP-EW-32-5	SCH 80 PVC	1.50	0.84
WHP-EW-32-6	SCH 80 PVC	1.94	2.00
WHP-EW-32-7	SDR-11 HDPE	1.92	4.33
WHP-EW-32-8	SDR-11 HDPE	1.92	4.21
WHP-EW-32-9	SDR-11 HDPE	1.92	19
WHP-EW-33-1	SDR-11 HDPE	1.53	0.10
WHP-EW-33-2	SDR-11 HDPE	1.53	21

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-33-3	SCH 80 PVC	1.50	2.00
WHP-EW-33-4	SCH 80 PVC	1.50	2.66
WHP-EW-33-5	SCH 80 PVC	1.50	0.84
WHP-EW-33-6	SCH 80 PVC	1.94	2.00
WHP-EW-33-7	SDR-11 HDPE	1.92	4.33
WHP-EW-33-8	SDR-11 HDPE	1.92	4.21
WHP-EW-33-9	SDR-11 HDPE	1.92	10
WHP-EW-34-1	SDR-11 HDPE	1.53	0.10
WHP-EW-34-2	SDR-11 HDPE	1.53	66
WHP-EW-34-3	SCH 80 PVC	1.50	2.00
WHP-EW-34-4	SCH 80 PVC	1.50	2.66
WHP-EW-34-5	SCH 80 PVC	1.50	0.84
WHP-EW-34-6	SCH 80 PVC	1.94	2.00
WHP-EW-34-7	SDR-11 HDPE	1.92	4.33
WHP-EW-34-8	SDR-11 HDPE	1.92	4.21
WHP-EW-34-9	SDR-11 HDPE	1.92	19
WHP-EW-35-1	SDR-11 HDPE	1.53	0.10
WHP-EW-35-2	SDR-11 HDPE	1.53	21
WHP-EW-35-3	SCH 80 PVC	1.50	2.00
WHP-EW-35-4	SCH 80 PVC	1.50	2.66
WHP-EW-35-5	SCH 80 PVC	1.50	0.84
WHP-EW-35-6	SCH 80 PVC	1.94	2.00
WHP-EW-35-7	SDR-11 HDPE	1.92	4.33
WHP-EW-35-8	SDR-11 HDPE	1.92	4.21
WHP-EW-35-9	SDR-11 HDPE	1.92	10
WHP-EW-36-1	SDR-11 HDPE	1.53	0.10
WHP-EW-36-2	SDR-11 HDPE	1.53	66
WHP-EW-36-3	SCH 80 PVC	1.50	2.00
WHP-EW-36-4	SCH 80 PVC	1.50	2.66
WHP-EW-36-5	SCH 80 PVC	1.50	0.84
WHP-EW-36-6	SCH 80 PVC	1.94	2.00
WHP-EW-36-7	SDR-11 HDPE	1.92	4.33
WHP-EW-36-8	SDR-11 HDPE	1.92	4.21
WHP-EW-36-9	SDR-11 HDPE	1.92	19

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-37-1	SDR-11 HDPE	1.53	0.10
WHP-EW-37-2	SDR-11 HDPE	1.53	18
WHP-EW-37-3	SCH 80 PVC	1.50	2.00
WHP-EW-37-4	SCH 80 PVC	1.50	2.66
WHP-EW-37-5	SCH 80 PVC	1.50	0.84
WHP-EW-37-6	SCH 80 PVC	1.94	2.00
WHP-EW-37-7	SDR-11 HDPE	1.92	4.33
WHP-EW-37-8	SDR-11 HDPE	1.92	4.21
WHP-EW-37-9	SDR-11 HDPE	1.92	10
WHP-EW-38-1	SDR-11 HDPE	1.34	0.10
WHP-EW-38-2	SDR-11 HDPE	1.34	69
WHP-EW-38-3	SCH 80 PVC	0.96	2.00
WHP-EW-38-4	SCH 80 PVC	1.50	2.66
WHP-EW-38-5	SCH 80 PVC	1.50	0.84
WHP-EW-38-6	SCH 80 PVC	1.94	2.00
WHP-EW-38-7	SDR-11 HDPE	1.92	4.33
WHP-EW-38-8	SDR-11 HDPE	1.92	4.21
WHP-EW-38-9	SDR-11 HDPE	1.92	19
WHP-EW-39-1	SDR-11 HDPE	1.53	0.10
WHP-EW-39-2	SDR-11 HDPE	1.53	18
WHP-EW-39-3	SCH 80 PVC	1.50	2.00
WHP-EW-39-4	SCH 80 PVC	1.50	2.66
WHP-EW-39-5	SCH 80 PVC	1.50	0.84
WHP-EW-39-6	SCH 80 PVC	1.94	2.00
WHP-EW-39-7	SDR-11 HDPE	1.92	4.33
WHP-EW-39-8	SDR-11 HDPE	1.92	4.21
WHP-EW-39-9	SDR-11 HDPE	1.92	10
WHP-EW-40-1	SDR-11 HDPE	1.34	0.10
WHP-EW-40-2	SDR-11 HDPE	1.34	71
WHP-EW-40-3	SCH 80 PVC	0.96	2.00
WHP-EW-40-4	SCH 80 PVC	1.50	2.66
WHP-EW-40-5	SCH 80 PVC	1.50	0.84
WHP-EW-40-6	SCH 80 PVC	1.94	2.00
WHP-EW-40-7	SDR-11 HDPE	1.92	4.33

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-40-8	SDR-11 HDPE	1.92	4.21
WHP-EW-40-9	SDR-11 HDPE	1.92	19
WHP-EW-41-1	SDR-11 HDPE	1.34	0.10
WHP-EW-41-2	SDR-11 HDPE	1.34	79
WHP-EW-41-3	SCH 80 PVC	0.96	2.00
WHP-EW-41-4	SCH 80 PVC	1.50	2.66
WHP-EW-41-5	SCH 80 PVC	1.50	0.84
WHP-EW-41-6	SCH 80 PVC	1.94	2.00
WHP-EW-41-7	SDR-11 HDPE	1.92	4.33
WHP-EW-41-8	SDR-11 HDPE	1.92	23
WHP-EW-42-1	SDR-11 HDPE	1.34	0.10
WHP-EW-42-2	SDR-11 HDPE	1.34	79
WHP-EW-42-3	SCH 80 PVC	0.96	2.00
WHP-EW-42-4	SCH 80 PVC	1.50	2.66
WHP-EW-42-5	SCH 80 PVC	1.50	0.84
WHP-EW-42-6	SCH 80 PVC	1.94	2.00
WHP-EW-42-7	SDR-11 HDPE	1.92	4.33
WHP-EW-42-8	SDR-11 HDPE	1.92	23
WHP-EW-43-1	SDR-11 HDPE	1.34	0.10
WHP-EW-43-2	SDR-11 HDPE	1.34	79
WHP-EW-43-3	SCH 80 PVC	0.96	2.00
WHP-EW-43-4	SCH 80 PVC	1.50	2.66
WHP-EW-43-5	SCH 80 PVC	1.50	0.84
WHP-EW-43-6	SCH 80 PVC	1.94	2.00
WHP-EW-43-7	SDR-11 HDPE	1.92	4.33
WHP-EW-43-8	SDR-11 HDPE	1.92	23
WHP-EW-44-1	SDR-11 HDPE	1.34	0.10
WHP-EW-44-2	SDR-11 HDPE	1.34	16
WHP-EW-44-3	SCH 80 PVC	0.96	2.00
WHP-EW-44-4	SCH 80 PVC	1.50	2.66
WHP-EW-44-5	SCH 80 PVC	1.50	0.84
WHP-EW-44-6	SCH 80 PVC	1.94	2.00
WHP-EW-44-7	SDR-11 HDPE	1.92	4.33
WHP-EW-44-8	SDR-11 HDPE	1.92	4.21

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-44-9	SDR-11 HDPE	1.92	10
WHP-EW-45-1	SDR-11 HDPE	1.34	0.10
WHP-EW-45-2	SDR-11 HDPE	1.34	73
WHP-EW-45-3	SCH 80 PVC	0.96	2.00
WHP-EW-45-4	SCH 80 PVC	1.50	2.66
WHP-EW-45-5	SCH 80 PVC	1.50	0.84
WHP-EW-45-6	SCH 80 PVC	1.94	2.00
WHP-EW-45-7	SDR-11 HDPE	1.92	4.33
WHP-EW-45-8	SDR-11 HDPE	1.92	4.21
WHP-EW-45-9	SDR-11 HDPE	1.92	19
WHP-EW-46-1	SDR-11 HDPE	1.34	0.10
WHP-EW-46-2	SDR-11 HDPE	1.34	27
WHP-EW-46-3	SCH 80 PVC	0.96	2.00
WHP-EW-46-4	SCH 80 PVC	1.50	2.66
WHP-EW-46-5	SCH 80 PVC	1.50	0.84
WHP-EW-46-6	SCH 80 PVC	1.94	2.00
WHP-EW-46-7	SDR-11 HDPE	1.92	4.33
WHP-EW-46-8	SDR-11 HDPE	1.92	4.21
WHP-EW-46-9	SDR-11 HDPE	1.92	10
WHP-EW-47-1	SDR-11 HDPE	1.34	0.10
WHP-EW-47-2	SDR-11 HDPE	1.34	74
WHP-EW-47-3	SCH 80 PVC	0.96	2.00
WHP-EW-47-4	SCH 80 PVC	1.50	2.66
WHP-EW-47-5	SCH 80 PVC	1.50	0.84
WHP-EW-47-6	SCH 80 PVC	1.94	2.00
WHP-EW-47-7	SDR-11 HDPE	1.92	4.33
WHP-EW-47-8	SDR-11 HDPE	1.92	4.21
WHP-EW-47-9	SDR-11 HDPE	1.92	19
WHP-EW-48-1	SDR-11 HDPE	1.34	0.10
WHP-EW-48-2	SDR-11 HDPE	1.34	37
WHP-EW-48-3	SCH 80 PVC	0.96	2.00
WHP-EW-48-4	SCH 80 PVC	1.50	2.66
WHP-EW-48-5	SCH 80 PVC	1.50	0.84
WHP-EW-48-6	SCH 80 PVC	1.94	2.00

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**
Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**						

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-48-7	SDR-11 HDPE	1.92	4.33
WHP-EW-48-8	SDR-11 HDPE	1.92	4.21
WHP-EW-48-9	SDR-11 HDPE	1.92	10
WHP-EW-49-1	SDR-11 HDPE	1.34	0.10
WHP-EW-49-2	SDR-11 HDPE	1.34	79
WHP-EW-49-3	SCH 80 PVC	0.96	2.00
WHP-EW-49-4	SCH 80 PVC	1.50	2.66
WHP-EW-49-5	SCH 80 PVC	1.50	0.84
WHP-EW-49-6	SCH 80 PVC	1.94	2.00
WHP-EW-49-7	SDR-11 HDPE	1.92	4.33
WHP-EW-49-8	SDR-11 HDPE	1.92	4.21
WHP-EW-49-9	SDR-11 HDPE	1.92	19
WHP-EW-50-1	SDR-11 HDPE	1.34	0.10
WHP-EW-50-2	SDR-11 HDPE	1.34	31
WHP-EW-50-3	SCH 80 PVC	0.96	2.00
WHP-EW-50-4	SCH 80 PVC	1.50	2.66
WHP-EW-50-5	SCH 80 PVC	1.50	0.84
WHP-EW-50-6	SCH 80 PVC	1.94	2.00
WHP-EW-50-7	SDR-11 HDPE	1.92	4.33
WHP-EW-50-8	SDR-11 HDPE	1.92	4.21
WHP-EW-50-9	SDR-11 HDPE	1.92	10
WHP-EW-51-1	SDR-11 HDPE	1.34	0.10
WHP-EW-51-2	SDR-11 HDPE	1.34	75
WHP-EW-51-3	SCH 80 PVC	0.96	2.00
WHP-EW-51-4	SCH 80 PVC	1.50	2.66
WHP-EW-51-5	SCH 80 PVC	1.50	0.84
WHP-EW-51-6	SCH 80 PVC	1.94	2.00
WHP-EW-51-7	SDR-11 HDPE	1.92	4.33
WHP-EW-51-8	SDR-11 HDPE	1.92	4.21
WHP-EW-51-9	SDR-11 HDPE	1.92	19
WHP-EW-52-1	SDR-11 HDPE	1.53	0.10
WHP-EW-52-2	SDR-11 HDPE	1.53	71
WHP-EW-52-3	SCH 80 PVC	1.50	2.00
WHP-EW-52-4	SCH 80 PVC	1.50	2.66

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-52-5	SCH 80 PVC	1.50	0.84
WHP-EW-52-6	SCH 80 PVC	1.94	2.00
WHP-EW-52-7	SDR-11 HDPE	1.92	4.33
WHP-EW-52-8	SDR-11 HDPE	1.92	23
WHP-EW-53-1	SDR-11 HDPE	1.53	0.10
WHP-EW-53-2	SDR-11 HDPE	1.53	65
WHP-EW-53-3	SCH 80 PVC	1.50	2.00
WHP-EW-53-4	SCH 80 PVC	1.50	2.66
WHP-EW-53-5	SCH 80 PVC	1.50	0.84
WHP-EW-53-6	SCH 80 PVC	1.94	2.00
WHP-EW-53-7	SDR-11 HDPE	1.92	4.33
WHP-EW-53-8	SDR-11 HDPE	1.92	23
WHP-EW-54-1	SDR-11 HDPE	1.34	0.10
WHP-EW-54-2	SDR-11 HDPE	1.34	63
WHP-EW-54-3	SCH 80 PVC	0.96	2.00
WHP-EW-54-4	SCH 80 PVC	1.50	2.66
WHP-EW-54-5	SCH 80 PVC	1.50	0.84
WHP-EW-54-6	SCH 80 PVC	1.94	2.00
WHP-EW-54-7	SDR-11 HDPE	1.92	4.33
WHP-EW-54-8	SDR-11 HDPE	1.92	23
WHP-EW-55-1	SDR-11 HDPE	1.34	0.10
WHP-EW-55-2	SDR-11 HDPE	1.34	68
WHP-EW-55-3	SCH 80 PVC	0.96	2.00
WHP-EW-55-4	SCH 80 PVC	1.50	2.66
WHP-EW-55-5	SCH 80 PVC	1.50	0.84
WHP-EW-55-6	SCH 80 PVC	1.94	2.00
WHP-EW-55-7	SDR-11 HDPE	1.92	4.33
WHP-EW-55-8	SDR-11 HDPE	1.92	23
WHP-EW-56-1	SDR-11 HDPE	1.53	0.10
WHP-EW-56-2	SDR-11 HDPE	1.53	69
WHP-EW-56-3	SCH 80 PVC	1.50	2.00
WHP-EW-56-4	SCH 80 PVC	1.50	2.66
WHP-EW-56-5	SCH 80 PVC	1.50	0.84
WHP-EW-56-6	SCH 80 PVC	1.94	2.00

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-56-7	SDR-11 HDPE	1.92	4.33
WHP-EW-56-8	SDR-11 HDPE	1.92	23
WHP-EW-57-1	SDR-11 HDPE	1.53	0.10
WHP-EW-57-2	SDR-11 HDPE	1.53	68
WHP-EW-57-3	SCH 80 PVC	1.50	2.00
WHP-EW-57-4	SCH 80 PVC	1.50	2.66
WHP-EW-57-5	SCH 80 PVC	1.50	0.84
WHP-EW-57-6	SCH 80 PVC	1.94	2.00
WHP-EW-57-7	SDR-11 HDPE	1.92	4.33
WHP-EW-57-8	SDR-11 HDPE	1.92	23
WHP-EW-58-1	SDR-11 HDPE	1.34	0.10
WHP-EW-58-2	SDR-11 HDPE	1.34	68
WHP-EW-58-3	SCH 80 PVC	0.96	2.00
WHP-EW-58-4	SCH 80 PVC	1.50	2.66
WHP-EW-58-5	SCH 80 PVC	1.50	0.84
WHP-EW-58-6	SCH 80 PVC	1.94	2.00
WHP-EW-58-7	SDR-11 HDPE	1.92	4.33
WHP-EW-58-8	SDR-11 HDPE	1.92	23
WHP-EW-59-1	SDR-11 HDPE	1.53	0.10
WHP-EW-59-2	SDR-11 HDPE	1.53	72
WHP-EW-59-3	SCH 80 PVC	1.50	2.00
WHP-EW-59-4	SCH 80 PVC	1.50	2.66
WHP-EW-59-5	SCH 80 PVC	1.50	0.84
WHP-EW-59-6	SCH 80 PVC	1.94	2.00
WHP-EW-59-7	SDR-11 HDPE	1.92	4.33
WHP-EW-59-8	SDR-11 HDPE	1.92	23
WHP-EW-60-1	SDR-11 HDPE	1.53	0.10
WHP-EW-60-2	SDR-11 HDPE	1.53	72
WHP-EW-60-3	SCH 80 PVC	1.50	2.00
WHP-EW-60-4	SCH 80 PVC	1.50	2.66
WHP-EW-60-5	SCH 80 PVC	1.50	0.84
WHP-EW-60-6	SCH 80 PVC	1.94	2.00
WHP-EW-60-7	SDR-11 HDPE	1.92	4.33
WHP-EW-60-8	SDR-11 HDPE	1.92	23

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-61-1	SDR-11 HDPE	1.53	0.10
WHP-EW-61-2	SDR-11 HDPE	1.53	71
WHP-EW-61-3	SCH 80 PVC	1.50	2.00
WHP-EW-61-4	SCH 80 PVC	1.50	2.66
WHP-EW-61-5	SCH 80 PVC	1.50	0.84
WHP-EW-61-6	SCH 80 PVC	1.94	2.00
WHP-EW-61-7	SDR-11 HDPE	1.92	4.33
WHP-EW-61-8	SDR-11 HDPE	1.92	23
WHP-EW-62-1	SDR-11 HDPE	1.53	0.10
WHP-EW-62-2	SDR-11 HDPE	1.53	72
WHP-EW-62-3	SCH 80 PVC	1.50	2.00
WHP-EW-62-4	SCH 80 PVC	1.50	2.66
WHP-EW-62-5	SCH 80 PVC	1.50	0.84
WHP-EW-62-6	SCH 80 PVC	1.94	2.00
WHP-EW-62-7	SDR-11 HDPE	1.92	4.33
WHP-EW-62-8	SDR-11 HDPE	1.92	23
WHP-EW-63-1	SDR-11 HDPE	1.53	0.10
WHP-EW-63-2	SDR-11 HDPE	1.53	77
WHP-EW-63-3	SCH 80 PVC	1.50	2.00
WHP-EW-63-4	SCH 80 PVC	1.50	2.66
WHP-EW-63-5	SCH 80 PVC	1.50	0.84
WHP-EW-63-6	SCH 80 PVC	1.94	2.00
WHP-EW-63-7	SDR-11 HDPE	1.92	4.33
WHP-EW-63-8	SDR-11 HDPE	1.92	10
WHP-EW-64-1	SDR-11 HDPE	1.53	0.10
WHP-EW-64-2	SDR-11 HDPE	1.53	73
WHP-EW-64-3	SCH 80 PVC	1.50	2.00
WHP-EW-64-4	SCH 80 PVC	1.94	2.66
WHP-EW-64-5	SCH 80 PVC	1.94	0.84
WHP-EW-64-6	SCH 80 PVC	1.94	2.00
WHP-EW-64-7	SDR-11 HDPE	1.92	4.33
WHP-EW-64-8	SDR-11 HDPE	1.92	10
WHP-EW-65-1	SDR-11 HDPE	1.53	0.10
WHP-EW-65-2	SDR-11 HDPE	1.53	77

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-65-3	SCH 80 PVC	1.50	2.00
WHP-EW-65-4	SCH 80 PVC	1.94	2.66
WHP-EW-65-5	SCH 80 PVC	1.94	0.84
WHP-EW-65-6	SCH 80 PVC	1.94	2.00
WHP-EW-65-7	SDR-11 HDPE	1.92	4.33
WHP-EW-65-8	SDR-11 HDPE	1.92	11
WHP-EW-66-1	SDR-11 HDPE	1.53	0.10
WHP-EW-66-2	SDR-11 HDPE	1.53	76
WHP-EW-66-3	SCH 80 PVC	1.50	2.00
WHP-EW-66-4	SCH 80 PVC	1.94	2.66
WHP-EW-66-5	SCH 80 PVC	1.94	0.84
WHP-EW-66-6	SCH 80 PVC	1.94	2.00
WHP-EW-66-7	SDR-11 HDPE	1.92	4.33
WHP-EW-66-8	SDR-11 HDPE	1.92	10
WHP-EW-67-1	SDR-11 HDPE	1.53	0.10
WHP-EW-67-2	SDR-11 HDPE	1.53	76
WHP-EW-67-3	SCH 80 PVC	1.50	2.00
WHP-EW-67-4	SCH 80 PVC	1.94	2.66
WHP-EW-67-5	SCH 80 PVC	1.94	0.84
WHP-EW-67-6	SCH 80 PVC	1.94	2.00
WHP-EW-67-7	SDR-11 HDPE	1.92	4.33
WHP-EW-67-8	SDR-11 HDPE	1.92	10
WHP-EW-68-1	SDR-11 HDPE	1.53	0.10
WHP-EW-68-2	SDR-11 HDPE	1.53	76
WHP-EW-68-3	SCH 80 PVC	1.50	2.00
WHP-EW-68-4	SCH 80 PVC	1.94	2.66
WHP-EW-68-5	SCH 80 PVC	1.94	0.84
WHP-EW-68-6	SCH 80 PVC	1.94	2.00
WHP-EW-68-7	SDR-11 HDPE	1.92	4.33
WHP-EW-68-8	SDR-11 HDPE	1.92	10
WHP-EW-69-1	SDR-11 HDPE	1.53	0.10
WHP-EW-69-2	SDR-11 HDPE	1.53	71
WHP-EW-69-3	SCH 80 PVC	1.50	2.00
WHP-EW-69-4	SCH 80 PVC	1.94	2.66

Pipe Label	Material	Diameter (in)	Length (ft)
WHP-EW-69-5	SCH 80 PVC	1.94	0.84
WHP-EW-69-6	SCH 80 PVC	1.94	2.00
WHP-EW-69-7	SDR-11 HDPE	1.92	4.33
WHP-EW-69-8	SDR-11 HDPE	1.92	10

Notes:
1. HDPE – high density polyethylene
2. PVC – polyvinyl chloride
3. in – inches
4. ft – feet
5. P – pipe
6. WHP – well head pipe
7. EW – extraction well
8. The 0.1 ft length pipes are a necessary model construct and do not affect head loss calculations. The following pipes, which correspond to pipes of length of 0.1 ft were used to simulate the necessary model connection between the pump intake and the reservoir (i.e., the submersible sump): WHP-EW-1-1, WHP-EW-2-1, WHP-EW-3-1, WHP-EW-4-1, WHP-EW-5-1, WHP-EW-6-1, WHP-EW-7-1, WHP-EW-8-1, WHP-EW-9-1, WHP-EW-10-1, WHP-EW-11-1, WHP-EW-12-1, WHP-EW-13-1, WHP-EW-14-1, WHP-EW-15-1, WHP-EW-16-1, WHP-EW-17-1, WHP-EW-18-1, WHP-EW-19-1, WHP-EW-20-1, WHP-EW-21-1, WHP-EW-22-1, WHP-EW-23-1, WHP-EW-24-1, WHP-EW-25-1, WHP-EW-26-1, WHP-EW-27-1, WHP-EW-28-1, WHP-EW-29-1, WHP-EW-30-1, WHP-EW-31-1, WHP-EW-32-1, WHP-EW-33-1, WHP-EW-34-1, WHP-EW-35-1, WHP-EW-36-1, WHP-EW-37-1, WHP-EW-38-1, WHP-EW-39-1, WHP-EW-40-1, WHP-EW-41-1, WHP-EW-42-1, WHP-EW-43-1, WHP-EW-44-1, WHP-EW-45-1, WHP-EW-46-1, WHP-EW-47-1, WHP-EW-48-1, WHP-EW-49-1, WHP-EW-50-1, WHP-EW-51-1, WHP-EW-52-1, WHP-EW-53-1, WHP-EW-54-1, WHP-EW-55-1, WHP-EW-56-1, WHP-EW-57-1, WHP-EW-58-1, WHP-EW-59-1, WHP-EW-60-1, WHP-EW-61-1, WHP-EW-62-1, WHP-EW-63-1, WHP-EW-64-1, WHP-EW-65-1, WHP-EW-66-1, WHP-EW-67-1, WHP-EW-68-1, WHP-EW-69-1.

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Table 6. WaterGEMS Inputs and Outputs – Pumps

Pump Label	Pump Location	Pump Elevation (ft NAVD88)	Groundwater Elevation (ft NAVD88)	Goulds Pump Model	Motor Horsepower (HP)	Expected Design Parameters			Maximum Design Parameters		
						Design Flow (gpm)	Total Dynamic Head (ft)	Relative Speed Factor	Design Flow (gpm)	Total Dynamic Head (ft)	Relative Speed Factor
PMP-01	EW-01	38.03	53.03	10GS07	0.75	5	105.83	0.597	10	152.02	0.849
PMP-02	EW-02	35.33	50.33	10GS07	0.75	5	108.47	0.603	10	154.51	0.853
PMP-03	EW-03	25.55	40.55	10GS07	0.75	5	118.06	0.623	10	163.62	0.867
PMP-04	EW-04	22.48	37.48	13GS10	1.00	10	123.10	0.727	15	169.16	0.930
PMP-05	EW-05	22.42	37.42	18GS15	1.50	15	121.72	0.728	20	164.22	0.889
PMP-06	EW-06	8.80	23.80	18GS15	1.50	15	134.14	0.752	20	174.60	0.906
PMP-07	EW-07	17.10	32.10	18GS15	1.50	15	123.68	0.732	20	161.53	0.885
PMP-08	EW-08	12.49	27.49	18GS15	1.50	15	127.10	0.738	20	163.49	0.888
PMP-09	EW-09	3.28	18.28	13GS10	1.00	10	135.01	0.751	15	171.48	0.934
PMP-10	EW-10	4.93	19.93	13GS10	1.00	10	131.36	0.744	15	165.69	0.925
PMP-11	EW-11	30.11	45.11	13GS10	1.00	10	102.69	0.683	15	133.30	0.872
PMP-12	EW-12	1.89	16.89	13GS10	1.00	10	130.77	0.742	15	161.23	0.918
PMP-13	EW-13	0.84	15.84	13GS10	1.00	10	131.37	0.744	15	161.35	0.918
PMP-14	EW-14	10.71	25.71	18GS15	1.50	15	120.16	0.725	20	147.31	0.861
PMP-15	EW-15	15.22	30.22	18GS15	1.50	15	114.41	0.713	20	140.35	0.850
PMP-16	EW-16	16.79	31.79	13GS10	1.00	10	112.23	0.704	15	138.88	0.881
PMP-17	EW-17	22.30	37.30	18GS15	1.50	15	105.47	0.695	20	129.51	0.831
PMP-18	EW-18	42.39	47.39	10GS05	0.50	5	92.47	0.645	10	115.45	0.863

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pump Label	Pump Location	Pump Elevation (ft NAVD88)	Groundwater Elevation (ft NAVD88)	Goulds Pump Model	Motor Horsepower (HP)	Expected Design Parameters			Maximum Design Parameters		
						Design Flow (gpm)	Total Dynamic Head (ft)	Relative Speed Factor	Design Flow (gpm)	Total Dynamic Head (ft)	Relative Speed Factor
PMP-19	EW-19	13.24	28.24	13GS10	1.00	15	117.94	0.846	15	139.00	0.881
PMP-20	EW-20	20.87	35.87	13GS10	1.00	15	108.39	0.829	15	127.84	0.863
PMP-21	EW-21	20.08	35.08	18GS15	1.50	15	103.73	0.691	20	124.03	0.822
PMP-22	EW-22	55.00	70.00	25GS20	2.00	25	70.76	0.757	30	89.72	0.891
PMP-23	EW-23	69.38	74.38	5GS05R	0.50	5	59.76	0.695	5	75.72	0.734
PMP-24	EW-24	57.44	72.44	18GS15	1.50	20	65.04	0.712	20	80.20	0.742
PMP-25	EW-25	77.07	82.07	10GS05	0.50	5	50.98	0.517	10	67.83	0.754
PMP-26	EW-26	76.67	81.67	13GS10	1.00	10	52.22	0.563	15	69.55	0.760
PMP-27	EW-27	76.39	81.39	18GS10	1.00	10	51.20	0.531	20	68.25	0.768
PMP-28	EW-28	11.94	26.94	18GS15	1.50	20	112.90	0.802	20	127.55	0.828
PMP-29	EW-29	69.72	74.72	18GS15	1.50	20	59.27	0.700	20	73.16	0.728
PMP-30	EW-30	28.40	43.40	18GS10	1.00	10	89.06	0.657	20	107.53	0.862
PMP-31	EW-31	53.56	58.56	18GS10	1.00	10	72.54	0.605	20	89.02	0.819
PMP-32	EW-32	23.72	38.72	18GS15	1.50	20	97.80	0.775	20	111.05	0.799
PMP-33	EW-33	54.75	59.75	18GS10	1.00	10	69.74	0.596	20	84.79	0.809
PMP-34	EW-34	9.00	24.00	18GS15	1.50	20	111.80	0.800	20	123.91	0.821
PMP-35	EW-35	50.27	55.27	18GS10	1.00	10	73.71	0.609	20	88.38	0.817
PMP-36	EW-36	4.65	19.65	18GS15	1.50	20	115.64	0.807	20	127.36	0.827
PMP-37	EW-37	48.67	53.67	18GS10	1.00	10	74.53	0.612	20	88.56	0.818
PMP-38	EW-38	-2.99	12.01	13GS10	1.00	15	122.56	0.854	15	133.82	0.873

Pump Label	Pump Location	Pump Elevation (ft NAVD88)	Groundwater Elevation (ft NAVD88)	Goulds Pump Model	Motor Horsepower (HP)	Expected Design Parameters			Maximum Design Parameters		
						Design Flow (gpm)	Total Dynamic Head (ft)	Relative Speed Factor	Design Flow (gpm)	Total Dynamic Head (ft)	Relative Speed Factor
PMP-39	EW-39	57.43	62.43	18GS10	1.00	10	65.22	0.581	20	78.84	0.794
PMP-40	EW-40	5.32	20.32	13GS10	1.00	15	113.79	0.839	15	124.64	0.857
PMP-41	EW-41	5.33	20.33	13GS10	1.00	15	113.03	0.837	15	122.86	0.854
PMP-42	EW-42	1.66	16.66	13GS10	1.00	15	115.86	0.842	15	125.07	0.858
PMP-43	EW-43	4.15	19.15	13GS10	1.00	10	108.40	0.695	15	121.42	0.852
PMP-44	EW-44	57.62	62.62	10GS05	0.50	5	61.34	0.552	10	71.53	0.763
PMP-45	EW-45	1.01	16.01	13GS10	1.00	10	110.83	0.701	15	123.42	0.855
PMP-46	EW-46	43.00	48.00	10GS05	0.50	5	75.47	0.596	10	85.19	0.796
PMP-47	EW-47	-3.78	11.22	13GS10	1.00	15	119.19	0.848	15	127.05	0.861
PMP-48	EW-48	43.81	48.81	5GS05R	0.50	5	73.92	0.730	5	81.00	0.747
PMP-49	EW-49	1.32	16.32	13GS10	1.00	15	113.52	0.838	15	120.60	0.850
PMP-50	EW-50	46.14	51.14	5GS05R	0.50	5	70.39	0.721	5	76.66	0.736
PMP-51	EW-51	2.42	17.42	13GS10	1.00	15	111.08	0.834	15	117.34	0.845
PMP-52	EW-52	3.74	18.74	18GS15	1.50	20	105.76	0.789	20	111.23	0.799
PMP-53	EW-53	9.85	24.85	18GS15	1.50	20	97.93	0.775	20	102.42	0.783
PMP-54	EW-54	10.49	25.49	13GS10	1.00	15	98.56	0.812	15	102.36	0.819
PMP-55	EW-55	13.39	28.39	13GS10	1.00	15	94.74	0.806	15	97.46	0.810
PMP-56	EW-56	10.66	25.66	18GS15	1.50	20	96.18	0.772	20	99.23	0.777
PMP-57	EW-57	8.58	23.58	18GS15	1.50	20	100.65	0.780	20	104.45	0.787
PMP-58	EW-58	5.05	20.05	13GS10	1.00	15	109.34	0.831	15	114.04	0.839

Pump Label	Pump Location	Pump Elevation (ft NAVD88)	Groundwater Elevation (ft NAVD88)	Goulds Pump Model	Motor Horsepower (HP)	Expected Design Parameters			Maximum Design Parameters		
						Design Flow (gpm)	Total Dynamic Head (ft)	Relative Speed Factor	Design Flow (gpm)	Total Dynamic Head (ft)	Relative Speed Factor
PMP-59	EW-59	1.93	16.93	18GS15	1.50	20	112.45	0.801	20	117.95	0.811
PMP-60	EW-60	3.28	18.28	18GS15	1.50	20	113.10	0.802	20	119.37	0.813
PMP-61	EW-61	5.92	20.92	18GS15	1.50	20	111.96	0.800	20	118.88	0.813
PMP-62	EW-62	7.59	22.59	18GS15	1.50	20	111.35	0.799	20	118.77	0.812
PMP-63	EW-63	42.59	57.59	18GS15	1.50	20	77.81	0.737	25	88.72	0.869
PMP-64	EW-64	45.97	60.97	25GS20	2.00	25	77.32	0.768	30	88.94	0.890
PMP-65	EW-65	36.24	51.24	25GS20	2.00	25	87.72	0.785	30	99.67	0.905
PMP-66	EW-66	36.87	51.87	25GS20	2.00	25	88.86	0.787	30	101.88	0.908
PMP-67	EW-67	26.88	41.88	35GS20	2.00	30	103.95	0.779	35	118.81	0.869
PMP-68	EW-68	18.79	33.79	35GS20	2.00	25	110.29	0.736	35	129.36	0.887
PMP-69	EW-69	16.12	31.12	35GS20	2.00	25	113.06	0.742	35	132.23	0.892

Notes:

1. ft NAVD88 – feet North American Vertical Datum of 1988
2. gpm – gallons per minute
3. ft – feet
4. PMP – pump
5. EW – extraction well

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Table 7. WaterGEMS Outputs – Pipes

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
P-GWTP-10"-1	1,000	5.42	0.9	1,245	6.75	1.3
P-GWTP-10"-2	1,000	5.42	0.0	1,245	6.75	0.0
P-GWTP-10"-3	1,000	5.42	1.1	1,245	6.75	1.6
P-GWTP-10"-4	1,000	5.42	0.1	1,245	6.75	0.2
P-N-3"-01	0	0.00	0.0	0	0.00	0.0
P-N-3"-02	0	0.00	0.0	0	0.00	0.0
P-N-3"-03	5	0.25	0.0	10	0.51	0.1
P-N-3"-04	5	0.25	0.0	10	0.51	0.0
P-N-3"-05	10	0.51	0.1	20	1.02	0.3
P-N-3"-06	10	0.51	0.0	20	1.02	0.1
P-N-3"-07	15	0.76	0.1	30	1.53	0.5
P-N-3"-08	15	0.76	0.0	30	1.53	0.0
P-N-3"-09	25	1.28	0.4	45	2.30	1.1
P-N-3"-10	40	2.04	0.2	65	3.32	0.5
P-N-3"-11	40	2.04	0.5	65	3.32	1.2
P-N-3"-12	55	2.81	0.8	85	4.34	1.9
P-N-4"-01	55	1.70	0.0	85	2.63	0.1

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
P-N-4"-02	70	2.17	0.1	105	3.25	0.2
P-N-4"-03	70	2.17	0.2	105	3.25	0.4
P-N-4"-04	70	2.17	0.3	105	3.25	0.7
P-N-4"-05	85	2.63	0.1	125	3.87	0.1
P-N-4"-06	85	2.63	0.7	125	3.87	1.5
P-N-4"-07	95	2.94	0.5	140	4.34	0.9
P-N-4"-08	95	2.94	0.3	140	4.34	0.6
P-N-4"-09	105	3.25	0.2	155	4.80	0.5
P-N-4"-10	105	3.25	0.5	155	4.80	0.9
P-N-4"-11	105	3.25	0.8	155	4.80	1.6
P-N-6"-01	105	1.50	0.0	155	2.21	0.0
P-N-6"-02	115	1.64	0.2	170	2.43	0.4
P-N-6"-03	125	1.78	0.1	185	2.64	0.2
P-N-6"-04	125	1.78	0.1	185	2.64	0.2
P-N-6"-05	125	1.78	0.0	185	2.64	0.1
P-N-6"-06	135	1.93	0.3	200	2.85	0.5
P-N-6"-07	150	2.14	0.3	220	3.14	0.6
P-N-6"-08	150	2.14	0.1	220	3.14	0.3
P-N-6"-09	165	2.35	0.3	240	3.43	0.6
P-N-6"-10	165	2.35	0.1	240	3.43	0.2

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
P-N-6"-11	165	2.35	0.2	240	3.43	0.5
P-N-6"-12	175	2.50	0.1	255	3.64	0.3
P-N-6"-13	175	2.50	0.1	255	3.64	0.2
P-N-6"-14	190	2.71	0.3	275	3.92	0.6
P-N-6"-15	190	2.71	0.2	275	3.92	0.4
P-N-6"-16	210	3.00	0.1	300	4.28	0.2
P-N-6"-17	210	3.00	0.2	300	4.28	0.3
P-N-6"-18	210	3.00	0.2	300	4.28	0.4
P-N-6"-19	210	3.00	0.1	300	4.28	0.3
P-N-6"-20	225	3.21	0.6	315	4.50	1.1
P-N-6"-21	240	3.43	0.9	335	4.78	1.7
P-N-6"-22	240	3.43	0.1	335	4.78	0.1
P-N-6"-23	240	3.43	0.1	335	4.78	0.1
P-N-6"-24	240	3.43	0.1	335	4.78	0.2
P-N-6"-25	240	3.43	0.0	335	4.78	0.0
P-N-8"-01	240	2.02	0.0	335	2.82	0.1
P-N-8"-02	270	2.28	0.1	370	3.12	0.2
P-N-8"-03	270	2.28	0.2	370	3.12	0.4
P-N-8"-04	270	2.28	0.1	370	3.12	0.2
P-N-8"-05	295	2.49	0.2	400	3.37	0.4

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
P-N-8"-06	305	2.57	0.1	415	3.50	0.2
P-N-8"-07	305	2.57	0.0	415	3.50	0.0
P-N-8"-08	305	2.57	0.0	415	3.50	0.1
P-N-8"-09	305	2.57	0.1	415	3.50	0.1
P-N-8"-10	305	2.57	0.0	415	3.50	0.1
P-N-8"-11	335	2.82	0.3	455	3.84	0.5
P-N-8"-12	335	2.82	0.1	455	3.84	0.3
P-N-8"-13	365	3.08	0.4	495	4.17	0.6
P-N-8"-14	395	3.33	0.7	535	4.51	1.1
P-N-8"-15	425	3.58	0.2	575	4.85	0.3
P-N-10"-01	425	2.30	0.0	575	3.12	0.1
P-N-10"-02	455	2.47	0.1	615	3.33	0.2
P-N-10"-03	455	2.47	0.1	615	3.33	0.2
P-N-10"-04	480	2.60	0.2	650	3.52	0.4
P-N-10"-05	505	2.74	0.1	685	3.71	0.2
P-N-10"-06	505	2.74	0.1	685	3.71	0.2
P-N-10"-07	505	2.74	0.2	685	3.71	0.3
P-N-10"-08	520	2.82	0.3	700	3.80	0.5
P-N-10"-09	520	2.82	0.1	700	3.80	0.2
P-N-10"-10	535	2.90	0.2	715	3.88	0.3

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
P-N-10"-11	535	2.90	0.1	715	3.88	0.2
P-N-10"-12	545	2.95	0.3	730	3.96	0.5
P-N-10"-13	560	3.04	0.3	755	4.09	0.5
P-N-10"-14	580	3.14	0.2	780	4.23	0.3
P-N-10"-15	580	3.14	0.1	780	4.23	0.2
P-N-10"-16	580	3.14	0.0	780	4.23	0.1
P-N-10"-17	600	3.25	0.5	800	4.34	0.9
P-N-10"-18	620	3.36	0.5	820	4.45	0.8
P-N-10"-19	640	3.47	0.2	840	4.55	0.4
P-N-10"-20	640	3.47	0.4	840	4.55	0.7
P-N-10"-21	660	3.58	0.5	860	4.66	0.8
P-N-10"-22	675	3.66	0.5	875	4.74	0.8
P-N-10"-23	675	3.66	0.1	875	4.74	0.2
P-N-10"-24	675	3.66	0.2	875	4.74	0.3
P-N-10"-25	675	3.66	0.1	875	4.74	0.1
P-N-10"-26	675	3.66	0.0	875	4.74	0.0
P-N-10"-27	675	3.66	0.0	875	4.74	0.1
P-S-3"-01	0	0.00	0.0	0	0.00	0.0
P-S-3"-02	25	1.28	0.2	35	1.79	0.3
P-S-3"-03	50	2.55	0.5	70	3.57	1.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
P-S-4"-01	50	1.55	0.0	70	2.17	0.1
P-S-4"-02	80	2.48	0.3	105	3.26	0.5
P-S-4"-03	80	2.48	0.2	105	3.26	0.4
P-S-4"-04	80	2.48	0.1	105	3.26	0.2
P-S-4"-05	80	2.48	0.3	105	3.26	0.4
P-S-4"-06	105	3.26	0.8	135	4.19	1.2
P-S-6"-01	105	1.50	0.0	135	1.93	0.1
P-S-6"-02	130	1.86	0.2	165	2.35	0.3
P-S-6"-03	155	2.21	0.2	195	2.78	0.3
P-S-6"-04	155	2.21	0.1	195	2.78	0.1
P-S-6"-05	155	2.21	0.1	195	2.78	0.1
P-S-6"-06	175	2.50	0.1	220	3.14	0.1
P-S-6"-07	175	2.50	0.2	220	3.14	0.3
P-S-6"-08	175	2.50	0.2	220	3.14	0.3
P-S-6"-09	175	2.50	0.1	220	3.14	0.1
P-S-6"-10	175	2.50	0.1	220	3.14	0.1
P-S-6"-11	195	2.78	0.4	240	3.43	0.7
P-S-6"-12	215	3.07	0.4	260	3.71	0.6
P-S-6"-13	215	3.07	0.3	260	3.71	0.4
P-S-6"-14	235	3.35	0.9	280	4.00	1.2

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
P-S-6"-15	255	3.64	1.0	300	4.28	1.3
P-S-6"-16	270	3.85	0.4	315	4.50	0.5
P-S-6"-17	270	3.85	0.8	315	4.50	1.1
P-S-6"-18	290	4.14	1.0	335	4.78	1.3
P-S-8"-01	290	2.45	0.0	335	2.82	0.1
P-S-8"-02	310	2.61	0.2	355	2.99	0.2
P-S-8"-03	310	2.61	0.0	355	2.99	0.0
P-S-8"-04	310	2.61	0.0	355	2.99	0.0
P-S-8"-05	310	2.61	0.0	355	2.99	0.0
P-S-8"-06	310	2.61	0.0	355	2.99	0.0
P-S-8"-07	310	2.61	0.2	355	2.99	0.3
P-S-8"-08	310	2.61	0.0	355	2.99	0.0
P-S-8"-09	325	2.74	0.1	370	3.12	0.1
P-S-8"-10	325	2.74	0.1	370	3.12	0.1
P-S-8"-11	325	2.74	0.1	370	3.12	0.2
P-S-8"-12	325	2.74	0.1	370	3.12	0.1
P-S-8"-13	325	2.74	0.0	370	3.12	0.0
P-S-8"-14	325	2.74	0.0	370	3.12	0.1
P-S-8"-15	325	2.74	0.1	370	3.12	0.1
WHP-EW-1-1	5	1.14	0.0	10	2.27	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-1-2	5	1.14	0.1	10	2.27	0.5
WHP-EW-1-3	5	2.23	0.2	10	4.46	0.7
WHP-EW-1-4	5	0.91	0.0	10	1.82	0.0
WHP-EW-1-5	5	0.91	0.0	10	1.82	0.0
WHP-EW-1-6	5	0.54	0.0	10	1.09	0.0
WHP-EW-1-7	5	0.55	0.0	10	1.11	0.0
WHP-EW-1-8	5	0.55	0.0	10	1.11	0.0
WHP-EW-2-1	5	1.14	0.0	10	2.27	0.0
WHP-EW-2-2	5	1.14	0.1	10	2.27	0.5
WHP-EW-2-3	5	2.23	0.2	10	4.46	0.7
WHP-EW-2-4	5	0.91	0.0	10	1.82	0.0
WHP-EW-2-5	5	0.91	0.0	10	1.82	0.0
WHP-EW-2-6	5	0.54	0.0	10	1.09	0.0
WHP-EW-2-7	5	0.55	0.0	10	1.11	0.0
WHP-EW-2-8	5	0.55	0.0	10	1.11	0.0
WHP-EW-3-1	5	1.14	0.0	10	2.27	0.0
WHP-EW-3-2	5	1.14	0.2	10	2.27	0.6
WHP-EW-3-3	5	2.23	0.2	10	4.46	0.7
WHP-EW-3-4	5	0.91	0.0	10	1.82	0.0
WHP-EW-3-5	5	0.91	0.0	10	1.82	0.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-3-6	5	0.54	0.0	10	1.09	0.0
WHP-EW-3-7	5	0.55	0.0	10	1.11	0.0
WHP-EW-3-8	5	0.55	0.0	10	1.11	0.0
WHP-EW-4-1	10	2.27	0.0	15	3.41	0.0
WHP-EW-4-2	10	2.27	0.6	15	3.41	1.2
WHP-EW-4-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-4-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-4-5	10	1.82	0.0	15	2.72	0.0
WHP-EW-4-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-4-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-4-8	10	1.11	0.0	15	1.66	0.1
WHP-EW-5-1	15	2.61	0.0	20	3.48	0.0
WHP-EW-5-2	15	2.61	0.6	20	3.48	1.1
WHP-EW-5-3	15	2.72	0.2	20	3.63	0.4
WHP-EW-5-4	15	2.72	0.1	20	3.63	0.2
WHP-EW-5-5	15	2.72	0.0	20	3.63	0.0
WHP-EW-5-6	15	1.63	0.0	20	2.17	0.0
WHP-EW-5-7	15	1.66	0.0	20	2.22	0.1
WHP-EW-5-8	15	1.66	0.1	20	2.22	0.1
WHP-EW-6-1	15	2.61	0.0	20	3.48	0.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-6-2	15	2.61	0.8	20	3.48	1.4
WHP-EW-6-3	15	2.72	0.2	20	3.63	0.4
WHP-EW-6-4	15	2.72	0.1	20	3.63	0.2
WHP-EW-6-5	15	2.72	0.0	20	3.63	0.0
WHP-EW-6-6	15	1.63	0.0	20	2.17	0.0
WHP-EW-6-7	15	1.66	0.0	20	2.22	0.1
WHP-EW-6-8	15	1.66	0.1	20	2.22	0.1
WHP-EW-7-1	15	2.61	0.0	20	3.48	0.0
WHP-EW-7-2	15	2.61	0.7	20	3.48	1.3
WHP-EW-7-3	15	2.72	0.2	20	3.63	0.4
WHP-EW-7-4	15	2.72	0.1	20	3.63	0.2
WHP-EW-7-5	15	2.72	0.0	20	3.63	0.0
WHP-EW-7-6	15	1.63	0.0	20	2.17	0.0
WHP-EW-7-7	15	1.66	0.0	20	2.22	0.1
WHP-EW-7-8	15	1.66	0.1	20	2.22	0.1
WHP-EW-8-1	15	2.61	0.0	20	3.48	0.0
WHP-EW-8-2	15	2.61	0.8	20	3.48	1.5
WHP-EW-8-3	15	2.72	0.2	20	3.63	0.4
WHP-EW-8-4	15	2.72	0.1	20	3.63	0.2
WHP-EW-8-5	15	2.72	0.0	20	3.63	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-8-6	15	1.63	0.0	20	2.17	0.0
WHP-EW-8-7	15	1.66	0.0	20	2.22	0.1
WHP-EW-8-8	15	1.66	0.1	20	2.22	0.1
WHP-EW-9-1	10	2.27	0.0	15	3.41	0.0
WHP-EW-9-2	10	2.27	0.8	15	3.41	1.6
WHP-EW-9-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-9-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-9-5	10	1.82	0.0	15	2.72	0.0
WHP-EW-9-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-9-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-9-8	10	1.11	0.0	15	1.66	0.1
WHP-EW-10-1	10	2.27	0.0	15	3.41	0.0
WHP-EW-10-2	10	2.27	0.7	15	3.41	1.4
WHP-EW-10-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-10-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-10-5	10	1.82	0.0	15	2.72	0.0
WHP-EW-10-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-10-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-10-8	10	1.11	0.0	15	1.66	0.1
WHP-EW-11-1	10	2.27	0.0	15	3.41	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-11-2	10	2.27	0.6	15	3.41	1.3
WHP-EW-11-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-11-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-11-5	10	1.82	0.0	15	2.72	0.0
WHP-EW-11-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-11-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-11-8	10	1.11	0.0	15	1.66	0.1
WHP-EW-12-1	10	2.27	0.0	15	3.41	0.0
WHP-EW-12-2	10	2.27	0.8	15	3.41	1.6
WHP-EW-12-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-12-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-12-5	10	1.82	0.0	15	2.72	0.0
WHP-EW-12-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-12-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-12-8	10	1.11	0.0	15	1.66	0.1
WHP-EW-13-1	10	2.27	0.0	15	3.41	0.0
WHP-EW-13-2	10	2.27	0.8	15	3.41	1.7
WHP-EW-13-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-13-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-13-5	10	1.82	0.0	15	2.72	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-13-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-13-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-13-8	10	1.11	0.0	15	1.66	0.1
WHP-EW-14-1	15	2.61	0.0	20	3.48	0.0
WHP-EW-14-2	15	2.61	0.8	20	3.48	1.4
WHP-EW-14-3	15	2.72	0.2	20	3.63	0.4
WHP-EW-14-4	15	2.72	0.1	20	3.63	0.2
WHP-EW-14-5	15	2.72	0.0	20	3.63	0.0
WHP-EW-14-6	15	1.63	0.0	20	2.17	0.0
WHP-EW-14-7	15	1.66	0.0	20	2.22	0.1
WHP-EW-14-8	15	1.66	0.1	20	2.22	0.1
WHP-EW-15-1	15	2.61	0.0	20	3.48	0.0
WHP-EW-15-2	15	2.61	0.7	20	3.48	1.2
WHP-EW-15-3	15	2.72	0.2	20	3.63	0.4
WHP-EW-15-4	15	2.72	0.1	20	3.63	0.2
WHP-EW-15-5	15	2.72	0.0	20	3.63	0.0
WHP-EW-15-6	15	1.63	0.0	20	2.17	0.0
WHP-EW-15-7	15	1.66	0.0	20	2.22	0.1
WHP-EW-15-8	15	1.66	0.1	20	2.22	0.1
WHP-EW-16-1	10	2.27	0.0	15	3.41	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

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Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-16-2	10	2.27	0.7	15	3.41	1.5
WHP-EW-16-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-16-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-16-5	10	1.82	0.0	15	2.72	0.0
WHP-EW-16-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-16-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-16-8	10	1.11	0.0	15	1.66	0.1
WHP-EW-17-1	15	2.61	0.0	20	3.48	0.0
WHP-EW-17-2	15	2.61	0.7	20	3.48	1.2
WHP-EW-17-3	15	2.72	0.2	20	3.63	0.4
WHP-EW-17-4	15	2.72	0.1	20	3.63	0.1
WHP-EW-17-5	15	2.72	0.0	20	3.63	0.0
WHP-EW-17-6	15	1.63	0.0	20	2.17	0.0
WHP-EW-17-7	15	1.66	0.0	20	2.22	0.1
WHP-EW-17-8	15	1.66	0.1	20	2.22	0.1
WHP-EW-18-1	5	1.14	0.0	10	2.27	0.0
WHP-EW-18-2	5	1.14	0.1	10	2.27	0.3
WHP-EW-18-3	5	2.23	0.2	10	4.46	0.7
WHP-EW-18-4	5	0.91	0.0	10	1.82	0.0
WHP-EW-18-5	5	0.91	0.0	10	1.82	0.0

Pipe Label	**Expected Operating Parameters**			**Maximum Operating Parameters**		
	Design Flow (gpm)	**Velocity (fps)**	**Pressure Loss (psi)**	**Design Flow (gpm)**	**Velocity (fps)**	**Pressure Loss (psi)**
WHP-EW-18-6	5	0.54	0.0	10	1.09	0.0
WHP-EW-18-7	5	0.55	0.0	10	1.11	0.0
WHP-EW-18-8	5	0.55	0.0	10	1.11	0.0
WHP-EW-18-9	5	0.55	0.0	10	1.11	0.0
WHP-EW-19-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-19-2	15	3.41	1.3	15	3.41	1.3
WHP-EW-19-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-19-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-19-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-19-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-19-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-19-8	15	1.66	0.0	15	1.66	0.0
WHP-EW-19-9	20	2.22	0.1	25	2.77	0.2
WHP-EW-20-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-20-2	15	3.41	1.2	15	3.41	1.2
WHP-EW-20-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-20-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-20-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-20-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-20-7	15	1.66	0.0	15	1.66	0.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-20-8	15	1.66	0.1	15	1.66	0.1
WHP-EW-21-1	15	2.61	0.0	20	3.48	0.0
WHP-EW-21-2	15	2.61	0.7	20	3.48	1.3
WHP-EW-21-3	15	2.72	0.2	20	3.63	0.4
WHP-EW-21-4	15	2.72	0.1	20	3.63	0.2
WHP-EW-21-5	15	2.72	0.0	20	3.63	0.0
WHP-EW-21-6	15	1.63	0.0	20	2.17	0.0
WHP-EW-21-7	15	1.66	0.0	20	2.22	0.1
WHP-EW-21-8	15	1.66	0.1	20	2.22	0.1
WHP-EW-22-1	25	4.35	0.0	30	5.21	0.0
WHP-EW-22-2	25	4.35	1.1	30	5.21	1.6
WHP-EW-22-3	25	4.54	0.7	30	5.45	0.9
WHP-EW-22-4	25	2.72	0.1	30	3.26	0.1
WHP-EW-22-5	25	2.72	0.0	30	3.26	0.0
WHP-EW-22-6	25	2.72	0.1	30	3.26	0.1
WHP-EW-22-7	25	2.77	0.1	30	3.32	0.1
WHP-EW-22-8	25	2.77	0.1	30	3.32	0.2
WHP-EW-22-9	30	3.32	0.1	35	3.88	0.2
WHP-EW-23-1	5	1.14	0.0	5	1.14	0.0
WHP-EW-23-2	5	1.14	0.1	5	1.14	0.1

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-23-3	5	2.23	0.2	5	2.23	0.2
WHP-EW-23-4	5	0.91	0.0	5	0.91	0.0
WHP-EW-23-5	5	0.91	0.0	5	0.91	0.0
WHP-EW-23-6	5	0.54	0.0	5	0.54	0.0
WHP-EW-23-7	5	0.55	0.0	5	0.55	0.0
WHP-EW-23-8	5	0.55	0.0	5	0.55	0.0
WHP-EW-23-9	-5	0.55	0.0	-5	0.55	0.0
WHP-EW-24-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-24-2	20	3.48	0.7	20	3.48	0.7
WHP-EW-24-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-24-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-24-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-24-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-24-7	20	2.22	0.0	20	2.22	0.0
WHP-EW-24-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-24-9	25	2.77	0.1	30	3.32	0.1
WHP-EW-25-1	5	1.14	0.0	10	2.27	0.0
WHP-EW-25-2	5	1.14	0.1	10	2.27	0.2
WHP-EW-25-3	5	2.23	0.2	10	4.46	0.7
WHP-EW-25-4	5	0.91	0.0	10	1.82	0.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-25-5	5	0.91	0.0	10	1.82	0.0
WHP-EW-25-6	5	0.54	0.0	10	1.09	0.0
WHP-EW-25-7	5	0.55	0.0	10	1.11	0.0
WHP-EW-25-8	5	0.55	0.0	10	1.11	0.0
WHP-EW-25-9	-5	0.55	0.0	-10	1.11	0.0
WHP-EW-26-1	10	2.27	0.0	15	3.41	0.0
WHP-EW-26-2	10	2.27	0.2	15	3.41	0.4
WHP-EW-26-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-26-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-26-5	10	1.82	0.0	15	2.72	0.0
WHP-EW-26-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-26-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-26-8	10	1.11	0.0	15	1.66	0.0
WHP-EW-27-1	10	1.74	0.0	20	3.48	0.0
WHP-EW-27-2	10	1.74	0.1	20	3.48	0.3
WHP-EW-27-3	10	1.82	0.1	20	3.63	0.4
WHP-EW-27-4	10	1.82	0.0	20	3.63	0.2
WHP-EW-27-5	10	1.82	0.0	20	3.63	0.0
WHP-EW-27-6	10	1.09	0.0	20	2.17	0.0
WHP-EW-27-7	10	1.11	0.0	20	2.22	0.1

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-27-8	10	1.11	0.0	20	2.22	0.1
WHP-EW-27-9	10	1.11	0.0	20	2.22	0.1
WHP-EW-28-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-28-2	20	3.48	1.4	20	3.48	1.4
WHP-EW-28-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-28-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-28-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-28-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-28-7	20	2.22	0.0	20	2.22	0.0
WHP-EW-28-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-28-9	30	3.32	0.3	40	4.43	0.5
WHP-EW-29-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-29-2	20	3.48	0.3	20	3.48	0.3
WHP-EW-29-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-29-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-29-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-29-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-29-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-29-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-29-9	20	2.22	0.1	20	2.22	0.1

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-30-1	10	1.74	0.0	20	3.48	0.0
WHP-EW-30-2	10	1.74	0.3	20	3.48	1.0
WHP-EW-30-3	10	1.82	0.1	20	3.63	0.4
WHP-EW-30-4	10	1.82	0.0	20	3.63	0.2
WHP-EW-30-5	10	1.82	0.0	20	3.63	0.0
WHP-EW-30-6	10	1.09	0.0	20	2.17	0.0
WHP-EW-30-7	10	1.11	0.0	20	2.22	0.0
WHP-EW-30-8	10	1.11	0.0	20	2.22	0.1
WHP-EW-30-9	30	3.32	0.3	40	4.43	0.5
WHP-EW-31-1	10	1.74	0.0	20	3.48	0.0
WHP-EW-31-2	10	1.74	0.2	20	3.48	0.6
WHP-EW-31-3	10	1.82	0.1	20	3.63	0.4
WHP-EW-31-4	10	1.82	0.0	20	3.63	0.2
WHP-EW-31-5	10	1.82	0.0	20	3.63	0.0
WHP-EW-31-6	10	1.09	0.0	20	2.17	0.0
WHP-EW-31-7	10	1.11	0.0	20	2.22	0.1
WHP-EW-31-8	10	1.11	0.0	20	2.22	0.1
WHP-EW-31-9	10	1.11	0.0	20	2.22	0.1
WHP-EW-32-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-32-2	20	3.48	1.1	20	3.48	1.1

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-32-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-32-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-32-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-32-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-32-7	20	2.22	0.0	20	2.22	0.0
WHP-EW-32-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-32-9	30	3.32	0.3	40	4.43	0.5
WHP-EW-33-1	10	1.74	0.0	20	3.48	0.0
WHP-EW-33-2	10	1.74	0.1	20	3.48	0.5
WHP-EW-33-3	10	1.82	0.1	20	3.63	0.4
WHP-EW-33-4	10	1.82	0.0	20	3.63	0.2
WHP-EW-33-5	10	1.82	0.0	20	3.63	0.0
WHP-EW-33-6	10	1.09	0.0	20	2.17	0.0
WHP-EW-33-7	10	1.11	0.0	20	2.22	0.1
WHP-EW-33-8	10	1.11	0.0	20	2.22	0.1
WHP-EW-33-9	10	1.11	0.0	20	2.22	0.1
WHP-EW-34-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-34-2	20	3.48	1.3	20	3.48	1.3
WHP-EW-34-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-34-4	20	3.63	0.2	20	3.63	0.2

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-34-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-34-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-34-7	20	2.22	0.0	20	2.22	0.0
WHP-EW-34-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-34-9	30	3.32	0.3	40	4.43	0.5
WHP-EW-35-1	10	1.74	0.0	20	3.48	0.0
WHP-EW-35-2	10	1.74	0.1	20	3.48	0.5
WHP-EW-35-3	10	1.82	0.1	20	3.63	0.4
WHP-EW-35-4	10	1.82	0.0	20	3.63	0.2
WHP-EW-35-5	10	1.82	0.0	20	3.63	0.0
WHP-EW-35-6	10	1.09	0.0	20	2.17	0.0
WHP-EW-35-7	10	1.11	0.0	20	2.22	0.1
WHP-EW-35-8	10	1.11	0.0	20	2.22	0.1
WHP-EW-35-9	10	1.11	0.0	20	2.22	0.1
WHP-EW-36-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-36-2	20	3.48	1.3	20	3.48	1.3
WHP-EW-36-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-36-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-36-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-36-6	20	2.17	0.0	20	2.17	0.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-36-7	20	2.22	0.0	20	2.22	0.0
WHP-EW-36-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-36-9	30	3.32	0.3	40	4.43	0.5
WHP-EW-37-1	10	1.74	0.0	20	3.48	0.0
WHP-EW-37-2	10	1.74	0.1	20	3.48	0.4
WHP-EW-37-3	10	1.82	0.1	20	3.63	0.4
WHP-EW-37-4	10	1.82	0.0	20	3.63	0.2
WHP-EW-37-5	10	1.82	0.0	20	3.63	0.0
WHP-EW-37-6	10	1.09	0.0	20	2.17	0.0
WHP-EW-37-7	10	1.11	0.0	20	2.22	0.1
WHP-EW-37-8	10	1.11	0.0	20	2.22	0.1
WHP-EW-37-9	10	1.11	0.0	20	2.22	0.1
WHP-EW-38-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-38-2	15	3.41	1.5	15	3.41	1.5
WHP-EW-38-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-38-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-38-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-38-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-38-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-38-8	15	1.66	0.0	15	1.66	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-38-9	25	2.77	0.2	35	3.88	0.4
WHP-EW-39-1	10	1.74	0.0	20	3.48	0.0
WHP-EW-39-2	10	1.74	0.1	20	3.48	0.4
WHP-EW-39-3	10	1.82	0.1	20	3.63	0.4
WHP-EW-39-4	10	1.82	0.0	20	3.63	0.2
WHP-EW-39-5	10	1.82	0.0	20	3.63	0.0
WHP-EW-39-6	10	1.09	0.0	20	2.17	0.0
WHP-EW-39-7	10	1.11	0.0	20	2.22	0.1
WHP-EW-39-8	10	1.11	0.0	20	2.22	0.1
WHP-EW-39-9	10	1.11	0.0	20	2.22	0.1
WHP-EW-40-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-40-2	15	3.41	1.5	15	3.41	1.5
WHP-EW-40-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-40-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-40-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-40-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-40-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-40-8	15	1.66	0.0	15	1.66	0.0
WHP-EW-40-9	25	2.77	0.2	35	3.88	0.4
WHP-EW-41-1	15	3.41	0.0	15	3.41	0.0

Pipe Label	**Expected Operating Parameters**			**Maximum Operating Parameters**		
	Design Flow (gpm)	**Velocity (fps)**	**Pressure Loss (psi)**	**Design Flow (gpm)**	**Velocity (fps)**	**Pressure Loss (psi)**
WHP-EW-41-2	15	3.41	1.7	15	3.41	1.7
WHP-EW-41-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-41-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-41-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-41-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-41-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-41-8	15	1.66	0.1	15	1.66	0.1
WHP-EW-42-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-42-2	15	3.41	1.7	15	3.41	1.7
WHP-EW-42-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-42-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-42-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-42-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-42-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-42-8	15	1.66	0.1	15	1.66	0.1
WHP-EW-43-1	10	2.27	0.0	15	3.41	0.0
WHP-EW-43-2	10	2.27	0.8	15	3.41	1.7
WHP-EW-43-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-43-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-43-5	10	1.82	0.0	15	2.72	0.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-43-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-43-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-43-8	10	1.11	0.0	15	1.66	0.1
WHP-EW-44-1	5	1.14	0.0	10	2.27	0.0
WHP-EW-44-2	5	1.14	0.1	10	2.27	0.2
WHP-EW-44-3	5	2.23	0.2	10	4.46	0.7
WHP-EW-44-4	5	0.91	0.0	10	1.82	0.0
WHP-EW-44-5	5	0.91	0.0	10	1.82	0.0
WHP-EW-44-6	5	0.54	0.0	10	1.09	0.0
WHP-EW-44-7	5	0.55	0.0	10	1.11	0.0
WHP-EW-44-8	5	0.55	0.0	10	1.11	0.0
WHP-EW-44-9	5	0.55	0.0	10	1.11	0.0
WHP-EW-45-1	10	2.27	0.0	15	3.41	0.0
WHP-EW-45-2	10	2.27	0.7	15	3.41	1.6
WHP-EW-45-3	10	4.46	0.7	15	6.69	1.5
WHP-EW-45-4	10	1.82	0.0	15	2.72	0.1
WHP-EW-45-5	10	1.82	0.0	15	2.72	0.0
WHP-EW-45-6	10	1.09	0.0	15	1.63	0.0
WHP-EW-45-7	10	1.11	0.0	15	1.66	0.0
WHP-EW-45-8	10	1.11	0.0	15	1.66	0.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-45-9	15	1.66	0.1	25	2.77	0.2
WHP-EW-46-1	5	1.14	0.0	10	2.27	0.0
WHP-EW-46-2	5	1.14	0.1	10	2.27	0.3
WHP-EW-46-3	5	2.23	0.2	10	4.46	0.7
WHP-EW-46-4	5	0.91	0.0	10	1.82	0.0
WHP-EW-46-5	5	0.91	0.0	10	1.82	0.0
WHP-EW-46-6	5	0.54	0.0	10	1.09	0.0
WHP-EW-46-7	5	0.55	0.0	10	1.11	0.0
WHP-EW-46-8	5	0.55	0.0	10	1.11	0.0
WHP-EW-46-9	5	0.55	0.0	10	1.11	0.0
WHP-EW-47-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-47-2	15	3.41	1.6	15	3.41	1.6
WHP-EW-47-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-47-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-47-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-47-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-47-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-47-8	15	1.66	0.0	15	1.66	0.0
WHP-EW-47-9	20	2.22	0.1	25	2.77	0.2
WHP-EW-48-1	5	1.14	0.0	5	1.14	0.0

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-48-2	5	1.14	0.1	5	1.14	0.1
WHP-EW-48-3	5	2.23	0.2	5	2.23	0.2
WHP-EW-48-4	5	0.91	0.0	5	0.91	0.0
WHP-EW-48-5	5	0.91	0.0	5	0.91	0.0
WHP-EW-48-6	5	0.54	0.0	5	0.54	0.0
WHP-EW-48-7	5	0.55	0.0	5	0.55	0.0
WHP-EW-48-8	5	0.55	0.0	5	0.55	0.0
WHP-EW-48-9	5	0.55	0.0	5	0.55	0.0
WHP-EW-49-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-49-2	15	3.41	1.7	15	3.41	1.7
WHP-EW-49-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-49-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-49-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-49-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-49-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-49-8	15	1.66	0.0	15	1.66	0.0
WHP-EW-49-9	20	2.22	0.1	20	2.22	0.1
WHP-EW-50-1	5	1.14	0.0	5	1.14	0.0
WHP-EW-50-2	5	1.14	0.1	5	1.14	0.1
WHP-EW-50-3	5	2.23	0.2	5	2.23	0.2

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-50-4	5	0.91	0.0	5	0.91	0.0
WHP-EW-50-5	5	0.91	0.0	5	0.91	0.0
WHP-EW-50-6	5	0.54	0.0	5	0.54	0.0
WHP-EW-50-7	5	0.55	0.0	5	0.55	0.0
WHP-EW-50-8	5	0.55	0.0	5	0.55	0.0
WHP-EW-50-9	5	0.55	0.0	5	0.55	0.0
WHP-EW-51-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-51-2	15	3.41	1.6	15	3.41	1.6
WHP-EW-51-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-51-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-51-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-51-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-51-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-51-8	15	1.66	0.0	15	1.66	0.0
WHP-EW-51-9	20	2.22	0.1	20	2.22	0.1
WHP-EW-52-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-52-2	20	3.48	1.4	20	3.48	1.4
WHP-EW-52-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-52-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-52-5	20	3.63	0.0	20	3.63	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-52-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-52-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-52-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-53-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-53-2	20	3.48	1.3	20	3.48	1.3
WHP-EW-53-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-53-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-53-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-53-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-53-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-53-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-54-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-54-2	15	3.41	1.4	15	3.41	1.4
WHP-EW-54-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-54-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-54-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-54-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-54-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-54-8	15	1.66	0.1	15	1.66	0.1
WHP-EW-55-1	15	3.41	0.0	15	3.41	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-55-2	15	3.41	1.5	15	3.41	1.5
WHP-EW-55-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-55-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-55-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-55-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-55-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-55-8	15	1.66	0.1	15	1.66	0.1
WHP-EW-56-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-56-2	20	3.48	1.3	20	3.48	1.3
WHP-EW-56-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-56-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-56-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-56-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-56-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-56-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-57-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-57-2	20	3.48	1.3	20	3.48	1.3
WHP-EW-57-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-57-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-57-5	20	3.63	0.0	20	3.63	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-57-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-57-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-57-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-58-1	15	3.41	0.0	15	3.41	0.0
WHP-EW-58-2	15	3.41	1.5	15	3.41	1.5
WHP-EW-58-3	15	6.69	1.5	15	6.69	1.5
WHP-EW-58-4	15	2.72	0.1	15	2.72	0.1
WHP-EW-58-5	15	2.72	0.0	15	2.72	0.0
WHP-EW-58-6	15	1.63	0.0	15	1.63	0.0
WHP-EW-58-7	15	1.66	0.0	15	1.66	0.0
WHP-EW-58-8	15	1.66	0.1	15	1.66	0.1
WHP-EW-59-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-59-2	20	3.48	1.4	20	3.48	1.4
WHP-EW-59-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-59-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-59-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-59-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-59-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-59-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-60-1	20	3.48	0.0	20	3.48	0.0

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**
Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-60-2	20	3.48	1.4	20	3.48	1.4
WHP-EW-60-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-60-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-60-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-60-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-60-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-60-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-61-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-61-2	20	3.48	1.4	20	3.48	1.4
WHP-EW-61-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-61-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-61-5	20	3.63	0.0	20	3.63	0.0
WHP-EW-61-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-61-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-61-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-62-1	20	3.48	0.0	20	3.48	0.0
WHP-EW-62-2	20	3.48	1.4	20	3.48	1.4
WHP-EW-62-3	20	3.63	0.4	20	3.63	0.4
WHP-EW-62-4	20	3.63	0.2	20	3.63	0.2
WHP-EW-62-5	20	3.63	0.0	20	3.63	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-62-6	20	2.17	0.0	20	2.17	0.0
WHP-EW-62-7	20	2.22	0.1	20	2.22	0.1
WHP-EW-62-8	20	2.22	0.1	20	2.22	0.1
WHP-EW-63-1	20	3.48	0.0	25	4.35	0.0
WHP-EW-63-2	20	3.48	1.5	25	4.35	2.2
WHP-EW-63-3	20	3.63	0.4	25	4.54	0.7
WHP-EW-63-4	20	3.63	0.2	25	4.54	0.3
WHP-EW-63-5	20	3.63	0.0	25	4.54	0.0
WHP-EW-63-6	20	2.17	0.0	25	2.72	0.1
WHP-EW-63-7	20	2.22	0.1	25	2.77	0.1
WHP-EW-63-8	20	2.22	0.1	25	2.77	0.1
WHP-EW-64-1	25	4.35	0.0	30	5.21	0.0
WHP-EW-64-2	25	4.35	2.1	30	5.21	3.0
WHP-EW-64-3	25	4.54	0.7	30	5.45	0.9
WHP-EW-64-4	25	2.72	0.1	30	3.26	0.1
WHP-EW-64-5	25	2.72	0.0	30	3.26	0.0
WHP-EW-64-6	25	2.72	0.1	30	3.26	0.1
WHP-EW-64-7	25	2.77	0.1	30	3.32	0.2
WHP-EW-64-8	25	2.77	0.1	30	3.32	0.1
WHP-EW-65-1	25	4.35	0.0	30	5.21	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-65-2	25	4.35	2.2	30	5.21	3.1
WHP-EW-65-3	25	4.54	0.7	30	5.45	0.9
WHP-EW-65-4	25	2.72	0.1	30	3.26	0.1
WHP-EW-65-5	25	2.72	0.0	30	3.26	0.0
WHP-EW-65-6	25	2.72	0.1	30	3.26	0.1
WHP-EW-65-7	25	2.77	0.1	30	3.32	0.2
WHP-EW-65-8	25	2.77	0.1	30	3.32	0.1
WHP-EW-66-1	25	4.35	0.0	30	5.21	0.0
WHP-EW-66-2	25	4.35	2.2	30	5.21	3.1
WHP-EW-66-3	25	4.54	0.7	30	5.45	0.9
WHP-EW-66-4	25	2.72	0.1	30	3.26	0.1
WHP-EW-66-5	25	2.72	0.0	30	3.26	0.0
WHP-EW-66-6	25	2.72	0.1	30	3.26	0.1
WHP-EW-66-7	25	2.77	0.1	30	3.32	0.2
WHP-EW-66-8	25	2.77	0.1	30	3.32	0.1
WHP-EW-67-1	30	5.21	0.0	35	6.08	0.0
WHP-EW-67-2	30	5.21	3.1	35	6.08	4.1
WHP-EW-67-3	30	5.45	0.9	35	6.35	1.3
WHP-EW-67-4	30	3.26	0.1	35	3.80	0.2
WHP-EW-67-5	30	3.26	0.0	35	3.80	0.0

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Pipe Label	Expected Operating Parameters			Maximum Operating Parameters		
	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)	Design Flow (gpm)	Velocity (fps)	Pressure Loss (psi)
WHP-EW-67-6	30	3.26	0.1	35	3.80	0.1
WHP-EW-67-7	30	3.32	0.2	35	3.88	0.2
WHP-EW-67-8	30	3.32	0.1	35	3.88	0.2
WHP-EW-68-1	25	4.35	0.0	35	6.08	0.0
WHP-EW-68-2	25	4.35	2.2	35	6.08	4.1
WHP-EW-68-3	25	4.54	0.7	35	6.35	1.3
WHP-EW-68-4	25	2.72	0.1	35	3.80	0.2
WHP-EW-68-5	25	2.72	0.0	35	3.80	0.0
WHP-EW-68-6	25	2.72	0.1	35	3.80	0.1
WHP-EW-68-7	25	2.77	0.1	35	3.88	0.2
WHP-EW-68-8	25	2.77	0.1	35	3.88	0.2
WHP-EW-69-1	25	4.35	0.0	35	6.08	0.0
WHP-EW-69-2	25	4.35	2.1	35	6.08	3.9
WHP-EW-69-3	25	4.54	0.7	35	6.35	1.3
WHP-EW-69-4	25	2.72	0.1	35	3.80	0.2
WHP-EW-69-5	25	2.72	0.0	35	3.80	0.0
WHP-EW-69-6	25	2.72	0.1	35	3.80	0.1
WHP-EW-69-7	25	2.77	0.1	35	3.88	0.2
WHP-EW-69-8	25	2.77	0.1	35	3.88	0.2

Notes:

1. gpm – gallons per minute
2. fps – feet per second
3. psi – pounds per square inch
4. P- pipe
5. WHP - well head pipe
6. EW - extraction well

Table 8. WaterGEMS Inputs and Outputs – Junctions

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
ARV-01	87.10	30.7	49.7
ARV-02	79.19	31.2	46.0
ARV-03	72.91	31.8	44.2
ARV-04	77.55	27.1	36.8
ARV-05	93.10	17.0	23.6
ARV-06	75.91	21.6	25.9
ARV-07	76.19	20.7	24.6
ARV-08	70.73	22.1	25.2
ARV-09	73.73	18.1	19.5
ARV-10	73.79	18.1	19.2
ARV-11	72.67	18.9	20.2
ARV-12	118.01	5.5	9.1
FCO-01	87.10	30.7	49.7
FCO-02	81.64	33.0	52.0
FCO-03	77.55	34.7	53.5
FCO-04	72.37	36.8	55.2
FCO-05	70.19	37.2	54.5
FCO-06	70.73	35.5	50.9
FCO-07	69.10	33.9	46.8
FCO-08	69.64	32.0	43.2
FCO-09	75.64	28.4	38.5
FCO-10	68.28	30.0	38.6
FCO-11	84.37	21.0	27.7
FCO-12	72.37	25.1	31.0
FCO-13	67.46	25.7	30.5
FCO-14	73.19	22.3	26.4
FCO-15	69.64	22.7	25.9
FCO-16	67.73	22.1	24.3
FCO-17	73.79	18.2	19.3

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
FCO-18	67.08	23.4	25.3
FCO-19	69.87	24.6	27.5
FCO-20	118.01	5.4	9.0
FCO-21	106.53	12.2	16.9
FCO-22	82.19	23.7	29.3
J-EW-01	86.82	30.8	49.8
J-EW-02	81.10	33.3	52.2
J-EW-03	76.73	35.1	53.8
J-EW-04	72.10	36.9	55.2
J-EW-05	70.19	37.4	55.0
J-EW-06	70.19	36.7	53.3
J-EW-07	70.73	35.6	51.1
J-EW-08	78.91	31.4	46.2
J-EW-09	72.10	33.6	47.5
J-EW-10	68.55	34.3	47.5
J-EW-11	72.37	31.2	42.8
J-EW-12	67.19	33.3	44.6
J-EW-13	69.64	32.0	43.1
J-EW-14	69.91	31.6	42.4
J-EW-15	73.46	29.6	40.0
J-EW-16	76.46	27.7	37.5
J-EW-17	74.55	28.3	37.9
J-EW-18/19	67.46	30.9	39.9
J-EW-20	68.82	29.7	38.1
J-EW-21	71.28	28.0	35.9
J-EW-22/23	83.82	21.4	28.2
J-EW-24/25	91.73	17.5	24.0
J-EW-26	87.37	19.2	25.5
J-EW-27/28	75.37	24.1	30.2
J-EW-29/30	72.10	25.1	30.9
J-EW-31/32	74.28	23.8	29.3
J-EW-33/34	68.55	25.6	30.7

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
J-EW-35/36	67.46	25.9	30.7
J-EW-37/38	67.19	25.8	30.5
J-EW-39/40	70.19	24.2	28.7
J-EW-41	75.37	21.6	25.9
J-EW-42	73.19	22.2	26.2
J-EW-43	74.82	21.2	25.0
J-EW-44/45	67.46	24.1	27.7
J-EW-46/47	68.00	23.6	26.9
J-EW-48/49	71.00	21.9	25.0
J-EW-50/51	68.00	22.7	25.4
J-EW-52	67.73	22.3	24.7
J-EW-53	67.73	21.7	23.6
J-EW-54	68.55	20.9	22.5
J-EW-55	73.79	18.1	19.3
J-EW-56	72.11	19.3	20.7
J-EW-57	69.03	21.7	23.4
J-EW-58	67.08	23.7	25.8
J-EW-59	67.08	24.7	27.1
J-EW-60	68.75	24.9	27.6
J-EW-61	71.27	24.4	27.4
J-EW-62	74.63	23.4	26.6
J-EW-63	116.33	6.0	9.5
J-EW-64	115.21	6.8	10.6
J-EW-65	110.17	9.2	13.0
J-EW-66	109.05	10.5	14.8
J-EW-67	99.26	15.6	20.5
J-EW-68	91.42	19.6	25.0
J-EW-69	83.03	23.4	28.9
J-GWTP-1	86.50	11.3	11.9
J-GWTP-2	90.00	8.8	8.8
J-N-1	74.00	17.9	19.2
J-N-2	80.50	14.9	16.1

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	**Elevation (ft NAVD88)**	**@ Expected Design Flow Rate**	**@ Maximum Design Flow Rate**
		Pressure (psi)	**Pressure (psi)**
J-N-3	86.50	12.2	13.3
J-N-4	86.50	12.2	13.3
J-S-1	74.07	17.9	19.0
J-S-2	80.50	15.0	16.1
J-S-3	86.50	12.3	13.4
J-S-4	86.50	12.3	13.3
JB-N-4"-1-HV	71.82	34.8	50.0
JB-N-4"-2-V	68.00	34.9	48.4
JB-N-6"-1-H	68.82	32.4	43.7
JB-N-6"-10-H	83.55	21.5	28.4
JB-N-6"-2-H	69.91	31.3	41.8
JB-N-6"-3-H	75.91	28.2	38.2
JB-N-6"-4-V	67.73	31.0	40.2
JB-N-6"-5-H	67.73	30.7	39.6
JB-N-6"-6-H	68.00	30.4	39.1
JB-N-6"-7-H	77.00	24.6	31.7
JB-N-6"-8-V	77.28	24.4	31.5
JB-N-6"-9-V	83.28	21.8	28.8
JB-N-8"-1-H	84.37	20.4	26.6
JB-N-8"-2-V	84.10	20.4	26.7
JB-N-8"-3-V	78.10	23.0	29.2
JB-N-8"-4-H	75.64	24.0	30.2
JB-N-10"-1-H	72.91	23.0	27.4
JB-S-4"-1-H	108.77	10.9	15.3
JB-S-4"-2-H	108.77	11.0	15.5
JB-S-6"-1-H	75.19	23.2	26.5
JB-S-6"-2-V	76.87	22.6	25.9
JB-S-6"-3-H	97.30	14.0	17.4
JB-S-6"-4-V	112.97	7.4	10.9
JB-S-8"-1-V	72.95	18.7	20.0
JB-S-8"-2-V	68.20	20.8	22.1
JB-S-8"-3-V	68.20	20.8	22.1

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
JB-S-8"-4-V	72.67	18.9	20.2
JR-N-3"X4"	70.73	35.6	51.2
JR-N-4"X6"	72.64	31.1	42.7
JR-N-6"X8"	83.55	21.5	28.4
JR-N-8"X10"	67.46	25.9	30.8
JR-S-3"X4"	97.86	16.2	21.2
JR-S-4"X6"	109.61	9.5	13.3
JR-S-6"X8"	71.83	19.5	20.8
WHJ-EW-1-1	89.37	29.9	49.5
WHJ-EW-1-2	91.37	28.9	48.0
WHJ-EW-1-3	91.37	28.9	47.9
WHJ-EW-1-4	89.37	29.7	48.8
WHJ-EW-1-5	85.03	31.6	50.6
WHJ-EW-2-1	86.66	31.1	50.6
WHJ-EW-2-2	88.66	30.0	49.1
WHJ-EW-2-3	88.66	30.0	49.0
WHJ-EW-2-4	86.66	30.9	49.9
WHJ-EW-2-5	82.33	32.7	51.7
WHJ-EW-3-1	81.89	33.0	52.3
WHJ-EW-3-2	83.89	32.0	50.8
WHJ-EW-3-3	83.89	32.0	50.7
WHJ-EW-3-4	81.89	32.8	51.6
WHJ-EW-3-5	77.55	34.7	53.5
WHJ-EW-4-1	78.81	34.8	54.1
WHJ-EW-4-2	80.81	33.3	51.7
WHJ-EW-4-3	80.81	33.2	51.6
WHJ-EW-4-4	78.81	34.1	52.4
WHJ-EW-4-5	74.48	35.9	54.3
WHJ-EW-5-1	78.75	34.1	52.1
WHJ-EW-5-2	80.75	33.0	50.8
WHJ-EW-5-3	80.75	32.9	50.6
WHJ-EW-5-4	78.75	33.8	51.4

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-5-5	74.42	35.6	53.2
WHJ-EW-6-1	80.14	32.9	49.8
WHJ-EW-6-2	82.14	31.8	48.5
WHJ-EW-6-3	82.14	31.7	48.3
WHJ-EW-6-4	80.14	32.5	49.2
WHJ-EW-6-5	75.80	34.3	51.0
WHJ-EW-7-1	83.43	30.6	46.4
WHJ-EW-7-2	85.43	29.5	45.1
WHJ-EW-7-3	85.43	29.3	44.9
WHJ-EW-7-4	83.43	30.2	45.8
WHJ-EW-7-5	79.10	32.0	47.6
WHJ-EW-8-1	88.83	27.6	42.7
WHJ-EW-8-2	90.83	26.5	41.5
WHJ-EW-8-3	90.83	26.4	41.3
WHJ-EW-8-4	88.83	27.2	42.1
WHJ-EW-8-5	84.49	29.1	43.9
WHJ-EW-9-1	79.61	31.1	46.0
WHJ-EW-9-2	81.61	29.6	43.7
WHJ-EW-9-3	81.61	29.5	43.5
WHJ-EW-9-4	79.61	30.4	44.4
WHJ-EW-9-5	75.28	32.2	46.2
WHJ-EW-10-1	71.26	34.0	48.1
WHJ-EW-10-2	73.26	32.4	45.7
WHJ-EW-10-3	73.26	32.4	45.6
WHJ-EW-10-4	71.26	33.2	46.4
WHJ-EW-10-5	66.93	35.1	48.2
WHJ-EW-11-1	91.44	23.8	36.3
WHJ-EW-11-2	93.44	22.2	33.9
WHJ-EW-11-3	93.44	22.2	33.8
WHJ-EW-11-4	91.44	23.0	34.7
WHJ-EW-11-5	87.11	24.9	36.5
WHJ-EW-12-1	78.22	29.3	41.6

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-12-2	80.22	27.7	39.2
WHJ-EW-12-3	80.22	27.7	39.1
WHJ-EW-12-4	78.22	28.5	40.0
WHJ-EW-12-5	73.89	30.4	41.8
WHJ-EW-13-1	82.17	27.3	39.4
WHJ-EW-13-2	84.17	25.8	37.0
WHJ-EW-13-3	84.17	25.7	36.9
WHJ-EW-13-4	82.17	26.6	37.7
WHJ-EW-13-5	77.84	28.4	39.6
WHJ-EW-14-1	82.05	26.8	38.0
WHJ-EW-14-2	84.05	25.7	36.7
WHJ-EW-14-3	84.05	25.6	36.5
WHJ-EW-14-4	82.05	26.4	37.3
WHJ-EW-14-5	77.71	28.3	39.2
WHJ-EW-15-1	76.55	28.8	39.5
WHJ-EW-15-2	78.55	27.7	38.2
WHJ-EW-15-3	78.55	27.6	38.0
WHJ-EW-15-4	76.55	28.4	38.8
WHJ-EW-15-5	72.22	30.2	40.6
WHJ-EW-16-1	88.12	23.5	34.2
WHJ-EW-16-2	90.12	21.9	31.8
WHJ-EW-16-3	90.12	21.9	31.7
WHJ-EW-16-4	88.12	22.7	32.6
WHJ-EW-16-5	83.79	24.6	34.4
WHJ-EW-17-1	83.64	24.9	34.8
WHJ-EW-17-2	85.64	23.8	33.5
WHJ-EW-17-3	85.64	23.7	33.3
WHJ-EW-17-4	83.64	24.5	34.2
WHJ-EW-17-5	79.30	26.4	36.0
WHJ-EW-18-1	73.72	28.5	38.2
WHJ-EW-18-2	75.72	27.5	36.7
WHJ-EW-18-3	75.72	27.5	36.6

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-18-4	73.72	28.3	37.5
WHJ-EW-18-5	69.39	30.2	39.3
WHJ-EW-18-6	69.39	30.2	39.3
WHJ-EW-19-1	74.57	29.7	38.8
WHJ-EW-19-2	76.57	27.3	36.4
WHJ-EW-19-3	76.57	27.2	36.3
WHJ-EW-19-4	74.57	28.0	37.1
WHJ-EW-19-5	70.24	29.9	39.0
WHJ-EW-19-6	70.24	29.8	38.9
WHJ-EW-20-1	77.20	27.8	36.2
WHJ-EW-20-2	79.20	25.4	33.8
WHJ-EW-20-3	79.20	25.3	33.7
WHJ-EW-20-4	77.20	26.1	34.6
WHJ-EW-20-5	72.87	28.0	36.4
WHJ-EW-21-1	86.41	21.9	30.2
WHJ-EW-21-2	88.41	20.8	28.9
WHJ-EW-21-3	88.41	20.7	28.7
WHJ-EW-21-4	86.41	21.6	29.5
WHJ-EW-21-5	82.08	23.4	31.3
WHJ-EW-22-1	91.33	19.2	26.6
WHJ-EW-22-2	93.33	17.7	24.8
WHJ-EW-22-3	93.33	17.6	24.6
WHJ-EW-22-4	91.33	18.4	25.4
WHJ-EW-22-5	87.00	20.2	27.2
WHJ-EW-22-6	87.00	20.1	27.0
WHJ-EW-23-1	90.72	18.7	25.6
WHJ-EW-23-2	92.72	17.7	24.6
WHJ-EW-23-3	92.72	17.7	24.6
WHJ-EW-23-4	90.72	18.5	25.4
WHJ-EW-23-5	86.38	20.4	27.3
WHJ-EW-23-6	86.38	20.4	27.3
WHJ-EW-24-1	93.78	17.5	24.1

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-24-2	95.78	16.2	22.8
WHJ-EW-24-3	95.78	16.0	22.6
WHJ-EW-24-4	93.78	16.8	23.4
WHJ-EW-24-5	89.44	18.7	25.2
WHJ-EW-24-6	89.44	18.6	25.2
WHJ-EW-25-1	93.40	17.1	24.2
WHJ-EW-25-2	95.40	16.1	22.7
WHJ-EW-25-3	95.40	16.1	22.7
WHJ-EW-25-4	93.40	16.9	23.5
WHJ-EW-25-5	89.07	18.8	25.4
WHJ-EW-25-6	89.07	18.8	25.4
WHJ-EW-26-1	90.01	18.8	26.1
WHJ-EW-26-2	92.01	17.3	23.7
WHJ-EW-26-3	92.01	17.2	23.6
WHJ-EW-26-4	90.01	18.1	24.5
WHJ-EW-26-5	85.67	19.9	26.3
WHJ-EW-27-1	88.27	19.0	26.0
WHJ-EW-27-2	90.27	18.0	24.7
WHJ-EW-27-3	90.27	18.0	24.5
WHJ-EW-27-4	88.27	18.9	25.3
WHJ-EW-27-5	83.94	20.7	27.1
WHJ-EW-27-6	83.94	20.7	27.1
WHJ-EW-28-1	87.73	19.8	26.1
WHJ-EW-28-2	89.73	18.5	24.8
WHJ-EW-28-3	89.73	18.3	24.7
WHJ-EW-28-4	87.73	19.1	25.5
WHJ-EW-28-5	83.39	21.0	27.3
WHJ-EW-28-6	83.39	20.9	27.3
WHJ-EW-29-1	81.05	22.3	28.3
WHJ-EW-29-2	83.05	21.0	27.1
WHJ-EW-29-3	83.05	20.9	26.9
WHJ-EW-29-4	81.05	21.7	27.7

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	**Elevation (ft NAVD88)**	**@ Expected Design Flow Rate**	**@ Maximum Design Flow Rate**
		Pressure (psi)	**Pressure (psi)**
WHJ-EW-29-5	76.72	23.5	29.5
WHJ-EW-29-6	76.72	23.4	29.5
WHJ-EW-30-1	80.74	21.8	28.4
WHJ-EW-30-2	82.74	20.9	27.1
WHJ-EW-30-3	82.74	20.8	26.9
WHJ-EW-30-4	80.74	21.7	27.8
WHJ-EW-30-5	76.40	23.5	29.6
WHJ-EW-30-6	76.40	23.5	29.5
WHJ-EW-31-1	79.89	21.9	28.2
WHJ-EW-31-2	81.89	20.9	26.9
WHJ-EW-31-3	81.89	20.8	26.7
WHJ-EW-31-4	79.89	21.7	27.6
WHJ-EW-31-5	75.56	23.6	29.4
WHJ-EW-31-6	75.56	23.5	29.3
WHJ-EW-32-1	80.06	22.3	28.1
WHJ-EW-32-2	82.06	21.0	26.8
WHJ-EW-32-3	82.06	20.9	26.6
WHJ-EW-32-4	80.06	21.7	27.4
WHJ-EW-32-5	75.72	23.5	29.3
WHJ-EW-32-6	75.72	23.5	29.2
WHJ-EW-33-1	76.08	22.9	28.7
WHJ-EW-33-2	78.08	21.9	27.4
WHJ-EW-33-3	78.08	21.8	27.2
WHJ-EW-33-4	76.08	22.7	28.1
WHJ-EW-33-5	71.75	24.6	29.9
WHJ-EW-33-6	71.75	24.5	29.8
WHJ-EW-34-1	75.33	23.7	29.0
WHJ-EW-34-2	77.33	22.4	27.7
WHJ-EW-34-3	77.33	22.3	27.5
WHJ-EW-34-4	75.33	23.1	28.3
WHJ-EW-34-5	71.00	24.9	30.2
WHJ-EW-34-6	71.00	24.8	30.1

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	**Elevation (ft NAVD88)**	**@ Expected Design Flow Rate**	**@ Maximum Design Flow Rate**
		Pressure (psi)	**Pressure (psi)**
WHJ-EW-35-1	71.60	24.6	30.3
WHJ-EW-35-2	73.60	23.6	29.0
WHJ-EW-35-3	73.60	23.6	28.8
WHJ-EW-35-4	71.60	24.4	29.6
WHJ-EW-35-5	67.27	26.3	31.4
WHJ-EW-35-6	67.27	26.3	31.4
WHJ-EW-36-1	70.98	25.4	30.5
WHJ-EW-36-2	72.98	24.1	29.2
WHJ-EW-36-3	72.98	23.9	29.0
WHJ-EW-36-4	70.98	24.7	29.8
WHJ-EW-36-5	66.65	26.6	31.7
WHJ-EW-36-6	66.65	26.5	31.6
WHJ-EW-37-1	67.01	26.3	31.7
WHJ-EW-37-2	69.01	25.3	30.5
WHJ-EW-37-3	69.01	25.2	30.3
WHJ-EW-37-4	67.01	26.1	31.1
WHJ-EW-37-5	62.67	28.0	32.9
WHJ-EW-37-6	62.67	27.9	32.9
WHJ-EW-38-1	66.35	28.0	32.9
WHJ-EW-38-2	68.35	25.7	30.5
WHJ-EW-38-3	68.35	25.5	30.4
WHJ-EW-38-4	66.35	26.4	31.3
WHJ-EW-38-5	62.01	28.2	33.1
WHJ-EW-38-6	62.01	28.2	33.1
WHJ-EW-39-1	75.77	22.2	27.5
WHJ-EW-39-2	77.77	21.3	26.2
WHJ-EW-39-3	77.77	21.2	26.1
WHJ-EW-39-4	75.77	22.1	26.9
WHJ-EW-39-5	71.43	23.9	28.7
WHJ-EW-39-6	71.43	23.9	28.6
WHJ-EW-40-1	76.65	23.3	28.0
WHJ-EW-40-2	78.65	21.0	25.6

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-40-3	78.65	20.9	25.5
WHJ-EW-40-4	76.65	21.7	26.4
WHJ-EW-40-5	72.32	23.5	28.2
WHJ-EW-40-6	72.32	23.5	28.2
WHJ-EW-41-1	84.66	19.4	23.6
WHJ-EW-41-2	86.66	17.0	21.3
WHJ-EW-41-3	86.66	16.9	21.2
WHJ-EW-41-4	84.66	17.7	22.0
WHJ-EW-41-5	80.33	19.6	23.8
WHJ-EW-42-1	80.99	20.6	24.6
WHJ-EW-42-2	82.99	18.2	22.2
WHJ-EW-42-3	82.99	18.1	22.1
WHJ-EW-42-4	80.99	19.0	23.0
WHJ-EW-42-5	76.66	20.8	24.8
WHJ-EW-43-1	83.49	18.3	23.0
WHJ-EW-43-2	85.49	16.7	20.6
WHJ-EW-43-3	85.49	16.7	20.5
WHJ-EW-43-4	83.49	17.5	21.4
WHJ-EW-43-5	79.15	19.4	23.2
WHJ-EW-44-1	73.96	21.6	25.8
WHJ-EW-44-2	75.96	20.5	24.3
WHJ-EW-44-3	75.96	20.5	24.3
WHJ-EW-44-4	73.96	21.4	25.1
WHJ-EW-44-5	69.62	23.3	27.0
WHJ-EW-44-6	69.62	23.3	27.0
WHJ-EW-45-1	74.35	22.0	26.6
WHJ-EW-45-2	76.35	20.4	24.2
WHJ-EW-45-3	76.35	20.4	24.1
WHJ-EW-45-4	74.35	21.2	25.0
WHJ-EW-45-5	70.01	23.1	26.8
WHJ-EW-45-6	70.01	23.1	26.8
WHJ-EW-46-1	70.34	22.9	26.9

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Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-46-2	72.34	21.9	25.3
WHJ-EW-46-3	72.34	21.9	25.3
WHJ-EW-46-4	70.34	22.7	26.2
WHJ-EW-46-5	66.00	24.6	28.0
WHJ-EW-46-6	66.00	24.6	28.0
WHJ-EW-47-1	70.55	24.3	27.7
WHJ-EW-47-2	72.55	21.9	25.3
WHJ-EW-47-3	72.55	21.8	25.2
WHJ-EW-47-4	70.55	22.7	26.1
WHJ-EW-47-5	66.22	24.5	27.9
WHJ-EW-47-6	66.22	24.5	27.9
WHJ-EW-48-1	81.14	17.9	20.9
WHJ-EW-48-2	83.14	16.8	19.9
WHJ-EW-48-3	83.14	16.8	19.9
WHJ-EW-48-4	81.14	17.7	20.8
WHJ-EW-48-5	76.81	19.6	22.6
WHJ-EW-48-6	76.81	19.6	22.6
WHJ-EW-49-1	80.65	19.6	22.7
WHJ-EW-49-2	82.65	17.2	20.3
WHJ-EW-49-3	82.65	17.1	20.2
WHJ-EW-49-4	80.65	18.0	21.0
WHJ-EW-49-5	76.32	19.8	22.9
WHJ-EW-49-6	76.32	19.8	22.8
WHJ-EW-50-1	77.47	19.0	21.7
WHJ-EW-50-2	79.47	17.9	20.6
WHJ-EW-50-3	79.47	17.9	20.6
WHJ-EW-50-4	77.47	18.8	21.5
WHJ-EW-50-5	73.14	20.7	23.4
WHJ-EW-50-6	73.14	20.6	23.4
WHJ-EW-51-1	77.75	20.4	23.1
WHJ-EW-51-2	79.75	18.0	20.7
WHJ-EW-51-3	79.75	17.9	20.6

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-51-4	77.75	18.7	21.4
WHJ-EW-51-5	73.42	20.6	23.3
WHJ-EW-51-6	73.42	20.5	23.2
WHJ-EW-52-1	75.08	20.0	22.4
WHJ-EW-52-2	77.08	18.7	21.1
WHJ-EW-52-3	77.08	18.5	20.9
WHJ-EW-52-4	75.08	19.4	21.7
WHJ-EW-52-5	70.74	21.2	23.5
WHJ-EW-53-1	75.18	19.3	21.3
WHJ-EW-53-2	77.18	18.0	20.0
WHJ-EW-53-3	77.18	17.9	19.8
WHJ-EW-53-4	75.18	18.7	20.6
WHJ-EW-53-5	70.85	20.5	22.4
WHJ-EW-54-1	73.82	20.4	22.0
WHJ-EW-54-2	75.82	18.0	19.6
WHJ-EW-54-3	75.82	17.9	19.5
WHJ-EW-54-4	73.82	18.7	20.4
WHJ-EW-54-5	69.49	20.6	22.2
WHJ-EW-55-1	81.72	16.5	17.6
WHJ-EW-55-2	83.72	14.1	15.2
WHJ-EW-55-3	83.72	14.0	15.1
WHJ-EW-55-4	81.72	14.8	16.0
WHJ-EW-55-5	77.39	16.6	17.8
WHJ-EW-56-1	80.00	16.8	18.1
WHJ-EW-56-2	82.00	15.5	16.8
WHJ-EW-56-3	82.00	15.3	16.6
WHJ-EW-56-4	80.00	16.1	17.4
WHJ-EW-56-5	75.66	17.9	19.3
WHJ-EW-57-1	76.92	19.2	20.8
WHJ-EW-57-2	78.92	17.9	19.5
WHJ-EW-57-3	78.92	17.7	19.3
WHJ-EW-57-4	76.92	18.5	20.2

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Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-57-5	72.58	20.3	22.0
WHJ-EW-58-1	73.38	22.8	24.8
WHJ-EW-58-2	75.38	20.4	22.4
WHJ-EW-58-3	75.38	20.3	22.3
WHJ-EW-58-4	73.38	21.1	23.2
WHJ-EW-58-5	69.05	23.0	25.0
WHJ-EW-59-1	74.27	22.5	24.8
WHJ-EW-59-2	76.27	21.2	23.6
WHJ-EW-59-3	76.27	21.0	23.4
WHJ-EW-59-4	74.27	21.8	24.2
WHJ-EW-59-5	69.93	23.6	26.0
WHJ-EW-60-1	75.61	22.7	25.5
WHJ-EW-60-2	77.61	21.5	24.2
WHJ-EW-60-3	77.61	21.3	24.0
WHJ-EW-60-4	75.61	22.1	24.8
WHJ-EW-60-5	71.28	23.9	26.6
WHJ-EW-61-1	77.26	22.7	25.7
WHJ-EW-61-2	79.26	21.4	24.4
WHJ-EW-61-3	79.26	21.2	24.2
WHJ-EW-61-4	77.26	22.1	25.0
WHJ-EW-61-5	72.92	23.9	26.9
WHJ-EW-62-1	79.92	22.0	25.2
WHJ-EW-62-2	81.92	20.7	23.9
WHJ-EW-62-3	81.92	20.5	23.7
WHJ-EW-62-4	79.92	21.3	24.6
WHJ-EW-62-5	75.59	23.1	26.4
WHJ-EW-63-1	119.93	5.2	9.2
WHJ-EW-63-2	121.93	3.9	7.7
WHJ-EW-63-3	121.93	3.8	7.4
WHJ-EW-63-4	119.93	4.6	8.2
WHJ-EW-63-5	115.59	6.4	10.0
WHJ-EW-64-1	119.30	6.1	10.3

Junction Label	Elevation (ft NAVD88)	@ Expected Design Flow Rate	@ Maximum Design Flow Rate
		Pressure (psi)	Pressure (psi)
WHJ-EW-64-2	121.30	4.6	8.4
WHJ-EW-64-3	121.30	4.5	8.3
WHJ-EW-64-4	119.30	5.3	9.1
WHJ-EW-64-5	114.97	7.0	10.8
WHJ-EW-65-1	113.58	8.8	13.0
WHJ-EW-65-2	115.58	7.2	11.2
WHJ-EW-65-3	115.58	7.1	11.1
WHJ-EW-65-4	113.58	7.9	11.9
WHJ-EW-65-5	109.24	9.7	13.6
WHJ-EW-66-1	113.20	9.7	14.5
WHJ-EW-66-2	115.20	8.2	12.6
WHJ-EW-66-3	115.20	8.1	12.5
WHJ-EW-66-4	113.20	8.9	13.3
WHJ-EW-66-5	108.87	10.7	15.0
WHJ-EW-67-1	103.21	15.3	20.8
WHJ-EW-67-2	105.21	13.5	18.6
WHJ-EW-67-3	105.21	13.4	18.4
WHJ-EW-67-4	103.21	14.2	19.2
WHJ-EW-67-5	98.88	15.9	20.8
WHJ-EW-68-1	95.12	19.0	25.3
WHJ-EW-68-2	97.12	17.5	23.2
WHJ-EW-68-3	97.12	17.4	23.0
WHJ-EW-68-4	95.12	18.2	23.7
WHJ-EW-68-5	90.79	19.9	25.4
WHJ-EW-69-1	87.45	22.5	29.0
WHJ-EW-69-2	89.45	21.0	26.8
WHJ-EW-69-3	89.45	20.9	26.6
WHJ-EW-69-4	87.45	21.7	27.4
WHJ-EW-69-5	83.12	23.4	29.0

Notes:
1. ft NAVD88 – feet North American Vertical Datum of 1988
2. psi – pounds per square inch

CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

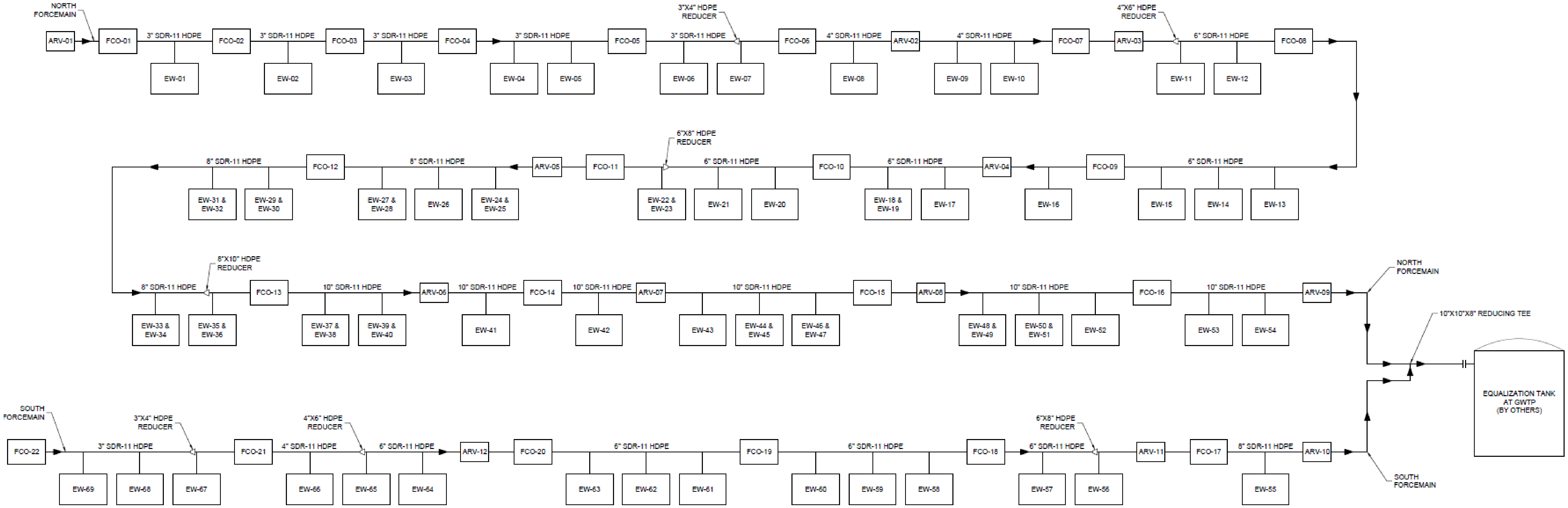
3. ARV – air release valve
4. FCO – forcemain cleanout
5. J – junction
6. WHJ – well head junction
7. EW – extraction well

FIGURES

CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Figure 1. Hydraulic Control System Layout



ARV – air release valve

FCO – forcemain cleanout

EW – extraction well

CP:	DHL	Date:	12/15/21	APC:	SV	Date:	12/20/21	CC:	BMT	Date:	12/20/21

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Figure 2a. Goulds 5GS Pump Curves

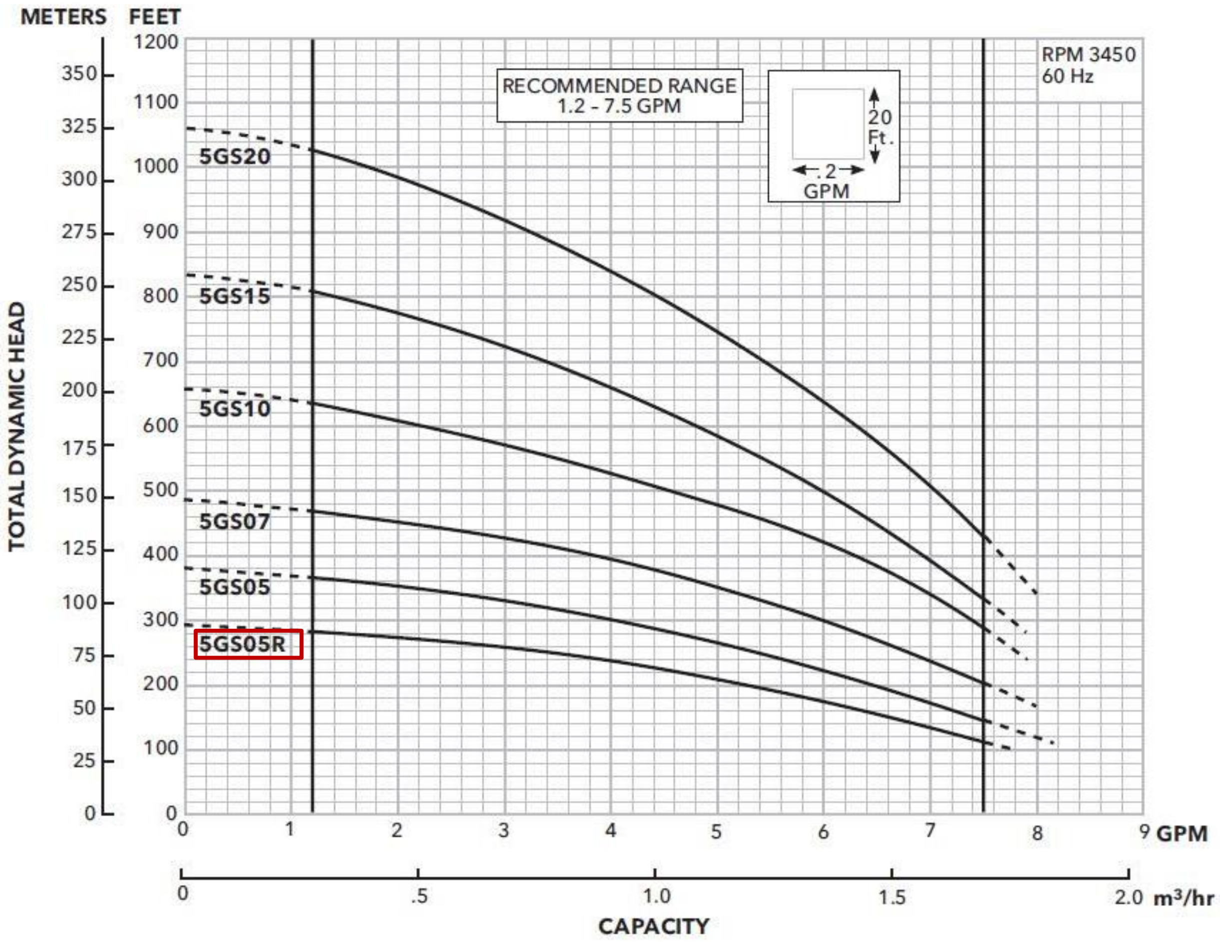
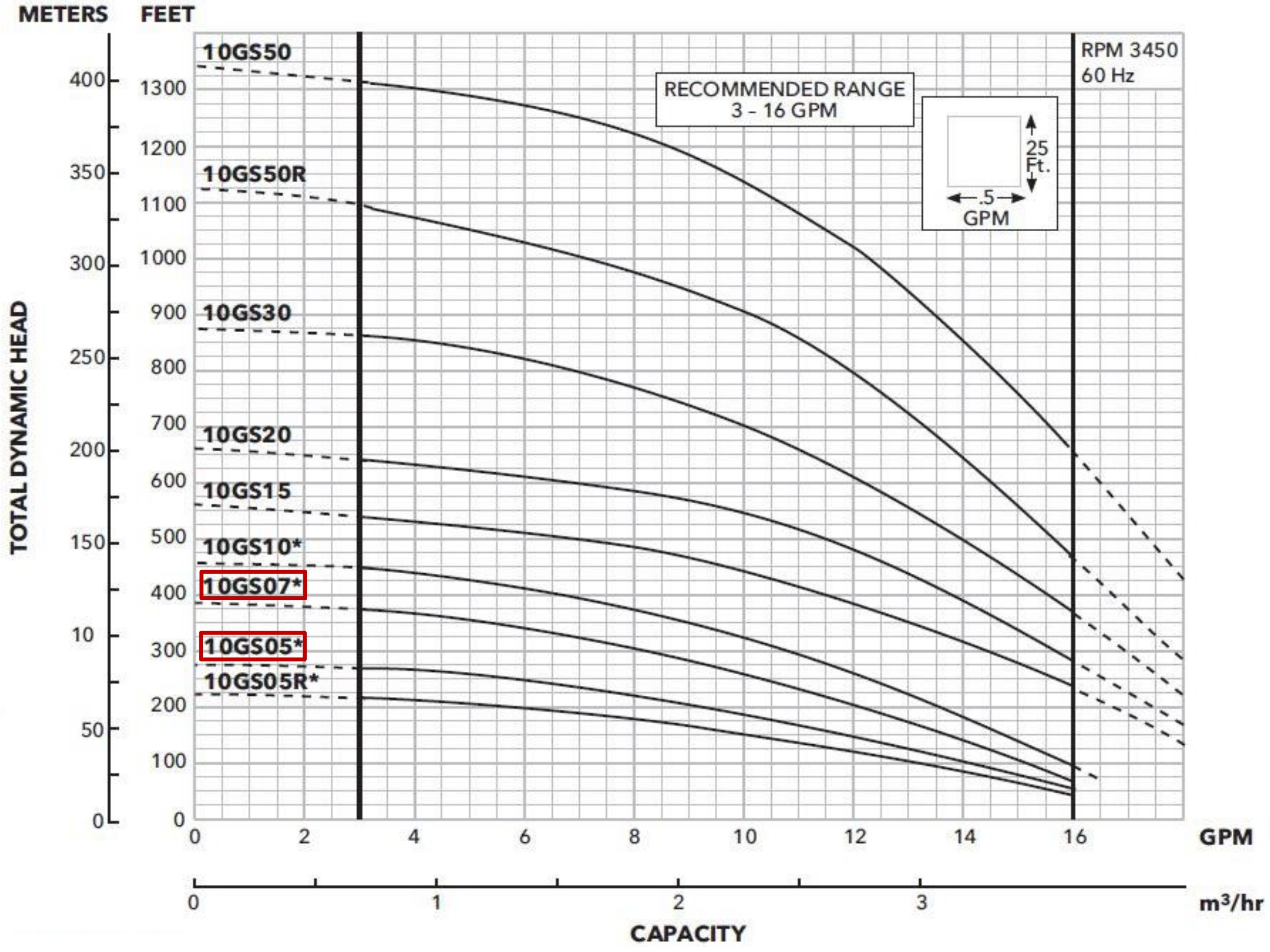


Figure 2b. Goulds 10GS Pump Curves



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Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

Figure 2c. Goulds 13GS Pump Curves

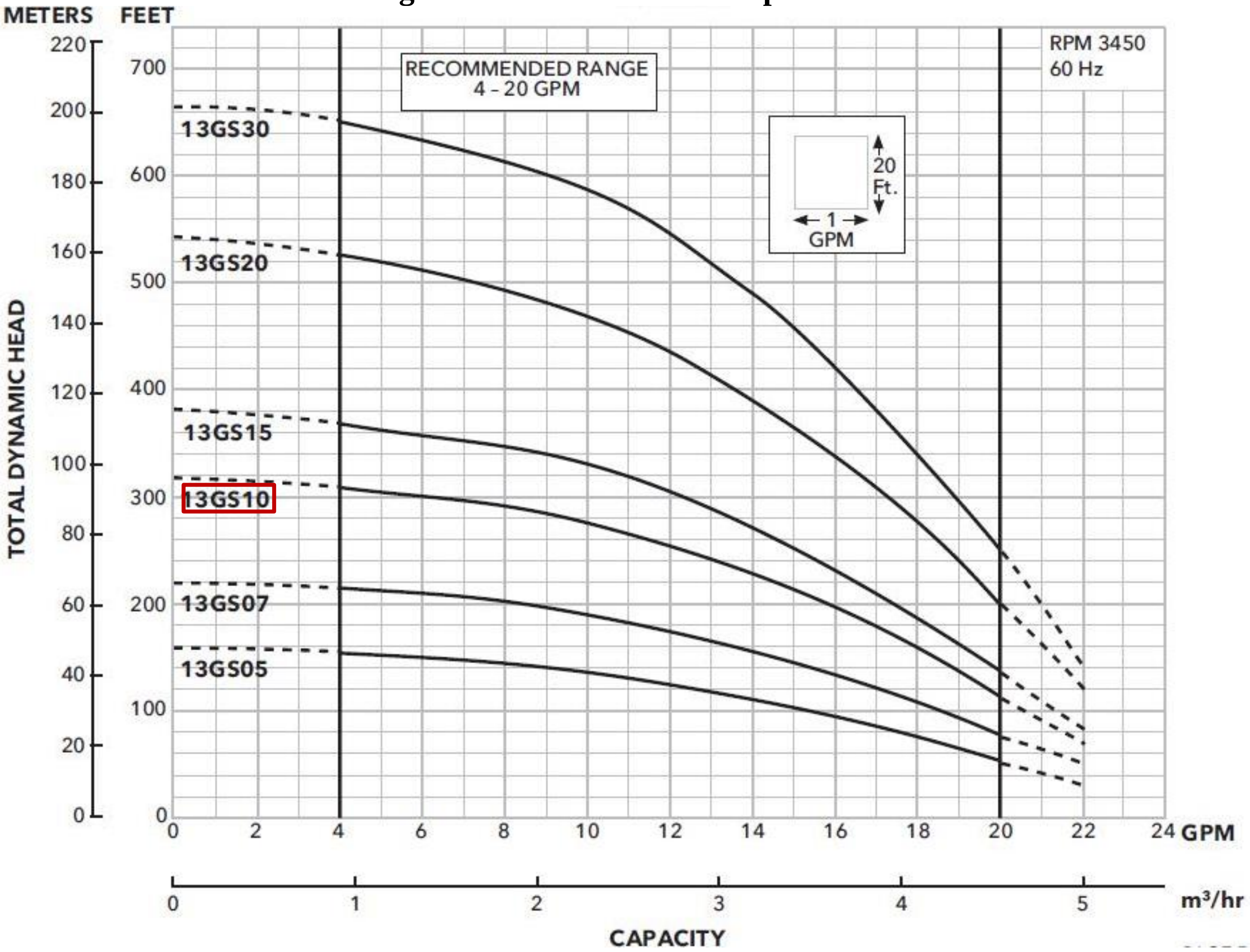
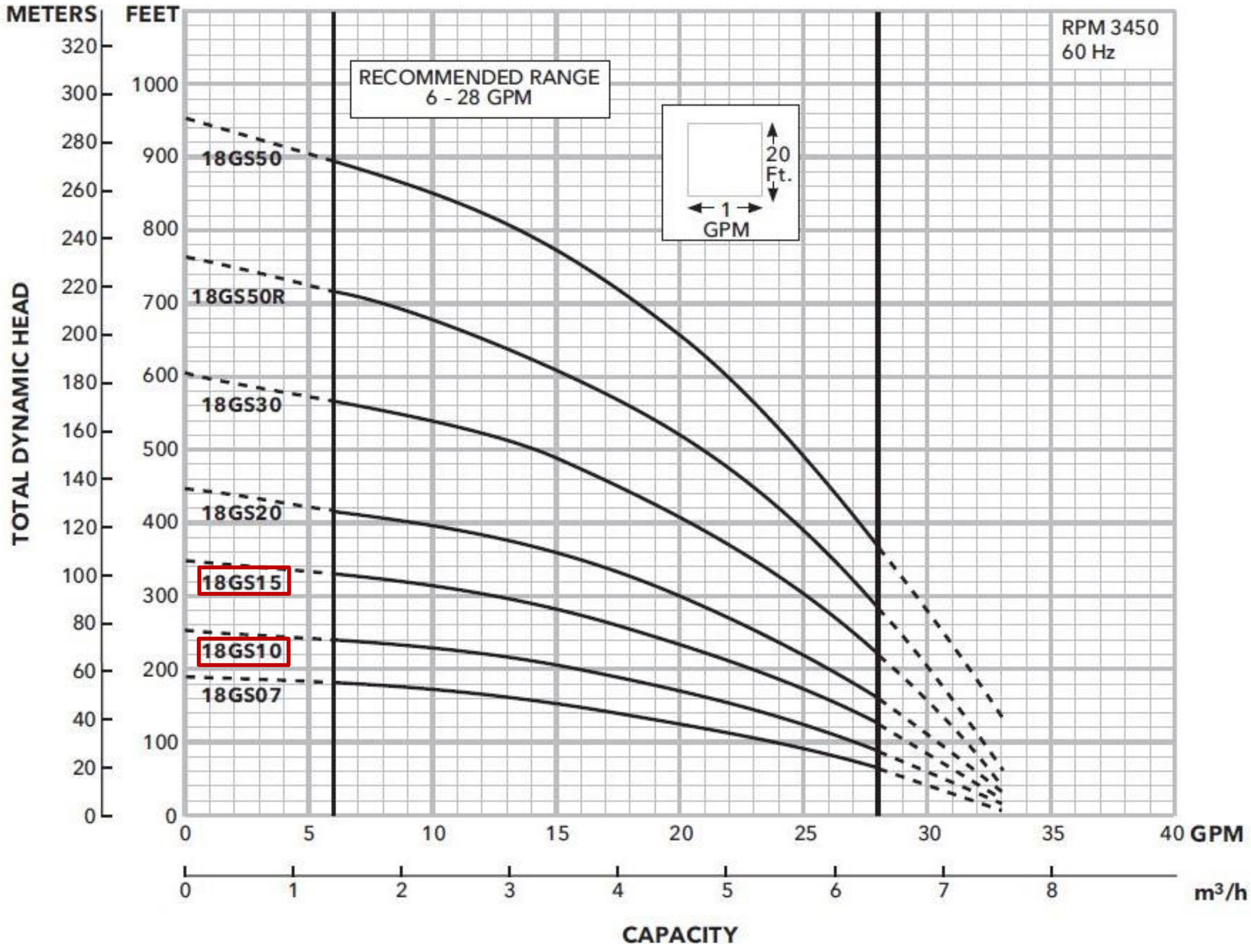


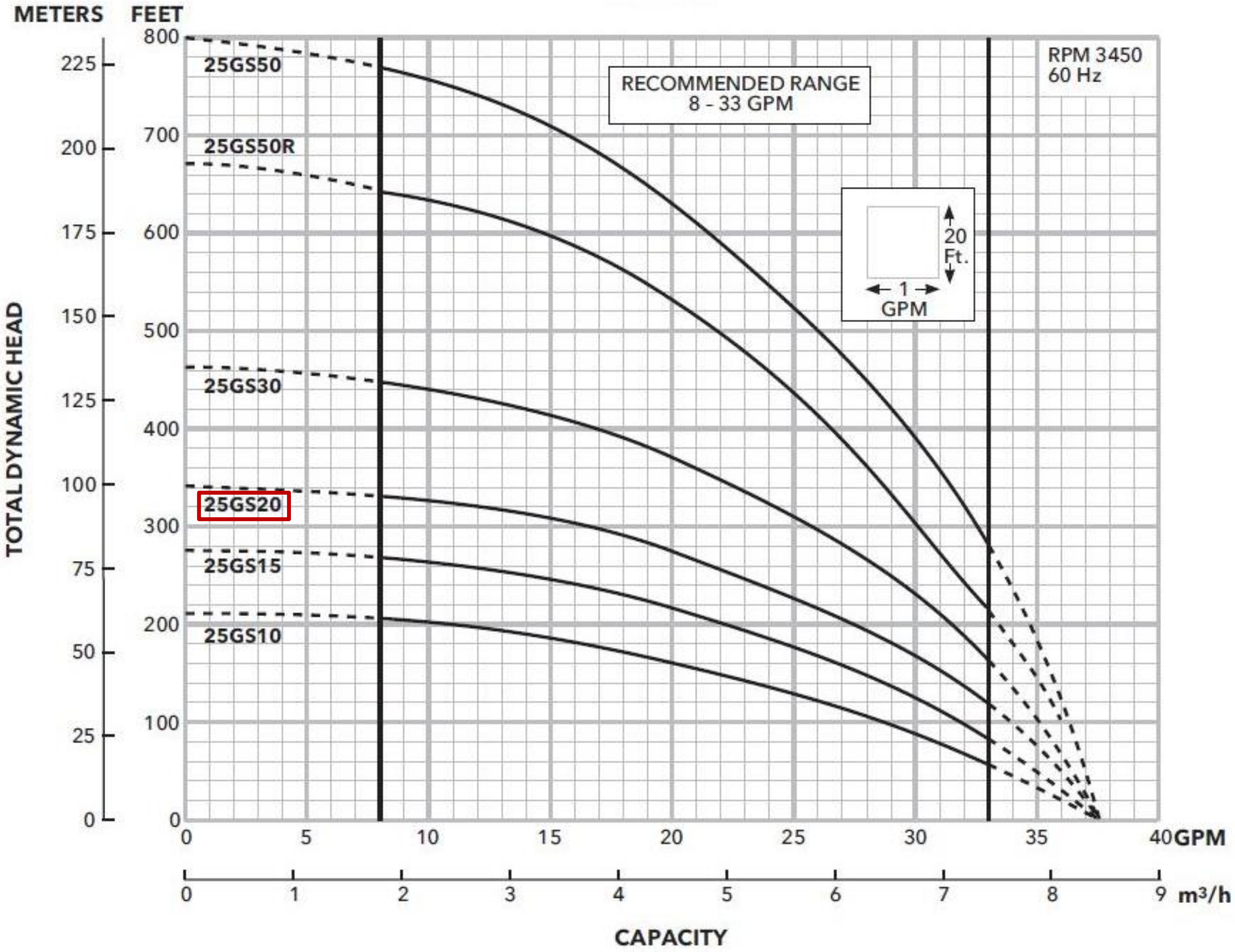
Figure 2d. Goulds 18GS Pump Curves



CP:	DHL	Date:	12/15/21	APC:	SV	Date:	12/20/21	CC:	BMT	Date:	12/20/21

Client:	Chemours	Project:	90% Design FW Groundwater Remedy Project	Project No:	TR7095A

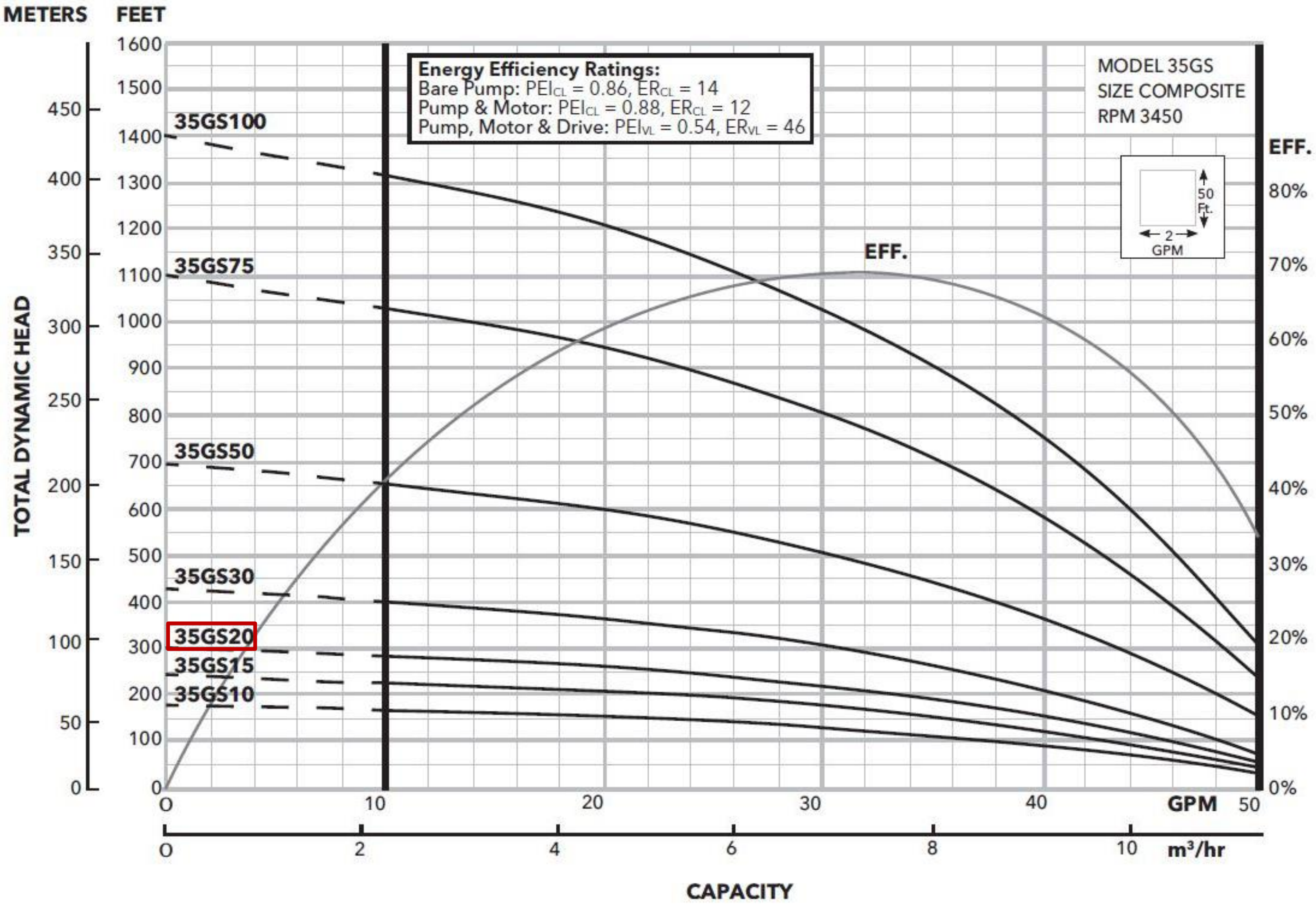
Figure 2e. Goulds 25GS Pump Curves



CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

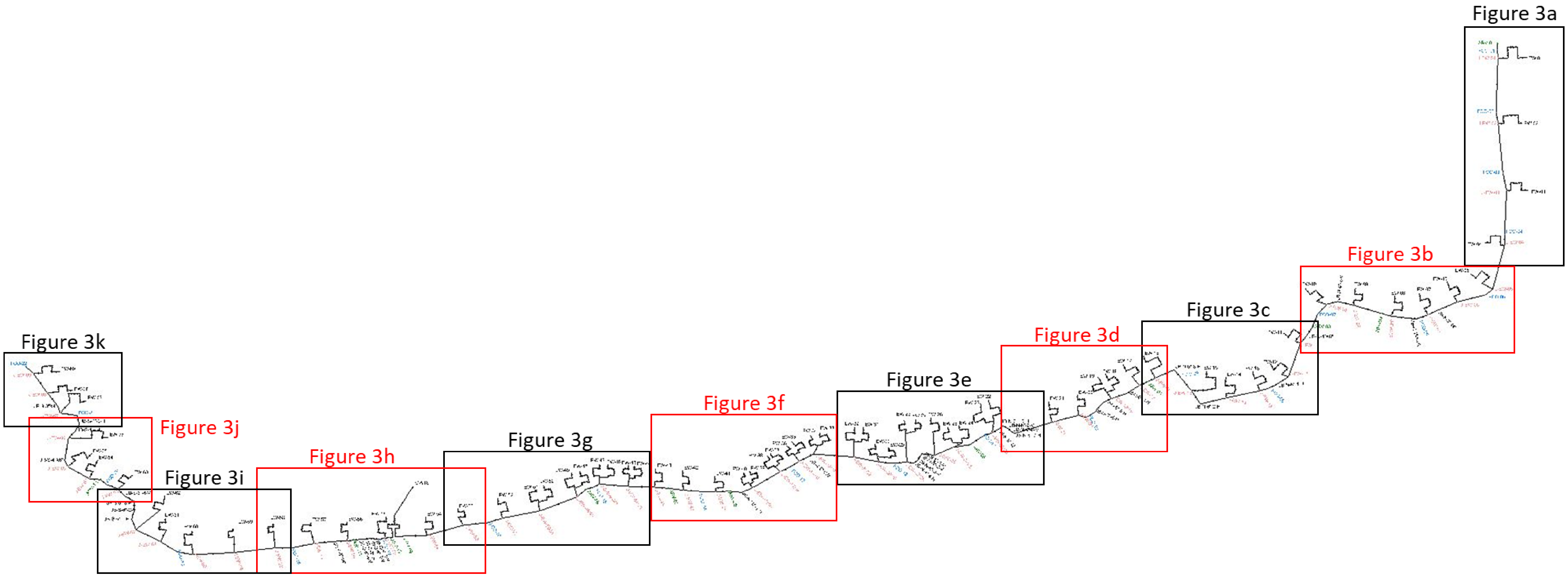
Figure 2f. Goulds 35GS Pump Curves



CP: DHL Date: 12/15/21 APC: SV Date: 12/20/21 CC: BMT Date: 12/20/21

Client: Chemours Project: 90% Design FW Groundwater Remedy Project Project No: TR7095A

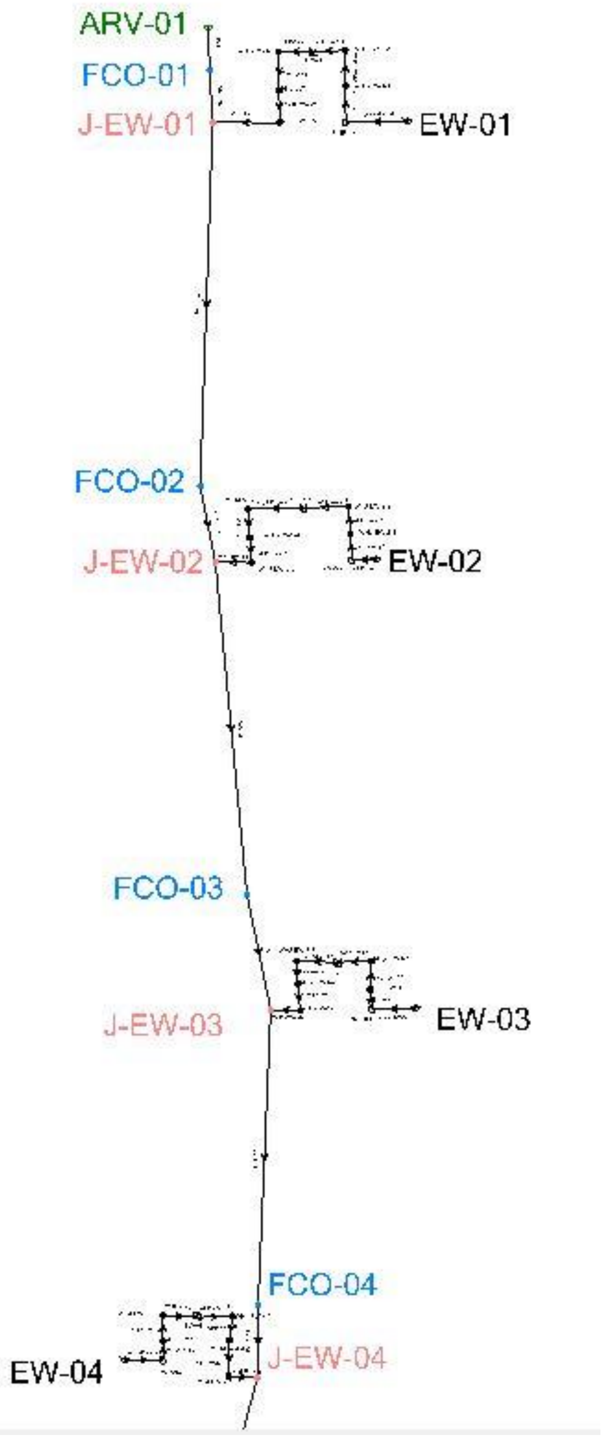
Figure 3. WaterGEMS Model Layout



CP:	**DHL**	Date:	**12/15/21**	APC:	**SV**	Date:	**12/20/21**	CC:	**BMT**	Date:	**12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Figure 3a. WaterGEMS Model Layout (Zoomed In)



CP:	DHL	Date:	12/15/21	APC:	SV	Date:	12/20/21	CC:	BMT	Date: 12/20/21

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Figure 3b. WaterGEMS Model Layout (Zoomed In)

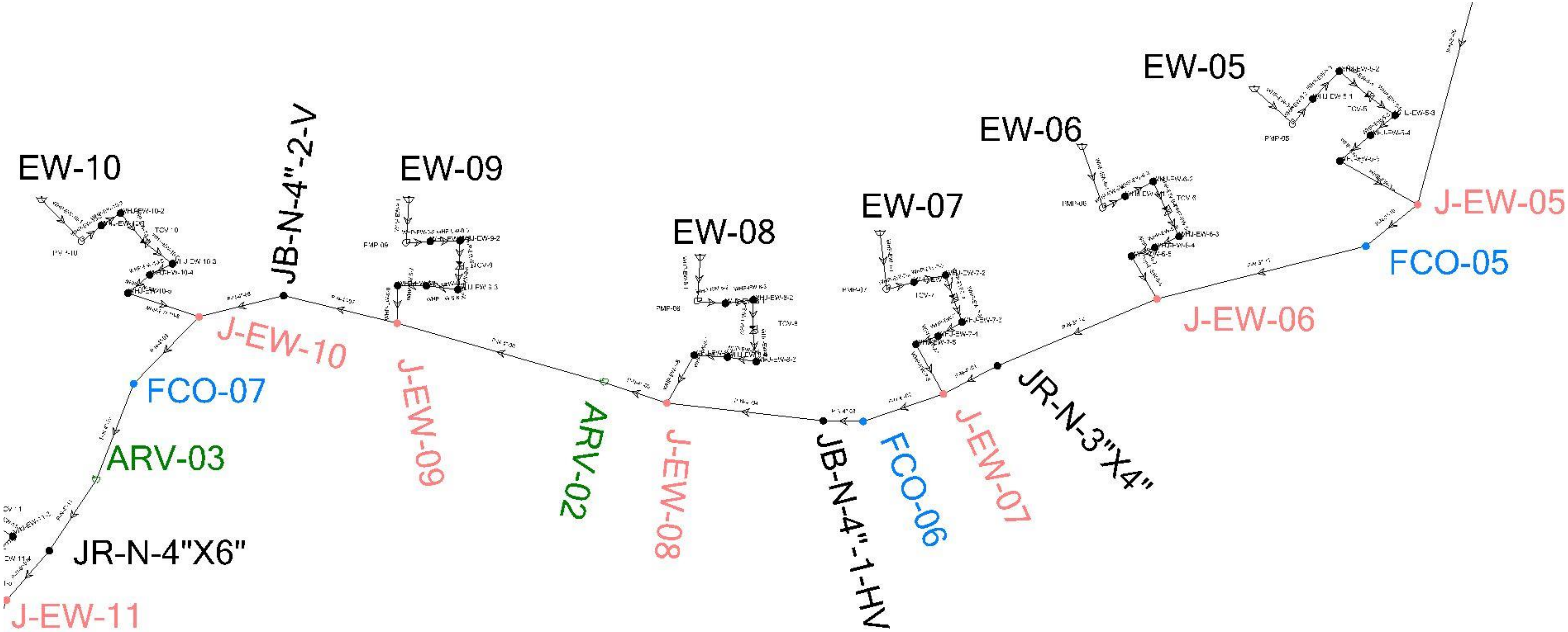
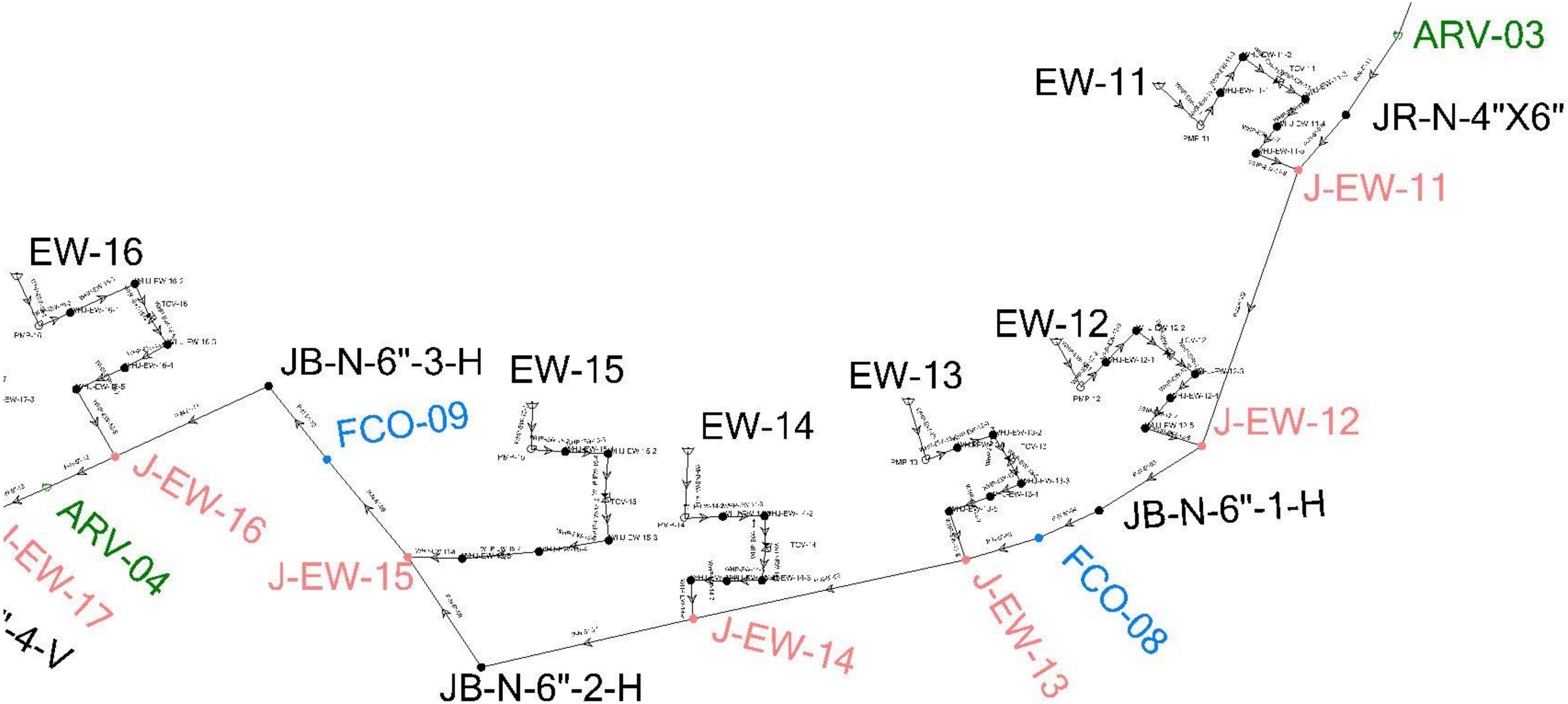


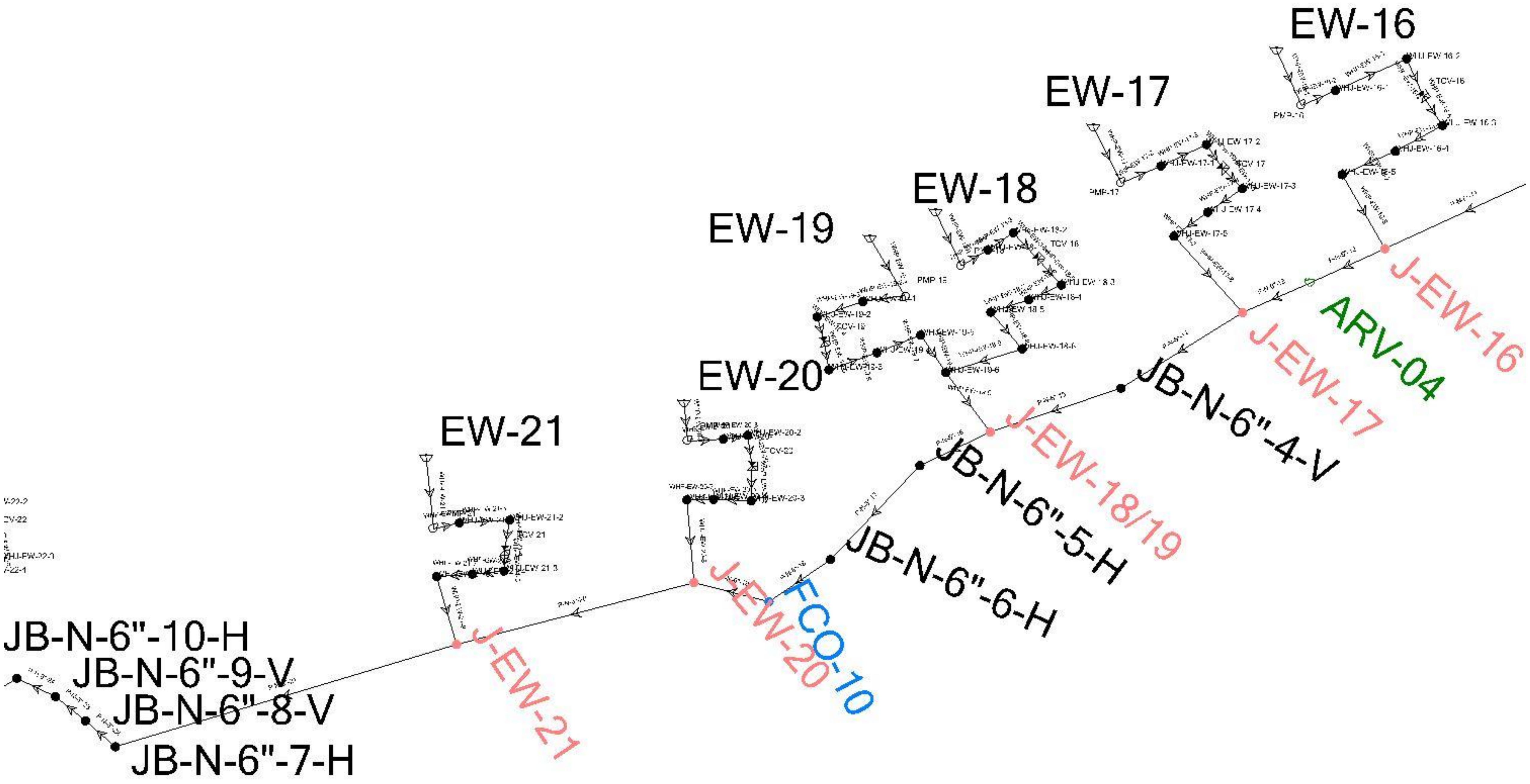
Figure 3c. WaterGEMS Model Layout (Zoomed In)



CP: **DHL** Date: **12/15/21** APC: **SV** Date: **12/20/21** CC: **BMT** Date: **12/20/21**

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

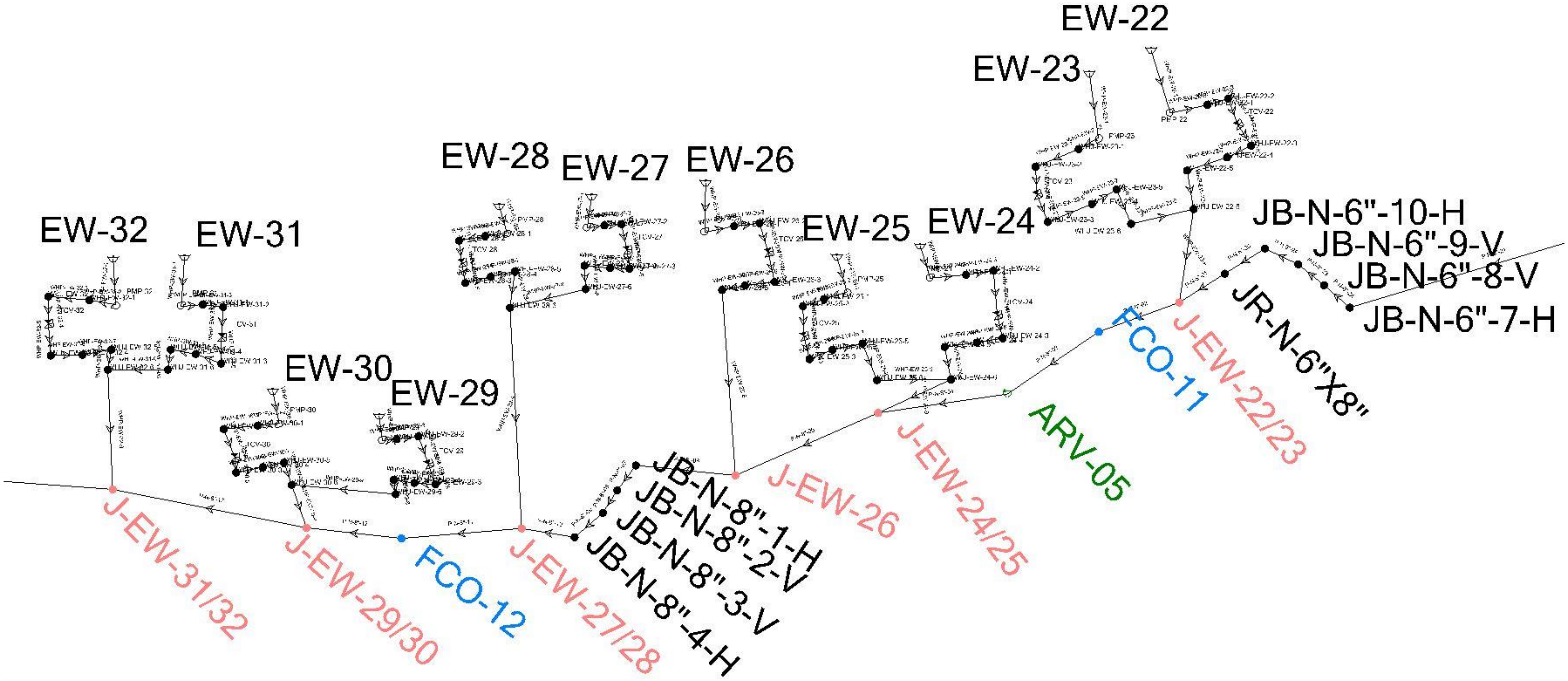
Figure 3d. WaterGEMS Model Layout (Zoomed In)



CP:	DHL	Date:	12/15/21	APC:	SV	Date:	12/20/21	CC:	BMT	Date: 12/20/21

Client: **Chemours** Project: **90% Design FW Groundwater Remedy Project** Project No: **TR7095A**

Figure 3e. WaterGEMS Model Layout (Zoomed In)



CP:	DHL	Date:	12/15/21	APC:	SV	Date:	12/20/21	CC:	BMT	Date:	12/20/21

Client:	Chemours	Project:	90% Design FW Groundwater Remedy Project	Project No:	TR7095A

Figure 3f. WaterGEMS Model Layout (Zoomed In)

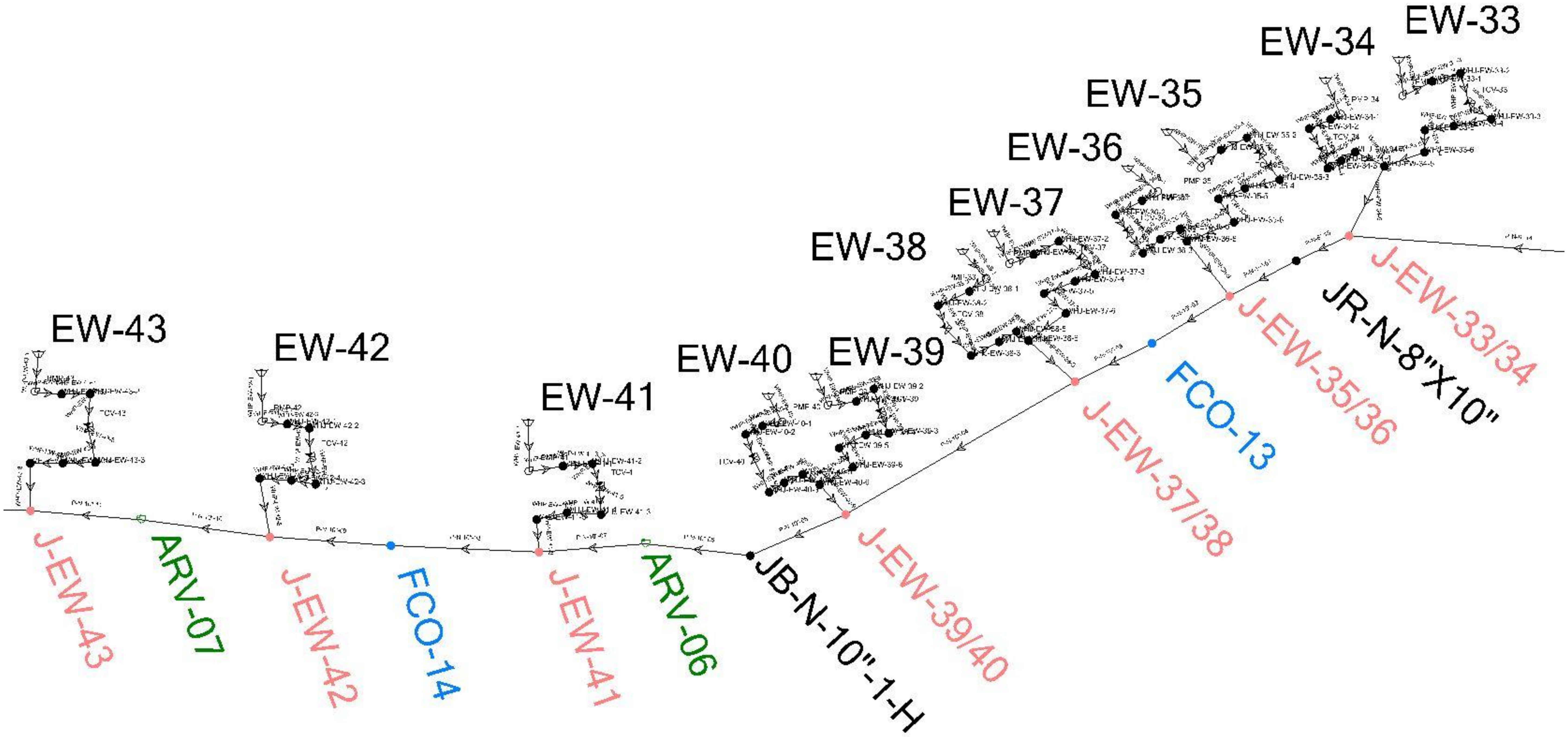


Figure 3g. WaterGEMS Model Layout (Zoomed In)

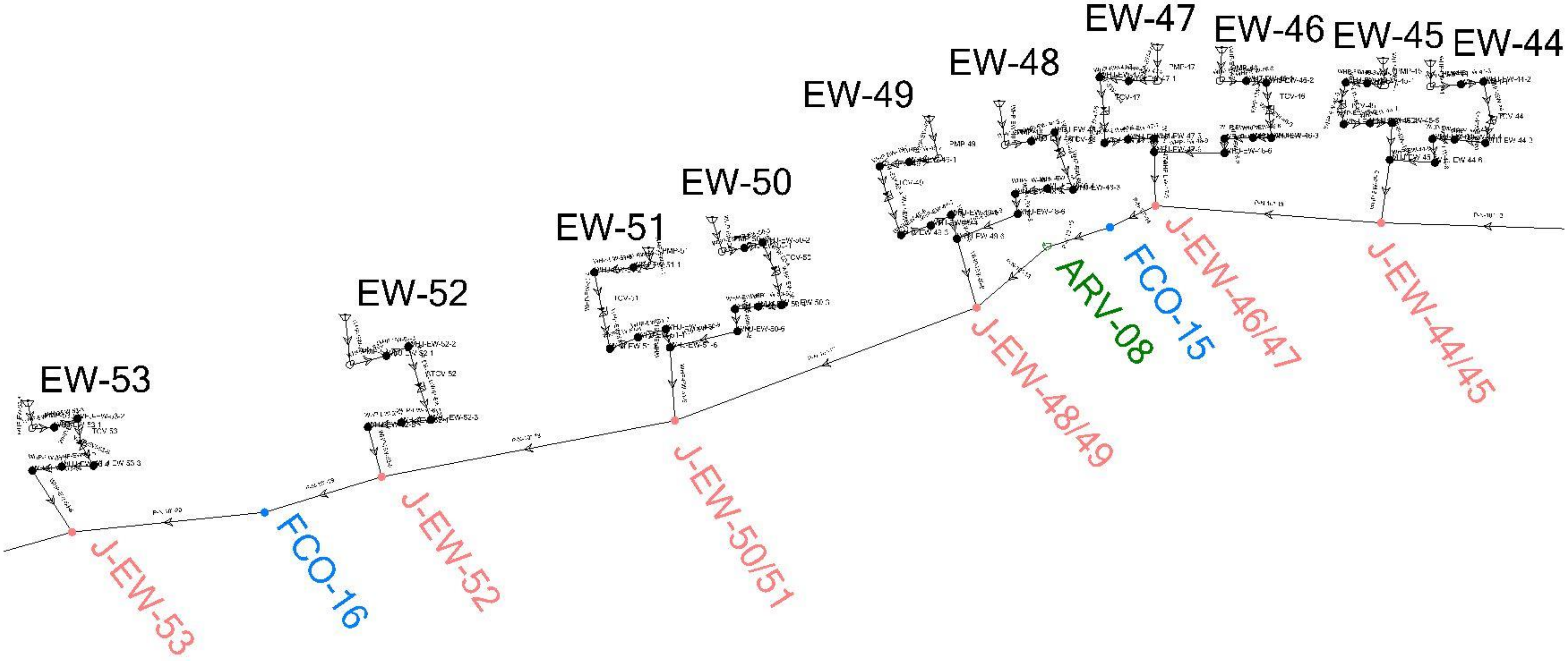


Figure 3h. WaterGEMS Model Layout (Zoomed In)

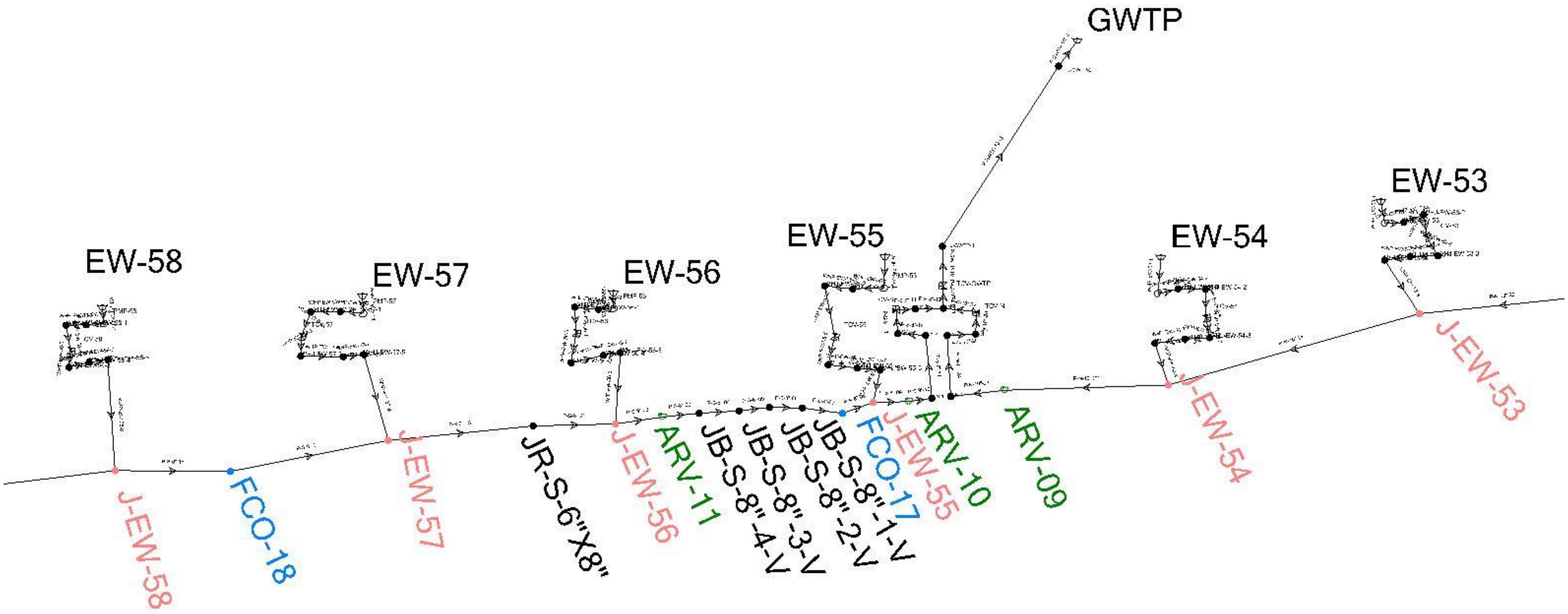


Figure 3i. WaterGEMS Model Layout (Zoomed In)

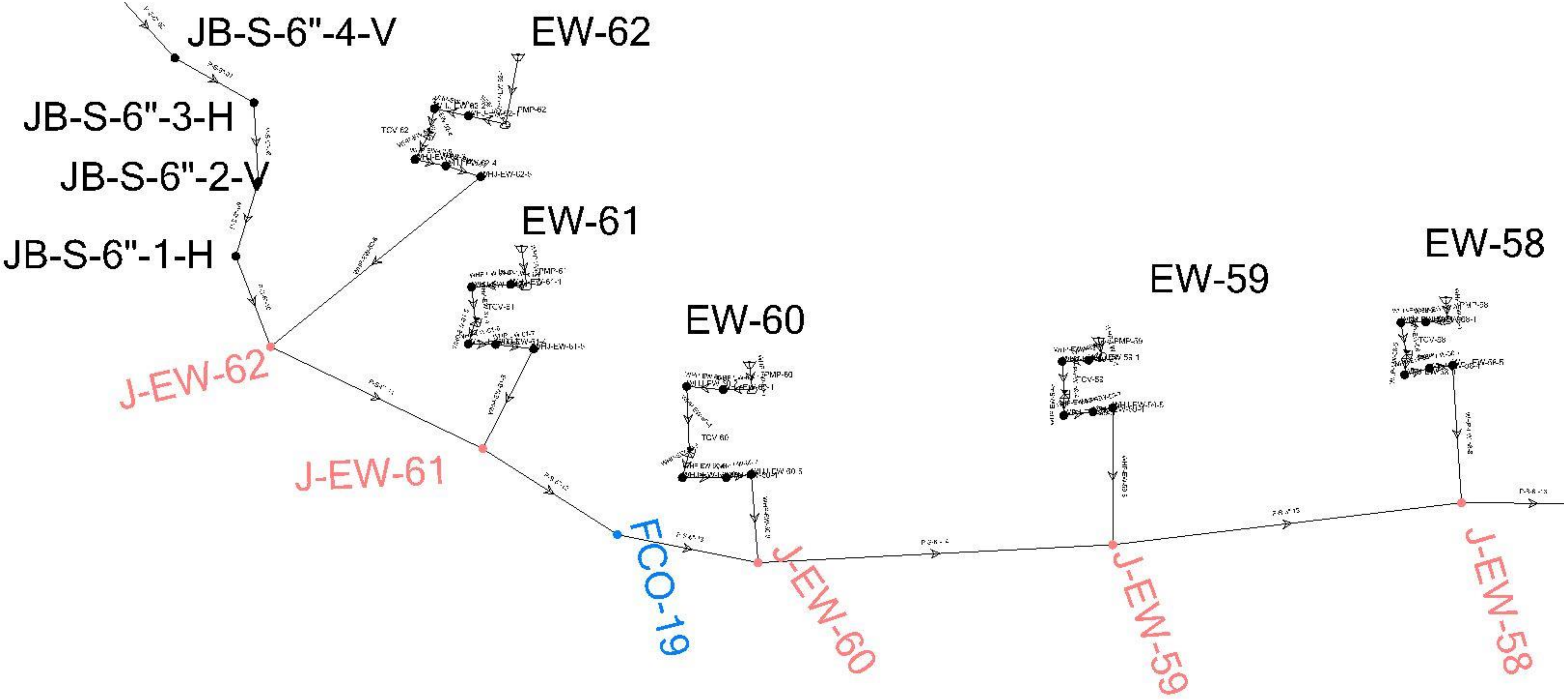
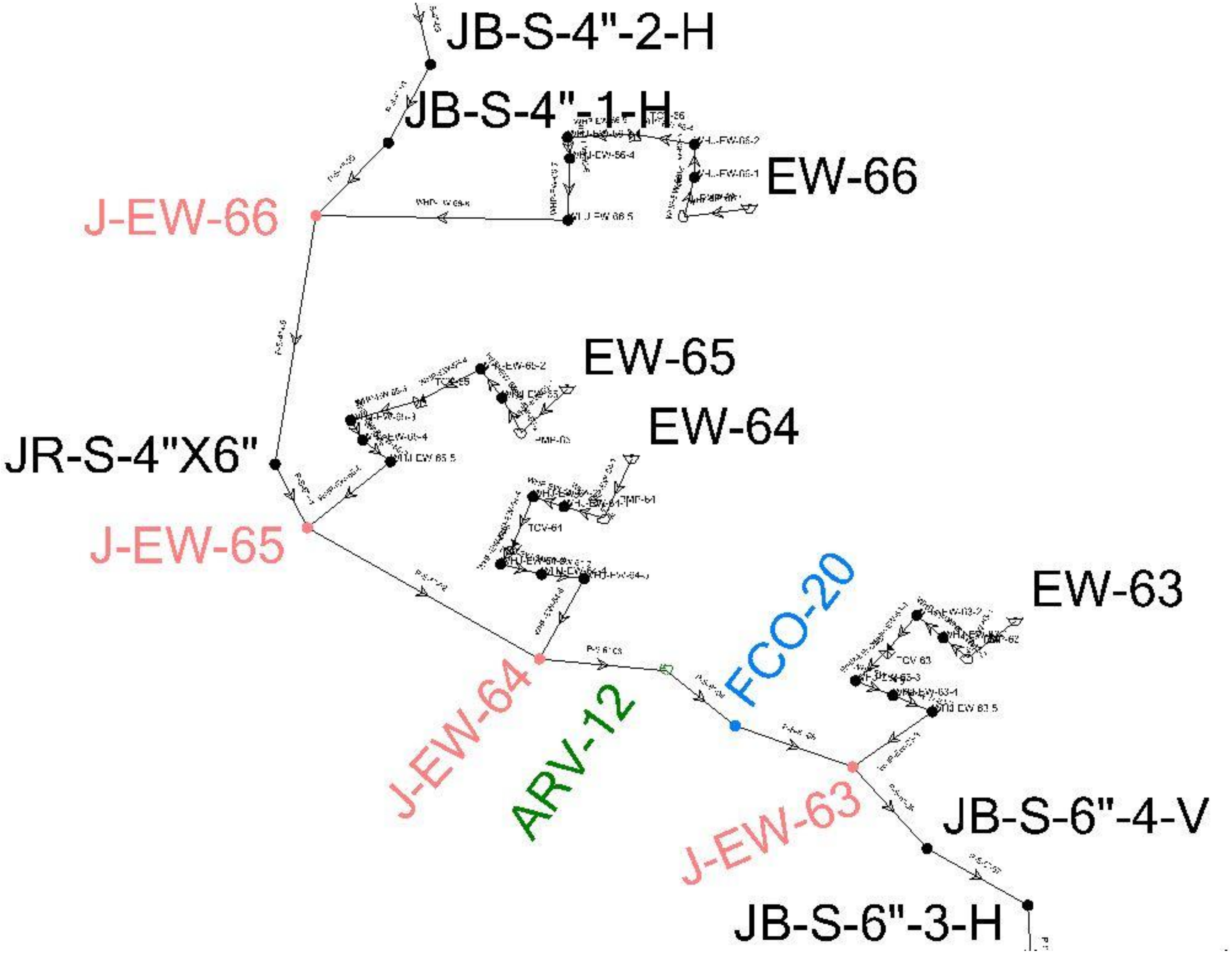


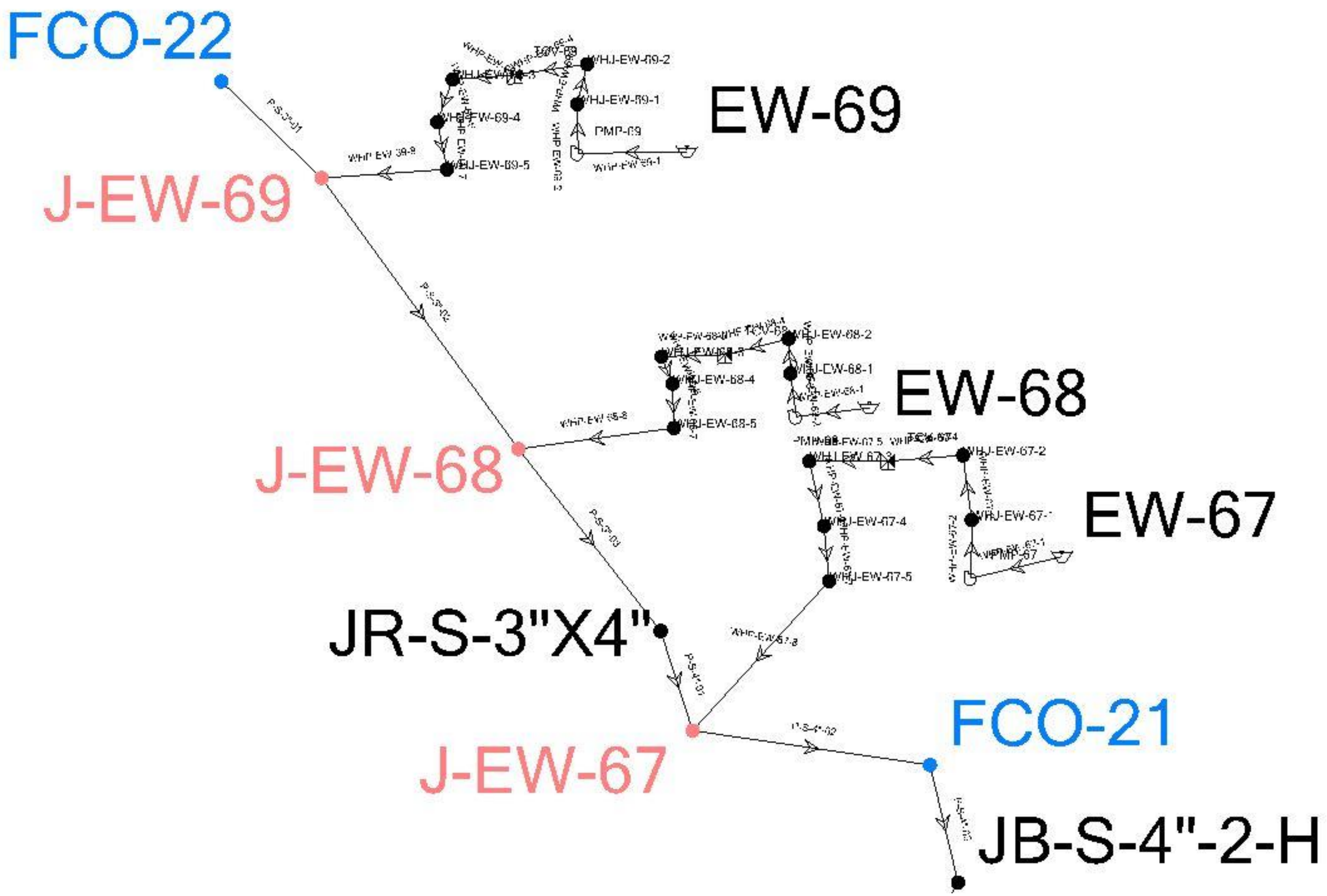
Figure 3j. WaterGEMS Model Layout (Zoomed In)



CP:	DHL	Date:	12/15/21	APC:	SV	Date:	12/20/21	CC:	BMT	Date:	12/20/21

Client:	**Chemours**	Project:	**90% Design FW Groundwater Remedy Project**	Project No:	**TR7095A**

Figure 3k. WaterGEMS Model Layout (Zoomed In)



Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

GEOServices, LLC, Geotechnical and Materials Engineers

Appendix D
Seep Flow at Barrier Wall Memo

Geosyntec consultants

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Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Memorandum

Date: March 2022

To: The Chemours Company, FC, LLC

From: Geosyntec Consultants of NC, P.C.

Subject: **Seep Flow at Barrier Wall – 90 Percent**

Introduction and Objectives

Geosyntec Consultants of NC, PC (Geosyntec) has prepared this updated memorandum for The Chemours Company, FC, LLC (Chemours) to describe the seeps upgradient of the underground barrier wall to be constructed pursuant to paragraph 2 of the Addendum to Consent Order Paragraph 12 (CO Addendum) among Chemours, the North Carolina Department of Environmental Quality (NCDEQ) and Cape Fear River Watch. This assessment describes seep flowrates upgradient of the barrier wall and additional assessment details since the August 2021 version.

Chemours operates the Chemours Fayetteville Works facility in Bladen County, North Carolina (the Site) where there are four onsite groundwater Seeps A, B, C, and D (Figure 1) that originate on the bluff at the Site and discharge into the Cape Fear River. Seep A crosses the barrier wall remedy at two locations named Seep A, and Seep A-Tributary. At Seeps A, B, and A-Tributary, which originate upgradient of the barrier wall remedy, Chemours will capture and treat dry weather base flow. Chemours will also capture and treat rain events up to 0.5 inches (“) in a 24-hour period at these three crossings. The Willis Creek Tributary, which originates upgradient of the groundwater remedy and discharges into Willis Creek will also be captured and sent for treatment. In addition to these seeps, several weep features have been identified, shown in Figure 2. Weeps are defined here as a low flow or ephemeral groundwater expressions at or upgradient of the planned barrier wall alignment with anticipated maximum flowrates of 12 gallons per minute or less. The weeps will capture dry weather baseflow volume and be sent for treatment. Surface flows of Seeps C and D originate wholly down gradient of the proposed barrier wall location and do not cross the barrier wall. Therefore, this assessment presents Seep A, A-Tributary, Seep B, and Willis Creek Tributary flowrates that are present upgradient of the groundwater remedy.

The objectives of this memorandum are:

1. To summarize measurement of the flowrates at Seep A, Seep A-Tributary, Seep B, and Willis Creek Tributary locations that daylight upgradient of the barrier wall alignment under dry weather conditions.
2. To summarize calculations of the stormwater runoff volumes and peak flowrates at Seep A, Seep A-Tributary, and Seep B locations which daylight upgradient of the barrier wall for rain events up to 0.5” over a 24-hour period.
3. Estimate volumes and flowrates from seeps as a design basis for seeps ex situ capture, retention, and conveyance designs.

These objectives are addressed through analysis of historical onsite flume and rainfall data, direct field flow measurements, and stormwater runoff volumes and flowrates calculation estimates. The remainder of this memorandum is organized into the following sections as follows:

- **Seep A and B Flume Data Assessment** – describes data collection methodology and results of the flume data relevant to the assessment of seep flows upgradient of the barrier wall.
- **Seep A Tributary and Willis Creek Tributary Flow Assessment** – describes the data collection methodology and processing workflow for the Seep A-Tributary and Willis Creek Tributary.
- **Weeps Flow Assessment** – describes the location, data collection methodology, and processing workflow for applicable weeps.
- **Stormwater Assessment** – describes the stormwater runoff volumes and peak flowrates from the Seep A, Seep A-Tributary, and Seep B catchment areas during rain events.
- **Summary of Basis of Design** – describes the recommended flowrates and stormwater volumes/flowrates to use as the basis of design for the ex-situ capture systems.

Seep A and B Flume Data Assessment

Chemours has previously installed several flumes at Seeps A and B including locations at the end of each seep, as close as practicable to the Cape Fear River, to estimate Seep flowrates entering the river. Additionally, several other flumes were installed at various tributaries that feed the main seep channels. The detailed locations and analysis of this flume data was presented in the Interim Seep Remediation System Plan (Geosyntec, 2020).

For the purposes of this assessment, only a subset of the flume installations were applicable in estimating the flow at the proposed barrier wall intersection. Figure 2 depicts the locations of flume installation at locations Seep A-4 and Seep B-2. These locations, while downgradient of the planned barrier wall route, are the closest representative flume locations to where the upgradient portions of Seep A and Seep B intersect the barrier wall, respectively. Therefore, these locations are used as a substitute for understanding potential flows at the intersection of the seep channels and the barrier wall.

These locations are interpreted to provide a conservative estimate (i.e., overestimate) of flows at the barrier wall as these two locations are substantially downgradient the barrier wall and therefore encompass larger drainage areas. The location of the flume measurement at Seep A-4 was approximately 500 feet (ft) downgradient of the proposed barrier wall location. A few minor tributaries join the main channel within that 500 ft. Similarly, Seep B-2 flume location was approximately 250 ft down gradient of the barrier wall location. However, there are no tributaries joining the seep channel within that 250 ft stretch, so measurement at Seep B-2 may be more representative than Seep A-4.

Data Collection

Flowrate data were monitored at Seep locations A-4 and B-2 (Figure 2) for the period of August 2019 to November 2020 and September 2019 to October 2020, respectively. The flowrates were measured by converting the depth of water in the flume using a formula based on the instrument geometry. The Extra-large 60° trapezoidal flume was used at Seep B-2 and a Large 60° trapezoidal flume was used at Seep A-4. These were installed using a pond liner in front of and below the flume to mitigate the potential for underflow and using plywood panels and sandbags at the sides to channel the seep flow and mitigate the potential for flow around the flumes. Level loggers (Solinst 3001 LT F30/M10) were installed to measure the water elevations in the flumes, these data were then barometrically corrected and used in flowrate estimates. Periodically, the flumes were inspected and maintained, particularly when field teams observed occurrences of bypass around the flumes or other obstructions near the measurement location.

Precipitation data and weather conditions for the monitored periods were assessed using the onsite meteorological station and supplementing that data with the existing USGS weather monitoring station at the W.O. Huske Dam (gage 02105500) when there were data gaps.

Flume Uncertainties

Uncertainties in the observed data may be present when using flumes to measure flowrates in channels for several reasons. Some of these potential reasons include:

- Missed flows:
    - Bypass of the flume due to leakage under the flume or new flow channels routing water around the flume.

- Inaccurate water depth estimates based on pressure:
    - Incorrect pressure measurement due to placement of pressure sensor.
    - Sediment buildup at the flume base that moves the elevation of zero water depth.
- Flowrate outside of flume accuracy ranges estimates due to flume sizing:
    - Flow can periodically be outside of the accuracy range of the flume resulting in too high or low ranges in pressure/depths.
- Inaccurate flowrate estimates due to compatibility limitations of the hydraulic assumptions behind the flume equations with field conditions:
    - Flow turbulence upstream of flume installation, inadequate length of straight channel or variable cross section size of channel prior to flume installation.
    - Obstructions (e.g., by branches, leaves, rocks) that alter the assumed cross-sectional area of flow (or that could affect the pressure measurement).

Maintenance events were completed approximately once every month. After maintenance events flumes were operating as per desired conditions (limited to no obstructions, no sediment accumulation, flow directed into flume, and liner to minimize underflow). As time extended past maintenance events, the potential for factors causing bias likely increases. A standard practice to reduce flume uncertainty is perform frequent maintenance.

Seep Flow Rate Assessment Methodology

Flume data underwent organization and preparation to represent flow readings on 30-minute intervals. Interval lengths were kept constant across the analysis for each flume to reduce potential bias when calculating statistics. The flowrate data were then paired with the corresponding precipitation data for that date and time. Precipitation data were taken from the onsite meteorological station and supplemented with precipitation data from the United States Geological Survey (USGS) monitoring station at the W.O. Huske Dam if there were no onsite precipitation data available.

Certain data points were excluded from the data set for each flume. Data were excluded when: (a) the flume was not operational, (b) the flume was inundated by elevated Cape Fear River water levels, (c) the flume data exhibited a low bias, and (d) the measured flow was above the upper limit or below the bottom limit of the flume's measurement range.

Categories based on precipitation were established to analyze the data under different weather conditions. The data were then assessed statistically and graphed based on the categories established. These categories included:

- Total data – All data except excluded data.
- Dry weather (i.e., No Rain) – Data that has a period of 24 hours prior to measurement with no precipitation measured.
- Rain ≤ 0.5” – Period of 24 hours with 0.5” or less of measured precipitation.
- Rain > 0.5”– Period of 24 hours with greater than 0.5” of measured precipitation.

Flume Flowrate Assessment Results

The data for Seep A-4 are shown Figure 3 and the data for Seep B-2 are shown in Figure 4. These time series (Figures 3 and 4) include an indication of the upper and lower flowrates that the flume can accurately measure. Data outside of these limits were excluded during the data preparation process prior to the statistical assessment. However, understanding where the data exceeds or falls below these limits may still be helpful with interpretation of the data, so the excluded data was plotted on Figure 3 and Figure 4 as grey data points to aide in visual interpretation of flume flow trends.

A table summarizing the numerical assessment of the flume flowrates at flume locations Seep A-4 and Seep B-2 is presented in Table 1 below.

Table 1: Seep A-4 and Seep B-2 Flow Rate Summary

Seep A-4				
Weather Conditions	**Number of days**	**25th percentile (gpm)**	**Median Flow (gpm)**	**95th percentile (gpm)**
Total	273	14	18	34
Dry Weather	179	14	18	31
Rain ≤ 0.5”	64	14	19	36
Rain > 0.5”	30	16	23	83
Seep B-2				
Weather Conditions	**Number of days**	**25th percentile (gpm)**	**Median Flow (gpm)**	**95th percentile (gpm)**
Total	276	68	83	170
Dry Weather	184	65	77	130
Rain ≤ 0.5”	64	74	92	160
Rain > 0.5”	28	95	130	340

To estimate the baseline flowrates at Seep A-4 and Seep B-2, the "Dry Weather" data in Table 1 should be considered. Seep A-4 had a median flowrate was 18 gpm and a 95th percentile flow of 31 gpm while Seep B-2 had a median flowrate of 77 gpm and a 95th percentile flow of 130 gpm, during 24-hour periods of no measured rainfall.

The dry weather flowrates at Seep A-4 had a measured 95th percentile flow rate of 31 gpm and storms up to 0.5" increased the measured 95th percentile flow to 36 gpm (16% increase), while dry weather flowrates at Seep B-2 had a 95th percentile of 130 gpm and storms up to 0.5" increased the measured 95th percentile flowrate to 160 gpm (23% increase). Rainfall will increase total seep runoff volumes as well as flowrates due to overland flow.

The CO Addendum requires the capture and treatment of total dry weather flow plus rain events up to 0.5" in a 24-hours period. Figure 5 and Figure 6 show the time series of dry weather data in addition to data for rain event up to and equal to 0.5" of rain in a rolling 24-hour period for Seep A-4 and Seep B-2, respectively. These figures show the representation of the flowrates from the observation period that need to be captured and treated upgradient of the barrier wall.

Seep A Tributary and Willis Creek Tributary Flow Assessment

Following the August 2021 memorandum, flowrates were directly measured at Seep A-Tributary and Willis Creek Tributary in September 2021. Individual flowrates were collected using a velocity meter and a timed volume accumulation estimate at each location. The Marsh McBirney flowmate velocity meter was used in relatively straight sections of each stream. Field personnel recorded stream dimensions and measured stream velocity at multiple positions to calculate an estimate for volumetric flowrates as described in the Seeps and Creeks Investigation Report (Geosyntec, 2019). At each tributary flowrates were also estimated using a 5-gallon bucket and a stopwatch. Field personnel used the bucket and stopwatch to record the duration of time required to accumulate a known volume of water. For each tributary, results from both methods were averaged together. Average flowrates of field measurements are shown in Table 2 as dry season flowrates.

Typically, the winter season is characterized by a higher frequency of rainfall and higher seep flow rates. Flow gauging in September 2021 occurred during a seasonally low flowrate regime typical of the summer season. As such, Table 2 also presents an estimate for the anticipated winter season flow for each seep tributary. To provide an estimate for a higher flowrate regime a "winter season scale-up factor" was developed using historic flume flowrate data at Seep A. Since no long-term flowrate monitoring has been conducted specifically at either tributary, the scale up factor developed for Seep A is applied to both Willis Creek Tributary and Seep A-Tributary summer flow measurements.

To scale up measured summer season flows, first the most recent summer season and winter season periods were identified using flume and rain gauge data at Seep A. Then, for the summer season time-period a daily median flowrate was calculated. For the winter season period, the daily 95th percentile flowrate was calculated. The daily median flowrate measured during the summer season period between September 24, 2019 and October 20, 2019 was 99 gpm. The 95th percentile flow during the most recent winter season period from March 13-26, 2020 was 230 gpm. The median summer season flow and 95th percentile winter season flow values were compared to provide a conservative estimate of the winter season flowrate increases at Seep A-Tributary and Willis Creek Tributary. The backup data for the winter season scaling factor process is included in Attachment A.

Table 2: Seep A-Tributary and Willis Creek Tributary Flow Rate Summary

Seep	Measured Summer Season Flow Rate (gpm)	Winter Season Scale-up Factor Median to 95th Percentile	Estimated Winter Season Flow Rate (gpm)
Willis Creek Tributary	16.8	133%	39
Seep A-Tributary	8.2	133%	19

Weeps Flow Assessment

Since the August 2021 memo, three weeps along the barrier wall alignment were observed as current sources of low flow groundwater seepage. Two of these features were identified by Geosyntec personnel in September 2021, with the additional weep identified by onsite personnel in November 2021. Measured weep locations are shown in Figure 2. The weep features are labeled in Figure 2 according to the chainage of the groundwater remedy. Additional weeps may also potentially occur during the higher rainfall winter period or as a result of barrier wall construction.

Between September and November 2021, the three weeps with observable flow were gauged to estimate their flowrates. Flowrates were measured using a 5-gallon bucket with a stopwatch. Field personnel used the stopwatch to record the duration for the bucket to capture a known volume of water. A minimum of three distinct measurements were conducted to ensure consistency. The average of these measurements for each weep are presented in Table 3. Weep flows during the summer period were measured up to 5.2 gpm. Two weeps are within the Seep A drainage basin and the other is in the Seep C drainage basin. The winter season scale up factor calculated for Seep A and C was applied to these weeps. Scaled flowrates suggest winter seasons flows up to 12 gpm. The backup data for the winter season scaling factor process is included in Attachment A.

Table 3: Weeps Flow Rate Summary

Weep Chainage	Measured Summer Season Flow Rate (gpm)	Winter Season Scale-up Factor Median to 95th Percentile	Estimated Winter Season Flow Rate (gpm)
Weep 39+50	1.1	133%	3
Weep 41+00	5.2	133%	12
Weep 22+00	3.0	241%	10

Stormwater Assessment

The seeps ex situ capture systems at Seeps A, A-Tributary, and Seep B must capture seeps flow during rainfall events up to 0.5” in depth over 24-hours. As stormwater flows are variable in nature and can occur at relatively high intensities the seeps ex situ capture systems are expected to utilize equalization storage to control flows to a groundwater treatment plant (GWTP) to not overwhelm plant capacity. Consequently, stormwater runoff volumes were assessed, for the Seep A, Seep A-Tributary, and Seep B drainage areas upgradient of the barrier wall. Stormwater is defined as wet weather-driven flows that exclude baseflows (such as groundwater exfiltration or seeps).

Sizing a stormwater control measure involves calculating the volume and/or flowrate of runoff resulting from the specified design storm, or the hypothetical discrete rainstorm. Guidance from the NCDEQ Stormwater Design Manual (Manual) was followed to perform static calculations for the CO Addendum specified design storm of 0.5” in 24-hours, and these calculations are outlined in the following subsections.

Drainage Area Characteristics

The static calculations include details of the drainage areas to the seep capture points for Seep A, Seep A-Tributary, and Seep B. The drainage areas were delineated using a digital elevation model and the proposed seep capture points as shown in Figure 7. The runoff coefficient for each drainage area was evaluated using aerial imagery. The drainage areas were divided into the following classifications: asphalt/concrete; building/rooftop; gravel/river rock; unimproved; wooded areas; and lawns, sandy soil, flat. **Error! Reference source not found.** shows the characterization of the drainage areas by land cover.

Runoff coefficients (C) were assumed based on land cover classification. The values used for each land cover classification were based on guidance from the Manual (Part B, Stormwater Calculations, Table 1). The gravel/river rock land cover classification was not included in the Manual; assumed values for this land cover classification are consistent with those used at other sites. These values are shown in Table 4. The land cover-based runoff coefficients were areaweighted for each drainage area. The resulting runoff coefficients were 0.27, 0.15, and 0.17 for the Seep A, Seep-A tributary, and Seep B drainage areas, respectively.

Table 4: Land Cover of Seep Drainage Areas

Land Cover	**Runoff Coefficient (C)**	**Drainage Area (acre)**		
		Seep A	**A-Tributary**	**Seep B**
Asphalt/concrete	0.95	2.4	0	0
Building/rooftop	0.9	0.56	0	0.10
Gravel/river rock	0.77	1.9	0	0.46
Unimproved	0.35	1.9	0	0
Wooded area	0.15	15	12.7	19
Lawns, sandy soil, flat	0.15	8.1	0	0.36
Total Area		**29.4**	**12.7**	**19.9**

Calculations

Static Calculation of Stormwater Runoff Volume

Stormwater runoff volumes from the Seep A, Seep A-Tributary, and Seep B drainage areas upgradient of the barrier wall were assessed for storm events with 0.5” of rainfall. Stormwater runoff volumes based on total rainfall depth were calculated using the Simple Method for Runoff Volume based on guidance from the Manual (Part B, Stormwater Calculations, Simple Method for Runoff Volume). This method first determines the runoff coefficient, which reflects the runoff potential, using the impervious fraction of the drainage area (discussed in the “Drainage Area Characteristics” subsection), as shown in Equation 1.

Equation 1: Runoff Coefficient

$$\boldsymbol{R_v = 0.05 + 0.9\ x\ I_A}$$

where,
R_v is the runoff coefficient (unitless); and
I_A is the impervious fraction (unitless).

$$R_v\ (Seep\ A) = 0.05 + 0.9\ x\ 0.24 = 0.27$$

$$R_v\ (A - Trib) = 0.05 + 0.9\ x\ 0.11 = 0.15$$

$$R_v\ (Seep\ B) = 0.05 + 0.9\ x\ 0.13 = 0.17$$

The stormwater runoff volumes were then calculated using Equation 2. At Seep A, Seep A-Tributary, and Seep B, the stormwater runoff volumes were calculated for a storm depth of 0.50" as specified in the CO Addendum. Table 5 shows the calculated stormwater runoff volumes for the Seep A, Seep A-Tributary, and B drainage areas for the designated design storm depth of 0.5", based on guidance from the Manual.

Equation 2: Design Volume

$$\boldsymbol{DV = 3630\ x\ R_D\ x\ R_V\ x\ A}$$

where,
DV is the design volume (cubic feet);
R_D is the design storm depth (inches);
R_v is the runoff coefficient (unitless); and
A is the drainage area (acres).

Table 5: Stormwater Runoff Volumes for Seep A, Seep A-Tributary and Seep B based on the Simple Method from the Manual

Seep	Design Storm Depth (in)	Stormwater Runoff Volume (cubic feet)	Stormwater Runoff Volume (gallons)
A	0.5	14,000	110,000
A-Tributary	0.5	3,400	26,000
B	0.5	6,200	46,000

Static Calculation of Stormwater Peak Flowrates

Storm events that meet the design storm criteria (0.5" or less in 24 hours) can vary considerably in rainfall intensity and duration. Some rain events may result in 0.5" or less of total rainfall in 24 hours but have very high intensity rainfall (over short durations), and these rain events will result in very high peak runoff flowrates.

Based on guidance from the Manual, stormwater peak flowrates may be assessed using the Rational Method (Part B, Stormwater Calculations, Rational Method for Runoff Volume). This method approximates the peak flow using the composite runoff coefficient, rainfall intensity, and drainage area, as shown in Equation 3. The Rational Method is most applicable to small drainage areas (the Manual notes 20 acres or less).

Equation 3: Rational Method for Peak Flow

$$Q_P = C \times i \times A$$

where,

Q_P is the peak flow for the storm of interest (cubic feet per second [cfs]);
C is the composite runoff coefficient (unitless);
i is the rainfall intensity for the storm of interest (inches per hour); and
A is the drainage area (acres).

The CO Addendum specifies a design storm depth of 0.5" in a 24-hour period. However, an hourly design rainfall intensity (typically 1-hour duration) is not specified (a design storm intensity is also not specified in the Manual). Therefore, the design storm intensities used in the Rational Method calculations, to determine the design peak stormwater runoff flowrate, were based on the National Resources Conservation Service (NRCS) (Soil Conservation Service [SCS]) design rainfall distribution (for a 24-hr storm event, type II) shown in Diagram 1 (NRCS, 1986). Diagram 2 illustrates how the Type II designation was selected, based on the Site location.

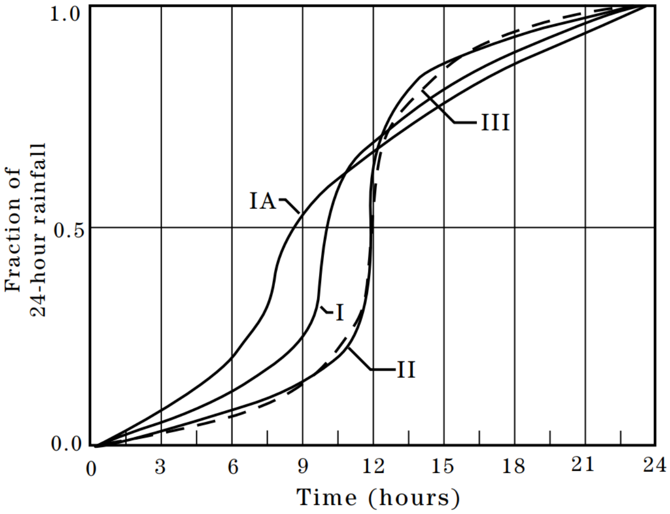

Diagram 1. NRCS (SCS) Rainfall Distribution Curve

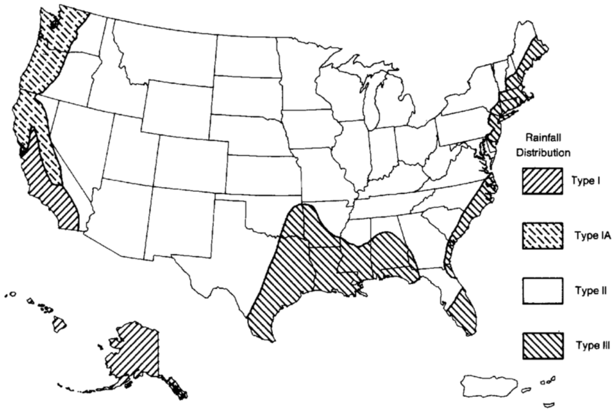

Diagram 2. Determination of Appropriate Type of Rainfall Distribution

The maximum, instantaneous rainfall intensity, based on the design rainfall depth of 0.5” in 24 hours and the NRCS (SCS) rainfall distribution, was 0.69” per hour (in/hr). Based on the NRCS (SCS) rainfall distribution, this instantaneous peak rainfall intensity is expected to occur for only a very short duration (i.e., approximately six minutes). The time of concentrations of the drainage areas, which is the time for rainfall to flow as runoff from the most remote point of the drainage area to the drainage area outlet, are greater than six minutes. Therefore, the peak instantaneous rainfall intensity will not occur over a long enough duration to generate a stormwater runoff response, based on that peak instantaneous rainfall intensity, from the entire drainage areas.

The peak stormwater runoff rates were also evaluated, using the Rational Method, based on the peak rainfall intensities from the NRCS (SCS) rainfall distribution averaged over durations of 0.5 and one hour. These rainfall intensities reflect intensities that are expected to occur for longer durations than the instantaneous peak intensity (i.e., 0.5 and one hour) and were determined based on averaging the NRCS (SCS) rainfall distribution rainfall intensities for 0.5- and one-hour durations. The peak of these 0.5-and one-hour duration intensities were then used in the Rational Method.

The stormwater peak flowrates for the design storm, as described above, for Seep A, Seep A-Tributary, and Seep B are shown in Table 6. Stormwater peak flowrates represent a design peak flowrate, based on the peak rainfall intensity from the NRCS (SCS) rainfall distribution for the design storm of 0.5” in 24 hours designated by the CO Addendum. It is possible that greater rainfall intensities may occur (and still be smaller than the CO Addendum design storm of 0.5” in 24 hours), which would result in larger stormwater peak flowrates.

Table 6: Stormwater Runoff Peak Flowrates for the 0.5", 24-hour design storm, based on the NRCS (SCS) Rainfall Distribution and the Rational Method from the Manual

Seep	Design Storm Intensity Duration (hr)	Design Storm Intensity (in/hr)	Peak Stormwater Runoff Flowrate (cfs)	Peak Stormwater Runoff Flowrate (gpm)
A	Instantaneous[1]	0.69	5.4	2,400
	0.5	0.33	2.6	1,200
	1[2]	0.21	1.7	750
A-Trib	Instantaneous[1]	0.69	1.3	580
	0.5[3]	0.33	0.63	280
	1[4]	0.21	0.40	180
B	Instantaneous[1]	0.69	2.3	1,000
	0.5[5]	0.33	1.1	510
	1[4]	0.21	0.72	320

[1] Rainfall intensity duration is approximately 6 minutes due to the data for the 24-hr NRCS (SCS) rainfall distribution being presented in 6-minute time intervals.

[2] The time of concentration for the Seep A drainage area was estimated to be approximately 1.4 hours. Therefore, this rainfall intensity approximately represents the largest rainfall intensity (based on the NRCS [SCS] rainfall distribution) that would result in a stormwater runoff response for the entire drainage area that is representative of the specified rainfall intensity.

[3] The time of concentration for the Seep A tributary drainage area was estimated to be approximately 0.5 hours. Therefore, this rainfall intensity represents the largest rainfall intensity (based on the NRCS [SCS] rainfall distribution) that would result in a stormwater runoff response for the entire drainage area that is representative of the specified rainfall intensity.

[4] One-hour design storms included because design rainfall intensities are typically presented as an intensity over a one-hour duration.

[5] The time of concentration for the Seep B drainage area was estimated to be approximately 0.4 hours. Therefore, this rainfall intensity approximately represents the largest rainfall intensity (based on the NRCS [SCS] rainfall distribution) that would result in a stormwater runoff response for the entire drainage area that is representative of the specified rainfall intensity.

Summary of Basis of Design

This section presents the recommended basis of design flowrates and stormwater volumes for the seeps ex situ capture systems. First, the recommended seeps baseflow are described, then the stormwater volumes for 0.5" or less rainfall events.

Dry weather flows were measured using flumes in Seeps A and B down gradient of the planned barrier wall location. The 95th percentile dry weather flows from both seep flumes are recommended to be used as the basis of design for dry weather flow capture. For Seep A this dry weather flowrate is 31 gpm and for Seep B 130 gpm. Dry weather flows for Seep A-Tributary and Willis Creek Tributary were measured using summer season field measurements and then scaled up to the 95th percentile winter season baseflows. For Seep A-Tributary this dry weather flowrate is 19 gpm, and for Willis Creek Tributary 39 gpm. The total estimated dry weather flow is then 219 gpm.

Stormwater runoff volumes for a 0.5” design storm were calculated using the Simple Method for Runoff Volume. For 0.5” rainstorms during a 24-hour period, Seep A was estimated to receive up to 110,000 gallons of stormwater flow, Seep A-Tributary receive up to 26,000 gallons, and Seep B receive up to 46,000 gallons of stormwater flow for a total volume of 182,000 gallons. The ex-situ seeps capture system will include equalization storage. Assuming the ability to store and equally meter out the entire 24-hr, 0.5” rain event flow volume to the GWTP over a 24-hour period yields estimated flowrates of 76 gpm for Seep A, 18 gpm for Seep A-Tributary, and 32 gpm for Seep B for a total of 126 gpm. This calculation is shown below in Table 7.

Table 7: Storm Flows Basis - Simple Method

Seep A		
Seep A - 0.5" Rain Volume	110,000	gal
0.5" Rain Volume over 24-hrs	76	gpm
Seep A-Tributary		
Seep A - 0.5" Rain Volume	26,000	gal
0.5" Rain Volume over 24-hrs	18	gpm
Seep B		
Seep B - 0.5" Rain Volume	46,000	gal
0.5" Rain Volume over 24-hrs	32	gpm
Combined		
Combined Volume - 0.5" Rain	182,000	gal
0.5" Rain Volume over 24-hrs	126	gpm

Taken together the dry weather and the stormflows for rainfall events up to 0.5” over 24-hrs comprise a total design flowrate of 345 gpm (Table 8), which will be directed to the GWTP. Additionally, the calculated peak instantaneous stormwater runoff flowrate provides an estimate for the design flowrate that will be directed to the equalization storage infrastructure.

Table 8: Design Flowrates and Volumes

Flow Source	Peak Instantaneous Stormwater Runoff Flowrate (gpm)	Flowrate to GWTP (gpm)	Stormwater Volume During 0.5” Storm (gallons)
Seep A Rainfall	2,400	76	110,000
Seep A-Tributary Rainfall	580	18	26,000
Seep B Rainfall	1,000	32	46,000
Subtotal		*126*	*182,000*

Flow Source	**Peak Instantaneous Stormwater Runoff Flowrate (gpm)**	**Flowrate to GWTP (gpm)**	**Stormwater Volume During 0.5" Storm (gallons)**
Seeps A Baseflow		31	-
Seep A-Tributary Baseflow		19	-
Seeps B Baseflow		130	-
Willis Creek Tributary Baseflow		39	-
Subtotal		*219*	-
Total		**345**	**182,000**

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Geosyntec 2020, Interim Seep Remediation System Plan, Prepared for The Chemours Company FC, LLC.

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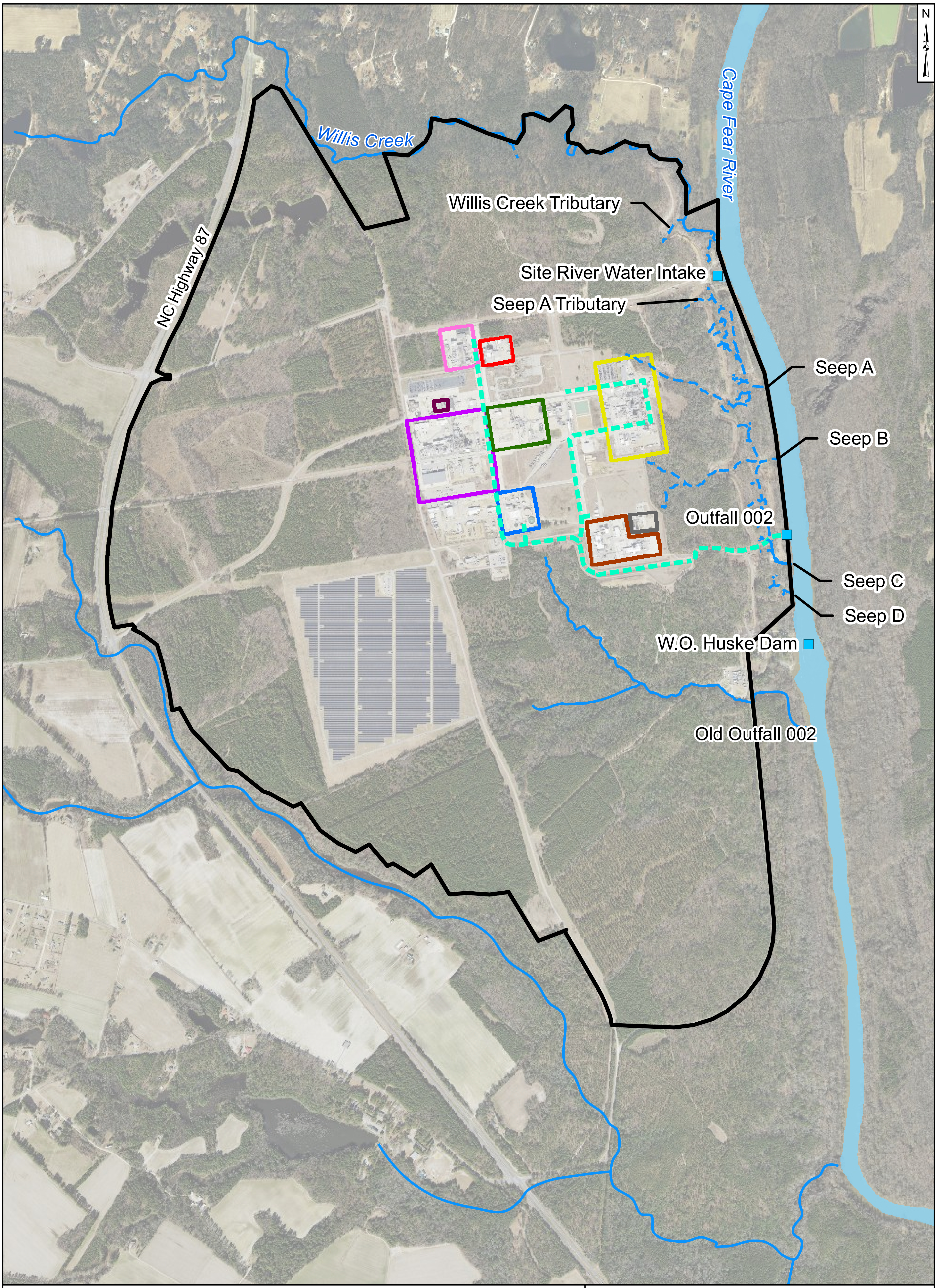
Figures



Legend

- 🟦 Site Features
- ━ Site Boundary
- ─ Nearby Tributary
- ‒ ‒ Observed Seep (Natural Drainage)
- ▬ ▬ Site Conveyance Network

Areas at Site

- ☐ Chemours Monomers IXM
- ☐ Chemours Polymer Processing Aid Area
- ☐ DuPont Polyvinyl Fluoride Leased Area
- ☐ Former DuPont PMDF Area
- ☐ Kuraray SentryGlas® Leased Area
- ☐ Kuraray Trosifol® Leased Area
- ☐ Wastewater Treatment Plant
- ☐ Power - Filtered and Demineralized Water Production
- ☐ Kuraray Laboratory

Notes:
1. The outline of Cape Fear River is approximate and is based on open data from ArcGIS Online and North Carolina Department of Environmental Quality Online GIS (MajorHydro shapefile).
2. Basemap source: NC OneMap (2019). North Carolina Department of Information Technology, Government Data Analytics Center, Center for Geographic Information and Analysis. Available at https://www.nconemap.gov.

1,000 500 0 1,000 Feet

Site Location Map

Chemours Fayetteville Works, North Carolina

Geosyntec
consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

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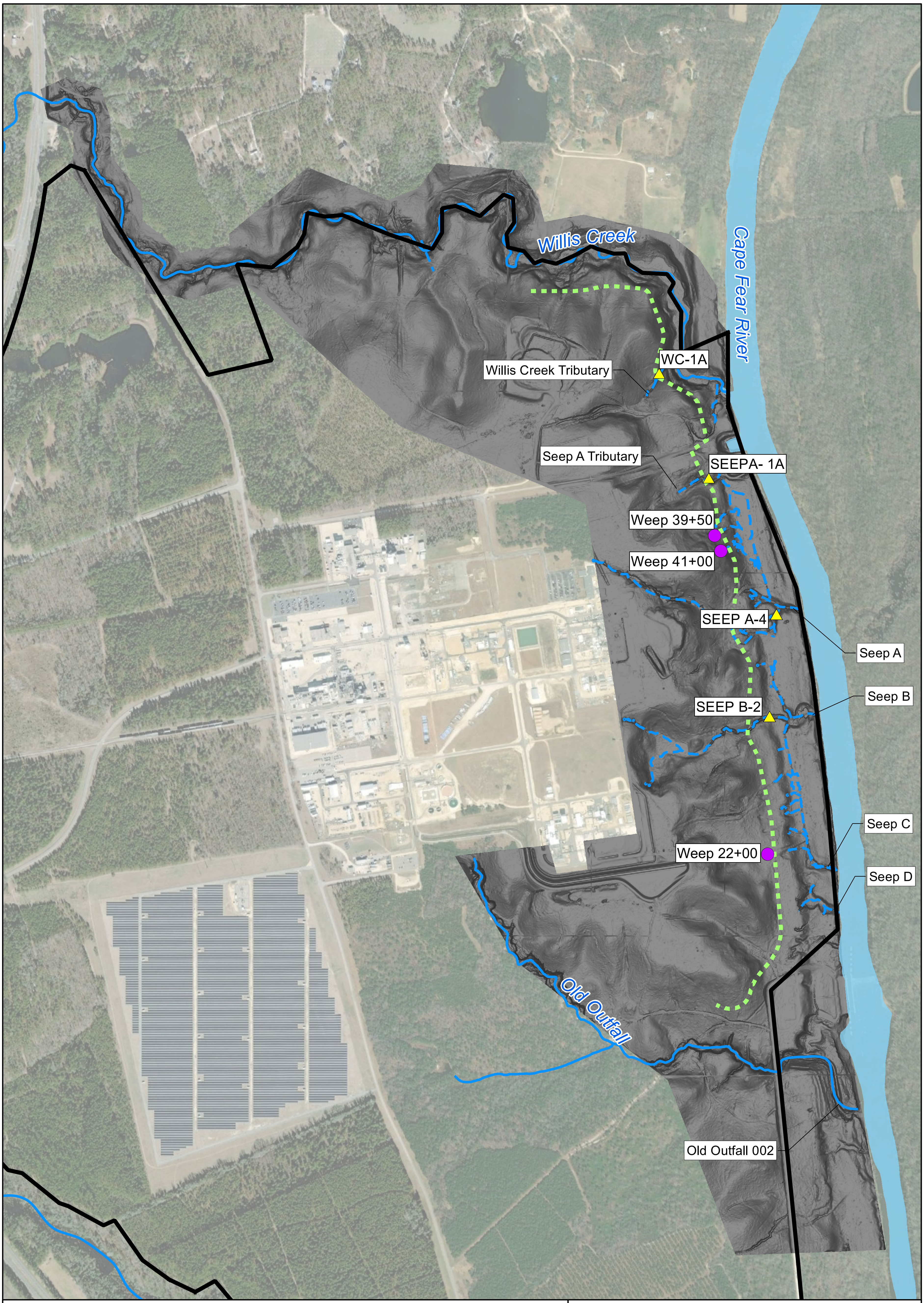
Figure
1



Legend

▲ Flow Measurement Location

● Anticipated Weep Location

Planned Groundwater Remedy Route

Site Boundary

Observed Seep

Nearby Tributary

Notes:

1. Topographic surface was generated using LiDAR scans performed on December 1, 2019 and December 19, 2019 by Spectral Data Consultants, Inc.
2. Seep locations identified visually as reported in Geosyntec, 2019. Seeps and Creeks Investigation Report. Chemours Fayetteville Works. 26 August 2019.
3. The outline of Cape Fear River is approximate and is based on open data from ArcGIS Online and North Carolina Department of Environmental Quality Online
4. Basemap source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

1,000 500 0 1,000 Feet

Seeps and Weeps Along Groundwater Remedy Route

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

Figure 2

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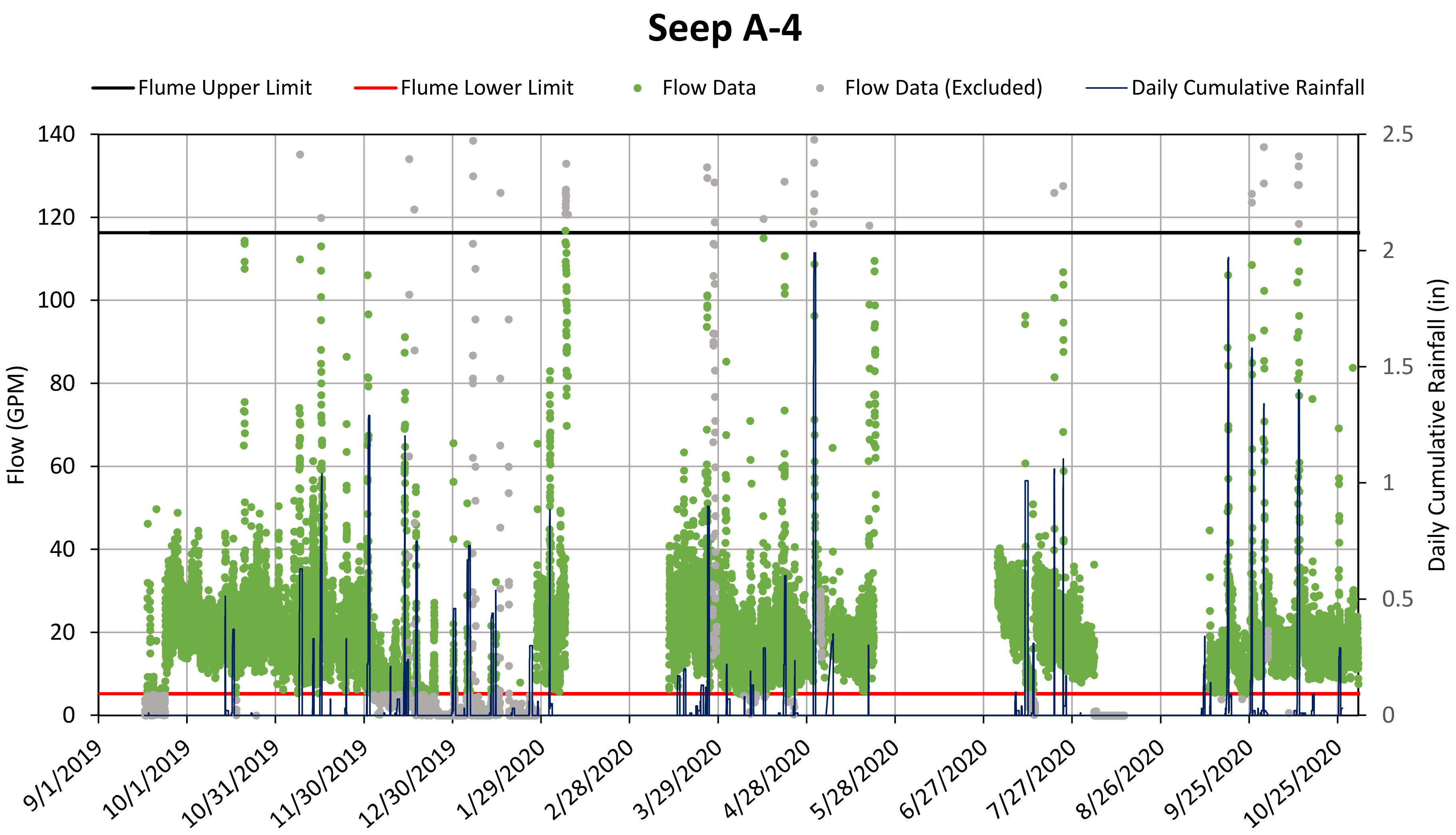


Notes:

1. Time spans without data are associated with periods when the flume was not operational.
2. Daily cumulative rainfall is the cumulative rainfall in one calendar day.
3. Excluded flow data was determined from river inundation and data outside of the flume limits.

Abbreviations:

gpm - gallon per minute
in - inch

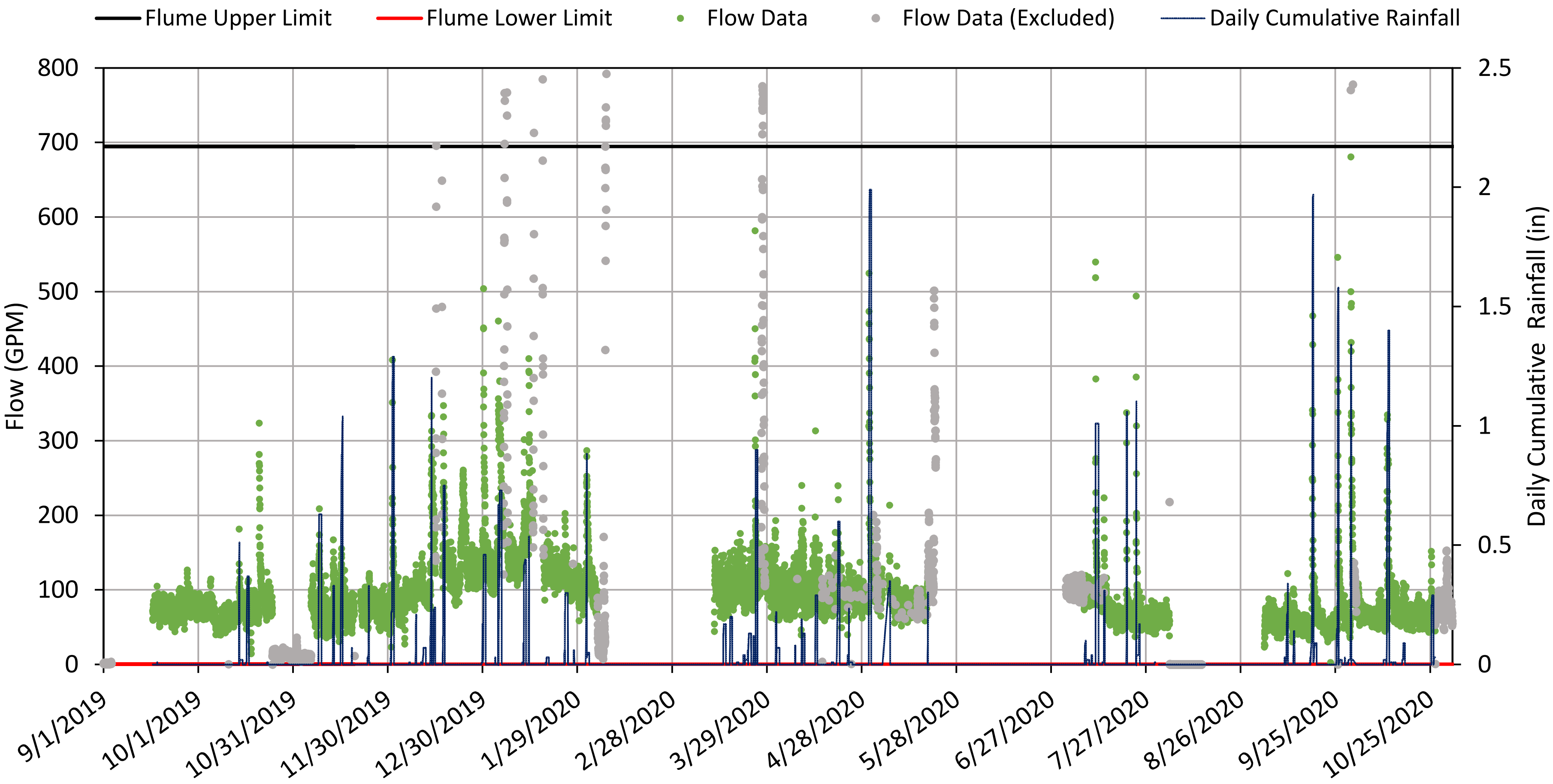
Seep A-4 Time Trends
Chemours Fayetteville Works, North Carolina

Geosyntec consultants
Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Figure 3

Raleigh | March 2022

Seep B-2



Notes:
1. Time spans without data are associated with periods when the flume was not operational.
2. Daily cumulative rainfall is the cummulative rainfall in one calendar day.
3. Excluded flow data was determined from river inundation and data outside of the flume limits.

Abbreviations:
gpm - gallon per minute
in - inch

Seep B-2 Time Trends
Chemours Fayetteville Works, North Carolina

Geosyntec consultants

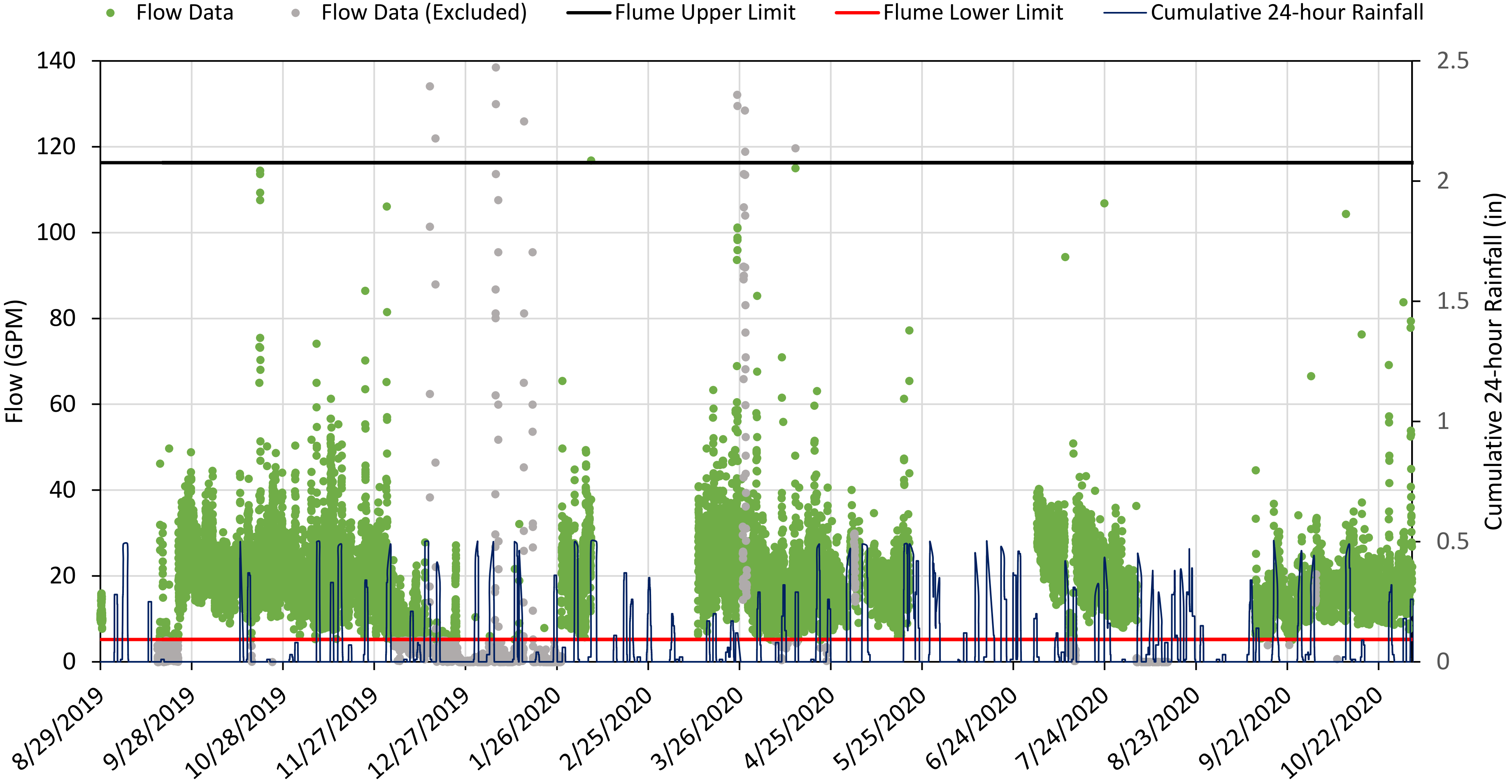
Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Figure 4

Raleigh

March 2022

Seep A-4



Notes:

1. Time spans without data are associated with periods when the flume was not operational.
2. Cumulative 24-hour rainfall is the cumulative rainfall over a rolling 24 hour period.
3. Excluded flow data was determined from river inundation and data outside of the flume limits.

Abbreviations:

gpm - gallon per minute
in - inch

Seep A-4 Time Trends
Cumulative 24-hour rainfall up to 0.5 inches
Chemours Fayetteville Works, North Carolina

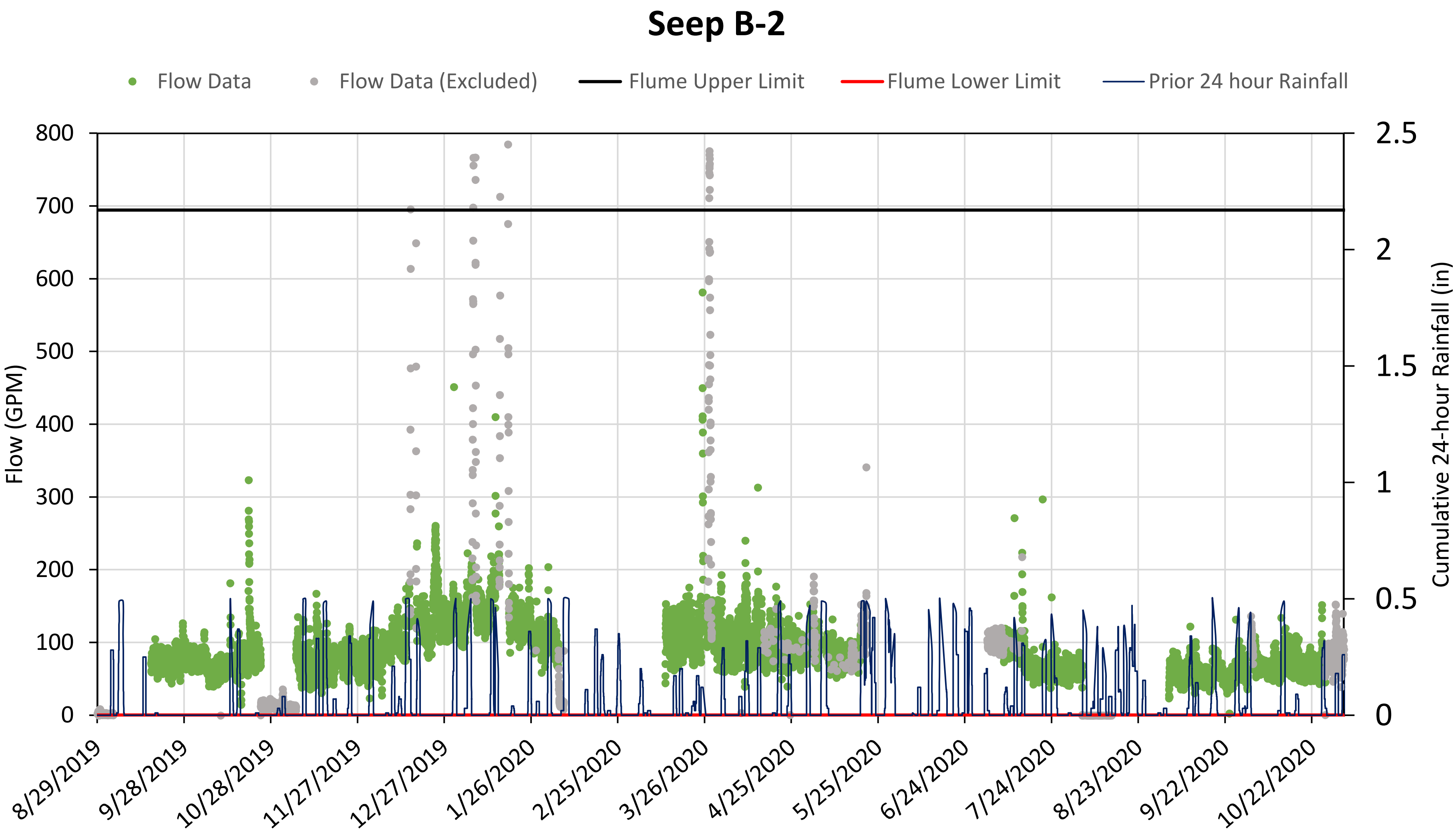
Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Raleigh

March 2022

Figure 5



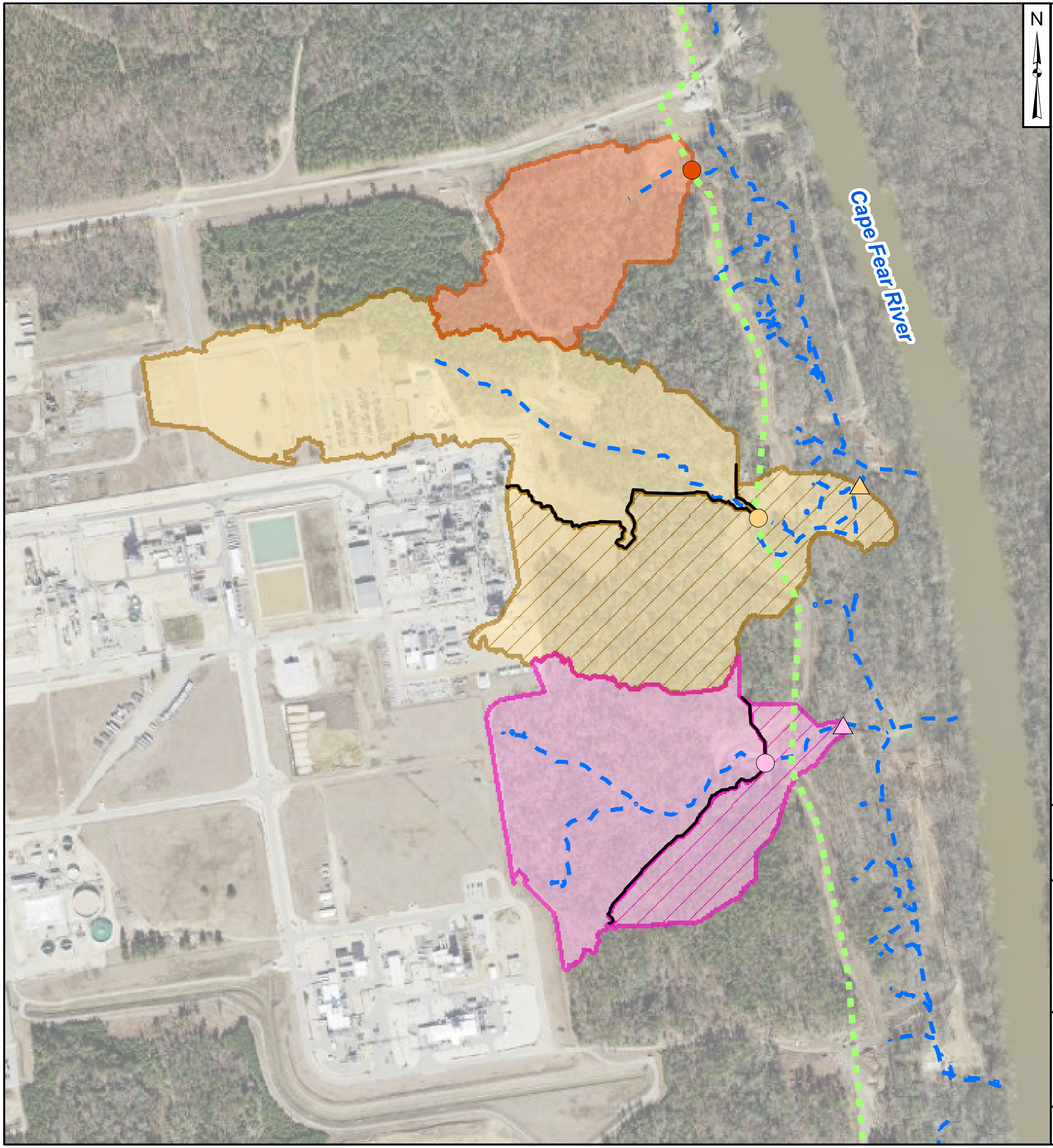
Notes:

1. Time spans without data are associated with periods when the flume was not operational.
2. Cumulative 24-hour rainfall is the cumulative rainfall over a rolling 24 hour period.
3. Excluded flow data was determined from river inundation and data outside of the flume limits.

Abbreviations:

gpm - gallon per minute
in - inch

Seep B-2 Time Trends **Cumulative 24-hour rainfall up to 0.5 inches** Chemours Fayetteville Works, North Carolina		
Geosyntec consultants Geosyntec Consultants of NC, P.C. NC License No.: C-3500 and C-295		Figure 6
Raleigh	March 2022	



Legend

- ● Seep A Tributary Capture
- ● Seep A Upstream Capture Point
- ● Seep B Upstream Capture Point
- △ SEEP A-4 Flume
- △ SEEP B-2 Flume Location
- ▪▪▪ Planned Groundwater Remedy Route
- ╌ Seep

Estimated Watershed

- ■ Seep A - Modeled Catchment
- ■ Seep B - Modeled Catchment
- ■ Seep A Tributary - Modeled Catchment
- ▨ Seep A - Additional Catchment Measured by Flume
- ▨ Seep B - Additional Catchment Measured by Flume

Notes:

1. Seep catchment areas were estimated using geospatial methods and tools, and based on lidar data collected for Chemours.
2. Seep locations identified visually as reported in Geosyntec, 2019. Seeps and Creeks Investigation Report. Chemours Fayetteville Works. 26 August 2019.
3. Basemap source: NC OneMap (2019). North Carolina Department of Information Technology, Government Data Analytics Center, Center for Geographic Information and Analysis. Available at https://www.nconemap.gov.

500 250 0 500 Feet

Seep Drainage Areas

Chemours Fayetteville Works, North Carolina

Geosyntec
consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

Raleigh

March 2022

Figure

7

Attachments

Attachment A - Seep A Wet Weather Scale Up Calculation Basis

Seep A Time Periods		
Category	**Date**	**Days Spanned**
Summer Season Time Period Start	24-Sep-19	26
Summer Season Time Period End	20-Oct-19	
Winter Season Time Period Start	13-Mar-20	13
Winter Season Time Period End	26-Mar-20	

Seep C Time Periods		
Category	**Date**	**Days Spanned**
Summer Season Time Period Start	3-Oct-19	16
Summer Season Time Period End	19-Oct-19	
Winter Season Time Period Start	13-Mar-20	13
Winter Season Time Period End	26-Mar-20	

Daily Flowrate Data Statistics			
Drainage Area	**Median Summer Season Flow (gpm)**	**95th Percentile Winter Season Flow (gpm)[2]**	**Increase Factor from Median Summer to 95th Percentile Winter Season Flow[3]**
Seep A	99	230	133%
Seep C	25	84	241%

Notes:
1. gpm indicates gallons per minute
2. Winter season statistics were calculated for days in which no precipitation fell in the preceding 24 hours not during that day.
3. To conservatively scale up flows the scale up factor was developed using the median summer and 95th percentile winter flows.

Geosyntec Consultants of NC, P.C.
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GEOServices, LLC, Geotechnical and Materials Engineers

Appendix E
Ex-Situ Capture Design Report

BARRIER WALL AND GROUNDWATER EXTRACTION AND TREATMENT SYSTEM:

EX-SITU CAPTURE REMEDY

90% DESIGN SUBMITTAL

Chemours Fayetteville Works

Prepared for

The Chemours Company FC, LLC
22828 NC Highway 87
Fayetteville, NC 28306

Prepared by

GEOServices, LLC
5559 North Lee Highway
Cleveland, TN 37312

March 2022

TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENTS

1 INTRODUCTION AND OBJECTIVES

The site for the proposed Barrier Wall and Groundwater Extraction System project is located at the existing Chemours Fayetteville Works facility located at 22828 NC Highway 87 in Fayetteville, North Carolina.

At the Chemours Fayetteville Works facility there are four on-site Seeps (A through D) with identified discharges into the nearby Cape Fear River. The seeps are currently being collected in in-situ flow-through cells to reduce loadings from the seeps to the Cape Fear River pursuant to Consent Order Paragraph 12 Addendum (COA) paragraph 2(a). Under COA paragraph 2(c)i, the Long-Term Seep Remediation Objective is to reduce the total annual mass loading of PFAS (as measured by indicator parameters) to the Cape Fear River from Seeps A through D by: (i) during dry weather flow, reducing total mass by at least 99%; (ii) during dry weather flow and following rain events of 0.5 inches or less, reduce total mass loading by at least 95%; and (iii) for any seep that daylights upgradient of the Barrier Wall, capture total dry weather flow plus rain events up to 0.5 inches in a 24-hour period upgradient of the Barrier Wall and treat PFAS (as measured by indicator parameters) with a removal efficiency of at least 99%.

The purpose of this document is to outline the conceptual design methods for the collection of dry weather and 0.5-inch or less rain event flows from Seep A (including a Seep A tributary) and Seep B that daylight upgradient of the Barrier Wall (Seeps C and D headwaters are below the barrier wall). The document also describes transportation of the collected water to the on-site water treatment plant. The following sections of this document and the supporting figures outline the design basis, capture basis, implementation, and verification methods utilized for this portion of the design.

2 SEEPS CAPTURE REMEDY DESIGN

Per the COA, the seep remedy at the sites of seeps designated Seep A and Seep B will consist of the ex-situ capture of dry weather baseflow and rain events up to one-half inch in a 24-hour period. Based on topography and the observed seeps on site, the Seep A flow and capture system is separated into two seeps designated as Seep A and Seep A tributary. Dry weather baseflow will also be collected from the Willis Creek tributary seep and from “weeps” that daylight upgradient of the Barrier Wall.

The seep remedy was developed based on flume data and catchment modeling prepared by Geosyntec Consultants of NC, P.C. (Geosyntec). The tables outlining the flows used for the design are included below.

Table 1: Hydraulic Loading from Dry Weather Flow

Channel	Dry Weather Flow Rate (gpm)
Willis Creek Tributary	39
Seep A Tributary	19
Seep A	31
Seep B	130
Weeps	12 (each)

Table 2: Hydraulic Loading from Stormflow (0.5” event in 24 hours)

Channel	Stormflow Volume (gallons)
Seep A Tributary	26,000
Seep A	110,000
Seep B	46,000

The remaining sections of this document discuss the basis for the design, the collection, storage, conveyance, and solid control and maintenance requirements for the Ex-Situ Capture design.

2.1 Seep Capture Basis of Design

Conceptual ex-situ capture systems for both Seep A and B were described in the 60 percent design submittal pursuant to the COA. In the 60 percent design systems, the seeps were captured and diverted to a series of storage ponds located near the seep collection system. The ponds were designed to smooth the peak flows to the water treatment plant while also settling solids from the seep waters very near their collection points.

Subsequent to the 60 percent design submittal, the flow rates have been refined using new information and the design has been modified to accommodate the new hydraulic loading while maintaining the simultaneous benefits of the equalization of flows and solids management before the water reaches the treatment plant. Additional dry weather flows from the Willis Creek Tributary and “weeps” daylighting above the Barrier Wall have also been included in the revised design. The design of the weep capture system and conveyance will be provided in the 90% design submittal.

Based on experience at the existing treatment plant at Outfall OO3, the ½” rainfall flow is expected to be the most sediment laden component of the proposed network. To allow for TSS control, the dry weather baseflow and stormflow will be pumped to a single surge pond prior to entering the water treatment plant. The single surge pond functions similar to the original design but combines all captured flow into one surge basin instead of individual basins at each capture location.

2.1.1 Seep Capture

In the revised design, the seeps will still be collected in existing topographic channels or adjacent low-lying areas, but the method of collection has changed to account for the topography of each location.

Based on the topography and the relatively small flows, flow from the Willis Creek Tributary and the seven surficial weeps will be collected in structures and pumped directly to the lined surge pond.

At the Seep A Tributary and Seep B locations, the lined basin has been located and graded such that the dry weather flow and stormflow will flow directly into the small basin located at each location before being conveyed to the surge pond.

The flows from Seep A manifest from two drainage areas that currently (before the barrier wall) convene into one collectable seep near the location of the temporary collection system. Once the barrier wall is installed, the flows from the two areas will manifest separately but close together so the revised design collects the north side of the Seep A area and conveys it via actuated sluice gate into the lined Seep A basin located further to the south (Sheet SC-0.3). Once both flows are collected into the Seep A basin near the Barrier Wall, the water is conveyed to the surge pond and ultimately to the water treatment plant.

2.1.2 Collected Water Conveyance

A series of pumps will be utilized to transport the dry weather flow and storm flow from the individual collection locations to the large surge pond. The pump stations will provide a steady/known flow to the surge pond via a force main system. Each seep (A and B, A tributary) will include a pump station. The pump station will be sized to function with the surge pond of each seep. A pump station will also be present at the Willis Creek feature.

The purpose of the single large surge pond is to replace the functionality (solids reduction and consistent flow rates to the treatment plant) of the original design settling basins. The combination of peak storm flow attenuation at the site of collection and the large surge pond provides multiple layers of surge protection for the water treatment system that is also handling flows from other sources. The Schematic Flow Diagram is shown on Figure SC-0.2.

2.2 Maintenance

As with all systems, general maintenance will be required. A summary of expected weekly inspections and maintenance is listed below:

- Inspect trash rack system at Seep A
- Remove all material from pipe guard grates (debris, leaves, limbs, sticks, etc.)
- Inspect base flow collection structures at Willis Creek Tributary and weeps including inlet grates. Remove any debris blocking the inlet grate.
- Measure sediment in each pond and record depths. Remove sediment, as necessary.
- Inspect pump stations and test each pump. Remove any collected solids.

In addition to the general maintenance listed above, the system shall be monitored during rainfall events to ensure proper operation.

3 SUMMARY AND CLOSING

The conceptual design of ex-situ seep capture is part of the overall Barrier Wall and Groundwater Extraction System planned to accomplish the requirements of the Consent Order Addendum with the State of North Carolina. Hydraulic modeling results and subsequent hydraulic loading information prepared by Geosyntec Consultants of NC, P.C. have been utilized to prepare the conceptual design drawings which are attached to this document.

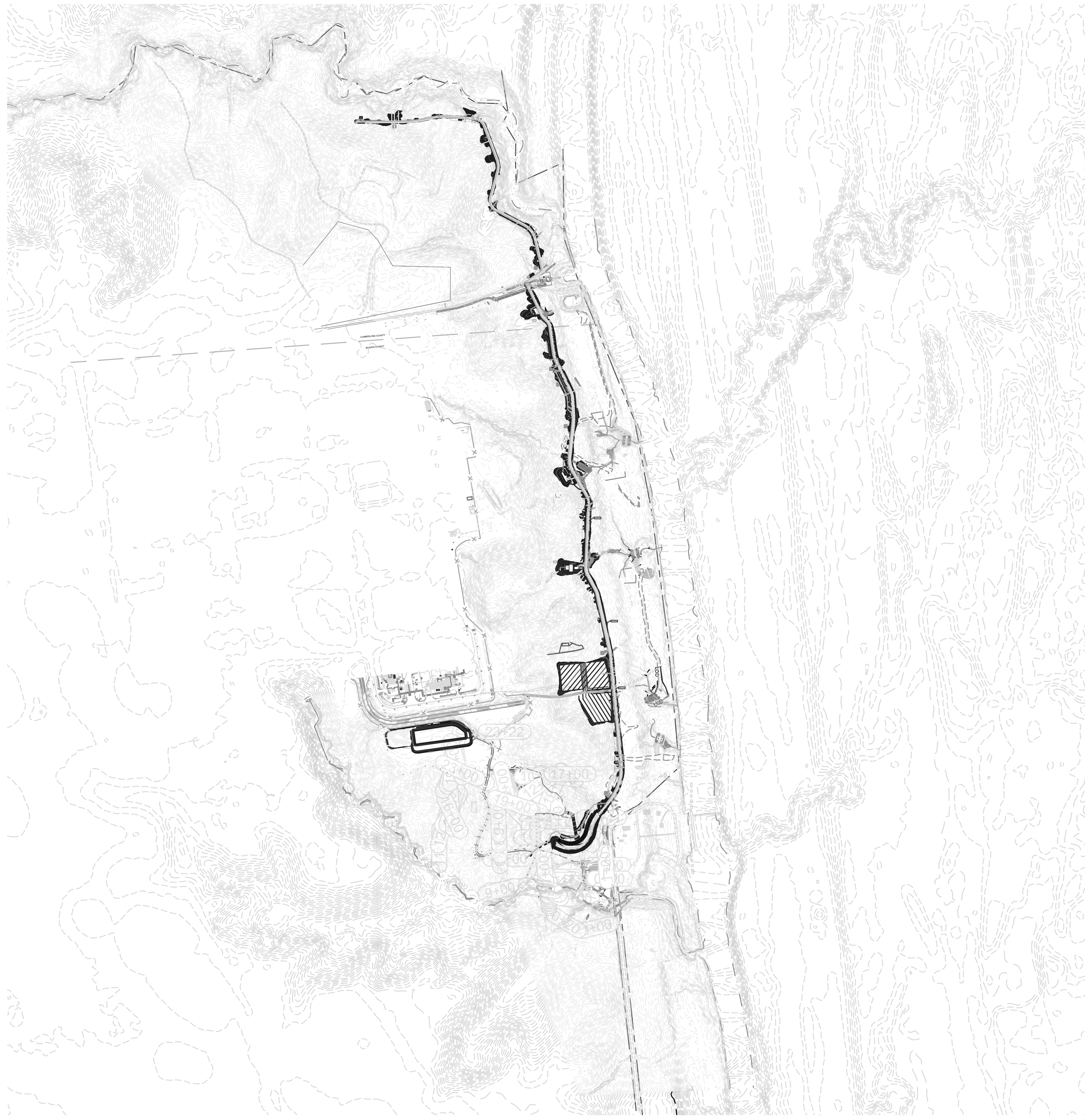
The conceptual design plan is based on the collection system for each seep functioning as part of an equalization chain between the seep capture and the treatment plant. This storage chain function allows the flow to the treatment plant to be controlled.

The Chemours Company

Fayetteville, North Carolina

EX-SITU CAPTURE REMEDY

FEBRUARY 2022



DRAWING INDEX

GEOS
Geotechnical, Environmental and Materials Engineers

90% EX-SITU CAPTURE REMEDY PACKAGE

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB
REVIEWED BY: TJD
DESIGNED BY: BB
APPROVED BY:
SCALE: AS SHOWN
DATE: FEBRUARY 2022

Revisions

No.	Date	Description	By:
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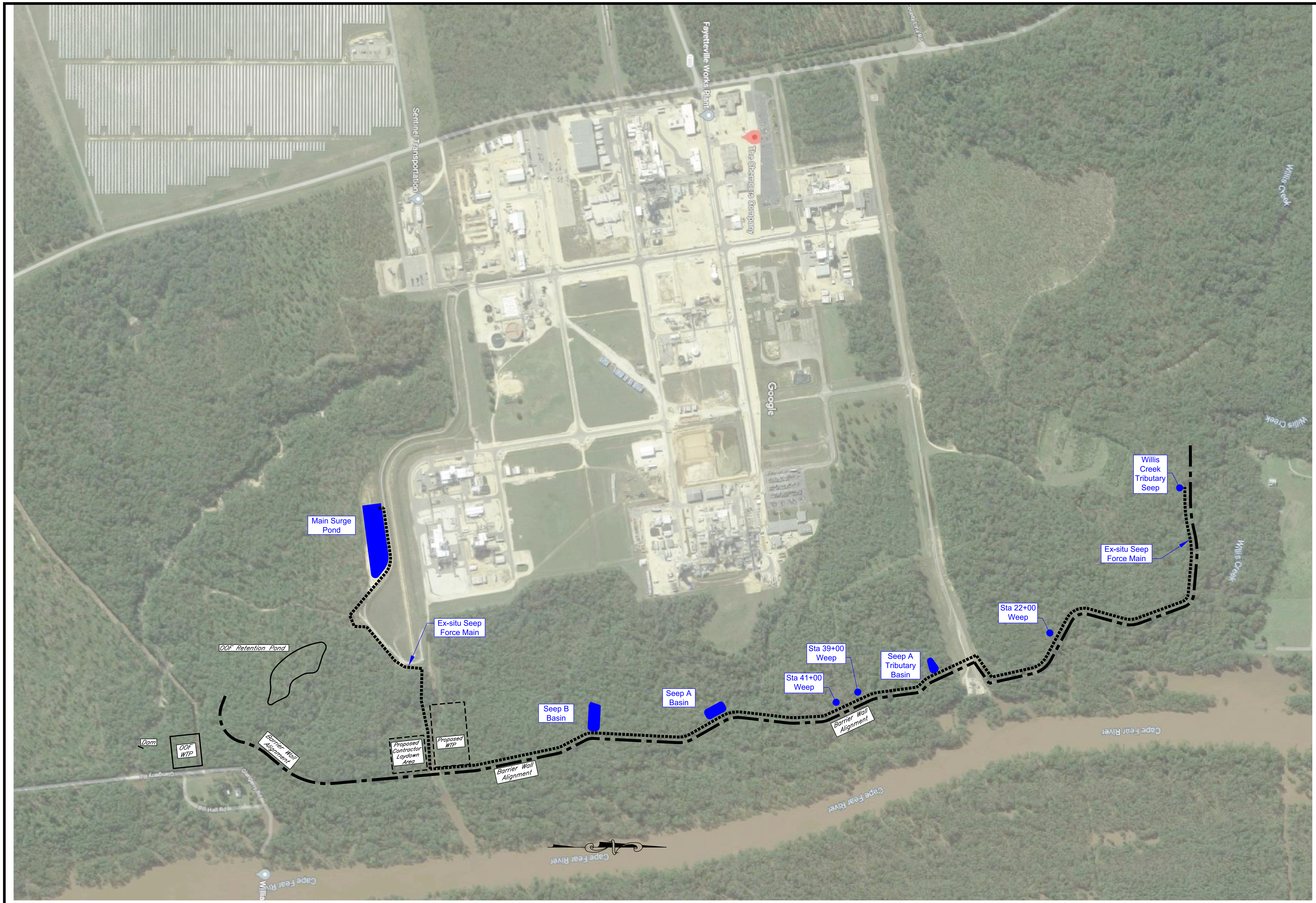
DRAWING: SC-0.0
PROJECT NUMBER: 45-20803



1 SC-0.1 Seep Capture – Location Plan

SCALE: 1" = 300'
0' 300' 600'

Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Location Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

No.	Date	Description	By:
1			
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DRAWING: SC-0.1

PROJECT NUMBER: 45-20803

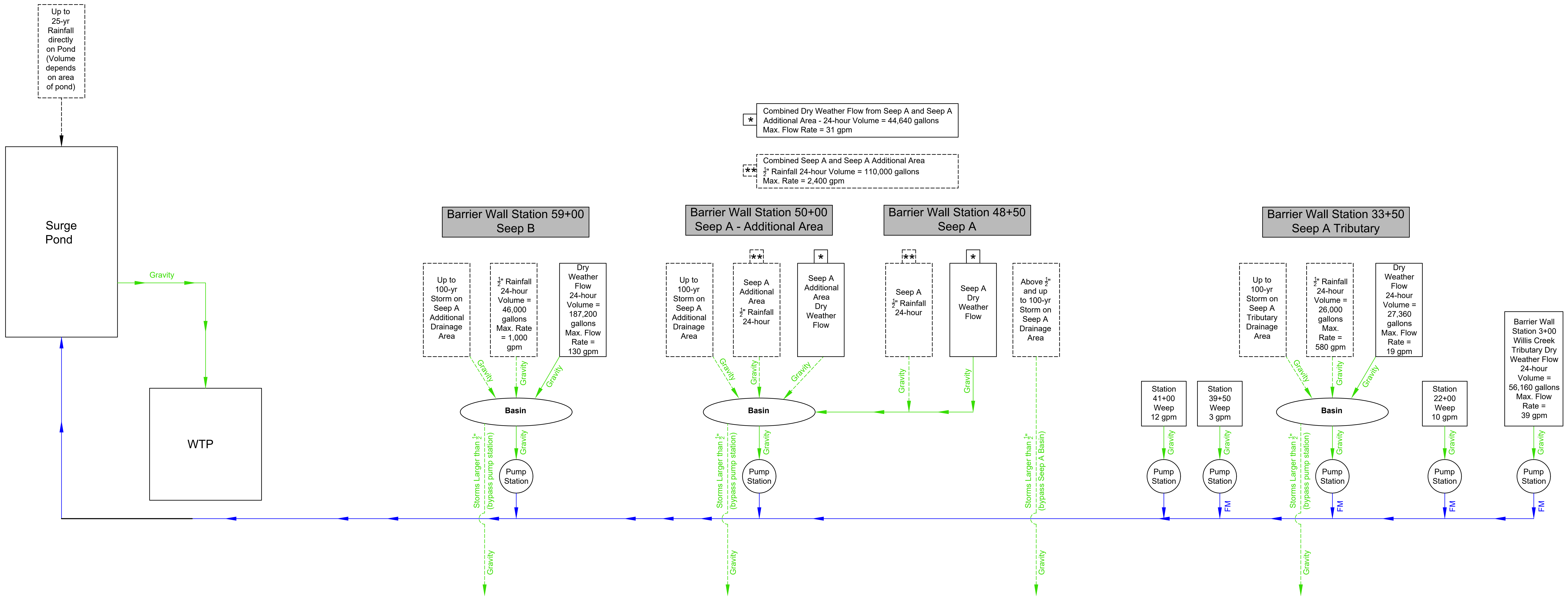
24-Hour Dry Weather Volume to Surge Pond	
Seep A	44,640 gallons
Seep B	187,200 gallons
Seep A Tributary	27,360 gallons
Willis Creek Tributary	56,160 gallons
Sta 22+00 Weep	14,400 gallons
Sta 39+50 Weep	4,320 gallons
Sta 41+00 Weep	17,280 gallons
Total Dry Weather Volume to Surge Pond	351,360 gallons

$\frac{1}{2}$" Rainfall Volume to Surge Pond	
Seep A	110,000 gallons
Seep B	46,000 gallons
Seep A Tributary	26,000 gallons
Willis Creek Tributary	N/A
Weeps	N/A
Total $\frac{1}{2}$" Rainfall Volume to Surge Pond	182,000 gallons

Surge Pond Total Volume Requirements	
48-Hour Dry Weather Volume (2 x 24-hour)	702,720 gallons
48-Hour $\frac{1}{2}$" Rainfall Volume (2 x 24-hour)	364,000 gallons
Direct Rainfall onto Surge Pond (25-year storm - 6.90 inches over Surge Pond Area of 80,100 s.f.)	344,510 gallons
Total Surge Pond Volume Required	1,411,230 gallons

Note: Actual Flow Rate into Surge Pond will vary dependent on water surface levels in each of the Seep Basins (pumps on or off) and the flow into the pump stations from each weep.

1 SC-0.2 *Surge Pond – Volume Requirement Calculations*



* Combined Dry Weather Flow from Seep A and Seep A Additional Area - 24-hour Volume = 44,640 gallons Max. Flow Rate = 31 gpm

** Combined Seep A and Seep A Additional Area $\frac{1}{2}$" Rainfall 24-hour Volume = 110,000 gallons Max. Rate = 2,400 gpm

2 SC-0.2 *Surge Pond – Schematic Flow Diagram*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Surge Pond - Schematic Flow Diagram

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
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DATE: February 2022	

Revisions

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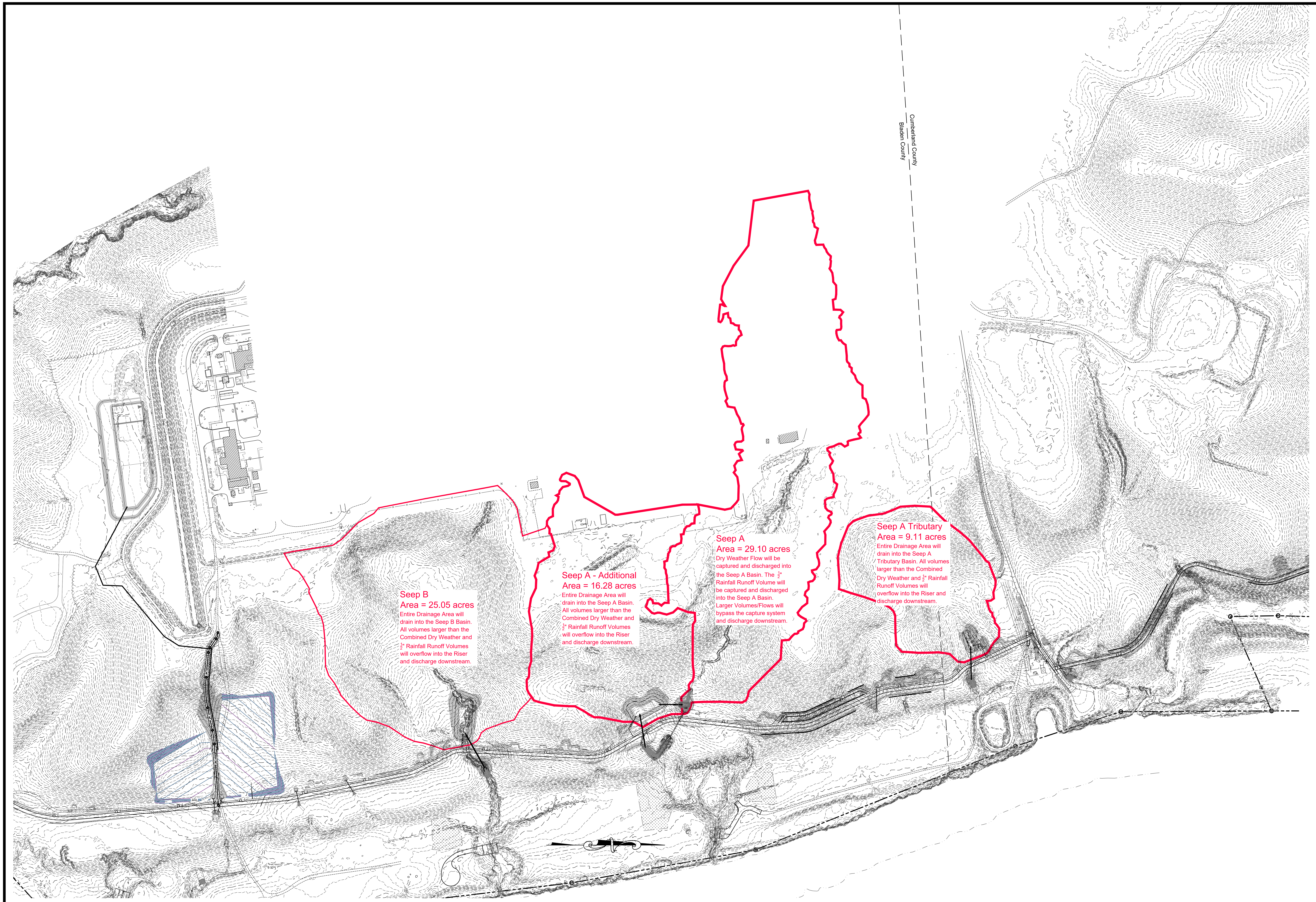
PROJECT NUMBER:
45-20803



Seep B
Area = 25.05 acres
Entire Drainage Area will drain into the Seep B Basin. All volumes larger than the Combined Dry Weather and $\frac{1}{2}$" Rainfall Runoff Volumes will overflow into the Riser and discharge downstream.

Seep A - Additional
Area = 16.28 acres
Entire Drainage Area will drain into the Seep A Basin. All volumes larger than the Combined Dry Weather and $\frac{1}{2}$" Rainfall Runoff Volumes will overflow into the Riser and discharge downstream.

Seep A
Area = 29.10 acres
Dry Weather Flow will be captured and discharged into the Seep A Basin. The $\frac{1}{2}$" Rainfall Runoff Volume will be captured and discharged into the Seep A Basin. Larger Volumes/Flows will bypass the capture system and discharge downstream.

Seep A Tributary
Area = 9.11 acres
Entire Drainage Area will drain into the Seep A Tributary Basin. All volumes larger than the Combined Dry Weather and $\frac{1}{2}$" Rainfall Runoff Volumes will overflow into the Riser and discharge downstream.

1 / SC-0.3 Seep Drainage Areas

SCALE: 1" = 200'
0' 200' 400'

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep Drainage Areas

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

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DRAWING:
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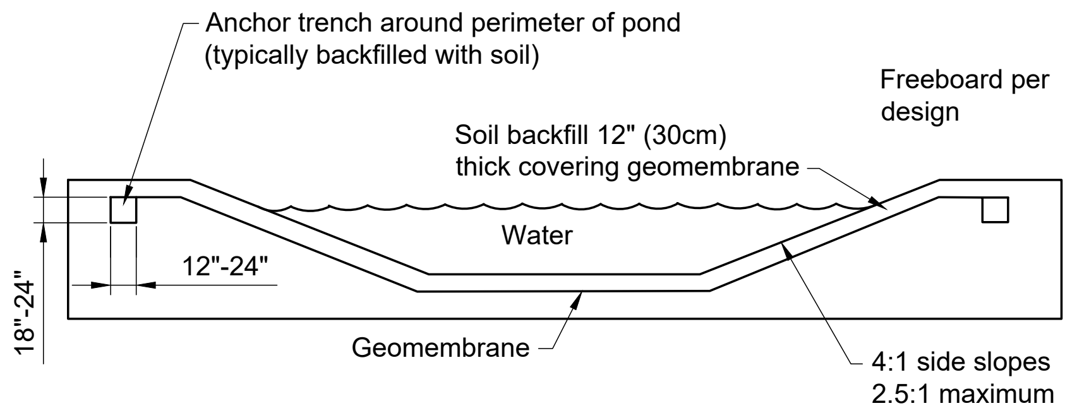
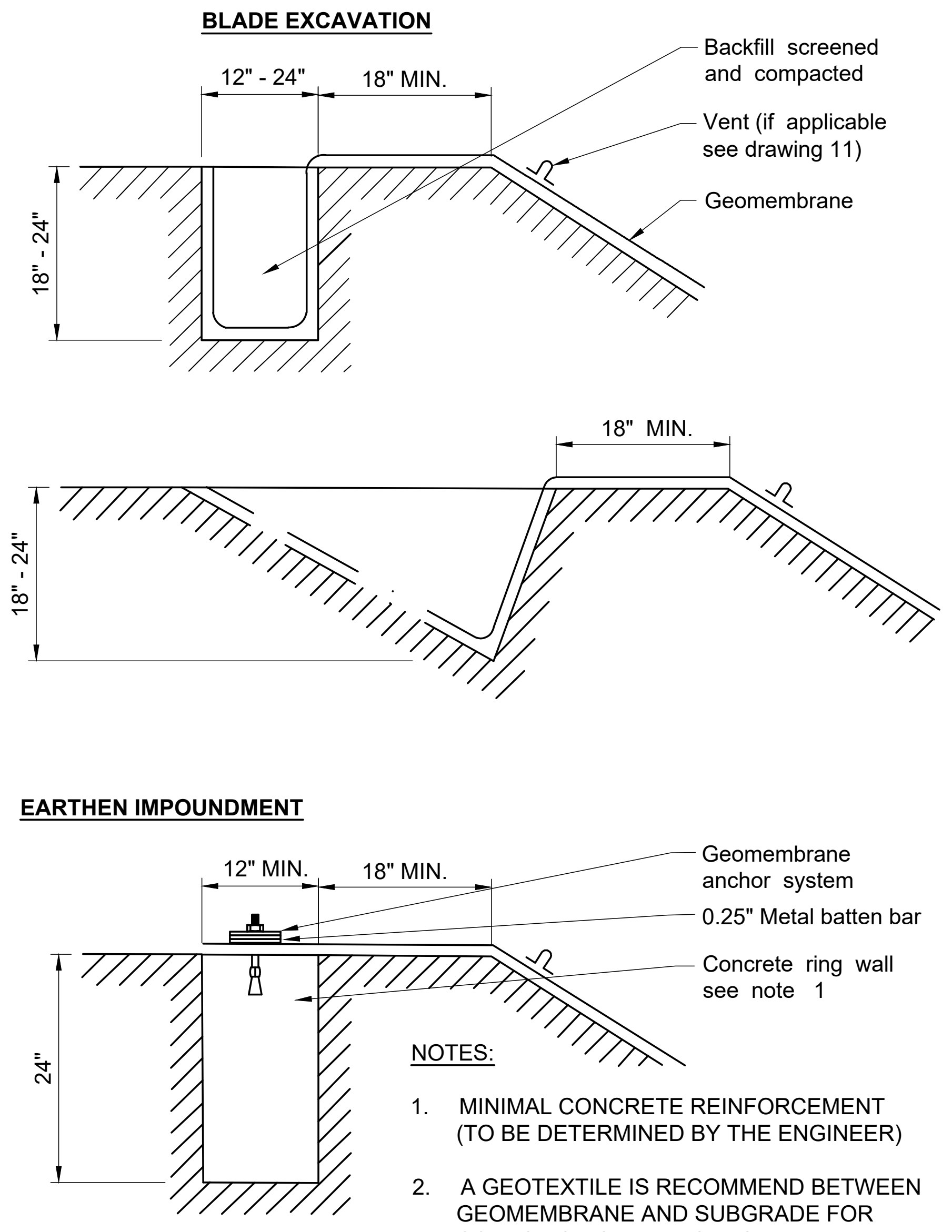
PROJECT NUMBER:
45-20803



1 SC-0.4 Typical Buried Liner System

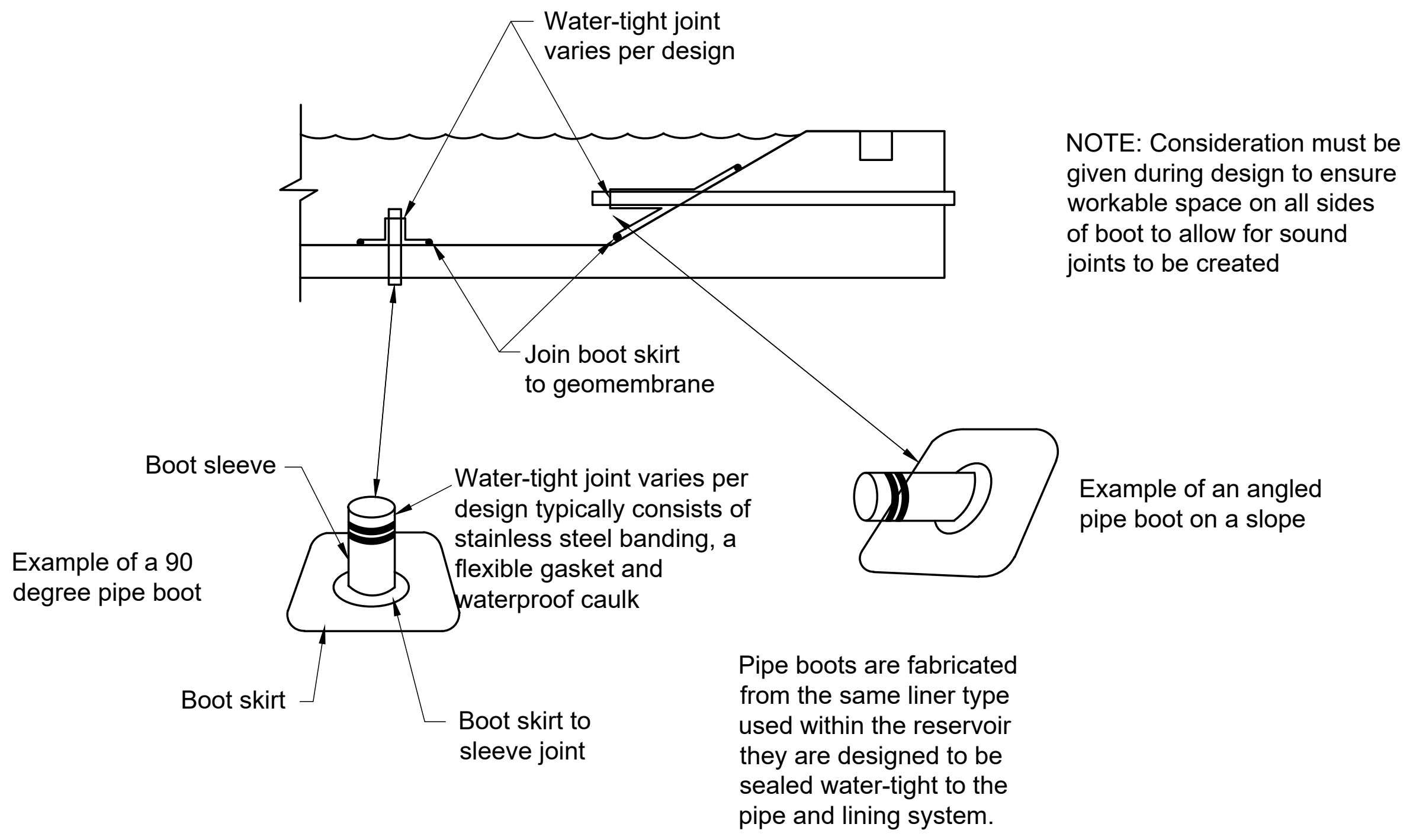


NOTES:

1. MINIMAL CONCRETE REINFORCEMENT (TO BE DETERMINED BY THE ENGINEER)
2. A GEOTEXTILE IS RECOMMEND BETWEEN GEOMEMBRANE AND SUBGRADE FOR COARSE OR SIMILAR SUBGRADE
3. ALLOW SUFFICIENT FREEBOARD, AS TO NOT BE AFFECTED BY WAVE ACTION

2 SC-0.4 Typical Geomembrane Perimeter Anchor Details

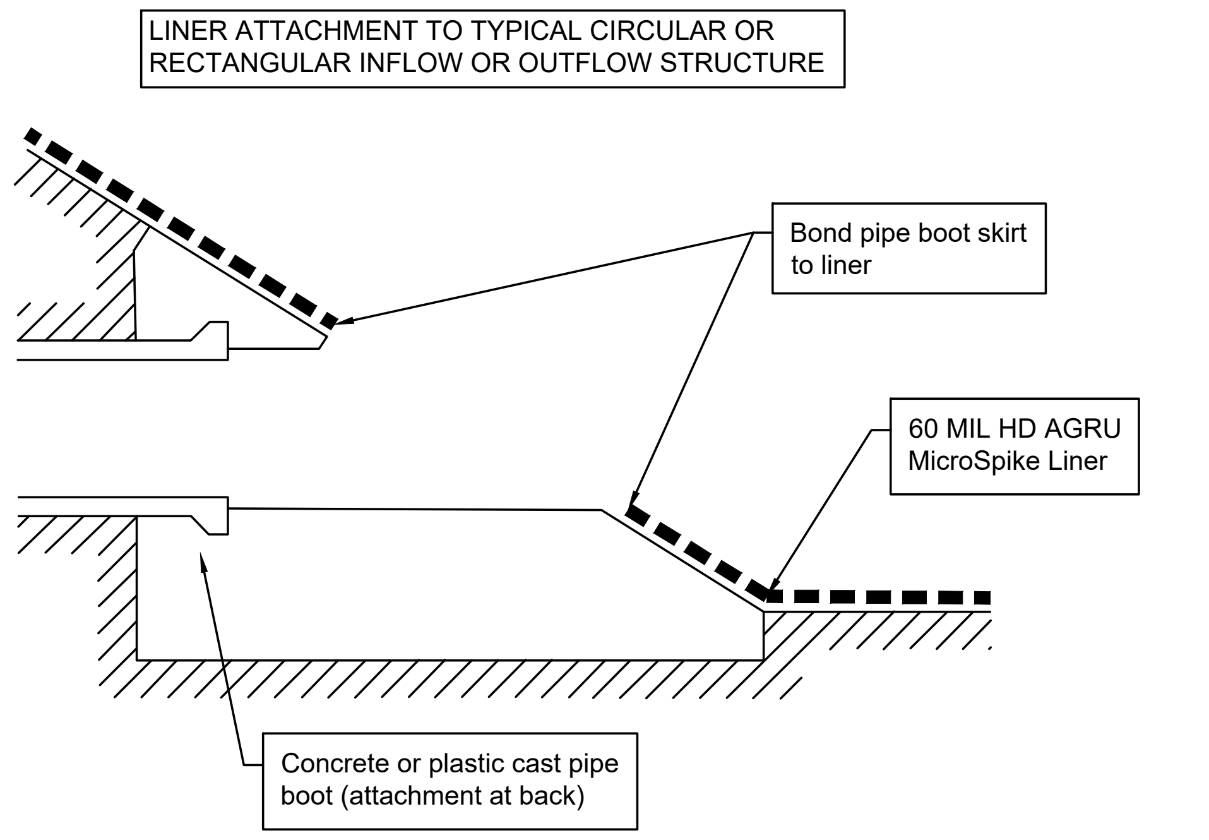
FOR ADDITIONAL DETAILS ON MECHANICAL ATTACHMENT TO PENETRATIONS OR STRUCTURES, SEE ASTM D6497



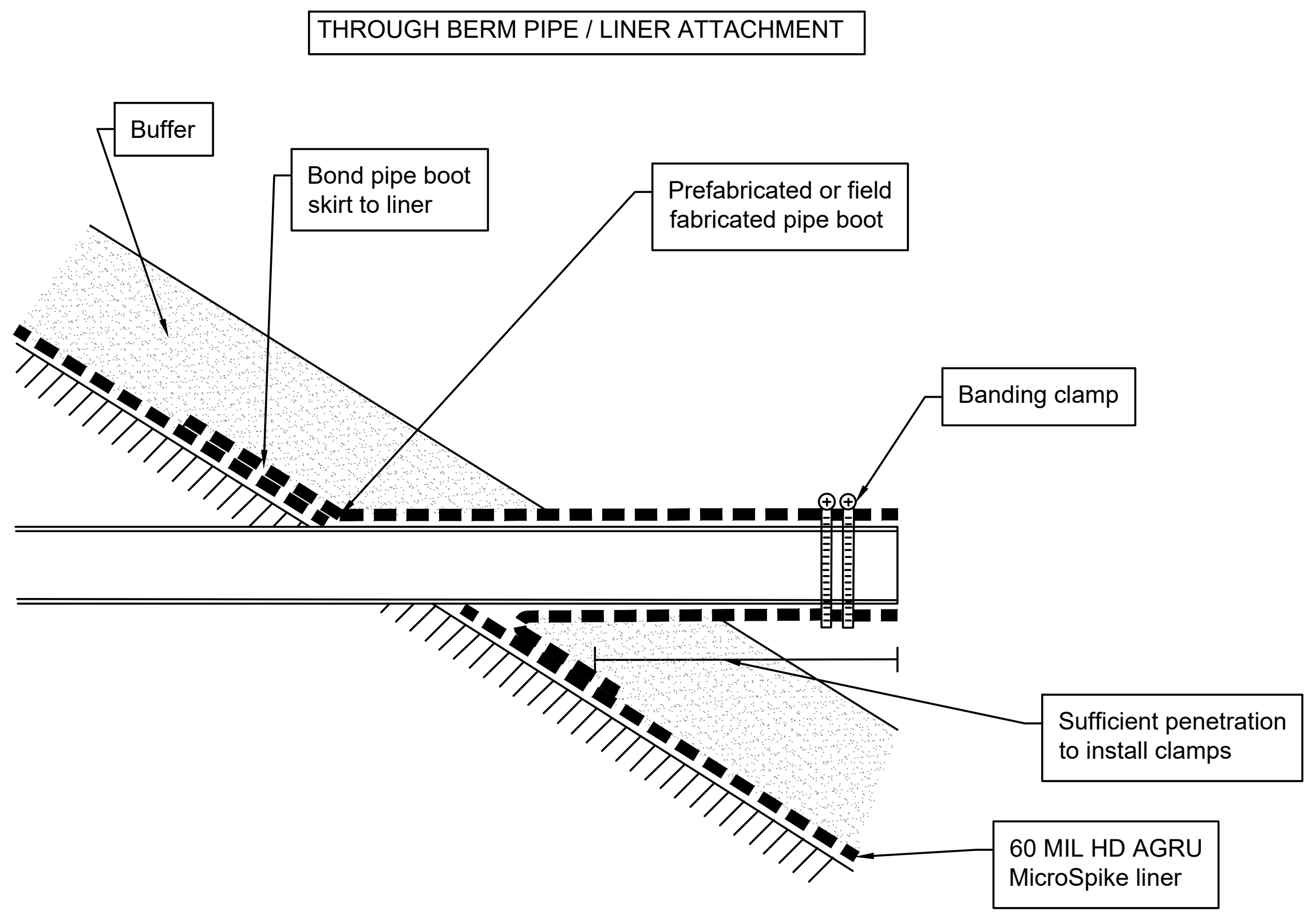
NOTE: Consideration must be given during design to ensure workable space on all sides of boot to allow for sound joints to be created

Pipe boots are fabricated from the same liner type used within the reservoir they are designed to be sealed water-tight to the pipe and lining system.

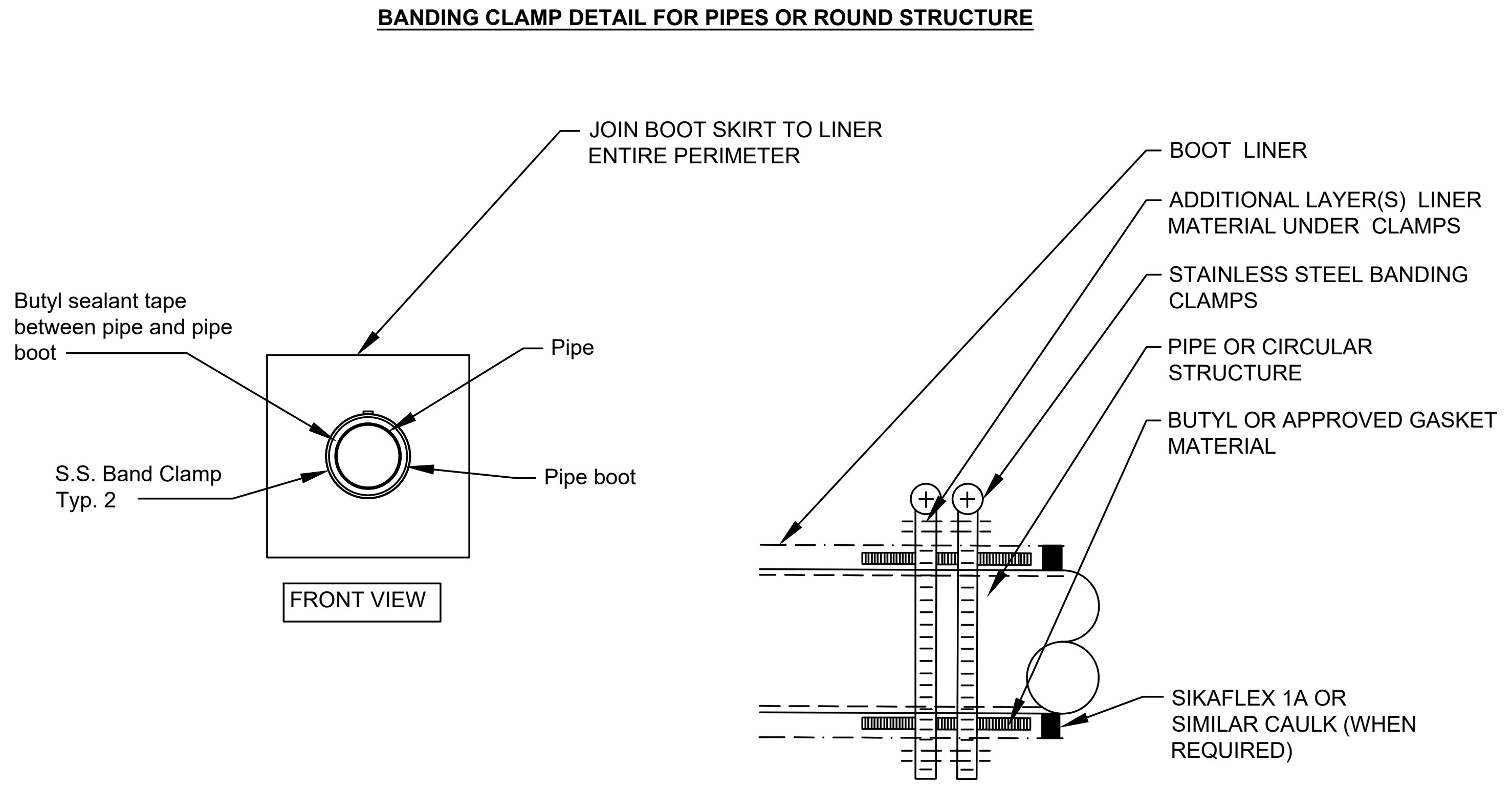
3 SC-0.4 Typical Penetration Details



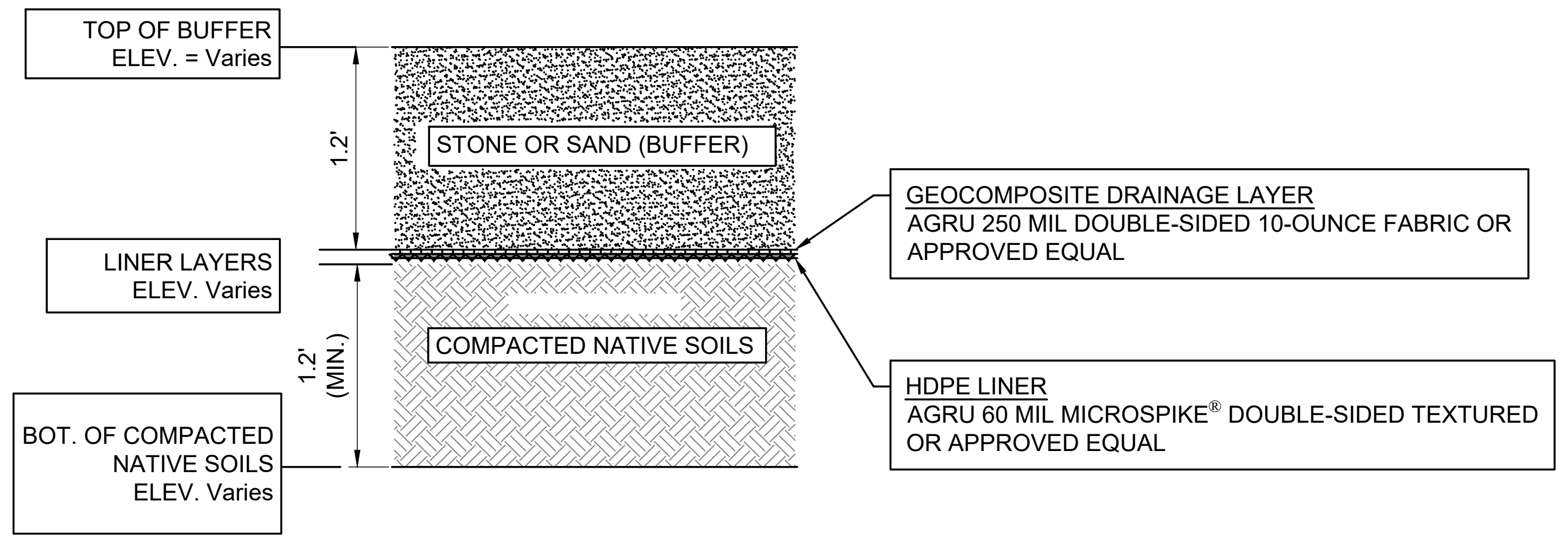
4 SC-0.4 Liner Attachment to Inflow or Outflow Structure



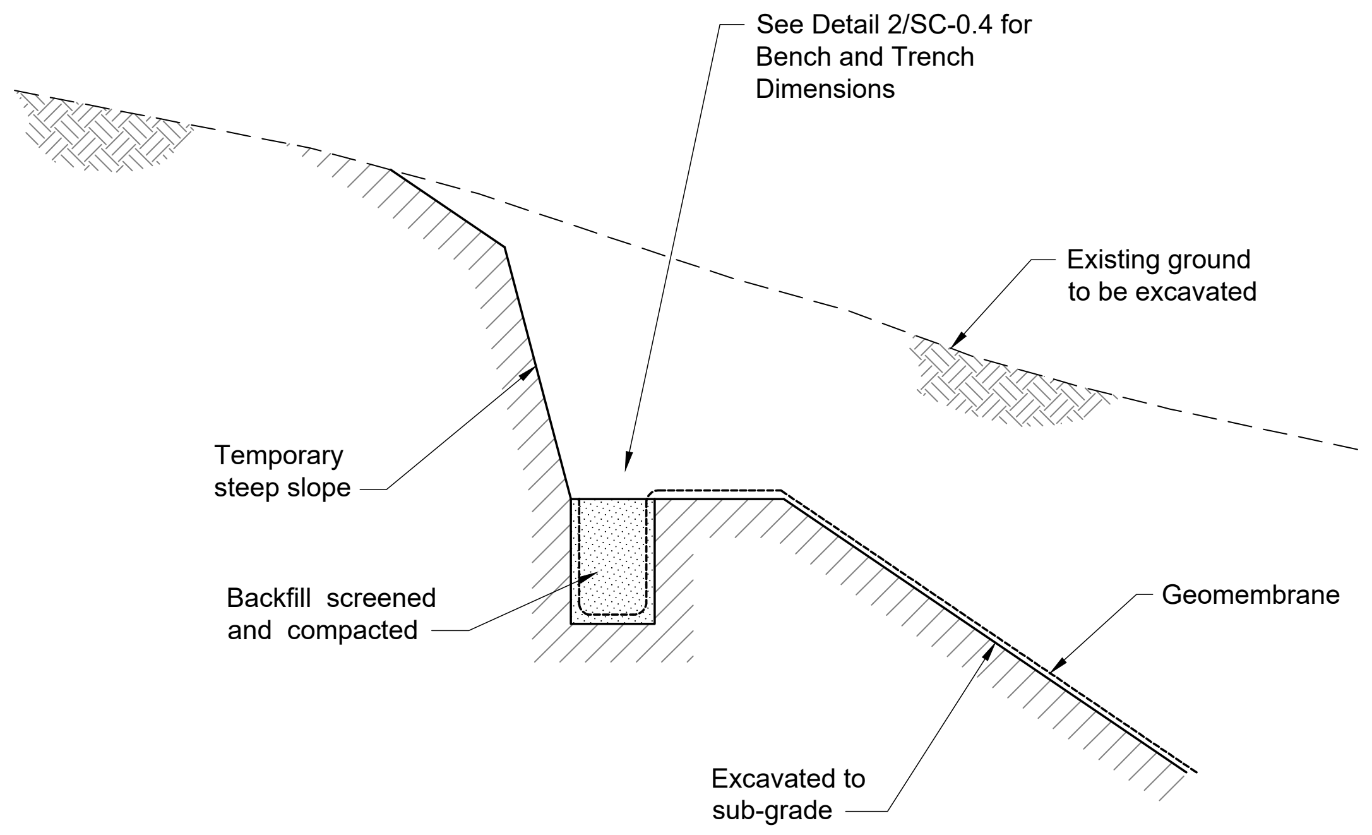
5 SC-0.4 Liner Attachment to Through Berm Penetration



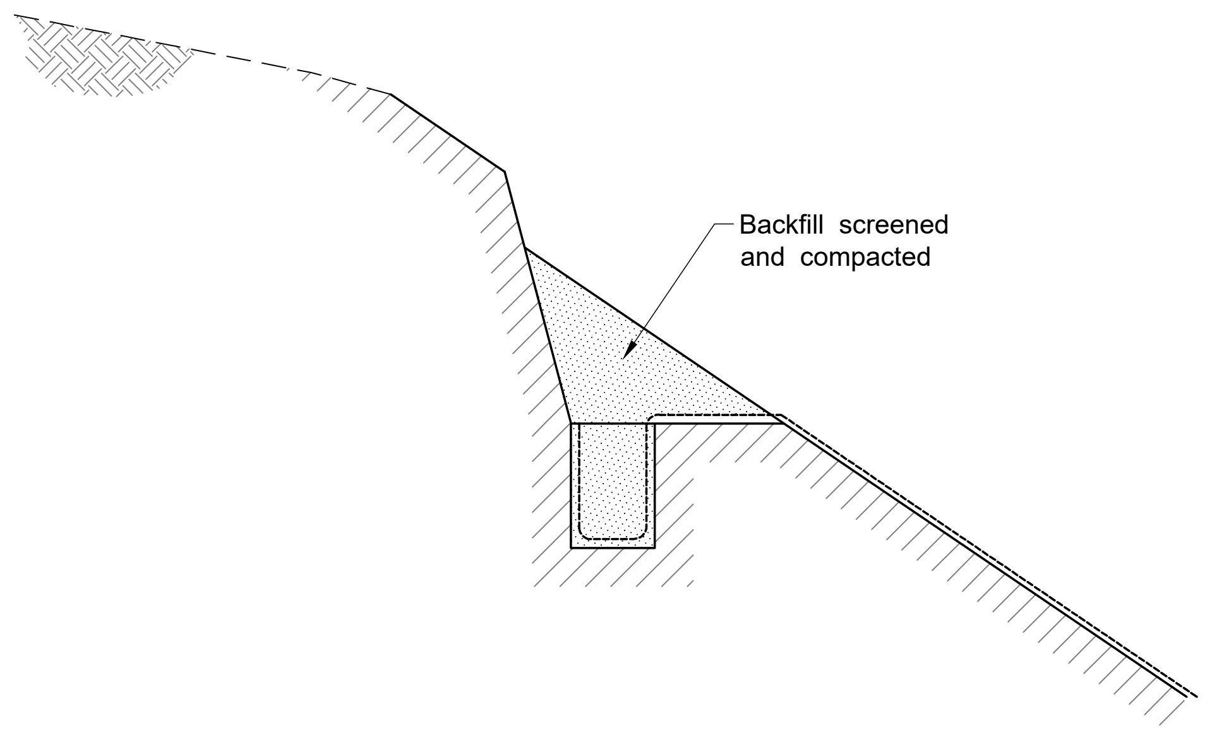
6 SC-0.4 Typical Banding Clamp Details



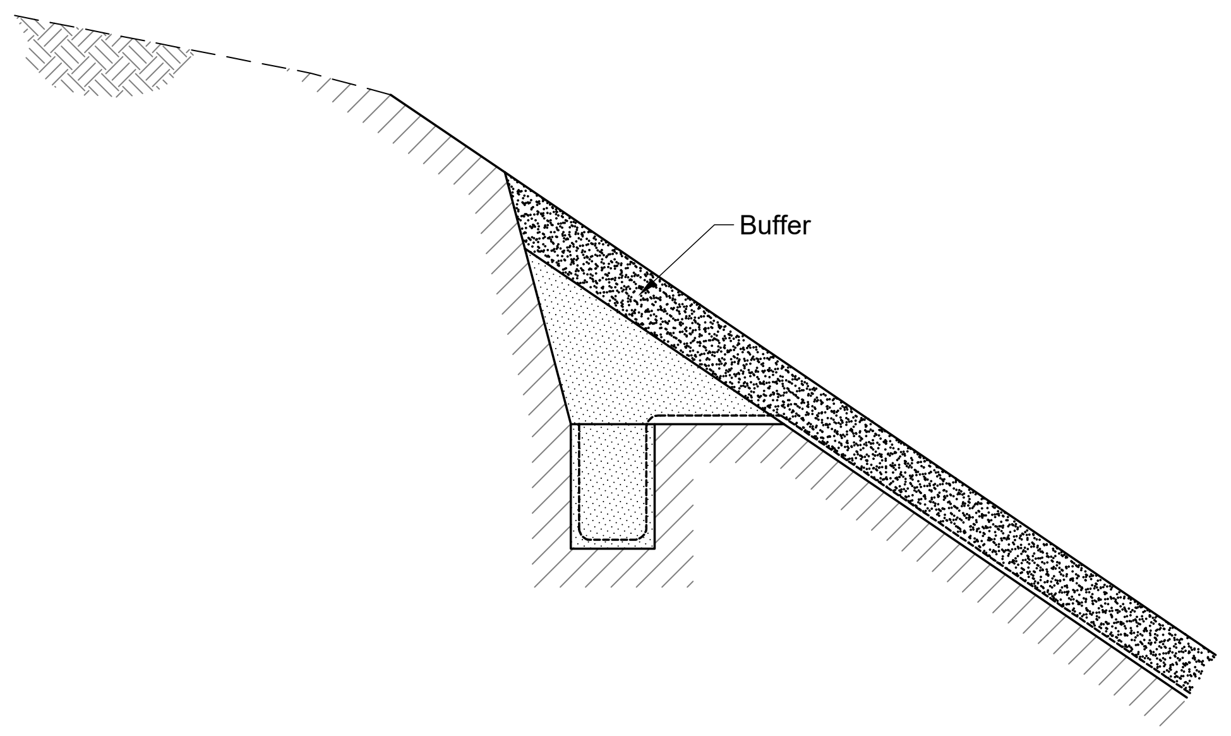
7 SC-0.4 Typical Liner Details



8 SC-0.4 Initial Liner Installation – Cut Area



9 SC-0.4 Bench Backfill Detail



10 SC-0.4 Buffer Installation over Liner

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Liner Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

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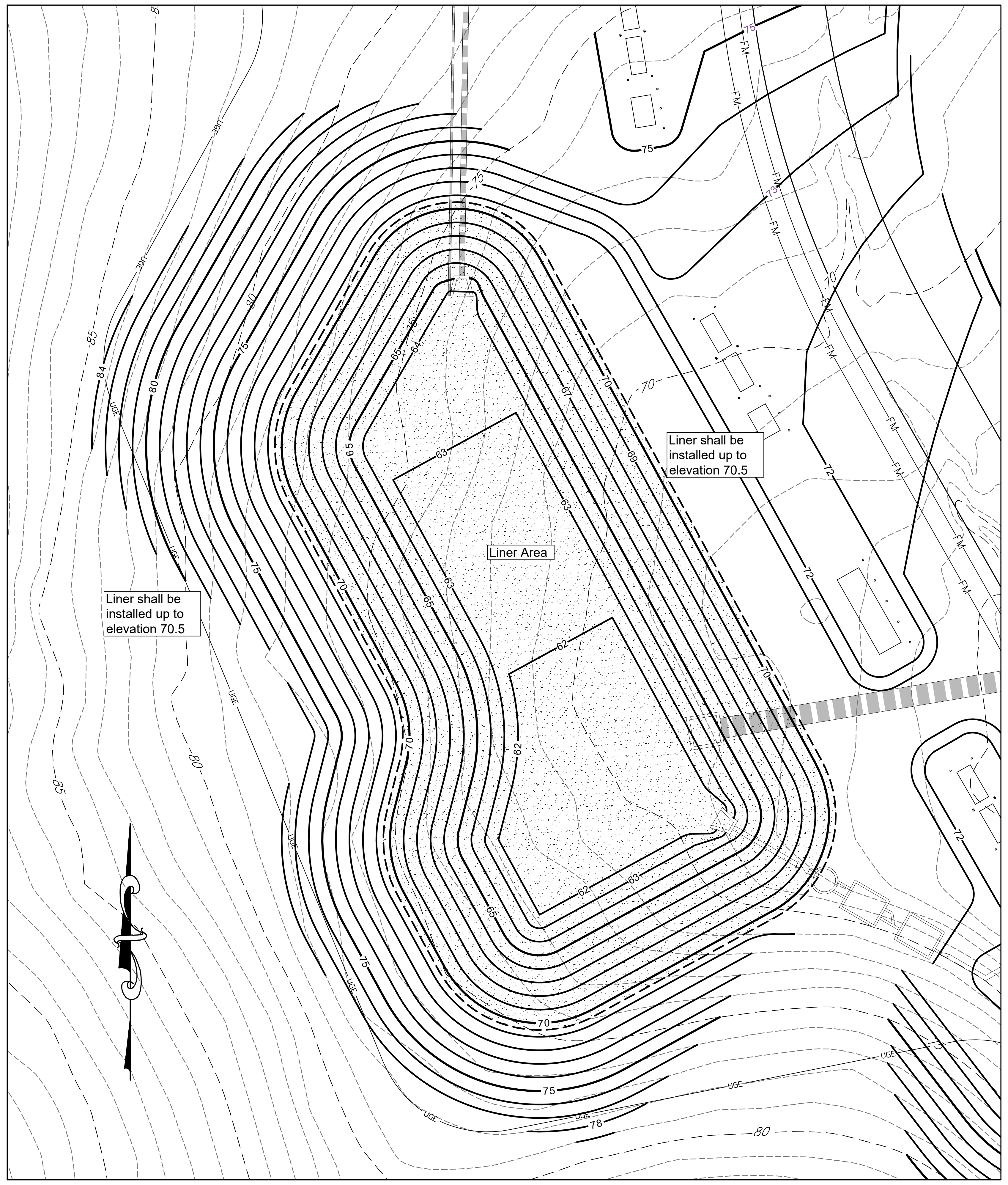
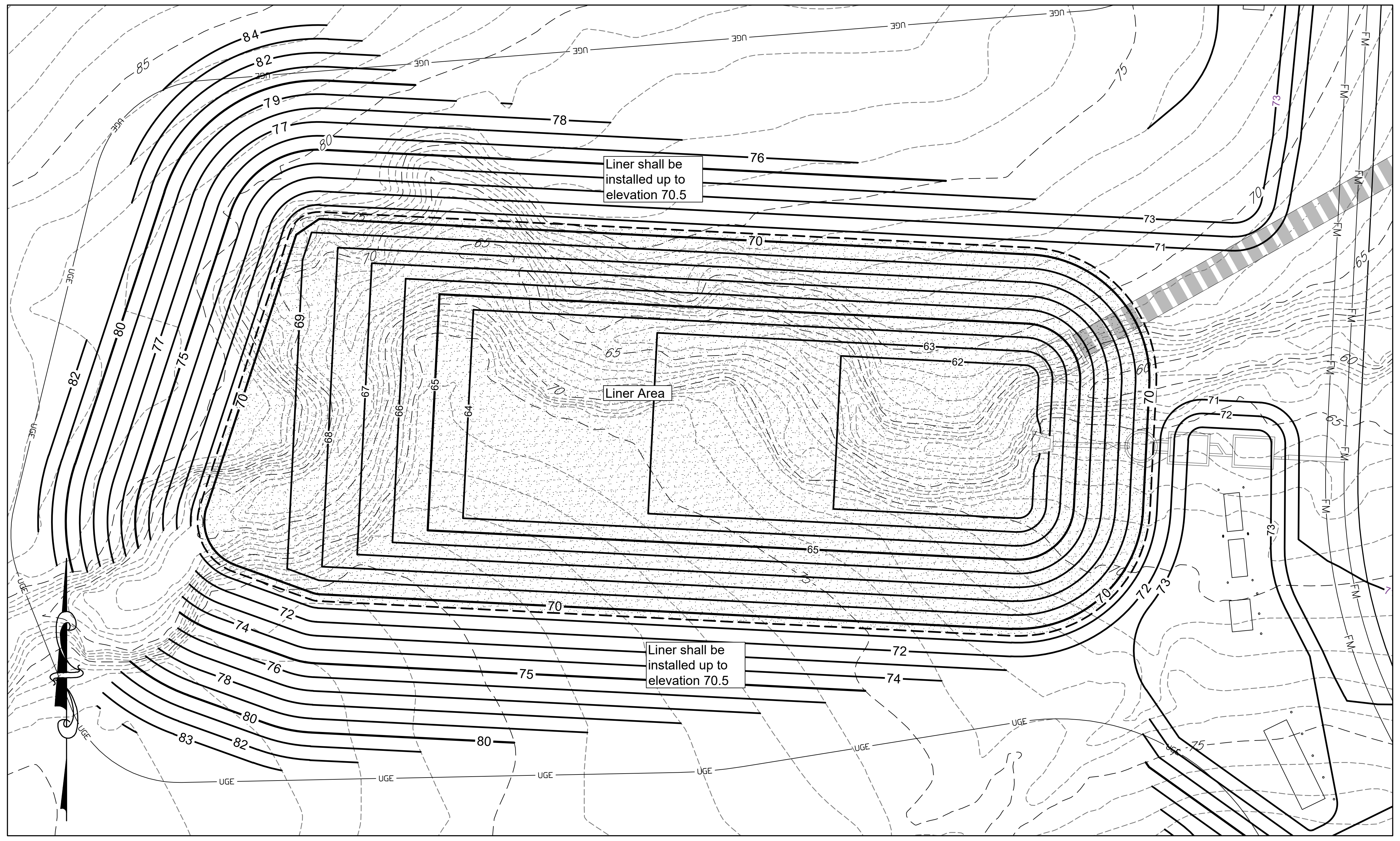
DRAWING: SC-0.4

PROJECT NUMBER: 45-20803



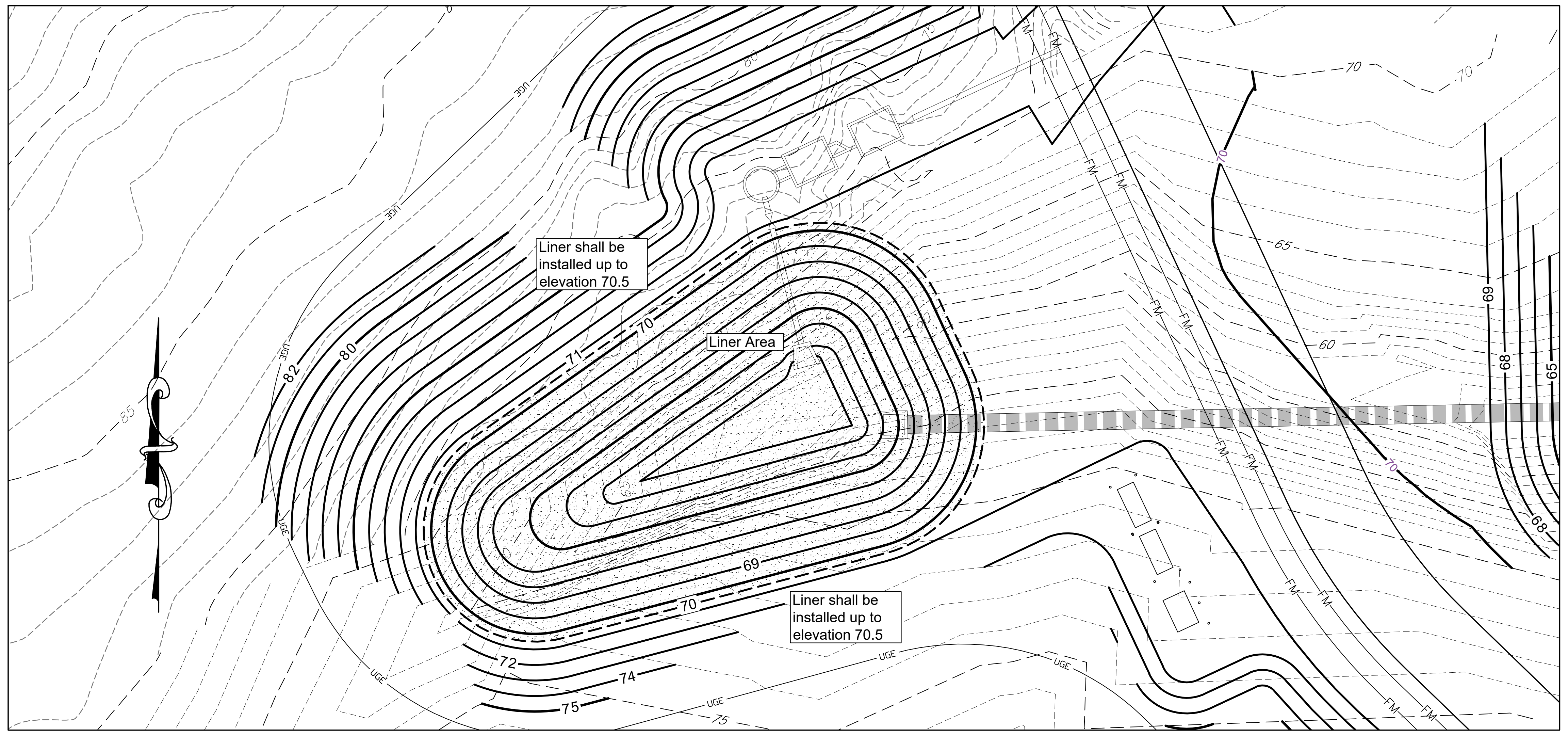
① SC-0.5 Seep A Basin – Liner Limits

SCALE: 1" = 20'
0' 20' 40'



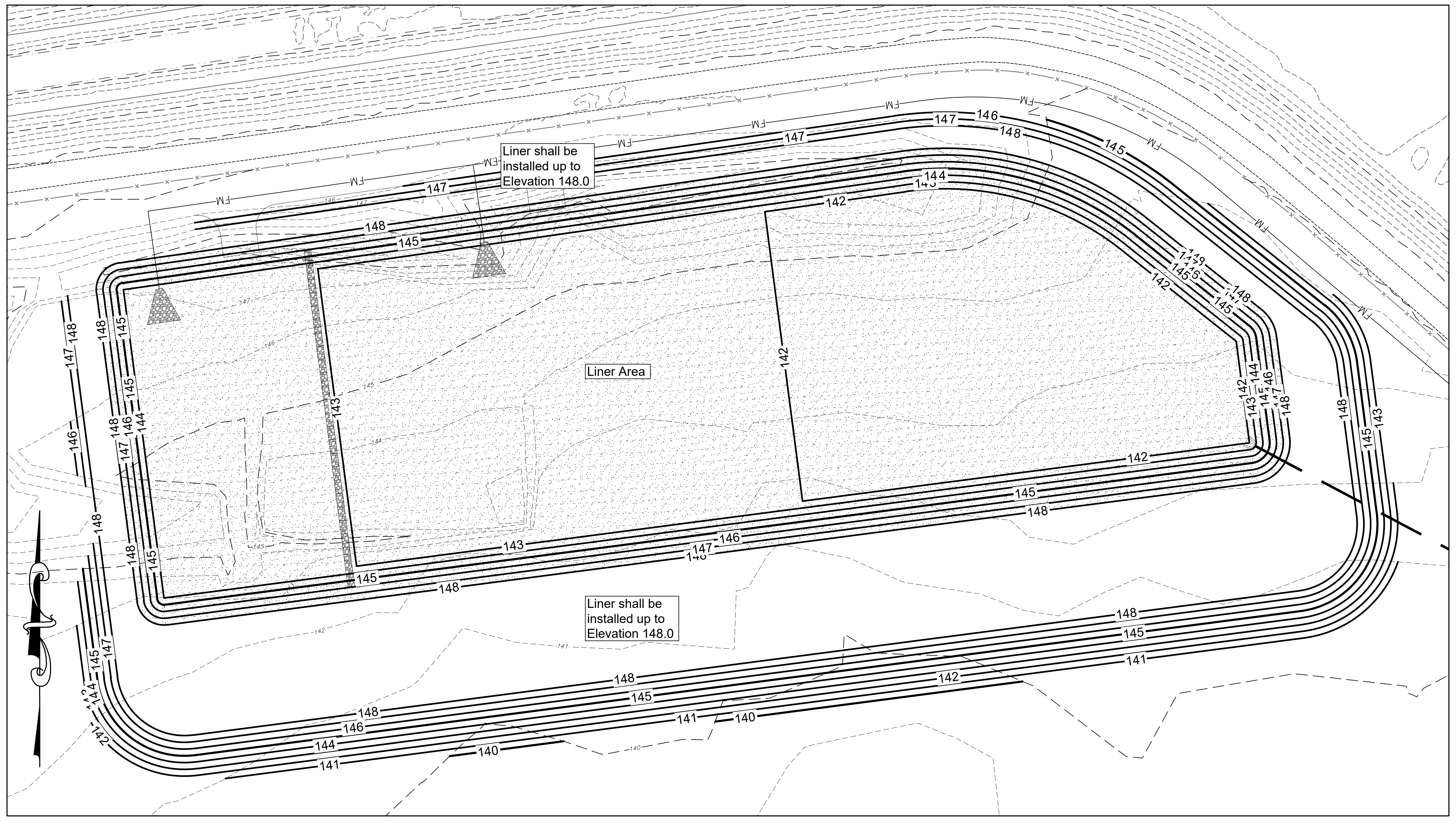
② SC-0.5 Seep B Basin – Liner Limits

SCALE: 1" = 20'
0' 20' 40'



③ SC-0.5 Seep A Tributaty Basin – Liner Limits

SCALE: 1" = 20'
0' 20' 40'



④ SC-0.5 Surge Pond – Liner Limits

SCALE: 1" = 40'
0' 40' 80'

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Liner Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

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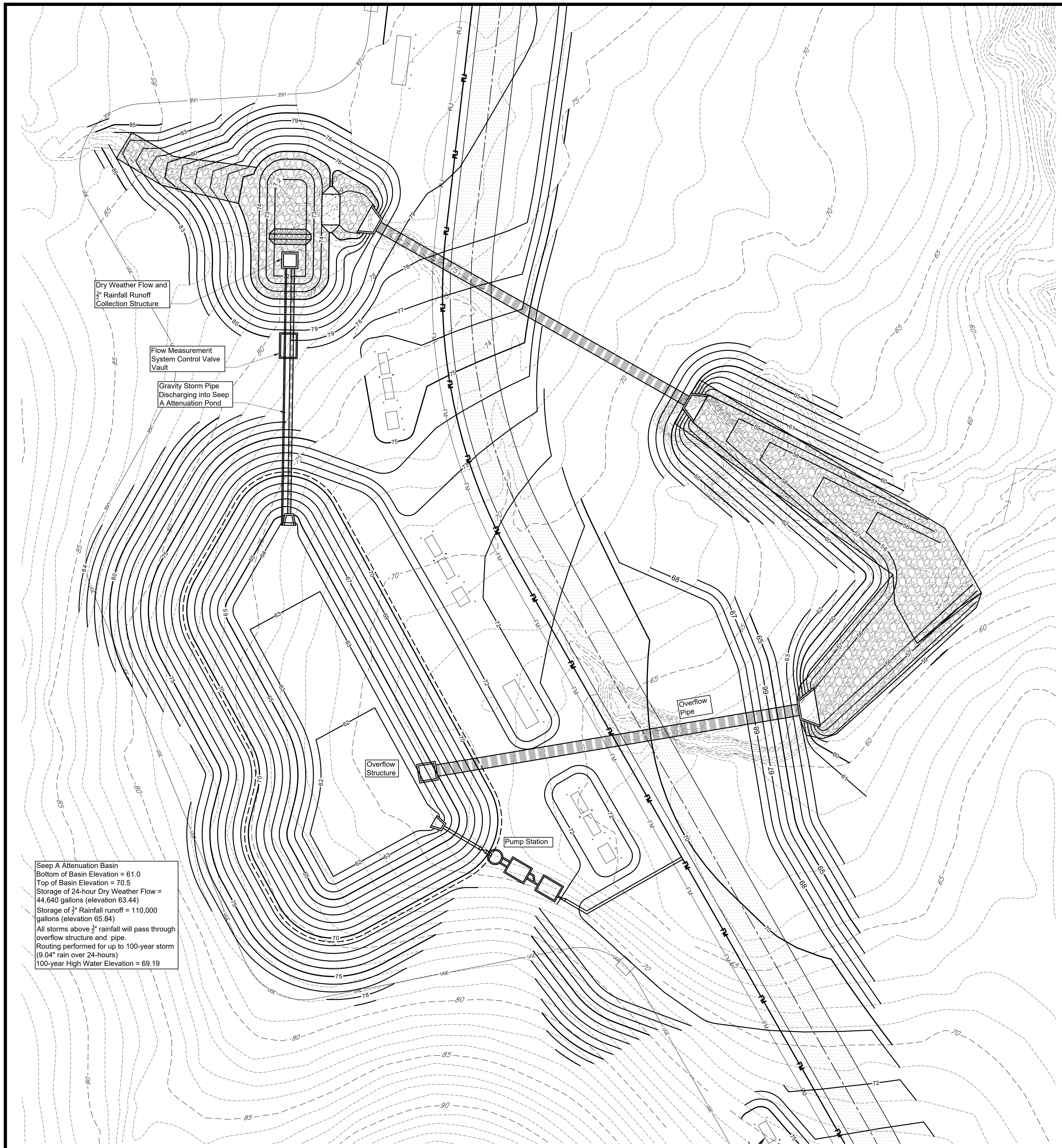
DRAWING: SC-0.5

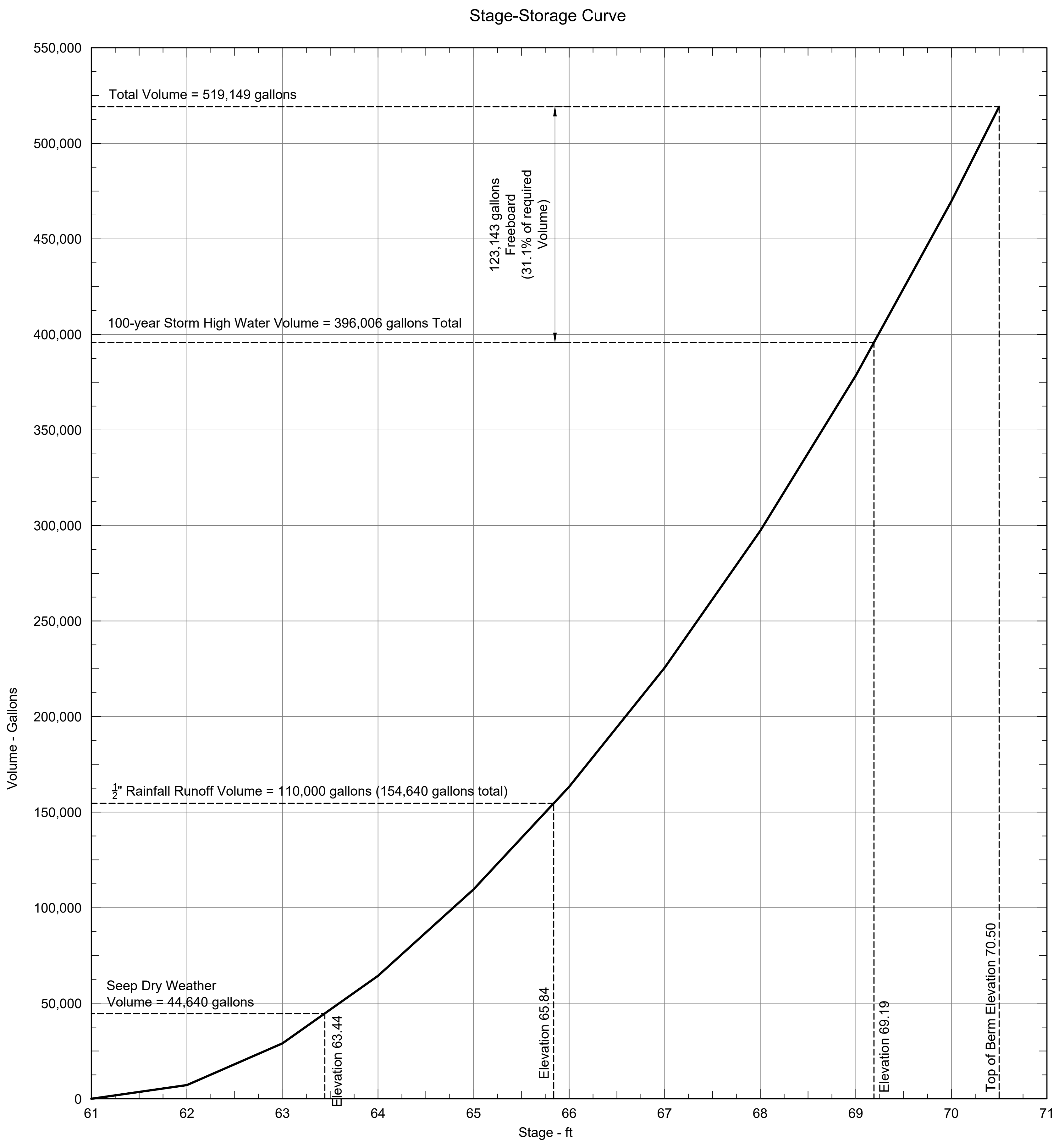
PROJECT NUMBER: 45-20803



Seep A Attenuation Basin
Bottom of Basin Elevation = 61.0
Top of Basin Elevation = 70.5
Storage of 24-hour Dry Weather Flow = 44,640 gallons (elevation 63.44)
Storage of ½" Rainfall runoff = 110,000 gallons (elevation 65.84)
All storms above ½" rainfall will pass through overflow structure and pipe.
Routing performed for up to 100-year storm (9.04" rain over 24-hours)
100-year High Water Elevation = 69.19

1 / SC-1.0 Seep A – Capture System & Basin Site Plan

SCALE: 1" = 20'
0' 20' 40'



2 / SC-1.0 Seep A Basin – Stage–Storage Curve

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Capture System Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

No.	Date	Description	By:
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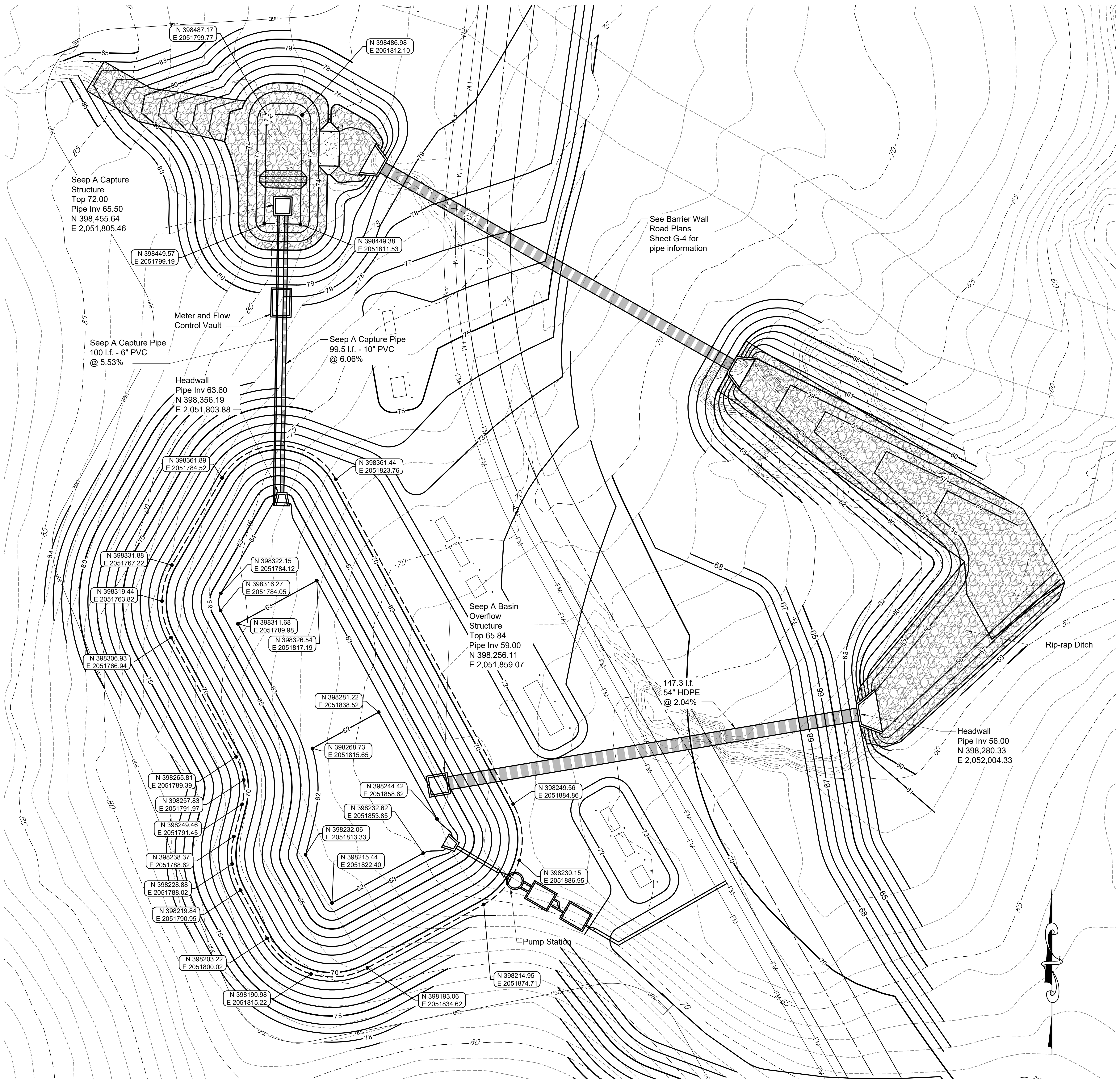
DRAWING:
SC-1.0

PROJECT NUMBER:
45-20803

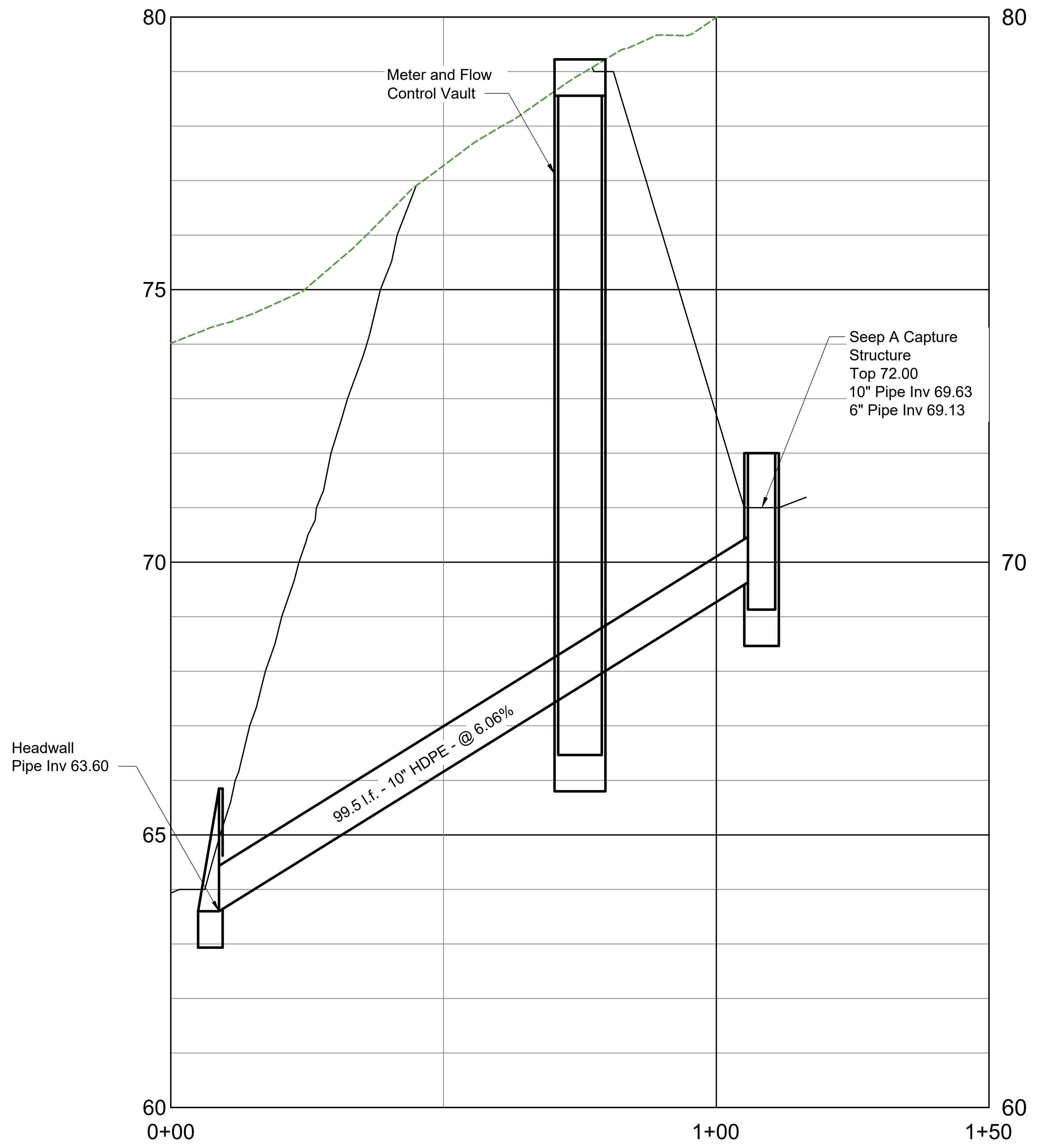


1 SC-1.1 Seep A Basin – Grading Plan

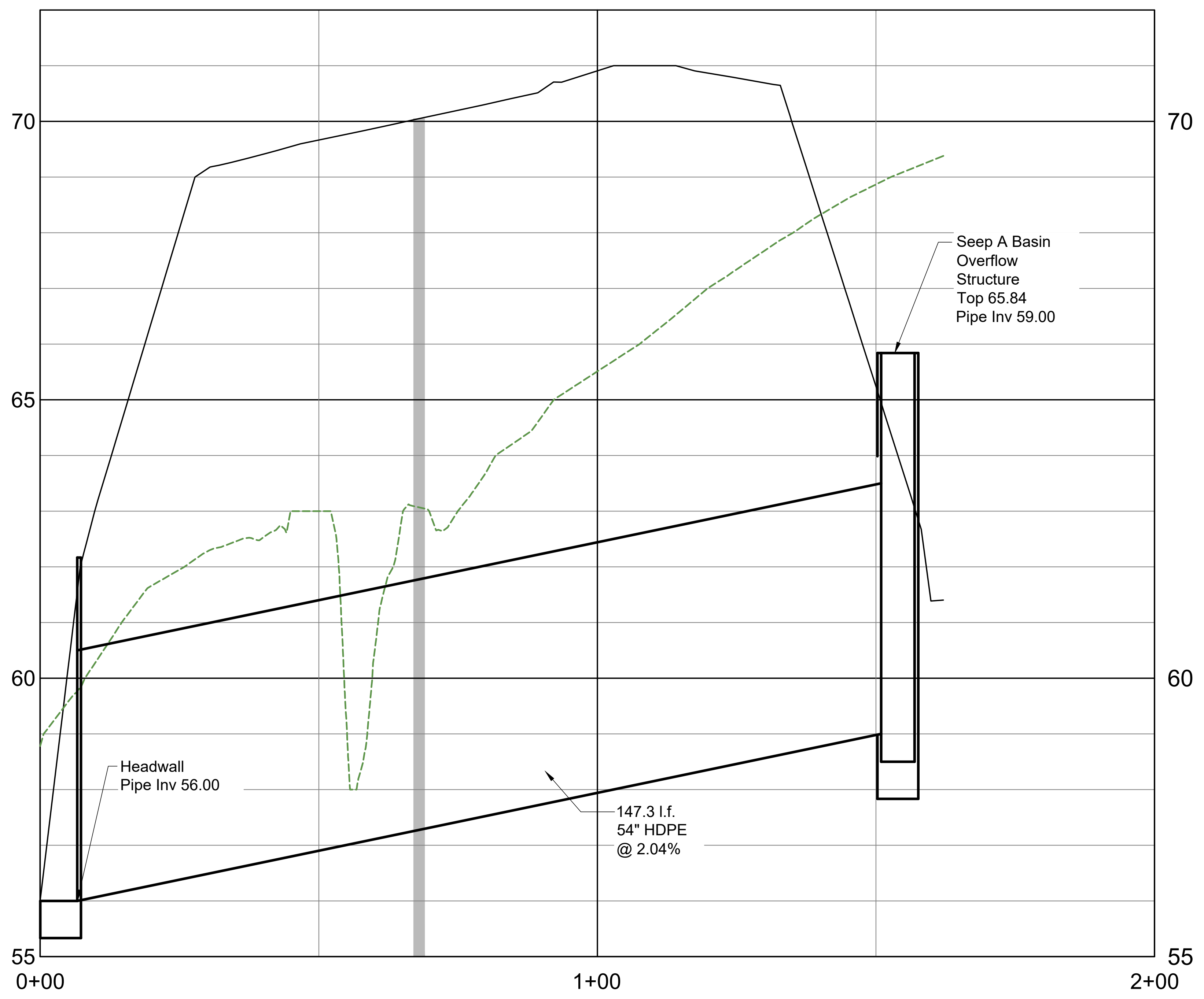
SCALE: 1" = 20'
0' 20' 40'

Seep A - Basin Notes

1. The existing elevation of the seep channel at the Barrier Road Crossing Location is higher than the adjacent low elevation of a portion of the drainage area to Seep A. Therefore, the basin for Seep A is located in the lower area and the Dry Weather Flow and the $\frac{1}{2}$" Rainfall Runoff from Seep A will be piped to the pond.
2. Shape and volume of basin, elevations of structures and pipes are critical to operation of the basin. The intent of the basin is to capture the Dry Weather Flow from Seep A and to capture the runoff from the $\frac{1}{2}$" rainfall from Seep A Drainage Area.
3. The grades and elevations shown are final grades and elevations. Contractor shall examine liner details to determine depth of liner and buffer requirements above the liner. The grades and elevations shown represent the top of the buffer.
4. The entire basin and all 3:1 slopes shall include permanent seeding and erosion control matting.
5. The outlet structure is sized to allow discharge of the 100-year storm while maintaining a maximum surface water elevation of 69.19.



2 SC-1.1 Seep A – Capture Pipe Profile



3 SC-1.1 Seep A Basin – Overflow Pipe Profile

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Capture System - Grading Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

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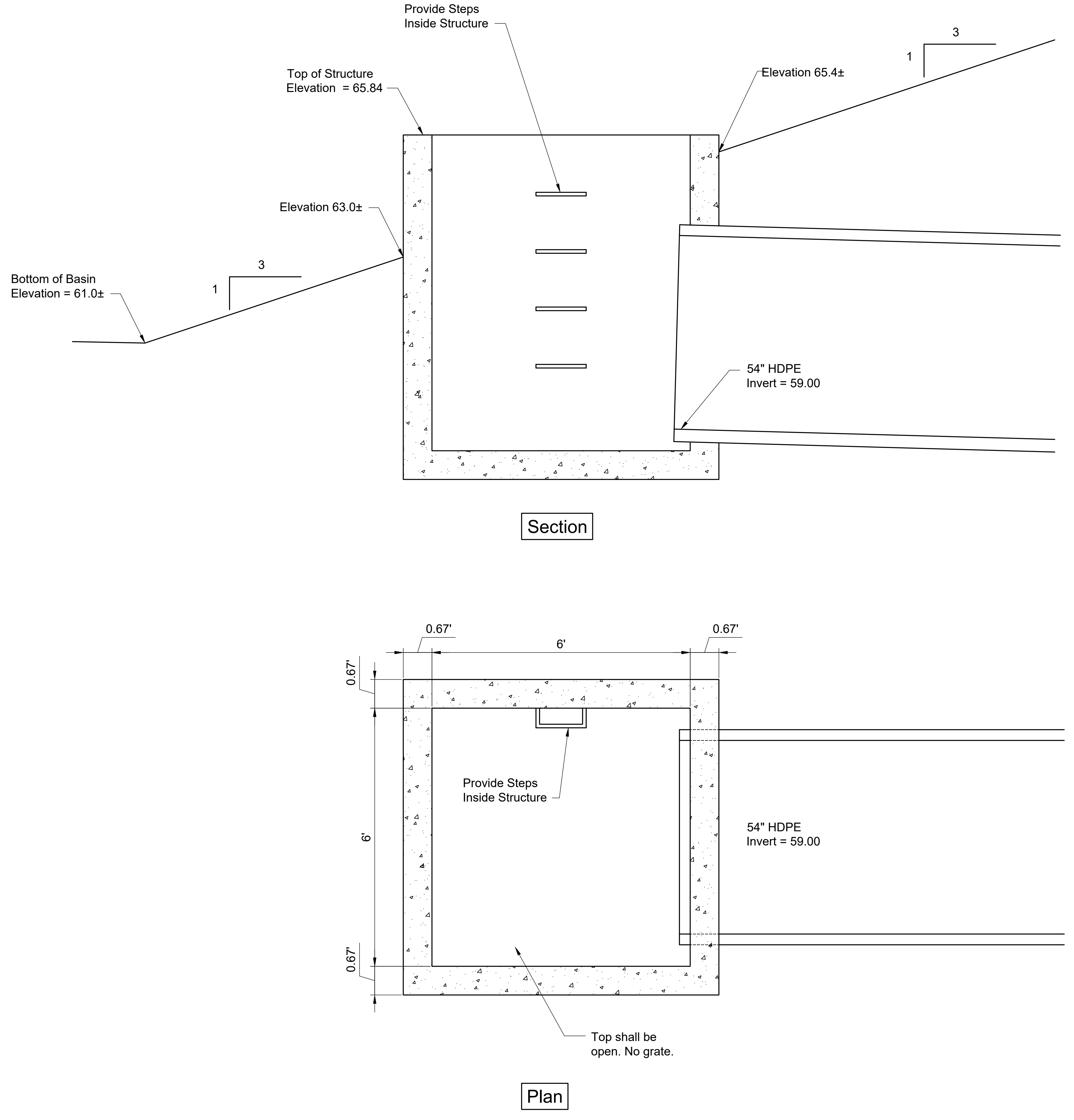
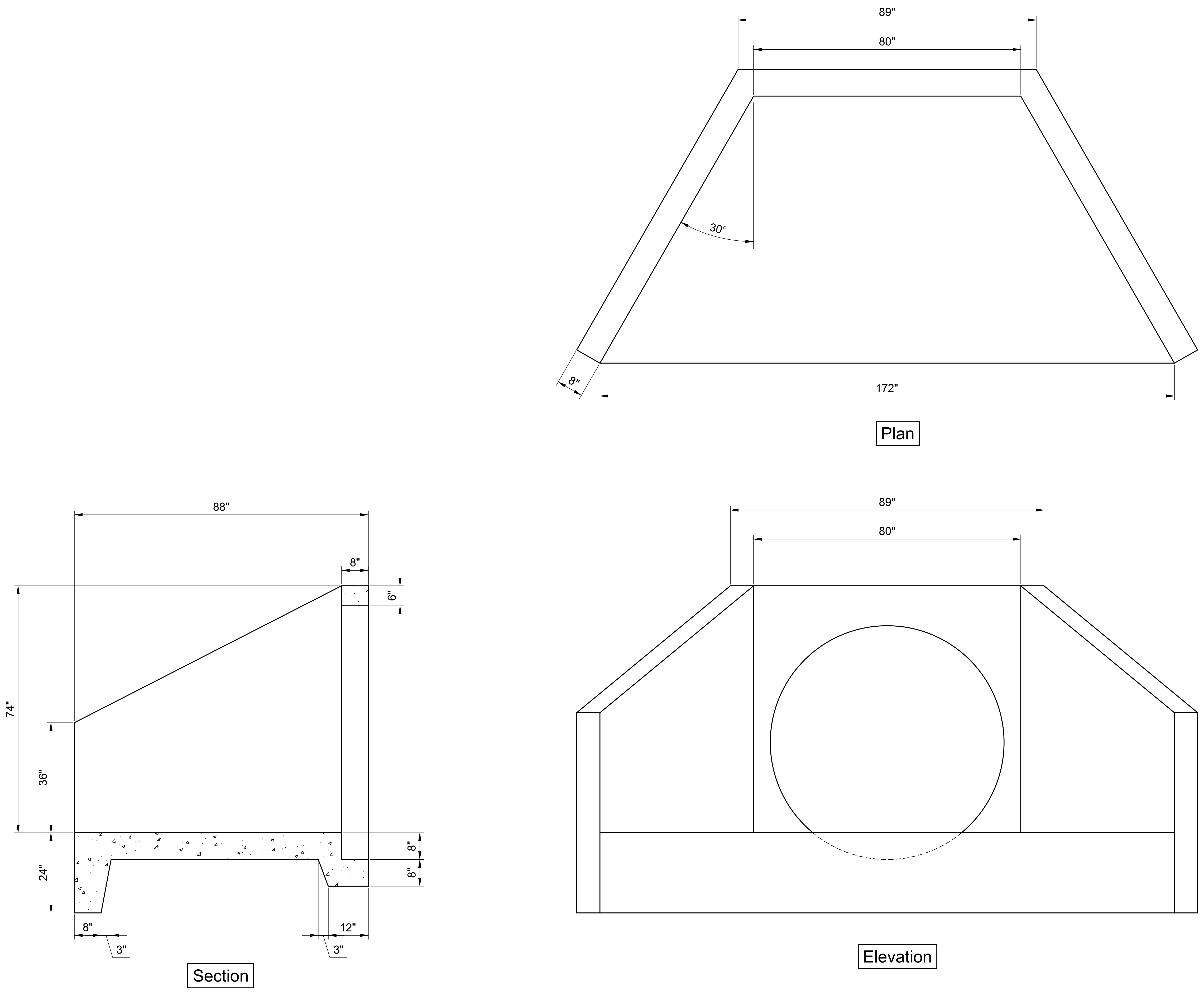
PROJECT NUMBER:
45-20803



1 SC-1.2 Seep A – Overflow Structure



2 SC-1.2 Seep A – 54" Pipe Concrete Headwall

Seep A - Overflow Structure Operation

1. The Seep A Basin will hold the 24-hour Dry Weather Volume 44,640 gallons (31 gpm x 1,440 minutes) and the runoff volume from the ½" storm - 110,000 gallons before it overtops the overflow structure. All volumes/storms larger than than the combined volume of 154,640 gallons will overtop the structure and discharge downstream of the barrier wall.
2. The overflow structure is designed for the 100-year storm event.

Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Capture System - Pump Station

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

SCALE:
AS SHOWN

DATE:
February 2022

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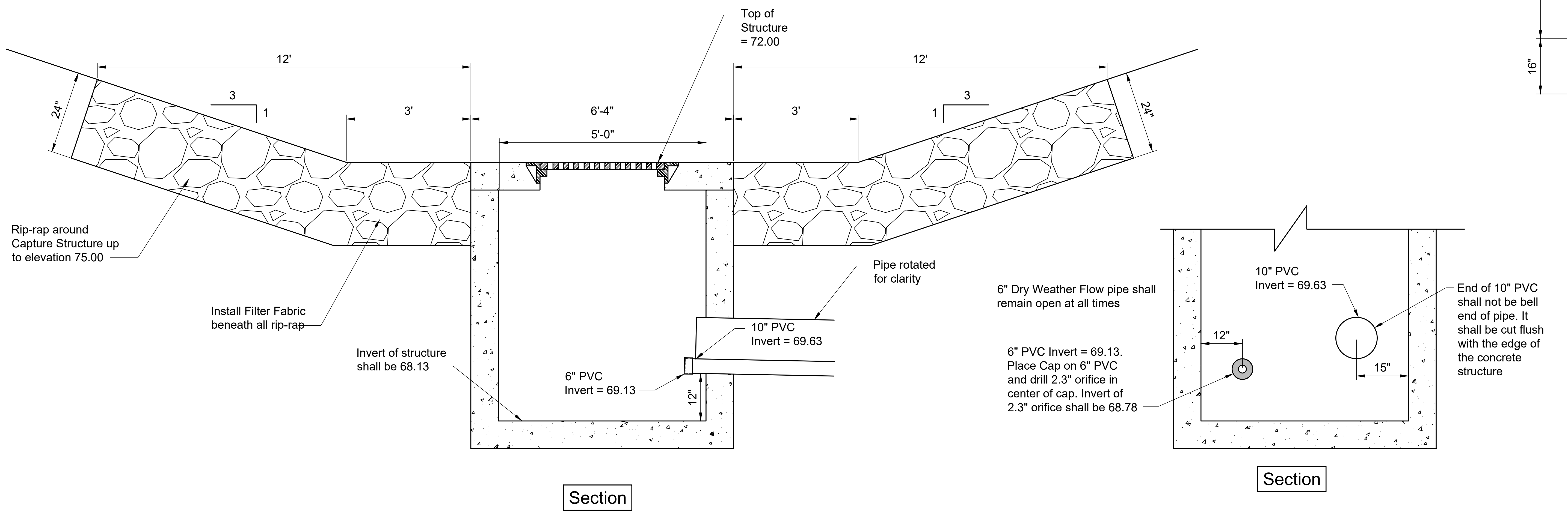
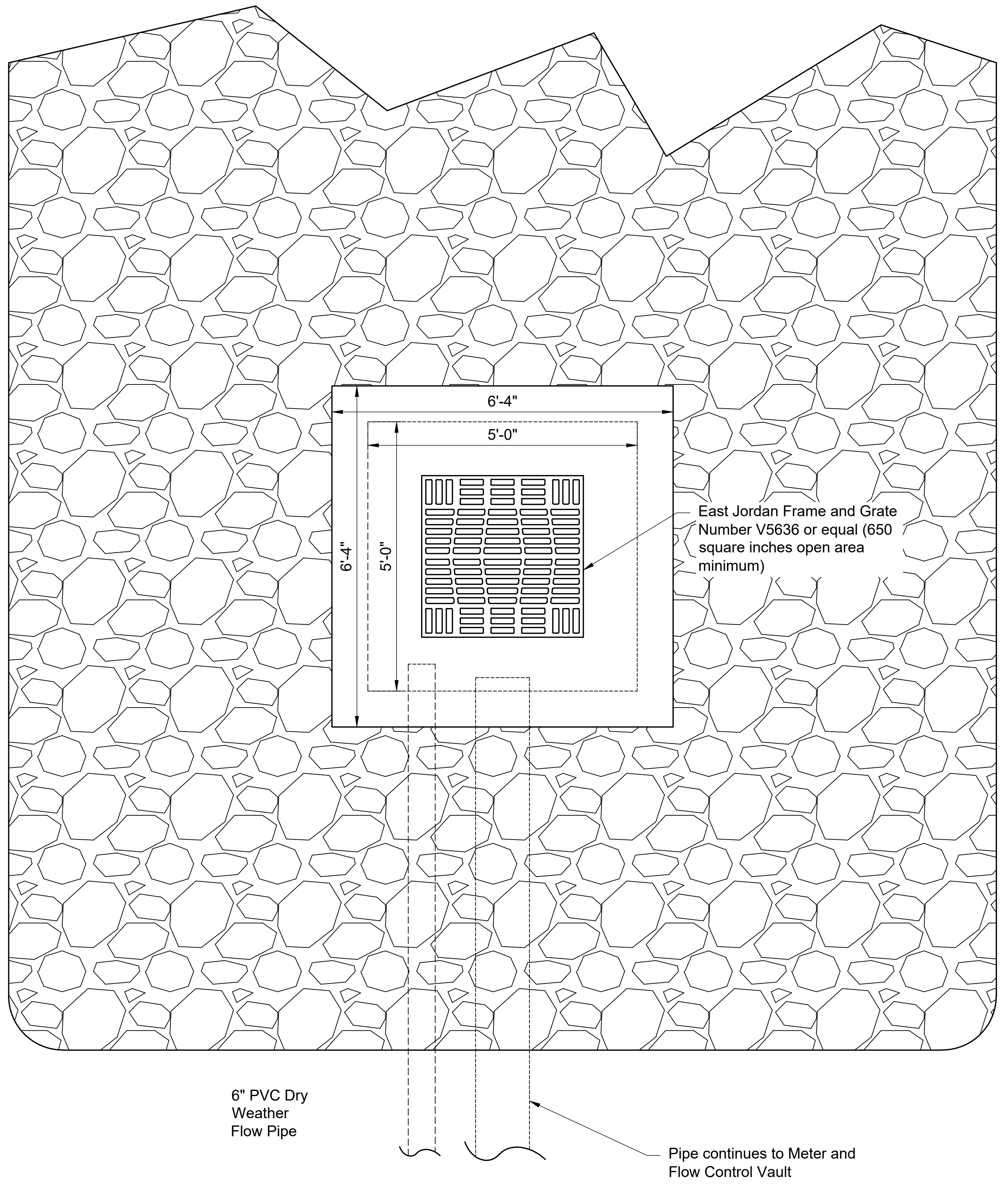
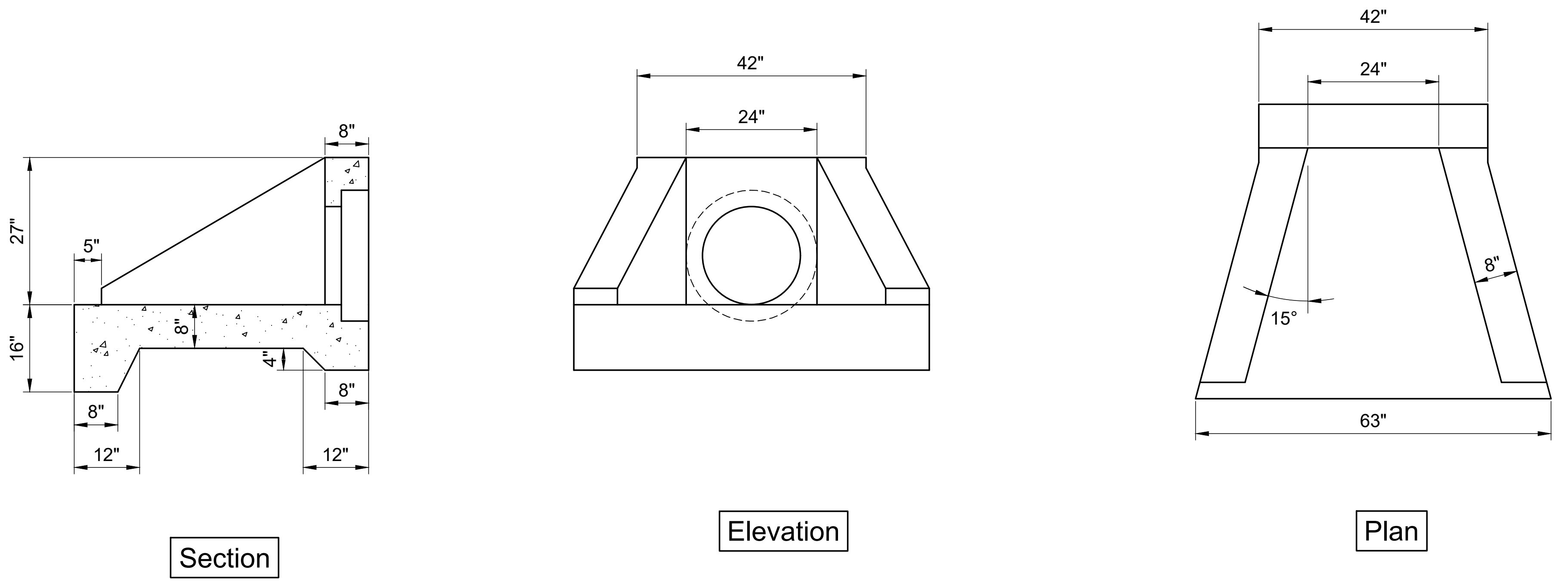
SC-1.2

PROJECT NUMBER:
45-20803





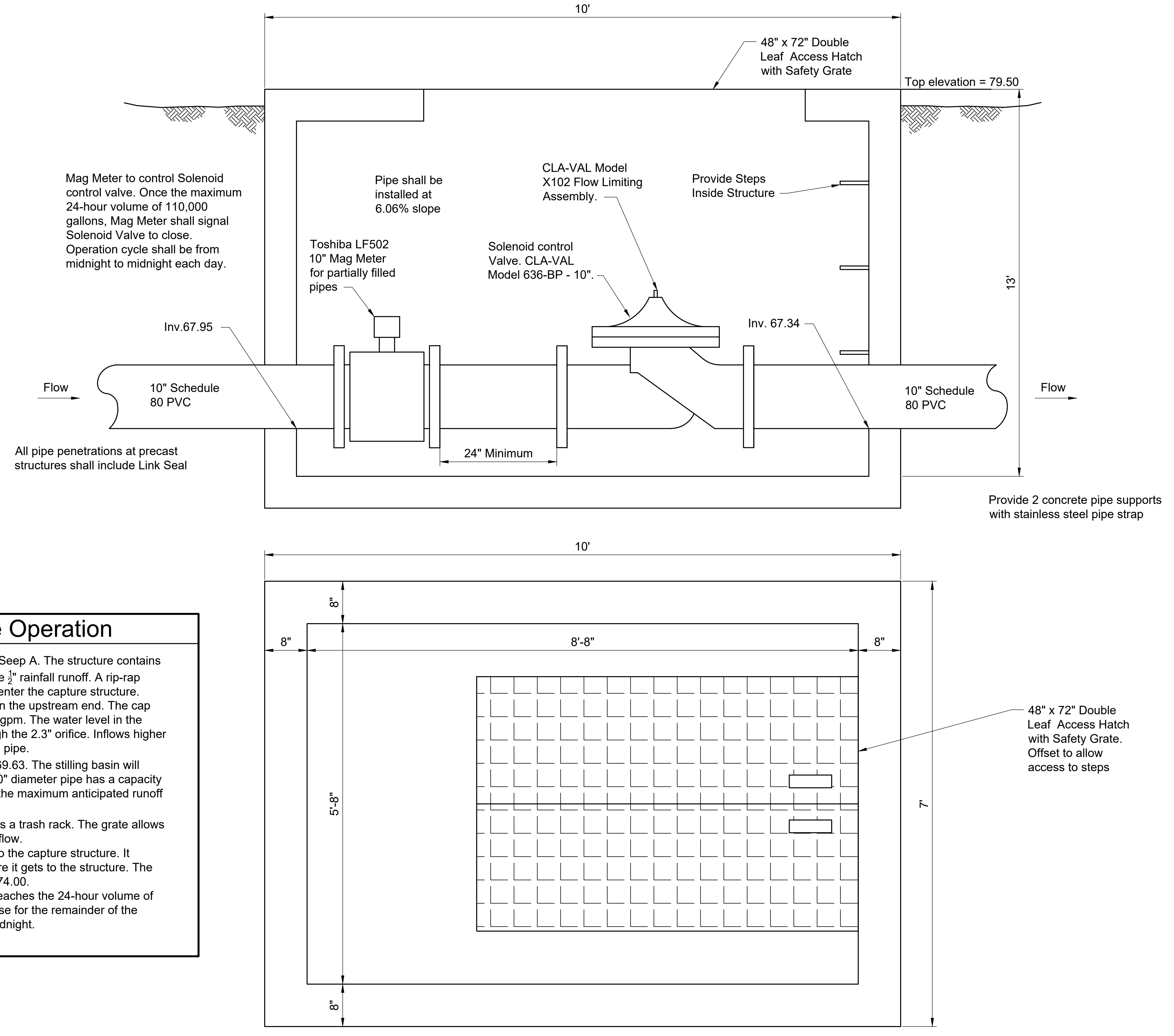
1 SC-1.3 Seep A – Capture Structure



2 SC-1.3 Seep A – 12" Pipe Concrete Headwall

Seep A - Capture Structure Operation

1. The Seep A Capture Structure is located in the flow channel of Seep A. The structure contains 2 pipes - one for the Dry Weather Flow (31 gpm) and one for the $\frac{1}{2}$" rainfall runoff. A rip-rap stilling basin will be constructed to allow the water to pond and enter the capture structure.
2. Dry Weather Flow Pipe - This pipe is a 6" diameter with a cap on the upstream end. The cap will include a 2.3" orifice to control the flow to approximately 31 gpm. The water level in the structure should pond to elevation 69.63 to allow 31 gpm through the 2.3" orifice. Inflows higher than 31 gpm will pond higher than 69.63 and will go into the 12" pipe.
3. $\frac{1}{2}$" Rainfall Runoff Pipe: This pipe is 10" diameter. The invert is 69.63. The stilling basin will allow the water to pond up to elevation 74.00 which gives the 10" diameter pipe has a capacity of 2,400 gpm with Headwater Elevation at 74.00. 2,400 gpm is the maximum anticipated runoff flow rate from the $\frac{1}{2}$" rainfall .
4. Structure Capacity - the structure includes a grate that will act as a trash rack. The grate allows more flow through than the pipe capacity and will not affect the flow.
5. Stilling Basin - The rip-rap stilling basin guides the lower flows to the capture structure. It includes an 8" high rip-rap check dam to filter some debris before it gets to the structure. The stilling basin includes a concrete overflow spillway at elevation 74.00.
6. The Mag Meter shall measure flow in the 10" pipe and once it reaches the 24-hour volume of 110,000 gallons, the meter shall signal the solenoid valve to close for the remainder of the 24-hour period. The 24-hour period shall reset every night at midnight.



3 SC-1.3 Seep A Capture Pipe – Meter and Flow Control Vault

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Capture System - Pump Station

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February, 2022	

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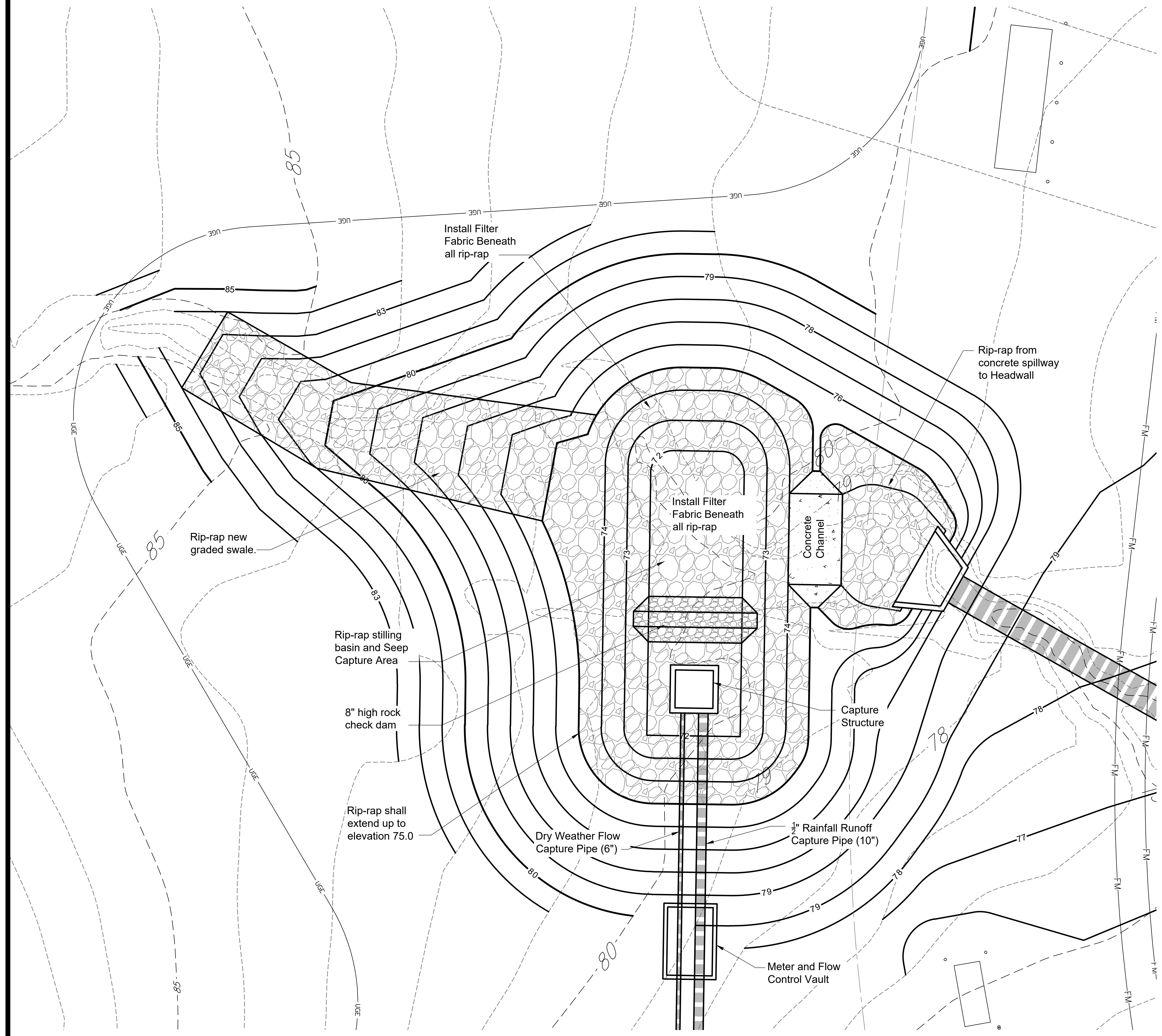
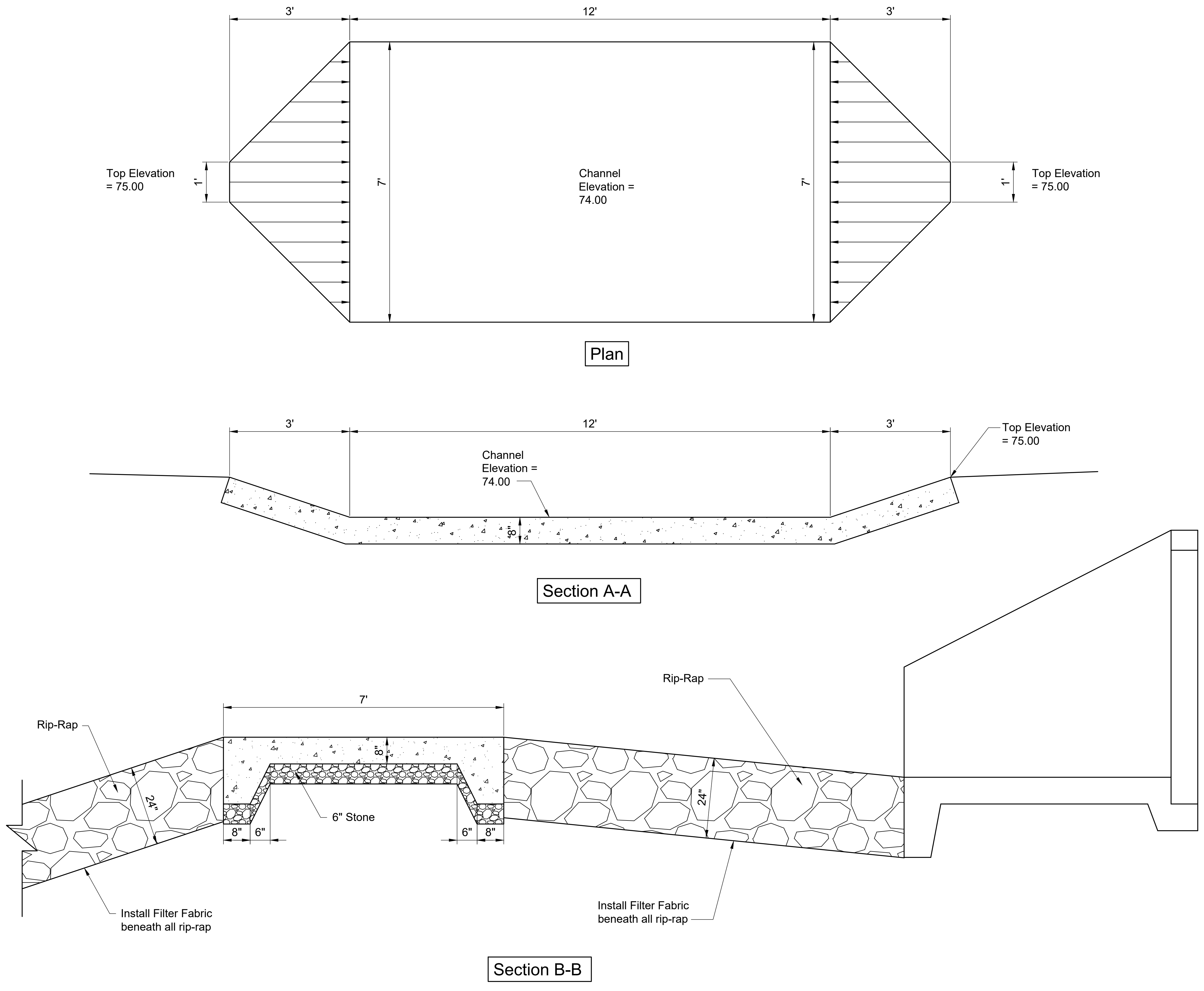
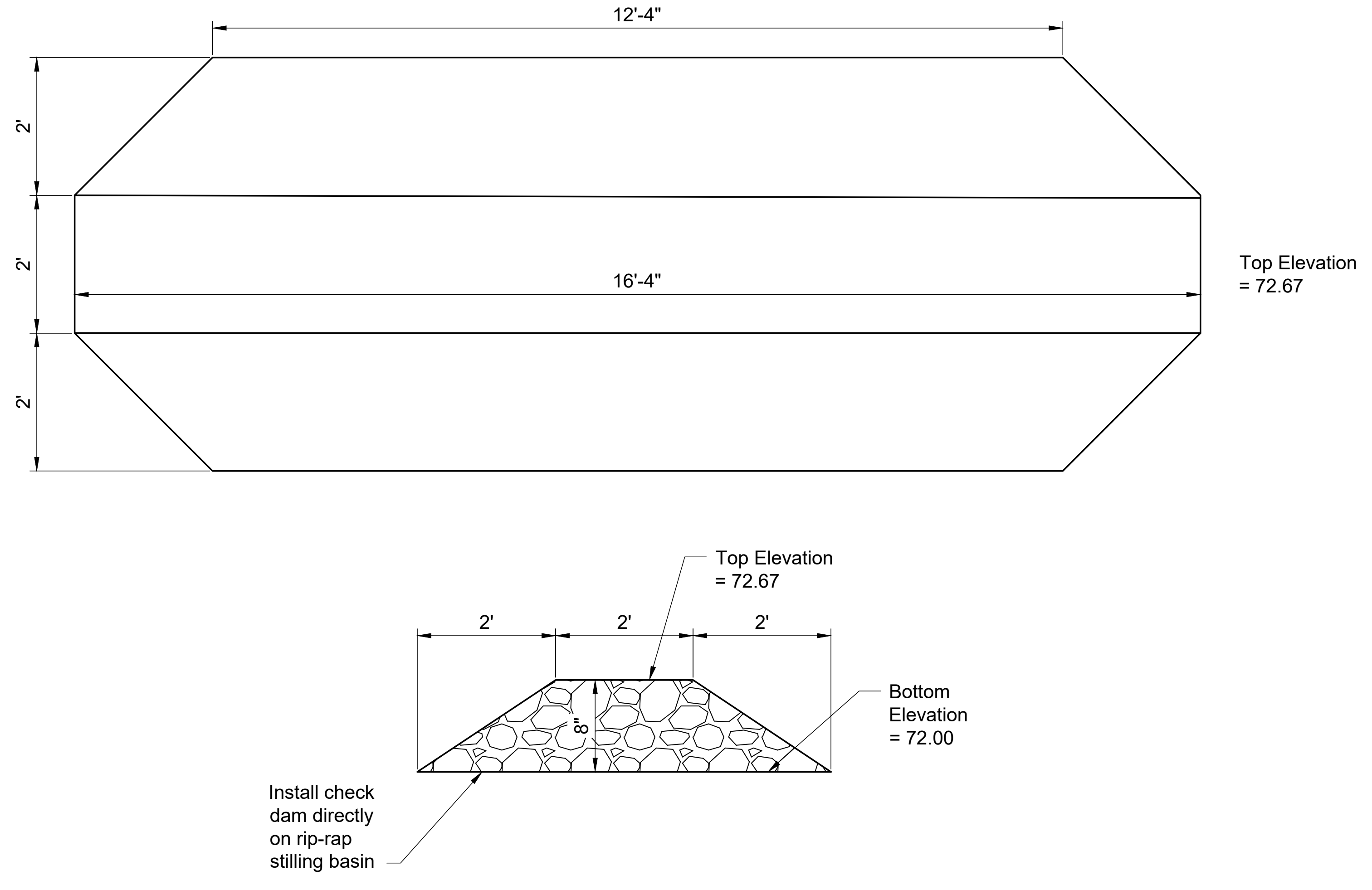
PROJECT NUMBER:
45-20803



① SC-1.4 Seep A – Capture Structure Stilling Basin



② SC-1.4 Seep A – Stilling Basin Concrete Channel



③ SC-1.4 Seep A – Stilling Basin Rock Check Dam

Seep A - Capture Structure Operation

1. The Seep A Capture Structure is located in the flow channel of Seep A. The structure contains 2 pipes - one for the Dry Weather Flow (31 gpm) and one for the $\frac{1}{2}$" rainfall runoff. A rip-rap stilling basin will be constructed to allow the water to pond and enter the capture structure.
2. Dry Weather Flow Pipe - This pipe is a 6" diameter with a cap on the upstream end. The cap will include a 2.3" orifice to control the flow to approximately 31 gpm. The water level in the structure should pond to elevation 69.63 to allow 31 gpm through the 2.3" orifice. Inflows higher than 31 gpm will pond higher than 69.63 and will go into the 12" pipe.
3. $\frac{1}{2}$" Rainfall Runoff Pipe: This pipe is 10" diameter. The invert is 69.63. The stilling basin will allow the water to pond up to elevation 74.00 which gives the 10" diameter pipe has a capacity of 2,400 gpm with Headwater Elevation at 74.00. 2,400 gpm is the maximum anticipated runoff flow rate from the $\frac{1}{2}$" rainfall .
4. Structure Capacity - the structure includes a grate that will act as a trash rack. The grate allows more flow through than the pipe capacity and will not affect the flow.
5. Stilling Basin - The rip-rap stilling basin guides the lower flows to the capture structure. It includes an 8" high rip-rap check dam to filter some debris before it gets to the structure. The stilling basin includes a concrete overflow spillway at elevation 74.00.
6. The Mag Meter shall measure flow in the 10" pipe and once it reaches the 24-hour volume of 110,000 gallons, the meter shall signal the solenoid valve to close for the remainder of the 24-hour period. The 24-hour period shall reset every night at midnight.

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Capture System - Pump Station

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB
REVIEWED BY: DKK
DESIGNED BY: BB
APPROVED BY:
SCALE: AS SHOWN
DATE: February 2022

Revisions

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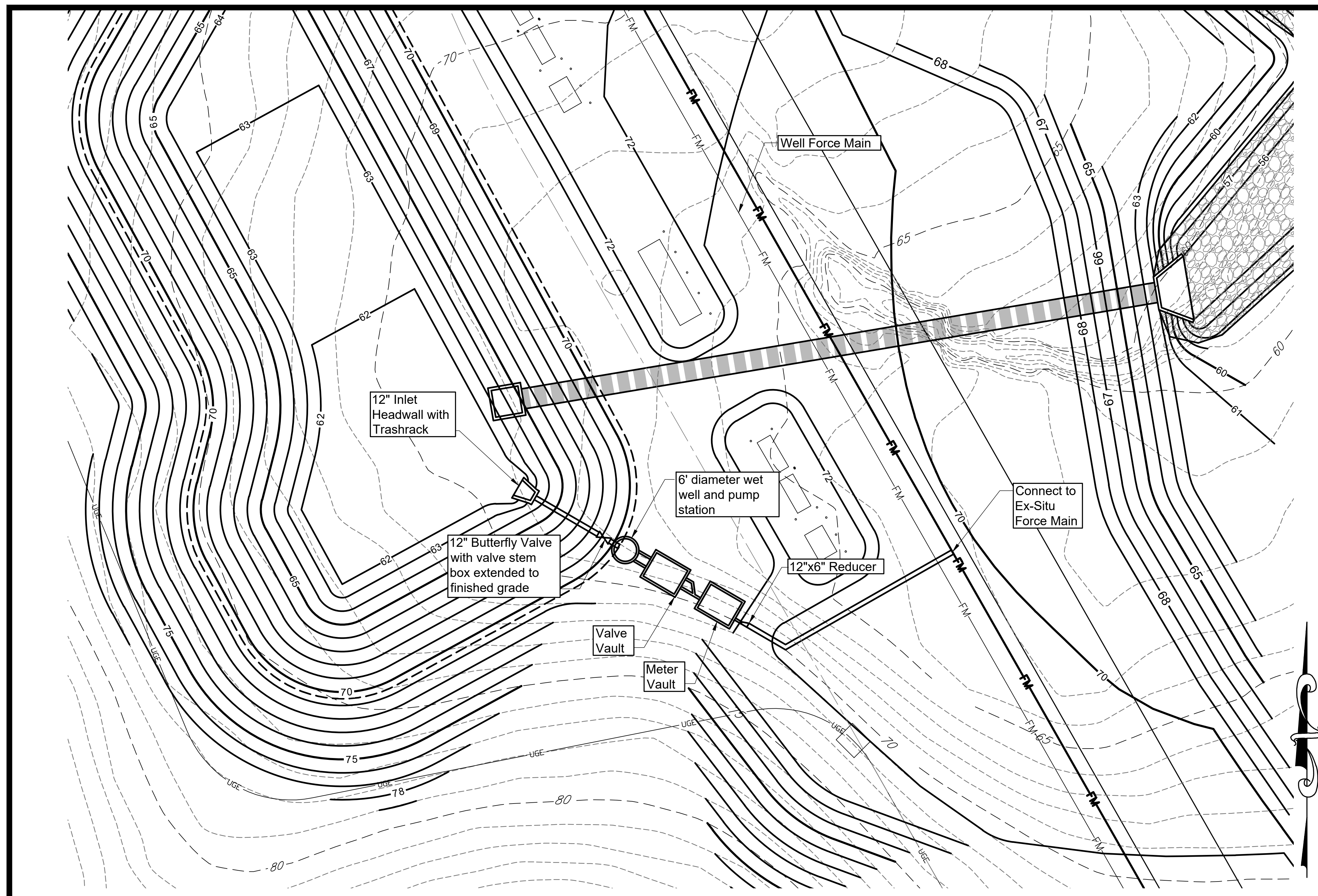
DRAWING: SC-1.4

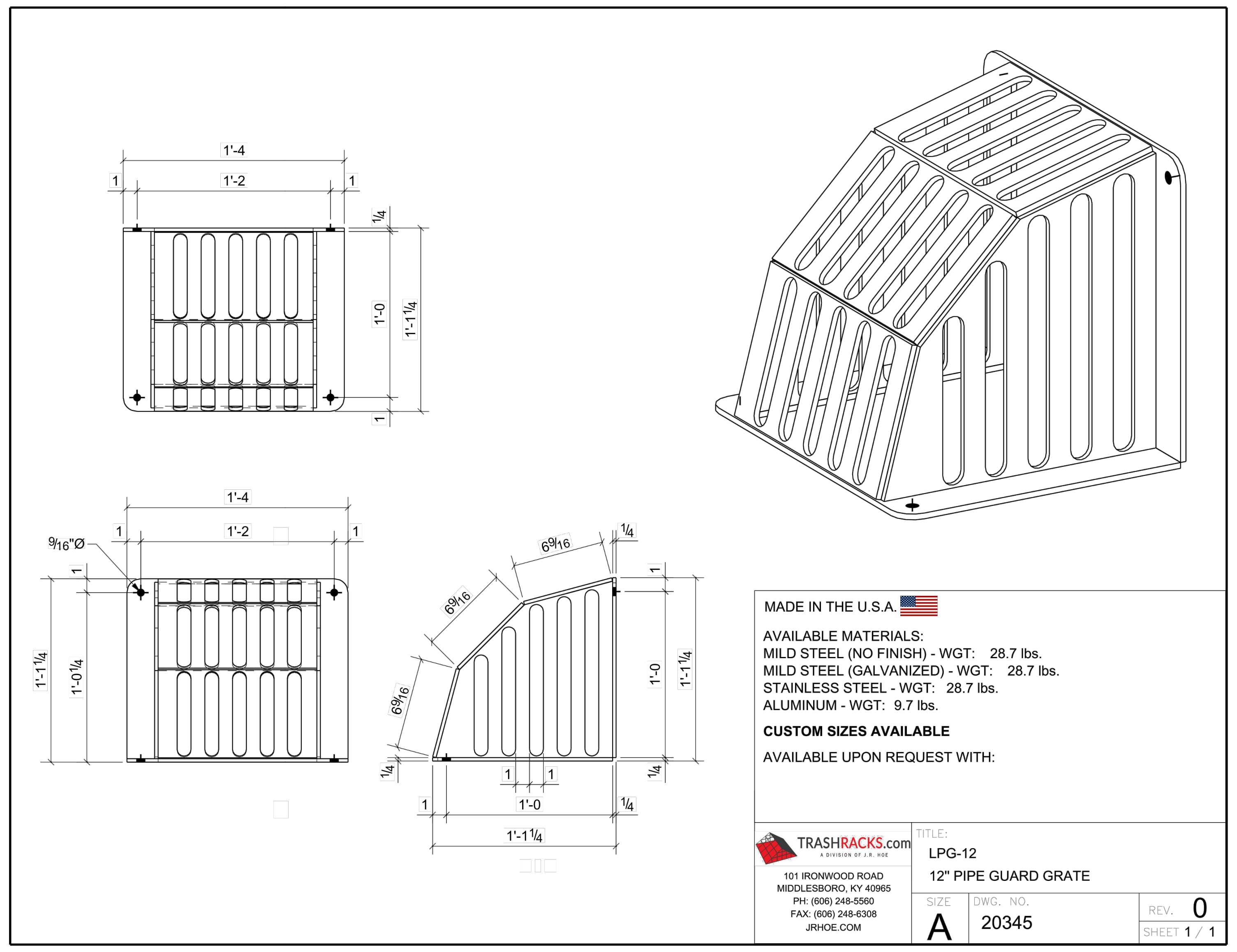
PROJECT NUMBER: 45-20803



1 SC-1.5 Seep A – Pump Station and Force Main Plan

Seep A - Pump Station Operation

1. The Seep A Basin is intended to catch the Dry Weather Flow and the runoff from the $\frac{1}{2}$" Rainfall each day.
2. The pump station will turn on at the end of each day and pump until the basin is dry.
   - 2.1. If their is no rainfall event, the basin will fill to the Dry Weather volume level. At the end of the day, the pump station will remove the water from the basin.
   - 2.2. If up to $\frac{1}{2}$" rainfall, the basin will fill to the $\frac{1}{2}$" rainfall runoff level. At the end of the day, the pump station will remove the Dry Weather flow and the $\frac{1}{2}$" Rainfall runoff from the basin.
   - 2.3. If greater than $\frac{1}{2}$" rainfall, the basin will fill above the $\frac{1}{2}$" rainfall runoff level and the additional depth will be discharged downstream via the overflow structure and pipe. At the end of the day, the pump station will remove the Dry Weather flow and the $\frac{1}{2}$" Rainfall runoff from the basin.



MADE IN THE U.S.A.

AVAILABLE MATERIALS:
MILD STEEL (NO FINISH) - WGT: 28.7 lbs.
MILD STEEL (GALVANIZED) - WGT: 28.7 lbs.
STAINLESS STEEL - WGT: 28.7 lbs.
ALUMINUM - WGT: 9.7 lbs.

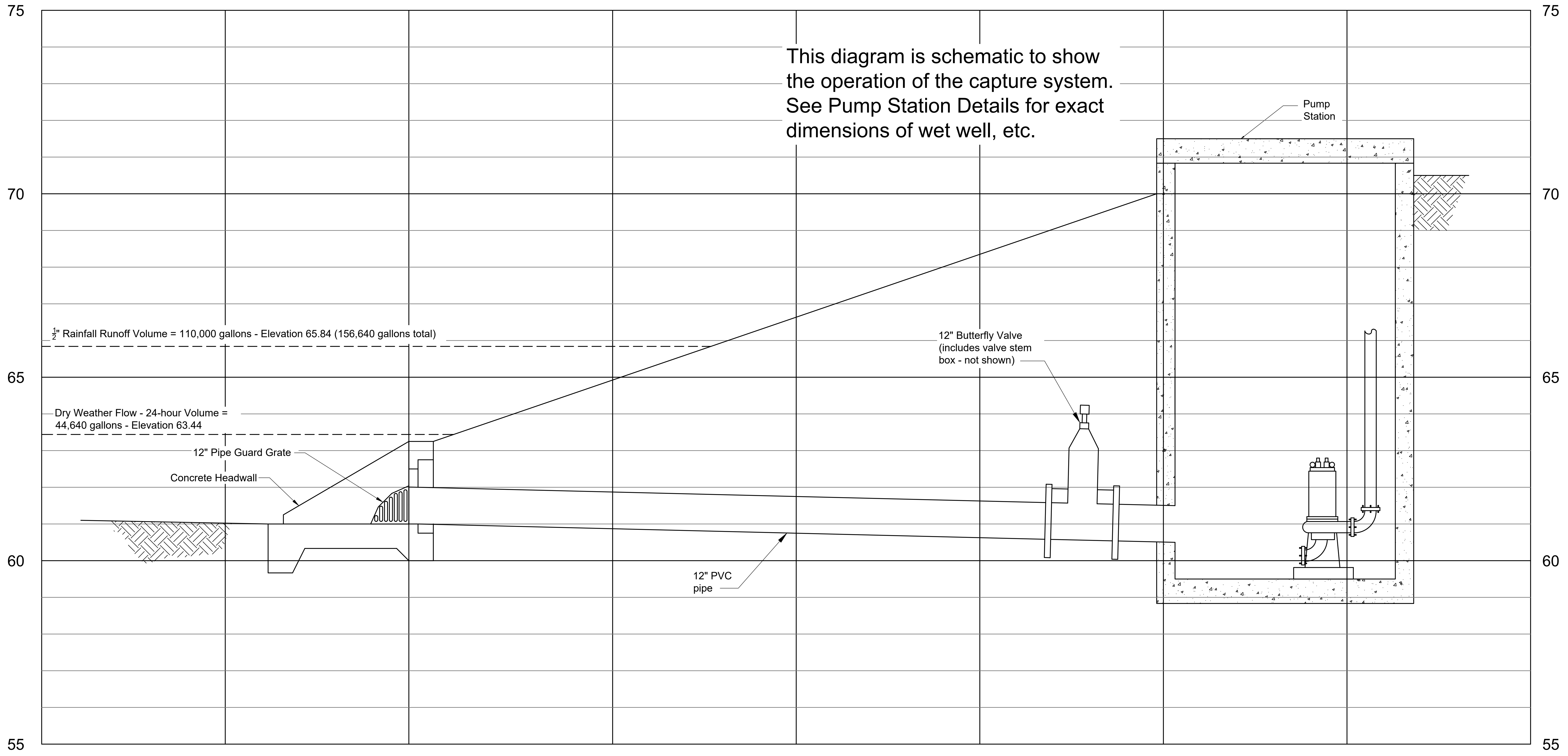
CUSTOM SIZES AVAILABLE

AVAILABLE UPON REQUEST WITH:

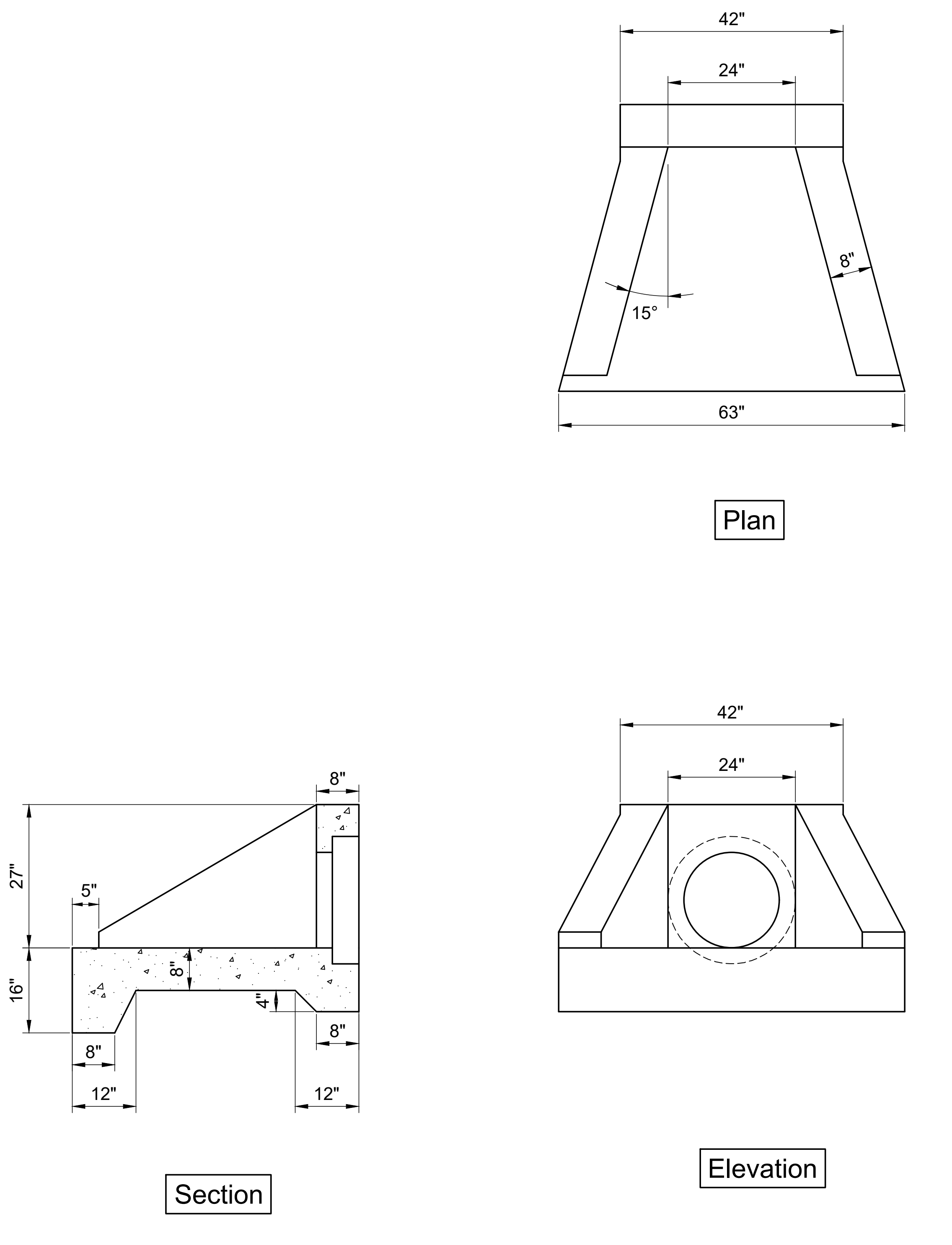
TRASHRACKS.com
A DIVISION OF J.R. HOE
101 IRONWOOD ROAD
MIDDLESBORO, KY 40965
PH: (606) 248-5560
FAX: (606) 248-6308
JRHOE.COM

TITLE: LPG-12
12" PIPE GUARD GRATE
SIZE A
DWG. NO. 20345
REV. 0
SHEET 1 / 1

3 SC-1.5 12" Pipe Guard Grate



2 SC-1.5 Seep A – Gravity Line from Basin to Wet Well Profile



4 SC-1.5 Seep A – 12" Pipe Concrete Headwall

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

SCALE: AS SHOWN
DATE: February 2022

Revisions

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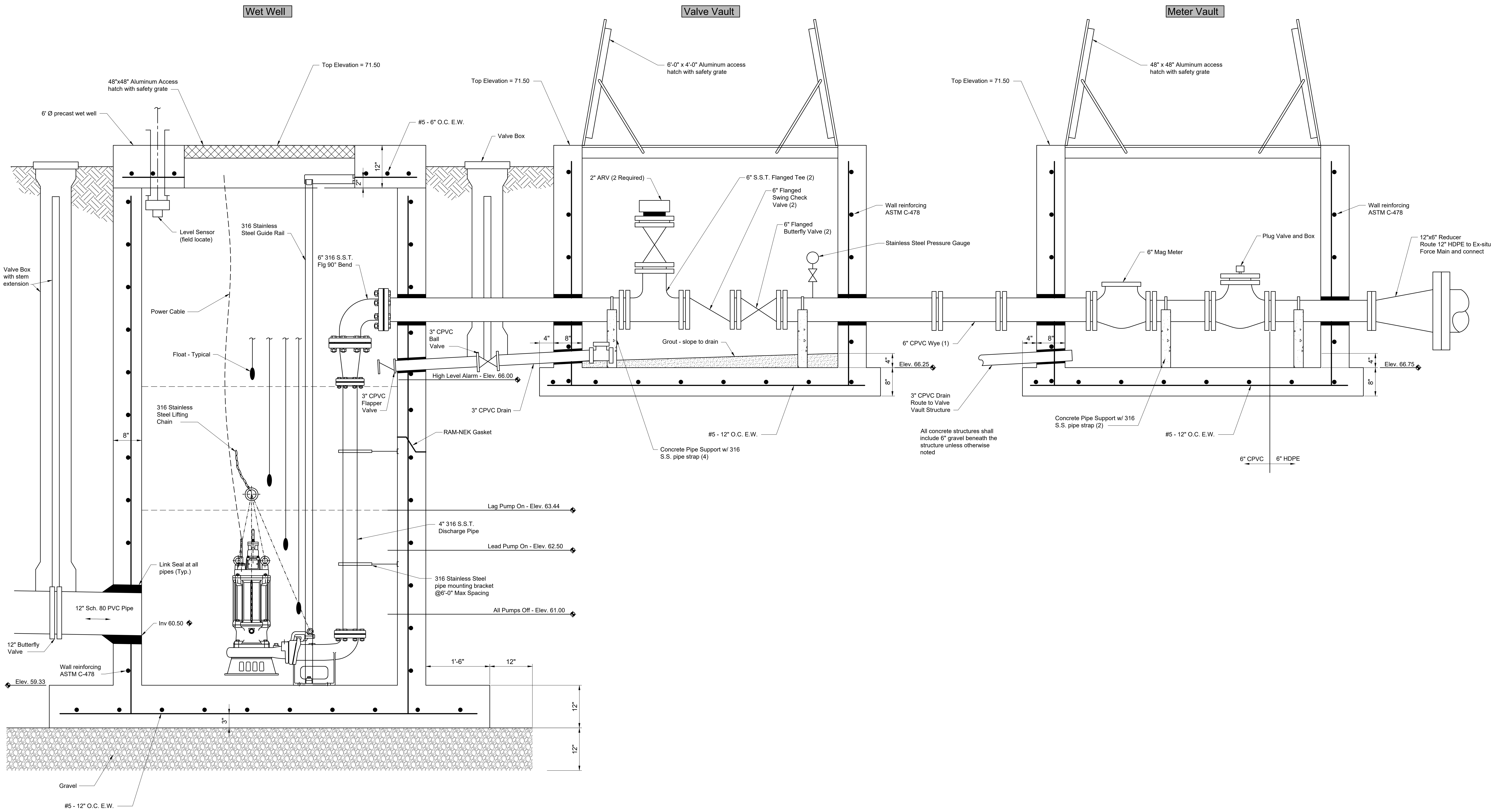
DRAWING: SC-1.5
PROJECT NUMBER: 45-20803



1 SC-1.6 Seep A – Pump Station Section

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY:	APPROVED BY:
BB	

SCALE:
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February 2022

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DRAWING:
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PROJECT NUMBER:
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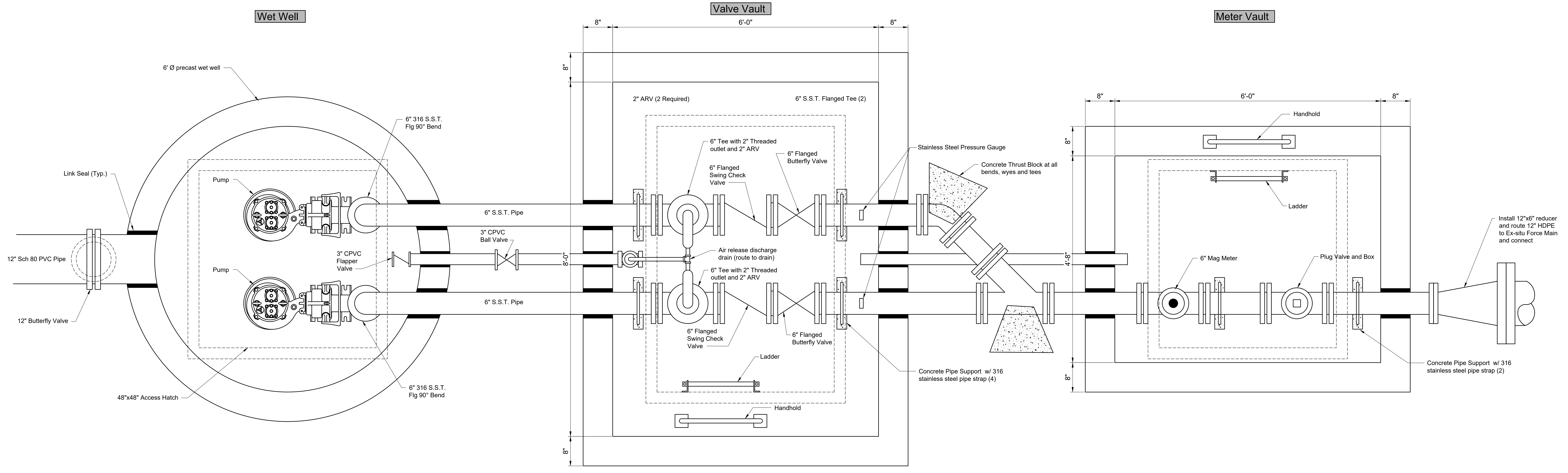
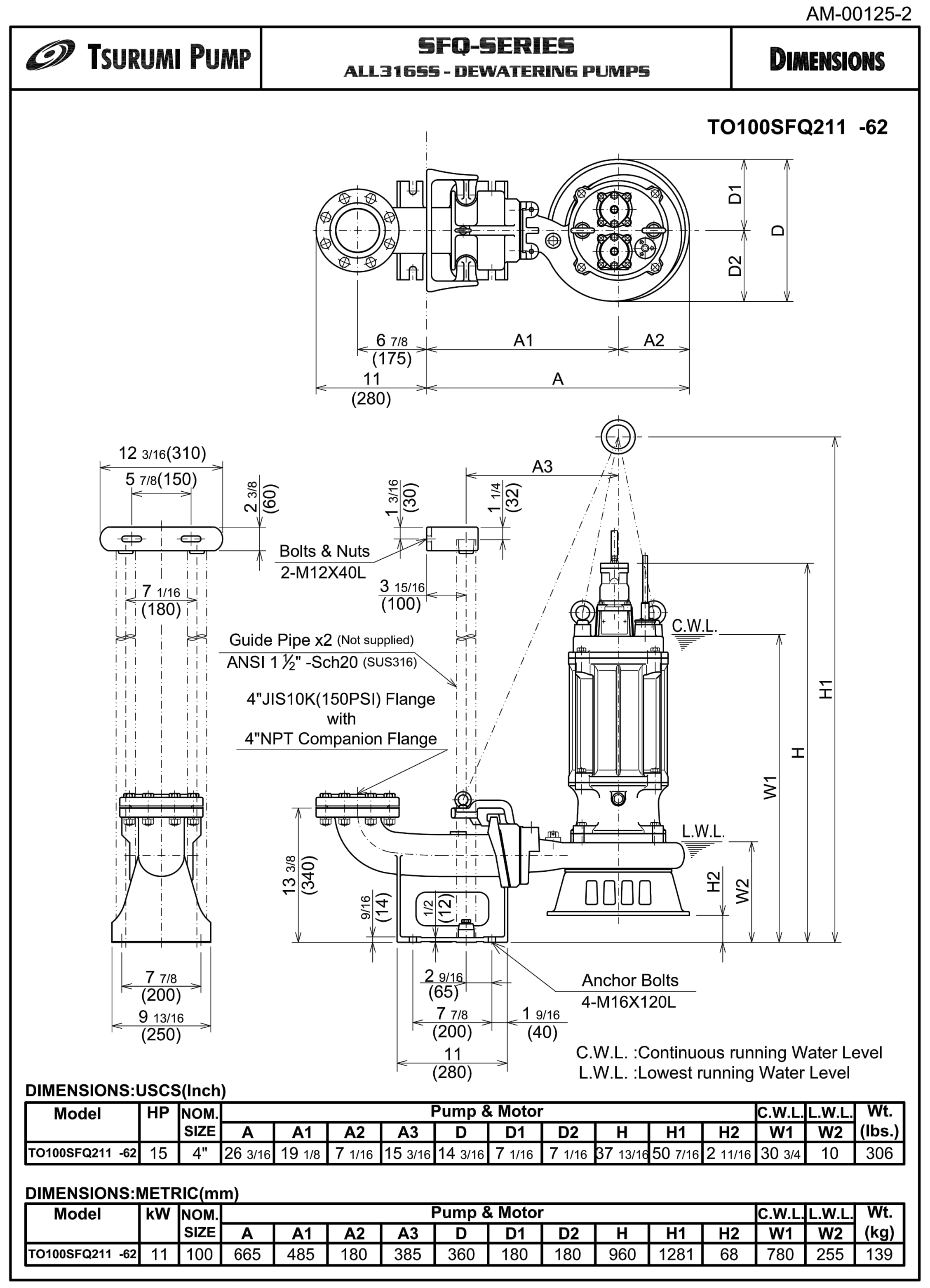


1
SC-1.7
Seep A – Pump Station Section



C.W.L. :Continuous running Water Level
L.W.L. :Lowest running Water Level

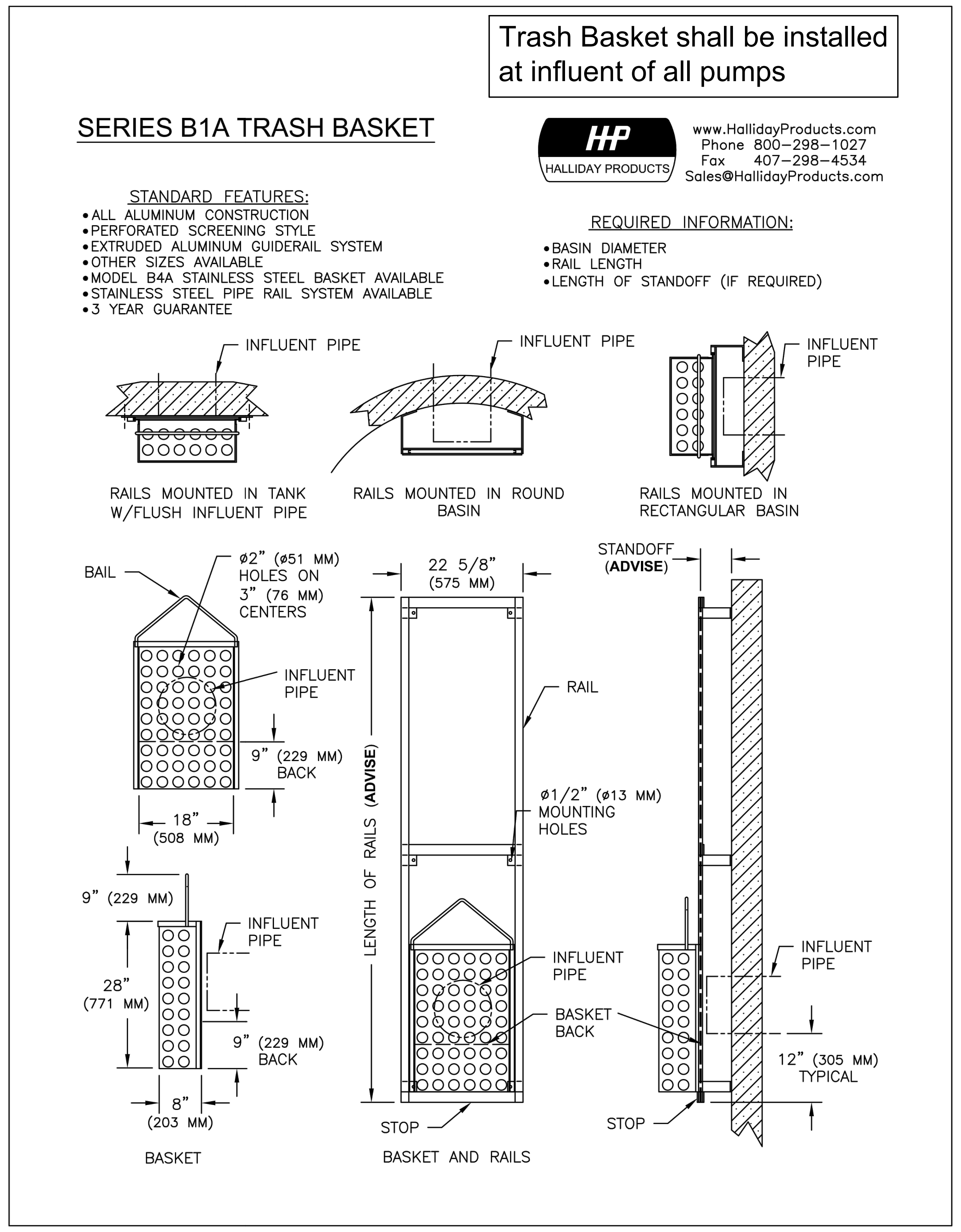
DIMENSIONS:USCS(Inch)

Model	HP	NOM. SIZE	Pump & Motor										C.W.L.	L.W.L.	Wt.
			A	A1	A2	A3	D	D1	D2	H	H1	H2	W1	W2	(lbs.)
TO100SFQ211 -62	15	4"	26 3/16	19 1/8	7 1/16	15 3/16	14 3/16	7 1/16	7 1/16	37 13/16	50 7/16	2 11/16	30 3/4	10	306

DIMENSIONS:METRIC(mm)

Model	kW	NOM. SIZE	Pump & Motor										C.W.L.	L.W.L.	Wt.
			A	A1	A2	A3	D	D1	D2	H	H1	H2	W1	W2	(kg)
TO100SFQ211 -62	11	100	665	485	180	385	360	180	180	960	1281	68	780	255	139

2
SC-1.7
Duplex Pumps


Trash Basket shall be installed at influent of all pumps

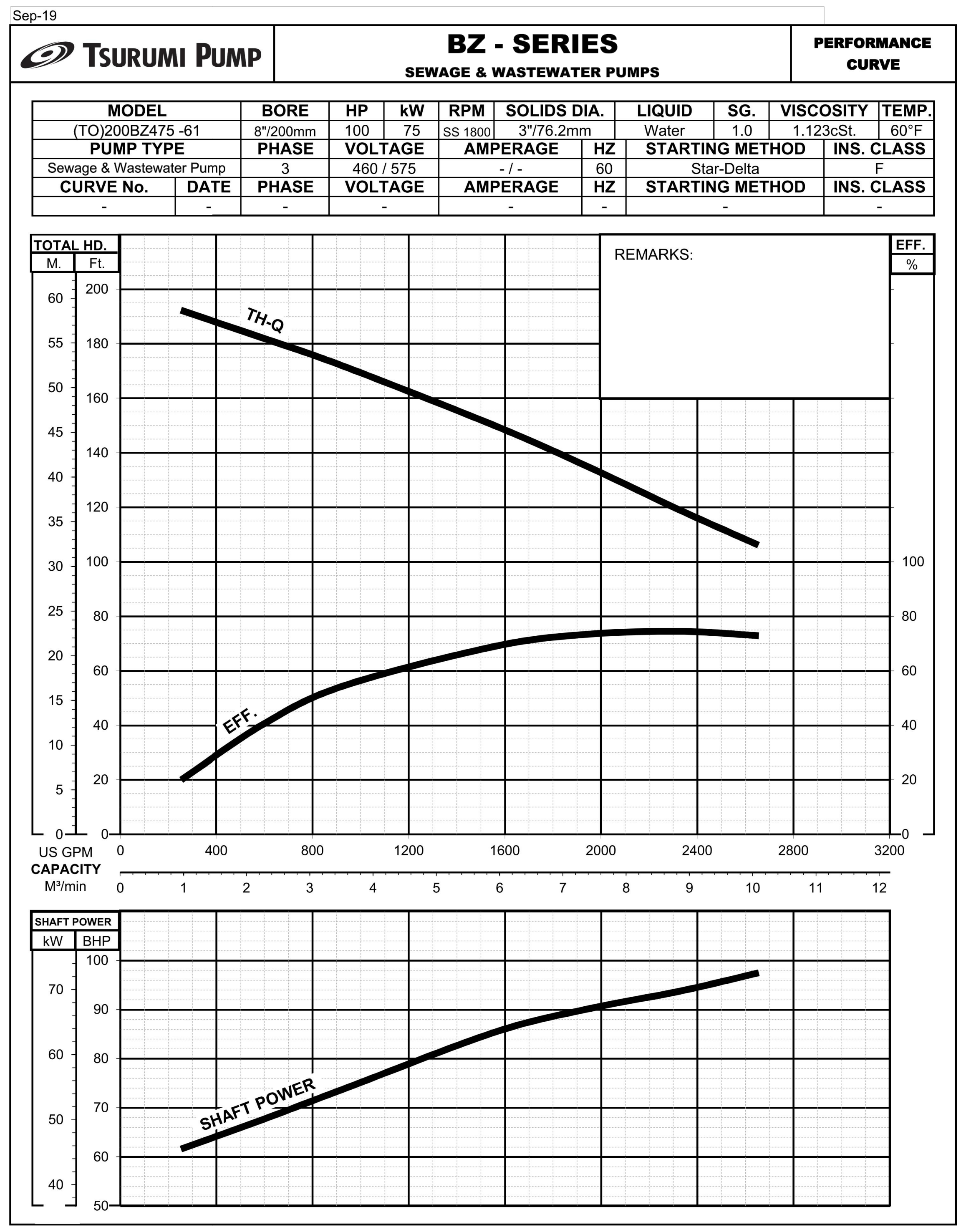
SERIES B1A TRASH BASKET

HP
HALLIDAY PRODUCTS
www.HallidayProducts.com
Phone 800–298–1027
Fax 407–298–4534
Sales@HallidayProducts.com

STANDARD FEATURES:
- ALL ALUMINUM CONSTRUCTION
- PERFORATED SCREENING STYLE
- EXTRUDED ALUMINUM GUIDERAIL SYSTEM
- OTHER SIZES AVAILABLE
- MODEL B4A STAINLESS STEEL BASKET AVAILABLE
- STAINLESS STEEL PIPE RAIL SYSTEM AVAILABLE
- 3 YEAR GUARANTEE

REQUIRED INFORMATION:
- BASIN DIAMETER
- RAIL LENGTH
- LENGTH OF STANDOFF (IF REQUIRED)

3
SC-1.7
Trash Basket


Sep-19

TSURUMI PUMP
BZ - SERIES
SEWAGE & WASTEWATER PUMPS
PERFORMANCE CURVE

MODEL		BORE	HP	kW	RPM	SOLIDS DIA.	LIQUID	SG.	VISCOSITY	TEMP.
(TO)200BZ475 -61		8"/200mm	100	75	SS 1800	3"/76.2mm	Water	1.0	1.123cSt.	60°F
PUMP TYPE		PHASE	VOLTAGE		AMPERAGE		HZ	STARTING METHOD		INS. CLASS
Sewage & Wastewater Pump		3	460 / 575		- / -		60	Star-Delta		F
CURVE No.	DATE	PHASE	VOLTAGE		AMPERAGE		HZ	STARTING METHOD		INS. CLASS
-	-	-	-		-		-	-		-

REMARKS:

4
SC-1.7
Pump Curve

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY:	APPROVED BY:
BB	

SCALE:
AS SHOWN

DATE:
February 2022

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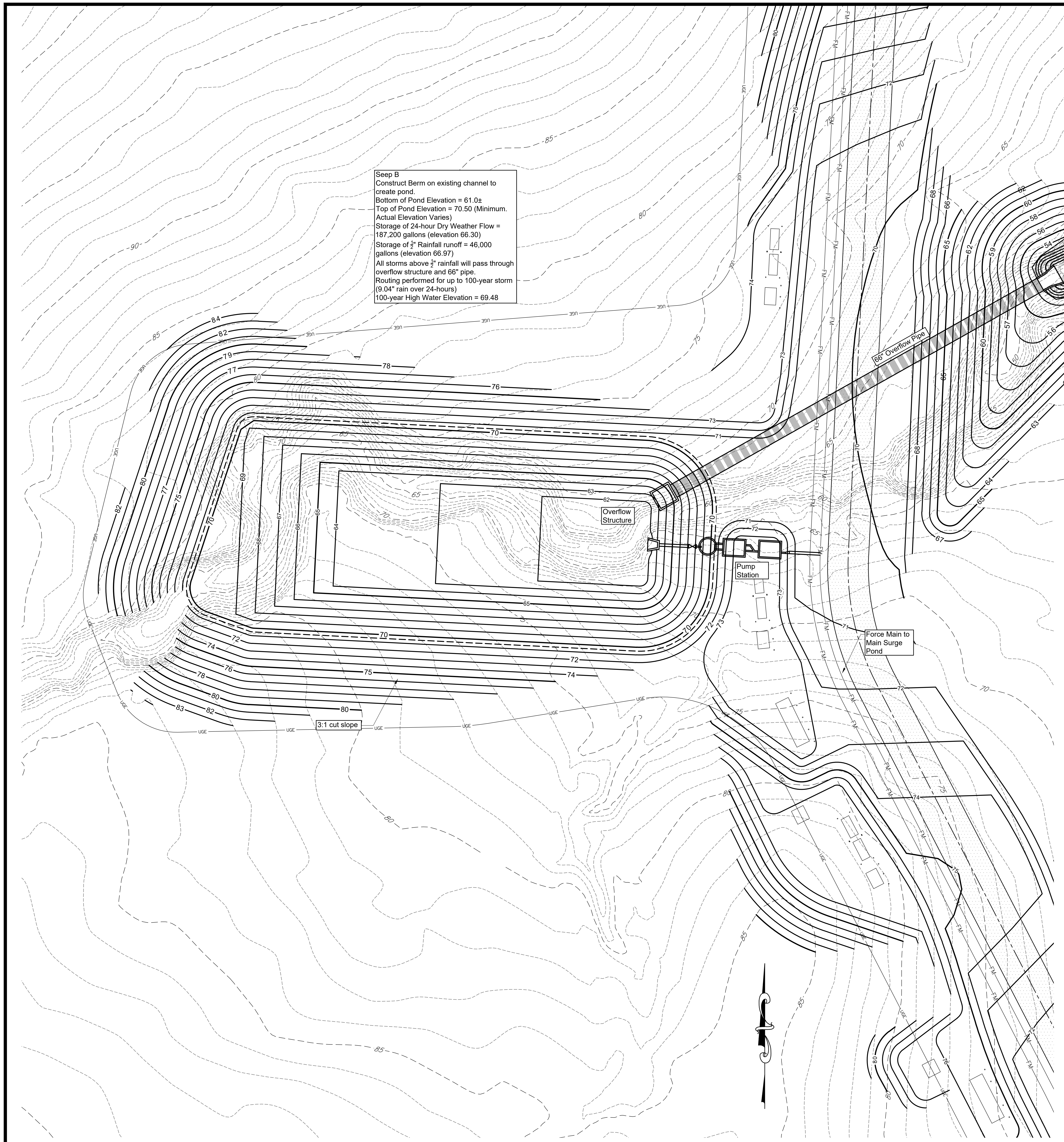
PROJECT NUMBER:
45-20803

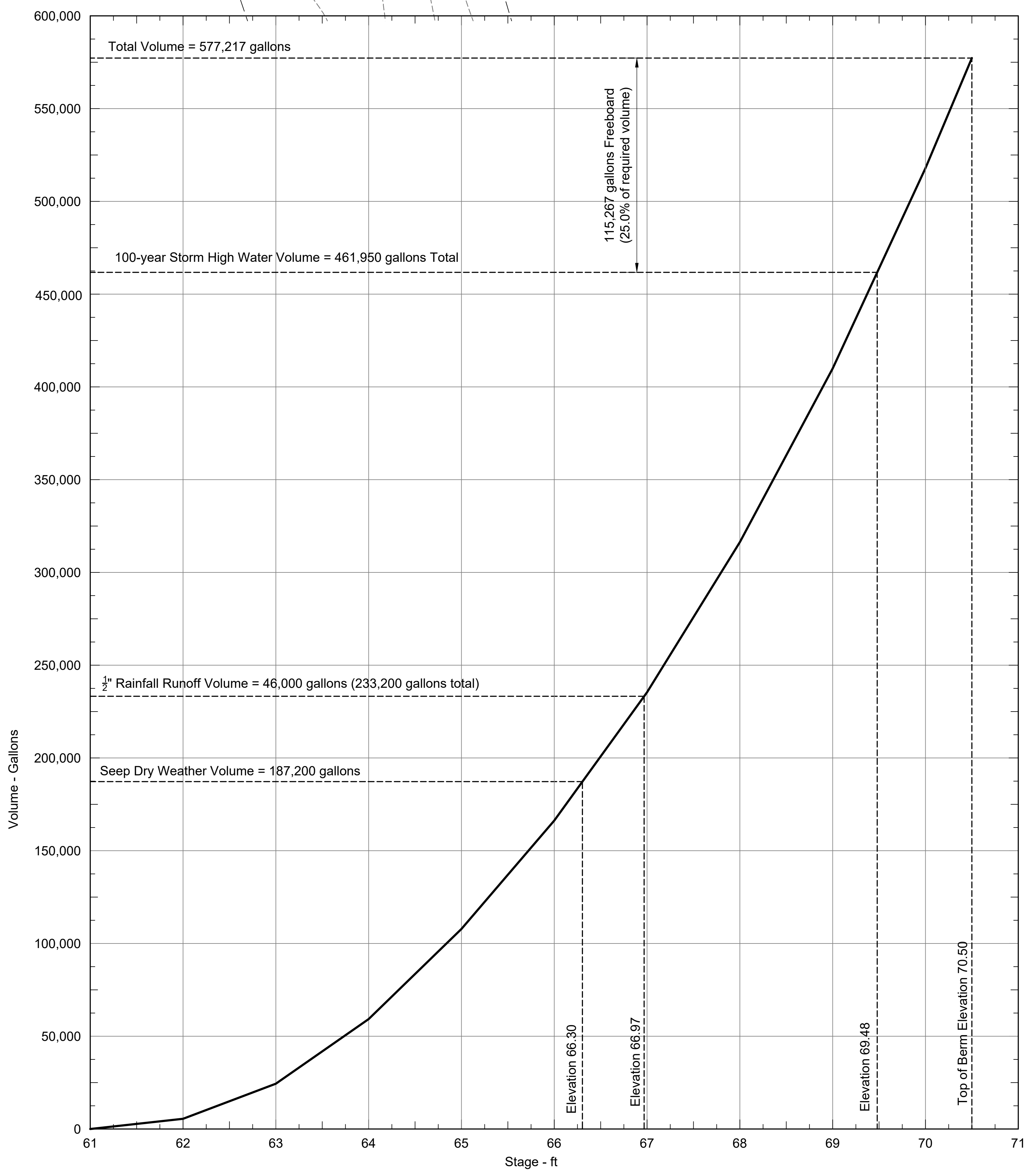


Seep B
Construct Berm on existing channel to create pond.
Bottom of Pond Elevation = 61.0±
Top of Pond Elevation = 70.50 (Minimum. Actual Elevation Varies)
Storage of 24-hour Dry Weather Flow = 187,200 gallons (elevation 66.30)
Storage of $\frac{1}{2}$" Rainfall runoff = 46,000 gallons (elevation 66.97)
All storms above $\frac{1}{2}$" rainfall will pass through overflow structure and 66" pipe.
Routing performed for up to 100-year storm (9.04" rain over 24-hours)
100-year High Water Elevation = 69.48

1 SC-2.0 Seep B – Capture System & Basin Plan

SCALE: 1" = 20'
0' 20' 40'

Stage-Storage Curve



GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep B Capture System Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB
REVIEWED BY: DKK
DESIGNED BY: BB
APPROVED BY:
SCALE: AS SHOWN
DATE: February 2022

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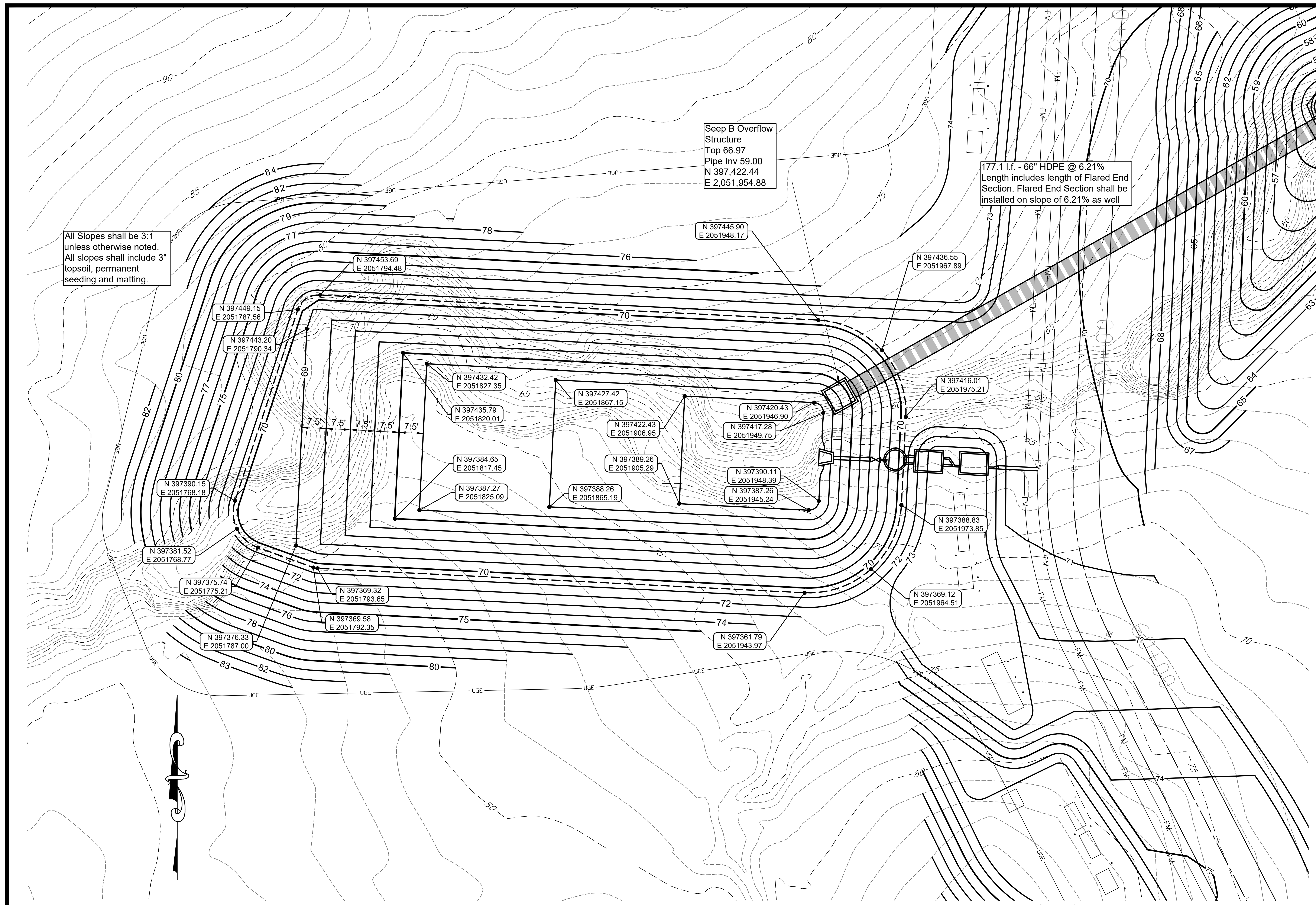
PROJECT NUMBER: 45-20803

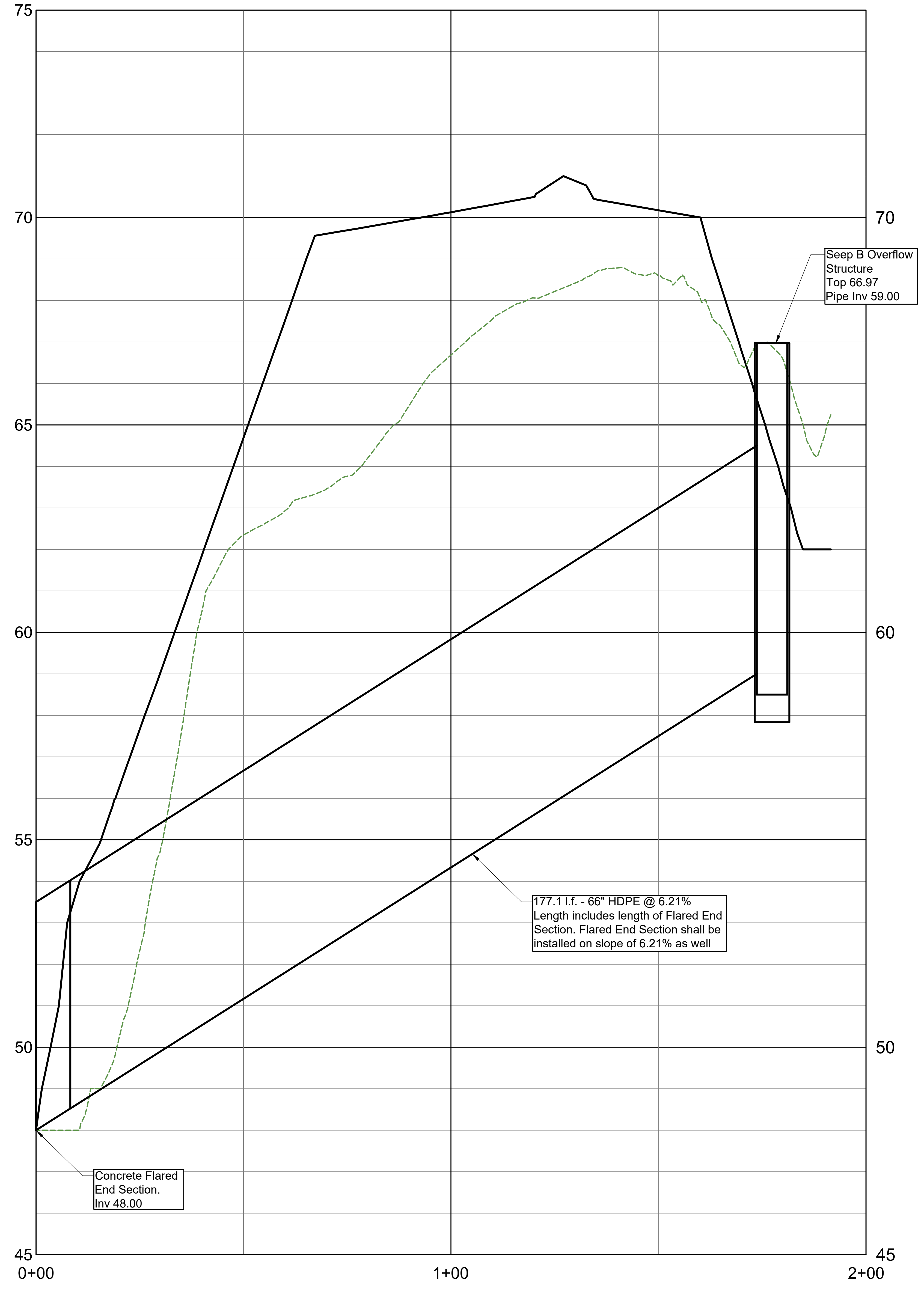


SCALE: 1" = 20'
0' 20' 40'

① SC-2.1 *Seep B – Capture System & Basin Layout Plan*

Seep B - Basin Notes

1. Shape and volume of pond, elevations of structures and pipes are critical to operation of the pond. The intent of the pond is to capture the Dry Weather Flow from Seep B and to capture the runoff from the ½" rainfall.
2. The grades and elevations shown are final grades and elevations. Contractor shall examine liner details to determine depth of liner and buffer requirements above the liner. The grades and elevations shown represent the top of the buffer.
3. The entire basin and all 3:1 slopes shall include permanent seeding and erosion control matting.
4. The outlet structure is sized to allow discharge of the 100-year storm while maintaining a maximum surface water elevation of 69.00 (1.5' below the emergency spillway).



② SC-2.1 *Seep B – Overflow Pipe Profile*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep B Capture System Grading Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

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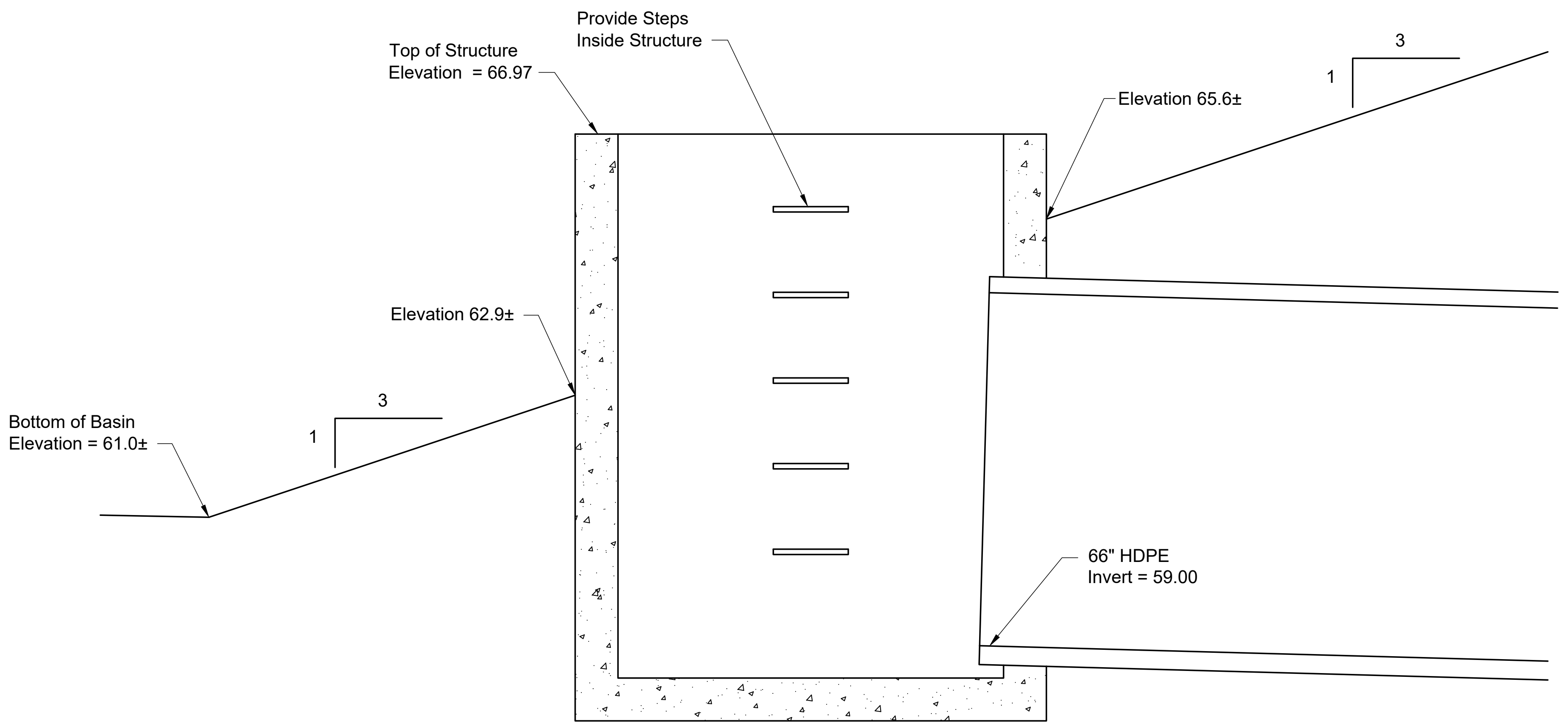
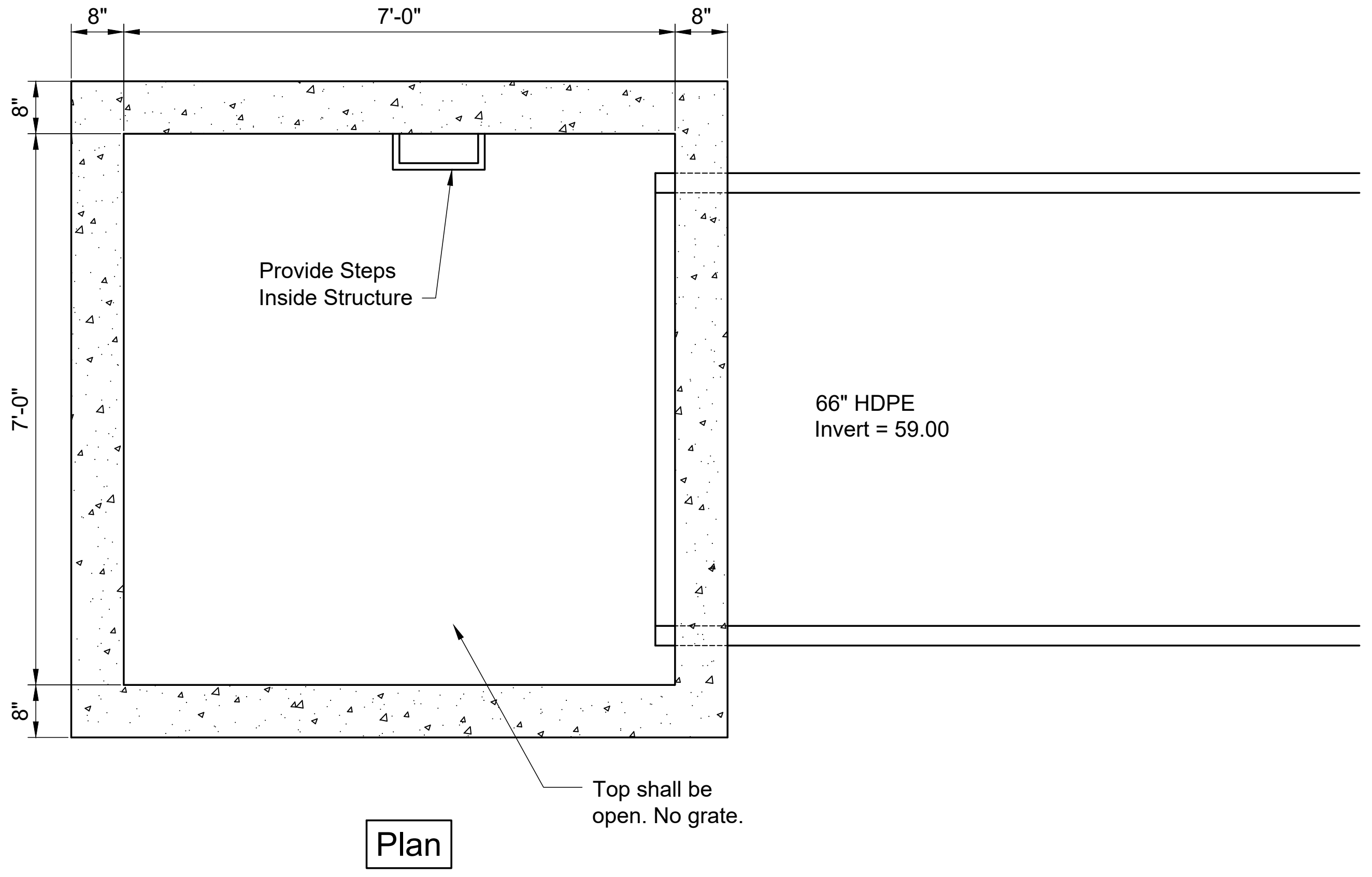
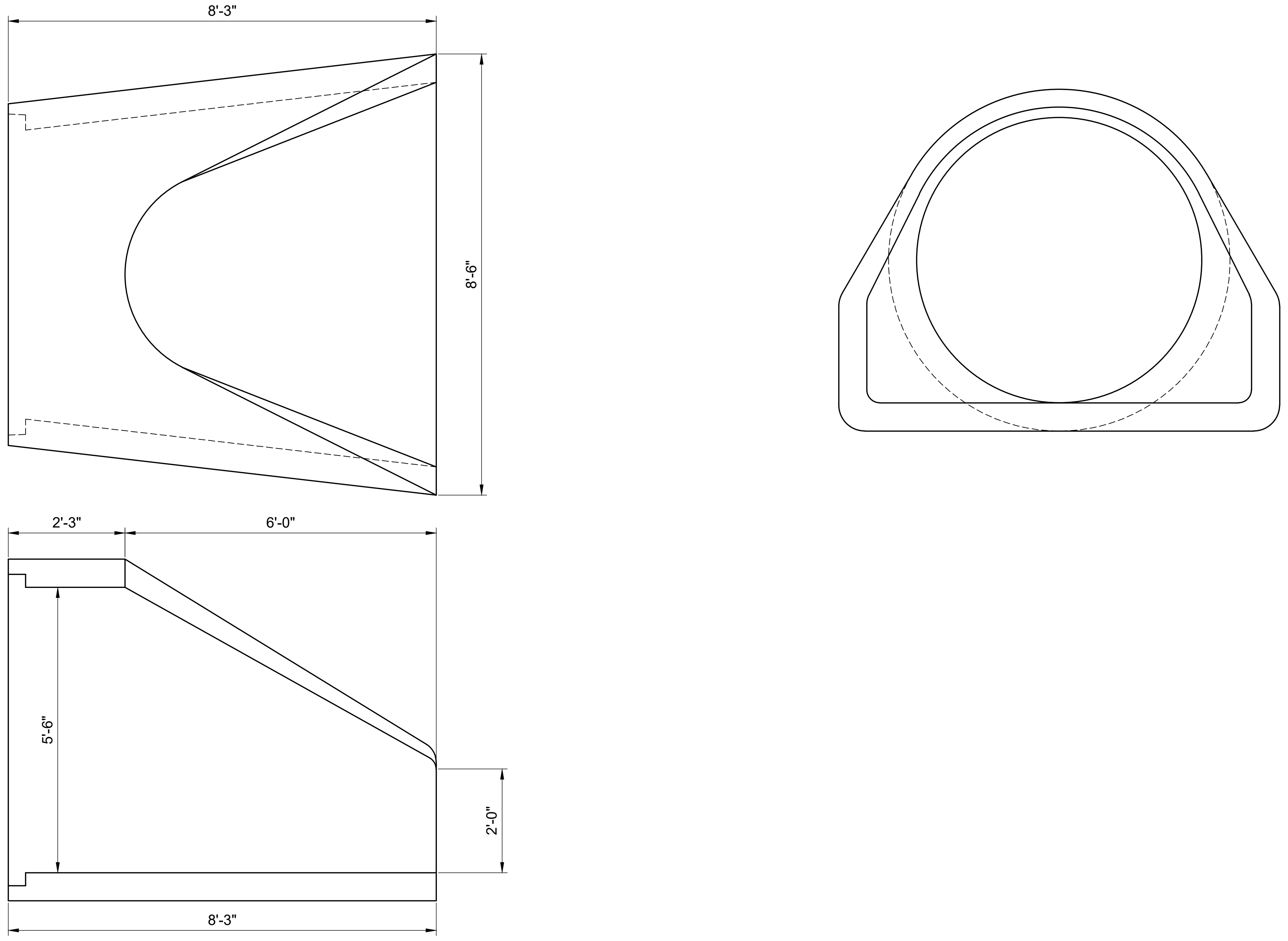


Section



Plan

1 SC-2.2 *Seep B – Overflow Structure*



Utilize Mar-Mac
Reinforced
Rubberized Mastic
Band (Coupler for
Dissimilar Pipes) to
connect 66" HDPE
to Concrete Flared
End Section

2 SC-2.1 *Seep B – 66" Pipe Concrete Flared End Section*

Seep B - Overflow Structure Operation

1. The Seep A Basin will hold the 24-hour Dry Weather Volume 187,200 gallons (130 gpm x 1,440 minutes) and the runoff volume from the $\frac{1}{2}$" storm - 46,000 gallons before it overtops the overflow structure. All volumes/storms larger than than the combined volume of 233,200 gallons will overtop the structure and discharge downstream of the barrier wall.
2. The overflow structure is designed for the 100-year storm event.

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep B Capture System Grading Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

SCALE:
AS SHOWN

DATE:
February 2022

Revisions

No.	Date	Description	By:
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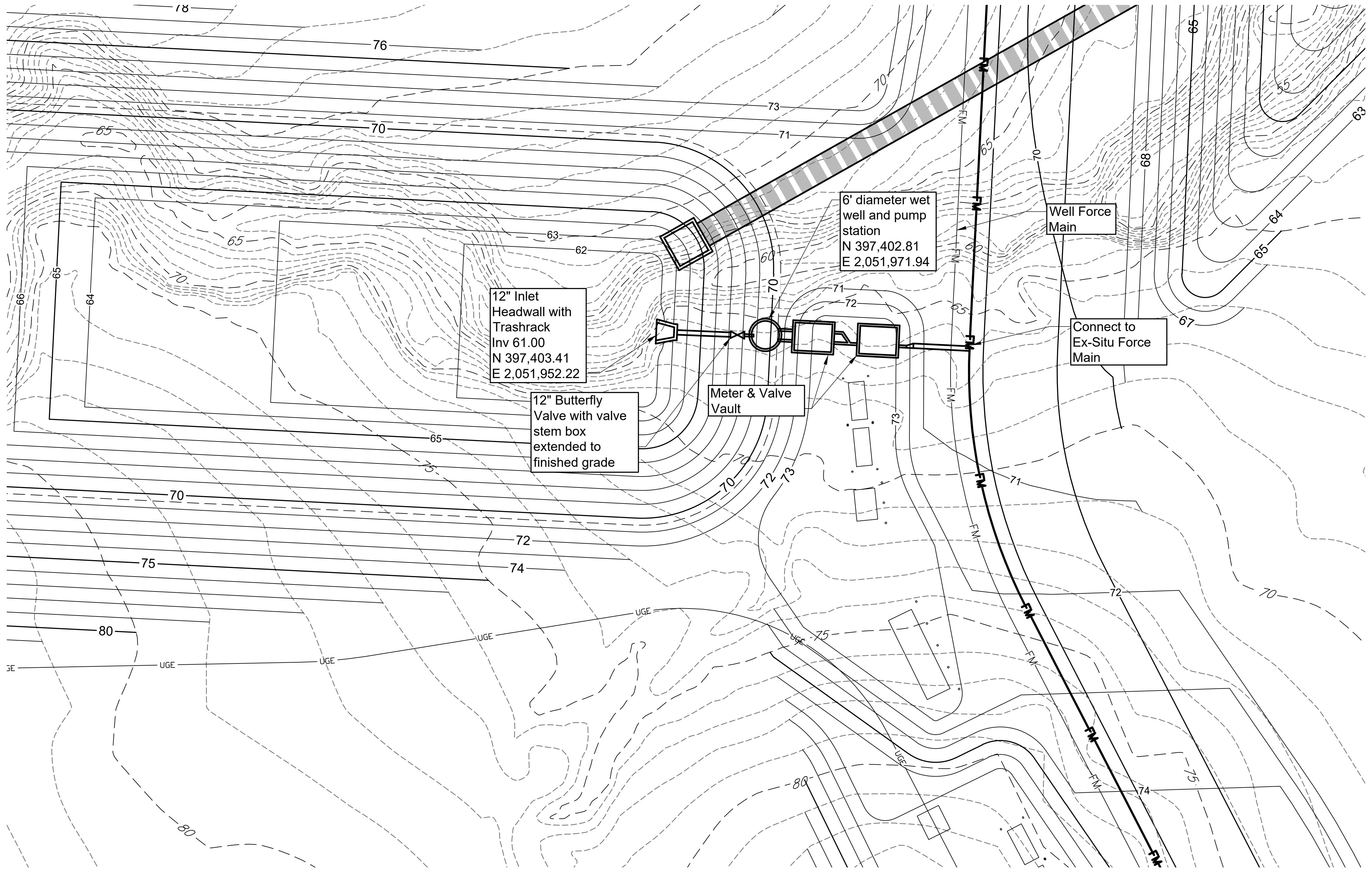
DRAWING:
SC-2.2

PROJECT NUMBER:
45-20803

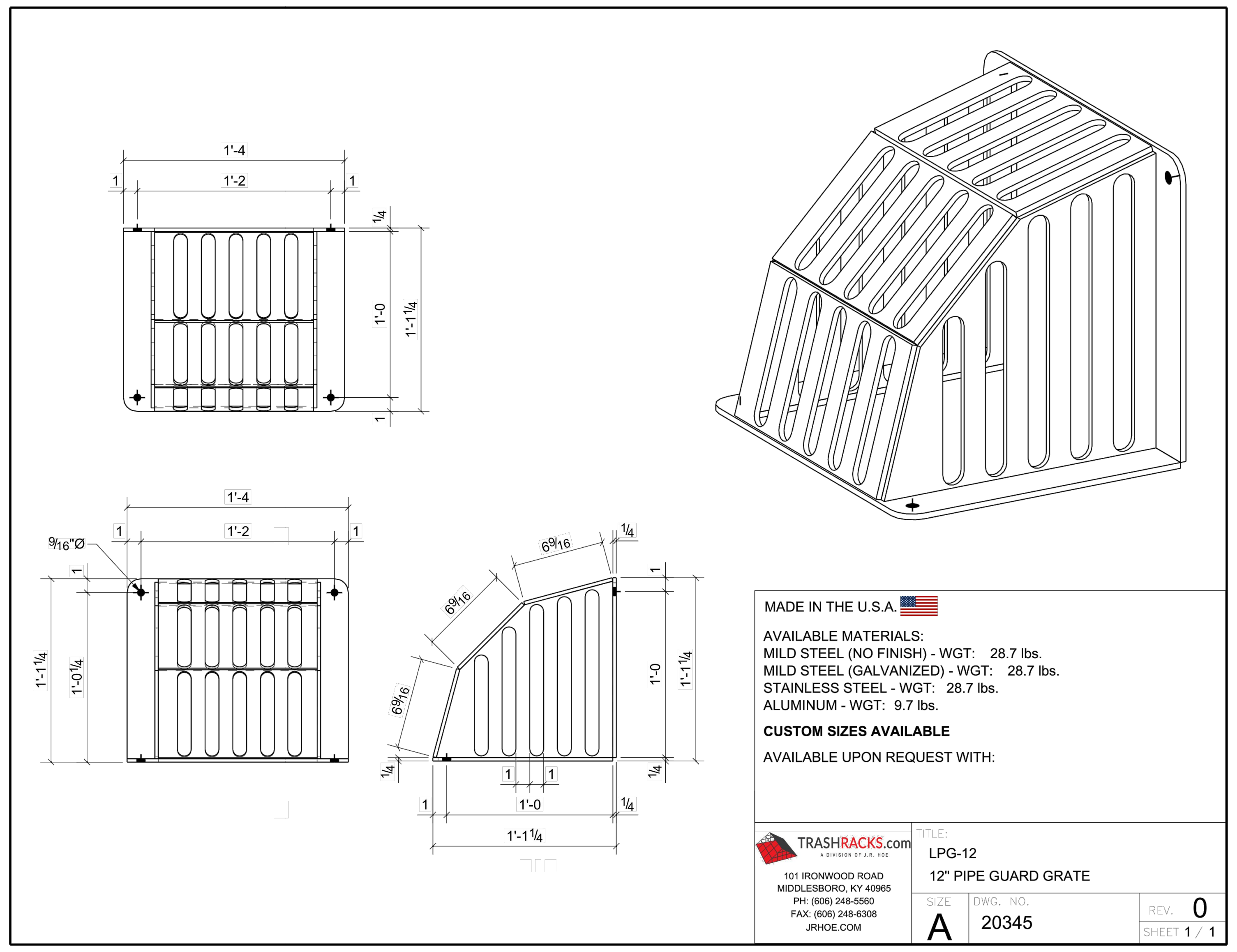


1 SC-2.3 *Seep B – Pump Station Site Plan*

SCALE: 1" = 20'
0' 20' 40'

Seep B - Pump Station Operation

1. The Seep B Basin is intended to catch the Dry Weather Flow and the runoff from the $\frac{1}{2}$" Rainfall each day.
2. The pump station will turn on at the end of each day and pump until the basin is dry.
   - 2.1. If their is no rainfall event, the basin will fill to the Dry Weather volume level. At the end of the day, the pump station will remove the water from the basin.
   - 2.2. If up to $\frac{1}{2}$" rainfall, the basin will fill to the $\frac{1}{2}$" rainfall runoff level. At the end of the day, the pump station will remove the Dry Weather flow and the $\frac{1}{2}$" Rainfall runoff from the basin.
   - 2.3. If greater than $\frac{1}{2}$" rainfall, the basin will fill above the $\frac{1}{2}$" rainfall runoff level and the additional depth will be discharged downstream via the overflow structure and pipe. At the end of the day, the pump station will remove the Dry Weather flow and the $\frac{1}{2}$" Rainfall runoff from the basin.



MADE IN THE U.S.A.

AVAILABLE MATERIALS:
MILD STEEL (NO FINISH) - WGT: 28.7 lbs.
MILD STEEL (GALVANIZED) - WGT: 28.7 lbs.
STAINLESS STEEL - WGT: 28.7 lbs.
ALUMINUM - WGT: 9.7 lbs.

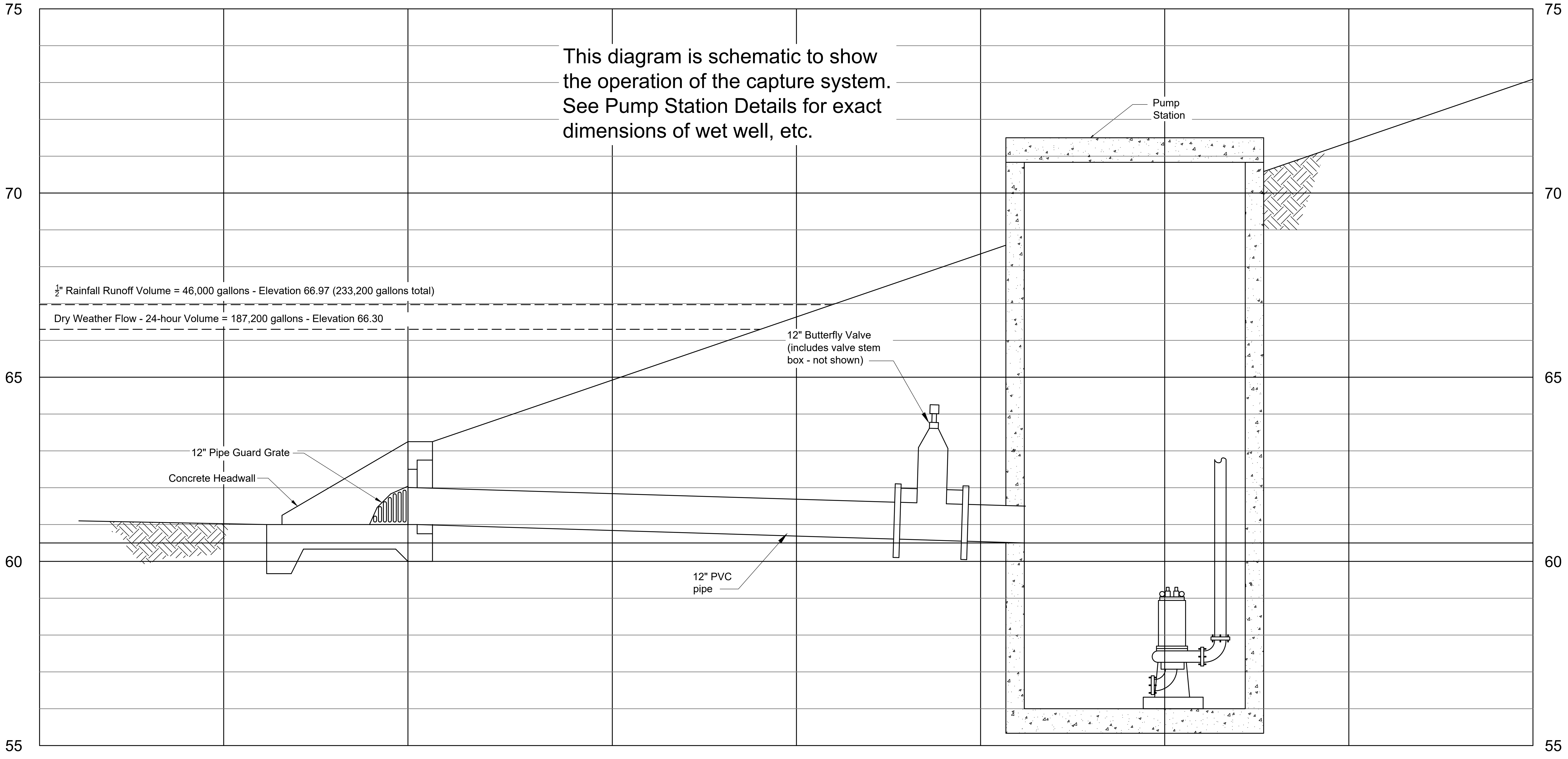
CUSTOM SIZES AVAILABLE

AVAILABLE UPON REQUEST WITH:

TRASHRACKS.com
A DIVISION OF J.R. HOE
101 IRONWOOD ROAD
MIDDLESBORO, KY 40965
PH: (606) 248-5560
FAX: (606) 248-6308
JRHOE.COM

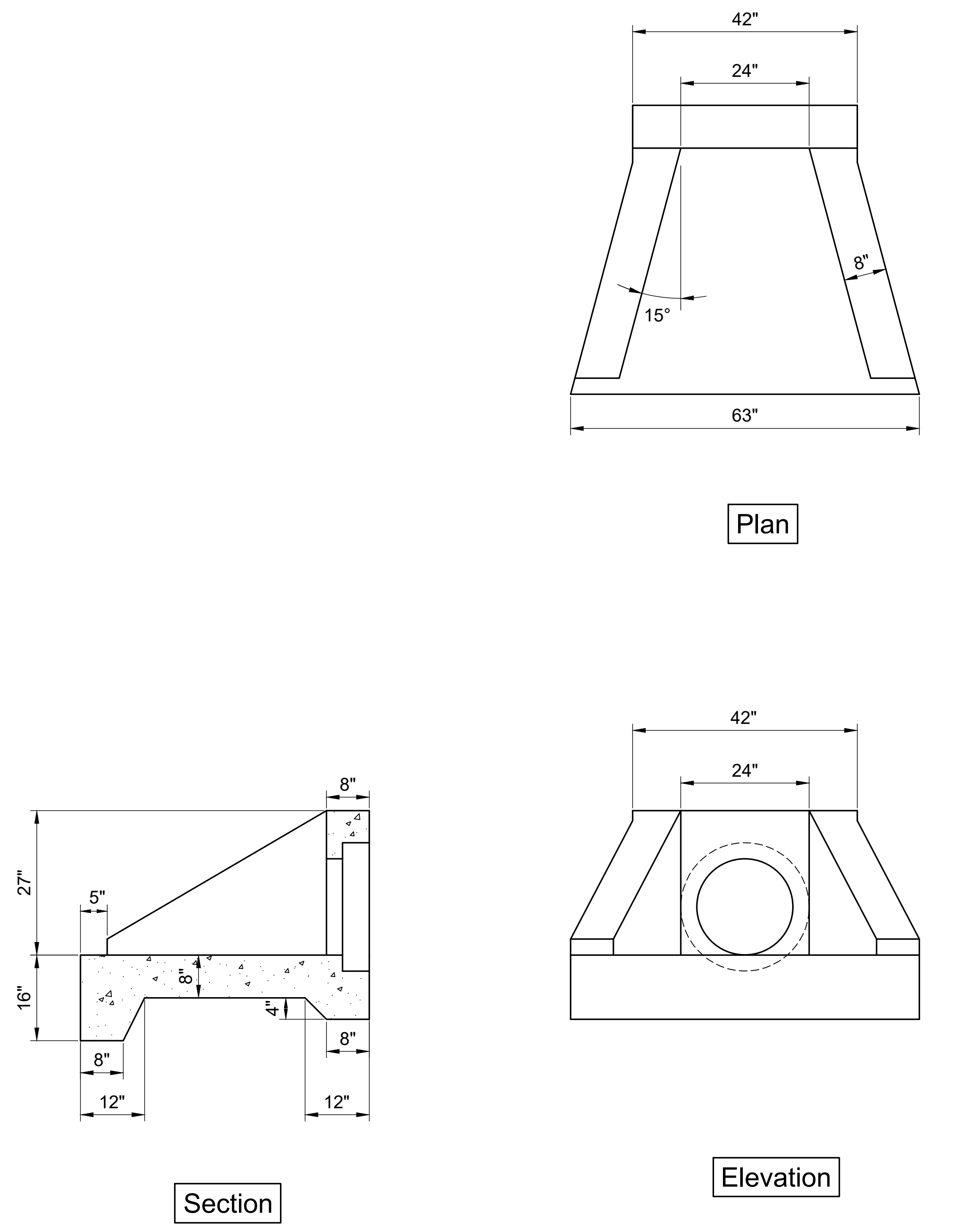
TITLE: LPG-12
12" PIPE GUARD GRATE
SIZE A
DWG. NO. 20345
REV. 0
SHEET 1 / 1

3 SC-2.3 *12" Pipe Guard Grate*



This diagram is schematic to show the operation of the capture system. See Pump Station Details for exact dimensions of wet well, etc.

2 SC-2.3 *Seep B – Gravity Line from Basin to Wet Well Profile*



4 SC-2.3 *Seep B – 12" Pipe Concrete Headwall*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep B Capture System Pump Station

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

SCALE: AS SHOWN

DATE: February 2022

Revisions

No.	Date	Description	By:
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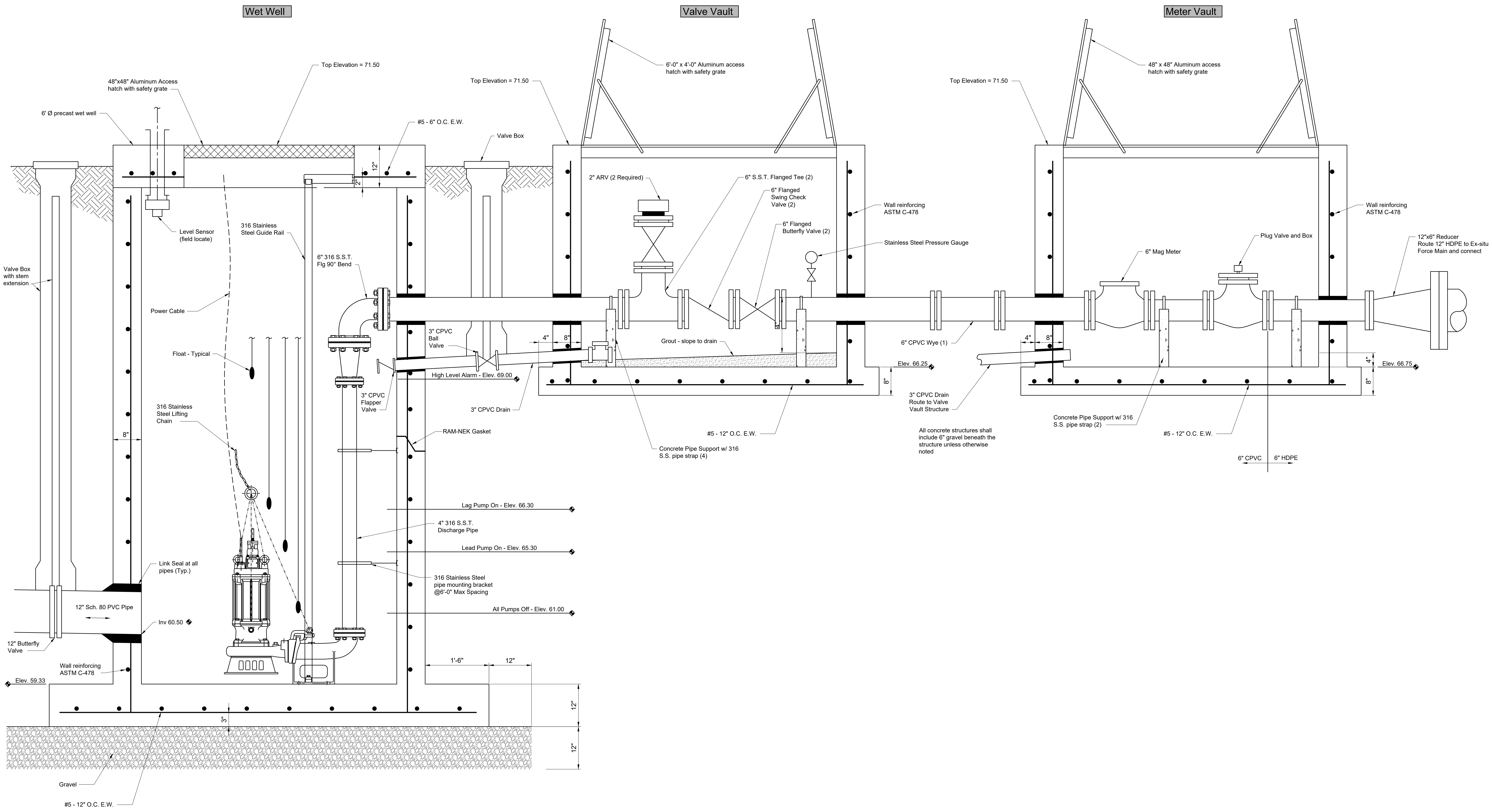
DRAWING: SC-2.3

PROJECT NUMBER: 45-20803



1
SC-2.4
Seep B – Pump Station Section

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep B - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

SCALE: AS SHOWN

DATE: February 2022

Revisions

No.	Date	Description	By:
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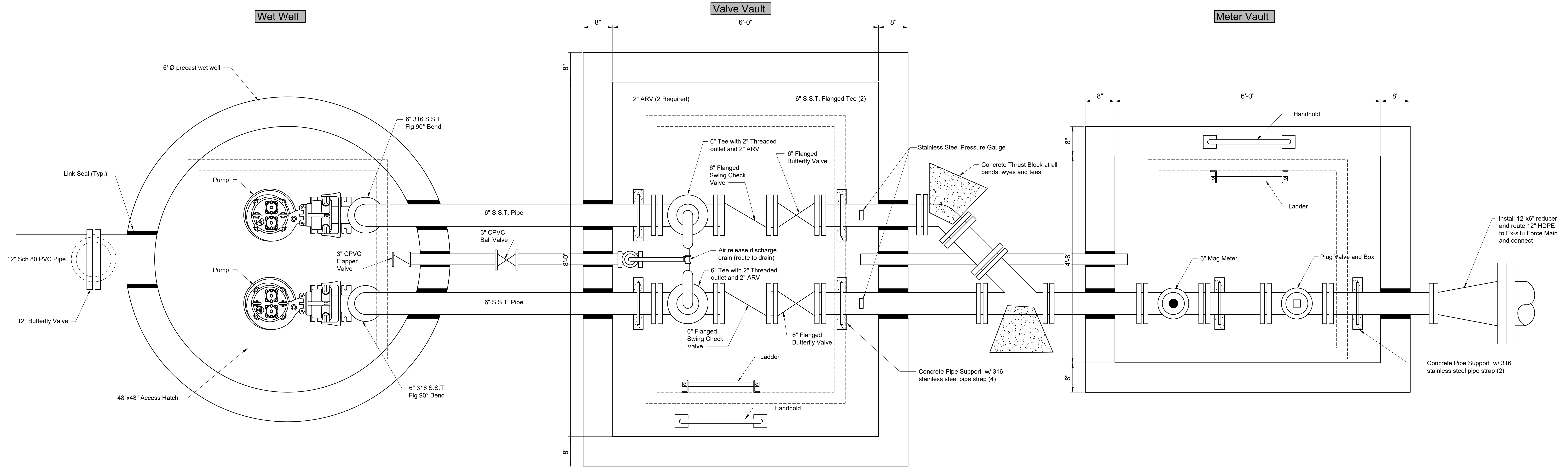
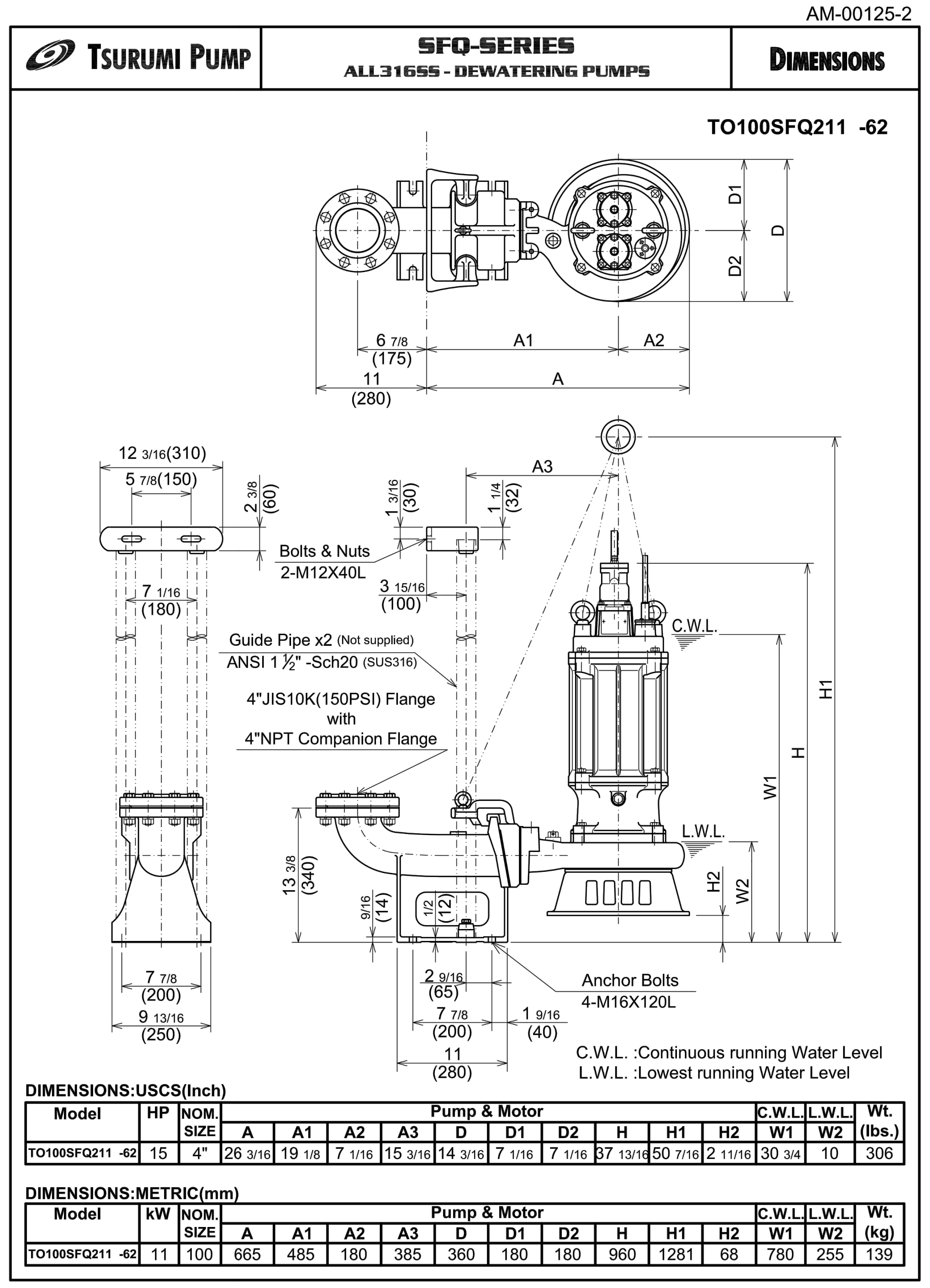
DRAWING: SC-2.4

PROJECT NUMBER: 45-20803



1 SC–2.5 Seep B – Pump Station Section



AM-00125-2

TSURUMI PUMP | **SFQ-SERIES** ALL316SS - DEWATERING PUMPS | **DIMENSIONS**

C.W.L. :Continuous running Water Level
L.W.L. :Lowest running Water Level

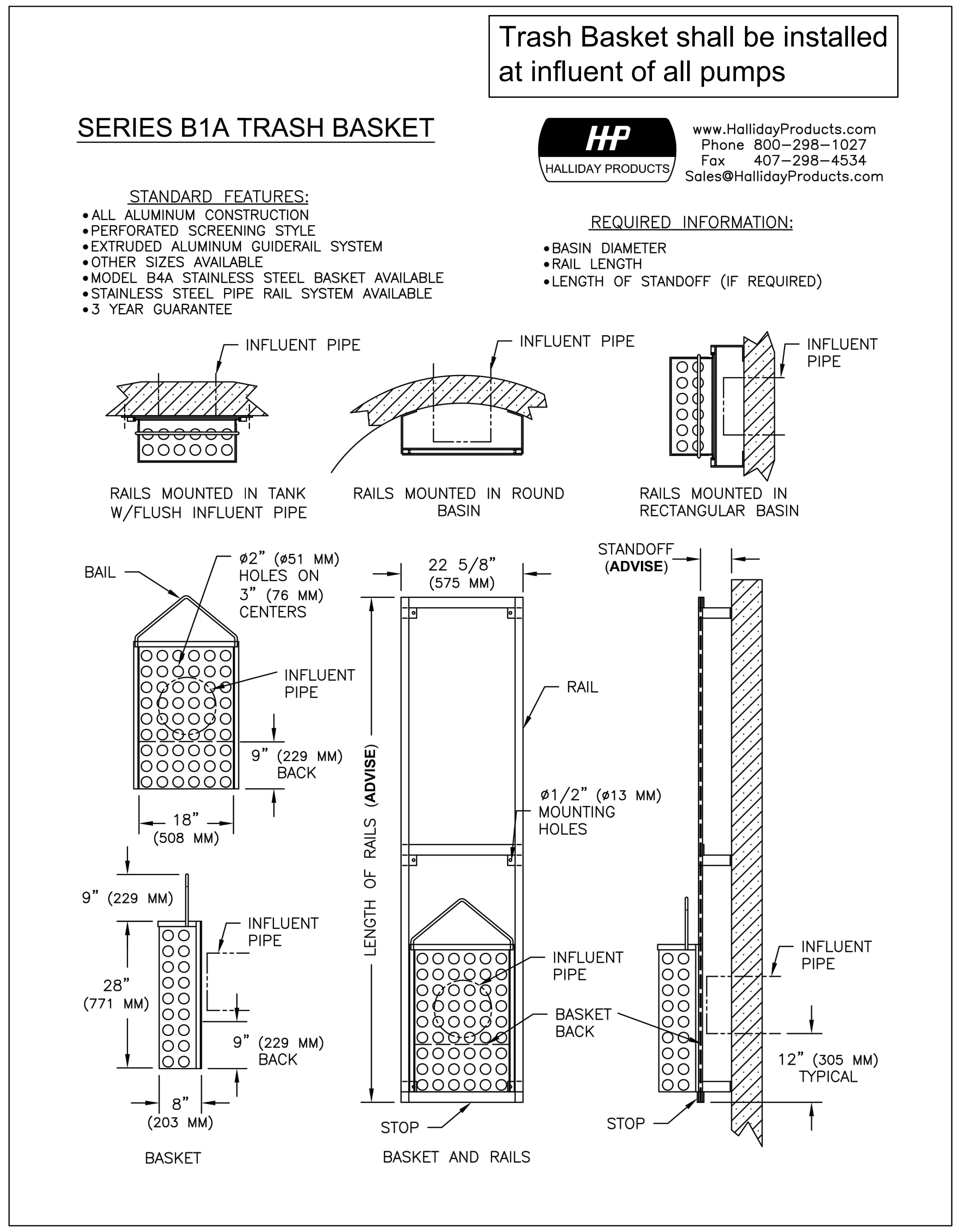
DIMENSIONS:USCS(Inch)

Model	HP	NOM. SIZE	Pump & Motor										C.W.L.	L.W.L.	Wt. (lbs.)
			A	A1	A2	A3	D	D1	D2	H	H1	H2	W1	W2	
TO100SFQ211 -62	15	4"	26 3/16	19 1/8	7 1/16	15 3/16	14 3/16	7 1/16	7 1/16	37 13/16	50 7/16	2 11/16	30 3/4	10	306

DIMENSIONS:METRIC(mm)

Model	kW	NOM. SIZE	Pump & Motor										C.W.L.	L.W.L.	Wt. (kg)
			A	A1	A2	A3	D	D1	D2	H	H1	H2	W1	W2	
TO100SFQ211 -62	11	100	665	485	180	385	360	180	180	960	1281	68	780	255	139

2 SC–2.5 Duplex Pumps



Trash Basket shall be installed at influent of all pumps

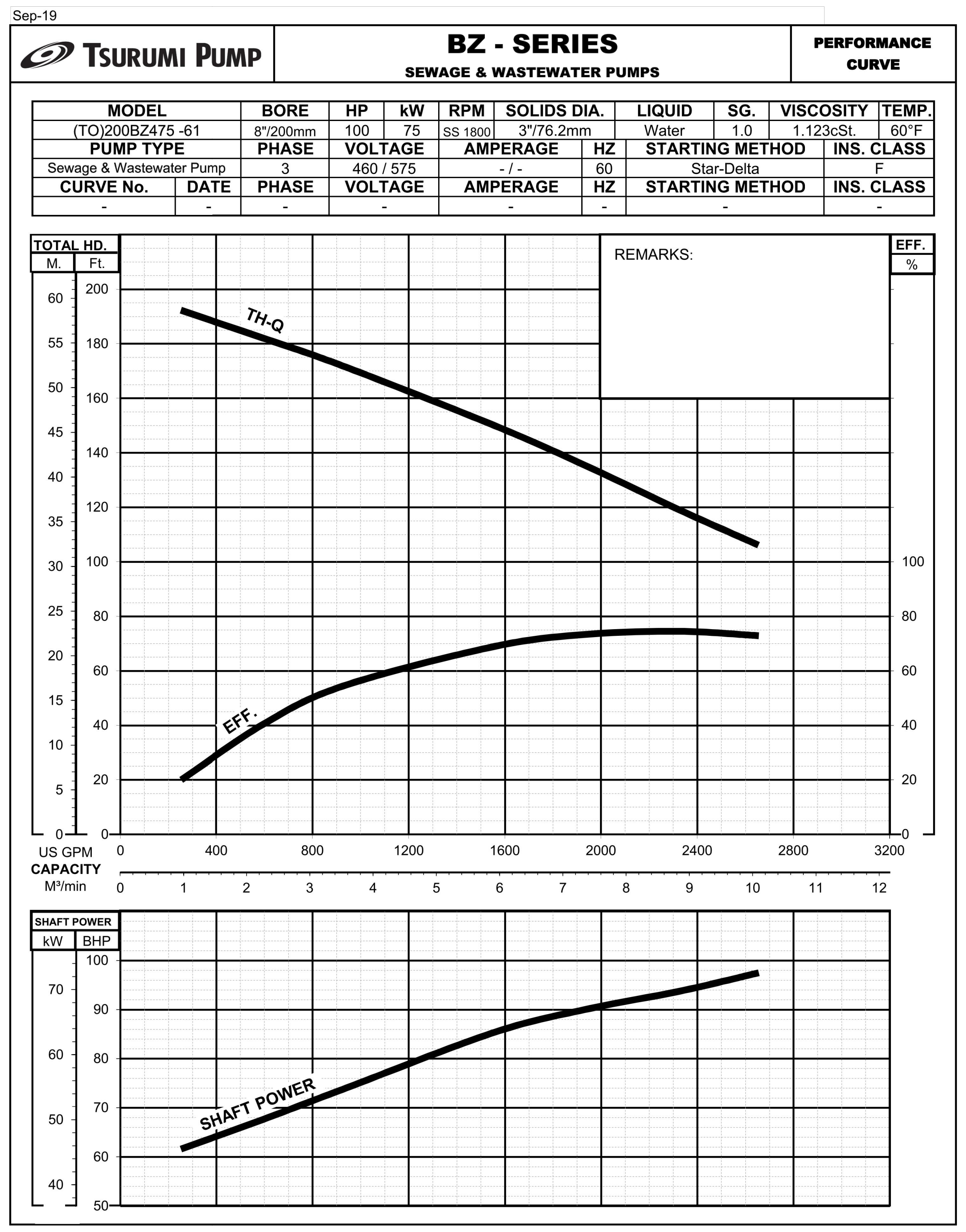
SERIES B1A TRASH BASKET

www.HallidayProducts.com
Phone 800–298–1027
Fax 407–298–4534
Sales@HallidayProducts.com

STANDARD FEATURES:
- ALL ALUMINUM CONSTRUCTION
- PERFORATED SCREENING STYLE
- EXTRUDED ALUMINUM GUIDERAIL SYSTEM
- OTHER SIZES AVAILABLE
- MODEL B4A STAINLESS STEEL BASKET AVAILABLE
- STAINLESS STEEL PIPE RAIL SYSTEM AVAILABLE
- 3 YEAR GUARANTEE

REQUIRED INFORMATION:
- BASIN DIAMETER
- RAIL LENGTH
- LENGTH OF STANDOFF (IF REQUIRED)

3 SC–2.5 Trash Basket



Sep-19

BZ - SERIES
SEWAGE & WASTEWATER PUMPS
PERFORMANCE CURVE

MODEL		BORE	HP	kW	RPM	SOLIDS DIA.		LIQUID	SG.	VISCOSITY	TEMP.
(TO)200BZ475 -61		8"/200mm	100	75	SS 1800	3"/76.2mm		Water	1.0	1.123cSt.	60°F
PUMP TYPE		PHASE	VOLTAGE		AMPERAGE		HZ	STARTING METHOD			INS. CLASS
Sewage & Wastewater Pump		3	460 / 575		- / -		60	Star-Delta			F
CURVE No.	DATE	PHASE	VOLTAGE		AMPERAGE		HZ	STARTING METHOD			INS. CLASS
-	-	-	-		-		-	-			-

4 SC–2.5 Pump Curve

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep B - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY:	APPROVED BY:
BB	

SCALE: AS SHOWN

DATE: Febraury 2022

Revisions

No.	Date	Description	By:
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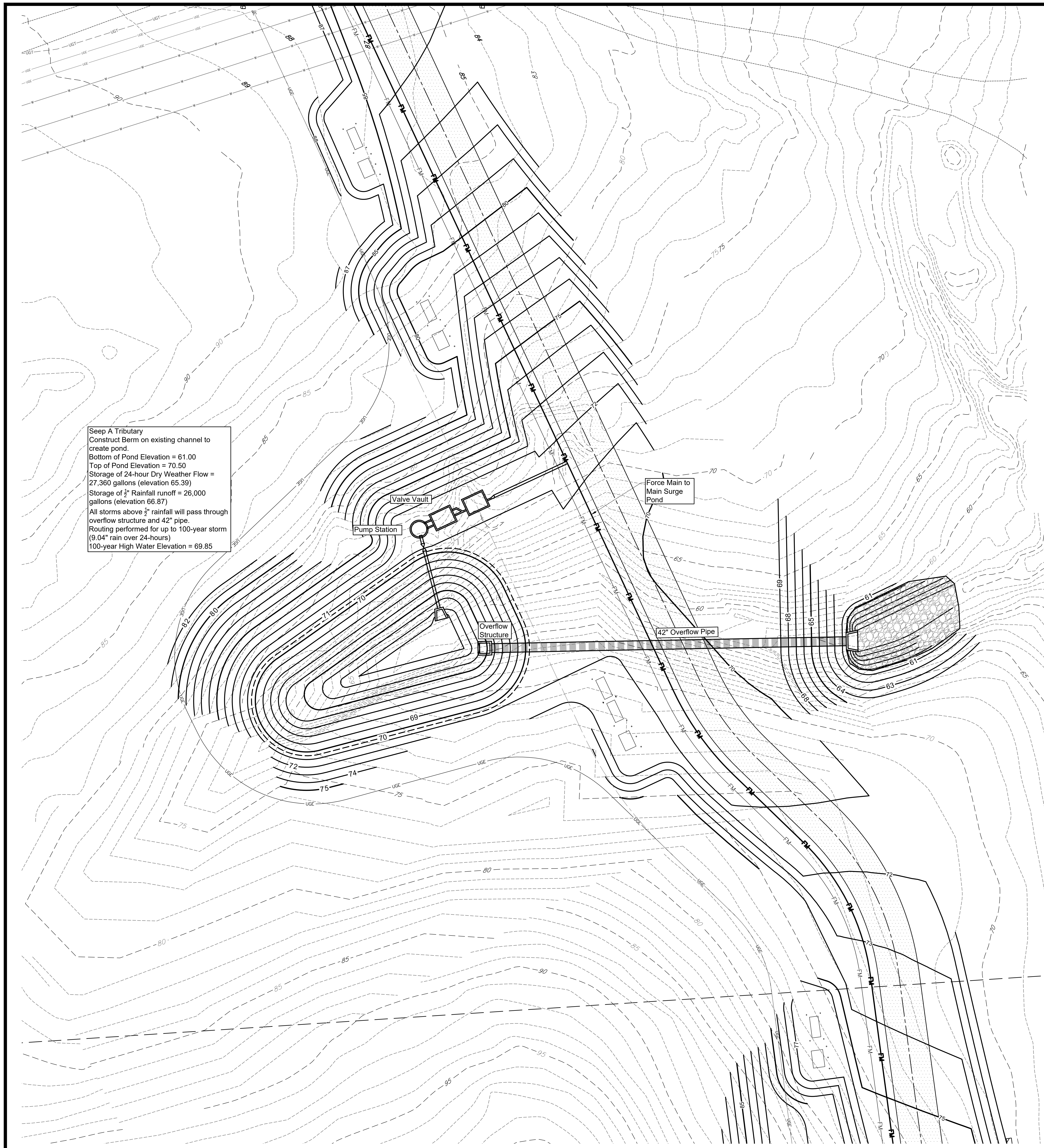
DRAWING: SC-2.5

PROJECT NUMBER: 45-20803

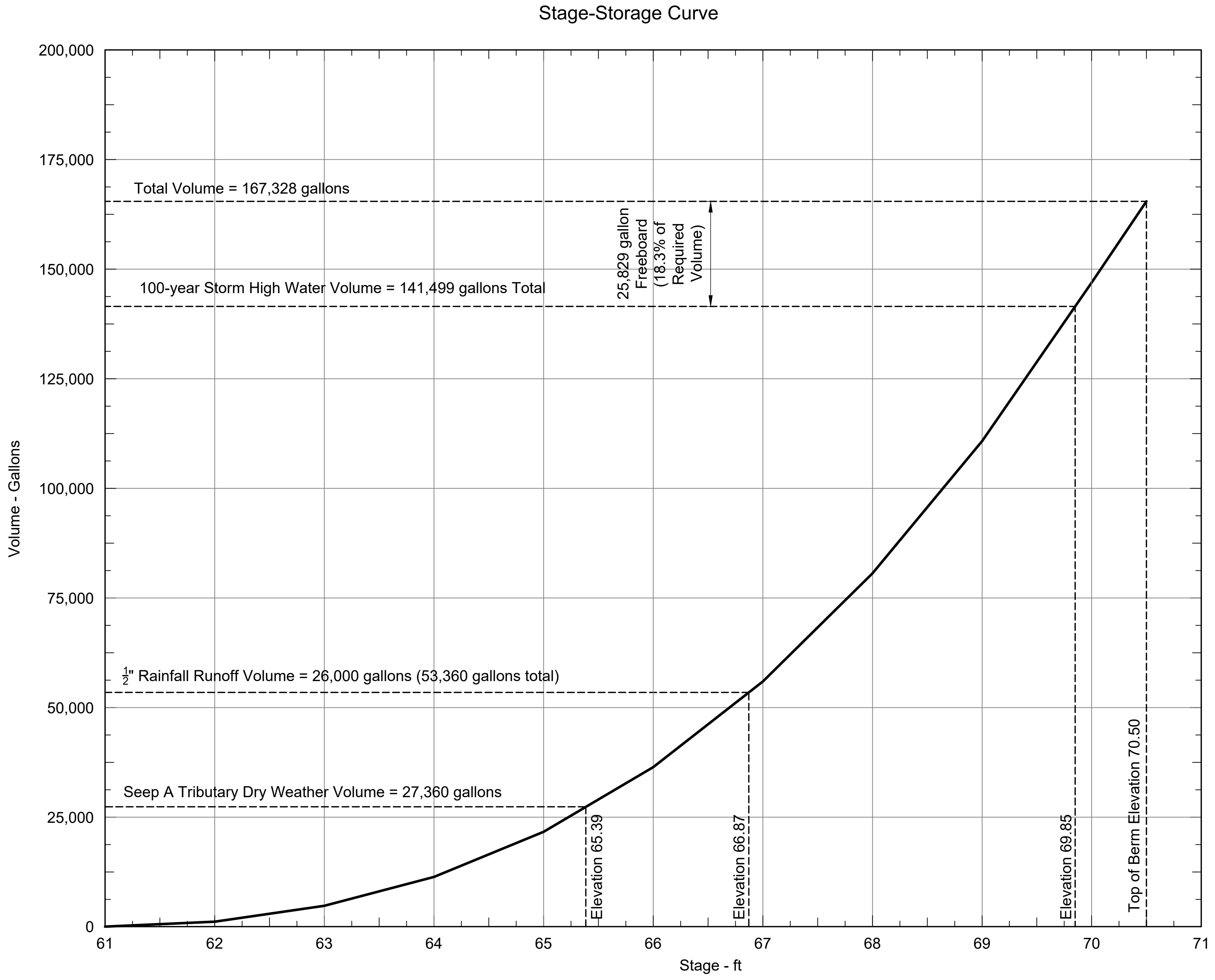


Seep A Tributary
Construct Berm on existing channel to create pond.
Bottom of Pond Elevation = 61.00
Top of Pond Elevation = 70.50
Storage of 24-hour Dry Weather Flow = 27,360 gallons (elevation 65.39)
Storage of ½" Rainfall runoff = 26,000 gallons (elevation 66.87)
All storms above ½" rainfall will pass through overflow structure and 42" pipe.
Routing performed for up to 100-year storm (9.04" rain over 24-hours)
100-year High Water Elevation = 69.85

1 SC-3.0 Seep A Tributary – Capture System & Basin Plan

SCALE: 1" = 20'
0' 20' 40'

Stage-Storage Curve



GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Tributary Capture System Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

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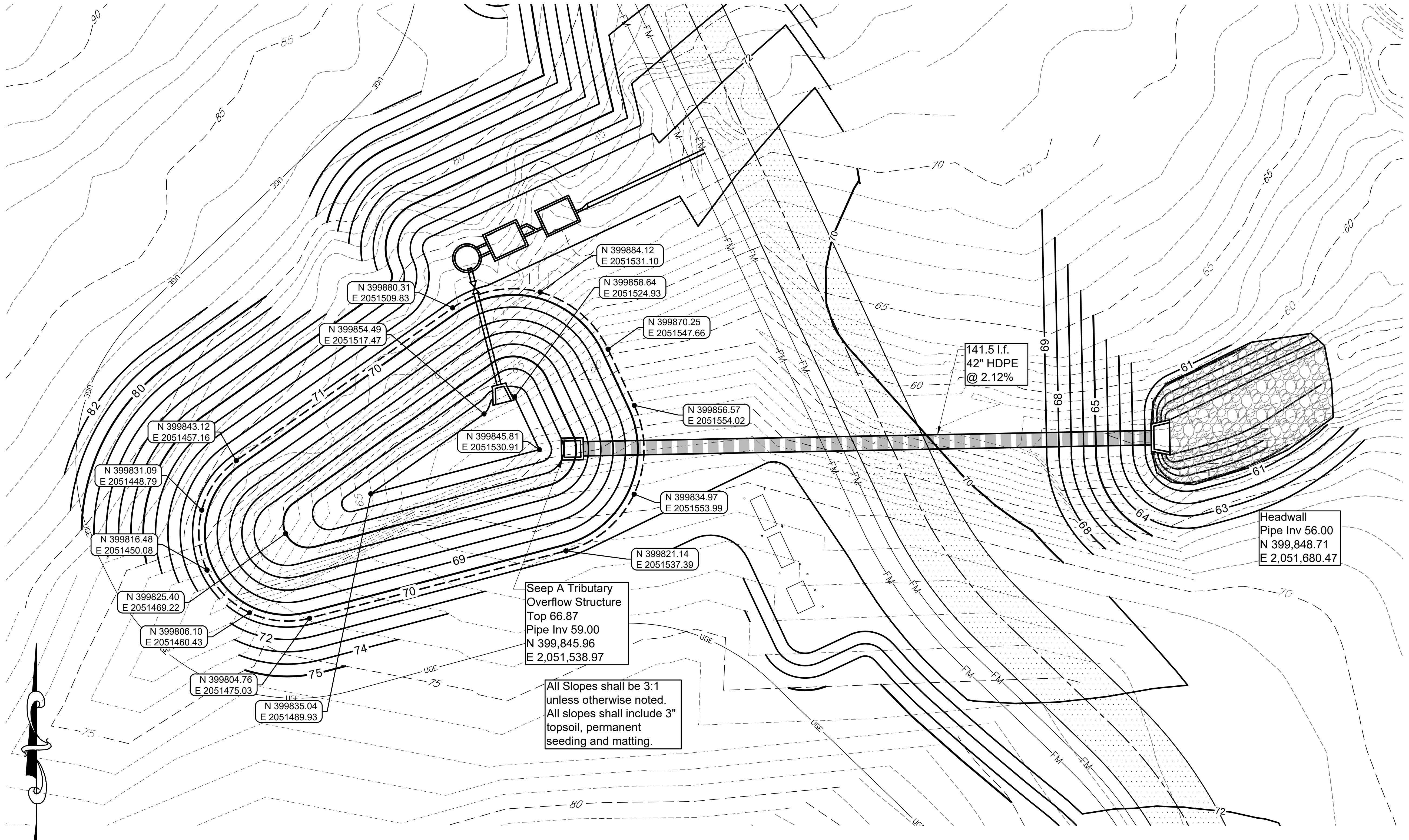
DRAWING:
SC-3.0

PROJECT NUMBER:
45-20803

Seep A Tributary - Basin Notes

1. Shape and volume of pond, elevations of structures and pipes are critical to operation of the pond. The intent of the pond is to capture the Dry Weather Flow from Seep A Tributary and to capture the runoff from the $\frac{1}{2}$" rainfall.
2. The grades and elevations shown are final grades and elevations. Contractor shall examine liner details to determine the depth of liner and the buffer requirements above the liner. The grades and elevations shown represent the top of the buffer.
3. The entire basin and all 3:1 slopes shall include permanent seeding and erosion control matting.
4. The outlet structure is sized to allow discharge of the 100-year storm while maintaining a maximum surface water elevation of 70.49. Note that this assumes the tailwater on the outlet pipe is at elevation 68.00 (the 100-year Flood Elevation of the Cape Fear River. This is a very conservative estimate as it assumes the Cape Fear River is at 100-year stage for the entire storm and thus there is no outflow from the pond until the water surface elevation in the pond rises above elevation 68.00.

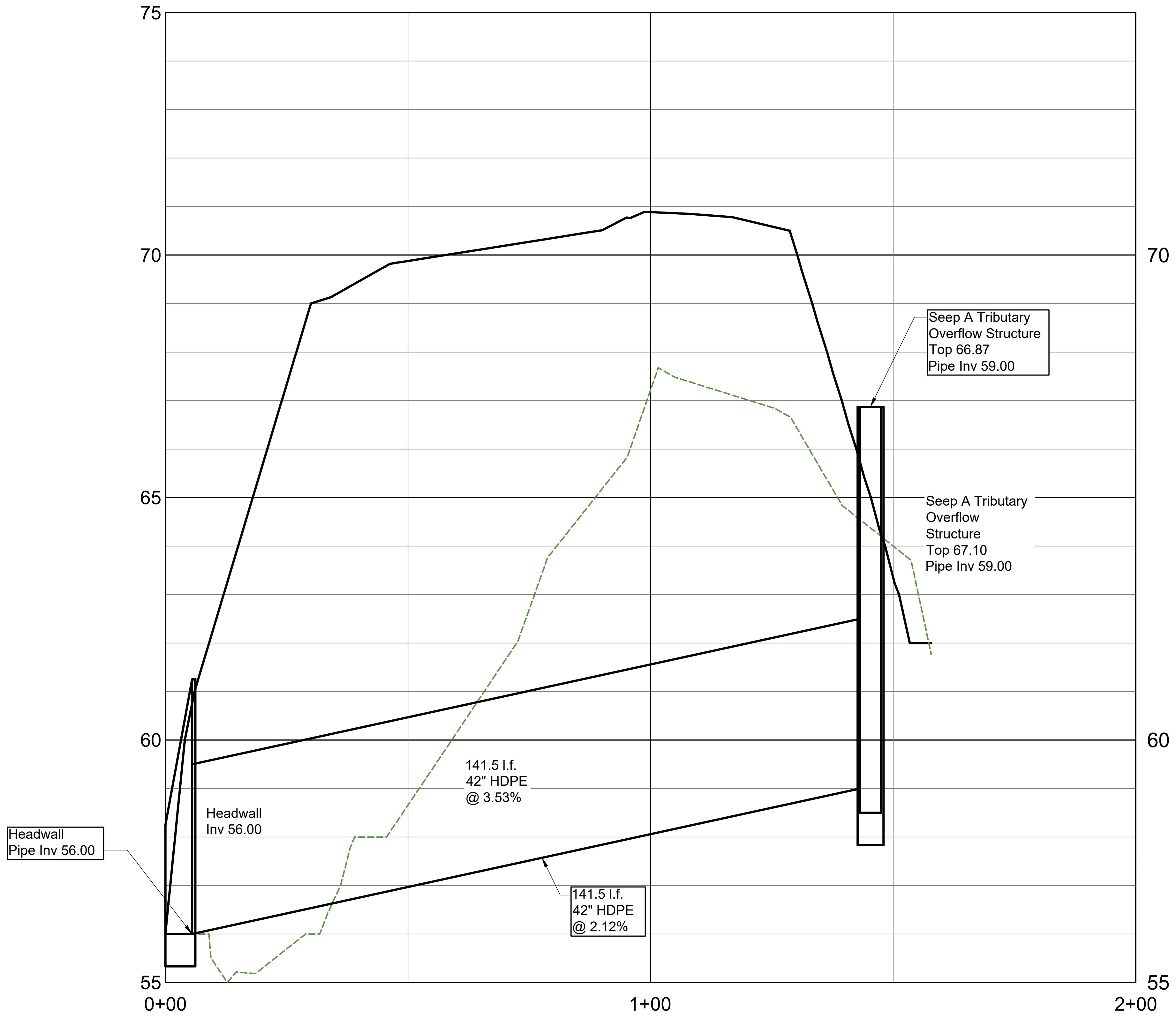


Seep A Tributary
Overflow Structure
Top 66.87
Pipe Inv 59.00
N 399,845.96
E 2,051,538.97

All Slopes shall be 3:1
unless otherwise noted.
All slopes shall include 3"
topsoil, permanent
seeding and matting.

1 SC-3.1 *Seep A Tributary – Capture System & Basin Layout Plan*

SCALE: 1" = 20'
0' 20' 40'



2 SC-3.1 *Seep A Tributary Basin – Overflow Pipe Profile*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Tributary Capture System Grading Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY:	APPROVED BY:
BB	
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

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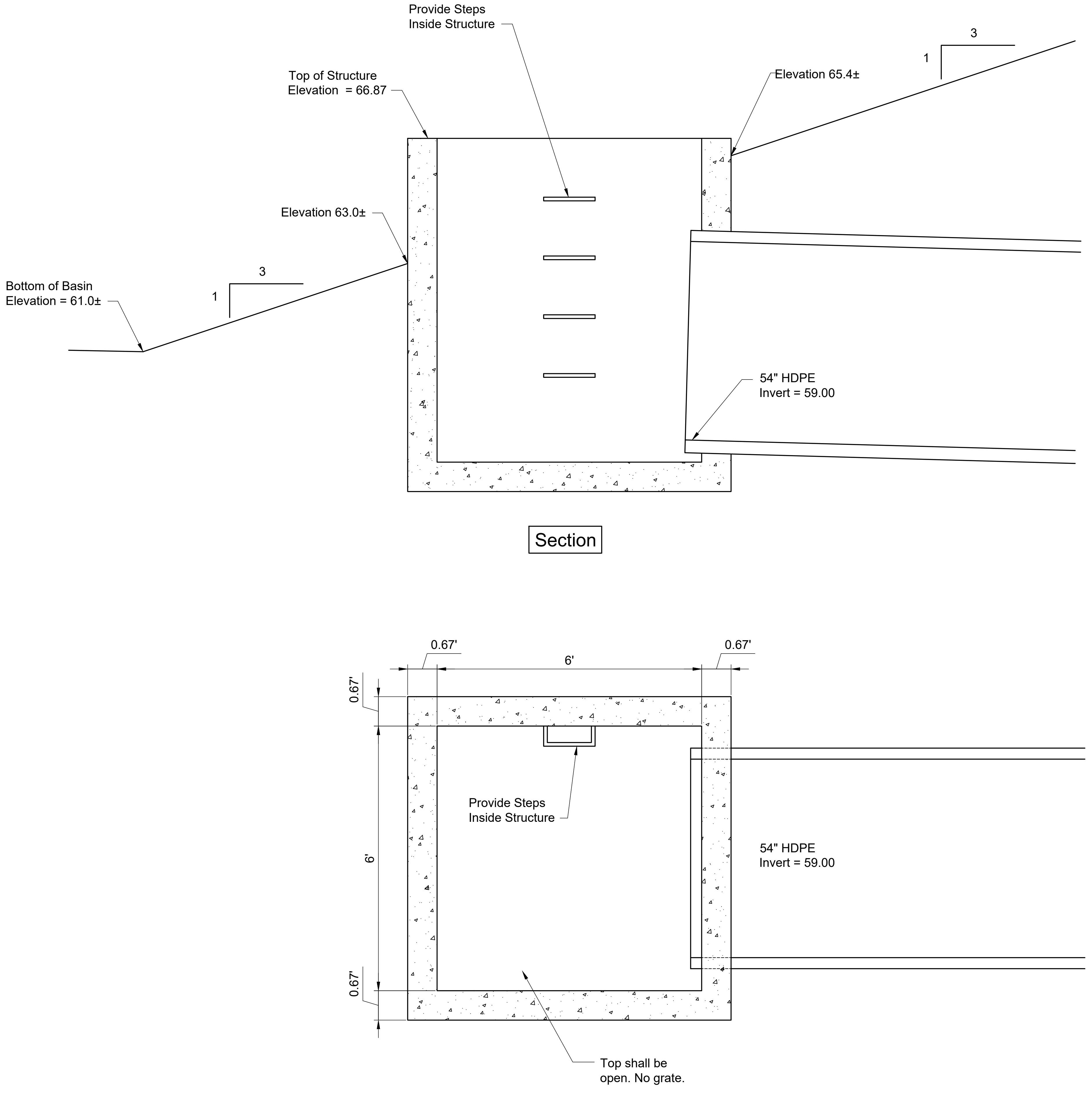
DRAWING:
SC-3.1

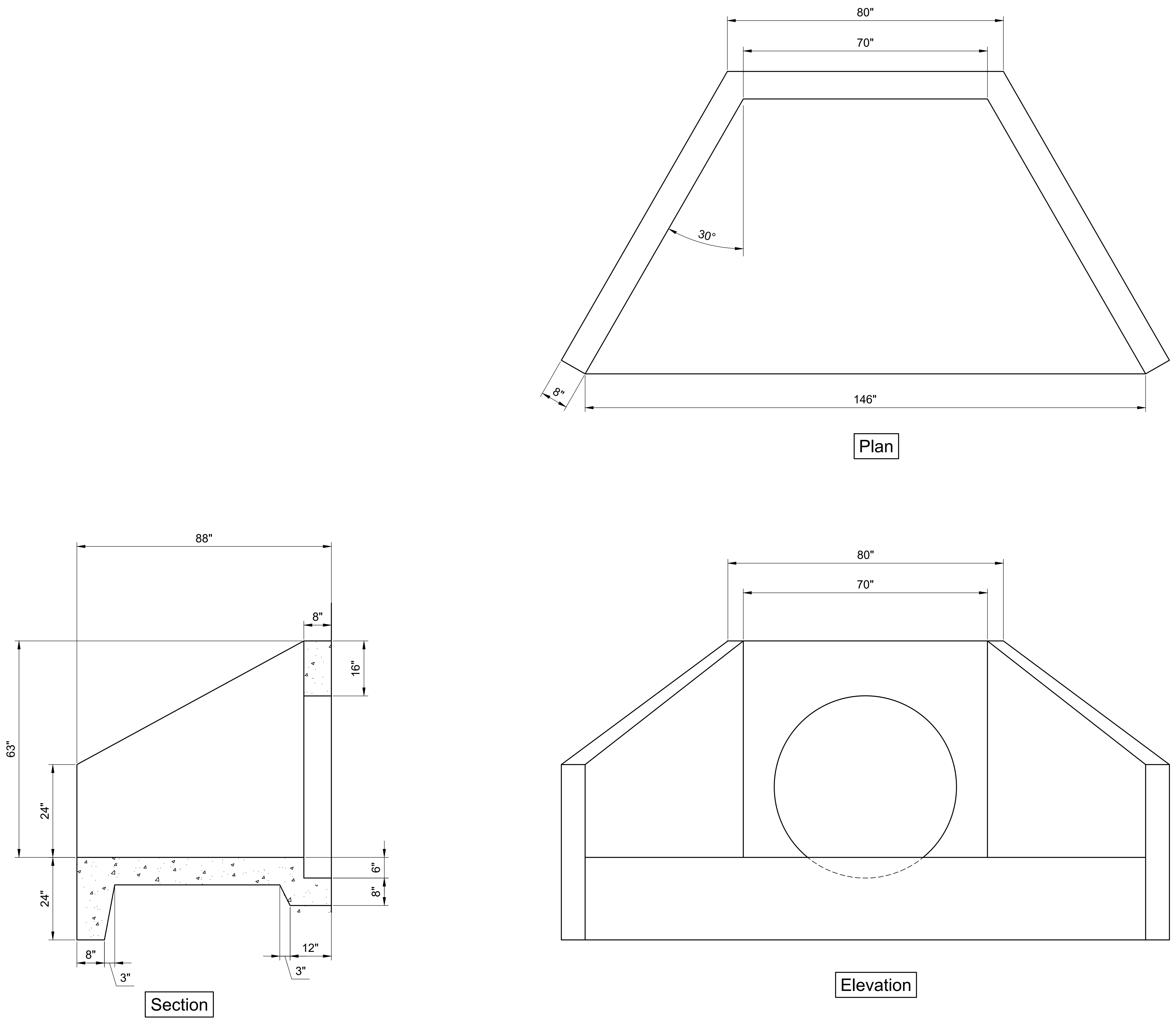
PROJECT NUMBER:
45-20803



Section

Plan

① SC-3.2 Seep A Tributary – Overflow Structure



Plan

Section

Elevation

② SC-3.2 Seep A Tributary – 42" Pipe Concrete Headwall

Seep A Tributary - Overflow Structure Operation

1. The Seep A Basin will hold the 24-hour Dry Weather Volume 27,360 gallons (19 gpm x 1,440 minutes) and the runoff volume from the $\frac{1}{2}$" storm - 26,000 gallons before it overtops the overflow structure. All volumes/storms larger than than the combined volume of 53,360 gallons will overtop the structure and discharge downstream of the barrier wall.
2. The overflow structure is designed for the 100-year storm event.

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Tributary Capture System Grading Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February, 2022	

Revisions

No.	Date	Description	By:
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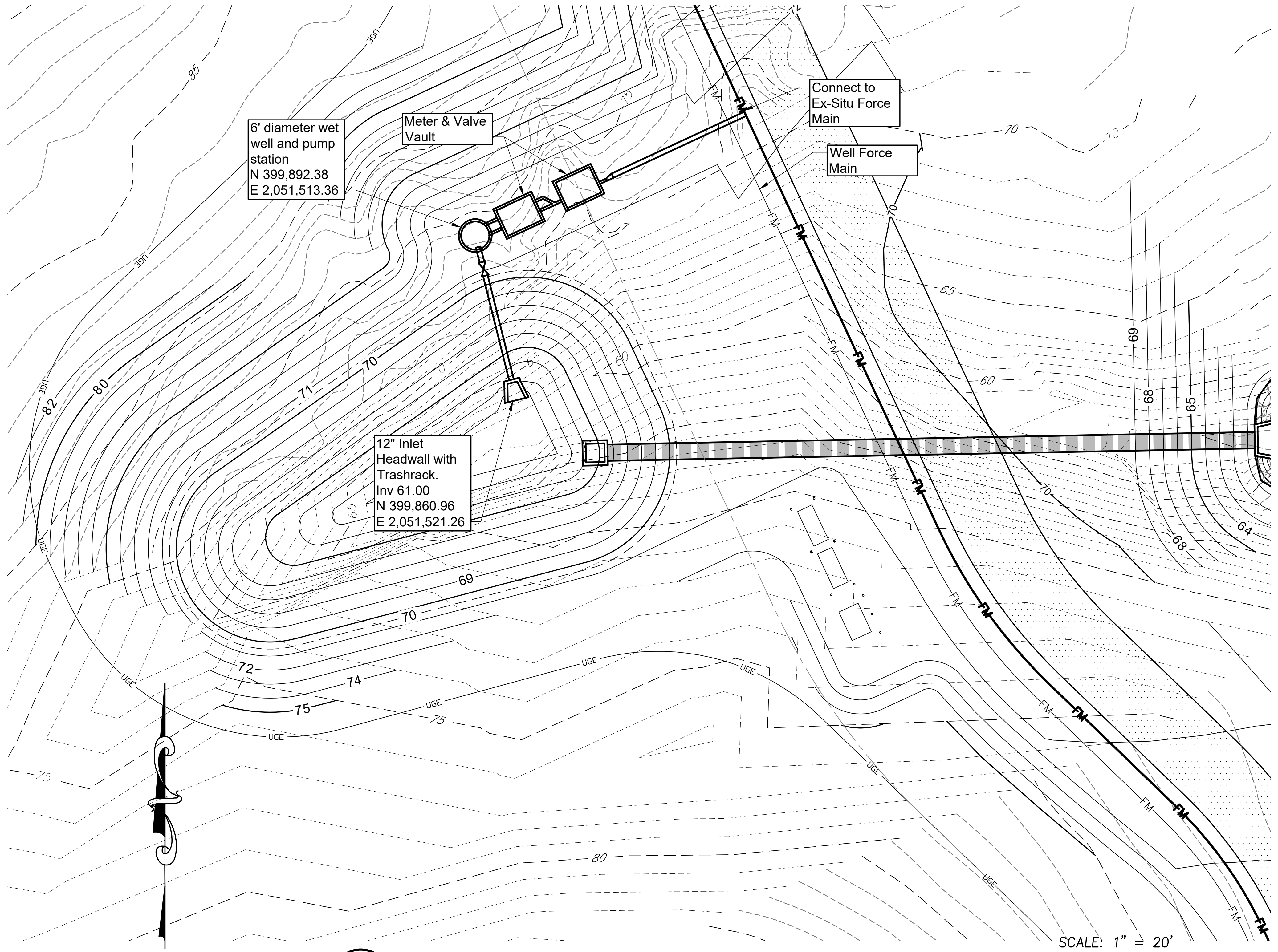
DRAWING: SC-3.2

PROJECT NUMBER: 45-20803

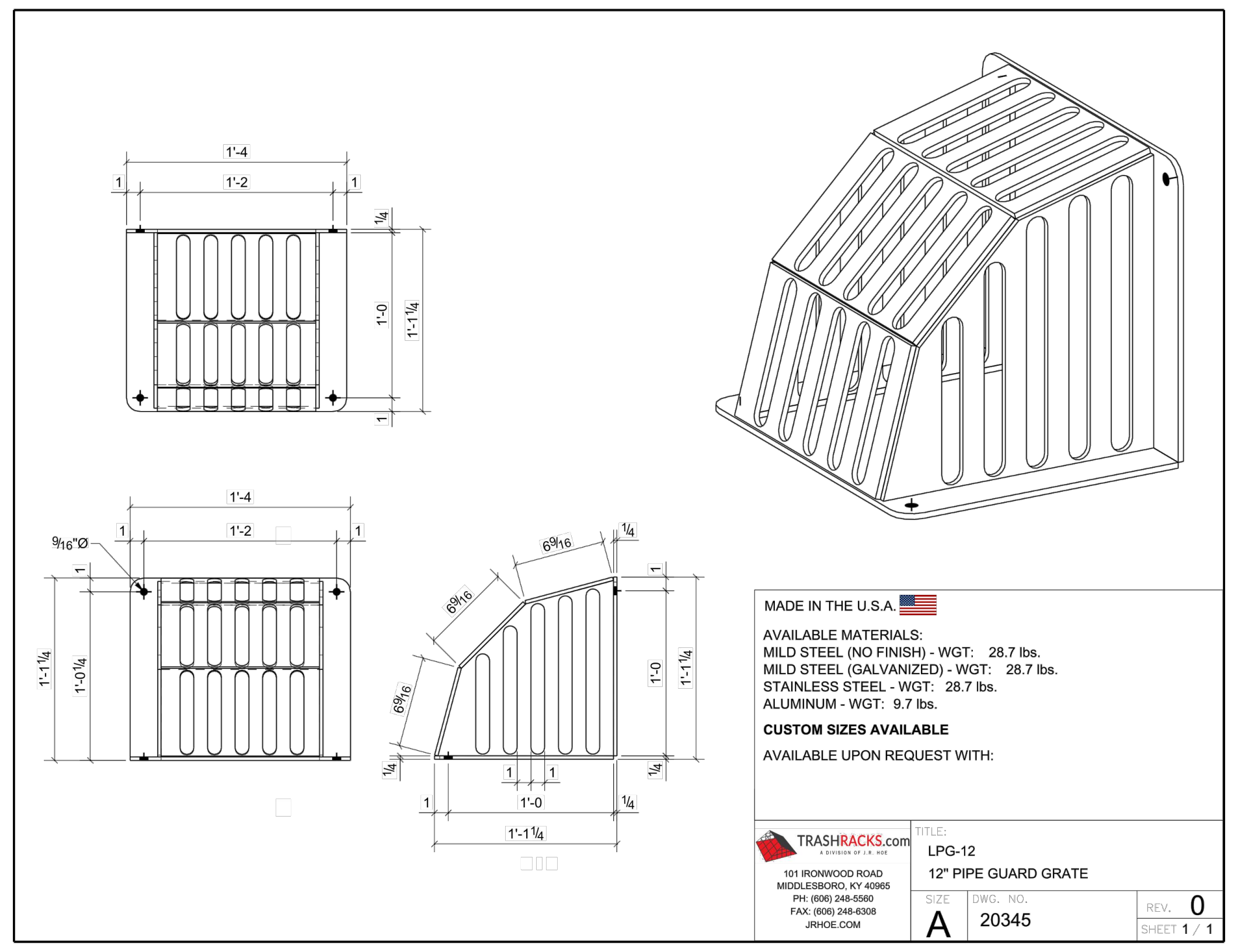


SCALE: 1" = 20'
0' 20' 40'

1 SC-3.3 *Seep A Tributary – Pump Station Site Plan*

Seep A Tributary - Pump Station Operation

1. The Seep B Basin is intended to catch the Dry Weather Flow and the runoff from the $\frac{1}{2}$" Rainfall each day.
2. The pump station will turn on at the end of each day and pump until the basin is dry.
    - 2.1. If their is no rainfall event, the basin will fill to the Dry Weather volume level. At the end of the day, the pump station will remove the water from the basin.
    - 2.2. If up to $\frac{1}{2}$" rainfall, the basin will fill to the $\frac{1}{2}$" rainfall runoff level. At the end of the day, the pump station will remove the Dry Weather flow and the $\frac{1}{2}$" Rainfall runoff from the basin.
    - 2.3. If greater than $\frac{1}{2}$" rainfall, the basin will fill above the $\frac{1}{2}$" rainfall runoff level and the additional depth will be discharged downstream via the overflow structure and pipe. At the end of the day, the pump station will remove the Dry Weather flow and the $\frac{1}{2}$" Rainfall runoff from the basin.



MADE IN THE U.S.A.

AVAILABLE MATERIALS:
MILD STEEL (NO FINISH) - WGT: 28.7 lbs.
MILD STEEL (GALVANIZED) - WGT: 28.7 lbs.
STAINLESS STEEL - WGT: 28.7 lbs.
ALUMINUM - WGT: 9.7 lbs.

CUSTOM SIZES AVAILABLE

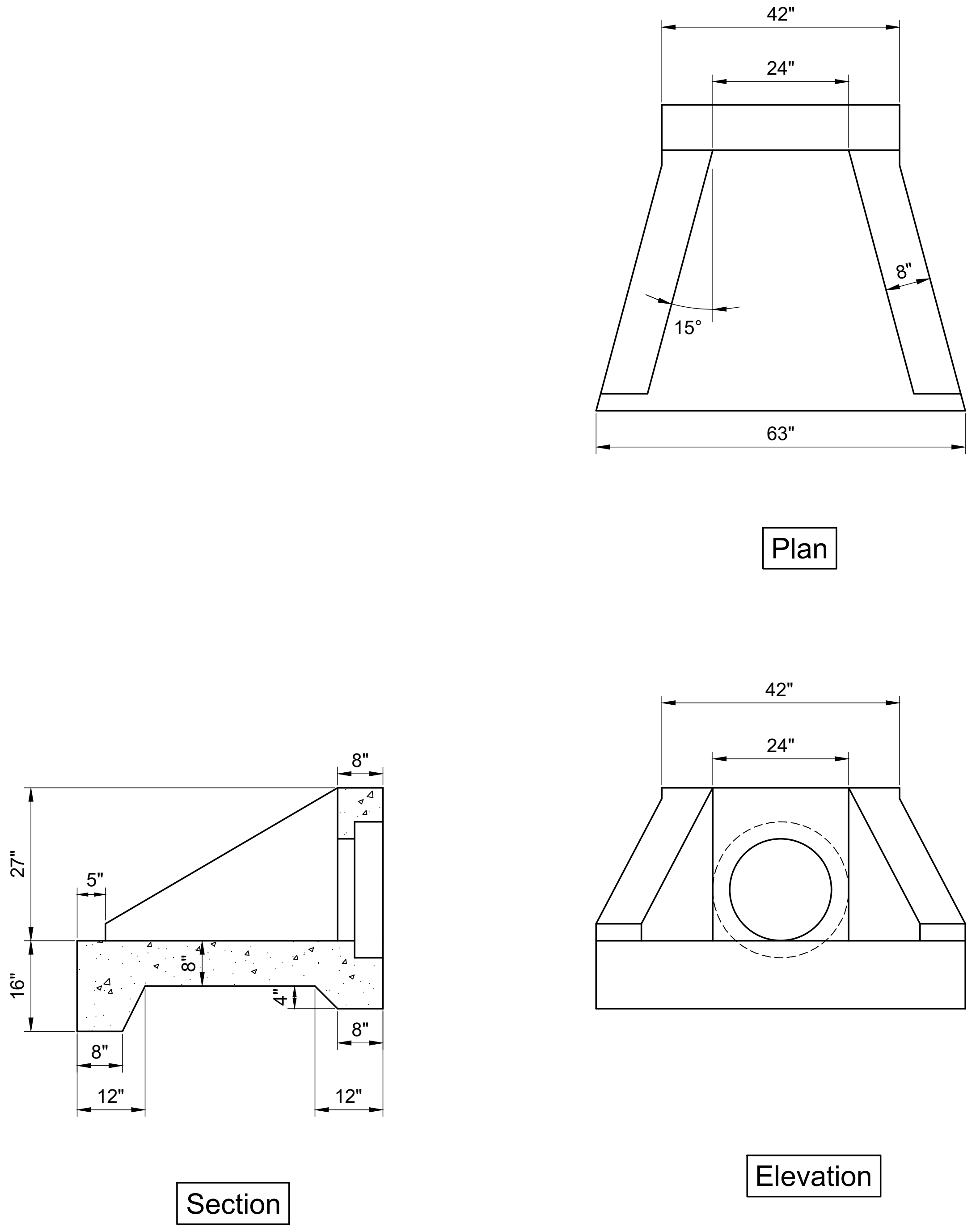
AVAILABLE UPON REQUEST WITH:

TRASHRACKS.com
A DIVISION OF J.R. HOE
101 IRONWOOD ROAD
MIDDLESBORO, KY 40965
PH: (606) 248-5560
FAX: (606) 248-6308
JRHOE.COM

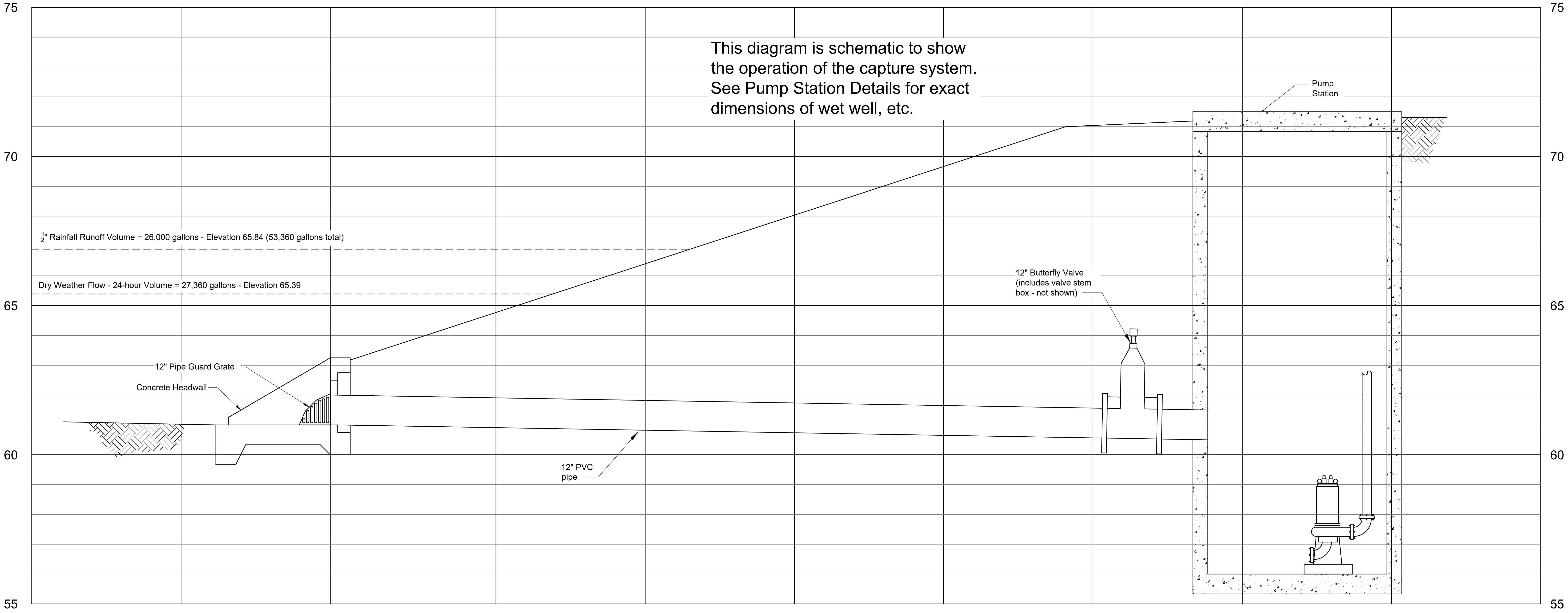
TITLE: LPG-12
12" PIPE GUARD GRATE

SIZE A
DWG. NO. 20345
REV. 0
SHEET 1 / 1

3 SC-3.3 *12" Pipe Guard Grate*



4 SC-3.3 *Seep A Tributary – 12" Pipe Concrete Headwall*



This diagram is schematic to show the operation of the capture system. See Pump Station Details for exact dimensions of wet well, etc.

2 SC-3.3 *Seep A Tributary – Gravity Line from Basin to Wet Well Profile*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep A Tributary Capture System Pump Station

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

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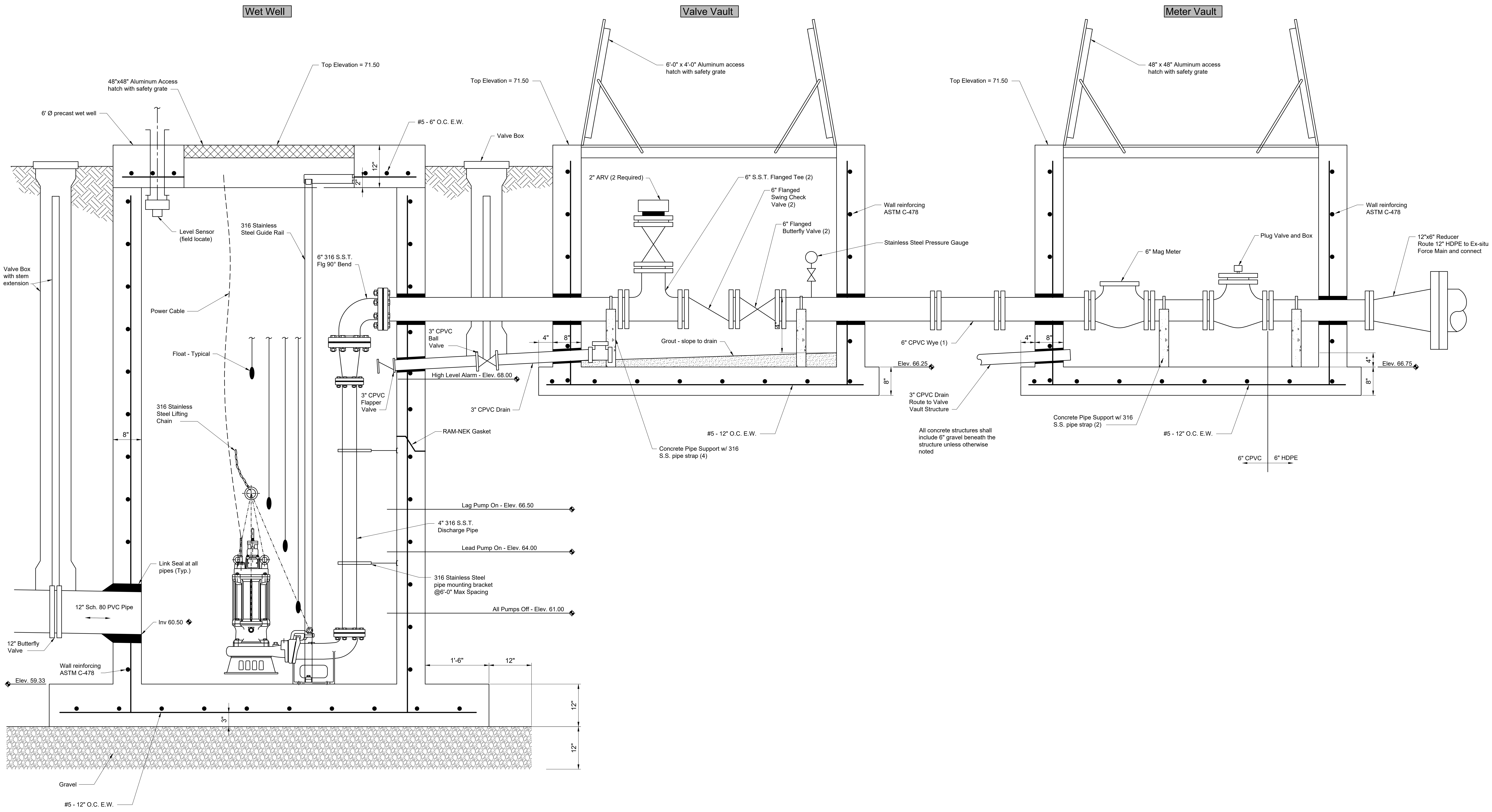
DRAWING: SC-3.3

PROJECT NUMBER: 45-20803



1
SC-3.4
Seep A Tributary – Pump Station Section

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep B - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB
REVIEWED BY: DKK
DESIGNED BY: BB
APPROVED BY:
SCALE: AS SHOWN
DATE: February 2022

Revisions

No.	Date	Description	By:
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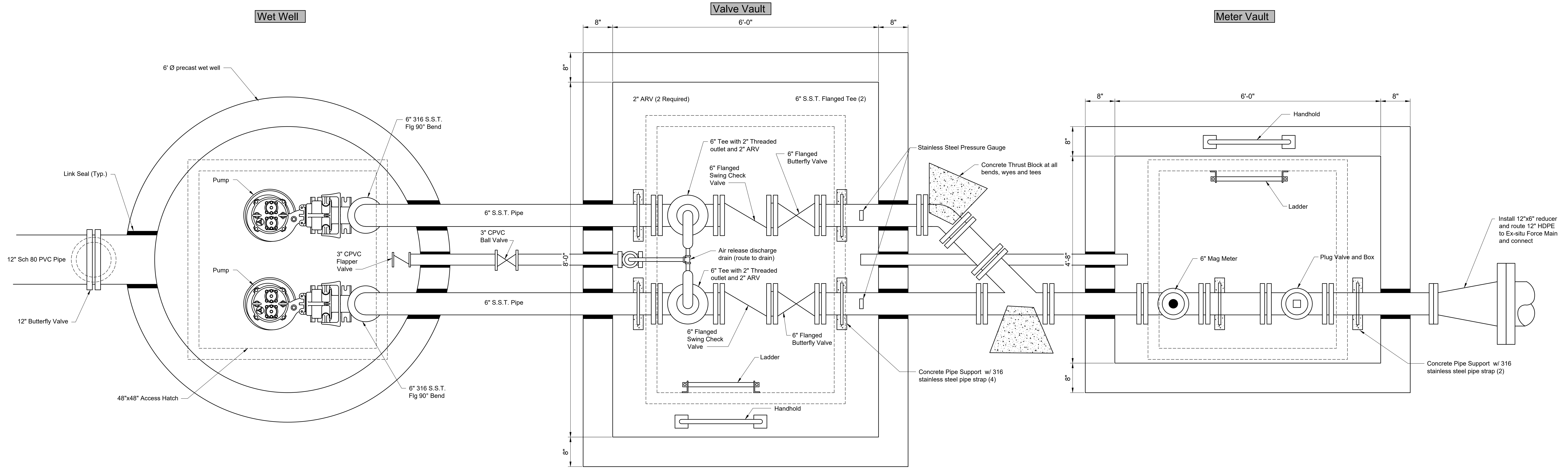
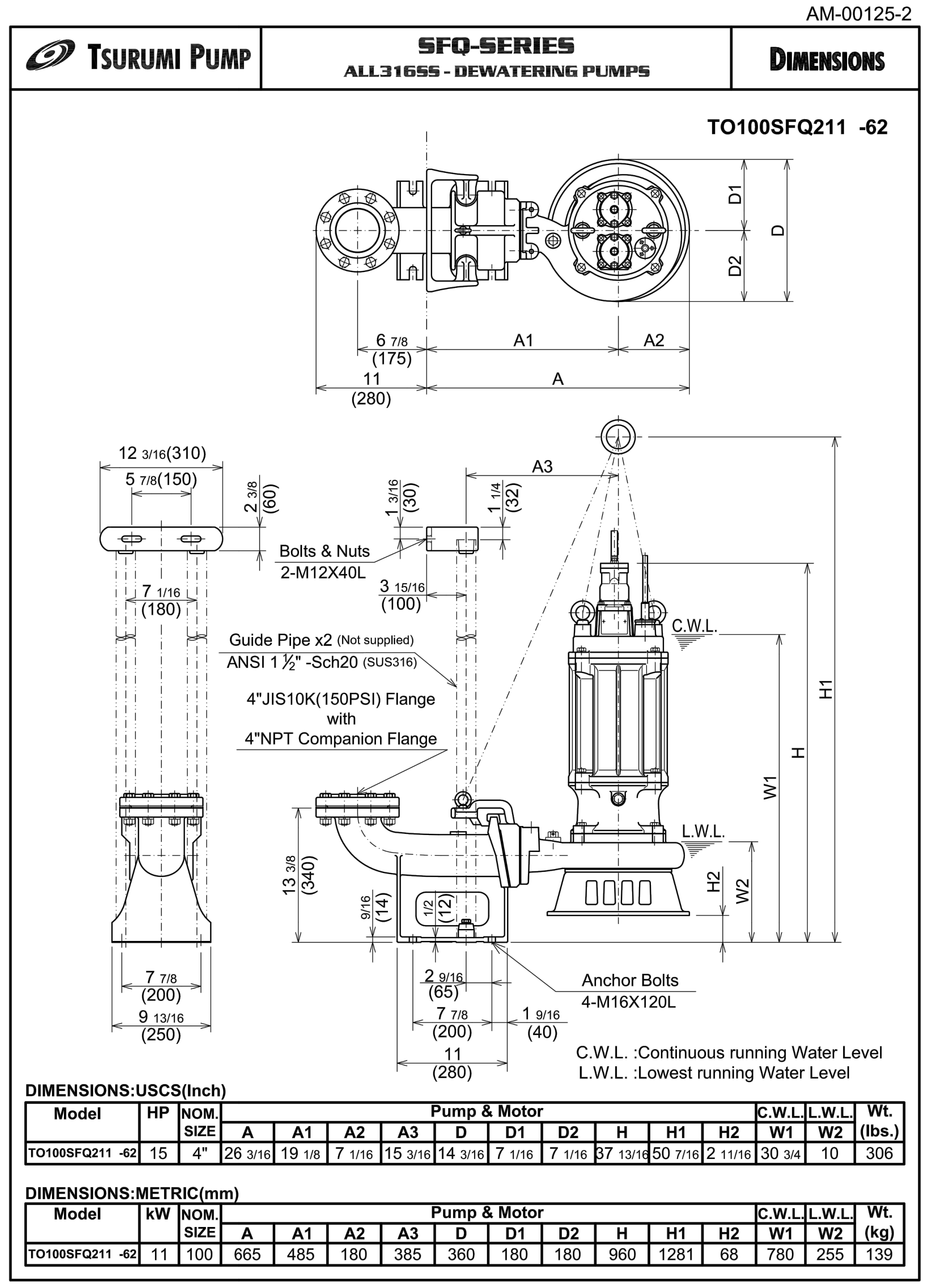
PROJECT NUMBER:
45-20803



1 SC-3.5 *Seep A Tributary – Pump Station Section*



C.W.L. :Continuous running Water Level
L.W.L. :Lowest running Water Level

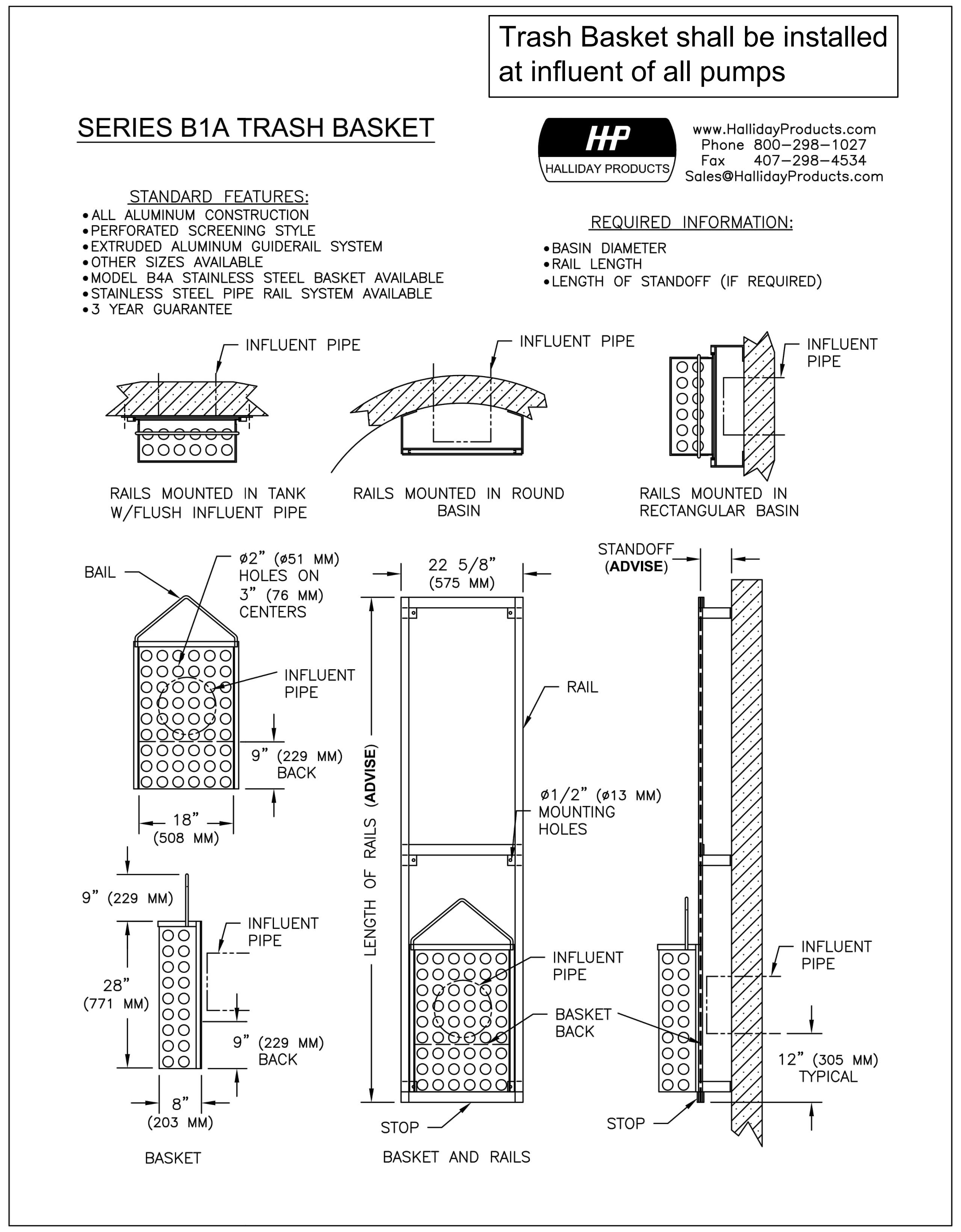
DIMENSIONS:USCS(Inch)

Model	HP	NOM. SIZE	Pump & Motor A	A1	A2	A3	D	D1	D2	H	H1	H2	C.W.L. W1	L.W.L. W2	Wt. (lbs.)
TO100SFQ211 -62	15	4"	26 3/16	19 1/8	7 1/16	15 3/16	14 3/16	7 1/16	7 1/16	37 13/16	50 7/16	2 11/16	30 3/4	10	306

DIMENSIONS:METRIC(mm)

Model	kW	NOM. SIZE	Pump & Motor A	A1	A2	A3	D	D1	D2	H	H1	H2	C.W.L. W1	L.W.L. W2	Wt. (kg)
TO100SFQ211 -62	11	100	665	485	180	385	360	180	180	960	1281	68	780	255	139

2 SC-3.5 *Duplex Pumps*


Trash Basket shall be installed at influent of all pumps

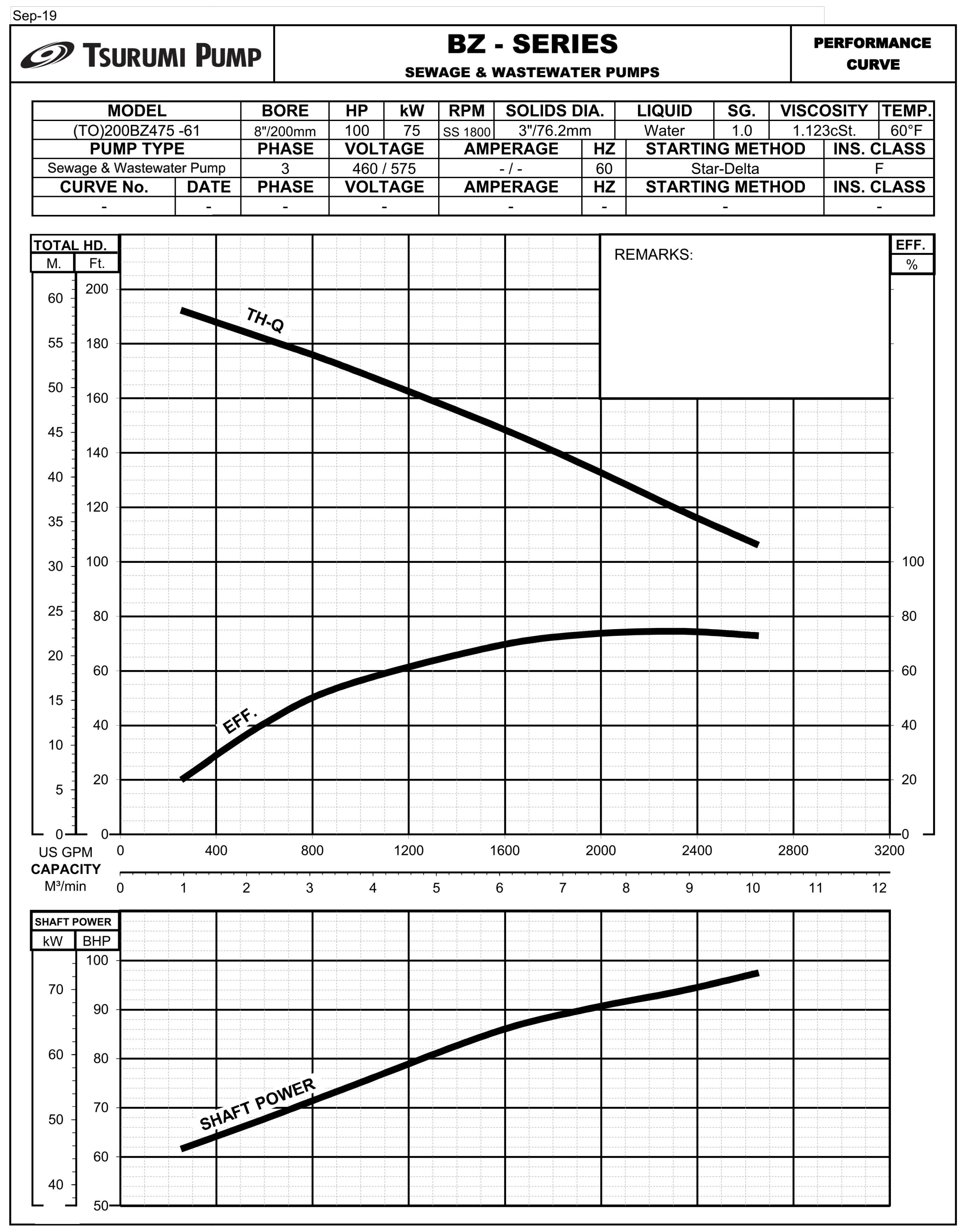
SERIES B1A TRASH BASKET

HALLIDAY PRODUCTS
www.HallidayProducts.com
Phone 800–298–1027
Fax 407–298–4534
Sales@HallidayProducts.com

STANDARD FEATURES:
- ALL ALUMINUM CONSTRUCTION
- PERFORATED SCREENING STYLE
- EXTRUDED ALUMINUM GUIDERAIL SYSTEM
- OTHER SIZES AVAILABLE
- MODEL B4A STAINLESS STEEL BASKET AVAILABLE
- STAINLESS STEEL PIPE RAIL SYSTEM AVAILABLE
- 3 YEAR GUARANTEE

REQUIRED INFORMATION:
- BASIN DIAMETER
- RAIL LENGTH
- LENGTH OF STANDOFF (IF REQUIRED)

3 SC-3.5 *Trash Basket*


Sep-19

TSURUMI PUMP — BZ - SERIES — SEWAGE & WASTEWATER PUMPS — PERFORMANCE CURVE

MODEL	BORE	HP	kW	RPM	SOLIDS DIA.	LIQUID	SG.	VISCOSITY	TEMP.
(TO)200BZ475 -61	8"/200mm	100	75	SS 1800	3"/76.2mm	Water	1.0	1.123cSt.	60°F

PUMP TYPE	PHASE	VOLTAGE	AMPERAGE	HZ	STARTING METHOD	INS. CLASS
Sewage & Wastewater Pump	3	460 / 575	- / -	60	Star-Delta	F

CURVE No.	DATE	PHASE	VOLTAGE	AMPERAGE	HZ	STARTING METHOD	INS. CLASS
-	-	-	-	-	-	-	-

4 SC-3.5 *Pump Curve*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Seep B - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

SCALE: AS SHOWN

DATE: February 2022

Revisions

No.	Date	Description	By:
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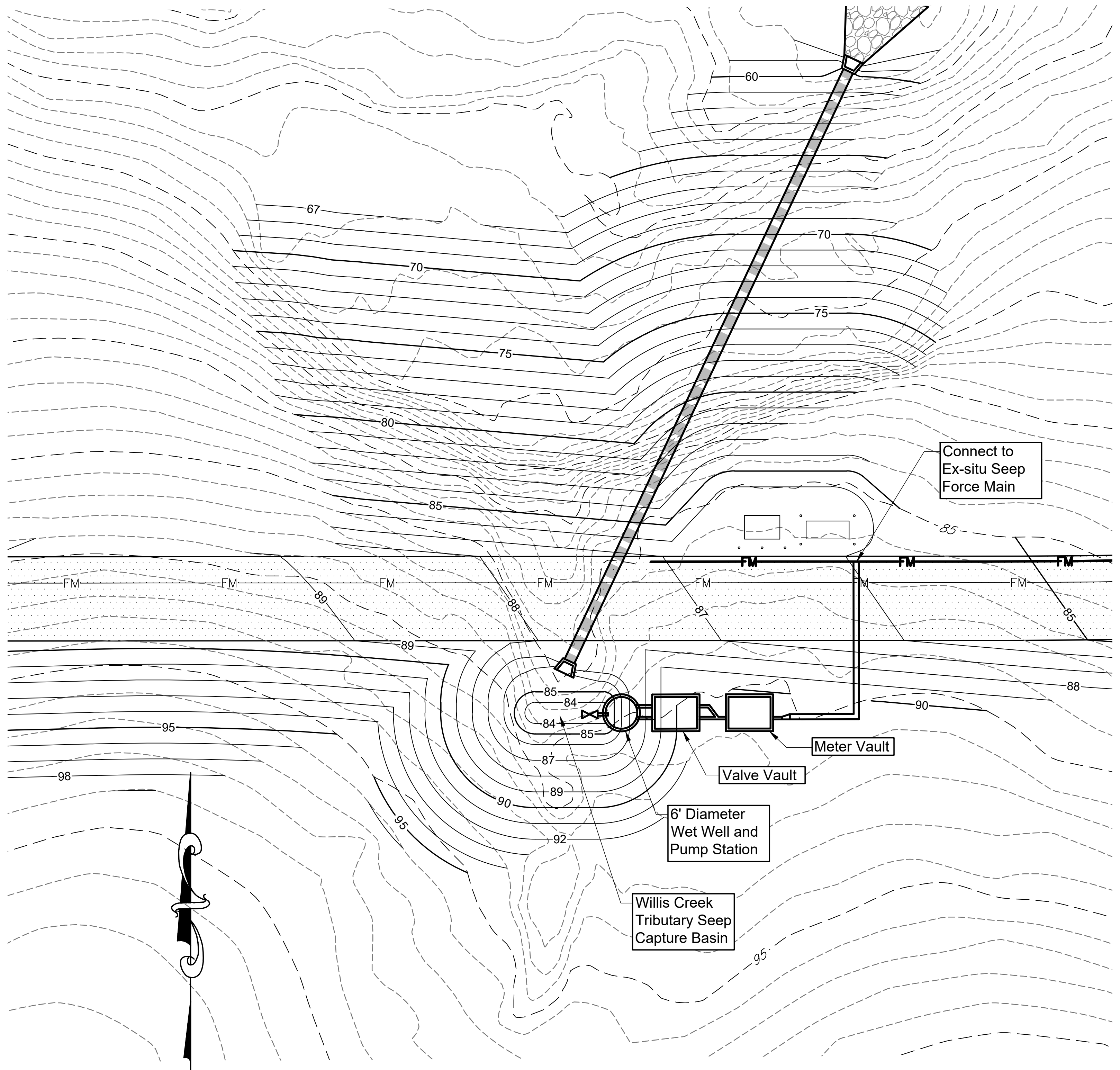
DRAWING: SC-3.5

PROJECT NUMBER: 45-20803



1
SC-4.0
Willis Creek Tributary Seep — Capture System Site Plan

SCALE: 1" = 20'
0' 20' 40'

Willis Creek Tributary - Pump Station Operation

1. The pump station will collect the Willis Creek Tributary Seep Dry Weather flow through a pipe extending into the channel. The flow is 39 gpm.
2. The wet well will fill to the pump on level in approximately 22 minutes at which point the lead pump will turn on and empty the wet well. The time required to empty the wet well is dependent on which other pumps are on in the force main system.
3. Flows greater than the Dry Weather Flow of 39 gpm, will overtop the stilling basin and discharge downstream of the wall through the overflow culvert.

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Willis Creek Tributary Seep - Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

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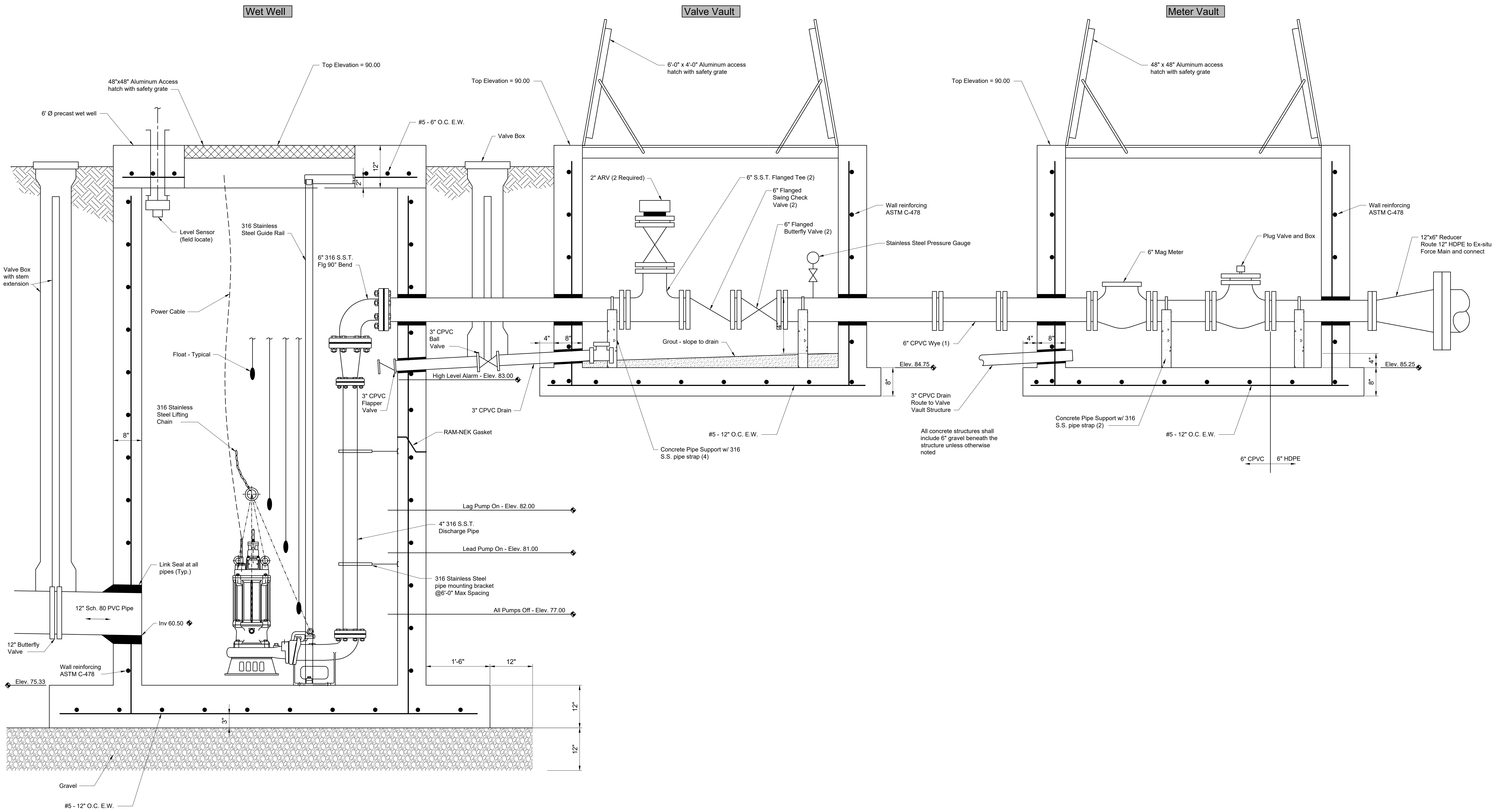
DRAWING:
SC-4.0

PROJECT NUMBER:
45-20803



1 SC-4.1 *Willis Creek Tributary – Pump Station Section*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Willis Creek Tributary - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY:	APPROVED BY:
BB	

SCALE:
AS SHOWN

DATE:
February 2022

Revisions

No.	Date	Description	By:
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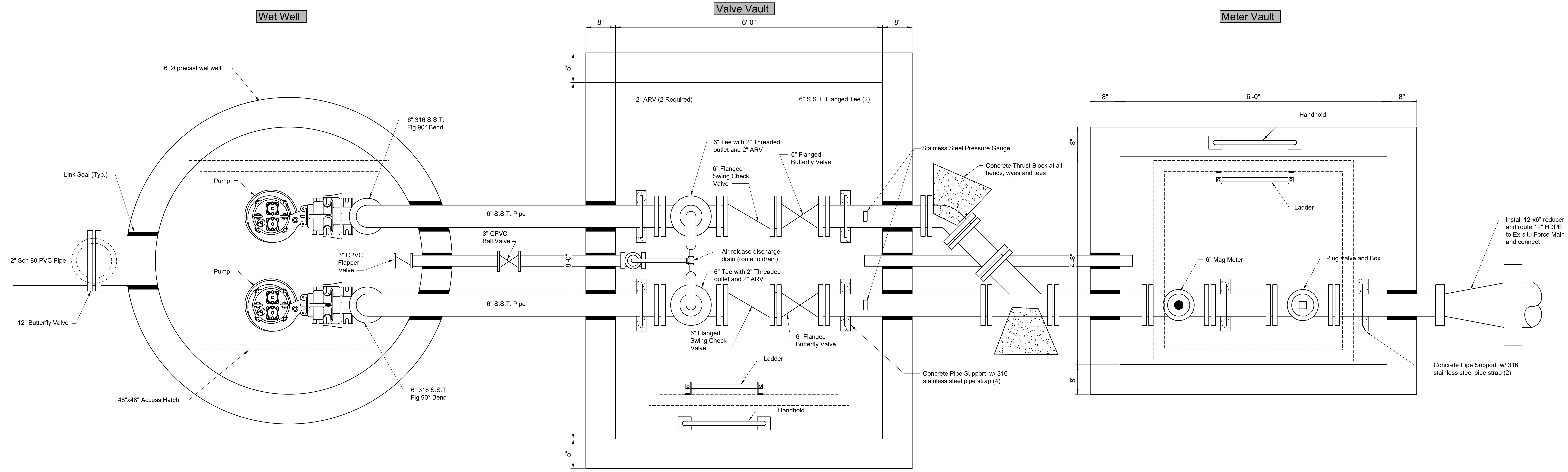
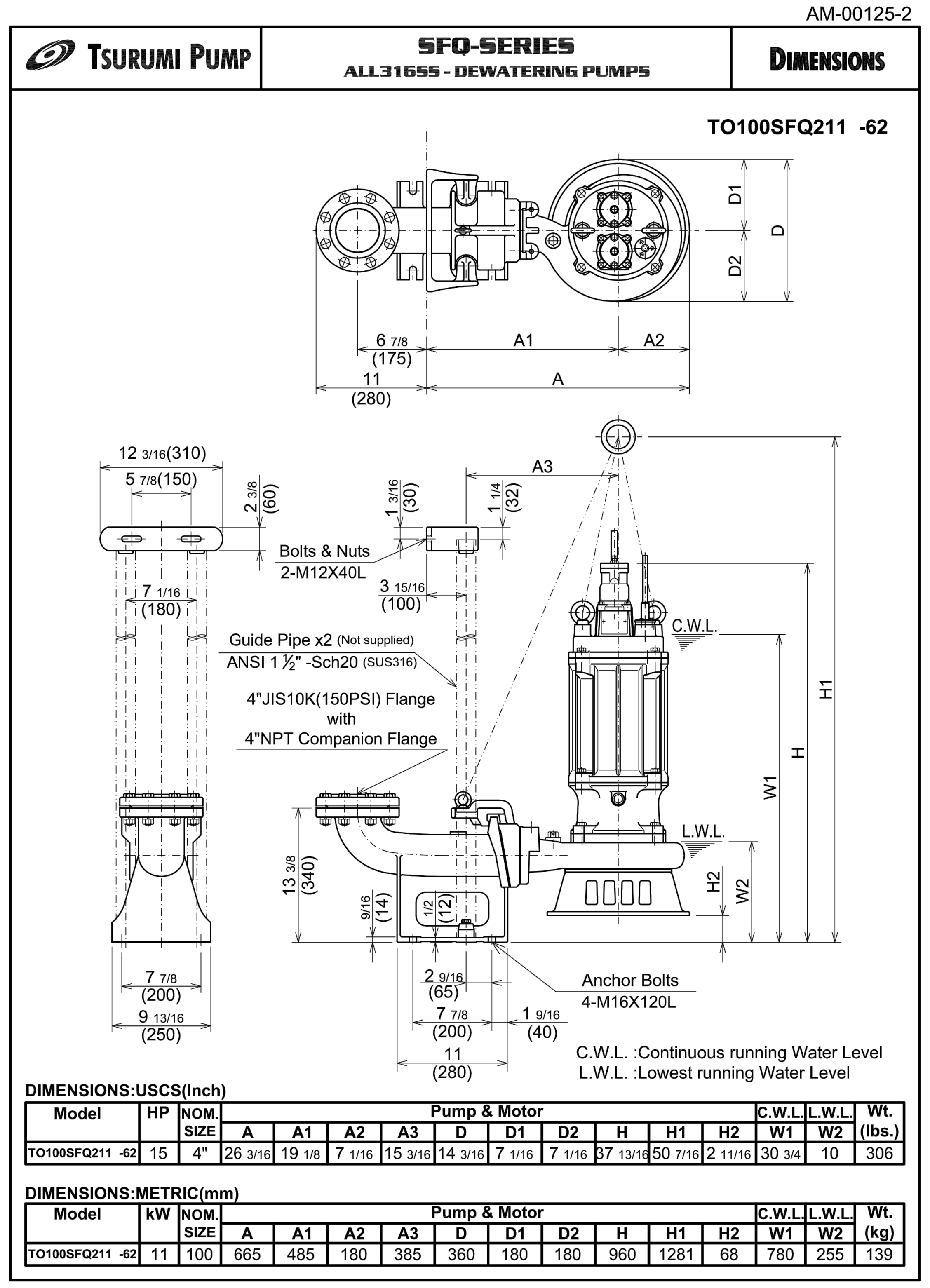
DRAWING:
SC-4.1

PROJECT NUMBER:
45-20803



1
SC-4.2
Willis Creek Tributary– Pump Station Section



AM-00125-2

TSURUMI PUMP | **SFQ-SERIES** ALL316SS - DEWATERING PUMPS | **DIMENSIONS**

TO100SFQ211 -62

C.W.L. :Continuous running Water Level
L.W.L. :Lowest running Water Level

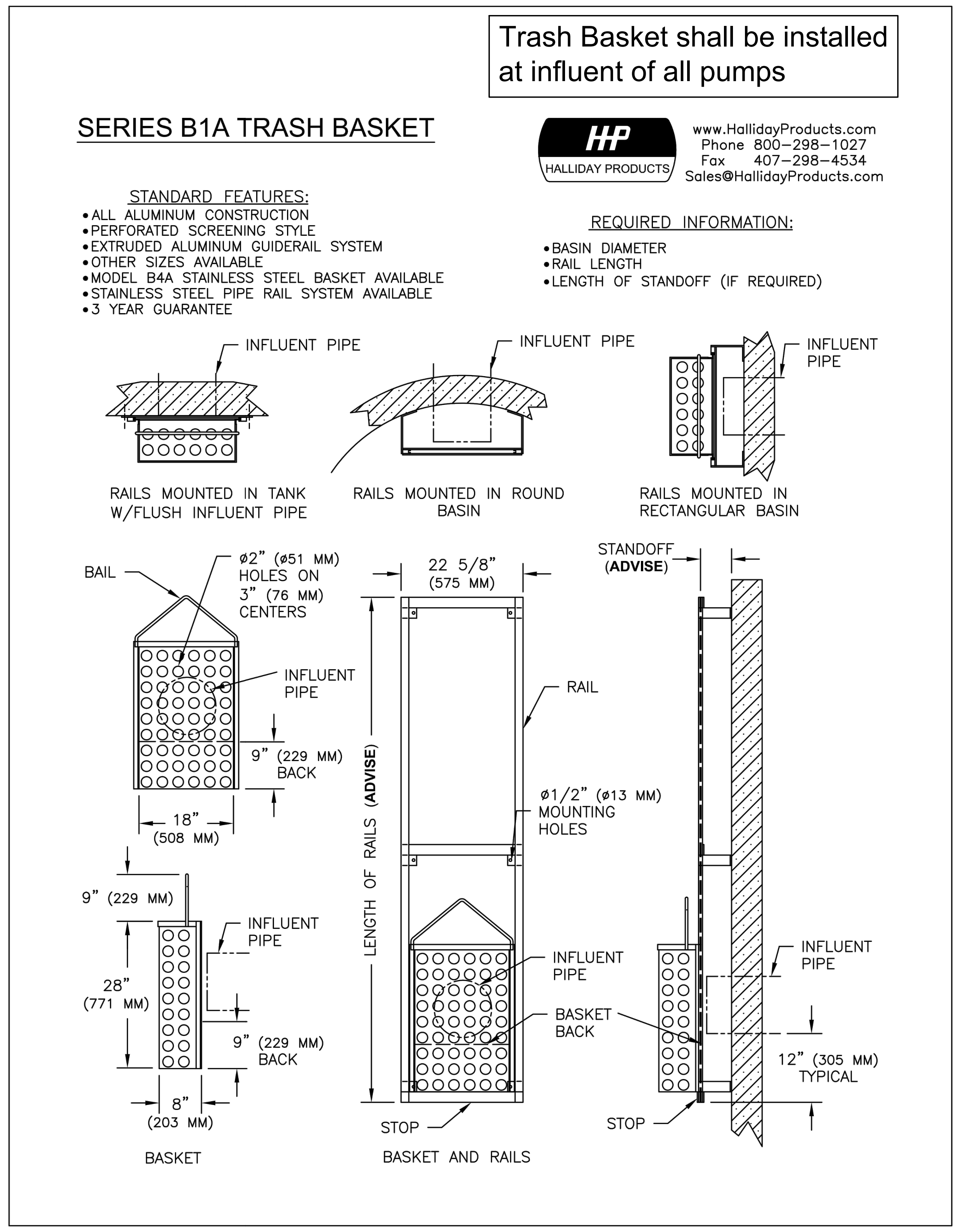
DIMENSIONS:USCS(Inch)

Model	HP	NOM. SIZE	Pump & Motor										C.W.L.	L.W.L.	Wt. (lbs.)
			A	A1	A2	A3	D	D1	D2	H	H1	H2	W1	W2	
TO100SFQ211 -62	15	4"	26 3/16	19 1/8	7 1/16	15 3/16	14 3/16	7 1/16	7 1/16	37 13/16	50 7/16	2 11/16	30 3/4	10	306

DIMENSIONS:METRIC(mm)

Model	kW	NOM. SIZE	Pump & Motor										C.W.L.	L.W.L.	Wt. (kg)
			A	A1	A2	A3	D	D1	D2	H	H1	H2	W1	W2	
TO100SFQ211 -62	11	100	665	485	180	385	360	180	180	960	1281	68	780	255	139

2
SC-4.2
Duplex Pumps



Trash Basket shall be installed at influent of all pumps

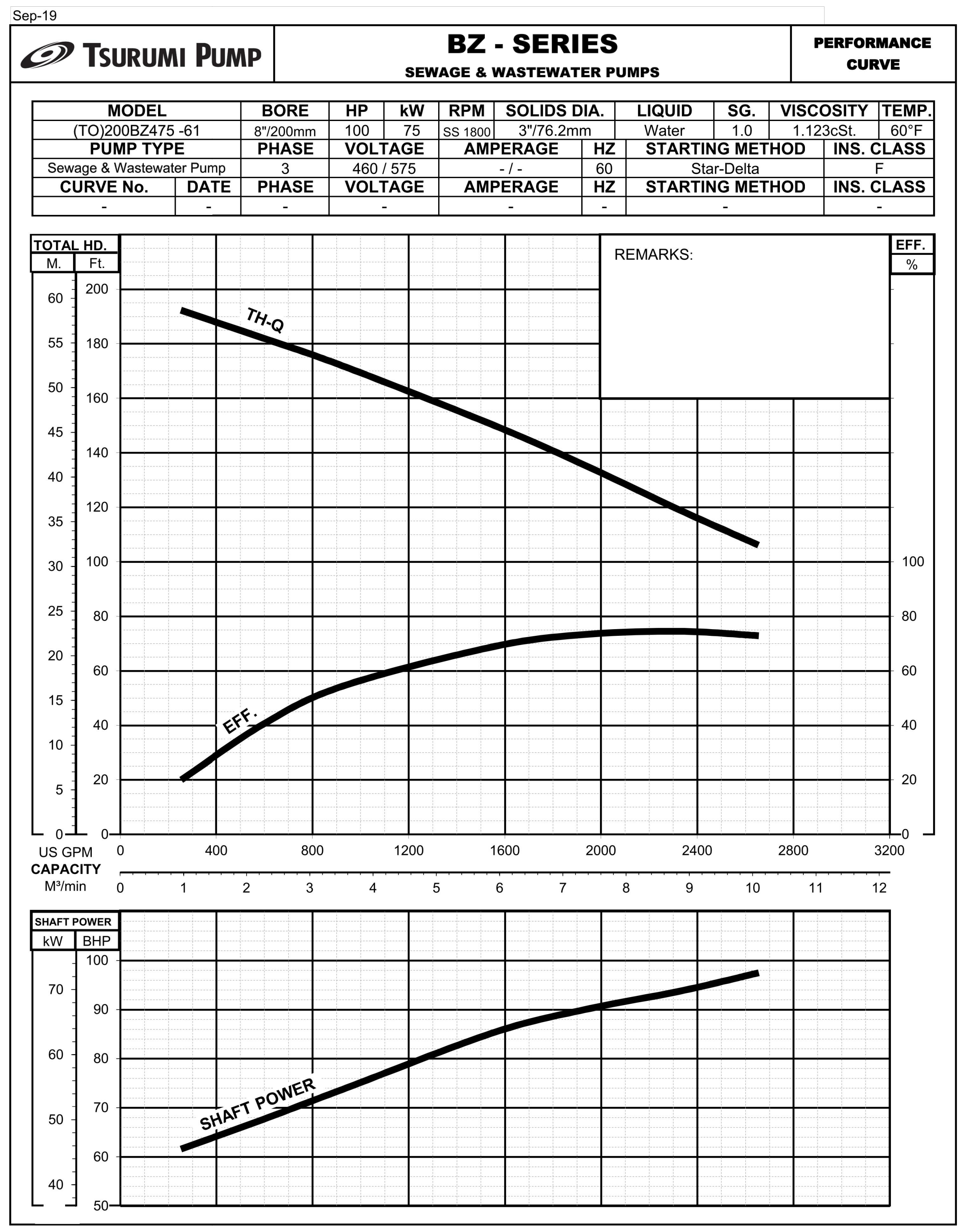
SERIES B1A TRASH BASKET

HALLIDAY PRODUCTS
www.HallidayProducts.com
Phone 800–298–1027
Fax 407–298–4534
Sales@HallidayProducts.com

STANDARD FEATURES:
- ALL ALUMINUM CONSTRUCTION
- PERFORATED SCREENING STYLE
- EXTRUDED ALUMINUM GUIDERAIL SYSTEM
- OTHER SIZES AVAILABLE
- MODEL B4A STAINLESS STEEL BASKET AVAILABLE
- STAINLESS STEEL PIPE RAIL SYSTEM AVAILABLE
- 3 YEAR GUARANTEE

REQUIRED INFORMATION:
- BASIN DIAMETER
- RAIL LENGTH
- LENGTH OF STANDOFF (IF REQUIRED)

3
SC-4.2
Trash Basket



Sep-19

TSURUMI PUMP | **BZ - SERIES** SEWAGE & WASTEWATER PUMPS | **PERFORMANCE CURVE**

MODEL		BORE	HP	kW	RPM	SOLIDS DIA.	LIQUID	SG.	VISCOSITY	TEMP.
(TO)200BZ475 -61		8"/200mm	100	75	SS 1800	3"/76.2mm	Water	1.0	1.123cSt.	60°F
PUMP TYPE		PHASE	VOLTAGE		AMPERAGE	HZ	STARTING METHOD		INS. CLASS	
Sewage & Wastewater Pump		3	460 / 575		- / -	60	Star-Delta		F	
CURVE No.	DATE	PHASE	VOLTAGE		AMPERAGE	HZ	STARTING METHOD		INS. CLASS	
-	-	-	-		-	-	-		-	

4
SC-4.2
Pump Curve

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Willis Creek Tributary - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

No.	Date	Description	By:
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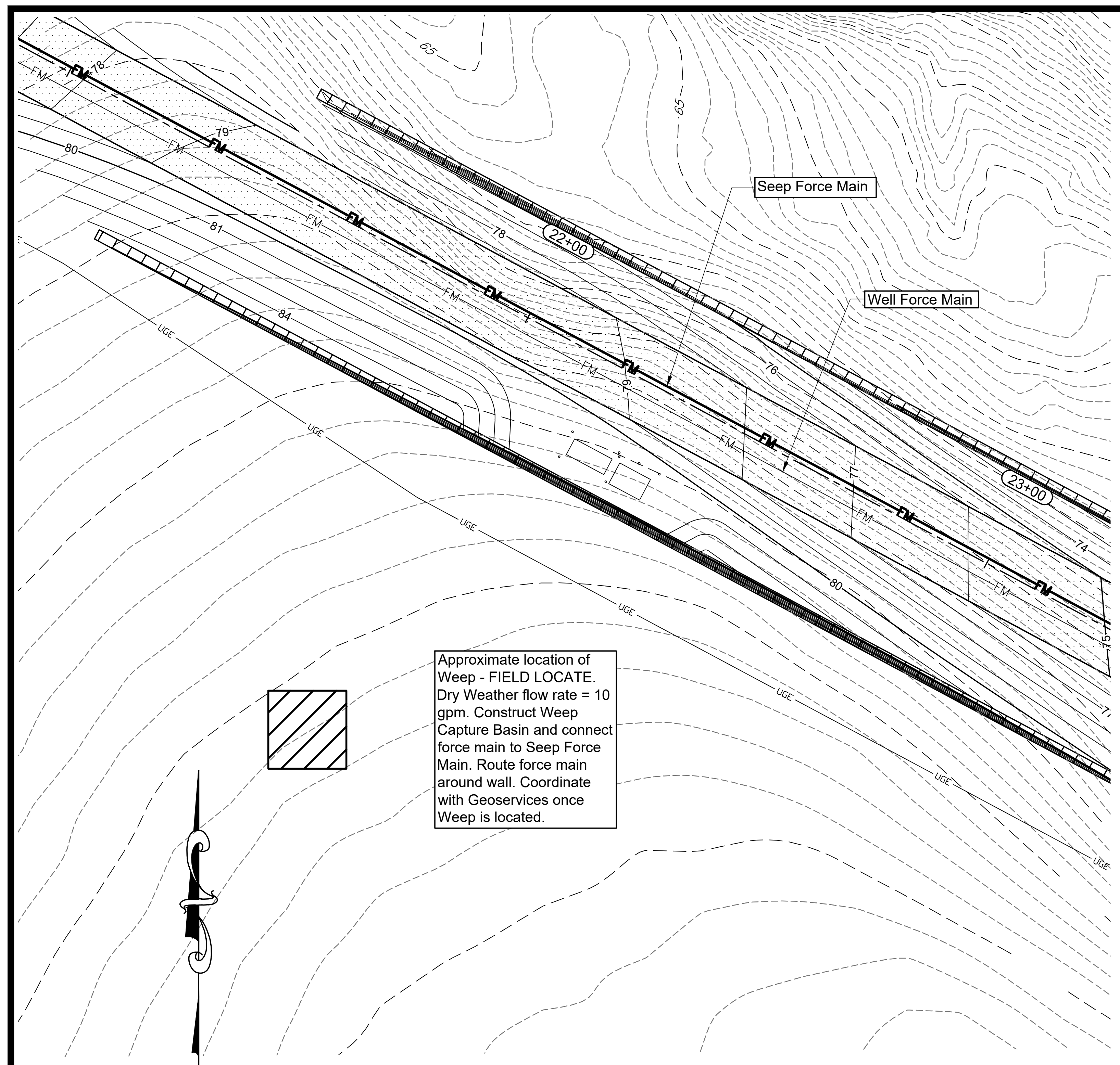
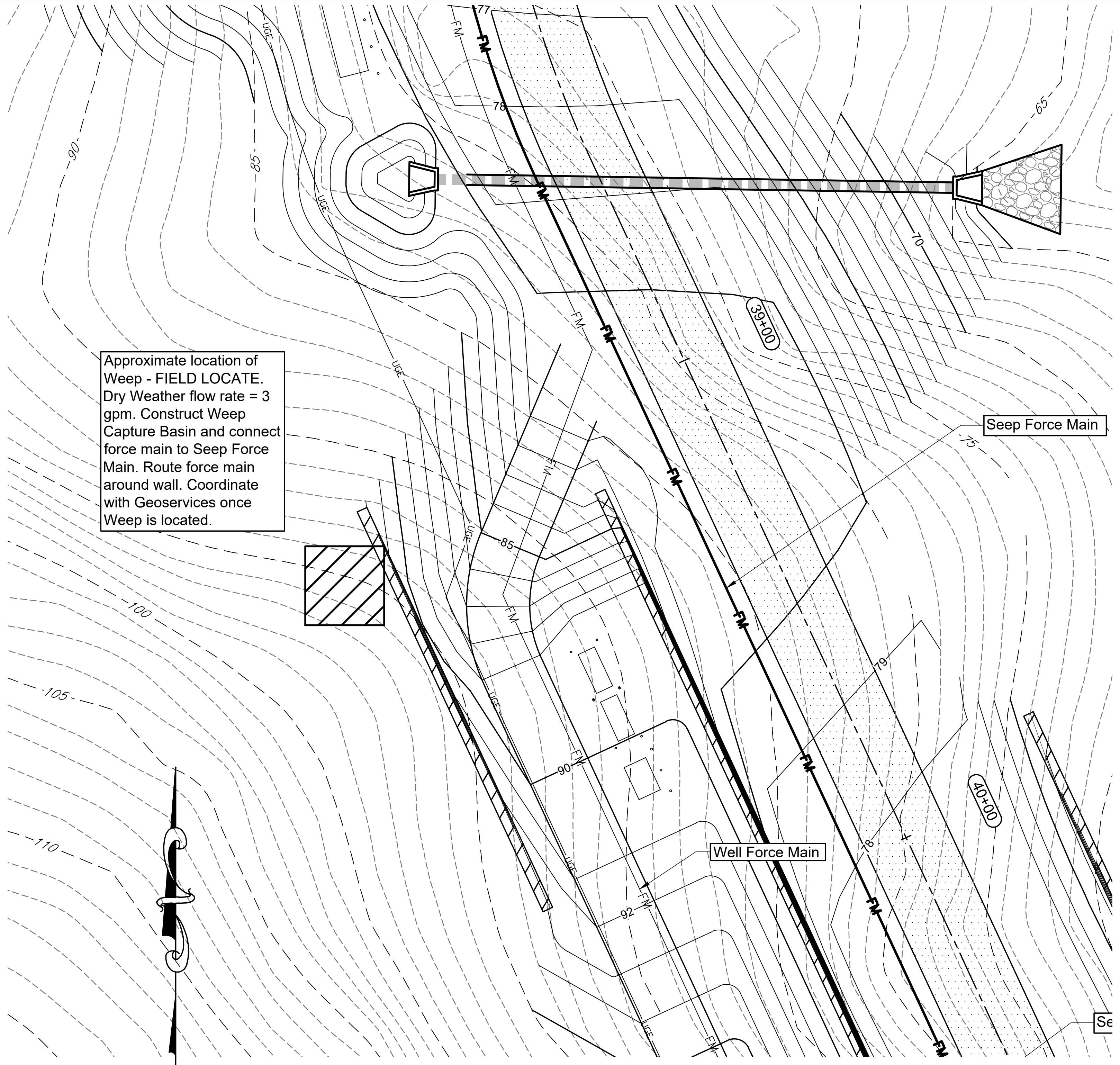
DRAWING:
SC-4.2

PROJECT NUMBER:
45-20803



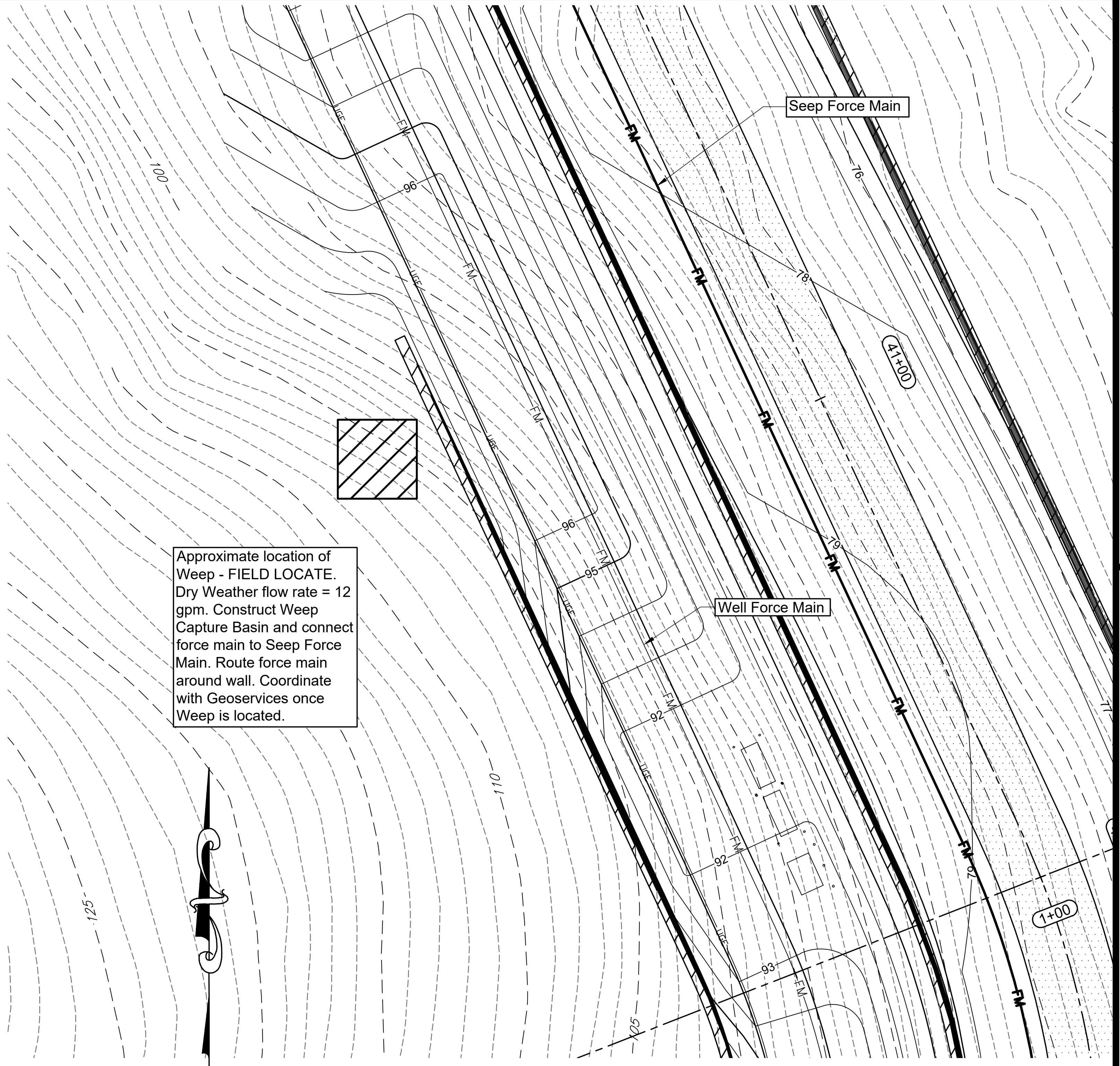
1 SC-5.0 Barrier Wall Station 22+00 – Weep

SCALE: 1" = 20'
0' 20' 40'



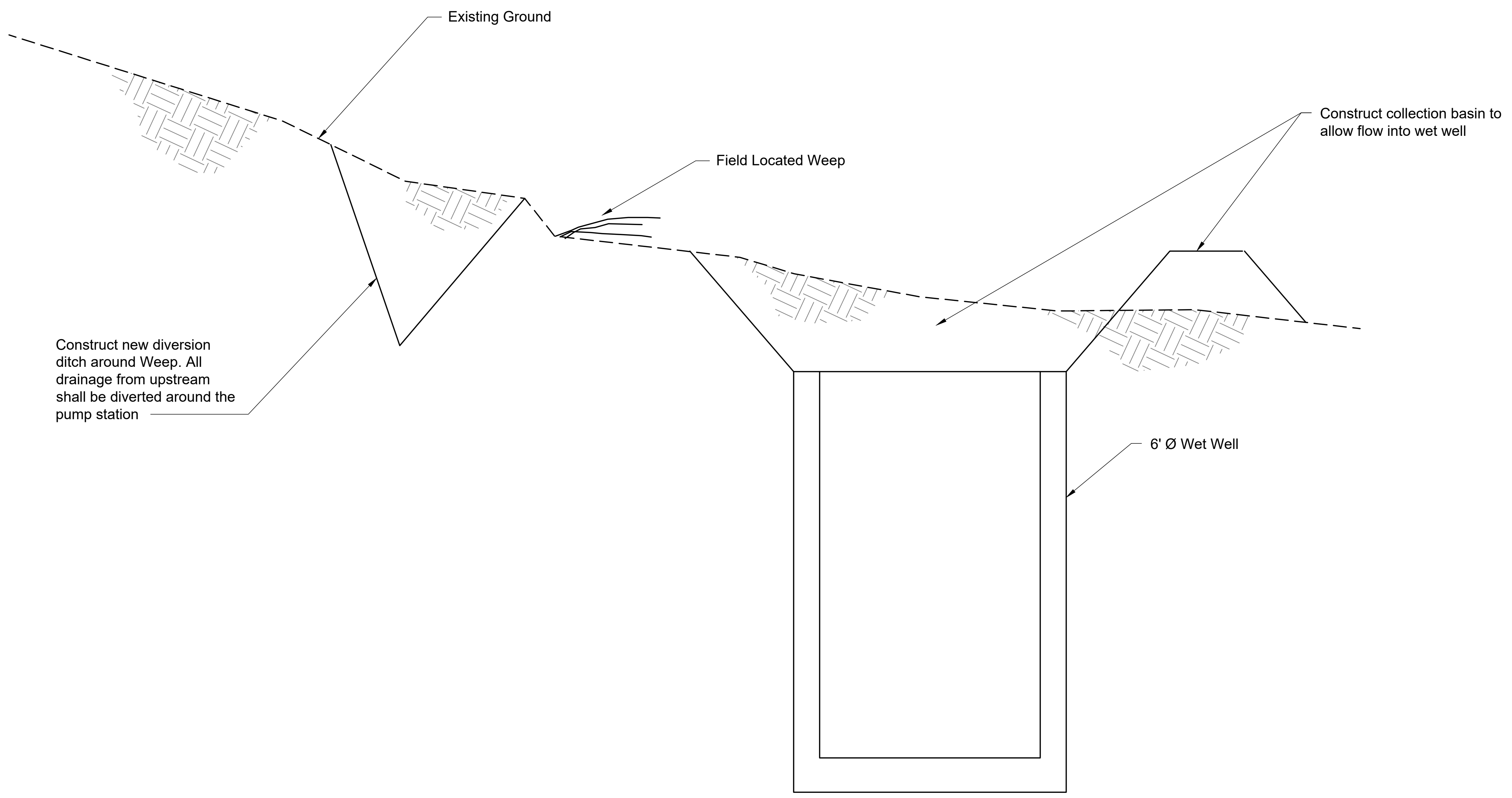
2 SC-5.0 Barrier Wall Station 39+50 – Weep

SCALE: 1" = 20'
0' 20' 40'

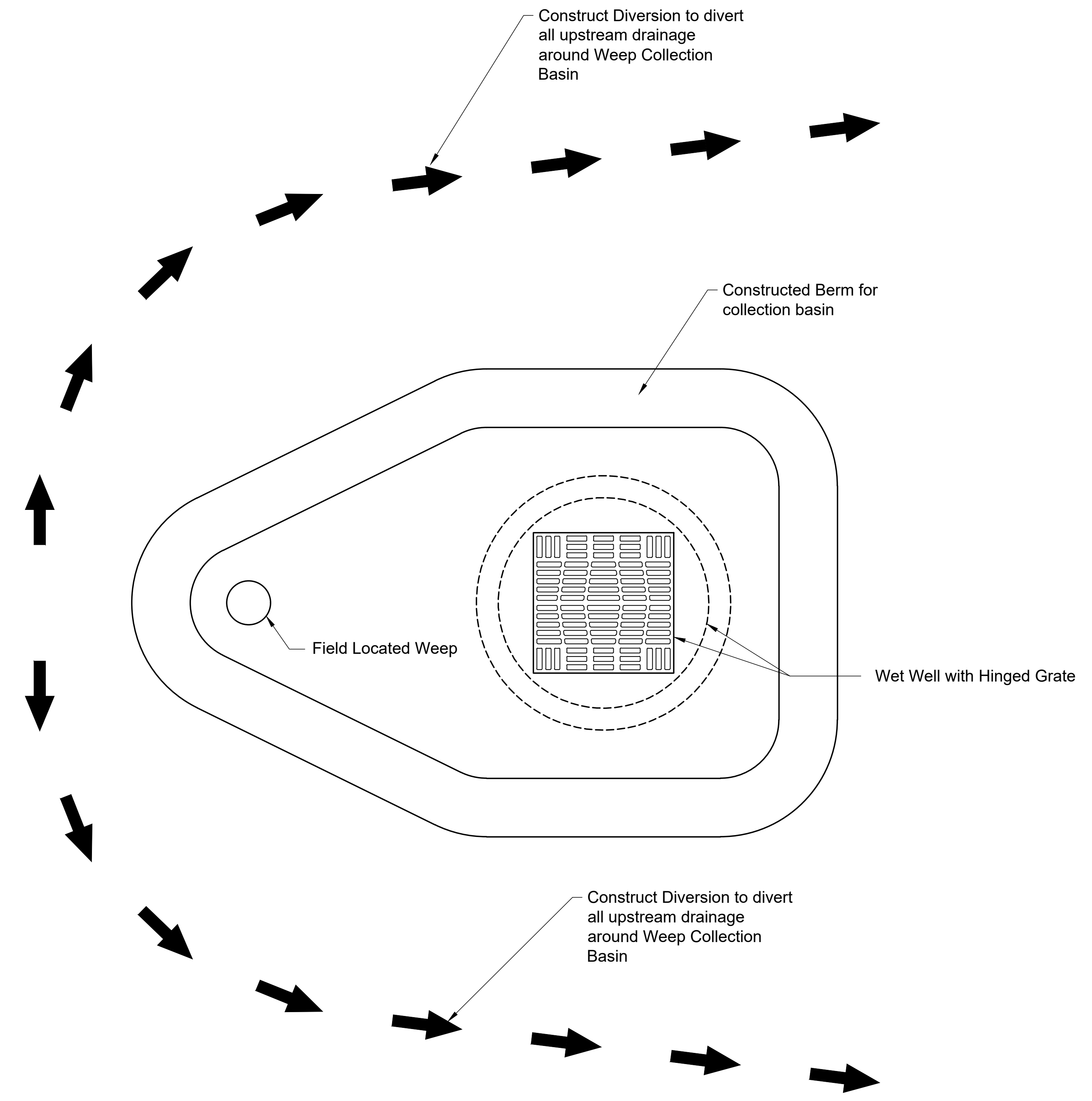


3 SC-5.0 Barrier Wall Station 41+00 – Weep

SCALE: 1" = 20'
0' 20' 40'



4 SC-5.0 Typical Weep Collection – Section View



5 SC-5.0 Typical Weep Collection – Plan View

Weep Collection - Contractor Notes

1. Contractor shall field locate weep and prepare a survey of the weep area (minimum of 50' on all sides of weep). Survey shall be provided to Geoservices in CAD format on the same coordinate system as the project. Geoservices will design the pump station based on the survey and provide new pump station details to the contractor.

Weep Collection - Pump Station Operation

1. The pump station wet wells will collect the Weep Dry Weather flow through a pipe extending into the channel. The flow varies for each weep.
2. The wet well pump operating levels will vary with each Weep and the geometry of each.

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Weep Collection Capture System Pump Station

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

SCALE: AS SHOWN

DATE: February 2022

Revisions

No.	Date	Description	By:
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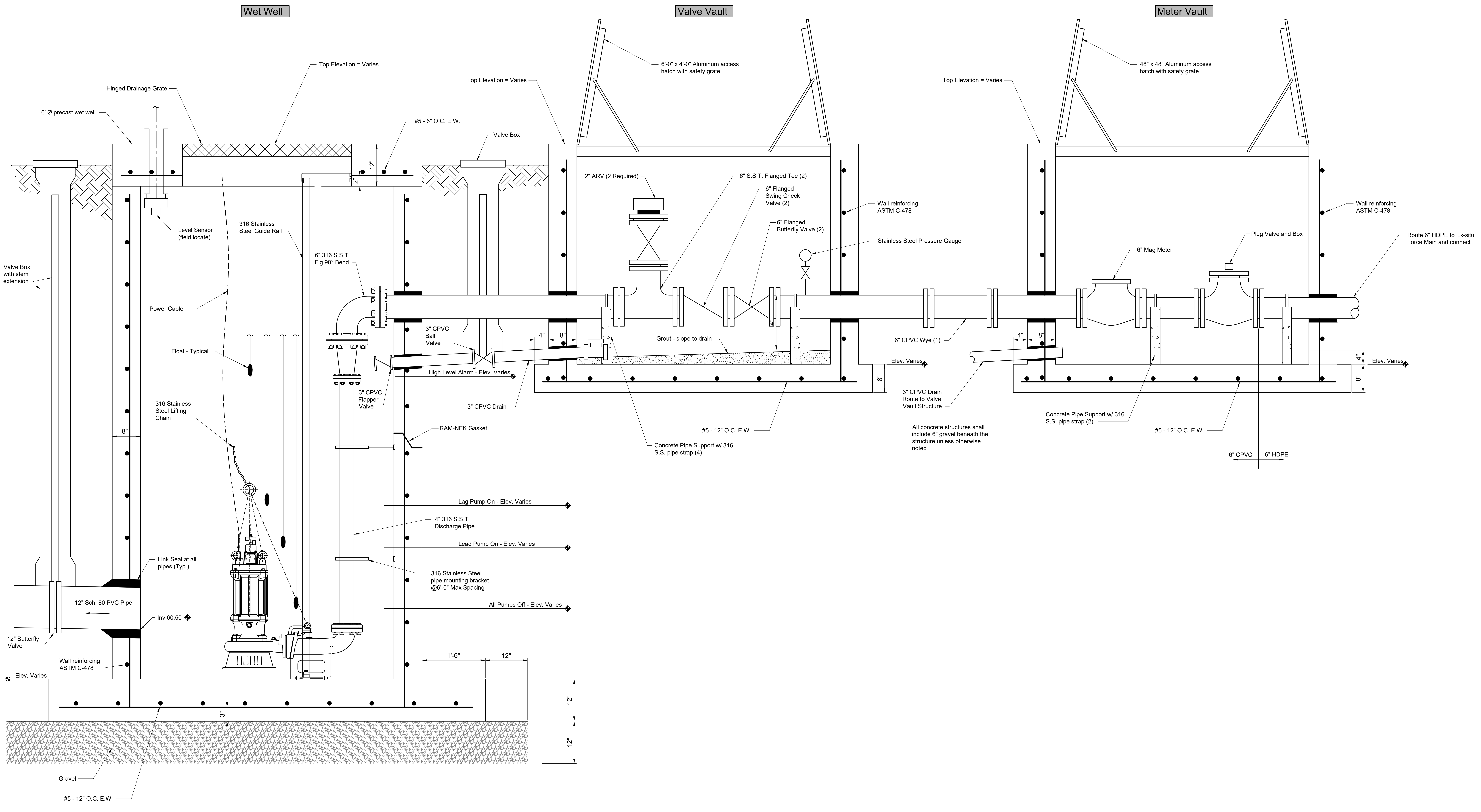
DRAWING: SC-5.0

PROJECT NUMBER: 45-20803



1 SC-5.1 *Typical Weep Collection – Pump Station Section*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Weep Collection - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:

SCALE: AS SHOWN
DATE: February 2022

Revisions

No.	Date	Description	By:
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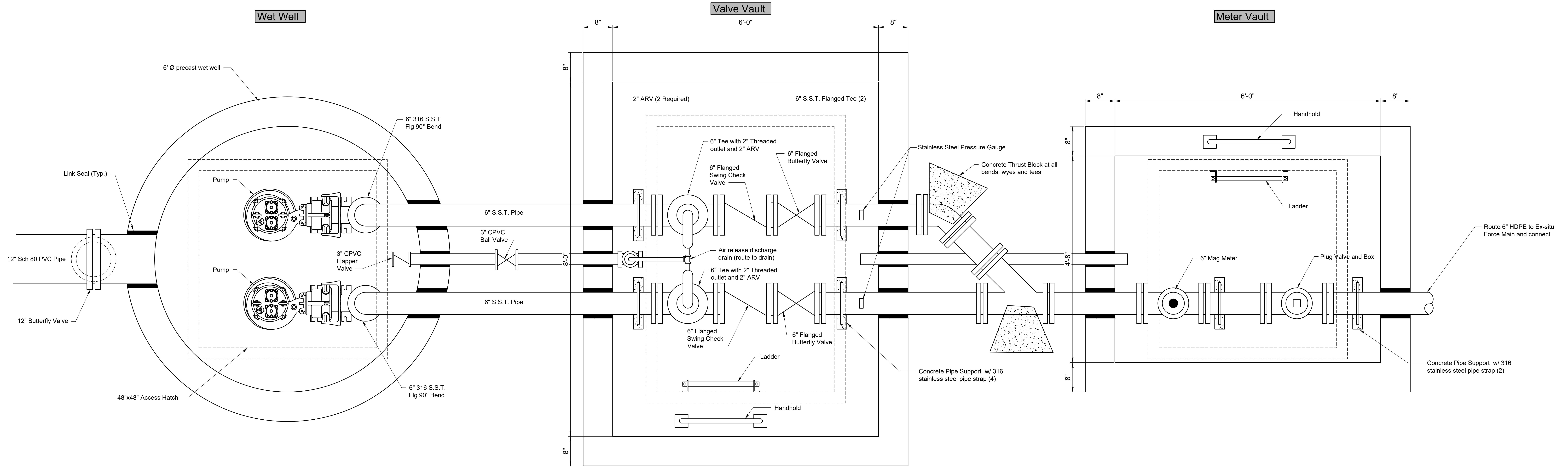
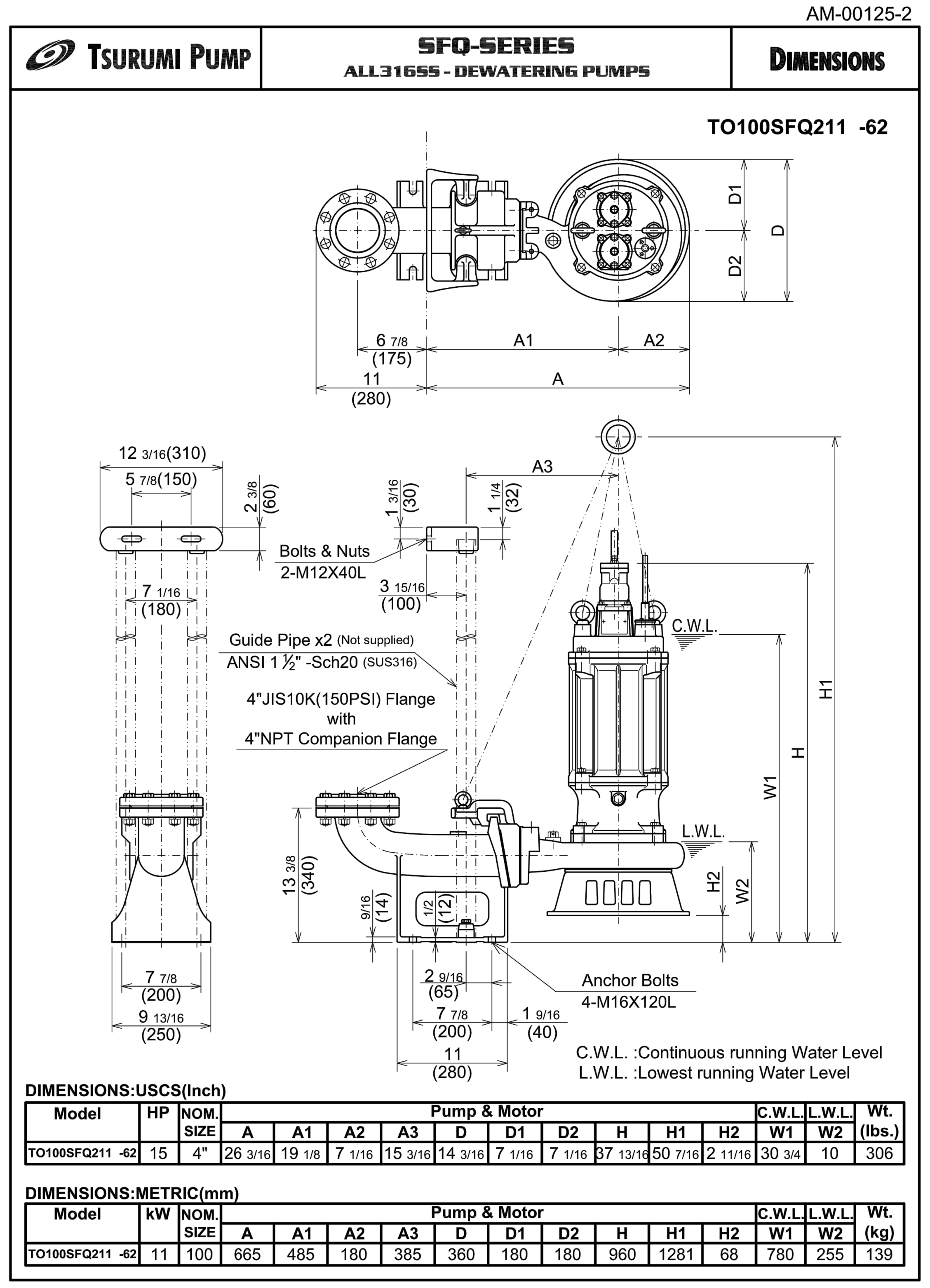
DRAWING: SC-5.1

PROJECT NUMBER: 45-20803



1 SC-5.2 Typical Weep Collection – Pump Station Section



C.W.L. :Continuous running Water Level
L.W.L. :Lowest running Water Level

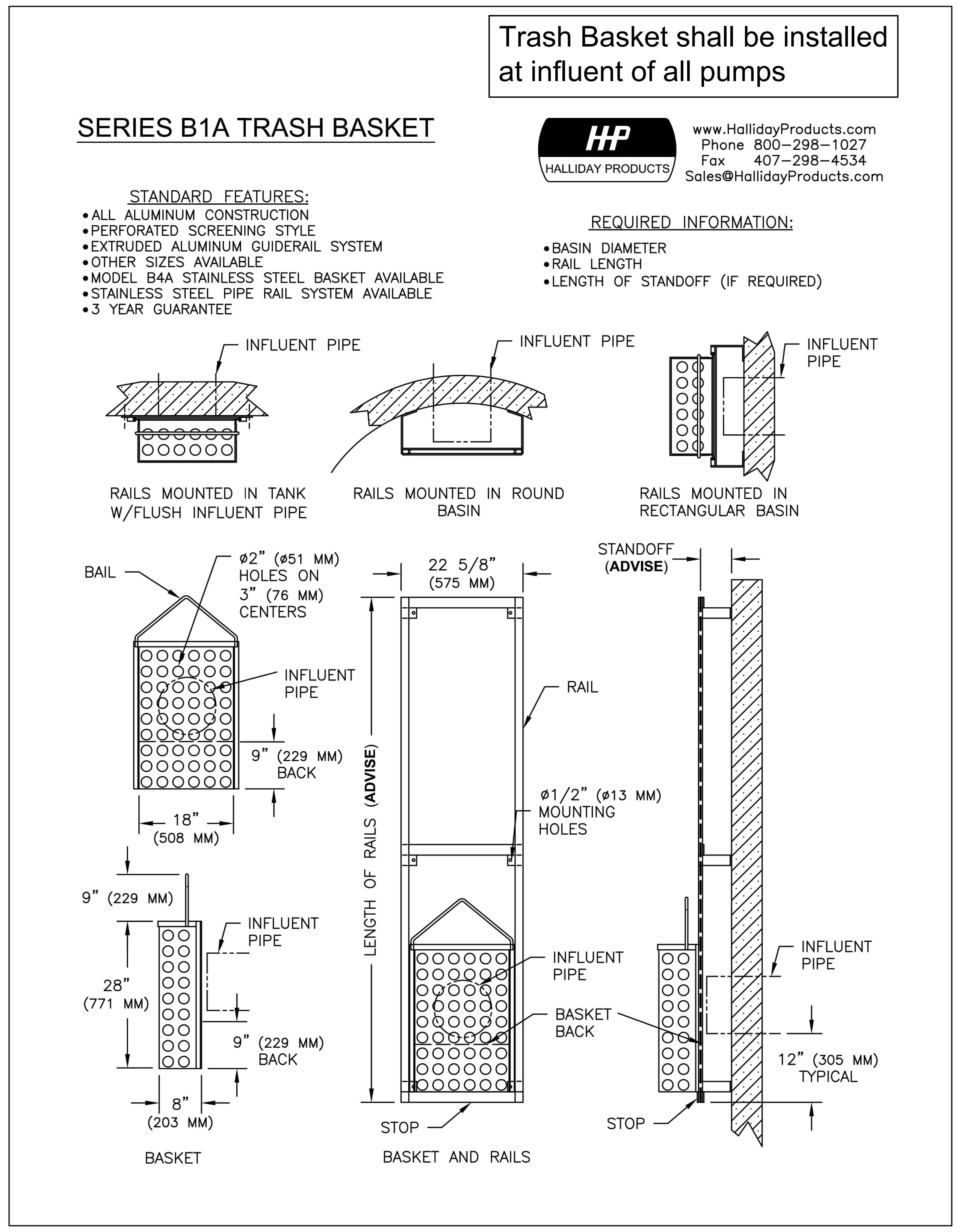
DIMENSIONS:USCS(Inch)

Model	HP	NOM. SIZE	Pump & Motor										C.W.L.	L.W.L.	Wt. (lbs.)
			A	A1	A2	A3	D	D1	D2	H	H1	H2	W1	W2	
TO100SFQ211 -62	15	4"	26 3/16	19 1/8	7 1/16	15 3/16	14 3/16	7 1/16	7 1/16	37 13/16	50 7/16	2 11/16	30 3/4	10	306

DIMENSIONS:METRIC(mm)

Model	kW	NOM. SIZE	Pump & Motor										C.W.L.	L.W.L.	Wt. (kg)
			A	A1	A2	A3	D	D1	D2	H	H1	H2	W1	W2	
TO100SFQ211 -62	11	100	665	485	180	385	360	180	180	960	1281	68	780	255	139

2 SC-5.2 Duplex Pumps


Trash Basket shall be installed at influent of all pumps

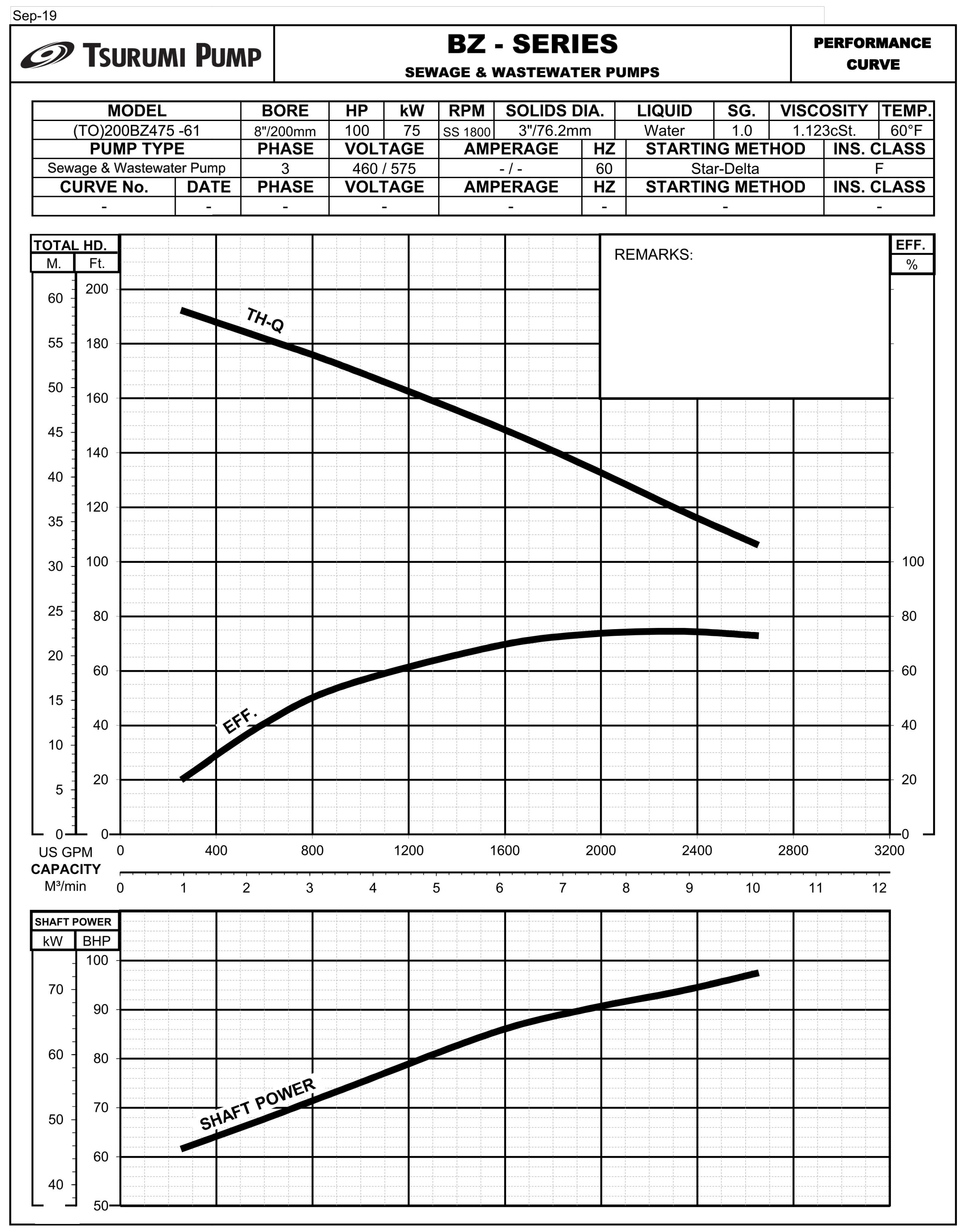
SERIES B1A TRASH BASKET

HALLIDAY PRODUCTS
www.HallidayProducts.com
Phone 800–298–1027
Fax 407–298–4534
Sales@HallidayProducts.com

STANDARD FEATURES:
- ALL ALUMINUM CONSTRUCTION
- PERFORATED SCREENING STYLE
- EXTRUDED ALUMINUM GUIDERAIL SYSTEM
- OTHER SIZES AVAILABLE
- MODEL B4A STAINLESS STEEL BASKET AVAILABLE
- STAINLESS STEEL PIPE RAIL SYSTEM AVAILABLE
- 3 YEAR GUARANTEE

REQUIRED INFORMATION:
- BASIN DIAMETER
- RAIL LENGTH
- LENGTH OF STANDOFF (IF REQUIRED)

3 SC-5.2 Trash Basket


Sep-19

TSURUMI PUMP

BZ - SERIES

SEWAGE & WASTEWATER PUMPS

PERFORMANCE CURVE

MODEL		BORE	HP	kW	RPM	SOLIDS DIA.	LIQUID	SG.	VISCOSITY	TEMP.
(TO)200BZ475 -61		8"/200mm	100	75	SS 1800	3"/76.2mm	Water	1.0	1.123cSt.	60°F

PUMP TYPE		PHASE	VOLTAGE	AMPERAGE	HZ	STARTING METHOD	INS. CLASS
Sewage & Wastewater Pump		3	460 / 575	- / -	60	Star-Delta	F
CURVE No.	DATE	PHASE	VOLTAGE	AMPERAGE	HZ	STARTING METHOD	INS. CLASS
-	-	-	-	-	-	-	-

REMARKS:

4 SC-5.2 Pump Curve

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Weep Collection - Pump Station Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY:	APPROVED BY:
BB	

SCALE:
AS SHOWN

DATE:
February 2022

Revisions

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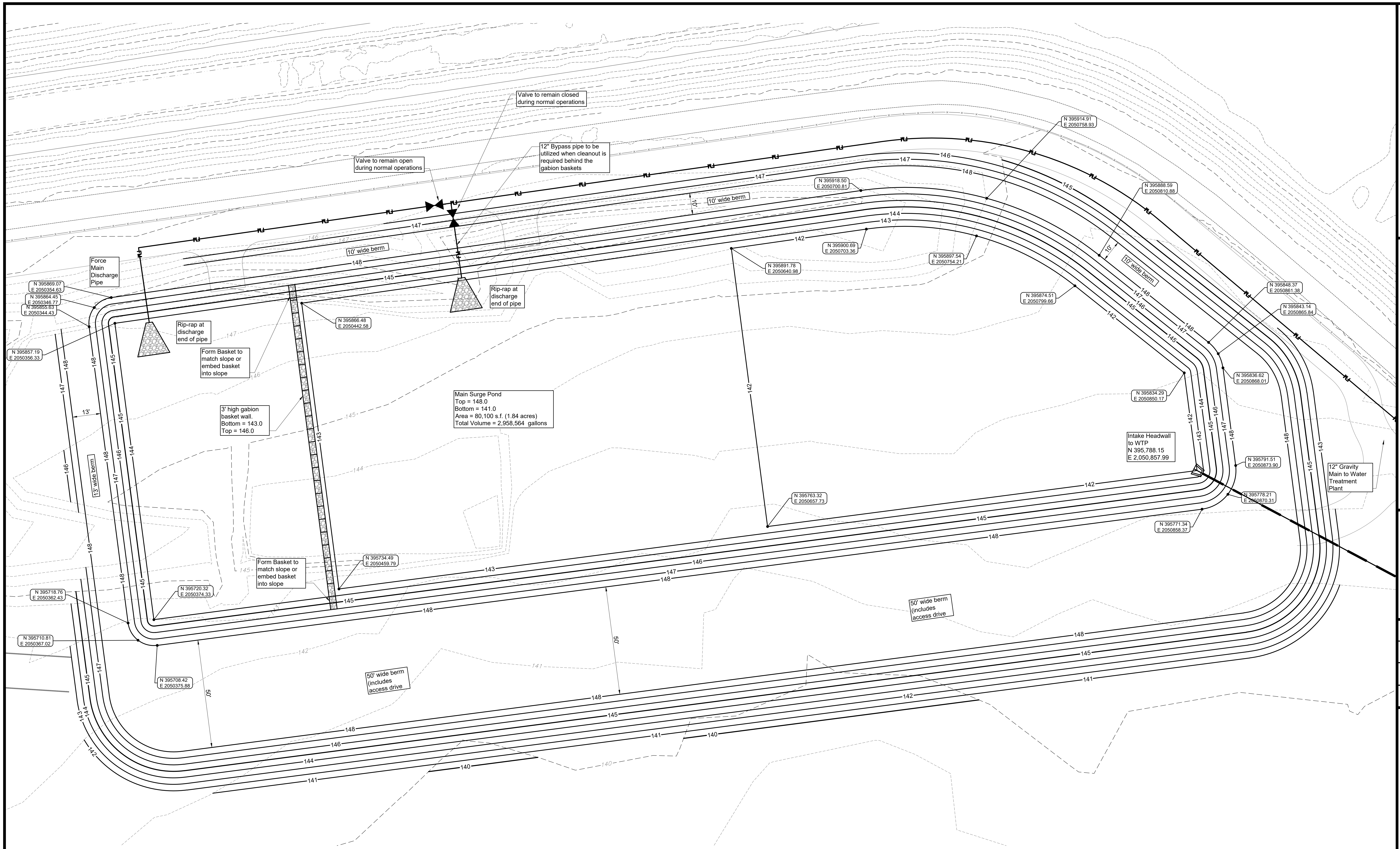
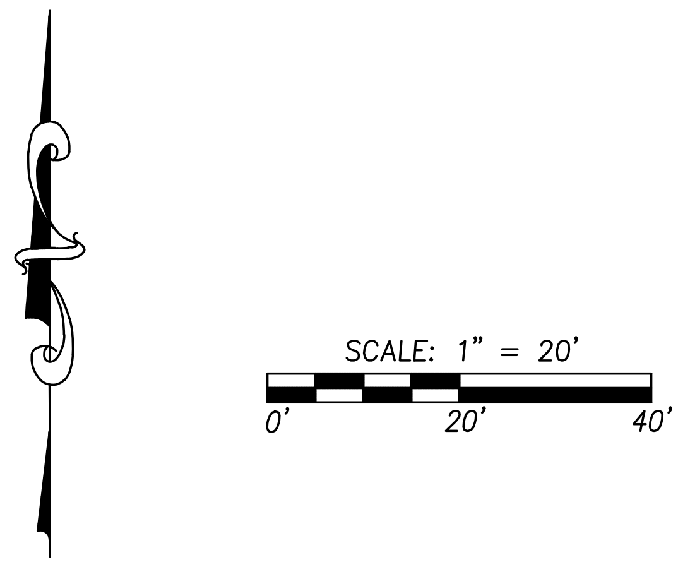
DRAWING:
SC-5.2

PROJECT NUMBER:
45-20803





1 SC-4.0 *Main Surge Pond Grading Plan*

Surge Pond Calculations

Volume Requirements	Dry Weather 24-hour Volume	1/2" Rainfall Runoff - 24-hour Volume	Direct Rainfall on Surge Pond	Total Volume Required = 1,411,230 gallons
Capacity for 48 hours of Dry Weather Flow + Capacity for 48 hours of ½' Rainfall Runoff (back to back storms) + Capacity for 100-year direct rainfall on the pond (9.04 inches)	Seep A = 44,640 gallons Seep B = 187,200 gallons Seep A Tributary = 27,360 gallons Willis Creek Seep = 56,160 gallons Sta 22+00 Weep = 14,400 gallons Seep 39+50 Weep = 4,320 gallons Seep 41+00 Weep = 17,280 gallons Total = 351,360 gallons	Seep A = 110,000 gallons Seep B = 46,000 gallons Seep A Tributary = 26,000 gallons Total = 182,000 gallons	25-year Rainfall = 6.90 inches Area of Pond = 80,100 s.f. 25-yr Volume = 344,510 gallons	Total Volume Provided = 2,958,564 gallons
	Surge Pond 48-hour Volume = 702,720 gallons	Surge Pond 48-hour Volume = 364,000 gallons		

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Surge Pond - Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY:	REVIEWED BY:
BB	DKK
DESIGNED BY:	APPROVED BY:
BB	

SCALE:
AS SHOWN

DATE:
February 2022

Revisions

No.	Date	Description	By:
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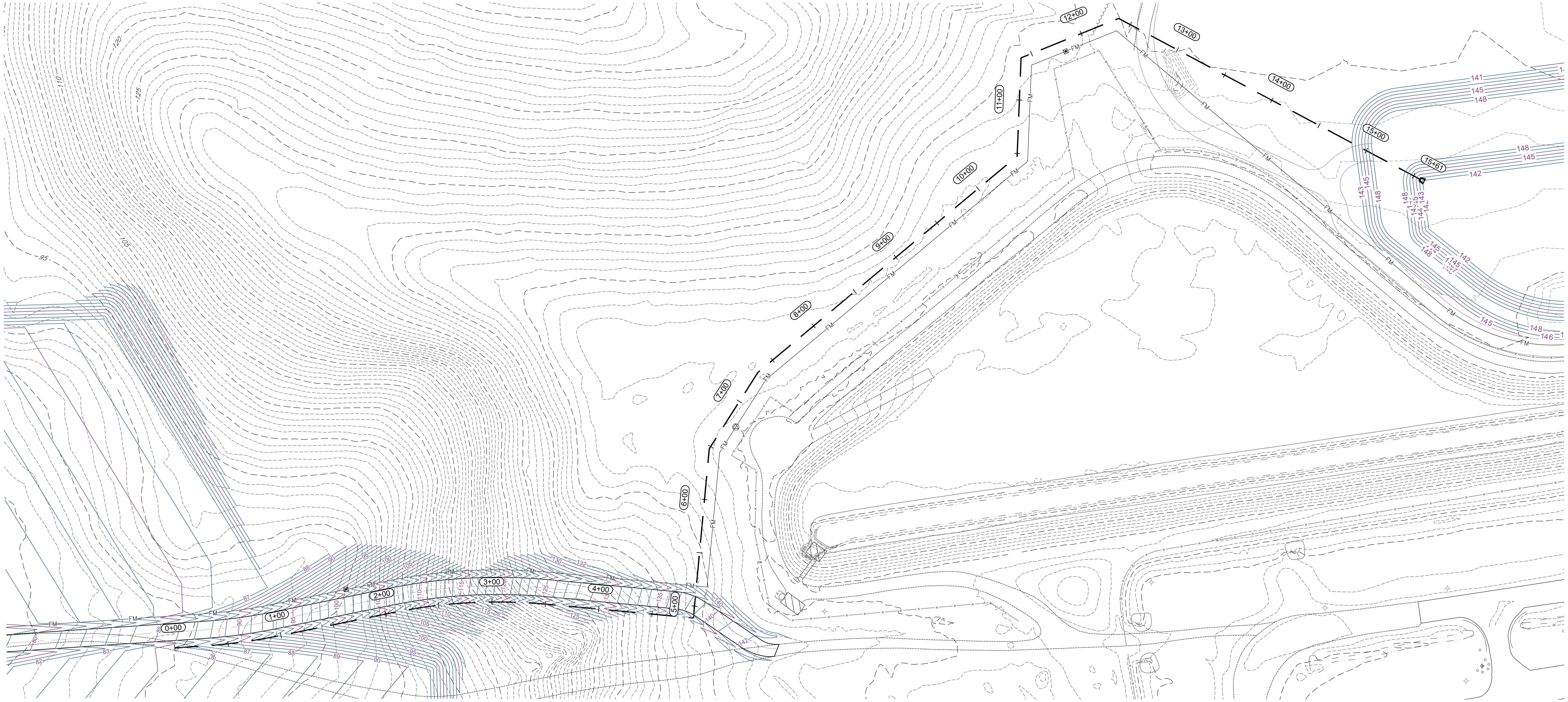
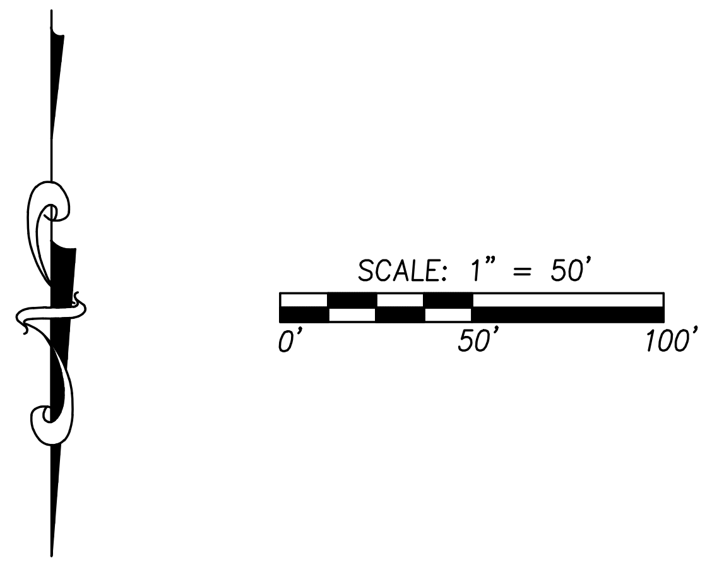
DRAWING:
SC-6.0

PROJECT NUMBER:
45-20803





1 SC-6.1 Gravity Main from Surge Pond to WTP – Plan

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Surge Pond - Gravity Main Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

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PROJECT NUMBER:
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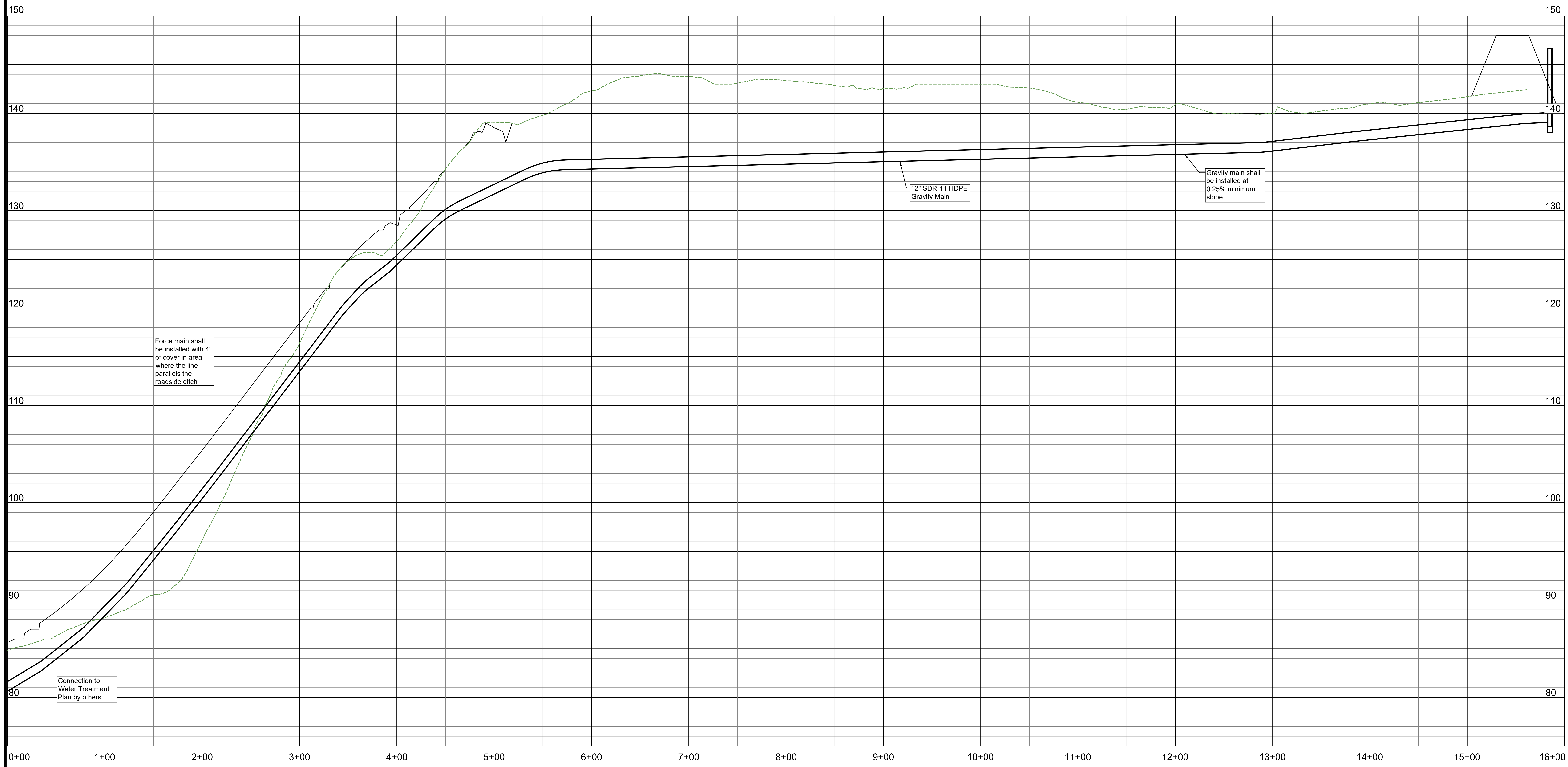

1 SC-6.2 Gravity Main from Surge Pond to WTP – Profile

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Surge Pond - Gravity Main Profile

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

No.	Date	Description	By:
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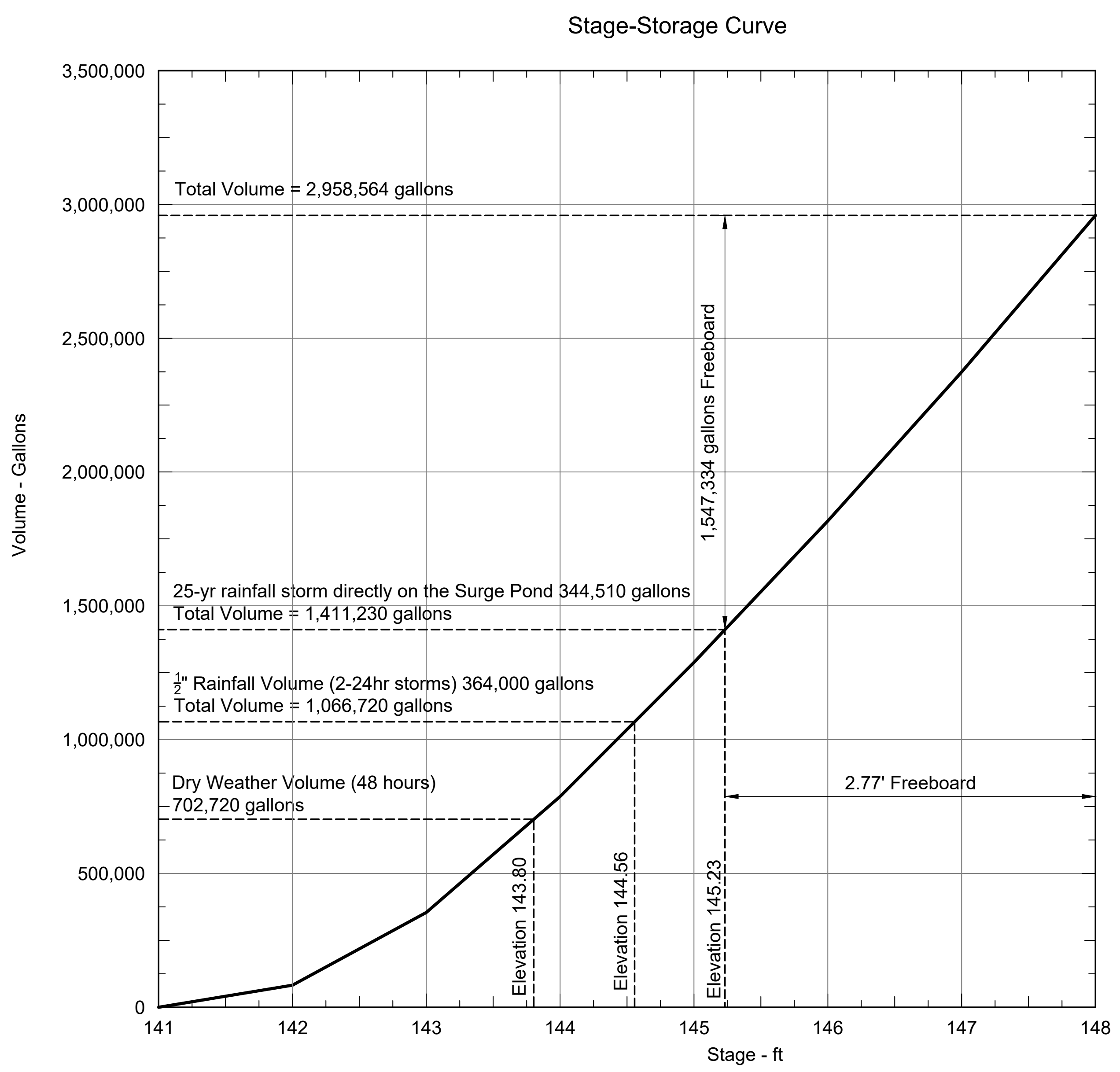
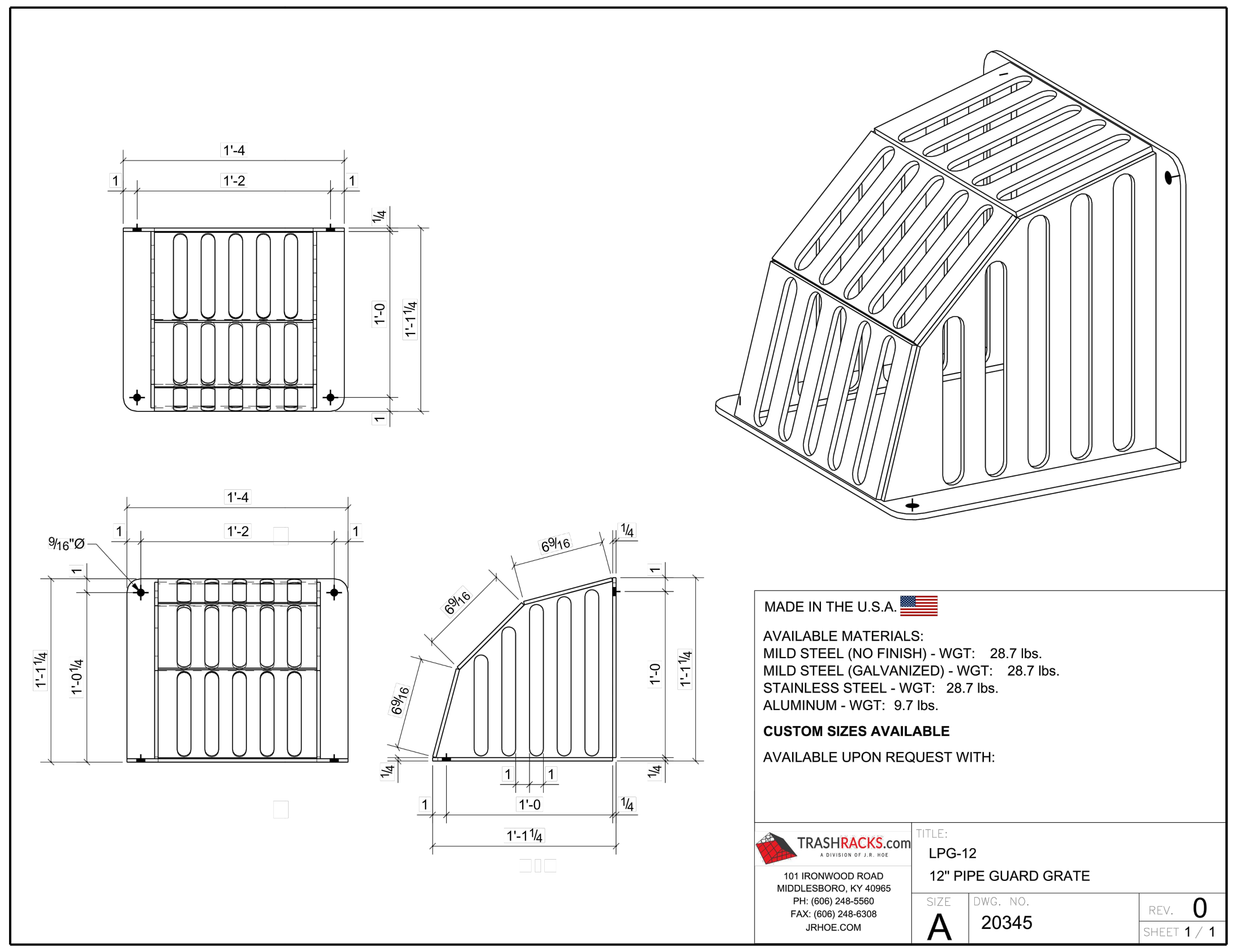
DRAWING:
SC-6.2

PROJECT NUMBER:
45-20803



1 SC-6.3 *Surge Pond – Stage–Storage Curve*



MADE IN THE U.S.A.

AVAILABLE MATERIALS:
MILD STEEL (NO FINISH) - WGT: 28.7 lbs.
MILD STEEL (GALVANIZED) - WGT: 28.7 lbs.
STAINLESS STEEL - WGT: 28.7 lbs.
ALUMINUM - WGT: 9.7 lbs.

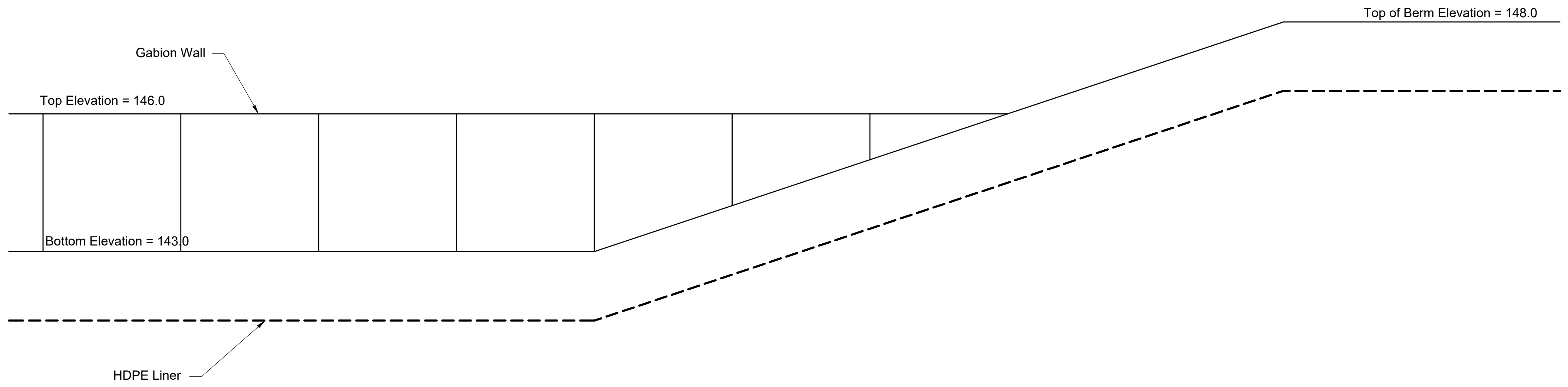
CUSTOM SIZES AVAILABLE

AVAILABLE UPON REQUEST WITH:

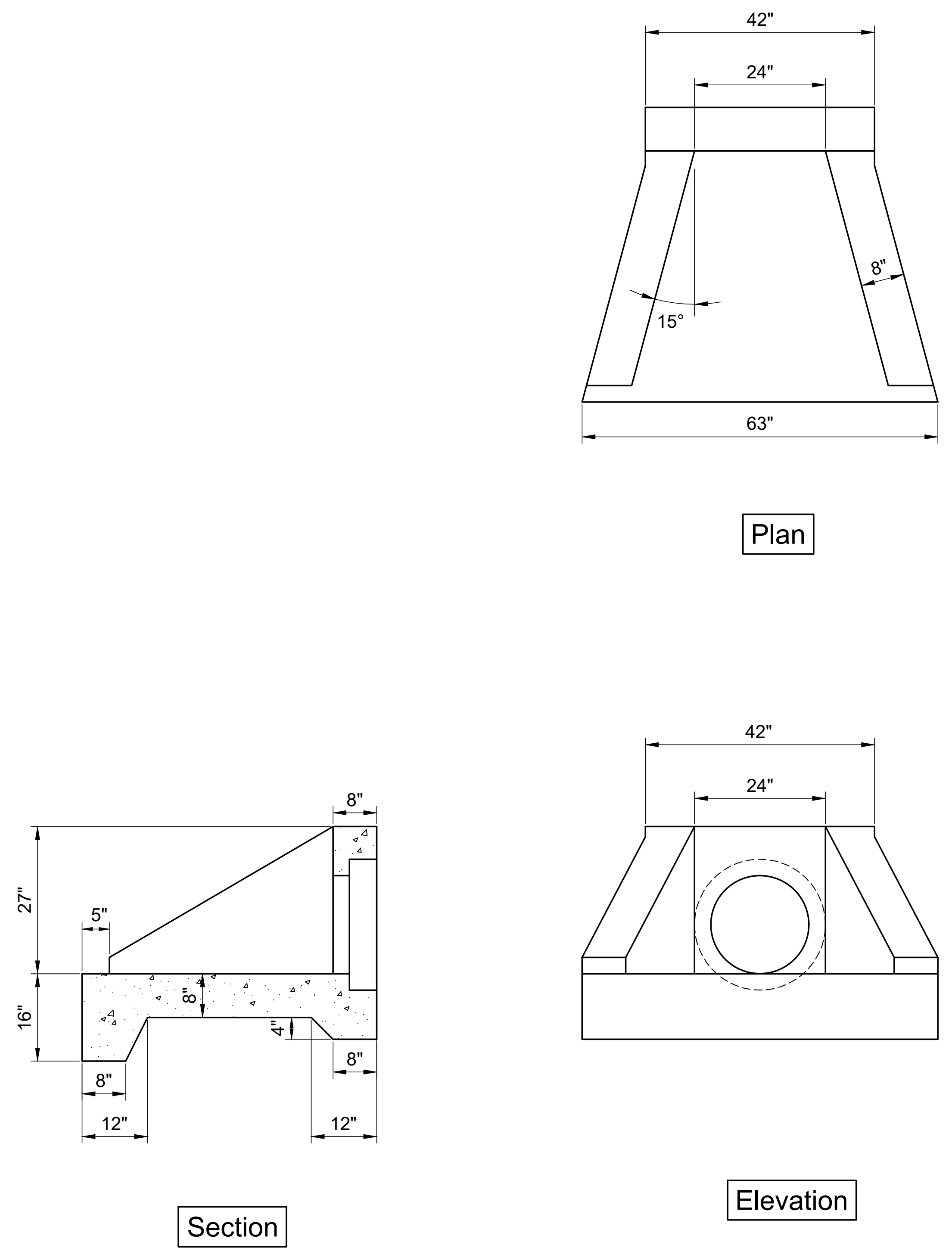
TRASHRACKS.com
A DIVISION OF J.R. HOE
101 IRONWOOD ROAD
MIDDLESBORO, KY 40965
PH: (606) 248-5560
FAX: (606) 248-6308
JRHOE.COM

TITLE: LPG-12
12" PIPE GUARD GRATE
SIZE A
DWG. NO. 20345
REV. 0
SHEET 1 / 1

2 SC-6.3 *12" Pipe Guard Grate*



3 SC-6.3 *Gabion Wall*



Plan

Section

Elevation

4 SC-6.3 *Surge Pond – 12" Pipe Concrete Headwall*

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Seep Capture Design Plans
Surge Pond - Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY:
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

No.	Date	Description	By:
1			
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DRAWING: SC-6.3

PROJECT NUMBER: 45-20803

SCALE: 1" = 300'
0' 3000' 600'

1 / SC-7.0 Ex–Situ Force Main Site Plan

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Force Main
Site Plan

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY: DAH

SCALE:
AS SHOWN

DATE:
February 2022

Revisions

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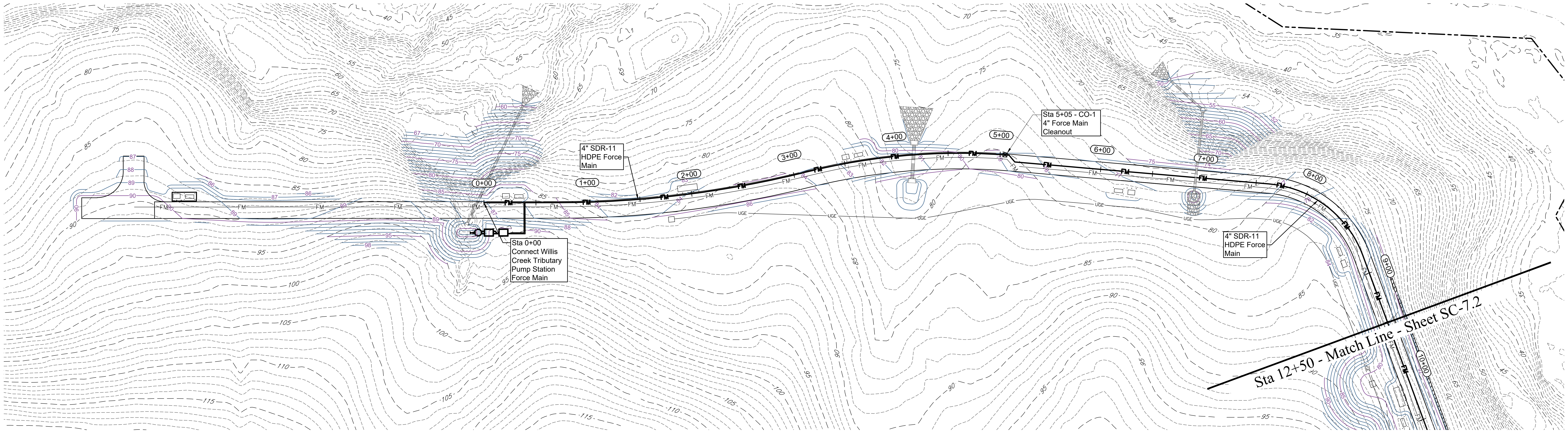
SC-7.0

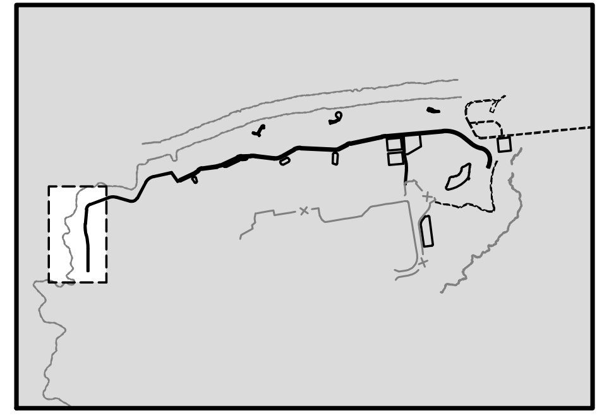
PROJECT NUMBER:

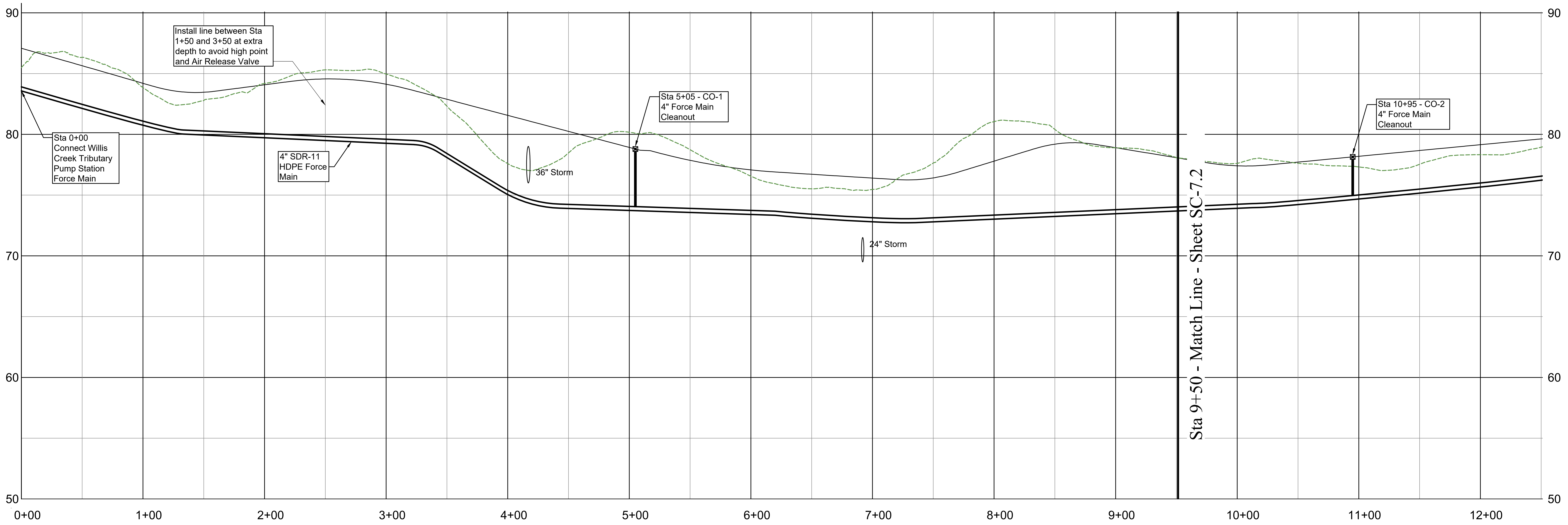


SCALE: 1" = 50'
0' 50' 100'

① SC-7.1 Ex–Situ Force Main Plan

Site Key





② SC-7.1 Ex–Situ Force Main Profile

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Force Main - Plan & Profile
Sta 0+00 to Sta 9+50

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY: DAH
SCALE: AS SHOWN	
DATE: February 2022	

Revisions

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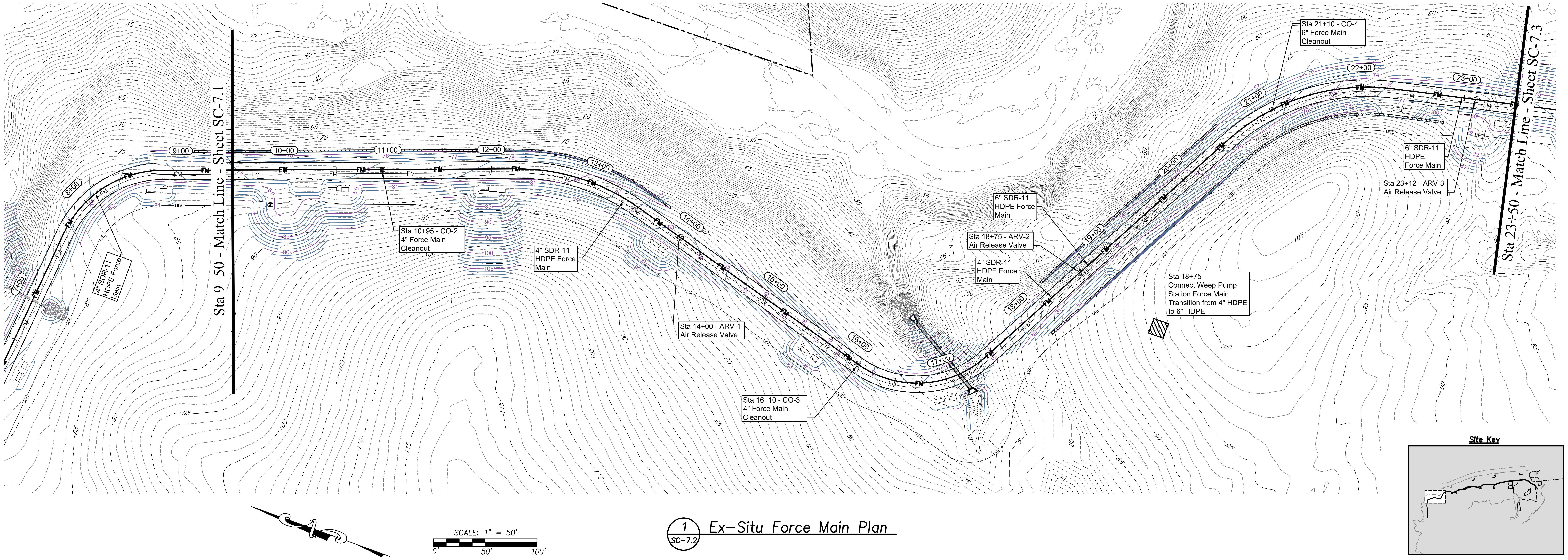
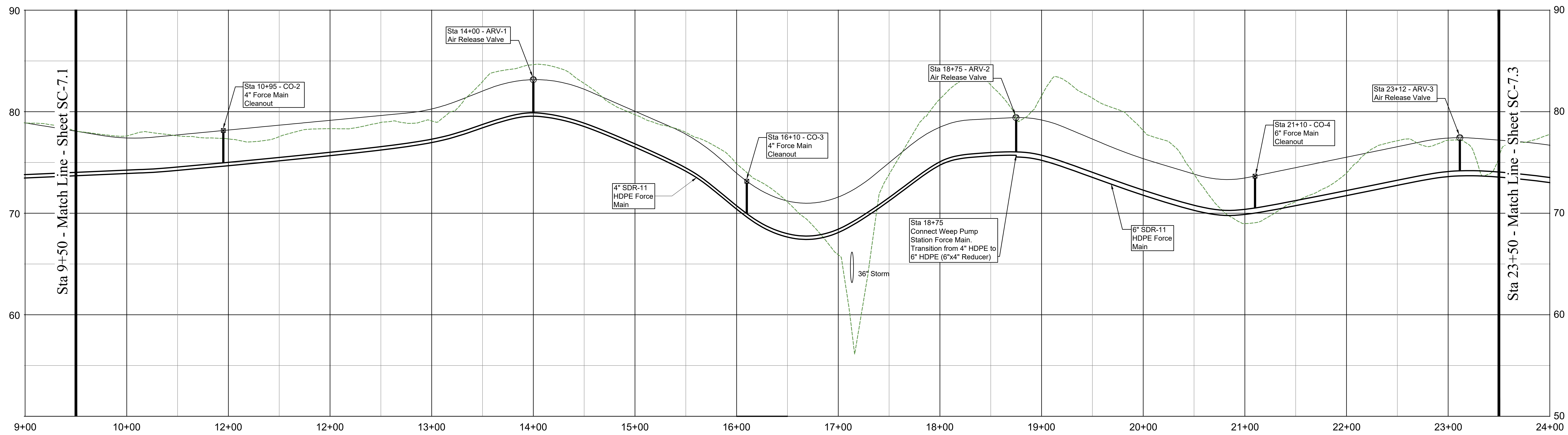
DRAWING:
SC7.1

PROJECT NUMBER:
45-20803



① SC-7.2 Ex–Situ Force Main Plan



② SC-7.2 Ex–Situ Force Main Profile

GEOS
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Ex-Situ Force Main - Plan & Profile
Sta 9+50 to Sta 23+50

Chemours Fayetteville Works
Fayetteville, North Carolina

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DATE: February 2022	

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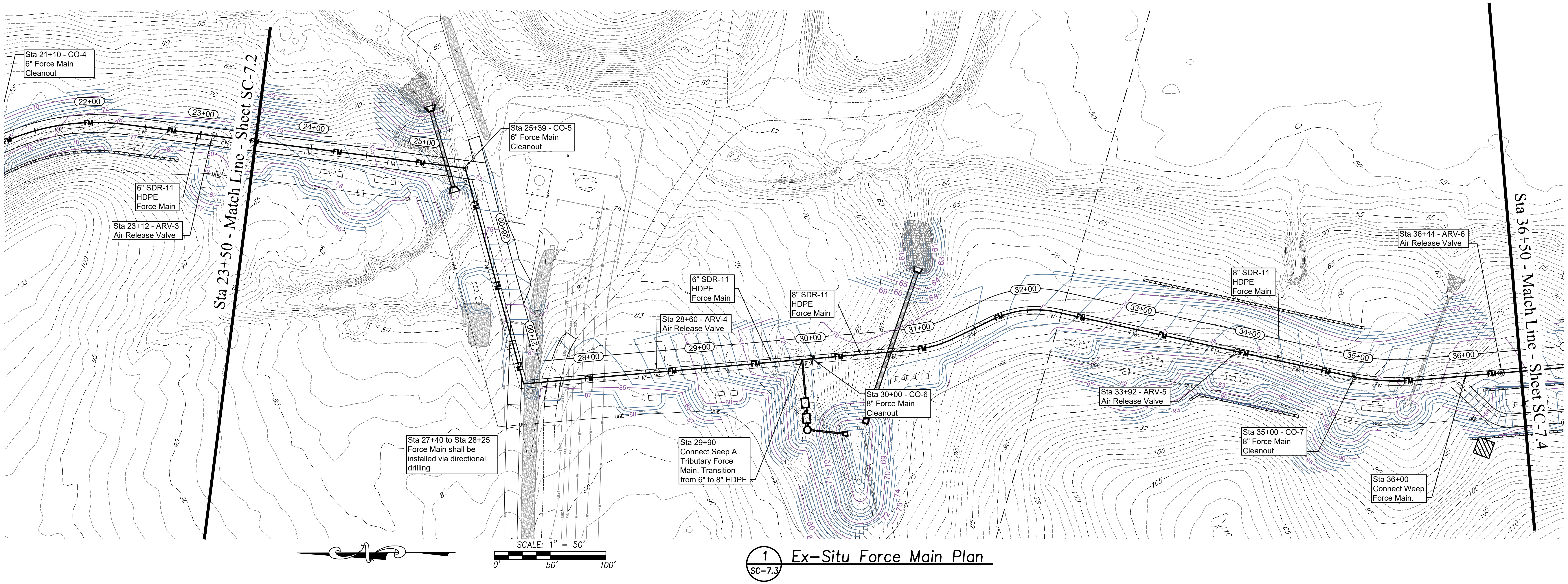

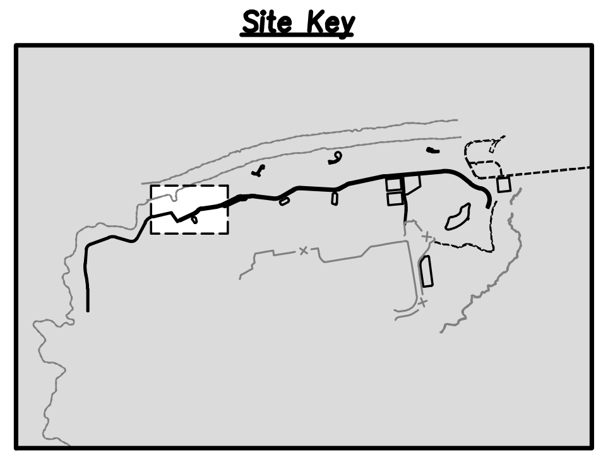

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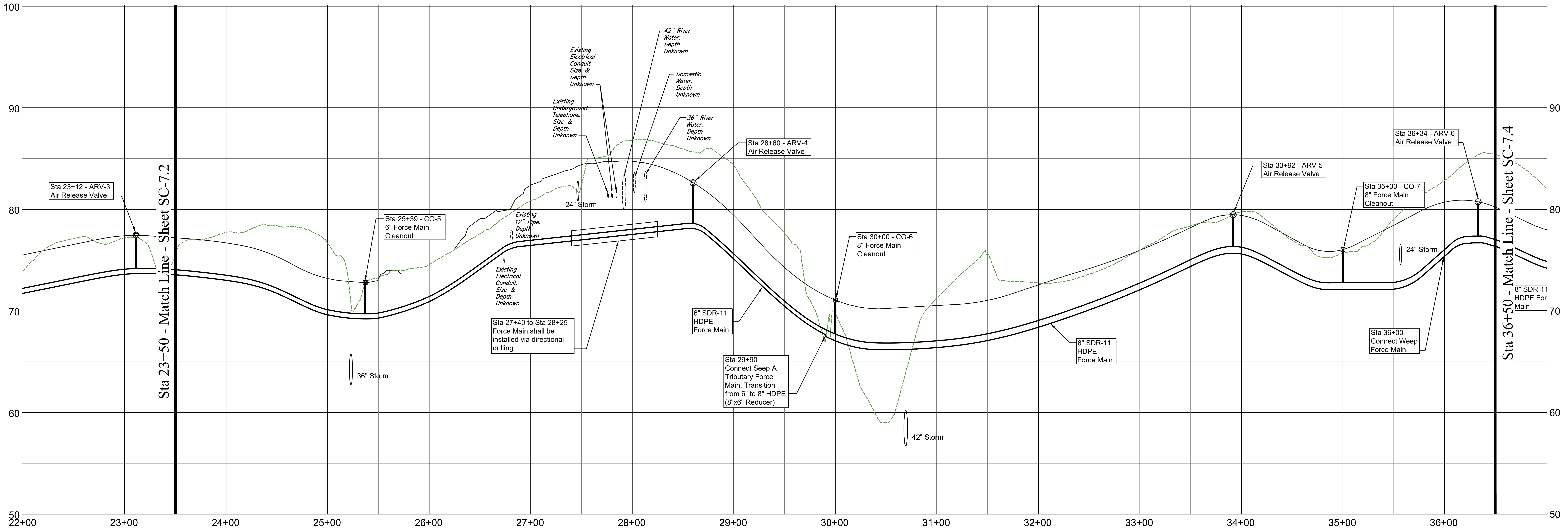

2 SC-7.3 Ex-Situ Force Main Profile

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Ex-Situ Force Main - Plan & Profile
Sta 23+50 to Sta 36+50

Chemours Fayetteville Works
Fayetteville, North Carolina

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February 2022

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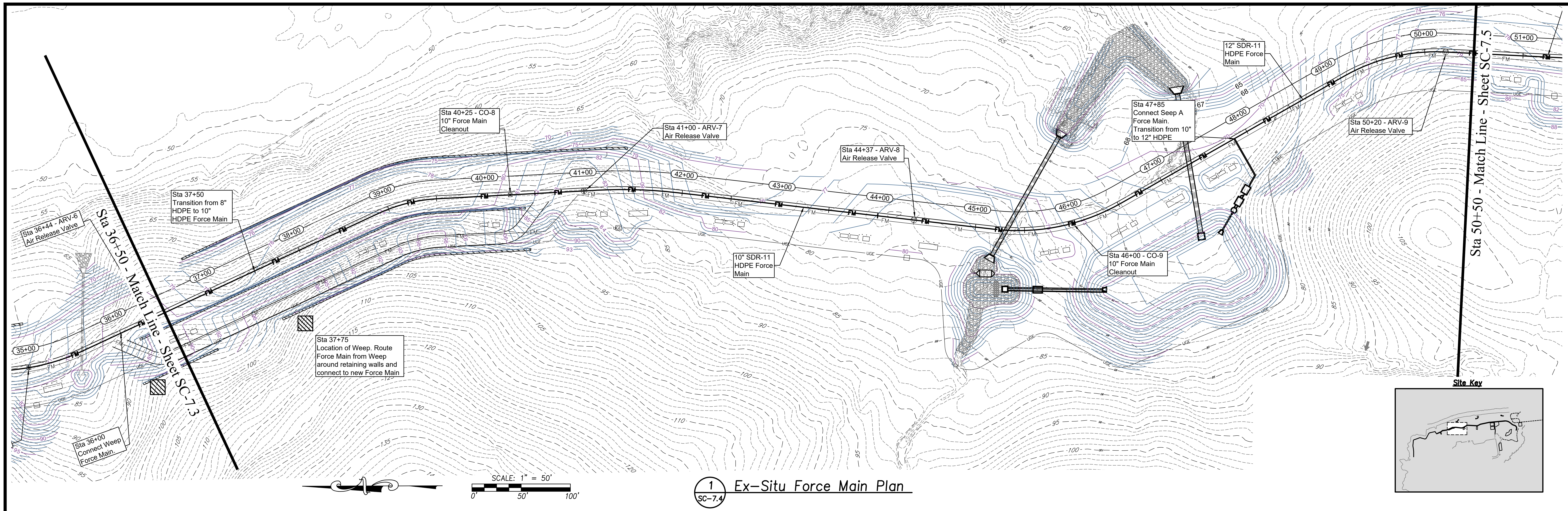
45-20803



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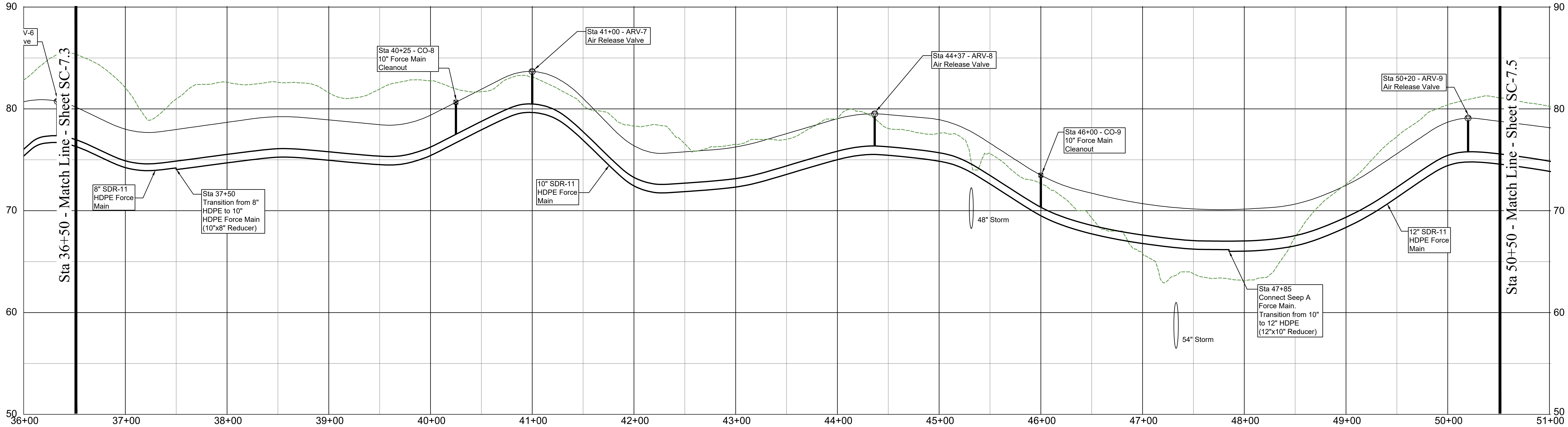

2 SC-7.4 Ex-Situ Force Main Profile

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Ex-Situ Force Main - Plan & Profile
Sta 36+50 to Sta 50+50

Chemours Fayetteville Works
Fayetteville, North Carolina

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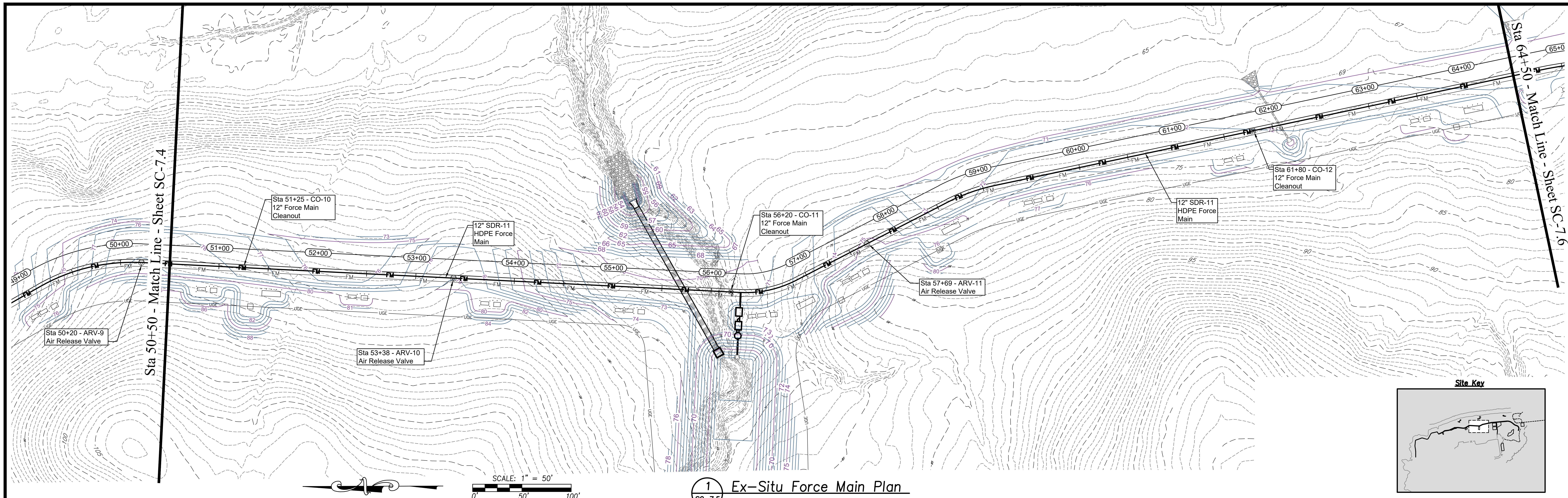

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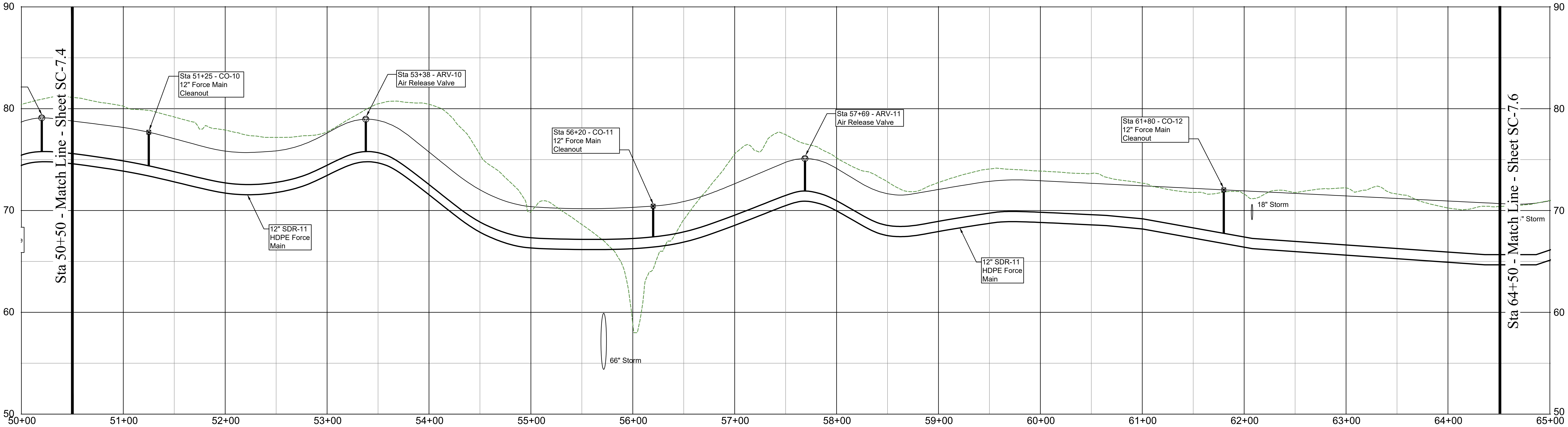
SC-7.5
Ex–Situ Force Main Plan



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SC-7.5
Ex–Situ Force Main Profile

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Force Main - Plan & Profile
Sta 50+50 to Sta 64+50

Chemours Fayetteville Works
Fayetteville, North Carolina

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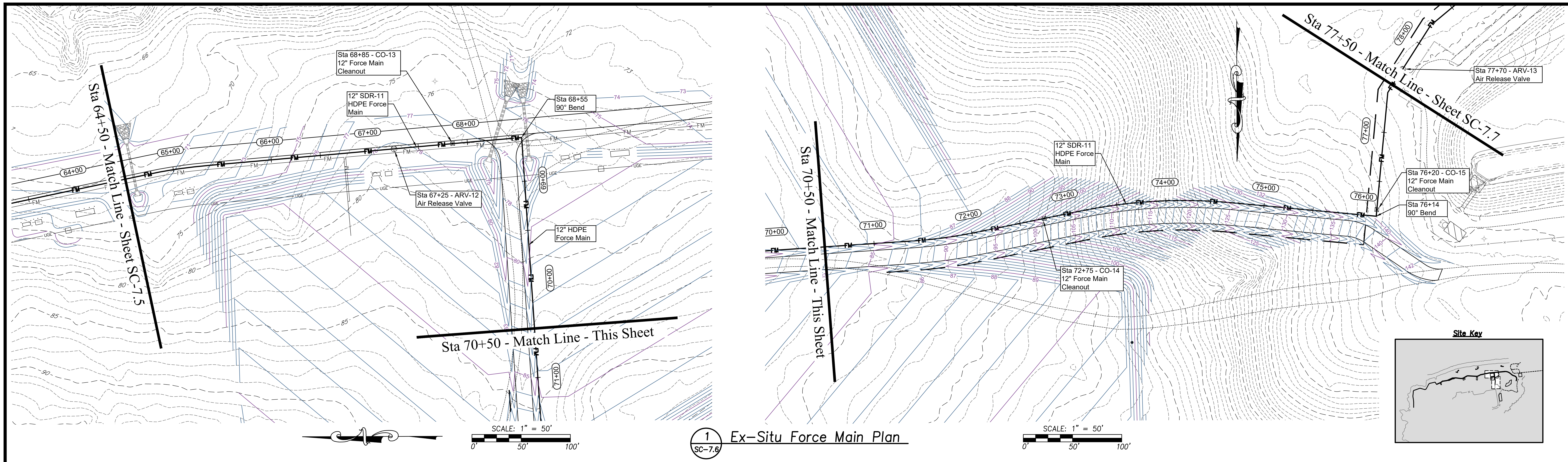

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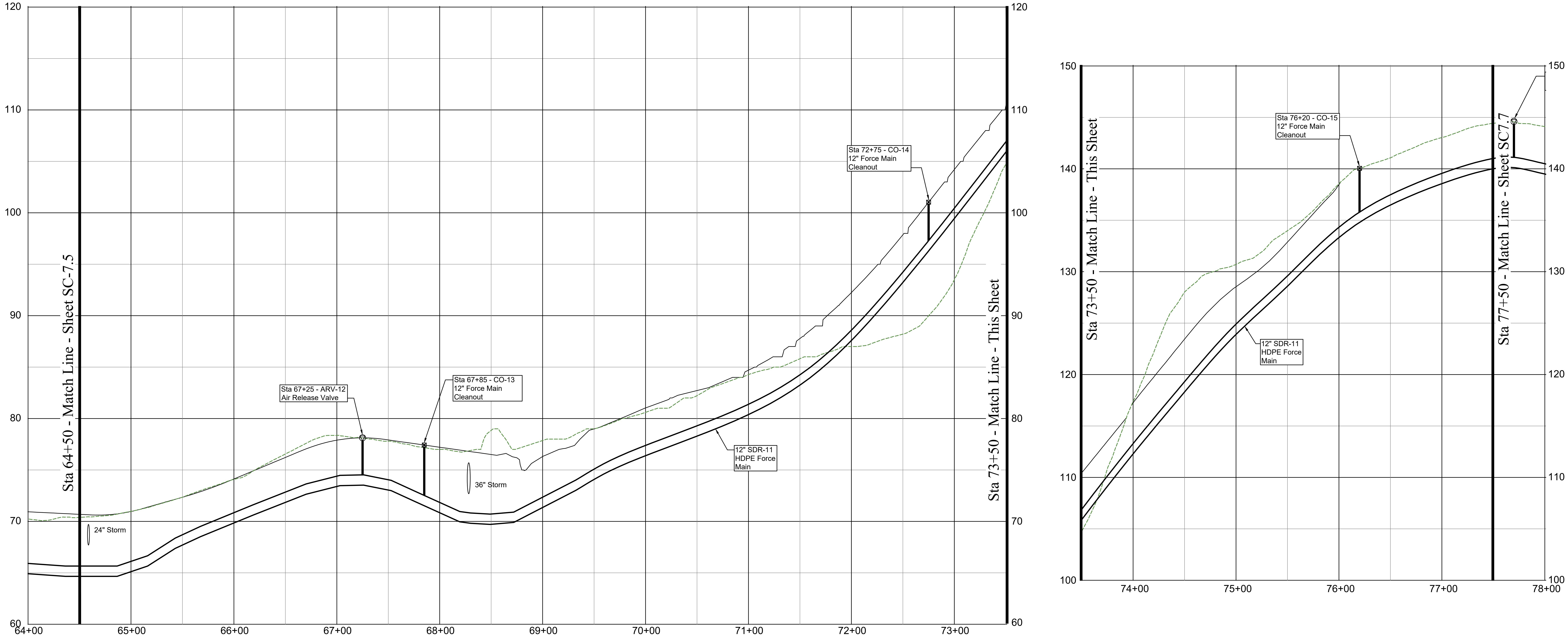

2 SC-7.6 Ex-Situ Force Main Profile

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Ex-Situ Force Main - Plan & Profile
Sta 64+50 to Sta 77+50

Chemours Fayetteville Works
Fayetteville, North Carolina

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DESIGNED BY: BB	APPROVED BY: DAH

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February 2022

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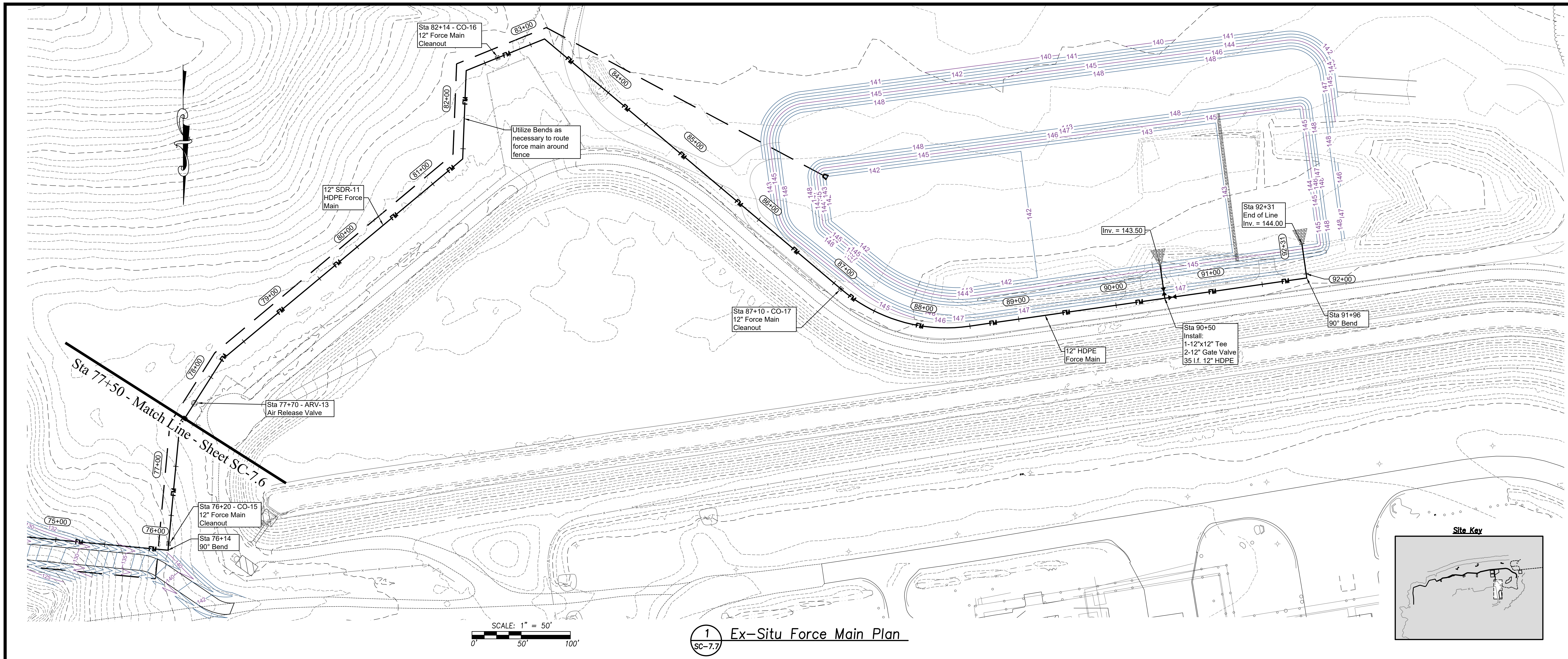
PROJECT NUMBER:
45-20803



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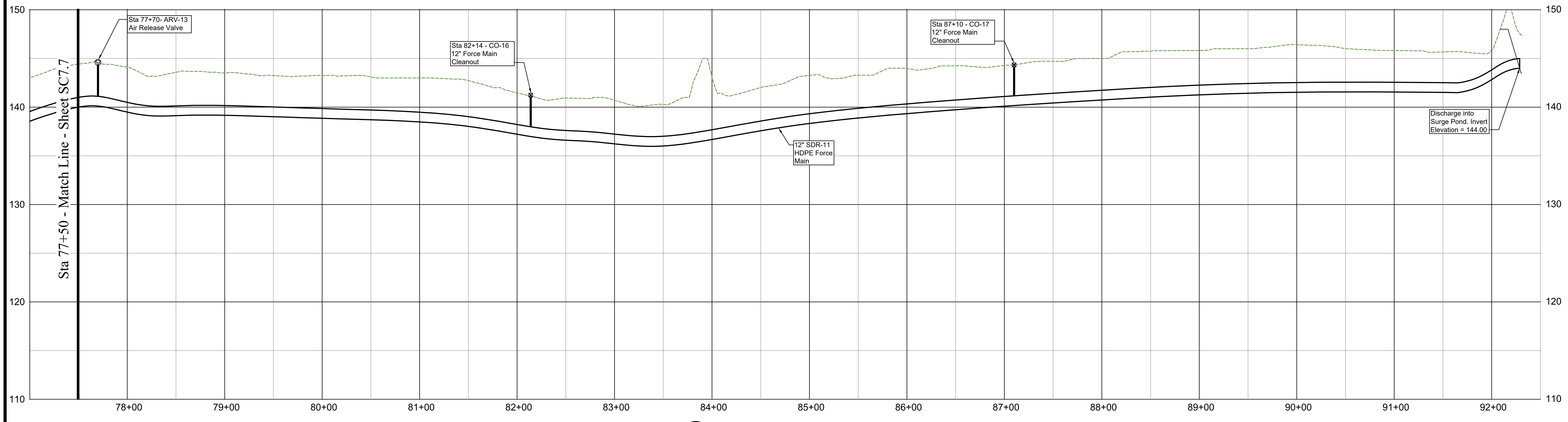

2 SC-7.7 Ex–Situ Force Main Profile

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Geotechnical, Environmental and Materials Engineers

Ex-Situ Force Main - Plan & Profile
Sta 77+50 to Sta 92+31 - End

Chemours Fayetteville Works
Fayetteville, North Carolina

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DESIGNED BY: BB	APPROVED BY: DAH
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DATE: February 2022	

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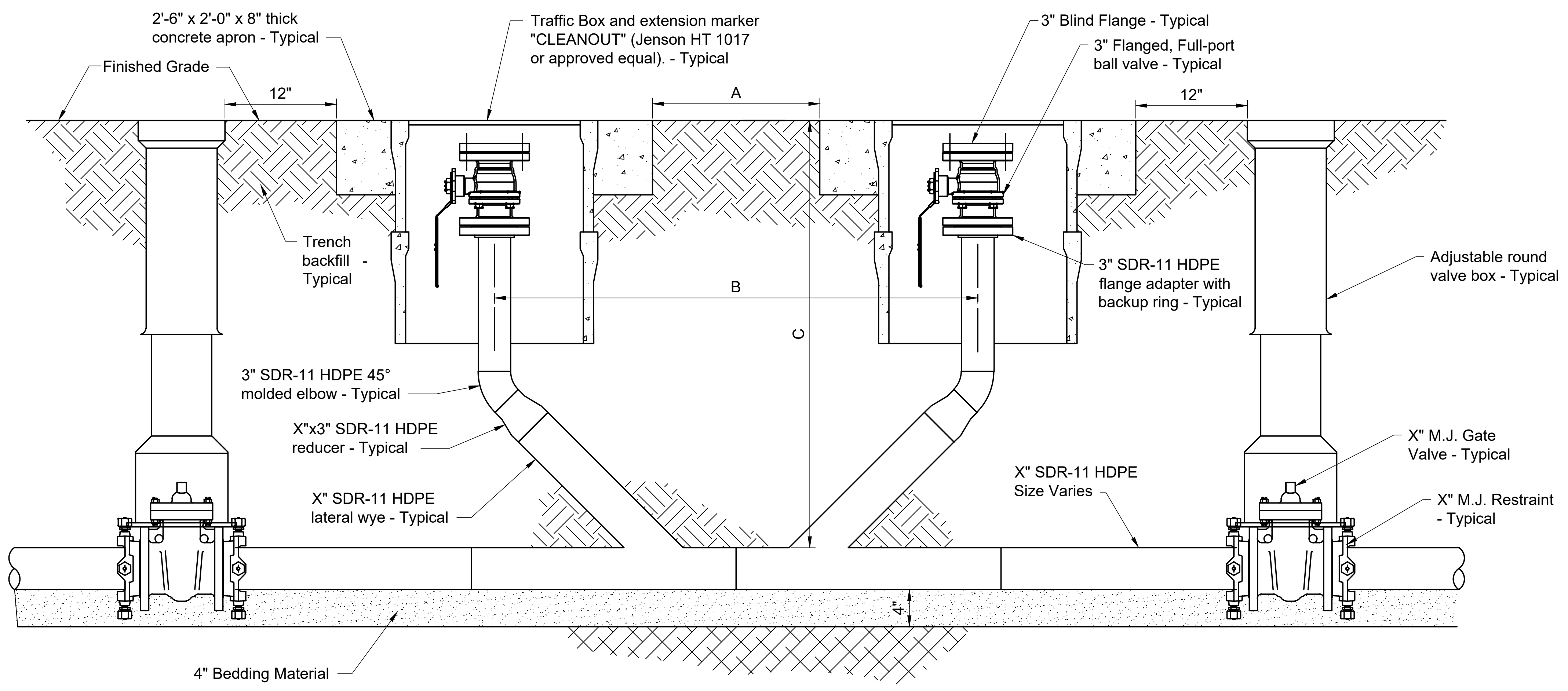
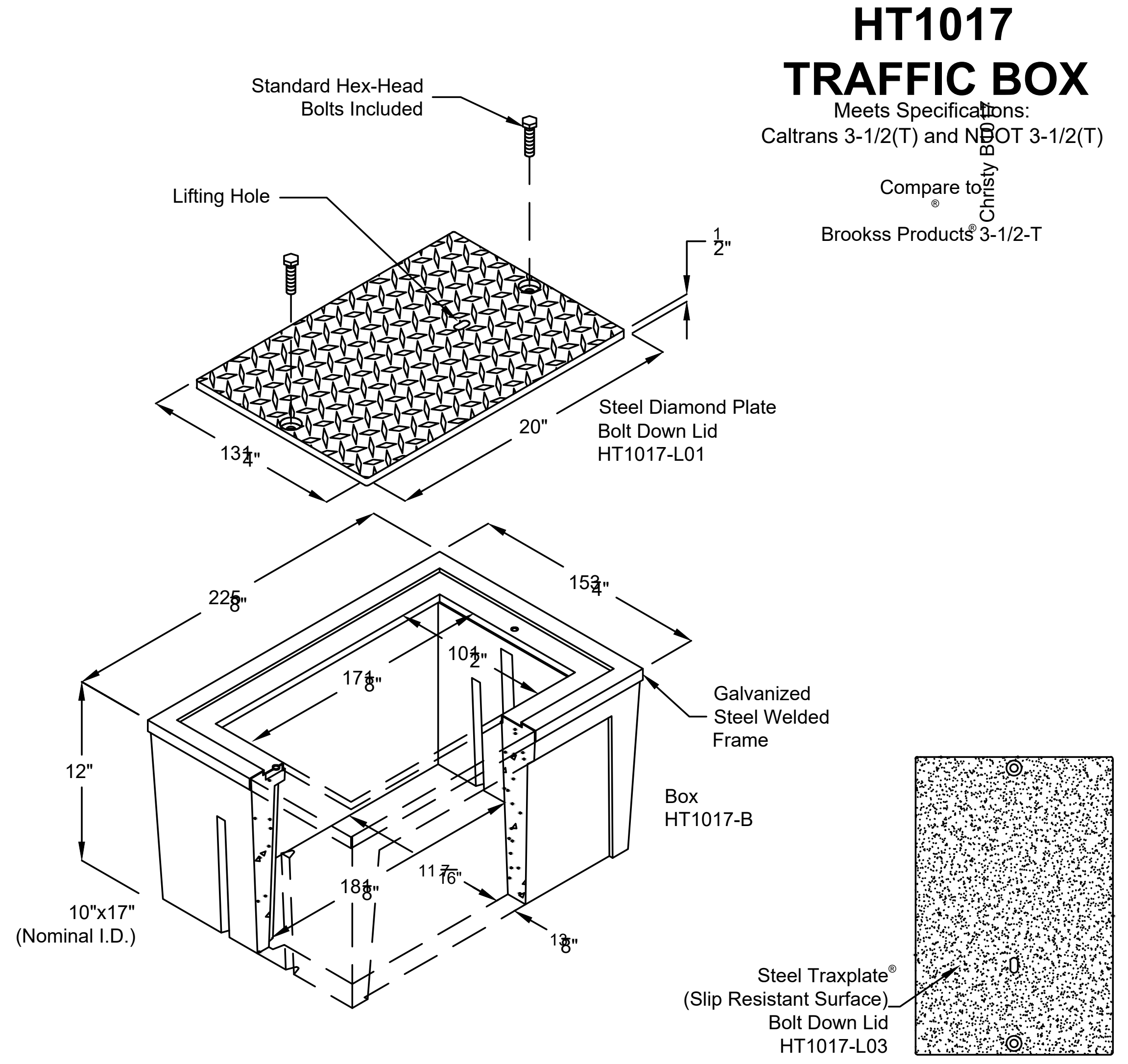
PROJECT NUMBER: 45-20803



X (Pipe Diameter - Inches)	A	B	C	Reducer Notes
4"	1'-6"	4'-4"	3'-10"	4"x3"
6"	2'-4 ½"	5'-2 ½"	4'-2"	6"x3"
8"	3'-5 ¼"	6'-3 ¼"	4'-7"	8"x6"; 6"x3"
10"	4'-11 ¼"	7'-9 ¼"	5'-0"	10"x6"; 6"x3"
12"	5'-6"	8'-4"	5'-3"	12"x6"; 6"x3"

1 SC-7.8 Ex-Situ Force Main Cleanout Detail



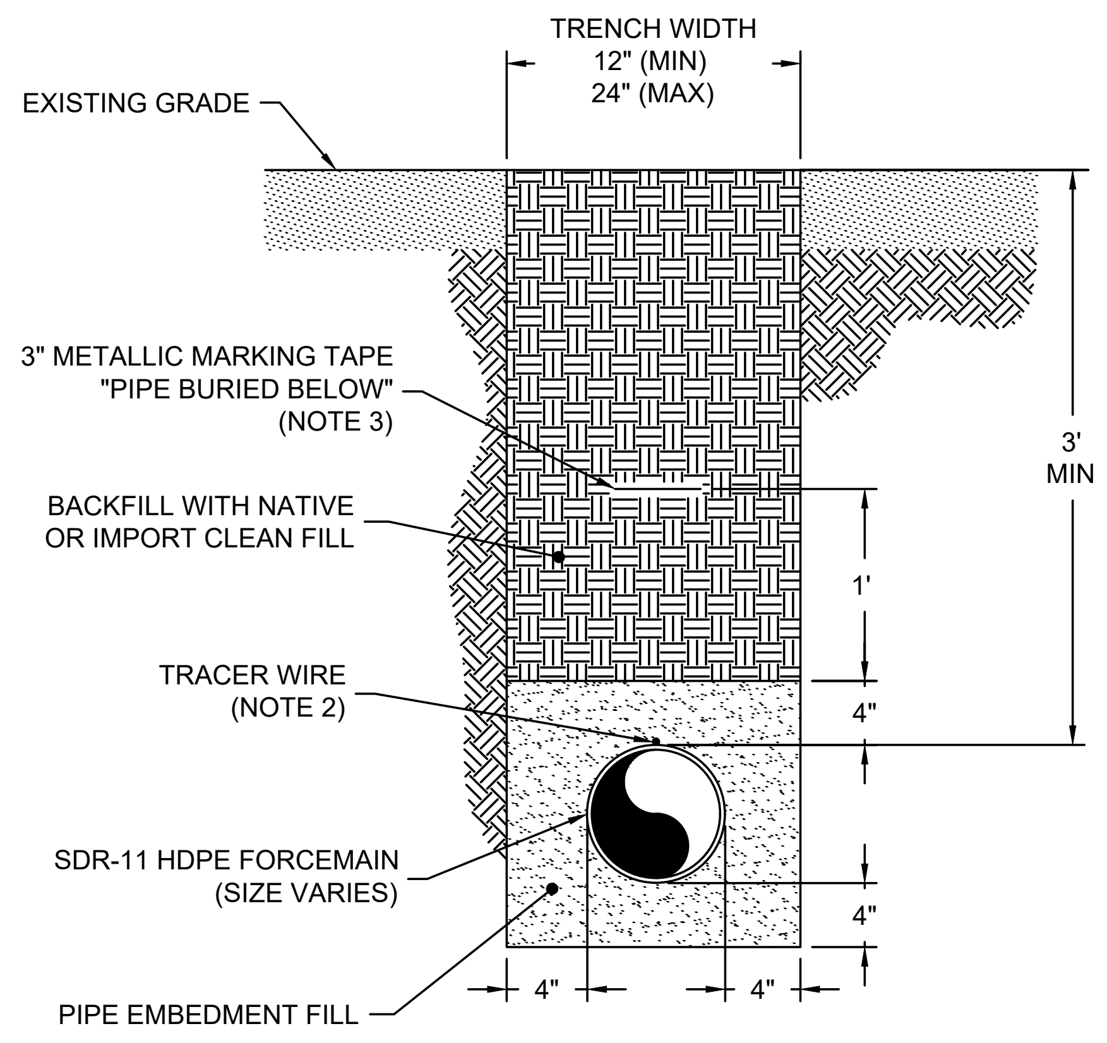
PART NO.	PRODUCT	DESCRIPTION	APPROX. WEIGHT	QTY. PER PALLET
HT1017-B	BOX	10"x17"x12" Concrete Traffic Rated Box (Comes Standard With Hex Bolts)	125	20
HT1017-E	EXTENSION	10"x17"x12" Concrete Extension	126	20
HT1017-L01	LID	Steel Diamond Plate Bolt Down Lid	38	
HT1017-L03	LID	Steel Traxplate Bolt Down Slip Resistant Cover	38	
GALVANIZING AVAILABLE ON ALL STEEL LIDS				

For penta head and other bolt options, see security hardware sheet.

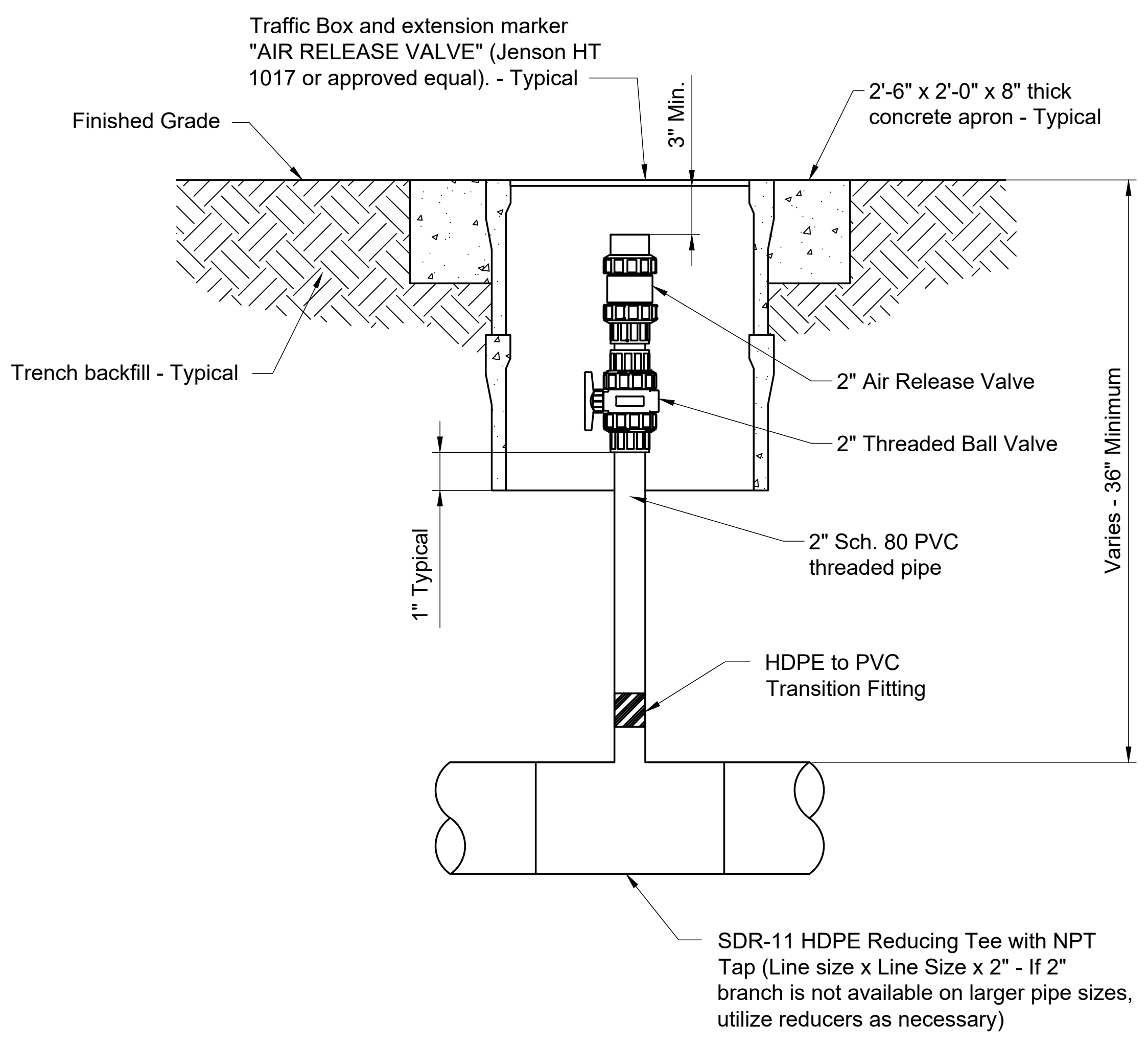
Design load: Traffic rated when installed per Caltrans ES-8B

JENSEN PRECAST
JENSENPRECAST.COM

2 SC-7.8 Traffic Box Detail



3 SC-7.8 Force Main Pipe Bedding



4 SC-7.8 Force Main Air Release Valve Detail

GEOS
Geotechnical, Environmental and Materials Engineers

Ex-Situ Force Main - Site Details

Chemours Fayetteville Works
Fayetteville, North Carolina

DRAWN BY: BB	REVIEWED BY: DKK
DESIGNED BY: BB	APPROVED BY: DAH
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DRAWING: SC-7.8

PROJECT NUMBER: 45-20803

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

GEOServices, LLC, Geotechnical and Materials Engineers

Appendix F
Groundwater Treatment Plant Design Process Narrative

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

Groundwater Treatment Plant – Process Narrative – 90% Design Submittal

Prepared for

The Chemours Company FC, LLC
1007 Market Street
PO Box 2047
Wilmington, DE 19899

Prepared by

Geosyntec Consultants of NC, P.C.
2501 Blue Ridge Road, Suite 430
Raleigh, NC 27607

March 2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

CIP	clean-in-place
GAC	granular activated carbon
gal	gallon
GPM	gallons per minute
GPD	gallons per day
GWTP	groundwater treatment plant
HFPO-DA	hexafluoropropylene oxide-dimer acid
mg/L	milligrams per liter
MTZ	mass transfer zone
ORP	oxidation-reduction potential
PFAS	per- and polyfluoroalkyl substances
PFMOAA	perfluoro-1-methoxyacetic acid
PMPA	perfluoro-2-methoxypropanoic acid
TSS	total suspended solids
UF	ultrafiltration

1. PROCESS NARRATIVE

Geosyntec Consultants of NC, P.C. has prepared this memorandum for the Chemours Company FC, LLC (Chemours) regarding the groundwater remediation project at the Chemours Fayetteville Works facility in Fayetteville, North Carolina (Site) pursuant to the Consent Order Addendum among Chemours, The North Carolina Department of Environmental Quality and Cape Fear River Watch. The purpose of this memorandum is to document the process narrative (unit operations and other technical details) associated with the 90% design milestone for the planned groundwater treatment plant (GWTP) being installed at the facility to remove per- and polyfluoroalkyl substances (PFAS) from extracted groundwater.

1.1 Overall Narrative

The GWTP comprises one of the various systems of the groundwater interception remedy for the Site. Immediately upstream of the GWTP inlet there will be a nominally 100,000-gallon break tank to receive raw water for treatment from a variety of sources, and a lead/lag pair of transfer pumps to feed water from the break tank to the GWTP.

Following the transfer pump(s), the treatment system will consist of the following series of treatment units:

1. Metals oxidation;
2. Ultrafiltration (UF);
3. Granular Activated Carbon (GAC) adsorption;
4. Solids Handling & Dewatering; and
5. Ancillary processes for backwashing and residuals handling.

The influent oxidation system is designed to help ensure complete oxidation of reduced iron species (or other dissolved metals) that may be present in the extracted groundwater or ex-situ seeps water, by means of pH adjustment, the addition of sodium hypochlorite to promote oxidation, and a coagulant such as polyaluminum chloride to promote settling. Following oxidation, flow will proceed to the ultrafiltration (UF) process, in which total suspended solids (TSS) will be reduced to below 1 milligram per liter (mg/L). The filtrate will then be pumped to the GAC adsorption process, which is designed to remove PFAS as demonstrated by the three indicator parameters (HFPO-DA, PFMOAA and PMPA)[1] from the water to a removal efficiency of 99% or greater. Influent flow to the carbon beds may be pH adjusted with sulfuric acid to improve treatment performance. If required, the GAC effluent will undergo further pH adjustment back to near-neutral conditions with sodium hydroxide and then be discharged to the Cape Fear River (river) via an approved National Pollutant Discharge Elimination System outfall, Outfall 004. Outfall 004

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[1] HFPO-DA: hexafluoropropylene oxide-dimer acid
PFMOAA: perfluoro-1-methoxyacetic acid
PMPA: perfluoro-2-methoxypropanoic acid

will be a pipe that conveys GWTP discharges to the pipe which conveys flows from the manufacturing facility Outfall 002 to the river.

The reject from the solids separation unit and solids separation unit cleaning, and GAC backwash water will collect in two thickener tanks. The thickened solids will be dewatered using a solid bowl centrifuge (Andritz). Following dewatering, the resulting sludge cake will be transferred into hoppers that will be sent off-site for disposal at an appropriate waste disposal facility. The dewatering filtrate will be returned to the headworks of the GWTP and blended with the influent downstream of the oxidation tanks. A 21,000-gallon treated effluent clearwell will store treated effluent for subsequent discharge or for process backwash water, as required. Based on vendor experience, Chemours' current operational experience at the Outfall 003 Treatment System: and the results of supporting pilot testing; the proposed treatment process is anticipated to successfully address treatment requirements.

A conceptual block flow diagram of the GWTP and the associated sludge handling system is shown in Figure 1. Not shown in this figure are the upstream break tank which receives groundwater to be treated, or the local forwarding pumps that send water from the tank to the first flange of the treatment process at the inlet to the oxidation tanks.

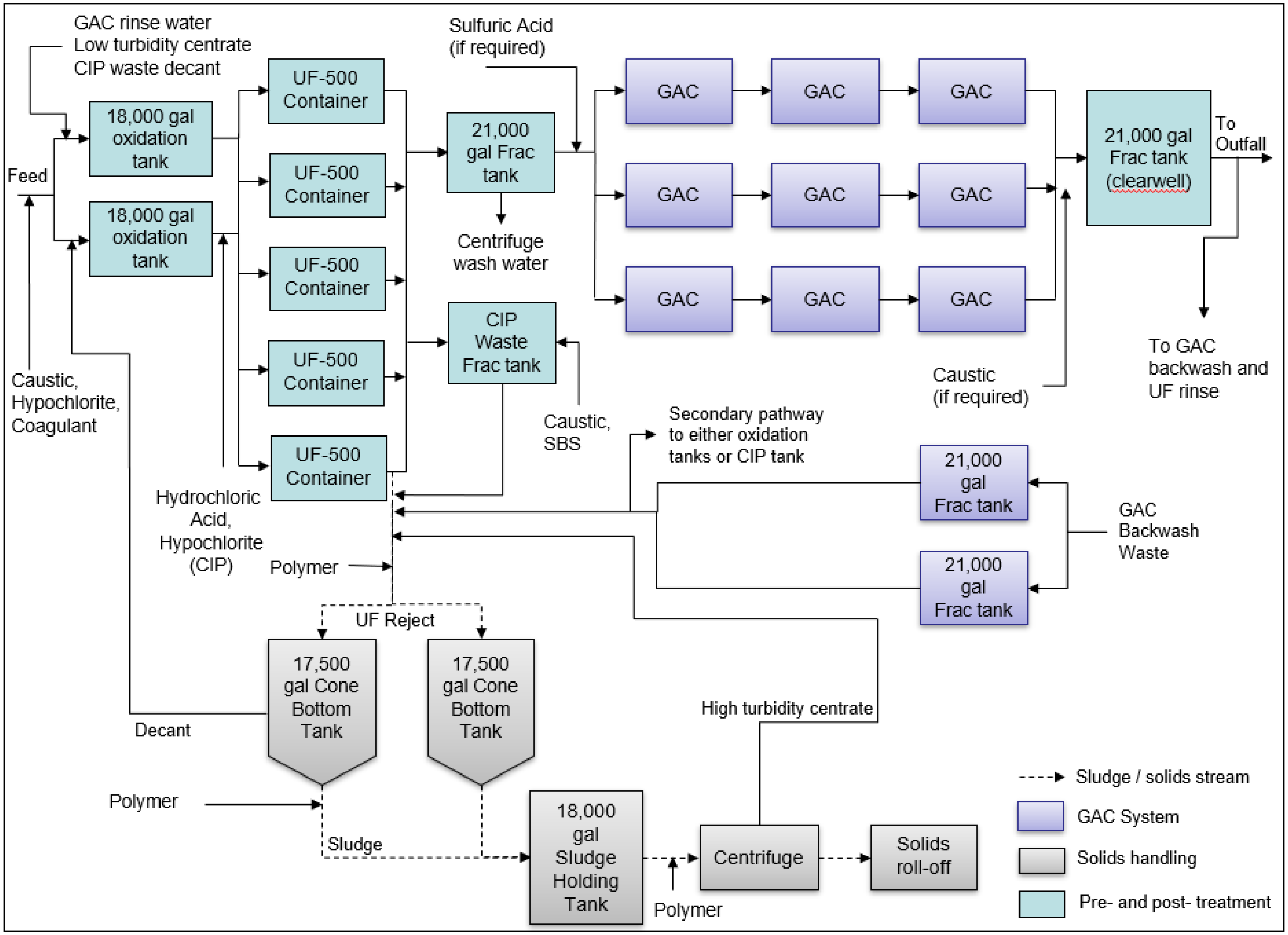


Figure 1: Conceptual Block Flow Diagram of Groundwater Treatment Plant

1.2 Individual Unit Operations

1.2.1 Metals Oxidation

Two, 18,000-gallon influent oxidation tanks have been selected to allow for a hydraulic retention time of 24 minutes at the design flow rate of 1,500 GPM. The oxidation tanks will be fed by two system feed pumps configured in a duty-standby configuration. Sodium hypochlorite will be added to assist in the oxidation of iron from the ferrous to ferric form. The pH will be adjusted to enhance the precipitation of ferric hydroxide, which has minimum solubility in the approximate pH range of 6.5 to 7.5.

The two oxidation tanks are currently configured to both operate online concurrently, with the capability of adding up to 4 more oxidation tanks in parallel if the process flow increases beyond the capacity offered by the original 2 tanks. The oxidation tanks also accept recycled clean-in-place (CIP) effluent from elsewhere in the process water and GAC rinse water, increasing the total influent flow up to 1,579 GPM (the total design influent flow of raw water from groundwater extraction and seeps capture is 1,500 GPM).

Immediately upstream of the oxidation tanks there is a 100,000-gallon break tank to receive raw water pumped from the groundwater extraction network and other potential secondary sources, and a lead/lag pair of feed pumps to supply this raw water to the oxidation tanks. Turbidity and pH of the influent will be measured downstream of the feed pumps from the influent break tank. After the feed pumps but upstream of the oxidation tanks, inorganic coagulant, sodium hydroxide, and sodium hypochlorite will be amended inline to adjust the pH, limit biofouling, and promote metals oxidation and coagulation in the retention tanks. Anticipated dosing rates are provided in Table 1.

Table 1: Oxidation Tank Amendment Dosing Parameters

	Storage Tank Volume	Concentration	Consumption	Pump Capacity
Coagulant	55 gal	100%	25 GPD	2 GPM
Sodium Hydroxide	5000 gal	50%	128 GPD	8 GPH
Sodium Hypochlorite	3000 gal	12.5%	72.5 GPD	8 GPH

These amendments will be mixed with the influent water via an inline mixer and the pH and oxidation-reduction potential (ORP) will be measured upon completion of mixing upstream of the oxidation tanks.

1.2.2 UltraFiltration

Combined effluent from the oxidation tanks will be pumped to the ultrafiltration (UF) stage via two skid-mounted transfer pumps in duty-standby configuration. pH and ORP probes will be used to monitor the influent to the UF system.

Containerized UF membrane banks will be used to remove fine solids and turbidity to achieve less than 1 mg/L TSS upstream of the GAC beds which should prevent fouling and extend runtimes between GAC backwashes or reduce GAC replacement frequency. The UF system will be provided as a series of five parallel containerized membrane systems, each comprised of a 500-gallon membrane tank containing a series of parallel banks of submerged membranes. The system will be configured such that up to three additional UF containers could be added in the future if capacity limits are reached with the original five containers.

Each prefabricated UF system includes the vessels, influent, effluent and backwash manifolds, automatic open/close valves, blowers, backpulse storage tanks, process effluent and reject pumps, and all other ancillary equipment, such as piping, CIP infrastructure, valving, structural components, and ventilation, as required. 31% hydrochloric acid will be dosed to the membrane systems from a 55-gallon drum for routine maintenance purposes.

Permeate from the UF process will be directed to a 21,000-gallon frac tank. The majority of this water, up to the maximum design flow of 1,500 GPM, will be sent to the GAC system via two GAC feed pumps in duty-standby configuration. A sidestream of up to 70 GPM may be directed to the centrifuge process as polymer makeup water and wash water for the centrifuge and solids conveyor. The GAC influent may be pH adjusted upstream of the GAC columns. The reject and backwash from the solids separation process will be routed to the sludge handling system via the UF reject pump, as included in the UF containers, to be dewatered prior to disposal.

Granular Activated Carbon Adsorption

PFAS removal will be accomplished using GAC adsorption. Filtered effluent will be pumped from the pH adjustment tank to the GAC system and will enter three GAC adsorption trains in parallel configuration, each designed to treat one third of the design flow (three trains of 500 GPM to treat 1,500 GPM). Each vessel will be configured as a down-flow process where water enters the top of the adsorber and exits through the bottom. In this configuration, adsorption of PFAS will begin in the upper portion of the GAC bed. The mass transfer zone (MTZ) will move from the top of the bed downwards as the adsorption capacity for PFAS is reached in each portion of the bed. Eventually, breakthrough will occur wherein the effluent of one vessel contains PFAS. The carbon vessels arranged in series in each train will be regularly monitored and rotated, to prevent breakthrough discharge to Outfall 004.

A three-column, lead/middle/lag, configuration per train is proposed for the GWTP. Based on current operating experience at the Outfall 003 Treatment System with similar water matrix and target constituents of concern, nearly complete breakthrough of the lead adsorption column may be realized while maintaining stable and compliant discharge from the lag column effluent. During routine operation the lead column will act as the primary contaminant remover. The MTZ will travel from the top of the bed to the bottom until breakthrough of PFAS. The spent GAC in the lead column will then be replaced with new GAC and the previous lead column will be placed in the lag column position. The spent GAC will be shipped offsite for disposal or, if appropriate, reactivation. The previous middle column will then become the lead column and the previous lag/third position column will become the second position column. Operating the system in this manner will allow effective utilization of the GAC in each bed without compromising removal efficiencies. The vessel trains can be configured to allow any of the three vessels to occupy any position in the train.

This arrangement of 12-foot diameter vessels that can each hold 20,000 pounds of carbon will provide for the required hydraulic loading rate and Empty Bed Contact Time for PFAS removal. The system will be configured such that two additional 3-pass GAC skids could be added if additional treatment capacity is required. Each vessel will be outfitted with an external ring header to simplify GAC changeout and prevent holdup of residual GAC, that may occur in a vessel with an inverted-hat design at the base.

Effluent from the GAC trains will be transferred to a 21,000-gallon frac tank functioning as an effluent clearwell for discharge or for GAC column backwash or UF rinse make-up water. A pH probe will be installed upstream of the GAC product storage tank and caustic and sulfuric acid will be dosed upstream of the GAC product storage tank as required to adjust the pH back to neutral prior to discharge. An additional pH probe will also monitor the pH downstream of the GAC product storage tank on the effluent discharge line. Table 2 provides an estimate of chemical amendment dosing required for product pH adjustment.

Table 2: GAC Effluent Amendment Dosing Parameters

	Storage Tank Volume	Concentration	Consumption	Pump Capacity
Sodium Hydroxide	5000 gal	50%	40 GPD	9 GPH
Sulfuric Acid	5000 gal	50%	4 GPH	8 GPH

The GAC waste and used backwash water will collect in a pair of 21,000-gallon frac tanks and be transferred to either the solids handling process for dewatering and disposal, recycled to the influent oxidation tanks for retreatment, or transferred to the CIP neutralization tank

1.2.3 Solids Handling and Dewatering

The UF reject, GAC waste and CIP neutralized waste will be transferred to two, 17,500-gallon cone bottomed tanks in the solids handling system. The flow rate of this combined solids handling system influent will be monitored via a flow meter upstream of the cone-bottomed tanks. Polymer will be dosed to the combined influent to the cone-bottomed tanks to promote solids flocculation and coagulation. The polymer will be dosed from a 280-gallon tote to a dosage target of 70-200 ppm and an estimated daily consumption rate of 14 GPD. The system is configured for the potential future addition of four more cone bottomed tanks, if the capacity of the current system becomes insufficient.

The thickened sludge from the cone bottomed tanks is then transferred via gravity to an 18,000-gallon sludge holding tank and the centrate is transferred to the influent oxidation tanks. The system will be configured to allow for the future addition of 5 additional sludge holding tanks if the capacity of the system requires expansion. The sludge from the sludge holding tank is then transferred to the centrifuge via a sludge transfer pump. Upstream of the centrifuge, dry polymer will be dosed from a 250-gallon tank to enhance solids separation. The centrifuge will dewater the sludge to form a cake that is 10 – 15% solids.

The dewatered solids from the centrifuge will then be transferred via a distribution conveyor to a roll-off bin. The liquid centrate from the centrifuge will be transferred to a centrate tank. The contents of this tank will be pumped via a centrate pump to either the cone-bottomed tanks in the solids handling system or recycled back to the influent oxidation tanks. High turbidity centrate will be recycled to the cone-bottomed tanks, whereas low turbidity centrate will be recycled to the oxidation tanks.

1.3 Operability and Maintenance Considerations

Process equipment has been selected from established vendors who maintain available inventory of critical spare parts, and the turnkey service provider should also have access to spares inventory based on duplication of unit operations in their commercial fleet. The modular nature of the process train means that it can be readily expanded or modified to adjust to future changes in process conditions or treatment requirements.

1.4 Process Monitoring

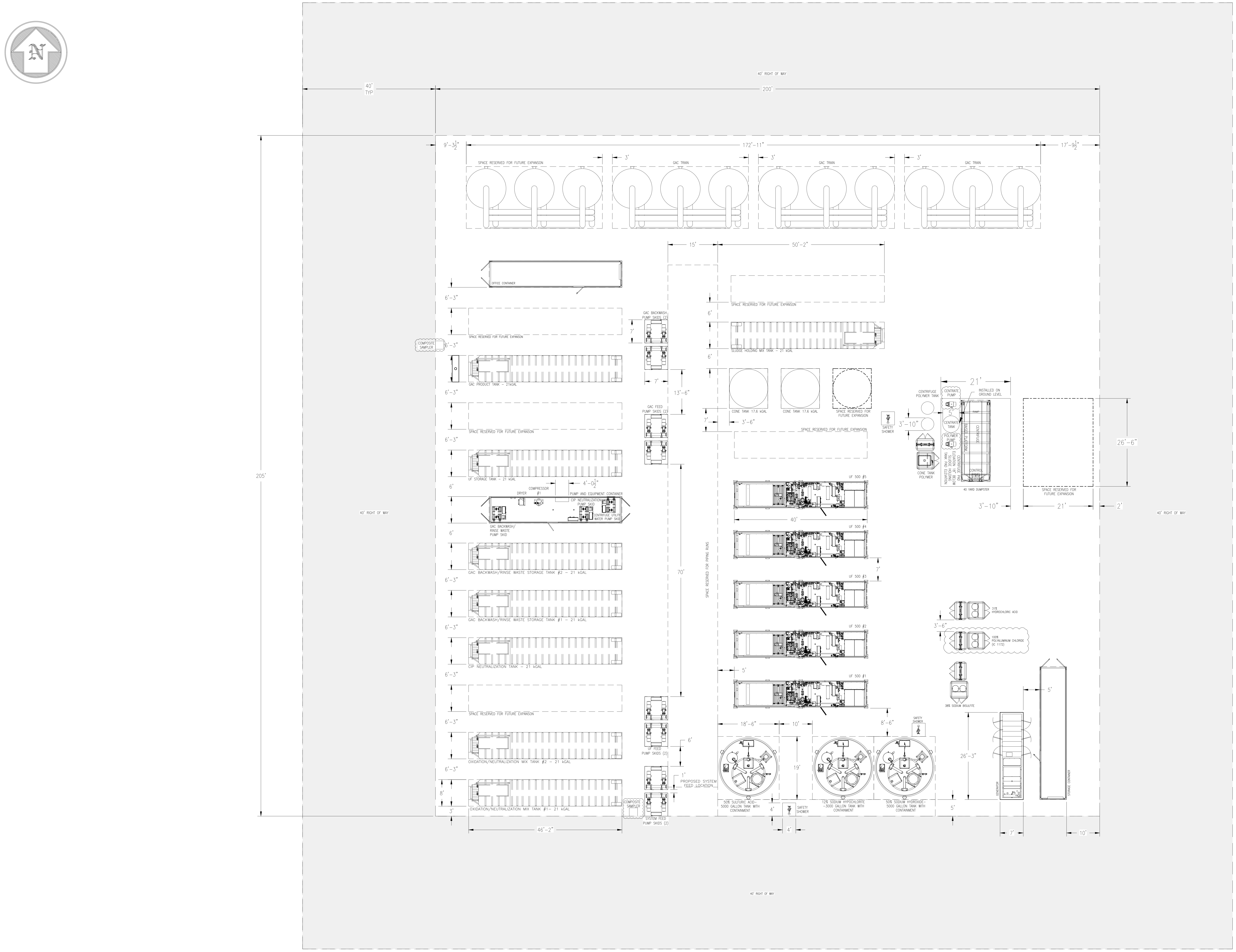
The treatment process will be instrumented to monitor process performance consistent with industry best practices. Process data will be recorded in a remotely accessible database with an extended storage capacity and uninterruptible power supply.

Regulatory compliance will be maintained by means of routine sampling and analytical testing of the untreated influent and treated water discharge points. In-process sampling will be conducted on a routine basis to ensure a compliant effluent with an optimized GAC change-out schedule.

Attachment
Vendor Drawing Package

NOTES:

1. ALL EQUIPMENT LOCATIONS ARE ESTIMATES ONLY. FINAL POSITIONS WILL VARY.
2. ALL DIMENSIONS FOR REFERENCE ONLY.
3. LAYOUT MAY CHANGE DEPENDING ON SITE CONDITIONS.
4. ELEVATION ASSUMED TO BE LEVEL.
5. SYSTEM FEED AND EFFLUENT CONNECTIONS UNKNOWN. SYSTEM LAYOUT MAY CHANGE DEPENDING ON CONNECTION LOCATIONS.
6. SYSTEM FEED PUMP SKID LOCATION TO BE DETERMINED BASED ON CUSTOMER FEED TANK LOCATION.



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CONTROLLED DOCUMENT

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
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TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE
BARRIER WALL

SYS, 1500 GPM, UF, GAC
EQUIPMENT LAYOUT

DRAWING NUMBER	REVISION
508581-AG-01	A

REF.: -
DOC. OWNER: -

PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
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LAST SAVED: Thursday, January 6, 2022 8:58:04 PM

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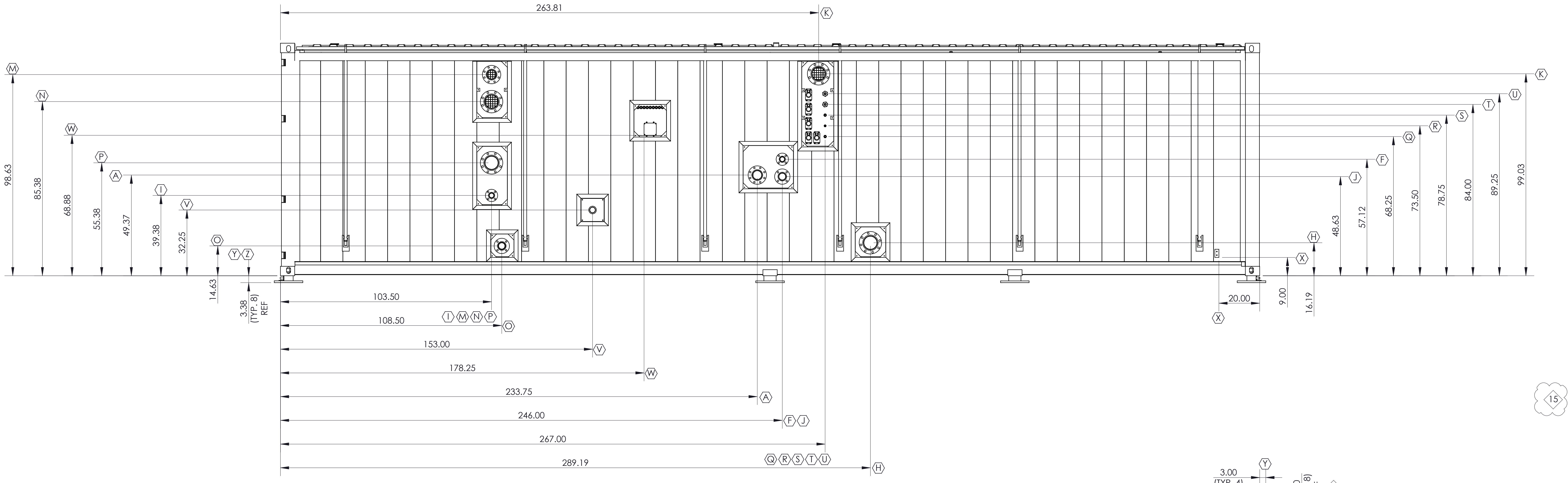
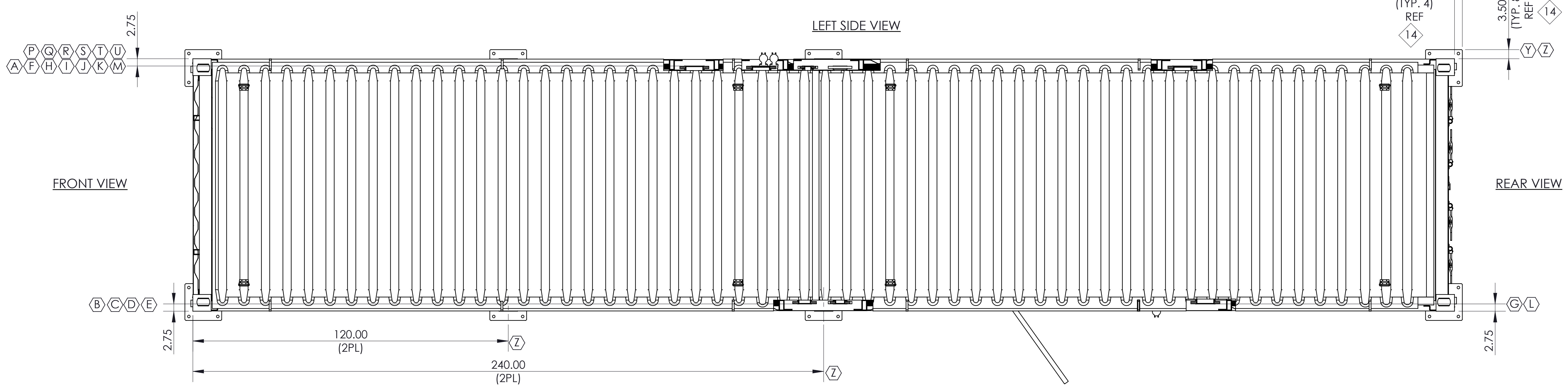
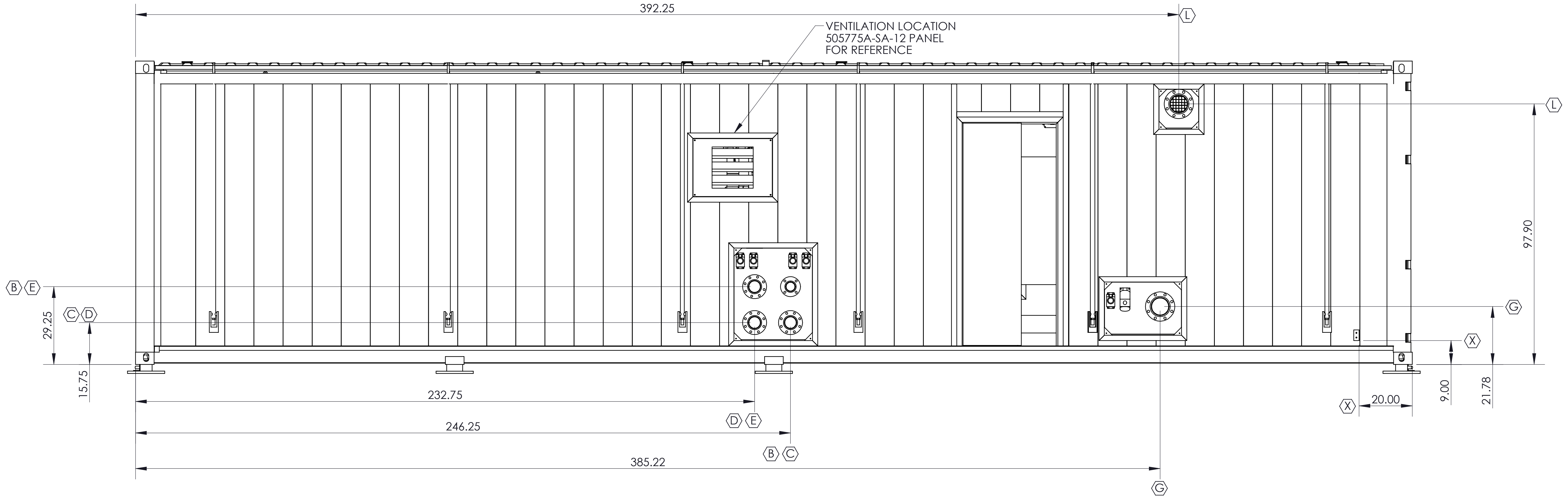


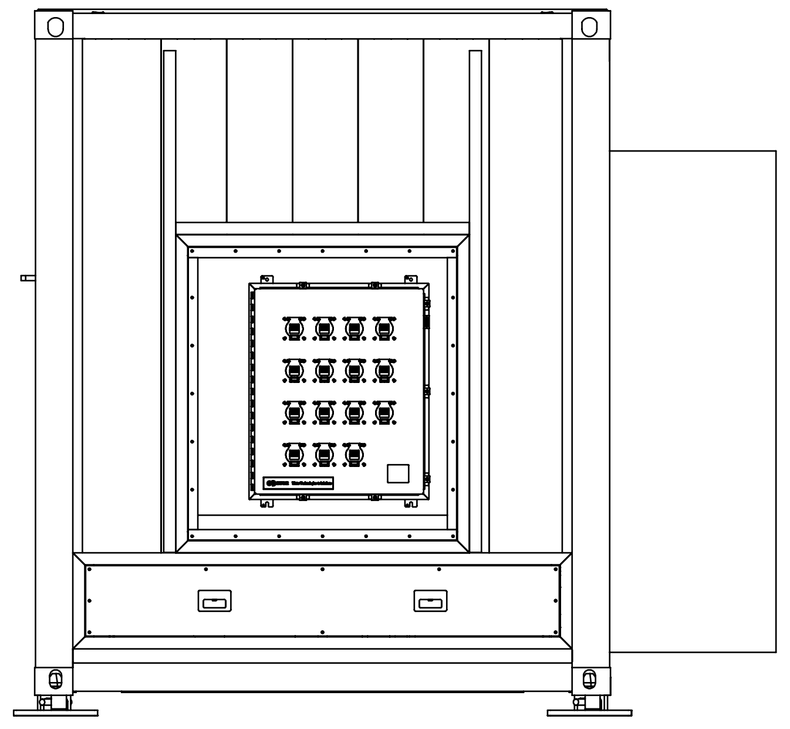
LEFT SIDE VIEW



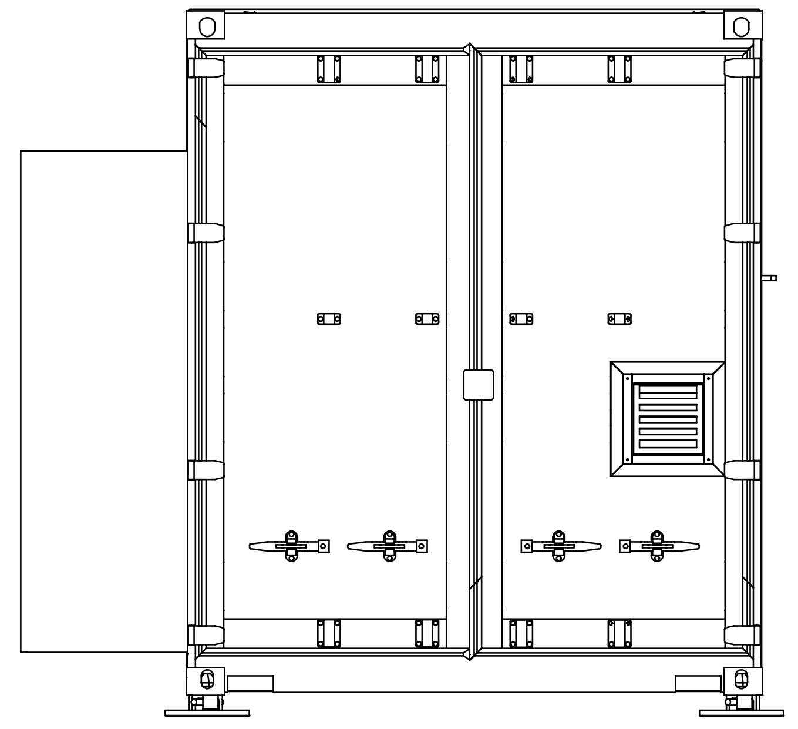
TOP VIEW



RIGHT SIDE VIEW



FRONT VIEW



REAR VIEW

NOTES:

1. CONNECTION TABLE:

ITEM	DESCRIPTION	TYPE	SIZE
A	CUSTOMER FEED	150# RF FLG	4.0
B	TO DRUM SCREEN	150# RF FLG	3.0
C	MBR MIXED LIQUOR #1 TO MEMBRANE TANK	150# RF FLG	4.0
D	MBR MIXED LIQUOR #2 TO MEMBRANE TANK	150# RF FLG	4.0
E	MBR MIXED LIQUOR RAS TO BIOREACTOR/ UF CIP WASTE TO CUSTOMER	150# RF FLG	4.0
F	MBR MIXED LIQUOR WAS TO CUSTOMER WASTE/ UF REJECT TO CUSTOMER WASTE	150# RF FLG	2.0
G	BIOREACTOR AIR	150# RF FLG	6.0
H	MEMBRANE TANK OVERFLOW/DRAIN TO CUSTOMER	150# RF FLG	6.0
I	TEMPORARY RECIRC LINE	150# RF FLG	2.0
J	NON-POTABLE UTILITY WATER FOR CLEANS	150# RF FLG	3.0
K	MEMBRANE TANK VENT	150# RF FLG	6.0
L	ATMOSPHERIC AIR INTAKE	150# RF FLG	6.0
M	BP TANK VENT	150# RF FLG	4.0
N	BP TANK OVERFLOW	150# RF FLG	6.0
O	BP TANK DRAIN	150# RF FLG	3.0
P	PERMEATE	150# RF FLG	6.0
Q	CAUSTIC INJECTION	TUBING	0.75
R	ANTI-FOAM INJECTION	TUBING	0.50
S	SODIUM BISULFITE INJECTION	TUBING	0.75
T	SODIUM HYPOCHLORITE FOR CLEANS	TUBING	0.75
U	CITRIC ACID INJECTION FOR CLEANS	TUBING	0.75
V	480 VAC POWER FEED	FNPT	2.5
W	CONTROL SIGNALS	FNPT	3 X 0.75
X	2 X GROUNDING LUG	PAD	2 X 4
Y	4 X CORNER SUPPORT	FASTLOCK	14 X 14
Z	4 X CENTER SUPPORT	FASTLOCK	14 X 14

15

2. SHIPPING WEIGHT: 50,000 LB/[22,680 Kg].
3. OPERATIONAL WEIGHT: 102,500 LB/[46,495 Kg].
4. ALL PIPING & EQUIPMENT SHOWN SHALL BE FULLY SUPPORTED BY SUEZ PRODUCTION.
5. ALL INTERCONNECTING PIPING SHALL BE FULLY & INDEPENDENTLY SUPPORTED BY OTHERS.
6. GASKET MATERIAL:
   DILUTION WATER: 1/8" THK EPDM.
7. FASTENER MATERIAL:
   ASTM F593G GRADE 316 HEX BOLTS/ASTM F594 GRADE 316 HEX NUTS
8. ALL DIMENSIONS IN INCHES.
9. REFERENCE - PIPING & INSTRUMENTATION DIAGRAM: 505775-AP-01.
10. REFERENCE - CONTAINER ELECTRICAL ASSEMBLY DRAWING 505775A-FE-01.
11. 505775AA-MA-06 IS ORDERED AS PART OF THE COMPRESSOR 505775A-MA-06.
12. TRIM AND PAINT ONE SIDE OF THE UNUSED TRANSFORMER WALL MOUNT FLANGE THAT EXTENDS INTO AISLE WAY.
13. COMPRESSOR DELIVERS WITH (4) EA. POLY SHIM BLOCKS THAT SHALL BE INSTALLED BETWEEN COMPRESSOR FEET AND COMPRESSOR TIE DOWN PLATES.
14. FASTLOCK BASE SHALL ONLY BE ANCHORED AFTER THE CONTAINER HAS BEEN SET ONTO THE FASTLOCKS.
15. HYDROCHLORIC ACID DOSING IS OPTIONAL BASED ON PROCESS AND SITE CONDITIONS.

SUEZ WTS
CONTROLLED DOCUMENT

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
C	REVISED TO UPDATE THE CHEMICAL PLUMBING		BG	RM	AM	16 JUN 21
B	DIMENSIONS UPDATED, PLMBS AND SPOOLS UPDATED FOR TANK SHIFT		BG	RM	JC	12 JAN 21
A	INITIAL RELEASE		BG	JG	JC	01 AUG 20

TOLERANCES UNLESS NOTED

DECIMALS	ANGLES
.X	+/-0.5°
.XX +/-0.50	FRAC
.XXX	1/2"

suez

CUSTOMER INFORMATION

MOBILE MBR
UF FILTRATION

SYS-CONT,40FT,MBR/UF,
4X500,HT,UL/CSA/CE

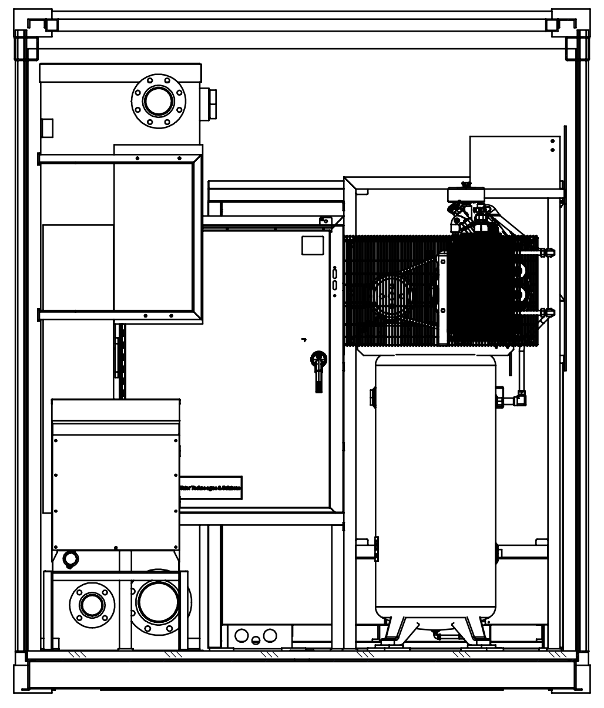
DRAWING NUMBER	REVISION
505775A-PG-01	C

REF.:
DOC. OWNER:

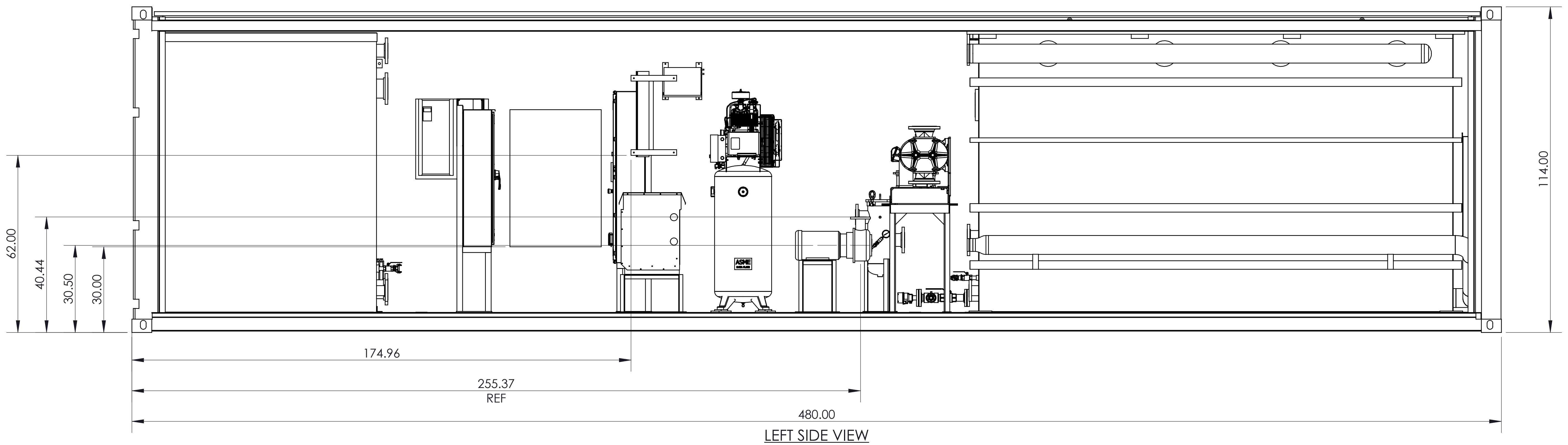
PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
505775	505775A	1:32	D	1 OF 8

LAST SAVED: Wednesday, June 16, 2021 4:30:00 PM

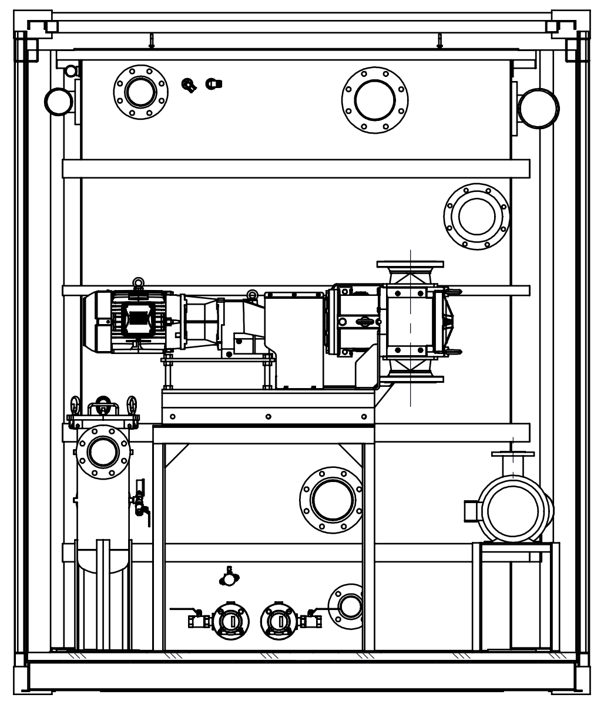
FILE LOCATION: D:\SWPDM\NAM\505775 - Mobile MBR UF Filtration\2. Mechanical Drawings\



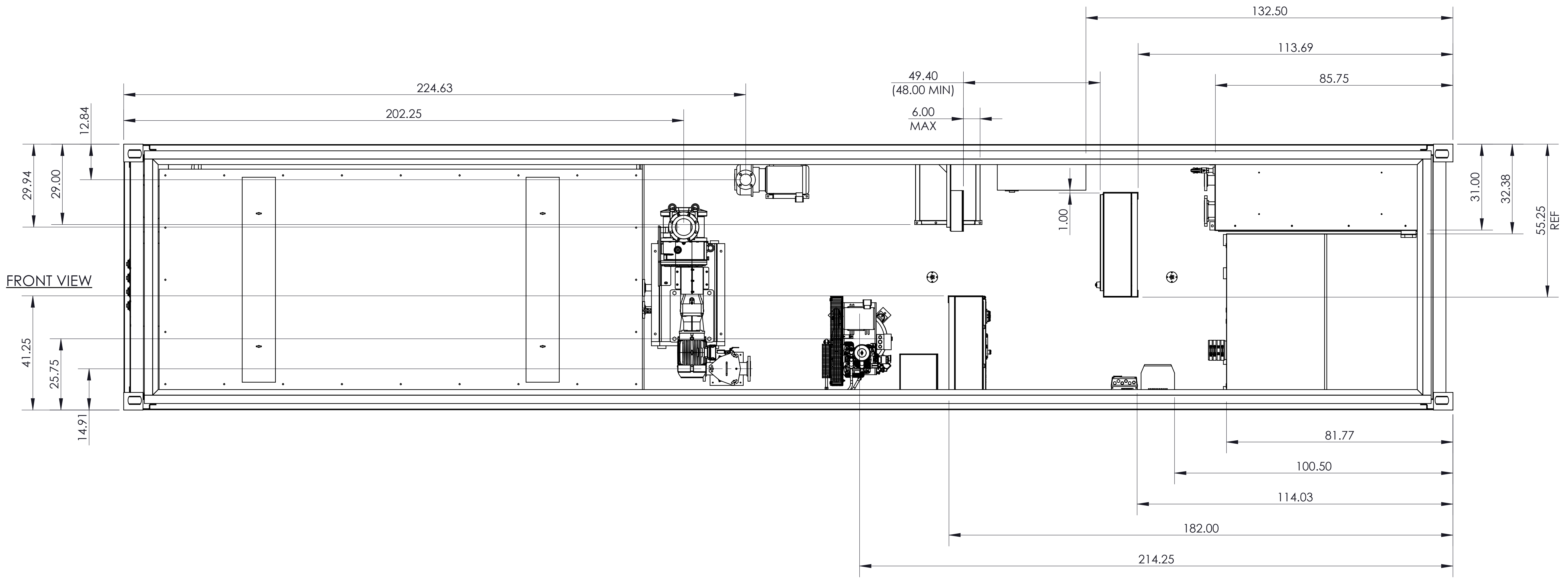
SECTION B-B
(EQUIPMENTS ONLY)



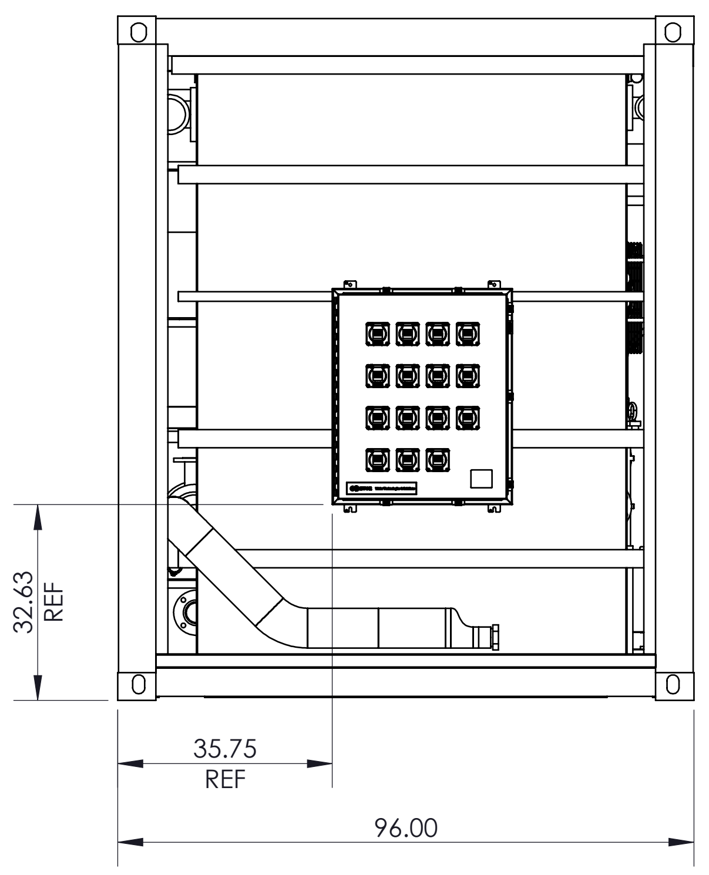
LEFT SIDE VIEW
(EQUIPMENTS ONLY)



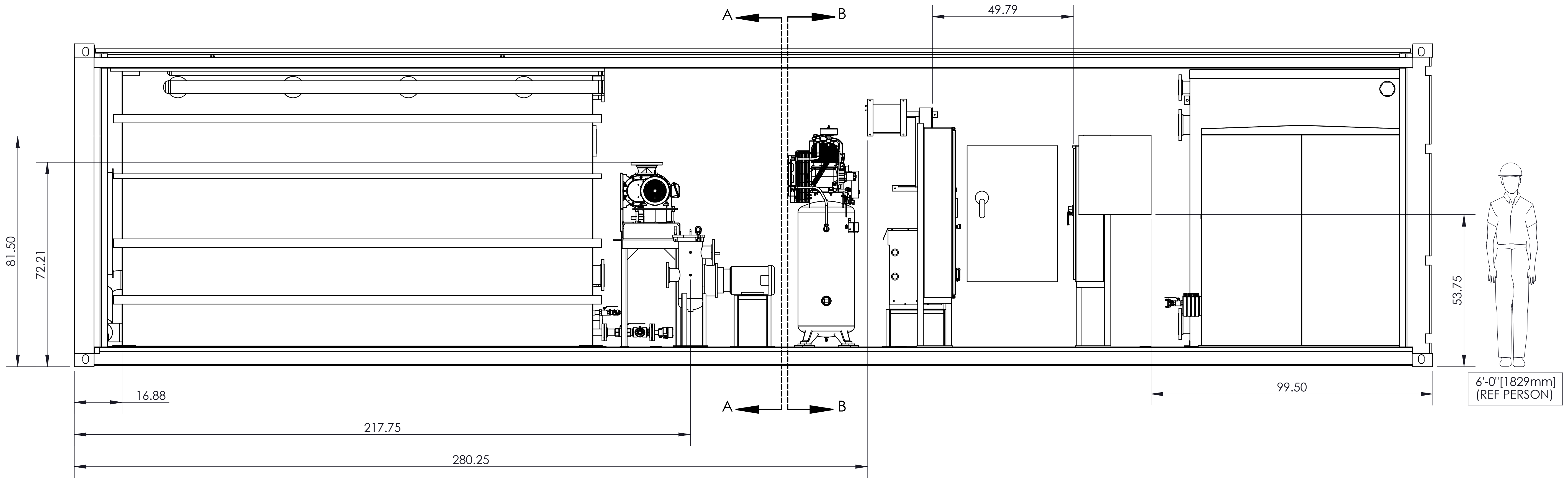
SECTION A-A
(EQUIPMENTS ONLY)



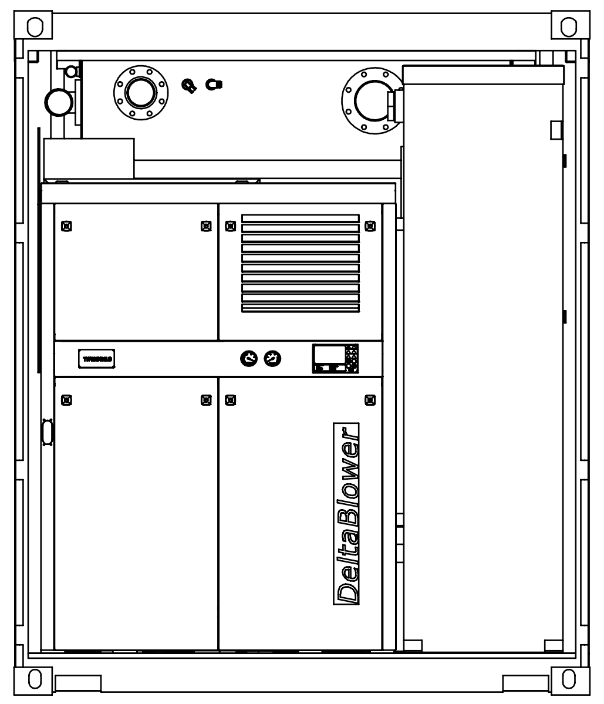
TOP VIEW
(EQUIPMENTS ONLY)



FRONT VIEW
(EQUIPMENTS ONLY)



RIGHT SIDE VIEW
(EQUIPMENTS ONLY)



REAR VIEW
(EQUIPMENTS ONLY)

	ITEM	QTY	SAP	Description
	1	496	3106203	SHEET,RED RUBBER,75-DURO,0.13X36.00
	2	1	3167135	VFD,7.5KW,380-480V,IP66,RFI,DANFOSS
	3	1	3169754	VFD,37KW,380-480V,IP66,RFI,FC202,DANFOSS
14	4	4	2660902Z-SA-05	BASE-CORNER,CONT,14X14,FASTLOCK,PAINT
14	5	4	2660902Z-SA-06	BASE-MIDDLE,CONT,14X14,FASTLOCK,PAINT
	6	1	504492B-MA-49	LOUVER-DAMPER,11.50X11.50
	7	1	504492B-MA-50	LOUVER-DAMPER,17.50X17.50
	8	1	504492B-MA-56	PLATE,ALUM,28.00X25.50X.25
	9	384	504492B-MA-60	FLAT,HDPE,WHITE,4.00X0.50
	10	1	504492B-SA-14	FRAME-WLD'T,304,PUMP,RAS,15.5X14.5X18
	11	1	504492B-SA-21	FRAME-WLD'T,304,ENCL,60X36X10
	12	1	504492B-SA-22	FRAME-WLD'T,304,ENCL,48X37.38X10
	13	1	504492B-SA-27	FRAME-WLD'T,304,DRYER,15.75X13.75X13
	14	1	505775A-EA-13	ELEC-ASSY,PANELBOARD,3P,480VAC,400AMP
	15	1	505775A-EA-14	ELEC-ASSY,LOADCENTER,1PH,120/240,150A,3R
12	16	1	505775A-EA-16	XFMR,400/480PRI,50/60HZ,30KVA,120/240
	17	1	505775A-EE-01	ENCL-ASSY,MAIN CNTRL PNL,120/1/60
	18	1	505775A-EE-02	ENCL-ASSY,MTR CNTRL PNL,480/3/60,3R
10	19	1	505775A-EZ-01	ELECT-ASSY,SYS,CONT,40FT,MBR/UF,4X500,HT,UL/CSA/CE
	20	1	505775A-MA-01	CONTAINER,40FT,MBR/UF,4XZW500DS,HARDTOP
	21	1	505775A-MA-02	PUMP-PD,CI/316L,10HP,480/400,BO,CL520
	22	1	505775A-MA-03	BLOWER-AIR,50HP,480/60/3,AER,760CFM
	23	1	505775A-MA-06	COMPRESSOR-AIR,5.0HP,480/60,400/50,GD,60
	24	1	505775A-MA-07	PUMP-CENT,316,10HP,480/60,GL,27SH4L45C5
	25	1	505775A-MZ-01	ASSY-TANK,316L,MEMBRANE,MOBILE MBR
	26	1	505775A-MZ-02	ASSY-TANK,316L,BACKPULSE,MOBILE MBR
	27	1	505775A-MZ-04	ASSY-INSTR,316,WALL-MOUNT
	28	1	505775A-MZ-05	FRAME-WLD'T,UNISTRUT MOUNTING
	29	1	505775A-PP-05	PLMB-INLET,316L,6.00,PROCESS PUMP
	30	1	505775A-PP-06	PLMB-PERM/BACKPULSE,316L,6.00X4.00
	31	1	505775A-PP-07	PLMB-INLET,316L,4.00X3.00,RAS PUMP
	32	1	505775A-PP-08	PLMB-FEED,316L,4.00,FILTER CAN
	33	1	505775A-PP-09	PLMB-DISCH,316L,4.00X2.50,RAS PUMP
	34	1	505775A-PP-10	PLMB-DISCH,316L,4.00X2.00,RAS PUMP
	35	1	505775A-PP-11	PLMB-RECYC,316L,4.00X3.00,REC CLEAN
	36	1	505775A-PP-12	PLMB-FEED,316L,1.50,SPRAY NOZZLE
	37	1	505775A-PP-13	PLMB-OVERFLOW/DRAIN,316L,6.00X3.00,MEMB
	38	1	505775A-PP-14	PLMB-VENT,316L,6.00,MEMB TANK
	39	1	505775A-PP-15	PLMB-DISCH,316L,6.00X4.00,BLOWER
	40	1	505775A-PP-16	PLMB-INLET,316L,6.00,BLOWER
	41	1	505775A-PP-17	PLMB-FEED,316L,6.00X4.00,MEMB TANK
	42	1	505775A-PP-18	PLMB-FEED,316L,3.00,UTILITY
	43	1	505775A-PP-19	PLMB-VENT,316L,4.00,BP TANK
	44	1	505775A-PP-20	PLMB-OVERFLOW,316L,6.00,BP TANK
	45	1	505775A-PP-21	PLMB-DRAIN,316L,3.00,BP TANK
	46	1	505775A-PP-23	PLMB-FEED,316L,4.0,FILTER CAN
	47	1	505775A-PP-24	PLMB-CHEM,PVC,0.75,SODIUM HYPOCHLORITE
15	48	1	505775A-PP-25	PLMB-CHEM,PVC,0.75,CITRIC ACID
	49	1	505775A-PP-26	PLMB-CHEM,316,0.50,ANTI-FOAM
	50	1	505775A-PP-27	PLMB-CHEM,316,0.75,CAUSTIC
	51	1	505775A-PP-40	PLMB-CHEM,316,0.75,SODIUM BISULFITE
	52	1	505775A-SA-15	FRAME-WLD'T,304,PUMP,PROCESS,40X26.5X41
	53	1	505775A-SA-20	FRAME-WLD'T,304,XFMR,22.00X12.13X24.41
	54	1	505775A-SA-28	FRAME-WLD'T,304,LOAD CENTER
13	55	4	505775A-SA-35	PLATE-COMPRESSOR,304,6X4X0.50,TIE DOWN
11	56	0	505775AA-MA-06	DRYER-REFRIG,1/7HP,120/60/1,GD,10SCFM

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A	INITIAL RELEASE		BG	JG	JC	01 AUG 20

TOLERANCES UNLESS NOTED

DECIMALS	ANGLES
.X	+/-0.5˚
.XX +/-0.50	FRAC
.XXX	1/2"

CUSTOMER INFORMATION

MOBILE MBR
UF FILTRATION

SYS-CONT,40FT,MBR/UF,
4X500,HT,UL/CSA/CE

DRAWING NUMBER
505775A-PG-01

REVISION
C

REF.:
DOC. OWNER:

PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
505775	505775A	1:32	**D**	2 OF 8

LAST SAVED: Wednesday, June 16, 2021 4:30:00 PM

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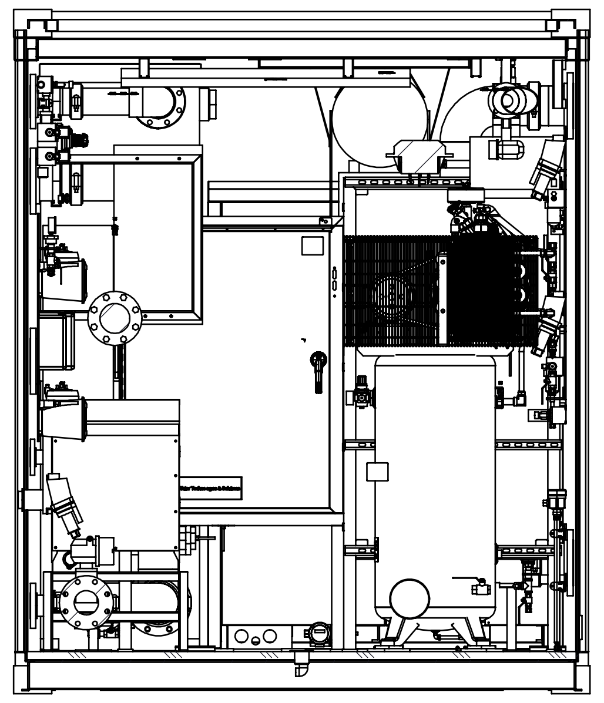

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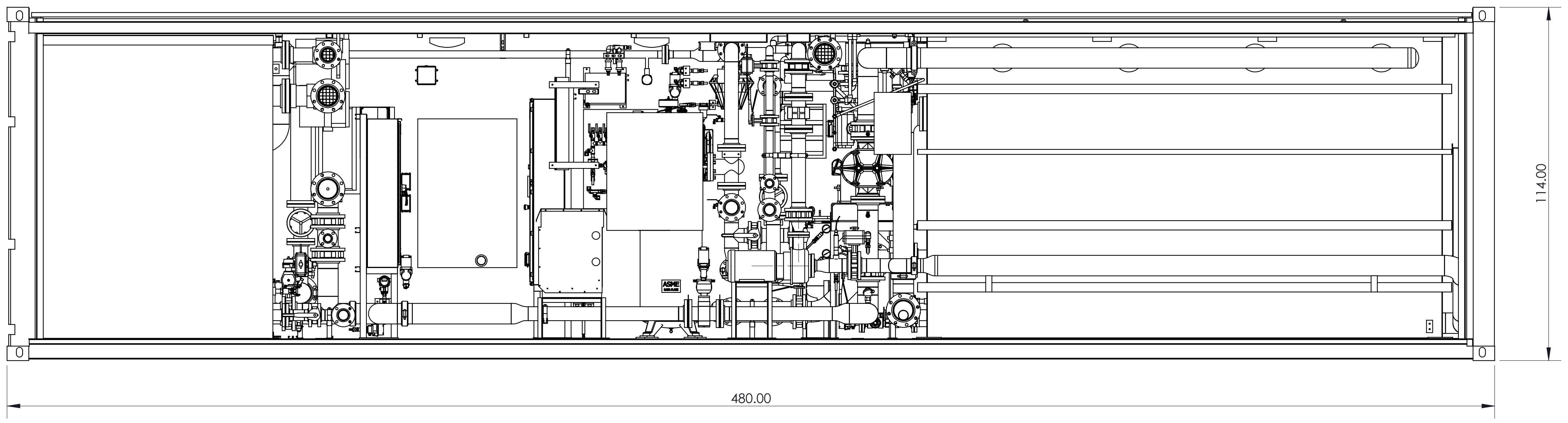
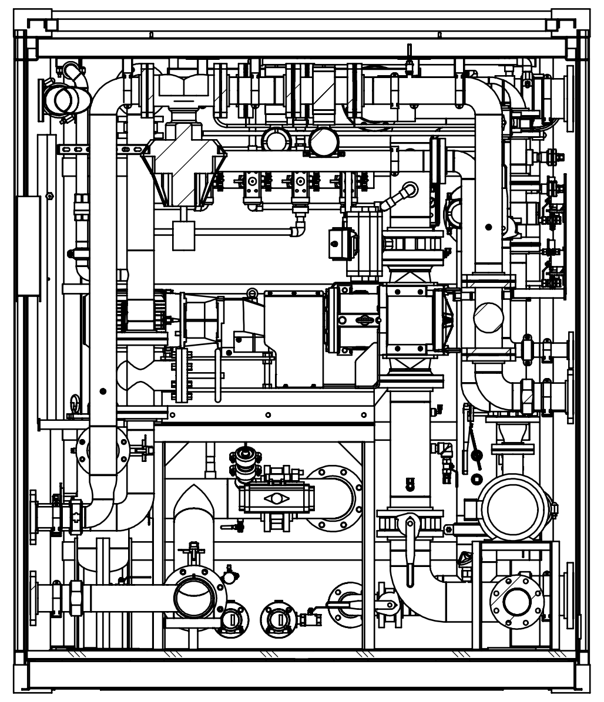


LEFT SIDE VIEW



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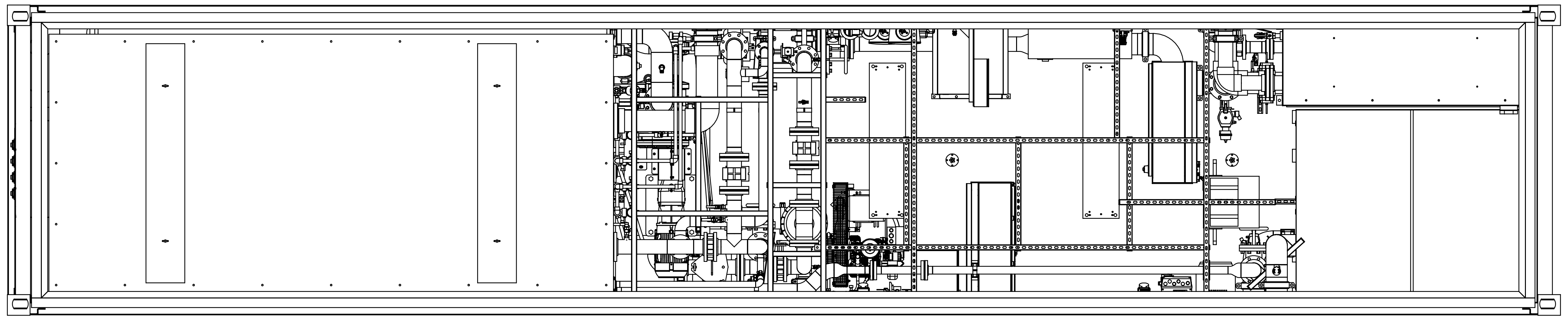
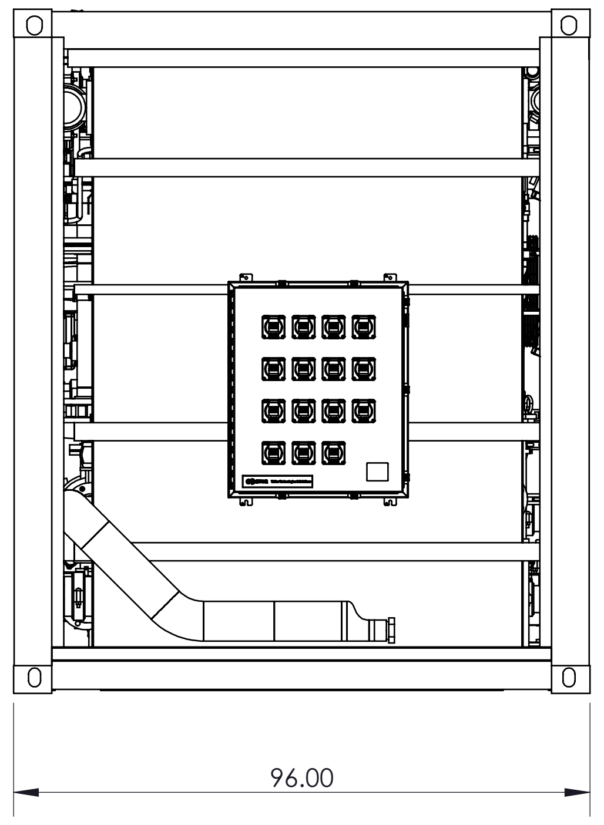
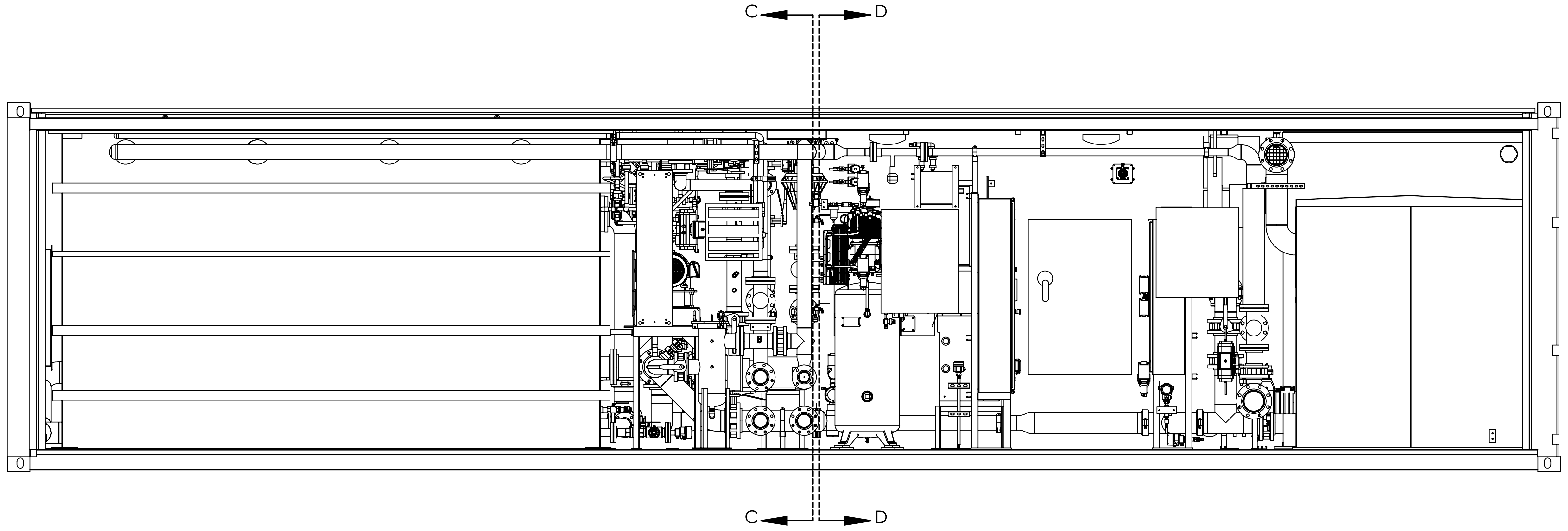


TOP VIEW



FRONT VIEW



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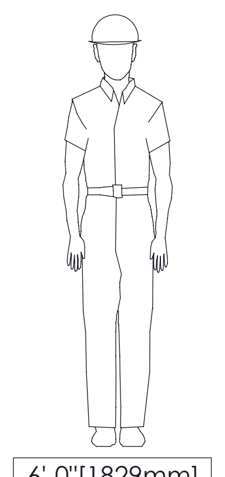

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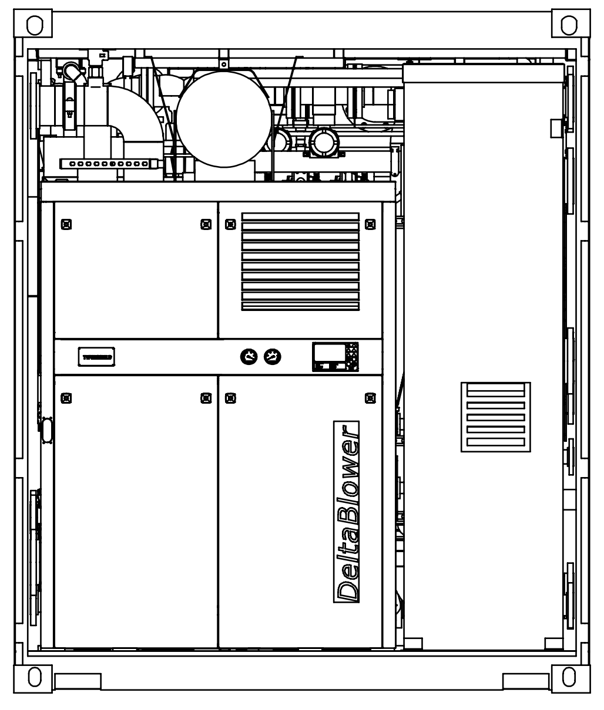
(REF PERSON)



REAR VIEW

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
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TOLERANCES UNLESS NOTED

DECIMALS	ANGLES
.X	+/-0.5°
.XX +/-0.50	FRAC
.XXX	1/2"

suez

CUSTOMER INFORMATION

MOBILE MBR
UF FILTRATION

SYS-CONT,40FT,MBR/UF,
4X500,HT,UL/CSA/CE

DRAWING NUMBER: 505775A-PG-01
REVISION: C
REF.:
DOC. OWNER:
PROJECT NO.: 505775
PART/MATERIAL NO.: 505775A
SCALE: 1:32
SIZE: D
SHEET: 3 OF 8

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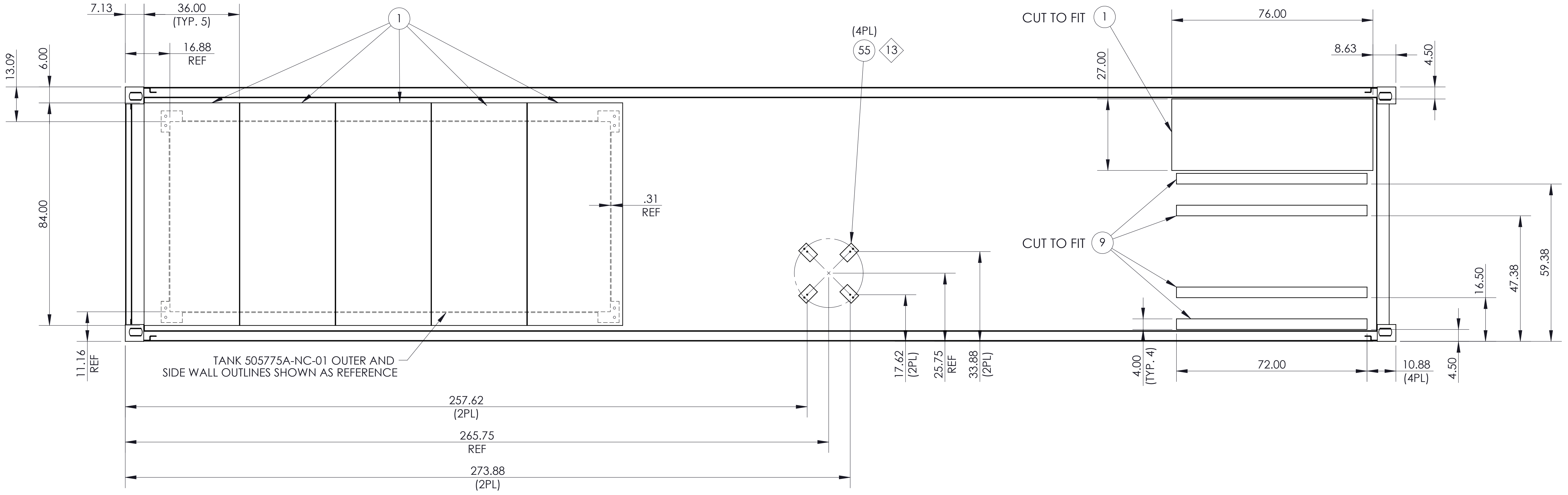
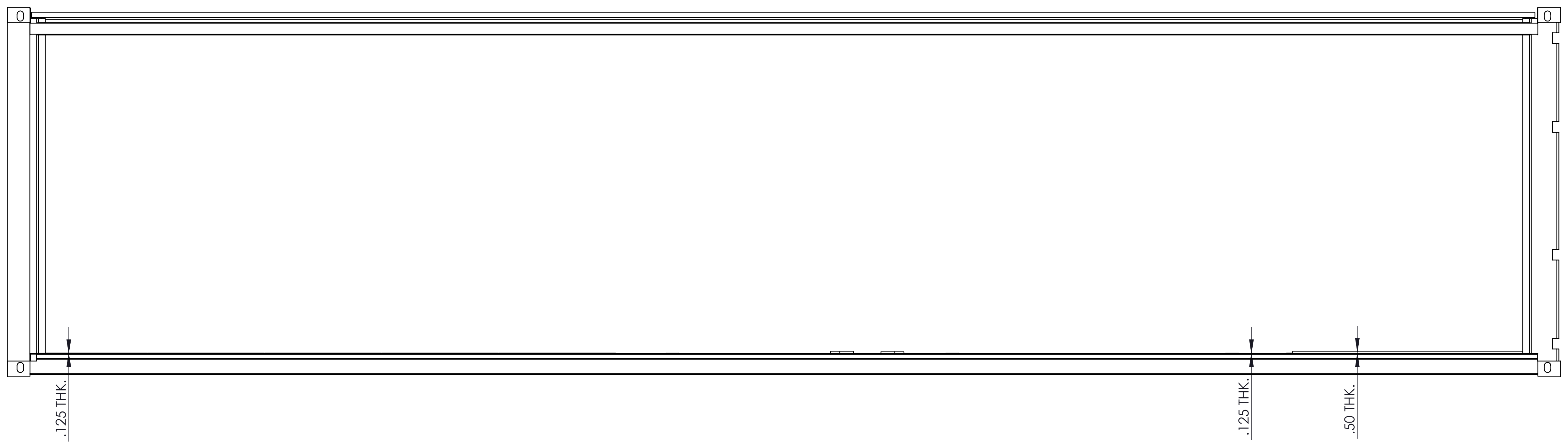
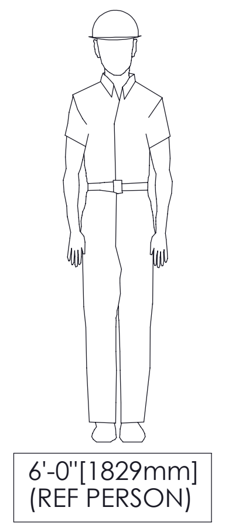
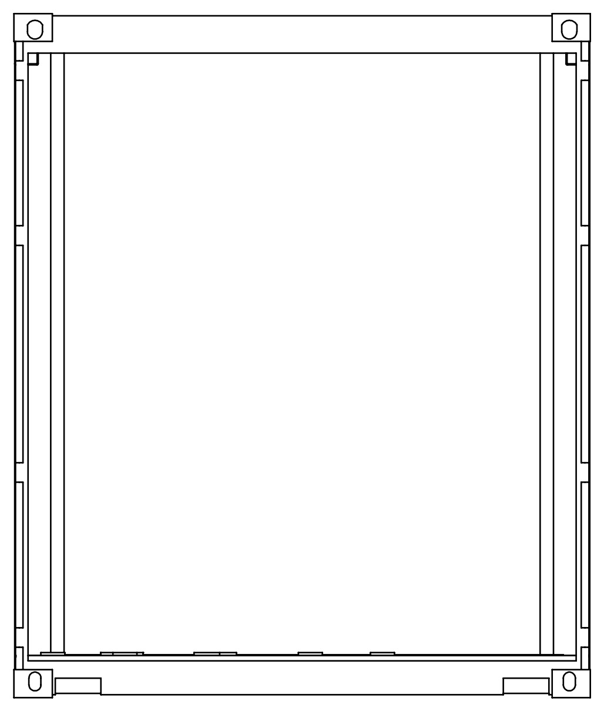


TOP VIEW



LEFT SIDE VIEW





REAR VIEW

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suez

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DRAWING NUMBER					REVISION
505775A-PG-01					C
REF.:	DOC. OWNER:				
PROJECT NO. 505775	PART/MATERIAL NO. 505775A	SCALE 1:32	SIZE **D**	SHEET 4 OF 8	

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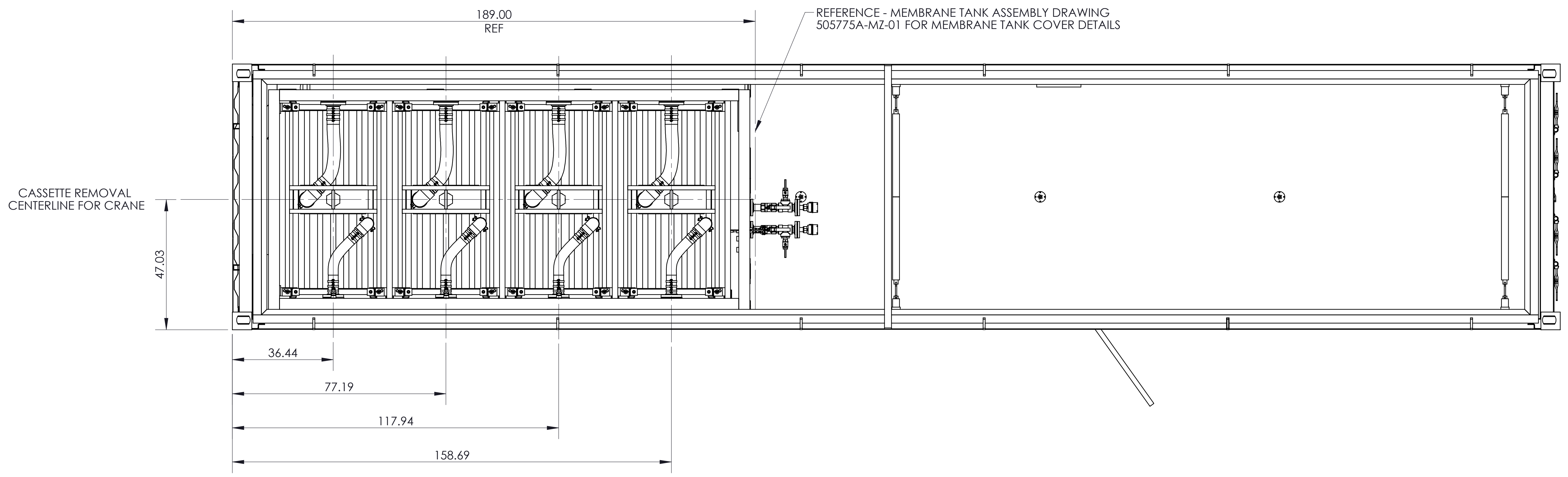
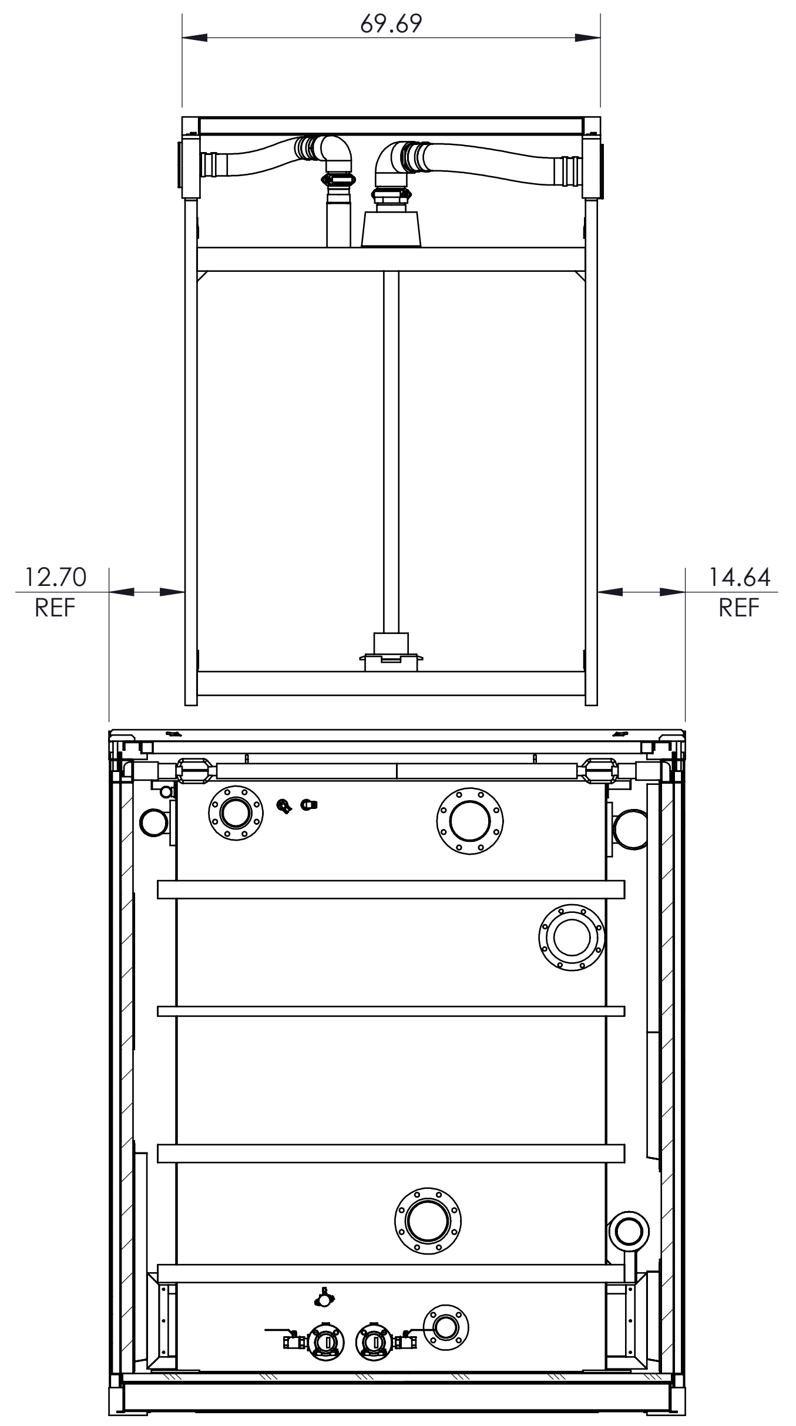
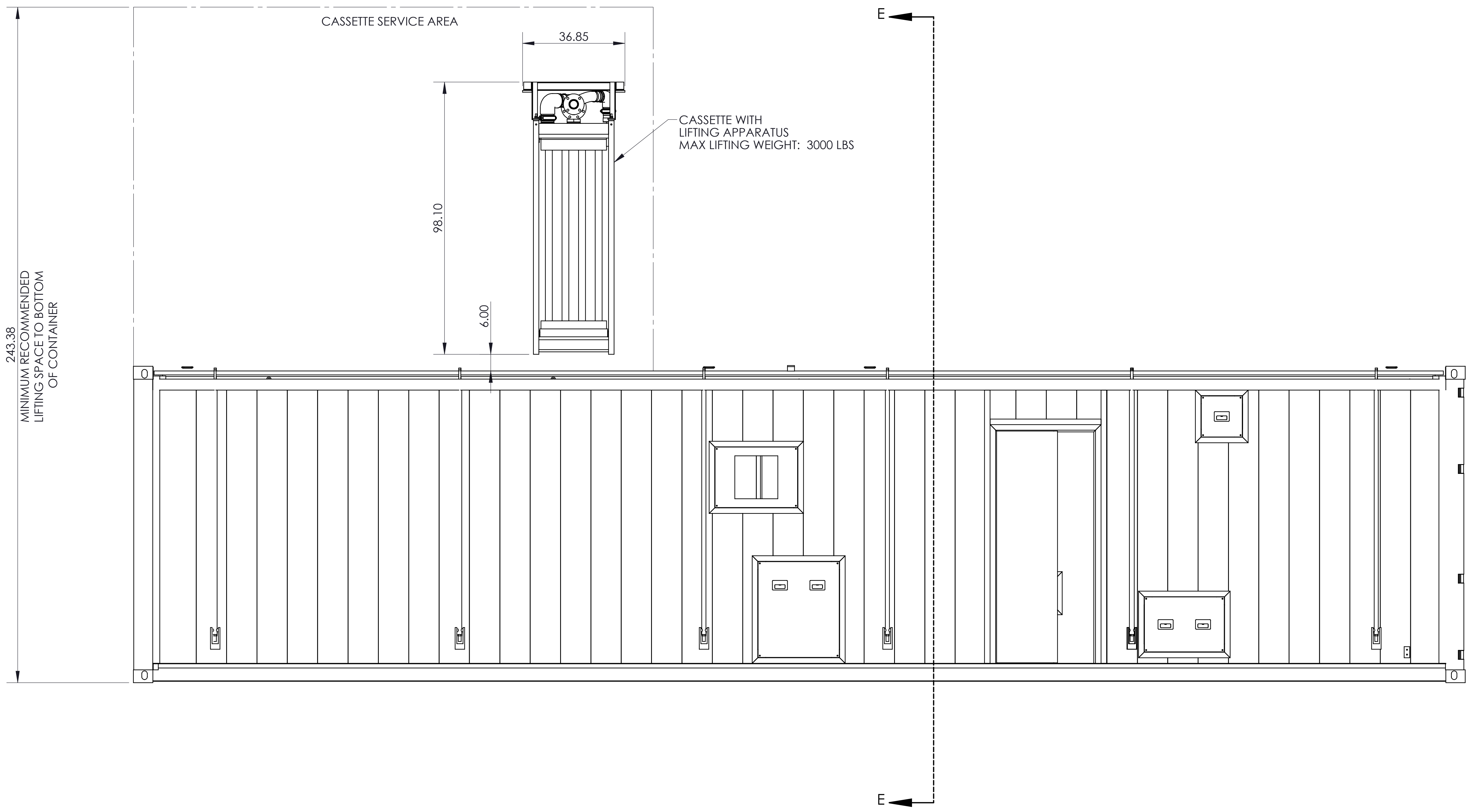




SECTION E-E
SCALE 1 : 32



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CUSTOMER INFORMATION

MOBILE MBR
UF FILTRATION

SYS-CONT,40FT,MBR/UF,
4X500,HT,UL/CSA/CE

DRAWING NUMBER				REVISION
505775A-PG-01				C
REF.:	DOC. OWNER:			
PROJECT NO. 505775	PART/MATERIAL NO. 505775A	SCALE 1:32	SIZE D	SHEET 5 OF 8

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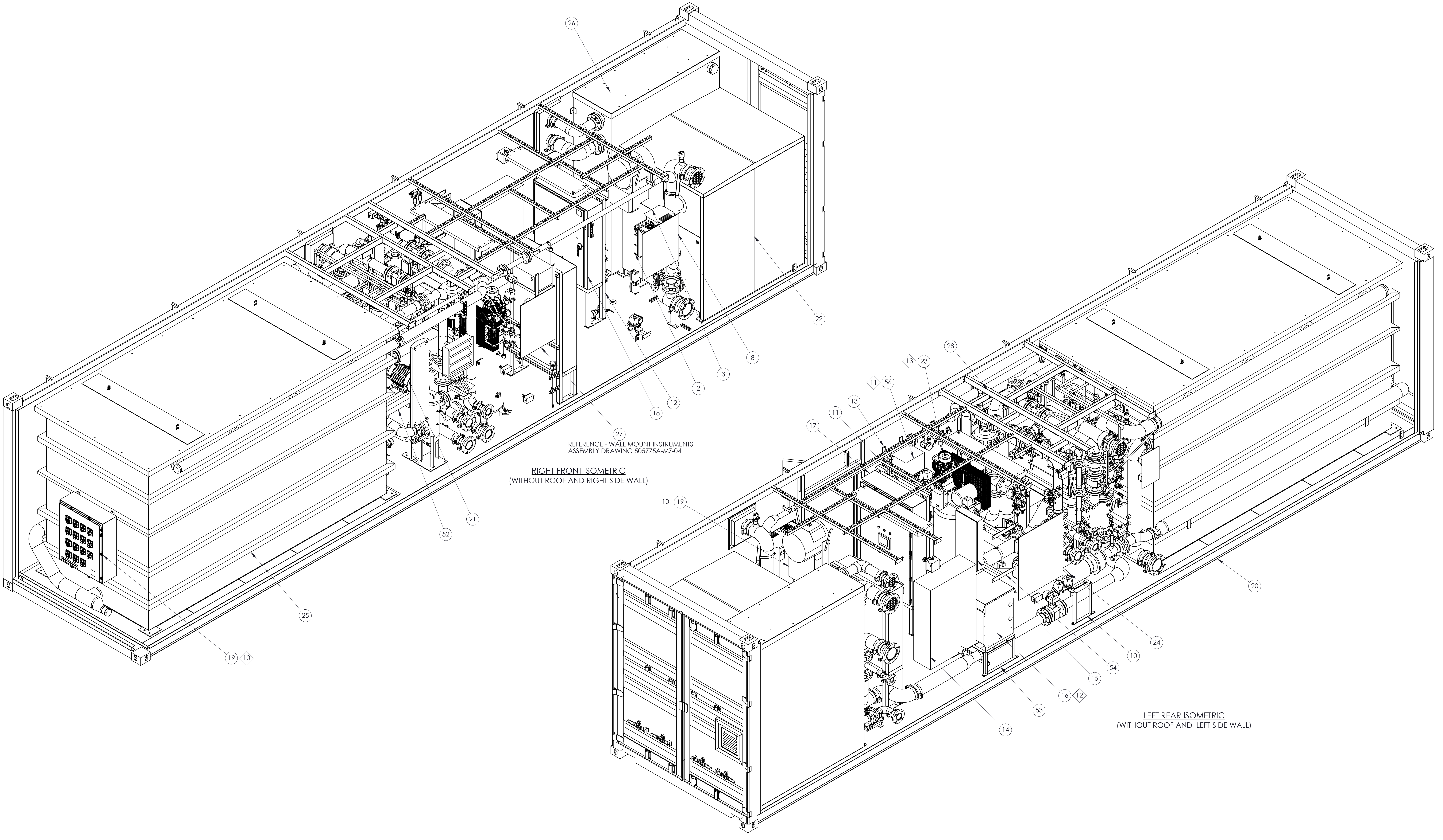


REFERENCE - WALL MOUNT INSTRUMENTS
ASSEMBLY DRAWING 505775A-MZ-04

RIGHT FRONT ISOMETRIC
(WITHOUT ROOF AND RIGHT SIDE WALL)

LEFT REAR ISOMETRIC
(WITHOUT ROOF AND LEFT SIDE WALL)

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
C	REVISED TO UPDATE THE CHEMICAL PLUMBING		BG	RM	AM	16 JUN 21
B	DIMENSIONS UPDATED, PLMBS AND SPOOLS UPDATED FOR TANK SHIFT		BG	RM	JC	12 JAN 21
A	INITIAL RELEASE		BG	JG	JC	01 AUG 20

TOLERANCES UNLESS NOTED

DECIMALS		ANGLES
.X		+/-0.5°
.XX +/-0.50		FRAC
.XXX		1/2"

CUSTOMER INFORMATION

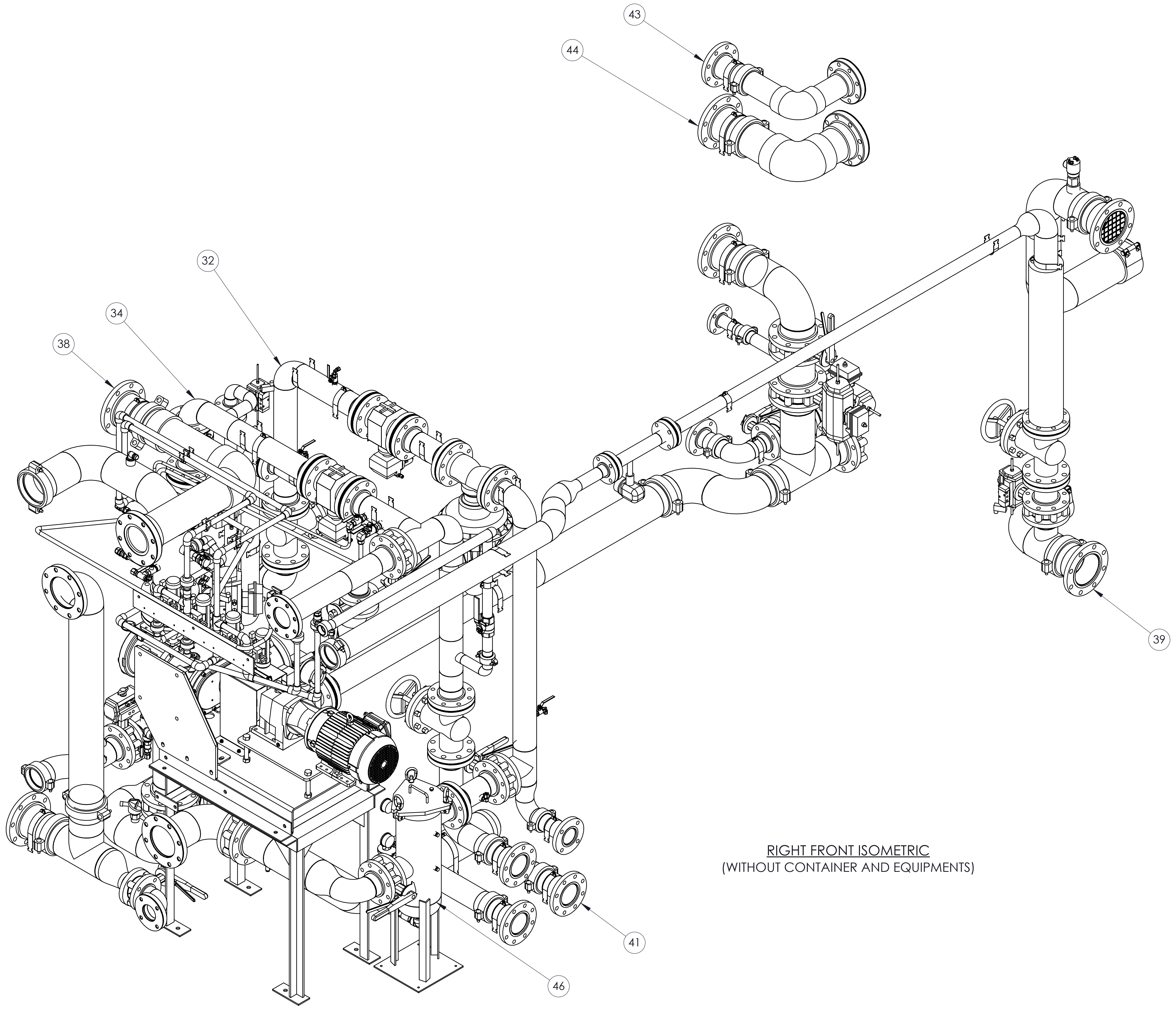
MOBILE MBR
UF FILTRATION

SYS-CONT,40FT,MBR/UF,
4X500,HT,UL/CSA/CE

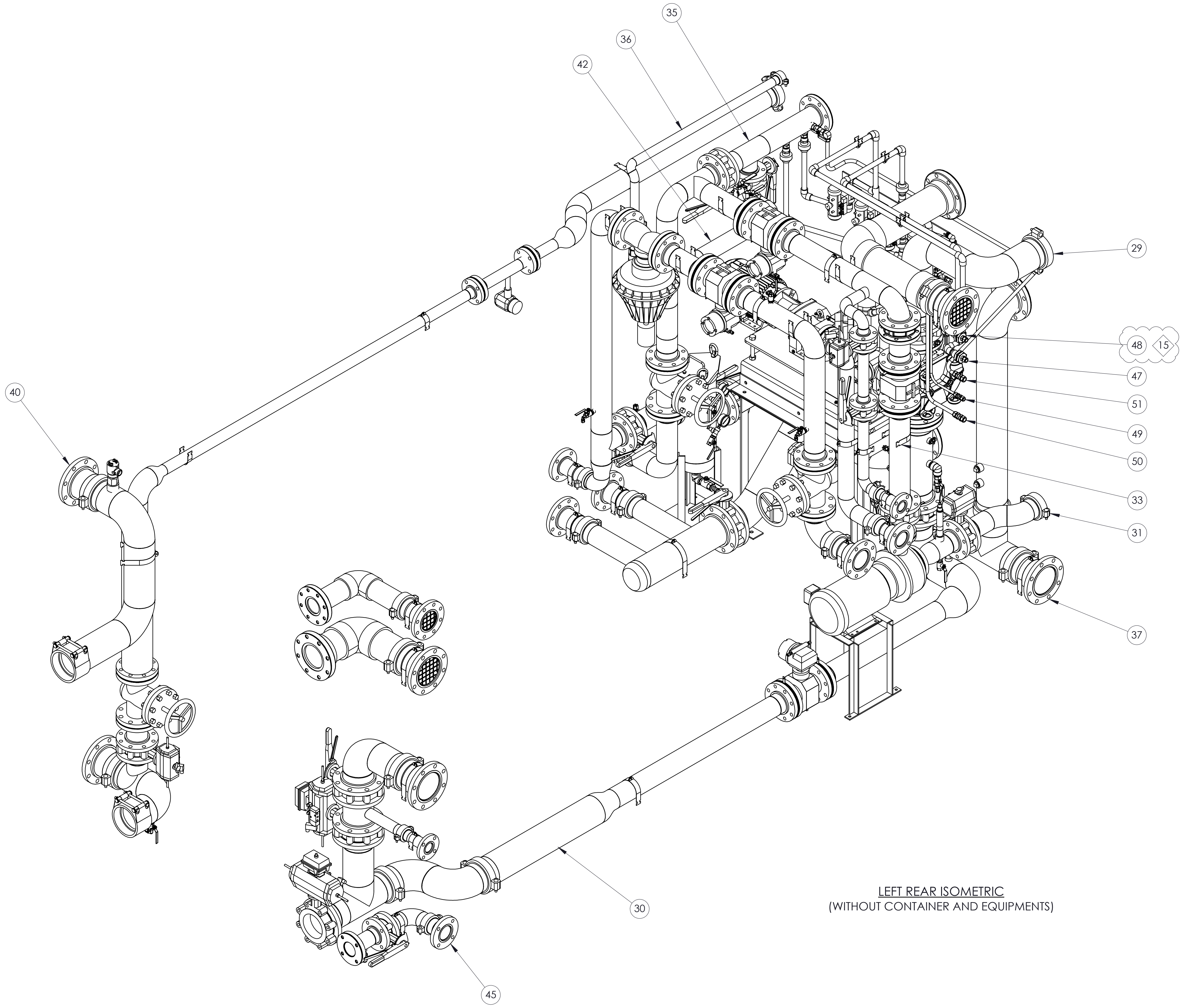
DRAWING NUMBER				REVISION
505775A-PG-01				C
REF.:	DOC. OWNER:			
PROJECT NO. 505775	PART/MATERIAL NO. 505775A	SCALE 1:24	SIZE D	SHEET 6 OF 8

LAST SAVED: Wednesday, June 16, 2021 4:30:00 PM

FILE LOCATION: D:\SWPDM\NAM\505775 - Mobile MBR UF Filtration\2. Mechanical Drawings\



RIGHT FRONT ISOMETRIC
(WITHOUT CONTAINER AND EQUIPMENTS)



LEFT REAR ISOMETRIC
(WITHOUT CONTAINER AND EQUIPMENTS)

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
C	REVISED TO UPDATE THE CHEMICAL PLUMBING		BG	RM	AM	16 JUN 21
B	DIMENSIONS UPDATED, PLMBS AND SPOOLS UPDATED FOR TANK SHIFT		BG	RM	JC	12 JAN 21
A	INITIAL RELEASE		BG	JG	JC	01 AUG 20

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TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X +/-0.5°
.XX +/-0.50 FRAC
.XXX 1/2"

CUSTOMER INFORMATION

MOBILE MBR
UF FILTRATION

SYS-CONT,40FT,MBR/UF,
4X500,HT,UL/CSA/CE

DRAWING NUMBER
505775A-PG-01

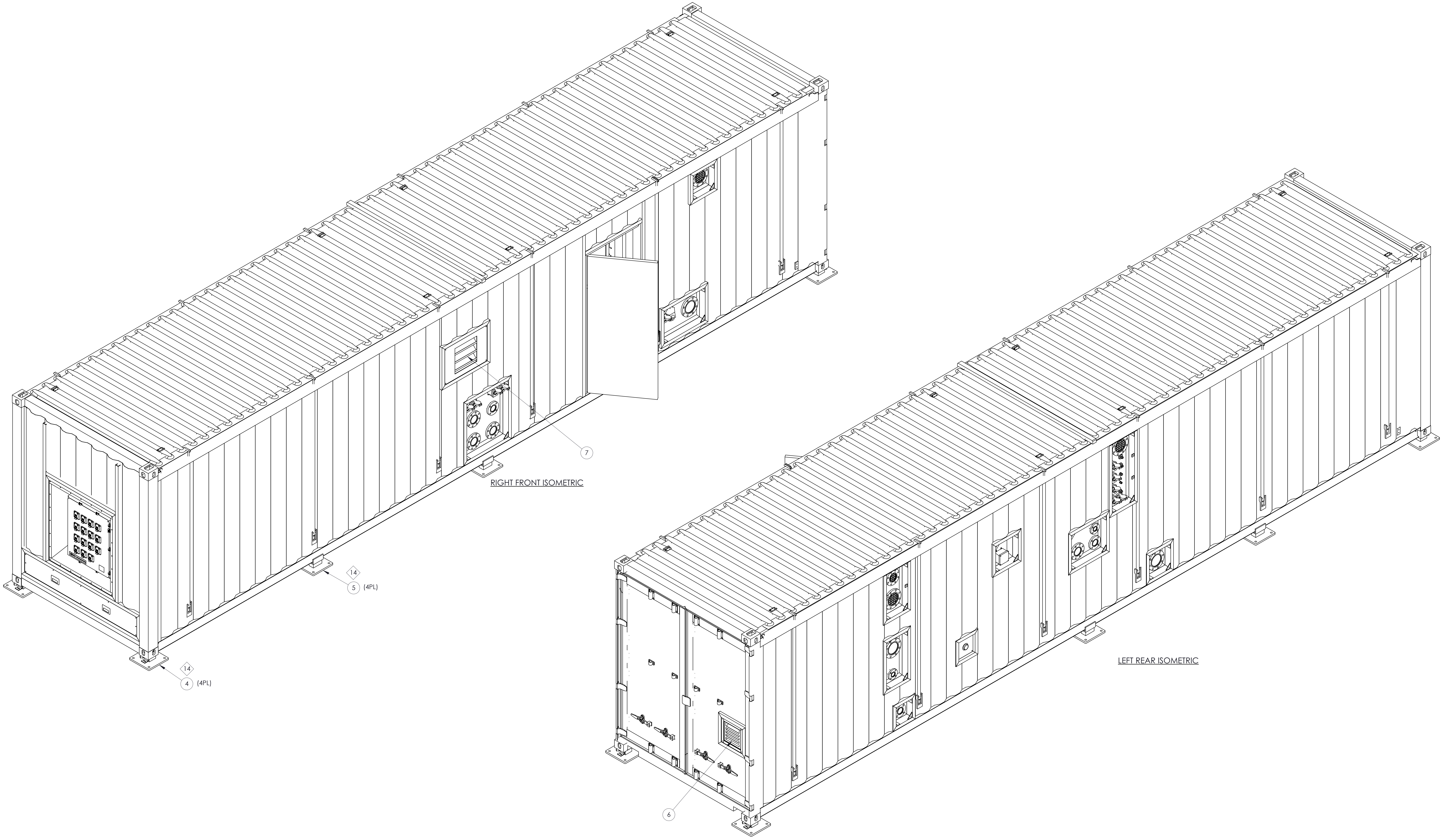
REVISION
C

REF.:
DOC. OWNER:

PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
505775	505775A	1:16	D	7 OF 8

LAST SAVED: Wednesday, June 16, 2021 4:30:00 PM

FILE LOCATION: D:\SWPDM\NAM\505775 - Mobile MBR UF Filtration\2. Mechanical Drawings\



REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
C	REVISED TO UPDATE THE CHEMICAL PLUMBING		BG	RM	AM	16 JUN 21
B	DIMENSIONS UPDATED, PLMBS AND SPOOLS UPDATED FOR TANK SHIFT		BG	RM	JC	12 JAN 21
A	INITIAL RELEASE		BG	JG	JC	01 AUG 20

TOLERANCES UNLESS NOTED

DECIMALS	ANGLES
.X	+/-0.5°
.XX +/-0.50	FRAC
.XXX	1/2"

CUSTOMER INFORMATION

MOBILE MBR
UF FILTRATION

SYS-CONT,40FT,MBR/UF,
4X500,HT,UL/CSA/CE

DRAWING NUMBER
505775A-PG-01

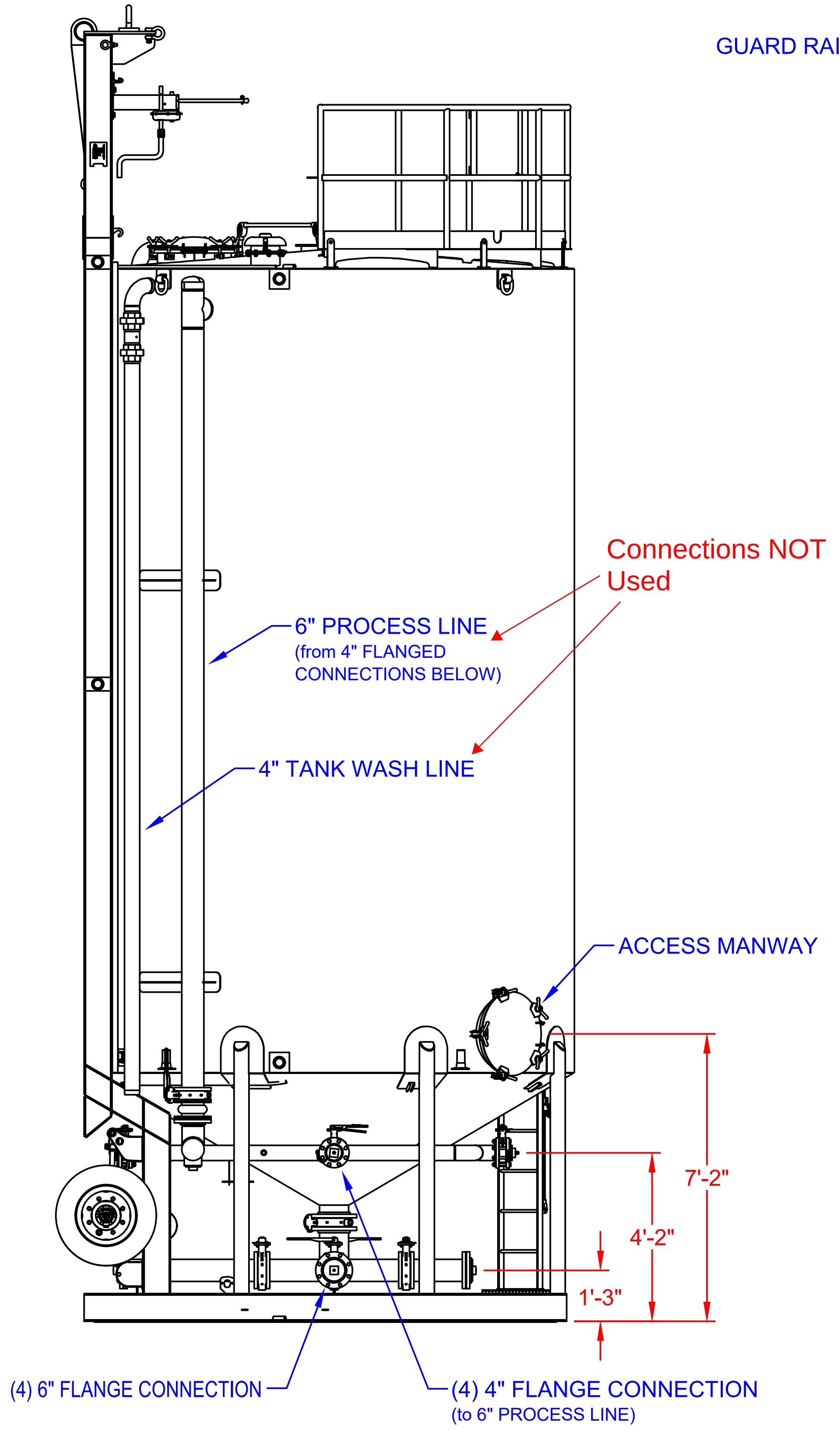
REVISION
C

REF.:
DOC. OWNER:

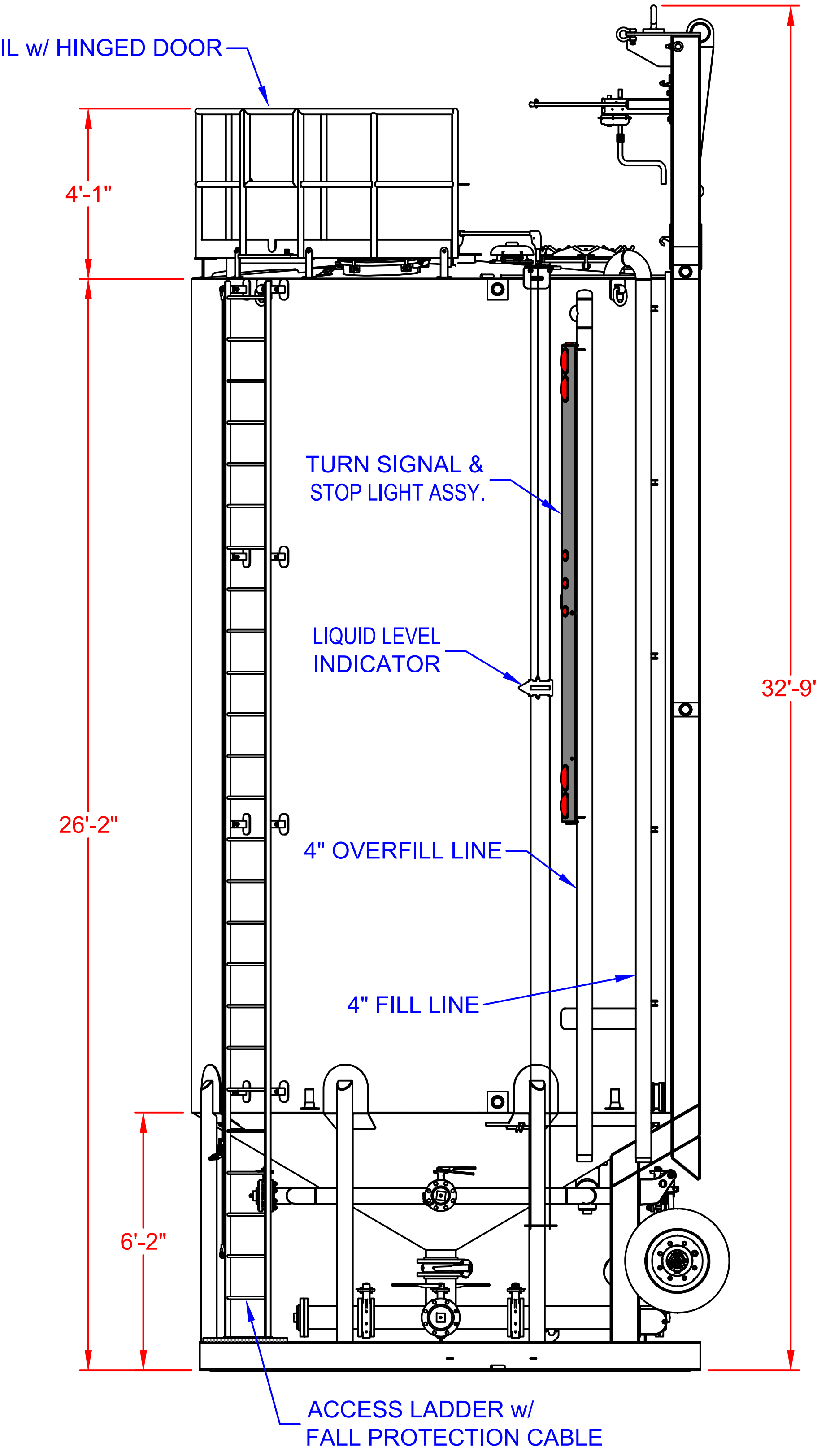
PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
505775	505775A	1:24	D	8 OF 8

LAST SAVED: Wednesday, June 16, 2021 4:30:00 PM

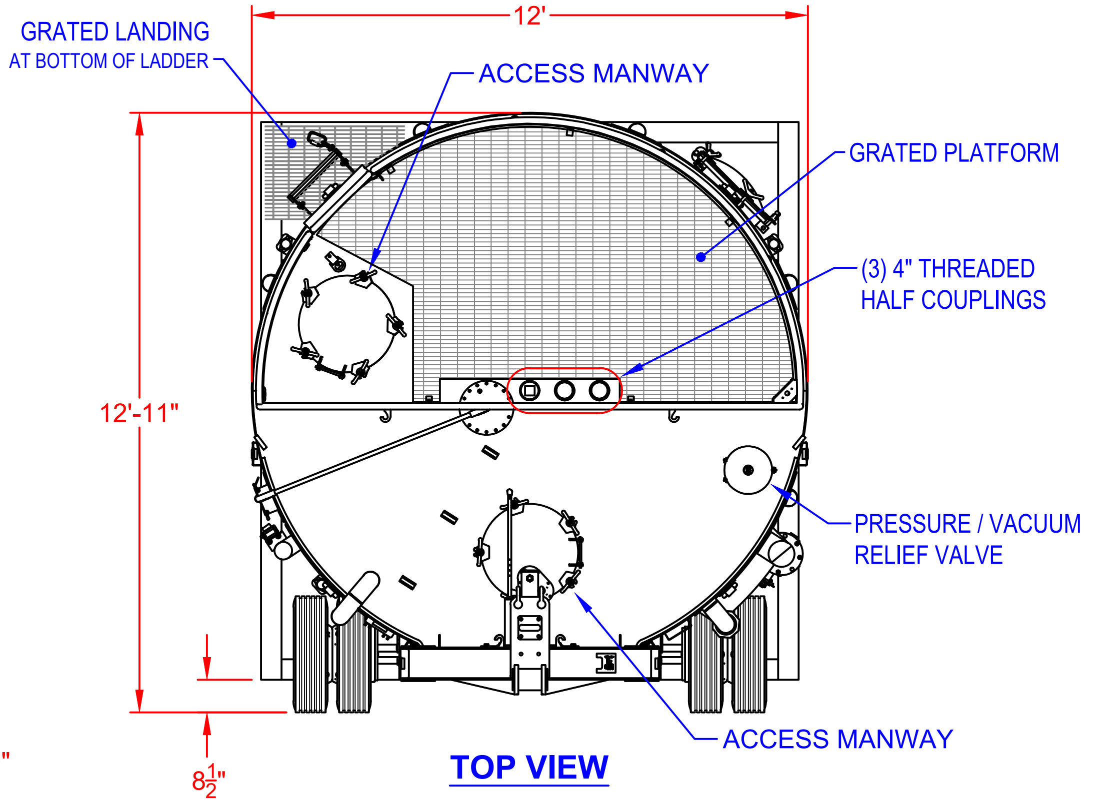
FILE LOCATION: D:\SWPDM\NAM\505775 - Mobile MBR UF Filtration\2. Mechanical Drawings\



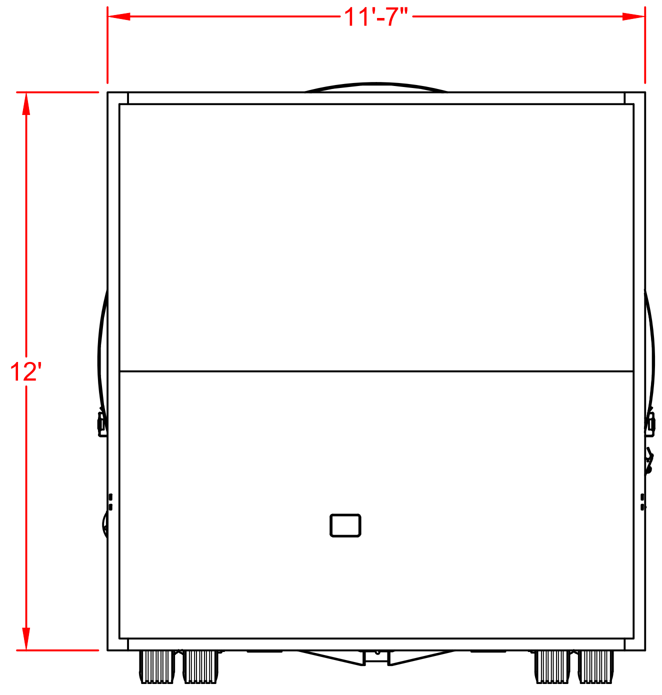
LEFT SIDE VIEW
(DRIVERS SIDE)



RIGHT SIDE VIEW
(PASSENGER SIDE)



TOP VIEW



BOTTOM VIEW

Product Data Sheet No.: 605-4100-01

NOTES:
1. MAX CAPACITY: 420 BBL (17,600 GALLONS)
2. DRY WEIGHT: 22,500 LBS.
3. MATERIAL: CARBON STEEL

DOCUMENT TITLE: CONE BOTTOM TANK GA
DOCUMENT #: 508581AC-PG-01
REVISION: 0

SUEZ WTS CONTROLLED DOCUMENT

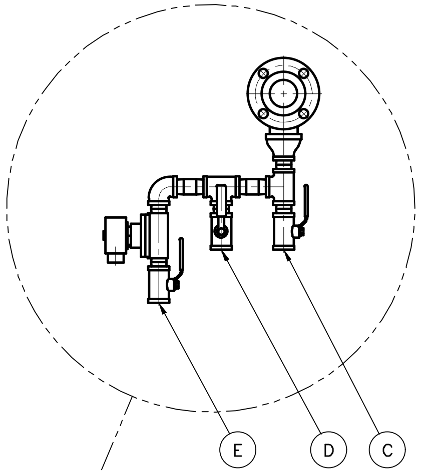
United Rentals®

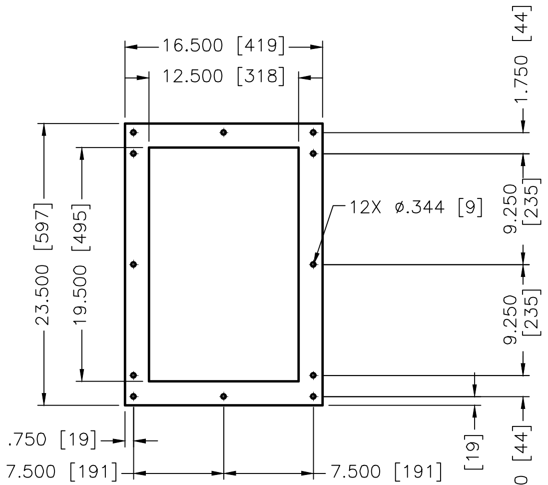
TITLE: **17.6K Gal. Upright Cone Bottom Tank**
Make: AFC / Model: UCBTK

SHEET SIZE: B
11" x 17"
MATERIAL:
FINISH:
CAT CLASS: 605-4100
BRANCH: CORP
DWG BY:
DATE:
SCALE:
SHEET: 1 OF: 1
CKD BY: P. BLACK
DATE: 02-23-14
DWG No: S-2-M0028-1
REV: B

PIPING CONNECTIONS

PORT	SIZE	DESCRIPTION
A	2" CLASS 150 ANSI RF FLANGE	FEED INLET
B	RECTANGULAR 12-1/2" x 19-1/2"	SOLIDS DISCHARGE
C	1" FNPT	SLUDGE SAMPLE
D	1" FNPT	POLYMER CONNECTION
E	1" FNPT	WASHWATER CONNECTION
F	8" CLASS 150 ANSI FF FLANGE	VENT
G	5" CLASS 150 ANSI FF FLANGE	CENTRATE DISCHARGE
H	ø1.181"	FRAME DRAIN

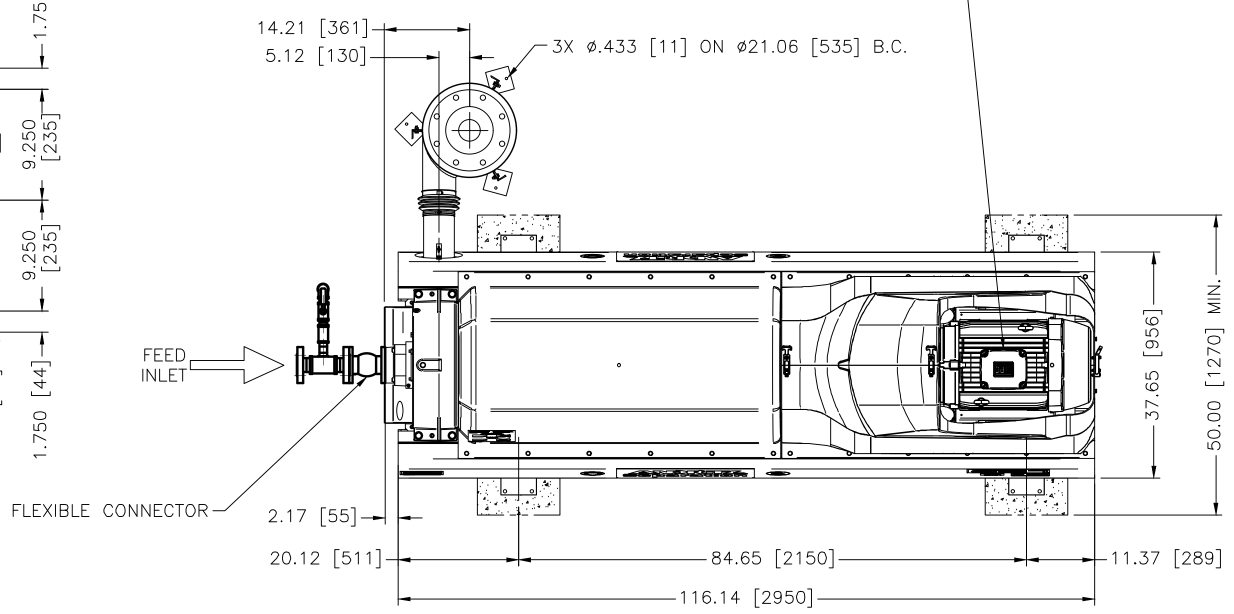


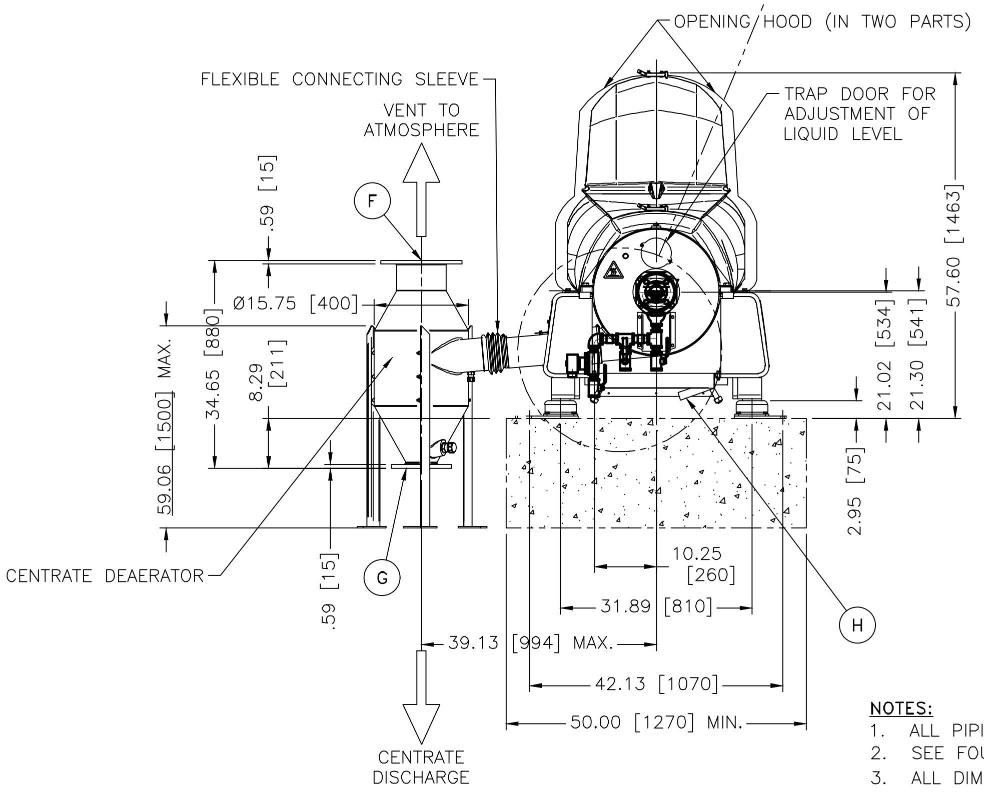


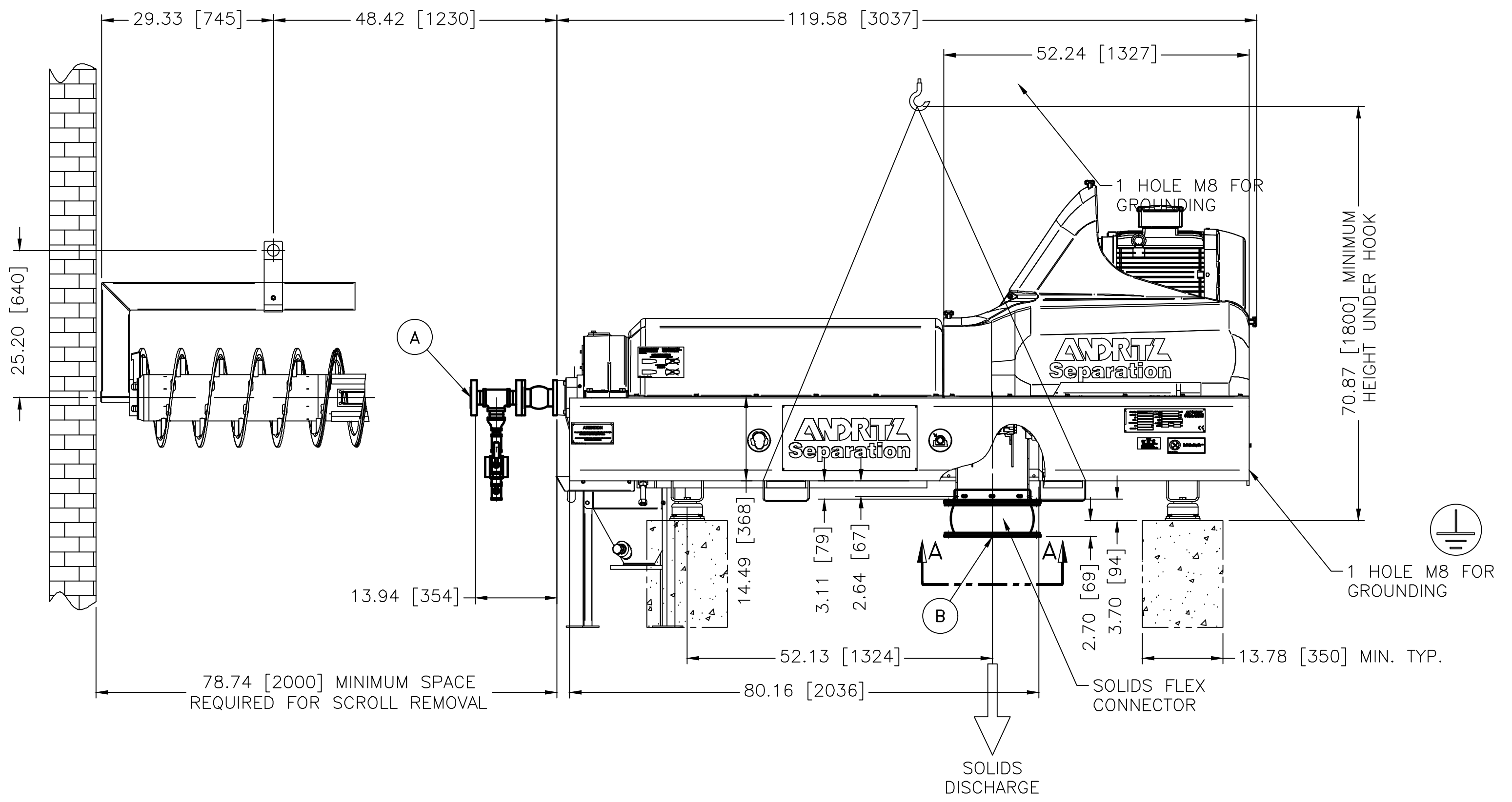
VIEW A-A

SOLIDS DISCHARGE FLANGE PATTERN
SCALE: 2X

NOTE: KEEP MOTOR CONDUITS AWAY FROM FRONT OF FIBERGLASS GUARDS. RUN MOTOR CONDUITS TOWARD REAR OF MACHINE TO ALLOW FOR COVER AND REMOVAL.







NOTES:
1. ALL PIPING TO AND FROM MACHINE TO BE COMPLETED WITH FLEXIBLE CONNECTIONS.
2. SEE FOUNDATION DETAILS FOR DESIGN LOADS AND CONNECTION DETAILS.
3. ALL DIMENSIONS ARE IN INCHES WITH mm IN [ ].
4. DRY WEIGHT OF MACHINE: 5,035 LBS [2,284 KG]
5. SCROLL+LIFTING BEAM: 767 LBS [348 KG]
6. NOISE LEVEL AT OPERATION SPEED: 82 dBA.
7. PROCESS REQUIREMENTS:
   WASHWATER: 35.2-70.4 GPM @ 43.5-58 PSI
   SHUTDOWN: 15 MIN
   CIP: 10 MIN
   AIR FLOW: 118 CFM
   MINIMUM SLUDGE INLET PRESSURE: 7.5 PSI AT CENTRIFUGE FEED FLANGE.
8. ALL CHUTES TO BE SUPPORTED BY OTHERS UNLESS NOTED OTHERWISE.
9. FRAME DRAIN TO BE CONNECTED TO CENTRATE PIPING WITH FLEXIBLE TUBUNG (SUPPLIED BY OTHERS).

DOCUMENT TITLE:
CENTRIFUGE SYSTEM GA
DOCUMENT #:
508581AE-PG-01
REVISION: 0

**SUEZ WTS
CONTROLLED DOCUMENT**

SIMILAR TO DMA1643

REV	EIR	REVISION	BY	APVD	DATE
0	NONE	ISSUED AS CERTIFIED	MDW	mw	12/03/21

AST No.-

ANDRITZ SEPARATION, INC.
1010 COMMERCIAL BLVD. SOUTH
ARLINGTON, TEXAS 76001
Phone: (817)465-5611
Telefax: (817)472-8589

CERTIFIED CORRECT FOR INSTALLATION
BY: WILKERSON DATE: 12/03/21
PROJECT No. 845462
THESE DWGS. REFLECT CUSTOMER'S CHANGES AND APPROVAL ON PREVIOUS DWG. TRANSMITTALS

ESTIMATED WEIGHT IN LBS: -

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
FABRICATION TOLERANCES .XXX±.040 ANG±1° HOLE±.020
MACHINING TOLERANCES .XXX±.005 ANG±.5° HOLE±.020
MILL FINISH ALL OVER

DRAWN BY: RR	DATE 12/02/21
CHECKED BY:	DATE
APPROVED BY: mw	DATE 12/02/21
THIRD ANGLE PROJECTION	

ANDRITZ

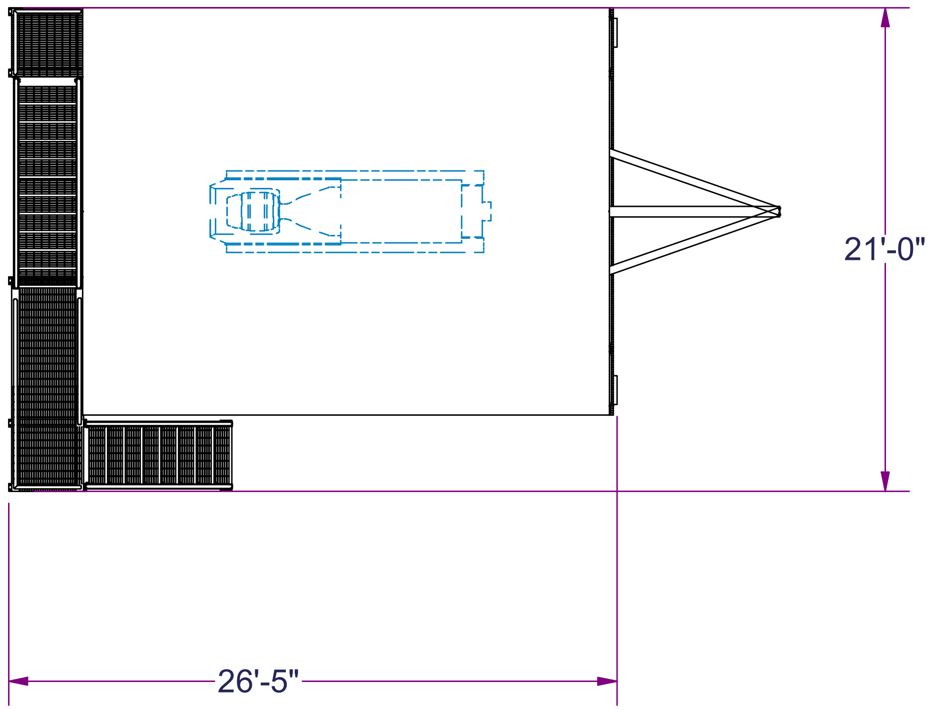
ANDRITZ SEPARATION, INC.
1010 COMMERCIAL BLVD. SOUTH
ARLINGTON, TEXAS 76001
PHONE: (817) 465-5611

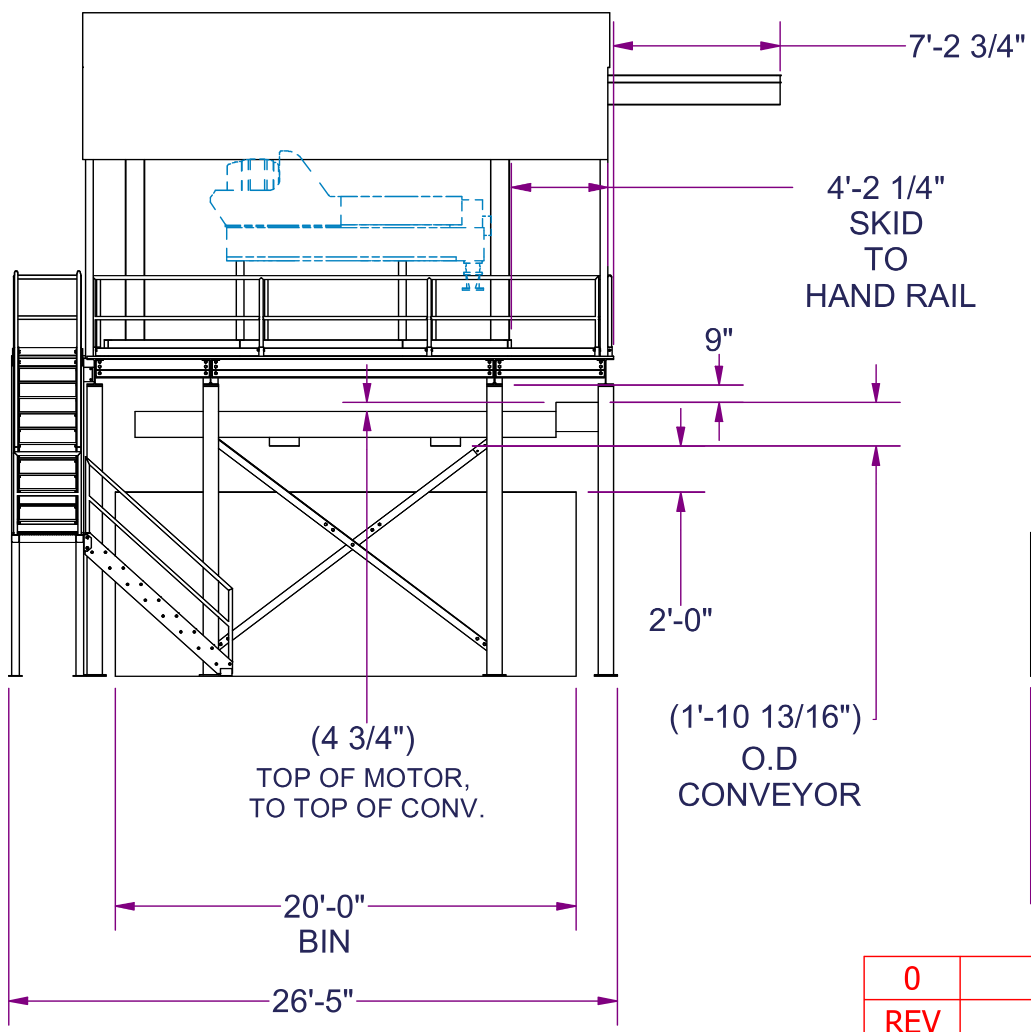
TITLE
D4L CENTRIFUGE
SUEZ CHEMOURS
GENERAL ARRANGEMENT

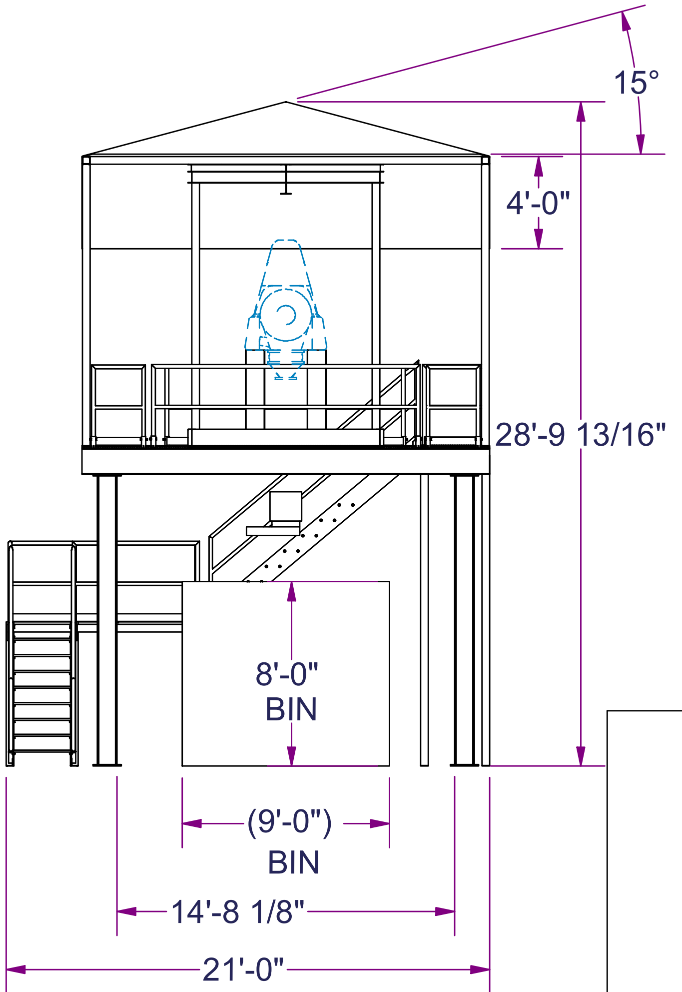
SIZE	DRAWING NUMBER	REV
D	M845462-1	0

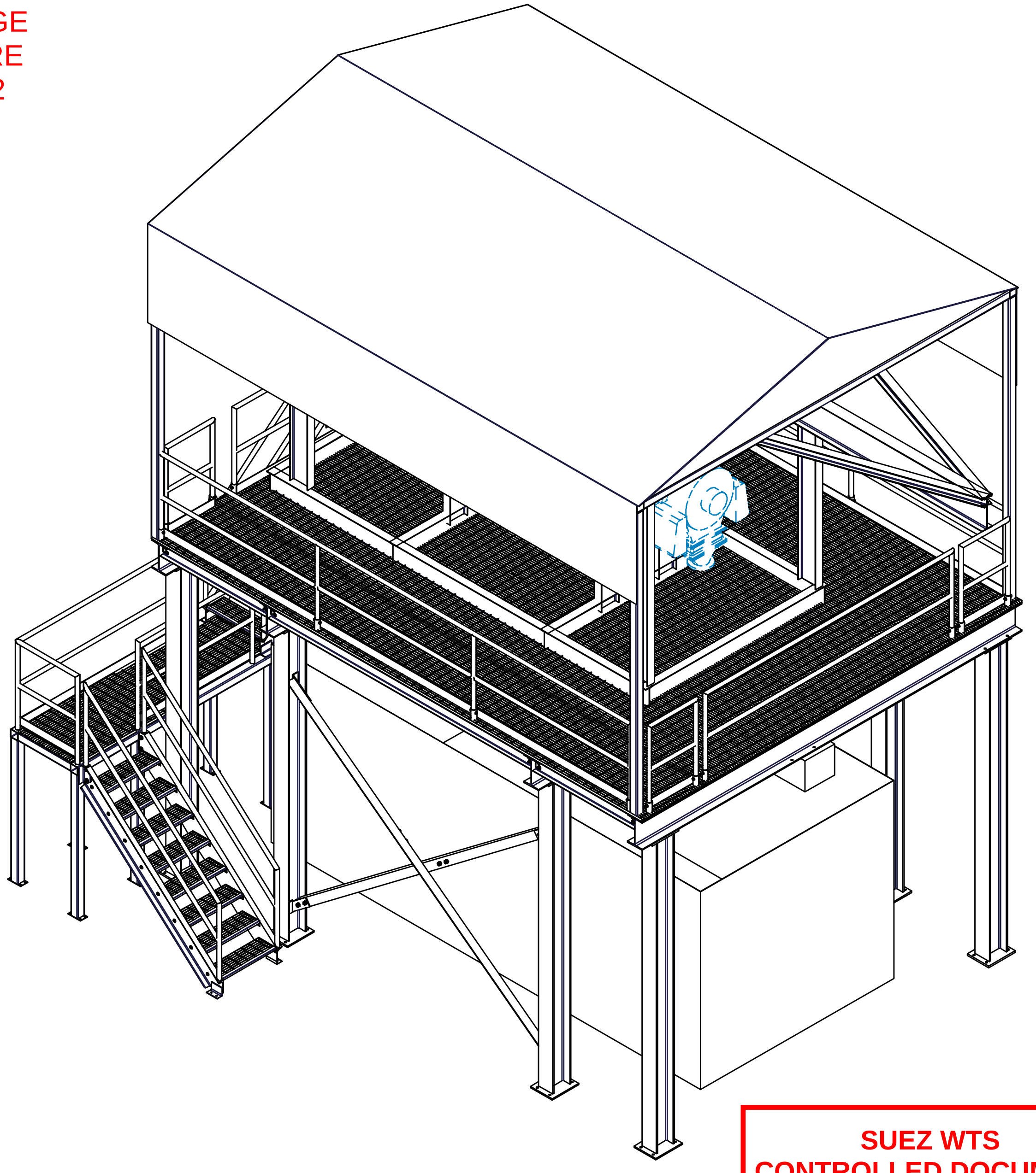
SCALE 1/16 FILE M845462-1 SHEET 1 OF 1

DOCUMENT TITLE: CENTRIFUGE SYSTEM SUPPORT STRUCTURE
DOCUMENT #: 508581AE-PG-02
REVISION: 0









SUEZ WTS
CONTROLLED DOCUMENT

0	INITIAL RELEASE	12/27/2021
REV	DESCRIPTION	DATE

REVISIONS

MEADOWS
ANALYSIS & DESIGN, LLC
-ENGINEERS-

5049 Edwards Ranch Rd, 4th Floor
Fort Worth, Texas 76109
817.927.8101; 800.315.9542 fax
www.meadowsanalysis.com
Texas Registered
Engineering Firm F-6031

TITLE
ANDRITZ 4040

MAIN STRUCTURE (DESIGN)

TOLERANCES
FRACTIONAL ± 1/16
DECIMAL .XX ± .03 .XXX ± .003
ANGULAR ± 1°
SIZE B
DWG NO. 4040-4001
REV 0
WEIGHT N/A
DATE 12/27/2021
DRAWN Arturo
CHECKED
SCALE NTS
SHEET 1 OF 1

Description	Quantity	**Dimensions**	**Weight Ea. (Lbs.)**	
		L x W x H	**Ship**	**Operate**
			(Lbs.)	**(Lbs.)**
SYSTEM FEED PUMP SKID	2	7' x 7' x 6'-6"	4000	5,000
NEUTRALIZATION/OXIDATION FEED TANK	2	51'-5" x 8'-6" x 10'-3"	36,000	225,000
CENTRATE PUMP	2			
UF FEED PUMP SKID	2	7' x 7' x 6'-6"	4000	5,000
UF500	6	40' x 8'	50,000	102,500.00
UF STORAGE TANK	2	45'-6" x 8'-6" x 9'-6"	29000	244,800.00
PUMP AND EQUIPMENT CONTAINER Total	1	40' x 8' x 9'-6"	28,500	85,000
GAC FEED PUMP SKID	2	7' x 7' x 6'-6"	4000	5,000
3-PASS GAC VESSEL	4	40' x 14' x 14' x 10"	66,000	282,300
GAC VESSEL PIPE RACK	4	24'-7 1/4" x 5'-10" x 10'-6 5/8"	14000	18,500
GAC PRODUCT STORAGE TANK	2	45-9" x 8'-6" x 9'-6"	29000	244,800
GAC BACKWASH PUMP SKID	2	7' x 7' x 6'-6"	4000	5,000
GAC WASTE FRAC TANK	2	45'-6" x 8'-6" x 9'-6"	29000	260,000
SOLIDS SETTLING CONE TANK	3	12' x 12' x 33'	22,500	239,000
SLUDGE STORAGE TANK	2	51'-5" x 8'-6" x 10'-3"	36,000	241,000
CENTRIFUGE POLYMER MAKEDOWN TANK	2	42" OD x 58.5" HT	300	4,000
CENTRIFUGE SYSTEM W/ HORIZONTAL CONVEYOR	2	26'-5" x 21' x 28'-9 3/16"	14000	40,350
CENTRATE TANK (UNDER CENTRIFUGE)	2	48" OD x 77" HT	400	5,500
CIP NEUTRALIZATION TANK	1	45'-9" X 8'-6" X 9'-9"	29000	256,000
SULFURIC ACID BULK STORAGE TANK	1	11'-11" DIA X 9'-9" HT	2200	64,800
SULFURIC ACID OVERFLOW TANK	1	30" DIA X 40.9" HT	200	1,800
SODIUM HYDROXIDE BULK STORAGE TANK	1	11'-11" DIA X 9'-9" HT	2200	79,200
SODIUM HYDROXIDE OVERFLOW TANK	1	30" DIA X 40.9" HT	200	1,800
SODIUM HYPOCHLORITE BULK STORAGE TANK	1	10'-2" DIA X 7'-7" HT	2000	38,500
SODIUM HYPOCHLORITE OVERFLOW TANK	1	30" DIA X 40.9" HT	200	1,400
COAGULANT PUMPING SKID/TOTE	1	67¼" x 41¼" x 74"	260	2,040.00
HYDROCHLORIC ACID PUMPING SKID/TOTE	1	67¼" x 41¼" x 74"	260	2,040.00
AS1001 POLYMER PUMPING SKID/TOTE	1	67¼" x 41¼" x 74"	260	2,040.00
SODIUM BISULFITE PUMPING SKID/DRUM	1	67¼" x 41¼" x 74"	260	2,040.00
STORAGE CONNEX	1	40' x 8' x 8'-6"	9,200	13,000
OFFICE/LAB CONTAINER	1	40' x 8' x 9'-6"	28,500	35,000
GENERATOR	1	CUSTOMER SUPPLIED		
SAFETY SHOWER	2	5'-8" x 6'-8" x 13'	3300	8,700
40 CUBIC YARD BIN	1	22' x 8' x 8'	16,000	105,600

DOCUMENT TITLE: SYSTEM COMPONENT WEIGHTS
DOCUMENT #: 508581-AG-02
Revision: 0

SUEZ WTS CONTROLLED DOCUMENT

SUEZ WTS CONTROLLED DOCUMENT

REFERENCE ONLY DO NOT USE FOR CONSTRUCTION

A6	INITIAL RELEASE		BG			31 Dec 21
REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION

CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

PROCESS FLOW DIAGRAM

UF-GAC-DEWATERING SYSTEM

DRAWING NUMBER: 508581-AM-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: -
SIZE: D
SHEET: 1 OF 6

LAST SAVED: Friday, December 31, 2021 5:46:23 PM

FILE LOCATION: C:_ADSKVault\NAM\508581 - CHEMOURS FAYETTEVILLE, NC BARRIER WALL PROJECT\1. PFD and P&ID\508581-AM-01.dwg

REFERENCE ONLY
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CONSTRUCTION

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
A6	INITIAL RELEASE		BG			31 Dec 21

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TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

PROCESS FLOW DIAGRAM
UF-GAC-DEWATERING SYSTEM

DRAWING NUMBER: 508581-AM-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: -
SIZE: D
SHEET: 2 OF 6

LAST SAVED: Friday, December 31, 2021 5:46:23 PM

FILE LOCATION: C:_ADSKVault\NAM\508581 - CHEMOURS FAYETTEVILLE, NC BARRIER WALL PROJECT\1. PFD and P&ID\508581-AM-01.dwg

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CONSTRUCTION

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
A6	INITIAL RELEASE		BG			31 Dec 21

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION

CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

PROCESS FLOW DIAGRAM

UF-GAC-DEWATERING SYSTEM

DRAWING NUMBER				REVISION
508581-AM-01				A
REF.: -	DOC. OWNER: -			
PROJECT NO. 508581	PART/MATERIAL NO. -	SCALE -	SIZE D	SHEET 3 OF 6

LAST SAVED: Friday, December 31, 2021 5:46:23 PM

FILE LOCATION: C:_ADSKVault\NAM\508581 - CHEMOURS FAYETTEVILLE, NC BARRIER WALL PROJECT\1. PFD and P&ID\508581-AM-01.dwg

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CONSTRUCTION

A6	INITIAL RELEASE		BG			31 Dec 21
REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

suez

CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

PROCESS FLOW DIAGRAM
UF-GAC-DEWATERING SYSTEM

DRAWING NUMBER: 508581-AM-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: -
SIZE: D
SHEET: 4 OF 6

LAST SAVED: Friday, December 31, 2021 5:46:23 PM

FILE LOCATION: C:_ADSKVault\NAM\508581 - CHEMOURS FAYETTEVILLE, NC BARRIER WALL PROJECT\1. PFD and P&ID\508581-AM-01.dwg

REFERENCE ONLY
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CONSTRUCTION

A6	INITIAL RELEASE		BG			31 Dec 21
REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION

CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

PROCESS FLOW DIAGRAM

UF-GAC-DEWATERING SYSTEM

DRAWING NUMBER				REVISION
508581-AM-01				A
REF.: -		DOC. OWNER: -		
PROJECT NO. 508581	PART/MATERIAL NO. -	SCALE -	SIZE D	SHEET 5 OF 6

LAST SAVED: Friday, December 31, 2021 5:46:23 PM

FILE LOCATION: C:_ADSKVault\NAM\508581 - CHEMOURS FAYETTEVILLE, NC BARRIER WALL PROJECT\1. PFD and P&ID\508581-AM-01.dwg

STREAM	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DESCRIPTION	SYSTEM FEED	UF FEED	UF PRODUCT/GAC FEED	GAC EFF	FINAL OUTFALL	CENTRATE RECYCLE	CIP NEUT WASTE RECYCLE	GAC B/W, SLUICE, RINSE WASTE RECYCLE	CONE-BOTTOM TANK DECANT	UF CIP WASTE	UF BACKPULSE WASTE	C/B SLUDGE TO TANK	SLUDGE TO DEWATERING	GAC B/W, RINSE, SLUICE, CIP NEUT WASTE RECYCLE
FLOW-AVERAGE (GPM)	1289	1289	1289	1289	1289	14	<1	<1	56	<1	56	14	14	<5
FLOW-PEAK (GPM)	1500	1579	1500	1500	1500	60	100	100	79	347	79	150	60	250
PRESSURE (PSI)	10	30	40	30	10	15	30	30	<10	26	26	40	<10	<10
TEMPERATURE (°F)	59-86	59-86	59-86	59-86	59-86	59-86	59-86	59-86	59-86	59-86	59-86	59-86	59-86	59-86
TSS (mg/L)	19-250	60-300	<1	<1	<1	<10-100	TBD	TBD	<10	2000-3000	2000-3000	TBD	10,000	10,000
% SOLIDS	-	-	-	-	-	-	-	-	-	-	0.2-0.3%	-	1%	1%
pH	*4.1	6.5-7.0	6.5-7/3.0	3.2-3.5	6-9	7.5	7.5-8	8-10	7.5-8	2.1-10	6.5-7.5	7.5-8	7.5-8	7.5-8
EVENT FREQUENCY	-	-	-	-	-	1/DAY	20/YR	12/YR	-	20/YR	-	1/DAY	1/DAY	1/DAY
VOLUME PER EVENT (GAL)	-	-	-	-	-	16K-24K	4,000	92,680	-	4,000	-	16K-24K	16K-24K	92,680

STREAM	15	16	17	18	19	20	21	22	23	24	25	26	27
DESCRIPTION	SOLIDS TO ROLLOFF	GAC BACKFLUSH SUPPLY	GAC RINSE SUPPLY	SLUICE SUPPLY WATER	GAC BACKWASH WASTE	GAC RINSE/SLUICE WASTE	CENTRATE-LOW TSS/TURB RECYCLE	UF PERM WASH/DILUTION WATER	NOT IN USE	UF TRAIN PERMEATE	BACKPULSE TANK FILL	BACKPULSE	UF PERM WASH, DILUTION WATER RECIRC
FLOW-AVERAGE (GPM)	6.5 (TON/D)	<1	<1	<1	<1	<1	TBD	<1	-	222	55	55	<1
FLOW-PEAK (GPM)	10 (TON/D)	1,356	500	200	1500	500	60	70	-	375	401	314	70
PRESSURE (PSI)	GRAVITY	30-40	30-40	40-50	20-30	20-30	15	40-50	-	15	20	25	50
TEMPERATURE (°F)	59-86	59-86	59-86	59-86	59-86	59-86	59-86	59-86	-	59-86	59-86	59-86	59-86
TSS (mg/L)	100-150K	<1	<1	<1	<10	<10	<30	<1	-	<1	<1	<1	<1
% SOLIDS	10-15%	-	-	-	-	-	-	-	-	-	-	-	-
pH	7-8	6-9	6-9	6-9	8-10	8-10	7.5	2-12	-	6.5-7	6.5-7.0	2.5-10	6.5-7.0
EVENT FREQUENCY	1/DAY	12/YR	12/YR	12/YR	12/YR	12/YR	1/DAY	20/YEAR	-	-	2-3/HR	2-3/HR	1/WEEEK
VOLUME PER EVENT (GAL)	200-300 (FT3/D)	40,680	42,000	10,000	40,680	52,680	TBD	TBD	-		785	785	TBD

STREAM	28	29	30	31	32
DESCRIPTION	CENTRATE-HIGH TSS/TURB RECYCLE	GAC RINSE WASTE RECYCLE	GAC B/W, RINSE, SLUICE WATER RECIRC	GAC RINSE WASTE	GAC FEED RECIRC
FLOW-AVERAGE (GPM)	TBE	<1	<1	<1	<1
FLOW-PEAK (GPM)	60	250	1500	300	1800
PRESSURE (PSI)	15	40	40	20-30	40
TEMPERATURE (°F)	59-86	59-86	59-86	59-86	59-86
TSS (mg/L)	>30	<1	<10	<10	<1
% SOLIDS	-	-	-	-	-
pH	7.5	6-9	6-9	6-9	6.5-7/3.0
EVENT FREQUENCY	-	12/YR	-	-	-
VOLUME PER EVENT (GAL)	-	-	-	-	-

*pH values in laboratory measurements were 4.1, system designed to this value. Functional Design Spec R.02 indicates 6.5-8.5

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REFERENCE ONLY
DO NOT USE FOR
CONSTRUCTION

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
A6	INITIAL RELEASE		BG			31 Dec 21

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

suez

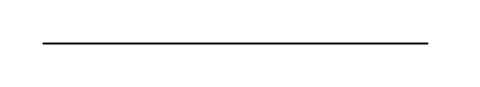
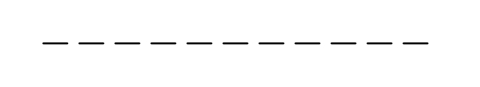
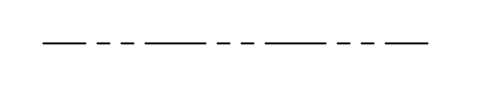
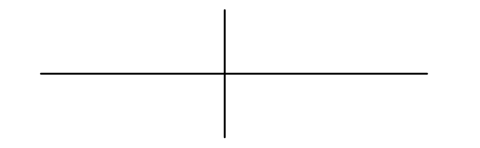
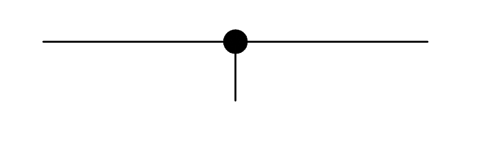
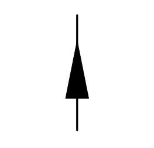
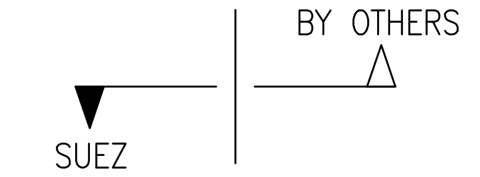
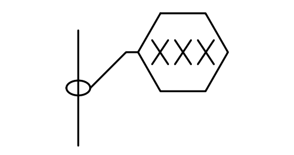
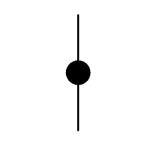
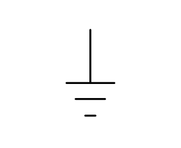
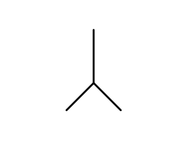
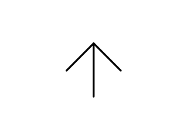
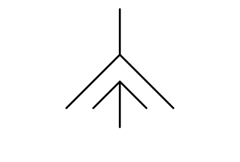
CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

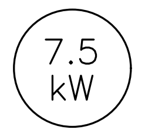
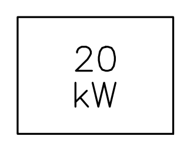
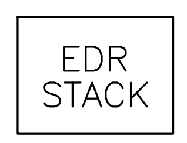
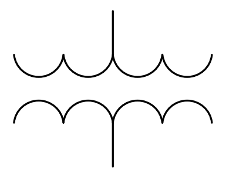
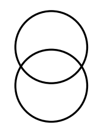
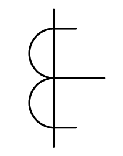
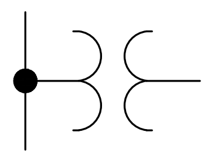
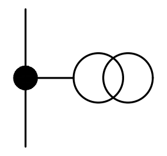
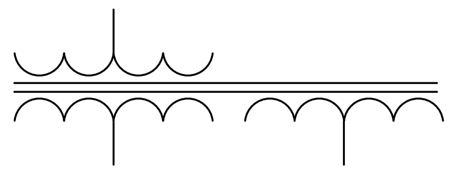
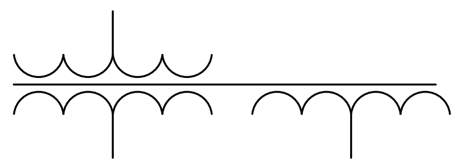
PROCESS FLOW DIAGRAM
UF-GAC-DEWATERING SYSTEM

DRAWING NUMBER: 508581-AM-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: -
SIZE: D
SHEET: 6 OF 6

LAST SAVED: Friday, December 31, 2021 5:46:23 PM

FILE LOCATION: C:_ADSKVault\NAM\508581 - CHEMOURS FAYETTEVILLE, NC BARRIER WALL PROJECT\1. PFD and P&ID\508581-AM-01.dwg

SYMBOL NAME	SYMBOL
POWER CONDUCTOR	
CONTROL, METERING, OR INSTRUMENTATION CONDUCTOR	
FUTURE COMPONENT OR CONDUCTOR	
ELECTRICAL ASSEMBLY BOUNDARY	
CROSSING OF CONDUCTORS (NOT CONNECTED)	
JUNCTION OF CONDUCTORS	
UPWARD POWER FLOW	
RESPONSIBILITY BREAK (SCOPE OF SUPPLY)	
CIRCUIT NUMBER	
TERMINAL BLOCK	
EARTH GROUND	
RECEPTACLE, FEMALE CONNECTOR	
PLUG, MALE CONNECTOR	
SEPARABLE CONNECTOR	

SYMBOL NAME	ANSI/CSA	IEC
MOTOR		
HEATER, LOAD		
ELECTRODIALYSIS STACK (ED, EDR, EDI, OR E-CELL)		
TRANSFORMER		
CURRENT TRANSFORMER		
POTENTIAL TRANSFORMER		
TRANSFORMER WITH MULTIPLE WINDINGS		
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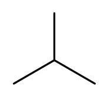
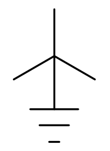
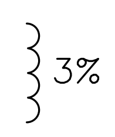
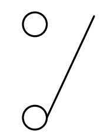
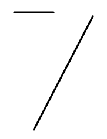
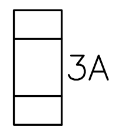
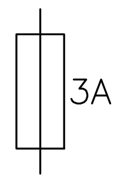
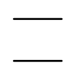
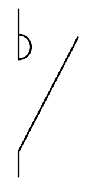
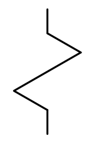
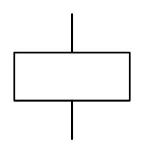
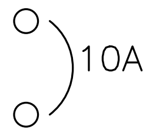
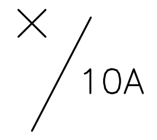
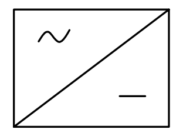
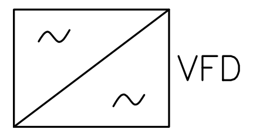
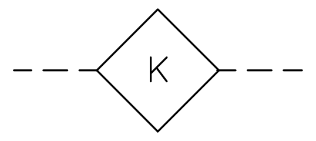
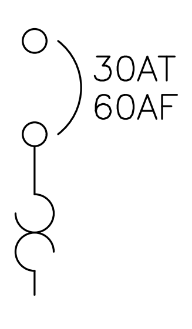
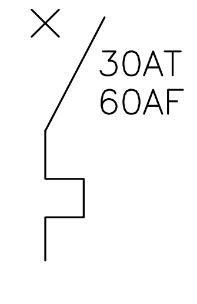
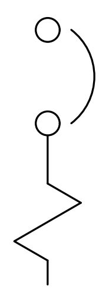
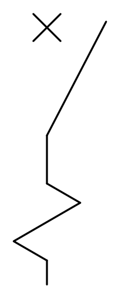
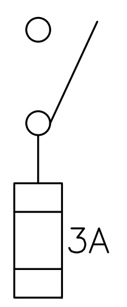
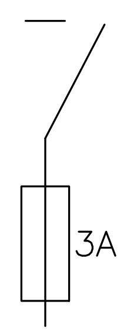
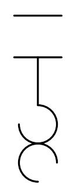
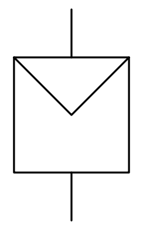
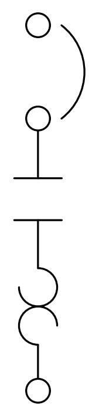
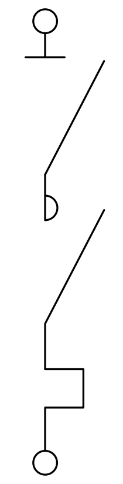
3-PHASE, WYE, UNGROUNDED		
3-PHASE, WYE GROUNDED NEUTRAL		
INDUCTOR, REACTOR		
CAPACITOR		

SYMBOL NAME	ANSI/CSA	IEC
SWITCH, DISCONNECT		
FUSE		
CONTACTOR		
OPERATING COIL		
SUPPLEMENTARY PROTECTOR		
AC/DC POWER SUPPLY, RECTIFIER, DC DRIVE		
VARIABLE FREQUENCY DRIVE, UNINTERRUPTIBLE POWER SUPPLY		
KEY INTERLOCK		
REFLECTED WAVE TRAP		
TRANSFER ARROW "TO"		
TRANSFER ARROW "FROM"		

SYMBOL NAME	ANSI/CSA	IEC
CIRCUIT BREAKER WITH THERMAL OVERCURRENT TRIP		
CIRCUIT BREAKER WITH MAGNETIC OVERCURRENT TRIP		
FUSED DISCONNECT SWITCH		
MAGNETIC STARTER WITH OVERLOAD DEVICE		
SELF-PROTECTED MAGNETIC MOTOR CONTROLLER		

DESIGNATIONS AND ABBREVIATIONS

A	AMPERE
AF	AMPERES FRAME
AT	AMPERES TRIP
AWG	AMERICAN WIRE GAUGE
FLA	FULL LOAD AMPERES
GND	GROUND
kA	KILO AMPERE
kAIC	KILO AMPERES INTERRUPTING CAPACITY
kVA	KILO VOLT AMPERE
kW	KILO WATT
MCC	MOTOR CONTROL CENTER
RMS	ROOT MEAN SQUARE
RPM	REVOLUTIONS PER MINUTE
SCCR	SHORT-CIRCUIT CURRENT RATING
UPS	UNINTERRUPTIBLE POWER SUPPLY
V	VOLTS
VA	VOLT AMPERE
VAC	VOLT, ALTERNATING CURRENT
VDC	VOLT, DIRECT CURRENT
VFD	VARIABLE FREQUENCY DRIVE
W	WATTS

REFERENCE ONLY
DO NOT USE FOR
CONSTRUCTION

SUEZ WTS
CONTROLLED DOCUMENT

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
A	INITIAL DESIGN		IS	MM	MM	10JAN22

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

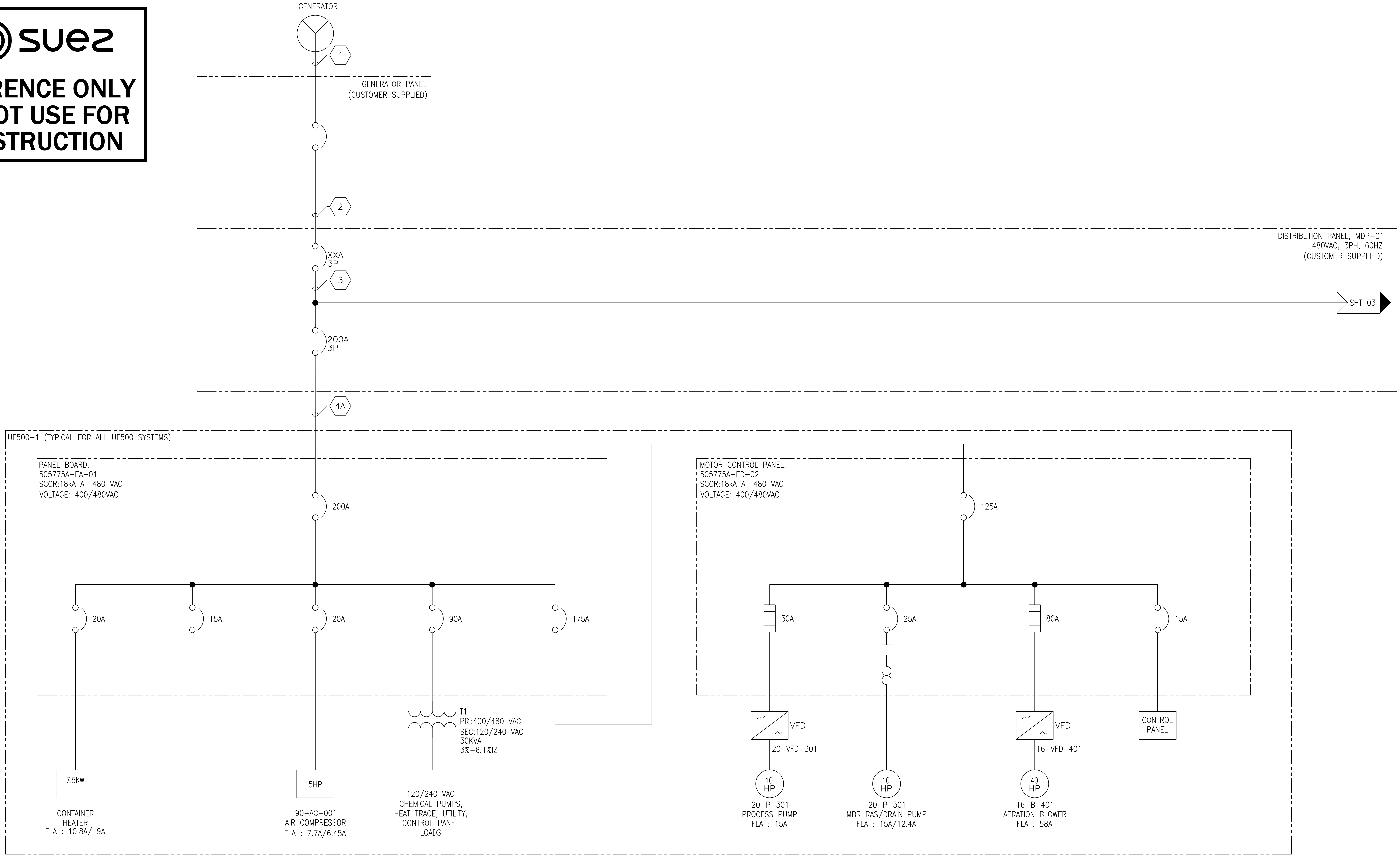
SINGLE LINE DIAGRAM

DRAWING NUMBER: 508581-ES-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: N.T.S.
SIZE: D
SHEET: 01 OF 15

LAST SAVED: Monday, January 10, 2022 1:37:54 PM

FILE LOCATION: D:\Users\RBA674\SUEZ\ES services-TCS (Group) - Electrical\OTR EMEA\2021\Marjorie\2021\Chemours Barrier Wall-508581\DELIVERY\SLD\Jan22\10Jan22\508581-ES-01.dwg

REFERENCE ONLY
DO NOT USE FOR
CONSTRUCTION



REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
A	INITIAL DESIGN		IS	MM	MM	10JAN22

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION

CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

SINGLE LINE DIAGRAM

DRAWING NUMBER
508581-ES-01

REVISION
A

REF.: -
DOC. OWNER: -

PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
508581	-	N.T.S.	D	02 OF 15

LAST SAVED: Monday, January 10, 2022 1:37:54 PM

FILE LOCATION: D:\Users\RBA674\SUEZ\ES services-TCS (Group) - Electrical\OTR EMEA\2021\Marjorie\2021\Chemours Barrier Wall-508581\DELIVERY\SLD\Jan22\10Jan22\508581-ES-01.dwg

**REFERENCE ONLY
DO NOT USE FOR
CONSTRUCTION**

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
A	INITIAL DESIGN		IS	MM	MM	10JAN22

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION

CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

SINGLE LINE DIAGRAM

DRAWING NUMBER: 508581-ES-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: N.T.S.
SIZE: D
SHEET: 03 OF 15

LAST SAVED: Monday, January 10, 2022 1:37:54 PM

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A	INITIAL DESIGN		IS	MM	MM	10JAN22

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
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CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

SINGLE LINE DIAGRAM

DRAWING NUMBER: 508581-ES-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: N.T.S.
SIZE: D
SHEET: 04 OF 15

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CUSTOMER INFORMATION

CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

SINGLE LINE DIAGRAM

DRAWING NUMBER
508581-ES-01

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PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
508581	-	N.T.S.	D	05 OF 15

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NOTES:
1. THE CENTRATE PUMP IS SUEZ SUPPLIED BUT WILL CONNECT TO THE CENTRIFUGE PANEL.

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CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

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BARRIER WALL PROJECT

SINGLE LINE DIAGRAM

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BARRIER WALL PROJECT

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NOTES:

1. HEAT TRACE FLA BASED ON 200 FT OF TRACE, 5 WATT/FT AT 50°F. WHEN SUPPLIED BY 20 AMP BREAKER MAXIMUM TRACE LENGTH IS 205 FT FOR 0°F START UP. LOAD INFORMATION MAY VARY DEPENDING ON HEAT TRACE MANUFACTURER.

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PROPRIETARY AND CONFIDENTIAL: THIS DRAWING AND ALL INFORMATION AND KNOWLEDGE CONTAINED OR REFERRED HEREIN ARE THE CONFIDENTIAL AND PROPRIETARY PROPERTY OF SUEZ AND AS SUCH ARE INSTRUMENTS OF SERVICE FOR USE SOLELY WITH RESPECT TO THIS PROJECT. THESE INSTRUMENTS OF SERVICE SHALL NOT BE REPRODUCED, TRANSMITTED, DISCLOSED OR USED OTHERWISE IN WHOLE OR IN PART, WITHOUT PRIOR WRITTEN AGREEMENT BY SUEZ AND MUST BE IMMEDIATELY RETURNED OR DESTROYED UPON REQUEST.

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BARRIER WALL PROJECT

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BARRIER WALL PROJECT

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CIRCUIT SCHEDULE

CIRCUIT INFORMATION							INSTALLATION INFORMATION						
NO.	**TYPE**	**QTY**	**DESCRIPTION**	**VOLTAGE**	**LOAD**	**FLA**	**OVERCURRENT PROTECTION**	**MS/VFD/CP PART NUMBER**	**TERM TEMP**	**AMB. TEMP**	**WIRING**	**CONDUIT**	**NOTES**
1	FEED	1	POWER FEED CONNECTION FROM GENERATOR TO GENERATOR PANEL	480VAC 3PH, 60HZ					75 C	40 C	BY OTHERS		CUSTOMER SUPPLIED
2	FEED	1	POWER FEED CONNECTION FROM GENERATOR PANEL TO DISTRIBUTION PANEL	480VAC 3PH, 60HZ			CIRCUIT BREAKER		75 C	40 C	BY OTHERS		CUSTOMER SUPPLIED
3	FEED	1	SYSTEM POWER FEED CONNECTION DISTRIBUTION PANEL MAIN BREAKER **(MDP-01)**	480VAC 3PH, 60HZ			CIRCUIT BREAKER XXA, 3P		75 C	40 C	BY OTHERS		CUSTOMER SUPPLIED
4	FEED	5	UF-500-1/2/3/4/5	480VAC 3PH, 60HZ			CIRCUIT BREAKER 200A, 3P		75 C	40 C			
5	FEED	1	SYSTEM FEED PUMP CONTROL PANEL 1 2X15HP, 33%	480VAC 3PH, 60HZ		42	CIRCUIT BREAKER 70A, 3P, HDL36070		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	2	SYSTEM FEED PUMP 1 & 2 03-P-101-1, 03-P-102-1	480VAC 3PH, 60HZ	15HP	21	CIRCUIT BREAKER 40A, 3P, HDL36040	MOTOR STARTER	60 C	40 C	3 X 10 AWG 10 AWG GND		
6	FEED	1	SYSTEM FEED PUMP CONTROL PANEL 2 2X15HP, 33%	480VAC 3PH, 60HZ		42	CIRCUIT BREAKER 70A, 3P, HDL36070		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	2	SYSTEM FEED PUMP 3 & 4 03-P-101-2, 03-P-102-2	480VAC 3PH, 60HZ	15HP	21	CIRCUIT BREAKER 40A, 3P, HDL36040	MOTOR STARTER	60 C	40 C	3 X 10 AWG 10 AWG GND		
7	FEED	1	UF FEED PUMP CONTROL PANEL 1 2X20 HP, 33%	480VAC 3PH, 60HZ		54	CIRCUIT BREAKER 90A, 3P, HDL36090		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	2	UF FEED PUMP 1 & 2 19-P-101-1, 19-P-102-1	480VAC 3PH, 60HZ	20HP	27	CIRCUIT BREAKER 60A, 3P, HDL36060	MOTOR STARTER	60 C	40 C	3 X 10 AWG 10 AWG GND		
8	FEED	1	UF FEED PUMP CONTROL PANEL 2 2X20HP, 33%	480VAC 3PH, 60HZ		54	CIRCUIT BREAKER 90A, 3P, HDL36090		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	2	UF FEED PUMP 3 & 4 19-P-101-2, 19-P-102-2	480VAC 3PH, 60HZ	20HP	27	CIRCUIT BREAKER 60A, 3P, HDL36060	MOTOR STARTER	60 C	40 C	3 X 10 AWG 10 AWG GND		
9	FEED	1	GAC FEED PUMP CONTROL PANEL 1 2X20HP, 33%	480VAC 3PH, 60HZ		54	CIRCUIT BREAKER 90A, 3P, HDL36090		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	2	GAC FEED PUMP 1 & 2 26-P-101-1, 26-P-102-1	480VAC 3PH, 60HZ	20HP	27	CIRCUIT BREAKER 60A, 3P, HDL36060	MOTOR STARTER	60 C	40 C	3 X 10 AWG 10 AWG GND		
10	FEED	1	GAC FEED PUMP CONTROL PANEL 2 2X20HP, 33%	480VAC 3PH, 60HZ		54	CIRCUIT BREAKER 90A, 3P, HDL36090		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	2	GAC FEED PUMP 3&4 26-P-101-2, 26-P-102-2	480VAC 3PH, 60HZ	20HP	27	CIRCUIT BREAKER 60A, 3P, HDL36060	MOTOR STARTER	60 C	40 C	3 X 10 AWG 10 AWG GND		
11	FEED	1	GAC BACKWASH PUMP CONTROL PANEL 1 2X20HP, 33%	480VAC 3PH, 60HZ		54	CIRCUIT BREAKER 90A, 3P, HDL36090		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	2	GAC BACKWASH PUMP 1 & 2 76-P-101-1, 76-P-102-1	480VAC 3PH, 60HZ	20HP	27	CIRCUIT BREAKER 60A, 3P, HDL36060	MOTOR STARTER	60 C	40 C	3 X 10 AWG 10 AWG GND		
12	FEED	1	GAC BACKWASH PUMP CONTROL PANEL 2 2X20HP, 33%	480VAC 3PH, 60HZ		54	CIRCUIT BREAKER 90A, 3P, HDL36090		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	2	GAC BACKWASH PUMP 3&4 76-P-101-2, 76-P-102-2	480VAC 3PH, 60HZ	20HP	27	CIRCUIT BREAKER 60A, 3P, HDL36060	MOTOR STARTER	60 C	40 C	3 X 10 AWG 10 AWG GND		

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ABBREVIATIONS: "NO." – CIRCUIT NUMBER; "QTY." – QUANTITY; "TERM TEMP" – TERMINAL TEMPERATURE RATING; "AMB. TEMP" – AMBIENT TEMPERATURE "NA" – NOT APPLICABLE
CIRCUIT TYPES: "BRAN" – BRANCH; "FEED" – FEEDER; "SERV" – SERVICE; "CTRL" – CONTROL; "INST" – INSTRUMENTATION;
ALL FIELD WIRING CONDUCTORS SHALL BE STRANDED COPPER
ELECTRICAL DESIGN IS FOR NFPA 70 – NATIONAL ELECTRICAL CODE
THE CONDUCTOR SIZES ARE MINIMUM SIZES. LARGER SIZES MAY BE NEEDED TO MEET CODE REQUIREMENTS FOR INSTALLATION CONDITIONS (SUCH AS AMBIENT TEMPERATURE OR LONG RUN VOLTAGE DROP).

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CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

SINGLE LINE DIAGRAM

DRAWING NUMBER: 508581-ES-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: N.T.S.
SIZE: D
SHEET: 12 OF 15

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CIRCUIT SCHEDULE

CIRCUIT INFORMATION							INSTALLATION INFORMATION						
NO.	TYPE	QTY	DESCRIPTION	VOLTAGE	LOAD	FLA	OVERCURRENT PROTECTION	MS/VFD/CP PART NUMBER	TERM TEMP	AMB. TEMP	WIRING	CONDUIT	NOTES
13	FEED	1	OXIDATION TANK 1 MIXERS CONTROL PANEL	480VAC 3PH, 60HZ		52	CIRCUIT BREAKER 100A, 3P		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	4	OXIDATION TANK 1 MIXERS 1/2/3/4 03-MX-001-1, 03-MX-002-1, 03-MX-003-1, 03-MX-004-1	480VAC 3PH, 60HZ	10HP	14		MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
14	FEED	1	OXIDATION TANK 2 MIXERS CONTROL PANEL	480VAC 3PH, 60HZ		52	CIRCUIT BREAKER 100A, 3P		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	4	OXIDATION TANK 2 MIXERS 1/2/3/4 03-MX-001-2, 03-MX-002-2, 03-MX-003-2, 03-MX-004-2	480VAC 3PH, 60HZ	10HP	14		MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
15	FEED	1	SLUDGE TANK MIXERS	480VAC 3PH, 60HZ		52	CIRCUIT BREAKER 100A, 3P		60 C	40 C	3 X 2 AWG 6 AWG GND		
	BRANCH	4	SLUDGE TANK MIXERS 1/2/3/4 86-MX-101, 86-MX-102, 86-MX-103, 86-MX-104	480VAC 3PH, 60HZ	10HP	14		MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
16	FEED	1	CENTRIFUGE POLYMER FEED PUMP	480VAC 3PH, 60HZ	0.75HP	1.6	CIRCUIT BREAKER 15A, 3P	MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
17	BRANCH	1	TRANSFORMER PRIMARY-480 VAC SECONDARY-208Y/120 VAC)	480VAC 3PH, 60HZ	TBD		CIRCUIT BREAKER TBD, 3P		75 C	40 C	3 X 4/0 AWG 4 AWG GND		
18	FEED	1	POWER FEED CONNECTION TO CENTRIFUGE MOTOR CONTROL PANEL	480VAC 3PH, 60HZ		TBD	CIRCUIT BREAKER 125A, 3P		75 C	40 C	3 X 1 AWG 6 AWG GND		
19	BRANCH	1	CENTRATE PUMP 80-P-501	480VAC 3PH, 60HZ	1.5HP	3	FUSE 15A	MOTOR STARTER	60 C	40 C			
20	FEED	1	POWER FEED CONNECTION TO POWER AND CONTROL CONTAINER **(MDP-02)**	480VAC 3PH, 60HZ	-	-	CIRCUIT BREAKER TBD, 3P		60 C	40 C			
21	FEED	1	CENTRIFUGE UTILITY PUMP SKID 2X5HP	480VAC 3PH, 60HZ		7.6	CIRCUIT BREAKER 15A, 3P		60 C	40 C	3 X 12 AWG 12 AWG GND		
	BRANCH	2	CENTRIFUGE UTILITY PUMP 1 & 2 80-P-101, 80-P-102	480VAC 3PH, 60HZ	5HP	7.6		MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
22	FEED	1	GAC WASTE RECYCLE PUMP SKID 2X7.5HP	480VAC 3PH, 60HZ		7.6	CIRCUIT BREAKER 20A, 3P		60 C	40 C	3 X 12 AWG 12 AWG GND		
	BRANCH	2	GAC WASTE RECYCLE PUMP 1 & 2 76-P-501, 76-P-502	480VAC 3PH, 60HZ	7.5HP	11		MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
23	FEED	1	CIP NEUTRALIZATION PUMP SKID 2X7.5HP	480VAC 3PH, 60HZ		7.6	CIRCUIT BREAKER 20A, 3P		60 C	40 C	3 X 12 AWG 12 AWG GND		
	BRANCH	2	CIP NEUTRALIZATION PUMP 1 & 2 81-P-101, 81-P-102	480VAC 3PH, 60HZ	7.5HP	11		MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
24	FEED	1	AIR COMPRESSOR 1, 90-AC-101A	480VAC 3PH, 60HZ	5HP	7.6	CIRCUIT BREAKER 15A, 3P	MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
25	FEED	1	AIR COMPRESSOR 2, 90-AC-101B	480VAC 3PH, 60HZ	5HP	7.6	CIRCUIT BREAKER 15A, 3P	MOTOR STARTER	60 C	40 C	3 X 12 AWG 12 AWG GND		
26	FEED	1	CONTAINER HEATER	480VAC 3PH, 60HZ	7.5kW	9	CIRCUIT BREAKER 20A, 3P		60 C	40 C	3 X 12 AWG 12 AWG GND		

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CIRCUIT SCHEDULE

CIRCUIT INFORMATION							INSTALLATION INFORMATION						
NO.	TYPE	QTY	DESCRIPTION	VOLTAGE	LOAD	FLA	OVERCURRENT PROTECTION	MS/VFD/CP PART NUMBER	TERM TEMP	AMB. TEMP	WIRING	CONDUIT	NOTES
27	FEED	1	POWER FEED CONNECTION TO DISTRIBUTION PANEL 208Y/120VAC **(LP-01)**	208Y/120VAC		TBD	CIRCUIT BREAKER TBD, DP		60 C	40 C			
28	BRANCH	1	SYSTEM FEED COAGULANT PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
29	BRANCH	1	SYSTEM FEED SODIUM HYPOCHLORITE PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
30	BRANCH	1	SYSTEM FEED SODIUM HYDROXIDE PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
31	BRANCH	1	GAC FEED SULFURIC ACID PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
32	BRANCH	1	GAC PRODUCT SODIUM HYDROXIDE PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
33	BRANCH	1	GAC PRODUCT SULFURIC ACID PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
34	BRANCH	1	POLYMER AS1001 PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
35	BRANCH	1	HYDROCHLORIC ACID CLEANING PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
36	BRANCH	1	SODIUM HYDROXIDE NEUTRALIZATION PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
37	BRANCH	1	SODIUM HYPOCHLORITE NEUTRALIZATION PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
38	BRANCH	1	SODIUM BISULFITE PUMP 1 & 2	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
39	BRANCH	1	SODIUM HYDROXIDE TANK HEATER	120VAC 1PH, 60HZ	-	-	CIRCUIT BREAKER 30A, 1P,EPD		60 C	40 C	3 X 10 AWG		
40	BRANCH	1	SODIUM HYDROXIDE PUMP ENCLOSURE HEATER	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		GFCI RECEPTACLE
41	BRANCH	1	CENTRIFUGE POLYMER MIXER	120VAC 1PH, 60HZ	-	TBD	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
42	BRANCH	20	HEAT TRACE CIRCUIT 1 TO 20	120VAC 1PH, 60HZ	-	8.33	CIRCUIT BREAKER 20A, 1P,EPD		60 C	40 C	3 X 12 AWG		
43	BRANCH	1	INSTRUMENT POWER	120VAC 1PH, 60HZ	-	-	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		
44	BRANCH	1	INSTRUMENT POWER	120VAC 1PH, 60HZ	-	-	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		
45	BRANCH	1	SYSTEM FEED SAMPLER	120VAC 1PH, 60HZ	-	-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
46	BRANCH	1	FINAL PRODUCT SAMPLER	120VAC 1PH, 60HZ	-	-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		

ABBREVIATIONS: "NO." – CIRCUIT NUMBER; "QTY." – QUANTITY; "TERM TEMP" – TERMINAL TEMPERATURE RATING; "AMB. TEMP" – AMBIENT TEMPERATURE "NA" – NOT APPLICABLE
CIRCUIT TYPES: "BRAN" – BRANCH; "FEED" – FEEDER; "SERV" – SERVICE; "CTRL" – CONTROL; "INST" – INSTRUMENTATION;
ALL FIELD WIRING CONDUCTORS SHALL BE STRANDED COPPER
ELECTRICAL DESIGN IS FOR NFPA 70 – NATIONAL ELECTRICAL CODE
THE CONDUCTOR SIZES ARE MINIMUM SIZES. LARGER SIZES MAY BE NEEDED TO MEET CODE REQUIREMENTS FOR INSTALLATION CONDITIONS (SUCH AS AMBIENT TEMPERATURE OR LONG RUN VOLTAGE DROP).

REFERENCE ONLY
DO NOT USE FOR
CONSTRUCTION

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
A	INITIAL DESIGN		IS	MM	MM	10JAN22

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

SINGLE LINE DIAGRAM

DRAWING NUMBER: 508581-ES-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: N.T.S.
SIZE: D
SHEET: 14 OF 15

LAST SAVED: Monday, January 10, 2022 1:37:54 PM

FILE LOCATION: D:\Users\RBA674\SUEZ\ES services-TCS (Group) - Electrical\OTR EMEA\2021\Marjorie\2021\Chemours Barrier Wall-508581\DELIVERY\SLD\Jan22\10Jan22\508581-ES-01.dwg

CIRCUIT SCHEDULE

CIRCUIT INFORMATION							INSTALLATION INFORMATION						
NO.	TYPE	QTY	DESCRIPTION	VOLTAGE	LOAD	FLA	OVERCURRENT PROTECTION	MS/VFD/CP PART NUMBER	TERM TEMP	AMB. TEMP	WIRING	CONDUIT	NOTES
47	BRANCH	1	SAFETY SHOWER	208 VAC 1PH, 60HZ	-	-	CIRCUIT BREAKER 30A, 2P,EPD		60 C	40 C	3 X 10 AWG		
48	BRANCH	1	SAFETY SHOWER	208 VAC 1PH, 60HZ	-	-	CIRCUIT BREAKER 30A, 2P,EPD		60 C	40 C	3 X 10 AWG		
49	FEED	1	POWER FEED CONNECTION TO 208Y/120VAC DISTRIBUTION PANEL **(OFFICE/LAB CONTAINER)**	208Y/120VAC 1PH, 60HZ		-	CIRCUIT BREAKER TBD, 2P		60 C	40 C			
50	BRANCH	1	LAB RECEPTACLE CIRCUIT 1	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
51	BRANCH	1	LAB RECEPTACLE CIRCUIT 2	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
52	BRANCH	1	OFFICE RECEPTACLE CIRCUIT 1	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
53	BRANCH	1	OFFICE RECEPTACLE CIRCUIT 2	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
54	BRANCH	1	OFFICE/LAB CONTAINER LIGHTING	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		
55	BRANCH	1	LAB HVAC	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
56	BRANCH	1	OFFICE HVAC	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
57	FEED	1	POWER FEED CONNECTION TO 208Y/120VAC DISTRIBUTION PANEL **(PUMP/CONTROL CONTAINER)**	208Y/120VAC 1PH, 60HZ		-	CIRCUIT BREAKER TBD, 2P		60 C	40 C			
58	BRANCH	1	LIGHTING CIRCUIT	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 15A, 1P		60 C	40 C	3 X 12 AWG		
59	BRANCH	1	UTILITY RECEPTACLE	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
60	BRANCH	1	SUPERVISORY CONTROL PANEL	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
61	BRANCH	1	INSTRUMENT AIR DRYER	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 20A, 1P		60 C	40 C	3 X 12 AWG		
62	BRANCH	1	COMPRESSOR AUTO DRAIN	120VAC 1PH, 60HZ		-	CIRCUIT BREAKER 15A,1P		60 C	40 C	3 X 12 AWG		

REFERENCE ONLY
DO NOT USE FOR
CONSTRUCTION

ABBREVIATIONS: "NO." – CIRCUIT NUMBER; "QTY." – QUANTITY; "TERM TEMP" – TERMINAL TEMPERATURE RATING; "AMB. TEMP" – AMBIENT TEMPERATURE "NA" – NOT APPLICABLE
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REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
A	INITIAL DESIGN		IS	MM	MM	10JAN22

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION
CHEMOURS FAYETTEVILLE, NC
BARRIER WALL PROJECT

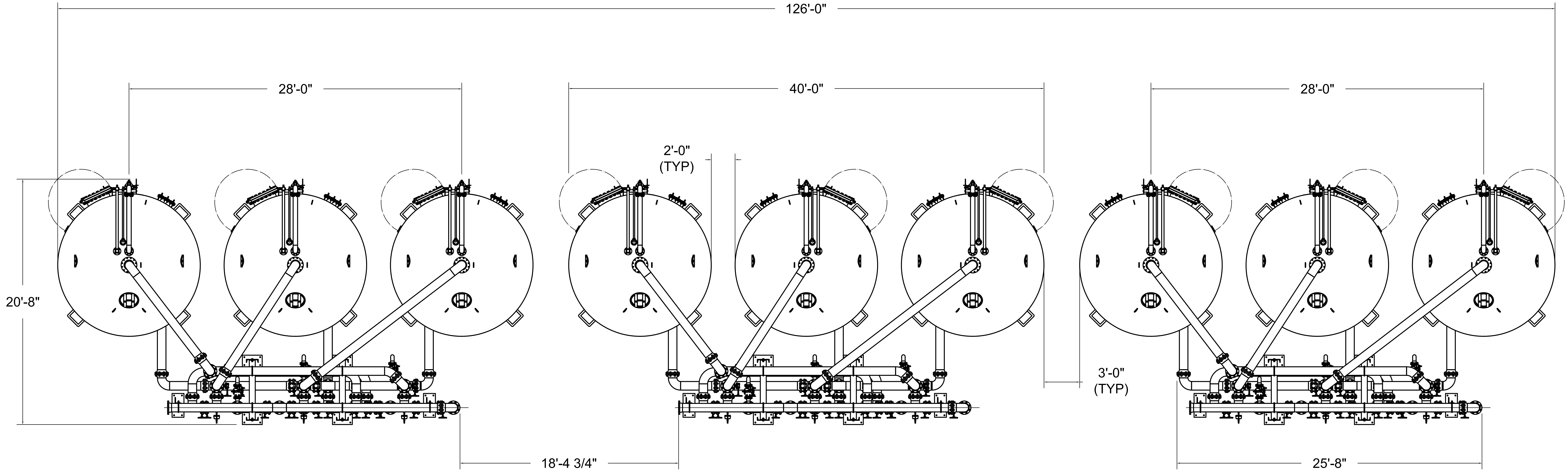
SINGLE LINE DIAGRAM

DRAWING NUMBER: 508581-ES-01
REVISION: A
REF.: -
DOC. OWNER: -
PROJECT NO.: 508581
PART/MATERIAL NO.: -
SCALE: N.T.S.
SIZE: D
SHEET: 15 OF 15

LAST SAVED: Monday, January 10, 2022 1:37:54 PM

FILE LOCATION: D:\Users\RBA674\SUEZ\ES services-TCS (Group) - Electrical\OTR EMEA\2021\Marjorie\2021\Chemours Barrier Wall-508581\DELIVERY\SLD\Jan22\10Jan22\508581-ES-01.dwg

DOCUMENT TITLE: GAC VESSEL GA
DOCUMENT NUMBER: 508581Y-PG-01
REVISION: 0

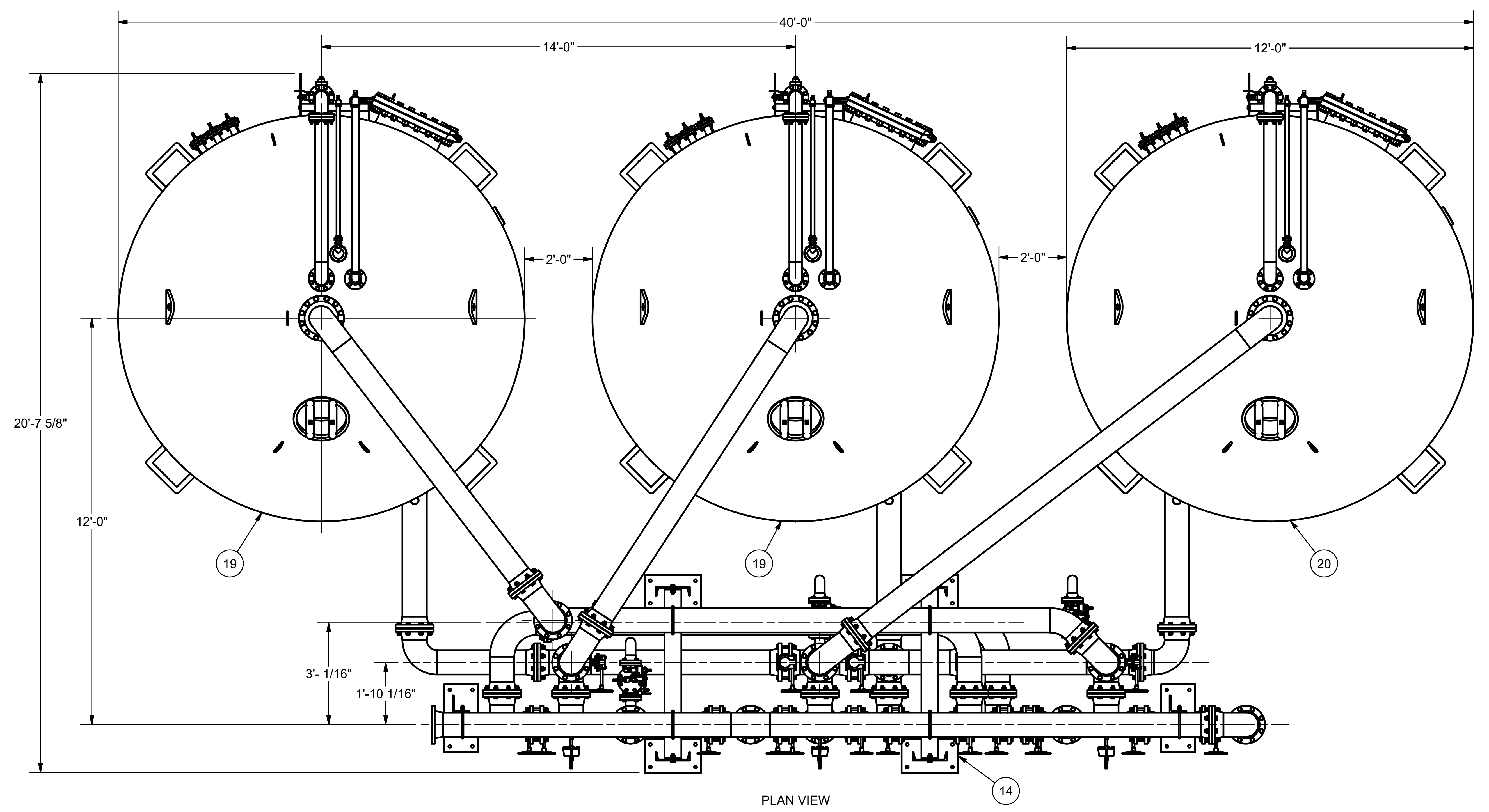


SUEZ WTS
CONTROLLED DOCUMENT

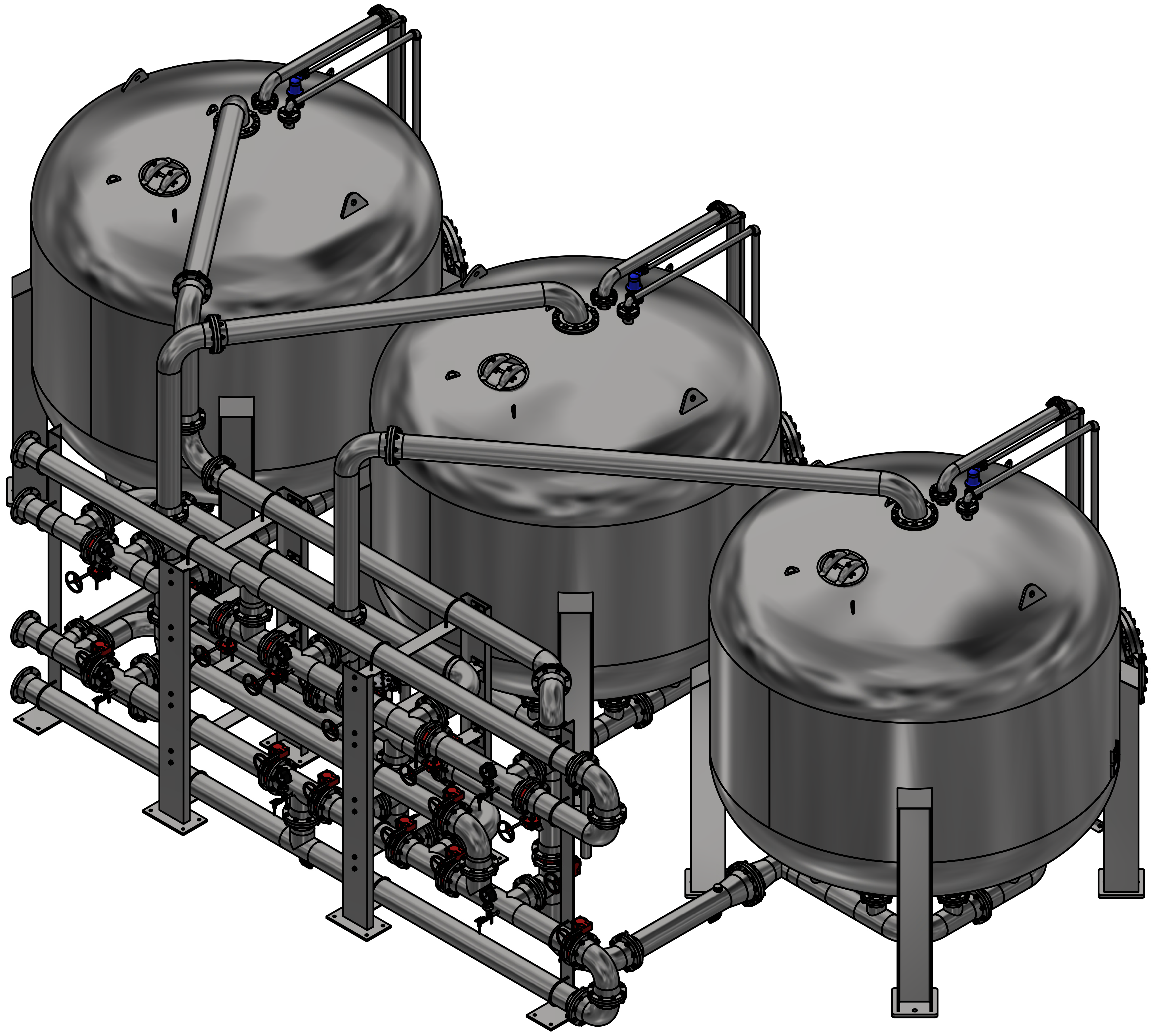
REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN

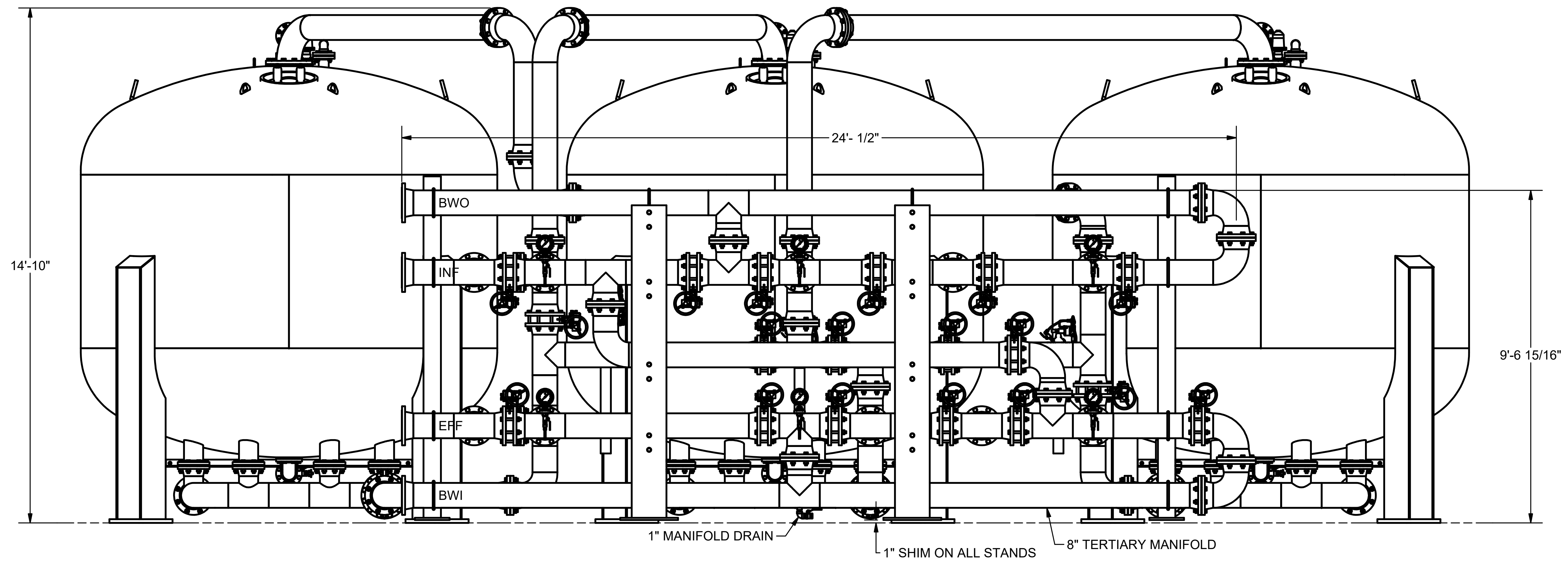
DESIGNER	DATE	TITLE Site Layout - (3) Tertiary GAC Systems
CHECKER	DATE	
ENGINEER CJG	DATE 10-21-21	CLIENT SUEZ WTS Services USA, Inc. (Fayetteville, NC)
MANAGER	DATE	AqueoUS VETS® Aqueous Vets Danville, CA
FILE:		
SCALE:		

PROJECT	CODE	DRAWING	SHEET	REV
M-00103		SITE-00103	1 OF 1	1.0

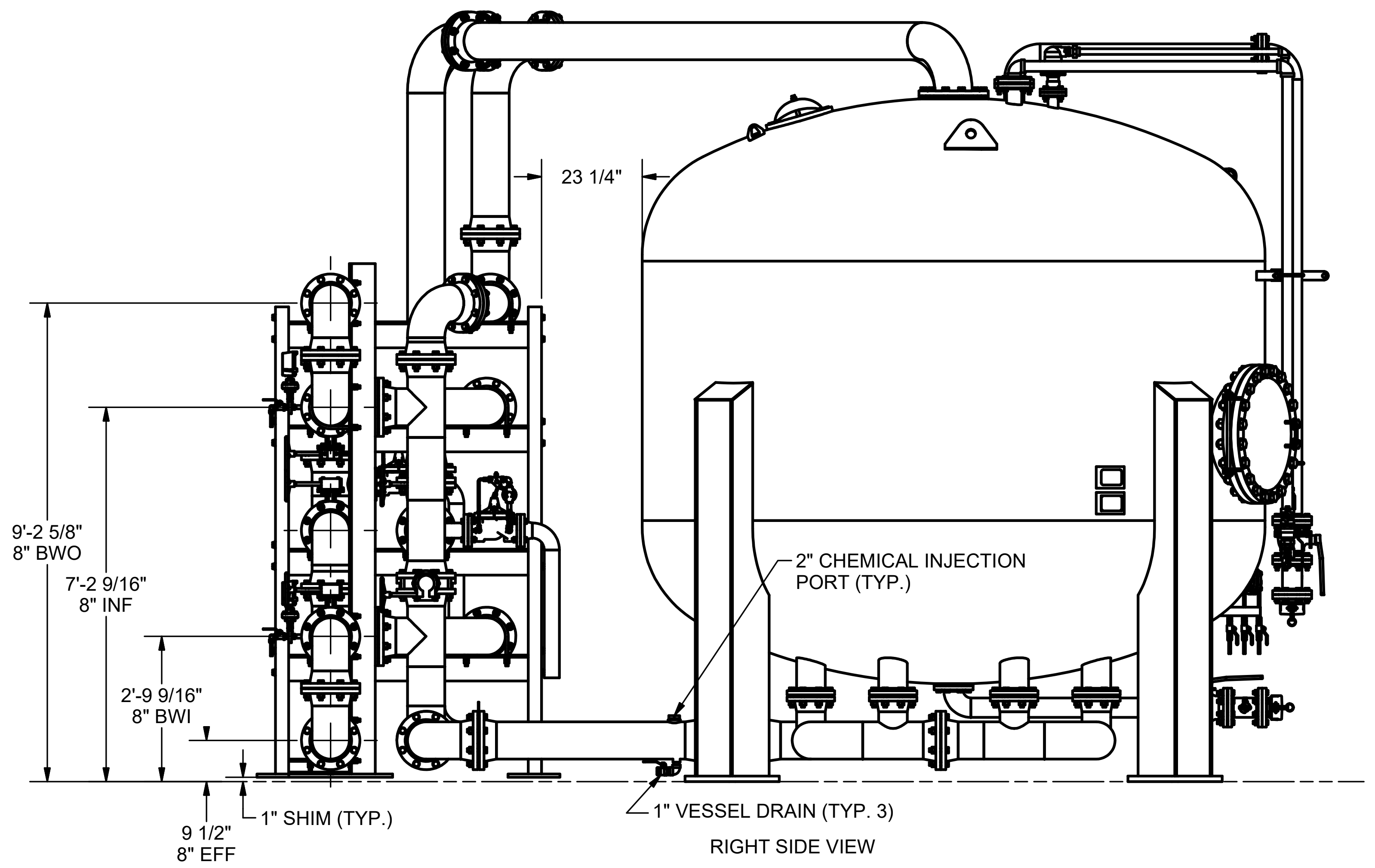


PLAN VIEW





ELEVATION VIEW



RIGHT SIDE VIEW

NOTES:
1. THIS DRAWING IS TO SHOW PIPING AND EQUIPMENT FOR CUSTOMER APPROVAL.
2. VESSELS SHALL BE 125 PSI, ASME CODE.
3. PIPING MATERIALS SHALL MEET: CS PIPE ASTM A-53 GRADE B (ERW); CS FITTINGS SA-234, ASME B16.9; SS THREADED FITTINGS ASTM A-351; SS PIPE ASTM A-312; SS BW FITTINGS ASTM A-403; MI THREADED FITTINGS ASME B-16.3.
4. SURFACE PREPERATION: VESSEL: SSPC-SP5 INTERIOR & SSPC-SP6 EXTERIOR. SYSTEM PIPING: SSPC-SP10 INTERIOR & SSPC-SP6 EXTERIOR.
5. FINISH VESSEL INTERIOR WITH 35-45 MILS OF PLASITE 4110, PREPARE AND APPLY STRICTLY IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS TO MEET NSF STD 61 REQUIREMENTS. LINING TO BE CONTINUOUS TO OD OF THE RAISED FACE ON ALL NOZZLE FLANGES.
6. FINISH VESSEL EXTERIOR WITH 3-5 MILS OF CARBOTHANE 133VOC URETHANE, COLOR TO BE 9225 CASHEW, OVER 5-8 MILS OF CARBOGUARD 60 RUST PREVENTATIVE EPOXY PRIMER, APPLIED PER MANUFACTURERS RECOMMENDATIONS.
7. MANIFOLD, RING HEADER, SLURRY PIPING, AND INTERCONNECTING PIPING TO BE FINISHED WITH 2-3 MILS OF SW POLYESTER TGIC TOPCOAT (COLOR: CARBOLINE #9225 CASHEW) OVER 8-12 MILS OF SW EPOXY PRIMER. PIPE 3" AND LARGER TO BE INTERNALLY LINED WITH 16MILS (MIN.) OF 3M SCOTCHKOTE 134 FUSION BONDED EPOXY.
8. SYSTEM ESTIMATED SHIPPING WEIGHT: 66,000 LBS.
9. GROUTING AND ANCHORING BY OTHERS IF REQUIRED.
10. ± 1" TOLERANCE ON CONNECTION DIMENSIONS.

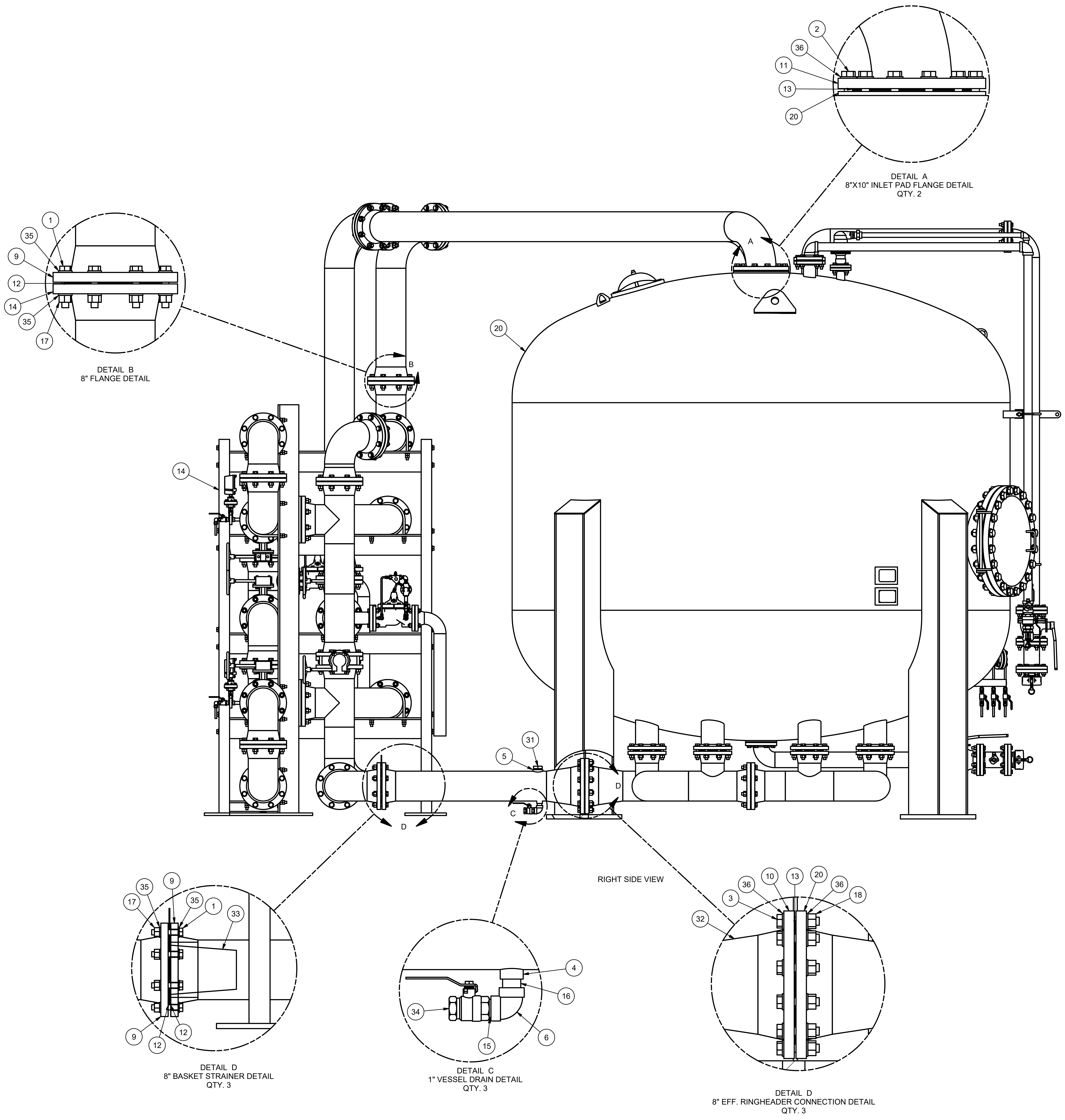
DESIGNER: AJA	DATE 11/10/2021
CHECKER: RM	DATE 11/10/2021
ENGINEER: JT	DATE 11/10/2021
MANAGER:	DATE
SCALE: 3/8" = 1'	

TITLE PF 12-520IX LP 3V SYS

CLIENT SUEZ WATER TECHNOLOGIES
CHEMOURS TERTIARY GAC SYSTEM - FAYETTEVILLE, NC

AqueoUS VETS®
16761 CLEAR CREEK ROAD
REDDING, CA 96001
925-331-0573

PROJECT	CODE	DRAWING NUMBER	SHEET	REV
M-00103		PF 12-520IX LP 3V SYS	1 OF 4	0



DETAIL A
8"X10" INLET PAD FLANGE DETAIL
QTY. 2

DETAIL B
8" FLANGE DETAIL

RIGHT SIDE VIEW

DETAIL D
8" BASKET STRAINER DETAIL
QTY. 3

DETAIL C
1" VESSEL DRAIN DETAIL
QTY. 3

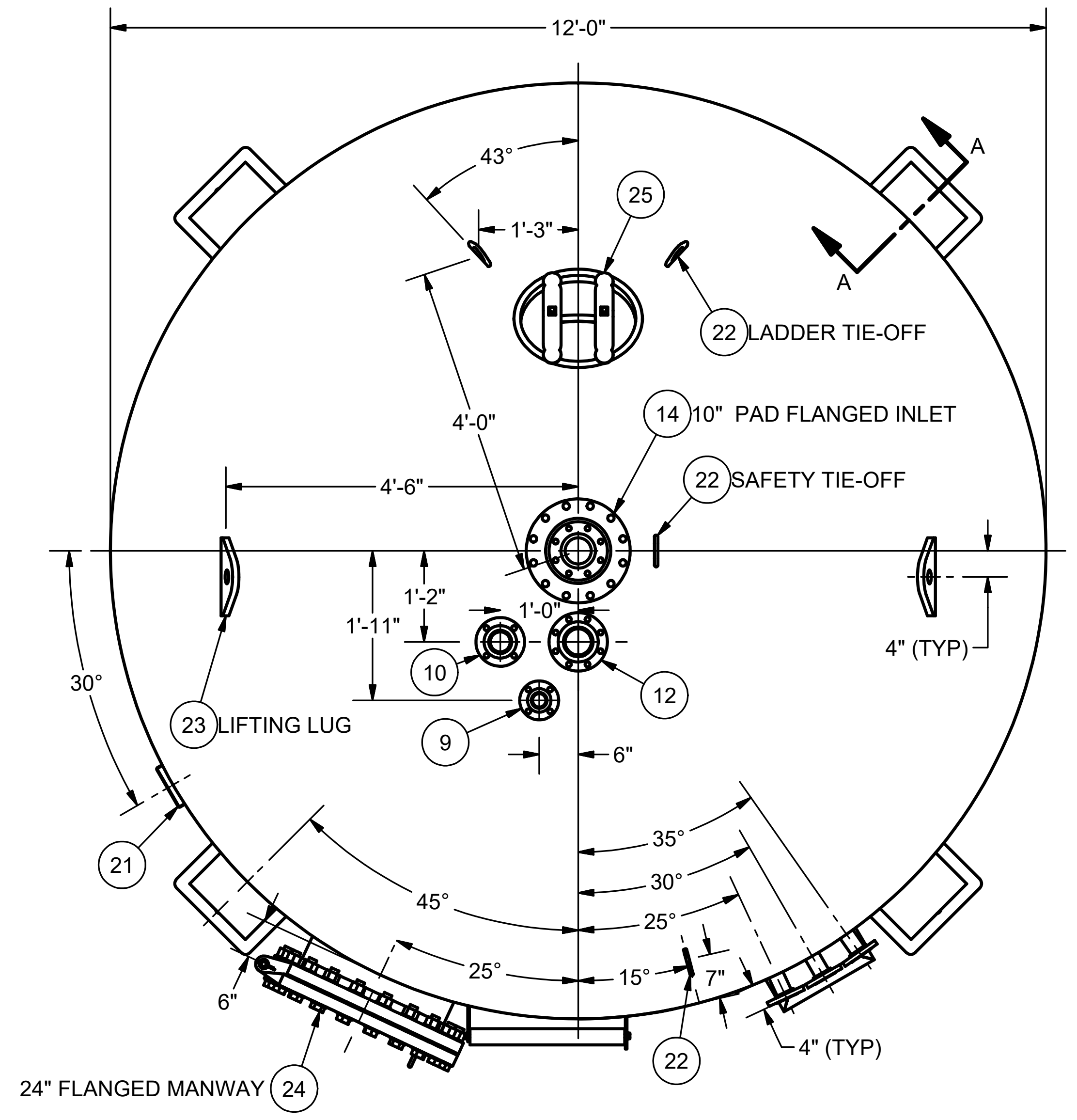
DETAIL D
8" EFF. RINGHEADER CONNECTION DETAIL
QTY. 3

PARTS LIST

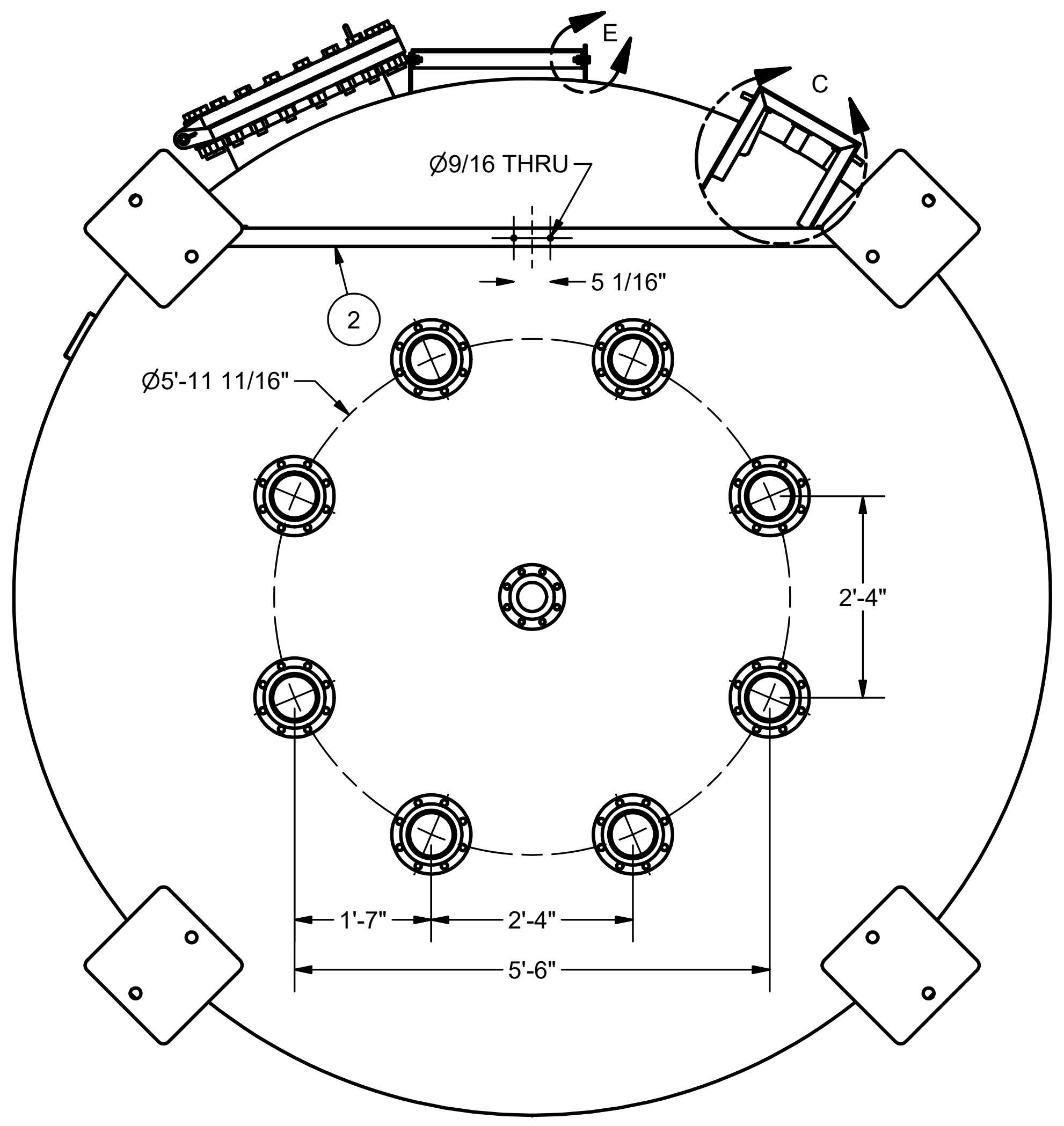
ITEM	QTY	DESCRIPTION	MATERIAL	LENGTH	WIDTH
1	88	BOLT, HEX 0.75IN D X 4IN L HDG GR A307	Steel, Galvanized		
2	36	BOLT, HEX 0.875IN D X 2.5IN L HDG GR A307	Steel, Galvanized		
3	36	BOLT, HEX 0.875IN D X 4IN L HDG GR A307	Steel, Galvanized		
4	3	COUPLING, 1IN HALF THD 3000 316SS	Stainless Steel		
5	3	COUPLING, 2IN HALF THD 3000 316SS	Stainless Steel		
6	3	ELBOW, 1IN 90 GALV THD STD WT STD R	Steel, Galvanized		
7	6	ELBOW, 8IN 90 STL WELD SCH 40 LR	Steel, Carbon		
8	2	ELBOW, 8IN 90 STL WELD SCH 40 SR	Steel, Carbon		
9	16	FLANGE, 8IN WELD NECK CS 150# RF	Steel, Carbon		
10	3	FLANGE, 10IN WELD NECK CS 150# RF	Steel, Carbon		
11	3	FLANGE, 10x8IN SLIPON RED CS 150# RF	Steel, Carbon		
12	14	GASKET, FLG 8IN EPDM RING 0.125IN THK 150# GARLOCK 98206	EPDM		
13	6	GASKET, FLG 10IN EPDM RING 0.125IN THK 150# GARLOCK 98206	EPDM		
14	1	MANIFOLD, 8" SCH40 CS 4 TIER W/ PRV 3 VESSEL			
15	3	NIPPLE, 1IN D X 1.5IN L SCH 40 316SS NPT TBE	Stainless Steel		
16	3	NIPPLE, 1IN D X 2IN L SCH 40 316SS NPT TBE	Stainless Steel		
17	88	NUT, HVY HEX 0.75-10 UNC GALV 2H	Steel, Galvanized		
18	36	NUT, HVY HEX 0.875-9 UNC GALV 2H	Steel, Galvanized		
19	2	PF12-520IX LP S/O SINGLE LEFT TANK LEFT RH ASSEMBLY			
20	1	PF12-520IX LP S/O SINGLE LEFT TANK RIGHT RH ASSEMBLY			
21	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	31 7/16 in	
22	2	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	43 5/8 in	
23	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	15/16 in	
24	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	43 5/8 in	
25	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	102 13/16 in	
26	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	57 9/16 in	
27	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	28 1/2 in	
28	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	168 11/16 in	
29	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	113 1/2 in	
30	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	57 9/16 in	
31	3	PLUG, 2IN THD GALV HEX HEAD STD WT	Steel, Galvanized		
32	3	REDUCER, CONC 10x8 WELD STL STD WT	Steel, Carbon		
33	3	STRAINER, TRUNC BASKET 8"D x 9.75"LG 150# 0.125" HOLES ON 0.1875" CTRS, REVERSE FLOW, 40 & 4 MESH, 150% AREA, HANDLE, 316SS	STN STL, 316		
34	3	VALVE, BALL 1IN NPT 316L APOLLO 76F-105	Stainless Steel		
35	176	WASHER, FLAT STRL 0.75IN GALV	Steel, Galvanized		
36	108	WASHER, FLAT STRL 0.875IN GALV	Steel, Galvanized		

DESIGNER: AJA	DATE 11/10/2021	TITLE	PF 12-520IX LP 3V SYS
CHECKER: RM	DATE 11/10/2021	CLIENT	SUEZ WATER TECHNOLOGIES CHEMOURS TERTIARY GAC SYSTEM - FAYETTEVILLE, NC
ENGINEER: JT	DATE 11/10/2021	AqueoUS VETS®	16761 CLEAR CREEK ROAD REDDING, CA 96001 925-331-0573
MANAGER:	DATE		

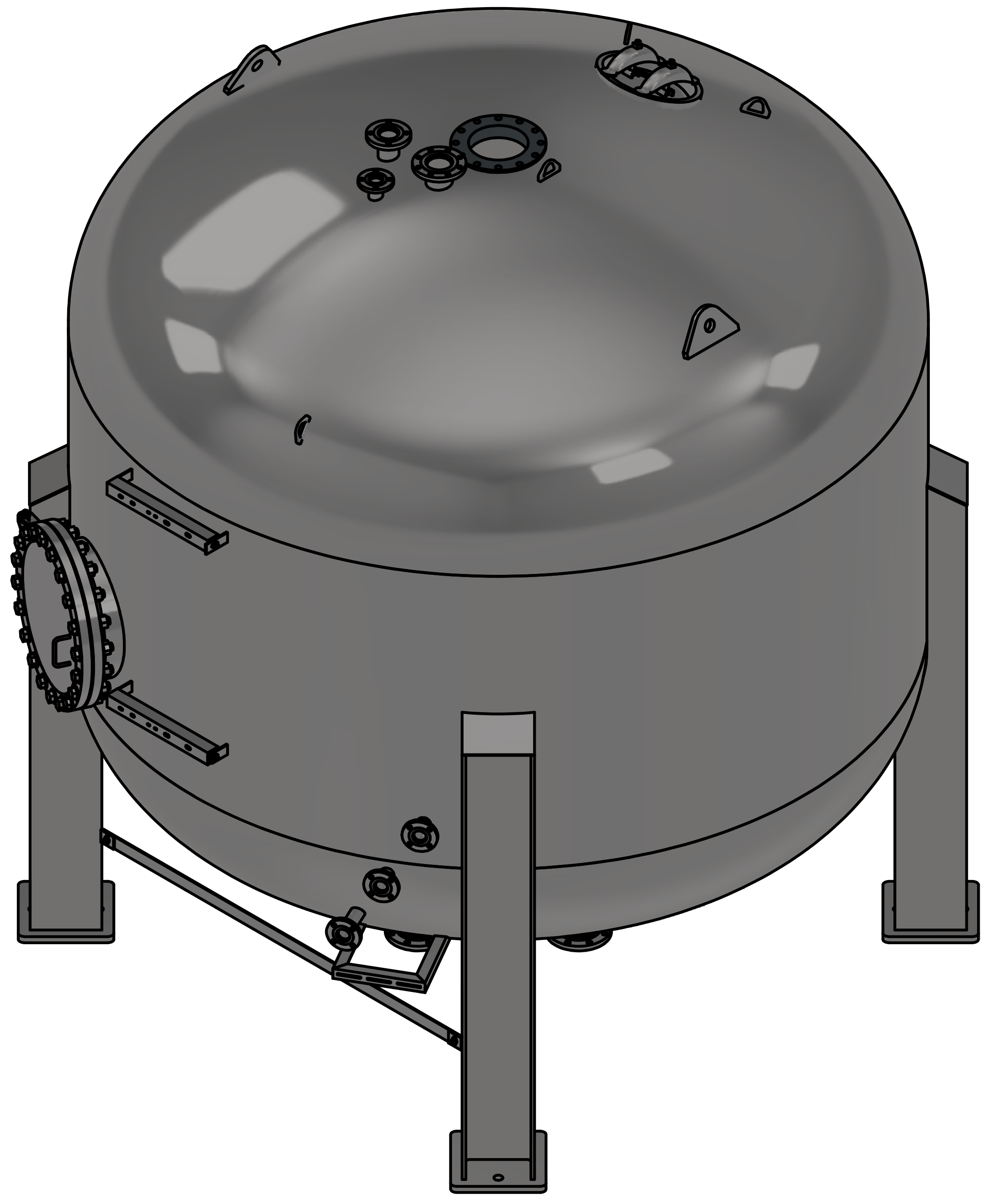
SCALE:	PROJECT	CODE	DRAWING NUMBER	SHEET	REV
3/8" = 1'	M-00103		PF 12-520IX LP 3V SYS	2 OF 4	0



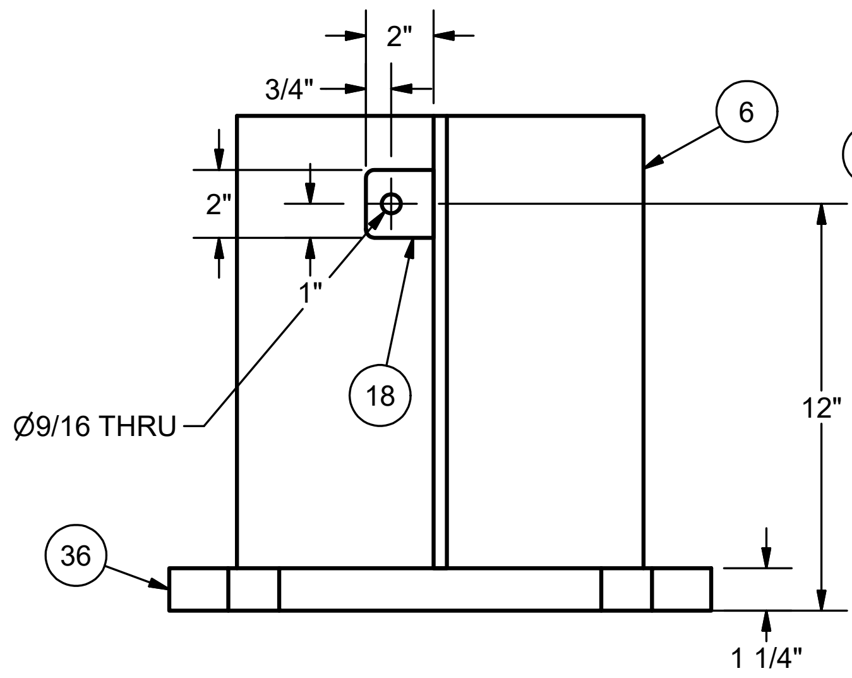
PLAN VIEW



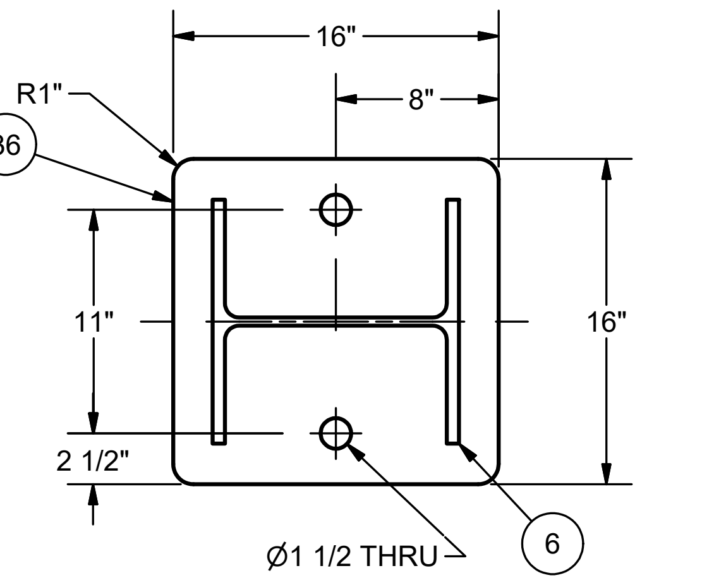
BOTTOM VIEW



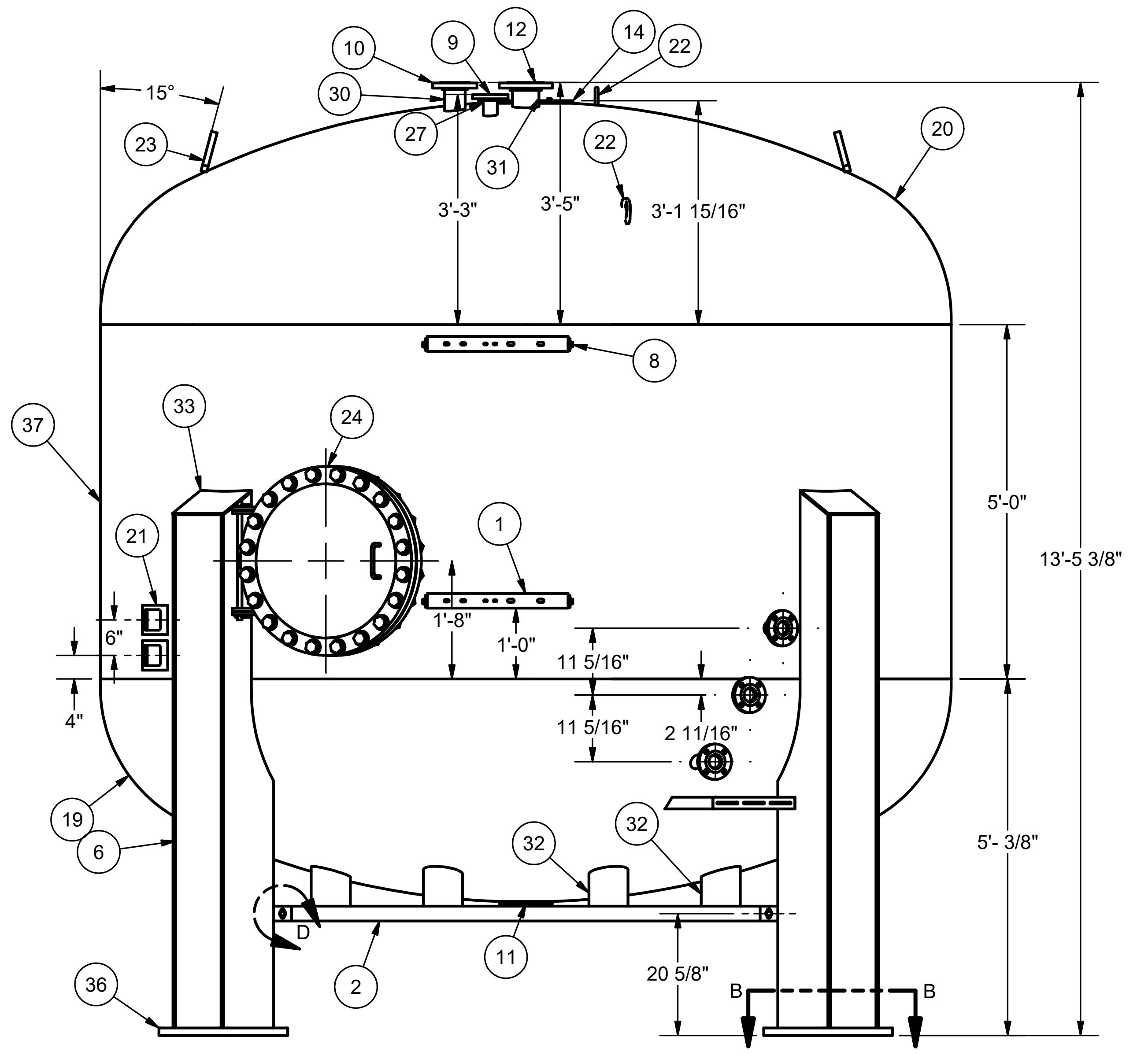
PARTS LIST					
ITEM	QTY	DESCRIPTION	MATERIAL	LENGTH	WIDTH
1	2	ANGLE, CS A36 2.5X2.5X0.25 IN	Steel, Carbon	23.8125 in	
2	1	ANGLE, CS A36 2.5X2.5X0.375 IN	Steel, Carbon	85.0589 in	
3	1	ANGLE, CS A36 2X2X0.25 IN	Steel, Carbon	16.5000 in	
4	1	ANGLE, CS A36 2X2X0.25 IN	Steel, Carbon	16.5000 in	
5	1	ANGLE, CS A36 2X2X0.25 IN	Steel, Carbon	16.0000 in	
6	4	BEAM, W12X65# CS A36	Steel, Carbon	90.7500 in	
7	2	BOLT, HEX 0.5IN D X 1.5IN L HDG GR A307	Steel, Galvanized		
8	4	BOLT, HEX 0.5IN D X 1.75IN L HDG GR A307	Steel, Galvanized		
9	4	FLANGE, 2IN SLIPON CS 150# RF	Steel, Carbon		
10	1	FLANGE, 3IN SLIPON CS 150# RF	Steel, Carbon		
11	1	FLANGE, 4IN PAD CS 1.25IN THK 150# RF	Steel, Carbon		
12	1	FLANGE, 4IN SLIPON CS 150# RF	Steel, Carbon		
13	8	FLANGE, 6IN SLIPON CS 150# RF	Steel, Carbon		
14	1	FLANGE, 10IN DOUBLE TAPPED PAD 316SS 2.5IN THK 150# RF	Stainless Steel		
15	2	FLAT, 2X0.25 IN CS A36	Steel, Carbon	5.5000 in	
16	1	FLAT, 2X0.25 IN CS A36	Steel, Carbon	5.0000 in	
17	1	FLAT, 2X0.25 IN CS A36	Steel, Carbon	3.8750 in	
18	1	FLAT, 2X0.25 IN SS 304L	Stainless Steel	2.0000 in	
19	1	HEAD, 144IN OD x 0.5IN THK 1.5IN SF 2 to 1 SE STL SA516-70	Steel, Carbon		
20	1	HEAD, 144IN OD x 0.5IN THK 1.5IN SF 2 to 1 SE STL SA516-70	Steel, Carbon		
21	2	ID BRACKET, 7" x 5" x 1" CS 10 GA.	Steel, Carbon		
22	4	LIFTING LUG SMALL 2 900 LUG	Steel, Carbon		
23	2	LIFTING LUG, 50000# A36	Steel, Carbon		
24	1	MANWAY, 24" ROUND 150# RFSO HDG NB&W FF NSF EPDM GASKET			
25	1	MANWAY, ELP PRESSURE 14x18x1x4 SA-106 STL w/ NSF GASKET	Steel, Carbon		
26	6	NUT, HVY HEX 0.5-13 UNC GALV 2H	Steel, Galvanized		
27	1	PIPE, 2IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	3.7500 in	
28	1	PIPE, 2IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	8.1250 in	
29	2	PIPE, 2IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	4.0000 in	
30	1	PIPE, 3IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	4.7500 in	
31	1	PIPE, 4IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	4.2500 in	
32	8	PIPE, 6IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	8.6250 in	
33	4	PLATE, STL A36/SA36 0.25 IN THK	Steel, Carbon	9.5193 in	12.1200 in
34	4	PLATE, STL A36/SA36 0.25 IN THK	Steel, Carbon	2.2500 in	2.2500 in
35	2	PLATE, STL A36/SA36 0.25 IN THK	Steel, Carbon	3.0000 in	2.5000 in
36	4	PLATE, STL A516-70/SA516-70 1.25 IN THK	Steel, Carbon	16.0000 in	16.0000 in
37	1	SHELL 144IN ODX60IN LX1/2IN SA-516-70			
38	12	WASHER, FLAT STRL 0.5IN GALV	Steel, Galvanized		



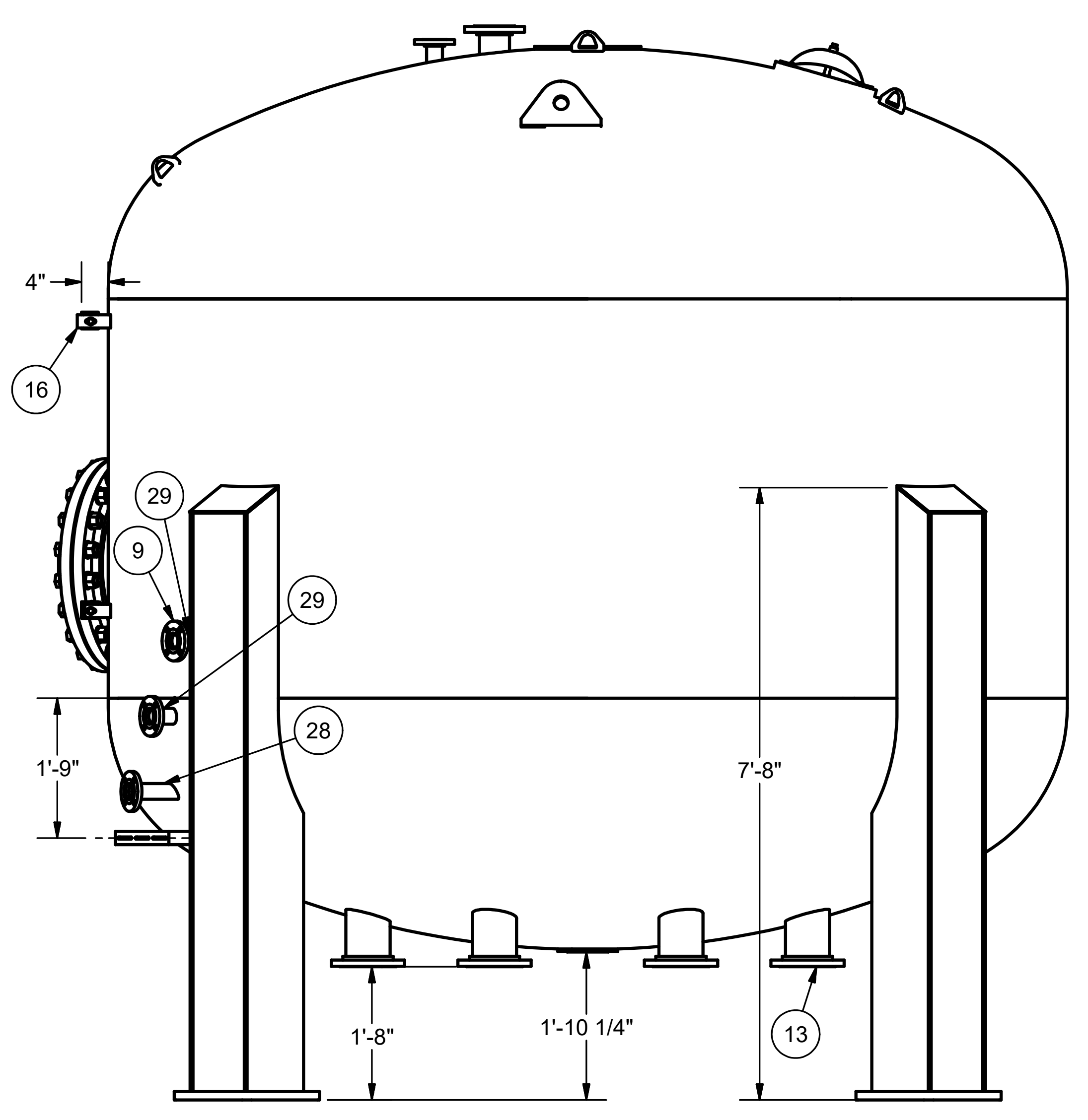
SECTION A-A
GROUNDING TAB DETAIL



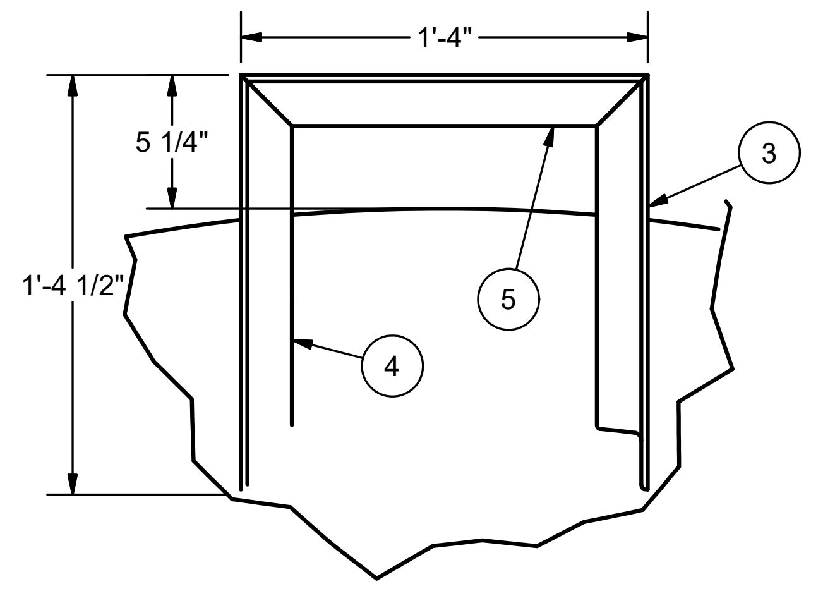
SECTION B-B
BASE PLATE ANCHOR DETAIL



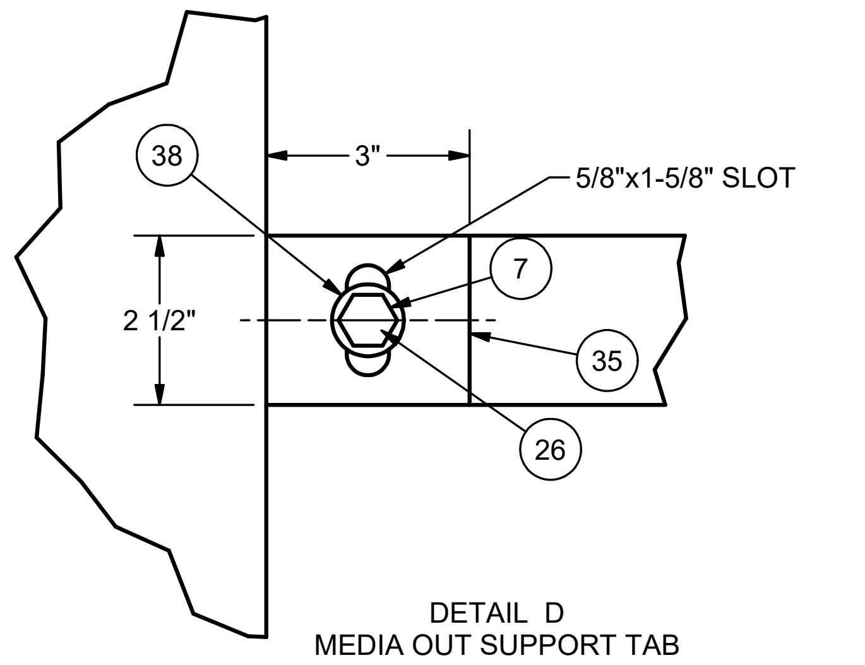
ELEVATION VIEW



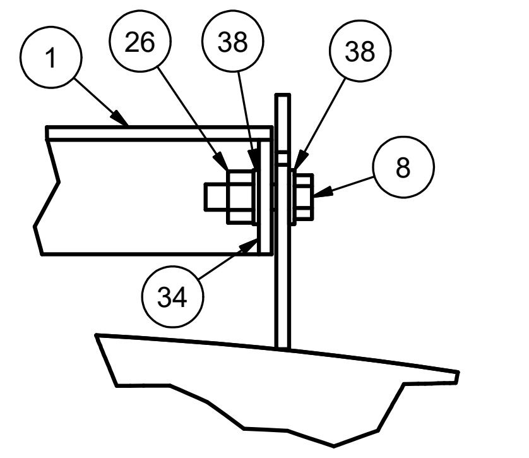
RIGHT SIDE VIEW



DETAIL C
SAMPLE PORT BRACKET
(BOTTOM VIEW)



DETAIL D
MEDIA OUT SUPPORT TAB

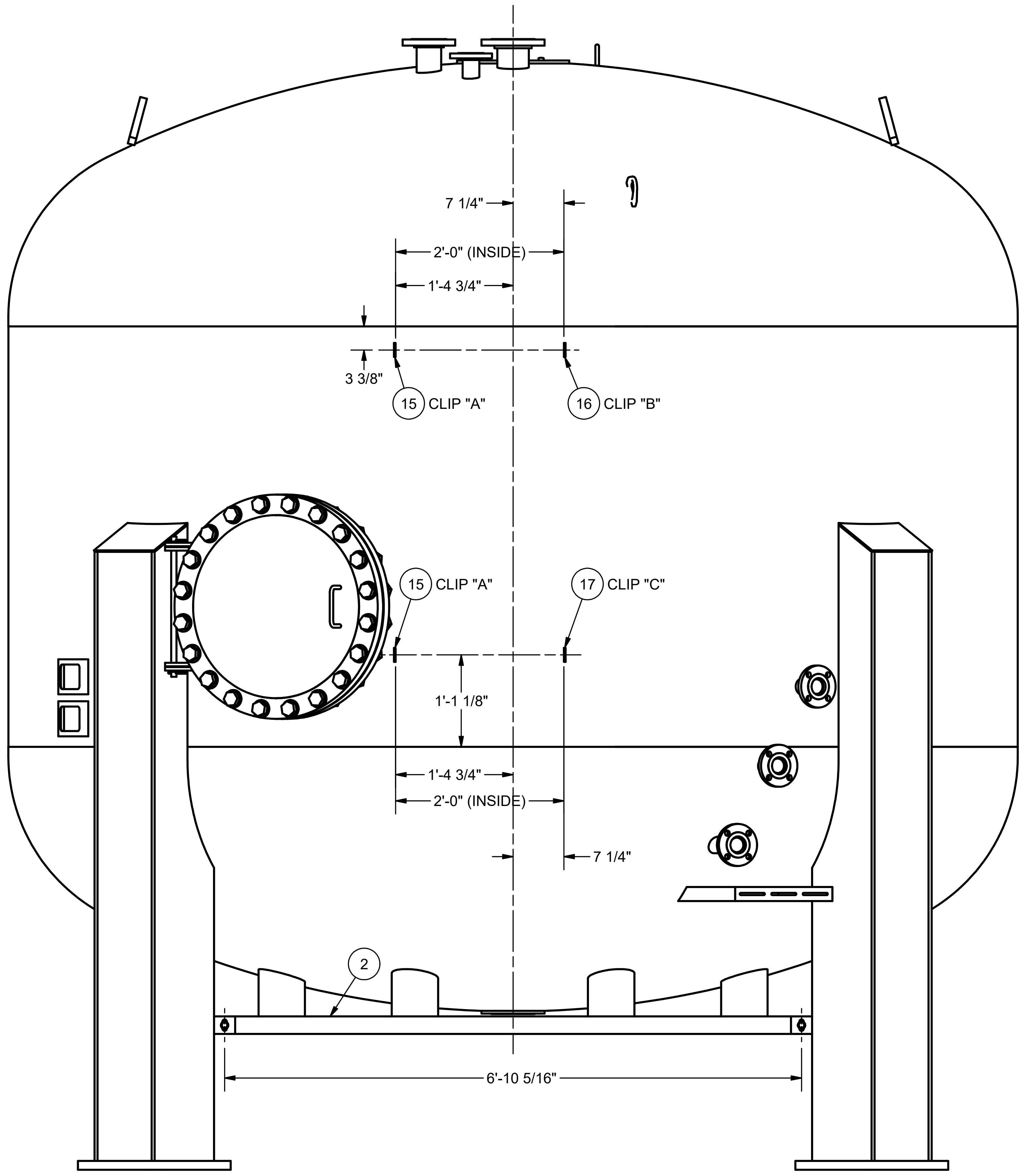


DETAIL E
ADJUSTABLE SERVICE BRACKET

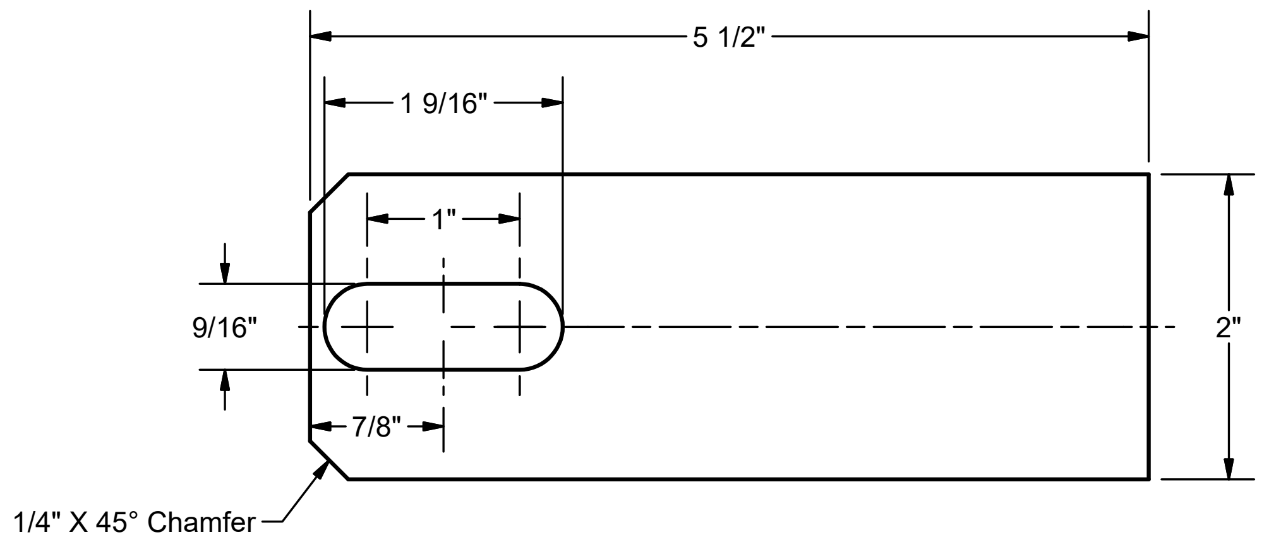
NOTE:

1. ASME STAMPED 125 PSI @ 150° F.
2. MATCH SEPTA RING HEADER TEMPLATE FOR 6" OUTLET NOZZLE FLANGES.
3. PE STAMPED VESSEL AND ANCHORING CALCS PER CURRENT CBC BY VESSEL MANUFACTURER. IP OF 1.5, SEISMIC SITE CLASS D.
4. FLANGED MANWAY TO HAVE FULL FACE NSF CERTIFIED EPDM GASKET.
5. ELLIPTICAL MANWAY TO HAVE RING NSF CERTIFIED EPDM GASKET.
6. MANWAY FASTENERS (NUTS, BOLTS, WASHERS) TO BE HOT DIPPED GALVANIZED.
7. PAD FLANGES TO BE 2 HOLED ON VESSEL EXTERIOR AND 1 HOLED INTERNALLY (WHERE APPLICABLE).
8. VESSEL SURFACE PREPERATION: SSPC-SP5 INTERIOR & SSPC-SP6 EXTERIOR
9. FINISH VESSEL INTERIOR WITH 35-45 MILS OF PLASITE 4110, PREPARE AND APPLY STRICTLY IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS TO MEET NSF STD 61 REQUIREMENTS. LINING TO BE CONTINUOUS TO OD OF THE RAISED FACE ON ALL NOZZLE FLANGES.
10. FINISH EXTERIOR WITH 3-5 MILS OF CARBOTHANE 133VOC URETHANE, COLOR TO BE 9225 CASHEW, OVER 5-8 MILS OF CARBOGUARD 60 RUST PREVENTATIVE EPOXY PRIMER, APPLIED PER MANUFACTURERS RECOMMENDATIONS.
11. LEFT VESSEL SHOWN, RIGHT VESSEL MIRRORED.
12. ESTIMATED WEIGHT: 14,250 LBS.

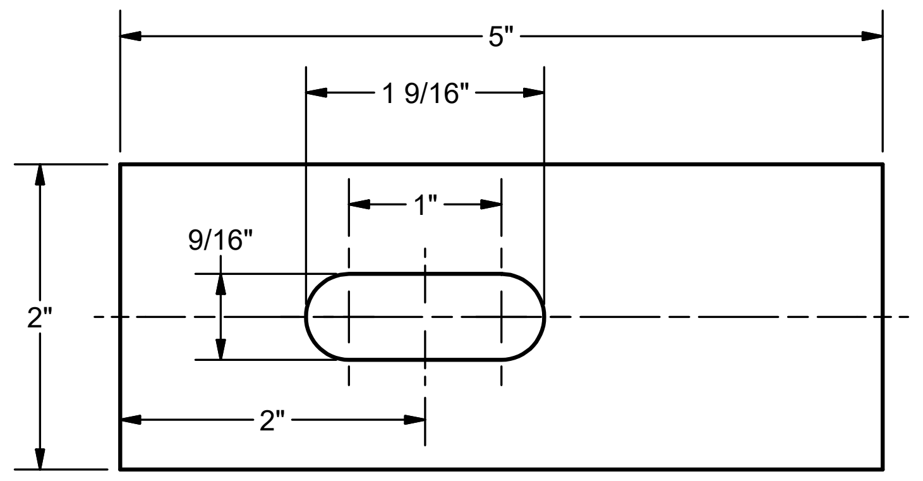
DESIGNER: AMN	DATE 10/29/2021	TITLE PF 12-520IX LOW PRO™ 125 PSI ASME CODE VESSEL (LEFT VESSEL SHOWN, RIGHT VESSEL MIRRORED)			
CHECKER: AJA	DATE 10/29/2021	CLIENT SUEZ Water Technologies Tertiary GAC System			
ENGINEER: JT	DATE	AqueoUS VETS® 16761 CLEAR CREEK ROAD REDDING, CA 96001 925-331-0573			
MANAGER:	DATE				
SCALE: 1/2" = 1'		PROJECT M-00103	CODE	DRAWING NUMBER PF 12-520IX LP BT	SHEET 1 OF 2
					REV



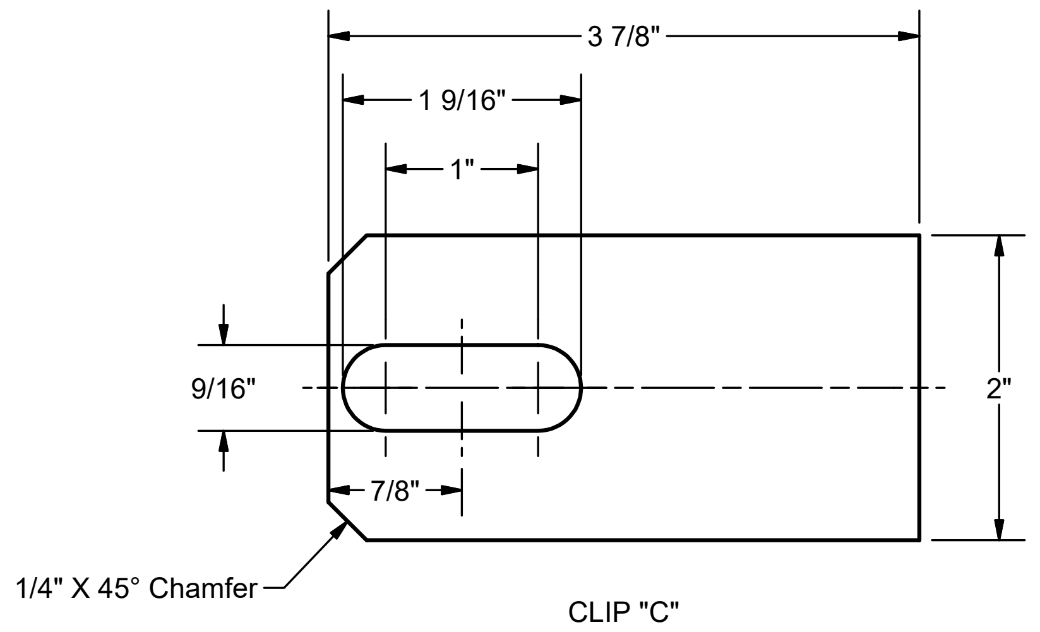
ELEVATION VIEW
(CLIP LOCATIONS)



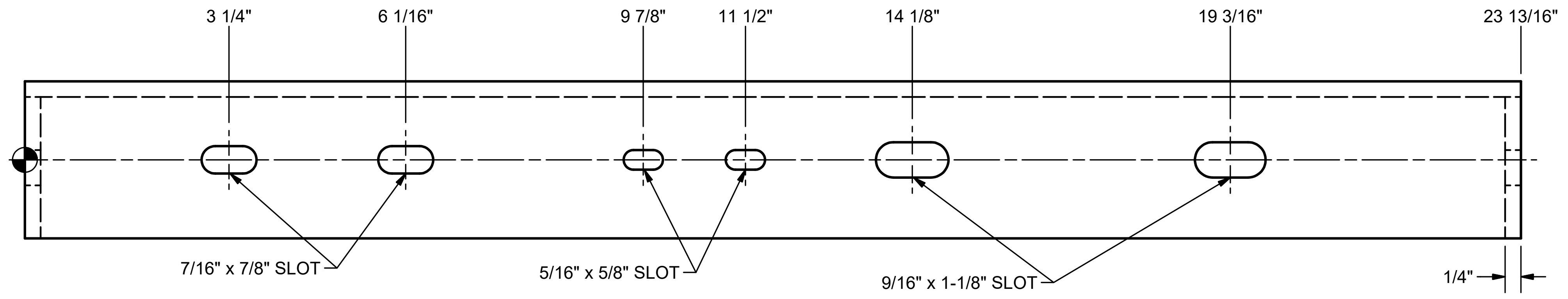
CLIP "A"
(QTY. 2)



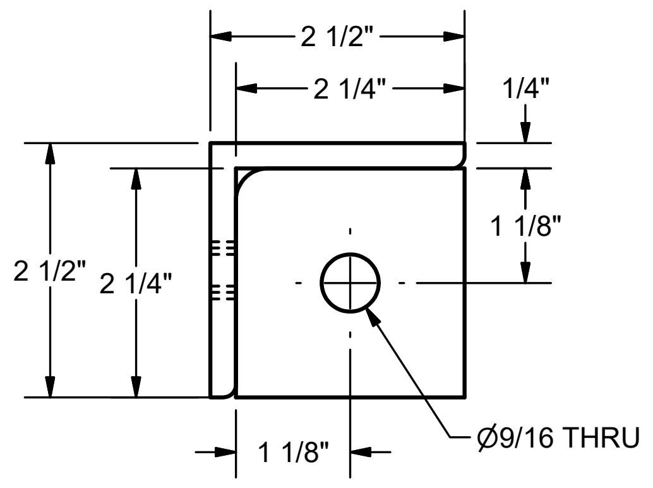
CLIP "B"
(QTY.1)



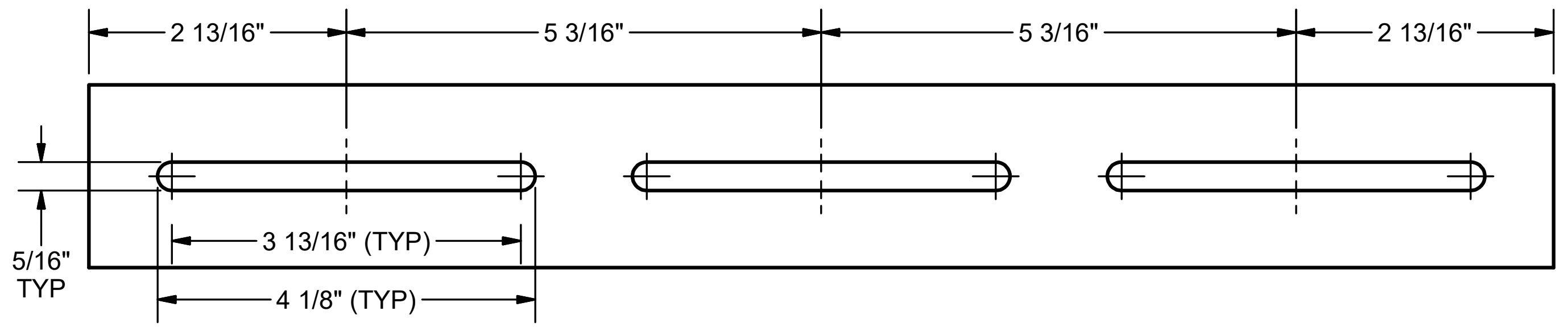
CLIP "C"
(QTY. 1)



SERVICE BRACKET DETAIL
FRONT VIEW
(QTY. 2)



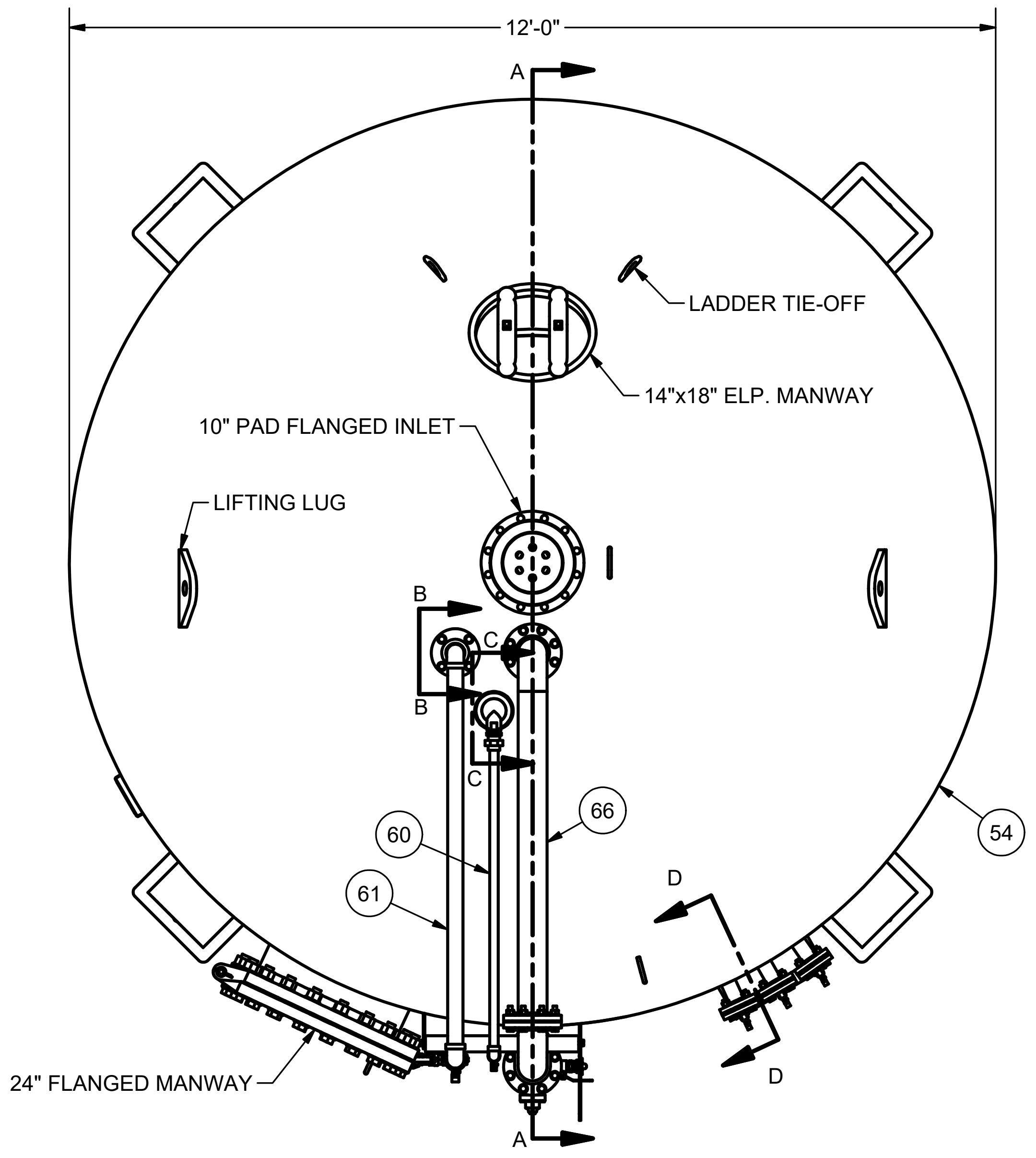
SIDE VIEW



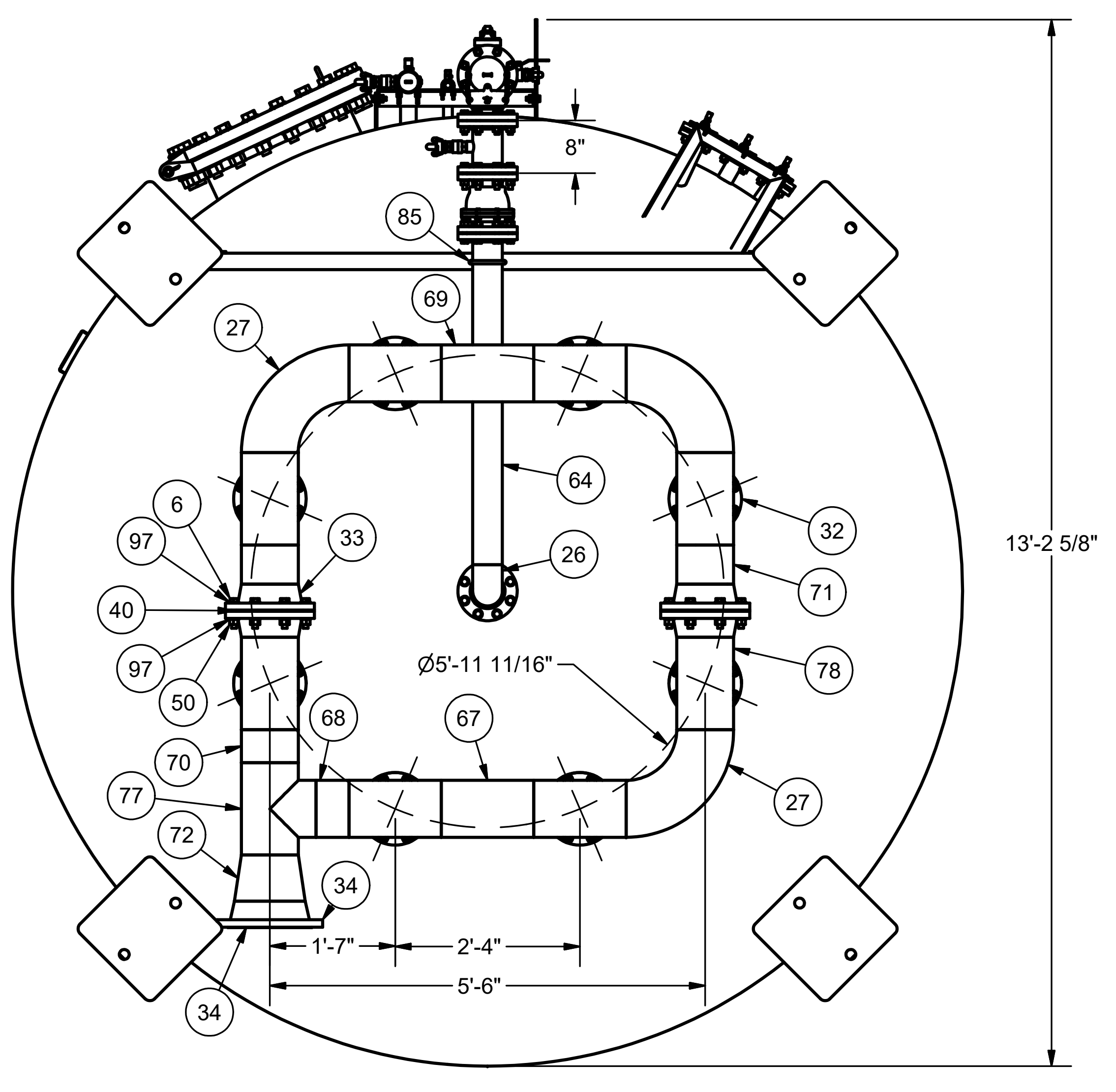
SAMPLE PORT BRACKET DETAIL
(QTY. 1)

DESIGNER: AMN	DATE 10/29/2021	TITLE PF 12-520IX LOW PRO™ 125 PSI ASME CODE VESSEL (LEFT VESSEL SHOWN, RIGHT VESSEL MIRRORED)
CHECKER: AJA	DATE 10/29/2021	CLIENT SUEZ Water Technologies Tertiary GAC System
ENGINEER: JT	DATE	AqueoUSVETS® 16761 CLEAR CREEK ROAD REDDING, CA 96001 925-331-0573
MANAGER:	DATE	
SCALE: 1/2" = 1'		

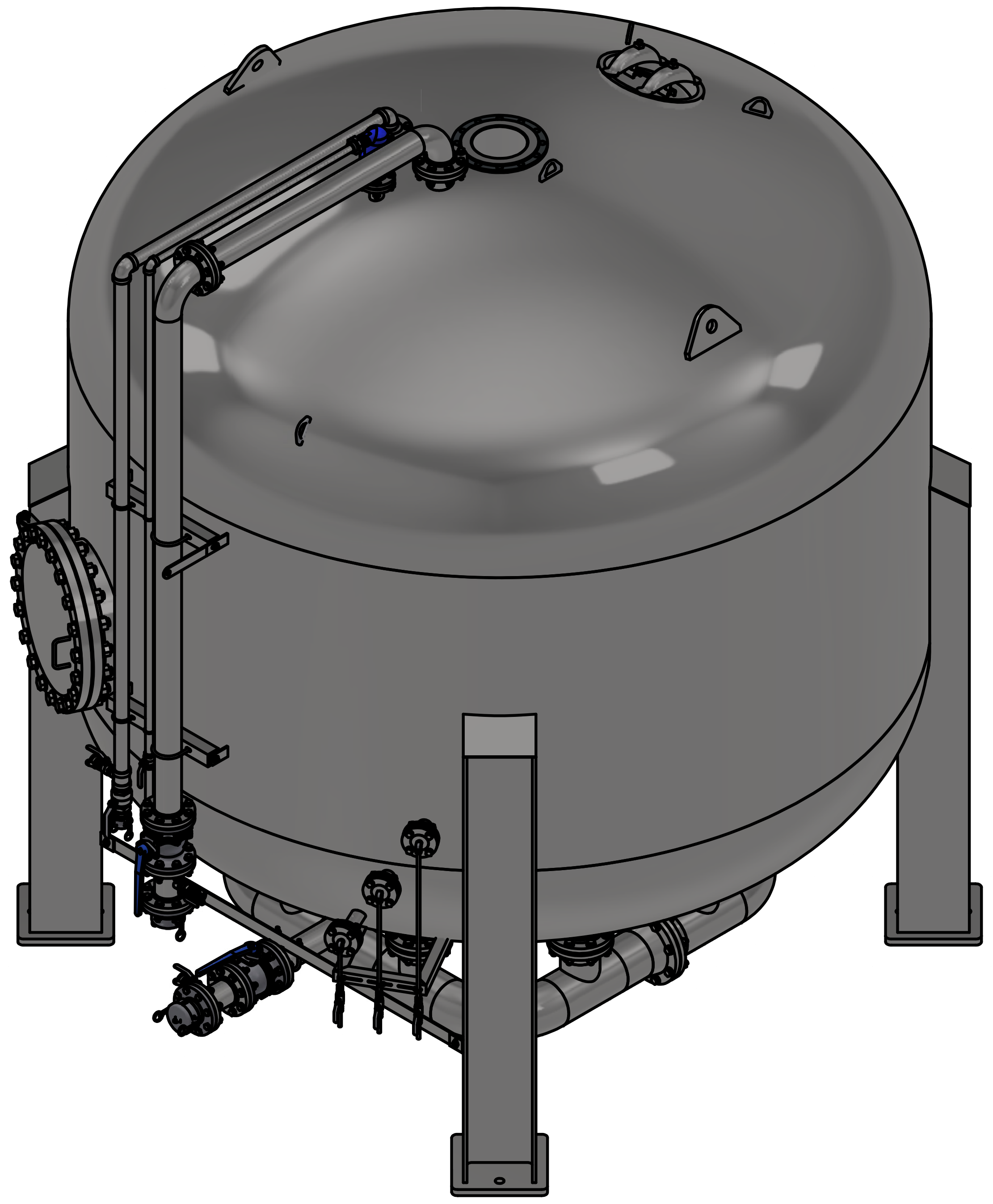
PROJECT	CODE	DRAWING NUMBER	SHEET	REV
M-00103		PF 12-520IX LP BT	2 OF 2	

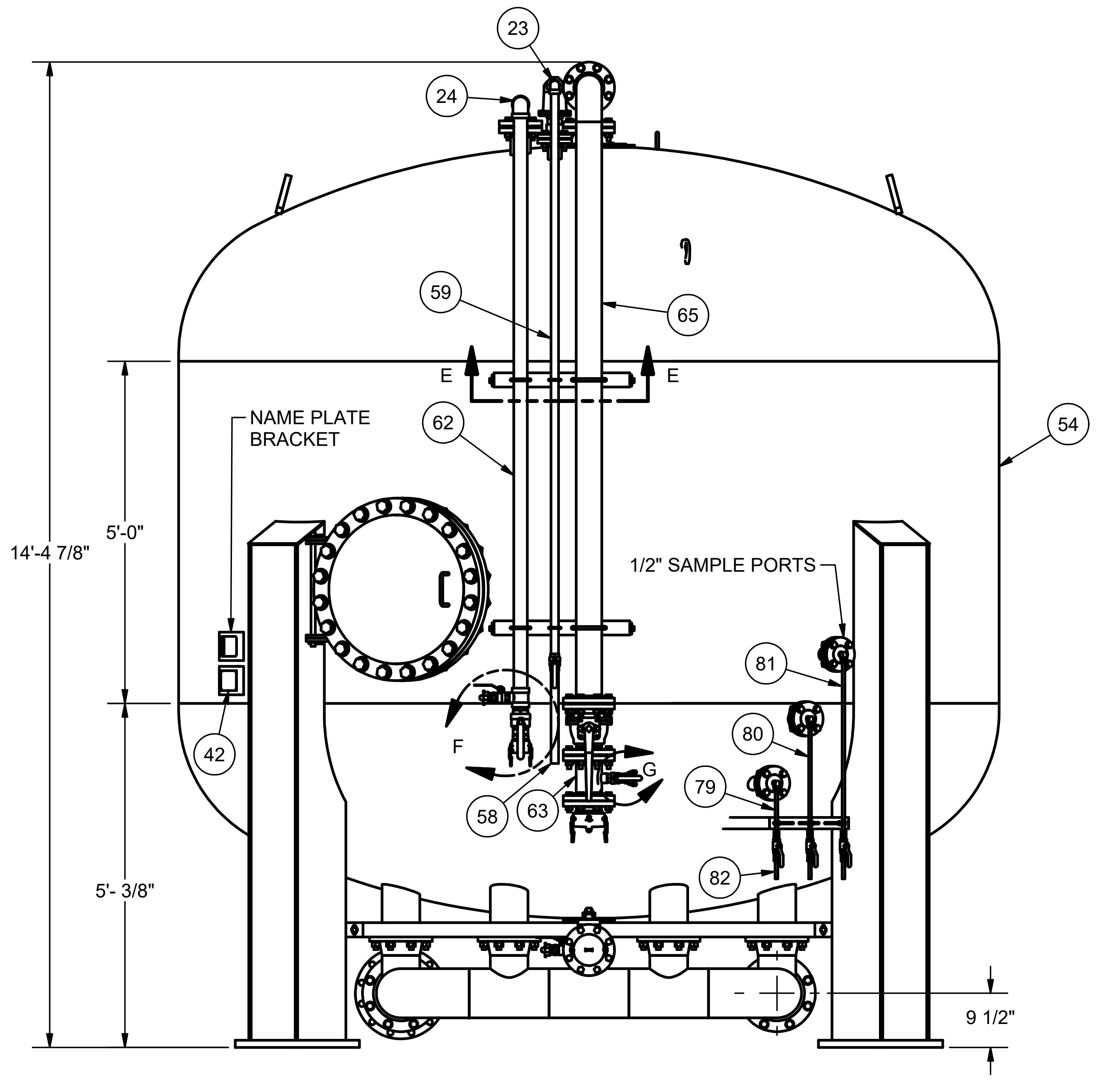


PLAN VIEW

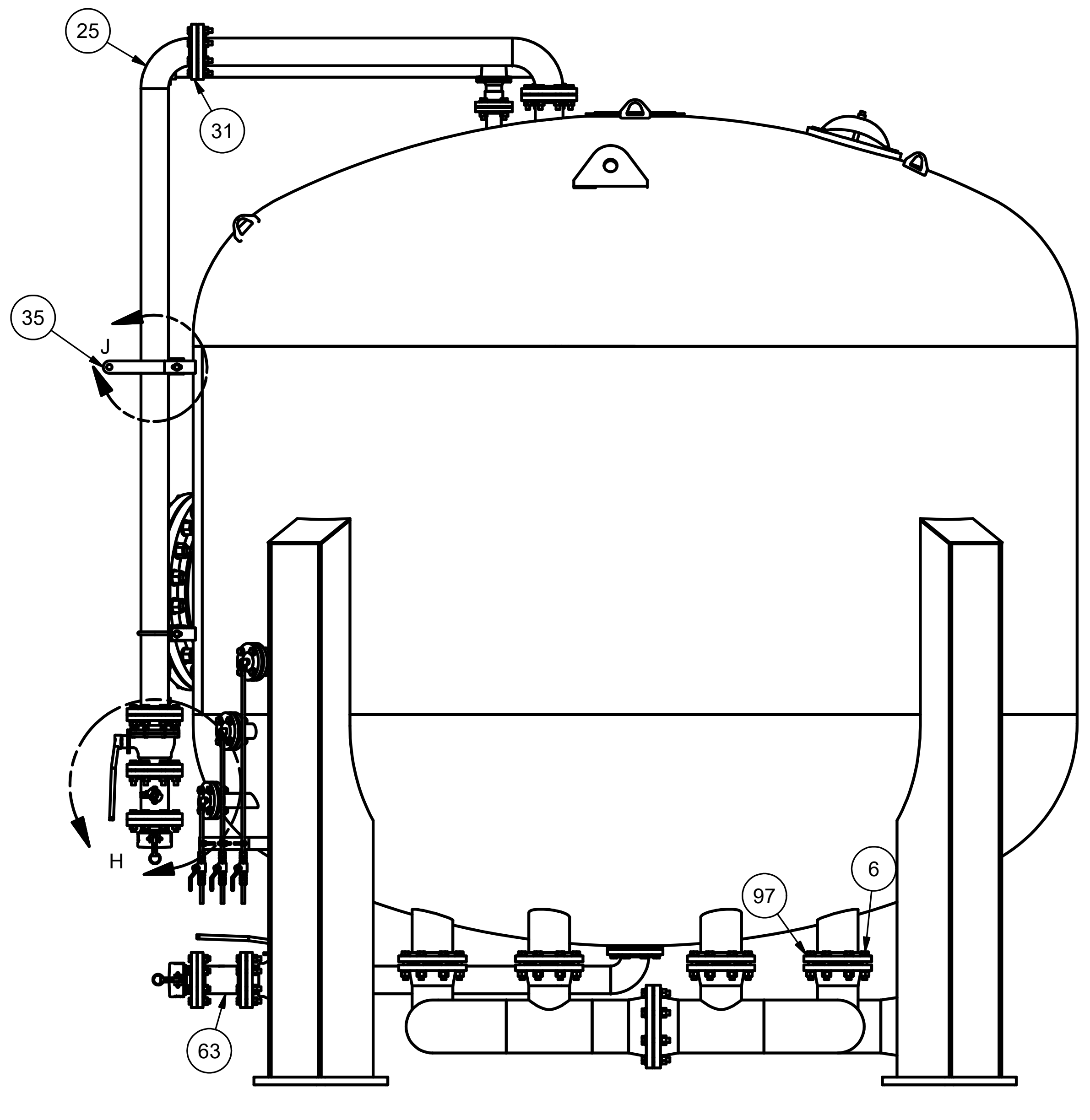


BOTTOM VIEW





ELEVATION VIEW

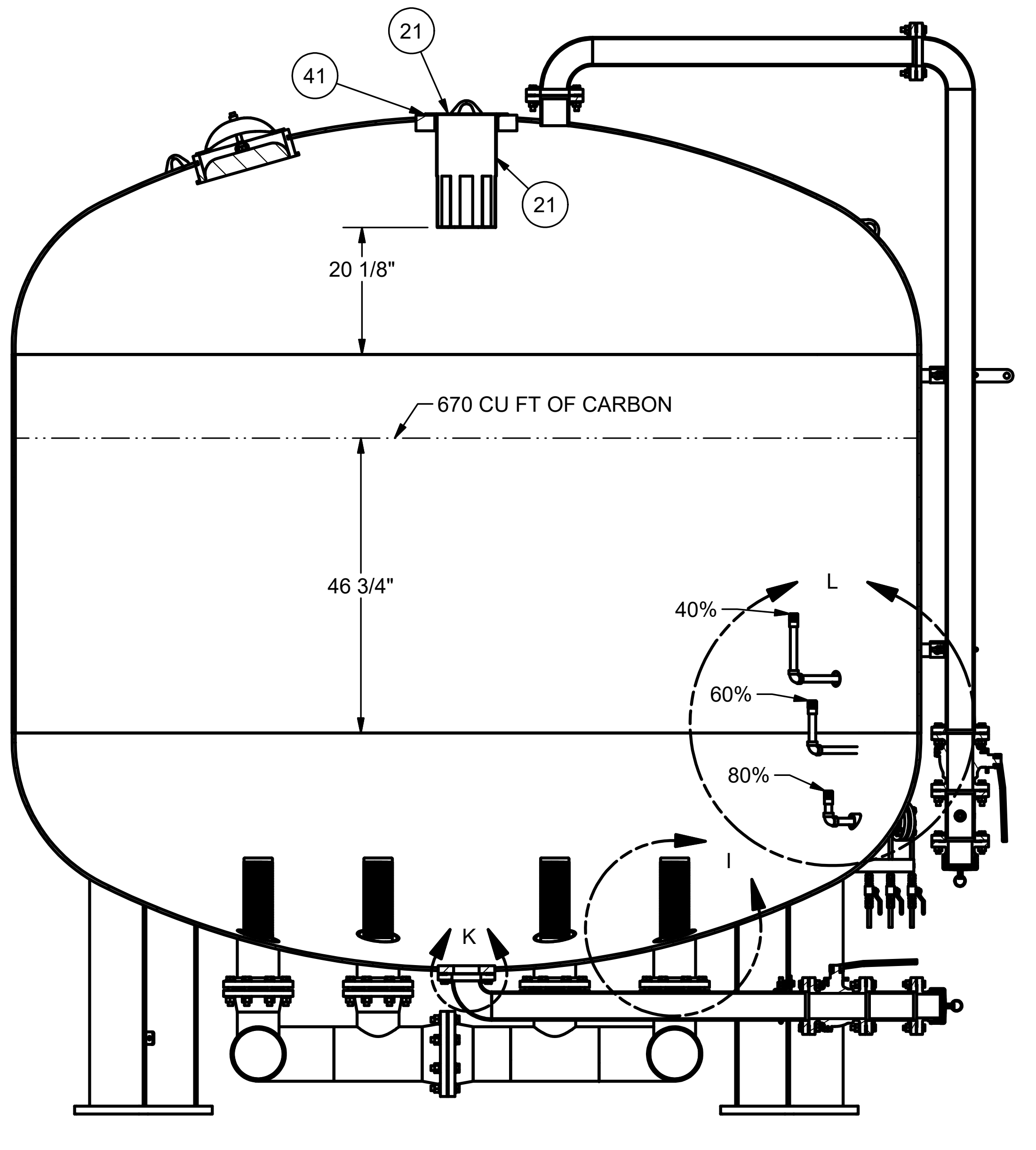


RIGHT SIDE

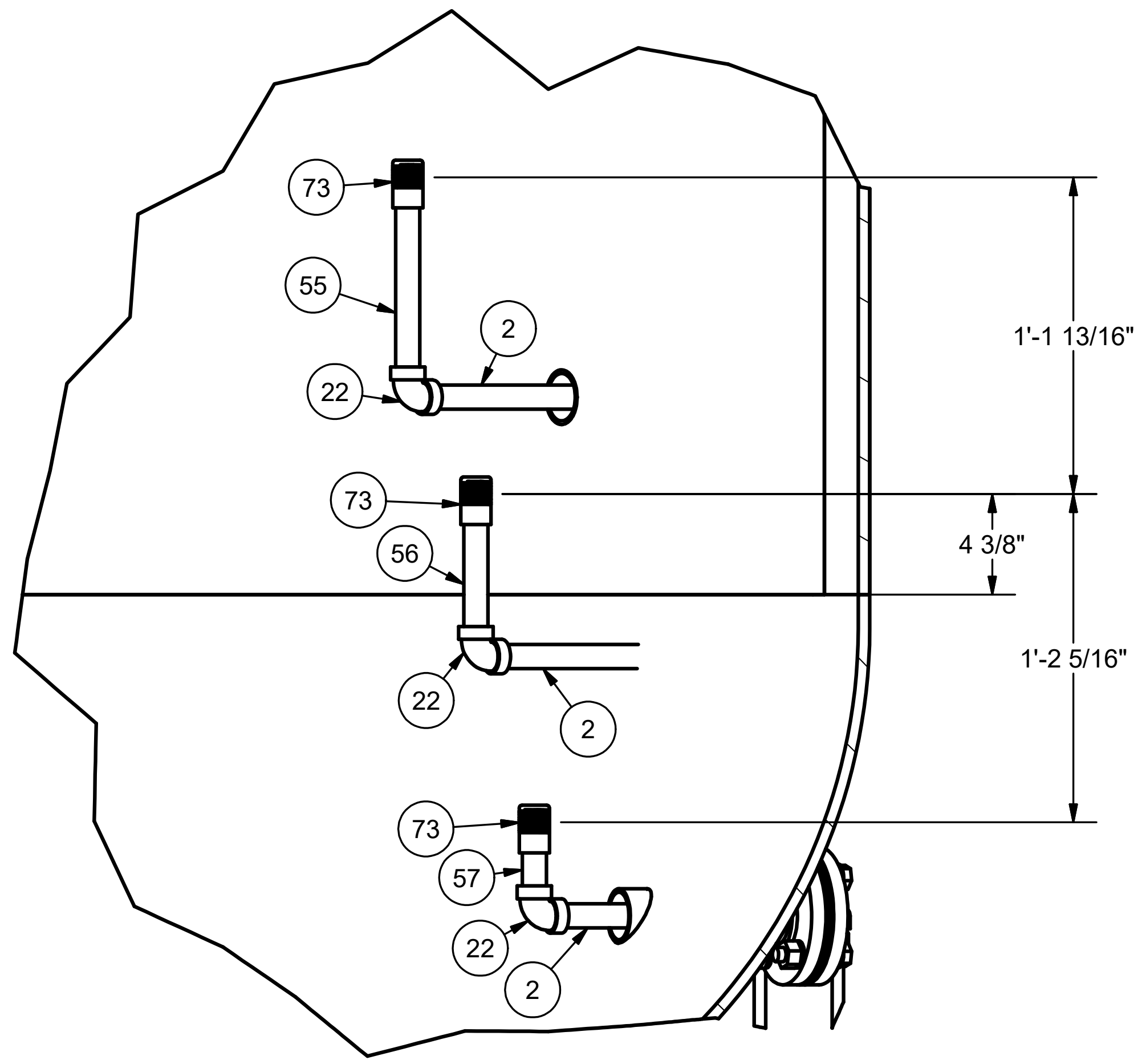
NOTE:
1. THIS DRAWING IS TO SHOW PIPING AND EQUIPMENT FOR CUSTOMER APPROVAL.
2. VESSELS SHALL BE 125 PSI, ASME CODE.
3. PIPING MATERIALS SHALL MEET: CS PIPE ASTM A-53 GRADE B (ERW); CS FITTINGS SA-234, ASME B16.9; SS THREADED FITTINGS ASTM A-351; SS PIPE ASTM A-312; SS BW FITTINGS ASTM A-403; MI THREADED FITTINGS ASME B-16.3.
4. SURFACE PREPERATION: VESSEL: SSPC-SP5 INTERIOR & SSPC-SP6 EXTERIOR. SYSTEM PIPING: SSPC-SP10 INTERIOR & SSPC-SP6 EXTERIOR.
5. FINISH VESSEL INTERIOR WITH 35-45 MILS OF PLASITE 4110, PREPARE AND APPLY STRICTLY IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS TO MEET NSF STD 61 REQUIREMENTS. LINING TO BE CONTINUOUS TO OD OF THE RAISED FACE ON ALL NOZZLE FLANGES.
6. FINISH VESSEL EXTERIOR WITH 3-5 MILS OF CARBOTHANE 133VOC URETHANE, COLOR TO BE 9225 CASHEW, OVER 5-8 MILS OF CARBOGUARD 60 RUST PREVENTATIVE EPOXY PRIMER, APPLIED PER MANUFACTURERS RECOMMENDATIONS.
7. RING HEADER, SLURRY PIPING, AND INTERCONNECTING PIPING TO BE FINISHED WITH 2-3 MILS OF SW POLYESTER TGIC TOPCOAT (COLOR: CARBOLINE #9225 CASHEW) OVER 8-12 MILS OF SW EPOXY PRIMER. PIPE 3" AND LARGER TO BE INTERNALLY LINED WITH 16MILS (MIN.) OF 3M SCOTCHKOTE 134 FUSION BONDED EPOXY.
8. VESSEL ESTIMATED SHIPPING WEIGHT: 16,500 LBS.
9. VESSEL ESTIMATED OPERATING WEIGHT: 81,500 LBS.
10. GROUTING AND ANCHORING BY OTHERS IF REQUIRED.
11. ±1" TOLERANCE ON CONNECTION DIMENSIONS.

DESIGNER: AMN	DATE 10/29/2021	TITLE	PF 12-520IX LOW PRO™ 125 PSI SINGLE TANK ASSEMBLY SIDE OUTLET
CHECKER: AJA	DATE 10/25/2021	CLIENT	SUEZ WATER TECHNOLOGIES CHEMOURS TERTIARY GAC SYSTEM - FAYETTEVILLE, NC
ENGINEER: JT	DATE		AqueoUS VETS® 16761 CLEAR CREEK ROAD REDDING, CA 96001 925-331-0573
MANAGER:	DATE		

SCALE:	PROJECT	CODE	DRAWING NUMBER	SHEET	REV
1/2" = 1'	M-00103		PF 12-520IX LP ST SO	1 OF 2	0



SECTION A-A



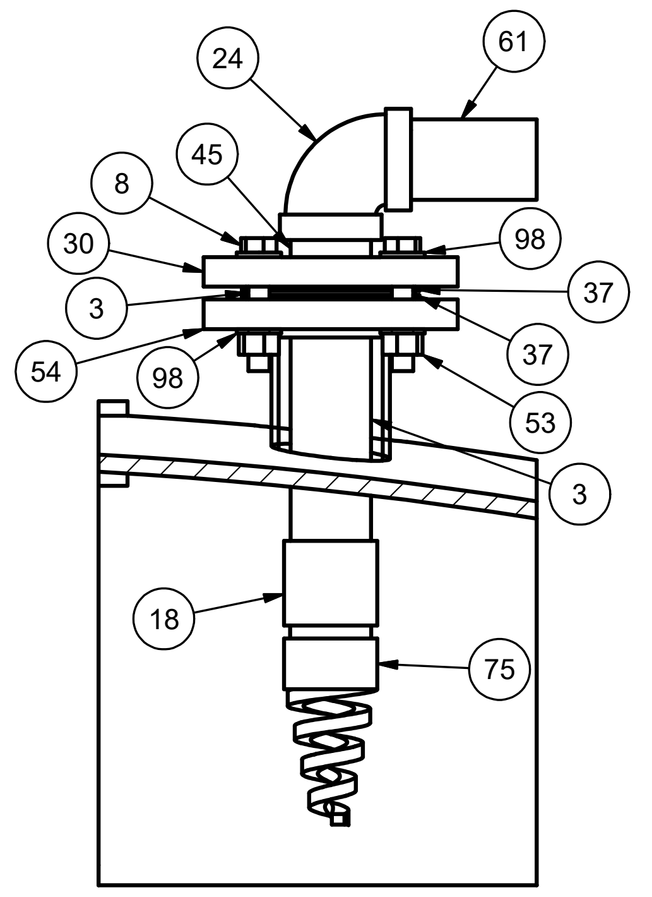
DETAIL L

PARTS LIST

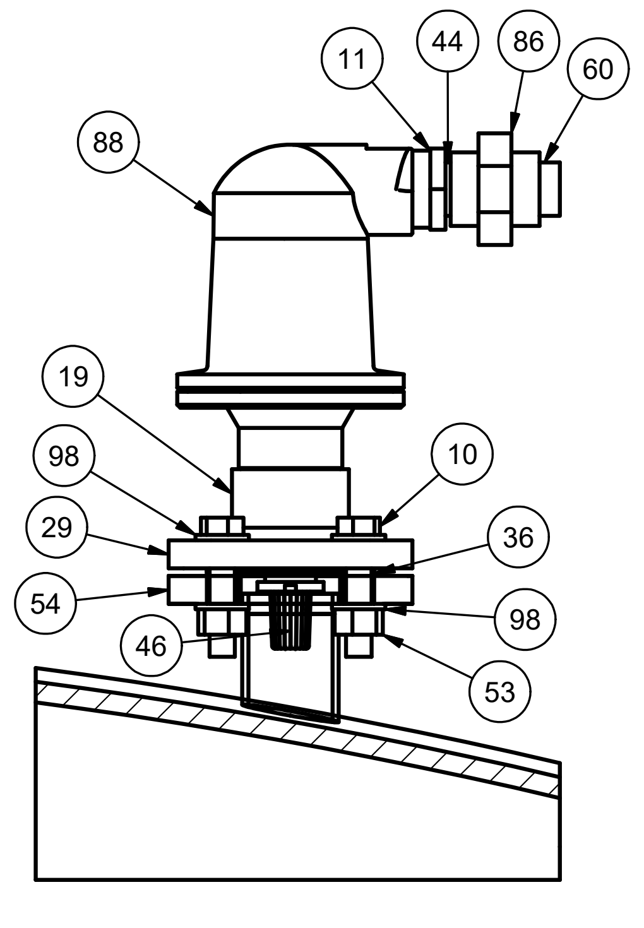
ITEM	QTY	DESCRIPTION	MATERIAL	LENGTH	WIDTH
1	3	ADAPTER, 0.5" COMP X 0.5" MPT 90° 316SS	STN STL, 316L		
2	3	ADAPTER, SAMPLE PORT WELDMENT 316SS			
3	1	ADAPTER, SPRAY NOZZLE 2" 316SS			
4	6	ADAPTER, STR 0.5" COMP x 0.5" NPT 316SS	STN STL, 316L		
5	3	BOLT, HEX 0.25IN D X 1IN L 304SS	Stainless Steel		
6	80	BOLT, HEX 0.75IN D X 4IN L HDG GR A307	Steel, Galvanized		
7	8	BOLT, HEX 0.625IN D X 2IN L HDG GR A307	Steel, Galvanized		
8	52	BOLT, HEX 0.625IN D X 3.5IN L HDG GR A307	Steel, Galvanized		
9	12	BOLT, HEX 0.625IN D X 3IN L 316SS	Stainless Steel		
10	20	BOLT, HEX 0.625IN D X 3IN L HDG GR A307	Steel, Galvanized		
11	1	BUSHING, 1.5IN x 1IN TxT STD WT 316SS	Stainless Steel		
12	1	CAMLOCK, 2" 316SS MALE X MPT	STN STL, 316		
13	2	CAMLOCK, 4" MALE X FLANGE 316SS	STN STL, 316L		
14	1	CAP, DUST 2" 316SS CAMLOCK	STN STL, 316		
15	2	CAP, DUST 4" 316SS FOR MALE CAMLOCK	STN STL, 304		
16	3	CLAMP, TUBE CUSHIONED 0.5" SS W/ RUBBER 17/64" HOLE FASTENAL# 0216777	STN STL, 18-8		
17	2	COUPLING, 1IN HALF THD 3000 316SS	Stainless Steel		
18	1	COUPLING, 2IN FULL THD STD WT 316SS	Stainless Steel		
19	1	COUPLING, 2IN HALF THD 3000 STL	Steel, Carbon		
20	3	COUPLING, UNIVERSAL 1" NPT 316SS DIXON RAM12	STN STL, 316L		
21	1	DIFFUSER, SLOTTED 10IN NOM 316SS	Stainless Steel		
22	3	ELBOW, 0.75IN 90 316L SS THD STD WT STD R	Stainless Steel		
23	1	ELBOW, 1IN 90 316L SS THD STD WT STD R	Stainless Steel		
24	2	ELBOW, 2IN 90 316L SS THD STD WT STD R	Stainless Steel		
25	2	ELBOW, 4IN 90 STL WELD SCH 40 LR	Steel, Carbon		
26	1	ELBOW, 4IN 90 STL WELD SCH 40 SR	Steel, Carbon		
27	3	ELBOW, 8IN 90 STL WELD SCH 40 LR	Steel, Carbon		
28	3	FLANGE, 2x0.5IN COMPANION CS 150# RF	Steel, Carbon		
29	1	FLANGE, 2x1IN COMPANION CS 150# RF	Steel, Carbon		
30	1	FLANGE, 3x2IN COMPANION CS 150# RF	Steel, Carbon		
31	10	FLANGE, 4IN SLIPON CS 150# RF	Steel, Carbon		
32	8	FLANGE, 6IN WELD NECK CS 150# RF	Steel, Carbon		
33	4	FLANGE, 8IN WELD NECK CS 150# RF	Steel, Carbon		
34	1	FLANGE, 10IN WELD NECK CS 150# RF	Steel, Carbon		
35	1	FLAT, 2X0.25 IN CS A36	Steel, Carbon	10.0000	
36	7	GASKET, FLG 2IN EPDM RING 0.125IN THK 150#	EPDM		
37	2	GASKET, FLG 3IN EPDM RING 0.125IN THK 150#	EPDM		
38	9	GASKET, FLG 4IN EPDM RING 0.125IN THK 150#	EPDM		
39	16	GASKET, FLG 6IN EPDM RING 0.125IN THK 150#	EPDM		
40	2	GASKET, FLG 8IN EPDM RING 0.125IN THK 150#	EPDM		
41	1	GASKET, FLG 10IN EPDM RING 0.125IN THK 150#	EPDM		
42	1	ID TAG 5.5X3.5	STN STL, 304		
43	3	NIPPLE, 1IN D X 1.5IN L SCH 40 316SS NPT TBE	Stainless Steel		
44	1	NIPPLE, 1IN D X 1.5IN L SCH 80 316SS NPT TBE	Stainless Steel		
45	2	NIPPLE, 2IN D X 2IN L SCH 40 316SS NPT TBE	Stainless Steel		
46	1	NOZZLE, 1" MNPT PP ORTHOS N8	POLYPROPENE		
47	3	NUT, HEX 0.25-20 UNC 304SS	Stainless Steel		
48	12	NUT, HVY HEX 0.5-13 UNC GALV 2H	Steel, Galvanized		
49	8	NUT, HVY HEX 0.25-20 UNC 316SS	Stainless Steel		
50	80	NUT, HVY HEX 0.75-10 UNC GALV 2H	Steel, Galvanized		

PARTS LIST

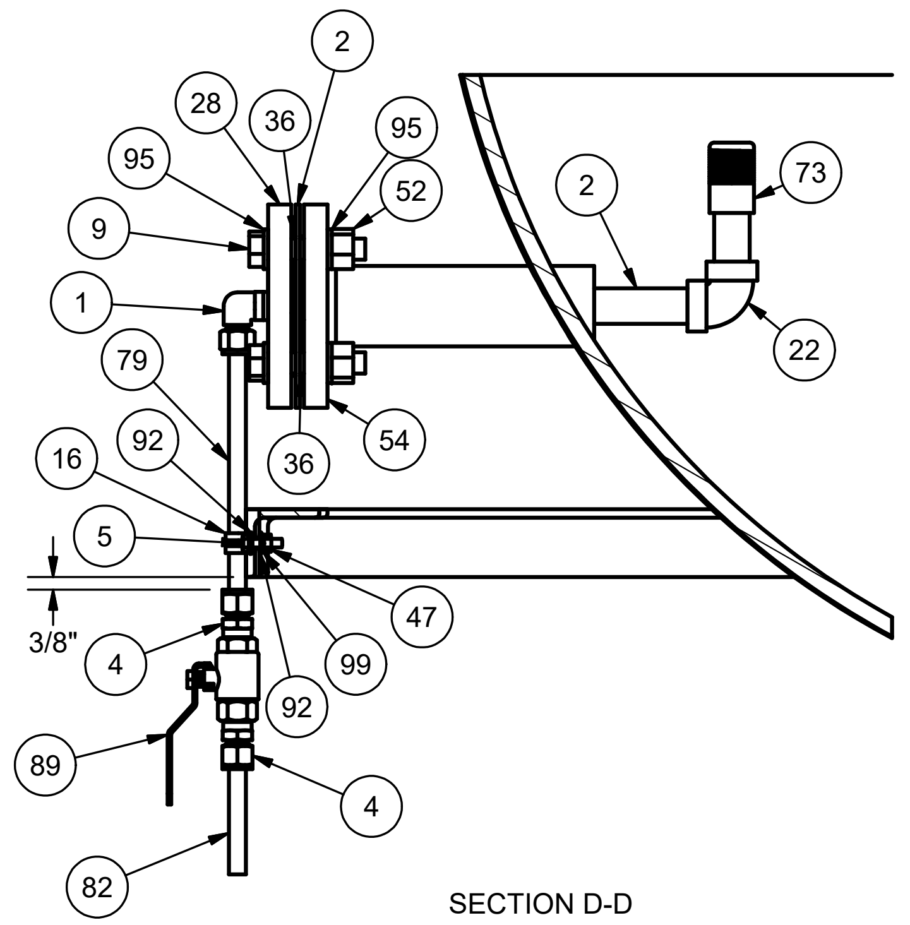
ITEM	QTY	DESCRIPTION	MATERIAL	LENGTH	WIDTH
51	8	NUT, HVY HEX 0.375-16 UNC 316SS	Stainless Steel		
52	12	NUT, HVY HEX 0.625-11 UNC 316SS	Stainless Steel		
53	72	NUT, HVY HEX 0.625-11 UNC GALV 2H	Steel, Galvanized		
54	1	PF 12-520LP LOW PROFILE 12 FT DIA 20K LB 125PSI BARE TANK			
55	1	PIPE, 0.75IN SCH 80 SST 316L	Stainless Steel	8.0000	
56	1	PIPE, 0.75IN SCH 80 SST 316L	Stainless Steel	5.5000	
57	1	PIPE, 0.75IN SCH 80 SST 316L	Stainless Steel	2.5000	
58	1	PIPE, 1IN SCH 40 SST 316L	Stainless Steel	17.0000	
59	1	PIPE, 1IN SCH 40 SST 316L	Stainless Steel	99.6427	
60	1	PIPE, 1IN SCH 40 SST 316L	Stainless Steel	47.4075	
61	1	PIPE, 2IN SCH 40 SST 316L	Stainless Steel	59.9375	
62	1	PIPE, 2IN SCH 40 SST 316L	Stainless Steel	101.5075	
63	2	PIPE, 4IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	7.0000	
64	1	PIPE, 4IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	49.7246	
65	1	PIPE, 4IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	101.5000	
66	1	PIPE, 4IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	50.7500	
67	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	14.0000	
68	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	5.0000	
69	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	14.0000	
70	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	5.0000	
71	2	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	5.9370	
72	1	REDUCER, CONC 10x8 WELD STL STD WT	Steel, Carbon		
73	3	SCREEN, 1.313IN OD X 1IN EFF X 0.75 FNPT CONN. 0.01IN SLOT 316LSS	Stainless Steel		
74	8	SEPTA, 4.5IN OD X 12IN EFF 0.012 SLOT 316SS	Stainless Steel		
75	1	SPRAY NOZZLE, 2" PVC NPT PN# 2HHSJ-PVC1701400	PVC		
76	1	TEE, 2x2x1IN 316SS THD 150# RED	Stainless Steel		
77	1	TEE, 8IN STL WELD STD WT STD	Steel, Carbon		
78	8	TEE, 8x8x6IN STL WELD STD WT RED	Steel, Carbon		
79	1	TUBE RND, 0.5IN 0.035 WALL SST 316L	Stainless Steel	8.7050	
80	1	TUBE RND, 0.5IN 0.035 WALL SST 316L	Stainless Steel	20.0050	
81	1	TUBE RND, 0.5IN 0.035 WALL SST 316L	Stainless Steel	31.3050	
82	3	TUBE RND, 0.5IN 0.035 WALL SST 316L	Stainless Steel	4.0000	
83	2	U-BOLT, 1IN PIPE 0.25IN DIA 316SS	Stainless Steel		
84	2	U-BOLT, 2IN PIPE 0.375IN DIA 316SS LONG TANGENT	Stainless Steel		
85	3	U-BOLT, 4IN PIPE 0.5IN DIA GALV LONG TANGENT	Steel, Galvanized		
86	1	UNION, 1IN 304 TxT 150#	STN STL, 304		
87	2	VALVE 4IN 316SS FULL PORT BALL VALVE MATCO PN#20SSFL11D	STN STL, 316		
88	1	VALVE, AIR/COMBO 2" NPT X 1.5" NPT CI BODY AIR D-040-C	Iron, Ductile		
89	3	VALVE, BALL 0.5IN NPT 316L PN#76F-103-01A	Stainless Steel		
90	4	VALVE, BALL 1IN NPT 316L PN#76F-105-01A	Stainless Steel		
91	1	VALVE, BALL 2IN NPT 316L PN#76F-108-01A	Stainless Steel		
92	6	WASHER, FLAT 0.25IN 304SS	Stainless Steel		
93	4	WASHER, FLAT SMALL OD 0.25IN 316SS	Stainless Steel		
94	4	WASHER, FLAT SMALL OD 0.375IN 316SS	Stainless Steel		
95	24	WASHER, FLAT SMALL OD M16 A4 0.625IN 316SS	Stainless Steel		
96	6	WASHER, FLAT STRL 0.5IN GALV	Steel, Galvanized		
97	160	WASHER, FLAT STRL 0.75IN GALV	Steel, Galvanized		
98	152	WASHER, FLAT STRL 0.625IN GALV	Steel, Galvanized		
99	3	WASHER, LOCK 0.25IN 304SS	Stainless Steel		



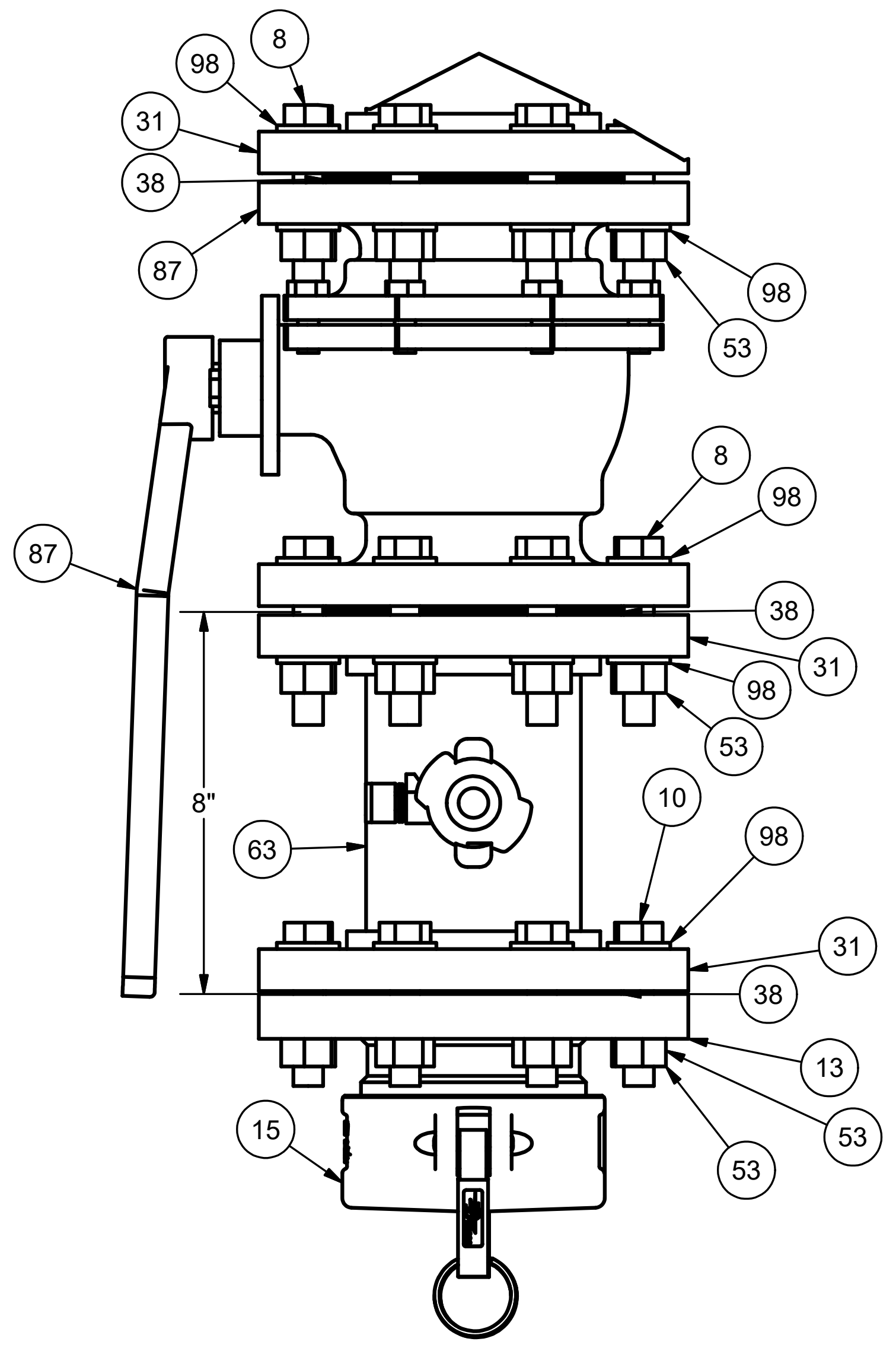
SECTION B-B
2" WASH DOWN
(QTY. 1)



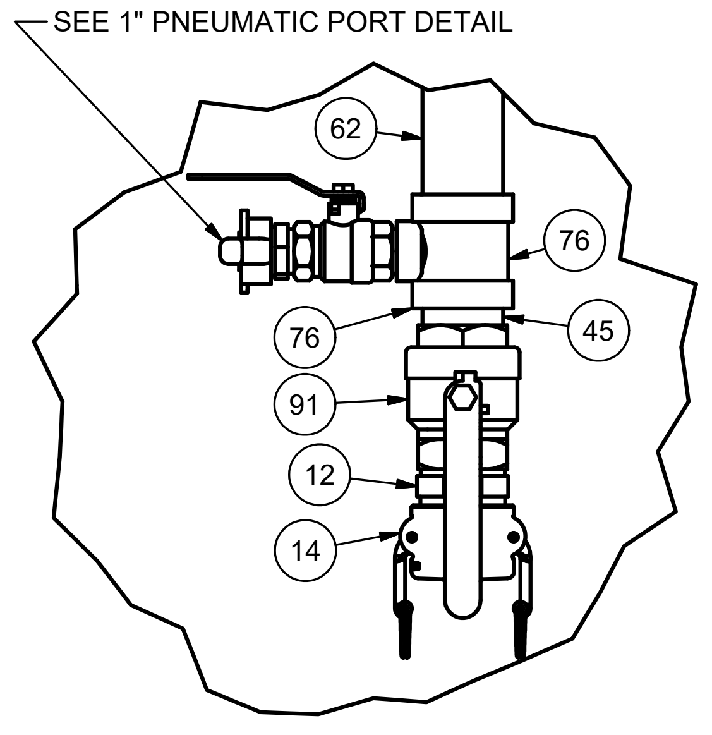
SECTION C-C
AIR RELEASE
(QTY. 1)



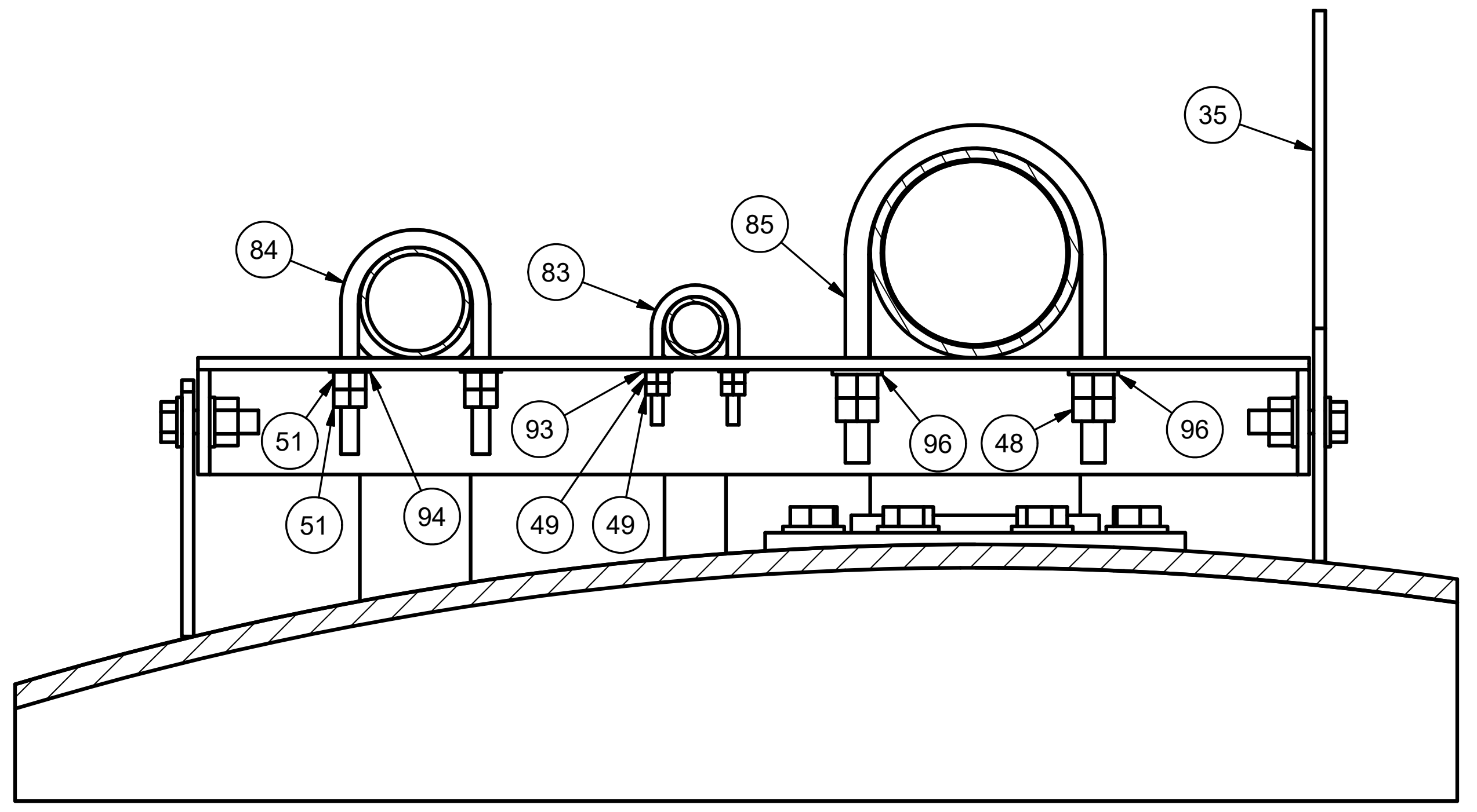
SECTION D-D
VESSEL SAMPLE PORT
(QTY. 3)



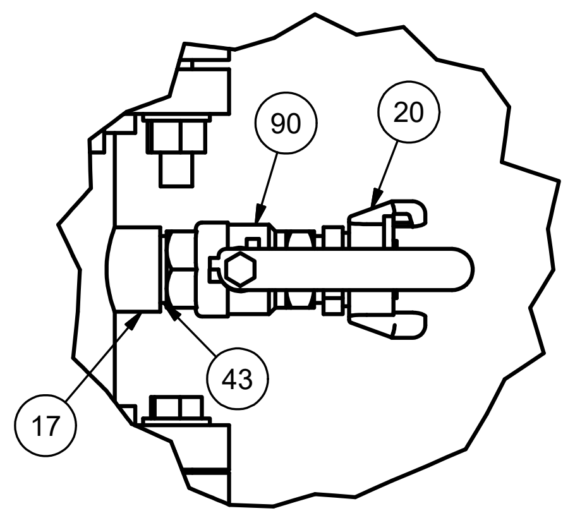
DETAIL H
4" SLURRY CONNECTION
(QTY. 2)



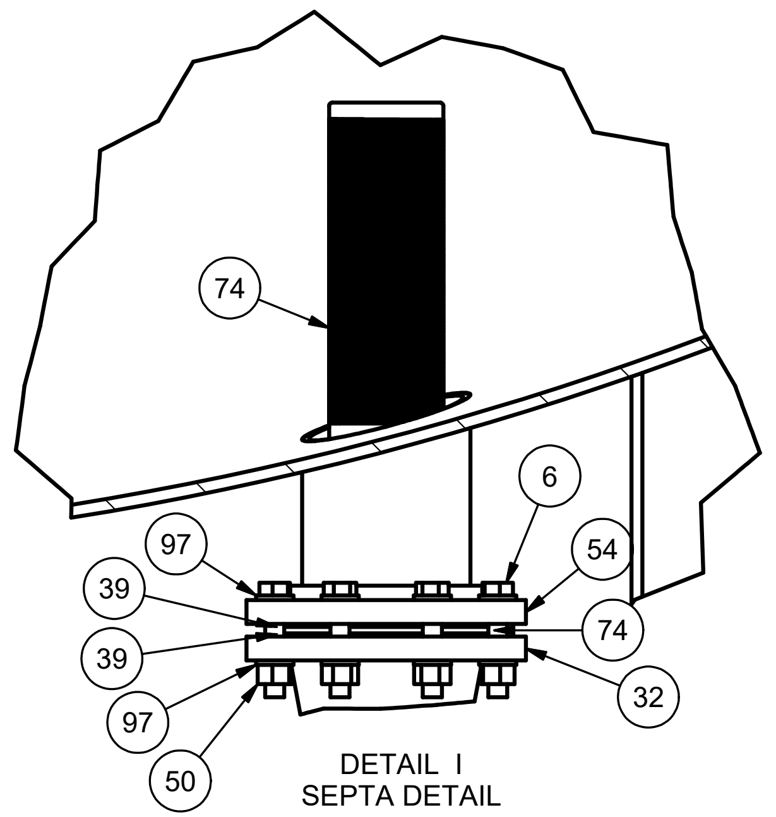
DETAIL F
2" WASHDOWN CONNECTION
(QTY.1)



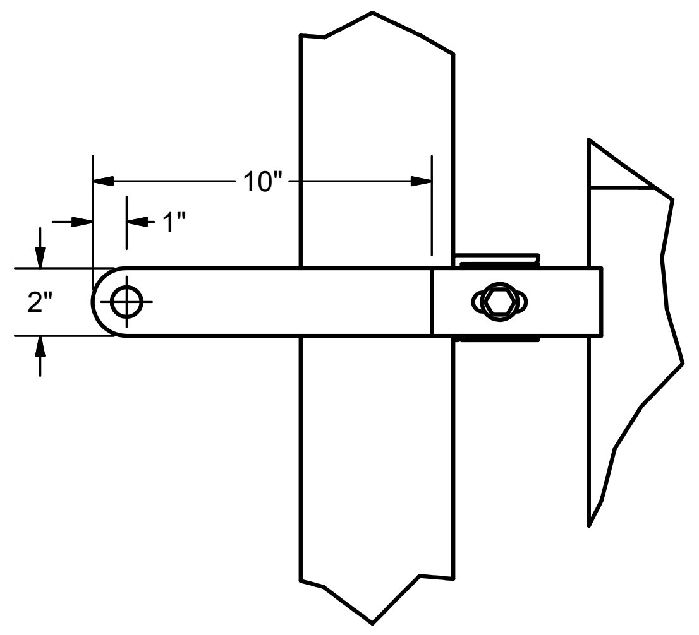
SECTION E-E



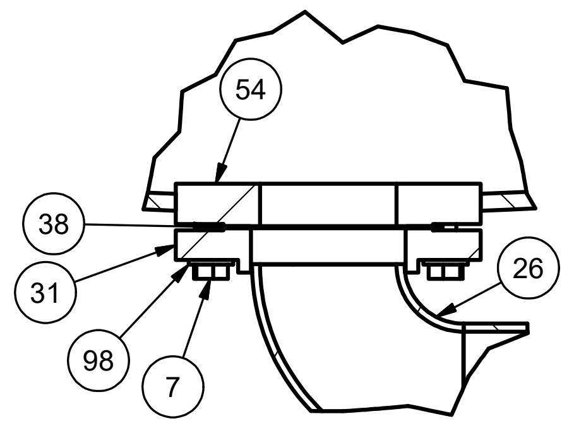
DETAIL G
1" PNEUMATIC CONNECTION
(QTY. 3)



DETAIL I
SEPTA DETAIL
(QTY. 8)



DETAIL J
LADDER TIE-OFF
(QTY. 1)



DETAIL K
MEDIA OUT PAD FLANGE
(QTY. 1)

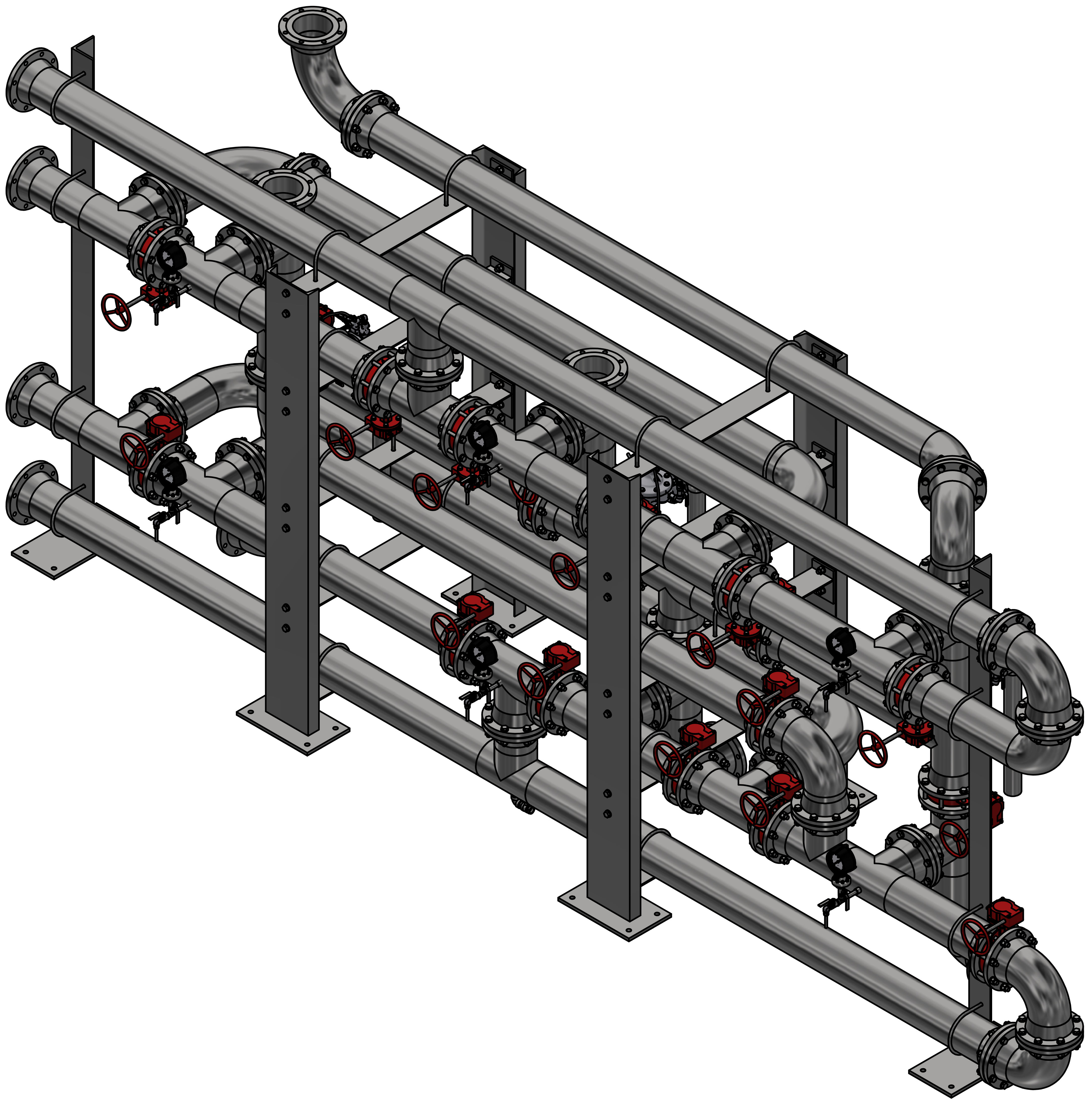
DESIGNER:	DATE
AMN	10/29/2021
CHECKER:	DATE
AJA	10/25/2021
ENGINEER:	DATE
JT	
MANAGER:	DATE
SCALE: 1/2" = 1'	

TITLE
PF 12-520IX LOW PRO™ 125 PSI SINGLE TANK ASSEMBLY
SIDE OUTLET

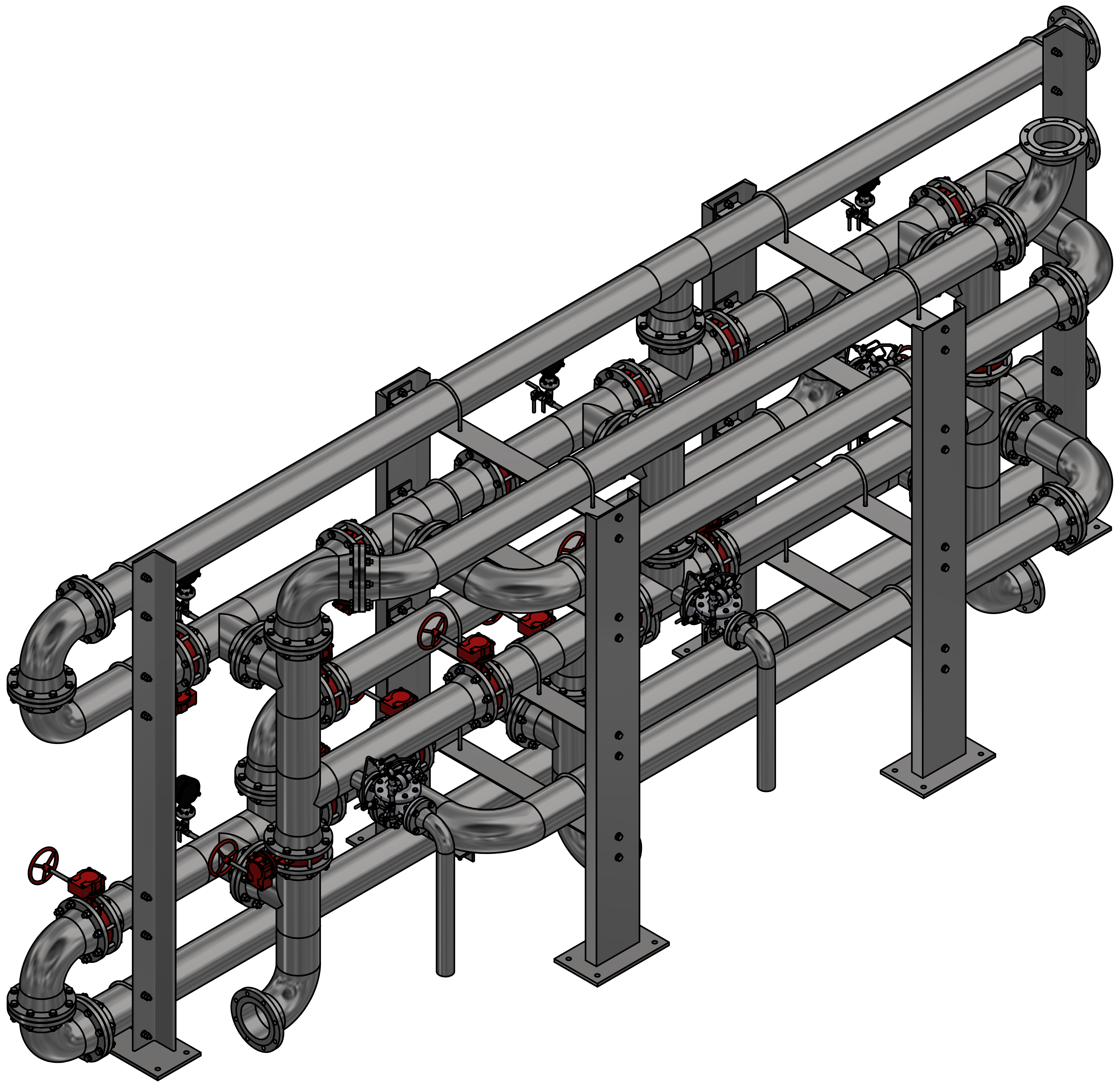
CLIENT
SUEZ WATER TECHNOLOGIES
CHEMOURS TERTIARY GAC SYSTEM - FAYETTEVILLE, NC

AqueoUSVETS®
16761 CLEAR CREEK ROAD
REDDING, CA 96001
925-331-0573

PROJECT	CODE	DRAWING NUMBER	SHEET	REV
M-00103		PF 12-520IX LP ST SO	2 OF 2	0



FRONT ISO VIEW



REAR ISO VIEW

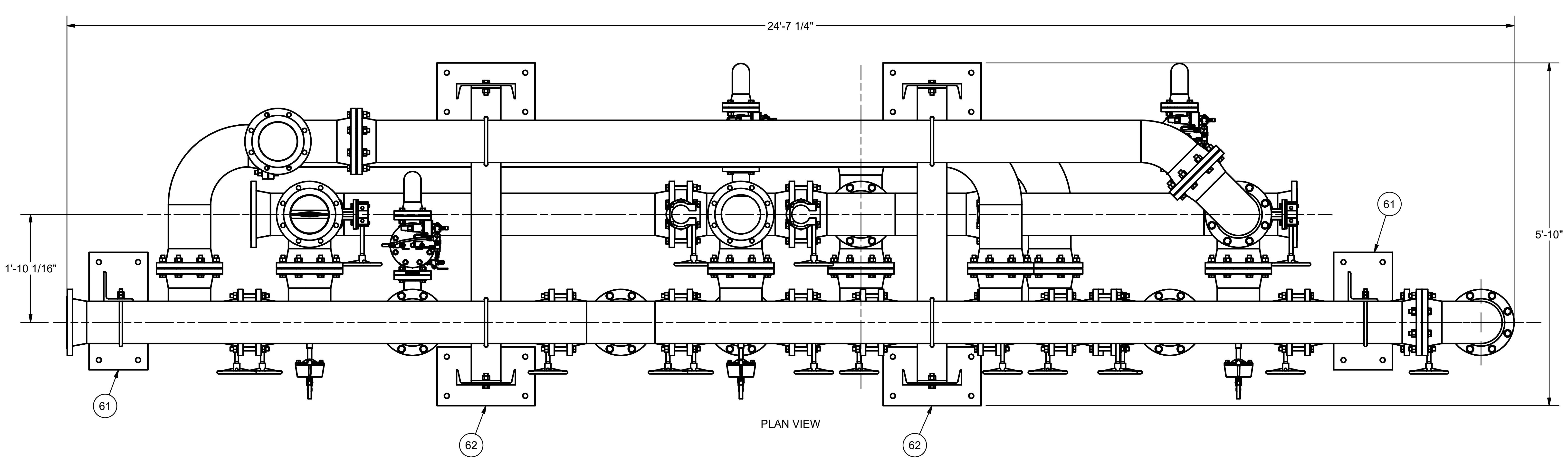
DESIGNER: AJA
DATE 11/12/2021
CHECKER: RM
DATE 11/12/2021
ENGINEER: JT
DATE 11/12/2021
MANAGER:
DATE
SCALE: 3/4" = 1'

TITLE
MANIFOLD, 8" CS 3 VESSEL 4 TIER W/ PRV

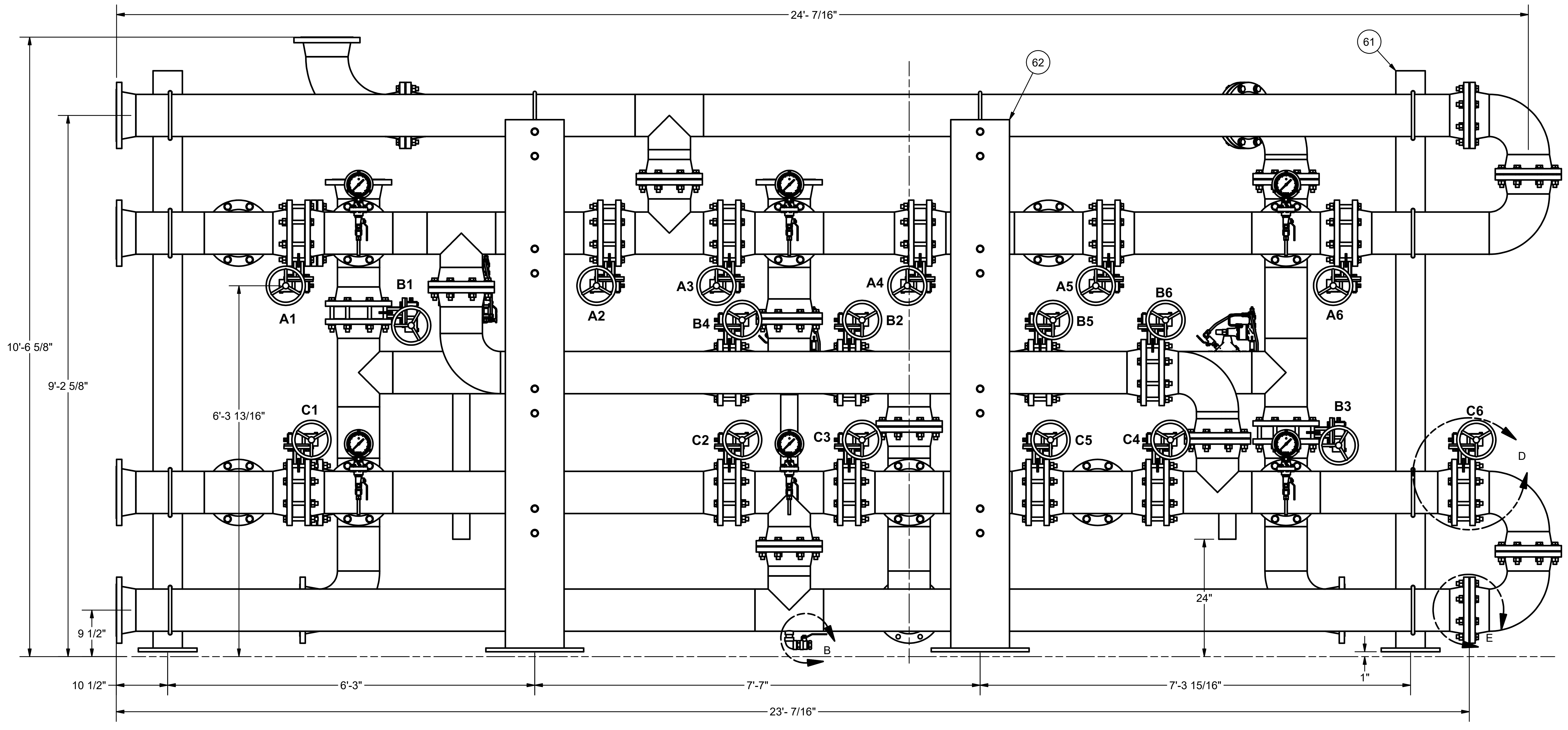
CLIENT
SUEZ WATER TECHNOLOGIES
CHEMOURS TERTIARY GAC SYSTEM - FAYETTEVILLE, NC

AqueoUS VETS®
16761 CLEAR CREEK ROAD
REDDING, CA 96001
925-331-0573

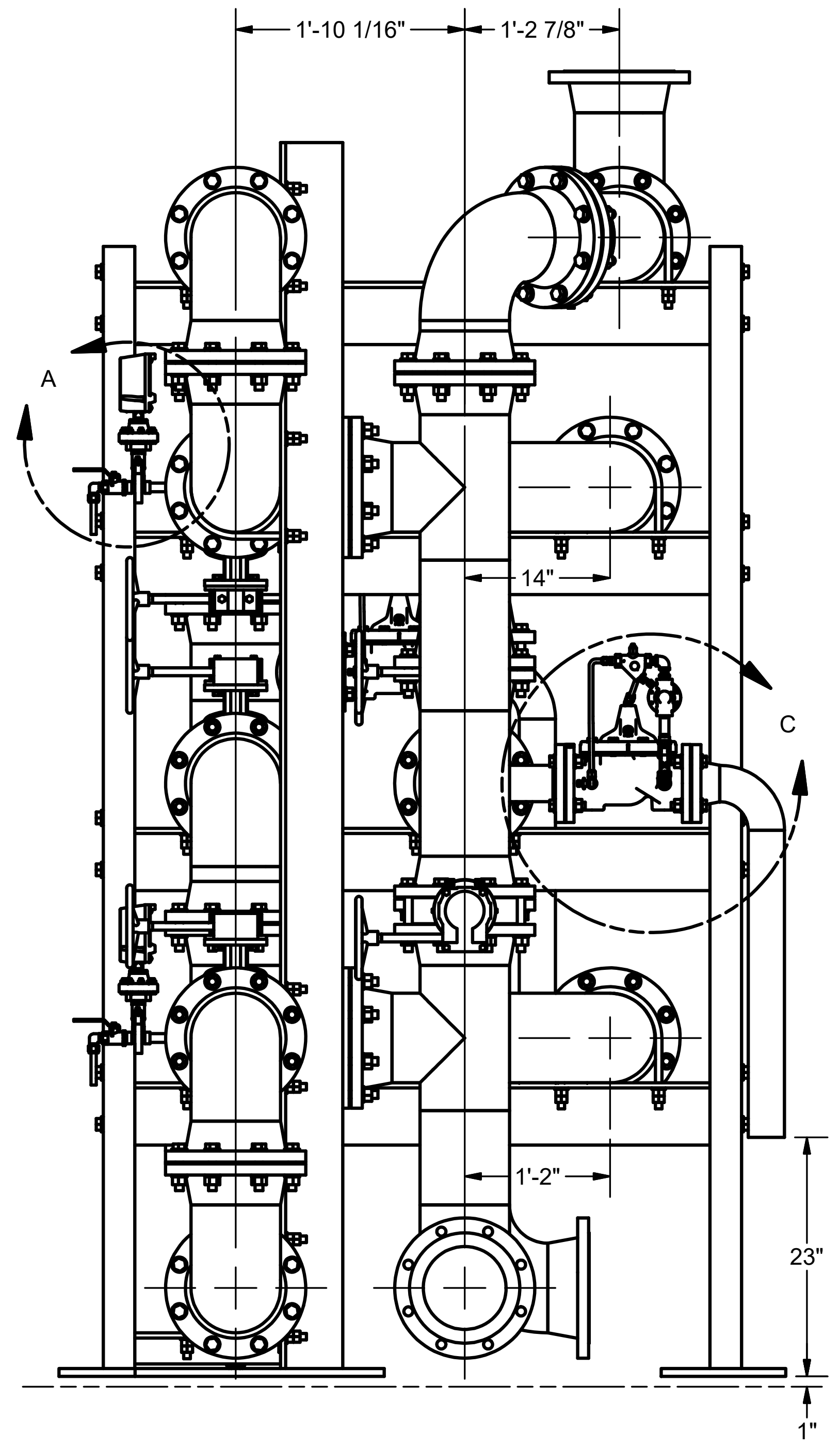
PROJECT	CODE	DRAWING NUMBER	SHEET	REV
M-00103		Man 8in CS 4 Tier PRV 3 Vessel	1 OF 4	0



PLAN VIEW

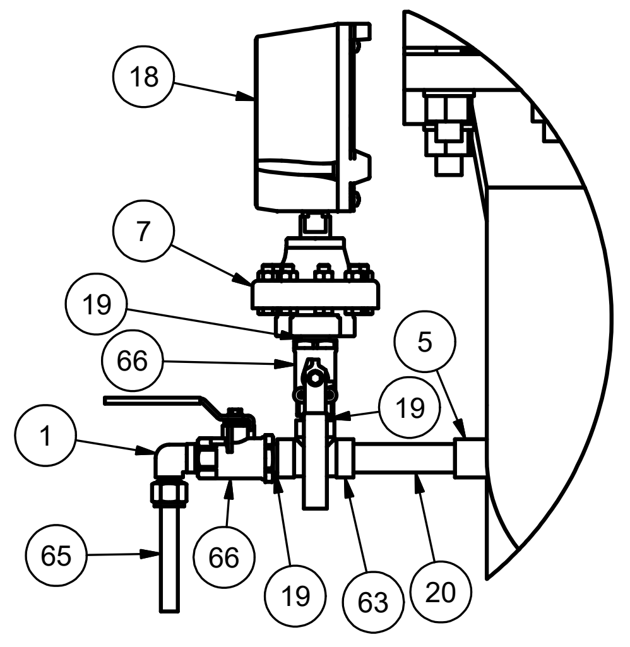


ELEVATION VIEW

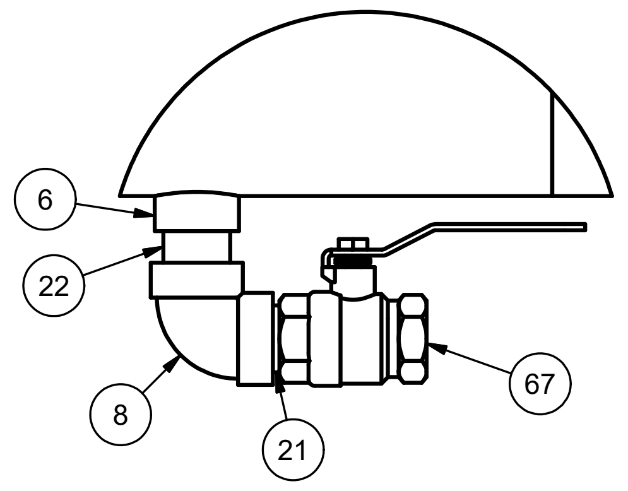


RIGHT SIDE VIEW

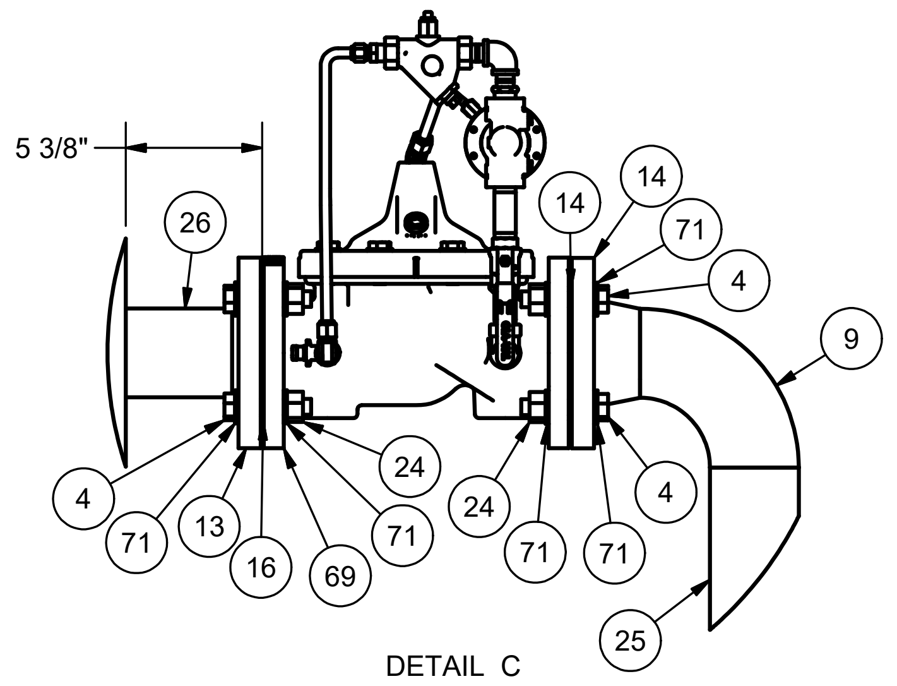
PARTS LIST					
ITEM	QTY	DESCRIPTION	MATERIAL	LENGTH	WIDTH
1	6	ADAPTER, 0.5" COMP X 0.5" MPT 90° 316SS	STN STL, 316L		
2	200	BOLT, HEX 0.75IN D X 4IN L HDG GR A307	Steel, Galvanized		
3	144	BOLT, HEX 0.75IN D X 6.5IN L HDG GR A307	Steel, Galvanized		
4	24	BOLT, HEX 0.625IN D X 3IN L HDG GR A307	Steel, Galvanized		
5	6	COUPLING, 0.5IN FULL THD 3000 316SS	Stainless Steel		
6	1	COUPLING, 1IN HALF THD 3000 316SS	Stainless Steel		
7	6	DIAPHRAGM SEAL, 1/2" NPT 316SS GLYCERINE FILLED ASHCROFT# 50-100SS-04T-XCG	Stainless Steel		
8	1	ELBOW, 1IN 90 GALV THD STD WT STD R	Steel, Galvanized		
9	3	ELBOW, 3IN 90 STL WELD SCH 40 LR	Steel, Carbon		
10	1	ELBOW, 8IN 45 STL WELD SCH 40 LR	Steel, Carbon		
11	5	ELBOW, 8IN 90 STL WELD SCH 40 LR	Steel, Carbon		
12	10	ELBOW, 8IN 90 STL WELD SCH 40 SR	Steel, Carbon		
13	3	FLANGE, 3IN SLIPON CS 150# RF	Steel, Carbon		
14	3	FLANGE, 3IN WELD NECK CS 150# RF	Steel, Carbon		
15	96	FLANGE, 8IN WELD NECK CS 150# RF	Steel, Carbon		
16	6	GASKET, FLG 3IN EPDM RING 0.125IN THK 150# GARLOCK 98206	EPDM		
17	25	GASKET, FLG 8IN EPDM RING 0.125IN THK 150# GARLOCK 98206	EPDM		
18	6	GAUGE, PRESSURE 0-160 PSI 4.5"DIA 0.5"L NPT ASHCROFT 45-1279SS-04L-160#	Phenolic Resin		
19	18	NIPPLE, 0.5IN D X 1.125IN L SCH 40 316SS NPT TBE	Stainless Steel		
20	6	NIPPLE, 0.5IN D X 4IN L SCH 40 316SS NPT TBE	Stainless Steel		
21	1	NIPPLE, 1IN D X 1.5IN L SCH 40 316SS NPT TBE	Stainless Steel		
22	1	NIPPLE, 1IN D X 2IN L SCH 40 316SS NPT TBE	Stainless Steel		
23	344	NUT, HVY HEX 0.75-10 UNC GALV 2H	Steel, Galvanized		
24	24	NUT, HVY HEX 0.625-11 UNC GALV 2H	Steel, Galvanized		
25	2	PIPE, 3IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	29 9⁄16 in	
26	3	PIPE, 3IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	5 ½ in	
27	1	PIPE, 3IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	40 ¼ in	
28	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	14 ½ in	
29	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	102 in	
30	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	152 7⁄16 in	
31	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	133 7⁄16 in	
32	3	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	9 1⁄16 in	
33	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	63 ½ in	
34	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	127 15⁄16 in	
35	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	143 7⁄16 in	
36	4	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	9 in	
37	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	14 ½ in	
38	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	63 ½ in	
39	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	2 7⁄16 in	
40	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	128 in	
41	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	4 in	
42	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	24 in	
43	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	10 ½ in	
44	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	6 7⁄16 in	
45	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	14 ½ in	
46	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	24 in	
47	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	14 in	
48	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	18 in	
49	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	7 in	
50	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	1 in	
51	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	156 in	
52	2	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	14 in	
53	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	38 in	
54	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	5 7⁄16 in	
55	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	126 ½ in	
56	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	14 in	
57	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	24 in	
58	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	2 in	
59	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	1 7⁄16 in	
60	1	PIPE, 8IN SCH 40 STL A53-SA53 GRADE B	Steel, Carbon	2 in	
61	2	STAND MAN 8IN 3 VESSEL "A" ANGLE STYLE			
62	2	STAND MAN 8IN 3 VESSEL "B" H STYLE			
63	6	TEE, 0.5IN 316 SS THD 150# STD	Stainless Steel		
64	26	TEE, 8IN STL WELD STD WT STD	Steel, Carbon		
65	6	TUBE RND, 0.5IN 0.035 WALL SST 316L	Stainless Steel	4 in	
66	12	VALVE, BALL 0.5IN NPT 316L SS APOLLO 76F-103-01A	Stainless Steel		
67	1	VALVE, BALL 1IN NPT 316L SS APOLLO 76F-105-01A	Stainless Steel		
68	18	VALVE, BFLY WFR HW 8" CI BDY NYLON COATED DI DISC EPDM SEAT BRAY S30;			
69	3	VALVE, PRV 3" FLGD DI/BDY 125PSI CLA-VAL 50-01;			
70	688	WASHER, FLAT STRL 0.75IN GALV	Steel, Galvanized		
71	48	WASHER, FLAT STRL 0.625IN GALV	Steel, Galvanized		



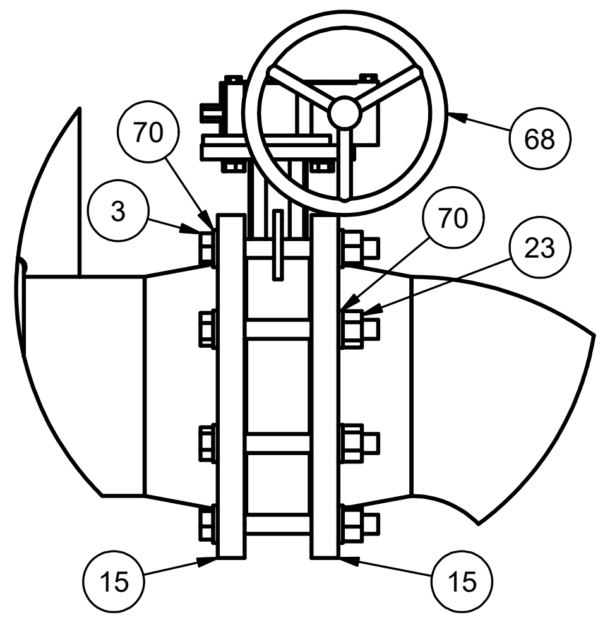
DETAIL A
1/2" SAMPLE PORT ASSY.
QTY. 6



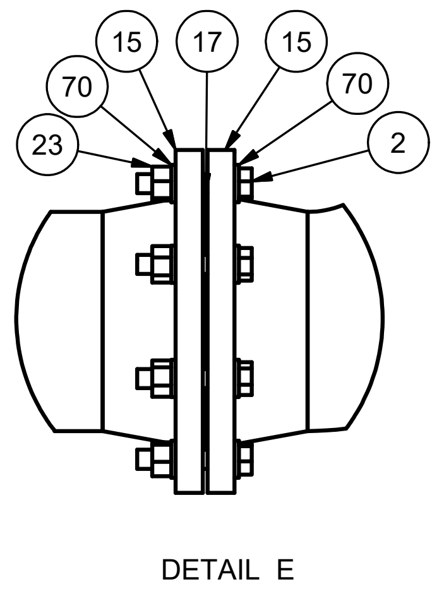
DETAIL B
1" MANIFOLD DRAIN
QTY. 1



DETAIL C
3" PRV DETAIL
QTY. 3



DETAIL D
8" BFV FLANGE DETAIL (TYP.)
QTY. 18



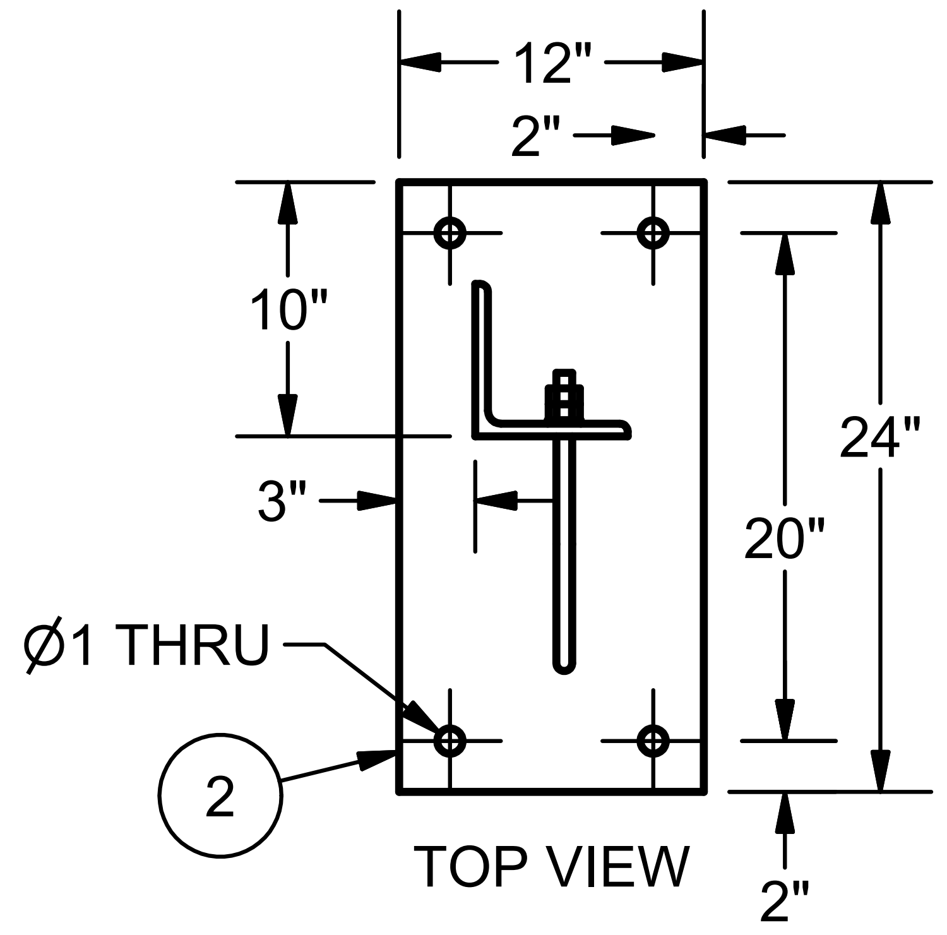
DETAIL E
8" FLANGE DETAIL (TYP.)

NOTES:
1. PIPING MATERIALS SHALL MEET: CS PIPE ASTM A-53 GRADE B (ERW);CS FITTINGS SA-234, ASME B16.9; SS THREADED FITTINGS ASTM A-351; SS PIPE ASTM A-312; SS BW FITTINGS ASTM A-403; MI THREADED FITTINGS ASME B-16.3.
2. MANIFOLD SURFACE PREPERATION: SSPC-SP10 INTERIOR & SSPC-SP6 EXTERIOR.
3. CS PROCESS PIPE TO BE FINISHED WITH 2-3 MILS OF SW POLYESTER TGIC TOPCOAT (COLOR: CARBOLINE #9225 CASHEW) OVER 8-12 MILS OF SW EPOXY PRIMER.
4. CS PROCESS PIPE TO BE INTERNALLY LINED WITH 16MILS (MIN.) OF 3M SCOTCHKOTE 134 FUSION BONDED EPOXY.
5. ESTIMATED SHIPPING WEIGHT: 14,000 LBS.
6. GROUTING AND ANCHORING BY OTHERS IF REQUIRED.
7. STANDS DESIGNED TO BE USED WITH 1" SHIMS.
8. ± 1" TOLERANCE ON CONNECTION DIMENSIONS.

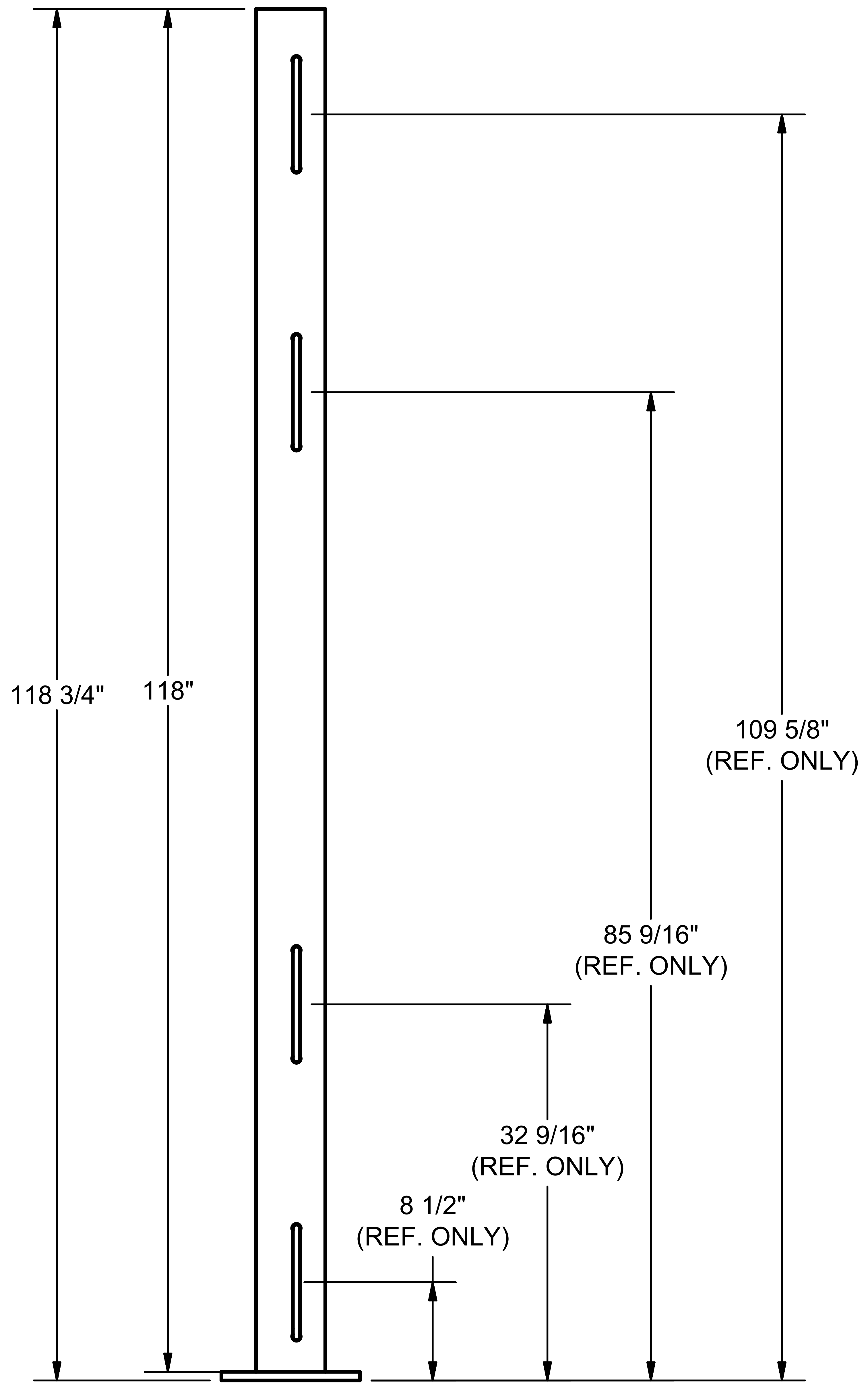
DESIGNER: AJA	DATE 11/12/2021	TITLE MANIFOLD, 8" CS 3 VESSEL 4 TIER W/ PRV				
CHECKER: RM	DATE 11/12/2021	CLIENT SUEZ WATER TECHNOLOGIES CHEMOURS TERTIARY GAC SYSTEM - FAYETTEVILLE, NC				
ENGINEER: JT	DATE 11/12/2021	AqueoUS VETS® 16761 CLEAR CREEK ROAD REDDING, CA 96001 925-331-0573				
MANAGER:	DATE					
SCALE: 3/4" = 1'		PROJECT M-00103	CODE	DRAWING NUMBER Man 8in CS 4 Tier PRV 3 Vessel	SHEET 2 OF 4	REV 0

PARTS LIST

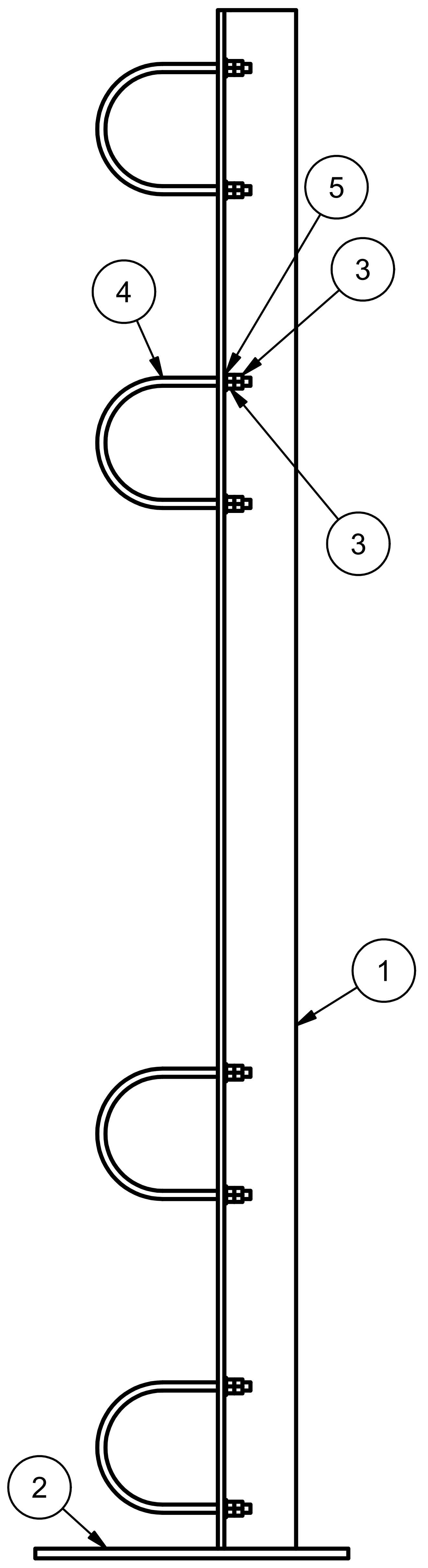
ITEM	QTY	DESCRIPTION	MATERIAL	LENGTH	WIDTH
1	1	ANGLE, CS A36 6X6X0.5 IN	Steel, Carbon	118 in	
2	1	FLAT, 12X0.75 IN CS A36	Steel, Carbon	24 in	
3	16	NUT, HVY HEX 0.625-11 UNC GALV 2H	Steel, Galvanized		
4	4	U-BOLT, 8IN PIPE 0.625IN DIA GALV LONG TANGENT	Steel, Galvanized		
5	8	WASHER, FLAT STRL 0.625IN GALV	Steel, Galvanized		



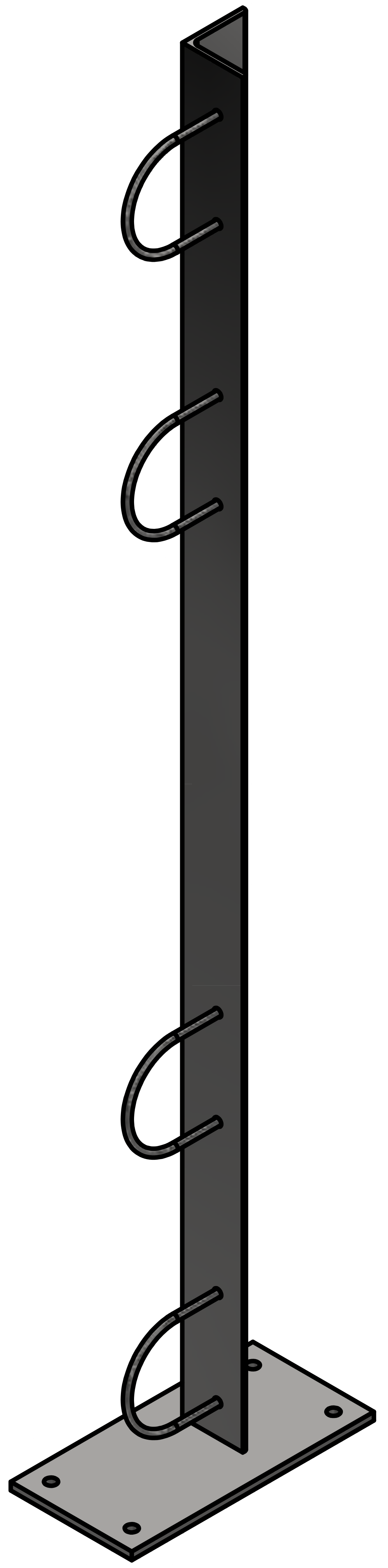
TOP VIEW



FRONT VIEW



SIDE VIEW



NOTE, UNLESS OTHERWISE SPECIFIED;

1. STANDS DESIGNED TO BE USED WITH 1" SHIMS.
2. STAND TO BE COATED WITH 2-3 MILS OF SW POLYESTER TGIC TOPCOAT (COLOR: CARBOLINE #9225 CASHEW) OVER 8-12 MILS OF SW EPOXY PRIMER.
3. BREAK ALL SHARP EDGES AND CORNERS.
4. ESTIMATED WEIGHT: 275 LBS.

COMPANY CONFIDENTIAL INFORMATION

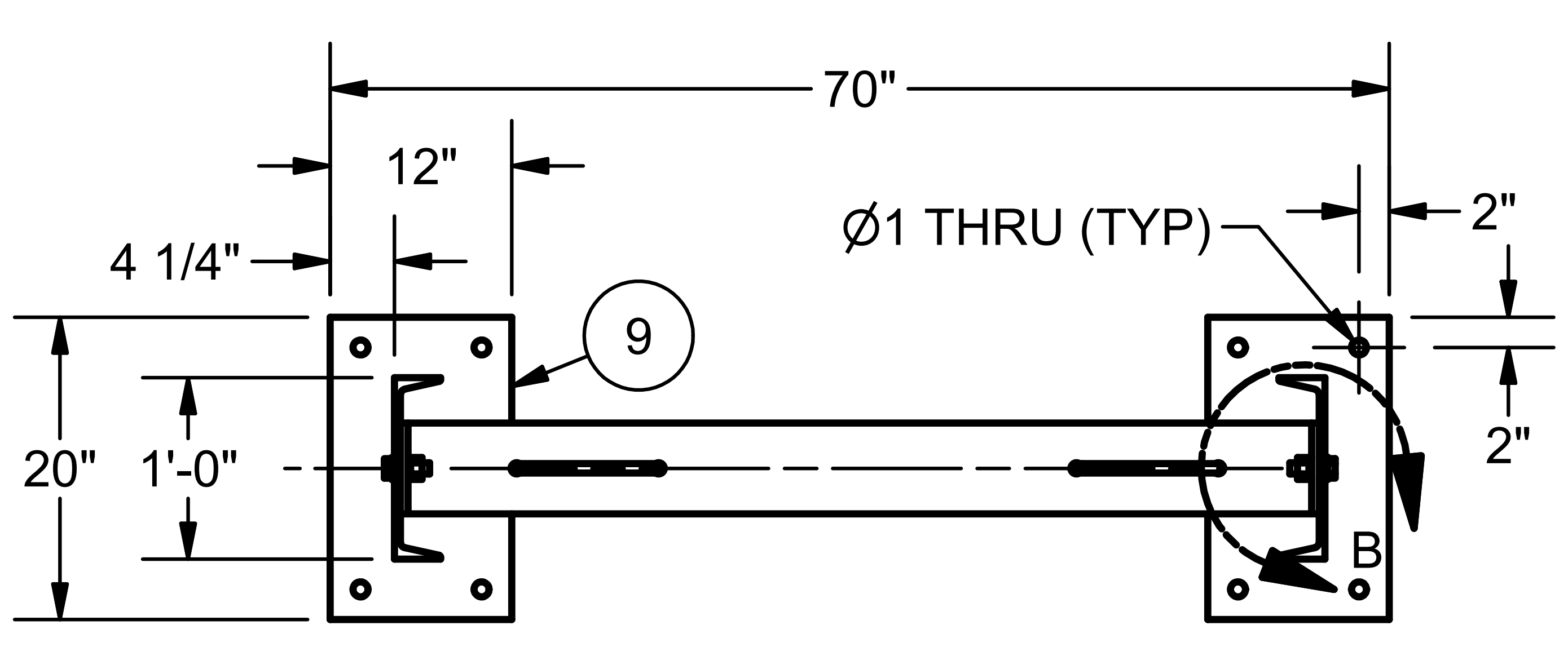
DESIGNER: AJA	DATE 11/12/2021	
CHECKER: RM	DATE 11/12/2021	
ENGINEER: JT	DATE 11/12/2021	
MANAGER:	DATE	
SCALE: 1:16		

TITLE
PIPE SUPPORT "A"
SINGLE PIPE STAND
QTY. 2

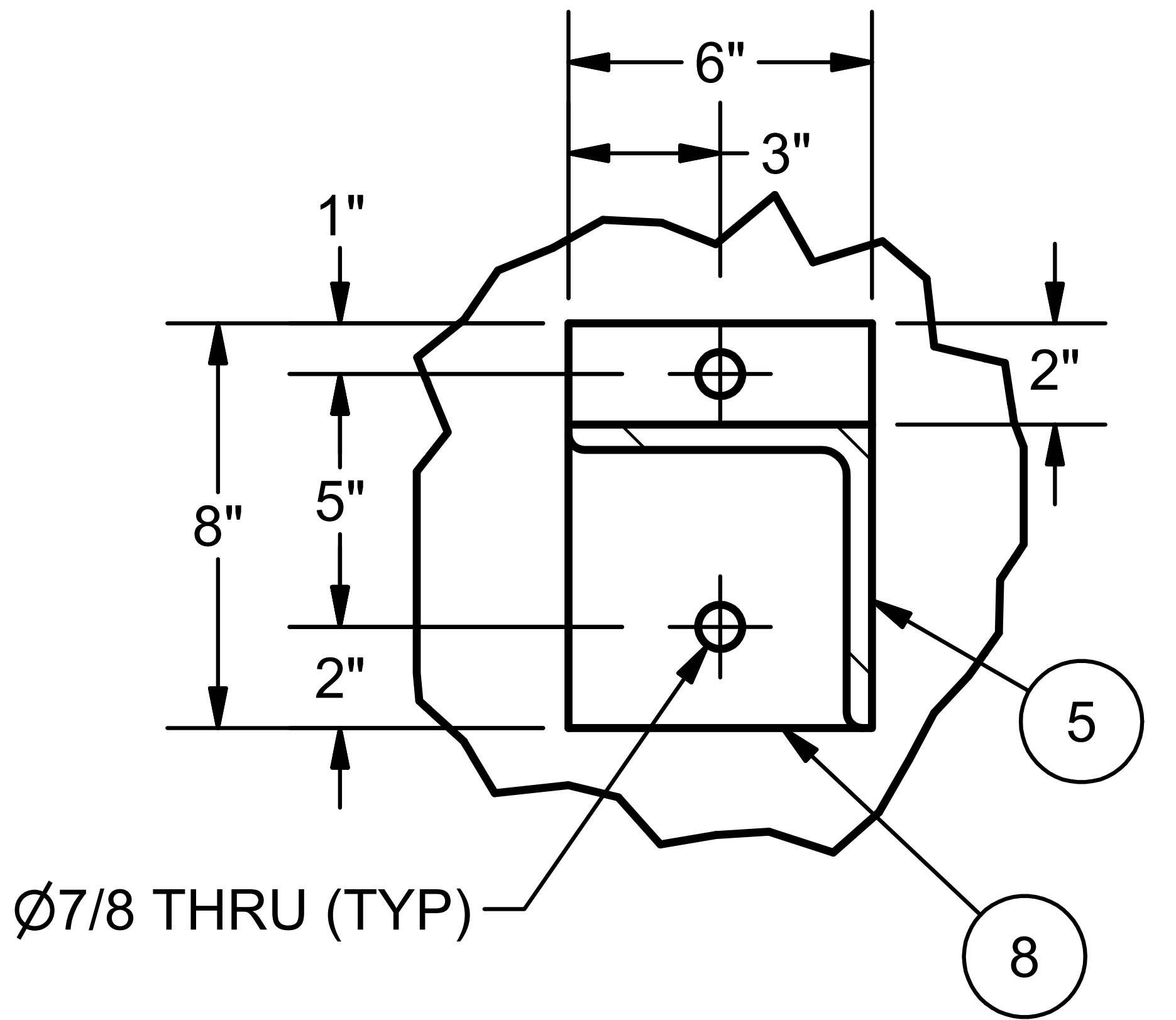
CLIENT
SUEZ WATER TECHNOLOGIES
CHEMOURS TERTIARY GAC SYSTEM - FAYETTEVILLE, NC

AqueoUS VETS®
16761 CLEAR CREEK ROAD
REDDING, CA 96001
925-331-0573

PROJECT	CODE	DRAWING NUMBER	SHEET	REV
M-00103		STAND MAN 8IN 3 VESSEL A	1 OF 1	0



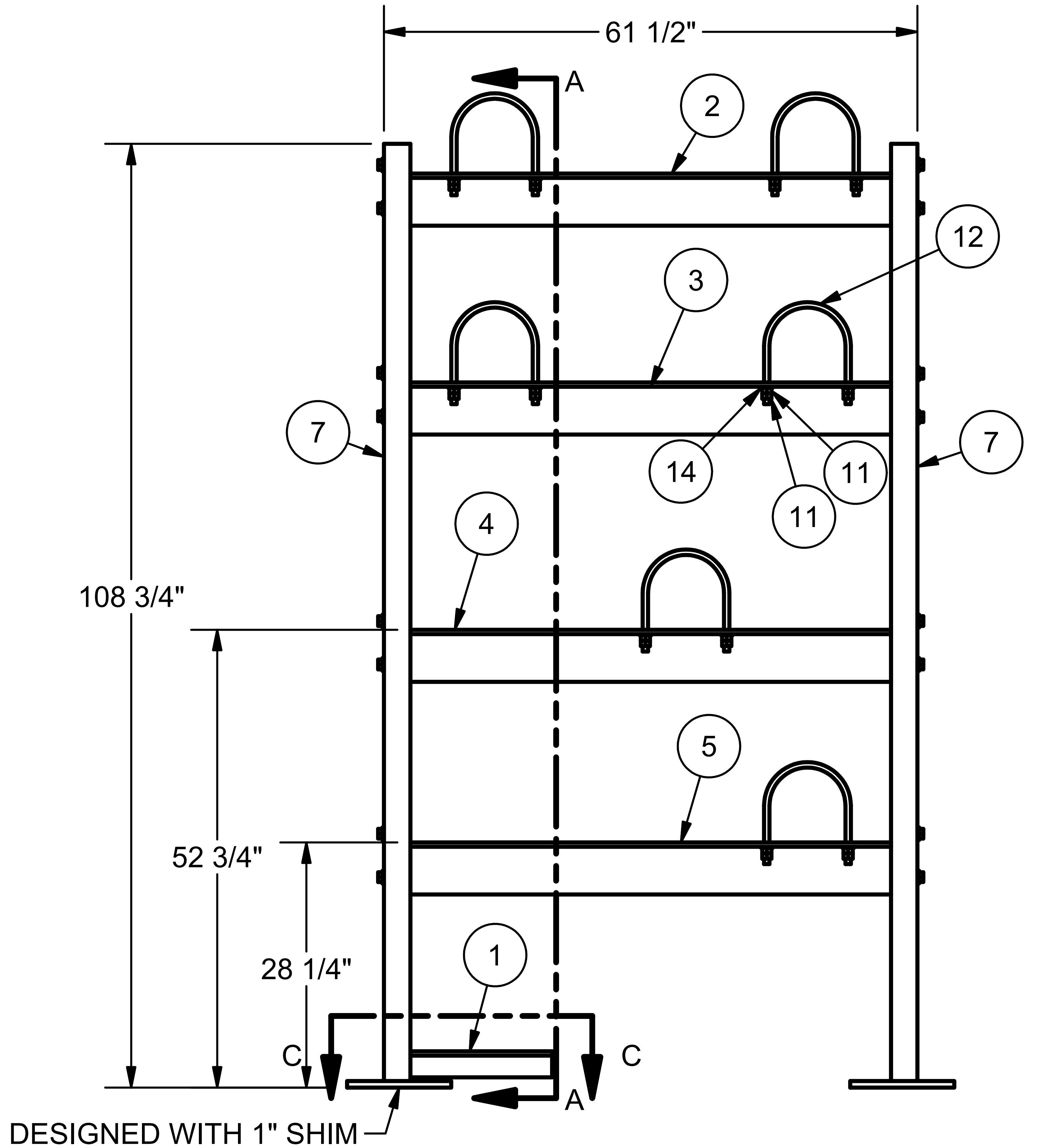
TOP VIEW



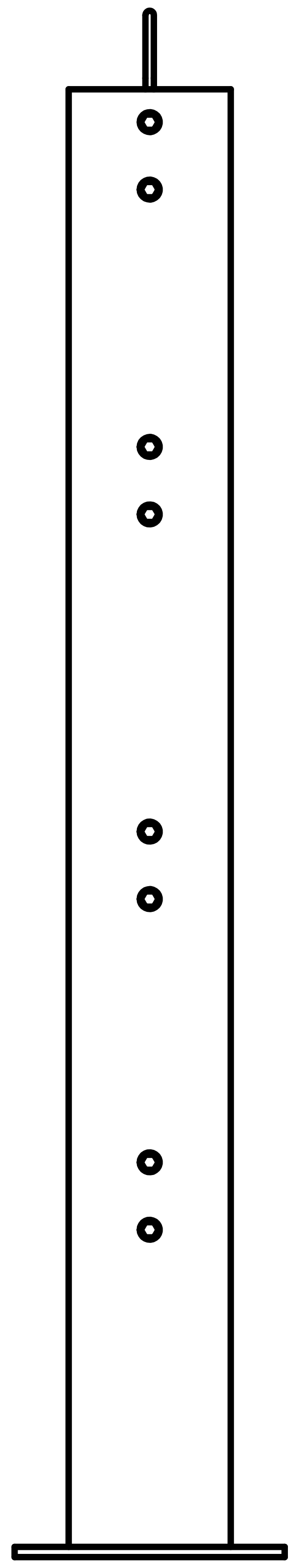
DETAIL A

PARTS LIST

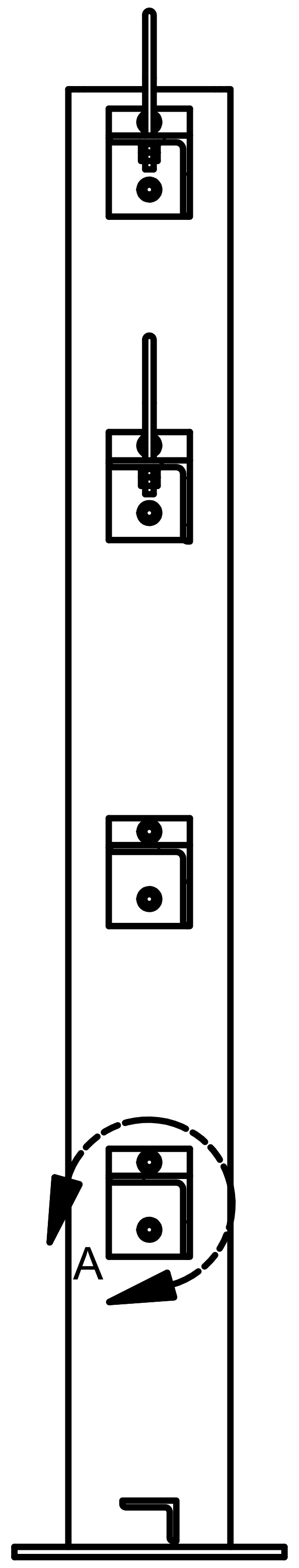
ITEM	QTY	DESCRIPTION	MATERIAL	LENGTH	WIDTH
1	1	ANGLE, CS A36 4X3X0.5 IN	Steel, Carbon	19 in	
2	1	ANGLE, CS A36 6X6X0.5 IN	Steel, Carbon	59 3/4 in	
3	1	ANGLE, CS A36 6X6X0.5 IN	Steel, Carbon	59 3/4 in	
4	1	ANGLE, CS A36 6X6X0.5 IN	Steel, Carbon	59 3/4 in	
5	1	ANGLE, CS A36 6X6X0.5 IN	Steel, Carbon	59 3/4 in	
6	16	BOLT, HEX 0.75IN D X 2.5IN L HDG GR A307	Steel, Galvanized		
7	2	CHANNEL, 12X25# CS A36	Steel, Carbon	108 in	
8	8	FLAT, 8X0.5 IN CS A36	Steel, Carbon	6 in	
9	2	FLAT, 12X0.75 IN CS A36	Steel, Carbon	20 in	
10	16	NUT, HVY HEX 0.75-10 UNC GALV 2H	Steel, Galvanized		
11	36	NUT, HVY HEX 0.625-11 UNC GALV 2H	Steel, Galvanized		
12	9	U-BOLT, 8IN PIPE 0.625IN DIA GALV LONG TANGENT	Steel, Galvanized		
13	32	WASHER, FLAT STRL 0.75IN GALV	Steel, Galvanized		
14	18	WASHER, FLAT STRL 0.625IN GALV	Steel, Galvanized		



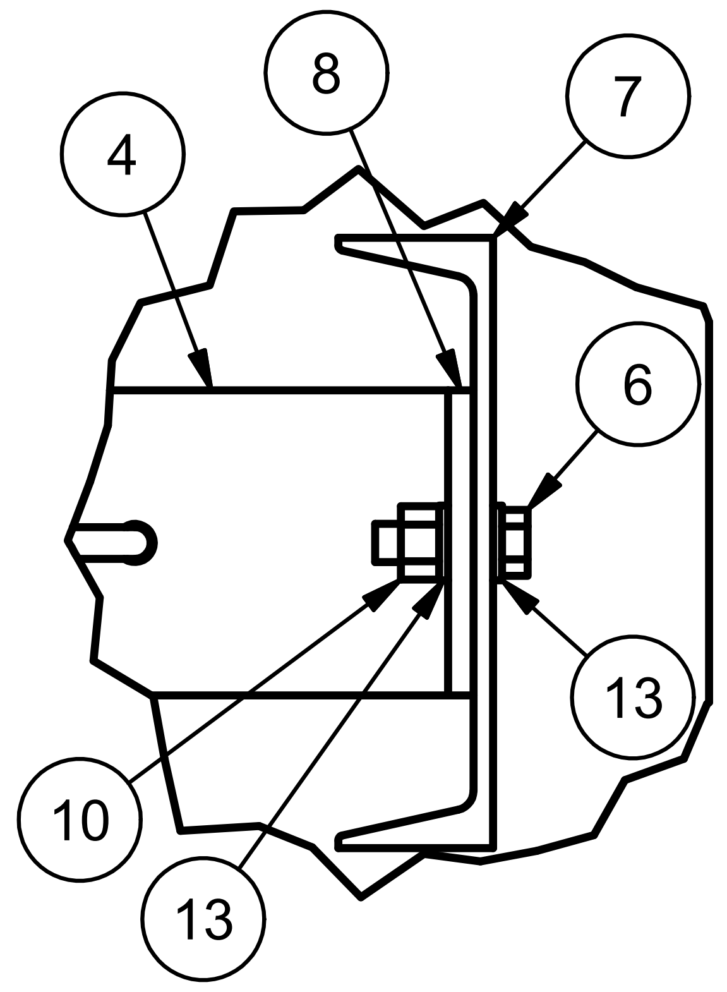
FRONT VIEW



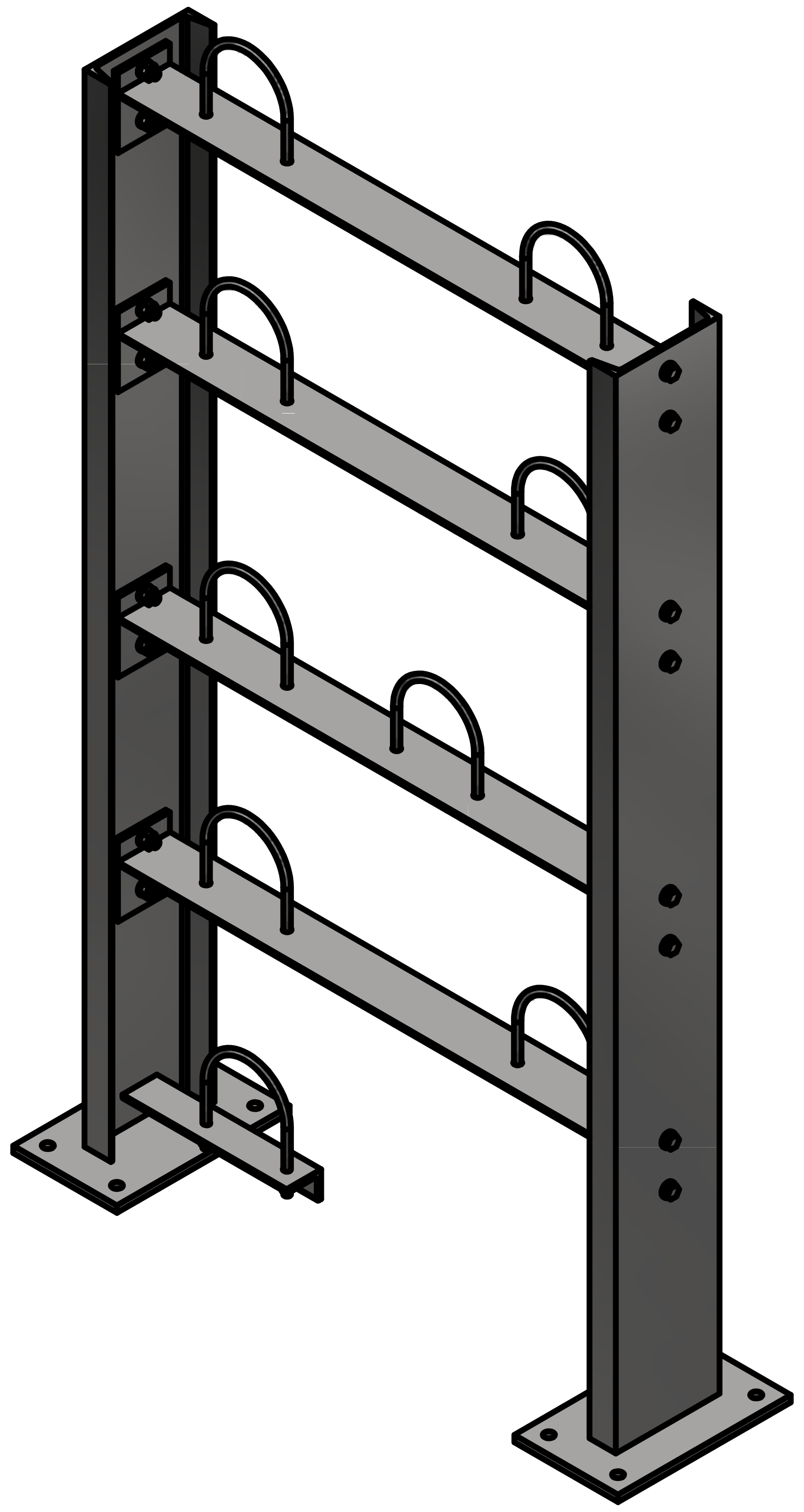
SIDE VIEW

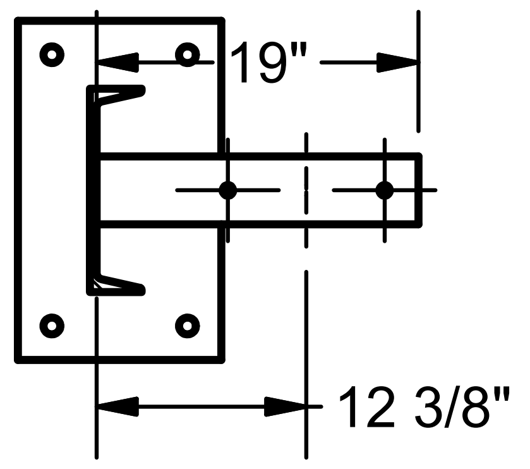


SECTION A-A



DETAIL B





SECTION C-C

NOTE, UNLESS OTHERWISE SPECIFIED;

1. STANDS DESIGNED TO BE USED WITH 1" SHIMS.
2. STAND TO BE COATED WITH 2-3 MILS OF SW POLYESTER TGIC TOPCOAT (COLOR: CARBOLINE #9225 CASHEW) OVER 8-12 MILS OF SW EPOXY PRIMER.
3. BREAK ALL SHARP EDGES AND CORNERS.
4. ESTIMATED WEIGHT: 900 LBS.

DESIGNER: AJA	DATE 11/12/2021	TITLE STAND, MANIFOLD SUPPORT "B" H STYLE STAND QTY. 2
CHECKER: CG	DATE 11/12/2021	CLIENT SUEZ WATER TECHNOLOGIES CHEMOURS TERTIARY GAC SYSTEM - FAYETTEVILLE, NC
ENGINEER: JT	DATE 11/12/2021	AqueoUS VETS® 16761 CLEAR CREEK ROAD REDDING, CA 96001 925-331-0573
MANAGER:	DATE	
SCALE: 1/2" = 1'		

PROJECT	CODE	DRAWING NUMBER	SHEET	REV
M-00103		STAND MAN 8IN 3V B	1 OF 1	0

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

GEOServices, LLC, Geotechnical and Materials Engineers

Appendix G
Performance Monitoring Plan

Geosyntec
consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

BARRIER WALL AND GROUNDWATER EXTRACTION SYSTEM

Performance Monitoring Plan

Chemours Fayetteville Works

Prepared for

The Chemours Company FC, LLC
22828 NC Highway 87
Fayetteville, NC 28306

Prepared by

Geosyntec Consultants of NC, P.C.
2501 Blue Ridge Road, Suite 430
Raleigh, NC 27607

Geosyntec Project Number TR0795A

March 2022

NORTH CAROLINA PROFESSIONAL ENGINEER
SEAL 039872
CHRIS SHORES
3/25/2022

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CAP	Corrective Action Plan
CFRW	Cape Fear River Watch
COA	Consent Order Addendum
DMR	Discharge Monitoring Report
DPT	direct push technology
GAC	granulated activated carbon
GWTP	groundwater treatment plant
NCDEQ	North Carolina Department of Environmental Quality
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PDI	pre-design investigation
PFAS	Per- and Polyfluoroalkyl Substances
PFM	passive flux meter
PLC	programmable logic controller
PMP	Performance Monitoring Plan
PVC	polyvinyl chloride
QA/QC	Quality Assurance / Quality Control
SOP	Standard Operating Procedure
System	Barrier Wall and Groundwater Extraction System

1 INTRODUCTION

Geosyntec Consultants of NC, P.C. (Geosyntec) has prepared for The Chemours Company, FC, LLC (Chemours) this Performance Monitoring Plan (PMP) for the Barrier Wall and Groundwater Extraction System (the "System") planned to be installed at the Chemours Fayetteville Works facility in Bladen County, North Carolina (the Site). An overview of the long-term groundwater remedy layout is provided in Figure 1. This report describes a plan to monitor and evaluate the effectiveness of the System at achieving the requirements of Consent Order Paragraph 12 Addendum, hereafter referred to as the Consent Order Addendum (COA), which requires that the System must reduce per- and polyfluoroalkyl substances (PFAS) loading from groundwater flow from under the Facility to the Cape Fear River and Willis Creek; prevent groundwater migration around, above, or under the barrier wall; and treat extracted groundwater to remove PFAS compounds[1] by at least 99%.

The 2017 NCDEQ Guidelines for the Investigation and Remediation of Soil and Groundwater Contamination has also been incorporated when preparing this PMP. As noted in Section 5.1 of the Guidelines, a monitoring plan shall be developed and established that adequately assesses the progress of the remedy and to verify that the remediation process is working as proposed, and shall include:

1. *A sufficient number of monitoring points, including groundwater monitoring wells and surface water locations as appropriate, to detect and monitor the movement of contaminants,*
2. *A monitoring schedule based on the physical and chemical characteristics of the contaminants, reaction rates, discharge rates, and site-specific hydrogeology, and*
3. *A list of constituents to be analyzed and the anticipated laboratory analytical methods. The list of constituents should include the target contaminants as well as any additional parameters that may provide an indication of the progress of remediation.*

1.1 Supporting Documents

This PMP complements other plans and reports that evaluate on-Site remedies, and/or estimated loads of PFAS to the Cape Fear River. As detailed in subsequent sections and tables, some monitoring components of this PMP are already in place and will be continued. In other instances, existing programs will be enhanced. Briefly summarized, these existing plans and reports consist of the following:

- Corrective Action Plan (CAP) Sampling: Pursuant to the Performance Monitoring section of the December 2019 CAP, Chemours performs annual groundwater sampling events.

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[1] As measured by indicator parameters hexafluoropropylene oxide dimer (HFPO-DA, i.e. GenX), perfluoromethoxypropyl carboxylic acid (PMPA), and perfluoro-2-methoxyaceticacid (PFMOAA)

Activities include collecting a synoptic round of water levels from onsite and offsite monitoring wells, measurement of field parameters, and sampling of Site groundwater monitoring wells.

- Cape Fear River PFAS Mass Loading: The estimated load of PFAS to the Cape Fear River, including the groundwater pathway as one component, is an ongoing calculation performed as part of the Cape Fear River PFAS Mass Loading Assessment, submitted in quarterly reports pursuant to COA Paragraph 1.b. The first and most recent quarterly reports prepared for this assessment were submitted on July 31, 2020 and December 23, 2021 respectively. This assessment includes but is not limited to monthly (2021) and quarterly (2022) sampling of up to 20 wells adjacent to the Cape Fear River and Willis Creek, monthly synoptic water level gauging of on- and off-Site wells, quarterly sampling at the mouth of Willis Creek, and twice weekly composite samples at Cape Fear River at Tar Heel Ferry Road bridge. Significantly with respect to this PMP, the mass loading model: (i) estimates the advective groundwater flux of Table 3+ PFAS[2] to the Cape Fear River, and (ii) includes routine sampling of the well-mixed Cape Fear River downstream of the facility adjacent to the Tar Heel Ferry Road bridge.

- Seeps (Long-Term): Chemours submitted in October 2020 the Onsite Seeps Long-Term Loading Calculation Plan (Geosyntec, 2020) that established the baseline and routine sampling plan that would evaluate the quantitative requirements of the Long-Term Seep Remediation Objective in Paragraph 2(c).

- Discharge of Treated Groundwater via Outfall 004: The effectiveness of the groundwater treatment plant (GWTP) with respect to discharge requirements in the National Pollutant Discharge Elimination System (NPDES) permit is anticipated to be evaluated in routine permit requirements such as Discharge Monitoring Reports (DMRs). The mass loading to the Cape Fear River of this treated groundwater discharge will be quantified in the mass loading model described above.

1.2 Objectives

This PMP complements the documents listed in Section 1.1 by developing a plan to evaluate the effectiveness of the System at reducing PFAS loading from groundwater to the Cape Fear River and Willis Creek. As detailed in subsequent sections of this PMP, this objective is proposed to be met with multiple lines of evidence:

- Hydraulic head both along the barrier wall alignment and downgradient of the barrier wall between the wall and the Cape Fear River, to assess groundwater capture and the reduction in hydraulic gradient downgradient of the System;

---

[2] Table 3+ Method PFAS compounds are often related to both historical and present operations at the Chemours Fayetteville Works Facility

- Passive flux meters (PFMs), to evaluate downgradient groundwater quality and reduction in PFAS flux;
- Surface water samples at Willis Creek, to evaluate reduction in PFAS loading to Willis Creek; and
- Surface water samples at Tar Heel Ferry Road, to evaluate PFAS concentrations and mass loads in the well-mixed Cape Fear River downstream of the facility.

The following table summarizes the complementary programs that together with this PMP will satisfy the requirements of the COA:

Line of Evidence	Assesses	Sampling and Evaluation Program
Hydraulic head along the barrier wall and downgradient of the barrier wall.	Groundwater capture zones and evaluation of the prevention of groundwater migrating around, above or under the barrier wall.	This PMP
PFMs in wells downgradient of barrier wall.	Downgradient groundwater and reduction in PFAS flux (i.e. reduced River PFAS loading)	This PMP
Advective Groundwater Flux from gradients and concentrations measured in wells downgradient of barrier wall.	Downgradient groundwater and PFAS fluxes and flux reductions. (i.e. reduced River PFAS loading)	Mass Loading Program
Willis Creek Surface Water samples upstream of remedy and at Willis Creek mouth.	Reductions in PFAS loading to Willis Creek.	This PMP
Cape Fear River Surface Water samples at Tar Heel Ferry Road.	Reductions in PFAS loading to the Cape Fear River.	Mass Loading Program
GWTP Influent and Effluent samples.	Removal efficiency of indicator PFAS by GWTP.	Future 004 NPDES permit requirements

1.3 Effectiveness Reporting

Per COA Paragraph 2(c)(v), quarterly reports will be prepared that document System flow rates, analytical sampling results, and the estimated removal efficiency of the treatment system. In addition, per COA Paragraph 2(c)(i), by March 15, 2025, Chemours will submit a Barrier Wall and Groundwater Extraction System Effectiveness Demonstration Report that documents the various quantitative reduction requirements have been achieved. After this initial demonstration report, Chemours will submit additional demonstration reports each year by March 15 for the first five years of operation.

The schedule and reporting plan was previously documented in Section 6 of the October 2020 Onsite Seeps Long-Term Calculation Plan (Geosyntec, 2020). The sampling and monitoring data that will be generated by this PMP will be included with the Seeps data documented in the October 2020 Plan, and will be consolidated in comprehensive quarterly and annual reporting for submittal to NCDEQ.

2 HYDRAULIC HEAD EVALUATION

Hydraulic head (groundwater elevations) will be measured both along the barrier wall alignment and downgradient of the barrier wall between the wall and the Cape Fear River. This provides a line of evidence of the remedy's performance by evaluating the following:

- Capture zone along representative sections of the groundwater extraction well network, i.e., that the spacing and pumping rate of the extraction wells is sufficient to intercept groundwater and reduce PFAS loading to Willis Creek and the Cape Fear River. This includes the development of new potentiometric surface maps post-operation.
- Hydraulic gradients between the barrier wall and the Cape Fear River, i.e., that the vertical barrier wall and groundwater extraction create a sufficiently reduced gradient in this downgradient area that indicates groundwater flow to the river has been reduced[3].

The subsequent sections provide detail on the hydraulic head monitoring program:

- The network that will be used to perform this evaluation, which includes existing monitoring wells, new proposed observation wells, and the extraction wells;
- The measurement methodology proposed, which includes manual water level gauging and transducers; and
- The schedule and frequency of the proposed measurement methods.

Additionally, if necessary, data generated during construction and startup of the remedy (e.g., lithologic characterization and aquifer pumping tests) may be incorporated into the existing model to perform sensitivity analyses and evaluate optimization of the model calibration.

2.1 Monitoring Network

The performance monitoring network is anticipated to consist of 69 extraction wells, 37 existing monitoring wells, and 41 new observation wells (approximately 147 total points).

2.1.1 Groundwater Extraction System

The System[4] includes 54 extraction wells screened in the Black Creek aquifer and 15 extraction wells screened in the surficial aquifer (69 total; Figure 1). Each extraction well will be equipped

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[3] A small degree of groundwater flux to the river downgradient of the barrier wall will occur due to rainfall recharge to the land surface between the barrier wall and the river. The wall is located at elevation 72 feet mean sea level, approximately 700 feet from the river, to limit damage to remedy infrastructure from periodic flooding events which can occur several times in a given year. These flooding events can also occur with little warning (less than 24 hours), which would have posed a significant risk to the barrier wall equipment if installation had been attempted closer to the river.

[4] The 60% design was submitted in August 2021 and the 90% design is currently in progress. Although some design details may change from what is presented in this PMP (e.g., the final number of extraction wells), they are not anticipated to materially affect this plan.

with a pressure transducer to monitor water levels in the well during operation; the transducers will be connected to communication cable that transmits the water level data to a centralized programmable logic controller (PLC) at the groundwater treatment pad. These transducers primarily serve two operational purposes: to monitor for excessive drawdown in the well and prevent pump cavitation, and also to maintain the drawdown at an optimal level such that the well screen remains saturated, which will help to reduce potential fouling of the screen. In addition to these operational requirements, the transducer data can also be used to develop potentiometric surfaces after operation; new observation wells and existing monitoring wells along the alignment will supplement the data from the extraction wells.

In addition to transducers, each extraction well will also be equipped with a magnetic totalizing flowmeter with transmitter to the PLC as above. The combination of water level data and flow data will allow for operational adjustments to increase pumping if drawdown is insufficient in one or more areas of the alignment.

2.1.2 Existing Network

As shown in Figure 2 and as detailed in Table 1, the existing network of wells proposed to be used for performance monitoring consists of the following:

- Along the proposed extraction alignment, there are up to 9 existing wells that may be suitable for evaluating capture of groundwater. PIW-9S and PIW-9D were considered suitable but need to be abandoned to facilitate construction of the barrier wall. Two observation wells will be installed after the barrier wall to replace these existing wells.
- Downgradient of the barrier wall, there are approximately 18 existing wells that may be suitable for evaluating hydraulic gradient between the barrier wall and the river. Of these 18, eight (8) are currently being used in the mass loading assessment segments[5].
- Upgradient of the remedy extent, there are approximately 10 existing that may be suitable for evaluating unstressed aquifer conditions (baseline).

These 37 existing wells will be used as observation points during performance monitoring, but are subject to change and may be removed from the program if the evaluation indicates a different existing well nearby would better perform the intended function (e.g., PIW-8D versus LTW-05).

2.1.3 Proposed Expansion

In addition to the existing network intended to be used in the monitoring program, Figure 2 also shows 41 additional observation wells that will be installed as follows:

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[5] Excluding PW-11 (Segment 8 of the mass loading assessment program) which is not adjacent to the river due to property boundary limitations, the mass loading assessment wells range between approximately 80 and 220 feet in distance to the river. The majority are located as close as practical to the river, at the top of the natural overbank formed from flood deposition.

- Along the extraction alignment, 29 new observation wells are proposed be installed, the majority of which will be installed in between a subset of extraction wells along representative sections of the alignment.
- Downgradient of the barrier wall, 12 new observation wells are proposed. Where practical, the location of these proposed downgradient observation wells was selected to refine the mass loading assessment (notably OW-28 along the Seep D access road, and OW-33 southeast of the property off of Bill Hall Road). The other mass loading assessment wells are already placed as close to the river as practical, therefore the remainder of the proposed downgradient observation wells are generally located between the existing mass loading model wells and the barrier wall.

The majority (37 of the 41) of the proposed observation wells will be Black Creek aquifer monitoring wells; four (4) of the wells installed along the alignment will be surficial aquifer monitoring wells.

The majority of the proposed new observation wells are anticipated to be used for hydraulic head evaluation only, and will be constructed using a direct push technology (DPT) drill rig with 1-inch diameter Schedule 40 polyvinyl chloride (PVC). A DPT rig will allow for improved access to difficult areas in the floodplain (e.g., OW-20 and OW-22). At a few accessible locations near the river, notably OW-28 near Seep D, and OW-30 and OW-33 at the off-site property, a sonic drill rig may be used to install a 2-inch diameter well, which may be used to refine the mass loading model in these areas of the site.

Due to the anticipated potential access constraints, the location of each proposed point may be subject to change based on access over steep terrain, wetlands, remedy infrastructure, or other constraints.

The following table summarizes the hydraulic head monitoring network to be comprised of existing and proposed wells:

Location	Number of Existing Wells	Number of Proposed Wells	Total
Upgradient of Remedy Extent	10 monitoring wells	0	10
Along Barrier Wall	9 monitoring wells	69 extraction wells and 29 observation wells	107
Downgradient of Barrier Wall	18 monitoring wells	12 observation wells	30
Total	37	110	147

2.2 Measurement Methods

Water levels in the 69 extraction wells will be measured with transducers that record data every 15 minutes during initial operation of the system. This frequency may be reduced if conditions stabilize during long-term operation.

For the 18 existing and 12 proposed observation well locations downgradient of the wall (30 total), transducers will be deployed in a subset to evaluate the dynamic effect of the interaction between the river and the groundwater pumping system. These transducers will not be connected to the centralized PLC with communication cable but will rather be routinely downloaded by O&M staff at the well.

For the 19 existing and 29 proposed locations along the alignment of the extraction wells or upgradient of the remedy (48 total), groundwater elevation will be measured manually.

2.3 Schedule and Frequency

A round of water levels will be measured in the monitoring network (existing and proposed) prior to startup. After pumping commences, groundwater elevations will be measured or downloaded from the transducers each month for the first two years of operation (anticipated to be approximately Summer 2022 through Summer 2024). It is anticipated that after this two-year period, this frequency can be reduced to quarterly. Potentiometric surface maps will be generated at the same frequency as data are retrieved.

2.4 Numerical Model

The installation and testing of the long-term groundwater remedy components will generate additional data that may be incorporated into the numerical groundwater model, including hydraulic conductivity from aquifer pumping tests performed on a subset of new extraction wells, Surficial and Black Creek aquifer thickness from drilling logs, and groundwater elevation data in observation wells. These data may be incorporated into the current numerical groundwater model to perform sensitivity analyses and evaluate if the calibration can be improved.

3 PASSIVE FLUX METER GROUNDWATER FLUX EVALUATIONS

The proposed groundwater remedy is a containment remedy designed to reduce hydraulic gradients and thereby reduce flux and loading to Willis Creek and the Cape Fear River. Groundwater concentrations for Table 3+ PFAS downgradient of the barrier wall will remain at present levels in the short-term. As such, groundwater sampling for laboratory analysis of PFAS downgradient of the System, without additional consideration of reduced hydraulic gradients, is not anticipated to be an effective method for evaluating the effectiveness of the System. Therefore, the reduction in mass flux to the Cape Fear River will be evaluated using PFMs (detailed here in this section of the PMP) and with groundwater flux analyses prepared as part of the ongoing mass loading program (an existing assessment program that was noted in Section 1.2). PFMs can assess groundwater Darcy velocity and Table 3+ PFAS flux along potential groundwater discharge paths located along the Cape Fear River. By comparing to baseline rounds of PFM deployment, performance monitoring rounds of PFMs can estimate the reduction in Darcy velocity and PFAS flux achieved by the pumping.

3.1 Baseline Deployment Network

To date, PFMs have been deployed in two rounds of sampling at the site:

- In October 2020, as part of the PDI, 17 PFMs were deployed, 15 in the Black Creek Aquifer and 2 in the Floodplain.
- In November 2021, as a baseline event prior to remedy operation, 15 PFMs were deployed, 13 in the Black Creek Aquifer, and 2 in the Floodplain.

It is anticipated that a third round of PFMs will be deployed in May/June 2022, shortly before the System is anticipated to be operational, to provide an additional round of baseline data.

3.2 Schedule and Frequency of Performance Monitoring PFM Deployments

After the system is operational, PFMs will be deployed in a similar network to the November 2021 network of 15 wells, with the addition of OW-28, OW-30, and PW-11, and with the omission of PMW-12, PMW-13, and PMW-14, which are only 20-50 feet away from nearby extraction wells, and thus flux data from within the cone of depression would not be informative for evaluating mitigation of flux to the river. Installation of additional monitoring wells between PMW-12/13/14 and Willis Creek is not possible due to steep grades in excess of 50%. See discussion of surface water sampling in Section 4 for more information on this area of the remedy.

The proposed PFM performance monitoring network is shown on Figure 3. PFMs will be deployed on an annual basis. The first deployment post-startup will be conducted when hydraulic head measurements (performed monthly) indicate the System has been effective at reducing hydraulic gradients downgradient of the barrier wall.

The deployment and retrieval protocol for the PFMs will generally follow what was performed during the pre-design investigation (PDI) in late 2020 (Geosyntec, 2021c). PFMs, provided by Enviroflux, are constructed with alternating layers of granulated activated carbon (GAC) to analyze Darcy velocity and a virgin macroporous polymer resin to assess PFAS flux. Each PFM is five feet long and one to three PFMs will be installed along the full length of the monitoring well screen length (Table 2). The time and date of installation will be recorded along with the initial and final water levels. After a minimum of fourteen days, the PFMs will be removed for analysis. The GAC and resin layers will be composited separately to produce two samples per monitoring well (one GAC, one resin). Sample material will be composited using decontaminated stainless-steel spatulas and stainless-steel mixing bowls. GAC samples will be packed on ice and shipped to Enviroflux, for Darcy velocity, and the resin samples will be packed on ice and shipped to Test America for PFAS analysis by Table 3+ Laboratory Standard Operating Procedure (SOP). PFAS analytical results will be provided to Enviroflux for the calculation of PFAS flux for each well.

4 SURFACE WATER SAMPLING

Surface water sampling will be conducted as follows to evaluate the effectiveness of the groundwater remedy:

- At upstream and downstream locations within Willis Creek (WC-2 and WC-3 upstream, and WC-1 at the mouth of Willis Creek before it reaches the Cape Fear River), 24-hour composite samples will be collected quarterly during dry weather conditions (sample locations shown on Figure 3). These samples will evaluate the performance of the Willis Creek section of the groundwater extraction system at reducing PFAS flux into Willis Creek. As noted in Section 3, steep grades in excess of 50% between this groundwater extraction area and Willis Creek are a significant challenge to installing monitoring wells between extraction wells and surface water. Since groundwater is the primary load to Willis Creek in this area, surface water sampling should be a viable metric for evaluating system effectiveness.
- As part of the mass loading model assessment, composite samples of the Cape Fear River are routinely collected at Tar Heel Ferry Road. This program will continue after the System is operational, and data will be used to evaluate the long-term performance of the groundwater remedy (in addition to other remedy components) at reducing surface water PFAS concentrations.

5 PLAN MODIFICATION

Due to the scale of the proposed long-term groundwater remedy, and the numerous variables that affect groundwater migration and PFAS loading to the river, this PMP will be evaluated yearly and updated as appropriate to reflect the most current operating conditions and optimize the program. If modification to the PMP is advised, Chemours will be submit a revised PMP to NCDEQ prior to implementation of changes.

6 REFERENCES

Geosyntec, 2019a. Corrective Action Plan. Chemours Fayetteville Works. December 31, 2019.

Geosyntec, 2020. Onsite Seeps Long-Term Loading Calculation Plan. Chemours Fayetteville Works. October 30, 2020.

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Geosyntec, 2021d. Cape Fear River PFAS Mass Loading Assessment – Third Quarter 2021 Report. Chemours Fayetteville Works. December 23, 2021.

NCDEQ, 2017. Guidelines for the Investigation and Remediation of Soil and Groundwater Contamination. 2017.

NCDEQ, 2019. Addendum to Consent Order Paragraph 12. General Court of Justice Superior Court Division. State of North Carolina. County of Bladen. October 12, 2020.

USEPA, 1994. Methods for Monitoring Pump-and-Treat Performance. EPA/600/R-94/123. June 1994.

USEPA, 1998. Evaluation of Subsurface Engineered Barriers at Waste Sites. EPA 542-R-98-005. August 1998.

Tables

Table 1 - Performance Monitoring Details
Groundwater Performance Monitoring Plan
Chemours Fayetteville Works
Fayetteville, North Carolina

Observation / Monitoring Well ID	Well Details			Function(s) in Existing Monitoring Programs			Function(s) in Proposed Monitoring Plan for Long-Term Groundwater Remedy		
	Status (Existing or Proposed)	Geologic Completion Zone	Screen Interval	Mass Loading Model Flux	Monthly Gauging (2021)	Annual Sampling (Corrective Action Plan)	Hydraulic Head Evaluation	Passive Flux Meter (PFM)	
								Number of PFMs Needed	Number of Composite Sampled Collected
BCA-01	Existing	Black Creek Aquifer	91 - 101			X	X		
BCA-02	Existing	Black Creek Aquifer	92 - 102			X	X		
LTW-02	Existing	Black Creek Aquifer	28 - 38	X	X	X	X		
LTW-03	Existing	Floodplain	15 - 30	X	X	X	X		
LTW-04	Existing	Floodplain	12 - 27		X	X		3	1
LTW-05	Existing	Black Creek Aquifer	29 - 44	X	X	X	X		
NAF-11B	Existing	Surficial Aquifer	33.5 - 43.5				X		
OW-2	Existing	Black Creek Aquifer	63 - 73				X		
OW-3	Existing	Black Creek Aquifer	63 - 73				X		
OW-4	Existing	Black Creek Aquifer	47 - 57				X	2	1
OW-6	Existing	Black Creek Aquifer	50 - 60				X		
OW-7	Existing	Black Creek Aquifer	57 - 67				X		
OW-8	Existing	Black Creek Aquifer	57 - 67				X		
OW-9	Existing	Black Creek Aquifer	54 - 64				X		
PIW-1D	Existing	Black Creek Aquifer	24.5 - 29.5	X	X	X	X	1	1
PIW-2D	Existing	Black Creek Aquifer	40 - 50			X	X		
PIW-3D	Existing	Black Creek Aquifer	19 - 24	X	X	X	X	1	1
PIW-4D	Existing	Black Creek Aquifer	32.3 - 37.3			X	X	1	1
PIW-5S	Existing	Surficial Aquifer	9.8 - 19.8			X	X		
PIW-6S	Existing	Floodplain	18 - 28			X		2	1
PIW-7D	Existing	Black Creek Aquifer	29 - 34	X	X	X	X	1	1
PIW-7S	Existing	Floodplain	7 - 17		X	X	X	2	1
PIW-8D	Existing	Black Creek Aquifer	35.5 - 45.5			X		2	1
PIW-10DR	Existing	Black Creek Aquifer	53 - 58			X	X		
PW-10R	Existing	Black Creek Aquifer	57 - 67			X	X	2	1
PIW-11	Existing	Black Creek Aquifer	47 - 57			X	X	2	1
PIW-12	Existing	Black Creek Aquifer	64 - 74			X	X		
PIW-13	Existing	Black Creek Aquifer	54 - 64			X	X		
PIW-14	Existing	Black Creek Aquifer	56 - 66			X	X		
PIW-15	Existing	Black Creek Aquifer	34 - 44			X	X	2	1
PW-02	Existing	Surficial Aquifer	50 - 60			X	X		
PW-03	Existing	Surficial Aquifer	35 - 45			X	X		
PW-04	Existing	Surficial Aquifer	17 - 27		X	X	X		
PW-11	Existing	Black Creek Aquifer	53 - 63	X	X*	X	X	2	1
PW-14	Existing	Black Creek Aquifer	136 - 146			X	X		
PW-15R	Existing	Black Creek Aquifer	110 - 120			X	X		
PZ-22	Existing	Black Creek Aquifer	36 - 46	X	X	X	X		
SMW-03B	Existing	Black Creek Aquifer	72 - 82			X	X		
SMW-09	Existing	Surficial Aquifer	52 - 62			X	X		
SMW-12	Existing	Black Creek Aquifer	88 - 98		X	X	X		
EW-1 through 69	Proposed	Black Creek Aquifer	TBD				X (69 total)		
OW-11 - OW-33; and OW-38 - OW-51	Proposed	Black Creek Aquifer	TBD				X (37 total)	4**	2**
OW-34 through OW-37	Proposed	Surficial Aquifer	TBD				X (4 total)		
Total	N/A	N/A	N/A	8	12	32	147	27	15

Notes:

TBD indicates to be determined, as the screen interval at this proposed location will depend on observations by the field geologist during drilling.

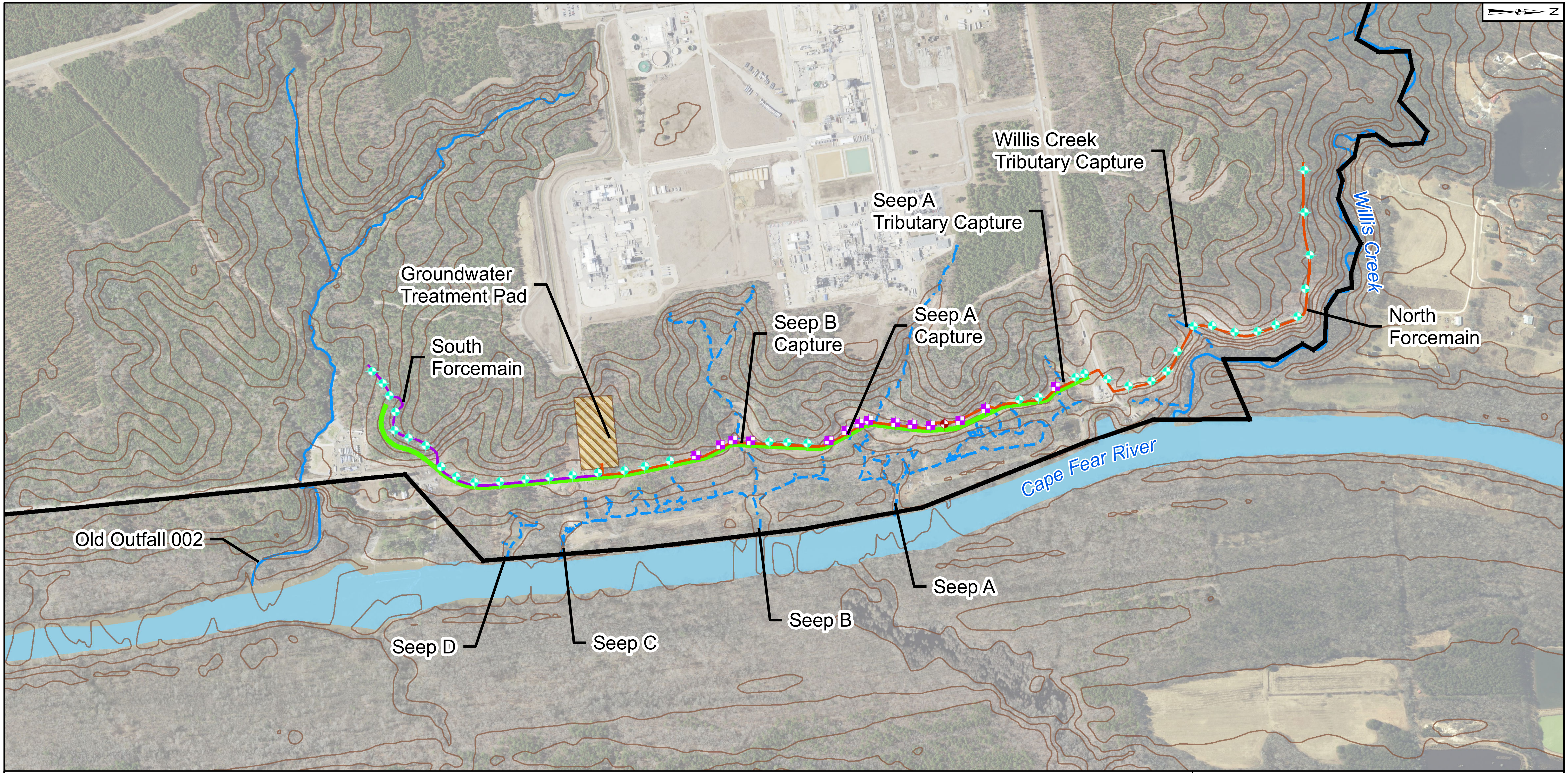
The numbering of proposed Observation Wells above reflects resolution of comments on the PMP, for clarity; the final numbering of OW's is subject to change.

Existing wells PIW-9S and PIW-9D are anticipated to be abandoned to facilitate barrier wall installation. Proposed wells OW-37 and OW-51 are intended to be replacement 2" monitoring wells in this area.

* PW-11 could not be sampled in August and September 2021 because it was being pumped as part of the Black Creek interim pumping program.

** These PFMs are proposed to be deployed in OW-28 and OW-30, new observation wells shown in Figure 3.

Figures



Legend

- ✦ Black Creek Aquifer Extraction Well
- ✦ Surficial Aquifer Extraction Well
- ✦ Surficial and Black Creek Aquifer Extraction Well
- ━ Site Boundary
- ━ North Forcemain
- ━ South Forcemain
- ━ Barrier Wall; approximate surface elevation at 72 feet mean sea level
- ▨ Groundwater Treatment Pad
- ━ Ground Surface Elevation Contour (ft NAVD88) - 10 feet interval
- ‒ ‒ Seep
- ━ Nearby Tributary
- ━ Nearby Tributary to River
- 🟦 Cape Fear River

Notes:
ft NAVD88 - feet North American Vertical Datum 1988.

1. Surficial Aquifer extraction wells have been offset for visibility. Therefore, the placement of these wells on this map do not reflect their true geographic coordinates.
2. Conveyance forcemain alignment is preliminary and is subject to change in future submittals.
3. Ground surface elevation contours are based on 20-foot DEM grid cells generated from LiDAR. Data from NC OneMap (https://assets.nconemap.gov/pages/hub/ncom-contours-dd.htm).
4. The outline of Cape Fear River is approximate and is based on open data from ArcGIS Online and North Carolina Department of Environmental Quality Online GIS (MajorHydro shapefile).
5. Basemap source: NC OneMap (2019). North Carolina Department of Information Technology, Government Data Analytics Center, Center for Geographic Information and Analysis. Available at https://www.nconemap.gov.

1,000 500 0 1,000 Feet

Groundwater Extraction and Barrier Wall System Overview

Chemours Fayetteville Works, North Carolina

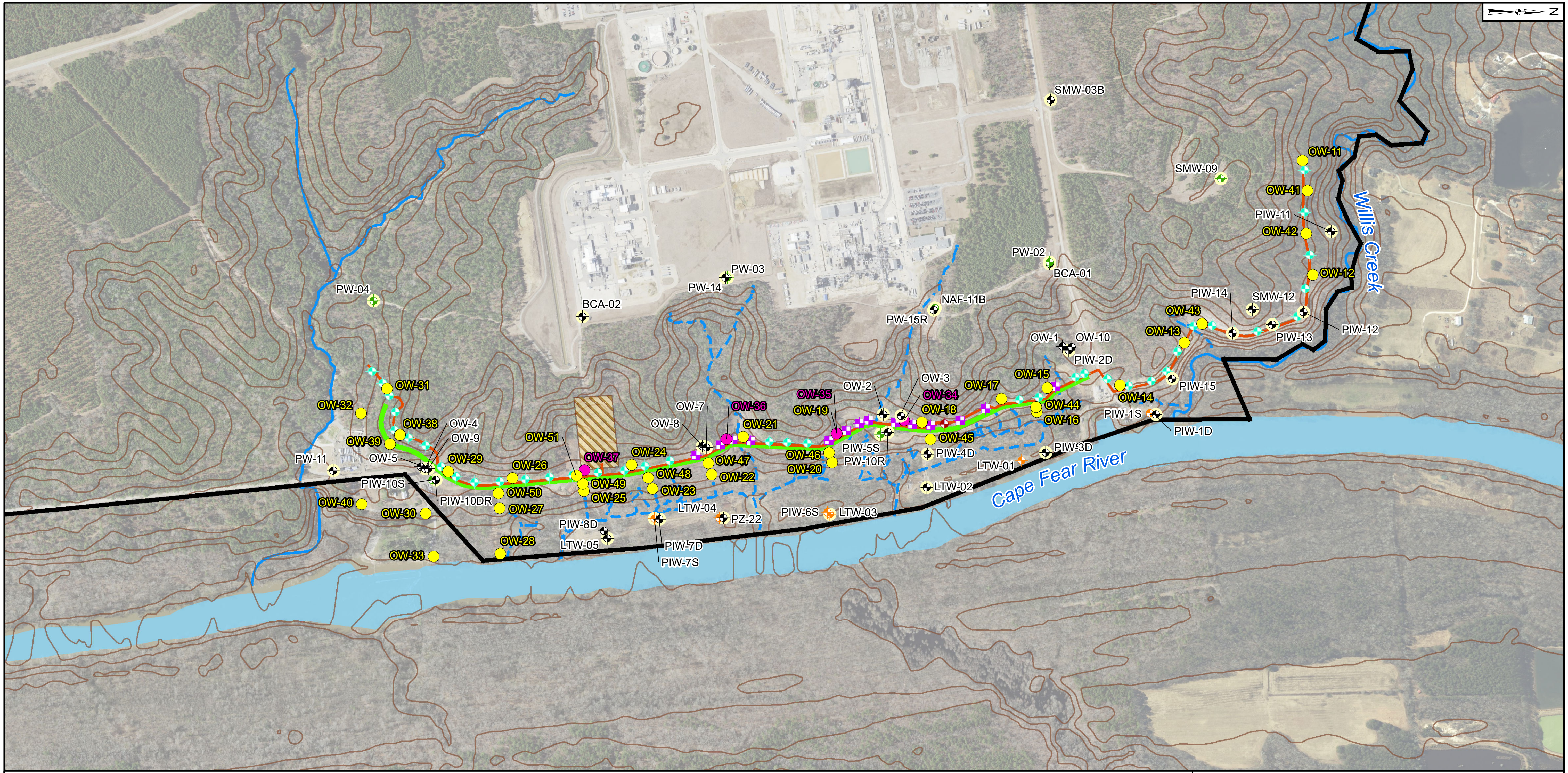
Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

Raleigh

March 2022

Figure 1



Legend

- ⊕ Perched Zone
- ⊕ Surficial Aquifer
- ⊕ Floodplain Deposits
- ⊕ Black Creek Aquifer
- ⊕ Black Creek Aquifer Extraction Well
- ⊕ Surficial Aquifer Extraction Well
- ⊕ Surficial and Black Creek Aquifer Extraction Well
- ● Hydraulic Head Observation (Existing Well)
- ● Hydraulic Head Observation (New Observation Well - Black Creek Aquifer)
- ● Hydraulic Head Observation (New Observation Well - Surficial Aquifer)
- ━ Site Boundary
- ━ Forcemain
- ━ Barrier Wall; approximate surface elevation at 72 feet mean sea level
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Notes:
ft NAVD88 - feet North American Vertical Datum 1988.
1. Surficial Aquifer extraction wells have been offset for visibility. Therefore, the placement of these wells on this map do not reflect their true geographic coordinates.
2. Conveyance forcemain alignment is preliminary and is subject to change in future submittals.
3. It is anticipated that existing wells PIW-9S and PIW-9D (not shown) will need to be abandoned to facilitate barrier wall installation. Replacement wells OW-37 and OW-51 are shown instead, and will be installed after the wall. The other proposed observation wells, where possible, will be installed prior to wall installation; however it is noted that change conditions during construction may result in adjustments to locations and/or damage to installed wells.
4. Ground surface elevation contours are based on 20-foot DEM grid cells generated from LiDAR. Data from NC OneMap (https://assets.nconemap.gov/pages/hub/ncom-contours-dd.htm).
5. The outline of Cape Fear River is approximate and is based on open data from ArcGIS Online and North Carolina Department of Environmental Quality Online GIS (MajorHydro shapefile).
6. Basemap source: NC OneMap (2019). North Carolina Department of Information Technology, Government Data Analytics Center, Center for Geographic Information and Analysis. Available at https://www.nconemap.gov.

1,000 500 0 1,000 Feet

Hydraulic Head Evaluation Network for Groundwater Remedy

Chemours Fayetteville Works, North Carolina

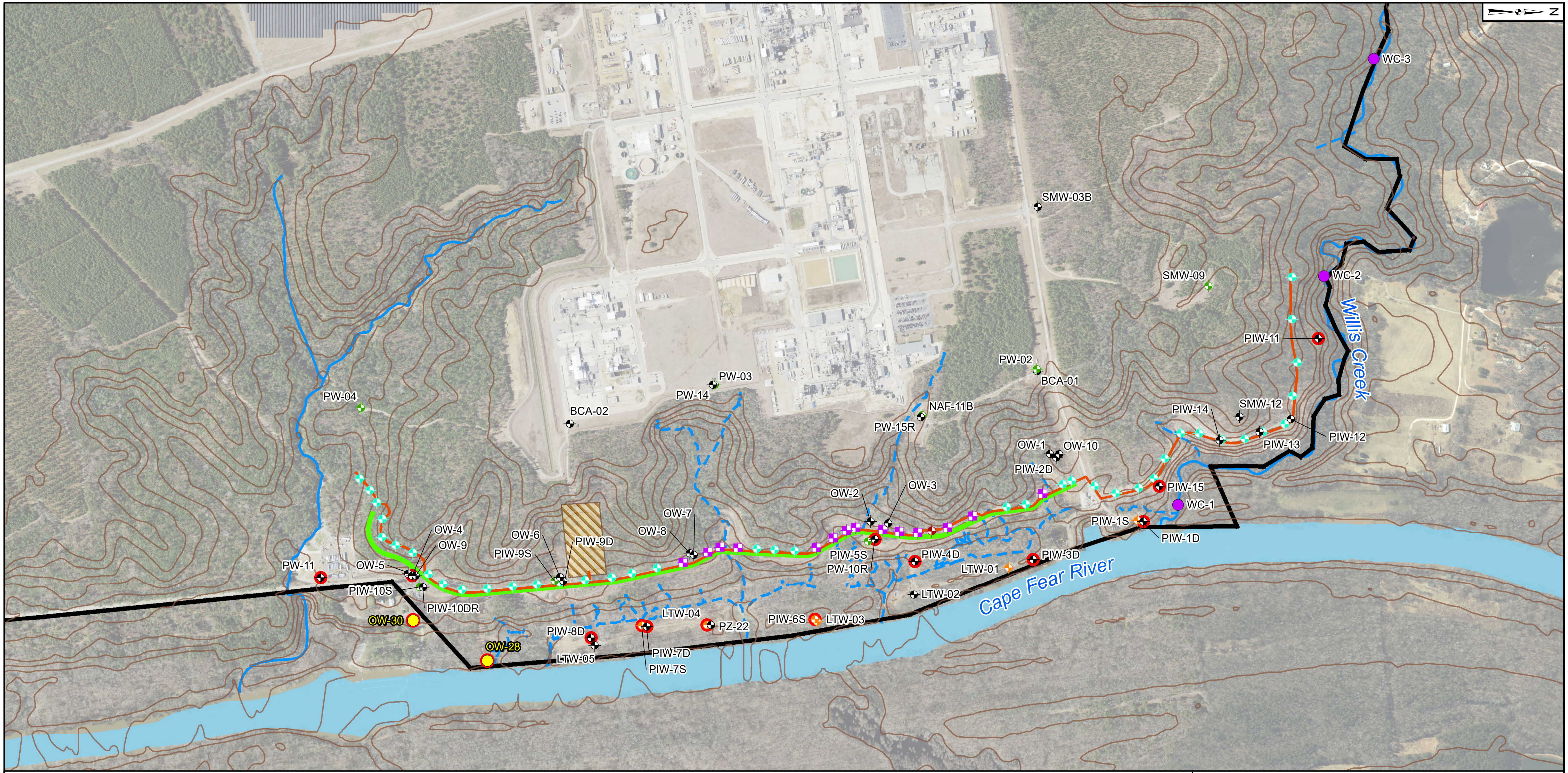
Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

Raleigh

March 2022

Figure
2



Legend

⊕ Perched Zone
⊕ Surficial Aquifer
⊕ Floodplain Deposits
⊕ Black Creek Aquifer
⊕ Black Creek Aquifer Extraction Well
⊕ Surficial Aquifer Extraction Well
⊕ Surficial and Black Creek Aquifer Extraction Well
● Willis Creek Sample Location
● Passive Flux Meter Deployment
● Hydraulic Head Observation (New Observation Well - Black Creek Aquifer)

▬ Site Boundary
▬ Forcemain
▬ Barrier Wall; approximate surface elevation at 72 feet mean sea level
▨ Groundwater Treatment Pad
▬ Ground Surface Elevation Contour (ft NAVD88) - 10 feet interval
- - Seep
▬ Nearby Tributary
▬ Nearby Tributary to River
▬ Cape Fear River

Notes:
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1. Surficial Aquifer extraction wells have been offset for visibility. Therefore, the placement of these wells on this map do not reflect their true geographic coordinates.
2. Conveyance forcemain alignment is preliminary and is subject to change in future submittals.
3. Ground surface elevation contours are based on 20-foot DEM grid cells generated from LiDAR. Data from NC OneMap (https://assets.nconemap.gov/pages/hub/ncom-contours-dd.htm).
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5. Basemap source: NC OneMap (2019). North Carolina Department of Information Technology, Government Data Analytics Center, Center for Geographic Information and Analysis. Available at https://www.nconemap.gov.

1,000 500 0 1,000 Feet

Passive Flux Meter Deployment Plan

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C 3500 and C 295

Figure

3

Raleigh

March 2022

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

GEOServices, LLC, Geotechnical and Materials Engineers

Appendix H
Barrier Wall Construction Quality Assurance Plan

GEOServices, LLC, Geotechnical and Materials Engineers

BARRIER WALL CONSTRUCTION QUALITY ASSURANCE PLAN

Chemours Fayetteville Works

Prepared for

The Chemours Company FC, LLC
22828 NC Highway 87
Fayetteville, NC 28306

Prepared by

GEOServices, LLC
5559 North Lee Highway
Cleveland, TN 37312

March 2022

TABLE OF CONTENTS

LIST OF ATTACHMENTS

JLT Laboratories Mix Design General Procedure

DEWIND One Pass Trenching Sample Forms

LIST OF ASTM STANDARD PROCEDURES

The most recent versions as of December 1, 2021, of the following standards:

ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D854	Standard Test Methods of Specific Gravity of Soil Solids by Water Pycnometer
ASTM D2166	Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
ASTM D2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil
ASTM D2974	Standard Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils
ASTM D4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D4972	Standard Test Methods for pH of Soils
ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5778	Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils
ASTM D5890	Standard Test Method of Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D6914	Standard Specification for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices

ASTM D7100	Standard Test Method of Hydraulic Conductivity Compatibility Testing of Soils with Aqueous Solutions
ASTM D8152	Standard Practice for Measuring Field Infiltration Rate and Calculating Field Hydraulic Conductivity Using the Modified Philip Dunne Infiltrometer Test

LIST OF ABBREVIATIONS

ASTM	American Society of Testing Materials
CAP	Corrective Action Plan
CFRW	Cape Fear River Watch
CM	Construction Manager
cm/s	centimeters per second
COA	Consent Order Addendum
CQA	Construction Quality Assurance
CQC	Construction Quality Control
CWP	Construction Work Plan
GWTP	Ground Water Treatment Plant
SCPT	Seismic Piezocone Penetration Tests
FOS	Factor of Safety
ft	feet
MSEW	Mechanically Stabilized Earth Wall
MSL	Mean Sea Level
NCDEQ	North Carolina Department of Environmental Quality
PDI	Pre-Design Investigation
PFAS	per- and polyfluoroalkyl substances
QA/QC	quality assurance/quality control
QCP	Quality Control Plan
RQD	Rock Quality Designation
SQD	Sample Quality Designation
UCS	Unconfined Compression Strength

1 INTRODUCTION AND OBJECTIVES

GEOServices, LLC (GEOS) has prepared this Barrier Wall Construction Quality Assurance Plan for The Chemours Company, FC, LLC (Chemours) as part of the work to be performed pursuant to the Consent Order Paragraph 12 Addendum (COA). The subject barrier wall system will be installed at the Chemours Fayetteville Works facility in Bladen County, North Carolina.

The purpose of this CQA Plan is to provide procedures that will confirm the underground barrier wall is constructed and documented as-designed by GEOS. Three primary design parameters are the subject of the quality assurance plan: a minimum wall thickness (3feet), maximum hydraulic conductivity (1x10-6 cm/s), and minimum barrier wall mix strength of 50psi for wall depths less than/equal to 75 feet and 100psi for wall depths exceeding 75 feet. In addition to the design parameters, the CQA plan is designed to also evaluate the continuity of the wall installation as the entire wall cannot be installed in one continuous pass. This document outlines the quality assurance roles, responsibilities, and reporting associated with the installation of the barrier wall portion of the groundwater extraction and treatment system.

2 CQA ROLES RESPONSIBILITIES AND QUALIFICATIONS

The scope of this plan includes general CQA requirements concerning roles, responsibilities, and qualifications of parties involved; the preconstruction meeting; and general inspection and documentation procedures. Specific CQA requirements address construction procedures and observation, field and laboratory testing frequency and methods, and acceptance criteria for each component during the construction of the barrier wall.

2.1 PROJECT TEAM

The project team, as a minimum, shall consist of representatives of the Client, Construction Manager, Consultant, and Subcontractor. Companies associated with each position are listed below:

Client: The Chemours Company FC, LLC

Client Construction Manager: AECOM

General Contractor: Summit Environmental Services, LLC

Quality Consultant: GEOServices, LLC

Barrier Wall Subcontractor: DeWind One Pass Trenching

2.1.1 CLIENT CONSTRUCTION MANAGER

The Client Construction Manager will perform and coordinate construction activities to facilitate the barrier wall construction. The client construction manager will coordinate the efforts of the general contractor, barrier wall subcontractor, and the other contractors on-site to facilitate a smooth construction process.

2.1.2 GENERAL CONTRACTOR (CIVIL)

The General Contractor will perform and coordinate construction activities to facilitate the barrier wall construction. Activities may include, but not limited to:

- Removal, treatment, and/or storage of barrier wall waste material
- Assembly of water supply (for mixing) to the barrier wall alignment
- Construction of erosion and sediment control devices
- Preparation of barrier wall work platform
- Preparation of barrier wall contractor's equipment and storage yard
- Preparation of access and construction roads
- Other necessary construction activities as may be directed by the Project Management Team.

2.1.3 QUALITY CONSULTANT

The Quality Consultant shall provide the CQA Officer, RPR, and field staffing necessary to implement the CQA Plan while also supervising the soils testing laboratory. Definitions of each role reporting to the Quality Consultant are described below.

2.1.3.1 CQA OFFICER

A designated CQA Officer shall supervise and be responsible for all inspections, testing, and related construction documentation as described in this CQA Plan. The CQA Officer shall be a North Carolina Registered Professional Engineer responsible for preparation of the construction documentation report to certify substantial compliance with the engineering design. The CQA Officer may delegate daily inspection, testing, and sampling duties to a qualified technician with experience in the assigned aspect of construction who will serve as the Resident Project Representative (RPR). Although these duties may be delegated, the CQA Officer will retain the responsibility for these activities. When an RPR is designated, the CQA Officer shall visit the construction site every 2 weeks, at a minimum, during active periods of construction to personally observe the construction and documentation procedures. The CQA Officer shall be readily available for consultation with project team members and DEQ officials, as needed.

2.1.3.2 RESIDENT PROJECT REPRESENTATIVES (RPR)

The designated RPR will carry out daily inspection, testing, and sampling duties under direct supervision from the CQA Officer. The RPR shall be qualified with experience in the assigned aspect of construction. The RPR will observe and document construction and installation procedures. The RPR will prepare daily summary and inspection reports and transmit these weekly to the CQA Officer. The RPR will immediately notify the CQA Officer of problems or deviations from the CQA Plan or design plans and specifications. Reporting, documentation, and resolution of problems and deficiencies shall be carried out as described herein. The RPR will not have authority to approve design or specification changes without consent from the CQA Officer.

2.1.3.3 SOILS TESTING LABORATORY

The Soils Testing Laboratory retained will participate and maintain AASHTO Accreditation through the AASHTO re:source and CCRL certification program. The selected laboratory will be required to be responsive to the project needs by providing test results within reasonable time frames. This shall include providing verbal communication on the status of ongoing tests and immediate communication of test results as needed to facilitate ongoing construction. Such information may include hydraulic conductivity test data, compressive strength data, and soil admixture data. Final laboratory reports will be certified by the soils testing laboratory and submitted to the CQA Officer.

2.1.4 BARRIER WALL SUBCONTRACTOR

The Barrier Wall Subcontractor (Subcontractor) shall have skilled workers experienced with the anticipated subsurface materials, water conditions, installation equipment, wall dimensions, and any special techniques proposed. The Subcontractor shall identify a Project Superintendent and Key Personnel to the CQA Officer and Client Construction Manager prior to construction.

The Subcontractor's Project Superintendent shall have a minimum of five (5) years of experience in the construction of similar deep in-situ soil mix wall construction. The Project Superintendent shall provide to the Client documentation for a minimum of three (3) similar completed projects which were under his direction.

The Subcontractor's other Key Personnel shall have a minimum of three (3) years of experience in the construction of similar deep in-situ wall construction. The Key personnel shall provide to the Client a minimum of three (3) similar completed projects which depict their level of participation.

Prior to mobilization the Subcontractor shall provide documentation showing the qualifications for any of its subcontractors or support companies.

If the Project Superintendent or any Key Personnel are replaced during the project the replacement personnel shall meet the qualifications provided here-in and be approved by the CQA Officer and Client Construction Manager.

3 PRECONSTRUCTION

Prior to construction of the barrier wall, a preconstruction submittal shall be prepared and submitted to the Client. The preconstruction submittal will include, at a minimum, the final version of the CQA Plan, incorporating project experience and input from the selected contractors, and documenting qualifications of the third-party construction quality assurance organization and testing laboratory.

3.1 PRECONSTRUCTION MEETING

A preconstruction meeting shall occur prior to commencement of Barrier Wall construction. The preconstruction meeting will include members of each constituent of the Project Team or their representatives. The objectives of this meeting include construction planning and coordination of tasks; identification of events with potential to cause difficulties and delays in construction; and proper interpretation of design intent by contractor(s). It is important that the rules regarding testing, repair, etc., be known and accepted by each party involved in construction of the barrier wall. Specific topics considered for this meeting include the following:

- Review critical design details of the project, including the plans and specifications.
- Make appropriate modifications to the CQA Plan and develop project-specific addendums (if necessary).
- Review the responsibilities of each party.

- Review lines of authority and communication.
- Review methods for documenting, reporting, and distributing documents and reports.
- Review requirements of the Soils Testing Laboratory.
- Testing Laboratory regarding sample sizes, methods of collection, and transport. Also review turnaround times for sample results and implications on construction schedule pending receipt of acceptance data.
- Review the time schedule for all operations.
- Observe where the site survey benchmarks are located, and review methods for maintaining vertical and horizontal control.
- Review the permit documentation requirements.
- Conduct a site walk to review material storage locations and general conditions relative to construction. The meeting will be documented by the Owner's designated representative and minutes will be distributed to all parties involved in the construction project.

3.2 BARRIER WALL CONTRACTOR SUBMITTALS

The Barrier Wall Subcontractor (Subcontractor) is responsible for submittals required to develop and satisfy the CQA Plan as described herein.

3.2.1 WORK PLAN

The Subcontractor shall submit a Construction Work Plan (CWP) to the Client Construction Manager, the Design Consultant, and the Quality Consultant for approval a minimum of sixty (60) workdays before the start of Work. Work shall not proceed until the CWP is approved by the Project Team. The CWP shall include:

- Description, size, and capacities of proposed equipment, including but not limited to excavation equipment, material handling equipment, material storage equipment, and other support equipment.
- Description of intended means, and methods.
- Proposed mix designs for barrier wall.
- Material certifications, test results, and size and shape specifications.

- Schedule of Work activities. The schedule shall be updated as needed during construction or at a minimum of every two weeks.
- Statement of qualifications and resumes of proposed Subcontractors.
- Remediation and/or corrective measures to be implemented for construction of the barrier wall around utilities or other obstructions that may be encountered within the barrier wall alignment. Proposed measures shall include proposed equipment, means, and methods.

3.2.2 MIX DESIGN

Samples from two distinct boring locations along the barrier wall have been collected for mix design. These areas were selected due to their variability in stratigraphy and represent the bounds of the two material types. A sufficient quantity of water from the site consistent with the site conditions will be collected and forwarded to JLT Laboratories, Inc., an independent laboratory engaged by the Subconsultant to formulate barrier wall mixture proportions. If JLT Laboratories, Inc. is unable or unwilling to participate as the mix designer, the Subcontractor shall submit an alternate third-party laboratory for approval by the Project Team.

The Independent Laboratory has provided a plan for developing a barrier wall mixture in conformance with project design requirements. The plan, attached to this document, outlines a four-phase plan for determining the final mix design:

- Phase 1 – Geotechnical & Water Property Evaluation
    - Determine soil and water properties to provide initial estimations of admixture composition and quantities
- Phase 2 – Bentonite Evaluation
    - Evaluate and determine which bentonite type will be used in the mix design based on performance with the soil and water conditions to be encountered on the project
- Phase 3 – Trial Mixes
    - Quantity of each additive tested in different quantities to determine optimal mix to meet project performance requirements
- Phase 4 – Compatibility Testing
    - Evaluate the groundwater effect on permeability of the soil mixture over time

The Quality Consultant has accepted the phased approach to mix design provided that the Independent Laboratory provides the following testing results on the final mix design (mixed with final proposed proportions of admixtures):

- Unconfined Compressive Strength (UCS) tests performed on a minimum of three (3) separate samples of the prepared mixture and tested at 7, 14 and 28 days in compliance with ASTM D 2166 and/or ASTM D 4832. Tests should be conducted on each of the representative soil mixtures provided to the Independent Laboratory.

- Permeability testing of the proposed mixture 7 days after mixing in accordance with ASTM D 5084 on a minimum of three (3) separate samples of the prepared mixture for each soil mixture.

All Pre-construction mix design testing data will be submitted to the Project Team for review and approval. Upon receipt of the mix design data, the Quality Consultant may choose to verify the proposed mix design through additional testing prior to initiating any field construction activities including the development of a test section.

3.2.3 SITE SAFETY PLAN

Prior to the start of Work, The Subcontractor shall provide their safety plan to the Project Team for approval. The Subcontractor shall comply with all applicable Chemours Site Safety requirements at all times on site. The Subcontractor shall restrict employee access to the site in accordance with direction from The Client and other members of the Project Team.

3.2.4 CONTRACTOR CONSTRUCTION QC

The Subcontractor shall submit a Quality Control (QC) Plan to the Client Construction Manager and Quality Consultant for approval a minimum of ten (10) working days before the start of Work. The QC Plan shall include all quality control procedures including but not limited to:

- The Subcontractor shall provide the qualifications of their CQC representative to the Project Team. The CQC will provide quality control testing services, observations, and monitoring of the subcontractor’s work product.

- Wall Performance Verification Procedures.

All QC submittals will be submitted for review by the Client Construction Manager and Quality Consultant.

3.2.5 MATERIAL SUBMITTALS

The Subcontractor shall coordinate with the Client Construction Manager, the General Contractor, and the CQA Officer to deliver and receive materials at the site. The subcontractor shall submit material certifications upon receiving materials on the project site. Material test results shall be submitted electronically within 48 hours after completion of the testing.

4 PRE-PRODUCTION TEST SECTION

Once the CWP Safety Plan, and QC Plan are approved, a full-scale Test Section a minimum of 50 feet in length, shall be installed prior to production to allow for performance criteria conformance (compressive strength requirements at 28 days, $1x10^{-6}$ cm/sec). The purpose of the Test Section is to evaluate the barrier wall installation process and measure in-situ performance parameters through quality testing of the Test Section. The pre-production test section installation shall also include a Boom Pressure Test to confirm the stiffness of the confining layers at the bottom of the barrier wall and help determine what boom pressure range the Trencher should encounter during production.

Test Section location shall be designated by the Project Team with consideration of all site activities and construction sequencing. The location may either be a portion of the final barrier wall alignment or at a location near the designed barrier wall location determined to be representative of conditions to be encountered in the barrier wall final alignment.

In-situ wet sampling of the Test Section shall be collected in accordance with the CQA Plan (sampling described in later sections) and provided to a laboratory approved by the Project Team. Testing of the collected samples shall be performed in accordance with the test procedures of the CQA Plan (testing described in later sections.

Post-installation sampling of the test section by CPT and sonic drilling techniques shall be performed to evaluate the testing methods outlined in the CQA Plan.

Upon completion of the Pre-Production Test Section, the Project Team will evaluate the installation. Based on the results of installation review, the Client Construction Manager will notify the subcontractor in writing if the Project Team allows the subcontractor to proceed at risk before the results of performance testing are complete.

5 QUALITY CONSULTANT CONSTRUCTION QA

The Client shall provide a CQA Representative (GEOS) who will provide quality assurance services, observations, and monitoring for the Project Team. The QA plan consists of sampling and testing methods designed to evaluate specific performance criteria described in the barrier wall design submittals.

5.1 GEOMETRY

Alignment of the proposed barrier wall will be maintained in the field by surveying and physical staking after daily discussion with the Barrier Wall Subconsultant (Subconsultant) to meet their construction needs. Stakes shall have the station location with grade elevation measured with an accuracy of 0.1 foot. Subconsultant shall be supplied with survey CAD files for their use. GPS monitoring of installation equipment will be required to further establish wall location. Alignment of the wall shall be within plus or minus 0.5 foot horizontal of planned location. The Subconsultant shall record working elevations at intervals not exceeding 25 feet in horizontal distance. Subconsultant shall provide daily record logs providing GPS information to the Quality Consultant.

Depth measurements will be collected by direct read of the excavation device mast or head above the ground surface. This measurement may be accomplished by establishing an elevation mark with a laser instrument or by using a machine mounted sensor. The elevation mark or sensor shall be calibrated with monitoring equipment in the operator's cabin so the operator can maintain appropriate depth control. At a minimum, calibration between the elevation mark or sensor and on-board monitoring equipment shall be conducted at the beginning of each shift or anytime that the wall excavation advancement is interrupted, stopped, or the Trencher is taken down for routine or non-routine maintenance. Elevation marks or sensors as well as on-board monitoring equipment shall be located so that QC/QA personnel may observe the calibration and real time work product. Penetration depth shall be determined by observation of the barrier wall soil mixture returning to the surface and correlation with the estimated depth from pre-construction subsurface geotechnical information. Penetration depth should extend beyond the estimated depth to the confining layer by approximately 5 feet to achieve appropriate cut-off depth. All data shall be recorded in real time on a daily log submitted to the CQA Officer.

To verify barrier wall width, the width of the excavation tools shall be checked at the beginning of each shift or if maintenance occurs on the equipment which effects the excavation tools. The data shall be recorded on a daily log submitted to the CQA Officer

Wall verticality shall be evaluated with level indicators or sensors attached to the vertical sections of the excavation tools to monitor the verticality of the excavation mast. On-board monitors shall be calibrated and checked at the start of each shift. Verticality checks shall be made in each direction and recorded at maximum intervals of 25 linear feet along the wall alignment. Allowable inclination of the excavation mast shall be within plus or minus 1 degree in either direction.

5.2 WALL HOMOGENEITY

Integrated electronic seismic piezocone test (CPT) soundings shall be advanced in the barrier wall mixture after a minimum of 7 days after each section of wall installation at intervals of approximately every 200 feet of the barrier wall. The direct push technology CPT soundings shall be in accordance with ASTM D 5778. CPT allows data to be obtained continuously (approximately every 2 inches). A computer connected to the cone shall record tip resistance, sleeve friction, and dynamic pore pressure via instruments in the cone. Additionally, the cone penetration will be stopped at selected intervals in order to measure pore pressures. At this point the piezocone will become a piezometer. While stopped, water will be injected into the barrier wall soil mixture to generate excess pore pressures, then without advancing the cone, the pressure is then allowed to dissipate and pore water pressures are automatically recorded at five-second intervals and the readings are stored in a dissipation file. Pore pressure dissipation testing will be used to evaluate the homogeneity of the in-place barrier wall mixture. The sounding will be backfilled with grout upon completion of each location.

Drilling methods in general accordance with ASTM D 6914 will be advanced after a minimum of 7 days of wall section installation and at intervals of approximately every 500 feet of the barrier wall. Sonic drilling will supply a continuous sample of the barrier wall soil mixture for evaluation. Sonic cores for each hole will be logged as to penetration rate, drill ability, flush returns, and photographs of core samples with stationing noted, bore hole depth and depth. Sample quality designation (SQD, similar to RQD) determinations) shall be determined on cores not more than 10 feet long and a minimum of 2 ¼ inches in diameter. SQD values shall have average minimum of 85% with no deleterious inclusions or defects greater than 3 inches. Upon completion of any further testing in the sonic borings, the borings will be backfilled with grout.

Drilling and CPT contractors are responsible for maintaining verticality such that the function of the barrier wall is not changed by testing.

5.3 WALL CONTINUITY

Continuity of the barrier wall will be evaluated by visual observation of the locations where wall construction has been temporarily terminated by any means such as end/beginning of shifts, maintenance, admixture supply interruption, construction around utility corridors, or other unforeseen work stoppage such as hazardous weather. Visual observation of each overlapping "joint" shall consist of physically measuring the previous work stoppage location and the beginning of the "new" work. Overlap of the new work and previous work shall be a minimum of 2 feet. Joint continuity shall also be evaluated by checking 20% of the joints by locating either the CPT or Sonic drilling borings on location of joints.

5.4 STRENGTH

Grab samples of the "wet" barrier wall mixture shall be sent to an independent laboratory. Shallow grab samples, approximately 3 to 6 feet below ground surface, shall be obtained at least once per shift and/or a maximum horizontal interval not to exceed 200 linear feet of the wall. Deep grab samples of the "wet" barrier wall mixture shall be obtained at depths and intervals selected by the CQA Officer based on the subsurface physical configuration of the wall. Deep grab samples shall be obtained for every 300 linear feet of wall. The deep grab samples shall be obtained at intervals of approximately 1/3 the depth, 2/3 the depth and near bottom of the wall configuration (within 5 feet of total depth).

All grab samples shall be transported to an independent laboratory where they will be cast into a minimum of eight (8) cylinder samples using 3 inch by 6 inch molds. Unconfined Compressive Strength (UCS) tests shall be performed on a minimum of three (3) separate samples of the prepared mixture and tested at 7, 14 and 28 days in compliance with ASTM D 2166 and/or ASTM D 4832. Two samples shall be retained for testing at 56 days should the other samples fail to make the design strength. Otherwise, they may be discarded once the design strength requirements have been verified.

5.5 WALL PERMEABILITY

Permeability testing shall be performed on 3 inch by 6 inch cylinders molded from grab samples collected as described in the strength testing section. Permeability testing will be performed on wall materials at 7 days in accordance with ASTM D5084. Ten percent of the grab samples (both shallow and deep) shall be tested as described above.

Insitu falling head permeability testing shall be performed in 50% the sonic borings. Tests shall be performed in accordance with a modified ASTM D8152 test procedure.

5.6 CONSTRUCTION DATA MANAGEMENT

Records of the quality control (QC) and quality assurance (QA) plans will be submitted to the Client Construction Manager for schedule analysis and compliance with the COA. Both the Quality Consultant and the Barrier Wall Subconsultant (Subconsultant) shall be responsible for their respective submittals.

5.6.1 SUBCONSULTANT CONSTRUCTION SUBMITTALS

Subconsultant shall be responsible for the following submittals

- Pre-construction Laboratory test data on the barrier wall mixture will be submitted and accepted prior to construction of either the test section or the production wall.
- Daily Field Production Shift Logs (samples attached) which include the following:
    - Production Starting Station
    - Production Ending Station
    - Approximate Depth of Installation Tooling
    - Mix Design/Soil Additives Quantity Used
    - Ground Elevation, verticality data, and linear feet of Barrier Wall constructed during shift
    - Notes concerning start time, end time, downtime, maintenance, obstructions noted, difficult advancement, or abnormalities in wall installation
    - Bulk Sample Selection Logs indicating depth, date, and station.
    - Mill certification or other valid documentation of admixture arrival on-site

5.6.2 QUALITY CONSULTANT CONSTRUCTION SUBMITTALS

The CQA Officer representing the Quality Consultant shall be responsible for compiling the following information related to quality for submittal to the Client.

- Bulk Sample Selection Logs (both Shallow and Deep) indicating Depth, Date, and Location shall also be provided.
- Laboratory Test data for both Pre-Construction, Pre-Production, Construction, and Post Construction work which includes sample referenced to the Bulk Sample Selection Logs. Test data shall include the UCS and Permeability data.
- Field test data including CPT boring data, Sonic drilling data, and in-situ permeability test data will be submitted to the client or their designated representative for acceptance.
- As-built alignment and profile drawings will be prepared to confirm the construction barrier wall meets project requirements.
- Preparation of the Turnover Documentation package for the barrier wall installation.

The Client or their representatives shall be responsible for data transmittal to the State of North Carolina at the conclusion of the project.

6 BARRIER WALL ACCEPTANCE CRITERIA

Final Acceptance of the Barrier Wall System shall be made by the Quality Consultant after review of the final construction data. Review of the Barrier Wall installation shall be completed within 14 calendar days of the date that the complete final data package is received by the Project Team.

Errors, omissions, deletions, clarifications, or edits may be required in the final documentation. The Subcontractor shall submit the data required for Final Acceptance in a timely manner. However, the Project Team may grant, at their discretion, Substantial Completion documents to the Subcontractor allowing the Subcontractor to demobilize their work force and equipment.

The Project Team recognizes that some data, such as UCC, permeability, or other test data may not be available prior to the anticipated completion of the final review.

If deficiencies in the construction of the Barrier Wall system are noted by the Project Team, the Subcontractor shall make repairs as requested by the Project Team prior to receiving substantial completion or final acceptance documents

7 REFERENCES

Geosyntec, 2019a. Corrective Action Plan. Chemours Fayetteville Works. December 31, 2019.

NCDEQ, 2019. Addendum to Consent Order Paragraph 12. General Court of Justice Superior Court Division. State of North Carolina. County of Bladen. February 25, 2019.

Attachments

JLT Laboratories Mix Design General Procedure

JLT LABORATORIES, INC.
GEOTECHNICAL, GEOSYNTHETIC AND MATERIALS TESTING AND RESEARCH

JLT Laboratories Mix Design General Procedure

For Soil-Bentonite & Soil-Cement-Bentonite Barrier Walls

JLT's general approach to designing Soil-Bentonite and Soil-Cement-Bentonite Barrier Walls consists of 4 phases as described below.

Phase I – Geotechnical & Water Properties

A.) For each backfill sample determine:

1.) Gradation	ASTM D-422
2.) Atterberg Limits (If Applicable)	ASTM D-4318
3.) As-Received Moisture Content	ASTM D-2216
4.) Specific Gravity	ASTM D-854
5.) Soil pH	ASTM D-4972
6.) Organic Content (If Applicable)	ASTM D-2974

These tests classify the soil and aide in estimating the quantity of additives required to satisfy project requirements. If the Organic Content is too high, the proposed backfill could be eliminated.

B.) Site Mix Water & Groundwater

Determine: pH
Total Dissolved Solids (TDS)
Alkalinity

Site mix water with adverse properties may eliminate its' use. Groundwater with properties that adversely effect bentonite or cement may require additional additives or changes in the bentonite types or cement type.

C.) Analytical Properties of Groundwater

The client should provide analytical test results of the groundwater sample including pH, hydrocarbons and salts. If hydrocarbons are significant, the backfill mix may require the addition of Organo Clay to arrest hydrocarbons. If salts are too high, the bentonite may have to be changed to a salt resistant bentonite. High concentrations of calcium can also adversely affect sodium bentonite changing it to a calcium bentonite.

Phase II – Bentonite Evaluation

Typical bentonites for backfill mixes include HydroGel 90, Federal Gel 90 Barakade 90 and Premium Gel 90. Other bentonite types include SW101 and salt resistant bentonites. Other clay types include Attapulgite or inexpensive fillers such as Kaolinite and related clays in powder form.

A.) Compatibility Testing Includes:

Swell Index	ASTM D-5890	Using 100% Site Mix Water
Swell Index	ASTM D-5890	Using Site Mix Water Contaminated With 10% Groundwater
Fluid Loss	ASTM D-5891	Using 100% Site Mix Water
Fluid Loss	ASTM D-5891	Using Site Mix Water Contaminated With 10% Groundwater

Typically three (3) bentonite types are tested. The Bentonite type with the best performing properties is used for the trial mixes. For some projects a plate glass test is warranted to evaluate bentonite slurry depending on the groundwater properties.

Phase III – Trial Mixes

A.) Soil-Bentonite Backfill Mixes

Based on the results of the Phase I & Phase II tests, the estimated quantity of bentonite to achieve the desired Permeability is selected. We typically select bentonite contents at the estimated quantity, lean of the estimated quantity and rich of the estimated quantity. In some cases, fillers are used to reduce the bentonite quantity such as borrowed fines to fill pore spaces of backfill soil.

For Example:

2%. 3.5% & 5% Bentonite by Moist Weight of Soil

B.) Soil-Cement-Bentonite Backfill Mix

The quantity of bentonite is selected similar to "A" above. The quantity of cement and type of cement is based on the Phase 1 and Phase II tests and the strength requirements of the project.

In most cases, slag cement is used in lieu of Portland Type 1 cement or a combination of Slag Cement and Portland cement. Slag cement cures at a slower rate and reduces Permeability better than Type 1 Cement. Slag cement is also less expensive in some parts of North America.

C.) Mix Preparation – S-B Wall

1.) Prepare a 40 second slurry using site mix water and the selected bentonite from Phase II.

A.) Determine Viscosity
B.) Determine pH
C.) Determine Density

2.) Using the backfill material at the as-received moisture content prepare three (3) trial mixes.

Example:

Trial Mix	Backfill grams	Dry Bentonite		Record Quantity of Slurry to Achieve a 5 Inch Slump
		%	Grams	
1	5,000	2	100	ml
2	5,000	3.5	175	ml
3	5,000	5	250	ml

Determine For Each Mix: Density
pH
Slump

Fabricate a sample for Permeability testing per ASTM D-5084. Plot Permeability vs Bentonite Content. From this plot determine the quantity of bentonite required to achieve the desired laboratory Permeability. For example, if the required field Permeability is $<1\text{x}10^{-7}$ cm/sec the target laboratory Permeability is $5\text{x}10^{-8}$ cm/sec to provide an adequate factor of safety in the field.

D.) Mix Preparation for S-C-B Wall

1.) Prepare 40 second slurry using site mix water and the selected bentonite.

Determine: Viscosity
pH
Density

2.) Trial mix preparation depends on the desired Permeability, project strength requirements and, often, the contractor likely to perform the work. It is noted the major slurry wall contractors have their own proprietary mixes. Since JLT performs work for most of the major contractors, the actual mixes cannot be documented herein.

However, most mixes contain a combination of Slag cement and Portland cement. The ratios of Slag cement to Portland cement typically range from 90% Slag and 10% Portland to 70% Slag and 30% Portland. Rarely is Portland cement used alone because Portland cement often increases Permeability. If Portland cement alone is used, the bentonite content must be increased considerably which is costly.

At JLT we typically perform 4 to 5 trial mixes with varying quantities of bentonite and cement (Slag & Portland). Similar to an S-B barrier wall, the bentonite and cement are added dry based on the moist weight of soil. The additives are thoroughly mixed with the soil and slurry is then added and mixed to achieve a 5" slump. In some cases, Marasperse or Spercene is used to reduce the viscosity.

We never add the bentonite and cement in slurry form because the quantities added are difficult to determine. Furthermore, cement in a slurry form tends to settle quickly. Thus, the quantity of cement added in slurry form is for all practical purposes, an unknown value.

3.) Upon completion of the mixes, the following is determined for each mix:

    A.) Density
    B.) pH
    C.) Slump

4.) Test cylinders are then prepared. Typically 2" x 4" or 3" to 6" cylinders are prepared depending on the grainsize of the backfill soil.

5.) The cylinders are capped and stored in a cooler covered with wet towels to cure at room temperature.

6.) After 7 or 14 days of curing one cylinder is tested for Unconfined Strength per ASTM D-1633 and another cylinder tested for Permeability per ASTM D-5084.

7.) Based on the results of these tests the design mix is selected. This design mix can be one of the trial mixes on a modification of a trial mix.

Phase IV – Compatibility Testing

Once the design mix is determined, a sample is subject to Compatibility testing per ASTM D-7100.

The test is performed similar to ASTM D-5084 but uses groundwater as the permeate. This test typically continues for 90 to 180 days or more. The longest tests performed by JLT Laboratories to date, has been 3.76 years (1,373 days). Based on ASTM D-7100 criteria the test is terminated when the following criteria is satisfied or as requested by the client.

1.) At least 2 pore volumes pass through the sample.
2.) EC inflow and outflow values are within 10%.
3.) Permeability either decreases over time or remains steady throughout the test.

This is JLT Laboratories general procedure for designing S-B or S-C-B Barrier walls. There are a host of other factors that can adjust or affect the program. For example, if Organo clay is used in the mix to arrest short chain hydrocarbons, analytical tests (performed by an analytical laboratory) are also performed on the outflow side of the sample.

If strength requirements apply to 7, 14 and 28 days, more strength tests are required.

Enclosures
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Attachments

DeWind One Pass Trenching Sample Forms

Soil Mix Installation Report
SuperSack Bags

Project:
Location:
General Contractor:
Trencher:
Operator:

Date:
Weather:
Upgraded PPE:
Hours on site:
Crew:

Soil-Mix Wall Installation Information

Trench width: 36 in **Soil Weight:** 110 pcf

Note(s)	Begin Station sta	Surface Elev. (ft)	Bottom Elev. (ft)	End Station Sta	Surface Elev. (ft)	Travel Rate (in/min)	Bag Weight (lbs)	Estimated Cement (bags)	Depth (ft)	Length (ft)	Area (vsft)	Estimated Cement (%)
supersack bags	6+87	7.00	-70.00	8+41	7.00	6.00	3500	27	77.00	154.0	11858.0	2.41
							Total	27.000		154.00	11858.00	

Quality Control

Station	Depth (ft)	Slump (in)	Weight (pcf)	Note(s)
07+00	50.00	5.00		

Wear Parts

Carbides (ea)	Man (hrs)	Cutters (ea)	Man (hrs)	Note(s)

Summary

Support Equipment

Telehandler, Excavator, Manlift

Soil Mix Installation Report
Pneumatic Bulk Trailers

Project:
Location:
General Contractor:
Trencher:
Operator:

Date:
Weather:
Upgraded PPE:
Hours on site:
Crew:

Soil-Mix Wall Installation Information

Trench width: 36 in

Soil Weight: 110 pcf

Start Station	End Station
+71	5+76

Load Number	Truck Ticket Weight (lbs)
5	52,500

Soil Mix Depth (Ft)	Track Speed (in/min)	Auger (revs)	Material %	Distance (ft)
100	6	35,855	5.1%	505
			TOTAL	505

Quality Control					**Wear Parts**				
Station	Depth (ft)	Slump (in)	Weight (pcf)	Note(s)	Carbides (ea)	Man (hrs)	Cutters (ea)	Man (hrs)	Note(s)
07+00	50.00	5.00							

Summary

Support Equipment

Survey File Points				GPS Data Logger						Trencher Rig Data							Injection Rate	Depth	Calculated Concentration	
Northing	Easting	Surface Elevation	Bott Elev	Date	Time (24 hr)	Northing	Easting	Station	Bott Elev	Date	Time (24 hr)	Track Speed (in/min)	Chain Speed (ft/sec)	Verticality (%)	BIN #1 (rev/min)	BIN #2 (rev/min)	(gpm)	(feet)	BIN #1 (%)	BIN #2 (%)

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

GEOServices, LLC, Geotechnical and Materials Engineers

Appendix I
Passive Flux Meter Memo

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

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Memorandum

Date: March 2022

To: Chemours Company FC, LLC

From: Geosyntec Consultants of NC, P.C.

Subject: Mass Flux in the Northern Portion of the Groundwater Remedy Alignment
Chemours Fayetteville Works Site

INTRODUCTION

Geosyntec Consultants of NC, P.C. (Geosyntec) has prepared this memorandum for The Chemours Company FC, LLC (Chemours) to assess the relative differences in per- and poly-fluorinated alkyl substances (PFAS) mass flux along the northern and southern/ central portions of the groundwater remedy alignment at the Fayetteville Works Site (the Site). The groundwater remedy includes a barrier wall that extends approximately 6,050 feet in length along the southern and central portions of the remedy and a groundwater extraction well network and conveyance system that extend along the entire remedy alignment (over 8,000 feet including the length of the barrier wall).

PFAS mass flux in the Black Creek Aquifer along the groundwater remedy alignment was assessed using passive flux meter (PFM) data from monitoring wells along and near the groundwater remedy alignment. The PFM data, along with cross-sectional areas of the Black Creek Aquifer obtained using the high-resolution cross section presented in the Pre-Design Investigation Report (PDI Report; Geosyntec, 2021), were used to calculate PFAS mass flux for discrete sections along the groundwater remedy alignment.

The results of the assessment indicate that the northern portion of the alignment, from Willis Creek to the facility water intake access road, accounts for 3-5% of the Table 3+ PFAS mass flux[1] in the Black Creek Aquifer, while the southern and central portions, from the facility water intake access road to the old Outfall Channel, account for 95-97% of the mass flux. This finding supports other results described in the 90% Design Submittal, including PFAS analytical data and geological and hydrogeological findings, which indicate that the independent use of groundwater extraction is

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[1] Table 3+ PFAS are often attributed to operations at the Chemours Fayetteville Works Site. Table 3+ PFAS results reported in text are for Table 3+ (17 compounds). As reported in the Matrix Interference During Analysis of Table 3+ Compounds memorandum (Geosyntec, 2020) quantitation of three compounds (R-PSDA, Hydrolyzed PSDA, and R-EVE) is inaccurate due to interferences by the sample matrix in both groundwater and surface water.

sufficient to reduce PFAS loading to the Cape Fear River from groundwater along the northern portion of the remedy alignment.

METHODS

PFMs were provided by Enviroflux and deployed in monitoring wells screened in the Black Creek Aquifer and Floodplain Deposits during deployments in October 2020 and November 2021. The monitoring wells where PFMs were deployed are listed in Table 1 for both deployments and shown in Figures 1A and 1B for the October 2020 deployment and the November 2021 deployment, respectively. Details on the October 2020 deployment are provided in the PDI Report (Geosyntec, 2021), and details on the November 2021 deployment are provided in Table 2. After fourteen to fifteen days, the PFMs were removed for analysis. Resin layers were sent to TestAmerica for PFAS analysis by the Table 3+ Laboratory Standard Operating Procedure (SOP), and granular activated carbon (GAC) layers were sent to Enviroflux for Darcy velocity analysis and subsequent PFAS flux calculation using the Darcy velocity and resin concentration data. Further details on the construction and analysis of the PFMs are provided in the PDI Report (Geosyntec, 2021).

PFAS flux was reported by Enviroflux for each Table 3+ compound in units of micrograms per square meter per day (µg/m^2/day). The flux values were summed to determine the Total Table 3+ flux for 17 compounds. R-PSDA, Hydrolyzed PSDA, and R-EVE were excluded due to matrix interferences for these three compounds discussed in the *Matrix Interference During Analysis of Table 3+ Compounds* memorandum (Geosyntec, 2020).

The location of each well where a PFM was deployed was projected onto the high-resolution cross section originally presented in the PDI Report (Geosyntec, 2021) and shown in Figure 2A for the October 2020 deployment and Figure 2B for the November 2021 deployment. PFMs deployed in Floodplain Deposits wells were included in the projection, since the Black Creek Aquifer and Floodplain Deposits are understood to be interconnected. The midpoint between PFM locations was measured and the cross-sectional area for segments of the Black Creek Aquifer represented by each PFM location was measured based on the distance between these midpoints and accounting for the vertical exaggeration of the cross section. Since the PFM deployments in October 2020 and November 2021 included different well lists, the cross- sectional area assigned to each PFM location varies between deployments. The segments of the Black Creek Aquifer assigned to each PFM location are shown in Figures 2A and 2B in cross-sectional view. PIW-11 is not shown on these figures since the Black Creek Aquifer is interpreted to pinch out between PIW-12 and PIW-11, with no Black Creek Aquifer observed in the PIW-11 borehole log.

The total Table 3+ (17 compounds) mass flux, in units of milligrams per second (mg/s) was calculated as the product of the total Table 3+ (17 compounds) flux reported by Enviroflux and the measured cross-sectional area of the Black Creek Aquifer for each PFM location, including unit conversions. For PIW-11, where the Black Creek Aquifer is not observed but PFAS flux is observed, the relevant cross-sectional area was estimated based on the height of the Black Creek Aquifer at adjacent well PIW-12 and the length of the remedy alignment at PIW-11. To evaluate the total Table 3+ (17 compounds) mass flux for the northern portion of the groundwater remedy alignment versus the southern/central portions, the facility water intake access road was used as a dividing line between the two areas, and mass flux values for PFM locations on either side of the road were summed to determine the relative total Table 3+ mass flux for the northern portion and the southern/central portion.

RESULTS AND DISCUSSION

For the PFMs deployed in October 2020, dry weight Table 3+ PFAS concentrations for the resin samples, Darcy velocity values, and flux values for each Table 3+ compound were reported in the PDI report (Geosyntec, 2021). For the PFMs deployed in November 2021, dry weight Table 3+ PFAS concentrations are reported in Table 3, and Darcy velocity values and flux values for each Table 3+ compound are shown in Table 4, as reported by Enviroflux. Laboratory reports and Data Verification Module (DVM) narrative reports for the associated data are provided in Attachment 1.

A graph showing the Darcy velocity and the Table 3+ PFAS flux values for each monitoring well where a PFM was deployed in November 2021 is shown in Figure 3. The corresponding figure for the October 2020 deployment is included in the PDI report (Geosyntec, 2021). In these figures, results at each location are aligned to show the horizontal location of the monitoring wells relative to the other PFM locations. During both deployments, the Darcy velocity ranged from 2.8 to 11.5 centimeters per day (cm/day) with the exception of PIW-1D, which had a Darcy velocity of 21.9 during the November 2021 deployment. Darcy velocity results for the Floodplain wells (PIW-6S, PIW-7S, and LTW-04) were similar to the results for the Black Creek Aquifer wells, suggesting that the Darcy velocity is similar among the Floodplain Deposits and Black Creek Aquifers. During both deployments, PFAS flux was highest for wells adjacent to the Site (PW-10R, PIW-7S, PIW-7D, and PIW-8D) while the flux for wells adjacent to Willis Creek (PIW-11, PIW-12, PIW-13, and PIW-14) was very small. Tables 5A and 5B present the calculated total table 3+ (17 compounds) mass flux for each PFM deployment location, for the October 2020 deployment and the November 2021 deployment respectively. Tables 5A and 5B also present the total table 3+ (17 compounds) mass flux summed for the northern portion of the remedy alignment, for wells located between Willis Creek and the facility water intake access road, and for the southern/ central portions of the remedy alignment, for wells located between the facility water intake access road and the old Outfall Channel. The October 2020 calculations indicate PFAS mass flux values of 0.067 mg/s in the northern portion of the remedy and 2.3 mg/s in the southern/ central portions of the remedy. The November 2021 calculations indicate PFAS mass flux values of 0.11 mg/s in the northern portion of the remedy and 2.2 mg/s in the southern/ central portions of the remedy. These totals suggest that, across the groundwater remedy alignment, the northern portion of the remedy accounts for 3-5% of the total mass flux in the Black Creek Aquifer, while the southern and central portions account for 95-97% of the total mass flux.

The calculations described above are useful to estimate the relative mass flux along the groundwater remedy alignment. The nature of the available data and calculations mean they are subject to certain limitations that introduce some uncertainty in the estimate. For example, these calculations assume that the thickness of the Black Creek Aquifer interpreted along the cross-section extends to all wells where a PFM was deployed. Downgradient of the cross-section closer to the Cape Fear River, the Black Creek Aquifer is understood to get thinner while the Floodplain Deposits become more dominant. The floodplain deposit wells show similar PFM derived groundwater flux values to Black Creek Aquifer wells, so this assumption is likely valid, but may introduce some uncertainty.

SUMMARY

The results described above suggest that PFAS mass flux in the northern portion of the remedy alignment is significantly smaller than the mass flux in the southern and central portions. The northern portion where groundwater will be controlled with an extraction system accounts for 3-5% of the mass flux in the Black Creek Aquifer along the remedy alignment, while the southern portion where groundwater will be controlled by a barrier wall and extraction system accounts for between 95-97%. This has been consistently demonstrated over the course of two PFM deployments.

These findings support other data related to the northern portion of the remedy alignment described in the 90% Design Submittal, including PFAS analytical data and geological and hydrogeological findings, which indicate that the independent use of groundwater extraction is sufficient to reduce PFAS loading to the Cape Fear River from groundwater along the northern portion of the remedy alignment.

REFERENCES

Geosyntec, 2021. Pre-Design Investigation Summary (Version 2). Chemours Fayetteville Works. June 29, 2021.

Geosyntec, 2020. Matrix Interference During Analysis of Table 3+ Compounds. Chemours Fayetteville Works. June 30, 2020.

Encl.

Tables	Table 1:	Wells Where Passive Flux Meters Were Deployed
	Table 2:	Passive Flux Meter Deployment Details – November 2021 Deployment
	Table 3:	PFM Resin PFAS Results – November 2021 Deployment
	Table 4:	Darcy Velocity and Flux Values – November 2021 Deployment
	Table 5A:	PFAS Mass Flux Along the Remedy Alignment – October 2020 Deployment
	Table 5B:	PFAS Mass Flux Along the Remedy Alignment – November 2021 Deployment
Figures	Figure 1A:	PFM Monitoring Well Locations and Remedy Alignment – October 2020 Deployment
	Figure 1B:	PFM Monitoring Well Locations and Remedy Alignment – November 2021 Deployment
	Figure 2A:	High Resolution Cross-Section with PFM Well Locations and Remedy Alignment Segments – October 2020 Deployment
	Figure 2B:	High Resolution Cross-Section with PFM Well Locations and Remedy Alignment Segments – November 2021 Deployment
	Figure 3:	November 2021 Passive Flux Meter Results – Darcy Velocities and PFAS Flux
Attachments	Attachment 1 - Laboratory Reports and DVM Narrative Reports	

* * * * *

Tables

TABLE 1
WELLS WHERE PASSIVE FLUX METERS WERE DEPLOYED
Chemours Fayetteville Works, North Carolina

Location ID	Water Bearing Unit	October 2020 Deployment	November 2021 Deployment
LTW-04	Floodplain Deposits	--	✓
OW-4	Black Creek Aquifer	--	✓
PIW-11	Black Creek Aquifer	✓	✓
PIW-12	Black Creek Aquifer	✓	✓
PIW-13	Black Creek Aquifer	✓	✓
PIW-14	Black Creek Aquifer	✓	✓
PIW-15	Black Creek Aquifer	✓	✓
PIW-1D	Black Creek Aquifer	✓	✓
PIW-2D	Black Creek Aquifer	✓	--
PIW-3D	Black Creek Aquifer	✓	✓
PIW-4D	Black Creek Aquifer	✓	✓
PIW-6S	Floodplain Deposits	✓	✓
PIW-7D	Black Creek Aquifer	✓	✓
PIW-7S	Floodplain Deposits	✓	✓
PIW-8D	Black Creek Aquifer	✓	✓
PIW-9D	Black Creek Aquifer	✓	--
PIW-10DR	Black Creek Aquifer	✓	--
PW-10R	Black Creek Aquifer	✓	✓
PW-11	Black Creek Aquifer	✓	--

Notes:

The well list was updated for the November 2021 deployment to exclude wells that were inaccessible due to interim pumping of the Black Creek Aquifer, and to prioritize wells downgradient of the groundwater remedy alignment.

TABLE 2
PASSIVE FLUX METER DEPLOYMENT DETAILS - NOVEMBER 2021 DEPLOYMENT
Chemours Fayetteville Works, North Carolina

Well ID	Geologic Completion Zone	Screen Interval (ft bgs)	PFM 1 (Upper Screen Interval)	PFM 2 (Lower Screen Interval)[1]	Date Placed	Time Placed	$\text{DTW}_{\text{initial}}$ (ft TOC)	$\text{DTW}_{\text{final}}$ (ft TOC)	Date Removed and Sampled	Time Removed	Days Elapsed	Transducer Present
OW-4	Black Creek Aquifer	47-57	PFM-2	PFM-1	10/21/2021	8:30	19.2	19.2	11/4/2021	7:40	14	No
PIW-7S	Surficial Aquifer	7-17	PFM-4	PFM-3	10/21/2021	9:30	5.3	5.2	11/4/2021	8:45	14	No
PIW-7D	Black Creek Aquifer	29-34	PFM-5	--	10/21/2021	9:13	5.4	5.4	11/4/2021	8:55	14	No
LTW-04	Black Creek Aquifer	12-27	PFM-8	PFM-6	10/21/2021	10:00	8.3	5.7	11/4/2021	9:35	14	Yes
PW-10R	Black Creek Aquifer	57-67	PFM-10	PFM-9	10/21/2021	10:50	26.77	27.20	11/4/2021	10:10	14	No
PIW-6S	Surficial Aquifer	18-28	PFM-12	PFM-11	10/21/2021	11:23	14.48	13.68	11/4/2021	10:45	14	Yes
PIW-3D	Black Creek Aquifer	19-24	PFM-13	--	10/21/2021	12:10	17.6	17.5	11/4/2021	11:30	14	Yes
PIW-4D	Black Creek Aquifer	32.2-37.3	PFM-14	--	10/21/2021	12:37	10.3	10.3	11/4/2021	11:53	14	Yes
PIW-1D	Black Creek Aquifer	25-30	PFM-15	--	10/21/2021	13:00	19.0	19.1	11/4/2021	12:35	14	Yes
PIW-15	Black Creek Aquifer	34-44	PFM-17	PFM-16	10/21/2021	13:35	34.5	34.5	11/4/2021	12:55	14	No
PIW-14	Black Creek Aquifer	56-66	PFM-28	PFM-27	10/21/2021	14:15	52.2	52.2	11/4/2021	13:30	14	No
PIW-13	Black Creek Aquifer	54-64	PFM-29	PFM-26	10/21/2021	14:50	48.7	48.7	11/4/2021	13:45	14	No
PIW-12	Black Creek Aquifer	64-74	PFM-24	PFM-22	10/21/2021	15:30	49.5	49.5	11/4/2021	14:10	14	No
PIW-11	Black Creek Aquifer	47-57	PFM-25	PFM-23	10/21/2021	16:10	22.0	18.6	11/4/2021	14:35	14	No
PIW-8D	Black Creek Aquifer	35-40	PFM-1	--	11/16/2021	11:15	--	--	11/30/2021	7:50	14	No

Notes:
1. For wells with ten foot screen intervals, two PFMs were placed.
-- Not recorded/not present
PFM - passive flux meter
ft BGS - feet below ground surface
ft TOC - feet from the top of casing
DTW - depth to water
$\text{DTW}_{\text{initial}}$ - measured DTW prior to PFM placement
$\text{DTW}_{\text{final}}$ - measured DTW after PFM placement

TABLE 3
PFM RESIN PFAS RESULTS - NOVEMBER 2021 DEPLOYMENT
Chemours Fayetteville Works, North Carolina

Location ID	**LTW-04**	**OW-4**	**PIW-1D**	**PIW-3D**	**PIW-4D**	**PIW-6S**	**PIW-7D**
Field Sample ID	**LTW04-20211104-R**	**OW4-20211104-R**	**PIW1D-20211104-R**	**PIW3D-20211104-R**	**PIW4D-20211104-R**	**PIW6S-20211104-R**	**PIW7D-20211104-R**
Sample Date	**11/04/2021**	**11/04/2021**	**11/04/2021**	**11/04/2021**	**11/04/2021**	**11/04/2021**	**11/04/2021**
QA/QC							
Sample Matrix	**SOLID**	**SOLID**	**SOLID**	**SOLID**	**SOLID**	**SOLID**	**SOLID**
Regulatory Location ID							
Sample Delivery Group (SDG)	**320-81329-1**	**320-81329-1**	**320-81329-1**	**320-81329-1**	**320-81329-1**	**320-81329-1**	**320-81329-1**
Lab Sample ID	**320-81329-7**	**320-81329-3**	**320-81329-12**	**320-81329-10**	**320-81329-11**	**320-81329-9**	**320-81329-5**
Units	**ng/kg**	**ng/kg**	**ng/kg**	**ng/kg**	**ng/kg**	**ng/kg**	**ng/kg**
Table 3+ SOP							
Hfpo Dimer Acid	**170,000**	**150,000 J**	**2,200,000**	**480,000**	<2,900	**110,000**	**1,600,000**
PFMOAA	**730,000**	**360,000**	**2,000,000**	**150,000**	<2,600	**2,900,000**	**8,500,000**
PFO2HxA	**270,000**	**160,000**	**1,600,000**	**300,000**	<2,400	**360,000**	**3,300,000**
PFO3OA	**35,000**	**51,000 J**	**280,000**	**50,000**	<3,800	**46,000**	**420,000**
PFO4DA	<13,000	**12,000**	**60,000**	**24,000**	<7,900	<14,000	**120,000**
PFO5DA	<12,000	<9,800	<13,000	<6,600	<7,200	<12,000	<58,000
PMPA	**200,000**	**56,000 J**	**1,800,000**	**300,000**	<5,000	**170,000**	**310,000**
PEPA	**60,000**	**17,000**	**510,000**	**110,000**	<3,100	**27,000**	**58,000**
PS Acid	<4,500	<3,700 UJ	<5,100	<2,500	<2,800	<4,700	<22,000
Hydro-PS Acid	<4,200	<3,500 UJ	**6,200**	**2,800**	<2,600	<4,400	<21,000
R-PSDA	<11,000	<8,900 UJ	<12,000	<6,000	<6,600	<11,000	<52,000
Hydrolyzed PSDA	<18,000	<15,000 UJ	<20,000	<9,900	<11,000	<19,000	<87,000
R-PSDCA	<4,500	<3,700 UJ	<5,100	<2,500	<2,800	<4,700	<22,000
NVHOS	**9,100**	**4,800 J**	**21,000**	<3,000	<3,300	**8,300**	**77,000**
EVE Acid	<4,200	<3,500	<4,700	<2,400	<2,600	<4,400	<21,000
Hydro-EVE Acid	<4,800	**7,800**	<5,400	<2,700	<2,900	<5,000	**31,000**
R-EVE	<14,000	<12,000 UJ	<16,000	<8,000	<8,800	<15,000	<70,000
PES	<4,800	<4,000 UJ	<5,400	<2,700	<2,900	<5,000	<23,000
PFECA B	<7,000	<5,800	<7,900	<3,900	<4,300	<7,400	<34,000
PFECA-G	<10,000	<8,600 UJ	<12,000	<5,800	<6,400	<11,000	<51,000
Total table 3+ (17 compounds)[1,2]	**1,500,000**	**820,000**	**8,500,000**	**1,400,000**	ND	**3,600,000**	**14,000,000**
Total table 3+ (20 compounds)[1]	**1,500,000**	**820,000**	**8,500,000**	**1,400,000**	ND	**3,600,000**	**14,000,000**
Other Parameters (%)							
Percent Moisture	**72.5**	**71.5**	**71.3**	**66.5**	**67.8**	**66**	**69.7**
Percent Solids	**27.5**	**28.5**	**28.7**	**33.5**	**32.2**	**34**	**30.3**

TABLE 3
PFM RESIN PFAS RESULTS - NOVEMBER 2021 DEPLOYMENT
Chemours Fayetteville Works, North Carolina

Location ID	**PIW-7S**	**PIW-7S**	**PIW-8D**	**PIW-10R**	**PIW-11**	**PIW-12**	**PIW-13**
Field Sample ID	**PIW7S-20211104-R**	**DUP-20211104-R**	**PIW8D-20211130-R**	**PIW10R-20211104-R**	**PIW11-20211104-R**	**PIW12-20211104-R**	**PIW13-20211104-R**
Sample Date	**11/04/2021**	**11/04/2021**	**11/30/2021**	**11/04/2021**	**11/04/2021**	**11/04/2021**	**11/04/2021**
QA/QC		**Field Duplicate**					
Sample Matrix	**SOLID**	**Solid**	**SOLID**	**SOLID**	**SOLID**	**SOLID**	**SOLID**
Regulatory Location ID							
Sample Delivery Group (SDG)	**320-81329-1**	**320-81329-1**	**320-82351-1**	**320-81329-1**	**320-81329-1**	**320-81329-1**	**320-81329-1**
Lab Sample ID	**320-81329-4**	**320-81329-6**	**320-82351-1**	**320-81329-8**	**320-81329-17**	**320-81329-16**	**320-81329-15**
Units	**ng/kg**	**ng/kg**	**ng/kg**	**ng/kg**	**ng/kg**	**ng/kg**	**ng/kg**
Table 3+ SOP							
Hfpo Dimer Acid	**240,000**	**260,000**	**3,300,000 J**	**1,800,000**	**27,000**	**14,000**	**180,000**
PFMOAA	**210,000**	**230,000**	**9,600,000 J**	**14,000,000**	**44,000**	**8,900**	**47,000**
PFO2HxA	**140,000**	**160,000**	**4,700,000 J**	**4,800,000**	**22,000**	**4,300**	**62,000**
PFO3OA	**53,000**	**58,000**	**1,600,000 J**	**340,000**	<4,800	<5,700	<5,400
PFO4DA	<10,000	<12,000	**260,000 J**	<88,000	<10,000	<12,000	<11,000
PFO5DA	<9,500	<11,000	<1,400 UJ	<80,000	<9,100	<11,000	<10,000
PMPA	**120,000**	**130,000**	**690,000 J**	**770,000**	**18,000**	**11,000**	**150,000**
PEPA	**50,000**	**51,000**	**240,000 J**	**170,000**	**5,400**	<4,700	**40,000**
PS Acid	<3,600	<4,100	<1,400 R	<31,000	<3,500	<4,200	<4,000
Hydro-PS Acid	<3,400	<3,900	**29,000 J**	<29,000	<3,300	<3,900	<3,700
R-PSDA	<8,600	<9,800	**95,000 J**	<72,000	<8,200	<9,900	<9,400
Hydrolyzed PSDA	<14,000	<16,000	**340,000 J**	<120,000	<14,000	<16,000	<16,000
R-PSDCA	<3,600	<4,100	**2,700 J**	<31,000	<3,500	<4,200	<4,000
NVHOS	**7,100**	**8,100**	**130,000 J**	**130,000**	**4,200**	<4,900	<4,700
EVE Acid	<3,400	<3,900	<1,400 UJ	<29,000	<3,300	<3,900	<3,700
Hydro-EVE Acid	**4,800**	**5,600**	**130,000 J**	<32,000	<3,700	<4,400	<4,200
R-EVE	<12,000	<13,000	**180,000 J**	<97,000	<11,000	<13,000	<13,000
PES	<3,900	<4,400	**1,900 J**	<32,000	<3,700	<4,400	<4,200
PFECA B	<5,700	<6,400	<1,400 UJ	<48,000	<5,400	<6,500	<6,200
PFECA-G	<8,400	<9,500	<1,400 UJ	<71,000	<8,000	<9,600	<9,200
Total table 3+ (17 compounds)[1,2]	**820,000**	**900,000**	**21,000,000**	**22,000,000**	**120,000**	**38,000**	**480,000**
Total table 3+ (20 compounds)[1]	**820,000**	**900,000**	**21,000,000**	**22,000,000**	**120,000**	**38,000**	**480,000**
Other Parameters (%)							
Percent Moisture	**72.5**	**72.3**	**71**	**70.9**	**69.2**	**72.6**	**68.9**
Percent Solids	**27.5**	**27.7**	**29**	**29.1**	**30.8**	**27.4**	**31.1**

TABLE 3
PFM RESIN PFAS RESULTS - NOVEMBER 2021 DEPLOYMENT
Chemours Fayetteville Works, North Carolina

Location ID	**PIW-14**	**PIW-15**	**EB**	**EB**	**FBLK**
Field Sample ID	**PIW14-20211104-R**	**PIW15-20211104-R**	**EB-20211104**	**EB-20211130**	**FB-20211104**
Sample Date	**11/04/2021**	**11/04/2021**	**11/04/2021**	**11/30/2021**	**11/04/2021**
QA/QC			**Equipment Blank**	**Equipment Blank**	**Field Blank**
Sample Matrix	**SOLID**	**SOLID**	**LIQUID**	**LIQUID**	**LIQUID**
Regulatory Location ID					
Sample Delivery Group (SDG)	**320-81329-1**	**320-81329-1**	**320-81329-1**	**320-82351-1**	**320-81329-1**
Lab Sample ID	**320-81329-14**	**320-81329-13**	**320-81329-2**	**320-82351-2**	**320-81329-1**
Units	**ng/kg**	**ng/kg**	**ng/L**	**ng/L**	**ng/L**
Table 3+ SOP					
Hfpo Dimer Acid	**31,000**	**570,000**	<2.0	<2.0	<2.0
PFMOAA	**11,000**	**550,000**	<2.0	<2.0	<2.0
PFO2HxA	**26,000**	**400,000**	<2.0	<2.0	<2.0
PFO3OA	<5,400	**51,000**	<2.0	<2.0	<2.0
PFO4DA	<11,000	<9,300	<2.0	<2.0	<2.0
PFO5DA	<10,000	<8,500	<2.0	<2.0	<2.0
PMPA	**54,000**	**450,000**	<10	<10	<10
PEPA	**12,000**	**150,000**	<20	<20	<20
PS Acid	<3,900	<3,200	<2.0	<2.0	<2.0
Hydro-PS Acid	<3,700	<3,000	<2.0	<2.0	<2.0
R-PSDA	<9,300	<7,700	<2.0	<2.0	<2.0
Hydrolyzed PSDA	<15,000	<13,000	<2.0	<2.0	<2.0
R-PSDCA	<3,900	<3,200	<2.0	<2.0	<2.0
NVHOS	<4,700	**5,300**	<2.0	<2.0	<2.0
EVE Acid	<3,700	<3,000	<2.0	<2.0	<2.0
Hydro-EVE Acid	<4,200	<3,400	<2.0	<2.0	<2.0
R-EVE	<13,000	<10,000	<2.0	<2.0	<2.0
PES	<4,200	<3,400	<2.0	<2.0	<2.0
PFECA B	<6,100	<5,100	<2.0	<2.0	<2.0
PFECA-G	<9,100	<7,500	<2.0	<2.0	<2.0
Total table 3+ (17 compounds)[1,2]	**130,000**	**2,200,000**	ND	ND	ND
Total table 3+ (20 compounds)[1]	**130,000**	**2,200,000**	ND	ND	ND
Other Parameters (%)					
Percent Moisture	**70.9**	**71**	--	--	--
Percent Solids	**29.1**	**29**	--	--	--

Notes:

1 - Total Table 3+ was calculated including J qualified data but not non-detect data. The total Table 3+ sum is rounded to two significant figures.

2 - Total Table 3+ (17 Compounds) does not include R-PSDA, Hydrolyzed PSDA and R-EVE.

Bold - Analyte detected above associated reporting limit.

J - Analyte detected. Reported value may not be accurate or precise.

ND - No Table 3+ compounds were detected above their associated reporting limits.

ng/kg - nanograms per kilogram

ng/L - nanograms per liter

PFAS - per- and poly-fluorinated alkyl substances

PFM - passive flux meter

QA/QC - Quality assurance/ quality control

SOP - standard operating procedure

< - Analyte not detected above associated reporting limit.

UJ - Analyte not detected. Reporting limit may not be accurate or precise.

TABLE 4
DARCY VELOCITY AND FLUX VALUES - NOVEMBER 2021 DEPLOYMNET
Chemours Fayetteville Works, North Carolina

Sample ID	Location ID	Depth below top of well casing (ft)	Darcy Velocity (cm/day)	Hfpo Dimer Acid (µg/m^2/day)	PFMOAA (µg/m^2/day)	PFO2HxA (µg/m^2/day)	PFO3OA (µg/m^2/day)	PFO4DA (µg/m^2/day)	PFO5DA (µg/m^2/day)	PMPA (µg/m^2/day)	PEPA (µg/m^2/day)
LTW04-20211104-G	LTW-04	27	6.1	370	1,600	590	77	29	26	440	130
OW4-20211104-G	OW-4	57	3.8	330	790	350	110	26	22	120	37
PW10R-20211104-G	PW-10R	67	11.5	4,000	31,000	11,000	750	190	180	1,700	370
PIW11-20211104-G	PIW-11	57	4.4	59	97	48	11	22	20	40	12
PIW12-20211104-G	PIW-12	74	4.3	31	20	10	13	26	24	24	10
PIW13-20211104-G	PIW-13	64	8.3	400	100	140	12	24	22	330	88
PIW14-20211104-G	PIW-14	66	4.2	68	24	57	12	24	22	120	26
PIW15-20211104-G	PIW-15	44	6.2	1,300	1,200	880	110	20	19	990	330
PIW1D-20211104-G	PIW-1D	30	21.9	4,800	4,400	3,500	620	130	29	4,000	1,100
PIW3D-20211104-G	PIW-3D	24	6.5	1,100	330	660	110	53	14	660	240
PIW4D-20211104-G	PIW-4D	37	6.9	6	6	5	8	17	16	11	7
PIW6S-20211104-G	PIW-6S	28	6.0	240	6,400	790	100	31	26	370	59
PIW7D-20211104-G	PIW-7D	34	8.1	3,500	19,000	7,300	920	260	130	680	130
PIW7S-20211104-G	PIW-7S	17	5.2	530	460	310	120	22	21	260	110
DUP-20211104-G	PIW-7S	17	5.0	570	500	350	130	26	24	280	110
PIW8D-20211130-G	PIW-8D	35	5.3	7,300	21,000	10,000	3,600	580	3	1,500	530

TABLE 4
DARCY VELOCITY AND FLUX VALUES - NOVEMBER 2021 DEPLOYMNET
Chemours Fayetteville Works, North Carolina

Sample ID	Location ID	Depth below top of well casing (ft)	Darcy Velocity (cm/day)	PS Acid (µg/m^2/day)	Hydro-PS Acid (µg/m^2/day)	R-PSDA (µg/m^2/day)	Hydrolyzed PSDA (µg/m^2/day)	R-PSDCA (µg/m^2/day)	NVHOS (µg/m^2/day)	EVE Acid (µg/m^2/day)	Hydro-EVE Acid (µg/m^2/day)
LTW04-20211104-G	LTW-04	27	6.1	10	9	24	40	10	20	9	11
OW4-20211104-G	OW-4	57	3.8	8	8	20	33	8	11	8	17
PW10R-20211104-G	PW-10R	67	11.5	68	64	160	260	68	290	64	70
PIW11-20211104-G	PIW-11	57	4.4	8	7	18	31	8	9	7	8
PIW12-20211104-G	PIW-12	74	4.3	9	9	22	35	9	11	9	10
PIW13-20211104-G	PIW-13	64	8.3	9	8	21	35	9	10	8	9
PIW14-20211104-G	PIW-14	66	4.2	9	8	20	33	9	10	8	9
PIW15-20211104-G	PIW-15	44	6.2	7	7	17	29	7	12	7	8
PIW1D-20211104-G	PIW-1D	30	21.9	11	14	26	44	11	46	10	12
PIW3D-20211104-G	PIW-3D	24	6.5	6	6	13	22	6	7	5	6
PIW4D-20211104-G	PIW-4D	37	6.9	6	6	14	24	6	7	6	6
PIW6S-20211104-G	PIW-6S	28	6.0	10	10	24	42	10	18	10	11
PIW7D-20211104-G	PIW-7D	34	8.1	48	46	110	190	48	170	46	68
PIW7S-20211104-G	PIW-7S	17	5.2	8	8	19	31	8	16	8	11
DUP-20211104-G	PIW-7S	17	5.0	9	9	21	35	9	18	9	12
PIW8D-20211130-G	PIW-8D	35	5.3	3	64	210	750	6	290	3	290

TABLE 4
DARCY VELOCITY AND FLUX VALUES - NOVEMBER 2021 DEPLOYMNET
Chemours Fayetteville Works, North Carolina

Sample ID	Location ID	Depth below top of well casing (ft)	Darcy Velocity (cm/day)	R-EVE (µg/m^2/day)	PES (µg/m^2/day)	PFECA B (µg/m^2/day)	PFECA-G (µg/m^2/day)
LTW04-20211104-G	LTW-04	27	6.1	31	11	15	22
OW4-20211104-G	OW-4	57	3.8	26	9	13	19
PW10R-20211104-G	PW-10R	67	11.5	210	70	110	160
PIW11-20211104-G	PIW-11	57	4.4	24	8	12	18
PIW12-20211104-G	PIW-12	74	4.3	29	10	14	21
PIW13-20211104-G	PIW-13	64	8.3	29	9	14	20
PIW14-20211104-G	PIW-14	66	4.2	29	9	13	20
PIW15-20211104-G	PIW-15	44	6.2	22	8	11	16
PIW1D-20211104-G	PIW-1D	30	21.9	35	12	17	26
PIW3D-20211104-G	PIW-3D	24	6.5	18	6	9	13
PIW4D-20211104-G	PIW-4D	37	6.9	19	6	9	14
PIW6S-20211104-G	PIW-6S	28	6.0	33	11	16	24
PIW7D-20211104-G	PIW-7D	34	8.1	150	51	75	110
PIW7S-20211104-G	PIW-7S	17	5.2	26	9	13	18
DUP-20211104-G	PIW-7S	17	5.0	28	10	14	21
PIW8D-20211130-G	PIW-8D	35	5.3	400	4	3	3

Notes:
Darcy velocity and PFAS flux data reported by EnviroFlux
All values rounded to 2 significant digits
ft - feet
ND - analyte not detected above the associated reporting limit
PFAS - per- and polyfluoroalkyl substances
PFM - passive flux meter
cm/day - centimeters per day
µg/m^2/day - micrograms per square meter per day

TABLE 5A
PFAS MASS FLUX ALONG THE REMEDY ALIGNMENT - OCTOBER 2020 DEPLOYMENT
Chemours Fayetteville Works, North Carolina

Groundwater Remedy Alignment Portion	PFM Sample ID	Location ID	Darcy Velocity (cm/day)[1]	Total Table 3+ (17 Compounds) Flux (µg/m^2/day)[1,2]	Cross Sectional Area of Black Creek Aquifer Segment (ft^2)[3]	Estimated Total Table 3+ (17 Compounds) Mass Flux (mg/sec)[2]
Northern Portion	PIW-11-47-57-G	PIW-11[4]	3.6	128	3,200	4.39E-04
	PIW-12-64-74-G	PIW-12	3.0	62	1,540	1.0E-04
	PIW-13-54-64-G	PIW-13	3.2	608	3,529	2.3E-03
	PIW-14-56-66-G	PIW-14	3.0	1,254	10,965	0.015
	PIW-15-34-44-G	PIW-15	3.3	3,497	7,239	0.027
	PIW-1D-25-30-G	PIW-1D	5.3	7,262	2,843	0.022
	Total - Northern Portion	--	--	**12,811**	**29,315**	**0.067**
Southern/ Central Portion	PIW-2D-40-50-G	PIW-2D	3.1	282	11,686	3.54E-03
	PIW-3D-20-25-G	PIW-3D	7.2	9,306	10,830	0.11
	PIW-4D-32-37-G	PIW-4D	4.5	1	13,872	1.8E-05
	PW-10R-57-67-G	PW-10R	6.6	28,149	9,776	0.30
	PIW-6S-18-28-G	PIW-6S	3.3	11,456	42,502	0.52
	PIW-7S-7-17-G / PIW-7D-29-34-G	PIW-7S / PIW-7D[5]	5.8	22,911	26,021	0.64
	PIW-8D-35-40-G	PIW-8D	3.1	46,022	7,571	0.37
	PIW-9D-40-45-G	PIW-9D	2.8	5,334	12,200	0.070
	PIW-10DR-48-58-G	PIW-10DR	3.0	5,547	16,011	0.095
	PW-11-54-64-G	PW-11	3.6	12,506	14,354	0.19
	Total - Southern Portion	--	--	**141,513**	**164,823**	**2.3**

Notes:

1 - Darcy velocity and Table 3+ flux for the October 2020 event is reported by Enviroflux and is presented in the Pre-Design Investigation Report (Geosyntec, 2021).

2 - Total Table 3+ (17 compounds) does not include R-PSDA, Hydrolyzed PSDA, and R-EVE.

3 - Cross-Sectional Areas of the Black Creek Aquifer for each PFM location are shown in Figure 2A.

4 - The Black Creek Aquifer is interpreted to pinch out to the south of PIW-11, however PFAS flux is observed at this location. The relevant cross- sectional area was estimated based on the height of the Black Creek Aquifer at adjacent well PIW-12 and the length of the remedy alignment at PIW-11.

5 - PIW-7S and PIW-7D both project to the same position on the high-resolution cross section (Figure 2A) therefore the reported flux for these two locations was averaged to calculate the mass flux.

cm/day - centimeters per day
ft^2 - square feet
mg/s - milligrams per second
PFAS - per- and poly-fluorinated alkyl substances
PFM - passive flux meter
µg/m^2/day - micrograms per square meter per day

TABLE 5B
PFAS MASS FLUX ALONG THE REMEDY ALIGNMENT - NOVEMBER 2021 DEPLOYMENT
Chemours Fayetteville Works, North Carolina

Groundwater Remedy Alignment Portion	PFM Sample ID	Location ID	Darcy Velocity (cm/day)[1]	Total Table 3+ (17 Compounds) Flux (µg/m^2/day)[1,2]	Cross Sectional Area of Black Creek Aquifer Segment (ft^2)[3]	Estimated Total Table 3+ (17 Compounds) Mass Flux (mg/sec)[2]
Northern Portion	PIW11-20211104-G	PIW-11[4]	4.4	394	3,200	1.4E-03
	PIW-12-64-74-G	PIW-12	4.3	259	1,540	4.3E-04
	PIW-13-54-64-G	PIW-13	8.3	1,208	3,529	4.6E-03
	PIW-14-56-66-G	PIW-14	4.2	448	10,965	5.3E-03
	PIW-15-34-44-G	PIW-15	6.2	4,891	7,239	0.038
	PIW-1D-25-30-G	PIW-1D	21.9	18,749	2,843	0.057
	Total - Northern Portion	--	--	**25,949**	**29,315**	**0.11**
Southern/ Central Portion	PIW-3D-20-25-G	PIW-3D	6.5	3,183	23,472	0.080
	PIW-4D-32-37-G	PIW-4D	6.9	144	13,179	2.0E-03
	PW10R-20211104-G	PW-10R	11.5	49,381	9,329	0.50
	PIW-6S-18-28-G	PIW-6S	6.0	8,111	35,395	0.31
	LTW04-20211104-G	LTW-04	6.1	3,387	24,576	0.089
	PIW-7D-29-34-G / PIW7S-20211104-G	PIW-7S / PIW-7D[5]	6.7	17,086	8,278	0.15
	PIW-8D-35-40-G	PIW-8D	5.3	45,927	20,317	1.0
	OW4-20211104-G	OW-4	3.8	1,892	31,952	0.065
	Total - Southern Portion	--	--	**129,110**	**166,498**	**2.2**

Notes:

1 - Darcy velocity and Table 3+ flux for the November 2021 event is reported by Enviroflux and is presented in Table 4.

2 - Total Table 3+ (17 compounds) does not include R-PSDA, Hydrolyzed PSDA, and R-EVE.

3 - Cross-Sectional Areas of the Black Creek Aquifer for each PFM location are shown in Figure 2B.

4 - The Black Creek Aquifer is interpreted to pinch out to the south of PIW-11, however PFAS flux is observed at this location. The relevant cross- sectional area was estimated based on the height of the Black Creek Aquifer at adjacent well PIW-12 and the length of the remedy alignment at PIW-11.

5 - PIW-7S and PIW-7D both project to the same position on the high-resolution cross section (Figure 2B) therefore the reported flux for these two locations was averaged to calculate the mass flux.

cm/day - centimeters per day

ft^2 - square feet

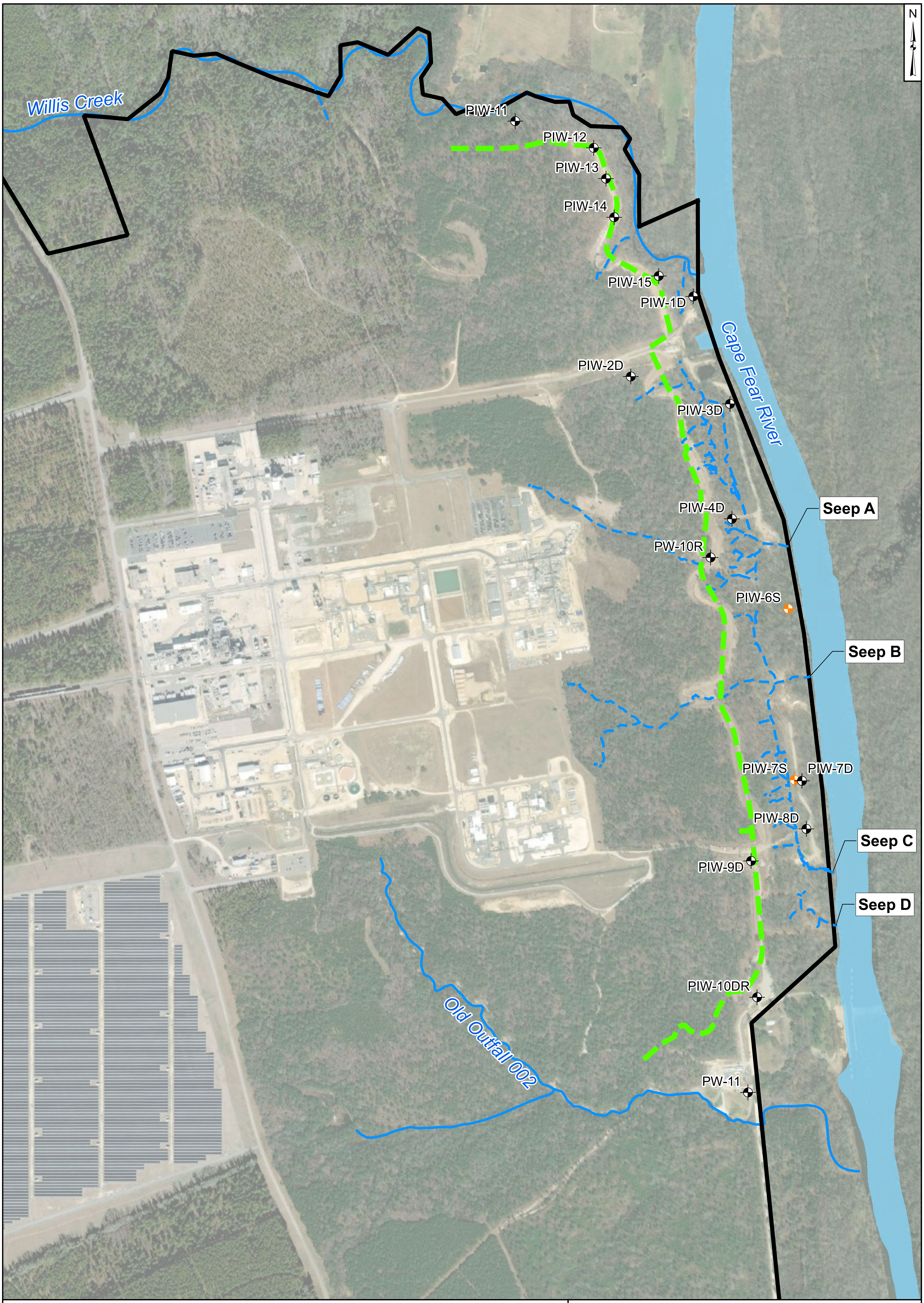
mg/s - milligrams per second

PFAS - per- and poly-fluorinated alkyl substances

PFM - passive flux meter

µg/m^2/day - micrograms per square meter per day

Figures



Legend

⊕ Floodplain Deposits

⊕ Black Creek Aquifer

— Nearby Tributary

- - Observed Seep

— Site Boundary

- - Remedy Alignment

1,000 500 0 1,000 Feet

Notes:
PFM - passive flux meter
1. Due to the scale of the map, pairs of wells that are in close proximity have been offset for visibility. Therefore, the placement of these wells on this map do not reflect their true geographic coordinates.
2. Remedy alignment is preliminary and is subject to change in future submittals.
3. The outline of Cape Fear River is approximate and is based on open data from ArcGIS Online and North Carolina Department of Environmental Quality Online GIS (MajorHydro shapefile).
4. PIW and PW-well locations were surveyed by a licensed North Carolina Surveyor.
5. Basemap source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

PFM Monitoring Well Locations and Remedy Alignment - October 2020 Deployment

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
NC License No.: C-3500 and C-295

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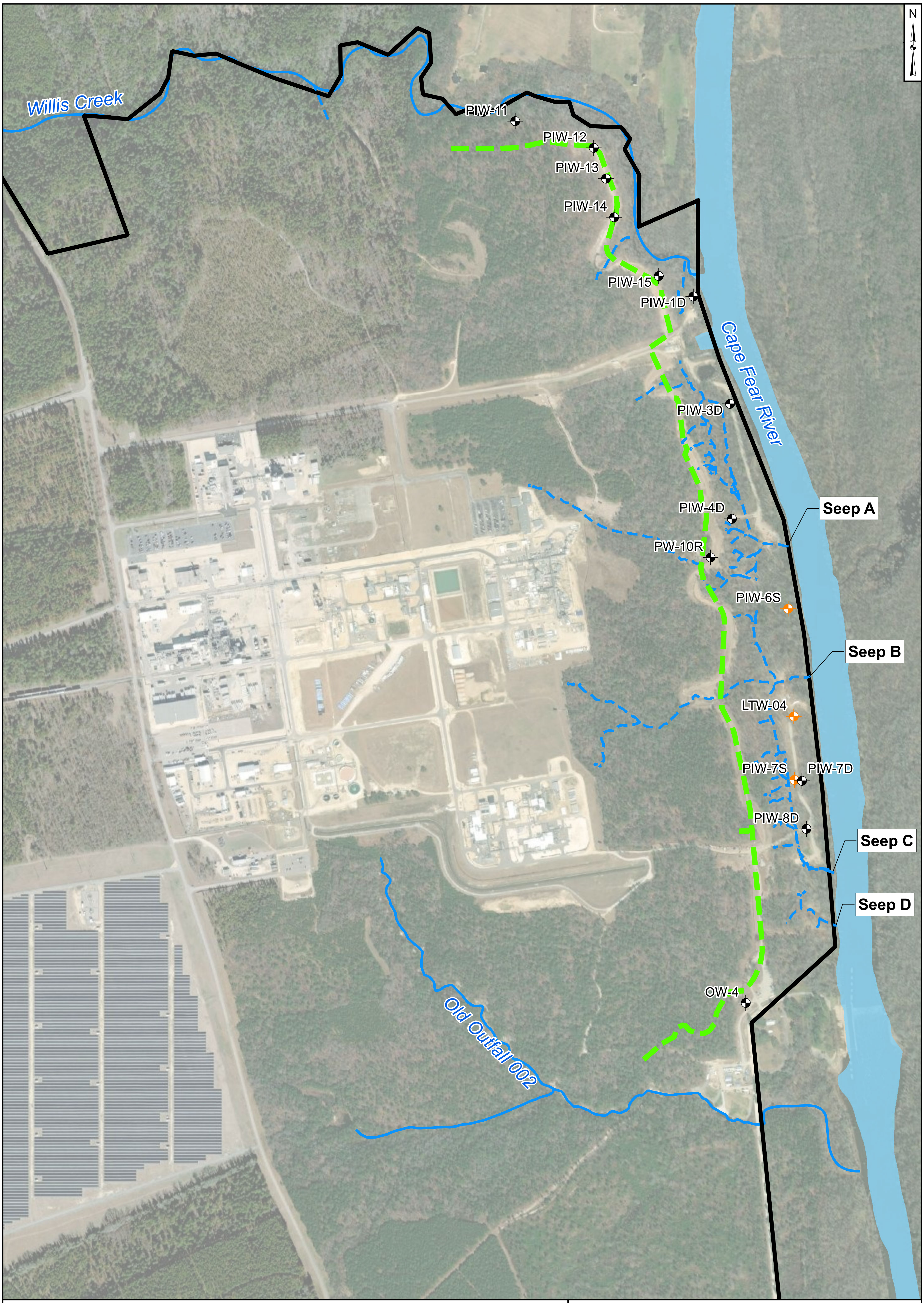
Figure
1A



Legend

⊕ Floodplain Deposits	─ Nearby Tributary	▬ ▬ Remedy Alignment
⊕ Black Creek Aquifer	- - Observed Seep	
	▬ Site Boundary	

1,000 500 0 1,000 Feet

Notes:
PFM - passive flux meter
1. Due to the scale of the map, pairs of wells that are in close proximity have been offset for visibility. Therefore, the placement of these wells on this map do not reflect their true geographic coordinates.
2. Remedy alignment is preliminary and is subject to change in future submittals.
3. The outline of Cape Fear River is approximate and is based on open data from ArcGIS Online and North Carolina Department of Environmental Quality Online GIS (MajorHydro shapefile).
4. PIW and PW-well locations were surveyed by a licensed North Carolina Surveyor.
5. Basemap source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

PFM Monitoring Well Locations and Remedy Alignment - November 2021 Deployment

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

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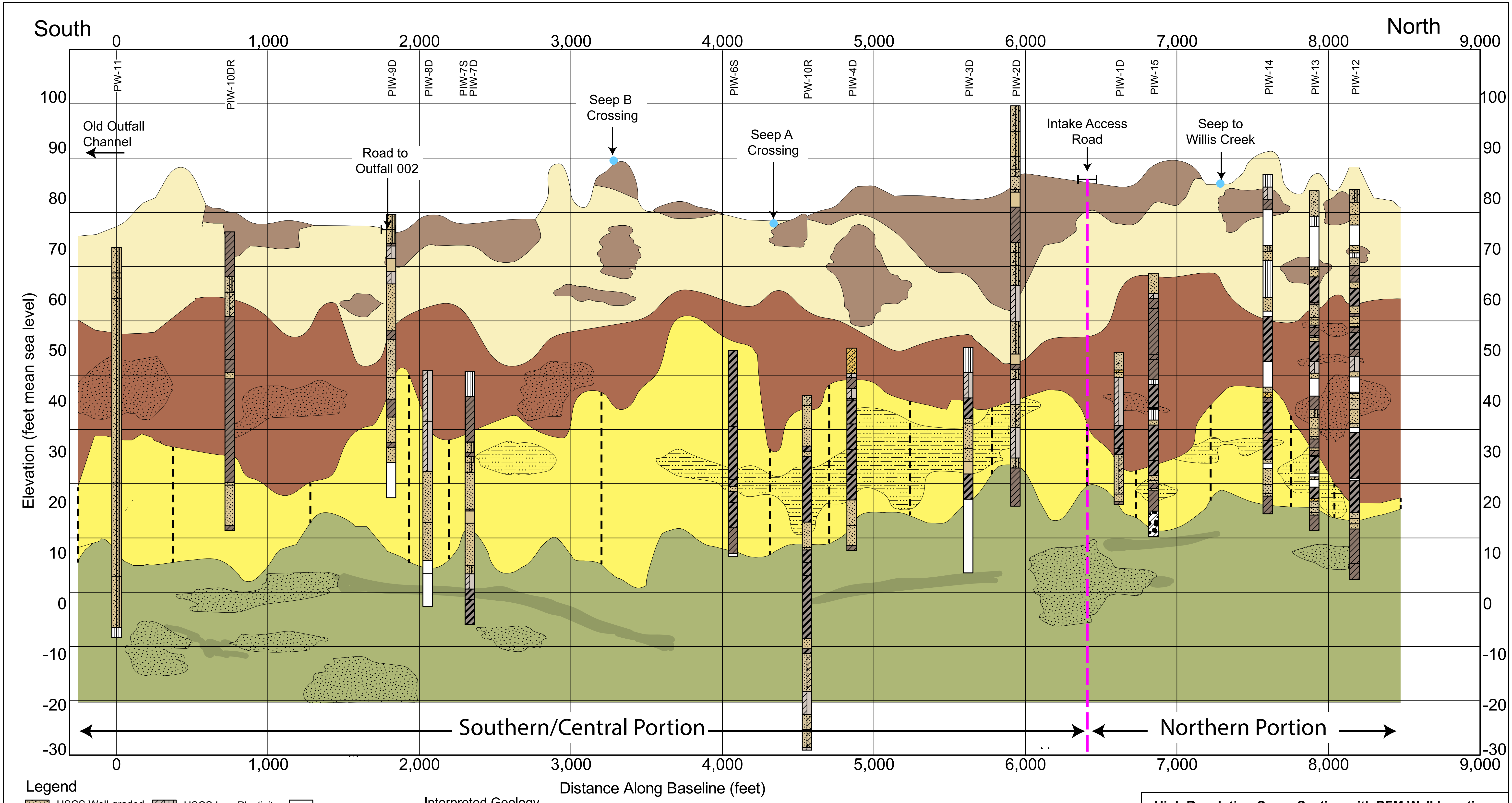
Figure

1B



Legend

▨ USCS Well-graded Sand	▥ USCS Low Plasticity Silty Clay	☐ No Core
▨ USCS High Plasticity Clay	▨ USCS Poorly-graded Sand	▨ USCS Low Plasticity Clay
▨ USCS Well-graded Sand with Silt	▨ USCS Well-graded Sand with Clay	▨ USCS Poorly-graded Sand with Silt
▥ USCS Elastic Silt	▨ USCS Clayey Sand	▥ USCS Silt
▨ USCS Low to High Plasticity Clay	▨ USCS Clayey Gravel	▥ USCS Silty Sand

Interpreted Geology

▇ Perched Clay	▇ Black Creek Aquifer
▇ Surficial Aquifer	▨ Black Creek Aquifer – Zone of Interspersed Finer Sediments
▇ Black Creek Confining Unit	▇ Upper Cape Fear Confining Unit
▨ Black Creek Confining Unit – Zone of Interspersed Coarser Sediments	▨ Upper Cape Fear Confining Unit – Zone of Interspersed Coarser Sediments

- - - Facility Water Intake Access Road Dividing Line

- - - Division between Black Creek Aquifer segments assigned to each PFM location

Notes:

PFM - Passive flux meter

PFMs are projected onto the cross-section; their lithology may differ from the lithology interpreted in the cross-section.

621 310 0 621 Feet

Horizontal 1" = 621' Vertical exaggeration is 33.5x

High Resolution Cross-Section with PFM Well Locations and Remedy Alignment Segments – October 2020 Deployment

Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
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Figure

2A

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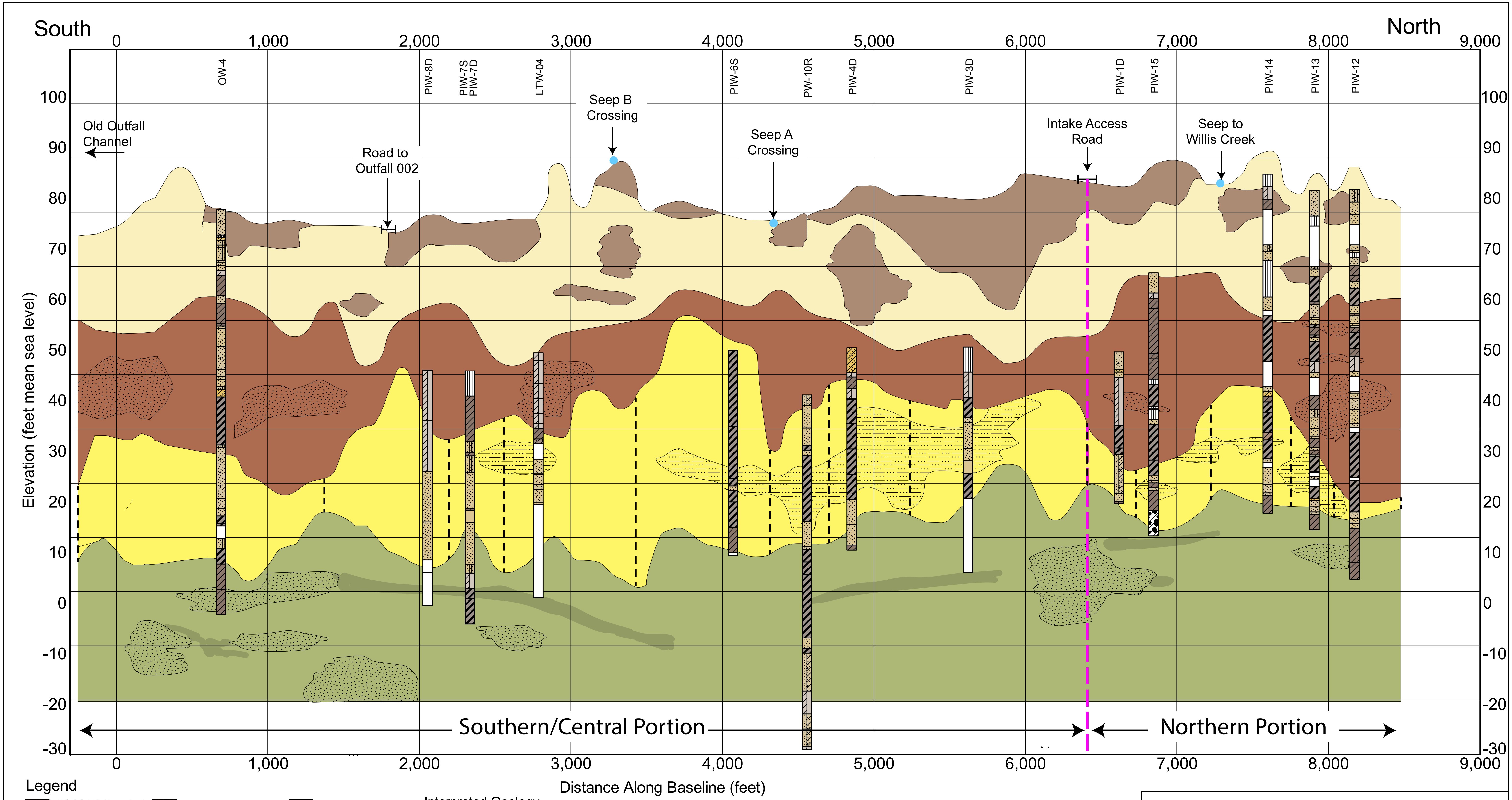

Legend

- ▨ USCS Well-graded Sand
- ▨ USCS High Plasticity Clay
- ▨ USCS Well-graded Sand with Silt
- ▥ USCS Elastic Silt
- ▨ USCS Low to High Plasticity Clay
- ▥ USCS Low Plasticity Silty Clay
- ▨ USCS Poorly-graded Sand
- ▨ USCS Well-graded Sand with Clay
- ▨ USCS Clayey Sand
- ▨ USCS Clayey Gravel
- ☐ No Core
- ▨ USCS Low Plasticity Clay
- ▨ USCS Poorly-graded Sand with Silt
- ▥ USCS Silt
- ▨ USCS Silty Sand

Interpreted Geology

- ■ Perched Clay
- ■ Surficial Aquifer
- ■ Black Creek Confining Unit
- ▨ Black Creek Confining Unit – Zone of Interspersed Coarser Sediments
- ■ Black Creek Aquifer
- ▨ Black Creek Aquifer – Zone of Interspersed Finer Sediments
- ■ Upper Cape Fear Confining Unit
- ▨ Upper Cape Fear Confining Unit – Zone of Interspersed Coarser Sediments

- – – Facility Water Intake Access Road Dividing Line
- - - - Division between Black Creek Aquifer segments assigned to each PFM location

Notes:

PFM - Passive flux meter

PFMs are projected onto the cross-section; their lithology may differ from the lithology interpreted in the cross-section.

621 310 0 621 Feet

Horizontal 1" = 621' Vertical exaggeration is 33.5x

High Resolution Cross-Section with PFM Well Locations and Remedy Alignment Segments – November 2021 Deployment

Chemours Fayetteville Works, North Carolina

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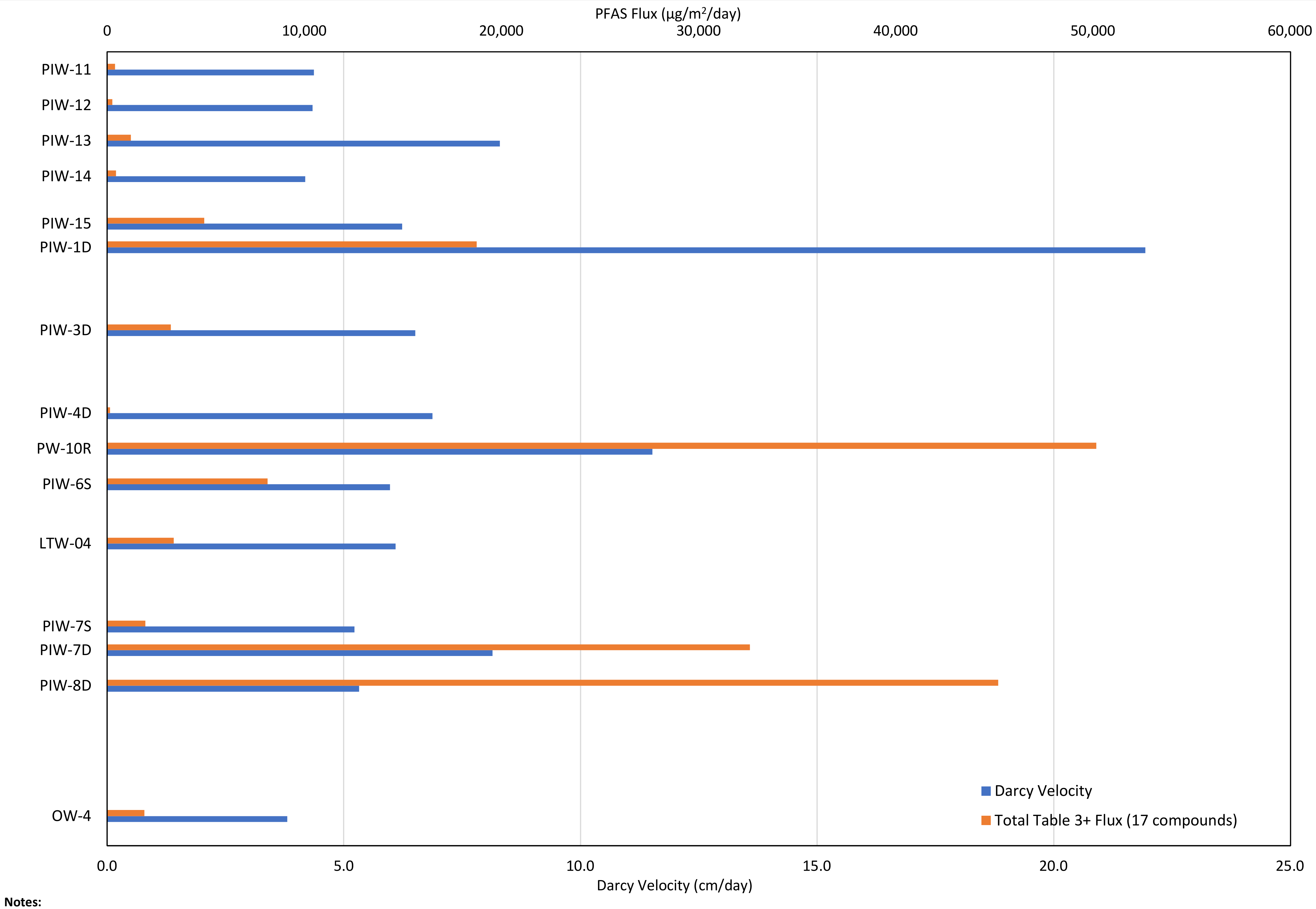
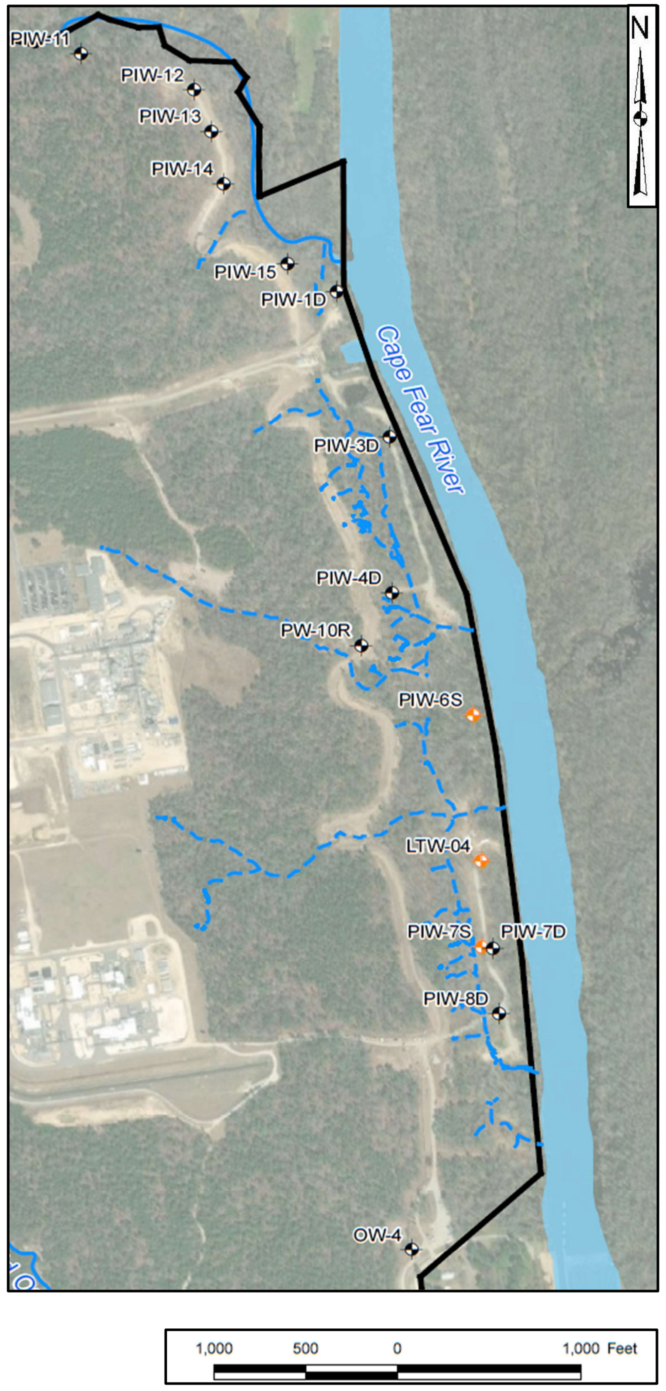
March 2022

Figure

2B





Notes:

Site map with PFM locations is shown for reference. Darcy velocity bars and PFAS flux bars are spaced to approximate their relative locations on the site map.

The Darcy Velocity is the rate at which a volume of water moves across a surface of specified area, giving units of $cm^3/cm^2/s$ which reduces to cm/s. This quantity is not the travel speed of groundwater.

Total Table 3+ (17 Compounds) does not include R-PSDA, Hydrolyzed PSDA and R-EVE.

All locations had measureable PFAS flux, however, PIW-4D was < 150 µg/m²/day .

PFM - Passive flux meter

cm/day - centimeters per day

PFAS - Per- and polyfluoroalkyl substances

PFM - Passive flux meter

µg/m²/day - Micrograms per square meter per day

PIW-7S and PIW-7D are screened in the Floodplain Deposits and Black Creek Aquifer, respectively

Legend

⊕	Floodplain Deposits	—	Nearby Tributary
⊕	Black Creek Aquifer	- - -	Observed Seep
		━	Site Boundary

November 2021 Passive Flux Meter Results – Darcy Velocities and PFAS Flux
Chemours Fayetteville Works, North Carolina

Geosyntec consultants

Geosyntec Consultants of NC, P.C.
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Figure 3

Raleigh

March 2022