The Port of Cleveland and Cleveland Metroparks

Cleveland Harbor Eastern Embayment Resilience Strategy (CHEERS)

Geotechnical Engineering Report - Early Action Project, The Habitat Loop

Reference: CHEERS-GER-002

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1. Introduction

This report has been prepared by Arup US, Inc. (Arup) at the direction of the Port of Cleveland and Cleveland Metroparks (Client). Arup has been appointed by the Client to carry out geotechnical engineering services to support the 90% design of the Cleveland Harbor Eastern Embayment Resilience Strategy (CHEERS) project in the city of Cleveland, Cuyahoga County, Ohio.

This Geotechnical Engineering Report (GER) was prepared in support to the portion of the CHEERS site, denominated “Habitat Loop Area” or “Revised Phase 1”. This portion of the full CHEERS park has been identified as a high priority for construction within a 3-year timeframe following design and permit approvals. This GER includes the following:

- A summary of the site-specific geology and subsurface conditions, including the preliminary design stratigraphy that has been adopted;
- A summary of the soil geotechnical design parameters that have been selected based on the currently available information;
- Seismic site classification;
- Estimation of breakwater settlements;
- Breakwater global stability analyses;
- Bearing capacity evaluation;
- Discussion of construction considerations; and
- Identification of significant geotechnical risks.

1.1 Project overview

The current 6,000 ft of the Lake Erie coastline will be revitalized by the introduction of shallow nearshore, emergent wetland, and coastal upland areas, which will elevate the coastal resilience to the advantage of the local community, economy, and environment.

The CHEERS project plans to create approximately 106 acres of improved coastal habitat through the strategic reuse of at least 4.0 million cubic yards of dredge material (predominantly fine sand, silt, and clay), coming from the Cleveland Harbor federal navigation channels. These channels are dredged on an annual basis, typically twice per year, because the recurrent shoals reduce the navigable depths for deep-draft commercial navigation. Dredging restores these channels to authorized project dimensions (USACE, 2014).

The CHEERS Park area covers the Lake Erie shoreline in Cleveland, from the East 55th Street Marina to the Intercity Yacht Club. Its southeastern boundary follows the existing shoreline breakwaters that run parallel to the Interstate 90 (I-90) freeway, as shown in Figure 1-1.

The full CHEERS project is anticipated to be constructed over approximately 20 years in phases based on availability of funding and dredge cycle schedules. Each phase has been named based on the site features, future habitat, and public access programming: The View, The Bay, The Launch, The Isle, The Cove, Habitat Loop and Gordon Hills. The phases have been broken down as shown in Figure 1-2.

The Habitat Loop is located along the existing waterfront between East 72nd Street and East 55th Street, adjacent to the Mandel Community Trail and I-90 bridge abutments. This approximately 6-acre site will introduce new habitat areas, walking paths, and opportunities for park programming integrated with the breakwater structure. The design will focus on enhancing ecological value, public access, and recreational use, serving as a foundational element of the broader CHEERS Vision. An initial conceptual plan is included in Figure 1-3.

This report focuses solely on "Habitat Loop". The terms "Habitat Loop", "Phase 1 Project Area" and "the Project" are used interchangeably across this report to refer to the area covered by this scope of work.

Figure 1-1 General site location plan

Figure 1-2 CHEERS proposed master plan

Figure 1-3 Phase 1 Project Area site

1.2 Proposed works

The dredge placement areas for The Habitat Loop will be protected by a series of breakwaters and weirs, as shown in Figure 1-3. These structures will be designed by coastal engineers at KS Associates, Inc (KS) as subconsultant to Arup.

The Project will require the construction of approximately 2,000 ft of new armor stone breakwater to be constructed at slopes ranging from 2H:1V, to 1.5H:1V. Roughly 700 ft will be entirely new, and the remaining 1,300 ft will be constructed atop the existing breakwater. The chosen armor stone is a dolomitic limestone. According to the laboratory report by Parkertown (2023), the selected armor stone has a specific gravity of 2.65 and a bulk unit weight of 165.5 lb/ft^3.

A typical new breakwater cross section is shown in Figure 1-4. The core of the breakwater is constructed using quarry run stones. This core is expected to settle after placement, depending on the breakwater height, due to consolidation settlement of the natural soils. The settled stone mixed with the native cohesive soil will form a sort of ground improved layer at the bottom of the breakwater. A layer of 5-to-7-ton armor stone will be placed along the exterior face of the structure facing the lake to dissipate wave energy. A 2-ft thick gravel lift will be placed on the opposite side of the breakwater.

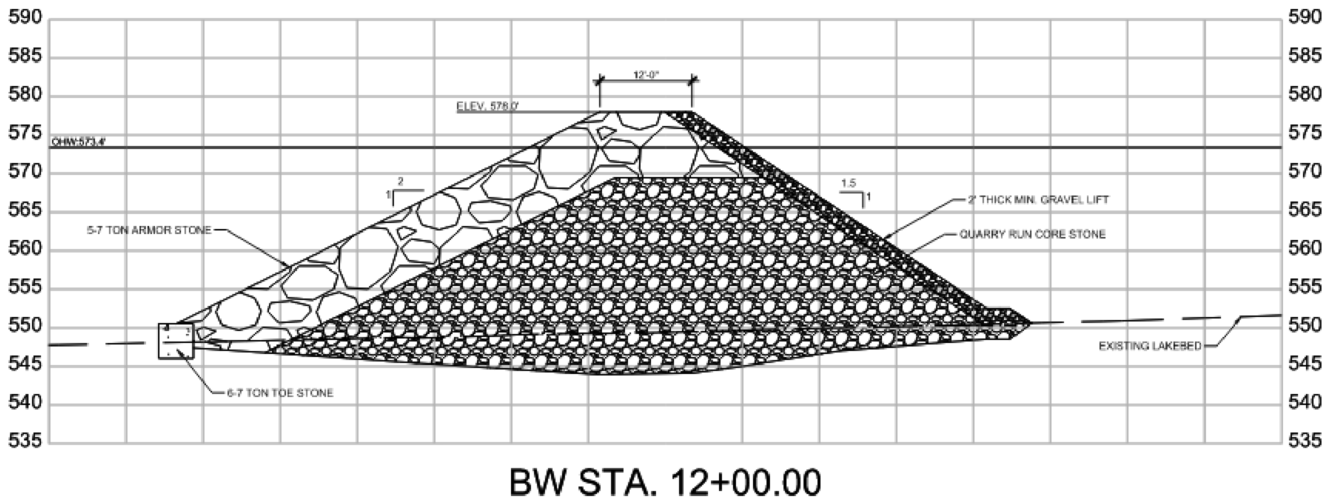

Figure 1-4 Typical new breakwater cross section

A significant portion of the proposed breakwater will be built on top of the existing breakwater, called Cold-Water Breakwaters and Warm-Water Breakwaters as shown in Figure 1-3. A typical cross section of breakwater built atop existing Cold-Water breakwater is shown in Figure 1-5. Details on the existing structures are presented in Section 2.3.

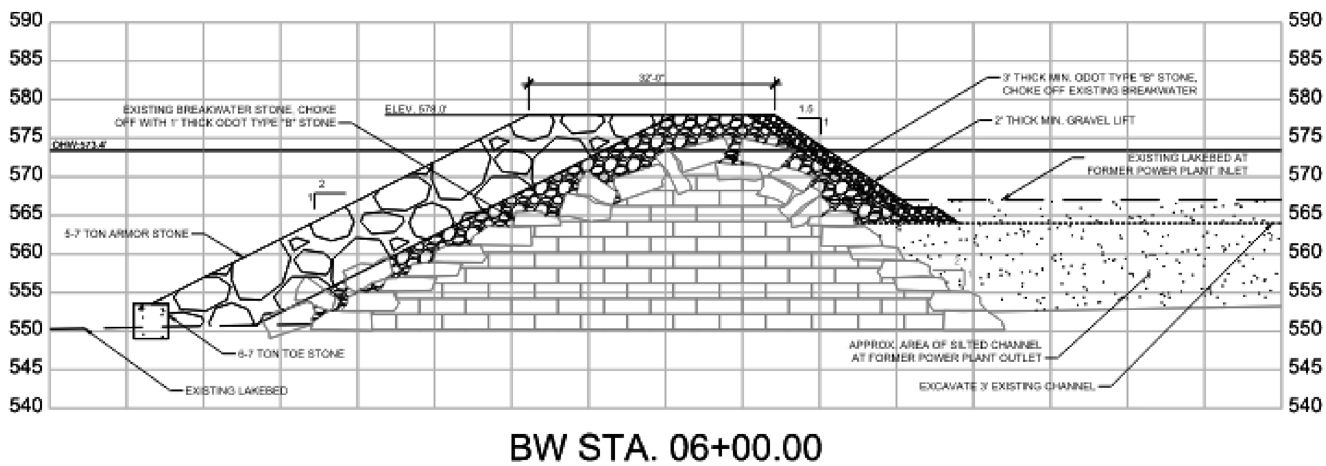

Figure 1-5 Typical cross section of breakwater built on top of existing Cold-Water breakwater

The analyses and assessments presented within this report are based on the geometry and 90% design provided by KS and dated January 22, 2026. If any of these designs are modified in later stages of the Project, additional assessments and geotechnical analyses will be necessary to ensure that the findings, evaluations, and conclusions in this report remain valid for the revised geometry.

2. Existing conditions

2.1 Topography

The CHEERS site is a relatively flat terrain sloping gently upwards from west to east from approximately El. 578 ft up to El. 583 ft. All the elevations (el.) referenced in this report are in feet and follow the IGLD 1985 vertical datum, as required by the U.S. Army Corps of Engineers (USACE) and Ohio Department of Natural Resources (ODNR).

Note that the geotechnical data report by CT Consultants, Inc (2023) that is referenced across this document uses NAVD88.

The vertical datum of the historical drawings of the existing breakwaters was assumed to be the National Geodetic Vertical Datum of 1929 (NGVD29) by KS (2023).

2.2 Lake Erie

Based on the survey data provided by KS (2023), the Lake Erie water level was found at el. 572 ft approximately. An ordinary high water mark elevation of 573.4 ft was indicated in the project plans. However, water levels may vary based on seasonal fluctuations of Lake Erie.

The mudline elevation across the CHEERS area was found to vary from el. 550 ft to el. 537 ft, based on the KS survey and as documented in the 90% design drawings.

2.3 Existing structures

The CHEERS site southeastern boundary follows the existing shoreline breakwaters indicated in Figure 2-1. These existing breakwater structures will be directly impacted by the placement of new fill. Above-water and underwater inspections of the existing waterfront infrastructure were carried out by KS. Potential damages and deteriorations that might impact the design and construction phases of the Project are presented in the "Coastal Structures Inspections Report" (2023).

The existing waterfront comprises the following locations, listed from southwest to northeast as identified in Figure 2-1: East 55th Street Marina breakwaters, Cleveland Lakefront Bikeway Seawall, Cleveland Lakefront Bikeway Revetments, Former Lake Shore Power Plant Breakwaters, and Gordon Park Revetment and Breakwater with Fishing Stations. The Former Lake Shore Power Plant Breakwaters consists of two breakwaters, the Cold-Water Breakwaters to the west and the Warm-Water Breakwaters to the east.

The Habitat loop area is adjacent to I-90, as shown in Figure 1-2. The existing structures located in this area include Cleveland lakefront Bikeway Revetments and the Former Lake Shore Power Plant Breakwaters. The Cleveland Lakefront Bikeway Revetments extend along the shoreline near both the Cold-Water and Warm-Water Breakwaters. The section west of the Cold-Water Breakwaters spans 240 feet and were constructed between 1980 and 1986. The slope of this revetment ranges from 1.5 horizontal to 1 vertical (1.5H:1V) to 2H:1V. As shown in Figure 2-2, the westernmost 115 feet of this revetment has been recently repaired, while the remaining 125-foot segment is narrower and contains less stone fill. The revetment between the Cold-Water and Warm-Water Breakwaters is 405 ft long. This segment was built during the same period using 2- to 4- ton and 3- to 5- ton armor stones with a 1.5H:1V slope.

Cold-Water Breakwaters were constructed between 1910 and 1911, shown in Figure 2-3. The Warm-Water Breakwaters were built later, although they first appeared on nautical charts in 1928. The western Cold-Water Breakwaters comprise of two segments, a 230 ft long concrete segment starting at the Cleveland Lakefront Bikeway revetment and a 500 ft long J-shaped segment. The 230 ft long concrete segment is an extension to a 510 ft long concrete wall running landward along the former intake channel. The J-shaped section was constructed using sandstone blocks typically 3 ft x 5 ft x 7ft in size, with the largest being 8 ft square.

The eastern Cold-Water Breakwaters are 500 ft long straight segment and was also built using stones of similar shapes and sizes used to build the western Cold-Water Breakwaters. A 40 ft long section connects this segment to a 28 ft diameter steel sheet pile cell. This cell is one of two remaining from an original continuous sheet pile cell breakwater, which was progressively dismantled between 1980 and 1993. The Warm-Water Breakwaters are curved and around 280 ft long, as shown in Figure 2-4. It has a concrete -slab walkway on its crest and was built using sandstone blocks similar to those of the Cold-Water Breakwaters. Approximately 40 feet west of the Warm-Water Breakwaters lies the second remaining steel sheet pile cell from the original sheet pile cell breakwater system.

The inspections showed that the structures along the East 55th Street Marina, the Cleveland Lakefront Bikeway, and the Gordon Park are in functional condition and able to hold the present shoreline. The concrete walkways and fishing platform built into them exhibit signs of cracking and spalling. This is also the case on the landward end of the western Cold-Water Breakwaters and the top of the Warm-Water Breakwaters, which also exhibits signs of differential settlements (KS, 2023). It should be noted that the structural condition or capacity of these structures was not evaluated as part of this report.

Figure 2-1 Key locations of the existing CHEERS waterfront (KS, 2023)

Figure 2-2 Recent photographs of Western Cleveland Lakefront Bikeway Revetment (KS, 2023)

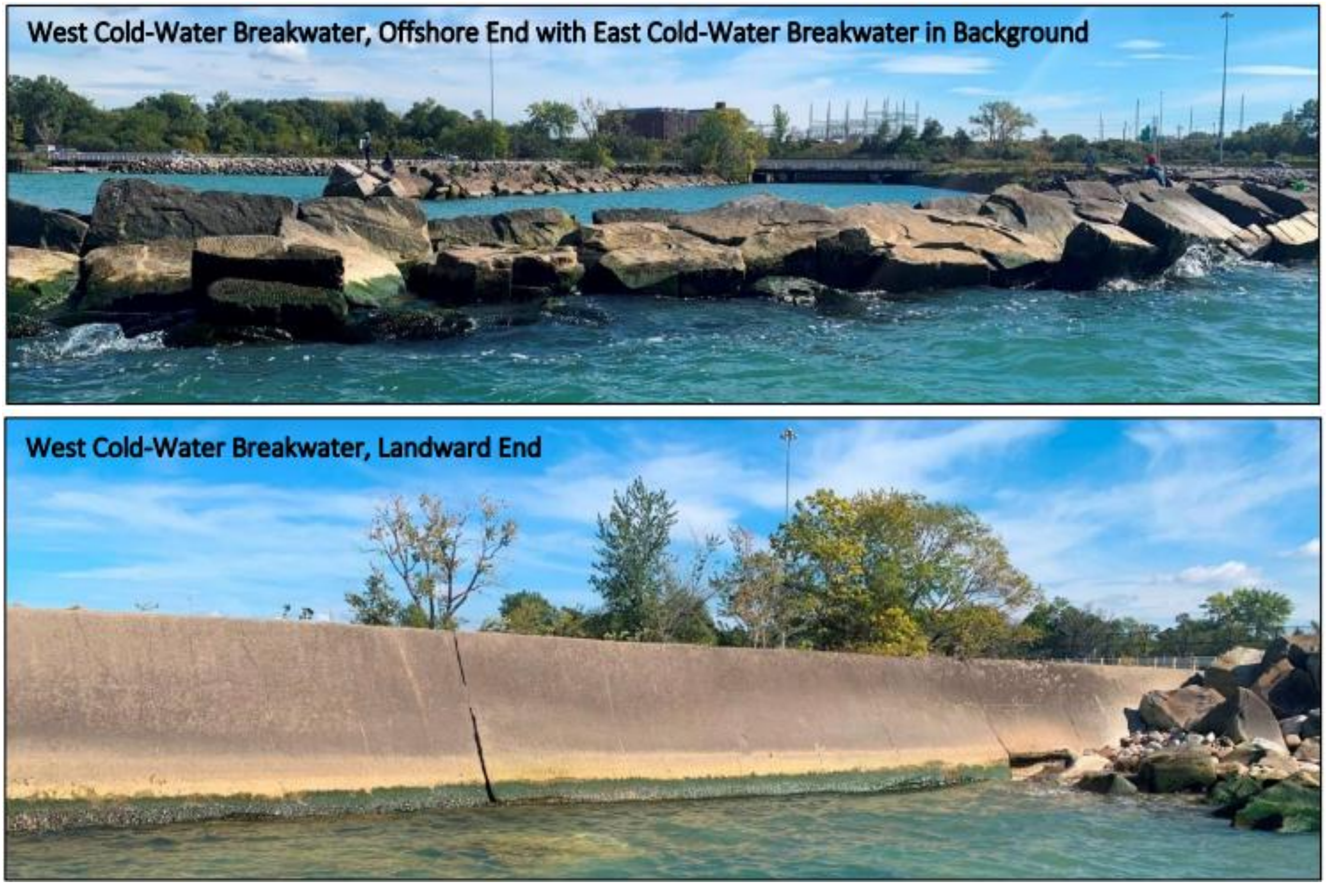

Figure 2-3 Recent photographs of Cold-Water Breakwaters (KS, 2023)

Figure 2-4 Recent photographs of Warm-water Breakwater (KS, 2023)

3. Geology and subsurface conditions

3.1 Regional geology

The Project site is located within the physiographic region of previously glaciated portion of Erie Lake Plain. This region is comprised of lacustrine deposits formed when surface water runoff washed fine grained sediments into the lakes that covered parts of Cuyahoga County during or immediately after the last period of glaciation. Over time, the silt and clay settled to the bottom of the lakes and accumulated into thick layers.

Bedrock underlying the unconsolidated material is Devonian Age Ohio Shale. Bedrock is reported to be several hundred feet below ground surface in deeper parts of Lake Erie (Hull & Associates, 2012). Close to the shoreline, the bedrock may be found at depths ranging from 50 to 200 ft beneath glacial sediments and lake deposits (Lewis et al, 2023).

3.2 Project geotechnical data

Arup completed a review of available geotechnical data at or near to the Project site location. Information from the following ground investigations (GI) was reviewed:

- CT Consultants, Inc (2023). Geotechnical Subsurface Investigation – Project CHEERS, Cleveland, Ohio;
- S&ME, Inc (2022). Report of Geotechnical Exploration Cleveland Metroparks – Community Sailing Center, Cleveland, Ohio;
- Hull & Associates (2018). ConeTec Presentation of Site Investigation Results – Port of Cleveland CDF Project, Cleveland, Ohio.
- Hull & Associates (2012). Geotechnical Exploration Report – Confined Disposal Facilities, North Marginal Road, Cleveland, Ohio; and
- David V. Lewin Corp. (1991). Geotechnical Investigation Report – Cleveland Port Authority Relocation Project (Report No. C. 4533), Cleveland, Ohio.
- A.M. Kinney, Inc. (1976). Confined Dredged Material Disposal Facility, Site 14, Cleveland Harbor, Ohio – Design Analysis, Phase II. Prepared for the U.S. Army Engineer District, Buffalo.
- U.S. Army Corps of Engineers, Buffalo District. (1979). Cleveland Harbor, Ohio – East Breakwater Major Rehabilitation: Design Memorandum. Buffalo, NY.
- U.S. Army Corps of Engineers, Buffalo District. (1994). Cleveland Harbor, Ohio – Confined Disposal Facility, Site 10B: Appendices (Coastal Design and Geotechnical Design). Buffalo, NY.

CT Associates, Inc, conducted a geotechnical investigation program in support of the design services for the CHEERS site in 2023. It consisted of ten boreholes: five boreholes were performed from land along the banks of Lake Erie, and the remaining five from the deck of a spud barge over the Lake. The exploration depths vary from 65 ft to 120.2 ft below mudline, and included standard penetration tests (SPTs) recovering split-spoon and Shelby tube samples for laboratory analysis. Unconfined compressive strength estimates were obtained for selected intact cohesive samples using a calibrated hand penetrometer. The laboratory test program included the following:

- Unified Soil Classification System (USCS) per ASTM D2487 and D2488;
- Moisture content testing (ASTM D2216);
- Dry density determinations;
- Unconfined compressive strength tests (ASTM D2166);

- Particle size analysis (ASTM D6913 and D7928);
- Atterberg limits tests (ASTM D4318);
- One one-point unconsolidated-undrained (UU) triaxial compressive strength test (ASTM D2850);
- Three single-point consolidated-undrained (CU') triaxial compressive strength tests with pore water pressure measurements (ASTM D4767);
- Two direct shear tests (ASTM D3080); and
- Three one-dimensional consolidation tests (ASTM D2435).

Refer to CT Consultants, Inc (2023) for more details on the geotechnical investigations and laboratory test results done on the Project site.

The geotechnical investigation conducted by S&ME, Inc. in 2022 was carried out in connection with the Cleveland Community Sailing Center Project located at the East 55th Street Marina on North Marginal Road in Cleveland. The investigation included seven boreholes extending to depths ranging from 50 to 80 ft, performing SPTs, recovering split-spoon and Shelby tube samples for laboratory analysis.

The geotechnical investigation conducted by Hull & Associates, Inc. in 2012 was carried out in connection with the Cleveland Confined Disposal Facilities Project. The investigation included drilling 16 boreholes extending to depths ranging from 20 to 65 ft, performing SPTs, recovering split-spoon and Shelby tube samples for laboratory analysis. A total of five cone penetration tests (CPTs) were also conducted as part of a supplemental investigation conducted in 2018. Two CPTs extended to a depth of 150.10 ft.

3.3 Ground modeling

Arup developed a 3D ground model using the factual GI data from CT Consultants (2023), and modelled in the software Leapfrog Works (Seequent, 2023.1). A total of ten boreholes placed across the project area as shown in Figure 3-1 are used to develop the 3D model. These boreholes were selected as representative of the Project area. The purpose of the 3D ground model is to visualize the available site GI data in a clear and consistent way, and to assist in making informed technical and commercial decisions in the future.

The current version of the 3D model is shown in Figure 3-2. Additional boreholes reviewed during the study were located outside the Project limits and were used to provide regional stratigraphic context only. Linear interpolation between the boreholes was used to connect the top and bottom elevations of each soil layer. Any soil layers shown in the model at depths below the termination of the boreholes are estimated boundaries and must not be used to make final design assumptions unless they are confirmed with additional ground investigations or construction data.

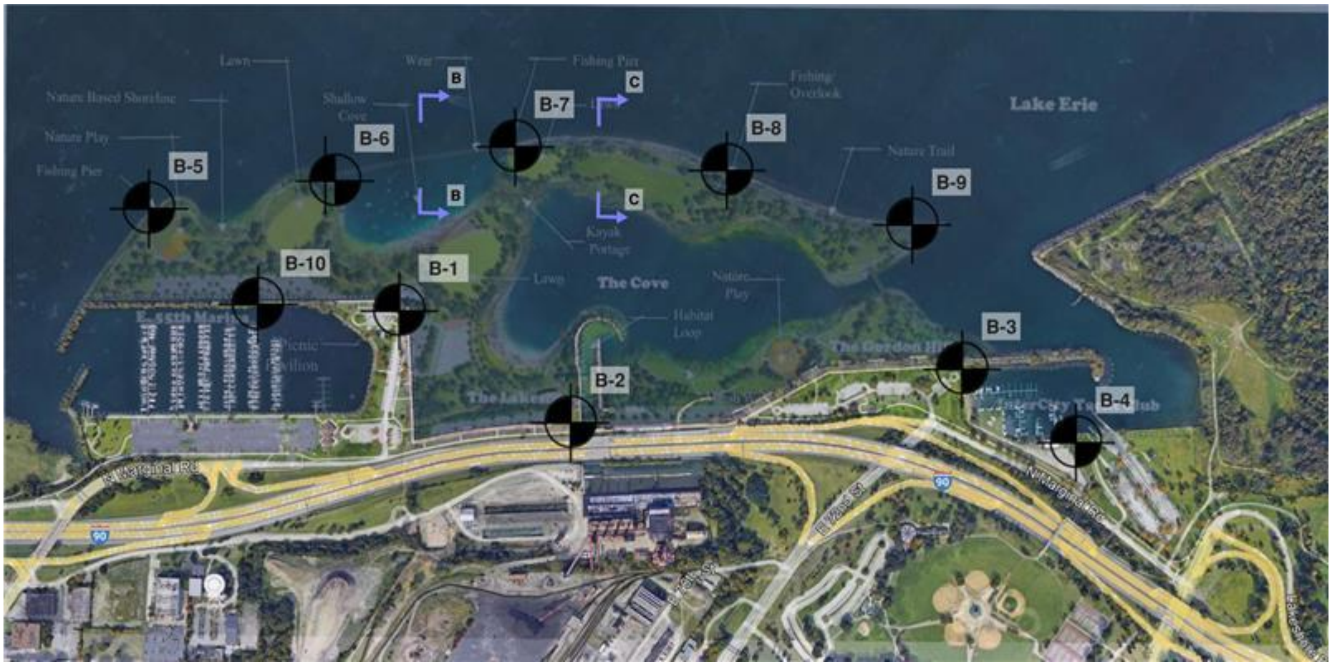

Figure 3-1 Boreholes plan

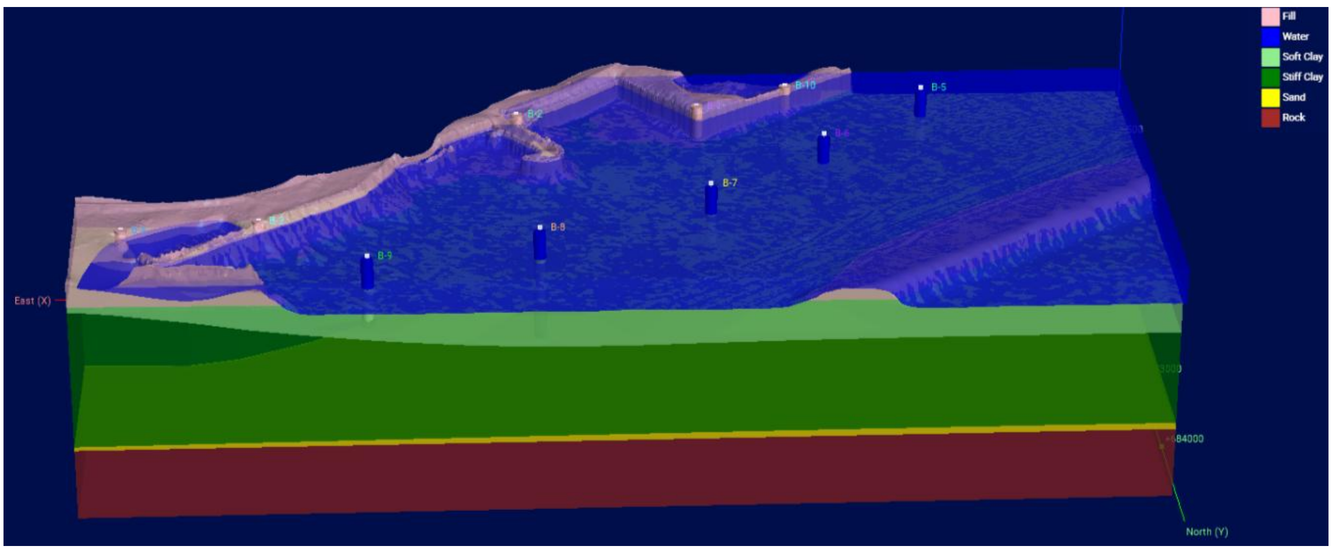

Figure 3-2 Leapfrog 3D model

3.4 Preliminary stratigraphy

Five strata layers were identified in the 3D ground model, shown in Figure 3-2. Typical cross sections are presented in Figure 3-3 and Figure 3-4. SPT N-values are included as bar graphs on the borehole sticks and shown in the cross sections. Typical descriptions of the strata are as follows:

1. Cohesionless fill (F) – At the ground surface, a heterogeneous layer of granular manmade fill materials was reported. It consisted predominantly of poorly graded sand (SP) and silty sand (SM) mixed with varying amount of gravel, concrete and brick fragments, and traces of organics (borehole B-3 and B-4). Isolated layers of medium stiff to stiff lean clay (CL) were reported in boreholes B-1 and B-3. The thickness of the fill layer varies between 22 and 37 ft across the CHEERS site.

2. Native cohesive soil (CL/ML) – Underlying the manmade fill layer and below the mudline of Lake Erie, a layer of cohesive soil was reported. This layer has been divided into two substrata for the purposes of visualization in this report as follows:

– Soft cohesive stratum (soft CL/ML) – from approximately el. 543 ft to el. 491 ft (maximum thickness = 52 ft) with SPT N-values less than 8 bpf (blow per foot);

– Stiff cohesive stratum (stiff CL/ML) – from approximately el. 491 ft to el. 396 ft (thickness = 95 ft) with SPT N-values equal or more than 8 bpf.

3. Cohesionless soil (SM) – Under the native cohesive soil layer, a dense granular soil stratum was reported. These granular soils consisted of silty sand (SM) with trace of gravel probably corresponding to decomposed rock. The thickness of this layer is 4 ft, as identified in borehole B-10.

4. Shale bedrock stratum (R) – Bedrock was encountered in borehole B-10 at approximately 188 ft of depth (el. 392 ft). One rock core was retrieved with a recovery of 80% and a RQD value of 67%.

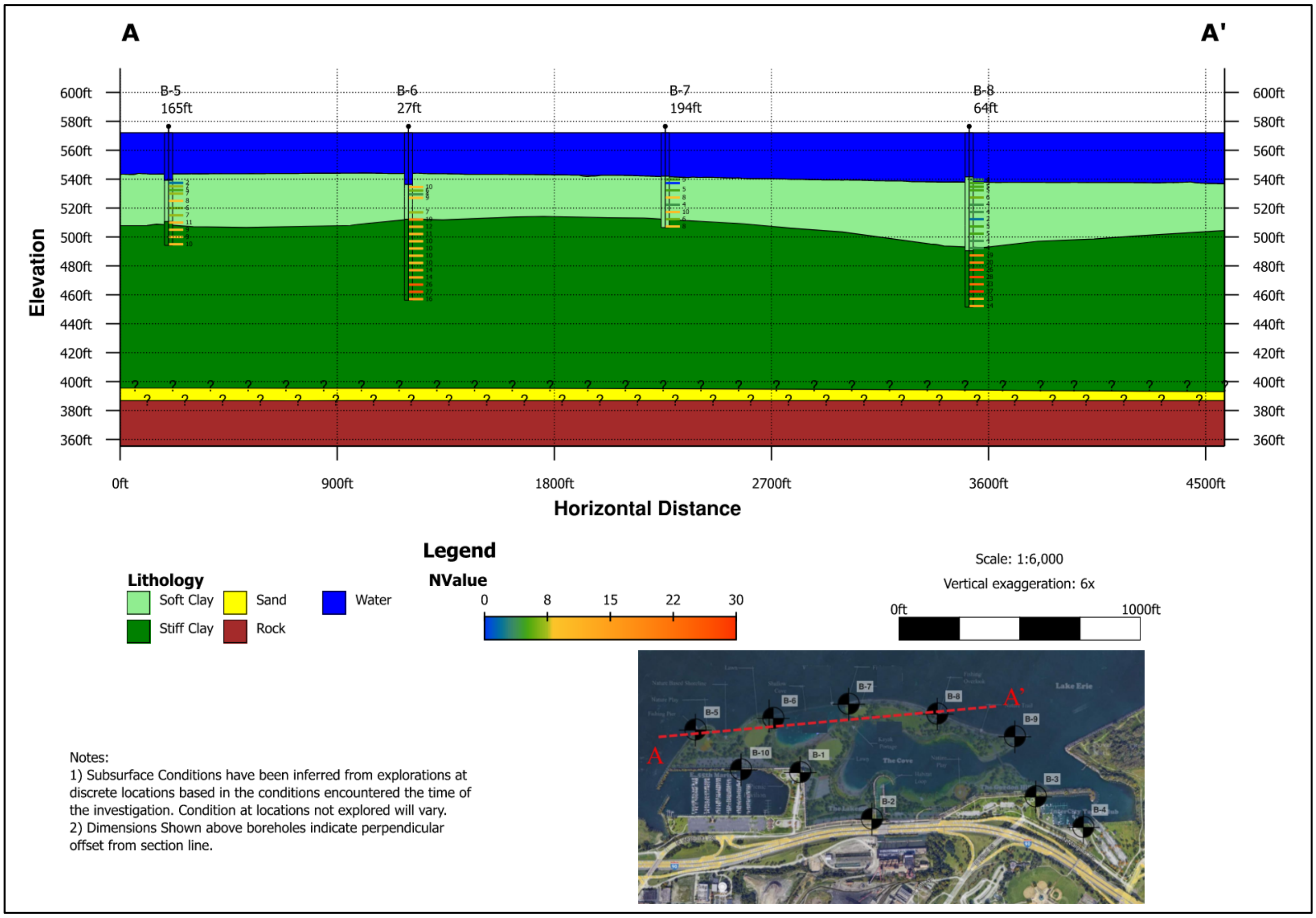

Figure 3-3 A-A' Cross section of the 3D Leapfrog soil stratigraphy model

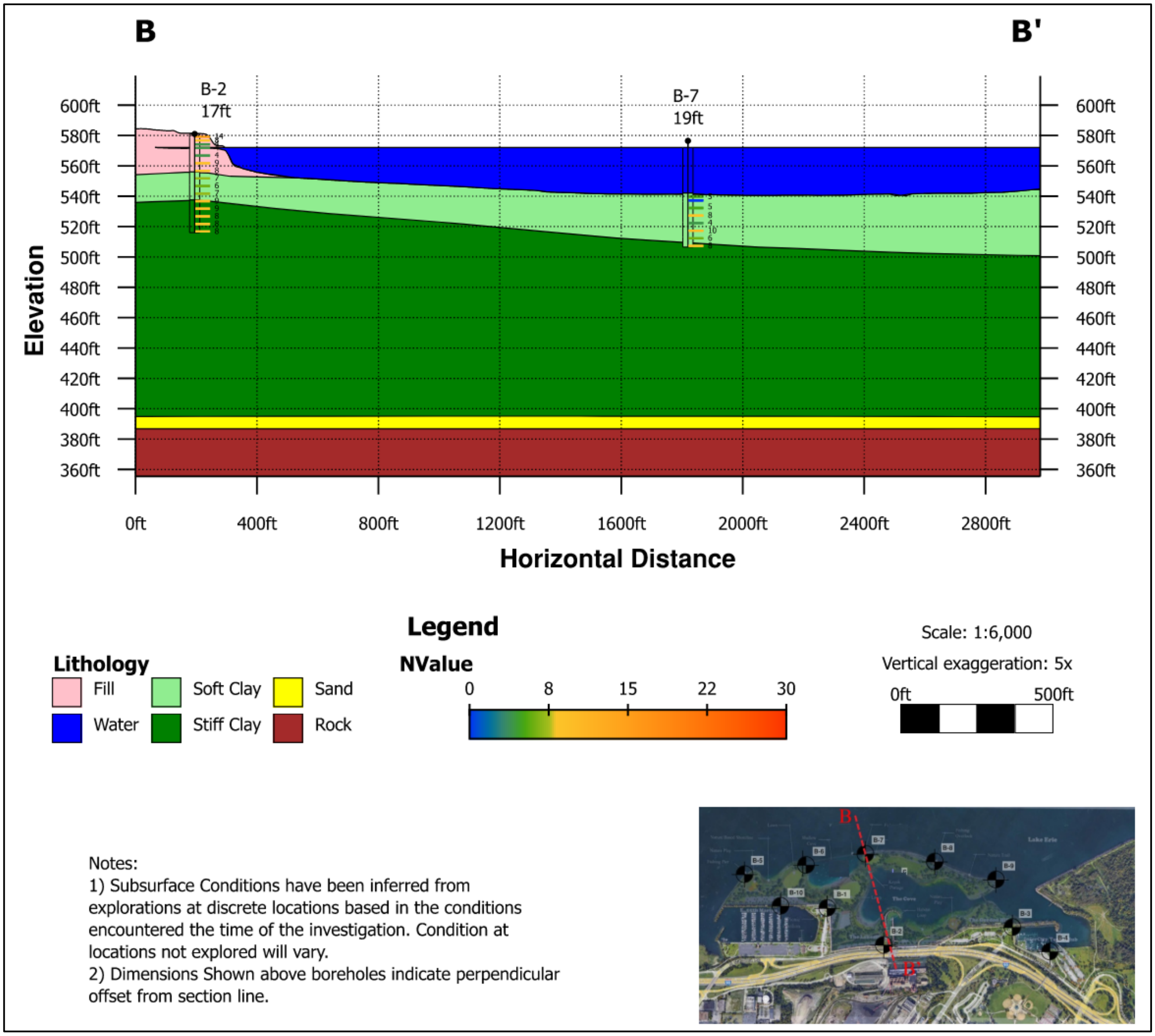

Figure 3-4 B-B' Cross section of the 3D Leapfrog soil stratigraphy model

3.5 Groundwater

Groundwater was encountered in all the boreholes performed during the geotechnical investigations performed by CT consultants (2023). Boreholes B-5 to B-9 were performed in Lake Erie and the recorded groundwater level is the lake surface level. A design groundwater level of elevation 573.4 feet was adopted, based on the Ordinary High Water Mark level of Lake Erie.

3.6 Geotechnical parameters

Soil parameters were derived based on the available geotechnical data and testing results from existing GIs, including in-situ testing and laboratory testing. Where no data exists, typical values were adopted based on sample descriptions and experience from other projects with similar subsurface conditions.

The data indicates reasonable consistency across the CHEERS site, and, while some local variation exists, the extent of these variations is not currently considered large enough to warrant use of localized values. Table 3-1The design values used in the analysis are shown in Figure 3-6. and Table 3-2 summarize the recommended Project geotechnical parameters.

3.6.1 SPT $N_{1,60}$

The corrected SPT blow count ($N_{1,60}$) is estimated using the uncorrected SPT N values and considering the effects of overburden stress and hammer efficiency (ER=80% for automatic trip hammer), borehole diameter, sampler, and rod length in accordance with methodologies presented by Bowles (1988). Variation of the calculated $N_{1,60}$ values versus elevation are shown in Figure 3-5, along with the design values.

3.6.2 Unit weight

Laboratory data, SPT N data, and soil descriptions were used to estimate the soil unit weight based on Table 2-8 in Mayne and Kulhawy (1990).

3.6.3 Poisson's ratio

Typical Poisson's Ratio (ν) values of 0.45 and 0.3 have been adopted for the cohesive and cohesionless soil units, respectively. This value is based on the soil type and relative density, as outlined in Mayne and Kulhawy (1990).

3.6.4 Effective angle of shearing resistance

Effective angle of shearing resistance (φ') was determined using the Peck et al. (1974) correlation with the available SPT data.

3.6.5 Overconsolidation ratio

The overconsolidation ratio (OCR) for cohesive soils was approximated through consideration of geological history, consolidation tests, and the following correlations:

- Mayne and Kemper (1988) with uncorrected SPT N
- Ladd and Foott (1974) with S_u data (SHANSEP: S=0.25, m=0.85)

The consolidation test results reported by CT did not report reliable direct measurement of OCR. Based on the geologic history of the site, the cohesive native materials are expected to be normally consolidated or slightly overconsolidated (S&ME, 2022). This is consistent with Arup's interpretation of the site geology, and it is also compatible with the observed strength of the clays. An OCR value of 1.5 has been adopted for both cohesive soil units of the Project as backed up by the SHANSEP approach.

3.6.6 Undrained shear strength

The design undrained shear strength (S_u) for cohesive soils was determined based on:

- Laboratory Tests
    - CU and UU triaxial tests
    - Unconfined compression tests
- Empirical Correlations
    - SPT-based correlation from Stroud and Butler (1975): S_u/N_{60} = 104.4 psf
    - CPT-based correlation from Lunne and Kleven (1981): N_k = 15
- SHANSEP method based on Ladd and Foott (1974): S=0.25, m=0.85, OCR=1.5

The upper bound of the design values is given by the S_u derived from CPT data taken at the Confined Disposal Facility 12, located southwest of the CHEERS Project (Hull, 2018). The derived S_u is representative of the native clay, which has been overlaid by approximately 50 ft of fill (effective pressure = 3 ksf) for the past 30 years. Assuming a normally consolidated top clay layer, the SHANSEP approach yields a S_u equal to 0.8 ksf at the mudline, which is consistent with the S_u derived from CPT data, as shown in Figure 3-5.

As shown in Figure 3-5, the S_u (OCR=1.5) line falls between the normally consolidated S_u and the CPT derived S_u profiles.

3.6.7 Stiffness

The small strain shear stiffness (G_{max}) of the cohesive soil units was estimated using the following correlations:

- Imai and Tonouchi (1982) with SPT $N_{1,60}$
- Weiler (1988) with S_u ($G_{max}/S_u = 1100$)

The elastic modulus (E_{max}) was estimated using Poisson's ratio discussed in Section 3.6.3. The representative degraded drained Young's Modulus (E_{deg}) was estimated as 30% of E_{max} based on an assumed working strain range for most geotechnical structures and associated normalized stiffness degradation curves. Figure 3-6 presents stiffness values along with design values.

3.6.8 Consolidation parameters

Consolidation parameters (e.g., compression index, recompression index, secondary compression index and coefficient of consolidation) were determined from the three consolidation tests (ASTM D2435) performed on undisturbed soil samples taken from the Project site, and from the following empirical correlations:

- Terzaghi, Peck and Mesri (1996) – based on Liquid Limit (LL)
- Wroth and Wood (1978) – based on Plasticity Index (PI)
- Jain et al. (2015) – based on PI
- Lambe and Whitman (1969) – based on natural water content (w_n)
- Kordanaeij et al. (2015) – based on LL

The design values used in the analysis are shown in Figure 3-6.

Table 3-1 Geotechnical design parameters

Soil unit [-]	SPT N1,60 [bpf]	Total unit weight, γ_t [pcf]	Effective friction angle, φ' [deg]	Undrained shear strength, S_u [ksf]	Drained cohesion, c' [ksf]	Overconsolidation ratio, OCR [-]	Young's modulus, E_{deg} [ksf]
Armor/ Quarry Run Stone	-	160	40	-	-	-	2,000
Dredge Material	-	120	32	-	10	-	1,000
F	-	125	28	-	-	-	400
Soft CL/ML	4	110	28	0.6 to 1.2[1]	0	1.5	500
Stiff CL/ML	10	110	28	1.2 to 2.9[2]	0	1.5	800
SM	-	125	32	-	-	-	1,305
R	-	150	-	-	-	-	1,500

Notes:

1. Undrained shear strength is equal to 0.6 ksf in the top 20 ft and then follows: $S_u = 0.25 + 0.25\ \sigma'_v\ 1.5^{0.85}$

2. Undrained shear strength follows: $S_u = 0.25 + 0.25\ \sigma'_v\ 1.5^{0.85}$

Table 3-2 Consolidation design parameters for cohesive soil units

Soil unit [-]	Compression index, C_c [-]	Recompression index, C_r [-]	Initial void ratio, e_0 [-]	C_v [ft^2/y]	C_{vr} [ft^2/y]	C_α [-]
Soft CL/ML	0.23	0.04	0.76	59	59	0.005
Stiff CL/ML	0.23	0.04	0.66	59	59	0.005

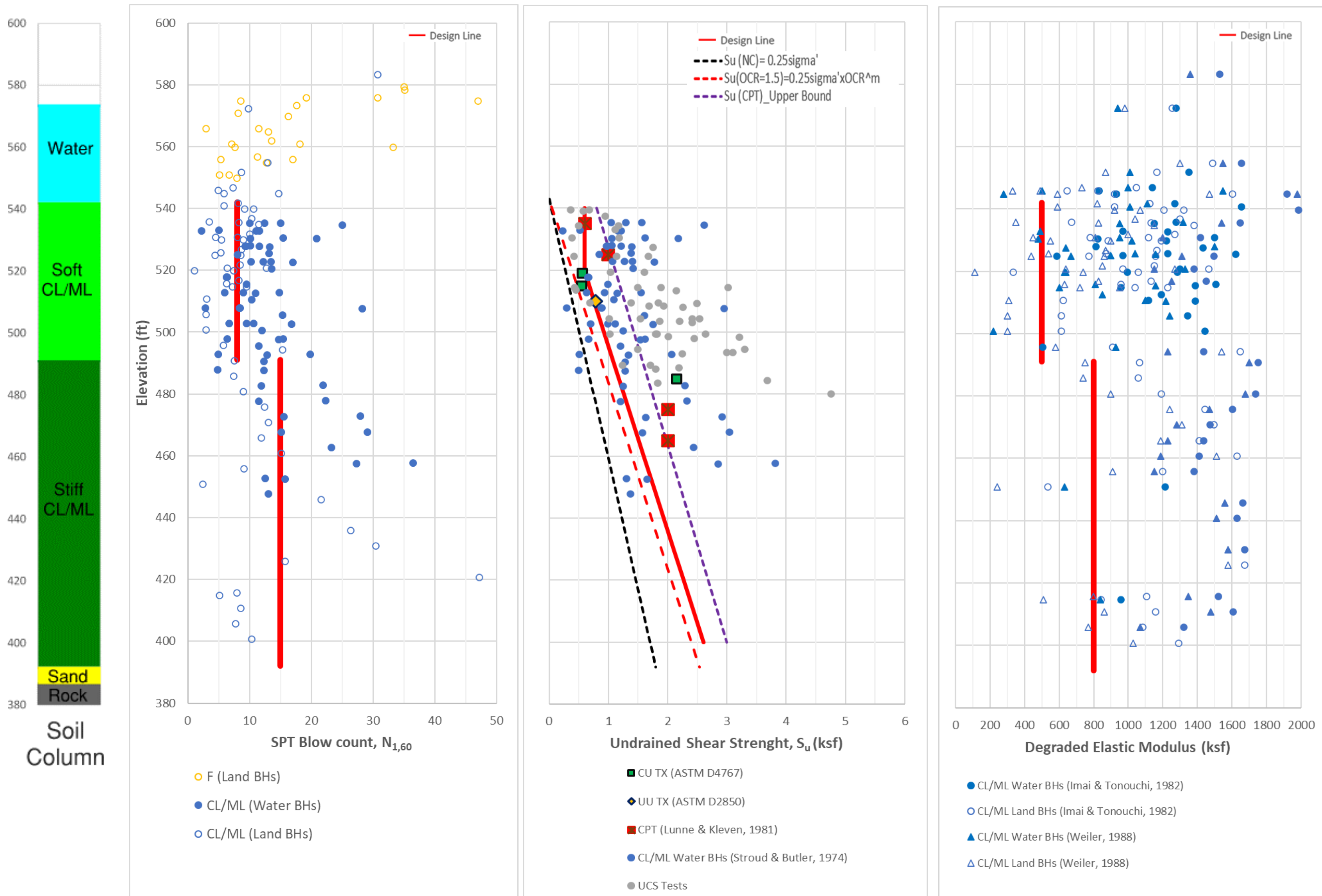

Figure 3-5 Idealized soil profile and associated strength and stiffness parameters

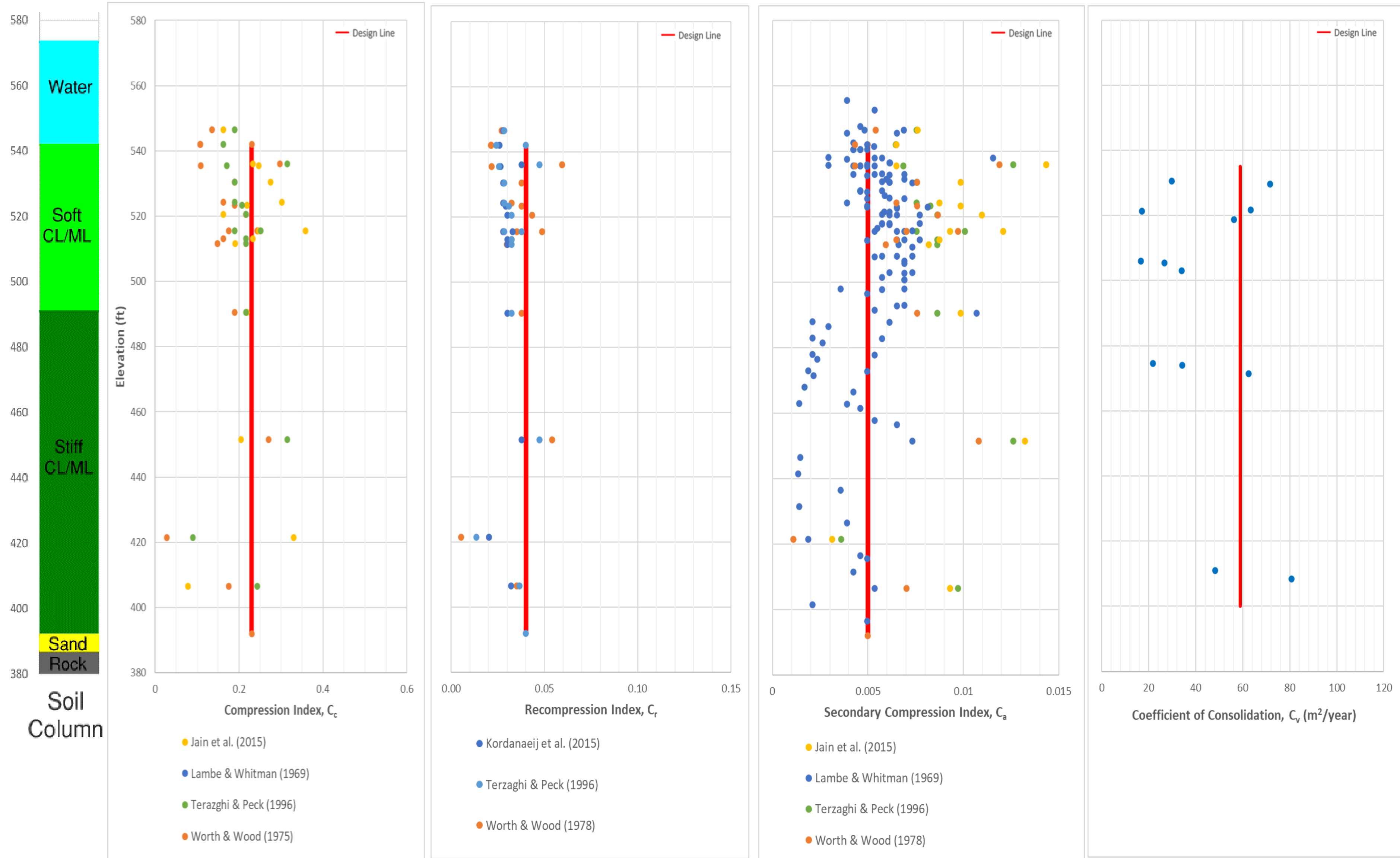

Figure 3-6 Correlated consolidation parameters for cohesive soil units

4. Seismic engineering considerations

4.1 Regional seismicity

As shown in Figure 4-1, the Project area shown in red box is in proximity of two major fault lines: the Akron magnetic boundary, and the Middleburg fault. However, seismic activity is infrequent and is usually of low magnitude. The three largest earthquakes reported in the area occurred in 1952, 1986, and 1998, and had estimated magnitudes between 4.5 and 5.0 (Hansen and Fox, 2020).

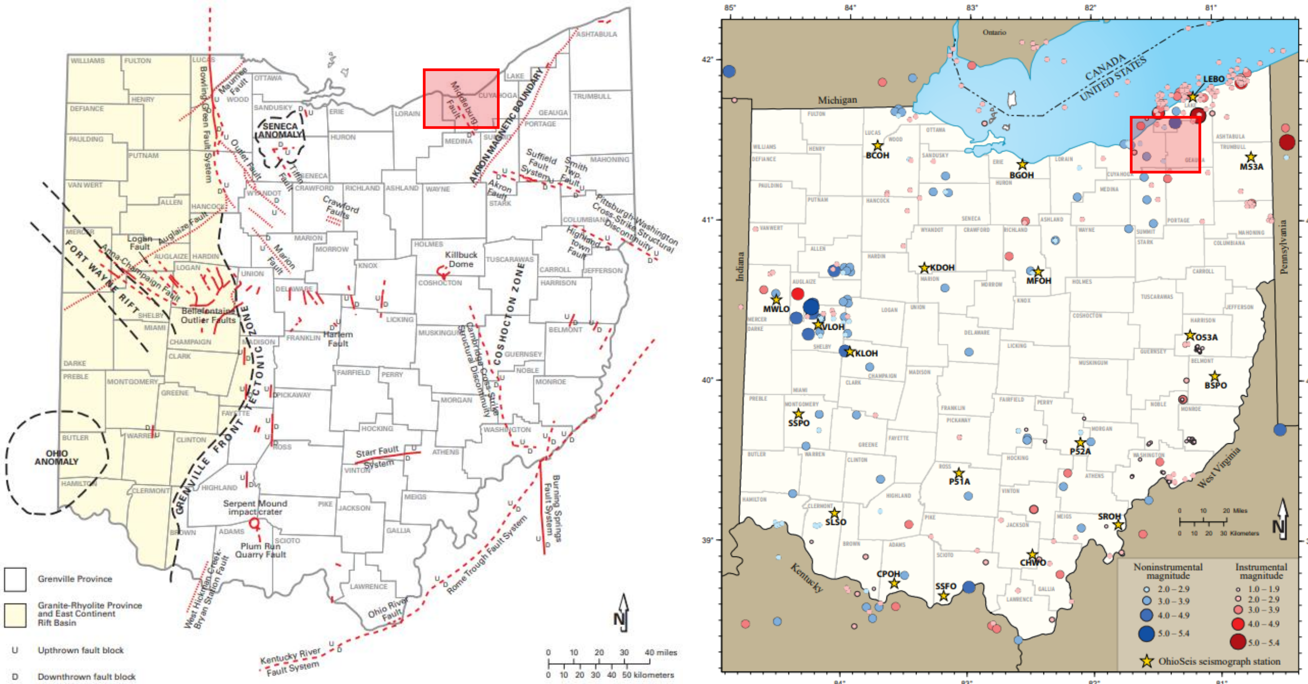

Figure 4-1 Seismicity maps of Ohio (USGS,ODNR)

4.2 Seismic site class

As specified in ASCE 7-16, seismic site class can be derived based on data from SPT, CPT, shear wave velocity (V_s) measurements, or geological information for the top 100 ft of a soil profile. Site Classes are designated based on the depth-weighted average of the measurements taken in the profile for the top 100 ft.

It should be noted that only one borehole (B-10 from CT Consultants, Inc, 2023) was extended to a depth greater than 100 ft and it was therefore used for the seismic site classification. The site class has been reviewed according to the available geotechnical data and Site Class E has been adopted according to ASCE 7-16 methods of the average undrained shear strength (Chapter 20.4.3) and the average field standard penetration resistance (Chapter 20.4.2).

Seismic parameters in accordance with ASCE 7-16 for the maximum considered earthquake (MCE, 2,475yr return period) and design-basis earthquake (DBE, approx. 1,000yr return period) are summarized in Table 4-1.

Table 4-1 Seismic parameters for MCE and DBE return periods as per ASCE 7-16

Parameter	Value
Risk category	IV (assumed)
Site class	E
Seismic design category	D
Seismic importance factor, I_e	1.5
Mapped Rock PGA (Site Class B)	0.079
Site coefficient, F_{PGA}	2.4
Surface PGA adjusted for site class effects, PGA_M	0.19
Rock short period spectral response acceleration, S_s	0.146
Short period site coefficient, F_a	2.4
Surface S_s	0.35
Rock 1 sec period spectral response acceleration, S_1	0.049
Long period site coefficient, F_v	4.2
Surface S_1	0.21
Surface PGA design earthquake basis	0.13
Short period design spectral response acceleration, S_{ds}	0.234
1 sec period design spectral response acceleration, S_{d1}	0.139

5. Geotechnical design and analyses

This section discusses the general geotechnical analysis and design adopted for the various elements of the Project, focusing on settlement and global stability of the breakwater structures. Note that this section does not include a detailed assessment of the existing or neighboring existing structures which will need to be assessed in the future and in coordination with the appropriate stakeholder.

The settlement and global stability analyses were conducted using two representative cross sections of the proposed breakwater, BW STA 06+00.00 and BW STA 12+00.00, as summarized in Table 5-1 and based on the geotechnical data presented in Section 3.6. The locations of these sections are shown in Figure 1-3. The breakwater at BW STA 06+00.00 is founded on the existing Cold-Water Breakwaters, whereas BW STA 12+00.00 represents a newly constructed segment. According to the 90% project Contract Drawings, the breakwater height ranges from 28 ft to 30 ft along the Project perimeter, retaining approximately 20 ft of dredge material.

Table 5-1 Cross sections locations summary

Section ID	Top breakwater elevation [ft]	Bottom breakwater elevation [ft]	Breakwater height [ft]
BW STA. 12+00.00	578	548	30
BW STA. 06+00.00	578	550	28

Table 5-2 summarizes the idealized stratigraphy, based on Borehole B-8, which is expected to be representative of the most critical stratigraphy in the CHEERS area, with the thickest soft CL/ML layer. The strength and consolidation parameters of the soil layers used in the analyses are presented in Table 3-1and Table 3-2 respectively.

Table 5-2 Idealized subsurface profile

Layer ID	Thickness [ft]	Top elevation [ft]	Bottom elevation [ft]
Water	-	573.4	Varies
Soft CL/ML (top of mudline)	52	Varying (548 ft to 550 ft)	496
Stiff CL/ML	95	496	401
SM	4	401	397
R	-	397	-

5.1 Assumed breakwater construction sequence

The assumed construction sequence of a newly constructed segment (BW STA. 12+00.00), as implemented in the analysis, is as follows:

1. Build embankment using the materials indicated in the Project Specifications Section 35 31 19:
   a. Breakwater will be built in 12 ft high lifts with a minimum 15-day waiting period between lifts. The estimated end of construction time is 1.5 months for a typical breakwater 30 ft height; and
   b. It will take approximately 14 months to complete the proposed breakwaters at the Habitat Loop.
2. Add dredge material next to the breakwater after completing breakwaters.
   a. Dredge material will be deposited in the Habitat Loop area in three stages; each stage is assumed to last six months; and
   b. It will take approximately 32 months to complete the Habitat loop area.
3. It will take 10 years to complete all the CHEERS breakwaters; and

4. It will take 20 years for the dredging process to be completed in all the other areas of the CHEERS project.

The construction sequence for the breakwater located atop the existing structure (BW STA 06+00.00), as modeled in the analysis, begins with the original construction of the Cold-Water Breakwater in 1910, approximately 115 years ago. During this period, the underlying soft CL/ML layer has consolidated under the structure's self-weight. Furthermore, sedimentation influenced by the breakwater candy-cane geometry has resulted in the accumulation of material adjacent to the structure, producing a mudline elevation higher than in surrounding areas. The new breakwater is modeled as being constructed atop the existing one at year 115, after which the breakwater construction sequence follows the same stages used for cross section BW STA 12+00.00. The estimated end of construction time is 1.5 months.

5.2 Settlement analyses

Settlement analyses were performed using the software Settle3 (Build 5.013, Rocscience Inc.) to estimate the magnitude of the settlements caused by the placement of the proposed breakwater on the native cohesive layers. The three-dimensional soil settlement analysis program provides constitutive models for calculating the three components of settlement anticipated for this Project:

1. Immediate (elastic) settlement is assumed to occur instantaneously during placement of the breakwater materials and is not treated as post-construction settlement in the analysis.
2. Primary consolidation settlement is assumed to occur gradually as excess pore pressures dissipate and effective stresses within the compressible cohesive layers increase.
3. Secondary consolidation (creep) is considered to occur after completion of primary consolidation and represents the long-term gradual deformation of the cohesive soils.

The following assumptions were used in the evaluation of settlement behavior for the breakwater:

- Double-drainage conditions are assumed for the consolidation analysis. The ground surface is considered drained, and the bottom of the stiff cohesive layer is also assumed drained due to the presence of a sand layer between the stiff clay and the underlying bedrock, as indicated in borehole B-10 and consistent with local geology.
- Staged construction of the breakwater is assumed so that the strength of the compressible cohesive layers can increase progressively under the applied fill loads. Each construction stage is modeled to capture the corresponding development of settlement, pore pressure dissipation, and degree of consolidation over time.
- Only the settlement of the native soils under the loading from the breakwater and the placement of dredge material was analyzed. No analysis was performed on the consolidation behavior of the dredge material itself.

Details of settlement analysis results are presented in Table 5-3. Refer to Appendix A where settlement calculations are presented in full.

The maximum primary consolidation and secondary compression settlements were calculated at highest cross-section (BW STA. 12+00.00), and they were estimated to be approximately 51 inches at 20 years. The cumulative elastic settlement at 32 months (end of dredge material placement) was approximately 9 inches. The time required to achieve 90% consolidation at BW STA. 12+00.00 was calculated to be between 20 to 25 years. Table 5-4 presents the estimated settlements associated with each construction lift after completion of the 15-day waiting period.

Settlements at the existing breakwater (BW STA. 06+00.00) are expected to be less than those at the new breakwater, as the underlying soft CL/ML clay layer has undergone consolidation over the past 115 years under the loading from the existing breakwater. The combined maximum primary consolidation plus secondary compression settlements were estimated to be approximately 11 inches at 20 years. The cumulative elastic settlement at 2 months (end of breakwater construction) was approximately 2 inches. The time required to achieve 90% consolidation at BW STA. 06+00.00 was calculated to be between 5 to 10 years.

Table 5-5 presents the average degree of consolidation of soft CL/ML soil unit over time.

Table 5-3 Settlement analyses results – Total settlements

Total settlement[1] [in]						
Section ID	Time = 0.12 years (1.5 months)[2]	Time = 1.16 year (14 months)	Time = 2.67 years (32 months)	Time = 5 years	Time = 10 years	Time = 20 years
BW STA 06+00.00 (H=28 ft)	3	5	7	8	10	13
BW STA 12+00.00 (H=30 ft)	21	35	43	48	54	60

Notes:
1. Settlements at embankment midline.
2. Estimated end of construction time.

Table 5-4 Settlement analyses results – Settlements after each lift following the 15-day waiting period

Settlements after each lift[1,2] [in]				
Lift No	Height [ft]	Immediate settlement	Total consolidation settlement	Total settlement
1	12	3.8	7.7	11.5
2	24	2.9	3.6	6.5

Notes:
1. Settlements at embankment midline.
2. Expected settlements after 15 days.

Table 5-5 Settlement analyses results – Average degree of consolidation

Average degree of consolidation of soft CL/ML[1] [%]						
Section ID	Time = 0.12 years (1.5 months)[2]	Time = 1.16 year (14 months)	Time = 2.67 years (32 months)	Time = 5 years	Time = 10 years	Time = 20 years
BW STA 06+00.00 (H = 28ft)	69	76	82	88	93	98
BW STA 12+00.00 (H = 30ft)	7	28	42	60	77	89

Notes:
1. Values presented herein are the calculated average values of the degree of consolidation across the entire depth of the soft CL/ML layer underneath the breakwater.
2. Estimated end of construction time.

5.3 Global stability analyses

Global stability analyses were performed using the software Slide2 (v9.0), a commercial 2D slope stability software by Rocscience (2024) that utilizes the Limit Equilibrium Method (LEM). The global stability analyses considered the following cases for the typical cross sections indicated in Table 5-1:

1. Short-term (end of construction) conditions, assuming undrained strength conditions in the clay layers; and

2. Long-term (post construction) conditions, assuming drained strength conditions.

The following assumptions and parameters were used in the slope stability analyses:

- Stability analyses were performed in accordance with USACE Slope Stability Manual EM 1110-2-1902 (2003).
- Spencer's method, which satisfies both force and moment equilibrium, was used to identify the critical slip surfaces.
- Lake Erie water level was modeled at Elevation 573.4 ft, corresponding to the ordinary high-water level.
- A surcharge load of 100 lb/ft² was applied at the top of the breakwaters, where above water, to represent pedestrian traffic or light utility vehicles for both short-term and long-term conditions.

5.3.1 Short-term conditions

According to the USACE (2003), an undrained condition analysis of a slope refers to a stability analysis where the pore water pressures in the soil have not yet dissipated. In undrained conditions, shear strength is primarily governed by total stress.

The undrained shear strength of the clay beneath the breakwater is expected to increase over time as consolidation progresses, with the strength increase (ΔS_u) is directly proportional to the increase in effective stress as per SHANSEP.

When constructing embankments over soft ground using staged construction practices, it is often not practical to allow each stage (lift of breakwater) to consolidate to 100%. At the end of each lift a updated undrained shear strength profile needs to be calculated using SHANSEP and allowing for pore pressure dissipation and over-consolidation ratio at that time.

Note that the ΔS_u under the breakwater structures varies both vertically and horizontally over time. To account for this variation, the soft clay beneath the breakwater was divided into zones as shown in Figure 5-1, and each zone was assigned a representative initial S_u profile. For simplicity, an average value was adopted for each zone over its full depth range. For a slope stability analysis representing the ground conditions at the beginning of each new lift, the adopted S_u profile is the greater of (1) the calculated undrained shear strength just before placing the lift, or (2) the initial design undrained shear strength profile.

The calculated S_u profiles at end-of-construction for the soft clay are presented in Table 5-6. The ΔS_u in the stiff CL/ML soil unit were deemed negligible for analysis purposes and therefore disregarded in the short-term analyses.

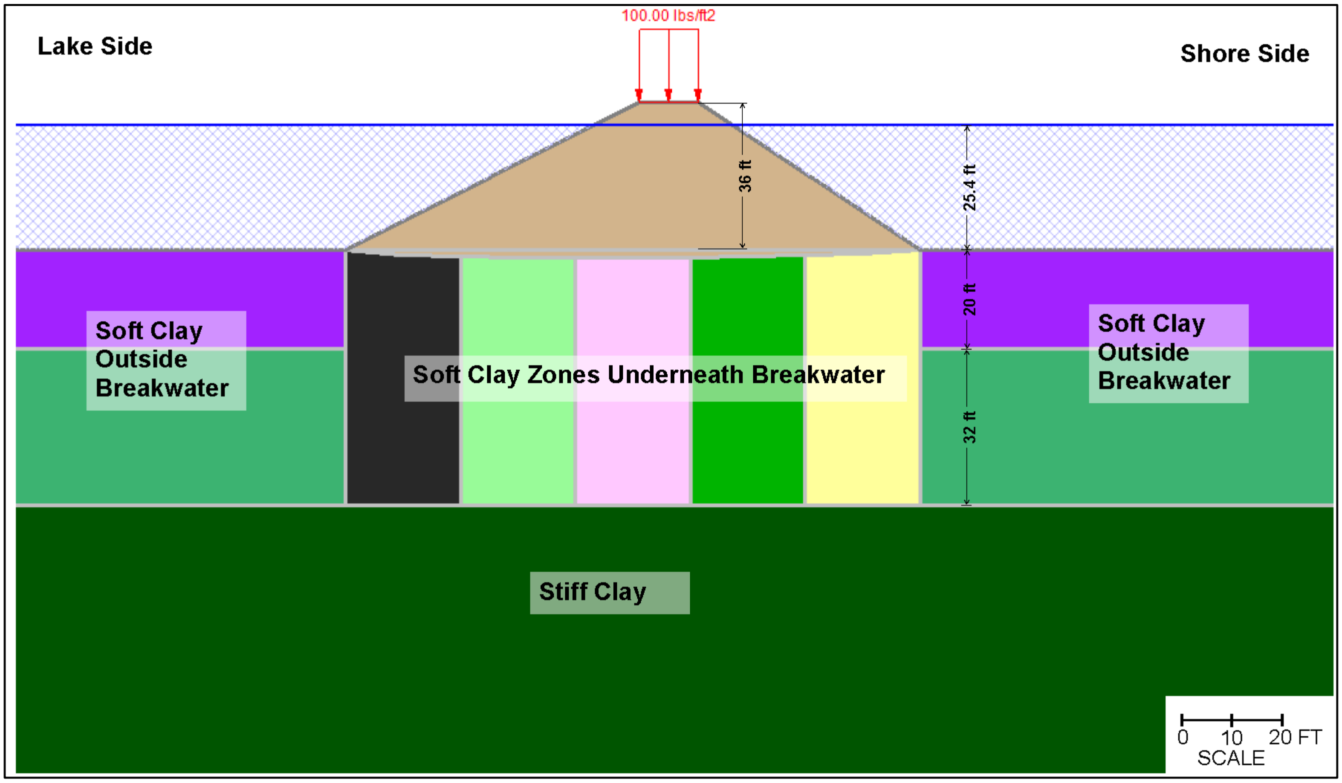

Figure 5-1 Zoning of soft CL/ML beneath the breakwater for slope stability analysis

Table 5-6 Undrained shear strength for short term conditions in soft CL/ML

Section ID	S_u (end-of-construction) [psf]
BW STA. 12+00.00 (H=30 ft)	From 720 to 738
BW STA. 08+00.00 (H=28 ft)	From 720 to 1,040

Table 5-7 and Appendix B summarize the results of the short-term global stability analyses. The factors of safety (FOS) reported in Table 5-7 represent the overall stability of the breakwater under gravity loading and live load surcharge conditions. All calculated FOS values exceed the minimum requirement for dam slopes specified by the USACE (2003), which prescribes a minimum FOS of 1.3 for short-term conditions.

Localized instabilities within the armor stone or core may still occur; however, such behavior is not anticipated to compromise the overall stability of the breakwater. Any localized movements can be addressed through construction-phase monitoring and minor remedial measures. This approach aligns with the USACE Coastal Engineering Manual (CEM, 2006), Part VI, Chapter 5, Armor Stone Stability, which allows controlled damage during temporary or construction phases provided that associated risks and exposure durations are limited.

During the next design phase, these analyses will be reviewed and refined to further assess the stability and confirm that the adopted safety factors remain appropriate.

Table 5-7 Slope stability analyses - Short-term analyses FOS

Section ID	FOS (Lake side)	FOS (Shore side)
BW STA. 12+00.00 (H=30 ft)	1.43	1.34[1]
BW STA 06+00.00 (H=28 ft)	1.48	2.6[1]
Note: 1. The FOS shown corresponds to deep-seated slip surfaces passing through the soft CL/ML layer. For slip surfaces within the breakwater, the FOS is less than 1.3 due to the relatively steep side slope of 1.5H:1V.		

5.3.2 Long-term conditions

According to the USACE (2003), a drained condition analysis of a slope refers to a stability analysis where the pore water pressures within the soil have dissipated. This results in long-term stability conditions where soil strength is governed primarily by effective stress. In a drained condition, the shear strength of the soil is modelled as zero cohesion and using the effective angle of friction.

Two possible long-term scenarios were analyzed:

1. Final breakwater configuration with added dredge material on the shore side. This is the most likely scenario considering that by the time the cohesive soils are drained (U > 95%), the construction is supposed to be completed according to the current schedule; and

2. Final breakwater configuration without dredge material next to the breakwater. This is a more conservative scenario that assumes a delay in construction.

The results of the global stability analyses are presented in Appendix B. The estimated FOS presented in Table 5-8 meet the minimum required per the USACE (2003).

Table 5-8 Slope stability analyses - Long-term analyses FOS

Section ID	Scenario	FOS (Lake side)	FOS (Shore side)
BW STA. 12+00.00 (H=30 ft)	No dredge material	1.71	1.53
	With dredge material	1.67	4.7[1]
BW STA 06+00.00 (H=28 ft)	No dredge material	1.57	2.73[1]
	With dredge material	1.55	4[1]
Note: 1. The FOS shown corresponds to deep-seated slip surfaces passing through the soft CL/ML layer. For slip surfaces within the breakwater, the FOS is less than 1.5 due to the relatively steep side slope of 1.5H:1V.			

5.3.3 Commentary on global stability analyses

Geotechnical analyses indicate factors of safety higher for the global stability of the Habitat Loop breakwater that are compliant with the USACE requirements for both short and long-term conditions. These analyses are based assumptions presented in Chapter 5.1 and the limited GI in the Habitat Loop area available at the time of preparing this report.

The following points should be considered in future stages of design and construction of the breakwater structures:

1. Any modifications to the breakwater geometry, construction material properties, construction sequence, schedule, or loading conditions must be reviewed with the geotechnical engineer, as such changes could significantly reduce the undrained shear strength profile of the soft CL/ML layer during construction, and compromise the stability and safety of the breakwater.

2. To increase the global stability FOS, the degree of consolidation of the soft clay can be increased either by (a) extending the waiting period between lifts or (b) by installing wick drains to accelerate porewater pressure dissipation. The use of wick drains would allow faster consolidation without extending the construction schedule. At the Habitat Loop, the current baseline recommendation is to wait at least 15 days between each lift, or until the settlements indicated in Table 5-4 have been achieved

3. A shallow layer of enhanced soil that may include geogrid reinforcement could be considered at the base of the breakwater to further enhance global stability.

4. A comprehensive monitoring program should be implemented to provide real-time feedback on the excess pore water pressure dissipation and vertical settlements throughout the staged construction process. Continuous monitoring will enable engineers to assess the rate of consolidation and confirm whether the anticipated undrained shear strength gains have been realized. By comparing observed data with design expectations, timely adjustments to the construction schedule can be made once target settlement levels and stability criteria are achieved. Moreover, this will help identify localized instabilities within the armor or core, allowing for prompt remedial measures during construction. Chapter 6.3 includes more details on the recommended construction monitoring and instrumentation.

5. To account for anticipated breakwater settlement, supplementary analyses were performed assuming a design elevation increased by 2 ft, recognizing that the Contractor may elect to offset expected settlements. Construction of a crest elevation more than 2 ft above the design level is not recommended; if such an increase is unavoidable, a longer waiting period should be allowed before proceeding with subsequent construction.

6. The current assessment focuses on static loading conditions. Wave loading, including dynamic hydraulic forces and pore-pressure effects, was not evaluated in this phase. Seismic loading and its potential influence on the stability of the breakwater were also not considered in the present analysis. These factors will be examined in detail during the final design stage.

5.4 Bearing capacity assessment

The bearing capacity of the base soil was assessed for the typical new breakwater cross section shown in Figure 1-4. Evaluations were conducted for both end-of-construction and long-term conditions.

In the case of the breakwater constructed atop the existing breakwater, the underlying soft clay has consolidated over the past century, resulting in increased undrained shear strength. As a result, this scenario is considered less critical in the bearing capacity assessment compared to the newly constructed breakwater.

5.4.1 Short-term conditions

For the short-term conditions (end of construction), the bearing capacity was evaluated using the undrained shear strength of the soft clay.

The undrained shear strength at the end of construction was estimated using the final undrained shear strength at the end of consolidation and the degree of consolidation achieved at the end of construction. Based on the Settle3 analysis, the average degree of consolidation in the soft clay layer is approximately 20% at end-of-construction.

The undrained shear strength at end of construction is approximately 720 psf based on Table 5-6.

The ultimate bearing capacity of the base soil was evaluated using the Meyerhof method, as outlined in Table 4-1 of Bowels (1997). Based on this method, the calculated ultimate bearing capacity is 3.9 ksf.

The load demand beneath the breakwater base varies along its width due to changes in height from the toe to the crest. The average load demand across the entire width of the breakwater is approximately 1.9 ksf.

Accordingly, the factor of safety (FOS) for bearing capacity at end-of-construction is estimated to be:

$$FOS = \frac{3.9\ ksf}{1.9\ ksf} = 2.0$$

5.4.2 Long-term condition

For the long-term condition, the bearing capacity was assessed based on the drained shear strength of the soft clay.

The ultimate bearing capacity of the base soil was determined using the Meyerhof method, as referenced in Table 4-1 of Bowels (1997), and the drained strength parameters of the soft clay presented in Table 3-1The design values used in the analysis are shown in Figure 3-6.. The calculated ultimate bearing capacity is 22.5 ksf.

The average load demand beneath the breakwater is approximately 1.9 ksf. Therefore, the factor of safety (FOS) for bearing capacity is:

$$FOS = \frac{22.5\ ksf}{1.9\ ksf} = 11.8$$

6. Construction considerations

6.1 Breakwater material

The materials used in the construction of breakwaters should conform to Specifications Section 35 31 19, provided by KS.

6.2 Impact on existing structures and utilities

Impacts on existing structures (e.g., adjacent breakwaters, the existing Mandel Community Trail, the I-90 bridge abutments) shall be evaluated during the next design phase. The assessment needs to address short-term construction-induced movements and long-term settlements associated with breakwater construction and dredge material placement, with particular attention to differential settlement, lateral deformation, and load transfer effects on structural performance and serviceability. Allowable movement criteria will be established in coordination with relevant stakeholders, and mitigation measures will be considered where predicted movements approach or exceed acceptable limits.

No utilities have been documented within the Project area to date; however, a pre-construction survey is recommended to identify any existing structures or utilities that may require protection. As discussed in Section 5.2, the calculated ground movements associated with the newly designed breakwaters are expected to be significant. Accordingly, any utilities identified within the Project limits or zones of influence should be assumed at risk and replaced, rerouted, or otherwise designed to accommodate the anticipated deformations.

It is understood that new utilities are planned for installation, including two HDPE pipes proposed to convey stormwater from the upland berm area to Lake Erie. During the next design phase, installation of these utilities will require close coordination with the overall construction sequencing to accommodate anticipated settlements and potential lateral movements associated with breakwater construction and dredge material placement

6.3 Instrumentation and construction monitoring

Instrumentation and Monitoring will be critical to verify the geotechnical assumptions made within this report. An Instrumentation and Construction Monitoring Plan should be developed in the next stage of design in coordination with the Coastal Engineer, Structural Engineer and the Geotechnical Engineer to define required instrumentation and the installation location, frequency of monitoring, trigger levels and action plans should any of these trigger levels be breached during or after construction.

The monitoring plan should address not only the Project components but also include monitoring of adjacent and existing infrastructure that could be affected by construction-induced movements. Coordination with relevant stakeholders (e.g., ODOT, The Port of Cleveland, Cleveland Metroparks) will be required to ensure that infrastructure performance criteria—such as allowable roadway settlement—are not exceeded. This plan will be developed in parallel with the regulatory process to ensure compliance with applicable permit conditions and agency requirements.

Given that breakwaters will require staged construction to ensure global stability, geotechnical instrumentation is essential for monitoring field performance and providing critical data to inform decisions about construction stages and methodology. The principal parameters monitored during the breakwater construction are pore water pressure and vertical displacement (settlement). As discussed in Section 5, the self-weight of the breakwater increases the pore water pressure. With time, the excess pore water pressure will dissipate, and the effective stresses and clay shear strength will increase.

Monitoring excess pore water pressures provides a direct means to assess the progress of consolidation and to determine when it is appropriate to proceed with subsequent stages of breakwater construction or surcharge placement.

To support design verification and construction control, the following key geotechnical monitoring parameters are anticipated (additional instrumentation may be required to satisfy the needs of other disciplines):

- **Settlement monitoring** to quantify vertical displacement of the breakwater and underlying foundation soils with time, assess total and differential settlement, and back-calculate the degree and rate of consolidation. Settlement measurements are typically obtained using settlement plates or settlement gauges installed at the foundation surface or within the compressible soil strata. In addition, repeated topographic and bathymetric surveys will be used to monitor settlement of the breakwater geometry, including submerged portions of the structure.
- **Structural deformation monitoring** to identify lateral movements, tilting, or rotation of the breakwater that may develop as a result of uneven settlement or foundation deformation. Such movements may be monitored using inclinometers, fixed survey points, or GPS-based systems located along the crest and shoulders of the breakwater.
- **Pore pressure monitoring** to measure excess pore water pressures within the foundation soils beneath and adjacent to the breakwater, evaluate the dissipation of pore pressures with time, and confirm the interim degree of consolidation achieved. Pore pressure measurements are typically obtained using vibrating-wire or pneumatic piezometers installed at multiple depths within the compressible soil profile.

The combined interpretation of settlement, deformation, and pore pressure data will be used to confirm consistency with design assumptions, evaluate construction performance, and inform decisions regarding construction staging, hold points, or the need for remedial measures.

Post-construction monitoring will be required to ensure that the breakwater continues to function as design over time, providing necessary containment for dredge material. This will be ensured with regular inspections and survey. This will be ensured with regular inspections and survey, and any issues identified during monitoring will be addressed with appropriate remedial measures to maintain stability and performance.

7. Limitations

Arup warrants that its services were performed within the limits prescribed by our client for the Project, in a manner consistent with the level of care and skill ordinarily exercised by members of the same profession. No other warranty or representation, either expressed or implied, is included or intended hereunder.

The information presented in this Geotechnical Engineering Report is based on the indicated Project criteria and data described in this report and is intended only for the purposes, site, location, and project described in this report. The information is subject to possible modifications, based on the conditions found during additional explorations, environmental changes that may occur, or are encountered during the construction when more information on subsurface conditions becomes available.

If at any time significant project changes are implemented during design, or if different soil and rock conditions from those described in this report are encountered, Arup should be notified promptly for evaluation and supplemental investigations and geotechnical analysis as necessary or as deemed appropriate.

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Appendix A

Settlement analyses results

A.1 Section BW-STA. 12+00.00 (H = 30 ft)

BW STA 12+00
Report Creation Date: 2026/01/14, 21:59:47

Table of Contents

Settle3 Analysis Information

BW STA 12+00

Project Settings

Document Name	BW STA 12+00.00
Date Created	9/8/2025, 4:26:54 PM
Last saved with Settle3 version	5.018
Stress Computation Method	Boussinesq
Stress Units	Imperial, stress as ksf
Settlement Units	inches
Time-dependent Consolidation Analysis	
Time Units	years
Permeability Units	feet/year

Advanced Settings

Start of secondary consolidation (% of primary)	95
Min. stress for secondary consolidation (% of initial)	1
Reset time when load changes for secondary consolidation	No
Minimum settlement ratio for subgrade modulus	0.9
Use average poisson's ratio to calculate layered stresses	
Update Cv in each time step (improves consolidation accuracy)	
Ignore negative effective stresses in settlement calculations	
Add field points to load edges	

Soil Profile

Layer Option	Horizontal Soil Layers
Vertical Axis	Elevation
Ground Elevation (ft)	548

Stage Settings

Stage #	Name	Time [years]
1	Stage 1: Initial conditions	0
2	Stage2:12ft	0
3	Stage 3	0.04
4	Stage 4:24ft	0.04
5	Stage 5	0.08
6	Stage 6:30ft	0.08
7	Stage 7	0.12
8	Stage 8	1
9	Stage 9	1.16
10	Stage 10:Fill=8ft	1.16
11	Stage 11	1.67
12	Stage 12:Fill=16ft	1.67
13	Stage 13	2.17
14	Stage 14:Fill=20ft	2.17
15	Stage 15	2.7
16	Stage 16	5
17	Stage 17	10
18	Stage 18	20
19	Stage 19	100

Results

Time taken to compute: 0 seconds

Stage: Stage 1: Initial conditions = 0 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	0
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	0
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	0	0
Loading Stress XX [ksf]	0	0
Loading Stress YY [ksf]	0	0
Effective Stress ZZ [ksf]	0	7.2476
Effective Stress XX [ksf]	0	7.2476
Effective Stress YY [ksf]	0	7.2476
Total Stress ZZ [ksf]	1.58496	18.255
Total Stress XX [ksf]	1.58496	18.255
Total Stress YY [ksf]	1.58496	18.255
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0
Pore Water Pressure [ksf]	1.58496	11.0074
Excess Pore Water Pressure [ksf]	0	0
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.5
Void Ratio	0	0.76
Permeability [ft/y]	0	14.6976
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage2:12ft = 0 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	3.75314
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	3.75314
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-2.26072e-06	1.92141
Loading Stress XX [ksf]	-0.475103	2.08815
Loading Stress YY [ksf]	-0.572925	3.24747
Effective Stress ZZ [ksf]	0	7.2476
Effective Stress XX [ksf]	-0.131815	9.32586
Effective Stress YY [ksf]	-0.323833	10.1074
Total Stress ZZ [ksf]	1.58496	18.9773
Total Stress XX [ksf]	1.45314	21.0556
Total Stress YY [ksf]	1.43354	21.8372
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-4.51628e-09	0.00384282
Pore Water Pressure [ksf]	1.58496	11.7297
Excess Pore Water Pressure [ksf]	-2.26072e-06	1.92141
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.5
Void Ratio	0	0.76
Permeability [ft/y]	0	14.6976
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 3 = 0.04 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	11.4354
Total Consolidation Settlement [in]	0	7.68226
Virgin Consolidation Settlement [in]	0	7.28891
Recompression Consolidation Settlement [in]	0	0.395341
Immediate Settlement [in]	0	3.75314
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-2.26072e-06	1.92141
Loading Stress XX [ksf]	-0.475103	2.08815
Loading Stress YY [ksf]	-0.572925	3.24747
Effective Stress ZZ [ksf]	0	7.96997
Effective Stress XX [ksf]	-0.131815	10.0482
Effective Stress YY [ksf]	-0.288837	10.8298
Total Stress ZZ [ksf]	1.58496	18.9773
Total Stress XX [ksf]	1.45314	21.0556
Total Stress YY [ksf]	1.43354	21.8372
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-4.51258e-06	0.36255
Pore Water Pressure [ksf]	1.58496	11.202
Excess Pore Water Pressure [ksf]	0	1.89651
Degree of Consolidation [%]	0	98.1885
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.50377
Void Ratio	0	0.760008
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 4:24ft = 0.04 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	14.3258
Total Consolidation Settlement [in]	0	7.68226
Virgin Consolidation Settlement [in]	0	7.28891
Recompression Consolidation Settlement [in]	0	0.395341
Immediate Settlement [in]	0	6.64363
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-2.83813e-06	3.84319
Loading Stress XX [ksf]	-0.736378	4.27799
Loading Stress YY [ksf]	-0.861139	6.40778
Effective Stress ZZ [ksf]	0	7.96997
Effective Stress XX [ksf]	-0.209522	12.2283
Effective Stress YY [ksf]	-0.504073	13.4712
Total Stress ZZ [ksf]	1.58496	19.4008
Total Stress XX [ksf]	1.37544	23.6592
Total Stress YY [ksf]	1.34871	24.902
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-4.51373e-06	0.36639
Pore Water Pressure [ksf]	1.57945	11.6506
Excess Pore Water Pressure [ksf]	-0.00551302	3.79269
Degree of Consolidation [%]	0	65.284
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.50377
Void Ratio	0	0.760008
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 5 = 0.08 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	17.9648
Total Consolidation Settlement [in]	0	11.3167
Virgin Consolidation Settlement [in]	0	10.7541
Recompression Consolidation Settlement [in]	0	0.562594
Immediate Settlement [in]	0	6.64363
Secondary Settlement [in]	0	0.00851623
Loading Stress ZZ [ksf]	-2.83813e-06	3.84319
Loading Stress XX [ksf]	-0.736378	4.27799
Loading Stress YY [ksf]	-0.861139	6.40778
Effective Stress ZZ [ksf]	0	8.39343
Effective Stress XX [ksf]	-0.209522	12.6518
Effective Stress YY [ksf]	-0.484856	13.8946
Total Stress ZZ [ksf]	1.58496	19.4008
Total Stress XX [ksf]	1.37544	23.6592
Total Stress YY [ksf]	1.34871	24.902
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-5.67552e-06	0.407076
Pore Water Pressure [ksf]	1.58496	11.5866
Excess Pore Water Pressure [ksf]	0	3.674
Degree of Consolidation [%]	0	98.5631
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.50428
Void Ratio	0	0.76001
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 6:30ft = 0.08 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	18.845
Total Consolidation Settlement [in]	0	11.3167
Virgin Consolidation Settlement [in]	0	10.7541
Recompression Consolidation Settlement [in]	0	0.562594
Immediate Settlement [in]	0	7.52378
Secondary Settlement [in]	0	0.00851623
Loading Stress ZZ [ksf]	-2.88844e-06	4.80292
Loading Stress XX [ksf]	-0.793527	5.40543
Loading Stress YY [ksf]	-0.939309	7.84901
Effective Stress ZZ [ksf]	0	8.39343
Effective Stress XX [ksf]	-0.226073	13.7763
Effective Stress YY [ksf]	-0.524978	15.1207
Total Stress ZZ [ksf]	1.58496	19.4906
Total Stress XX [ksf]	1.35889	24.8737
Total Stress YY [ksf]	1.33238	26.2181
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-5.67562e-06	0.408974
Pore Water Pressure [ksf]	1.57975	11.682
Excess Pore Water Pressure [ksf]	-0.00520554	4.47352
Degree of Consolidation [%]	0	92.4893
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.50428
Void Ratio	0	0.76001
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 7 = 0.12 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	21.1385
Total Consolidation Settlement [in]	0	13.6067
Virgin Consolidation Settlement [in]	0	12.8354
Recompression Consolidation Settlement [in]	0	0.777175
Immediate Settlement [in]	0	7.52378
Secondary Settlement [in]	0	0.0156399
Loading Stress ZZ [ksf]	-2.88844e-06	4.80292
Loading Stress XX [ksf]	-0.793527	5.40543
Loading Stress YY [ksf]	-0.939309	7.84901
Effective Stress ZZ [ksf]	0	8.48322
Effective Stress XX [ksf]	-0.226073	13.8664
Effective Stress YY [ksf]	-0.506757	15.2108
Total Stress ZZ [ksf]	1.58496	19.4906
Total Stress XX [ksf]	1.35889	24.8737
Total Stress YY [ksf]	1.33238	26.2181
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-5.78492e-06	0.42248
Pore Water Pressure [ksf]	1.58496	11.5947
Excess Pore Water Pressure [ksf]	0	4.31625
Degree of Consolidation [%]	0	98.8903
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.50792
Void Ratio	0	0.76001
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 8 = 1 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	34.7542
Total Consolidation Settlement [in]	-0.0364627	27.1725
Virgin Consolidation Settlement [in]	0	25.7392
Recompression Consolidation Settlement [in]	-0.0364627	1.55666
Immediate Settlement [in]	0	7.52378
Secondary Settlement [in]	0	0.0822192
Loading Stress ZZ [ksf]	-2.88844e-06	4.80292
Loading Stress XX [ksf]	-0.793527	5.40543
Loading Stress YY [ksf]	-0.939309	7.84901
Effective Stress ZZ [ksf]	0	8.48322
Effective Stress XX [ksf]	-0.226073	13.8664
Effective Stress YY [ksf]	-0.417473	15.2108
Total Stress ZZ [ksf]	1.58496	19.4906
Total Stress XX [ksf]	1.35889	24.8737
Total Stress YY [ksf]	1.33238	26.2181
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-9.21506e-06	0.426934
Pore Water Pressure [ksf]	1.58496	11.0624
Excess Pore Water Pressure [ksf]	0	3.50889
Degree of Consolidation [%]	0	99.7208
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.56006
Void Ratio	0	0.760016
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 9 = 1.16 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	35.8092
Total Consolidation Settlement [in]	-0.0441575	28.2195
Virgin Consolidation Settlement [in]	0	26.7213
Recompression Consolidation Settlement [in]	-0.0441575	1.62287
Immediate Settlement [in]	0	7.52378
Secondary Settlement [in]	0	0.0891599
Loading Stress ZZ [ksf]	-2.88844e-06	4.80292
Loading Stress XX [ksf]	-0.793527	5.40543
Loading Stress YY [ksf]	-0.939309	7.84901
Effective Stress ZZ [ksf]	0	8.48322
Effective Stress XX [ksf]	-0.226073	13.8664
Effective Stress YY [ksf]	-0.41487	15.2108
Total Stress ZZ [ksf]	1.58496	19.4906
Total Stress XX [ksf]	1.35889	24.8737
Total Stress YY [ksf]	1.33238	26.2181
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.02206e-05	0.427245
Pore Water Pressure [ksf]	1.58496	11.0191
Excess Pore Water Pressure [ksf]	0	3.39125
Degree of Consolidation [%]	0	99.746
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.56682
Void Ratio	0	0.760018
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 10:Fill=8ft = 1.16 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	36.1538
Total Consolidation Settlement [in]	-0.0441575	28.2195
Virgin Consolidation Settlement [in]	0	26.7213
Recompression Consolidation Settlement [in]	-0.0441575	1.62287
Immediate Settlement [in]	0	7.86835
Secondary Settlement [in]	0	0.0891599
Loading Stress ZZ [ksf]	-1.53531e-06	4.80245
Loading Stress XX [ksf]	-0.779963	5.04357
Loading Stress YY [ksf]	-1.06462	7.35498
Effective Stress ZZ [ksf]	0	8.48322
Effective Stress XX [ksf]	-0.276327	13.4557
Effective Stress YY [ksf]	-0.45226	14.6169
Total Stress ZZ [ksf]	1.58496	19.7725
Total Stress XX [ksf]	1.30863	24.7263
Total Stress YY [ksf]	1.3016	25.9055
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.01712e-05	0.427243
Pore Water Pressure [ksf]	1.58411	11.6083
Excess Pore Water Pressure [ksf]	-0.000845152	3.4455
Degree of Consolidation [%]	0	90.4397
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.56682
Void Ratio	0	0.760018
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 11 = 1.67 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	38.7301
Total Consolidation Settlement [in]	-0.0199264	30.7762
Virgin Consolidation Settlement [in]	0	28.9983
Recompression Consolidation Settlement [in]	-0.0199264	1.89967
Immediate Settlement [in]	0	7.86835
Secondary Settlement [in]	0	0.10982
Loading Stress ZZ [ksf]	-1.53531e-06	4.80245
Loading Stress XX [ksf]	-0.779963	5.04357
Loading Stress YY [ksf]	-1.06462	7.35498
Effective Stress ZZ [ksf]	0	8.76516
Effective Stress XX [ksf]	-0.276327	13.7189
Effective Stress YY [ksf]	-0.446662	14.8982
Total Stress ZZ [ksf]	1.58496	19.7725
Total Stress XX [ksf]	1.30863	24.7263
Total Stress YY [ksf]	1.3016	25.9055
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.31742e-05	0.428004
Pore Water Pressure [ksf]	1.58496	11.1605
Excess Pore Water Pressure [ksf]	0	3.30609
Degree of Consolidation [%]	0	99.7584
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.57536
Void Ratio	0	0.760023
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 12:Fill=16ft = 1.67 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	39.1833
Total Consolidation Settlement [in]	-0.0199264	30.7762
Virgin Consolidation Settlement [in]	0	28.9983
Recompression Consolidation Settlement [in]	-0.0199264	1.89967
Immediate Settlement [in]	0	8.34281
Secondary Settlement [in]	0	0.10982
Loading Stress ZZ [ksf]	-1.9846e-06	4.80247
Loading Stress XX [ksf]	-1.0358	4.6883
Loading Stress YY [ksf]	-1.40045	6.86433
Effective Stress ZZ [ksf]	0	8.76516
Effective Stress XX [ksf]	-0.334363	13.2936
Effective Stress YY [ksf]	-0.564673	14.3444
Total Stress ZZ [ksf]	1.58496	20.1757
Total Stress XX [ksf]	1.2506	24.616
Total Stress YY [ksf]	1.21918	25.6764
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.31129e-05	0.428005
Pore Water Pressure [ksf]	1.58226	11.6262
Excess Pore Water Pressure [ksf]	-0.00269853	3.40681
Degree of Consolidation [%]	0	89.9163
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.57536
Void Ratio	0	0.760023
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 13 = 2.17 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	41.1166
Total Consolidation Settlement [in]	0	32.6933
Virgin Consolidation Settlement [in]	0	30.6683
Recompression Consolidation Settlement [in]	0	2.20367
Immediate Settlement [in]	0	8.34281
Secondary Settlement [in]	0	0.133525
Loading Stress ZZ [ksf]	-1.9846e-06	4.80247
Loading Stress XX [ksf]	-1.0358	4.6883
Loading Stress YY [ksf]	-1.40045	6.86433
Effective Stress ZZ [ksf]	0	9.16834
Effective Stress XX [ksf]	-0.334363	13.6087
Effective Stress YY [ksf]	-0.561745	14.6691
Total Stress ZZ [ksf]	1.58496	20.1757
Total Stress XX [ksf]	1.2506	24.616
Total Stress YY [ksf]	1.21918	25.6764
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.57886e-05	0.428554
Pore Water Pressure [ksf]	1.58496	11.4377
Excess Pore Water Pressure [ksf]	0	3.27069
Degree of Consolidation [%]	0	99.7748
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.57874
Void Ratio	0	0.760028
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 14:Fill=20ft = 2.17 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	41.5733
Total Consolidation Settlement [in]	0	32.6933
Virgin Consolidation Settlement [in]	0	30.6683
Recompression Consolidation Settlement [in]	0	2.20367
Immediate Settlement [in]	0	8.8362
Secondary Settlement [in]	0	0.133525
Loading Stress ZZ [ksf]	-2.72882e-06	4.80249
Loading Stress XX [ksf]	-1.28555	4.42226
Loading Stress YY [ksf]	-1.81454	6.49081
Effective Stress ZZ [ksf]	0	9.16834
Effective Stress XX [ksf]	-0.383329	13.2735
Effective Stress YY [ksf]	-0.658558	14.2773
Total Stress ZZ [ksf]	1.58496	20.566
Total Stress XX [ksf]	1.20163	24.5544
Total Stress YY [ksf]	1.15331	25.5582
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.57329e-05	0.428554
Pore Water Pressure [ksf]	1.5836	11.8543
Excess Pore Water Pressure [ksf]	-0.00135565	3.44852
Degree of Consolidation [%]	0	91.9437
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.57874
Void Ratio	0	0.760028
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 15 = 2.7 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	43.4768
Total Consolidation Settlement [in]	0	34.5605
Virgin Consolidation Settlement [in]	0	32.3396
Recompression Consolidation Settlement [in]	0	2.44242
Immediate Settlement [in]	0	8.8362
Secondary Settlement [in]	0	0.153311
Loading Stress ZZ [ksf]	-2.72882e-06	4.80249
Loading Stress XX [ksf]	-1.28555	4.42226
Loading Stress YY [ksf]	-1.81454	6.49081
Effective Stress ZZ [ksf]	0	9.55867
Effective Stress XX [ksf]	-0.383329	13.5471
Effective Stress YY [ksf]	-0.649668	14.5509
Total Stress ZZ [ksf]	1.58496	20.566
Total Stress XX [ksf]	1.20163	24.5544
Total Stress YY [ksf]	1.15331	25.5582
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.83355e-05	0.429012
Pore Water Pressure [ksf]	1.58496	11.6799
Excess Pore Water Pressure [ksf]	0	3.34783
Degree of Consolidation [%]	0	99.7971
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.5769
Void Ratio	0	0.760032
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 16 = 5 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	48.8572
Total Consolidation Settlement [in]	0	39.8489
Virgin Consolidation Settlement [in]	0	36.8491
Recompression Consolidation Settlement [in]	0	3.23745
Immediate Settlement [in]	0	8.8362
Secondary Settlement [in]	0	0.225361
Loading Stress ZZ [ksf]	-2.72882e-06	4.80249
Loading Stress XX [ksf]	-1.28555	4.42226
Loading Stress YY [ksf]	-1.81454	6.49081
Effective Stress ZZ [ksf]	0	9.55867
Effective Stress XX [ksf]	-0.383329	13.5471
Effective Stress YY [ksf]	-0.640812	14.5509
Total Stress ZZ [ksf]	1.58496	20.566
Total Stress XX [ksf]	1.20163	24.5544
Total Stress YY [ksf]	1.15331	25.5582
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-3.2489e-05	0.430302
Pore Water Pressure [ksf]	1.58496	11.2411
Excess Pore Water Pressure [ksf]	0	3.05997
Degree of Consolidation [%]	0	99.8933
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.571
Void Ratio	0	0.760057
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 17 = 10 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	55.2464
Total Consolidation Settlement [in]	0	46.1365
Virgin Consolidation Settlement [in]	0	41.8949
Recompression Consolidation Settlement [in]	0	4.53523
Immediate Settlement [in]	0	8.8362
Secondary Settlement [in]	0	0.316753
Loading Stress ZZ [ksf]	-2.72882e-06	4.80249
Loading Stress XX [ksf]	-1.28555	4.42226
Loading Stress YY [ksf]	-1.81454	6.49081
Effective Stress ZZ [ksf]	0	9.55867
Effective Stress XX [ksf]	-0.383329	13.5471
Effective Stress YY [ksf]	-0.639701	14.5509
Total Stress ZZ [ksf]	1.58496	20.566
Total Stress XX [ksf]	1.20163	24.5544
Total Stress YY [ksf]	1.15331	25.5582
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-4.26085e-05	0.431753
Pore Water Pressure [ksf]	1.58496	11.0074
Excess Pore Water Pressure [ksf]	0	2.58527
Degree of Consolidation [%]	0	99.9453
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.50819
Void Ratio	0	0.760075
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 18 = 20 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	61.5442
Total Consolidation Settlement [in]	0	52.2751
Virgin Consolidation Settlement [in]	0	46.6223
Recompression Consolidation Settlement [in]	0	5.95694
Immediate Settlement [in]	0	8.8362
Secondary Settlement [in]	0	0.471532
Loading Stress ZZ [ksf]	-2.72882e-06	4.80249
Loading Stress XX [ksf]	-1.28555	4.42226
Loading Stress YY [ksf]	-1.81454	6.49081
Effective Stress ZZ [ksf]	0	9.55867
Effective Stress XX [ksf]	-0.383329	13.5471
Effective Stress YY [ksf]	-0.640561	14.5509
Total Stress ZZ [ksf]	1.58496	20.566
Total Stress XX [ksf]	1.20163	24.5544
Total Stress YY [ksf]	1.15331	25.5582
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-3.70507e-05	0.433204
Pore Water Pressure [ksf]	1.58496	11.0074
Excess Pore Water Pressure [ksf]	0	1.59539
Degree of Consolidation [%]	0	99.9744
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.5068
Void Ratio	-0.00243924	0.760065
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Stage 19 = 100 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	71.3092
Total Consolidation Settlement [in]	0	60.6916
Virgin Consolidation Settlement [in]	0	53.7912
Recompression Consolidation Settlement [in]	0	7.0134
Immediate Settlement [in]	0	8.8362
Secondary Settlement [in]	0	2.49143
Loading Stress ZZ [ksf]	-2.72882e-06	4.80249
Loading Stress XX [ksf]	-1.28555	4.42226
Loading Stress YY [ksf]	-1.81454	6.49081
Effective Stress ZZ [ksf]	0	9.55867
Effective Stress XX [ksf]	-0.383329	13.5471
Effective Stress YY [ksf]	-0.638084	14.5509
Total Stress ZZ [ksf]	1.58496	20.566
Total Stress XX [ksf]	1.20163	24.5544
Total Stress YY [ksf]	1.15331	25.5582
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-5.47028e-06	0.436574
Pore Water Pressure [ksf]	1.58496	11.0074
Excess Pore Water Pressure [ksf]	-0.00105317	0.0938275
Degree of Consolidation [%]	0	99.9994
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.50083
Void Ratio	-0.00836961	0.76001
Permeability [ft/y]	0	84.5111
Coefficient of Consolidation [ft^2/y]	0	59
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Embankments

1. Embankment: "Embankment Load 1"

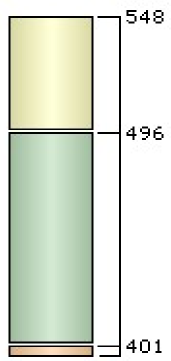
Label	Embankment Load 1
Center Line	(800, -58.5) to (0, -58.5)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	7

Layer	Stage	Unit Weight (kips/ft3)
1	Stage2:12ft	0.16
2	Stage 4:24ft	0.16
3	Stage 6:30ft	0.16
4	Stage 14:Fill=20ft	0.12
5	Stage 14:Fill=20ft	0.12
6	Stage 12:Fill=16ft	0.12
7	Stage 10:Fill=8ft	0.12

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Elevation [ft]	Drained at Bottom
1	Soft cohesive soil	52	548	No
2	Stiff cohesive soil	95	496	Yes
3	Cohesionless soil	4	401	No



Soil Properties

Property	Soft cohesive soil	Stiff cohesive soil	Cohesionless soil
Color			
Unit Weight [kips/ft3]	0.11	0.11	0.115
Saturated Unit Weight [kips/ft3]	0.11	0.11	0.125
K0	1	1	1
Immediate Settlement	Enabled	Enabled	Enabled
Es [ksf]	500	800	1305
Esur [ksf]	500	800	1096
Primary Consolidation	Enabled	Enabled	Disabled
Material Type	Non-Linear	Non-Linear	
Cc	0.23	0.23	-
Cr	0.04	0.04	-
e0	0.76	0.66	-
OCR	1.5	1.5	-
Cv [ft2/y]	59	59	-
Cvr [ft2/y]	59	59	-
B-bar	1	1	-
Secondary Consolidation	Standard	Standard	Disabled
Ca	0.005	0.005	-
Car	0.005	0.005	-
Undrained Su A [kips/ft2]	0	0.8	0
Undrained Su S	0.25	0.25	0
Undrained Su m	0.85	0.85	0.8
Piezo Line ID	1	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft3

Piezometric Line Entities

ID	Elevation (ft)
1	573.4 ft

A.2 Section BW-STA. 06+00.00 (H = 28 ft)

rocscience

BW STA 06+00

Report Creation Date: 2026/01/22, 05:36:55

Table of Contents

Settle3 Analysis Information

BW STA 06+00

Project Settings

Document Name	BW STA 06+00.00
Date Created	9/8/2025, 4:26:54 PM
Last saved with Settle3 version	5.018
Stress Computation Method	Boussinesq
Stress Units	Imperial, stress as ksf
Settlement Units	inches
Time-dependent Consolidation Analysis	
Time Units	years
Permeability Units	feet/year

Advanced Settings

Start of secondary consolidation (% of primary)	95
Min. stress for secondary consolidation (% of initial)	1
Reset time when load changes for secondary consolidation	No
Minimum settlement ratio for subgrade modulus	0.9
Use average poisson's ratio to calculate layered stresses	
Update Cv in each time step (improves consolidation accuracy)	
Ignore negative effective stresses in settlement calculations	
Add field points to load edges	

Soil Profile

Layer Option	Horizontal Soil Layers
Vertical Axis	Elevation
Ground Elevation (ft)	550

Stage Settings

Stage #	Name	Time [years]
1	Initial conditions	0
2	Start Existing break water construction	0
3	Start PH1 fill (h=8ft)	1
4	End PH1 fill (h=16 ft)	65
5	Start PH1 fill (h=20 ft)	65
6	End PH1 fill (h=20 ft)	115
7	Start PH1_200ft long breakwater (h=8 ft)	115
8	End PH1_200ft long breakwater (h=8 ft)	115.041
9	Start PH_200 ft long breakwater (h=16 ft)	115.041
10	End PH_200 ft long breakwater (h=16 ft)	115.082
11	Start PH1_200 ft Remaining	115.082
12	End PH1_200 ft long Remaining	115.123
13	time = 1 year	116
14	time = 1.16 years New dredge	116.16
15	time = 2.67 years	117.67
16	time = 5 years	120
17	time = 10 years	125
18	time = 20 years	135

Results

Time taken to compute: 0 seconds

Stage: Initial conditions = 0 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	0
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	0
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	0	0
Loading Stress XX [ksf]	0	0
Loading Stress YY [ksf]	0	0
Effective Stress ZZ [ksf]	0	7.2476
Effective Stress XX [ksf]	0	7.2476
Effective Stress YY [ksf]	0	7.2476
Total Stress ZZ [ksf]	1.46016	18.1302
Total Stress XX [ksf]	1.46016	18.1302
Total Stress YY [ksf]	1.46016	18.1302
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	0
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.5
Void Ratio	0	0.76
Permeability [ft/y]	0	27.4023
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Start Existing break water construction = 0 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.04517
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	6.04517
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.00793397	3.83998
Loading Stress XX [ksf]	-0.629382	4.32808
Loading Stress YY [ksf]	-0.766552	6.31378
Effective Stress ZZ [ksf]	0	7.2476
Effective Stress XX [ksf]	-0.0676996	11.5572
Effective Stress YY [ksf]	-0.389415	12.6284
Total Stress ZZ [ksf]	1.45223	19.1144
Total Stress XX [ksf]	1.5489	23.424
Total Stress YY [ksf]	1.27427	24.4951
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-1.32198e-05	0.00767995
Pore Water Pressure [ksf]	1.45223	11.8668
Excess Pore Water Pressure [ksf]	-0.00793397	3.83998
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	1.5
Void Ratio	0	0.760023
Permeability [ft/y]	0	27.4023
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Start PH1 fill (h=8ft) = 1 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	34.9036
Total Consolidation Settlement [in]	0	28.5021
Virgin Consolidation Settlement [in]	0	26.7351
Recompression Consolidation Settlement [in]	0	1.81345
Immediate Settlement [in]	0	6.40146
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.00793397	3.83998
Loading Stress XX [ksf]	-0.695684	3.97423
Loading Stress YY [ksf]	-0.957417	5.83466
Effective Stress ZZ [ksf]	0	8.23186
Effective Stress XX [ksf]	0.0634249	12.1332
Effective Stress YY [ksf]	-0.398739	13.0129
Total Stress ZZ [ksf]	1.46016	19.4036
Total Stress XX [ksf]	1.61182	23.2692
Total Stress YY [ksf]	1.20024	24.1597
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00170805	0.405675
Pore Water Pressure [ksf]	1.46007	11.319
Excess Pore Water Pressure [ksf]	-8.56895e-05	2.60728
Degree of Consolidation [%]	0	87.8616
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	48.5616
Void Ratio	0	0.763006
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: End PH1 fill (h=16 ft) = 65 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	58.3364
Total Consolidation Settlement [in]	0	49.2996
Virgin Consolidation Settlement [in]	0	43.203
Recompression Consolidation Settlement [in]	0	6.11009
Immediate Settlement [in]	0	6.40146
Secondary Settlement [in]	0	2.86224
Loading Stress ZZ [ksf]	-0.00793397	3.83998
Loading Stress XX [ksf]	-0.695684	3.97423
Loading Stress YY [ksf]	-0.957417	5.83466
Effective Stress ZZ [ksf]	0	8.52101
Effective Stress XX [ksf]	0.0695624	12.3866
Effective Stress YY [ksf]	-0.385072	13.2772
Total Stress ZZ [ksf]	1.46016	19.4036
Total Stress XX [ksf]	1.61182	23.2692
Total Stress YY [ksf]	1.20024	24.1597
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.0016401	0.414231
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	-0.00444294	0.0101289
Degree of Consolidation [%]	0	99.9998
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	45.6491
Void Ratio	0	0.762887
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Start PH1 fill (h=20 ft) = 65 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	58.7062
Total Consolidation Settlement [in]	0	49.2996
Virgin Consolidation Settlement [in]	0	43.203
Recompression Consolidation Settlement [in]	0	6.11009
Immediate Settlement [in]	0	6.77126
Secondary Settlement [in]	0	2.86224
Loading Stress ZZ [ksf]	-0.00793397	3.83998
Loading Stress XX [ksf]	-0.905973	3.71426
Loading Stress YY [ksf]	-1.16854	5.48859
Effective Stress ZZ [ksf]	0	8.52101
Effective Stress XX [ksf]	0.112692	12.0596
Effective Stress YY [ksf]	-0.464413	12.8545
Total Stress ZZ [ksf]	1.46016	19.7219
Total Stress XX [ksf]	1.66327	23.1775
Total Stress YY [ksf]	1.1394	23.9725
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.0016401	0.414231
Pore Water Pressure [ksf]	1.46016	11.2512
Excess Pore Water Pressure [ksf]	-2.39349e-08	0.720439
Degree of Consolidation [%]	0	98.7914
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	45.6491
Void Ratio	0	0.762887
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: End PH1 fill (h=20 ft) = 115 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	61.2247
Total Consolidation Settlement [in]	0	50.6748
Virgin Consolidation Settlement [in]	0	44.3191
Recompression Consolidation Settlement [in]	0	6.43525
Immediate Settlement [in]	0	6.77126
Secondary Settlement [in]	0	4.1023
Loading Stress ZZ [ksf]	-0.00793397	3.83998
Loading Stress XX [ksf]	-0.905973	3.71426
Loading Stress YY [ksf]	-1.16854	5.48859
Effective Stress ZZ [ksf]	0	8.83938
Effective Stress XX [ksf]	0.112701	12.295
Effective Stress YY [ksf]	-0.464353	13.0899
Total Stress ZZ [ksf]	1.46016	19.7219
Total Stress XX [ksf]	1.66327	23.1775
Total Stress YY [ksf]	1.1394	23.9725
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00163948	0.4154
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	0.0104456
Degree of Consolidation [%]	0	99.9999
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	45.6233
Void Ratio	0	0.762885
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Start PH1_200ft long breakwater (h=8 ft) = 115 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	61.3689
Total Consolidation Settlement [in]	0	50.6748
Virgin Consolidation Settlement [in]	0	44.3191
Recompression Consolidation Settlement [in]	0	6.43525
Immediate Settlement [in]	0	6.91548
Secondary Settlement [in]	0	4.1023
Loading Stress ZZ [ksf]	-2.95649e-07	3.83998
Loading Stress XX [ksf]	-0.880901	3.66653
Loading Stress YY [ksf]	-0.994163	5.3932
Effective Stress ZZ [ksf]	0	8.83938
Effective Stress XX [ksf]	0.0882045	12.2603
Effective Stress YY [ksf]	-0.476911	13.1367
Total Stress ZZ [ksf]	1.46016	19.7716
Total Stress XX [ksf]	1.68739	23.2218
Total Stress YY [ksf]	1.17245	24.0982
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	2.52506e-06	0.4154
Pore Water Pressure [ksf]	1.45999	10.9893
Excess Pore Water Pressure [ksf]	-0.000171833	1.28805
Degree of Consolidation [%]	0	99.4621
Pre-consolidation Stress [ksf]	0.0037128	10.489
Over-consolidation Ratio	1	45.6233
Void Ratio	0	0.759996
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: End PH1_200ft long breakwater (h=8 ft) = 115.041 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	61.3741
Total Consolidation Settlement [in]	0	50.6795
Virgin Consolidation Settlement [in]	0	44.3208
Recompression Consolidation Settlement [in]	0	6.43754
Immediate Settlement [in]	0	6.91548
Secondary Settlement [in]	0	4.10231
Loading Stress ZZ [ksf]	-2.95649e-07	3.83998
Loading Stress XX [ksf]	-0.880901	3.66653
Loading Stress YY [ksf]	-0.994163	5.3932
Effective Stress ZZ [ksf]	0	8.88903
Effective Stress XX [ksf]	0.116281	12.3393
Effective Stress YY [ksf]	-0.448835	13.2157
Total Stress ZZ [ksf]	1.46016	19.7716
Total Stress XX [ksf]	1.68739	23.2218
Total Stress YY [ksf]	1.17245	24.0982
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.000726401	0.415401
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	1.00266
Degree of Consolidation [%]	0	99.968
Pre-consolidation Stress [ksf]	0.00379464	10.489
Over-consolidation Ratio	1	1.38225
Void Ratio	0	0.756273
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Start PH_200 ft long breakwater (h=16 ft) = 115.041 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	61.5905
Total Consolidation Settlement [in]	0	50.6795
Virgin Consolidation Settlement [in]	0	44.3208
Recompression Consolidation Settlement [in]	0	6.43754
Immediate Settlement [in]	0	7.13192
Secondary Settlement [in]	0	4.10231
Loading Stress ZZ [ksf]	2.84018e-09	3.83998
Loading Stress XX [ksf]	-0.912924	3.62571
Loading Stress YY [ksf]	-1.08093	5.33825
Effective Stress ZZ [ksf]	0	8.88903
Effective Stress XX [ksf]	0.0705946	12.3062
Effective Stress YY [ksf]	-0.546973	13.2781
Total Stress ZZ [ksf]	1.46016	19.8367
Total Stress XX [ksf]	1.69385	23.2788
Total Stress YY [ksf]	1.14148	24.2507
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.000800658	0.415401
Pore Water Pressure [ksf]	1.45608	10.9893
Excess Pore Water Pressure [ksf]	-0.00407777	1.46784
Degree of Consolidation [%]	0	98.9078
Pre-consolidation Stress [ksf]	0.00379464	10.489
Over-consolidation Ratio	1	1.38225
Void Ratio	0	0.756261
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: End PH_200 ft long breakwater (h=16 ft) = 115.082 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	61.6003
Total Consolidation Settlement [in]	0	50.6891
Virgin Consolidation Settlement [in]	0	44.3258
Recompression Consolidation Settlement [in]	0	6.44119
Immediate Settlement [in]	0	7.13192
Secondary Settlement [in]	0	4.10231
Loading Stress ZZ [ksf]	2.84018e-09	3.83998
Loading Stress XX [ksf]	-0.912924	3.62571
Loading Stress YY [ksf]	-1.08093	5.33825
Effective Stress ZZ [ksf]	2.98489e-07	8.95417
Effective Stress XX [ksf]	0.0907019	12.3962
Effective Stress YY [ksf]	-0.526866	13.3681
Total Stress ZZ [ksf]	1.46016	19.8367
Total Stress XX [ksf]	1.69385	23.2788
Total Stress YY [ksf]	1.14148	24.2507
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.000800658	0.415402
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	1.3526
Degree of Consolidation [%]	0	99.9413
Pre-consolidation Stress [ksf]	0.00379613	10.489
Over-consolidation Ratio	1	1.3509
Void Ratio	0	0.75518
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: Start PH1_200 ft Remaining = 115.082 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	63.0013
Total Consolidation Settlement [in]	0	50.6891
Virgin Consolidation Settlement [in]	0	44.3258
Recompression Consolidation Settlement [in]	0	6.44119
Immediate Settlement [in]	0	8.56148
Secondary Settlement [in]	0	4.10231
Loading Stress ZZ [ksf]	2.14022e-10	4.48161
Loading Stress XX [ksf]	-0.999279	4.35887
Loading Stress YY [ksf]	-1.2713	6.56004
Effective Stress ZZ [ksf]	2.98489e-07	8.95417
Effective Stress XX [ksf]	0.0580556	13.0886
Effective Stress YY [ksf]	-0.6418	14.3617
Total Stress ZZ [ksf]	1.46016	20.069
Total Stress XX [ksf]	1.7189	24.2259
Total Stress YY [ksf]	1.09925	25.4951
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.000941295	0.416682
Pore Water Pressure [ksf]	1.45007	11.1398
Excess Pore Water Pressure [ksf]	-0.010087	1.60441
Degree of Consolidation [%]	0	94.0749
Pre-consolidation Stress [ksf]	0.00379613	10.489
Over-consolidation Ratio	1	1.3509
Void Ratio	0	0.755177
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: End PH1_200 ft long Remaining = 115.123 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	63.4394
Total Consolidation Settlement [in]	0	51.1271
Virgin Consolidation Settlement [in]	0	44.7527
Recompression Consolidation Settlement [in]	0	6.45148
Immediate Settlement [in]	0	8.56148
Secondary Settlement [in]	0	4.10232
Loading Stress ZZ [ksf]	2.14022e-10	4.48161
Loading Stress XX [ksf]	-0.999279	4.35887
Loading Stress YY [ksf]	-1.2713	6.56004
Effective Stress ZZ [ksf]	2.95863e-07	9.18647
Effective Stress XX [ksf]	0.0755799	13.3433
Effective Stress YY [ksf]	-0.624276	14.6126
Total Stress ZZ [ksf]	1.46016	20.069
Total Stress XX [ksf]	1.7189	24.2259
Total Stress YY [ksf]	1.09925	25.4951
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.000941295	0.425424
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	1.49846
Degree of Consolidation [%]	0	99.8387
Pre-consolidation Stress [ksf]	0.00379685	10.489
Over-consolidation Ratio	1	1.33183
Void Ratio	0	0.754493
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: time = 1 year = 116 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	65.0909
Total Consolidation Settlement [in]	0	52.7777
Virgin Consolidation Settlement [in]	0	46.3646
Recompression Consolidation Settlement [in]	0	6.49796
Immediate Settlement [in]	0	8.56148
Secondary Settlement [in]	0	4.10272
Loading Stress ZZ [ksf]	2.14022e-10	4.48161
Loading Stress XX [ksf]	-0.999279	4.35887
Loading Stress YY [ksf]	-1.2713	6.56004
Effective Stress ZZ [ksf]	2.95863e-07	9.18647
Effective Stress XX [ksf]	0.152649	13.3433
Effective Stress YY [ksf]	-0.543276	14.6126
Total Stress ZZ [ksf]	1.46016	20.069
Total Stress XX [ksf]	1.7189	24.2259
Total Stress YY [ksf]	1.09925	25.4951
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.000941295	0.425442
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	1.16463
Degree of Consolidation [%]	0	99.9613
Pre-consolidation Stress [ksf]	0.00379871	10.489
Over-consolidation Ratio	1	1.30834
Void Ratio	0	0.751998
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: time = 1.16 years New dredge = 116.16 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	65.6692
Total Consolidation Settlement [in]	0	52.942
Virgin Consolidation Settlement [in]	0	46.5256
Recompression Consolidation Settlement [in]	0	6.50312
Immediate Settlement [in]	0	8.94668
Secondary Settlement [in]	0	4.10281
Loading Stress ZZ [ksf]	2.02527e-10	4.48161
Loading Stress XX [ksf]	-1.23172	4.11325
Loading Stress YY [ksf]	-1.47652	6.17781
Effective Stress ZZ [ksf]	2.95863e-07	9.18647
Effective Stress XX [ksf]	0.190357	13.0164
Effective Stress YY [ksf]	-0.625765	14.2122
Total Stress ZZ [ksf]	1.46016	20.3954
Total Stress XX [ksf]	1.77017	24.1433
Total Stress YY [ksf]	1.03986	25.3597
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.00101428	0.425445
Pore Water Pressure [ksf]	1.45645	11.2641
Excess Pore Water Pressure [ksf]	-0.00370616	1.15527
Degree of Consolidation [%]	0	93.4766
Pre-consolidation Stress [ksf]	0.00379877	10.489
Over-consolidation Ratio	1	1.3065
Void Ratio	0	0.751798
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: time = 2.67 years = 117.67 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	66.9833
Total Consolidation Settlement [in]	0	54.254
Virgin Consolidation Settlement [in]	0	47.7466
Recompression Consolidation Settlement [in]	0	6.60606
Immediate Settlement [in]	0	8.94668
Secondary Settlement [in]	0	4.10429
Loading Stress ZZ [ksf]	2.02527e-10	4.48161
Loading Stress XX [ksf]	-1.23172	4.11325
Loading Stress YY [ksf]	-1.47652	6.17781
Effective Stress ZZ [ksf]	2.95851e-07	9.51286
Effective Stress XX [ksf]	0.192212	13.2607
Effective Stress YY [ksf]	-0.62391	14.4772
Total Stress ZZ [ksf]	1.46016	20.3954
Total Stress XX [ksf]	1.77017	24.1433
Total Stress YY [ksf]	1.03986	25.3597
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.00101428	0.425472
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	1.03849
Degree of Consolidation [%]	0	99.9446
Pre-consolidation Stress [ksf]	0.00379917	10.489
Over-consolidation Ratio	1	1.29294
Void Ratio	0	0.75075
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: time = 5 years = 120 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	68.3253
Total Consolidation Settlement [in]	0	55.5901
Virgin Consolidation Settlement [in]	0	49.0054
Recompression Consolidation Settlement [in]	0	6.67883
Immediate Settlement [in]	0	8.94668
Secondary Settlement [in]	0	4.10742
Loading Stress ZZ [ksf]	2.02527e-10	4.48161
Loading Stress XX [ksf]	-1.23172	4.11325
Loading Stress YY [ksf]	-1.47652	6.17781
Effective Stress ZZ [ksf]	2.95851e-07	9.51286
Effective Stress XX [ksf]	0.192931	13.2607
Effective Stress YY [ksf]	-0.623191	14.4772
Total Stress ZZ [ksf]	1.46016	20.3954
Total Stress XX [ksf]	1.77017	24.1433
Total Stress YY [ksf]	1.03986	25.3597
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.00101428	0.425512
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	0.918736
Degree of Consolidation [%]	0	99.9607
Pre-consolidation Stress [ksf]	0.00379931	10.489
Over-consolidation Ratio	1	1.27906
Void Ratio	0	0.750558
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: time = 10 years = 125 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	70.2172
Total Consolidation Settlement [in]	0	57.4676
Virgin Consolidation Settlement [in]	0	50.766
Recompression Consolidation Settlement [in]	0	6.78173
Immediate Settlement [in]	0	8.94668
Secondary Settlement [in]	0	4.11629
Loading Stress ZZ [ksf]	2.02527e-10	4.48161
Loading Stress XX [ksf]	-1.23172	4.11325
Loading Stress YY [ksf]	-1.47652	6.17781
Effective Stress ZZ [ksf]	2.95851e-07	9.51286
Effective Stress XX [ksf]	0.19338	13.2607
Effective Stress YY [ksf]	-0.622742	14.4772
Total Stress ZZ [ksf]	1.46016	20.3954
Total Stress XX [ksf]	1.77017	24.1433
Total Stress YY [ksf]	1.03986	25.3597
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.00101428	0.425597
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	0.662291
Degree of Consolidation [%]	0	99.9715
Pre-consolidation Stress [ksf]	0.0037994	10.489
Over-consolidation Ratio	1	1.26246
Void Ratio	0	0.750467
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Stage: time = 20 years = 135 y

Data Type	Minimum	Maximum
Total Settlement [in]	0	72.283
Total Consolidation Settlement [in]	0	59.493
Virgin Consolidation Settlement [in]	0	52.6542
Recompression Consolidation Settlement [in]	0	6.90248
Immediate Settlement [in]	0	8.94668
Secondary Settlement [in]	0	4.14303
Loading Stress ZZ [ksf]	2.02527e-10	4.48161
Loading Stress XX [ksf]	-1.23172	4.11325
Loading Stress YY [ksf]	-1.47652	6.17781
Effective Stress ZZ [ksf]	2.95851e-07	9.51286
Effective Stress XX [ksf]	0.193666	13.2607
Effective Stress YY [ksf]	-0.622456	14.4772
Total Stress ZZ [ksf]	1.46016	20.3954
Total Stress XX [ksf]	1.77017	24.1433
Total Stress YY [ksf]	1.03986	25.3597
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0.00101428	0.425757
Pore Water Pressure [ksf]	1.46016	10.8826
Excess Pore Water Pressure [ksf]	0	0.346009
Degree of Consolidation [%]	0	99.9854
Pre-consolidation Stress [ksf]	0.00379946	10.489
Over-consolidation Ratio	1	1.2609
Void Ratio	0	0.750297
Permeability [ft/y]	0	157.563
Coefficient of Consolidation [ft^2/y]	0	110
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	0
Undrained Shear Strength	0	2.4983

Embankments

1. Embankment: "Embankment Load 1"

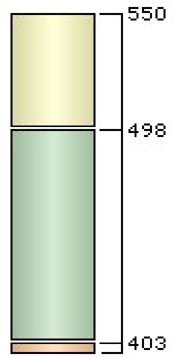
Label	Embankment Load 1
Center Line	(0, 0) to (800, 0)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	7

Layer	Stage	Unit Weight (kips/ft3)
1	Start PH1_200ft long breakwater (h=8 ft)	0.16
2	Start PH_200 ft long breakwater (h=16 ft)	0.16
3	Start Existing break water construction	0.16
4	Start PH1_200 ft Remaining	0.16
5	time = 1.16 years New dredge	0.12
6	Start PH1 fill (h=20 ft)	0.12
7	Start PH1 fill (h=8ft)	0.12

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Elevation [ft]	Drained at Bottom
1	Soft cohesive soil	52	550	No
2	Stiff cohesive soil	95	498	Yes
3	Cohesionless soil	4	403	No



Soil Properties

Property	Soft cohesive soil	Stiff cohesive soil	Cohesionless soil
Color			
Unit Weight [kips/ft3]	0.11	0.11	0.115
Saturated Unit Weight [kips/ft3]	0.11	0.11	0.125
K0	1	1	1
Immediate Settlement	Enabled	Enabled	Enabled
Es [ksf]	500	800	1305
Esur [ksf]	500	800	1096
Primary Consolidation	Enabled	Enabled	Disabled
Material Type	Non-Linear	Non-Linear	
Cc	0.23	0.23	-
Cr	0.04	0.04	-
e0	0.76	0.66	-
OCR	1.5	1.5	-
Cv [ft2/y]	110	110	-
Cvr [ft2/y]	110	110	-
B-bar	1	1	-
Secondary Consolidation	Standard	Standard	Disabled
Ca	0.005	0.005	-
Car	0.005	0.005	-
Undrained Su A [kips/ft2]	0	0.8	0
Undrained Su S	0.25	0.25	0
Undrained Su m	0.85	0.85	0.8
Piezo Line ID	1	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft3

Piezometric Line Entities

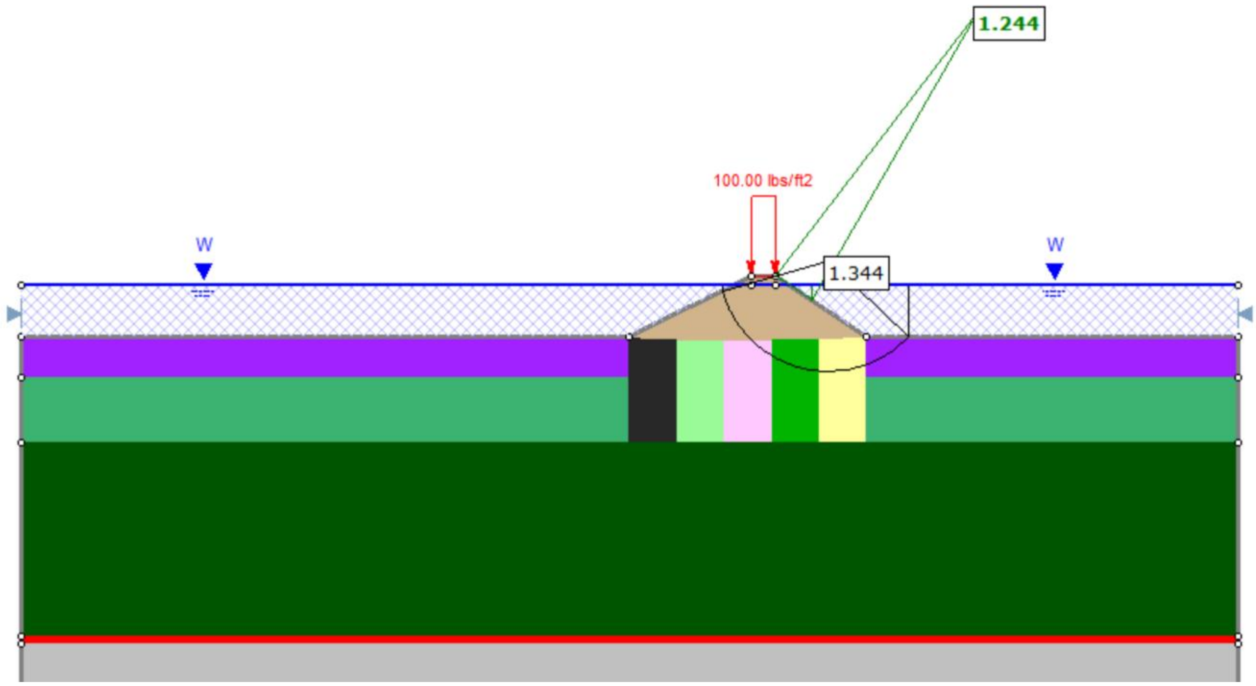
ID	Elevation (ft)
1	573.4 ft

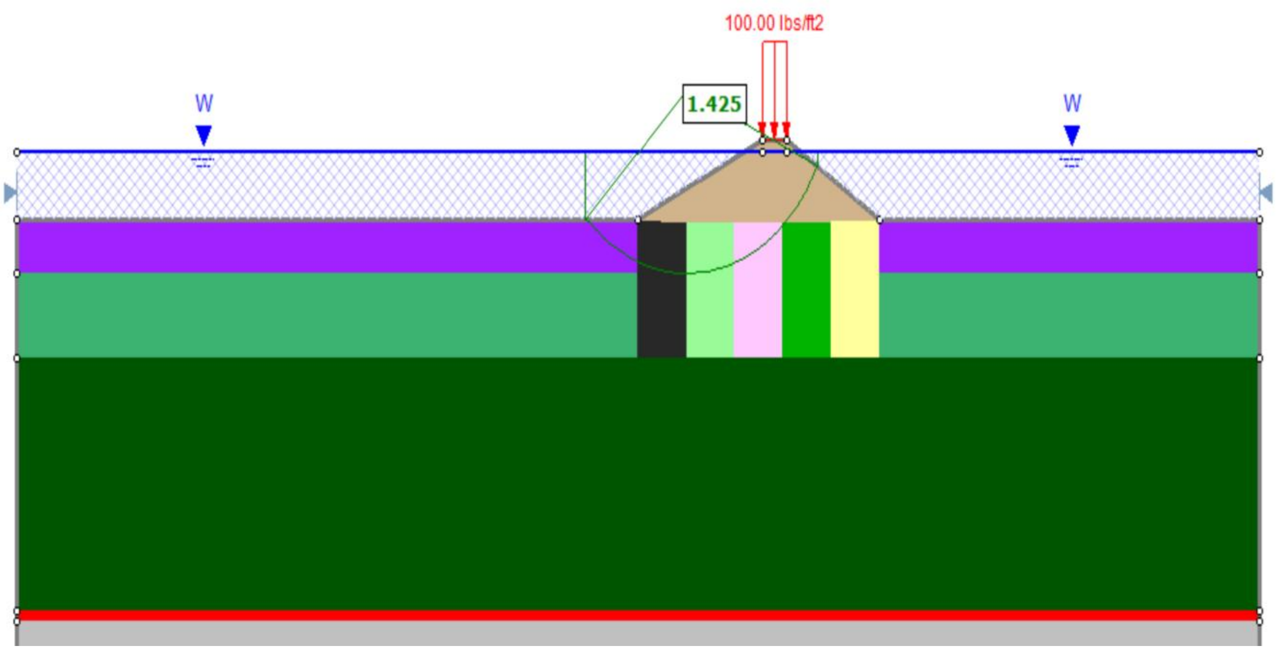
Appendix B

Global stability analyses results

B.1 Section BW-STA. 12+00.00 (H = 30 ft)

B.1.1 Short-term conditions





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CS BW 12+00.00_Short term_TSSP - 12 ft
Slide2 - An Interactive Slope Stability Program
Date Created: 9/11/2025, 12:11:23 PM
Software Version: 9.039

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Slide2 Analysis Information

CS BW 12+00.00_Short term_TSSP - 12 ft

Project Summary

File Name:	CS BW 12+00.00_Short term_TSSP - 12 ft.slmd
Last saved with Slide2 version:	9.039
Project Title:	Slide2 - An Interactive Slope Stability Program
Date Created:	9/11/2025, 12:11:23 PM

Currently Open Scenarios

Group Name	Scenario Name	Compute Time
Right to left	Master Scenario	
Left to right	Master Scenario	

General Settings

Units of Measurement:	Imperial Units	
Time Units:	days	
Permeability Units:	feet/second	
Data Output:	Standard	
	Master Scenario	**Master Scenario**
Failure Direction:	Right to Left	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
	Corps of Engineers #1
	Corps of Engineers #2
	GLE/Morgenstern-Price with interslice force function (Half Sine)
	Janbu simplified
	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
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:	Slope Search
Number of Surfaces:	5000
Upper Angle [deg]:	Not Defined
Lower Angle [deg]:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
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]:	100
Orientation:	Normal to boundary

Materials

Breakwater stones	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	160 lbs/ft3
Cohesion	0 psf
Phi	40 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Soft Clay	
Color	
Strength Type	SHANSEP
Unit Weight	110 lbs/ft3
A	250 psf
S	0.25
m	0.85
Stress History Type	Overconsolidation Ratio
Use Material dependent vertical stress	No
Definition Method	Constant [1.5]
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Stiff Clay	
Color	
Strength Type	SHANSEP
Unit Weight	110 lbs/ft3
A	250 psf
S	0.25
m	0.85
Stress History Type	Overconsolidation Ratio
Use Material dependent vertical stress	No
Definition Method	Constant [1.5]
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Cohesionless soil	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	125 lbs/ft3
Cohesion	0 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Shale bedrock	
Color	
Strength Type	Infinite Strength
Unit Weight	150 lbs/ft3
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	0
Specify alternate strength type above water surface	No

Soft clay Su = 600 psf	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	600 psf
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

SC 1	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	722.6 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

SC 2	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	726.63 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

SC 3	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	738.69 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

SC 4	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	737.57 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

SC 5	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	722.6 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Materials In Use

Material	Right to left	Left to right
Breakwater stones	✓	✓
Soft Clay	✓	✓
Stiff Clay	✓	✓
Cohesionless soil	✓	✓
Shale bedrock	✓	✓
Soft clay Su = 600 psf	✓	✓
SC 1	✓	✓
SC 2	✓	✓
SC 3	✓	✓
SC 4	✓	✓
SC 5	✓	✓

Entity Information

Right to left

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 397 300, 401 300, 496 300, 528 300, 548 117, 548 72, 578 60, 578 0, 548 -300, 548 -300, 528 -300, 496 -300, 401 -300, 397 -300, 200 300, 200
Material Boundary	-300, 397 300, 397
Material Boundary	-300, 401 300, 401
Material Boundary	-300, 496 0, 496 23.6, 496 46.8, 496 70.2, 496 93.6, 496 117, 496 300, 496
Material Boundary	0, 548 117, 548
Material Boundary	0, 548 11.7, 546.92 23.6, 546.676 35.1, 546.44 46.8, 546.41 58.5, 546.38 70.2, 546.51 81.9, 546.64 93.6, 546.97 105.3, 547.3 117, 548
Material Boundary	0, 528 0, 548
Material Boundary	0, 496 0, 528
Material Boundary	117, 528 117, 548

Material Boundary	117, 496 117, 528
Material Boundary	-300, 528 0, 528
Material Boundary	117, 528 300, 528
Material Boundary	23.6, 496 23.6, 546.676
Material Boundary	46.8, 496 46.8, 546.41
Material Boundary	70.2, 496 70.2, 546.51
Material Boundary	93.6, 496 93.6, 546.97

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Soft clay Su = 600 psf ... and 5 more
Distributed Load	72, 578 60, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

Left to right

Shared Entities

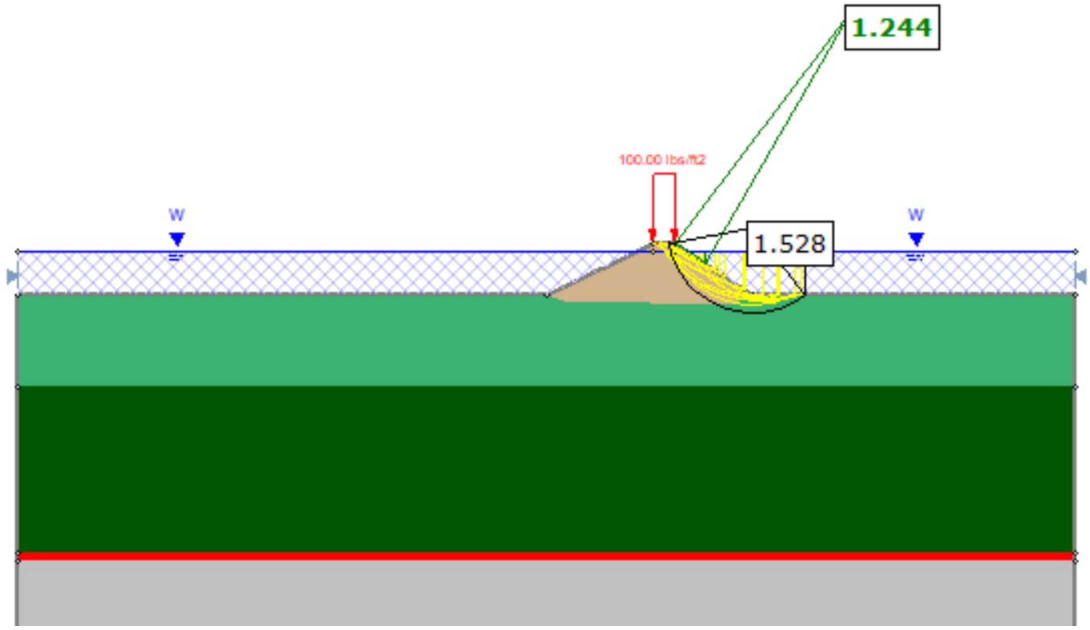
Type	Coordinates (x,y)
External Boundary	300, 397 300, 401 300, 496 300, 528 300, 548 117, 548 72, 578 60, 578 0, 548 -300, 548 -300, 528 -300, 496 -300, 401 -300, 397 -300, 200 300, 200

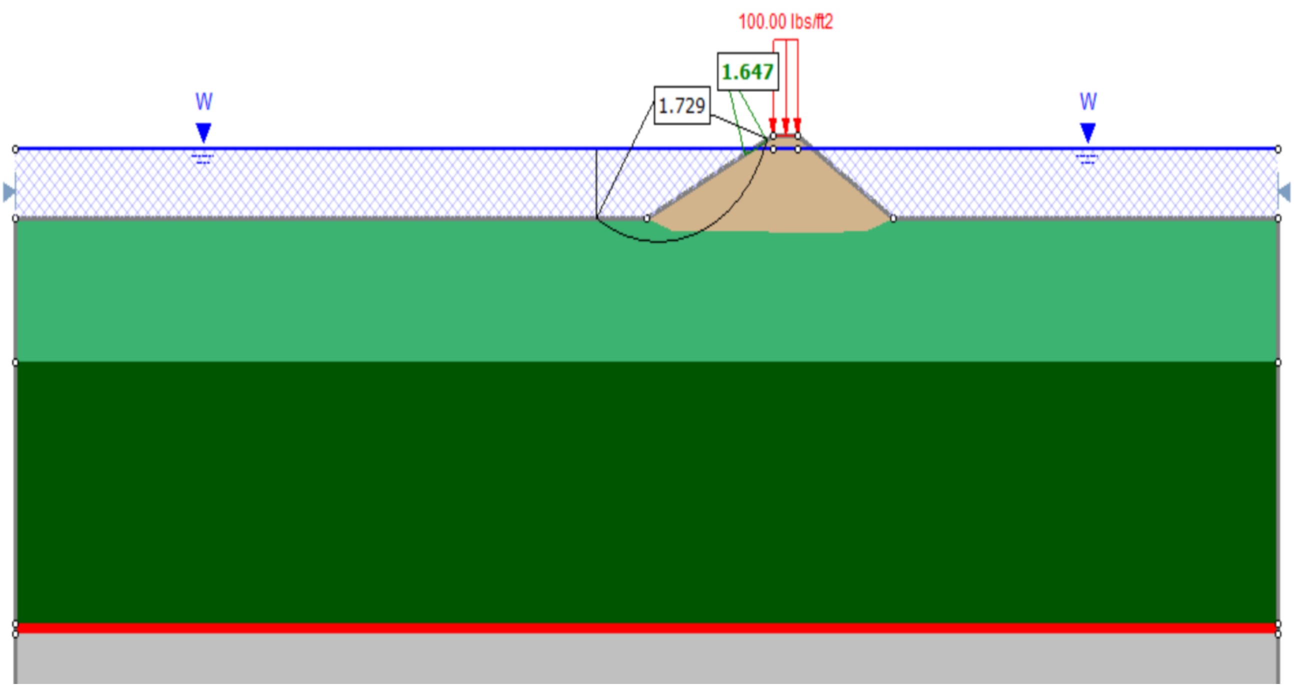
Material Boundary	-300, 397 300, 397
Material Boundary	-300, 401 300, 401
Material Boundary	-300, 496 0, 496 23.6, 496 46.8, 496 70.2, 496 93.6, 496 117, 496 300, 496
Material Boundary	0, 548 117, 548
Material Boundary	0, 548 11.7, 546.92 23.6, 546.676 35.1, 546.44 46.8, 546.41 58.5, 546.38 70.2, 546.51 81.9, 546.64 93.6, 546.97 105.3, 547.3 117, 548
Material Boundary	0, 528 0, 548
Material Boundary	0, 496 0, 528
Material Boundary	117, 528 117, 548
Material Boundary	117, 496 117, 528
Material Boundary	-300, 528 0, 528
Material Boundary	117, 528 300, 528
Material Boundary	23.6, 496 23.6, 546.676
Material Boundary	46.8, 496 46.8, 546.41
Material Boundary	70.2, 496 70.2, 546.51
Material Boundary	93.6, 496 93.6, 546.97

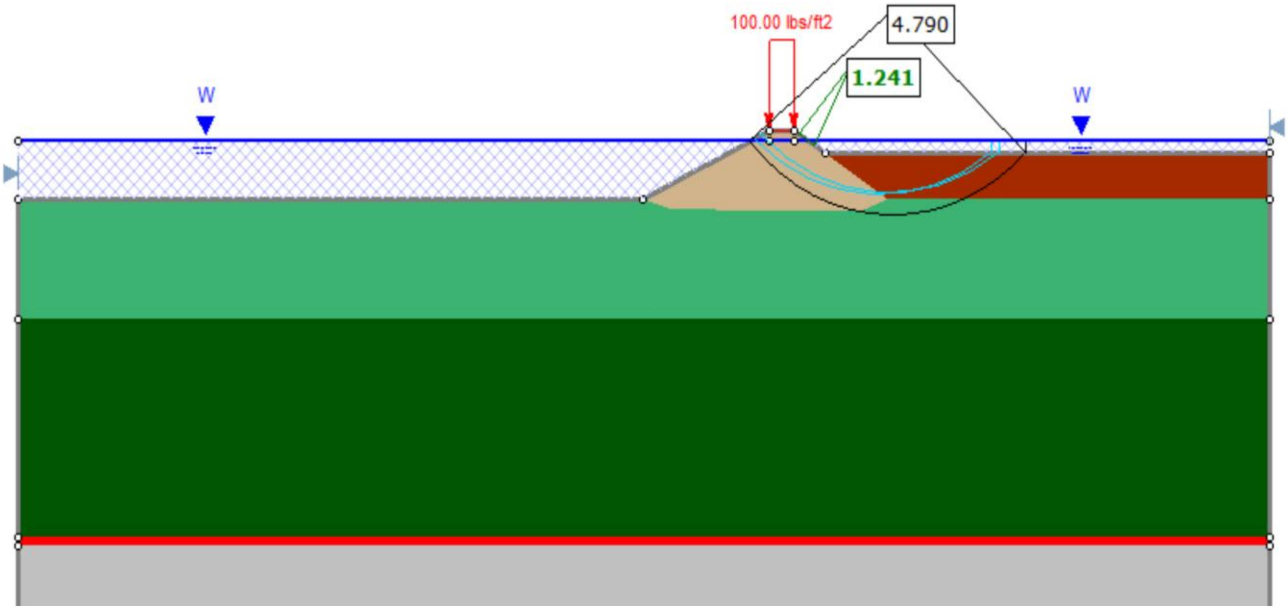
Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Soft clay Su = 600 psf ... and 5 more
Distributed Load	72, 578 60, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

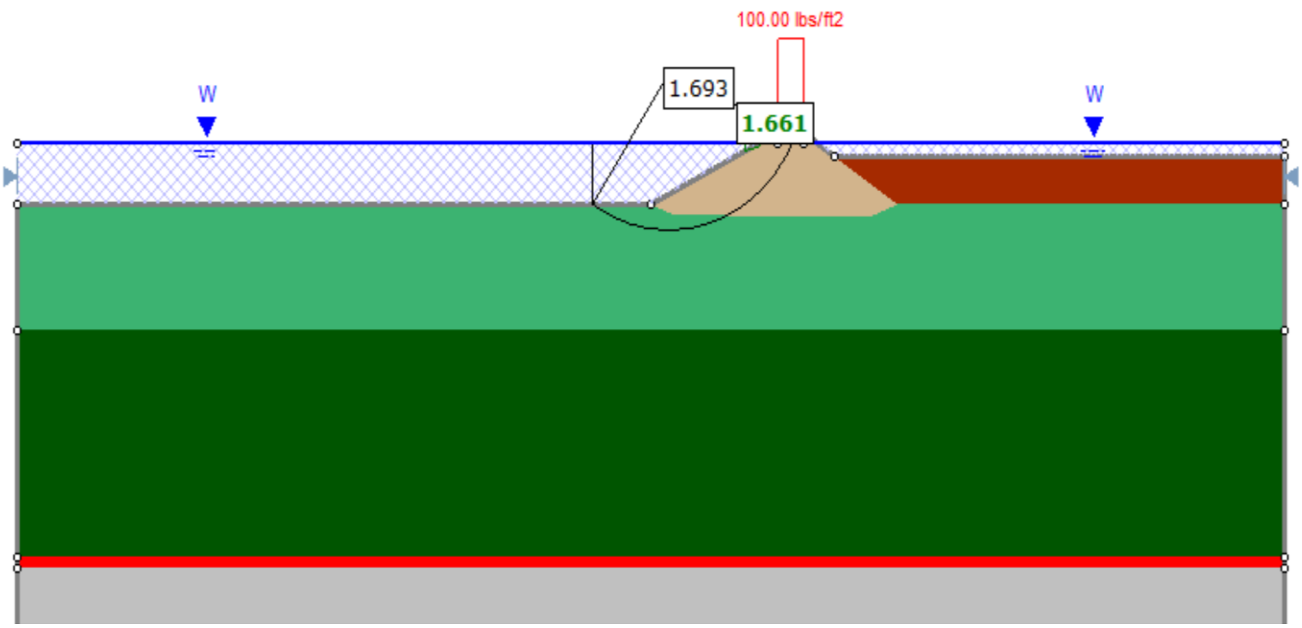
B.1.2 Long-term conditions







100.00 lbs/ft2
4.790
1.241
W
W



100.00 lbs/ft2
1.693
1.661
W
W

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CS BW 12+00.00_No dredge
Slide2 - An Interactive Slope Stability Program
Date Created: 9/11/2025, 12:11:23 PM
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Slide2 Analysis Information

CS BW 12+00.00_No dredge

Project Summary

File Name:	CS BW 12+00.00_No dredge.slmd
Last saved with Slide2 version:	9.039
Project Title:	Slide2 - An Interactive Slope Stability Program
Date Created:	9/11/2025, 12:11:23 PM

Currently Open Scenarios

Group Name	Scenario Name	Compute Time
Left to right	Master Scenario	
Right to left	Master Scenario	

General Settings

Units of Measurement:	Imperial Units	
Time Units:	days	
Permeability Units:	feet/second	
Data Output:	Standard	
	Master Scenario	**Master Scenario**
Failure Direction:	Left to Right	Right to Left

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
	Corps of Engineers #1
	Corps of Engineers #2
	GLE/Morgenstern-Price with interslice force function (Half Sine)
	Janbu simplified
	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
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:	Slope Search
Number of Surfaces:	5000
Upper Angle [deg]:	Not Defined
Lower Angle [deg]:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
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]:	100
Orientation:	Normal to boundary

Materials

Breakwater stones	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	160 lbs/ft3
Cohesion	0 psf
Phi	40 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Soft Clay	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	110 lbs/ft3
Cohesion	0 psf
Phi	28 °
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Stiff Clay	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	110 lbs/ft3
Cohesion	0 psf
Phi	28 °
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Cohesionless soil	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	125 lbs/ft3
Cohesion	0 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Shale bedrock	
Color	
Strength Type	Infinite Strength
Unit Weight	150 lbs/ft3
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	0
Specify alternate strength type above water surface	No

Materials In Use

Material	Left to right	Right to left
Breakwater stones	✓	✓
Soft Clay	✓	✓
Stiff Clay	✓	✓
Cohesionless soil	✓	✓
Shale bedrock	✓	✓

Entity Information

Left to right

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 397 300, 401 300, 496 300, 548 117, 548 72, 578 60, 578 0, 548 -300, 548 -300, 496 -300, 401 -300, 397 -300, 200 300, 200
Material Boundary	-300, 397 300, 397
Material Boundary	-300, 401 300, 401
Material Boundary	-300, 496 300, 496
Material Boundary	0, 548 11.7, 544 35.1, 543.5 58.5, 543 81.9, 542.8 105.3, 543.6 117, 548

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock
Distributed Load	72, 578 60, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

Right to left

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 397 300, 401 300, 496 300, 548 117, 548 72, 578 60, 578 0, 548 -300, 548 -300, 496 -300, 401 -300, 397 -300, 200 300, 200
Material Boundary	-300, 397 300, 397
Material Boundary	-300, 401 300, 401
Material Boundary	-300, 496 300, 496
Material Boundary	0, 548 11.7, 544 35.1, 543.5 58.5, 543 81.9, 542.8 105.3, 543.6 117, 548

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock
Distributed Load	72, 578 60, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

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CS BW 12+00.00_Dredge
Slide2 - An Interactive Slope Stability Program
Date Created: 9/11/2025, 12:11:23 PM
Software Version: 9.039

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Slide2 Analysis Information

CS BW 12+00.00_Dredge

Project Summary

File Name:	CS BW 12+00.00_Dredge.slmd
Last saved with Slide2 version:	9.039
Project Title:	Slide2 - An Interactive Slope Stability Program
Date Created:	9/11/2025, 12:11:23 PM

Currently Open Scenarios

Group Name	Scenario Name	Compute Time
Right to left	Master Scenario	
Left to right	Master Scenario	

General Settings

Units of Measurement:	Imperial Units	
Time Units:	days	
Permeability Units:	feet/second	
Data Output:	Standard	
	Master Scenario	**Master Scenario**
Failure Direction:	Right to Left	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
	Corps of Engineers #1
	Corps of Engineers #2
	GLE/Morgenstern-Price with interslice force function (Half Sine)
	Janbu simplified
	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
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:	Slope Search
Number of Surfaces:	5000
Upper Angle [deg]:	Not Defined
Lower Angle [deg]:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
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]:	100
Orientation:	Normal to boundary

Materials

Breakwater stones	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	160 lbs/ft3
Cohesion	0 psf
Phi	40 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Soft Clay	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	110 lbs/ft3
Cohesion	0 psf
Phi	28 °
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Stiff Clay	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	110 lbs/ft3
Cohesion	0 psf
Phi	28 °
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Cohesionless soil	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	125 lbs/ft3
Cohesion	0 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Shale bedrock	
Color	
Strength Type	Infinite Strength
Unit Weight	150 lbs/ft3
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	0
Specify alternate strength type above water surface	No

Dredge	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	120 lbs/ft3
Cohesion	10 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Materials In Use

Material		Right to left	Left to right
Breakwater stones		✓	✓
Soft Clay		✓	✓
Stiff Clay		✓	✓
Cohesionless soil		✓	✓
Shale bedrock		✓	✓
Dredge		✓	✓

Entity Information

Right to left

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 397 300, 401 300, 496 300, 548 300, 568 87, 568 72, 578 60, 578 0, 548 -300, 548 -300, 496 -300, 401 -300, 397 -300, 200 300, 200
Material Boundary	-300, 397 300, 397
Material Boundary	-300, 401 300, 401
Material Boundary	-300, 496 300, 496
Material Boundary	0, 548 11.7, 544 35.1, 543.5 58.5, 543 81.9, 542.8 105.3, 543.6 117, 548
Material Boundary	87, 568 117, 548
Material Boundary	117, 548 300, 548

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Dredge
Distributed Load	72, 578 60, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

Left to right

Shared Entities

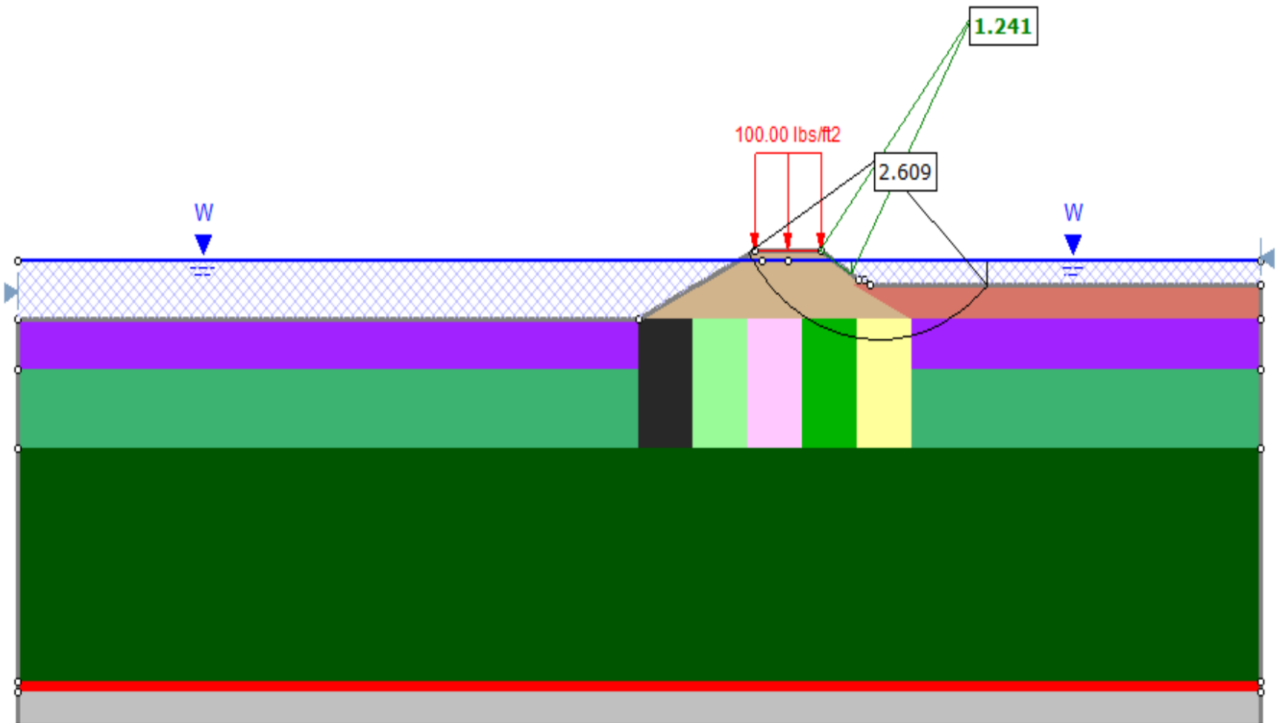
Type	Coordinates (x,y)
External Boundary	300, 397 300, 401 300, 496 300, 548 300, 568 87, 568 72, 578 60, 578 0, 548 -300, 548 -300, 496 -300, 401 -300, 397 -300, 200 300, 200
Material Boundary	-300, 397 300, 397
Material Boundary	-300, 401 300, 401
Material Boundary	-300, 496 300, 496
Material Boundary	0, 548 11.7, 544 35.1, 543.5 58.5, 543 81.9, 542.8 105.3, 543.6 117, 548
Material Boundary	87, 568 117, 548
Material Boundary	117, 548 300, 548

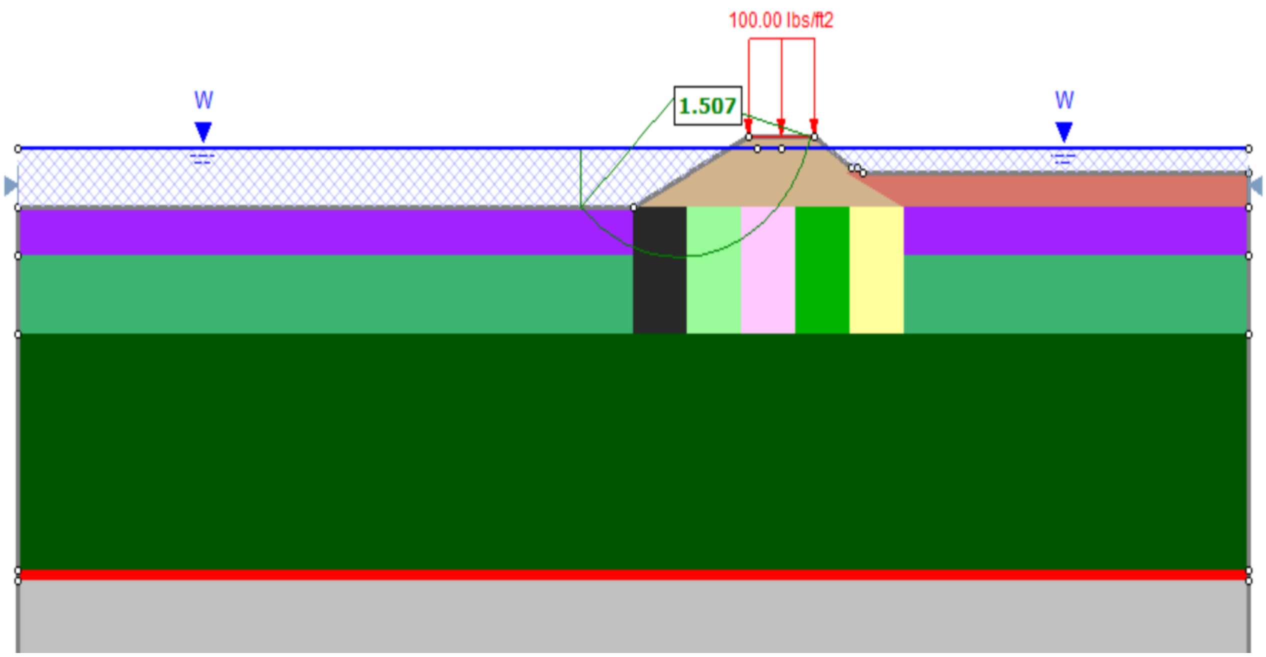
Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Dredge
Distributed Load	72, 578 60, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

B.2 Section BW-STA. 06+00.00 (H = 28 ft)

B.2.1 Short-term conditions





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CS BW 06+00.00_Short term
Slide2 - An Interactive Slope Stability Program
Date Created: 9/11/2025, 12:11:23 PM
Software Version: 9.039

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Slide2 Analysis Information

CS BW 06+00.00_Short term

Project Summary

File Name:	CS BW 06+00.00_Short term.slmd
Last saved with Slide2 version:	9.039
Project Title:	Slide2 - An Interactive Slope Stability Program
Date Created:	9/11/2025, 12:11:23 PM

Currently Open Scenarios

Group Name	Scenario Name	Compute Time
Right to left	Master Scenario	
Left to right	Master Scenario	

General Settings

Units of Measurement:	Imperial Units	
Time Units:	days	
Permeability Units:	feet/second	
Data Output:	Standard	
	Master Scenario	**Master Scenario**
Failure Direction:	Right to Left	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
	Corps of Engineers #1
	Corps of Engineers #2
	GLE/Morgenstern-Price with interslice force function (Half Sine)
	Janbu simplified
	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
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:	Slope Search
Number of Surfaces:	5000
Upper Angle [deg]:	Not Defined
Lower Angle [deg]:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
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]:	100
Orientation:	Normal to boundary

Materials

Breakwater stones	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	160 lbs/ft3
Cohesion	0 psf
Phi	40 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Soft Clay	
Color	
Strength Type	SHANSEP
Unit Weight	110 lbs/ft3
A	250 psf
S	0.25
m	0.85
Stress History Type	Overconsolidation Ratio
Use Material dependent vertical stress	No
Definition Method	Constant [1.5]
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Stiff Clay	
Color	
Strength Type	SHANSEP
Unit Weight	110 lbs/ft3
A	250 psf
S	0.25
m	0.85
Stress History Type	Overconsolidation Ratio
Use Material dependent vertical stress	No
Definition Method	Constant [1.5]
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Cohesionless soil	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	125 lbs/ft3
Cohesion	0 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Shale bedrock	
Color	
Strength Type	Infinite Strength
Unit Weight	150 lbs/ft3
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	0
Specify alternate strength type above water surface	No

Soft clay Su = 600 psf	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	600 psf
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

SC 1	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	720.42 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

SC 2	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	728.25 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

SC 3	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	1047.15 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

SC 4	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	1000.32 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

SC 5	
Color	
Strength Type	Undrained
Unit Weight	110 lbs/ft3
Cohesion Type	Constant
Cohesion	792.64 psf
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Dredge	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	120 lbs/ft3
Cohesion	10 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Materials In Use

Material		Right to left	Left to right
Breakwater stones		✓	✓
Soft Clay		✓	✓
Stiff Clay		✓	✓
Cohesionless soil		✓	✓
Shale bedrock		✓	✓
Soft clay Su = 600 psf		✓	✓
SC 1		✓	✓
SC 2		✓	✓
SC 3		✓	✓
SC 4		✓	✓
SC 5		✓	✓
Dredge		✓	✓

Entity Information

Right to left

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 399 300, 403 300, 498 300, 530 300, 550 300, 564 112, 564 109, 566 106, 566 88, 578 56, 578 0, 550 -300, 550 -300, 530 -300, 498 -300, 403 -300, 399 -300, 200 300, 200
Material Boundary	-300, 399 300, 399
Material Boundary	-300, 403 300, 403
Material Boundary	-300, 498 0, 498 26.4, 498 52.8, 498 79.2, 498 105.6, 498 132, 498 300, 498
Material Boundary	20, 550 26.4, 550 52.8, 550 79.2, 550 105.6, 550 132, 550
Material Boundary	104, 564 132, 550
Material Boundary	132, 550 300, 550
Material Boundary	20, 550 68, 574 84, 574 104, 564
Material Boundary	104, 564 112, 564

Material Boundary	0, 550 20, 550
Material Boundary	0, 498 0, 530 0, 550
Material Boundary	26.4, 498 26.4, 550
Material Boundary	52.8, 498 52.8, 550
Material Boundary	79.2, 498 79.2, 550
Material Boundary	105.6, 498 105.6, 550
Material Boundary	132, 498 132, 530 132, 550
Material Boundary	-300, 530 0, 530
Material Boundary	132, 530 300, 530

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Soft clay Su = 600 psf ... and 6 more
Distributed Load	88, 578 56, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

Left to right

Shared Entities

Type	Coordinates (x,y)

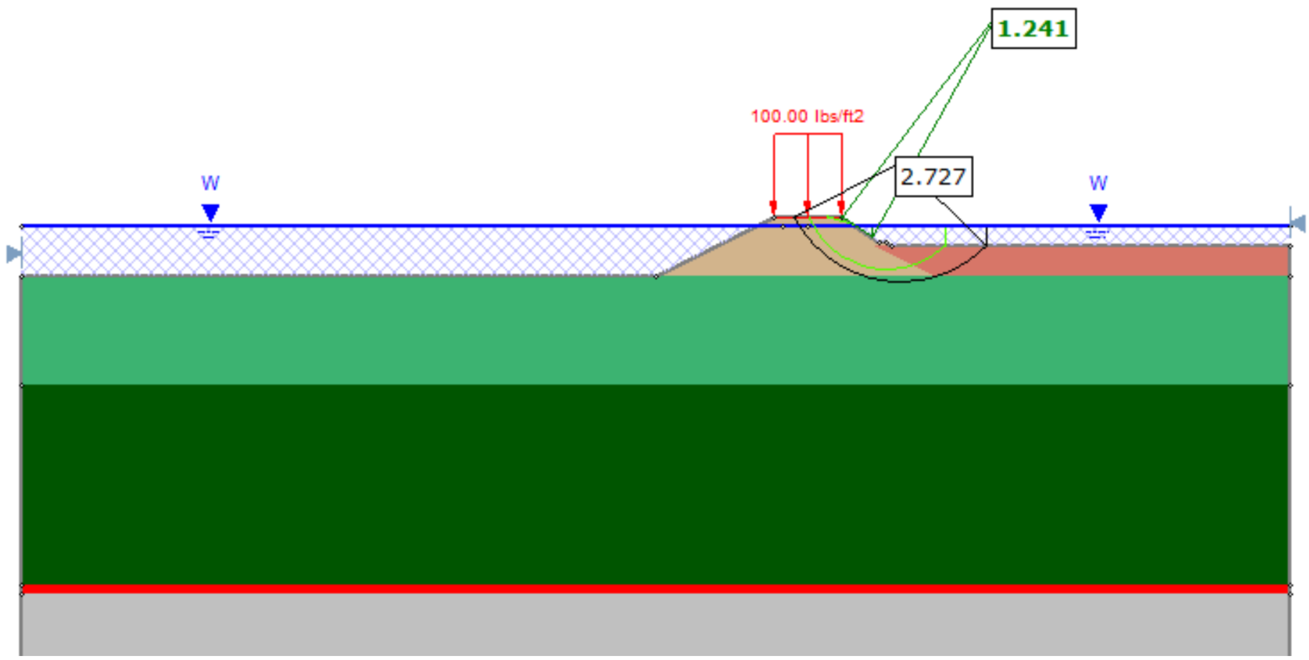
External Boundary	300, 399 300, 403 300, 498 300, 530 300, 550 300, 564 112, 564 109, 566 106, 566 88, 578 56, 578 0, 550 -300, 550 -300, 530 -300, 498 -300, 403 -300, 399 -300, 200 300, 200
Material Boundary	-300, 399 300, 399
Material Boundary	-300, 403 300, 403
Material Boundary	-300, 498 0, 498 26.4, 498 52.8, 498 79.2, 498 105.6, 498 132, 498 300, 498
Material Boundary	20, 550 26.4, 550 52.8, 550 79.2, 550 105.6, 550 132, 550
Material Boundary	104, 564 132, 550
Material Boundary	132, 550 300, 550
Material Boundary	20, 550 68, 574 84, 574 104, 564
Material Boundary	104, 564 112, 564
Material Boundary	0, 550 20, 550
Material Boundary	0, 498 0, 530 0, 550
Material Boundary	26.4, 498 26.4, 550
Material Boundary	52.8, 498 52.8, 550

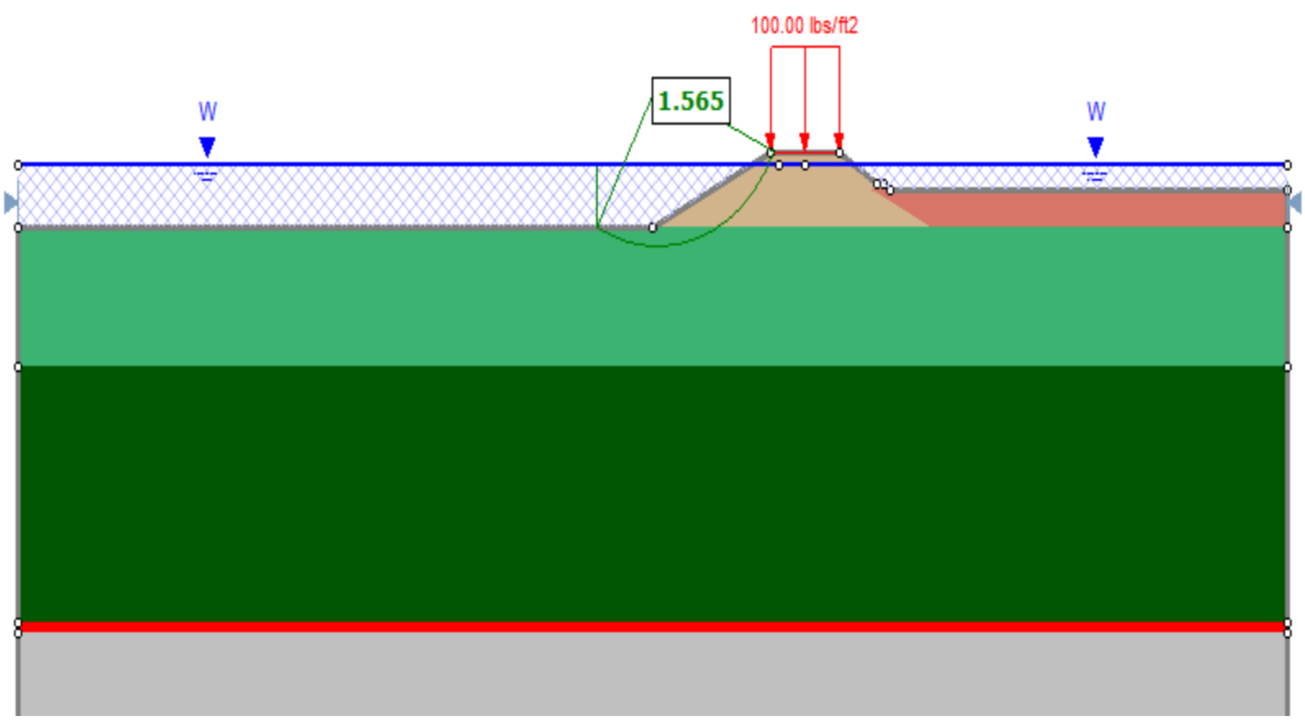
Material Boundary	79.2, 498 79.2, 550
Material Boundary	105.6, 498 105.6, 550
Material Boundary	132, 498 132, 530 132, 550
Material Boundary	-300, 530 0, 530
Material Boundary	132, 530 300, 530

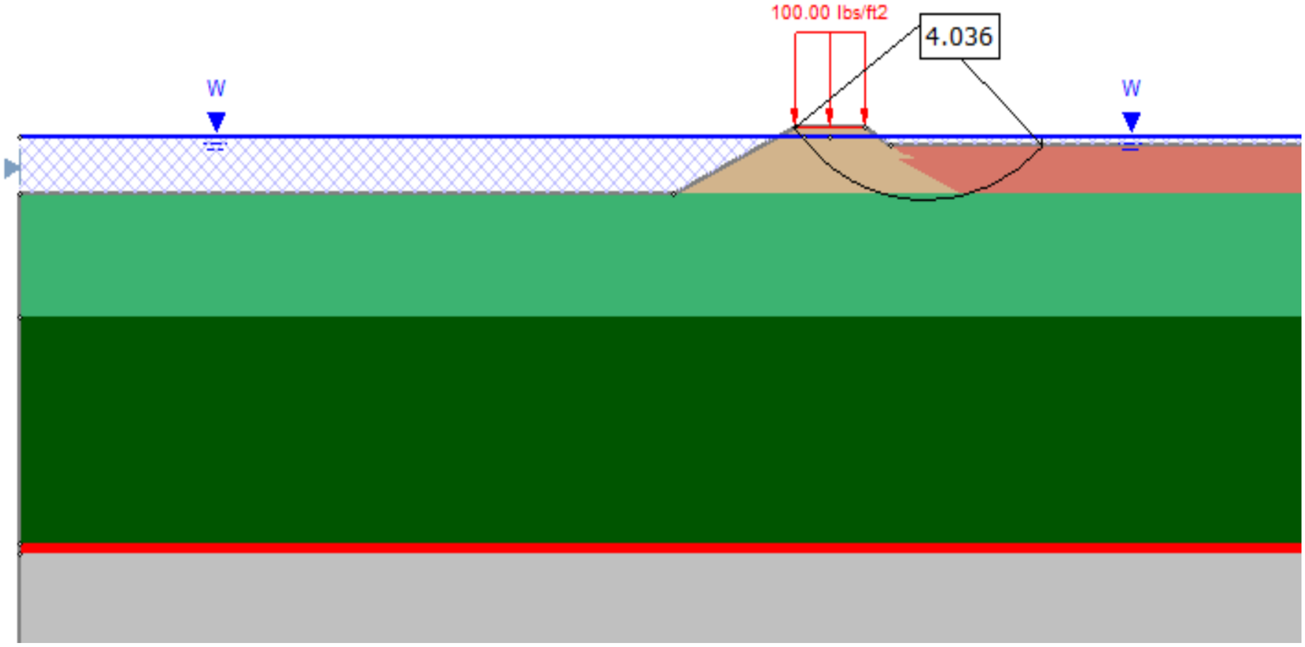
Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Soft clay Su = 600 psf ... and 6 more
Distributed Load	88, 578 56, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

B.2.2 Long-term conditions



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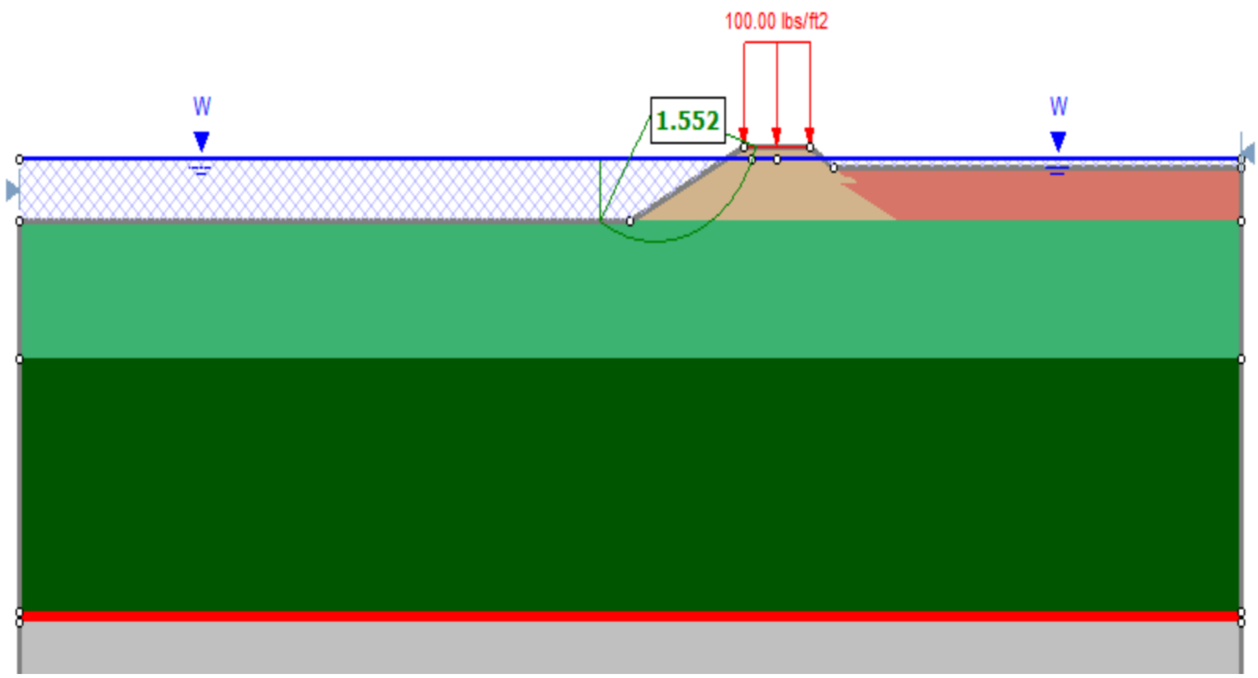
W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W

CS BW 06+00.00_No dredge
Slide2 - An Interactive Slope Stability Program
Date Created: 9/11/2025, 12:11:23 PM
Software Version: 9.039

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Slide2 Analysis Information

CS BW 06+00.00_No dredge

Project Summary

File Name:	CS BW 06+00.00_No dredge.slmd
Last saved with Slide2 version:	9.039
Project Title:	Slide2 - An Interactive Slope Stability Program
Date Created:	9/11/2025, 12:11:23 PM

Currently Open Scenarios

Group Name	Scenario Name	Compute Time
Right to left	Master Scenario	
Left to right	Master Scenario	

General Settings

Units of Measurement:	Imperial Units	
Time Units:	days	
Permeability Units:	feet/second	
Data Output:	Standard	
	Master Scenario	**Master Scenario**
Failure Direction:	Right to Left	Left to Right

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
	Corps of Engineers #1
	Corps of Engineers #2
	GLE/Morgenstern-Price with interslice force function (Half Sine)
	Janbu simplified
	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
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:	Slope Search
Number of Surfaces:	5000
Upper Angle [deg]:	Not Defined
Lower Angle [deg]:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
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]:	100
Orientation:	Normal to boundary

Materials

Breakwater stones	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	160 lbs/ft3
Cohesion	0 psf
Phi	40 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Soft Clay	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	110 lbs/ft3
Cohesion	0 psf
Phi	28 °
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Stiff Clay	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	110 lbs/ft3
Cohesion	0 psf
Phi	28 °
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Cohesionless soil	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	125 lbs/ft3
Cohesion	0 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Shale bedrock	
Color	
Strength Type	Infinite Strength
Unit Weight	150 lbs/ft3
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	0
Specify alternate strength type above water surface	No

Dredge	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	120 lbs/ft3
Cohesion	10 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Materials In Use

Material	Right to left	Left to right
Breakwater stones	✓	✓
Soft Clay	✓	✓
Stiff Clay	✓	✓
Cohesionless soil	✓	✓
Shale bedrock	✓	✓
Dredge	✓	✓

Entity Information

Right to left

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 399 300, 403 300, 498 300, 550 300, 564 112, 564 109, 566 106, 566 88, 578 56, 578 0, 550 -300, 550 -300, 498 -300, 403 -300, 399 -300, 200 300, 200
Material Boundary	-300, 399 300, 399
Material Boundary	-300, 403 300, 403
Material Boundary	-300, 498 300, 498
Material Boundary	20, 550 132, 550
Material Boundary	104, 564 132, 550
Material Boundary	132, 550 300, 550
Material Boundary	20, 550 68, 574 84, 574 104, 564
Material Boundary	104, 564 112, 564
Material Boundary	0, 550 20, 550

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Dredge
Distributed Load	88, 578 56, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

Left to right

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 399 300, 403 300, 498 300, 550 300, 564 112, 564 109, 566 106, 566 88, 578 56, 578 0, 550 -300, 550 -300, 498 -300, 403 -300, 399 -300, 200 300, 200
Material Boundary	-300, 399 300, 399
Material Boundary	-300, 403 300, 403
Material Boundary	-300, 498 300, 498
Material Boundary	20, 550 132, 550
Material Boundary	104, 564 132, 550
Material Boundary	132, 550 300, 550
Material Boundary	20, 550 68, 574 84, 574 104, 564
Material Boundary	104, 564 112, 564
Material Boundary	0, 550 20, 550

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Dredge
Distributed Load	88, 578 56, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

CS BW 06+00.00 dredge
Slide2 - An Interactive Slope Stability Program
Date Created: 9/11/2025, 12:11:23 PM
Software Version: 9.039

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Slide2 Analysis Information

CS BW 06+00.00 dredge

Project Summary

File Name:	CS BW 06+00.00 dredge.slmd
Last saved with Slide2 version:	9.039
Project Title:	Slide2 - An Interactive Slope Stability Program
Date Created:	9/11/2025, 12:11:23 PM

Currently Open Scenarios

Group Name	Scenario Name	Compute Time
Left to right	Master Scenario	
Right to left	Master Scenario	

General Settings

Units of Measurement:	Imperial Units	
Time Units:	days	
Permeability Units:	feet/second	
Data Output:	Standard	
	Master Scenario	**Master Scenario**
Failure Direction:	Left to Right	Right to Left

Analysis Options

All Open Scenarios

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
	Corps of Engineers #1
	Corps of Engineers #2
	GLE/Morgenstern-Price with interslice force function (Half Sine)
	Janbu simplified
	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
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:	Slope Search
Number of Surfaces:	5000
Upper Angle [deg]:	Not Defined
Lower Angle [deg]:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
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]:	100
Orientation:	Normal to boundary

Materials

Breakwater stones	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	160 lbs/ft3
Cohesion	0 psf
Phi	40 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Soft Clay	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	110 lbs/ft3
Cohesion	0 psf
Phi	28 °
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Stiff Clay	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	110 lbs/ft3
Cohesion	0 psf
Phi	28 °
Water Surface	Assigned per scenario
Hu Type	Automatically Calculated
Specify alternate strength type above water surface	No

Cohesionless soil	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	125 lbs/ft3
Cohesion	0 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Shale bedrock	
Color	
Strength Type	Infinite Strength
Unit Weight	150 lbs/ft3
Allow Sliding Along Boundary	Yes
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	0
Specify alternate strength type above water surface	No

Dredge	
Color	
Strength Type	Mohr-Coulomb
Unit Weight	120 lbs/ft3
Cohesion	10 psf
Phi	32 °
Water Surface	Assigned per scenario
Hu Type	Custom
Hu	1
Specify alternate strength type above water surface	No

Materials In Use

Material	Left to right	Right to left
Breakwater stones	✓	✓
Soft Clay	✓	✓
Stiff Clay	✓	✓
Cohesionless soil	✓	✓
Shale bedrock	✓	✓
Dredge	✓	✓

Entity Information

Left to right

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 399 300, 403 300, 498 300, 550 300, 570 100, 570 88, 578 56, 578 0, 550 -300, 550 -300, 498 -300, 403 -300, 399 -300, 200 300, 200
Material Boundary	-300, 399 300, 399
Material Boundary	-300, 403 300, 403
Material Boundary	-300, 498 300, 498
Material Boundary	20, 550 132, 550
Material Boundary	104, 564 132, 550
Material Boundary	132, 550 300, 550
Material Boundary	20, 550 68, 574 84, 574 104, 564
Material Boundary	104, 564 112, 564
Material Boundary	0, 550 20, 550
Material Boundary	100, 570 106, 566 109, 566 112, 564

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Dredge
Distributed Load	88, 578 56, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No

Right to left

Shared Entities

Type	Coordinates (x,y)
External Boundary	300, 399 300, 403 300, 498 300, 550 300, 570 100, 570 88, 578 56, 578 0, 550 -300, 550 -300, 498 -300, 403 -300, 399 -300, 200 300, 200
Material Boundary	-300, 399 300, 399
Material Boundary	-300, 403 300, 403
Material Boundary	-300, 498 300, 498
Material Boundary	20, 550 132, 550
Material Boundary	104, 564 132, 550
Material Boundary	132, 550 300, 550
Material Boundary	20, 550 68, 574 84, 574 104, 564
Material Boundary	104, 564 112, 564
Material Boundary	0, 550 20, 550
Material Boundary	100, 570 106, 566 109, 566 112, 564

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	-300, 573.4 60, 573.4 72, 573.4 300, 573.4	Assigned to: Breakwater stones Soft Clay Stiff Clay Cohesionless soil Shale bedrock Dredge
Distributed Load	88, 578 56, 578	Constant DistributionOrientation: Normal to boundaryMagnitude: 100 lbs/ft2Creates Excess Pore Pressure: No