

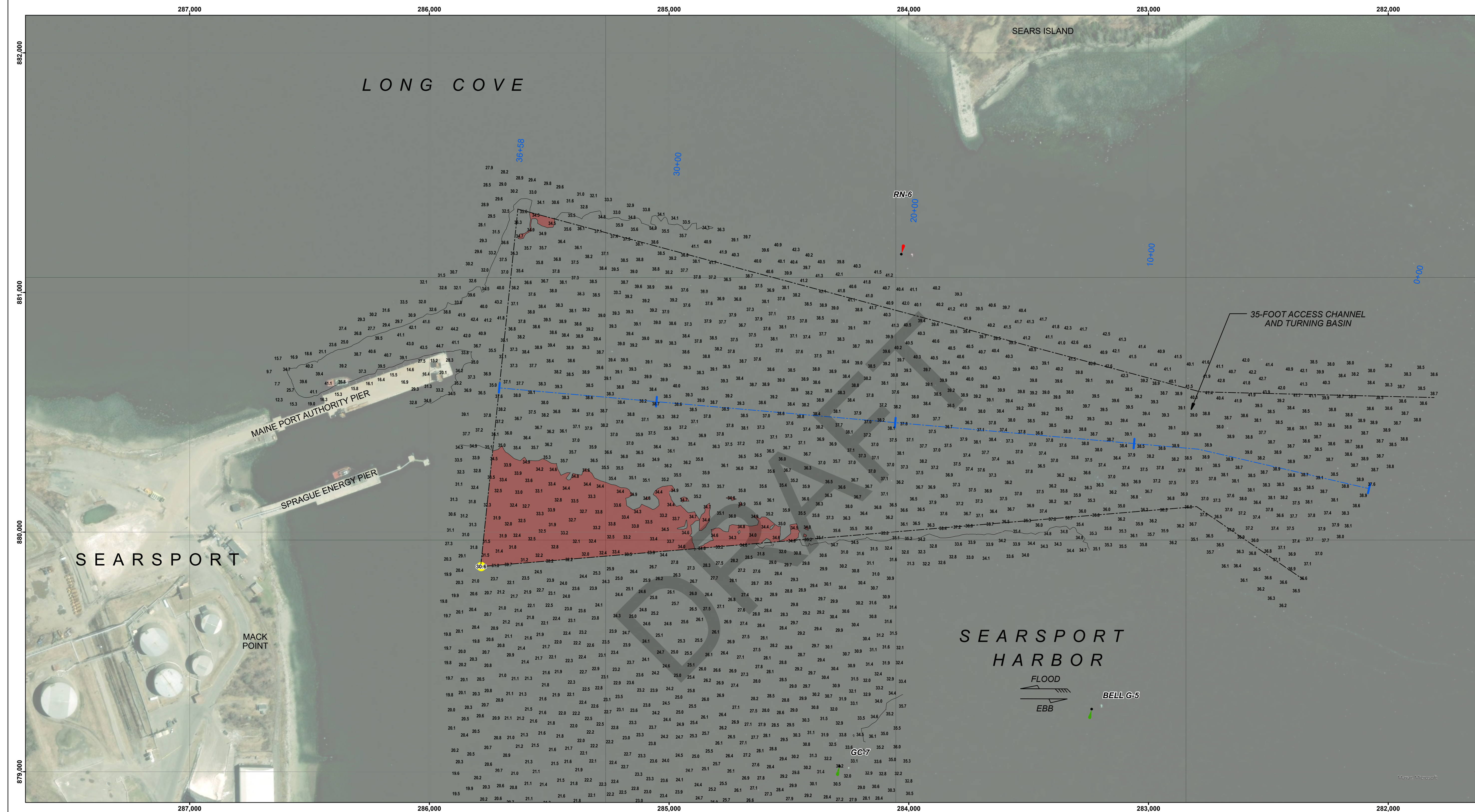
PRELIMINARY ASSESSMENT FOR MAINTENANCE  
DREDGING SEARSPORT HARBOR FEDERAL  
NAVIGATION PROJECT - SEARSPORT, MAINE

APPENDIX F  
ENGINEERING DESIGNS

DRAFT

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SURVEYED BY: NCD		CHECKED BY: WHV		ISSUE DATE: 4/2/2025	
SUBMITTED BY: Joshua Bromberg		APPROVED BY: NAE Survey		MAP DOCUMENT: ME_29_SEA_20250318_CS_023	
U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DISTRICT		SIZE: ANSI D			

**SEARSPORT HARBOR  
SEARSPORT, MAINE  
CONDITION SURVEY  
35-FOOT ACCESS CHANNEL  
AND TURNING BASIN**

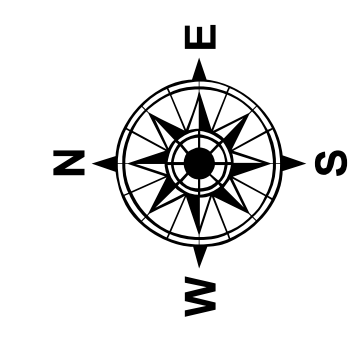
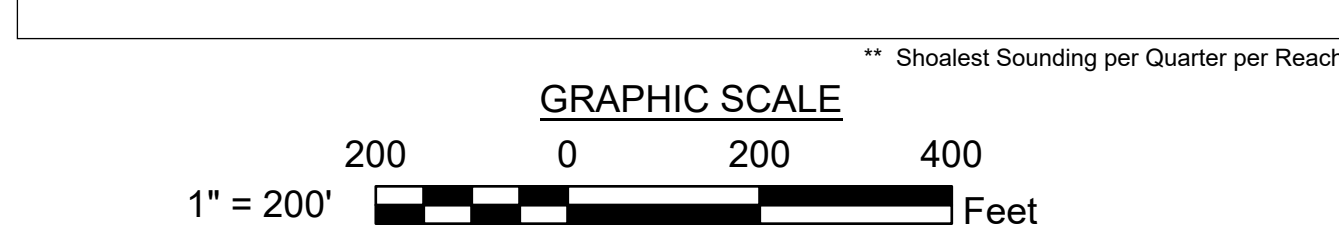
File Name: ME\_29\_SEA\_20250318\_CS\_023

**SHEET  
IDENTIFICATION**  
Searsport Harbor  
Sheet 2 of 2



**LEGEND**

--- Federal Navigation Channel	✳ Fixed Navigation Aids
--- Channel Center Line	! Red Navigation Buoy
..... Cable/pipeline area	! Green Navigation Buoy
--- Pipes (Gas/Sewer)	■ Shoaling Area
— Contour Line	● Shoalest Sounding**



**Notes:**  
Horizontal Datum: Maine East, ME-1801 NAD 83  
Distance Units: U.S. Survey Feet  
Vertical Datum: MLLW  
Depth Units: U.S. Survey Feet  
Vessel Name: KEEGAN  
Sonaar System: Reson T50 (Multibeam Sonar)  
Sounding Frequency: 300-400 kHz  
Survey Method: RTK GPS Tides  
GPS System: Applanix POS MV (RTK)  
RTK Base Station: Steamboat (2005)  
Software Used: Hypack  
Sounding Sort Distance: 50'  
Field Books: R&H 4984  
Survey No.: ME\_29\_SEA\_20250318\_CS\_023  
Reference NOAA Chart No.: ENC US5BGRHE

**General Notes**  
The sounding information shown on this map represents the SHOALEST soundings of those obtained from hydrographic surveys conducted during March 2025. The positions of aids to navigation were located during survey operations, are provided for information only and should not be used for navigation. Orthorectification is from a variety of sources and dates and is intended to portray general characteristics of the shoreline and other features. Temporal changes may have occurred since this dataset was collected and some parts may no longer be an accurate representation of the conditions. The information depicted on this map should NOT be used to determine volumes as volumes are determined from more sounding information than shown.

**Water Level Information**  
Tides were recorded using RTK GPS. NAVD88 to MLLW corrections were logged utilizing NOAA's V-Datum regional model ME/NH/MA Region Version 2.3. The corrections in the project area is 5.84 feet. MLLW is below NAVD88; therefore, the correction should be added to NAVD88 to convert to MLLW (e.g. -10 NAVD88 = -8 MLLW when using a 2-foot correction).

**Project Remarks**  
NONE

The information depicted on these charts represents the results of surveys made on the dates indicated, and can only be considered as indicating the conditions existing at that time.





## Searsport Harbor Slope Stability Summary

Slope stability calculations were conducted for 5 cross sections, three oriented north/south and two oriented east/west in support of the preliminary design of a CAD cell near Searsport Harbor, Maine. Stratigraphy for each cross section was developed by using the nearest borehole from the 2024 GEI investigation. Slope stability geometry for each profile is provided in figures at the end of this appendix.

Six distinct soil types were identified. Typical stratigraphy consists of Bay Sediments over Glacial Marine Sediments over Glacial Till. Each is briefly described below:

- Bay Sediments were described as very soft to soft black to gray organic silts and clays (OL, OH). These are highly elastic silts and fat clays with field N-values ranging from Weight of Rod (WOR) to 4. Bay Sediments were identified at surface throughout the investigation, ranging from 9 to 25 feet thick.
- Glacial Marine Sediments were described as lean clay (CL) with low to high plasticity. This is interpreted as the Presumpscot Formation. The upper region was generally stiff with field N-values ranging from 2 to 18, whereas the lower region was generally soft with consistent WOR field N-values. The top of the Glacial Marine Sediment ranged from 9 to 25 feet below the mudline. The bottom of the Glacial Marine Sediments was not located in all test holes. Where identified it ranged from 37 to 49 feet below the mudline.
- Glacial Till ranged from sandy lean clay (CL) to clayey gravel with sand (GC-GM) with varying amounts of silt. Field N-values ranged from 7 to 22 indicating medium to very stiff clays. The top of Glacial Till was identified in three borings. The bottom of Glacial Till was not identified in any borings. The top of Glacial Till ranged from 37 to 49 feet below the mudline.

Two other distinct layers were identified at specific locations. A layer of silty sand (SM) was identified in FD24-04 within the very soft Glacial Marine clay. A sandy lean clay (CL) was identified at FD24-06 over the soft clay.

Field data collection consisted of SPT blow counts in situ, as well as pocket penetrometer and torvane readings on disturbed samples. Granular soil properties were estimated based on typical industry practices for numerical modeling. Clay soil properties were developed using correlations to Atterberg Limit properties. Correlations were selected from Unified Facilities Criteria (UFC) 3-220-10 (Change 1, March 2025) and verified against the field disturbed sample measurements. Shear strength values developed from the clay correlations were lower than the average torvane values observed in the field.

A summary of typical stratigraphy, soil descriptions, and assigned properties is provided in Table 1 below. Many field N-values were Weight of Rod (WOR) and pocket penetrometer readings were zero, indicating very soft silts and clays. The liquidity index of the elastic silts and weight of rods clay both exceeded 1, indicating that these soils are in a liquid state as defined by the Atterberg Limits tests. In this condition, the clays will have very low shear resistance and may flow when disturbed.

Engineer Regulations and Manuals require consideration of both drained (long term) and undrained (short term) conditions. Since this project consists of excavation of soils, an undrained (excess pore pressure) condition is not expected to develop because no excess surcharge will be applied. However, some stress redistribution is anticipated. These effects have not been evaluated, so undrained conditions are also analyzed for reference.

# Searsport Harbor Slope Stability Summary

Drained conditions were analyzed using a Mohr-Coulomb friction angle approach with zero cohesion. This applies to all drained scenarios and the elastic silt and silty sand in the undrained scenarios. Undrained clay properties were analyzed using SHANSEP undrained strength ratios with minimum cohesion values developed from Sabatini et al. (2002) using effective stress at mid depth of the stratum.

**Table 1: Soil Strength Parameters Used in Slope Stability Modeling**

Name	Description	Drained Conditions	Undrained	
		Phi <sup>1,2</sup> (degrees)	Minimum Cohesion <sup>3</sup> (psf)	Stress Ratio <sup>4</sup>
Bay Sediment	High Elasticity Organic Silt	22	40	0.28
N=6 Clay	Soft to Medium Clay	30	150	0.16
WOR Clay	V. Soft to Soft Clay	28	200	0.16
Glacial Till	Clayey Sand	32	always drained	always drained
WOR Silt	Elastic Silt	25	always drained	always drained
Silty Sand (N=10)	Silty Sand	30	always drained	always drained

Correlations

1 - Drained friction angle for clays from Ladd et al. 1977, after Kenney 1959, Bjerrum and Simons 1960.  
 2 - Friction angle for silts and sands from industry practice, such as Carter and Bentley 2016 based on soil type, and Meyerhof 1956 based on N-values.  
 3 - Minimum cohesion values from Sabatini 2002.  
 4 - Stress ratios from Larson 1980.

Slope stability calculations were conducted using the Slope/W module in the Geostudio software suite version 2024.2.1 using Spencer’s Method with a cuckoo search of 100 iterations and 30 nests for a total of 3,000 trials. This 2D plane strain model assumes an infinitely long slope in the third dimension, as would be the case in a linear feature such as an embankment. However, when constructed, the slope will be confined by the adjacent side slopes of the CAD cell, resulting in higher factors of safety than those calculated by the 2D model. Calculated minimum factors of safety are provided in Table 2 below.

**Table 2: Calculated Minimum Factor of Safety**

Cross Section	Minimum Factor of Safety	
	Drained	Undrained
N-N	1.2	1.1
B-B	1.2	1.3
C-C	1.2	1.2
D-D	1.2	1.1
E-E	1.1	1.1

These factors of safety are based on 1V:3H side slopes. This slope is consistent with the angle of repose of most marine sediments after dredging and confirmed by the very shallow critical slip surface and low Factor of Safety in the drained analyses. This observation in the model confirms what would be anticipated in the field, an approximate 1V:3H slope is stable, but near critical, meaning that steeper slopes likely are not constructible in these sediments.

## Searsport Harbor Slope Stability Summary

On the other hand, the deep seated failure of the undrained analyses is unlikely to occur due to the increase in shear strength due to the confining pressures provided by the adjacent side slopes of the CAD cell.

The factors of safety determined by the model indicate stable slopes near critical stability. This suggests that a 1V:3H side slope is likely the most aggressive achievable. It may be prudent to plan for 1V:4H side slopes on some sides to account for in-situ variability. Also, the highly elastic organic silts and very soft clays were found to exceed the Atterberg Liquid Limit, which suggests that they may bulge or flow into the CAD cell if stress conditions are not managed appropriately. A more gradual slope would also reduce this potential effect. Specific analyses for strength, deformation and clay sensitivity should be prepared during design to assess these conditions. Once these soils fail, their residual strength is significantly lower than the initial strength, which could result in excess material entering an open excavation. It should be clear to the contractor that means and methods, including excess sloughing into the excavation are at the contractor's discretion.

### Correlation Citations

Carter, M. and Bentley, S.P. 2016. *Soil Properties and their Correlations*. John Wiley & Sons, Ltd.

Ladd, C.C., Foott, R., Ishihara, K., Schlosser, F., and Poulos, H.G. 1977. "Stress-Deformation and Strength Characteristics." *Proc. Of the 9<sup>th</sup> In. Conf. on Soil Mechanics and Foundation Engineering*, Tokyo, Japan, 421-494.

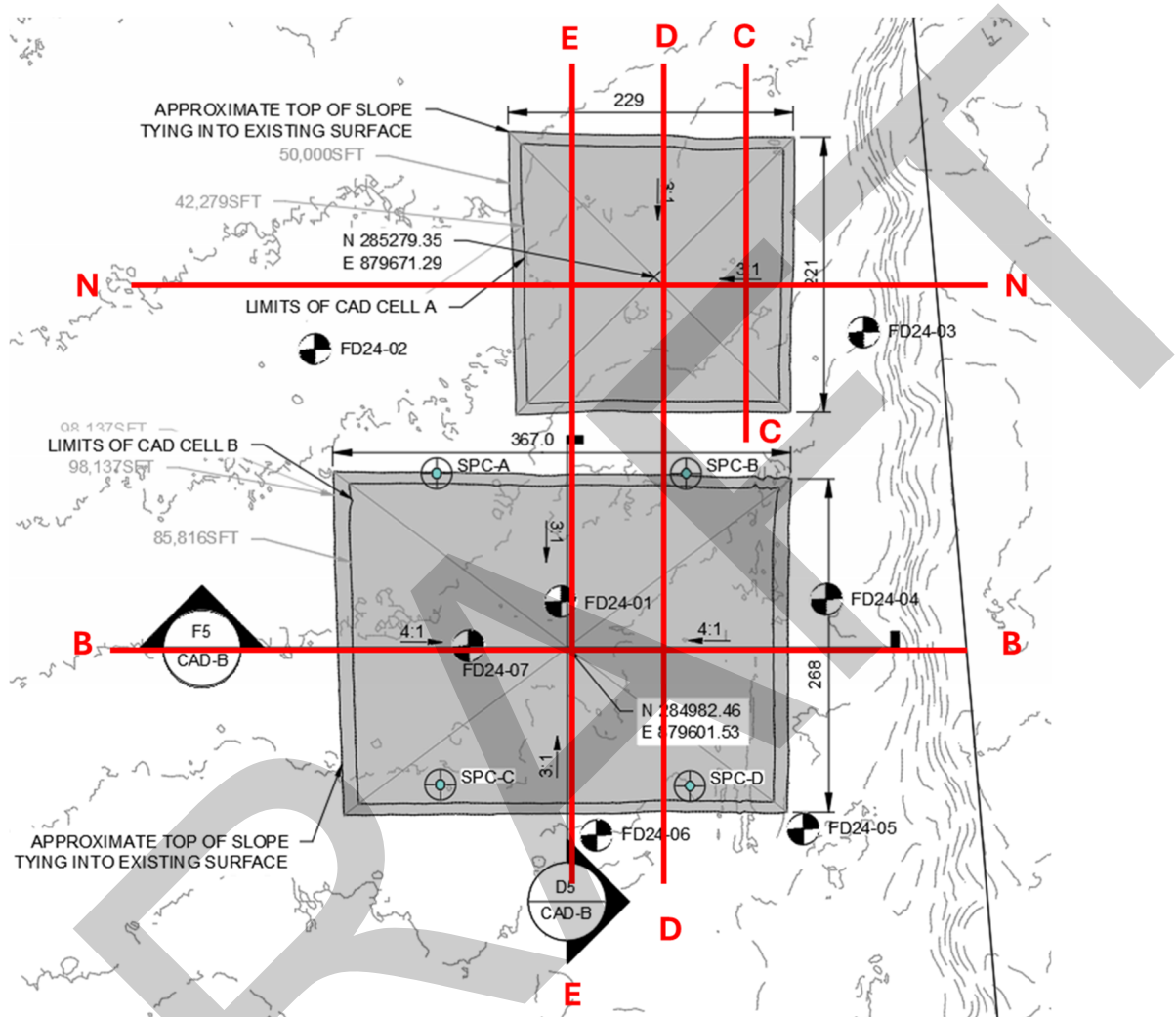
Larson, E. 1980. "Undrained Strength in Stability Calculation of Embankments and Foundation of Soft Clays." *Canadian Geotechnical Journal*, 17(4), 591-602.

Meyerhoff, G.G. 1956. "Penetration Tests and Bearing Capacity of Cohesionless Soils." *Journal of the Soil Mechanics and Foundation Division*, 82(1), 1-19.

Sabatini, P.J., Bachus, R.C., Mayne, P.W., Schneider, J.A., and Zettler, T.E. 2002. *Geotechnical Engineering Circular No. 5: Evaluation of Soil and Rock Properties*. Federal Highway Administration.

# Searsport Harbor Slope Stability Summary

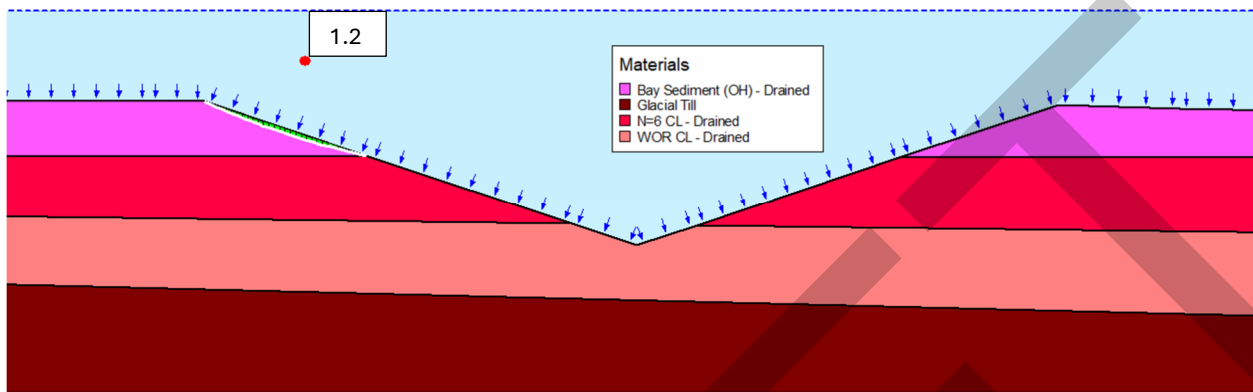
## Approximate Cross Section Locations



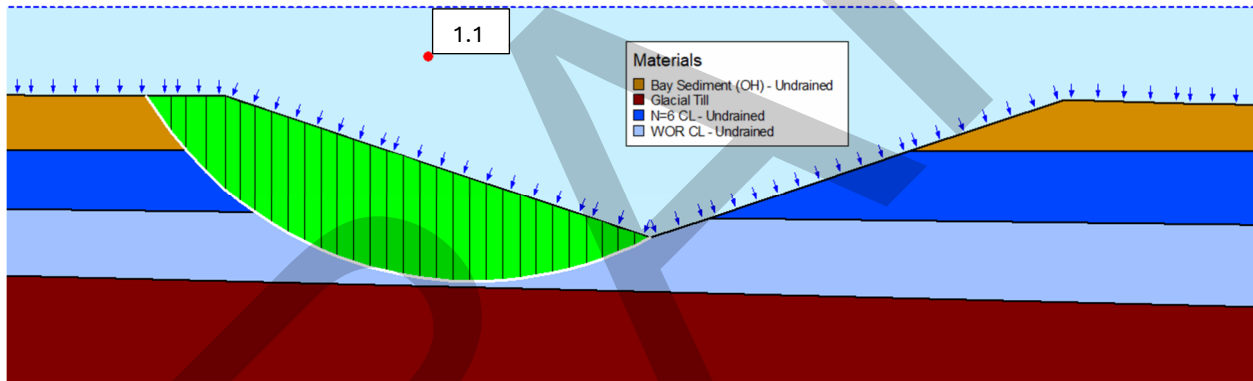
# Searsport Harbor Slope Stability Summary

## Slope Stability Model Outputs Showing Critical Slip Surface

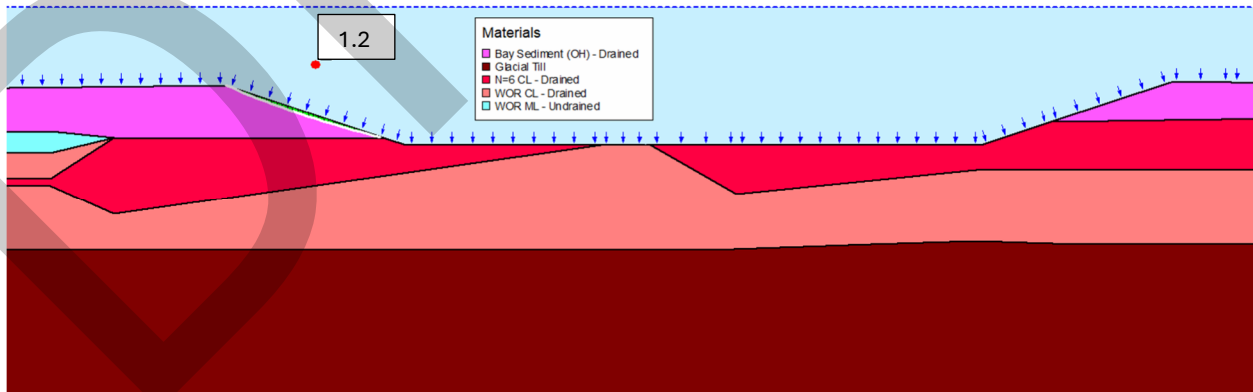
Section N-N Drained (CAD Cell A)



Section N-N Undrained (CAD Cell A)

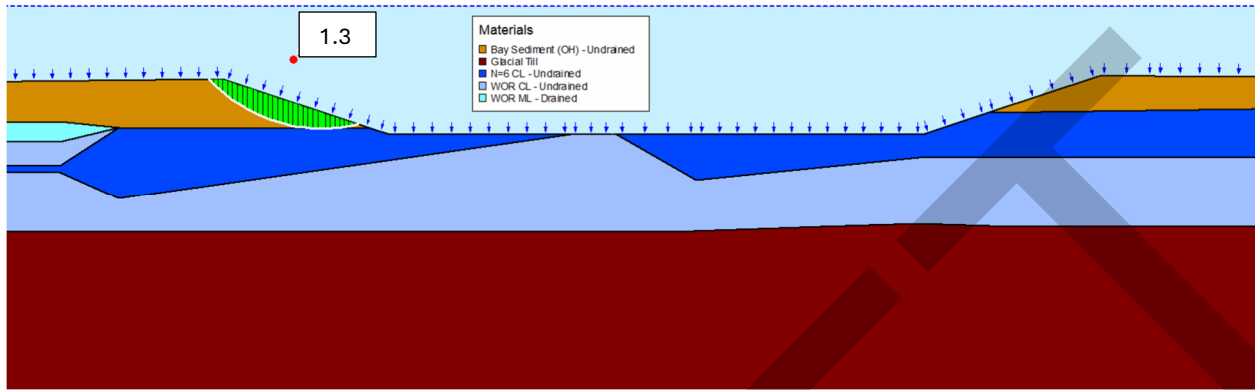


Section B-B Drained (CAD Cell B)

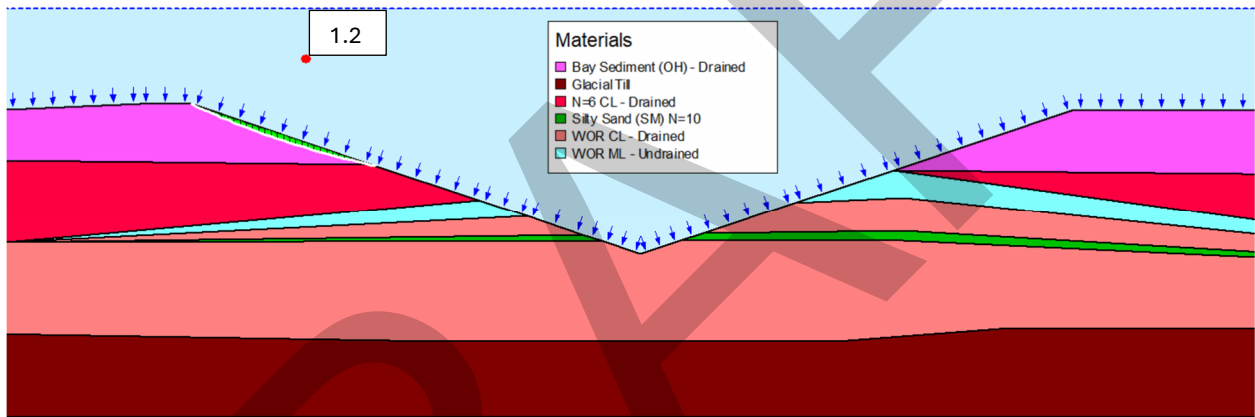


# Searsport Harbor Slope Stability Summary

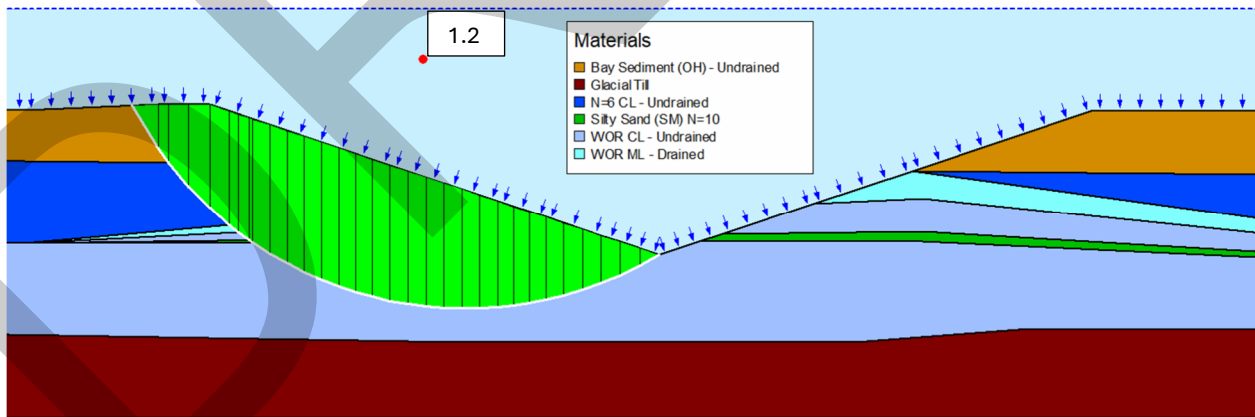
## Section B-B Undrained (CAD Cell B)



## Section C-C Drained (CAD Cell A)

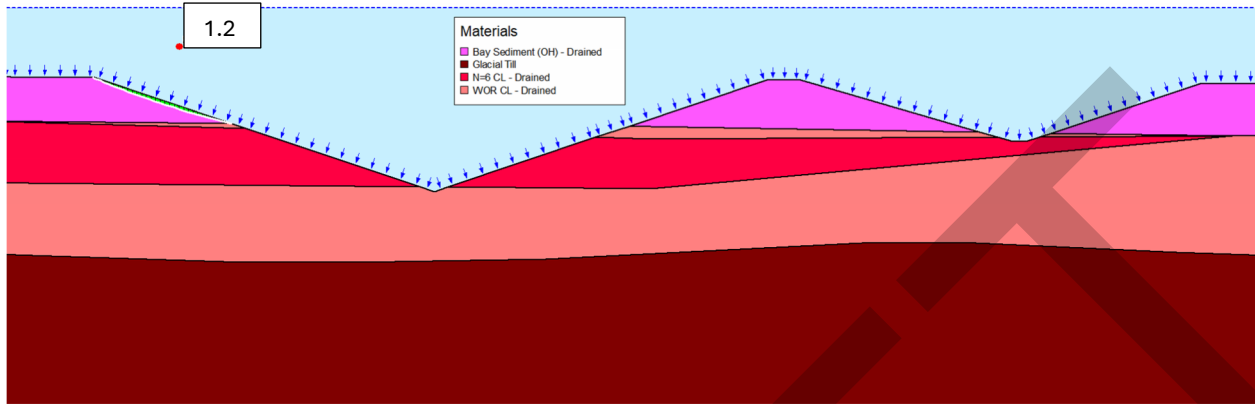


## Section C-C Undrained (CAD Cell A)

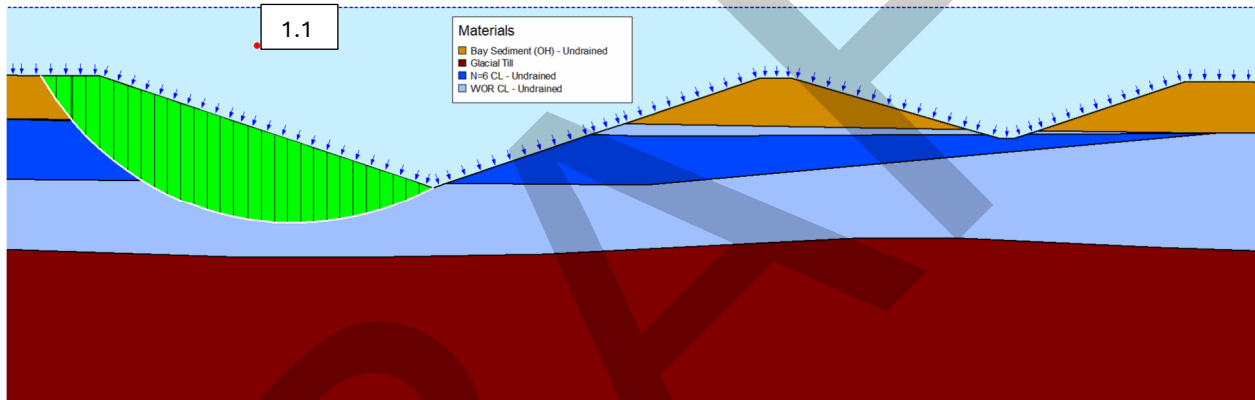


# Searsport Harbor Slope Stability Summary

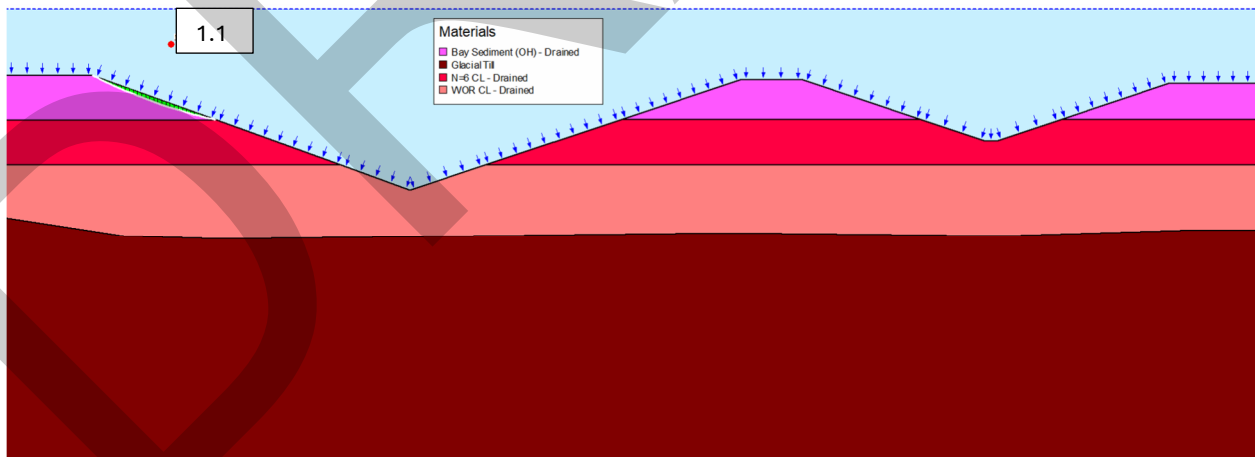
## Section D-D Drained (CAD Cells A and B)



## Section D-D Undrained (CAD Cells A and B)



## Section E-E Drained (CAD Cells A and B)



# Searsport Harbor Slope Stability Summary

Section E-E Undrained (CAD Cells A and B)

