Public Records Request #3016

The following materials have been gathered in response to public records request #3016. These materials include:

- ITB #00-10-00: I-77 West Trade Underpass Enhancement
- Addendum #1
- Addendum #2
- Addendum #3
- Addendum #4
- City Council – 7/22/19 – Agenda #27
- Bid Results
- Bid Tab
- Itemized Bid
- Project Geotechnical Investigation
- Pre-Bid Meeting Attendance
- Warranty Items

This information was provided as a response to a public records request on 11/18/19 and is current to that date. There is a possibility of more current information and/or documents related to the stated subject matter.

Further Information

For further information about this request or the Citywide Records Program, please contact:

Cheyenne Flotree
Citywide Records Program Manager
City of Charlotte/City Clerk's Office
600 East 4th Street, 7th Floor
Charlotte, NC 28202
Cheyenne.Flotree@charlottenc.gov

Amelia Knight
Public Records Specialist
City of Charlotte/City Clerk's Office
600 East 4th Street, 7th Floor
Charlotte, NC 28202
Amelia.Knight@charlottenc.gov

00 10 00 – INVITATION TO BID

The City of Charlotte (hereinafter the "City") will receive sealed bids for the following Project:

PROJECT NAME: **I-77 West Trade Underpass Enhancement**
PROJECT NUMBER: **512-16-070**

PRE-BID DATE AND TIME: **May 15, 2019, AT 10:00 AM**
PRE-BID LOCATION: Charlotte-Mecklenburg Government Center,
14th Floor Large Conference Room
600 East Fourth Street, Charlotte, NC 28202

The Pre-Bid meeting is not mandatory, but attendance is strongly encouraged.

BID DUE DATE AND TIME: **May 28, 2019 AT 2:30PM**
BID OPENING LOCATION: Charlotte-Mecklenburg Government Center,
12th Floor, ROOM 1288
600 East Fourth Street, Charlotte, NC 28202

DESCRIPTION OF WORK:
The I-77 West Trade Underpass Enhancement project will provide new sidewalk and curb and gutter in key locations, decorative pavers, electrical outlets, site furnishings, lighting and a decorative retaining wall.

Bidding documents, which includes a printed copy of one (1) Project Manual and one (1) full-size Drawing set, are available for a non-refundable charge of **$116.00** (including tax) at the following:

Duncan-Parnell, Inc.
900 South McDowell Street, Charlotte, NC 28204
Phone: (704) 372-7766 Fax: (704) 333-3845
Email: michaela.bruinius@duncan-parnell.com
Contact: **Michaela Bruinius**

Bidders must be properly licensed under North Carolina state law to perform the work.
A **5%** bid security is required with each bid that equals or exceeds **$300,000**.

The estimated cost of this Project is **$1,515,000.00**

For information regarding this Invitation to Bid, contact as follow:

Nancy Denis, Contracts Administrator
600 East Fourth Street, Charlotte, NC 28202
Direct Phone: (704) 336-3614; Main Phone (704) 336-2291
Email: nndanu@charlottenc.gov
Website: http://charlottenc.gov/epmcontracts

Please submit questions or inquiries at least seven (7) calendar days before the Bid Due Date. Questions or inquiries past this deadline may not be addressed by the City prior to the Bid Due Date.

The City of Charlotte reserves the right to reject any and all bids and to waive any informalities or technicalities as it may deem to be in its best interest.

This project is subject to the requirements of the City's Charlotte Business INClusion Program to promote diversity, inclusion, and local business opportunities in the City's contracting and procurement process for Minority, Women, and Small Business Enterprises headquartered in the Charlotte Combined Statistical Area.

A SBE Contract Goal of **20%** and a MBE Contract Goal of **8%** have been established for this project.

CHARLOTTE.

ADDENDUM No. 1

TO: Prospective Bidders

FROM: **Nancy Denis**, *Engineering Contracts Specialist*

DATE: **May 17, 2019**

PROJECT: **I-77 West Trade Underpass Enhancement**
Project No.: 512-16-070
Bid Number: HC2018-1535

The following items are being issued herein for modification and clarification to the Bid Requirements for the project referenced above. All Bidders shall acknowledge this Addendum within their submittal.

MODIFICATIONS

PROJECT MANUAL

1) On page ……00 10 00-1 Invitation to Bid Section, Change the "BID DUE DATE AND TIME" as follows:

BID DUE DATE AND TIME: ~~**May 28, 2019 at 2:30 PM**~~

June 11, 2019 at 1:30 PM

END OF ADDENDUM NO. 1

ADDENDUM No. 2

TO: Prospective Bidders

FROM: **Nancy Denis**, *Engineering Contracts Specialist*

DATE: **Friday, May 24, 2019**

PROJECT: **I-77 West Trade Underpass Enhancement**
Project No.: 512-16-070
Bid Number: HC2018-1535

The following items are being issued herein for modification and clarification to the Bid Requirements for the project referenced above. All Bidders shall acknowledge this Addendum within their submittal.

MODIFICATIONS

PROJECT MANUAL

1) Delete **SP-18; SITE FURNISHINGS** in **its entirety** and replace it with the attached REVISED SP18; SITE FURNISHINGS – herein provided as attachment No. 2

DRAWINGS

2) On page 00 40 00-3, under "ITEMIZED BID" in BID FORM AND SUPPLEMENTS, the following item has been changed to:

Item	*Section*	*ITEM DESCRIPTION*	*Quantity*	*Unit*	*Unit Price*	*Amount*
34	SP-08	Cast in Place (CIP) Gravity Retaining Walls	~~314~~ 12	CY		

3) On the DRAWINGS, replace each drawing sheet Drawing Sheet #3B, 3C of 9 and UC4, UC5 of UC6 indicated below with the revised drawing sheets included as part of this Addendum No. 2: See attachments No. 2

SHEET NO	DRAWING TITLE
3B	DETAILS (HARDSCAPE AND FURNISHING)
3C	DETAILS (HARDSCAPE AND FURNISHING)
UC4	UTILITY CONSTRUCTION (ELECTRICAL LIGHTING SCHEDULE)
UC5	UTILITY CONSTRUCTION (ELECTRICAL LIGHTING DETAILS)

QUESTIONS & ANSWERS

1. Why are some electrical broken out in multiple specifications and some covered in one lump sum?

Answer: ***The site electrical features are covered by multiple bid items. All non-standard NCDOT specification items for this project are listed and included under Special Provision #18 (bid item #45). These non-standard items include: illuminating bollards. The standard site electrical and lighting bid items covered by standard NCDOT specifications include: Underpass Lighting-Luminaires, Underpass Lighting –Circuitry, Light Control Equipment, Feeder Circuits (Bollards #12AWG). Empty conduits for use by others to install pedestrian lighting circuitry, and for future use are included under bid items included in Special Provision #12 and #13 - Conduit, PVC, 1", Schedule 80; Conduit, PVC, 2", Schedule 80; and Pull Box, Duke, (24" x 36" x 24").***

2. Some details have manufacturers specified (Bomanite paving was an example). Does the manufacturer have to be the one that is listed, and isn't that against the statute in North Carolina?

Answer: ***This has been addressed in the plans by noting "or approved equal" in all instances of details referenced. Plan sheets 3B, 3C, UC-4, and UC-5 have been revised accordingly and have been provided as part of this Addendum as Revision #1 to the bid plans. Sheets 3B, 3C, UC-4, and UC-5 of the bid plans should be replaced with sheets provided under this Addendum.***

3. In past experience, soil nail walls of similar height as I-77 should have footing. The aggregate base may not be enough.

Answer: ***NCDOT Geotechnical Standard drawing for "Soil Nail Wall – Typical Section" was used which details a 6" aggregate leveling pad. The aggregate leveling pad is also specified in the Special Provision #9 used for this project. The wall can be built with the aggregate leveling pad as detailed. The Contractor can provide a concrete leveling pad if they choose to do so, but at no additional cost to the Owner.***

4. Is there any type of finish on the concrete surface of the soil nail wall?

Answer: ***Although the soil nail wall shall be coated with an approved anti-graffiti product per the special provision #9, in the future a painted art mural will be placed on the wall. The finish of the wall should be smooth and the anti-graffiti product should be able to be removed or be able to accept a product which will also accept paint.***

5. The project special provisions indicate a sealant or coating on certain walls or concrete surfaces. Please clarify exactly which items will have what type of coatings?

Answer: ***The soil nail wall shall have an anti-graffiti coating applied as well as the bridge girders. Please review special provision #7 for specific information regarding products acceptable for use on the bridge girders.***

6. Item 34 covers the 73 LF CIP Gravity Retaining Walls only, correct? The quantity of 314 CY seems extremely inflated. Please clarify.

Answer: ***SEE MODIFICATIONS- PROJECT MANUAL revisions Item No.2 provided page 1 of this Addendum.***

Item	*Section*	*ITEM DESCRIPTION*	*Quantity*	*Unit*	*Unit Price*	*Amount*
34	SP-08	Cast in Place (CIP) Gravity Retaining Walls	~~314~~ 12	CY		

7. Item# 34 lists 314 CY of Cast in Place Gravity Retaining Wall. The drawings show the wall length of 73 LF from sheet 5. I calculate that at 73 LF there is a total of 20 CY of concrete at 4' wall height. Is 314 CY wrong or is there more wall than shown on the drawings?

Answer: ***SEE MODIFICATIONS- PROJECT MANUAL revisions Item No.2 provided page 1 of this Addendum.***

8. SP-18, Site Furnishings, specifies Trash Receptacles, Bigbelly High Capacity Two-Unit Compactor and states there is a quantity of 2 required. I only see what appears to be 1, Two-Unit Compactor on the plans. Where is the other shown on the plans?

Answer: ***SP-18; Site Furnishings has been hereby revised to indicate a quantity of 1. SP-18 has been revised accordingly and provided as part of this Addendum #2 to the Project Manual. SP-18 should be replaced in its entirety with SP-18 provided under this Addendum.***

END OF ADDENDUM NO. 2

ADDENDUM No. 3

TO: Prospective Bidders

FROM: **Nancy Denis**, *Engineering Contracts Specialist*

DATE: **Thursday, June 06, 2019**

PROJECT: **I-77 West Trade Underpass Enhancement**
Project No.: 512-16-070
Bid Number: HC2018-1535

The following items are being issued herein for modification and clarification to the Bid Requirements for the project referenced above. All Bidders shall acknowledge this Addendum within their submittal.

MODIFICATIONS

PROJECT MANUAL

1) On page…..00 10 00-1 Invitation to Bid Section, Change the "BID DUE DATE AND TIME" as follows:

BID DUE DATE AND TIME: ~~**June 11, 2019 at 2:30 PM**~~

June 13, 2019 at 3:00 PM

2) Delete **REVISED SP-18; SITE FURNISHINGS and SP-09; SOIL NAIL RETAINING WALLS** in **its entirety** and replace it with the attached REVISED 2 SP-18; SITE FURNISHINGS AND REVISED SP-09; SOIL NAIL RETAINING WALLS- herein provided as attachment No. 3

DRAWINGS

3) On the DRAWINGS, replace each drawing sheet Drawing Sheet UC3 of UC6 and REVISED 3B of 9 indicated below with the revised drawing sheets included as part of this Addendum No. 3: Drawings will be issued by ***Duncan Parnell***:

SHEET NO	DRAWING TITLE
UC3 of UC6	UTILITY CONSTRUCTION (ELECTRICAL LIGHTING PLAN EAST OF I-77)
3B OF 9 REVISED	DETAILS (HARDSCAPE AND FURNISHING)

QUESTIONS & ANSWERS

1. The plans illustrate Planting Mix to be placed in all the planting strips and to the cut/fill limits. The specification describes excavating and placing 18 inches of Planting Soil Mix within the medians, but here aren't any medians on this project. Is it the intent to excavate and place 18 inches in all the areas illustrated on the plans?

   Answer: The planting mix is proposed to be placed in the planting strips to a depth of 6" and within the cut/fill limits behind the sidewalks to a depth of 6". The earthwork cut/fill volumes calculated for the project were adjusted to account for the planting mix quantity (volume) in the locations illustrated on the bid plans.

2. Addendum2, Q&A #4 and #5 refer to anti-graffiti coating for the soil nail wall. I have not seen in special provision (SP-09) where it refers to an anti-graffiti coating. If an anti-graffiti coating is required for the cast-in-place concrete facing, please provide a specification or indicate where it is referred to in the special provisions for the soil nail wall.

   Answer: SP-09; SOIL NAIL RETAINING WALLS has been hereby revised accordingly and provided as part of this Addendum #3 to the Project Manual.

3. The plans call out to "Clean and repaint exterior bridge fascia girders." My understanding is this will cover the exterior (outermost) girders on the west and east ends of the bridge only. Is that correct? Does this include the exterior, interior, top of flange, and bottom of flange, of the aforementioned girders? Is the anti-graffiti application area the same as cleaned and painted area of girders?

   Answer: The work called out on the plans to "Clean and repaint exterior bridge fascia girders" is for the outward facing exterior east and west girders only. These girders are called out on the bid plans on sheet 5. This work includes everything from the bottom of the bottom flange up to the bottom of the top flange (including all surfaces of the flanges and girder) within these limits on the outside face. The anti-graffiti coating shall be applied to the same areas as the cleaned and painted surfaces.

END OF ADDENDUM NO. 3

ADDENDUM No. 4

TO: Prospective Bidders

FROM: **Nancy Denis**, *Engineering Contracts Specialist*

DATE: **Tuesday, June 11, 2019**

PROJECT: **I-77 West Trade Underpass Enhancement**
Project No.: 512-16-070
Bid Number: HC2018-1535

The following items are being issued herein for modification and clarification to the Bid Requirements for the project referenced above. All Bidders shall acknowledge this Addendum within their submittal.

MODIFICATIONS

PROJECT MANUAL

1) Added **SP-20; WARRANTY ITEMS** included in attachment No. 4
2) Geotechnical Report is attached with this Addendum 4

QUESTIONS & ANSWERS

1. On Sheet UC5, it shows two types of electrical boxes, a pull box and a junction box.
   On Sheet UC3, the sheet indicates location of Pull Boxes but not the junction boxes.
   Can you identify where the junction boxes are located?

   Answer: The plans do not call for any locations which utilize the junction box detail. Pull boxes, as called out in the plans, should be fiber reinforced polymer concrete, with bolt down fiber reinforced polymer concrete covers rated Tier 15 per specification SP-16 and NCDOT 1411 adequately sized to accommodate conduits and cable bend radius.

END OF ADDENDUM NO. 4

City of Charlotte

Agenda Date: 7/22/2019

Agenda #: 27.**File #:** 15-10924 **Type:** Consent Item

Construct I-77/West Trade Street Underpass Enhancement Project

Action:
Approve a contract in the amount of $2,218,958.35 to the lowest responsive bidder Sealand Contractors Corp. for the I-77/West Trade Street Underpass Enhancement project.

Staff Resource(s):
Mike Davis, General Services
David Wolfe, General Services
Lamar Davis, General Services

Explanation
- This contract includes construction services for the I-77/West Trade Street Underpass Enhancement Project, identified in the West Trade/Rozzelles Ferry Comprehensive Neighborhood Improvement Program (CNIP), located in Council District 2.
- Included in the project are sidewalks, curb, gutter, wheelchair ramps, pedestrian lighting, signage and benches. Landscaping and a decorative retaining wall will also be installed under the I-77 bridge as part of the project.
- This CNIP project will enhance connections between uptown Charlotte and the West Corridor including the new Five Points Public plaza, Frazier Park, residential and commercial properties and Johnson C. Smith University.
- On April 29, 2019, the city issued an Invitation to Bid; four bids were received.
- Sealand Contractors Corp. was selected as the lowest responsive, responsible bidder.
- The project is anticipated to be complete by fourth quarter 2020.

Charlotte Business INClusion
Established SBE Goal: 20.00%
Committed SBE Goal: 20.00%

Sealand Contractors Corp. met the established SBE subcontracting goal, and has committed 20.00% ($443,834) of the total contract amount to the following certified SBE firms (Part B: Section 3 of the Charlotte Business INClusion Policy):
- On Time Construction, Inc. (SBE) ($163,320) (concrete, masonry)
- Axiom Foundations, LLC (SBE) ($130,891) (foundation engineering)
- Darnell Jones Trucking, Inc (SBE, MBE) ($59,250) (hauling)
- Streeter Trucking Company, Inc. (SBE, MBE) ($59,250) (hauling)
- Frady Tree Care (SBE) ($17,750) (tree and shrub removal)
- Striping Concepts, LLC (SBE) ($8,983) (pavement markings)
- P and TL, Inc. (SBE) ($4,390) (erosion control)

Established MBE Goal: 8.00%
Committed MBE Goal: 5.34%

Sealand Contractors Corp. failed to meet the established MBE subcontracting goal at bid, but earned the required Good Faith Efforts Points (Part B: Section 5 of the Charlotte Business INClusion Policy) and are recommended for award. At bid, Sealand Contractors Corp. committed 5.34% ($118,500) of the total contract amount to the following certified firms (Part B: Section 3 of the Charlotte Business INClusion Policy):

- Darnell Jones Trucking, Inc (SBE, MBE) ($59,250) (hauling)
- Streeter Trucking Company, Inc. (SBE, MBE) ($59,250) (hauling)

Fiscal Note
Funding: General Capital Investment Plan

Attachment(s)
Map

BID OPENING RESULTS

Project Name	I-77 West Trade Underpass Enhancement
Project #	512-16-070
Prebid Date	Wednesday, May 15, 2019
Bid Date	Thursday, June 13, 2019
CBI Goal	**SBE - 20%, MBE - 8%**
Estimate	$1,515,000.00
Project Manager	Lamar Davis

Distribution

Stakeholders	***Division***
Stana Jones (704) 336-2291	EPM Customer Service - Reception
Nancy Denis	Contracts Specialist
Tonia Wimberly	Construction Manager
Greg Tate	Contracts Administrator
Courtney Farmer	CBI Liaison
Pam Price	Webmaster
Maria Miles	Engineering Contracts Manager
DPR	Digital Plan Room

	Bidder's of Record Firm Name	***Total Amount of Bid***	***Bid Bond***	**SBE Goal**	**MBE Goal**	***Addendum # 1*** ***5/17/2019***	***Addendum # 2*** ***5/24/2019***	***Addendum # 3*** ***6/7/2019***	***Addendum # 4*** ***6/11/2019***
✓	Blythe Development Company	$3,045,237.38	✓	10.97%	10.55%	✓	✓	✓	✓
	Crowder Construction Company								
✓	Nassiri Development	$2,262,994.50	✓	20.00%	11.32%	✓	✓	✓	✓
✓	OnSite Development, LLC.	$2,270,712.95	✓	21.05%	8.01%	✓	✓	✓	
✓	Sealand Contractors Corp.	$2,219,054.07	✓	20.00%	5.34%	✓	✓	✓	✓
	United Construction Company, Inc								

Bids opened by: N Haven

Bids recorded by: Courtney Farmer

BIDTAB

			BIDDER	BIDDER	BIDDER	BIDDER
Project Name:	**I-77 West Trade Underpass Enhancement**		1	2	3	4
Project #:	**512-16-070**					
Bid Number:	**HC2018-1535**					
Estimate $:	$1,515,000.00		**Sealand Contractors Corp.**	**Nassiri Development**	**OnSite Development, LLC.**	**Blythe Development Company**
Bid Opening Date:	Thursday, June 13, 2019					
AC Adjust $:	$505.45		***$ 1,929,529.00***	***$ 1,967,728.50***	***$ 1,974,446.00***	***$ 2,647,946.60***
Contingency:	15%		***$ 289,429.35***	***$ 295,159.28***	***$ 296,166.90***	***$ 397,191.99***
		TOTAL BID	***$ 2,218,958.35***	***$ 2,262,887.78***	***$ 2,270,612.90***	***$ 3,045,138.59***

Item #	*Section*	*Item Description*	*Qty*	*Unit*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*
1	800	Mobilization	1	LS	$ 110,000.00	$ 110,000.00	$ 185,000.00	$ 185,000.00	$ 115,000.00	$ 115,000.00	$ 132,350.00	$ 132,350.00
2	226	Undercut Excavation	50	CY	$ 80.00	$ 4,000.00	$ 50.00	$ 2,500.00	$ 175.00	$ 8,750.00	$ 175.00	$ 8,750.00
3	300	Foundation Conditioning Geotextile	202	SY	$ 2.00	$ 404.00	$ 12.00	$ 2,424.00	$ 9.00	$ 1,818.00	$ 2.00	$ 404.00
4	520	Aggregate Base Course	80	TN	$ 80.00	$ 6,400.00	$ 48.00	$ 3,840.00	$ 95.00	$ 7,600.00	$ 65.00	$ 5,200.00
5	610	Asphalt Concrete Base Course, Type B 25.0C	180	TN	$ 115.00	$ 20,700.00	$ 160.00	$ 28,800.00	$ 150.00	$ 27,000.00	$ 146.00	$ 26,280.00
6	610	Asphalt Concrete Intermediate Course, Type I 19.0C	49	TN	$ 125.00	$ 6,125.00	$ 160.00	$ 7,840.00	$ 150.00	$ 7,350.00	$ 146.00	$ 7,154.00
7	610	Asphalt Concrete Surface Course, Type S 9.5C	36	TN	$ 160.00	$ 5,760.00	$ 160.00	$ 5,760.00	$ 150.00	$ 5,400.00	$ 150.00	$ 5,400.00
8	620	Asphalt Binder for Plant Mix	16	TN	$ 625.00	$ 10,000.00	$ 650.00	$ 10,400.00	$ 505.00	$ 8,080.00	$ 600.00	$ 9,600.00
9	848	4 " Concrete Sidewalk	1825	SY	$ 40.00	$ 73,000.00	$ 45.00	$ 82,125.00	$ 65.00	$ 118,625.00	$ 52.00	$ 94,900.00
10	848	6 " Concrete Sidewalk or Pad	240	SY	$ 65.00	$ 15,600.00	$ 55.00	$ 13,200.00	$ 85.00	$ 20,400.00	$ 58.00	$ 13,920.00
11	858	Adjustment of Manholes	3	EA	$ 600.00	$ 1,800.00	$ 1,250.00	$ 3,750.00	$ 1,750.00	$ 5,250.00	$ 1,500.00	$ 4,500.00
12	846	2' 6" Concrete Curb and Gutter	745	LF	$ 33.00	$ 24,585.00	$ 45.00	$ 33,525.00	$ 60.00	$ 44,700.00	$ 55.00	$ 40,975.00
13	846	1'-6" Median Curb and Gutter - CLDS 10.17B	68	LF	$ 33.00	$ 2,244.00	$ 72.00	$ 4,896.00	$ 85.00	$ 5,780.00	$ 82.00	$ 5,576.00
14	863	Remove Existing Guardrail	80	LF	$ 11.00	$ 880.00	$ 15.00	$ 1,200.00	$ 55.00	$ 4,400.00	$ 10.00	$ 800.00
15	862	Steel Beam Guardrail	85	LF	$ 21.50	$ 1,827.50	$ 44.00	$ 3,740.00	$ 125.00	$ 10,625.00	$ 48.00	$ 4,080.00
16	862	Guardrail Anchor Units, Type CAT-1	2	EA	$ 3,400.00	$ 6,800.00	$ 1,925.00	$ 3,850.00	$ 2,750.00	$ 5,500.00	$ 1,650.00	$ 3,300.00
17	901	Contractor Furnished, Type E Sign	66	SF	$ 38.00	$ 2,508.00	$ 40.00	$ 2,640.00	$ 85.00	$ 5,610.00	$ 48.00	$ 3,168.00
18	903	Ground Mounted Sign Supports (2lb Steel U-channel)	8	EA	$ 165.00	$ 1,320.00	$ 225.00	$ 1,800.00	$ 325.00	$ 2,600.00	$ 205.00	$ 1,640.00
19	1205	Thermoplastic Pavement Marking Lines, 24", 120 mils	62	LF	$ 16.00	$ 992.00	$ 19.00	$ 1,178.00	$ 25.00	$ 1,550.00	$ 20.00	$ 1,240.00
20	1205	Thermoplastic Pavement Marking Lines, 4", 120 mils	107	LF	$ 5.00	$ 535.00	$ 6.00	$ 642.00	$ 3.00	$ 321.00	$ 6.20	$ 663.40
21	1205	Thermoplastic Pavement Marking Lines, 8", 120 mils	1591	LF	$ 2.75	$ 4,375.25	$ 3.50	$ 5,568.50	$ 6.00	$ 9,546.00	$ 3.50	$ 5,568.50

BIDTAB

Project Name:	**I-77 West Trade Underpass Enhancement**
Project #:	**512-16-070**
Bid Number:	**HC2018-1535**
Estimate $:	$1,515,000.00
Bid Opening Date:	Thursday, June 13, 2019
AC Adjust $:	$505.45
Contingency:	15%

	BIDDER 1	BIDDER 2	BIDDER 3	BIDDER 4
	Sealand Contractors Corp.	**Nassiri Development**	**OnSite Development, LLC.**	**Blythe Development Company**
	$ 1,929,529.00	***$ 1,967,728.50***	***$ 1,974,446.00***	***$ 2,647,946.60***
	$ 289,429.35	***$ 295,159.28***	***$ 296,166.90***	***$ 397,191.99***
TOTAL BID	***$ 2,218,958.35***	***$ 2,262,887.78***	***$ 2,270,612.90***	***$ 3,045,138.59***

Item #	*Section*	*Item Description*	*Qty*	*Unit*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*
22	1205	Thermoplastic Pavement Marking Lines, 8", 90 mils	23	LF	$ 5.75	$ 132.25	$ 7.00	$ 161.00	$ 8.00	$ 184.00	$ 6.90	$ 158.70
23	1412	Underpass Lighting- Luminaires	10	EA	$ 160.00	$ 1,600.00	$ 850.00	$ 8,500.00	$ 3,500.00	$ 35,000.00	$ 920.00	$ 9,200.00
24	1412	Underpass Lighting -Circuitry	1	LS	$ 2,650.00	$ 2,650.00	$ 30,250.00	$ 30,250.00	$ 25,000.00	$ 25,000.00	$ 37,535.00	$ 37,535.00
25	1408	Light Control Equipment	2	EA	$ 18,000.00	$ 36,000.00	$ 17,250.00	$ 34,500.00	$ 12,500.00	$ 25,000.00	$ 20,115.00	$ 40,230.00
26	1410	Feeder Circuits (Bollards #12AWG)	720	LF	$ 14.00	$ 10,080.00	$ 18.65	$ 13,428.00	$ 35.00	$ 25,200.00	$ 21.00	$ 15,120.00
27	1715	Directional Drill 1-1” Conduit	90	LF	$ 73.00	$ 6,570.00	$ 35.00	$ 3,150.00	$ 95.00	$ 8,550.00	$ 43.00	$ 3,870.00
28	1715	Directional Drill 1-2” Conduit	154	LF	$ 86.00	$ 13,244.00	$ 55.00	$ 8,470.00	$ 95.00	$ 14,630.00	$ 66.00	$ 10,164.00
29	SP-01	Comprehensive Grading	1	LS	$ 356,085.00	$ 356,085.00	$ 425,000.00	$ 425,000.00	$ 459,000.00	$ 459,000.00	$ 433,040.00	$ 433,040.00
30	SP-03	Select Material	25	TN	$ 75.00	$ 1,875.00	$ 48.00	$ 1,200.00	$ 75.00	$ 1,875.00	$ 45.00	$ 1,125.00
31	SP-05	Traffic Control	1	LS	$ 100,000.00	$ 100,000.00	$ 80,000.00	$ 80,000.00	$ 35,000.00	$ 35,000.00	$ 250,000.00	$ 250,000.00
32	SP-06	6" Concrete Wheelchair Ramps	383	SY	$ 100.00	$ 38,300.00	$ 135.00	$ 51,705.00	$ 175.00	$ 67,025.00	$ 160.00	$ 61,280.00
33	SP-07	Painting Existing Structure and Pollution Control	1	LS	$ 161,000.00	$ 161,000.00	$ 175,000.00	$ 175,000.00	$ 45,000.00	$ 45,000.00	$ 115,000.00	$ 115,000.00
34	SP-08	Cast in Place (CIP) Gravity Retaining Walls	12	CY	$ 2,000.00	$ 24,000.00	$ 1,750.00	$ 21,000.00	$ 2,300.00	$ 27,600.00	$ 6,000.00	$ 72,000.00
35	SP-09	Soil Nail Retaining Wall	2943	SF	$ 112.00	$ 329,616.00	$ 42.00	$ 123,606.00	$ 105.00	$ 309,015.00	$ 172.00	$ 506,196.00
36	SP-09	Soil Nail Verification	2	EA	$ 7,400.00	$ 14,800.00	$ 9,000.00	$ 18,000.00	$ 12,500.00	$ 25,000.00	$ 2,660.00	$ 5,320.00
37	SP-09	Soil Nail Proof Tests	4	EA	$ 2,100.00	$ 8,400.00	$ 2,750.00	$ 11,000.00	$ 7,500.00	$ 30,000.00	$ 3,000.00	$ 12,000.00
38	SP-10	Root Excavation & Cutting	50	LF	$ 12.00	$ 600.00	$ 40.00	$ 2,000.00	$ 150.00	$ 7,500.00	$ 150.00	$ 7,500.00
39	SP-11	Planting Soil Mix	475	CY	$ 65.00	$ 30,875.00	$ 42.00	$ 19,950.00	$ 75.00	$ 35,625.00	$ 76.00	$ 36,100.00
40	SP-12	Conduit, PVC, 1", Schedule 80	1110	LF	$ 12.00	$ 13,320.00	$ 18.00	$ 19,980.00	$ 22.00	$ 24,420.00	$ 18.00	$ 19,980.00
41	SP-12	Conduit, PVC, 2", Schedule 80	1946	LF	$ 16.00	$ 31,136.00	$ 20.00	$ 38,920.00	$ 27.00	$ 52,542.00	$ 24.00	$ 46,704.00
42	SP-13	Pull Box, Duke, (24" x 36" x 24")	37	EA	$ 1,400.00	$ 51,800.00	$ 5,250.00	$ 194,250.00	$ 750.00	$ 27,750.00	$ 5,875.00	$ 217,375.00
43	SP-16	Decorative Concrete Pentagonal Paving	1560	SF	$ 65.00	$ 101,400.00	$ 41.00	$ 63,960.00	$ 55.00	$ 85,800.00	$ 50.00	$ 78,000.00
44	SP-17	Concrete Unit Pavers (with Latex mortar bed)	4195	SF	$ 42.00	$ 176,190.00	$ 36.00	$ 151,020.00	$ 35.00	$ 146,825.00	$ 44.00	$ 184,580.00

BIDTAB

Project Name:	**I-77 West Trade Underpass Enhancement**		BIDDER	BIDDER	BIDDER	BIDDER
Project #:	**512-16-070**		1	2	3	4
Bid Number:	**HC2018-1535**					
Estimate $:	$1,515,000.00		**Sealand Contractors Corp.**	**Nassiri Development**	**OnSite Development, LLC.**	**Blythe Development Company**
Bid Opening Date:	Thursday, June 13, 2019					
AC Adjust $:	$505.45		***$ 1,929,529.00***	***$ 1,967,728.50***	***$ 1,974,446.00***	***$ 2,647,946.60***
Contingency:	15%		***$ 289,429.35***	***$ 295,159.28***	***$ 296,166.90***	***$ 397,191.99***
		TOTAL BID	***$ 2,218,958.35***	***$ 2,262,887.78***	***$ 2,270,612.90***	***$ 3,045,138.59***

Item #	*Section*	*Item Description*	*Qty*	*Unit*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*	*Unit Price*	*Line Total*
45	SP-18	Site Furnishings	1	LS	$ 120,000.00	$ 120,000.00	$ 68,000.00	$ 68,000.00	$ 45,000.00	$ 45,000.00	$ 110,000.00	$ 110,000.00

JOEL E. WOOD & ASSOCIATES
PLANNING • ENGINEERING • MANAGEMENT

GEOTECHNICAL INVESTIGATION
SOIL NAIL WALL
WEST TRADE / I-77 UNDERPASS ENHANCEMENT
CHARLOTTE, NORTH CAROLINA

For

AECOM

June 7, 2018

JWA File No.: 180510

P.O. Box 296
Clover, South Carolina 29710
2160 Filbert Highway
York, South Carolina 29745
Tel. (803) 684-3390 • Fax. (803) 628-2891
EMAIL: cewood@comporium.net

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104 N. Dilling St.
Kings Mountain, NC
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P.O. Box 296
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Tel.: (704) 739-2565
Fax.: (704) 739-2565

June 7, 2018

Mr. Chris Petterson, PE
AECOM
6000 Fairview Rd, Suite 200
Charlotte, NC 28210

Re.: Geotechnical Report
Soil Nail Wall
West Trade / I-77 Underpass Enhancement
Charlotte, North Carolina

Dear Mr. Petterson:

Submitted herein is the report of our geotechnical evaluation for the above referenced project. Included is a summary of our field investigation, findings, and recommendations.

It has been a pleasure working for you on this project and we appreciate the opportunity to be of service. Please notify us if there are any questions or if we may be of further assistance with the implementation of our recommendations.

Sincerely,

JOEL E. WOOD & ASSOCIATES

Christopher E. Wood, P.E.
President

JOEL E. WOOD & ASSOCIATES
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Table of Contents

1.0 INTRODUCTION

1.1 General

A geotechnical investigation has been performed for the soil nail wall proposed for the West Trade / I-77 Underpass Enhancement Project in Charlotte, North Carolina. The investigation was authorized by AECOM under Purchase Order 100524ACM.

1.2 Project Objectives

The primary objectives of this investigation were to gather information on subsurface conditions and develop recommendations for construction of the soil nail retaining wall. The objectives were accomplished by executing the following:

1. Advancing soil test borings to provide data on soil stratigraphy and to obtain samples for laboratory analysis;
2. Performing laboratory analyses on select samples to determine soil index properties and design parameters; and
3. Performing engineering analyses to develop design guidelines and recommendations.

1.3 Project Description

The project will consist of pedestrian enhancements for the West Trade / I-77 Underpass which will include a soil nail retaining wall. The maximum height of the wall will be approximately 11 feet tall and extend under the I-77 overpass for the sidewalk and pedestrian enhancements proposed along West Trade Street. The general layout of the wall is depicted on the Soil Test Boring Location Plans in Appendix A.

Subsequent sections of this report contain descriptions of the field investigation, findings, and design recommendations.

2.0 FIELD INVESTIGATION

On May 9 and 10, 2018, four soil test borings (B-1 to B-4) were advanced to depths ranging from approximately 20 to 30 feet below existing grades. The soil test borings were advanced utilizing a Diebrich D50 track mounted drill rig and hollow stem augers. Standard split-spoon samples (SPT tests) were obtained at regular intervals throughout the depths of the boring in general accordance with ASTM D-1586 to determine the relative densities and consistencies of the subsurface soils. Shelby tube samples were also collected at the borings locations for consolidated undrained triaxial shear tests on relatively undisturbed embankment soils. In addition, vane shear tests were performed

at shallow depths adjacent to the borings in order to evaluate short term shear strength parameters and are provided on the boring logs.

All of the collected soil samples were sealed in containers and transported to the laboratory for further examination. The soil samples were visually classified based upon the Unified Soil Classification System. The locations of the borings were determined in the field by Joel E. Wood & Associates personnel based upon the provided plan. The approximate locations of the soil test borings are provided on the Boring Location Plans in Appendix A.

3.0 LABORATORY TESTING

Select samples were tested in the laboratory to determine applicable physical and engineering properties. The laboratory program included grain size distribution and Atterberg limits tests to evaluate the index properties of the soils and to verify classification of the soils in accordance with the Unified Soil Classification System (USCS). Consolidated undrained triaxial shear tests with pore water measurement were utilized to evaluate both the short term and long term (effective) strength parameters of the embankment soils for utilization in the retaining wall evaluation. The results of the laboratory test program are presented in Appendix A.

4.0 SITE & SUBSURFACE CONDITIONS

4.1 Site Location and Description

ITEM	DESCRIPTION
Location	The site is located at the West Trade Street underpass at the intersection of I-77 in Charlotte, NC.
Existing Development	The site currently consists of the West Trade Street and I-77 Interchange. Work was on-going along West Trade Street.
Current Ground Cover	Mostly grassed within the interchange with asphalt paving on the ramps and roadways.
Existing Topography	The existing embankment is approximately 25 feet tall with the overpass sloping down from I-77 to West Trade Street.

4.2 Area Geology

The project is situated in Piedmont Province of North Carolina. Geologic mapping indicates that the site is underlain by metamorphosed quartz diorite and tonalite rock. The Piedmont comprises the area from the foothills of the mountains to the "Fall Line." This dissected peneplain surface slopes from elevations of about 2,000 feet in the northwest to about 400 feet along the southeast boundary. The Piedmont has a rolling to gently undulating land surface dissected by streams typically with dentritic patterns. The "Fall Line" represents the change from igneous and metamorphic rocks of the Piedmont to unconsolidated sediments of the Coastal Plain. Piedmont rocks range from low rank

metamorphosed sediments and volcanics to high rank metasedimentary and metaigneous rocks and intrusive acid to basic igneous rocks. These rocks are folded and faulted and are thought to be the late Precambrian to early Paleozoic in age. Mineral resources consist of granite, vermiculite, kyanite, barite, gold, silver, copper, sericite, manganese asbestos, topaz, pyrophyllite, and shale.

Soils in the Piedmont have clayey to loamy surface layers and clay subsoils. These soils have undergone moderate to severe erosion. Alluvial soils have developed along the major stream courses. Most of the soils of the Piedmont have developed from the chemical weathering of crystalline bedrock, so that rock type and soil type are closely related.

4.3 Soil Stratigraphy

In general, the soil test borings encountered approximately 6 to 8 inches of topsoil below the ground surface. Below the surface materials, the embankment soils generally consist of firm to very stiff elastic silt with sand (MH) and sandy silt (ML) in general accordance with the Unified Soil Classification System (USCS). The standard penetration values (N-values) range from 5 to 19 blows per foot (bpf). Below the embankment soils, the residual soils consist of loose to dense silty sands (SM) to boring termination. The N-values in the silty sands range from 6 to 54 bpf. A general soil profile with design parameters utilized in the analysis of the proposed soil nail wall is provided in Figure 4 of Appendix A.

Detailed descriptions of the soils encountered are provided on the boring logs in the Appendix. As with any geologic formation, the depth and thickness of the soil strata will vary across the site. Although we have designated strata changes at specific depths in our description of the soil stratigraphy and on the boring logs in the Appendix, transitions between soil strata are generally gradual. Therefore, the outlined subsurface data should only be considered general on-site soil conditions and should not be utilized as an absolute indicator.

4.4 Groundwater

Groundwater was not encountered within the depths of the soil test borings at the time of the field investigation. Regardless, positive site drainage should be maintained at all times and contingencies should be made for dealing with perched groundwater within excavations if excavations are open during rain events.

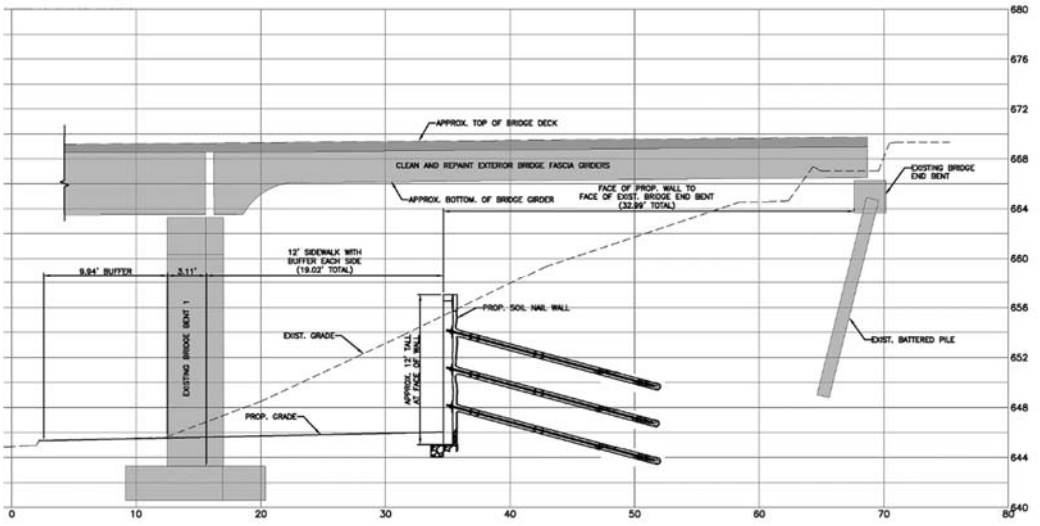
5.0 RECOMMENDATIONS AND CONCLUSIONS

The recommendations presented in this report are based upon the general soil conditions encountered in the soil test borings, our analyses of the site and subsurface conditions, and our experience on similar projects. The recommendations do not reflect variations in subsurface conditions or the presence of unsuitable soil conditions and obstructions. If subsurface conditions are discovered that would impact the assumptions developed in

the design process, JOEL E. WOOD & ASSOCIATES should be contacted to evaluate the impact of the identified conditions.

5.1 Soil Nail Retaining Wall Recommendations

A soil nail wall is proposed under the I-77 overpass for the grades to accommodate the proposed pedestrian enhancements. The maximum wall height will be approximately 11 feet as indicated in the cross section presented below.



Soil design parameters have been developed from the laboratory test program and empirical relationships between soil types and N-values. These design parameters are presented in the generalized soil profile, Figure 4, in Appendix A and have been utilized in the evaluation of the soil nail wall.

A geotechnical analysis was performed utilizing the FHWA software Snap_2 in order to analyze nail spacing and pullout, global stability, bearing capacity, and sliding. Both a short term undrained analysis with seismic loading and a long-term drained static analysis were considered. Seismic loading was based upon a peak ground acceleration of 0.12 g. The results of each evaluation are presented in Appendices B and C. Within the data provided in the Appendices are a complete summary of the assumed wall facing components utilized in the evaluation for review by the structural engineer. The factors of safety utilized in the evaluation are as follows.

Failure Mode	Resisting Component	Symbol	Minimum Recommended Factors of Safety		
			Static Loads[1]		Seismic Loads[2] (Temporary and Permanent Structures)
			Temporary Structure	Permanent Structure	
External Stability	Global Stability (long-term)	FS_G	1.35	1.5[1]	1.1
	Global Stability (excavation)	FS_G	1.2-1.3[2]		NA
	Sliding	FS_{SL}	1.3	1.5	1.1
	Bearing Capacity	FS_H	2.5[3]	3.0[3]	2.3[5]
Internal Stability	Pullout Resistance	FS_P	2.0		1.5
	Nail Bar Tensile Strength	FS_T	1.8		1.35
Facing Strength	Facing Flexure	FS_{FF}	1.35	1.5	1.1
	Facing Punching Shear	FS_{FP}	1.35	1.5	1.1
	H.-Stud Tensile (A307 Bolt)	FS_{HT}	1.8	2.0	1.5
	H.-Stud Tensile (A325 Bolt)	FS_{HT}	1.5	1.7	1.3

Based upon our evaluation, we recommend a soil nail wall with the following configuration:

- Temporary Facing: Welded Wire Mesh with 4 in. Shotcrete
- Permanent Facing: 8 in. Cast in Place Concrete
- Nail: 1 in. Diameter Bar w/ Minimum 8 in. Diameter Augered Drill Hole
- Nail Spacing: 3 ft x 3 ft
- Nail Length: 18 ft
- Nail Angle: 15°
- Geotechnical Drainage Composite Behind Wall
- 1 Foot Wall Embedment with 6 in. Gravel Leveling Pad

A detailed specification should also be developed to ensure a proper construction and monitoring program along with both verification and proof testing of designated nails. Proof testing should be performed on at least 5 percent of the production soil nails in each row.

All open excavations should adhere to OSHA regulations and guidelines for maintaining safe working conditions.

6.0 LIMITATIONS OF REPORT

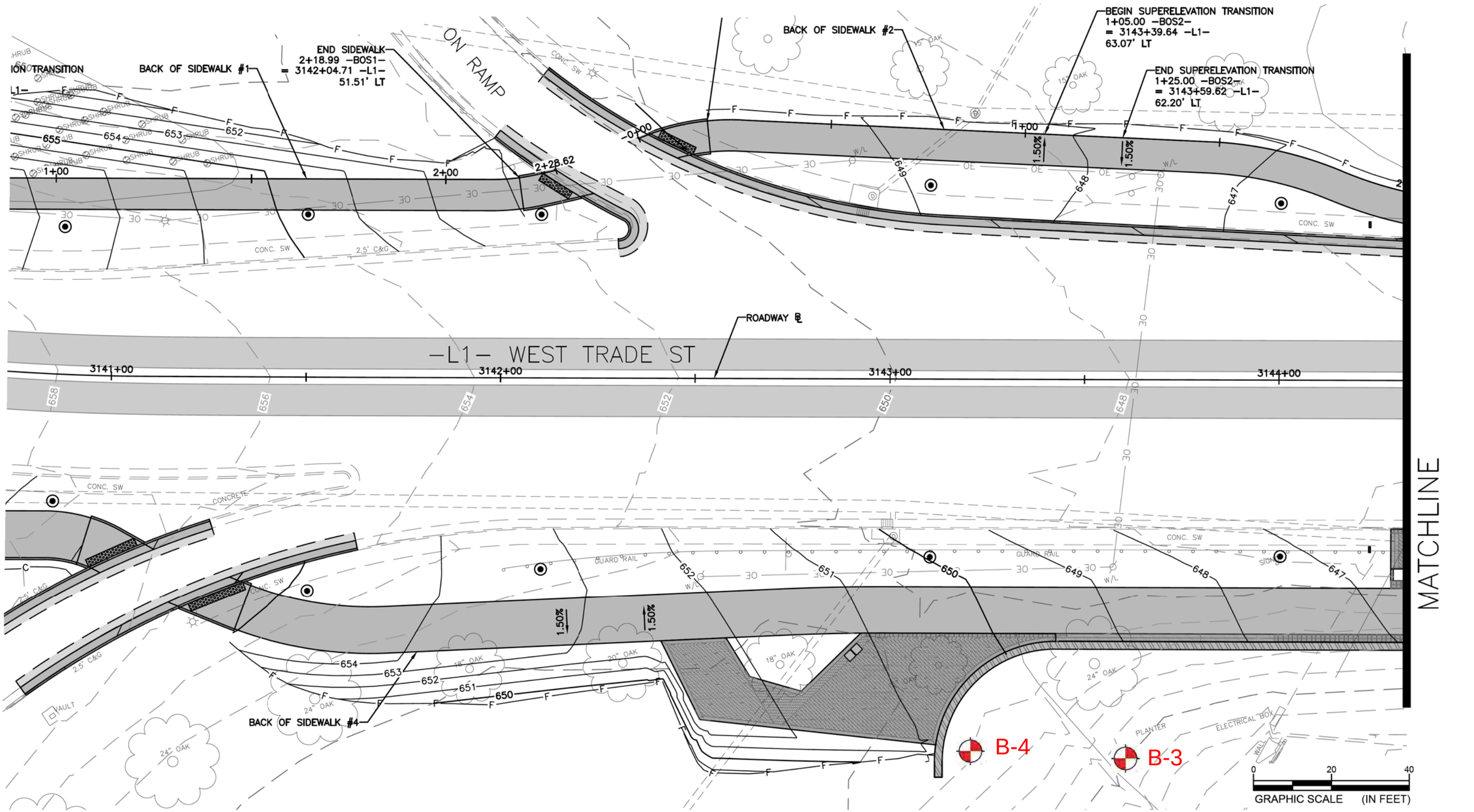
This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained herein are based upon applicable standards in this geographic area at the time this report was prepared. No other warranty, expressed or implied, is made.

The analyses and recommendations submitted herein are based, in part, upon the data obtained from the subsurface exploration. The nature and extent of variations between the borings will not become evident until construction begins. If variations appear evident, we request the opportunity to re-evaluate the recommendations in this report. In the event that any changes in nature or design of the project are planned, the recommendations contained in the report will not be considered valid unless the changes are reviewed and verified in writing.

APPENDIX A

SITE LOCATION

FIGURE 1
WEST TRADE/I-77 UNDERPASS



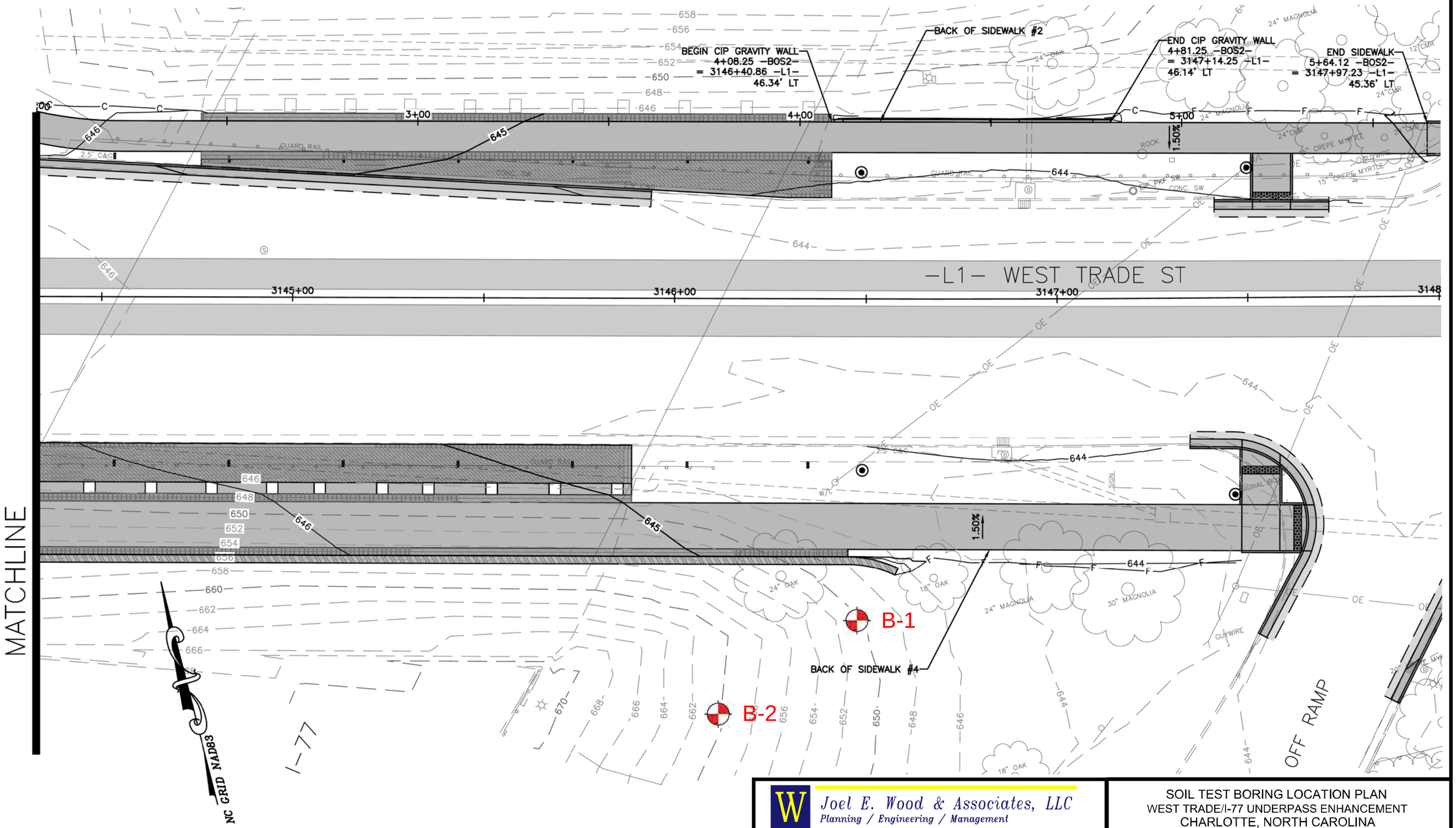
BORING LOCATIONS ARE APPROXIMATE

Joel E. Wood & Associates, LLC
Planning / Engineering / Management

AECOM

SOIL TEST BORING LOCATION PLAN
WEST TRADE/I-77 UNDERPASS ENHANCEMENT
CHARLOTTE, NORTH CAROLINA

DRAWN BY:	N/A	SCALE:	SHOWN
CHECKED BY:	N/A	PROJECT:	180510
APPROVED BY:	N/A	FIGURE:	2



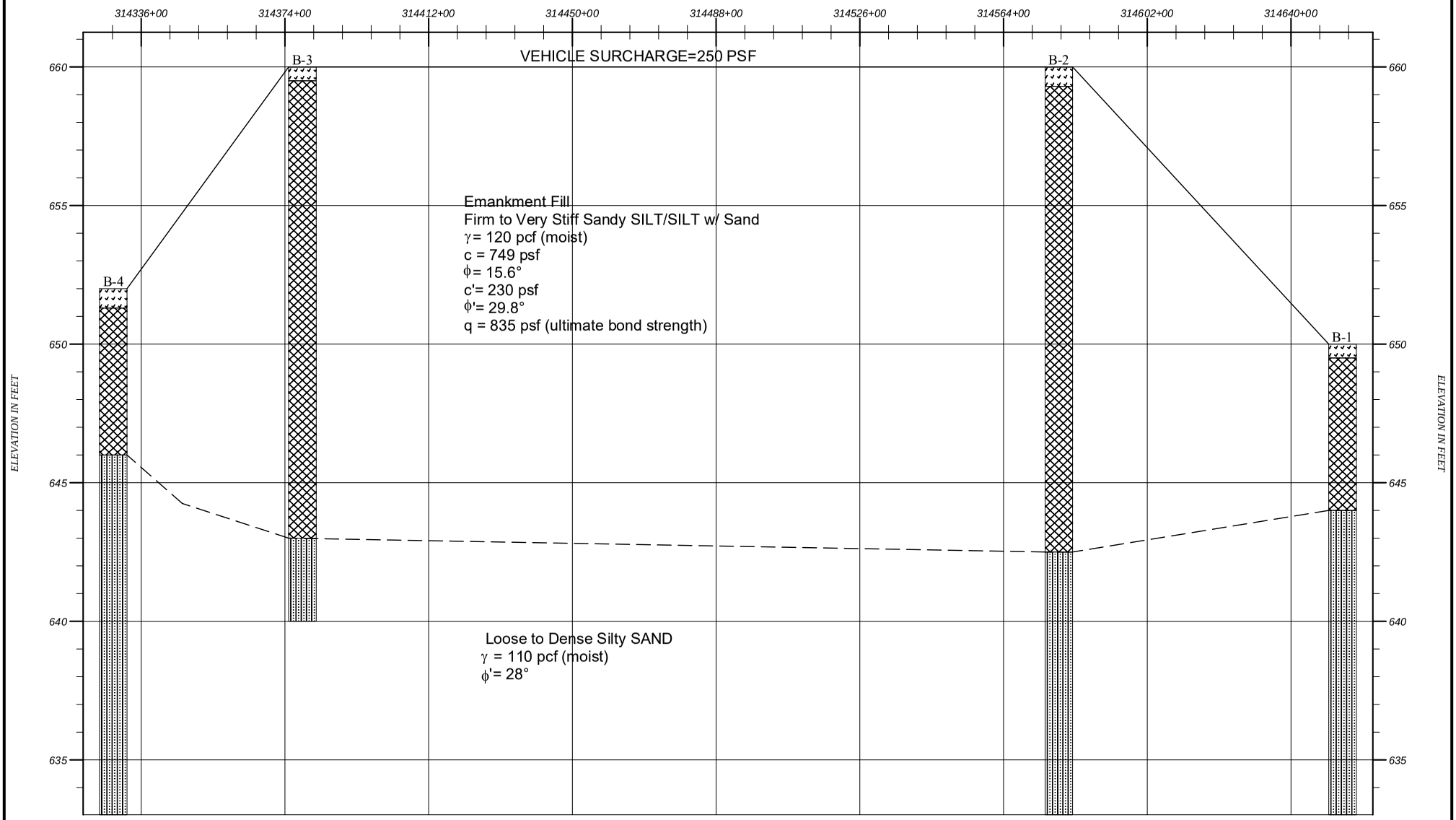
BORING LOCATIONS ARE APPROXIMATE

Joel E. Wood & Associates, LLC
Planning / Engineering / Management

AECOM

SOIL TEST BORING LOCATION PLAN
WEST TRADE/I-77 UNDERPASS ENHANCEMENT
CHARLOTTE, NORTH CAROLINA

DRAWN BY:	N/A	SCALE:	SHOWN
CHECKED BY:	N/A	PROJECT:	180510
APPROVED BY:	N/A	FIGURE:	3



Plan View

Strata symbols

- Topsoil
- Fill
- Silty SAND

JOEL E. WOOD & ASSOCIATES

GENERALIZED SOIL PROFILE

HORIZONTAL SCALE: 1"=(proportional)'	DRAWN BY/APPROVED BY	DATE
VERTICAL SCALE: 1"=5'		6/7/2018

West Trade/I-77 Underpass
Charlotte, NC

PROJECT NO. 180510

FIGURE 4

JOEL E. WOOD & ASSOCIATES

PLANNING • ENGINEERING • MANAGEMENT

West Trade/I-77 Underpass
Charlotte, NC

LOG OF BORING No. B-1

Station: 314650
Offset:

Date Drilled: 5/9/18 | Supervisor: HAB | Notes: Diedrich D50 Track Rig

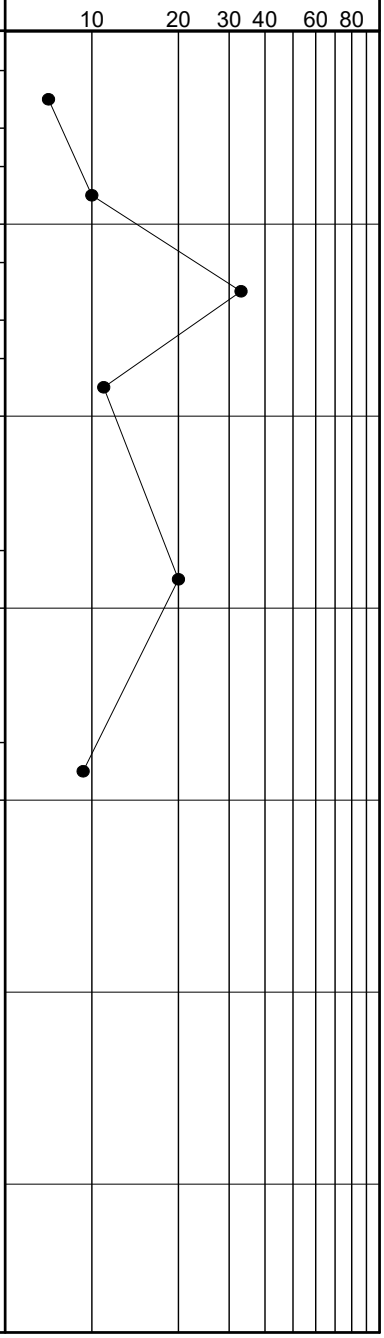
Casing Length: N/A | Ground Elevation: 650.0

Hammer Type: ☐ Gravity ☒ Automatic ☐ Other:

Water Level: N/A ATD, hours AD | Drilling Method: HSA

Elevation (ft.)	Depth (ft.)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft.)	Sample No./Type	1st 6 in.	2nd 6 in.	3rd 6 in.	N Value
650	0.5	Topsoil		1.0	SS-1	2	3	2	5
		Firm to Stiff Dark Red Sandy SILT (ML) - Fill		3.5	SS-2	2	5	5	10
		q = 2530 psf							
645	6.0	Dense to loose Tan Silty SAND (SM)		6.0	SS-3	5	8	25	33
				8.5	SS-4	3	6	5	11
640									
				13.5	SS-5	7	8	12	20
635									
				18.5	SS-6	3	4	5	9
630	20.0	Boring Terminated @ 20.0 Feet							
625									
620									

STD. PENETRATION TEST DATA (blows/foot)



LEGEND

SAMPLER TYPE				DRILLING METHOD			
SS	- Split Spoon	NQ	- Rock Core, 1-7/8"	HSA	- Hollow Stem Auger	RW	- Rotary Wash
ST	- Shelby Tube	CU	- Cuttings	CFA	- Continuous Flight Augers	RC	- Rock Core
AWG	- Rock Core, 1-1/8"	CT	- Continuous Tube	DC	- Driving Casing		

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West Trade/I-77 Underpass
Charlotte, NC

LOG OF BORING No. B-2

Station: 314575
Offset:

Date Drilled: 5/9/18 | Supervisor: HAB | Notes: Diedrich D50 Track Rig

Casing Length: N/A | Ground Elevation: 660.0

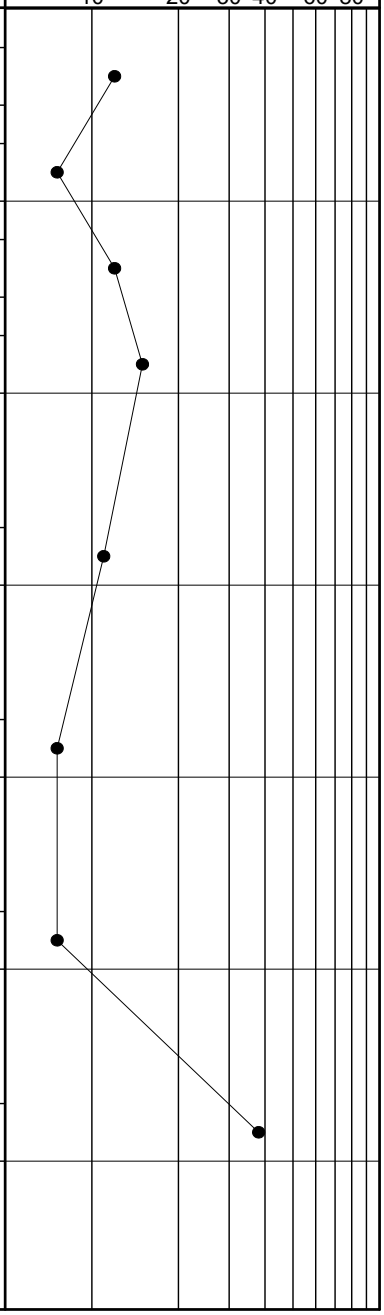
Hammer Type: ☐ Gravity ☒ Automatic ☐ Other:

Water Level: N/A ATD, hours AD | Drilling Method: HSA

Elevation (ft.)	Depth (ft.)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6 in.	2nd 6 in.	3rd 6 in.	N Value
660	0.7	Topsoil	1.0	SS-1	6	6	6	12
		Stiff to Firm Tan Sandy SILT (ML) - Fill q = 1730 psf	3.5	SS-2	3	2	4	6
655		Stiff Red Sandy SILT (ML) - FIll	6.0	SS-3	5	6	6	12
			8.5	SS-4	4	7	8	15
650								
			13.5	SS-5	4	5	6	11
645								
	17.5	Loose Red and Tan Silty SAND (SM)	18.5	SS-6	3	3	3	6
640								
		Loose to Dense Tan, White, and Black Silty SAND (SM)	23.5	SS-7	2	3	3	6
635								
			28.5	SS-8	12	16	22	38
630	30.0	Boring Terminated @ 30.0 Feet						

STD. PENETRATION TEST DATA (blows/foot)

10 20 30 40 60 80



LEGEND

SAMPLER TYPE				DRILLING METHOD			
SS	- Split Spoon	NQ	- Rock Core, 1-7/8"	HSA	- Hollow Stem Auger	RW	- Rotary Wash
ST	- Shelby Tube	CU	- Cuttings	CFA	- Continuous Flight Augers	RC	- Rock Core
AWG	- Rock Core, 1-1/8"	CT	- Continuous Tube	DC	- Driving Casing		

JOEL E. WOOD & ASSOCIATES

PLANNING • ENGINEERING • MANAGEMENT

West Trade/I-77 Underpass
Charlotte, NC

LOG OF BORING No. B-3

Station: 314375
Offset:

Date Drilled: 5/9/18
Supervisor: HAB
Notes: Diedrich D50 Track Rig

Casing Length: N/A
Ground Elevation: 660.0

Hammer Type: ☐ Gravity ☒ Automatic ☐ Other:

Water Level: N/A ATD, hours AD
Drilling Method: HSA

Elevation (ft.)	Depth (ft.)	MATERIAL DESCRIPTION	Sample Depth (ft.)	Sample No./Type	1st 6 in.	2nd 6 in.	3rd 6 in.	N Value
660	0.5	Topsoil	1.0	SS-1	5	3	4	7
		Firm to Very Stiff Red Elastic SILT with Sand (MH) - Fill	3.5	SS-2	1	4	3	7
655			6.0	SS-3	6	9	10	19
		Very Stiff to Firm Red and Tan Sandy SILT (ML) - Fill	8.5	SS-4	4	7	9	16
650								
			13.5	SS-5	2	3	2	5
645								
	17.0	Dense Tan and Black Silty SAND (SM)	18.5	SS-6	14	17	28	45
640	20.0	Boring Terminated @ 20.0 Feet						
635								
630								

STD. PENETRATION TEST DATA (blows/foot)
10 20 30 40 60 80

LEGEND

SAMPLER TYPE

SS	- Split Spoon	NQ	- Rock Core, 1-7/8"
ST	- Shelby Tube	CU	- Cuttings
AWG	- Rock Core, 1-1/8"	CT	- Continuous Tube

DRILLING METHOD

HSA	- Hollow Stem Auger	RW	- Rotary Wash
CFA	- Continuous Flight Augers	RC	- Rock Core
DC	- Driving Casing		

JOEL E. WOOD & ASSOCIATES

PLANNING • ENGINEERING • MANAGEMENT

West Trade/I-77 Underpass
Charlotte, NC

LOG OF BORING No. B-4

Station: 314325
Offset:

Date Drilled: 5/10/18 | Supervisor: HAB | Notes: Diedrich D50 Track Rig

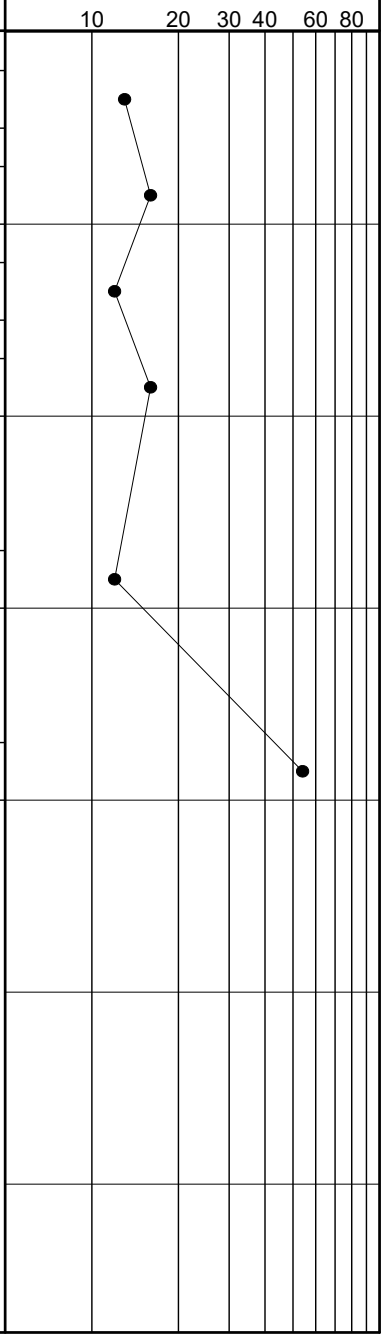
Casing Length: N/A | Ground Elevation: 652.0

Hammer Type: ☐ Gravity ☒ Automatic ☐ Other:

Water Level: N/A ATD, hours AD | Drilling Method: HSA

Elevation (ft.)	Depth (ft.)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft.)	Sample No./Type	1st 6 in.	2nd 6 in.	3rd 6 in.	N Value
650	0.7	Topsoil Stiff to Very Stiff Red and Tan Sandy SILT (ML) - Fill		1.0	SS-1	5	4	9	13
				3.5	SS-2	5	7	9	16
645	6.0	Firm to Very Dense Red and Dark Tan Silty SAND (SM)		6.0	SS-3	5	6	6	12
				8.5	SS-4	4	6	10	16
640				13.5	SS-5	4	4	8	12
635				18.5	SS-6	14	24	30	54
	20.0	Boring Terminated @ 20.0 Feet							
630									
625									
620									

STD. PENETRATION TEST DATA (blows/foot)

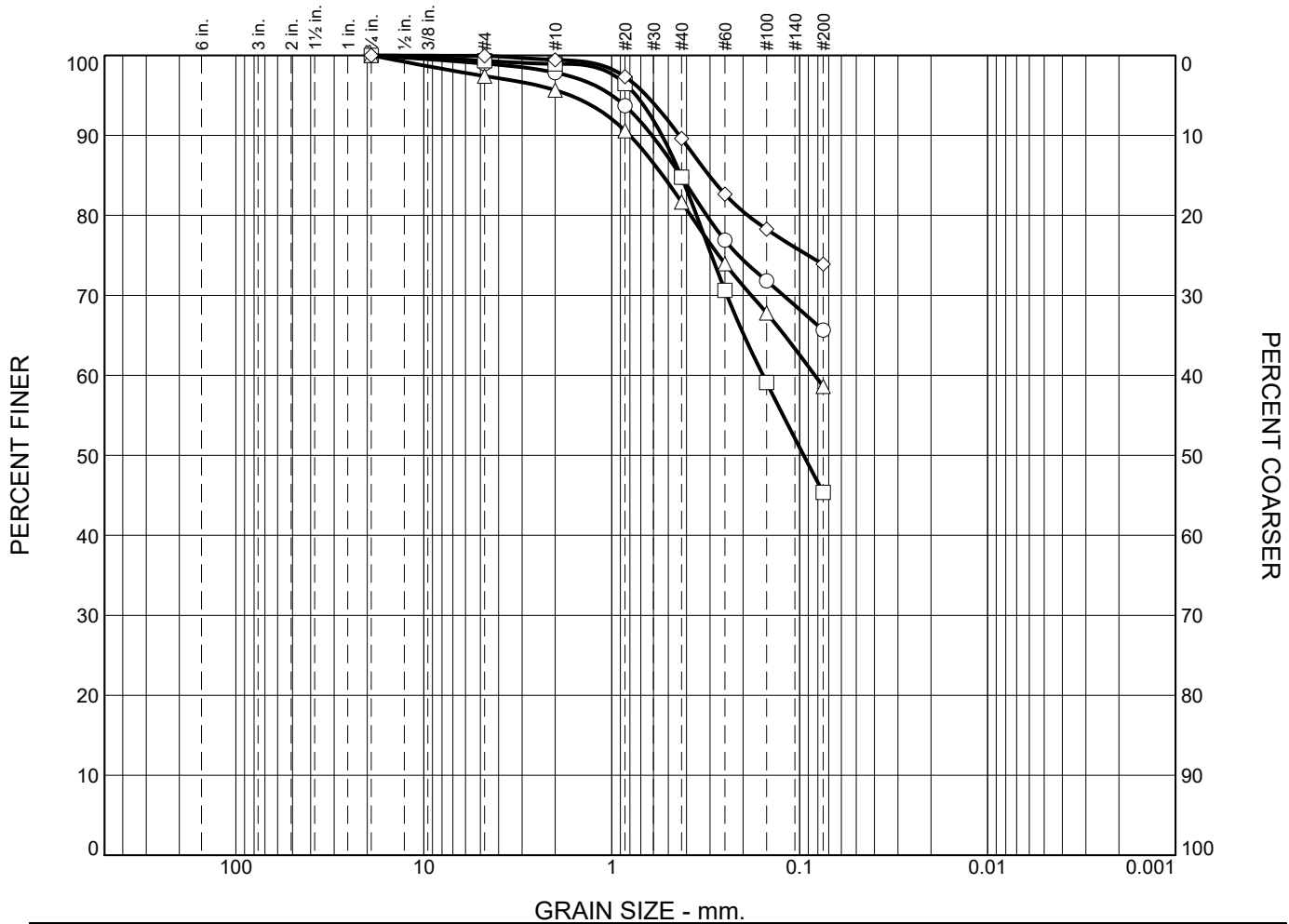


LEGEND

SAMPLER TYPE			
SS	- Split Spoon	NQ	- Rock Core, 1-7/8"
ST	- Shelby Tube	CU	- Cuttings
AWG	- Rock Core, 1-1/8"	CT	- Continuous Tube

DRILLING METHOD			
HSA	- Hollow Stem Auger	RW	- Rotary Wash
CFA	- Continuous Flight Augers	RC	- Rock Core
DC	- Driving Casing		

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.0	1.2	13.0	19.2	65.6	
□	0.0	0.0	0.7	0.4	14.1	39.4	45.4	
△	0.0	0.0	2.6	1.7	14.0	23.1	58.6	
◇	0.0	0.0	0.1	0.5	9.8	15.7	73.9	
▽								

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-1	SS-2	3.5	Sandy SILT	ML
□	B-1	SS-5	13.5	Silty SAND	SM
△	B-2	SS-2	3.5	Sandy SILT	ML
◇	B-3	SS-1	1.0	Elastic SILT w/ Sand	MH

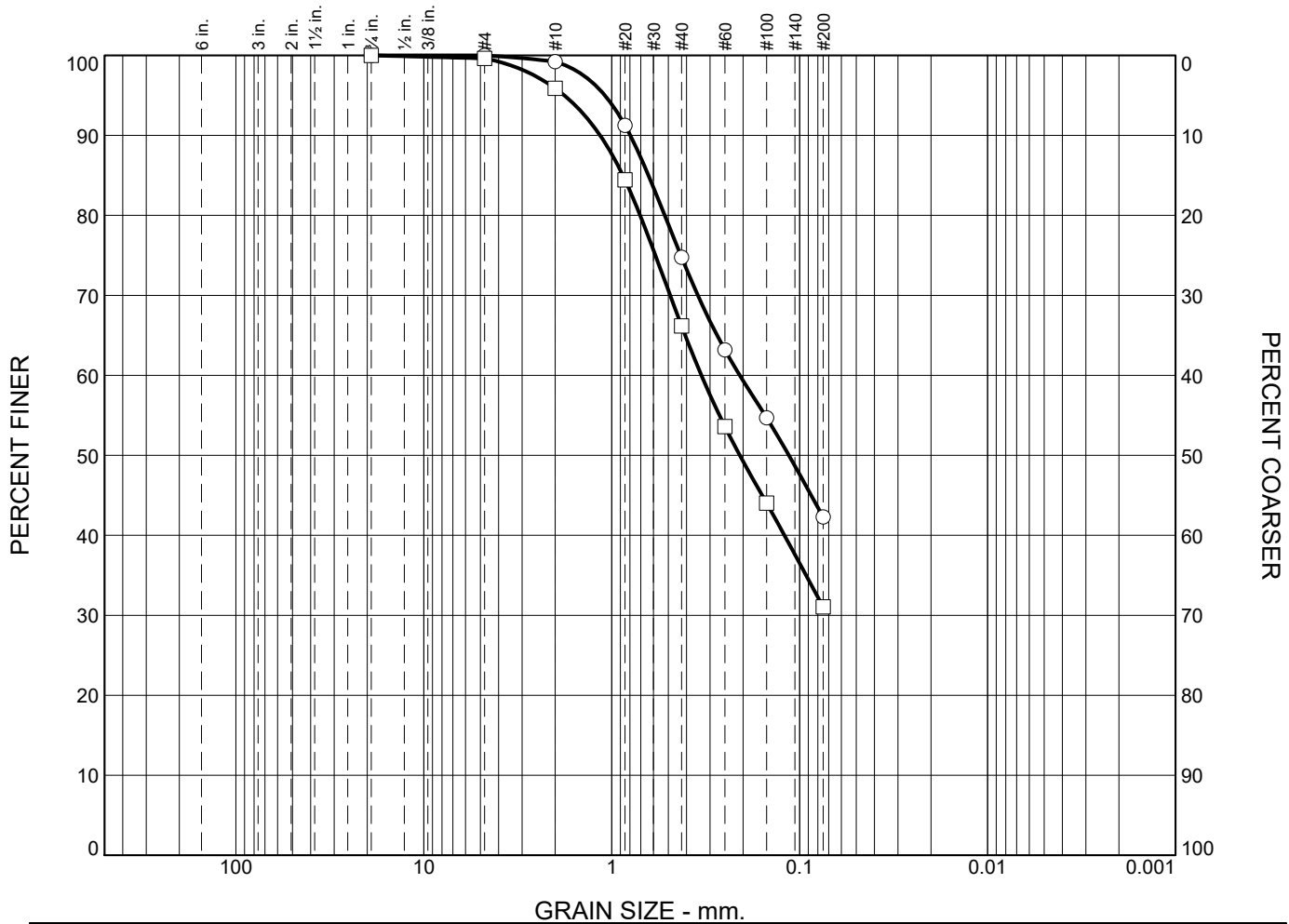
JOEL E. WOOD & ASSOCIATES, L.L.C.

Client: AECOM

Project: West Trade/I-77 Underpass
Charlotte, NC

Project No.: 180510 **Figure** GS-1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.8	24.4	32.5	42.3	
□	0.0	0.0	0.4	3.7	29.7	35.2	31.0	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	B-4	SS-3	6.0	Silty SAND	SM
□	B-4	SS-4	8.5	Silty SAND	SM

JOEL E. WOOD & ASSOCIATES, L.L.C.

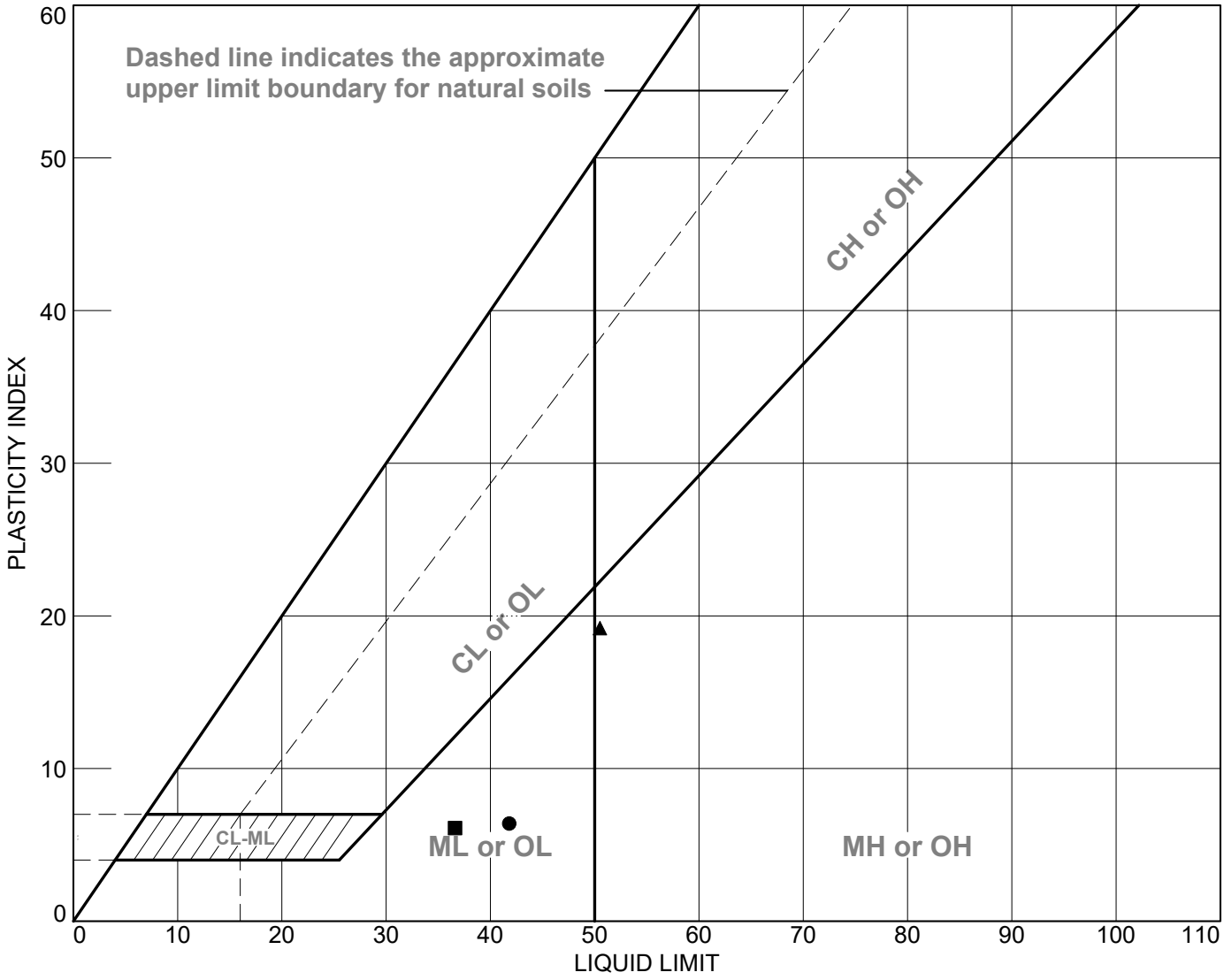
Client: AECOM

Project: West Trade/I-77 Underpass
Charlotte, NC

Project No.: 180510

Figure GS-2

LIQUID AND PLASTIC LIMITS TEST REPORT

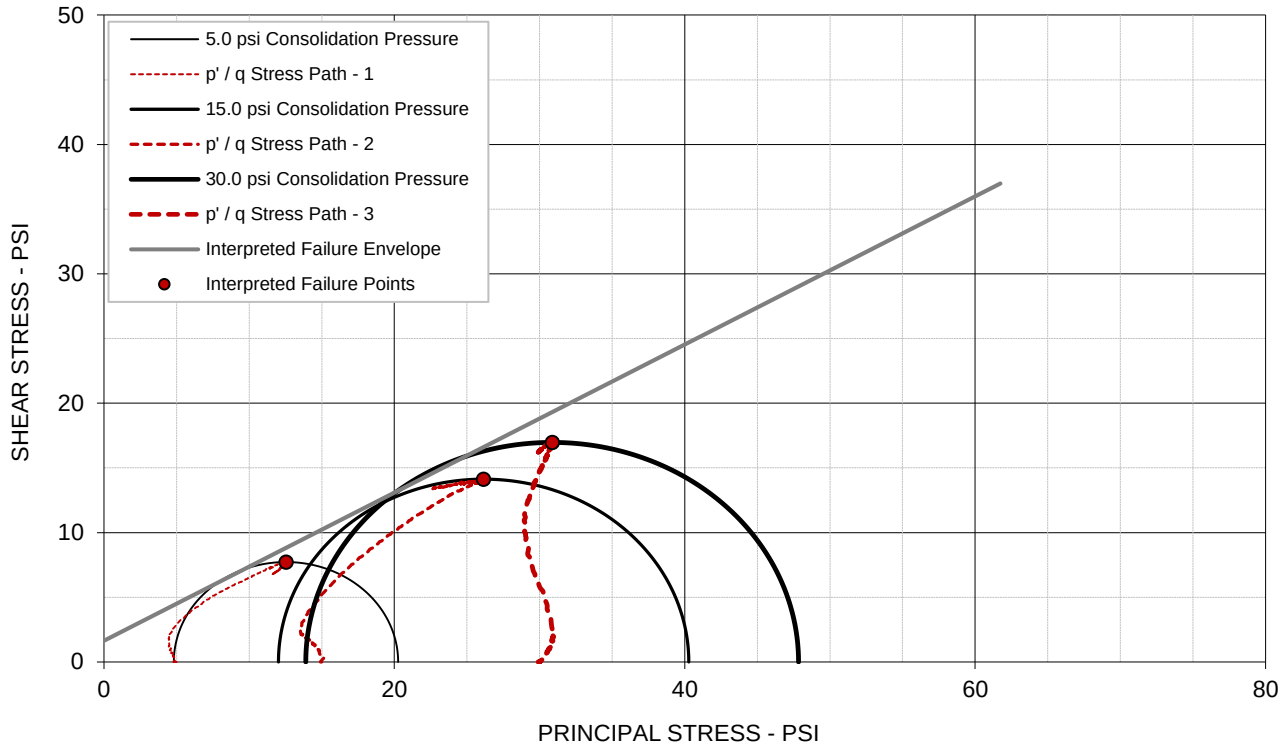


SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-1	SS-2	3.5		35.4	41.8	6.4	ML
■	B-2	SS-2	3.5		30.5	36.6	6.1	ML
▲	B-3	SS-1	1.0		31.3	50.5	19.2	MH

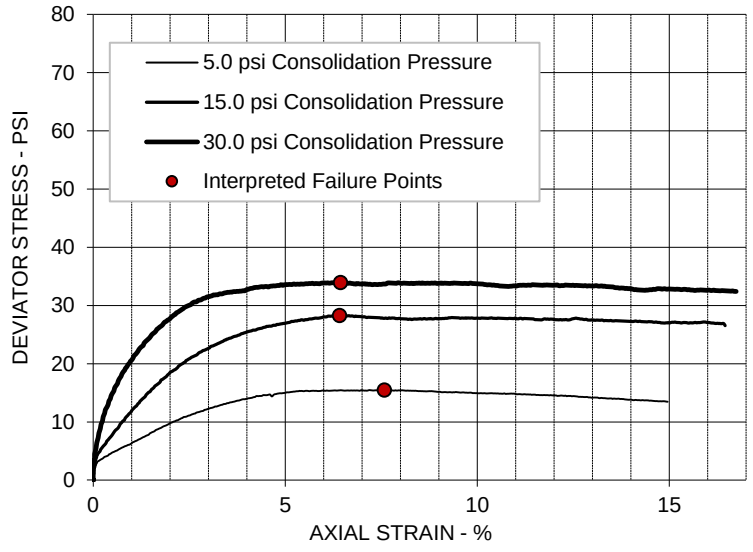
JOEL E. WOOD & ASSOCIATES, L.L.C.

Client: AECOM
Project: West Trade/I-77 Underpass
Charlotte, NC
Project No.: 180510 **Figure** AL-1

ICU TRIAXIAL COMPRESSION TEST



EFFECTIVE STRESS PARAMETERS	ϕ' = 29.8 deg	c' = 1.6 psi



SPECIMEN NO.	1	2	3
INITIAL			
Moisture Content - %	26.8	23.4	25.3
Dry Density - pcf	93.0	93.4	82.7
Diameter - inches	2.84	2.84	2.84
Height - inches	6.05	5.67	5.37
AT TEST			
Final Moisture - %	32.7	33.9	41.2
Dry Density - pcf	93.0	93.4	82.8
Calculated Diameter - in.	2.84	2.84	2.84
Height - inches	6.05	5.67	5.37
Effect. Consol. Stress - psi	5.0	15.0	30.0
Failure Stress - psi	15.45	28.26	33.94
Total Pore Pressure - psi	50.2	53.0	66.1
Strain Rate - inches/min.	0.0050	0.0050	0.0050
Failure Strain - %	7.6	6.4	6.4
σ_1' Failure - psi	20.26	40.28	47.84
σ_3' Failure - psi	4.81	12.02	13.90

TEST DESCRIPTION

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION

SAMPLE TYPE: Undisturbed

DESCRIPTION: Red & Yellow Sandy Silt

SAMPLE: B-2

ASSUMED SPECIFIC GRAVITY: 2.7

LL: 46 PL: 31 PI: 15 Percent -200: 65.1

REMARKS:

PROJECT INFORMATION

PROJECT: Joel Wood Lab Testing

LOCATION: York, SC

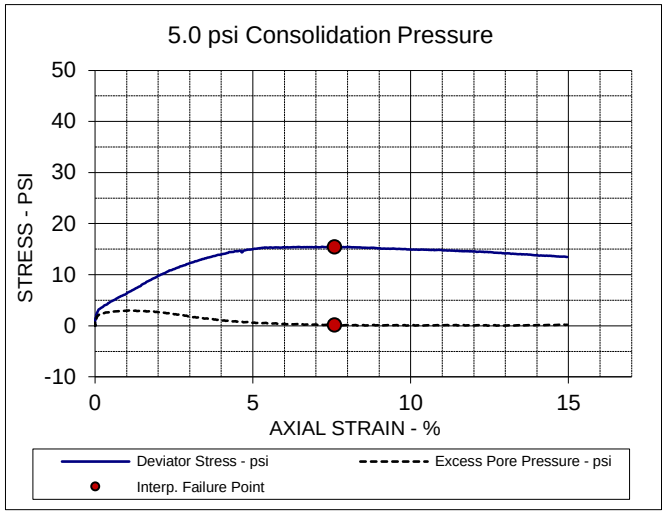
PROJECT NO: EN181105

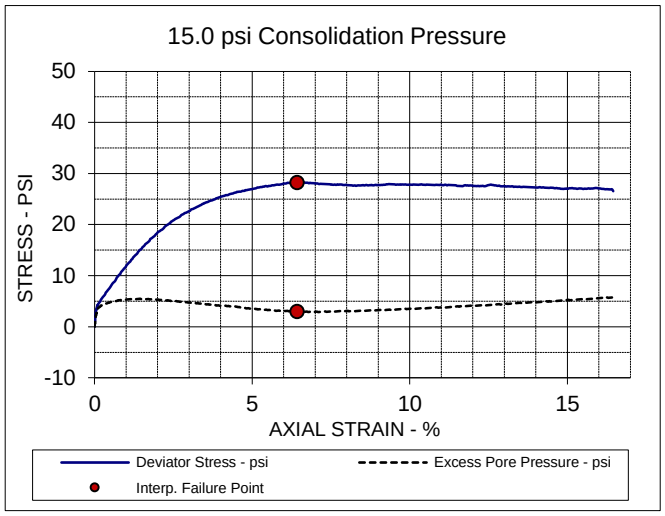
CLIENT: Joel E. Wood & Associates, LLC.

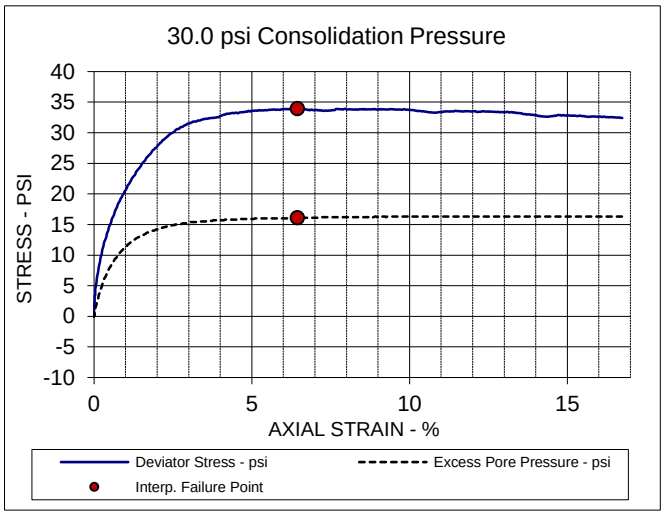
DATE: 5.29.18

1450 Fifth St W
North Charleston, SC

Terracon

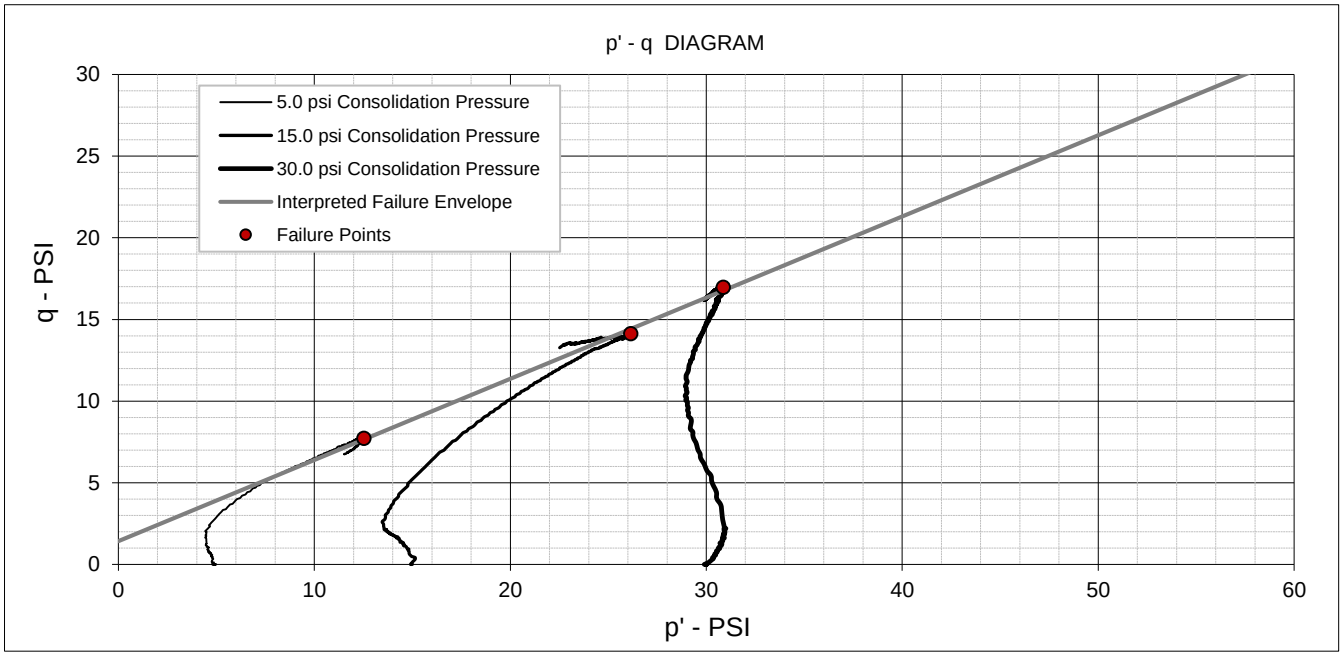






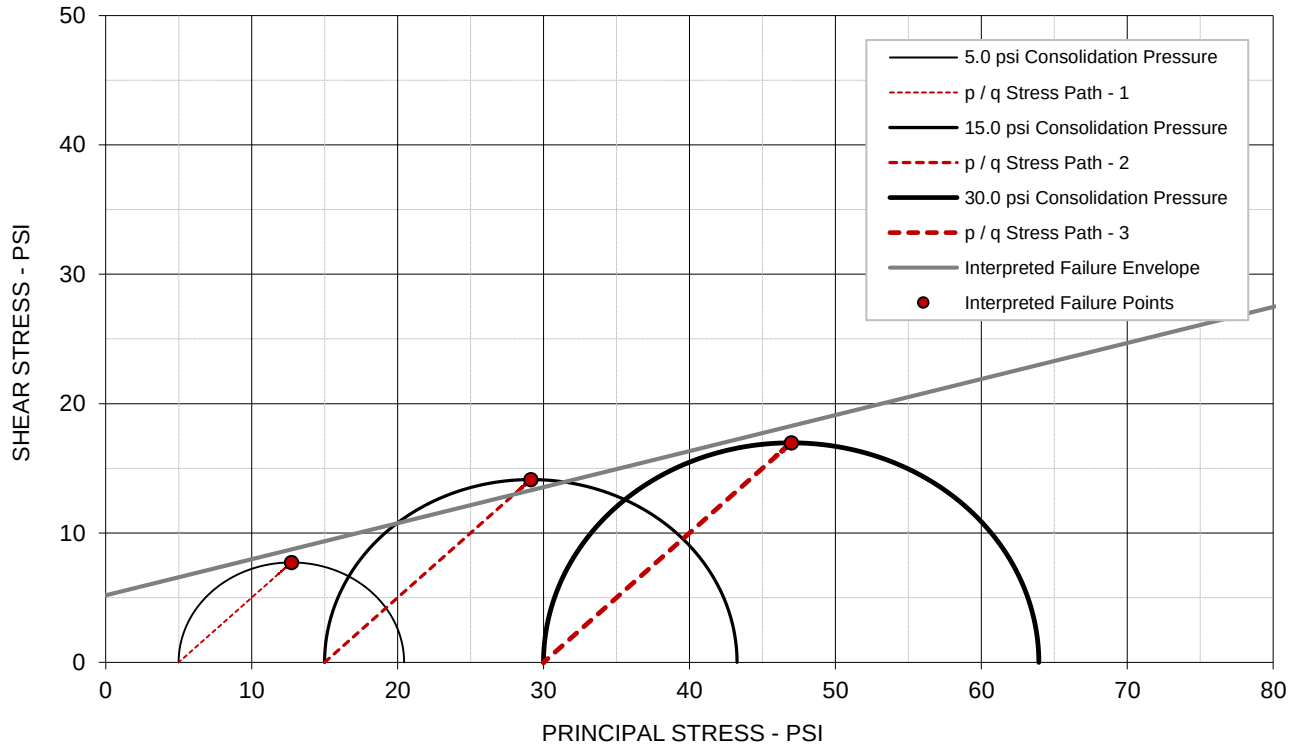
SPECIMEN FAILURE ILLUSTRATIONS

1 2 3

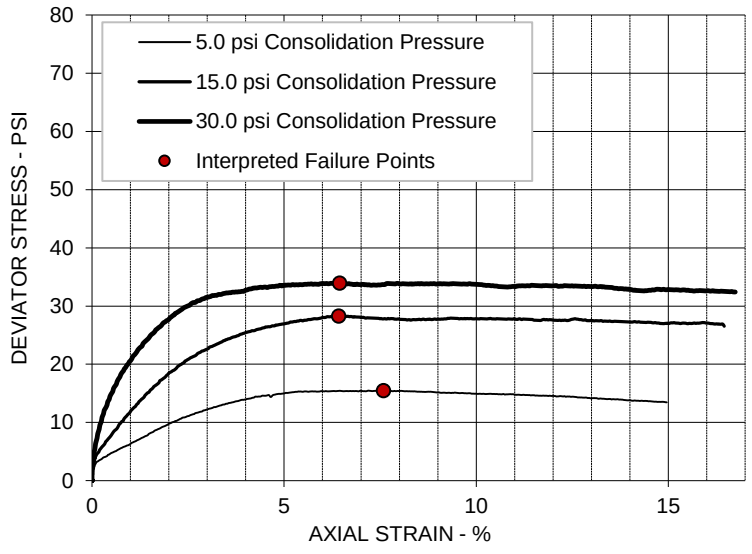


EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α = 26.4 deg	a = 1.4 psi
PROJECT: Joel Wood Lab Testing		ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST	
LOCATION: York, SC		CLIENT: Joel E. Wood & Associates, LLC.	
SAMPLE: B-2 DESCRIPTION: Red & Yellow Sandy Silt		**1450 Fifth St W** **North Charleston, SC**	Terracon

ICU TRIAXIAL COMPRESSION TEST



TOTAL STRESS PARAMETERS	ϕ = 15.6 deg	c = 5.2 psi



SPECIMEN NO.	1	2	3
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Dry Density - pcf	93.0	93.4	82.7
Diameter - inches	2.84	2.84	2.84
Height - inches	6.05	5.67	5.37
AT TEST			
Final Moisture - %	32.7	33.9	41.2
Dry Density - pcf	93.0	93.4	82.8
Calculated Diameter (in.)	2.84	2.84	2.84
Height - inches	6.05	5.67	5.37
Effect. Consol. Stress - psi	5.0	15.0	30.0
Failure Stress - psi	15.45	28.26	33.94
Total Pore Pressure - psi	50.2	53.0	66.1
Strain Rate - inches/min.	0.00500	0.00500	0.00500
Failure Strain - %	7.6	6.4	6.4
σ_1 Failure - psi	20.45	43.26	63.94
σ_3 Failure - psi	5.00	15.00	30.00

TEST DESCRIPTION

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SAMPLE: B-2

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LOCATION: York, SC

PROJECT NO: EN181105

CLIENT: Joel E. Wood & Associates, LLC.

DATE: 5.29.18

1450 Fifth St W
North Charleston, SC

Terracon

APPENDIX B

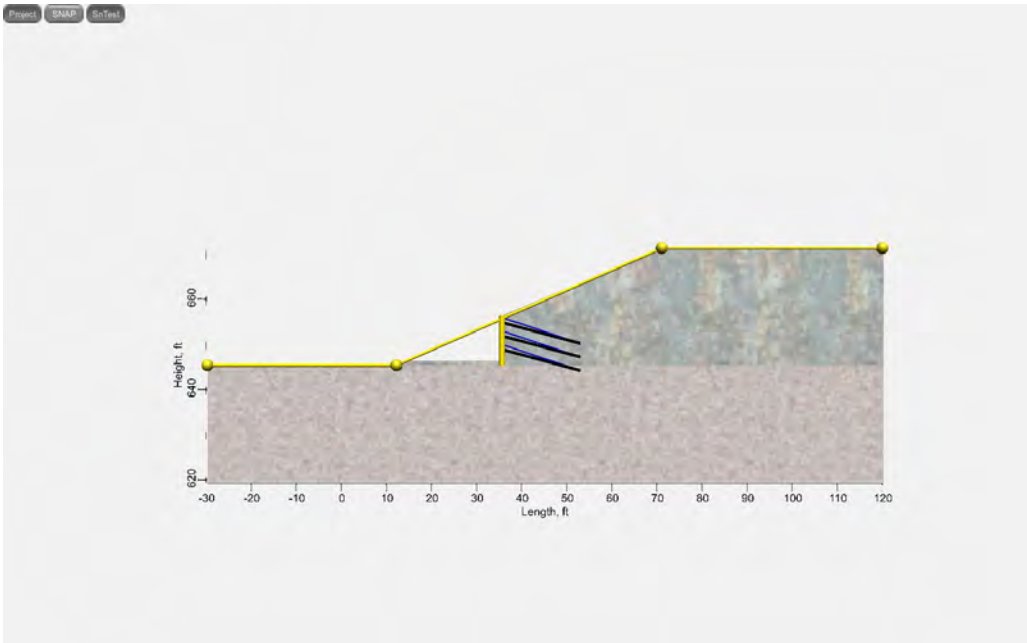
SNAP_2 Short Term Undrained Soil Nail Wall Loading

SNAP_2 Report

Name	Number	Company	Wall #	Designer	Date
I77 Gateway	180510	JWA	1	CEW	6/4/18

Name: Name of project.
Number: Project number or ID
Company: Name of company
Wall #: Wall number
Designer: Name of person performing design.
Date: Date of project

Existing Slope



Existing Slope Points

#	X, ft	Y, ft
1	-30.0	645.0
2	12.0	645.0
3	71.0	671.0
4	120.0	671.0

X: Horizontal coordinates
Y: Vertical coordinates

Soils

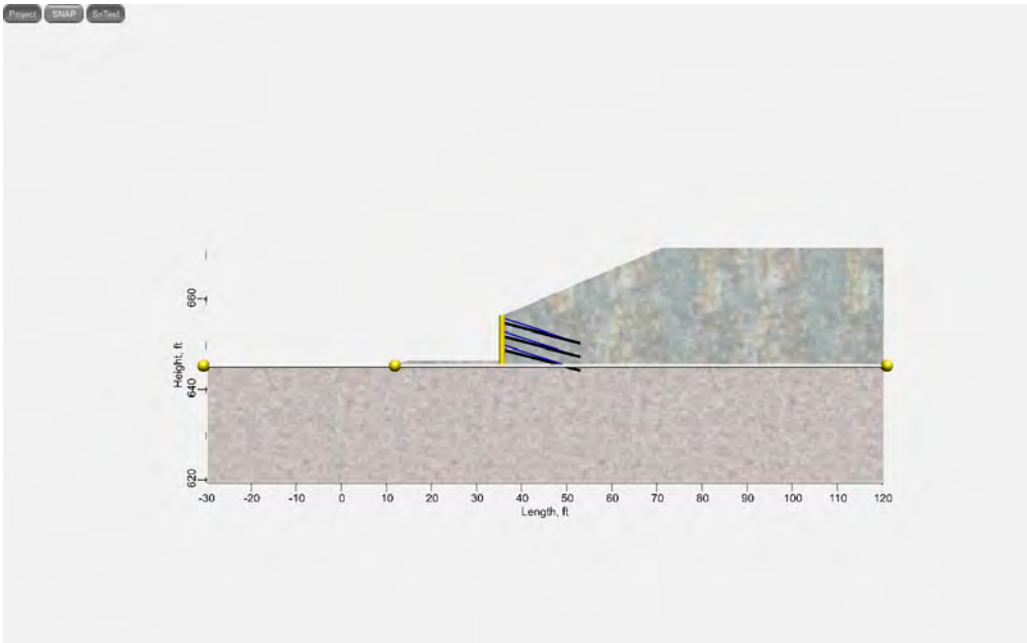
Soil Properties

#	Name	Texture	Color	γ'_s, pcf	ϕ', ^{o}	δ_s, ^{o}	c', psf	q_u, psi	N_c	N_q	N_γ
1	Soil 1	silt	white	120	15.6	10.4	749.0	5.8	11.4	4.2	2.9

2	Soil 2	sand	white	110	28	18.7	0.0	5.8	25.8	14.7	16.7

Name: Name of soil
Texture: Soil/rock Type
Color: Soil color
γ'_s: Effective unit weight of soil
ϕ': Effective soil friction angle / angle of internal friction
δ_s: Wall-soil interface friction angle, $\delta = 2/3\phi$
c': Effective cohesion of soil
q_u: Ultimate bond strength
N_c: N_c bearing capacity factor
N_q: N_q bearing capacity factor
N_γ: N_γ bearing capacity factor

Soil 2: Points at top of Soil 2

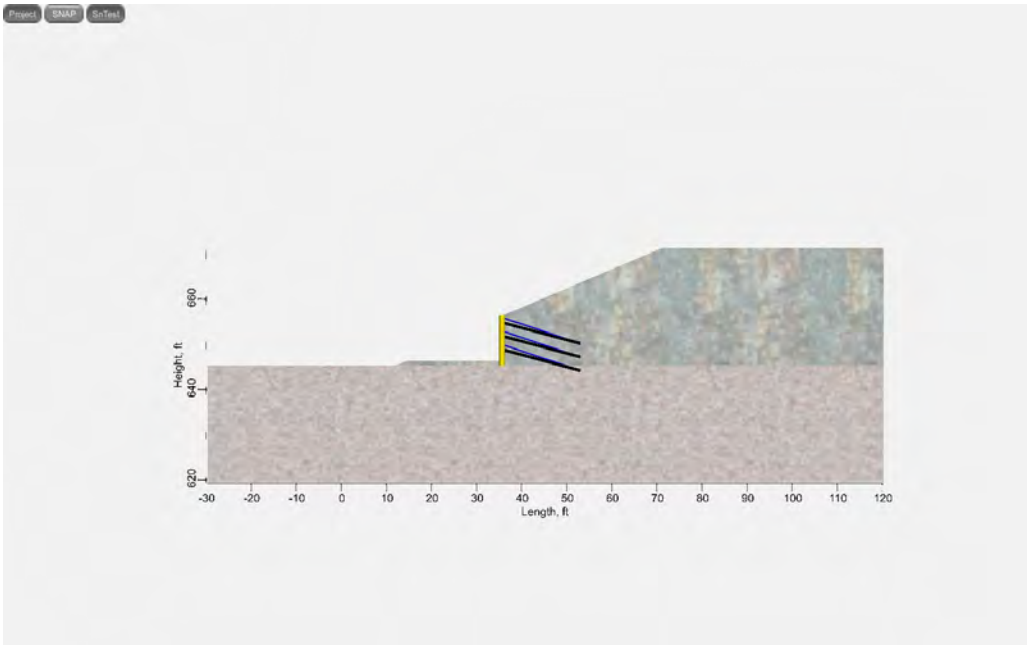


Points at top of Soil 2

#	X, ft	Y, ft
1	-30.0	645.0
2	12.0	645.0
3	120.0	645.0

X: Horizontal coordinates
Y: Vertical coordinates

Ground Water



Nails

Default Factors of Safety

U	F_y FoS	F_{ys} FoS	F_p FoS	F_{ps} FoS
true	1.80	1.35	2.00	1.50

U: Use same factors of safety for each bar
F_y FoS: Factor of safety for yield strength
F_{ys} FoS: Seismic factor of safety for yield strength
F_p FoS: Factor of safety for pullout
F_{ps} FoS: Seismic factor of safety for pullout

Bar Properties

Name	D, in	D_{out}, in	D_{in}, in	Bar No, Bar #	F_y, ksi
Bar 1	8.0	1.000	0.000	8.0	75.0

Name: Name of bar set
D: Drill hole diameter
D_{out}: Outside diameter of bar
D_{in}: Inside diameter of bar
Bar No: Nail size 3-18
F_y: Steel yield strength of bar

Facings

Facing Properties

#	Type	Name	Description
1	Temp SNW	Temp SNW 1	Shotcrete
2	Perm SNW	Perm SNW 1	CIP

Type: Facing type
Name: Name of facing
Description: Facing description

Temp SNW 1: Shotcrete

Mesh	Bars
true	true

Mesh: true if temporary facing has mesh reinforcement
Bars: true if temporary facing has bar reinforcement

Mesh: Temporary facing mesh

S_{vw}, in	S_{hw}, in	A_{wire}, in^2	$Mesh_{F_y}$, ksi
6.0	6.0	0.029	60.0

S_{vw}: Vertical mesh spacing of wires
S_{hw}: Horizontal mesh spacing of wires
A_{wire}: Mesh area of wire
$Mesh_{F_y}$: Wire mesh yield strength

Bars: Temporary facing bars

H_{Bars}	hr, in	H, Bar #	d_W, in	H_{F_y}, ksi	V_{Bars}	vr, in	V, Bar #	d_B, in	$L_{c_{vb}}$, ft	V_{F_y}, ksi
2	12	4	0.500	60.0	2	12	4	0.500	2.0	60.0

H_{Bars}: Number of horizontal waler bars
hr: Horizontal reinforcement spacing
H: Horizontal waler bar size, 3-10
d_W: Horizontal bar diameter
H_{F_y}: Horizontal bar yield strength
V_{Bars}: Number of vertical bearing bars
vr: Vertical reinforcement spacing
V: Vertical bearing bar size, 3-10
d_B: Vertical bearing bar diameter
$L_{c_{vb}}$: Vertical bearing bar length
V_{F_y}: Bearing bar yield strength

Shotcrete: Temporary shotcrete facing

$f_{c'}$, psi	h_c, in	C_F	C_S	TF FoS	TF_s FoS
4000	4.0	1	1	1.35	1.10

$f_{c'}$: Shotcrete facing compressive strength
h_c: Shotcrete facing thickness
C_F: Flexure pressure factor (Accounts for non-uniformity of pressure at back of facing)
C_S: Shear pressure factor
TF FoS: Factor of safety for flexure and punching
TF_s FoS: Seismic factor of safety for flexure and punching

Plate: Temporary facing plate

b_{PL}, in	b_d, in	F_F
8.0	1.0	0.5

b_{PL}: Bearing plate side length
b_d: Bearing plate thickness
F_F: Nail head service load factor

Perm SNW 1: CIP

Temporary Facing	Mesh	Bars	Studs
Temp SNW 1	false	true	true

Temporary Facing: Temporary wall facing behind this permanent facing
Mesh: True if permanent facing has mesh reinforcement
Bars: true if permanent facing has bar reinforcement
Studs: true if permanent facing has studs

Bars: Permanent facing bars

hr, in	H, Bar #	d_W, in	H_{F_y}, ksi	vr, in	V, Bar #	d_B, in	V_{F_y}, ksi
12	4	0.500	60.0	12	4	0.500	60.0

hr: Horizontal reinforcement spacing
H: Horizontal waler bar size, 3-10
d_W: Horizontal bar diameter
H_{F_y}: Horizontal bar yield strength
vr: Vertical reinforcement spacing
V: Vertical bearing bar size, 3-10
d_B: Vertical bearing bar diameter
V_{F_y}: Bearing bar yield strength

Concrete: Permanent facing concrete

$f_{c'}$, psi	h_c, in	C_F	C_S	PF FoS	PF_s FoS
4000.000	8	1.000	1.000	1.50	1.10

$f_{c'}$: Concrete compressive strength
h_c: Permanent facing thickness
C_F: Flexure Pressure Factor, Table 4.2 (Accounts for non-uniformity of pressure at back of facing)
C_S: Shear pressure factor
PF FoS: Factor of safety for flexure and punching
PF_s FoS: Seismic factor of safety for flexure and punching

Studs: Permanent facing studs

D_{Hs}, in	D_H, in	t_H, in	L_S, in	S_{hs}, in	F_y, ksi	P_{Thick}, in	N_H	HT FoS	HT_s FoS
0.75	1.25	0.375	5.188	5	60	1	4	2.00	1.50

D_{Hs}: Stud body diameter
D_H: Stud head diameter, d_h: Stud head diameter OK: $d_h >= 1.58 * d_{hs}$, 1.25 >= 1.58 * 0.75, 1.25 >= 1.185
t_H: Stud head thickness, t_h: Stud head thickness Ok: $t_h >= (d_h - d_{hs}) / 2$, 0.375 >= (1.25 - 0.75) / 2, 0.375 >= 0.25
L_S: Stud overall length
S_{hs}: Stud spacing
F_y: Stud yield strength
P_{Thick}: Plate thickness
N_H: Number of headed-studs in the connection
HT FoS: Headed-stud tensile fracture factor (for ASTM A307, $?_{FHS}$ = 0.50; for ASTM A325 $?_{FHS}$ = 0.59)
HT_s FoS: Seismic headed-stud tensile fracture factor

Wall types

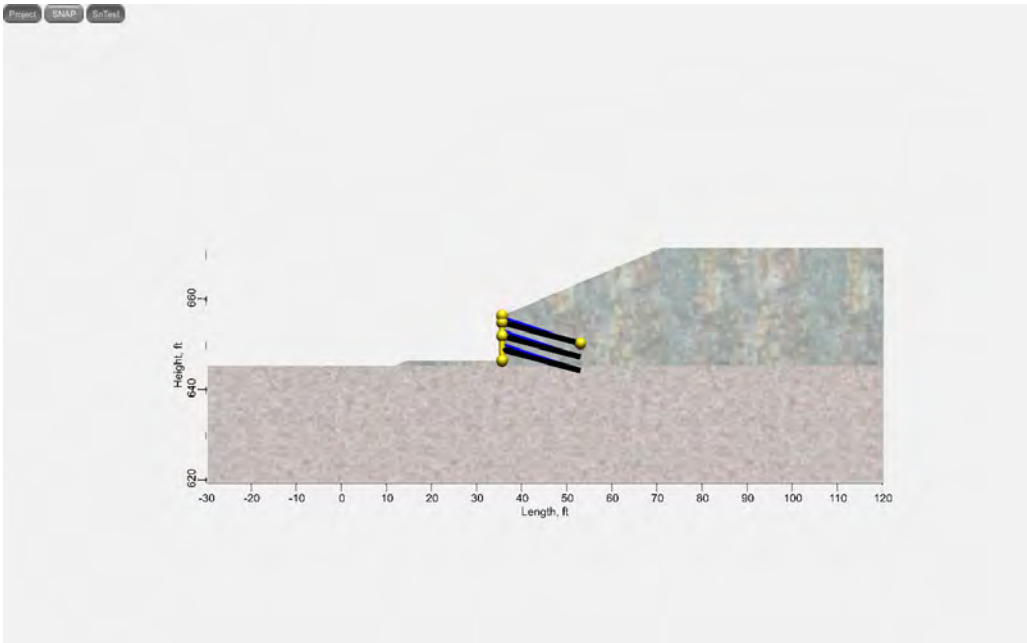
Name	Description
SN Wall 1	-

Name: Name of wall
Description: Wall Description

SN Wall 1:

Static Case

Wall: Soil nail wall geometry



Construction: Construction specification

Construction #	Con_{seq}
40	1

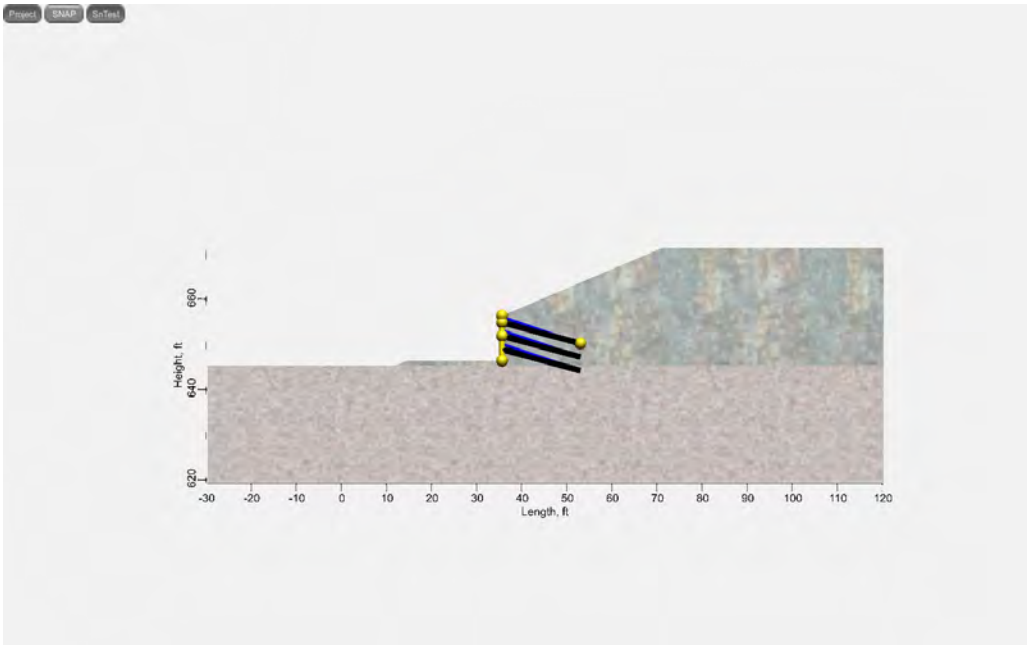
Construction #: Construction number, adds stage cuts and nails according to assigned construction sequences
Con_{seq}: Construction (stage cut) sequence when wall construction begins ie. "1" or "2,4-6"

Wall: Soil nail wall size and location

Facing	Base, ft	Top, ft	H, ft	θ, º	Emb, ft	Width, ft
Temp SNW 1	35.5,646.0	35.5,656.0	10.0	0.0	1.0	200

Facing: Wall facing
Base: Base of wall
Top: Top of wall
H: Wall height
θ: Wall batter angle, degrees from vertical
Emb: Embedment, depth below ground surface at toe
Width: Width of wall, extending along Z-Axis

Nails: Soil nail wall nail geometry



Shorten T_F
false

Shorten T_F: Shorten T-Forces on lower nails due to deformation during construction

Nails: Soil nail sizes and locations

Nail	L, ft	S_V, ft	S_H, ft	δ, °	C_d, ft	O	U
Bar 1	18.00	3.00	3.00	15.0	1.50	false	true

Nail: Bar used for this nail
L: Nail length
S_V: Vertical nail spacing
S_H: Horizontal nail spacing
δ: Nail inclination, degrees from horizontal
C_d: Cantilever distance, vertical distance from top of wall to top nail
O: Offset pattern, true if nails in even rows are offset to midspan, otherwise nails are in a square pattern
U: Use uniform nails
Nail List: Nail properties

Nail[1]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
1.50	-	0.00	0.0

C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	14.1	Soil 1	Punching/Flexure Failure
2	17.82	0.2	Soil 1	Pullout

3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Nail[2]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
4.50	-	0.00	0.0

C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	14.1	Soil 1	Punching/Flexure Failure
2	17.82	0.2	Soil 1	Pullout
3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Nail[3]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
7.50	-	0.00	0.0

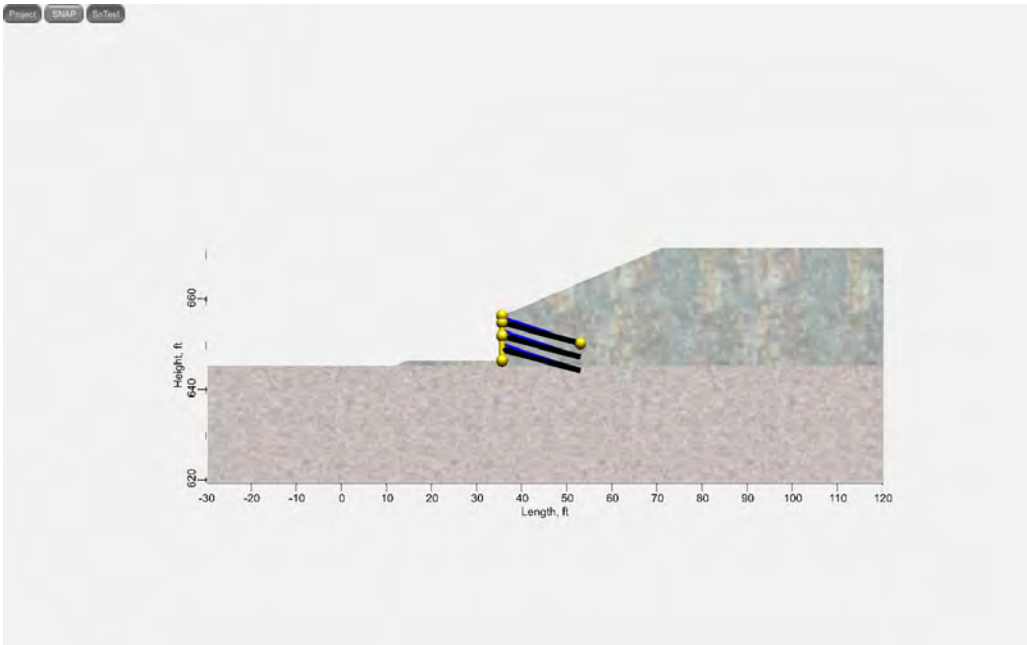
C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

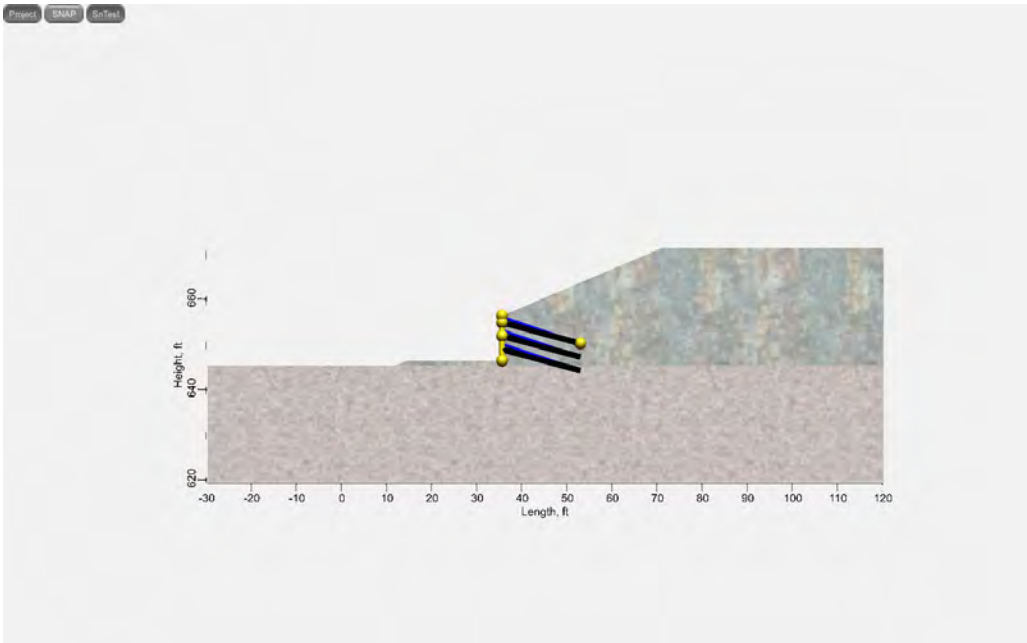
#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	14.1	Soil 1	Punching/Flexure Failure
2	17.82	0.2	Soil 1	Pullout
3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Slope: Backslope and downslope cuts



Checks: Soil nail wall design checks



Checks: Facing design checks

T_F, lbf	t_F, lbf	V, lbf/ft	M, ft-lbf/ft	L_{VB}, ft	L_S, in	ecc, ft	FS_{SL}	FS_{BC}	FoS_{GS}
13904	5093	2247.8	1317.6	2.1	12.9	0.3	1.4	5.8	1.79

T_F: Allowable nail head strength - minimum of temporary facing T_{FF} and T_{FP}, T_F: Nail Head Load Ok: $t_F < T_F$: 5093 < 13904
t_F: Estimated nail head service load, Nail Head Load Ok: $t_F < T_F$: 5093 < 13904
V: Allowable one-way unit shear strength, One-way Unit Shear in Upper Cantilever OK: v < 0.67 V

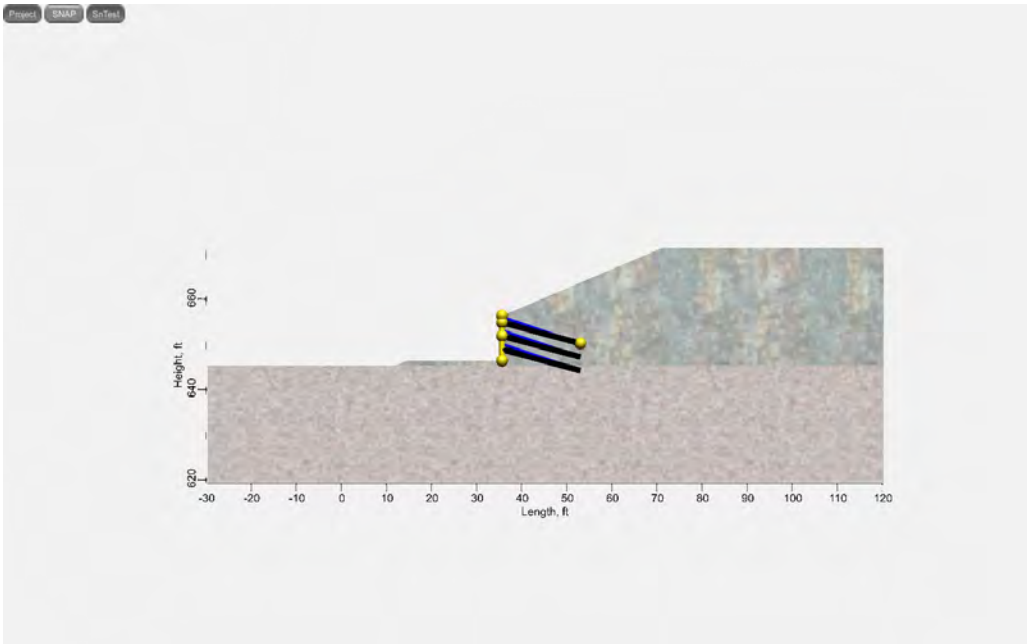
M: Allowable one-way unit moment, Design for Flexure in Upper Cantilever OK: mS < 0.67 M
L_{VB}: Minimum total length of vertical bearing bars, Bearing bar embedment length OK
L_S: Minimum waler splice length, AASHTO 8.32, Waler splice length must be greater of 12 in. or LDwb, Ok
ecc: Eccentricity check for overturning, Ok: ecc < B / 4
FS_{SL}: Factor of safety with respect to base sliding, Ok: FS_{SL} >= 1.3
FS_{BC}: Factor of safety with respect to bearing capacity $FS_{BC} = q_{ult}/\sigma_v$, Ok: FS_{BC} >= 2.5
FoS_{GS}: Factor of safety of global stability slip surface, Ok: FoS_{GS} >= 1.35

Displacement: Long-term wall deformation and displacement parameters

$\delta_{h/H}$	κ	δ, in	λ, ft
0.003	1.50	0.4	15.0

$\delta_{h/H}$: Displacement ratio: (weathered rock/stiff soil: 0.001) (sandy soil: 0.002) (fine-grained soil: 0.003)
κ: Damping coefficient used to estimate wall displacement: (weathered rock/stiff soil: 0.8) (sandy soil: 1.25) (fine-grained soil: 1.5)
δ: Estimated displacement at the top of soil nail wall, L/H ratio outside 0.7 - 1.0, Estimation may not be accurate
λ: Horizontal distance behind soil nail wall where ground deformation can be significant

Vars: Soil nail internal variables



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SC Facing Vars: Shotctrete facing design intermediate variables

$A_{S_{NEG}}$, in^2	$A_{S_{POS}}$, in^2	$m_{V_{NEG}}$, ft-lbf/ft	$m_{V_{POS}}$, ft-lbf/ft	D'_C, in	D_C, in	V_N, lbf	A_C, in^2	A_{GC}, in^2
0.574	0.174	1779	568	12.0	16.0	38149	201	50

$A_{S_{NEG}}$: Cross sectional area of steel near the nail head
$A_{S_{POS}}$: Cross sectional area of steel near the nail mid-point
$m_{V_{NEG}}$: NEG average nominal unit moment resistance
$m_{V_{POS}}$: POS average nominal unit moment resistance
D'_C: Effective diameter of punching cone
D_C: Base diameter of punching cone
V_N: Nominal internal punching shear strength of the shotcrete facing
A_C: Cross-sectional area at base of punching cone
A_{GC}: Cross-sectional area of grout column

SC Facing Vars 2: More shotctrete facing design intermediate variables

T_{FN_F}, lbf	T_{F_F}, lbf	T_{FN_P}, lbf	T_{F_P}, lbf	MaxDevLen, in	%CVB, %	L_{DBwb}, in	L_{Dwb}, in	L_D, in	MaxDevLenMesh, in
18771	13904	43403	32150	7.5	69.7	7.6	12.9	1.864	8.0

T_{FN_F}: Nominal nail head strength - flexure
T_{F_F}: Allowable nail head strength - flexure
T_{FN_P}: Nominal nail head strength - punching
T_{F_P}: Allowable nail head strength - punching
MaxDevLen: Maximum of ($L_{c_{vb}}$/20), (15*d_B), and (h_c/2)
%CVB: Percent coverage from vertical bars
L_{DBwb}: Basic development length of waler bars, AASHTO 8.25.1
L_{Dwb}: Development length of waler bars, AASHTO 8.25
L_D: Basic development length of wire mesh, AASHTO 8.30
MaxDevLenMesh: Minimum wire mesh splice length

SC Facing Vars 3: More shotctrete facing design intermediate variables

K_A	A_N, in^2	T_{NN}, lbf	T_N, lbf	$K_{A_{LC}}$	v, lbf/ft	V_{NS}, lbf/ft	m_S, ft-lbf/ft
0.943	0.79	58904.9	32725.0	0.928	125.2	3034.5	62.0

K_A: Coulomb active earth pressure coefficient
A_N: Nail tendon area
T_{NN}: Nominal nail tendon tensile load
T_N: Allowable nail tendon tensile load
$K_{A_{LC}}$: Active earth pressure coefficient for load component normal to wall
v: One-way unit service shear force
V_{NS}: Nominal one-way unit shear strength
m_S: One-way unit service moment

Ex Vars: External stability intermediate variables

θ, °	β, °	q_s, psf	ϕ, °	ϕ_f, °	γ_1, pcf	γ_2, pcf	c, psf	δ, °
0.0	22.9	0	15.6	15.6	120.0	120.0	749.0	10.4

θ: Inclination of back wall measured CCW from vertical plane
β: Inclination of ground slope behind wall measured CCW from horiz. plane
q_s: Surcharge load behind wall
ϕ: Internal friction angle of weakest retained soil
ϕ_f: Internal friction angle of weakest foundation soil
γ_1: Unit weight of weakest retained soil
γ_2: Unit weight of weakest foundation soil
c: Cohesion - weakest foundation soil
δ: Wall/soil interface friction angle

Ex Vars 2: More external stability intermediate variables

B, ft	h, ft	Nγ	N_c	N_q	H2, ft	K_a	S, °
17.4	17.3	2.9	11.4	4.2	12.7	0.943	2.541

B: Effective width of wall at the base
h: Effective total height of soil at back of reinforced soil mass
Nγ: See Fig 4.4.7.1.1.4B and Table 4.4.7.1A AASHTO
N_c: Bearing capacity coefficient - weakest foundation soil
N_q: Bearing capacity coefficient - weakest foundation soil
H2: A height near the back of wall for calculating PIR and PAE
K_a: Active earth pressure coefficient - no seismic forces
S: Angle relating the horizontal and vertical seismic coefficients

Ex Vars 3: More external stability intermediate variables

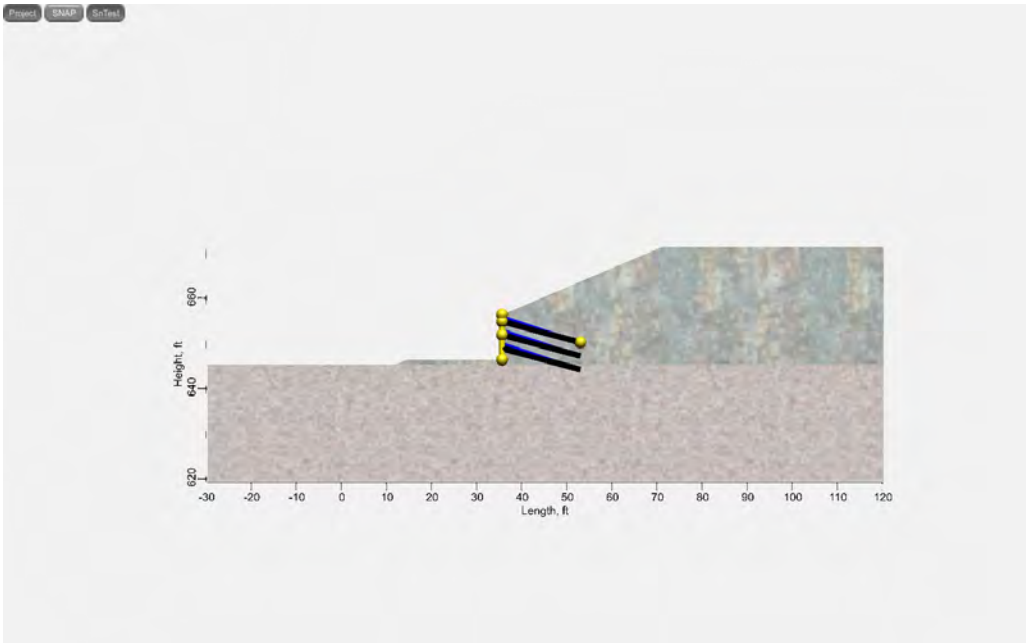
F_T, lbf/ft	F_H, lbf/ft	F_V, lbf/ft	V_2, lbf/ft	V_1, lbf/ft	F_2, lbf/ft
17028.1	15685.3	6627.6	7663.9	20863.9	0.0

F_T: Lateral earth pressure
F_H: Horizontal lateral earth pressure
F_V: Vertical lateral earth pressure
V_2: Weight of soil above wall
V_1: Weight of soil above wall
F_2: Surcharge load

Ex Vars 4: More external stability intermediate variables

P_{IR}, lbf/ft	Y_{IR}, ft	σ_v, psf	q_{ult}, psf	q_{allow}, psf
1042.2	5.7	2084.4	12025	4810

P_{IR}: Horizontal inertial force
Y_{IR}: Y-coordinate of centroid of mass for inertial force
σ_v: Vertical effective stress at base of footing
q_{ult}: Terzaghi bearing capacity
q_{allow}: Terzaghi bearing capacity $q_{allow} = q_{ult}/FOS$



Seismic Case

Wall: Soil nail wall geometry

Construction: Construction specification

Construction #	Con_{seq}
40	1

Construction #: Construction number, adds stage cuts and nails according to assigned construction sequences
Con_{seq}: Construction (stage cut) sequence when wall construction begins ie. "1" or "2,4-6"

Wall: Soil nail wall size and location

Facing	Base, ft	Top, ft	H, ft	θ, º	Emb, ft	Width, ft
Temp SNW 1	35.5,646.0	35.5,656.0	10.0	0.0	1.0	200

Facing: Wall facing
Base: Base of wall
Top: Top of wall
H: Wall height
θ: Wall batter angle, degrees from vertical
Emb: Embedment, depth below ground surface at toe
Width: Width of wall, extending along Z-Axis

Nails: Soil nail wall nail geometry

Shorten T_F
false

Shorten T_F: Shorten T-Forces on lower nails due to deformation during construction

Nails: Soil nail sizes and locations

Nail	L, ft	S_V, ft	S_H, ft	δ, º	C_d, ft	O	U
Bar 1	18.00	3.00	3.00	15.0	1.50	false	true

Nail: Bar used for this nail
L: Nail length
S_V: Vertical nail spacing
S_H: Horizontal nail spacing
δ: Nail inclination, degrees from horizontal
C_d: Cantilever distance, vertical distance from top of wall to top nail
O: Offset pattern, true if nails in even rows are offset to midspan, otherwise nails are in a square pattern
U: Use uniform nails
Nail List: Nail properties

Nail[1]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
1.50	-	0.00	0.0

C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	17.3	Soil 1	Punching/Flexure Failure
2	17.82	0.2	Soil 1	Pullout
3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Nail[2]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
4.50	-	0.00	0.0

C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	17.3	Soil 1	Punching/Flexure Failure
2	17.82	0.2	Soil 1	Pullout
3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Nail[3]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
7.50	-	0.00	0.0

C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	17.3	Soil 1	Punching/Flexure Failure
2	17.82	0.2	Soil 1	Pullout
3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Slope: Backslope and downslope cuts

Checks: Soil nail wall design checks

Checks: Facing design checks

T_F, lbf	t_F, lbf	V, lbf/ft	M, ft-lbf/ft	L_{VB}, ft	L_S, in	ecc, ft	FS_{SL}	FS_{BC}	FoS_{GS}
17065	5093	2758.7	1617.0	2.1	12.9	1.3	1.1	4.8	1.79

T_F: Allowable nail head strength - minimum of temporary facing T_{FF} and T_{FP}, T_F: Nail Head Load Ok: $t_F < T_F$: 5093 < 17065
t_F: Estimated nail head service load, Nail Head Load Ok: $t_F < T_F$: 5093 < 17065
V: Allowable one-way unit shear strength, One-way Unit Shear in Upper Cantilever OK: v < 0.67 V
M: Allowable one-way unit moment, Design for Flexure in Upper Cantilever OK: mS < 0.67 M
L_{VB}: Minimum total length of vertical bearing bars, Bearing bar embedment length OK
L_S: Minimum waler splice length, AASHTO 8.32, Waler splice length must be greater of 12 in. or LDwb, Ok
ecc: Eccentricity check for overturning, Ok: ecc < B / 4
FS_{SL}: Factor of safety with respect to base sliding, Ok: FS_{SL} >= 1.1
FS_{BC}: Factor of safety with respect to bearing capacity $FS_{BC} = q_{ult}/\sigma_v$, Ok: FS_{BC} >= 2.3
FoS_{GS}: Factor of safety of global stability slip surface, Ok: FoS_{GS} >= 1.1

Displacement: Long-term wall deformation and displacement parameters

$\delta_{h\,/\,H}$	κ	δ, in	λ, ft
0.003	1.50	0.4	15.0

$\delta_{h\,/\,H}$: Displacement ratio: (weathered rock/stiff soil: 0.001) (sandy soil: 0.002) (fine-grained soil: 0.003)
κ: Damping coefficient used to estimate wall displacement: (weathered rock/stiff soil: 0.8) (sandy soil: 1.25) (fine-grained soil: 1.5)
δ: Estimated displacement at the top of soil nail wall, L/H ratio outside 0.7 - 1.0, Estimation may not be accurate
λ: Horizontal distance behind soil nail wall where ground deformation can be significant

Vars: Soil nail internal variables

SC Facing Vars: Shotctrete facing design intermediate variables

$A_{S_{NEG}}$, in^2	$A_{S_{POS}}$, in^2	$m_{V_{NEG}}$, ft-lbf/ft	$m_{V_{POS}}$, ft-lbf/ft	D'_C, in	D_C, in	V_N, lbf	A_C, in^2	A_{GC}, in^2
0.574	0.174	1779	568	12.0	16.0	38149	201	50

$A_{S_{NEG}}$: Cross sectional area of steel near the nail head
$A_{S_{POS}}$: Cross sectional area of steel near the nail mid-point
$m_{V_{NEG}}$: NEG average nominal unit moment resistance
$m_{V_{POS}}$: POS average nominal unit moment resistance
D'_C: Effective diameter of punching cone
D_C: Base diameter of punching cone
V_N: Nominal internal punching shear strength of the shotcrete facing
A_C: Cross-sectional area at base of punching cone
A_{GC}: Cross-sectional area of grout column

SC Facing Vars 2: More shotctrete facing design intermediate variables

T_{FN_F}, lbf	T_{F_F}, lbf	T_{FN_P}, lbf	T_{F_P}, lbf	MaxDevLen, in	%CVB, %	L_{DBwb}, in	L_{Dwb}, in	L_D, in	MaxDevLenMesh, in
18771	17065	43403	39457	7.5	69.7	7.6	12.9	1.864	8.0

T_{FN_F}: Nominal nail head strength - flexure
T_{F_F}: Allowable nail head strength - flexure
T_{FN_P}: Nominal nail head strength - punching
T_{F_P}: Allowable nail head strength - punching
MaxDevLen: Maximum of ($L_{c_{vb}}/20$), ($15*d_B$), and ($h_c/2$)
%CVB: Percent coverage from vertical bars
L_{DBwb}: Basic development length of waler bars, AASHTO 8.25.1
L_{Dwb}: Development length of waler bars, AASHTO 8.25
L_D: Basic development length of wire mesh, AASHTO 8.30
MaxDevLenMesh: Minimum wire mesh splice length

SC Facing Vars 3: More shotctrete facing design intermediate variables

K_A	A_N, in^2	T_{NN}, lbf	T_N, lbf	$K_{A_{LC}}$	v, lbf/ft	V_{NS}, lbf/ft	m_S, ft-lbf/ft
0.943	0.79	58904.9	43633.3	0.928	125.2	3034.5	62.0

K_A: Coulomb active earth pressure coefficient
A_N: Nail tendon area
T_{NN}: Nominal nail tendon tensile load
T_N: Allowable nail tendon tensile load
$K_{A_{LC}}$: Active earth pressure coefficient for load component normal to wall
v: One-way unit service shear force
V_{NS}: Nominal one-way unit shear strength
m_S: One-way unit service moment

Ex Vars: External stability intermediate variables

θ, °	β, °	q_s, psf	ϕ, °	ϕ_f, °	γ_1, pcf	γ_2, pcf	c, psf	δ, °
0.0	22.9	0	15.6	15.6	120.0	120.0	749.0	10.4

θ: Inclination of back wall measured CCW from vertical plane
β: Inclination of ground slope behind wall measured CCW from horiz. plane
q_s: Surcharge load behind wall
ϕ: Internal friction angle of weakest retained soil
ϕ_f: Internal friction angle of weakest foundation soil
γ_1: Unit weight of weakest retained soil
γ_2: Unit weight of weakest foundation soil
c: Cohesion - weakest foundation soil
δ: Wall/soil interface friction angle

Ex Vars 2: More external stability intermediate variables

B, ft	h, ft	Nγ	N_c	N_q	H2, ft	K_a	S, °
17.4	17.3	2.9	11.4	4.2	12.7	0.943	2.541

B: Effective width of wall at the base
h: Effective total height of soil at back of reinforced soil mass
Nγ: See Fig 4.4.7.1.1.4B and Table 4.4.7.1A AASHTO
N_c: Bearing capacity coefficient - weakest foundation soil
N_q: Bearing capacity coefficient - weakest foundation soil
H2: A height near the back of wall for calculating PIR and PAE
K_a: Active earth pressure coefficient - no seismic forces
S: Angle relating the horizontal and vertical seismic coefficients

Ex Vars 3: More external stability intermediate variables

F_T, lbf/ft	F_H, lbf/ft	F_V, lbf/ft	V_2, lbf/ft	V_1, lbf/ft	F_2, lbf/ft
17028.1	15685.3	6627.6	7663.9	20863.9	0.0

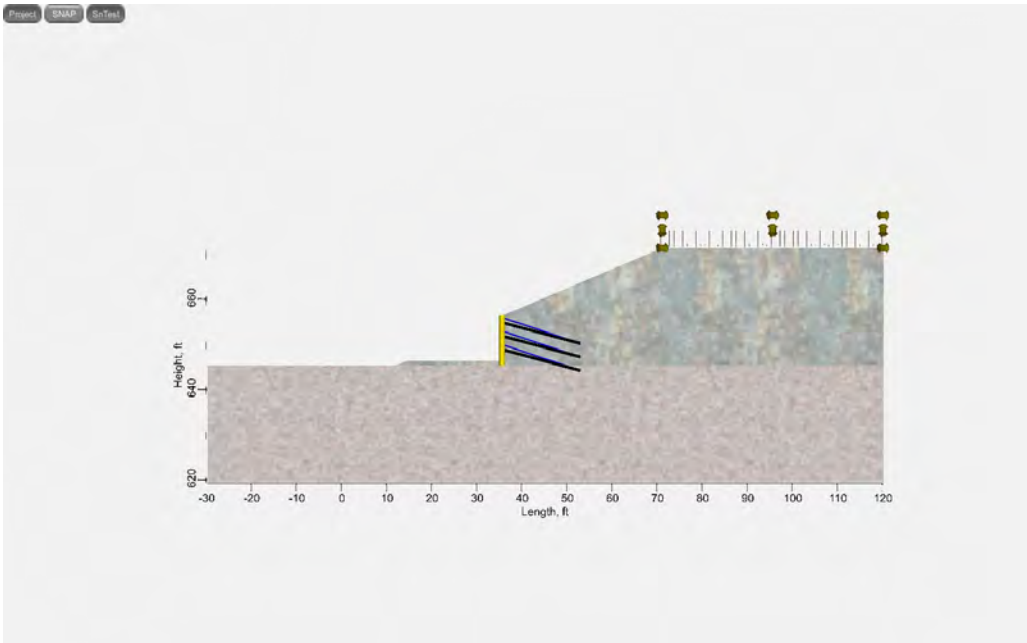
F_T: Lateral earth pressure
F_H: Horizontal lateral earth pressure
F_V: Vertical lateral earth pressure
V_2: Weight of soil above wall
V_1: Weight of soil above wall
F_2: Surcharge load

Ex Vars 4: More external stability intermediate variables

P_{IR}, lbf/ft	Y_{IR}, ft	σ_v, psf	q_{ult}, psf	q_{allow}, psf
1042.2	5.7	2497.8	12025	4810

P_{IR}: Horizontal inertial force
Y_{IR}: Y-coordinate of centroid of mass for inertial force
σ_v: Vertical effective stress at base of footing
q_{ult}: Terzaghi bearing capacity
q_{allow}: Terzaghi bearing capacity $q_{allow} = q_{ult}/FOS$

Surcharge



Con_{seq}	X1, ft	X2, ft	q_s, psf	q_{sH}, psf
1-4	71.0	120.0	250	0

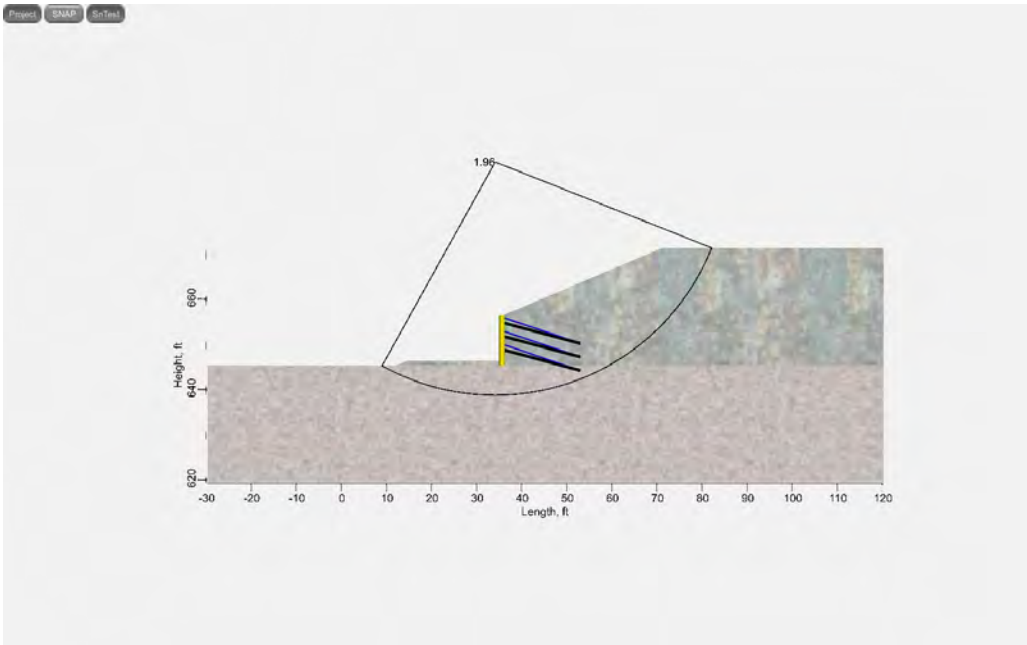
Con_{seq}: Construction sequence for applying surcharge, ie. "1-5" or "2,4-6"
X1: Surcharge X range start
X2: Surcharge X range end
q_s: Vertical surcharge load on slope segment as a number (250) or a linearly interpolated range (100~250)
q_{sH}: Horizontal surcharge load on slope segment as a number (250) or a linearly interpolated range (100~250)

Seismic

Seismic	d, in	A	A_m	Calc K_h	K_h	K_v
true	8.000	0.120	0.16	true	0.044	0.000

Seismic: Use seismic loading for external and global stability analysis
d: Tolerable seismically induced wall lateral movement
A: Peak ground acceleration coefficient as a fraction of gravity
A_m: Normalized horizontal acceleration, $A_m = A (1.45 - A)$
Calc K_h: Automatically calculate K_h from A, if d is between 25 and 203, $K_h = 0.74 A_m (A_m/d)^{0.25}$, else $K_h = A/2$
K_h: Horizontal seismic coefficient
K_v: Vertical seismic coefficient

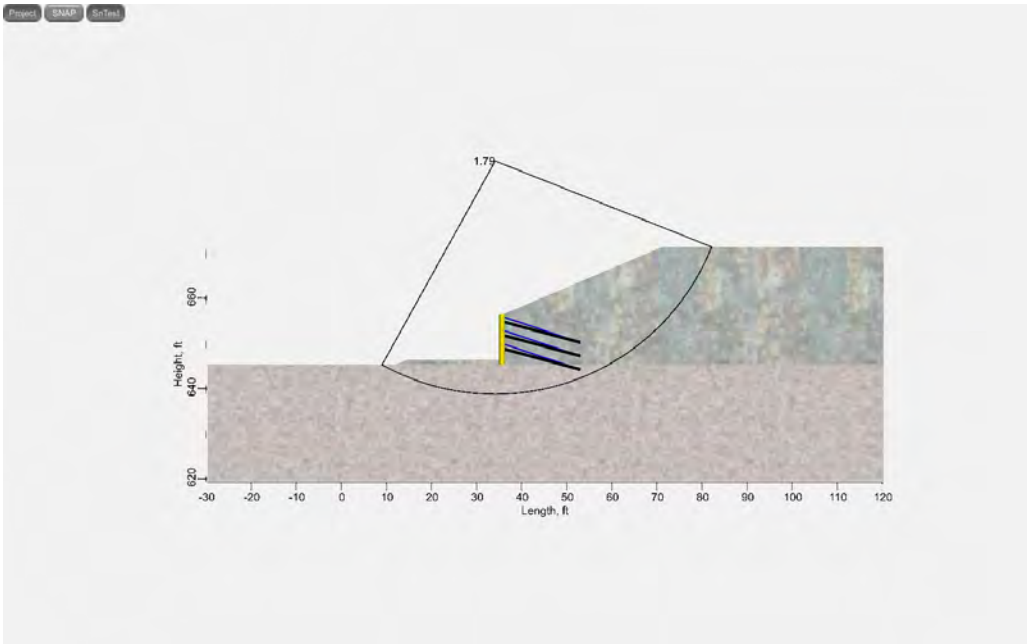
Static global stability for construction sequence 6



Construction #	Resolution, ft	Min_{Depth}, ft	Seismics	Center, ft	Radius, ft	FoS
6	1.0	2.0	false	34.0,690.0	51.6	1.96

Construction #: Construction number, adds stage cuts and nails according to assigned construction sequences
Resolution: Resolution for Bishop Method (smaller values require longer computation time)
Min_{Depth}: Minimum height of failure circle arc. Use this to remove small failure circles.
Seismics: Select to use seismic case, unselect for static case
Center: Center of minimum factor of safety failure circle
Radius: Radius of minimum factor of safety failure circle
FoS: Minimum factor of safety

Seismic global stability for construction sequence 6



Construction #	Resolution, ft	Min_{Depth}, ft	Seismics	Center, ft	Radius, ft	FoS

6	1.0	2.0	true	34.0,690.0	51.6	1.79

Construction #: Construction number, adds stage cuts and nails according to assigned construction sequences
Resolution: Resolution for Bishop Method (smaller values require longer computation time)
Min_{Depth}: Minimum height of failure circle arc. Use this to remove small failure circles.
Seismics: Select to use seismic case, unselect for static case
Center: Center of minimum factor of safety failure circle
Radius: Radius of minimum factor of safety failure circle
FoS: Minimum factor of safety

APPENDIX C

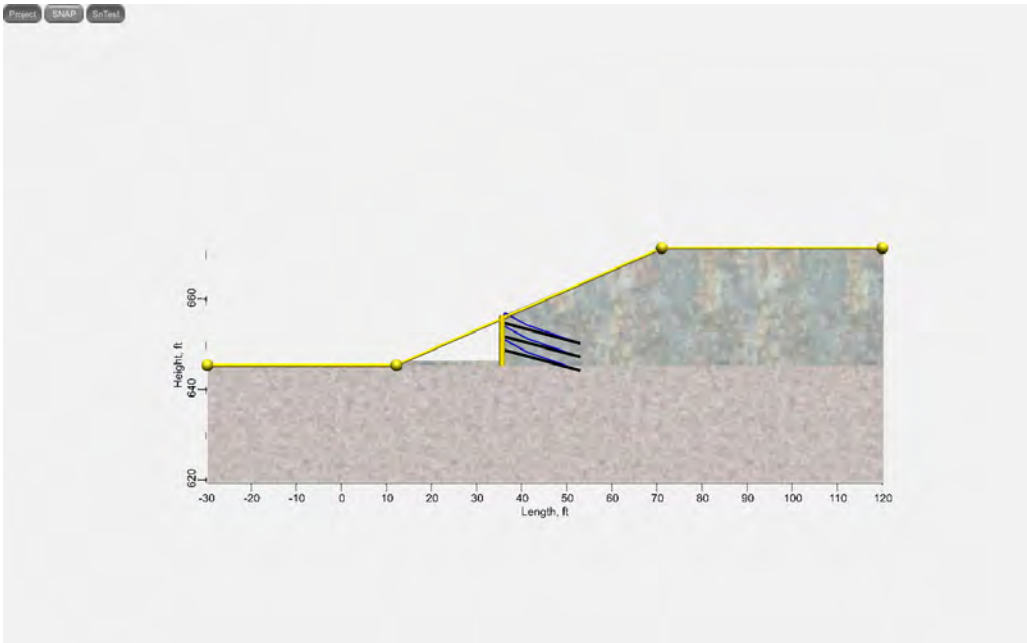
SNAP_2 Long Term Drained (Effective) Soil Nail Wall Loading

SNAP_2 Report

Name	Number	Company	Wall #	Designer	Date
I77 Gateway	180510	JWA	1	CEW	6/4/18

Name: Name of project.
Number: Project number or ID
Company: Name of company
Wall #: Wall number
Designer: Name of person performing design.
Date: Date of project

Existing Slope



Existing Slope Points

#	X, ft	Y, ft
1	-30.0	645.0
2	12.0	645.0
3	71.0	671.0
4	120.0	671.0

X: Horizontal coordinates
Y: Vertical coordinates

Soils

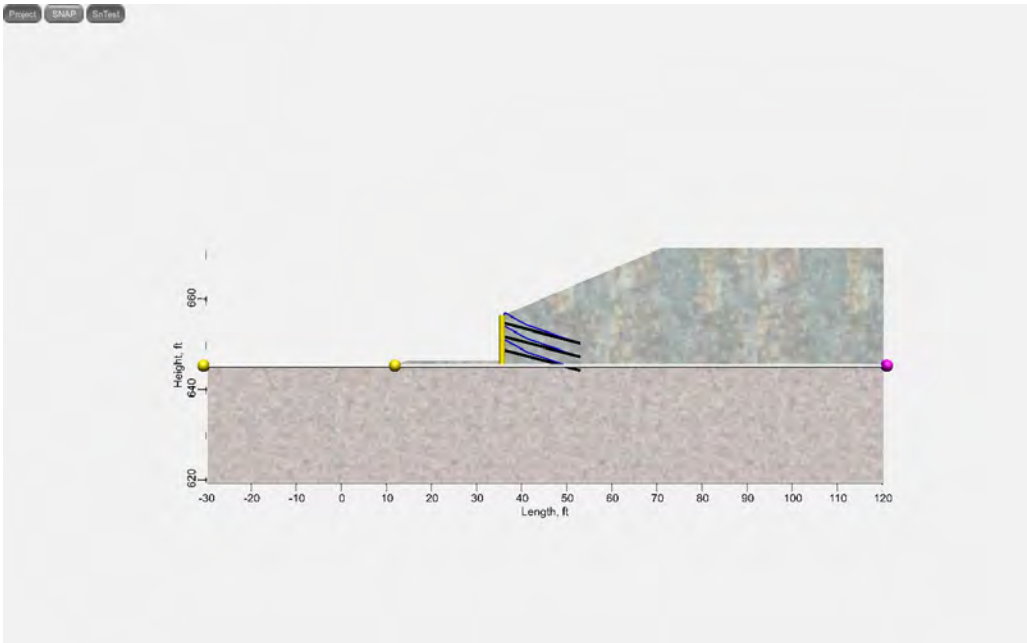
Soil Properties

#	Name	Texture	Color	γ'_s, pcf	ϕ', ^{o}	δ_s, ^{o}	c', psf	q_u, psi	N_c	N_q	N_γ
1	Soil 1	silt	white	120	29.8	19.9	230.0	5.8	29.7	18.0	21.8

2	Soil 2	sand	white	110	28	18.7	0.0	5.8	25.8	14.7	16.7

Name: Name of soil
Texture: Soil/rock Type
Color: Soil color
γ'_s: Effective unit weight of soil
ϕ': Effective soil friction angle / angle of internal friction
δ_s: Wall-soil interface friction angle, $\delta = 2/3\phi$
c': Effective cohesion of soil
q_u: Ultimate bond strength
N_c: N_c bearing capacity factor
N_q: N_q bearing capacity factor
N_γ: N_γ bearing capacity factor

Soil 2: Points at top of Soil 2

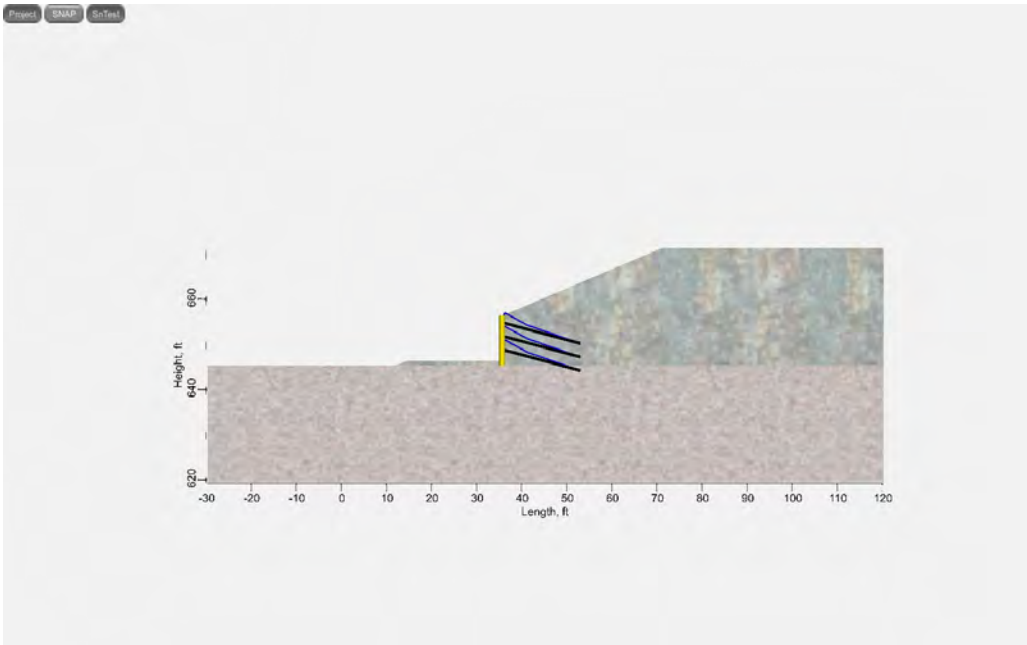


Points at top of Soil 2

#	X, ft	Y, ft
1	-30.0	645.0
2	12.0	645.0
3	120.0	645.0

X: Horizontal coordinates
Y: Vertical coordinates

Ground Water



Nails

Default Factors of Safety

U	F_y FoS	F_{ys} FoS	F_p FoS	F_{ps} FoS
true	1.80	1.35	2.00	1.50

U: Use same factors of safety for each bar
F_y FoS: Factor of safety for yield strength
F_{ys} FoS: Seismic factor of safety for yield strength
F_p FoS: Factor of safety for pullout
F_{ps} FoS: Seismic factor of safety for pullout

Bar Properties

Name	D, in	D_{out}, in	D_{in}, in	Bar No, Bar #	F_y, ksi
Bar 1	8.0	1.000	0.000	8.0	75.0

Name: Name of bar set
D: Drill hole diameter
D_{out}: Outside diameter of bar
D_{in}: Inside diameter of bar
Bar No: Nail size 3-18
F_y: Steel yield strength of bar

Facings

Facing Properties

#	Type	Name	Description
1	Temp SNW	Temp SNW 1	Shotcrete
2	Perm SNW	Perm SNW 1	CIP

Type: Facing type
Name: Name of facing
Description: Facing description

Temp SNW 1: Shotcrete

Mesh	Bars
true	true

Mesh: true if temporary facing has mesh reinforcement
Bars: true if temporary facing has bar reinforcement

Mesh: Temporary facing mesh

S_{vw}, in	S_{hw}, in	A_{wire}, in^2	$Mesh_{F_y}$, ksi
6.0	6.0	0.029	60.0

S_{vw}: Vertical mesh spacing of wires
S_{hw}: Horizontal mesh spacing of wires
A_{wire}: Mesh area of wire
$Mesh_{F_y}$: Wire mesh yield strength

Bars: Temporary facing bars

H_{Bars}	hr, in	H, Bar #	d_W, in	H_{F_y}, ksi	V_{Bars}	vr, in	V, Bar #	d_B, in	$L_{c_{vb}}$, ft	V_{F_y}, ksi
2	12	4	0.500	60.0	2	12	4	0.500	2.0	60.0

H_{Bars}: Number of horizontal waler bars
hr: Horizontal reinforcement spacing
H: Horizontal waler bar size, 3-10
d_W: Horizontal bar diameter
H_{F_y}: Horizontal bar yield strength
V_{Bars}: Number of vertical bearing bars
vr: Vertical reinforcement spacing
V: Vertical bearing bar size, 3-10
d_B: Vertical bearing bar diameter
$L_{c_{vb}}$: Vertical bearing bar length
V_{F_y}: Bearing bar yield strength

Shotcrete: Temporary shotcrete facing

$f_{c'}$, psi	h_c, in	C_F	C_S	TF FoS	TF_s FoS
4000	4.0	2	1	1.35	1.10

$f_{c'}$: Shotcrete facing compressive strength
h_c: Shotcrete facing thickness
C_F: Flexure pressure factor (Accounts for non-uniformity of pressure at back of facing)
C_S: Shear pressure factor
TF FoS: Factor of safety for flexure and punching
TF_s FoS: Seismic factor of safety for flexure and punching

Plate: Temporary facing plate

b_{PL}, in	b_d, in	F_F
8.0	1.0	0.5

b_{PL}: Bearing plate side length
b_d: Bearing plate thickness
F_F: Nail head service load factor

Perm SNW 1: CIP

Temporary Facing	Mesh	Bars	Studs
Temp SNW 1	false	true	true

Temporary Facing: Temporary wall facing behind this permanent facing
Mesh: True if permanent facing has mesh reinforcement
Bars: true if permanent facing has bar reinforcement
Studs: true if permanent facing has studs

Bars: Permanent facing bars

hr, in	H, Bar #	d_W, in	H_{F_y}, ksi	vr, in	V, Bar #	d_B, in	V_{F_y}, ksi
12	4	0.500	60.0	12	4	0.500	60.0

hr: Horizontal reinforcement spacing
H: Horizontal waler bar size, 3-10
d_W: Horizontal bar diameter
H_{F_y}: Horizontal bar yield strength
vr: Vertical reinforcement spacing
V: Vertical bearing bar size, 3-10
d_B: Vertical bearing bar diameter
V_{F_y}: Bearing bar yield strength

Concrete: Permanent facing concrete

$f_{c'}$, psi	h_c, in	C_F	C_S	PF FoS	PF_s FoS
4000.000	8	1.000	1.000	1.50	1.10

$f_{c'}$: Concrete compressive strength
h_c: Permanent facing thickness
C_F: Flexure Pressure Factor, Table 4.2 (Accounts for non-uniformity of pressure at back of facing)
C_S: Shear pressure factor
PF FoS: Factor of safety for flexure and punching
PF_s FoS: Seismic factor of safety for flexure and punching

Studs: Permanent facing studs

D_{Hs}, in	D_H, in	t_H, in	L_S, in	S_{hs}, in	F_y, ksi	P_{Thick}, in	N_H	HT FoS	HT_s FoS
0.75	1.25	0.375	5.188	5	60	1	4	2.00	1.50

D_{Hs}: Stud body diameter
D_H: Stud head diameter, d_h: Stud head diameter OK: $d_h >= 1.58 * d_{hs}$, 1.25 >= 1.58 * 0.75, 1.25 >= 1.185
t_H: Stud head thickness, t_h: Stud head thickness Ok: $t_h >= (d_h - d_{hs}) / 2$, 0.375 >= (1.25 - 0.75) / 2, 0.375 >= 0.25
L_S: Stud overall length
S_{hs}: Stud spacing
F_y: Stud yield strength
P_{Thick}: Plate thickness
N_H: Number of headed-studs in the connection
HT FoS: Headed-stud tensile fracture factor (for ASTM A307, $?_{FHS}$ = 0.50; for ASTM A325 $?_{FHS}$ = 0.59)
HT_s FoS: Seismic headed-stud tensile fracture factor

Wall types

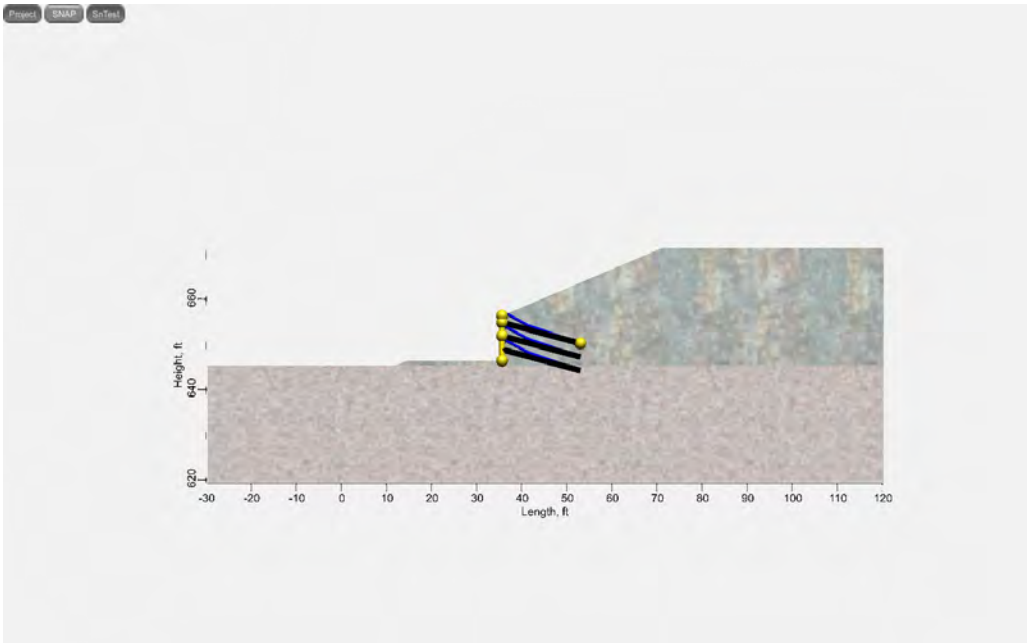
Name	Description
SN Wall 1	-

Name: Name of wall
Description: Wall Description

SN Wall 1:

Static Case

Wall: Soil nail wall geometry



Construction: Construction specification

Construction #	Con_{seq}
40	1

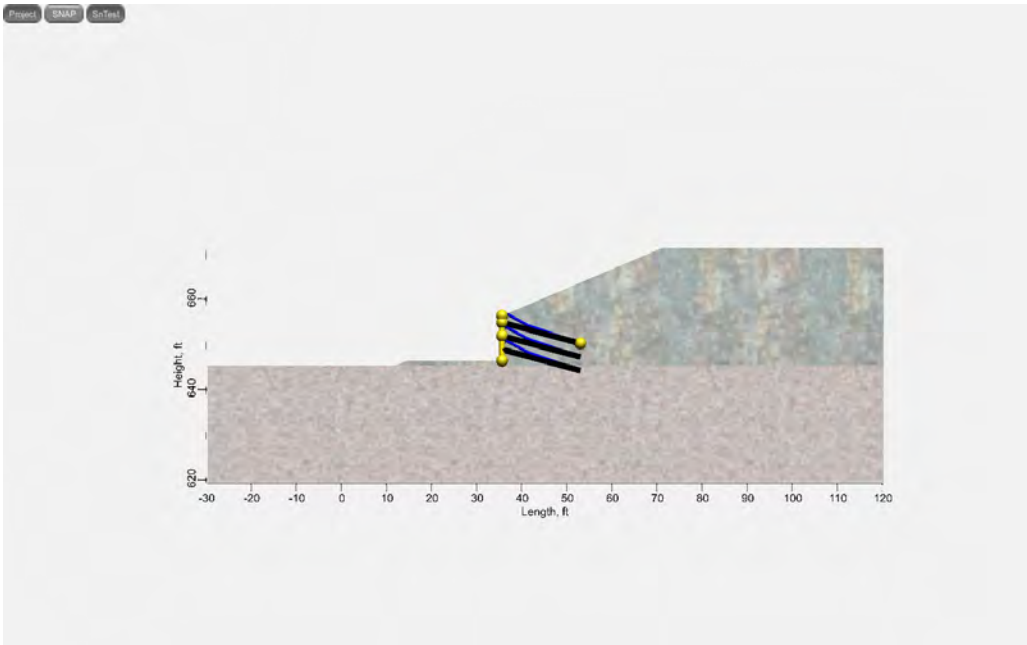
Construction #: Construction number, adds stage cuts and nails according to assigned construction sequences
Con_{seq}: Construction (stage cut) sequence when wall construction begins ie. "1" or "2,4-6"

Wall: Soil nail wall size and location

Facing	Base, ft	Top, ft	H, ft	θ, º	Emb, ft	Width, ft
Temp SNW 1	35.5,646.0	35.5,656.0	10.0	0.0	1.0	200

Facing: Wall facing
Base: Base of wall
Top: Top of wall
H: Wall height
θ: Wall batter angle, degrees from vertical
Emb: Embedment, depth below ground surface at toe
Width: Width of wall, extending along Z-Axis

Nails: Soil nail wall nail geometry



Shorten T_F
false

Shorten T_F: Shorten T-Forces on lower nails due to deformation during construction

Nails: Soil nail sizes and locations

Nail	L, ft	S_V, ft	S_H, ft	δ, º	C_d, ft	O	U
Bar 1	18.00	3.00	3.00	15.0	1.50	false	true

Nail: Bar used for this nail
L: Nail length
S_V: Vertical nail spacing
S_H: Horizontal nail spacing
δ: Nail inclination, degrees from horizontal
C_d: Cantilever distance, vertical distance from top of wall to top nail
O: Offset pattern, true if nails in even rows are offset to midspan, otherwise nails are in a square pattern
U: Use uniform nails
Nail List: Nail properties

Nail[1]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
1.50	-	0.00	0.0

C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	28.0	Soil 1	Punching/Flexure Failure
2	5.58	10.9	Soil 1	Pullout

3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Nail[2]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
4.50	-	0.00	0.0

C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	28.0	Soil 1	Punching/Flexure Failure
2	5.58	10.9	Soil 1	Pullout
3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Nail[3]

C_{dH}, ft	Failure	L_{fail}, ft	T_{Force}, kip
7.50	Pullout from Soil 2	15.33	2.3

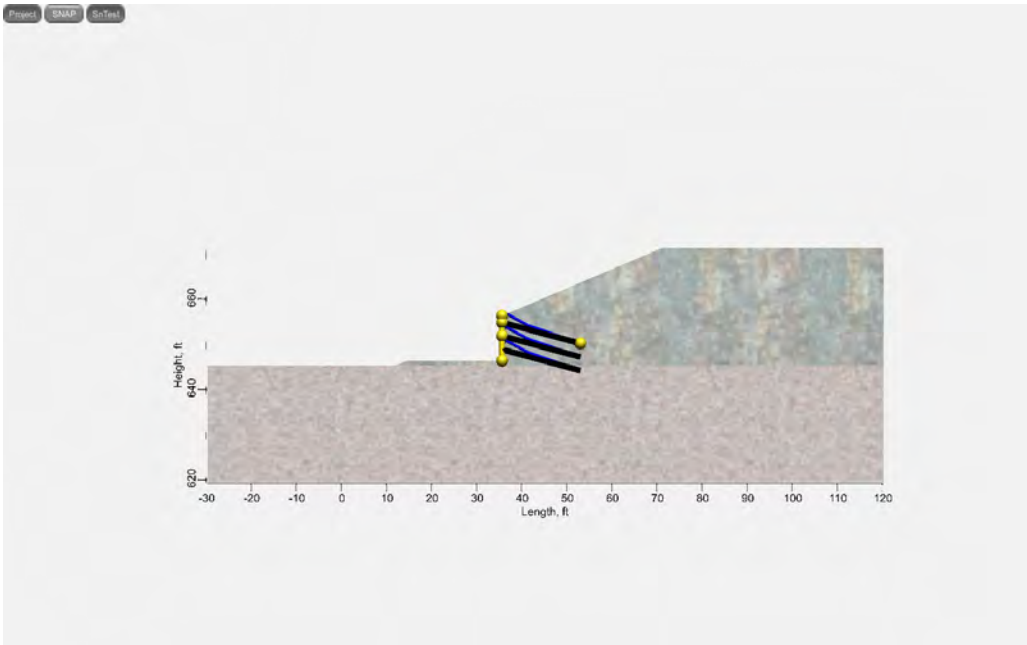
C_{dH}: Cantilever distance, vertical distance from top of wall to this nail
Failure: Failure mode for wall slip surface
L_{fail}: Distance from nail head to failure surface
T_{Force}: Nail T-force

T-Forces: Nail T-forces

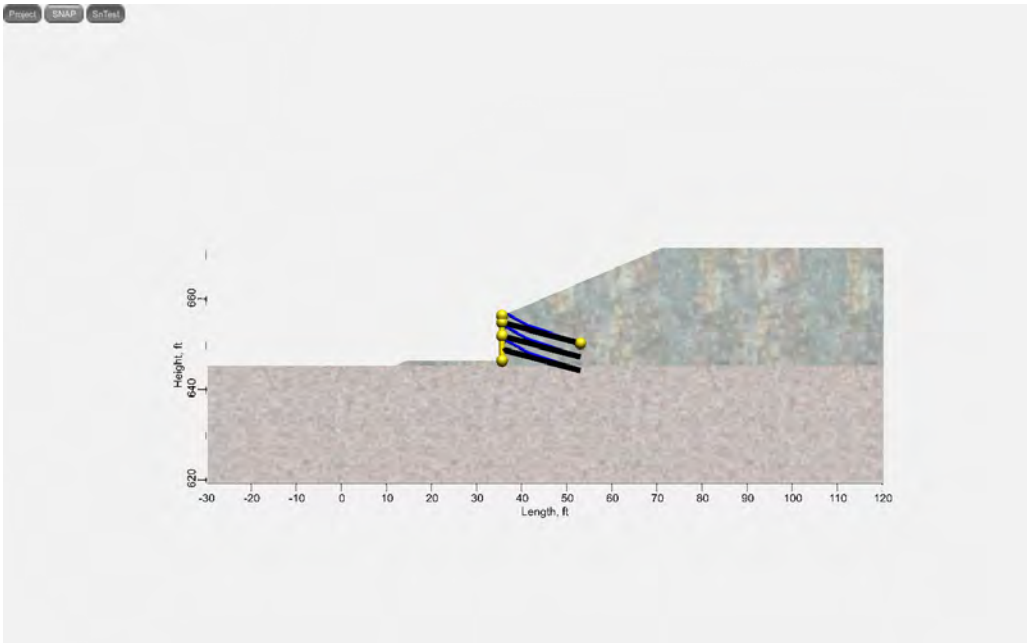
#	Dist, ft	T-Force, kip	Soil	Failure
1	0.00	28.0	Soil 1	Punching/Flexure Failure
2	5.58	10.9	Soil 1	Pullout
3	18.00	0.0	Soil 1	Pullout

Dist: Horizontal distance of T-force from nail head
T-Force: Nail T-force
Soil: Soil layer at T-force location
Failure: Failure mode at T-force location

Slope: Backslope and downslope cuts



Checks: Soil nail wall design checks



Checks: Facing design checks

T_F, lbf	t_F, lbf	V, lbf/ft	M, ft-lbf/ft	L_{VB}, ft	L_S, in	ecc, ft	FS_{SL}	FS_{BC}	FoS_{GS}
27809	2517	2247.8	1317.6	2.1	12.9	-0.2	1.8	10.7	1.75

T_F: Allowable nail head strength - minimum of temporary facing T_{FF} and T_{FP}, T_F: Nail Head Load Ok: $t_F < T_F$: 2517 < 27809
t_F: Estimated nail head service load, Nail Head Load Ok: $t_F < T_F$: 2517 < 27809
V: Allowable one-way unit shear strength, One-way Unit Shear in Upper Cantilever OK: v < 0.67 V

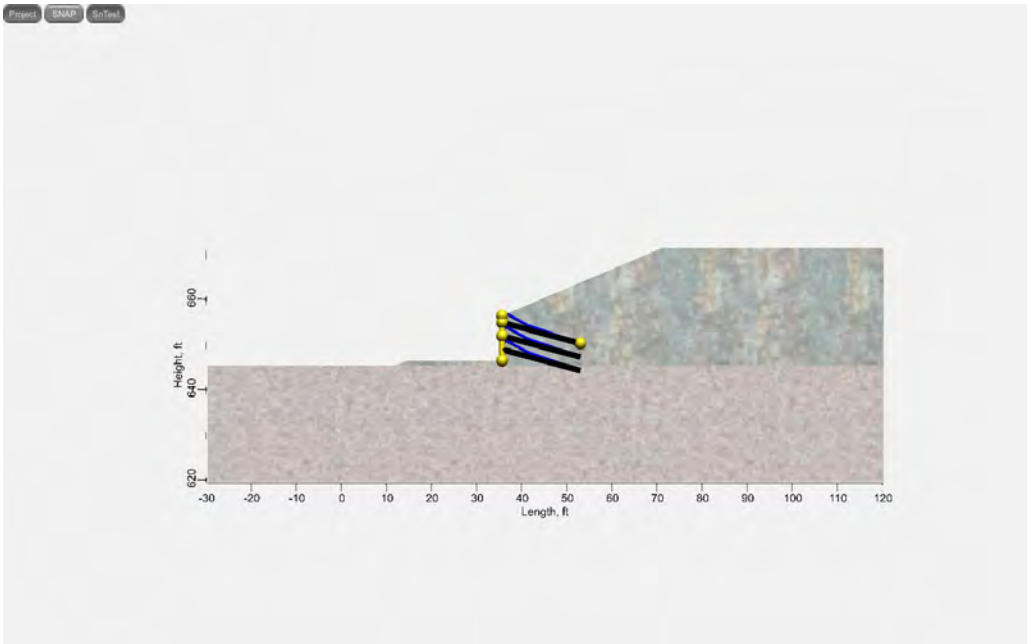
M: Allowable one-way unit moment, Design for Flexure in Upper Cantilever OK: mS < 0.67 M
L_{VB}: Minimum total length of vertical bearing bars, Bearing bar embedment length OK
L_S: Minimum waler splice length, AASHTO 8.32, Waler splice length must be greater of 12 in. or LDwb, Ok
ecc: Eccentricity check for overturning, Ok: ecc < B / 4
FS_{SL}: Factor of safety with respect to base sliding, Ok: FS_{SL} >= 1.3
FS_{BC}: Factor of safety with respect to bearing capacity $FS_{BC} = q_{ult}/\sigma_v$, Ok: FS_{BC} >= 2.5
FoS_{GS}: Factor of safety of global stability slip surface, Ok: FoS_{GS} >= 1.35

Displacement: Long-term wall deformation and displacement parameters

$\delta_{h/H}$	κ	δ, in	λ, ft
0.003	1.50	0.4	15.0

$\delta_{h/H}$: Displacement ratio: (weathered rock/stiff soil: 0.001) (sandy soil: 0.002) (fine-grained soil: 0.003)
κ: Damping coefficient used to estimate wall displacement: (weathered rock/stiff soil: 0.8) (sandy soil: 1.25) (fine-grained soil: 1.5)
δ: Estimated displacement at the top of soil nail wall, L/H ratio outside 0.7 - 1.0, Estimation may not be accurate
λ: Horizontal distance behind soil nail wall where ground deformation can be significant

Vars: Soil nail internal variables



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SC Facing Vars: Shotctrete facing design intermediate variables

$A_{S_{NEG}}$, in^2	$A_{S_{POS}}$, in^2	$m_{V_{NEG}}$, ft-lbf/ft	$m_{V_{POS}}$, ft-lbf/ft	D'_C, in	D_C, in	V_N, lbf	A_C, in^2	A_{GC}, in^2
0.574	0.174	1779	568	12.0	16.0	38149	201	50

$A_{S_{NEG}}$: Cross sectional area of steel near the nail head
$A_{S_{POS}}$: Cross sectional area of steel near the nail mid-point
$m_{V_{NEG}}$: NEG average nominal unit moment resistance
$m_{V_{POS}}$: POS average nominal unit moment resistance
D'_C: Effective diameter of punching cone
D_C: Base diameter of punching cone
V_N: Nominal internal punching shear strength of the shotcrete facing
A_C: Cross-sectional area at base of punching cone
A_{GC}: Cross-sectional area of grout column

SC Facing Vars 2: More shotctrete facing design intermediate variables

T_{FN_F}, lbf	T_{F_F}, lbf	T_{FN_P}, lbf	T_{F_P}, lbf	MaxDevLen, in	%CVB, %	L_{DBwb}, in	L_{Dwb}, in	L_D, in	MaxDevLenMesh, in
37542	27809	43403	32150	7.5	69.7	7.6	12.9	1.864	8.0

T_{FN_F}: Nominal nail head strength - flexure
T_{F_F}: Allowable nail head strength - flexure
T_{FN_P}: Nominal nail head strength - punching
T_{F_P}: Allowable nail head strength - punching
MaxDevLen: Maximum of ($L_{c_{vb}}$/20), (15*d_B), and (h_c/2)
%CVB: Percent coverage from vertical bars
L_{DBwb}: Basic development length of waler bars, AASHTO 8.25.1
L_{Dwb}: Development length of waler bars, AASHTO 8.25
L_D: Basic development length of wire mesh, AASHTO 8.30
MaxDevLenMesh: Minimum wire mesh splice length

SC Facing Vars 3: More shotctrete facing design intermediate variables

K_A	A_N, in^2	T_{NN}, lbf	T_N, lbf	$K_{A_{LC}}$	v, lbf/ft	V_{NS}, lbf/ft	m_S, ft-lbf/ft
0.509	0.79	58904.9	32725.0	0.482	59.6	3034.5	29.5

K_A: Coulomb active earth pressure coefficient
A_N: Nail tendon area
T_{NN}: Nominal nail tendon tensile load
T_N: Allowable nail tendon tensile load
$K_{A_{LC}}$: Active earth pressure coefficient for load component normal to wall
v: One-way unit service shear force
V_{NS}: Nominal one-way unit shear strength
m_S: One-way unit service moment

Ex Vars: External stability intermediate variables

θ, °	β, °	q_s, psf	ϕ, °	ϕ_f, °	γ_1, pcf	γ_2, pcf	c, psf	δ, °
0.0	22.9	0	28.0	28.0	110.0	110.0	0.0	18.7

θ: Inclination of back wall measured CCW from vertical plane
β: Inclination of ground slope behind wall measured CCW from horiz. plane
q_s: Surcharge load behind wall
ϕ: Internal friction angle of weakest retained soil
ϕ_f: Internal friction angle of weakest foundation soil
γ_1: Unit weight of weakest retained soil
γ_2: Unit weight of weakest foundation soil
c: Cohesion - weakest foundation soil
δ: Wall/soil interface friction angle

Ex Vars 2: More external stability intermediate variables

B, ft	h, ft	Nγ	N_c	N_q	H2, ft	K_a	S, °
17.4	17.3	16.7	25.8	14.7	12.7	0.509	2.541

B: Effective width of wall at the base
h: Effective total height of soil at back of reinforced soil mass
Nγ: See Fig 4.4.7.1.1.4B and Table 4.4.7.1A AASHTO
N_c: Bearing capacity coefficient - weakest foundation soil
N_q: Bearing capacity coefficient - weakest foundation soil
H2: A height near the back of wall for calculating PIR and PAE
K_a: Active earth pressure coefficient - no seismic forces
S: Angle relating the horizontal and vertical seismic coefficients

Ex Vars 3: More external stability intermediate variables

F_T, lbf/ft	F_H, lbf/ft	F_V, lbf/ft	V_2, lbf/ft	V_1, lbf/ft	F_2, lbf/ft
8416.2	7752.6	3275.8	7025.2	19125.2	0.0

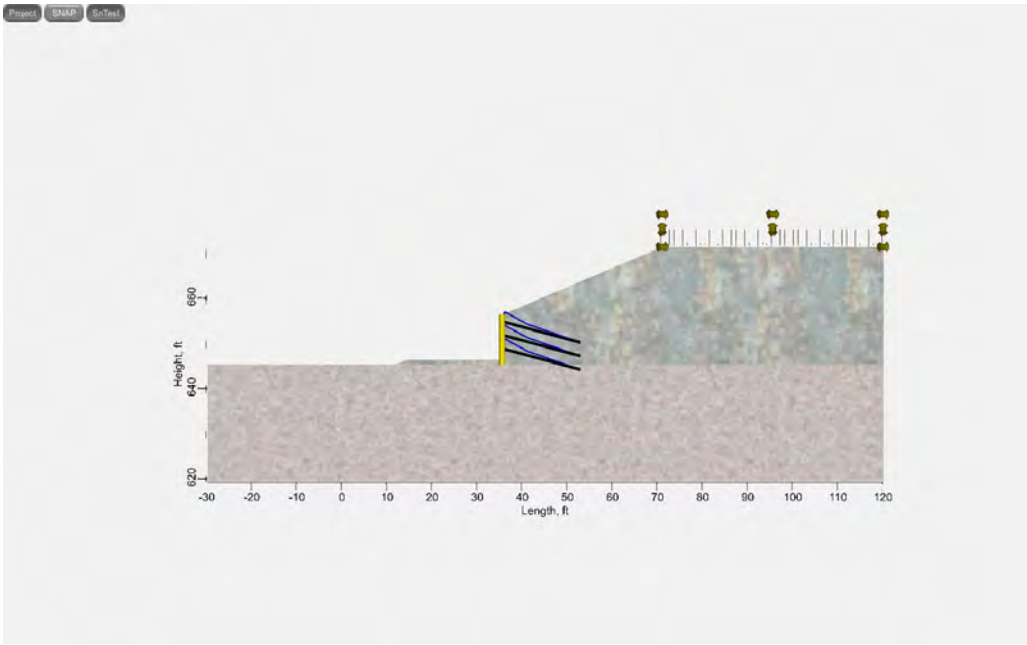
F_T: Lateral earth pressure
F_H: Horizontal lateral earth pressure
F_V: Vertical lateral earth pressure
V_2: Weight of soil above wall
V_1: Weight of soil above wall
F_2: Surcharge load

Ex Vars 4: More external stability intermediate variables

P_{IR}, lbf/ft	Y_{IR}, ft	σ_v, psf	q_{ult}, psf	q_{allow}, psf
955.4	5.7	1648.2	17605	7042

P_{IR}: Horizontal inertial force
Y_{IR}: Y-coordinate of centroid of mass for inertial force
σ_v: Vertical effective stress at base of footing
q_{ult}: Terzaghi bearing capacity
q_{allow}: Terzaghi bearing capacity $q_{allow} = q_{ult}/FOS$

Surcharge



Con_{seq}	X1, ft	X2, ft	q_s, psf	q_{sH}, psf
1-4	71.0	120.0	250	0

Con_{seq}: Construction sequence for applying surcharge, ie. "1-5" or "2,4-6"
X1: Surcharge X range start
X2: Surcharge X range end
q_s: Vertical surcharge load on slope segment as a number (250) or a linearly interpolated range (100~250)
q_{sH}: Horizontal surcharge load on slope segment as a number (250) or a linearly interpolated range (100~250)

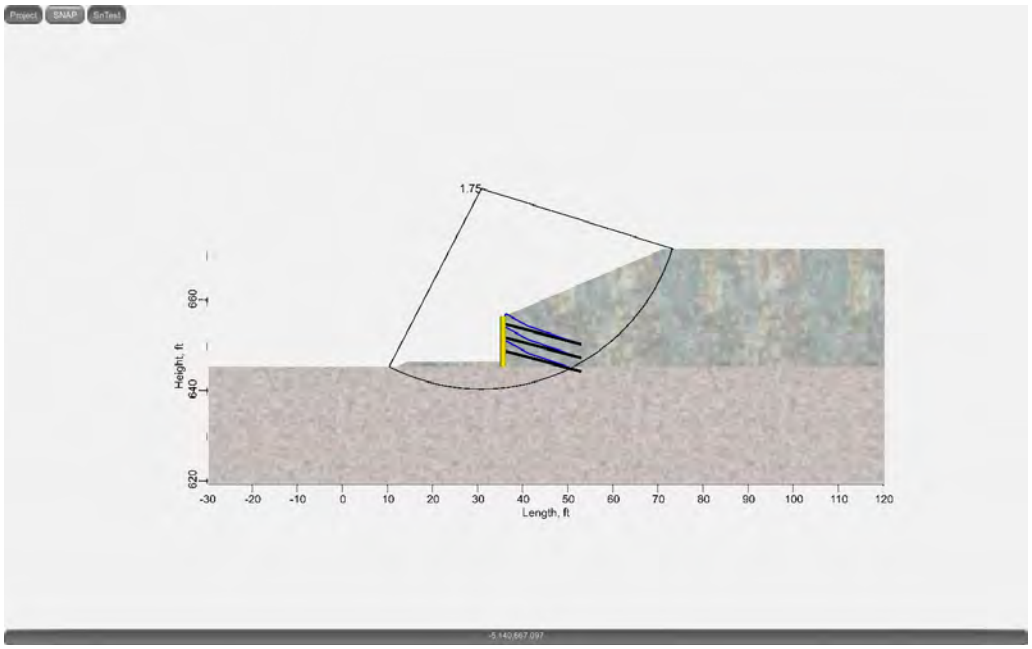
Seismic

Seismic	d, in	A	A_m	Calc K_h	K_h	K_v

false	8.000	0.120	0.16	true	0.044	0.000

Seismic: Use seismic loading for external and global stability analysis
d: Tolerable seismically induced wall lateral movement
A: Peak ground acceleration coefficient as a fraction of gravity
A_m: Normalized horizontal acceleration, $A_m = A (1.45 - A)$
Calc K_h: Automatically calculate K_h from A, if d is between 25 and 203, $K_h = 0.74 A_m (A_m/d)^{0.25}$, else $K_h = A/2$
K_h: Horizontal seismic coefficient
K_v: Vertical seismic coefficient

Static global stability for construction sequence 6



Construction #	Resolution, ft	Min_{Depth}, ft	Seismics	Center, ft	Radius, ft	FoS
6	1.0	2.0	false	30.7,684.3	44.4	1.75

Construction #: Construction number, adds stage cuts and nails according to assigned construction sequences
Resolution: Resolution for Bishop Method (smaller values require longer computation time)
Min_{Depth}: Minimum height of failure circle arc. Use this to remove small failure circles.
Seismics: Select to use seismic case, unselect for static case
Center: Center of minimum factor of safety failure circle
Radius: Radius of minimum factor of safety failure circle
FoS: Minimum factor of safety

ITEMIZED BID

BIDDER NAME: _____

PROJECT #: 512-16-070

PROJECT NAME: I-77 West Trade Underpass Enhancement

SECTION 1: BID **REVISED 5-24-19**

Item	*Section*	*ITEM DESCRIPTION*	*Quantity*	*Unit*	*Unit Price*	*Amount*
1	800	Mobilization	1	LS		$0.00
2	226	Undercut Excavation	50	CY		$0.00
3	300	Foundation Conditioning Geotextile	202	SY		$0.00
4	520	Aggregate Base Course	80	TN		$0.00
5	610	Asphalt Concrete Base Course, Type B 25.0C	180	TN		$0.00
6	610	Asphalt Concrete Intermediate Course, Type I 19.0C	49	TN		$0.00
7	610	Asphalt Concrete Surface Course, Type S 9.5C	36	TN		$0.00
8	620	Asphalt Binder for Plant Mix	16	TN		$0.00
9	848	4 " Concrete Sidewalk	1825	SY		$0.00
10	848	6 " Concrete Sidewalk or Pad	240	SY		$0.00
11	858	Adjustment of Manholes	3	EA		$0.00
12	846	2' 6" Concrete Curb and Gutter	745	LF		$0.00
13	846	1'-6" Median Curb and Gutter - CLDS 10.17B	68	LF		$0.00
14	863	Remove Existing Guardrail	80	LF		$0.00
15	862	Steel Beam Guardrail	85	LF		$0.00
16	862	Guardrail Anchor Units, Type CAT-1	2	EA		$0.00
17	901	Contractor Furnished, Type E Sign	66	SF		$0.00
18	903	Ground Mounted Sign Supports (2lb Steel U-channel)	8	EA		$0.00
19	1205	Thermoplastic Pavement Marking Lines, 24", 120 mils	62	LF		$0.00
20	1205	Thermoplastic Pavement Marking Lines, 4", 120 mils	107	LF		$0.00
21	1205	Thermoplastic Pavement Marking Lines, 8", 120 mils	1,591	LF		$0.00
22	1205	Thermoplastic Pavement Marking Lines, 8", 90 mils	23	LF		$0.00
23	1412	Underpass Lighting- Luminaires	10	EA		$0.00

Item	*Section*	*ITEM DESCRIPTION*	*Quantity*	*Unit*	*Unit Price*	*Amount*
24	1412	Underpass Lighting -Circuitry	1	LS		$0.00
25	1408	Light Control Equipment	2	EA		$0.00
26	1410	Feeder Circuits (Bollards #12AWG)	720	LF		$0.00
27	1715	Directional Drill 1-1” Conduit	90	LF		$0.00
28	1715	Directional Drill 1-2” Conduit	154	LF		$0.00
29	SP-01	Comprehensive Grading	1	LS		$0.00
30	SP-03	Select Material	25	TN		$0.00
31	SP-05	Traffic Control	1	LS		$0.00
32	SP-06	6" Concrete Wheelchair Ramps	383	SY		$0.00
33	SP-07	Painting Existing Structure and Pollution Control	1	LS		$0.00
34	**SP-08**	**Cast in Place (CIP) Gravity Retaining Walls**	**12**	**CY**		$0.00
35	SP-09	Soil Nail Retaining Wall	2,943	SF		$0.00
36	SP-09	Soil Nail Verification	2	EA		$0.00
37	SP-09	Soil Nail Proof Tests	4	EA		$0.00
38	SP-10	Root Excavation & Cutting	50	LF		$0.00
39	SP-11	Planting Soil Mix	475	CY		$0.00
40	SP-12	Conduit, PVC, 1", Schedule 80	1,110	LF		$0.00
41	SP-12	Conduit, PVC, 2", Schedule 80	1,946	LF		$0.00
42	SP-13	Pull Box, Duke, (24" x 36" x 24")	37	EA		$0.00
43	SP-16	Decorative Concrete Pentagonal Paving	1,560	SF		$0.00
44	SP-17	Concrete Unit Pavers (with Latex mortar bed)	4,195	SF		$0.00
45	SP-18	Site Furnishings	1	LS		$0.00
					Subtotal	$0.00
				15.0%	**Contingency**	$0.00
					Total Bid	$0.00

Do <u>not</u> include any North Carolina Sales and Use Tax that qualifies as Eligible Taxes per Section 00 70 00, Subsection 2.17 “Sales and Use Tax”.

PRE-BID MEETING ATTENDANCE SHEET

Project Name	Five Points Plaza Improvement and I-77 West Trade Underpass Enhancement Project
Project #	512-16-069 and 512-16-070
Prebid Date	Wednesday, May 15, 2019 10:00 AM
Prebid Location	14th Floor Large
Contracts Specialist	Nancy Denis
Project Manager	Lamar Davis

Company Name	*Representative's Name (PLEASE PRINT NAME)*	*Address*	*Phone number*	*Email*
City of Charlotte - EPM-Contracts	Nancy Denis	600 East Fourth Street Charlotte, NC 28202	704-336-3614	nndanu@charlottenc.gov
United or Cons.	Jack Gould	1008 N. Tryon CLT, N C.	704 361 9459	jack@unitedcarolinas.com
Carolina Bomanite	John Fletcher	4933 Chastain Ave Charlotte, NC 28217	704-525-8585	John@carolinabomanite.com
Blythe Development Co	Eve Hibbler	1415 E. Westinghouse Blvd Charlotte, NC 28273	704-588-0023	ehibbler@blythedevelopment.com
R&R Eudy Construction	Del DelaCruz	P.O. Box 5463 Concord NC 28027	704-792-2064	DEL@EUDYCONSTRUCTION.COM
Mickey Geiser	AECOM	6000 Fairview Road Suite 200 28210	704-716-0724	Mickey.geiser@aecom.com
Myron Ross	MORcon	3611 Mt. Holly - Huntersville Rd.	(980) 254-1208	mross@morcon.net
MLS (Williams Lighting)	Alfredo Knowles	3310 N. Davidson #305	(510) 461-7702	wes.davis@m-lightingsolutions.com

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Company Name	Representative's Name (PLEASE PRINT NAME)	Address	Phone number	Email
City of Charlotte - EPM-Contracts		600 East Fourth Street Charlotte, NC 28202		
~~Andy Babson EPM~~ City of Charlotte	Andy Babson	"	704 336-4333	ababson@ci.charlotte.nc.us
City of Charlotte ~~EPM~~	Mae Bryant	"	704.622.9823	mbryant@charlottenc.gov
City of Charlotte EPM	Chris Jiles	"	704-336-3005	CJiles@charlottenc.gov
AECOM	JOE LANE	6000 FAIRVIEW RD STE 200, 28210	704-716-0736	joseph.lane@aecom.com
City of Charlotte Compliance EPM	Courtney Farmer	600 E. Fourth St Charlotte, NC 28202	704-336-3651	courtney.farmer@charlottenc.gov
Beam Elec				JBecker@BeamElectric.com
AECOM	Chris Petterson	6000 Fairview Rd. Ste. 200	704.716.0762	Chris.petterson@aecom.com

PRE-BID MEETING ATTENDANCE SHEET

Project Name	Five Points Plaza Improvement and I-77 West Trade Underpass Enhancement Project
Project #	512-16-069 and 512-16-070
Prebid Date	Wednesday, May 15, 2019 10:00 AM
Prebid Location	14th Floor Large
Contracts Specialist	Nancy Denis
Project Manager	Lamar Davis

Company Name	*Representative's Name (PLEASE PRINT NAME)*	*Address*	*Phone number*	*Email*
City of Charlotte - EPM-Contracts		600 East Fourth Street Charlotte, NC 28202		
SEALAND CONTRACTORS CORP.	JASON BREE	1708 N. CALDWELL ST. CHARLOTTE NC 28206	7045321102	jason.bree@sealandcontractors.com
CROWDER CONSTRUCTION	HANS MCDONALD	6409 BROOKSHIRE BLVD CHARLOTTE NC 28216	704 348-1392	hmcdonald@crowderusa.com
Millennium Lighting Solutions	WES DAVIS	3310 N. Davidson #305	704-305-7071	Wes.Davis@m-lightingsolutions.com
R&P Eudy Const	Ron Eudy	Po Box 5463 Concord NC	704 792 2064	ronnie@eudyconstruction.com

SP-20; WARRANTY ITEMS

1.0 GENERAL

The Contractor shall warrant the items listed within this special provision to be free from defects in materials and workmanship for the minimum periods and terms noted.

The time period for WARRANTY ITEMS begins at Substantial Completion and extends for the duration of warranty terms as listed herein for each warranty item. Contractor shall provide to the City of Charlotte all Manufacturer warranties or extended warranties provided to Contractor by Manufacturers which may exceed minimum warranty periods listed or for items which may not be listed below. Contractor shall provide to the City of Charlotte a listing of all warranties along with all warranty documents after project completion and acceptance.

There shall be no payment for the work of WARRANTY ITEMS. Payment shall be included with the individual bid items as listed herein.

A table of the items covered by this Special Provision, at a minimum, and WARRANTY periods and terms follows:

Bid Item#	Special Provision Reference	Item Description	Warranty Period	Warranty Terms
45	SP-18	Precast Benches	5 years	Defects in material or workmanship
45	SP-18	Precast Stoops	5 years	Defects in material or workmanship
45	SP-18	Park Bench	3 years	Defects in material or workmanship
45	SP-18	Bicycle Racks	3 years	Defects in material or workmanship
45	SP-18	Trash Receptacles	1 year	1 year Limited / 6 year battery

2.0 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect/Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence.

1. Bind warranties in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8½ by 11-inch (215-by-280-mm) paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product or installation. Provide a typical description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Provide additional copies of each warranty to include in operation and maintenance manuals.