TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

May 22, 2023
Project No. T-5915-3

Mr. Stephen Nornes
Presbyterian Homes & Services and Senior Housing Partners
2823 Hamline Avenue North
Roseville, Minnesota 55113

Subject: Response to Comments
Geotechnical Report Addendum
Wesley Homes Expansion
Puyallup, Washington

Reference: Geotechnical Report Addendum, Wesley Homes Expansion, Puyallup, Washington, Project No. T-5915-3, prepared by Terra Associates, Inc., dated December 29, 2022

Dear Mr. Nornes:

Subsequent submittal of the referenced addendum, the City of Puyallup has requested additional information regarding the Landslide Hazard Area. Specifically, the city has requested Puyallup Municipal Code (PMC) 21.06.1230 (2) (A-F) and .1230 (11) be addressed in detail. In addition, the city has requested we address pier design foundations in more detail and the presence of seeps on the site. The following summarizes our review and response to these comments.

PMC 21.06.1230 (2) (a)

This section of the PMC requires that the proposed development in a landslide hazard area not decrease the factor of safety for landslide occurrences below 1.5 for static conditions and 1.2 for dynamic (seismic) conditions. To address this comment, we completed a stability analysis of a representative cross section of the slope that included grading and application of building loading from the proposed development. We also completed additional subsurface exploration to better define the limits of the unsuitable existing fill soils and underlying competent native soils. Supplemental test pit locations and test pit logs are attached as Figures 1 through 9. The location of the cross section analyzed is also shown on Figure 1.

We completed the stability analysis using the SLIDE2 computer program published by RocScience. Results of the analysis indicate that with the exiting unsuitable fill soils removed and replaced with structural fill placed and compacted in accordance with recommendations in our geotechnical report, the minimum safety factor under static conditions of 1.5 or greater would be met. A graphic of the cross section showing these results along with soil parameters used in the analysis is attached as Figure 10.

Seismic (Psuedostatic) analysis was then completed along this section. The acceleration input into the analysis was the Peak Ground Acceleration (PGA) for the maximum considered event (MCE) as defined by the current International Building Code (IBC). This value represents an earthquake with a 2 percent chance of exceedance in 50 years (1 in 2500 years). This acceleration was adjusted for sloping conditions. The results of this analysis indicate safety factors less than the required 1.2 minimum would be present. These results are shown on attached Figure 11.

We would note that pseudostatic safety factors of less than 1 (one) do not necessarily reflect that a slope failure or a landslide would occur. The ground shaking may cause the slope to displace downgradient, but the amount of displacement may not be significant or sufficient to cause damage to the facility that would be considered a life safety issue. To evaluate this condition, we completed additional dynamic analysis of the slope section to evaluate potential lateral downslope displacements (Newmark Analysis). The earthquake record used in this analysis was a Cape Mendocino event that had a PGA of .59 which is similar to this sites PGA. This analysis indicates that the maximum displacement along the western side of the building would be less than two-inches with displacements diminishing to less than one-half-inch towards the mid-point of the structure. This amount of movement would not be categorized as a slope failure or landslide. Damage to the building would occur, however, this amount of lateral movement would cause damage of a cosmetic nature and would not be a life safety issue that would require design which would mitigate the displacement, in our opinion. Results of this analysis are shown on attached Figure 12.

In our opinion, provided the owner is willing to accept the risk of building damage caused by minimal downslope displacement following a design level earthquake, no design measures need to be implemented to mitigate this movement. However, if the owner is not willing to accept this risk, then the western half of the building paralleling the crest of the slope should be supported on pile foundations.

PMC 21.06.1230 (2) (b)

The proposed development will actually decrease the potential for slope movements, particularly during a seismic event, than what currently exists.

PMC 21.06.1230 (2) (c)

The proposed development will reduce surface water discharge on the slope by collecting rainfall runoff in the stormwater system and discharging it to an approved controlled location.

PMC 21.06.1230 (2) (d)

The structure's location does not alter the slope's existing gradient. As shown on the structural drawings, spread footings parallel to the slope crest will be deepened to provide a minimum horizonal distance of one half the slope height (ten feet) from the edge of footing to the slope face in accordance with the IBC.

PMC 21.06.1230 (2) (e)

A short height engineered retaining wall will be used along the crest of the slope to create an access path on the west side of the building. The height of this wall is less than seven-feet.

PMC 21.06.1230 (2) (f)

As noted in response to PMC 21.06.1230 (2) (c), the development will improve drainage conditions on the slope by collecting rainfall runoff and directing it to a controlled approved point of discharge. This will reduce the landslide and erosion hazards that currently exist.

PMC 21.06.1230 (11)

For monitoring we would recommend adding the following note to the project drawings:

- During site grading and building construction the geotechnical engineer of record or his/her representative will perform bi-weekly reconnaissance of the slope and issue a field report regarding site conditions. These bi-weekly slope recons will continue until building shell construction and stormwater facilities are completed and functional. Post building construction slope recons shall occur on a quarterly basis for a period of no less than two years. If no instability or erosion issues are present at that time, monitoring can be terminated.

Rammed Aggregate Piers (RAP's)

RAPs are densely compact columns of aggregate, either processed crushed or non-crushed gravel, that are installed below the building foundations. Construction machinery used to construct the piers is similar to that used to construct drilled shaft piles or piers. The piers are not installed as structural elements but rather are a form of excavation and refilling with compacted structural fill. The number of piers required and spacing is calculated using a replacement ratio where the overall engineering characteristics of the fill is improved to the soil parameters required, to provide for suitable foundation support and/or site slope stability. If used, they are typically designed and constructed by a geotechnical specialty contractor.

Site Seepage

The site seepage mentioned in the referenced addendum took place on the east and south sides of the existing Lodge building. Flat grades along these sides of the building along with relatively low permeable fill soils resulted in ponding water areas that eventually seeped into the Lodge lower-level garage. Photographs documenting conditions observed in April 2019 are attached for reference.

This condition clearly demonstrates that infiltration of stormwater using low impact development elements such as permeable pavement would not be feasible at the site. To further demonstrate this, in addition to excavating the supplemental test pits, we performed a small-scale pilot infiltration test (PIT) in the proposed pavement area south of the new building. This PIT location is shown on Figure 1. Approximately 50 gallons of water was introduced into the test pit at a depth 2.5 feet. This resulted in a head of about six inches. After two hours, no reduction in the head occurred demonstrating the fill soils do not infiltrate. The log for the PIT along with testing comments is included with the test pit logs.

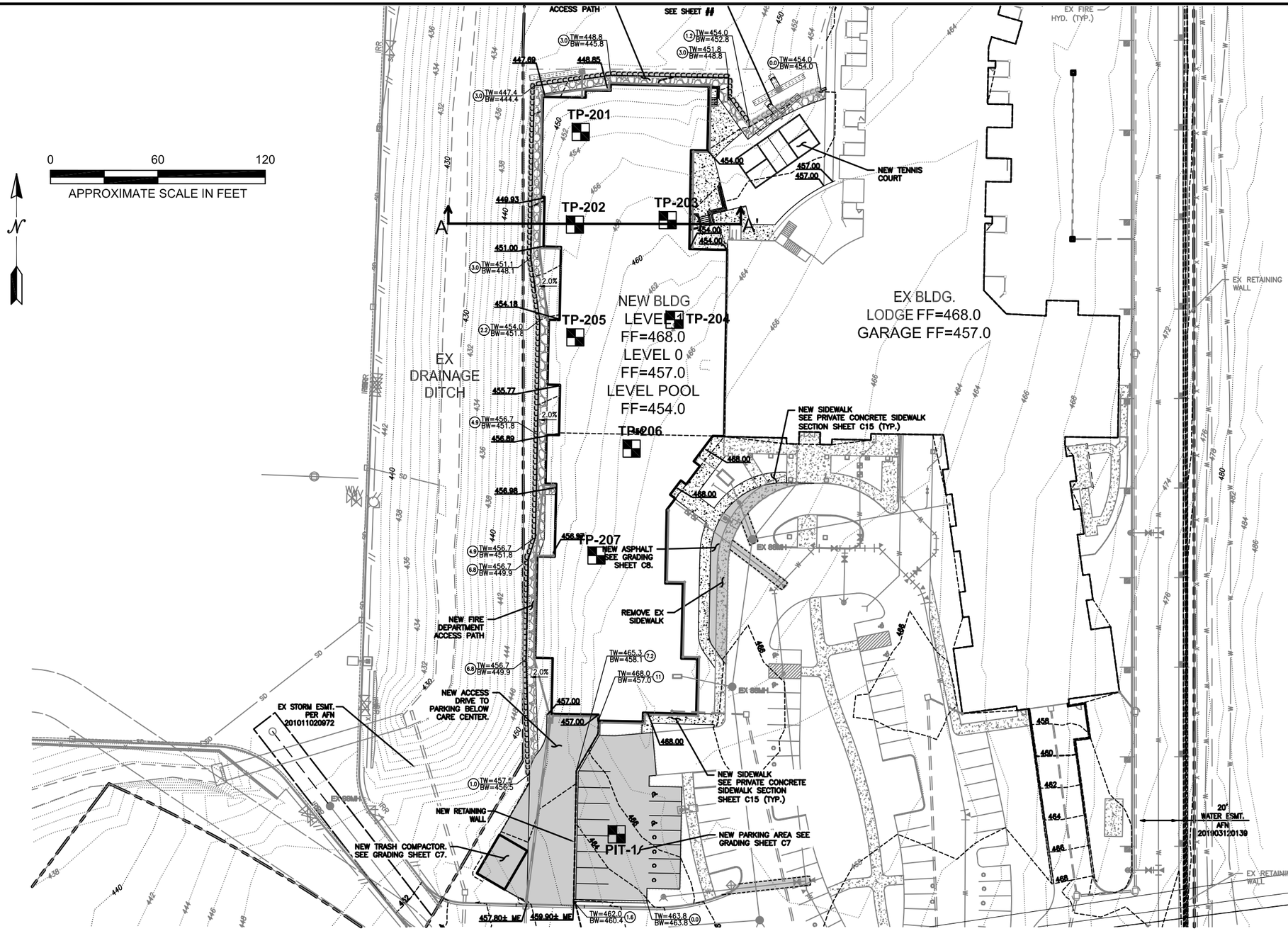
We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

Theodore J. Schepper, P.E. 5-22-2023
Senior Principal Engineer

Cc: Ms. Jill Krance, In Site Architects
Mr. Dan Balmelli, P.E., Barghausen Consulting Engineers

Attachments: Figure 1 – Exploration Location Plan
Figures 2 through 9 – Test Pit Logs
Figures 10 through 12 – SLIDE2 Stability Analysis Results
Site Phots



NOTES:

1. WALL DESIGN BY OTHERS.

RETAINING WALL LEGEND:

1 PROPOSED LOCK + LOAD RETAINING WALL (TYP.) SEE BUILDING PERMIT #____

TW=505.0 BW=500.0 (6.0)

TOP OF WALL ELEV (TYP.)

WALL HEIGHT (TYP.)

BOTTOM OF WALL ELEV. AT EXPOSED FACE UNLESS OTHERWISE SPECIFIED (TYP.)

Draft

No.	Date	By	Chkd.	Appr.

Title: GRADING PLA

For: WESLEY HOMES

Designed CK. Drawn BGK. Scale: Horizontal

Barghausen Consulting Engineers, Inc.

NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE:

SITE PLAN PROVIDED BY BARGHAUSEN CONSULTING ENGINEERS

LEGEND:

APPROXIMATE TEST PIT LOCATION

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EXPLORATION LOCATION PLAN
WESLEY BRADLEY PARK PHASE 2
PUYALLUP, WASHINGTON

Proj. No.T-5915-3	Date MAY 2023	Figure 1

LOG OF TEST PIT NO. 201

FIGURE 2

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** JCS

LOCATION: Puyallup, Washington **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** ~452

DATE LOGGED: January 31, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, scattered cobbles, trace of geosynthetic fabric fragments. (SM)	Medium Dense	21.6
2		Fill: Brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist to wet, scattered cobbles, numerous organic silty sand pockets and layers, scattered wood debris. (SM) (Strippings)		
7		- Numerous wood debris below about 7 feet.		
12	1	Gray-brown silty SAND to SAND with silt, fine grained, trace of fine gravel, moist, scattered mottling, trace of black organic fragments. (SM/SP-SM)	Medium Dense to Dense	
14		Gray silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist to wet, trace of cobbles. (SM)		
15		Test pit terminated at 14.5 feet. No groundwater seepage.		
18				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 202

FIGURE 3

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** JCS

LOCATION: Puyallup, Washington **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** ~455

DATE LOGGED: January 31, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–2		Fill: Brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, scattered cobbles, trace of geosynthetic fabric fragments. (SM)	Medium Dense	
2–12		Fill: Brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist to wet, scattered cobbles, trace of 1.5- to 2-foot diameter boulders, numerous organic silty sand pockets and layers, numerous wood debris. (SM) (Strippings)		
12–13		Gray-brown silty SAND to SAND with silt, fine grained, trace of fine to coarse gravel, wet, scattered mottling, trace of black organic fragments. (SM/SP-SM)		
13		Test pit terminated at 13 feet. No groundwater seepage.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 203

FIGURE 4

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** JCS

LOCATION: Puyallup, Washington **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** ~459

DATE LOGGED: January 31, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–1		Fill: Brown silty GRAVEL with sand, fine to coarse gravel, fine to coarse sand, wet. (GM)	Dense	
1–2		Fill: Brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, trace of cobbles. (SM)	Medium Dense	
2–13		Fill: Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, scattered cobbles, numerous dark brown organic silty sand pockets and layers, scattered to numerous wood debris. (SM) (Strippings)		
13–16	1	Gray-brown SILT with sand to silty SAND, fine sand, scattered fine to coarse gravel, wet (grading moist with depth). (ML/SM)	Medium Dense to Dense	24.3
16–18		Test pit terminated at 16 feet. No groundwater seepage.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 204

FIGURE 5

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** JCS

LOCATION: Puyallup, Washington **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** ~464

DATE LOGGED: January 31, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown silty GRAVEL with sand, fine to coarse gravel, fine to coarse sand, moist to wet. (GM)	Dense	
3		Fill: Gray to brown silty GRAVEL with sand, fine to coarse gravel, fine to medium sand, moist to wet, scattered cobbles, trace of 1-foot diameter boulders. (GM)		
4		Fill: Brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, scattered cobbles, scattered dark brown organic silty sand pockets and layers, scattered to numerous wood debris. (SM) (Strippings)	Medium Dense	
14		Gray-brown silty SAND, fine grained, moist to wet. (SM)		
15		Test pit terminated at 15 feet. No groundwater seepage.		
18				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 205

FIGURE 6

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** JCS

LOCATION: Puyallup, Washington **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** ~458

DATE LOGGED: January 31, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0–1		Fill: Brown silty SAND with gravel, fine sand, fine to coarse gravel, moist. (SM)	Medium Dense	
1–12		Fill: Brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist to wet, scattered cobbles, scattered dark brown organic silty sand pockets and layers, scattered to numerous wood debris. (SM) (Strippings)		
12–14		Gray silty SAND, fine grained, trace of fine to coarse gravel, moist to wet, scattered faint mottling. (SM)		
14–18		Test pit terminated at 14 feet. No groundwater seepage.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 206

FIGURE 7

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** JCS

LOCATION: Puyallup, Washington **SURFACE CONDITIONS:** Sparse grass **APPROX. ELEV:** ~465

DATE LOGGED: January 31, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Gray-brown silty GRAVEL with sand, fine to coarse gravel, fine to coarse sand, wet. (GM)	Dense	
3		Fill: Brown silty SAND with gravel, fine sand, fine to coarse gravel, moist, scattered cobbles, scattered dark brown organic silty sand pockets and layers, trace of wood debris. (SM) (Strippings)	Medium Dense	
10		Gray-brown silty SAND to SAND with silt, fine grained, moist, scattered mottling. (SM/SP-SM)		
11	1			17.1
12		Test pit terminated at 12 feet. No groundwater seepage.		
18				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 207

FIGURE 8

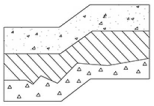
PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** JCS

LOCATION: Puyallup, Washington **SURFACE CONDITIONS:** Sparse grass **APPROX. ELEV:** ~464

DATE LOGGED: January 31, 2023 **DEPTH TO GROUNDWATER:** 1.5-2 ft **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Gray-brown silty GRAVEL with sand, fine to coarse gravel, fine to coarse sand, wet, numerous cobbles. (GM)	Dense	
1 ▼				
2		Fill Gray-brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist to wet. (SM)	Medium Dense	
3				
4				
5		Fill: Gray to gray-brown silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist to wet, scattered cobbles, trace of wood debris. (SM)	Dense	
6				
7				
8				
9	1	Brown silty GRAVEL with sand, fine to coarse gravel, fine to coarse sand, moist to wet. (GM)	Medium Dense to Dense	9.1
10	2	Brown SAND with silt, fine to medium grained, trace of fine gravel, moist. (SP-SM)	Medium Dense	25.1
11		Gray-brown SILT with fine sand, moist, mottled. (ML)	Medium Dense to Dense	
12	3			32.2
13				
14		Test pit terminated at 14 feet. Light groundwater seepage between 1.5 and 2 feet.		
15				
16				
17				
18				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF PILOT INFILTRATION TEST NO. 1

FIGURE 9

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** JCS

LOCATION: Puyallup, Washington **SURFACE CONDITIONS:** Sparse grass **APPROX. ELEV:** ~464

DATE LOGGED: January 31, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist to wet, scattered rounded to angular cobbles. (SM)		
1				
2		- Infiltration test surface at approximately 2.5 feet.	Dense	
3		Small-Scale Test: PIT Dimensions approximately 3 feet x 4 feet. Test Depth approximately 2.5 feet. - Ran approximately 48 gallons into pit at approximately 3.5 gallons per minute. - Started flow at approximately 8:00 AM. - Stopped flow when water depth reached 0.5 feet at 8:11 AM. - Observed water level from 8:11 AM to 10:00 AM. - No change in water level. - Not infiltrating.		
4				
5		Test pit terminated at 5 feet. No groundwater seepage. Small-scale pilot infiltration test performed at approximately 2.5 feet.		
6				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
New Structural Fill		125	Mohr-Coulomb	50	36	Water Surface	Custom	1
Existing Fill		115	Mohr-Coulomb	50	26	Water Surface	Custom	1
Native Silty Sand/ Sandy Silt		120	Mohr-Coulomb	100	34	Water Surface	Custom	1

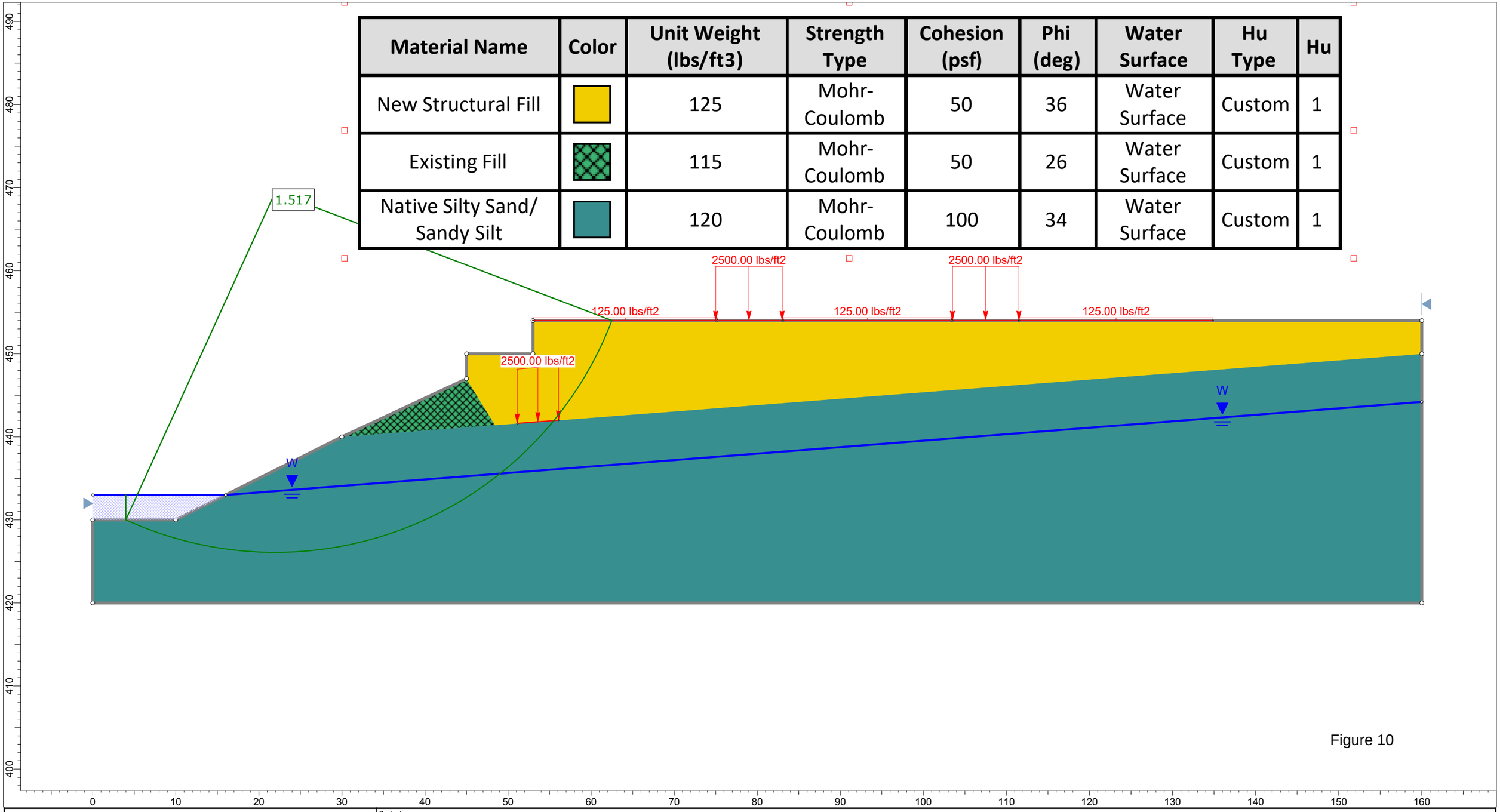

Figure 10

rocscience	Project	SLIDE - An Interactive Slope Stability Program	
	Group	Group 1	Scenario: Master Scenario
	Drawn By		Company: Terra Associates, Inc.
	Date	5/16/2023, 9:57:40 AM	File Name: Care Center Section A-A' Built Condition.slmd

SLIDEINTERPRET 9.008

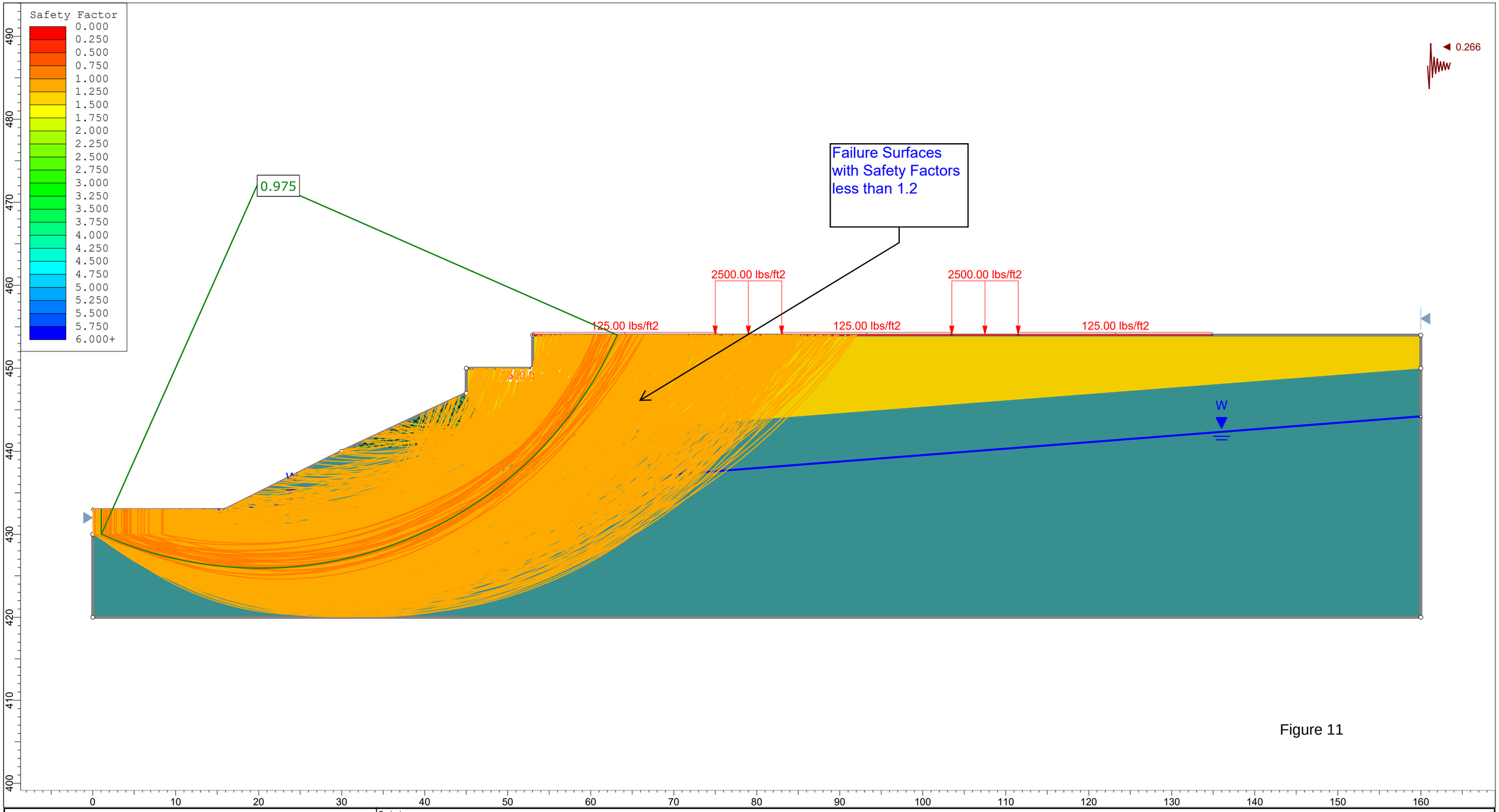

Figure 11

rocscience	*Project*	SLIDE - An Interactive Slope Stability Program	
	Group	Group 1	*Scenario* Master Scenario
	Drawn By		*Company* Terra Associates, Inc.
	Date	5/16/2023, 9:57:40 AM	*File Name* Care Center Section A-A' Built Condition Seismic.slmd

SLIDEINTERPRET 9.008

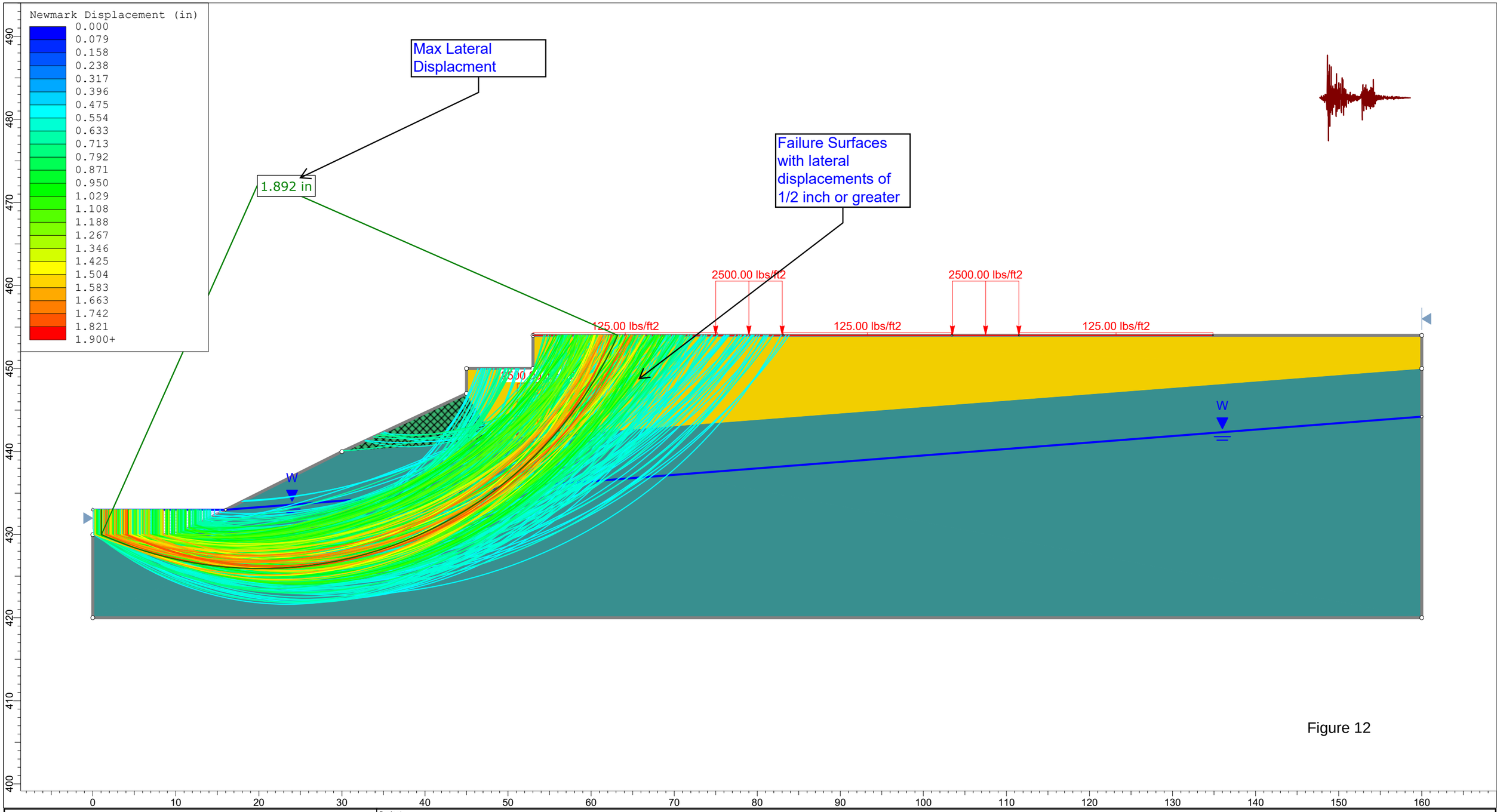

Figure 12

rocscience	*Project*	SLIDE - An Interactive Slope Stability Program	
	Group	Group 1	*Scenario* Master Scenario
	Drawn By		*Company* Terra Associates, Inc.
SLIDEINTERPRET 9.008	*Date*	5/16/2023, 9:57:40 AM	*File Name* Care Center Section A-A' Built Condition Newmark Seismic.slmd

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