GEOTECHNICAL REPORT

3036 – 67th Avenue Southeast
Mercer Island, Washington

Project No. T-8718

Terra Associates, Inc.

Prepared for:

William E. Buchan, Inc.
Bellevue, Washington

August 18, 2022

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

August 18, 2022
Project No. T-8718

Mr. Jamie Buchan
William E. Buchan, Inc.
2630 – 116th Avenue Northeast, Suite 100
Bellevue, Washington 98004

Subject: Geotechnical Report
3036 – 67th Avenue Southeast
Mercer Island, Washington

Dear Mr. Buchan:

As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our field exploration indicates the site is generally underlain by 9 inches of grass sod and organic topsoil overlying 20 to 25 feet of loose to medium dense interbedded sand and silt with varying gravel content overlying dense to very dense, sand and silt with little gravel content to the termination of the test borings. Groundwater was encountered in all test borings at depths of 7.5 to 10 feet.

In our opinion, soil and groundwater conditions at the site will be suitable for support of the development as planned, provided recommendations contained herein are incorporated into project design and construction specifications.

We trust the information provided in the attached report is sufficient for your current needs. If you have any questions or need additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

Tyler A. Gilsdorf, G.I.T.
Staff Geologist

CAROLYN S. DECKER
STATE OF WASHINGTON
41016
REGISTERED
PROFESSIONAL ENGINEER

8-18-2022

Carolyn S. Decker, P.E.
President

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Geotechnical Report
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1.0 PROJECT DESCRIPTION

The project consists of demolishing the existing residence and construction of a new single-family residence along with associated access and utilities. Based on review of the preliminary site plan prepared by Buchan Homes dated July 20, 2022, the new single-family residence will be constructed approximately in the same location as the existing residence and will be a two- to- three-story, wood-framed building with a below-grade garage on the north side of the residence, which daylights at street level. Based on existing site grades and the preliminary site plan prepared by Buchan Homes, we expect cuts and fills between one and ten feet will be required to achieve building elevations. A short retaining wall with a maximum height of two feet is planned upslope to the east of the residence to help accommodate grade transitions. Structural loading should be relatively light, with bearing walls carrying loads of 2 to 3 kips per foot and isolated columns carrying maximum loads of 30 to 40 kips.

The recommendations in the following sections of this report are based on the design discussed above. If actual features vary or changes are made, we should review the plans in order to modify our recommendations as needed. We should review final design drawings and specifications as they become available to verify our recommendations have been properly interpreted and incorporated into the project design.

2.0 SCOPE OF WORK

On March 9, 2022, we observed soil and groundwater conditions at 2 soil test borings drilled to a maximum depth of approximately 26.5 feet below existing grades. Using the information obtained from the subsurface exploration and laboratory testing, we performed analyses to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions.
- Seismic design parameters per the current International Building Code (IBC).
- Geologic Hazards per the City of Mercer Island Municipal Code.
- Site preparation and grading.
- Relative slope stability.
- Excavation.
- Foundations.

- Floor Slab-on-grade.
- Lateral earth pressures on below-grade walls.
- Drainage.
- Utilities.

It should be noted, recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment are beyond Terra Associates, Inc.'s purview. A building envelope specialist or contactor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The project site consists of a single residential tax parcel (King County Parcel #: 2174501025) totaling approximately 0.29 acres located at 3036 – 67th Avenue Southeast in Mercer Island, Washington. The approximate site location is shown on Figure 1.

The site is currently developed with a single-family residence and associated access and landscaping. Site topography consists of a slight slope that descends from the east to the west with an overall relief of approximately 18 feet.

3.2 Subsurface

In general, the soil conditions at the site consist of approximately 9 inches of grass sod and organic topsoil overlying 20 to 25 feet of loose to medium dense interbedded sand and silt with varying gravel content overlying dense to very dense, sand and silt with little gravel content to the termination of the test borings.

The *Geologic Map of Mercer Island, Washington* by K.G. Troost & A.P. Wisher (2006) shows the site as being underlain by Vashon Glacial Till (Qvt) and pre-Olympia age nonglacial deposits (Qpon). We observed native soils consistent with pre-Olympia age nonglacial deposits at the test boring locations. We did not observe native soils consistent with glacial till at the boring locations.

The preceding discussion is intended to be a general review of the soil conditions encountered. For more detailed descriptions, please refer to the Test Boring Logs in Appendix A. The approximate location of the test borings is shown on the Exploration Location Plan, Figure 2.

3.3 Groundwater

Groundwater was observed in the borings at depths ranging from 7.5 to 10 feet below current site grades. The groundwater observed in our borings is interpreted to be groundwater perched above less-permeable layers in the soil formation and not indicative of a regional groundwater table. However, the groundwater appears to be present through out the project site in the upper 20 to 25 feet of soil.

3.4 Geologic Hazards

We evaluated site conditions for the presence of geologic hazards including erosion hazard areas, landslide hazard areas, and seismic hazard areas. Our findings are presented below.

3.4.1 Erosion Hazard Areas

Section 19.16.010 of the Mercer Island Municipal Code (MIMC) defines an erosion hazard as "those areas greater than 15 percent slope and subject to a severe risk of erosion due to wind, rain, water, slope, and other natural agents including those soil types and/or areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service as having a "severe" or "very severe" rill and inter-rill erosion hazard."

The soils observed onsite are classified as *KpB, Kitsap Silt Loam, 2 to 8 percent slopes* by the United States Department of Agriculture Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service. With the existing slope gradients, these soils will have a moderate potential for erosion when exposed. Therefore, the site is not categorized as an erosion hazard area per the MIMC. Regardless, erosion protection measures as required by the City of Mercer Island will need to be in place prior to starting grading activities on the site. This would include perimeter silt fencing to contain erosion onsite and cover measures to prevent or reduce soil erosion during and following construction.

3.4.2 Landslide Hazard Areas

Section 19.16.010 of the MIMC defines a landslide hazard as "areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors, including:

1. Areas of historic failures.

2. Areas with all three of the following characteristics:

    a. Slopes steeper than 15 percent.

    b. Hillsides intersecting geologic contacts with relatively permeable sediment overlying a relatively impermeable sediment or bedrock.

    c. Springs or groundwater seepage.

3. Areas that have shown evidence of past movement or that are underlain or covered by mass wastage debris from past movements.

4. Areas potentially unstable because of rapid stream incision and stream bank erosion.

5. Steep Slope. Any slope of 40 percent or greater calculated by measuring the vertical rise over any 30-foot horizontal run."

While the site does not meet any of the above conditions, the site is mapped as a 'Landslide Hazard Area' on *Mercer Island Landslide Hazard Assessment* Map dated April 2009. The property generally slopes from the east towards the west with a total vertical relief of approximately 18 to 20 feet at a grade of approximately 16 to 19 percent. The slope across the property includes a rockery at the toe of the slope, which appears to have been constructed to establish a level front yard area for the existing home. In accordance with the City requirements, we have completed a slope stability analysis. The analysis and results are in Section 4.3 of this report.

3.4.3 Seismic Hazard Areas

Section 19.16.010 of the MIMC defines a seismic hazard area as "areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction or surface faulting."

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations. Liquefaction mainly affects geologically recent deposits of fine-grained sand below the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction; thus, eliminating the soil's strength.

A review of a map titled "*Mercer Island Seismic Hazards Assessment Map*," dated April 2009 by K.G. Troost and A.P. Wisher, shows that the subject site is not mapped within a "Seismic Hazard Area".

Based on the soil and groundwater conditions we observed at the site, the risk for damage resulting from soil liquefication or subsidence during a severe seismic event is negligible in our opinion. Therefore, unusual seismic hazard areas do not exist at the site and design in accordance with local building codes for determining seismic forces would adequately mitigate impacts associated with ground shaking.

3.5 Seismic Design Parameters

Based on soil conditions noted in the subsurface explorations and our knowledge of the area geology, per Chapter 16 of the 2018 International Building Code (IBC), site class "D" should be used in structural design.

3.6 City of Mercer Island Critical Area Requirement

Per Section 19.307.160.B.3, "An evaluation of site-specific subsurface conditions demonstrates that the proposed development is not located in a landslide hazard area or seismic hazard area".

Based on the site topography and soil explorations, the site is not within a landslide hazard area or seismic hazard area. Therefore, it is our opinion that the proposed project can be constructed as designed without negatively impacting the project site, adjacent body of water, or adjacent properties.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Based on our study, development of the site as proposed is feasible from a geotechnical engineering standpoint. The primary geotechnical concern is the groundwater in the upper 20 to 25 feet that will need to be controlled behind the permanent basement walls in order to achieve global stability. Recommendations to control the groundwater and achieve global stability are detailed within Section 4.3 of this report.

The residential buildings can be supported on conventional spread footings bearing on medium dense native soils, re-compacted native soils, and/or structural fill placed above suitable native soils. Floor slabs and pavements can be similarly supported.

Based on our conversations with the architectural design team, the expect the foundations of the new residence to be constructed at an elevation of 98.75 feet. The soils encountered in our borings at the proposed foundation elevation were observed to be in a loose to medium dense condition. Soils in a loose condition would not be a suitable bearing surface for foundations. Soils exposed at foundation elevation that are observed to be in a loose condition should either be re-compacted to a firm condition or over-excavated and replaced with new structural fill. The need for recompaction or over excavation and replacement should be determined by observations in the field during grading.

The native soils encountered at the site contain a sufficient amount of soil fines that will make them difficult to compact as structural fill when too wet. The ability to use native and existing fill soil from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during winter, the owner should be prepared to import clean granular material for use as structural fill and backfill.

Additionally, the soils' high moisture content and inherent moisture sensitivity indicate they have the potential to quickly degrade under construction traffic and stabilization of subgrades may be required prior to and during grading activities at the site.

While not observed in our borings, older fill material may be present in areas where we did not explore near the existing residence.

The following sections provide detailed recommendations regarding the preceding issues and other geotechnical design considerations. These recommendations should be incorporated into the final design drawings and construction specifications.

4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious material should be stripped and removed from the site. Surface stripping depths of nine inches should be expected to remove the organic surface soils and vegetation. In the developed portions of the site, demolition of existing structures should include removal of existing foundations and abandonment of underground septic systems and other buried utilities. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil. Soil containing organic material will not be suitable for use as structural fill but may be used for limited depths in nonstructural areas.

Once clearing and stripping operations are complete, cut and fill operations can be initiated to establish desired building grades. Prior to placing fill, all exposed bearing surfaces should be observed by a representative of Terra Associates, Inc. to verify soil conditions are as expected and suitable for support of new fill or building elements. Our representative may request a proof roll using heavy rubber-tired equipment to determine if any isolated soft and yielding areas are present. If excessively yielding areas are observed, and they cannot be stabilized in place by compaction, the affected soils should be excavated and removed to firm bearing and grade restored with new structural fill. If the depth of excavation to remove unstable soils is excessive, the use of geotextile fabrics such as Mirafi 500X or an equivalent fabric can be used in conjunction with clean granular structural fill. Our experience has shown, in general, a minimum of 18 inches of a clean, granular structural fill placed and compacted over the geotextile fabric should establish a stable bearing surface.

Our study indicates the site soils contain a sufficient percentage of fines (silt-sized particles) that will make them difficult to compact as structural fill if they are too wet or too dry. The ability to use the native soils as structural fill will depend on their moisture content and the prevailing weather conditions when site grading activities take place. If wet soils are encountered, the contractor will need to dry the soils by aeration during dry weather conditions. Alternatively, the use of an additive such as Portland cement or lime to stabilize the soil moisture can be considered. If the soil is amended, additional Best Management Practices (BMPs) addressing the potential for elevated pH levels will need to be included in the Stormwater Pollution Prevention Program (SWPPP) prepared with the Temporary Erosion and Sedimentation Control (TESC) plan.

If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet-weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

* Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-1557 (Modified Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

4.3 Relative Slope Stability

The project includes construction of a new building in an area mapped as a 'Landslide Hazard Area' on *Mercer Island Landslide Hazard Assessment* Map dated April 2009, therefore, in accordance with the City of Mercer Island requirements, we have completed a slope stability analysis to determine the effects of the new building loading on the existing slope.

The analysis was performed at the locations designated as Cross Section A-A' and Cross Section B-B' using the computer program Slide 2. The approximate cross section locations are shown on Figure 2.

Our analysis considered both static and pseudostatic (seismic) conditions. A horizontal acceleration of 0.33g was used in the pseudostatic analysis to simulate slope performance under earthquake loading. This value is based on the maximum considered earthquake (MCE) peak ground acceleration (PGA) and is equal to one-half of the peak horizontal ground acceleration with a two percent in 50-year probability of exceedance as defined by the 2018 International Building Code (IBC).

Based on our field exploration, laboratory testing, and previous experience with similar soil types, we chose the following parameters for our analysis:

Table 1 – Slope Stability Analysis Soil Parameters

Soil Type	Unit Weight (pcf)	Friction Angle (Degrees)	Cohesion (psf)
Loose to Medium Dense SAND & SILT	120	30	150
Dense to Very Dense SILT & SAND	120	30	250
Structural Fill	120	34	50

The results of our slope stability analysis, as shown by the lowest safety factors for each condition, are presented in the following table:

Table 2 – Slope Stability Analysis Results

Cross Section	Minimum Safety Factors	
	Existing Conditions	*Post Construction*
A-A'	3.85 (Seismic FS = 1.37)	2.83 (Seismic FS = 1.47)
B-B'	2.93 (Seismic FS = 1.07)	2.19 (Seismic FS = 1.12)

Based on our analysis, the existing slope is stable in its current condition and post construction the factors of safety remain above engineering standards of 1.5 for static and 1.1 for pseudostatic. Therefore, based on the City of Mercer Island requirements, the proposed structure can be constructed as shown without impacting the site or adjacent properties. The results of our analysis are attached in Appendix B.

However, in order for the basement excavation to be stable post construction, layers of geogrid reinforcement will be required along with a chimney drain. A detail showing these requirements is attached as Figure 3.

4.4 Excavations

All excavations at the site associated with confined spaces, such as those for utility construction, must be completed in accordance with local, state, or federal requirements. Based on current Washington Industrial Safety and Health Act (WISHA) regulations, soils found on the project site would be classified as Type C soils.

For properly dewatered excavations more than 4 feet, but less than 20 feet in depth, the side slopes should be laid back at an inclination no steeper than 1.5:1 (Horizontal: Vertical). If there is insufficient space to complete the excavations in this manner, or if excavations greater than 20 feet in depth are planned, temporary shoring to support the excavations may be required. Properly designed and installed shoring trench boxes can be used to support utility trench excavations where required. All exposed temporary slope faces that will remain open for an extended period of time should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation.

Based on our study, groundwater should be anticipated within excavations extending below depths of about seven and one-half to ten feet below existing surface grades. Excavations extending below this depth will likely encounter groundwater with volumes and flow rates sufficient to require some level of dewatering. The observed groundwater conditions have the ability to impact the stability of the proposed excavations and the contractor should be prepared to implement excavation dewatering by using conventional sump-pumping procedures along with a system of collection trenches.

This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

4.5 Foundation Support

The residential buildings may be supported on conventional spread footing foundations bearing on competent native soils or on structural fill placed on a competent native soil subgrade. Foundation subgrades should be prepared as recommended in Section 4.2 of this report. Perimeter foundations exposed to the weather should bear a minimum depth of 1.5 feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab.

As noted above, some of the existing fill soils are in a loose condition. If exposed at the foundation subgrade, in order to achieve suitable bearing, the material will need to be scarified and recompacted to a firm condition.

The native soils that will likely be exposed at the expected foundation elevations are moisture sensitive and will be easily disturbed by normal construction activity when wet. As a measure to protect the soils from disturbance during construction, consideration should be given to placing a four-inch layer of clean crushed rock or lean mix concrete over the foundation subgrade to serve as a working surface. This will be an especially critical consideration where groundwater seepage is present at foundation subgrade elevations.

Foundations bearing on competent soil, can be dimensioned for a net allowable bearing capacity of 2,000 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. With the anticipated loads and this bearing stress applied, building settlements should be less than one-inch total and one-half inch differential.

For designing foundations to resist lateral loads, a base friction coefficient of 0.30 can be used. Passive earth pressures acting on the side of the footing and buried portion of the foundation stem wall can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pcf. We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent soil and backfilled with structural fill, as described in Section 4.2 of this report. The recommended values include a safety factor of 1.5.

4.6 Slab-on-Grade Floors

Slab-on-grade floors may be supported on subgrade prepared as recommended in Section 4.2 of this report. Immediately below the floor slab, we recommend placing a four-inch-thick capillary break layer composed of clean, coarse sand or fine gravel that has less than five percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction and to aid in uniform curing of the concrete slab. It should be noted, if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will not be effective in assisting uniform curing of the slab and can actually serve as a water supply for moisture transmission through the slab, potentially affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained. We recommend floor designers and contractors refer to the current American Concrete Institute (ACI) Manual of Concrete Practice for further information regarding vapor barrier installation below slab-on-grade floors.

4.7 Lateral Earth Pressures for Wall Design

The magnitude of earth pressure development on retaining walls will partly depend on the quality and compaction of the wall backfill. We recommend placing and compacting wall backfill as structural fill, as described in Section 4.2. To prevent overstressing the walls during backfilling, heavy construction machinery should not be operated within five feet of the wall. Wall backfill in this zone should be compacted with hand-operated equipment. To prevent hydrostatic pressure development, wall drainage must also be installed. A typical wall drainage detail is shown on Figure 4. All drains should be routed to the storm sewer system or other approved point of controlled discharge. This drain will be in addition to the chimney drain shown on Figure 3.

With drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pounds per cubic foot (pcf). For restrained walls, an additional uniform load of 100 psf should be added to the 35 pcf. To account for typical traffic surcharge loading, the walls can be designed for an additional imaginary height of two feet (two-foot soil surcharge). For evaluation of wall performance under seismic loading, a uniform pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall should be applied in addition to the static lateral earth pressure. These values assume a horizontal backfill condition and that no other surcharge loading, sloping embankments, or adjacent buildings will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 4.4.

4.8 Infiltration Feasibility

Based on our study, it is our opinion that subsurface conditions are generally not favorable for infiltration of site stormwater. The native soils observed at the site contain a high percentage of soil fines that would impede any downward migration of site stormwater. Additionally, shallow groundwater and evidence of shallow groundwater seepage was observed in both of our test borings. Based on these conditions, it is our opinion that onsite infiltration is not a viable option for management of site stormwater and that even low impact development (LID) techniques, such as rain gardens and permeable pavement would likely mound up and overtop during rain events if not constructed with an underdrain system. Therefore, the development stormwater should be managed using conventional methods.

4.9 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the site at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building areas. We recommend providing a positive drainage gradient away from the building perimeters. If this gradient cannot be provided, surface water should be collected adjacent to the structures and directed to appropriate storm facilities.

Subsurface

We recommend installing perimeter foundation drains adjacent to shallow foundations. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The drains can consist of four-inch diameter perforated PVC pipe enveloped in washed pea gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. Roof and foundation drains should be tightlined separately to the storm drains. All drains should be provided with cleanouts at easily accessible locations.

4.10 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or City of Mercer Island specifications. At a minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report.

As noted, the surficial native soils excavated on the site should be suitable for use as backfill material during dry weather conditions. However, native soils excavated below a depth of approximately seven and one-half feet below existing grades will likely be excavated in a wet condition and would not be suitable for use as trench backfill unless dried back to a moisture content that will facilitate proper compaction. If utility construction takes place during the wet winter months, it will likely be necessary to import suitable wet weather fill for utility trench backfilling.

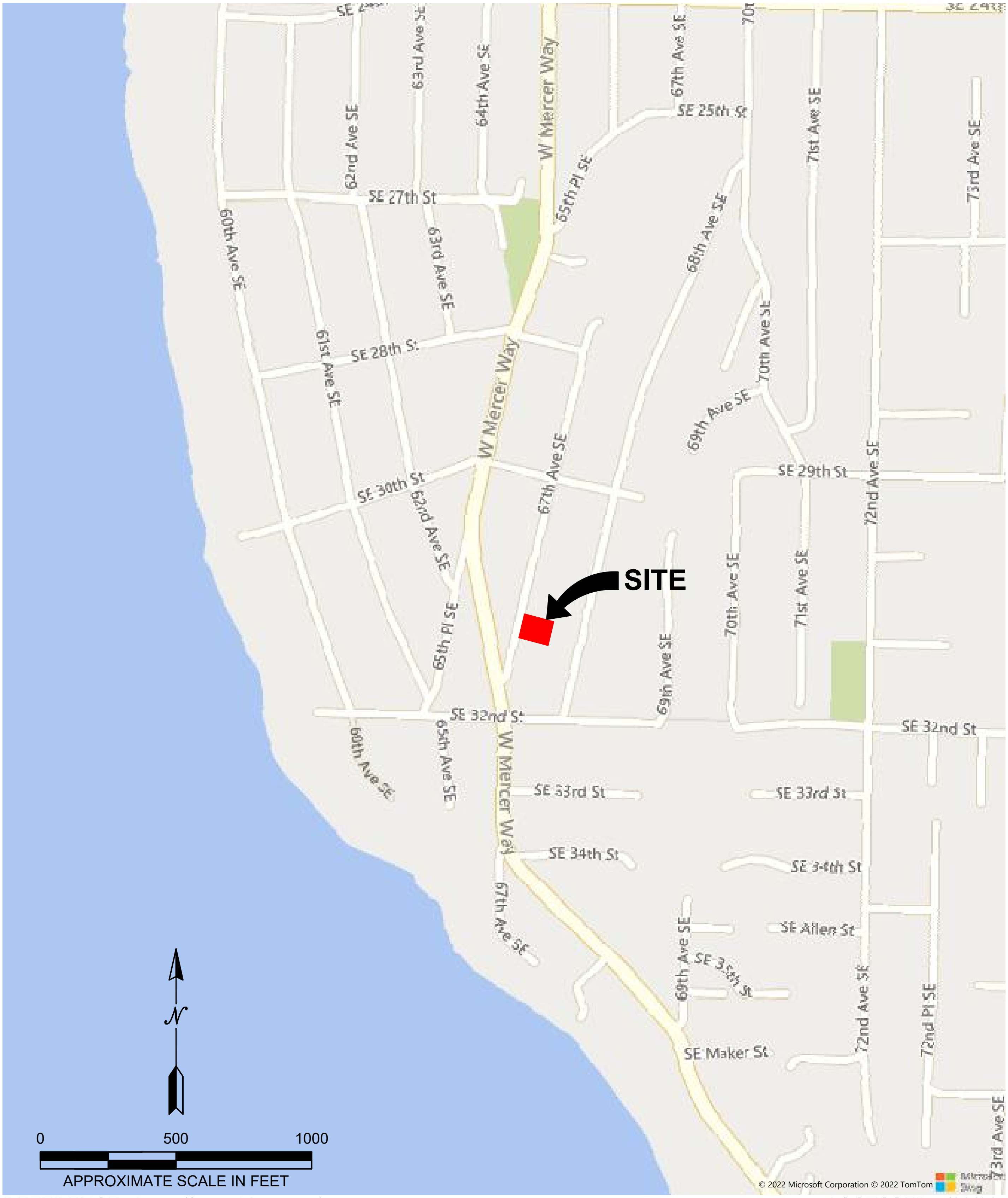
5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final design drawings and specifications in order to verify earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical service during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the 3036 – 67th Avenue Southeast project in Mercer Island, Washington. This report is for the exclusive use of William E. Buchan, Inc., and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the subsurface explorations completed onsite. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.



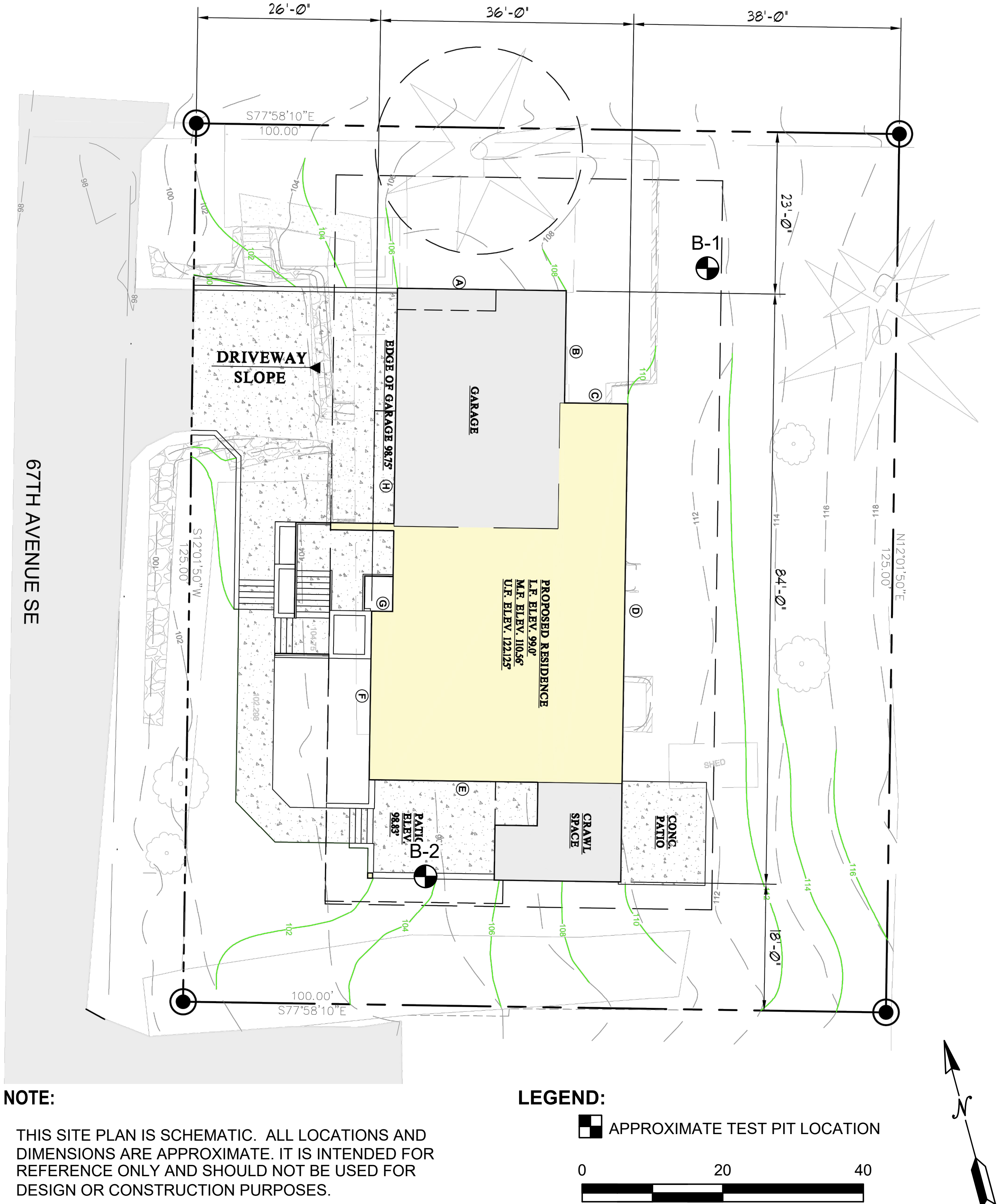
REFERENCE: https://www.bing.com/maps

ACCESSED 5/20/22

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

VICINITY MAP
3036 67TH AVE SE
MERCER ISLAND, WASHINGTON

Proj.No. T-8718	Date: AUG 2022	Figure 1



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 BUCHAN HOMES.

LEGEND:

APPROXIMATE TEST PIT LOCATION

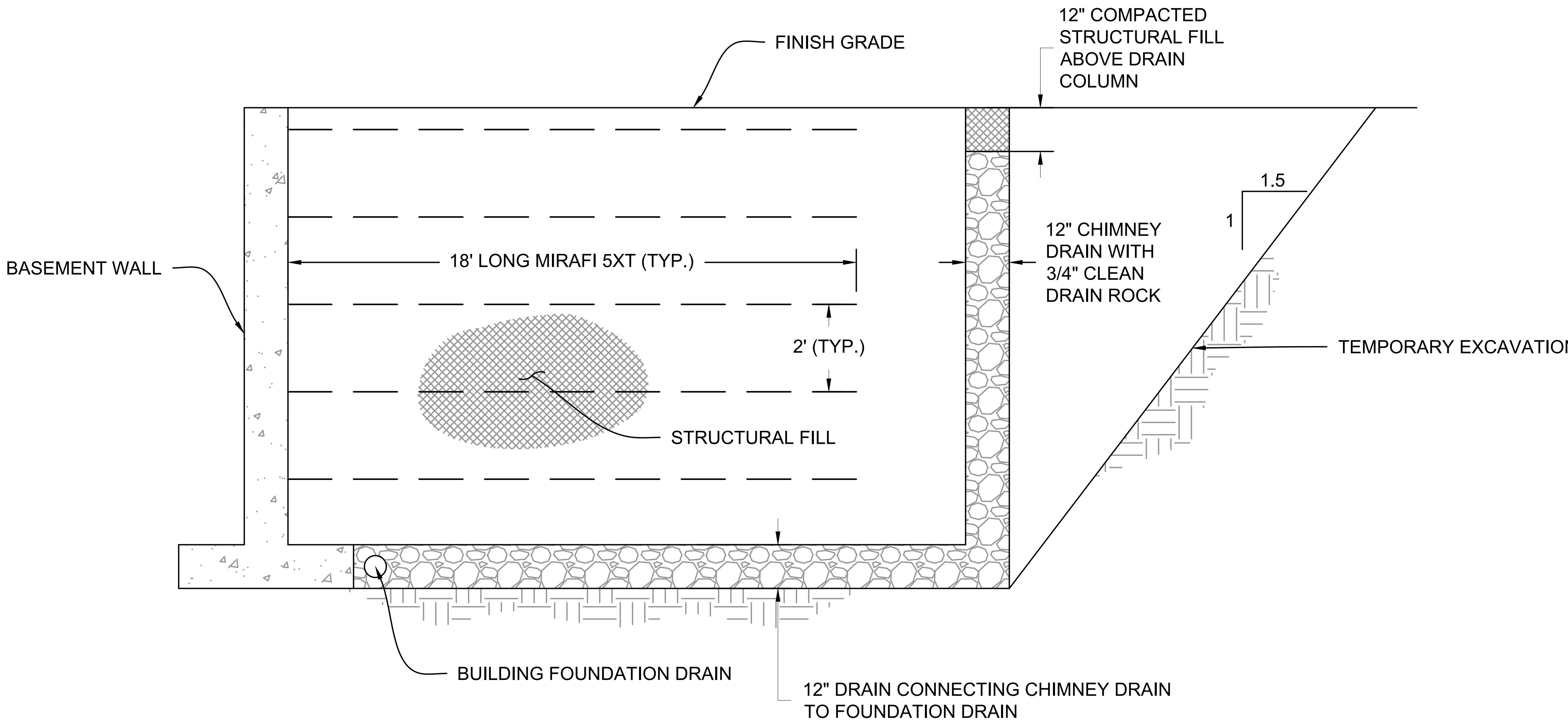
0 20 40

APPROXIMATE SCALE IN FEET

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
3036 67TH AVE SE
MERCER ISLAND, WASHINGTON

Proj.No. T-8718	Date: AUG 2022	Figure 2



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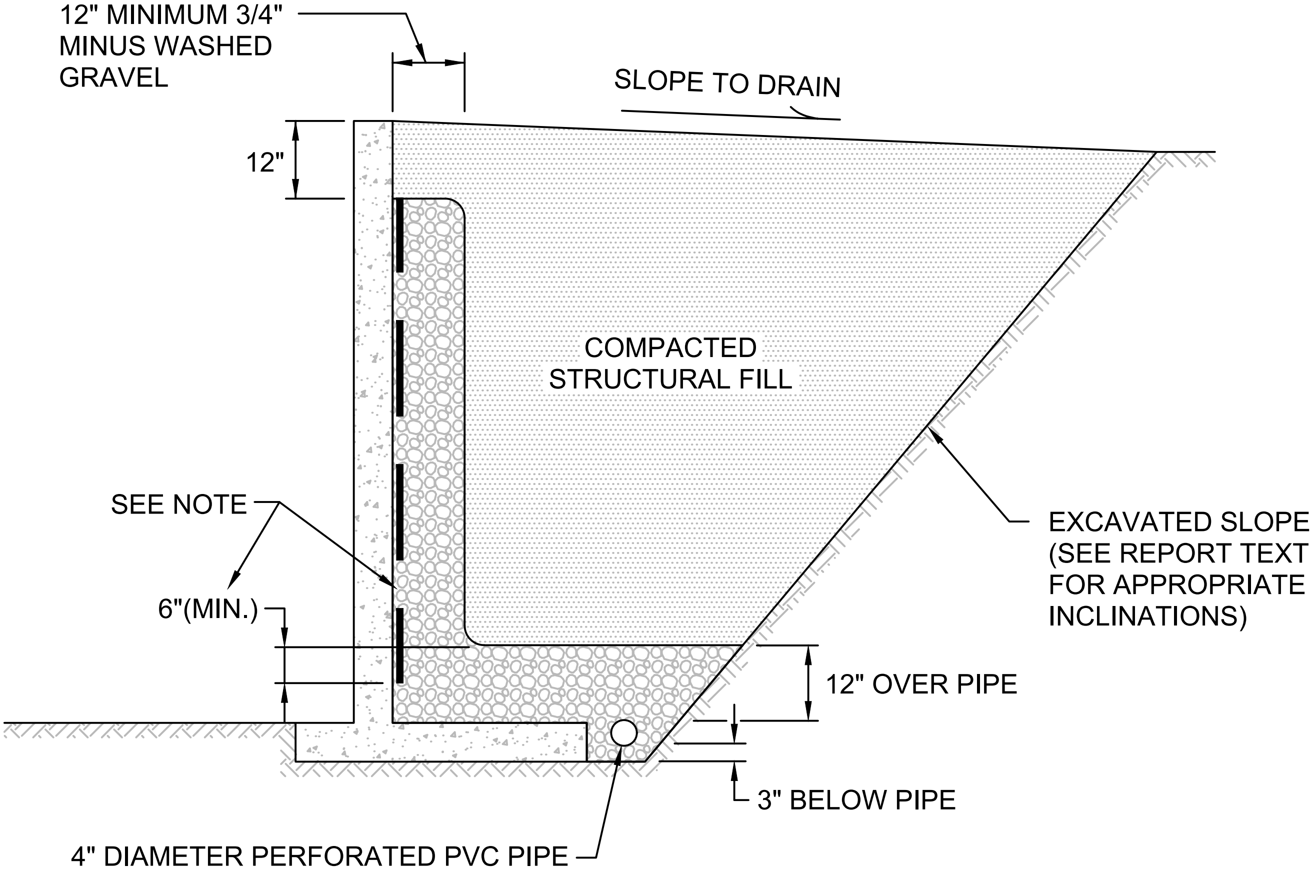
Geology and
Environmental Earth Sciences

WALL DETAIL
3036 67TH AVE SE
MERCER ISLAND, WASHINGTON

Proj.No. T-8718	Date: AUG 2022	Figure 3



NOT TO SCALE

NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

Terra Associates, Inc. Consultants in Geotechnical Engineering Geology and Environmental Earth Sciences	TYPICAL WALL DRAINAGE DETAIL 3036 67TH AVE SE MERCER ISLAND, WASHINGTON	
Proj.No. T-8718	Date: AUG 2022	Figure 4

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

3036 – 67th Avenue Southeast
Mercer Island, Washington

On March 9, 2022, we investigated subsurface conditions at the site at 2 test borings drilled to a maximum depth of about 26.5 feet below existing grades. The test boring locations were approximately determined in the field using GPS tracking and by pacing and sighting from existing site features. The approximate test boring locations are shown on the attached Exploration Location Plan, Figure 2. The Test Boring Logs are presented as Figures A-2 and A-3.

A geologist from our office conducted the field exploration. Our representative classified the soil conditions encountered, maintained a log of each test boring, obtained representative soil samples, and recorded water levels observed during excavation. During drilling, soil samples were obtained in general accordance with ASTM Test Designation D-1586. Using this procedure, a 2-inch (outside diameter) split barrel sampler is driven into the ground 18 inches using a 140-pound hammer free falling from a height of 30 inches. The number of blows required to drive the sampler 12 inches after an initial 6-inch set is referred to as the Standard Penetration Resistance value or N value. This is an index related to the consistency of cohesive soils and relative density of cohesionless materials. N values obtained for each sampling interval are recorded on the Test Boring Logs. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1.

Representative soil samples obtained from the test borings were placed in sealed plastic bags and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the Test Boring Logs. Grain size analyses were performed on select soil samples. The results are shown on Figures A-4 and A-5.

MAJOR DIVISIONS				LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	More than 50% material larger than No. 200 sieve size	**GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
			Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
				GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
		SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, sands with gravel, little or no fines.
				SP	Poorly-graded sands, sands with gravel, little or no fines.
			Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
				SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS	More than 50% material smaller than No. 200 sieve size	**SILTS AND CLAYS** Liquid Limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.
				CL	Inorganic clays of low to medium plasticity. (Lean clay)
				OL	Organic silts and organic clays of low plasticity.
		SILTS AND CLAYS Liquid Limit is greater than 50%		MH	Inorganic silts, elastic.
				CH	Inorganic clays of high plasticity. (Fat clay)
				OH	Organic clays of high plasticity.
HIGHLY ORGANIC SOILS				PT	Peat.

DEFINITION OF TERMS AND SYMBOLS

COHESIONLESS

Density	Standard Penetration Resistance in Blows/Foot
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	>50

COHESIVE

Consistancy	Standard Penetration Resistance in Blows/Foot
Very Soft	0-2
Soft	2-4
Medium Stiff	4-8
Stiff	8-16
Very Stiff	16-32
Hard	>32

Symbol	Definition
I	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
II	2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
▼	WATER LEVEL (Date)
Tr	TORVANE READINGS, tsf
Pp	PENETROMETER READING, tsf
DD	DRY DENSITY, pounds per cubic foot
LL	LIQUID LIMIT, percent
PI	PLASTIC INDEX
N	STANDARD PENETRATION, blows per foot

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

UNIFIED SOIL CLASSIFICATION SYSTEM
3036 67TH AVE SE
MERCER ISLAND, WASHINGTON

Proj.No. T-8718 | Date: AUG 2022 | Figure A-1

LOG OF BORING NO. B-1

Figure No. A-2

Project: 3036 67th Ave SE **Project No:** T-8718 **Date Drilled:** 3/9/22

Client: William E. Buchan, Inc. **Driller:** Boretec **Logged By:** TG

Location: Mercer Island, Washington **Depth to Groundwater:** 10 feet **Approx. Elev:** 112'

Depth (ft)	Soil Description
0	(9 inches Grass Sod & Topsoil)
	Brownish Gray, silty SAND, fine to coarse sand, moist to wet, mottled, small rootlets to 5' (SM) (Pre-Olympia Sediments)
	*Soil contains increased gravel and becomes wet
▼ 10	Gray to Brownish Gray, silty SAND with gravel to SAND with silt and gravel, fine to coarse sand, fine gravel, wet to saturated, stratified, water within cleaner sands (SP-SM/SM) (Pre-Olympia Sediments)
	Light Brown to Dark Brownish Gray, interbedded SAND with silt and gravel, silty SAND with gravel, and SILT with sand, fine to coarse sand, fine to coarse gravel, wet to saturated, lightly mottled, highly stratified, water within cleaner sands (SP-SM/SM/ML) (Pre-Olympia Sediments)
	Gray to Dark Gray, silty SAND with gravel, fine to coarse sand, fine to coarse gravel, wet, somewhat unsorted (SM) (Pre-Olympia Sediments)
20	Gray to Brownish Gray, interbedded silty SAND with gravel, and sandy SILT, fine to coarse sand, fine gravel, wet, highly stratified (SM/ML) (Pre-Olympia Sediments) *Harder drilling observed at 22.5'
	Boring terminated at approximately 26.5 feet. Groundwater seepage observed at 10 feet.

Sample Depth (ft)	Consistency/ Relative Density	SPT (N) Blows / foot	Moisture Content (%)
2.5	Loose to Medium Dense	11	15.3
5	Loose	10	19.1
7.5	Medium Dense	13	21.7
10	Loose	6	29.9
12.5	Medium Dense	15	48.9
15	Loose	6	14.9
20	Medium Dense	20	25.5
25	Dense	44	30.9

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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LOG OF BORING NO. B-2

Figure No. A-3

Project: 3036 67th Ave SE **Project No:** T-8718 **Date Drilled:** 3/9/22

Client: William E. Buchan, Inc. **Driller:** Boretec **Logged By:** TG

Location: Mercer Island, Washington **Depth to Groundwater:** 7.5 feet & 20 feet **Approx. Elev:** 105'

Depth (ft)	Soil Description	Consistency/ Relative Density	SPT (N) Blows / foot	Moisture Content (%)
0	(9 inches of Grass Sod & Topsoil)			
	Gray to Brownish Gray, interbedded sandy SILT and SILT, fine to medium sand, wet, mottled, stratified (ML) (Pre-Olympia Sediments)	Stiff	12	28.2
5	*Color ranges to Light Brown		11	38.3
	Brownish Gray to Gray, interbedded SAND with silt and gravel, silty SAND with gravel, and sandy SILT, fine to coarse sand, fine gravel, wet to saturated, highly stratified, mottled to 10', water within cleaner sands (SP-SM/SM/ML) (Pre-Olympia Sediments)	Medium Dense	23	38.9
10		Loose	10	19.3
	*Color ranges to Dark Gray, soil contains fine to coarse gravel, and lower density within water bearing zones at 10'		7	22.9
15	Gray to Dark Gray, interbedded silty SAND and sandy SILT, fine to medium sand, moist to wet, stratified (SM/ML) (Pre-Olympia Sediments)		9	25.3
20	*Soil becomes wet	Very Dense	58	28.6
25	Gray to Dark Gray, sandy SILT to SILT with sand, fine sand, moist to wet, laminated (ML) (Pre-Olympia Sediments)	Hard	38	23.3
	Boring terminated at approximately 26.5 feet. Groundwater seepage observed at 7.5 feet and 20 feet.			
30				

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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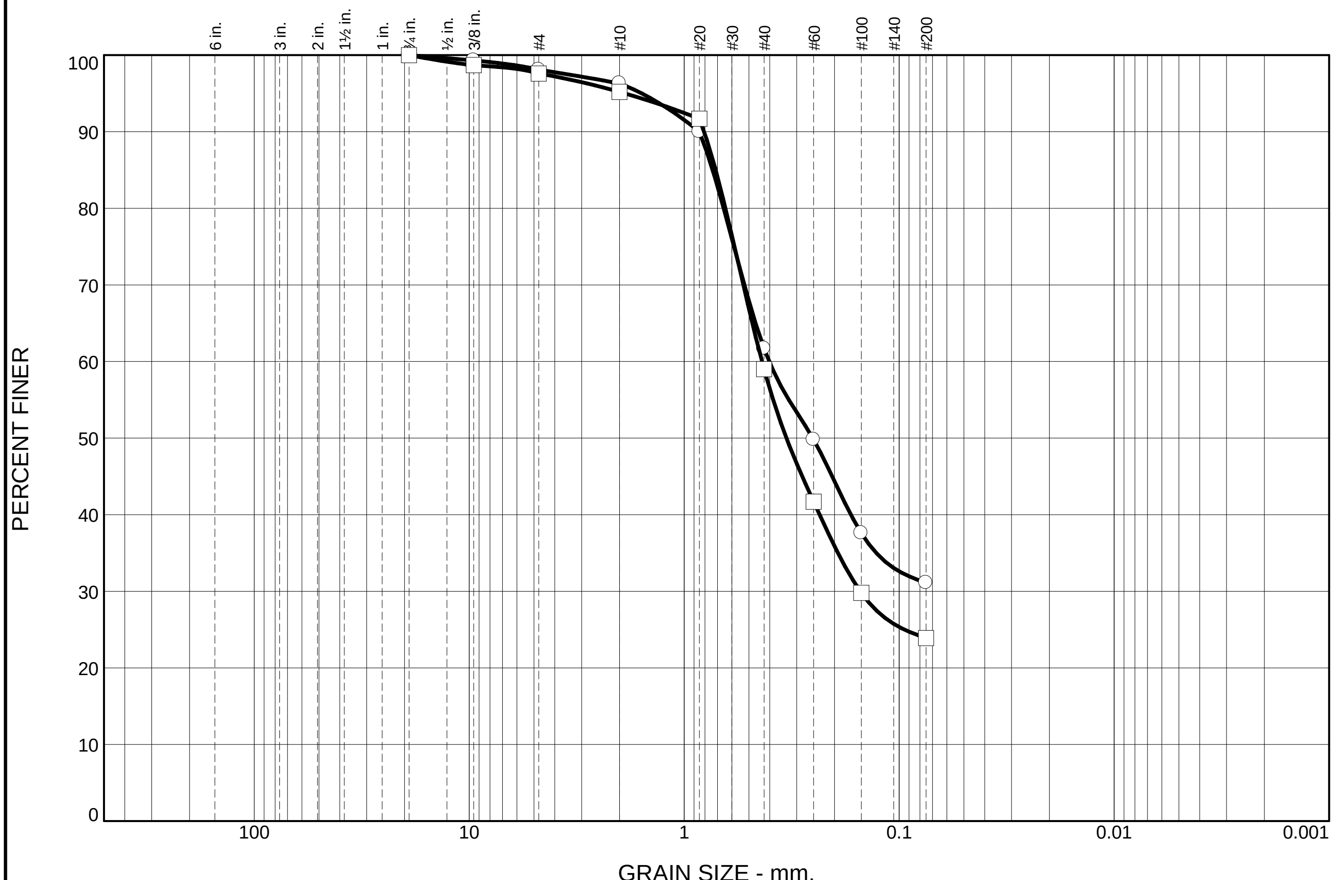
Geology and
Environmental Earth Sciences

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.9	1.8	34.6	30.6	31.1	
□	0.0	0.0	2.4	2.4	36.2	35.1	23.9	

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7375	0.4023	0.2523					
□			0.7137	0.4346	0.3345	0.1518				

Material Description	USCS	AASHTO
○ silty SAND	SM	
□ silty SAND	SM	

Project No. T-8718 **Client:** William E. Buchan, Inc.

Project: 3036 67th Ave SE

○ **Location:** B-1 **Depth:** 2.5'

□ **Location:** B-1 **Depth:** 5'

Remarks:

○Tested on 3/23/22

□Tested on 3/23/22

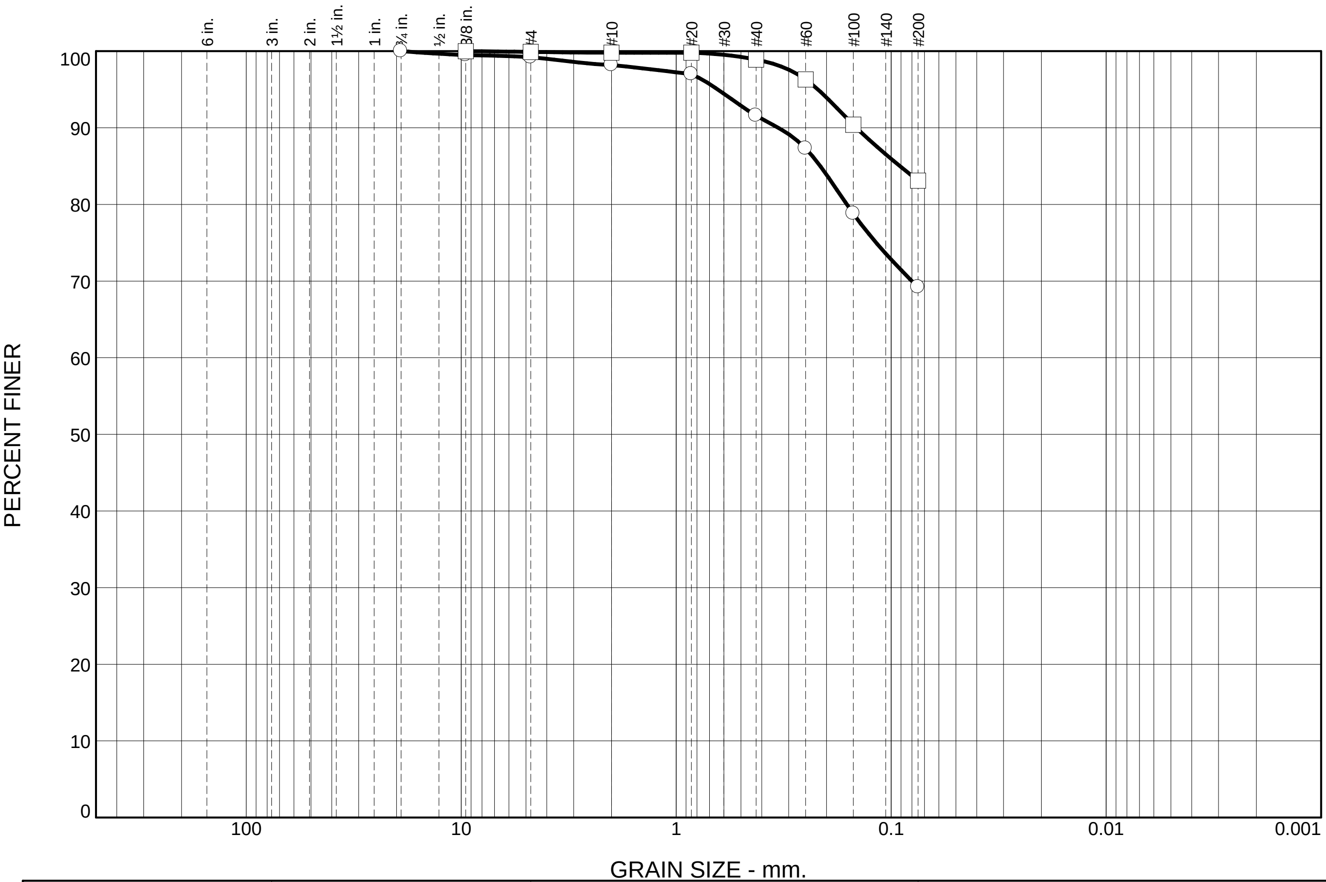
Terra Associates, Inc.

Kirkland, WA

Figure A-4

Tested By: KJ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.8	1.0	6.6	22.4	69.2	
□	0.0	0.0	0.1	0.1	0.9	15.8	83.1	

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2136							
□			0.0910							

Material Description	USCS	AASHTO
○ sandy SILT	ML	
□ sandy SILT	ML	

Project No. T-8718 **Client:** William E. Buchan, Inc.
Project: 3036 67th Ave SE

○ **Location:** B-2 **Depth:** 2.5'
□ **Location:** B-2 **Depth:** 5'

Terra Associates, Inc.

Kirkland, WA

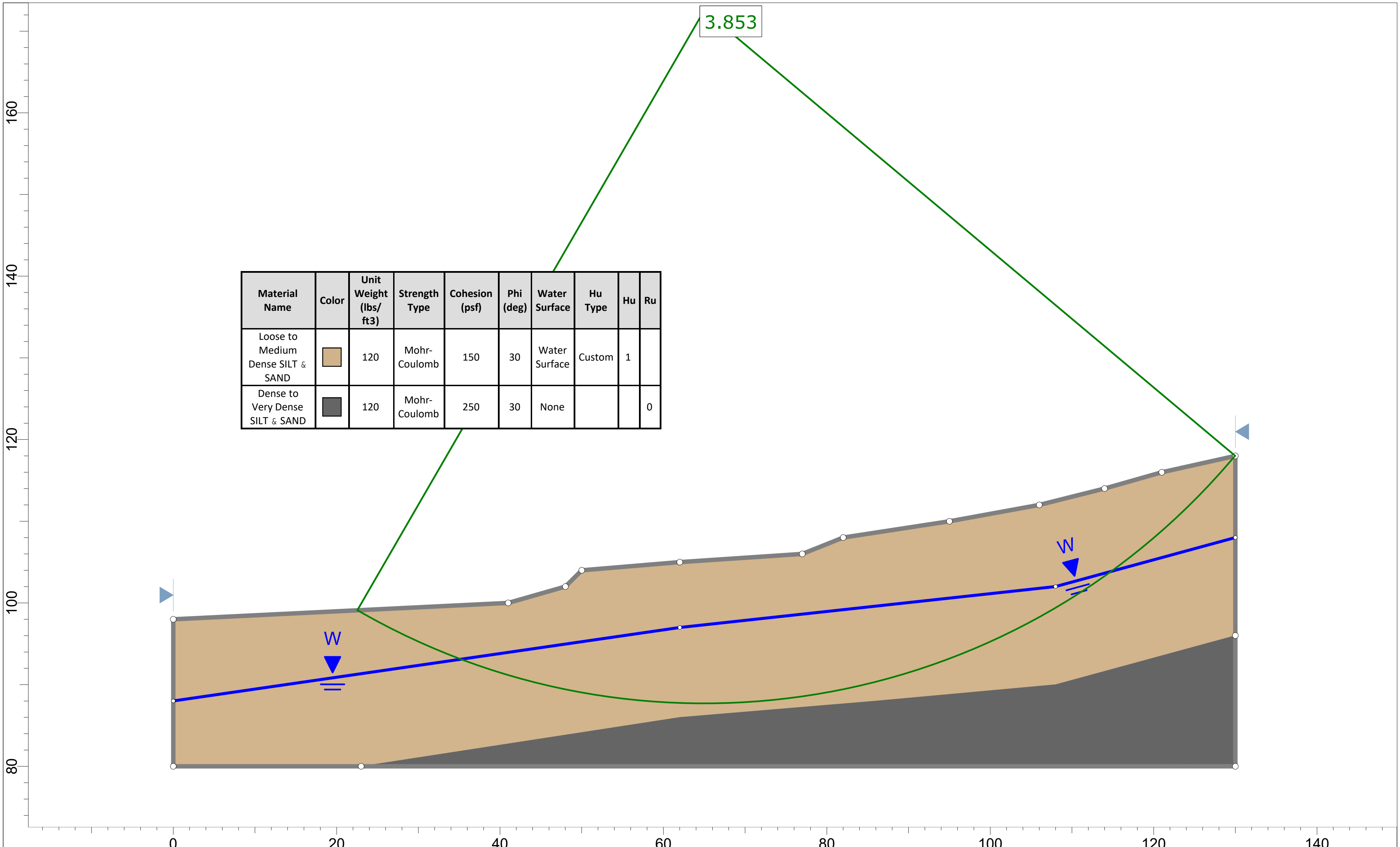
Remarks:
○Tested on 3/23/22
□Tested on 3/23/22

Figure A-5

Tested By: KJ

APPENDIX B

SLIDE OUTPUT

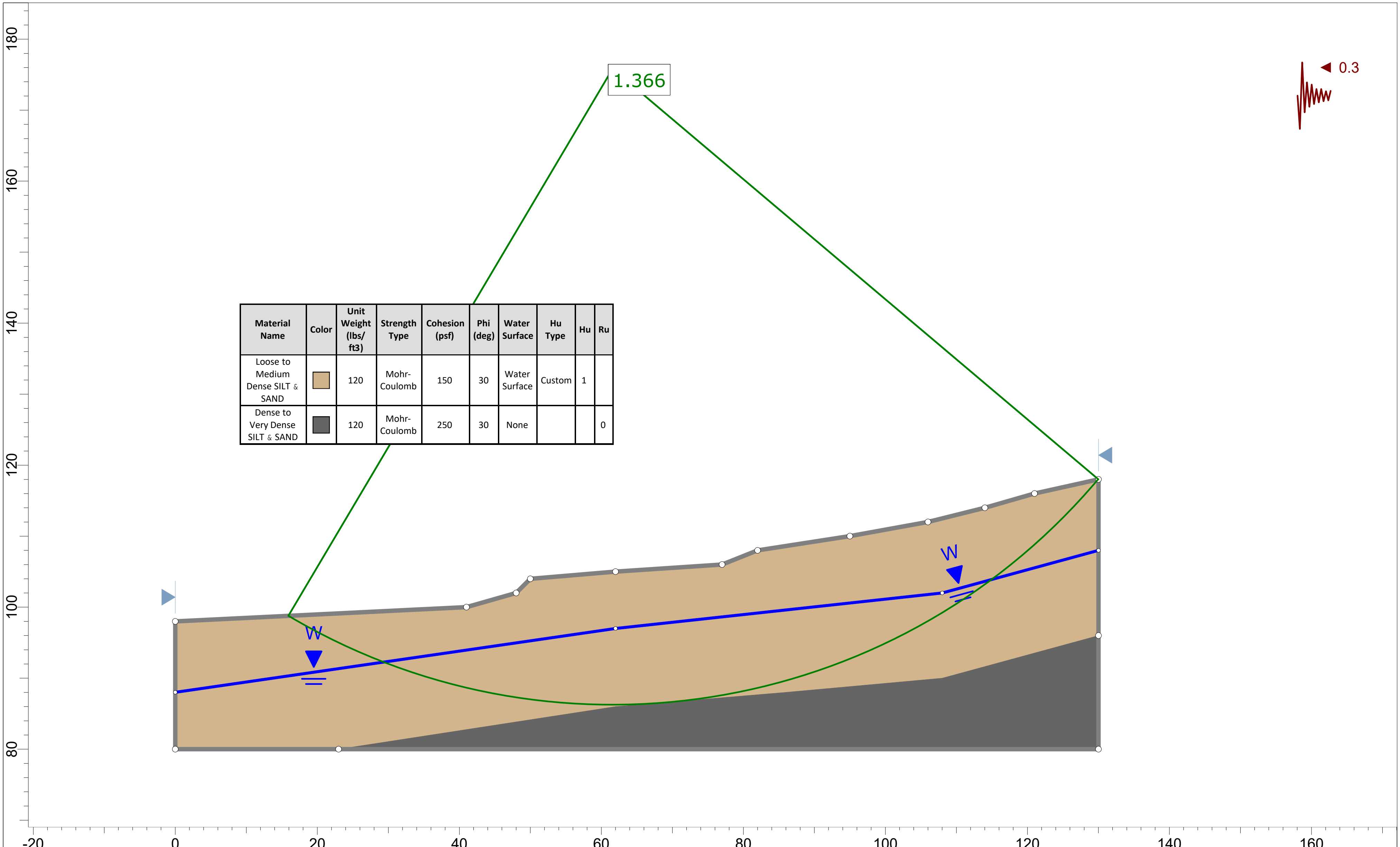


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Loose to Medium Dense SILT & SAND		120	Mohr-Coulomb	150	30	Water Surface	Custom	1	
Dense to Very Dense SILT & SAND		120	Mohr-Coulomb	250	30	None			0

rocscience

SLIDEINTERPRET 9.008

Project	3036 - 67th Ave		
Group	Existing Conditions	*Scenario*	Master Scenario
Drawn By	T. Gilsdorf/C. Decker	*Company*	Terra Associates, Inc.
Date	May 19, 2022	*File Name*	A-A' Existing.slmd



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Loose to Medium Dense SILT & SAND		120	Mohr-Coulomb	150	30	Water Surface	Custom	1	
Dense to Very Dense SILT & SAND		120	Mohr-Coulomb	250	30	None			0

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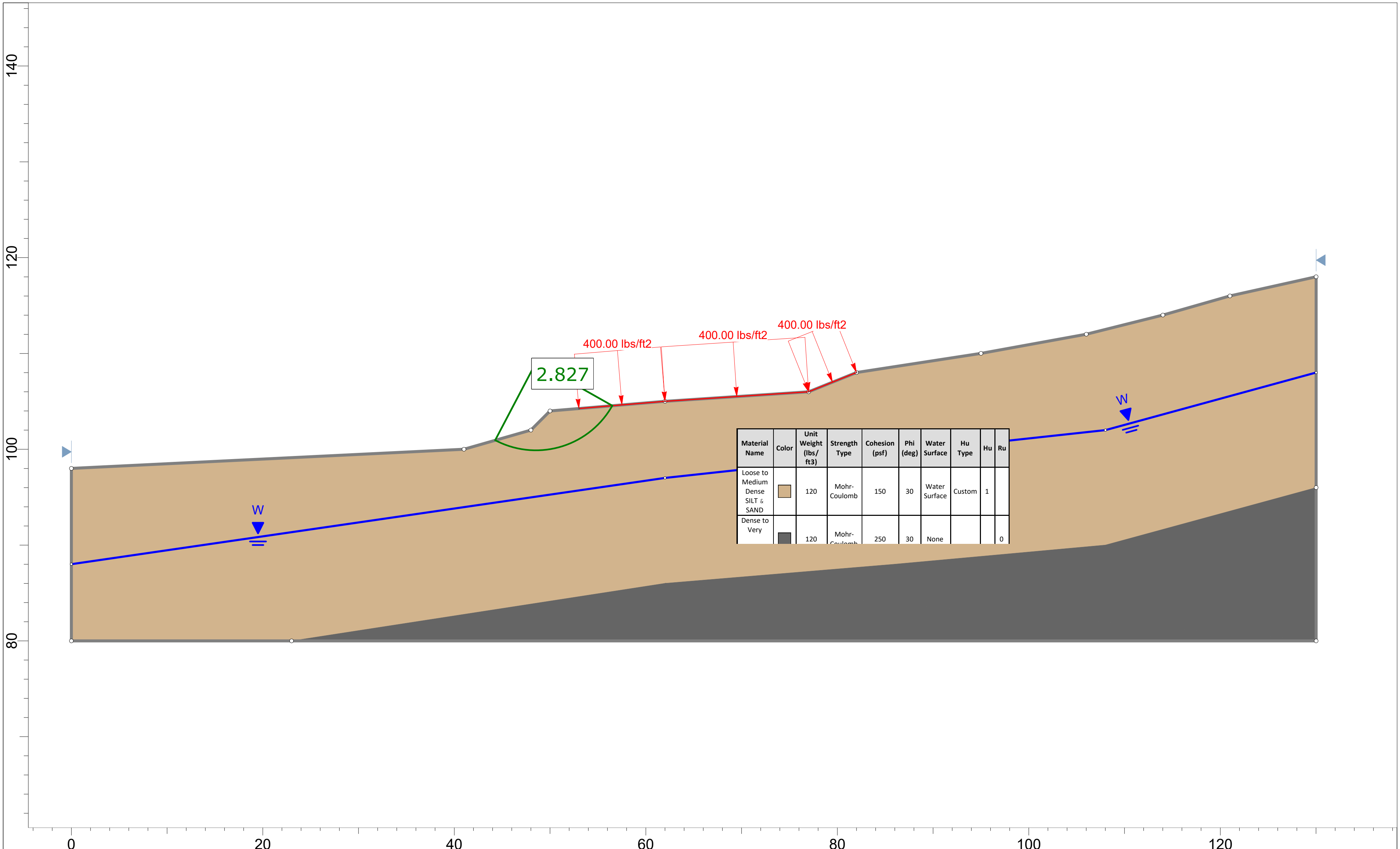
SLIDEINTERPRET 9.008

Project	3036 - 67th Ave		
Group	Existing Conditions	*Scenario*	Seismic
Drawn By	T. Gilsdorf/C. Decker	*Company*	Terra Associates, Inc.
Date	May 19, 2022	*File Name*	A-A' Existing.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Loose to Medium Dense SILT & SAND		120	Mohr-Coulomb	150	30	Water Surface	Custom	1	
Dense to Very		120	Mohr-Coulomb	250	30	None			0

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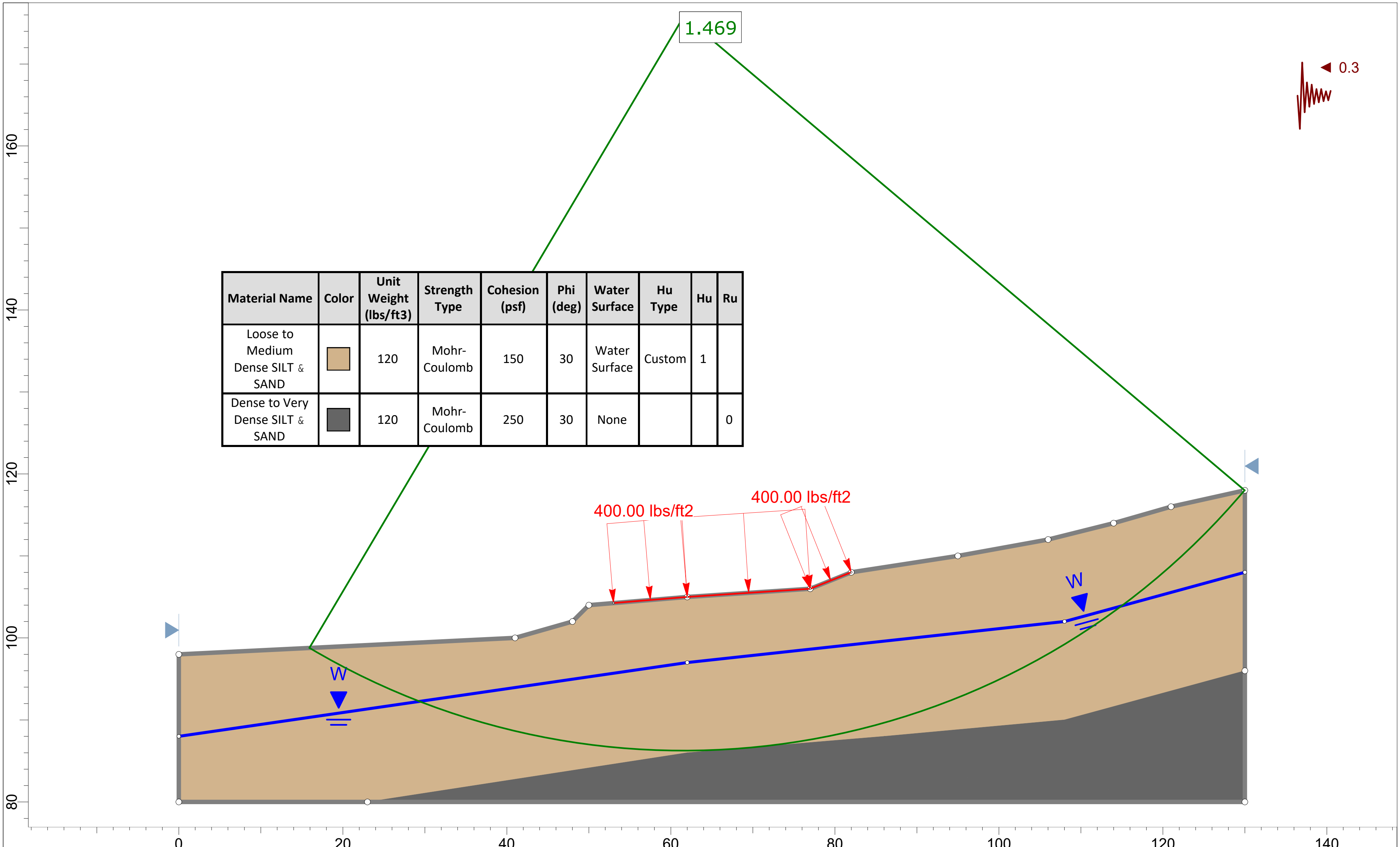
SLIDEINTERPRET 9.008

Project	3036 - 67th Ave		
Group	Post Construction	*Scenario*	Master Scenario
Drawn By	T. Gilsdorf/C. Decker	*Company*	Terra Associates, Inc.
Date	May 19, 2022	*File Name*	A-A' Existing.slmd

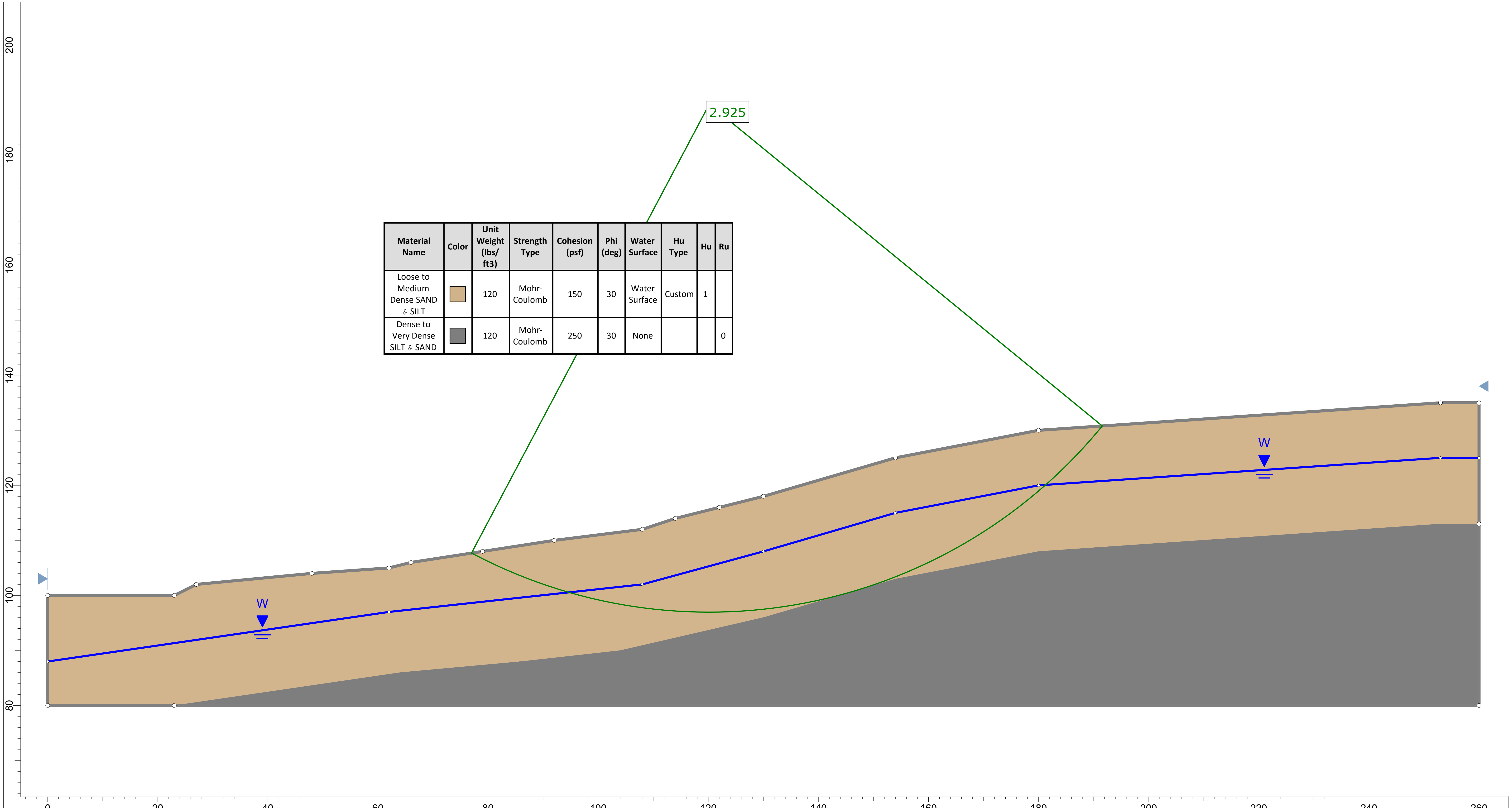


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Loose to Medium Dense SILT & SAND		120	Mohr-Coulomb	150	30	Water Surface	Custom	1	
Dense to Very Dense SILT & SAND		120	Mohr-Coulomb	250	30	None			0

rocscience

SLIDEINTERPRET 9.008

Project	3036 - 67th Ave		
Group	Post Construction	*Scenario*	Seismic
Drawn By	T. Gilsdorf/C. Decker	*Company*	Terra Associates, Inc.
Date	May 19, 2022	*File Name*	A-A' Existing.slmd



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Loose to Medium Dense SAND & SILT		120	Mohr-Coulomb	150	30	Water Surface	Custom	1	
Dense to Very Dense SILT & SAND		120	Mohr-Coulomb	250	30	None			0

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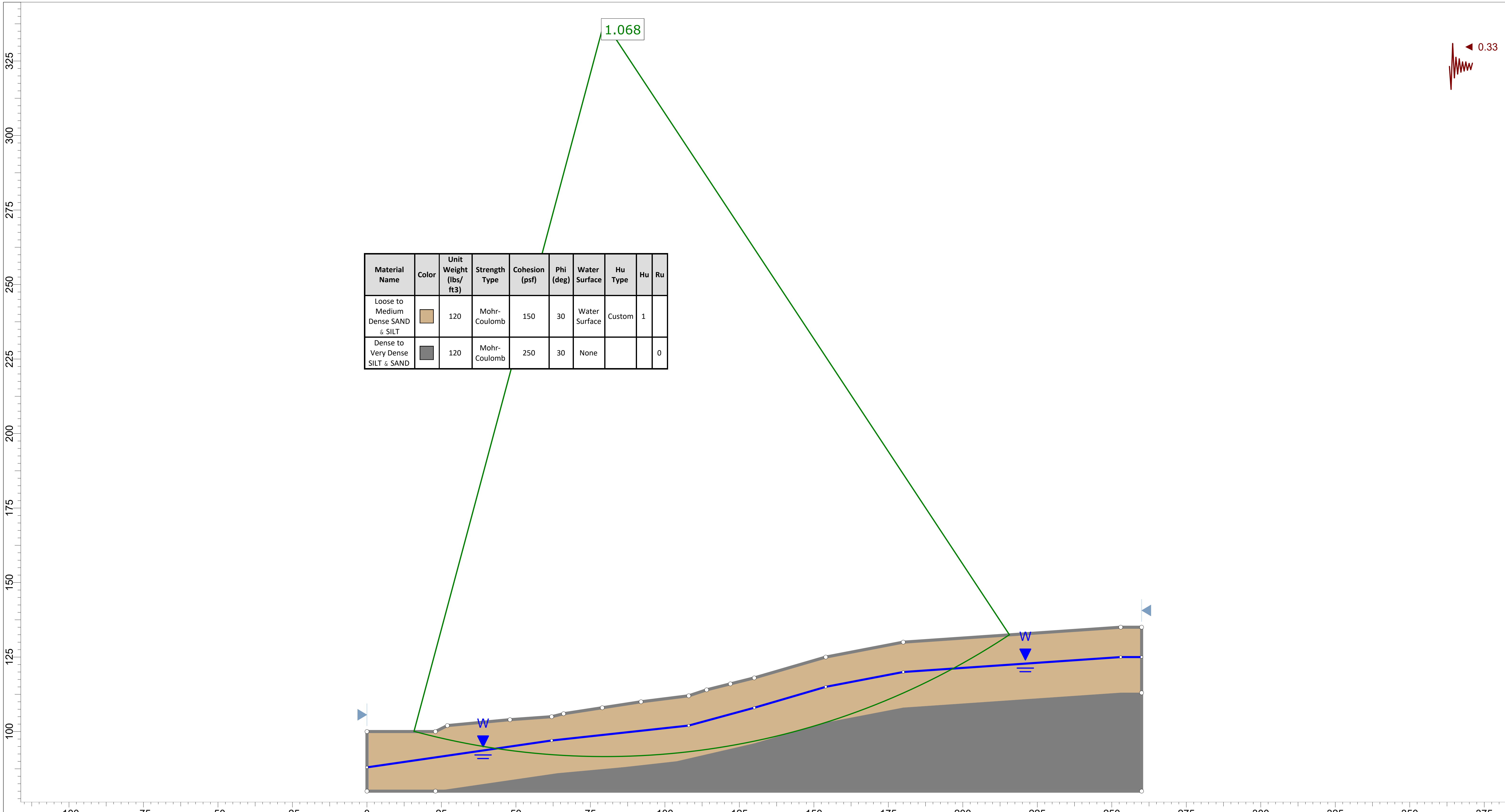
SLIDEINTERPRET 9.008

Project	3036 - 67th Ave SE		
Group	Existing Conditions	*Scenario*	Master Scenario
Drawn By	C. Decker	*Company*	Terra Associates, Inc.
Date	May 19, 2022	*File Name*	Cross Section B-B'.slmd



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Loose to Medium Dense SAND & SILT		120	Mohr-Coulomb	150	30	Water Surface	Custom	1	
Dense to Very Dense SILT & SAND		120	Mohr-Coulomb	250	30	None			0

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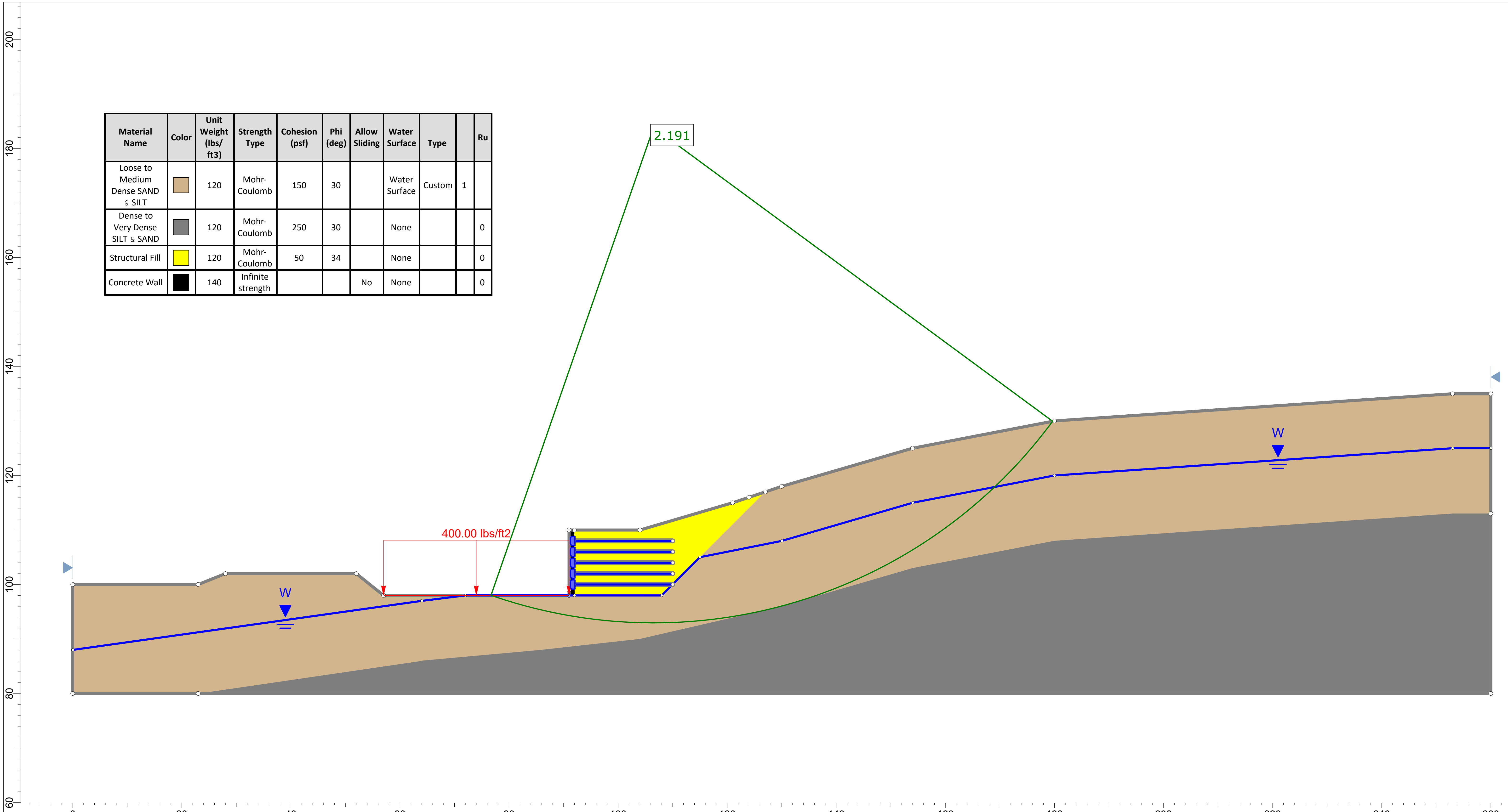
SLIDEINTERPRET 9.008

Project	3036 - 67th Ave SE		
Group	Existing Conditions	*Scenario*	Seismic
Drawn By	C. Decker	*Company*	Terra Associates, Inc.
Date	May 19, 2022	*File Name*	Cross Section B-B'.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Type		Ru
Loose to Medium Dense SAND & SILT		120	Mohr-Coulomb	150	30		Water Surface	Custom	1	
Dense to Very Dense SILT & SAND		120	Mohr-Coulomb	250	30		None			0
Structural Fill		120	Mohr-Coulomb	50	34		None			0
Concrete Wall		140	Infinite strength			No	None			0

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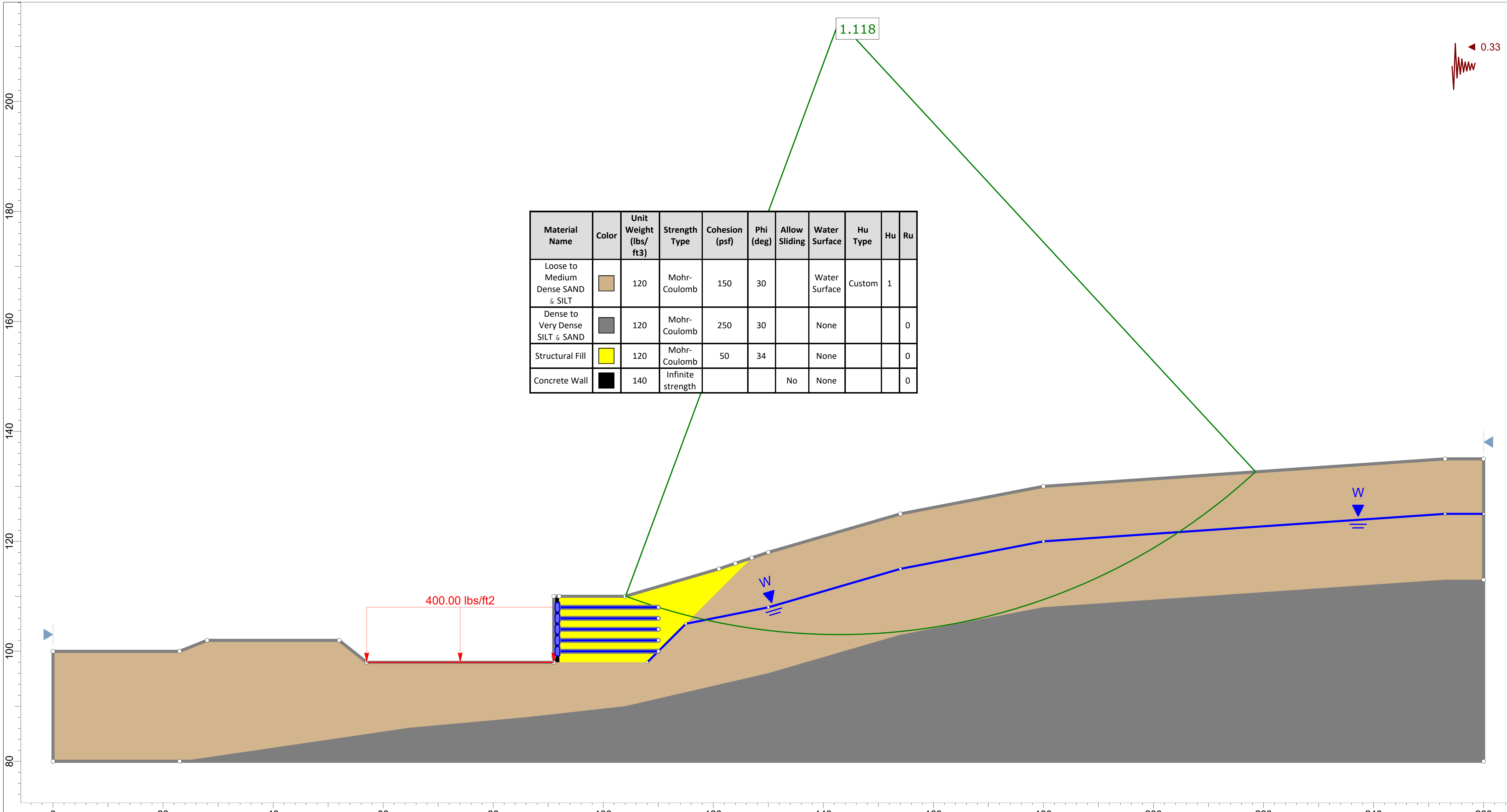
SLIDEINTERPRET 9.008

Project	3036 - 67th Ave SE		
Group	Post Construction	*Scenario*	Master Scenario
Drawn By	C. Decker	*Company*	Terra Associates, Inc.
Date	May 19, 2022	*File Name*	Cross Section B-B'.slmd



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Hu Type	Hu	Ru
Loose to Medium Dense SAND & SILT		120	Mohr-Coulomb	150	30		Water Surface	Custom	1	
Dense to Very Dense SILT & SAND		120	Mohr-Coulomb	250	30		None			0
Structural Fill		120	Mohr-Coulomb	50	34		None			0
Concrete Wall		140	Infinite strength			No	None			0

rocscience

SLIDEINTERPRET 9.008

Project	3036 - 67th Ave SE		
Group	Post Construction	*Scenario*	Seismic
Drawn By	C. Decker	*Company*	Terra Associates, Inc.
Date	May 19, 2022	*File Name*	Cross Section B-B'.slmd