GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists
& Environmental Specialists

June 26, 2023 G-5861

Mr. Ananta Gudipaty
3737 – 77th Avenue SE
Mercer Island, Washington 98040

Subject: Response to Geotechnical Review Comments, Proposed New Residence, 3626 – 90th Avenue SE, Mercer Island, Washington.

Reference: Geotechnical Engineering Investigation, Proposed New Residence, 3626 – 90th Avenue SE, Mercer Island, Washington. GEO Group Northwest, Inc., April 18, 2023.

Dear Mr. Gudipaty:

GEO Group Northwest, Inc. has prepared this response letter to the geotechnical review comments dated May 9, 2023, regarding the proposed construction of a new residence at the subject location in Mercer Island, Washington. The comments and our responses are provided below.

**Comment #1**

> Please replace geotechnical contact information with new geotechnical engineer of record.

Comment acknowledged. We understand that the project plans will be updated with this information.

**Comment #2**

> When the final plan set is approved, please provide an updated letter from the geotechnical engineer of record that includes a review of the final plan set and statement of risk in accordance with MICC 19.07.160.B.3.

Comment acknowledged. We will provide an updated plans review letter following receipt and review of the revised project plans.

**Comment #3**

> IBC requires use of MCE loading not design earthquake loading for seismic stability analysis. The local standard of practice has included a seismic coefficient of $a_{max}$ / 2 or 0.33 for the MCE loading.

The soil loading parameters used for our analysis are based on the MCE loading criteria for a 2 percent chance of exceedance in a 50-year period (equivalent to a 2,475-year return period) for the site location and for the assigned Site Class D. Our description of the seismic analysis being for a 'design earthquake' was not intended to refer the design earthquake as defined by ASCE Standard 7, and the loading criteria for that case was not used.

> Please include discussion of how the seismic coefficient (0.22) was determined. Please include calculations for review and cite references used to determine the seismic coefficient.

The pseudo-static acceleration value that was used in our analysis described in our geotechnical report was based on applying a coefficient value of 0.5 to two-thirds of the $PGA_M$ value for the site. The adjustment of the $PGA_M$ value was performed to represent the maximum horizontal acceleration (MHA) value for the overall slope mass. This coefficient, therefore, is equivalent to 0.33 as multiplied by the $PGA_M$ value, resulting in a value of 0.22g for the MCE loading.

> If the use of the seismic coefficient of 0.22 cannot be supported by calculation or technical references citing alternate methodologies please revise seismic stability analyses. Discuss impacts of seismic slope instability, e.g., estimated slope deformations and associated structural impacts. Please provide mitigation recommendations, if

applicable. Please present revised stability analysis results and subsequent recommendations in a report addendum.

Following receipt of the review comments, we have reviewed technical literature regarding alternative procedures for the estimation of the pseudo-static coefficient value for the analysis of seismic ground motion on slope stability. We used the procedures described in Bray and Travasarou (2011)[1] to evaluate the relationship between seismic displacement and pseudo-static coefficient for use in our analysis.

Slope height was assigned using the topographic survey for the site and the City of Mercer Island IGS topographic information enclosed in Attachment A. The average shear wave velocity for the slope mass was assigned as 1,200 ft/s (equivalent to 365 m/ sec), based on this being the value used for soils at the boundary between Site Class C and D soils in ASCE Standard 7 (2016), Chapter 20.

The value for the fundamental site period, $T_s$ was determined per the method in Bray and Travasarou (2011). The value for the site spectral acceleration, $S_a$, for the period of $1.5T_s$ was assigned the value for $S_{MS}$ for the site, obtained from the ASCE 7 Hazard Tool application (the application report is enclosed in Attachment A).

The value for D was assigned to be the mean seismic displacement value per the recommendations in Bray and Travasarou (2011). Determination of the numerical value for D was based on the proposed project consisting wood-frame construction of a two-story residence being designed consistent applicable design and construction codes. This value is also below the value of 15 cm that has been recommended by the Association of Professional Engineers and Geologists of British Columbia (APEGBC) for projects of this type[2]. The earthquake moment magnitude was assigned a value of 7, and the nearest earthquake source is represented as a buried crustal earthquake along the nearby Seattle Fault zone.

These parameters are presented below:

1 Bray, J.D., and T. Travasarou, Pseudostatic Slope Stability Procedure. 5th International Conference on Earthquake Geotechnical Engineering, 2011.
2 APEGBC, Guidelines for Legislated Landslide Assessments of Proposed Residential Development in British Columbia. May 2010.

- Slope height: 10m
- Fundamental site period, $T_s$ 0.11s
- Degraded site period, $1.5T_s$ 0.16s
- Site spectral acceleration value, $S_a$, at $1.5T_s$ 1.403g
- Allowable soil displacement, D 10cm
- Average soil shear wave velocity 365m/s
- Earthquake moment magnitude 7

The calculation of the pseudo-static coefficient, k, was obtained from the equations below:

$k = \exp [(-a + b^{0.5})/ 0.665]$, where

$a = 2.83 – 0.566*\ln S_a$, and

$b = a^2 – 1.33[\ln D + 1.10 – 3.04*\ln S_a + 0.244*(\ln S_a)^2 – 1.5*T_s – 0.278*(M-7) – e]$,

where $T_s > 0.05$. The value of $e = 0$ for case where the median seismic displacement value is being used (as in the present case).

The calculations are summarized below:

$a = 2.83 – 0.566*(\ln(1.403)) = \underline{2.638}$

$b = 6.961 – 1.33((\ln(10) + 1.1 – 3.04*\ln(1.403) + 0.244*(\ln(1.403))^2 – 0.16 – 0)$
$= 6.961 – 1.33(2.3026 + 1.1 – 1.0294 + 0.0280 – 0.16)$
$= 6.961 – 1.33(2.2412) = \underline{3.980}$

$k = \exp((-2.638 + (3.980)^{0.5} )/0.665) = \exp(-0.9669) = 0.\underline{380}$

The value for the pseudo-static coefficient value is calculated to be 0.380 for the specified conditions. When multiplied by the $PGA_M$ value of 0.66g for the site, the pseudo-static loading to be used for the stability analysis is calculated to be 0.251.

Based on findings from the above-described analysis, we updated our slope stability analysis for the project site using the value of 0.251g, for the pseudo-static loading. The results from the updated analysis are presented in Attachment B to this letter.

The results are filtered to illustrate the potential soil movement surfaces having a safety factor of less than 1.2. Bray and Travasarou (2011) note that adding a safety factor to the analysis results may not be warranted, as the determination of k has already considered displacement magnitude and probabilistic occurrence. Nevertheless, we have included the safety factor, as it provides an additional measure of conservatism to the analysis and is consistent with current local practice.

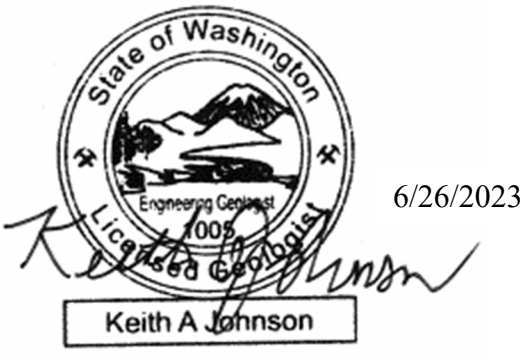
The results indicate that the extents of the potential slope displacement surfaces do not intersect the proposed residence location. The minimum distance between the building foundations and the surfaces is approximately 8 feet; the outermost foundation element shown in the results profile is an exterior deck column footing that is separate from the building.

Based on the analysis findings, it is our opinion that the proposed residence has minimal risk of harm to life safety due to soil displacement from an earthquake as considered in our analysis.

**Closing**

Please feel welcome to contact us if you have any questions.

Sincerely,
GEO Group Northwest, Inc.




6/26/2023


6/26/2023

Keith Johnson
Project Geologist

William Chang, PE
Principal Engineer

Attachment A – Mercer Island IGS Topographic Map and ASCE7 Hazard Tool Report
Attachment B – Updated Slope Stability Analysis Results

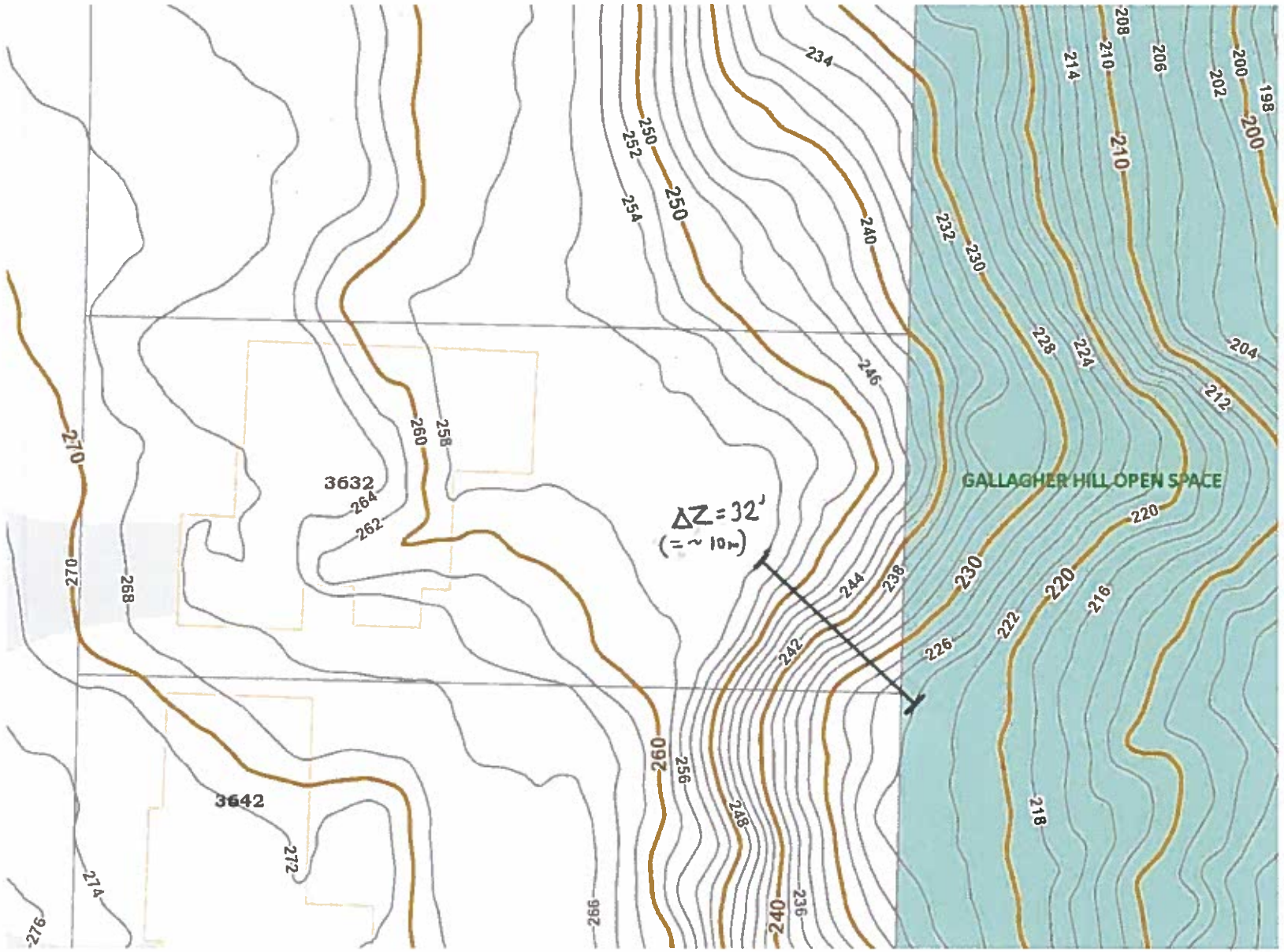
**ATTACHMENT A**

**G-5861**

**MERCER ISLAND IGS TOPOGRAPHIC MAP AND ASCE7 HAZARD TOOL REPORT**

**GEO Group Northwest, Inc.**

# City of Mercer Island




## Legend

- 10ft Lidar Contours (2016)
- 2ft Lidar Contours (2016)
- Address
- Building
- Property Line
- Docks
- Freeway
- Major Street
- Street
- Paved Driveway
- Paved Road
- Paved Parking Area
- Parks
- Lake Washington

0 29 59 Feet

1 inch = 58.9761405 feet



Map Printed: June 26, 2023

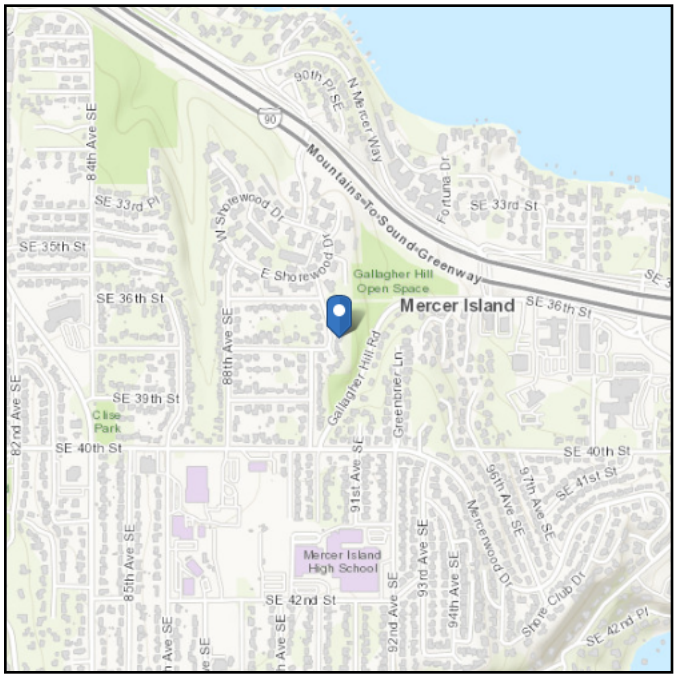


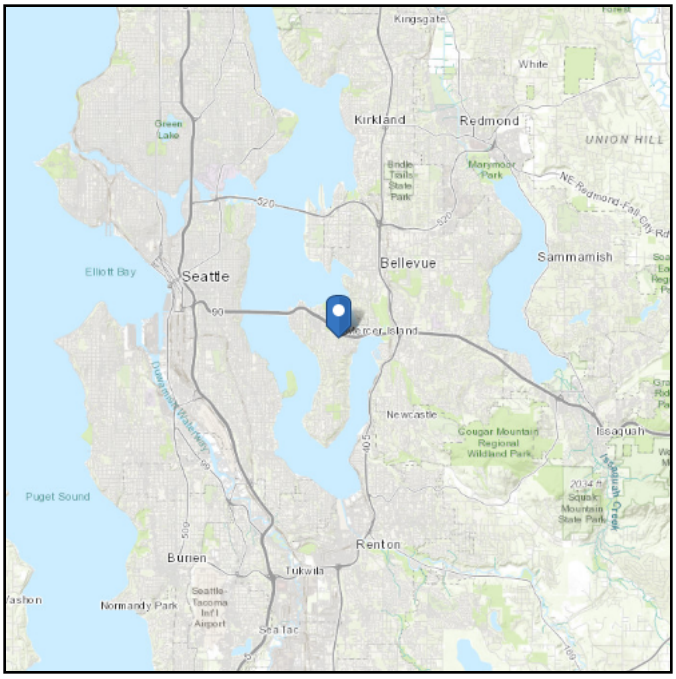
**Notes**

# ASCE 7 Hazards Report

**Address:**
3632 90th Ave SE
Mercer Island, Washington
98040

| | | | |
|---|---|---|---|
| **Standard:** | ASCE/SEI 7-16 | **Latitude:** | 47.577207 |
| **Risk Category:** | II | **Longitude:** | -122.218117 |
| **Soil Class:** | D - Stiff Soil | **Elevation:** | 262.03454223024943 ft (NAVD 88) |



# Seismic

**Site Soil Class:** D - Stiff Soil

**Results:**

| | | | |
|---|---|---|---|
| $S_S$ : | 1.403 | $S_{D1}$ : | N/A |
| $S_1$ : | 0.488 | $T_L$ : | 6 |
| $F_a$ : | 1 | PGA : | 0.6 |
| $F_v$ : | N/A | $PGA_M$ : | 0.66 |
| $S_{MS}$ : | 1.403 | $F_{PGA}$ : | 1.1 |
| $S_{M1}$ : | N/A | $I_e$ : | 1 |
| $S_{DS}$ : | 0.935 | $C_v$ : | 1.381 |

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

**Data Accessed:** Mon Jun 19 2023

**Date Source:** USGS Seismic Design Maps

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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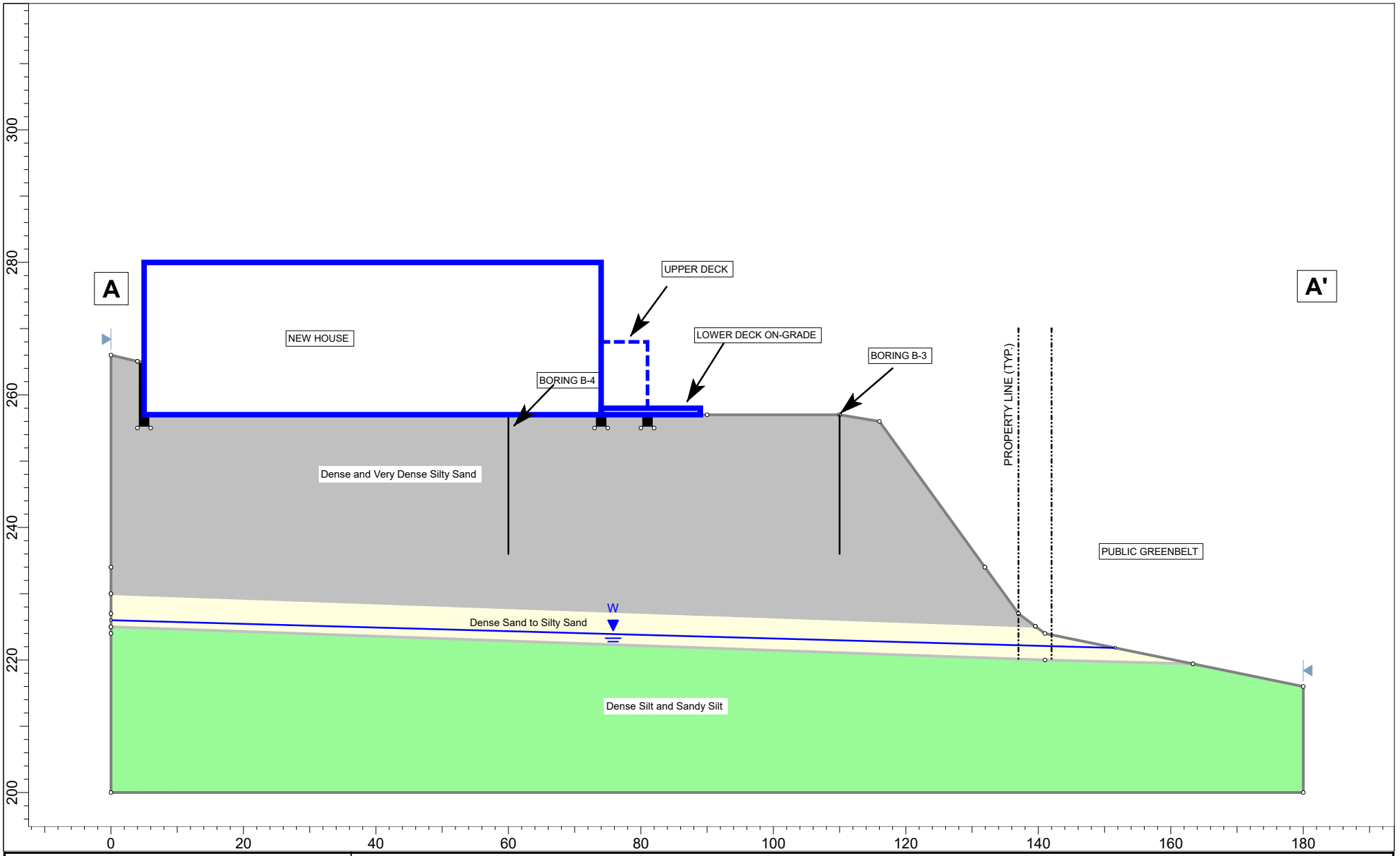
**ATTACHMENT B**

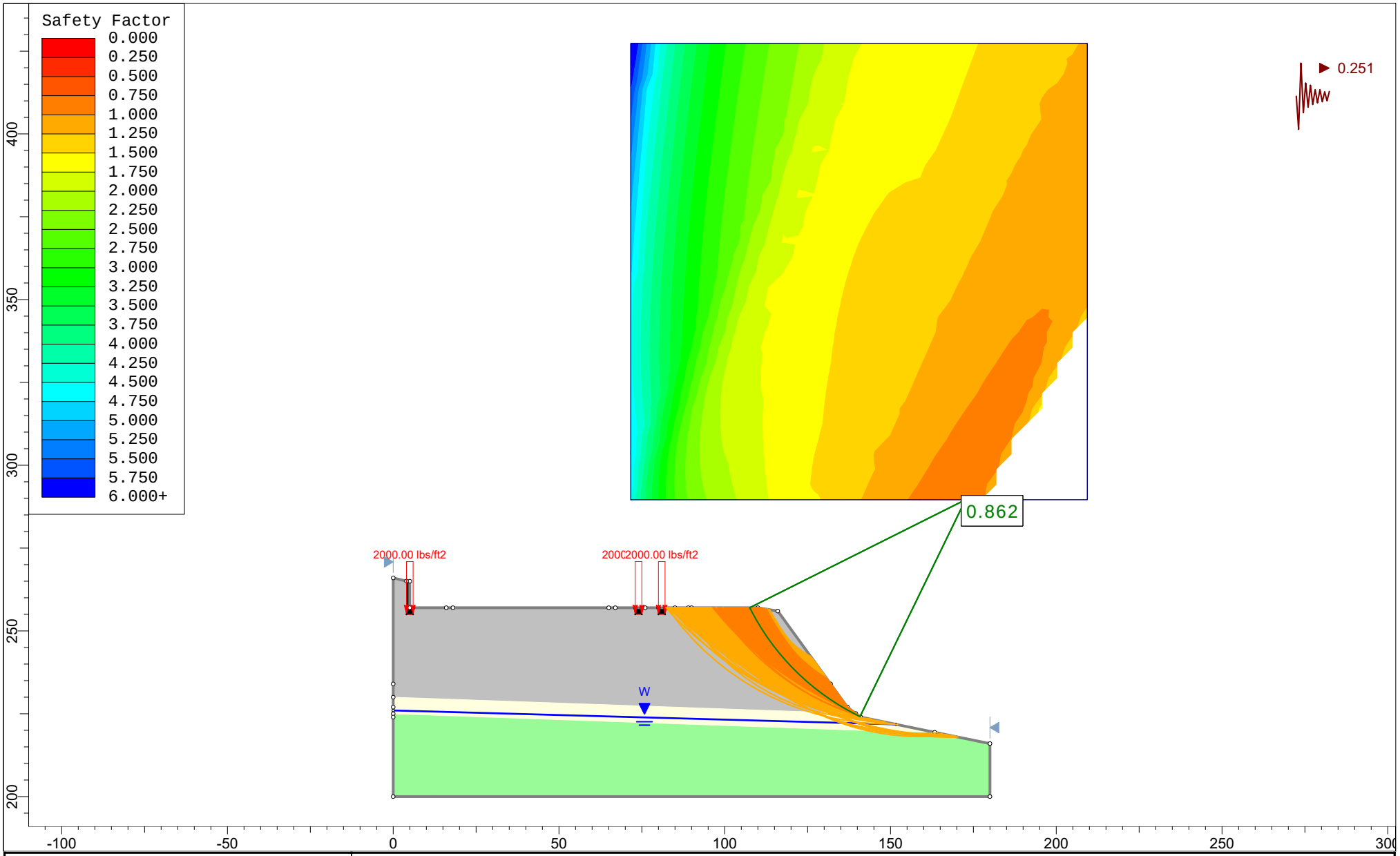
**G-5861**

**UPDATED SLOPE STABILITY ANALYSIS RESULTS**

**GEO Group Northwest, Inc.**




| | | | |
|---|---|---|---|
| *Project* | Proposed Residence 3632 90th Ave E Mercer Island WA | | |
| *Analysis Description* | Profile A A' Post-Construction | | |
| *Drawn By* | | *Scale* 1:240 | *Company* |
| *Date* | | | *File Name* Gud 2 proposed profile A3.slim |

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|---|---|---|---|
| rocscience | Project: Proposed Residence 3632 90th Ave E Mercer Island WA | | |
| | Analysis Description: Profile A - A' Post-Construction | | |
| | Drawn By: | Scale: 1:480 | Company: |
| | Date: | | File Name: Gud 2 proposed profile A3 seismic analysis rev 1.slim |

SLIDEINTERPRET 7.038