



Wood Environment & Infrastructure Solutions, Inc.
4020 Lake Washington Blvd NE, Suite 200
Kirkland, Washington 98033
USA
T: 425-368-1000
www.woodplc.com

November 10, 2021

Project No. PS21-20341-B

Paul Skidmore
City of Mercer Island
9611 SE 36th Street
Mercer Island, Washington 98040

Subject: Third-Party Geotechnical Engineering Review - Permit# 2011-119
Xing Hua Group LLC
Mercer Island Mixed-Use Development
2885 78th Ave SE
Mercer Island, Washington

Dear Mr. Skidmore:

Wood Environment & Infrastructure Solutions, Inc. (Wood) presents this letter that summarizes our third-party geotechnical engineering review of the proposed ground improvement design for the Mercer Island Mixed-Use Development. Wood reviewed the following documents:

- Design Submittal – *Geopier Soil Reinforcement REVISED, Mercer Island Mixed-Use Development* letter, by Geopier Northwest, dated January 15, 2021.
- *Geotechnical Engineering Design Report, Multi-Family Development*, Mercer Island, by Hart Crowser, dated November 3, 2020.
- Geopier plan sheets GP1.0, by Geopier Northwest, dated December 20, 2020, and 2.0 dated August 30, 2021, respectively.
- Structural plan sheets: S001; S004; S200.1; S200.1s; S200.2, by PCS Structural Solutions, dated September 1, 2021.

Site and Project Description

The proposed development will be to demolish the existing structures and construct a four-story mixed-use building with two levels of parking underground, retail at ground level, and apartments in the upper floors. The lowest finished floor elevation is around 71 feet, and the subgrade will be about 68 feet.

Soil conditions consist of loose to medium dense fill soils to various depths across the site; underlain by stiff silt and medium dense sand; and below these layers hard silt was encountered. For design purposes, the elevation of the top of competent bearing soils is displayed in Figure 10 of the *Geotechnical Engineering Design Report*.

Perched groundwater is anticipated at shallow depths, and for design purposes the groundwater table is estimated at elevation 75 feet.

To construct the foundations in these subsurface conditions, shoring and dewatering is planned to allow excavation to the subgrade elevation. Then ground improvement with Geopiers will be installed on the west side of the building where unsuitable soils are anticipated. The building will be supported on a mat foundation over most of the area, including all of the area of ground improvement.

Review Comments

Wood reviewed the documents to assess whether they are consistent with the geotechnical engineering report and the structural foundations plans, and if they meet the standards of geotechnical engineering practice.

We agree with the applicant's proposal for ground improvement in the form of Geopiers to support the mat foundation for the building. This seems to be a good solution for the site conditions and proposed development. The location of ground improvement is consistent with the geotechnical engineering recommendations and the structural foundation plans. The geotechnical engineering report recommended ground improvement where competent soils are deeper than elevation 66 feet as shown in Figure 10; and the area of ground improvement encompasses this area and extends a little further east. This is appropriate because the elevations estimated in Figure 10 are based on limited explorations. The recommendations in the geotechnical engineering report allow for flexibility during construction in the event that the elevation of competent soils vary. Over-excavation and backfill could replace some ground improvement area, or the ground improvement area could extend further.

The resulting design shown on the Geopier Northwest plan sheets may be reasonable, however more detailed information should be provided to verify and fully document the design. We have the following comments regarding the design letter and calculations.

1. The soil conditions vary across the site, as described in the geotechnical engineering report and as summarized in Geopier Northwest's design letter. After the summary, Geopier Northwest should describe or show in a figure the design soil cross-section/column that they assumed for their analyses. For example, we do not know why they are using a stronger stiffness from 8 feet to 10 feet deep (elevation 61 feet - 59 feet); and we don't know why they are using such a high over-consolidation pressure for soils below elevation 59 feet.
2. Geopier Northwest should state or clearly show the groundwater table elevation that they assumed for design. The geotechnical engineering report recommended assuming ground water at elevation 75 feet and recommended floor drainage, so it seems that groundwater should be assumed at the floor subgrade elevation (elevation 69 feet), however Geopier assumed the groundwater was 5 feet deeper (elevation 65 feet) in their calculations.
3. Geopier Northwest's discussion about the design foundation bearing pressure is confusing and it is not clear if the design is consistent with the geotechnical engineering report and the structural foundation plans.
 - a. The geotechnical engineering report recommends the mat foundation be designed for 3,000 pounds per square foot (psf).
 - b. The structural foundation plans say that the mat foundation and the spread footings have been designed for 3,000 psf.

- c. Geopier Northwest says they designed for a maximum bearing pressure of 4,000 psf (with no supporting calculations), however it can be increased by another 1/3 for seismic loading. They go on to state they designed for the average bearing pressure of 1,500 psf based on actual loads. They also state that they designed for 60 kips over 36 sf, which is 1,667 psf.
 - d. All three documents should clearly state the same design bearing pressures and/or subgrade modulus for the mat foundation.
4. The tolerable total settlement and differential settlement should be clearly stated since the Geopier analyses calculate settlement. The structural engineer should provide the settlement tolerance or approve the estimate settlement by Geopier Northwest.
5. Geopier Northwest states that the piers will be drilled 15 feet below subgrade, or refusal, whichever comes first. This raises two comments.
 - a. Provide calculations demonstrating that 15 feet deep piers that haven't reached the competent bearing soils will still achieve the design bearing pressure and settlement tolerances.
 - b. The calculations provided assume 10 feet deep piers. Does this mean the minimum depth of piers needs to be 10 feet? If so, state this in the calculations and the plan sheets, and state that other construction methods may need to be implemented to achieve the minimum depth (for example excavate obstructions or auger drill the pier).
6. In the calculation spreadsheet, how was the edge influence factor determined? 0.75 for 9 feet below a 186-foot footing seems low, since we estimated 0.9 by considering an equivalent footing distribution of 2V:1H.
7. It seems like the settlement calculations should include a much deeper lower zone. The calculations only considered 30 feet below subgrade for an equivalent footing width is 185 feet (that results in a 0.78 influence factor by assuming 2V:1H). How much settlement is estimate for soils deeper than 30 feet?
8. Revise the "Spread Foundation Settlement" paragraph to describe the site-specific properties and calculation methods. State that the consolidation approach was used for the lower zone.
9. Geopier Northwest should add a statement about post-seismic liquefaction settlement. Based on the liquefaction settlement predicted in the geotechnical engineering report, will the ground improvement design mitigate that settlement, or should the structural mat foundation accommodate the liquefaction settlement?
10. Geopier Northwest's revised letter should include the date with the signature and professional engineer's seal.

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Page 4 of 4


Closure

It should be noted that our scope of work for this letter was limited to a review of the documents provided to us. Our scope did not include a site visit, exploration of actual subsurface conditions, nor does our review purport to verify the accuracy of any geotechnical engineering results presented within the documents.

We hope this letter meets your current needs. If you have any questions, please do not hesitate to contact us at your convenience.

Sincerely,

Wood Environment & Infrastructure Solutions, Inc.

A handwritten signature in black ink that reads "Todd D. Wentworth". The signature is written in a cursive style with a large, sweeping initial "T".

Todd D. Wentworth, P.E., L.G.
Principal Geotechnical Engineer
Direct Tel: (425) 368-0938
E-mail: Todd.Wentworth@woodplc.com

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