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February 9, 2022

TO: Johnston Architects

SUBJECT: Design Comment Response
Mercer Island Mixed-Use Development
Mercer Island, WA

This letter and the attached documents represent our comment response for Geopier® soil reinforcement at the site of the Mercer Island Mixed-Use development located in Mercer Island, WA.

Geopier Comment Response

Comment 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.

- RESPONSE: Our design utilizes the geotechnical information and cross sections provided by Hart Crowser. We have included this information in Appendix A: Geotechnical Information in our design submittal. We have also provided more commentary on the design settlement soil profiles in the settlement discussion in our design submittal. Regarding the two examples mentioned in the comment:
    - We are using a stronger stiffness in the lower 2 feet because it is assumed the bottom 2 feet is into the stiffer transition material into the competent soil. It should be noted that the Hart Crowser depth to competent bearing soils only goes as deep as Elevation 63 feet so our modelling is conservative, refer to Figure 10 of the geotechnical report for competent soil contours.
    - The high over consolidation pressure in the competent bearing soils was an artificially high OCR so that the soil did not go into virgin compression and the high OCR does not affect the settlement calculations in the competent bearing soils. We have modified our calculations to utilize an OCR of 10 in our design calculations for the near surface lower zone and an OCR of 20 for the much deeper zone.

Comment 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.

- RESPONSE: We have modified our groundwater depth to match an elevation of 69 feet in our calculations.

Comment 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).

- RESPONSE: We have modified our design submittal to provide an allowable bearing capacity of 3,000 psf.

b. The structural foundation plans say that the mat foundation and the spread footings have been designed for 3,000 psf.

- RESPONSE: We have modified our design submittal to provide an allowable bearing capacity of 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.

- RESPONSE: Geopier designs are based on bearing capacity and settlement control, which are two separate performance requirements. A vast majority of the ground improvement designs are controlled by settlement control as the mat foundation factor of safety for a bearing capacity failure are very high. We have included bearing capacity calculations utilizing the 3,000 psf which is much higher than what the actual loads are on the mat foundation. For settlement estimates we utilize the actual loads on the mat foundation which average 1,500 psf. Our cell capacity is what the piers could be designed up to in terms of load and we selected that 6 ft o.c. spacing to control settlements to tolerable levels and have taken out this statement so as to not confuse the support issue and address this comment. We have modified our submittal to discuss this information and have included the actual mat foundation loads provided to us during design in Appendix B: Structural Loading. Additionally, we have provided beading capacity calculations in Appendix D: Bearing Capacity. Finally, a Geopier load test to 150% of the design load will be conducted to verify the parameters in the field.

d. All three documents should clearly state the same design bearing pressures and/or subgrade modulus for the mat foundation.

- RESPONSE: We have modified our design submittal to provide an allowable bearing capacity of 3,000 psf with a 1/3 increase for short duration loads.

Comment 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.

- RESPONSE: We have provided calculations for deep and shallow Geopier elements. These settlement estimates show approximately 1.5 inches for the deep elements and 1.1 inches for the shallow elements. Utilizing our lower zone parameters for the area of the mat unsupported by Geopier elements yields approximately 1 inch of settlement.

Based on our calculations, total settlements for the mat foundation should range between 1.0 and 1.5 inches with a maximum of 0.5 inches of differential settlement over 40 feet. We have modified our submittal documents with the information above. Additionally, it should be noted that a large portion of the settlement will occur during construction as the settlement due to the dead loads will occur during construction so total post-construction settlements should be less than 1 inch.

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.

- RESPONSE: We utilized the very conservative 15-foot maximum depth to ensure that we reach the bearing soil elevation and do not anticipate installing Geopier elements to that depth. The 15-foot depth corresponds to an elevation of 54 feet while the geotechnical information anticipates a maximum elevation of bearing soils of 63 feet which corresponds to an approximate depth of 6 feet assuming a working pad elevation of 69 feet.

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).

- RESPONSE: As a portion of the site does not require ground improvement due to competent soil it is reasonable to assume that there is no minimum depth for Geopier elements as they will gradually transition to competent soil being present at the bottom of the mat foundation. We have included a calculation for a shallow Geopier element with a 3-foot length and even shorter lengths are acceptable within the transition zone as long as they are reaching refusal at the competent bearing elevation.

Comment 6. In the calculation spreadsheet, how was the edge influence factor determined? 0.75 for 9 feet below a 186-feet footing seems low, since we estimated 0.9 by considering an equivalent footing distribution of 2V:1H.

- RESPONSE: Our edge influence factor is based on a Boussinesq stress distribution, which as the designer we believe is applicable. Additionally, our settlement estimates are utilizing the conservative center of mat foundation settlements and the edge settlement calculations do not factor into the design on this project.

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?

- RESPONSE: Based on the geotechnical information and geotechnical report we assumed that the deeper soils were incompressible hard silts. We have modified our settlement calculations to calculate settlements to 100 feet but do not feel this is a

reasonable estimate as the very small incremental settlement is calculated in the hard silt over a great depth leads to potentially erroneously large settlement estimates.

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.

- RESPONSE: We have revised our settlement discussion to discuss our soil profiles utilized in our calculations. Geopier parameters are proprietary and have not been requested previously by third party reviews conducted by the reviewer's firm on both mat and spread foundations. It should be noted that a Geopier load test to 150% of the design load will be conducted to verify the parameters in the field.

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?

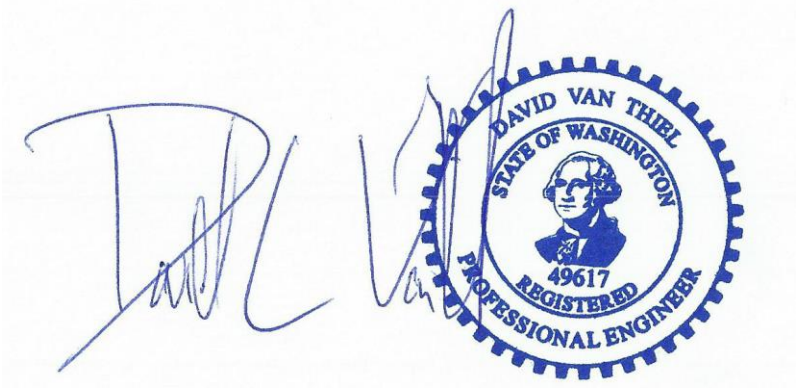
- RESPONSE: The Geopier design does not include liquefaction mitigation. While our tight spacing of 6 ft o.c. will provide improved seismic performance and liquefaction mitigation it has not been included as part of the design. Therefore, we conservatively recommend that the structural design of the mat foundation accommodate the amount of potential liquefaction settlement discussed in the geotechnical report.

10. Geopier Northwest's revised letter should include the date with the signature and professional engineer's seal.

- RESPONSE: We have revised our submittal documents as requested.

We appreciate the opportunity to work with you on this project. If you have any questions or require further information, please call.

Sincerely,
Geopier Northwest Inc.



David Van Thiel, P.E., G.E.