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MEMORANDUM

DATE: June 9, 2023

TO: Mr. Brandon Spitzenberg

CC: Mr. Mark Wierenga

FROM: Khaled M. Shawish, PE
Lee S. Bellah

RE: Groundwater Monitoring Memorandum
Spitzenberg Grove Street Apartment Building Development
1902 Grove Street
Marysville, Washington
NGA File No. 1374822

KHALED M. SHAWISH STATE OF WASHINGTON 35215 REGISTERED PROFESSIONAL ENGINEER 6.09.2023

INTRODUCTION

This memo presents a summary of our groundwater monitoring at the proposed Spitzenberg Grove Street Apartment Building project located at **1902 Grove Street in Marysville, Washington**.

We previously prepared a geotechnical engineering evaluation for the project dated August 17, 2022. We have been requested to provide groundwater monitoring data to ensure the proposed infiltration systems meet Site Suitability Criteria 5 (SSC-5) per the 2019 Stormwater Management Manual for Western Washington (SWMMWW).

OBSERVATIONS

We previously installed two groundwater monitoring piezometers within Test Pits 1 and 4 within the site, as shown in Figure 2 in our previous geotechnical report. MW-1 and MW-2 were installed to a depth of 10.0 feet below the ground surface. We observed groundwater seepage during our explorations at the time the wells were installed on July 20, 2023. Subsequent groundwater elevation readings were taken on August 5, 2022, March 9, 2023 and April 5, 2023, Specific groundwater elevation readings can be found in Table 1 below.

Table 1: Groundwater Depth Readings

	Depth From Surface (Feet)	
Date	**TP-1/MW-1**	**TP-4/MW-2**
7/20/22	5.5	5.5
8/5/22	4.8	4.75
3/9/23	3.8	3.3
4/5/23	4.0	4.0

CONCLUSIONS AND OPINION

Based on our observations and subsequent groundwater monitoring readings we anticipate that the groundwater depth observations obtained from March 9, 2023 at depths of 3.8 and 3.3 feet below the ground surface within MW-1 and MW-2, respectively are likely the seasonal high groundwater elevations with the proposed development area and should not fluctuate significantly higher than these elevations.

The stormwater manual recommends a five-foot separation between the base of an infiltration system and any underlying bedrock, impermeable horizon, or groundwater. The separation of the proposed infiltration system and the seasonal high groundwater levels can be reduced to three feet provided additional analyses are performed. This is typically done with a mounding analysis to establish minimum separation criteria and to verify the proposed facility operation is viable for the native soils and design infiltration rate. NGA can provide these additional services if required at the request of the client as designs are finalized. The client should be aware that additional site characterization and analysis may be required for final infiltration facility design and municipal approval given the subsurface conditions encountered.

To provide the greatest separation from the seasonal high groundwater level, we recommend that any proposed infiltration systems consist of shallow systems such as rain gardens and/or bio-retention swales. We recommend that the base of the systems be as shallow as possible but should be founded within the native granular outwash soils encountered at relatively shallow depths throughout the site. Specific recommendations regarding these shallow infiltration systems are included in our previous report.

Site elevations could be raised to achieve adequate separation from the base of any proposed infiltration systems and the observed seasonal high groundwater elevation. Depending on final development plans and layout, fill areas could be strategically placed within proposed infiltration areas to minimize material import and grading activities. Any proposed infiltration systems should extend through the upper surficial topsoil and be founded within the native sand deposits, and any proposed fill placement should consist of clean, well-graded sand and gravel (pit run). The project civil engineer should be consulted to design the overall layout and specific drainage plans. We anticipate we will need to further evaluate the proposed systems and provide groundwater mounding analyses to confirm that the proposed systems will not be impacted by the seasonal high groundwater table. All other recommendations provided in our previous report should be strictly followed.

CLOSURE

We recommend that NGA be retained to review final project plans and to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities comply with contract plans and specifications.

We trust this memorandum should satisfy your needs at this time. Please contact us if you have any questions or require additional services.

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August 17, 2022

Mr. Brandon Spitzenberg
P.O. Box 27229
Seattle, WA 98165
Via Email: **bspitzenberg7@gmail.com**

Geotechnical Engineering Evaluation
Spitzenberg Grove Street Apartment Building Development
1902 Grove Street
Marysville, Washington
NGA File No. 1374822

Dear Mr. Spitzenberg:

We are pleased to submit the attached report titled **"Geotechnical Engineering Evaluation – Spitzenberg Grove Street Apartment Building Development – 1902 Grove Street – Marysville, Washington."** This report summarizes our observations of the existing surface and subsurface conditions within the site and provides general recommendations for the proposed site development. Our services were completed in general accordance with the proposal signed by you on July 1, 2022.

The property is currently occupied with two multi-family residence structures within the southwestern and southeastern portions of the property. The ground surface within the site is relatively level to gently sloping down from the north to the south. We understand that the proposed development will include removal of the existing site structures and construction of a new four-story apartment building within the southwestern portion of the property along with a paved driveway and parking area within the eastern portion of the property. The City of Marysville has requested a geotechnical report regarding the proposed development, and we have been requested to provide this report for geotechnical recommendations for development considerations.

We monitored the excavation of four trackhoe excavated test pits within the property. Our explorations indicated that the site was underlain by surficial undocumented fill and/or topsoil with competent, native outwash sand soils at depth.

We have concluded that the site was generally compatible with the planned development. We have recommended that the new structures be founded on the medium dense or better native glacial outwash soils for bearing capacity and settlement considerations. These soils should generally be encountered approximately one to two feet below the existing ground surface, based on our explorations. However, deeper areas of loose soil and/or undocumented fill could also exist within unexplored areas of the site.

Infiltration analysis in accordance with the Washington State Department of Ecology 2019 Stormwater Management Manual for Western Washington was also performed. The subsurface soils generally consisted of fine to medium sand with generally low silt content. Due to the granular nature of the site soils and the soils being classified as recessional outwash, infiltration rates were determined by performing grain size analyses on samples obtained at various depths throughout the site. Based on our laboratory analyses and the granular nature of the native outwash soils encountered throughout the site, it is our opinion that stormwater infiltration is feasible within this site.

In the attached report, we have also provided general recommendations for site grading, foundation support, slabs-on-grade, structural fill placement, erosion control, and drainage. We should be retained to review and comment on final development plans and observe the earthwork phase of construction. We also recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications.

It has been a pleasure to provide service to you on this project. Please contact us if you have any questions regarding this report or require further information.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Khaled M. Shawish, PE
Principal

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Spitzenberg Grove Street Apartment Building Development
1902 Grove Street
Marysville, Washington

INTRODUCTION

This report presents the results of our geotechnical engineering investigation and evaluation of the planned Spitzenberg Grove Street Apartment Building project. The project site is located at **1902 Grove Street in Marysville, Washington,** as shown on the Vicinity Map in Figure 1. The purpose of this study is to explore and characterize the site's surface and subsurface conditions and to provide geotechnical recommendations for the planned site development.

The property is currently occupied with two multi-family residence structures within the southwestern and southeastern portions of the property. The ground surface within the site is relatively level to gently sloping down from the north to the south. We understand that the proposed development will include removal of the existing site structures and construction of a new four-story apartment building within the southwestern portion of the property along with a paved driveway and parking area within the eastern portion of the property. The existing site layout and proposed building location are shown on the Site Plan in Figure 2.

At the time this report was prepared, no specific grading or stormwater plans were available. However, we understand that stormwater generated within this site will be directed to on-site infiltration systems, if feasible. We will evaluate the feasibility of stormwater infiltration within the site based on the Washington State Department of Ecology's 2019 Stormwater Management Manual for Western Washington. According to this manual, we understand that long-term design infiltration rates for this site can be determined from laboratory analyses of soil samples collected in the field since the soils underlying the site have not been consolidated by glacial advance.

We also understand that the City of Marysville will likely require monitoring of the underlying groundwater table within the property. As a result, we installed two groundwater piezometers to monitor the groundwater levels during the wet season months. These piezometers will be monitored periodically throughout the wet season or longer if deemed necessary as approved by the client.

SCOPE

The purpose of this study is to explore and characterize the site surface and subsurface conditions and provide general recommendations for site development.

Specifically, our scope of services included the following:

1. Review available soil and geologic maps of the area.
2. Explore the subsurface soil and groundwater conditions within the site with trackhoe-excavated test pits. Excavation services were provided by NGA.
3. Determine feasibility of on-site stormwater infiltration.
4. Provide long-term design infiltration rates based on grain-size analysis per the 2019 SWMMWW.
5. Analyze selected, representative soil samples obtained from our explorations for Cation Exchange Capacity (CEC) and organic content.
6. Install piezometers within the test pit explorations throughout the site. Well materials to be provided by NGA.
7. Provide recommendations for infiltration system installation.
8. Provide recommendations for site drainage and erosion control.
9. Provide recommendations for site preparation and earthwork.
10. Provide recommendations for foundation support.
11. Provide recommendations for temporary and permanent slopes, if needed.
12. Provide recommendations for slab and pavement subgrade preparation.
13. Document the results of our findings, conclusions, and recommendations in a written geotechnical report.
14. Provide monthly groundwater level monitoring during the rainy season months or longer as required by the City of Marysville, as requested.

SITE CONDITIONS

Surface Conditions

The site consists of an irregular-shaped parcel covering approximately 0.75 acres. The property is currently occupied with two multi-family residence structures within the southwestern and southeastern portions of the property. The ground surface within the site is relatively level to gently sloping down from the north to the south. The site is vegetated with grass yard areas, landscaping plants, sparse trees and underbrush. We did not observe surface water within the site during our site visit on July 20, 2022.

Subsurface Conditions

Geology: The geologic units for this area are shown on the Geologic Map of the Marysville Quadrangle, Snohomish County, Washington, by James P. Minard, et al. (USGS, 1985). The site is mapped as Marysville Sand (Qvrm). The Marysville Sand is described as well-drained, stratified to massive outwash sand with fine gravel, silt and clay. Our explorations generally encountered surficial topsoil underlain by fine to medium grained sand with varying amounts of silt consistent with the description of Marysville sand mapped in this area.

Explorations: The subsurface conditions within the site were explored on July 20, 2022 by excavating four test pits to approximate depths in the range of 7.5 to 8.0 feet below the existing ground surface using a mini-trackhoe. The approximate locations of our explorations are shown on the Site Plan in Figure 2. A geologist from NGA was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the test pits. The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 3. The logs of our test pits are attached to this report and are presented as Figures 4 and 5. We present a brief summary of the subsurface conditions in the following paragraph. For a detailed description of the subsurface conditions, the logs of the test pits should be reviewed. At the surface of all of our explorations, we generally encountered approximately 1.0 to 1.5 feet of surficial grass and topsoil. Underlying the surficial topsoil in all of our explorations, we encountered brown-gray, fine to medium sand with trace silt, which we interpreted as native outwash deposits. Test Pits 1 through 4 were terminated within the native outwash deposits at depths in the range of 7.5 to 8.0 feet below the existing ground surface.

Hydrogeologic Conditions

Moderate to heavy groundwater seepage was encountered in all of our explorations at a depth of 5.5 feet below the ground surface during our field evaluation on July 20, 2022. We installed piezometer monitoring wells within Test Pits 1 and 4 to monitor groundwater levels throughout the wet season. We monitored the groundwater levels again within the piezometers on August 5, 2022. We observed that groundwater levels within Test Pit 1 and Test Pit 4 were at 4.8 and 4.75 feet below the existing ground surface, respectively. We interpreted this groundwater to be associated with the regional groundwater table within the area. Based on our experience within the vicinity of the site, it is our opinion that the observed groundwater table varies slightly throughout the year and is greatly influenced by precipitation.

Due to the explorations being performed in the summer months, the City of Marysville will require that the groundwater levels within the piezometers be measured three times during the wet season months (November through April) to determine the seasonal high groundwater elevation within the site.

SENSITIVE AREA EVALUATION

Seismic Hazard

We reviewed the 2018 International Building Code (IBC) and the ASCE 7-16 for seismic site classification for this project. Since competent glacial outwash soils were encountered at depth within the subject site, the site conditions best fit the IBC description for Site Class D. Table 1 below provides seismic design parameters for the site that are in conformance with the 2018 IBC, which specifies a design earthquake having a two percent probability of occurrence in 50 years (return interval of 2,475 years), and the 2014 USGS seismic hazard maps.

Table 1 – ASCE 7-16 Seismic Design Parameters

Site Class	Spectral Acceleration at 0.2 sec. (g) S_s	Spectral Acceleration at 1.0 sec. (g) S_1	Site Coefficients		Design Spectral Response Parameters	
			F_a	F_v	S_{DS}	S_{D1}
D	1.113	0.396	1.055	Null	0.783	Null

The spectral response accelerations were obtained from the USGS Earthquake Hazards Program Interpolated Probabilistic Ground Motion website (2014 data) for the project latitude and longitude. Hazards associated with seismic activity include liquefaction potential and amplification of ground motion. Liquefaction is caused by a rise in pore pressures in a loose, fine sand deposit beneath the groundwater table. It is our opinion that the medium dense or better native glacial outwash deposits interpreted to underlie the site have a low potential for liquefaction or amplification of ground motion.

Erosion Hazard

The criteria used for determination of the erosion hazard for affected areas include soil type, slope gradient, vegetation cover, and groundwater conditions. The erosion sensitivity is related to vegetative cover and the specific surface soil types, which are related to the underlying geologic soil units. The Soil Survey of Snohomish County Area, Washington by the Natural Resources Conservation Service (NRCS), classifies the site as Lynnwood loamy sand, 0 to 3 percent slopes. Based on our experience in the area and our observations in the field, it is our opinion that the site would have a slight to moderate erosion hazard for areas where the soils are exposed. It is our opinion that the erosion hazard for site soils should be low in areas where vegetation is not disturbed.

LABORATORY ANALYSIS

Grain-size Analysis: We performed two grain-size distribution analyses on soil samples obtained from Test Pits 1 and 4 at a depth of 3.0 and 3.5 feet below the existing ground surface, respectively. In general, the soils tested are classified as sand with trace amounts of silt. The results of the grain-size analysis are presented in Figures 5 and 6.

Water Quality Chemical Testing: In accordance with the 2019 SWMMWW infiltration facilities that double as treatment facilities will need to be tested for Cation Exchange Capacity (USEPA method 9081) and Organic Content (ASTM D 2974) to determine if the soil is adequate for removing the target pollutants. Cation Exchange Capacity (CEC) and Organic Content tests were conducted by AMTest Laboratories on soil samples obtained from the site as shown on Tables 1 and 2 below, respectively. The 2019 SWMMWW requires soil to be used for treatment to have a CEC greater or equal to 5 milliequivalents (meq) CEC per 100 grams (CEC/100g). The manual also specifies that filtration soils must have a minimum of 1.0 percent organic content. Based on the test results, the native outwash soils meet the minimum organic content requirements, but do not meet the minimum CEC requirements for use as filtration soils. The test results are attached to this report as Appendix A. The test results are also summarized in the following Tables 1 and 2.

Table 1. Cation Exchange Capacity Results

Test Pit Number	Depth (Feet)	Cation Test Results (CEC/100g)	Suitable for Filtration (Yes/No)
Test Pit 1	3.0	3.4	No
Test Pit 4	3.5	3.6	No

Table 2. Organic Content Results

Test Pit Number	Depth (Feet)	Organic Content Results (Percent)	Suitable for Filtration (Yes/No)
Test Pit 1	3.0	1.2	Yes
Test Pit 4	3.5	1.8	Yes

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion from a geotechnical standpoint that the site planned development is feasible. Our explorations indicated that the site was underlain by surficial undocumented fill soils with competent glacial outwash soils at relatively shallow depths throughout the site. The native glacial outwash soils should provide adequate support for foundation, slab, and pavement loads. We recommend that the new structures be designed utilizing shallow foundations. Footings should extend through any loose soil and be founded on the underlying medium dense or better native bearing soil, or structural fill extending to these soils. The competent soil should typically be encountered approximately two feet below the existing surface. We should note that deeper areas of unsuitable soils and/or undocumented fill could be encountered in the unexplored areas of the site. This condition, if encountered, would require deeper excavations in foundation, slab, and pavement areas to remove the unsuitable soils.

It is our opinion that the native granular outwash soils encountered at depth within our explorations are suitable for stormwater infiltration. The City of Marysville utilizes the 2019 Washington State Department of Ecology Stormwater Management Manual for Western Washington to determine long-term design infiltration rates for the site. In accordance with the manual, laboratory analysis of soil samples collected in the field as well as onsite testing can be used to determine the infiltration system design as well as long-term design infiltration rates due to the site being located within outwash type soils that have not been glacially overridden. We performed two grain-size analyses in accordance with the manual to determine the infiltration capabilities of the site soils. Based on our observations and testing, we recommend that a long-term design infiltration rate of no more than ten inches/hour be used in the design of the stormwater handling systems within this site. We have included details of our on-site infiltration testing in the **Infiltration Testing** subsection of this report. Any proposed infiltration systems also utilized as water-quality filtration systems may need to be amended in order to satisfy the cation exchange capacity requirements. If the on-site soil is amended to satisfy this requirement, it should be retested to confirm infiltration rates.

We did encounter the regional groundwater table at approximately 5.5 feet below the existing ground surface during our site visit on July 20, 2022 and between approximately 4.75 and 4.8 feet below the existing ground surface on August 5, 2022. Based on our experience within the vicinity of the site, it is our opinion that the observed groundwater table is greatly influenced by precipitation and varies slightly throughout the year.

Based on our observations within our explorations and experience in the nearby vicinity, it is our opinion that the seasonal high groundwater table may be as shallow as 3.0 to 4.0 feet below the existing ground surface. However, this would need to be verified by monitoring the groundwater levels during the wet season. As such, we have installed groundwater piezometers in Test Pits 1 and 4 in order to monitor the groundwater level during the wetter period of the year. Due to the explorations being performed in the summer months, the City of Marysville will require that the groundwater levels within the piezometers be measured three times during the wet season months (November through April) to determine the seasonal high groundwater elevation within the site.

The stormwater manual recommends a five-foot separation between the base of an infiltration system and any underlying bedrock, impermeable horizon, or groundwater. The separation of the proposed infiltration system and the seasonal high groundwater levels can be reduced to three feet provided additional analyses are performed. This is typically done with a mounding analysis to establish minimum separation criteria and to verify the proposed facility operation is viable for the native soils and design infiltration rate. NGA can provide these additional services if required at the request of the client as designs are finalized. The client should be aware that additional site characterization and analysis may be required for final infiltration facility design and municipal approval given the subsurface conditions encountered.

To provide the greatest separation from the seasonal high groundwater level, we recommend that any proposed infiltration systems consist of shallow systems such as rain gardens and/or bio-retention swales. We recommend that the base of the systems be as shallow as possible but should be founded within the native granular outwash soils encountered at relatively shallow depths throughout the site. Specific recommendations regarding these shallow infiltration systems are included in the Shallow Infiltration System Design subsection of this report.

Site elevations could be raised to achieve adequate separation from the base of any proposed infiltration systems and the observed seasonal high groundwater elevation. Depending on final development plans and layout, fill areas could be strategically placed within proposed infiltration areas to minimize material import and grading activities. Any proposed infiltration systems should extend through the upper surficial topsoil and be founded within the native sand deposits. The project civil engineer should be consulted to design the overall layout and specific drainage plans. We anticipate we will need to further evaluate the proposed systems and provide groundwater mounding analyses to confirm that the proposed systems will not be impacted by the seasonal high groundwater table.

The surficial soils encountered on this site are considered moisture-sensitive and may disturb easily when wet. We recommend that construction take place during the drier summer months, if possible. If construction is to take place during wet weather, the soils may disturb, and additional expenses and delays should be expected due to the wet conditions. Additional expenses could include the need for placing a blanket of rock spalls to protect exposed subgrades and construction traffic areas. Some of the native granular on-site soils may be suitable for use as structural fill depending on the moisture content of the soil during construction. This will depend on the moisture content of the soils at the time of construction. NGA should be retained to determine if the on-site soils can be used as structural fill material during construction.

Erosion Control

The erosion hazard for the on-site soils is interpreted to be slight to moderate for exposed soils, but actual erosion potential will be dependent on how the site is graded and how water is allowed to concentrate. Best Management Practices (BMPs) should be used to control erosion. Areas disturbed during construction should be protected from erosion. Erosion control measures may include diverting surface water away from the stripped or disturbed areas. Silt fences and/or straw bales should be erected to prevent muddy water from leaving the site. Disturbed areas should be planted as soon as practical, and the vegetation should be maintained until it is established. The erosion potential of areas not stripped of vegetation should be low.

Site Preparation and Grading

After erosion control measures are implemented, site preparation should consist of removing loose soils, topsoil, and any undocumented fill from foundations, slab, and pavement areas, to expose medium dense or better native glacial bearing soils at depth. The stripped soil should be removed from the site or stockpiled for later use as a landscaping fill. Based on our observations, we anticipate native, medium dense or better soil to be encountered at approximately two feet across the site. We recommend that if loose soils are encountered at the foundation subgrades exposing native granular outwash soils, that the subgrade be compacted to a non-yielding condition using a vibratory roller or a heavy plate compactor. We should note that deeper areas of unsuitable soils and/or undocumented fill could be encountered in the unexplored areas of the site. This condition, if encountered, would require deeper excavations in foundation, slab, and pavement areas to remove the unsuitable soils.

After site preparation, if the exposed subgrade is deemed loose, it should be compacted to a non-yielding condition and then proof-rolled with a heavy rubber-tired piece of equipment. Areas observed to pump or weave during the proof-roll test should be reworked to structural fill specifications or over-excavated and replaced with properly compacted structural fill or rock spalls. If loose soils are encountered in the foundation areas, the loose soils should be removed and replaced with rock spalls. If significant surface water flow is encountered during construction, this flow should be diverted around areas to be developed, and the exposed subgrades should be maintained in a semi-dry condition.

If wet conditions are encountered, alternative site grading techniques might be necessary. These techniques could include using large excavators equipped with wide tracks and a smooth bucket to complete site grading and covering exposed subgrade with a layer of crushed rock for protection. If wet conditions are encountered or construction is attempted in wet weather, the subgrade should not be compacted, as this could cause further subgrade disturbance. In wet conditions, it may be necessary to cover the exposed subgrade with a layer of crushed rock as soon as it is exposed to protect the moisture sensitive soils from disturbance by machine or foot traffic during construction. The prepared subgrade should be protected from construction traffic and surface water should be diverted around areas of prepared subgrade.

Temporary and Permanent Slopes

Temporary cut slope stability is a function of many factors, including the type and consistency of soils, depth of the cut, surcharge loads adjacent to the excavation, length of time a cut remains open, and the presence of surface or groundwater. It is exceedingly difficult under these variable conditions to estimate a stable, temporary, cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations at all times as indicated in OSHA guidelines for cut slopes. The following information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Nelson Geotechnical Associates, Inc. assumes responsibility for job site safety. Job site safety is the sole responsibility of the project contractor.

For planning purposes, we recommend that temporary cuts in the on-site soils be no steeper than 2 Horizontal to 1 Vertical (2H:1V). If significant groundwater seepage or surface water flow were encountered, we would expect that flatter inclinations would be necessary. We recommend that excavations below the water table be limited if possible. Any proposed excavations below the water table will require temporary shoring in the form of trench boxes along with dewatering. This should be determined during final design based on depths and location of deeper excavations.

We recommend that cut slopes be protected from erosion. The slope protection measures may include covering cut slopes with plastic sheeting and diverting surface runoff away from the top of cut slopes. We do not recommend vertical slopes for cuts deeper than four feet, if worker access is necessary. We recommend that cut slope heights and inclinations conform to appropriate OSHA/WISHA regulations. Permanent cut and fill slopes should be no steeper than 3H:1V. However, flatter inclinations may be required in areas where loose soils are encountered. Permanent slopes should be vegetated, and the vegetative cover maintained until established.

Foundations

Conventional shallow spread foundations should be placed on medium dense or better native bearing soils or be supported on structural fill or rock spalls extending to those soils. Medium dense soils should be encountered approximately two feet below ground surface based on our explorations. Where undocumented fill or less dense soils are encountered at footing bearing elevation, the subgrade should be over-excavated to expose suitable bearing soil. The over-excavation may be filled with structural fill, or the footing may be extended down to the competent native soils. If footings are supported on structural fill, the fill zone should extend outside the edges of the footing a distance equal to one half of the depth of the over-excavation below the bottom of the footing.

Footings should extend at least 18 inches below the lowest adjacent finished ground surface for frost protection and bearing capacity considerations. Foundations should be designed in accordance with the 2018 IBC. Footing widths should be based on the anticipated loads and allowable soil bearing pressure. Water should not be allowed to accumulate in footing trenches. All loose or disturbed soil should be removed from the foundation excavation prior to placing concrete.

For foundations constructed as outlined above, we recommend an allowable bearing pressure of not more than 2,000 pounds per square foot (psf) be used for the design of footings founded on the medium dense or better native bearing soils or structural fill extending to the competent native bearing material. The foundation bearing soil should be evaluated by a representative of NGA. We should be consulted if higher bearing pressures are needed. Current IBC guidelines should be used when considering increased allowable bearing pressure for short-term transitory wind or seismic loads. Potential foundation settlement using the recommended allowable bearing pressure is estimated to be less than 1-inch total and ½-inch differential between adjacent footings or across a distance of about 20 feet, based on our experience with similar projects.

Lateral loads may be resisted by friction on the base of the footing and passive resistance against the subsurface portions of the foundation. A coefficient of friction of 0.35 may be used to calculate the base friction and should be applied to the vertical dead load only. Passive resistance may be calculated as a triangular equivalent fluid pressure distribution. An equivalent fluid density of 200 pounds per cubic foot (pcf) should be used for passive resistance design for a level ground surface adjacent to the footing. This level surface should extend a distance equal to at least three times the footing depth. These recommended values incorporate safety factors of 1.5 and 2.0 applied to the estimated ultimate values for frictional and passive resistance, respectively. To achieve this value of passive resistance, the foundations should be poured "neat" against the native medium dense soils or compacted fill should be used as backfill against the front of the footing. We recommend that the upper one foot of soil be neglected when calculating the passive resistance.

Structural Fill

General: Fill placed beneath foundations, pavement, or other settlement-sensitive structures should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards, and is monitored by an experienced geotechnical professional or soils technician. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The area to receive the fill should be suitably prepared as described in the **Site Preparation and Grading** subsection prior to beginning fill placement. Sloping areas to receive fill should be benched using a minimum 8-foot-wide horizontal benches into competent soils.

Materials: Structural fill should consist of a good quality, granular soil, free of organics and other deleterious material, and be well graded to a maximum size of about three inches. All-weather fill should contain no more than five-percent fines (soil finer than U.S. No. 200 sieve, based on that fraction passing the U.S. 3/4-inch sieve). Some of the more granular on-site soils may be suitable for use as structural fill depending on the moisture content of the soil during construction. We should be retained to evaluate all proposed structural fill material prior to placement.

Fill Placement: Following subgrade preparation, placement of structural fill may proceed. All filling should be accomplished in uniform lifts up to eight inches thick. Each lift should be spread evenly and be thoroughly compacted prior to placement of subsequent lifts. All structural fill underlying building areas and pavement subgrade should be compacted to a minimum of 95 percent of its maximum dry density. Maximum dry density, in this report, refers to that density as determined by the ASTM D-1557 Compaction Test procedure.

The moisture content of the soils to be compacted should be within about two percent of optimum so that a readily compactable condition exists. It may be necessary to over-excavate and remove wet soils in cases where drying to a compactable condition is not feasible. All compaction should be accomplished by equipment of a type and size sufficient to attain the desired degree of compaction and should be tested.

Slab-on-Grade

Slabs-on-grade should be supported on subgrade soils prepared as described in the **Site Preparation and Grading** subsection of this report. We recommend that all floor slabs be underlain by at least six inches of free-draining gravel with less than three percent by weight of the material passing Sieve #200 for use as a capillary break. A suitable vapor barrier, such as heavy plastic sheeting (6-mil minimum), should be placed over the capillary break material. An additional 2-inch-thick moist sand layer may be used to cover the vapor barrier. This sand layer is optional and is intended to be used to protect the vapor barrier membrane and to aid in curing the concrete.

Pavements

Pavement subgrade preparation and structural filling where required, should be completed as recommended in the **Site Preparation and Grading** and **Structural Fill** subsections of this report. The pavement subgrade should be proof-rolled with a heavy, rubber-tired piece of equipment, to identify soft or yielding areas that require repair. The pavement section should be underlain by a minimum of six inches of clean granular pit run or crushed rock. We should be retained to observe the proof-rolling and recommend subgrade repairs prior to placement of the asphalt or hard surfaces.

Utilities

We recommend that underground utilities be bedded with a minimum six inches of pea gravel prior to backfilling the trench with on-site or imported material. Trenches within settlement sensitive areas should be compacted to 95% of the modified proctor as described in the **Structural Fill** subsection of this report. Trenches located in non-structural areas should be compacted to a minimum 90% of the maximum dry density. Utility excavations below the water table will require temporary shoring in the form of trench boxes and also dewatering. This should be determined during final design based on depths and locations of underground utilities. Trench backfill compaction should be tested.

Infiltration Testing

General: We performed two grain-size analyses on selected soil samples obtained within the site in accordance with the 2019 Washington State Department of Ecology (WSDOE) Stormwater Management Manual for Western Washington. Laboratory tests were performed on samples taken from Test Pit 1 and 4 at 3.0 and 3.5 feet below the existing ground surface, respectively. The results of the sieve analyses are presented as Figures 5 and 6. Based on the laboratory analysis, the soils encountered in our explorations within the proposed infiltration area meet the classification of sand in the USDA Textural Triangle.

An equation provided in Section V-5.4 of the 2019 WSDOE Stormwater Management Manual for Western Washington was used to determine the infiltration capabilities of the site soil utilizing data from the grain-size analyses. Based on this equation and information obtained from the grain-size analyses, initial short-term infiltration rates in the range of 72.2 to 90.03 inches/hour were calculated. We also referenced Table V-5.1 of the manual to provide an adequate correction factor to infiltration rates obtained from the above equation to calculate a long-term design rate. Correction factors of 0.80, 0.40, and 0.90 were utilized in this equation for CFv, CFt, CFm, respectively. We applied the correction factors to the most conservative rate obtained from the grain-size analysis calculations which is 72.2 inches/hour and computed a long-term design infiltration rate of 20.80 inches per hour. However, we recommend a maximum long-term design infiltration rate of 10 inches per hour be utilized to design on-site infiltration systems founded within the native granular outwash soils encountered at shallow depths throughout the property. We recommend that any infiltration system be extended down through the surficial soils and founded within the native granular outwash soils at depth. Based on our explorations, the native granular outwash soils should be encountered at approximately two feet below the existing ground surface. We should be retained during construction to evaluate the soils exposed in the infiltration systems to verify that the soils are appropriate for infiltration.

We did encounter the regional groundwater table at approximately 5.5 feet below the existing ground surface during our site visit on July 20, 2022 and between approximately 4.75 and 4.8 feet below the existing ground surface on August 5, 2022. The stormwater manual recommends a five-foot separation between the base of an infiltration system and any underlying bedrock, impermeable horizon, or groundwater. It is our opinion that any observed groundwater within the site is associated with the regional groundwater table.

Based on our experience within the vicinity of the site, it is our opinion that the observed groundwater table is greatly influenced by precipitation and varies slightly throughout the year. Based on our observations within our explorations and experience in the nearby vicinity, it is our opinion that the seasonal high groundwater table may be as shallow as 3.0 to 4.0 feet below the existing ground surface. However, this would need to be verified by monitoring the groundwater levels during the wet season months (November through April). As such, we have installed groundwater piezometers in Test Pits 1 and 4 in order to monitor the groundwater level during the wetter period of the year. Due to the explorations being performed in the summer months, the City of Marysville will require that the groundwater levels within the piezometers be measured three times during the wet season months to determine the seasonal high groundwater elevation within the site.

The stormwater manual recommends a five-foot separation between the base of an infiltration system and any underlying bedrock, impermeable horizon, or groundwater. The separation of the proposed infiltration system and the seasonal high groundwater levels can be reduced to three feet provided additional analyses are performed. This is typically done with a mounding analysis to establish minimum separation criteria and to verify the proposed facility operation is viable for the native soils and design infiltration rate. NGA can provide these additional services if required at the request of the client as designs are finalized. The client should be aware that additional site characterization and analysis may be required for final infiltration facility design and municipal approval given the subsurface conditions encountered.

To provide the greatest separation from the seasonal high groundwater level, we recommend that any proposed infiltration systems consist of shallow systems such as rain gardens and/or bio-retention swales. We recommend that the base of the systems be as shallow as possible but should be founded within the native granular outwash soils encountered at relatively shallow depths throughout the site.

Site elevations could also be raised to achieve adequate separation from the base of any proposed infiltration systems and the observed seasonal high groundwater elevation. Depending on final development plans and layout, fill areas could be strategically placed within proposed infiltration areas to minimize material import and grading activities. Any proposed infiltration systems should extend through the upper surficial topsoil and fill to be founded within the native sand deposits at depth. The project civil engineer should be consulted to design the overall layout and specific drainage plans. We anticipate we will need to further evaluate the proposed systems and provide groundwater mounding analyses to confirm that the proposed systems will not be impacted by the seasonal high groundwater table.

The cation exchange capacity (CEC) of the on-site soils was also evaluated but found to be below the minimum value required by the design manual. Onsite soils utilized for filtration purposes may need to be amended to meet minimum CEC requirements. This will require a re-evaluation of the amended soils to verify infiltration rates.

Site Drainage

Surface Drainage: The finished ground surface should be graded such that stormwater is directed to an appropriate stormwater collection system. Water should not be allowed to stand in any areas where footings, slabs, or pavements are to be constructed. Final site grades should allow for drainage away from the proposed structures. We suggest that the finished ground be sloped at a minimum downward gradient of three percent, for a distance of at least 10 feet away from the proposed structures. Surface water should be collected by permanent catch basins and drain lines and be discharged into an approved discharge system; however, the infiltration rates should be confirmed during installation if soil amendment is proposed.

Subsurface Drainage: If groundwater is encountered during construction, we recommend that the contractor slope the bottom of the excavation and collect the water into ditches and small sump pits where the water can be pumped out and routed into a permanent storm drain. We recommend the use of footing drains around the structures. Footing drains should be installed at least one foot below planned finished floor elevation. The drains should consist of a minimum 4-inch-diameter, rigid, slotted or perforated, PVC pipe surrounded by free-draining material wrapped in a filter fabric. We recommend that the free-draining material consist of an 18-inch-wide zone of clean (less than three-percent fines), granular material placed along the back of walls. Pea gravel is an acceptable drain material. The free-draining material should extend up the wall to one foot below the finished surface. The top foot of backfill should consist of impermeable soil placed over plastic sheeting or building paper to minimize surface water or fines migration into the footing drain. Footing drains should discharge into tightlines leading to an approved collection and discharge point with convenient cleanouts to prolong the useful life of the drains. Roof drains should not be connected to wall or footing drains.

CONSTRUCTION MONITORING

We should be retained to provide construction monitoring services during the earthwork phase of the project to evaluate subgrade conditions, temporary cut conditions, fill compaction, and drainage system installation.

USE OF THIS REPORT

NGA has prepared this report for **Mr. Brandon Spitzenberg** and his agents, for use in the planning and design of the development on this site only. The scope of our work does not include services related to construction safety precautions and our recommendations are not intended to direct the contractors' methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. There are possible variations in subsurface conditions between the explorations and also with time. Our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions. A contingency for unanticipated conditions should be included in the budget and schedule.

We recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

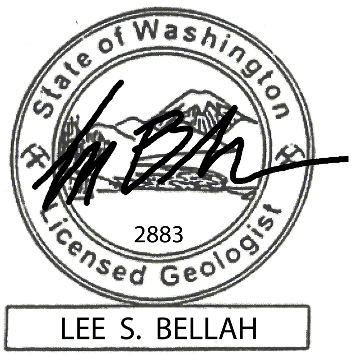
Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this report was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

o-o-o

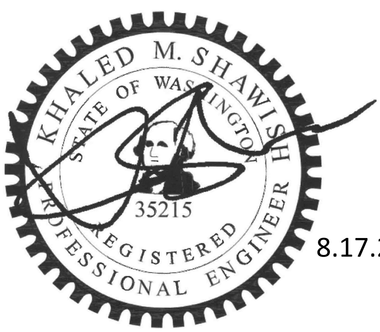
It has been a pleasure to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.



Lee S. Bellah, LG
Senior Geologist



8.17.2022

Khaled M. Shawish, PE
Principal Engineer

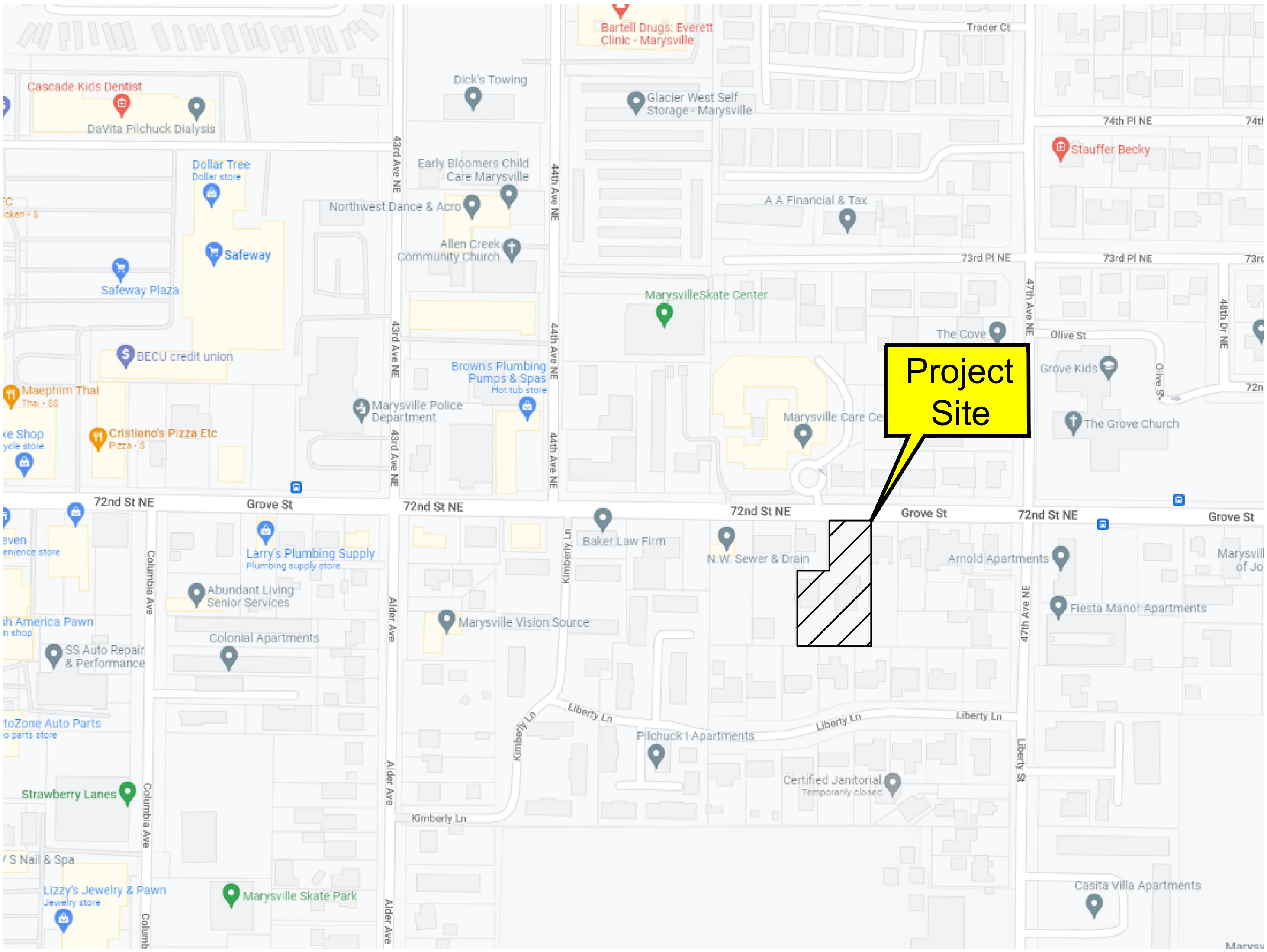
LSB:KMS:dy

Attachments: Six Figures
Appendix A

VICINITY MAP

Not to Scale

N



Marysville, WA

Project Number	Spitzenberg Grove Street Apartment Building Development Vicinity Map	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
1374822		Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510	1	8/5/22	Original	LSB	KMS
Figure 1		Wenatchee Office 105 Palouse St. Wenatchee, WA 98801 (509) 665-7696 / Fax: 665-7692					
		www.nelsongeotech.com					

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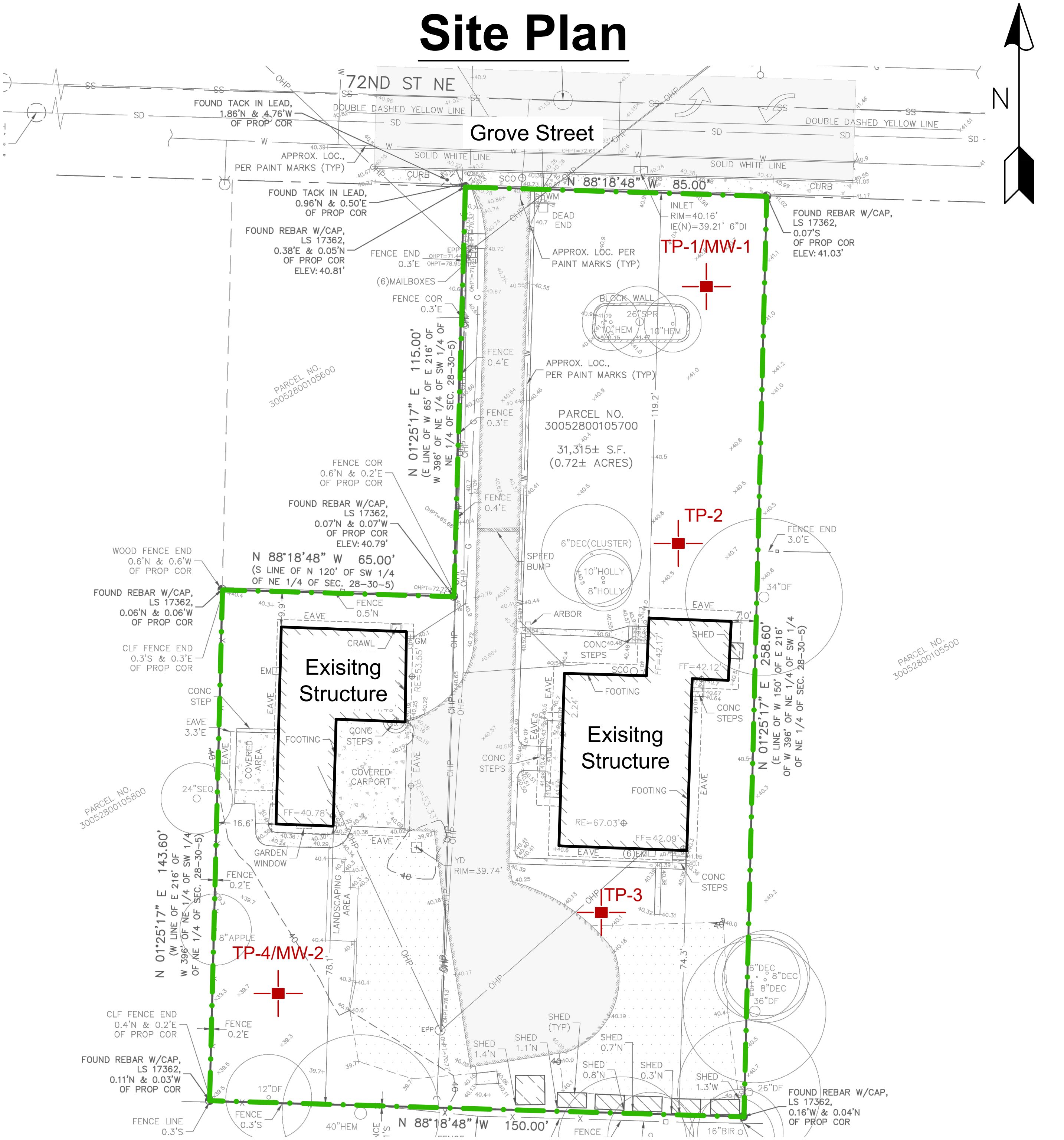
Site Plan



LEGEND

Property line

TP-1 — Number and approximate location of test pit

TP-1/MW-1 — Number and approximate location of test pit and monitoring well

0 40 80

Scale: 1 inch = 40 feet

Reference: Site Plan based on a plan dated April 1, 2022 titled "Topographic Survey - 1902 Grove St," prepared by BBA Land Surveying.

Project Number	Spitzenberg Grove Street Apartment Building Development Site Plan	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
1374822		Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510; Wenatchee Office 105 Palouse St. Wenatchee, WA 98801 (509) 665-7696 / Fax: 665-7692; www.nelsongeotech.com	1	8/5/22	Original	LSB	LSB
Figure 2							

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UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 % OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.

2) Soil classification using laboratory tests is based on ASTM D 2488-93.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water.

Wet - Visible free water or saturated, usually soil is obtained from below water table

Project Number	Spitzenberg Grove Street Apartment Building Development Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
1374822			1	8/5/22	Original	LSB	KMS
Figure 3							

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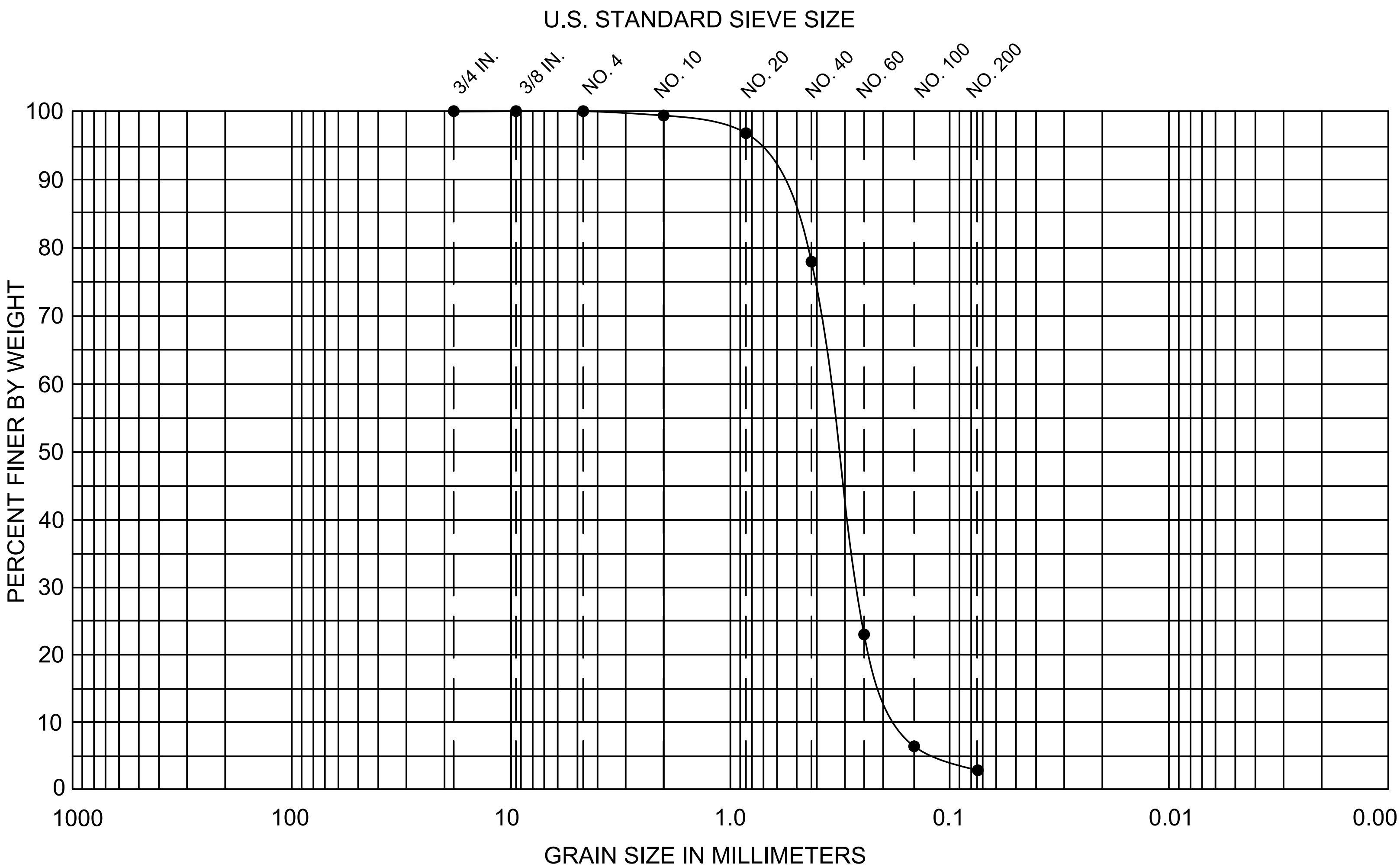
LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT ONE		
0.0 – 1.0		GRASS/TOPSOIL
1.0 – 8.0	SP	GRAY-BROWN, FINE TO MEDIUM SAND WITH TRACE SILT (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLES WERE COLLECTED AT 3.0, AND 6.0 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 5.5 FEET TEST PIT CAVING WAS ENCOUNTERED BETWEEN 5.5 AND 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 7/20/22
TEST PIT TWO		
0.0 – 1.0		GRASS/TOPSOIL
1.0 – 7.5	SP	GRAY-BROWN, FINE TO MEDIUM SAND WITH TRACE SILT (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLES WERE COLLECTED AT 3.0, AND 6.5 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 5.5 FEET TEST PIT CAVING WAS ENCOUNTERED BETWEEN 5.5 AND 7.5 FEET TEST PIT WAS COMPLETED AT 7.5 FEET ON 7/20/22
TEST PIT THREE		
0.0 – 1.0		GRASS/TOPSOIL
1.0 – 8.0	SP	GRAY-BROWN, FINE TO MEDIUM SAND WITH TRACE SILT (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLES WERE COLLECTED AT 3.5, AND 6.0 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 5.5 FEET TEST PIT CAVING WAS ENCOUNTERED AT BETWEEN 5.5 AND 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 7/20/22
TEST PIT FOUR		
0.0 – 1.0		GRASS/TOPSOIL
1.0 – 8.0	SP	GRAY-BROWN, FINE TO MEDIUM SAND WITH TRACE SILT (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLES WERE COLLECTED AT 3.0, AND 6.0 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 5.5 FEET TEST PIT CAVING WAS ENCOUNTERED BETWEEN 5.5 AND 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 7/20/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP	TP-1	3.0 feet	Fine to medium sand with trace silt	Gravel = 0% Sand = 97% Silt/Clay = 3%

Project Number
1374822
Figure 5

Spitzenberg Grove Street
Apartment Building
Development
Sieve Analysis

NELSON GEOTECHNICAL
ASSOCIATES, INC
Woodinville Office
17311-135th Ave. NE, A-500
Woodinville, WA 98072
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Wenatchee Office
105 Palouse St.
Wenatchee, WA 98801
(509) 665-7696 / Fax: 665-7692
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No.	Date	Revision	By	CK
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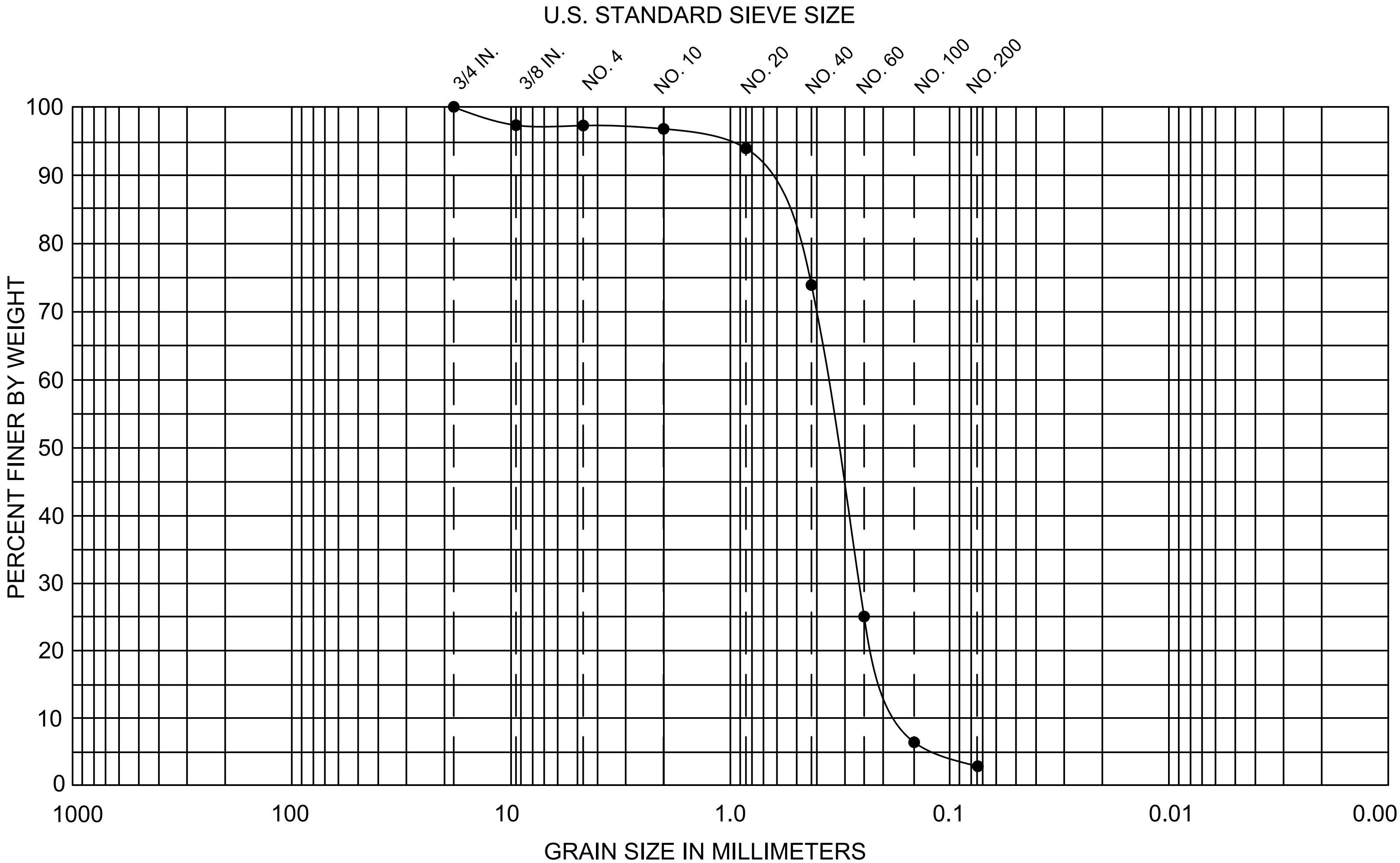

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP	TP-4	3.5 feet	Fine to medium sand with trace silt	Gravel = 20% Sand = 95% Silt/Clay = 3%

Project Number
1374822

Figure 6

Spitzenberg Grove Street
Apartment Building
Development
Sieve Analysis

NELSON GEOTECHNICAL ASSOCIATES, INC

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Woodinville, WA 98072
(425) 486-1669 / Fax: 481-2510

Wenatchee Office
105 Palouse St.
Wenatchee, WA 98801
(509) 665-7696 / Fax: 665-7692

www.nelsongeotech.com

No.	Date	Revision	By	CK
1	8/5/22	Original	LSB	LSB

APPENDIX A

Cation Exchange Capacity (CEC) and Organic Content Laboratory Test Results

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

NELSON GEOTECH
17311 135TH AVE NE
WOODINVILLE, WA 98072
Attention: LEE BELLAH
Project Name: SPITZENBERG RESDEV
Project #: 1374822
All results reported on an as received basis.

Date Received: 07/26/22
Date Reported: 8/ 1/22

AMTEST Identification Number **22-A012515**
Client Identification **TEST PIT 1 @3.0 FT**
Sampling Date **07/26/22, 09:00**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	3.4	meq/100g		0.5	SW-846 9081	CM	07/28/22

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Organic Matter	1.2	%			SM 2540G	KF	07/27/22

NELSON GEOTECH
Project Name: SPITZENBERG RESDEV
AmTest ID: 22-A012516

AMTEST Identification Number **22-A012516**
Client Identification **TEST PIT 4 @3.5 FT**
Sampling Date **07/26/22, 09:00**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	3.6	meq/100g		0.5	SW-846 9081	CM	07/28/22

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Organic Matter	1.8	%			SM 2540G	KF	07/27/22

Kathy Fugiel
President