NELSON GEOTECHNICAL ASSOCIATES, INC.

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June 27, 2022

Jennifer Hsiao
VIA Email: jhsiao168@msn.com

Geotechnical Engineering Evaluation
Hsiao Short Plat Development
4100 – 81st Place NE
Marysville, Washington 98270
NGA File No. 1368322

Dear Jennifer:

We are pleased to submit the attached report titled **"Geotechnical Engineering Evaluation – Hsiao Short Plat Development – 4100 - 81st Place NE – 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 May 10, 2022.

Two combined rectangular parcels form an irregularly-shaped site that covers approximately 1.14 acres in area. It is currently vacant and undeveloped land that is located east of Damascus Road Church. The property is bordered by 81st Place NE to the north, by Damascus Road Church to the west, and by existing residential development on all other sides. Topographically, the site is relatively level. We understand the plans for development include short-platting the site to form five new lots, including the construction of new residences on each lot. We have been requested to provide this report for determination of geological hazards that may be affecting the site, as well as development considerations for the proposed site development. We also understand that stormwater generated within the property may be directed to onsite infiltrations systems, if feasible.

We monitored the excavation of five trackhoe excavated test pits at the site on May 20, 2022. Our explorations indicated that the site was underlain by surficial undocumented fill with competent, native outwash sand soils at depth.

We have concluded that the site is generally compatible with the planned development. We have recommended that the new residences be founded on the medium dense native outwash soils for bearing capacity and settlement considerations. These soils should generally be encountered approximately two to four 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 light brown to gray, 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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Geotechnical Engineering Evaluation
Hsiao Short Plat Development
4100 – 81st Place NE
Marysville, Washington

INTRODUCTION

This report presents the results of our geotechnical engineering investigation and evaluation of the planned Hsiao Short Plat Development project. The project site is located at **4100 – 81st Place NE 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 parcel number for the affected properties are 00550600001200, -013-00, and -003-147-00.

The two combined rectangular parcel forms an irregularly-shaped site that covers approximately 1.14 acres in area. It is currently vacant and undeveloped land that is located east of Damascus Road Church. The property is bordered by 81st Place NE to the north, by Damascus Road Church to the west, and by existing residential development on all other sides. Topographically, the site is relatively level. We understand the plans for development include short-platting the site to form five new lots, including the construction of new residences on each lot.

Specific grading and stormwater plans have not been developed, but we understand that stormwater may be directed to on-site infiltration systems, if feasible. We have been requested to evaluate the infiltration capacity of the site soils. We will collect samples and determine the infiltration rate based on the Department of Ecology's 2019 Stormwater Management Manual for Western Washington (2019 SWMMWW), utilized by the City of Marysville. According to this manual, we understand that long-term design infiltration rates for this site can be determined by performing grain size analyses.

For our use in preparing this report, we were provided with a survey site plan titled "Boundary and Topographic Survey for Jennifer Hsiao," dated April 29, 2022 and prepared by James Watkins. We were also provided with a Draft Revision 3 of the proposed 5-lot short plat layout dated June 3, 2022.

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. Reviewing available soil and geologic maps of the area.
2. Exploring the subsurface soil and groundwater conditions within the site using trackhoe-excavated test pits. Excavation services to be subcontracted by NGA.
3. Installing piezometers in at least two test pits to monitor seasonal groundwater levels, as needed.
4. Providing long-term design infiltration rates based on laboratory grain size sieve analyses per the 2019 SWMMWW, if feasible.
5. Providing recommendations for earthwork and foundation support.
6. Providing recommendations for retaining walls.
7. Providing recommendations for temporary and permanent slopes.
8. Providing recommendations for subsurface utilities and pavement subgrade preparation.
9. Providing general recommendations for site drainage and erosion control.
10. Documenting the results of our findings, conclusions, and recommendations in a written geotechnical report.

SITE CONDITIONS

Surface Conditions

The combined rectangular parcel forms an irregularly-shaped site that covers approximately 1.14 acres in area. It is currently vacant and undeveloped land that is located east of Damascus Road Church. The property is bordered by 81st Place NE to the north, by Damascus Road Church to the west, and by existing residential development on all other sides. Topographically, the site is relatively level. We observed some gravel surfacing near the road, and irrigation control boxes within the site; however, no other signs of disturbance were noted. We did not observe surface water within the site during our site visit on May 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 undocumented fill 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 May 20, 2022 by excavating five test pits to approximate depths of 10 to 11 feet below the existing ground surface using a 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 Figure 4. 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. We installed two monitoring wells MW-1 and MW-2 within Test Pit One and Test Pit Three, respectively.

Undocumented Fill/Topsoil: Stratigraphy encountered was generally the same across the site. We encountered 1.8 to 4.0-feet of grass underlain by dark brown silty fine to medium sand with gravel, roots, various debris and iron oxide staining.

Marysville Sand: Underlying the topsoil, we encountered orange-brown to gray fine to coarse sand with gravel with occasional silty beds. This sand was encountered in a medium dense or better condition, and we interpreted it to be Marysville Sand mapped to the depths explored.

Hydrogeologic Conditions

We observed groundwater within TP-3, TP-4, and TP-5 below depths of 9 to 10.0 feet. While some groundwater encountered could be attributed to perched conditions on top of siltier layers, we interpret most of the water encountered to be associated with the regional groundwater table within the area. We would expect the groundwater elevation to be slightly lower during drier times of the year and slightly higher during wetter periods.

SENSITIVE AREA EVALUATION

Seismic Hazard

We reviewed the 2018 International Building Code (IBC) for seismic site classification for this project. Since competent glacial outwash soils are inferred to underlie the site at depth, 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 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps.

Table 1 – 2018 IBC 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	1.111	0.396	1.2	null	0.889	null

The spectral response accelerations were obtained from the USGS Earthquake Hazards Program Interpolated Probabilistic Ground Motion website (2008 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 to moderate 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 Ragnar fine sandy loam, 0 to 8 percent slopes. This soil is listed as having moderate erosion hazard. 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

We performed three grain-size analyses on a selected soil samples obtained from the site. Laboratory tests were performed on samples taken from Test Pit 1 at 7.5 feet, Test Pit 3 at 2.0 feet, and Test Pit 5 at 10.0 feet. In general, the soils tested were classified as fine to medium sand with trace to minor amounts of silt. The results of the sieve analysis are presented as Figures 5 through 7.

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 native bearing soil, or structural fill extending to these soils. The competent soil should typically be encountered approximately 2.0- to 4.0-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 can be used to determine the infiltration system design along with long-term design infiltration rates due to the site being located within outwash type soils that have not been glacially overridden. We performed three 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 5.45 inches/hour be used in the design of the stormwater handling systems within this site. We have included details of our on-site infiltration evaluation in the **Infiltration Evaluation** subsection of this report.

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. 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 to four 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 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 denser native bearing soils or be supported on structural fill or rock spalls extending to those soils. Medium dense soils should be encountered approximately two to four 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 denser 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. Trench backfill compaction should be tested.

Infiltration Evaluation

We performed three 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 at 7.5 feet, Test Pit 3 at 2.0 feet, and Test Pit 5 at 10.0 feet. In general, the soils tested were classified as fine to medium sand with trace to minor amounts of silt. The results of the sieve analysis are presented as Figures 5 through 7. Based on the laboratory analysis, the soils encountered in our explorations within the proposed infiltration area meet the classification of sand and loamy 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 21.3 to 44.3 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 0.80 were utilized in this equation for CF_v, CF_t, CF_m, respectively. We applied the correction factors to the rate obtained from the grain-size analysis calculations which is 21.3 inches/hour and concluded that a long-term design infiltration rate of 5.45 inches per hour could 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 unsuitable undocumented fill soils and founded within the clean native granular outwash soils. Based on our explorations, the native granular outwash soils should be encountered at depths in the range of 2.0 to 4.0 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.

The stormwater manual recommends a five-foot separation between the base of an infiltration system and any underlying bedrock, impermeable horizon, or groundwater. We did encounter groundwater within three of our explorations down to depths of 9.0 to 10.0 feet below the existing ground surface. It is our opinion that any observed groundwater within the site would likely be associated with the regional groundwater table. We do not anticipate that the groundwater levels would fluctuate significantly throughout the year based on our understating of the nearby vicinity; however, we have installed two monitoring wells MW-1 and MW-2 within Test Pit One and Test Pit Three, respectively, to monitor groundwater fluctuations if needed based on infiltration system design.

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.

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 **Jennifer Hsiao and Kechien Yang**, and their 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.

Katelyn S. Brower, GIT
Project Geologist

6.27.2022

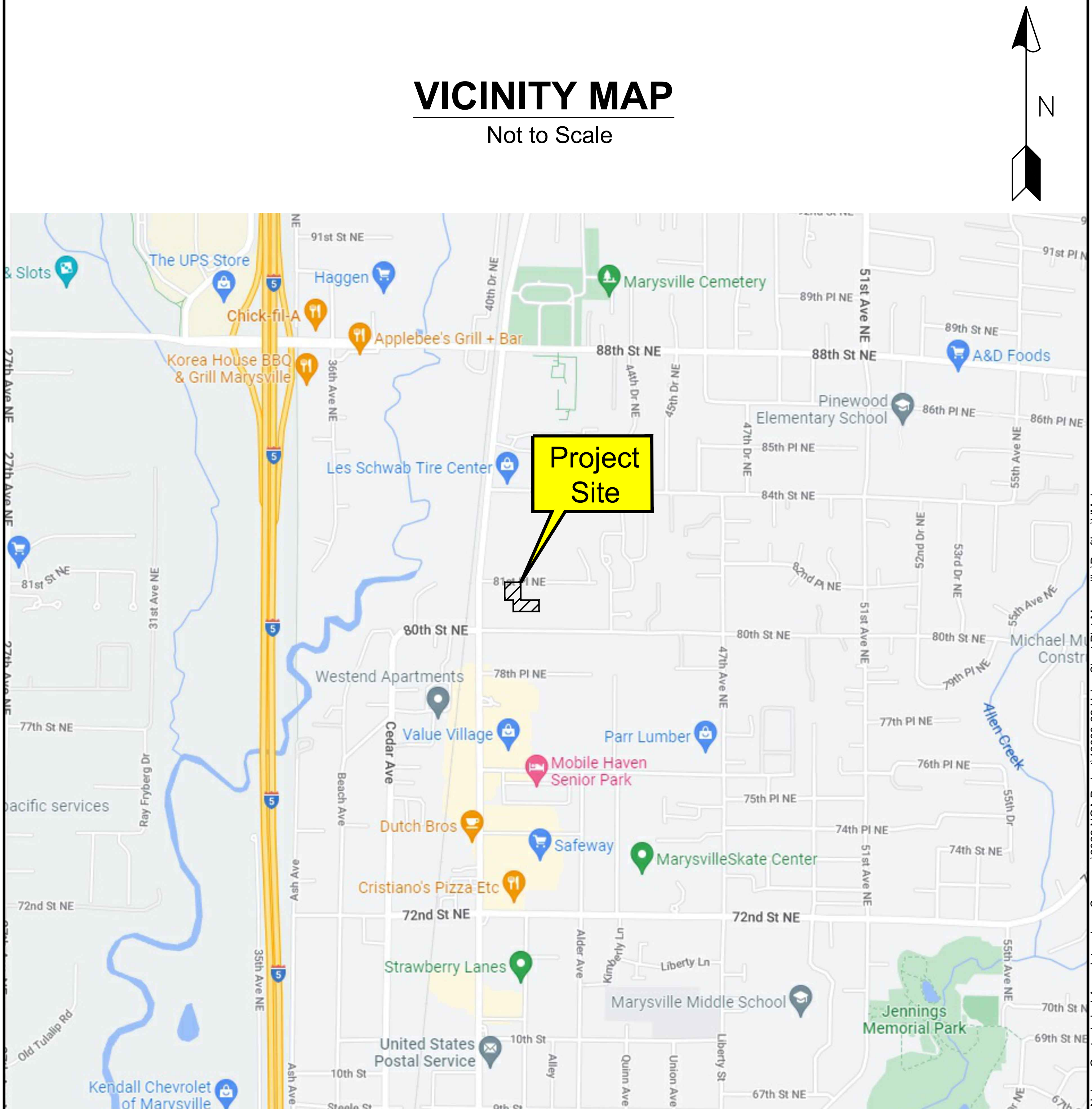
Khaled M. Shawish, PE
Principal Engineer

KSB:KMS:dy

Seven Figures Attached

VICINITY MAP

Not to Scale



Marysville, WA

Project Number	Hsiao Short Plat Vicinity Map	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
1368322		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	5/31/22	Original	DPN	KSB
Figure 1							

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Project Number
1368322

Figure 2

Hsiao Short Plat
Site Plan

NELSON GEOTECHNICAL ASSOCIATES, INC

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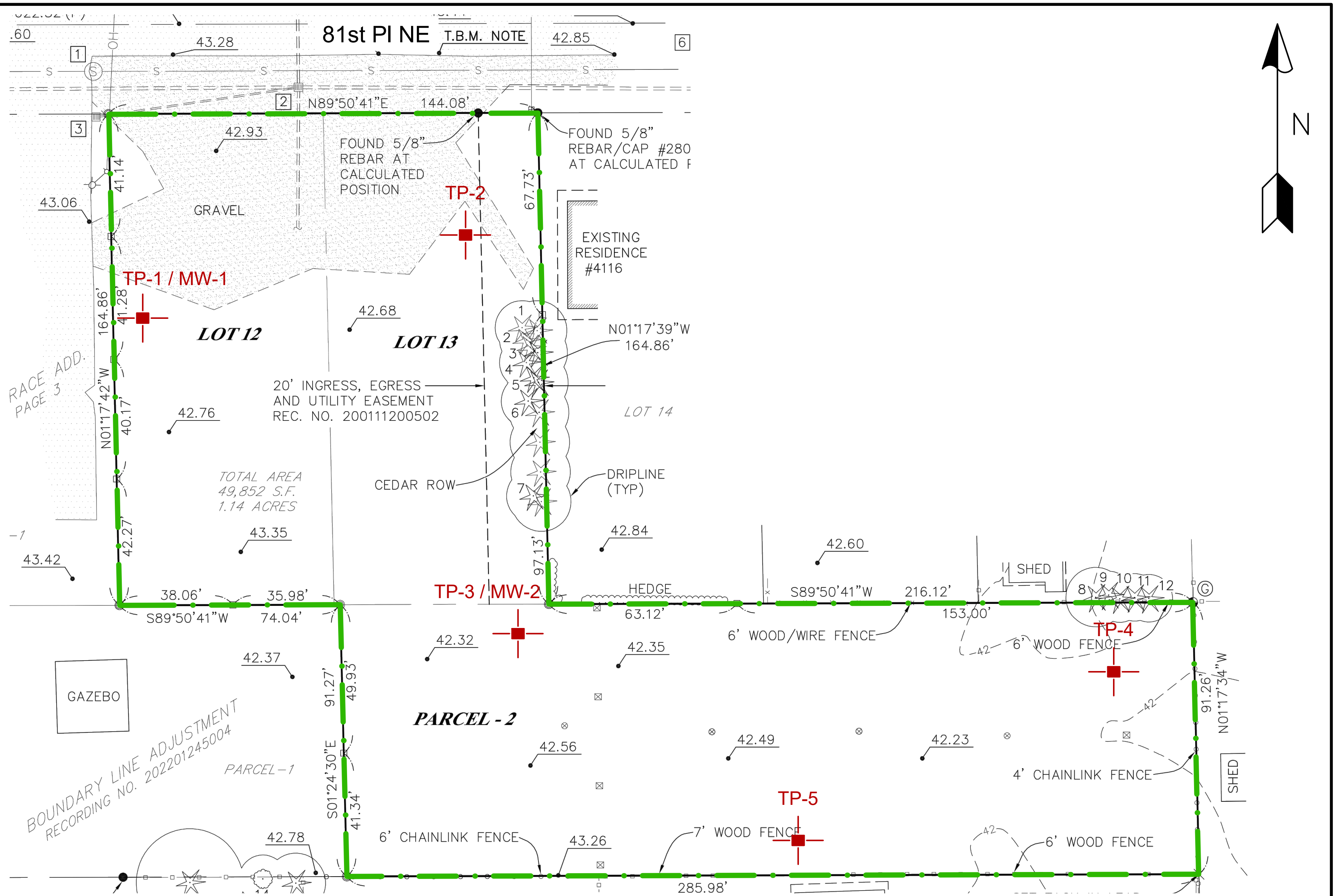
No.	Date	Revision	By	CK
1	5/31/22	Original	DPN	KSB



LEGEND

Property line

TP-1 — Number and approximate location of test pit

MW-1 — Number and approximate location of monitoring well

0 50 100

Scale: 1 inch = 50 feet

Reference: Site plan based on a plan dated April 29, 2022 titled "Boundary and Topographic Survey for Jennifer Hsiao," prepared by Allied Land Surveying, Inc.

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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 1368322	Hsiao Short Plat Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
Figure 3			1	5/31/22	Original	DPN	KSB

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LOG OF EXPLORATION

DEPTH (FEET)	USCS	SOIL DESCRIPTION
TEST PIT ONE		
0.0 – 4.0		GRASS UNDERLAIN BY DARK BROWN, SILTY FINE TO MEDIUM SAND WITH ORGANICS, ROOTS, AND GRAVEL (LOOSE, MOIST) (**FILL**)
4.0 – 10.5	SP	GRAY, MEDIUM TO COARSE SAND (MEDIUM DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 4.0, 7.5, AND 10.5 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED MINOR TEST PIT CAVING WAS ENCOUNTERED FROM 4.0 TO 10.5 FEET TEST PIT WAS COMPLETED AT 10.5 FEET ON 05/20/2022
TEST PIT TWO		
0.0 – 2.0		GRASS UNDERLAIN BY DARK BROWN TO ORANGE, SILTY FINE TO MEDIUM SAND WITH GRAVEL AND DEBRIS (LOOSE, MOIST) (**FILL**)
2.0 – 9.0	SP	GRAY, MEDIUM TO COARSE SAND WITH GRAVEL (MEDIUM DENSE, MOIST)
9.0 – 10.5	SW-SM	GRAY SAND WITH SILT LENSES AND IRON-OXIDE STAINING (MEDIUM DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 4.0, 9.0, AND 10.5 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 10.5 FEET ON 05/20/2022
TEST PIT THREE		
0.0 – 2.0		GRASS UNDERLAIN BY DARK BROWN TO BROWN, SILTY FINE TO MEDIUM SAND WITH ORGANICS AND GRAVEL (LOOSE, MOIST) (**FILL**)
2.0 – 11.0	SP	GRAY, MEDIUM TO COARSE SAND WITH GRAVEL AND TRACE IRON-OXIDE STAINING (MEDIUM DENSE, MOIST TO WET)
		SAMPLE WAS COLLECTED AT 3.5 FEET RAPID GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 10.0 FEET TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 11.0 FEET ON 05/20/2022
TEST PIT FOUR		
0.0 – 3.0		GRASS UNDERLAIN BY DARK BROWN TO BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, ORGANICS, TREE ROOTS, AND IRON-OXIDE STAINING (LOOSE, MOIST) (**FILL**)
3.0 – 9.0	SW	GRAY, FINE TO COARSE SAND WITH GRAVEL AND TRACE SILT (MEDIUM DENSE, MOIST TO WET)
9.0 – 10.0	SW-SM	GRAY SAND WITH SILT LENSES AND IRON-OXIDE STAINING (MEDIUM DENSE, WET)
		SAMPLES WERE COLLECTED AT 7.5 AND 10.0 FEET MODERATE GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 9.0 FEET TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 10.0 FEET ON 05/20/2022
TEST PIT FIVE		
0.0 – 1.8		GRASS UNDERLAIN BY DARK BROWN TO BROWN, SILTY FINE TO MEDIUM SAND WITH ROOTS, ORGANICS, AND GRAVEL (LOOSE, MOIST) (**FILL**)
1.8 – 10.0	SW	ORANGE-BROWN TO BROWN, FINE TO COARSE SAND WITH GRAVEL AND TRACE IRON-OXIDE STAINING (MEDIUM DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 4.0 AND 10.0 FEET MODERATE GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 9.0 FEET TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 10.0 FEET ON 05/20/2022

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Figure 5

Hsiao Short Plat
Sieve Analysis

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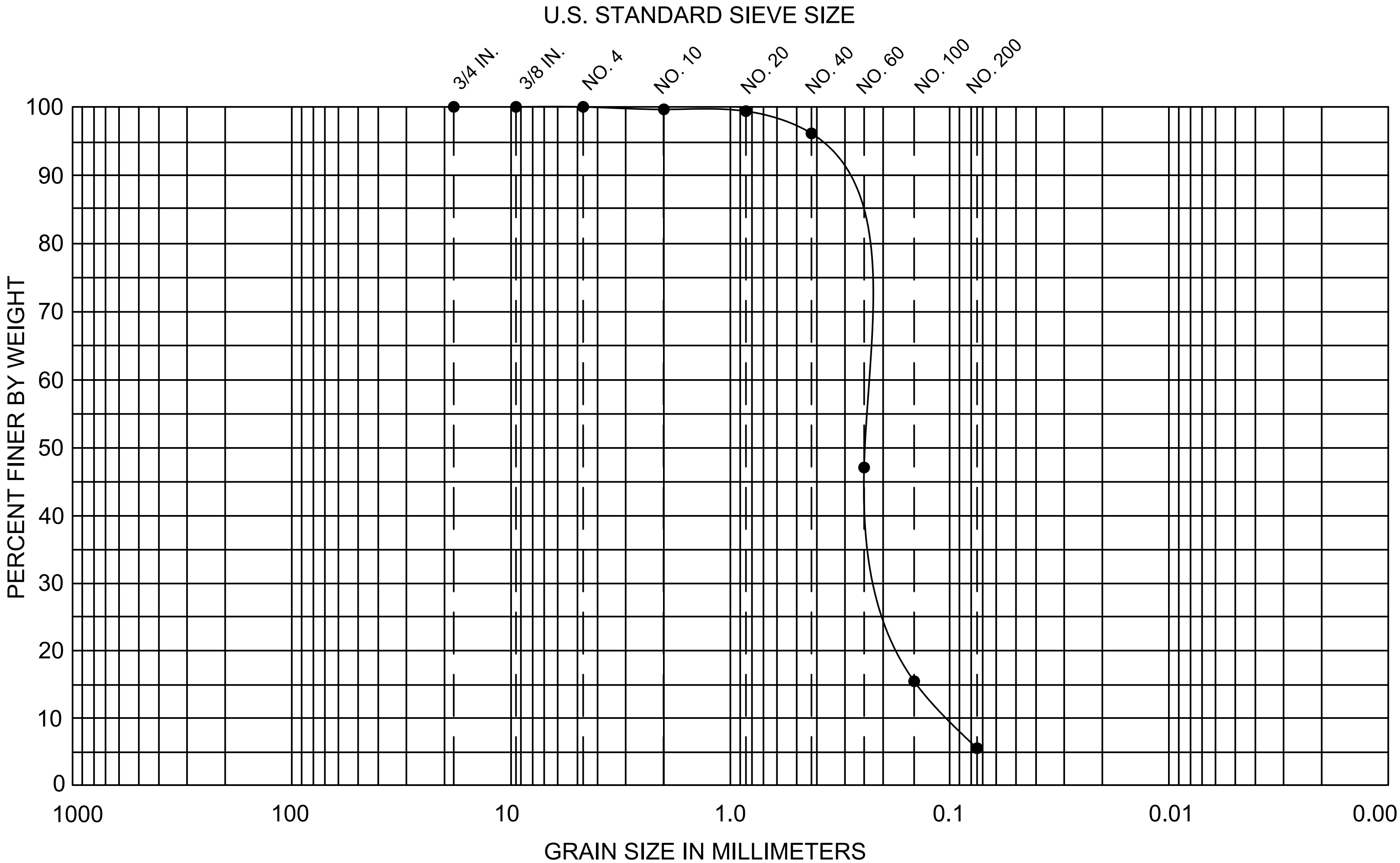

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP-SM	TP-1	7.5 feet	Fine sand with silt	Gravel = 0% Sand = 94% Silt/Clay = 6%

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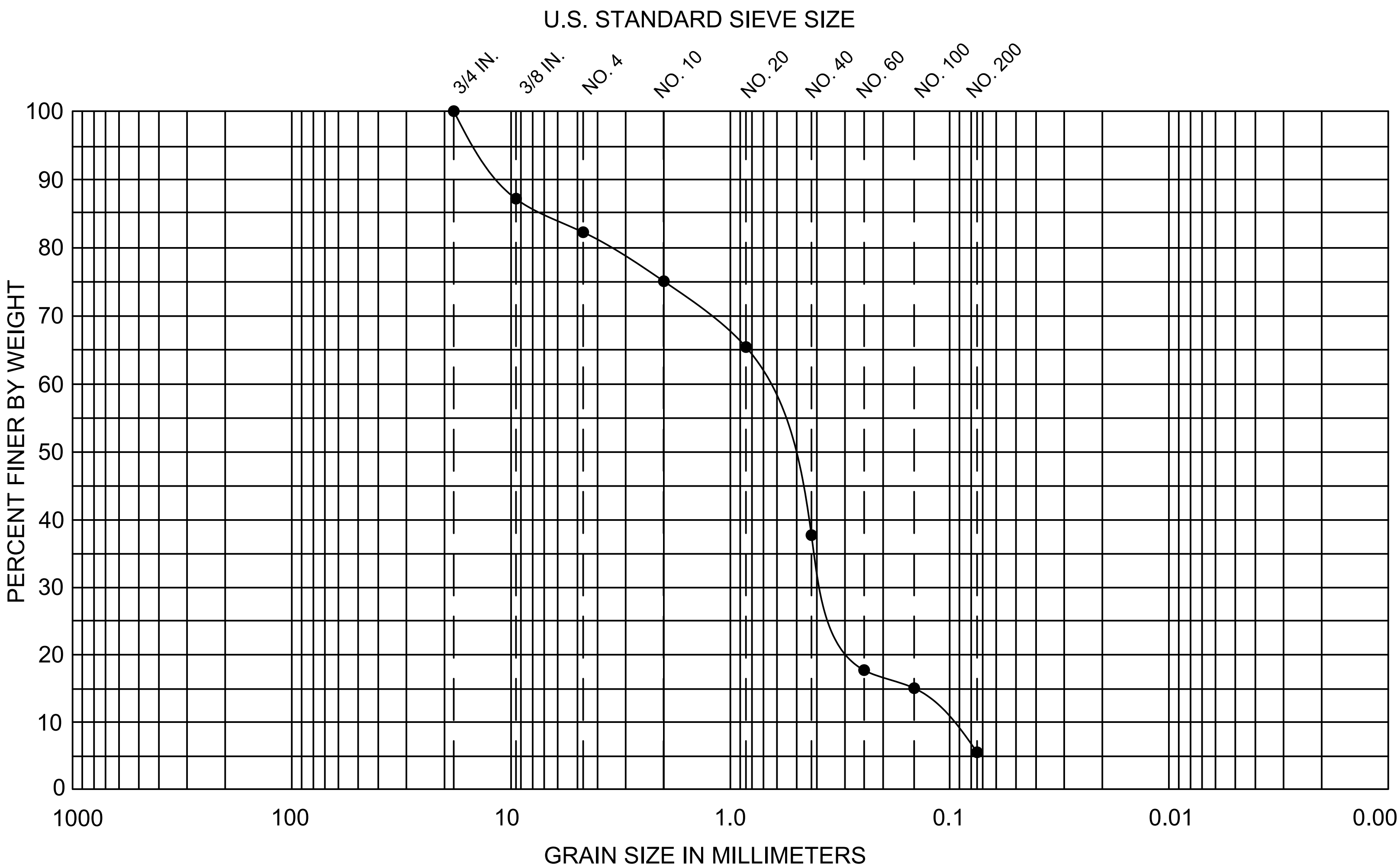
Figure 6

Hsiao Short Plat
Sieve Analysis



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP-SM	TP-3	2.0 feet	Fine medium sand with gravel and silt	Gravel = 17% Sand = 77% Silt/Clay = 6%

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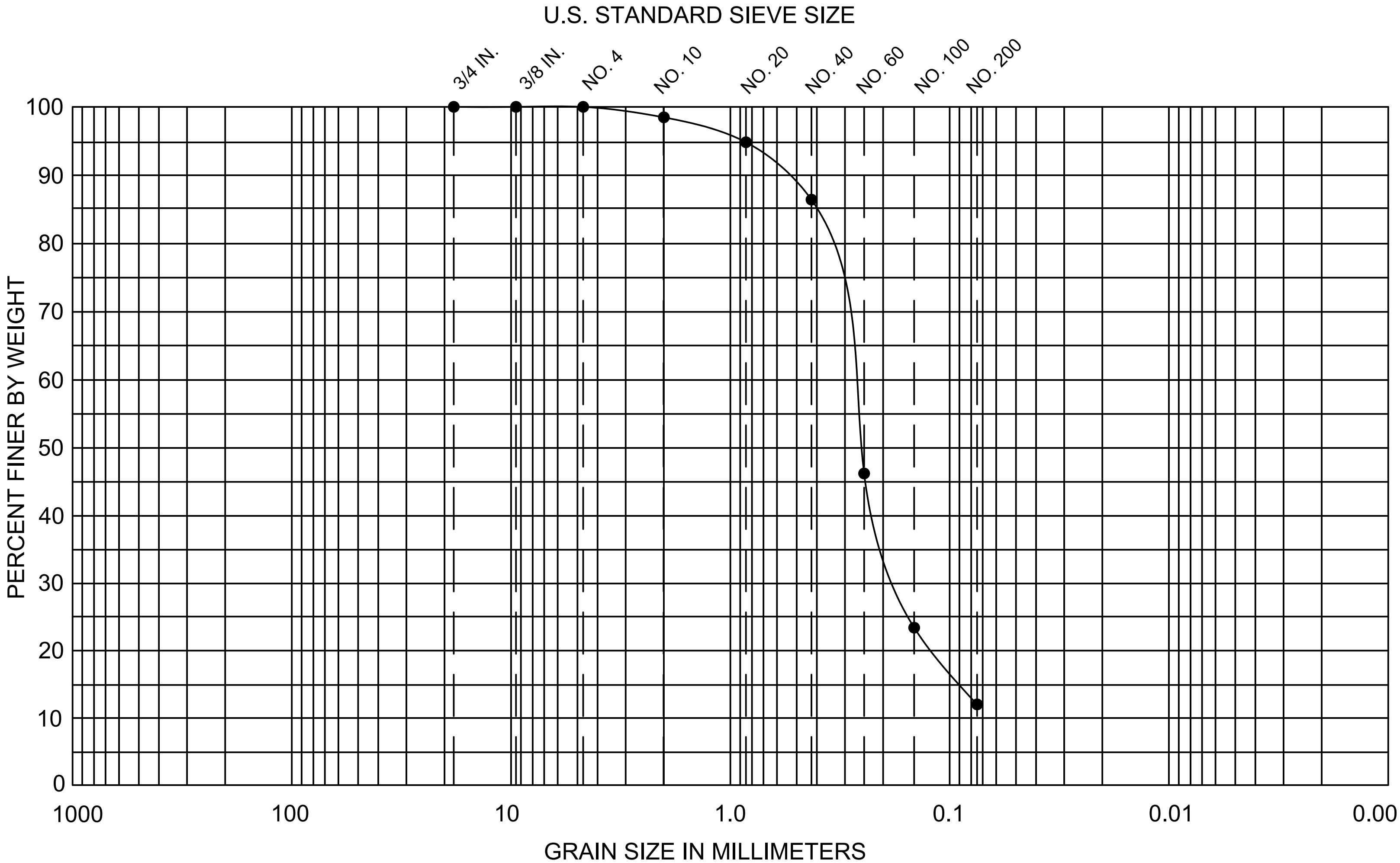

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP-SM	TP-5	10.0 feet	Fine sand with silt	Gravel = 0% Sand = 88% Silt/Clay = 12%

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Figure 7

Hsiao Short Plat
Sieve Analysis

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