



April 8, 2022

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Soils Report: Stormwater Feasibility
Proposed Commercial Development
2315 Inter Ave
Puyallup, Washington
PN: 2105200140
Doc ID: CIMCO.InterAve.SR

INTRODUCTION

This stormwater *Soils Report* addresses the feasibility of onsite infiltration of stormwater runoff generated by the proposed commercial development to be constructed at 2315 Inter Avenue in Puyallup, Washington. The approximate site location is shown on the attached Site Location Map, Figure 1.

Our understanding of this project is based on our email correspondence with you and representatives from Larson & Associates (Larson); our review of the provided *Topographic Survey* by Larson dated October 7, 2021; our understanding of the City of Puyallup development codes; and our experience in the area. The site consists of a single tax parcel which is currently developed with an existing building, paved parking areas, and utilities. We understand that you propose to construct a new building that will add or replace about 5,000 square feet of hard surfacing.

To provide flexibility in the final design of the site development we proposed a scope of work consistent with creating more than 5,000 square feet of impervious surface. We understand the City of Puyallup (the City) is requiring a *Soils Report* be prepared in accordance with the *2019 Stormwater Management Manual for Western Washington (SWMMWW)*, which included in-situ infiltration testing and wet season groundwater monitoring.

SCOPE

The purpose of our services was to evaluate the surface and subsurface conditions at the site as a basis for developing and providing geotechnical stormwater recommendations for the proposed development. Specifically, our scope of services for the project included the following:

1. Reviewing the available geologic, hydrogeologic, and geotechnical data for the site area;
2. Exploring surface and subsurface conditions by reconnoitering the site and excavating a series of test pits 3 at select locations across the site and installing 2 shallow (less than 10 feet) piezometers in selected test pits;

3. Performing one small-scale pilot infiltration test (PIT) at the site;
4. Describing surface and subsurface conditions, including soil type, depth to groundwater, if encountered, and an estimate of seasonal high groundwater levels;
5. Monitoring of groundwater levels at the site during the prescriptive wet season;
6. Providing our opinion about the feasibility of onsite infiltration in accordance with the 2019 SWMMWW, including a preliminary design infiltration rate based on in-situ testing, as applicable; and,
7. Preparing a *Soils Report* that satisfies the 2019 SWMMWW requirements and summarizes our site observations and conclusions, our geotechnical recommendations and design criteria, along with the supporting data.

The above scope of work was summarized in our *Proposal for Geotechnical Engineering Services* dated November 29, 2021. We received written authorization to proceed with our scope of work from you on December 3, 2021.

SITE CONDITIONS

Surface Conditions

The site is located at 2315 Inter Avenue in Puyallup, Washington within an area of existing commercial development. Based on information obtained from the Pierce County Public GIS website, the site is generally rectangular in shape, measures approximately 200 feet wide (east to west) by 400 to 405 feet long (north to south) and encompasses about 1.86 acres. The site is bounded by Inter Avenue to the south, single-family residence to the east, and by existing commercial development to the north and west.

The site generally flat with less than 2 feet of topographic relief. The vegetation in the area of the proposed development had been generally cleared and consisted of grasses, brambles, and other low lying native and invasive species. No areas of surficial erosion, seeps, or springs were observed at the time of our reconnaissance. Standing water was not observed in the existing pond/depressions on the northwest and portions of the site at the time of our December 2021 site visit. The existing site topography is shown on the Site Exploration Map, Figure 2.

Site Soils

The USDA Natural Resource Conservation Services (NRCS) Web Soil Survey maps the site as being underlain by Briscot loam soils (6A). The Briscot soil type 6A is derived from alluvium, form on slopes of 0 to 2 percent and has a "slight" potential for erosion when exposed. The upper, weathered soil horizons are listed in hydrologic soils group B, while the deeper soil horizons are listed in hydrologic soils group D. A copy of the referenced NRCS Soils Map for the site area is included as Figure 3.

Site Geology

The draft of the *Geologic Map of the Puyallup 7.5-Minute Quadrangle, Washington* (Troost et al.) maps the site and surrounding area as being underlain by alluvium (Qal). Alluvium generally consists of a poorly sorted, lightly stratified mixture of silts and sands that may contain localized deposits of clay and gravel that were deposited by fluvial processes. The alluvial deposits are considered

normally consolidated and generally have moderate strength and compressibility characteristics where undisturbed. An excerpt of the above referenced map is included as Figure 4.

Subsurface Explorations

On December 21, 2021, we visited the site and monitored the excavation of three test pits to depths of 6.5 to 8.0 feet below the existing ground surface, one of which was completed as a PIT. Our representative logged the subsurface conditions encountered in each test pit and obtained representative soil samples. We also performed in-situ infiltration testing at 2 feet below existing grades in PIT-1. The test pits were excavated by a small track-mounted excavator operated by a licensed earthwork contractor working for GeoResources. Table 1, below, summarizes the approximate functional locations, surface elevations, and termination depths of our explorations.

**TABLE 1:
 APPROXIMATE LOCATIONS, ELEVATIONS, AND DEPTHS OF EXPLORATIONS**

Exploration Number	Functional Location	Surface Elevation (feet)	Termination Depth (feet)	Termination Elevation ¹ (feet)
TP-1	East portion of proposed development	60	6.5	53.5
TP-2	West portion of proposed development	60	8.0	52.0
PIT-1	Central portion of proposed development	60	5.0	55.0

Notes:
 1 = Surface elevation estimated from the provided by the Pierce County Public GIS contours based on NAVD 88

The specific number, locations, and depths of our explorations were selected based on the configuration of the proposed development and were adjusted in the field based on consideration for underground utilities, existing site conditions, site access limitations and encountered stratigraphy. Soil densities presented on the logs were based on the difficulty of excavation and our experience. Representative soil samples obtained from the test pits were placed in sealed plastic containers and then taken to our laboratory for further examination and testing as deemed necessary. The test pits were then backfilled with the excavated soils and bucket tamped, but not otherwise compacted.

The subsurface explorations excavated as part of this evaluation indicate the subsurface conditions at specific locations only, as actual subsurface conditions can vary across the site. Furthermore, the nature and extent of such variation would not become evident until additional explorations are performed or until construction activities have begun. Based on our experience and extent of prior explorations in the area, it is our opinion that the soils encountered in the explorations are generally representative of the soils at the site.

The approximate locations and numbers of our test pits are shown on the attached Site Exploration Map, Figure 2. The soils encountered were visually classified in accordance with the Unified Soil Classification System (USCS) and ASTM D: 2488. The USCS is included in Appendix A as Figure A-1, while the descriptive logs of our test pits are included as Figure A-2.

Subsurface Conditions

At the locations of our explorations, we encountered generally uniform subsurface conditions that in our opinion confirmed the mapped stratigraphy at the site. In general, our test pit explorations encountered about 1.2 to 1.4 feet of brown topsoil in a loose, moist condition mantling about 3.8 to 4.2 feet of iron-oxide stained brown to dark grey silty sand in a loose, moist condition. These surficial soils were underlain by iron-oxide stained mottled dark grey to black silty sand in a loose and wet condition to the full depth explored. We interpret the soils encountered at the site to be consistent with alluvium deposits. Table 2 below summarizes the soils encountered in our explorations.

TABLE 2:
APPROXIMATE THICKNESS, DEPTHS, AND ELEVATION OF ENCOUNTERED SOIL TYPES

Exploration Number	Thickness of Topsoil (Feet)	Thickness of Surficial Silty Sand (feet)	Depth to Restrictive SILT Layer(s) (feet)	Depth to Deeper Silty Sand (feet)	Elevation ¹ of Deeper Silty Sand (feet)
TP-1/P-1	0.5	5.0	5.5	6.0	54.0+
TP-2/P-2	0.5	2.5	3.0	3.5	56.5 – 52.5
PIT-1	0.5	2.5	NE	3.0	57.0

Notes:
 1 = Surface elevation estimated from the provided by the Pierce County Public GIS contours based on NAVD 88
 NE = Not encountered
 + = Did not encounter silt layer beneath silty sand

Laboratory Testing

Geotechnical laboratory tests were performed on select samples retrieved from the test pits to estimate index engineering properties of the soils encountered. Laboratory testing included visual soil classification per ASTM D: 2488 and ASTM D: 2489, moisture content determinations per ASTM D: 2216, and grain size analyses per ASTM D: 6913 standard procedures. The results of the laboratory tests are summarized below in Table 3 and graphical outputs are included in Appendix B.

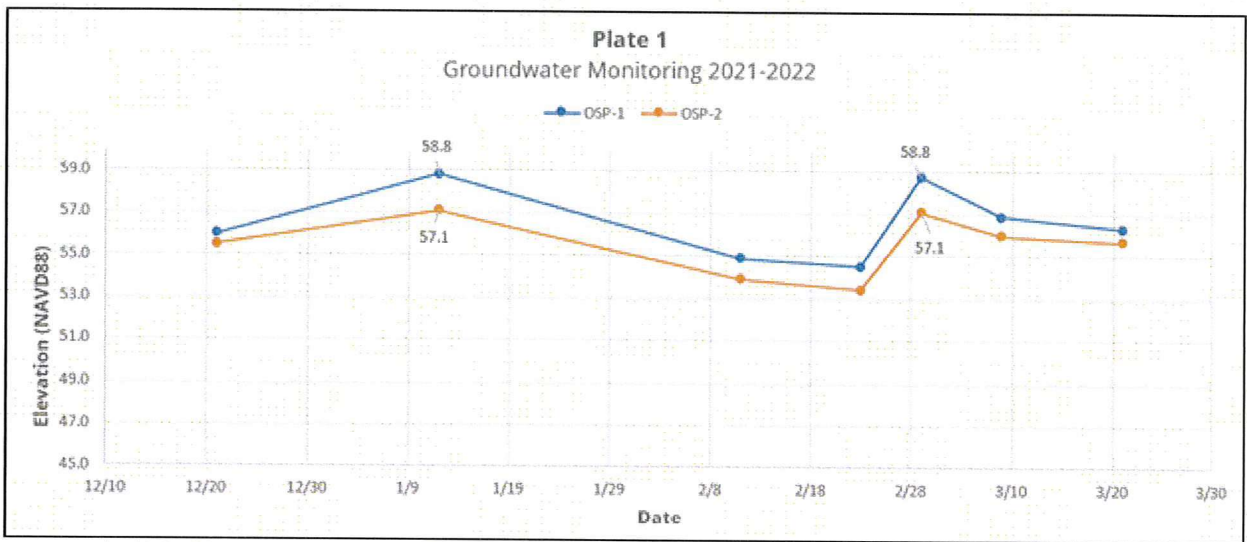
TABLE 3:
LABORATORY TEST RESULTS FOR ON-SITE SOILS

Sample	Soil Type	Lab ID	Gravel Content (percent)	Sand Content (percent)	Silt/Clay Content (percent)	D10 Ratio (mm)
PIT-1, S-2, 5'	SM	103087	0	82.1	17.9	>0.075

Groundwater Conditions

At the time of exploration, groundwater seepage was observed at depths of 4 to 4.5 feet below existing grades. Groundwater monitoring wells were installed at the site at the time of exploration. The locations of the observation wells are shown on the Site & Exploration Plan, Figure 2. Groundwater readings for the observation wells were manually measured on a bi-monthly basis from December 21, 2021 to March 21, 2022.

Based on our wet season monitoring, it appears that seasonal high groundwater occurs at about Elevation 59 feet (NAVD 88) at the locations monitored, approximately 1.2 feet below the ground surface. These levels were recorded on January 12, 2022 and March 1, 2022. Plate 1, below, summarizes the groundwater levels recorded as part of our groundwater monitoring program during our monitoring period.



We anticipate fluctuations in the local groundwater levels will occur in response to precipitation patterns, off site construction activities, and site utilization. As such, water level observations made at the time of our field investigation may vary from those encountered during the construction phase. Analysis or modeling of anticipated groundwater levels during construction is beyond the scope of this report.

CONCLUSIONS AND RECOMMENDATIONS

Based on our site reconnaissance and subsurface explorations, it is our opinion that shallow onsite infiltration is feasible for the proposed development if grades at the site are raised to protect and maintain the required vertical separation from groundwater. We measured an infiltration rate of 1 inch per hour in the silty sand soils observed at about 2 feet below existing grades at the site. Further conclusions and recommendations are contained herein.

Infiltration Recommendations

Based on our subsurface explorations, infiltration testing, and groundwater monitoring, it is our opinion that stormwater infiltration via permeable pavement is feasible at the site, provided the bottom of the facility is located at elevation 59 (NAVD88) or higher. This elevation is based on the topographic information obtained from the Pierce County Public GIS and should be surveyed in the field.

Permeable Pavement

Per the 2019 SWMMWW, permeable pavement is considered feasible if there is at least 1 foot of clearance from the expected bottom elevation of the infiltration facility to the seasonal high ground water table. For the purposes of this infiltration feasibility evaluation, we have assumed that, at a minimum, the standard permeable pavement section (6 inches of pavement over 6 inches of storage course) would be used. Deeper trenches and thicker storage courses may be designed by a civil engineer where the vertical separation requirements can be met.

As previously stated, we performed one PIT at about 2 feet below existing grades in the silty sand soils and measured 1 inch per hour. After applying appropriate correction factors to this rate, in accordance with the 2019 SWMMWW for site variability ($F_{variability}$), testing method ($F_{testing}$) and maintenance for situation biofouling ($F_{maintenance}$), a long-term design infiltration rate of 0.34 inches for the permeable pavement should be used for this project. Depending on the proposed storage course thickness, site grades will likely need to be raised at least 1 foot to meet the vertical separation requirements for permeable pavement.

Downspout Infiltration

For the purposes of this infiltration feasibility evaluation, we have assumed that, at a minimum, the standard infiltration trench section (6 inches of topsoil over a 2 foot deep trench) would be used. Based on our site observations, groundwater monitoring, and subsurface explorations, it is our opinion that deeper infiltration using trench systems will likely be feasible at the site during the drier months of the year. Because the PIT results indicate limited infiltration in the shallow soils, we completed one soil gradation analyses on the sandier alluvium soils encountered at about 3 to 5 feet below grades the 2019 SWMMWW and in accordance with ASTM D6913. Based on our gradation analysis, a design infiltration rate of 2 inches per hour be used for infiltration facilities located within the sandier soils encountered between elevations 55 to 57 feet (NAVD88) in the areas of test pit TP-2 and PIT-1. The soils in the area of test pit TP-1 at that depth had interlaced layers of mottled silt that would not be conducive to infiltration. Appropriate correction factors for testing have been applied to this value in accordance with the 2019 SWMMWW.

It should be noted that based on our groundwater monitoring, the 1-foot separation will likely not be met during the majority of the winter wet season unless grades are raised about 0.5 to 1.5 feet. Overflows that are directed to an appropriate discharge point should be incorporated into the design of this project. Alternatively, dispersion into the existing system could also be considered for this project and may prove to be more cost effective.

All proposed infiltration facilities should be designed and constructed in accordance with the 2019 SWMMWW. All minimum separations, setback requirements, and infeasibility criteria per 2019 SWMMWW should be considered prior to the selection, design and location of any stormwater facility for the proposed development.

LIMITATIONS

We have prepared this report for use by CIMCO and other members of the design team, for use in the design of a portion of this project. The data used in preparing this report and this report should be provided to prospective contractors for their bidding or estimating purposes only. Our report, conclusions and interpretations are based on our subsurface explorations, data from others

and limited site reconnaissance, and should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations and may also occur with time. A contingency for unanticipated conditions should be included in the budget and schedule. Sufficient monitoring, testing and consultation should be provided by our firm 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 earthwork and foundation installation activities comply with contract plans and specifications.

The scope of our services does not include services related to environmental remediation and construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

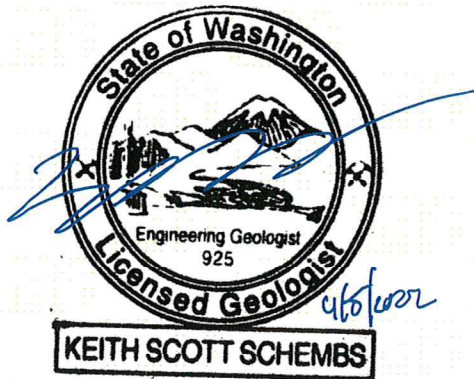
If there are any changes in the loads, grades, locations, configurations or type of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide written modifications or verifications, as appropriate.



We have appreciated the opportunity to be of service to you on this project. If you have any questions or comments, please do not hesitate to call at your earliest convenience.

Respectfully submitted,
GeoResources, LLC


Andrew E. Schnitger, EIT
Staff Engineer

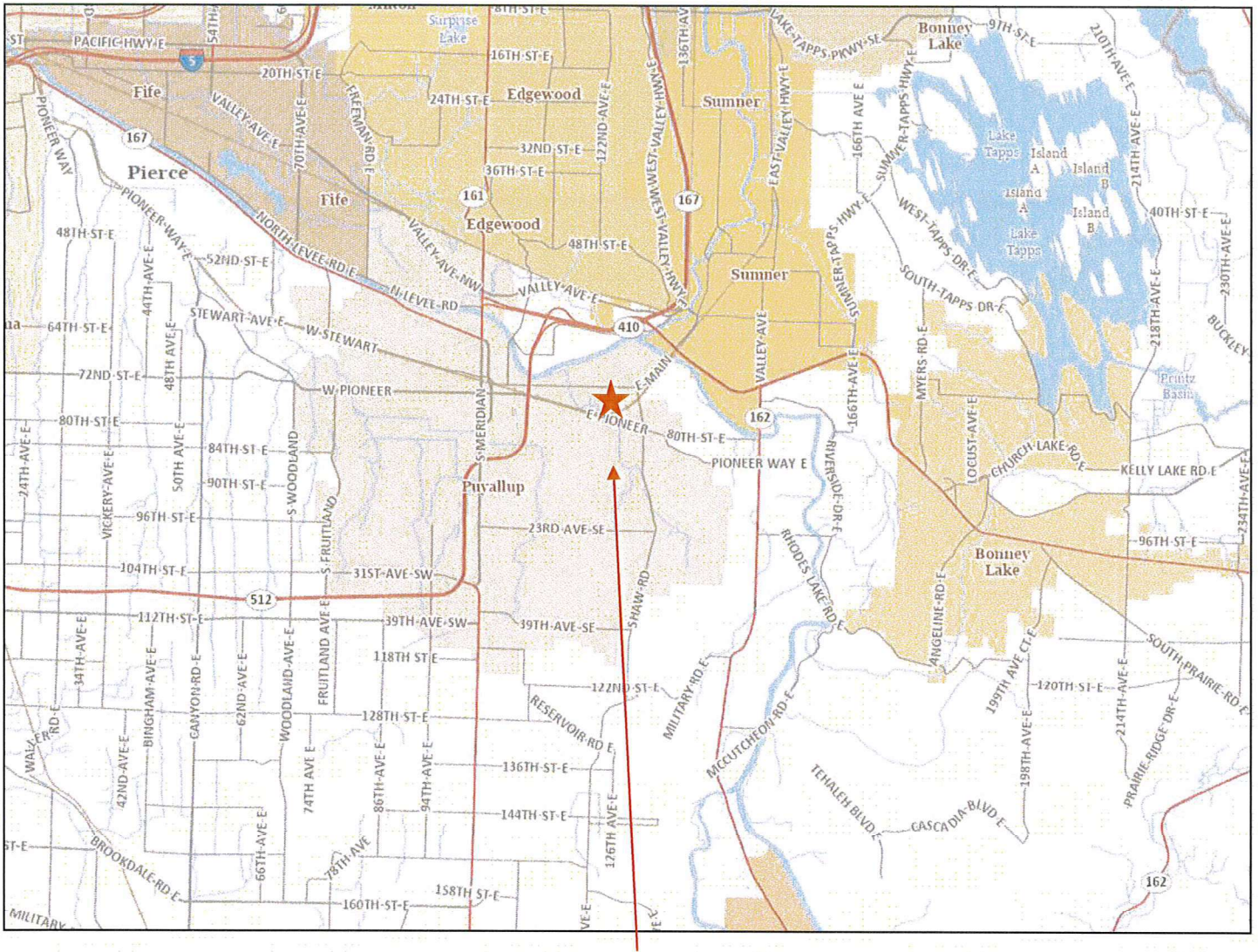


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Senior Geotechnical Engineer

AES:KSS:EWH/aes
DocID: CIMCO.InterAve.SR
Attachments: Figure 1: Site Location Map
Figure 2: Site Exploration Map
Figure 3: NRCS Soils Map
Figure 4: Geologic Map
Appendix A: Subsurface Explorations
Appendix B: Laboratory Results



Approximate Site Location

(map created from Pierce County Public GIS <http://matterhorn3.co.pierce.wa.us/publicgis/>)



Not to Scale

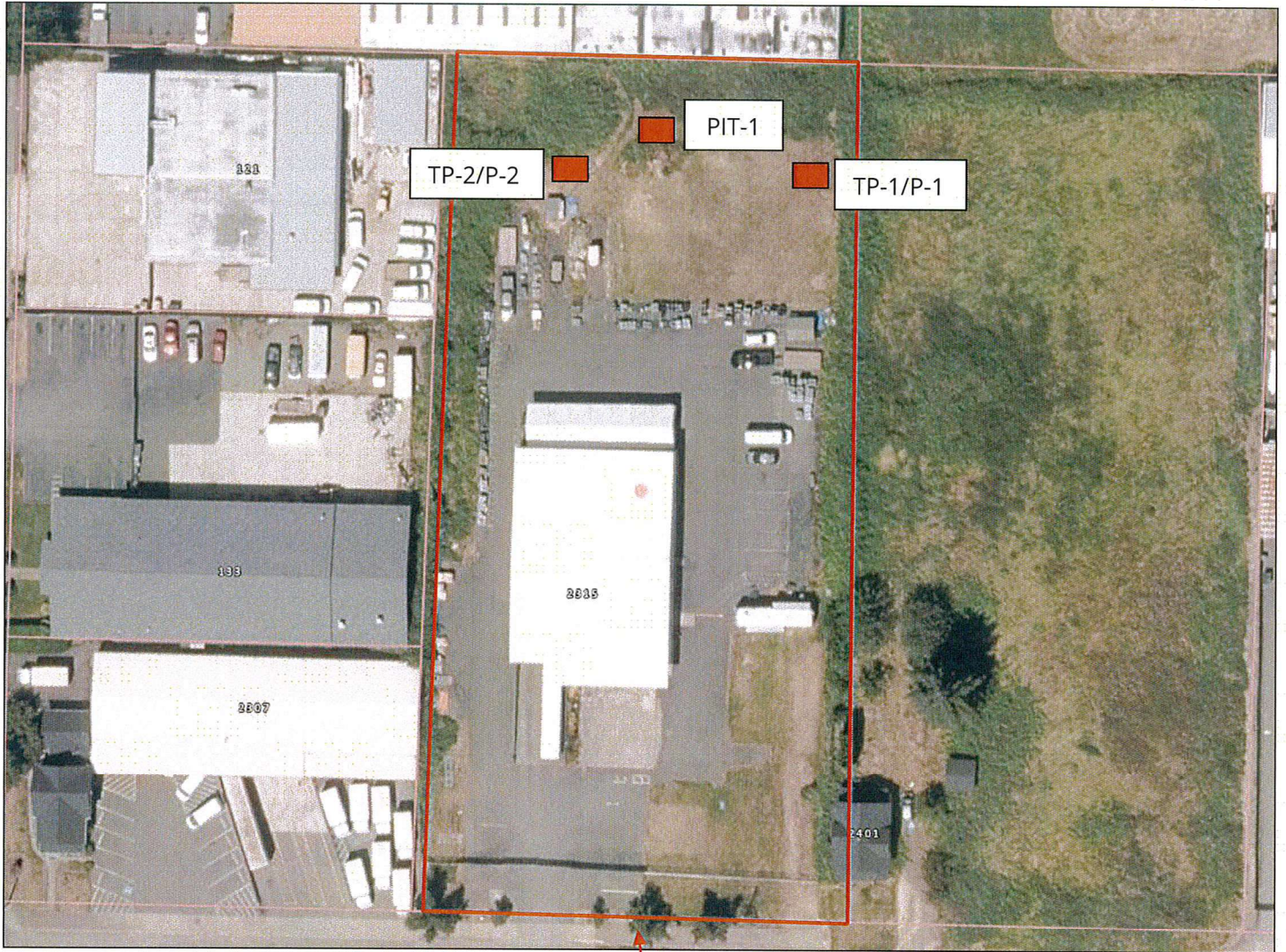


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Site Location Map

Proposed Commercial Development
 2315 Inter Avenue
 Puyallup, Washington
 PN: 2105200140

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Approximate Site Location

Map created from Pierce County Public GIS (<https://matterhornwab.co.pierce.wa.us/publicgis/>)

 Number and approximate location of test pit/Pilot Infiltration Test



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Site & Exploration Map
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Approximate Site Location

Map created from Web Soil Survey (<http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>)

Soil Type	Soil Name	Parent Material	Slopes	Erosion Hazard	Hydrologic Soils Group
6A	Briscot loam	Alluvium	-	Slight	D
31A	Puyallup fine sandy loam	Alluvium	0 to 3	Slight	B



Not to Scale



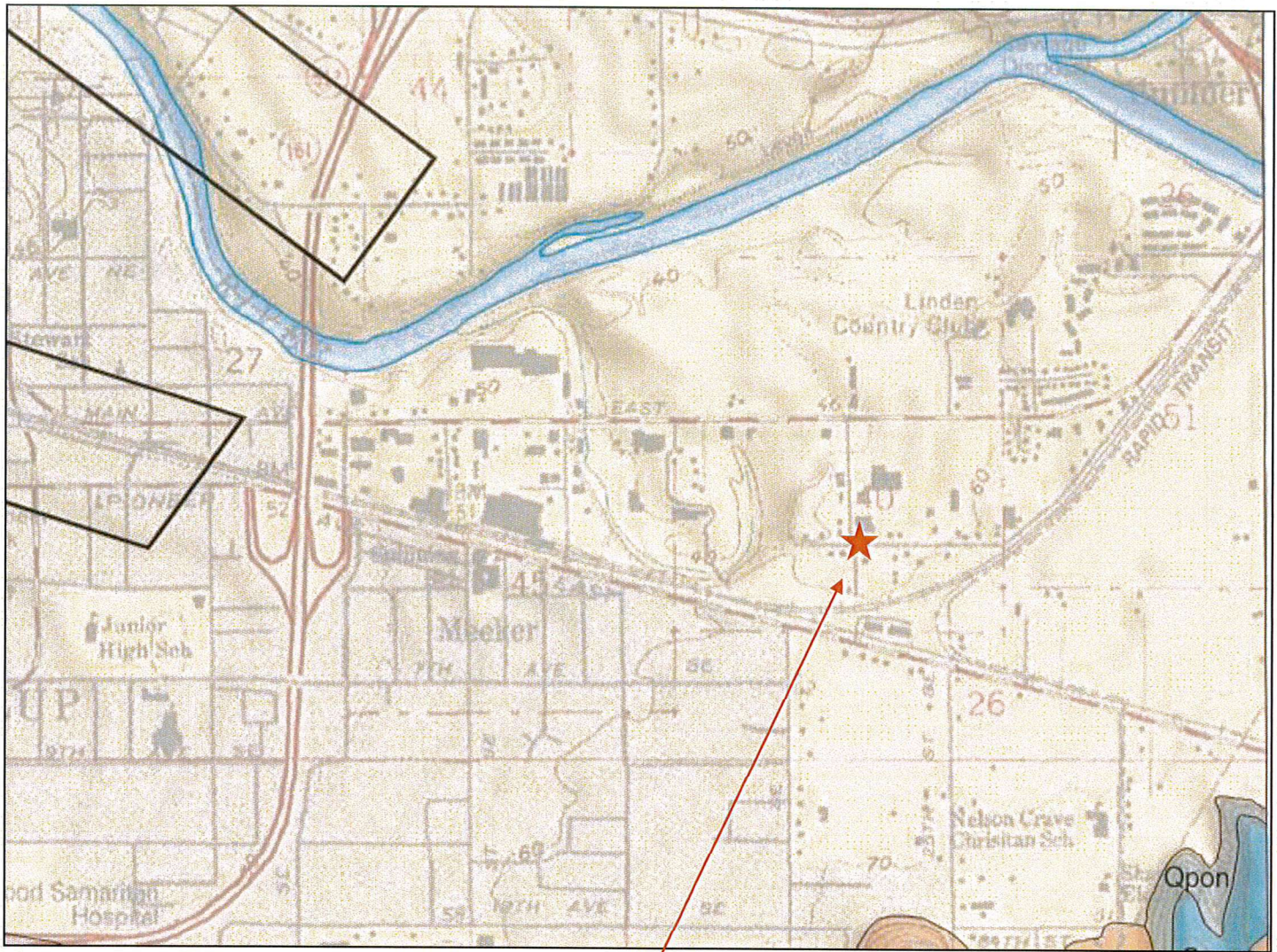
NRCS Soils Map
 Proposed Commercial Development
 2315 Inter Avenue
 Puyallup, Washington
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Doc ID: CIMCO.InterAve.F

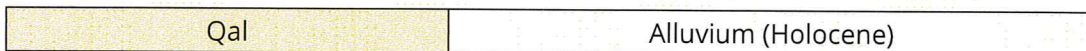
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Figure 3



Approximate Site Location

An excerpt from the draft the *Geologic Map of the Puyallup 7.5-minute Quadrangle, Washington* by Kathy G. Troost (in review)



Not to Scale



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Geologic Map
 Proposed Commercial Development
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BZO

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Figure 4

Appendix A
Subsurface Explorations

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 GRAVEL, 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
	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 D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Description of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and or test data.

SOIL MOISTURE MODIFIERS:

- Dry- Absence of moisture, dry to the touch
- Moist- Damp, but no visible water
- Wet- Visible free water or saturated, usually soil is obtained from below water table



Unified Soils Classification System

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Test Pit TP-1

Location: West portion of parcel
Approximate Elevation: 60' (NAVD88)

Depth (ft)	Soil Type	Soil Description
0 - 0.5	-	Topsoil
0.5 - 3.0	SM	Brown silty SAND (loose, moist) (alluvium)
3.0 - 5.5	SM/ML	Gray, orange iron oxide stained silty SAND, interbedded gray mottled silt (medium dense/stiff, moist to wet) (alluvium)
5.5 - 6.0	ML	Gray mottled SILT (stiff, wet) (alluvium)
6.0 - 6.5	SP	Gray SAND (medium dense, wet) (alluvium)

Terminated at 3.2 feet below ground surface.
No caving observed.
Slow groundwater seepage observed at 4 feet below existing grades.

Test Pit TP-2

Location: SW central portion of parcel
Approximate Elevation: 60' (NAVD88)

Depth (ft)	Soil Type	Soil Description
0 - 0.5	-	Topsoil
0.5 - 3.0	SM	Reddish brown silty SAND (loose to medium dense, moist) (alluvium)
3.0 - 3.5	ML	Light gray SILT (medium stiff, moist) (alluvium)
3.5 - 6.0	SP	Gray mottled SAND (medium dense, wet) (alluvium)
6.0 - 7.5	SM	Gray mottled silty SAND (medium dense, wet) (alluvium)
7.5 - 8.0	ML	Gray SILT (stiff, wet) (alluvium)

Terminated at 8.0 feet below ground surface.
No caving observed.
Slow groundwater observed at 4.5 feet below ground surface

Logged by: AES

Observed on: December 21, 2021



Test Pit Logs
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Figure A-2

Pilot Infiltration Test PIT-1

Location: West portion of parcel
Approximate Elevation: 60' (NAVD88)

Depth (ft)	Soil Type	Soil Description
0 - 0.5	-	Topsoil
0.5 - 2.0	SM	Reddish brown silty SAND (loose to medium dense, moist) (alluvium)
2.0 - 3.0	SM	Gray silty SAND (medium dense, moist) (alluvium)
3.0 - 5.0	SM	Gray mottled silty SAND (medium dense, moist) (alluvium)

Infiltration testing performed at 2 feet below existing grades.
Measured 1 inch per hour.
Overexcavated to 5 feet below existing grades.
No caving observed.
No groundwater seepage observed.

Logged by: AES

Observed on: December 21, 2021



Test Pit Logs
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Figure A-3

Appendix B

Laboratory Test Results

