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BRADLEY HEIGHTS APARTMENTS

Stormwater Site Plan

Drainage Report

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JOB NO: 3227

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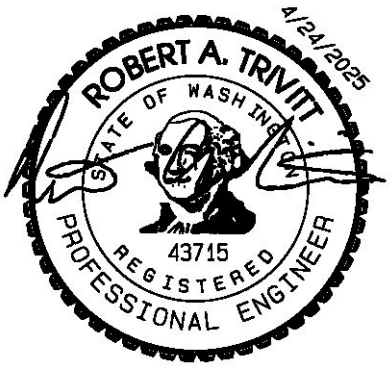

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Section I - Project Overview

Overview:

The project site is located on the south side of 27th Ave SE, east of the intersection with S Meridian. The site address is 202 27th Ave SE. Tax parcel number is 041903-6-006. Parcel area is 7.78 acres. The project is an apartment project with 8 apartment buildings and a recreation building.

Improvements for the project will include the parking lot, storm drainage facilities, sanitary sewer main extension, water main extension, construction of 8 multi-family buildings and a recreation building, and construction of curb, gutter, and sidewalk along the project frontage.

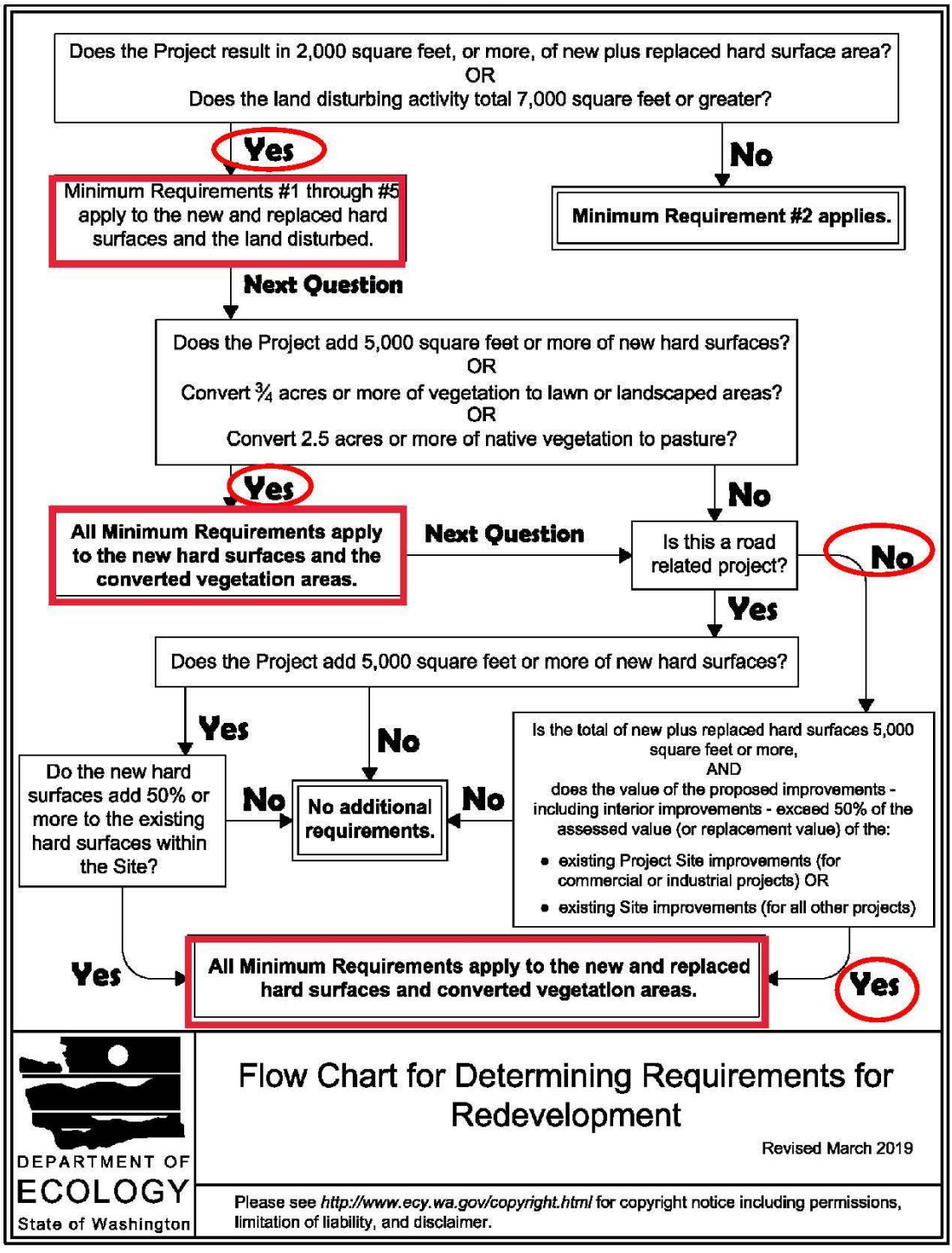
Project Requirements:

Determination of Applicable Minimum Requirements

Per PMC 21.10.040 the City of Puyallup has adopted the Washington State Department of Ecology Stormwater Management Manual for Western Washington (SMMWW), with the version in effect being "the most current version approved for city use by the council." The city adopted the 2019 DOE Manual on July 1, 2022, and it is the controlling regulation and is referred to as "the Manual" or "SMMWW" hereinafter.

The project consists of over 270,000 sf of new plus replaced hard surfaces onsite. The existing hard surfaces are 135,105 sf or 40% of the project site and therefore, the project is considered redevelopment. Since the total new plus replaced hard surfaces for the project are greater than 5,000 square feet, and the value of improvements exceed 50% of the assessed value of the existing site improvements, all minimum requirements apply to the new and replaced hard surfaces and converted vegetation areas. Note that all of the existing vegetated areas are already lawn/landscaping so therefore there are no converted vegetation areas. Therefore, the minimum requirements only apply to the new and replaced hard surfaces.

Figure I-3.2: Flow Chart for Determining Requirements for Redevelopment



Discussion of Minimum Requirements

The Minimum Requirements per Section I-2.5 of the Manual:

Minimum Requirement #1: Preparation of Stormwater Site Plans

The Stormwater Site Plan consists of a report and construction plans. This report and the construction drawings satisfy Minimum Requirement #1.

Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPPP)

The SWPPP consists of a narrative and drawings. The narrative is addressed in Section V of this report. The civil construction plans include a TESC plan, notes, and details.

Minimum Requirement #3: Source Control of Pollution

A Pollution Source Control Plan has been prepared in conformance with requirements of Volume IV of the Manual and is included with this submittal as a separate document.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls

Currently, drainage from the site sheet flows to the north into 27th Ave SE, then west in the gutter and closed conveyance system. The proposed drainage improvements will connect to this same closed conveyance system to preserve existing drainage systems and outfalls.

Minimum Requirement #5: On-site Stormwater Management

Because the project triggers MR #1-9, and is inside the urban growth area, the project must either meet the Low Impact Development Performance Standard, or use List #2 to determine applicable On-Site Stormwater Management BMPs. This project will use List #2. For each surface the BMP's must be considered in the order listed for that type of surface and use the first BMP that is considered feasible.

Lawn and Landscaped Areas:

- All lawn and landscaped areas will meet the requirements of BMP T5.13, Post Construction Soil Quality and Depth with notes on the plans to this effect.

Roofs:

1. BMP T5.30: Full Dispersion – infeasible due to lack of native vegetation and flowpath length onsite; BMP T5.10A: Downspout Full Infiltration – infeasible based on field tested infiltration rates.
2. Bioretention – infeasible based on field tested infiltration rates
3. BMP T5.10B: Downspout dispersion system – not feasible based on required flowpath lengths
4. BMP T5.10C: Perforated Stub-out connections – will be used for all roof drains.

Other Hard Surfaces:

1. BMP T5.30: Full Dispersion – infeasible due to lack of native vegetation and flowpath length
2. BMP T5.15: Permeable pavement – infeasible based on field tested infiltration rates
3. Bioretention – infeasible based on field tested infiltration rates
4. BMP T5.12: Sheet Flow Dispersion & BMP T5.11: Concentrated Flow Dispersion – infeasible due to lack of flowpath length

Minimum Requirement #6: Runoff Treatment

New plus replaced pollution generating hard surfaces (PGHS) is the parking lot paving. The total area is well over 5,000 square feet and therefore runoff treatment is required. As a multi-family development, enhanced treatment is required. Two methods of enhanced treatment will be used. A Filterra system will be used for the area draining to detention system #1, and a treatment train of wet-vault followed by filter media (StormFilter with ZPG) will be used for the rest of the project. The frontage improvements are required to meet basic treatment. A StormFilter catch basin with PhosphSorb (PSORB) media will be used to treat runoff from the frontage improvements.

Minimum Requirement #7: Flow Control

The total new plus replaced hard surface for the project is well over 10,000 sf and therefore flow control is required. Any existing pervious surface to be disturbed is already lawn, and therefore the converted vegetation thresholds are not exceeded, and the minimum requirements do not apply to the pervious areas. To meet this minimum requirement stormwater discharges shall match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50 percent of the 2-year recurrence interval peak flow up to the full 50-year peak flow. Predeveloped condition to be matched shall be forested land cover. Note that the forested land cover only applies to the new and replaced impervious areas since the existing land cover is lawn. Therefore, for the onsite lawn in developed conditions, and offsite tributary areas, the land cover is modeled as in existing conditions, i.e. lawn. The frontage area is included in the flow control requirements since removal down to base or subgrade will be required. This drainage is accounted for as bypass in the hydrologic analysis. See below for hydrologic analysis.

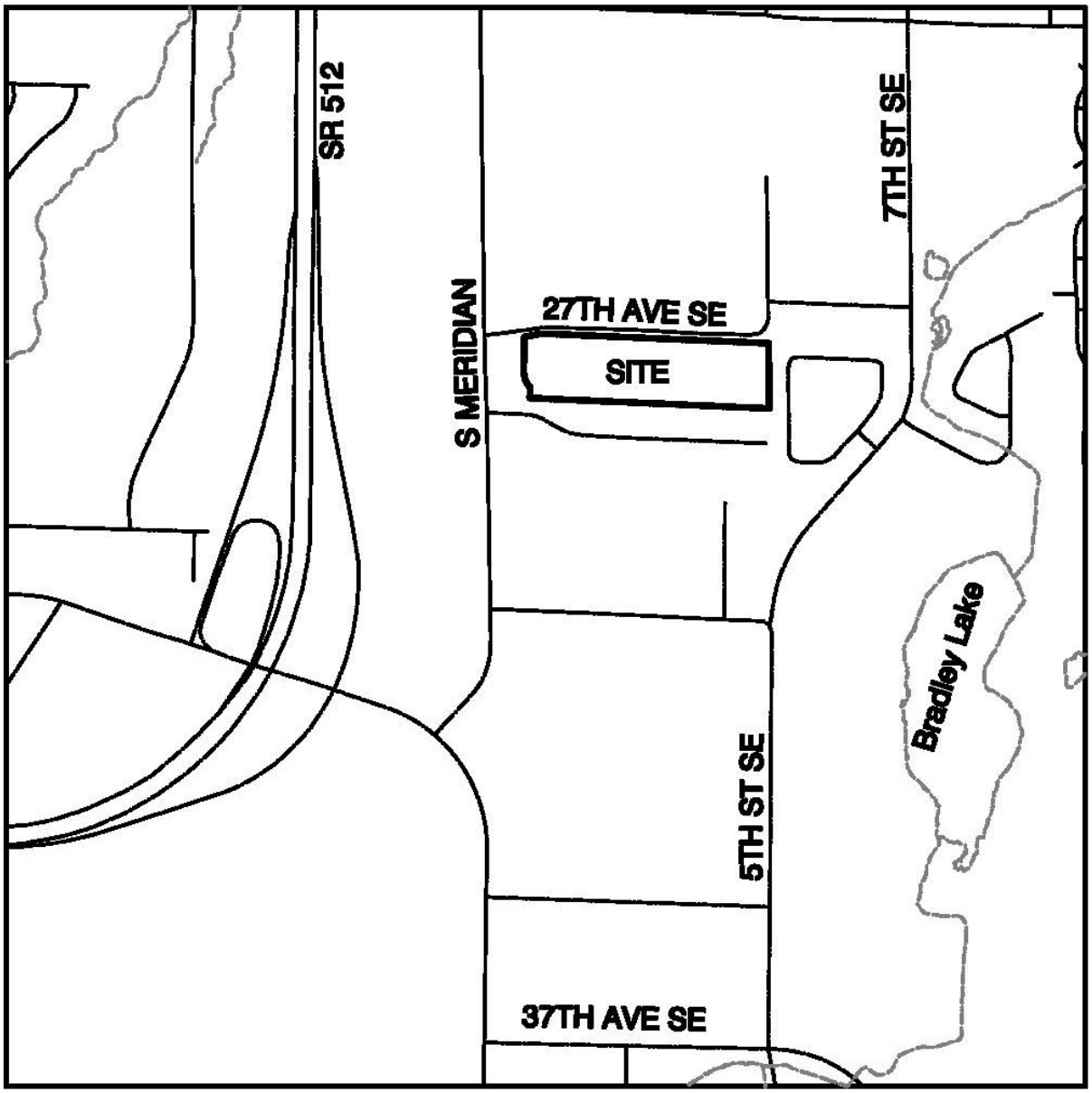
Minimum Requirement #8: Wetlands Protection

There are no wetlands on or near the site.

Minimum Requirement #9: Operation and Maintenance

The stormwater facilities required for this project that require a maintenance plan are: conveyance system, detention vault, flow restrictor, Filterra, Stormfilter vault, and StormFilter catch basin. All onsite stormwater facilities will be owned, operated, and maintained by the property owner. An O&M plan is included as a separate document. Frontage improvements will be owned and maintained by the City of Puyallup.

Figure 1. Site Location:



VICINITY MAP

Section II – Existing Conditions Summary

Topography:
In existing conditions the site slopes to the northwest, with slopes generally between 5 and 10%. The steepest portion of the site is 14%, with about 10 feet of fall in the west end of the property.

Ground Cover:
The site is developed as a mobile home park. A drive aisle runs through the site with parking areas for each unit. The non-hard surface areas are covered with lawn and landscaping.

Drainage:
There is no defined drainage course onsite. Any surface runoff that does not infiltrate sheet flows northwest into 27th Ave SE.

Soils:
The NRCS Soil Survey of Pierce County indicates the soils on the majority of the site are Everett gravelly sandy loam (13B & 13C). The soils in the northwest corner of the site are mapped as Kitsap silt loam (20B). Based on the soils exploration performed by GeoResources, the soils vary over site, consisting of recessional outwash, glacial till, and glaciolacustrine soils, generally matching the USDA mapping. Groundwater monitoring was performed during the winter of 2021 with peak groundwater reaching elevation 361.0 on the west end of the site and 383.0 on the east end of the site. The field tested infiltration rate was less than 0.1 inch per hour and therefore infiltration of runoff is deemed infeasible.

Floodplain
The project site does not include a floodplain based on latest FIRM and Pierce County flood data.

Section III – Off-Site Analysis

Upstream

Approximately 3.9 acres immediately south and east of the site drains onto the site. The drainage area is limited by 28th Ave SE and the drainage system within that road that collects any other upstream runoff. The tributary area is similar in topography to the site and is developed with moderate density single-family lots.

Downstream

From the project site, runoff sheet flows north into 27th Ave SE and is collected in the public closed conveyance system consisting of 12-inch pipe along the project frontage. This system flows west, with pipe size increasing to 24-inch right before connecting in the Meridian conveyance system. The Meridian conveyance system is a 24-inch pipe flowing north for approximately 1150 feet to the ¼ mile downstream point. This point is approximately 400 feet north of 23rd Ave SW

Problems

There are no known drainage problems along this downstream route, the road grade is approximately 8% for several hundred feet of fall.

Section IV – Permanent Stormwater Control Plan

Various basing and points of compliance (POC) are used in the hydrologic analysis. Of primary importance is POC 1, which is used to show overall flows from the site and compliance with flow control requirements. POC 7 is used for an offsite analysis to show that the offsite flows are not required to be bypassed around the detention systems. POC 2-6, 8 and 9 are used for treatment analysis. Because WWHM will not output treatment results if there is not a corresponding basin in the pre-development conditions, basins are created in the predeveloped scenario connected to these POC, but the data is unimportant and simply are placeholders so that the WWHM report will show treatment rates/volumes. The following tables summarize the various basins and POC used:

WWHM Basin & POC Summary		
PreDeveloped		
Basin Name/Number	Connected to	Purpose
1	POC 1	Comparison of Flows for Flow Control
2	POC 2	Placeholder for Treatment Analysis
3	POC 3	Placeholder for Treatment Analysis
4	POC 4	Placeholder for Treatment Analysis
5	POC 5	Placeholder for Treatment Analysis
6	POC 6	Placeholder for Treatment Analysis
7	POC 7	Offsite flow analysis
8	POC 8	Placeholder for Treatment Analysis
9	POC 9	Placeholder for Treatment Analysis
Mitigated		
Basin Name/Number	Connected to	Purpose
1	StormTank 1 then to POC 1	Analysis of StormTank 1 and Flow Control Analysis
2	Vault 2 then to POC 1; also to POC 4	Analysis of Vault 2 and Flow Control Analysis; also for treatment volume analysis
3	Vault 3 then to POC 1	Analysis of Vault 3 and Flow Control Analysis
4	Vault 4 then to POC 1	Analysis of Vault 4 and Flow Control Analysis
5	POC 1	Bypass flows for Flow Control Analysis
8	POC 7	Offsite flow analysis
Filterra 1-1	POC 2	Sizing of Filterra
Filterra 1-2	POC 3	Sizing of Filterra
Vault 3 South	POC 5	Treatment volume analysis
Vault 3 North	POC 6	Treatment volume analysis
Vault 4	POC 8	Treatment volume analysis
Frontage Treatment	POC 9	Treatment flow rate analysis

Existing Site Hydrology

In existing conditions, any runoff travels northwesterly across the site as sheet flow and is collected along the frontage in the storm system in 27th Ave SE. The areas that must be considered in the hydrologic analysis are the project site itself, the area within the frontage that will be disturbed, and the offsite tributary area.

Drainage Analysis	sf	ac
Project Onsite Area	339103	7.7847
Frontage Area	36972	0.8488
Upstream Trib Area	170772	3.9204
Total	546847	12.5539

Offsite tributary runoff

Because the offsite tributary runoff will not be bypassed, that area is modeled as in existing conditions. Section III-2.4 of the Manual allows this as long as the 100-year peak flow rate from the area not requiring mitigation is less than 50% of the 100-year undetained developed peak flow rate from the area requiring mitigation. The non-mitigation area consists of the 3.92 ac of upstream offsite area shown above. The offsite tributary area is delineated as:

Upstream Area	sf	ac
Total Area	170772	3.9204
Driveway	20279	0.4655
Shoulder	2550	0.0585
Roof	27690	0.6357
Patio	3804	0.0873
Total Impervious	54323	1.2471
Lawn	116449	2.6733

The total non-mitigation and mitigation required areas are tabulated below. POC 7 is used in the WWHM for this comparison/analysis:

POC 7	Non Mitigation Area		Mitigation Area	
Impervious	sf	acre	sf	acre
Roof	27690	0.6357	89617	2.0573
Driveway, Flat	20279	0.4655	0	0.0000
Sidewalk	3804	0.0873	43168	0.9910
Parking, Flat	2550	0.0585	138544	3.1805
Total Impervious	54323	1.2471	271329	6.2289
C, Lawn, Mod	116449	2.6733	221195	5.0779
Total	170772	3.9204	492524	11.3068

The resulting runoff rates are:

Flow Frequency		
Flow(cfs)	Predeveloped	Mitigated
2 Year =	0.6097	2.5690
5 Year =	0.9047	3.5789
10 Year =	1.1363	4.3342
25 Year =	1.4737	5.3921
50 Year =	1.7597	6.2585
100 Year =	2.0774	7.1950

The predeveloped 100-year runoff rate of the non-mitigated areas is 2.08 cfs, which is 29% of the undetained area to mitigated runoff rate of 7.20 cfs. Since this is less than 50%, the non-mitigated area may be treated as it's existing condition in the hydrologic analysis.

Pre-Developed Hydrology

Because the existing site is developed, the existing lawn area that will remain as lawn does not need to address the minimum requirements, so that only the new and replaced impervious areas are modeled as forest in pre-developed conditions. This will consist of 27,684 sf of paving and sidewalk sidewalk in 27th Ave SE and 236,648 sf of new impervious onsite, for a total of 264,332 sf to be modeled as forest. The resulting breakdown of areas for pre-developed conditions are:

PREDEVELOPED	sf	ac
Total Area	546847	12.5539
Pervious		
C, Forest, Mod	264332	6.0682
C, Lawn, Mod	228192	5.2386
Total Pervious	492524	11.3068
Impervious		
Roof	27690	0.6357
Driveways, Flat	20279	0.4655
Sidewalks, Flat	3804	0.0873
Parking, Flat	2550	0.0585
Total Impervious	54323	1.2471

Based on the USDA soil mapping of the site, the soils are a mix of hydrologic group A and C. However, because the tested infiltration rate shows that infiltration is infeasible, the soils are modeled as hydrologic group C. The slopes are moderate. The project site is within the 42-inch, East rainfall zone and WWHM is run with 15-minute intervals. See Appendix A for WWHM analysis. POC 1 is used for comparison of pre-developed and developed conditions.

The peak runoff rates calculated by WWHM2012 for predeveloped conditions are:

Flow Frequency	
Flow(cfs)	0501 15m
2 Year =	0.8491
5 Year =	1.3562
10 Year =	1.7684
25 Year =	2.3845
50 Year =	2.9184
100 Year =	3.5212

Developed Site Hydrology

Drainage Basins

Due to topographical constraints, four separate detention facilities will be used to provide flow control. It is not feasible to collect drainage from the frontage or the west edge of the project, so this area is designated as bypass for the flow control analysis. The drainage basin delineations below are for developed conditions. All detention sub-basins are routed to detention vault modules, while the bypass basin is routed directly to POC 1 for proper accounting of developed flow conditions for the flow control requirements.

	Area (ac)					
Cover	Detention #1	Vault #2	Vault #3	Vault #4	Bypass	Total
C, Lawn, Mod	0.5500	0.9477	0.9517	2.2262	0.4023	5.0779
Impervious						
Parking/Road, Flat	0.3901	0.6489	0.3897	1.8678	0.4081	3.7046
Sidewalk, Flat	0.0634	0.1478	0.2081	0.2710	0.3881	1.0783
Roof	0.3275	0.7918	0.4604	1.1134	0.0000	2.6930
Total Imperv	0.7809	1.5885	1.0581	3.2521	0.7962	7.4759
Total	1.3309	2.5362	2.0099	5.4784	1.1986	12.5539

The peak runoff rates calculated by WWHM2012 for developed conditions (prior to detention) are:

```
   Flow Frequency
 Flow(cfs)  0701 15m
2 Year   =    2.7112
5 Year   =    3.7542
10 Year  =    4.5307
25 Year  =    5.6142
50 Year  =    6.4987
100 Year =    7.4521
```

Flow Control

StormTank, an underground detention lattice structure, will be used for detention for area #1 on the west end of the project. Three other detention vaults will be used across the site. Each detention system will have a separate outlet control device. But, all four detention systems are tied to POC 1 to show compliance with flow control requirements. The requirement is that stormwater discharges shall match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50 percent of the 2-year recurrence interval peak flow up to the full 50-year peak flow. The vaults are sized to meet this requirement with a minimum of six inches of freeboard between the 50-year stage and the bottom of lid. StormTank #1, and vault #3 are configured with a single orifice, and notched standpipe for outlet control. Vault #2 is configured with a single orifice and flat standpipe with height set at 0.9 feet below maximum design stage elevation. Vault #4 is configured with a 3-orifice standpipe. Following are the vault configurations:

Detention Systems					
	StormTank #1	Vault #2	Vault #3		Vault #4
Length (feet)	100	276	240		396
Width (feet)	20	16.5	16		18.5
Storage Depth (feet)	2	4.5	6		6
Live Storage Volume(cf)	4000	20493	23040		43956
Orifice dia. (in)	1	1.3125	0.75		2
Riser Height (ft)	2	3.6	6		6
Notch Height (ft)	0.5	1	1.5	2nd orifice dia (in)	0.75
Notch Width (ft)	0.5	0.5	0.1875	2nd orifice height(ft)	2.75
Riser Dia. (in)	12	12	12	3rd orifice dia (in)	2
				3rd orifice height (ft)	4.75

The WWHM analysis in Appendix A shows that POC 1 meets the flow control requirement. Following are the developed flows, being the combined flows of all detention systems plus bypass, all flow rates are less than pre-developed conditions:

Flow Frequency

Flow(cfs)	0801 15m
2 Year =	0.5994
5 Year =	0.8791
10 Year =	1.1107
25 Year =	1.4635
50 Year =	1.7754
100 Year =	2.1340

The stage of detention in the vaults:

Stage Frequency

(feet)	Det #1	Vault #2	Vault #3	Vault #4
2 Year =	1.6471	2.3029	3.4387	2.5486
5 Year =	1.7944	3.0442	4.4467	3.5614
10 Year =	1.8571	3.4889	4.9957	4.2580
25 Year =	1.9131	4.0066	5.5838	5.1661
50 Year =	1.9433	4.3647	5.9596	5.8624
100 Year =	1.9668	4.7023	6.2920	6.5755

Runoff Treatment

Because the project is multi-family, enhanced treatment of onsite runoff is required. For Basin #1 on the west end of the project, Filterra devices will be used due to lack of depth. Filterra has GULD approval for enhanced treatment. For the other three onsite basins, a treatment train consisting of combined wetvault/detention vault, followed by StormFilter cartridges with ZPG media will be used. Each vault will have a wetvault, with a single StormFilter vault for all three detention vaults. For the frontage improvements a StormFilter catch basin with Phosorb media will be used. Phosorb media has GULD approval for basic treatment

Filterra

Two Filterra vaults will be used for the west end of the project. Per the DOE GULD for Filterra, the required size of the system is based on a design infiltration rate. For both basic and enhanced treatment, the required infiltration rate is 175 in/hr. The following table shows the drainage basins to both Filterra devices, the resulting treatment flow rates, the required Filterra area, the selected Filterra model with provided area.

	Filterra 1-1		Filterra 1-2	
	POC 2		POC 3	
Cover	Area		Area	
	sf	ac	sf	ac
C, Lawn, Mod	21447	0.4924	2509	0.0576
Paving	8886	0.2040	8105	0.1861
Roof	787	0.0181	0	0.0000
Sidewalk	373	0.0086	2387	0.0548
Total Imperv	10046	0.2306	10492	0.2409
Total Area	31493	0.7230	13001	0.2985
Treatment Flow (cfs)	0.0213		0.0216	
Q100 (cfs)	0.3834		0.234	
Fiterra Rate (in/hr)	175			
Required Area (sf)	5.26		5.33	
Filterra Model	FTPD0404		FTPD0404	
Bay Area (sf)	16		16	

Treatment Train

Vaults #2, #3, & #4 will use a treatment train to provide enhanced treatment. The first stage of the treatment train will be wetvaults, incorporated as dead storage beneath the live storage in each of the vaults. The required wetvault volume is calculated as the treatment volume within WWHM. The wetvaults are required to consist of two cells, with a minimum dead storage depth of 4 feet in the first cell, and 35% of the storage in the first cell. The minimum required length to width ratio is 3:1. Due to configuration and structural limitations, meeting the 35% first cell requirement is not always practical, in these cases, the total volume provided exceeds the required volume as a mitigating measure.

For the treatment volume analysis by WWHM, separate POCs are used from the flow control analysis. For vault #2, the drainage area is the same as to detention, but POC 4 is used. For vaults #3 and #4, some roof area is routed separately so separate basins are used, plus vault #3 has two inlets, with separate wetcells. Vault #3 uses POC 5 for drainage into the south end of the vault and POC 6 for drainage into the north end of the vault. Vault #4 uses a separate basin and is connected to POC 8 for treatment analysis. The following table summarizes the separate basins used for vaults 3 and 4:

	Detention Vault #3				Detention Vault #4	
	3-South		3-North		4	
	POC 5		POC 6		POC 8	
	Area		Area		Area	
	sf	ac	sf	ac	sf	ac
C, Lawn, Mod	27828	0.6388	13630	0.3129	96975	2.2262
Paving	16446	0.3775	530	0.0122	81361	1.8678
Roof	4703	0.1080	9455	0.2171	29317	0.6730
Sidewalk	2193	0.0503	6871	0.1577	11804	0.2710
Total Imperv	23342	0.5359	16856	0.3870	122482	2.8118
Total Area	51170	1.1747	30486	0.6999	219457	5.0380

The following table shows the required and provided treatment volumes in the wetvaults as well as the resulting length to width ratios.

Wetvaults				
	Vault #2	Vault #3-S	Vault #3-N	Vault #4
POC	4	5	6	8
Req'd Treat Volume (ac-f	0.2024	0.0792	0.0522	0.3781
Req'd Treat Volume (cf)	8817	3450	2274	16470
Cell #1 depth	4	4	4	4
Cell #1 Length	92	24	32	82
Cell #1 Width	16.5	16	16	18.5
Cell #1 Volume	6072	1536	2048	6068
Cell #1 Required Volume	3086	1207	796	5765
Cell #2 depth	4	4	4	4
Cell #2 Length	92	43	59	182
Cell #2 Width	16.5	16	16	18.5
Cell #2 Volume	6072	2752	3776	13468
Cell #2 Required Volume	5731	2242	1478	10706
Total Volume Provided	12144	4288	5824	19536
L:W	11.2	4.2	5.7	14.3

The second stage of the treatment train is a StormFilter vault with 18-inch Stormfilter cartridges with PhosphoSorb media. All three vaults will drain to a single vault. For post-detention filters, the design rate is the two year release rate. The flow rate per cartridge is 12.53 gpm.

StormFilter		
	2-year release rate (cfs)	100-year release rate (cfs)
Vault 2	0.0775	0.7042
Vault 3	0.0356	0.4513
Vault 4	0.1735	0.4828
Total	0.2866	1.6383
Design Rate (gpm)	128.6	
Cartridge flow rate (gpm	12.53	
Req'd # of cartridges	11	

Treatment Train

StormFilter Catch Basin – Frontage Treatment

Drainage from the frontage road improvements will be routed to a StormFilter catch basin at the west end of the improvements. The drainage basin delineation for the frontage improvements is:

	POC 9 Area	
	sf	ac
C, Lawn, Mod	16333	0.3750
Paving	17778	0.4081
Roof	0	0.0000
Sidewalk	16905	0.3881
Total Imperv	34683	0.7962
Total Area	51016	1.1712
Treatment Flow (cfs)	0.0711	
Treatment Flow (gpm)	31.91	
Cartridge Rate (gpm/cart)	18.79	
Req'd # of Cartridges	2	
Q100 (cfs)	0.8285	

The treatment flow rate is 0.0711 cfs, or 31.91 gpm. 27-inch cartridges with Phosorb media will be used with a per cartridge flow rate of 18.79 gpm, resulting in 2 cartridges required. The peak 100-year rate is 0.8285 cfs.

Conclusions

As explained above, the Minimum Requirements only apply to new and replaced hard surfaces. Drainage from all new and replaced hard surfaces will be routed to detention structures and treatment devices. The analysis shows that the flow control and treatment requirements are met.

Section V – Construction Stormwater Pollution Prevention Plan

Following are the 12 elements of the SWPPP. Where specific BMP's are prescribed, they are explained as shown on the engineering drawings for the project. Alternate BMP's may be acceptable in lieu of, or as a supplement to the prescribed BMP's. Where identified, alternate BMP's are listed and requirements included.

Element #1 – Mark Clearing Limits

Construction fencing will be used to mark clearing limits, except where boundary fencing already exists.

Element #2 – Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site. A construction access will be installed at each of the three proposed driveway approach locations. The specific BMPs to be used include:

- BMP C105: Stabilized Construction Access

Alternative BMPs:

- BMP C106: Wheel Wash
- BMP C107: Construction Road/Parking Area Stabilization

Element #3 – Control Flow Rates

Concentrated runoff shall be collected and conveyed to a sediment pond for detention and release. The required surface area of the sediment pond is based on the 2-year flow rate. The required orifice size is based on the sediment pond surface area. The riser diameter and overflow spillway are based on the 100-year flow rate. The following tables detail the sediment pond sizing requirements.

BMP's:

- BMP C241: Sediment Pond

Sediment Pond Sizing	
Q_2 (cfs)	2.46
SA (sf)	5117
Live Depth (ft)	3.5
Area of orifice (sf)	0.046
Orifice Dia. (in)	2.90
6:1 L:W	
Minimum Width (ft)	29
Length @ Min. W (ft)	175
3:1 L:W	
Maximum Width (ft)	41
Length @ Max. W (ft)	124
Overflow Spillway	
Q100 (cfs)	7.62
Height of Water (ft)	0.479
side slope (:1)	3
Length of Weir (ft)	6
Q100 (cfs)	7.62
Riser diameter	
Head (ft)	1.0
Diameter (in)	18

Element #4 – Install Sediment Controls

All stormwater runoff from disturbed areas shall pass through an appropriate sediment removal BMP before leaving the construction site or prior to being discharged to an infiltration facility. Interceptor swales will be used to collect runoff from the majority of the site for routing to the sediment pond discussed above in Element #3. Drainage from small areas around the perimeter will flow through silt fence. The specific BMPs to be used for controlling sediment on this project include:

- BMP C200: Interceptor Dike and Swale
- BMP C207: Check Dams
- BMP C233: Silt Fence

Element #5 – Stabilize Soils

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that shall be used on this project include:

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching

Exposed areas and soil stockpiles must be stabilized according to the following schedule:

1. From April 1 to October 31 all disturbed areas at final grade and all exposed areas that are scheduled to remain unworked for more than 30 days shall be stabilized within 10 days.
2. From November 1 to March 31 all exposed soils at final grade shall be stabilized immediately using permanent or temporary measures. Exposed soils with an area greater than 5,000 square feet that are scheduled to remain unworked for more than 24 hours and exposed areas of less than 5,000 square feet that will remain unworked for more than seven (7) days shall be stabilized immediately.

All disturbed areas which are not planned to be constructed on within 90 days from time of clearing and grading shall be revegetated with the native vegetation.

In general, cut and fill slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. All stockpiled soils shall be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

Alternate BMP's:

- BMP C123: Plastic Covering
- BMP C124: Sodding
- BMP C125: Topsoiling

Element #6 – Protect Slopes

The slopes within the clearing limits/area to be disturbed are nearly flat. A retaining wall will be constructed early in the construction process, mitigating the need for any slope protection.

Element #7 – Protect Drain Inlets

All storm drain inlets and culverts made operable during construction shall be protected to prevent unfiltered or untreated water from entering the drainage conveyance system. However, the first priority is to keep all access roads clean of sediment and keep street wash water separate from entering storm drains until treatment can be provided. Storm Drain Inlet Protection (BMP C220) will be implemented for all drainage inlets and culverts that could potentially be impacted by sediment-laden runoff on and near the project site. The following inlet protection measures will be applied on this project:

- BMP C220: Storm Drain Inlet Protection

Element #8 – Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels or discharged to a stream or some other natural drainage point, efforts will be taken to prevent downstream erosion. No surface channels or outlets are proposed for this project.

Element #9 – Control Pollutants

All pollutants, including waste materials and demolition debris, that occur onsite shall be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventative measures will be taken to ensure that the site will be kept clean, well organized, and free of debris. If required, BMPs to be implemented to control specific sources of pollutants are discussed below.

Vehicles, construction equipment, and/or petroleum product storage/dispensing:

- All vehicles, equipment, and petroleum product storage/dispensing areas will be inspected regularly to detect any leaks or spills, and to identify maintenance needs to prevent leaks or spills.
- On-site fueling tanks and petroleum product storage containers shall include secondary containment.
- Spill prevention measures, such as drip pans, will be used when conducting maintenance and repair of vehicles or equipment.
- In order to perform emergency repairs on site, temporary plastic will be placed beneath and, if raining, over the vehicle.
- Contaminated surfaces shall be cleaned immediately following any discharge or spill incident.

Specific construction related BMP's to be used include:

- Concrete Handling (C151)
- Sawcutting and Surfaceing Pollution Prevention (C152)
- Material Delivery, Storage and Containment (C153)
- Concrete Washout Area (C154)
- Treating and Disposing of High pH Water (C252)

Element #10 – Control Dewatering

Work will commence during the dry season, therefore no dewatering is likely to be required. If groundwater is encountered during construction, the water from all de-watering systems for trenches and foundations may be disposed of in one of the following manners:

(1) Foundation, vault, and trench de-watering water which have similar characteristics to stormwater runoff at the site shall be discharged into a controlled conveyance system prior to discharge to a sediment trap or sediment pond.

(2) Clean, non-turbid de-watering water, such as well-point ground water, can be discharged to systems tributary to or directly into surface waters of the state, provided the de-watering flow does not cause erosion or flooding of receiving waters. Clean de-watering water should not be routed through stormwater sediment ponds. Other disposal options for clean, non-turbid de-watering water may include:

(a) Infiltration;

(b) Transportation off-site in a vehicle (such as a vacuum flush truck) for legal disposal in a manner that does not pollute state waters;

(c) On-site chemical treatment or other suitable treatment technologies approved by the department and Washington State Department of Ecology;

(d) Sanitary sewer discharge with local sewer district approval, if there is no other option; and

(e) Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized de-watering water.

Element #11 – Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with each particular BMP's specifications. Visual monitoring of the BMPs will be conducted at least once every calendar week and within 24 hours of any rainfall event (typically around 0.5" in 24-hour period) that causes a discharge from the site. If the site becomes inactive, and is temporarily stabilized, the inspection frequency may be reduced to once every month, during the dry season

All temporary erosion and sediment control BMPs shall be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. The need for TESC measures continuance or removal shall be determined by the designated site CESC lead person with concurrence of the County inspector. Trapped sediment shall be removed or stabilized on site. Disturbed soil resulting from removal of BMPs or vegetation shall be permanently stabilized.

Element #12 – Manage the Project

Erosion and sediment control BMPs for this project have been designed based on the following principles:

- Design the project to fit the existing topography, soils, and drainage patterns.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of the area exposed.
- Keep runoff velocities low.
- Retain sediment on site.
- Thoroughly monitor site and maintain all ESC measures. A Certified Erosion and Sedimentation Control Lead (CESCL) person shall be assigned to the project and will file regular and special inspection reports with the County Planning and Land Services Department.
- Schedule major earthwork during the dry season.

In addition, project management will incorporate the key components listed below:
As this project site is located west of the Cascade Mountain Crest, the project will be managed according to the following key project components:

Phasing of Construction

- The construction project is being phased to the extent practicable in order to prevent soil erosion, and, to the maximum extent possible, the transport of sediment from the site during construction.
- Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities during each phase of construction, per the Scheduling BMP (C 162).

Seasonal Work Limitations

- From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:
  - ☐ Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters; and
  - ☐ Limitations on activities and the extent of disturbed areas; and
  - ☐ Proposed erosion and sediment control measures.
- Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance.
- The following activities are exempt from the seasonal clearing and grading limitations:
  - ☐ Routine maintenance and necessary repair of erosion and sediment control BMPs;
  - ☐ Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
  - ☐ Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

Coordination with Utilities and Other Jurisdictions

- Care has been taken to coordinate with utilities, other construction projects, and the local jurisdiction in preparing this SWPPP and scheduling the construction work.

Inspection and Monitoring

- All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person has the necessary skills to:
  - ☐ Assess the site conditions and construction activities that could impact the quality of stormwater, and
  - ☐ Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.
- Whenever inspection and/or monitoring reveals that the BMPs identified in this SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP

- This SWPPP shall be retained on-site or within reasonable access to the site.
- The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.
- The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) days following the inspection.

Specific management related BMP's to be used include:

- Certified Erosion and Sediment Control Lead (C160)
- Scheduling (C162)

Section VI – Special Reports and Studies

See Geotech report in Appendix B.

Section VII – Other Permits

Required permits include, but are not limited to:

- Building permits will be required for construction of the future buildings.
- Building permits for concrete detention vaults
- Building permits for retaining walls
- Sewer service permits for each building
- Water service permits for each building
- NPDES coverage through DOE

Section VIII – Operation and Maintenance Manual

An Operations and Maintenance Manual is required for the StormTank gallery, Detention/Wetvaults, Filterra, StormFilter vault, StormFilter catch basin and conveyance system. The O&M Manual is included as a separate document.

Section IX – Bond Quantities Worksheet

Any required bond amounts will be calculated when required for permit issuance.

APPENDIX A

WWHM Analysis

APPENDIX B

Geotechnical Report

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February 10, 2022

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Geotechnical Engineering Report
Proposed Multi-Family Development
202 – 27th Avenue Southeast
Puyallup, Washington
PN: 0419036006
Doc ID: Timberlane.BradleyHeights.RG

INTRODUCTION

This *geotechnical engineering report* summarizes our site observations, subsurface explorations, laboratory testing and engineering analyses, and provides geotechnical recommendations and design criteria for the proposed multi-story, multi-family residential development to be located at 202 – 27th Avenue Southeast in the City of Puyallup within Pierce County, Washington. The development is proposed to be on one Pierce County tax parcel, numbered 0419036006. The site is currently in use as a trailer park with multiple single-family trailers and access road. The general location of the site is shown on the attached Site Location Map, Figure 1.

Our understanding of the project is based on our discussions with you, a review of the *Conceptual Site Plan* provided to us by Azure Green Consultants (attached as our Figure 2), our subsurface explorations, including those completed during our most recent December 22, 2021 site visit, and our experience in the general area.

We understand that the proposed development will include the construction of 12 multi-family residential structures and one clubhouse building. We anticipate the structures will range from one to three stories and will be supported by conventional spread footings. Additional development will include paved drive lanes and parking areas, a below-grade stormwater facility, and associated typical below grade utilities.

SCOPE

The purpose of our services was to evaluate the surface and subsurface conditions across the site as a basis for providing geotechnical recommendations and design criteria for the proposed development. Specifically, the scope of services for this project will include the following:

1. Reviewed available geological, hydrogeological, and geotechnical literature for the site area;

2. Monitoring the drilling of three hollow-stem auger borings to depths of about 21 feet below existing grades and completed as groundwater observation wells;
3. Describing surface and subsurface conditions, including soil type, and depth to groundwater;
4. Performing one Small Scale (PIT) at a location and elevation determined and approved by the project civil engineer;
5. Providing seismic design parameters, including 2018 IBC site class;
6. Providing geotechnical conclusions and recommendations regarding site grading activities, including site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut slopes and drainage and erosion control measures;
7. Providing recommendations for the design and construction of shallow foundations and slabs-on-grade including bearing capacity and subgrade modulus as appropriate;
8. Providing our opinion about the feasibility of onsite infiltration in accordance with the 2012 (with 2014 updates) Department of Ecology Stormwater Management Manual for Western Washington (SWMMWW);
9. Providing recommendations for erosion and sediment control during wet weather grading and construction;
10. Preparing this written *Geotechnical Engineering Report* summarizing our site observations and conclusions, and our geotechnical recommendations and design criteria, along with the supporting data; and,
11. Monitoring groundwater levels on a monthly basis during the prescribed wet season and prepare a written report addendum summarizing the collected data.
12. Provided a design infiltration rate based on in-situ testing, as applicable; and,
13. Updated our preliminary *Geotechnical Engineering Report*, summarized our site observations and conclusions, our geotechnical recommendations and design criteria, along with supporting data.

The above scope of work was summarized in our Proposal for Geotechnical Engineering Services dated December 3, 2021. We received authorization from Mr. David R. Enslow the same day.

SITE CONDITIONS

Surface Conditions

The site is located at 202 – 27th Avenue Southeast in Puyallup, Washington (PN: 0419036006), within an area of existing residential development. The site is generally rectangular in shape, measures approximately 1,115 to 1,130 feet wide (east to west) by 300 feet long (north to south), and encompasses about 7.78 acres. The site is bounded by residential development to the south, east, and west, and by 27th Avenue Southeast to the north.

The site generally slopes gently down from southeast to northwest towards the intersection of 27th Avenue Southeast and South Meridian. The southeastern and south-central portions of the site slope down at approximately 3 to 5 percent, while the north-central and southwestern portions of the site slope down to the northwest at approximately 7 to 10 percent, with localized slopes of approximately 20 to 22 percent located in the southwestern corner of the site. The northwestern corner of the site slopes down to 27th Avenue Southeast at approximately 2 to 4 percent. The total topographic

relief across the site is on the order of 48 to 50 feet.

Vegetation across the site generally consists of typical residential landscaping and grass lawn areas with occasional coniferous and deciduous trees along the site perimeter and scattered within the existing lots. No areas of erosion or slope instability were noted at the site at the time of our reconnaissance.

Site Soils

The USDA Natural Resource Conservation Survey (NRCS) Web Soil Survey maps most of the site, including the areas of proposed development, as being underlain by Everett gravelly sandy loam (13B and 13C). An area in the northwestern portion of the site is mapped as being underlain by Kitsap silt loam (20B). An excerpt from the NRCS soils map for the site area is included as Figure 3. These soils are described below.

- Everett very gravelly sandy loam (13B, 13C): The Everett soils are typically derived from sandy and gravelly glacial outwash and form on slopes of 0 to 8 (13B) and 8 to 15 (13C) percent. These soils are listed as having a "slight" (13B) and "moderate," (13C) erosion hazard when exposed, and are included in hydrologic soils group A.

- Kitsap Silt Loam (20B): The Kitsap soils are derived from glaciolacustrine deposits, form on slopes of 2 to 8 percent, are listed as having a "slight to moderate" erosion hazard, and are included in hydrologic soils group C/D.

Site Geology

The draft *Geologic Map of the Puyallup 7.5-minute Quadrangle, Washington* by K. W. Troost (in review) maps the site as being underlain by recessional outwash ($Qvsb_4$) and adjacent to areas mapped as underlain by recessional lacustrine deposits (Qvrl). These glacial soils were deposited during near the end of the Vashon Stade of the Fraser Glaciation, approximately 12,000 to 15,000 years ago. An excerpt of the above reference geologic map is attached as Figure 3. Description of the geologic units is provided below.

- Recessional Outwash ($Qvsb_4$): Recessional outwash deposits typically consist of a poorly sorted, lightly to moderately stratified mixture of sand and gravel that may locally contain silt or clay. Recessional outwash was deposited by meltwater streams issuing from the receding continental ice mass. Accordingly, they are considered normally consolidated and offer moderate strength properties where undisturbed. The potential for stormwater infiltration is generally favorable, depending on grain size.

- Recessional-Lacustrine (Qvrl): Recessional-lacustrine or glaciolacustrine deposits typically consist of a stratified to varved deposit of clay, silt, and sand that was deposited within glacial lakes or other low energy fluvial environments. These deposits are considered normally consolidated and exhibit low to moderate strength and moderate compressibility characteristics where undisturbed. Because of the silty nature of recessional lacustrine soils, the potential for stormwater infiltration is low.

Subsurface Explorations

As part of the scope of work for this study, on January 24, 2020 a GeoResources representative was on site and monitored the drilling of three hollow-stem auger borings to depths of 21 to 21½ feet

below existing grades. After termination of drilling, each boring was completed as a groundwater monitoring well in accordance with Washington Department of Ecology Regulations. On December 22, 2021, a GeoResources representative returned to the site and monitored the excavation of two test pits (TP-101 and TP-102) and performed a small-scale pilot infiltration test (PIT) in general accordance with the 2019 Department of Ecology Stormwater Management Manual of Western Washington (2019 SWMMWW) to determine the initial saturated hydraulic conductivity ($K_{sat,\ initial}$) of the subsurface soils at 4 feet below existing grades. The PIT was completed at the location of TP-102. The test pits were excavated by a licensed contractor operating a track mounted excavator working for us.

On March 21, 2018, we monitored the excavation of five test pits to depths of 7½ to 8½ feet below existing grades under a separate scope of work. The work was completed for a different client as a portion of their feasibility period to purchase the property. The test pits are labeled as TP-1 through TP-5 and their locations are approximately shown on the Site and Exploration Plan, Figure 2.

The specific number, locations, and depths of our explorations were selected by GeoResources personnel based on the configuration of the proposed development and were adjusted in the field based on site access limitations. Given the existing development, access limitations were significant. A field representative from our office continuously monitored the test pit explorations, maintained logs of the subsurface conditions encountered, obtained representative soil samples, and observed pertinent site features. The soil densities presented on the test pit logs were based on the difficulty of excavation and our experience. Each test pit was then backfilled with the excavated material and abandoned.

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 in the area 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 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. The approximate locations of our explorations are indicated on the attached Site and Exploration Map, Figure 2, while the descriptive logs of our explorations and are included in Appendix A.

Subsurface Conditions

In our opinion, the soils we encountered generally confirmed the mapped stratigraphy at the site and typical conditions for the general site area. In the western portion of the site, we generally encountered tan to light brown massive to laminated silt that was in a soft wet condition which we interpret as glaciolacustrine recessional outwash. In the central portions of the site, we encountered variable surficial conditions ranging from silt, silty sand, and sandy gravel that was in a loose/soft to medium dense/medium stiff, moist to wet condition. We interpret these soils as glaciolacustrine recessional outwash and uncontrolled fill. In the eastern portion of the site, we encountered dense silty sand with gravel that we interpret as glacial till. It appears the surficial soils in the central and western portions of the site were underlain by glacial till at depth.

Given the limitations of our subsurface exploration program because of the developed conditions, we anticipate that additional areas of uncontrolled fill may be present on the site.

Additional subsurface explorations would be required to determine the depths, extents, and composi of uncontrolled fill at the site.

Laboratory Testing

Geotechnical laboratory tests were performed on select samples retrieved from the borings and test pits to estimate index engineering properties of the soils encountered. Laboratory testing included visual soil classification per ASTM D: 2488 and ASTM D: 2487, moisture content determinations per ASTM D: 2216, and grain size analyses per ASTM D: 6913 standard procedures. The results of the laboratory tests are included in Appendix B, and summarized below in Table 1.

TABLE 1:
LABORATORY TEST RESULTS FOR ON-SITE SOILS

Soil Type	Sample	Lab ID Number	Gravel Content (percent)	Sand Content (percent)	Silt/Clay Content (percent)
Poorly graded GRAVEL with silt and sand (GP-GM)	B-1/S-5/12½ft	099117	53.0	36.9	10.1
Well-graded GRAVEL with silt and sand (GW-GM)	B-2/S-4/10ft	099123	55.4	38.5	6.1
SILT (ML)	B-3/S-4/10ft	099129	NA	NA	97.0
NA = Not Applicable					

Groundwater Conditions

Groundwater monitoring was completed during the wet season between October 2020 to April 2021 in each of the three monitoring wells installed at the site. Monitoring was completed using downhole pressure transducers that collected daily measurements of water levels in each monitoring well. Additionally, one pressure transducer was installed at the site to provide daily measurements of barometric pressure. Measurements of barometric pressure were used to correct water level measurements for the effects of atmospheric pressure fluctuations.

Our observations indicate a seasonal perched groundwater table develops during the wet season in the western and central portions of the site. A perched groundwater table typically develops when the vertical infiltration of precipitation through a more permeable soil is slowed at depth by a deeper, less permeable soil type, such as glacial till. The groundwater table appears to have a limited thickness and fluctuates relatively rapidly. Total seasonal variation was on the order of 2 to 4 feet. Below, Table 2 summarizes the depths and elevations of groundwater observations for the site. Graphical outputs of wet season groundwater level measurements are included in Appendix C.

TABLE 2:
APPROXIMATE DEPTHS AND ELEVATIONS OF GROUNDWATER ENCOUNTERED IN EXPLORATIONS

Well ID	Depth to Seasonal High Groundwater (feet)	Seasonal High Elevation of Groundwater (feet)	Date Observed
MW-1	17	361	February 23, 21
MW-2	17	383	January 13, 21
MW-3	NE	NE	NA

Notes: NE = Not encountered NA = Not applicable

ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our data review, site reconnaissance, subsurface explorations and our experience in the area, it is our opinion that the site is suitable for the proposed multi-family development. Pertinent conclusions and geotechnical recommendations regarding the design and construction of the proposed multi-family development are presented below.

Seismic Design

The site is located in the Puget Sound region of western Washington, which is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca and North American plates. The Juan de Fuca plate is subducting beneath the North American plate at the Cascadia Subduction Zone (CSZ). This produces both intercrustal (between plates) and intracrustal (within a plate) earthquakes. In the following sections we discuss the design criteria and potential hazards associated with the regional seismicity.

Seismic Site Class

Based on our observations and the subsurface units mapped at the site, we interpret the structural site conditions to correspond to a seismic Site Class "C" in accordance with the 2018 IBC documents and American Society of Civil Engineers (ASCE) standard 7-16 Chapter 20 Table 20.3-1. This is based on the reviewed range of SPT (Standard Penetration Test) blow counts for the soil types in the site area. These conditions were assumed to be representative for the subsurface conditions for the site.

Design parameters

The U.S. Geological Survey (USGS) completed probabilistic seismic hazard analyses (PSHA) for the entire country in November 1996, which were updated and republished in 2002 and 2008. We used the *ATC Hazard by Location* website to estimate seismic design parameters at the site. Table 4, below, summarizes the recommended design parameters.

TABLE 3:
2018 IBC Parameters for Design of Seismic Structures

Spectral Response Acceleration (SRA) and Site Coefficients	Short Period	1 Second Period
Mapped SRA	S_s = 1.263	S_1 = 0.435
Site Coefficients (Site Class C)	F_a = 1.2	F_v = 1.5
Maximum Considered Earthquake SRA	S_{MS} = 1.516	S_{M1} = 0.653
Design SRA	S_{DS} = 1.010	S_{D1} = 0.435

Peak Ground Acceleration

The mapped peak ground acceleration (PGA) for this site is 0.5g. To account for site class, the PGA is multiplied by a site amplification factor (F_{PGA}) of 1.2. The resulting site modified peak ground acceleration (PGA_M) is 0.6g. In general, estimating seismic earth pressures (k_h) by the Mononobe-Okabe method or seismic inputs for slope stability analysis are taken as 1/3 to 1/2 of the PGA_M, or 0.2g to 0.3g.

Seismic Hazards

Earthquake-induced geologic hazards may include liquefaction, lateral spreading, slope instability, and ground surface fault rupture. Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure in soils. The increase in pore water pressure is induced by seismic vibrations. Liquefaction primarily affects geologically recent deposits of loose, uniformly graded, fine-grained sands and granular silts that are below the groundwater table. The site is mapped as having a "very low" liquefaction susceptibility by the *Liquefaction Susceptibility Map of Pierce County, Washington* (2004); an excerpt of this map is included as Figure 5. The soils encountered in our explorations consisted of a relatively limited thickness of loose to medium dense silty sand and medium stiff to stiff sandy silt underlain by dense to very dense glacial till. Give the limited perched groundwater table, we anticipate that settlements caused by liquefaction would be limited to less than estimated static settlements.

The ground surface at the project site is gently sloping. Accordingly, it is our opinion the potential for earthquake-induced slope instability on the site is low. No evidence of ground fault rupture was observed in the subsurface explorations or out site reconnaissance. Therefore, in our opinion, the proposed structures should have no greater risk for ground fault rupture than other structures located in the area.

Foundation Support

Based on the encountered subsurface conditions at the locations explored and the preliminary building plans, we recommend that spread footings be founded on the medium dense to very dense native glacial soils, or on structural fill that extends to suitable native soils. Based on our understanding of the proposed locations of the structures, it is our opinion that shallow foundations may be used to support the buildings; however, considerations for uncontrolled fill and loose to medium stiff native soils should be made. We have not been provided with the design loads and have assumed the structures will be lightly loaded based on our experience with similar projects.

Complete Fill Removal

Uncontrolled fill soils and soft silt deposits encountered in the lower, western portion of the site are not a suitable bearing soil for the proposed footings. Any known locations of uncontrolled fill or uncontrolled filled encountered during grading should be removed from the building envelopes of the proposed structures. Soft silt soils in the western portion of the site can likely be mitigated through grading and placement of structural fill.

We recommend that all footing elements be supported by a minimum of 2 feet of properly placed structural fill. In areas where deeper fill removal is required the foundation elements may be deepened to extend to the base of the excavation, or the excavation may be backfilled with structural fill. After removal of the fill materials, the exposed surface should be evaluated prior to placing structural fill.

Spread Footing design

Footings should bear on properly placed and compacted structural fill as discussed in the "Complete Fill Removal" section, above. Removal of unsuitable soils below the footings should extend beyond the foundation edges 1-foot horizontally for every 1-foot of vertical excavation. Loose, soft, or other unsuitable material present at the base of the excavation should be removed prior to placement of structural fill. The soil at the base of the excavations should be protected against disturbance from weather, traffic, or other adverse conditions. The excavation should be backfilled with suitable materials as described in the **"Structural Fill"** section of this report. If Control Density Fill (CDF) is used as backfill, the horizontal extent of the excavation can be limited to 1H:2V on each side of the footing.

We recommend a minimum width of 24 inches for isolated footings and at least 18 inches for continuous wall footings. All footing elements should be embedded at least 18 inches below grade for frost protection. For footing bearing surfaces prepared as described in the "Complete Fill Removal" we recommend using an allowable soil bearing capacity of 2,000 psf (pounds per square foot) for design.nnThese values are for combined dead and long-term live loads. The weight of the footing and any overlying backfill may be neglected. The allowable bearing value may be increased by one-third for transient loads such as those induced by seismic events or wind loads.

Lateral loads may be resisted by friction on the base of footings and floor slabs and as passive pressure on the sides of footings. We recommend that an allowable coefficient of friction of 0.35 be used to calculate friction between the concrete and the underlying structural fill. Passive pressure may be determined using an allowable equivalent fluid density of 300 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

We estimate that settlements of footings designed and constructed as recommended will be less than 1 inch, for the anticipated load conditions, with differential settlements between comparably loaded footings of ½ inch or less. Most of the settlements should occur essentially as loads are being applied; however, disturbance of the foundation subgrade during construction could result in larger settlements than estimated.

Floor Slab Support

We anticipate that the lower level of the structures will consist of a slab-on-grade floor. Slab-on-grade floors should be supported on medium dense native soils or on structural fill prepared as

described above. Areas of uncontrolled fill material should be evaluated during grading activity for suitability of structural support. Areas of significant organic debris should be removed.

We recommend that floor slabs be directly underlain by a minimum 4-inch thick pea gravel or washed 5/8-inch crushed rock and should contain less than 5 percent fines. This layer should be placed and compacted to an unyielding condition.

A synthetic vapor retarder is recommended to control moisture migration through the slabs. This is of particular importance where moisture migration through the slab is an issue, such as where adhesives are used to anchor carpet or tile to the slab.

A subgrade modulus of 350 kcf (kips per cubic foot) may be used for floor slab design. We estimate that settlement of the floor slabs designed and constructed as recommended, will be 1/2 inch or less over a span of 50 feet.

Subgrade/Basement Walls

The lateral pressures acting on retaining walls (such as basement or grade separation walls) will depend upon the nature and density of the soil behind the wall as well as the presence or absence of hydrostatic pressure. Below we provide recommended design values and drainage recommendations for retaining walls.

Design Values

For walls backfilled with granular well-drained soil and a level backslope, the design active pressure may be taken as 35 pcf (equivalent fluid density). For walls that are braced or otherwise restrained, the design at-rest pressure may be taken as 55 pcf. For the condition of an inclined back slope, higher lateral pressures would act on the walls. For a 3H:1V (Horizontal to Vertical) slope above the wall, the pressure may be taken as 35 pcf (equivalent fluid density). For walls that are braced or otherwise active pressure may be taken as 48 pcf; for a 2H:1V back slope condition, a wall design pressures of 55 pcf may be assumed If basement walls taller than 6 feet are required, as seismic surcharge of 12H should be included where required by the code. If walls will be constructed with a backslope and will be braced or otherwise restrained against movement, we should be notified so that we can evaluate the anticipated conditions and recommend an appropriate at-rest earth pressure.

Lateral loads may be resisted by friction on the base of footings and as passive pressure on the sides of footings and the buried portion of the wall, as described in the "**Foundation Support**" section of this report.

Wall Drainage

Adequate drainage behind retaining structures is imperative. Positive drainage which controls the development of hydrostatic pressure can be accomplished by placing a zone of drainage behind the walls. Granular drainage material should contain less than 2 percent fines and at least 30 percent retained on the US No. 4 sieve.

A minimum 4 inch diameter perforated or slotted PVC pipe should be placed in the drainage zone along the base and behind the wall to provide an outlet for accumulated water and direct accumulated water to an appropriate discharge location. We recommend that a nonwoven geotextile filter fabric be placed between the soil drainage material and the remaining wall backfill to reduce silt migration into the drainage zone. The infiltration of silt into the drainage zone can, with time, reduce the permeability of the granular material. The filter fabric should be placed such that it fully separates the drainage material and the backfill, and should be extended over the top of the drainage zone.

A soil drainage zone should extend horizontally at least 18 inches from the back of the wall. The drainage zone should also extend from the base of the wall to within 1 foot of the top of the wall. The soil drainage zone should be compacted to approximately 90 percent of the maximum dry density (MDD), as determined in accordance with ASTM D: 1557. Over-compaction should be avoided as this can lead to excessive lateral pressures on the wall. A geocomposite drain mat may also be used instead of free draining soils, provided it is installed in accordance with the manufacturer's instructions.

Below Grade Vaults

The proposed below grade vault should be designed to resist the static and dynamic lateral earth pressures presented in the **"Subgrade/Basement Walls"** section of this report. We recommend the proposed vault be completely waterproofed (exterior of foundation walls and underside of slab) to prevent water intrusion. The walls and floor slabs associated with these structures should be designed to resist the lateral and uplift forces associated with maximum estimated seasonal high groundwater levels. We recommend using a soil unit weight of 130 pcf to calculate vertical forces acting on the vault lid, base extensions, or anti-flotation slabs.

Temporary Excavations

All job site safety issues and precautions are the responsibility of the contractor providing services/work. The following cut/fill slope guidelines are provided for planning purposes only. Temporary cut slopes will likely be necessary during grading operations or utility installation. All excavations at the site associated with confined spaces, such as utility trenches and retaining walls, must be completed in accordance with local, state, or federal requirements including Washington Administrative Code (WAC) and Washington Industrial Safety and Health Administration (WISHA). Excavation, trenching, and shoring is covered under WAC 296-155 Part N.

Based on WAC 296-155-66401, it is our opinion that the glaciolacustrine recessional outwash soils on the site would be classified as Type C soils, while the underlying glacial till would be classified as Type A soils. For temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be sloped at a maximum inclination of 1½ H:1V or flatter from the toe to top of the slope; while side slopes in Type A soils should be sloped at a maximum inclination of ¾H:1V or flatter from the toe to top of the slope. All exposed slope faces should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, if construction materials will be stockpiled along the slope crest, or if construction traffic will be routed along the slope crest.

Where it is not feasible to slope the site soils back at these inclinations, shoring will be required. All shoring for the project should incorporate applicable criteria presented in the **"Subgrade/Basement Walls"** section of this report into the design. Settlement of the ground surface can occur behind shoring during excavation. The amount of settlement depends heavily on the type of shoring system, the contractor's workmanship, and soil conditions. Accordingly, we recommend that structures in the vicinity of the planned shoring installation be reviewed with regard to foundation support and tolerance to settlement.

This information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that GeoResources, LLC assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor..

Permanent Cut and Fill Slopes

We do not anticipate that permanent cut and fill slopes will be utilized for this project. However, if cut and fill slopes are required, we recommend a maximum slope of 2H:1V (Horizontal:Vertical) for permanent cut and fill slopes. Where 2H:1V slopes are not feasible, retaining structures should be considered. Where retaining structures are greater than 4 feet in height (bottom of footing to top of structure) or have slopes of greater than 15 percent above them, they should be designed by a qualified engineer.

Fill slopes constructed on grades that are steeper than 5H:1V (20 percent) should be "keyed" into the undisturbed native soils by cutting a series of horizontal benches and should be constructed in accordance with Appendix J of the 2018 IBC. The benches should be 1½ times the width of the equipment used for grading and be a maximum of 3 feet in height. Subsurface drainage may be required in areas where significant seepage is encountered during grading. Collected drainage should be directed to an appropriate discharge point.

Site Drainage

All ground surfaces, pavements and sidewalks at the site should be sloped to direct surface water away from the structures and property lines. Surface water runoff should be controlled by a system of curbs, berms, drainage swales, and or catch basins, and conveyed to an appropriate discharge point.

We recommend that footing drains are installed for the residence in accordance with IBC 1805.4.2, and basement walls (if utilized) have a wall drain as describe above. The roof drain should not be connected to the footing drain.

Stormwater Infiltration

In the following sections we provide an opinion regarding the feasibility of infiltration, and construction considerations.

Infiltration Feasibility

Based on our observations, laboratory testing, in-situ infiltration testing, and experience, it is our opinion that the soils at the site will not support on-site infiltration. On December 22, 2021, we completed a small-scale pilot infiltration test (PIT) in the lower, western portion of the site in accordance with method outlined by the current Stormwater Management Manual for Western Washington. The results of our PIT indicated the saturated hydraulic conductivity of the soils was less than 0.1 inches per hour, below the infeasibility threshold for infiltration facilities. Accordingly, we recommend that alternative stormwater management methods are used.

Construction Considerations

To reduce potential clogging of stormwater facilities, they should not be connected to the stormwater runoff system until after construction is complete and the site area is landscaped, paved or otherwise protected. Additional measures may also be taken during construction to minimize the potential of fines contamination of the proposed stormwater facility, such as utilizing an alternative

storm water management location during construction. All contractors working on the site (builders and subcontractors) should divert sediment laden stormwater away from proposed infiltration facilities during construction and landscaping activities. No concrete trucks should be washed or cleaned, and washout areas should not be within the vicinity of the proposed infiltration facilities. After construction activities have been completed, periodic sweeping of the paved areas will help extend the life of the stormwater facility.

Pavement Section Design

We understand that several pavement sections may be used for the onsite portion of the development, including hot mix asphalt (HMA) pavement sections in the passenger car parking stalls, passenger car drive lanes, and either HMA or Portland cement concrete (PCC) pavement in emergency vehicle or truck areas.

Pavement Subgrades

Pavement subgrade areas should be prepared by removing any soft or deleterious material down to firm and unyielding soils in accordance with the "**Site Preparation**" section of this report. The prepared subgrade should be evaluated by proof-rolling with a fully-loaded dump truck or equivalent point load equipment. Soft, loose, or wet areas that are identified should be recompacted or removed, as appropriate. Over-excavated areas should be backfilled with compacted structural fill. Where fill is placed, the upper 2 feet of roadway subgrade should have a maximum dry density of at least 95 percent, as determined in accordance with the ASTM D: 1557.

Pavement Sections

Pavement section thicknesses should conform to appropriate minimum sections provided in the most current City of Puyallup *Public Works Engineering & Construction Standards*, Section 100 for roadway design.

Pavement Frost Conditions

Frost-susceptible soil is generally regarded as having greater than 3 percent finer than 0.02 millimeter (mm). Soil with a fines content not exceeding 7 percent passing the No. 200 sieve, based on the minus ¾-inch fraction, can normally be expected to have 3 percent or less finer than 0.02 mm. Based on the soils observed during our construction monitoring, most of the near-surface soils could be considered frost-susceptible. Based on information provided in the WSDOT Pavement Policy, we recommend assuming the frost depth would be about 18 inches. For both rigid and flexible pavements, WSDOT recommends that the total depth of the pavement section be at least 50 percent of the frost depth.

Pavement Materials and Construction

In general, the aggregate base course, HMA, and PCC should be constructed in accordance with the most current City of Puyallup *Public Works Engineering & Construction Standards*, Section 100 for roadway design. Where not covered by Section 100, we recommend defaulting to WSDOT Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications, 2016). HMA should conform to Section 5-04 in the WSDOT Standard Specifications and the PCC should conform to Section 5-05 of the WSDOT Standard Specifications. We recommend that crushed rock used as CSBC in pavement sections consist of material of approximately the same quality as "crushed

surfacing (base course)" (or better) described in Section 9-03.9(3) of the WSDOT Standard Specifications. We further recommend that CSBC material be compacted to at least 95 percent of the MDD based on the modified Proctor procedure (ASTM D;1577).

EARTHWORK RECOMMENDATIONS

Site Preparation

All structural areas on the site to be graded should be stripped of vegetation, organic surface soils, and other deleterious materials including existing structures, foundations or abandoned utility lines. Organic topsoil is not suitable for use as structural fill, but may be used for limited depths in non-structural areas. Stripping depths ranging from 4 to 12 inches should be expected to remove these unsuitable soils. Areas of thicker topsoil or organic debris may be encountered in areas of heavy vegetation or depressions.

Where placement of fill material is required, the stripped/exposed subgrade areas should be compacted to a firm and unyielding surface prior to placement of any fill. Excavations for debris removal should be backfilled with structural fill compacted to the densities described in the "**Structural Fill**" section of this report.

We recommend that a member of our staff evaluate the exposed subgrade conditions after removal of vegetation and topsoil stripping is completed and prior to placement of structural fill. The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment during dry weather or probed with a 1/2-inch-diameter steel rod during wet weather conditions.

Soft, loose, or otherwise unsuitable areas delineated during proofrolling or probing should be recompacted, if practical, or over-excavated and replaced with structural fill. The depth and extent of overexcavation should be evaluated by our field representative at the time of construction. The areas of old fill material should be evaluated during grading operations to determine if they need mitigation; recompaction or removal.

Structural Fill

All material placed as fill associated with mass grading, as utility trench backfill, under building areas, or under roadways should be placed as structural fill. The structural fill should be placed in horizontal lifts of appropriate thickness to allow adequate and uniform compaction of each lift. Structural fill should be compacted to at least 95 percent of MDD (maximum dry density as determined in accordance with ASTM D: 1557).

The appropriate lift thickness will depend on the structural fill characteristics and compaction equipment used. We recommend that the appropriate lift thickness be evaluated by our field representative during construction. We recommend that our representative be present during site grading activities to observe the work and perform field density tests.

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing US No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend use of well-graded sand and gravel with less than 5 percent (by weight) passing the US No. 200 sieve based on that fraction passing the 3/4-inch sieve, such as *Gravel Backfill for Walls* (WSDOT 9-03.12(2)). If prolonged dry weather prevails during

the earthwork and foundation installation phase of construction, higher fines content (up to 10 to 12 percent) may be acceptable.

Material placed for structural fill should be free of debris, organic matter, trash and cobbles greater than 6-inches in diameter. The moisture content of the fill material should be adjusted as necessary for proper compaction.

Suitability of On-Site Materials as Fill

During dry weather construction, the non-organic, granular on-site soil may be considered for use as structural fill; provided it meets the criteria described above in the "**Structural Fill"** section and can be compacted as recommended. If the soil material is over-optimum in moisture content when excavated, it will be necessary to aerate or dry the soil prior to placement as structural fill. We generally did not observe the site soils to be excessively moist at the time of our subsurface exploration program.

The uncontroleld fill encountered at shallow depths consist of a mixture of sand, silt, and gravel with debris. We do not anticipate that these soils will be suitable for use as structural fill because of their fines content and the presence of debris. The deeper glacial till is generally comparable to "common borrow" material and will be suitable for use as structural fill provided the moisture content is maintained within 2 percent of the optimum moisture level.

We recommend that completed graded-areas be restricted from traffic or protected prior to wet weather conditions. The graded areas may be protected by paving, placing asphalt-treated base, a layer of free-draining material such as pit run sand and gravel or clean crushed rock material containing less than 5 percent fines, or some combination of the above.

Erosion Control

Weathering, erosion and the resulting surficial sloughing and shallow land sliding are natural processes. As noted, no evidence of surficial raveling or sloughing was observed at the site. To manage and reduce the potential for these natural processes, we recommend erosion protection measures will need to be in place prior to grading activity on the site. Erosion hazards can be mitigated by applying Best Management Practices (BMP's) outlined in the current Stormware *Management Manual for Western Washington.* These may include, but are not limited to silt fence per BMP C233, straw wattles per BMP C235, temporary and permanent seeding per BMP C120, and mulch per BMP C121.

Wet Weather and Wet Condition Considerations

In the Puget Sound area, wet weather generally begins about mid-October and continues through about May, although rainy periods could occur at any time of year. Therefore, it is strongly encouraged that earthwork be scheduled during the dry weather months of June through September. Most of the soil at the site contains sufficient fines to produce an unstable mixture when wet. Such soil is highly susceptible to changes in water content and tends to become unstable and impossible to proof-roll and compact if the moisture content exceeds the optimum.

In addition, during wet weather months, the groundwater levels could increase, resulting in seepage into site excavations. Performing earthwork during dry weather would reduce these problems and costs associated with rainwater, construction traffic, and handling of wet soil. However, should wet weather/wet condition earthwork be unavoidable, the following recommendations are provided:

- The ground surface in and surrounding the construction area should be sloped as much as possible to promote runoff of precipitation away from work areas and to prevent ponding of water.
- Work areas or slopes should be covered with plastic when not being worked. The use of sloping, ditching, sumps, dewatering, and other measures should be employed as necessary to permit proper completion of the work.
- Earthwork should be accomplished in small sections to minimize exposure to wet conditions. That is, each section should be small enough so that the removal of unsuitable soils and placement and compaction of clean structural fill could be accomplished on the same day. The size of construction equipment may have to be limited to prevent soil disturbance. It may be necessary to excavate soils with a backhoe, or equivalent, and locate them so that equipment does not pass over the excavated area. Thus, subgrade disturbance caused by equipment traffic would be minimized.
- Fill material should consist of clean, well-graded, sand and gravel, of which not more than 5 percent fines by dry weight passes the No. 200 mesh sieve, based on wet-sieving the fraction passing the ¾-inch mesh sieve. The gravel content should range from between 20 and 50 percent retained on a No. 4 mesh sieve. The fines should be non-plastic.
- No exposed soil should be left uncompacted and exposed to moisture. A smooth-drum vibratory roller, or equivalent, should roll the surface to seal out as much water as possible.
- In-place soil or fill soil that becomes wet and unstable and/or too wet to suitably compact should be removed and replaced with clean, granular soil (see gradation requirements above).
- Excavation and placement of structural fill material should be observed on a full-time basis by a geotechnical engineer (or representative) experienced in wet weather/wet condition earthwork to determine that all work is being accomplished in accordance with the project specifications and our recommendations.
- Grading and earthwork should not be accomplished during periods of heavy, continuous rainfall.

We recommend that the above requirements for wet weather/wet condition earthwork be incorporated into the contract specifications.

LIMITATIONS

We have prepared this report for use by Bradley Heights SS, LLC 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.

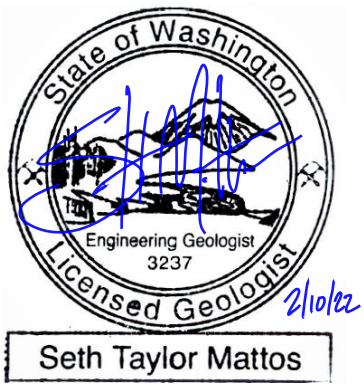
If there are any changes in the loads, grades, locations, configurations or type of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide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

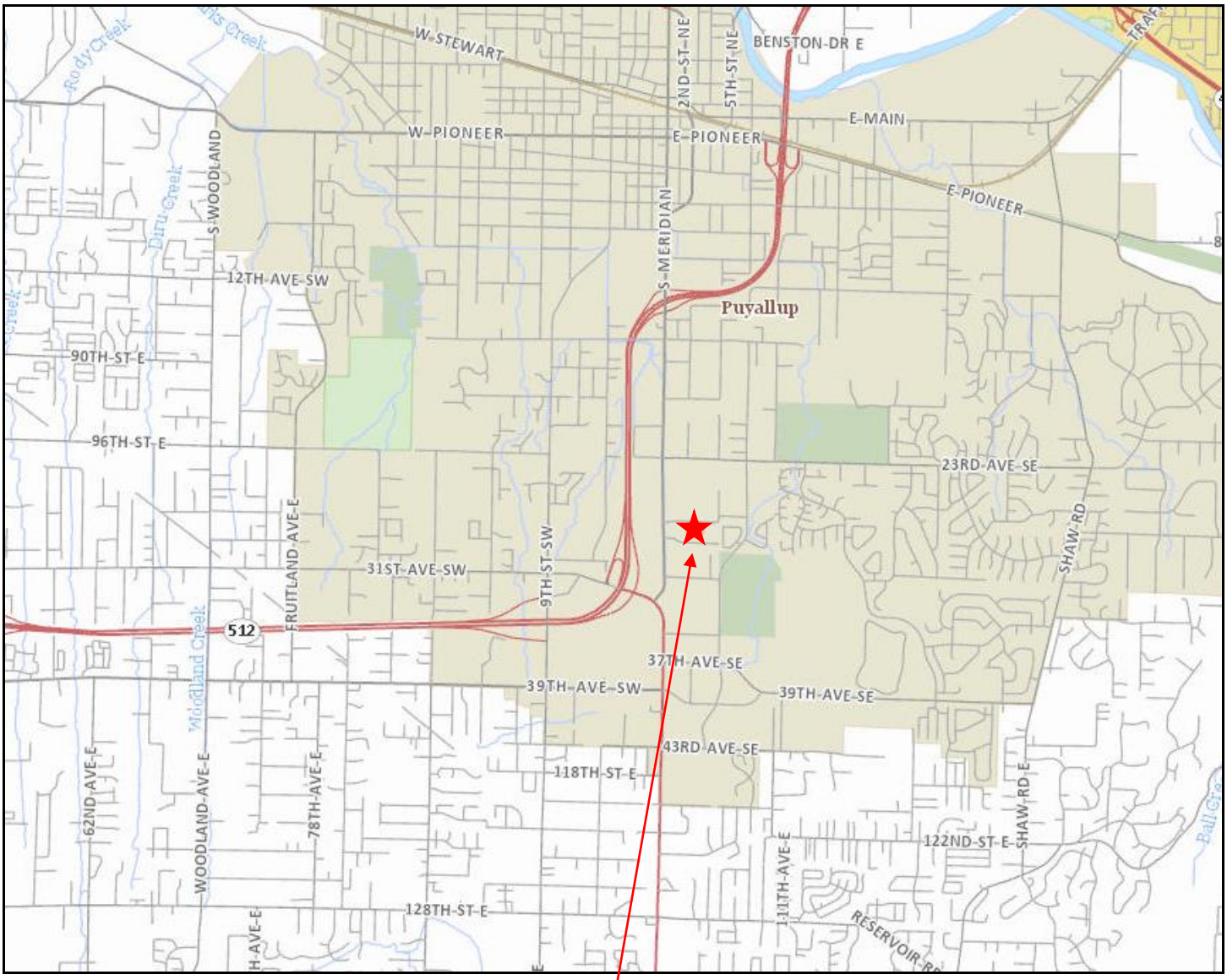
Tyler S. Slothower, EIT
Staff Engineer



Seth Taylor Mattos
Associate

Eric W. Heller, PE, LG
Senior Geotechnical Engineer

TSS:STM/EWH/tss
DocID: Timberlane.BradleyHeights.RG
Attachments: Figure 1: Site Location Map
Figure 2: Site & Exploration Plan
Figure 3: NRCS Soils Map
Figure 4: Geologic Map
Figure 5: Liquefaction Hazard Map
Appendix "A" - Subsurface Explorations
Appendix "B" - Laboratory Test results
Appendix "C" – Groundwater Monitoring Data



Approximate Site Location

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

N
W E
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Not to Scale

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Site Location Map

Proposed Multi-Family Development
202-27th Avenue SE
Pierce County, Washington
PN: 00419036006

DocID: Timberlane.BradleyHeights.F	February 2022	Figure 1

Conceptual site plan provided by Azure Green Consultants

Number and approximate location of borings (1/24/20)

Number and approximate location of test pits (excavated 3/21/2018 & 12/22/21)

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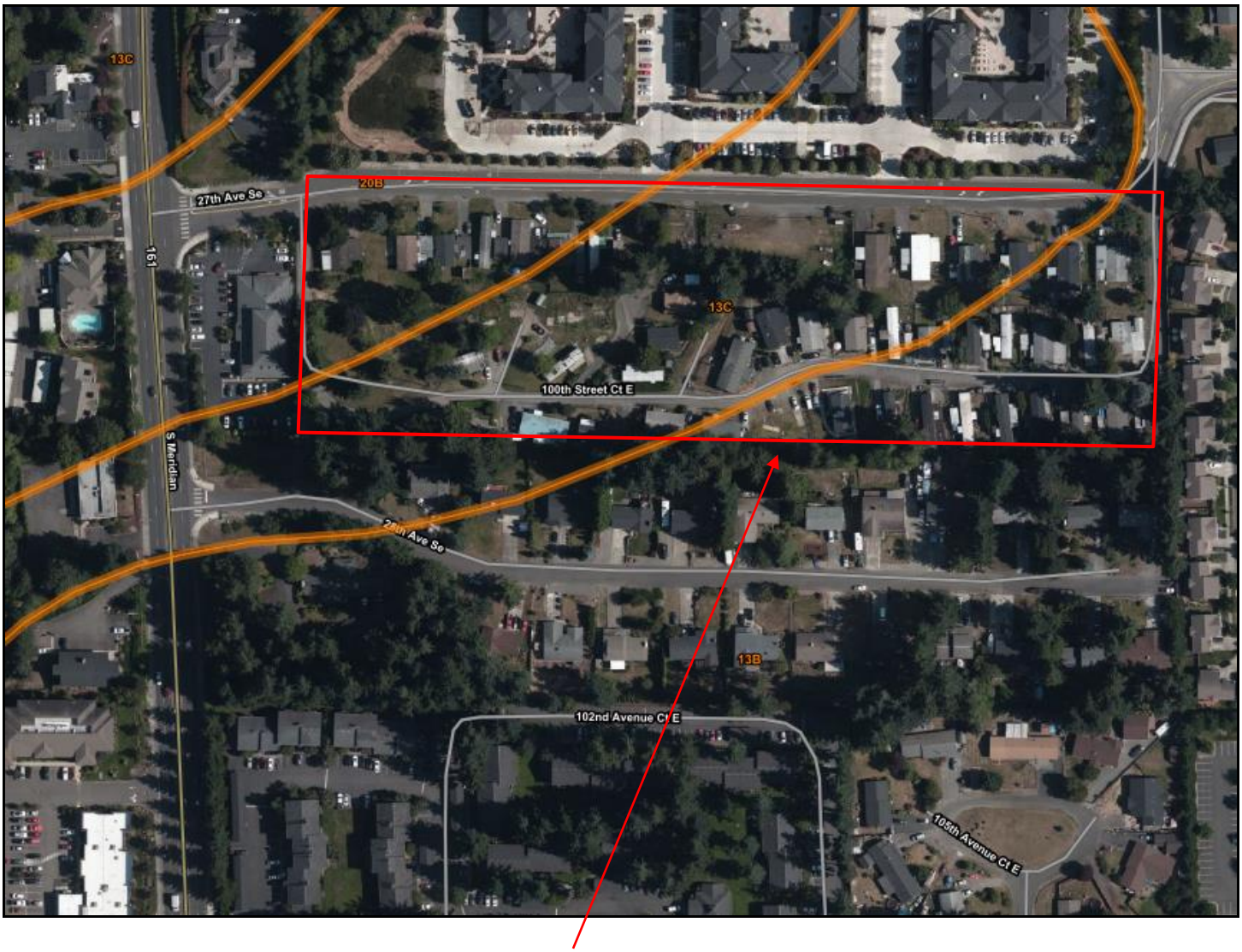
Site and Exploration Plan
Proposed Multifamily Redevelopment
202 – 27th Ave SE
Puyallup, Washington

Doc:ID: Timberlane.BradleyHeights.F2.1	February 2022	Figure 2



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
13B	Everett very gravelly sandy loam	Sandy and gravelly glacial outwash	0 to 8	Slight	A
13C			8 to 15	Moderate	
20B	Kitsap silt loam	Glaciolacustrine deposits	2 to 8	Slight to moderate	C/D

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NRCS Soils Map

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Pierce County, Washington
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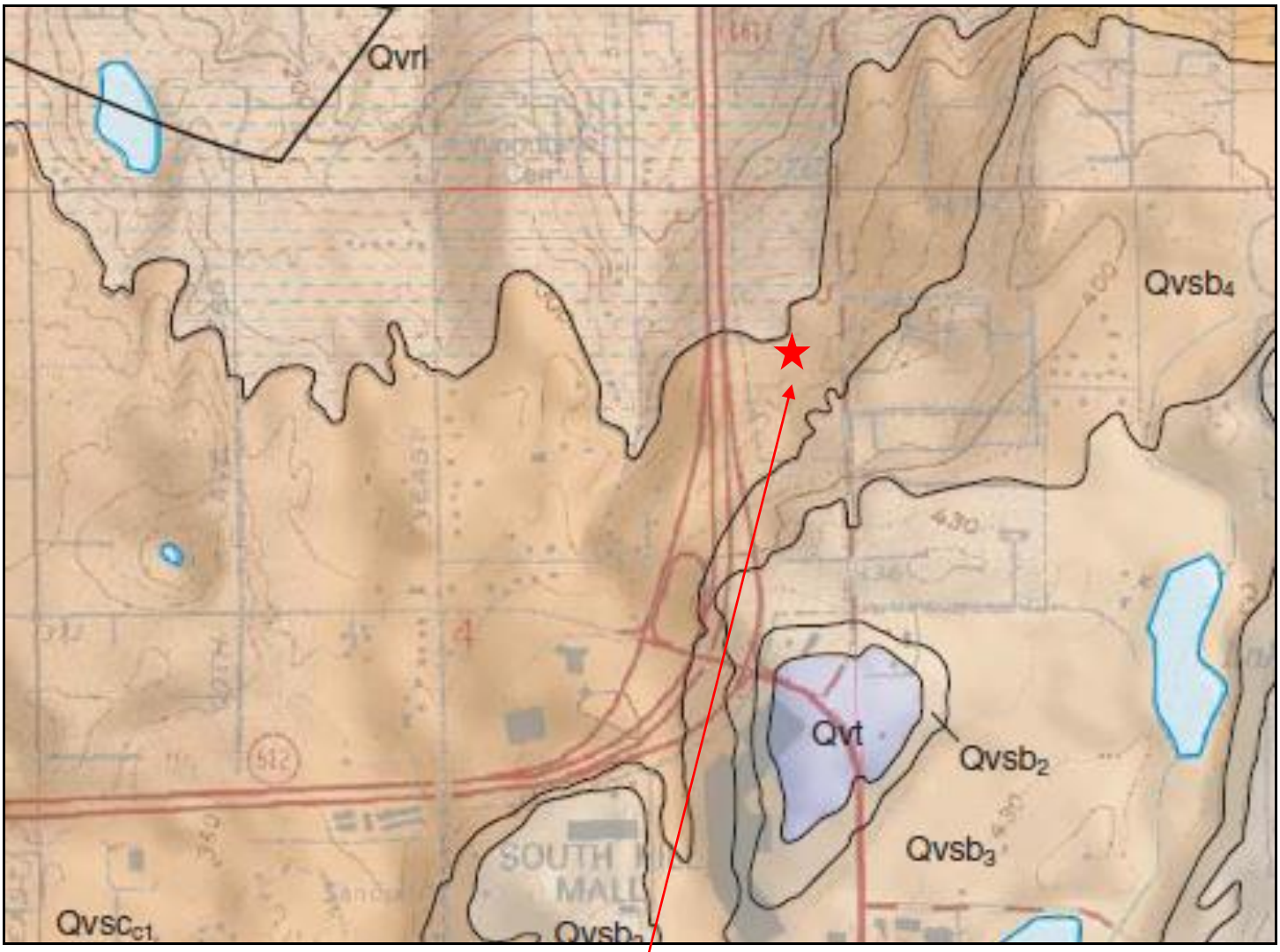

Approximate Site Location

An excerpt from *the draft Geologic Map of the Puyallup 7.5-minute Quadrangle, Washington*, by Troost, K.G.

Qvrl	Recessional Lacustrine Deposits
$Qvsc_{C1}$	Steilacoom gravel-Clover Creek Channel
$Qvsb_4$	Vashon recessional outwash-Bradley Channel

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Geologic Map

Proposed Multi-Family Development
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Pierce County, Washington
PN: 00419036006

DocID: Timberlane.BradleyHeights.F	February 2022	Figure 4

Approximate Site Location

An excerpt from *the Liquefaction Susceptibility Map of Pierce County, Washington* by Palmer et Al. (2004)

- Liquefaction susceptibility: HIGH
- Liquefaction susceptibility: MODERATE to HIGH
- Liquefaction susceptibility: MODERATE
- Liquefaction susceptibility: LOW to MODERATE
- Liquefaction susceptibility: LOW
- Liquefaction susceptibility: VERY LOW to LOW
- Liquefaction susceptibility: VERY LOW
- Bedrock

N W E S

Not to Scale

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Geologic Map

Proposed Multi-Family Development
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Pierce County, Washington
PN: 00419036006

DocID: Timberlane.BradleyHeights.F	February 2022	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
		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 D2488-90.
2. Soil classification using laboratory tests is based on ASTM D6913.
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

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Unified Soils Classification System

Proposed Multi-Family Development
202-27th Avenue SE
Pierce County, Washington
PN: 00419036006

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LOG OF BORING

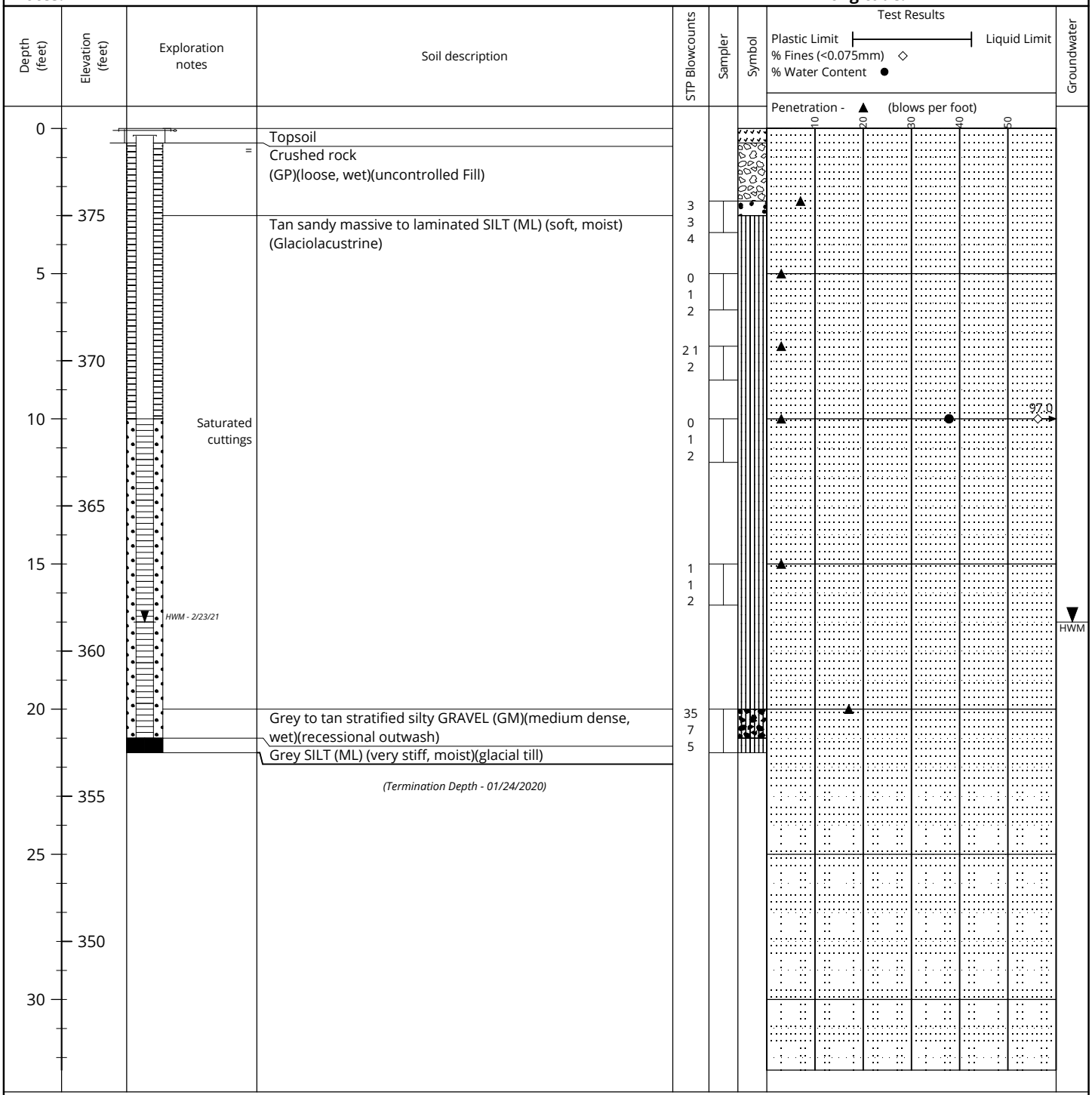
MW-1

Proposed Multi-Family Development
202 - 27th Avenue Southwest
Puyallup, WA

1. Refer to log key for definition of symbols, abbreviations, and codes
2. USCS disination is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. NE = Not Encountered
5. ATD = At Time of Drilling
6. HWM = Highest Groundwater Level

Notes:

Drilling Company:	Holocene	**Logged By:**	EJF
Drilling Method:	HSA	**Drilling Date:**	01/24/2020
Drilling Rig:	D-50	**Datum:**	NAVD 88
Sampler Type:	2-inch OD Split spoon	**Elevation:**	378 feet
Hammer Type:	Auto	**Termination Depth:**	21.5
Hammer Weight:	140 lbs	**Latitude:**	
		Longitude:	



Paving | Gravel frac | Silty sand | Poorly graded GRAVEL with silt | Silty gravel | Topsoil

JOB: Timberlane.BradleyHts

FIG. A-2

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LOG OF BORING

MW-2

Proposed Multi-Family Development
202 - 27th Avenue Southwest
Puyallup, WA

1. Refer to log key for definition of symbols, abbreviations, and codes
2. USCS disination is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. NE = Not Encountered
5. ATD = At Time of Drilling
6. HWM = Highest Groundwater Level

Notes:

Drilling Company:	Holocene	**Logged By:**	EJF
Drilling Method:	HSA	**Drilling Date:**	01/24/2020
Drilling Rig:	Track	**Datum:**	NAVD 88
Sampler Type:	Cathead?	**Elevation:**	400 feet
Hammer Type:		**Termination Depth:**	21
Hammer Weight:	140 lbs	**Latitude:**	
		Longitude:	

Depth (feet)	Elevation (feet)	Exploration notes	Soil description	STP Blowcounts	Sampler	Symbol	Test Results: Plastic Limit — Liquid Limit; % Fines (<0.075mm) ◇; % Water Content ●; Penetration - ▲ (blows per foot) 10 20 30 40 50	Groundwater
0	400		Topsoil					
			Tan well-graded GRAVEL with silt and sand (GW-GM) (moist to wet, medium dense) (Recessional Outwash)	8 9 6				
5	395			12 12 8				
				13 8 8				
10	390		Tan well-graded sandy GRAVEL with silt (GW-GM), lightly stratified (moist, medium dense)	12 5 10				
15	385		Tan SAND (SP) (medium dense, moist)(recessional outwash)	11 11 6				
20	380		Grey, mottled SILT (ML)(very stiff, moist)(Glacial till)	4 7 10				
			(Termination Depth - 01/24/2020)					
25	375							
30	370							

Paving | Gravel frac | Silty sand | Poorly graded GRAVEL with silt | Silty gravel | Topsoil

JOB: Timberlane.BradleyHts

FIG. A-3

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LOG OF BORING

MW-3

Proposed Multi-Family Development
202 - 27th Avenue Southwest
Puyallup, WA

1. Refer to log key for definition of symbols, abbreviations, and codes
2. USCS disination is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. NE = Not Encountered
5. ATD = At Time of Drilling
6. HWM = Highest Groundwater Level

Notes:

Drilling Company:	Holocene	**Logged By:**	EJF
Drilling Method:	HSA	**Drilling Date:**	01/24/2020
Drilling Rig:	Track	**Datum:**	NAVD 88
Sampler Type:	Cathead?	**Elevation:**	426 feet
Hammer Type:		**Termination Depth:**	21
Hammer Weight:	140 lbs	**Latitude:**	
		Longitude:	

Depth (feet)	Elevation (feet)	Exploration notes	Soil description	STP Blowcounts	Sampler	Symbol	Test Results	Groundwater
0	425		Asphalt CSTC/CSBC crushed rock (road Fill)				Plastic Limit — Liquid Limit % Fines (<0.075mm) ◇ % Water Content ●	
5	420		Reddish brown silty SAND, reworked (SM)(medium dense, moist to wet)(uncontrolled fill)	2 4 6			Penetration - ▲ (blows per foot) 10 20 30 40 50	
		Chatter	Grey silty SAND with gravel (SM) (wet, medium dense) (Weathered Glacial Till)	19 17 20				
10	415		Grey to light grey sandy gravel with silt (GP-GM) (moist to wet, very dense) (Glacial Till)	24 34 31 20 31 50/4"			65 105	
15	410	Chatter		26 50/5" 28 50/5"			120 120	
20	405		*(Termination Depth - 01/24/2020)*	36 50/5"			120	
25	400							
30	395							

Paving | Gravel frac | Silty sand | Poorly graded GRAVEL with silt | Silty gravel

JOB: Timberlane.BradleyHts

FIG. A-4

Test Pit TP-101

Location: central-western portion of property
Approximate Elevation: 388 feet (NAVD 88)

Depth (ft)			Soil Type	Soil Description
0	-	¼	-	Topsoil
¼	-	1½	SM	Brown silty sand (medium dense, moist) (weathered till)
1½	-	9½	SM	Grey silty sand (dense to very dense, moist) (glacial till)

Terminated at 9½ feet below ground surface.
No caving was observed at time of excavation.
Mottling was observed at 1½ feet below ground surface.

Test Pit TP-102/PIT-1

Location: Northwestern portion of property
Approximate Elevation: 378 feet (NAVD 88)

Depth (ft)			Soil Type	Soil Description
0	-	¼	-	Topsoil
¼	-	6½	ML	Tan to grey silt (medium stiff, moist) (weathered till)

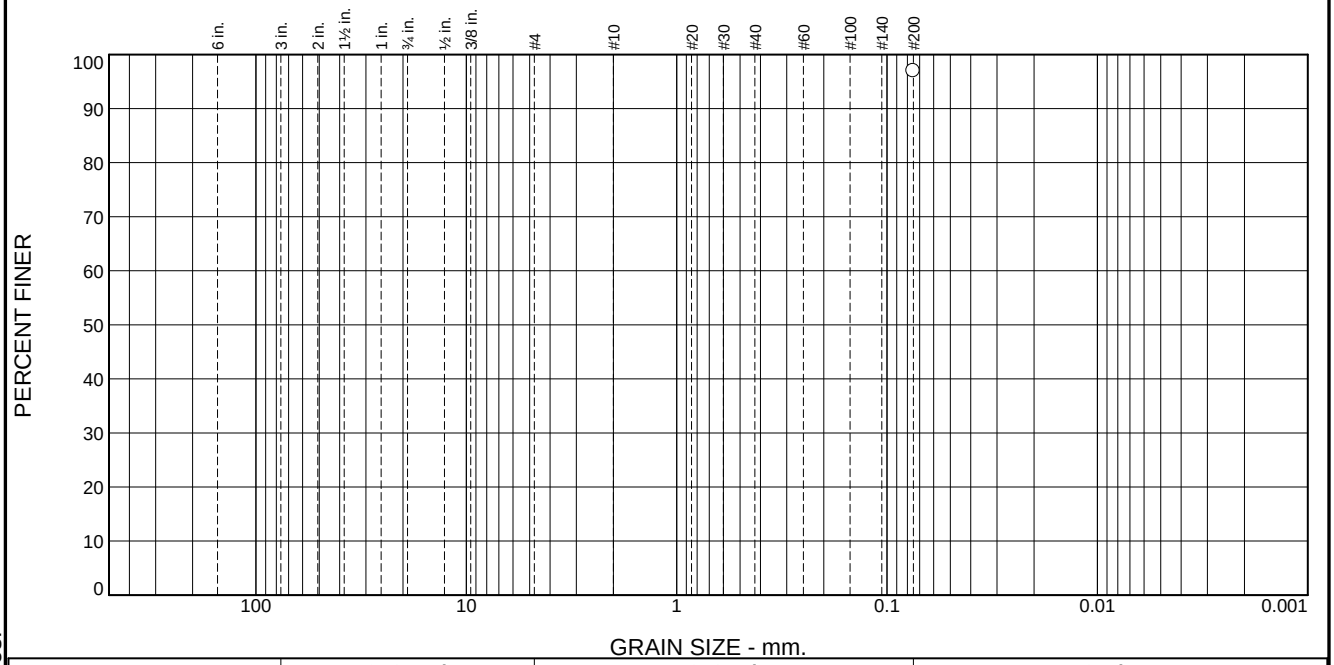
Terminated at 6½ feet below ground surface.
Caving observed from 2 to 6 feet below ground surface.
No mottling or groundwater seepage observed.
Small-scale PIT completed at 4 feet below ground surface.

Logged by: TSS **Excavated on: December 22, 2021**

Appendix B

Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						97.0	

Test Results (ASTM D 6913 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	97.0		

* (no specification provided)

Material Description

Tan, mottled, SILT (ML), laminated (wet, soft)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Moisture = 37.8%

Date Received: 01/24/2020 **Date Tested:** 02/18/2020

Tested By: EJF

Checked By: _____

Title: _____

Source of Sample: MW-1 **Depth:** 10
Sample Number: S-4

Date Sampled: 01/24/2020

GeoResources, LLC

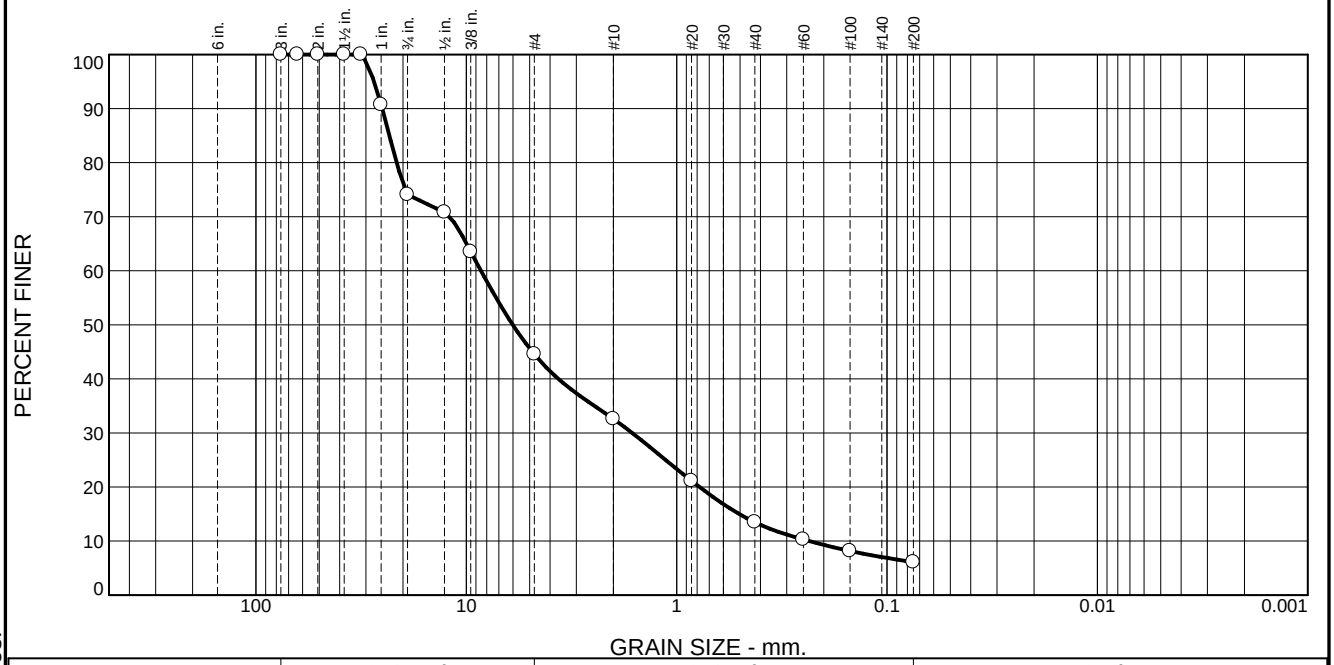
Fife, WA

Client: Bradley Heights SS, LLC
Project: Proposed Multi-Family Development

Project No: Timberlane.BradleyHts **Figure** B-3

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	25.9	29.5	12.0	19.1	7.4	6.1	

Test Results (ASTM D 6913 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	90.7		
.75	74.1		
.5	70.8		
0.375	63.5		
#4	44.6		
#10	32.6		
#20	21.1		
#40	13.5		
#60	10.3		
#100	8.2		
#200	6.1		

* (no specification provided)

Material Description

Tan well-graded sandy gravel with silt (GW-GM), lightly stratified (wet, medium dense)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 25.1048 D_{85}= 23.2261 D_{60}= 8.5264
D_{50}= 6.0116 D_{30}= 1.6294 D_{15}= 0.5038
D_{10}= 0.2347 C_u= 36.33 C_c= 1.33

Remarks

Moisture = 6.3%

Date Received: 01/24/2020 **Date Tested:** 02/19/2020

Tested By: EJF

Checked By:

Title:

Source of Sample: MW-2 **Depth:** 10 **Date Sampled:** 01/24/2020

Sample Number: S-4

GeoResources, LLC

Fife, WA

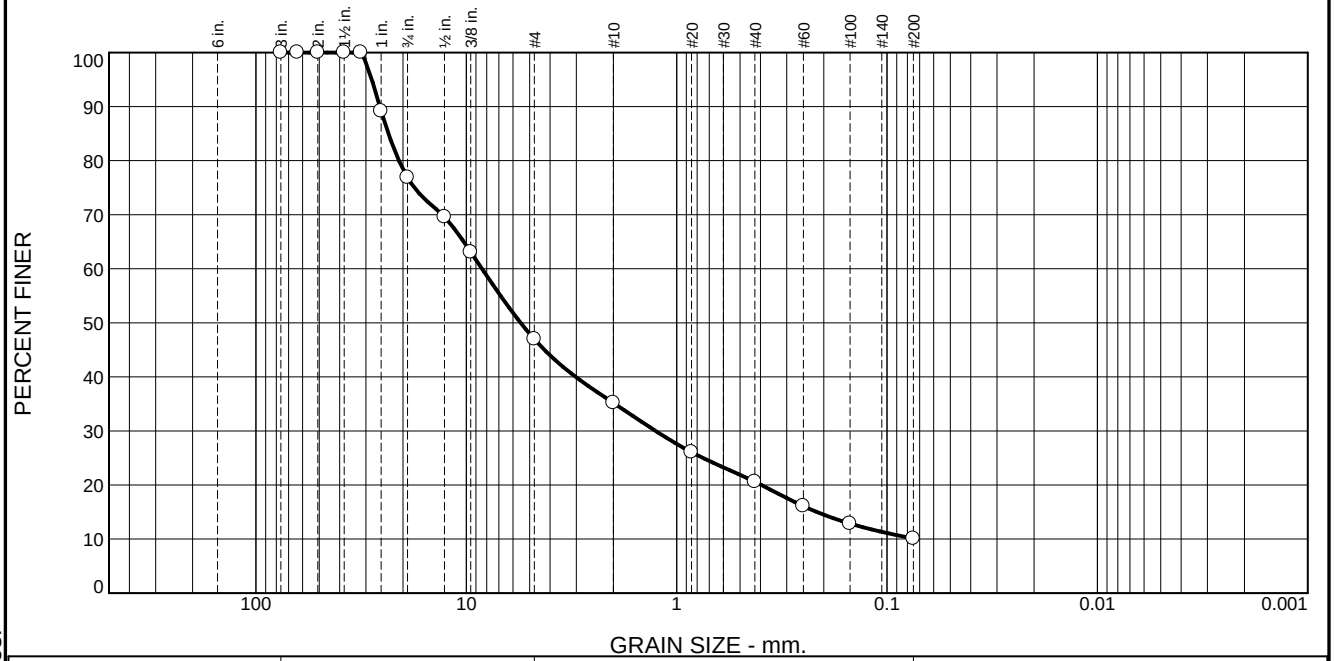
Client: Bradley Heights SS, LLC

Project: Proposed Multi-Family Development

Project No: Timberlane.BradleyHts **Figure** B-2

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	23.1	29.9	11.8	14.6	10.5	10.1	

Test Results (ASTM D 6913 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3.0	100.0		
2.5	100.0		
2.0	100.0		
1.5	100.0		
1.25	100.0		
1	89.2		
.75	76.9		
.5	69.6		
0.375	63.1		
#4	47.0		
#10	35.2		
#20	26.1		
#40	20.6		
#60	16.1		
#100	12.9		
#200	10.1		

* (no specification provided)

Material Description

Tan, poorly graded sandy gravel with silt (GP-GM) (moist to wet, dense)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GP-GM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 25.7745 D_{85}= 23.4789 D_{60}= 8.4277
D_{50}= 5.5158 D_{30}= 1.2593 D_{15}= 0.2156
D_{10}= C_u= C_c=

Remarks

Moisture = 6.0%

Date Received: 01/24/2020 **Date Tested:** 02/18/2020

Tested By: EJF

Checked By: _____

Title: _____

Source of Sample: MW-3 **Depth:** 12.5
Sample Number: S-5

Date Sampled: 01/24/2020

GeoResources, LLC

Fife, WA

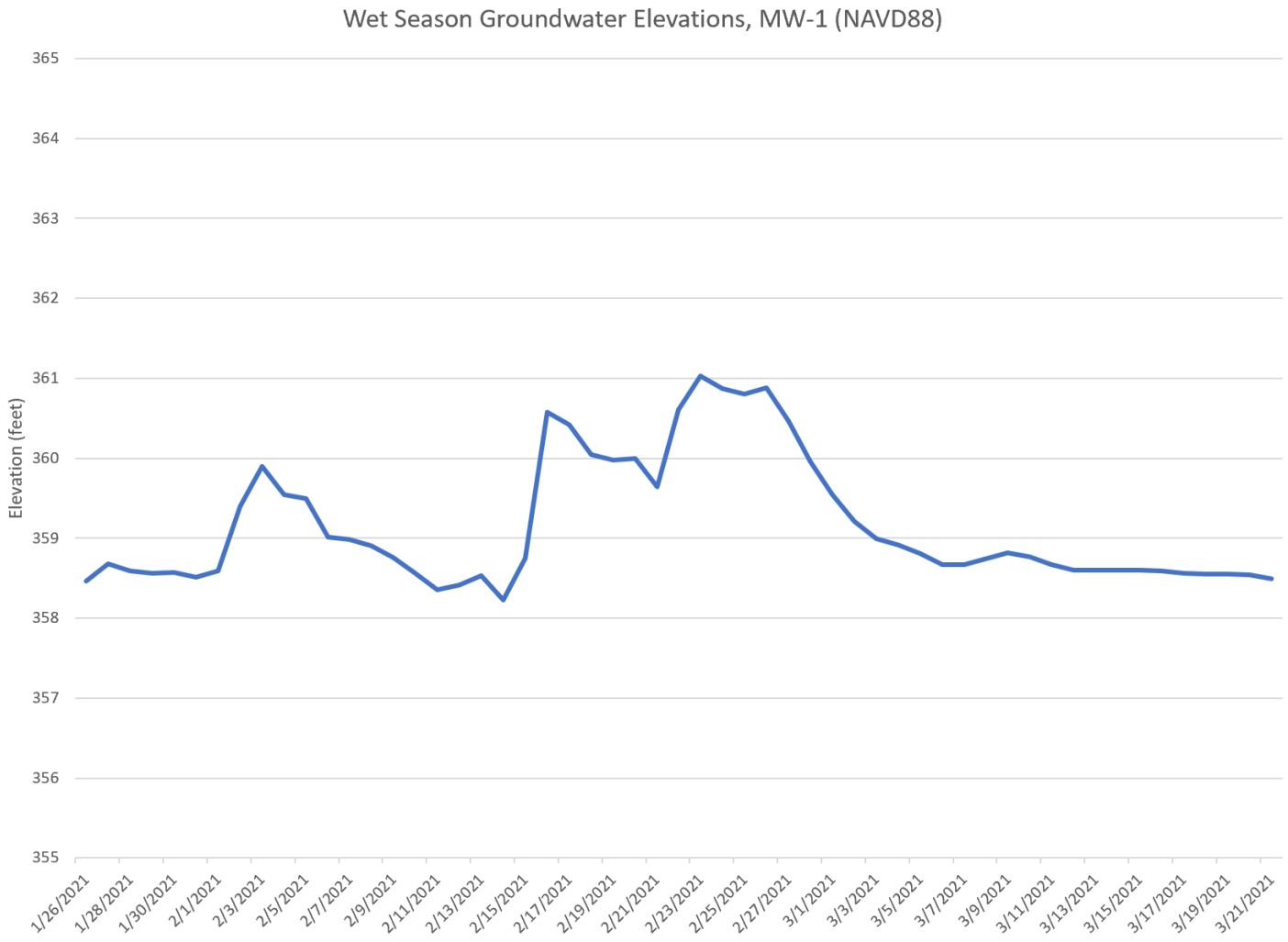
Client: Bradley Heights SS, LLC
Project: Proposed Multi-Family Development

Project No: Timberlane.BradleyHts **Figure** B-1

Tested By: _____ **Checked By:** _____

Appendix C

Groundwater Monitoring Data



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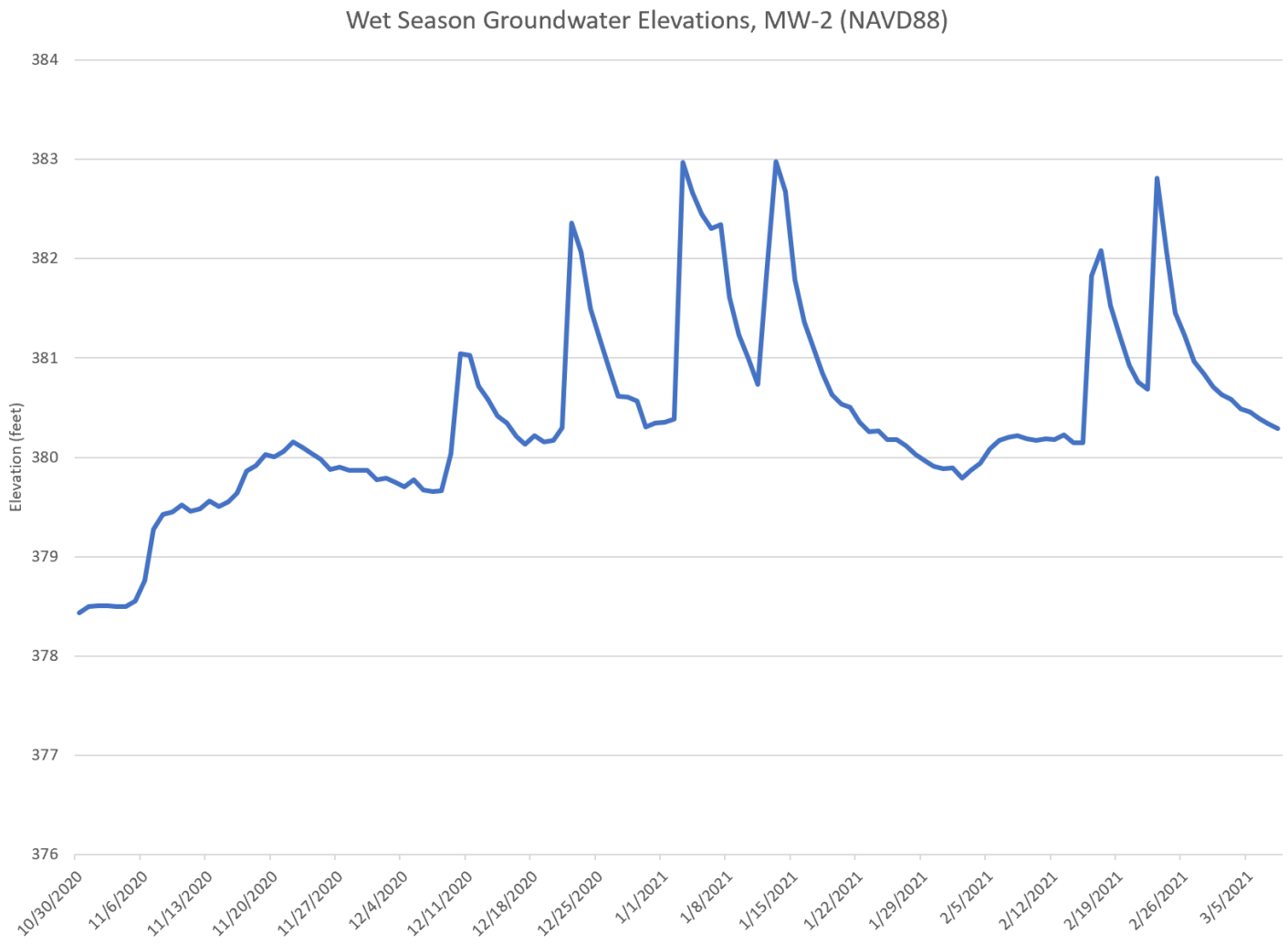
Seasonal Groundwater Levels

Proposed Multi-Family Development
202-27th Avenue SE
Pierce County, Washington
PN: 00419036006

DocID: Timberlane.BradleyHeights.F	February 2022	Figure C-1



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4809 Pacific Hwy. E. | Fife, WA 98424 | 253.896.1011 | www. georesources.rocks

Seasonal Groundwater Levels

Proposed Multi-Family Development
202-27th Avenue SE
Pierce County, Washington
PN: 00419036006

DocID: Timberlane.BradleyHeights.F	February 2022	Figure C-2

APPENDIX C

Filterra GULD

WASHINGTON STATE DEPARTMENT OF ECOLOGY

June 2020

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS), ENHANCED, PHOSPHORUS & OIL TREATMENT

For

CONTECH Engineered Solutions Filterra®

Ecology's Decision:

Based on Contech's submissions, including the Final Technical Evaluation Reports, dated August 2019, March 2014, December 2009, and additional information provided to Ecology dated October 9, 2009, Ecology hereby issues the following use level designations:

1. A General Use Level Designation for Basic, Enhanced, Phosphorus, and Oil Treatment for the Filterra® system constructed with a minimum media thickness of 21 inches (1.75 feet), at the following water quality design hydraulic loading rates:

Treatment	Infiltration Rate (in/hr) for use in Sizing
Basic	175
Phosphorus	100
Oil	50
Enhanced	175

2. The Filterra is not appropriate for oil spill-control purposes.
3. Ecology approves Filterra systems for treatment at the hydraulic loading rates listed above, and sized based on the water quality design flow rate for an off-line system. Calculate the water quality design flow rates using the following procedures:

- Western Washington: for treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.
- Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three flow rate based methods described in Chapter 2.7.6 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
- Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.

4. This General Use Level Designation has no expiration date, but Ecology may revoke or amend the designation, and is subject to the conditions specified below.

Ecology's Conditions of Use:

Filterra systems shall comply with these conditions shall comply with the following conditions:

1. Design, assemble, install, operate, and maintain the Filterra systems in accordance with applicable Contech Filterra manuals and this Ecology Decision.
2. The minimum size filter surface-area for use in Washington is determined by using the design water quality flow rate (as determined in this Ecology Decision, Item 3, above) and the Infiltration Rate from the table above (use the lowest applicable Infiltration Rate depending on the level of treatment required). Calculate the required area by dividing the water quality design flow rate (cu-ft/sec) by the Infiltration Rate (converted to ft/sec) to obtain required surface area (sq-ft) of the Filterra unit.
3. Each site plan must undergo Contech Filterra review before Ecology can approve the unit for site installation. This will ensure that design parameters including site grading and slope are appropriate for use of a Filterra unit.
4. Filterra media shall conform to the specifications submitted to and approved by Ecology and shall be sourced from Contech Engineered Solutions, LLC with no substitutions.
5. Maintenance includes removing trash, degraded mulch, and accumulated debris from the filter surface and replacing the mulch layer. Use inspections to determine the site-specific maintenance schedules and requirements. Follow maintenance procedures given in the most recent version of the Filterra Operation and Maintenance Manual.
6. Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured treatment device.
    - Contech designs Filterra systems for a target maintenance interval of 6 months in the Pacific Northwest. Maintenance includes removing and replacing the mulch layer above the media along with accumulated sediment, trash, and captured organic materials therein, evaluating plant health, and pruning the plant if deemed necessary.
    - Conduct maintenance following manufacturer's guidelines.
7. Filterra systems come in standard sizes.
8. Install the Filterra in such a manner that flows exceeding the maximum Filterra operating rate are conveyed around the Filterra mulch and media and will not resuspend captured sediment.
9. Discharges from the Filterra units shall not cause or contribute to water quality standards violations in receiving waters.

Approved Alternate Configurations

Filterra Internal Bypass - Pipe (FTIB-P)

1. The Filterra® Internal Bypass – Pipe allows for piped-in flow from area drains, grated inlets, trench drains, and/or roof drains. Design capture flows and peak flows enter the structure through an internal slotted pipe. Filterra® inverted the slotted pipe to allow design flows to drop through to a series of splash plates that then disperse the design flows over the top surface of the Filterra® planter area. Higher flows continue to bypass the slotted pipe and convey out the structure.
2. To select a FTIB-P unit, the designer must determine the size of the standard unit using the sizing guidance described above.

Filterra Internal Bypass – Curb (FTIB-C)

1. The Filterra® Internal Bypass –Curb model (FTIB-C) incorporates a curb inlet, biofiltration treatment chamber, and internal high flow bypass in one single structure. Filterra® designed the FTIB-C model for use in a "Sag" or "Sump" condition and will accept flows from both directions along a gutter line. An internal flume tray weir component directs treatment flows entering the unit through the curb inlet to the biofiltration treatment chamber. Flows in excess of the water quality treatment flow rise above the flume tray weir and discharge through a standpipe orifice; providing bypass of untreated peak flows. Americast manufactures the FTIB-C model in a variety of sizes and configurations and you may use the unit on a continuous grade when a single structure providing both treatment and high flow bypass is preferred. The FTIB-C model can also incorporate a separate junction box chamber to allow larger diameter discharge pipe connections to the structure.
2. To select a FTIB-C unit, the designer must determine the size of the standard unit using the sizing guidance described above.

Filterra® Shallow

1. The Filterra Shallow provides additional flexibility for design engineers and designers in situations where various elevation constraints prevent application of a standard Filterra configuration. Engineers can design this system up to six inches shallower than any of the previous Filterra unit configurations noted above.
2. Ecology requires that the Filterra Shallow provide a media contact time equivalent to that of the standard unit. This means that with a smaller depth of media, the surface area must increase.
3. To select a Filterra Shallow System unit, the designer must first identify the size of the standard unit using the modeling guidance described above.
4. Once the size of the standard Filterra unit is established using the sizing technique described above, use information from the following table to select the appropriate size Filterra Shallow System unit.

Shallow Unit Basic, Enhanced, Phosphorus, and Oil Treatment Sizing

Standard Depth	Equivalent Shallow Depth
4x4	4x6 or 6x4
4x6 or 6x4	6x6
4x8 or 8x4	6x8 or 8x6
6x6	6x10 or 10x6
6x8 or 8x6	6x12 or 12x6
6x10 or 10x6	13x7

Notes:
1. Shallow Depth Boxes are less than the standard depth of 3.5 feet but no less than 3.0 feet deep (TC to INV).

Applicant: Contech Engineered Solutions, LLC.

Applicant's Address: 11815 NE Glenn Widing Drive
Portland, OR 97220

Application Documents:

- State of Washington Department of Ecology Application for Conditional Use Designation, Americast (September 2006)
- Quality Assurance Project Plan Filterra® Bioretention Filtration System Performance Monitoring, Americast (April 2008)
- Quality Assurance Project Plan Addendum Filterra® Bioretention Filtration System Performance Monitoring, Americast (June 2008)
- Draft Technical Evaluation Report Filterra® Bioretention Filtration System Performance Monitoring, Americast (August 2009)
- Final Technical Evaluation Report Filterra® Bioretention Filtration System Performance Monitoring, Americast (December 2009)
- Technical Evaluation Report Appendices Filterra® Bioretention Filtration System Performance Monitoring, Americast, (August 2009)
- Memorandum to Department of Ecology Dated October 9, 2009 from Americast, Inc. and Herrera Environmental Consultants
- Quality Assurance Project Plan Filterra® Bioretention System Phosphorus treatment and Supplemental Basic and Enhanced Treatment Performance Monitoring, Americast (November 2011)
- Filterra® letter August 24, 2012 regarding sizing for the Filterra® Shallow System.
- University of Virginia Engineering Department Memo by Joanna Crowe Curran, Ph. D dated March 16, 2013 concerning capacity analysis of Filterra® internal weir inlet tray.
- Terraphase Engineering letter to Jodi Mills, P.E. dated April 2, 2013 regarding Terraflume Hydraulic Test, Filterra® Bioretention System and attachments.
- Technical Evaluation Report, Filterra® System Phosphorus Treatment and Supplemental Basic Treatment Performance Monitoring. March 27th, 2014.
- State of Washington Department of Ecology Application for Conditional Use Level Designation, Contech Engineered Solutions (May 2015)

- Quality Assurance Project Plan Filterra® Bioretention System, Contech Engineered Solutions (May 2015)
- Filterra Bioretention System Armco Avenue General Use Level Designation Technical Evaluation Report, Contech Engineered Solutions (August 2019)

Applicant's Use Level Request:

General Level Use Designation for Basic (175 in/hr), Enhanced (175 in/hr), Phosphorus (100 in/hr), and Oil Treatment (50 in/hr).

Applicant's Performance Claims:

Field-testing and laboratory testing show that the Filterra® unit is promising as a stormwater treatment best management practice and can meet Ecology's performance goals for basic, enhanced, phosphorus, and oil treatment.

Findings of Fact:

Field Testing 2015-2019

1. Contech completed field testing of a 4 ft. x 4 ft. Filterra® unit at one site in Hillsboro, Oregon from September 2015 to July 2019. Throughout the monitoring period a total of 24 individual storm events were sampled, of which 23 qualified for TAPE sampling criteria.
2. Contech encountered several unanticipated events and challenges that prevented them from collecting continuous flow and rainfall data. An analysis of the flow data from the sampled events, including both the qualifying and non-qualifying events, demonstrated the system treated over 99 % of the influent flows. Peak flows during these events ranged from 25 % to 250 % of the design flow rate of 29 gallons per minute.
3. Of the 23 TAPE qualified sample events, 13 met requirements for TSS analysis. Influent concentrations ranged from 20.8 mg/L to 83 mg/L, with a mean concentration of 46.3 mg/L. The UCL95 mean effluent concentration was 15.9 mg/L, meeting the 20 mg/L performance goal for Basic Treatment.
4. All 23 TAPE qualified sample events met requirements for dissolved zinc analysis. Influent concentrations range from 0.0384 mg/L to 0.2680 mg/L, with a mean concentration of 0.0807 mg/L. The LCL 95 mean percent removal was 62.9 %, meeting the 60 % performance goal for Enhanced Treatment.
5. Thirteen of the 23 TAPE qualified sample events met requirements for dissolved copper analysis. Influent concentrations ranged from 0.00543 mg/L to 0.01660 mg/L, with a mean concentration of 0.0103 mg/L. The LCL 95 mean percent removal was 41.2 %, meeting the 30 % performance goal for Enhanced Treatment.
6. Total zinc concentrations were analyzed for all 24 sample events. Influent EMCs for total zinc ranged from 0.048 mg/L to 5.290 mg/L with a median of 0.162 mg/L. Corresponding effluent EMCs for total zinc ranged from 0.015 mg/L to 0.067 mg/L with a median of

0.029 mg/L. Total event loadings for the study for total zinc were 316.85 g at the influent and 12.92 g at the effluent sampling location, resulting in a summation of loads removal efficiency of 95.9 %.

7. Total copper concentrations were analyzed for all 24 sample events. Influent EMCs for total copper ranged from 0.003 mg/L to 35.600 mg/L with a median value of 0.043 mg/L. Corresponding effluent EMCs for total copper ranged from 0.002 mg/L to 0.015 mg/L with a median of 0.004 mg/L. Total event loadings for total copper for the study were 1,810.06 g at the influent and 1.90 g at the effluent sampling location, resulting in a summation of loads removal efficiency of 99.9 %.

Field Testing 2013

1. Filterra completed field-testing of a 6.5 ft x 4 ft. unit at one site in Bellingham, Washington. Continuous flow and rainfall data collected from January 1, 2013 through July 23, 2013 indicated that 59 storm events occurred. Water quality data was obtained from 22 storm events. Not all the sampled storms produced information that met TAPE criteria for storm and/or water quality data.
2. The system treated 98.9 % of the total 8-month runoff volume during the testing period. Consequently, the system achieved the goal of treating 91 % of the volume from the site. Stormwater runoff bypassed Filterra treatment during four of the 59 storm events.
3. Of the 22 sampled events, 18 qualified for TSS analysis (influent TSS concentrations ranged from 25 to 138 mg/L). The data were segregated into sample pairs with influent concentration greater than and less than 100 mg/L. The UCL95 mean effluent concentration for the data with influent less than 100 mg/L was 5.2 mg/L, below the 20-mg/L threshold. Although the TAPE guidelines do not require an evaluation of TSS removal efficiency for influent concentrations below 100 mg/L, the mean TSS removal for these samples was 90.1 %. Average removal of influent TSS concentrations greater than 100 mg/L (three events) was 85 %. In addition, the system consistently exhibited TSS removal greater than 80 % at flow rates equivalent to a 100 in/hr infiltration rate and was observed at 150 in/hr.
4. Ten of the 22 sampled events qualified for TP analysis. Americast augmented the dataset using two sample pairs from previous monitoring at the site. Influent TP concentrations ranged from 0.11 to 0.52 mg/L. The mean TP removal for these twelve events was 72.6 %. The LCL95 mean percent removal was 66.0, well above the TAPE requirement of 50 %. Treatment above 50 % was evident at 100 in/hr infiltration rate and as high as 150 in/hr. Consequently, the Filterra test system met the TAPE Phosphorus Treatment goal at 100 in/hr. Influent ortho-P concentrations ranged from 0.005 to 0.012 mg/L; effluent ortho-P concentrations ranged from 0.005 to 0.013 mg/L. The reporting limit/resolution for the ortho-P test method is 0.01 mg/L, therefore the influent and effluent ortho-P concentrations were both at and near non-detect concentrations.

Field Testing 2008-2009

1. Filterra completed field-testing at two sites at the Port of Tacoma. Continuous flow and rainfall data collected during the 2008-2009 monitoring period indicated that 89 storm events occurred. The monitoring obtained water quality data from 27 storm events. Not all the sampled storms produced information that met TAPE criteria for storm and/or water quality data.
2. During the testing at the Port of Tacoma, 98.96 to 99.89 % of the annual influent runoff volume passed through the POT1 and POT2 test systems respectively. Stormwater runoff bypassed the POT1 test system during nine storm events and bypassed the POT2 test system during one storm event. Bypass volumes ranged from 0.13 % to 15.3% of the influent storm volume. Both test systems achieved the 91 % water quality treatment-goal over the 1-year monitoring period.
3. Consultants observed infiltration rates as high as 133 in/hr during the various storms. Filterra did not provide any paired data that identified percent removal of TSS, metals, oil, or phosphorus at an instantaneous observed flow rate.
4. The maximum storm average hydraulic loading rate associated with water quality data is <40 in/hr, with the majority of flow rates < 25 in/hr. The average instantaneous hydraulic loading rate ranged from 8.6 to 53 in/hr.
5. The field data showed a removal rate greater than 80 % for TSS with an influent concentration greater than 20 mg/L at an average instantaneous hydraulic loading rate up to 53 in/hr (average influent concentration of 28.8 mg/L, average effluent concentration of 4.3 mg/L).
6. The field data showed a removal rate generally greater than 54 % for dissolved zinc at an average instantaneous hydraulic loading rate up to 60 in/hr and an average influent concentration of 0.266 mg/L (average effluent concentration of 0.115 mg/L).
7. The field data showed a removal rate generally greater than 40 % for dissolved copper at an average instantaneous hydraulic loading rate up to 35 in/hr and an average influent concentration of 0.0070 mg/L (average effluent concentration of 0.0036 mg/L).
8. The field data showed an average removal rate of 93 % for total petroleum hydrocarbon (TPH) at an average instantaneous hydraulic loading rate up to 53 in/hr and an average influent concentration of 52 mg/L (average effluent concentration of 2.3 mg/L). The data also shows achievement of less than 15 mg/L TPH for grab samples. Filterra provided limited visible sheen data due to access limitations at the outlet monitoring location.
9. The field data showed low percentage removals of total phosphorus at all storm flows at an average influent concentration of 0.189 mg/L (average effluent concentration of 0.171 mg/L). We may relate the relatively poor treatment performance of the Filterra system at this location to influent characteristics for total phosphorus that are unique to the Port of Tacoma site. It appears that the Filterra system will not meet the 50 % removal performance goal when the majority of phosphorus in the runoff is expected to be in the dissolved form.

Laboratory Testing

1. Filterra performed laboratory testing on a scaled down version of the Filterra unit. The lab data showed an average removal from 83-91 % for TSS with influents ranging from 21 to 320 mg/L, 82-84 % for total copper with influents ranging from 0.94 to 2.3 mg/L, and 50-61 % for orthophosphate with influents ranging from 2.46 to 14.37 mg/L.
2. Filterra conducted permeability tests on the soil media.
3. Lab scale testing using Sil-Co-Sil 106 showed removals ranging from 70.1 % to 95.5 % with a median removal of 90.7 %, for influent concentrations ranging from 8.3 to 260 mg/L. Filterra ran these laboratory tests at an infiltration rate of 50 in/hr.
4. Supplemental lab testing conducted in September 2009 using Sil-Co-Sil 106 showed an average removal of 90.6 %. These laboratory tests were run at infiltration rates ranging from 25 to 150 in/hr for influent concentrations ranging from 41.6 to 252.5 mg/L. Regression analysis results indicate that the Filterra system's TSS removal performance is independent of influent concentration in the concentration rage evaluated at hydraulic loading rates of up to 150 in/hr.

Contact Information:

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Applicant's Website: http://www.conteches.com

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology:
Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
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Date	**Revision**
December 2009	GULD for Basic, Enhanced, and Oil granted, CULD for Phosphorus
September 2011	Extended CULD for Phosphorus Treatment
September 2012	Revised design storm discussion, added Shallow System.
January 2013	Revised format to match Ecology standards, changed Filterra contact information
February 2013	Added FTIB-P system
March 2013	Added FTIB-C system
April 2013	Modified requirements for identifying appropriate size of unit

June 2013	Modified description of FTIB-C alternate configuration
March 2014	GULD awarded for Phosphorus Treatment. GULD updated for a higher flow-rate for Basic Treatment.
June 2014	Revised sizing calculation methods
March 2015	Revised Contact Information
June 2015	CULD for Basic and Enhanced at 100 in/hr infiltration rate
September 2019	GULD for Basic and Enhanced at 175 in/hr infiltration rate
February 2020	Revised sizing language to note sizing based on off-line calculations
June 2020	Added Phosphorus to Filterra Shallow sizing table

APPENDIX D

StormFilter GULD

WASHINGTON STATE DEPARTMENT OF ECOLOGY

April 2017

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS) AND PHOSPHORUS TREATMENT
For
CONTECH Engineered Solutions
Stormwater Management StormFilter®
with PhosphoSorb® media

Ecology's Decision:

1. **Based on Contech Engineered Solutions application, Ecology hereby issues the following use level designation for the Stormwater Management StormFilter® using PhosphoSorb® media cartridges:**

   - **General Use Level Designation (GULD) for Basic Treatment (total suspended solids) and for Phosphorus (total phosphorus) treatment.**
     - **Sized at a hydraulic loading rate of no greater than 1.67 gallon per minute (gpm) per square foot (sq ft.) of media surface, per Table 1.**
     - **Using Contech's PhosphoSorb media. Specifications for the media shall match the specifications provided by the manufacturer and approved by Ecology.**

   Table 1. StormFilter cartridge design flow rates for 18-inch diameter cartridges with PhosphoSorb media operating at 1.67 gpm/sq ft.

Effective cartridge height (in)	Cartridge flow rate (gpm/cartridge)
12	8.35
18	12.53
27	18.79

2. **Ecology approves StormFilter systems containing PhosphoSorb media for treatment at the cartridge flow rate shown in Table 1, and sized based on the water quality design flow rate for an off-line system. Contech designs their StormFilter systems to maintain treatment of the water quality design flow while routing excess flows around the treatment chamber during periods of peak bypass. Calculate the water quality design flow rates using the following procedures:**
    - **Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.**
    - **Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.**
    - **Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.**
3. **The GULD designation has no expiration date but it may be amended or revoked by Ecology and is subject to the conditions specified below.**

Ecology's Conditions of Use:

StormFilter systems containing PhosphoSorb media shall comply with these conditions:

1. **Design, assemble, install, operate, and maintain StormFilter systems containing PhosphoSorb media in accordance with applicable Contech Engineered Solutions manuals, documents, and the Ecology Decision.**
2. **Use sediment loading capacity, in conjunction with the water quality design flow rate, to determine the target maintenance interval.**
3. **Owners shall install StormFilter systems in such a manner that bypass flows exceeding the water quality treatment rate or flows through the system will not re-suspend captured sediments.**
4. **Pretreatment of TSS and oil and grease may be necessary, and designers shall provide pre-treatment in accordance with the most current versions of the CONTECH *Product Design Manual* or the applicable Ecology Stormwater Manual. Design pre-treatment using the performance criteria and pretreatment practices provided in the Stormwater Management Manual for Western Washington (SWMMWW), the Stormwater Management Manual for Eastern Washington (SWMMEW), or on Ecology's "Evaluation of Emerging Stormwater Treatment Technologies" website.**
5. **Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.**
    - **Typically, CONTECH designs StormFilter systems for a target filter media replacement interval of 12 months. Maintenance includes removing accumulated**

sediment from the vault, and replacing spent cartridges with recharged cartridges.

- **Indications of the need for maintenance include the effluent flow decreasing to below the design flow rate, as indicated by the scumline above the shoulder of the cartridge.**
- **Owners/operators must inspect StormFilter with PhosphoSorb media for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the *SWMMWW,* the wet season in western Washington is October 1 to April 30. According to *SWMMEW,* the wet season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.**
- **Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.**
- **When inspections are performed, the following findings typically serve as maintenance triggers:**
    - **Accumulated vault sediment depths exceed an average of 2 inches, or**
    - **Accumulated sediment depths on the tops of the cartridges exceed an average of 0.5 inches, or**
    - **Standing water remains in the vault between rain events, or**
    - **Bypass during storms smaller than the design storm.**
- **Note: If excessive floatables (trash and debris) are present, perform a minor maintenance consisting of gross solids removal, not cartridge replacement.**

6. **Discharges from the StormFilter systems containing PhosphoSorb media shall not cause or contribute to water quality standards violations in receiving waters.**

Applicant:	CONTECH Engineered Solutions
Applicant's Address:	11835 NE Glenn Widing Dr. Portland, OR 97220

Application Documents:

- The Stormwater Management StormFilter, PhosphoSorb at a Specific Flow Rate of 1.67 gpm/ft^2, Conditional Use Level Designation Application. August 2012.
- Quality Assurance Project Plan The Stormwater Management StormFilter® PhosphoSorb® at a Specific Flow Rate of 1.67 gpm/ft^2 Performance Evaluation. August 2012.
- The Stormwater Management StormFilter® PhosphoSorb® at a Specific Flow Rate of 1.67 gpm/ft^2, General Use Level Designation, Technical Evaluation Report. October 2015.

Applicant's Use Level Request:

- General use level designation as a basic (TSS) and phosphorus (total phosphorus) treatment device in accordance with Table 2 of Ecology's 2011 *Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE).*

Applicant's Performance Claims:

Based on results from laboratory and field-testing, the applicant claims:

- The Stormwater Management StormFilter® with PhosphoSorb® media operating at 1.67 gpm/ft^2 is able to remove 80% of Total Suspended Solids (TSS) for influent concentrations greater than 100 mg/L, is able to remove greater than 80% TSS for influent concentrations greater than 200 mg/L, and achieve a 20 mg/L effluent for influent concentrations less than 100 mg/L.
- The StormFilter with PhosphoSorb media is able to remove 50% or greater total phosphorus for influent concentrations between 0.1 to 0.5 mg/L.

Recommendations:

Ecology finds that:

- CONTECH Engineered Solutions has shown Ecology, through laboratory and field testing, that the Stormwater Management StormFilter® with PhosphoSorb® media is capable of attaining Ecology's Basic and Total Phosphorus treatment goals.

Findings of Fact:

Laboratory testing

- A Phosphosorb StormFilter cartridge test unit, operating at 28 L/min (equivalent to 1.0 gpm/ sq. ft.), and subject to SSC with a silt loam texture (25% sand, 65% silt, and 10% clay by mass) originating from SCS 106 provides a mean SSC removal efficiency of 88%;
- A Phosphosorb StormFilter cartridge test unit, operating at 56 L/min (equivalent to 2.0 gpm/sq. ft.), and subject to SSC with a silt loam texture (25% sand, 65% silt, and 10% clay by mass) originating from SCS 106 provides a mean turbidity reduction of 82%;

- Laboratory testing of PhosphoSorb media in a Horizontal Flow Column (HFC; a 1/24th scale of a full cartridge) resulted in 50 percent dissolved phosphorus removal for the first 1,000 bed volumes. Granular activated carbon (GAC) tested under the same conditions resulted in 30 percent removal of dissolved phosphorus.

Field testing

- Contech conducted monitoring of a StormFilter® with PhosphoSorb® media at a site along Lolo Pass Road in Zigzag, Oregon between February 2012 and February 2015. The manufacturer collected flow-weighted influent and effluent composite samples during 17 separate storm events. The system treated approximately 96 percent of the flows recorded during the monitoring period. The applicant sized the system at 1.67 gpm/sq. ft.
    - Influent TSS concentrations for qualifying sampled storm events ranged from 40 to 780 mg/L. For influent concentrations less than 100 mg/L (n=2) the effluent concentration was less than 10 mg/L. For influent concentrations greater than 100 mg/L the bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean TSS reduction was 85%.
    - Total phosphorus removal for 16 events with influent TP concentrations in the range of 0.1 to 0.5 mg/L averaged 75 percent. A bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean total phosphorus reduction was 67 percent.

Other StormFilter system with PhosphoSorb media items the Company should address:

1. Conduct testing to obtain information about maintenance requirements in order to come up with a maintenance cycle.
2. Conduct loading tests on the filter to determine maximum treatment life of the system.

Technology Description: Download at: http://www.conteches.com/Products/Stormwater-Management/Treatment/Stormwater-Management-StormFilter®.aspx

Contact Information:

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Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
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Revision History

Date	Revision
December 2012	Original use-level-designation document: CULD for basic and phosphorus treatment.
January 2013	Revised document to match standard formatting
August 2014	Revised TER and expiration dates
November 2015	Approved GULD designation for Basic and Phosphorus treatment
November 2016	Revised Contech contact information
April 2017	Revised sizing language to note sizing based on Off-line calculations

Bradley Heights - Drainage Report

Section 3, Township 19 N, Range 4 E, Willamette Meridian, Pierce County, Washington

DRAINAGE BASIN LEGEND

- DRAINAGE BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- ON-SITE DRAINAGE SUB BASIN = 7.7847 AC
- FRONTAGE SUB-BASIN = 0.8488 AC
- OFF-SITE UPSTREAM BASIN = 3.9204 AC

UPSTREAM OFF-SITE IMPERVIOUS COVERAGE LEGEND

- ROOF AREA = 0.6357 AC
- DRIVEWAY AREA = 0.4655 AC
- PATIO AREA = 0.0873 AC (MODELED AS SIDEWALKS)
- SHOULDER AREA = 0.0585 AC (MODELED AS PARKING)

DRAINAGE BASIN MODELING

UPSTREAM OFF-SITE MODELED AS EXISTING CONDITIONS
SEE LEGEND TO LEFT FOR IMPERVIOUS AREAS
LAWN = 2.6733 AC

ONSITE AND FRONTAGE MODELED AS:
AREAS OF NEW AND REPLACED IMPERVIOUS
MODELED AS FOREST = 6.0682 AC

EXISTING LAWN THAT REMAINS LAWN/LANDSCAPED
MODELED AS LAWN = 2.5653 AC

PRE-DEVELOPED DRAINAGE BASIN

FOR FLOW CONTROL ANALYSIS

PERVIOUS
C, FOREST, MOD = 6.0682 AC
C, LAWN, MOD = 5.2386 AC
TOTAL PERVIOUS = 11.3068 AC

IMPERVIOUS
ROOF = 0.6357 AC
DRIVEWAY, FLAT = 0.4655 AC
SIDEWALK, FLAT = 0.0873 AC
PARKING, FLAT = 0.0585 AC
TOTAL IMPERV. = 1.2471 AC

TOTAL AREA = 12.5539 AC

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GRAPHIC SCALE 1"=50'
0 50 100 150

Project Desc: Bradley Heights Path: F:\Jobs\3227 - Bradley Heights\Tmwk\bradley heights 20250424 ENG.pro Plot Date/Time: 4/24/2025/1:48:15PM

ROBERT A. TRIVITT — 4/24/2025 — STATE OF WASHINGTON — 24015 — REGISTERED PROFESSIONAL ENGINEER

REVISION	DATE
1 Added map D-3: Treatment Drainage Areas.	1/6/24
2 Revised per City review.	3/6/25
3 Corrected hatching, revised drainage for roof for Building G.	3/6/25
4	
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JOB NO. 3227
DATE 2024
DESIGNED BY: Rob Trivitt
DRAWN BY: Rob Trivitt
CHECKED BY: Paul Green
APPROVED BY: Paul Green

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Drainage Basins - Existing

Bradley Heights

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1816 11th Ave Unit C
Seattle, WA, 98122
Phone 509.899.0326
Fax jorden@timberlanepartners.com

DRAWING
D-1
SHEET 1
OF 4

Bradley Heights - Drainage Report

Section 3, Township 19 N, Range 4 E, Willamette Meridian, Pierce County, Washington

GRAPHIC SCALE 1"=50'

0 50 100 150

DRAINAGE BASIN LEGEND

SUB-BASIN BOUNDARY		
STORMTECH #1 SUB BASIN	=	1.3309 AC
VAULT #2 SUB-BASIN	=	2.5362 AC
VAULT #3 SUB-BASIN	=	1.9019 AC
VAULT #4 SUB-BASIN	=	5.5864 AC
BYPASS SUB-BASIN	=	1.1986 AC
TOTAL AREA	=	12.5539 AC

IMPERVIOUS COVERAGE LEGEND

- ROOF
- DRIVEWAY/ROAD/PARKING
- PATIO/WALKWAY
- SHOULDER AREA (MODELED AS PARKING)

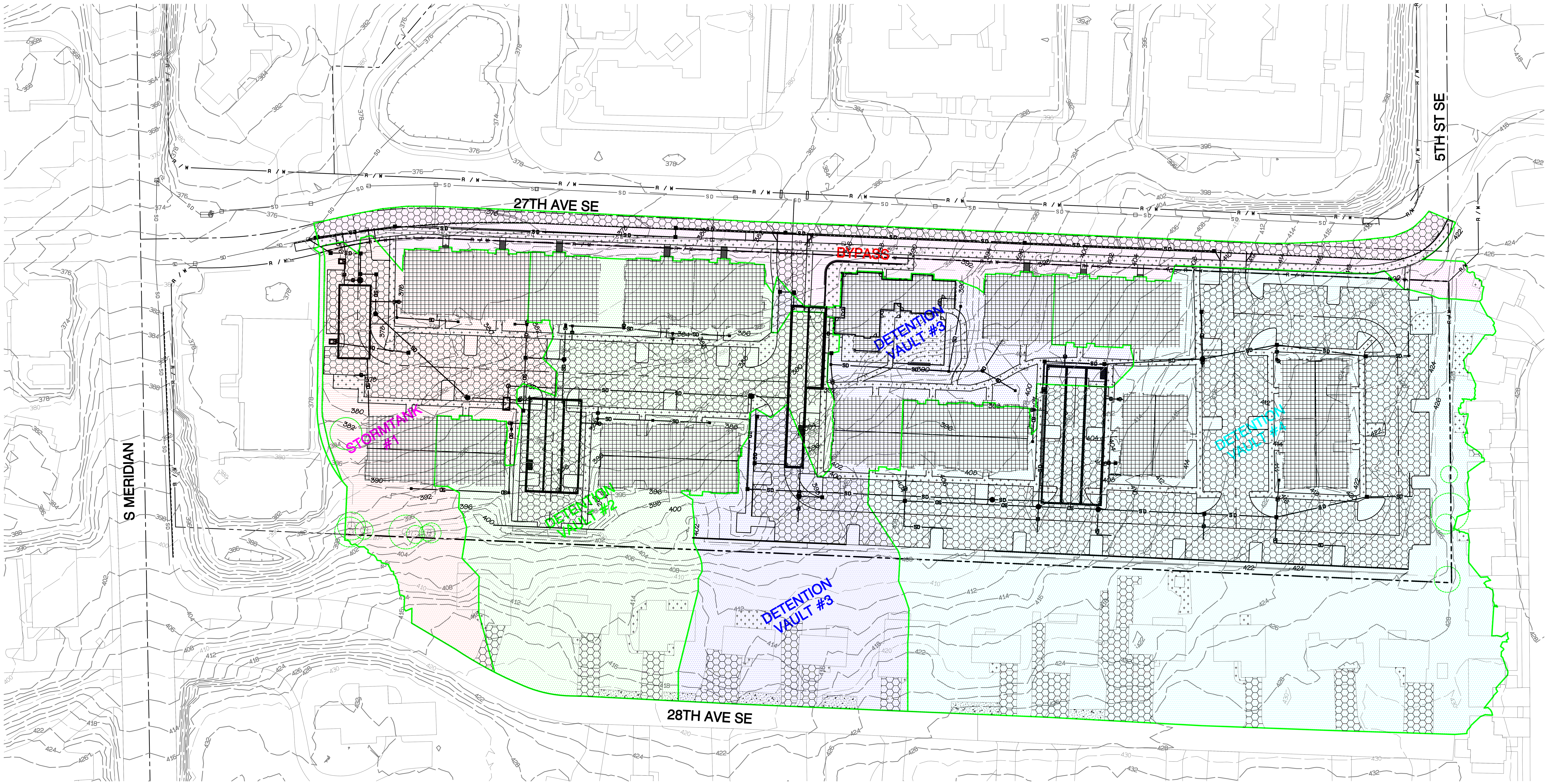
DEVELOPED DRAINAGE BASIN
FOR FLOW CONTROL & VAULT ANALYSIS - POC 1

Cover	STank #1 AC	Vault #2 AC	Vault #3 AC	Vault #4 AC	Bypass AC
C, Lawn, Mod	0.5500	0.9477	0.9517	2.2262	0.4023
Impervious					
Parking/Road, Flat	0.3901	0.6489	0.3897	1.8678	0.4081
Sidewalk, Flat	0.0634	0.1478	0.2081	0.2710	0.3881
Roof	0.3275	0.7918	0.3524	1.2213	0.0000
Total Imperv	0.7809	1.5885	0.9502	3.3601	0.7962
Total	1.3309	2.5362	1.9019	5.5864	1.1986

DEVELOPED DRAINAGE BASIN
FOR NON-MITIGATION LIMIT - POC 7

TO ALLOW THE OFF-SITE UPSTREAM AREA TO BE ROUTED TO THE DETENTION SYSTEM, IT MUST BE SHOWN THAT THE UPSTREAM 100-YEAR FLOWS ARE LESS THAN 50% OF THE THE AREAS TO BE MITIGATED. THE NON-MITIGATION AREA CONSISTS OF THE OFFSITE UPSTREAM AREA. THE MITIGATION AREA CONSISTS OF THE ONSITE AND FRONTAGE AREAS.

		NON-MIT	MIT	
PERVIOUS				
C, LAWN, MOD	=	3.9833 AC	1.0946 AC	
IMPERVIOUS				
ROOF	=	0.6357 AC	2.0573 AC	
DRIVEWAY, FLAT	=	0.4655 AC	0.0000 AC	
SIDEWALK, FLAT	=	0.0873 AC	0.9910 AC	
PARKING, FLAT	=	0.0585 AC	3.1805 AC	(NON-MIT=PARKING AREA) (MIT=PARKING + ROAD)
TOTAL IMPERV.	=	1.2471 AC	6.2289 AC	
TOTAL AREA	=	5.2304 AC	7.3235 AC	



ROBERT A. TRIVITT
STATE OF WASHINGTON
43715
REGISTERED PROFESSIONAL ENGINEER
4/24/2025

REVISION	DATE
1 Added map D-3: Treatment Drainage Areas.	11/19/24
2 Revised per City review.	3/6/25
3 Corrected hatching, revised drainage for roof for Building D.	3/6/25
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JOB NO: 3227
DATE: May 16, 2024
DESIGNED BY: Rob Trivitt
DRAWN BY: Rob Trivitt
CHECKED BY: Paul Green
APPROVED BY: Paul Green

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Drainage Basins - Developed

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DRAWING
D-2
SHEET 2 OF 4

Bradley Heights - Drainage Report

Section 3, Township 19 N, Range 4 E, Willamette Meridian, Pierce County, Washington

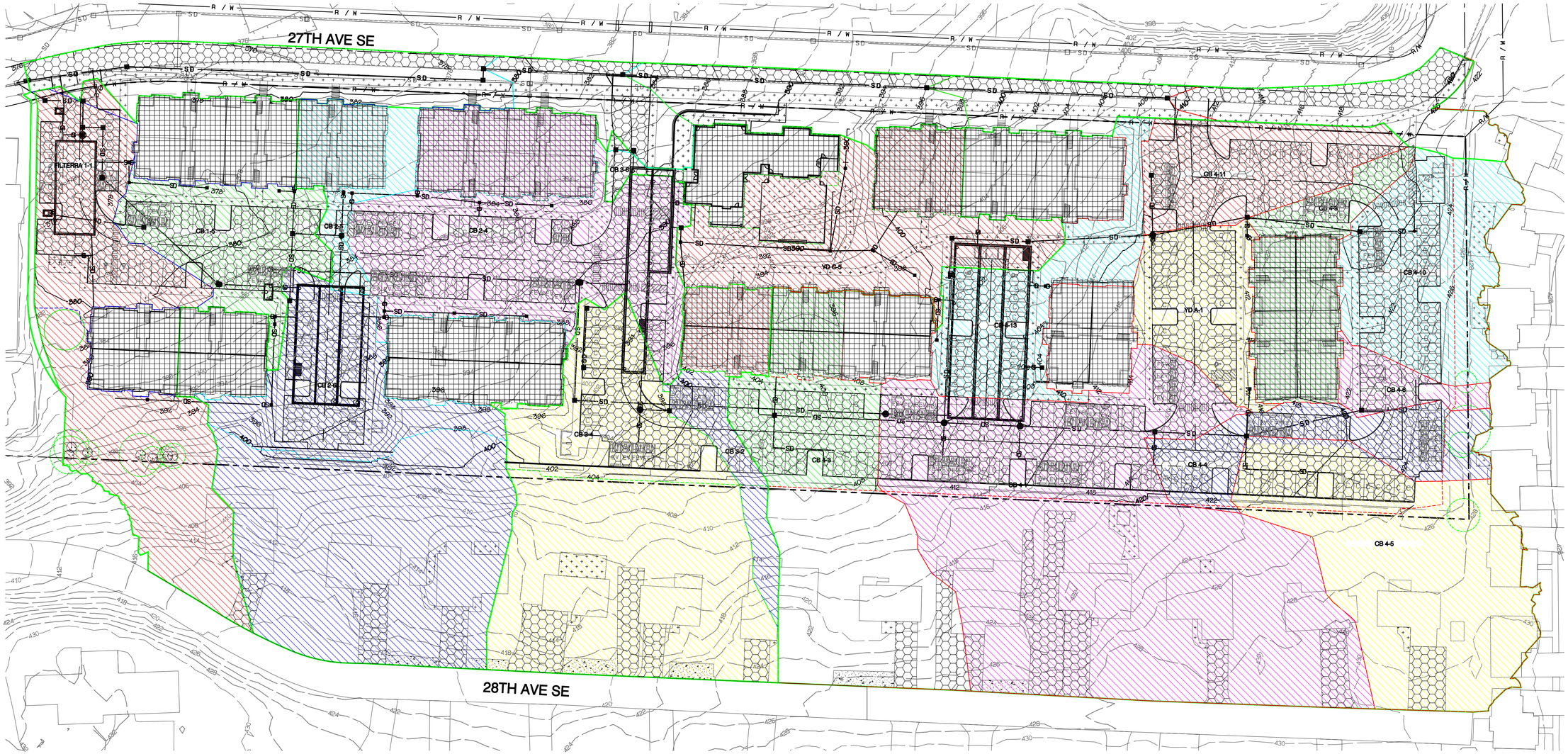
IMPERVIOUS COVERAGE LEGEND

- ROOF
- DRIVEWAY/ROAD/PARKING
- PATIO/WALKWAY
- SHOULDER AREA (MODELED AS PARKING)

N W E S

GRAPHIC SCALE 1"=40'

0 40 80 120



Project Desc.: Bradley Heights Path: F:\Jobs\3227 - Bradley Heights\Tmain\bradley heights 20250424 ENG.pro Plot Date/Time: 4/24/2025/2:15:03PM

ROBERT A. TRIVITT — 4/24/2025 — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

REVISION	DATE
1 Change D-3: Treatment Drainage Areas.	11/6/24
2 Revised per City review.	3/6/25
3 Corrected hatching, revised drainage for roof for Building G.	3/6/25
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JOB NO. 3227
DATE May 6, 2024
DESIGNED BY: Rob Trivitt
DRAWN BY: Rob Trivitt
CHECKED BY: Paul Green
APPROVED BY: Paul Green

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Drainage Basins - Catch Basins

Bradley Heights

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Fax jorden@timerlanepartners.com

DRAWING

D-3

SHEET 3
OF 4

Bradley Heights - Drainage Report

Section 3, Township 19 N, Range 4 E, Willamette Meridian, Pierce County, Washington

TREATMENT DRAINAGE SUB-BASIN LEGEND

- FILTERRA 1-1 = 0.7230 AC
- FILTERRA 1-2 = 0.2985 AC
- WET-VAULT#2 = 2.5362 AC
- WET-VAULT #3 SOUTH = 1.1747 AC
- WET-VAULT #3 NORTH = 0.5919 AC
- WET-VAULT#4 = 5.1460 AC
- FRONTAGE = 1.1712 AC

IMPERVIOUS COVERAGE LEGEND

- ROOF
- DRIVEWAY/ROAD/PARKING
- PATIO/WALKWAY
- SHOULDER AREA (MODELED AS PARKING)

DEVELOPED DRAINAGE BASIN

FOR TREATMENT

	FILT 1-1	FILT 1-2	Vault #2	Vault #3S	Vault #3N	Vault #4	Frontage
POC	2	3	4	5	6	8	9
Cover	AC	AC	AC	AC	AC	AC	AC
C, Lawn, Mod	0.4924	0.0576	0.9477	0.6388	0.3129	2.2262	0.3750
Impervious							
Parking/Road, Flat	0.2040	0.1861	0.6489	0.3775	0.0122	1.8678	0.4081
Sidewalk, Flat	0.0086	0.0548	0.1478	0.0503	0.1577	0.2710	0.3881
Roof	0.0181	0.0000	0.7918	0.1080	0.1091	0.7810	0.0000
Total Imperv	0.2306	0.2409	1.5885	0.5359	0.2790	2.9198	0.7962
Total	0.7230	0.2985	2.5362	1.1747	0.5919	5.1460	1.1712

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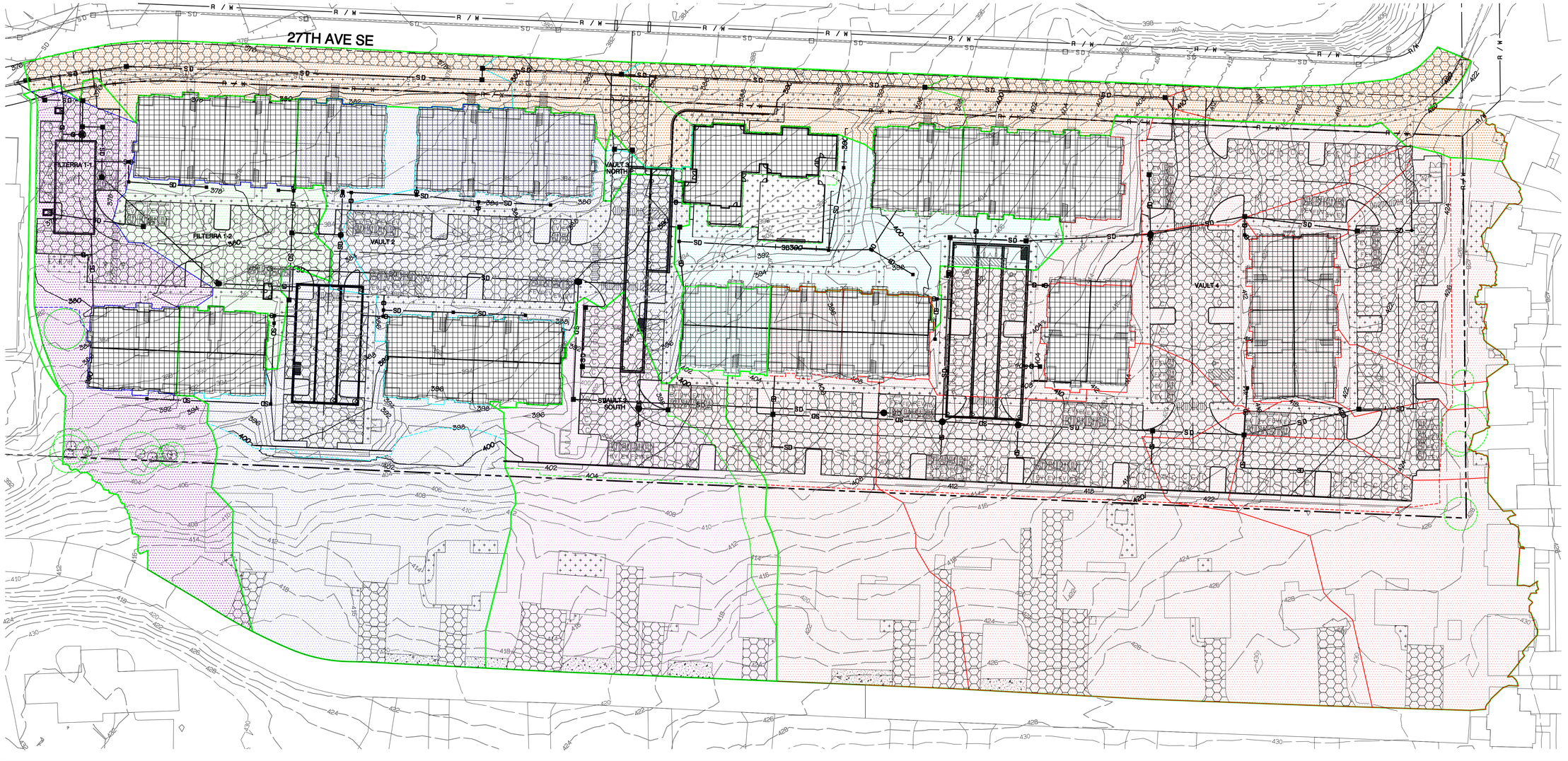
GRAPHIC SCALE 1"=40'

0 40 80 120



Project Desc.: Bradley Heights Path: F:\Jobs\3227 - Bradley Heights\Tmwin\bradley heights 20250424 ENG.pro Plot Date/Time: 4/24/2025/2:06:31PM

ROBERT A. TRIVITT — 4/24/2025 — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

REVISION	DATE
1 Added Dp 3: Treatment Drainage Areas.	11/6/24
2 Revised per City review.	3/6/25
3 Corrected hatching, revised drainage for roof for Building D.	3/6/25
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JOB NO. 3227
DATE NOV. 2024
DESIGNED BY: Rob Trivitt
DRAWN BY: Rob Trivitt
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APPROVED BY: Paul Green

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Drainage Basins - Treatment

Bradley Heights

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DRAWING
D-4
SHEET 4
OF 4