PRELIMINARY
STORM
DRAINAGE REPORT

FOR

GRANDVIEW ADDITION

City of Spokane, Washington

March 23, 2022

2021-3017

Prepared by:

Whipple Consulting Engineers
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Spokane Valley, WA
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This report has been prepared by Whipple Consulting Engineers under the direction of the undersigned professional engineer whose seal and signature appears hereon:

Justin Penner, P.E.

INTRODUCTION:

The purpose of this drainage narrative is to identify drainage impacts resulting from the proposed development of Grandview Addition. This drainage narrative will determine the drainage infrastructure improvements that are necessary to control and treat the stormwater runoff from the project site. The report will demonstrate there is no negative impact to the adjacent properties with the proposed development. The proposed project lies within the City of Spokane and will be designed in accordance with the Spokane Regional Stormwater Manual (SRSM). As outlined in the SRSM, treatment methods will be based on equation 6-1d:, V=1815A.

NARRATIVE:

PROJECT DESCRIPTION:

The proposed project is a 96-lot subdivision located near Grandview Ave and H Street. There are six (6) new roads. The proposed development of the site will result in 96 new lots, driveways, extension of public streets, and associated onsite storm drainage facilities. The proposed and existing stormwater facilities will adequately collect, treat, and discharge the stormwater runoff from the proposed development

The subject property is located within the City of Spokane in a portion of the NE 1/4 of Section 26, T 25 N., R 42 E., W.M. The parcel numbers for the project are 25261.2606, 25261.2607, 25261.2901, 25261.2812, 25261.3001 thru 25261.3005, 25261.3101, 25261.3305, 25261.3301, 25261.3204, and 25261.3203. Please see the Vicinity Map attached in the Appendix.

GEOTECHNICAL INFORMATION:

Per a geotechnical report completed by Budinger and Associates dated 9/20/2021 the site is centered on a bluff of a remnant basalt lava plateau with steep sides eroded and undercut by glacial flood waters. Geologic mapping of this area shows Glacial Lake Missoula outburst flood deposits across but primarily along the lower reaches of middle Miocene Epoch Basalt lava belong to the Priest Rapids Member of the Wanapum Basalt, Columbia River Basalt Group.

Outflow rates were provided within the Geotech and ranged from a single depth drywell outflow rate of 0.3 cfs at TP-15 and the use of a gravel gallery elsewhere with a recommended outflow rate of 14cf/d/lf. See appendix for geotechnical recommendations.

PRE-DEVELOPMENT BASIN INFORMATION:

As shown on the pre-basin map the site consists of undeveloped land with abundant outcrop of rock and steep rock faces with accumulated talus. There are two benches above the overall plateau surface with a maximum relief of approximately 78 ft from the top of the benches towards 17th Ave. The site is currently covered with trees, field grass, weeds, etc. The site was divided into three (3) pre basins based on the contours of the existing site. The majority of the site drains both north and south gentler grades on the south and steeper grades on the north.

The offsite stormwater flow path to the north is generally directed towards H St where the stormwater sheet flows to the north and in the shallow ditch along H St before pooling and crossing 17th Ave to the north. From there the stormwater continues northwest where it is intersected by Interstate 90 stormwater facilities. The stormwater that flows offsite to the south is collected in various low points in the adjacent properties or pools in the unused F St right of way.

Table 1 – Pre-Development Project Site Basin Summary

	Total Basin Area (sf)	Impervious Area (sf)	Pervious Area (sf)
Pre-Basin A	475,334	0	475,334
Pre-Basin B	351,967	0	351,967
Pre-Basin C	140,622	0	140,622

POST-DEVELOPMENT BASIN INFORMATION:

The Post-Development stormwater was separated into four (4) major basins with additional subbasins to be developed in the design phase of the project.

The Basins were determined by the collection and discharge point for the stormwater. Due to the hillside nature of the project the stormwater will be collected via catch basin and pipe system.

Basins A and B utilized a pipe and catch basin system while Basin C and Basin D discharge offsite in the direction of the predeveloped condition.

While the SRSM requires analysis of the 10 and 25-year storm events, for this project due to its soils and hillside nature, we have provided bowstring calculations and pond sizing for the 100-year event for conservatism.

Table 2 – Post-Development Project Site Basin Summary

	Total Basin Area (sf)	Impervious Area (sf)	Pervious Area (sf)
Post A	391,802	242,630	149,172
Post B	343,290	197,120	146,170
Post C	124,055	9,600	114,455
Post D	108,776	19,200	89,576

Table 3 – Post-Development Project Site Pond Summary

	PGIS Area (sf)	(Method 1815A (ac)) Treatment Area/Volume (square feet/cubic feet)	
		Required	Provided
Post A	98,130	4,089	7,647
Post B	71,520	2,980	8,444
Post C	0	0	n/a
Post D	0	0	n/a

Refer to basin calculations in Appendix for areas and peak flows for all basins.

Operational Characteristics:

The stormwater for the Grandview Addition development will be collected in proposed catch basins and pipes that will discharge into storm drainage ponds. The drainage ponds in turn will discharge underground via drywell of gravel gallery.

The stormwater pond for Basin B will act as cutoff ditch for stormwater flowing to the south while Pond C and proposed cutoff ditch will intercept stormwater flowing the southeast. Any excess stormwater flowing the north will continue in the same flow path as in the pre developed condition.

Methodology:

As required by the SRSM, the storm drainage facilities proposed for this site have been sized to attenuate the 10- and 25-year storm events using the Rational Method as outlined in Section 5.5 of the SRSM. It should be noted that due to the hillside nature of the project site, storage calculations have been completed using the 100-year storm event for conservatism. The peak flows and volumes for these storm events are shown in the calculations that are included within the Appendix of this report.

Water Quality Treatment:

The proposed storm drainage ponds have been designed to provide treatment volume based on Equation 6-1d (V=1815A) of the SRSM, as outlined in Section 6.7.1. Once the treated stormwater exceeds a height of 12 inches, it will spill into drywells, where it will be discharged underground. It is to be noted that the ponds are to be L.I.D. ponds.

Critical Areas:

Based on the Critical Area Maps provided by Spokane County, (DNR Streams, Fish and Wildlife, Wetlands, Geo-hazard Area and Critical Aquifer Resource Area), there are no critical areas onsite except steep slopes greater than 30% and the project site has a CARA susceptibility rating of high.

Results:

As shown in Table 3 within this report we have provided the required treatment volume for the improvements proposed for the development. Table 4 below shows the onsite pond/swale storage summary for the 100-year storm event.

Table 4 – Project Site Pond/Swale Storage Summary

	100-YR Storm	
	Required	Provided
Basin	Vol. (cf)	Vol. (cf)
Basin A	35,747	42,072
Basin B	15,535	29,800
Basin C	3,877	5,841
Basin D	0	n/a

Perpetual Maintenance of Facilities:

This is a residential development with public roads as access. The surface maintenance of the ponds, pond structure maintenance, and pond replacement will be provided by the Homeowners Association while street structure maintenance and replacement are to be done by the City of Spokane. A maintenance plan will be provided to the owner if requested.

Offsite Easements:

There are no offsite easements required for this property.

Regional Facilities:

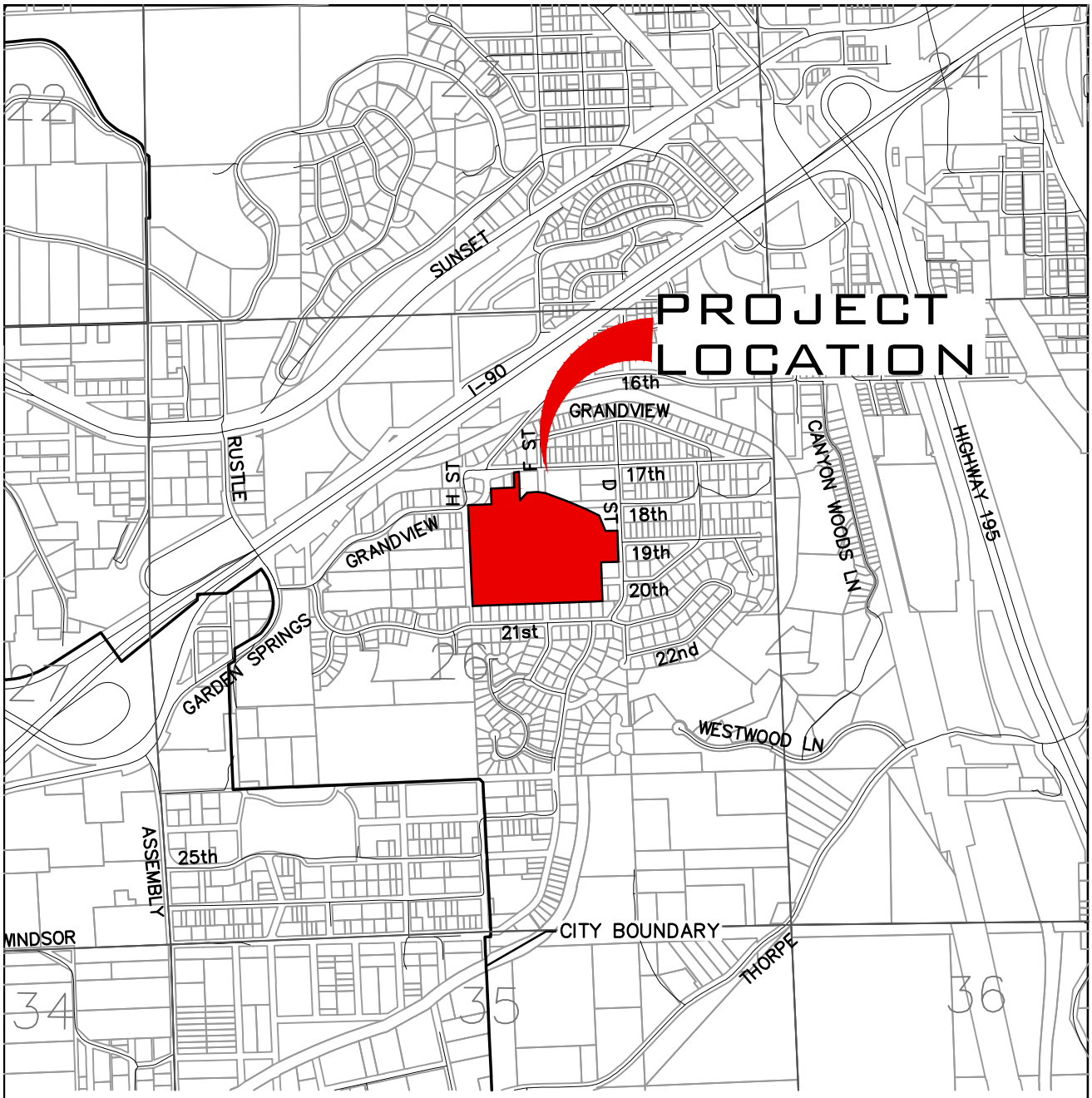
There are no known regional facilities that lie within the project site. However, the project does have offsite stormwater that will be passed the project site.

CONCLUSION:

As required by the City of Spokane and the Spokane Regional Stormwater Manual, the onsite storm drainage facilities for this project will adequately collect, treat, and discharge stormwater runoff generated by the site during the 10-year storm event. Also, the storm drainage facilities will contain and discharge the 100-year storm. Therefore, this project will have no adverse impact to adjacent and/or downstream properties.

APPENDIX

VICINITY MAP



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W E

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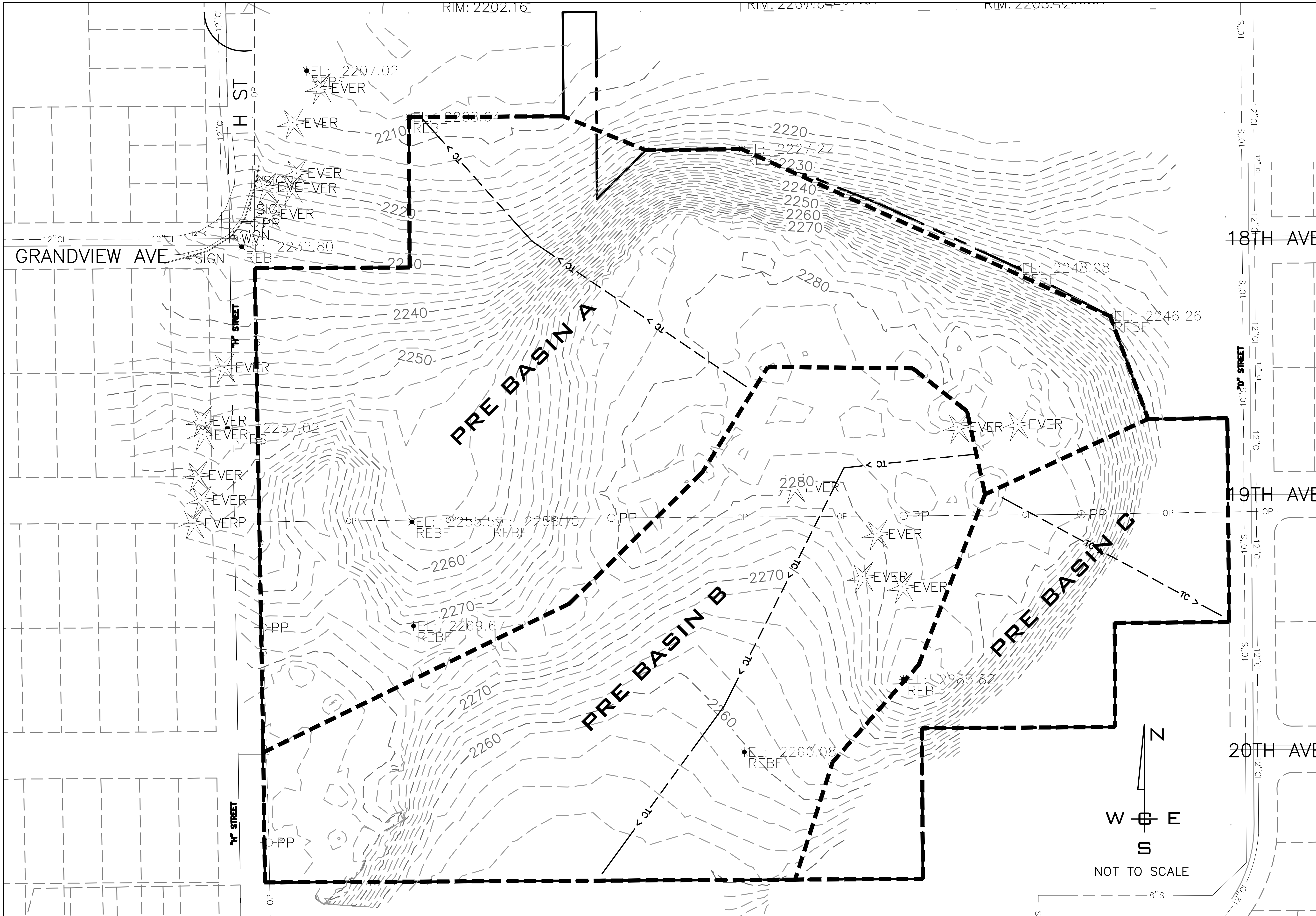
NOT TO SCALE

PROJ #: 21-3017 DATE: 3/22/22 DRAWN: JPP APPROVED: JPP	DRAINAGE REPORT **GRAND VIEW ADDITION** GRANDVIEW AVE & H ST SPOKANE, WASHINGTON	WCE WHIPPLE CONSULTING ENGINEERS 21 SOUTH PINES RD SPOKANE VALLEY, WASHINGTON 99206 PH: 509-893-2617 FAX: 509-926-0227
FIGURE 1	VICINITY MAP	

BASIN MAPS



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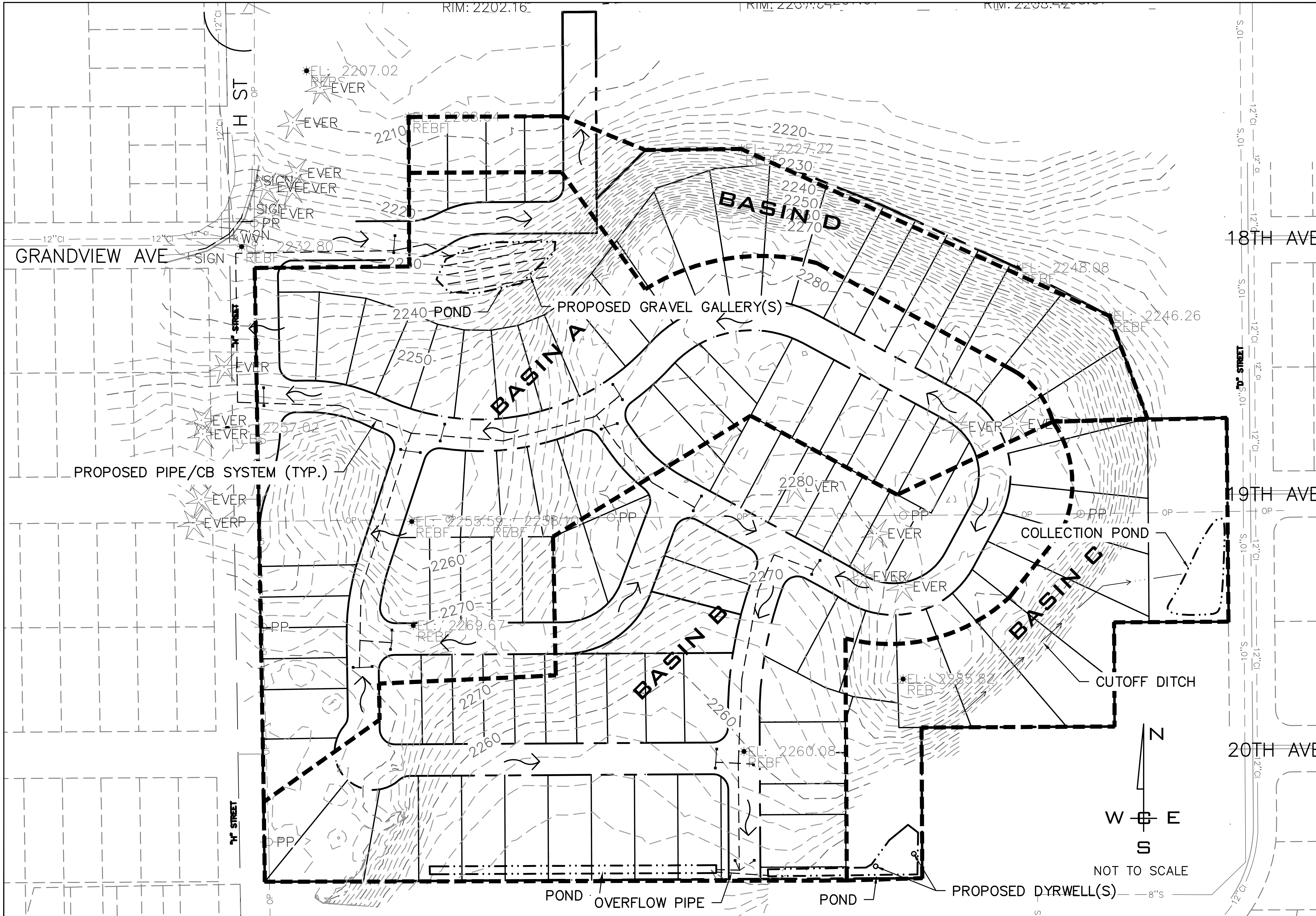
PRE-DEVELOPMENT BASIN MAP

GRANDVIEW ADDITION

GRANDVIEW AVE & H ST

SPOKANE, WASHINGTON

SHEET 1 OF 2



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PRE-DEVELOPMENT BASIN MAP
GRANDVIEW ADDITION
GRANDVIEW AVE & H ST
SPOKANE, WASHINGTON

SHEET
2 OF 2

BASIN SUMMARY SHEET

Whipple Consulting Engineers

Basin Calculation Worksheet

Imp 0.9

Per 0.15

Intensities from SRSM eqn. 5-13, per Table 5-7, Assumes Tc = 5 min

I (2 yr) = 1.418 inches I (10 yr)= 2.619 inches NOTE:

I (25 yr) = 3.319 inches I (50 yr)= 3.843 inches

I (100 yr) = 4.381 inches

	WCE No.	Project Name
3/23/2022	21-3017	Grandview Addition
JPP		

SPOKANE COUNTY - SRSM - GRASSED PERCOLATION METHOD

1815 A

Basin	Total sf	Access/Parking /Street (sf)	Sidewalk sf	DV WY	Buildings sf	Total Impervious	Total Pervious	Weighted "C"	PGIS sf	Pond Area (sf)	Pond Vol (cf)	Q=CIA (cfs) 2 yr	10 yr	25 yr	50 yr	100 yr
Pre A	475,334	0	0	0	0	0	475,334	0.15	0	0	0	2.32	4.29	5.43	6.29	7.17
Pre B	351,967	0	0	0	0	0	351,967	0.15	0	0	0	1.72	3.17	4.02	4.66	5.31
Pre C	140,622	0	0	0	0	0	140,622	0.15	0	0	0	0.69	1.27	1.61	1.86	2.12
Pre Total	**967,923**	**0**	**0**	**0**	**0**	**0**	**967,923**	**0.15**	**0.00**	**0.00**	**0.00**	**4.73**	**8.73**	**11.06**	**12.81**	**14.60**
Post Onsite Flow																
Post A	391,802	80,850	24,500	17,280	120,000	242,630	149,172	0.61	98,130	8,178	4,089	7.84	14.47	18.34	21.24	24.21
Post B	343,290	58,080	44,000	13,440	81,600	197,120	146,170	0.58	71,520	5,960	2,980	6.49	11.98	15.19	17.59	20.05
Post C	124,055	0	0	0	9,600	9,600	114,455	0.21	0	0	0	0.84	1.55	1.97	2.28	2.60
Post D	108,776	0	0	0	19,200	19,200	89,576	0.28	0	0	0	1.00	1.85	2.34	2.71	3.09
Total	**967,923**	**138,930**	**68,500**	**30,720**	**230,400**	**468,550**	**499,373**	**0.51**	**169,650**	**14,138**	**7,069**	16.17	29.86	37.84	43.81	49.95

POND VOLUME & INFILTARTION

WHIPPLE CONSULTING ENGINEERS **Date: 3/23/2022**

POND VOLUME CALC SHEET

Project: 21-3017

Designer: JPP Grandview Addition

								Treatment					*Storage*
Basins	Ponds/ Swales	Bottom Area sf	Treatment Area (w/ Side Slopes)	Squared Side lf	Pond Bottom Elevation at Drywell	Pond Drywell Elevation	Pond Outlet Elevation (avg)	Conic Volume to Rim cf	Side Slope Volume cf	Total Volume to to Rim cf	Conic Volume to Inlet cf	Side Slope Volume cf	Total Volume to Inlet cf
A	A1	7,140	8,209	84.50	1000.00	1001.00	1004.00	7,140	507	7,647	28,560	8,112	36,672
B	B1	3,700	4,469	60.83	1000.00	1001.00	1003.00	3,700	365	4,065	11,100	3,285	14,385
	B2	4,000	4,800	63.25	1000.00	1001.00	1003.00	4,000	379	4,379	12,000	3,415	15,415
B TOTAL		**7,700**								**8,444**			**29,800**
C	C	5,400	5,865	73.48	1000.00	1000.50	1001.00	2,700	110	2,810	5,400	441	5,841

WHIPPLE CONSULTING ENGINEERS

GRAVEL GALLERY CALC SHEET

3/23/2022

21-3017 Grandview Addition
DESIGNER JPP

Porsity: **0.3**
Infiltration Rate: **14 gpd/lf**
Convert gpd to cfs **1.5472E-06**

Note: infiltration rates per Budinger Geotechnical Report Dated December 1, 2021
14 gpd/lf of gallery

BASIN		Number of Galleries	Length	Width	Depth	Ground Water EL.	Gravel Gallery Bott. EL	Volume	Storage Volume	Outflow
			ft	ft	ft	ft	ft	cf	cf	cfs
A		5	120.00	3.00	3.00	-	1000.00	5,400	1,620	0.013
Total			600					5,400	**1,620**	**0.013**

Storage Volume = Volume* Porosity
Sidewall Area= Perimeter*Depth
OutFlow = Sidewall Area+ Bottom Area * Infiltration Rate

Note: Outflow Assumes a Full Gallery

100-YEAR STORM EVENT BOWSTRING CALCULATIONS

PEAK FLOW CALCULATION PROJECT: **21-3017**

100-Year Design Storm

BASIN: A

Tot. Area	391,802 SF	8.99 Acres	
Imp. Area	242,630 SF	C=	0.9
Perv. Area	149,172 SF	C=	0.15
Wt. C =	0.61	PGIS Area =	98,130

WCE Applicable Travel Time Ground Cover Coefficients		
Per Table 5-6 SRSM		
Type of Cover	K (ft/min)	
Short Pasture	420	
Nearly Bare Ground	600	
Small Roadside Ditch/ Grass	900	
Paved Area (use for parking lots)	1200	
Gutter - 4 inches deep	1500	
Gutter - 6 inches deep	2400	
Pipe - 12-inch PVC/DI	3000	
Pipe - 15/18-inch PVC/DI	3900	
Pipe - 24-inch PVC/DI	4700	

Reaches		
Reach 1	Offsite	also applicable for Pre-Developed Tc
Length	100.00	
K	420.00	
Slope (ft/ft)	0.0400	be sure this is decimal equivalent slope 0.0000
Travel Time	1.19	Minutes
Reach 2	Finished Lot from House to Street	
Length	100.00	
K	420.00	
Slope (ft/ft)	0.0300	be sure this is decimal equivalent slope 0.0000
Travel Time	1.37	Minutes
Reach 3	Gutter Flow to Inlet/Catch Basin	
Length	300.00	
K	2400.00	
Slope (ft/ft)	0.0300	be sure this is decimal equivalent slope 0.0000
Travel Time	0.72	Minutes
Reach 4	Pipe Flow 1	Pipe Reach One (only need one if no Dia change)
Length	1300.00	
K	3000.00	12-inch Pipe minimum
Slope (ft/ft)	0.1000	Average Slope for total pipe run
Travel Time	1.37	Minutes
Reach 5	Pipe Flow 2	Add additional pipe reacheds for other Dia
Length	0.00	
K	3900.00	15/18-inch Pipe
Slope (ft/ft)	0.1000	Average Slope for total pipe run
Travel Time	0.00	Minutes
Sum of Tc	4.66	Minutes
Tc for Analysis	5.00	Minutes

BOWSTRING METHOD PROJECT: 21-3017

DETENTION BASIN DESIGN BASIN: A

DESIGNER: JPP

DATE: 23-Mar-22

Time Increment (min)	10
Time of Conc. (min)	5.00
Outflow (cfs)	0.013
Design Year Flow T	100
Area (acres)	8.99
Impervious Area (sq ft)	242630
'C' Factor	0.61
Area * C	5.527
PGIS Area	98,130

Time (min)	Time Inc. (sec)	Intens. (in/hr)	Q Devel. (cfs)	Vol.In (cu ft)	Vol.Out (cu ft)	Storage (cu ft)	
5.00	300	4.38	24.21	9732	4	9728	
15	900	2.16	11.95	11969	12	11958	
25	1500	1.56	8.60	13779	20	13759	
35	2100	1.25	6.93	15255	27	15228	
45	2700	1.07	5.89	16515	35	16480	
55	3300	0.94	5.18	17624	43	17581	
65	3900	0.84	4.65	18621	51	18570	
75	4500	0.77	4.24	19530	59	19472	
85	5100	0.71	3.92	20370	66	20303	
95	5700	0.66	3.65	21151	74	21077	
105	6300	0.62	3.42	21884	82	21802	
115	6900	0.58	3.22	22575	90	22485	
125	7500	0.55	3.06	23230	98	23132	
135	8100	0.53	2.91	23853	105	23748	
145	8700	0.50	2.78	24448	113	24335	
155	9300	0.48	2.66	25019	121	24898	
165	9900	0.46	2.56	25567	129	25438	
175	10500	0.45	2.46	26094	137	25958	
185	11100	0.43	2.37	26603	144	26459	
195	11700	0.42	2.30	27095	152	26943	
205	12300	0.40	2.22	27572	160	27412	
215	12900	0.39	2.16	28034	168	27866	
225	13500	0.38	2.09	28482	176	28307	
235	14100	0.37	2.04	28919	183	28736	
245	14700	0.36	1.98	29344	191	29153	
255	15300	0.35	1.93	29758	199	29559	
265	15900	0.34	1.88	30162	207	29955	
275	16500	0.33	1.84	30556	215	30342	
285	17100	0.33	1.80	30942	222	30719	
295	17700	0.32	1.76	31319	230	31088	
305	18300	0.31	1.72	31688	238	31450	
315	18900	0.31	1.69	32049	246	31803	
325	19500	0.30	1.65	32403	254	32150	
335	20100	0.29	1.62	32751	261	32489	
345	20700	0.29	1.59	33091	269	32822	
355	21300	0.28	1.57	33513	277	33236	
365	21900	0.28	1.54	33784	285	33500	
375	22500	0.27	1.51	34143	293	33851	
385	23100	0.27	1.51	35049	300	34749	

Rainfall Intensity Coefficients for ***Spokane***

taken from Table 5-7 SRSM

M_{100} = 12.33

N_{100} = 0.643

Flow (weighted c)

Qwc= 24.21 cfs

Flow (time of concentration)

Qtc= 24.21 cfs

Time (min)	Time Inc. (sec)	Intens. (in/hr)	Q Devel (cfs)	Vol.In (cu ft)	Vol.Out (cu ft)	Storage (cu ft)	
385							
395	23700	0.26	1.46	34640	308	34332	
405	24300	0.26	1.46	35514	316	35198	
415	24900	0.25	1.40	35005	324	34681	
425	25500	0.25	1.40	35845	332	35514	
435	26100	0.24	1.34	35237	339	34898	
445	26700	0.24	1.34	36044	347	35697	
455	27300	0.23	1.29	35336	355	34981	
465	27900	0.23	1.29	36110	363	35747	<==
475	28500	0.22	1.23	35303	371	34933	
485	29100	0.22	1.23	36044	378	35665	
495	29700	0.21	1.18	35137	386	34751	
505	30300	0.21	1.18	35845	394	35451	
515	30900	0.20	1.12	34839	402	34437	
525	31500	0.20	1.12	35513	410	35103	
535	32100	0.19	1.07	34407	417	33990	
545	32700	0.19	1.07	35048	425	34623	
555	33300	0.18	1.01	33844	433	33411	
565	33900	0.18	1.01	34451	441	34011	
575	34500	0.17	0.96	33147	449	32699	
585	35100	0.17	0.96	33722	456	33266	
595	35700	0.16	0.90	32318	464	31854	
605	36300	0.16	0.90	32860	472	32388	
615	36900	0.15	0.85	31356	480	30876	
625	37500	0.15	0.85	31865	488	31377	
635	38100	0.14	0.79	30262	495	29766	
645	38700	0.14	0.79	30737	503	30234	
655	39300	0.13	0.74	29035	511	28524	
665	39900	0.13	0.74	29477	519	28958	
675	40500	0.12	0.68	27675	527	27149	
685	41100	0.12	0.68	28084	534	27550	
695	41700	0.11	0.63	26183	542	25641	
705	42300	0.11	0.63	26559	550	26009	
715	42900	0.10	0.57	24558	558	24000	
725	43500	0.10	0.57	24900	566	24335	
735	44100	0.09	0.52	22800	573	22227	
745	44700	0.09	0.52	23110	581	22529	

"1815A" TREATMENT REQUIREMENTS	
Minimum "1815" Volume Required	4,089 cu ft
Provided Treatment Volume - Min.	7,647 cu ft
STORAGE REQ. - 100 YEAR DESIGN STORM	
Maximum Storage Required by Bowstring	35,747 cu ft
Provided Pond Storage Volume to Inlet - Min.	36,672 cu ft
Provided Drywell/Gallery Storage Volume	5,400 cu ft
Total Provided Volume	**42,072 cu ft**

PEAK FLOW CALCULATION PROJECT: **21-3017**

100-Year Design Storm

BASIN: B

Tot. Area	343,290 SF	7.88 Acres	
Imp. Area	197,120 SF	C=	0.9
Perv. Area	146,170 SF	C=	0.15
Wt. C =	0.58	PGIS Area =	71,520

WCE Applicable Travel Time Ground Cover Coefficients			
Per Table 5-6 SRSM			
Type of Cover		K (ft/min)	
Short Pasture		420	
Nearly Bare Ground		600	
Small Roadside Ditch/ Grass		900	
Paved Area (use for parking lots)		1200	
Gutter - 4 inches deep		1500	
Gutter - 6 inches deep		2400	
Pipe - 12-inch PVC/DI		3000	
Pipe - 15/18-inch PVC/DI		3900	
Pipe - 24-inch PVC/DI		4700	
Reaches			
Reach 1	Offsite	also applicable for Pre-Developed Tc	
Length	100.00		
K	420.00		
Slope (ft/ft)	0.0400	be sure this is decimal equivalent slope 0.0000	
Travel Time	1.19	Minutes	
Reach 2	Finished Lot from House to Street		
Length	100.00		
K	420.00		
Slope (ft/ft)	0.0300	be sure this is decimal equivalent slope 0.0000	
Travel Time	1.37	Minutes	
Reach 3	Gutter Flow to Inlet/Catch Basin		
Length	300.00		
K	2400.00		
Slope (ft/ft)	0.0300	be sure this is decimal equivalent slope 0.0000	
Travel Time	0.72	Minutes	
Reach 4	Pipe Flow 1	Pipe Reach One (only need one if no Dia change)	
Length	1200.00		
K	3000.00	12-inch Pipe minimum	
Slope (ft/ft)	0.0500	Average Slope for total pipe run	
Travel Time	1.79	Minutes	
Reach 5	Pipe Flow 2	Add additional pipe reacheds for other Dia	
Length	1200.00		
K	3900.00	15/18-inch Pipe	
Slope (ft/ft)	0.0500	Average Slope for total pipe run	
Travel Time	1.38	Minutes	
Sum of Tc	6.45	Minutes	
Tc for Analysis	6.45	Minutes	

BOWSTRING METHOD PROJECT: 21-3017

DETENTION BASIN DESIGN BASIN: B

DESIGNER: JPP

DATE: 23-Mar-22

Time Increment (min)	10
Time of Conc. (min)	6.45
Outflow (cfs)	0.600
Design Year Flow	100
Area (acres)	7.88
Impervious Area (sq ft)	197120
'C' Factor	0.58
Area * C	4.576
PGIS Area	71,520

Time (min)	Time Inc. (sec)	Intens. (in/hr)	Q Devel. (cfs)	Vol.In (cu ft)	Vol.Out (cu ft)	Storage (cu ft)	
6.45	387	3.72	17.02	8826	232	8594	
15	900	2.16	9.89	10203	540	9663	
25	1500	1.56	7.12	11620	900	10720	
35	2100	1.25	5.74	12801	1260	11541	
45	2700	1.07	4.88	13819	1620	12199	
55	3300	0.94	4.29	14720	1980	12740	
65	3900	0.84	3.85	15532	2340	13192	
75	4500	0.77	3.51	16275	2700	13575	
85	5100	0.71	3.24	16962	3060	13902	
95	5700	0.66	3.02	17602	3420	14182	
105	6300	0.62	2.83	18203	3780	14423	
115	6900	0.58	2.67	18771	4140	14631	
125	7500	0.55	2.53	19309	4500	14809	
135	8100	0.53	2.41	19821	4860	14961	
145	8700	0.50	2.30	20311	5220	15091	
155	9300	0.48	2.20	20781	5580	15201	
165	9900	0.46	2.12	21232	5940	15292	
175	10500	0.45	2.04	21666	6300	15366	
185	11100	0.43	1.97	22085	6660	15425	
195	11700	0.42	1.90	22491	7020	15471	
205	12300	0.40	1.84	22884	7380	15504	
215	12900	0.39	1.79	23265	7740	15525	
225	13500	0.38	1.73	23635	8100	15535	<==
235	14100	0.37	1.69	23995	8460	15535	
245	14700	0.36	1.64	24345	8820	15525	
255	15300	0.35	1.60	24687	9180	15507	
265	15900	0.34	1.56	25020	9540	15480	
275	16500	0.33	1.52	25345	9900	15445	
285	17100	0.33	1.49	25664	10260	15404	
295	17700	0.32	1.46	25975	10620	15355	
305	18300	0.31	1.43	26279	10980	15299	
315	18900	0.31	1.40	26578	11340	15238	
325	19500	0.30	1.37	26870	11700	15170	
335	20100	0.29	1.34	27157	12060	15097	
345	20700	0.29	1.32	27439	12420	15019	
355	21300	0.28	1.30	27787	12780	15007	
365	21900	0.28	1.27	28011	13140	14871	
375	22500	0.27	1.25	28307	13500	14807	
385	23100	0.27	1.25	29058	13860	15198	

Rainfall Intensity Coefficients for ***Spokane***

taken from Table 5-7 SRSM

M_{100} = 12.33

N_{100} = 0.643

Flow (weighted c)

Qwc= 20.05 cfs

Flow (time of concentration)

Qtc= 17.02 cfs

Time (min)	Time Inc. (sec)	Intens. (in/hr)	Q Devel (cfs)	Vol.In (cu ft)	Vol.Out (cu ft)	Storage (cu ft)
385						
395	23700	0.26	1.21	28718	14220	14498
405	24300	0.26	1.21	29441	14580	14861
415	24900	0.25	1.16	29018	14940	14078
425	25500	0.25	1.16	29714	15300	14414
435	26100	0.24	1.11	29209	15660	13549
445	26700	0.24	1.11	29877	16020	13857
455	27300	0.23	1.07	29290	16380	12910
465	27900	0.23	1.07	29931	16740	13191
475	28500	0.22	1.02	29261	17100	12161
485	29100	0.22	1.02	29874	17460	12414
495	29700	0.21	0.98	29122	17820	11302
505	30300	0.21	0.98	29708	18180	11528
515	30900	0.20	0.93	28874	18540	10334
525	31500	0.20	0.93	29432	18900	10532
535	32100	0.19	0.88	28515	19260	9255
545	32700	0.19	0.88	29046	19620	9426
555	33300	0.18	0.84	28047	19980	8067
565	33900	0.18	0.84	28550	20340	8210
575	34500	0.17	0.79	27469	20700	6769
585	35100	0.17	0.79	27945	21060	6885
595	35700	0.16	0.75	26781	21420	5361
605	36300	0.16	0.75	27230	21780	5450
615	36900	0.15	0.70	25983	22140	3843
625	37500	0.15	0.70	26404	22500	3904
635	38100	0.14	0.66	25076	22860	2216
645	38700	0.14	0.66	25470	23220	2250
655	39300	0.13	0.61	24059	23580	479
665	39900	0.13	0.61	24425	23940	485
675	40500	0.12	0.56	22931	24300	-1369
685	41100	0.12	0.56	23270	24660	-1390
695	41700	0.11	0.52	21694	25020	-3326
705	42300	0.11	0.52	22006	25380	-3374
715	42900	0.10	0.47	20348	25740	-5392
725	43500	0.10	0.47	20631	26100	-5469
735	44100	0.09	0.43	18891	26460	-7569
745	44700	0.09	0.43	19147	26820	-7673

"1815A" TREATMENT REQUIREMENTS	
Minimum "1815A" Volume Required	2,980 cu ft
Provided Treatment Volume - Min.	8,444 cu ft
STORAGE REQ. - 100 YEAR DESIGN STORM	
Maximum Storage Required by Bowstring	15,535 cu ft
Provided Pond Storage Volume to Inlet - Min.	29,800 cu ft
Provided Drywell/Gallery Storage Volume	0 cu ft
Total Provided Volume	**29,800 cu ft**

PEAK FLOW CALCULATION PROJECT: **21-3017**

100-Year Design Storm

BASIN: C

Tot. Area	124,055 SF	2.85 Acres	
Imp. Area	9,600 SF	C=	0.9
Perv. Area	114,455 SF	C=	0.15
Wt. C =	0.21	PGIS Area =	0

WCE Applicable Travel Time Ground Cover Coefficients	
Per Table 5-6 SRSM	
Type of Cover	K (ft/min)
Short Pasture	420
Nearly Bare Ground	600
Small Roadside Ditch/ Grass	900
Paved Area (use for parking lots)	1200
Gutter - 4 inches deep	1500
Gutter - 6 inches deep	2400
Pipe - 12-inch PVC/DI	3000
Pipe - 15/18-inch PVC/DI	3900
Pipe - 24-inch PVC/DI	4700

Reaches		
Reach 1	Offsite	also applicable for Pre-Developed Tc
Length	100.00	
K	420.00	
Slope (ft/ft)	0.0400	be sure this is decimal equivalent slope 0.0000
Travel Time	1.19	Minutes
Reach 2	Finished Lot from House to Street	
Length	100.00	
K	420.00	
Slope (ft/ft)	0.0300	be sure this is decimal equivalent slope 0.0000
Travel Time	1.37	Minutes
Reach 3	Gutter Flow to Inlet/Catch Basin	
Length	300.00	
K	2400.00	
Slope (ft/ft)	0.0300	be sure this is decimal equivalent slope 0.0000
Travel Time	0.72	Minutes
Reach 4	Pipe Flow 1	Pipe Reach One (only need one if no Dia change)
Length	1500.00	
K	3000.00	12-inch Pipe minimum
Slope (ft/ft)	0.0500	Average Slope for total pipe run
Travel Time	2.24	Minutes
Reach 5	Pipe Flow 2	Add additional pipe reacheds for other Dia
Length	1500.00	
K	3900.00	15/18-inch Pipe
Slope (ft/ft)	0.0500	Average Slope for total pipe run
Travel Time	1.72	Minutes
Sum of Tc	7.24	Minutes
Tc for Analysis	7.24	Minutes

BOWSTRING METHOD PROJECT: 21-3017

DETENTION BASIN DESIGN BASIN: C

DESIGNER: JPP

DATE: 23-Mar-22

Time Increment (min)	10
Time of Conc. (min)	7.24
Outflow (cfs)	0.0
Design Year Flow	100
Area (acres)	2.85
Impervious Area (sq ft)	9600
'C' Factor	0.21
Area * C	0.592
PGIS Area	0

Time (min)	Time Inc. (sec)	Intens. (in/hr)	Q Devel. (cfs)	Vol.In (cu ft)	Vol.Out (cu ft)	Storage (cu ft)	
7.24	435	3.45	2.05	1191	0	1191	
15	900	2.16	1.28	1342	0	1342	
25	1500	1.56	0.92	1519	0	1519	
35	2100	1.25	0.74	1669	0	1669	
45	2700	1.07	0.63	1799	0	1799	
55	3300	0.94	0.56	1915	0	1915	
65	3900	0.84	0.50	2019	0	2019	
75	4500	0.77	0.45	2115	0	2115	
85	5100	0.71	0.42	2203	0	2203	
95	5700	0.66	0.39	2285	0	2285	
105	6300	0.62	0.37	2363	0	2363	
115	6900	0.58	0.35	2436	0	2436	
125	7500	0.55	0.33	2505	0	2505	
135	8100	0.53	0.31	2571	0	2571	
145	8700	0.50	0.30	2635	0	2635	
155	9300	0.48	0.29	2695	0	2695	
165	9900	0.46	0.27	2753	0	2753	
175	10500	0.45	0.26	2809	0	2809	
185	11100	0.43	0.25	2864	0	2864	
195	11700	0.42	0.25	2916	0	2916	
205	12300	0.40	0.24	2967	0	2967	
215	12900	0.39	0.23	3016	0	3016	
225	13500	0.38	0.22	3064	0	3064	
235	14100	0.37	0.22	3110	0	3110	
245	14700	0.36	0.21	3155	0	3155	
255	15300	0.35	0.21	3200	0	3200	
265	15900	0.34	0.20	3243	0	3243	
275	16500	0.33	0.20	3285	0	3285	
285	17100	0.33	0.19	3326	0	3326	
295	17700	0.32	0.19	3366	0	3366	
305	18300	0.31	0.18	3405	0	3405	
315	18900	0.31	0.18	3444	0	3444	
325	19500	0.30	0.18	3482	0	3482	
335	20100	0.29	0.17	3519	0	3519	
345	20700	0.29	0.17	3555	0	3555	
355	21300	0.28	0.17	3600	0	3600	
365	21900	0.28	0.16	3629	0	3629	
375	22500	0.27	0.16	3668	0	3668	
385	23100	0.27	0.16	3765	0	3765	

Rainfall Intensity Coefficients for ***Spokane***

taken from Table 5-7 SRSM

M_{100} = 12.33

N_{100} = 0.643

Flow (weighted c)

Qwc= 2.60 cfs

Flow (time of concentration)

Qtc= 2.05 cfs

Time (min)	Time Inc. (sec)	Intens. (in/hr)	Q Devel (cfs)	Vol.In (cu ft)	Vol.Out (cu ft)	Storage (cu ft)	
385							
395	23700	0.26	0.16	3721	0	3721	
405	24300	0.26	0.16	3814	0	3814	
415	24900	0.25	0.15	3759	0	3759	
425	25500	0.25	0.15	3850	0	3850	
435	26100	0.24	0.14	3784	0	3784	
445	26700	0.24	0.14	3871	0	3871	
455	27300	0.23	0.14	3794	0	3794	
465	27900	0.23	0.14	3877	0	3877	<==
475	28500	0.22	0.13	3791	0	3791	
485	29100	0.22	0.13	3870	0	3870	
495	29700	0.21	0.13	3773	0	3773	
505	30300	0.21	0.13	3848	0	3848	
515	30900	0.20	0.12	3740	0	3740	
525	31500	0.20	0.12	3813	0	3813	
535	32100	0.19	0.11	3694	0	3694	
545	32700	0.19	0.11	3763	0	3763	
555	33300	0.18	0.11	3633	0	3633	
565	33900	0.18	0.11	3698	0	3698	
575	34500	0.17	0.10	3558	0	3558	
585	35100	0.17	0.10	3620	0	3620	
595	35700	0.16	0.10	3469	0	3469	
605	36300	0.16	0.10	3527	0	3527	
615	36900	0.15	0.09	3366	0	3366	
625	37500	0.15	0.09	3420	0	3420	
635	38100	0.14	0.08	3248	0	3248	
645	38700	0.14	0.08	3299	0	3299	
655	39300	0.13	0.08	3116	0	3116	
665	39900	0.13	0.08	3164	0	3164	
675	40500	0.12	0.07	2970	0	2970	
685	41100	0.12	0.07	3014	0	3014	
695	41700	0.11	0.07	2810	0	2810	
705	42300	0.11	0.07	2850	0	2850	
715	42900	0.10	0.06	2635	0	2635	
725	43500	0.10	0.06	2672	0	2672	
735	44100	0.09	0.06	2447	0	2447	
745	44700	0.09	0.06	2480	0	2480	

"1815A" TREATMENT REQUIREMENTS	
Minimum "1815A" Volume Required	0 cu ft
Provided Treatment Volume - Min.	0 cu ft
STORAGE REQ. - 100 YEAR DESIGN STORM	
Maximum Storage Required by Bowstring	3,877 cu ft
Provided Pond Storage Volume to Inlet - Min.	5,841 cu ft
Provided Drywell/Gallery Storage Volume	0 cu ft
Total Provided Volume	**5,841 cu ft**

GEOTECH REPORT

Geotechnical Conditions Report
Grandview 92-Lot Development
Spokane County, WA

Prepared for:

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Toll Brothers
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Prepared by:

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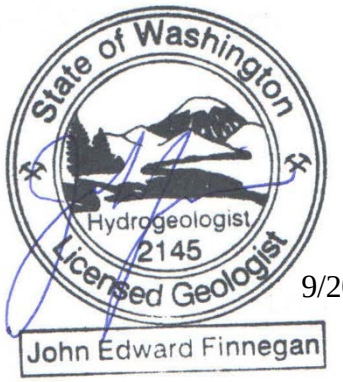
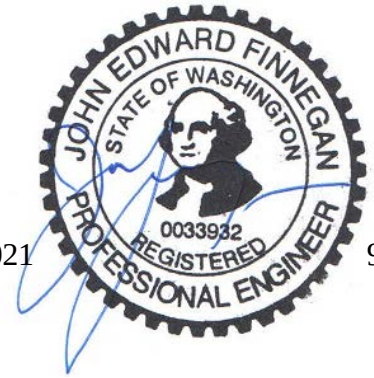
Spokane Valley, WA 99212



9/20/2021



9/20/2021

John Finnegan, PE, LHG
Geotechnical Engineer, Principal

David Lehn, PG
Senior Geologist

Budinger
& Associates

BAI Project Number: S21702

September 20, 2021

CONTENTS

EMBEDDED TABLES

ATTACHED FIGURES

CONTEXT

This conceptual phase geotechnical conditions report (GCR) presents the results of limited geotechnical exploration and analysis for design of the proposed development. Our work was contracted and coordinated with Toll Brothers, Inc., represented by David Morse.

Project Considerations

A single-family residential housing development is planned in the Grandview Avenue-17th Avenue neighborhood in the City of Spokane, WA. It will consist of approximately 92 residential lots and 6 Tracts. The proposed site occupies approximately 22.4 acres. Preliminary plans for the lot layout were provided by Whipple Consulting Engineers, dated May 8, 2021.

This report addresses general geotechnical information needed to complete planning, layout, and conceptual design. Additional geotechnical services will be needed to complete a geotechnical engineering report (GER) appropriate for civil design, structural design, and construction.

Location

The site is approximately ½-mile south of Sunset Highway at Rustle Road and ½-mile east on Grandview at 17th. It is positioned on the south side of 17 th between H and D Streets, to the west and east, respectively. The site occupies 15 Spokane County Parcels, numbered 25261.2606, .2607, .2710, .2812, .2901, .3001, .3002, .3003, .3004, .3005, .3101, .3203, .3204, .3301, and .3305. It is in the SW ¼ of the NE ¼ of Section 26, Township 25N, Range 42E WM, Washington, as illustrated in the *Vicinity Map* and *Site Plan*.

Scope

This geotechnical study involved interpretation of subsurface soil conditions to assess the suitability of the site for the overall conceptual design phase. We endeavored to conduct these services in accordance with generally accepted geotechnical engineering practices as outlined in proposal, S21702, dated August 19, 2021. The following scope was completed:

Conceptual Phase Evaluation

The first Task included exploring subsurface conditions with 13 test pits excavated to depths ranging from 1 to 17 feet deep. Test pits were excavated by your earthwork contractor and backfilled in compacted lifts upon completion.

Subsurface conditions were logged by a qualified geologist.

Limited laboratory testing was completed on representative soil samples. The testing included moisture content, Atterberg Limits, and gradation.

Characterization of subsurface conditions encountered included:

- Layering (stratification);
- Soil texture and classification;
- Risks from existing, undocumented fill soils;
- Soil moisture, capillarity, and groundwater; and,
- Seismic considerations.

This report presents conclusions and recommendations limited to engineering parameters for general site development including depth to bedrock, and potential infiltration areas. Parameters to complete design of individual lot foundations, earthwork, retaining walls, slabs, pavements, and stormwater infiltration rates are beyond the scope of this proposed phase. Recommendations for determining which individual lots should be scheduled for specific geotechnical engineering exploration and analysis, if any, are included.

Further subsurface exploration, not authorized at this time, includes: borings for exploration and analysis with additional soil testing for stormwater infiltration in accordance with *Spokane Regional Stormwater Manual* (SRSM), dynamic cone penetrometer soundings for soil density estimates, and pavement DCP for subgrade soil strength analysis and pavement section design. These results can be presented as addenda to this report.

Design Phase Evaluation
Information needed to complete design-level geotechnical services includes anticipated structural loads, anticipated pavement traffic loads, anticipated finish floor elevations, and locations and heights of retaining walls, if required.

ENCOUNTERED CONDITIONS

Physical Setting

The site is centered on a bluff of a remnant basalt lava plateau with steep sides eroded and undercut by glacial flood waters. Geologic mapping of this area shows Glacial Lake Missoula outburst flood deposits (*Qfg*) across but primarily along the lower reaches of middle Miocene Epoch Basalt lava (~~*M*~~*wp*) belonging to the Priest Rapids Member of the Wanapum Basalt, Columbia River Basalt Group. (WSDNR, 2004). An interflow of lacustrine sediments of the Latah Formation occurs between the Priest Rapids Basalt and underlying Grande Ronde Basalt.

Qfg is described as "*thick-bedded to massive mixture of boulders, cobbles, pebbles, granules, and sand; contains beds and lenses of sand and silt; gray, yellowish gray, or light brown; poorly to moderately sorted; both matrix and clast supported; locally composed of boulders and cobbles in a matrix of mostly pebbles and coarse sand"* (WSDNR, 2004).

The ~~*M*~~*wp* unit is described as "*Dark gray to black, fine-grained, dense basalt. [It] lies directly on pre-Miocene rocks, Latah Formation, or Grande Ronde Basalt; contact with the underlying Grande Ronde Basalt occurs between 2,200 and 2,300 ft elevation"* (WSDNR, 2004).

Soil types at the site, as mapped by the USDA Web Soil Survey, consist of *Rockly-Fourmound complex, 0 to 15 percent slopes* (unit *3114*), *Northstar-Rock outcrop complex, 3 to 15 percent slopes* (Unit *3115*), *Rock outcrop-Northstar complex, 15 to 30 percent slopes* (Unit *3126*), and *Urban land-Northstar, disturbed complex, 3 to 8 percent slopes* (unit *7131*) (NRCS, 2020).

Units *3114* and *3115* are rated by the NRCS as hydrologic soil groups D and C, respectively. The saturated hydraulic conductivity for units *3114* and *3115* is approximately 1.3 and 7.7 inches per hour, respectively (NRCS, 2020).

Surface Conditions

The site consisted of undeveloped land with abundant outcrop of rock and steep rock faces with accumulated talus. Site topography is best described as two relatively level benches above the overall plateau surface. Maximum total relief across the site was 78 feet from the top of the benches down to the plateau surface to the north at 17th. Elevations of the top of the benches were 2,270 feet (City Datum). Steep slopes ranging from 36 to 100 percent inclinations at heights of 20 to 40 feet were observed along the margins of the benches. Steeper slopes were generally observed along southern exposures.

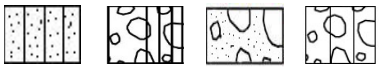
The benches are bisected by a northwest-southeast trending saddle between two small basins as illustrated in the *Geo-LIDAR Overview Plan*. Two meadows occupy the basins containing a wide assemblage of vegetation including shrubs and Ponderosa Pine trees. The basins sloped gently from the saddle at elevation of 2,264 feet down to elevation 2,240 feet at 15 percent inclinations. The remainder of the site sloped gently down to the plateau surface.

Subsurface Conditions

Conditions encountered in the test pits are described in the *Test Pit Logs* in accordance with methods described in *Field Exploration*. The following groups of subsurface materials were differentiated based on characteristics relevant to this project:

soil

Log symbols:



Silt with sand was the predominant soil encountered across the site. It was present between outcrop and directly overlying rock in 5 test pits. Where encountered, the silt with sand ranged from 2 to 6 feet thick beginning at the ground surface. It averaged 4.5 feet thick. Fines content (percent, by weight, passing the US #200 sieve) was 79 percent for one representative sample tested. Fines were non-plastic. At Test Pit 13 (TP-13), it overlayed two horizons consisting of silty gravel overlying sand with gravel, with rock beginning 6 feet below ground surface (BGS).

Silty sand with gravel varying to silty gravel with sand and cobbles was encountered in 4 test pits directly overlying rock. It ranged from 1.5 to 5.5 feet thick and averaged 3.5 feet thick. At TP-5 and TP-13, it was 2 feet thick. This stratum was likely coarse alluvium originally deposited on rock with fines washed into the open graded deposit as described in the following paragraph.

TP-5 encountered 2 feet of surficial colluvium consisting of angular gravel and cobbles in a matrix of silt and sand beginning at the ground surface. A thick deposit of gravel with silt, sand, and cobbles extended from 2 feet BGS to greater than 17 feet BGS, the maximum reach of the excavator. The characteristic differing this horizon from the surficial silty gravel was in the fines content of 7.7 percent.

An isolated deposit of sand with gravel and cobbles with 3.3 percent fines was encountered in TP-13. It was only 2 feet thick between 4 and 6 feet BGS laying directly on rock. This appears to be the only occurrence of permeable soil. However, it lacks sufficient thickness and lateral extent to qualify as an infiltration stratum as follows:

The primary relevant stormwater design documents are the *Spokane Regional Stormwater Manual* (SRSM, 2008) and *Stormwater Management Manual for Eastern Washington* (SMMEW, 2019). The SRSM includes Geotechnical Site Characterization (GSC) requirements for characterizing the suitability of soil units for receiving stormwater by infiltration structures. Use of infiltration structures requires a suitable target soil of adequate thickness, extent, and permeability. Extensive thick permeable soils for rapid infiltration appear to be lacking across this site.

basalt
Log symbol

Extrusive *basalt* lava rock was observed as outcrop across the site and in all but one test pit beginning at depths ranging from 0 to 6 feet BGS. TP-5 did not encounter rock to the depth of reach of the excavator at 17 feet BGS. Encountered *basalt* was moderately to highly weathered in the top 0.5 to 6 feet with an average weathered surface less than 2 feet thick. The exposed *basalt* comprises the upper, entablature, portion of the flow. Unlike columnar *basalt* found at lower elevations, it generally contains randomly oriented very close to closely spaced jointing in good condition. As such, it may require significant hoe-ram breaking to remove competent segments.

Surface and Groundwater Hydrology

Surface waters were not observed on site. A 12.98-acre Freshwater Emergent Wetland occurred in a topographic basin 100 feet to the southwest of the site. Although surface water was not observed during the dry summer, the area is classified as PEM1C (USFWS). The classification *PEM1C* includes, but is not limited to, the presence of *herbaceous hydrophytes for most of the growing season* and visible *surface water for extended periods.*

Groundwater was not encountered during explorations which were primarily up on the rock benches. Mottled textures in the soil that would indicate the presence of fluctuating groundwater over long periods of time were not observed. Local well reports obtained through the Washington State Department of Ecology website show ground water levels beginning at depths greater than 60 feet BGS in the within 0.75-mile of the site.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Soils are generally thin across the site with the exception of TP-5 which extended below the depth of reach of the excavator, 17 feet BGS. Predominant soil is silt with fine sand. Limited thickness and extent of gravel was encountered in 4 test pits.

The subgrade contains abundant *basalt* rock.

With the exception of TP-5, the depth to *basalt* ranged in depth from outcrop to 6 feet BGS. The condition of *basalt* varied throughout the site. Weathered rock segments were excavatable to depths of up to 8 feet with the 50 to 60-ton excavator used during the subsurface explorations. Excavation in the fresh rock was as little as 1 foot.

Some areas were fresh, competent, and contained randomly oriented very close to closely spaced

jointing in good condition. As such, it may require significant hoe-ram breaking to remove fresh rock segments.
The fine-grained silty soils are not suitable for re-use as structural fill. These soils are also susceptible to frost heave and capable of wicking moisture throughout the soil profile.

Suitable stormwater infiltration areas require a suitable target soil of adequate thickness, extent, and permeability. Such soil was not found on the site during this task. Alternative systems (infiltration galleries, under-drain systems, etc) may be required. Test pit infiltration test methods in accordance with the *SRSM* can be used for alternative design.

The site includes topography that exhibits slopes of 30 percent or greater. The Spokane County Critical Areas Ordinance, Chapter 11.20, defines such slopes as *geologically hazardous areas* and further delineation and characterization will apply.

Seismic Considerations

The recommended seismic site class designation is Site Class C, "*very dense soil and soft rock.*" Spectral response acceleration parameters, adjusted for Site Class C, were calculated using USGS, U.S. Seismic Design Web Services through the Applied Technology Council website (ATC, 2019). The values of predicted earthquake ground motion for short period structural elements (0.2 second spectral response acceleration, Ss) and for long period structural elements (1.0 second spectral response acceleration, S_1) are provided in the table below. The design parameters (S_{DS} and S_{D1}) are equal to ⅔ of the maximum earthquake spectral response accelerations (S_{MS} and S_{M1}).

Table 1. Seismic Design Parameters

Site Class	Latitude	Longitude	PGA	Ss	S_1	S_{DS}	S_{D1}
C	47.64 N	-117.46 W	0.142g	0.329g	0.115g	0.264g	0.129g

Due to the presence of relatively shallow rock, the low probability of high ground acceleration, and absence of shallow groundwater, estimated liquefaction potential is very low.

Earthwork

Development in the northeast and southwest portions of the site will involve the most *basalt* excavation but settlement risks will be minimized in this area. Rock will be difficult to excavate and may require breaking hammers and blasting. The remainder of the site will offer the least amount of *basalt* excavation, but there may be settlement risks associated with loose soil conditions. Foundations that span both *soil* and *basalt* should be over-excavated to avoid differential settlement risks.

The overburden soils are generally granular in nature, consistent with Type C materials per WISHA excavation criteria. WISHA specifies a maximum inclination of 1-½ horizontal to 1 vertical (1-½ H:1V) in the temporary condition for Type C.

Fill material. The encountered coarse-grained soils may be suitable for re-use as structural fill provided that deleterious items (anthropogenic debris, organics, and over-sized materials, etc.) are removed prior to their re-use. However, these soils are comprised of fine sands and silts, are moisture-sensitive and may be difficult to compact. If imported fill is used a material such as Common Borrow in WSDOT Standard Specifications for Road, Bridge, and Municipal

Construction Section 9-03.14(3) is recommended.

Additional Services

Effective geotechnical services involve cooperation with the owner, designer, and constructor as follows:

1. Preliminary study to assist in planning and to economically adapt the project to its geologic environment.
2. Soil exploration and analysis to characterize subsurface conditions and recommend design criteria.
3. Consultation with the designer to adapt the specific design to the site in accordance with the recommendations.
4. Construction observation to verify the conditions encountered and to make recommendations for modifications as necessary.
5. Construction material testing, quality control, and special inspection.

This GCR satisfies Item 1 of the 5-phase endeavor. Additional geotechnical services will be needed to complete a GER when design-level information is available. We are eager to provide assistance with design and construction as appropriate to assist in completing a safe and economical project.

FIELD EXPLORATION

The fieldwork was conducted by lead geologist Jason Pritzl, GIT, and supervised by geotechnical engineer John Finnegan, PE, on August 9, 2021. The field activities generally consisted of the following:

- Reconnaissance of the site and surrounding area;
- Logging subsurface conditions for 13 test pits; and
- Obtaining bulk samples of the soils.

Results are presented in *Figures*.

Test Pits

Test pits were excavated with a Volvo EC480 excavator with a 48-inch bucket by Selland's Construction, Inc. Criteria governing the depth to which test pits were excavated included limits of equipment reach and digging refusal with a 50-ton, 373hp excavator on competent *basalt*.

Soil Samples

Samples were obtained by capturing representative material from the bucket of the excavator or from within the excavation while less than 4 feet below grade.

Soil and Rock Classification

WSDOT Soil and Rock Classification and Logging. Field descriptions of soils and rock were completed in accordance with the current version of the Washington State Department of Transportation, *Geotechnical Design Manual* (GDM), M 46-03.11, except that fines (silt and clay) were described in accordance with ASTM D 2487. Whereas, the GDM uses the terms 'silty' and

'clayey' to describe a very broad range of fines from 10 to 49 percent; ASTM D 2487 uses those terms for percentages greater than 12 and the term 'with' for fines ranging from 5 to 12 percent, which is typically necessary to describe variations relevant to soil permeability per the SRSM. A key to the descriptions is provided in *Guide to Soil and Rock Descriptions.*

Location

Horizontal & vertical control. Plans were provided by the client. The *Site Plan* is based on measured offsets from existing site features at the time of exploration.

Elevations presented on the *Test Pit Logs* were correlated from topographical data illustrated on the provided plans. Horizontal and vertical locations can be considered accurate to within 5-foot and 1-foot, respectively, relative to the information provided.

LABORATORY ANALYSIS

Laboratory testing was performed on representative samples of the soils encountered to provide data used in our assessment of soil characteristics.

Tests were conducted, where practical, in accordance with nationally recognized standards (ASTM, AASHTO, etc.), which are intended to model in-situ soil conditions and behavior. The results are presented in *Figures.*

Index Parameters

Moisture content – ASTM D2216. Moisture contents were determined by direct weight proportion (weight of water/weight of dry soil) determined by drying soil samples in an oven until reaching constant weight.

Gradation – ASTM D6913. Gradation analysis was performed by the mechanical sieve method. The mechanical sieve method is utilized to determine particle size distribution based upon the dry weight of sample passing through sieves of varying mesh sizes. The results of gradation are provided in *Grain Size Distribution Results*.

Atterberg Limits – ASTM D4318. Atterberg limits describe the properties of a soil's fine-grained constituents by relating the water content to the soil's limits of engineering behavior. As the water content increases, the state of the soil changes from a brittle solid to a plastic solid and then to a viscous liquid.

The liquid limit (LL) is the water content above which the soil tends to behave as a viscous liquid. Similarly, the plastic limit (PL) is defined as the water content below which the soil tends to behave as a brittle solid. The plasticity index describes the range of water content over which a soil is plastic and is derived by subtracting the PL from the LL. The soil is classified as "non-plastic" if rolling a 1/8-inch bead is not possible at any water content.

LIMITATIONS

The conclusions and recommendations presented herein are based upon the results of field

explorations and laboratory testing results. They are predicated upon our understanding of the project, its design, and its location as defined in by the client. We endeavored to conduct this study in accordance with generally accepted geotechnical engineering practices in this area.

This GCR - presents our professional interpretation of exploration data developed, which we believe meets the standards of the geotechnical profession in this area; we make no other warranties, express or implied. Attached is a document titled "*Important Information About Your Geotechnical Engineering Report,*" which we recommend you review carefully to better understand the context within which these services were completed.

Unless test locations are specified by others or limited by accessibility, the scope of analysis is intended to develop data from a representative portion of the site. However, the areas tested are discreet. Interpolation between these discreet locations is made for illustrative purposes only but should be expected to vary. If a greater level of detail is desired, the client should request an increased scope of exploration.

REFERENCES

Applied Technology Council (ATC), Hazards by Location, Seismic Loads Application. Available online at https://hazards.atcouncil.org/#/ .

ASTM International, 2011, Standard Practice for Classification of Soils for Engineering Purposes, D 2487-11.

International Code Council, 2015, International Building Code.

Natural Resources Conservation Service (NRCS), United States Department of Agriculture. Web Soil Survey (2018?). Available online at https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Spokane County, Washington, Critical Areas Ordinance for the Protection of Wetlands, Fish and Wildlife Habitats, Geo-hazard Areas and Critical Aquifer Recharge Areas, Chapter 11.20.

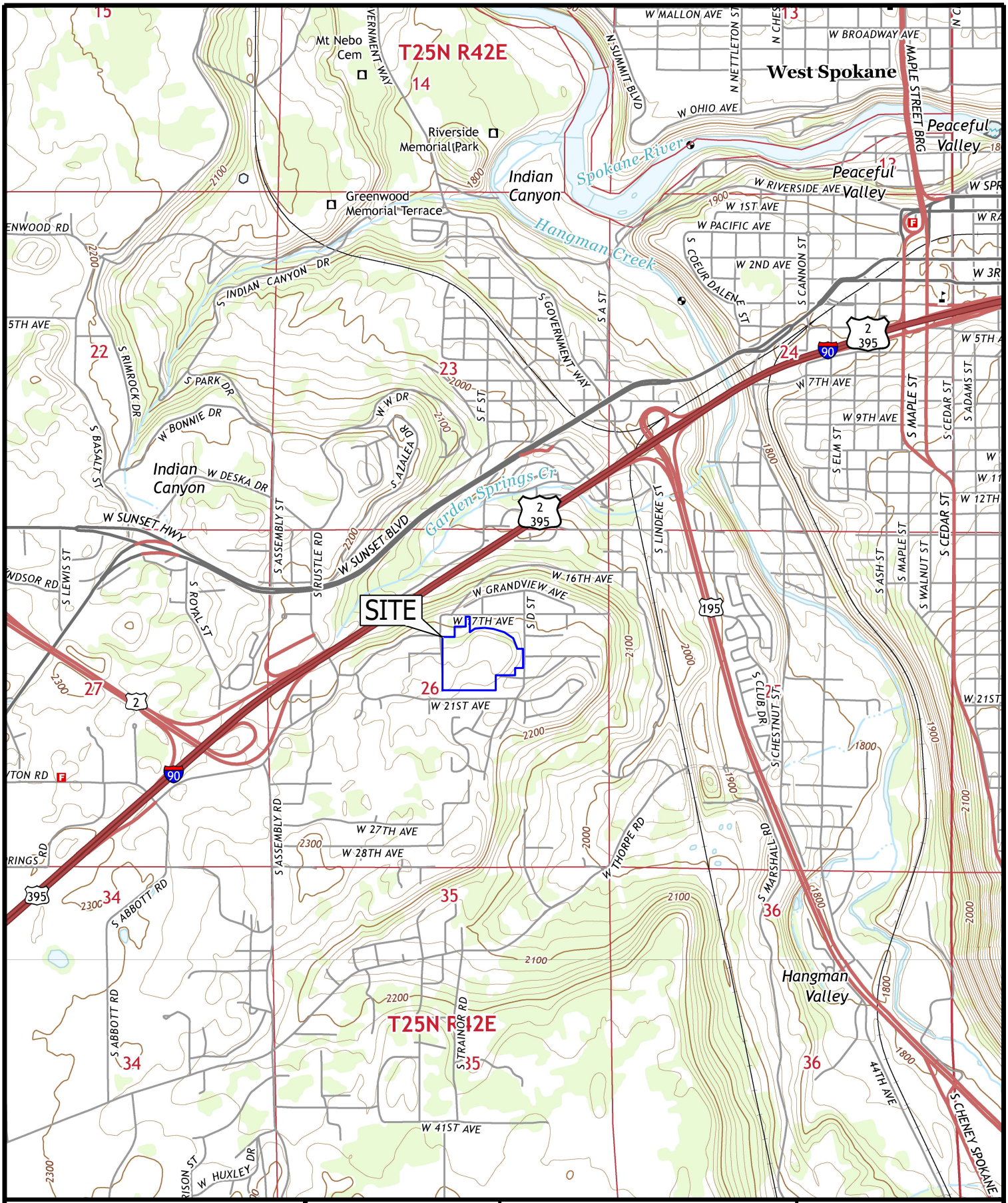
USFWS, 2019, Wetland Mapper https://www.fws.gov/wetlands/Data/Mapper.html

USGS, 2014, Topographic Map of the Spokane NW, 7.5-Minute Quadrangle, Spokane County, Washington

Washington State Department of Natural Resources (WSDNR), 2004, Geologic Map of the Spokane Northwest 7.5-minute Quadrangle, Spokane County, Washington, OFR 2004-3.

Washington State Department of Transportation, 2019, Geotechnical Design Manual (WSDOT GDM).

Washington State Department of Transportation, 2020, Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT SS).



N

SCALE: 1"=2000'
0 1000 2000

SECTION 26
T 25 N R 42 E
USGS 2014

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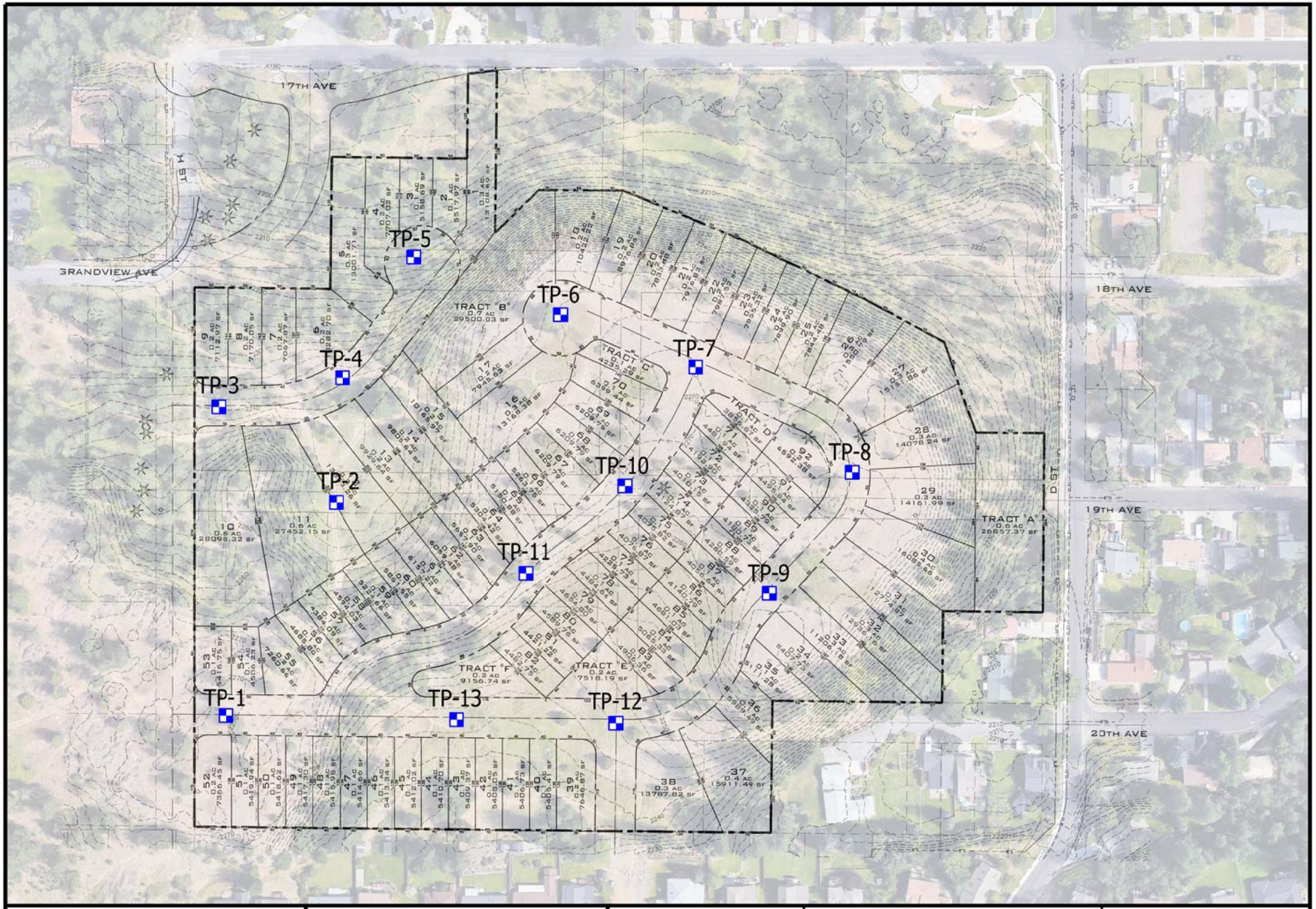
VICINITY MAP

GRANDVIEW 92-LOT HOUSING DEVELOPMENT
SPOKANE, WASHINGTON

FIGURE 1

PROJECT NUMBER S21702

DATE: 8/2021



TEST PIT LOCATION (TP-1)

N

SCALE: 1"=200'

0 100 200

BASE PLAN FROM WCE

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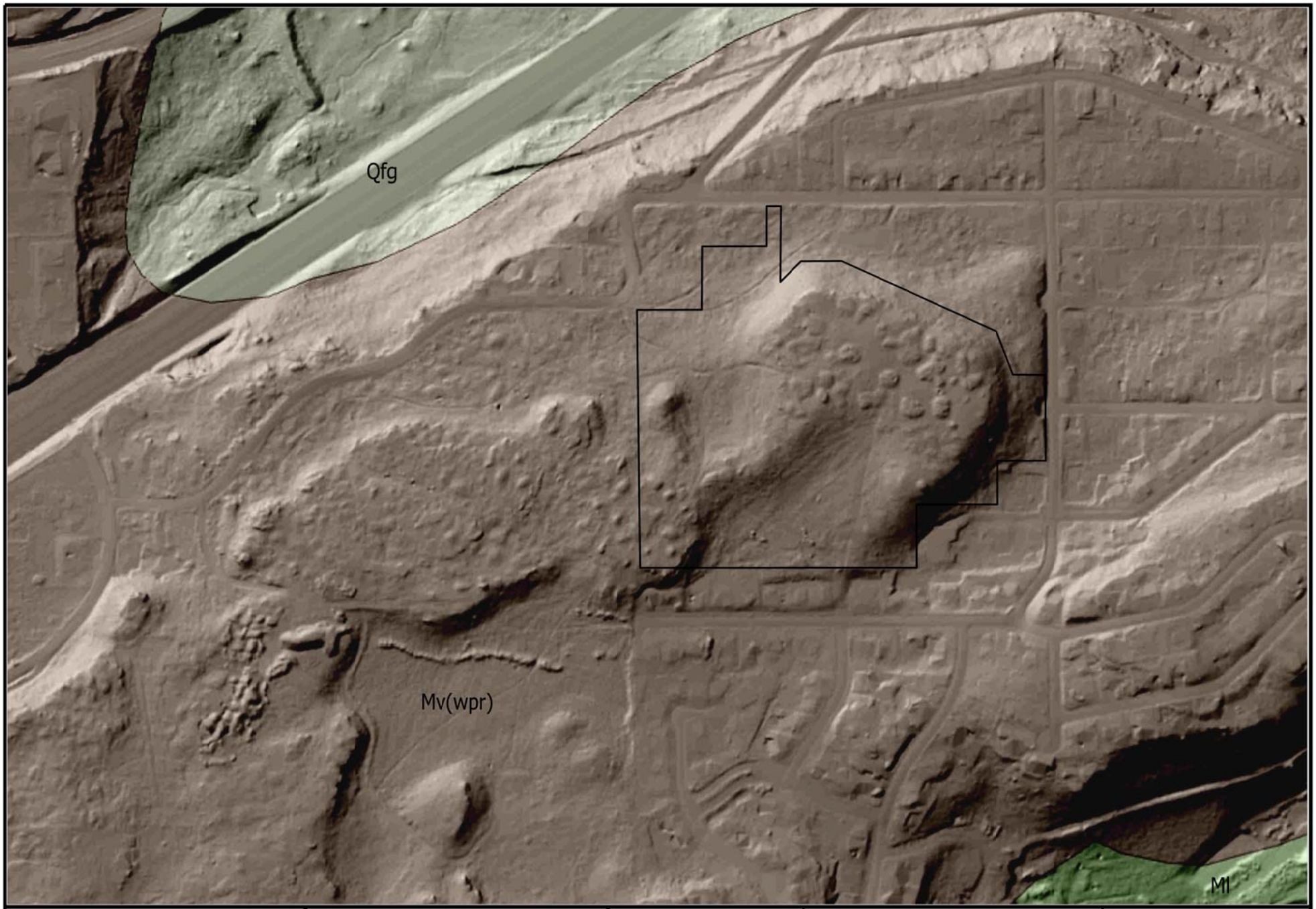
SITE PLAN

GRANDVIEW 92-LOT HOUSING DEVELOPMENT
SPOKANE, WASHINGTON

FIGURE 2-1

PROJECT NUMBER S21702

DATE: 8/2021



Qfg - Pleistocene outburst flood deposits
Mv(wpr) - Priest Rapids Basalt
Ml - Latah Formation

N
SCALE: 1"=400'
0 200 400

BASE PLAN FROM WSDNR GEOLOGY PORTAL

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GEO-LIDAR OVERVIEW PLAN

GRANDVIEW 92-LOT HOUSING DEVELOPMENT
SPOKANE, WASHINGTON

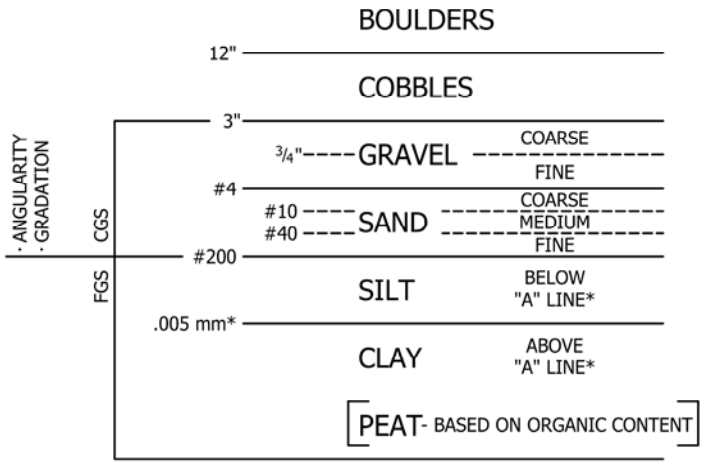
FIGURE 2-2

PROJECT NUMBER S21702

DATE: 8/2021

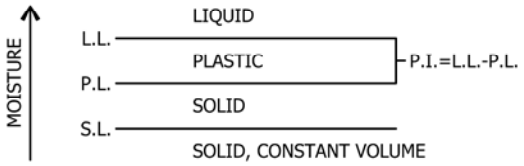
GUIDE TO SOIL & ROCK DESCRIPTIONS

SOIL CLASSIFICATION

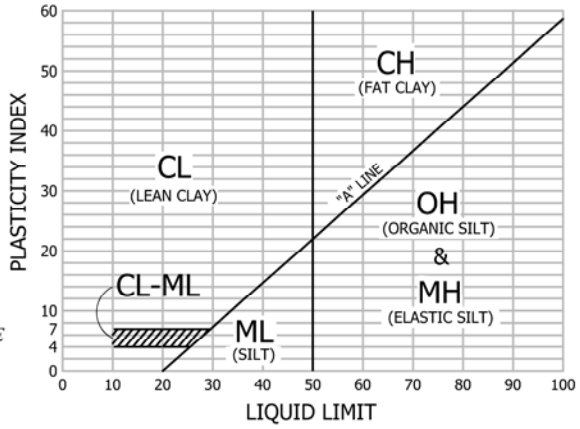


** SEE PLASTICITY CHART*
CGS - COARSE GRAINED SOIL - MORE THAN 50% RETAINED ON A #200 SIEVE
FGS - FINE GRAINED SOIL - 50% MORE PASSES, #200 SIEVE
FINES - PORTION FINER THAN #200 SIEVE

ATTERBERG LIMITS



PLASTICITY CHART



NOTE - CHART APPLIES TO FGS AND MINUS #40 SIEVE FRACTION OF CGS

GUIDE TO SOIL DESCRIPTION MODIFIERS, MOISTURE, AND CONDITION PRESENTED ON LOGS

MODIFIER	ESTIMATED PERCENTAGE OF MATERIAL
SUFFIX "LY" OR "Y"	30% OR MORE FOR COARSE PARTS IN FGS GREATER THAN 12% FOR FINES IN CGS
WITH	15% - 29% FOR COARSE PARTS IN FGS 6% - 14% FOR FINES IN CGS

NOTE - VISUAL ESTIMATES OF MATERIAL PERCENTAGES TYPICALLY VARY 0 TO 10% FROM THOSE DETERMINED BY LABORATORY TESTING.

MOISTURE

DRY
MOIST
SATURATED OR WET

SOIL CONDITION

CGS:
- VERY LOOSE
- LOOSE
- MEDIUM DENSE
- DENSE
- VERY DENSE

FGS:
- VERY SOFT
- SOFT
- MEDIUM STIFF
- STIFF
- VERY STIFF
- HARD

SAMPLES

- STANDARD 2" PENETRATION TEST SAMPLER WITH BLOWS PER FOOT
- 3" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT
- DRILL CUTTING SAMPLE
- BULK SAMPLE
- THIN-WALLED TUBE SAMPLE
- DIAMOND CORE RUN WITH % RECOVERY & ROCK QUALITY DESIGNATION
- 2.5" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT
- CONTINUOUS SOIL SAMPLE
- R — REFUSAL OF SAMPLE (50+ BLOWS PER 6")

ROCK WEATHERING	ROCK CONDITION
FRESH	EXTREMELY WEAK
SLIGHTLY WEATHERED	VERY WEAK
MODERATELY WEATHERED	MODERATELY WEAK
HIGHLY WEATHERED	MODERATELY STRONG
COMPLETELY WEATHERED	STRONG
RESIDUAL SOIL	VERY STRONG

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FIGURE 3

TEST PIT 1

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; north of proposed Lot 52
Surface: grass and weeds

Elevation: 2270 ft
Logged by: J. Pritzl
Size of hole: 6 X 10 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS
0		dry, light brown	SILT with fine Sand, occasional angular to subangular Gravel and Cobbles, moderate amount of small roots to 0.5 feet.		ATTERBERG LIMITS PL LL; WATER CONTENT; 10 20 30 40 50 60 70 80 90
			Basalt Fresh		
5		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 4.5 ft		
10					
15					
20					

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TEST PIT LOGS **FIGURE 4-1**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 2

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Center property line between proposed Lots 11 & 12
Surface: grass and weeds

Elevation: 2242 ft
Logged by: J. Pritzl
Size of hole: 6 X 11 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS
0		dry, light brown	SILT with fine Sand, occasional angular to subangular Gravel and Cobbles, moderate amount of small roots to 0.5 feet.		ATTERBERG LIMITS PL — LL; WATER CONTENT ○
5		dark brownish gray	BASALT, moderately weathered		
10		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 6 ft		
15					
20					

TEST RESULTS: 10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-2**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 3

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; north of proposed Lot 10
Surface: grass and weeds

Elevation: 2240 ft
Logged by: J. Pritzl
Size of hole: 6 X 13 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		dry, light brown	SILT with Sand, Gravel, and Cobbles (colluvium)	
5		dark brownish gray	BASALT, highly weathered with zones of saprolite	
10		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 8 ft	
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-3**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 4

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; south of proposed Lot 6
Surface: grass and weeds

Elevation: 2238 ft
Logged by: J. Pritzl
Size of hole: 6 X 12 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		dry, light brown	SILT with Sand, Gravel and Cobbles (colluvium)	
5		dark brownish gray	BASALT, highly weathered with zones of saprolite	
10		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 5 ft	
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-4**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 5

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Center of proposed cul-de-sac south of proposed Lot 3
Surface: grass and weeds

Elevation: 2210 ft
Logged by: J. Pritzl
Size of hole: 6 X 14 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		dry, light brown	SILT with Sand, Gravel and Cobbles (colluvium)	
5		dry, grayish brown	GRAVEL with Silt, Sand, and Cobbles, coarse, angular (colluvium)	
10				
15				
20		no free groundwater observed	End of Excavation @ 17 ft	

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-5**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 6

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Center of proposed cul-de-sac south of proposed Lot 18
Surface: grass and weeds

Elevation: 2266 ft
Logged by: J. Pritzl
Size of hole: 6 X 12 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		dry, light brown	SILT with fine Sand	
5		dark brownish gray	BASALT, moderately weathered	
10		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 6.5 ft	
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-6**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 7

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; south of proposed Lot 22
Surface: grass and weeds

Elevation: 2270 ft
Logged by: J. Pritzl
Size of hole: 5 X 8 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		dark brownish gray	BASALT, moderately weathered	
		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 1.5 ft	
5				
10				
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-7**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 8

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; west of proposed Lot 29
Surface: grass and weeds

Elevation: 2271 ft
Logged by: J. Pritzl
Size of hole: 5 X 8 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS
0		dark brownish gray	BASALT, moderately weathered		ATTERBERG LIMITS PL — LL; WATER CONTENT ○
		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 1 ft		10 20 30 40 50 60 70 80 90
5					
10					
15					
20					

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TEST PIT LOGS **FIGURE 4-8**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 9

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; west of proposed Lot 33
Surface: grass and weeds

Elevation: 2269 ft
Logged by: J. Pritzl
Size of hole: 6 X 12 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS
0		dry, dark orangish brown	SILT with fine Sand		ATTERBERG LIMITS PL LL WATER CONTENT 10 20 30 40 50 60 70 80 90
5			Basalt, fresh		
		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 6 ft		
10					
15					
20					

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TEST PIT LOGS **FIGURE 4-9**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 10

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; west of proposed Lot 75
Surface: grass and weeds

Elevation: 2268 ft
Logged by: J. Pritzl
Size of hole: 6 X 10 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		dry, dark orangish brown	SILT with fine Sand	
5		dark brownish gray	BASALT, moderately weathered	
10		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 6.5 ft	
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-10**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 11

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; west of proposed Lot 80
Surface: grass and weeds

Elevation: 2263 ft
Logged by: J. Pritzl
Size of hole: 6 X 9 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS
0		dry, grayish brown	SILTY GRAVEL with Sand, Cobbles and Boulders, coarse, angular (colluvium)		ATTERBERG LIMITS PL LL WATER CONTENT 10 20 30 40 50 60 70 80 90
5			Basalt, fresh		
		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 6 ft		
10					
15					
20					

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TEST PIT LOGS **FIGURE 4-11**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 12

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; south of proposed Tract E
Surface: grass and weeds

Elevation: 2246 ft
Logged by: J. Pritzl
Size of hole: 6 X 13 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS
0		dry, grayish brown	SILTY GRAVEL with Sand and Cobbles, coarse, angular (colluvium)		ATTERBERG LIMITS PL — LL; WATER CONTENT ○
5		dark grayish brown	BASALT, moderately to highly weathered		
10		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 7.5 ft		
15					
20					

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE 4-12**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 13

Date: 8-9-21
Excavator: Selland's Construction
Equipment: Volvo EC480
Location: Proposed road alignment CL; north of proposed Lot 43
Surface: grass and weeds

Elevation: 2243 ft
Logged by: J. Pritzl
Size of hole: 6 X 12 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		dry, light brown	SILT with fine Sand	
		dry, grayish brown	SILTY GRAVEL with Sand and Cobbles, coarse, angular (colluvium)	
5		dry, gray	SAND with Gravel and Cobbles, coarse, angular to subangular, micaceous	
		dark grayish brown	BASALT, moderately weathered	
10		no free groundwater observed	(digging refusal on fresh Basalt) End of Excavation @ 7.5 ft	
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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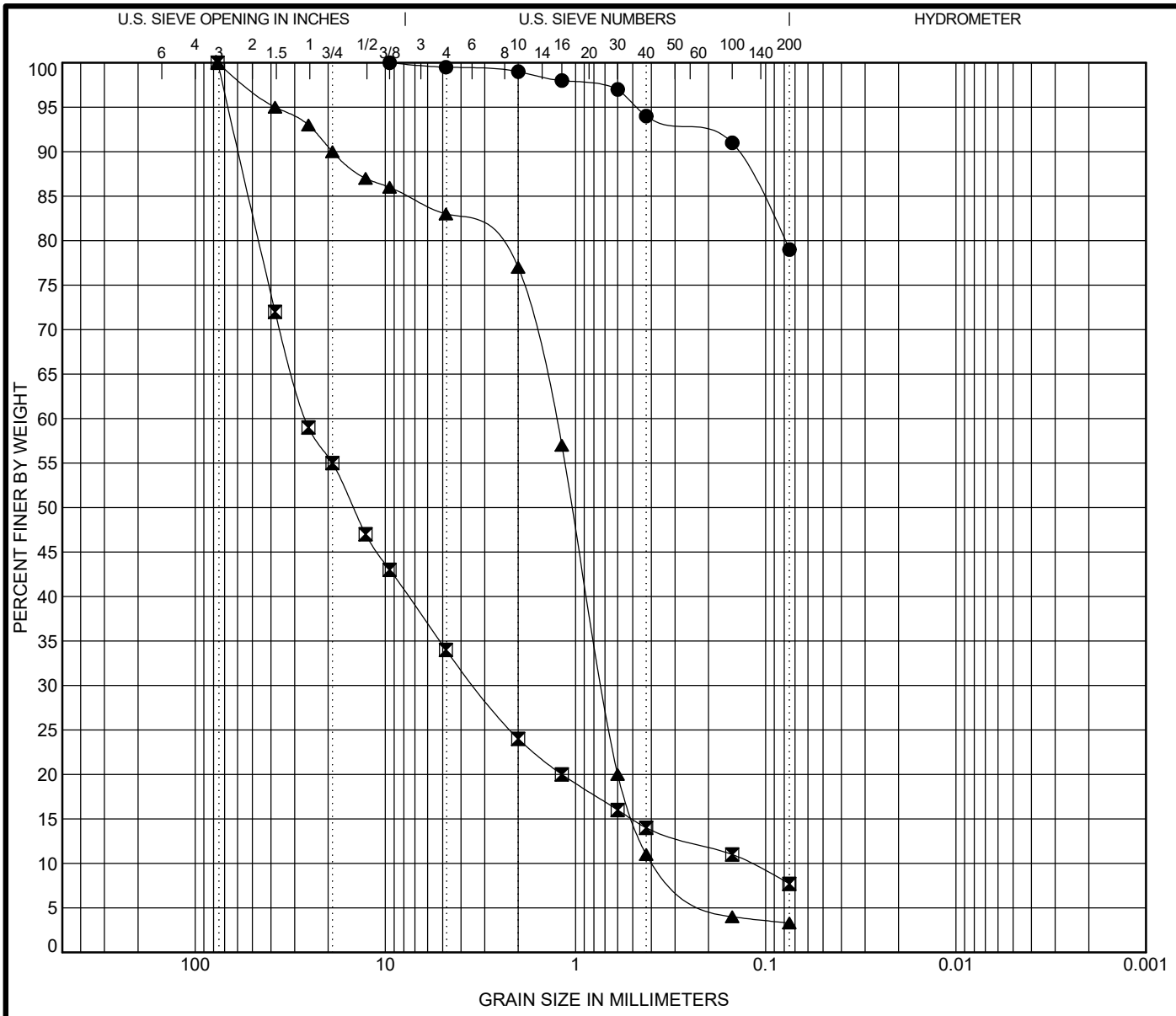
TEST PIT LOGS **FIGURE 4-13**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

SOIL MECHANICS
LABORATORY SUMMARY

		Units	Test Methods			
LABORATORY NUMBER				21-5581	21-5582	21-5583
TEST PIT NUMBER				TP-2	TP-5	TP-13
DEPTH	TOP	feet		3	10	4.5
	BOTTOM	feet		4	12	5.5
MOISTURE CONTENT		%	ASTM D2216	4.8	8.8	3
PLASTICITY INDEX		%	ASTM D4318	NP	NP	NP
UNIFIED CLASSIFICATION			ASTM D2487	ML	GP-GM	SP
SIEVE ANALYSIS			ASTM D6913			
	3"				100	100
	1 1/2"				72	95
S	1"	%			59	93
I	3/4"				55	90
E	1/2"	P			47	87
V	3/8"	A			43	86
E	#4	S		100	34	83
	#10	S		99	24	77
S	#16	I		98	20	57
I	#30	N		97	16	20
Z	#40	G		94	14	11
E	#100			91	11	4
	#200			79	7.7	3.3
*NP= Non Plastic					+7% Cobbles	+6% Cobbles

FIGURE 5



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	2	3.0	SILT with SAND(ML)	NP	NP	NP		
⊠	5	10.0	POORLY GRADED GRAVEL with SILT and SAND(GP-GM)	NP	NP	NP	3.59	215.49
▲	13	4.5	POORLY GRADED SAND with GRAVEL(SP)	NP	NP	NP	1.11	3.49

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	2	3.0	9.5				0.5	20.5	79.0	
⊠	5	10.0	76.2	26.199	3.382	0.122	65.5	26.2	7.7	
▲	13	4.5	76.2	1.277	0.72	0.366	17.0	79.6	3.3	

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GRAIN SIZE DISTRIBUTION RESULTS

Project: Grandview 92-Lot Housing Development

Location: Spokane, WA

Number: S21702

FIGURE 6

US GRAIN SIZE S21702.GPJ BUDINGER.GDT 8/18/21

Appendix A: ***GBC - Important Information About Your Geotechnical Report***

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

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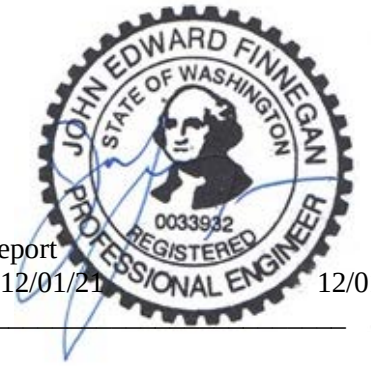
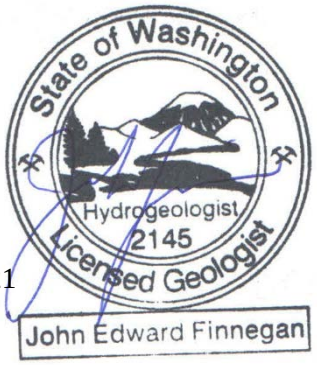
Geotechnical Engineering
Environmental Engineering
Construction Materials Testing
Subsurface Exploration
Special Inspection

TECHNICAL MEMORANDUM
To: Erin Hopkins, Toll Brothers, Inc.
From: David Lehn, LG, and John Finnegan, PE
Date:December 1, 2021
Project: S21702 Grandview 92-lot Development
Spokane, WA
Subject: Addendum 1 to Geotechnical Conditions Report
Results of Test Pit Infiltration Testing



12/01/21



12/01/21

This addendum to the Geotechnical Conditions Report (GCR) presents the results of field testing and analysis of infiltration potential at 3 locations. The target areas were delineated in an updated site plan provided by Whipple Consulting Engineers, dated August 25, 2021.

Scope

Infiltration tests were completed in accordance with the Test Pit Infiltration Method of the *Spokane Regional Stormwater Manual* (SRSM Appendix 4-C). Due to subsurface conditions observed in the initial field exploration, test pit infiltration tests were conducted in lieu of borings as outlined in Task 2 of proposal S21702, revised August 6, 2021. Limited depth of explorations and infiltration testing provide results suitable for single-depth drywell design.

We logged the subsurface conditions in 3 test pits prior to performing infiltration tests. A site plan with test locations, test pit logs, infiltration test results, and laboratory test results are presented in *Figures*.

Subsurface Conditions

Test Pit 14 (TP-14) was excavated at the proposed infiltration basin in the eastern portion of the site which is located west of D Street and approximately 160 feet south of 19th Avenue. Stratified colluvium consisting of clast-supported, angular basalt gravel and cobbles in a matrix of silt was encountered from 1 to 10 feet below ground surface (BGS). A lacustrine silt horizon was encountered beginning below 10 feet and extended to greater than 11 feet BGS.

TP-15 was excavated near the southeast corner of the site. Stratified colluvium, similar to that observed in TP-14, was encountered to 4 feet BGS. Below that, clean gravel with sand was encountered to greater than 9 feet BGS. Fines content (percent passing the US#200 sieve) for one representative sample tested was 1.1 percent (very low fines). The excavation was terminated due to excessive caving of the gravel and sand below the overlying silty soil. Infiltration was rapid with complete drawdown in less than 10 minutes.

TP-16 was excavated near the northwest corner of the site. It consisted of 1.5 feet of stratified colluvium overlying 3 feet of gravel with sand and cobbles. The sand within the gravel and cobbles was relatively clean, similar to TP-15. A 6-inch-thick stratum of volcanic ash was

encountered from 5 to 5.5 feet BGS. It was underlain by dense gravel with silt and sand that extended below the bottom of the test pit at 7 feet. Testing of one representative sample of the gravel with silt and sand sediments yielded a fines content of 8.4 percent. Excavation refusal occurred in the very dense gravel with silt and sand. Infiltration was moderately low at about 8 gallons per minute.

Table 1: Test Pit Infiltration Results

Test Pit ID	Q[1]	H[2]	q_N[3]	q_{ND}[4]	H_D[5]	q_A[6]	FS[7]	q_D[8]
TP-14	0.0038	4.5	0.00085	0.0040	6	0.024	NS[9]	NS
TP-15	0.056	2.2	0.026	0.065	6	0.39	1.4	0.28
TP-16	0.019	2.8	0.0068	0.018	6	0.11	2.1	0.051

1. Stabilized flow rate observed near the end of the constant-head portion of the test in cubic feet per second (cfs).
2. Level of water within the test pit in feet.
3. Normalized outflow rate of the test pit in cfs per foot.
4. Normalized outflow rate of the drywell in cfs per foot.
5. Maximum design drywell head in feet.
6. 'Actual' (calculated by SRSM method) outflow rate in cfs.
7. Factor of safety from the SRSM, Table 4C-1.
8. Calculated design drywell outflow rate in cfs.
9. Not suitable for drywell disposal per SRSM design criteria.

Conclusions and Recommendations

Drywells do not appear to be feasible in the vicinity of TP-14 (east portion of site) due to high fines content and low infiltration test rates. Gravel galleries may be feasible, but at very limited rates.

Good infiltration potential was encountered at TP-15. We recommend sizing single-depth drywells at a maximum outflow rate of 0.3 cfs within a 50-foot radius of TP-15.

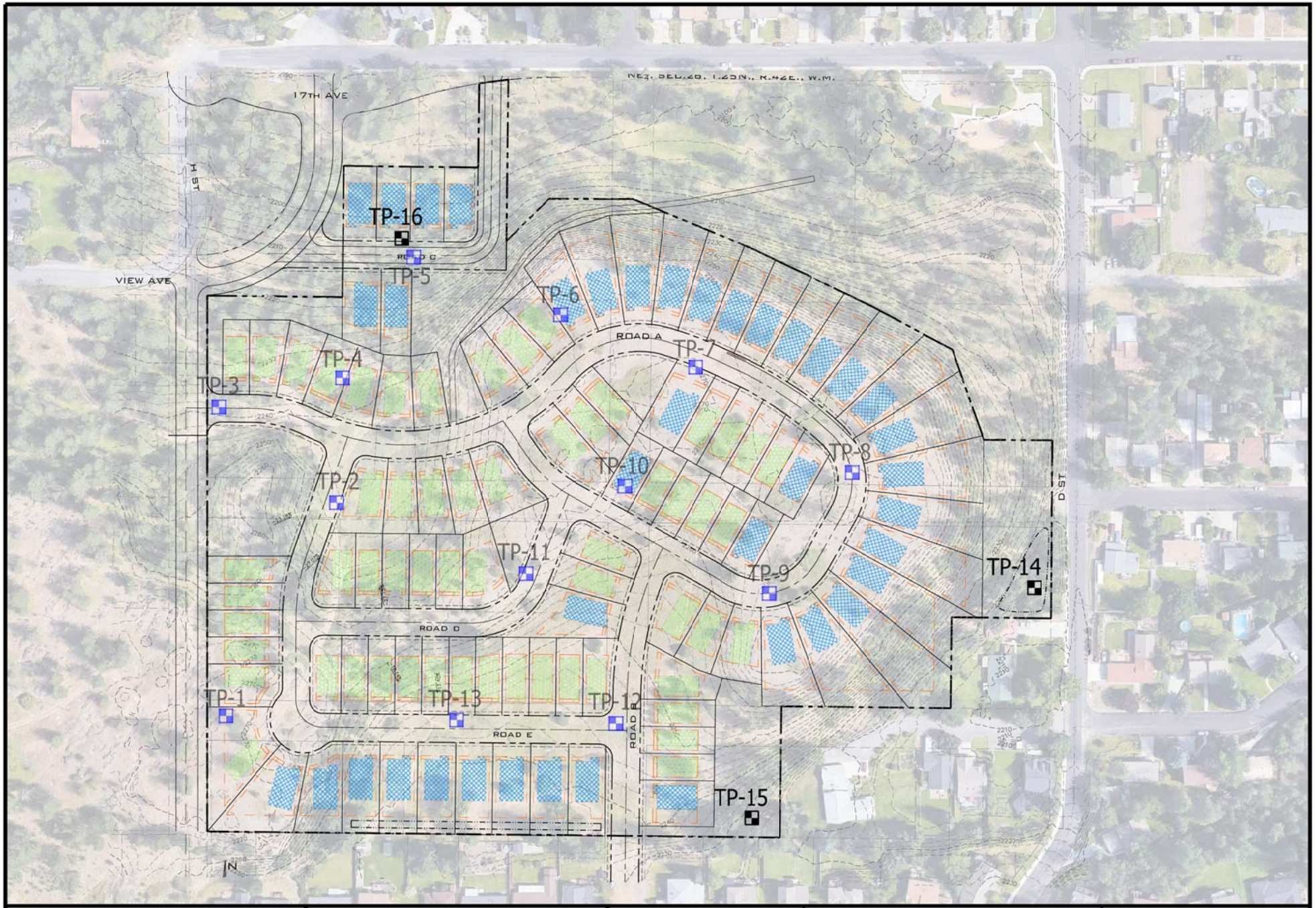
The volcanic ash stratum encountered in TP-16 represents a limiting layer and may render the use of single-depth drywells as infeasible. However, this area appears to be suitable for biofiltration utilizing a gallery approach with gravel trenches as follows:

- Perforated pipe in a 3-foot tall by 3-foot wide trench lined with filter fabric and filled with rounded drain rock. The pipe should be placed at least 12 inches below the biofiltration bottom.
- The recommended infiltration gallery discharge rate is 14 cubic feet per day per foot of trench length.
    - It is based on hydraulic conductivity, K, of 9.2 inches per hour (18.4 feet per day) from correlation with grain size distribution. A safety factor of 3.5 was applied to Darcy's equation q = k x *i* x A with *i* = 0.3 due to low gradient (*i*) from mounding above the lower permeability limiting layer and A = w + (2 x h) where w and h are the gallery height and width, respectively.

Monitoring. We recommend installing and measuring water levels in a minimum of 3 monitoring wells near property lines in the downgradient direction from infiltration structures. The minimum recommended measurement frequency is 2 per year.

This report is subject to the limitations stated in the original report, to which it should be permanently affixed.

Attachments:
Figure A1-1: Site Plan
Figure A1-2: Guide to soil and rock descriptions
Figure A1, 3-14 to A1, 3-16: Infiltration Test Pit Logs
Figures A1, 4-1 to A1, 4-6: Infiltration Test Results
Figure A1-5: Laboratory Summary
Figure A1-6: Grain Size Distributions



TEST PIT LOCATION (TP-1)
TEST PIT INFILTRATION (TP-14)

N
SCALE: 1"=200'
0 100 200

BASE PLAN FROM WCE-08/25/21

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SITE PLAN

GRANDVIEW 92-LOT HOUSING DEVELOPMENT
SPOKANE, WASHINGTON

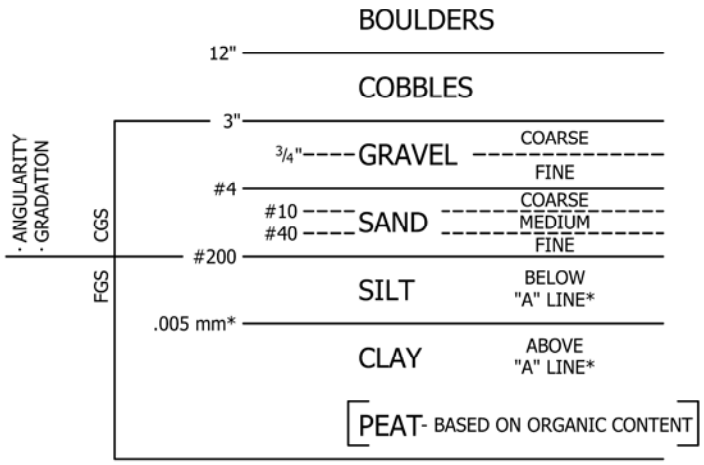
FIGURE A1-1

PROJECT NUMBER S21702

DATE: 11/2021

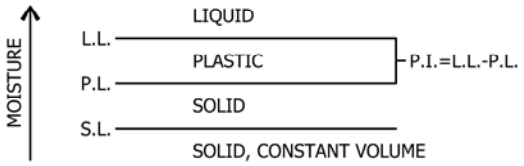
GUIDE TO SOIL & ROCK DESCRIPTIONS

SOIL CLASSIFICATION

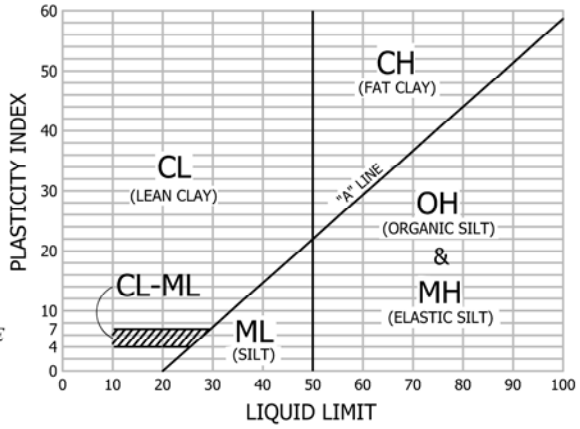


** SEE PLASTICITY CHART*
CGS - COARSE GRAINED SOIL - MORE THAN 50% RETAINED ON A #200 SIEVE
FGS - FINE GRAINED SOIL - 50% MORE PASSES, #200 SIEVE
FINES - PORTION FINER THAN #200 SIEVE

ATTERBERG LIMITS



PLASTICITY CHART



NOTE - CHART APPLIES TO FGS AND MINUS #40 SIEVE FRACTION OF CGS

GUIDE TO SOIL DESCRIPTION MODIFIERS, MOISTURE, AND CONDITION PRESENTED ON LOGS

MODIFIER	ESTIMATED PERCENTAGE OF MATERIAL
SUFFIX "LY" OR "Y"	30% OR MORE FOR COARSE PARTS IN FGS GREATER THAN 12% FOR FINES IN CGS
WITH	15% - 29% FOR COARSE PARTS IN FGS 6% - 14% FOR FINES IN CGS

NOTE - VISUAL ESTIMATES OF MATERIAL PERCENTAGES TYPICALLY VARY 0 TO 10% FROM THOSE DETERMINED BY LABORATORY TESTING.

MOISTURE

DRY
MOIST
SATURATED OR WET

SOIL CONDITION

CGS:
- VERY LOOSE
- LOOSE
- MEDIUM DENSE
- DENSE
- VERY DENSE

FGS:
- VERY SOFT
- SOFT
- MEDIUM STIFF
- STIFF
- VERY STIFF
- HARD

SAMPLES

- STANDARD 2" PENETRATION TEST SAMPLER WITH BLOWS PER FOOT
- 3" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT
- DRILL CUTTING SAMPLE
- BULK SAMPLE
- THIN-WALLED TUBE SAMPLE
- DIAMOND CORE RUN WITH % RECOVERY & ROCK QUALITY DESIGNATION
- 4" SPLIT SPOON SAMPLER WITH BLOWS PER FOOT
- R — REFUSAL OF SAMPLE (50+ BLOWS PER 6")

ROCK WEATHERING	ROCK CONDITION
FRESH	EXTREMELY WEAK
SLIGHTLY WEATHERED	VERY WEAK
MODERATELY WEATHERED	MODERATELY WEAK
HIGHLY WEATHERED	MODERATELY STRONG
COMPLETELY WEATHERED	STRONG
RESIDUAL SOIL	VERY STRONG

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FIGURE A1-2

TEST PIT 14

Date: 11-2-21
Excavator: B.Anderson
Equipment: CASE Extendahoe
Location: Infiltration 1
Surface: pine needles and grass

Elevation: 2215 ft
Logged by: D. Lehn
Size of hole: 2.5 x8

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		moist, dark brown, loose	SILT with Sand and Gravel and organics	
		dry, tan, medium dense	SILT with Sand, Gravel, and Cobbles, non-plastic (Colluvium)	
5			Stratified cobbles below 5 ft.	
10		dry, light gray, medium dense	SANDY SILT, stratified, blocky, lacustrine	
		no free groundwater observed	End of Excavation @ 11 ft	
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE A1, 3-14**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 15

Date: 11-2-21
Excavator: B.Anderson
Equipment: CASE Extendahoe
Location: Infiltration 2
Surface: pine needles and grass

Elevation: 2225 ft
Logged by: D. Lehn
Size of hole: 2.5 x8

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		moist, dark brown, loose	SILT with Sand and Gravel and organics	
		dry, tan, medium dense	SILTY GRAVEL with Sand and Cobbles, coarse, subangular (Colluvium)	
5				
		moist, gray, medium dense	GRAVEL with Sand, fine, angular	
			Refusal due to excessive caving	
10		no free groundwater observed	End of Excavation @ 9 ft	
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE A1, 3-15**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

TEST PIT 16

Date: 11-2-21
Excavator: B.Anderson
Equipment: CASE Extendahoe
Location: Infiltration 3
Surface: pine needles and grass

Elevation: 2210 ft
Logged by: D. Lehn
Size of hole: 2.5 x8

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG
0		moist, dark brown, loose	SILT with Sand and Gravel and organics	
		dry, tan, medium dense	GRAVEL with Silt, Sand, and Cobbles, coarse, subangular (Colluvium)	
		moist, tan, medium dense	GRAVEL with Sand and Cobbles, coarse, subangular, alluvial	
5		moist, white, medium dense	SILT (volcanic ash)	
		moist, white, very dense	GRAVEL with Silt and Sand, coarse to fine, subangular, alluvial	
		no free groundwater observed	End of Excavation @ 7 ft Excavation refusal on very dense gravel with silt and sand	
10				
15				
20				

TEST RESULTS

ATTERBERG LIMITS
PL — LL
WATER CONTENT ○

10 20 30 40 50 60 70 80 90

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TEST PIT LOGS **FIGURE A1, 3-16**

Project: Grandview 92-Lot Housing Development
Location: Spokane, WA
Number: S21702

Infiltration Test Results

TP-14

Total Depth (ft) 11.00

Date/Time	Time (min)	meter 1 (gal)	Cumulative Volume (gal)	Rate (gpm)	Head
11/2/2021 10:20	0	3971827	0	0	0.00
11/2/2021 10:30	10	3971844	17	1.7	4.17
11/2/2021 10:40	20	3971861	34	1.7	4.35
11/2/2021 10:50	30	3971878	51	1.7	4.35
11/2/2021 11:00	40	3971895	68	1.7	4.42
11/2/2021 11:10	50	3971912	85	1.7	4.37
11/2/2021 11:20	60	3971929	102	1.7	4.33
11/2/2021 11:30	70	3971945	118	1.7	4.54
11/2/2021 11:40	80	3971962	135	1.7	4.50
11/2/2021 11:50	90	3971979	152	1.7	4.44
11/2/2021 12:00	100	3971996	169	1.7	4.42
11/2/2021 12:10	110	3972013	186	1.7	4.50
11/2/2021 12:20	120	3972030	203	1.7	4.48
11/2/2021 12:25	125				4.36
11/2/2021 12:30	130				4.23
11/2/2021 12:35	135				4.21
11/2/2021 12:40	140				4.18
11/2/2021 12:45	145				4.16
11/2/2021 12:50	150				4.13

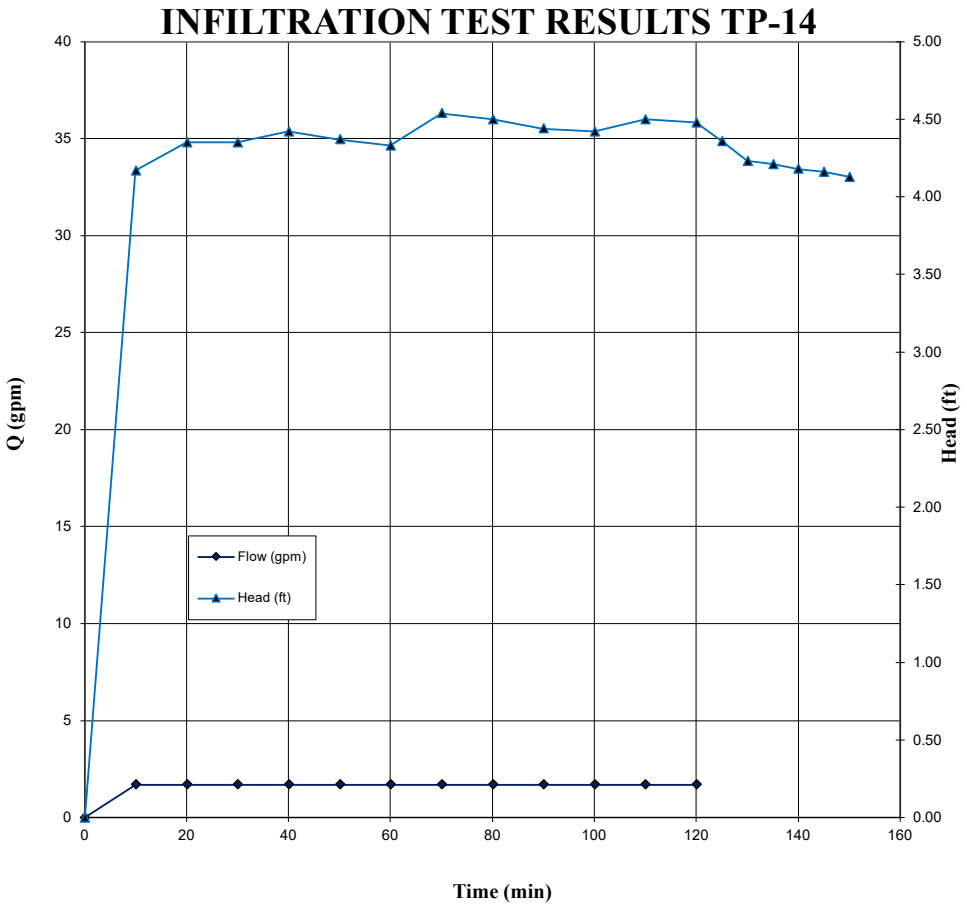

INFILTRATION TEST RESULTS TP-14
Q (gpm)
Head (ft)
Time (min)
Flow (gpm)
Head (ft)
0
5
10
15
20
25
30
35
40
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
0
20
40
60
80
100
120
140
160

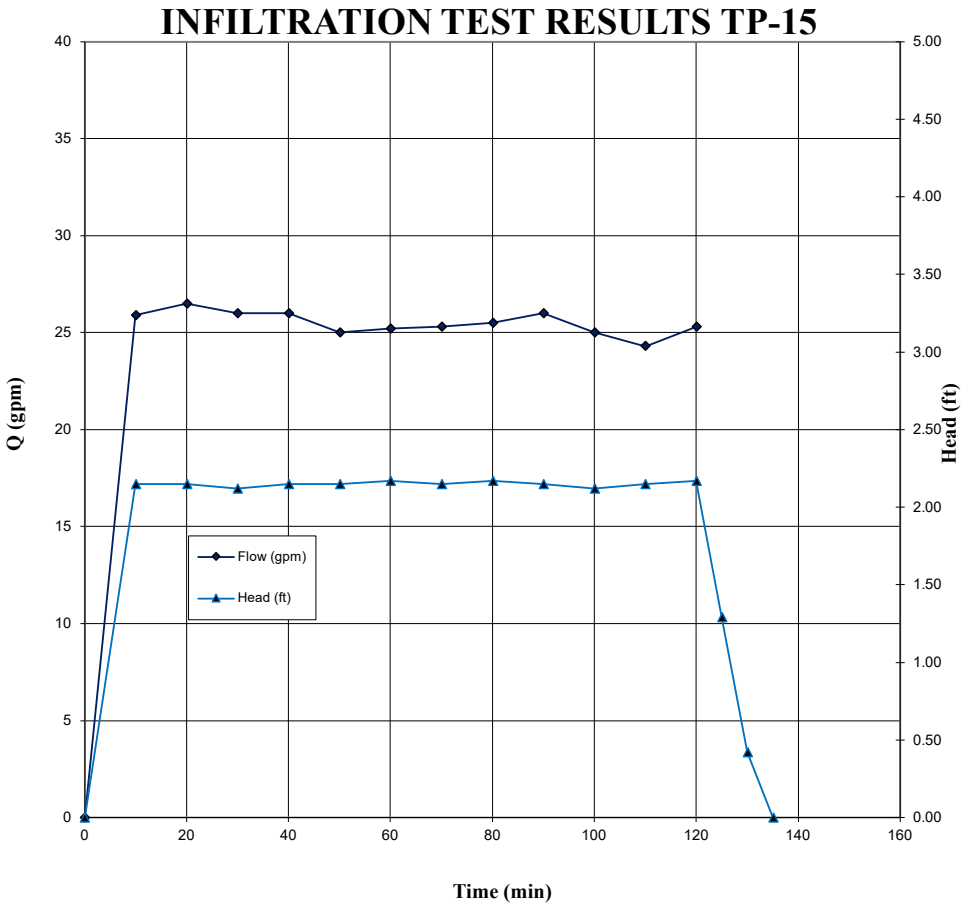
Figure A1, 4-2

Infiltration Test Results

TP-15

Total Depth (ft) 8.00

Date/Time	Time (min)	meter 1 (gal)	Cumulative Volume (gal)	Rate (gpm)	Head
11/2/2021 14:00	0	3972586.0	0	0	0.00
11/2/2021 14:10	10	3972845.0	259	25.9	2.15
11/2/2021 14:20	20	3973110.0	524	26.5	2.15
11/2/2021 14:30	30	3973370.0	784	26.0	2.12
11/2/2021 14:40	40	3973630.0	1044	26.0	2.15
11/2/2021 14:50	50	3973880.0	1294	25.0	2.15
11/2/2021 15:00	60	3974132.0	1546	25.2	2.17
11/2/2021 15:10	70	3974385.0	1799	25.3	2.15
11/2/2021 15:20	80	3974640.0	2054	25.5	2.17
11/2/2021 15:30	90	3974900.0	2314	26.0	2.15
11/2/2021 15:40	100	3975150.0	2564	25.0	2.12
11/2/2021 15:50	110	3975393.0	2807	24.3	2.15
11/2/2021 16:00	120	3975646.0	3060	25.3	2.17
11/2/2021 16:05	125				1.29
11/2/2021 16:10	130				0.42
11/2/2021 16:15	135				0.00

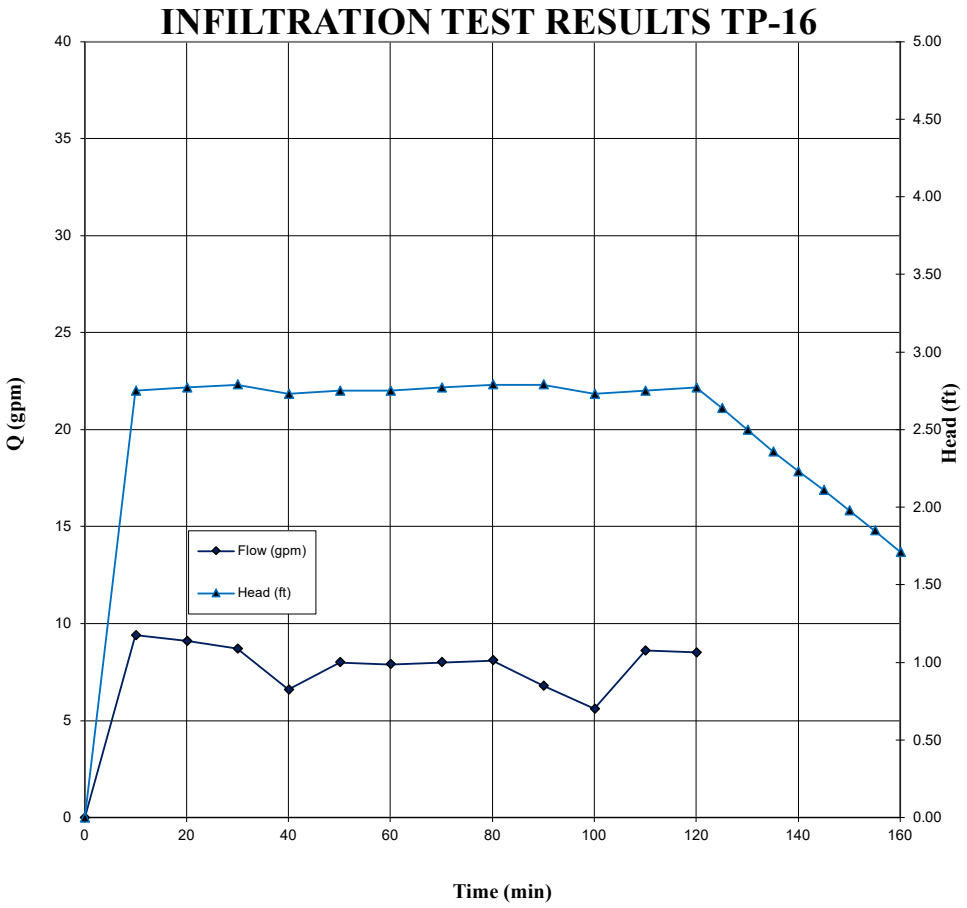

INFILTRATION TEST RESULTS TP-15
Q (gpm)
Head (ft)
Time (min)
Flow (gpm)
Head (ft)
0
5
10
15
20
25
30
35
40
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
0
20
40
60
80
100
120
140
160

Infiltration Test Results

TP-16

Total Depth (ft) 6.70

Date/Time	Time (min)	meter 1 (gal)	Cumulative Volume (gal)	Rate (gpm)	Head
11/3/2021 8:50	0	3976334	0	0	0.00
11/3/2021 9:00	10	3976428	94	9.4	2.75
11/3/2021 9:10	20	3976519	185	9.1	2.77
11/3/2021 9:20	30	3976606	272	8.7	2.79
11/3/2021 9:30	40	3976672	338	6.6	2.73
11/3/2021 9:40	50	3976752	418	8.0	2.75
11/3/2021 9:50	60	3976831	497	7.9	2.75
11/3/2021 10:00	70	3976911	577	8.0	2.77
11/3/2021 10:10	80	3976992	658	8.1	2.79
11/3/2021 10:20	90	3977060	726	6.8	2.79
11/3/2021 10:30	100	3977116	782	5.6	2.73
11/3/2021 10:40	110	3977202	868	8.6	2.75
11/3/2021 10:50	120	3977287	953	8.5	2.77
11/3/2021 10:55	125				2.64
11/3/2021 11:00	130				2.50
11/3/2021 11:05	135				2.36
11/3/2021 11:10	140				2.23
11/3/2021 11:15	145				2.11
11/3/2021 11:20	150				1.98
11/3/2021 11:25	155				1.85
11/3/2021 11:30	160				1.71

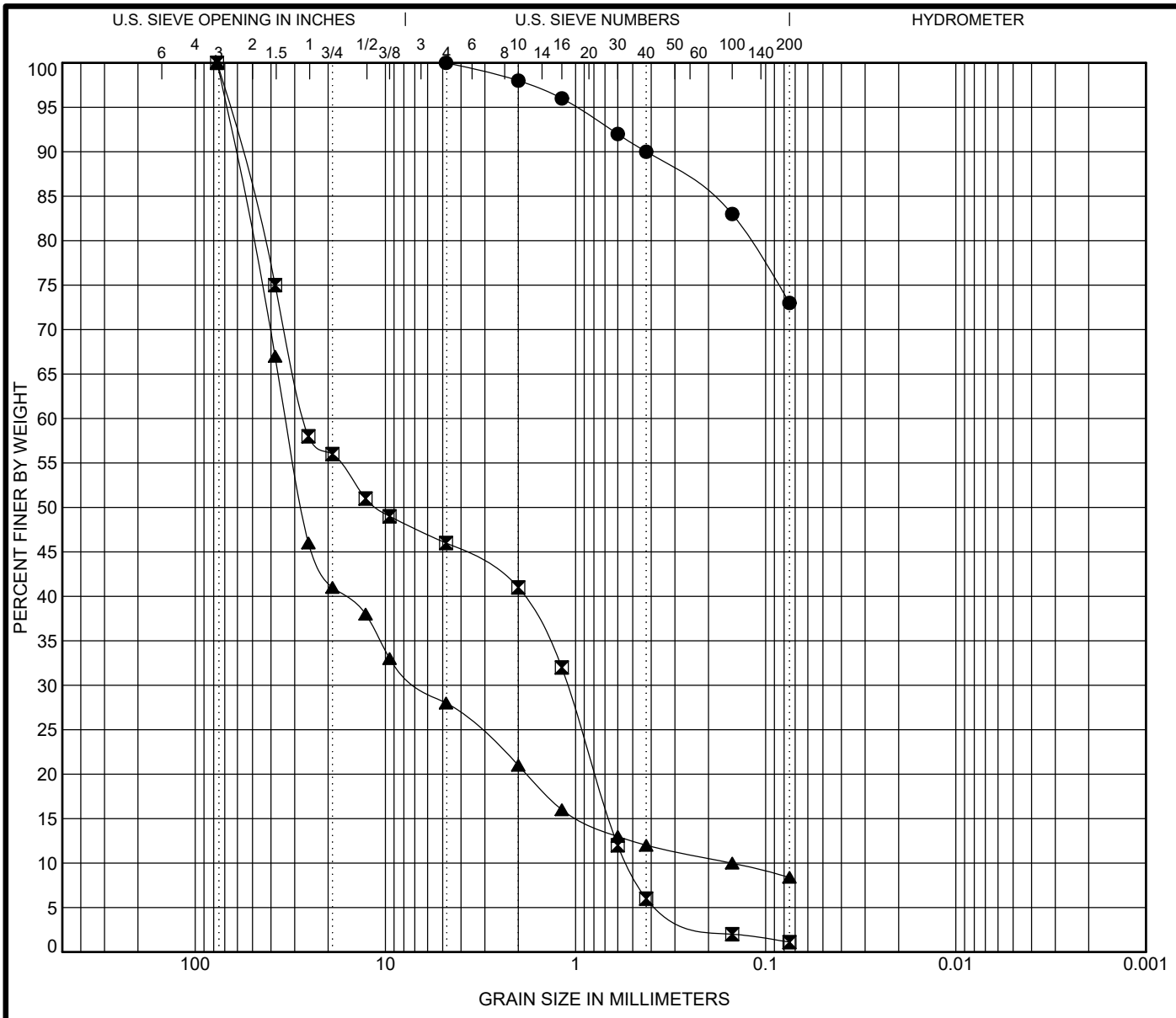

INFILTRATION TEST RESULTS TP-16
Q (gpm)
Head (ft)
Time (min)
Flow (gpm)
Head (ft)
0
5
10
15
20
25
30
35
40
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
0
20
40
60
80
100
120
140
160

SOIL MECHANICS
LABORATORY SUMMARY

		Units	Test Methods			
LABORATORY NUMBER				21-5747	21-5748	21-5749
TEST PIT NUMBER				TP-14	TP-15	TP-16
DEPTH	TOP	feet		9	8	6
	BOTTOM	feet		10	9	7
MOISTURE CONTENT		%	ASTM D2216	8.2	2.3	7.5
PLASTICITY INDEX		%	ASTM D4318	NP		NP
UNIFIED CLASSIFICATION			ASTM D2487	ML	GP	GP-GM
SIEVE ANALYSIS			ASTM D6913			
	3"				100	100
	1 1/2"				75	67
S	1"	%			58	46
I	3/4"				56	41
E	1/2"	P			51	38
V	3/8"	A			49	33
E	#4	S		100	46	28
	#10	S		98	41	21
S	#16	I		96	32	16
I	#30	N		92	12	13
Z	#40	G		90	6	12
E	#100			83	2	10
	#200			73	1.1	8.4

*NP= Non Plastic

FIGURE A1- 5



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	14	9.0	SILT with SAND(ML)	NP	NP	NP		
⊠	15	7.0	POORLY GRADED GRAVEL with SAND(GP)	NP	NP	NP	0.09	49.79
▲	16	6.0	POORLY GRADED GRAVEL with SILT and SAND(GP-GM)	NP	NP	NP	7.98	221.50

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	14	9.0	4.8				0.0	27.0	73.0	
⊠	15	7.0	76.8	26.633	1.103	0.535	53.2	44.8	1.1	
▲	16	6.0	76.8	33.225	6.307	0.15	71.0	19.5	8.4	

Budinger & Associates
1101 North Fancher Road
Spokane Valley, WA 99212

GRAIN SIZE DISTRIBUTION RESULTS

Project: Grandview 92-Lot Housing Development

Location: Spokane, WA

Number: S21702

FIGURE A1-6

US GRAIN SIZE S21702.GPJ BUDINGER.GDT 11/15/21