STORM DRAINAGE REPORT

FOR

COMMONS ON REGAL
REGAL STREET & 53RD AVENUE

City of Spokane, Washington

May, 2017

2015-1537

Prepared by:

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This report has been prepared by Elliott Whipple under the direction of the undersigned professional engineer whose seal and signature appears hereon:

TODD R. WHIPPLE
STATE OF WASHINGTON
25462
REGISTERED PROFESSIONAL ENGINEER

5/25/17

Todd R. Whipple, P.E.

INTRODUCTION:

The purpose of this drainage report is to identify drainage runoff characteristics resulting from development of the proposed Commons on Regal project. This drainage report will determine the drainage infrastructure improvements that are necessary to control and treat the storm water 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 Storm Water Manual (SRSM). Due to the poor-draining onsite soil beneath the proposed ponds, treatment methods will be based on equation 6-1d:, V=1815A, as outlined in the SRSM. However, the proposed pond volumes analysis, will be based on the SCS Curve Number method. The peak flows and volumes for these storm events are shown in the calculations that are included within the Appendix of this report.

NARRATIVE:

PROJECT DESCRIPTION:

The proposed project is a two (2) phase shopping center located east of Regal Street, west of Fiske Road and between 55th Avenue and 53rd Avenue. This storm drainage report will address storm drainage solution to phase one (1) of this development.

When this projected began in 2014, the existing site was covered with field grass, weeds, and pine trees found in the topographic survey. Since then these features have been removed because of the regrading effort taking place today. The existing buildings are to be removed at the time of the development.

The proposed development of the site will be for a shopping center and associated onsite storm drainage facilities. The proposed storm water facilities will adequately collect, treat and discharge the storm water runoff from the proposed development.

The proposed project is located east of Regal Street, west of Fiske Road and between 55th Avenue and 53rd Avenue. The site is located within Spokane County and lies in the NW ¼ of Section 03, T. 24 N., R. 43 E., W.M. The parcel numbers for the site were recently changed from 34032.0494, 34032.0480, 34032.0481, 34032.0446, and 34032.0447 to parcel number 34032.0494. A vicinity map is attached in the Appendix.

GEOTECHNICAL INFORMATION:

The existing soils are listed as 7106 Urban land sandy substratum, 0-15 percent slopes, 7120 Urban Land Marble, distributed complex, 0-3 percent slopes, 7150 Urban Land-Seabolt, distributed complex, 0 to 3 Percent slopes by the United States Department of Agriculture's (USDA) Natural Resource Conservation Service (NRCS) Web Soil Survey soil map. A soil map is included in the Appendix. Per the Soil Survey, the onsite soils are classified as Hydrologic Soil Group Type D.

A Geotechnical Evaluation was completed on site by GeoEngineers Dated May 18, 2016. The Geotechnical Evaluation verifies the soil types listed above and provides soil tests and recommendations.

Per the attached geotechnical evaluation, the geotechnical engineer states a traditional bio-infiltration swale will not be feasible. That being said, five (5) options were provided for storm drainage solutions: (1) discharge into Hazels Creek Storm Basin, a City of Spokane regional drainage facility, (2) using shallow infiltration swales, (3) draining to drywells instead of basalt rock, (4) holding storm water in retention swale, (5) or all of the above.

PRE-DEVELOPMENT BASIN INFORMATION:

Pre-development, a preliminary survey showed the site sloping to the northwest corner of the property and along 53rd Avenue with assorted pine trees, field grass and weeds. A Pre-Development Basin Map is located in the Appendix. Because of the site grading that has taken place, this site no longer reflects the original report and topography.

Table 1 – Pre-Development Project Site Basin Summary

Basins	Total Basin Area (sf)	Impervious Area (sf)	Pervious Area (sf)	PGIS (sf)
Pre A	168,710	1,905.00	166,805.00	0.00
Pre B	198,996	0.00	198,996.00	0.00
PRE TOTAL	367,706	1,905.00	365,801.00	0.00

POST-DEVELOPMENT BASIN INFORMATION:

The Post-Development basins are defined by designed finish grades and storm drain facilities. The project site has twelve (12) basins determined by first site grading and second treatment and discharge ponds. A copy of the basin map and calculations are included in the appendix with a summary provided in the following table.

Table 2 – Post-Development Project Site Basin Summary

Basins	Ponds	Total Basin Area (sf)	Impervious Area (sf)	Pervious Area (sf)	PGIS (sf)
Post A	**Pond A**	5,799	1,843.00	3,956.00	1,843.00
Post B	**Pond B**	22,071	16,385.00	5,686.00	16,385.00
Post C	**Pond C**	35,558	27,409.00	8,149.00	24,056.00
Post D	**Pond D**	7,942	5,824.00	2,118.00	5,538.00
Post E	**Pond E**	30,041	24,592.00	5,449.00	21,631.00
Post F	**Pond F**	13,765	10,795.00	2,970.00	10,282.00
Post G	**Pond G**	8,602	4,002.00	4,600.00	2,937.00
Post H	**Pond H**	19,603	14,706.00	4,897.00	14,126.00
Post J	**	4,845	4,845.00	0.00	0.00
Post K	**	8,453	8,453.00	0.00	0.00
Post L	**	8,462	8,462.00	0.00	0.00
Post M	**	4,842	4,842.00	0.00	0.00
TOTAL	-	169,983	132,158.00	37,825.00	96,798.00

** Buildings, see Basin Map to Determine Pond

Table 3 – Post-Development Project Site Pond Summary

Basins	Ponds	(Method 1815A (ac)) Treatment Area/Volume (square feet/cubic feet)				
		Required		Provided		
		Pond area	Pond vol.	Pond area	Treatment vol.	Storage vol.
Post A	A	153.58 sf	76.79 cf	1,318 sf	713 cf	1,194 cf
Post B	B	1,365.42 sf	682.71 cf	1,245 sf	823 cf	1,131 cf
Post C	C	2,004.67 sf	1,002.33 cf	995 sf	1,184 cf	2,238 cf
Post D	D	461.50 sf	230.75 cf	425 sf	243 cf	419 cf
Post E	E	1,802.58 sf	901.29 cf	543 sf	942 cf	1,129 cf
Post F	F	856.83 sf	428.42 cf	775 sf	429 cf	727 cf
Post G	G	244.75 sf	122.38 cf	1,093 sf	596 cf	1,001 cf
Post H	H	1,177.17 sf	588.58 cf	1,126 sf	613 cf	1,030 cf

Operational Characteristics:

The storm water generated on post basins of this site will discharge into proposed bio-retention swales. The water will infiltrate through the 18" of treatment soil and then through the gravel galleries, ergo Storm Tech chambers beneath the proposed ponds, as approved by Section 4.4 of the Eastern Washington Low Impact Development Guidance Manual. The Storm Tech chambers are hydraulically linked to one another. In all proposed bio-retention swale, there is a control structure which is comprised of a catch basin with a domed beehive grate. Within the proposed catch basin there is a 12" PVC tee that will have a 1.25" hole drilled into the bottom cap of the tee. The top of the tee will be extended above the bottom of the pond bottom within the domed beehive grate, and allow an emergency overflow visible to above ground observation.

The storm water will fill up the proposed ponds and either infiltrate through the treatment soil or will overflow the rim of the proposed catch basin where the stormwater will then flow into the Stormtech chamber. Once the chamber fills up the control structure (the 1.25" hole) will begin to discharge into the next Stormtech chamber in the series. This design ensures that the pond with its treatment volume and the chambers storage volume will be full before releasing any stormwater, even under a frozen ground condition. As previously described an additional emergency overflow is provided via the top of the tee. Located within the domes beehive grate the overflow is set to prevent stormwater from overtopping the ponds.

It is this system that moves the treated stormwater down a cascading series of ponds and chambers to the discharge point into the Hazels Creek storm system located in 53rd Avenue. The last structure CS-02 as shown on the drainage plans connects to the storm manhole in 53rd Avenue via a 4-inch pipe. The structure requires that stormwater enter the structure by cresting the rim of the structure and filling the structure for release via a control structure (the 1.25" hole). The 1.25" hole only allows a specific amount of water to be released at the maximum discharge rate. Please see the results section.

Methodology:

As required by the SRSM, the storm drainage facilities proposed for this site have been sized to treat and hold the stormwater runoff, per the Rational Method as outlined in Section 5.5 of the SRSM and the Curve number method outlined in section 5.3.

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. The water will infiltrate through the 18" of treatment soil and then through the gravel galleries ergo "Storm Tech Chambers" beneath the proposed ponds, as approved by Section 4.4 of the Eastern Washington Low Impact Development Guidance Manual.

Detention & Discharge:

The series of ponds, chambers and structures have been analyzed via the curve number method of the SRSM as implemented in Hydraflow Hydrographs

Critical Areas:

There does not appear to be any critical areas on site based on the Critical Area Maps provided by Spokane County (DNR Streams, Fish and Wildlife, Wetlands, Geo-hazard Area and Critical Aquifer Resource Area). No inventoried wetlands or federal flood zones are present within the project site.

Down-Gradient Analysis:

A down-gradient analysis is not needed for this site, as the proposed storm drainage system proposes to detain the 25-year design storm and continue to drain into the Hazels Creek Storm System at a rate less than the current rate of 1.5 gallons per minute per acre or 12.66 gallons per minute/ 0.0282 cfs for the entire 8.44-acre site.

Results:

As previously mentioned the site has been allotted a 1.5 gallon per minute per acre rate as its contribution of stormwater to Hazels Creek Storm Basin. This will be considered the predevelopment flow rate of the site which when calculated results in a rate of 0.0282 cfs:

$$1.5\ \frac{gallon/minute}{acre} \times 8.4413\ acre = 12.66195\ \frac{gallon}{minute} \times \frac{0.133681\ cubic\ feet}{1.0\ gallons} \times \frac{1\ minute}{60\ seconds} = 0.0282 cfs$$

As shown in Table 4 the post development detention system is anticipated to release stormwater out of Structure SC-02 into the Hazels Creek storm system at the following rates.

Table 4 – Basin Summary Discharge to Hazels Creek

Storms	Post Development	
	Development Discharge Structure SC-02	
	Rate (cfs)	Rate (gpm)
2 Yr	0.000	0.00
10 Yr	0.012	4.49
25 Yr	0.015	5.61
100 Yr	0.020	7.48

Additionally, with the development of Phase 2 under the same design of cascading ponds and galleries the outflow to hazels creek will remain constant with the 1.25" size hole.

Designers Note: Through this analysis. infiltration has been primarily not addressed, simply because the Geotechnical report did not provide an infiltration analysis of the fractured basalt that lays underneath the project site. Having completed the development of property directly to the southwest of the project over the recent years. We understand that the basalt that lies under the area is the same formation. For that project, the Geotechnical engineer provided an infiltration rate into the fractured basalt at 1.2 x 10^{-5} cfs/sf (See Attached). If we just consider this infiltration rate applied to the total pond bottom area of the site (7,520 sf) the site would infiltrate 0.09 cfs over a 24-hr storm the volume of stormwater that would be disposed of through infiltration would be 7,796 cf. By inspection the designer does not believe that discharge to the Hazels Creek will occur, except under heavy periods of rain like those experienced this year, however having the option to discharge to Hazels Creek provides assurances that the project site will not have any issues with stormwater.

Table 5 – Project Operation Summary (Per the SCS method)

Basin	Storm Facilities			50-yr Storm		100-yr Storm	
	P	C	TS	BR_{50}	$TS-BR_{50}$	BR_{100}	$TS-BR_{100}$
	Pond	Chamber	Total Storage	Basin Runoff	Difference	Basin Runoff	Difference
	Vol. (cf)	Vol. (cf)	Vol. (cf)	Vol. (cf)	Vol. (cf)	Vol. (cf)	Vol. (cf)
A	902	1,194	2,247	627	2,814	708	2,733
B	3,697	1,131	1,498	2,602	27	2,925	-296
C	6,740	2,238	2,097	4,800	-465	5,375	-1,040
D	1,305	419	1,498	918	999	1,032	885
E	5,454	1129	1,498	3,931	-1,304	4,383	-1,756
F	2,423	727	749	1,725	-249	1,932	-456
G	1,159	1001	1,198	768	1,431	882	1,317
H	3,407	1030	749	2,426	-647	2,717	-938
J	-	-	-	738	-738	813	-813
K	-	-	-	1,276	-1,276	1,404	-1,404
L	-	-	-	1,276	-1,276	1,404	-1,404
M	-	-	-	738	-738	813	-813
Total	8,869	11,534	20,403	21,825	-1,422	24,388	-3,985
Hazels Creek Discharge (1.25" Hole) (0.0282cfs *24*3600)					2,436		2,436
Difference					1,014		-1,549

As shown in Table 5 and as is expected under storm conditions for a 50-year and 100-year storm event, the proposed storm facilities are anticipated to retain the storm in the 50-year event with the anticipated discharge. For the 100-year event the proposed facility is anticipated to hold the majority of the stormwater with the remaining volume anticipated to be stored within the parking area at the pond inlets, until the waters recede.

Perpetual Maintenance of Facilities:

This is commercial development with a public road accesses. A maintenance plan will be provided to the owner if requested.

Offsite Easements:

There are no offsite easements required for this property.

Regional Facilities:

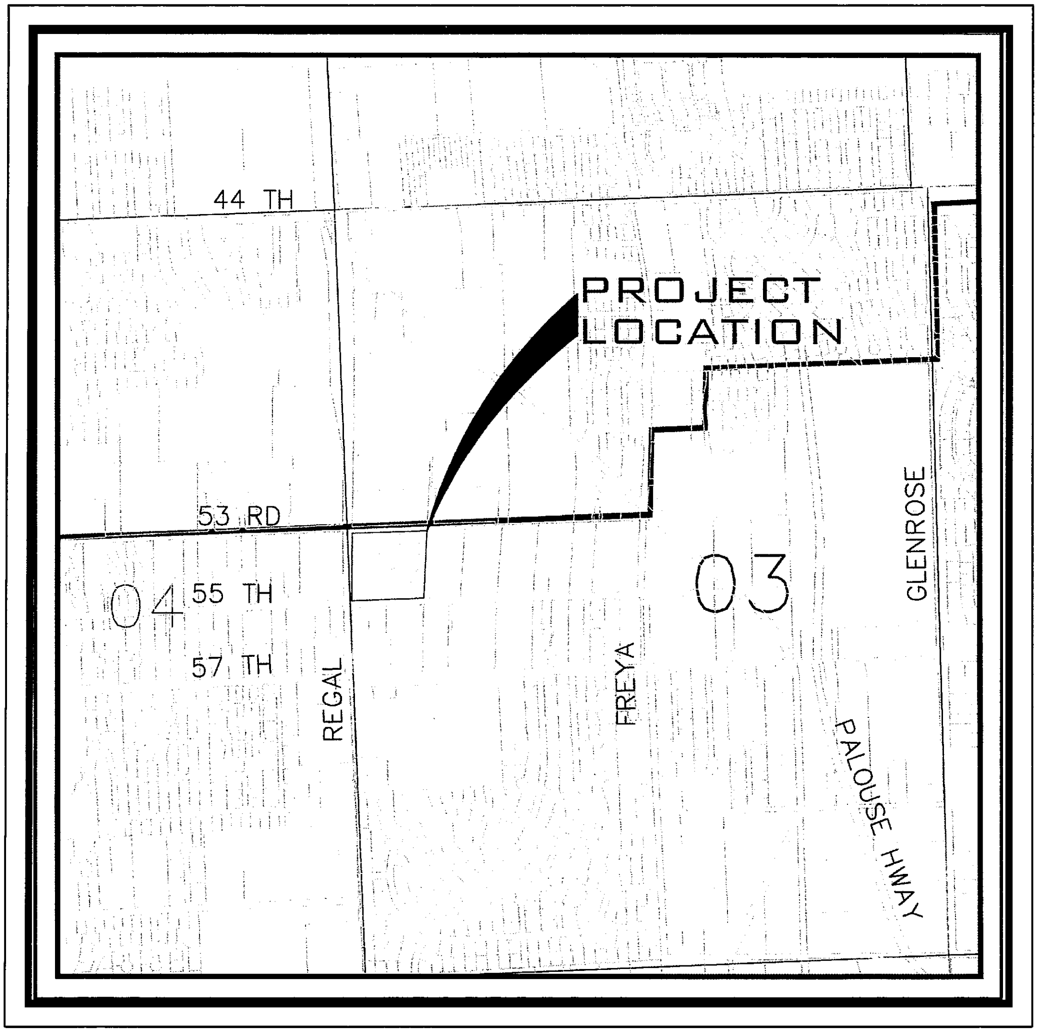
There are no known regional facilities that lie within the project site.

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 2- and 25-year storm events. Also, the storm drainage facilities will contain and discharge the 2, 10, 25, 50, and 100-year storm. Therefore, this project will have no adverse impact to adjacent and/or downstream properties.

APPENDIX

VICINITY MAP



VICINITY MAP

PROJ #: 15-1537
DATE: 05/04/17
DRAWN: TEW
APPROVED: TRW

DRAINAGE REPORT
COMMONS ON REGAL
53RD AVE & REGAL STREET
SPOKANE, WASHINGTON

WCE
WHIPPLE CONSULTING ENGINEERS
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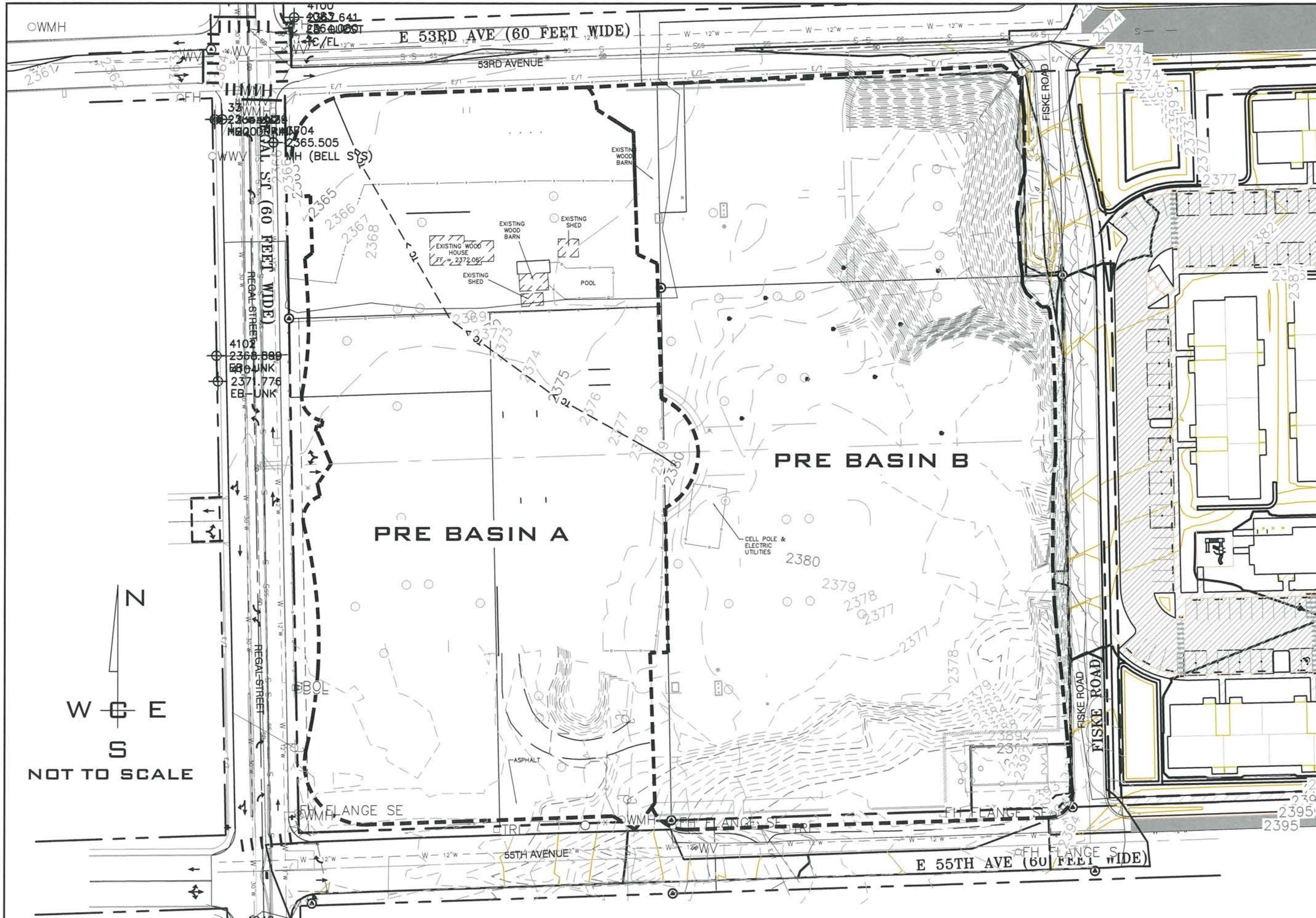
FIGURE 1

VICINITY MAP

BASIN MAPS



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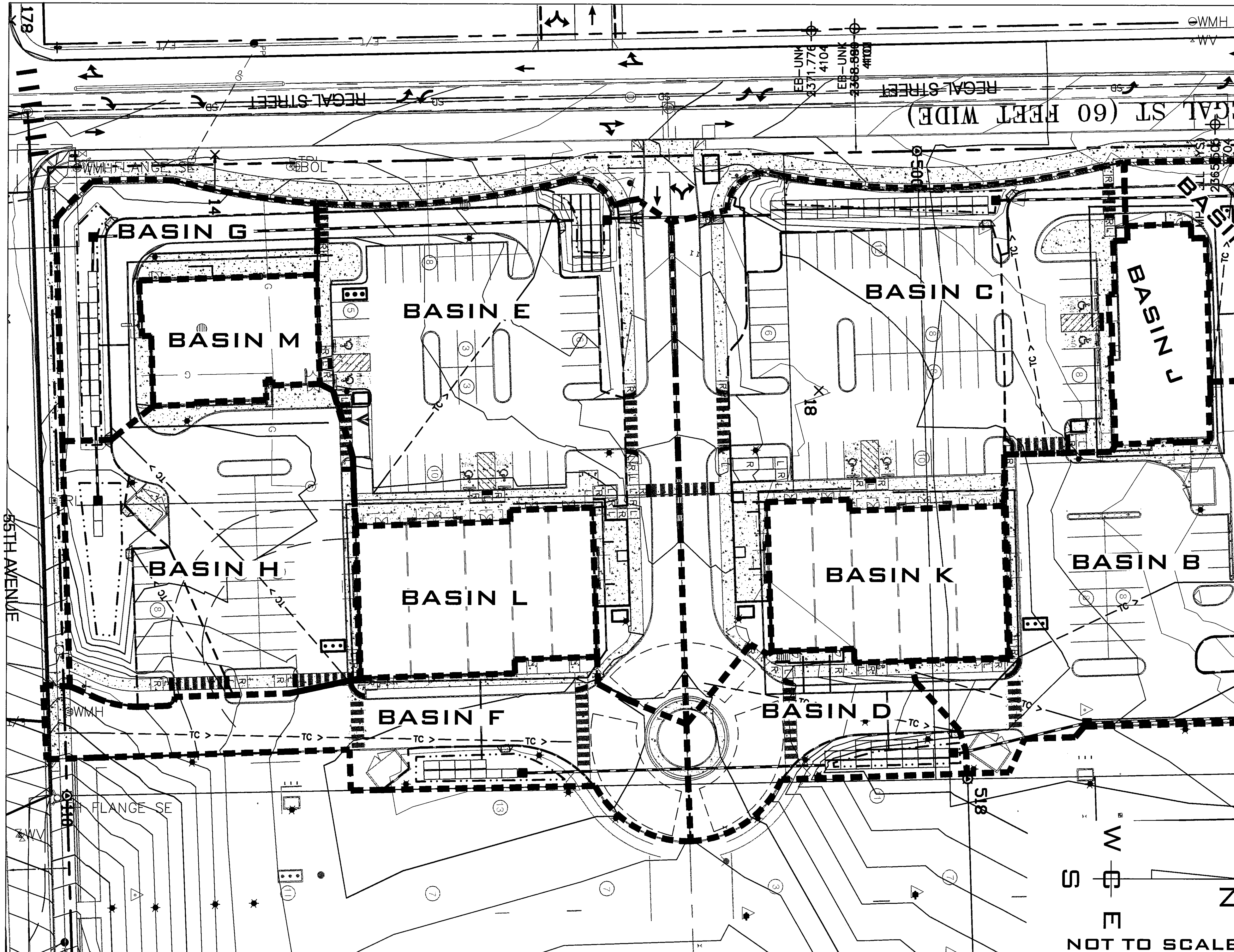
PROJ #: 15-1537
DATE: 05/23/16
DRAWN: BNG
APPROVED: TRW

PRE DEVELOPMENT BASIN MAP
COMMONS ON REGAL
53RD AVE & REGAL STREET
SPOKANE, WASHINGTON

SHEET 1 OF 3

P:\WCE_WORK\2015 WCE PROJECTS\2015-1537 Vaughn - 53rd to 55th and Regal\DWG\1537 BASIN MAP tew.dwg, 5/24/2017 9:03:47 AM, C60



POST DEVELOPMENT BASIN MAP

COMMONS ON REGAL

53RD AVE & REGAL STREET
SPOKANE, WASHINGTON

PROJ #: 15-1537
DATE: 02/06/17
DRAWN: TEW
APPROVED: TRW

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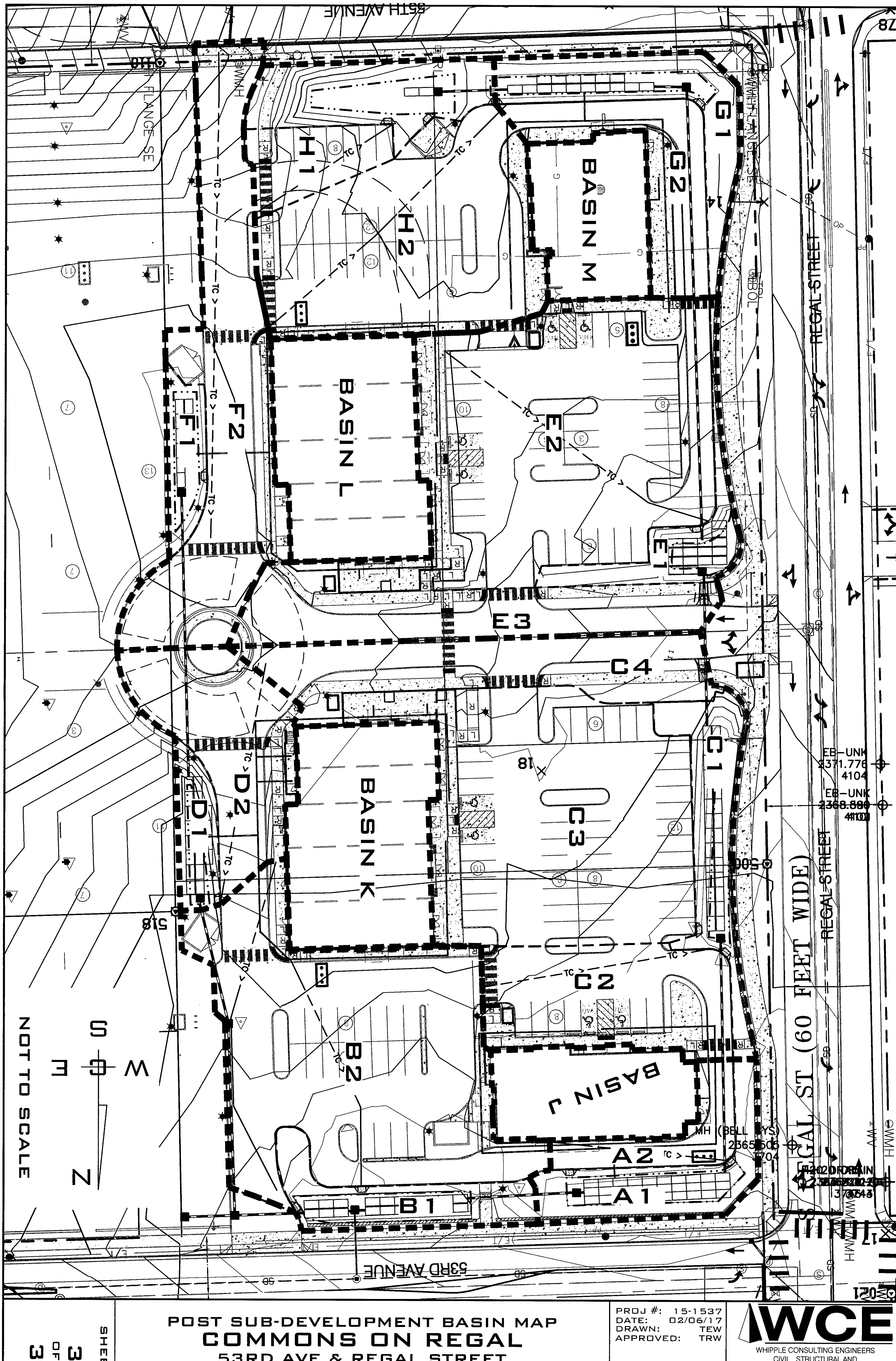

POST SUB-DEVELOPMENT BASIN MAP
COMMONS ON REGAL
53RD AVE & REGAL STREET
SPOKANE, WASHINGTON

PROJ #: 15-1537
DATE: 02/06/17
DRAWN: TEW
APPROVED: TRW

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SHEET
3 OF 3

BASIN SUMMARY SHEET

Whipple Consulting Engineers
Basin Calculation Worksheet

Imp 0.9
Per 0.2

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
I (25 yr) =	3.319 inches	I (50 yr)=	3.843 inches
I (100 yr) =	4.381 inches		

NOTE:

WCE No. Project Name
15-1537 Commons on Regal

5/23/2017
TEW

SPOKANE COUNTY - SRSM - GRASSED PERCOLATION METHOD

Basin	Total		Access/Parking	Sidewalk	DV	Buildings	Total	Total	Weighted	PGIS	Pond (1815 A)	Pond	Q=CIA (cfs)				
	ac	sf	/Street (sf)	sf	WY	sf	Impervious	Pervious	"C"	sf	Area (sf)	Vol (cf)	2 yr	10 yr	25 yr	50 yr	100 yr
PRE A	3.87	168,710	0	0	0	1,905	1,905.00	166,805.00	0.16	0.00	0.00	0.00	0.87	1.61	2.04	2.36	2.69
PRE B	4.57	198,996	0	0	0	0	0.00	198,996.00	0.15	0.00	0.00	0.00	0.97	1.79	2.27	2.63	3.00
Pre Total	**8.44**	**367,706**	**0**	**0**	**0**	**1,905**	**1,905.00**	**365,801.00**	**0.15**	**0.00**	**0.00**	**0.00**	1.84	**3.40**	4.31	**4.99**	5.69
Post Onsite Flow																	
A1	0.08	3,563	0	0	0	0	0.00	3,563.00	0.15	0.00	0.00	0.00	0.02	0.03	0.04	0.05	0.05
A2	0.05	2,236	1,843	0	0	0	1,843.00	393.00	0.77	1,843.00	153.58	76.79	0.06	0.10	0.13	0.15	0.17
Total A	0.13	**5,799**	1,843	0	0	0	**1,843.00**	**3,956.00**	0.39	**1,843.00**	153.58	**76.79**	0.07	0.14	0.17	0.20	0.23
B1	0.04	1,851	0	0	0	0	0.00	1,851.00	0.15	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.03
B2	0.46	20,220	16,385	0	0	0	16,385.00	3,835.00	0.76	16,385.00	1,365.42	682.71	0.50	0.92	1.17	1.35	1.54
TOTAL B	0.51	**22,071**	16,385	0	0	0	**16,385.00**	**5,686.00**	0.71	**16,385.00**	1,365.42	**682.71**	0.51	0.94	1.19	1.38	1.57
C1	0.10	4,506	0	0	0	0	0.00	4,506.00	0.15	0.00	0.00	0.00	0.02	0.04	0.05	0.06	0.07
C2	0.16	7,027	5,394	838	0	0	6,232.00	795.00	0.82	5,394.00	449.50	224.75	0.19	0.34	0.44	0.51	0.58
C3	0.40	17,421	14,681	785	0	0	15,466.00	1,955.00	0.82	14,681.00	1,223.42	611.71	0.46	0.85	1.08	1.25	1.43
C4	0.15	6,604	3,981	1,730	0	0	5,711.00	893.00	0.80	3,981.00	331.75	165.88	0.17	0.32	0.40	0.47	0.53
TOTAL C	0.82	**35,558**	24,056	3,353	0	0	**27,409.00**	**8,149.00**	0.73	**24,056.00**	2,004.67	**1,002.33**	0.84	1.56	1.97	2.28	2.60
D1	0.04	1,575	0	0	0	0	0.00	1,575.00	0.15	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02
D2	0.15	6,367	5,538	286	0	0	5,824.00	543.00	0.84	5,538.00	461.50	230.75	0.17	0.32	0.41	0.47	0.54
TOTAL D	0.18	**7,942**	5,538	286	0	0	**5,824.00**	**2,118.00**	0.70	**5,538.00**	461.50	**230.75**	0.18	0.33	0.42	0.49	0.56
E1	0.05	2,349	0	0	0	0	0.00	2,349.00	0.15	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.04
E2	0.45	19,539	17,033	1,426	0	0	18,459.00	1,080.00	0.86	17,033.00	1,419.42	709.71	0.55	1.01	1.28	1.48	1.69
E3	0.19	8,153	4,598	1,535	0	0	6,133.00	2,020.00	0.71	4,598.00	383.17	191.58	0.19	0.35	0.44	0.51	0.59
TOTAL E	0.69	**30,041**	21,631	2,961	0	0	**24,592.00**	**5,449.00**	0.76	**21,631.00**	1,802.58	**901.29**	0.75	1.38	1.75	2.02	2.31

Whipple Consulting Engineers
Basin Calculation Worksheet

Imp 0.9
Per 0.2

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
5/23/2017 15-1537 Commons on Regal
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SPOKANE COUNTY - SRSM - GRASSED PERCOLATION METHOD

Basin	Total		Access/Parking	Sidewalk	DV	Buildings	Total	Total	Weighted	PGIS	Pond	Pond	Q=CIA (cfs)				
	ac	sf	/Street (sf)	sf	WY	sf	Impervious	Pervious	"C"	sf	Area (sf) 1815 A	Vol (cf)	2 yr	10 yr	25 yr	50 yr	100 yr
F1	0.05	2,102	0	0	0	0	0.00	2,102.00	0.15	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.03
F2	0.27	11,663	10,282	513	0	0	10,795.00	868.00	0.84	10,282.00	856.83	428.42	0.32	0.59	0.75	0.87	0.99
TOTAL F	0.32	**13,765**	10,282	513	0	0	**10,795.00**	**2,970.00**	0.74	**10,282.00**	856.83	**428.42**	0.33	0.61	0.77	0.90	1.02
G1	0.10	4,172	0	0	0	0	0.00	4,172.00	0.15	0.00	0.00	0.00	0.02	0.04	0.05	0.06	0.06
G2	0.10	4,430	2,937	1,065	0	0	4,002.00	428.00	0.83	2,937.00	244.75	122.38	0.12	0.22	0.28	0.32	0.37
TOTAL G	0.20	**8,602**	2,937	1,065	0	0	**4,002.00**	**4,600.00**	0.50	**2,937.00**	244.75	**122.38**	0.14	0.26	0.33	0.38	0.43
H1	0.10	4,222	0	0	0	0	0.00	4,222.00	0.15	0.00	0.00	0.00	0.02	0.04	0.05	0.06	0.06
H2	0.35	15,381	14,126	580	0	0	14,706.00	675.00	0.87	14,126.00	1,177.17	588.58	0.43	0.80	1.02	1.18	1.34
TOTAL H	0.45	**19,603**	14,126	580	0	0	**14,706.00**	**4,897.00**	0.71	**14,126.00**	1,177.17	**588.58**	0.45	0.84	1.06	1.23	1.41
J	0.11	**4,845**	0	0	0	4,845	**4,845.00**	**0.00**	0.90	**0.00**	0.00	**0.00**	0.14	0.26	0.33	0.38	0.44
K	0.19	**8,453**	0	0	0	8,453	**8,453.00**	**0.00**	0.90	**0.00**	0.00	**0.00**	0.25	0.46	0.58	0.67	0.77
L	0.19	**8,462**	0	0	0	8,462	**8,462.00**	**0.00**	0.90	**0.00**	0.00	**0.00**	0.25	0.46	0.58	0.67	0.77
M	0.11	**4,842**	0	0	0	4,842	**4,842.00**	**0.00**	0.90	**0.00**	0.00	**0.00**	0.14	0.26	0.33	0.38	0.44
POST TOTAL	3.90	**169,983**	**96,798**	**8,758**	**0**	**26,602**	**132,158.00**	**37,825.00**	0.73	**96,798.00**	8,066.50	**4,033.25**	**4.06**	**7.49**	**9.49**	**10.99**	**12.53**
Combined Basins																	
A & J	0.24	10,644	1,843	0	0	4,845	**6,688.00**	**3,956.00**	0.62	**1,843.00**	153.58	**76.79**	0.22	0.40	0.50	0.58	0.67
D & K	0.38	16,395	5,538	286	0	8,453	**14,277.00**	**2,118.00**	0.80	**5,538.00**	461.50	**230.75**	0.43	0.79	1.00	1.16	1.32
F & L	0.51	22,227	10,282	513	0	8,462	**19,257.00**	**2,970.00**	0.80	**10,282.00**	856.83	**428.42**	0.58	1.07	1.35	1.57	1.79
G & M	0.31	13,444	2,937	1,065	0	4,842	**8,844.00**	**4,600.00**	0.64	**2,937.00**	244.75	**122.38**	0.28	0.52	0.66	0.76	0.87

POND VOLUME WORKSHEET

WHIPPLE CONSULTING ENGINEERS
POND VOLUME CALC SHEET

Date: 5/23/2017

Project: 15-1537 Commons on Regal
Designer: TEW

									Treatment			*Storage*
Basins	Ponds/ Swales	Bottom Area sf	Squared Side lf	Pond Bottom Elevation at Drywell	Pond Drywell Elevation	Pond Inlet 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	**A**	1,318	36.30	2,366.00	2,366.50	2,366.80	659	54	713	1,054	139	1,194
B	**B**	1,245	35.28	2,365.00	2,365.60	2,365.80	747	76	823	996	135	1,131
C	**C**	995	31.54	2,365.65	2,366.65	2,367.35	995	189	1,184	1,691	547	2,238
D	**D**	425	20.62	2,369.22	2,369.72	2,370.02	213	31	243	340	79	419
E	**E**	543	23.30	2,368.97	2,370.27	2,370.47	706	236	942	815	315	1,129
F	**F**	775	27.84	2,373.60	2,374.10	2,374.40	388	42	429	620	107	727
G	**G**	1,093	33.06	2,373.38	2,373.88	2,374.18	547	50	596	874	127	1,001
H	**H**	1,126	33.56	2,373.04	2,373.54	2,373.84	563	50	613	901	129	1,030
Totals		7,520	-	-	-	-	-	-	**5,545**	-	-	**8,870**

StormTech CHAMBER VOLUMES

INFILTRATION CALCULATIONS

PROJECT: REGAL COMMON'S
POND: A
DESIGNER TEW
DATE: 04/17/17

Stormtech Chamber System

SC-740	Length (f	Width (ft)	Height
unit dim	7.11	4.25	2.5
ends/side	2	2	1

Rows	Columns	
10	3	Note: Chambers in this scenario are spred out in three locations

	Length	Width	Height
Gallery	73.1	15.75	3.5

Storage

30 Units

74.9 cf/unit

Foundatic Depth 6 in

2,247.00 cf Storage Provided

Bottom Area	1151.325
Perimeter Area	621.95
Total Area	1773.275
Infiltration Rate	5.00E-07
Outflow	**0.0008866** cfs

Gravel Volume in Gallery

30 Units

2.8 cy/unit

Foundation Depth 6 in

84 cy

StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
42 (1067)	↑ 45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (940)	↓ 45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	↑ 0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	↓ 0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

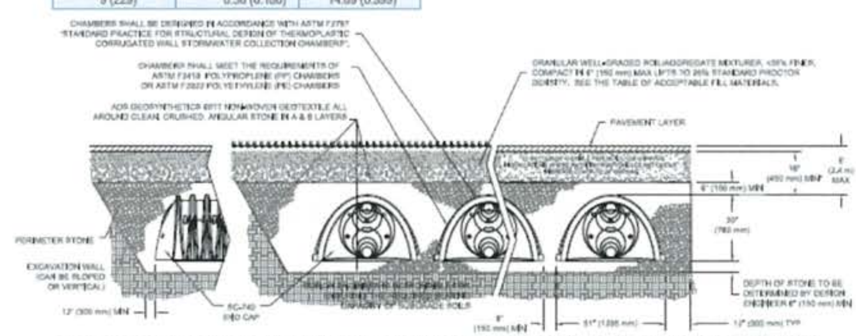
	Stone Foundation Depth		
ENGLISH TONS (yd³)	**6"**	**12"**	**18"**
StormTech SC-740	3.8 (2.8 yd³)	4.6 (3.3 yd³)	5.5 (3.9 yd³)
METRIC KILOGRAMS (m³)	**150 mm**	**300 mm**	**450 mm**
StormTech SC-740	3450 (2.1 m³)	4170 (2.5 m³)	4490 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	**12" (300 mm)**	**18" (450 mm)**
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

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INFILTRATION CALCULATIONS

PROJECT: REGAL COMMON'S
POND: B
DESIGNER TEW
DATE: 04/17/17

Stormtech Chamber System

SC-740	Length (f	Width (ft)	Height
unit dim	7.11	4.25	2.5
ends/side	2	2	1

Rows Columns Note: Chambers in this scenario are spred out in three locations
10 2

	Length	Width	Height	Storage		Foundatic Depth
Gallery	73.1	11	3.5	20	Units	
				74.9	cf/unit	6

Bottom Area	804.1
Perimeter Area	588.7
Total Area	1392.8
Infiltration Rate	5.00E-07
Outflow	0.0006964 cfs

1,498.00 cf Storage Provided

in

Gravel Volume in Gallery

20 Units
Foundation Depth
2.8 cy/unit 6 in

56 cy

StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
42 (1067)	↑ 45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (940)	↓ 45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.308)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	↑ 0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	↓ 0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

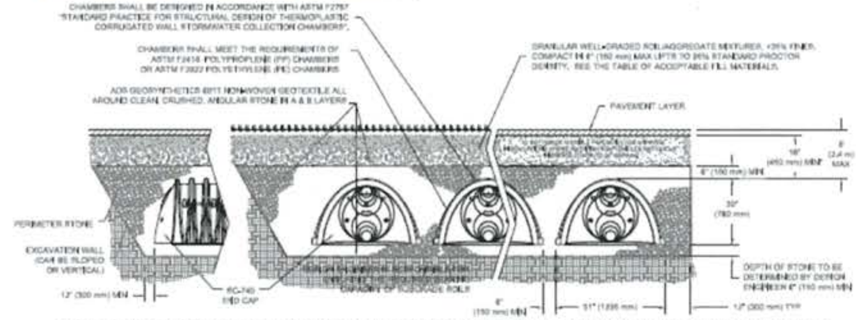
	Stone Foundation Depth		
ENGLISH TONS (yd³)	6"	12"	18"
StormTech SC-740	3.8 (2.8 yd³)	4.6 (3.3 yd³)	5.5 (3.9 yd³)
METRIC KILOGRAMS (m³)	150 mm	300 mm	450 mm
StormTech SC-740	3450 (2.1 m³)	4170 (2.5 m³)	4490 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



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INFILTRATION CALCULATIONS	PROJECT: REGAL COMMON'S
	POND: C
	DESIGNER TEW
	DATE: 04/17/17

Stormtech Chamber System

SC-740	Length (ft)	Width (ft)	Height
unit dim	7.11	4.25	2.5
ends/side	2	2	1

Rows	Columns
14	2

Note: Chambers in this scenario are spred out in three locations

	Length	Width	Height
Gallery	101.54	11	3.5

Storage

28 Units

74.9 cf/unit

Foundation Depth 6 in

2,097.20 cf Storage Provided

Bottom Area	1116.94
Perimeter Area	787.78
Total Area	1904.72
Infiltration Rate	5.00E-07
Outflow	**0.0009524** cfs

Gravel Volume in Gallery

28 Units

Foundation Depth

2.8 cy/unit 6 in

78.4 cy

StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft^3 (m^3)	Total System Cumulative Storage Ft^3 (m^3)
42 (1067)	↑ 45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (948)	↓ 45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft^3 (m^3)	Total System Cumulative Storage Ft^3 (m^3)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	↑ 0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	↓ 0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m^3) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft^3 (m^3)

	Bare Chamber Storage	Chamber and Stone Stone Foundation Depth in. (mm)		
	ft^3 (m^3)	6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

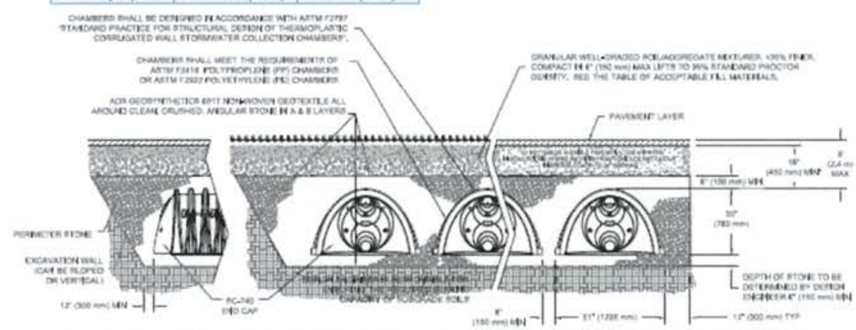
	Stone Foundation Depth		
ENGLISH TONS (yd^3)	6"	12"	18"
StormTech SC-740	3.8 (2.8 yd^3)	4.6 (3.3 yd^3)	5.5 (3.9 yd^3)
METRIC KILOGRAMS (m^3)	150 mm	300 mm	450 mm
StormTech SC-740	3450 (2.1 m^3)	4170 (2.5 m^3)	4490 (3.0 m^3)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd^3 (m^3)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



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INFILTRATION CALCULATIONS

PROJECT: REGAL COMMON'S
POND: D
DESIGNER TEW
DATE: 04/17/17

Stormtech Chamber System

SC-740	Length (ft)	Width (ft)	Height
unit dim	7.11	4.25	2.5
ends/side	2	2	1

Rows 10 Columns 2 Note: Chambers in this scenario are spred out in three locations

	Length	Width	Height
Gallery	73.1	11	3.5

Storage
20 Units
74.9 cf/unit
Foundation Depth 6 in

1,498.00 cf Storage Provided

Bottom Area	804.1
Perimeter Area	588.7
Total Area	1392.8
Infiltration Rate	5.00E-07
Outflow	0.0006964 cfs

Gravel Volume in Gallery

20 Units
2.8 cy/unit
Foundation Depth 6 in

56 cy

StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber
Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
42 (1067)	↑ 45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (940)	↓ 45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	↑ 0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	↓ 0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

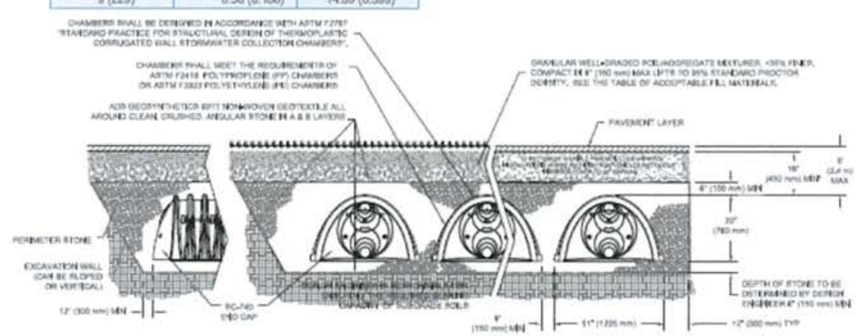
	Stone Foundation Depth		
ENGLISH TONS (yd³)	6"	12"	18"
StormTech SC-740	3.8 (2.8 yd³)	4.6 (3.3 yd³)	5.5 (3.9 yd³)
METRIC KILOGRAMS (m³)	150 mm	300 mm	450 mm
StormTech SC-740	3450 (2.1 m³)	4170 (2.5 m³)	4490 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



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INFILTRATION CALCULATIONS

PROJECT: REGAL COMMON'S
POND: E
DESIGNER TEW
DATE: 04/17/17

Stormtech Chamber System

SC-740	Length (f	Width (ft)	Height
unit dim	7.11	4.25	2.5
ends/side	2	2	1

Rows Columns Note: Chambers in this scenario are spred out in three locations
4 5

	Length	Width	Height
Gallery	30.44	25.25	3.5

Storage
20 Units
74.9 cf/unit

Foundatic Depth
6

1,498.00 cf Storage Provided

Bottom Area	768.61
Perimeter Area	389.83
Total Area	1158.44
Infiltration Rate	5.00E-07
Outflow	**0.0005792** cfs

in

Gravel Volume in Gallery

20 Units

Foundation Depth
2.8 cy/unit 6 in

56 cy

StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber
Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
42 (1067)	↑ 45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (940)	↓ 45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	↑ 0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	↓ 0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

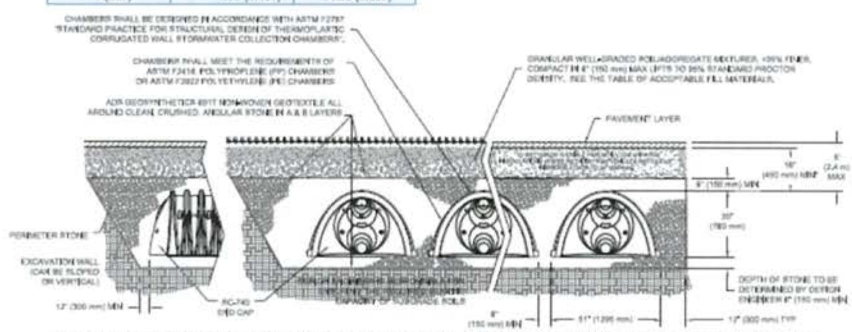
	Stone Foundation Depth		
ENGLISH TONS (yd³)	6"	12"	18"
StormTech SC-740	3.8 (2.8 yd³)	4.6 (3.3 yd³)	5.5 (3.9 yd³)
METRIC KILOGRAMS (m³)	150 mm	300 mm	450 mm
StormTech SC-740	3450 (2.1 m³)	4170 (2.5 m³)	4490 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



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INFILTRATION CALCULATIONS

PROJECT: REGAL COMMON'S
POND: F
DESIGNER TEW
DATE: 04/17/17

Stormtech Chamber System

SC-740	Length (ft)	Width (ft)	Height
unit dim	7.11	4.25	2.5
ends/side	2	2	1

Rows 5 | Columns 2 | Note: Chambers in this scenario are spred out in three locations

	Length	Width	Height
Gallery	37.55	11	3.5

Storage
10 Units
74.9 cf/unit

Foundation Depth
6 in

749.00 cf Storage Provided

Bottom Area	413.05
Perimeter Area	339.85
Total Area	752.9
Infiltration Rate	5.00E-07
Outflow	0.0003765 cfs

Gravel Volume in Gallery

10 Units
2.8 cy/unit
Foundation Depth 6 in

28 cy

StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
42 (1067)	45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (948)	45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

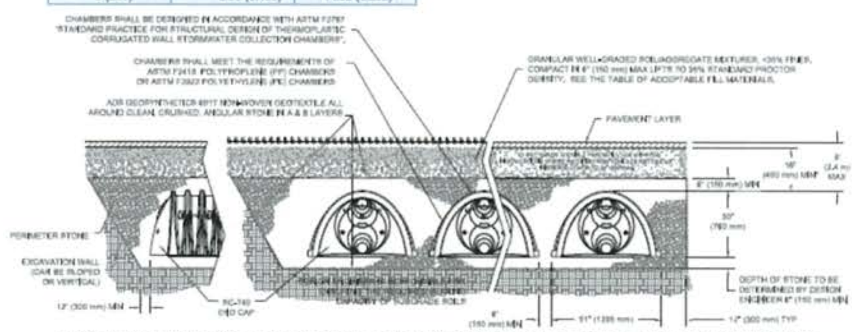
	Stone Foundation Depth		
ENGLISH TONS (yd³)	6"	12"	18"
StormTech SC-740	3.8 (2.8 yd³)	4.6 (3.3 yd³)	5.5 (3.9 yd³)
METRIC KILOGRAMS (m³)	150 mm	300 mm	450 mm
StormTech SC-740	3450 (2.1 m³)	4170 (2.5 m³)	4490 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



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INFILTRATION CALCULATIONS

PROJECT: REGAL COMMON'S
POND: G
DESIGNER TEW
DATE: 04/17/17

Stormtech Chamber System

SC-740	Length (f	Width (ft)	Height
unit dim	7.11	4.25	2.5
ends/side	2	2	1

Rows 8 Columns 2 Note: Chambers in this scenario are spred out in three locations

	Length	Width	Height
Gallery	58.88	11	3.5

Storage: 16 Units; 74.9 cf/unit; Foundation Depth 6 in

1,198.40 cf Storage Provided

Bottom Area	647.68
Perimeter Area	489.16
Total Area	1136.84
Infiltration Rate	5.00E-07
Outflow	0.0005684 cfs

Gravel Volume in Gallery

16 Units

2.8 cy/unit; Foundation Depth 6 in

44.8 cy

StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
42 (1067)	45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (940)	45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

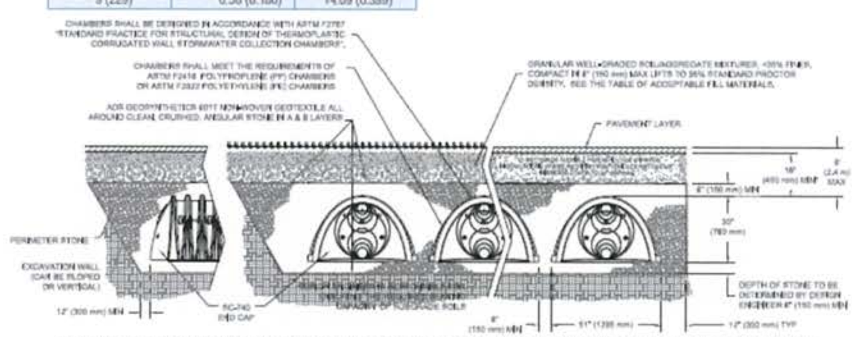
	Stone Foundation Depth		
ENGLISH TONS (yd³)	6"	12"	18"
StormTech SC-740	3.8 (2.8 yd³)	4.6 (3.3 yd³)	5.5 (3.9 yd³)
METRIC KILOGRAMS (m³)	150 mm	300 mm	450 mm
StormTech SC-740	3450 (2.1 m³)	4170 (2.5 m³)	4490 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



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INFILTRATION CALCULATIONS

PROJECT: REGAL COMMON'S
POND: H
DESIGNER TEW
DATE: 05/23/17

Stormtech Chamber System

SC-740	Length (f	Width (ft)	Height
unit dim	7.11	4.25	2.5
ends/side	2	2	1

Rows Columns Note: Chambers in this scenario are spred out in three locations
2 1

	Length	Width	Height	Storage		
Gallery	16.22	6.25	3.5	10 Units	Foundati Depth
				74.9 cf/unit	6

749.00 cf Storage Provided

Bottom Area	101.375
Perimeter Area	157.29
Total Area	258.665

Infiltration Rate 5.00E-07

Outflow **0.0001293** cfs

in

Gravel Volume in Gallery

10 Units
Foundation Depth
2.8 cy/unit 6 in

28 cy

StormTech SC-740 Chamber

SC-740 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
42 (1067)	↑ 45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (940)	↓ 45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)

SC-740 Cumulative Storage Volumes Per Chamber (cont.)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage Ft³ (m³)	Total System Cumulative Storage Ft³ (m³)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	↑ 0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone Foundation 0	4.51 (0.125)
3 (76)	0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	↓ 0	1.13 (0.032)

Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage	Chamber and Stone Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
StormTech SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% porosity.

Amount of Stone Per Chamber

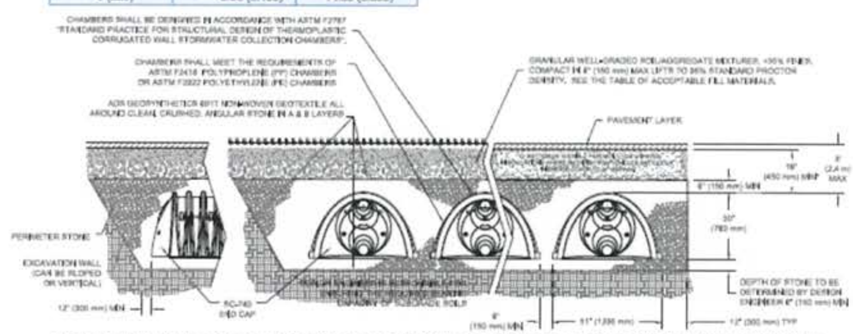
	Stone Foundation Depth		
ENGLISH TONS (yd³)	6"	12"	18"
StormTech SC-740	3.8 (2.8 yd³)	4.6 (3.3 yd³)	5.5 (3.9 yd³)
METRIC KILOGRAMS (m³)	150 mm	300 mm	450 mm
StormTech SC-740	3450 (2.1 m³)	4170 (2.5 m³)	4490 (3.0 m³)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume of Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. Volume of excavation will vary as depth of cover increases.



THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

9 Call StormTech at **860.529.8188** or **888.892.2694** or visit our website at **www.stormtech.com** for technical and product information.

SCS CALCULATIONS

WCE

Whipple Consulting Engineers, Inc

2528 N. Sullivan Road
Spokane Valley, WA 99216
Ph 509-893-2617 Fax 509-926-0227

DESIGN MEMORANDUM

TO:	DRAINAGE REPORT		
FROM:	Todd R. Whipple, PE		
DATE:	May 4, 2017		
PROJECT NO:	1537	**NAME:**	VAUGHN – COMMONS ON REGAL
REGARDING:	PIPE CALCULATION DISCUSSION		

As this project sizes the ponds using the 1815A method of the SRSM, routing through the system was sized via the SCS Curve Number method using Hydraflow Hydrographs Extension for AutoCAD. The overall intent of the system is to capture parking lot rain events in surface ponds and then treat and pass this water through SRSM treatment soil in the pond bottom or during frozen ground conditions, store the events in the pond with overflow via the control structures and pipes in each pond. Each control structure then has two outlets; one outlet is a 12-inch PVC pipe directly to the infiltrators. This pipe functions as an in and out regulating pipe. The slope into the infiltrators is 1-percent and the average length of pipe is assumed to be 5-feet.

As can be seen in the Hydrograph Return Period Recap, the largest pipe flow occurs from the control structure from Pond E to the Infiltrators under Pond C. This flow for the 100 year event is 0.479 cfs. A pipe calculation sheet is attached. This flow results in a depth of 0.37 feet in the pipe. Velocity is 2.58 fps.

As the detained storm routes through the site the pipe flow for the site is limited by a 1¼" orifice located in the discharges "Tee's" in the control structures on site. The maximum offsite storm flow 0.025 cfs per the attached storm drainage report.

Culvert Report

Pipe Flow from StormTech Chambers E to StormTech Chambers C - 100yr Storm ev

Invert Elev Dn (ft)	= 2362.65
Pipe Length (ft)	= 78.00
Slope (%)	= 4.26
Invert Elev Up (ft)	= 2365.97
Rise (in)	= 12.0
Shape	= Circular
Span (in)	= 12.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Pipe, Beveled Ring Entrance
Culvert Entrance	= 45D bevels
Coeff. K,M,c,Y,k	= 0.0018, 2.5, 0.03, 0.74, 0.2

Embankment

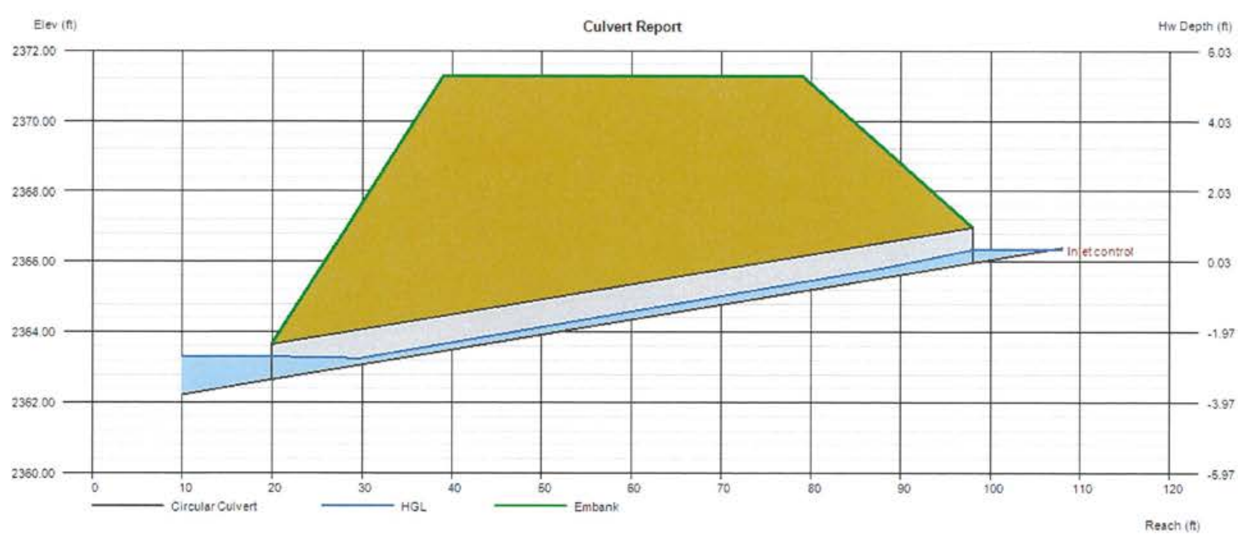
Top Elevation (ft)	= 2371.27
Top Width (ft)	= 40.00
Crest Width (ft)	= 0.00

Calculations

Qmin (cfs)	= 0.12
Qmax (cfs)	= 0.48
Tailwater Elev (ft)	= (dc+D)/2

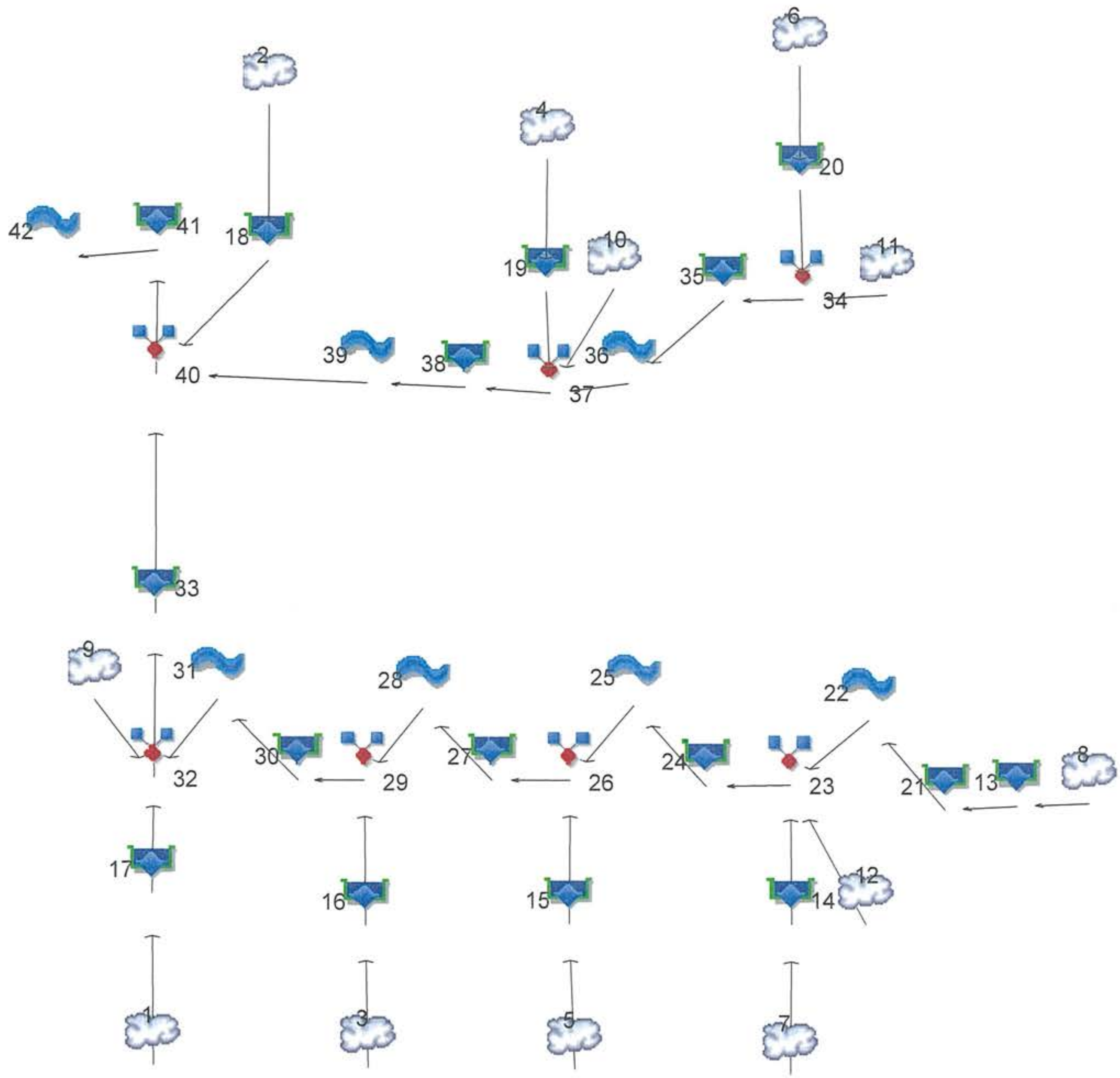
Highlighted

Qtotal (cfs)	= 0.48
Qpipe (cfs)	= 0.48
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 0.90
Veloc Up (ft/s)	= 2.58
HGL Dn (ft)	= 2363.29
HGL Up (ft)	= 2366.26
Hw Elev (ft)	= 2366.34
Hw/D (ft)	= 0.37
Flow Regime	= Inlet Control



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: 1537 2ND SUBMITTAL 1-30-17 .gpw	Monday, 03 / 6 / 2017

Legend

Hyd.	Origin	Description
1	SCS Runoff	Basin A
2	SCS Runoff	Basin B
3	SCS Runoff	Basin C
4	SCS Runoff	Basin D
5	SCS Runoff	Basin E
6	SCS Runoff	Basin F
7	SCS Runoff	Basin G
8	SCS Runoff	Basin H
9	SCS Runoff	Basin J
10	SCS Runoff	Basin K
11	SCS Runoff	Basin L
12	SCS Runoff	Basin M
13	Reservoir	Pond H
14	Reservoir	Pond G
15	Reservoir	Pond E
16	Reservoir	Pond C
17	Reservoir	Pond A
18	Reservoir	Pond B
19	Reservoir	Pond D
20	Reservoir	Pond F
21	Reservoir	CHAMBER H
22	Reach	Pipe H – Chamber G
23	Combine	Pipe H + Building M + Pond G
24	Reservoir	Chamber G
25	Reach	Pipe G – Chamber E

Hyd.	Origin	Description
26	Combine	Pipe G + Pond E
27	Reach	Chamber E
28	Reach	Pipe E – Chamber C
29	Combine	Pipe E + Pond C
30	Reservoir	Chamber C
31	Reach	Pipe C – Chamber A
32	Combine	Pipe C + Pond A + Building J
33	Reservoir	Chamber A
34	Combine	Pond F + Building L
35	Reservoir	Chamber F
36	Reach	Pipe F – Chamber D
37	Combine	Pipe F + Pond D + Building K
38	Reservoir	Chamber D
39	Reach	Pipe D – Chamber B
40	Combine	Pipe D + Pipe A + Pond B
41	Reservoir	Chamber B
42	Reach	Out to hazel's creak

Hydraflow Rainfall Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Wednesday, 05 / 24 / 2017

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	3.1790	0.1000	0.5318	--------
3	0.0000	0.0000	0.0000	--------
5	0.0000	0.0000	0.0000	--------
10	6.8534	0.1000	0.6029	--------
25	0.0000	0.0000	0.0000	--------
50	10.8789	0.1000	0.6403	--------
100	12.0329	0.1000	0.6277	--------

File name: spokane.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	1.34	0.93	0.75	0.64	0.57	0.52	0.48	0.45	0.42	0.40	0.38	0.36
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	2.57	1.70	1.33	1.12	0.98	0.88	0.80	0.74	0.69	0.65	0.61	0.58
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	3.83	2.47	1.91	1.59	1.38	1.23	1.11	1.02	0.95	0.89	0.84	0.79
100	4.33	2.82	2.19	1.83	1.59	1.42	1.29	1.19	1.10	1.03	0.97	0.92

Tc = time in minutes. Values may exceed 60.

Precip. file name: P:\WCE_WORK\DOCUMENTS\!!! A Storm Drainage File\Spokane SCS Rev 1-6-16.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	1.20	0.00	0.00	1.80	2.00	2.20	2.40
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.016	1	476	246	------	------	------	BASIN A
2	SCS Runoff	0.070	1	475	1,061	------	------	------	BASIN B
3	SCS Runoff	0.137	1	480	2,037	------	------	------	BASIN C
4	SCS Runoff	0.025	1	475	374	------	------	------	BASIN D
5	SCS Runoff	0.121	1	473	1,736	------	------	------	BASIN E
6	SCS Runoff	0.050	1	474	732	------	------	------	BASIN F
7	SCS Runoff	0.013	1	480	255	------	------	------	BASIN G
8	SCS Runoff	0.070	1	474	1,029	------	------	------	BASIN H
9	SCS Runoff	0.027	1	470	369	------	------	------	BASIN J
10	SCS Runoff	0.046	1	470	637	------	------	------	BASIN K
11	SCS Runoff	0.046	1	470	637	------	------	------	BASIN L
12	SCS Runoff	0.027	1	470	369	------	------	------	BASIN M
13	Reservoir	0.013	1	904	410	8	2373.55	635	POND H
14	Reservoir	0.000	1	n/a	0	7	2373.60	255	POND G
15	Reservoir	0.022	1	870	682	5	2370.28	1,075	POND E
16	Reservoir	0.026	1	895	832	3	2366.66	1,237	POND C
17	Reservoir	0.000	1	n/a	0	1	2366.18	246	POND A
18	Reservoir	0.012	1	1183	221	2	2365.61	855	POND B
19	Reservoir	0.005	1	993	122	4	2369.72	256	POND D
20	Reservoir	0.008	1	889	232	6	2374.11	409	POND F
21	Reservoir	0.008	1	1386	298	13	2368.85	149	CHMABER H
22	Reach	0.008	1	1386	163	21	------	------	PIPE H - CHAMBER G
23	Combine	0.027	1	470	532	12, 14, 22	------	------	PIPE H + BUILDING M + POND G
24	Reservoir	0.001	1	1387	15	23	2368.91	373	CHAMBER G
25	Reach	0.000	1	1387	0	24	------	------	PIPE G - CHABMER E
26	Combine	0.022	1	870	683	15, 25	------	------	PIPE G + POND E
27	Reservoir	0.004	1	1447	75	26	2364.55	540	CHAMBER E
28	Reach	0.002	1	1447	7	27	------	------	PIPE E - CHAMBER C
29	Combine	0.026	1	895	839	16, 28	------	------	PIPE E + POND C
30	Reservoir	0.001	1	1463	10	29	2361.17	677	CHAMBER C
31	Reach	0.000	1	1463	0	30	------	------	PIPE C - CHABMER A
32	Combine	0.027	1	470	369	9, 17, 31	------	------	PIPE C + POND A + BUILDING J
33	Reservoir	0.000	1	349	0	32	2359.62	138	CHAMBER A

1537 3rd Submittal tew 5-04-17 .gpw	Return Period: 2 Year	Wednesday, 05 / 24 / 2017

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
34	Combine	0.046	1	470	869	11, 20,	------	------	POND F + BUILDING L
35	Reservoir	0.010	1	1221	727	34	2369.57	188	CHMABER F
36	Reach	0.009	1	1221	373	35	------	------	PIPE F - CHABMER D
37	Combine	0.050	1	470	1,132	10, 19, 36	------	------	PIPE F + POND D + BUILDING K
38	Reservoir	0.008	1	1222	380	37	2364.90	704	CHACMBER D
39	Reach	0.005	1	1222	62	38	------	------	PIPE D - CHAMBER B
40	Combine	0.016	1	1222	283	18, 33, 39	------	------	PIPE D + PIPE A + POND B
41	Reservoir	0.000	1	1114	0	40	2359.78	213	CHAMBER B
42	Reach	0.000	1	1110	0	41	------	------	OUT TO HAZ'S CREAK

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.032	1	473	469	------	------	------	BASIN A
2	SCS Runoff	0.138	1	473	1,966	------	------	------	BASIN B
3	SCS Runoff	0.259	1	478	3,667	------	------	------	BASIN C
4	SCS Runoff	0.049	1	473	694	------	------	------	BASIN D
5	SCS Runoff	0.219	1	472	3,036	------	------	------	BASIN E
6	SCS Runoff	0.094	1	472	1,318	------	------	------	BASIN F
7	SCS Runoff	0.035	1	476	549	------	------	------	BASIN G
8	SCS Runoff	0.132	1	472	1,854	------	------	------	BASIN H
9	SCS Runoff	0.042	1	470	590	------	------	------	BASIN J
10	SCS Runoff	0.073	1	470	1,019	------	------	------	BASIN K
11	SCS Runoff	0.073	1	470	1,019	------	------	------	BASIN L
12	SCS Runoff	0.042	1	470	590	------	------	------	BASIN M
13	Reservoir	0.041	1	541	1,234	8	2373.56	651	POND H
14	Reservoir	0.000	1	n/a	0	7	2373.84	549	POND G
15	Reservoir	0.074	1	533	1,983	5	2370.30	1,095	POND E
16	Reservoir	0.086	1	544	2,463	3	2366.68	1,267	POND C
17	Reservoir	0.000	1	n/a	0	1	2366.33	469	POND A
18	Reservoir	0.031	1	656	1,126	2	2365.62	871	POND B
19	Reservoir	0.013	1	583	441	4	2369.73	259	POND D
20	Reservoir	0.032	1	529	809	6	2374.12	420	POND F
21	Reservoir	0.013	1	1376	1,049	13	2369.44	529	CHMABER H
22	Reach	0.013	1	1405	857	21	------	------	PIPE H - CHAMBER G
23	Combine	0.042	1	470	1,447	12, 14, 22	------	------	PIPE H + BUILDING M + POND G
24	Reservoir	0.008	1	1721	720	23	2369.23	776	CHAMBER G
25	Reach	0.007	1	1721	263	24	------	------	PIPE G - CHABMER E
26	Combine	0.074	1	533	2,246	15, 25	------	------	PIPE G + POND E
27	Reservoir	0.012	1	1449	1,160	26	2365.16	1,523	CHAMBER E
28	Reach	0.011	1	1531	725	27	------	------	PIPE E - CHAMBER C
29	Combine	0.086	1	544	3,187	16, 28	------	------	PIPE E + POND C
30	Reservoir	0.011	1	1469	1,165	29	2361.85	2,215	CHAMBER C
31	Reach	0.011	1	1692	779	30	------	------	PIPE C - CHABMER A
32	Combine	0.042	1	470	1,369	9, 17, 31	------	------	PIPE C + POND A + BUILDING J
33	Reservoir	0.004	1	2248	122	32	2360.06	776	CHAMBER A

1537 3rd Submittal tew 5-04-17 .gpw	Return Period: 10 Year	Wednesday, 05 / 24 / 2017

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
34	Combine	0.073	1	470	1,828	11, 20,	------	------	POND F + BUILDING L
35	Reservoir	0.015	1	1286	1,593	34	2370.31	784	CHMABER F
36	Reach	0.015	1	1392	1,411	35	------	------	PIPE F - CHABMER D
37	Combine	0.080	1	470	2,872	10, 19, 36	------	------	PIPE F + POND D + BUILDING K
38	Reservoir	0.015	1	1449	1,657	37	2365.36	1,441	CHACMBER D
39	Reach	0.014	1	1689	1,487	38	------	------	PIPE D - CHAMBER B
40	Combine	0.035	1	660	2,734	18, 33, 39	------	------	PIPE D + PIPE A + POND B
41	Reservoir	0.012	1	2315	1,325	40	2360.47	1,172	CHAMBER B
42	Reach	0.012	1	2341	1,309	41	------	------	OUT TO HAZ'S CREAK

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.038	1	473	547	------	------	------	BASIN A
2	SCS Runoff	0.162	1	472	2,281	------	------	------	BASIN B
3	SCS Runoff	0.300	1	478	4,231	------	------	------	BASIN C
4	SCS Runoff	0.057	1	472	805	------	------	------	BASIN D
5	SCS Runoff	0.252	1	471	3,482	------	------	------	BASIN E
6	SCS Runoff	0.109	1	472	1,521	------	------	------	BASIN F
7	SCS Runoff	0.043	1	476	657	------	------	------	BASIN G
8	SCS Runoff	0.153	1	472	2,138	------	------	------	BASIN H
9	SCS Runoff	0.048	1	470	664	------	------	------	BASIN J
10	SCS Runoff	0.082	1	470	1,147	------	------	------	BASIN K
11	SCS Runoff	0.082	1	470	1,147	------	------	------	BASIN L
12	SCS Runoff	0.048	1	470	664	------	------	------	BASIN M
13	Reservoir	0.061	1	517	1,519	8	2373.57	659	POND H
14	Reservoir	0.006	1	1370	55	7	2373.89	612	POND G
15	Reservoir	0.112	1	499	2,428	5	2370.31	1,105	POND E
16	Reservoir	0.126	1	510	3,026	3	2366.69	1,282	POND C
17	Reservoir	0.000	1	n/a	0	1	2366.39	547	POND A
18	Reservoir	0.042	1	604	1,441	2	2365.63	878	POND B
19	Reservoir	0.021	1	526	553	4	2369.73	262	POND D
20	Reservoir	0.050	1	497	1,009	6	2374.13	426	POND F
21	Reservoir	0.015	1	1379	1,311	13	2369.69	693	CHMABER H
22	Reach	0.015	1	1404	1,119	21	------	------	PIPE H - CHAMBER G
23	Combine	0.048	1	470	1,839	12, 14, 22	------	------	PIPE H + BUILDING M + POND G
24	Reservoir	0.010	1	1740	1,006	23	2369.36	949	CHAMBER G
25	Reach	0.009	1	1740	360	24	------	------	PIPE G - CHABMER E
26	Combine	0.112	1	499	2,788	15, 25	------	------	PIPE G + POND E
27	Reservoir	0.013	1	1450	1,444	26	2365.39	1,901	CHAMBER E
28	Reach	0.013	1	1523	1,160	27	------	------	PIPE E - CHAMBER C
29	Combine	0.126	1	510	4,186	16, 28	------	------	PIPE E + POND C
30	Reservoir	0.013	1	1469	1,487	29	2362.09	2,753	CHAMBER C
31	Reach	0.013	1	1661	1,426	30	------	------	PIPE C - CHABMER A
32	Combine	0.048	1	470	2,090	9, 17, 31	------	------	PIPE C + POND A + BUILDING J
33	Reservoir	0.007	1	1941	478	32	2360.12	916	CHAMBER A

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Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
34	Combine	0.088	1	494	2,156	11, 20,	------	------	POND F + BUILDING L
35	Reservoir	0.017	1	1309	1,890	34	2370.59	1,004	CHMABER F
36	Reach	0.017	1	1404	1,710	35	------	------	PIPE F - CHABMER D
37	Combine	0.089	1	470	3,410	10, 19, 36	------	------	PIPE F + POND D + BUILDING K
38	Reservoir	0.016	1	1450	1,930	37	2365.50	1,673	CHACMBER D
39	Reach	0.016	1	1675	1,834	38	------	------	PIPE D - CHAMBER B
40	Combine	0.045	1	604	3,754	18, 33, 39	------	------	PIPE D + PIPE A + POND B
41	Reservoir	0.015	1	2575	1,716	40	2360.72	1,579	CHAMBER B
42	Reach	0.015	1	2595	1,697	41	------	------	OUT TO HAZ'S CREAK

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Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.044	1	473	627	------	------	------	BASIN A
2	SCS Runoff	0.186	1	472	2,602	------	------	------	BASIN B
3	SCS Runoff	0.343	1	478	4,800	------	------	------	BASIN C
4	SCS Runoff	0.066	1	472	918	------	------	------	BASIN D
5	SCS Runoff	0.285	1	470	3,931	------	------	------	BASIN E
6	SCS Runoff	0.124	1	471	1,725	------	------	------	BASIN F
7	SCS Runoff	0.051	1	475	768	------	------	------	BASIN G
8	SCS Runoff	0.175	1	471	2,426	------	------	------	BASIN H
9	SCS Runoff	0.053	1	470	738	------	------	------	BASIN J
10	SCS Runoff	0.091	1	470	1,276	------	------	------	BASIN K
11	SCS Runoff	0.091	1	470	1,276	------	------	------	BASIN L
12	SCS Runoff	0.053	1	470	738	------	------	------	BASIN M
13	Reservoir	0.103	1	487	1,807	8	2373.58	675	POND H
14	Reservoir	0.009	1	1159	166	7	2373.89	613	POND G
15	Reservoir	0.214	1	482	2,877	5	2370.33	1,130	POND E
16	Reservoir	0.226	1	492	3,596	3	2366.72	1,314	POND C
17	Reservoir	0.000	1	n/a	0	1	2366.44	627	POND A
18	Reservoir	0.062	1	537	1,762	2	2365.63	890	POND B
19	Reservoir	0.031	1	497	666	4	2369.74	264	POND D
20	Reservoir	0.096	1	482	1,212	6	2374.14	439	POND F
21	Reservoir	0.017	1	1377	1,577	13	2369.97	869	CHMABER H
22	Reach	0.017	1	1400	1,385	21	------	------	PIPE H - CHAMBER G
23	Combine	0.053	1	470	2,290	12, 14, 22	------	------	PIPE H + BUILDING M + POND G
24	Reservoir	0.011	1	1737	1,249	23	2369.53	1,167	CHAMBER G
25	Reach	0.011	1	2053	934	24	------	------	PIPE G - CHABMER E
26	Combine	0.214	1	482	3,811	15, 25	------	------	PIPE G + POND E
27	Reservoir	0.015	1	1450	1,794	26	2365.64	2,293	CHAMBER E
28	Reach	0.015	1	1518	1,756	27	------	------	PIPE E - CHAMBER C
29	Combine	0.226	1	492	5,352	16, 28	------	------	PIPE E + POND C
30	Reservoir	0.015	1	1470	1,765	29	2362.34	3,301	CHAMBER C
31	Reach	0.015	1	1641	1,697	30	------	------	PIPE C - CHABMER A
32	Combine	0.053	1	470	2,435	9, 17, 31	------	------	PIPE C + POND A + BUILDING J
33	Reservoir	0.008	1	2880	629	32	2360.20	1,095	CHAMBER A

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Hydrograph Summary Report

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Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
34	Combine	0.174	1	480	2,487	11, 20,	------	------	POND F + BUILDING L
35	Reservoir	0.019	1	1330	2,180	34	2370.87	1,231	CHMABER F
36	Reach	0.018	1	1416	2,011	35	------	------	PIPE F - CHABMER D
37	Combine	0.099	1	470	3,952	10, 19, 36	------	------	PIPE F + POND D + BUILDING K
38	Reservoir	0.018	1	1450	2,170	37	2365.65	1,912	CHACMBER D
39	Reach	0.017	1	1662	2,064	38	------	------	PIPE D - CHAMBER B
40	Combine	0.064	1	538	4,455	18, 33, 39	------	------	PIPE D + PIPE A + POND B
41	Reservoir	0.018	1	2880	2,027	40	2360.93	1,916	CHAMBER B
42	Reach	0.018	1	2880	2,008	41	------	------	OUT TO HAZ'S CREAK

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	0.050	1	472	708	------	------	------	BASIN A
2	SCS Runoff	0.210	1	472	2,925	------	------	------	BASIN B
3	SCS Runoff	0.385	1	477	5,375	------	------	------	BASIN C
4	SCS Runoff	0.074	1	472	1,032	------	------	------	BASIN D
5	SCS Runoff	0.318	1	470	4,383	------	------	------	BASIN E
6	SCS Runoff	0.140	1	471	1,932	------	------	------	BASIN F
7	SCS Runoff	0.059	1	474	882	------	------	------	BASIN G
8	SCS Runoff	0.196	1	471	2,717	------	------	------	BASIN H
9	SCS Runoff	0.058	1	469	813	------	------	------	BASIN J
10	SCS Runoff	0.100	1	469	1,404	------	------	------	BASIN K
11	SCS Runoff	0.100	1	469	1,404	------	------	------	BASIN L
12	SCS Runoff	0.058	1	469	813	------	------	------	BASIN M
13	Reservoir	0.171	1	481	2,097	8	2373.60	697	POND H
14	Reservoir	0.011	1	1013	280	7	2373.89	615	POND G
15	Reservoir	0.299	1	480	3,330	5	2370.35	1,149	POND E
16	Reservoir	0.337	1	486	4,170	3	2366.74	1,344	POND C
17	Reservoir	0.000	1	n/a	0	1	2366.49	708	POND A
18	Reservoir	0.083	1	518	2,085	2	2365.64	901	POND B
19	Reservoir	0.058	1	482	780	4	2369.75	269	POND D
20	Reservoir	0.130	1	480	1,416	6	2374.15	447	POND F
21	Reservoir	0.018	1	1380	1,845	13	2370.27	1,055	CHMABER H
22	Reach	0.018	1	1400	1,653	21	------	------	PIPE H - CHAMBER G
23	Combine	0.058	1	469	2,747	12, 14, 22	------	------	PIPE H + BUILDING M + POND G
24	Reservoir	0.013	1	1747	1,460	23	2369.69	1,385	CHAMBER G
25	Reach	0.012	1	2031	1,334	24	------	------	PIPE G - CHABMER E
26	Combine	0.299	1	480	4,664	15, 25	------	------	PIPE G + POND E
27	Reservoir	0.017	1	1451	2,042	26	2365.90	2,698	CHAMBER E
28	Reach	0.017	1	1514	2,000	27	------	------	PIPE E - CHAMBER C
29	Combine	0.337	1	486	6,170	16, 28	------	------	PIPE E + POND C
30	Reservoir	0.016	1	1470	2,001	29	2362.60	3,856	CHAMBER C
31	Reach	0.016	1	1627	1,932	30	------	------	PIPE C - CHABMER A
32	Combine	0.058	1	469	2,745	9, 17, 31	------	------	PIPE C + POND A + BUILDING J
33	Reservoir	0.009	1	2880	816	32	2360.24	1,202	CHAMBER A

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Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
34	Combine	0.224	1	478	2,820	11, 20,	------	------	POND F + BUILDING L
35	Reservoir	0.020	1	1346	2,424	34	2371.18	1,462	CHMABER F
36	Reach	0.020	1	1426	2,313	35	------	------	PIPE F - CHABMER D
37	Combine	0.154	1	480	4,497	10, 19, 36	------	------	PIPE F + POND D + BUILDING K
38	Reservoir	0.019	1	1450	2,386	37	2365.80	2,157	CHACMBER D
39	Reach	0.019	1	1653	2,273	38	------	------	PIPE D - CHAMBER B
40	Combine	0.085	1	519	5,174	18, 33, 39	------	------	PIPE D + PIPE A + POND B
41	Reservoir	0.020	1	2880	2,328	40	2361.17	2,305	CHAMBER B
42	Reach	0.020	1	2880	2,308	41	------	------	OUT TO HAZ'S CREAK

HAZEL'S CREEK SUB-BASIN PLANNING AND SCHEMATIC DESIGN REPORT

Hazel's Creek Sub-basin Planning & Schematic Design

PREPARED FOR: Mr. Bill Peacock, P.E.
City of Spokane, Wastewater
Management Department

PREPARED BY: Mark Brower, P.E.

DATE: April 26, 2012

Background and Purpose

This memorandum serves to report on the planning and schematic design of a regional stormwater management system within the Hazel's Creek (HC) sub-basin. The Hazel's Creek sub-basin is located on the plateau of Spokane's south hill. The project location and sub-basin area is provided on ***Attachment A – Figure 1***.

Purpose and Objectives

The purpose of this project is to develop a regional stormwater management system, upstream of the Hazel's Creek Regional Drainage and Conservation Area (HCRDCA) that:

- Takes advantage of downstream infiltration capacity for stormwater disposal at HCRDCA to accept outflow of 1.5 GPM/Acre for developing infill parcels
- Concepts provide alternatives to utilize the existing evaporative ponds on 55th/57th and the KXLY A.M. Antenna Site as locations for stormwater facilities
- Allows for multiple site uses for regional stormwater facilities, consistent with Comprehensive Plan, and developer agreements, such as bike/pedestrian trails, viewscapes, etc.
- Sets the stage for economic development by reducing the amount of high value commercial infill land required to serve stormwater purposes via evaporative ponds
- Allows for flexibility to implement in phases as needed to meet demand.

Additional key benefits for implementing a regional stormwater management system within the HC sub-basin include:

- Opportunity to accommodate properties along the 57th Street Corridor, from Palouse Highway to the Spokane County evaporation ponds, west of Regal Street.
- Maximum allowable peak flows of 1.5 PM/Acre for developing parcels helps manage basin-wide infrastructure size requirements and capital costs (detention pond sizes, conveyance sizes).
- Avoids exacerbation of known groundwater issues through use of piped conveyance and lined ponds.
- Opportunity to convert Spokane County evaporation ponds to detention ponds, minimizing the footprint of standing water, and thereby improving vector control, safety, etc.
- Creates opportunities to for development of multiple infrastructure improvements, such as:
  - Bicycle/pedestrian trails for neighborhood connectivity
  - Public spaces such as soccer fields, walking paths, interpretive sites, view corridors, etc. at the KXLY Antenna site
  - A safe 4-Way intersection at Regal Street and Palouse Highway

Technical Requirements Summary

In 2008, WHPacific, Inc. (under agreement with the City of Spokane and KXLY) conducted a site master plan study for the KXLY antenna site, whereby specific parameters for regional stormwater facilities have been defined. See ***Attachment B – "Altamont Stormwater Area Pond Project – Technical Requirements Summary, WHPacific, July 30, 2008."*** These parameters were reviewed to ensure they are current, and were subsequently leveraged for development of the schematic concepts defined herein, *with modifications as described below.*

Hydrology and Downstream Disposal

Managed Peak Flow Rates. Since the 2008 WHPacific study was complete, the City of Spokane has undertaken studies of the HCRDCA to ascertain a better understanding of the capacity of the regional stormwater treatment and infiltration facility to handle basin inflows. Once this was understood, the City distributed the capacity over the sub-basin area to determine the maximum peak flow rates that could be accepted at the site from any given site development project. The result was 1.5 gallons/minute/acre (GPM/Acre).

The ability for commercial projects to discharge at this pre-determined rate will allow them to construct detention ponds for stormwater control rather than evaporative ponds, which traditionally occupy 30%-40% of the developed parcel. Stormwater treatment will still be required with the detention ponds, and may be either integrated into the detention ponds, or designed as a standalone treatment process.

Further, this determined rate helps the City manage regional stormwater management infrastructure capital costs, by managing the sizes of conveyance and detention facilities to handle mitigated peak flows, rather than uncontrolled peak flow rates.

For the purpose of this study, parcels that have been identified as likely to develop or redevelop have been analyzed as contributing flows of 1.5 GPM/Acre. Existing street systems and existing contributing sites that are not targeted for redevelopment are assumed to be contributing at full-force peak flow rates.

Contributing Areas. Since the 2008 WHPacific study was complete, the City of Spokane has been working with developers to implement stormwater solutions using the managed peak flow rates and onsite treatment and detention Best Management Practices (BMPs). Developments have primarily been focused east of Regal Street, and north of 57th Avenue. Infrastructure has been designed and developed to direct flows from recent development to existing storm mains in Regal Street, and directly north to the HCRDCA. This infrastructure may serve other developing parcels in this sub-area.

Contributing parcels under consideration for this study are primarily located adjacent to the 57th Ave. corridor or are west of Regal Street, between 57th Ave. and 43rd Ave. Contributing parcels considered are shown in ***Attachment A – Figure 2.*** Stormwater calculations are provided in ***Attachment C.***

Implementation Flexibility. The City of Spokane would like to be as flexible as possible to accommodate market-driven commercial development opportunities within the sub-basin. As such, the City would like to leverage as much of the existing infrastructure as practicable, including conveyance systems and Spokane County's evaporation ponds. Opportunities to leverage these facilities to quickly respond to stormwater needs must be considered. For example, the County's existing evaporation ponds may be used as a 'pass-through' facility, where 1.5 gpm is released for each acre of commercial property that is developed within the subbasin and connected to the County's 57th Avenue piping system.

Regional Stormwater Facilities

Groundwater at KXLY Antenna Site. Due to seasonal presence of high groundwater on the KXLY Antenna Site the pond bottoms must be covered with an impermeable liner, and constructed above the seasonal high groundwater elevation. Seasonal groundwater may reach as high as 2-feet below ground surface at locations on the site[1].

[1] Geotechnical Engineering Evaluation – Proposed Altamont Stormwater Detention Ponds, GeoEngineers, February 12, 2009

KXLY Site Constraints. Previous studies[2] and ongoing dialogue with KXLY operations personnel have provided a comprehensive understanding of the physical and operational constraints associated with the KXLY antenna site. Overall, the site is well suited for secondary use as a regional stormwater facility in that it is relatively flat, and is located in the historic natural drainage path. There is shallow rock located in the NE corner of the site, and seasonally fluctuating perched groundwater[1].

Operationally, two significant A.M. radio antenna towers occupy the site and function as an emergency broadcasting facility. The towers are surrounded by security fencing. The two towers have significant foundations, and have bare copper grounding wires that radiate out from the antenna bases 350', approximately 6 to 10 inches below the ground surface. There is a communications and power corridor that extends from the operations/maintenance building to the antennae, and maintenance access to the towers will need to be maintained. KXLY has indicated that the presence of surface water near the antenna bases serves to boost the AM signal. KXLY operations personnel must be directly involved with any proposed project on the site.

Implementation Concepts

Three stormwater management solutions were identified to meet the aforementioned goals and objectives of the project:

- Concept 1: Pumped Bypass to Regal Main
- Concept 2: Gravity Route to Regal Main via KXLY Antenna Site
- Concept 3: Stormwater Facilities at KXLY Antenna Site

The phase solutions are described in detail as follows.

Concept 1: Pumped Bypass to Regal Main

Concept 1 consists of modifying the existing County lined evaporation ponds at 57th and/or 55th Avenues so that additional flows from new commercial development are passed through the ponds. This would be achieved by constructing a discharge outlet, as well as conveyance piping that would tie them to the existing stormwater main in Regal Street. ***Attachment A, Figure 3*** provides an overview of this concept.

The elevation of the Regal Street stormwater main is higher than the outlet elevation for the ponds. A pump will be necessary to convey the flows to the Regal Street main. The pumped outlet system will allow for flexibility to manage outflow rates for the ponds as desired.

Within Concept 1, there are two alternatives for the location of the discharge outlet and the conveyance route to the Regal Street stormwater main:

- Alternative 1: Outlet to 57th pond only, on 55th Avenue
- Alternative 2: Outlet to 57th and 55th ponds, on 53rd Avenue

Both alternatives are favorable to provide additional stormwater capacity for development needs. Locating the outlet on 53rd Avenue provides the additional benefit of being able to manage the available stormwater capacity across both sites, such that pond sizes and locations may be altered as needed for possible complementary or alternate site uses.

Key Benefits. Implementation of Concept 1 provides the following benefits:

- Relatively low capital cost.
- Allows for rapid response to developer capacity needs on 57th corridor.
- Allows for reconfiguration of 57th/55th pond sites for alternative and/or complementary site uses, such as non-motorized connectivity, or other public uses.
- Potential to drain the ponds after storm events, reducing standing water issues.

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[2] Altamont Stormwater Area Project – Pond and Site Use Concepts, WHPacific, Inc., November 26, 2008

- Leverages available capacity in existing facilities, and at the HCRDCA.

Key Technical Issues. The following technical issues will need to be addressed during implementation of Concept 1:

- Capacity of Regal Street stormwater main. This facility was designed with 30% spare capacity. Analyses will be required as new inputs to the system are planned to ensure spare capacity is available.
- Capacity of the 57th Avenue stormwater main. The existing conveyance main in 57th Avenue varies in size from 18" to 30". Previous studies of this conveyance indicate that additional capacity exists. See ***Attachment D – "Capacity Analysis – 57th Ave. Stormwater Conveyance System, WHPacific, August, 2007."*** Analyses will be required as new inputs to the system are planned to ensure spare capacity is available.
- Sizing of stormwater pumping system. Elements of the pumping system, such as the wet well and force main, must be sized to accommodate increasing flows as additional properties are developed in the subbasin. It is likely that the pumps themselves will be replaced and upsized as this development occurs.

Concept 2: Gravity Route to Regal Main via KXLY Antenna Site

Concept 2 consists of converting the existing County lined evaporation ponds at 57th and/or 55th Avenues to detention facilities by providing an gravity outlet and conveyance pipe that would tie the ponds to the existing stormwater main in Regal Street via an easement through the KXLY Commercial Site. ***Attachment A, Figure 4*** provides an overview of this concept.

With this option, the outlet conveyance from the 55th/57th ponds would be sized to convey, by gravity, the 1.5 GPM/Acre peak flows from the ultimate assumed build-out condition which would include all of the contributing parcels identified in ***Attachment A, Figure 2***. The conveyance would direct flows from the ponds to the KXLY Antenna site via Smith Court. The flows may combine with direct stormwater discharge flows from the KXLY Commercial site in an appropriately-sized detention pond.

Key Benefits. Implementation of Concept 2 provides the following benefits:

- Moderate capital cost with managed conveyance flows and infrastructure sizes, potentially offset by significant capacity for development, and associated revenues.
- Allows for meeting developer capacity needs on 57th corridor, 55th/53rd corridors, and the KXLY and Black Commercial sites on Regal Street.
- Allows for potential elimination of 57th pond and reconfiguration of 55th pond site for alternative and/or complimentary site uses, such as non-motorized connectivity, or higher uses.
- Potential to drain the ponds after storm events, reducing standing water issues.
- Leverages capacity in existing facilities, and at the HCRDCA.
- Allows for complementary site uses for KXLY Antenna site, consistent with the City's Comprehensive Plan.
- Allows for potential use of stormwater in a year-round irrigation pond site amenity.
- No need for a stormwater pump station.

Key Technical Issues. The following technical issues will need to be addressed during implementation of Concept 2:

- Capacity of Regal Street stormwater main. This facility was designed with 30% spare capacity. Analyses will be required as new inputs to the system are planned to ensure spare capacity is available.
- Capacity of the 57th Avenue stormwater main. The existing conveyance main in 57th Avenue varies in size from 18" to 30". Previous studies of this conveyance indicate that additional capacity exists. See ***Attachment D – "Capacity Analysis – 57th Ave. Stormwater Conveyance System, WHPacific, August, 2007."*** Analyses will be required as new inputs to the system are planned to ensure spare capacity is available.
- KXLY site constraints. As previously discussed, physical constraints at the KXLY site, such as shallow bedrock and groundwater will need to be considered. Further, operational constraints such as antenna security, electrical and communications pathways, maintenance access needs, and antenna grounding infrastructure will need to be considered.

Concept 3: Stormwater Facilities at KXLY Antenna Site

Concept 3 consists of converting the existing County lined evaporation ponds at 57th and/or 55th Avenue to much smaller detention facilities (or eliminating them entirely), by providing a gravity outlet and conveyance pipe that would extend the piping system in 57th Avenue to new ponds on the KXLY Commercial Site. ***Attachment A, Figure 5*** provides an overview of this concept.

With this concept, the 55th/57th ponds may be partially or completely replaced with new stormwater detention facilities on the KXLY antenna site. Gravity conveyance would carry flows from 57th through the 55th/57th pond sites, then via Smith Court to the KXLY antenna site. Conveyance would be sized to carry 100-year peak flows from all of the contributing parcels, as described in ***Attachment A, Figure 2***. The ponds would be sized to manage 25-year peak flow volumes, and would discharge to the Regal Street stormwater main at a maximum rate of 1.5GPM/Acre of total contributing area.

Key Benefits. Implementation of Concept 3 provides the following benefits:

- High capital costs, potentially offset by significant capacity for development, and associated revenues.
- Opportunity to free up evaporation pond parcels on 55th/57th for higher uses, and associated revenues.
- Allows for meeting developer capacity needs on 57th corridor, 55th/53rd corridors, and the KXLY and Black Commercial sites on Regal Street.
- Leverages capacity in existing facilities, and at the HCRDCA.
- Allows for complementary site uses for KXLY Antenna site, consistent with City's Comprehensive Plan.
- Allows for potential use of stormwater in a year-round irrigation pond site amenity.
- No need for a stormwater pump station.

Key Technical Issues. The following technical issues will need to be addressed during implementation of Concept 3:

- Capacity of Regal Street stormwater main. This facility was designed with 30% spare capacity. Analyses will be required as new inputs to the system are planned to ensure spare capacity is available.
- Capacity of the 57th Avenue stormwater main. The existing conveyance main in 57th Avenue varies in size from 18" to 30". Previous studies of this conveyance indicate that additional capacity exists. See ***Attachment D – "Capacity Analysis – 57th Ave. Stormwater Conveyance System, WHPacific, August, 2007."*** Analyses will be required as new inputs to the system are planned to ensure spare capacity is available.

- KXLY site constraints. As previously discussed, physical constraints at the KXLY site, such as shallow bedrock and groundwater will need to be considered. Further, operational constraints such as antenna security, electrical and communications pathways, maintenance access needs, and antenna grounding infrastructure will need to be considered.

Budget-Level Cost Estimates

Budget-level cost estimates were prepared for each of the Concepts described, and are summarized in Table 1. Cost estimates for each Concept are mutually exclusive, and do not account for accomplishment of work on a previous Concept. Detailed cost estimates are provided in ***Attachment E.***

TABLE 1
Budget-Level Cost Estimate Summary

	Concept 1	Concept 2	Concept 3
Construction Cost[a]	$158,000	$765,000	$1,524,000
Design & Construction Management	$28,000	$138,000	$274,000
TOTAL COST BUDGET	**$186,000**	**$903,000**	**$1,798,000**

[a] Costs to not include relocation of KXLY/Spokane Radio Infrastructure or implementation of complimentary site uses/amenities, including non-motorized facilities, playfields, irrigation pond, etc.

Stakeholder Coordination & Public Outreach Summary

A public-private stakeholder group was assembled and met regularly throughout this brief planning and schematic design effort. The group consisted of City staff and management from several departments, including Wastewater, Parks, Economic Development, Legal, and Finance. The group also included developer representatives from NAI Black and KXLY. The group developed and refined the project goals and objectives, and collaborated on a number of technical, political, and financial issues surrounding this effort. The group held coordination meetings on the following dates:

- August 24, 2011
- September 28, 2011
- November 2, 2011
- December 7, 2011

In addition, members of the stakeholder group attended a Southgate Neighborhood Association meeting on October 12, 2011. At this meeting, an overview of the proposed storm drainage concept was presented by Doug Busko, CH2M HILL.

Available coordination meeting notes are provided in ***Attachment F***.

ATTACHMENT A

FIGURES

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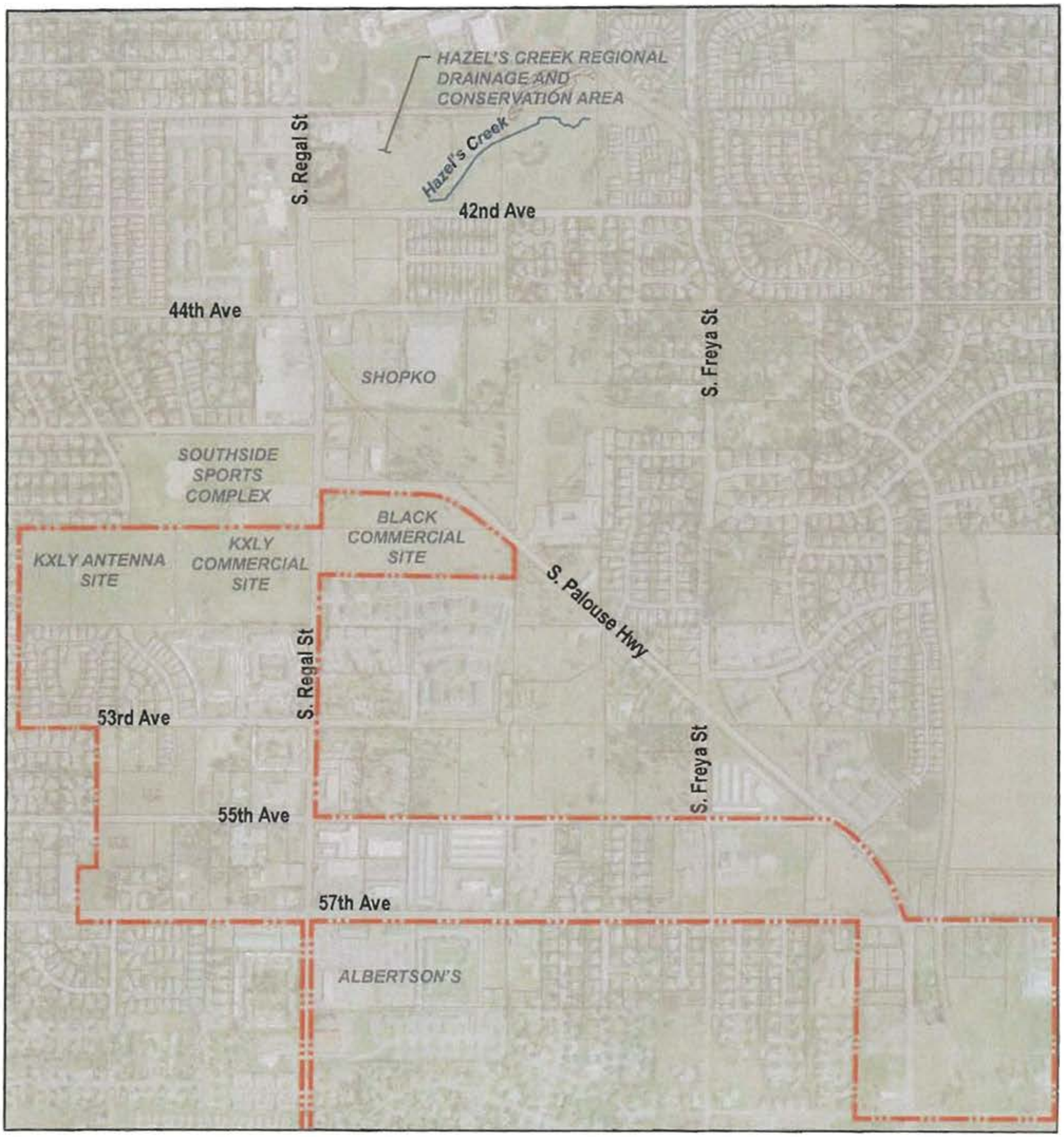


LEGEND:

Basin Boundary

North

0 300 600 900

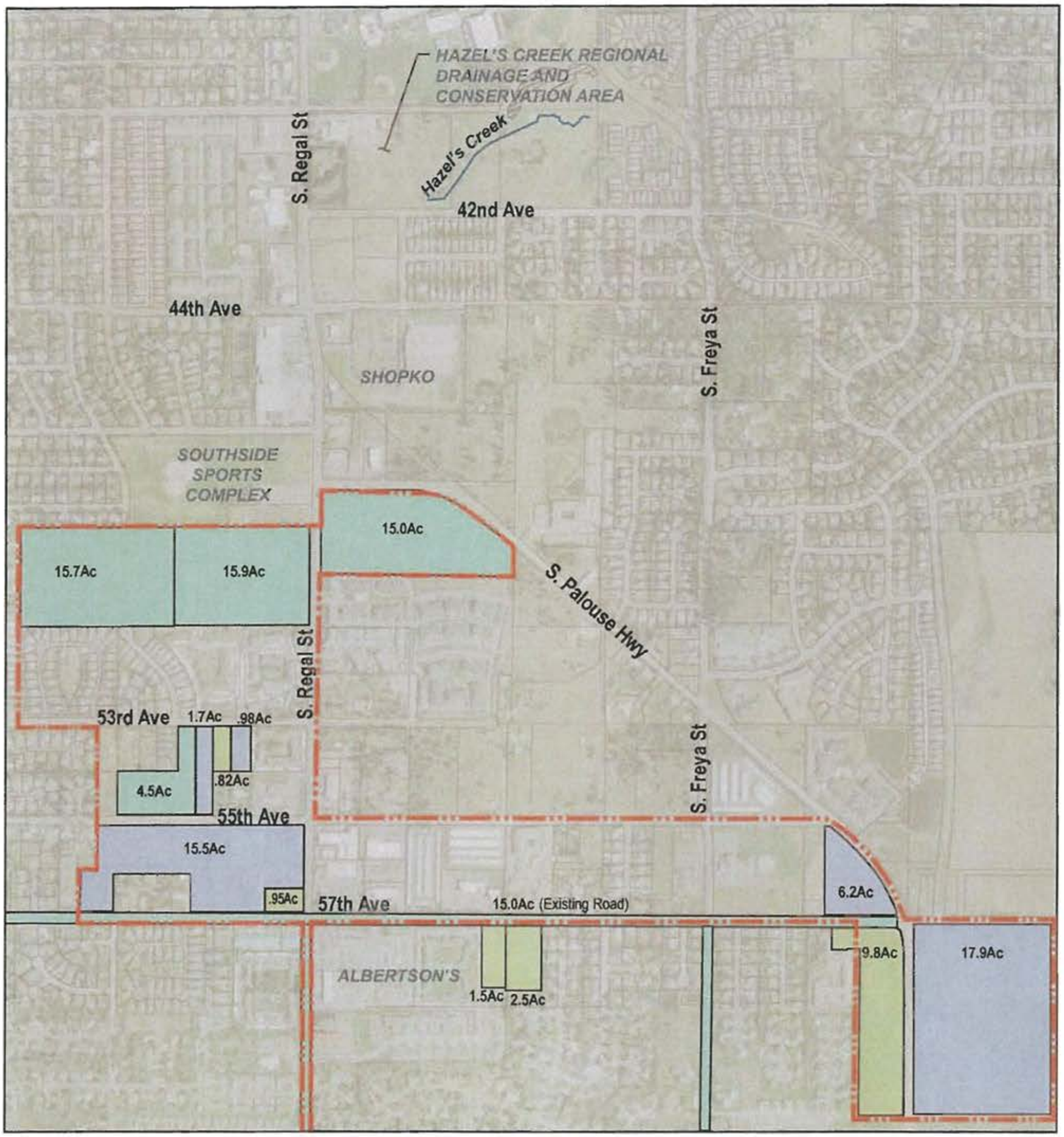
Approximate scale in feet

CH2MHILL.

FIGURE 1
Project Vicinity Map
City of Spokane

WBG101011024354SPK

CH2MHILL



LEGEND:

Land Type	Peak Flow Assumptions
Redevelop	1.5 GMP/Acre
Undeveloped	1.5 GMP/Acre
To Be Developed	Full Development Flow

CITY OF SPOKANE

CH2MHILL.

FIGURE 2
Contributing Areas Plan
City of Spokane

CH2MHILL

WBG101011024354SPK

UIC REPORT

DEPARTMENT OF ECOLOGY State of Washington

Underground Injection Control

Non-Municipal Stormwater

For UIC stormwater wells used along roads and in parking lots not owned by a county or city.

Registration Status

Site Number: 33511
Authorization Status: Pending
Comments:

Facility/Site Information

Facility Name: CommonsRegal
Address: 5415 S Regal Street
PO Box/Suite/Building:
City: Spokane
State: WA **ZIP:** 99223
Phone: 509-321-2002
County: Spokane
Facility Site ID:

Contact Information

Well Owner
Name: Cyrus Vaughn
Organization: C & O Vaughn Development
Address: 1311 N Washington
PO Box/Suite/Building:
City: Spokane
State: WA **ZIP:** 99201
E-mail:
Phone: 509-321-2002

Property Owner
Name: Cyrus Vaughn
Organization: C & O Vaughn Development
Address: 1311 N Washington
PO Box/Suite/Building:
City: Spokane
State: WA **ZIP:** 99201
E-mail:
Phone: 509-321-2002

Technical Contact
Name: Todd Whipple
Organization: Whipple Consulting Engineers
Address: 2528 N Sullivan Rd
PO Box:
City: Spokane Valley
State: WA **ZIP:** 99216
E-mail: toddw@whipplece.com
Phone: 509-893-2617

Main Well Information

Well Name	Right-of-way Location	Construction Date	EPA Well Type	Status	UIC Construction Type	Depth of UIC Well (ft.)	Latitude	Longitude
08		10/14/2017	5H1 - Stormwater	Proposed	StormTech Chambers	7	47.604188	-117.367400
07		10/14/2017	5H1 - Stormwater	Proposed	StormTech Chambers	7	47.604212	-117.367970
06		10/14/2017	5H1 - Stormwater	Proposed	StormTech Chambers	7	47.604720	-117.637040
05		10/14/2017	5H1 - Stormwater	Proposed	StormTech Chambers	7	47.604743	-117.368170
04		10/14/2017	5H1 - Stormwater	Proposed	StormTech Chambers	7	47.605051	-117.367070
03		10/14/2017	5H1 - Stormwater	Proposed	StormTech Chambers	7	47.605228	-117.368120
02		10/14/2017	5H1 - Stormwater	Proposed	StormTech Chambers	7	47.605662	-117.367420
01		10/14/2017	5H1 -	Proposed	StormTech Chambers	7	47.605696	-117.367760

Main Well Information (continued)

Well Name	IT constructed in accordance with approved stormwater manual?	Within 1000 feet of surface water?	Within 100 feet of a drinking water well or spring?	Zoning	Within a Ground Water Protection Area?
08		N	N	Commercial	Sole Source Aquifer
07		N	N	Commercial	Sole Source Aquifer
06		N	N	Commercial	Sole Source Aquifer
05		N	N	Commercial	Sole Source Aquifer
04		N	N	Commercial	Sole Source Aquifer
03		N	N	Commercial	Sole Source Aquifer
02		N	N	Commercial	Sole Source Aquifer
01		N	N	Commercial	Sole Source Aquifer

Wells Constructed on or after 2/3/2006 (Excluding Infiltration Trenches)

Well Name	Type of Drainage Area	At least five feet between the well and the water table?	Treatment capacity of the vadose zone from Table 5.2	Pollutant loading classification from Table 5.3	Treatment from Table 5.4	Treatment selected from stormwater manual
08	Parking lot or Driveway, Non Pollutant Roof	Y	High	Medium	Pretreatment, Remove Soilds, Remove Oil	Bioretention Swale
07	Parking lot or Driveway, Non Pollutant Roof	Y	High	Medium	Pretreatment, Remove Soilds, Remove Oil	Bioretention Swale
06	Parking lot or Driveway, Non Pollutant Roof	Y	High	Medium	Pretreatment, Remove Soilds, Remove Oil	Bioretention Swale
05	Parking lot or Driveway, Non Pollutant Roof	Y	High	Medium	Pretreatment, Remove Soilds, Remove Oil	Bioretention Swale
04	Parking lot or Driveway, Non Pollutant Roof	Y	High	Medium	Pretreatment, Remove Soilds, Remove Oil	Bioretention Swale
03	Parking lot or Driveway, Non Pollutant Roof	Y	High	Medium	Pretreatment, Remove Soilds, Remove Oil	Bioretention Swale
02	Parking lot or Driveway, Non Pollutant Roof	Y	High	Medium	Pretreatment, Remove Soilds, Remove Oil	Bioretention Swale
01	Parking lot or Driveway, Non Pollutant Roof	Y	High	Medium	Pretreatment, Remove Soilds, Remove Oil	Bioretention Swale

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UIC Version: 2.4.1

UIC Registration Signature Page

Site Number/ID: 33511

I hereby certify that the information contained in the above referenced registration is true and correct to the best of my knowledge.

Elliott Whipple
Name of legally authorized representative

[signature]
Signature of legally authorized representative

Engineering Tech
Title

04/18/17
Date

Please return this signed and dated signature page, along with any required documentation, to:

Washington State Department of Ecology
ATTN: UIC Coordinator, Water Quality Program
P.O. Box 47600
Olympia, WA 98504-7600

- or -

Fax to: (360) 407-6426

- or -

Scan and email to: maha461@ecy.wa.gov

GEOTECHNICAL REPORT

Proposed South Regal Street Commercial Development
South Regal Street and East 55th Avenue
Spokane, Washington

for
Vaughn's 57th Avenue, LLC
c/o Cornerstone Property Advisors, LLC

January 22, 2014

GeoEngineers
Earth Science + Technology

Preliminary Geotechnical Evaluation

Proposed South Regal Street Commercial Development
South Regal Street and East 55th Avenue
Spokane, Washington

for

Vaughn's 57th Avenue, LLC
c/o Cornerstone Property Advisors, LLC

January 22, 2014

GeoEngineers
523 East Second Avenue
Spokane, Washington 99202
509.363.3125

Preliminary Geotechnical Evaluation

Proposed South Regal Street Commercial Development
South Regal Street and East 55th Avenue
Spokane, Washington

File No. 21349-001-00

January 22, 2014

Prepared for:

Vaughn's 57th Avenue, LLC
c/o Cornerstone Property Advisors, LLC
1311 North Washington Street, Suite C
Spokane, Washington 99201

Attention: Guy Byrd, Property Manager

Prepared by:

GeoEngineers, Inc.
523 East Second Avenue
Spokane, Washington 99202
509.363.3125

David R. Lauder, PE
Senior Engineer

James B. Harakas, PE, LEG
Senior Principal

DAVID RYAN LAUDER
STATE OF WASHINGTON
42304
REGISTERED
PROFESSIONAL ENGINEER
1/22/14

cc: Paul Shelton, Construction Management & Forensics

DRL:JBH:tjh

GEOENGINEERS

Table of Contents

INTRODUCTION

This report presents the results of our preliminary geotechnical evaluation of property at the corner of South Regal Street and East 55th Avenue in Spokane, Washington. The project site is located at the northeast corner of the above-noted intersection, approximately as shown on the Vicinity Map, Figure 1.

We understand development of the five properties totaling approximately 8.6 acres (Spokane County tax parcels 34032.0480, 34032.0447, 34032.0446, 34032.0412, and 34032.0481) will be commercial in nature. More detailed information regarding the proposed development was not available at the time we prepared this report.

SCOPE OF SERVICES

The scope of services for this evaluation was presented in our revised proposal dated December 11, 2013. The purpose of our services was to assess subsurface conditions and provide preliminary geotechnical data sufficient for conceptual-level design purposes. Our services were authorized on December 13, 2013. Our specific scope of services included:

1. Review of information in our files and information that is readily available in the published literature regarding soil, rock and groundwater conditions in the site vicinity.
2. Notification of the one-call underground utility notification service in advance of our on-site explorations, in accordance with state regulations.
3. Exploration of soil and groundwater conditions beneath the subject property by excavating nine test pits.
4. Limited laboratory testing to assess select physical properties of the soil encountered.
5. A preliminary assessment of the feasibility of supporting proposed structures on conventional spread foundations. We also provide an assessment of the feasibility of on-site disposal of stormwater based on results of our exploration and lab testing programs, and geotechnical issues that should be considered during design.

SITE CONDITIONS

General

Soil, rock and groundwater conditions at the site were explored on December 30, 2013 by excavating nine test pits (TP-1 through TP-9) at the approximate locations shown on Site Plan, Figure 2. The test pits were excavated to depths ranging between about ½ to 11 feet below existing site grade.

Representative soil samples from the explorations were returned to our laboratory for evaluation and testing. Detailed descriptions of our site exploration and laboratory testing programs along with exploration logs and laboratory test results are presented in Appendix A.

We also reviewed and considered results of prior explorations completed by GeoEngineers on and adjacent to the site for previous geotechnical projects. Approximate locations of those prior explorations also are shown on Figure 2.

Literature Review

Geologic Map Review

The Washington Division of Geology and Earth Resources, *Preliminary Geologic Map of the Spokane SE 7.5-Minute Quadrangle, Spokane County, Washington* (Derkey, Hamilton, Stradling and Kiver) indicates the site is located on an outcrop of Wanapum Basalt, Priest Rapids Member (Mvwp) of the Columbia River Basalt Group. The Wanapum Basalt is described as dark gray to black, fine-grained, dense basalt.

Soil Survey Review

Surficial soil conditions, generally located in the uppermost 60 inches below the ground surface also are described on the United States Department of Agriculture (USDA), National Resources Conservation Service (NRCS), Web Soil Survey. At the project site, the NRCS soil survey indicates that a small area within the northwest portion of the site is underlain by “Urban land-Marble, disturbed complex, 0 to 3 percent slopes” (7120), the southeast portion of the site is underlain by “Urban land-sandy substratum, 0 to 15 percent slopes” (7106), and the remainder of the site is underlain by “Urban land-Seaboldt, disturbed complex, 0 to 3 percent slopes” (7150).

The Urban land-Marble, disturbed complex typically formed in sandy, glacial outwash deposits. The upper 60 inches of the soil profile typically consists of 8 inches of loamy sand overlying sand. The soil is well drained.

The Urban land-sandy substratum complex also typically formed in sandy, glacial outwash deposits. This complex is very similar to the Urban land-Marble disturbed complex with the exception of the presence of gravel throughout the upper 60 inches of the soil profile.

The Urban land-Seaboldt, disturbed complex typically formed in loess (wind-blown clay, silt and fine sand) with an influence of volcanic ash over glacial outwash deposits overlying residuum from basalt. The upper 60 inches of the soil profile typically consists of about 10 inches of ashy loam, overlying about 13 inches of loam to sandy loam, overlying 5 inches of basalt residuum (extremely gravelly, sandy loam). These soil units overlie in-place basalt. The soil is well drained.

In-house Information

We reviewed the report “Geotechnical Engineering Study - Proposed Communications Tower – South Regal Lumber Site” prepared by GeoEngineers on August 29, 2002. Specifically we reviewed one boring log (B-1) completed in the central portion of the site, located approximately as shown on Figure 2. Soil conditions described in the boring log include approximately 5 feet of silty fine to coarse sand overlying fine to coarse gravel with silt, sand and cobbles, which extended to a depth of about 19 feet below site grade. Basalt rock was encountered from a depth of approximately 19 feet, to the termination of the boring at a depth of about 24½ feet. The sand and gravel soil deposits were not identified as fill on this log but could possibly be fill. Groundwater conditions at this location were not observed because of the use of drilling fluids during exploration.

We also reviewed unpublished logs of four borings (B-1a through B-1d) drilled by GeoEngineers in 2003 within the South Regal Street right-of-way at the approximate locations shown on Figure 2. These borings were located west of the largest South Regal Lumber Yard building. Subsurface conditions at these boring locations generally consisted of about 3½ feet to 7 feet of sand and gravel overlying weathered basalt rock. The hollow-stem auger drill used for exploration at these locations was able to penetrate about 2½ feet to 4½ feet into the weathered rock.

We also reviewed a City of Spokane as-built plan for a sanitary sewer line in South Regal Street. The profile portion of this plan documented depth to rock at several discrete locations between East 53rd Avenue and East 55th Avenue. Generally, depth to rock varied from about 3 to about 5 feet below ground surface in the central one-third of the block, and varied from about 5 feet to about 8 feet below ground surface with the north and south thirds of the block.

Surface Conditions

The approximate 8.6-acre project site is located in the northeast quadrant of the intersection of East 55th Avenue and South Regal Street in Spokane County, Washington. It measures approximately 630 feet by 630 feet in plan dimensions. The southwest corner of the site is currently occupied by the South Regal Lumberyard and consists of several commercial buildings as well as asphalt- and gravel- surfaced areas. The east half of the site appears to be used predominately as a storage area for the lumberyard, although it is partly occupied by a communications tower and two residential structures, one of which appears to be in use. The northwest corner of the site currently is occupied by two residences, one of which is in use.

The ground surface across the site generally slopes down towards the northwest. The western half of the site and the northern third of the eastern half of the site are relatively level. Eastern portions of the site appear to have been filled, creating an approximate 5- to 15-foot-high slope, which traverses the central and northeast portions of the site. Site vegetation consists of pine trees and some deciduous, evergreen ornamental trees near the residences and lumberyard, as well as some open grass and weed areas near the residences and the northwest corner of the site.

Subsurface Conditions

General

During our most recent visit to the site, we encountered variable subsurface conditions in our explorations to the depths explored. For the purposes of this report, we characterized the soil and rock encountered into four general units including: (1) fill; (2) low-permeability alluvial deposits; (3) high-permeability alluvial deposits; and (4) basalt/residuum. We encountered approximately 3 inches of topsoil at the ground surface in test pits TP-1, TP-3, TP-4, and TP-8.

Fill

We encountered fill, which extended from the ground surface to depths ranging from about 2 feet to 5 feet below the ground surface in test pits TP-6, TP-7, and TP-9. The fill consisted of loose to medium dense, silty, fine to coarse gravel with sand, cobbles and asphalt debris in a moist condition in test pits TP-6 and TP-7. In TP-9, the fill consisted of medium stiff silt with sand, gravel, and trace metal debris. We characterized the fill unit as having variable strength, compressibility, permeability, and susceptibility to changes in moisture content.

Low-permeability Alluvial Deposits

We encountered low-permeability alluvial deposits in test pits TP-3, TP-5 and TP-9. The low-permeability alluvial deposits generally consisted of medium dense, silty fine sand and silty, fine to coarse gravel with sand. We characterized the low-permeability alluvium as having moderate to high strength, low compressibility, low permeability, and moderate to high susceptibility to changes in moisture content.

High-permeability Alluvial Deposits

Underlying the low-permeability alluvial deposits, where encountered, we observed a unit of high-permeability alluvium in test pits TP-3, TP-5 and TP-9. This deposit generally consisted of medium dense, fine to coarse gravel with sand and trace silt. We characterized the high-permeability alluvium as having moderate strength, low compressibility, high permeability, and low susceptibility to changes in moisture content.

Basalt/Residuum

At the location of each test pit, the excavator met refusal on or in basalt rock at depths ranging from about ½ foot to 11 feet below the ground surface. The basalt was observed to be fractured and weathered. In test pits TP-1, TP-2, TP-4, TP-6, and TP-8, the basalt was overlain by about 9 inches to 2 feet of basalt-derived residuum, typically consisting of silty fine to coarse gravel with sand. We characterized: the residuum as having moderate to high strength, low permeability, and low to moderate susceptibility to changes in moisture content; and the basalt unit as having high strength, low compressibility, low permeability and low susceptibility to changes in moisture content. Based on our understanding of overall geologic conditions in the site vicinity, subsurface conditions beneath the site may be characterized by variable depth to rock and variable elevations of the rock surface.

Groundwater Conditions

We did not encounter groundwater in any of the test pits during exploration. However, we encountered groundwater at the location of our previous boring B-1d, completed in January 2003. Perched groundwater was encountered within basalt rock at a depth of about 8 feet below pavement grade within South Regal Street. Based on our experience in the site vicinity and in similar geologic conditions, shallow groundwater can be perched on low permeability confining layers such as the basalt rock encountered at the site. The location, extent and elevation of perched groundwater can vary seasonally, and from year to year depending on a number of factors including the topographic configuration of low-permeability confining layers; and precipitation, irrigation, infiltration and other forms of natural and artificial groundwater recharge.

CONCLUSIONS AND RECOMMENDATIONS

General

Details of the proposed development were not provided at the time we prepared this report. Please note that developing meaningful geotechnical recommendations, which may be used for final civil and structural engineering design purposes, in the absence of specific site development and building plans are not possible. For this reason, this report should be considered preliminary in nature and its use should be limited to assist in conceptual planning.

Earthwork Considerations

Based on the results of our explorations, we anticipate that the required stripping depth to remove topsoil and root zones of existing field grass and small vegetation will be relatively minor, less than about 3 to 6 inches. Clearing, stripping and grubbing to greater depths might be required to remove localized zones of soil with more than about 15 percent organic matter (by volume), to remove root balls of larger trees, or that could be present in areas of the site that were not explored.

Note that for the purposes of this report, we define topsoil as fine-grained soil with an appreciable amount of organic matter. We did not evaluate the mineralogical, organic matter content or gradational characteristics of site soil to assess its suitability for reuse as topsoil. However, based on the results of our explorations, existing site soil appears to contain a low percentage of organic matter and possibly is not suitable for reuse as topsoil to establish permanent vegetation. Therefore, in the absence of completing a more thorough evaluation of reusing site soil as permanent topsoil, by a qualified professional such as a landscape architect or soil scientist, we suggest that project plans, specifications and estimates include provisions for importing topsoil.

In our opinion, site soil overlying basalt rock can be excavated using conventional excavating equipment and procedures, including use of excavators. Based on the results of our explorations, the excavatability of basalt rock beneath the site appears to be highly variable. In some areas of the site, it might be possible to excavate several feet into weathered basalt using large excavators with toothed buckets. Within other areas of the site, excavation using pneumatic hammers (hoe-rams), rippers, or drilling and blasting might be required. Plans for future development should consider costs associated with rock excavation.

Portions of the site soil are moderately to highly moisture sensitive, particularly the low-permeability alluvial unit and existing fill (the soil classified as ML, SM, GM on the test pit logs) encountered at the locations of our test pits. Moisture-sensitive site soil will be difficult to work or compact if moisture contents are greater or less than the optimum moisture content by about 2 to 4 percentage points. Accordingly, earthwork during wet weather should be avoided, if possible. If earthwork activities cause excessive subgrade disturbance, replacement with structural fill might be necessary. Disturbance to a greater depth should be expected if site preparation work is conducted during periods of wet weather when the moisture content of the site soil could exceed optimum. Accordingly, if earthwork activities are performed during wet or freezing weather, we recommend that budgets include provisions for removal of additional unsuitable material, and replacement and compaction of imported structural fill.

The suitability of on-site soil for reuse as structural fill depends on the soil gradation and moisture content at the time of compaction. The low-permeability alluvial deposits and existing fill soil should be suitable for reuse as structural fill only during extended periods of dry weather, provided this soil can be properly moisture conditioned before placement and compaction. Preliminarily, for conceptual design purposes, we recommend that these soil units not be considered for reuse as structural fill within the footprint of proposed buildings. Otherwise, these soil units may be placed in non-settlement sensitive areas such as landscaping (if approved by the project architect or engineer), or properly disposed of off-site.

The high-permeability alluvial soil unit (the soil classified as GP on the exploration logs) exhibits low susceptibility to changes in moisture content and should generally be suitable for reuse as an all-weather structural fill, including within building limits. Excavated basalt rock might be suitable for reuse as structural fill. However, screening might be required to remove cobble-sized rock. Additionally, mixing excavated rock with other suitable on-site or imported structural fill might be required in order to produce a well-graded material suitable for use as structural fill.

While not encountered at the locations of our test pits, contractors should be prepared to manage perched groundwater, particularly if earthwork is conducted during the late winter through spring.

Shallow Foundation Feasibility

We evaluated the feasibility of supporting future buildings and other structures with typical shallow foundation systems. Based on the results of our subsurface exploration, it is our opinion that the natural alluvial soil deposits and basalt rock are suitable for supporting conventional shallow spread foundations, provided they conform to the following guidelines. Foundation elements may bear on properly prepared natural alluvial soil deposits, on compacted and tested structural fill, or properly prepared basalt rock.

Allowable bearing pressures for typical commercial buildings should range between about 2,500 to 6,000 pounds per square foot (psf), depending on whether the bearing surface is soil or rock, and on the magnitude of foundation loads and settlement tolerances of proposed buildings. The entire foundation system of a single building or other structure should bear on either undisturbed basalt rock or a combination of properly prepared natural soil and/or compacted structural fill. Where a structure's foundation system transitions between properly prepared natural soil or compacted and tested structural fill, and basalt rock, there should be at least 6 inches of structural fill between the bottom of foundations and basalt rock. Existing fill should be removed from beneath the building footprints, and replaced with properly compacted structural fill. The intent of these recommendations is to reduce the potential for differing foundation support conditions which could result in detrimental differential foundation settlement.

Details regarding proper subgrade and basalt bedrock preparation as well as guidelines for placing and compacting structural fill can be impacted by project-specific details, and are not included herein.

Infiltration Feasibility

Conventional stormwater management (on-site disposal using bio-infiltration swales and standard drywells) is not feasible at this site because of the presence of shallow basalt rock underlying the site, and observed in our explorations. Shallow low-permeability confining layers (such as basalt rock) tend to result in reduced effectiveness of conventional stormwater disposal systems. This is because concentrating stormwater into small disposal areas tends to result in groundwater mounding and reduced infiltration rates of swales and reduced outflow capacity of drywells. This, in turn, can result in detrimental impacts to the site and downgradient sites, including surface and subsurface flooding, particularly during and following large storm events, and during extended periods of wet weather. Therefore, the presence of basalt rock at shallow depths across the site could impact both the rates at which stormwater can be infiltrated and the volume of stormwater that can be infiltrated without detrimental site and downgradient impacts.

Possible solutions for post-development on-site disposal of stormwater include: (1) contacting the City of Spokane to inquire about the possibility of connecting stormwater facilities at the site to the City's regional stormwater facility; (2) using shallow infiltration swales; (3) using drywells installed in basalt rock; and (4) using on-site retention (evaporation) ponds; or (5) a combination of these options. Regardless of which option is selected, we strongly recommend that if infiltration of stormwater is used as a disposal method at this site, disposal facilities be dispersed across the site instead of concentrating stormwater infiltration into one area.

Based on a conversation with Gary Nyberg with Spokane County, we understand that other developments located adjacent to South Regal Street in the site vicinity have connected their stormwater facilities to the Hazel's Creek regional stormwater facility, managed by the City of Spokane (City). We contacted the City to inquire if the subject site would qualify for connection to the regional facility. Based on information provided by a City representative, the site is located within the Hazel's Creek basin, and therefore should be eligible to connect to the regional stormwater facility. In our opinion, this option should provide the lowest risk of negative site impacts related to increased stormwater runoff following site development, compared to other possible options presented in this report.

Shallow infiltration swales will most likely need to be larger than typical bio-infiltration swales because of the combined effect of the low permeability of the surficial silty sand and gravel deposits, and the potential for shallow basalt to create mounding effects below swales. The Spokane Regional Stormwater Manual (adopted by Spokane County) specifies a minimum 4-foot vertical separation between the bottom of infiltration facilities and the top of low-permeability confining layers. Based on review of available subsurface information, areas of the site which might be conducive to siting shallow infiltration swales could include the southwest and northwest corners of the site near South Regal Street, and areas near test pits TP-6 and TP-9. Although depth to rock at the location of previous boring B-1 is about 19 feet, the location of the boring near the top of the existing relatively steep slope is not a suitable location for siting an infiltration swale.

We recommend that Spokane County be consulted to discuss the county's willingness to accept non-conventional drywells installed in rock before proceeding with an evaluation of the feasibility of using such a system. If drywells are acceptable to the county, we recommend that the feasibility of infiltrating into rock be assessed.

The location of shallow basalt rock and the potential for shallow perched groundwater also should be considered if an on-site stormwater retention pond will be used to dispose of stormwater.

Additionally, the feasibility of on-site subsurface disposal of stormwater will depend on the nature of the proposed development, the net increase in impervious surface area relative to existing conditions, and the resulting volume of stormwater (both from the design storm event and on an average annual basis) which will have to be managed.

Recommended Additional Study

After the type, number and locations of proposed buildings have been identified, and a conceptual grading plan has been developed for the site, we should be consulted to provide a proposal for a project-specific, design-level geotechnical engineering evaluation. At that time we can consult with the project structural engineer and civil engineer to evaluate the geotechnical engineering-related information they need to complete their designs. We also can evaluate the proposed development relative to our existing subsurface information to assess if additional subsurface explorations are warranted in order to develop our recommendations, or to reduce uncertainty related to subsurface conditions, and the potential risks those uncertainties pose to the project proponents.

Preliminarily, we recommend that additional explorations be completed at proposed swale locations during design to evaluate subsurface conditions. In-place infiltration testing likely will be warranted to assess infiltration rates of site soils.

If infiltration into basalt rock will be further considered during design, we envision that additional site assessment to evaluate the feasibility of this stormwater disposal method could include: (1) drilling borings at proposed drywell locations and obtaining rock cores to evaluate the ability of rock to infiltrate water; specifically the degree of fracturing, and the nature of infilling of fractures and joints within the rock; (2) completing borehole percolation tests to assess the permeability of fractured rock (if present) ; and (3) installing groundwater monitoring wells within borings, and periodically measuring groundwater through at least one winter/spring season to evaluate the potential for shallow perched groundwater, the presence of which could negatively impact the feasibility to infiltrating into rock.

LIMITATIONS

We prepared this report for Vaughn's 57th Avenue, LLC and their authorized agents and regulatory agencies for a preliminary geotechnical evaluation during drainage plan preparation for the site located at the northeast corner of the intersection of South Regal Street and East 55th Avenue in Spokane, Washington. Vaughn's 57th Avenue, LLC may distribute copies of this report to Vaughn's 57th Avenue, LLC's authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document.

The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix C, titled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.

REFERENCES

City of Spokane, As-Built Drawing numbered RBGA(3) 3-24-43, titled “Regal Street, 57th Avenue to 53rd Avenue, “ stamped by Michael Kennedy on June 7, 1988.

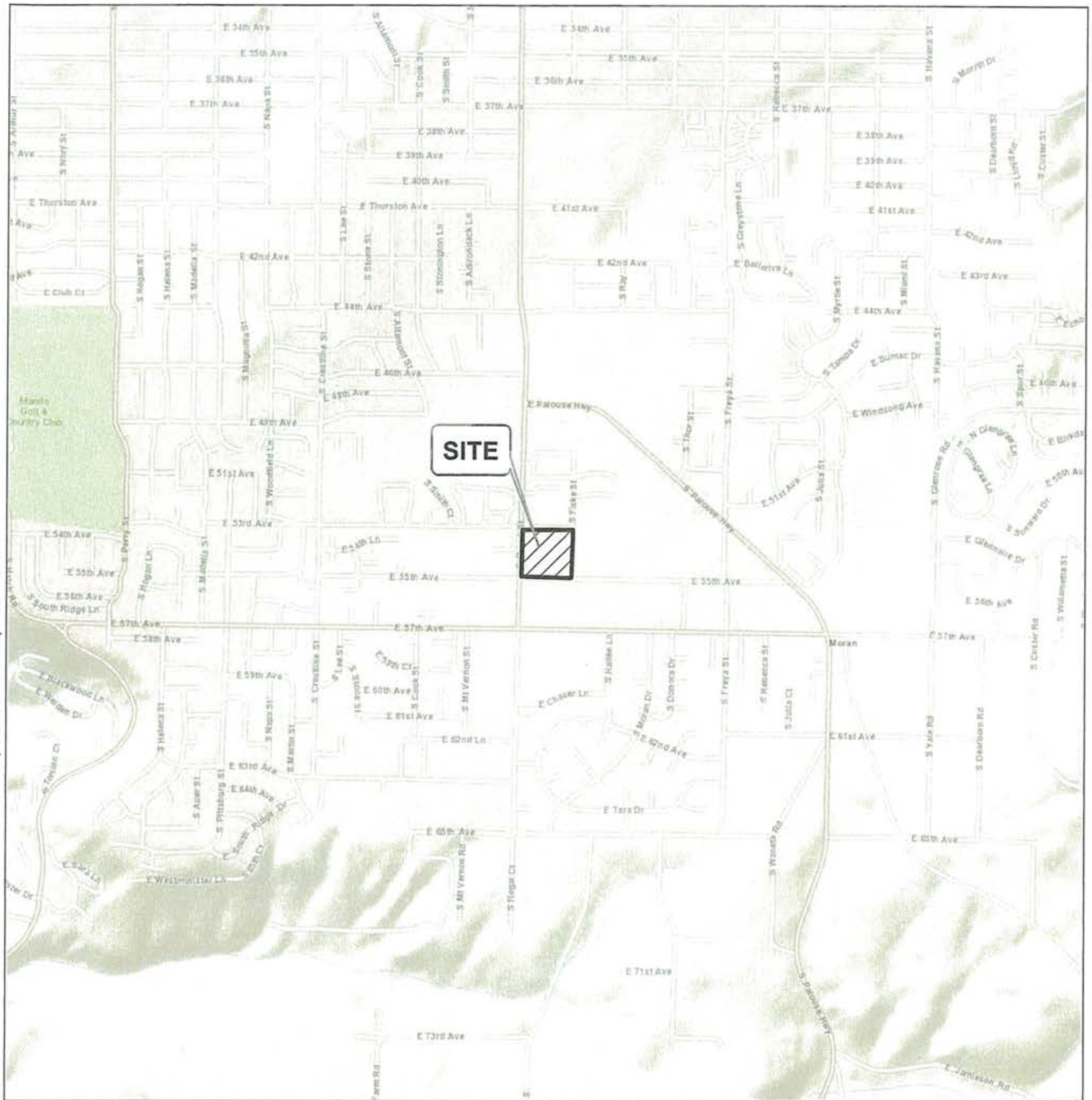
Derkey, Robert E., Hamilton, Michael M., Stradling, Dale F. and Kiver, E. G., 1999. “Preliminary Geologic Map of the Spokane SE 7.5-Minute Quadrangle, Spokane County, Washington,” Washington State Division of Geology and Earth Resources, Open File Report 99-6.

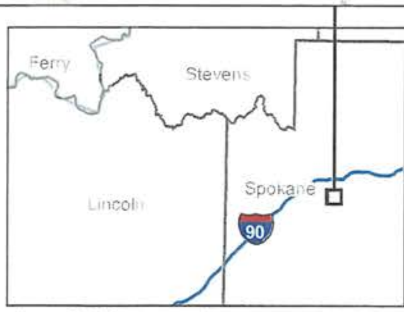
GeoEngineers, Inc. “Geotechnical Engineering Study, Proposed Communication Tower, South Regal Lumber Site, Spokane, Washington,” August 29, 2002, GEI File No. 8421-008-00.

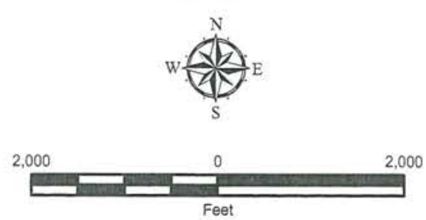
United States Department of Agricultural, Natural Resources Conservation Service, Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed December 20, 2013.

FIGURES

GeoEngineers







Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Data Sources: ESRI Data & Maps, Street Maps 2008.
Base map from ESRI Data Online.
Projection: NAD 1983, UTM Zone 11 North.

Vicinity Map

Proposed South Regal Street Commercial Development
Spokane, Washington

GEOENGINEERS

Figure 1

Office: PORT Path: P:\21\2134900100_GIS\GIS\MXD\2134900100_F1_VM.mxd Map Revised: 14 January 2014 ccabrera

Data Source: Contours (2007), parcel boundary and streets from City of Spokane GIS, http://www.spokanecity.org/services/gis/data/.
Aerial image base from ArcGIS Online.

Projection: NAD 1983 UTM Zone 11N

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Office: PORT Path: P:\21\21349001_GIS\GIS\MXD\2134900100_F2_SP.mxd Map Revised: 14 January 2014 ccabrera

Site Plan

Proposed South Regal Street Commercial Development
Spokane, Washington

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Figure 2

APPENDICES

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APPENDIX A
Field Explorations and Laboratory Testing

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

Soil, rock and groundwater conditions were explored at select locations at the site by excavating nine test pits (TP-1 through TP-9) at the approximate locations shown on Figure 2. Test pits were excavated to depths between about ½ foot and 11 feet below the ground surface using a track-mounted excavator operated by Vietzke Excavation under subcontract to GeoEngineers.

The excavations were continuously monitored by an engineer from our office who maintained a detailed log of subsurface explorations, visually classified the soil encountered and obtained representative soil samples from the test pits. The densities noted on the logs are based on the difficulty of excavation and our experience and judgment. Recovered soil samples were visually classified in the field in general accordance with ASTM D 2488 and the classification chart listed in Key to Exploration Logs, Figure A-1. Logs of the test pits are presented in Logs of Test Pits, Figures A-2 through A-10. Following excavation, the test pits were backfilled in approximate 2-foot-thick lifts of soil with each soil lift tamped in place with the excavator bucket.

The test pit locations were established in the field by taping and pacing from existing site features and recorded in the field by our engineer using an iPad 2 equipped with GPS and GISPro Software. The accuracy of the locations was recorded at about 16 feet (the highest published resolution for the software), although actual resolution could be less than 16 feet. Test pit elevations were interpolated from the contour lines shown on the Site Plan. The contour lines are from a topographic map provided by the city of Spokane. The city did not indicate the vertical datum for the topographic data. Based on field observations, the topographic map is considered to be current and accurate with the exception of the southeast site corner. The topographic map shows an approximate 10-foot-tall stockpile (approximately 40 feet by 40 feet, in plan dimensions) in the southeastern corner of the site; the stockpile did not exist at the time of our fieldwork. Instead, the stockpile area is generally level and at the same grade as the area immediately to the west (approximate Elevation 2,392 feet). Exploration locations and elevations should be considered accurate to the degree implied by the method used.

Laboratory Testing

Select soil samples obtained from the explorations were tested in the laboratory to assess pertinent physical properties in general accordance with applicable ASTM International (ASTM) test procedures. Percent-passing-the-U.S. No. 200 sieve (ASTM D 1140) tests were completed on four representative soil samples. The results of the percent-fines testing are presented on the exploration logs at the respective sample depths. Three sieve analyses (ASTM C 136) also were completed on representative samples. Results are presented in Sieve Analysis Results, Figure A-11.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Material Description Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

- 2.4-inch I.D. split barrel
- Standard Penetration Test (SPT)
- Shelby tube
- Piston
- Direct-Push
- Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PP	Pocket penetrometer
PPM	Parts per million
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

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FIGURE A-1

Date Excavated:	12/30/2013
Equipment:	John Deere 490 Excavator
Logged By:	EBD
Total Depth (ft)	4.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
					TS		Dark brown silt with sand (medium stiff, moist) (topsoil)		
	1				GM		Brown silty fine to coarse gravel with sand and cobbles (medium dense, moist) (residuum)		
	2				RX		Basalt, partly decomposed, pit to crater quality, intersecting open planes, (DBD0 to DDD0) - Remolds to fine to coarse gravel with silt, sand and cobbles (very dense, moist)		
	3								
	4								

Test pit terminated at approximately 4 foot depth due to excavator refusal in basalt rock
No groundwater seepage observed
Minor caving observed
Approximate ground Elevation = 2,365 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-1

GeoEngineers

Project:	Proposed South Regal Street Commercial Development
Project Location:	Spokane, Washington
Project Number:	21349-001-00

Figure A-2
Sheet 1 of 1

Date Excavated: 12/30/2013

Equipment: John Deere 490 Excavator

Logged By: EBD

Total Depth (ft) 0.5

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
					GM		Brown silty fine to coarse gravel with cobbles (medium dense, moist) (residuum)		

Test pit terminated at approximately ½ foot depth due to excavator refusal on basalt rock
No groundwater seepage observed
No caving observed
Approximate ground Elevation = 2,371 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-2

GeoEngineers

Project: Proposed South Regal Street Commercial Development
Project Location: Spokane, Washington
Project Number: 21349-001-00

Figure A-3
Sheet 1 of 1

Date Excavated: 12/30/2013	Logged By: EBD
Equipment: John Deere 490 Excavator	Total Depth (ft) 4.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
					TS		Dark brown silt with roots, leaves (medium stiff, moist) (topsoil)		
	1				SM		Brown silty fine to medium sand with occasional gravel (medium dense, moist) (alluvium)		
	2	X	1 %F					5	%F=23
	3				GP		Gray fine to coarse gravel with sand and trace silt (medium dense, moist) (alluvium)		
	4	X	2 SA					6	%F=2

Test pit terminated at approximately 4 foot depth due to excavator refusal on basalt rock
No groundwater seepage observed
Minor caving observed
Approximate ground Elevation = 2,367 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-3

GEOENGINEERS

Project: Proposed South Regal Street Commercial Development
Project Location: Spokane, Washington
Project Number: 21349-001-00

Figure A-4
Sheet 1 of 1

Date Excavated: 12/30/2013

Equipment: John Deere 490 Excavator

Logged By: EBD

Total Depth (ft) 1.0

Elevation (feet)	Depth (feet)	SAMPLE Testing Sample	Sample Name Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
					TS		Dark brown silt with roots and leaves (medium stiff, moist) (topsoil)		
	1				GM		Brown silty fine to coarse gravel with sand (medium dense, moist) (residuum)		

Test pit terminated at approximately 1 foot depth due to excavator refusal on basalt rock

No groundwater seepage observed

No caving observed

Approximate ground Elevation = 2,369 feet

Notes: See Figure A-1 for explanation of symbols.

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-4

GEOENGINEERS

Project: Proposed South Regal Street Commercial Development

Project Location: Spokane, Washington

Project Number: 21349-001-00

Figure A-5

Sheet 1 of 1

Date Excavated: 12/30/2013

Equipment: John Deere 490 Excavator

Logged By: EBD

Total Depth (ft) 4.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
	0–2				GM		Brown silty fine to coarse gravel with sand, cobbles and boulders (medium dense, moist) (alluvium)		
	2–2.5				GP		Gray fine to coarse gravel with sand, cobbles and trace silt (medium dense, moist) (alluvium)		
	2.5–4				RX		Basalt, partly decomposed, pit to dent quality, intersecting open planes (DBD0 to DCD0) - Remolds to fine to coarse gravel with silt, sand and cobbles (very dense, moist)		

Test pit terminated at approximately 4 foot depth due to excavator refusal in basalt rock
No groundwater seepage observed
No caving observed
Approximate ground Elevation = 2,373 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-5

GEOENGINEERS

Project: Proposed South Regal Street Commercial Development
Project Location: Spokane, Washington
Project Number: 21349-001-00

Date Excavated: 12/30/2013 Logged By: EBD

Equipment: John Deere 490 Excavator Total Depth (ft) 7.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
	0				GM		Brown silty fine to coarse gravel with sand, cobbles and asphalt debris (medium dense, moist) (fill)		
	3	X	1 SA					12	%F=22
	5				GM		Brown silty fine to coarse gravel with sand, cobbles, boulders and roots (medium dense, moist) (residuum)		
	7								

Test pit terminated at approximately 7 foot depth due to excavator refusal on basalt rock
No groundwater seepage observed
Minor caving observed
Approximate ground Elevation = 2,387 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Spokane: Date:1/21/14 Path:P:\21\21349001\00\GINT\2134900100.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-6

GEOENGINEERS

Project: Proposed South Regal Street Commercial Development
Project Location: Spokane, Washington
Project Number: 21349-001-00

Figure A-7
Sheet 1 of 1

Date Excavated: 12/30/2013

Equipment: John Deere 490 Excavator

Logged By: EBD

Total Depth (ft) 2.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
	0–2				GM		Brown silty fine to coarse gravel with sand, cobbles and asphalt debris (medium dense, moist) (fill)		

Test pit terminated at approximately 2 foot depth due to excavator refusal on basalt rock

No groundwater seepage observed

No caving observed

Approximate ground Elevation = 2,387 feet

Notes: See Figure A-1 for explanation of symbols.

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-7

GEOENGINEERS

Project: Proposed South Regal Street Commercial Development

Project Location: Spokane, Washington

Project Number: 21349-001-00

Date Excavated: 12/30/2013
Equipment: John Deere 490 Excavator

Logged By: EBD
Total Depth (ft) 1.0

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
					TS		Brown silt with sand, gravel, roots and grass (medium stiff, moist) (topsoil)		
	1				GM		Brown silty fine to coarse gravel with sand and cobbles (medium dense, moist) (residuum)		

Test pit terminated at approximately 1 foot depth due to excavator refusal on basalt rock
No groundwater seepage observed
No caving observed
Approximate ground Elevation = 2,388 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Spokane: Date:1/21/14 Path:P:\21\21349001\00\GINT\2134900100.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_TESTPIT_1P_GEOTEC

Log of Test Pit TP-8

GeoEngineers

Project: Proposed South Regal Street Commercial Development
Project Location: Spokane, Washington
Project Number: 21349-001-00

Figure A-9
Sheet 1 of 1

Date Excavated: 12/30/2013

Equipment: John Deere 490 Excavator

Logged By: EBD

Total Depth (ft) 11.0

Elevation (feet)	Depth (feet)	SAMPLE Testing Sample	SAMPLE Sample Name Testing	Graphic Log	Group Classification	Encountered Water	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
	0				ML		Brown silt with sand, gravel and trace trash and roots (medium stiff, moist) (fill)		
	2.5				SM		Brown silty fine to medium sand with occasional gravel (medium dense, moist) (alluvium)		
	3.5	X	1 %F					7	%F=41
	5				GP		Brown fine to coarse gravel with sand, cobbles and trace silt (medium dense, moist) (alluvium)		
	6	X	2 SA					6	%F=5
	8				RX		Basalt, partly decomposed, dent to crater quality, intersecting open planes (DCD0 to DDD0) - Remolds to fine to coarse gravel with silt, sand and cobbles (very dense, moist)		
	11								

Test pit terminated at approximately 11 foot depth due to slow excavation progress in basalt rock

No groundwater seepage observed

Minor caving observed

Approximate ground Elevation = 2,392 feet

Notes: See Figure A-1 for explanation of symbols.

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Log of Test Pit TP-9

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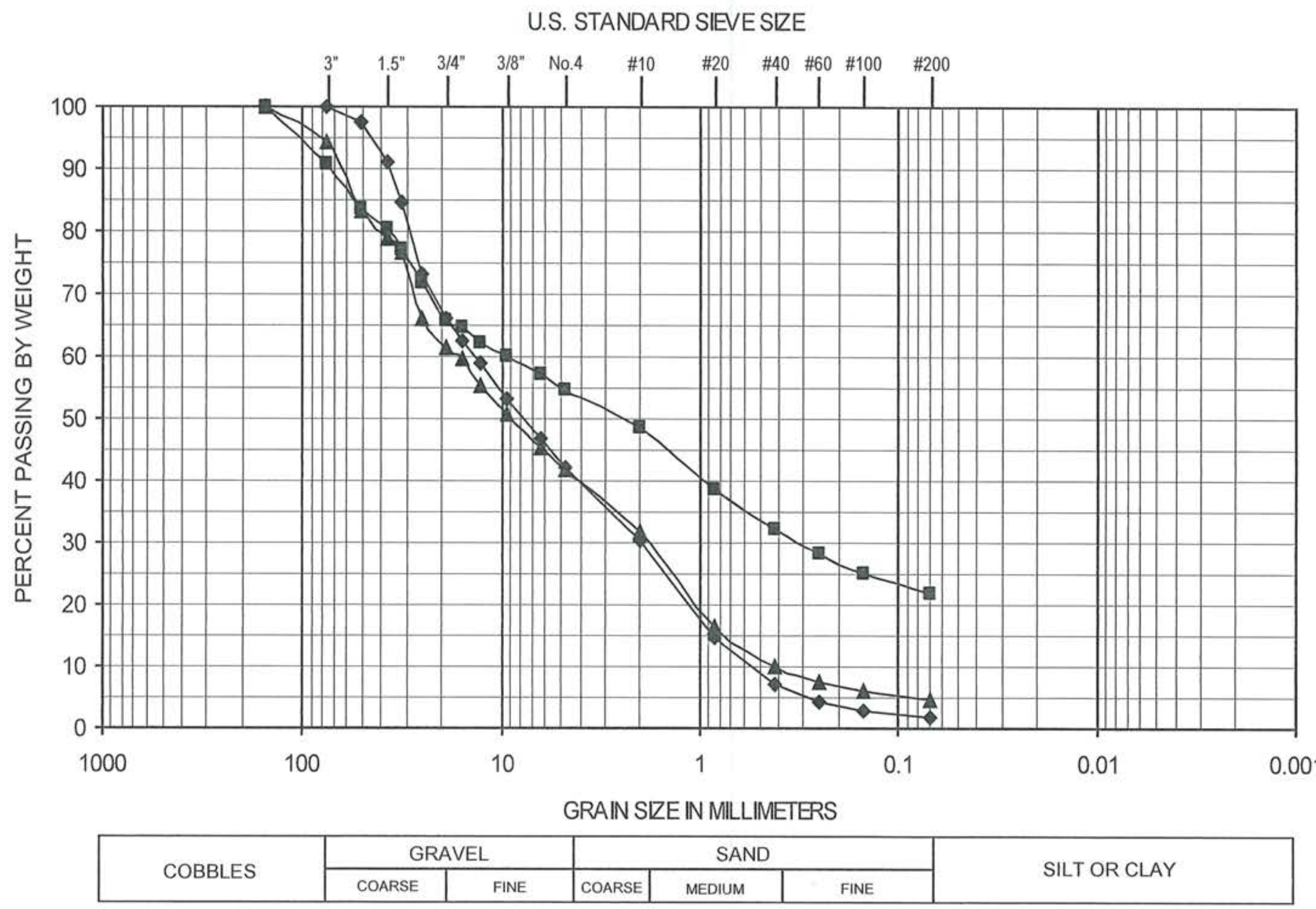
Project: Proposed South Regal Street Commercial Development

Project Location: Spokane, Washington

Project Number: 21349-001-00

Figure A-10

Sheet 1 of 1



Symbol	Exploration Number	Sample Depth (feet)	Soil Classification
◆	TP-3	3½-4	Fine to coarse gravel with sand and trace silt
■	TP-6	3-3½	Silty fine to coarse gravel with sand and cobbles
▲	TP-9	6-6½	Fine to coarse gravel with sand, cobbles and trace silt

Sieve Analysis Results

Proposed South Regal Street Commercial Development
Spokane, Washington

GeoEngineers

Figure A-11

Appendix B
Report Limitations and Guidelines for Use

APPENDIX B
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report was prepared for Vaughn's 57th Avenue, LLC and for the project site specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the project, and its schedule and budget, our services have been executed in accordance with our Agreement with Vaughn's 57th Avenue, LLC, dated December 13, 2013 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the Proposed South Regal Commercial Development project located at the northeast corner of the intersection of South Regal Street and East 55th Avenue in Spokane, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

The construction recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

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Please let us know by visiting **www. geoengineers.com/feedback**.

GeoEngineers

DESIGNERS NOTE
Reference Material

WCE

Whipple Consulting Engineers, Inc

2528 N. Sullivan Road
Spokane Valley, WA 99216
Ph 509-893-2617 Fax 509-926-0227

MEMORANDUM

TO:	Spokane County Attn: Gary Nyberg		
FROM:	Todd R. Whipple, PE		
DATE:	March 31, 2017		
PROJECT NO:	805	**NAME:**	Swartout – Retail at 55^{th}
REGARDING:	Pond Certification Memorandum		

TODD R. WHIPPLE STATE OF WASHINGTON 25462 REGISTERED PROFESSIONAL ENGINEER 3/31/17

Gary,

Per a request from Paul Reiner of Baker Construction and in talking with Ben Swartout (Owner) I offer the following recap of construction and certification of the storm drainage element from this project.

Attached to this memo and for reference are the following:

1. Current site photos taken as part of a field visit on March 28, 2017
2. A marked up copy of Sheet C7.0 noting what changes to the design were made to accommodate storm on site.
3. Updated drainage calculations showing that the revised plan will handle the appropriate design storm as well as annual infiltration.
4. Non-destructive financial verification that Pond B was drilled and installed as per the Strata recommendations from their March 4, 2011 Geotech Report
5. Strata Geotech Report dated March 4, 2011

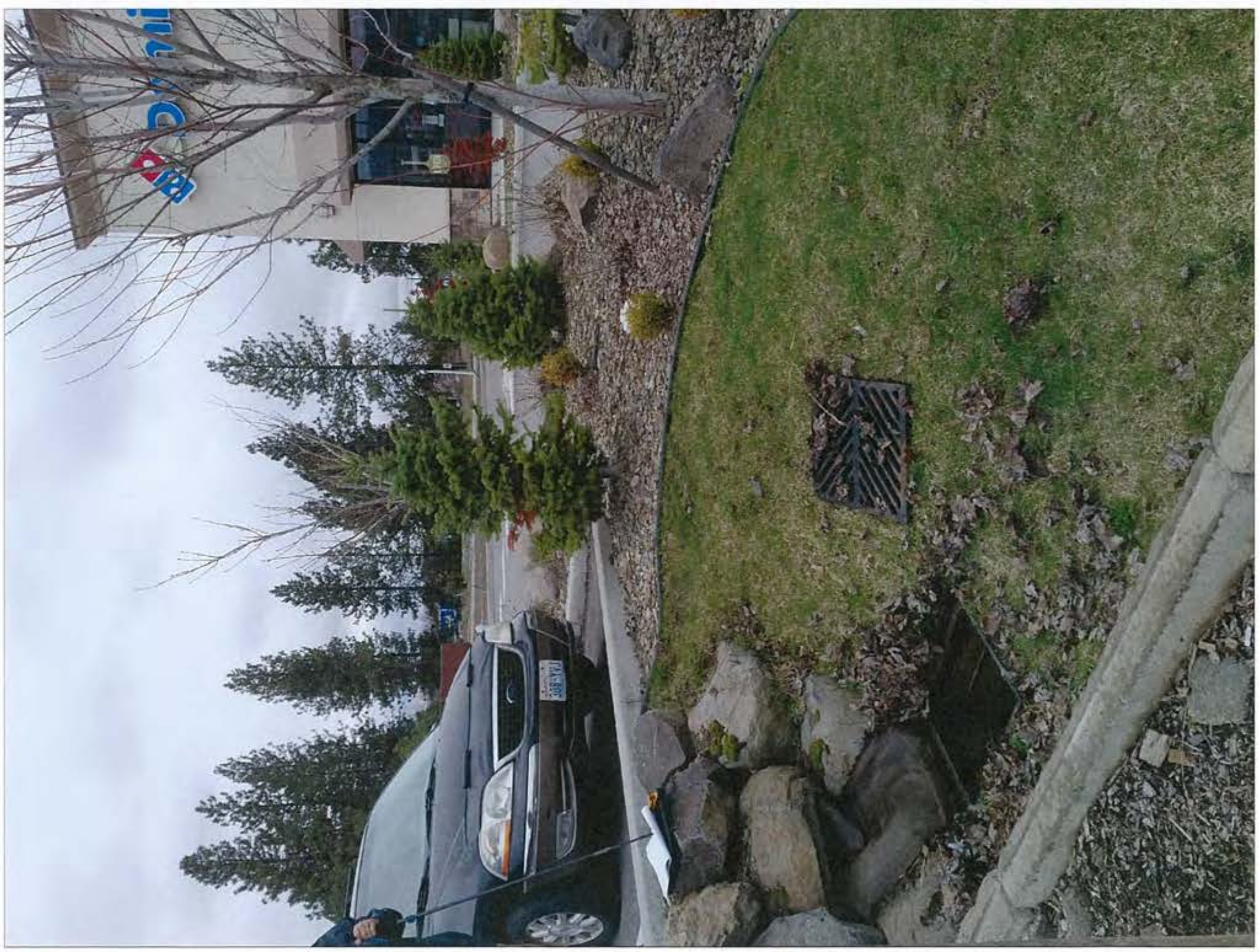
The site was generally constructed as designed.

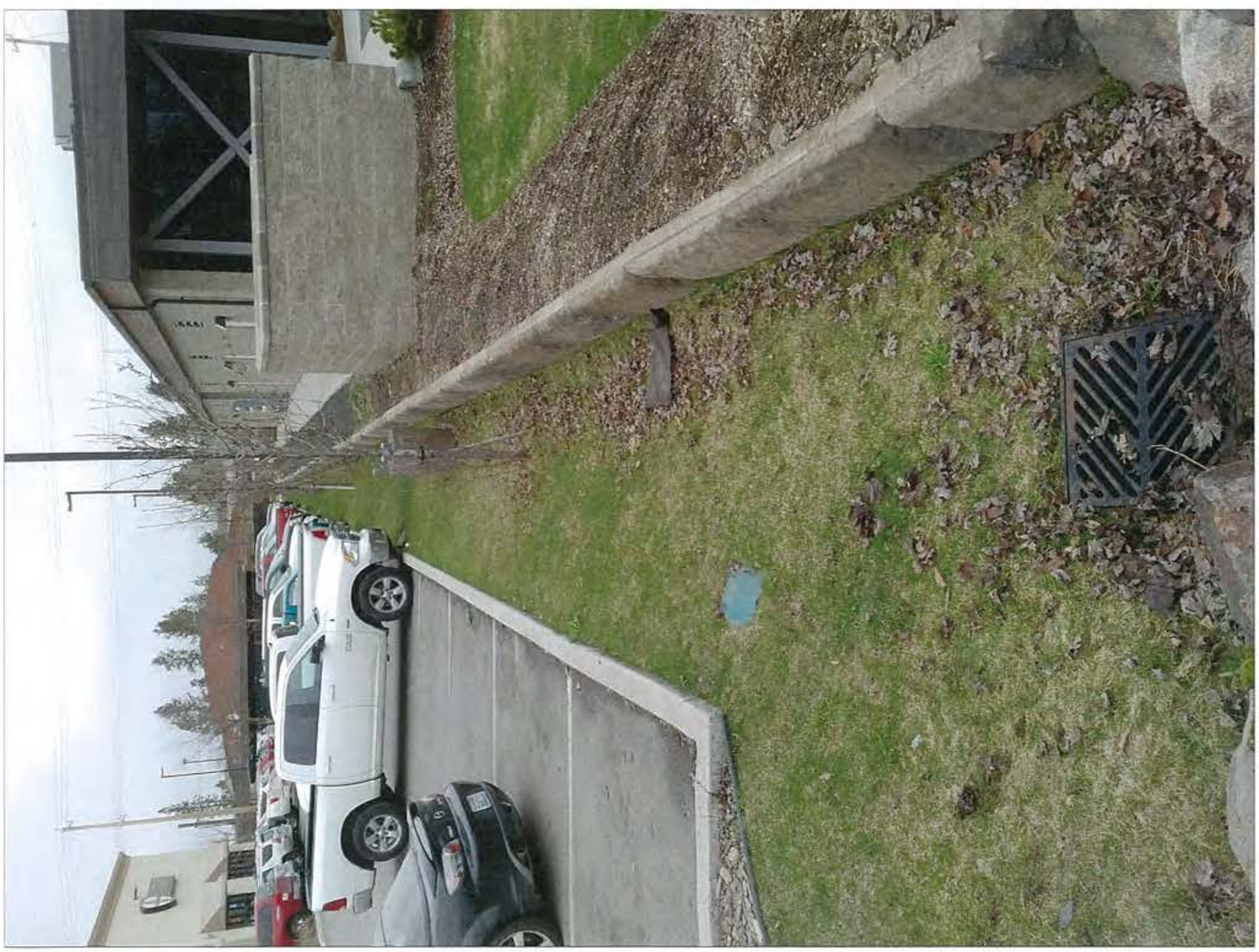
As it relates to the storm drainage facilities, the large infiltrator system was omitted in lieu of drilled holes in Pond 1.

The Strata report on pages 7 and 8 which note that with drilled shafts the infiltration in the pond bottom of 0.5 in/hr of pond bottom infiltration.

With this construction change, the system continues to meet the requirement of Spokane County and the SRSM.

See attached documentation.

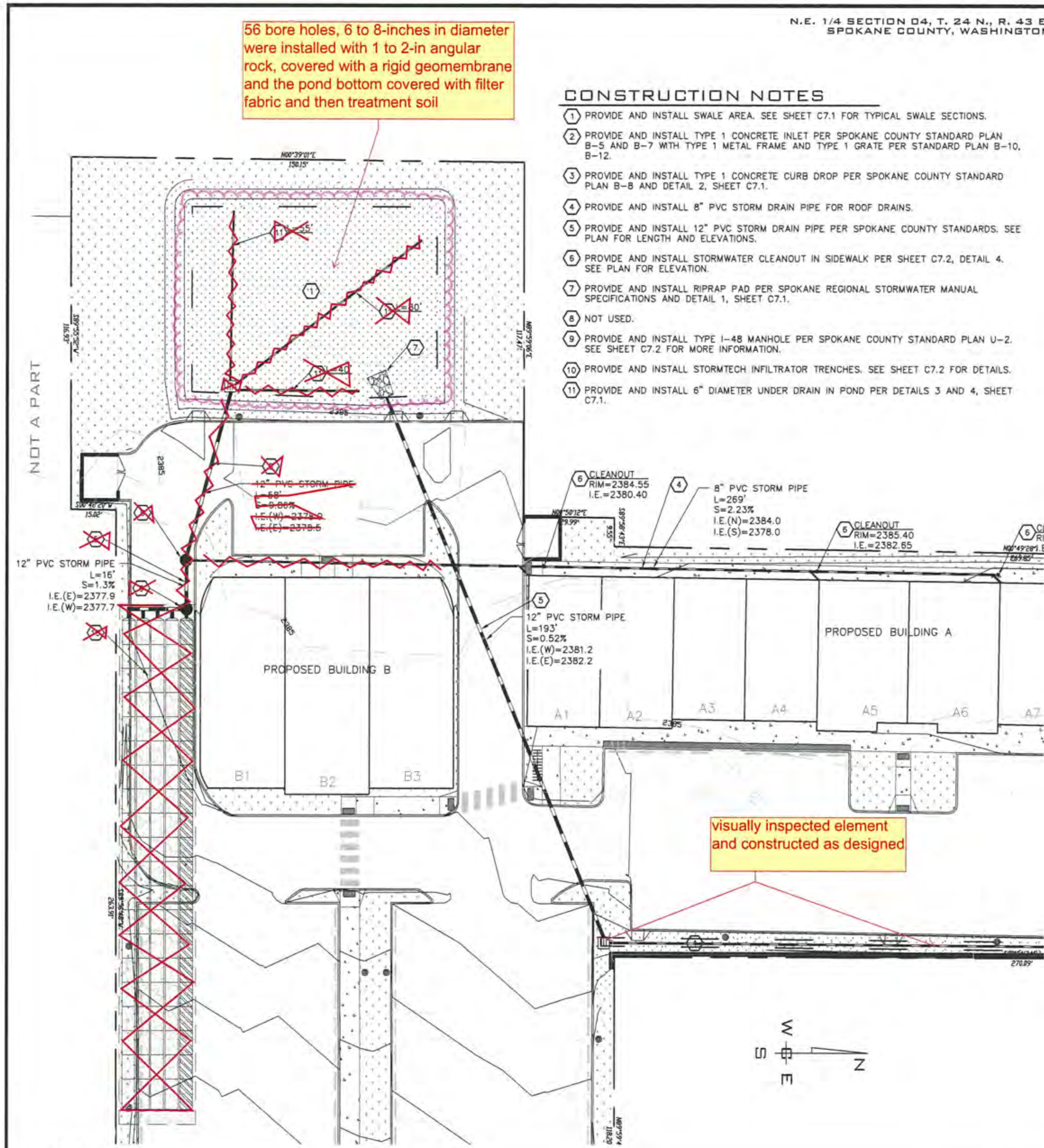




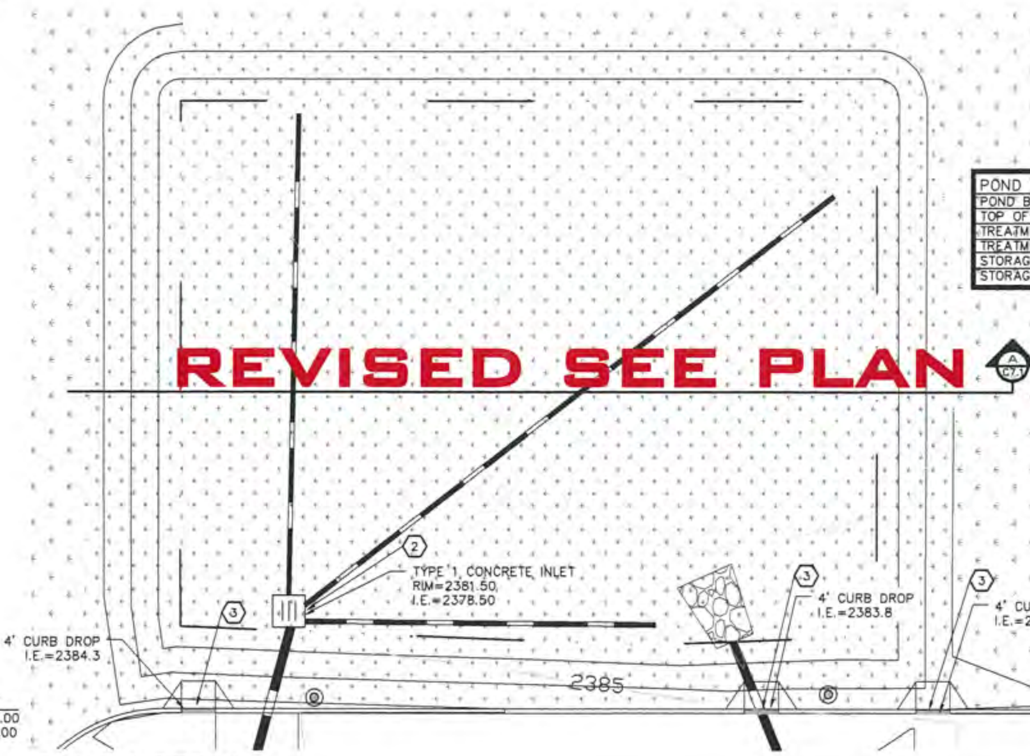
N.E. 1/4 SECTION 04, T. 24 N., R. 43 E., W.M.
SPOKANE COUNTY, WASHINGTON

CONSTRUCTION NOTES

1. PROVIDE AND INSTALL SWALE AREA. SEE SHEET C7.1 FOR TYPICAL SWALE SECTIONS.
2. PROVIDE AND INSTALL TYPE 1 CONCRETE INLET PER SPOKANE COUNTY STANDARD PLAN B-5 AND B-7 WITH TYPE 1 METAL FRAME AND TYPE 1 GRATE PER STANDARD PLAN B-10, B-12.
3. PROVIDE AND INSTALL TYPE 1 CONCRETE CURB DROP PER SPOKANE COUNTY STANDARD PLAN B-8 AND DETAIL 2, SHEET C7.1.
4. PROVIDE AND INSTALL 8" PVC STORM DRAIN PIPE FOR ROOF DRAINS.
5. PROVIDE AND INSTALL 12" PVC STORM DRAIN PIPE PER SPOKANE COUNTY STANDARDS. SEE PLAN FOR LENGTH AND ELEVATIONS.
6. PROVIDE AND INSTALL STORMWATER CLEANOUT IN SIDEWALK PER SHEET C7.2, DETAIL 4. SEE PLAN FOR ELEVATION.
7. PROVIDE AND INSTALL RIPRAP PAD PER SPOKANE REGIONAL STORMWATER MANUAL SPECIFICATIONS AND DETAIL 1, SHEET C7.1.
8. NOT USED.
9. PROVIDE AND INSTALL TYPE I-48 MANHOLE PER SPOKANE COUNTY STANDARD PLAN U-2. SEE SHEET C7.2 FOR MORE INFORMATION.
10. PROVIDE AND INSTALL STORMTECH INFILTRATOR TRENCHES. SEE SHEET C7.2 FOR DETAILS.
11. PROVIDE AND INSTALL 6" DIAMETER UNDER DRAIN IN POND PER DETAILS 3 AND 4, SHEET C7.1.



SITE PLAN
SCALE: 1"=30'

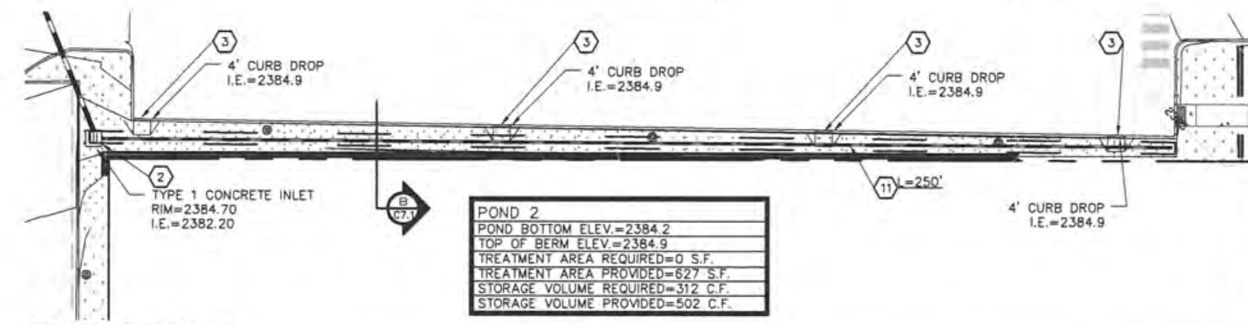


POND 1
POND BOTTOM ELEV.=2381.2
TOP OF BERM ELEV.=2383.2
TREATMENT AREA REQUIRED=4,288 S.F.
TREATMENT AREA PROVIDED=5,100 S.F.
STORAGE VOLUME REQUIRED=5,407 C.F.
STORAGE VOLUME PROVIDED=10,200 C.F.

POND 1 DETAIL
SCALE: 1"=10'

Line Table

Line #	Length	Direction
L1	61.40	S89° 56' 56.33"W
L2	81.31	N0° 01' 02.72"W
L3	62.55	N89° 56' 47.66"E
L4	27.36	S2° 10' 49.45"E
L5	54.02	S2° 17' 47.15"W
L6	253.31	N0° 31' 01.77"E
L7	2.75	N89° 56' 07.11"E
L8	253.31	S0° 31' 01.77"W
L9	2.75	S89° 56' 07.11"W



POND 2
POND BOTTOM ELEV.=2384.2
TOP OF BERM ELEV.=2384.9
TREATMENT AREA REQUIRED=0 S.F.
TREATMENT AREA PROVIDED=627 S.F.
STORAGE VOLUME REQUIRED=312 C.F.
STORAGE VOLUME PROVIDED=502 C.F.

POND 2 DETAIL
SCALE: 1"=10'

UNDERGROUND SERVICE ALERT
ONE-CALL NUMBER
811
CALL TWO BUSINESS DAYS BEFORE YOU DIG

NAVD-88 DATUM
ELEVATIONS SHOWN ARE BASED ON DATUM ON CITY NOTES FOR COR.#180 AT S.E. CORNER OF REGAL & 57TH. TBM "X" ON BRONZE MON. ELEV =2393.42

NO.	DATE	BY	REVISIONS

SCALE: HORIZONTAL: AS SHOWN VERTICAL: N/A
PROJ #: 2010-805
DATE: 09/28/11
DRAWN: MAT
APPROVED: TRW

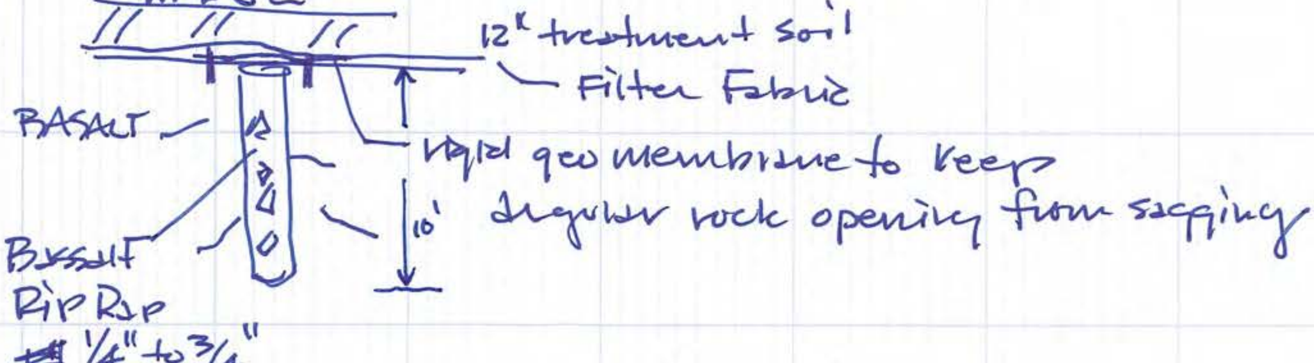
WCE
WHIPPLE CONSULTING ENGINEERS
CIVIL AND TRANSPORTATION ENGINEERING
2528 NORTH SULLIVAN ROAD
SPOKANE VALLEY, WA 99216
PH 509-893-2617 FAX 509-926-0227

BP-11001521
CONSTRUCTION SET
CIVIL PLANS
DRAINAGE PLAN
SWARTOUT - RETAIL STRIP MALL
SPOKANE COUNTY, WASHINGTON

SHEET C7.0
JOB NUMBER 2010-805

TODD R. WHIPPLE, STATE OF WASHINGTON, 25462 REGISTERED PROFESSIONAL ENGINEER 9/28/11

Drilled Pond calculation @ Pond B



1/4" to 3/4"
Angular - Free draining aggregate ...

Per March 4, 2011 strata report (Attached)

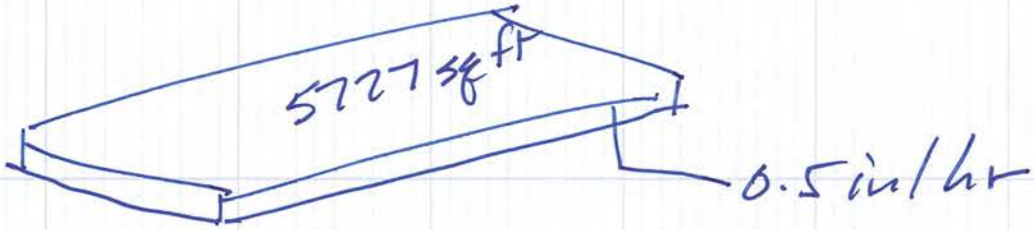
undrilled 0.15 in/hr @ 1.0' of penetration

drilled 0.5 in/hr @ 10' depth @ 4' center
∴ 56 bore holes

As designed Pond B was drilled w/ 56 bore holes to a depth of 10'; bore holes were 6" to 8" in diameter

∴ infiltration 0.5 in/hr

outflow calculation



$$\frac{.5\,in}{hr} = \frac{1'}{12''} = \frac{0.042'}{hr}$$

$$\frac{0.042'}{hr} = \frac{1\,hr}{3600\,sec} = \frac{1.2E\text{-}5'}{sec}$$

$$5727 \times \frac{1.2E\text{-}5'}{sec} = 0.066\ cfs$$

Whipple Consulting Engineers, Inc. 2528 N. Sullivan Rd. • Spokane Valley, WA 99216 Phone 509-893-2617 • Fax 509-926-0227	Traffic ☐ Planning ☐ Survey ☐ Structural ☐ Landscape ☐ Civil ☐	NAME OF PROJECT			SHEET NUMBER 3 OF
		COMPUTED BY	CHECKED BY	JOB NUMBER	DATE 3/30/17

Ignoring frozen Ground condition where little to no infiltration may or may not occur @ 0.5 in/hr the total infiltration available for a 30 day month would be

$30 \times 24 \times 0.5 = \frac{360 \text{ inches}}{12 \text{ in/ft}}$

$\approx$ approximately 30 ft / month

or

1.0 ft / day

Assuming a 50% degradation over time

$\therefore$

use 0.5' / day

PEAK FLOW CALCULATION PROJECT: **2010-805 SWARTOUT**

10-Year Design Storm

BASIN: 1

Tot. Area	89,826 SF	2.06 Acres	
Imp. Area	63,722 SF	C = 0.90	
Per. Area	26,104 SF	C = 0.15	
Wt. C	0.68	208 Area =	51454.00

CASE 1

=======

10 ft. Overland Flow

Ct = 0.15
L = 10 ft.
n = 0.05
S = 0.0200

Tc = 0.32 min., by Equation 3-2 of Guidelines

293 ft. Gutter flow

Z1 =	50.0	For Z2	
Z2 =	1.0	Type B = 1.0	
n =	0.016	Rolled = 3.5	
S =	0.0300		
d =	0.2190 ft.	Flow Width	11.0 ft.

A	R	Q	Tc	Tc total	I	Qc
1.22	0.11	4.49	1.33	5.00	3.18	4.47

Qpeak for Case 1 = 4.47 cfs

CASE 2

=======

Case 2 assumes a Time of Concentration less than 5 minutes so that the peak flow =.90(Tc=5 intensity)(Imp. Area) = 4.18 cfs

So, the Peak flow for the Basin is the greater of the two flows,
4.47 cfs

BOWSTRING METHOD PROJECT: 2010-805 SWARTOUT

DETENTION BASIN DESIGN BASIN: 1

DESIGNER: TRW

DATE: 30-Mar-17

Time Increment (min)	5
Time of Conc. (min)	5.00
Outflow (cfs)	6.60E-02
Design Year Flow	10
Area (acres)	2.06
Impervious Area (sq ft)	63722
'C' Factor	0.68
Area * C	1.406
Asphaltic Area	51,454

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	3.18	4.47	1797	20	1777	
5	300	3.18	4.47	1797	19.8	1777	
10	600	2.24	3.15	2213	39.6	2173	
15	900	1.76	2.47	2473	59.4	2414	
20	1200	1.45	2.04	2661	79.2	2582	
25	1500	1.23	1.73	2769	99	2670	
30	1800	1.05	1.48	2808	118.8	2690	
35	2100	0.91	1.28	2821	138.6	2682	
40	2400	0.81	1.14	2849	158.4	2690	
45	2700	0.74	1.04	2913	178.2	2734	
50	3000	0.69	0.97	3005	198	2807	
55	3300	0.65	0.91	3105	217.8	2887	
60	3600	0.61	0.86	3197	237.6	2959	
65	3900	0.58	0.82	3290	257.4	3033	
70	4200	0.56	0.79	3414	277.2	3137	
75	4500	0.55	0.78	3588	297	3291	
80	4800	0.55	0.77	3785	316.8	3468	
85	5100	0.53	0.75	3910	336.6	3574	<==
90	5400	0.50	0.70	3849	356.4	3493	
95	5700	0.47	0.66	3835	376.2	3459	
100	6000	0.45	0.63	3832	396	3436	

"208" TREATMENT REQUIREMENTS

Minimum "208" Volume Required	2,144 cu ft
Provided Treatment Volume - Minimum	2,897 cu ft

DRYWELL REQUIREMENTS - 10 YEAR DESIGN STORM

Maximum Storage Required by Bowstring	3,574 cu ft
Provided Storage Volume - Minimum	10,200 cu ft
Number and Type of Drywells Required	0 Single
	0 Double

PEAK FLOW CALCULATION PROJECT: **2010-805 SWARTOUT**

50-Year Design Storm

BASIN: 1

Tot. Area	89,826 SF	2.06 Acres	
Imp. Area	63,722 SF	C=	0.9
Perv. Area	26,104 SF	C=	0.15
Wt. C =	0.68	208 Area =	51454

CASE 1
=======

10 ft. Overland Flow

Ct = 0.15
L = 10 ft.
n = 0.05
S= 0.0200

Tc = 0.30 min., by Equation 3-2 of Guidelines

293 ft. Gutter flow

Z1 =	50.0	For Z2
Z2 =	1.0	Type B = 1.0
n =	0.016	Rolled = 3.5
S =	0.0300	

d = 0.2500 ft. Flow Width 12.5 ft.

A	R	Q	Tc	Tc total	I	Qc
1.59	0.12	6.39	1.22	5.00	4.58	6.44

Qpeak for Case 1 = 6.44 cfs

CASE 2
=======

Case 2 assumes a Time of Concentration less than 5 minutes so that the peak flow =.90(Tc=5 intensity)(Imp. Area) = 6.03 cfs

So, the Peak flow for the Basin is the greater of the two flows,
6.44 cfs

BOWSTRING METHOD
DETENTION BASIN DESIGN

PROJECT: 2010-805 SWARTOUT
BASIN: 1
DESIGNER TRW
DATE: 30-Mar-17

Time Increment (min)	5
Time of Conc. (min)	5.00
Outflow (cfs)	0.066
Design Year Flow	50
Area (acres)	2.06
Impervious Area (sq ft)	63722
'C' Factor	0.68
Area * C	1.406
Treatment Area	51,454

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	4.58	6.44	2589	20	2569	
5	300	4.58	6.44	2589	19.8	2569	
10	600	3.21	4.51	3166	39.6	3127	
15	900	2.44	3.43	3440	59.4	3381	
20	1200	1.98	2.79	3627	79.2	3548	
25	1500	1.68	2.36	3777	99	3678	
30	1800	1.46	2.05	3904	118.8	3785	
35	2100	1.30	1.83	4022	138.6	3883	
40	2400	1.18	1.66	4144	158.4	3985	
45	2700	1.08	1.52	4271	178.2	4093	
50	3000	1.01	1.42	4394	198	4196	
55	3300	0.94	1.32	4501	217.8	4283	
60	3600	0.88	1.24	4591	237.6	4353	
65	3900	0.83	1.17	4682	257.4	4425	
70	4200	0.79	1.12	4806	277.2	4529	
75	4500	0.77	1.08	4985	297	4688	
80	4800	0.75	1.06	5198	316.8	4881	
85	5100	0.73	1.03	5370	336.6	5033	
90	5400	0.70	0.98	5407	356.4	5050	<==
95	5700	0.66	0.92	5365	376.2	4989	
100	6000	0.63	0.88	5364	396	4968	

"208" TREATMENT REQUIREMENTS

Minimum "208" Volume Required	2,144 cu ft
Provided Treatment Volume - Minimum	2,897 cu ft

DRYWELL REQUIREMENTS - 50 YEAR DESIGN STORM

Maximum Storage Required by Bowstring	5,050 cu ft
Provided Storage Volume to Inlet - Minumum	10,200 cu ft
Number and Type of Drywells Required	0 Single
	0 Double

WHIPPLE CONSULTING ENGINEERS

POND VOLUME CALC SHEET

3/30/2017

2010-805 Swartout - Retail Strip Mall
Engineer MAT

Basins	Ponds	Bottom Area sf	Squared Side lf	Pond Bottom Elevation at Drywell	Pond Drywell Elevation	Pond Inlet 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
1	1	5,100	71	2381.20	2381.70	2383.20	2,550	107	2,657	10,200	1,714	11,914
1	2	627	25	2384.20	2384.70	2385.00	314	38	351	502	96	598
Totals		**5,727**	**96**				**2,864**	**145**	**3,008**	**10,702**	**1,810**	**12,512**

Whipple Consulting Engineers
Basin Calculation Worksheet

30-Mar-17 2010-805 Swartout - Retail Strip Mall
MAT

NOTE:

Imp	0.9	Intensities from IDF Curves - Spokane, Reardan, etc..			
		I (2 yr) =	2 inches	I (10 yr)=	3.18 inches
Per	0.15	I (25 yr) =	4 inches	I (50 yr)=	4.57 inches
		I (100 yr) =	5.1 inches		

SRSM Section 6.7.1 - Equation 6-1d (V=1815A)

													Q=CIA (cfs)				
Basin	Total sf	Street sf	Existing Street sf	Sidewalk sf	Buildings # of	Building sf	Total Impervious	Total Pervious	Weighted "C"	208 Area sf	208 Pond Area (sf)	208 Pond Vol (cf)	2 yr Storm	10 yr Storm	25 yr Storm	50 yr Storm	100 yr Storm
Pre-Developed 1	25,783.00	0.00	18,678.00	0.00	1.00	3,169.00	21,847.00	3,936.00	0.79	18,678.00	1556.50	778.25	0.93	1.48	1.86	2.12	2.37
Pre-Developed 2	71,612.00	0.00	5,906.00	313.00	6.00	5,269.00	11,488.00	60,124.00	0.27	5,906.00	492.17	246.08	0.89	1.41	1.78	2.03	2.27
Pre Total	**97,395.00**	**0.00**	**24,584.00**	**313.00**	**7.00**	**8,438.00**	**33,335.00**	**64,060.00**	**0.41**	**24,584.00**	**2,048.67**	**1,024.33**	**1.82**	**2.89**	**3.64**	**4.16**	**4.64**
1	89,826.00	41,780.00	0.00	3,776.00	2.00	18,166.00	63,722.00	26,104.00	0.68	51,454.00	4,287.83	2143.92	2.81	4.47	5.63	6.43	7.17
2	7,569.00	1,954.00	0.00	1,254.00	0.00	0.00	3,208.00	4,361.00	0.47	1,954.00	162.83	81.42	0.16	0.26	0.33	0.37	0.41
Post Total	**97,395.00**	**43,734.00**	**0.00**	**5,030.00**	**2.00**	**18,166.00**	**66,930.00**	**30,465.00**	**0.67**	**53,408.00**	**4,450.67**	**2,225.33**	**2.98**	**4.73**	**5.95**	**6.80**	**7.59**

Combined Basin Calculation Area / Inlet Basin Area

Project :	Swartout
Job No.:	805
Date:	3/30/17
Designer:	Saywers
Pond Bottom Area:	5,727 sq. ft.
Pond Bottom Perimeter:	303 ft
Pond Side Slopes:	3 : 1
Assumed Pond Depth:	3.0 ft
Assumed Pond Volume:	17,181 c.ft.

Evaporative / Detention

Combination Pond

CONDITION B - with Discharge Point

	AMC II	AMC III	- -
	Normal	Nov., Mar	Dec.-Feb.
Pre-Dev. (Impervious) CN:	98	99	99
Pre-Dev. (Permeable) CN:	61	78	95
Post-Dev. (Impervious) CN:	98	99	99
Post-Dev. (Permeable) CN:	61	78	95
Pre-Dev.(Impervious) S:	0.20	0.10	0.10
Pre-Dev.(Permeable) S:	6.39	2.82	0.53
Post-Dev.(Impervious) S:	0.20	0.10	0.10
Post-Dev.(Permeable) S:	6.39	2.82	0.53

	Pre-dev	Post-dev	
Impervious Basin Size:	0.01	1.46 acres	
Impervious Pond Size:	0.01	0.13 acres	
Pervious Basin Size:	2.06	-0.49 acres	
	2.08	1.10 acres	1.10

Mean Annual Precipitation	
Airport	16.11
Project Site	18.00
Multiplier	1.12

Month	Precip. "P" (in.)	Adj. "P" (in)	Imp pre-dev (P-0.2S)	Perm. pre-dev (P-0.2S)	Imp post-dev (P-0.2S)	Perm post-dev (P-0.2S)	Imp pre-dev Runoff Depth (in)	Perm pre-dev Runoff Depth (in)	Imp post-dev Runoff Depth (in)	Perm post-dev Runoff Depth (in)	Imp pre-dev runoff volume (cft)	Perm pre-dev runoff volume (cft)	TOTAL PRE VOL (cft)	Imp post-dev runoff volume (cft)	Perm post-dev runoff volume (cft)	TOTAL POST VOL (cft)	NET Increase in Volume (cft)	Pan Evap. (in.)	Evap Volume Out (cft) 28% Adj.	Total Volume to Handle (cft)	Current Volume in Pond (cft)	Spill Volume to Detention or Disposal < PRE (cft)	Pond Depth (ft)	Monthly Infiltration in Pond (ft)	End of Month Depth (ft)
Oct.	1.22	1.36	1.32	0.08	1.32	0.08	1.15	0.00	1.15	0.00	42	8	50	6,630	-2	6,628	6,578	2.58	887	5,741	5,741	0	0.0	15	0.0
Nov.	2.02	2.26	2.24	1.69	2.24	1.69	2.14	0.63	2.14	0.63	78	4,748	4,826	12,386	-1,139	11,246	6,421	0.92	316	16,671	16,671	0	0.0	15	0.0
Dec.	2.22	2.48	2.46	2.38	2.46	2.38	2.36	1.94	2.36	1.94	86	14,539	14,625	13,677	-3,489	10,188	0	0.51	175	26,684	17,181	9,503	1.7	15	0.0
Jan.	2.05	2.29	2.27	2.19	2.27	2.19	2.17	1.76	2.17	1.76	79	13,169	13,248	12,579	-3,160	9,419	0	0.61	210	26,391	17,181	9,210	1.6	15	0.0
Feb.	1.57	1.75	1.73	1.65	1.73	1.65	1.64	1.25	1.64	1.25	59	9,347	9,406	9,483	-2,243	7,240	0	1.11	381	24,040	17,181	6,859	1.2	15	0.0
Mar.	1.38	1.54	1.52	0.98	1.52	0.98	1.43	0.25	1.43	0.25	52	1,882	1,934	8,258	-452	7,807	5,873	2.28	783	24,204	17,181	7,023	1.2	15	0.0
Apr.	1.11	1.24	1.20	0.00	1.20	0.00	1.03	0.00	1.03	0.00	37	0	37	5,932	0	5,932	5,895	4.45	1,529	21,584	17,181	4,403	0.8	15	0.0
May	1.37	1.53	1.49	0.25	1.49	0.25	1.31	0.01	1.31	0.01	48	71	119	7,584	-17	7,567	7,448	6.69	2,299	22,449	17,181	5,268	0.9	15	0.0
June	1.27	1.42	1.38	0.14	1.38	0.14	1.20	0.00	1.20	0.00	44	23	66	6,947	-5	6,942	6,876	8.14	2,797	21,326	17,181	4,145	0.7	15	0.0
July	0.50	0.56	0.52	0.00	0.52	0.00	0.37	0.00	0.37	0.00	13	0	13	2,150	0	2,150	2,136	10.7	3,677	15,654	15,654	0	0.0	15	0.0
Aug.	0.60	0.67	0.63	0.00	0.63	0.00	0.48	0.00	0.48	0.00	17	0	17	2,752	0	2,752	2,734	9.42	3,237	15,169	15,169	0	0.0	15	0.0
Sept.	0.80	0.89	0.85	0.00	0.85	0.00	0.69	0.00	0.69	0.00	25	0	25	3,984	0	3,984	3,959	5.9	2,027	17,125	17,125	0	0.0	15	0.0
Oct.	1.22	1.36	1.32	0.08	1.32	0.08	1.15	0.00	1.15	0.00	42	8	50	6,630	-2	6,628	6,578	2.58	887	22,866	17,181	5,685	1.0	15	0.0
Nov.	2.02	2.26	2.24	1.69	2.24	1.69	2.14	0.63	2.14	0.63	78	4,748	4,826	12,386	-1,139	11,246	6,421	0.92	316	28,111	17,181	10,930	1.9	15	0.0
Dec.	2.22	2.48	2.46	2.38	2.46	2.38	2.36	1.94	2.36	1.94	86	14,539	14,625	13,677	-3,489	10,188	0	0.51	175	27,194	17,181	10,013	1.7	15	0.0
Jan.	2.05	2.29	2.27	2.19	2.27	2.19	2.17	1.76	2.17	1.76	79	13,169	13,248	12,579	-3,160	9,419	0	0.61	210	26,391	17,181	9,210	1.6	15	0.0
Feb.	1.57	1.75	1.73	1.65	1.73	1.65	1.64	1.25	1.64	1.25	59	9,347	9,406	9,483	-2,243	7,240	0	1.11	381	24,040	17,181	6,859	1.2	15	0.0
Mar.	1.38	1.54	1.52	0.98	1.52	0.98	1.43	0.25	1.43	0.25	52	1,882	1,934	8,258	-452	7,807	5,873	2.28	783	24,204	17,181	7,023	1.2	15	0.0
Apr.	1.11	1.24	1.20	0.00	1.20	0.00	1.03	0.00	1.03	0.00	37	0	37	5,932	0	5,932	5,895	4.45	1,529	21,584	17,181	4,403	0.8	15	0.0
May	1.37	1.53	1.49	0.25	1.49	0.25	1.31	0.01	1.31	0.01	48	71	119	7,584	-17	7,567	7,448	6.69	2,299	22,449	17,181	5,268	0.9	15	0.0
June	1.27	1.42	1.38	0.14	1.38	0.14	1.20	0.00	1.20	0.00	44	23	66	6,947	-5	6,942	6,876	8.14	2,797	21,326	17,181	4,145	0.7	15	0.0
July	0.50	0.56	0.52	0.00	0.52	0.00	0.37	0.00	0.37	0.00	13	0	13	2,150	0	2,150	2,136	10.7	3,677	15,654	15,654	0	0.0	15	0.0
Aug.	0.60	0.67	0.63	0.00	0.63	0.00	0.48	0.00	0.48	0.00	17	0	17	2,752	0	2,752	2,734	9.42	3,237	15,169	15,169	0	0.0	15	0.0
Sept.	0.80	0.89	0.85	0.00	0.85	0.00	0.69	0.00	0.69	0.00	25	0	25	3,984	0	3,984	3,959	5.9	2,027	17,125	17,125	0	0.0	15	0.0
Oct.	1.22	1.36	1.32	0.08	1.32	0.08	1.15	0.00	1.15	0.00	42	8	50	6,630	-2	6,628	6,578	2.58	887	22,866	17,181	5,685	1.0	15	0.0
																			18318					15	0.0

total annual pre 44,367 ɔtal annual post 81,854 47,919 Net Increase Amount spilled 63,536

16.11 **18.00 Mean Annual Precipitation for Project Site**

ADD INFLOW FROM POND "A"

8291

SWARTOUT FAMILY INVESTMENTS LLC
P.O. BOX 30009
SPOKANE, WA 99223-3000
(509) 448-5074

INLAND NORTHWEST BANK
Spokane, WA 99207

28-810-1251

EZShield™ Check Fraud Protection for Business

DATE 11/17/11

PAY Two Thousand Two Hundred Forty & 00/100 ———— DOLLARS $2,240.00

TO THE ORDER OF

Specialty Construction Inc
1750 Meyer Rd.
Post Falls, ID. 83854

VOID IF NOT CASHED WITHIN 90 DAYS

NOT NEGOTIABLE

⑈008291⑈ ⑆125108104⑆ 810048 30⑈

SWARTOUT FAMILY INVESTMENTS LLC

8291

Deluxe For Business 1-800-225-6380 or www.nebs.com
PRODUCT 55203N

DATE	DESCRIPTION	AMOUNT
11/17/11	11/1/11 Invoice #1202 - $2,240.00 Drill Holes @ 57th & Regal Commercial Center / Project	$2240.00

#1800

Specialty Construction Inc.
1750 Meyer Rd.
Post Falls, ID 83854

SPOKANE WA 990
15 NOV 2011 PM 4 L

E-MAILED

OK to PAY

SFI
57'm
REGAL
RETAIL

Dennis Swartout
P.O. Box 30009
Spokane, WA. 99223-3000

99223+3000

SPECIALTY CONSTRUCTION INC
1750 MEYER RD
POST FALLS, ID 83854
(208)699-7866

Invoice

Bill To:
Dennis Swartout PO Box 30009 Spokane Wa. 99223-3000 PH: (509)448-5045 FX: (509)448-5435

Date	Invoice No.	P.O. Number	Terms	Project
11/01/11	1202	57th, Regal	Due on receipt	

Item	Description	Quantity	Rate	Amount
Drill	Drill hours, for holes in swale for project at Regal and 57th	14	160.00	2,240.00
			Total	$2,240.00

Hi Dennis
Sorry To Take So Long
To get This To you.
We Tried To Send it To
All of your E-Mail Addresses
But had No Luck.
Thank you for The Work
Sonny

SWARTOUT FAMILY INVESTMENTS LLC
P.O. BOX 30009
SPOKANE, WA 99223-3000
(509) 448-5074

INLAND NORTHWEST BANK
Spokane, WA 99207

8275

28-810-1251

DATE 11/2/11

PAY Two Thousand & 00/100 DOLLARS $2,000.00

TO THE ORDER OF DENNIS SWARTOUT

VOID IF NOT CASHED WITHIN 90 DAYS

NOT NEGOTIABLE

⑈008275⑈ ⑆125108104⑆ 81004830⑈

SWARTOUT FAMILY INVESTMENTS LLC

8275

Deluxe For Business 1-800-225-6380 or www.nebs.com
PRODUCT 55203N

DATE	DESCRIPTION	AMOUNT
11/2/11	3 - REIMBURSEMENTS PAID CASH FOR: • 10/26/11 PAID WORKER FOR MOVING CONES AND BARRICADES - $100.00 • 11/1/11 PAID 2 WORKERS FOR CLEANING OUT 56 HOLES IN WEST 208 POND - $400.00 • 11/1/11 208 POND PAID FOR PUMP TRUCK 10 HOURS @ $150 PER HOUR - $1,500.00	$2,000.00 TOTAL #1800

11-1-11 JOE,

DAD PAID 2 WORKERS $400.00 FOR CLEANING OUT 56 HOLES IN WEST 208 POUND IN GEM 57 DEVELOPMENT

REIMBURSE DAD.

JON

10-26-11 JOE,

DAD PAID WORKER $100.00 FOR MOVING BARICADES AND CONES TO GEM 57 DEVELOPMENT.

REIMBURSE DAD.

JON

11-1-11 JOE,

DAD PAID $1,500.00 FOR PUMP TRUCK AT SEM57 DEVELOPMENT, 10 HOURS AT $150 PER HOUR WEST 208 POUND WORK.

REIMBURSE DAD.

JON

STRATA

Integrity from the Ground Up

March 4, 2011
File: SWAFAM S11010A

Mr. Ben Swartout
Swartout Family Investments, LLC
PO Box 30009
Spokane, WA 99223

RE: **Geotechnical Engineering Services**
Proposed Commercial Development
55th Avenue and Regal Street
Spokane, Washington

Dear Mr. Swartout:

Strata, A Professional Services Corporation, (STRATA) has performed the authorized geotechnical engineering services for the proposed commercial development planned southwest of 55th Avenue and Regal Street in Spokane, Washington. STRATA accomplished our evaluation to assess subsurface site soil and rock conditions and provide geotechnical recommendations to assist with specific aspects of project planning, design and construction. We accomplished our geotechnical services referencing the authorized proposal dated January 21, 2011.

This report summarizes our field evaluation and laboratory testing results, engineering opinions and geotechnical recommendations. The subsurface conditions observed at the site in conjunction with soil engineering and construction characteristics are presented herein. The geotechnical recommendations presented must be read and implemented in their entirety. Portions or individual sections of our report cannot be relied upon without the supporting text. Our opinion is, proposed construction success will depend, in part, upon the contractor following the report recommendations, conducting good construction practices and the owner or contractor providing the necessary construction monitoring, testing and geotechnical consultation to verify the work has been completed as recommended. We recommend STRATA be retained to provide monitoring, testing and consultation services to verify the report recommendations are being followed. If we are not retained to verify our recommendations are followed during construction, we cannot be responsible for designer or contractor errors, omissions or report misinterpretations.

We appreciate the opportunity to work with Swartout Family Investments, LLC and Whipple Consulting Engineers on this project. Please do not hesitate to contact us if you have any questions or comments.

Sincerely,
STRATA, Inc.

Angela K. Lemmerman, P.E.
Project Manager and Engineer

Chris M. Comstock, P.E., P.G.
Senior Engineer

Geotechnical Engineering Services
Proposed Commercial Development
55th Avenue and Regal Street
Spokane, Washington

PREPARED FOR:
Mr. Ben Swartout
Swartout Family Investments, LLC
PO Box 30009
Spokane, WA 99223

CARBON COPIED TO:
Mr. John F. Saywers, P.E. & Mr. Todd Whipple, P.E.
Whipple Consulting Engineers
2528 N. Sullivan Road
Spokane Valley, WA 99216

WCE

PREPARED BY:
STRATA, Inc.
10020 East Knox Avenue, Suite 200
Spokane, Washington 99206

March 4, 2011

TABLE OF CONTENTS

INTRODUCTION

STRATA accomplished our geotechnical engineering services to assess the subsurface soil and bedrock conditions within the proposed project area to prepare geotechnical recommendations to assist with specific aspects of project planning, design and construction. We accomplished the following services referencing the authorized proposal dated January 21, 2011.

1. STRATA provided a site sketch outlining proposed exploration locations for review by the project design and ownership team, prior to scheduling exploration. We coordinated an appropriate exploration time with the design and ownership team.
2. STRATA coordinated with a public utility locating service to locate public utilities at the project site. STRATA also coordinated with Mr. Ben Swartout to identify any private utilities at the project site.
3. STRATA subcontracted a trackhoe and operator to advance 6 test pits at the project site. One (1) test pit was excavated by hand due to utility conflicts. A field professional observed, described and classified the subsurface conditions encountered referencing the *Unified Soil Classification System* (USCS) and retained select soil samples for laboratory testing. Test pits were backfilled loosely following completion and were slightly heaped to provide camber to help accommodate future test pit backfill settlement.
4. STRATA performed a single-ring infiltration test in test pits accomplished in proposed stormwater Pond C and Pond D at a depth of 8 inches below the ground surface. We referenced the *Spokane Regional Stormwater Manual* (Stormwater Manual) for the *Single-Ring Infiltration Test Method*.
5. STRATA subcontracted a water truck to discharge clean water into test pit TP-6 advanced several feet into basalt bedrock in the overflow infiltration area. We monitored the flow rate required to maintain a constant head level in the test pit. We documented hydraulic head levels and flow rates over the course of 2 hours after achieving a stabilized flow rate. STRATA obtained photographs during the infiltration test. We referenced the Stormwater Manual for the infiltration test method.
6. STRATA walked the surrounding properties and subject property boundary to help identify downgradient properties that may be impacted by on-site stormwater disposal. We performed such reconnaissance and took field notes to support our evaluation of stormwater infiltration impacts to adjacent properties, as required by the Stormwater Manual.
7. STRATA performed laboratory testing on select soil samples referencing *ASTM International* (ASTM) test standards to help assist soil classification and to estimate soil engineering properties. Our laboratory testing included:

- Percent passing the No. 200 sieve
- Washed gradations

8. STRATA reviewed the subsurface conditions encountered, laboratory test results and the proposed construction to support our geotechnical analyses to provide recommendations for the following:
    - Stormwater disposal referencing the Stormwater Manual
        - Allowable soil infiltration rate
        - Recommended soil infiltration soil
        - Stormwater disposal hazards and site drainage considerations
        - Impacts to downgradient properties
        - Bedrock infiltration considerations
    - Soil liner system recommendations
        - Recommended liner soil type
        - Liner soil compaction and processing considerations
        - Maintenance considerations
    - Synthetic liner recommendations
        - Liner anchorage requirements
        - Liner cushion and overburden considerations
        - Maintenance considerations
    - Earthwork for pavement subgrades
        - Pavement subgrade preparation
        - Excavation characteristics
        - Structural fill criteria and compaction requirements
        - Wet weather/wet soil construction
    - Flexible pavement design – heavy and standard-duty
        - Correlations to soil resilient modulus
        - Recommended AASHTO flexible pavement design
        - Geotextile applications
    - Additional recommended services
9. STRATA prepared and provided this final report summarizing our recommendations including a site plan and exploration logs. We provided 3 hard copies and 1 electronic copy of our final geotechnical report for your use.
10. STRATA will attend 1 meeting or 1 conference call with the team and/or Spokane County (County) following report publication to discuss any questions or concerns relating to our report. STRATA will prepare up to 1 response to County comments, if necessary. Our response is not intended to guarantee stormwater approval, but rather, to address reasonable County comments or requested clarification, assuming no additional research, fieldwork, laboratory testing or site mobilizations are required.
11. STRATA will accomplish plan and specification review for stormwater disposal aspects, once project plans are developed to the 80 percent level or more, to

evaluate if our geotechnical recommendations have been incorporated. We will provide comments to Whipple via electronic mail or telephone conversation.

PROJECT UNDERSTANDING

We base our project understanding on our ongoing conversations with the project civil engineer Mr. John Saywers, P.E. with Whipple Consulting Engineers (Whipple), yourself and Mr. Matt Zarecor, P.E. with the County. Additionally, STRATA reviewed a *Preliminary Geotechnical Evaluation* report compiled by GeoEngineers for the project site dated August 22, 2008.

We understand you plan to develop an approximate 2.23-acre commercial development, comprised of several parcels, located southwest of the intersection of 55th Avenue and Regal Street in Spokane, Washington. Development plans currently include 2, single-story, slab-on-grade, post-framed structures with asphalt paved parking and drive lanes and on-site stormwater disposal. A preliminary site schematic provided by Whipple indicates 4 stormwater ponds (A through D) and an overflow infiltration area are planned to collect, treat and dispose of site stormwater via a combination of evaporation and infiltration. Based on our conversations with Mr. Zarecor, we understand the County is concerned with the presence of shallow basalt bedrock at the site and site stormwater negatively impacting the existing development located west and north of the site. We understand the County must approve the stormwater system and Mr. Zarecor indicated the system must prevent impacts to adjacent downgradient properties.

To help meet County requirements, Whipple requested STRATA accomplish geotechnical services to assist stormwater disposal design. In addition, per our proposal, STRATA provides asphalt pavement design and evaporation pond liner design considerations herein to assist the design team with project civil design. We understand you plan to use *International Building Code* (IBC) minimum design parameters for the proposed building foundation and slab structural design and did not request STRATA provide a geotechnical evaluation for the proposed buildings.

FIELD AND LABORATORY EVALUATION

Site Exploration

We evaluated the site subsurface conditions by observing 6 exploratory test pits. Exploration locations presented on Plate 1, *Site Plan*, are approximate and were located in the field by measuring from existing site features. A STRATA engineer conducted fieldwork on February 14, 2011. The subsurface conditions encountered during exploration were visually described, classified and logged referencing the USCS. Appendix A presents exploratory test pit logs and a USCS explanation, which should be used to help interpret soil terms used throughout this report. We obtained select subsurface soil samples within test pits for laboratory testing and to assist soil classification.

We advanced test pits to depths of 2.5 to 4.5 feet using a John Deere 160LC trackhoe equipped with a 24-inch wide bucket with standard soil excavation teeth. TP-4 was advanced by hand to a depth of 2.0 feet due to utility conflicts. Test pits were loosely backfilled following completion. In locations where test pits underlie structures or pavements, we recommend the loose test pit backfill be removed and replaced with structural fill as outlined herein.

In TP-4 and TP-5, STRATA accomplished a single-ring infiltration test at approximately 8 inches below the existing ground surface referencing the *Single-Ring Infiltration Test Method* outlined in the Stormwater Manual. STRATA also accomplished a large-scale infiltration test in TP-6 referencing the *Test Pit Method* outlined in the Stormwater Manual. For the large-scale test, we monitored the flow rate required to maintain a constant head level in the test pit. We documented hydraulic head levels and flow rates over the course of 2 hours after achieving a stabilized flow rate. STRATA documented stabilized outflow rates and resulting infiltration rates to assist stormwater disposal design as discussed in the *Stormwater Disposal* report section.

Subsurface Conditions

Test pits TP-1 and TP-2 accomplished in the northern portion of the site encountered native silty sand alluvium at the ground surface to depths ranging from 1.5 to 2.0 feet. Silty sand was reddish brown to tan, medium dense and wet, and contained significant vegetation and organics to approximately 7.0 inches below the ground surface. In TP-1, native silty sand was underlain by poorly-graded sand with gravel to a depth of 2.75 feet, where basalt bedrock was encountered. In TP-2, basalt bedrock was encountered beneath native silty sand alluvium at a depth of 2.0 feet. Basalt bedrock was grey with tan coating, moderately fractured, slightly weathered to fresh and dense, and resulted in excavation refusal in TP-1 and TP-2.

TP-3 accomplished in the central portion of the site encountered approximately 3.5 feet of uncontrolled fill consisting of silty sand with gravel and trace cobbles, which was dark brown to dark tan, loose to medium dense and moist. Uncontrolled fill contained brick, concrete and asphalt debris throughout. Significant vegetation and organics were observed to a depth of 4.0 inches below the ground surface. Uncontrolled fill was underlain by sandy silt topsoil, which was dark brown, firm and wet and underlain by native silty sand to the test pit termination depth at 4.5 feet beneath the ground surface. The uncontrolled fill visually appeared to extend to portions of the site below proposed buildings.

TP-4 and TP-5 accomplished in existing swales located near the proposed Pond C and Pond D, respectively, encountered sandy silt topsoil to a depth of 6.0 inches underlain by silty sand, which extended to the termination depth of TP-4 and to a depth of 1.75 feet beneath the ground surface in TP-5 where basalt bedrock was encountered. Significant vegetation and organics were observed to 3.0 to 4.0 inches beneath the ground surface in these test pits.

Finally, TP-6 encountered surficial uncontrolled fill consisting of silty gravel with sand, which was dark brown, medium dense and moist and extended to a depth of 6.0 inches. Uncontrolled fill was underlain by native silty sand to a depth of 1.5 feet where basalt bedrock was encountered. Basalt bedrock was excavated from a depth of 1.5 feet beneath the ground surface to a depth of 4.0 feet beneath the ground surface to allow for a large-scale infiltration test to be performed in the bedrock. Cobbles and gravel were observed at the soil-rock interface at 1.5 feet beneath the ground surface and bedrock was not generally excavatable below a depth of 4.0 feet using the exploration equipment. The bedrock rippability varied throughout the test pit in short horizontal and vertical distances. Appendix B provides photographic documentation of soil and rock conditions in TP-6 and the infiltration testing apparatus in TP-4.

We did not encounter groundwater during exploration. However, groundwater has the potential to fluctuate with seasonal variations in precipitation and runoff can become temporarily perched along the soil-bedrock interface. The above subsurface description and exploration logs provided in Appendix A provide a summary of the subsurface geology at the project site consisting of alluvium deposited over relatively shallow basalt bedrock.

Laboratory Testing

STRATA tested select soil samples to help evaluate their engineering characteristics and to assist soil classification. We completed the following laboratory tests:

- Percent passing the No. 200 sieve
- Washed gradations

Index laboratory test results are summarized on the exploratory logs in Appendix A. We performed laboratory testing referencing applicable ASTM test standards. STRATA will retain soil samples in our laboratory for a period of 90 days following the date of the final report unless we receive written notification to retain the samples for a longer time period.

GEOTECHNICAL OPINIONS AND RECOMMENDATIONS

The following geotechnical recommendations are presented to assist aspects of project planning, design and construction of the proposed commercial development to be located southwest of 55th Avenue and Regal Street in Spokane, Washington. We base our geotechnical recommendations on our experience with similar soil and geologic conditions, findings from our field and laboratory evaluation and our understanding of the proposed construction. If development plans change, we should be contacted to review the project modifications and revise our recommendations, if necessary. Additionally, if conditions are exposed during construction that are different than what we encountered during exploration, STRATA should be retained to review our recommendations and provide any necessary revisions or modifications. Per our authorized proposal dated January 21, 2011, you have retained STRATA to review stormwater-related project plans and specifications, which are developed to the 80 percent level or more to evaluate if the geotechnical recommendations herein have been incorporated.

Stormwater Disposal

STRATA performed 1 single-ring infiltration test in TP-4 and TP-5 at a depth of 8.0 inches below existing ground surface in silty sand. STRATA also performed a large-scale bedrock infiltration test in TP-6. Infiltration test results yielded an estimated, unfactored, vertical field stormwater infiltration rate of approximately 0.9 inches per hour (in/hr) in TP-4 (Pond C), negligible infiltration in TP-5 (Pond D) and 0.315 in/hr in TP-6 (overflow infiltration area).

Pond C and Pond D

From our conversations with Whipple and Mr. Swartout, we understand the existing swale that exists below the proposed Pond C, performs well and generally drains without backing up stormwater to the parking area. Based on utility locate markers observed during fieldwork and discussions with Mr. Swartout, we understand several utility corridors traverse through this swale area. The existing development has been in place for several decades and Mr. Swartout and STRATA are not aware of any impacts to downgradient structures from this swale infiltration. Due to utility conflicts, we were unable to advance exploration to basalt bedrock in the Pond C footprint, although this area is one of the highest elevation areas on the site, which may suggest a thicker soil profile. The proposed Pond D area exists near an existing swale, which is lower than the Pond C swale and reportedly exhibits wet conditions throughout much of the year. From our exploration results, basalt bedrock is very near the current swale base and the soil exhibited a much higher plasticity than the soil encountered in the Pond C footprint. STRATA is not aware of any utility corridors through the Pond D swale footprint or the conveyance swale that exists at the extreme south property boundary.

Based on infiltration testing results as presented, we recommend Pond C be designed using an allowable infiltration rate of 0.45 in/hr based on a factor of safety of 2.0. This assumes Pond C is constructed with a similar or higher invert elevation to the existing swale. If the Pond C invert is higher than the existing swale invert, we recommend the pond be filled using backfill with an infiltration rate greater than 1.0 in/hr. This pond backfill infiltration rate can be validated via grain size distribution results or field testing. Based on the negligible infiltration rates observed in the area of Pond D, we recommend Pond D be designed for total storage and not rely on any vertical infiltration. Even if the Pond D invert is filled to raise grades, our opinion is the slightly plastic soil and shallow bedrock will create negligible infiltration rates.

Overflow Infiltration Area

Appendix B provides photographic documentation of the large-scale infiltration test accomplished in TP-6 within basalt bedrock near the proposed Pond B overflow infiltration area. We recommend the infiltration area be designed for an allowable infiltration rate of 0.15 in/hr using a factor of safety of 2.0 based on our field test results. This infiltration rate assumes excavation will penetrate bedrock to a minimum depth of 1.0 foot to expose fractures. STRATA shall be retained to identify the actual bedrock surface, which can be misinterpreted by inexperienced persons as the transition zone between soil and bedrock. Excavation shall be completed in a manner that precludes any soil from reaching the excavation and clogging potential bedrock fractures. The contractor shall protect the excavation from soil fines contamination at all times until the overflow infiltration excavation is backfilled.

If the owner or design team desire to use a higher infiltration rate for bedrock, we recommend air track drilling or other methods of fracturing and exposing bedrock fractures be considered. One option is to advance air track borings through the bedrock to a minimum depth of 10 feet. If bedrock excavation is accomplished to a depth of 1.0 foot and air track drilling is accomplished from this elevation in the facility's footprint, an allowable infiltration rate of 0.5 in/hr can be used to design this facility. To rely upon this infiltration rate, air track or equivalent borings must be drilled on maximum 4-foot spacings to a minimum depth of 10.0 feet below the 1.0-foot overexcavation base. Air track must be advanced using a minimum 3.0-inch-diameter bit and should be immediately backfilled with clean, coarse, free draining aggregate with a nominal maximum particle size between ¼ and ¾ inches. This allowable infiltration rate assumes that infiltration will be verified during construction via a large-scale flood test and that STRATA is allowed the opportunity to observe air track drilling and infiltration gallery construction. If large-scale flood tests during construction yield an infiltration rate less than 0.5 in/hr, additional air track holes should be drilled or the area increased until the allowable infiltration rate is achieved. We recommend stormwater design and project specifications be approved and permitted contingent upon actual field infiltration testing during construction. The above recommendations for the overflow infiltration area also assume negligible turbidity based on the proposed stormwater treatment conducted via Pond B and the proposed oil-water separator between Pond B and the overflow infiltration area. STRATA's design assumes the bedrock fractures and conveyance systems will not be clogged with fine-grained soil particles based on our conversations with Whipple and their design assumptions for stormwater conveyed to the infiltration gallery. We do not recommend any utilities be constructed within the proposed infiltration gallery.

Impacts to Downgradient Properties

STRATA traversed the subject property and immediate surrounding properties to help identify downgradient properties that may be impacted by on-site stormwater disposal. In our opinion, adverse downgradient effects due to on-site stormwater disposal will not be realized. We understand Pond A located near the northwest corner of the property will be lined and, in our opinion, leakage will be negligible (i.e. less than predevelopment rates). Pond B planned in the southwest corner of the property is lower than the surrounding properties and therefore will not have an adverse affect on downgradient properties. Proposed areas of Pond C and Pond D are currently operating as swales for the existing development and we are unaware of any negative downgradient effects attributed to these swales based on conversations with Mr. Swartout.

As discussed previously, the existing swales in Pond C and Pond D footprints have been operating for many years and the project team is not aware of any downgradient impacts from these current swales. The swale north of the carwash (proposed Pond C location) has contained utilities for several years and the presence of these utilities does not appear to be impacting downgradient properties. Further, the Pond C footprint may reduce the size of this swale and, therefore, reducing the potential stormwater disposed to subsurface utilities. Accordingly, our opinion is constructing ponds near existing swales north and south of the carwash facility will not impact the subsurface infiltration characteristics of the parcel nor impact downgradient properties. Finally, the proposed infiltration gallery located in the south-central portion of the site is lower than the surrounding properties. The invert elevation for this gallery will be lower than the ground surface in all portions of the development area. Our opinion is the slow rate infiltration plan for the infiltration gallery will allow water to migrate vertically through bedrock fractures and will not impact adjacent properties. The gently sloping nature of the area suggests this water will not daylight on steep slopes and will impact groundwater in bedrock similarly to naturally occurring subsurface moisture in the area.

Evaporation Pond Liner Design and Considerations

Soil Liner System

If a soil liner is selected to line Pond A for the project, we recommend the liner be placed on slopes no steeper than 3H:1V (horizontal to vertical). The soil liner should be a minimum of 12 inches thick placed continuously at the pond base and on side slopes to at least 12 vertical inches above the overflow invert. The soil liner should be compacted to a minimum of 95 percent of ASTM D 1557 (Modified Proctor) at or higher than optimum moisture content fro compaction. This compacted state should yield a permeability of less than 10^{-6} in/hr, which corresponds roughly to 2 orders of magnitude less than the native soil beneath the pond. We recommend the soil for the proposed liner contain less than 50 percent sand and gravel (i.e. classified as a ML, CL, CH or MH per the USCS). Topsoil can be placed over the pond liner, however, we recommend it be vegetated and irrigated to reduce the potential for soil liner drying and cracking. Penetrations in the soil liner must be backfilled and compacted with the soil liner material for the entire penetration depth.

While, typically, a soil liner is less expensive, the liner will require oversight and testing during construction to ensure compaction is achieved and to validate in-place permeability. We recommend project specifications reflect the requirement for the contractor to provide the owner and civil engineer with a sample of the proposed liner material. STRATA shall be retained to review the liner submittal and perform gradation, permeability or plasticity tests to verify our recommendations for soil liner material are followed. Moderate maintenance will be required of the liner to reduce the potential for liner drying and cracking, which will increase liner permeability and leakage.

Synthetic Liner System

If a synthetic liner is selected to line Pond A, we recommend the liner be placed on slopes no steeper than 2H:1V. The liner should have a permeability of less than 10^{-6} in/hr and a mill thickness of at least 15 inches. The liner should be PVC or other equivalent synthetic material rated for burial. Prior to lining placement, we recommend the following specific subgrade preparations be accomplished.

1. Compact the native or fill subgrade in the pond and all side slopes using a smooth drum roller to create a smooth surface, free of depressions or surface irregularities greater than 1 inch in diameter. No sharp, pointed or otherwise detrimental areas to synthetic liners should be evident. STRATA, the earthwork contractor and liner supplier/installer must inspect the subgrade for conditions which may damage the liner during installation and/or reduce its effective life due to puncture or wear. Upon STRATA's review and approval of the above liner preparations, the liner can be placed directly over the prepared subgrade. Undulating subgrades and any subgrade exhibiting bedrock or gravel must receive additional preparations as recommended below.
2. Place 8 inches of native soil containing less than 10 percent particles larger than the No. 4 sieve. Proof compact the soil between the subgrade and synthetic liner using moderate compaction effort with a smooth-drum or smooth surface compactor. Alternatively, install a non-woven geotextile suitable to the liner manufacturer and installer on the pond subgrade between the subgrade and synthetic liner.

We recommend the synthetic liner be anchored into an 18-inch-ide by 18-inch-deep trench constructed a minimum of 18 inches from the pond embankment slope crest along the top of the embankment. Backfill for the trench shall be placed and compacted to 95 percent of ASTM D 1557 (Modified Proctor).

The synthetic liner must be installed, inspected and tested in strict accordance with the manufacturer recommendations. In addition, typical suppliers require subgrade inspection by a representative of their company prior to contractor installation. If the liner is not rated for ultraviolet (UV) ray exposure, the liner must be covered with soil or otherwise be protected from UV damage using methods and systems determined by the manufacturer.

Groundwater was not encountered at the site, however, as mentioned previously, it is common for groundwater to occur during spring and summer months as minor seeps perched above the bedrock surface. If groundwater does occur at the subgrade surface, the liner could be disturbed and "bubble" or be otherwise damaged from groundwater disturbance. If the pond is full, the hydrostatic pressure from the water will minimize the groundwater effect. However, this risk will still exist and, if the pond evaporates before groundwater dissipates, the risk of liner disturbance from groundwater effects will increase. Depending upon the actual pond depth, our opinion is the hydrostatic pressure from groundwater will be less than 1.0 or .0 feet, based on relatively thin soil profile in this area. Accordingly, up to 2.0 feet of hydrostatic pressure can be mitigated using at least 1.0 foot of anchorage or soil ballast having a soil moist unit weight greater than 125 pounds per cubic foot.

Earthwork for Pavement Subgrades

Pavement Subgrade Preparation

We recommend exploratory test pits be surveyed and relocated prior to or during mass grading. If loose test pit backfill underlies any pavement, flatwork or building structure, we recommend loose test pit backfill be completely removed to undisturbed native soil or bedrock and replaced with structural fill according to the recommendations provided herein.

We recommend all soil containing significant vegetation and organics (topsoil) be removed below any planned pavement or fill area. We observed 4 to 7 inches of significant vegetation and organics in proposed pavement areas and this soil should be removed to expose soil that contains less than 3 percent organics (by weight). Furthermore, uncontrolled fill was encountered in TP-3 located within a planned pavement area. Geotechnical standard-of-care indicates uncontrolled fill should be removed to expose native soil and replaced with structural fill beneath all proposed structures, including pavements. Uncontrolled fill is variable in nature and may result in inconsistent subgrade support performance and could ultimately lead to inconsistent asphalt surface performance if it remains in-place. However, the cost to remove uncontrolled fill at the project site may not be a viable option for the project and, therefore, we have accomplished our design taking into consideration the anticipated inconsistent fill performance from leaving the uncontrolled fill in-place. The fill is granular in nature and has been on the site for an extended period of time. Ultimately, the owner must acknowledge and accept the risk of potentially inconsistent fill performance as it relates to asphalt surface performance if uncontrolled fill will remain in-place.

Following topsoil and exploratory test pit remediation, we recommend the pavement subgrade be scarified, moisture-conditioned and recompacted to structural fill requirements to a minimum depth of 8 inches. Recompacting the subgrade will require moisture-conditioning and soil processing as described in the *Structural Fill* section below. Subgrade preparations can often help identify areas susceptible to subgrade pumping and rutting. Although pumping or rutting is not expected during dry weather conditions, pumping or rutting subgrade areas should be removed to a depth of 12 inches below the subgrade. The excavation from removing such pumping and rutting areas (overexcavation) should be replaced with structural fill or Crushed Surfacing and compacted as recommended in the *Structural Fill* report section. After the above subgrade compaction procedures are accomplished and verified by STRATA, structural fill and/or the pavement section may be placed over the recompacted subgrade according to the report requirements.

Excavation Characteristics

We anticipate the on-site soil may be excavated using conventional soil excavation techniques. In general, slopes and excavations must be excavated, shored or braced in accordance with the *Washington Industrial Safety and Health Act* (WISHA) specifications and local codes. The on-site soil is generally classified as a "C" type soil according to WISHA requirements. As such, we recommend provisions be made to allow temporary excavations of any type and soil to be sloped back to at least 1.5H:1V or as otherwise determined to be safe according to the selected contractor's competent person. Ultimately, the selected contractor is responsible for site safety and determining appropriate excavations for the conditions and soil types encountered during construction. STRATA accepts no responsibility for temporary excavation stability.

Trenches shallower than 4.0 feet in depth may stand vertically for short periods of time, depending upon the soil type and soil moisture conditions. However, the on-site soil has few fines and can cave readily during excavation at depths deeper than 4.0 feet. Construction vibrations could still cause vertical excavations to slough or cave within the silty sand sediments.

Excavations must be planned carefully, allowing water collection points and utilizing conventional sumps and pumps to remove nuisance water from runoff, precipitation or groundwater seeps. If soil excavations in silty soil are not immediately backfilled, they may degrade when exposed to runoff and require overexcavation and replacement with granular fill. We recommend construction activities and excavation backfilling be performed as rapidly as possible following excavation to reduce the potential for subgrades to degrade under construction traffic.

Based on the conditions encountered during construction and our understanding of preliminary site grades, we expect utility excavation, stormwater improvements or other trenching/excavation activities will encounter basalt bedrock. If bedrock is encountered, excavation beyond 1 to 2 feet into the basalt is expected to require hydraulic hammers or heavy equipment with ripper shanks and/or blasting. The following bullets outline example specifications and considerations for rock excavation.

- The earthwork contractor is ultimately responsible for the method for rock excavation and safety.
- Bedrock excavation shall be performed with late-model, track-mounted hydraulic excavators equipped with a 24-inch-wide (maximum), short-tip-radius rock bucket; rated at not less than 140-hp flywheel power with a bucket-curling force of not less than 28,000 lbf and stick-crowd force of not less than 18,500 lbf; measured according to SAE J1179.
- Rock excavation includes removal and disposal. All rock excavation is expected to be basalt rock excavation. Experience has shown that a minimum 7,500-pound hoe ram is required to break out basalt rock when not fractured or weathered. Rock requiring hoe rams of this size or larger for excavation shall be paid as rock excavation. Excavation using the equipment discussed above that does not require a 7,500-pound hoeram should not be paid as rock excavation.
- Rock excavation shall be measured as the neat cut lines required for trench and utility construction plus 1 foot laterally on each side of the trench. Rock breakout and required backfill beyond these limits should not be paid.

Structural Fill

All fill placed to support structures should be placed as structural fill. All structural fill must meet Table 1 requirements presented below.

Table 1. Structural Fill Specifications and Allowable Use

Soil Fill Product	Allowable Use	Material Specifications
Unsatisfactory Soil	**NONE**	• Soil classified as CH, MH, OH, OL or PT may not be used at the project site. • Any soil type not maintaining moisture contents within 3 percent of optimum moisture during compaction is unsatisfactory soil[1]. • Any soil containing more than 3 percent organics by weight or other deleterious substances (wood, metal, plastic, waste, etc).
Structural Fill	All site grading, utility backfill and embankments below pavements.	• Soil must be classified as GP, GM, GW, SP, SM, or SW according to the USCS. • Soil may not contain particles larger than 6 inches in median diameter. • Soil may not contain more than 3 percent (by weight) organics or other deleterious substances such as wood, metal, plastic, waste, etc.
Crushed Surfacing[2]	Pavement section and slab support, general structural fill.	• Soil meeting requirements stated in *Section 9-03.9(3) – Crushed Surfacing* of WSDOT Standards[3].

1. Satisfactory soil that is wetted or dried to within 3 percent of optimum moisture may be used as satisfactory soil.
2. Includes both top course and base course *Crushed Surfacing*.
3. *Washington State Department of Transportation* (WSDOT) *Standard Specifications for Road, Bridge and Municipal Construction* (WSDOT Standards).

Structural fill should be compacted to a minimum of 95 percent of the maximum dry density of the soil referencing ASTM D 1557 (Modified Proctor). Any structural fill products should be moisture-conditioned to near optimum moisture content and placed in maximum 12-inch-thick, loose lifts. The above compaction and structural fill requirements assume large compaction equipment such as vibratory rollers with drum energy of 10 tons or greater is used to attempt compaction. If smaller or lighter compaction equipment is provided, the lift thickness may have to be reduced to meet the compaction requirements presented herein.

We anticipate the native soil encountered in test pits may be reused as structural fill, provided it can be moisture-conditioned and compacted to meet the structural fill requirements presented in Table 1 above. We do not recommend soil with more than 3 percent organics or containing roots larger than ½ inch be reused as structural fill. We expect the native soil will be over optimum moisture content during most periods of the year and will require drying prior to its reuse as structural fill.

Any on-site soil or imported soil used as structural fill comprising material with more than 30 percent by weight coarser than ¾ inch, is too coarse for Proctor density testing (i.e. oversize material). Therefore, oversize soil material placed as structural fill must be compacted using a "method specification" which requires at least 5 complete passes of a 10-ton or larger vibratory roller. This method of compaction effort must create a dense and interlocking surface that does not exhibit pumping, rutting or deflection beneath construction equipment and is free of loose soil debris and standing water. Method compaction must be observed by STRATA on a near full-time basis at the onset of placement to establish final roller pass requirements and to verify the material is compacted to as high a density as practical with the actual compaction equipment.

Construction Scheduling/Wet Weather Construction

If possible, we recommend earthwork construction take place during dry weather conditions. The on-site soil is highly susceptible to pumping or rutting from heavy loads such as rubber-tired equipment or vehicles any time of the year if wet soil conditions persist. If construction commences before soil can dry after precipitation or during wet periods of the year (November through May), we recommend earthwork be completed by low pressure, track-mounted equipment that spread and reduce vehicle load. Allowing time for proper moisture-conditioning during dry weather is critical to reduce excessive overexcavations and avoid unnecessary subgrade rework.

During earthwork, intersect runoff from rainfall or snowfall and temporarily divert it to help prevent ponding of water on the project site. Always seal, adequately slope and daylight subgrades to help direct water away from construction areas after the end of each day or before expected precipitation. Once a subgrade is established, it is the contractor's responsibility to maintain the subgrade's stability and to repair any degradation due to traffic, weather or other environmental effect. The Owner will not be responsible to reimburse the contractor for subgrade rework or overexcavations caused by construction traffic or weather conditions.

Flexible Pavement Design

The following pavement section design is provided referencing the *American Association of State Highway and Transportation Officials* (AASHTO) *Guide for Design of Pavement Structures* (1993). Whipple provided estimated Average Daily Traffic (ADT) and percent truck data to STRATA for use in estimating traffic loading. STRATA assumed additional design parameters based on typical flexible pavement design criteria in the eastern Washington area, results from laboratory testing and our understanding of the subsurface conditions and proposed construction. The following tables present our design parameters and references as well as the resulting pavement section design recommendations.

Table 2. Pavement Section Design Parameters

Design Parameter	Value Used	Reference
Reliability (R)	90%	Assumed
Standard Deviation (S)	0.45	AASHTO 1993
Initial Serviceability (PSI_i)	4.2	Typical eastern Washington area values
Terminal Serviceability (PSI_z)	2.2	Typical eastern Washington area values
Traffic Loading	15,000 ESALS[1] (Standard-Duty) 50,000 ESALS[1] (Heavy-Duty)	Based on ADT estimates provided by Whipple.[2]
Pavement Design Life	20 years	Assumed
Resilient Modulus (M_r)	10,000 psi[3]	Based on CBR and M_r correlations (see paragraph below)
Asphalt Layer Coefficient (a_1)	0.42	Figure 2.5 AASHTO 1993
Top Course Layer Coefficient (a_2)	0.14	Figure 2.6 AASHTO 1993
Top Course Drainage Coefficient (m_2)	0.90	Table 2.4 AASHTO 1993 for "poor" drainage, 5 to 10 percent saturation

1. Equivalent Single Axle Loads (ESALs).
2. Assuming ADT of 757 and 0.5% trucks with equivalent axle load factor (EALF) = 1.2.
3. Pounds per square inch (psi).

Based on CBR and resilient modulus correlations published by AASHTO, and our experience with resilient modulus testing, we estimate the anticipated subgrade soil will have a resilient modulus value of approximately 10,000 psi, provided the subgrade is prepared as recommended in the *Earthwork for Pavement Subgrades* report section. Based on the above pavement design parameters, Table 3 and Table 4 provide our flexible pavement design recommendations for standard-duty and heavy-duty sections, respectively.

Table 3. Flexible Pavement Design – *Standard-Duty Section*[1]

Pavement Section Material	Recommended Thickness (inches)	Material Specifications
Asphalt Concrete	2.5	Hot-mix asphalt (HMA) conforming to *Section 5-04* of the latest edition of WSDOT Standards. HMA should consist of Class 1/2-inch or Class 3/4-inch.
Crushed Surfacing[2]	6.0	Top course or base course conforming to the latest WSDOT Standards *Section 9-03.9(3) Crushed Surfacing*

1. For construction convenience and consistency between standard and heavy duty pavement construction, the *standard-duty section only* can be revised to include 3 inches of asphalt concrete and 5 inches of Crushed Surfacing OR alternatively, 2.0 inches of asphalt concrete and 10 inches of Crushed Surfacing.
2. Includes either top course or base course per WSDOT Standards section 9-03.9(3).

Table 4. Flexible Pavement Design – *Heavy-Duty Section*

Pavement Section Material	Recommended Thickness (inches)	Material Specifications
Asphalt Concrete	3.0	Hot-mix asphalt (HMA) conforming to *Section 5-04* of the latest edition of WSDOT Standards. HMA should consist of Class 1/2-inch or Class 3/4-inch.
Crushed Surfacing[1]	10.0	Top course or base course conforming to the latest WSDOT Standards *Section 9-03.9(3) Crushed Surfacing*

1. Includes either top course or base course per WSDOT Standards section 9-03.9(3).

We recommend civil design specify that standard-duty asphalt pavement be constructed only where passenger vehicles will access the parking areas. Any location that will be regularly accessed by delivery vehicles, garbage trucks or heavy-duty traffic should be specified to receive the heavy-duty asphalt pavement section presented in Table 4. As noted in Table 3 above, the standard-duty section may be modified, such that both pavement sections can be more easily constructed if they are located adjacent to each other. We recommend the designer consider constructing a rigid concrete apron for the dumpster storage area and staging area where a garbage truck may transfer waste from the dumpster to the truck's waste compaction area.

We recommend crack maintenance be accomplished on all pavement surfaces every 3 to 5 years to reduce the potential for surface water infiltration into the underlying pavement subgrade. Surface and subgrade drainage are extremely important to the performance of the pavement section. Therefore, we recommend the subgrade, Crushed Surfacing and asphalt surfaces slope at no less than 2 percent to an appropriate stormwater disposal system or other appropriate location that does not impact adjacent buildings or properties. The pavement's life will be dependent upon achieving adequate drainage throughout the section and especially at the subgrade. Water ponding at the pavement subgrade surface can induce heaving during the freeze-thaw process which can readily damage pavement. Pavements near stormwater facilities are especially prone to water saturation and poor performance if site grades allow water to infiltrate the subgrade.

The above pavement sections assume the pavement subgrade will be prepared as described in the *Pavement Subgrade Preparation* report section. We recommend STRATA be retained to observe and traverse the pavement subgrade to identify areas that deviate from what we have assumed for design and to help identify soft, rutting or pumping soil areas.

ADDITIONAL RECOMMENDED SERVICES

Geotechnical Design Continuity

The information contained in this report is based on ongoing development plans. Final site geometry, stormwater invert elevations, grading and actual subsurface conditions can alter our opinions and design recommendations. Therefore, we recommend STRATA provide geotechnical continuity through final project planning and design as individual design aspects become available. Per our authorized scope, Swartout Family Investments, LLC has retained STRATA to review geotechnical-related sections of the project plans and specifications to verify the plans and specifications are commensurate with our geotechnical recommendations. Additionally, we recommend STRATA be on-site during earthwork, pavement subgrade preparations and stormwater facility construction to verify the conditions encountered during exploration are encountered during construction and that our recommendations are followed. Verification of the subsurface conditions during construction is an important part of the geotechnical design process. If a firm other than STRATA is selected to observe and interpret the subsurface conditions during construction, we request Swartout Family Investments, LLC notify the selected firm of these responsibilities and require the firm to interpret and implement our report as the geotechnical engineer-of-record for the project.

Construction Observation and Monitoring

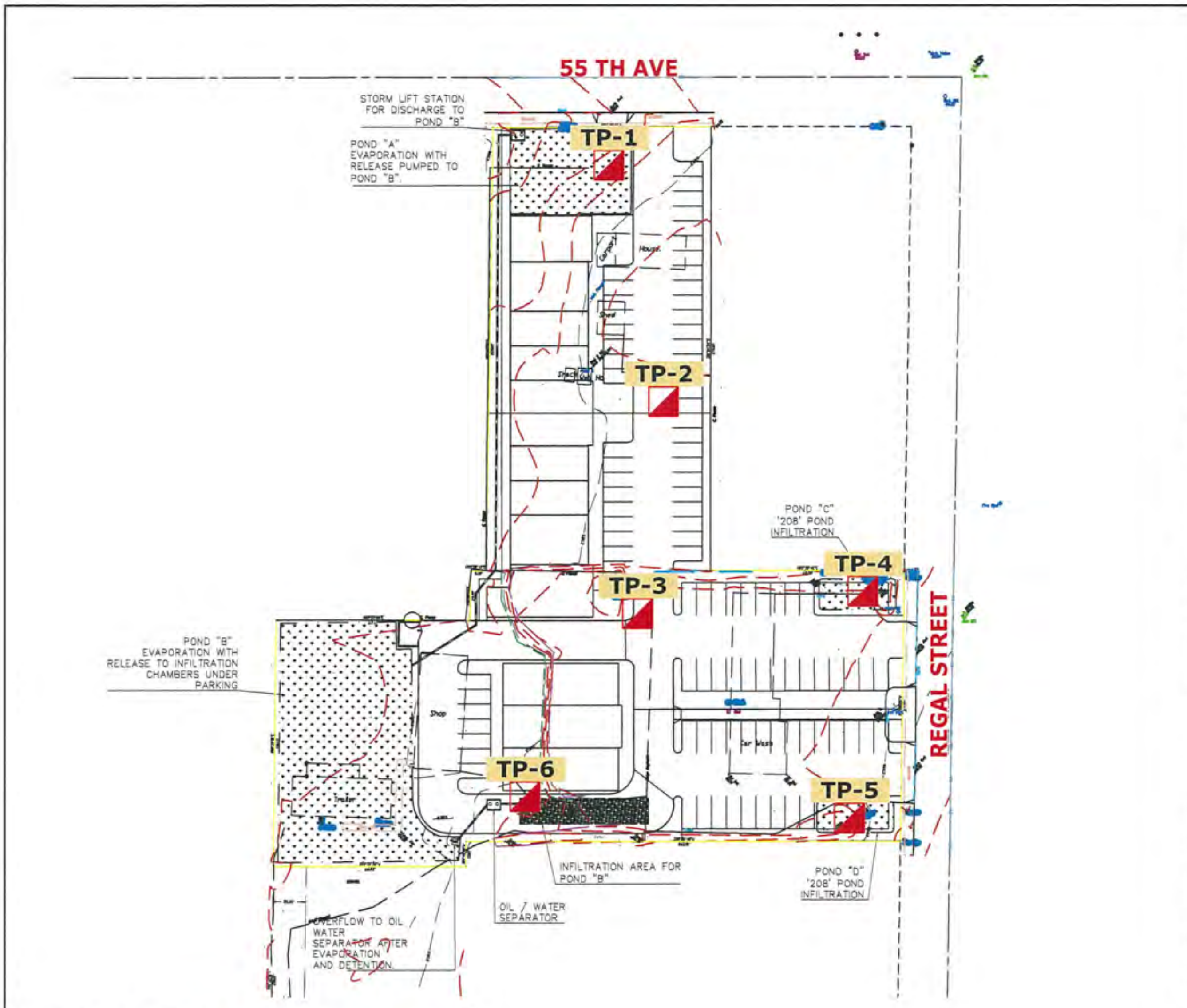
Our opinion is the success of the proposed construction will, in part, be dependent upon following the report recommendations, providing good construction practices and the necessary construction monitoring, testing and consultation to verify the work is completed as recommended. We recommend STRATA provide construction monitoring, testing and consultation services to verify the report recommendations are being followed. If we are not retained to verify our recommendations are followed, we cannot be responsible for designer or contractor errors, omissions, or report misinterpretations.

EVALUATION LIMITATIONS

This report has been prepared to assist planning, design and construction of the proposed commercial development to be located southwest of 55th Avenue and Regal Street in Spokane, Washington. Our services consist of professional opinions and recommendations provided in accordance with generally accepted geotechnical engineering principles and practices as they exist at this time and in the area of this report. This report has been prepared specifically for this project and exclusively for the use of Swartout Family Investments, LLC, Whipple Consulting Engineers and the project design team. We do not authorize its use by other firms. The geotechnical recommendations provided herein are based on the premise that STRATA will continue our project involvement during construction to verify compliance with our recommendations and to confirm conditions between exploration locations. STRATA provided recommendations for pavement section thickness and to assist stormwater disposal only. In authorizing STRATA to provide these services, you understood that additional services to support the development process were available. STRATA did not provide recommendations to support building design and we are not assuming the role of engineer-of-record for any other services or structure not explicitly presented herein and in our January 21, 2011, proposal. This acknowledgement is in lieu of any express or implied warranty.

The following plates and appendices accompany and complete this report:

Plate 1:	Site Plan
Appendix A:	USCS Explanation
	Exploratory Test Pit Logs
Appendix B:	Photographic Documentation



VICINITY MAP
NOT TO SCALE

SITE PLAN
Proposed Commercial Development
55th and Regal Street
Spokane, Washington

0 50 100 200

SCALE: 1 inch = 100 ft

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SWAFAM S11010A	PLATE: 1
DRAWN BY: DMS	CHECKED BY: AKL

Reference: Site Plan Provided by Whipple Consulting Engineers, Date: 2–2011.

APPENDIX A

Unified Soil Classification System (USCS)
Exploration Logs

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UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL NAMES
COARSE GRAINED SOILS	GRAVELS	CLEAN GRAVELS		GW	Well-Graded Gravel, Gravel-Sand Mixtures.
				GP	Poorly-Graded Gravel, Gravel-Sand Mixtures.
		GRAVELS WITH FINES		GM	Silty Gravel, Gravel-Sand-Silt Mixtures.
				GC	Clayey Gravel, Gravel-Sand-Clay Mixtures.
	SANDS	CLEAN SANDS		SW	Well-Graded Sand, Gravelly Sand.
				SP	Poorly-Graded Sand, Gravelly Sand.
		SANDS WITH FINES		SM	Silty Sand, Sand-Silt Mixtures.
				SC	Clayey Sand, Sand-Clay Mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50%			ML	Inorganic Silt, Sandy or Clayey Silt.
				CL	Inorganic Clay of Low to Medium Plasticity, Sandy or Silty Clay.
				OL	Organic Silt and Clay of Low Plasticity.
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%			MH	Inorganic Silt, Mica-ceous Silt, Plastic Silt.
				CH	Inorganic Clay of High Plasticity, Fat Clay.
				OH	Organic Clay of Medium to High Plasticity.
				PT	Peat, Muck and Other Highly Organic Soils.

BORING LOG SYMBOLS	GROUNDWATER SYMBOLS	TEST PIT LOG SYMBOLS
Standard 2-Inch OD Split-Spoon Sample	Groundwater After 24 Hours	BG Baggie Sample
California Modified 3-Inch OD Split-Spoon Sample	(7-3-07) Indicates Date of Reading	BK Bulk Sample
Rock Core	Groundwater at Time of Drilling	RG Ring Sample
Shelby Tube 3-Inch OD Undisturbed Sample		

Shorthand Notation:
BGS = Below Existing Ground Surface
N.E. = None Encountered

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USCS Description	DEPTH (ft)	U.S.C.S. CLASS	SYMBOL	Sample Type	USDA SOIL Textural Classification	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	REMARKS Note: BGS = Below Ground Surface
(SM) Silty SAND (Native Alluvium). Reddish Brown to tan, medium dense, wet.	0 1	SM		BG		45.3		13.1		Significant vegetation and organics observed to 7 inches BGS.
(SP) Poorly-Graded SAND with Gravel. Grey, medium dense, moist.	2	SP		BG						
(RX) Basalt BEDROCK. Grey with tan coating, moderately fractured, slightly weathered to fresh, dense.	3	RX								

Test Pit Terminated at 3.0 Feet.

Client: SWAFAM	**Test Pit Number:** TP-1	**EXPLORATORY TEST PIT LOG**
Project: S11010A	**Date Excavated:** 02-14-2011	
Backhoe: Deere 160LC Trackhoe	**Bucket Width:** 30"	
Depth to Groundwater: N.E.	**Logged By:** CMC	Sheet 1 Of 1

STRATA
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USCS Description	DEPTH (ft)	U.S.C.S. CLASS	SYMBOL	Sample Type	USDA SOIL Textural Classification	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	REMARKS Note: BGS = Below Ground Surface
(SM) Silty SAND (Native Alluvium). Reddish brown to tan, medium dense, wet.	0 1	SM		BG						Significant vegetation and organics observed to 7 inches BGS. Trace to moderate gravel encountered. Gravel content increased with depth.
(RX) Basalt BEDROCK. Grey with tan coating, moderately fractured, slightly weathered to fresh, dense.	2	RX								

Test Pit Terminated at 2.5 Feet.

Client: SWAFAM	**Test Pit Number:** TP-2	STRATA A Professional Services Corporation *Integrity from the Ground Up*	**EXPLORATORY TEST PIT LOG**
Project: S11010A	**Date Excavated:** 02-14-2011		
Backhoe: Deere 160LC Trackhoe	**Bucket Width:** 30"		
Depth to Groundwater: N.E.	**Logged By:** CMC		Sheet 1 Of 1

USCS Description	DEPTH (ft)	U.S.C.S. CLASS	SYMBOL	Sample Type	USDA SOIL Textural Classification	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	REMARKS Note: BGS = Below Ground Surface
(SM) Silty SAND with Gravel (Uncontrolled Fill). Dark brown to dark tan, loose to medium dense, moist.	0 1 2 3	SM		BK		26.3				Significant vegetation and organics observed to 4 inches BGS. Fill contains brick, concrete and asphalt debris. Trace cobbles to 6 inches in diameter encountered.
(ML) Sandy SILT (Topsoil). Dark brown, firm, wet.		ML								
(SM) Silty SAND (Native Alluvium). Reddish brown to tan, medium dense, wet.	4	SM								

Test Pit Terminated at 4.5 Feet.

Client: SWAFAM	**Test Pit Number:** TP-3	STRATA A Professional Services Corporation Integrity From the Ground Up	**EXPLORATORY TEST PIT LOG**
Project: S11010A	**Date Excavated:** 02-14-2011		
Backhoe: Deere 160LC Trackhoe	**Bucket Width:** 30"		
Depth to Groundwater: N.E.	**Logged By:** CMC		Sheet 1 Of 1

USCS Description	DEPTH (ft)	U.S.C.S. CLASS	SYMBOL	Sample Type	USDA SOIL Textural Classification	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	REMARKS Note: BGS = Below Ground Surface
(ML) Sandy SILT (Topsoil). Dark brown, firm, wet.	0	ML								Significant vegetation and organics observed to 3 inches BGS.
(SM) Silty SAND (Native Alluvium). Reddish brown to tan, medium dense, wet.	1	SM		BG		18.3		14.3		Single-ring infiltration test performed at 8 inches BGS. Rate observed = 0.9 inches per hour. Soil Non-Plastic. Note: Excavation advanced by hand due to numerous utility conflicts.
Test Pit Terminated at 2.0 Feet.	2									

Client: SWAFAM	**Test Pit Number:** TP-4	**EXPLORATORY TEST PIT LOG**
Project: S11010A	**Date Excavated:** 02-14-2011	
Backhoe: Deere 160LC Trackhoe	**Bucket Width:** 30"	
Depth to Groundwater: N.E.	**Logged By:** CMC	Sheet 1 Of 1

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USCS Description	DEPTH (ft)	U.S.C.S. CLASS	SYMBOL	Sample Type	USDA SOIL Textural Classification	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	REMARKS Note: BGS = Below Ground Surface
(ML) Sandy SILT (Topsoil). Dark brown, firm, wet.	0	ML								Significant vegetation and organics observed to 4 inches BGS. Trace standing water observed at surface.
(SM) Silty SAND (Native Alluvium). Reddish brown to tan, medium dense, wet.	1	SM		BG		14.8		26.1		Single-ring infiltration test performed at 8 inches BGS. Infiltration negligible. Soil plasticity observed.
(RX) Basalt BEDROCK. Grey with tan coating, moderately fractured, slightly weathered to fresh, dense.	2	RX								

Test Pit Terminated at 2.0 Feet.

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Client: SWAFAM	**Test Pit Number:** TP-5	STRATA A Professional Services Corporation *Integrity from the Ground Up*	**EXPLORATORY TEST PIT LOG**
Project: S11010A	**Date Excavated:** 02-14-2011		
Backhoe: Deere 160LC Trackhoe	**Bucket Width:** 30"		
Depth to Groundwater: N.E.	**Logged By:** CMC		Sheet 1 Of 1

USCS Description	DEPTH (ft)	U.S.C.S. CLASS	SYMBOL	Sample Type	USDA SOIL Textural Classification	% Passing No. 200 Sieve	Dry Density (pcf)	Moisture Content (%)	Pocket Pen. (tsf)	REMARKS Note: BGS = Below Ground Surface
(GM) Silty GRAVEL with Sand (Uncontrolled Fill). Dark brown, medium dense, moist.	0	GM								No vegetation or organics observed at the ground surface.
(SM) Silty SAND (Native Alluvium). Reddish brown to tan, medium dense, moist.	1	SM								Note: cobbles and gravel observed above bedrock surface.
(RX) Basalt BEDROCK. Grey with tan coating, moderately fractured, slightly weathered to fresh, dense.	2 3	RX								Large-scale infiltration test performed in bedrock. Rate observed = 0.315 inches per hour. Test pit terminated at 4 feet BGS due to bedrock refusal.
Test Pit Terminated at 4.0 Feet.	4									

Client: SWAFAM	**Test Pit Number:** TP-6	STRATA A Professional Services Corporation Integrity from the Ground Up	**EXPLORATORY TEST PIT LOG**
Project: S11010A	**Date Excavated:** 02-14-2011		
Backhoe: Deere 160LC Trackhoe	**Bucket Width:** 30"		
Depth to Groundwater: N.E.	**Logged By:** CMC		Sheet 1 Of 1

APPENDIX B

Photographic Documentation

STRATA

A PROFESSIONAL SERVICES CORPORATION

Integrity from the Ground Up

Photograph 1 – View of single-ring infiltration test performed in TP-4 (Pond C).

Photograph 2 – View of large-scale flood test area performed in TP-6 (overflow infiltration area).

Photograph 3 – View of water discharge methods for large-scale flood test performed in TP-6.

Photograph 4 – View of TP-6 sidewall showing mixed soil and rock overlying fractured basalt rock.

Photograph 5 – View of basalt rock in TP-6 excavation base (looking down at test pit bottom).

Photograph 6 – View of TP-6 sidewall showing mixed soil and rock overlying fractured basalt rock.

Photographic Documentation Proposed Commercial Development 55^{th} Avenue and Regal Street Spokane, Washington
STRATA A PROFESSIONAL SERVICES CORPORATION *Integrity from the Ground Up*
Appendix B SWAFAM S11010A