WCE

Whipple Consulting Engineers, Inc.

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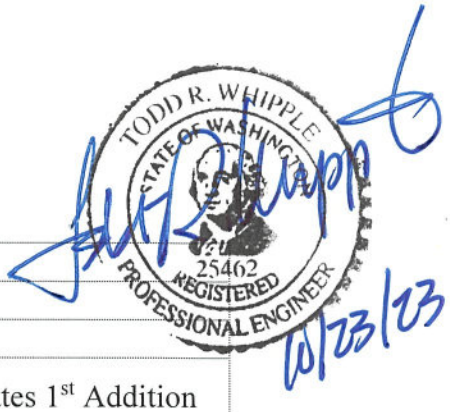
Spokane Valley, WA 99206
Ph 509-893-2617 Fax 509-926-0227



MEMORANDUM

TO:	Mike Nilsson, P.E.		
FROM:	Todd R. Whipple, P. E.		
DATE:	10-23-2023		
PROJECT NO:	22-3376	**NAME:**	Replat of Crest View Estates 1st Addition
REGARDING:	Storm Drainage Report		

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

INTRODUCTION:

This Report is for the redevelopment of the Easterly storm pond at the Crest View Estates 1st Addition. The purpose of this drainage report is to identify drainage impacts resulting from the proposed Crest View Estates Short Plat. This drainage report will describe the drainage infrastructure improvements that are necessary to control and treat the stormwater runoff from the project site. The results reported will demonstrate there is no negative impact to the adjacent properties with the proposed redevelopment. The proposed project lies within the City of Spokane and will be designed in accordance with the Spokane Regional Stormwater Manual (SRSM). and treatment methods will be based on equation 6-1d; V=1815A, as outlined in the SRSM, and updated soil, and swale amendments per the 2019 Eastern Washington Stormwater Management Manual (EWSMM).

The proposed project is a 2-lot short replat development on an approximately 0.56 +/- acre site located off Tieton Avenue & Ash Street. The site is currently mostly developed with an existing grassed storm swale. The site is located within the City of Spokane and lies in the SE 1/4 of Section 24, T 26 N., R 42 E., W.M.

The proposed 2-lot short replat receives stormwater for the existing Crestview 1st additional subdivision. The proposal will attenuate redirect and consolidate the stormwater from the existing subdivision.

Table 1 -Site Summary

Item No.	Description	Volume @ 0.5 ft of depth
A	Required treatment volume	3,101 cf **Generated by this Project**
B	Provided treatment volume	5,408 cf **Provided by this Project**
C	Extra area if Any (A – B)	2,307 sf/cf **Excess**

NARRATIVE:

Project Description:

- Parcel # 26241.0410 & 26241.0310
- Property address: 8903 N ASH ST & 8904 N ASH ST
- NE 1/4 of Section 24, T 26 N., R 42 E., W.M.
- Lot size: 24,393 sf or 0.56± ac
- Bio-infiltration swales proposed with 12" treatment depth, & 2.5-foot gravel gallery beneath pond
- See Geotech information below for surface soils
- Existing site is vegetated with, field grass, and weeds.

Geotechnical Information:

Job No. 21425
April 5, 2022

4.2 Drainage and Stormwater Infiltration Recommendations

Drainage retention swales may be utilized to treat and retain stormwater. The following recommendations should be used by the civil engineer to retention swales:

- The depth to a restrictive layer is at least three feet below the ground surface based on the shallow bedrock encountered at the site during the exploration.
- Swales should be located 10-feet from the edge of buildings and concrete hardscapes to minimize the effects of retention.

OCT 3 1995

3820 E. Broadway Spokane, Washington 99202

budinger & associates
geotechnical & material engineers

September 29, 1995

Project Number H95235

Tomlinson North
8205 N. Division
Spokane, WA 99208

Attention: Bob Frisch

PROJECT: CRESTVIEW ESTATES
Stormwater Facilities
Spokane, WA

SUBJECT: Limited Subsurface Evaluation
For Stormwater Management

In accordance with your request, we have conducted subsurface exploration and testing at specific locations along the Maple Street alignment of the proposed Crestview Estates development to provide recommendations for stormwater handling. The site is located on Five Mile Prairie in the City of Spokane.

Our evaluation has consisted of site reconnaissance, geotechnical drilling, logging (borings and backhoe pits), geophysical testing, sampling, percolation testing, and laboratory testing. Four (4) borings were advanced near the intersections of proposed roads on August 3, 1995, and 2 backhoe pits were logged on September 8, 1995. Boring and test pit logs are provided as Figures 6.2. Infiltrometer test results are provided as Figure 6.2.5. Results of gradation analysis are presented as Figure 7.1.3, with the results summarized in Table 7.0. Two (2) shallow seismic refraction surveys were conducted to evaluate the soundness of rock. Results are presented as Figures 6.7.

(509) 535-8841

F.C. Budinger PE
Stephen D. Burchett PE

Seasonal groundwater flow is believed to follow the surface topography to the south at a gradient of approximately 0.02 (i=0.02). We did not encounter groundwater during our exploration of the site.

A single-ring infiltrometer test was conducted adjacent to Test Pit #5 in accordance with Spokane County specifications to evaluate the permeability of the clean gravel, sand, and cobble deposit. The 10" I.D. steel casing was driven approximately 3" below the excavated surface of the clean sand and gravel. The results were k=36 ft/day (18 in/hr). These results were somewhat lower than Hazen's Approximation of permeability from gradation analysis of a bulk sample of this material, indicating k=150 ft/day.

CONCLUSIONS

We conclude that the subsurface conditions are poorly suited for on-site disposal of stormwater by subsurface infiltration throughout most of the site. However, a limited zone of permeable soils appears to be present in the southern area of the site. The majority of the soils offer moderately slow permeability on the order of 1 ft/day (0.5 in/hr). The permeable sand and gravel encountered in the southern portion of the site offers more favorable permeability on the order of 40 ft/day (20 in/hr).

If cuts are required to achieve grade, excavation difficulty may be encountered due to shallow rock.

RECOMMENDATIONS

We recommend that accumulated stormwater be discharged to slowly percolating retention swales utilizing permeability rates of the sod and topsoil or 0.5 in/hr, whichever is slower. Excess stormwater in the southern portion of the site may be discharged to the permeable sand and gravel through an infiltration gallery at a permeability of k=30 ft/day (15 in/hr).

It has been a pleasure to be of service to you on this project. If we may be of further assistance, or if these results require further clarification, please do not hesitate to contact us.

Respectfully Submitted:
BUDINGER & ASSOCIATES

By: John E. Finnegan, EIT
Geotechnical Engineer

JEF/sr
Addressee - 5
Scott Busch - 1
Attachments

Reviewed By: Stephen D. Burchett, PE
PE Expires 9/24/95

PRE-DEVELOPMENT BASIN INFORMATION:

As shown on the Pre-Developed Basin Map and table 1 Below, the site gradually slopes to the south at approximately 1% to 2%. Per the original civil engineering plans in 2003 the stormwater is conveyed to two (2) existing ponds with a gravel galleries and a discharge structures connected to the gravel galleries.

Per the original storm report in 2003 they accounted for 41-acres of undeveloped grass and field runoff to the existing crest view estates subdivision. Since then development has occurred in the 5-mile area and Basin 1 has been developed into an existing subdivision, and Basin 2 has also had portion of it developed. Leaving a 2.5± acres of undeveloped grass field that is being discharged to Crest View Estates 1st Addition, and conveyed along the easter property line in a ditches to ponds A and B per WCE proposed short replat located along Ash Street and Tieton. The table 1 reflect this reduction in runoff compared to the Taylor report, therefore the offsite basin A is smaller

It should be noted that Pre basin A is made up of 18-sub basins with localized roadside swales. This was not a part of the original report but after visiting the site and seeing the curb drop and roadside swales this information has been added to the stormwater report.

Table 1 – Pre-Development Project Site Basin Summary

Pre-Basin	Ponds	Total Basin Area (sf)	Impervious Area (sf)	Pervious Area (sf)	PGIS Area (sf)
Pre A	N/A	202,690	26,559	176,131	48,099
Pre B	1-16	107,724	0	107,724	0
Total	-	310,414.00	69,620	240,794	69,620


W Johannsen Rd
Spokane Jump Company
N Cedar Rd
PROJECT
W Tieton Ave


W Dawn Ave
W Chaucer Ave
W Sienna Ave
N Bradbury Dr
W Jay Ct
N Cedar Rd
N Ash St
W Maxine Ct
PROJECT
W Tieton Ave
W Tieton Ct
W Kedlin Ln
N Maple St
N Kensington Dr
W Strong Rd
Palm Pl
SCOUT
Spokane County

POST-DEVELOPMENT BASIN INFORMATION:

The Post-Development basins has been divided into 18 sub basin that flows to road side swales and then overflow downstream to the next pond, and eventual to the proposed expanded pond A, see Table 2 and 3.

Per the original report Taylor report in the appendix accounted for 41-acres of undeveloped grass field runoff to the existing crest view estates subdivision. Since then development has occurred in the 5-mile area and Basin 1 has been developed into an existing subdivision, and Basin 2 has also had portion of it developed. Leaving a 2.5-acres of undeveloped grass field that is being discharge to Crest View Estates 1st Addition.

Table 2 – Post-Development Project Site Basin Summary

Pre-Basin	Ponds	Total Basin Area (sf)	Impervious Area (sf)	Pervious Area (sf)	PGIS Area (sf)
POST A	A	152,704	67,220	85,484	67,220
POST B	1-16	49,986	7,200	42,786	7,200
POST C	N/A	107,724	0	107,724	0
Total	-	310,414.00	74,420	235,994	74,420

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 volume	Pond vol.
Basin A	Pond A	5,602 sf	2,801 cf	1,905	1,196 cf	1,196 cf
Basin B	Pond A	600 sf	300 cf	8,154 sf	4,212 cf	16,433 cf
Basin C	Pond A	0 sf	0 cf	0.00 sf	0.00 cf	0.00 cf
TOTAL	-	**6,202 sf**	**3,101 cf**	**10,059, sf**	**5,408 cf**	**17,628 cf**

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

Critical Areas:

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

Down-Gradient Analysis:

The updated Pond A is designed and analyzed to store, treat and discharge the 100-year storm event, therefore, no further downstream flows are anticipated

Methodology:
As required by the SRSM, and the EWLID the storm drainage facilities proposed for this site have been sized to attenuate the 50- and 100-year storm events using the SCS / TR-55 Method. The SCS / TR-55 Method has been used to calculate peak flows, volumes, and time for storm event interactions for this project as there is one (1) offsite drainage basin (existing field) that discharges to this project and proposed Pond A. The rational method was used onsite to determine localized stormflows, and offsite for the other projects, but when combining all the projects together the rational method is not the best fit. The peak flows and volumes for these storm events are shown in the calculations that are included within the Appendix of this report.

Water Quality Treatment:
The proposed storm drainage pond has been designed to provide treatment volume based on SWMMEW (Stormwater Management Manual for Eastern Washington) chapter 5.4.3, SSC-6 Soil Physical and Chemical Suitability for Treatment, and Equation 6-1d (V=1815A) of the SRSM, and as outlined in Section 6.7.1. see the below description for bio-infiltration swale.

Results:
Within this report we have provided the required treatment volume for the improvements proposed for the redevelopment. In the below snippet form the Hydro Cad report we show that the updated Pond A can attenuate and infiltrate the 100-year storm event

Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Subdivision Runoff Area=3.510 ac 30.00% Impervious Runoff Depth=1.01"
Flow Length=725' Tc=1.8 min CN=81 Runoff=0.77 cfs 0.297 af

Subcatchment 3S: Back Yards Runoff Area=1.150 ac 0.00% Impervious Runoff Depth=0.67"
Flow Length=649' Slope=0.0130 '/' Tc=13.6 min CN=74 Runoff=0.11 cfs 0.064 af

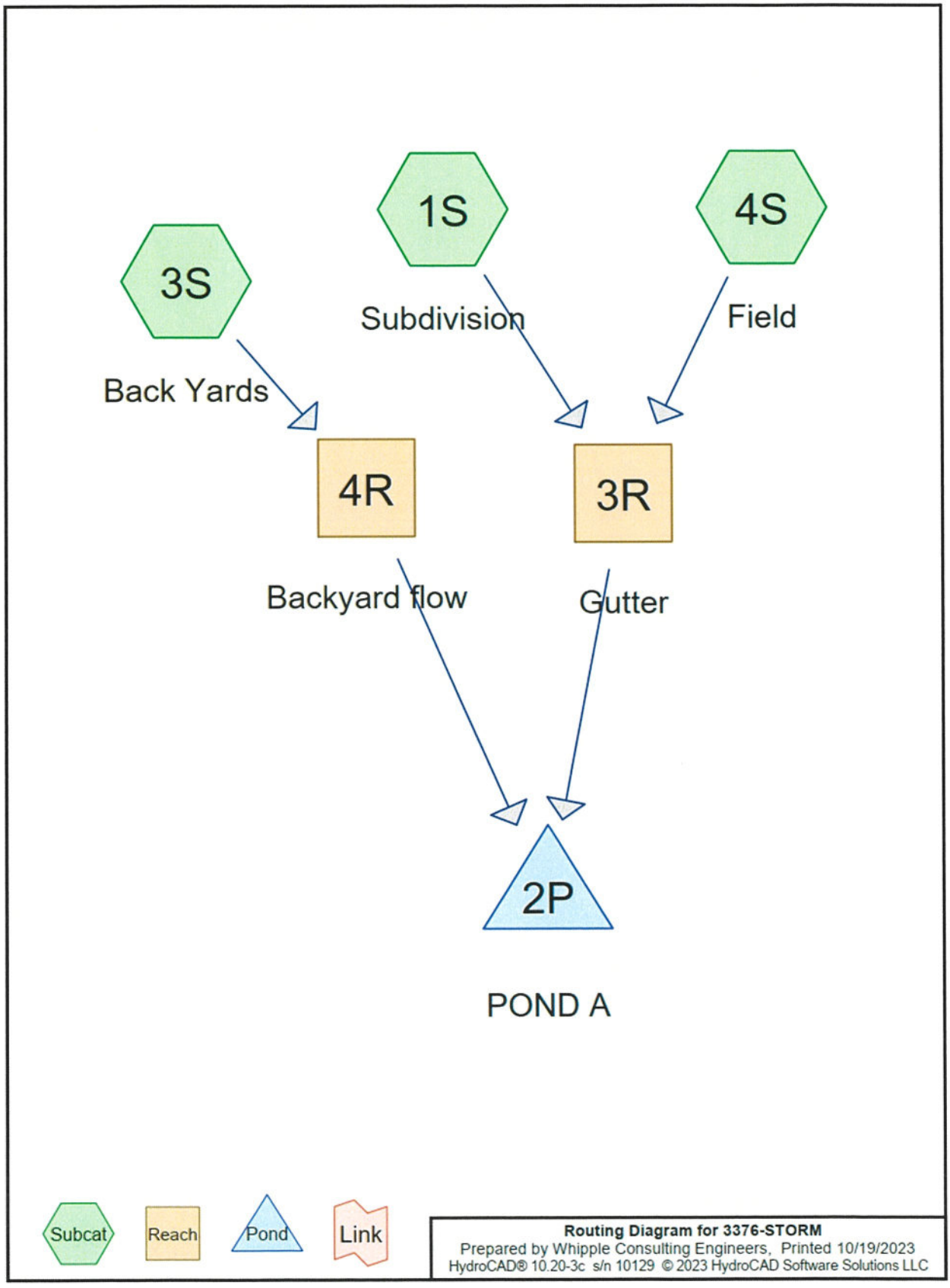
Subcatchment 4S: Field Runoff Area=2.470 ac 0.00% Impervious Runoff Depth=1.13"
Flow Length=800' Slope=0.0150 '/' Tc=15.6 min CN=83 Runoff=0.59 cfs 0.233 af

Reach 3R: Gutter Avg. Flow Depth=0.12' Max Vel=2.27 fps Inflow=1.33 cfs 0.530 af
n=0.013 L=700.0' S=0.0130 '/' Capacity=37.59 cfs Outflow=1.27 cfs 0.530 af

Reach 4R: Backyard flow Avg. Flow Depth=0.02' Max Vel=0.06 fps Inflow=0.11 cfs 0.064 af
n=0.240 L=649.0' S=0.0130 '/' Capacity=9.53 cfs Outflow=0.05 cfs 0.063 af

Pond 2P: POND A Peak Elev=1,001.90' Storage=17,503 cf Inflow=1.27 cfs 0.593 af
Outflow=0.13 cfs 0.407 af

Total Runoff Area = 7.130 ac Runoff Volume = 0.593 af Average Runoff Depth = 1.00"
85.23% Pervious = 6.077 ac 14.77% Impervious = 1.053 ac



Routing Diagram for 3376-STORM
Prepared by Whipple Consulting Engineers, Printed 10/19/2023
HydroCAD® 10.20-3c s/n 10129 © 2023 HydroCAD Software Solutions LLC

Summary for Pond 2P: POND A

Inflow Area = 7.130 ac, 14.77% Impervious, Inflow Depth > 1.00" for 100 year event
Inflow = 1.27 cfs @ 8.09 hrs, Volume= 0.593 af
Outflow = 0.13 cfs @ 24.33 hrs, Volume= 0.407 af, Atten= 90%, Lag= 974.3 min
Primary = 0.13 cfs @ 24.33 hrs, Volume= 0.407 af

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,001.90' @ 24.33 hrs Surf.Area= 10,328 sf Storage= 17,503 cf

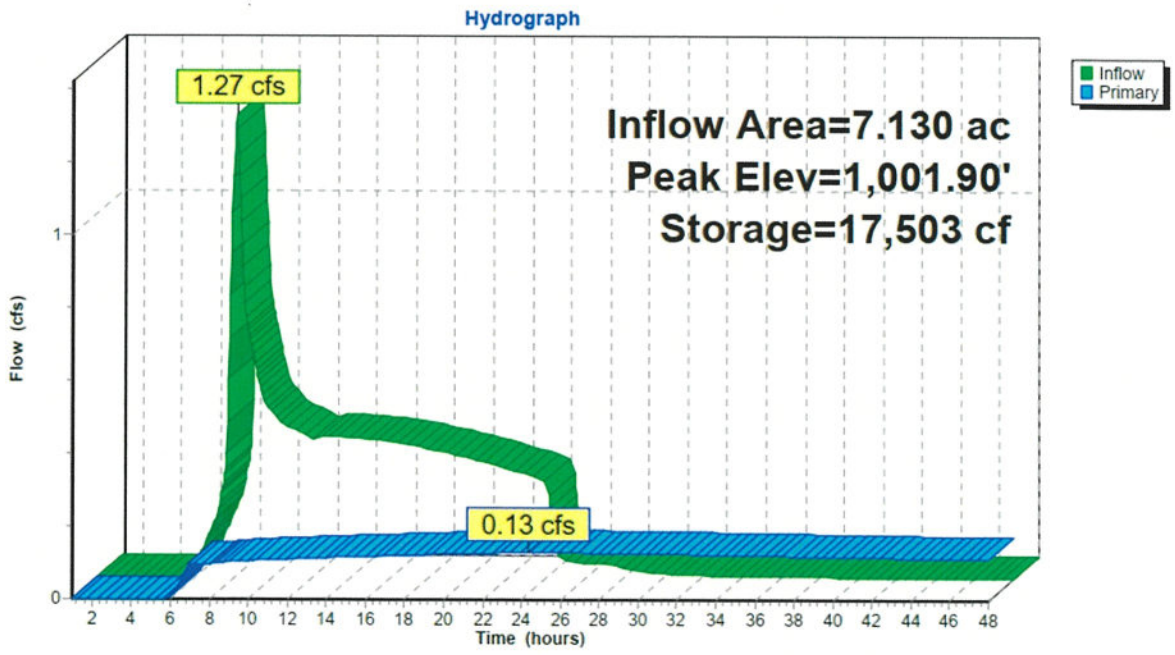
Plug-Flow detention time= 944.9 min calculated for 0.406 af (69% of inflow)
Center-of-Mass det. time= 757.3 min (1,649.1 - 891.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,000.00'	18,544 cf	**90.23'W x 90.23'L x 2.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	1,000.00'	**0.500 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 980.00'

Primary OutFlow Max=0.13 cfs @ 24.33 hrs HW=1,001.90' (Free Discharge)
1=Exfiltration (Controls 0.13 cfs)

Pond 2P: POND A



Operation Characteristics:

Bio-infiltration Swale "A"

The stormwater generated by the existing street, driveways & front roofs will be conveyed in the existing Ash street gutters, to updated pond "A". this updated include are large pond bottom and addition catch basins and pipes to collect and discharge storm flow in the Ash Street gutter. Once the storm water has been discharged to the existing pond "A" the stormwater will infiltrate through the existing and proposed 12-inches of treatment soil, to the existing gravel gallery. Once the stormwater exceeds the height of 6-inches, excess stormwater will spill into a single depth drywell and be discharged to the existing gravel gallery per the Spokane Regional Stormwater Manual, and the Eastern Washington Low Impact Development Guidance Manual.

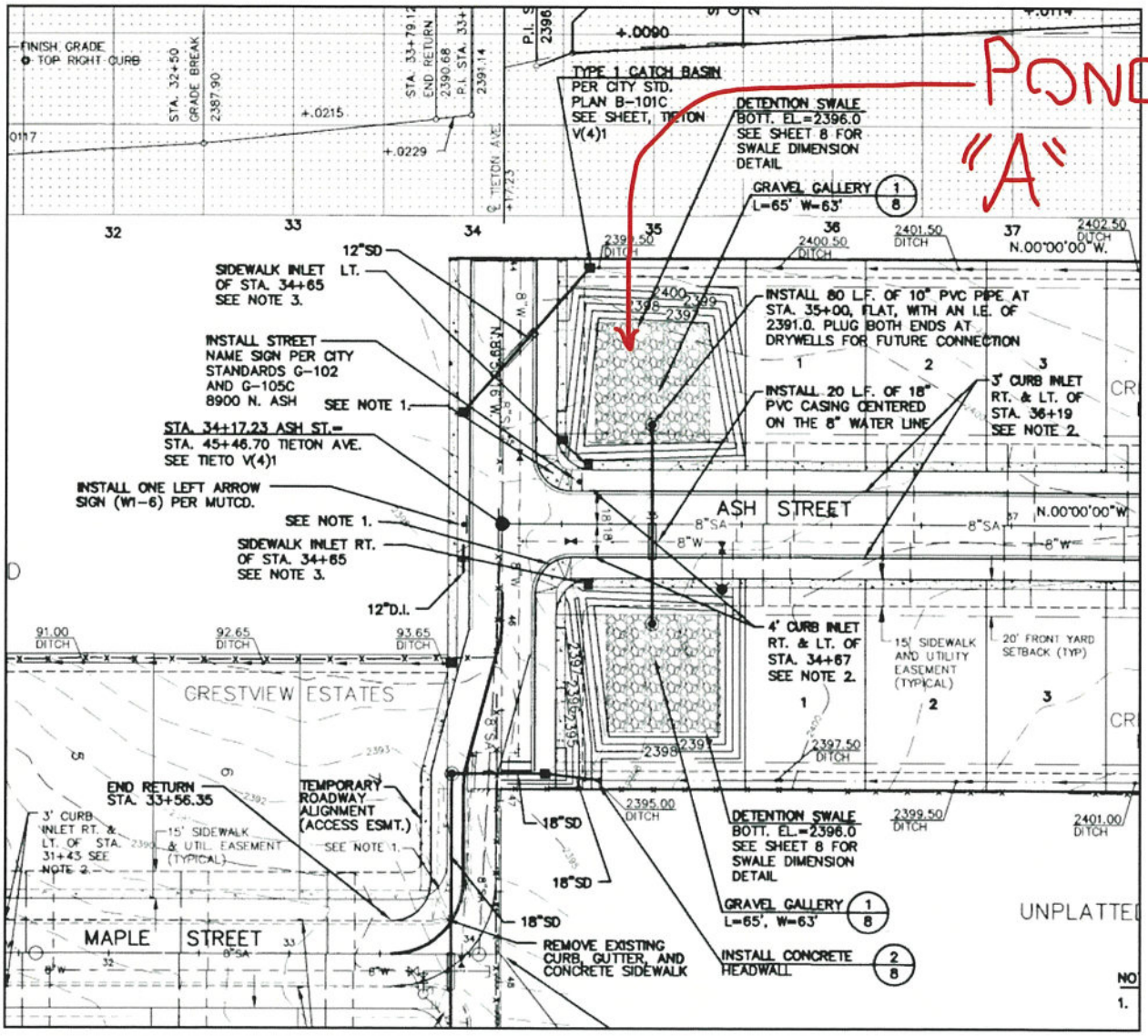
Bio-infiltration Swale "1-16"

The stormwater generated within the Ash Street sub basin 0-16 will sheet flow across the pavement to the gutter where it will then be detained by the existing bio-infiltration swales 1 through 16. These swales are existing and attenuate the flow to pond A. These ponds do not have drywells or discharge points other than Pond A, so while they will collect and detain/retain stormwater their potential volume has been ignored for this analysis.

The infiltration rate given by Budinger engineers as required per the Spokane Regional Stormwater Manual, and the Eastern Washington Low Impact Development Guidance Manual. Is still valid as no changes to the gallery are proposed.

Results:

Refer to Table 1 and Pre & Post basin tables in Appendix for Post-Development storm drainage information.


POND "A"
FINISH GRADE
TOP RIGHT CURB
GRADE BREAK
STA. 32+50
2387.90
+.0215
+.0229
STA. 33+79.12
END RETURN
2390.68
P.I. STA. 33+
2391.14
TIETON AVE.
+17.23
P.I.
2396
+.0090
TYPE 1 CATCH BASIN
PER CITY STD.
PLAN B-101C
SEE SHEET, TIETON
V(4)1
DETENTION SWALE
BOTT. EL.=2396.0
SEE SHEET 8 FOR
SWALE DIMENSION
DETAIL
GRAVEL GALLERY 1/8
L=65' W=63'
32
33
34
35
36
37
2399.50 DITCH
2400.50 DITCH
2401.50 DITCH
2402.50 DITCH
N.00°00'00" W.
12"SD
SIDEWALK INLET LT.
OF STA. 34+65
SEE NOTE 3.
INSTALL STREET
NAME SIGN PER CITY
STANDARDS G-102
AND G-105C
8900 N. ASH
SEE NOTE 1.
STA. 34+17.23 ASH ST.=
STA. 45+46.70 TIETON AVE.
SEE TIETO V(4)1
INSTALL ONE LEFT ARROW
SIGN (W1-6) PER MUTCD.
SEE NOTE 1.
SIDEWALK INLET RT.
OF STA. 34+65
SEE NOTE 3.
12"D.I.
INSTALL 80 L.F. OF 10" PVC PIPE AT
STA. 35+00, FLAT, WITH AN I.E. OF
2391.0. PLUG BOTH ENDS AT
DRYWELLS FOR FUTURE CONNECTION
INSTALL 20 L.F. OF 18"
PVC CASING CENTERED
ON THE 8" WATER LINE
3' CURB INLET
RT. & LT. OF
STA. 36+19
SEE NOTE 2.
ASH STREET
8"SA
8"W
N.00°00'00"W
4' CURB INLET
RT. & LT. OF
STA. 34+67
SEE NOTE 2.
15' SIDEWALK
AND UTILITY
EASEMENT
(TYPICAL)
20' FRONT YARD
SETBACK (TYP)
91.00 DITCH
92.65 DITCH
93.65 DITCH
CRESTVIEW ESTATES
END RETURN
STA. 33+56.35
TEMPORARY
ROADWAY
ALIGNMENT
(ACCESS ESMT.)
SEE NOTE 1.
3' CURB
INLET RT. &
LT. OF STA.
31+43 SEE
NOTE 2.
15' SIDEWALK
& UTIL. EASEMENT
(TYPICAL)
18"SD
2395.00 DITCH
2397.50 DITCH
2399.50 DITCH
2401.00 DITCH
DETENTION SWALE
BOTT. EL.=2396.0
SEE SHEET 8 FOR
SWALE DIMENSION
DETAIL
GRAVEL GALLERY 1/8
L=65', W=63'
MAPLE STREET
REMOVE EXISTING
CURB, GUTTER, AND
CONCRETE SIDEWALK
INSTALL CONCRETE 2/8
HEADWALL
UNPLATTED
NO
1.

Perpetual Maintenance of Facilities:

There is an existing homeowner association and the swales within the proposed tracts "A" will be maintained by the existing HOA. The City of Spokane will not be liable for any maintenance or operation of the facilities. 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 or are affected by 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 50 & 100-year storm event. Also, the storm drainage facilities will contain and discharge the 50 & 100-year storm under non frozen conditions. Therefore, this project will have no adverse impact to adjacent and/or downstream properties.

APPENDIX

APPENDIX

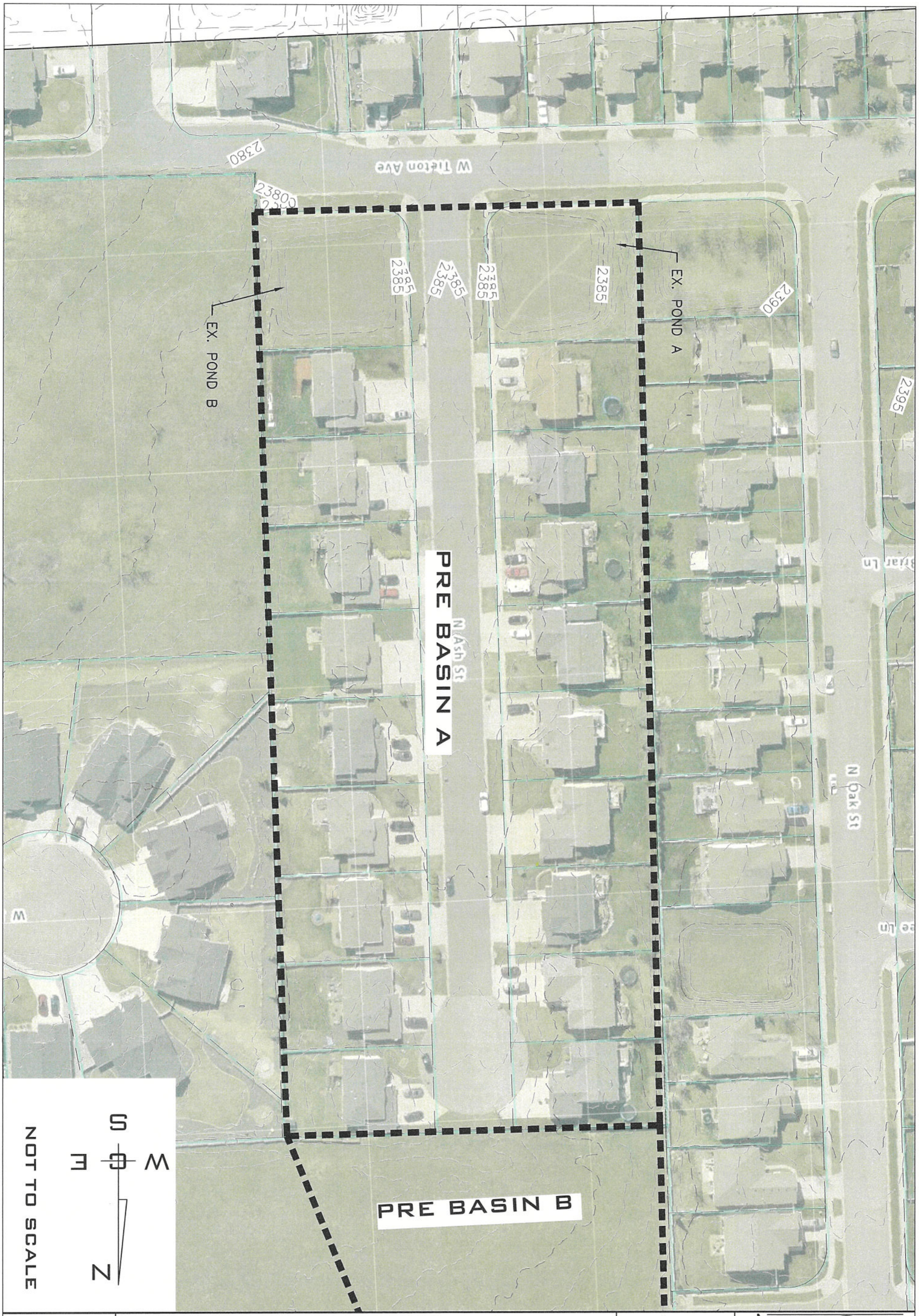
VICINITY MAP

VICINITY MAP

N
W E
S
NOT TO SCALE

PROJ #: 22-TOM DATE: 09/07/22 DRAWN: TEW APPROVED: TRW	DRAINAGE REPORT REPLAT OF CRESTVIEW ESTATS 1ST ADD. 8904 N. ASH STREET SPOKANE, WASHINGTON	WCE WHIPPLE CONSULTING ENGINEERS 21 SOUTH PINES ROAD SPOKANE VALLEY, WASHINGTON 99206 PH: 509-893-2617 FAX: 509-926-0227
FIGURE 1	VICINITY MAP	

BASIN MAPS



PRE-DEVELOPMENT BASIN MAP
REPLAT OF CRESTVIEW ESTATS 1ST ADD.
8904 N. ASH STREET
SPOKANE, WASHINGTON

SHEET 1 OF 4

PROJ #: 22-TOM
DATE: 09/07/22
DRAWN: TEW
APPROVED: TRW

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CIVIL , STRUCTURAL AND
TRANSPORTATION ENGINEERING
21 SOUTH PINES ROAD
SPOKANE VALLEY, WASHINGTON 99206
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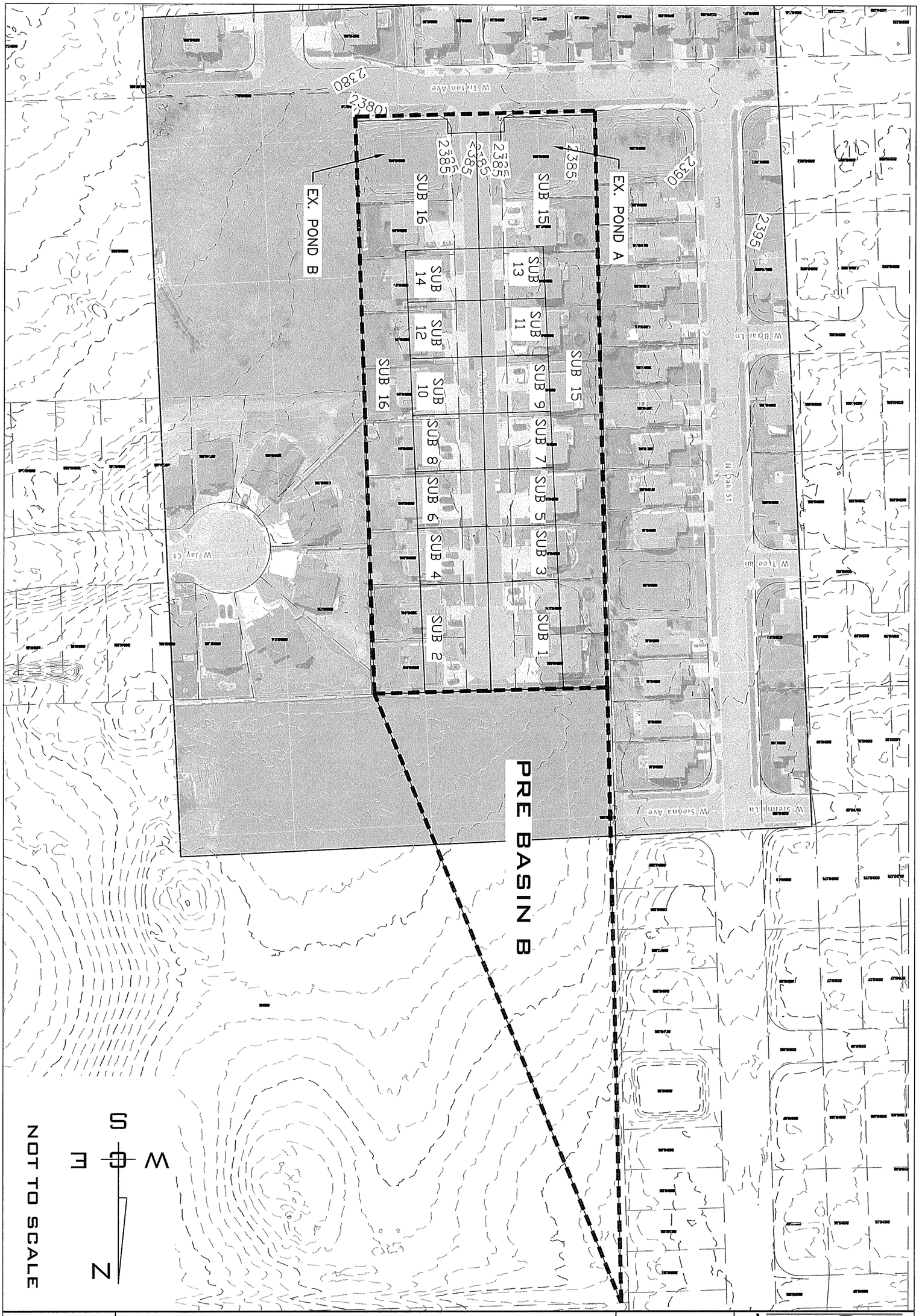

SHEET 2 OF 4

PRE OVER ALL -DEVELOPMENT BASIN MAP
REPLAT OF CRESTVIEW ESTATS 1ST ADD.
8904 N. ASH STREET
SPOKANE, WASHINGTON

PROJ #: 22-TOM
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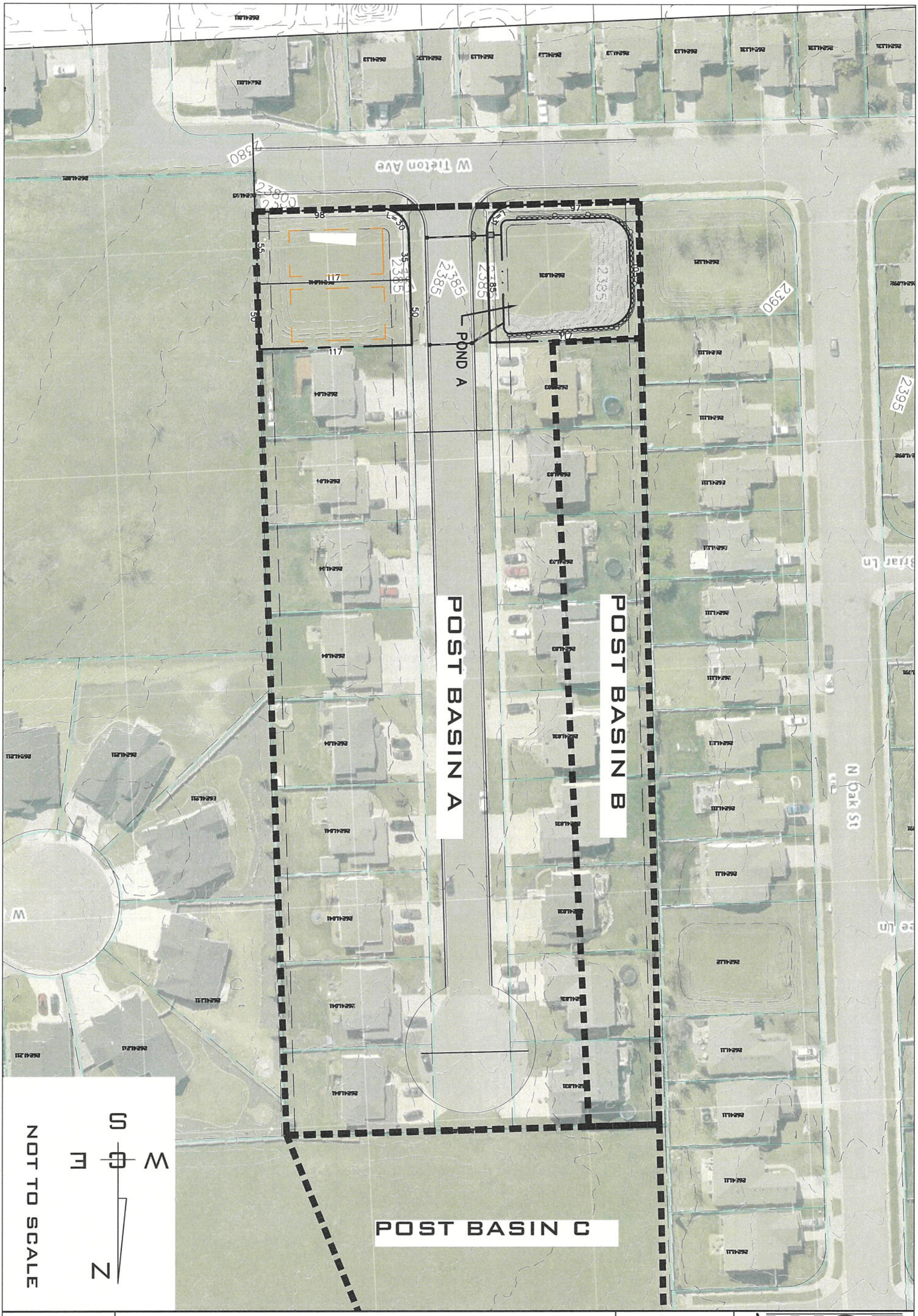

POST-DEVELOPMENT BASIN MAP
REPLAT OF CRESTVIEW ESTATS 1ST ADD.
8904 N. ASH STREET
SPOKANE, WASHINGTON

SHEET 3 OF 4

PROJ #: 22-TOM
DATE: 09/07/22
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POST-DEVELOPMENT BASIN MAP
REPLAT OF CRESTVIEW ESTATS 1ST ADD.
8904 N. ASH STREET
SPOKANE, WASHINGTON

SHEET 4 OF 4

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BASIN SUMMARY SHEET

Whipple Consulting Engineers
Basin Calculation Worksheet

	WCE No.	Project Name
10/19/2023	-	Crest View Short Plat
TEW		

Imp 0.9
Per 0.15

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

I (2 yr) = 1.418 inches I (10 yr)= 2.619 inches NOTE:
I (25 yr) = 3.319 inches I (50 yr)= 3.843 inches
I (100 yr) = 4.381 inches

driveway area	1,200 sf
1/2 House Area	1,200 sf

SPOKANE COUNTY - SRSM - GRASSED PERCOLATION METHOD

Basin	Total Ac	Total sf	Access/Parking /Street (sf)	Sidewalk sf	Lot #	DV sf	Buildings sf	Total Impervious	Total Pervious	Wtd "C"	PGIS sf	1815 A Pond Area (sf)	Pond Vol (cf)	Q=CIA (cfs) 2 yr	10 yr	25 yr	50 yr	100 yr
Pre Onsite Flow																		
Pre A	4.65	202,690	26,420	0	18	21,600	79	48,099	154,591	0	48,099	4,008	2,004	2.16	4.00	5.07	5.86	6.69
Pre B	2.47	107,724	0	0	0	0	0	0	107,724	0	0	0	0	0.53	0.97	1.23	1.43	1.63
Total	**7.13**	**310,414.00**	**26,420.00**	**0.00**	**18.00**	**21,600**	**21,600**	**69,620**	**240,794**	**0**	**69,620**	**5,802**	**2,901**	**3.22**	**5.94**	**7.53**	**8.71**	**9.93**
PRE SUB BASIN SAMPLE																		
SUB 1	0.27	11,580	3,190	0	2	2,400	2,400	7,990	3,590	0.67	7,990	666	333	0.25	0.46	0.59	0.68	0.78
SUB 2	0.25	10,750	3,190	0	2	2,400	2,400	7,990	2,760	0.71	7,990	666	333	0.25	0.46	0.58	0.67	0.76
SUB 3	0.13	5,850	1,250	0	1	1,200	1,200	3,650	2,200	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 4	0.13	5,850	1,250	0	1	1,200	1,200	3,650	2,200	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 5	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 6	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 7	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 8	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 9	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 10	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 11	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 12	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 13	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 14	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 15	1.26	54,930	2,520	0	1	1,200	1,200	4,920	50,010	0.22	4,920	410	205	0.39	0.72	0.91	1.05	1.20
SUB 16	1.26	54,930	2,520	0	1	1,200	1,200	4,920	50,010	0.22	4,920	410	205	0.39	0.72	0.91	1.05	1.20
Total	**4.65**	**202,690**	**26,420**	**0**	**18**	21,600	21,600	69,620	133,070	0.41	69,620	5,802	2,901	**2.69**	**4.97**	**6.30**	**7.29**	**8.31**

Whipple Consulting Engineers

Basin Calculation Worksheet

Imp 0.9
Per 0.15

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

I (2 yr) = 1.418 inches I (10 yr)= 2.619 inches NOTE:
I (25 yr) = 3.319 inches I (50 yr)= 3.843 inches
I (100 yr) = 4.381 inches

WCE No. - Project Name Crest View Short Plat

10/19/2023

TEW

driveway area 1,200 sf

Post Onsite Flow																		
POST A	3.51	152,704	26,420	0	17	20,400	20,400	67,220	85,484	0.48	67,220	5,602	2,801	2.39	4.41	5.59	6.47	7.37
POST B	1.15	49,986	0	0	3	3,600	3,600	7,200	42,786	0.26	7,200	600	300	0.42	0.78	0.98	1.14	1.30
POST C	2.47	107,724	0	0	0	0	0	0	107,724	0.15	0	0	0	0.53	0.97	1.23	1.43	1.63
Total	**7.13**	**310,414.00**	**26,420.00**	**0.00**	**20.00**	**24,000**	**24,000**	**74,420**	**235,994**	**0.33**	**74,420**	**6,202**	**3,101**	**3.33**	**6.16**	**7.80**	**9.03**	**10.30**

POST SUB BASIN SAMPLE																		
SUB 1	0.27	11,580	3,190	0	2	2,400	2,400	7,990	3,590	0.67	7,990	666	333	0.25	0.46	0.59	0.68	0.78
SUB 2	0.25	10,750	3,190	0	2	2,400	2,400	7,990	2,760	0.71	7,990	666	333	0.25	0.46	0.58	0.67	0.76
SUB 3	0.13	5,850	1,250	0	1	1,200	1,200	3,650	2,200	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 4	0.13	5,850	1,250	0	1	1,200	1,200	3,650	2,200	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 5	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 6	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 7	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 8	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 9	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 10	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 11	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 12	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 13	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 14	0.13	5,880	1,250	0	1	1,200	1,200	3,650	2,230	0.62	3,650	304	152	0.12	0.22	0.28	0.32	0.36
SUB 15	0.11	4,942	2,520	0	0	0	0	2,520	2,422	0.53	2,520	210	105	0.09	0.16	0.20	0.23	0.26
SUB 16	0.31	13,565	2,520	0	0	0	0	2,520	11,045	0.29	2,520	210	105	0.13	0.24	0.30	0.35	0.39
SUB 17	0.95	41,367	0	0	1	1,200	1,200	2,400	38,967	0.19	2,400	200	100	0.26	0.48	0.61	0.71	0.81
Total	**3.51**	**152,704**	**26,420**	**0**	**17**	**20,400**	**20,400**	**67,220**	**85,484**	**0.48**	**67,220**	**5,602**	**2,801**	**2.39**	**4.41**	**5.59**	**6.47**	**7.37**

POND VOLUME WORKSHEET

WHIPPLE CONSULTING ENGINEERS **Date: 10/19/2023**

POND VOLUME CALC SHEET Proposed Swales

Project: 22-3376 CREST VIEW ESTATS SHORT PLAT

Designer: TEW

								Treatment			*Storage*		
Basins	Ponds/ Swales	Bottom Area sf	Treatment Area (w/ Side Slopes)	Squared Side lf	Pond Bottom Elevation at Drywell	Pond Drywell Elevation	Pond 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**	40	59	6.32	1000.00	1000.50	1000.50	20	9	**29**	20	9	29
2	**2**	100	130	10.00	1000.00	1000.50	1000.50	50	15	**65**	50	15	65
3	**3**	100	130	10.00	1000.00	1000.50	1000.50	50	15	**65**	50	15	65
4	**4**	90	118	9.49	1000.00	1000.50	1000.50	45	14	**59**	45	14	59
5	**5**	200	242	14.14	1000.00	1000.50	1000.50	100	21	**121**	100	21	121
6	**6**	80	107	8.94	1000.00	1000.50	1000.50	40	13	**53**	40	13	53
7	**7**	80	107	8.94	1000.00	1000.50	1000.50	40	13	**53**	40	13	53
8	**8**	0	0	0.00	1000.00	1000.50	1000.50	0	0	**0**	0	0	0
9	**9**	40	59	6.32	1000.00	1000.50	1000.50	20	9	**29**	20	9	29
10	**10**	130	164	11.40	1000.00	1000.50	1000.50	65	17	**82**	65	17	82
11	**11**	245	292	15.65	1000.00	1000.50	1000.50	123	23	**146**	123	23	146
12	**12**	75	101	8.66	1000.00	1000.50	1000.50	38	13	**50**	38	13	50
13	**13**	130	164	11.40	1000.00	1000.50	1000.50	65	17	**82**	65	17	82
14	**14**	75	101	8.66	1000.00	1000.50	1000.50	38	13	**50**	38	13	50
15	**15**	280	330	16.73	1000.00	1000.50	1000.50	140	25	**165**	140	25	165
16	**16**	240	286	15.49	1000.00	1000.50	1000.50	120	23	**143**	120	23	143
Total	**Total**	1,905	-	-	-	-	-	-	-	**1,196**	-	-	**1,196**
17	**A**	8154.00	**8,425**	90.30	1000.00	1000.50	1001.80	4,077	135	**4,212**	14,677	1,755	**16,433**
Totals		**10,059**	-	-	-	-	-	-	-	**5,408**	-	-	**17,628**

* LID ponds do not calculate side slopes.

CURB INLET CALCULATIONS

Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Oct 19 2023

WEST SIDE OF ASH CURB INLET 1

Grate Inlet

Location	= On grade
Curb Length (ft)	= -0-
Throat Height (in)	= -0-
Grate Area (sqft)	= -0-
Grate Width (ft)	= 1.61
Grate Length (ft)	= 1.61

Gutter

Slope, Sw (ft/ft)	= 0.020
Slope, Sx (ft/ft)	= 0.020
Local Depr (in)	= -0-
Gutter Width (ft)	= 1.50
Gutter Slope (%)	= 2.00
Gutter n-value	= 0.016

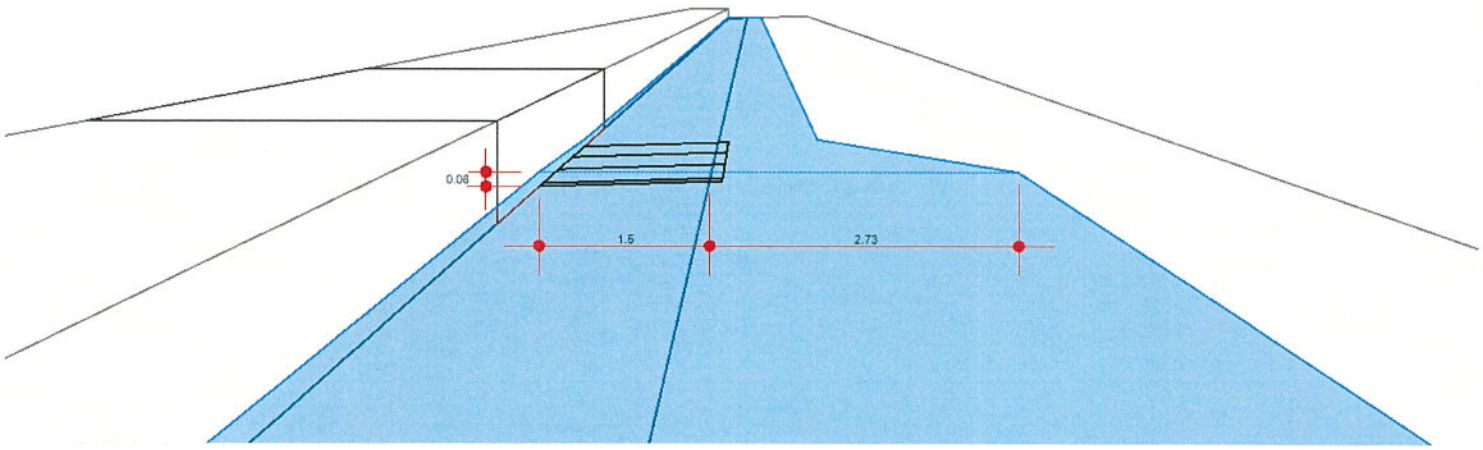
Calculations

Compute by:	Known Q
Q (cfs)	= 0.34

Highlighted

Q Total (cfs)	= 0.34
Q Capt (cfs)	= 0.25
Q Bypass (cfs)	= 0.09
Depth at Inlet (in)	= 1.01
Efficiency (%)	= 72
Gutter Spread (ft)	= 4.23
Gutter Vel (ft/s)	= 1.90
Bypass Spread (ft)	= 2.61
Bypass Depth (in)	= 0.63

All dimensions in feet



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Oct 19 2023

WEST SIDE OF ASH CURB INLET 2

Curb Inlet

Location	= On grade
Curb Length (ft)	= 2.95
Throat Height (in)	= 6.00
Grate Area (sqft)	= -0-
Grate Width (ft)	= -0-
Grate Length (ft)	= -0-

Gutter

Slope, Sw (ft/ft)	= 0.020
Slope, Sx (ft/ft)	= 0.020
Local Depr (in)	= -0-
Gutter Width (ft)	= 1.50
Gutter Slope (%)	= 2.00
Gutter n-value	= 0.016

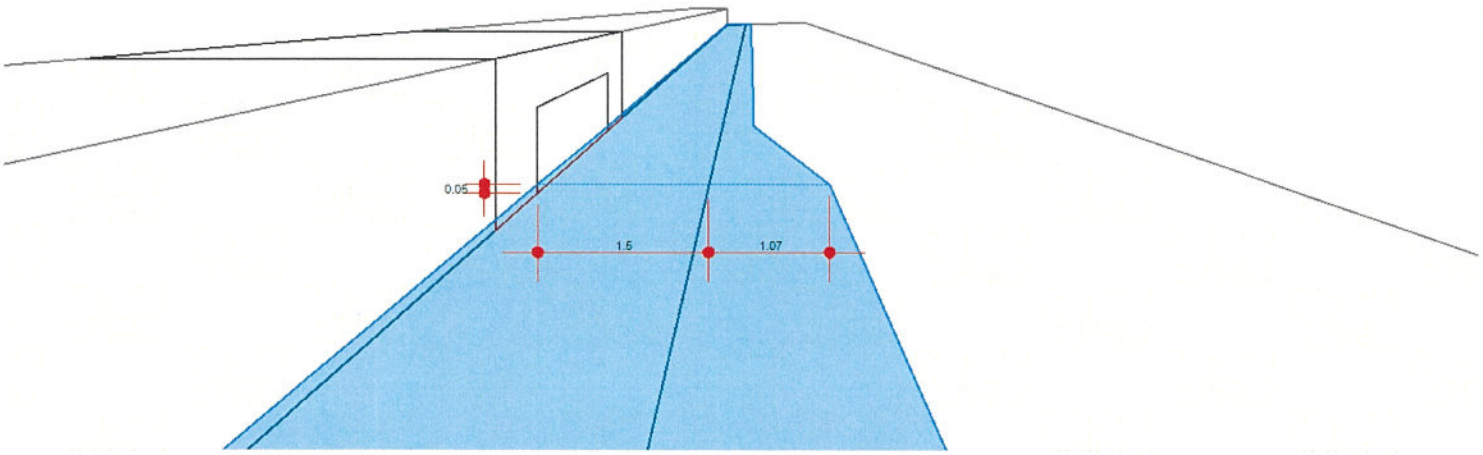
Calculations

Compute by:	Known Q
Q (cfs)	= 0.09

Highlighted

Q Total (cfs)	= 0.09
Q Capt (cfs)	= 0.05
Q Bypass (cfs)	= 0.04
Depth at Inlet (in)	= 0.62
Efficiency (%)	= 54
Gutter Spread (ft)	= 2.57
Gutter Vel (ft/s)	= 1.36
Bypass Spread (ft)	= 1.92
Bypass Depth (in)	= 0.46

All dimensions in feet



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Oct 19 2023

EAST SIDE OF ASH CATCH BASIN 1

Grate Inlet

Location	= On grade
Curb Length (ft)	= -0-
Throat Height (in)	= -0-
Grate Area (sqft)	= -0-
Grate Width (ft)	= 1.61
Grate Length (ft)	= 1.61

Gutter

Slope, Sw (ft/ft)	= 0.020
Slope, Sx (ft/ft)	= 0.020
Local Depr (in)	= -0-
Gutter Width (ft)	= 1.50
Gutter Slope (%)	= 2.00
Gutter n-value	= 0.016

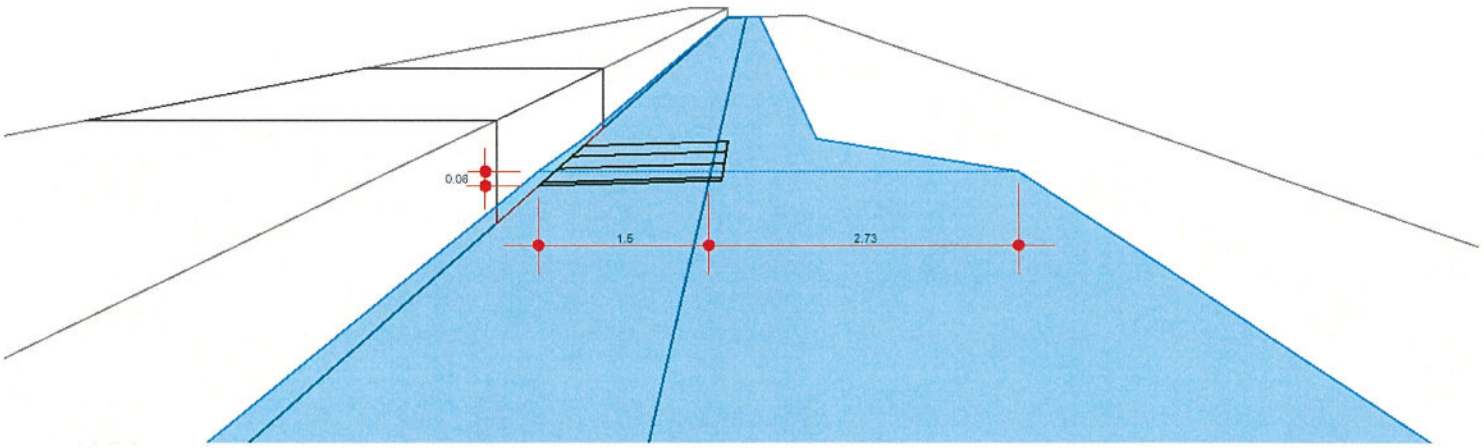
Calculations

Compute by:	Known Q
Q (cfs)	= 0.34

Highlighted

Q Total (cfs)	= 0.34
Q Capt (cfs)	= 0.25
Q Bypass (cfs)	= 0.09
Depth at Inlet (in)	= 1.01
Efficiency (%)	= 72
Gutter Spread (ft)	= 4.23
Gutter Vel (ft/s)	= 1.90
Bypass Spread (ft)	= 2.61
Bypass Depth (in)	= 0.63

All dimensions in feet



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Oct 19 2023

EAST SIDE OF ASH CATCH BASIN 2

Grate Inlet

Location	= On grade
Curb Length (ft)	= -0-
Throat Height (in)	= -0-
Grate Area (sqft)	= -0-
Grate Width (ft)	= 1.61
Grate Length (ft)	= 1.61

Gutter

Slope, Sw (ft/ft)	= 0.020
Slope, Sx (ft/ft)	= 0.020
Local Depr (in)	= -0-
Gutter Width (ft)	= 1.50
Gutter Slope (%)	= 2.00
Gutter n-value	= 0.016

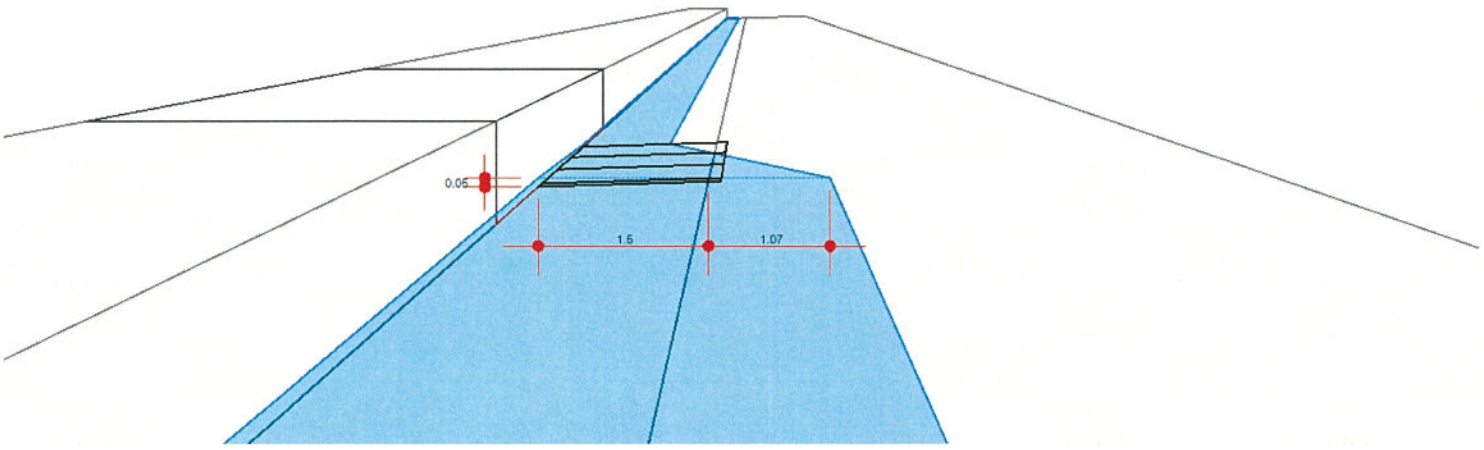
Calculations

Compute by:	Known Q
Q (cfs)	= 0.09

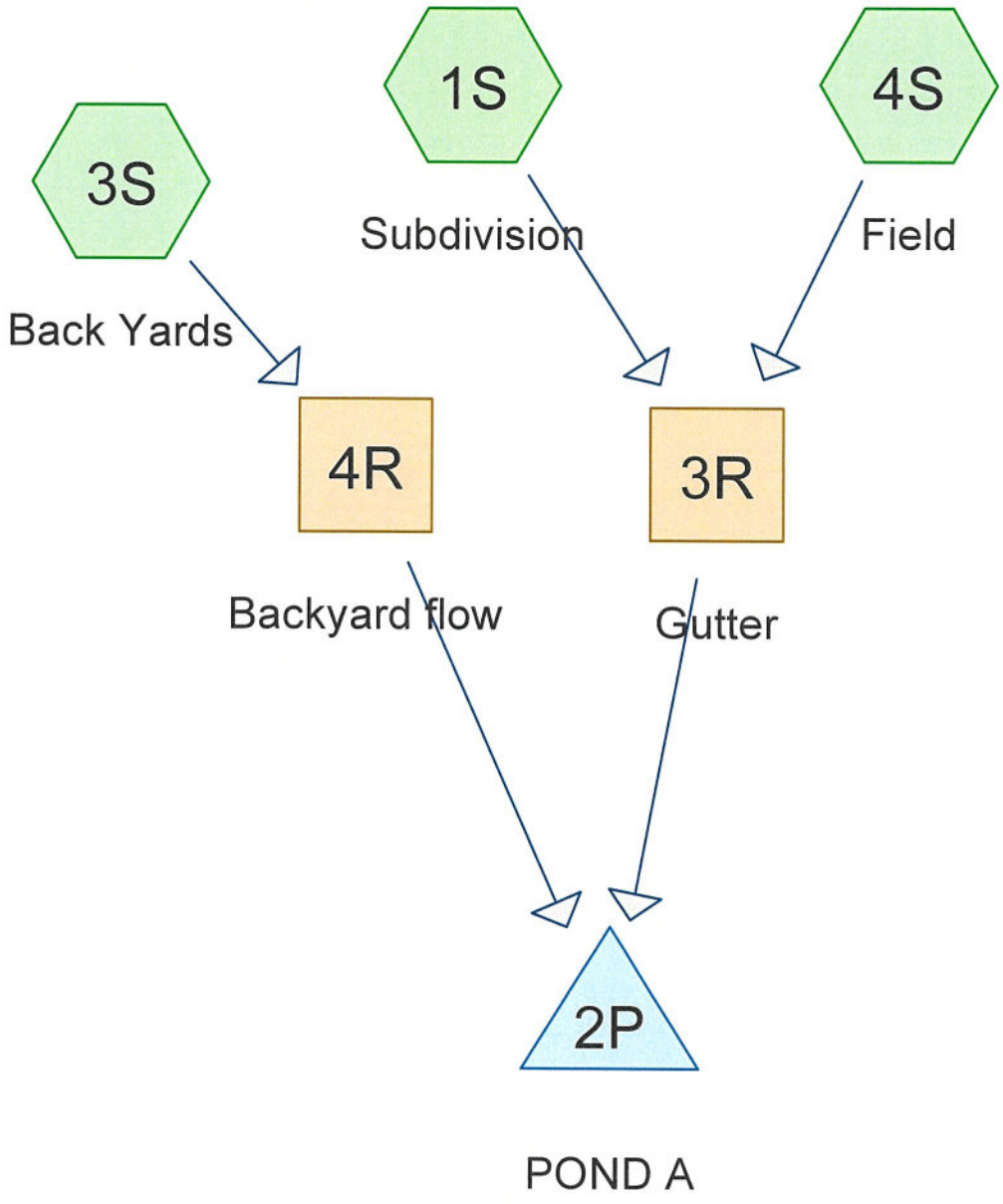
Highlighted

Q Total (cfs)	= 0.09
Q Capt (cfs)	= 0.08
Q Bypass (cfs)	= 0.01
Depth at Inlet (in)	= 0.62
Efficiency (%)	= 92
Gutter Spread (ft)	= 2.57
Gutter Vel (ft/s)	= 1.36
Bypass Spread (ft)	= 0.98
Bypass Depth (in)	= 0.23

All dimensions in feet



HydroCAD



Subcat Reach Pond Link

Routing Diagram for 3376-STORM
Prepared by Whipple Consulting Engineers, Printed 10/19/2023

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	10 year	Type IA 24-hr		Default	24.00	1	1.80	2
2	25 year	Type IA 24-hr		Default	24.00	1	2.20	2
3	100 year	Type IA 24-hr		Default	24.00	1	2.60	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.510	81	1/3 acre lots, 30% imp, HSG C (1S)
1.150	74	>75% Grass cover, Good, HSG C (3S)
2.470	83	Legumes, contoured, Poor, HSG C (4S)
7.130	**81**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
7.130	HSG C	1S, 3S, 4S
0.000	HSG D	
0.000	Other	
7.130		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	3.510	0.000	0.000	3.510	1/3 acre lots, 30% imp	1S
0.000	0.000	1.150	0.000	0.000	1.150	>75% Grass cover, Good	3S
0.000	0.000	2.470	0.000	0.000	2.470	Legumes, contoured, Poor	4S
0.000	**0.000**	**7.130**	**0.000**	**0.000**	**7.130**	**TOTAL AREA**	

Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Subdivision Runoff Area=3.510 ac 30.00% Impervious Runoff Depth=0.48"
Flow Length=725' Tc=1.8 min CN=81 Runoff=0.29 cfs 0.141 af

Subcatchment3S: Back Yards Runoff Area=1.150 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=649' Slope=0.0130 '/' Tc=13.6 min CN=74 Runoff=0.02 cfs 0.025 af

Subcatchment4S: Field Runoff Area=2.470 ac 0.00% Impervious Runoff Depth=0.56"
Flow Length=800' Slope=0.0150 '/' Tc=15.6 min CN=83 Runoff=0.24 cfs 0.116 af

Reach 3R: Gutter Avg. Flow Depth=0.08' Max Vel=1.74 fps Inflow=0.50 cfs 0.257 af
n=0.013 L=700.0' S=0.0130 '/' Capacity=37.59 cfs Outflow=0.46 cfs 0.257 af

Reach 4R: Backyard flow Avg. Flow Depth=0.01' Max Vel=0.04 fps Inflow=0.02 cfs 0.025 af
n=0.240 L=649.0' S=0.0130 '/' Capacity=9.53 cfs Outflow=0.02 cfs 0.025 af

Pond 2P: POND A Peak Elev=1,000.66' Storage=5,584 cf Inflow=0.46 cfs 0.281 af
Outflow=0.11 cfs 0.281 af

Total Runoff Area = 7.130 ac Runoff Volume = 0.282 af Average Runoff Depth = 0.47"
85.23% Pervious = 6.077 ac 14.77% Impervious = 1.053 ac

Summary for Subcatchment 1S: Subdivision

[49] Hint: Tc<2dt may require smaller dt

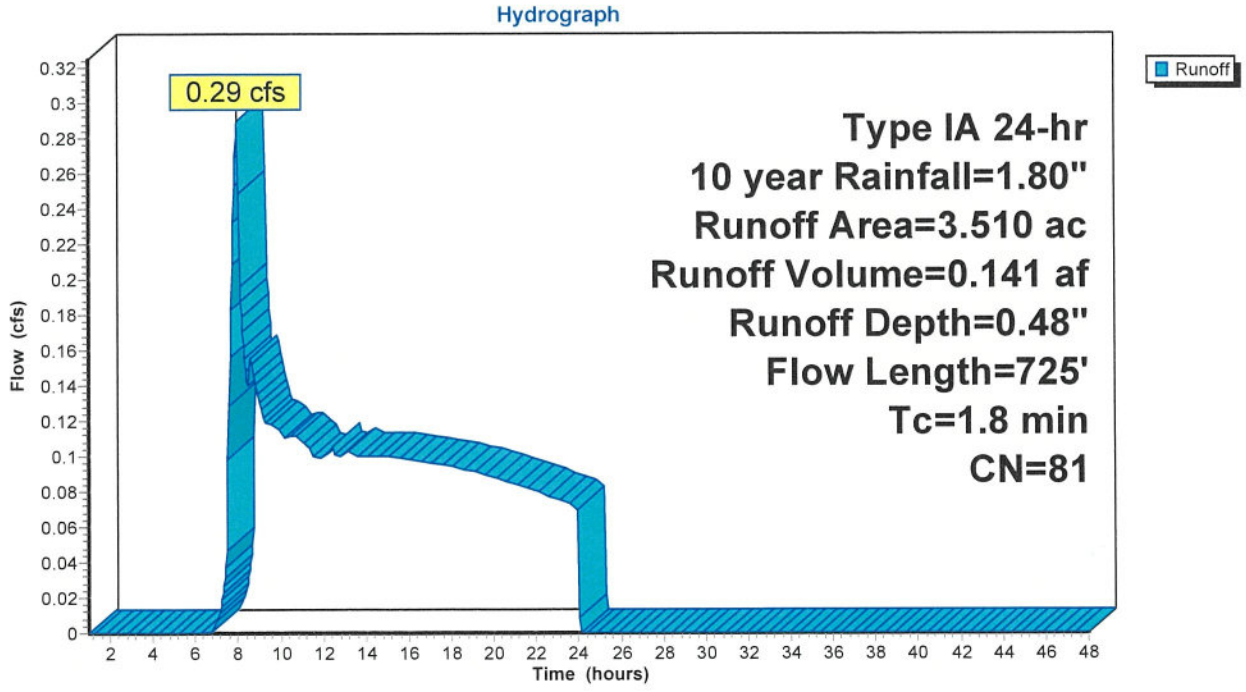
Runoff = 0.29 cfs @ 7.98 hrs, Volume= 0.141 af, Depth= 0.48"
Routed to Reach 3R : Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 year Rainfall=1.80"

Area (ac)	CN	Description
3.510	81	1/3 acre lots, 30% imp, HSG C
2.457		70.00% Pervious Area
1.053		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	60	0.0200	2.28		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
1.4	665	0.0130	7.70	3.85	**Channel Flow,** Area= 0.5 sf Perim= 1.1' r= 0.45' n= 0.013 Concrete, trowel finish
1.8	725	Total			

Subcatchment 1S: Subdivision



Summary for Subcatchment 3S: Back Yards

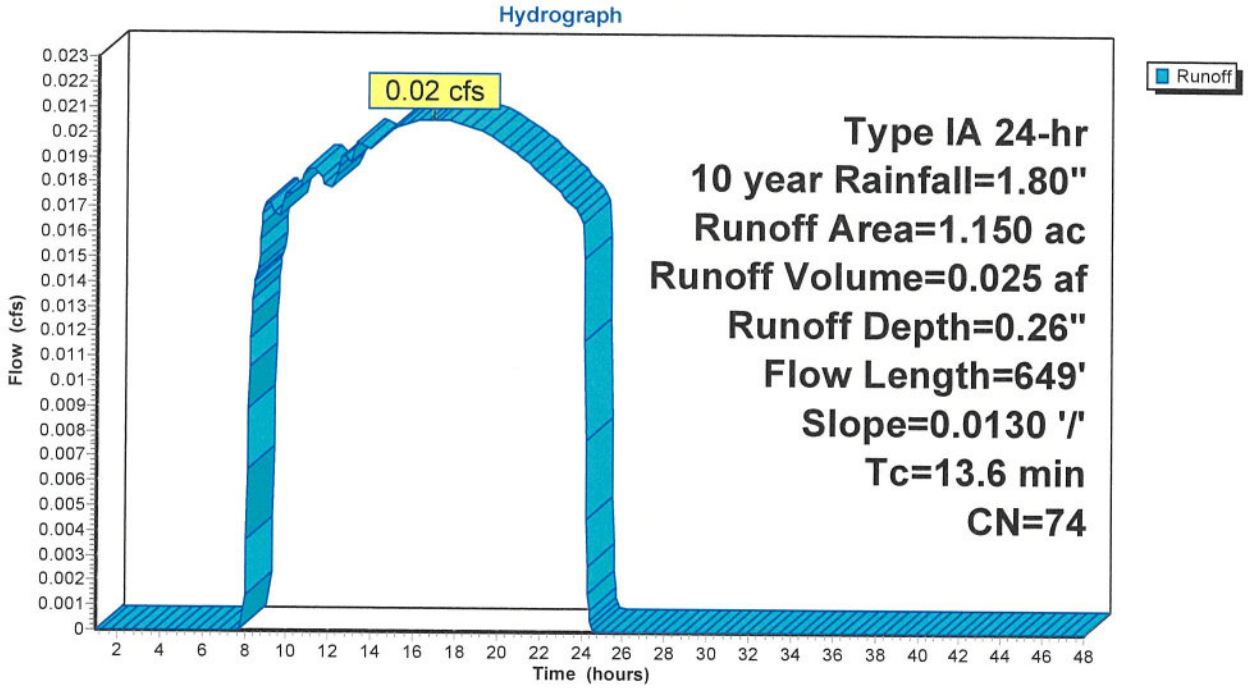
Runoff = 0.02 cfs @ 16.93 hrs, Volume= 0.025 af, Depth= 0.26"
Routed to Reach 4R : Backyard flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 year Rainfall=1.80"

Area (ac)	CN	Description
1.150	74	>75% Grass cover, Good, HSG C
1.150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.6	649	0.0130	0.80		**Shallow Concentrated Flow, Backyards** Short Grass Pasture Kv= 7.0 fps

Subcatchment 3S: Back Yards



Summary for Subcatchment 4S: Field

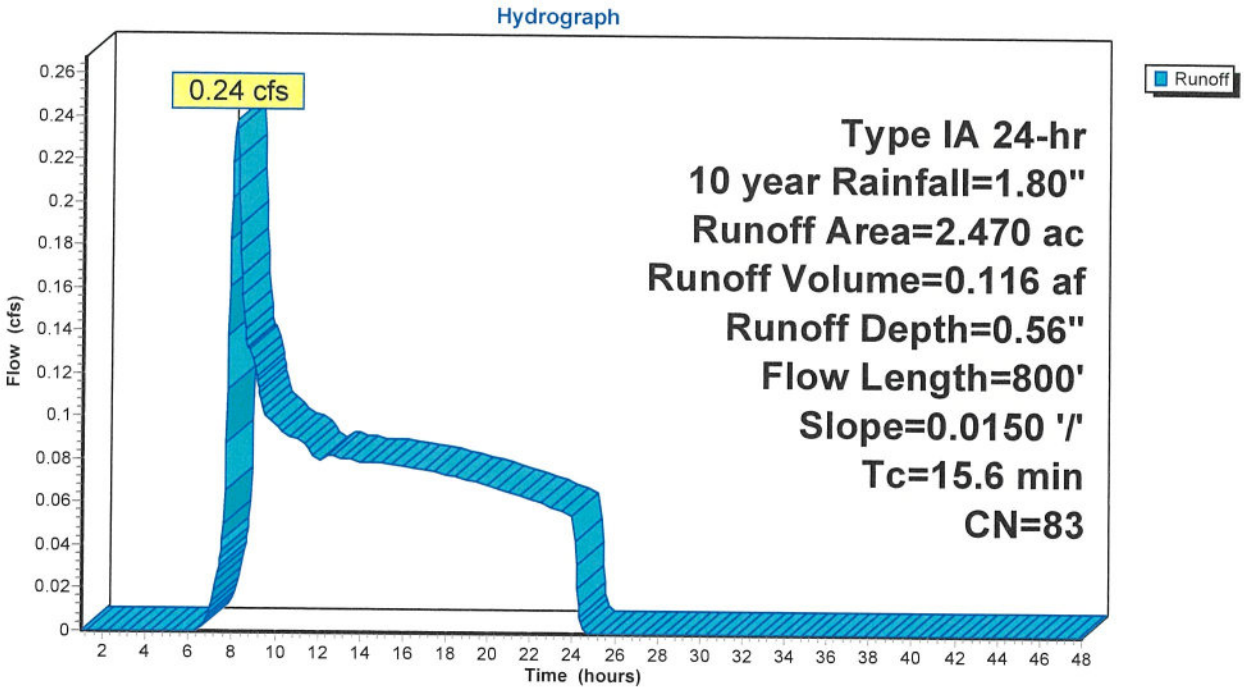
Runoff = 0.24 cfs @ 8.10 hrs, Volume= 0.116 af, Depth= 0.56"
Routed to Reach 3R : Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10 year Rainfall=1.80"

Area (ac)	CN	Description
2.470	83	Legumes, contoured, Poor, HSG C
2.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6	800	0.0150	0.86		**Shallow Concentrated Flow, Field** Short Grass Pasture Kv= 7.0 fps

Subcatchment 4S: Field



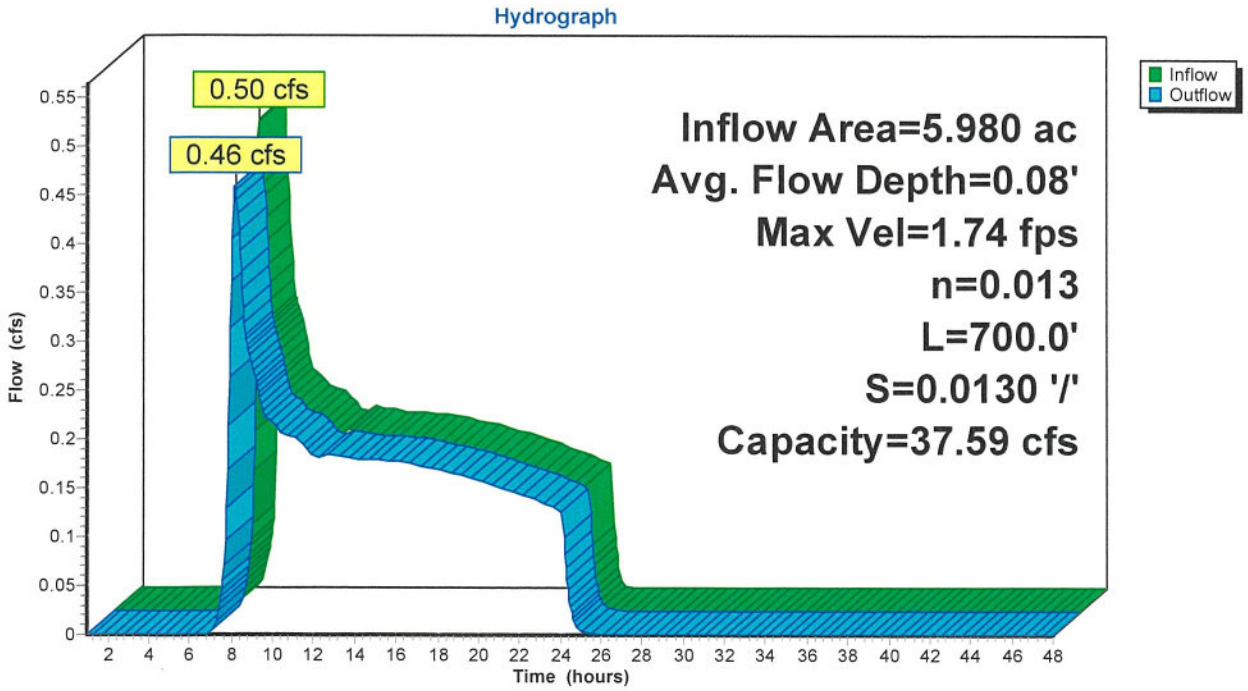
Summary for Reach 3R: Gutter

Inflow Area = 5.980 ac, 17.61% Impervious, Inflow Depth = 0.51" for 10 year event
Inflow = 0.50 cfs @ 7.99 hrs, Volume= 0.257 af
Outflow = 0.46 cfs @ 8.16 hrs, Volume= 0.257 af, Atten= 9%, Lag= 10.6 min
Routed to Pond 2P : POND A

Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.74 fps, Min. Travel Time= 6.7 min
Avg. Velocity = 1.17 fps, Avg. Travel Time= 9.9 min

Peak Storage= 186 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.08' , Surface Width= 5.39'
Bank-Full Depth= 0.50' Flow Area= 7.1 sf, Capacity= 37.59 cfs

1.50' x 0.50' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 0.5 50.0 '/' Top Width= 26.75'
Length= 700.0' Slope= 0.0130 '/'
Inlet Invert= 1,011.10', Outlet Invert= 1,002.00'



Summary for Reach 4R: Backyard flow

Inflow Area = 1.150 ac, 0.00% Impervious, Inflow Depth = 0.26" for 10 year event
Inflow = 0.02 cfs @ 16.93 hrs, Volume= 0.025 af
Outflow = 0.02 cfs @ 24.81 hrs, Volume= 0.025 af, Atten= 6%, Lag= 473.0 min
Routed to Pond 2P : POND A

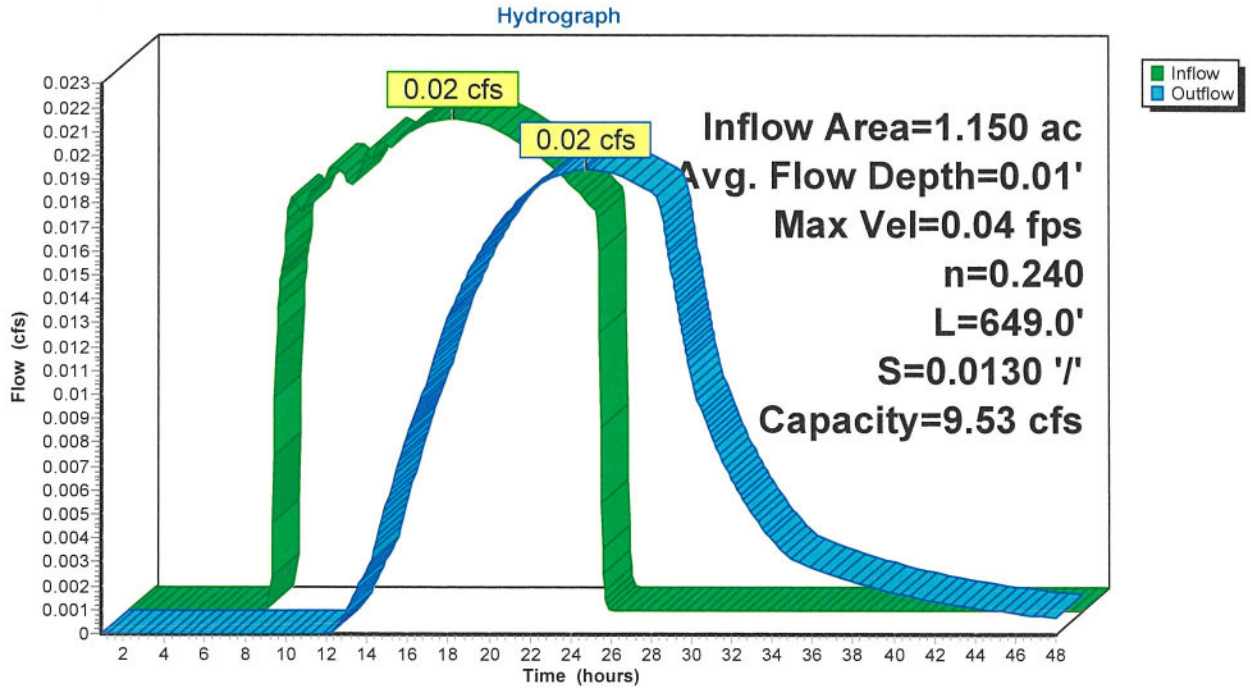
Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.04 fps, Min. Travel Time= 256.3 min
Avg. Velocity = 0.03 fps, Avg. Travel Time= 381.9 min

Peak Storage= 299 cf @ 20.54 hrs
Average Depth at Peak Storage= 0.01' , Surface Width= 31.50'
Bank-Full Depth= 0.50' Flow Area= 27.5 sf, Capacity= 9.53 cfs

30.00' x 0.50' deep channel, n= 0.240 Sheet flow over Dense Grass
Side Slope Z-value= 50.0 '/' Top Width= 80.00'
Length= 649.0' Slope= 0.0130 '/'
Inlet Invert= 1,010.44', Outlet Invert= 1,002.00'

‡

Reach 4R: Backyard flow



Summary for Pond 2P: POND A

Inflow Area = 7.130 ac, 14.77% Impervious, Inflow Depth > 0.47" for 10 year event
Inflow = 0.46 cfs @ 8.16 hrs, Volume= 0.281 af
Outflow = 0.11 cfs @ 24.24 hrs, Volume= 0.281 af, Atten= 77%, Lag= 964.6 min
Primary = 0.11 cfs @ 24.24 hrs, Volume= 0.281 af

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,000.66' @ 24.24 hrs Surf.Area= 8,868 sf Storage= 5,584 cf

Plug-Flow detention time= 523.1 min calculated for 0.281 af (100% of inflow)
Center-of-Mass det. time= 522.4 min (1,472.4 - 950.0)

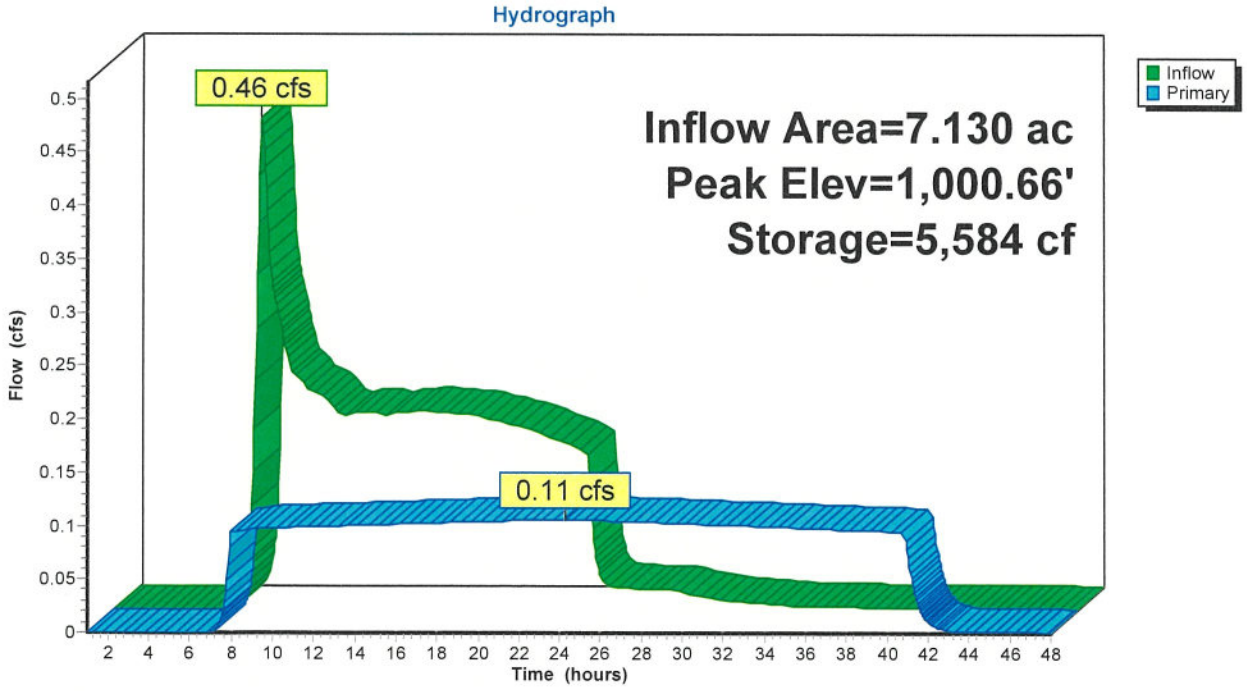
Volume	Invert	Avail.Storage	Storage Description
#1	1,000.00'	18,544 cf	**90.23'W x 90.23'L x 2.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	1,000.00'	**0.500 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 980.00'

Primary OutFlow Max=0.11 cfs @ 24.24 hrs HW=1,000.66' (Free Discharge)
1=Exfiltration (Controls 0.11 cfs)

Pond 2P: POND A

Hydrograph



Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Subdivision Runoff Area=3.510 ac 30.00% Impervious Runoff Depth=0.73"
Flow Length=725' Tc=1.8 min CN=81 Runoff=0.51 cfs 0.215 af

Subcatchment3S: Back Yards Runoff Area=1.150 ac 0.00% Impervious Runoff Depth=0.45"
Flow Length=649' Slope=0.0130 '/' Tc=13.6 min CN=74 Runoff=0.05 cfs 0.043 af

Subcatchment4S: Field Runoff Area=2.470 ac 0.00% Impervious Runoff Depth=0.84"
Flow Length=800' Slope=0.0150 '/' Tc=15.6 min CN=83 Runoff=0.41 cfs 0.172 af

Reach 3R: Gutter Avg. Flow Depth=0.10' Max Vel=2.03 fps Inflow=0.89 cfs 0.387 af
n=0.013 L=700.0' S=0.0130 '/' Capacity=37.59 cfs Outflow=0.84 cfs 0.387 af

Reach 4R: Backyard flow Avg. Flow Depth=0.02' Max Vel=0.05 fps Inflow=0.05 cfs 0.043 af
n=0.240 L=649.0' S=0.0130 '/' Capacity=9.53 cfs Outflow=0.03 cfs 0.042 af

Pond 2P: POND A Peak Elev=1,001.27' Storage=11,228 cf Inflow=0.84 cfs 0.429 af
Outflow=0.12 cfs 0.367 af

Total Runoff Area = 7.130 ac Runoff Volume = 0.430 af Average Runoff Depth = 0.72"
85.23% Pervious = 6.077 ac 14.77% Impervious = 1.053 ac

Summary for Subcatchment 1S: Subdivision

[49] Hint: Tc<2dt may require smaller dt

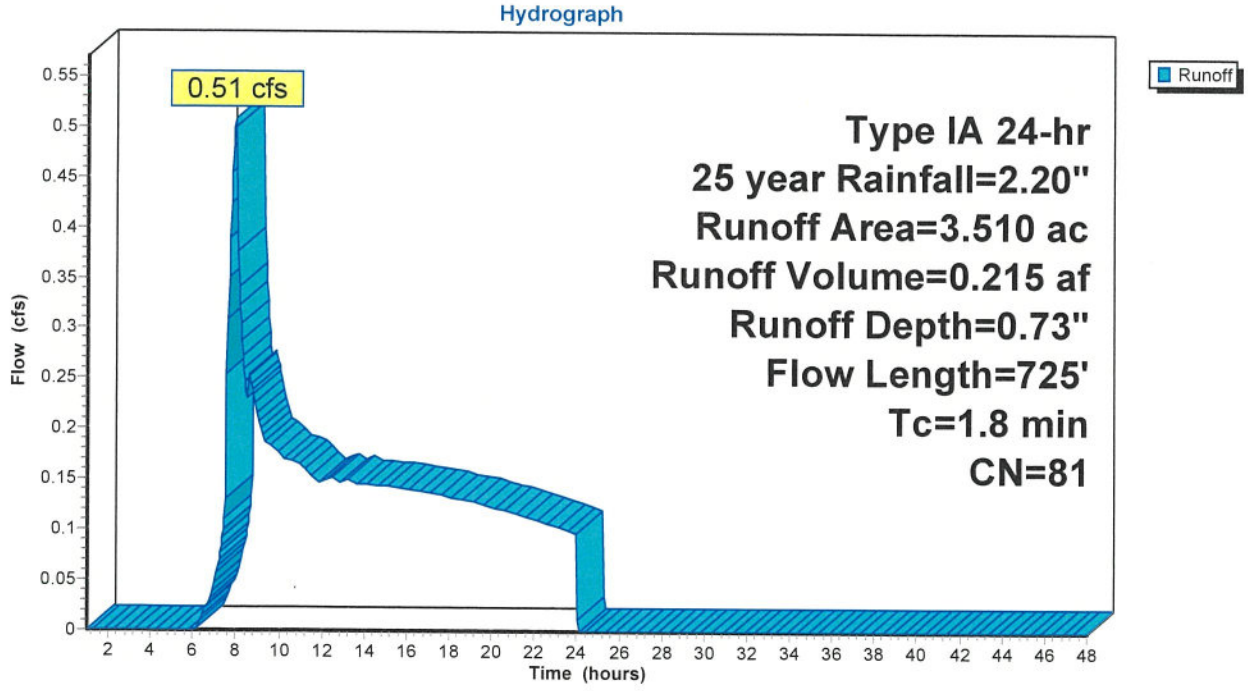
Runoff = 0.51 cfs @ 7.95 hrs, Volume= 0.215 af, Depth= 0.73"
Routed to Reach 3R : Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 year Rainfall=2.20"

Area (ac)	CN	Description
3.510	81	1/3 acre lots, 30% imp, HSG C
2.457		70.00% Pervious Area
1.053		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	60	0.0200	2.28		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
1.4	665	0.0130	7.70	3.85	**Channel Flow,** Area= 0.5 sf Perim= 1.1' r= 0.45' n= 0.013 Concrete, trowel finish
1.8	725	Total			

Subcatchment 1S: Subdivision



Summary for Subcatchment 3S: Back Yards

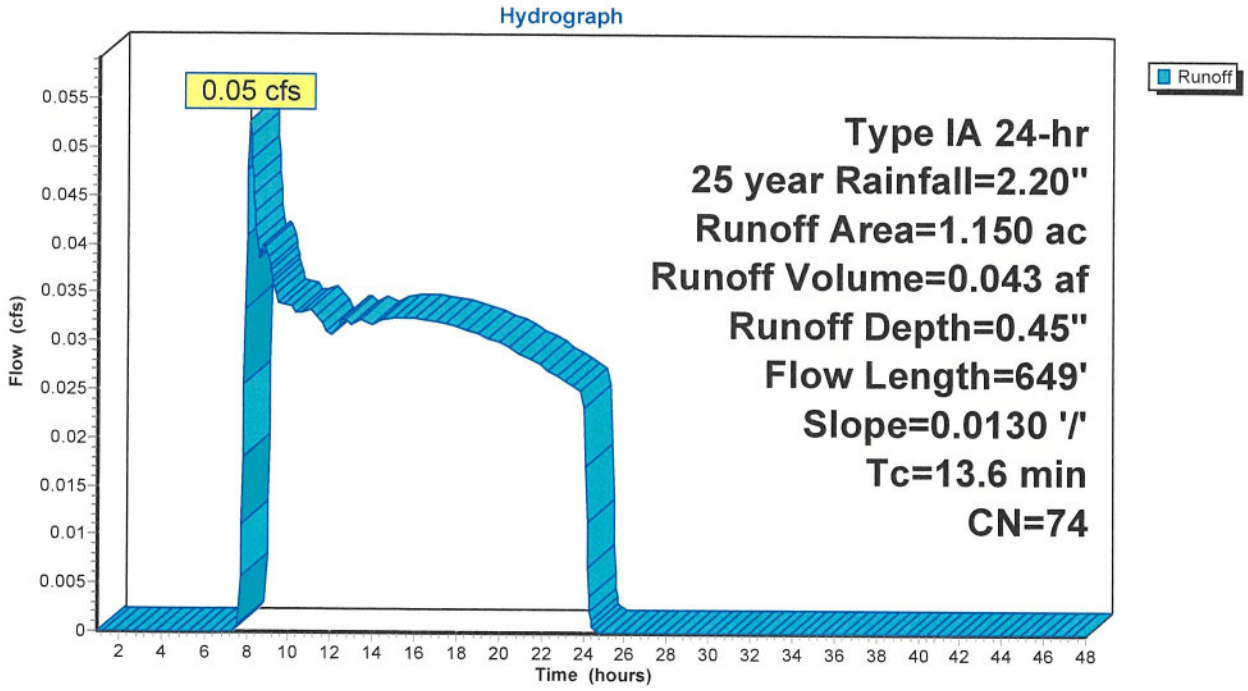
Runoff = 0.05 cfs @ 8.14 hrs, Volume= 0.043 af, Depth= 0.45"
Routed to Reach 4R : Backyard flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 year Rainfall=2.20"

Area (ac)	CN	Description
1.150	74	>75% Grass cover, Good, HSG C
1.150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.6	649	0.0130	0.80		**Shallow Concentrated Flow, Backyards** Short Grass Pasture Kv= 7.0 fps

Subcatchment 3S: Back Yards



Summary for Subcatchment 4S: Field

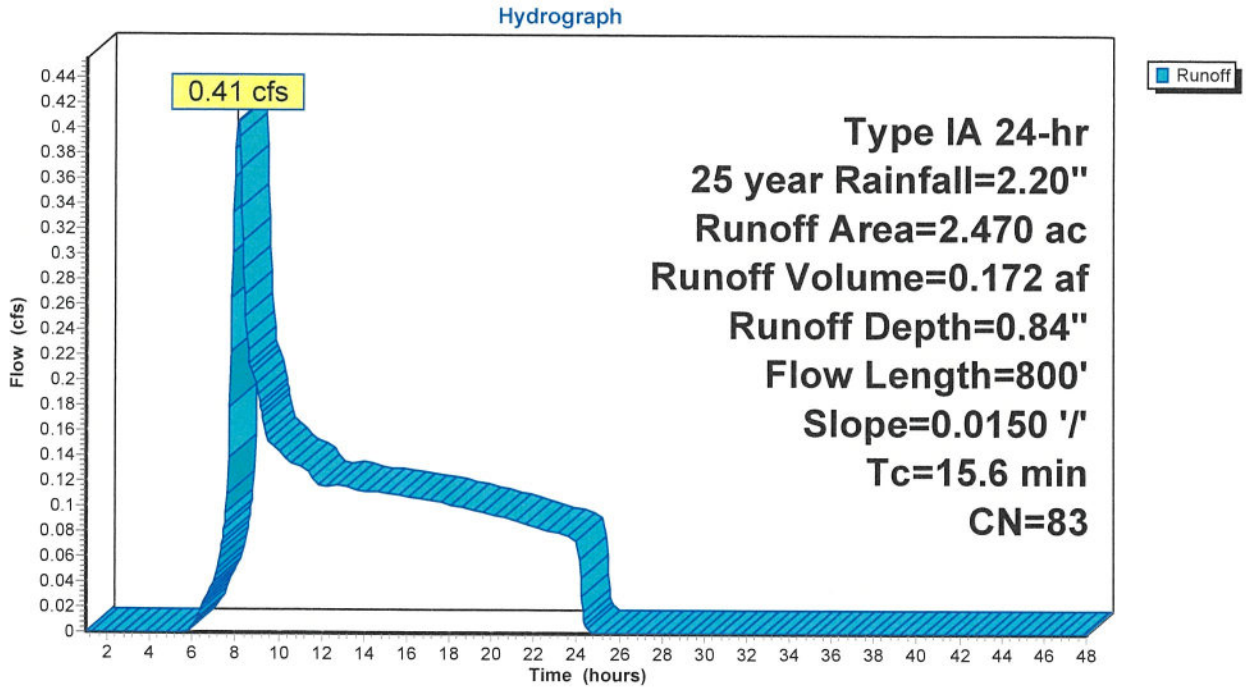
Runoff = 0.41 cfs @ 8.09 hrs, Volume= 0.172 af, Depth= 0.84"
Routed to Reach 3R : Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25 year Rainfall=2.20"

Area (ac)	CN	Description
2.470	83	Legumes, contoured, Poor, HSG C
2.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6	800	0.0150	0.86		**Shallow Concentrated Flow, Field** Short Grass Pasture Kv= 7.0 fps

Subcatchment 4S: Field



Summary for Reach 3R: Gutter

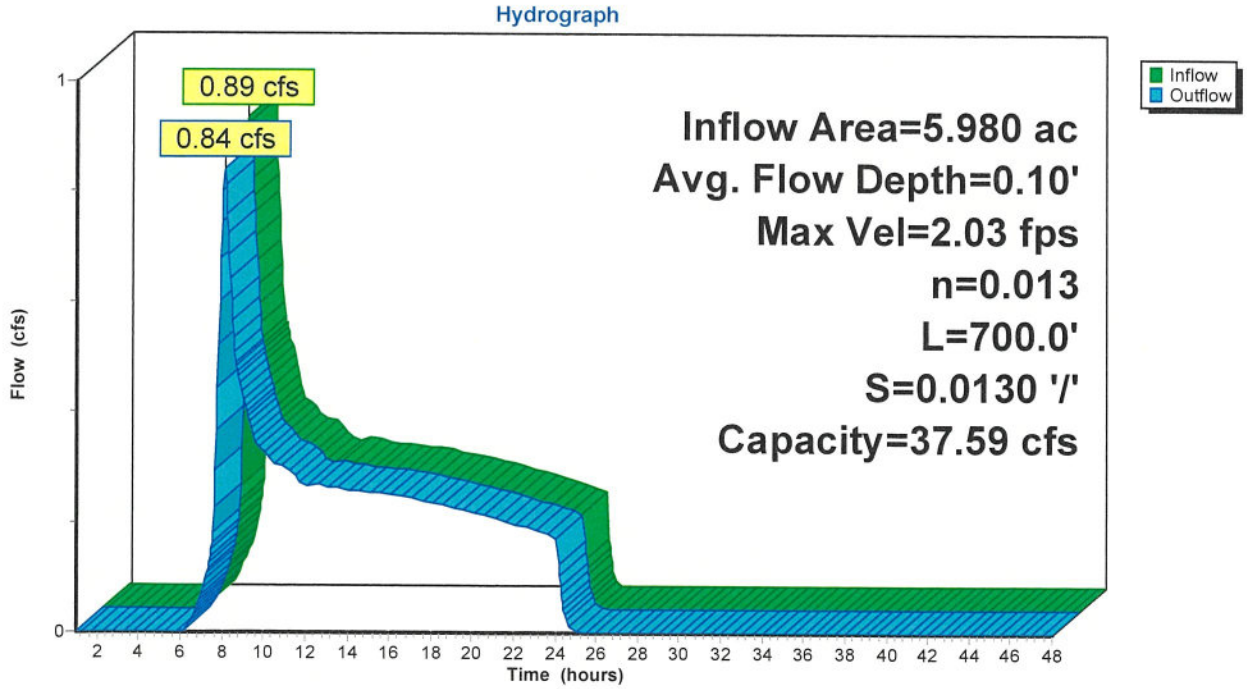
Inflow Area = 5.980 ac, 17.61% Impervious, Inflow Depth = 0.78" for 25 year event
Inflow = 0.89 cfs @ 7.98 hrs, Volume= 0.387 af
Outflow = 0.84 cfs @ 8.12 hrs, Volume= 0.387 af, Atten= 6%, Lag= 8.2 min
Routed to Pond 2P : POND A

Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.03 fps, Min. Travel Time= 5.7 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 9.1 min

Peak Storage= 290 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.10' , Surface Width= 6.64'
Bank-Full Depth= 0.50' Flow Area= 7.1 sf, Capacity= 37.59 cfs

1.50' x 0.50' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 0.5 50.0 '/' Top Width= 26.75'
Length= 700.0' Slope= 0.0130 '/'
Inlet Invert= 1,011.10', Outlet Invert= 1,002.00'

Reach 3R: Gutter



Summary for Reach 4R: Backyard flow

Inflow Area = 1.150 ac, 0.00% Impervious, Inflow Depth = 0.45" for 25 year event
Inflow = 0.05 cfs @ 8.14 hrs, Volume= 0.043 af
Outflow = 0.03 cfs @ 21.74 hrs, Volume= 0.042 af, Atten= 40%, Lag= 815.8 min
Routed to Pond 2P : POND A

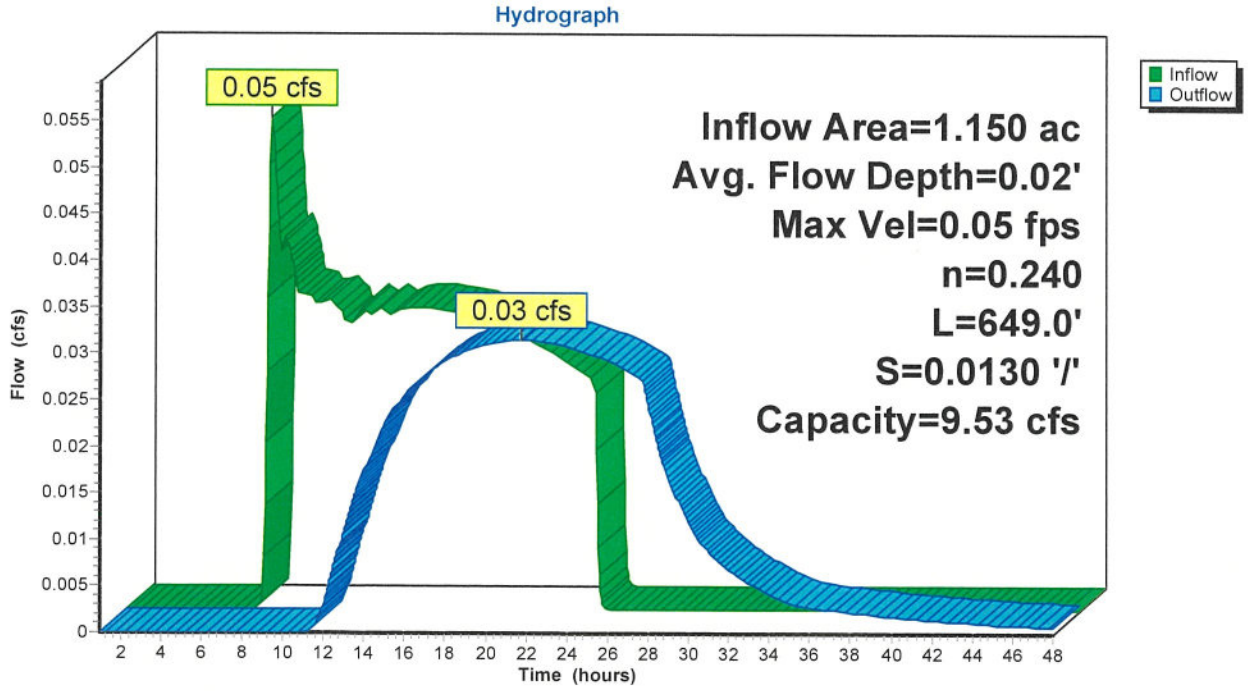
Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.05 fps, Min. Travel Time= 212.6 min
Avg. Velocity = 0.03 fps, Avg. Travel Time= 328.1 min

Peak Storage= 401 cf @ 18.19 hrs
Average Depth at Peak Storage= 0.02' , Surface Width= 32.00'
Bank-Full Depth= 0.50' Flow Area= 27.5 sf, Capacity= 9.53 cfs

30.00' x 0.50' deep channel, n= 0.240 Sheet flow over Dense Grass
Side Slope Z-value= 50.0 '/' Top Width= 80.00'
Length= 649.0' Slope= 0.0130 '/'
Inlet Invert= 1,010.44', Outlet Invert= 1,002.00'

‡

Reach 4R: Backyard flow



Summary for Pond 2P: POND A

Inflow Area = 7.130 ac, 14.77% Impervious, Inflow Depth > 0.72" for 25 year event
Inflow = 0.84 cfs @ 8.12 hrs, Volume= 0.429 af
Outflow = 0.12 cfs @ 24.30 hrs, Volume= 0.367 af, Atten= 86%, Lag= 970.8 min
Primary = 0.12 cfs @ 24.30 hrs, Volume= 0.367 af

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,001.27' @ 24.30 hrs Surf.Area= 9,574 sf Storage= 11,228 cf

Plug-Flow detention time= 830.6 min calculated for 0.367 af (86% of inflow)
Center-of-Mass det. time= 735.6 min (1,652.4 - 916.8)

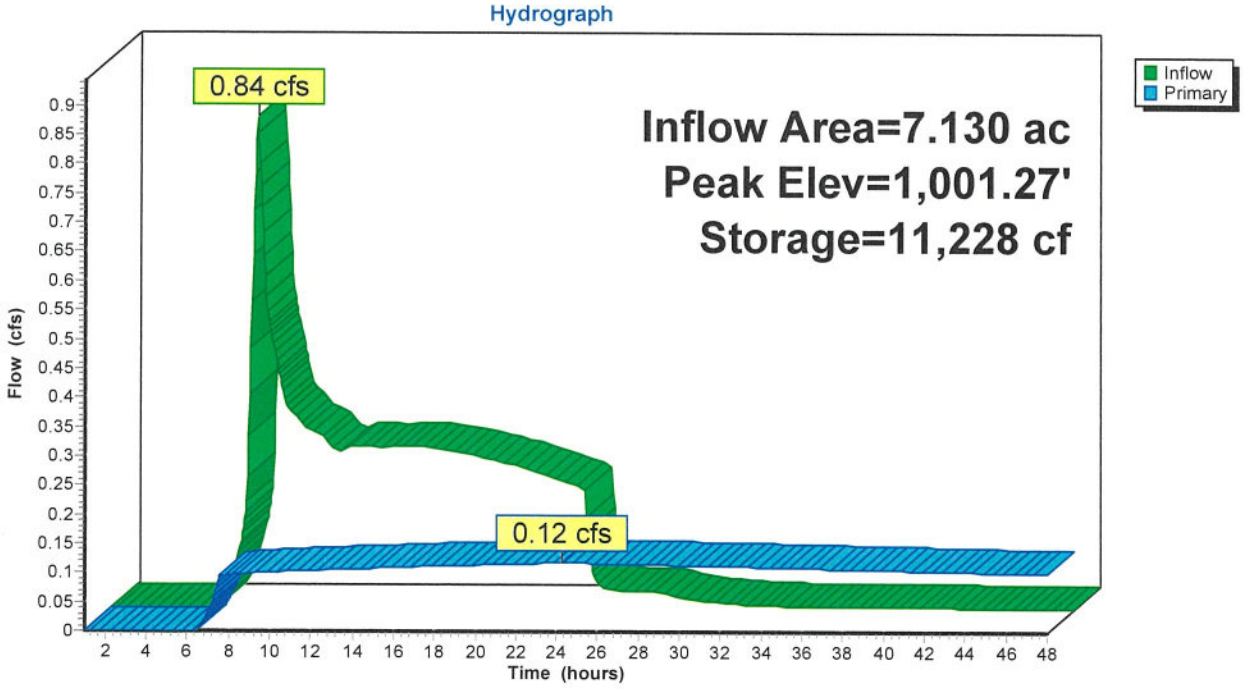
Volume	Invert	Avail.Storage	Storage Description
#1	1,000.00'	18,544 cf	**90.23'W x 90.23'L x 2.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	1,000.00'	**0.500 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 980.00'

Primary OutFlow Max=0.12 cfs @ 24.30 hrs HW=1,001.27' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.12 cfs)

Pond 2P: POND A

Hydrograph



Time span=1.00-48.00 hrs, dt=0.05 hrs, 941 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Subdivision Runoff Area=3.510 ac 30.00% Impervious Runoff Depth=1.01"
Flow Length=725' Tc=1.8 min CN=81 Runoff=0.77 cfs 0.297 af

Subcatchment3S: Back Yards Runoff Area=1.150 ac 0.00% Impervious Runoff Depth=0.67"
Flow Length=649' Slope=0.0130 '/' Tc=13.6 min CN=74 Runoff=0.11 cfs 0.064 af

Subcatchment4S: Field Runoff Area=2.470 ac 0.00% Impervious Runoff Depth=1.13"
Flow Length=800' Slope=0.0150 '/' Tc=15.6 min CN=83 Runoff=0.59 cfs 0.233 af

Reach 3R: Gutter Avg. Flow Depth=0.12' Max Vel=2.27 fps Inflow=1.33 cfs 0.530 af
n=0.013 L=700.0' S=0.0130 '/' Capacity=37.59 cfs Outflow=1.27 cfs 0.530 af

Reach 4R: Backyard flow Avg. Flow Depth=0.02' Max Vel=0.06 fps Inflow=0.11 cfs 0.064 af
n=0.240 L=649.0' S=0.0130 '/' Capacity=9.53 cfs Outflow=0.05 cfs 0.063 af

Pond 2P: POND A Peak Elev=1,001.90' Storage=17,503 cf Inflow=1.27 cfs 0.593 af
Outflow=0.13 cfs 0.407 af

Total Runoff Area = 7.130 ac Runoff Volume = 0.593 af Average Runoff Depth = 1.00"
85.23% Pervious = 6.077 ac 14.77% Impervious = 1.053 ac

Summary for Subcatchment 1S: Subdivision

[49] Hint: Tc<2dt may require smaller dt

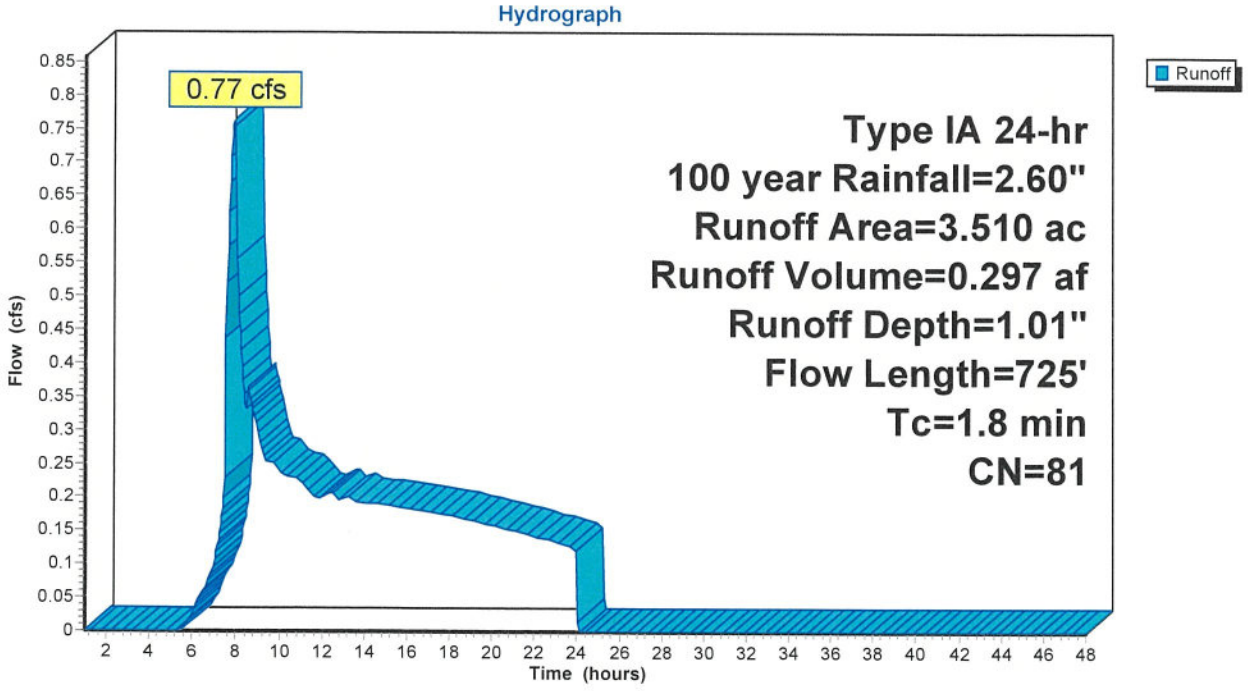
Runoff = 0.77 cfs @ 7.94 hrs, Volume= 0.297 af, Depth= 1.01"
Routed to Reach 3R : Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 year Rainfall=2.60"

Area (ac)	CN	Description
3.510	81	1/3 acre lots, 30% imp, HSG C
2.457		70.00% Pervious Area
1.053		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	60	0.0200	2.28		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
1.4	665	0.0130	7.70	3.85	**Channel Flow,** Area= 0.5 sf Perim= 1.1' r= 0.45' n= 0.013 Concrete, trowel finish
1.8	725	Total			

Subcatchment 1S: Subdivision



Summary for Subcatchment 3S: Back Yards

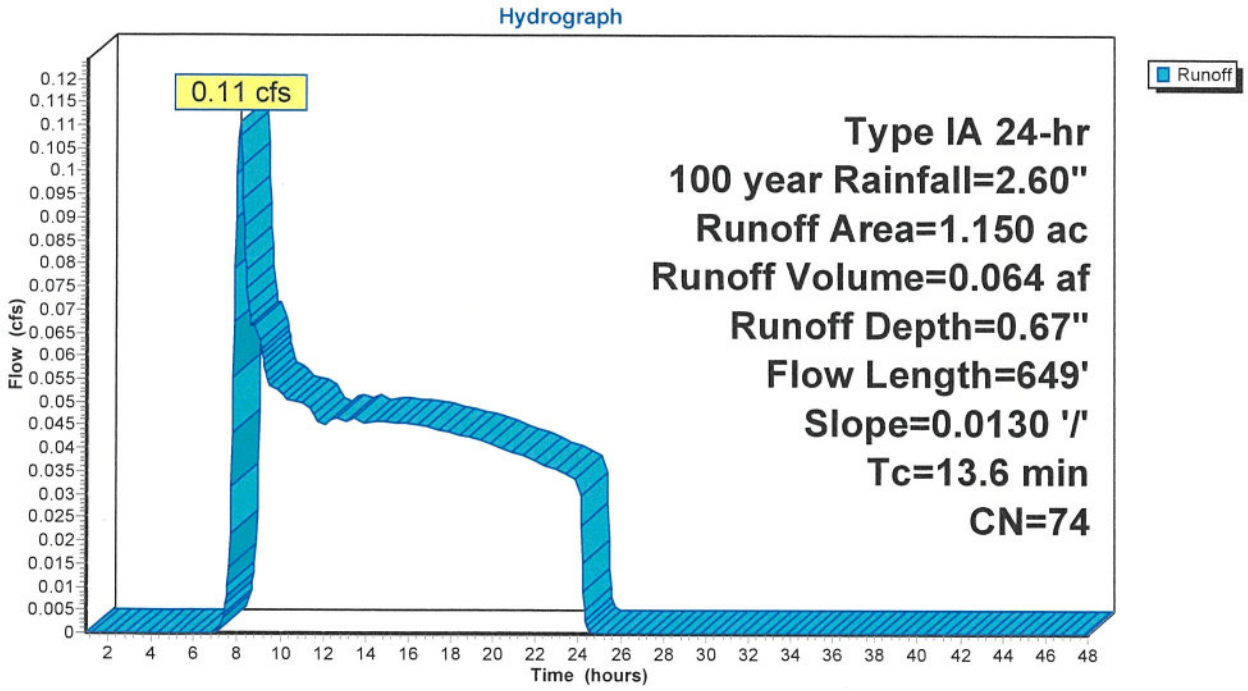
Runoff = 0.11 cfs @ 8.10 hrs, Volume= 0.064 af, Depth= 0.67"
Routed to Reach 4R : Backyard flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 year Rainfall=2.60"

Area (ac)	CN	Description
1.150	74	>75% Grass cover, Good, HSG C
1.150		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.6	649	0.0130	0.80		**Shallow Concentrated Flow, Backyards** Short Grass Pasture Kv= 7.0 fps

Subcatchment 3S: Back Yards



Summary for Subcatchment 4S: Field

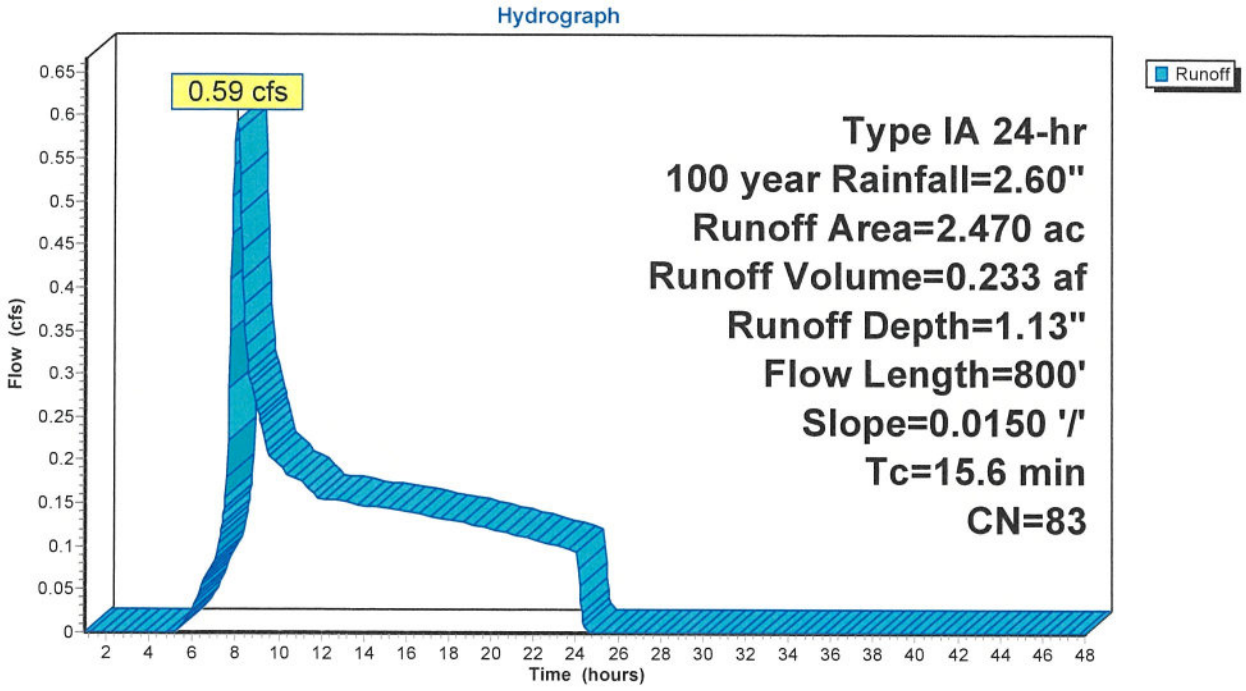
Runoff = 0.59 cfs @ 8.08 hrs, Volume= 0.233 af, Depth= 1.13"
Routed to Reach 3R : Gutter

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100 year Rainfall=2.60"

Area (ac)	CN	Description
2.470	83	Legumes, contoured, Poor, HSG C
2.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.6	800	0.0150	0.86		**Shallow Concentrated Flow, Field** Short Grass Pasture Kv= 7.0 fps

Subcatchment 4S: Field



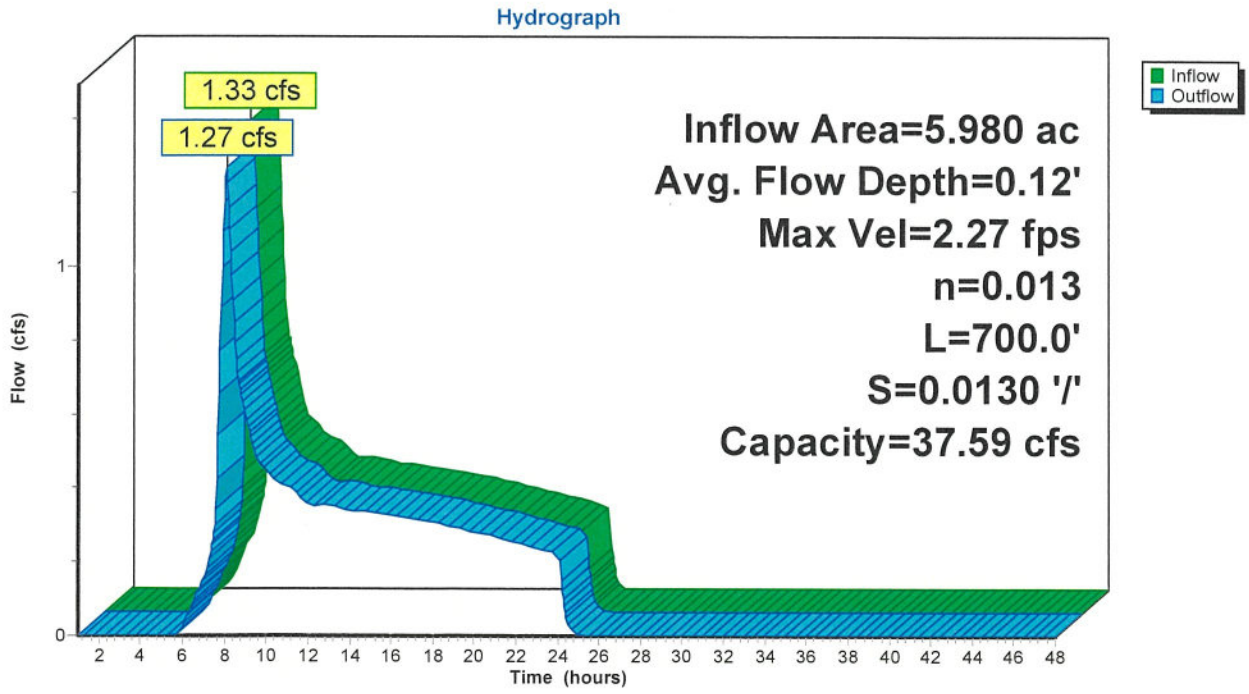
Summary for Reach 3R: Gutter

Inflow Area = 5.980 ac, 17.61% Impervious, Inflow Depth = 1.06" for 100 year event
Inflow = 1.33 cfs @ 7.98 hrs, Volume= 0.530 af
Outflow = 1.27 cfs @ 8.09 hrs, Volume= 0.530 af, Atten= 5%, Lag= 7.0 min
Routed to Pond 2P : POND A

Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.27 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 8.4 min

Peak Storage= 394 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.12' , Surface Width= 7.69'
Bank-Full Depth= 0.50' Flow Area= 7.1 sf, Capacity= 37.59 cfs

1.50' x 0.50' deep channel, n= 0.013 Concrete, trowel finish
Side Slope Z-value= 0.5 50.0 '/' Top Width= 26.75'
Length= 700.0' Slope= 0.0130 '/'
Inlet Invert= 1,011.10', Outlet Invert= 1,002.00'



Summary for Reach 4R: Backyard flow

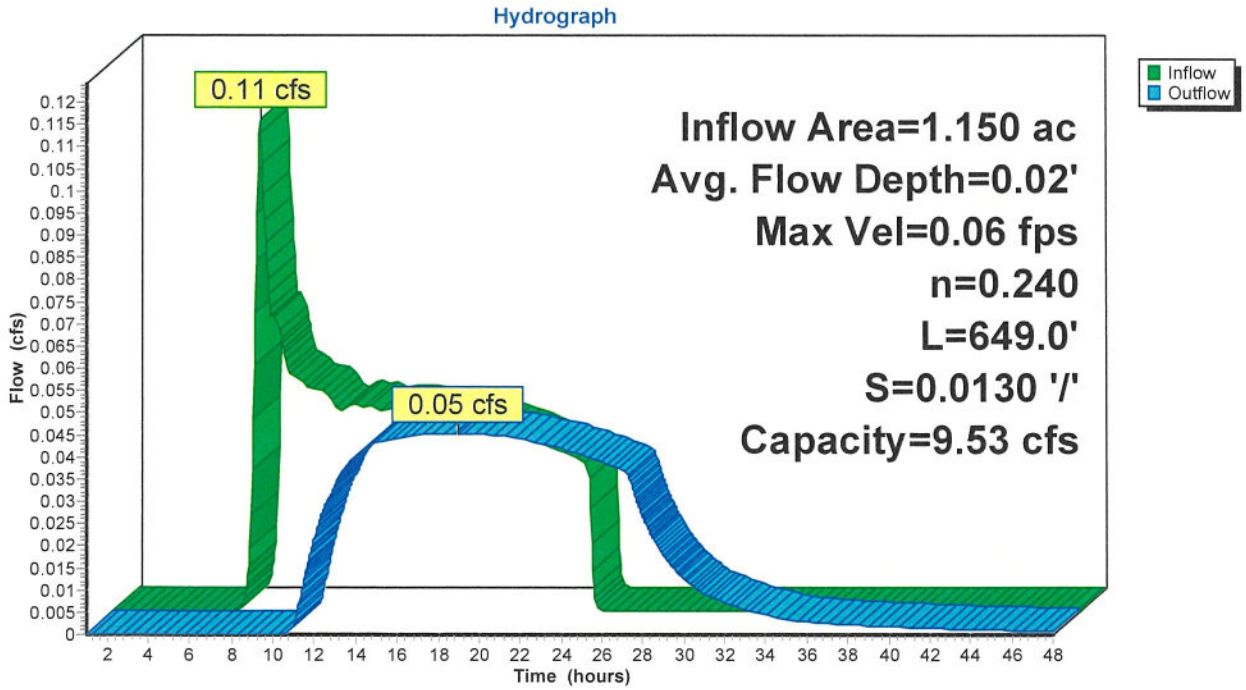
Inflow Area = 1.150 ac, 0.00% Impervious, Inflow Depth = 0.67" for 100 year event
Inflow = 0.11 cfs @ 8.10 hrs, Volume= 0.064 af
Outflow = 0.05 cfs @ 19.01 hrs, Volume= 0.063 af, Atten= 59%, Lag= 654.8 min
Routed to Pond 2P : POND A

Routing by Stor-Ind+Trans method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.06 fps, Min. Travel Time= 184.7 min
Avg. Velocity = 0.04 fps, Avg. Travel Time= 293.0 min

Peak Storage= 503 cf @ 15.94 hrs
Average Depth at Peak Storage= 0.02' , Surface Width= 32.48'
Bank-Full Depth= 0.50' Flow Area= 27.5 sf, Capacity= 9.53 cfs

30.00' x 0.50' deep channel, n= 0.240 Sheet flow over Dense Grass
Side Slope Z-value= 50.0 '/' Top Width= 80.00'
Length= 649.0' Slope= 0.0130 '/'
Inlet Invert= 1,010.44', Outlet Invert= 1,002.00'

Reach 4R: Backyard flow



Summary for Pond 2P: POND A

Inflow Area = 7.130 ac, 14.77% Impervious, Inflow Depth > 1.00" for 100 year event
Inflow = 1.27 cfs @ 8.09 hrs, Volume= 0.593 af
Outflow = 0.13 cfs @ 24.33 hrs, Volume= 0.407 af, Atten= 90%, Lag= 974.3 min
Primary = 0.13 cfs @ 24.33 hrs, Volume= 0.407 af

Routing by Stor-Ind method, Time Span= 1.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1,001.90' @ 24.33 hrs Surf.Area= 10,328 sf Storage= 17,503 cf

Plug-Flow detention time= 944.9 min calculated for 0.406 af (69% of inflow)
Center-of-Mass det. time= 757.3 min (1,649.1 - 891.8)

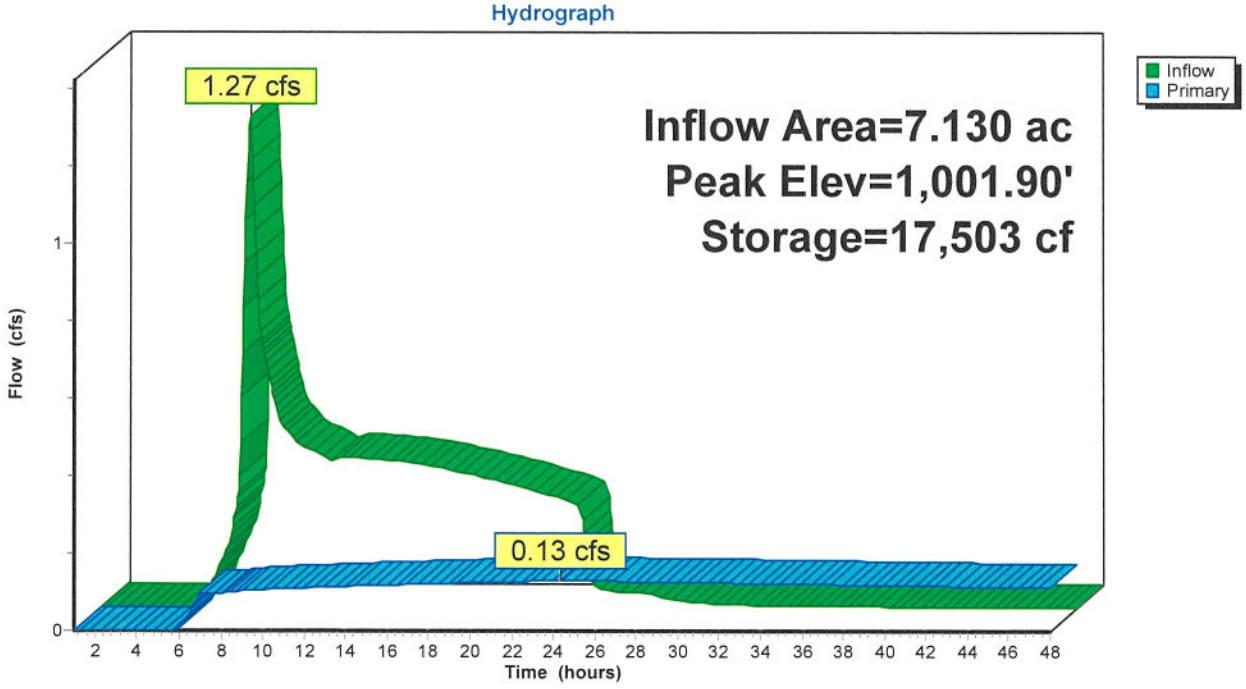
Volume	Invert	Avail.Storage	Storage Description
#1	1,000.00'	18,544 cf	**90.23'W x 90.23'L x 2.00'H Prismatoid Z=3.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	1,000.00'	**0.500 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 980.00'

Primary OutFlow Max=0.13 cfs @ 24.33 hrs HW=1,001.90' (Free Discharge)
↑**1=Exfiltration** (Controls 0.13 cfs)

Pond 2P: POND A

Hydrograph



GEOTECHNICAL REPORT

Geotechnical Engineering Report
Crestview Estates 1st Addition
Ash Street and Tieton Avenue
Spokane County, Washington

Prepared For:
Austin J Fuller
Whipple Consulting Engineers, Inc.
21 South Pines Road
Spokane Valley, Washington 99206

Prepared By:

Liberty Geotechnical Engineering, Inc.
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Spokane Valley, Washington 99216
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BENJAMIN D VANCE
STATE OF WASHINGTON
54048
REGISTERED
PROFESSIONAL ENGINEER

Report Date: April 5, 2022
Job Number: 21425

Table of Contents

Appendices

1.0 EXECUTIVE SUMMARY

The following geotechnical engineering report has been prepared for Crestview Estates 1st Addition in Ash Street, Spokane County, Washington. The following items have been identified at the project site and proposed construction that should be carefully considered during design and construction:

- Standing water was observed within the existing drywells located at the site. This may be due to fluctuations of groundwater and perching between the topsoil or undocumented fill, and bedrock at the site.
- Swales consisting of single or double-depth drywells were not feasible across the site due to the limiting layer of shallow bedrock. Drainage retention swales are recommended to treat and retain the stormwater.
- The area appears to be a stormwater disposal facility. Drain rock, filter fabric and drywells were observed in the area.
- Undocumented fill was observed in both test pits to a depth of 1 ½- to 2-feet below the ground surface. Undocumented fill may be reused as *Embankment Fill* provided it meets the requirements of *Table 4.1.2.A* of this report.

Liberty Geotech should be involved in the design development and earthwork construction to help ensure that the report recommendations are incorporated into the design and construction. Liberty Geotech is available to discuss these items further in-person or via a conference call.

2.0 PROPOSED CONSTRUCTION

The proposed construction consists of a stormwater drainage facility. Stormwater disposal will consist of swales and typical single or double-depth drywells position within the swale areas. The recommendations included in this report are based on a plat map prepared by Taylor Engineering, Inc. dated October 10, 2003.

3.0 GEOTECHNICAL EXPLORATION

Subsurface exploration was performed by excavating two test pits with a SANY SY26U mini-excavator. Subsurface exploration was performed at the project site on December 2, 2021. The test pits were excavated through the topsoil, undocumented fill, and bedrock and terminated on the rock surface. The contractor or client is recommended to notify Liberty Geotech if the soil conditions are different from those described in the following sections.

Throughout this report, test pits are abbreviated TP and are hyphenated with a numbering system that corresponds to Appendix A: *Exploration Site Plan* and Appendix B: *Subsurface Exploration Results*. The test pits depicted in Appendix A were located using the accuracy of a cell phone location system. The locations were not surveyed and the accuracy is expected to be

within 10-feet of the depicted location. Also, the elevation of each test pit was estimated using Google Earth™ mapping service with the GWS84 EGM96 geoid.

3.1 Geology, Topography, and Current Site Use

The *Geologic map of the Spokane Northwest 7.5-minute quadrangle, Spokane County, Washington* (Derkey, 2004) was reviewed to determine the geologic deposit at the site. The geologic map indicated that the geologic unit was the Priest Rapids Member of the Wanapum Basalt, Columbia River Basalt Group (middle Miocene). In addition, the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Web Soil Survey (NRCS, 2021) was reviewed. The soil survey indicates that the soil unit is the Urban land-Seaboldt, warm, disturbed-Brincken, moist, disturbed complex consisting of ashy loam from the ground surface to a depth of 10 inches, loam from 10 inches to 16 inches, sandy loam from 16 inches to 23 inches, extremely gravelly sandy loam from 23 inches to 28 inches, and bedrock from 28 inches to 38 inches. The soil survey describes the soil as loess mixed with minor amounts of volcanic ash over glaciofluvial deposits over residuum from basalt.

The two lots have existing drainage swales and both with a single-depth drywell. According to the historical aerial images, the earthwork construction for the residential development within the site's vicinity was between 2003 to 2006. The existing swales and drywells appeared to be placed within the site during that time. In addition, based on the topography obtained from Google Earth™, the site is relatively level with approximately five to seven feet of relief across the site.

3.2 Summary of Soil and Rock Encountered During Exploration

The soil encountered during the exploration is generally consistent with the geologic research. However, both test pits observed undocumented fill to depths of 2 ½- to 3-feet below the ground surface. The test pits encountered one foot of topsoil overlying a separation fabric overlying drain rock with a separation fabric overlying bedrock.

3.3 Estimated Groundwater and Bedrock Elevations

Groundwater was not observed in both test pits. However, there was standing water at the drywells during the exploration. This may be due to fluctuations of groundwater and perching between the topsoil and bedrock at the site.

According to the well logs in the vicinity of the site (Ecology), the static water level is approximately 37-feet below the ground surface. Seasonal and annual fluctuations in groundwater levels should be anticipated.

Both test pits met refusal due to basalt bedrock to depths ranging from three to four feet below the ground surface. In TP-2, residual bedrock was observed 2 ½-feet below the ground surface.

4.0 GEOTECHNICAL RECOMMENDATIONS

4.1 Earthwork

The following recommendations should be considered by the general contractors and earthwork subcontractors prior to providing a cost estimate for the earthwork on the project.

4.1.1 Subgrade Preparation

Clear and grub all vegetation, strip all topsoil. Topsoil and undocumented fill removal are estimated to be one to three feet across the site.

Liberty Geotech should be contacted once the subgrade areas have been exposed to review the subgrade conditions.

4.1.2 Earthwork Soil Products, Compaction, and Testing Frequency

Different soil products should be used for different applications. The following table presents recommendations for anticipated earthwork construction:

Table 4.1.2.A - Soil product selection.

Soil Product	Project Use	Soil Description
Embankment Fill	• Utility trench backfill	Soil classified as: • GP-GM or GW-GM • GM • SP-SM or SW-SM • SM • ML Soil should have less than 6% organic deleterious material, and all material larger than 3-inches in diameter.

The following table provides compaction recommendations specific to ASTM D1557 *Laboratory Compaction Characteristics of Soil Using Modified Effort*. All fill products should be compacted in lifts of soil not exceeding 12 inches measured prior to compaction.

Table 4.1.2.B - Compaction recommendation.

Project Use	Recommended Compaction
• Exterior wall backfill. • Utility trench backfills.	92 percent of the maximum dry density of Modified Proctor.
• Non-structural fill areas.	80 to 85 percent of the maximum

• Vegetated areas.	dry density of Modified Proctor.

If more than 30 percent of native or imported *Structural Fill* material is retained on the ¾" sieve, ASTM D1557 *Laboratory Compaction Characteristics of Soil Using Modified Effort* is not recommended to be used. In this case, a soil-specific method specification can be developed. A nuclear density gauge can be used during earthwork operations to establish a moisture and compaction method that provides an acceptable maximum dry density. Method specification earthwork operations are recommended to have full-time soil testing to ensure adequate compaction.

The soil products are recommended to have passing compaction testing results at the following frequency to ensure the soil is uniformly meeting compaction requirements. Failing test results should be retested after additional compactive effort and, if necessary, water is added. At least 90% of the compaction testing results must achieve the required maximum dry density.

Table 4.1.2.C - Testing Frequency.

Project Use	Testing Frequency
• Utility trenches for every two vertical feet of trench backfill.	100 lineal feet and a minimum of 2 tests.

The jurisdictional requirements should be conformed to if there is a conflict with the requirements of Table 5.1.2.C. Excavations deeper than four feet must have adequate trenching protection or be sloped back in accordance with state and federal requirements in order to be compaction tested.

4.2 Drainage and Stormwater Infiltration Recommendations

Drainage retention swales may be utilized to treat and retain stormwater. The following recommendations should be used by the civil engineer to retention swales:

- The depth to a restrictive layer is at least three feet below the ground surface based on the shallow bedrock encountered at the site during the exploration.
- Swales should be located 10-feet from the edge of buildings and concrete hardscapes to minimize the effects of retention.

5.0 DESIGN REVIEW AND CONSTRUCTION OBSERVATIONS

5.1 Geotechnical Consultant versus Geotechnical Inspector

In order to retain Liberty Geotech as the geotechnical engineer of record, the client must contact Liberty Geotech or require their contractor to contact Liberty Geotech to perform the observations and notifications that are recommended within this report. Liberty Geotech is not the engineer of record and has no liability for the construction or design based on this report if

observations and material testing are not performed and meet the recommendations contained within this report. In addition, Liberty Geotech's liability is limited to the authorized proposal dated November 24, 2021.

5.2 Revisions and Transfer of Geotechnical Recommendations

Liberty Geotech should be notified to update recommendations if the proposed development changes or subsurface soil or groundwater conditions vary from those described in this report. This report cannot be relied upon by property owners adjacent to this property without confirmation of their specific site soil conditions. Also, the report recommendations cannot be transferred to other business entities or subsequent property owners without written authorization. No warranty or certification of construction is provided with this report. Liberty Geotech should review the final construction drawings to confirm the incorporation of the recommendations of this report.

7.0 REFERENCES

ACI Committee 302. "Guide for Concrete Floor and Slab Construction." ACI 302.1R-15. American Concrete Institute, P.O. Box 19150 Redford Station, Detroit, Michigan 48219.

Derkey, Robert E., Hamilton, Michael M., Stradling, Dale F., 2004. Geologic Map of the Spokane Northwest 7.5-Minute Quadrangle, Spokane County, Washington. Washington Division of Geology and Earth Resources.

Spokane County, City of Spokane, and City of Spokane Valley. "Spokane Regional Stormwater Manual." April 2008.

United States Department of Agriculture, Natural Resources Conservation Service. "Web Soil Survey." Accessed December 23, 2021. http://websoilsurvey.nrcs.usda.gov/

Washington State Department of Ecology. "Washington State Well Report Viewer." Accessed December 23, 2021. fortress.wa.gov/ecy/wellconstruction/map/WCLSWebMap/

APPENDIX A

Exploration Site Plan

EXPLORATION SITE PLAN

CRESTVIEW ESTATES 1ST ADDITION

ASH STREET AND TIETON AVENUE

SPOKANE COUNTY, WASHINGTON

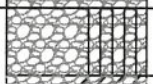
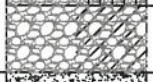
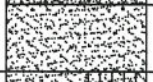
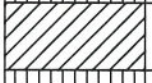
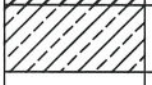
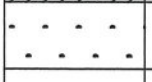
LIBERTY GEOTECH

JOB NO. 21425	APRIL 5, 2022	PLATE 1

APPENDIX B

Subsurface Exploration Logs

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS GROUP SYMBOL	SOIL DECRIPTION
COURSE GRAINED SOIL	GRAVEL	CLEAN GRAVEL		GW	WELL-GRADED GRAVEL
				GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES		GM	SILTY GRAVEL SILTY GRAVEL WITH SAND
				GC	CLAYEY GRAVEL CLAYEY GRAVEL WITH SAND
	SAND	CLEAN SAND		SW	WELL-GRADED SAND
				SP	POORLY-GRADED SAND
		SAND WITH FINES		SM	SILTY SAND
				SC	CLAYEY SAND
	SILT AND CLAY LIQUID LIMIT LESS THAN 50%			ML	INELASTIC SILT
				CL	LEAN CLAY
				OL	ORGANIC SILT
FINE GRAINED SOIL	SILT AND CLAY LIQUID LIMIT GREATER THAN 50%			MH	ELASTIC SILT
				CH	FAT CLAY
				OH	ORGANIC CLAY
				PT	PEAT

ABBREVATIONS
BGS - BELOW EXISTING GROUND SURFACE
N.E. - NOT ENCOUNTERED

USCS DESCRIPTION	ELEVATION (FT)	DEPTH (FT)	LITHOLOGY	SAMPLE INTERVAL	POCKET PEN. (TSF)	% PASSING NO. 200 SIEVE	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	VOID RATIO (%)	ADDITIONAL NOTES
TOPSOIL - Well-Graded Sand with Silt (SW-SM) Medium Dense, Brown, Moist	2385									1-foot treatment soil overlying geo fabric overlying drain rock overlying bedrock.
UNDOCUMENTED FILL - Well-Graded Gravel (GW) Medium Dense, Black, Moist		3								

Test pit terminated at 3-feet bgs due to bedrock.

Client: Whipple Consulting Engineers, Inc.	Test Pit Number: 1		
Project: Crestview Estates 1st Addition	Project Number: 21425		
Equipment: SANY SY26U	Date Excavated: 12/2/2021		
Depth to Groundwater: NE	Logged By: TMC		Sheet: 1 of 2

USCS DESCRIPTION	ELEVATION (FT)	DEPTH (FT)	LITHOLOGY	SAMPLE INTERVAL	POCKET PEN. (TSF)	% PASSING NO. 200 SIEVE	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	VOID RATIO (%)	ADDITIONAL NOTES
TOPSOIL - Well-Graded Sand with Silt (SW-SM) Medium Dense, Brown, Moist	2385									1-foot treatment soil overlying geo fabric overlying drain rock overlying geo fabric overlying bedrock. Drain rock.
UNDOCUMENTED FILL - Poorly-Graded Gravel (GP) Medium Dense, Black, Moist										
BEDROCK - Well-Graded Gravel (GW) Very Dense, Black, Dry		4								

Test pit terminated at 4-feet bgs due to bedrock.

Client: Whipple Consulting Engineers, Inc.	Test Pit Number: 2		
Project: Crestview Estates 1st Addition	Project Number: 21425		
Equipment: SANY SY26U	Date Excavated: 12/2/2021		
Depth to Groundwater: NE	Logged By: TMC		Sheet: 2 of 2

APPENDIX C

Photo Log

Appendix C: Photo Log

PHOTO 1: TP-1 LOCATION

PHOTO 2: GEOFABRIC WITHIN TP-1

PHOTO 3: TP-1 EXCAVATED SOILS

PHOTO 4: BOULDERS WITHIN TP-1

Appendix C: Photo Log

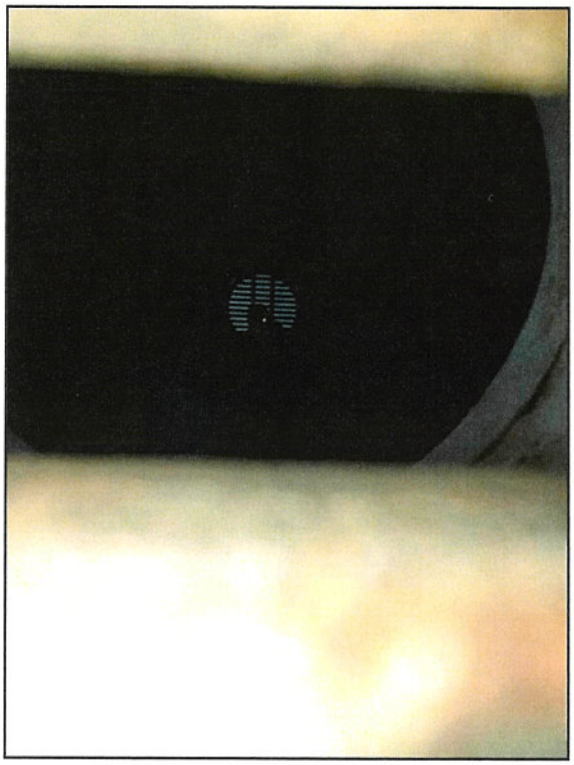


PHOTO 5: TP-1 STANDING WATER WITHIN DRYWELL

PHOTO 6: TP-2 LOCATION

PHOTO 7: TP-2 EXCAVATED SOILS AND BOULDERS

PHOTO 8: GEOFABRIC WITHIN TP-2

TAYLOR 1996 STORM REPORT

UIC

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:38047
Authorization Status: Pending
Comments:

Facility/Site Information

Facility Name: CrEview Homeowners Association
Address:8400 N Ash Street
PO Box/Suite/Building:
City: Spokane
State:Zip:WA99208
Phone:509-458-5542
County: Spokane

Contact Information

Well Owner

Name: Terry Tombari
Organization: CrEview Homeowners Association
Address:8205 N Division St
PO Box/Suite/Building:
City:SPOKANE
State:Zip:WA99208
Email:terry@tombariproperties.com
Phone:509-458-5542

Property Owner

Name: Terry Tombari
Organization: CrEview Homeowners Association
Address:8205 N Division St
PO Box/Suite/Building:
City:SPOKANE
State:Zip:WA99208
Email:terry@tombariproperties.com
Phone:509-458-5542

Technical Contact

Name: Elliott Whipple
Organization: Whipple Consulting Engineers
Address:21 S Pines Rd
PO Box/Suite/Building:
City: Spokane Valley
State:Zip:WA99206
Email:ewhipple@whipplece.com
Phone:505-893-2617

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	Google Map Link
02		6/1/2003	Stormwater (residential, paved streets, roofs, parking lots)	Proposed	Manhole with perforated pipe	4	47.738940	-117.438900	https://google.com/maps/place/47.738940,-117.438900/@47.738940,-

Well Name	Right-of-way Location	Construction Date	EPA Well Type	Status	UIC Construction Type	Depth of UIC Well (ft.)	Latitude	Longitude	Google Map Link
01		6/1/2003	Stormwater (residential, paved streets, roofs, parking lots)	Proposed	Manhole with perforated pipe	4	47.739003	-117.435650	https://google.com/maps/place/47.739003,-117.435650/@47.739003,-

Main Well Information (cont.)

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?	Is High Susceptible Aquifer?	Is Confining Layer Present?	Zoning	Within a Ground Water Protection Area?
02		N	N	N	Y	Residential	Critical Aquifer Recharge Area
01		N	N	N	N	Residential	Critical Aquifer Recharge Area

Documents

Document Type	Document	Uploaded By
Miscellaneous Support Documents	ENG - Street, 2003070, ASH, STRONG, STREET PLAN AND PROFILE.pdf	whipplece on 9/5/2023 11:52:10 AM
UIC Drainage Plans	Choose File No file chosen	

UIC Registration Signature Page

Site Number: 38047

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

Elliott Whipple	TECH
Name of legally authorized representative	Title
Elliott Whipple	09/05/2023
Signature of legally authorized representative	Date