Storm Water Design Report
6^{th} Street and Birch Avenue Improvements

City of College Place Washington

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Fall 2023

Prepared by:

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2.1 Introduction

This Design Report documents the proposed storm water improvements at SE 6th Street and Birch Ave. in College Place, Washington. These improvements are identified in the City's Storm Water Master Plan (CIP #52) to re-route Thompson Creek, which is located mid-block on SE Birch Avenue, to connect with the existing storm drainage system in S. College Avenue. Currently, untreated storm water enters Thompson Creek via a break in the existing curb and a small diameter culvert pipe.

The extents of the storm water improvements include SE 6th Street between S. College Avenue and SE Birch Avenue and on SE Birch Avenue between SE 4th Street and SE 6th Street. These improvements include new storm water pipes, catch basins, manholes, infiltration trenches, and connections to the existing storm water system on S. College Avenue. Due to the extent of the storm water improvements and impacts to the existing streets, substantial street improvements are also necessary and include new cement concrete curb, sidewalk, and pedestrian ramps. Following approval of this Design Report, final plans and specifications will be developed in anticipation of construction funding.

Figure 1 - Location Map

2.2 Basin Description

The project is in the sub watersheds Lower Mill Creek and Garrison Creek-Walla Walla River. The existing roadways are slightly crowned at centerline. SE 6th Street drains from east to west and SE Birch Avenue drains from north to south.

Figure 2-Basin Map

2.3 Site Description

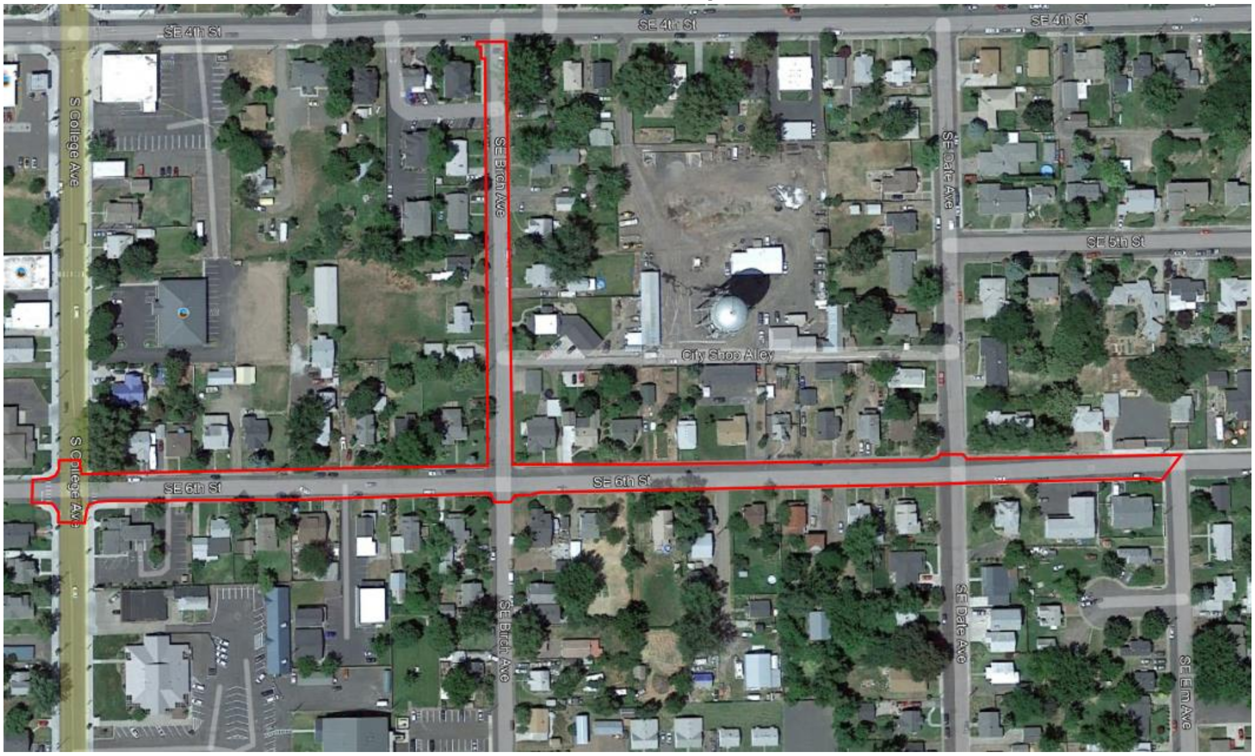


Figure 3-Project Limits

<u>Land Use</u>
The current and future land use is residential. Structures include roadway, utility poles, utility pedestals, catch basins, and sidewalks.

<u>Existing Stormwater Features</u>
No stormwater collection or treatment facilities exist within the limits of the project that address the current water quality concerns. Storm water on the north half of SE Birch Avenue is directed along existing dilapidated curbs to makeshift openings that direct flows directly into Thompson Creek. Drainage on the south half of SE Birch Avenue is split between the east and west sides of the road. The east side drains southerly to a single catch basin located at the northeast corner of SE Birch Avenue and SE 6th Street, while the west side flows around the southwest corner of the intersection and continues westerly to S. College Avenue.

Storm water on SE 6th Street east of S. College Avenue collects and drains to catch basins on S. College Avenue, a length of approximately 625 feet. Catch basins are located at the east side of the intersection of S College Ave. and SE 6th St. There are currently no water quality treatment facilities.

Proposed Stormwater Features

Proposed stormwater features include the removal of all connectivity to Thompson Creek, installation of 24-In. Diam. storm drain pipe, 72-In. Diam. storm drain manholes, 48-In. Diam. storm drain manholes, catch basins, and infiltration trench. The new stormwater system will connect to the existing system on S. College Avenue.

Table 1-Surface Breakdown

Existing Impervious Surface	77,680 SF
Asphalt Grind and Pave	26,517 SF
Replaced Sidewalk/Curb and Gutter	3,427 SF
New Sidewalk/Curb and Gutter	3,362 SF
Trench Asphalt Restoration	19,380 SF

Vegetation

The project area is comprised of urban landscape features. The project area includes paved urban roads with residential single-family houses.

Existing Soils

See *College Place Drywell Feasibility Study-Infiltration Testing Study* in Appendix A. Existing soils are gravel with trace sand.

Access Locations

The access locations for this project are existing paved city streets. Temporary road closures and detours will impact access as phases of construction change.

2.4 Minimum Requirement/Core Element Analysis

The stormwater manual used for this project is the 2019 Stormwater Management Manual for Eastern Washington (SMMEW).

Table 2-PGIS Breakdown

Surface	**Birch Avenue Basin**	**6th Street Basin**
New PGIS	3,362 SF	0 SF
Replaced PGIS	0 SF	19,380 SF
Existing PGIS	20,690 SF	56,990 SF

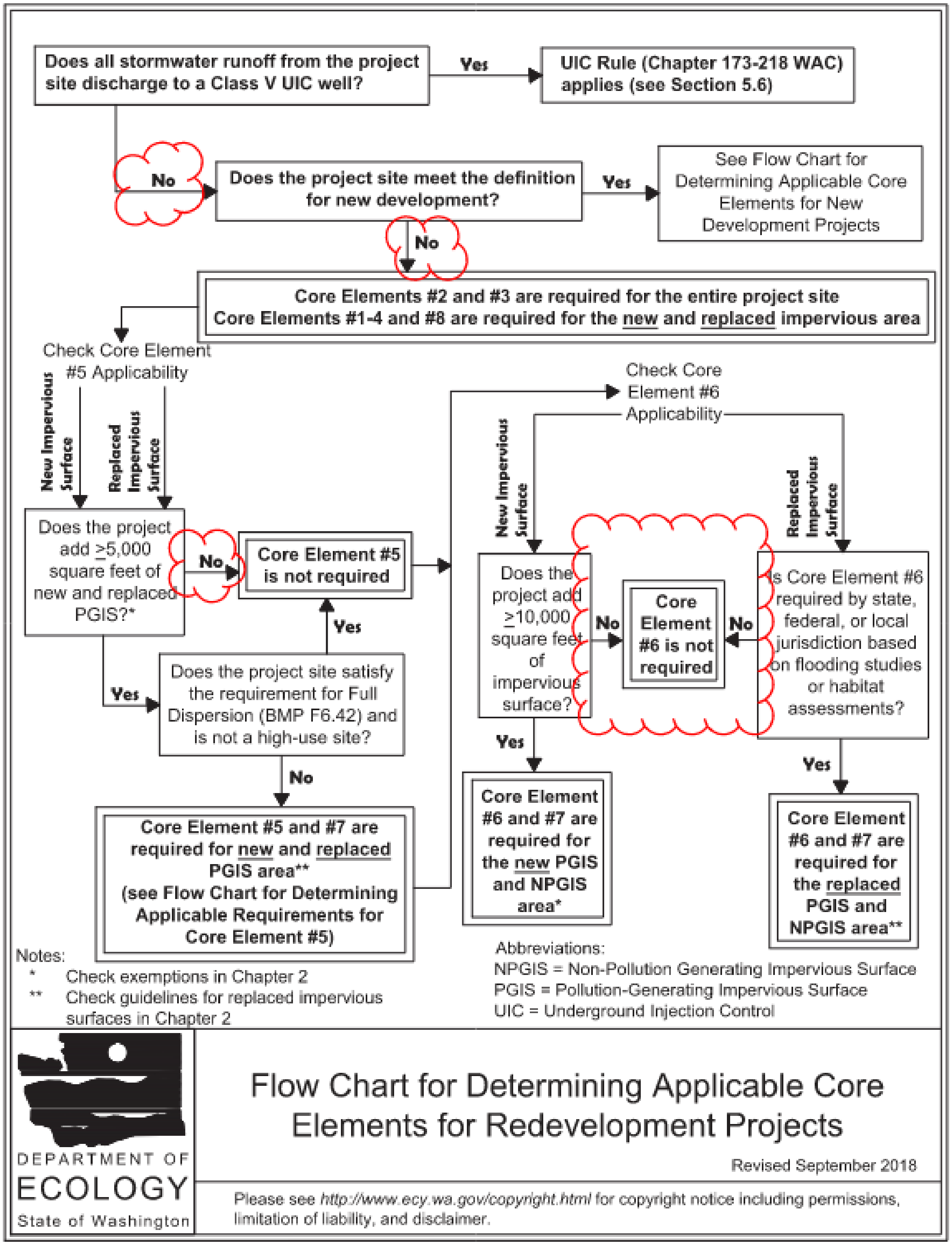


Figure 4-Flow Chart Determining Applicable Core Elements for Redevelopment Projects for the 6th St. Basin

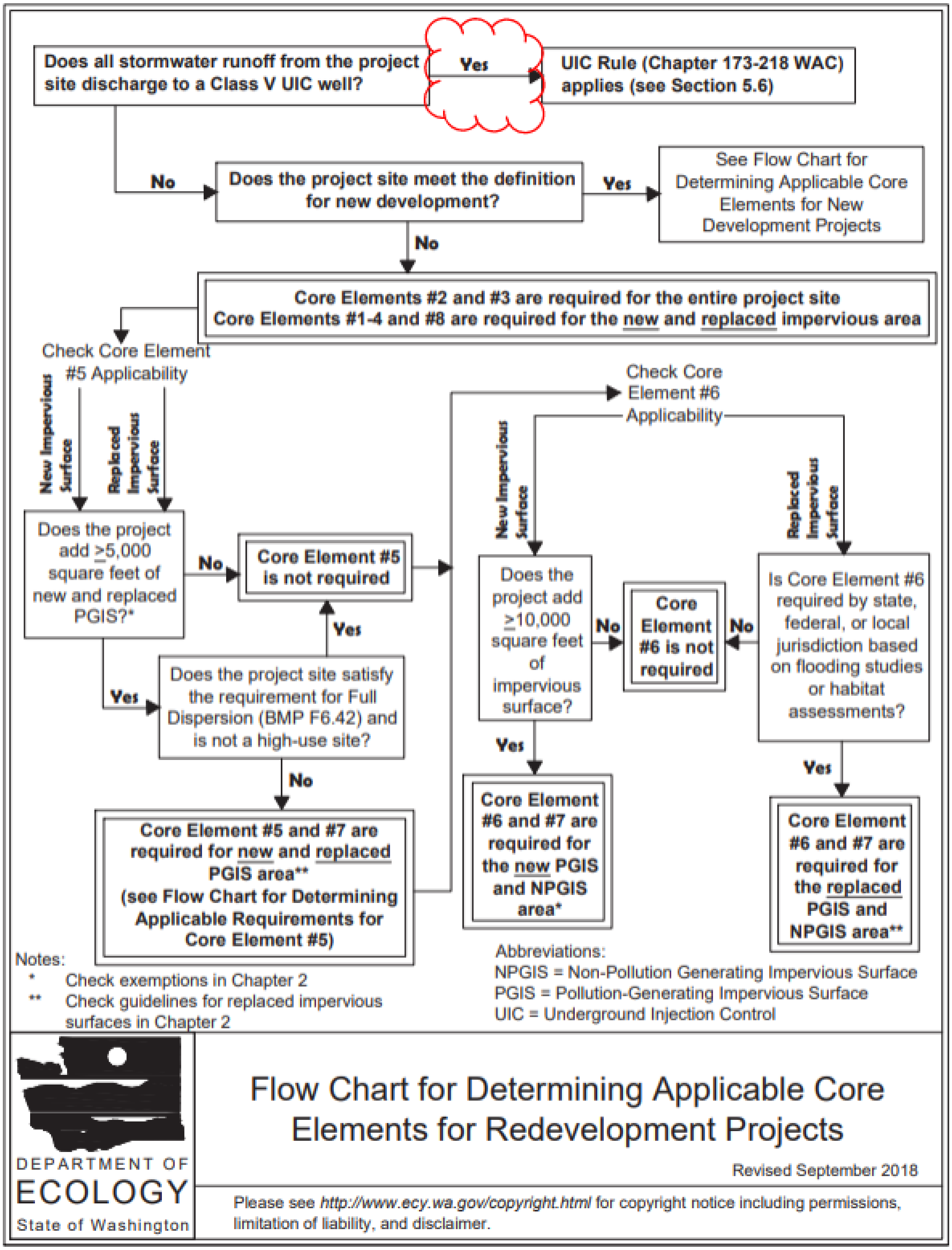


Figure 5-Flow Chart Determining Applicable Core Elements for Redevelopment Projects for the Birch Ave. Basin

The flow chart from SWMMEW in Figure 4 shows there are no core elements required from this project. Figure 5 shows that the UIC rule applies to this project.

2.5 Alternatives Considered

Surface level treatment impacted ROW limits, leaving infiltration trenches being the desired design.

2.6 Design Analysis

Design Requirements:

The site is designed to retain the entire 100-year, 24-hour Type IA storm and the Walla Walla County 25-year, 3-hour short duration storm.

Design Input:

SCS Type 1A 100-hr, 25-yr strom precipitation = 2.40 inches

Per Natural Resource Conservation Service Custom Soil Resource Report

Design Infiltration Rate = 21.8 inches/hr

Site Design Conditions:

The site was divided into drainage basins. The stormwater is collected from the imperviouse surfaces via catch basins, and conveyed via storm pipe into a infiltration trenche.

The infiltration trenche is designed to retain the entire design storm modeling infiltration only out of the infiltration trench. The tables below list the size and description of each sub-basin, in addition to the storage volume provided by the trenches.

Hydrologic Soil Group, HSG = C

For Impervious Areas, CN = 98

Drainage Basin	To Facility	Basin Area (SF)	Basin Area (Acres)	Loss (CN)
Sub-01	Sw-Tr-1	21,344	0.49	98

Infiltration Trenches:

Rock Void Space = 0.33

PERC TRENCH VOLUMES

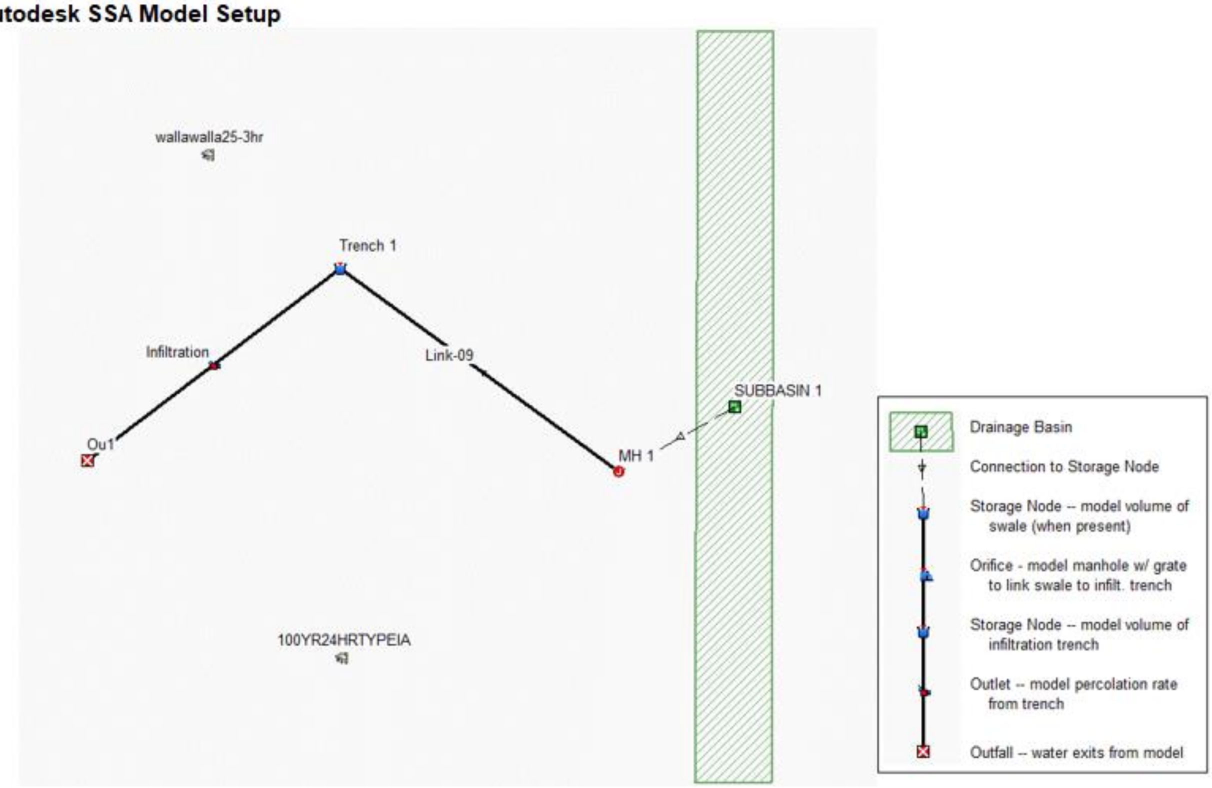
Facility Name	Width (FT)	Height (FT)	Length (FT)	Perf. Pipe Diam. (FT)	No. of Pipes	Volume (CF)	Addt'l Width (for SSA model)
Trench-1	5	5	160	1.00	1	1404	48

INITIAL PERC RATE (BOTTOM) & MAX PERC RATE (BOTTOM & SIDES)

Facility Name	Width (FT)	Height (FT)	Length (FT)	Perc. Rate (IN/HR)	Sides #	IPR (CFS)	MPR (CFS)
Trench-1	5	5.00	160	21.80	1	0.404	0.807

Note: IPR = Initial Percolation Rate; MPR = Maximum Percolation Rate

Autodesk SSA Model Setup



Infiltration Modeling Narrative

The computer software Autodesk Storm and Sanitary Analysis (SSA) was used to model the 100-year, 24-hour storm based on the SCS TR-55 hydrology method. The runoff from each sub-basin is routed through the storage facility and is infiltrated into the soil. The total runoff that flows to each stormwater facility is shown in SSA Results in Appendix B. Due to the fact that stormwater is discharged from the facilities throughout the duration of the storm via infiltration, the stormwater facilities are not required to store the entire volume of runoff from the subbasins. Early in the storm, when precipitation amounts are small, and therefore runoff flow rates are small, the facility is able to infiltrate all or most of the water that it receives. However, as the storm intensity increases, the rate of infiltration is not able to keep up with the incoming flow rate, so the storage facility begins to fill with water. At the peak intensity of the storm, the facility rapidly fills with water. Depending on the varying combination of impervious area directed to the facility, discharge rate due to infiltration, and storage capacity, the facility reaches a peak volume sometime between the peak storm intensity (12 hrs) and the end of the storm (24 hrs). Once the peak volume is reached, the water level in the facility begins to decrease as it is infiltrated. It is the peak volume that is critical for sizing the facility, which is given in the above table as "Peak Storage Volume Required." These values are less than or equal to the"Stormwater Facility Volume" which combines the volume of the total volume of the facility listed earlier in this report. The Walla Walla 25-year, 3-hour storm was also modeled similarily

2.7 Quantify the Water Quality Benefit

The proposed storm water improvements provide runoff treatment where there wasn't any before. Removing the connectivity of SE Birch Street stormwater with Thompson Creek eliminates untreated stormwater from entering natural water bodies. Construction of a tight lined system connected into the City's existing stormwater system ensures drainage from these roadways is collected and treated prior to entering any surface waterbody.

The proposed infiltration trench infiltrates all of the 0.49-acre basin that drains to it. Therefore the water quality and flow control benefit is 100% of the 0.49 acres. Since the facility is sized to infiltrate the 100-year storm vs the water quality storm (treatment) and 25-year storm (flow control), the benefit is actually a bit higher, but not included in Ecology's water quality benefit calculations.

2.8 Engineer's Opinion of Probable Cost

See Attachments

2.9 Proposed Schedule

This design of the project is currently at the 90% Design Level and is being paid for with City funds. An application for construction funding will be submitted by the City through the Washington State Department of Ecology's Water Quality Combined Funding Program. The project will be ready to advertise for construction once the award of program funds is confirmed.

2.10 Attachments

Cost Estimates

City of College Place

SE Birch Avenue and SE 6th Street - Thompson Drainage and Road Improvements

JUB Project No. 30-20-075-032 Birch - 4th to 6th **90% SUBMITTAL** **8/31/2023**

Description	Total Schedule Cost	Construction Cost	Construction Engineering
Storm Drainage Improvements Schedule 1 **Participating costs for treatment of SE Birch Ave Roadway runoff and connection to College Place Ave Storm System on SE 6th Street**	**$ 628,000**	**$ 546,000**	**$ 82,000**
Roadway improvemnts Schedule 2 **Non-Participating costs to reconstruct SE Birch from SE 4th St to SE 6th St**	**$ 270,000**	**$ 235,000**	**$ 35,000**
TOTAL PROJECT COSTS	**$ 898,000**	**$ 781,000**	**$ 117,000**

ENGINEER'S OPINION OF PROBABLE COST

8/31/2023

DOE Eligible Funding

PROJECT DESCRIPTION: SE BIRCH AVE AND SE 6TH ST

SCHEDULE: 1 - THOMPSON DRAINAGE IMPROVEMENTS

CLIENT: City of College Place

J-U-B PROJ. NO.: 30-2(**90% SUBMITTAL**

ITEM NO.	WSDOT STD NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
		PREPARATION				
1	0001	MOBILIZATION (10% OF CONSTRUCTION COST)	1	L.S.	$ 47,300.00	$ 47,300.00
2	0108	REMOVING CEMENT CONC. CURB AND GUTTER	1,283	LF	$ 12.00	$ 15,396.00
3		REMOVING CATCH BASIN	2	EA	$ 500.00	$ 1,000.00
4		REMOVING EXISTING CULVERT	40	LF	$ 25.00	$ 1,000.00
5	0120	REMOVING ASPHALT CONC. PAVEMENT	0	S.Y	$ 10.00	$ -
		GRADING				
6	0310	ROADWAY EXCAVATION INCL. HAUL	1,100	C.Y.	$ 30.00	$ 33,000.00
		SURFACING				$ -
7	5100	CRUSHED SURFACING BASE COURSE	647	TON	$ 37.50	$ 24,262.50
8	5120	CRUSHED SURFACING TOP COURSE	483	TON	$ 35.00	$ 16,905.00
		HOT MIX ASPHALT				
9	5767	HMA CL. 1/2 IN. PG 64-28H	455	TON	$ 140.00	$ 63,700.00
		STORM SEWER				
10	3091	CATCH BASIN TYPE 1	3	EA	$ 2,464.35	$ 7,393.05
11	7360	MANHOLE 48 IN. DIAM. TYPE 1	1	EA	$ 4,500.00	$ 4,500.00
12	7365	MANHOLE 72 IN. DIAM. TYPE 3	4	EA	$ 10,500.00	$ 42,000.00
13	3577	SOLID WALL PVC STORM SEWER PIPE 12 IN. DIAM.	97	LF	$ 70.00	$ 6,790.00
14	3582	SOLID WALL PVC STORM SEWER PIPE 24 IN. DIAM.	944	LF	$ 130.00	$ 122,720.00
15	3582	PLAIN ST. CULV. PIPE 24 INCH DIA 0.064 IN THK	7	LF	$ 200.00	$ 1,400.00
16		INFILTRATION TRENCH	160	LF	$ 100.00	$ 16,000.00
17		SHORING-TRENCH SAFETY SYSTEMS	1,041	LF	$ 1.00	$ 1,041.00
		EROSION CONTROL AND PLANTING				
18	6471	INLET PROTECTION	3	EACH	$ 150.00	$ 450.00
		TRAFFIC				
19	6700	CEMENT CONC. TRAFFIC CURB AND GUTTER	1,352	L.F.	$ 40.00	$ 54,080.00
20	6971	PROJECT TEMPORARY TRAFFIC CONTROL - MINIMUIM BID $25,000	1	L.S.	$ 37,100.00	$ 37,100.00
		OTHER ITEMS				
21	9605	CONNECTION TO DRAINAGE STRUCTURE	1	EA	$ 500.00	$ 500.00
22	7038	ROADWAY SURVEYING	1	L.S.	$ 16,000.00	$ 16,000.00
23		RECORD DRAWINGS	1	L.S.	$ 5,000.00	$ 5,000.00
24		EROSION CONTROL AND WATER POLUTION	1	L.S.	$ 2,300.00	$ 2,300.00
		SUBTOTAL CONSTRUCTION COST				**$ 519,837.55**
		SALES TAX @ 0%	**0%**			**$ -**
		CONTINGENCY	**5%**			**$ 25,991.88**
		CONSTRUCTION CONTRACT TOTAL (ROUNDED)				**$ 546,000.00**
		CONSTRUCTION ENGINEERING (ROUNDED)	**15%**			**$ 82,000.00**
		TOTAL PROJECT COST				**$ 628,000.00**

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ENGINEER'S OPINION OF PROBABLE COST

8/31/2023

Non Participating - DOE Funding

PROJECT DESCRIPTION: SE BIRCH AVE AND SE 6TH ST

SCHEDULE: 2 - ROADWAY IMPROVEMENTS

CLIENT: City of College Place

J-U-B PROJ **90% SUBMITTAL**

ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
	PREPARATION				
1	MOBILIZATION (10% OF CONSTRUCTION COST)	1	L.S.	$ 20,400.00	$ 20,400.00
2	REMOVING CEMENT CONC. CURB AND GUTTER	836	LF	$ 12.00	$ 10,032.00
3	REMOVING ASPHALT CONC. PAVEMENT	2,178	S.Y	$ 10.00	$ 21,780.00
4	REMOVING CEMENT CONC. SIDEWALK	488	SY	$ 13.00	$ 6,344.00
5	PLANING BITUMINOUS PAVEMENT	2,899	S.Y.	$ 4.00	$ 11,596.00
	SURFACING				$ -
6	CRUSHED SURFACING TOP COURSE	15	TON	$ 35.00	$ 525.00
	HOT MIX ASPHALT				
7	HMA CL. 1/2 IN. PG 64-28H	507	TON	$ 140.00	$ 70,980.00
8	PAVEMENT REPAIR TYPE 1	1,098	S.Y.	$ 5.75	$ 6,313.50
9	PAVEMENT REPAIR TYPE 2	1,080	S.Y.	$ 5.75	$ 6,210.00
	TRAFFIC				
10	PAINTED CROSSWALK LINE	416	S.F.	$ 20.00	$ 8,320.00
11	PAINTED STOP LINE	30	L.F.	$ 10.00	$ 300.00
	OTHER ITEMS				
12	ADA FEATURES SURVEYING	1	L.S.	$ 2,500.00	$ 2,500.00
13	CEMENT CONC. SIDEWALK	458	SY	$ 85.00	$ 38,930.00
14	DETECABLE WARNING SURFACE	52	SF	$ 70.00	$ 3,640.00
15	CEMENT CONC. CURB RAMP TYPE PARALLEL A	3	EA	$ 2,000.00	$ 6,000.00
16	CEMENT CONC. CURB RAMP TYPE SINGLE DIRECTINON TYPE A	3	EA	$ 1,800.00	$ 5,400.00
17	MOVING EXISTING HYDRANTS	1	EA	$ 5,000	$ 5,000.00
	SUBTOTAL CONSTRUCTION COST				**$ 224,270.50**
	SALES TAX @ 0%	**0%**			**$ -**
	CONTINGENCY	**5%**			**$ 11,214**
	CONSTRUCTION CONTRACT TOTAL (ROUNDED)				**$ 235,000**
	CONSTRUCTION ENGINEERING (ROUNDED)	**15%**			**$ 35,000**
	TOTAL PROJECT COST				**$ 270,000**

Appendix A

Aspect CONSULTING

MEMORANDUM

Project No.: 210093-A

August 31, 2021

To: Spencer Myrlie, City of College Place

From:

8/31/21

Erik Pruneda, PE, CPESC, CFM
Senior Water Resources Engineer
epruneda@aspectconsulting.com

John Knutson, PE
Principal Water Resources Engineer
jknutson@aspectconsulting.com

Re: **College Place Drywell Feasibility Study – Infiltration Testing Study Memorandum**

Introduction

The City of College Place (City) has retained Aspect Consulting, LLC (Aspect) to provide stormwater infiltration retrofit feasibility services for the City's Drywell Feasibility Study project (Project). A large portion of City stormwater runoff is currently collected and conveyed to local creeks including Garrison and Stone Creek, and the City's 2018 – 2023 Capital Improvement Plan identifies the need for future, regional stormwater flow control and water quality facilities in the City's storm drainage basins to reduce flooding and stormwater pollution and enhance aquatic habitat in local creeks and wetlands. To meet these goals, the City desires to infiltrate some stormwater through regional, infiltration-based facilities before discharging to local waterbodies.

Work for this project included the following key elements:

- Site evaluation, prioritization, and selection of high priority sites for field testing
- Infiltration planning, testing, and results
- Assess feasibility and suitability of surface and/or subsurface infiltration BMPs

Site Evaluation, Prioritization, and Selected Testing Locations

The City identified several drainage problem locations within the project area where stormwater infiltration BMP retrofits are being considered. Aspect developed prioritization criteria to rank each drainage problem location and identify four high priority sites for infiltration testing. Prioritization criteria are provided in Attachment 1 and included: likely soil/groundwater suitability, availability of existing nearby infiltration test data, planned roadway/utility improvement projects, severity of drainage problem, existing nearby stormwater infrastructure, and average daily traffic counts / pollutant loading benefit. The four high priority sites selected for infiltration testing are shown in Attachment 2 and are described below:

- INF-1 – Infiltration test performed in the roadway of SE 10th Street east of the intersection of SE Birch Avenue on the south side of the road.
- INF-2 – Infiltration test performed in the roadway of SW 12th Street west of the intersection of SW Bade Avenue on the south side of the road.
- INF-3 – Infiltration test performed in the roadway of SE 9th Street east of the intersection of S College Avenue on the south side of the road.
- INF-4 – Infiltration test performed in the roadway of SE 6th Street east of the intersection of SE Birch Avenue on the south side of the road.

Infiltration Planning, Testing, and Results

Infiltration Planning

Aspect prepared an Infiltration Testing Plan to guide field work. The testing plan covered issues such as: property access, water supply, traffic control, test methods, soil samples/tests, test phasing and schedule, utility issues, and field work safety considerations.

Infiltration Testing

Aspect completed four pilot infiltration tests (PITs) from July 20 thru July 23, 2021. Infiltration test locations were selected to assess the feasibility and suitability of infiltration BMPs and provide field infiltration data for determining design infiltration rates at high priority drainage problem locations within the City. Infiltration test depths were selected to target receptor soil depths representative of potential surface or subsurface infiltration facilities. The following subsections describe observed subsurface conditions and infiltration testing methodology.

Subsurface Conditions

All explorations were excavated and completed by subcontractor, Richardson Excavation. Soils were classified per the Unified Soil Classification System (USCS) in general accordance with the American Society for Testing and Materials (ASTM) D2488, Standard Practice for Description and Identification of Soils (Visual and Manual Procedure) (2012). The relative density/consistency of excavated materials was roughly evaluated by observing the excavated material and samples taken from the excavation.

The material encountered in the explorations observed by Aspect generally agreed with the materials that were expected based on research of well logs and NRCS soil surveys in the project area. A breakdown of the consistency of the soils encountered is shown in Table 1. Detailed descriptions of the subsurface conditions encountered in our explorations, as well as the depths where characteristics of the soils changed, are indicated on the test pit logs presented in Attachment 3. Photographs of each test pit are provided in Attachment 4.

Table 1. Soils Encountered

Location	Description	Cobble	Gravel	Sand	Fines
INF-1	Gravel w/ Trace Sand	4%	82%	11%	3%
INF-2	Sandy Silt	0%	0%	36.6%	63.4%
INF-3	Gravel w/ Trace Sand	9%	72%	14%	5%
INF-4	Gravel w/ Trace Sand	4%	68%	24%	4%

Groundwater was not encountered in any of the excavations. Following the infiltration tests, INF-1, INF-3, and INF-4 were over-excavated to a depth of 7.5 feet below the ground surface; no change in subsurface conditions and no indication of mounding was observed.

Sample Collection and Laboratory Testing

Manual soil grab samples were collected from the bottom of each test pit (see test pit logs in Attachment 3). The collected samples were submitted to a contracted analytical laboratory for grain size analysis, organic matter content, and cation exchange capacity (CEC). Results of the laboratory testing are provided in Attachment 5 and summarized in Table 2.

Table 2. Laboratory Results

Location	Organic Matter Content (%)	Cation Exchange Capacity (meq/100g)
INF-1	3.30	23.3
INF-2	1.95	17.2
INF-3	3.33	24.5
INF-4	1.63	13.7

Note: Per 2019 SWMMEW, native soils suitable for treatment must have an organic content greater than 1% and cation exchange capacities greater than 5 meq/100g.

Infiltration Test Methods

Small-scale PITs were performed at each location in general accordance with the 2019 Stormwater Management Manual for Eastern Washington (SWMMEW). Test durations were shortened in order to accomplish testing at a single test location within an eight-hour onsite workday. PIT details are summarized in Table 3.

Table 3. Pilot Infiltration Test Details

Location	Target Test Type	Test Date	Excavation Depth (ft)	PIT Surface Area (sq-ft)
INF-1	Small	7/22/21	6	24
INF-2	Small	7/20/21	6	26
INF-3	Small	7/23/21	6	22.5
INF-4	Small	7/21/21	6	24

PIT Design

The PIT design included preparation of the test pit areas following the small-scale PIT guidelines with excavation depths at an assumed depth (bottom) of proposed infiltration BMPs. The bottom of each test area was leveled to the extent practical. A representative of Aspect observed test area preparation, logged soils, and collected soil samples for laboratory testing.

Water for the infiltration tests was supplied from a water truck supplied by the City. Direct-read flow meters and valving equipment were installed by Aspect to monitor discharge to the excavations during execution of the small-scale PITs.

Small-scale PITs were generally performed in four parts:

1. **Filling** – Test areas are filled with water to a targeted water level (approximately 12 inches).
2. **Pre-Soaking Evaluation** – Once the water level in the test area reached the target level, the water flow to the test pit area is turned off temporarily allowing field crew members an opportunity to visually monitor a decline in water level (head) and verify that infiltration is occurring before proceeding with the constant head portion of the test.
3. **Constant Head Test** – During this portion of the test, the water flow rate into the test area is recorded using a flow meter, and the water level is monitored using a staff gage along with a pressure transducer placed at the bottom of the excavation to monitor water level continuously. The water flow rate into the test area is adjusted as needed to achieve a constant water level for a constant flow rate.
4. **Falling Head Test** – Upon completion of the constant head test, flow into the test area is stopped, and the rate of water level decline is monitored.

The small-scale PIT procedure described above was modified in the field as needed depending on the initial observed infiltration rates and available time to complete the tests. At each test area, Aspect reduced and leveled off flows upon reaching the targeted test water level (approximately 12 inches).

The constant head/constant flow data is used to calculate the measured infiltration rate that, when safety factors are applied, determines the long-term infiltration rate for designing infiltration facilities for the test site. The falling head data, also with safety factors applied, is used to verify that a planned infiltration facility will drain down within an allowable timeframe.

Infiltration Testing Results

Results for the constant head portion for each PIT are summarized in Table 4. Results for the falling head portion are summarized in Table 5. PIT data for each site is presented in Attachment 6.

The measured infiltration rates were completed at constant head water depths ranging from 12.0 to 12.6 inches with PIT bottom areas ranging from of 22.5 to 26 square feet and with PIT sidewall areas ranging from 20 to 21 square feet. Since for a small PIT sidewall infiltration likely contributed significantly to the overall infiltration flow rate, measured infiltration rates were conservatively calculated using the PIT bottom and sidewall areas. Based on Darcy's Law and infiltration dynamics, it is reasonable to assume that the infiltration rate changes approximately linearly with head – increasing the depth of ponding on the infiltration surface will roughly proportionally increase the infiltration rate. The maximum infiltration rate occurs through the PIT bottom area and at the bottom of the sidewalls where the water pressure head is at a maximum. The head and sidewall infiltration rate approaches zero at the top of the ponded water. Therefore, since the average ponded head on the sidewall is one half the total head, the average sidewall infiltration rate is assumed to be approximately one half the bottom infiltration rate for a given water depth. This relationship is used to calculate the maximum (bottom) infiltration rate given the constant infiltration flow rate, the associated constant head water depth, the test pit bottom area, and the test pit wetted sidewall area for the given depth.

As water depth (or head) varies in the facility, so does the water pressure on the infiltrating surfaces, which results in higher infiltration rates for deeper water (higher pressure) and lower infiltration for shallower water (lower pressure). The measured infiltration rates presented in Table 4 correspond to the water depth during the test. For other water depths, a depth dependent infiltration rate was also calculated that assumes that infiltration rates vary linearly with water depth.

General Infiltration BMP Sizing Approaches

Constant Infiltration Rate Approach: Assumes the infiltration rate is constant for all facility water depths, resulting in a constant flow rate out of the facility at each time step. Can result in a more conservative facility size when anticipated water depths are greater than the constant head infiltration test depth.

Depth Dependent Infiltration Rate Approach: Accounts for the head in the facility and the corresponding infiltration rate to estimate a flow rate out of the facility at a each timestep. Results in a more accurately sized facility.

Table 4. Constant Head Test Results

Location	Average Flow Rate		Total Infiltration Area[1]		Approx. Constant Water Depth (in)	Measured Infiltration Rate (in/hr)	Measured Depth Dependent Infiltration Rate (in/hr/ft)
	gal/min	in^3/hr	ft^2	in^2			
INF-1	26.2	362,527	44.4	6,394	12.2	73.6	72.2
INF-2	1.1	15,147	47.0	6,768	12.0	2.9	2.9
INF-3	8.7	120,582	42.5	6,113	12.6	25.8	24.6
INF-4	23.7	328,212	44.2	6,365	12.1	66.8	66.2

Notes:
[1] Total Infiltration Area includes PIT bottom area and sidewall area.

Table 5. Falling Head Test Results

Location	Initial Reading		Final Reading		Change in Reading		Measured Drawdown Rate (in/hr)
	Time	Water Level (in)	Time	Water Level (in)	Elapsed Time (min)	Water Level (in)	
INF-1	12:30	1.06	12:44	0.07	14	0.99	16.8
INF-2	13:30	1.00	15:30	0.60	120	0.40	0.8
INF-3	12:13	1.06	13:13	0.15	60	0.91	3.6
INF-4	12:08	1.00	12:24	0.07	16	0.93	13.8

To determine the design (long-term) infiltration rate for each site, appropriate correction factors must be applied to the measured (short-term) infiltration rate. Selected correction factors from Table 6.4 of the SWMMEW are described below:

- Site variability and number of locations tested = 0.75
- Test method (small-scale PIT) = 0.5
- Degree of influent control to prevent siltation and bio-buildup = 0.9

The total correction factor is determined by multiplying the individual correction factors together (0.75 x 0.5 x 0.9 = 0.33). Note that the City typically uses/specifies a safety factor of 0.25 for simplicity unless the City Engineer determines otherwise.

The design (long-term) depth dependent infiltration rate is calculated by multiplying the measured depth dependent infiltration rate by the total correction factor. The design depth dependent infiltration rate for each test location is shown in Table 6.

Table 6. Design Infiltration Rates

Location	Measured Depth Dependent Infiltration Rate (in/hr/ft)	Correction Factor	Design Depth Dependent Infiltration Rate (in/hr/ft)
INF-1	72.2	0.33	23.8
INF-2	2.9	0.33	1.0
INF-3	24.6	0.33	8.1
INF-4	66.2	0.33	21.8

Site Feasibility and Suitability for Infiltration BMPs

The feasibility and suitability for surface and subsurface infiltration BMPs was evaluated. Guidance for the design of surface infiltration BMPs is presented in Section 5.4 of the SWMMEW, while guidance for the design of subsurface infiltration BMPs is presented in Section 5.6 of the SWMMEW.

Surface Infiltration Suitability Criteria

For surface infiltration BMPs, site suitability criteria (SSC) must be considered when siting the BMPs. The following site suitability criteria relate to the infiltration testing results and observed subsurface conditions.

SSC-4 Soil Infiltration Rate / Drawdown Time

For infiltration BMPs used for treatment purposes, the design (long-term) infiltration rates should be ≤ 3 in/hr per the SSC-4 requirement in the SWMMEW. The design (long-term) infiltration rates for INF-1 thru INF-4 are 23.8, 1.0, 8.1, and 21.8 in/hr, respectively. The INF-2 test location meets the SSC-4 requirement; however, the remaining test locations do not. Aspect recommends amending the base of each infiltration facility with 18-inches of treatment soil meeting the requirements of Bioretention Soil Media (SWMMEW Section BMP T5.31: Bioretention, Bioretention Soil Media).

The proposed infiltration facilities must meet the 72-hour or less SSC-4 drawdown time requirement. For this evaluation, a design drawdown rate was calculated for each test location by multiplying the measured drawdown rate (from Table 5) by the total correction factor (0.33), as shown in Table 7. The design drawdown rates were then used to calculate the estimated time (in hours) for drawdown assuming facility depths of 1-foot and 2-foot. Note that both a 1-foot or 2-foot facility depth will meet the 72-hour or less drawdown time requirement.

Table 7. Approximate Drawdown Time

Test Location	Measured Drawdown Rate (in/hr)	Correction Factor	Design Drawdown Rate (in/hr)	Drawdown Time 1-ft Facility (hrs)	Drawdown Time 2-ft Facility (hrs)
INF-1	50.9	0.33	16.8	0.7	1.4
INF-2	2.4	0.33	0.8	15.2	30.3
INF-3	10.9	0.33	3.6	3.3	6.7
INF-4	41.9	0.33	13.8	0.9	1.7

SSC-5 Depth to Bedrock, Groundwater Table, or Impermeable Layer

The base of all infiltration facilities should be ≥ 5 feet above the seasonal groundwater table, bedrock, hardpan, or other low-permeability layer.

Groundwater was not encountered in any of the test pit explorations completed as part of this work to a depth of 6 feet below ground surface (bgs) for INF-2 and up to 7.5 feet bgs for INF-1, INF-3, and INF-4. Based on a review of available well logs in the project vicinity, surficial soils are generally comprised of silt, sands, and gravels, down to approximately 30 to 50 feet bgs. These surficial soils are underlain by deeper gravels and sands associated with the shallow unconfined gravel aquifer underlying the valley floor. Based on the well logs reviewed, static water levels were reported from 15 to 65 feet bgs at the time of drilling. Based on available geotechnical reports in the vicinity of the test locations, static water levels were not encountered at the time of exploration, but were reported to be greater than 15-feet in the vicinity of INF-1, INF-3, and INF-4 and greater than 25-feet in the vicinity of INF-2 based on the completed exploration depths.

Bedrock, hardpan, or other restrictive layer was not encountered in any of the test pit explorations completed as part of this work or any of the prior geotechnical explorations reviewed.

SSC-6 Soil Physical and Chemical Suitability for Treatment

The texture and chemical characteristics of receptor soils at each test location meet Ecology's stormwater treatment Site Suitability Criteria for surface infiltration facilities (SSC-6):

- Organic matter content is greater than 1 percent, ranging from 1.6 to 3.3 percent.
- Cation exchange capacity is greater than 5 meq/100 grams, ranging from 13.7 to 24.5 meq/100 grams.

SSC-6 also requires a minimum treatment soil depth of 18 inches below the base of the infiltration facility. Over-excavation of INF-1, INF-3, and INF-4 revealed similar subsurface materials for a depth of 18-inches below the base of the excavation. INF-2 was not over-excavated, but is presumed to have similar subsurface materials for a depth of 18-inches below the base of the excavation based on the results of the infiltration testing and available nearby geotechnical information.

Since all four test locations meet the SSC-6 requirements, the use of amended soils or basic treatment of the water quality storm event prior to infiltration will not be required; however, Section 5.4.3 of the SWMMEW states that "*Infiltration BMPs must be preceded by a pretreatment BMP, such as a presettling basin or emerging technology, to reduce the occurrence of plugging*". To reduce plugging of infiltration BMPs, Aspect recommends incorporating pre-settling basins or similar sediment pre-treatment methods into the overall design where appropriate.

Subsurface Infiltration Suitability Criteria

Subsurface infiltration BMPs (e.g., drywells or infiltration trenches with perforated pipe) must be designed and constructed following either the presumptive or demonstrative approach per the SWMMEW. The following presumptive approach criteria and site suitability criteria relate to the infiltration testing results and observed subsurface conditions.

Vadose Zone Treatment Capacity

The treatment capacity of the vadose zone between the bottom of the UIC well and the top of the highest known seasonal groundwater table is determined using Table 5.21 from the SWMMEW. Observed subsurface soil conditions, sieve analyses, saturated hydraulic conductivities / infiltration rates, organic content, cation exchange capacity, and other physical properties are used to identify the vadose zone treatment capacity category (High, Medium, Low, and None). Aspect utilized available data to assign each test location to one of the four vadose zone treatment capacity categories, as shown in Table 8. For INF-1, INF-3, and INF-4, the soil physical and chemical properties had attributes falling across more than one category.

Table 8. Vadose Zone Treatment Capacity

Test Location	Assumed Vadose Zone Treatment Capacity	Required Minimum Thickness (feet)
INF-1	Med / Low	10 / 25
INF-2	High	5
INF-3	Med / Low	10 / 25
INF-4	Med / Low	10 / 25

Pollutant Loading Classification

Areas contributing stormwater runoff to subsurface infiltration facilities are grouped into four classification categories based on expected pollutant loading potential: Insignificant, Low, Medium, and High. Following Table 5.22 from the SWMMEW, all four test locations would be classified as having a Low pollutant loading.

Treatment Required for Solids, Oil, and Metals

Subsurface infiltration facilities must have an appropriate level of treatment for solids, oil, and metals prior to runoff entering the facility. Table 5.23 from the SWMMEW lists the required treatment based on the vadose zone treatment capacity and the pollutant loading classification. A summary of the required treatment for each test location is provided in Table 9.

Table 9. Treatment Required for Subsurface Infiltration

Test Location	Vadose Zone Treatment Capacity	Pollutant Loading	Treatment Required
INF-1	Med/Low	Low	Pretreatment[1]
INF-2	High	Low	Two-Stage Drywell[2]
INF-3	Med/Low	Low	Pretreatment[1]
INF-4	Med/Low	Low	Pretreatment[1]

Notes:
[1] Pretreatment removes solids, but at a level less than basic treatment. Ecology's definition for pretreatment is 50% removal. Aspect has specified the use of a sedimentation manhole with down-turned elbow for prior projects with Ecology approval. Note that treatment requirements are the same for facilities with Low or Medium vadose zone treatment capacities and Low pollutant loading (refer to Table 5.23 in the SWMMEW).
[2] A two-stage drywell has a catch basin or other presettling device that traps small quantities of oils and solids.

Drawdown Time

Subsurface infiltration facilities should be designed to drain down within 72 hours after flow to the facility has ceased. For this evaluation, the design drawdown rates from Table 7 were used to calculate the estimated time (in hours) for drawdown assuming facility depths of 4-foot and 8-foot. This could correspond to a 4-foot deep infiltration trench or 4- or 8-foot drywell. As shown in Table 10, all test locations could generally accommodate 4-foot and 8-foot deep subsurface infiltration facilities, with the exception of INF-2 which would need to be limited to a 4-foot deep facility in order to meet the drawdown time requirement.

Table 10. Approximate Drawdown Time for Subsurface Infiltration Facilities

Test Location	Design Drawdown Rate (in/hr)	Drawdown Time 4-ft Facility (hrs)	Drawdown Time 8-ft Facility (hrs)
INF-1	16.8	2.8	5.7
INF-2	0.8	60	120
INF-3	3.6	13.3	26.7
INF-4	13.8	3.5	6.9

SSC-5 Depth to Bedrock, Groundwater Table, or Impermeable Layer

Similar to surface infiltration facilities, the base of all subsurface infiltration facilities should be ≥ 5 feet above the seasonal groundwater table, bedrock, hardpan, or other low-permeability layer. However, when following the presumptive approach, the required minimum thickness of the vadose zone depends on the vadose zone treatment capacity of the native soil (see Table 8). However, Ecology may allow the use of amended soil below and around

As discussed previously, groundwater was not encountered in any of the test pit explorations and static water levels are reported to range from 15 to 65 feet bgs based on review of available well logs and inferred from prior geotechnical work. In addition, bedrock, hardpan, or other restrictive layer was not encountered in any of the test pit explorations completed as part of this work or any of the prior geotechnical explorations reviewed.

Recommended Category of Infiltration BMP

Infiltration testing results and review of available groundwater depth information suggest that both surface and subsurface infiltration facilities are likely suitable at each of the test locations. Recommended surface infiltration BMPs that may work well in a roadside setting include infiltration swales or bio-infiltration swales. Recommended subsurface infiltration BMPs include infiltration trenches with perforated pipe or drywells. To meet Ecology's subsurface infiltration pretreatment requirement, Aspect recommends the use of a sedimentation manhole with a down-turned elbow for the removal of sediment, debris, and small amounts of oil which will help extend the life of the subsurface infiltration facility.

Given the uncertainty in the depth to groundwater, shallow infiltration facilities may be more appropriate for use within the City. However, during the planning phase of a potential stormwater retrofit project, a more detailed groundwater exploration may show a larger separation to groundwater which would allow the use of deeper subsurface infiltration facilities and may also use of the native soil vadose zone to meet treatment requirements.

Recommended infiltration BMPs along with limiting factors and recommended key design issues are provided in Table 11 for each test location.

Table 11. Recommended Infiltration BMPs by Test Location

Test Location	Infiltration BMP Category & Example BMPs	Limiting Factors	Recommended Key Design Issues
INF-1 INF-3 INF-4	**Surface** Infiltration Swale, Bio-Infiltration Swale	• Measured initial infiltration rates > 9 in/hr (per SSC-4 requirement). • Potentially limited separation to groundwater. • Space constraints.	• Utilize amended treatment soil to address high infiltration rate. • Consider forward compatibility with planned roadway/utility projects. • Consider continuous inflow, curb cut, or piped inflow. • Driveway ingress/egress. • Connect overflow to existing storm infrastructure or consider downstream impacts of excess flows.
	Subsurface Infiltration Trench, Drywell, or other Proprietary Device	• Measured initial infiltration rates > 9 in/hr (per SSC-4 requirement). • Vadose zone treatment capacity (Med/Low) requires a greater separation to season high groundwater. • Potentially limited separation to groundwater.	• Vadose treatment capacity can be considered High if basic treatment is used in advance of facility or 18 inches of amended treatment soil is placed beneath infiltration trench, allowing a minimum separation of 5-feet to seasonal high groundwater. • Conduct site specific groundwater exploration. • Connect overflow to existing storm infrastructure or consider downstream impacts of excess flows.
INF-2	**Surface** Infiltration Swale, Bio-Infiltration Swale	• Potentially limited separation to groundwater. • Space constraints.	• Consider forward compatibility with planned roadway/utility projects. • Consider continuous inflow, curb cut, or piped inflow. • Driveway ingress/egress. • Connect overflow to existing storm infrastructure or consider downstream impacts of excess flows.
	Subsurface Infiltration Trench, Drywell, or other Proprietary Device	• Potentially limited separation to groundwater.	• Conduct site specific groundwater exploration. • Connect overflow to existing storm infrastructure or consider downstream impacts of excess flows.

References

Washington State Department of Ecology (Ecology), 2019, Stormwater Management Manual for Eastern Washington (SWMMEW).

Limitations

Work for this project was performed for the City of College Place (Client), and this memorandum was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

Attachments:
- Attachment 1 – Problem Area Prioritization Matrix
- Attachment 2 – Infiltration Test Location Maps
- Attachment 3 – Test Pit Logs
- Attachment 4 – Test Pit Photo Log
- Attachment 5 – Laboratory Test Results
- Attachment 6 – Pilot Infiltration Test Results

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ATTACHMENT 1

Problem Area Prioritization Matrix

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City of College Place - Drywell Feasibility Study

Problem Area Prioritization Matrix

Problem Area	Problem Area Location	Problem Description	Prioritization Criteria: Soil/Groundwater Suitability	Existing Nearby Infiltration Test Data	Planned Roadway/Utility Improvement Project	Severity of Drainage Problem	Exist. Stormwater Infrastructure	ADT / Pollutant Loading Benefit	Total
1	SE Birch (4th to 12th St)	Assume not enough storm drains, undersized storm pipe.	5	1	3	1	1	0.5	**11.5**
2	SW 12th St @ SW Bade	Lack of proper storm drains.	5	2	0	0	1	0.5	**8.5**
3*	SW 10th St (College Ave to Dead End)	Street has lost its crown and is sinking in. A lot of the street is sheet draining to Garrison Creek.	5	2	3	1	0	0.5	**11.5**
4*	SW Puff Ln	Lack of storm inlets, road is sinking in.	5	2	3	1	1	0.5	**12.5**
5	SE 9th St (College Ave to Dead End)	No storm infrastructure, unmanaged dirt road.	5	2	3	0	1	1	**12**
6*	SW Bade Ave (9th to 11th St)	Lack of storm inlets.	5	2	3	1	0	0.5	**11.5**
7	SE 6th St (College Ave to Birch)	Lack of storm inlets, street crown starting to falter.	0	2	3	1	0	1	**7**
8	SW 5th St (Bade to Dead End)	Road surface in bad condition, lack of storm infrastructure.	0	2	0	0	1	0.5	**3.5**
9	SE 3rd St (College Ave to Ash)	Road chip sealed many times. Sacrifices storm runoff.	0	1	0	0	0	1	**2**
10	SW 3rd (Davis to Academy)	No curb and gutter or storm infrastructure.	3	1	0	1	1	0.5	**6.5**
11	SW 2nd (Davis to Academy)	No curb and gutter or storm infrastructure.	3	1	0	1	1	0.5	**6.5**
12	SW 1st (Davis to Academy)	No curb and gutter or storm infrastructure.	3	1	0	1	1	0.5	**6.5**
13	NW Earl Ln (Whitman to Evans)	Street has lost its crown and is sinking in. Lots of stormwater pools in middle of roadway. Lack of storm inlets.	5	2	0	1	1	0.5	**9.5**
14	NW Spagnuolo Lp (NW B, NW B)	Lack of storm inlets.	5	0	0	0	1	0.5	**6.5**
15	E Whitman @ Ash St	Lack of storm inlets, lots of storm runoff running downhill on Ash from Davis Elementary area.	0	1	0	2	0	1	**4**

(Shaded) High Priority for Infiltration Testing - Based on Prioritization Ranking and City Preference

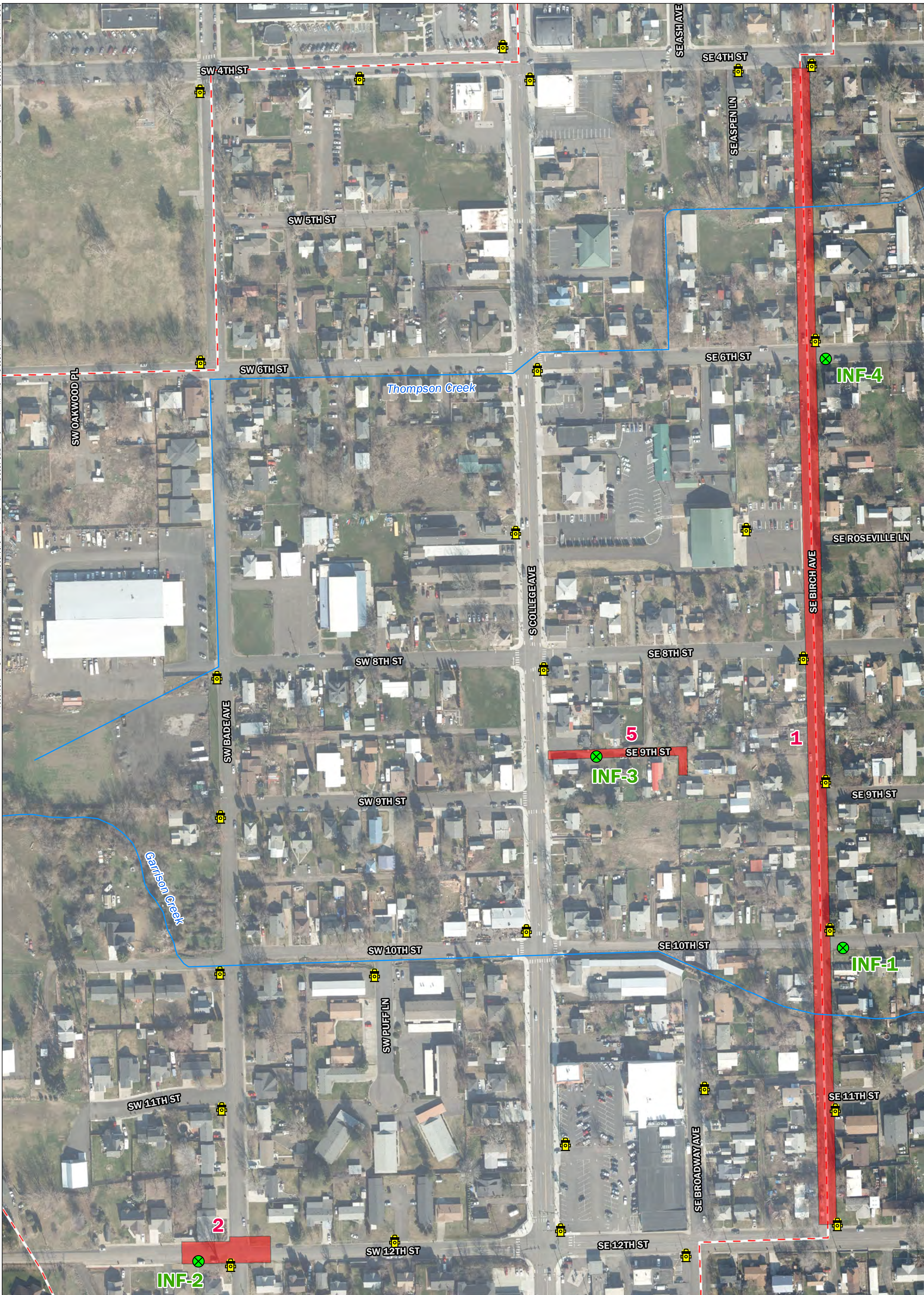
* Infiltration testing for these high ranking problem areas will be deferred due to upcoming chip seal projects.

Prioritization Criteria	
Soil/Groundwater Suitability	0 - Likely Not Suitable for Surface or Sub-Surface Infiltration
	3 - Likely Suitable for Surface Only Due to Shallow Groundwater
	5 - Likely Suitable for Surface or Sub-Surface Infiltration
Existing Nearby Infiltration Test Data	0 - Infiltration Test Data Very Close By
	1 - Some data in the vicinity
	2 - No Data nearby
Planned Roadway/Utility Improvement Project	0 - No planned projects, stand-alone BMP retrofits would be necessary
	3 - Infiltration test can be used to support design of planned project and/or infiltration BMPs can be installed as part of the planned project
Severity of Drainage Problem	0 - Nuisance issues - insignificant/very minor damage/disruptions
	1 - Drainage issues, causes minor to moderate damage/disruptions
	2 - Causes significant damages/disruptions
Existing Stormwater Infrastructure	0 - Existing stormwater conveyance infrastructure (trunklines) are nearby and have sufficient capacity to accept additional runoff. 1 - No existing stormwater conveyance infrastructure nearby.
ADT / Pollutant Loading Benefit	0.5 - Residential Land Use / Low ADT, Less Water Quality Benefit
	1 - Some Commercial / Moderate ADT / Unpaved Roadway, More Water Quality Benefit

ATTACHMENT 2

Infiltration Test Location Maps

Aspect CONSULTING



Infiltration Test Location

5 High Priority Focus Area / Problem Area

Hydrant

Project Area Census Blocks

City Limits

N

0 100 200

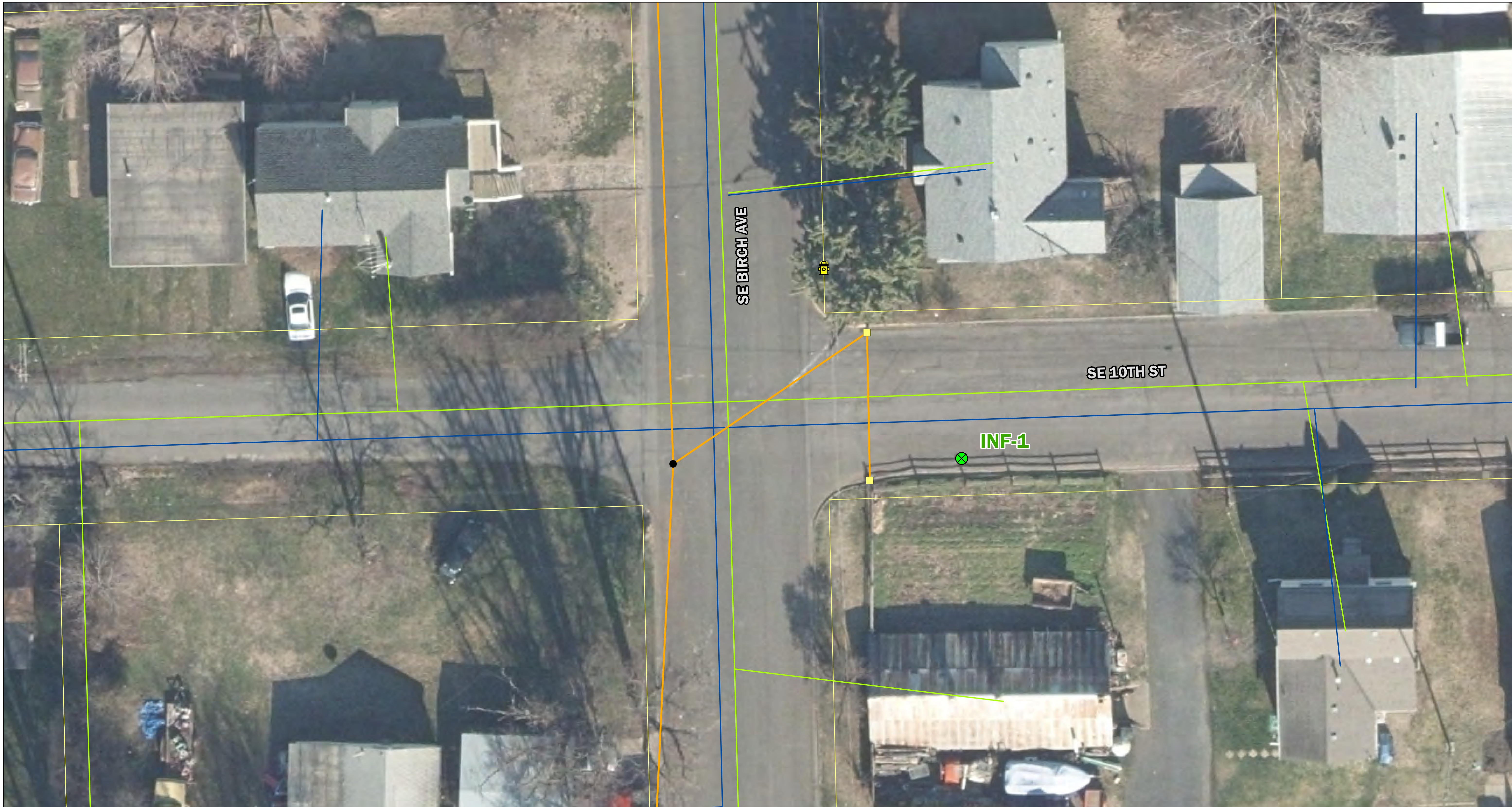
Feet

High Priority
Focus Areas / Problem Areas
for Infiltration Testing

Drywell Feasibility Study
City of College Place, WA

Aspect CONSULTING	JUN-2021	BY: EBP	FIGURE NO.
	PROJECT NO. 210093	REVISED BY: - - -	1

GIS Path: L:\Projects\210093 College Place Drywell Feasibility\GIS\mxds\InfiltrationTestMapRev.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 6/24/2021 || User: epruneda || Print Date: 6/24/2021



Infiltration Test Location
Stream
Storm Catch Basin
Storm Outfall
Storm Manhole
Storm UIC
Storm Outlet
Storm Inlet
Storm Culvert
Ditch
Storm Infiltration Trench
Storm Pipe
Storm Infiltration Swale
Storm Biofiltration Swale
Hydrant
Water Line
Sanitary Sewer
City Limits
Parcel

INF #1
Latitude = 46.040209988
Longitude = -118.385885338
Approximate Excavation Dimensions = 4' Wide x 6' Long x 4' Deep

Note: Utilities shown are approximate. City staff to perform utility locates prior to excavation.

0 20 40
Feet

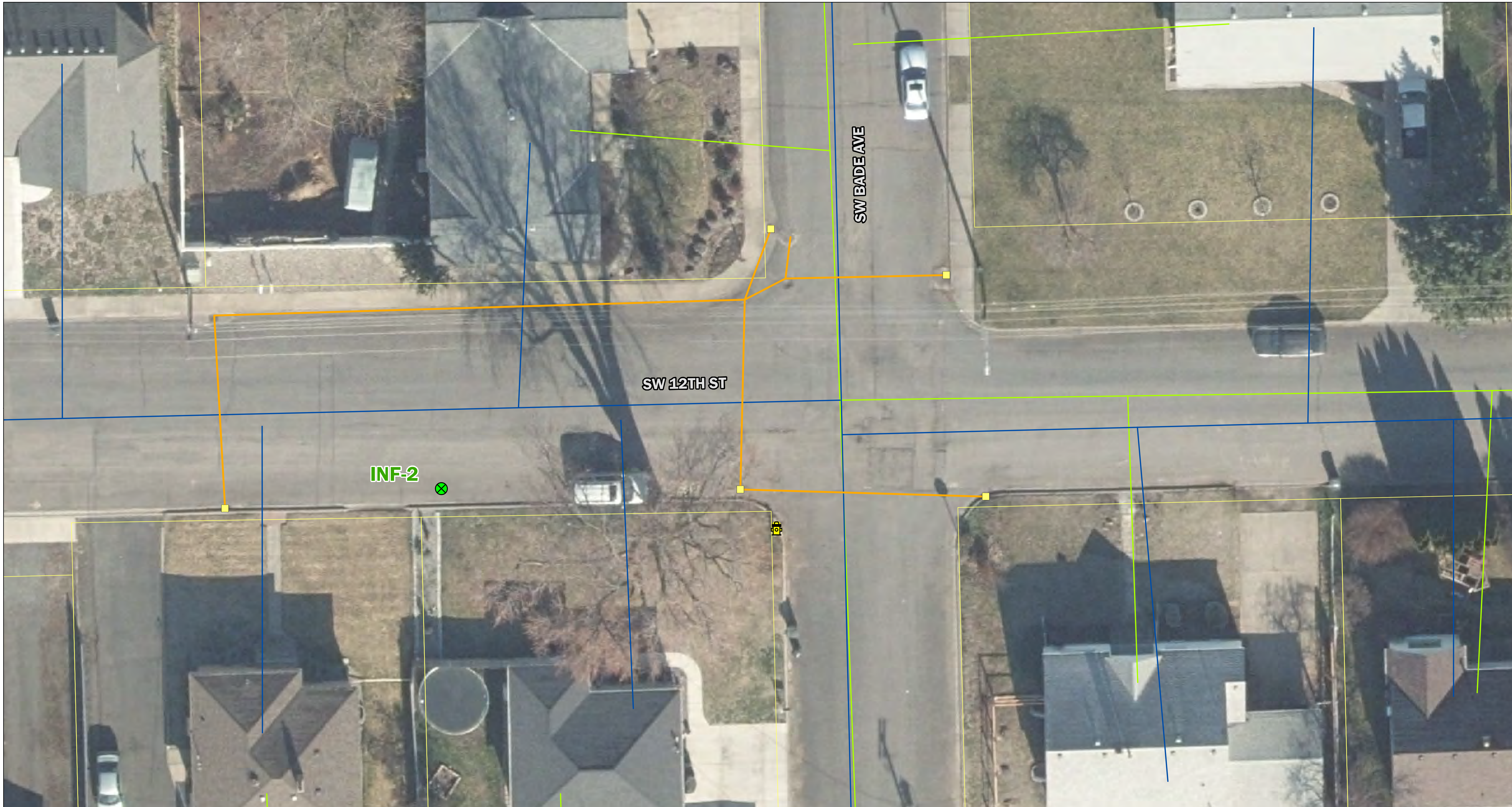
Infiltration Test #1 (INF-1)

Drywell Feasibility Study
City of College Place, WA

Aspect CONSULTING

JUN-2021	BY: EBP	FIGURE NO. 2
PROJECT NO. 210093	REVISED BY: - - -	

GIS Path: L:\Projects\210093 College Place Drywell Feasibility\GIS\mxds\InfiltrationTest#1.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 6/24/2021 || User: epruneda || Print Date: 6/24/2021



Infiltration Test Location	Storm UIC	Storm Infiltration Trench	Water Line
Stream	Storm Outlet	Storm Pipe	Sanitary Sewer
Storm Catch Basin	Storm Inlet	Storm Infiltration Swale	City Limits
Storm Outfall	Storm Culvert	Storm Biofiltration Swale	Parcel
Storm Manhole	Ditch	Hydrant	

INF #2
Latitude = 46.038390604
Longitude = -118.391637558
Approximate Excavation Dimensions = 4' Wide x 6' Long x 4' Deep

Note: Utilities shown are approximate. City staff to perform utility locates prior to excavation.

N

0 20 40
Feet

Infiltration Test #2 (INF-2)

Drywell Feasibility Study
City of College Place, WA

Aspect CONSULTING

JUN-2021	BY: EBP	FIGURE NO. 3
PROJECT NO. 210093	REVISED BY: - - -	

GIS Path: L:\Projects\210093 College Place Drywell Feasibility\GIS\mxds\InfiltrationTest#2.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 6/24/2021 || User: epruneda || Print Date: 6/24/2021

Infiltration Test Location	Storm UIC	Storm Infiltration Trench	Water Line
Stream	Storm Outlet	Storm Pipe	Sanitary Sewer
Storm Catch Basin	Storm Inlet	Storm Infiltration Swale	City Limits
Storm Outfall	Storm Culvert	Storm Biofiltration Swale	Parcel
Storm Manhole	Ditch	Hydrant	

INF #3
Latitude = 46.041425465
Longitude = -118.388012931
Approximate Excavation Dimensions =
4' Wide x 6' Long x 4' Deep

Note: Utilities shown are approximate.
City staff to perform utility locates prior to excavation.

N

0 30 60
Feet

Infiltration Test #3
(INF-3)

Drywell Feasibility Study
City of College Place, WA

Aspect CONSULTING

JUN-2021	BY: EBP	FIGURE NO.
PROJECT NO. 210093	REVISED BY: - - -	4

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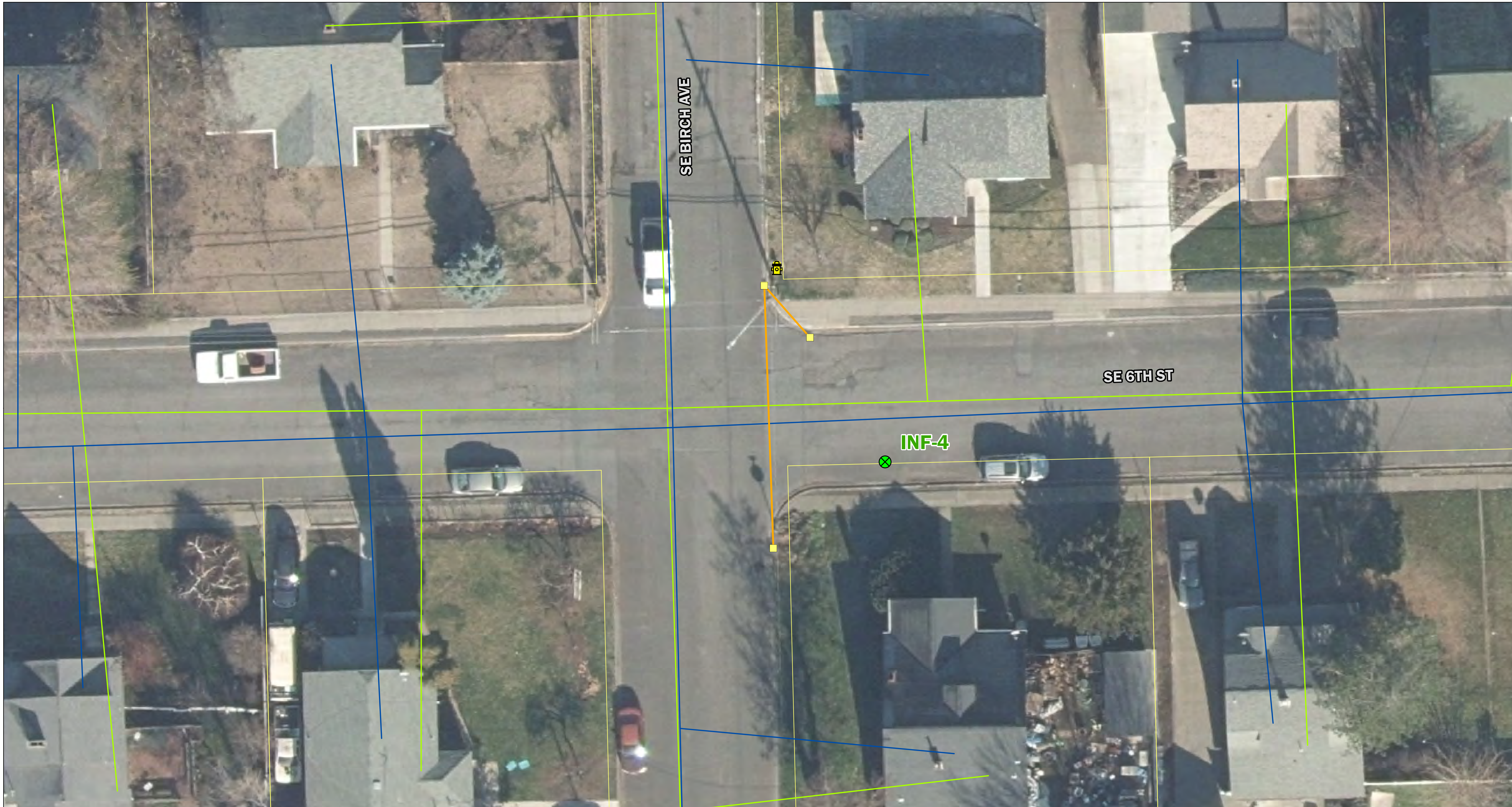


- Infiltration Test Location
- Stream
- Storm Catch Basin
- Storm Outfall
- Storm Manhole
- Storm UIC
- Storm Outlet
- Storm Inlet
- Storm Culvert
- Ditch
- Storm Infiltration Trench
- Storm Pipe
- Storm Infiltration Swale
- Storm Biofiltration Swale
- Hydrant
- Water Line
- Sanitary Sewer
- City Limits
- Parcel

INF #4
Latitude = 46.043828944
Longitude = -118.385899228
Approximate Excavation Dimensions =
4' Wide x 6' Long x 4' Deep

Note: Utilities shown are approximate. City staff to perform utility locates prior to excavation.

0 20 40
Feet

Infiltration Test #4 (INF-4)

Drywell Feasibility Study
City of College Place, WA

Aspect CONSULTING

JUN-2021	BY: EBP	FIGURE NO.	
PROJECT NO. 210093	REVISED BY: - - -	5	

GIS Path: L:\Projects\210093 College Place Drywell Feasibility\GIS\mxds\InfiltrationTest#4.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 6/24/2021 || User: epruneda || Print Date: 6/24/2021

ATTACHMENT 3

Test Pit Logs

Aspect consulting earth+water

BORING LOG

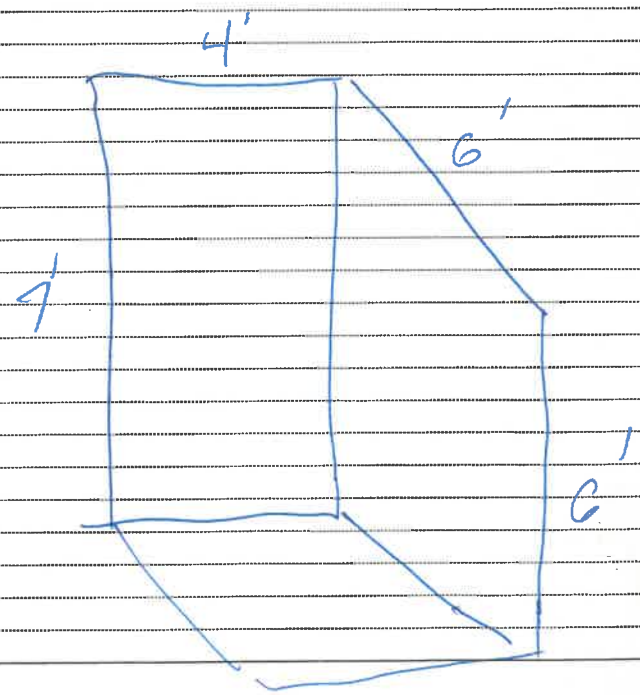
SHEET ____ OF

LOCATION OF BORING: INF-1	PROJECT NO. 210393
	PROJECT NAME: COLLEGE PLACE INF TESTING
	BORING NO. INF-1
SKETCH OF LOCATION	DRILLING METHOD: INFILTRATION TEST
	LOGGED BY: GUYTON
	DRILLER: RICHARDSON
	SAMPLING METHOD: INFILTRATION TEST
	HAMMER WEIGHT/SAMPLER DIAMETER
	OBSERVATION WELL INSTALL YES ____ NO ____
DATUM	GRADE ELEV.

					START	FINISH
WATER LEVEL					TIME: 7/22	TIME
TIME						
DATE					DATE: 0756	DATE
CASING DEPTH						

SURFACE CONDITION

GRAVEL	SAND (SIZE RANGE)	FINES	SAMPLE NO. / SAMPLE TYPE	SAMPLE DEPTH	INCHES DRIVEN / INCHES RECV'D	DEPTH IN FEET	PENETRATION RESISTANCE	USCS SUMMARY	DESCRIPTION: Density, moisture, color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc. DRILL ACTION
									ASPHALT / ~~[illegible]~~ 3" TOP LAYER
						1			
40	20	40							DARK SANDY SILT W/ GRAVEL
						2			
50	20	30							DARK SANDY SILT ~~LARGER~~ SMALLER GRAVEL ~~[illegible]~~
						3			2.5' DOWN PIPE DISCOVERY (1" DIAM.) SOUTH EDGE OF PIT
50	20	30							
						4			DARK SANDY SILT W/ PEA GRAVEL
						5			
60	15	25		6'					DARK SANDY SILT W/ 6" MINUS GRAVEL
						6			TEST BOTTOM @ 6'
						7			
						8			OVEREXCAVATE TO 8' NO CHANGE MATERIAL WET
						9			
						0			
						1			
						2			
						3			
						4			
						5			
						6			
						7			
						8			
						9			
						0			



Aspect consulting earth+water

BORING LOG

SHEET ____ OF ____

LOCATION OF BORING	PROJECT NO. 210093	BORING NO.
INF-2	PROJECT NAME: CP INF TESTING	

SKETCH OF LOCATION

DRILLING METHOD: EXCAVATOR

LOGGED BY: GUYTON

DRILLER: RICHARDSON

SAMPLING METHOD: INF TESTING SMALL PIT

HAMMER WEIGHT/SAMPLER DIAMETER

OBSERVATION WELL INSTALL YES ____ NO ____

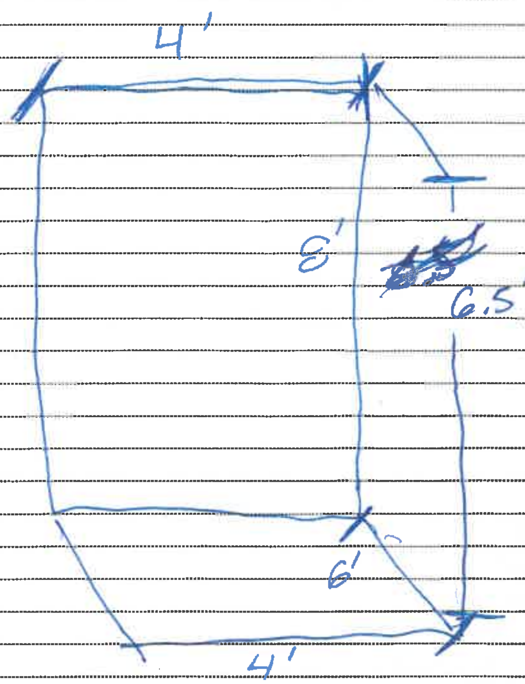
WATER LEVEL					START	FINISH
					TIME	TIME
TIME					0808	
DATE					DATE	DATE
CASING DEPTH					7/20/21	

DATUM

GRADE ELEV.

SURFACE CONDITION

GRAVEL	SAND (SIZE RANGE)	FINES	SAMPLE NO. / SAMPLE TYPE	SAMPLE DEPTH	INCHES DRIVEN / INCHES RECV'D	DEPTH IN FEET	PENETRATION RESISTANCE	USCS SUMMARY	DESCRIPTION: Density, moisture, color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc. DRILL ACTION
									ASPHALT / BASE COURSE
						1			TOP 12"
									LT BROWN LOAM ~~SANDY~~ SANDY SILT
						2			6" GRAVEL FILL FOR GAS LINE? SOUTH SIDE ONLY
						3			DARK BROWN SANDY SILT
									LOW LATENCY
						4			
						5			SOME ROOTS
2	25	73		6'		6			TEST BOTTOM 6 FEET
						7			
						8			
						9			
						0			
						1			
						2			
						3			
						4			
						5			
						6			
						7			
						8			
						9			
						0			



Aspect consulting earth+water

BORING LOG

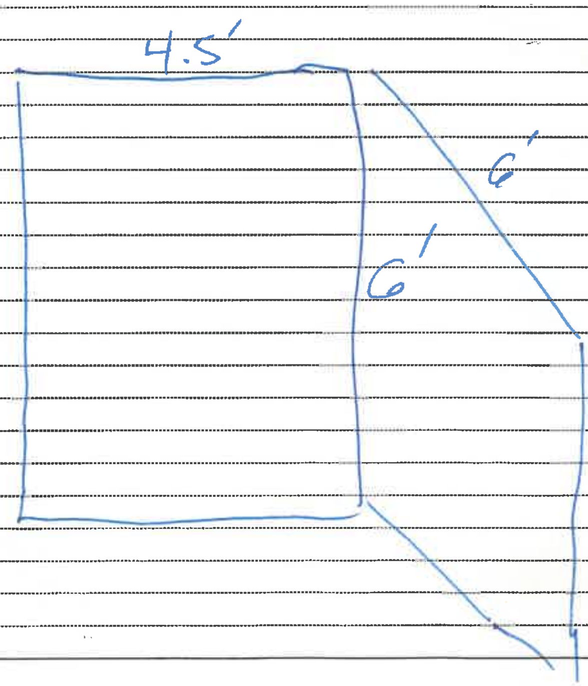
SHEET ____ OF ____

LOCATION OF BORING: INF-3	PROJECT NO. 210093
	PROJECT NAME: College Place
	BORING NO. INF-3
SKETCH OF LOCATION	DRILLING METHOD: Excavator
	LOGGED BY: Guyton
	DRILLER: Richardson
	SAMPLING METHOD: Small Scale Pit
	HAMMER WEIGHT/SAMPLER DIAMETER
	OBSERVATION WELL INSTALL YES ____ NO ____
DATUM	GRADE ELEV.

					START	FINISH
WATER LEVEL					TIME	TIME
TIME						
DATE					DATE	DATE
CASING DEPTH					7/23/21	

SURFACE CONDITION

GRAVEL	SAND (SIZE RANGE)	FINES	SAMPLE NO. / SAMPLE TYPE	SAMPLE DEPTH	INCHES DRIVEN / INCHES RECV'D	DEPTH IN FEET	PENETRATION RESISTANCE	USCS SUMMARY	DESCRIPTION: Density, moisture, color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc. DRILL ACTION
38	30	40				1			Top 2" 3/4" Minus Gravel Light Brown Sandy Silt
5	15	80				2			Dark Brown Sandy Silt Higher Moisture
						3			
						4			
50	15	35				5			Increase of Cobbles 6" Minus Orange Color Intermittently
70	10	26		6'		6			Test Pit Bottom 6' Overexcavate To 7'
						7			Same Material
						8			
						9			
						0			
						1			
						2			
						3			
						4			
						5			
						6			
						7			
						8			
						9			
						0			



Aspect consulting earth+water

BORING LOG

SHEET ____ OF

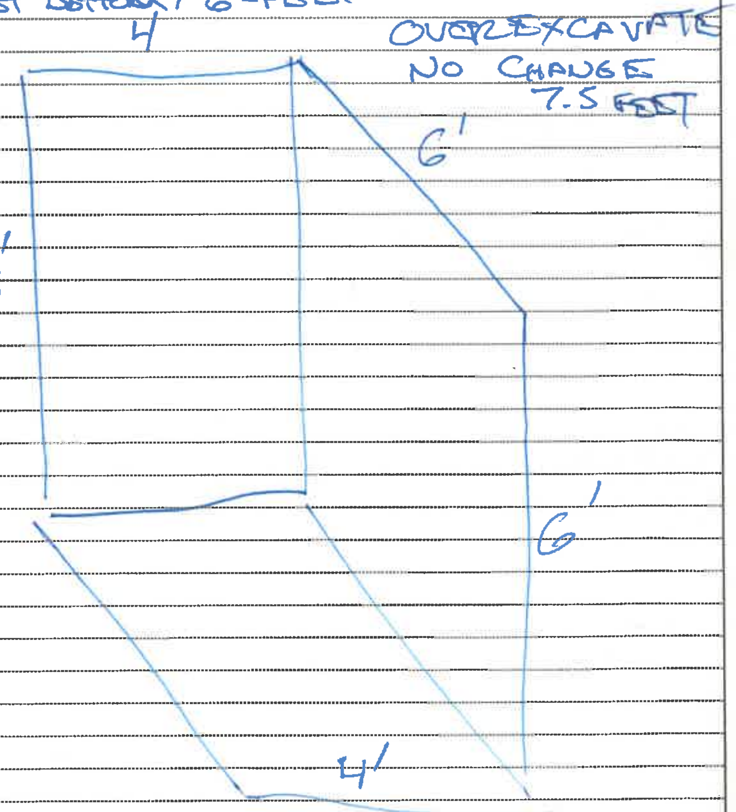
LOCATION OF BORING: INF-4	PROJECT NO. 210093
	PROJECT NAME: CP INF TESTING
	BORING NO.
SKETCH OF LOCATION	DRILLING METHOD: EXCAVATOR
	LOGGED BY: GUTTON
	DRILLER: RICHARDSON
	SAMPLING METHOD: INF TESTING SMALL PIT
	HAMMER WEIGHT/SAMPLER DIAMETER
	OBSERVATION WELL INSTALL YES ____ NO ____
	WATER LEVEL
	TIME
	DATE
DATUM	CASING DEPTH
GRADE ELEV.	

START	FINISH
TIME	TIME
DATE 7/21/21	DATE

SURFACE CONDITION

DESCRIPTION: Density, moisture, color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc. DRILL ACTION

GRAVEL	SAND (SIZE RANGE)	FINES	SAMPLE NO. / SAMPLE TYPE	SAMPLE DEPTH	INCHES DRIVEN / INCHES RECV'D	DEPTH IN FEET	PENETRATION RESISTANCE	USCS SUMMARY	DESCRIPTION
						1			ASPHALT / BASE COURSE FIRST 12"
~~[crossed out]~~						2			DARK BROWN HIGH MOISTURE WARM TEMP MED ORGANICS
5	35	60				3			LOW DILATENCY
50	20	30				4			INCREASE ROCK 4"-5" MINUS ANGULAR BASALT
						5			
				6'		6			TEST BOTTOM / 6-FEET
						7			OVEREXCAVATE NO CHANGE 7.5 FEET
						8			
						9			
						0			
						1			
						2			
						3			
						4			
						5			
						6			
						7			
						8			
						9			
						0			



ATTACHMENT 4

Test Pit Photo Log

Photograph 1. INF #1 small-scale PIT. (July 22, 2021)

Photograph 2. INF #1 small-scale PIT. (July 22, 2021)

Photograph 3. INF #2 small-scale PIT. (July 20, 2021)

Photograph 4. INF #2 small-scale PIT. (July 20, 2021)

Photograph 5. INF #3 small-scale PIT. (July 23, 2021)

Photograph 6. INF #3 small-scale PIT. (July 23, 2021)

Photograph 7. INF #4 small-scale PIT. (July 21, 2021)

Photograph 8. INF #4 small-scale PIT. (July 21, 2021)

ATTACHMENT 5

Laboratory Test Results

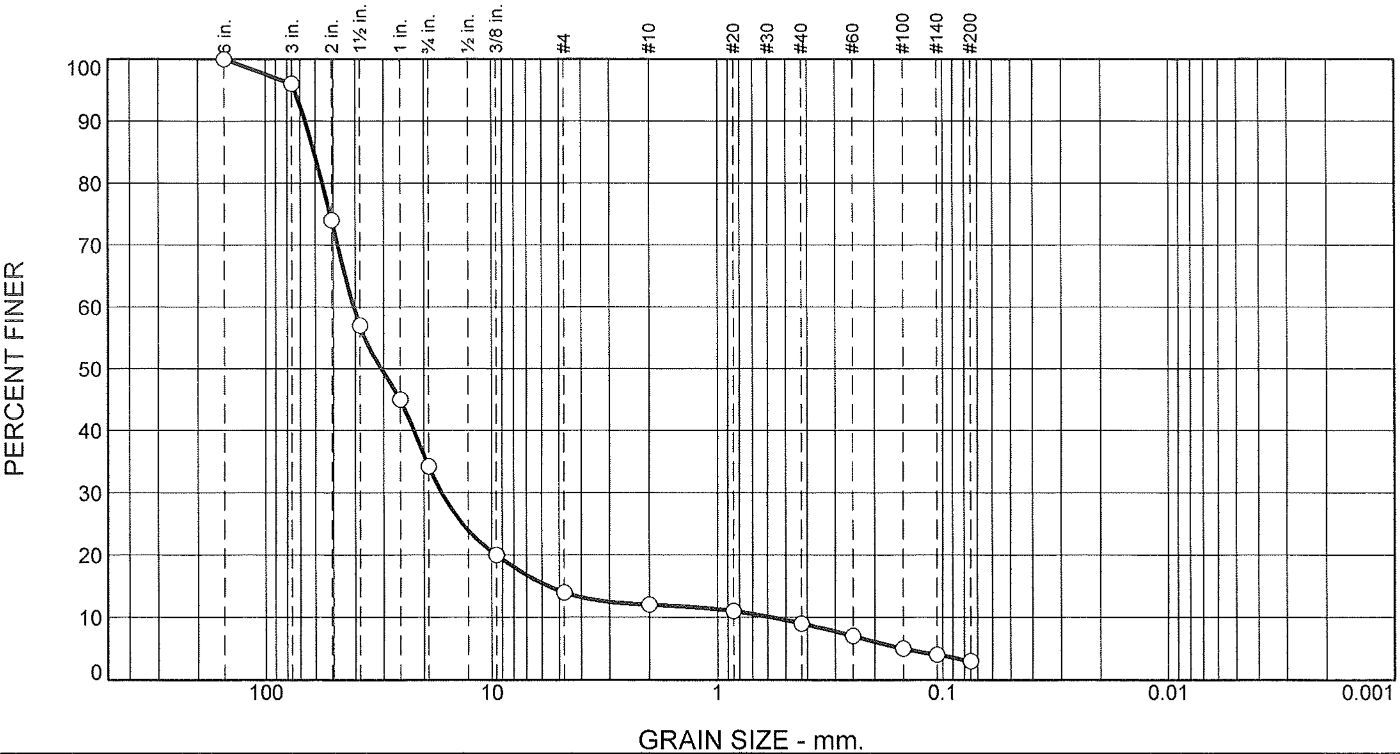
Aspect CONSULTING

LABORATORY SUMMARY

LABORATORY NUMBER			70339	70340	70341	70342
SAMPLE NUMBER			1	2	3	4
SAMPLE DATE			7/22/21	7/20/21	7/20/21	7/21/21
SAMPLE TYPE			Bulk	Bulk	Bulk	Bulk
SAMPLED BY			Client	Client	Client	Client
DATE RECEIVED			7/23/21	7/23/21	7/23/21	7/23/21
SAMPLE LOCATION			INF-1 (6')	INF-2 (6')	INF-3 (6')	INF-4 (6')
			210093	210093	210093	210093
	UNITS	Test Methods				
[1]**ORGANIC MATTER**	%	ASTM D2974	3.30	1.95	3.33	1.63
[1]**CATION EXCHANGE CAPACITY**	meq/100g	EPA 9081	23.3	17.2	24.5	13.7
SAMPLE MOISTURE	%	ASTM D2213	10.3	20.9	21.7	7.8
SIEVE ANALYSIS		ASTM D6913				
6"			100		100	100
3"			96		91	96
2"			74		73	83
S 1 1/2"			57		62	71
I 1"	%		45		46	55
E 3/4"			34.2		36.3	47.0
V 3/8"	P		20	100	24	35
E #4	A		14	100	19	28
#10	S		12	99.7	15	24
S #20	S		11	99.3	13	20
I #40	I		9	98.3	10	16
Z #60	N		7	93.9	8	11
E #100	G		5	82.6	7	7
#140			4	73.7	6	5
#200			3	63.4	5	4

[1]Conducted by our subcontractor, NW Agricultural Consultants

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
4.0	61.8	20.2	2.0	3.0	6.0	3.0	

Test Results (ASTM D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
6"	100.0		
3"	96.0		
2"	74.0		
1.5"	57.0		
1"	45.0		
3/4"	34.2		
3/8"	20.0		
#4	14.0		
#10	12.0		
#20	11.0		
#40	9.0		
#60	7.0		
#100	5.0		
#140	4.0		
#200	3.0		

* (no specification provided)

Material Description

Gravel w/ Trace Sand

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 66.4228 D_{85}= 60.6101 D_{60}= 40.4992
D_{50}= 30.6945 D_{30}= 16.7096 D_{15}= 5.5835
D_{10}= 0.5765 C_u= 70.25 C_c= 11.96

Remarks

Sampled By: Client
Moisture: 10.3%

Date Received: 7/23/21 **Date Tested:** 7/30/21

Tested By: PH

Checked By: SW

Title: CSM

Location: INF 1
Sample Number: 70339 **Depth:** -6'

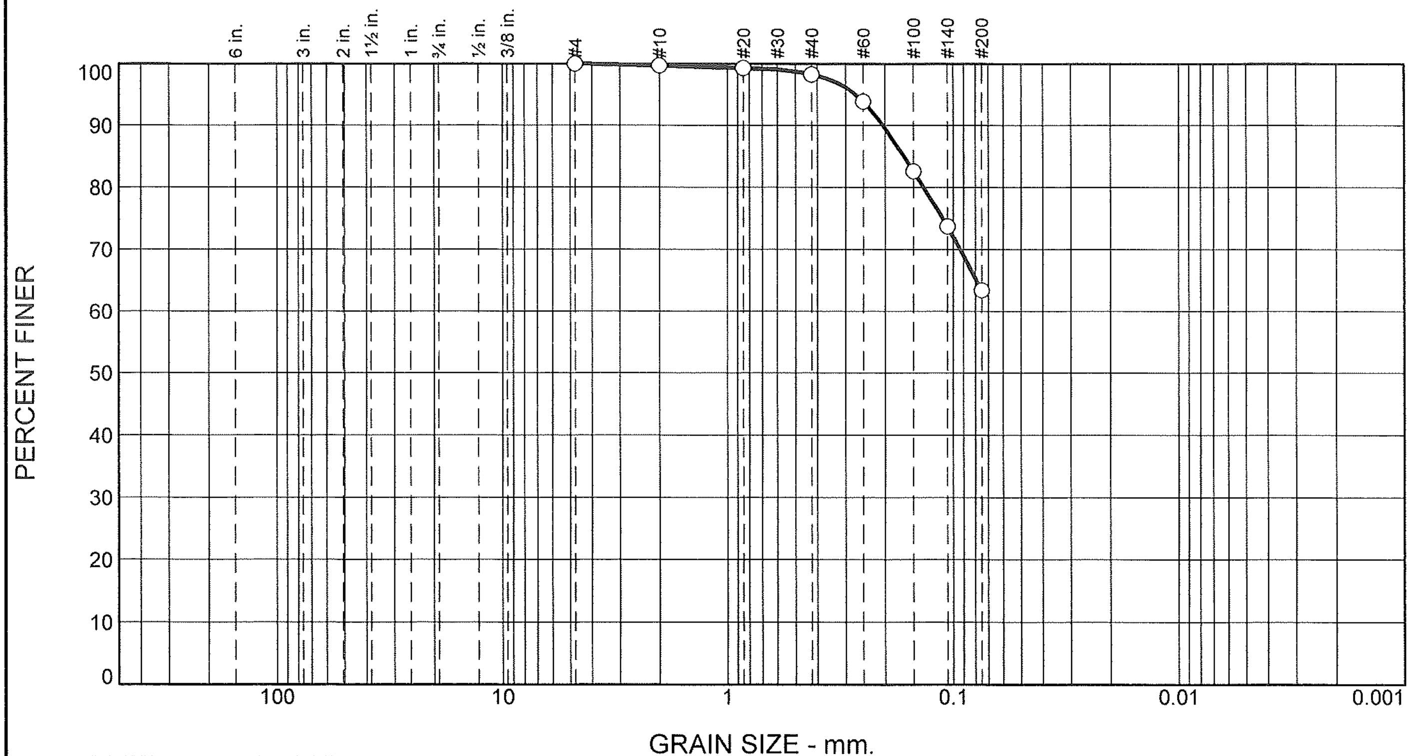
Date Sampled:

Intermountain Materials Testing & Geotechnical

Client: Aspect Consulting
Project: College Place Infiltration Testing

Project No: L21134 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	1.4	34.9	63.4	

Test Results (ASTM D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.7		
#20	99.3		
#40	98.3		
#60	93.9		
#100	82.6		
#140	73.7		
#200	63.4		

* (no specification provided)

Material Description

Sandy Silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

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

Coefficients

D_{90}= 0.2040 D_{85}= 0.1652 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sampled By: Client

Date Received: 7/23/21 **Date Tested:** 7/30/21

Tested By: PH

Checked By: SW

Title: CSM

Location: INF 2

Sample Number: 70340 **Depth:** -6'

Date Sampled:

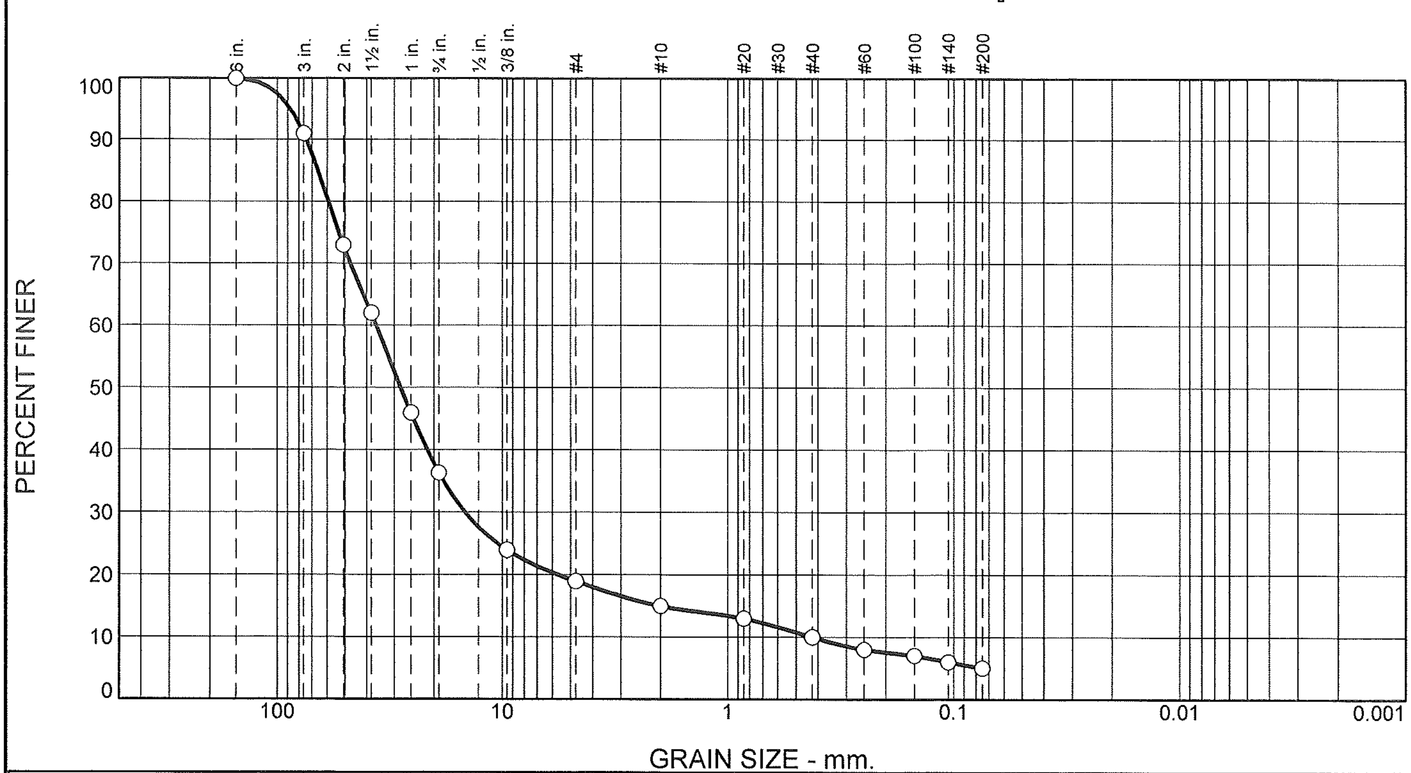
Intermountain Materials Testing & Geotechnical

Client: Aspect Consulting

Project: College Place Infiltration Testing

Project No: L21134 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
9.0	54.7	17.3	4.0	5.0	5.0	5.0	

Test Results (ASTM D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
6"	100.0		
3"	91.0		
2"	73.0		
1.5"	62.0		
1"	46.0		
3/4"	36.3		
3/8"	24.0		
#4	19.0		
#10	15.0		
#20	13.0		
#40	10.0		
#60	8.0		
#100	7.0		
#140	6.0		
#200	5.0		

* (no specification provided)

Material Description

Gravel w/ Trace Sand

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

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

Coefficients

D_{90}= 74.1483 D_{85}= 65.8410 D_{60}= 36.1620
D_{50}= 28.1475 D_{30}= 14.6010 D_{15}= 2.0000
D_{10}= 0.4250 C_u= 85.09 C_c= 13.87

Remarks

Sampled By: Client

Date Received: 7/23/21 **Date Tested:** 7/30/21

Tested By: PH

Checked By: SW

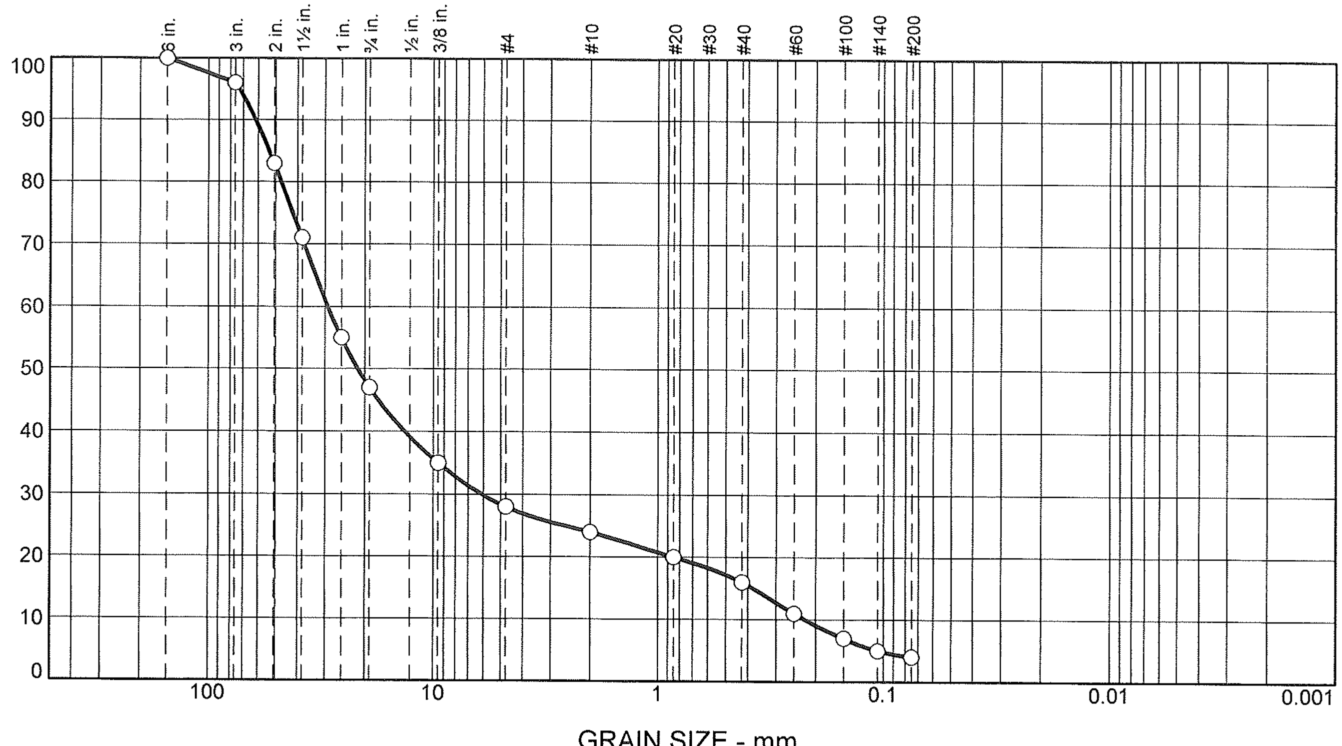
Title: CSM

Location: INF 3
Sample Number: 70341 **Depth:** -6'
Date Sampled:

Intermountain Materials Testing & Geotechnical

Client: Aspect Consulting
Project: College Place Infiltration Testing
Project No: L21134 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
4.0	49.0	19.0	4.0	8.0	12.0	4.0	

Test Results (ASTM D6913 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
6"	100.0		
3"	96.0		
2"	83.0		
1.5"	71.0		
1"	55.0		
3/4"	47.0		
3/8"	35.0		
#4	28.0		
#10	24.0		
#20	20.0		
#40	16.0		
#60	11.0		
#100	7.0		
#140	5.0		
#200	4.0		

* (no specification provided)

Material Description

Gravel w/ Trace Sand

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

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

Coefficients

D_{90}= 61.4262 D_{85}= 53.4718 D_{60}= 29.1788
D_{50}= 21.4785 D_{30}= 6.0771 D_{15}= 0.3787
D_{10}= 0.2233 C_u= 130.69 C_c= 5.67

Remarks

Sampled By: Client

Date Received: 7/23/21 **Date Tested:** 7/30/21

Tested By: PH

Checked By: SW

Title: CSM

Location: INF 4
Sample Number: 70342 **Depth:** -6'

Date Sampled:

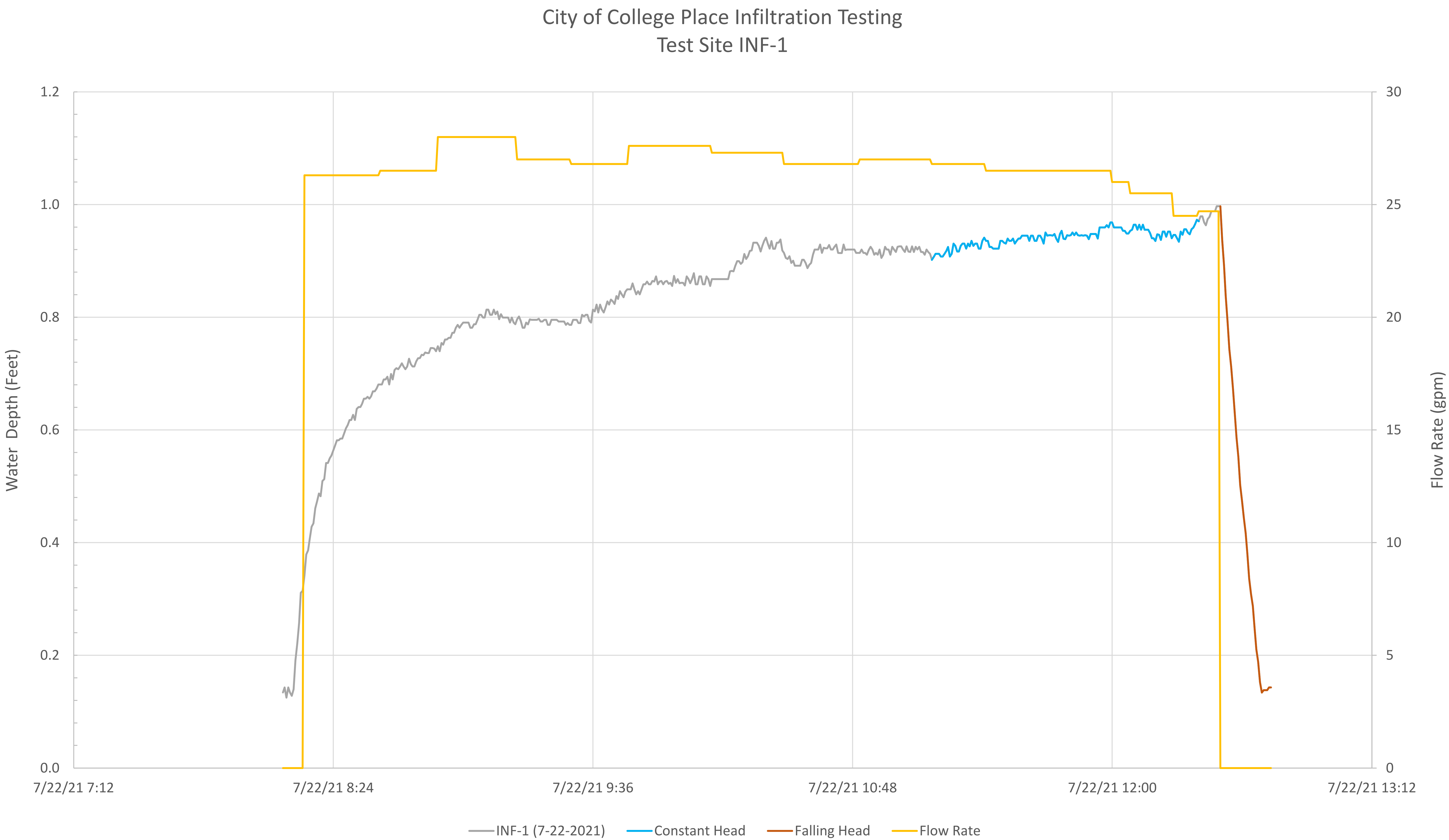
Intermountain Materials Testing & Geotechnical

Client: Aspect Consulting
Project: College Place Infiltration Testing

Project No: L21134 **Figure**

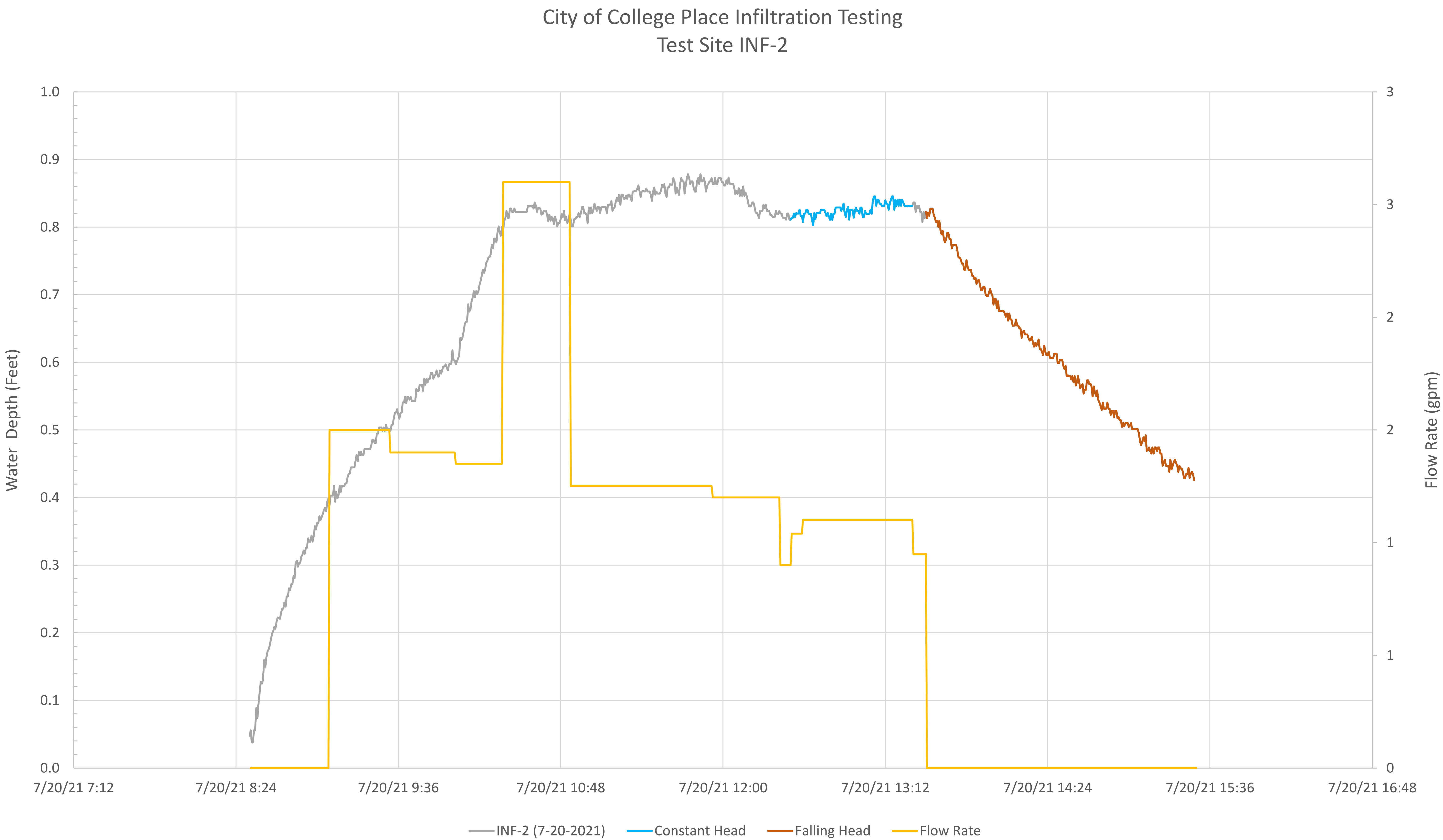
ATTACHMENT 6

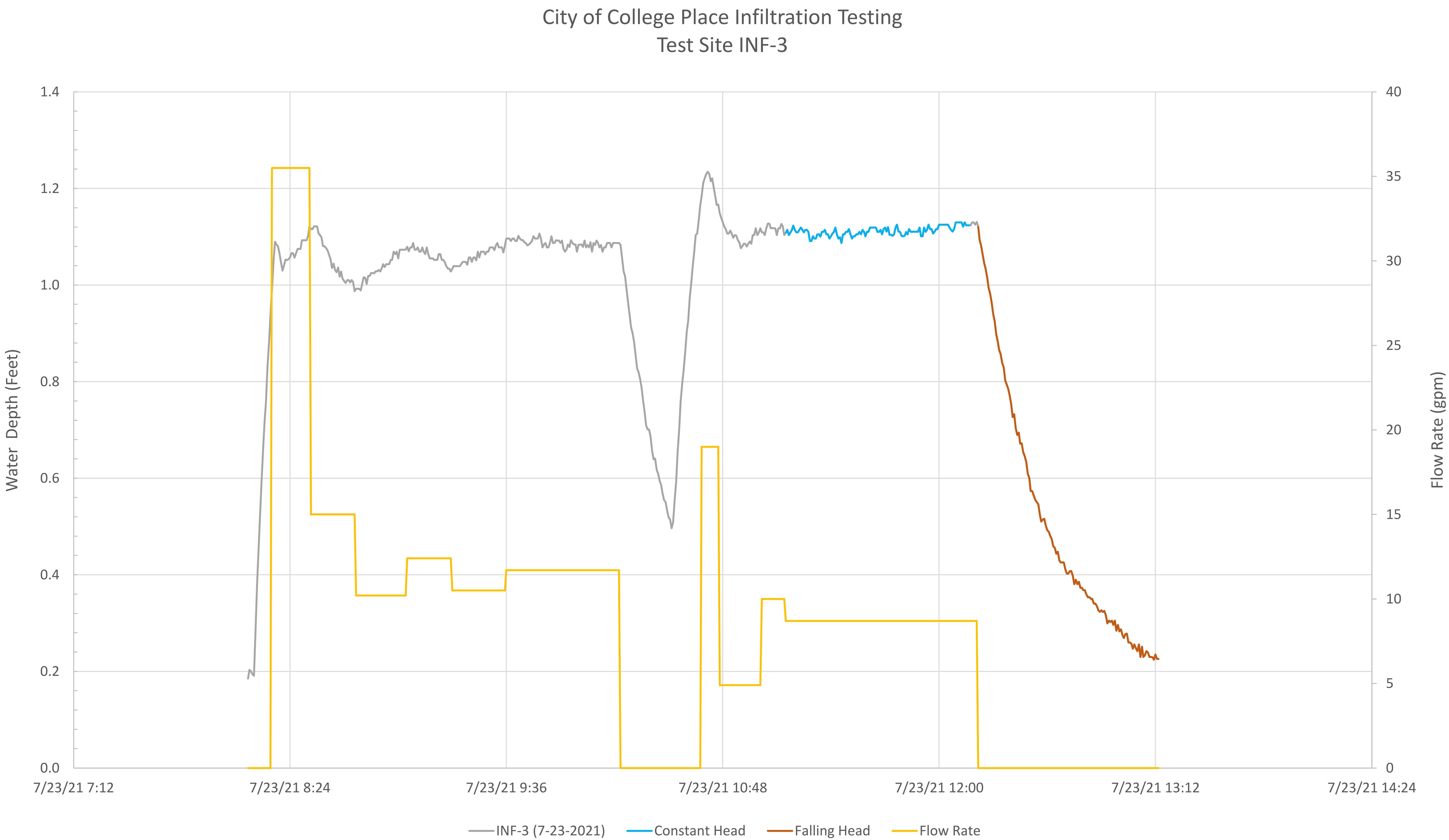
Pilot Infiltration Test Results



Aspect Consulting
8/4/2021
L:\Projects\210093 College Place Drywell Feasibility\Tasks\2.2 Percolation Planning & Testing\Field Testing July 2021\DIVER Data\Diver Data Analysis 21_0727.xlsx

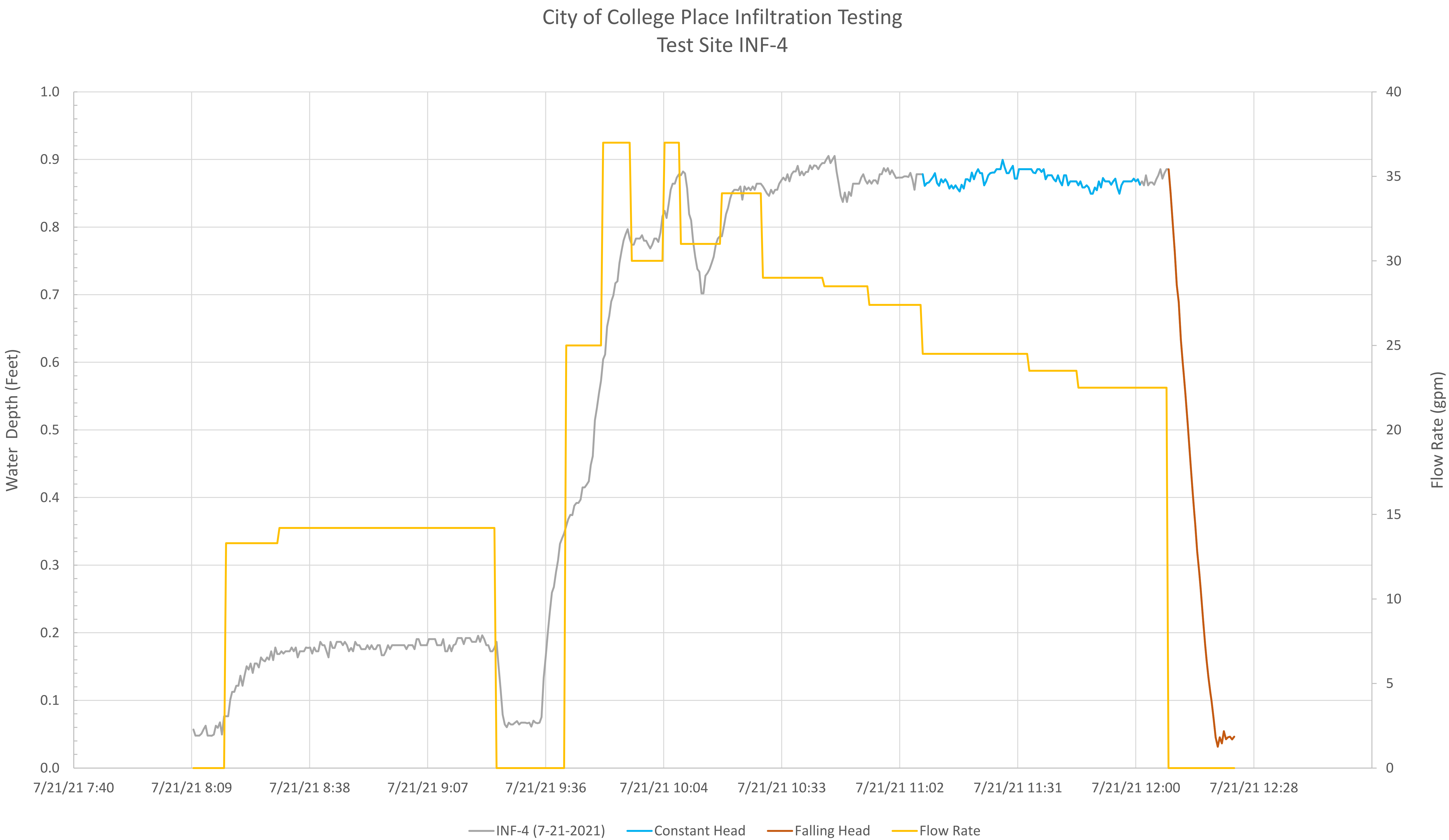
Attachment 6
Pilot Infiltration Test Results


City of College Place Infiltration Testing
Test Site INF-2
Water Depth (Feet)
Flow Rate (gpm)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3
3
2
2
1
1
0
7/20/21 7:12
7/20/21 8:24
7/20/21 9:36
7/20/21 10:48
7/20/21 12:00
7/20/21 13:12
7/20/21 14:24
7/20/21 15:36
7/20/21 16:48
INF-2 (7-20-2021)
Constant Head
Falling Head
Flow Rate



Aspect Consulting
8/4/2021
L:\Projects\210093 College Place Drywell Feasibility\Tasks\2.2 Percolation Planning & Testing\Field Testing July 2021\DIVER Data\Diver Data Analysis 21_0727.xlsx

Attachment 6
Pilot Infiltration Test Results


City of College Place Infiltration Testing
Test Site INF-4
Water Depth (Feet)
Flow Rate (gpm)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
40
35
30
25
20
15
10
5
0
7/21/21 7:40
7/21/21 8:09
7/21/21 8:38
7/21/21 9:07
7/21/21 9:36
7/21/21 10:04
7/21/21 10:33
7/21/21 11:02
7/21/21 11:31
7/21/21 12:00
7/21/21 12:28
INF-4 (7-21-2021)
Constant Head
Falling Head
Flow Rate

Appendix B

3 HR SSA Results

Project Description

File Name .... 30-20-075-033_SSA.SPF

Project Options

Flow Units .... CFS
Elevation Type .... Elevation
Hydrology Method .... SCS TR-55
Time of Concentration (TOC) Method .... User-Defined
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .... YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:06:00	days hh:mm:ss
Routing Time Step	2	seconds

Number of Elements

	Qty
Rain Gages	11
Subbasins	1
Nodes	3
Junctions	1
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	2
Channels	0
Pipes	1
Pumps	0
Orifices	0
Weirs	0
Outlets	1
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	wallawalla25-3hr	Cumulative	inches					User Defined

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	SUBBASIN 1	0.49	484.00	98.00	1.95	1.73	0.85	2.11	0 00:06:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	MH 1	Junction	0.00	7.00	0.00	0.00	0.00	2.10	5.96	0.00	1.04	0 00:00	0.00	0.00
2	Ou1	Outfall	0.00					0.72	0.00					
3	Trench 1	Storage Node	0.00	5.00	0.00		700.00	2.08	4.65				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-09	Pipe	MH 1	Trench 1	80.00	5.00	4.70	0.3700	12.000	0.0150	2.08	1.89	1.10	3.15	0.78	0.79	0.00	> CAPACITY
2	Infiltration	Outlet	Trench 1	Ou1		0.00	0.00				0.72							

Subbasin Hydrology

Subbasin : SUBBASIN 1

Input Data

Area (ac) 0.49
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID .... *

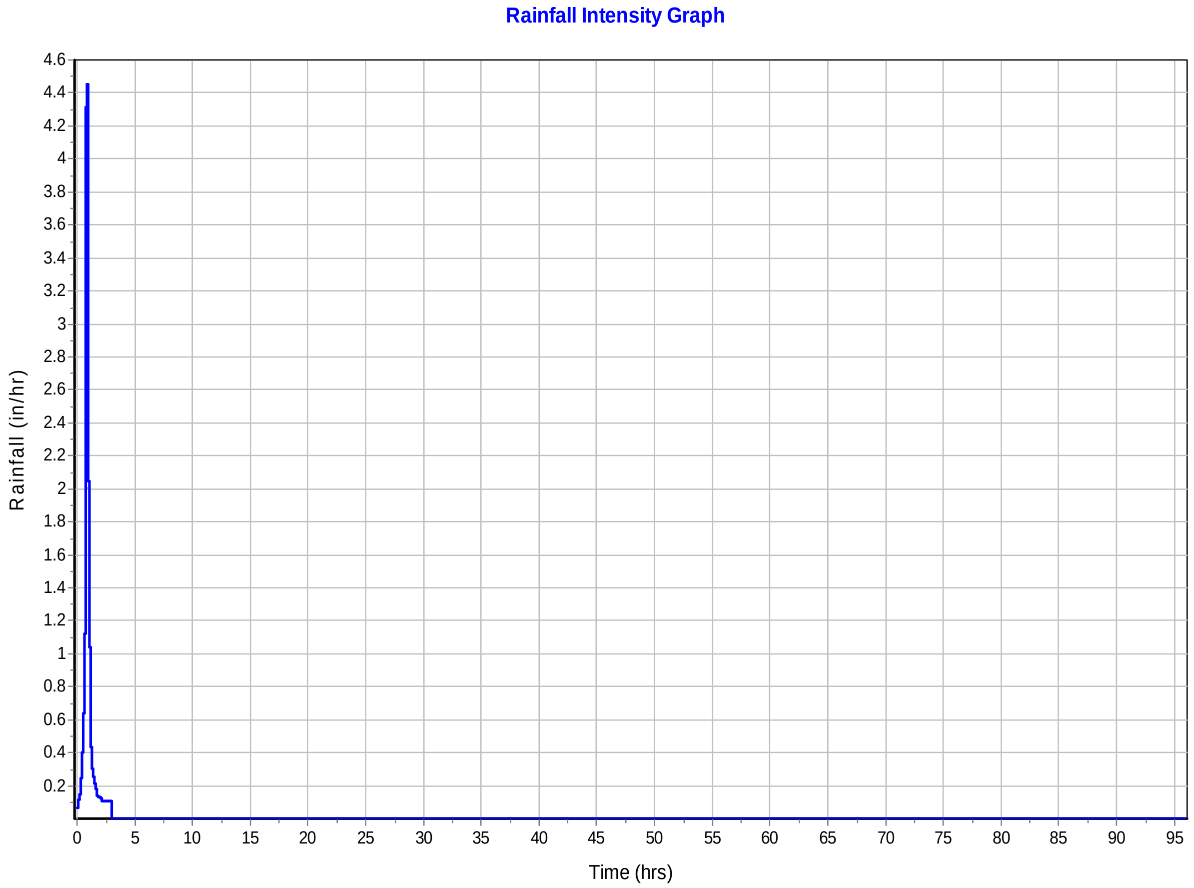
Composite Curve Number

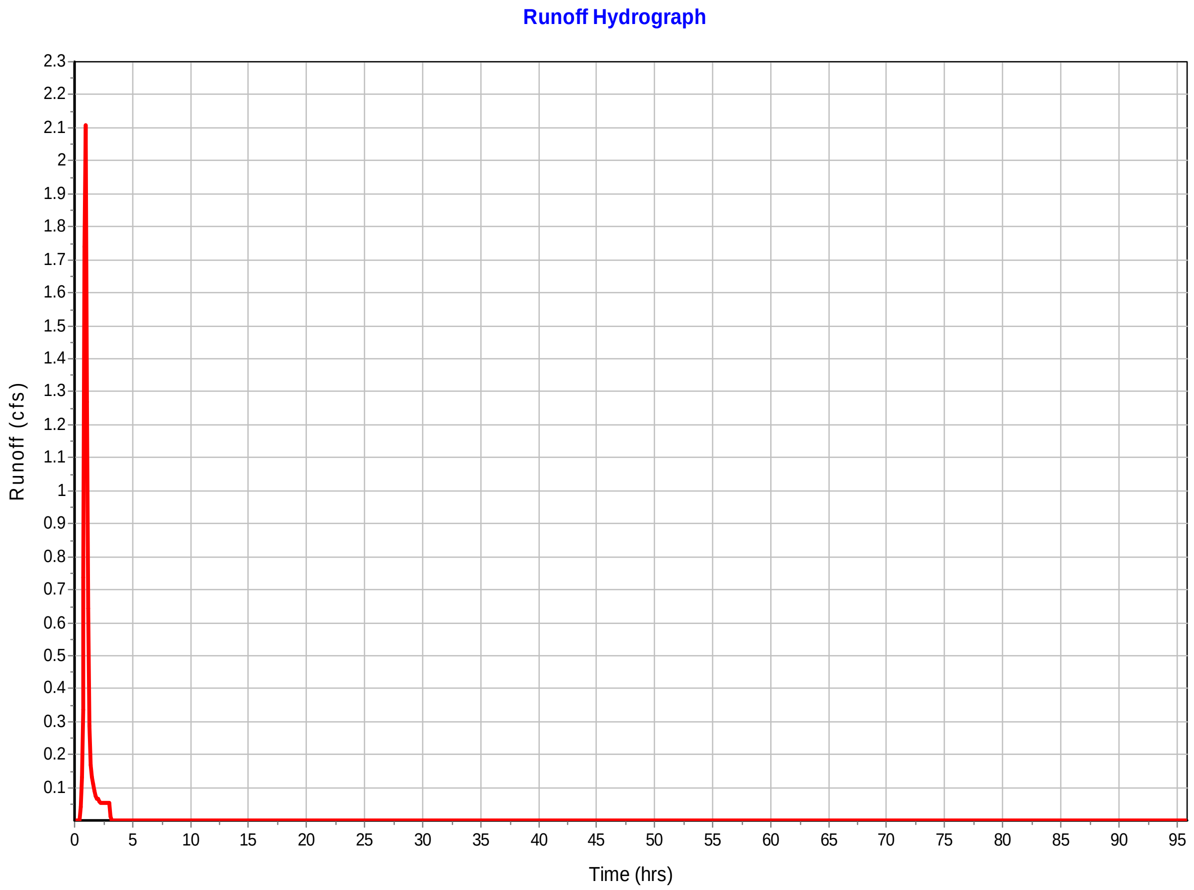
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	0.35	-	98
Composite Area & Weighted CN	0.35		98

Subbasin Runoff Results

Total Rainfall (in) 1.95
Total Runoff (in) 1.73
Peak Runoff (cfs) 2.11
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:06:00

Subbasin : SUBBASIN 1





Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	MH 1	0.00	7.00	7.00	0.00	0.00	0.00	-7.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	MH 1	2.10	2.10	5.96	5.96	0.00	1.04	4.97	4.97	0 01:06	0 00:00	0.00	0.00

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Link-09	80.00	5.00	5.00	4.70	4.70	0.30	0.3700	CIRCULAR	12.000	12.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-09	2.08	0 01:06	1.89	1.10	3.15	0.42	0.78	0.79	0.00		> CAPACITY

Storage Nodes

Storage Node : Trench 1

Input Data

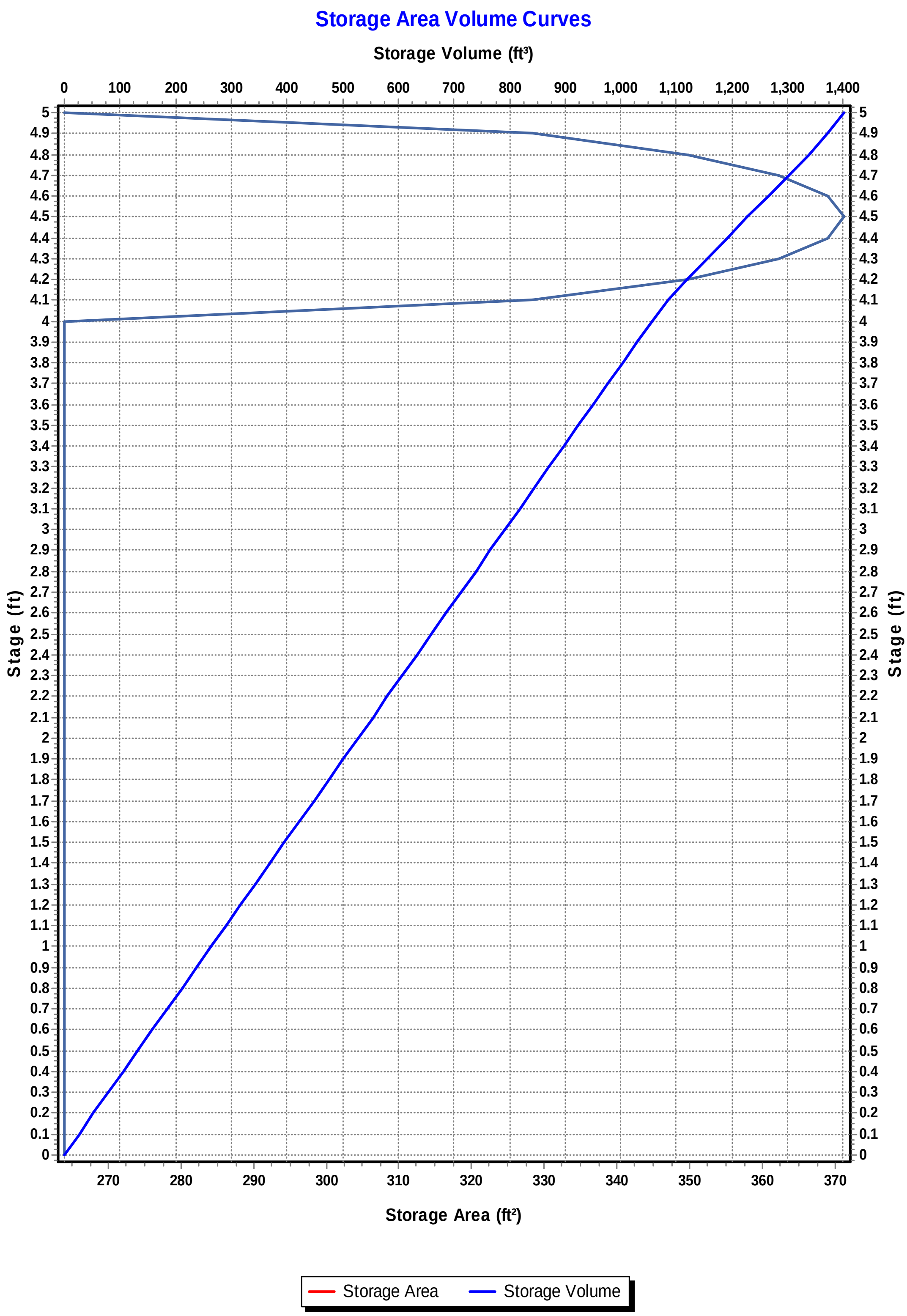
Invert Elevation (ft) 0
Max (Rim) Elevation (ft) 5
Max (Rim) Offset (ft) 5
Initial Water Elevation (ft) 0
Initial Water Depth (ft) 0
Ponded Area (ft²) 700
Evaporation Loss 0

Storage Area Volume Curves

Storage Curve : 05x05x160-1-12

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	264	0
0.1	264	26.4
0.2	264	52.8
0.3	264	79.2
0.4	264	105.6
0.5	264	132
0.6	264	158.4
0.7	264	184.8
0.8	264	211.2
0.9	264	237.6
1	264	264
1.1	264	290.4
1.2	264	316.8
1.3	264	343.2
1.4	264	369.6
1.5	264	396
1.6	264	422.4
1.7	264	448.8
1.8	264	475.2
1.9	264	501.6
2	264	528
2.1	264	554.4
2.2	264	580.8
2.3	264	607.2
2.4	264	633.6
2.5	264	660
2.6	264	686.4
2.7	264	712.8
2.8	264	739.2
2.9	264	765.6
3	264	792
3.1	264	818.4
3.2	264	844.8
3.3	264	871.2
3.4	264	897.6
3.5	264	924
3.6	264	950.4
3.7	264	976.8
3.8	264	1003.2
3.9	264	1029.6
4	264	1056
4.1	328.32	1085.62
4.2	349.76	1119.52
4.3	362.2504	1155.12

4.4	369.0341	1191.68
4.5	371.2	1228.69
4.6	369.0341	1265.7
4.7	362.2504	1302.26
4.8	349.76	1337.86
4.9	328.32	1371.76
5	264	1401.38


Storage Area Volume Curves
Storage Volume (ft³)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
Stage (ft)
Storage Area (ft²)
270
280
290
300
310
320
330
340
350
360
370
Storage Area
Storage Volume

Storage Node : Trench 1 (continued)

Output Summary Results

Peak Inflow (cfs) 2.08
Peak Lateral Inflow (cfs) 0
Peak Outflow (cfs) 0.72
Peak Exfiltration Flow Rate (cfm) 0
Max HGL Elevation Attained (ft) 4.65
Max HGL Depth Attained (ft) 4.65
Average HGL Elevation Attained (ft) 0.03
Average HGL Depth Attained (ft) 0.03
Time of Max HGL Occurrence (days hh:mm) 0 01:17
Total Exfiltration Volume (1000-ft³) 0
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

24 HR SSA Results

Project Description

File Name	30-20-075-033_SSA.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:06:00	days hh:mm:ss
Routing Time Step	2	seconds

Number of Elements

	Qty
Rain Gages	11
Subbasins	1
Nodes	3
Junctions	1
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	2
Channels	0
Pipes	1
Pumps	0
Orifices	0
Weirs	0
Outlets	1
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	wallla walla 100 IA	Cumulative	inches					User Defined

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	SUBBASIN 1	0.49	484.00	98.00	2.40	2.17	1.06	0.27	0 00:06:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	MH 1	Junction	0.00	7.00	0.00	0.00	0.00	0.27	5.28	0.00	1.72	0 00:00	0.00	0.00
2	Ou1	Outfall	0.00					0.40	0.00					
3	Trench 1	Storage Node	0.00	5.00	0.00		700.00	0.27	0.00				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-09	Pipe	MH 1	Trench 1	80.00	5.00	4.70	0.3700	12.000	0.0150	0.27	1.89	0.14	1.82	0.25	0.25	0.00	Calculated
2	Infiltration	Outlet	Trench 1	Ou1		0.00	0.00				0.40							

Subbasin Hydrology

Subbasin : SUBBASIN 1

Input Data

Area (ac) 0.49
Peak Rate Factor 484
Weighted Curve Number 98
Rain Gage ID .... *

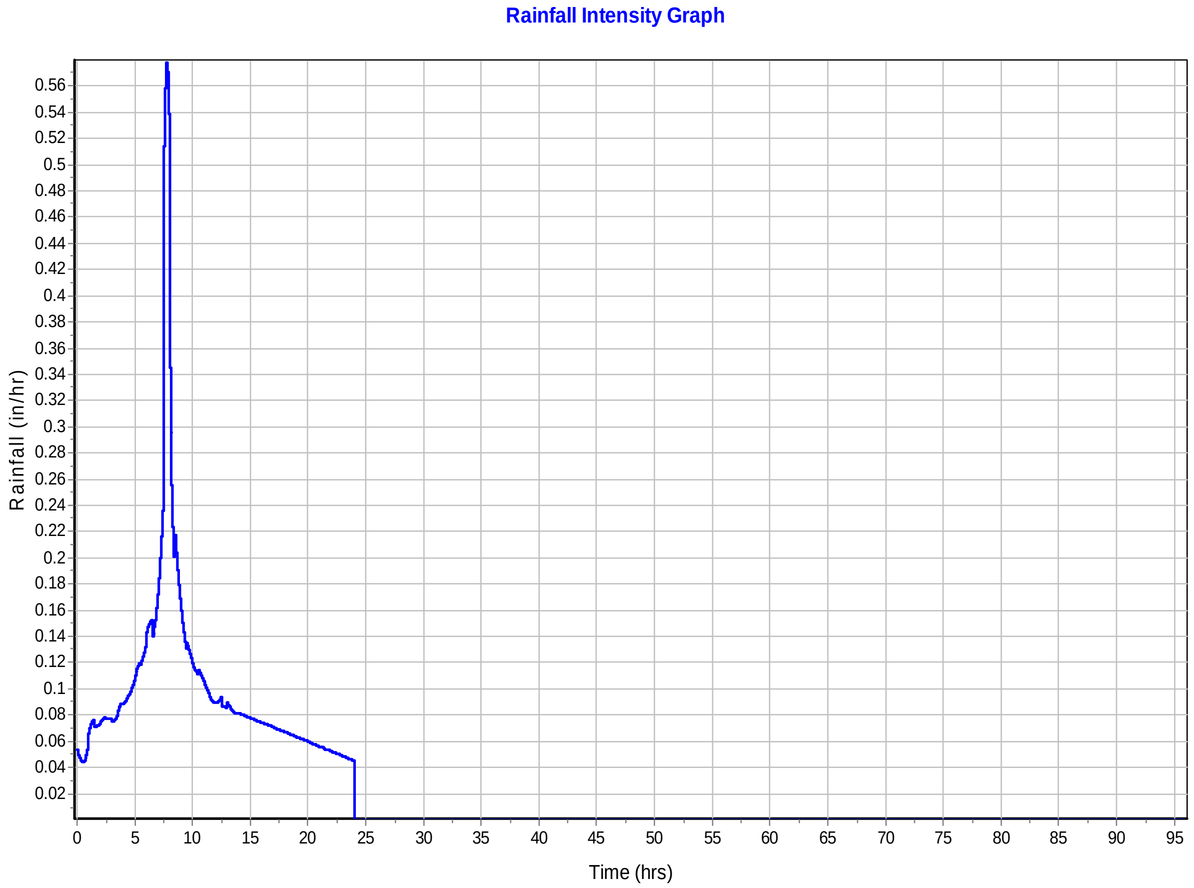
Composite Curve Number

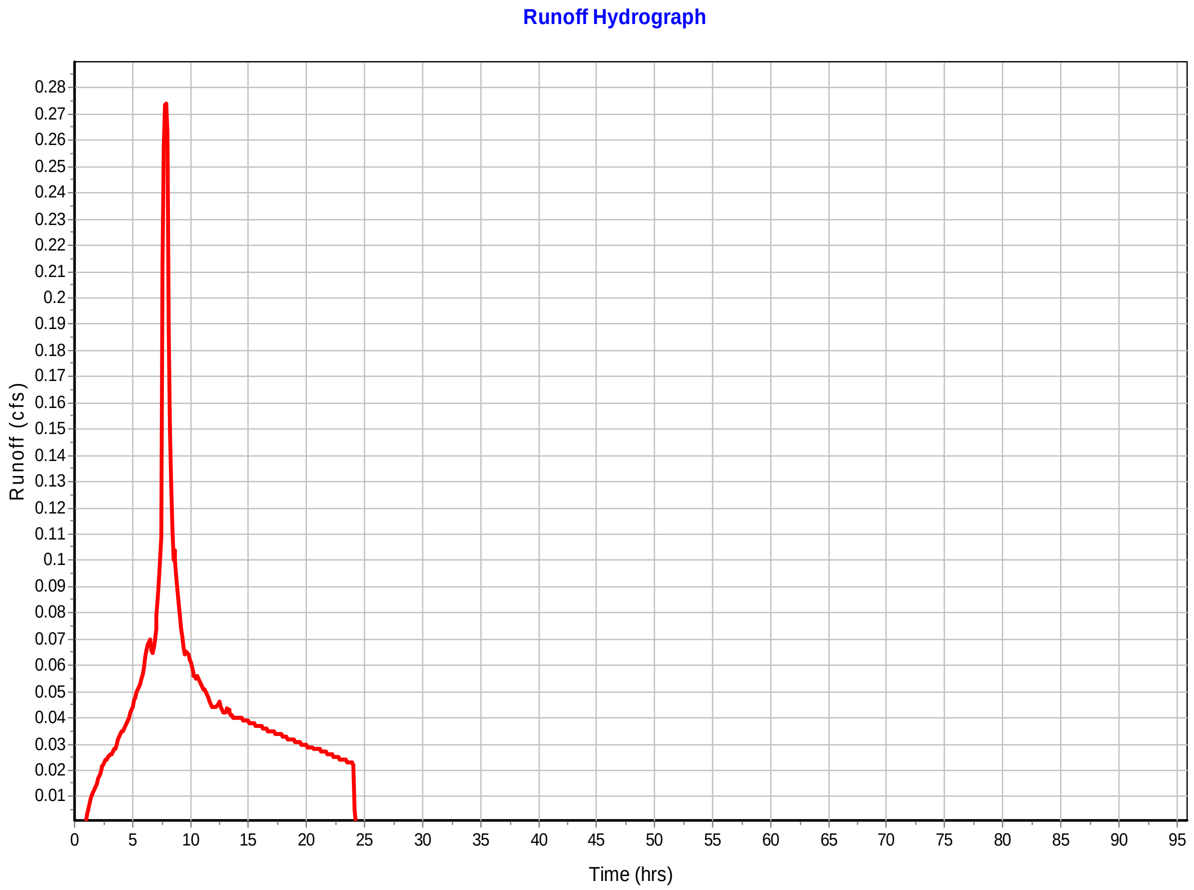
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	0.35	-	98
Composite Area & Weighted CN	0.35		98

Subbasin Runoff Results

Total Rainfall (in) 2.4
Total Runoff (in) 2.17
Peak Runoff (cfs) 0.27
Weighted Curve Number 98
Time of Concentration (days hh:mm:ss) 0 00:06:00

Subbasin : SUBBASIN 1





Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	MH 1	0.00	7.00	7.00	0.00	0.00	0.00	-7.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	MH 1	0.27	0.27	5.28	5.28	0.00	1.72	4.92	4.92	0 08:00	0 00:00	0.00	0.00

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Link-09	80.00	5.00	5.00	4.70	4.70	0.30	0.3700	CIRCULAR	12.000	12.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-09	0.27	0 08:00	1.89	0.14	1.82	0.73	0.25	0.25	0.00		Calculated

Storage Nodes

Storage Node : Trench 1

Input Data

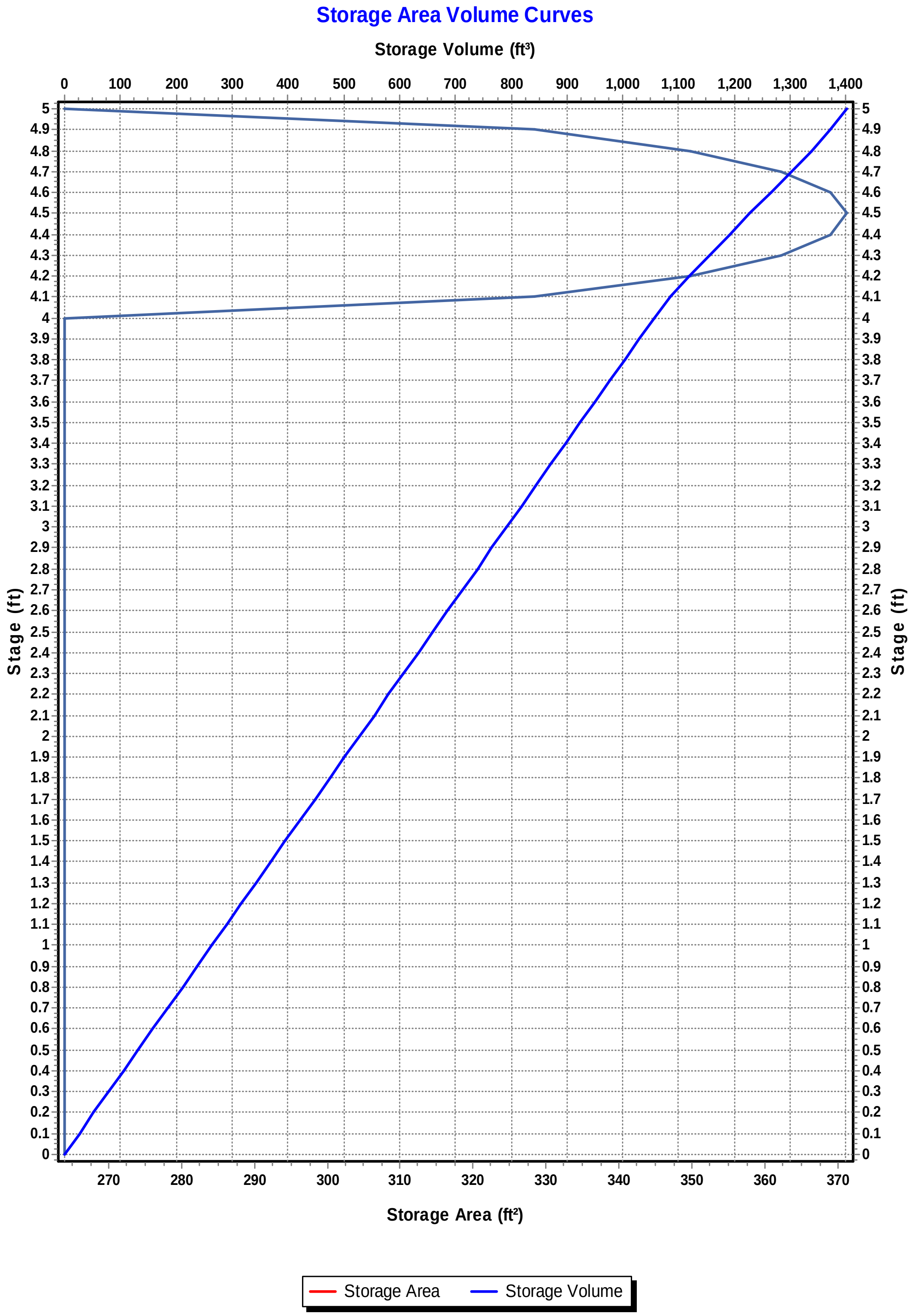
Invert Elevation (ft) 0
Max (Rim) Elevation (ft) 5
Max (Rim) Offset (ft) 5
Initial Water Elevation (ft) 0
Initial Water Depth (ft) 0
Ponded Area (ft²) 700
Evaporation Loss 0

Storage Area Volume Curves

Storage Curve : 05x05x160-1-12

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	264	0
0.1	264	26.4
0.2	264	52.8
0.3	264	79.2
0.4	264	105.6
0.5	264	132
0.6	264	158.4
0.7	264	184.8
0.8	264	211.2
0.9	264	237.6
1	264	264
1.1	264	290.4
1.2	264	316.8
1.3	264	343.2
1.4	264	369.6
1.5	264	396
1.6	264	422.4
1.7	264	448.8
1.8	264	475.2
1.9	264	501.6
2	264	528
2.1	264	554.4
2.2	264	580.8
2.3	264	607.2
2.4	264	633.6
2.5	264	660
2.6	264	686.4
2.7	264	712.8
2.8	264	739.2
2.9	264	765.6
3	264	792
3.1	264	818.4
3.2	264	844.8
3.3	264	871.2
3.4	264	897.6
3.5	264	924
3.6	264	950.4
3.7	264	976.8
3.8	264	1003.2
3.9	264	1029.6
4	264	1056
4.1	328.32	1085.62
4.2	349.76	1119.52
4.3	362.2504	1155.12

4.4	369.0341	1191.68
4.5	371.2	1228.69
4.6	369.0341	1265.7
4.7	362.2504	1302.26
4.8	349.76	1337.86
4.9	328.32	1371.76
5	264	1401.38


Storage Area Volume Curves
Storage Volume (ft³)
Stage (ft)
Storage Area (ft²)
Storage Area
Storage Volume

Storage Node : Trench 1 (continued)

Output Summary Results

Peak Inflow (cfs)	0.27
Peak Lateral Inflow (cfs)	0
Peak Outflow (cfs)	0.4
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	0
Max HGL Depth Attained (ft)	0
Average HGL Elevation Attained (ft)	0
Average HGL Depth Attained (ft)	0
Time of Max HGL Occurrence (days hh:mm)	0 08:00
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0