All Saints Drainage

SITE ADDRESS: 607 3rd St SW, Puyallup, WA 98371
SECTION 28, TOWNSHIP 20N, RANGE 04E, QUARTER SE

Drainage Report

Associated Permit Number

Prepared For: **Sarah Commet – Wedermann Architects**
204 6th Ave SW
Puyallup, WA 98371
253-973-6611
sarah@weddermann.com

Date Prepared: **August, 2021**

Prepared By: **Jamie Suh, EIT**
Civil Design Engineer

Reviewed By: **Jim Cook, P.E.**
Civil Engineering Director
Beyler Consulting LLC
5920 100th St SW, #25
Lakewood, WA 98499
253-984-2900

CONTACT
(253) 984-2900
info@beylerconsulting.com
beylerconsulting.com

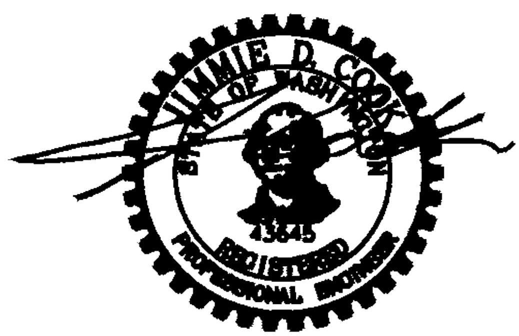
CORPORATE OFFICE
5920 100th St. SW, #25
Lakewood, WA 98499

Project Engineers Certificate

I hereby certify that this **Drainage Report** for the **All Saints Drainage** project has been prepared by me or under my direct supervision and meets minimum standards of care and expertise which is usual and customary in this community for professional engineers. I understand that the **City of Puyallup** does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me.

8/23/2021

Date



Seal

TABLE OF CONTENTS

APPENDICES

APPENDIX A – Maps, Tables, and Figures

A1 – Site Vicinity Map

A2 – Development Flowchart

A3 – MR #5 Flowchart

A4 – Soil Map

A5 – FEMA Flood Map

APPENDIX B - Calculations

B1 – Pre-Developed Basin Map

B2 – Developed Basin Map

B3 – Conveyance Analysis

APPENDIX C – Additional Reports

C1 – CSWPPP

C2 – Geotechnical Report

I. DRAINAGE CONTROL PLAN

Section 1 – Project Description

This project proposes the construction of a Food Warehouse building, concrete driveway/parking spaces, and associated stormwater infrastructure and landscaping. The project is located on the SE Quarter, Section 28, Township 20N, Range 04E, at 607 3rd St SW, Puyallup on parcel #5745300550. The total area of the subject property is approximately 13,054 square feet (0.30 ac). The parcel is zoned High Density Multiple-Family Residential, (RM-20). Refer to Appendix A1 – Vicinity Map for more information.

According to Section 21.10.040 of the Puyallup Municipal Code, the City of Puyallup adopts the Washington State Department of Ecology Stormwater Management Manual for Western Washington. This report demonstrates how the proposed project satisfies the requirements of the 2019 Stormwater Management Manual for Western Washington (2019 Manual).

The project proposes to add or replace approximately 5,730 square feet (0.13 ac) of combined impervious surface from the roof of the Food Warehouse building and proposed concrete driveway/parking spaces. Per Figure I-3.1 of the Department of Ecology Stormwater Management Manual for Western Washington (2019 Manual), the project must meet Minimum Requirements #1-9 because it adds more than 5,000 square feet of new plus replaced hard surface area. Refer to Appendix A2 – Development Flowchart for more information.

Table 1 – Proposed Impervious Areas

Driveway	Roof	Concrete	Gravel	Total
2,230 sf	3,500 sf	0 sf	0 sf	5,730 sf

Section 2 - Discussion of Minimum Requirements (MRs)

MR #1 – Preparation of a Stormwater Site Plan

Minimum requirement #1 is satisfied with the completion of this drainage report and associated plans.

MR #2 – Construction Stormwater Pollution Prevention Plan

This minimum requirement is satisfied with the inclusion of a Construction Stormwater Pollution Prevention Plan (CSWPPP) that will be provided as Appendix C1 – Construction Stormwater Pollution Prevention Plan.

MR #3 – Source Control of Pollution

The project site is not known to have pollutants affecting the following: pH, total suspended solids, oils and greases, oxygen-demanding substances, metals, nutrients, toxic organic compounds and other chemicals and substances; therefore, stormwater will not come into contact with these pollutants. See Appendix C1 – Construction Stormwater Pollution Prevention Plan for more information on the source control of potential pollutants from construction activities.

MR #4 – Preservation of Natural Drainage Systems and Outfalls

The project proposes to discharge excess site-generated stormwater runoff offsite to the existing discharge location at the western and eastern sides of the property to the maximum extent practicable in order to maintain stormwater benefits that the natural drainage systems provide. See Section 6 – Site Hydrology and Floodplain Analysis, Appendix B1 – Predeveloped Basin Map, and Appendix B2 – Developed Basin Map for more information on stormwater discharge locations for the project site.

MR #5: On-Site Stormwater Management

Figure I-3.3 from the 2019 Manual was followed to determine compliance options for a project triggering Minimum Requirements #1-9. The project qualifies as flow control exempt, therefore, the project will use onsite stormwater management BMPs from List #3. See Appendix A3 – MR#5 Flowchart and below for more information on how the BMPs will be applied, respectively.

Lawn and landscaped Areas

Onsite disturbed areas and offsite landscape areas shall be amended with post construction soils per BMP T5.13.

Roofs

Downspout Full Infiltration (BMP T5.10A) – there is lack of usable space for full infiltration; therefore, this BMP is infeasible.

Downspout Dispersion Systems (BMP T5.10B) – Minimum setbacks requirements cannot be met on the project site; therefore, this BMP is infeasible.

Perforated Stub-out Connections (BMP T5.10C) – will be utilized to satisfy onsite stormwater management for roof runoff.

Other Hard Surfaces

Concentrated or Sheet Flow Dispersion (BMP T5.11,12) – minimum flow path lengths and setbacks cannot be achieved on the project site; therefore, this BMP is infeasible

All suggested BMPs are infeasible for other hard surface runoff; therefore, stormwater runoff generated by these surfaces will be sheet flowing directly to the right-of-way, 3rd St SW located west of the property and the Alley located east of the property, by following the grades of the surface.

MR #6: Runoff Treatment

Water quality treatment is not required for this project. According to I-3.4.6 of the Manual, projects that produce 5,000 square feet or more of pollution-generating hard surface (PGHS) in a threshold discharge area require runoff treatment. The project proposes 2,230 square feet of PGHS, therefore, treatment facilities are not required.

MR #7: Flow Control

The proposed project is not required to meet the Standard Flow Control performance requirements. According to I-3.4.7 of the Manual, projects that produce 10,000 square feet or more of effective impervious surface in a threshold discharge area require flow control. The project proposes 5,730 square feet of effective impervious surfaces, therefore, flow control facilities are not required.

MR #8: Wetlands Protection

Pierce County GIS was consulted to determine potential critical areas on the project site. No known wetlands or wetland buffers exist on the project site; therefore, this project is exempt from wetlands protection requirements.

MR #9: Operations and Maintenance
Operation and maintenance manual for stormwater facilities will be provided upon request.

Section 3 – Existing Conditions

The existing site is approximately 13,054 square feet (0.30 ac), is in developed condition and zoned High Density Multiple-Family Residential, (RM-20). It is developed with two existing buildings, a detached garage, a covered carport, and concrete driveway and walkways. These will not remain. There are developed residential parcels adjacent to the north of the project site and an undeveloped landscaped parcel adjacent to the south. The western boundary is bounded by 3rd St SW and the eastern by a gravel alley.

Topography

The entire site is generally flat and slopes from east to west at approximately 0.5%-5%.

Difficult Site Conditions

There are no known difficult site conditions onsite.

Critical Areas and Easements

Pierce County GIS was consulted to determine potential critical areas onsite or downstream of the property. There are no known critical areas existing on the project site.

Section 4 – Infiltration Rates/Soils

An infiltration test performed by JMJ Team on February 24, 2021 indicates that the onsite soils have a design infiltration rate of 0.31 inches per hour. Groundwater was observed during the PIT to be at a depth of approximately 30-inches below finish grade. See Appendix C2 – Geotechnical Report for more information.

The Natural Resources Conservation Service (NRCS) custom soil resource report for the parcel indicates that there is one primary soil type underlaying the project, Puyallup find sandy loam (31A). This soil is hydrologic soil group A soils. See Appendix A4 – Soil Map for more information.

Section 5 – Wells and Septic Systems

There are no known wells or septic systems on site.

Section 6 – Fuel Tanks

There are no known fuel tanks located on the property.

Section 7 – Site Hydrology

The existing site is approximately 13,054 square feet (0.30 ac), is in developed condition and zoned High Density Multiple-Family Residential, (RM-20). It is developed with two existing buildings, a detached garage, a covered carport, and concrete driveway and walkways. Stormwater currently leaves the site following the natural drainage pattern, from east toward the west where flows are discharged in the right-of-way, 3rd St SW. The project proposes to discharge flows into this natural drainage pattern to the maximum extent feasible.

The project proposes to discharge flows from the proposed building through a perforated stub-out connection located north of the building and discharge into the public storm system. Flows from the driveway/parking areas will sheet flow onto 3rd St SW and the gravel alley by following the surface grades.

There are no streams or wetlands located on the project site. There are also no apparent seeps, springs, closed depressions, or signs of erosion.

Section 8 – Floodplain Analysis

The FEMA flood map panel # 53053C0341E shows that the project site is located within Zone X, which is designated as areas outside the 0.2% Annual Chance Flood Hazard. See Appendix A5 – FEMA Flood Map for more details.

Section 9 – Aesthetic Considerations for Facilities

Any native vegetation converted to stormwater facilities and lawn condition will be aesthetically pleasing and provide attractive landscape to the project site.

Section 10 – Facility Sizing and Downstream Analysis

This section provides an overview of how stormwater travels downstream of the project site, the stormwater BMPs used for the project, a description of the permanent stormwater facilities used, and applicable criteria that were used to design the facilities and conveyance. Where applicable, this section also discusses stormwater runoff treatment, flow control, and conveyance design.

a. Downstream Analysis

The project proposes to discharge flows into the natural drainage pattern to the maximum extent feasible. Roof areas will discharge through a perforated stub-out connection located north of the proposed building and discharge into the public storm system. Flows from the proposed driveway/parking areas located west of the proposed building will sheet flow into the right-of-way, 3rd St SW, and is assumed, from the GIS contours, to travel south along the curb and gutter where it will be captured by a storm manhole approximately 195 feet away from the project parcel. Flows from the proposed driveway/parking areas located east of the proposed building will sheet flow into the gravel alley located along the eastern side of the project parcel. Flows will be conveyed through the public storm system to a ditch that discharges into Meeker Creek.

b. Permanent Stormwater Control Plan

Stormwater generated by roof impervious will be managed using perforated stub-out connections (BMP T5.10C), to the maximum extent feasible under BMP design constraints. Sizing details and other criteria for each element are shown in the next section.

Tables 2 and 3 show a breakdown of the pervious and impervious areas found on the existing and developed site.

Table 2 – Existing Areas

Surface	Area (sf)	Area (ac)
Roof	2,630	0.06
Driveway	280	0.006
Concrete	775	0.018
Lawn	9,369	0.22
Total Impervious	**3,685**	**0.084**
Total PGHS	**280**	**0.006**
Total Pervious	**9,369**	**0.22**

Table 3 – Proposed Areas

Surface	Area (sf)	Area (ac)
Roof	3,500	0.08
Driveway	2,230	0.05
Lawn	2,250	0.05
Forest	5,074	0.12
Total Impervious	**5,730**	**0.13**
Total PGHS	**2,230**	**0.05**
Total Pervious	**7,324**	**0.17**

c. Stormwater Facility Criteria and Sizing

<u>Perforated Stub-out Connections (Vol. V, Sec. 4.1)</u>
Perforated stub-out connections will meet the intent of applicable criteria, per the 2019 Manual:

<u>Limitations</u>

- Perforated stub-outs are not appropriate when the seasonal water table is less than one foot below the trench bottom.

- To facilitate maintenance, do not locate the perforated pipe portion of the system under impervious or heavily compacted (e.g., driveways and parking areas) surfaces.

- Have a licensed geologist, hydrogeologist, or engineering geologist evaluate potential runoff discharges towards landslide hazard areas. Do not place the perforated portion of the pipe on or above slopes greater than 20% or above erosion hazard areas without evaluation by a licensed engineer in the state of Washington with geotechnical expertise or qualified geologist and jurisdiction approval.

- For sites with septic systems, the perforated portion of the pipe must be downgradient of the drainfield primary and reserve areas. This requirement can be waived if site topography will clearly prohibit flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary.

<u>Design Criteria</u>
Perforated stub out connections consist of at least 10 feet of perforated pipe per 5,000 square feet of roof area laid in a level, 2 foot wide trench backfilled with washed drain rock. Extend the drain rock to a depth of at least 8 inches below the bottom of the pipe and cover the pipe. Lay the pipe level and cover the rock trench with filter fabric and 6 inches of fill.

Roof Perforated Stub-Out Connection

The roof of the building is approximately 3,500 square feet, requiring 1 perforated stub-out connection at 5,000 square feet of contributing area. The perforated stub-out connection will be located north of the proposed building and connect into the existing storm drain system along 3rd St SW.

d. Conveyance Systems

Stormwater runoff generated by roof impervious area will be conveyed by 4" PVC pipe to the perforated stub-out connection. Refer to Appendix B3 – Conveyance Analysis for more information.

Section 11 – Utilities

All utilities will be installed in a manner as not to conflict with any existing utilities. Dry utilities will be coordinated by the owner and the purveyor. Minimum separations will be maintained for sewer, water, and storm lines during installation.

Section 12 – Covenants, Dedications, Easements

All stormwater facilities located on private property shall be owned, operated and maintained by the property owners and their successors. A declaration of covenant will be provided upon request.

Section 13 – Property Owners' Association Articles of Incorporation

No property owners' association is required for this project.

Section 14 – Other Permits or Conditions Placed on the Project

The building permit will be coordinated and obtained by the owner and/or contractor.

II. CONCLUSION

Based on the calculations and analysis provided in this report and the information made available to Beyler Consulting at this time, the proposed drainage project satisfies the requirements of the City of Puyallup and 2019 Manual.

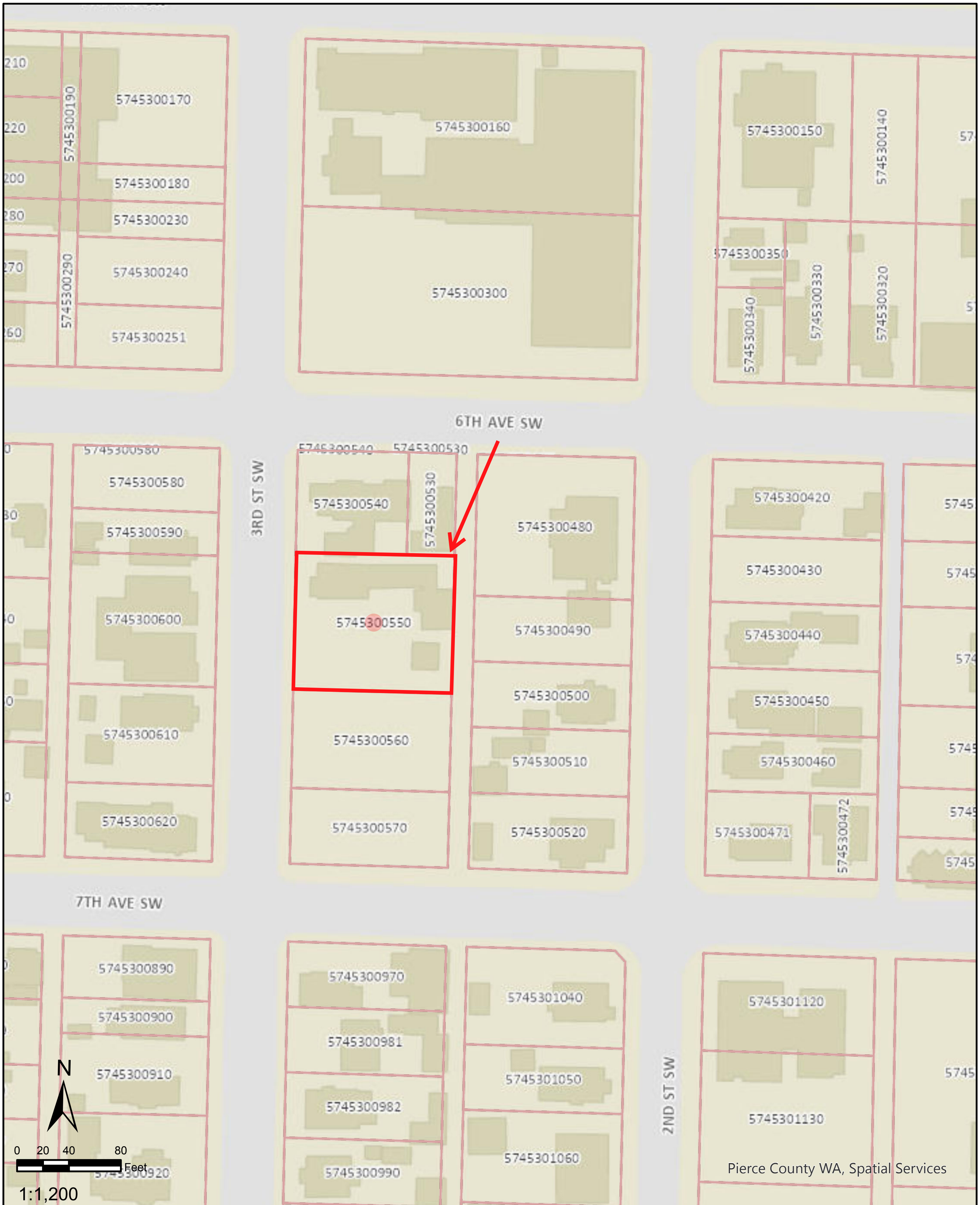
Jamie Suh, EIT
Civil Design Engineer

/file
/js

APPENDIX A – Maps, Tables, and Figures

A1 – Site Vicinity Map

Vicinity Map

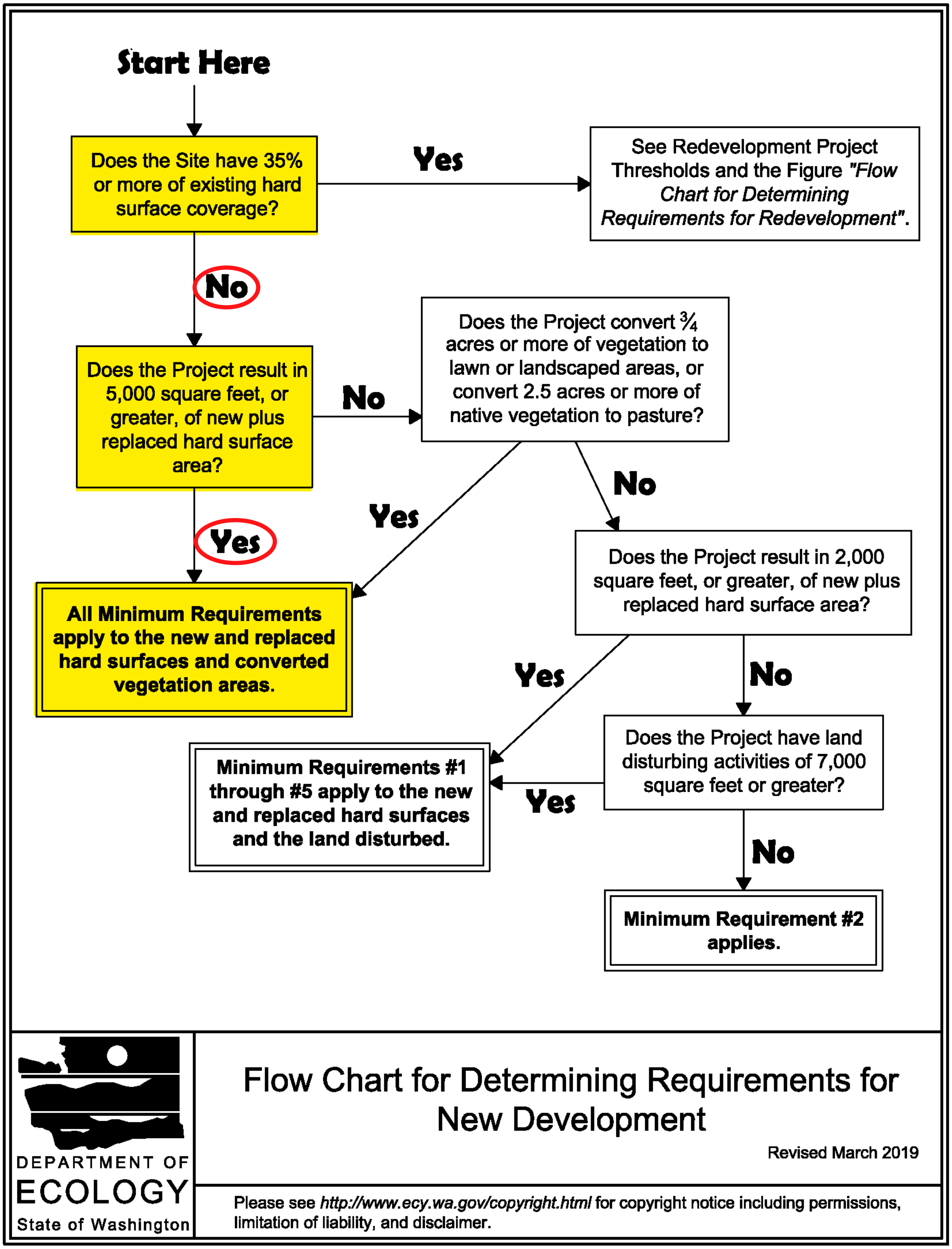


Disclaimer: The map features are approximate and have not been surveyed. Additional features not yet mapped may be present. Pierce County assumes no liability for variations ascertained by formal survey.

Date: 8/23/2021 09:57 AM

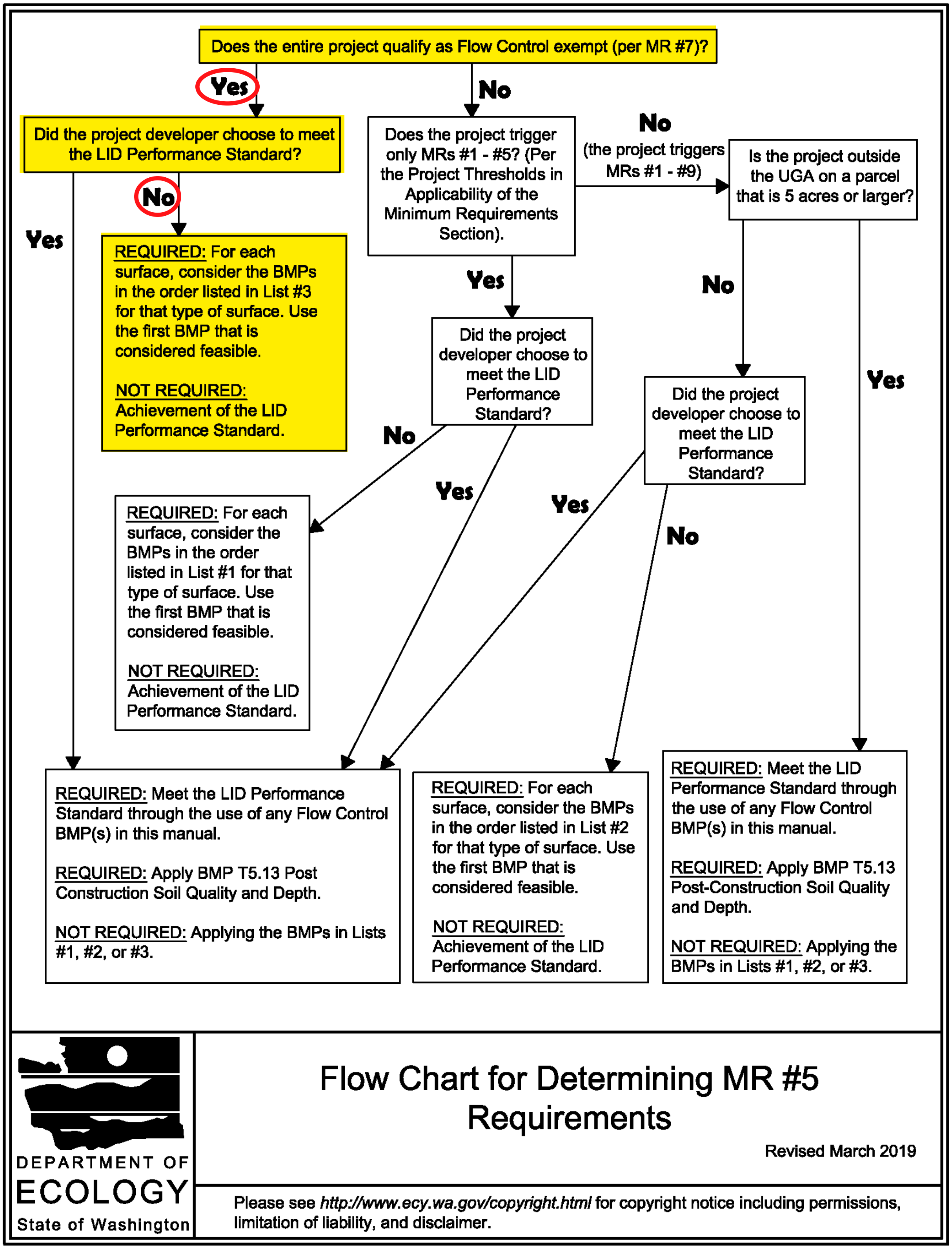
A2 – Development Flowchart

Figure I-3.1: Flow Chart for Determining Requirements for New Development



A3 – MR #5 Flowchart

Figure I-3.3: Flow Chart for Determining MR #5 Requirements



A4 – Soil Map

Map Scale: 1:270 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 4 8 16 24

Feet: 0 10 20 40 60

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Pierce County Area, Washington
Survey Area Data: Version 16, Jun 4, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 18, 2020—Aug 2, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

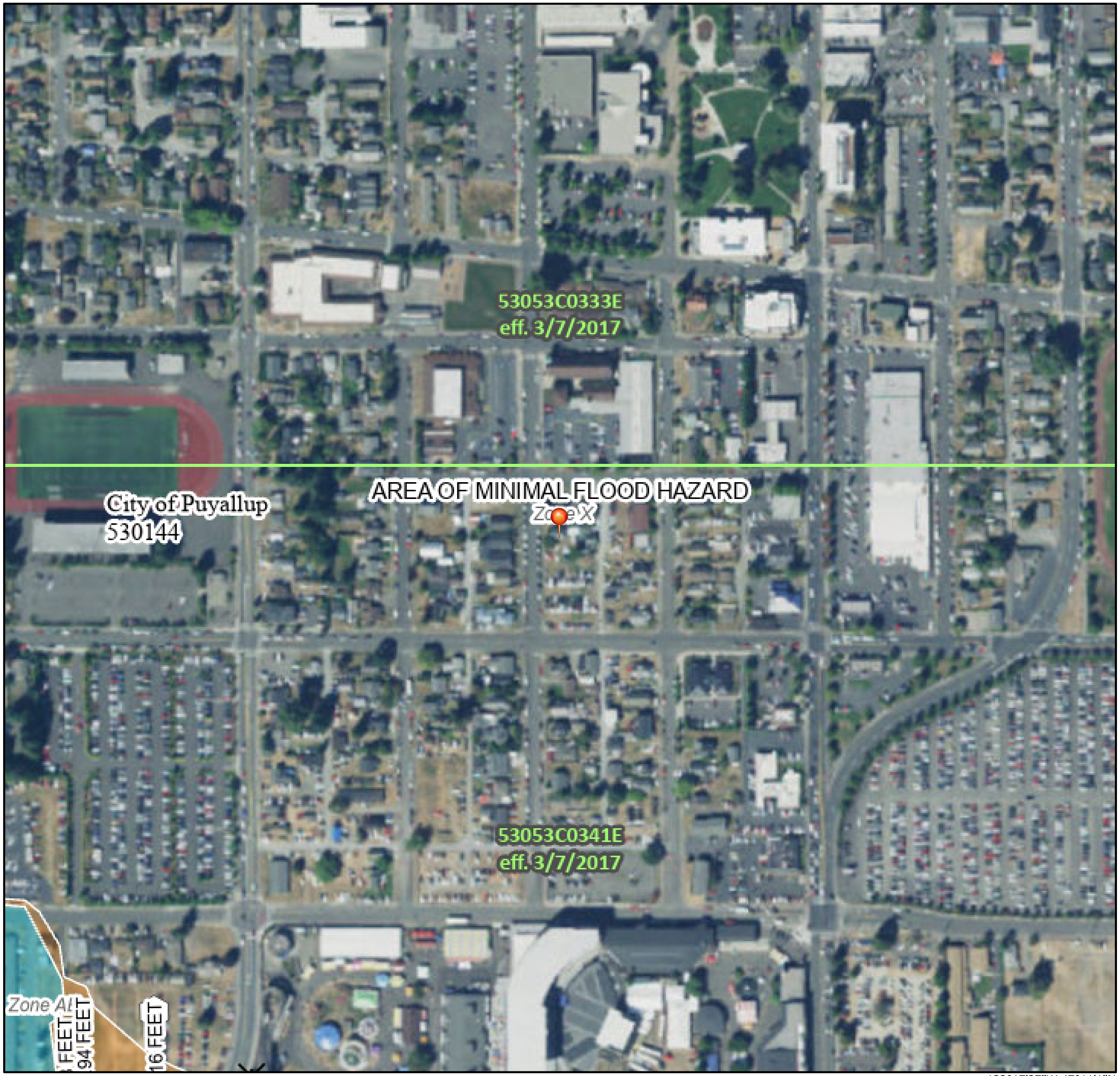
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
31A	Puyallup fine sandy loam	0.3	100.0%
Totals for Area of Interest		**0.3**	**100.0%**

A5 – FEMA Flood Map

National Flood Hazard Layer FIRMette

FEMA

122°18'5"W 47°11'25"N



122°17'27"W 47°11'1"N

Feet 0 250 500 1,000 1,500 2,000

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/23/2021 at 4:22 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

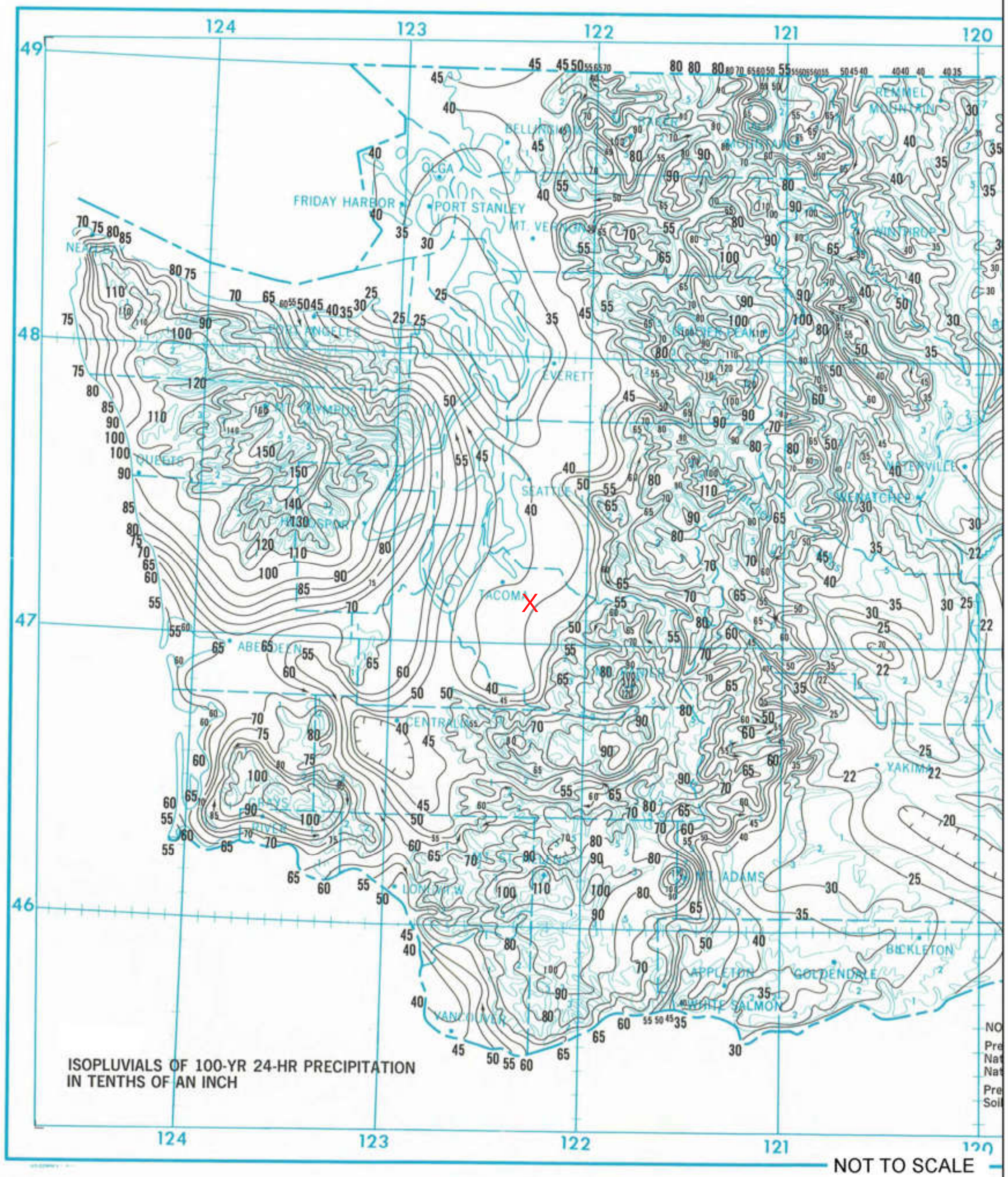
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX B - Calculations

B1 – Pre-Developed Basin Map

B2 – Developed Basin Map

Figure III-B.3: Western Washington Isopluvial 100-year, 24 hour



Western Washington Isopluvial
100-year, 24 hour

Revised June 2016

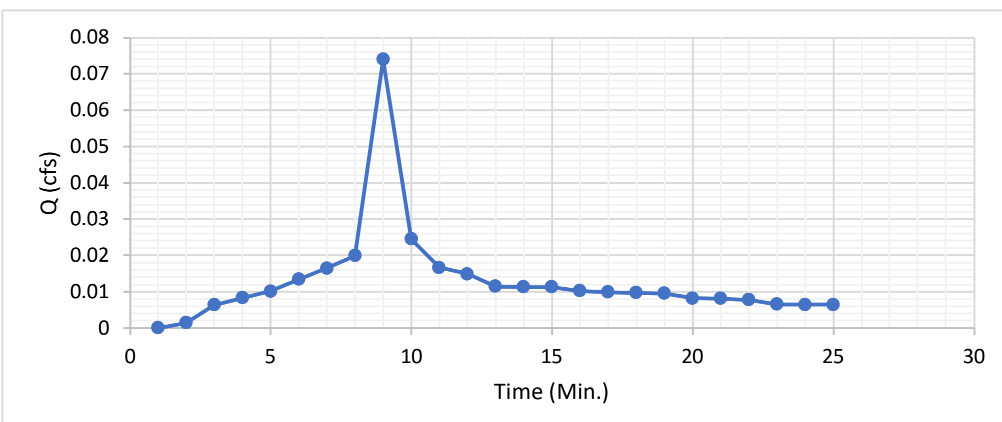
DEPARTMENT OF ECOLOGY
State of Washington

SBUH Q100
08/23/21

Total Area (acre)	0.080
Routing Constant	0.3226
Pt (in)	4
dt (min)	6
Tc (min)	6.3
Impervious Area (acre)	0.0803
CN, Imperv	98
S	0.20
0.2*S	0.041
Perv Area (Acre)	0.00
CN, perv	74
S, perv	3.51
0.2*S, perv	0.70

Max Q (cfs) = 0.0746

Time Increment #	Time (min)	Incremental Rainfall (fraction)	Incremental Rainfall (in)	P, Cum Runoff (in)	Incr Runoff, Perv. (in)	Inc runoff from Perv. area	Cum runoff from Imperv.	Inc runoff from Imperv. Area	Total Runoff	Inst Q (cfs)	Design Q (cfs)
1	0	0	0	0	0	0	0	0	0	0	0
11	60	0.002	0.008	0.08	0	0	0.006311	0.002178	0.0022	0.00176	0.001
21	120	0.003	0.012	0.2	0	0	0.069755	0.008083	0.0081	0.00655	0.006
31	180	0.003	0.012	0.328	0	0	0.167882	0.009877	0.0099	0.008	0.008
41	240	0.004	0.016	0.464	0	0	0.2855	0.014262	0.0143	0.01155	0.010
51	300	0.004	0.016	0.624	0	0	0.432006	0.014903	0.0149	0.01207	0.013
61	360	0.006	0.024	0.824	0.0040478	0.001426	0.621289	0.022949	0.0229	0.01859	0.016
71	420	0.007	0.028	1.072	0.0351242	0.004906	0.860819	0.027218	0.0272	0.02205	0.020
81	480	0.022	0.088	1.7	0.2204929	0.033548	1.477455	0.086892	0.0869	0.0704	0.074
91	540	0.007	0.028	2.08	0.3878596	0.013466	1.853668	0.027765	0.0278	0.0225	0.024
101	600	0.005	0.02	2.308	0.5034332	0.01054	2.079955	0.019862	0.0199	0.01609	0.017
111	660	0.004	0.016	2.496	0.6059977	0.008965	2.266764	0.015905	0.0159	0.01289	0.015
121	720	0.004	0.016	2.656	0.6979152	0.009372	2.425875	0.015916	0.0159	0.01289	0.011
131	780	0.004	0.016	2.804	0.7863934	0.009717	2.573138	0.015924	0.0159	0.0129	0.011
141	840	0.003	0.012	2.944	0.8729068	0.007518	2.712506	0.011948	0.0119	0.00968	0.011
151	900	0.003	0.012	3.076	0.9568067	0.007717	2.84396	0.011952	0.012	0.00968	0.010
161	960	0.003	0.012	3.204	1.0401804	0.007897	2.971471	0.011956	0.012	0.00969	0.010
171	1020	0.003	0.012	3.324	1.1200345	0.008056	3.091045	0.011959	0.012	0.00969	0.010
181	1080	0.003	0.012	3.44	1.1986919	0.008201	3.206661	0.011961	0.012	0.00969	0.010
191	1140	0.003	0.012	3.548	1.2731495	0.008329	3.314324	0.011964	0.012	0.00969	0.008
201	1200	0.003	0.012	3.652	1.3459089	0.008447	3.418019	0.011966	0.012	0.00969	0.008
211	1260	0.003	0.012	3.748	1.4139508	0.00855	3.513751	0.011967	0.012	0.0097	0.008
221	1320	0.002	0.008	3.836	1.477032	0.005762	3.601516	0.007979	0.008	0.00646	0.007
231	1380	0.002	0.008	3.92	1.5378536	0.005817	3.685302	0.00798	0.008	0.00647	0.006
241	1440	0.002	0.008	4	1.5963106	0.005868	3.765106	0.007981	0.008	0.00647	0.006



Sizing Gravity Storm Lines

Based on Manning's Equation:

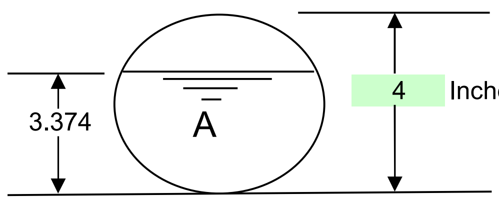
$$Q = \frac{1.49}{n} A R^{2/3} S_o^{1/2}$$

Project Information

Date: 08/23/21
Project Name: All Saints
Pipe Check: 607 3rd St SW
Flow Frequency: 100 yr = 0.07 cfs

Piping Data

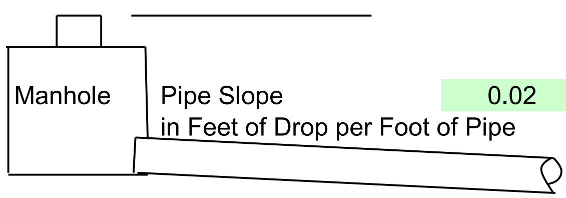
"n" Value:	0.015	DOE Min. 0.013
Design % Full:	90.0%	(Per Volume)
% Full:	84.4%	(Per Depth In Pipe)
Min. Velocity (Full):	2.00	DOE Requires a velocity of 2 fps - Flowing full



4 Inches

Calculated Area:	11.31	Sq. Inches
Wetted Perimeter:	9.313	Inches
R (Hydraulic Radius):	1.214	Inches

Site Data Piping



Pipe Slope 0.02
in Feet of Drop per Foot of Pipe

Slope input was: 2 Percent

Slope Check: **#N/A**
Min. Slope for a 4 Inch Pipe is: #N/A

Site Data Flows

Total Building Sq. Footage:		
% Loss to unusable space:		
1 Employee per:		
Flow per employee:		
Hours per unit flow:		
Total Employees:		
Total Average Daily Flow:		gpd
Peaking Factor - Pipe Design:		
Min. Design Flow:		
	0.1	CFS
		GPM

Actual Results

Flow Rate:	414	Cub Inc/Sec	=	0.2396028	cfs	=
Diameters of Pipe:	4	inches	=	0.3333333	Ft	
Depth of Flow in Pipe:	3.374	Inches	=	0.2811748	Ft	
Area of Pipe:	12.57	Sq.Inches	=	0.0872665	Sq. Ft	
Wetted Area of Pipe:	11.31	Sq.Inches	=	0.0785398	Sq.Ft	
Wetted Perimeter:	9.313	Inches	=	0.776072	Ft	
Perimeter:	12.57	Inches	=	1.0471976	Ft	
Velocity:	36.61	Inch./Sec	=	3.050717	fps	
Full Flow Flow rate:	404.2	Cub Inc/Sec	=	0.2338855	cfs	=
Full Flow Velocity:	32.16	Inch./Sec	=	2.6801299	fps	
Hydraulic Radius:	1.214	Inch	=	0.1012017	Ft	
Hydraulic Radius Full Flow:	1	Inch	=	0.0833333	Ft	

154,849 GPD
6,452.02 GPH= 107.5 gpm

CHECKS

Vel. Meets 2 FPS?
OK
Capacity At 90% Full?
OK
Capacity at 100% Full?
OK

6,298.07 GPH= 105 gpm
151,154 GPD

0.07 cfs < 0.24 cfs (4" Pipe Has Sufficient Capacity)

APPENDIX C – Additional Reports

C1 – CSWPPP

Will be provided as a separate document.

C2 – Geotechnical Report

Infiltration Testing Report

All Saints Church

Puyallup, WA

Prepared for

All Saints Church
607 3rd St SW
Puyallup, WA 98371

Prepared by

JMJ TEAM
905 Main St
Suite 200
Sumner, WA 98390
206.596.2020
Justin Jones, PE

March 31, 2021

JMJTEAM

PROJECT ENGINEER'S CERTIFICATION

I hereby certify that this Infiltration Testing Report for All Saints Church has been prepared by me or under my supervision and meets minimum standards of the Department of Ecology Stormwater Management Manual for Western Washington.

____

Justin Jones, PE

JUSTIN M. JONES
STATE OF WASHINGTON
41829
REGISTERED
PROFESSIONAL ENGINEER

03-31-21

TABLE OF CONTENTS

JMJTEAM

SUMMARY

This report details the results of infiltration testing for use in the stormwater system design of All Saints Church located within Puyallup, WA. One Pilot Infiltration Test (PIT) was conducted along 3rd St SW to determine the onsite stormwater infiltration rate. The test hole was excavated and backfilled by a licensed contractor and the PIT was completed in accordance with the Department of Ecology (ECY) Stormwater Management Manual for Western Washington (Stormwater Manual). A test hole was excavated and ground water was observed approximately 30-inches below grade, the whole was presoaked overnight. The test hole gained 2-feet of water, which was deemed unusable for the PIT. A second test hole was excavated 15-feet away from the failed test hole and only to a depth of 18-inches, this was done to maintain a separated from the observed ground water level to be able to conduct a PIT and receive accurate results.

The PIT process evaluates the infiltration within a 12 SF area by first measuring the rate of water required to maintain a constant water elevation of approximately 12-inches in the test pit. And second by measuring the drawdown rate of the water within the test pit. The drawdown is done using a data logger.

The field data is then analyzed, and a factor of safety applied to determine the stormwater design infiltration rate. Below is a summary of the results.

Test Pit Location

Summary of Results

Per the PIT, the site soils are suitable for stormwater infiltration but will require a treatment layer for pollution generating surfaces as the soil characteristics for water quality are below ECY thresholds.

Testing	Test PIT No. B-24-01	Results	ECY Threshold
Infiltration Rate	Pit Depth	18-inches	N/A
	Groundwater Present	Approx. 30-inches below finish grade	N/A
	Uncorrected Infiltration Rate	0.69 inches per hour	N/A
	Factor of Safety	0.45	N/A
	Design Infiltration Rate	0.31 inches per hour	≥ 0.3 inches per hour
Water Quality	Cation Exchange Capacity	-	≥ 5.0 milliequivalents CEC/100g
	Percent Organics	-	≥ 1.0%

INFILTRATION TEST PROCEDURES

Below is the process taken for the PIT:

- ☐ Identify PIT locations based on the site survey of existing buildings and utilities as well as the potential locations of infiltration facilities based on the preliminary site plan.
- ☐ Obtain public and private utility locates. Prior to the PIT utility locates will be called to ensure there are no utilities present in the PIT locations.
- ☐ Excavation of PIT holes (approximately 3-feet x 4-feet 18-inches deep). A 3-feet x 4-feet x2-feet tall wood box is inserted into the test hole to ensures that the bottom surface area is exactly 12 SF. The box is backfilled to the top edge to ensure stability and infiltration only through the bottom of the test hole for the duration of the PIT.
- ☐ A soil sample is collected from the bottom of the hole to test treatment capability. A lab tests the cation exchange rate and organic matter content of soils. Lab results confirm if the soil is suitable for treatment based on Stormwater Manual criteria.
- ☐ A float system with a water hose connection is set into the center of the test hole. The float system is equipped with a leveling plate, a measuring ruler for visual inspection of water levels and a perforated pipe housing for the data collector.
- ☐ Using water transfer tanks or hose spigot as available, the test hole is filled to a 12-inch water depth that is maintained. The presoak period ensures that the soils have been fully saturated before conducting the PIT. A 1-hour stabilization test is performed after the presoak period to confirm soil stabilization. If the test yields 4 constant gallon per minute (GPM) readings that are conducted every 15-minutes, the stabilization of the soil is confirmed.
- ☐ A 1-hour GPM test is conducted per the Stormwater Manual. Using a water meter accurate to the nearest tenth of a gallon, a GPM flow rate is recorded every 15-minutes while the water level is maintained at a 12-inch depth. An infiltration rate (in/hr) can be determined using the GPM flow rate and the 12 SF bottom surface area of the hole.
- ☐ A drawdown test is performed per Stormwater Manual to determine the drawdown infiltration capability of the soil. A CRS451V (Pressure Transducer) is placed into the test hole and set to take pressure (PSI) readings every 10-minutes. The water source is shutoff, and the pressure transducer will measure water drawdown for a 2.5-hour period. At the end of the period the sensors are removed from the test hole, the data is collected using a PC interface module and the HydroSci program to communicate with the sensor to retrieve the data.
- ☐ The wood box and the float system are removed from the test hole.
- ☐ Over excavate test hole to confirm there is no ground water mounding.
- ☐ The test pit is then backfilled and restored to prior state of excavation.

FINDINGS AND RECOMMENDATIONS

Groundwater Conditions

Groundwater was observed during the PIT to be at a depth approximately 30-inches below finish grade.

The Stormwater Manual specifies minimum separations between the seasonal high groundwater elevation and the bottom of the infiltration facility based on different best management practices (BMP):

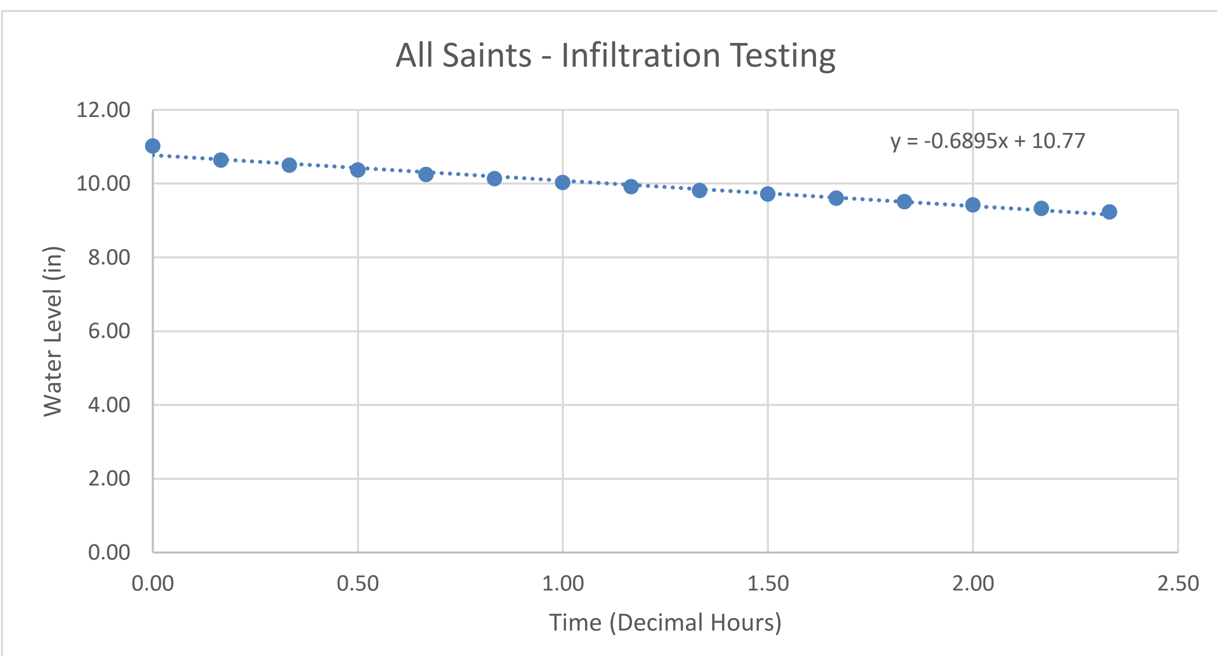
- **Downspout Infiltration:** 1-foot
- **Permeable Pavement:** 1-foot
- **Bioretention Facility:** 3-foot

Based on known groundwater conditions for the test hole, there is adequate spacing between groundwater and all BMPs that require a minimum of 1-foot separation from groundwater. An overflow should be installed with all BMPs in the event of large storm events.

Field Measured Infiltration Rate

The infiltration rate was collected using two methods in during the PIT. The first method is to measure the gallons per minute flowrate required to maintain a constant water level in the test pit. The average of the flowrate measurements taken over an hour timeframe result in an infiltration rate of 0.0 inches per hour.

The second method is to measure the drawdown rate of the test pit. Measurements were taken both visually and with a data logger. The average of the drawdown measurements result in an infiltration rate of 0.69 inches per hour. Below is a graph of the corrected drawdown data from the data logger.



Based on these results, the infiltration rate from the drawdown sensor test is recommended resulting in a field measured infiltration rate of 0.69 inches per hour.

Design Infiltration Rate

Per the Stormwater Manual a minimum design infiltration rate of 0.3 inches per hour is required for onsite infiltration. The design infiltration rate takes the field measured infiltration rate and applies a factor of safety based on three correction factors. The three corrections are based on site variability, test method, and degree of influent control (See Appendix D).

Issue	Partial Correction Factor
Site variability and number of locations tested	CF_v = 0.33 to 1.0
Test Method	
• Large-scale PIT	CF_t = 0.75
• Small-scale PIT	= 0.50
• Other small-scale (e.g. Double ring, falling head)	= 0.40
• Grain Size Method	= 0.40
Degree of influent control to prevent siltation and bio-buildup	CF_m = 0.9

Total Correction Factor, $CF_T = CF_v \times CF_t \times CF_m$

Based on multiple geotechnical reports from nearby projects, soils are known to be consistent in this area. Per the Stormwater Manual, a site variability correction of 1 is used. A correction of 0.5 for the small-scale PIT and 0.9 for the degree of influent are also used. A total correction factor of 0.45 is applied to the measured infiltration rate yielding a recommended design infiltration rate of 0.31 inches per hour (See Appendix A for Data Sheets).

Treatment Suitability

Per the Stormwater Manual the soils that stormwater is infiltrated into may be used for treatment of pollution generating surfaces if the soil meets specific requirements. Otherwise a treatment layer is required to treat pollution generating surfaces. The treatment threshold of the infiltrated soil per the Stormwater Manual is a Cation Exchange Capacity greater than or equal to 5 milliequivalents CEC/100g and a minimum of 1.0% organic content.

A soil sample was taken from the PIT, the soil sample can be submitted for testing upon request if onsite treatment is being utilized.

TEST PIT PHOTO DOCUMENTATION

3-feet x 4-feet x 18-inches

Test Pit Pre-soak at 12-inches

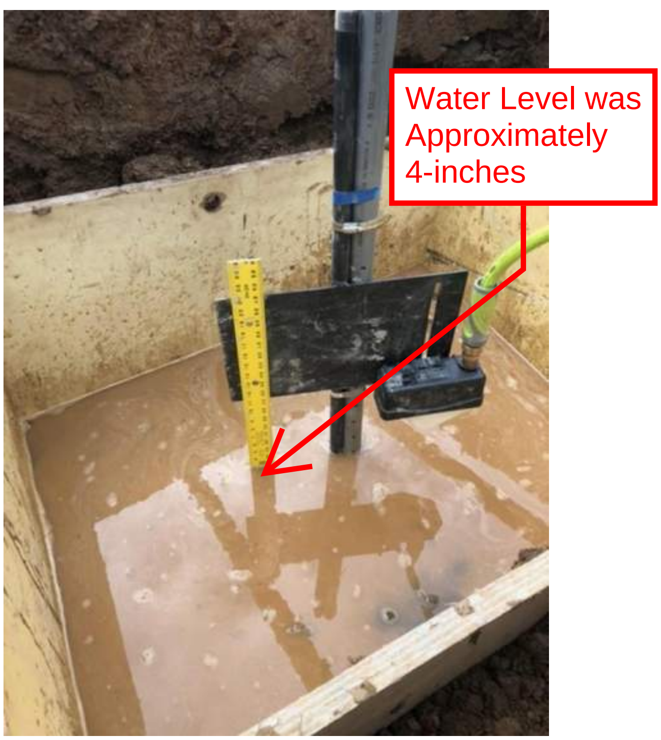
1-hour GPM Test

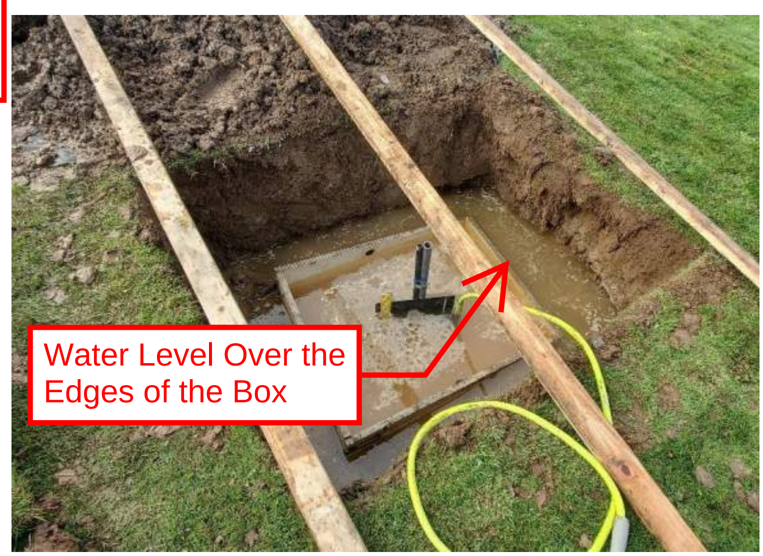
Pressure Transducer Drawdown Test

Over Excavation to observe if Groundwater is Mounding

Backfill Test Hole

TEST PIT PHOTO DOCUMENTATION – FAILED TEST HOLE

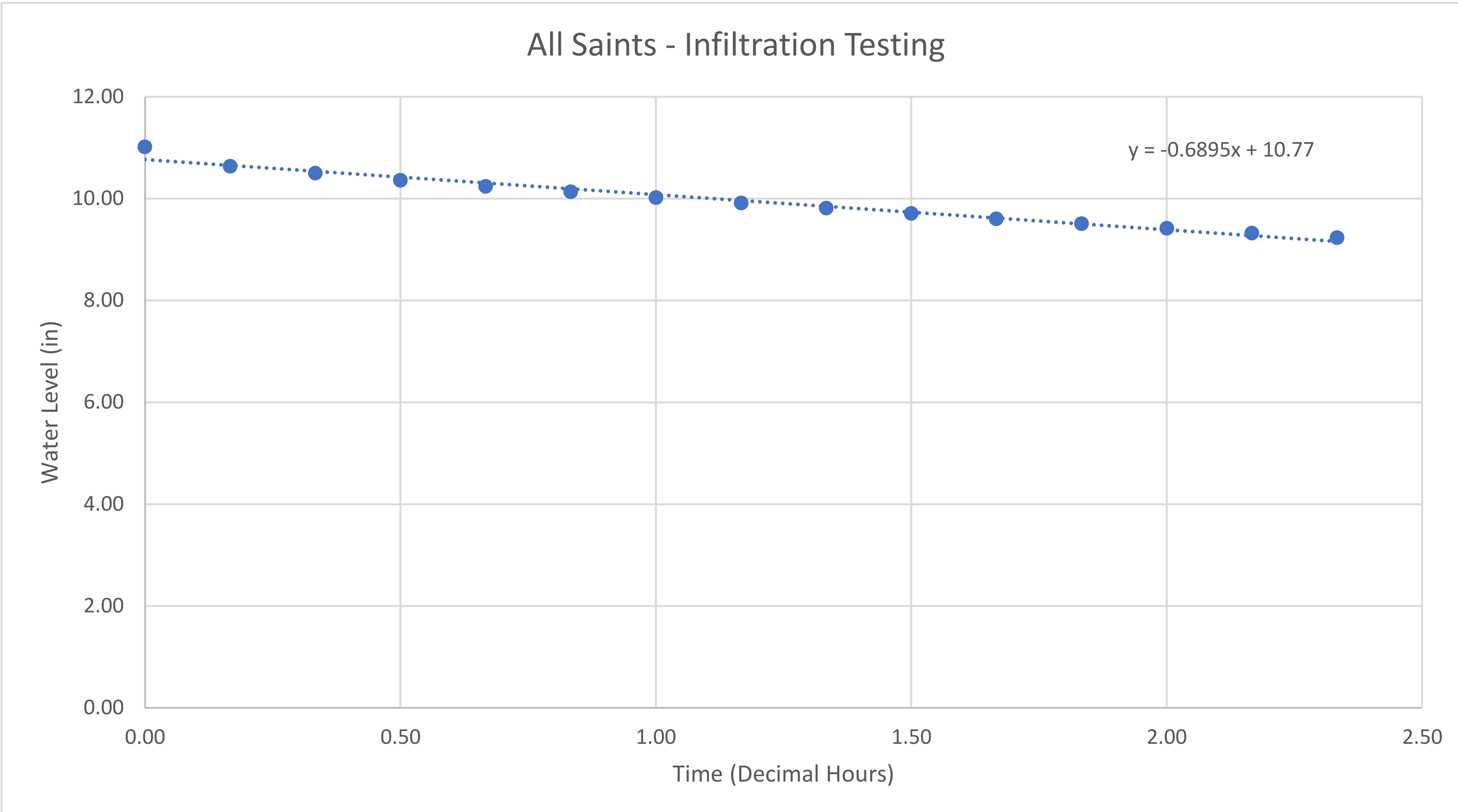




APPENDIX A

Infiltration Testing Data Sheets

Project Location:		All Saints						
Date of Test:		2/24/2021	Test start		5			
					4.4			
Test Pit Dimensions:		Width (feet)	3	Length (feet)	4	Depth (inches)	18	
Presoak:		at 12-inch water column						
Infiltration Test:								
		Water Column Maintained (inches):		12				
		Gallons Per Inch:	7.48					
		Time(Minutes)	**Volume (gallons)**	**Flow Rate (GPM)**			**Flow (Gallons)**	**Infiltration Rate (in/hr)**
				Meter Start	Meter End	Flow (Gallons)		
10am		0		2200.8	2200.8	0.00	0.00	
		15		2200.8	2200.8	0.00	0.00	
		30		2200.8	2200.8	0.0	0.0	
		45		2200.8	2200.8	0.0	0.0	
		60		2200.8	2200.8	0.0	0.0	**0.0**
Drawdown Test (Sensor):								
Sensor Name:		JMJ 01 (**CRS451V Sensors from Campbell Scientic**)						
Time (Decimal Hours)	**Measurement (Min)**	**Time Stamp**	**Record #**	**Reading (PSI)**	**Level (in)**			
0.00	0	12:10 PM	0	0.40	11.02			
0.17	10	12:20 PM	1	0.38	10.64			
0.33	20	12:30 PM	2	0.38	10.50			
0.50	30	12:40 PM	3	0.37	10.37			
0.67	40	12:50 PM	4	0.37	10.25			
0.83	50	1:00 PM	5	0.36	10.14			
1.00	60	1:10 PM	6	0.36	10.03			
1.17	70	1:20 PM	7	0.36	9.92			
1.33	80	1:30 PM	8	0.35	9.81			
1.50	90	1:40 PM	9	0.35	9.72			
1.67	100	1:50 PM	10	0.35	9.61			
1.83	110	2:00 PM	11	0.34	9.51			
2.00	120	2:10 PM	12	0.34	9.42			
2.17	130	2:20 PM	13	0.34	9.33			
2.33	140	2:30 PM	14	0.33	9.23			
				Average Infiltration Rate:		**0.69**		
					Factor of Safety:	**0.45**		
					Infiltration Rate of 0.31 Used for Sizing of System			


All Saints - Infiltration Testing
y = -0.6895x + 10.77
Water Level (in)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.00
0.50
1.00
1.50
2.00
2.50
Time (Decimal Hours)

APPENDIX B

PRODUCT

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

CRS451V

Stainless-Steel Vented Stand-Alone Pressure Transducer

Pressure Transducer Combined with a Recorder

High resolution and accuracy

Overview

The CRS451V consists of a submersible water-level and water-temperature sensor with its own time clock and memory to store the collected data—in a compact stainless-steel case. This data logging capability frees users to place the sensor in remote sites and let it collect data for long periods. HydroSci software is included and elegantly supports test setup, data retrieval, and data display. Long battery life and rugged construction mean you can trust the CRS451V to collect important data. Low cost and ease of use make it a good choice in a variety of applications. The CRS456V is the same as this, but with a titanium case.

Benefits and Features

- Sensors and data-collection features in one instrument case
- Rugged stainless-steel case protects piezoresistive sensor
- Quality construction ensures product reliability
- Fully temperature-compensated
- Fast scan rate
- Large data-storage capacity
- Long battery life
- Easy-to-use software

Detailed Description

The CRS451V has several pressure range options.

HydroSci software is available for download. This software simplifies the process of configuring the CRS451V. Users can configure the CRS451V to monitor surface water, ground water, or a standard pump test.

HydroSci software will display the data in tabular or graphical formats.

Specifications

Venting	Vented	Measurement Time	< 1.0 s

APPENDIX C

INFILTRATION TEST

The Washington State Department of Ecology Stormwater Manual provides testing procedures and best practices, which are described below.

- Testing should occur between December 1 and April 1.
- The horizontal and vertical locations of the PIT shall be surveyed by a licensed land surveyor and accurately shown on the design drawings.
- Excavate the test pit to the estimated elevation of the proposed infiltration into the native soil. Note that for some proposed BMPs, such as and BMP T5.15: Per- meable Pavements, this will be below the proposed finished grade. If the native soils will have to meet a minimum subgrade compaction requirement (for example, the road subgrade if using BMP T5.15: Permeable Pavements), compact the native soil to that requirement prior to testing. Lay back the slopes sufficiently to avoid caving and erosion during the test. Altern- atively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be approximately 100 square feet. Document the size and geometry of the test pit.
- Install a vertical measuring rod (long enough to measure the ponded water depth, minimum 5- ft. long) marked in half-inch increments in the center of the pit bottom.
- Use a rigid 6-inch diameter pipe with a splash plate on the bottom to convey water to the test pit and reduce side-wall erosion or excessive disturbance of the test pit bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates.
- Add water to the pit at a rate that will maintain a water level between 6 and 12 inches above the bottom of the pit. A rotameter can be used to measure the flow rate into the pit.

The depth should not exceed the proposed maximum depth of water expected in the completed BMP. For infiltration BMPs serving large drainage areas, designs with multiple feet of standing water can have infiltration tests with greater than 1 foot of standing water.

- Every 15-30 min, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point on the measuring rod.
- Keep adding water to the pit until one hour after the flow rate into the pit has stabilized (constant flow rate; a goal of 5% or less variation in the total flow) while maintaining the same pond water level. The total of the pre-soak time plus one hour after the flow rate has stabilized should be no less than 6 hours.
- After the flow rate has stabilized for at least one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty. Consider running this falling head phase of the test several times to estimate the

dependency of the infiltration rate with head.

- At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to the hydraulic restricting layer, and is determined by the engineer or certified soils professional. Mounding is an indication that a mounding analysis is necessary.

DATA ANALYSIS

Calculate and record the initial K_{sat} rate in inches per hour in 30 minutes or one-hour increments until one hour after the flow has stabilized.

Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.*Example*

The area of the bottom of the test pit is 8.5-ft. by 11.5-ft. (97.75 sq. ft.).

Water flow rate was measured and recorded at intervals ranging from 15 to 30 minutes throughout the test. Between 400 minutes and 1,000 minutes the flow rate stabilized between 10 and 12.5 gal- lons per minute or 600 to 750 gallons per hour, or 80.2 to 100 ft^3 per hour. Dividing this rate by the surface area gives an initial K_{sat} of 9.8 to 12.3 inches per hour.

K_{sat} Determination Option 2: Small Scale Pilot Infiltration Test (PIT)

A small-scale PIT can be substituted for Ksat Determination Option 1: Large Scale Pilot Infiltration Test (PIT) in any of the following instances:

- The drainage area to the infiltration BMP is less than 1 acre.
- The testing is for BMP T7.30: Bioretention or BMP T5.15: Permeable Pavements that either serve small drainage areas and/or are widely dispersed throughout a project site.
- The site has a high infiltration rate (>4 in/hr), making a large scale PIT difficult, and the site geo- technical investigation suggests uniform subsurface characteristics.

INFILTRATION TEST

Use the same procedures described above in Ksat Determination Option 1: Large Scale Pilot Infiltra-tion Test (PIT), with the following changes:

- The horizontal surface area of the bottom of the test pit should be 12 to 32 square feet. It may be circular or rectangular. Document the size and geometry of the test pit.
- The rigid pipe with a splash plate used to convey water to the pit may be a 3-inch diameter pipe for

pits on the smaller end of the recommended surface area, or a 4-inch pipe for pits on the larger end of the recommended surface area.

- Pre-soak period: Add water to the pit so that there is standing water for at least 6 hours. Maintain the pre-soak water level at least 12 inches above the bottom of the pit.
- At the end of the pre-soak period, add water to the pit at a rate that will maintain a 6-12 inch water level above the bottom of the pit over a full hour. The depth should not exceed the pro- posed maximum depth of water expected in the completed facility.
- Every 15 minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point (between 6 inches and 1 foot) on the measuring rod. The specific depth should be the same as the maximum designed pond- ing depth (usually 6 – 12 inches).

After one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty.

- A self-logging pressure sensor may also be used to determine water depth and drain-down.
- At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to the hydraulic restricting layer, and is determined by the engineer or certified soils professional. The soils professional should judge whether a mounding analysis is necessary.

APPENDIX D

CALCULATED DESIGN INFILTRATION RATE:

Site variability and number of locations tested (CF_v) - The number of locations tested must be capable of producing a picture of the subsurface conditions that fully rep- resents the conditions throughout the proposed location of the infiltration BMP. The partial correction factor used for this issue depends on the level of uncertainty that adverse subsurface conditions may occur. If the range of uncertainty is low - for example, conditions are known to be uniform through previous exploration and site geological factors

- one pilot infiltration test (or grain size analysis location) may be adequate to justify a partial correction factor at the high end of the range.

If the level of uncertainty is high, a partial correction factor near the low end of the range may be appropriate. This might be the case where the site conditions are highly variable due to conditions such as a deposit of ancient landslide debris, or buried stream channels. In these cases, even with many explorations and several pilot infiltration tests (or several grain size test locations), the level of uncertainty may still be high.

A partial correction factor near the low end of the range could be assigned where conditions have a more typical variability, but few explorations and only one pilot infiltration test (or one grain size analysis location) is conducted. That is, the number of explorations and tests conducted do not match the degree of site variability anticipated.

- **Uncertainty of test method (CF_t)** accounts for uncertainties in the testing methods. For the full scale PIT method, CF_t = 0.75; for the small-scale PIT method, CF_t = 0.50; for smaller-scale infiltration tests such as the double-ring infiltrometer test, CF_t = 0.40; for grain size analysis, CF_t = 0.40. These values are intended to represent the difference in each test's ability to estimate the actual saturated hydraulic conductivity. The assumption is the larger the scale of the test, the more reliable the result.
- **Degree of influent control to prevent siltation and bio-buildup (CF_m)** Even with a pre-settling basin or a basic treatment BMP for pre-treatment, the soil's initial infiltration rate will gradually decline as more and more stormwater, with some amount of suspended material, passes through the soil profile. The maintenance schedule calls for removing sediment when the BMP is infiltrating at only 90% of its design capacity. Therefore, a correction factor, CF_m, of 0.9 is called for.

Table V-5.1: Correction Factors to be Used With In-Situ Saturated Hydraulic Conductivity Measurements to Estimate Design Rates

Issue	Partial Correction Factor
Site variability and number of locations tested	CF_v = 0.33 to 1.0
Test Method	
• Large-scale PIT • Small-scale PIT • Other small-scale (e.g. Double ring, falling head) • Grain Size Method	CF_t = 0.75 = 0.50 = 0.40 = 0.40
Degree of influent control to prevent siltation and bio-buildup	CF_m = 0.9

Total Correction Factor, $CF_T = CF_v \times CF_t \times CF_m$

Total Correction Factor, CF_T = 1.0 x 0.5 x 0.9

CF_T = 0.45

- The design infiltration rate (K_{sat}design) is calculated by multiplying the initial K_{sat} by the total correction factor:

K_{sat} design = K_{sat} initial X CF

K_{sat} design = 0.79 inches per hour X 0.45

K_{sat} design = 0.36 inches per hour