Stormwater Site Plan

PREPARED FOR:

Mr. Don Huber
SPP Manufacturing
PO Box 64160
Tacoma, WA 98465

PROJECT:

Puyallup 2nd Street Apartments
XXX 2nd Street NE
Puyallup, WA
2190606.10

PREPARED BY:

Allyson Burket
Project Engineer

REVIEWED BY:

J. Matthew Weber, PE
Principal

DATE

December 2021
Revised August 2022
Revised November 2022
Revised February 2024

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02/07/2024

I hereby state that this Stormwater Site Plan for the Puyallup 2nd Street Apartments project has been prepared by me or under my supervision and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that City of Puyallup does not and will not assume liability for the sufficiency, suitability, or performances of drainage facilities prepared by me.

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1.0 Proposed Project Description

The Puyallup 2nd Street Apartments project proposes to develop 0.77 acre in Puyallup, Washington. The project is located northeast of the intersection of 2nd Street NE and 5th Avenue NE on Tax Parcel 7600200051. Refer to Appendix A-1 for a Vicinity Map.

The project proposes an approximately 7,600-square foot footprint apartment building, consisting of 24 residential units. Other improvements will include driveways, site paving, landscaping, and improvements to the adjacent right-of-way. Proposed utilities include storm drainage, a sanitary sewer connection, and a water system.

2.0 Summary of Minimum Requirements

This project is subject to the 2021 Pierce County *Stormwater Management and Site Development Manual (SMSDM)*. This project is a new development that will add more than 5,000 square feet of impervious surfaces; therefore, all Minimum Requirements apply.

2.1 MR 1 – Preparation of Stormwater Site Plans

This report and project plans represent the Stormwater Site Plan for this project and satisfy MR 1.

2.2 MR 2 – Construction Stormwater Pollution Prevention

A Construction Stormwater Pollution Prevention Plan (CSWPPP) has been prepared and submitted under separate cover.

2.3 MR 3 – Source Control of Pollution

The proposed project is required to provide source control of pollution. The following are proposed measures to be implemented as part of the civil plans.

- All pollutants, including waste materials and demolition debris created onsite during construction, shall be handled and disposed of in a manner that does not cause contamination of surface water.
- Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site (see Chapter 173-304 WAC for the definition of inert waste).
- Maintenance and repair of heavy equipment and vehicles that may result in discharge or spillage of pollutants to the ground or into surface water runoff must be conducted using spill prevention measures, such as drip pans.
- Concrete Handling (BMP C151) and Sawcutting and Surface Pollution Prevention (BMP C152) shall be used to prevent or treat contamination of surface water runoff by pH modifying sources.

The CSWPPP provides details on the control of pollution during construction.

2.4 MR 4 – Preservation of Natural Drainage Systems and Outfalls

The site is currently several feet lower than the adjacent roads. Runoff is either infiltrated onsite or flows toward the adjacent property to the east. In the developed condition, all runoff will be infiltrated onsite through infiltration trenches or permeable sidewalk.

Refer to Appendix A-2 for the Existing Conditions Map.

2.5 MR 5 – Onsite Stormwater Management

This project is to either meet the Low Impact Development (LID) performance standard or use the list approach using List 2. The project will meet the LID performance standards by infiltrating all stormwater onsite.

2.6 MR 6 – Runoff Treatment

More than 5,000 square feet of pollution generating hard surface (PGHS) will be added as part of these improvements; therefore, runoff treatment is required for this site. Runoff treatment is further discussed in Section 10.1

2.7 MR 7 – Flow Control

The project proposes to infiltrate all stormwater onsite, using an underground gravel infiltration trench, permeable concrete, and an infiltration ditch. The facilities were sized using the 2012 Western Washington Hydrology Model (WWHM) to meet flow control standards. Refer to Section 10.0 for flow control facility information. In accordance with City of Puyallup requirements, all proposed concrete sidewalks within the right-of-way will be permeable concrete.

2.8 MR 8 – Wetland Protection

To our knowledge, no wetlands are located on or immediately downstream of the site.

2.9 MR 9 – Operation and Maintenance

An Operations and Maintenance Manual has been prepared and submitted under separate cover.

2.10 MR 10 – Financial Liability

Performance bonding to be provided by SPP Manufacturing, as required by the City.

3.0 Existing Site Conditions

The existing 0.77-acre site is primarily undeveloped. A gravel road cuts through the southeast corner of the site, connecting the neighboring property to 5th Avenue NE. The remaining ground cover is grass.

The project is bounded to the north by an auto sales lot and a single-family residence, and to the east by a single-family residence and an apartment building.

3.1 Offsite drainage to the property

Run-on to the project site from offsite properties is not anticipated.

3.2 Creeks, lakes, ponds, wetlands, ravines, gullies, steep slopes, and other environmentally sensitive areas on or down gradient of the property

The site is located southwest of the Puyallup River.

3.3 Is the project located in an aquifer recharge area or wellhead protection area, as defined by the Tacoma-Pierce County Health Department, the Environmental Protection Agency, or the County?

The project is within the aquifer recharge area, as identified by the Pierce County Aquifer Recharge Area Map (see Appendix A-6). As such, per Pierce County Code (PCC) 18.E.50.040.D.1, stormwater treatment and flow control shall be provided in conformance with the 2021 *SMSDM*.

To our knowledge, the site is not located within a wellhead protection area (see Appendix A-7).

3.4 Are there any specific requirements included in a basin plan for the area?

To our knowledge, there are no basin requirements other than the general requirements of the most recent issue of the *SMSDM*.

3.5 Are there drains, channels, and swales within the project site and immediately adjacent?

A 12-inch storm drain and manhole are located on the property's southwest corner. Two storm catch basins are located west of the property, within the 2nd Street NE right-of-way.

3.6 Points of exit for existing drainage from the property

The majority of stormwater is assumed to infiltrate onsite. Any stormwater that does not infiltrate sheet flows southeast to the neighboring property.

3.7 Are there any known historical drainage problems such as flooding, erosion, etc.?

No known flooding or erosion issues exist on the site.

4.0 Soils Reports

The Natural Resources Conservation Service (NRCS) Soils Map in Appendix A-5 identifies the onsite soils as primarily Puyallup fine sandy loam.

The onsite soils have been explored and summarized in a report by South Sound Geotechnical Consulting dated August 8, 2019. Native subsurface soils consist of sand and silty sand in a generally loose condition. A corrected long-term design infiltration rate of 1.4 inches per hour was recommended. This rate was used for sizing of the stormwater facilities.

South Sound Geotechnical Consulting also completed groundwater monitoring through the 2020 winter season. The highest groundwater level recorded was 10 feet 10 inches. This value will be used to determine appropriate vertical setbacks from stormwater infiltration facilities. Refer to Appendix C for the full Geotechnical Engineering Report and the Groundwater Monitoring Report.

5.0 Wells and Septic Systems

No known well or septic system exists onsite. However, if one is encountered during construction, it will be decommissioned and removed or abandoned according to Tacoma-Pierce County Health Department standards under separate permit.

6.0 Fuel Tanks

To our knowledge, no existing underground fuel tanks are located on the site. If located during construction, the fuel tanks will be abandoned according to Tacoma-Pierce County Health Department standards.

7.0 Sub-Basin Description

The site is modeled as six sub-basins. Sub-basins 1, 2, and 3 direct stormwater from the parking lot to the site's proposed gravel infiltration trench. Runoff from the Roof Basin is conveyed directly to the gravel infiltration trench through roof drains.

A gravel infiltration ditch along the property's east edge will infiltrate stormwater runoff from the landscape buffer between the parking lot and neighboring property. Stormwater along the frontage of the proposed apartments will infiltrate through the permeable concrete sidewalks. Refer to Appendix B-1 for the Basin Map.

8.0 Analysis of the 100-Year Flood

According to the FEMA Flood Insurance Rate Maps, the site is outside the 100-year floodplain (see Appendix A-4).

9.0 Aesthetic Consideration for Facilities

All stormwater facilities will be located below grade. The overall site development will include landscape plantings and will be aesthetically pleasing.

10.0 Facility Sizing and Downstream Analysis

Stormwater quality and quantity control for this project will be provided by infiltrating stormwater into native soils. Facilities are sizes using WWHM. The following sections describe the design.

10.1 Quality Control Facility Sizing

For sites within 0.25 mile of the Puyallup River, Enhanced Treatment of stormwater is required. Although the site is located exactly 0.25 mile from the river, measured in a straight line, after reviewing GIS contours of the area, AHBL believes that the direction of groundwater flow is likely to the northwest. This results in a flow length to the river of more than 0.25 mile, and therefore Basic Treatment is proposed.

Stormwater runoff will be treated by three proprietary filter units with Department of Ecology (Ecology) General Use Level Designation (GULD) approval for Basic Treatment. The facilities were sized using the off-line water quality flow rate determined through continuous modeling by WWHM. Refer to the table below for the required and provided water quality flow rates. Refer to Appendix B-2 for the full WWHM Report.

Water Quality Flow Rates (gpm)		
Basin	**Required Treatment Flow Rate**	**Provided Treatment Flowrate**
1	4.04	7.5
2	4.04	7.5
3	5.61	7.5

Runoff form the proposed roofs, alongside the east property line, and along the frontage of the proposed building will be treated by infiltrating into the native soils onsite. The existing soils meet the Cation Exchange Capacity (CEC) requirements of 5 milliequivalents. The CEC for the site was evaluated to be 7.5 milliequivalents (refer to Appendix C).

10.2 Quantity Control Facility Sizing

Stormwater quantity control is provided by infiltrating stormwater through an infiltration trench, permeable sidewalk, or a gravel infiltration ditch. The infiltration and gravel trench facilities were designed using WWHM. Infiltration testing determined a corrected infiltration rate of 1.4 in/hr. Refer to Appendix C for the Geotechnical Engineering Report. Refer to Appendix B for the basin map, infiltration rates, and WWHM reports.

10.3 Downstream Drainage Analysis

The project proposes to infiltrate all stormwater onsite. No changes to the downstream stormwater network are proposed.

11.0 Utilities

Sewer, power, and water utilities will extend to the new buildings.

12.0 Covenants, Dedications, and Easements

A 5-foot wide section of the property along 2nd Street NE and 5th Avenue NE will be dedicated to City of Puyallup for right-of-way purposes.

13.0 Property Owners Association Articles of Incorporation

Not applicable.

14.0 Other Permits or Conditions Placed on the Project

The following permits will also be required for this project:

- Puyallup: Site Development Permit
- Puyallup: Fill and Grade Permit
- Puyallup: Tree Clearing Permit
- National Pollutant Discharge Elimination System (NPDES) Permit

15.0 Conclusion

This analysis is based on data and records either supplied to, or obtained by, AHBL. These documents are referenced within the text of the analysis. The analysis has been prepared using procedures and practices within the standard accepted practices of the industry. We conclude that this project, as proposed, will not create any new problems within the existing downstream drainage system. This project will not noticeably aggravate any existing downstream problems due to either water quality or quantity.

AHBL, Inc.

Allyson Burket
Project Engineer

AB/

December 2021
Revised August 2022
Revised November 2022
Revised February 2024

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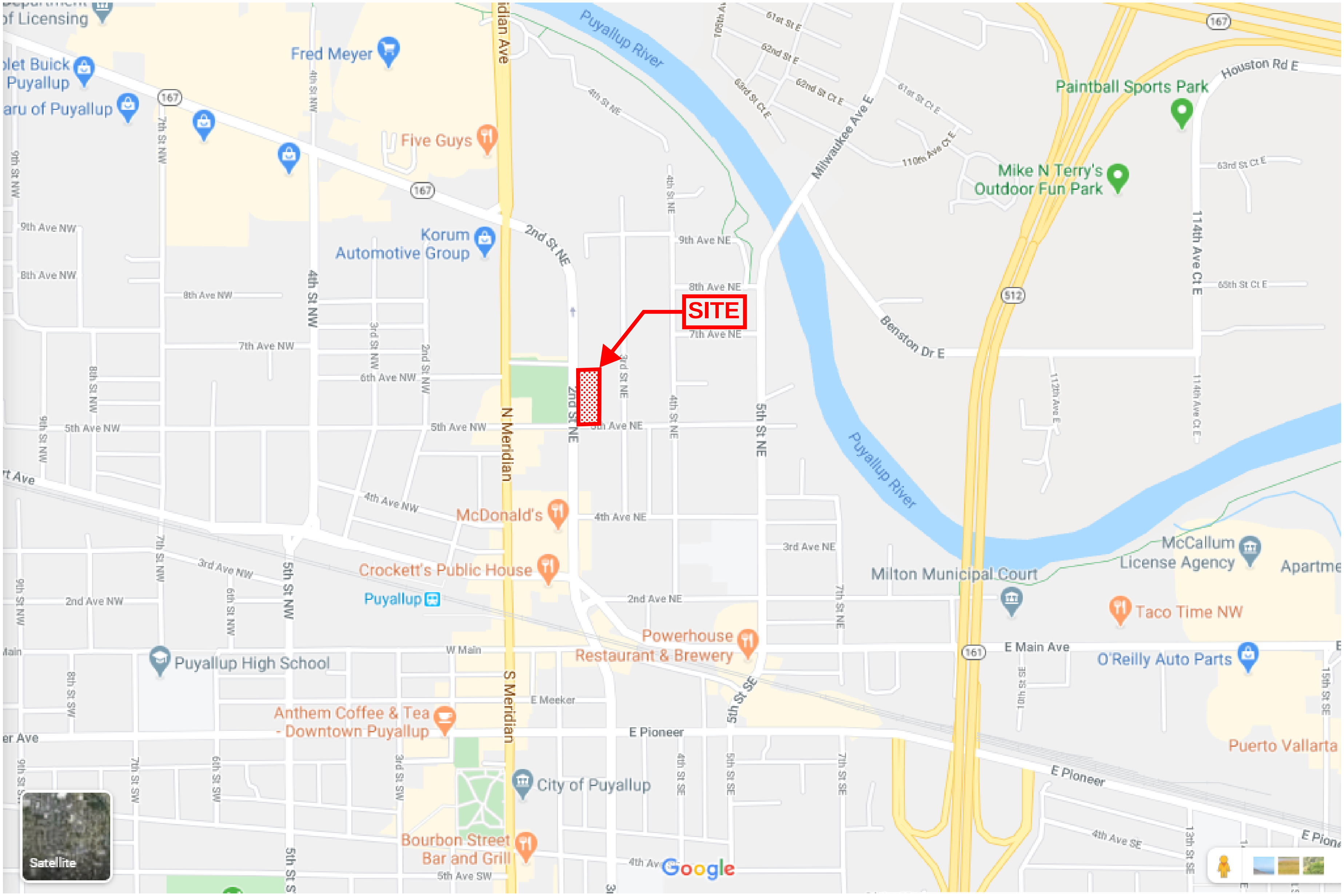
Appendix A

Exhibits

A-1 .... Vicinity Map
A-2 .... Existing Conditions Map
A-3 .... Developed Conditions Map
A-4 .... FEMA Flood Insurance Rate Map
A-5 .... NRCS Soils Map
A-6 .... Aquifer Recharge Area Map
A-7 .... Wellhead Protection Zone Map



AHBL
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Suite 300
Tacoma, WA 98403
253.383.2422 TEL
253.383.2572 FAX

PUYALLUP 2ND STREET APARTMENTS
2190606.10

VICINITY MAP

A-1

SPP MANUFACTURING-PUYALLUP SURVEY

A PORTION OF THE NW 1/4 OF THE NW 1/4 OF SEC. 27, TWN. 20 N., RGE. 04 E. W.M.

CITY OF PUYALLUP, PIERCE COUNTY, WASHINGTON.

LEGAL DESCRIPTION

(PER OLD REPUBLIC TITLE, LTD., ORDER NUMBER 5217024093–CB, EFFECTIVE DATE MAY 23, 2018, AT 8:00 A.M.):

PARCEL A:

THAT PORTION OF THE NORTHWEST QUARTER OF THE NORTHWEST QUARTER OF SECTION 27, TOWNSHIP 20 NORTH, RANGE 4 EAST, W.M., DESCRIBED AS FOLLOWS:

BEGINNING ON THE EAST BOUNDARY OF 2ND STREET N.E. IN THE CITY OF PUYALLUP, 149.78 FEET NORTH OF THE SOUTHWEST CORNER OF BLOCK 4, SHUMAN'S ADDITION TO PUYALLUP, PIERCE COUNTY, WASHINGTON, ACCORDING TO THE PLAT THEREOF, RECORDED IN VOLUME 5 OF PLATS, PAGE 99, RECORDS OF PIERCE COUNTY, WASHINGTON;

THENCE CONTINUE NORTH ON SAID BOUNDARY, 130.22 FEET;
THENCE EAST PARALLEL WITH THE SOUTH LINE OF SAID BLOCK 4, 120 FEET;
THENCE SOUTH PARALLEL WITH SAID EAST BOUNDARY OF 2ND STREET N.E., 130.22 FEET TO THE NORTH LINE OF SAID BLOCK 4;
THENCE WEST 120 FEET TO THE POINT OF BEGINNING.

PARCEL B:

LOTS 1, 2 AND 3, BLOCK 4, SHUMAN'S SECOND ADDITION TO PUYALLUP, PIERCE COUNTY, WASHINGTON, ACCORDING TO THE PLAT THEREOF, RECORDED IN VOLUME 5 OF PLATS, PAGE 99, RECORDS OF PIERCE COUNTY, WASHINGTON.

BOTH SITUATE IN THE COUNTY OF PIERCE, STATE OF WASHINGTON.

VERTICAL DATUM

NAVD 1988 VERTICAL DATUM ON ORTHOMETRICALLY CORRECTED GPS OBSERVATION USING WSRN AND GEOID 2012A.

BASIS OF BEARING

NAD 1983
WASHINGTON STATE PLANE SOUTH PROJECTION, BASED ON GPS OBSERVATIONS USING WSRN AND GEOID 2012A. UNITS OF MEASUREMENT ARE US SURVEY FEET.

UTILITY NOTES

1. SURFACE UTILITY FACILITIES ARE SHOWN HEREON PER FIELD LOCATED VISIBLE EVIDENCE. THERE MAY BE UTILITIES THAT EXIST ON THIS SITE OTHER THAN THOSE GRAPHICALLY DEPICTED HEREON.

2. UNDERGROUND (BURIED) UTILITIES SHOWN HEREON ARE BASED ON COMBINATIONS OF VISIBLE SURFACE EVIDENCE, UTILITY LOCATOR MARKINGS AND RECORD DATA (SUCH AS AS–BUILT OR UTILITY DESIGN DRAWINGS). ALL UNDERGROUND UTILITIES SHOWN HEREON ARE APPROXIMATE AND, IN SOME CASES, ARE SHOWN AS STRAIGHT LINES BETWEEN FIELD LOCATED SURFACE UTILITY FACILITIES. UNDERGROUND UTILITIES MAY HAVE BENDS, CURVES OR CONNECTIONS WHICH ARE NOT SHOWN.

3. ALTHOUGH LOCATIONS OF UNDERGROUND UTILITIES BASED ON UTILITY LOCATOR MARKINGS AND RECORD DATA (SUCH AS AS–BUILT OR UTILITY DESIGN DRAWINGS) ARE DEEMED RELIABLE, AHBL, INC. ASSUMES NO LIABILITY FOR THE ACCURACY OF SAID DATA.

4. CALL 1–800–424–5555 BEFORE ANY CONSTRUCTION.

RELIANCE NOTE

THIS SURVEY WAS PREPARED AT THE REQUEST OF DON HUBER FOR THE SOLE AND EXCLUSIVE USE OF SPP MANUFACTURING. RIGHTS TO RELY UPON AND, OR USE THIS SURVEY DO NOT EXTEND TO ANY OTHER PARTY EXCEPT THROUGH EXPRESS RECERTIFICATION BY THE PROFESSIONAL LAND SURVEYOR WHOSE STAMP AND SIGNATURE APPEAR HEREON.

EQUIPMENT USED

3" TOTAL STATION UTILIZING STANDARD FIELD TRAVERSE METHODS FOR CONTROL AND STAKING.

SURVEYOR'S CERTIFICATE

I, DAVID C. FOLLANSBEE, A PROFESSIONAL LAND SURVEYOR IN THE STATE OF WASHINGTON, HEREBY CERTIFY THAT THIS MAP CORRECTLY REPRESENTS A SURVEY MADE BY ME OR UNDER MY DIRECT SUPERVISION IN JULY 2018 IN COMPLIANCE WITH THE REQUIREMENTS OF THE SURVEY RECORDING ACT, CHAPTER 58.09 R.C.W. AND 332–130 W.A.C., AT THE REQUEST OF THE SPP MANUFACTURING.

DAVID C. FOLLANSBEE, PLS 45161 DATE

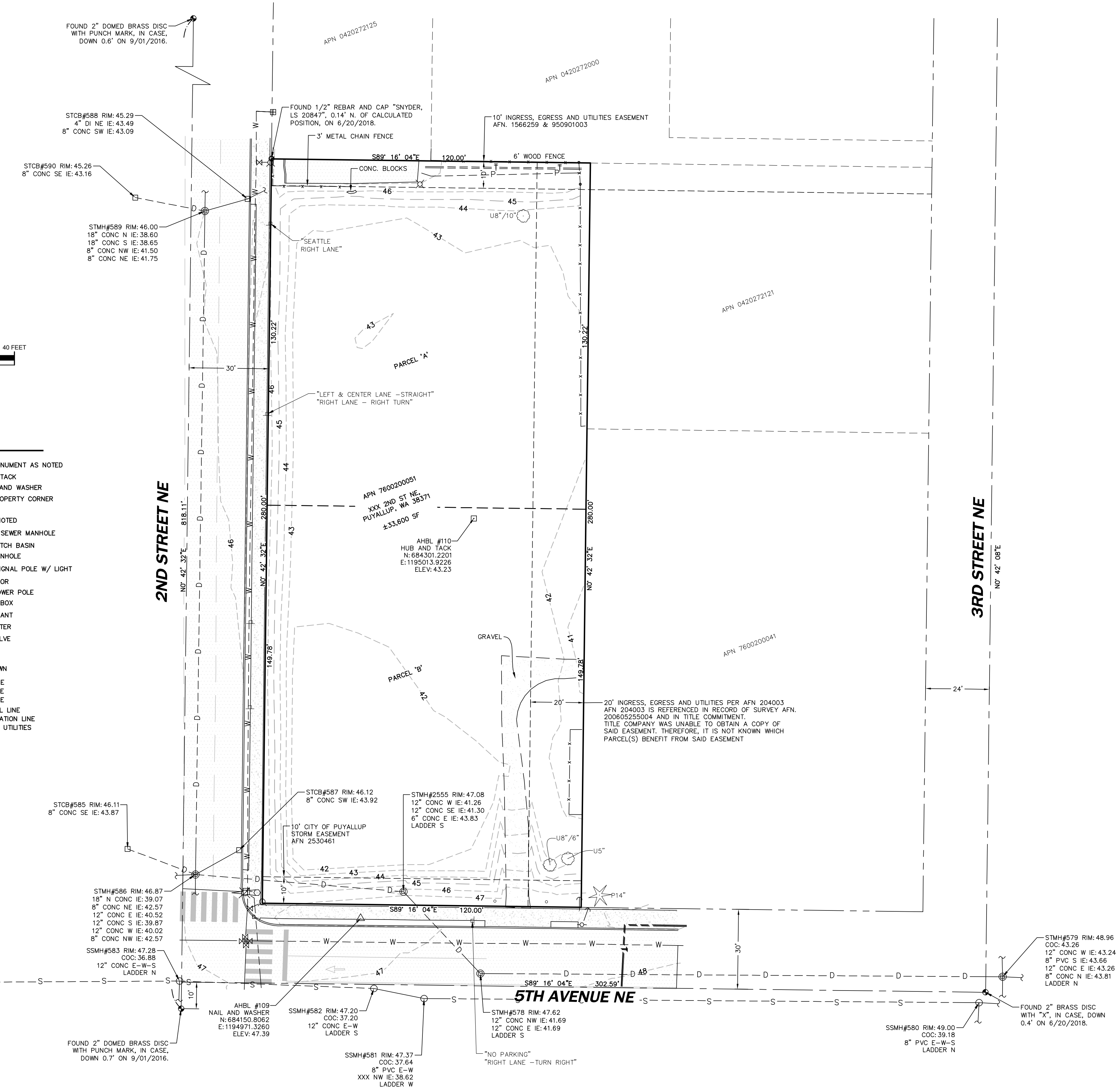
GRAPHIC SCALE

0 10 20 40 FEET

1" = 20 FEET

LEGEND

- FOUND MONUMENT AS NOTED
- HUB AND TACK
- SET NAIL AND WASHER
- FOUND PROPERTY CORNER
- BOLLARD
- SIGN AS NOTED
- SANITARY SEWER MANHOLE
- STORM CATCH BASIN
- STORM MANHOLE
- TRAFFIC SIGNAL POLE W/ LIGHT
- GUY ANCHOR
- UTILITY POWER POLE
- JUNCTION BOX
- FIRE HYDRANT
- WATER METER
- WATER VALVE
- P=PINE
- U=UNKNOWN
- D — STORM LINE
- S — SEWER LINE
- W — WATER LINE
- P — ELECTRICAL LINE
- T — COMMUNICATION LINE
- OHP — OVERHEAD UTILITIES
- x — FENCE
- ASPHALT
- CONCRETE
- GRAVEL



AHBL

TACOMA · SEATTLE · SPOKANE · TRI-CITIES

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Project Title:

SPP MANUFACTURING PUYALLUP SURVEY

Client:
SPP MANUFACTURING

PO BOX 64160
TACOMA, WA 98464

DON HUBER

Job No.

2180463.52

Issue Set & Date:

JULY 24, 2018

DAVID C. FOLLANSBEE STATE OF WASHINGTON 45161 REGISTERED PROFESSIONAL LAND SURVEYOR

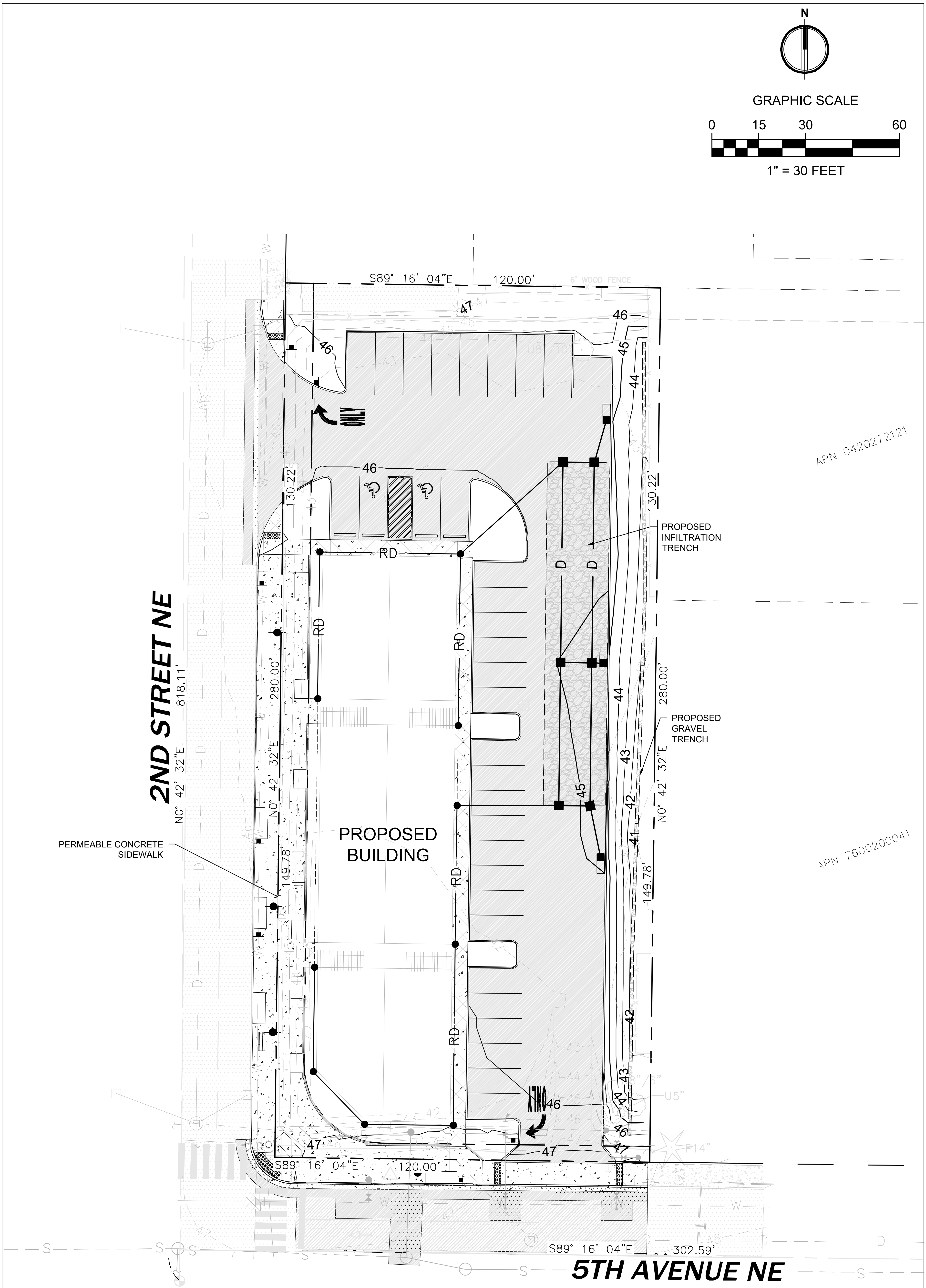
PRELIMINARY

NOTICE

Revisions:

EXISTING CONDITIONS MAP

EXHIBIT A-2



AHBL
Civil Engineers
Structural Engineers
Landscape Architects
Community Planners
Land Surveyors
Neighbors
TACOMA SEATTLE
2215 North 30th Street, Suite 300, Tacoma, WA 98403 253.383.2422 TEL
316 Occidental Avenue South, Suite 320, Seattle, WA 98104 206.267.2425 TEL

PUYALLUP 2ND STREET APARTMENTS
2190606.10

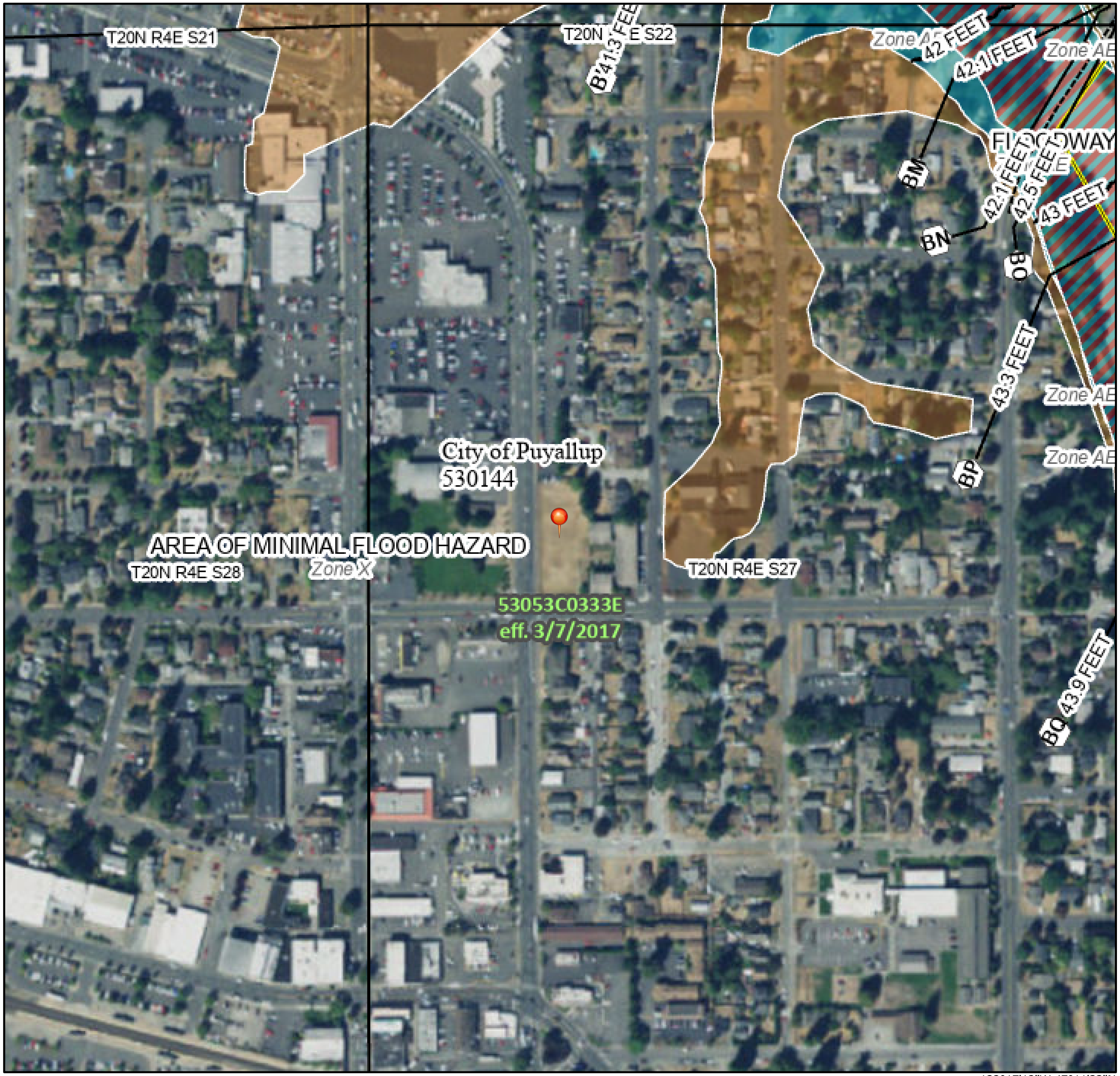
DEVELOPED CONDITIONS MAP

A-3

National Flood Hazard Layer FIRMette

FEMA

122°17'49"W 47°11'58"N



122°17'12"W 47°11'33"N

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

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 1/3/2024 at 6:08 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.

Soil Map—Pierce County Area, Washington

Map Scale: 1:485 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 5, 10, 20, 30

Feet: 0, 20, 40, 80, 120

N

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 19, Aug 29, 2023

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

Date(s) aerial images were photographed: Jul 31, 2022—Aug 8, 2022

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	0.7	100.0%
Totals for Area of Interest		**0.7**	**100.0%**

Pierce County

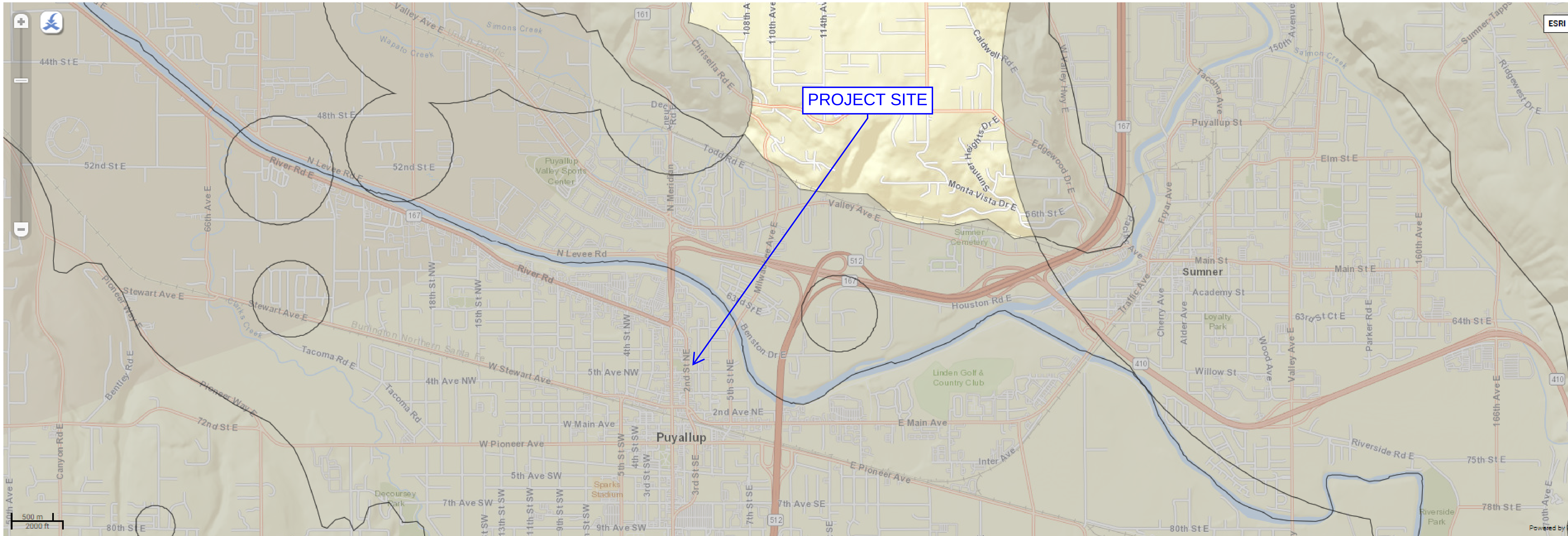
Sign In

Aquifer - Recharge Areas

Based on Aquifer - Recharge Areas

Aquifer recharge area polygons throughout Pierce County are used to define wellhead protection areas, potential groundwater pollution areas, and

More Views | Export | Discuss | Embed | About



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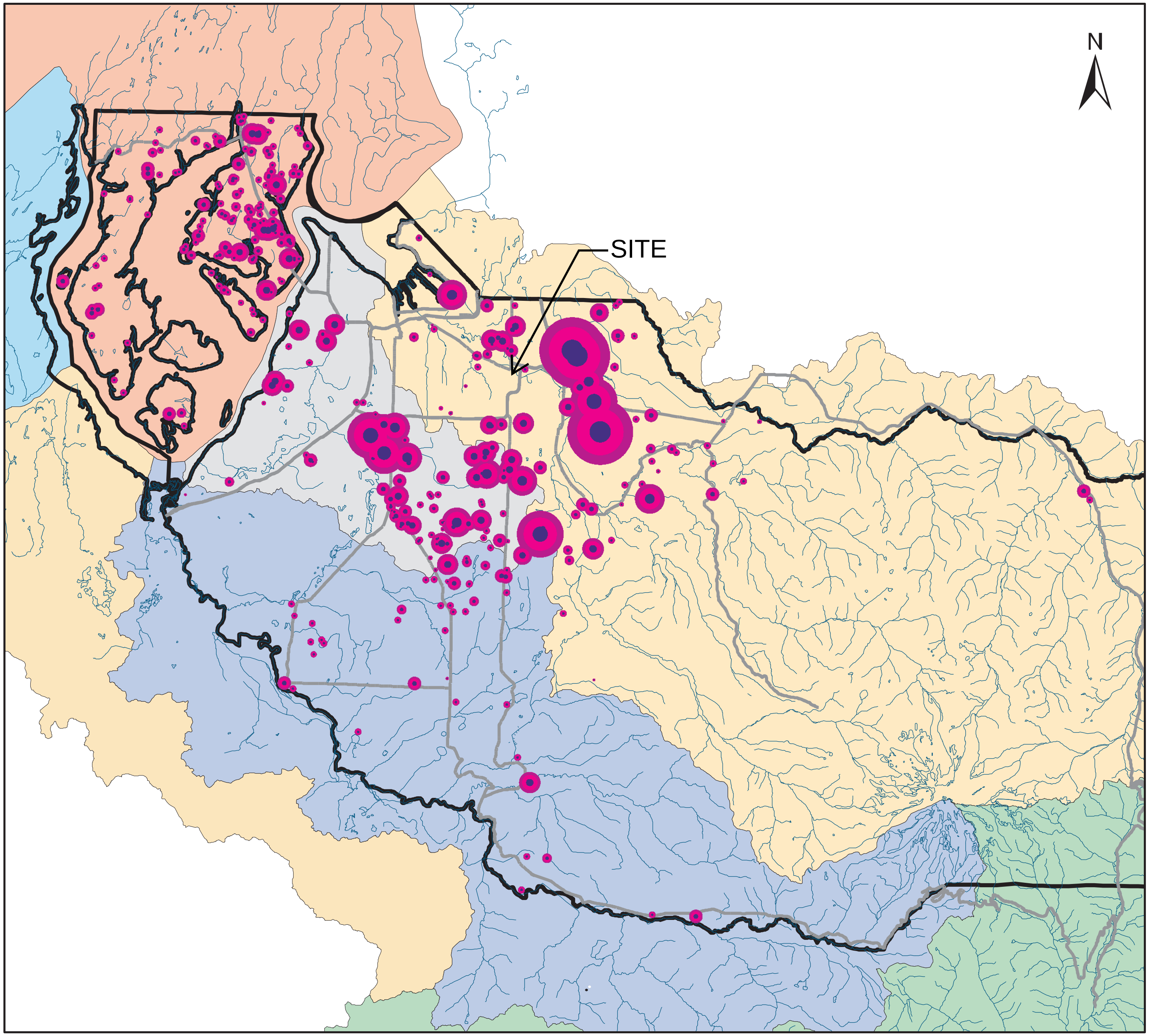
AQUIFER RECHARGE AREA MAP (FROM PIERCE COUNTY OPEN)

A-6

Fixed Wellhead Protection Zones

A-7

June 2007



Map Legend

- 1yr Fixed
- 5yr Fixed
- 10yr Fixed

WRIA

- Chambers-Clover
- Cowlitz
- Deschutes
- Kennedy-Goldsborough
- Kitsap
- Naches
- Puyallup-White
- Nisqually

0 3 6 12 Miles

Tacoma | Pierce County
Health Department
Healthier. Safer. Smarter.

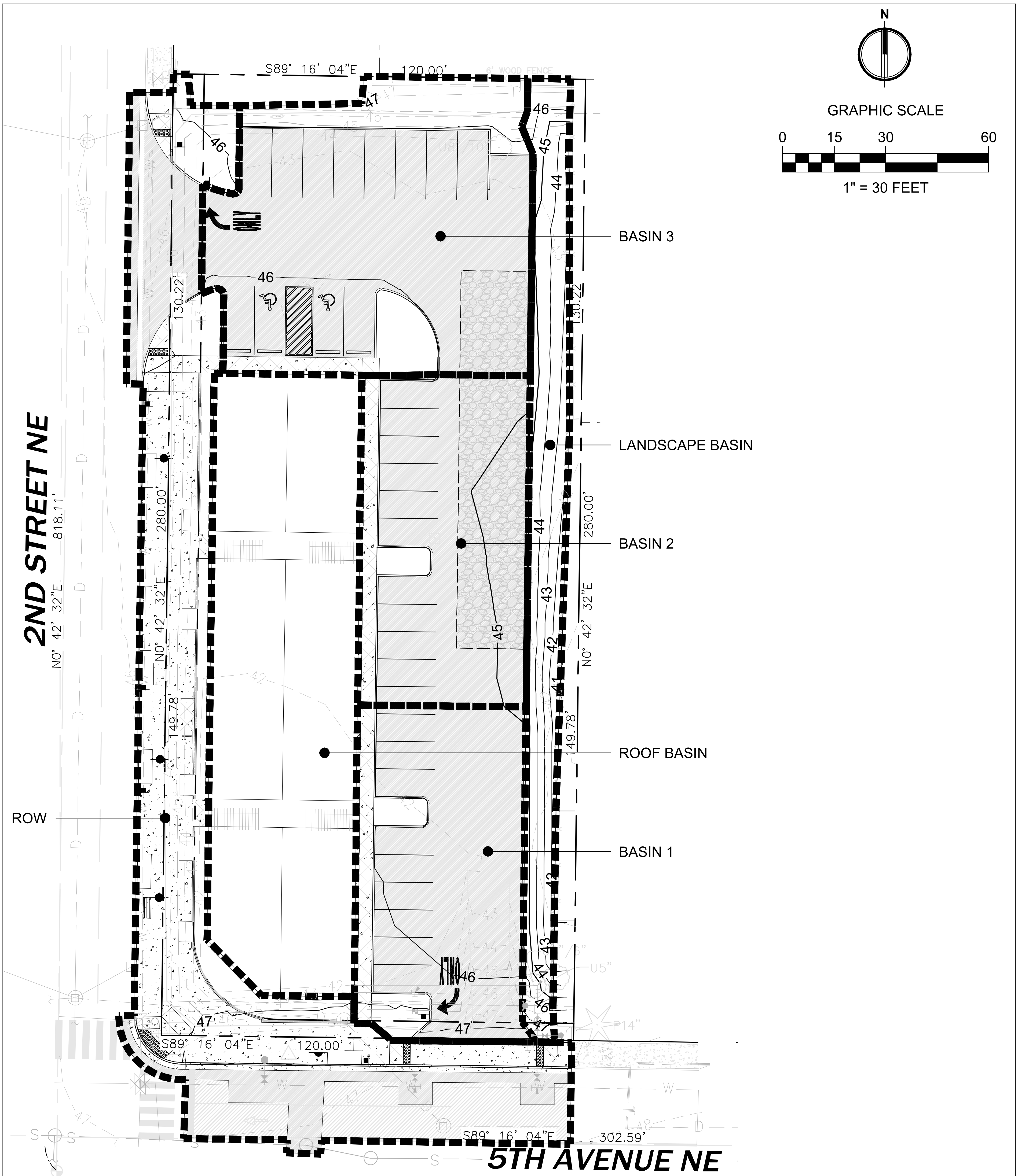
Pierce County
Geographic Information Services

The map features are approximate and are intended only to provide an indication of said feature. Additional areas that have not been mapped may be present. This is not a survey. The County assumes no liability for variations ascertained by actual survey. ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. The County makes no warranty of fitness for a particular purpose.

Appendix B

Exhibits

B-1 .... Basin Map
B-2 .... Infiltration Facilities Sizing WWHM Report
B-3 .... Water Quality Calculations
B-4 .... GULD Approval



BASIN AREA								
BASIN	PARKING	ROAD	SIDEWALK	PERM. SIDEWALK	ROOF	LAWN, FLAT	LAWN, STEEP	TOTAL
1	0.09 AC	-	0.01 AC	-	-	0.01 AC	-	0.11 AC
2	0.09 AC	-	0.01 AC	-	-	0.01 AC	-	0.11 AC
3	0.13 AC	-	0.005 AC	-	-	0.04 AC	-	0.17 AC
ROOF	-	-	-	-	0.18 AC	-	-	0.18 AC
LANDSCAPE	-	-	-	-	-	-	0.07 AC	0.07 AC
ROW	-	0.09 AC	0.01 AC	0.09 AC	-	0.06 AC	-	0.25 AC

AHBL
TACOMA SEATTLE
Civil Engineers
Structural Engineers
Landscape Architects
Community Planners
Land Surveyors
Neighbors
2215 North 30th Street, Suite 300, Tacoma, WA 98403 253.383.2422 TEL
316 Occidental Avenue South, Suite 320, Seattle, WA 98104 206.267.2425 TEL

PUYALLUP 2ND STREET APARTMENTS
2190606.10

BASIN MAP

B-1

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Infiltration
Site Name:	
Site Address:	
City:	
Report Date:	2/2/2024
Gage:	42 IN EAST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1,2,3, Roof

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	0.58
Pervious Total	0.58
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.58

Element Flows To:

Surface	Interflow	Groundwater

By-pass

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Steep	0.07
Pervious Total	0.07
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.07

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	0.01
Pervious Total	0.01
Impervious Land Use	acre
SIDEWALKS FLAT	0.01
PARKING FLAT	0.09
Impervious Total	0.1
Basin Total	0.11

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Basin 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	0.01
Pervious Total	0.01
Impervious Land Use	acre
SIDEWALKS FLAT	0.01
PARKING FLAT	0.09
Impervious Total	0.1
Basin Total	0.11

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Basin 3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	0.04
Pervious Total	0.04
Impervious Land Use	acre
SIDEWALKS FLAT	0.01
PARKING FLAT	0.13
Impervious Total	0.14
Basin Total	0.18

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Roof Basin

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROOF TOPS FLAT	0.18
Impervious Total	0.18
Basin Total	0.18

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Landscape Basin

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Steep	0.07
Pervious Total	0.07
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.07

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 2	Gravel Trench Bed 2	

Routing Elements
Predeveloped Routing

Mitigated Routing

Gravel Trench Bed 1

Bottom Length:	110.00 ft.
Bottom Width:	20.00 ft.
Trench bottom slope 1:	0.0000000001 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	1
Pour Space of material for first layer:	0.33
Material thickness of second layer:	1.5
Pour Space of material for second layer:	0.33
Material thickness of third layer:	1.5
Pour Space of material for third layer:	0.33
Infiltration On	
Infiltration rate:	1.4
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	247.769
Total Volume Through Riser (ac-ft.):	0.004
Total Volume Through Facility (ac-ft.):	247.773
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height: 4 ft.

Riser Diameter: 12 in.

Element Flows To:

Outlet 1 Outlet 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.050	0.000	0.000	0.000
0.0556	0.050	0.000	0.000	0.071
0.1111	0.050	0.001	0.000	0.071
0.1667	0.050	0.002	0.000	0.071
0.2222	0.050	0.003	0.000	0.071
0.2778	0.050	0.004	0.000	0.071
0.3333	0.050	0.005	0.000	0.071
0.3889	0.050	0.006	0.000	0.071
0.4444	0.050	0.007	0.000	0.071
0.5000	0.050	0.008	0.000	0.071
0.5556	0.050	0.009	0.000	0.071
0.6111	0.050	0.010	0.000	0.071
0.6667	0.050	0.011	0.000	0.071
0.7222	0.050	0.012	0.000	0.071
0.7778	0.050	0.013	0.000	0.071
0.8333	0.050	0.013	0.000	0.071
0.8889	0.050	0.014	0.000	0.071
0.9444	0.050	0.015	0.000	0.071
1.0000	0.050	0.016	0.000	0.071
1.0556	0.050	0.017	0.000	0.071
1.1111	0.050	0.018	0.000	0.071
1.1667	0.050	0.019	0.000	0.071
1.2222	0.050	0.020	0.000	0.071
1.2778	0.050	0.021	0.000	0.071

1.3333	0.050	0.022	0.000	0.071
1.3889	0.050	0.023	0.000	0.071
1.4444	0.050	0.024	0.000	0.071
1.5000	0.050	0.025	0.000	0.071
1.5556	0.050	0.025	0.000	0.071
1.6111	0.050	0.026	0.000	0.071
1.6667	0.050	0.027	0.000	0.071
1.7222	0.050	0.028	0.000	0.071
1.7778	0.050	0.029	0.000	0.071
1.8333	0.050	0.030	0.000	0.071
1.8889	0.050	0.031	0.000	0.071
1.9444	0.050	0.032	0.000	0.071
2.0000	0.050	0.033	0.000	0.071
2.0556	0.050	0.034	0.000	0.071
2.1111	0.050	0.035	0.000	0.071
2.1667	0.050	0.036	0.000	0.071
2.2222	0.050	0.037	0.000	0.071
2.2778	0.050	0.038	0.000	0.071
2.3333	0.050	0.038	0.000	0.071
2.3889	0.050	0.039	0.000	0.071
2.4444	0.050	0.040	0.000	0.071
2.5000	0.050	0.041	0.000	0.071
2.5556	0.050	0.042	0.000	0.071
2.6111	0.050	0.043	0.000	0.071
2.6667	0.050	0.044	0.000	0.071
2.7222	0.050	0.045	0.000	0.071
2.7778	0.050	0.046	0.000	0.071
2.8333	0.050	0.047	0.000	0.071
2.8889	0.050	0.048	0.000	0.071
2.9444	0.050	0.049	0.000	0.071
3.0000	0.050	0.050	0.000	0.071
3.0556	0.050	0.050	0.000	0.071
3.1111	0.050	0.051	0.000	0.071
3.1667	0.050	0.052	0.000	0.071
3.2222	0.050	0.053	0.000	0.071
3.2778	0.050	0.054	0.000	0.071
3.3333	0.050	0.055	0.000	0.071
3.3889	0.050	0.056	0.000	0.071
3.4444	0.050	0.057	0.000	0.071
3.5000	0.050	0.058	0.000	0.071
3.5556	0.050	0.059	0.000	0.071
3.6111	0.050	0.060	0.000	0.071
3.6667	0.050	0.061	0.000	0.071
3.7222	0.050	0.062	0.000	0.071
3.7778	0.050	0.063	0.000	0.071
3.8333	0.050	0.063	0.000	0.071
3.8889	0.050	0.064	0.000	0.071
3.9444	0.050	0.065	0.000	0.071
4.0000	0.050	0.066	0.000	0.071
4.0556	0.050	0.069	0.138	0.071
4.1111	0.050	0.072	0.389	0.071
4.1667	0.050	0.075	0.703	0.071
4.2222	0.050	0.077	1.046	0.071
4.2778	0.050	0.080	1.383	0.071
4.3333	0.050	0.083	1.683	0.071
4.3889	0.050	0.086	1.921	0.071
4.4444	0.050	0.089	2.088	0.071
4.5000	0.050	0.091	2.203	0.071

4.5556	0.050	0.094	2.347	0.071
4.6111	0.050	0.097	2.462	0.071
4.6667	0.050	0.100	2.571	0.071
4.7222	0.050	0.103	2.676	0.071
4.7778	0.050	0.105	2.777	0.071
4.8333	0.050	0.108	2.875	0.071
4.8889	0.050	0.111	2.969	0.071
4.9444	0.050	0.114	3.060	0.071
5.0000	0.050	0.117	3.149	0.071

Gravel Trench Bed 2

Bottom Length:	253.90 ft.
Bottom Width:	1.00 ft.
Trench bottom slope 1:	1 To 1
Trench Left side slope 0:	1 To 1
Trench right side slope 2:	1 To 1
Material thickness of first layer:	0
Pour Space of material for first layer:	0
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	1.4
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	15.141
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	15.141
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height: 0 ft.

Riser Diameter: 0 in.

Element Flows To:

Outlet 1 Outlet 2

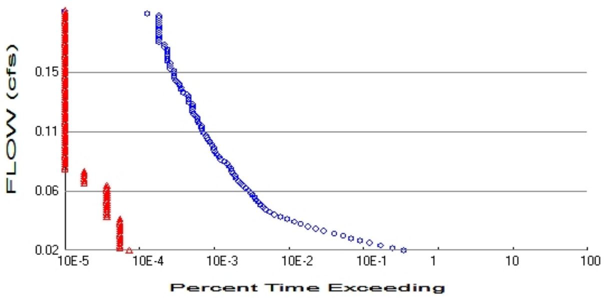
Gravel Trench Bed Hydraulic Table

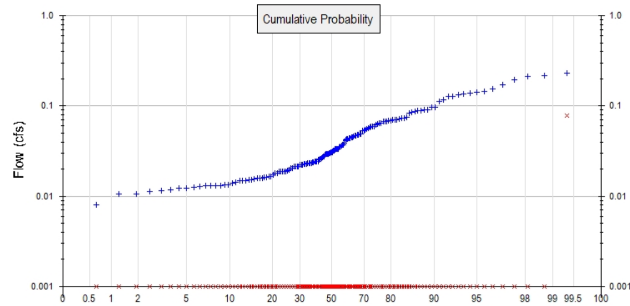
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.005	0.000	0.000	0.000
0.0111	0.006	0.000	0.000	0.008
0.0222	0.006	0.000	0.000	0.008
0.0333	0.006	0.000	0.000	0.008
0.0444	0.006	0.000	0.000	0.008
0.0556	0.006	0.000	0.000	0.008
0.0667	0.006	0.000	0.000	0.008
0.0778	0.006	0.000	0.000	0.008
0.0889	0.006	0.000	0.000	0.008
0.1000	0.007	0.000	0.000	0.008
0.1111	0.007	0.000	0.000	0.008
0.1222	0.007	0.000	0.000	0.008
0.1333	0.007	0.000	0.000	0.008
0.1444	0.007	0.001	0.000	0.008
0.1556	0.007	0.001	0.000	0.008
0.1667	0.007	0.001	0.000	0.008
0.1778	0.007	0.001	0.000	0.008
0.1889	0.008	0.001	0.000	0.008
0.2000	0.008	0.001	0.000	0.008
0.2111	0.008	0.001	0.000	0.008
0.2222	0.008	0.001	0.000	0.008
0.2333	0.008	0.001	0.000	0.008
0.2444	0.008	0.001	0.000	0.008
0.2556	0.008	0.001	0.000	0.008
0.2667	0.009	0.002	0.000	0.008
0.2778	0.009	0.002	0.000	0.008

0.2889	0.009	0.002	0.000	0.008
0.3000	0.009	0.002	0.000	0.008
0.3111	0.009	0.002	0.000	0.008
0.3222	0.009	0.002	0.000	0.008
0.3333	0.009	0.002	0.000	0.008
0.3444	0.009	0.002	0.000	0.008
0.3556	0.010	0.002	0.000	0.008
0.3667	0.010	0.002	0.000	0.008
0.3778	0.010	0.003	0.000	0.008
0.3889	0.010	0.003	0.000	0.008
0.4000	0.010	0.003	0.000	0.008
0.4111	0.010	0.003	0.000	0.008
0.4222	0.010	0.003	0.000	0.008
0.4333	0.010	0.003	0.000	0.008
0.4444	0.011	0.003	0.000	0.008
0.4556	0.011	0.003	0.000	0.008
0.4667	0.011	0.004	0.000	0.008
0.4778	0.011	0.004	0.000	0.008
0.4889	0.011	0.004	0.000	0.008
0.5000	0.011	0.004	0.000	0.008
0.5111	0.011	0.004	0.000	0.008
0.5222	0.012	0.004	0.000	0.008
0.5333	0.012	0.004	0.000	0.008
0.5444	0.012	0.004	0.000	0.008
0.5556	0.012	0.005	0.000	0.008
0.5667	0.012	0.005	0.000	0.008
0.5778	0.012	0.005	0.000	0.008
0.5889	0.012	0.005	0.000	0.008
0.6000	0.012	0.005	0.000	0.008
0.6111	0.013	0.005	0.000	0.008
0.6222	0.013	0.005	0.000	0.008
0.6333	0.013	0.006	0.000	0.008
0.6444	0.013	0.006	0.000	0.008
0.6556	0.013	0.006	0.000	0.008
0.6667	0.013	0.006	0.000	0.008
0.6778	0.013	0.006	0.000	0.008
0.6889	0.013	0.006	0.000	0.008
0.7000	0.014	0.007	0.000	0.008
0.7111	0.014	0.007	0.000	0.008
0.7222	0.014	0.007	0.000	0.008
0.7333	0.014	0.007	0.000	0.008
0.7444	0.014	0.007	0.000	0.008
0.7556	0.014	0.007	0.000	0.008
0.7667	0.014	0.007	0.000	0.008
0.7778	0.015	0.008	0.000	0.008
0.7889	0.015	0.008	0.000	0.008
0.8000	0.015	0.008	0.000	0.008
0.8111	0.015	0.008	0.000	0.008
0.8222	0.015	0.008	0.000	0.008
0.8333	0.015	0.008	0.000	0.008
0.8444	0.015	0.009	0.000	0.008
0.8556	0.015	0.009	0.000	0.008
0.8667	0.016	0.009	0.000	0.008
0.8778	0.016	0.009	0.000	0.008
0.8889	0.016	0.009	0.000	0.008
0.9000	0.016	0.010	0.000	0.008
0.9111	0.016	0.010	0.000	0.008
0.9222	0.016	0.010	0.000	0.008

0.9333	0.016	0.010	0.000	0.008
0.9444	0.017	0.010	0.000	0.008
0.9556	0.017	0.010	0.000	0.008
0.9667	0.017	0.011	0.000	0.008
0.9778	0.017	0.011	0.000	0.008
0.9889	0.017	0.011	0.000	0.008
1.0000	0.017	0.011	0.000	0.008

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.58
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.06
Total Impervious Area: 0.52

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.033071
5 year	0.065044
10 year	0.09543
25 year	0.146973
50 year	0.196784
100 year	0.258105

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.021	0.000
1903	0.015	0.000
1904	0.112	0.000
1905	0.019	0.000
1906	0.008	0.000
1907	0.060	0.000
1908	0.024	0.000
1909	0.033	0.000
1910	0.069	0.000
1911	0.046	0.000

1912	0.234	0.000
1913	0.029	0.000
1914	0.196	0.000
1915	0.016	0.000
1916	0.037	0.000
1917	0.011	0.000
1918	0.021	0.000
1919	0.019	0.000
1920	0.042	0.000
1921	0.031	0.000
1922	0.076	0.000
1923	0.036	0.000
1924	0.015	0.000
1925	0.015	0.000
1926	0.027	0.000
1927	0.015	0.000
1928	0.021	0.000
1929	0.065	0.000
1930	0.019	0.000
1931	0.021	0.000
1932	0.023	0.000
1933	0.028	0.000
1934	0.097	0.000
1935	0.018	0.000
1936	0.030	0.000
1937	0.074	0.000
1938	0.021	0.000
1939	0.008	0.000
1940	0.029	0.000
1941	0.013	0.000
1942	0.070	0.000
1943	0.032	0.000
1944	0.088	0.000
1945	0.025	0.000
1946	0.048	0.000
1947	0.012	0.000
1948	0.049	0.000
1949	0.048	0.000
1950	0.014	0.000
1951	0.017	0.000
1952	0.173	0.000
1953	0.137	0.000
1954	0.025	0.000
1955	0.016	0.000
1956	0.010	0.000
1957	0.024	0.000
1958	0.085	0.000
1959	0.073	0.000
1960	0.015	0.000
1961	0.128	0.000
1962	0.026	0.000
1963	0.014	0.000
1964	0.138	0.000
1965	0.059	0.000
1966	0.017	0.000
1967	0.067	0.000
1968	0.024	0.000
1969	0.026	0.000

1970	0.054	0.000
1971	0.064	0.000
1972	0.215	0.000
1973	0.058	0.000
1974	0.063	0.000
1975	0.142	0.000
1976	0.096	0.000
1977	0.013	0.000
1978	0.090	0.000
1979	0.044	0.000
1980	0.069	0.000
1981	0.029	0.000
1982	0.016	0.000
1983	0.057	0.000
1984	0.049	0.000
1985	0.088	0.000
1986	0.023	0.000
1987	0.071	0.000
1988	0.023	0.000
1989	0.023	0.000
1990	0.033	0.000
1991	0.053	0.000
1992	0.047	0.000
1993	0.030	0.000
1994	0.056	0.000
1995	0.016	0.000
1996	0.062	0.000
1997	0.022	0.000
1998	0.053	0.000
1999	0.012	0.000
2000	0.031	0.000
2001	0.016	0.000
2002	0.134	0.000
2003	0.034	0.000
2004	0.044	0.000
2005	0.145	0.000
2006	0.015	0.000
2007	0.042	0.000
2008	0.035	0.000
2009	0.017	0.000
2010	0.024	0.000
2011	0.011	0.000
2012	0.030	0.000
2013	0.043	0.000
2014	0.027	0.000
2015	0.128	0.000
2016	0.013	0.000
2017	0.036	0.000
2018	0.083	0.000
2019	0.117	0.078
2020	0.059	0.000
2021	0.045	0.000
2022	0.037	0.000
2023	0.039	0.000
2024	0.215	0.000
2025	0.022	0.000
2026	0.045	0.000
2027	0.023	0.000

2028	0.013	0.000
2029	0.032	0.000
2030	0.068	0.000
2031	0.013	0.000
2032	0.012	0.000
2033	0.013	0.000
2034	0.019	0.000
2035	0.070	0.000
2036	0.030	0.000
2037	0.013	0.000
2038	0.072	0.000
2039	0.012	0.000
2040	0.022	0.000
2041	0.030	0.000
2042	0.067	0.000
2043	0.046	0.000
2044	0.043	0.000
2045	0.023	0.000
2046	0.024	0.000
2047	0.019	0.000
2048	0.023	0.000
2049	0.033	0.000
2050	0.034	0.000
2051	0.090	0.000
2052	0.018	0.000
2053	0.024	0.000
2054	0.155	0.000
2055	0.020	0.000
2056	0.012	0.000
2057	0.019	0.000
2058	0.019	0.000
2059	0.088	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.2338	0.0783
2	0.2150	0.0000
3	0.2147	0.0000
4	0.1956	0.0000
5	0.1735	0.0000
6	0.1548	0.0000
7	0.1453	0.0000
8	0.1422	0.0000
9	0.1383	0.0000
10	0.1366	0.0000
11	0.1341	0.0000
12	0.1283	0.0000
13	0.1282	0.0000
14	0.1174	0.0000
15	0.1124	0.0000
16	0.0971	0.0000
17	0.0962	0.0000
18	0.0903	0.0000
19	0.0902	0.0000
20	0.0885	0.0000
21	0.0884	0.0000
22	0.0876	0.0000

23	0.0850	0.0000
24	0.0835	0.0000
25	0.0755	0.0000
26	0.0741	0.0000
27	0.0731	0.0000
28	0.0720	0.0000
29	0.0710	0.0000
30	0.0700	0.0000
31	0.0698	0.0000
32	0.0690	0.0000
33	0.0686	0.0000
34	0.0678	0.0000
35	0.0673	0.0000
36	0.0672	0.0000
37	0.0648	0.0000
38	0.0642	0.0000
39	0.0626	0.0000
40	0.0624	0.0000
41	0.0596	0.0000
42	0.0590	0.0000
43	0.0590	0.0000
44	0.0582	0.0000
45	0.0566	0.0000
46	0.0556	0.0000
47	0.0540	0.0000
48	0.0530	0.0000
49	0.0528	0.0000
50	0.0494	0.0000
51	0.0493	0.0000
52	0.0484	0.0000
53	0.0481	0.0000
54	0.0469	0.0000
55	0.0465	0.0000
56	0.0463	0.0000
57	0.0454	0.0000
58	0.0451	0.0000
59	0.0438	0.0000
60	0.0437	0.0000
61	0.0434	0.0000
62	0.0431	0.0000
63	0.0420	0.0000
64	0.0417	0.0000
65	0.0385	0.0000
66	0.0370	0.0000
67	0.0370	0.0000
68	0.0364	0.0000
69	0.0357	0.0000
70	0.0347	0.0000
71	0.0336	0.0000
72	0.0336	0.0000
73	0.0334	0.0000
74	0.0332	0.0000
75	0.0331	0.0000
76	0.0320	0.0000
77	0.0318	0.0000
78	0.0308	0.0000
79	0.0307	0.0000
80	0.0305	0.0000

81	0.0302	0.0000
82	0.0298	0.0000
83	0.0297	0.0000
84	0.0296	0.0000
85	0.0295	0.0000
86	0.0295	0.0000
87	0.0291	0.0000
88	0.0276	0.0000
89	0.0275	0.0000
90	0.0268	0.0000
91	0.0261	0.0000
92	0.0261	0.0000
93	0.0254	0.0000
94	0.0253	0.0000
95	0.0244	0.0000
96	0.0244	0.0000
97	0.0242	0.0000
98	0.0241	0.0000
99	0.0239	0.0000
100	0.0238	0.0000
101	0.0231	0.0000
102	0.0231	0.0000
103	0.0231	0.0000
104	0.0230	0.0000
105	0.0230	0.0000
106	0.0226	0.0000
107	0.0225	0.0000
108	0.0225	0.0000
109	0.0224	0.0000
110	0.0224	0.0000
111	0.0215	0.0000
112	0.0214	0.0000
113	0.0214	0.0000
114	0.0213	0.0000
115	0.0206	0.0000
116	0.0203	0.0000
117	0.0195	0.0000
118	0.0192	0.0000
119	0.0189	0.0000
120	0.0189	0.0000
121	0.0188	0.0000
122	0.0188	0.0000
123	0.0187	0.0000
124	0.0182	0.0000
125	0.0178	0.0000
126	0.0173	0.0000
127	0.0166	0.0000
128	0.0166	0.0000
129	0.0163	0.0000
130	0.0163	0.0000
131	0.0159	0.0000
132	0.0158	0.0000
133	0.0157	0.0000
134	0.0154	0.0000
135	0.0153	0.0000
136	0.0152	0.0000
137	0.0149	0.0000
138	0.0149	0.0000

139	0.0148	0.0000
140	0.0142	0.0000
141	0.0141	0.0000
142	0.0135	0.0000
143	0.0133	0.0000
144	0.0132	0.0000
145	0.0132	0.0000
146	0.0131	0.0000
147	0.0131	0.0000
148	0.0127	0.0000
149	0.0124	0.0000
150	0.0123	0.0000
151	0.0122	0.0000
152	0.0117	0.0000
153	0.0115	0.0000
154	0.0114	0.0000
155	0.0107	0.0000
156	0.0105	0.0000
157	0.0081	0.0000
158	0.0079	0.0000

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0165	19080	4	0	Pass
0.0184	13446	3	0	Pass
0.0202	9435	3	0	Pass
0.0220	6692	3	0	Pass
0.0238	4964	3	0	Pass
0.0256	3757	3	0	Pass
0.0275	2948	3	0	Pass
0.0293	2241	3	0	Pass
0.0311	1623	3	0	Pass
0.0329	1263	3	0	Pass
0.0347	990	3	0	Pass
0.0366	792	3	0	Pass
0.0384	649	3	0	Pass
0.0402	523	3	0	Pass
0.0420	426	2	0	Pass
0.0438	350	2	0	Pass
0.0457	307	2	0	Pass
0.0475	268	2	0	Pass
0.0493	250	2	0	Pass
0.0511	228	2	0	Pass
0.0529	216	2	0	Pass
0.0548	204	2	0	Pass
0.0566	193	2	1	Pass
0.0584	179	2	1	Pass
0.0602	172	2	1	Pass
0.0621	158	2	1	Pass
0.0639	146	2	1	Pass
0.0657	135	2	1	Pass
0.0675	124	1	0	Pass
0.0693	116	1	0	Pass
0.0712	108	1	0	Pass
0.0730	105	1	0	Pass
0.0748	98	1	1	Pass
0.0766	95	1	1	Pass
0.0784	93	0	0	Pass
0.0803	88	0	0	Pass
0.0821	83	0	0	Pass
0.0839	76	0	0	Pass
0.0857	67	0	0	Pass
0.0875	64	0	0	Pass
0.0894	60	0	0	Pass
0.0912	57	0	0	Pass
0.0930	54	0	0	Pass
0.0948	54	0	0	Pass
0.0966	52	0	0	Pass
0.0985	48	0	0	Pass
0.1003	46	0	0	Pass
0.1021	44	0	0	Pass
0.1039	43	0	0	Pass
0.1057	40	0	0	Pass
0.1076	38	0	0	Pass
0.1094	37	0	0	Pass
0.1112	37	0	0	Pass

0.1130	35	0	0	Pass
0.1149	33	0	0	Pass
0.1167	33	0	0	Pass
0.1185	31	0	0	Pass
0.1203	29	0	0	Pass
0.1221	28	0	0	Pass
0.1240	28	0	0	Pass
0.1258	28	0	0	Pass
0.1276	28	0	0	Pass
0.1294	25	0	0	Pass
0.1312	25	0	0	Pass
0.1331	25	0	0	Pass
0.1349	24	0	0	Pass
0.1367	21	0	0	Pass
0.1385	20	0	0	Pass
0.1403	20	0	0	Pass
0.1422	19	0	0	Pass
0.1440	18	0	0	Pass
0.1458	17	0	0	Pass
0.1476	16	0	0	Pass
0.1494	16	0	0	Pass
0.1513	16	0	0	Pass
0.1531	16	0	0	Pass
0.1549	14	0	0	Pass
0.1567	14	0	0	Pass
0.1585	14	0	0	Pass
0.1604	13	0	0	Pass
0.1622	13	0	0	Pass
0.1640	13	0	0	Pass
0.1658	13	0	0	Pass
0.1677	13	0	0	Pass
0.1695	13	0	0	Pass
0.1713	12	0	0	Pass
0.1731	12	0	0	Pass
0.1749	10	0	0	Pass
0.1768	10	0	0	Pass
0.1786	10	0	0	Pass
0.1804	10	0	0	Pass
0.1822	10	0	0	Pass
0.1840	10	0	0	Pass
0.1859	10	0	0	Pass
0.1877	10	0	0	Pass
0.1895	10	0	0	Pass
0.1913	10	0	0	Pass
0.1931	10	0	0	Pass
0.1950	10	0	0	Pass
0.1968	7	0	0	Pass

Water Quality

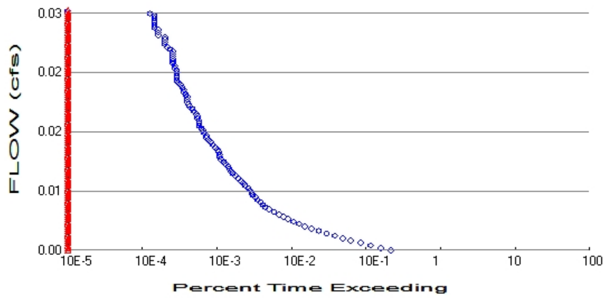
Water Quality BMP Flow and Volume for POC #1

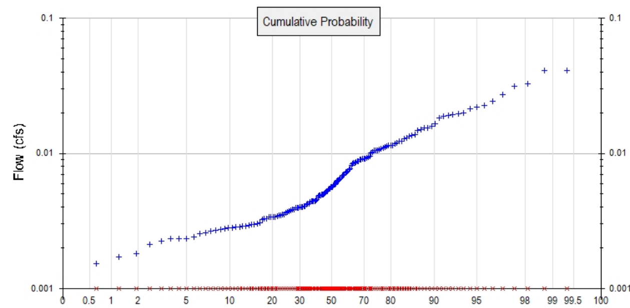
On-line facility volume:	0.0126 acre-feet
On-line facility target flow:	0.017 cfs.
Adjusted for 15 min:	0.017 cfs.
Off-line facility target flow:	0.0099 cfs.
Adjusted for 15 min:	0.0099 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Gravel Trench Bed 1 POC	☐	225.47			☐	100.00			
Total Volume Infiltrated		225.47	0.00	0.00		100.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 0.07
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.07
Total Impervious Area: 0

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.00596
5 year	0.01111
10 year	0.015811
25 year	0.023529
50 year	0.030782
100 year	0.039514

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1902	0.004	0.000
1903	0.003	0.000
1904	0.020	0.000
1905	0.003	0.000
1906	0.001	0.000
1907	0.010	0.000
1908	0.005	0.000
1909	0.006	0.000
1910	0.010	0.000
1911	0.007	0.000
1912	0.033	0.000

1913	0.004	0.000
1914	0.041	0.000
1915	0.003	0.000
1916	0.007	0.000
1917	0.002	0.000
1918	0.003	0.000
1919	0.003	0.000
1920	0.007	0.000
1921	0.005	0.000
1922	0.013	0.000
1923	0.005	0.000
1924	0.003	0.000
1925	0.003	0.000
1926	0.005	0.000
1927	0.003	0.000
1928	0.004	0.000
1929	0.012	0.000
1930	0.004	0.000
1931	0.004	0.000
1932	0.005	0.000
1933	0.005	0.000
1934	0.015	0.000
1935	0.003	0.000
1936	0.005	0.000
1937	0.012	0.000
1938	0.004	0.000
1939	0.002	0.000
1940	0.006	0.000
1941	0.004	0.000
1942	0.011	0.000
1943	0.006	0.000
1944	0.015	0.000
1945	0.004	0.000
1946	0.009	0.000
1947	0.003	0.000
1948	0.009	0.000
1949	0.008	0.000
1950	0.003	0.000
1951	0.003	0.000
1952	0.023	0.000
1953	0.019	0.000
1954	0.005	0.000
1955	0.003	0.000
1956	0.002	0.000
1957	0.004	0.000
1958	0.013	0.000
1959	0.011	0.000
1960	0.003	0.000
1961	0.022	0.000
1962	0.005	0.000
1963	0.003	0.000
1964	0.027	0.000
1965	0.009	0.000
1966	0.003	0.000
1967	0.012	0.000
1968	0.004	0.000
1969	0.005	0.000
1970	0.010	0.000

1971	0.009	0.000
1972	0.041	0.000
1973	0.009	0.000
1974	0.010	0.000
1975	0.019	0.000
1976	0.016	0.000
1977	0.002	0.000
1978	0.013	0.000
1979	0.008	0.000
1980	0.011	0.000
1981	0.005	0.000
1982	0.003	0.000
1983	0.009	0.000
1984	0.009	0.000
1985	0.015	0.000
1986	0.004	0.000
1987	0.012	0.000
1988	0.004	0.000
1989	0.004	0.000
1990	0.007	0.000
1991	0.011	0.000
1992	0.008	0.000
1993	0.006	0.000
1994	0.009	0.000
1995	0.003	0.000
1996	0.009	0.000
1997	0.004	0.000
1998	0.009	0.000
1999	0.003	0.000
2000	0.006	0.000
2001	0.003	0.000
2002	0.019	0.000
2003	0.006	0.000
2004	0.008	0.000
2005	0.021	0.000
2006	0.003	0.000
2007	0.009	0.000
2008	0.007	0.000
2009	0.003	0.000
2010	0.004	0.000
2011	0.002	0.000
2012	0.006	0.000
2013	0.007	0.000
2014	0.004	0.000
2015	0.018	0.000
2016	0.003	0.000
2017	0.006	0.000
2018	0.011	0.000
2019	0.020	0.000
2020	0.010	0.000
2021	0.008	0.000
2022	0.014	0.000
2023	0.007	0.000
2024	0.032	0.000
2025	0.004	0.000
2026	0.011	0.000
2027	0.004	0.000
2028	0.002	0.000

2029	0.005	0.000
2030	0.016	0.000
2031	0.002	0.000
2032	0.003	0.000
2033	0.002	0.000
2034	0.004	0.000
2035	0.011	0.000
2036	0.005	0.000
2037	0.002	0.000
2038	0.012	0.000
2039	0.005	0.000
2040	0.004	0.000
2041	0.006	0.000
2042	0.012	0.000
2043	0.007	0.000
2044	0.007	0.000
2045	0.005	0.000
2046	0.005	0.000
2047	0.004	0.000
2048	0.004	0.000
2049	0.006	0.000
2050	0.006	0.000
2051	0.014	0.000
2052	0.003	0.000
2053	0.004	0.000
2054	0.024	0.000
2055	0.004	0.000
2056	0.004	0.000
2057	0.003	0.000
2058	0.003	0.000
2059	0.015	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	0.0413	0.0000
2	0.0408	0.0000
3	0.0325	0.0000
4	0.0316	0.0000
5	0.0271	0.0000
6	0.0242	0.0000
7	0.0227	0.0000
8	0.0219	0.0000
9	0.0215	0.0000
10	0.0200	0.0000
11	0.0196	0.0000
12	0.0195	0.0000
13	0.0191	0.0000
14	0.0189	0.0000
15	0.0183	0.0000
16	0.0165	0.0000
17	0.0159	0.0000
18	0.0154	0.0000
19	0.0153	0.0000
20	0.0150	0.0000
21	0.0148	0.0000
22	0.0138	0.0000
23	0.0136	0.0000

24	0.0134	0.0000
25	0.0130	0.0000
26	0.0129	0.0000
27	0.0124	0.0000
28	0.0123	0.0000
29	0.0119	0.0000
30	0.0117	0.0000
31	0.0115	0.0000
32	0.0115	0.0000
33	0.0114	0.0000
34	0.0113	0.0000
35	0.0111	0.0000
36	0.0111	0.0000
37	0.0108	0.0000
38	0.0107	0.0000
39	0.0105	0.0000
40	0.0105	0.0000
41	0.0104	0.0000
42	0.0102	0.0000
43	0.0100	0.0000
44	0.0095	0.0000
45	0.0094	0.0000
46	0.0092	0.0000
47	0.0092	0.0000
48	0.0092	0.0000
49	0.0091	0.0000
50	0.0090	0.0000
51	0.0090	0.0000
52	0.0087	0.0000
53	0.0087	0.0000
54	0.0087	0.0000
55	0.0085	0.0000
56	0.0085	0.0000
57	0.0084	0.0000
58	0.0082	0.0000
59	0.0076	0.0000
60	0.0076	0.0000
61	0.0073	0.0000
62	0.0073	0.0000
63	0.0073	0.0000
64	0.0072	0.0000
65	0.0069	0.0000
66	0.0069	0.0000
67	0.0068	0.0000
68	0.0066	0.0000
69	0.0065	0.0000
70	0.0064	0.0000
71	0.0063	0.0000
72	0.0063	0.0000
73	0.0062	0.0000
74	0.0060	0.0000
75	0.0059	0.0000
76	0.0058	0.0000
77	0.0058	0.0000
78	0.0057	0.0000
79	0.0056	0.0000
80	0.0056	0.0000
81	0.0055	0.0000

82	0.0054	0.0000
83	0.0054	0.0000
84	0.0052	0.0000
85	0.0052	0.0000
86	0.0051	0.0000
87	0.0051	0.0000
88	0.0050	0.0000
89	0.0050	0.0000
90	0.0050	0.0000
91	0.0049	0.0000
92	0.0049	0.0000
93	0.0049	0.0000
94	0.0048	0.0000
95	0.0047	0.0000
96	0.0046	0.0000
97	0.0045	0.0000
98	0.0045	0.0000
99	0.0044	0.0000
100	0.0044	0.0000
101	0.0044	0.0000
102	0.0043	0.0000
103	0.0042	0.0000
104	0.0042	0.0000
105	0.0042	0.0000
106	0.0041	0.0000
107	0.0040	0.0000
108	0.0040	0.0000
109	0.0040	0.0000
110	0.0040	0.0000
111	0.0040	0.0000
112	0.0039	0.0000
113	0.0039	0.0000
114	0.0039	0.0000
115	0.0038	0.0000
116	0.0038	0.0000
117	0.0037	0.0000
118	0.0037	0.0000
119	0.0036	0.0000
120	0.0035	0.0000
121	0.0035	0.0000
122	0.0035	0.0000
123	0.0035	0.0000
124	0.0034	0.0000
125	0.0034	0.0000
126	0.0034	0.0000
127	0.0034	0.0000
128	0.0034	0.0000
129	0.0033	0.0000
130	0.0033	0.0000
131	0.0033	0.0000
132	0.0030	0.0000
133	0.0030	0.0000
134	0.0030	0.0000
135	0.0030	0.0000
136	0.0029	0.0000
137	0.0029	0.0000
138	0.0029	0.0000
139	0.0029	0.0000

140	0.0029	0.0000
141	0.0028	0.0000
142	0.0028	0.0000
143	0.0028	0.0000
144	0.0027	0.0000
145	0.0027	0.0000
146	0.0026	0.0000
147	0.0026	0.0000
148	0.0025	0.0000
149	0.0024	0.0000
150	0.0023	0.0000
151	0.0023	0.0000
152	0.0023	0.0000
153	0.0022	0.0000
154	0.0021	0.0000
155	0.0018	0.0000
156	0.0017	0.0000
157	0.0015	0.0000
158	0.0015	0.0000

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0030	11955	0	0	Pass
0.0033	8781	0	0	Pass
0.0035	6343	0	0	Pass
0.0038	4646	0	0	Pass
0.0041	3443	0	0	Pass
0.0044	2690	0	0	Pass
0.0047	2107	0	0	Pass
0.0049	1630	0	0	Pass
0.0052	1289	0	0	Pass
0.0055	1016	0	0	Pass
0.0058	839	0	0	Pass
0.0061	698	0	0	Pass
0.0063	595	0	0	Pass
0.0066	500	0	0	Pass
0.0069	429	0	0	Pass
0.0072	377	0	0	Pass
0.0075	322	0	0	Pass
0.0078	274	0	0	Pass
0.0080	244	0	0	Pass
0.0083	227	0	0	Pass
0.0086	213	0	0	Pass
0.0089	194	0	0	Pass
0.0092	184	0	0	Pass
0.0094	167	0	0	Pass
0.0097	161	0	0	Pass
0.0100	153	0	0	Pass
0.0103	145	0	0	Pass
0.0106	132	0	0	Pass
0.0108	126	0	0	Pass
0.0111	117	0	0	Pass
0.0114	107	0	0	Pass
0.0117	98	0	0	Pass
0.0120	90	0	0	Pass
0.0122	85	0	0	Pass
0.0125	81	0	0	Pass
0.0128	78	0	0	Pass
0.0131	72	0	0	Pass
0.0134	68	0	0	Pass
0.0137	63	0	0	Pass
0.0139	61	0	0	Pass
0.0142	60	0	0	Pass
0.0145	58	0	0	Pass
0.0148	57	0	0	Pass
0.0151	53	0	0	Pass
0.0153	49	0	0	Pass
0.0156	46	0	0	Pass
0.0159	43	0	0	Pass
0.0162	40	0	0	Pass
0.0165	40	0	0	Pass
0.0167	37	0	0	Pass
0.0170	36	0	0	Pass
0.0173	34	0	0	Pass
0.0176	32	0	0	Pass

0.0179	32	0	0	Pass
0.0181	32	0	0	Pass
0.0184	30	0	0	Pass
0.0187	30	0	0	Pass
0.0190	29	0	0	Pass
0.0193	27	0	0	Pass
0.0195	26	0	0	Pass
0.0198	24	0	0	Pass
0.0201	23	0	0	Pass
0.0204	22	0	0	Pass
0.0207	22	0	0	Pass
0.0210	22	0	0	Pass
0.0212	21	0	0	Pass
0.0215	20	0	0	Pass
0.0218	20	0	0	Pass
0.0221	19	0	0	Pass
0.0224	18	0	0	Pass
0.0226	17	0	0	Pass
0.0229	16	0	0	Pass
0.0232	16	0	0	Pass
0.0235	16	0	0	Pass
0.0238	16	0	0	Pass
0.0240	16	0	0	Pass
0.0243	15	0	0	Pass
0.0246	15	0	0	Pass
0.0249	14	0	0	Pass
0.0252	14	0	0	Pass
0.0254	14	0	0	Pass
0.0257	14	0	0	Pass
0.0260	14	0	0	Pass
0.0263	14	0	0	Pass
0.0266	13	0	0	Pass
0.0269	12	0	0	Pass
0.0271	11	0	0	Pass
0.0274	11	0	0	Pass
0.0277	11	0	0	Pass
0.0280	11	0	0	Pass
0.0283	9	0	0	Pass
0.0285	9	0	0	Pass
0.0288	9	0	0	Pass
0.0291	8	0	0	Pass
0.0294	8	0	0	Pass
0.0297	8	0	0	Pass
0.0299	8	0	0	Pass
0.0302	8	0	0	Pass
0.0305	8	0	0	Pass
0.0308	7	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0.0078 acre-feet
On-line facility target flow:	0.0109 cfs.
Adjusted for 15 min:	0.0109 cfs.
Off-line facility target flow:	0.0063 cfs.
Adjusted for 15 min:	0.0063 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Gravel Trench Bed 2 POC	☐	13.78			☐	100.00			
Total Volume Infiltrated		13.78	0.00	0.00		100.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 4

POC #4 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 5

POC #5 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

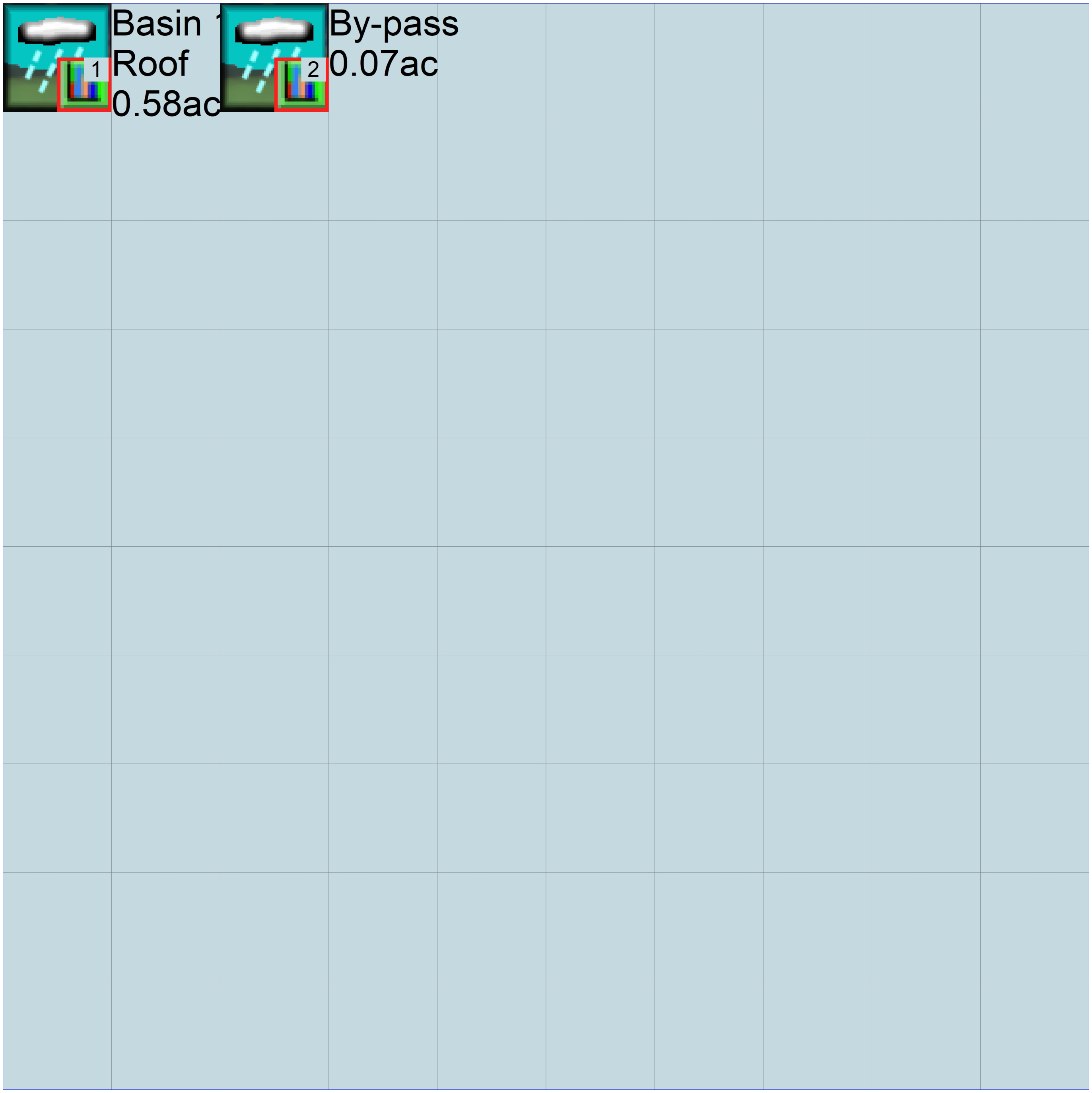
PERLND Changes

No PERLND changes have been made.

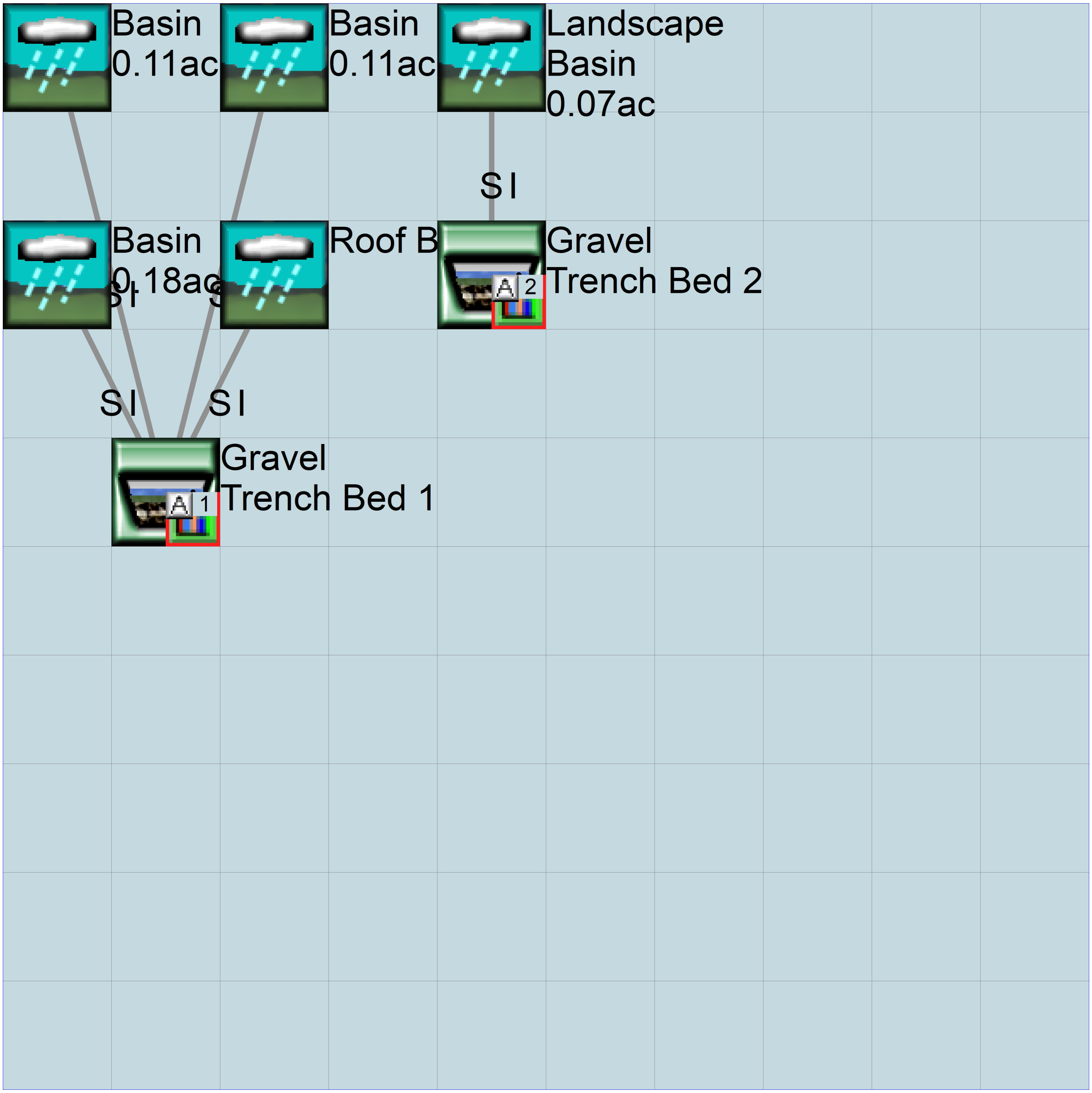
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   Infiltration.wdm
MESSU      25   PreInfiltration.MES
           27   PreInfiltration.L61
           28   PreInfiltration.L62
           30   POCInfiltration1.dat
           31   POCInfiltration2.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      16
      PERLND      18
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin 1,2,3, Roof           MAX                     1    2   30    9
    2        By-pass                     MAX                     1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
  501        1    1
  502        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   16      C, Lawn, Flat           1    1    1    1   27    0
   18      C, Lawn, Steep          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   16         0    0    1    0    0    0    0    0    0    0    0    0
   18         0    0    1    0    0    0    0    0    0    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   18         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   16         0    0    0    0    0    0    0    0    0    0    0
   18         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   16              0       4.5      0.03       400      0.05       0.5     0.996
   18              0       4.5      0.03       400      0.15       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   16              0         0         2         2         0         0         0
   18              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   16            0.1      0.25      0.25         6       0.5      0.25
   18            0.1      0.15      0.25         6       0.3      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   16              0         0         0         0       2.5         1         0
   18              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                        in  out         ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
```

```
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin 1,2,3, Roof***
PERLND  16                        0.58     COPY   501     12
PERLND  16                        0.58     COPY   501     13
By-pass***
PERLND  18                        0.07     COPY   502     12
PERLND  18                        0.07     COPY   502     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
```

```
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Infiltration.wdm
MESSU      25   MitInfiltration.MES
           27   MitInfiltration.L61
           28   MitInfiltration.L62
           31   POCInfiltration2.dat
           30   POCInfiltration1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      16
      IMPLND       8
      IMPLND      11
      IMPLND       4
      PERLND      18
      RCHRES       1
      RCHRES       2
      COPY         2
      COPY       502
      COPY         1
      COPY       501
      DISPLY       2
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    2        Gravel Trench Bed 2         MAX                    1    2   31    9
    1        Gravel Trench Bed 1         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
    2        1    1
  502        1    1
  501        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   16      C, Lawn, Flat           1    1    1    1   27     0
   18      C, Lawn, Steep          1    1    1    1   27     0
```

```
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   16         0    0    1    0    0    0    0    0    0    0    0    0
   18         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   18         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   16         0    0    0    0    0    0    0    0    0    0    0
   18         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   16              0       4.5      0.03       400      0.05       0.5     0.996
   18              0       4.5      0.03       400      0.15       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   16              0         0         2         2         0         0         0
   18              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   16            0.1      0.25      0.25         6       0.5      0.25
   18            0.1      0.15      0.25         6       0.3      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   16              0         0         0         0       2.5         1         0
   18              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    8      SIDEWALKS/FLAT         1    1    1   27    0
   11      PARKING/FLAT           1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    8         0    0    1    0    0    0
   11         0    0    1    0    0    0
```

```
    4         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    8         0    0    4    0    0    0    1    9
   11         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    8         0    0    0    0    0
   11         0    0    0    0    0
    4         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    8            400      0.01       0.1       0.1
   11            400      0.01       0.1       0.1
    4            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    8              0         0
   11              0         0
    4              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    8              0         0
   11              0         0
    4              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  16                        0.01     RCHRES   2      2
PERLND  16                        0.01     RCHRES   2      3
IMPLND   8                        0.01     RCHRES   2      5
IMPLND  11                        0.09     RCHRES   2      5
Basin  2***
PERLND  16                        0.01     RCHRES   2      2
PERLND  16                        0.01     RCHRES   2      3
IMPLND   8                        0.01     RCHRES   2      5
IMPLND  11                        0.09     RCHRES   2      5
Basin  3***
PERLND  16                        0.04     RCHRES   2      2
PERLND  16                        0.04     RCHRES   2      3
IMPLND   8                        0.01     RCHRES   2      5
IMPLND  11                        0.13     RCHRES   2      5
Roof Basin***
IMPLND   4                        0.18     RCHRES   2      5
Landscape Basin***
PERLND  18                        0.07     RCHRES   1      2
PERLND  18                        0.07     RCHRES   1      3

******Routing******
```

```
PERLND  16                        0.01     COPY     1     12
IMPLND   8                        0.01     COPY     1     15
IMPLND  11                        0.09     COPY     1     15
PERLND  16                        0.01     COPY     1     13
PERLND  16                        0.01     COPY     1     12
IMPLND   8                        0.01     COPY     1     15
IMPLND  11                        0.09     COPY     1     15
PERLND  16                        0.01     COPY     1     13
PERLND  16                        0.04     COPY     1     12
IMPLND   8                        0.01     COPY     1     15
IMPLND  11                        0.13     COPY     1     15
PERLND  16                        0.04     COPY     1     13
IMPLND   4                        0.18     COPY     1     15
PERLND  18                        0.07     COPY     2     12
PERLND  18                        0.07     COPY     2     13
RCHRES   2                           1     COPY   501     17
RCHRES   1                           1     COPY   502     17
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
    1     Gravel Trench Be-013    2    1    1    1   28    0    1
    2     Gravel Trench Be-008    2    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
    2        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.05       0.0       0.0       0.5       0.0
    2             2      0.02       0.0       0.0       0.5       0.0
  END HYDR-PARM2
```

```
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                          ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0          4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2           0          4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      2
   92    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.050505  0.000000  0.000000  0.000000
  0.055556  0.050505  0.000926  0.000000  0.071296
  0.111111  0.050505  0.001852  0.000000  0.071296
  0.166667  0.050505  0.002778  0.000000  0.071296
  0.222222  0.050505  0.003704  0.000000  0.071296
  0.277778  0.050505  0.004630  0.000000  0.071296
  0.333333  0.050505  0.005556  0.000000  0.071296
  0.388889  0.050505  0.006481  0.000000  0.071296
  0.444444  0.050505  0.007407  0.000000  0.071296
  0.500000  0.050505  0.008333  0.000000  0.071296
  0.555556  0.050505  0.009259  0.000000  0.071296
  0.611111  0.050505  0.010185  0.000000  0.071296
  0.666667  0.050505  0.011111  0.000000  0.071296
  0.722222  0.050505  0.012037  0.000000  0.071296
  0.777778  0.050505  0.012963  0.000000  0.071296
  0.833333  0.050505  0.013889  0.000000  0.071296
  0.888889  0.050505  0.014815  0.000000  0.071296
  0.944444  0.050505  0.015741  0.000000  0.071296
  1.000000  0.050505  0.016667  0.000000  0.071296
  1.055556  0.050505  0.017593  0.000000  0.071296
  1.111111  0.050505  0.018519  0.000000  0.071296
  1.166667  0.050505  0.019444  0.000000  0.071296
  1.222222  0.050505  0.020370  0.000000  0.071296
  1.277778  0.050505  0.021296  0.000000  0.071296
  1.333333  0.050505  0.022222  0.000000  0.071296
  1.388889  0.050505  0.023148  0.000000  0.071296
  1.444444  0.050505  0.024074  0.000000  0.071296
  1.500000  0.050505  0.025000  0.000000  0.071296
  1.555556  0.050505  0.025926  0.000000  0.071296
  1.611111  0.050505  0.026852  0.000000  0.071296
  1.666667  0.050505  0.027778  0.000000  0.071296
  1.722222  0.050505  0.028704  0.000000  0.071296
  1.777778  0.050505  0.029630  0.000000  0.071296
  1.833333  0.050505  0.030556  0.000000  0.071296
  1.888889  0.050505  0.031481  0.000000  0.071296
  1.944444  0.050505  0.032407  0.000000  0.071296
  2.000000  0.050505  0.033333  0.000000  0.071296
  2.055556  0.050505  0.034259  0.000000  0.071296
  2.111111  0.050505  0.035185  0.000000  0.071296
  2.166667  0.050505  0.036111  0.000000  0.071296
  2.222222  0.050505  0.037037  0.000000  0.071296
  2.277778  0.050505  0.037963  0.000000  0.071296
  2.333333  0.050505  0.038889  0.000000  0.071296
  2.388889  0.050505  0.039815  0.000000  0.071296
  2.444444  0.050505  0.040741  0.000000  0.071296
  2.500000  0.050505  0.041667  0.000000  0.071296
  2.555556  0.050505  0.042593  0.000000  0.071296
  2.611111  0.050505  0.043519  0.000000  0.071296
  2.666667  0.050505  0.044444  0.000000  0.071296
  2.722222  0.050505  0.045370  0.000000  0.071296
  2.777778  0.050505  0.046296  0.000000  0.071296
  2.833333  0.050505  0.047222  0.000000  0.071296
  2.888889  0.050505  0.048148  0.000000  0.071296
```

2.944444	0.050505	0.049074	0.000000	0.071296
3.000000	0.050505	0.050000	0.000000	0.071296
3.055556	0.050505	0.050926	0.000000	0.071296
3.111111	0.050505	0.051852	0.000000	0.071296
3.166667	0.050505	0.052778	0.000000	0.071296
3.222222	0.050505	0.053704	0.000000	0.071296
3.277778	0.050505	0.054630	0.000000	0.071296
3.333333	0.050505	0.055556	0.000000	0.071296
3.388889	0.050505	0.056481	0.000000	0.071296
3.444444	0.050505	0.057407	0.000000	0.071296
3.500000	0.050505	0.058333	0.000000	0.071296
3.555556	0.050505	0.059259	0.000000	0.071296
3.611111	0.050505	0.060185	0.000000	0.071296
3.666667	0.050505	0.061111	0.000000	0.071296
3.722222	0.050505	0.062037	0.000000	0.071296
3.777778	0.050505	0.062963	0.000000	0.071296
3.833333	0.050505	0.063889	0.000000	0.071296
3.888889	0.050505	0.064815	0.000000	0.071296
3.944444	0.050505	0.065741	0.000000	0.071296
4.000000	0.050505	0.066667	0.000000	0.071296
4.055556	0.050505	0.069473	0.138729	0.071296
4.111111	0.050505	0.072278	0.389839	0.071296
4.166667	0.050505	0.075084	0.703432	0.071296
4.222222	0.050505	0.077890	1.046030	0.071296
4.277778	0.050505	0.080696	1.383552	0.071296
4.333333	0.050505	0.083502	1.683468	0.071296
4.388889	0.050505	0.086308	1.921105	0.071296
4.444444	0.050505	0.089113	2.088233	0.071296
4.500000	0.050505	0.091919	2.203335	0.071296
4.555556	0.050505	0.094725	2.347596	0.071296
4.611111	0.050505	0.097531	2.462179	0.071296
4.666667	0.050505	0.100337	2.571662	0.071296
4.722222	0.050505	0.103143	2.676671	0.071296
4.777778	0.050505	0.105948	2.777713	0.071296
4.833333	0.050505	0.108754	2.875206	0.071296
4.888889	0.050505	0.111560	2.969500	0.071296
4.944444	0.050505	0.114366	3.060890	0.071296
5.000000	0.050505	0.117172	3.149630	0.071296
5.055556	0.050505	0.119978	3.235937	0.071296

END FTABLE 2
FTABLE 1
92 5

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Outflow2 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.005829	0.000000	0.000000	0.000000		
0.011111	0.005959	0.000065	0.000000	0.008228		
0.022222	0.006089	0.000132	0.000000	0.008228		
0.033333	0.006219	0.000201	0.000000	0.008228		
0.044444	0.006349	0.000271	0.000000	0.008228		
0.055556	0.006479	0.000342	0.000000	0.008228		
0.066667	0.006609	0.000415	0.000000	0.008228		
0.077778	0.006740	0.000489	0.000000	0.008228		
0.088889	0.006870	0.000564	0.000000	0.008228		
0.100000	0.007000	0.000641	0.000000	0.008228		
0.111111	0.007130	0.000720	0.000000	0.008228		
0.122222	0.007261	0.000800	0.000000	0.008228		
0.133333	0.007391	0.000881	0.000000	0.008228		
0.144444	0.007521	0.000964	0.000000	0.008228		
0.155556	0.007651	0.001048	0.000000	0.008228		
0.166667	0.007782	0.001134	0.000000	0.008228		
0.177778	0.007912	0.001221	0.000000	0.008228		
0.188889	0.008043	0.001310	0.000000	0.008228		
0.200000	0.008173	0.001400	0.000000	0.008228		
0.211111	0.008304	0.001492	0.000000	0.008228		
0.222222	0.008434	0.001585	0.000000	0.008228		
0.233333	0.008565	0.001679	0.000000	0.008228		
0.244444	0.008695	0.001775	0.000000	0.008228		
0.255556	0.008826	0.001872	0.000000	0.008228		
0.266667	0.008956	0.001971	0.000000	0.008228		
0.277778	0.009087	0.002071	0.000000	0.008228		

```
  0.288889  0.009217  0.002173  0.000000  0.008228
  0.300000  0.009348  0.002276  0.000000  0.008228
  0.311111  0.009479  0.002381  0.000000  0.008228
  0.322222  0.009609  0.002487  0.000000  0.008228
  0.333333  0.009740  0.002594  0.000000  0.008228
  0.344444  0.009871  0.002703  0.000000  0.008228
  0.355556  0.010002  0.002814  0.000000  0.008228
  0.366667  0.010132  0.002925  0.000000  0.008228
  0.377778  0.010263  0.003039  0.000000  0.008228
  0.388889  0.010394  0.003154  0.000000  0.008228
  0.400000  0.010525  0.003270  0.000000  0.008228
  0.411111  0.010656  0.003387  0.000000  0.008228
  0.422222  0.010787  0.003507  0.000000  0.008228
  0.433333  0.010917  0.003627  0.000000  0.008228
  0.444444  0.011048  0.003749  0.000000  0.008228
  0.455556  0.011179  0.003873  0.000000  0.008228
  0.466667  0.011310  0.003998  0.000000  0.008228
  0.477778  0.011441  0.004124  0.000000  0.008228
  0.488889  0.011572  0.004252  0.000000  0.008228
  0.500000  0.011703  0.004381  0.000000  0.008228
  0.511111  0.011834  0.004512  0.000000  0.008228
  0.522222  0.011966  0.004644  0.000000  0.008228
  0.533333  0.012097  0.004778  0.000000  0.008228
  0.544444  0.012228  0.004913  0.000000  0.008228
  0.555556  0.012359  0.005050  0.000000  0.008228
  0.566667  0.012490  0.005188  0.000000  0.008228
  0.577778  0.012621  0.005327  0.000000  0.008228
  0.588889  0.012753  0.005468  0.000000  0.008228
  0.600000  0.012884  0.005610  0.000000  0.008228
  0.611111  0.013015  0.005754  0.000000  0.008228
  0.622222  0.013146  0.005900  0.000000  0.008228
  0.633333  0.013278  0.006046  0.000000  0.008228
  0.644444  0.013409  0.006195  0.000000  0.008228
  0.655556  0.013540  0.006344  0.000000  0.008228
  0.666667  0.013672  0.006496  0.000000  0.008228
  0.677778  0.013803  0.006648  0.000000  0.008228
  0.688889  0.013935  0.006802  0.000000  0.008228
  0.700000  0.014066  0.006958  0.000000  0.008228
  0.711111  0.014198  0.007115  0.000000  0.008228
  0.722222  0.014329  0.007273  0.000000  0.008228
  0.733333  0.014461  0.007433  0.000000  0.008228
  0.744444  0.014592  0.007595  0.000000  0.008228
  0.755556  0.014724  0.007758  0.000000  0.008228
  0.766667  0.014855  0.007922  0.000000  0.008228
  0.777778  0.014987  0.008088  0.000000  0.008228
  0.788889  0.015119  0.008255  0.000000  0.008228
  0.800000  0.015250  0.008424  0.000000  0.008228
  0.811111  0.015382  0.008594  0.000000  0.008228
  0.822222  0.015514  0.008766  0.000000  0.008228
  0.833333  0.015645  0.008939  0.000000  0.008228
  0.844444  0.015777  0.009113  0.000000  0.008228
  0.855556  0.015909  0.009289  0.000000  0.008228
  0.866667  0.016041  0.009467  0.000000  0.008228
  0.877778  0.016172  0.009646  0.000000  0.008228
  0.888889  0.016304  0.009826  0.000000  0.008228
  0.900000  0.016436  0.010008  0.000000  0.008228
  0.911111  0.016568  0.010191  0.000000  0.008228
  0.922222  0.016700  0.010376  0.000000  0.008228
  0.933333  0.016832  0.010563  0.000000  0.008228
  0.944444  0.016964  0.010750  0.000000  0.008228
  0.955556  0.017096  0.010940  0.000000  0.008228
  0.966667  0.017228  0.011130  0.000000  0.008228
  0.977778  0.017360  0.011322  0.000000  0.008228
  0.988889  0.017492  0.011516  0.000000  0.008228
  1.000000  0.017624  0.011711  0.000000  0.008228
  1.011111  0.017756  0.011908  0.000000  0.008228
  END FTABLE  1
END FTABLES

EXT SOURCES
```

```
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   2 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
RCHRES   1 HYDR   RO     1 1        1      WDM   1004 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1005 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      2 1        1      WDM   1006 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1007 STAG     ENGL      REPL
COPY     2 OUTPUT MEAN   1 1     48.4      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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BASIN 1

Water Quality

On-Line BMP

24 hour Volume (ac-ft): 0.0113

Standard Flow Rate (cfs): 0.0155

Off-Line BMP

Standard Flow Rate (cfs): 0.0090

Flow Frequency		
Flow(cfs)		0801 15m
2 Year	=	0.0371
5 Year	=	0.0499
10 Year	=	0.0591
25 Year	=	0.0718
50 Year	=	0.0820
100 Year	=	0.0929

BASIN 2

Water Quality

On-Line BMP

24 hour Volume (ac-ft): 0.0113

Standard Flow Rate (cfs): 0.0155

Off-Line BMP

Standard Flow Rate (cfs): 0.0090

Flow Frequency		
Flow(cfs)		0802 15m
2 Year	=	0.0371
5 Year	=	0.0499
10 Year	=	0.0591
25 Year	=	0.0718
50 Year	=	0.0820
100 Year	=	0.0929

BASIN 1 & 2

WQ FLOW RATE (OFFLINE): 0.0090 CFS (4.04 GPM)
CARTRIDGE FLOW RATE: 7.5 GPM
CARTRIDGES REQUIRED: 0.54
CARTRIDGES PROVIDED: 1

BASIN 3

Water Quality

On-Line BMP

24 hour Volume (ac-ft): 0.0165

Standard Flow Rate (cfs): 0.0217

Off-Line BMP

Standard Flow Rate (cfs): 0.0125

Flow Frequency		
Flow(cfs)		0803 15m
2 Year	=	0.0532
5 Year	=	0.0720
10 Year	=	0.0858
25 Year	=	0.1047
50 Year	=	0.1200
100 Year	=	0.1362

BASIN 3

WQ FLOW RATE (OFFLINE): 0.0125 CFS (5.61 GMP)
CARTRIDGE FLOW RATE: 7.5 GPM
CARTRIDGES REQUIRED: 0.75
CARTRIDGES PROVIDED: 1

WASHINGTON STATE DEPARTMENT OF ECOLOGY

April 2017

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS) TREATMENT

For

CONTECH Engineered Solutions
Stormwater Management StormFilter®
With ZPG Media at 1 gpm/sq ft media surface area

Ecology's Decision:

Based on the CONTECH Engineered Solutions' (CONTECH) application submissions, Ecology hereby issues a General Use Level Designation (GULD) for the Stormwater Management StormFilter® (StormFilter):

1. **As a basic stormwater treatment practice for total suspended solids (TSS) removal,**
   - **Using ZPG™ media (zeolite/perlite/granular activated carbon), with the size distribution described below,**
   - **Sized at a hydraulic loading rate of 1 gpm/ft² of media surface area, per Table 1, and**
   - **Internal bypassing needs to be consistent with the design guidelines in CONTECH's current product design manual.**

Table 1. StormFilter Design Flow Rates per Cartridge

Effective Cartridge Height (inches)	12	18	27
Cartridge Flow Rate (gpm/cartridge)	5	7.5	11.3

2. **Ecology approves StormFilter systems containing ZPG™ media for treatment at the hydraulic loading rates shown in Table 1, and sized based on the water quality design flow rate for an off-line system when using an external bypass vault or a treatment vault with an internal bypass. Contech designs their StormFilter systems to maintain treatment of the water quality design flow while routing excess flows around the treatment chamber during periods of peak bypass. The water quality design flow rates are calculated using the following procedures:**
   - **Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.**

- **Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.**
- **Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.**

3. This designation has no expiration date, but Ecology may amend or revoke it.

<u>Ecology's Conditions of Use</u>:

The StormFilter with ZPG media shall comply with the following conditions:

1. **Design, install, operate, and maintain the StormFilter with ZPG media in accordance with applicable Contech Engineered Solutions manuals, documents, and the Ecology Decision.**

2. **Install StormFilter systems to bypass flows exceeding the water quality treatment rate. Additionally, high flows will not re-suspend captured sediments. Design StormFilter systems in accordance with the performance goals in Ecology's most recent Stormwater Manual and CONTECH's *Product Design Manual Version 4.1 (April 2006)*, or most current version, unless otherwise specified.**

3. **Owners must follow the design, pretreatment, land use application, and maintenance criteria in CONTECH's Design Manual.**

4. **Pretreatment of TSS and oil and grease may be necessary, and designers shall provide pre-treatment in accordance with the most current versions of the CONTECH's *Product Design Manual (April 2006)* or the applicable Ecology Stormwater Manual. Design pre-treatment using the performance criteria and pretreatment practices provided on Ecology's "Evaluation of Emerging Stormwater Treatment Technologies" website.**

5. **Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.**

    - **Typically, CONTECH designs StormFilter systems for a target filter media replacement interval of 12 months. Maintenance includes removing accumulated sediment from the vault, and replacing spent cartridges with recharged cartridges.**

- **Indications of the need for maintenance include effluent flow decreasing to below the design flow rate, as indicated by the scumline above the shoulder of the cartridge.**
- **Owners/operators must inspect StormFilter with ZPG media for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to SWMMEW, the wet season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.**
- **Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.**
- **When inspections are performed, the following findings typically serve as maintenance triggers:**
  - **Accumulated vault sediment depths exceed an average of 2 inches, or**
  - **Accumulated sediment depths on the tops of the cartridges exceed an average of 0.5 inches, or**
  - **Standing water remains in the vault between rain events, or**
  - **Bypass occurs during storms smaller than the design storm.**
- **Note: If excessive floatables (trash and debris) are present, perform a minor maintenance consisting of gross solids removal, not cartridge replacement.**

6. **CONTECH shall maintain readily available reports listed under "Application Documents" (above) as public, as well as the documentation submitted with its previous conditional use designation application. CONTECH shall provide links to this information from its corporate website, and make this information available upon request, at no cost and in a timely manner.**

7. **ZPG™ media used shall conform with the following specifications:**

- **Each cartridge contains a total of approximately 2.6 cubic feet of media. The ZPG™ cartridge consists of an outer layer of perlite that is approximately 1.3 cubic feet in volume and an inner layer, consisting of a mixture of 90% zeolite and 10% granular activated carbon, which is approximately 1.3 cubic feet in volume.**
- **Perlite Media: Perlite media shall be made of natural siliceous volcanic rock free of any debris or foreign matter. The expanded perlite shall**

have a bulk density ranging from 6.5 to 8.5 lbs per cubic foot and particle sizes ranging from 0.09” (#8 mesh) to 0.38” (3/8” mesh).

- **Zeolite Media: Zeolite media shall be made of naturally occurring clinoptilolite. The zeolite media shall have a bulk density ranging from 44 to 50 lbs per cubic foot and particle sizes ranging from 0.13” (#6 mesh) to 0.19” (#4 mesh). Additionally, the cation exchange capacity (CEC) of zeolite shall range from approximately 1.0 to 2.2 meq/g.**

- **Granular Activated Carbon: Granular activated carbon (GAC) shall be made of lignite coal that has been steam-activated. The GAC media shall have a bulk density ranging from 28 to 31 lbs per cubic foot and particle sizes ranging from a 0.09” (#8 mesh) to 0.19” (#4 mesh).**

Approved Alternate Configurations

Peak Diversion StormFilter

1. The Peak Diversion StormFilter allows for off-line bypass within the StormFilter structure. Design capture flows and peak flows enter the inlet bay which contains an internal weir. The internal weir allows design flows to enter the cartridge bay through a transfer hole located at the bottom of the inlet bay while the unit routs higher flows around the cartridge bay.
2. To select the size of the Peak Diversion StormFilter unit, the designer must determine the number of cartridges required and size of the standard StormFilter using the site-specific water quality design flow and the **StormFilter Design Flow Rates per Cartridge** as described above.
3. New owners may not install the Peak Diversion StormFilter at an elevation or in a location where backwatering may occur.

Applicant: Contech Engineered Solutions

Applicant’s Address: 11835 NE Glenn Widing Dr.
Portland, OR 97220

Application Documents:

The applicant’s master report, titled, “The Stormwater Management StormFilter Basic Treatment Application for General Use Level Designation in Washington”, Stormwater Management, Inc., November 1, 2004, includes the following reports:

- (Public) *Evaluation of the Stormwater Management StormFilter Treatment System: Data Validation Report and Summary of the Technical Evaluation Engineering Report (TEER) by Stormwater Management Inc.*, October 29, 2004 Ecology’s technology assessment protocol requires the applicant to hire an independent consultant to complete the following work:

1. Complete the data validation report.
2. Prepare a TEER summary, including a testing summary and conclusions compared with the supplier's performance claims.
3. Provide a recommendation of the appropriate technology use level.
4. Work with Ecology to post recommend relevant information on Ecology's website.
5. Provide additional testing recommendations, if needed."
6. This report, authored by Dr. Gary Minton, Ph. D., P.E., Resource Planning Associates, satisfies the Ecology requirement.

- (Public) "Performance of the Stormwater Management StormFilter Relative to the Washington State Department of Ecology Performance Goals for Basic Treatment," is a summary of StormFilter performance that strictly adheres to the criteria listed in the Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol – Ecology (TAPE).
- "Heritage Marketplace Field Evaluation: Stormwater Management StormFilter with ZPG™ Media," is a report showing all of the information collected at Site A as stated in the SMI Quality Assurance Project Plan (QAPP). This document contains detailed information regarding each storm event collected at this site, and it provided a detailed overview of the data and project.
- "Lake Stevens Field Evaluation: Stormwater Management StormFilter with ZPG™ Media," is a report that corresponds to Site E as stated in the SMI QAPP. This document contains detailed information regarding each storm collected at this site, and includes a detailed overview of the data and project.
- (Public) "Evaluation of the Stormwater Management StormFilter for the removal of SIL-CO-SIL 106, a standardized silica product: ZPG™ at 7.5 GPM" is a report that describes laboratory testing at full design flow.
- "Factors Other Than Treatment Performance."
- "State of Washington Installations."
- "Peak Diversion StormFilter" is a technical document demonstrating the Peak Diversion StormFilter system complies with the Stormwater Management Manual for Western Washington Volume V Section 4.5.1.

Above-listed documents noted as "public" are available by contacting CONTECH.

Applicant's Use Level Request:

That Ecology grant a General Use Level Designation for Basic Treatment for the StormFilter using ZPG™ media (zeolite/perlite/granular activated carbon) at a hydraulic loading rate of 1 gpm/ft^2 of media surface area in accordance with Ecology's 2011 *Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE).*

Applicant's Performance Claim:

The combined data from the two field sites reported in the TER (Heritage Marketplace and Lake Stevens) indicate that the performance of a StormFilter system configured for inline bypass with ZPG™ media and a hydraulic loading rate of 1 gpm/ft^2 of media surface area meets Ecology performance goals for Basic Treatment.

Ecology's Recommendations:

Based on the weight of the evidence and using its best professional judgment, Ecology finds that:

- StormFilter, using ZPG™ media and operating at a hydraulic loading rate of no more than 1 gpm/ft^2 of media surface area, is expected to provide effective stormwater treatment achieving Ecology's Basic Treatment (TSS removal) performance goals. Contech demonstrated this is through field and laboratory testing performed in accordance with the approved protocol. StormFilter is deemed satisfactory with respect to factors other than treatment performance (e.g., maintenance; see the protocol's Appendix B for complete list).

Findings of Fact:

- Influent TSS concentrations and particle size distributions were generally within the range of what Ecology considers "typical" for western Washington (silt-to-silt loam).
- Contech sampled thirty-two (32) storm events at two sites for storms from April 2003 to March 2004, of which Contech deemed twenty-two (22) as "qualified" and were therefore included in the data analysis set.
- Statistical analysis of these 22 storm events verifies the data set's adequacy.
- Analyzing all 22 qualifying events, the average influent and effluent concentrations and aggregate pollutant load reduction are 114 mg/L, 25 mg/L, and 82%, respectively.
- Analyzing all 22 qualifying events based on the *estimated average* flow rate during the event (versus the *measured peak* flow rate), and more heavily weighting those events near the design rate (versus events either far above or well below the design rate) does not significantly affect the reported results.
- For the 7 qualifying events with influent TSS concentrations greater than 100 mg/L, the average influent and effluent concentrations and aggregate pollutant load reduction are 241 mg/L, 34 mg/L, and 89%, respectively. If we exclude the 2 of 7 events that exceed the maximum 300 mg/L specified in Ecology's guidelines, the average influent and effluent concentrations and aggregate pollutant load reduction are 158 mg/L, 35 mg/L, and 78%, respectively.
- For the 15 qualifying events with influent TSS concentrations less than 100 mg/L, the average influent and effluent concentrations and aggregate pollutant load reduction are 55 mg/L, 20 mg/L, and 61%, respectively. If the 6 of 15 events that fall below the minimum 33 mg/L TSS specified in Ecology's guidelines are excluded, the average

influent and effluent concentrations and aggregate pollutant load reduction are 78 mg/L, 26 mg/L, and 67%, respectively.

- For the 8 qualifying events with peak discharge exceeding design flow (ranging from 120 to 257% of the design rate), results ranged from 52% to 96% TSS removal, with an average of 72%.
- Due to the characteristics of the hydrographs, the field results generally reflect flows below (ranging between 20 and 60 percent of) the tested facilities' design rate. During these sub-design flow rate periods, some of the cartridges operate at or near their *individual* full design flow rate (generally between 4 and 7.5 GPM for an 18" cartridge effective height) because their float valves have opened. Float valves remain closed on the remaining cartridges, which operate at their base "trickle" rate of 1 to 1.5 GPM.
- Laboratory testing using U.S. Silica's Sil-Co-Sil 106 fine silica product showed an average 87% TSS removal for testing at 7.5 GPM per cartridge (100% design flow rate).
- Other relevant testing at I-5 Lake Union, Greenville Yards (New Jersey), and Ski Run Marina (Lake Tahoe) facilities shows consistent TSS removals in the 75 to 85% range. *Note that the evaluators operated the I-5 Lake Union at 50%, 100%, and 125% of design flow*.
- SMI's application included a satisfactory "Factors other than treatment performance" discussion.

Note: Ecology's 80% TSS removal goal applies to 100 mg/l and greater influent TSS. Below 100 mg/L influent TSS, the goal is 20 mg/L effluent TSS.

Technology Description:

The Stormwater Management StormFilter® (StormFilter), a flow-through stormwater filtration system, improves the quality of stormwater runoff from the urban environment by removing pollutants. The StormFilter can treat runoff from a wide variety of sites including, but not limited to: retail and commercial development, residential streets, urban roadways, freeways, and industrial sites such as shipyards, foundries, etc.

Operation:

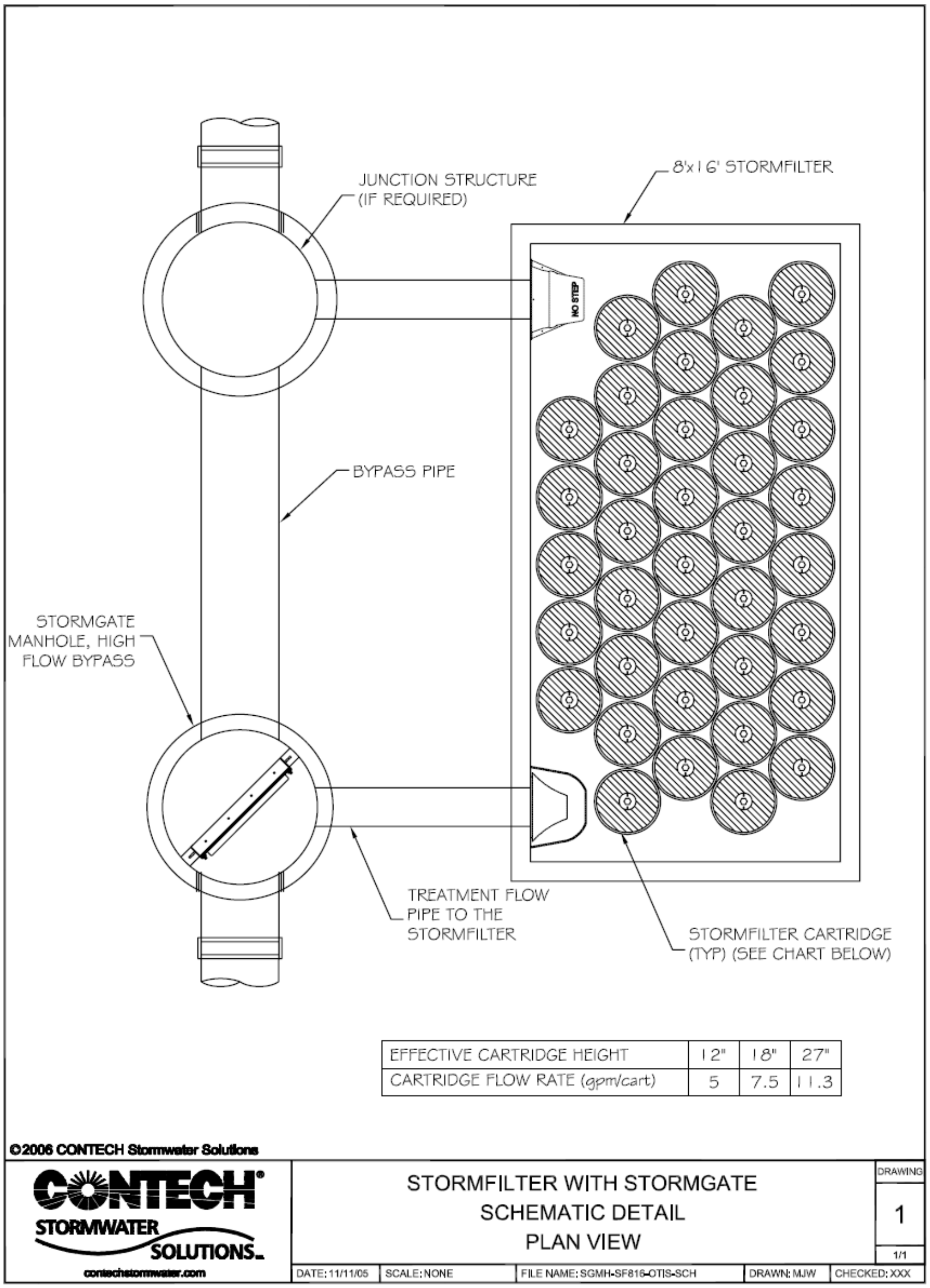
The StormFilter is typically comprised of a vault that houses rechargeable, media-filled, filter cartridges. Various media may be used, but this designation covers only the zeolite-perlite-granulated activated carbon (ZPG™) medium. Stormwater from storm drains percolates through these media-filled cartridges, which trap particulates and may remove pollutants such as dissolved metals, nutrients, and hydrocarbons. During the filtering process, the StormFilter system also removes surface scum and floating oil and grease. Once filtered through the media, the treated stormwater is directed to a collection pipe or discharged to an open channel drainage way.

This document includes a bypass schematic for flow rates exceeding the water quality design flow rate on page 8.

StormFilter Configurations:

Contech offers the StormFilter in multiple configurations: precast, high flow, catch basin, curb inlet, linear, volume, corrugated metal pipe, drywell, and CON/Span form. Most configurations use pre-manufactured units to ease the design and installation process. Systems may be either uncovered or covered underground units.

The typical precast StormFilter unit is composed of three sections: the energy dissipater, the filtration bay, and the outlet sump. As Stormwater enters the inlet of the StormFilter vault through the inlet pipe, piping directs stormwater through the energy dissipater into the filtration bay where treatment will take place. Once in the filtration bay, the stormwater ponds and percolates horizontally through the media contained in the StormFilter cartridges. After passing through the media, the treated water in each cartridge collects in the cartridge's center tube from where piping directs it into the outlet sump by a High Flow Conduit under-drain manifold. The treated water in the outlet sump discharges through the single outlet pipe to a collection pipe or to an open channel drainage way. In some applications where you anticipate heavy grit loads, pretreatment by settling may be necessary.



EFFECTIVE CARTRIDGE HEIGHT	12"	18"	27"
CARTRIDGE FLOW RATE (gpm/cart)	5	7.5	11.3

Figure 1. Stormwater Management StormFilter Configuration with Bypass

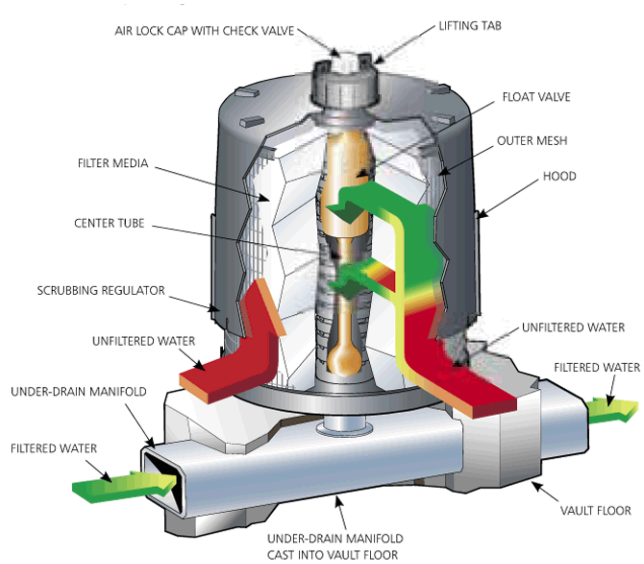


Figure 2. The StormFilter Cartridge

Cartridge Operation:

As the water level in the filtration bay begins to rise, stormwater enters the StormFilter cartridge. Stormwater in the cartridge percolates horizontally through the filter media and passes into the cartridge's center tube, where the float in the cartridge is in a closed (downward) position. As the water level in the filtration bay continues to rise, more water passes through the filter media and into the cartridge's center tube. Water displaces the air in the cartridge and it purges from beneath the filter hood through the one-way check valve located in the cap. Once water fills the center tube there is enough buoyant force on the float to open the float valve and allow the treated water to flow into the under-drain manifold. As the treated water drains, it tries to pull in air behind it. This causes the check valve to close, initiating a siphon that draws polluted water throughout the full surface area and volume of the filter. Thus, water filters through the entire filter cartridge throughout the duration of the storm, regardless of the water surface elevation in the filtration bay. This continues until the water surface elevation drops to the elevation of the scrubbing regulators. At this point, the siphon begins to break and air quickly flows beneath the hood through the scrubbing regulators, causing energetic bubbling between the inner surface of the hood and the outer surface of the filter. This bubbling agitates and cleans the surface of the filter, releasing accumulated sediments on the surface, flushing them from beneath the hood, and allowing them to settle to the vault floor.

Adjustable cartridge flow rate:

Inherent to the design of the StormFilter is the ability to control the individual cartridge flow rate with an orifice-control disc placed at the base of the cartridge. Depending on the treatment requirements and on the pollutant characteristics of the influent stream as specified in the CONTECH *Product Design Manual*, operators may adjust the flow rate through the filter cartridges. By decreasing the flow rate through the filter cartridges, the influent contact time with the media is increased and the water velocity through the system is decreased, thus increasing both the level of treatment and the solids removal efficiencies of the filters, respectively (de Ridder, 2002).

Recommended research and development:

Ecology encourages CONTECH to pursue continuous improvements to the StormFilter. To that end, CONTECH recommends the following actions:

- Determine, through laboratory testing, the relationship between accumulated solids and flow rate through the cartridge containing the ZPG™ media. **Completed 11/05.**
- Determine the system's capabilities to meet Ecology's enhanced, phosphorus, and oil treatment goals.
- Develop easy-to-implement methods of determining that a StormFilter facility requires maintenance (cleaning and filter replacement).

Contact Information:

Applicant Contact: Jeremiah Lehman
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503-258-3136
jlehman@conteches.com

Applicant Web link http://www.conteches.com/

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology Contact: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

Revision History

Date	**Revision**
Jan 2005	Original Use Level Designation
Dec 2007	Revision
May 2012	Maintenance requirements updated
November 2012	Design Storm and Maintenance requirements updated
January 2013	Updated format to match Ecology standard format
September 2014	Added Peak Diversion StormFilter Alternate Configuration
November 2016	Revised Contech contact information
April 2017	Revised sizing language to note sizing based on Off-line calculations

Appendix C

Geotechnical Engineering Report

Groundwater Monitoring Report

South Sound Geotechnical Consulting

August 8, 2019

Doec, LLC
11192 – 25th Avenue East
Tacoma, Washington 98445

Attention: Mr. Don Huber

Subject: Geotechnical Engineering Report
2nd Street NE Apartments
Puyallup, Washington
SSGC Project No. 19055

Mr. Huber,

South Sound Geotechnical Consulting (SSGC) has prepared this geotechnical engineering report regarding the planned apartment development on 2nd Street NE at 5th Avenue NE in Puyallup, Washington. Our services have been completed in general conformance with our proposal P19059 (dated June 21, 2019) and authorized per signature of our agreement for services. The purpose of our services was to assess subgrade soils to provide geotechnical recommendations for the apartment building. Our scope of services included drilling two borings, excavation of 2 test pits, and completion of one infiltration test, laboratory testing, engineering analyses, and preparation of this report.

PROJECT DESCRIPTION

The project property is in the northeast corner of the intersection of 2nd Street NE and 5th Avenue NE in Puyallup, Washington. It encompasses about 0.75 (+/-) acres and is currently vacant. Development plans include construction of a 4-story apartment building, with the ground floor used for parking.

SURFACE CONDITIONS

The property is on the order of 5 to 6 feet lower than street grade (2nd Street NE and 5th Avenue NE) and is principally covered with grass. Overall the site is level with slopes rising along the boundaries with the streets. Several trees are in the northeast corner.

SUBSURFACE CONDITIONS

Subsurface conditions were explored by drilling two borings, two test pits, and one infiltration test hole on July 15, 2019. Borings were advanced to depths of 76.5 and 16.5 feet below surface grades, with test pits extending between 7 and 8 feet. Approximate locations of the explorations are shown on Figure 1, Exploration Plan. A summary description of observed subgrade soils is provided below, with logs of the borings and test pits provided in Appendix A. Please note subsurface conditions can vary across the site from those observed at the exploration locations.

Soil Conditions

Fill was observed below the surface in test pit TP-2 and extended to a depth of about 3 feet. Fill consisted of mixed silt, sand, and debris and was in a loose condition. Topsoil was observed at the surface of the other explorations and extended to about 1 foot. It should be expected that fill thickness may vary across this site.

Native soils below the fill or topsoil consisted of an upper silty sand in a loose condition extending to 2 to 6 feet. Sand with trace silt and gravel was below the upper silty sand. This soil was in a generally loose condition and extended to about 33 feet in boring B-1. Sandy silt to silt with sand and variable clay was below the loose sand and extended to the termination depth of the boring. It was in a soft to medium stiff condition, grading to very stiff at about 65 feet.

Groundwater

Groundwater was observed in borings B-1 and B-2 at a depth of about 14 feet at the time of drilling. Groundwater was not observed in the test pits completed at shallower depths. A piezometer was installed in boring B-2 to monitor groundwater levels through the 2019 – 2020 winter season.

Geologic Setting

Geology of this area is depicted on the "Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington" issued in 2015. Soils mapped on the site are labeled as Holocene Alluvium. These soils are described as "Loose, stratified to massively bedded silt, sand, and gravel." Soils observed in the test pits and borings appear to conform to the mapped soil types.

The site is in a "Potential Liquefaction and/or Dynamic Settlement Hazard Area" per the Potential Seismic Hazard Areas Map by the Pierce County Department of Planning and Land Services, dated March, 2005.

GEOTECHNICAL DESIGN CONSIDERATIONS

Subgrade conditions at this site include upper loose sand over generally soft to medium stiff silt alluvial deposits. These soils are considered highly susceptible to liquefaction during an earthquake. Mitigation of liquefaction utilizing piles or ground improvement methods (e.g. stone columns) will be required for support of the apartment building. We recommend foundations and floor slabs are supported on piles with grade beams, or on a zone of structural fill over stone columns (or other ground improvement methods). .

Recommendations presented in the following sections are based upon the subsurface conditions observed in the test pits and borings and our current understanding of project plans. Our recommendations assume finish site grades will be similar to existing grades. It should be noted subsurface conditions across the site may vary from those depicted on the exploration logs and can change with time. Therefore, proper site preparation will depend upon the weather and soil conditions encountered at the time of construction. We recommend that SSGC review final plans to verify that plans and specifications conform to the recommendations of this report.

Site Preparation

Preparation for site grading and earthwork should include procedures intended to drain ponded water and control surface water runoff. Grading the site without adequate drainage control measures may negatively impact site soils, resulting in increased export of impacted soil and import of fill materials, potentially increasing the cost of the earthwork and subgrade preparation phases of the project.

Site grading should include removal (stripping) of topsoil and fill in building and pavement areas. Stripping depths will vary across the site, but should average between about 1 to 3 feet. Localized deeper fill may be encountered. Final stripping depths can only be determined at the time of construction.

The contractor is responsible for designing and constructing stable, temporary excavations (including utility trenches) as required to maintain the stability of both the excavation sides and bottoms. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards. The upper loose sand may require shoring of excavations deeper than several feet at this site. Temporary excavation cuts should be sloped at inclinations of 2H:1V (Horizontal:Vertical) or flatter, unless the contractor can demonstrate the safety of steeper inclinations.

Subgrade Preparation

Exposed subgrades should consist of undisturbed native soils following stripping. We recommend that exposed subgrades in the building footprint are covered with a layer of coarse gravel, spalls, or shot-rock to provide a working surface and protect the loose subgrades from being disturbed during installation of piles or stone columns.

Native subgrades in pavement areas should be proofrolled using a large roller, loaded dump truck, or other mechanical equipment to assess subgrade conditions following stripping. Proofrolling efforts should result in the upper 1 foot of subgrade soils achieving a compaction level of at least 95 percent of the maximum dry density (MDD) per the ASTM D1557 test method. Wet, loose, or soft subgrades that cannot achieve this compaction level should be removed (over-excavated) and replaced with structural fill. The depth of over-excavation should be based on soil conditions at the time of construction. A representative of SSGC should be present to assess subgrade conditions during proofrolling.
Native subgrades in pavement areas should be proofrolled

Structural Fill

The suitability of soil for use as structural fill depends primarily on the gradation and moisture content of the soil when it is placed. As the amount of fines (soil fraction passing the U.S. No. 200 sieve) increases, soils can become increasingly sensitive to small changes in moisture content. It is often difficult to achieve adequate compaction if soil moisture is outside of optimum condition for soils that contain more than 5 percent fines. In general, optimum moisture is within about +/- 2 percent of the moisture content required to achieve the maximum density per the ASTM D-1557 test method.

Site Soils: Fill is not considered suitable for structural fill due to overall unknown types and presence of debris. Upper native soils consist of silty sand which can be moisture sensitive during wetter seasons of the year or during extensive precipitation. They potentially could be used during the drier seasons provided they can be moisture conditioned to within optimum moisture content range. Optimum moisture is considered within about +/- 2 percent of the moisture content required to achieve the maximum dry density (MDD) per the ASTM D-1557 test method. If moisture content is higher or lower than optimum, soils would need to be dried or wetted prior to placement as structural fill.

Import Structural Fill Materials: We recommend import structural fill placed during dry weather periods consist of material which meets the specifications for *Gravel Borrow* as described in Section 9-03.14(1) of the 2018 Washington State Department of Transportation (WSDOT) Specifications for Road, Bridge, and Municipal Construction (Publication M 41-10). Gravel Borrow should be protected from disturbance if exposed to wet conditions after placement.

During wet weather, or for backfill on wet subgrades, import soil suitable for compaction in wetter conditions should be provided. Imported fill for use in wet conditions should generally conform to specifications for *Select Borrow* as described in Section 9-03.14(2), or *Crushed Surfacing* per Section 9-03.9(3) of the 2018 WSDOT M-41 manual, with the modification that a maximum of 5 percent by weight shall pass the U.S. No. 200 sieve for these soil types.

It should be noted that structural fill placement and compaction is weather-dependent. Delays due to inclement weather are common, even when using select granular fill. We recommend site grading and earthwork be scheduled for the drier months of the year. Structural fill should not consist of frozen material.

Structural Fill Placement: We recommend structural fill is placed in lifts not exceeding 10 inches in loose measure. It may be necessary to adjust lift thickness based on site and fill conditions during placement and compaction. Finer grained soil used as structural fill and/or lighter weight compaction equipment may require significantly thinner lifts to attain required compaction levels. Coarser granular soil with lower fines contents could potentially be placed in thicker lifts if they can be adequately compacted. Structural fill should be compacted to attain the recommended levels presented in Table 1, Compaction Criteria.

Table 1. Compaction Criteria

Fill Application	Compaction Criteria*
Footing areas (below structures and retaining walls)	95 %
Upper 2 feet in pavement areas, slabs and sidewalks, and utility trenches	95 %
Below 2 feet in pavement areas, slabs and sidewalks, and utility trenches	92 %
Utility trenches or general fill in non-paved or -building areas	90 %

*Per the ASTM D 1557 test method.

Trench backfill within about 2 feet of utility lines should not be over-compacted to reduce the risk of damage to the line. In some instances the top of the utility line may be within 2 feet of the surface. Backfill in these circumstances should be compacted to a firm and unyielding condition.

We recommend all fill procedures include maintaining grades that promote drainage and do not allow for ponding of water within the fill area. The contractor should protect compacted fill subgrades from disturbance during wet weather. In the event of rain during structural fill placement, the exposed fill surface should be allowed to dry prior to placement of additional fill. Alternatively, the wet soil can be removed. Structural fill should not consist of frozen material.

Foundations

Mitigation of seismic settlement potential will require soil improvement of the saturated, loose (soft) native soils or pile support of the building. Stone column piers have been successfully used for similar soil conditions in this area of Sumner.

Soil improvement systems consisting of stone columns can be used to improve the strength and support characteristics of thick zones of saturated, loose or soft soils. These stone columns can also reduce static and seismic induced settlements. The design of these columns is typically completed by the pier contractor. On a preliminary basis we anticipate that these piers would average on the order of 20 to 30 feet deep, although deeper piers may be necessary. A layer of compacted structural fill, at least 18 inches thick, should be placed between the bottom of the footings (or floor slab) and the top of the stone columns to provide a uniform base.

Depending on the depth, size, and spacing of these columns, allowable bearing pressures of 3,000 psf or higher are expected. Static total and differential settlements would be less than 1-inch and ½-inch, respectively. Seismic settlements could be substantially reduced. We are available to assist in working with local stone column contractors in the design. We are also available to assist in the design of a pile-supported structure, if requested.

Conventional spread footing foundations can be placed on a structural fill zone above the stone columns. The following recommendations have been prepared for conventional spread footing foundations on a properly prepared subgrade.

Bearing Capacity (net allowable):	3,000 pounds per square foot (psf) for footings supported on a structural fill zone (at least 12 inches thick) over stone columns.	
Footing Width (Minimum):	18 inches (Strip) 24 inches (Column)	
Embedment Depth (Minimum):	18 inches (Exterior) 12 inches (Interior)	
Settlement:	Total:	< 1 inch
	Differential:	< 1/2 inch (over 40 feet)
Allowable Lateral Passive Resistance:	325 psf/ft* (below 18 inches)	
Allowable Coefficient of Friction:	0.35*	

*These values include a factor of safety of approximately 1.5

The net allowable bearing pressures presented above may be increased by one-third to resist transient, dynamic loads such as wind or seismic forces. Lateral resistance to footings should be ignored in the upper 12-inches from exterior finish grade.

Foundation Construction Considerations

All foundation subgrades should be free of water and loose soil prior to placing concrete, and should be prepared as recommended in this report. Concrete should be placed soon after excavating and compaction to reduce disturbance to bearing soils. Should soils at foundation level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. We recommend that SSGC observe all foundation subgrades prior to placement of concrete.

Foundation Drainage

We recommend footing drains are installed around building foundations. Footing drains should include a minimum 4-inch diameter perforated rigid plastic or metal drain line installed at the base of the footing. The perforated drain lines should be connected to a tight line pipe that discharges to an approved storm drain receptor. The drain line should be surrounded by a zone of clean, free-draining granular material having less than 5 percent passing the No. 200 sieve or meeting the requirements of section 9-03.12(2) "Gravel Backfill for Walls" in the 2010 WSDOT Standard Specifications for Road, Bridge, and Municipal Construction manual (M41-10). The free-draining aggregate zone should be at least 12 inches wide and wrapped in filer fabric. The granular fill should extend to within 6 inches of final grade where it should be capped with compacted fill containing sufficient fines to reduce infiltration of surface water into the footing drains. Cleanouts are recommended for maintenance of the drain system.

Floor Slabs

Post-construction floor slab settlement should be anticipated to be similar to stone column supported foundation settlements provided subgrades have been prepared as discussed in this report. We recommend a vertical subgrade soil modulus value of 250 kips per cubic foot (kcf) for structural fill compacted as described in this report. Soil modulus of stone column supported slabs with other types of fill should be supplied by the stone column designer.

We recommend a minimum 4 inches of free-draining granular material be placed under the slab to serve as a capillary break. The fines content of the capillary break material should be limited to 3 percent or less, by weight, and at least 50 percent of the capillary break material should be retained on the No. 4 sieve

Seismic Considerations

Recommended seismic parameters and values presented in Table 2 are based on the 2015 International Building Code (IBC).

Table 2. Seismic Parameters

PARAMETER	VALUE
2015 International Building Code (IBC) Site Classification[1]	E
S_s Spectral Acceleration for a Short Period	1.253g
S_1 Spectral Acceleration for a 1-Second Period	0.482
F_a Site Coefficient for a Short Period	0.9
F_v Site Coefficient for a 1-Second Period	2.4

[1] Note: In general accordance with *2012 International Building Code,* Section 1613.3.2 for risk categories I,II,III. IBC Site Class is based on the estimated characteristics of the upper 100 feet of the subsurface profile. S_s, S_1, F_a, and F_v values based on the OSHPD Seismic Design Maps website.

Liquefaction

Soil liquefaction is a condition where loose, typically granular soils located below the groundwater surface lose strength during ground shaking, and is often associated with earthquakes. Native soils observed in the test pits consist of loose sand with variable silt. Groundwater was observed at a depth of 14 feet in the borings at the time of drilling, and is expected to be at shallower depth during the wetter seasons of the year. Loose clean sand extended to depths of about 33 feet. The condition of the soils and groundwater level suggest that these soils are highly susceptible to liquefaction during a design level earthquake. We estimate differential ground deformations over 6 inches could occur during a design level earthquake based on our analyses of subgrade conditions in the borings. Pile support or ground improvements (stone columns) are recommended to reduce the potential seismic settlement to levels similar to static conditions.

Infiltration Characteristics

Assessment of infiltration characteristics of the upper native silty sand was completed per the Washington State Department of Ecology (DOE) 2012 Stormwater Management Manual for Western Washington. One small-scale Pilot Infiltration Test (PIT) was completed on the site. Result of the infiltration test is provided in Table 3.

Table 3. Infiltration Rates

Test Site and Depth (ft)	Soil Type	Field Infiltration Rate (in/hr)	Corrected Infiltration Rate (in/hr)	Correction Factors* (CFv/CFt/CFm)
PIT-1, 3 ft	Silty Sand (Alluvium)	3.5	1.4	(0.9/0.5/0.9)

*Correction Factors from the DOE 2012 Stormwater Management Manual for Western Washington.

Calculated and corrected infiltration rate is considered appropriate for the soil tested, and similar to test results completed in the area with similar soils. We recommend a design infiltration rate of 1.4 inches per hour (in/hr) for infiltration facilities located in the upper 4 feet of native soils on the site

Groundwater was encountered at about 14 feet below the surface at the time of our field evaluation. No evidence of heavy soil mottling was observed in the test pits or borings (indicative of significantly higher groundwater levels). A piezometer was installed in boring B-2 to monitor groundwater levels through the 2019 – 2020 winter season.

Cation Exchange Capacity (CEC) and organic content test were completed on a sample from the base of the PIT-1 site. Test results are summarized in the table below.

Table 4. CEC and Organic Content Results

Test Location, Sample Number, and Depth	CEC Results (milliequivalents)	CEC Required* (milliequivalents)	Organic Content Results (%)	Organic Content Required* (%)
PIT-1, S-1, 3 ft	7.5	≥ 5	1.75	≥1.0

*Per the 2012 DOE Stormwater Management Manual for Western Washington

Test results indicate CEC and organic content values satisfies DOE requirements.

Conventional Pavement Sections

Subgrades for conventional pavement areas should be prepared as described in the "*Subgrade Preparation*" section of this report. Subgrades below pavement sections should be graded or crowned to promote drainage and not allow for ponding of water beneath the section. If drainage is not provided and ponding occurs, the subgrade soils could become saturated, lose strength, and result in premature distress to the pavement. In addition, the pavement surfacing should also be graded to promote drainage and reduce the potential for ponding of water on the pavement surface.

Minimum recommended pavement sections for conventional pavements are presented in Table 5. Pavement sections in public right-of-ways should conform to City of Puyallup requirements for the road designation.

Table 5. Preliminary Pavement Sections

Traffic Area	Minimum Recommended Pavement Section Thickness (inches)			
	Asphalt Concrete Surface[1]	Portland Cement Concrete[2]	Aggregate Base Course[3,4]	Subbase Aggregate[5]
Access Drives	3	6	6	12
Parking	2	5	4	12

[1] 1/2 –inch nominal aggregate hot-mix asphalt (HMA) per WSDOT 9-03.8(1)

[2] A 28 day minimum compressive strength of 4,000 psi and an allowable flexural strength of at least 250 psi

[3] Crushed Surfacing Base Course per WSDOT 9-03.9(3)

[4] Although not required for structural support under concrete pavements, a minimum four-inch thick base course layer is recommended to help reduce potentials for slab curl, shrinkage cracking, and subgrade "pumping" through joints

[5] Native granular soils compacted to 95% of the ASTM D1557 test method, or Gravel Borrow per WSDOT 9-03.14(1) or Crushed Surfacing Base Course WSDOT 9-03.9(3)

Conventional Pavement Maintenance

The performance and lifespan of pavements can be significantly impacted by future maintenance. The above pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be completed. Proper maintenance will slow the rate of pavement deterioration, and will improve pavement performance and life. Preventative maintenance consists of both localized maintenance (crack and joint sealing and patching) and global maintenance (surface sealing).

REPORT CONDITIONS

This report has been prepared for the exclusive use of Doec, LLC for specific application to the project as discussed and has been prepared in accordance with generally accepted geotechnical engineering practices in the area. No warranties, either express or implied, are intended or made. Site safety and earthwork construction procedures are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless SSGC reviews the changes and either verifies or modifies the conclusions of this report in writing.

The analysis and recommendations presented in this report are based upon the data obtained from the explorations completed at the indicated locations and from other information as discussed. This report does not reflect variations that may occur between explorations, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

This report was prepared for the planned type of development of the site as discussed herein. It is not valid for third party entities or alternate types of development on the site without the express written consent of SSGC. If development plans change we should be notified to review those changes and modify our recommendations as necessary.

The scope of services for this project does not include environmental or biological assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. Specific environmental studies should be performed if the owner is concerned about the potential for contamination or pollution.

We appreciate the opportunity to work with you on this project. Please contact us if additional information is required or we can be of further assistance.

Respectfully,

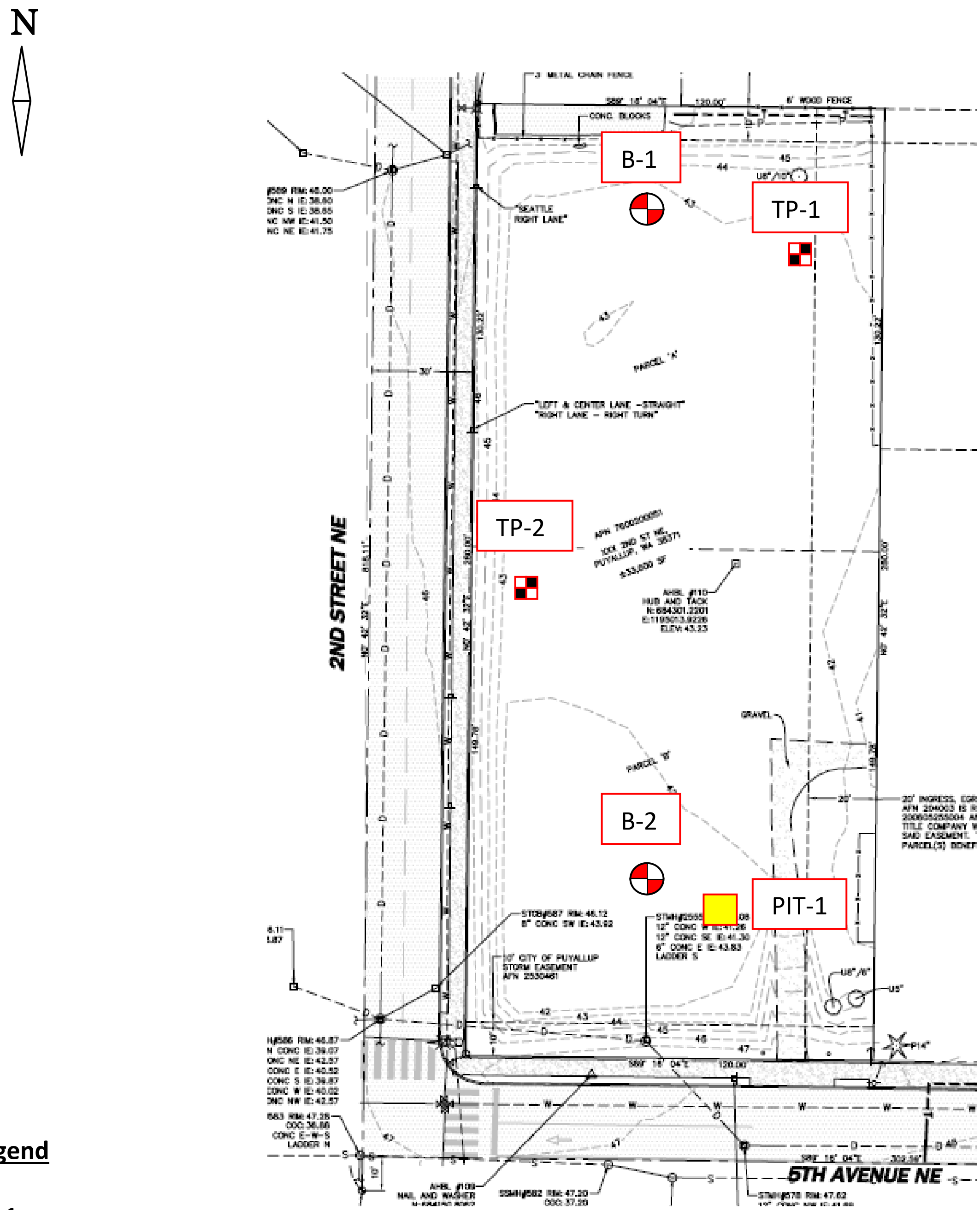
South Sound Geotechnical Consulting

TIMOTHY H. ROBERTS
STATE OF WASHINGTON
43126
REGISTERED
PROFESSIONAL ENGINEER

8-8-19

Timothy H. Roberts, P.E.
Member/Geotechnical Engineer

Attachments: Figure 1, Exploration Plan
Appendix A: Exploration Procedures and Boring Logs
Appendix B: Laboratory Testing and Results
Unified Soil Classification System



Legend

B - 1

Approximate Boring Location

TP - 1

Approximate Test Pit Location

PIT - 1

Approximate Infiltration Test Location

Scale: NTS

Base map from drawing titled "SPP Manufacturing Puyallup Survey", by AHBL, dated July 24, 2018

South Sound Geotechnical Consulting
P.O. Box 39500
Lakewood, WA 98496
(253) 973-0515

Figure 1 – Exploration Plan

2nd Street NE Apartments
Puyallup, WA

SSGC Project #19055

Appendix A

Subsurface Exploration Procedures and Boring Logs

Field Exploration Procedures

Our field exploration for this project included two borings, two test pits and one Pilot Infiltration Test completed on July 15, 2019. The exploration locations were determined by measuring distances from existing site features. Ground surface elevation was estimated from drawing "SPP Manufacturing Puyallup Survey", by AHBL, dated July 24, 2018. The referenced elevations should be considered accurate only to the degree implied by the means and methods used.

An independent drilling contractor working under subcontract to SSGC drilled the borings and installed the monitoring well (piezometer). Borings were continuously observed by a representative of SSGC who logged observed subgrade conditions and collected representative soil samples. Soil samples were stored in moisture tight containers for further visual identification. The driller was responsible for backfilling borings in accordance with Washington State Department of Ecology regulations.

Test pits and the infiltration test hole were excavated by a private excavation company subcontracted to SSGC. Test holes were backfilled with cuttings and tamped following excavation. Note that backfill material may settle with time and require remedial measures at the time of construction.

The exploration logs indicate the observed lithology of soils and other materials observed. Where a soil contact was observed to be gradational, our log indicates the average contact depth. The logs also show the approximate depth of groundwater, when observed. Classification of the soils indicated on the logs is in general accordance with the Unified Soil Classification System.

PROJECT: 2nd Street Apartments **JOB NO.** 19055 **BORING** B-1

Location: Puyallup, WA **Approximate Elevation:** 42 feet

Depth (ft)	Soil Description	Sample Number	Ground Water	N-values (Standard, blows per foot)	Testing
0	**Silty Fine SAND**: Very loose, moist, dark brown.				
2.5–4		S-1		2	
4	**SAND with trace silt and gravel:** Loose, moist, dark gray.				
5–6.5		S-2		5	Grad
7.5–9		S-3		9	
10–11.5		S-4		8	
13.5	Grades wet		▼ ATD		
15–16.5		S-5		2	Grad
20–21.5		S-6		9	
25					

Penetration Resistance: ▲ Standard, △ Other; Blows per foot 0–50

Explanation

- 2-inch O.D. split spoon sample
- 3-inch I.D Shelby tube sample
- ⊗ No Recovery
- ▼ ATD: Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — **Natural** — **Liquid Limit**

South Sound Geotechnical Consulting

BORING LOG | **Boring B-1**

Date Drilled: 7/15/19 | **Logged By: THR**

Location: Puyallup, WA **Approximate Elevation:** 42 feet

Depth (ft)	Soil Description	Sample Number	Ground Water	Penetration Resistance (Blows per foot)	N-values	Testing
25–26.5	**SAND with trace silt and gravel:** Loose to medium dense, wet, dark gray.	S-7		▲ Standard	17	
30–31.5		S-8		▲ Standard	7	
33	**Sandy SILT:** Soft to medium stiff, wet, dark gray.					
35–36.5		S-9		▲ Standard	6	Grad
40–41.5		S-10		▲ Standard	3	
45–46.5		S-11		▲ Standard	4	
50						

Explanation

- 2-inch O.D. split spoon sample
- 3-inch I.D Shelby tube sample
- No Recovery
- ATD: Groundwater level at time of drilling or date of measurement

Monitoring Well Key
- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — Natural — Liquid Limit

PROJECT: 2nd Street Apartments | **JOB NO.** 19055 | **BORING** B-1 |

Location: Puyallup, WA | **Approximate Elevation:** 42 feet

Depth (ft)	Soil Description	Sample Type	Sample Number	Ground Water	Penetration Resistance (Blows per foot)	N-values	Testing
	SILT with some fine sand: Soft to medium stiff, wet, gray.	2-inch O.D. split spoon	S-12		▲	2	
55		2-inch O.D. split spoon	S-13		▲	5	
60		2-inch O.D. split spoon	S-14		▲	8	
65	Grades very stiff	2-inch O.D. split spoon	S-15		▲	28	grad
70		2-inch O.D. split spoon	S-16		▲	22	
75							

Explanation

- 2-inch O.D. split spoon sample
- 3-inch I.D Shelby tube sample
- No Recovery
- Groundwater level at time of drilling or date of measurement (ATD)

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — **Natural** — **Liquid Limit**

PROJECT: 2nd Street Apartments	**JOB NO.** 19055	**BORING** B-1	**PAGE 4 OF 4**
Location: Puyallup, WA	**Approximate Elevation:** 42 feet		

Depth (ft)	Soil Description	Sample Type	Sample Number	Ground Water	Penetration Resistance (▲ Standard / △ Other; Blows per foot 0 10 20 30 40 50)	N-values	Testing
	Sandy SILT: Stiff to very stiff, wet, gray.	I	S-17		▲	17	
	Boring completed at approximately 76.5 feet on 7/15/19. Groundwater observed at about 14 feet at time of drilling.						
80							
85							
90							
95							
100							

Explanation

- I 2-inch O.D. split spoon sample
- II 3-inch I.D Shelby tube sample
- ⊗ No Recovery
- ▼ ATD Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

0 10 20 30 40 50

Moisture Content

Plastic Limit — **Natural** — **Liquid Limit**

Zipper Zeman Associates, Inc. **Geotechnical & Environmental Consultants**	**BORING LOG**	**Boring B-1**
	Date Drilled: 7/15/19	**Logged By: THR**

PROJECT: 2nd Street Apartments | **JOB NO.** 19055 | **BORING** B-2 | **PAGE 1 OF 1**

Location: Puyallup, WA | **Approximate Elevation:** 42 feet

Depth (ft)	Soil Description	Sample Interval	Sample Number	Ground Water	Penetration Resistance (Blows per foot; ▲ Standard, △ Other)	N-values	Testing
0	**Silty Fine SAND**: Very loose, moist, brown.						
3		I	S-1		▲	9	
5.5	**SAND with trace silt and gravel:** Loose, moist, dark gray.	I	S-2		▲	13	
8		I	S-3		▲	9	
10.5		I	S-4		▲	8	
14	Grades wet			▼ ATD			
15.5		I	S-5		▲	7	

Boring completed at approximately 16.5 feet on 7/15/19.
Groundwater observed at about 14 feet at time of drilling.
Observation well installed in boring.

Explanation

- I 2-inch O.D. split spoon sample
- II 3-inch I.D Shelby tube sample
- ⊗ No Recovery
- ▼ ATD Groundwater level at time of drilling or date of measurement

Monitoring Well Key

- Clean Sand
- Cuttings
- Bentonite
- Grout
- Screened Casing

Moisture Content

Plastic Limit — Natural — Liquid Limit

South Sound Geotechnical Consulting	BORING LOG	Boring B-2
	Date Drilled: 7/15/19	Logged By: THR

Test Pit TP-1

Depth (feet)	Material Description
0 – 1	**Topsoil**
1 – 2	Silty SAND: Loose, damp, brown.
2 – 5.5	SAND with trace to some silt: Loose, moist, gray.
5.5 - 7	SAND with trace to some silt and occasional gravel: Loose, moist, dark gray.

Test pit completed at approximately 7 feet on 7/15/19.
Groundwater not observed at time of excavation.
Approximate surface elevation: 43 feet

Test Pit TP-2

Depth (feet)	Material Description
0 – 3	**Fill:** Silt, sand, with minor debris (wire, brick): Loose, damp, brown to gray.
3 – 3.5	Silty SAND: Loose, damp, grayish brown.
3.5 - 8	SAND with trace to some silt: Loose, moist, gray. (Sample S-1 @ 4 feet; Sample S-2 @ 8 feet)

Test pit completed at approximately 8 feet on 7/15/19.
Groundwater not observed at time of excavation.
Approximate surface elevation: 43 feet

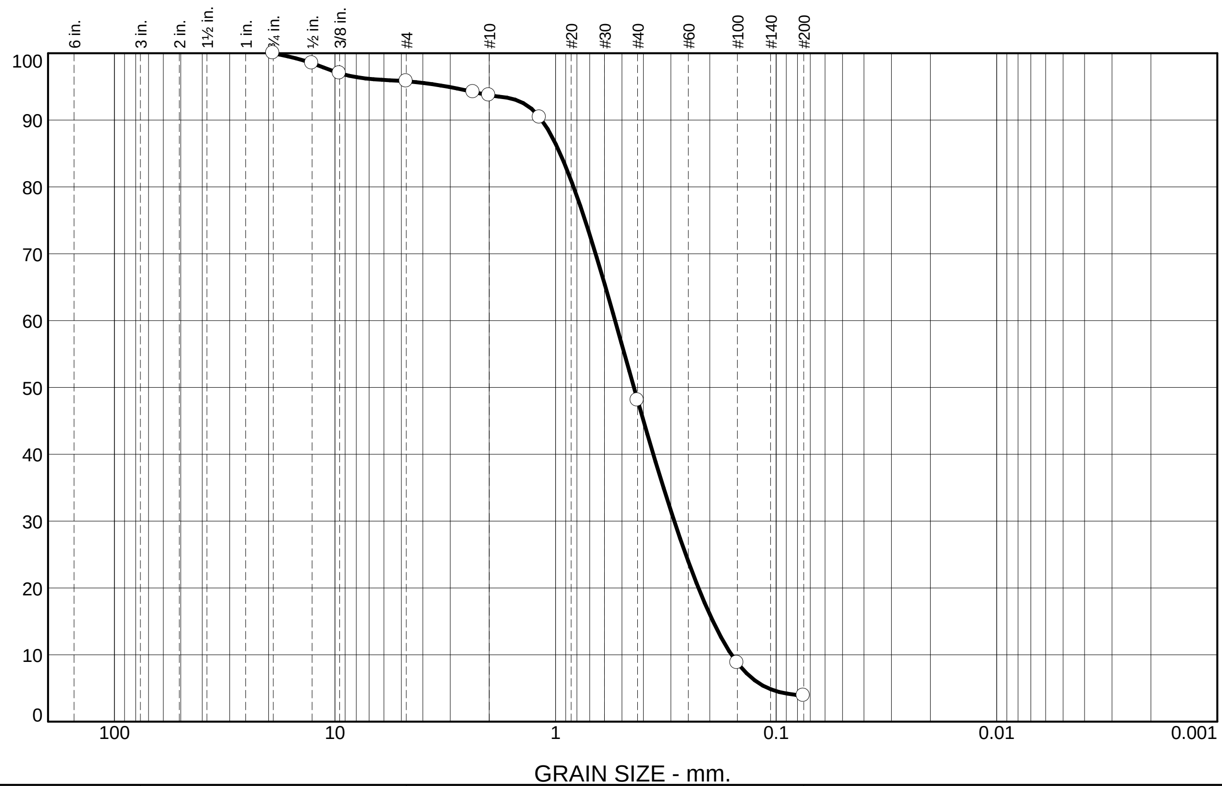
Appendix B

Laboratory Testing and Results

Laboratory Testing

Select soil samples were tested for grain size distribution (gradation) by Construction Testing Laboratories (CTL) of Puyallup, Washington. Cation Exchange Capacity (CEC) and organic content tests were completed by Northwest Agricultural Consultants of Kennewick, Washington. Results of the laboratory testing are included in this appendix.

Particle Size Distribution Report ASTM C-117,C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	4	2	46	44	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100		
1/2"	98		
3/8"	97		
#4	96		
#8	94		
#10	94		
#16	90		
#40	48		
#100	9		
#200	3.9		

* (no specification provided)

Material Description

Grab Sample, S-2

Atterberg Limits

PL= LL= PI=

Classification

USCS= SP AASHTO=

Remarks

Report: #01

Sampled by: Client

Source of Sample: B-1
Sample Number: 19-1040

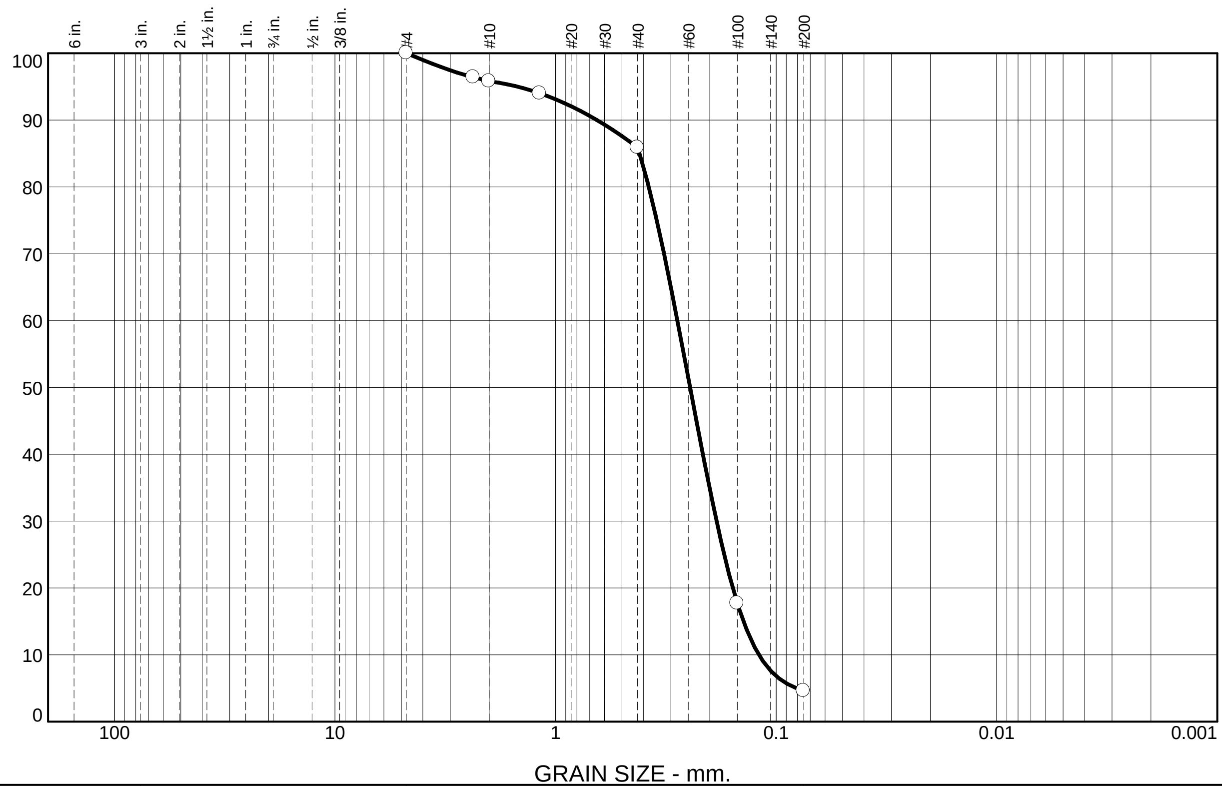
Date: 07-15-19

Construction Testing Laboratories
400 Valley Ave. NE, Suite #102
Puyallup WA, 98372 Tel. (253) 383-8778

Client: South Sound Geotechnical
Project: 2nd Street Apartments
19055
Project No: 7940 **Figure**

Tested By: M Armstrong **Checked By:** C Pedersen

Particle Size Distribution Report ASTM C-117,C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	4	10	81	5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#8	96		
#10	96		
#16	94		
#40	86		
#100	18		
#200	4.6		

* (no specification provided)

Material Description

Grab Sample, S-5

Atterberg Limits

PL= LL= PI=

Classification

USCS= SP AASHTO=

Remarks

Report: #03

Sampled by: Client

Source of Sample: B-1
Sample Number: 19-1042

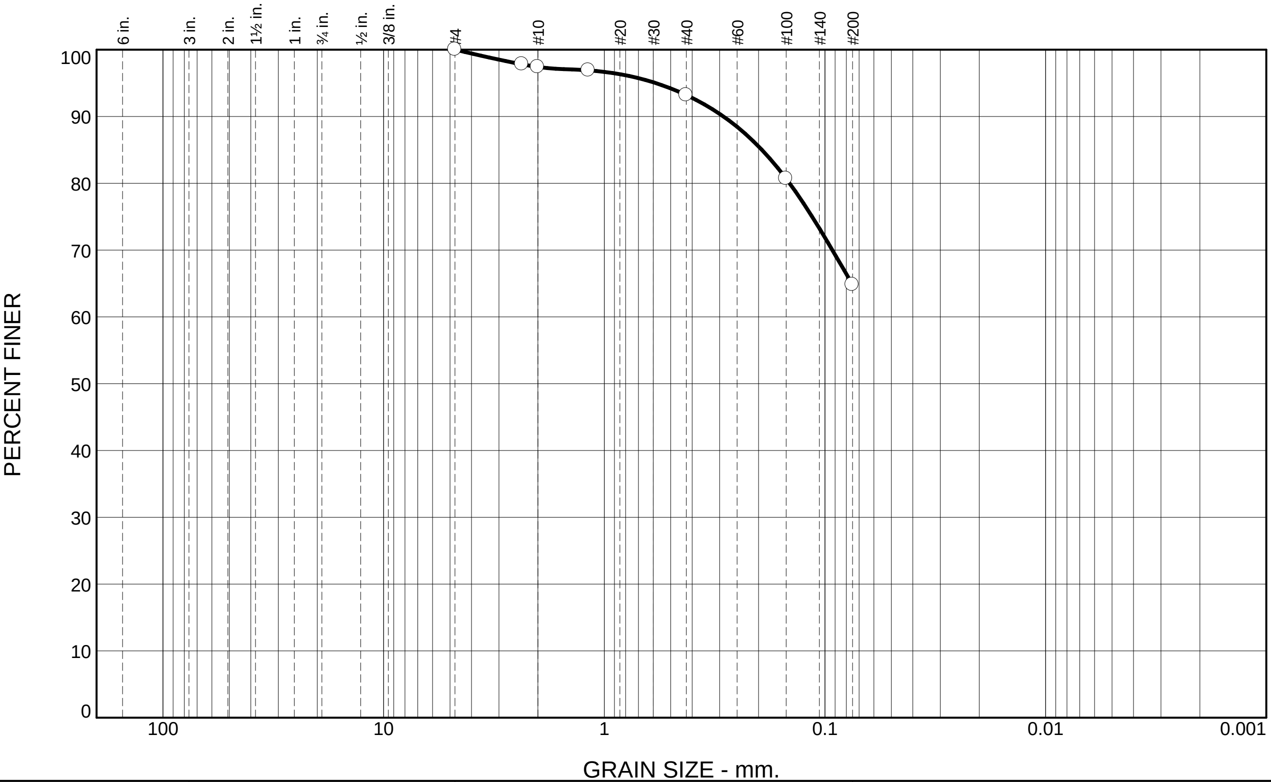
Date: 07-15-19

Construction Testing Laboratories
400 Valley Ave. NE, Suite #102
Puyallup WA, 98372 Tel. (253) 383-8778

Client: South Sound Geotechnical
Project: 2nd Street Apartments
19055
Project No: 7940 **Figure**

Tested By: M Armstrong **Checked By:** C Pedersen

Particle Size Distribution Report ASTM C-117,C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	3	4	28	65	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#8	98		
#10	97		
#16	97		
#40	93		
#100	81		
#200	65		

* (no specification provided)

Material Description

Grab Sample, S-9

Atterberg Limits

PL= LL= PI=

Classification

USCS= AASHTO=

Remarks

Report: #04

Sampled by: Client

Source of Sample: B-1
Sample Number: 19-1043

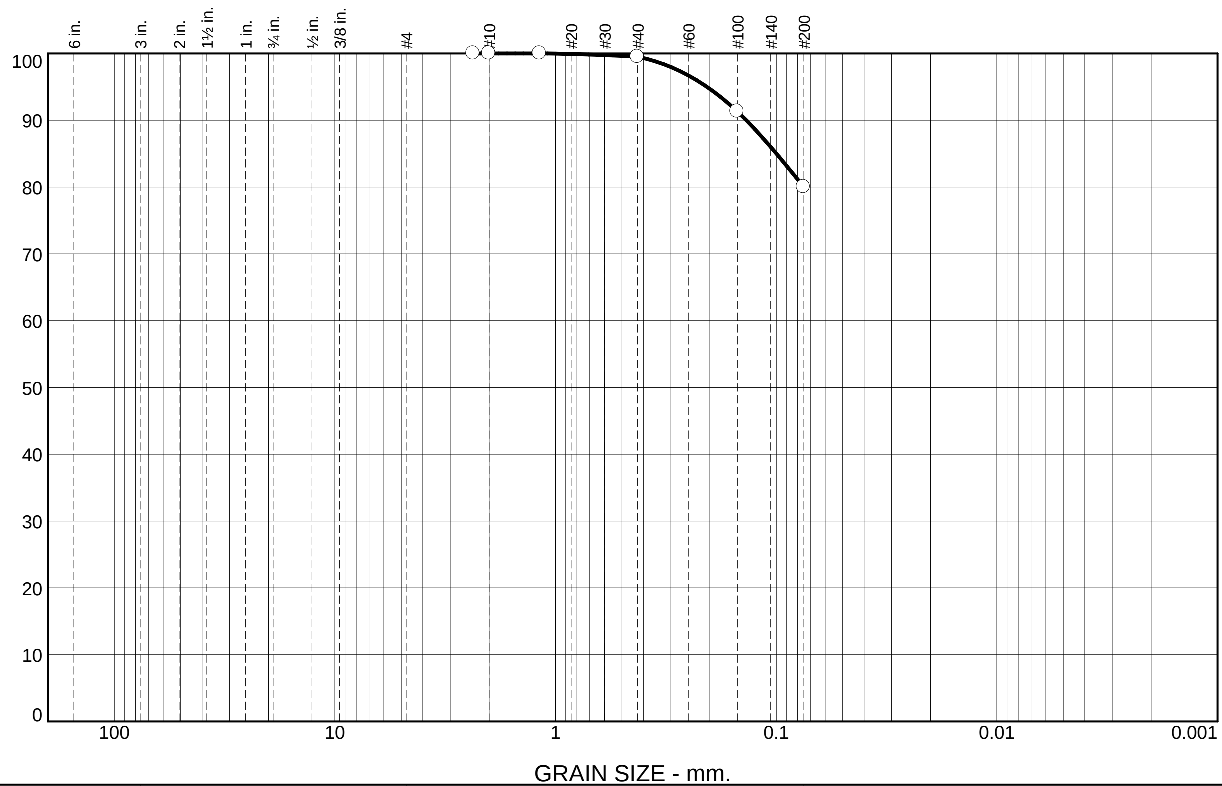
Date: 07-15-19

Construction Testing Laboratories
400 Valley Ave. NE, Suite #102
Puyallup WA, 98372 **Tel. (253) 383-8778**

Client: South Sound Geotechnical
Project: 2nd Street Apartments
19055
Project No: 7940 **Figure**

Tested By: M Armstrong **Checked By:** C Pedersen

Particle Size Distribution Report ASTM C-117,C136



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	0	20	80	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100		
#10	100		
#16	100		
#40	100		
#100	91		
#200	80		

* (no specification provided)

Material Description

Grab Sample, S-15

Atterberg Limits

PL= LL= PI=

Classification

USCS= AASHTO=

Remarks

Report: #02

Sampled by: Client

Source of Sample: B-1
Sample Number: 19-1041

Date: 07-15-19

Construction Testing Laboratories
400 Valley Ave. NE, Suite #102
Puyallup WA, 98372 Tel. (253) 383-8778

Client: South Sound Geotechnical
Project: 2nd Street Apartments
19055
Project No: 7940 **Figure**

Tested By: M Armstrong **Checked By:** C Pedersen

Northwest Agricultural Consultants

South Sound Geotechnical Consulting
PO Box 39500
Lakewood, WA 98496

2545 W Falls Avenue
Kennewick, WA 99336
509.783.7450
www.nwag.com
lab@nwag.com

PAP-Accredited
NAPT

Report: 48534-1
Date: July 22, 2019
Project No: 19055
Project Name: 2nd St. Apartments

Sample ID	Organic Matter	Cation Exchange Capacity
PIT-1, S-1	1.75%	7.5 meq/100g
Method	**ASTM D2974**	**EPA 9081**

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]					Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]		GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]		GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH		GM	Silty gravel[F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]		SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]		SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH		SM	Silty sand[G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	$PI > 7$ and plots on or above "A" line[J]		CL	Lean clay[K,L,M]
			$PI < 4$ or plots below "A" line[J]		ML	Silt[K,L,M]
		organic	Liquid limit - oven dried	< 0.75	OL	Organic clay[K,L,M,N]
			Liquid limit - not dried			Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line		CH	Fat clay[K,L,M]
			PI plots below "A" line		MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried	< 0.75	OH	Organic clay[K,L,M,P]
			Liquid limit - not dried			Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

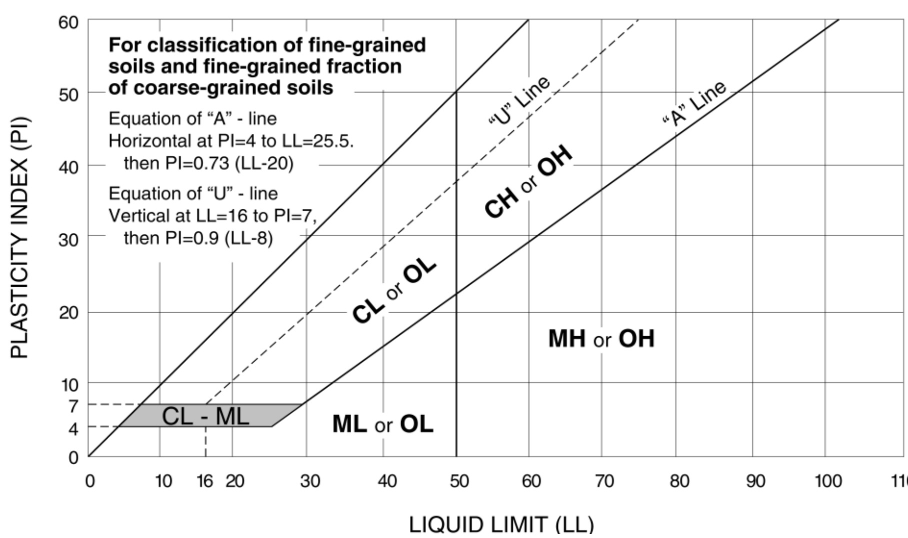
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ and plots on or above "A" line.

[O] $PI < 4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



South Sound Geotechnical Consulting

April 30, 2020

Doec, LLC
11192 – 25th Avenue East
Tacoma, Washington 98445

Attention: Mr. Don Huber

Subject: Groundwater Monitoring (Winter 2019 – 2020)
2nd Street NE Apartments
Puyallup, Washington
SSGC Project No. 19055

Mr. Huber,

South Sound Geotechnical Consulting (SSGC) has completed monitoring of groundwater levels through the 2020 winter season (2020) at the 2nd Street Apartment project in Puyallup, Washington. One groundwater monitoring well was installed (in Boring B-2) on the property in July 2019 as part of our geotechnical evaluation of the site (report dated August 8, 2019). Approximate location of the boring with the well is shown on Figure 1, Exploration Plan. Groundwater levels measured from the original drilling date of the boring/monitoring well to early April 2020 are presented in the table below.

Boring	Date	Groundwater Level (Below Surface)
B-2	7/15/19	14’
	10/27/19	14’ 5”
	12/4/19	13’ 9”
	1/18/20	12’ 2”
	2/12/20	10’ 10”
	3/8/20	11’ 2”
	4/7/20	12’ 1”

Groundwater levels in the well demonstrate seasonal precipitation variation over the winter season. February 2020 was an abnormally wet month historically with February and March demonstrating the highest groundwater levels. We recommend the February level is used in design of stormwater control facilities for this site.

REPORT CONDITIONS

This report has been prepared for the exclusive use of Doec, LLC for specific application to the project discussed, and has been prepared in accordance with generally accepted geotechnical engineering practices in the area. No warranties, either express or implied, are intended or made of future groundwater conditions.

We appreciate the opportunity to work with you on this project. Please contact us if additional information is required or we can be of further assistance.

Respectfully,

South Sound Geotechnical Consulting

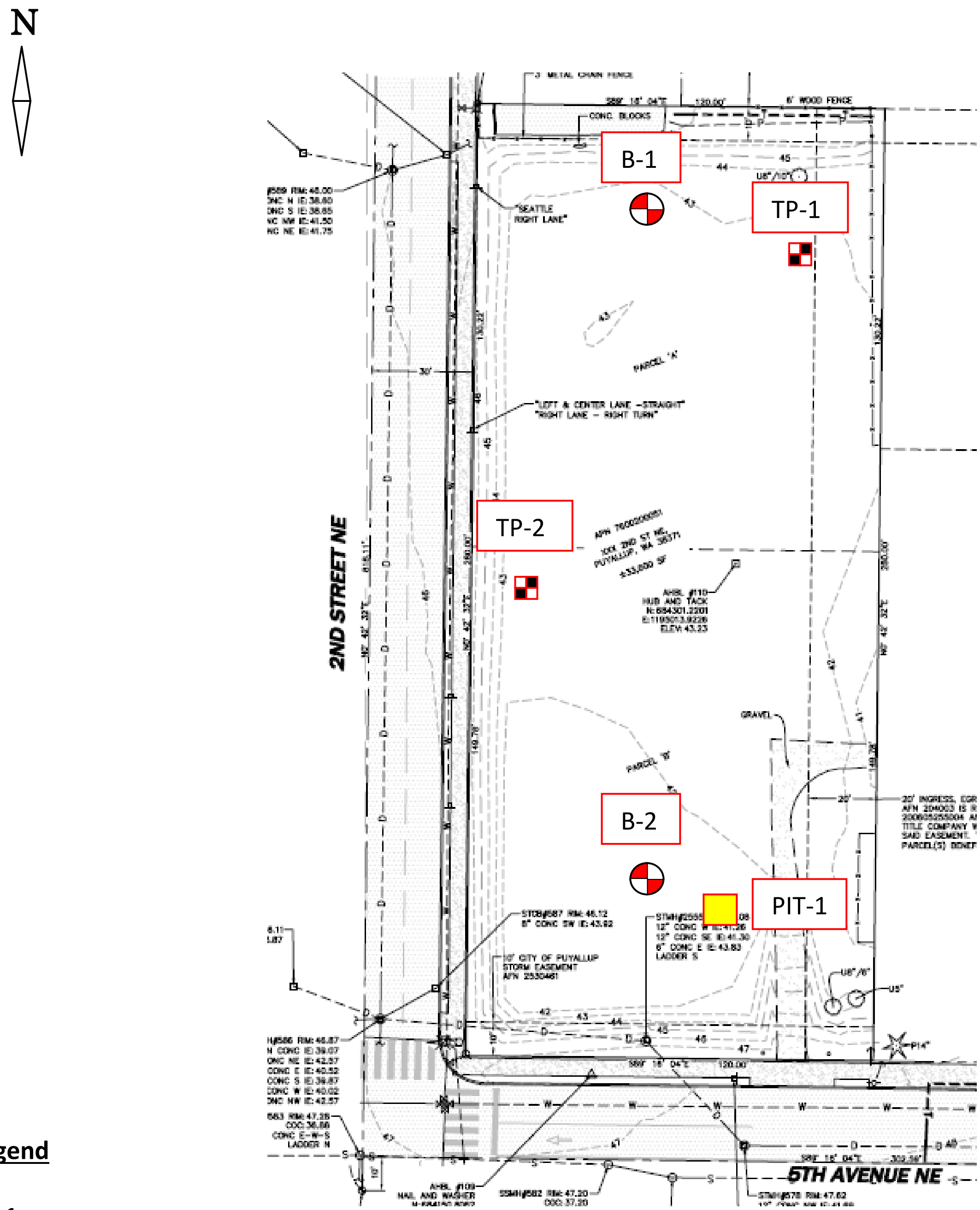
TIMOTHY H. ROBERTS
STATE OF WASHINGTON
43126
REGISTERED
PROFESSIONAL ENGINEER

4-30-20

Timothy H. Roberts, P.E.
Member/Geotechnical Engineer

Attachments: Figure 1 – Exploration Plan

cc: AHBL, Inc. – Mr. Ken Leland, P.E.



Legend

B - 1

Approximate Boring Location

TP - 1

Approximate Test Pit Location

PIT - 1

Approximate Infiltration Test Location

Scale: NTS

Base map from drawing titled "SPP Manufacturing Puyallup Survey", by AHBL, dated July 24, 2018

South Sound Geotechnical Consulting
P.O. Box 39500
Lakewood, WA 98496
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Figure 1 – Exploration Plan

2nd Street NE Apartments
Puyallup, WA

SSGC Project #19055