LAND TECHNOLOGIES, INC.
PLANNING • PERMITTING • ENGINEERING

MAKING A "WAY" OUT OF "NO WAY"

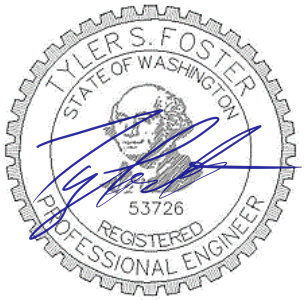
Smokey Point Investments LLC

14XXX Smokey Pt Blvd, Marysville, WA 98271

PN SPA _____

SEPA SPA: October 2021

Stormwater Site Plan Report for Undi Commerce Park



10/21/2021

Reviewed by:
Tyler Foster, P.E.
360-652-9727
Email:Tyler@landtechway.com

Contents

Figures

Tables

Acronyms

The following acronyms and abbreviations may or may not be called out within the body of this report.

- ASTM - American Society for Testing and Materials
- BMPs - Best Management Practices
- CB - Catch Basin
- CAO - Critical Areas Ordinance
- CESCL - Certified Erosion and Sediment Control Lead
- DOE - Department of Ecology
- EDDS - Engineering Design & Development Standards
- FEMA - Federal Emergency Management Agency
- HSPF - Hydrological Simulation Program—Fortran
- LiDAR - Light Detecting And Ranging
- LDA - Land disturbing activity
- LID - Low Impact Development
- LID Manual - DOE 2005 LID Technical Guidance Manual for Puget Sound
- MRs - Minimum Requirements (for Stormwater Management)
- MS4 - Municipal Separate Storm Sewer System
- MSL - Mean Sea Level
- NAVD88 - North American Vertical Datum of 1888
- NGVD29 - National Geodetic Vertical Datum of 1929
- NPDES - National Pollutant Discharge Elimination System
- NRCS - Natural Resources Conservation Service
- NPGIS - Non-Pollutant Generating Impervious Surface
- O&M - Operations and Maintenance
- PGIS - Pollutant Generating Impervious Surface
- PGPS - Pollutant Generating Pervious Surface
- PLSS - Public Land Survey System
- POC - Point of Compliance
- RCW - Revised Code of Washington
- ROW - Right-of-Way
- SCDM-2010 - Snohomish County 2010 Drainage Manual
- SMMWW - DOE 2005 Stormwater Management Manual for Western Washington
- SWPPP - Stormwater Pollution Prevention Plan
- TDA - Threshold Discharge Area
- TESC - Temporary Erosion and Sediment Controls
- USDA - United States Department of Agriculture
- US EPA - United States Environmental Protection Agency
- WSDOT - Washington State Department of Transportation
- WWHM - Western Washington Hydrology Model

Section 1 – Report Summary

1.1 Project Description

Smokey Point Investments LLC is planning for the future development of 47.95-*acres* of land in north Marysville, WA alongside Smokey Point Boulevard. The proposed development will be a Commerce Park which will house several large buildings. A SEPA plan approval is pursued for the future development of the commerce park in part or whole.

Stormwater Management for the anticipated full build out of the site will rely on full infiltration. Stormwater is divided amongst the site based on NPGHS and PGHS. All NPGHS is infiltrated within a rock infiltration chamber. All PGHS is distributed within a bioretention cell/swale that is comprised of 1.5-*feet* of bioretention soil media. The bioretention soil media is placed on top of an expanded rock infiltration bed that exceeds the footprint of the bioretention cell. This expansive rock infiltration bed is modeled independently in the WWHM to account for the larger surface area interface provided by the rock blanket dimensions.

Buildings within the bulk of the site may be equipped with loading docks. The three proposed buildings along the northern panhandle extending to 152nd St will be at grade with overhead doors.

Groundwater monitoring is currently underway for the 2021-22 Wet Season to establish a precise groundwater elevation and trend. Due to the potential likelihood of shallow groundwater at the site and significant size of land, stormwater is proposed to be pumped from the loading dock zones to adjacent surface bioretention swales for treatment. Loading dock zones are less than 4-ft from the final grade of building elevation. Extensive fill would be required to provide gravity flow from these elements. It is anticipated that stormwater generated from buildings and passenger vehicle parking areas will sheet flow to adjacent stormwater facilities.

The enhanced treatment afforded by the bioretention swales will provide a multitude of uses for future tenants provided adequate pre-treatment is maintained.

The parcel is currently vacant and vegetated with pasture type grasses. No known critical areas occur onsite or directly offsite. An unregulated ditch extends through the project site.

The site will be accessed along Smokey Point Boulevard at each parcel's frontage location. The northern panhandle portion of the site will be accessed via 152nd St NE. At full buildout the parcels will be connected through a drive aisle. However, each parcel requires its own independent access and fire lane so each parcel may be a standalone project based on timing and phasing.

The 2014 DOE Stormwater Management Manual for Western Washington will be adhered to for stormwater management. Stormwater management will rely on infiltration of treated stormwater.

Extensive groundwater monitoring and geologic studies have occurred in the past for adjacent properties. Some geotechnical work has already been conducted and more is planned.

Per NRCS mappings, type "C/D" Norma and Custer fine sandy loam soils are found throughout the site. The site lies within Recessional Outwash soils of the Marysville Sand member. These sands begin at depth and are clean and extensive.

1.2 Project Data Summary

Existing and proposed project areas are presented for determination of stormwater management requirements based on prescribed thresholds as outlined in the Marysville Municipal Code (MMC 22C) and the 2014 SMMWW Vol-1, Ch-2, Section 2.4 are summarized in the following tables.

Table 1 - Project Parcel Summary

Project Data:	
Applicant	Smokey Point Investments
Site Owner	Smokey Point Investments LLC
Project Name	Undi Commerce Park
Project T.S.R. Location	Twn 31 N, Rng 5 E, Sec 33, Qtr-W
Project Address	14XXX Smokey Pt Blvd, Marysville, WA 98271
Parcel ID(s)	3105330030-2500,-1900,-0300,-1000,-2200,-3100,-2600,-2300,-2700,-0900,-0500,-3000,-1100,-1200
Watershed	Snohomish
Basin	Quilceda Creek
Sub-Basin	Hayho Creek
WRIA Number	7
Analysis Standard	2014 DOE SMMWW

Table 2 - Project Area Analysis & Activities Summary

Existing Conditions:		
Total Site Area	2,088,697	sf (47.95 ac)
Existing Impervious Area	0	sf (0.00 ac) 0%
Proposed Activity:		
Proposed Activity	LI – Commerce Park	
Total Proposed Disturbance Area	2,088,697	sf (47.95 ac)
Proposed Grading Area	2,088,697	sf (47.95 ac)
Proposed New NPGIS (roof)	815,484	sf (18.7 ac)
Proposed New PGIS (Road and Driveway/Parking)	959,908	sf (22.0 ac)
Proposed Replaced Impervious Area	0	sf (0.00 ac)
Native Vegetation convert to Lawn	0	sf (0.00 ac)
Native Vegetation convert to Pasture	0	sf (0.00 ac)
Total New Impervious Area	1,775,392 sf	sf (40.7 ac)
Total Site Impervious Area (new+exist)	1,775,392 sf	sf (40.7 ac)
Grading is ≤ 2 feet from P/L	No	
Any excavation 4+' at <1:1 slope to P/L	No	
Fill Slopes 4+' and >33% slope	No	

Section 2 - Minimum Requirements

2.1 Assessment of Minimum Requirements and Thresholds

Minimum requirements and thresholds are established by City of Marysville Municipal Code 14.15.050 – Minimum Requirements. Minimum Requirements for new development and Redevelopment are based on a development's disturbance area. Existing and proposed project areas for determination of stormwater management requirements are presented in Table 2.

The existing impervious area is less than 35% so this project qualifies as 'new development'. The proposed condition of the fully developed site will have impervious area in excess of 5,000 sf. This requires construction activities and stormwater management to comply with Minimum Requirements 1 through 9. A full construction SWPPP is also required.

Minimum Requirements per SMMWW:

MR-1: Prepare Stormwater Site Plan. MMC 14.15.050 (1)

MR-2: Stormwater Pollution Prevention Plan (SWPPP). MMC 14.15.050 (2)

MR-3: Water pollution source control for new development. MMC 14.15.050 (3)

MR-4: Preservation of natural drainage systems and outfalls. MMC 14.15.050 (4)

MR-5: On-site stormwater management. MMC 14.15.050 (5)

MR-6: Runoff treatment. MMC 14.15.050 (6)

MR-7: Flow control requirements. MMC 14.15.050 (7)

MR-8: Detention or treatment in wetlands and wetland buffers. MMC 14.15.050 (8)

MR-9: Inspection, operation and maintenance requirements. MMC 14.15.050 (9)

Each Minimum Requirements is described in the following sections. There are no additional requirements to be met.

2.2 MR #1: Preparation of Stormwater Site Plans

This document is the Stormwater Site Plan Report that addresses the requirements of MR-1. This section presents the portion of the Stormwater Site Plan that includes recommendations, calculations, and procedures required to adhere to Minimum Requirement #1. The evaluation of the existing site conditions follows.

2.2.1 Site Location

The site is located in the West half of Section 33 of Township 31 North, Range 5 East. The street address is 14XXX Smokey Pt Blvd, Marysville, WA 98271 and the parcels are located on the south side of 152nd St NE and East along Smokey Point Boulevard. See Figure 1 for a vicinity map.

2.2.2 Site Description, Existing Conditions

The project site is 47.95-*acres*. The parcels are owned by Smokey Point Investments LLC. The Snohomish County parcel number are 3105330030-2500,-1900,-0300,-1000,-2200,-3100,-2600,-2300,-2700,-0900,-0500,-3000,-1100,-1200. It is zoned Light Industrial and is located in Snohomish County.

The parcel is vacant. The existing drainage system(s) are undetermined but largely surface runoff over the top silt layer and some infiltration. One parcel group recently had an early grade permit with a detention pond installed. Site investigation reveals that not much stormwater can reach this pond based on grade.

All maps and figures are presented in the Support Data section of this document.

A vicinity map that shows the site location is shown as Figure 1.

A site map that shows the property lines is shown in Figure 2.

A topographic map that shows the site boundaries, study area boundaries, and the downstream flow-paths is also presented in Figure 3.

2.2.3 Existing Basin Analysis

The project is defined by the development within the subject parcels. Existing project flow paths are shown in Figure 2.

The study area is located in the Hayho Creek sub-basin of the Quilceda Creek Basin in the Snohomish watershed (WRIA-7), which drains to the Puget Sound.

All existing flow assessment and site related basin delineations were established by tracing analysis of a LIDAR surface model.

2.2.4 Other Information on the Study Area

The site is not in or adjacent to a USEPA Sole Source Aquifer.

The site is not in a well-head protection area.

The site is not in a floodway or floodplain.

2.2.5 Critical Areas

No recent Critical Area Report or Study has been conducted. No wetlands were observed after a site visit in October 2021. No wetlands are mapped or recorded within the City's GIS repository. An unregulated ditch flows through the site but is not considered a critical area.

2.2.6 Topography

The site and surrounding topography is analyzed using survey topographic points provided by the Puget Sound Lidar Consortium. A 3D surface model was generated and augmented with on-site survey topographic provided by Innova Architects.

The site has mostly flat slopes with a high point around 108 feet MSL in the northwest corner of the site.

Slopes average in the range of 0 to 2 percent for the majority of the developable area. The site has an average slope of 0.5%.

2.2.7 Soils

Per NRCS mappings, type "C/D" Norma and Custer fine sandy loam soils are found throughout the site. The site lies within Recessional Outwash soils of the Marysville Sand member. These sands begin at depth and are clean and extensive.

Norma loam soils have a 0-10 *inch* first layer of fine ashy loam with the remaining profile being sandy loam. Custer fine sandy loam soils have 0 to 9 inch first layer of fine sandy loam with the remaining profile being sand.

Detailed physical and chemical properties of these soils are presented in Section 4.1. The NRCS mapping can be seen in Figure 5.

Onsite geotechnical work and soils exploration by Zipper Geotech's is underway. An updated Geotech report was issued in August of 2021. Preliminary groundwater elevations of 3 to 4-ft BPG are reported and a preliminary infiltration rate of 2-*in/hr* is stated. Stormwater design relies on this stunted 2-*in/hr* rate. Stormwater management will be preliminarily designed with these values. Groundwater elevation is conservatively shallower within the preliminary concept project drawings.

2.2.8 Field Inspection

The site was visited in October 2021, a clear and dry Sunday. All site evaluation conducted per remote sensing

2.2.9 Upstream Analysis

A relative high point of 110 *feet* MSL is located offsite directly northwest of the site. The upstream area to the site is directly to the north- northwest of the site on the adjoining parcel and north of 152nd St NE. This upstream area drains to the unregulated ditch. The unregulated ditch is conveyed through the site in an existing 36-inch diameter CMP Culvert to the unregulated ditch along the eastern property boundary.

2.2.10 Downstream Analysis

The downstream area was established by tracing analysis of a LIDAR surface model and evaluation of various GIS data, aerial imagery, and City of Marysville Drainage Inventory. The development area flows to the east property boundary line and flows south in the unregulated ditch. Stormwater then flows east at the southernmost property corner. This unregulated ditch flows east along the southernmost border of the Marysville Regional Stormwater pond where it joins with the Hayho Creek. Stormwater flows along Hayho Creek to the crossing of 136th St NE. Hayho Creek crosses beneath 136th St NE within a 48 *inch* diameter culvert. Hayho Creek travels south before reaching the Quilceda Creek. Quilceda Creek drains to the Puget Sound.

Stormwater generated from the project site is to be infiltrated. (Stormwater will be treated prior to discharge).

Figure 3 shows a portion of the downstream flow path.

2.3 MR #2: Stormwater Pollution Prevention Plans (SWPPPs)

MMC 14.15.050 (2) specifies the requirements for development and redevelopment projects to be responsible for preventing erosion and discharge of sediment and other pollutants into receiving waters. Volume I, Chapter 2.5.2 of the 2014 SMMWW specifies that all new development and redevelopment implement a Stormwater Pollution Prevention Plans (SWPPP), which is a list of 13 elements that present measures and methods for all permanent and temporary erosion and sediment control (TESC), pollution prevention, inspection/monitoring activities, and recordkeeping required during the proposed construction project.

Based on the MR#2 thresholds, this project generates more than 2,000 *square feet* of impervious area, so a full SWPPP is required. Required elements for the SWPPP:

- SWPPP element 1: Preserve vegetation/mark clearing limits
- SWPPP element 2: Establish construction access
- SWPPP element 3: Control flow rates
- SWPPP element 4: Install sediment controls
- SWPPP element 5: Stabilize soils
- SWPPP Element 6: Protect slopes
- SWPPP element 7: Protect permanent drain inlets
- SWPPP element 8: Stabilize channels and outlets
- SWPPP element 9: Control pollutants
- SWWP element 10: Control dewatering
- SWPPP element 11: Maintain best management practices
- SWPPP element 12: Manage the project
- SWPPP element 13: Protect On-Site Stormwater Management BMPs for Runoff from Roofs and Other Hard Surfaces

The SWPPP is assembled as a separate document for portability and reproduction purposes. The document is titled "**Stormwater Pollution Prevention Plan for Undi Commerce Park**", dated 21 October 2021. This document will be provided with Construction Plan Submittal.

2.4 MR #3: Source Control of Pollution

MMC 14.15.050 (3) specifies the requirements for water pollution source control for new development or redevelopment activities in accordance with Volume IV of the SMMWW. These activities are primarily commercial industrial developments that represent significant pollutant generation potential and the associated source control BMPs are designed to suit those activities.

Per Chapter 2.5.3, MR#3 does not apply to the intended future use of this industrial development. Hence such source controls are not specified for this project. Project specific controls may be required for specific proposals. The site is designed to accommodate these source controls for specific tenants as required.

2.5 MR #4: Preservation of Natural Drainage Systems and Outfalls

MMC 14.15.050 (4) specifies the requirements for preservation of natural drainage systems or outfalls for all new development and redevelopment activities under Minimum Requirement 4 in the 2014 SMMWW.

Natural drainage patterns as they once existed shall be retained. Existing conditions experience a sheet drainage pattern to the site's east property boundary. Stormwater generated onsite reaches the property boundary through surface runoff during only extreme storm events (exceeding 100-year storm). Stormwater is infiltrated onsite.

2.6 MR #5: On-Site Stormwater Management

MMC 14.15.050 (5) specifies requirements for implementing on-site stormwater BMPs. This requirement mandates that on-site stormwater runoff be infiltrated, dispersed, and/or retained to the maximum extent feasible without causing flooding or erosion impacts. Projects triggering Minimum Requirements 1 through 5 must use On-site stormwater management BMPs from List #1 for all surfaces or demonstrate compliance with the LID Performance Standard. Projects triggering Minimum Requirements 1 through 9 must meet the requirements of Table 2.5.1 in Vol. 1 of the 2014 SMMWW. Table 2.5.1 specifies the requirements for new or redevelopment depending on UGA and parcel size to meet the requirements of the LID Performance Standard and/or List #2. List #1 and List #2 specify stormwater BMPs in order of preference. The first BMP determined feasible is required.

<u>This project triggers MR's 1-9.</u> This project is within the City's UGA. This project is required to adhere to the LID Performance Standard or List #2 per Table 2.5.1.

List #1 and #2 contain appropriate BMPs to mitigate a particular developed surface. The surfaces included in the list are Lawn and Landscaped Areas, Roofs, and other hard surfaces (road/driveway/parking).

> Lawn/Landscape is required to utilize BMP T5.13, Post-Construction Soil Quality and Depth.
>
> Roofs are required to employ BMP T5.30 Full Dispersion or Downspout Infiltration, Rain Gardens or Bioretention, BMP T5.10A Downspout Dispersion Systems, or perforated stub-out connections. The first feasible BMP in this list must be used.
>
> Other Hard surfaces (Roads, Driveways, Parking Lots, Etc.) must utilize BMP T5.30 Full Dispersion, BMP T5.15 Permeable Pavement, Bioretention, Sheet Flow Dispersion, or Concentrated Flow Dispersion. The first feasible BMP in this list must be used.

Lawn/landscape will utilize BMP T5.13, Post Construction Soil Quality and Depth.

Roofs and Driveways will not be able to provide BMP T5.30 Full Dispersion. Full Dispersion requires 100 *foot* flow paths within native areas. The project will not be able to maintain 65% open space.

Individual "Lot" Infiltration is feasible based on the permeability of native soils. Roofs will be routed to rock infiltration chambers for full infiltration.

BMP T5.10B Downspout Dispersion or Driveway Dispersion will not be utilized as each individual building site lacks the prescriptive flow path length through native vegetation.

Road and Driveway/Parking areas will be routed to Bioretention Cells, BMP T7.30. The bioretention cells will treat stormwater through filtering, phytoremediation, and microbial action from within the compost. The Bioretention Cells also perform enhanced treatment.

Bioretention cells will treat more than 99% of incoming stormwater generated from the PGIS (per MR #6). See Minimum Requirement #6.

Permeable pavement may not be used as due to the site use is a commercial/industrial activity defined by 40 CFR 122.26(b)(14).

A site plan showing the stormwater management and development can be seen in Figure 4.

2.7 MR #6: Runoff Treatment

Minimum Requirement #6 in MMC 14.15.050 (6) specifies the requirements for providing runoff treatment. The threshold for requiring a treatment BMP is 5,000 *square feet* of PGIS (Pollution Generating Impervious Surface) or a total of more than ¾ of an acre of PGPS (Pollution Generating Pervious Surface).

This project is expected to generate 959,908 *square feet* (22.0 *acres*) of PGIS based on road, driveway, sidewalk, and parking areas, therefore treatment facility BMPs are required for this project.

Runoff treatment facility selection is outlined in Vol. I, Ch. 4.2, Step V of the 2014 SMMWW. Step V outlines the treatment facility selection flow chart based on the intended use of a project. Treatment selection is based on if the site is a high-use site, if the downstream receiving waters are phosphorous sensitive, and/or if the site is required to provide enhanced treatment. The definitions of high-use, phosphorous control, and enhanced treatment can be found in Step V in Section 4.2 of the 2014 SMMWW.

The project is not a high use site and infiltration is practicable for the site.

Enhanced and Basic treatment is provided through the use of a bioretention facility per Vol. III Section 3.3.12 of the 2014 SMMWW. The bioretention specified will provide enhanced treatment. The bio-cell treats stormwater through the percolation of stormwater through soils and their ability to absorb pollutants. See Vol III. Section 3.3.12 of the 2014 SMMWW for specific soil design criteria.

If the project is determined to be a high-use site in the future – oil control facilities may be required prior to discharge to the bioretention cell. These areas will primarily be located in the loading dock zones of the development and may be pumped from the oil control facility prior to the bioretention cells for final treatment and infiltration.

The bioretention cell mitigates polluted stormwater through physical, chemical and biological treatment processes. The treatment process will break down heavy metals that are not easily separated by physical means. Stormwater percolates through compost amended soils and plantings to obtain treatment. Stormwater flows through this part of the cell at a rate of 2.0 *inches/hour*. Infiltration is allowed to occur below the bio-cells. The total percolated runoff through the bio-cell's amended soils is well over the 91% total runoff volume treatment requirement. See Section 7.

2.8 MR #7: Flow Control

Minimum Requirement #7 in MMC 14.15.050 (7) specifies the requirements for runoff flow control. The threshold for requiring Minimum Requirement #7 is 5,000 *square feet* of impervious surface. Flow control shall be provided if the project creates more than 10,000 *square feet* of effective impervious area in a threshold discharge area, converts ¾ of an acre or more of native vegetation to lawn, 2.5 *acres* or more native vegetation is converted to pasture, or a combination of impervious and converted pervious surfaces cause a 0.1 *cfs* increase in the 100-*year* flow frequency from a continuous simulation runoff model.

The project exceeds this requirement and is required to provide flow control. Flow Control is provided by infiltration.

The project uses bioretention cells to detain and treat all incoming stormwater flow from PGIS. The bioretention cell marginally detains stormwater but provides 100% treatment of stormwater generated by PGIS. The bio-cells are comprised of 1.5 *feet* of amended soils. The bioretention cells discharge to a rock infiltration bed beneath. The rock infiltration bed has an expanded footprint beneath the cells to position the infiltrating blanket beneath pavement, sidewalk, and curb. The bio-cell utilizes a 0.5 *foot* ponded area with 0.5 *feet* of freeboard to allow stormwater to infiltrate through the amended soils and in to this rock infiltration chamber. The modeled bioretention cell element is connected at both Outlets 1 and 2 to the rock bed to precisely monitor all stormwater leaving the amended soils to the rock bed. The rock bed is receiving all stormwater flowing through the bioretention cell. The rock bed infiltrates to the native soils below. The modeling for this bioretention cell and expanded rock bed was required to be separate facilities due to the inequivalent width of both facilities and the required 'expanded' rock bed to permit 100% infiltration of stormwater.

Roofs will be directed to a separate rock infiltration chamber. Rock infiltration chambers are provided to mimic BMP T5.10A Full Infiltration but utilize the WWHM for size determination. The rock infiltration chamber is 1 *feet* thick and has an overall footprint of 6500-*ft* x 20-*ft* (130,000 *square feet*.)

See Section 7 for bio-cell and rooftop infiltration modeling parameters.

2.9 MR #8: Wetlands Protection

MMC 14.15.050 (8) specifies requirements for discharge of stormwater in wetlands and wetland buffers as well as discharge of stormwater to a stream.

Since there is no detention or treatment in critical areas, MR-8 does not apply to this project.

2.10 MR # 9: Operation and Maintenance

Minimum Requirement #9 specified in MMC 14.15.050 (9) contains requirements for inspection, operation and maintenance of stormwater facilities and BMPs. Specific maintenance standards and requirements are outlined in Volume V of the 2014 SMMWW. The 2014 SMMWW requires the regular maintenance and inspection of drainage facilities.

For portability and reproduction purposes, the Operations and Maintenance Manual is presented in a separate stand-alone document titled "**Operations and Maintenance Manual for Undi Commerce Park"**, dated **21 October 2021.** This document will be provided with the construction plan submittal.

Section 3 - Maps & Figures

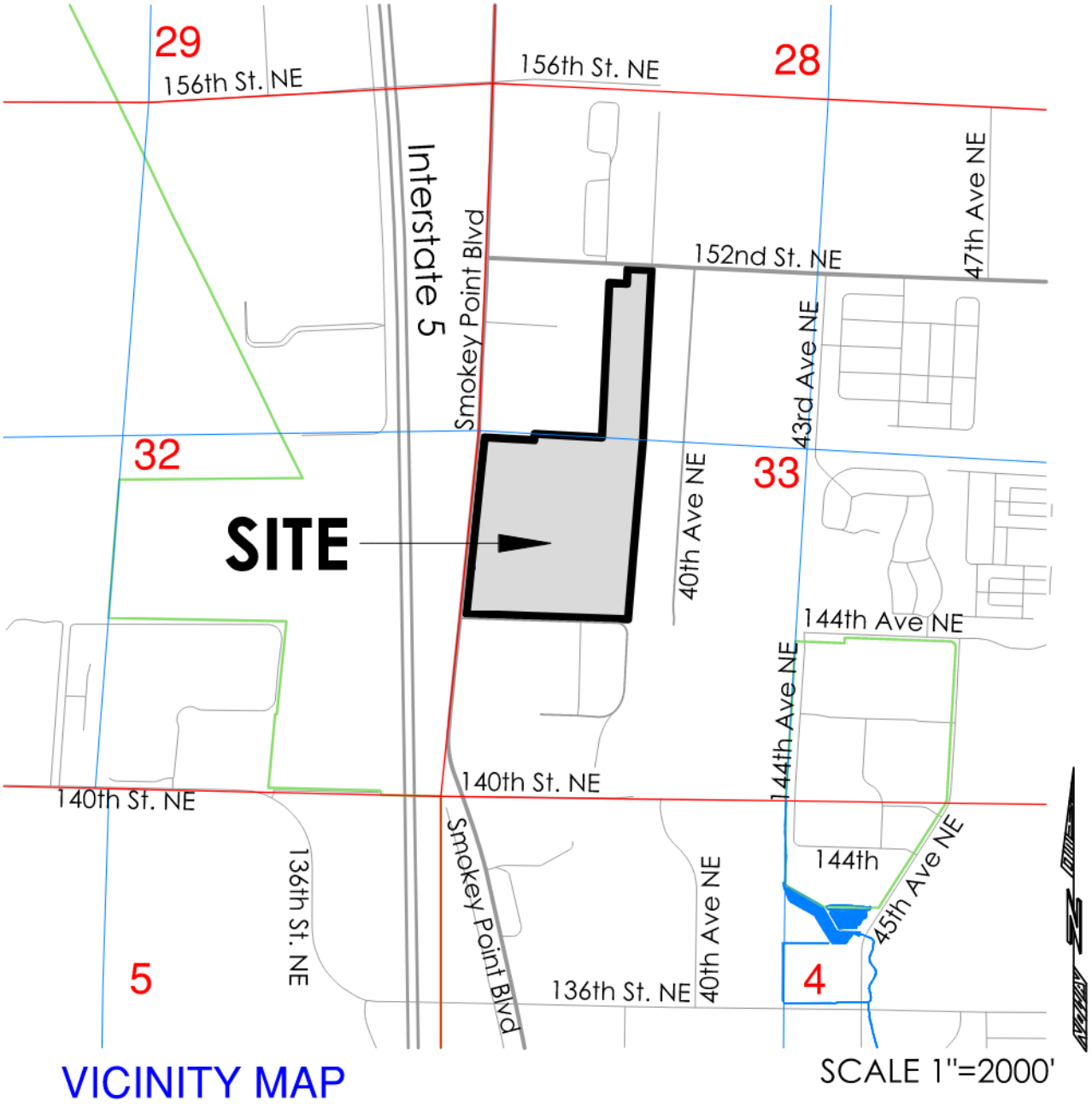


Figure 1 - Vicinity Map

Figure 2 - Existing Conditions (not to scale)

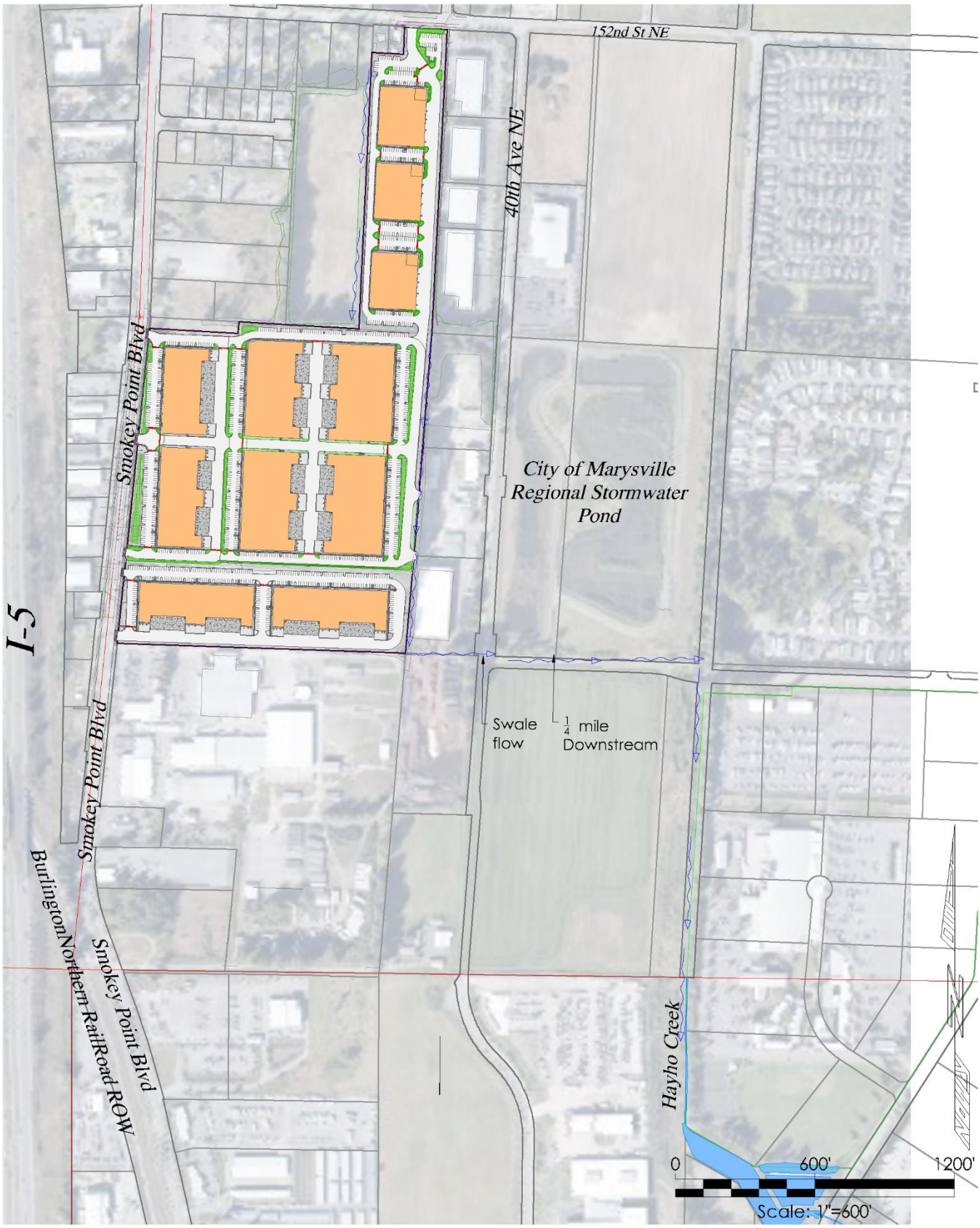


Figure 3 – Downstream Flow Path

Figure 4 - Site Plan

Figure 5 – Soil Map (Not to Scale)

Section 4 - Support Data

4.1 Soils Data

13—Custer fine sandy loam
Map Unit Setting
National map unit symbol: 2hy0
Elevation: 0 to 150 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Prime farmland if irrigated and drained
Map Unit Composition
Custer, undrained, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.
Description of Custer, Undrained
Setting
Landform: Outwash plains
Parent material: Glacial outwash
Typical profile
H1 - 0 to 9 inches: fine sandy loam
H2 - 9 to 35 inches: sand
H3 - 35 to 60 inches: sand
Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: 20 to 40 inches to strongly contrasting textural stratification
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.1 inches)
Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Forage suitability group: Wet Soils (G002XN102WA)
Hydric soil rating: Yes
Minor Components
Norma, undrained
Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Custer, drained
Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes
Indianola
Percent of map unit: 5 percent
Hydric soil rating: No
39—Norma loam
Map Unit Setting
National map unit symbol: 2hyx
Elevation: 0 to 1,000 feet
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Prime farmland if drained
Map Unit Composition
Norma, undrained, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.
Description of Norma, Undrained
Setting
Landform: Depressions, drainageways
Parent material: Alluvium
Typical profile
H1 - 0 to 10 inches: ashy loam
H2 - 10 to 28 inches: sandy loam
H3 - 28 to 60 inches: sandy loam
Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water storage in profile: Moderate (about 9.0 inches)
Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Forage suitability group: Wet Soils (G002XN102WA)
Hydric soil rating: Yes
Minor Components
Bellingham, undrained
Percent of map unit: 5 percent
Landform: Depressions

Hydric soil rating: Yes

Norma, drained

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Terric medisaprists, undrained

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Custom Soil Resource Report

Section 5 Works Cited

Puget Sound Action Team. (2005, January). Low Impact Development Technical Guidance Manual for Puget Sound. *Publication No. PSAT 05-03*. Washington: Washington State University - Pierce County Extension.

Puget Sound LIDAR Consortium. (2003, April). LIDAR Bare Earth DEM File. q47121h24be.e00. Snohomish County, Washington. Retrieved May 2013, from http://pugetsoundlidar.ess.washington.edu/index.htm

Snohomish County Planning and Development Services. (2007, October 1). Aquifer Recharge/Wellhead Protection. Everett, WA.

Snohomish County Surface Water Management Division. (2002, December). Snohomish UGA Drainage Needs Report. Everett, Washington.

Section 6 - Continuous Simulation Modeling

6.1 Continuous Simulation Background

HSPF based continuous simulation modeling was used to evaluate the hydrologic performances of the pre-developed and developed sub-basins in order to accurately assess flow rates.

The currently adopted continuous simulation models use the HSPF (Hydraulic Simulation Program in FORTRAN) software engine. The HSPF model uses a robust and detail accounting of the 'water budget', including evaporation, evapotranspiration, interception, interflow, and groundwater. The modeling accounts for and assesses land segment areas that include vegetation or impervious cover, soil types, and slopes. The modeling also uses utilized over 50 years of continuous rainfall data (precipitation) and evaporation data for the area. The HSPF continuous modeling is considered the best available science for hydrologic analysis.

6.2 Modeling Methodology

HSPF modeling was managed via the Western Washington Hydrology Model (WWHM) interface program. The current professional version of WWHM by Clearcreek Solutions, Inc., WWHM-2012 was used. The current data precipitation and evaporation set provided by DOE with the WWHM-2012 software interface was used that includes quantized data in 15-minute time steps from October 1948 to October 2009. Projects within the WSDOT Data zones may also elect to use the WSDOT precipitation data that extends the time series to 1901 and extrapolates to 2058. The WSDOT precipitation data may be used.

The WWHM program comes packaged with generic, well considered HSPF modeling parameters. These settings allow for the modeling of the majority of the topological conditions found in the Puget Sound area. Where conditions fall reasonably outside the range of the default HSPF parameters, adjustments should be made to more accurately reflect those conditions. These is generally limited to the pervious land segments (IMPLNDS) and are mostly limited to slopes (SLSUR), infiltration rates (INFILT), and length of flow path (LSUR). For this project, HSPF parameters were not adjusted to reflect site conditions.

6.2.1 Existing Conditions

The surface vegetative cover is assumed fully forested with an average slope of 1% in the area of development, based on the LIDAR based TIN analysis. The LIDAR model represents the pre-graded conditions and is in accordance with the predeveloped requirements to be represented as native vegetation and soils that existed at a site prior to the influence of Euro-American settlement.

The NRCS soil mapping of Custer within the modeled area is a Type C/D hydrologic soils by NRCS and DOE.

6.2.2 Developed Conditions

Default mapping for flat road was used for the road, driveway, and parking areas. These areas will be pumped or sheet flow to bioretention cells placed throughout the site.

The entire site is required fill to maintain separation between the high groundwater table. Fill beneath the facilities is required to have infiltration properties consistent with the native soils.

The bioretention cells discharge to a rock infiltration chamber beneath. The rock infiltration chamber has an expanded footprint beneath the cells to position the infiltrating blanket beneath pavement, sidewalk, and curb. The bio-cell utilizes a 0.5 *foot* ponded area with 0.5 *feet* of freeboard to allow stormwater to infiltrate through the amended soils and in to this rock infiltration chamber. The bioretention cell is connected at both WWHM outlets 1 and 2 to the rock bed. The rock bed is receiving all stormwater flowing through the bioretention cell. The rock bed infiltrates to the native soils below. The modeling for this bioretention cell and expanded rock bed is required to be separate facilities due to the inequivalent width of both facilities and the required 'expanded' rock bed to permit 100% infiltration of stormwater. This modeling method permits the accurate infiltration component to be calculated within the rock bed. The infiltration of the bioretention cell matches the rate of the BSM and is connected (outflows) to the rock bed. This is the Outlet 2 connection of the WWHM element.

It should be noted that when ponds, bio-swales, or other open detention facilities are used, the corresponding WWHM analysis module includes the ponded area. Consequently, this area is not included in the basin land segment mappings, so the total area is often different between the developed and pre-developed conditions. The bioretention cells provided account for 0.96 *acres* of surface area that is accounted for.

Per C.10.3 Modeling of Multiple Bioretention facilities of Volume III, of the 2014 DOE SMMWW, multiple bio-cell facilities, have similar characteristics, could represent as one large bio-cell facility serving the cumulative area tributary to those facilities. The bioretention areas will be specified at a ratio that is consistent with the entire site plan for the Commerce Park as development occurs.

The current DOE specification for amended soils in 2014 is labeled as 'SMMWW' in the Bio-Swale and other WWHM modules that employ amended soils. The parameters for modeling the SMMWW are preset and based on current state-of-the-art modeling using a combination of the Darcy's and Van Genuchten's equations to account for the variability of permeability and water content as the soils transition from dry or partly damp to saturated conditions as the bio-cell cycles through the process of filling, emptying, and drying out. The SMMWW settings based on the WSU amended soils.

The rooftop rock infiltration chambers are separately modeled and follow the multiple facilities as described above. In the future, specific construction plans for individual buildings and sites within the commerce park will likely have their own modeling and design constituents. The rooftop rock infiltration chambers are modeled based on cumulative area draining to each. Chambers will be parsed through the site at a ratio of rooftop draining to each.

The pasture representative in the model as bypass will likely drain to bioretention cells on the site or discharge to the native drainage pathways. These areas are distributed throughout the entire 50-*acre* parcel and not representative of any one single, or significant area.

Section 7 - Software Output

The following WWHM reports in this section represent individual sub-basin analysis for hydrologic flow evaluations. The following heading is common to all reports.

Western Washington Hydrology Model,

PROJECT REPORT

WWHM2012
PROJECT REPORT

Project Name: Undi Commerce SEPA Plan
Site Name: Undi Commerce SEPA
Site Address: Smky Pt Blvd
City : Marysville
Report Date: 10/20/2021
MGS Regoin : Puget East
Data Start : 1901/10/1
Data End : 2058/09/30
DOT Data Number: 05
Version Date: 2019/09/13
Version : 4.2.17

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No
GroundWater: No

Pervious Land Use	acre
C, Forest, Flat	47.95
Pervious Total	47.95

Impervious Land Use	acre
Impervious Total	0
Basin Total	47.95

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No
GroundWater: No

Pervious Land Use	acre
Pervious Total	0

Impervious Land Use	acre
PARKING FLAT	22.03
Impervious Total	22.03
Basin Total	22.03

Element Flows To:

Surface	Interflow	Groundwater
Surface retention 1	Surface retention 1	

Name : Bioretention 1
Bottom Length: 7000.00 ft.
Bottom Width: 3.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW 12 in/hr
Material thickness of second layer: 0
Material type for second layer: Sand
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Infiltration On
Infiltration rate: 12
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 9581.809
Total Volume Through Riser (ac-ft.): 30.981
Total Volume Through Facility (ac-ft.): 9612.79
Percent Infiltrated: 99.68
Total Precip Applied to Facility: 228.001
Total Evap From Facility: 117.491
Underdrain not used
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 12 in.

Element Flows To:

Outlet 1	Outlet 2
Gravel Trench Bed 1	Gravel Trench Bed 1

Bioretention 1 Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.4821	0.0000	0.0000	0.0000
0.0330	0.4821	0.0073	0.0000	0.0000
0.0659	0.4821	0.0145	0.0000	0.0000
0.0989	0.4821	0.0218	0.0000	0.0000
0.1319	0.4821	0.0291	0.0000	0.0001
0.1648	0.4821	0.0363	0.0000	0.0131
0.1978	0.4821	0.0436	0.0000	0.0203
0.2308	0.4821	0.0509	0.0000	0.0293
0.2637	0.4821	0.0581	0.0000	0.0405
0.2967	0.4821	0.0654	0.0000	0.0538
0.3297	0.4821	0.0727	0.0000	0.0694
0.3626	0.4821	0.0799	0.0000	0.0875
0.3956	0.4821	0.0872	0.0000	0.1081

0.4286	0.4821	0.0945	0.0000	0.1315
0.4615	0.4821	0.1018	0.0000	0.1576
0.4945	0.4821	0.1090	0.0000	0.1865
0.5275	0.4821	0.1163	0.0000	0.2185
0.5604	0.4821	0.1236	0.0000	0.2535
0.5934	0.4821	0.1308	0.0000	0.2917
0.6264	0.4821	0.1381	0.0000	0.3332
0.6593	0.4821	0.1454	0.0000	0.3780
0.6923	0.4821	0.1526	0.0000	0.4263
0.7253	0.4821	0.1599	0.0000	0.4781
0.7582	0.4821	0.1672	0.0000	0.5335
0.7912	0.4821	0.1744	0.0000	0.5926
0.8242	0.4821	0.1817	0.0000	0.6555
0.8571	0.4821	0.1890	0.0000	0.7222
0.8901	0.4821	0.1962	0.0000	0.7928
0.9231	0.4821	0.2035	0.0000	0.8674
0.9560	0.4821	0.2108	0.0000	0.9460
0.9890	0.4821	0.2180	0.0000	1.0288
1.0220	0.4821	0.2253	0.0000	1.1158
1.0549	0.4821	0.2326	0.0000	1.2071
1.0879	0.4821	0.2398	0.0000	1.3026
1.1209	0.4821	0.2471	0.0000	1.4026
1.1538	0.4821	0.2544	0.0000	1.5070
1.1868	0.4821	0.2616	0.0000	1.6159
1.2198	0.4821	0.2689	0.0000	1.7293
1.2527	0.4821	0.2762	0.0000	1.8474
1.2857	0.4821	0.2835	0.0000	1.9700
1.3187	0.4821	0.2907	0.0000	2.0974
1.3516	0.4821	0.2980	0.0000	2.2293
1.3846	0.4821	0.3053	0.0000	2.3660
1.4176	0.4821	0.3125	0.0000	2.5071
1.4505	0.4821	0.3198	0.0000	2.6525
1.4835	0.4821	0.3271	0.0000	2.8008
1.5000	0.4821	0.3307	0.0000	3.8889

Surface retention 1 Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
1.5000	0.4821	0.3307	0.0000	2.9167	0.0000
1.5330	0.4927	0.3468	0.0000	2.9167	0.0000
1.5659	0.5033	0.3632	0.0000	3.0449	0.0000
1.5989	0.5139	0.3799	0.0000	3.1090	0.0000
1.6319	0.5245	0.3971	0.0000	3.1731	0.0000
1.6648	0.5351	0.4145	0.0000	3.2372	0.0000
1.6978	0.5457	0.4323	0.0000	3.3013	0.0000
1.7308	0.5563	0.4505	0.0000	3.3654	0.0000
1.7637	0.5669	0.4690	0.0000	3.4295	0.0000
1.7967	0.5775	0.4879	0.0000	3.4936	0.0000
1.8297	0.5881	0.5071	0.0000	3.5577	0.0000
1.8626	0.5987	0.5267	0.0000	3.6218	0.0000
1.8956	0.6093	0.5466	0.0000	3.6859	0.0000
1.9286	0.6199	0.5668	0.0000	3.7500	0.0000
1.9615	0.6305	0.5874	0.0000	3.8141	0.0000
1.9945	0.6411	0.6084	0.0000	3.8782	0.0000
2.0275	0.6517	0.6297	0.0483	3.8889	0.0000
2.0604	0.6623	0.6514	0.1574	3.8889	0.0000
2.0934	0.6729	0.6734	0.3014	3.8889	0.0000
2.1264	0.6835	0.6957	0.4712	3.8889	0.0000
2.1593	0.6941	0.7185	0.6597	3.8889	0.0000

2.1923	0.7047	0.7415	0.8600	3.8889	0.0000
2.2253	0.7153	0.7649	1.0650	3.8889	0.0000
2.2582	0.7259	0.7887	1.2676	3.8889	0.0000
2.2912	0.7366	0.8128	1.4606	3.8889	0.0000
2.3242	0.7472	0.8372	1.6378	3.8889	0.0000
2.3571	0.7578	0.8620	1.7939	3.8889	0.0000
2.3901	0.7684	0.8872	1.9255	3.8889	0.0000
2.4231	0.7790	0.9127	2.0318	3.8889	0.0000
2.4560	0.7896	0.9386	2.1153	3.8889	0.0000
2.4890	0.8002	0.9648	2.1826	3.8889	0.0000
2.5220	0.8108	0.9913	2.2755	3.8889	0.0000
2.5549	0.8214	1.0182	2.3463	3.8889	0.0000
2.5879	0.8320	1.0455	2.4150	3.8889	0.0000
2.6209	0.8426	1.0731	2.4818	3.8889	0.0000
2.6538	0.8532	1.1010	2.5468	3.8889	0.0000
2.6868	0.8638	1.1293	2.6102	3.8889	0.0000
2.7198	0.8744	1.1580	2.6721	3.8889	0.0000
2.7527	0.8850	1.1870	2.7327	3.8889	0.0000
2.7857	0.8956	1.2163	2.7918	3.8889	0.0000
2.8187	0.9063	1.2461	2.8498	3.8889	0.0000
2.8516	0.9169	1.2761	2.9066	3.8889	0.0000
2.8846	0.9275	1.3065	2.9624	3.8889	0.0000
2.9176	0.9381	1.3373	3.0170	3.8889	0.0000
2.9505	0.9487	1.3684	3.0708	3.8889	0.0000
2.9835	0.9593	1.3998	3.1236	3.8889	0.0000
3.0000	0.9646	1.4157	3.1755	3.8889	0.0000

Name : Surface retention 1

Element Flows To:

Outlet 1	**Outlet 2**
Gravel Trench Bed 1	Bioretention 1

Name : Gravel Trench Bed 1
Bottom Length: 7000.00 ft.
Bottom Width: 15.00 ft.
Trench bottom slope 1: 0 To 1
Trench Left side slope 0: 0 To 1
Trench right side slope 2: 0 To 1
Material thickness of first layer: 0.5
Pour Space of material for first layer: 0.4
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: 2
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 9612.214
Total Volume Through Riser (ac-ft.): 0.016
Total Volume Through Facility (ac-ft.): 9612.23
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Discharge Structure

Riser Height: 0.5 ft.
Riser Diameter: 24 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	2.410	0.000	0.000	0.000
0.0056	2.410	0.005	0.000	4.861
0.0111	2.410	0.010	0.000	4.861
0.0167	2.410	0.016	0.000	4.861
0.0222	2.410	0.021	0.000	4.861
0.0278	2.410	0.026	0.000	4.861
0.0333	2.410	0.032	0.000	4.861
0.0389	2.410	0.037	0.000	4.861
0.0444	2.410	0.042	0.000	4.861
0.0500	2.410	0.048	0.000	4.861
0.0556	2.410	0.053	0.000	4.861
0.0611	2.410	0.058	0.000	4.861
0.0667	2.410	0.064	0.000	4.861
0.0722	2.410	0.069	0.000	4.861
0.0778	2.410	0.075	0.000	4.861
0.0833	2.410	0.080	0.000	4.861
0.0889	2.410	0.085	0.000	4.861
0.0944	2.410	0.091	0.000	4.861
0.1000	2.410	0.096	0.000	4.861
0.1056	2.410	0.101	0.000	4.861
0.1111	2.410	0.107	0.000	4.861
0.1167	2.410	0.112	0.000	4.861
0.1222	2.410	0.117	0.000	4.861
0.1278	2.410	0.123	0.000	4.861
0.1333	2.410	0.128	0.000	4.861
0.1389	2.410	0.133	0.000	4.861
0.1444	2.410	0.139	0.000	4.861
0.1500	2.410	0.144	0.000	4.861
0.1556	2.410	0.150	0.000	4.861
0.1611	2.410	0.155	0.000	4.861
0.1667	2.410	0.160	0.000	4.861
0.1722	2.410	0.166	0.000	4.861
0.1778	2.410	0.171	0.000	4.861
0.1833	2.410	0.176	0.000	4.861
0.1889	2.410	0.182	0.000	4.861
0.1944	2.410	0.187	0.000	4.861
0.2000	2.410	0.192	0.000	4.861
0.2056	2.410	0.198	0.000	4.861
0.2111	2.410	0.203	0.000	4.861
0.2167	2.410	0.208	0.000	4.861
0.2222	2.410	0.214	0.000	4.861
0.2278	2.410	0.219	0.000	4.861
0.2333	2.410	0.225	0.000	4.861
0.2389	2.410	0.230	0.000	4.861
0.2444	2.410	0.235	0.000	4.861
0.2500	2.410	0.241	0.000	4.861
0.2556	2.410	0.246	0.000	4.861
0.2611	2.410	0.251	0.000	4.861
0.2667	2.410	0.257	0.000	4.861

0.2722	2.410	0.262	0.000	4.861
0.2778	2.410	0.267	0.000	4.861
0.2833	2.410	0.273	0.000	4.861
0.2889	2.410	0.278	0.000	4.861
0.2944	2.410	0.283	0.000	4.861
0.3000	2.410	0.289	0.000	4.861
0.3056	2.410	0.294	0.000	4.861
0.3111	2.410	0.300	0.000	4.861
0.3167	2.410	0.305	0.000	4.861
0.3222	2.410	0.310	0.000	4.861
0.3278	2.410	0.316	0.000	4.861
0.3333	2.410	0.321	0.000	4.861
0.3389	2.410	0.326	0.000	4.861
0.3444	2.410	0.332	0.000	4.861
0.3500	2.410	0.337	0.000	4.861
0.3556	2.410	0.342	0.000	4.861
0.3611	2.410	0.348	0.000	4.861
0.3667	2.410	0.353	0.000	4.861
0.3722	2.410	0.358	0.000	4.861
0.3778	2.410	0.364	0.000	4.861
0.3833	2.410	0.369	0.000	4.861
0.3889	2.410	0.375	0.000	4.861
0.3944	2.410	0.380	0.000	4.861
0.4000	2.410	0.385	0.000	4.861
0.4056	2.410	0.391	0.000	4.861
0.4111	2.410	0.396	0.000	4.861
0.4167	2.410	0.401	0.000	4.861
0.4222	2.410	0.407	0.000	4.861
0.4278	2.410	0.412	0.000	4.861
0.4333	2.410	0.417	0.000	4.861
0.4389	2.410	0.423	0.000	4.861
0.4444	2.410	0.428	0.000	4.861
0.4500	2.410	0.433	0.000	4.861
0.4556	2.410	0.439	0.000	4.861
0.4611	2.410	0.444	0.000	4.861
0.4667	2.410	0.450	0.000	4.861
0.4722	2.410	0.455	0.000	4.861
0.4778	2.410	0.460	0.000	4.861
0.4833	2.410	0.466	0.000	4.861
0.4889	2.410	0.471	0.000	4.861
0.4944	2.410	0.476	0.000	4.861
0.5000	2.410	0.482	0.000	4.861

Name : Basin 2
Bypass: Yes
GroundWater: No

Pervious Land Use	**acre**
C, Pasture, Flat	**6.24**
Pervious Total	**6.24**

Impervious Land Use	**acre**
Impervious Total	**0**

Basin Total **6.24**

Element Flows To:

Surface **Interflow** **Groundwater**

Name : Basin 3
Bypass: No
GroundWater: No

Pervious Land Use	**acre**
Pervious Total	**0**

Impervious Land Use	**acre**
ROOF TOPS FLAT	**18.72**
Impervious Total	**18.72**

Basin Total **18.72**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Gravel Trench Bed 2	Gravel Trench Bed 2	

Name : Gravel Trench Bed 2
Bottom Length: 6500.00 ft.
Bottom Width: 20.00 ft.
Trench bottom slope 1: 0.1 To 1
Trench Left side slope 0: 0.1 To 1
Trench right side slope 2: 0.1 To 1
Material thickness of first layer: 1
Pour Space of material for first layer: 0.4
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: 2
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 8074.363
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 8074.363
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Discharge Structure
Riser Height: 0.99 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	2.984	0.000	0.000	0.000
0.0111	2.984	0.013	0.000	6.019
0.0222	2.985	0.026	0.000	6.019
0.0333	2.985	0.039	0.000	6.020
0.0444	2.985	0.053	0.000	6.021
0.0556	2.986	0.066	0.000	6.021
0.0667	2.986	0.079	0.000	6.022

0.0778	2.986	0.092	0.000	6.023
0.0889	2.987	0.106	0.000	6.023
0.1000	2.987	0.119	0.000	6.024
0.1111	2.987	0.132	0.000	6.025
0.1222	2.988	0.146	0.000	6.025
0.1333	2.988	0.159	0.000	6.026
0.1444	2.988	0.172	0.000	6.027
0.1556	2.989	0.185	0.000	6.027
0.1667	2.989	0.199	0.000	6.028
0.1778	2.989	0.212	0.000	6.029
0.1889	2.990	0.225	0.000	6.029
0.2000	2.990	0.239	0.000	6.030
0.2111	2.990	0.252	0.000	6.031
0.2222	2.991	0.265	0.000	6.031
0.2333	2.991	0.278	0.000	6.032
0.2444	2.991	0.292	0.000	6.033
0.2556	2.992	0.305	0.000	6.033
0.2667	2.992	0.318	0.000	6.034
0.2778	2.992	0.332	0.000	6.035
0.2889	2.993	0.345	0.000	6.036
0.3000	2.993	0.358	0.000	6.036
0.3111	2.993	0.372	0.000	6.037
0.3222	2.994	0.385	0.000	6.038
0.3333	2.994	0.398	0.000	6.038
0.3444	2.994	0.411	0.000	6.039
0.3556	2.995	0.425	0.000	6.040
0.3667	2.995	0.438	0.000	6.040
0.3778	2.995	0.451	0.000	6.041
0.3889	2.996	0.465	0.000	6.042
0.4000	2.996	0.478	0.000	6.042
0.4111	2.996	0.491	0.000	6.043
0.4222	2.997	0.505	0.000	6.044
0.4333	2.997	0.518	0.000	6.044
0.4444	2.997	0.531	0.000	6.045
0.4556	2.998	0.545	0.000	6.046
0.4667	2.998	0.558	0.000	6.046
0.4778	2.998	0.571	0.000	6.047
0.4889	2.999	0.585	0.000	6.048
0.5000	2.999	0.598	0.000	6.048
0.5111	2.999	0.611	0.000	6.049
0.5222	3.000	0.625	0.000	6.050
0.5333	3.000	0.638	0.000	6.050
0.5444	3.000	0.651	0.000	6.051
0.5556	3.001	0.665	0.000	6.052
0.5667	3.001	0.678	0.000	6.052
0.5778	3.001	0.691	0.000	6.053
0.5889	3.002	0.705	0.000	6.054
0.6000	3.002	0.718	0.000	6.054
0.6111	3.002	0.731	0.000	6.055
0.6222	3.003	0.745	0.000	6.056
0.6333	3.003	0.758	0.000	6.056
0.6444	3.003	0.771	0.000	6.057
0.6556	3.004	0.785	0.000	6.058
0.6667	3.004	0.798	0.000	6.058
0.6778	3.004	0.811	0.000	6.059
0.6889	3.005	0.825	0.000	6.060
0.7000	3.005	0.838	0.000	6.060
0.7111	3.005	0.851	0.000	6.061

0.7222	3.006	0.865	0.000	6.062
0.7333	3.006	0.878	0.000	6.062
0.7444	3.006	0.892	0.000	6.063
0.7556	3.007	0.905	0.000	6.064
0.7667	3.007	0.918	0.000	6.064
0.7778	3.007	0.932	0.000	6.065
0.7889	3.008	0.945	0.000	6.066
0.8000	3.008	0.958	0.000	6.066
0.8111	3.008	0.972	0.000	6.067
0.8222	3.009	0.985	0.000	6.068
0.8333	3.009	0.999	0.000	6.068
0.8444	3.009	1.012	0.000	6.069
0.8556	3.010	1.025	0.000	6.070
0.8667	3.010	1.039	0.000	6.070
0.8778	3.010	1.052	0.000	6.071
0.8889	3.011	1.065	0.000	6.072
0.9000	3.011	1.079	0.000	6.072
0.9111	3.011	1.092	0.000	6.073
0.9222	3.012	1.106	0.000	6.074
0.9333	3.012	1.119	0.000	6.074
0.9444	3.012	1.132	0.000	6.075
0.9556	3.013	1.146	0.000	6.076
0.9667	3.013	1.159	0.000	6.076
0.9778	3.013	1.173	0.000	6.077
0.9889	3.014	1.186	0.000	6.078
1.0000	3.014	1.199	0.010	6.078

ANALYSIS RESULTS
Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:47.95
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:6.24
Total Impervious Area:40.75

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	1.036878
5 year	1.574987
10 year	1.862724
25 year	2.152995
50 year	2.324448
100 year	2.46489

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.159235
5 year	0.256797
10 year	0.333181
25 year	0.443407
50 year	0.535719
100 year	0.636989

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1902	1.275	0.188
1903	0.497	0.083
1904	1.083	0.250
1905	0.518	0.083
1906	0.387	0.069
1907	1.558	0.257
1908	0.992	0.147
1909	1.013	0.151
1910	1.625	0.264
1911	0.873	0.137
1912	3.380	0.630
1913	1.443	0.213
1914	0.379	0.066
1915	0.539	0.096
1916	0.875	0.139
1917	0.404	0.065
1918	0.915	0.140
1919	0.777	0.120
1920	0.945	0.146
1921	0.991	0.157
1922	1.045	0.184
1923	0.849	0.156
1924	0.496	0.089
1925	0.549	0.097
1926	0.840	0.145
1927	1.071	0.165
1928	0.674	0.118
1929	1.615	0.260
1930	0.879	0.129
1931	0.929	0.149
1932	0.696	0.131
1933	0.794	0.147
1934	2.102	0.347
1935	0.810	0.125
1936	1.202	0.177
1937	1.334	0.252
1938	1.015	0.147
1939	0.132	0.060
1940	0.853	0.145
1941	0.810	0.134
1942	1.364	0.215
1943	0.540	0.101
1944	1.557	0.383
1945	0.970	0.160
1946	0.827	0.151
1947	0.616	0.105
1948	2.042	0.299
1949	1.756	0.297
1950	0.896	0.143
1951	0.989	0.149
1952	3.095	0.560
1953	2.509	0.468
1954	0.826	0.141
1955	0.710	0.111
1956	0.544	0.095

1957	1.143	0.170
1958	2.627	0.413
1959	1.585	0.253
1960	0.570	0.095
1961	1.630	0.240
1962	0.904	0.153
1963	0.692	0.115
1964	1.931	0.538
1965	1.909	0.280
1966	0.464	0.082
1967	0.766	0.146
1968	1.034	0.166
1969	0.766	0.132
1970	1.136	0.209
1971	1.976	0.290
1972	1.304	0.429
1973	1.640	0.273
1974	0.969	0.178
1975	2.260	0.411
1976	1.008	0.209
1977	0.635	0.105
1978	1.812	0.283
1979	0.526	0.085
1980	0.980	0.148
1981	0.970	0.145
1982	0.634	0.101
1983	1.576	0.230
1984	0.464	0.145
1985	1.121	0.173
1986	0.879	0.144
1987	1.806	0.304
1988	1.169	0.170
1989	1.019	0.157
1990	1.262	0.189
1991	0.974	0.160
1992	1.310	0.197
1993	1.223	0.189
1994	1.946	0.292
1995	0.551	0.087
1996	2.141	0.329
1997	1.065	0.163
1998	1.023	0.187
1999	0.037	0.033
2000	0.747	0.150
2001	0.537	0.092
2002	1.724	0.357
2003	1.141	0.185
2004	1.124	0.184
2005	1.549	0.290
2006	0.697	0.112
2007	0.808	0.127
2008	1.039	0.156
2009	0.651	0.104
2010	0.573	0.092
2011	0.651	0.100
2012	1.061	0.219
2013	0.851	0.128
2014	0.510	0.084

2015	1.553	0.360
2016	0.362	0.062
2017	1.606	0.248
2018	2.936	0.469
2019	3.116	0.558
2020	0.974	0.206
2021	1.320	0.217
2022	0.495	0.082
2023	1.080	0.162
2024	3.777	0.770
2025	0.864	0.144
2026	1.550	0.245
2027	0.739	0.128
2028	0.408	0.077
2029	1.047	0.153
2030	2.071	0.331
2031	0.576	0.094
2032	0.483	0.089
2033	0.534	0.091
2034	0.573	0.099
2035	2.385	0.365
2036	1.219	0.194
2037	0.277	0.052
2038	1.287	0.228
2039	0.155	0.034
2040	0.535	0.108
2041	0.719	0.117
2042	2.565	0.431
2043	1.165	0.197
2044	1.471	0.210
2045	0.904	0.131
2046	1.087	0.174
2047	0.756	0.127
2048	1.066	0.170
2049	0.964	0.175
2050	0.657	0.113
2051	1.112	0.286
2052	0.551	0.089
2053	1.013	0.162
2054	1.368	0.345
2055	0.483	0.090
2056	0.409	0.072
2057	0.648	0.115
2058	0.818	0.129

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	3.7773	0.7700
2	3.3797	0.6298
3	3.1157	0.5596
4	3.0947	0.5583
5	2.9360	0.5378
6	2.6265	0.4695
7	2.5654	0.4681
8	2.5093	0.4305
9	2.3848	0.4288
10	2.2599	0.4133

11	2.1415	0.4108
12	2.1015	0.3827
13	2.0713	0.3655
14	2.0416	0.3598
15	1.9761	0.3575
16	1.9459	0.3470
17	1.9311	0.3451
18	1.9088	0.3306
19	1.8120	0.3285
20	1.8058	0.3039
21	1.7558	0.2992
22	1.7236	0.2971
23	1.6403	0.2922
24	1.6297	0.2899
25	1.6247	0.2897
26	1.6152	0.2860
27	1.6063	0.2829
28	1.5853	0.2796
29	1.5764	0.2733
30	1.5582	0.2638
31	1.5569	0.2597
32	1.5527	0.2568
33	1.5498	0.2533
34	1.5485	0.2516
35	1.4714	0.2497
36	1.4428	0.2479
37	1.3684	0.2446
38	1.3636	0.2397
39	1.3343	0.2302
40	1.3202	0.2283
41	1.3102	0.2193
42	1.3043	0.2168
43	1.2872	0.2147
44	1.2749	0.2133
45	1.2622	0.2097
46	1.2226	0.2094
47	1.2189	0.2085
48	1.2024	0.2063
49	1.1688	0.1971
50	1.1651	0.1966
51	1.1433	0.1938
52	1.1409	0.1893
53	1.1363	0.1889
54	1.1239	0.1879
55	1.1211	0.1872
56	1.1118	0.1852
57	1.0869	0.1840
58	1.0832	0.1837
59	1.0798	0.1783
60	1.0715	0.1767
61	1.0656	0.1752
62	1.0648	0.1736
63	1.0614	0.1728
64	1.0470	0.1702
65	1.0448	0.1702
66	1.0389	0.1697
67	1.0337	0.1656
68	1.0232	0.1653

69	1.0191	0.1626
70	1.0154	0.1624
71	1.0133	0.1617
72	1.0128	0.1604
73	1.0078	0.1598
74	0.9918	0.1574
75	0.9913	0.1572
76	0.9889	0.1563
77	0.9797	0.1561
78	0.9739	0.1528
79	0.9736	0.1528
80	0.9700	0.1514
81	0.9699	0.1508
82	0.9687	0.1496
83	0.9638	0.1495
84	0.9447	0.1489
85	0.9292	0.1484
86	0.9148	0.1470
87	0.9040	0.1469
88	0.9037	0.1466
89	0.8955	0.1464
90	0.8791	0.1457
91	0.8789	0.1454
92	0.8747	0.1450
93	0.8731	0.1450
94	0.8640	0.1447
95	0.8533	0.1445
96	0.8515	0.1444
97	0.8486	0.1433
98	0.8400	0.1413
99	0.8273	0.1402
100	0.8260	0.1391
101	0.8182	0.1367
102	0.8099	0.1338
103	0.8096	0.1319
104	0.8080	0.1311
105	0.7938	0.1305
106	0.7773	0.1291
107	0.7663	0.1289
108	0.7659	0.1281
109	0.7556	0.1276
110	0.7472	0.1273
111	0.7386	0.1265
112	0.7191	0.1249
113	0.7100	0.1201
114	0.6973	0.1182
115	0.6962	0.1166
116	0.6924	0.1155
117	0.6741	0.1152
118	0.6569	0.1127
119	0.6513	0.1116
120	0.6506	0.1111
121	0.6479	0.1079
122	0.6350	0.1053
123	0.6340	0.1046
124	0.6161	0.1044
125	0.5755	0.1015
126	0.5733	0.1014

127	0.5729	0.0997
128	0.5697	0.0988
129	0.5512	0.0965
130	0.5510	0.0964
131	0.5486	0.0953
132	0.5444	0.0949
133	0.5395	0.0940
134	0.5388	0.0925
135	0.5375	0.0918
136	0.5351	0.0907
137	0.5341	0.0897
138	0.5258	0.0894
139	0.5178	0.0894
140	0.5096	0.0888
141	0.4966	0.0872
142	0.4957	0.0849
143	0.4948	0.0842
144	0.4831	0.0834
145	0.4829	0.0828
146	0.4637	0.0820
147	0.4637	0.0817
148	0.4092	0.0771
149	0.4084	0.0721
150	0.4037	0.0694
151	0.3870	0.0663
152	0.3794	0.0646
153	0.3623	0.0619
154	0.2768	0.0599
155	0.1548	0.0525
156	0.1317	0.0343
157	0.0373	0.0328

Stream Protection Duration
POC #1
The Facility PASSED
The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.5184	13447	8	0	Pass
0.5367	12377	7	0	Pass
0.5549	11355	6	0	Pass
0.5732	10400	4	0	Pass
0.5914	9621	3	0	Pass
0.6097	8951	2	0	Pass
0.6279	8286	2	0	Pass
0.6461	7651	1	0	Pass
0.6644	7097	1	0	Pass
0.6826	6616	1	0	Pass
0.7009	6181	1	0	Pass
0.7191	5738	1	0	Pass
0.7373	5340	1	0	Pass
0.7556	4983	1	0	Pass
0.7738	4643	0	0	Pass
0.7921	4319	0	0	Pass
0.8103	4034	0	0	Pass
0.8286	3767	0	0	Pass
0.8468	3516	0	0	Pass

0.8650	3274	0	0	Pass
0.8833	3081	0	0	Pass
0.9015	2898	0	0	Pass
0.9198	2729	0	0	Pass
0.9380	2552	0	0	Pass
0.9563	2406	0	0	Pass
0.9745	2250	0	0	Pass
0.9927	2113	0	0	Pass
1.0110	2000	0	0	Pass
1.0292	1870	0	0	Pass
1.0475	1773	0	0	Pass
1.0657	1690	0	0	Pass
1.0840	1607	0	0	Pass
1.1022	1535	0	0	Pass
1.1204	1453	0	0	Pass
1.1387	1385	0	0	Pass
1.1569	1323	0	0	Pass
1.1752	1263	0	0	Pass
1.1934	1208	0	0	Pass
1.2117	1145	0	0	Pass
1.2299	1080	0	0	Pass
1.2481	1024	0	0	Pass
1.2664	976	0	0	Pass
1.2846	932	0	0	Pass
1.3029	896	0	0	Pass
1.3211	848	0	0	Pass
1.3394	822	0	0	Pass
1.3576	791	0	0	Pass
1.3758	764	0	0	Pass
1.3941	739	0	0	Pass
1.4123	720	0	0	Pass
1.4306	697	0	0	Pass
1.4488	667	0	0	Pass
1.4670	635	0	0	Pass
1.4853	607	0	0	Pass
1.5035	587	0	0	Pass
1.5218	559	0	0	Pass
1.5400	536	0	0	Pass
1.5583	502	0	0	Pass
1.5765	480	0	0	Pass
1.5947	468	0	0	Pass
1.6130	448	0	0	Pass
1.6312	425	0	0	Pass
1.6495	402	0	0	Pass
1.6677	384	0	0	Pass
1.6860	374	0	0	Pass
1.7042	353	0	0	Pass
1.7224	340	0	0	Pass
1.7407	326	0	0	Pass
1.7589	307	0	0	Pass
1.7772	294	0	0	Pass
1.7954	281	0	0	Pass
1.8137	272	0	0	Pass
1.8319	263	0	0	Pass
1.8501	248	0	0	Pass
1.8684	242	0	0	Pass
1.8866	229	0	0	Pass
1.9049	211	0	0	Pass

1.9231	200	0	0	Pass
1.9414	190	0	0	Pass
1.9596	177	0	0	Pass
1.9778	168	0	0	Pass
1.9961	157	0	0	Pass
2.0143	146	0	0	Pass
2.0326	137	0	0	Pass
2.0508	129	0	0	Pass
2.0691	122	0	0	Pass
2.0873	112	0	0	Pass
2.1055	103	0	0	Pass
2.1238	98	0	0	Pass
2.1420	92	0	0	Pass
2.1603	87	0	0	Pass
2.1785	84	0	0	Pass
2.1968	81	0	0	Pass
2.2150	75	0	0	Pass
2.2332	69	0	0	Pass
2.2515	63	0	0	Pass
2.2697	57	0	0	Pass
2.2880	53	0	0	Pass
2.3062	49	0	0	Pass
2.3244	46	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Water Quality	Percent Treated	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft.)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Comment
Gravel Trench Bed 1 POC	N		8747.13			N	100.00	
retention 1	N		8747.64			N	99.68	
Gravel Trench Bed 2 POC	N		7347.67			N	100.00	
Total Volume Infiltrated			24842.44	0.00	0.00		99.89	
0.00	0%	No Treat. Credit						

Compliance with LID Standard 8
Duration Analysis Result = Passed

Perlnd and Implnd Changes

No changes have been made.