LAND TECHNOLOGIES, INC.
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MAKING A "WAY" OUT OF "NO WAY"

James G. Murphy Co.

3803 & 3821 136th St NE, Marysville, WA 98271

PN -_____

1st SPA/Clearing&Grading: October 2022

Stormwater Site Plan Report for James G. Murphy Co.

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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

James G. Murphy Co. is proposing a storage yard for their business operations to complement the existing building and parking on site. A prior permit to bring in fill material to the property has been completed. This permit will be for the surfacing of that fill material, provide stormwater management, and complement the Site Plan Approval for the operations base of James G. Murphy Co. Commercial and Industrial Auctioneers.

The proposed grading permit will be on 6.82-*acres* of land in northern Marysville, WA adjacent to Smokey Point Blvd with access from 136th St. Pre-Application Review has been conducted in Early 2022.

A large portion of the parcel is currently filled with imported soil. An existing warehouse and parking lot are located in the southeast corner of the parcel. No critical areas are known to occur onsite.

The proposed grading permit will convert this imported fill soil to a graveled storage yard for equipment, vehicles, and auction inventory dependent on the liquidated business at the time. The storage yard will be surrounded by an 8-ft tall iron security fence and combined with perimeter vegetation consistent with the zoning and setbacks required for adequate landscape screening. Gravel surfacing of the site is mandatory.

The 2019 DOE Stormwater Management Manual for Western Washington will be used for stormwater management.

Per NRCS mappings, type “C/D” Custer fine sandy loam soils are found throughout the site. Sandy, permeable soils are found at depth.

Stormwater from the new impervious gravel yard will be conveyed to on-site bioretention cells. Bioretention cells are situated at entrance locations to serve as a vegetated focal point for aesthetic value. The entrance points to the storage yard are also the topographic low point of the site. Stormwater will be filtered through the bioretention cells soil media before 100% infiltration. Separation to the groundwater table is 3-feet. The existing impervious surfaces, rooftop, and asphalt parking areas are conveyed to an existing stormwater system which conveys to the existing ROW.

The entire developable project area is in a single natural discharge area with a single discharge location to West Fork Quilceda Creek. Stormwater BMPs will be employed to mitigate polluted and unpolluted surface water flows.

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 2019 SMMWW Vol-1, Ch-2, Section 2.4 are summarized in the following tables.

Table 1 - Project Parcel Summary

Project Data:	
Applicant	James G. Murphy Co.
Site Owner	James G. Murphy Co.
Project Name	James G. Murphy Co.
Project T.S.R. Location	Twn 30 N, Rng 5 E, Sec 4, Qtr-NW
Project Address	3803 & 3821 136th St NE, Marysville, WA 98271
Parcel ID(s)	300504-002-005-00, -002-00
Watershed	Snohomish
Basin	Snohomish
Sub-Basin	Quilceda Creek
WRIA Number	7
Analysis Standard	2019 DOE SMMWW

Table 2 - Project Area Analysis & Activities Summary

Existing Conditions:		
Total Site Area	296,924	sf (6.82 ac)
Existing Impervious Area	0	sf (0.00 ac) 0%
Proposed Activity:		
Proposed Activity	Gravel Surfacing	
Total Proposed Disturbance Area	248,631	sf (5.7 ac)
Proposed Grading Area	248,631	sf (5.7 ac)
Proposed New NPGIS	0	sf (0.00 ac)
Proposed New PGIS	199,478	sf (4.58 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	199,478	sf (4.58 ac)
Total Site Impervious Area (new+exist)	199,478	sf (4.58 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 less than 2,000 sf. The project does not convert more than 2.5 acres of native vegetation to pasture. The project does cause more than 7,000 *square feet* of land disturbing activity. 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 the 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 NW quarter of Section 4 of Township 30 North, Range 5 East. The street address is 3803 & 3821 136th St NE, Marysville, WA 98271 and the parcels are located on the east side of Smokey Point Blvd and on the north side of 136th St NE. See Figure 1 for a vicinity map.

2.2.2 Site Description, Existing Conditions

The project site is 6.82-*acres* parcel. The parcels are owned by James G. Murphy Co.. The Snohomish County parcel number are 300504-002-005-00, -002-00. They are zoned Light Industrial and are located in Snohomish County.

The site contains an existing warehouse building and parking areas. The existing drainage system(s) of the vacant areas are undetermined but largely surface runoff to the west and some infiltration. Surface runoff overall flows west. An existing culvert located in the Smokey Point Blvd as-built plans would infer that the vacant area of the site (~5-acres of pasture) is drained to the Smokey Point Blvd road system. The parking and rooftop of the warehouse are conveyed to the 136th St ROW stormwater system.

The existing site was pasture prior to the early grading permit. The site is currently compacted soil.

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 parcel. Existing project flow paths are shown in Figure 2.

The study area is located in the Quilceda Creek sub-basin of the Snohomish 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 critical areas are known to occur onsite or directly offsite. A critical areas determination was submitted with the Early Grading permit and accompany the Site Plan Approval/Grading permit.

2.2.6 Topography

The site and surrounding topography was analyzed using survey topographic points provided by the Puget Sound Lidar Consortium. A 3D surface model was generated.

The site has mostly flat slopes with a low point around 92 *feet* MSL along the southwest property corner. The site slopes up from the west to a high point of 95 *feet* associated with the Existing warehouse building. It appears the site has been filled in the past for creation of building and parking.

Slopes average in the range of 0 to 1 percent for the majority of the developable area. The site has an average slope of 0.50%.

2.2.7 Soils

The majority of the site is situated on Custer fine sandy loam soils, a hydrologic Type-C/D soil per the NRCS mapping. Custer fine sandy loam soils have a 0-9 *inch* first layer of fine sandy loam with the remaining profile being sand. Much surface runoff is attributed to the fine sandy loam layer.

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

A geotechnical report produced by Cobalt Geosciences, Inc. indicates the groundwater table to be 2.25 to 2.75-ft below grade. A conservative elevation attributed to the high groundwater is 90.5-ft MSL. This was utilized by corresponding the topographic elevations of the test pits with the depth of groundwater found at each pit. The highest elevation of the groundwater table was 90.5-ft in these pits and therefore assumed to be the high groundwater of the site.

The Cobalt Geosciences, inc. report also calculated an infiltration rate of 2.8-inches/hour utilizing grain-size analysis. This is a conservative infiltration rate given the knowledge of similar sites in the area. A more expensive, and accurate PIT test will likely reveal long-term rates up to 8-in/hr similar to the tests AESI conducted on the site directly to the northeast. The long-term rate of 2.8-inches/hour is used for the sizing of bioretention cells. This calculated long-term rate also utilized a safety factor for degree of siltation. For bioretention cells, this safety factor may be discounted from the calculation but is retained for a conservative assessment of the site.

2.2.8 Field Inspection

The site has been visited recently directly following the stripping of top-soil and vegetation for the early grade permit. No notable features were identified. The site was bare. No water, seeps, or soils of hydric qualities were found.

2.2.9 Upstream Analysis

The upstream is comprised of a developed storage unit complex with driveways and buildings. This upstream system has not been determined to discharge stormwater to the property. City of Marysville GIS locates a stormwater system on this property discharging to the Smokey Point Blvd storm system within the ROW. Stormwater generated from the adjacent north parcel is likely to be captured and conveyed to independent stormwater facilities. A single storm culvert is noted in the City of Marysville As-Built drawings for the widening of Smokey Point Blvd to extend in to the site to provide a stormwater connection. It has not yet been verified the capacity this connection can accept. The proposed project will elect not to discharge stormwater to this connection due to the identified flooding issues mentioned in the Pre-App comments. All stormwater generated from new impervious surfaces will be fully infiltrated on-site.

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 southeast corner and into the existing culvert connection to the City's stormwater system. Stormwater is conveyed along this existing conveyance system to the south and crosses Smokey Point Blvd via a 24" PVC culvert. Stormwater flows west and then discharges to the Railroad ROW. The Railroad ROW may be associated with an untyped, unnamed conveyance and eventually flows beneath Interstate 5 and into West Fork Quilceda Creek.

The existing parking area and building appear to be connected to the 136th St NE Stormwater system and flows to the east. This stormwater system flows several hundred feet in closed conveyance before reaching Hayho Creek. Hayho Creek travels south before reaching the Quilceda Creek. Quilceda Creek drains to the Puget Sound.

Stormwater generated from the project site will be fully infiltrated. Infiltration of converted areas will mitigate stormwater issues that have been present in the Hayho Creek corridor.

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 are responsible for preventing erosion and discharge of sediment and other pollutants into receiving waters. Volume I, Chapter 2.5.2 of the 2019 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 James G. Murphy Co."**.

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. The objective of Source Control BMPs is to prevent stormwater for coming in contact with pollutants.

Per Chapter 2.5.3, MR#3 does not apply to auction yards, hence such source controls are not specified for this project.

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 2019 SMMWW.

Natural drainage patterns as they once existed shall be retained. Existing conditions experience a sheet drainage pattern to the site's west property boundary and southwest corner. Pre-developed conditions experience surface runoff. Stormwater generated onsite will be fully infiltrated consistent with the requirements of MR 5 and MR 7.

2.6 MR #5: On-Site Stormwater Management

MMC 14.15.050 (5) specifies requirements for 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 2019 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 where applicable. Landscape is provided around the perimeter of the site and will utilize these soils.

Roofs are not proposed. No Rooftop BMPs will be provided. Existing rooftops are on-site and associated with existing drainage systems.

Driveway/parking areas 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.

Driveway/Aisle/Parking gravel storage yard will be routed to bioretention areas. The bioretention cells will treat stormwater through filtering, phytoremediation, and microbial action from within the compost. Bioretention cells will treat more than 91% of incoming stormwater generated from the PGIS (per MR #6). See Minimum Requirement #6. Bioretention cells will infiltrate the stormwater record and comply with Minimum Requirement #7 – Flow Control.

Permeable pavement will not be used as the site will be a storage yard within the LI zone. Imported fill material across the site will render this BMP infeasible. Operations of the yard will destroy any pavement or permeable pavements.

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 199,478 *square feet* (4.58 *acres*) of PGIS based on aisle, 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 2019 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 2019 SMMWW.

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

Basic treatment is provided through the use of a bioretention facility per Vol. III Section 3.3.12 of the 2019 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.

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 12.0 *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. The bioretention cells infiltrate 100%.

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 through bioretention.

The project uses bioretention cells to treat and infiltrate 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 bio-cell utilizes a 0.5 *foot* ponded area with 0.5 *feet* of freeboard to allow stormwater to infiltrate through the amended soils.

The combination of full infiltration Bioretention BMPs for the gravel areas meet compliance with the flow control standard, MR 7.

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 any critical areas, MR-8 does not apply to this project.

2.10 MR # 9: Operation and Maintenance

Minimum Requirement #9 specified 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 2019 SMMWW. The 2019 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 James G. Murphy Co."**.

Section 3 - Maps & Figures

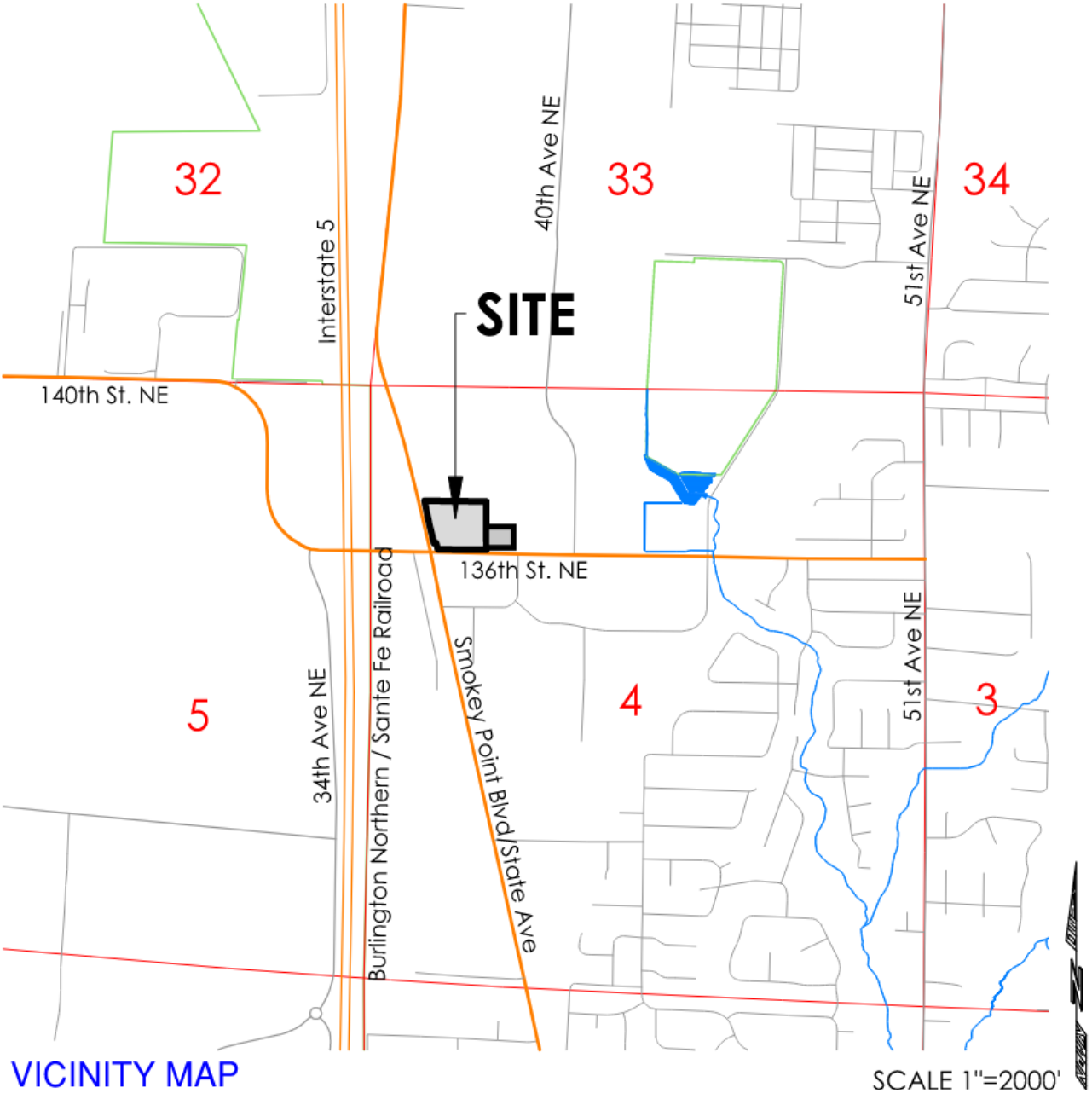

Figure 1 - Vicinity Map

Figure 2 - Existing Conditions (not to scale)

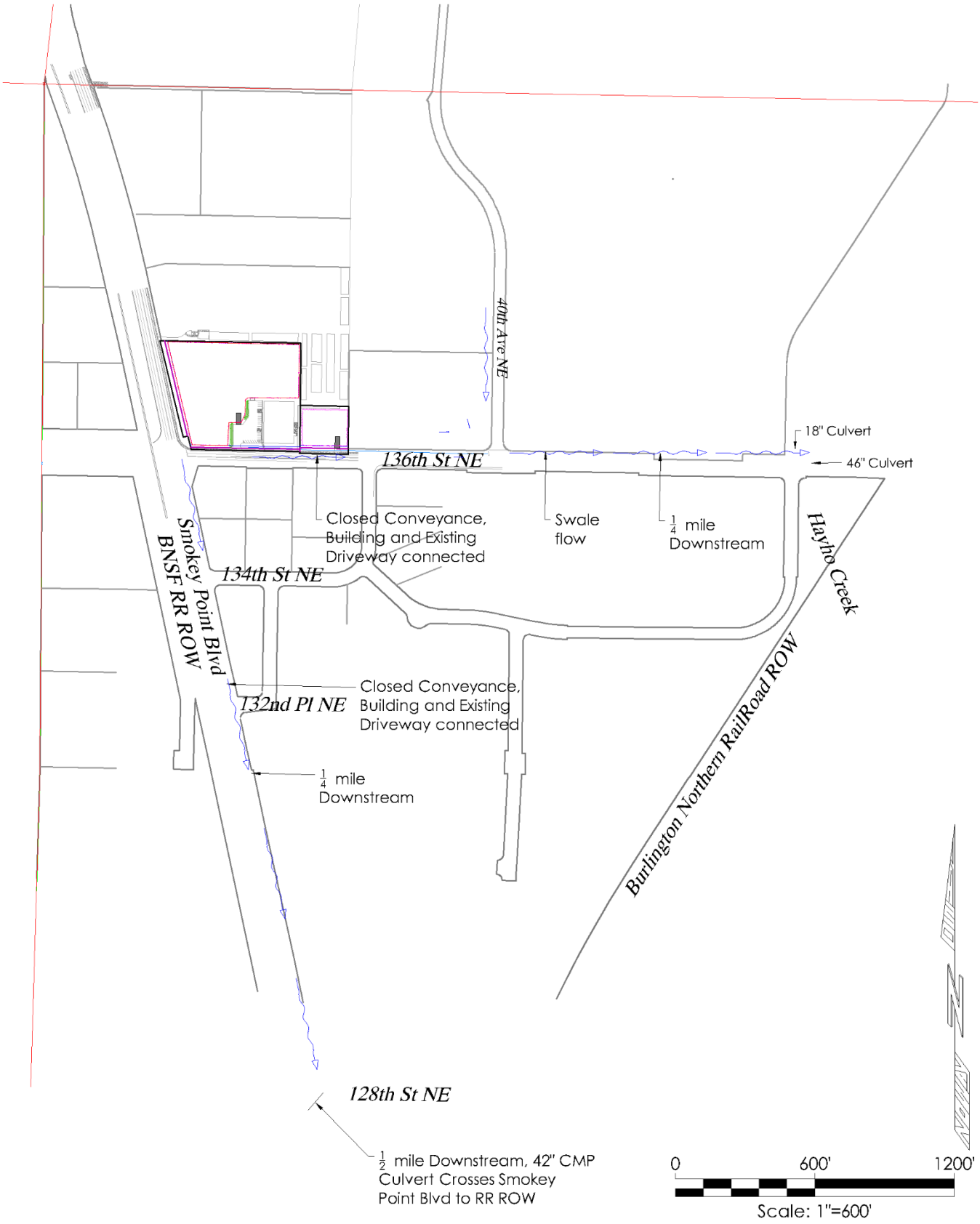

Figure 3 – Downstream Flow Path

Figure 4 - Site Plan

Figure 5 – Soil Map (Not to Scale, from Geotech Report)

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

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.

5.1 Topographic Data

- The various on and off site topography, utilities, and drainage elements were professionally surveyed by Pacific Coast Surveying in 2015.

- Snohomish County 2003 LiDAR survey was used to augment the existing site topography and the downstream and surrounding areas.

The modeled coordinate system:
Lateral - Washington State Plan Plane - North, FIPS 4601;
Vertical – NAVD 88

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 utilizes 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. The WSDOT Data uses for this model extends the precipitation record from 1901 to 2048.

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.

6.3 Existing Conditions

The surface vegetative cover is assumed forested with a flat slope. The NRCS soil maps indicate Custer soils throughout the project area. For hydrologic modeling, Lynnwood soils are A type soils. Note: the predeveloped scenario for the site is included but not required since the project is complying with 100% infiltration. The comparison of predeveloped flows is for discharges to downstream conveyances. The existing site is pasture. Outside of the disturbance area, there is no land conversion.

6.4 Developed Conditions

The site is flat and grading will consist of stripping existing soils and importing new soils. Driveway/Parking area will be added to the developed site. These areas are accounted for and used in the WHMM program. The remaining area of the site will be used for stormwater management. The stormwater bio-retention cells will be excavated down below the filled surface layer to allow stormwater to readily infiltrate. The bio-swale areas are not accounted for in the WWHM bio-retention element and are therefore duplicating rainfall for this portion of the land segment. This was done as a conservative step in the site design. The preceding section contains input and output of parameters relevant to the existing and developed site to achieve 100% infiltration meeting current DOE standards.

6.5 Software Output

WWHM2012
PROJECT REPORT

Project Name: JG Murphy Bioretention Construction Plans
Site Name: Murphy
Site Address:
City : Marysville
Report Date: 9/30/2022
MGS Regoin : Puget East
Data Start : 1901/10/1
Data End : 2058/09/30
DOT Data Number: 06
Version Date: 2021/08/18
Version : 4.2.18

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Undeveloped Exst Pasture Prcl 1
Bypass: No
GroundWater: No

Pervious Land Use	acre
C, Forest, Flat	4.57
Pervious Total	4.57

Impervious Land Use	acre
Impervious Total	0

Basin Total 4.57

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : West Storage Yard
Bypass: No
GroundWater: No

Pervious Land Use	acre
Pervious Total	0

Impervious Land Use	acre
DRIVEWAYS FLAT	1.92
Impervious Total	1.92

Basin Total 1.92

Element Flows To:

Surface	Interflow	Groundwater
Surface Bioretention	Surface Bioretention	

Name : W Bioretention
Bottom Length: 180.00 ft.
Bottom Width: 13.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW
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: 2.8
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 943.145
Total Volume Through Riser (ac-ft.): 0.409
Total Volume Through Facility (ac-ft.): 943.554
Percent Infiltrated: 99.96
Total Precip Applied to Facility: 25.103
Total Evap From Facility: 9.602
Underdrain not used
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 6 in.

Element Flows To:

Outlet 1	Outlet 2

W Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0537	0.0000	0.0000	0.0000
0.0275	0.0537	0.0006	0.0000	0.0000
0.0549	0.0537	0.0012	0.0000	0.0000
0.0824	0.0537	0.0018	0.0000	0.0000
0.1099	0.0537	0.0024	0.0000	0.0000
0.1374	0.0537	0.0030	0.0000	0.0002
0.1648	0.0537	0.0036	0.0000	0.0014
0.1923	0.0537	0.0041	0.0000	0.0021
0.2198	0.0537	0.0047	0.0000	0.0029
0.2473	0.0537	0.0053	0.0000	0.0038
0.2747	0.0537	0.0059	0.0000	0.0049
0.3022	0.0537	0.0065	0.0000	0.0062
0.3297	0.0537	0.0071	0.0000	0.0077
0.3571	0.0537	0.0077	0.0000	0.0094
0.3846	0.0537	0.0083	0.0000	0.0112
0.4121	0.0537	0.0089	0.0000	0.0133
0.4396	0.0537	0.0095	0.0000	0.0156
0.4670	0.0537	0.0101	0.0000	0.0181
0.4945	0.0537	0.0107	0.0000	0.0208
0.5220	0.0537	0.0113	0.0000	0.0238
0.5495	0.0537	0.0119	0.0000	0.0270
0.5769	0.0537	0.0124	0.0000	0.0304
0.6044	0.0537	0.0130	0.0000	0.0341

0.6319	0.0537	0.0136	0.0000	0.0380
0.6593	0.0537	0.0142	0.0000	0.0422
0.6868	0.0537	0.0148	0.0000	0.0467
0.7143	0.0537	0.0154	0.0000	0.0514
0.7418	0.0537	0.0160	0.0000	0.0565
0.7692	0.0537	0.0166	0.0000	0.0618
0.7967	0.0537	0.0172	0.0000	0.0674
0.8242	0.0537	0.0178	0.0000	0.0733
0.8516	0.0537	0.0184	0.0000	0.0794
0.8791	0.0537	0.0190	0.0000	0.0859
0.9066	0.0537	0.0196	0.0000	0.0927
0.9341	0.0537	0.0201	0.0000	0.0998
0.9615	0.0537	0.0207	0.0000	0.1073
0.9890	0.0537	0.0213	0.0000	0.1150
1.0165	0.0537	0.0219	0.0000	0.1231
1.0440	0.0537	0.0225	0.0000	0.1315
1.0714	0.0537	0.0231	0.0000	0.1402
1.0989	0.0537	0.0237	0.0000	0.1493
1.1264	0.0537	0.0243	0.0000	0.1517
1.1538	0.0537	0.0249	0.0000	0.1517
1.1813	0.0537	0.0255	0.0000	0.1517
1.2088	0.0537	0.0261	0.0000	0.1517
1.2363	0.0537	0.0267	0.0000	0.1517
1.2637	0.0537	0.0273	0.0000	0.1517
1.2912	0.0537	0.0278	0.0000	0.1517
1.3187	0.0537	0.0284	0.0000	0.1517
1.3462	0.0537	0.0290	0.0000	0.1517
1.3736	0.0537	0.0296	0.0000	0.1517
1.4011	0.0537	0.0302	0.0000	0.1517
1.4286	0.0537	0.0308	0.0000	0.1517
1.4560	0.0537	0.0314	0.0000	0.1517
1.4835	0.0537	0.0320	0.0000	0.1517
1.5000	0.0537	0.0324	0.0000	0.1517

Surface Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
1.5000	0.0537	0.0324	0.0000	0.3250	0.0171
1.5275	0.0598	0.0339	0.0000	0.3250	0.0343
1.5549	0.0659	0.0356	0.0000	0.3369	0.0515
1.5824	0.0720	0.0375	0.0000	0.3429	0.0688
1.6099	0.0781	0.0396	0.0000	0.3488	0.0860
1.6374	0.0842	0.0418	0.0000	0.3548	0.1033
1.6648	0.0903	0.0442	0.0000	0.3607	0.1206
1.6923	0.0965	0.0468	0.0000	0.3667	0.1380
1.7198	0.1026	0.0495	0.0000	0.3726	0.1554
1.7473	0.1088	0.0524	0.0000	0.3786	0.1728
1.7747	0.1149	0.0555	0.0000	0.3845	0.1903
1.8022	0.1211	0.0587	0.0000	0.3905	0.2078
1.8297	0.1273	0.0621	0.0000	0.3964	0.2253
1.8571	0.1335	0.0657	0.0000	0.4024	0.2428
1.8846	0.1397	0.0695	0.0000	0.4083	0.2604
1.9121	0.1459	0.0734	0.0000	0.4143	0.2780
1.9396	0.1522	0.0775	0.0000	0.4202	0.2956
1.9670	0.1584	0.0818	0.0000	0.4262	0.3133
1.9945	0.1647	0.0862	0.0000	0.4321	0.3310
2.0220	0.1710	0.0908	0.0173	0.4333	0.3487
2.0495	0.1772	0.0956	0.0580	0.4333	0.3665
2.0769	0.1835	0.1006	0.1109	0.4333	0.3843

2.1044	0.1898	0.1057	0.1701	0.4333	0.4021
2.1319	0.1961	0.1110	0.2299	0.4333	0.4200
2.1593	0.2025	0.1165	0.2845	0.4333	0.4379
2.1868	0.2088	0.1221	0.3293	0.4333	0.4558
2.2143	0.2152	0.1279	0.3619	0.4333	0.4737
2.2418	0.2215	0.1339	0.3840	0.4333	0.4917
2.2692	0.2279	0.1401	0.4086	0.4333	0.5097
2.2967	0.2343	0.1465	0.4289	0.4333	0.5278
2.3242	0.2407	0.1530	0.4483	0.4333	0.5459
2.3516	0.2471	0.1597	0.4669	0.4333	0.5640
2.3791	0.2535	0.1666	0.4848	0.4333	0.5821
2.4066	0.2599	0.1736	0.5021	0.4333	0.6003
2.4341	0.2663	0.1808	0.5188	0.4333	0.6185
2.4615	0.2728	0.1882	0.5349	0.4333	0.6367
2.4890	0.2792	0.1958	0.5506	0.4333	0.6440
2.5000	0.2818	0.1989	0.5659	0.4333	0.0000

Name : Surface Bioretention

Element Flows To:

Outlet 1	**Outlet 2**
W Bioretention	

Name : East C Parking on Prcl 2
Bypass: No
GroundWater: No

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

Impervious Land Use	**acre**
PARKING FLAT	**0.45**
Impervious Total	**0.45**
Basin Total	**0.45**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Surface Bioretention	Surface Bioretention	

Name : EC Bioretention
Bottom Length: 100.00 ft.
Bottom Width: 3.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW
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: 2.8
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 220.513
Total Volume Through Riser (ac-ft.): 0.001

Total Volume Through Facility (ac-ft.): 220.514
Percent Infiltrated: 100
Total Precip Applied to Facility: 4.192
Total Evap From Facility: 1.175
Underdrain not used
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 6 in.

Element Flows To:
Outlet 1 **Outlet 2**

EC Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0069	0.0000	0.0000	0.0000
0.0275	0.0069	0.0001	0.0000	0.0000
0.0549	0.0069	0.0002	0.0000	0.0000
0.0824	0.0069	0.0002	0.0000	0.0000
0.1099	0.0069	0.0003	0.0000	0.0000
0.1374	0.0069	0.0004	0.0000	0.0000
0.1648	0.0069	0.0005	0.0000	0.0002
0.1923	0.0069	0.0005	0.0000	0.0003
0.2198	0.0069	0.0006	0.0000	0.0004
0.2473	0.0069	0.0007	0.0000	0.0005
0.2747	0.0069	0.0008	0.0000	0.0006
0.3022	0.0069	0.0008	0.0000	0.0008
0.3297	0.0069	0.0009	0.0000	0.0010
0.3571	0.0069	0.0010	0.0000	0.0012
0.3846	0.0069	0.0011	0.0000	0.0014
0.4121	0.0069	0.0011	0.0000	0.0017
0.4396	0.0069	0.0012	0.0000	0.0020
0.4670	0.0069	0.0013	0.0000	0.0023
0.4945	0.0069	0.0014	0.0000	0.0027
0.5220	0.0069	0.0014	0.0000	0.0030
0.5495	0.0069	0.0015	0.0000	0.0035
0.5769	0.0069	0.0016	0.0000	0.0039
0.6044	0.0069	0.0017	0.0000	0.0044
0.6319	0.0069	0.0017	0.0000	0.0049
0.6593	0.0069	0.0018	0.0000	0.0054
0.6868	0.0069	0.0019	0.0000	0.0060
0.7143	0.0069	0.0020	0.0000	0.0066
0.7418	0.0069	0.0021	0.0000	0.0072
0.7692	0.0069	0.0021	0.0000	0.0079
0.7967	0.0069	0.0022	0.0000	0.0086
0.8242	0.0069	0.0023	0.0000	0.0094
0.8516	0.0069	0.0024	0.0000	0.0102
0.8791	0.0069	0.0024	0.0000	0.0110
0.9066	0.0069	0.0025	0.0000	0.0119
0.9341	0.0069	0.0026	0.0000	0.0128
0.9615	0.0069	0.0027	0.0000	0.0138
0.9890	0.0069	0.0027	0.0000	0.0147
1.0165	0.0069	0.0028	0.0000	0.0158
1.0440	0.0069	0.0029	0.0000	0.0169
1.0714	0.0069	0.0030	0.0000	0.0180
1.0989	0.0069	0.0030	0.0000	0.0191
1.1264	0.0069	0.0031	0.0000	0.0194
1.1538	0.0069	0.0032	0.0000	0.0194
1.1813	0.0069	0.0033	0.0000	0.0194

1.2088	0.0069	0.0033	0.0000	0.0194
1.2363	0.0069	0.0034	0.0000	0.0194
1.2637	0.0069	0.0035	0.0000	0.0194
1.2912	0.0069	0.0036	0.0000	0.0194
1.3187	0.0069	0.0036	0.0000	0.0194
1.3462	0.0069	0.0037	0.0000	0.0194
1.3736	0.0069	0.0038	0.0000	0.0194
1.4011	0.0069	0.0039	0.0000	0.0194
1.4286	0.0069	0.0040	0.0000	0.0194
1.4560	0.0069	0.0040	0.0000	0.0194
1.4835	0.0069	0.0041	0.0000	0.0194
1.5000	0.0069	0.0041	0.0000	0.0194

Surface Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
1.5000	0.0069	0.0041	0.0000	0.0417	0.0095
1.5275	0.0102	0.0044	0.0000	0.0417	0.0190
1.5549	0.0136	0.0047	0.0000	0.0432	0.0285
1.5824	0.0170	0.0051	0.0000	0.0440	0.0381
1.6099	0.0204	0.0056	0.0000	0.0447	0.0477
1.6374	0.0238	0.0063	0.0000	0.0455	0.0574
1.6648	0.0272	0.0070	0.0000	0.0462	0.0670
1.6923	0.0306	0.0077	0.0000	0.0470	0.0768
1.7198	0.0341	0.0086	0.0000	0.0478	0.0865
1.7473	0.0375	0.0096	0.0000	0.0485	0.0962
1.7747	0.0410	0.0107	0.0000	0.0493	0.1060
1.8022	0.0444	0.0119	0.0000	0.0501	0.1159
1.8297	0.0479	0.0131	0.0000	0.0508	0.1257
1.8571	0.0514	0.0145	0.0000	0.0516	0.1356
1.8846	0.0549	0.0160	0.0000	0.0524	0.1455
1.9121	0.0584	0.0175	0.0000	0.0531	0.1555
1.9396	0.0620	0.0192	0.0000	0.0539	0.1655
1.9670	0.0655	0.0209	0.0000	0.0546	0.1755
1.9945	0.0690	0.0228	0.0000	0.0554	0.1855
2.0220	0.0726	0.0247	0.0173	0.0556	0.1956
2.0495	0.0762	0.0268	0.0580	0.0556	0.2057
2.0769	0.0798	0.0289	0.1109	0.0556	0.2159
2.1044	0.0833	0.0311	0.1701	0.0556	0.2260
2.1319	0.0869	0.0335	0.2299	0.0556	0.2362
2.1593	0.0906	0.0359	0.2845	0.0556	0.2465
2.1868	0.0942	0.0385	0.3293	0.0556	0.2567
2.2143	0.0978	0.0411	0.3619	0.0556	0.2670
2.2418	0.1015	0.0438	0.3840	0.0556	0.2773
2.2692	0.1051	0.0467	0.4086	0.0556	0.2877
2.2967	0.1088	0.0496	0.4289	0.0556	0.2981
2.3242	0.1125	0.0527	0.4483	0.0556	0.3085
2.3516	0.1162	0.0558	0.4669	0.0556	0.3189
2.3791	0.1199	0.0590	0.4848	0.0556	0.3294
2.4066	0.1236	0.0624	0.5021	0.0556	0.3399
2.4341	0.1273	0.0658	0.5188	0.0556	0.3505
2.4615	0.1310	0.0694	0.5349	0.0556	0.3611
2.4890	0.1348	0.0730	0.5506	0.0556	0.3653
2.5000	0.1363	0.0745	0.5659	0.0556	0.0000

Name : Surface Bioretention

Element Flows To:

Outlet 1 **Outlet 2**

EC Bioretention

Name : WC Storage Yard
Bypass: No
GroundWater: No

Pervious Land Use	acre
Pervious Total	**0**

Impervious Land Use	acre
ROADS FLAT	**1.81**
Impervious Total	**1.81**

Basin Total	**1.81**

Element Flows To:

Surface	Interflow	Groundwater
Surface Bioretention	Surface Bioretention	

Name : WCentral Bioretention
Bottom Length: 94.00 ft.
Bottom Width: 21.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW
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: 2.8
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 886.176
Total Volume Through Riser (ac-ft.): 2.688
Total Volume Through Facility (ac-ft.): 888.864
Percent Infiltrated: 99.7
Total Precip Applied to Facility: 22.375
Total Evap From Facility: 8.37
Underdrain not used
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 6 in.

Element Flows To:

Outlet 1	Outlet 2

WCentral Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0453	0.0000	0.0000	0.0000
0.0275	0.0453	0.0005	0.0000	0.0000
0.0549	0.0453	0.0010	0.0000	0.0000
0.0824	0.0453	0.0015	0.0000	0.0000
0.1099	0.0453	0.0020	0.0000	0.0000
0.1374	0.0453	0.0025	0.0000	0.0002
0.1648	0.0453	0.0030	0.0000	0.0012

0.1923	0.0453	0.0035	0.0000	0.0018
0.2198	0.0453	0.0040	0.0000	0.0024
0.2473	0.0453	0.0045	0.0000	0.0032
0.2747	0.0453	0.0050	0.0000	0.0042
0.3022	0.0453	0.0055	0.0000	0.0053
0.3297	0.0453	0.0060	0.0000	0.0065
0.3571	0.0453	0.0065	0.0000	0.0079
0.3846	0.0453	0.0070	0.0000	0.0095
0.4121	0.0453	0.0075	0.0000	0.0112
0.4396	0.0453	0.0080	0.0000	0.0131
0.4670	0.0453	0.0085	0.0000	0.0153
0.4945	0.0453	0.0090	0.0000	0.0176
0.5220	0.0453	0.0095	0.0000	0.0200
0.5495	0.0453	0.0100	0.0000	0.0227
0.5769	0.0453	0.0105	0.0000	0.0256
0.6044	0.0453	0.0110	0.0000	0.0288
0.6319	0.0453	0.0115	0.0000	0.0321
0.6593	0.0453	0.0120	0.0000	0.0356
0.6868	0.0453	0.0125	0.0000	0.0394
0.7143	0.0453	0.0130	0.0000	0.0434
0.7418	0.0453	0.0135	0.0000	0.0476
0.7692	0.0453	0.0140	0.0000	0.0521
0.7967	0.0453	0.0145	0.0000	0.0568
0.8242	0.0453	0.0150	0.0000	0.0618
0.8516	0.0453	0.0155	0.0000	0.0670
0.8791	0.0453	0.0160	0.0000	0.0725
0.9066	0.0453	0.0165	0.0000	0.0782
0.9341	0.0453	0.0170	0.0000	0.0842
0.9615	0.0453	0.0175	0.0000	0.0905
0.9890	0.0453	0.0180	0.0000	0.0970
1.0165	0.0453	0.0185	0.0000	0.1038
1.0440	0.0453	0.0190	0.0000	0.1109
1.0714	0.0453	0.0195	0.0000	0.1183
1.0989	0.0453	0.0200	0.0000	0.1260
1.1264	0.0453	0.0205	0.0000	0.1279
1.1538	0.0453	0.0210	0.0000	0.1279
1.1813	0.0453	0.0215	0.0000	0.1279
1.2088	0.0453	0.0220	0.0000	0.1279
1.2363	0.0453	0.0225	0.0000	0.1279
1.2637	0.0453	0.0230	0.0000	0.1279
1.2912	0.0453	0.0235	0.0000	0.1279
1.3187	0.0453	0.0240	0.0000	0.1279
1.3462	0.0453	0.0245	0.0000	0.1279
1.3736	0.0453	0.0250	0.0000	0.1279
1.4011	0.0453	0.0255	0.0000	0.1279
1.4286	0.0453	0.0260	0.0000	0.1279
1.4560	0.0453	0.0265	0.0000	0.1279
1.4835	0.0453	0.0270	0.0000	0.1279
1.5000	0.0453	0.0273	0.0000	0.1279

Surface Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
1.5000	0.0453	0.0273	0.0000	0.2742	0.0091
1.5275	0.0485	0.0286	0.0000	0.2742	0.0183
1.5549	0.0518	0.0300	0.0000	0.2842	0.0274
1.5824	0.0550	0.0314	0.0000	0.2892	0.0366
1.6099	0.0583	0.0330	0.0000	0.2943	0.0459
1.6374	0.0616	0.0346	0.0000	0.2993	0.0551

1.6648	0.0648	0.0364	0.0000	0.3043	0.0644
1.6923	0.0681	0.0382	0.0000	0.3093	0.0738
1.7198	0.0714	0.0401	0.0000	0.3143	0.0831
1.7473	0.0748	0.0421	0.0000	0.3194	0.0925
1.7747	0.0781	0.0442	0.0000	0.3244	0.1019
1.8022	0.0814	0.0464	0.0000	0.3294	0.1114
1.8297	0.0848	0.0487	0.0000	0.3344	0.1209
1.8571	0.0881	0.0511	0.0000	0.3394	0.1304
1.8846	0.0915	0.0535	0.0000	0.3445	0.1399
1.9121	0.0949	0.0561	0.0000	0.3495	0.1495
1.9396	0.0983	0.0587	0.0000	0.3545	0.1591
1.9670	0.1017	0.0615	0.0000	0.3595	0.1688
1.9945	0.1051	0.0643	0.0000	0.3646	0.1784
2.0220	0.1085	0.0673	0.0173	0.3656	0.1881
2.0495	0.1120	0.0703	0.0580	0.3656	0.1979
2.0769	0.1154	0.0734	0.1109	0.3656	0.2076
2.1044	0.1189	0.0766	0.1701	0.3656	0.2174
2.1319	0.1223	0.0799	0.2299	0.3656	0.2273
2.1593	0.1258	0.0834	0.2845	0.3656	0.2371
2.1868	0.1293	0.0869	0.3293	0.3656	0.2470
2.2143	0.1328	0.0905	0.3619	0.3656	0.2569
2.2418	0.1363	0.0942	0.3840	0.3656	0.2669
2.2692	0.1398	0.0980	0.4086	0.3656	0.2769
2.2967	0.1434	0.1018	0.4289	0.3656	0.2869
2.3242	0.1469	0.1058	0.4483	0.3656	0.2969
2.3516	0.1505	0.1099	0.4669	0.3656	0.3070
2.3791	0.1540	0.1141	0.4848	0.3656	0.3171
2.4066	0.1576	0.1184	0.5021	0.3656	0.3272
2.4341	0.1612	0.1228	0.5188	0.3656	0.3374
2.4615	0.1648	0.1272	0.5349	0.3656	0.3476
2.4890	0.1684	0.1318	0.5506	0.3656	0.3517
2.5000	0.1699	0.1337	0.5659	0.3656	0.0000

Name : Surface Bioretention

Element Flows To:

Outlet 1	**Outlet 2**
WCentral Bioretention	

Name : East Bioretention
Bottom Length: 32.00 ft.
Bottom Width: 12.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW
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: 2.8
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 195.981
Total Volume Through Riser (ac-ft.): 0.282
Total Volume Through Facility (ac-ft.): 196.263
Percent Infiltrated: 99.86
Total Precip Applied to Facility: 4.517

Total Evap From Facility: 1.597
Underdrain not used
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 6 in.

Element Flows To:
Outlet 1 **Outlet 2**

East Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0088	0.0000	0.0000	0.0000
0.0275	0.0088	0.0001	0.0000	0.0000
0.0549	0.0088	0.0002	0.0000	0.0000
0.0824	0.0088	0.0003	0.0000	0.0000
0.1099	0.0088	0.0004	0.0000	0.0000
0.1374	0.0088	0.0005	0.0000	0.0000
0.1648	0.0088	0.0006	0.0000	0.0002
0.1923	0.0088	0.0007	0.0000	0.0003
0.2198	0.0088	0.0008	0.0000	0.0005
0.2473	0.0088	0.0009	0.0000	0.0006
0.2747	0.0088	0.0010	0.0000	0.0008
0.3022	0.0088	0.0011	0.0000	0.0010
0.3297	0.0088	0.0012	0.0000	0.0013
0.3571	0.0088	0.0013	0.0000	0.0015
0.3846	0.0088	0.0014	0.0000	0.0018
0.4121	0.0088	0.0015	0.0000	0.0022
0.4396	0.0088	0.0016	0.0000	0.0026
0.4670	0.0088	0.0017	0.0000	0.0030
0.4945	0.0088	0.0018	0.0000	0.0034
0.5220	0.0088	0.0018	0.0000	0.0039
0.5495	0.0088	0.0019	0.0000	0.0044
0.5769	0.0088	0.0020	0.0000	0.0050
0.6044	0.0088	0.0021	0.0000	0.0056
0.6319	0.0088	0.0022	0.0000	0.0062
0.6593	0.0088	0.0023	0.0000	0.0069
0.6868	0.0088	0.0024	0.0000	0.0077
0.7143	0.0088	0.0025	0.0000	0.0084
0.7418	0.0088	0.0026	0.0000	0.0093
0.7692	0.0088	0.0027	0.0000	0.0101
0.7967	0.0088	0.0028	0.0000	0.0111
0.8242	0.0088	0.0029	0.0000	0.0120
0.8516	0.0088	0.0030	0.0000	0.0130
0.8791	0.0088	0.0031	0.0000	0.0141
0.9066	0.0088	0.0032	0.0000	0.0152
0.9341	0.0088	0.0033	0.0000	0.0164
0.9615	0.0088	0.0034	0.0000	0.0176
0.9890	0.0088	0.0035	0.0000	0.0189
1.0165	0.0088	0.0036	0.0000	0.0202
1.0440	0.0088	0.0037	0.0000	0.0216
1.0714	0.0088	0.0038	0.0000	0.0230
1.0989	0.0088	0.0039	0.0000	0.0245
1.1264	0.0088	0.0040	0.0000	0.0249
1.1538	0.0088	0.0041	0.0000	0.0249
1.1813	0.0088	0.0042	0.0000	0.0249
1.2088	0.0088	0.0043	0.0000	0.0249
1.2363	0.0088	0.0044	0.0000	0.0249
1.2637	0.0088	0.0045	0.0000	0.0249

1.2912	0.0088	0.0046	0.0000	0.0249
1.3187	0.0088	0.0047	0.0000	0.0249
1.3462	0.0088	0.0048	0.0000	0.0249
1.3736	0.0088	0.0049	0.0000	0.0249
1.4011	0.0088	0.0050	0.0000	0.0249
1.4286	0.0088	0.0051	0.0000	0.0249
1.4560	0.0088	0.0052	0.0000	0.0249
1.4835	0.0088	0.0053	0.0000	0.0249
1.5000	0.0088	0.0053	0.0000	0.0249

Surface Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
1.5000	0.0088	0.0053	0.0000	0.0533	0.0032
1.5275	0.0099	0.0056	0.0000	0.0533	0.0064
1.5549	0.0111	0.0059	0.0000	0.0553	0.0096
1.5824	0.0122	0.0062	0.0000	0.0563	0.0128
1.6099	0.0134	0.0065	0.0000	0.0572	0.0161
1.6374	0.0145	0.0069	0.0000	0.0582	0.0194
1.6648	0.0157	0.0073	0.0000	0.0592	0.0228
1.6923	0.0169	0.0078	0.0000	0.0602	0.0262
1.7198	0.0181	0.0083	0.0000	0.0611	0.0296
1.7473	0.0193	0.0088	0.0000	0.0621	0.0330
1.7747	0.0205	0.0093	0.0000	0.0631	0.0365
1.8022	0.0217	0.0099	0.0000	0.0641	0.0400
1.8297	0.0230	0.0105	0.0000	0.0651	0.0436
1.8571	0.0242	0.0112	0.0000	0.0660	0.0471
1.8846	0.0255	0.0118	0.0000	0.0670	0.0507
1.9121	0.0268	0.0126	0.0000	0.0680	0.0544
1.9396	0.0281	0.0133	0.0000	0.0690	0.0580
1.9670	0.0294	0.0141	0.0000	0.0699	0.0617
1.9945	0.0307	0.0149	0.0000	0.0709	0.0654
2.0220	0.0320	0.0158	0.0173	0.0711	0.0692
2.0495	0.0333	0.0167	0.0580	0.0711	0.0730
2.0769	0.0347	0.0176	0.1109	0.0711	0.0768
2.1044	0.0360	0.0186	0.1701	0.0711	0.0806
2.1319	0.0374	0.0196	0.2299	0.0711	0.0845
2.1593	0.0388	0.0206	0.2845	0.0711	0.0884
2.1868	0.0401	0.0217	0.3293	0.0711	0.0924
2.2143	0.0415	0.0228	0.3619	0.0711	0.0963
2.2418	0.0429	0.0240	0.3840	0.0711	0.1003
2.2692	0.0444	0.0252	0.4086	0.0711	0.1044
2.2967	0.0458	0.0264	0.4289	0.0711	0.1084
2.3242	0.0472	0.0277	0.4483	0.0711	0.1125
2.3516	0.0487	0.0290	0.4669	0.0711	0.1167
2.3791	0.0501	0.0304	0.4848	0.0711	0.1208
2.4066	0.0516	0.0318	0.5021	0.0711	0.1250
2.4341	0.0531	0.0332	0.5188	0.0711	0.1292
2.4615	0.0546	0.0347	0.5349	0.0711	0.1335
2.4890	0.0561	0.0362	0.5506	0.0711	0.1352
2.5000	0.0567	0.0369	0.5659	0.0711	0.0000

Name : Surface Bioretention

Element Flows To:

Outlet 1	**Outlet 2**
East Bioretention	

Name : East Park Prcl 2

Bypass: No
GroundWater: No

Pervious Land Use	acre
Pervious Total	0

Impervious Land Use	acre
DRIVEWAYS FLAT	0.4
Impervious Total	0.4

Basin Total	0.4

Element Flows To:

Surface	Interflow	Groundwater
Surface Bioretention	Surface Bioretention	

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:4.57
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:4.58

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.113445
5 year	0.167183
10 year	0.202961
25 year	0.247964
50 year	0.281215
100 year	0.314176

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.479227
5 year	1.217197
10 year	1.791602
25 year	2.525405
50 year	3.044647
100 year	3.525764

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

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail

0.0567	66996	165	0	Pass
0.0590	60555	161	0	Pass
0.0613	55023	156	0	Pass
0.0635	50002	153	0	Pass
0.0658	45703	151	0	Pass
0.0681	41723	148	0	Pass
0.0703	38078	145	0	Pass
0.0726	34814	142	0	Pass
0.0749	32023	141	0	Pass
0.0771	29507	136	0	Pass
0.0794	27145	134	0	Pass
0.0817	24899	132	0	Pass
0.0839	22978	128	0	Pass
0.0862	21139	124	0	Pass
0.0885	19510	121	0	Pass
0.0907	17952	119	0	Pass
0.0930	16559	116	0	Pass
0.0953	15249	114	0	Pass
0.0975	14131	113	0	Pass
0.0998	13080	109	0	Pass
0.1021	12183	105	0	Pass
0.1043	11302	103	0	Pass
0.1066	10526	102	0	Pass
0.1089	9821	101	1	Pass
0.1111	9105	98	1	Pass
0.1134	8494	96	1	Pass
0.1157	7933	93	1	Pass
0.1179	7388	90	1	Pass
0.1202	6876	89	1	Pass
0.1225	6479	89	1	Pass
0.1248	6105	88	1	Pass
0.1270	5747	88	1	Pass
0.1293	5428	86	1	Pass
0.1316	5127	82	1	Pass
0.1338	4870	80	1	Pass
0.1361	4614	77	1	Pass
0.1384	4308	76	1	Pass
0.1406	4059	75	1	Pass
0.1429	3852	75	1	Pass
0.1452	3658	75	2	Pass
0.1474	3479	74	2	Pass
0.1497	3332	73	2	Pass
0.1520	3180	72	2	Pass
0.1542	3036	72	2	Pass
0.1565	2889	72	2	Pass
0.1588	2742	69	2	Pass
0.1610	2624	68	2	Pass
0.1633	2514	67	2	Pass
0.1656	2395	64	2	Pass
0.1678	2280	63	2	Pass
0.1701	2168	63	2	Pass
0.1724	2048	61	2	Pass
0.1746	1911	61	3	Pass
0.1769	1808	61	3	Pass
0.1792	1698	59	3	Pass
0.1814	1624	58	3	Pass
0.1837	1537	57	3	Pass
0.1860	1456	56	3	Pass

0.1882	1389	53	3	Pass
0.1905	1322	52	3	Pass
0.1928	1261	52	4	Pass
0.1950	1201	52	4	Pass
0.1973	1143	52	4	Pass
0.1996	1094	51	4	Pass
0.2018	1040	49	4	Pass
0.2041	977	48	4	Pass
0.2064	911	47	5	Pass
0.2087	846	46	5	Pass
0.2109	785	45	5	Pass
0.2132	739	45	6	Pass
0.2155	676	44	6	Pass
0.2177	609	43	7	Pass
0.2200	569	42	7	Pass
0.2223	545	42	7	Pass
0.2245	520	41	7	Pass
0.2268	480	40	8	Pass
0.2291	444	39	8	Pass
0.2313	419	38	9	Pass
0.2336	388	38	9	Pass
0.2359	360	37	10	Pass
0.2381	340	36	10	Pass
0.2404	322	36	11	Pass
0.2427	303	36	11	Pass
0.2449	281	36	12	Pass
0.2472	258	35	13	Pass
0.2495	237	35	14	Pass
0.2517	214	35	16	Pass
0.2540	190	35	18	Pass
0.2563	166	33	19	Pass
0.2585	146	32	21	Pass
0.2608	129	31	24	Pass
0.2631	116	31	26	Pass
0.2653	102	31	30	Pass
0.2676	93	31	33	Pass
0.2699	85	29	34	Pass
0.2721	69	28	40	Pass
0.2744	57	27	47	Pass
0.2767	48	27	56	Pass
0.2789	40	27	67	Pass
0.2812	30	27	90	Pass

Perlnd and Implnd Changes

No changes have been made.