Preliminary Drainage Report

Salem Costco

2322.14429.01

Prepared for

Costco Wholesale Corporation

999 Lake Drive

Issaquah, WA 98020

4/23/2018

Prepared for	Costco Wholesale Corporation
Project Name	Preliminary Drainage Report
Job Number	2322.14429.01
Date	4/23/2018

DOWL
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Name	Title	Date	Revision	Reviewer
RHH	Project Engineer	4/23/18		JRS

Executive Summary

The proposed Costco Salem development is located on Tax lot 1800, 1900, 2000, and 2100 off Kuebler Boulevard SE in Salem, Oregon (See Figure 1-1). The proposed development will construct a Costco Wholesale, a commercial retail store. The site includes a commercial retail building with associated access drives, parking lot, and fuel station in the northeast corner of the site.

The proposed storm design will meet the requirements of the City of Salem as listed in the Department of Public Works Administrative Rules Design Standards, Chapter 109, Division 004 and 012 dated January 2014, the Salem Revised Code Chapter 71, and the Stormwater Design Handbook for Developers and Large Projects dated May 2014. The project has more than 10,000 sq.-ft of combined new and replaced impervious area; therefore, this project is classified as a “large project” and will follow the specified large project requirements.

Water Quality

The City of Salem requires the use of green stormwater infrastructure (GSI) to the maximum extent feasible. Water quality at the Costco Salem site will be met through two vegetated swales. Of the total new and replaced impervious area, at least 80% will be treated using GSI (vegetated swales). The vegetated swales will be constructed on the east side of the property, downstream of the underground detention facility. One 2-cartridge stormfilter catch basin is proposed for the building loading dock basin, as there is no feasible way to drain the impervious surface to the vegetated swales due to grade.

Water Quantity

The City of Salem requires flow control to protect downstream properties, infrastructure, and natural resources from the increased stormwater runoff and volume resulting from development. When using non-GSI for detention storage, the stormwater detention facilities must be designed such that post-development peak runoff rate is equal to or less than the pre-development peak runoff rate for the 100-year, 24-hour storm. The proposed Costco Salem proposes to utilize underground chambers to detain the post-development peak runoff to the pre-development peak runoff.

Conveyance

An on-site conveyance analysis was not completed and shown to be able to convey the 10-year storm event.

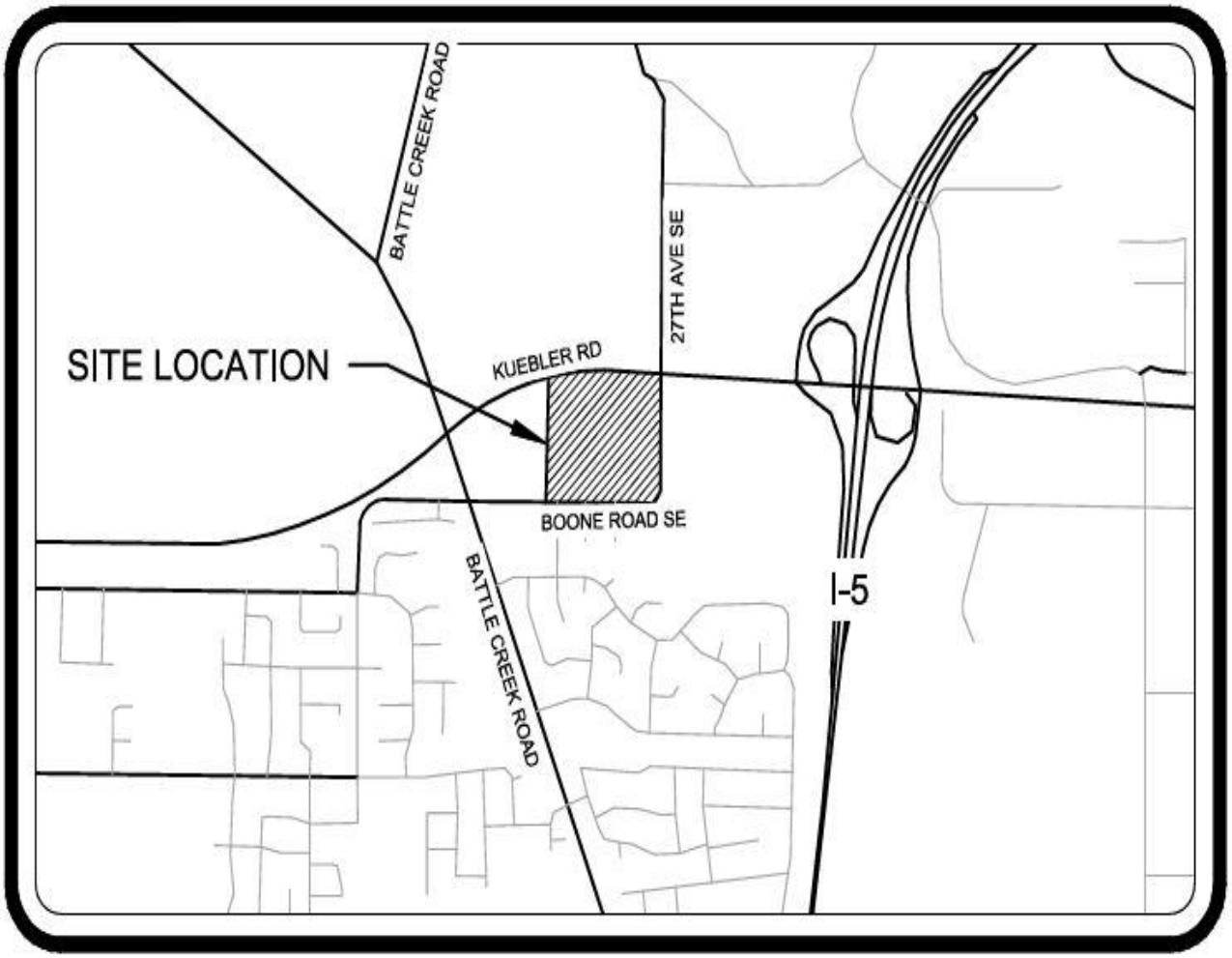
Table of Contents

Tables

Figures

1 VICINITY MAP

Figure 1-1 Vicinity Map



2 PROJECT DESCRIPTION

2.1 Project Overview

The proposed Costco Salem development is located on Tax lot 1800, 1900, 2000, and 2100 off Kuebler Boulevard SE in Salem, Oregon (See Figure 1-1). The proposed development will construct a Costco Wholesale, a commercial retail store. The site includes a commercial retail building with associated access drives, parking lot, and fuel station in the northeast corner of the site.

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3 EXISTING CONDITIONS

3.1 Topography

The existing site is a cleared and grass lined site, with a large grove of trees in the Southwest corner of the site. Historically, the site was undeveloped grass land with trees throughout the site. A historic stream went through the Southeast corner of the site. east portion of the site was a drive-in movie theater. The highest elevation of 205 is located in the center of the site. The lowest elevation of 198 is located in the southwest property corner. Site slopes range from 2.0% to nearly flat and slope downward to the west.

3.2 Climate

The site is in Salem, Oregon approximately 50 miles inland from the Pacific Ocean. There is a gradual change in seasons with defined seasonal characteristics. Average daily temperatures range from 35°F to 70°F. Average annual rainfall recorded in this area is 40 inches. Average snowfall is approximately 5.5 inches between December and February.

3.3 Site Geology

The underlying soil types are classified by the United States Department of Agriculture Soil Survey of Marion County, Oregon and are identified in Table 3-1 (See Technical Appendix A: USGS Soils Map - Marion County).

Table 3-1 Soil Characteristics

Soil Type	Hydrologic Group
Nekia Silty Clay Loam, 2 to 7 percent	C
Nekia Stony Silty Clay Loam, 2 to 12 percent	C
Salcum Silty Clay Loam, Basin, 0 to 6 percent	B

Soils are classified as B or C. Most of the site is group C soils and will be conservatively used for this analysis. Group C soils have low infiltration rates at the surface when thoroughly saturated.

3.4 Groundwater/Infiltration

A Report of Geotechnical Engineering Services was completed for the Costco Salem site by Terracon Consultants dated April 16, 2018. The report will be submitted with the final permit application.

Terracon performed several borings and test pits on the site to determine the groundwater elevations. Groundwater was encountered at varying depths, but as shallow as 4 feet below existing ground surface.

At the location of the proposed vegetated swales, Terracon performed boring explorations to determine the groundwater and pursue infiltration testing. Terracon found groundwater elevation to be shallow, and the report does not recommend infiltration stormwater facilities because of the shallow groundwater presence.

3.5 Hydrology

Stormwater runoff sheets flow inward to an existing stormwater collection pond before discharging to the 27th Avenue SE right-of-way located along the eastern property boundary. Water quality treatment, detention, or infiltration is not provided on the site.

An existing ditch in the center of the site collects and conveys water to an existing stormwater pond on east boundary of the site. Stormwater is then discharged to 27th Avenue SE through a 24-inch storm line to the existing road side ditch along 27th Avenue.

The ditch along 27th Avenue conveys runoff to north to an existing public stormwater conveyance system at the intersection of Kuebler Boulevard and 27th Avenue. The public stormwater system then drains east of 27th Avenue to an existing conveyance ditch along the south side of Kuebler Boulevard. The existing ditch continues east, turning north just before Interstate 5. Both culverts drain to Mill Creek. The capacity of the existing stormwater conveyance in 27th Avenue and ditch along Kuebler Boulevard were not evaluated as part of this analysis, as the proposed development will detain for the 100-year storm event.

3.6 Curve Number

The curve number represents runoff potential from the soil. The major factors for determining the CN values are hydrologic soil group, cover type, treatment, hydrologic condition and antecedent runoff condition. A composite curve number was determined to be 69 for the site (See Technical Appendix: Composite Curve Number)

3.7 Time of Concentration

The time of concentration (T_C) as described in NEH-4 Chapter 15 is defined in two ways; the time for runoff to travel from the furthermost point of the watershed to the point in question, and the time from the end of excess rainfall to the point of inflection on the trailing limb of the unit hydrograph. Time of concentration can be estimated from several formulas. The NRCS method was used in this analysis.

The minimum time of concentration is 5 minutes in highly developed urban areas (i.e. parking lots) and the maximum is 100 minutes in rural areas. The existing time of concentration was calculated to be 30 minutes (See Technical Appendix: Time of Concentration).

3.8 Basin Areas

Basin areas for existing conditions are shown in Table 3-2. This basin was modeled as required by City of Salem standards for allowable outflow. City of Salem of standards requires existing pre-developed conditions to be undeveloped, mixed (See Technical Appendix: Exhibit 1 – Existing Basin Delineation).

Table 3-2 Existing Basin Areas

Basin	Impervious Area, ac	Pervious Area, ac	Total Area, ac
Onsite	0.27	20.70	20.97

4 PROPOSED CONDITIONS

4.1 Hydrology

Runoff from the proposed Costco Salem site is collected through a series of catch basins and conveyed to an underground detention system for quantity control and a vegetated swale for water quality treatment. The design of the vegetated swale is included within the water quality section of this report, and the design of the underground detention is included in the water quantity section of this report. The proposed system will discharge into the 27th Avenue right-of-way.

The proposed building loading dock will be treated with a new Contech Stormfilter system and underground detention is proposed for flow control due to grade feasibly limiting the connection to the vegetated swales. This Stormfilter and underground detention system is proposed to discharge to the public storm system in Boone Rd SE.

4.2 Curve Number

In the proposed condition, a curve number of 87 to be used for pervious surfaces and a curve number of 98 is to be used for impervious surfaces.

4.3 Time of Concentration

A time of concentration of 10 minutes was for our delineated basins.

4.4 Basin Areas

Impervious and pervious surface areas for the proposed conditions are shown in Table 4-1. The site is approximately 79.5% impervious in proposed conditions (See Technical Appendix: Exhibit 2 – Post-Developed Basin Delineation).

Table 4-1 Proposed Basin Areas

Basin ID	Proposed Basin Area (Pavement, Roof, Other)	Impervious (ac)	Pervious (ac)	Total (ac)
1	Pavement	8.91	0.89	9.80
2	Pavement	6.22	0.16	6.38
3	Pavement	0.19	0.01	0.20
4	Pavement	0.97	3.20	4.17
Subtotal	-	16.29	4.26	20.55
5	Off-Site	0.38	0.04	0.42

Basin 5 drains off-site to the 27th Avenue SE public right-of-way. This area will be included in the public improvements drainage report.

5 HYDROLOGIC ANALYSIS DESIGN GUIDELINES

5.1 Design Guidelines

The analysis and design criteria used for stormwater management described in this section will follow the City of Salem *Department of Public Works Administrative Rules Design Standards* dated January 2014. Division 004 subsection 4.2(o) describes the allowable flow determination methods including the selected SUBH method.

5.2 Hydrograph Method

The hydrograph method generates storm runoff based on physical characteristics of the site. The Santa Barbara Urban Hydrograph (SBUH) was used for this analysis. The SBUH method is based on the curve number (CN) approach, and uses the Soil Conservation Service's (SCS) equations for computing soil absorption and precipitation excess. The SBUH method converts the incremental runoff depths into instantaneous hydrographs, which are then routed through an imaginary reservoir with a time delay equal to the basin time of concentration.

The runoff function of xpswmm generates surface and subsurface runoff based on design or measured rainfall conditions, land use and topography. xpswmm Version 15.1 was used for our hydrology and hydraulics analysis. xpswmm is based on the public EPA SWMM program. xpswmm is an approved method of analysis by the City of Salem.

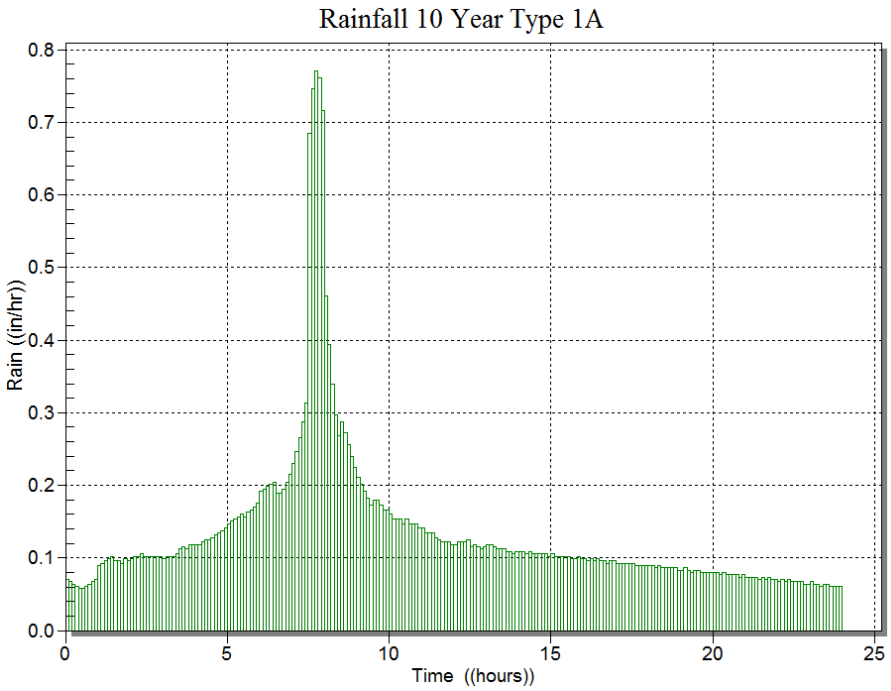
5.3 Design Storm

The rainfall distribution to be used within the City of Salem is the design storm of 24-hour duration based on the standard Type 1A rainfall distribution. Table 4-1 shows total precipitation depths for different storm events. The storm distribution for a type 1A 24-hour rainfall distribution for a 10-year storm event is shown in Figure 4-1.

Table 5-1 Precipitation Depth

Recurrence interval (years)	Total Precipitation Depth (in)
WQ	1.38
2	2.20
10	3.20
100	4.40

Figure 5-1 10-Year Type 1A Rainfall Ditribution



5.4 Basin Runoff

Table 4-2 lists the runoff rates for existing and proposed conditions for the site during the 2, 10, and 100-year storm events. (See Technical Appendix: Existing and Proposed Hydrographs).

Table 5-2 Runoff Rates

Recurrence Interval (years)	Existing Peak Runoff Rate (cfs)	Proposed Peak Runoff Rate (cfs)
2	0.08	0.04
10	0.28	0.28
100	0.79	0.68

6 CONVEYANCE ANALYSIS

6.1 Design Guidelines

The analysis and design criteria described in this section will follow Section 4.8 Conveyance Systems of the *City of Salem Administrative Rules.* The manual requires storm drainage systems and facilities be designed to convey the 10-year storm event for drainage areas less than 50 acres. A Manning's 'n' value of 0.013 was selected for all storm drain pipes per the City of Salem standards. The Manning's 'n' value is 8 percent higher than the recommended Manning's 'n' value for concrete pipe (n = 0.012) to account for entrance, exit, junction, and bend head losses.

Catch basins are proposed within the new customer parking lot to collect and convey stormwater to the underground detention and stormwater vegetated swale.

6.2 System Capacities

The proposed conveyance system was designed to convey and contain the peak runoff from a 10-year design storm. The proposed conveyance system will have sufficient capacity to handle all storm events up to and including the 100-year storm event without flooding. The onsite conveyance system will be analyzed on its ability to convey and contain the peak runoff from a 100-year design storm within the final Drainage Report.

7 FLOODWAY & FLOODPLAIN ANALYSIS

The site is not located within the floodplain.

8 SOURCE CONTROL

The proposed project does include garbage and recycling for the new retail store. Garbage and recycling will be handled with sealed compactors that are connected to the west side of the building.

No separate outdoor garbage or recycling disposal locations are proposed with the project.

9 WATER QUALITY

9.1 Water Quality Guidelines

The proposed water quality facilities were designed per City of Salem standards. The proposed facilities were designed using a rainfall depth of 1.38 inches over a 24-hour period as outlined in

Division 004, subsection 4.2(p) of the City of Salem *Department of Public Works Administrative Rules Design Standards* dated January 2014. Furthermore, the site was designed to utilize Green Stormwater Infrastructure to the Maximum Extent Feasible per the requirements of Appendix 4E of the same document. Over 80% of the new impervious area of the site is treated with vegetated swales. Two areas not treated by the swales, including the site entrance to 27th Avenue SE (draining into the public right-of-way) and the proposed building loading dock that is treated by Contech StormFilters due to grade restrictions.

9.2 Water Quality Facility

Onsite

Water quality will be provided with one Contech StormFilter (on the west side of the site), and two vegetated swales located on the east side of the property, downstream from the underground detention per the City of Salem Public Works standards. The vegetated swales will treat 90% of onsite impervious area, exceeding the GSI treatment standard. The remaining area will be treated by StormFilter Catch Basin.

Swales are landscaped reservoirs that collect and treat stormwater runoff through vegetation and soil media. They also provide pollutant reduction and flow attenuation to reduce hydraulic impacts from urban developments on downstream rivers. Specific elements are incorporated into the swale design to increase the effectiveness of this stormwater facility type. Design elements include using soil media to provide stormwater filtration and vegetation to will provide plant uptake. The area draining to each swale, the calculated water quality flow, and design parameters are listed in Table 9-1. The swale section is listed below:

- Freeboard Depth: 8 inches
- Treatment Water Depth: 4 inches
- Growing Media Depth: 18 inches

Due to high groundwater on the site, the swales are proposed to be a filtration facility only and will not be utilized for infiltration disposal.

Table 9-1 Onsite Vegetated Swale

Swale ID	Impervious Area (ac)	Pervious Area (ac)	Water Quality Flow (cfs)	Design Length (ft)	Bottom Width (ft)	Treatment Depth (in)	Total Depth (in)
1	8.91	0.89	0.77	186	21	4	4
2	6.22	0.16	1.74	180	15	4	12

A Contech StormFilter will provide treatment for the previously listed areas not draining to the swale. StormFilters are designed to treat urban runoff including TSS, soluble heavy metals, total nutrients, oil, and grease by providing a high level of water quality treatment. Each cartridge filter has a treatment capacity of 0.033 cfs (15 gpm). The maximum bypass flow is 1.80 cfs. The selected StormFilter contains cartridges filled with ZPG filter media (a mixture of zeolite, perlite, and granular activated carbon), which are designed to remove sediment, metals, and stormwater pollutants from stormwater runoff. The required number of cartridges is shown in Table 9-2.

Table 9-2 Onsite Mechanical Water Quality Facilities

Basin ID	Cartridge Size	Impervious Area (sf)	Water Quality Flow Rate (cfs)	Quantity of Cartridges
3	Standard	8,537	0.05	2.0

10 WATER QUANTITY

10.1 Water Quantity Guidelines

The City of Salem requires flow control to protect downstream properties, infrastructure, and natural resources from the increased stormwater runoff and volume resulting from development. When using Structural Flow Control Facilities, the post-developed 100-year storm event must be detained to the pre-developed 100-year storm event.

10.2 Facility Design

Detention will be provided within the proposed underground chamber detention system. Three systems have been designed to dry detention pond.

10.3 Release Rates

The allowable release rates for the site are based on the existing site generated 100-year storm event release rate.

10.4 Stage and Volume

The proposed site requires a total detention of 133,750 CF to detain the post-developed 100-year storm event to the pre-developed. Manufactured chambers are proposed to provide the required detention storage volume. The chamber facilities are designed such the top of the chambers are below the lowest catch basin rim elevation and more than a foot of freeboard is provided to the proposed building.

The water quantity depth and volume are provided in Table 8-1

Table 10-1 Water Quantity Detention Design

Basin	Detention Volume (CF)
1	71,300
2	60,800
3	1,650
Total	133,750

11 SUMMARY

The proposed water quality and quantity design follows the City of Salem *Public Works Administrative Rules Design Standards* dated January 2014.

The proposed treatment system includes a vegetated swale, and Contech StormFilter treatment facility to treat the impervious area not draining to the swales. 90 percent of the all treatment will occur within GSI facilities, beyond the 80 percent minimum requirement.

The proposed storm system was designed to detain the 100-year storm event.

Technical Appendix

Technical Appendix

- Exhibit 1 – Existing Basin Delineation
- Exhibit 2 – Proposed Basin Delineation
- Figure 3 – Proposed Water Quality Layout
- Figure 4 – Proposed Underground Detention Layout

- USGS Soil Map – Marion County
- Composite Curve Number Calculations
- Table 4D-6 – Runoff Curve Numbers
- Time of Concentration Calculation
- Water Quality Swale Design Calculation
- xpswmm Pre-Developed and Post-Developed Results

BASIN AREAS

BASIN 1:
- IMPERVIOUS AREA - 0.00
- PERVIOUS AREA - 9.80
- TOTAL AREA - 9.80

BASIN 2:
- IMPERVIOUS AREA - 0.00
- PERVIOUS AREA - 6.38
- TOTAL AREA - 6.38

BASIN 3:
- IMPERVIOUS AREA - 0.00
- PERVIOUS AREA - 0.20
- TOTAL AREA - 0.20

BASIN 4:
- IMPERVIOUS AREA - 0.27
- PERVIOUS AREA - 3.91
- TOTAL AREA - 4.18

BASIN 5:
- IMPERVIOUS AREA - 0.00
- PERVIOUS AREA - 0.42
- TOTAL AREA - 0.42

TOTAL:
- IMPERVIOUS AREA - 0.27
- PERVIOUS AREA - 20.71
- TOTAL AREA - 20.98

BASIN 5

BASIN 1

BASIN 3

BASIN 4 (OUTER)

BASIN 2

WETLANDS AREA

BOONE RD.

27TH AVENUE

N

100 0 100

SCALE IN FEET

Q:\2201\14429-01\65CADD\EXHIBITS\2018-04-20 - BASIN AREAS\BASIN AREAS EXISTING.dwg PLOT DATE 2018-4-24 08:29 SAVED DATE 2018-04-20 14:48 USER: klebe

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720 SW Washington Street, #750
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COSTCO SALEM
EXISTING BASIN AREAS

PROJECT	14429-01
DATE	2018-04-20

FIGURE 1

BASIN AREAS

BASIN 1:
- IMPERVIOUS AREA - 8.91
- PERVIOUS AREA - 0.89
- TOTAL AREA - 9.80

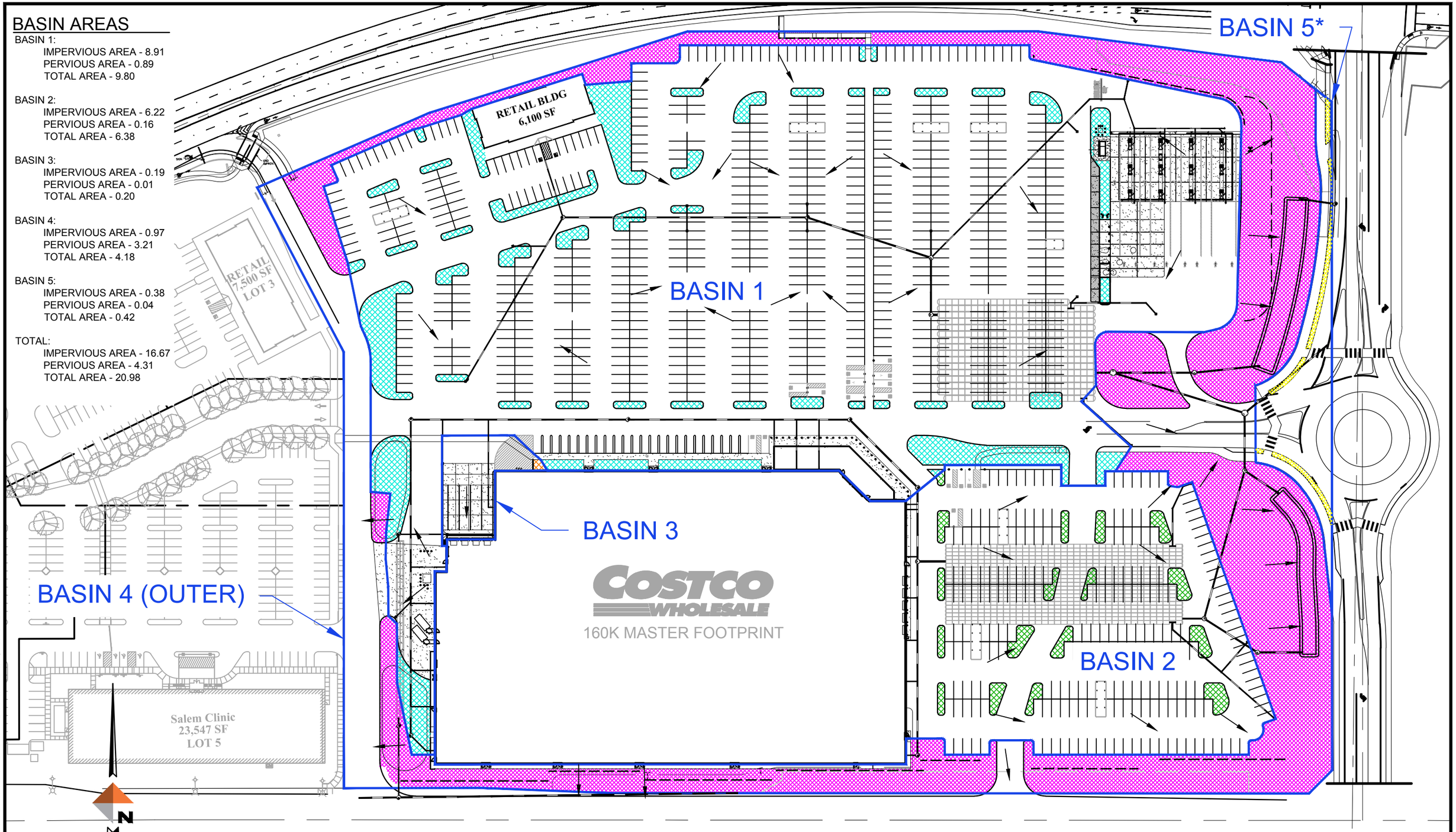
BASIN 2:
- IMPERVIOUS AREA - 6.22
- PERVIOUS AREA - 0.16
- TOTAL AREA - 6.38

BASIN 3:
- IMPERVIOUS AREA - 0.19
- PERVIOUS AREA - 0.01
- TOTAL AREA - 0.20

BASIN 4:
- IMPERVIOUS AREA - 0.97
- PERVIOUS AREA - 3.21
- TOTAL AREA - 4.18

BASIN 5:
- IMPERVIOUS AREA - 0.38
- PERVIOUS AREA - 0.04
- TOTAL AREA - 0.42

TOTAL:
- IMPERVIOUS AREA - 16.67
- PERVIOUS AREA - 4.31
- TOTAL AREA - 20.98



*BASIN 5 DRAINS OFF-SITE TO 27TH AVE ROW. DRAINAGE AREA UNDER PUBLIC IMPROVEMENTS DRAINAGE REPORT

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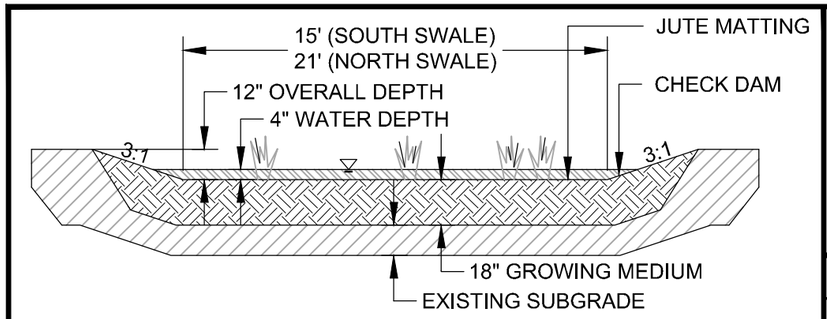
COSTCO SALEM
PROPOSED BASIN AREAS

PROJECT	14429-01
DATE	2018-04-20

FIGURE 2



VEGETATED STORMWATER QUALITY SWALE

SCALE: 1" = 5'

TREATMENT FACILITIES

- (A) PROPOSED VEGETATED STORMWATER QUALITY SWALE. (NORTH)
- (B) PROPOSED VEGETATED STORMWATER QUALITY SWALE. (SOUTH)
- (C) PROPOSED 2 FILTER WATER QUALITY CATCH BASIN.

FAST FOOD
2,138 SF
LOT 2

RETAIL
7,500 SF
LOT 3

Salem Clinic
23,547 SF
LOT 5

COSTCO WHOLESALE
160K MASTER FOOTPRINT

27TH AVENUE

N

100 0 100
SCALE IN FEET

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COSTCO SALEM
PROPOSED TREATMENT FACILITIES

PROJECT	14429-01
DATE	2018-04-24

FIGURE 3

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DETENTION FACILITIES

1. PROPOSED STORMTECH UNDERGROUND DETENTION SYSTEM (MC-3500 CHAMBERS).
   TOTAL VOLUME: 71,300 CF
   TOTAL CHAMBERS: 378
   TOTAL END CAPS: 32

2. PROPOSED STORMTECH UNDERGROUND DETENTION SYSTEM (SC-740 CHAMBERS).
   TOTAL VOLUME: 60,800 CF
   TOTAL CHAMBERS: 756
   TOTAL END CAPS: 42

3. PROPOSED STORMTECH UNDERGROUND DETENTION SYSTEM (SC-310 CHAMBERS).
   TOTAL VOLUME: 1,650 CF
   TOTAL CHAMBERS: 52
   TOTAL END CAPS: 4

RETAIL BLDG
6,100 SF

LOT 2

COSTCO WHOLESALE
160K MASTER FOOTPRINT

Salem Clinic
23,547 SF
LOT 5

27TH AVENUE

N

100 0 100
SCALE IN FEET

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COSTCO SALEM
PROPOSED DETENTION FACILITIES

PROJECT	14429-01
DATE	2018-04-24

FIGURE 4

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Map Scale: 1:2,490 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 35 70 140 210

Feet: 0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Marion County Area, Oregon
Survey Area Data: Version 14, Sep 19, 2017

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

Date(s) aerial images were photographed: Jun 15, 2015—Jun 23, 2015

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NeB	Nekia silty clay loam, 2 to 7 percent slopes	C	15.7	64.1%
NkC	Nekia stony silty clay loam, 2 to 12 percent slopes	C	3.0	12.4%
SlB	Salkum silty clay loam, basin, 0 to 6 percent slopes	B	5.7	23.4%
Totals for Area of Interest			**24.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Composite Curve Number Calculations

Subject	Costco Salem	By	RHH	Date	4/16/2018
Project	14429				

Runoff Curve Number - Proposed

Soil Name and Hydrologic group	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connect impervious area ratio)	CN HSG A	CN HSG B	CN HSG C	CN HSG D	Area acres	Product of CN **X** area
$CN(Weighted) = \frac{Total\_Product}{Total\_Area}$							
Basin 1							
B	Open spaces-lawns, parks, golf courses, cemeteries		58			5.00	290
C	Open spaces-lawns, parks, golf courses, cemeteries			72		15.97	1150
			Totals			20.97	1440
			Use CN			69	

		CN For Hydrologic Soil Group			
Cover Description		**A**	**B**	**C**	**D**
Urban Areas	**Source: NRCS TR55 Table 2-2a (1986)**				
	% Impervious				
Open Space					
Poor condition (grass cover <50%		68	79	86	89
Fair condition (grass cover 50% to 70%)		49	69	79	84
Good condition (grass cover >75%) **Amended Soils**		39	61	74	80
City of Salem Pre-development		35	58	72	79
Impervious Areas					
Paved parking lots, roofs, driveways (excluding right-of-way)		98	98	98	98
Streets and roads					
Paved: curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved: open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way) **Un-amended Soils**		72	82	87	89
Urban districts					
Commercial and Business	85	89	92	94	92
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acres or less (town houses)	65	77	85	90	92
¼ acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
½ acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Agricultural Lands	**Source: NRCS TR55 Table 2-2c (1986)**				
	Hydrologic Condition				
Pasture, grassland, or range- combined forage for grazing					
<50% ground cover or heavily grazed with no mulch	Poor	68	79	86	89
50 to 75% ground cover and not heavily grazed	Fair	49	69	79	84
>75% ground cover and lightly or only occasionally grazed	Good	39	61	74	80
Meadow- continuous grass, protected from grazing and generally mowed for hay		30	58	71	78
Brush- weed/ grass mixture with brush as the major element					

		CN For Hydrologic Soil Group			
Cover Description		**A**	**B**	**C**	**D**
<50% Ground cover	Poor	48	67	77	83
50 to 75% ground cover	Fair	35	56	70	77
>75% ground cover	Good	30	48	65	73
Woods/ grass combination (orchard or tree farm)	Poor	57	73	82	86
	Fair	43	65	76	80
	Good	32	58	72	79
Woods					
Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning	Poor	45	66	77	83
Woods are grazed but not burned, and some forest litter covers the soil	Fair	36	60	73	79
Woods are protected from grazing and litter and brush adequately covers the soil	Good	30	55	70	77
Impervious Surface Reduction Facilities	**Source: Portland Stormwater Management Manual (2008)**				
Type	**Hydrologic Condition**				
Pervious Pavement		76	85	89	n/a
Trees					
New and/or existing evergreen		36	60	73	79
New and/or existing deciduous		36	60	73	79
Green Roof	Good	n/a	61	n/a	n/a
Roof Garden	Good	n/a	48	n/a	n/a
Infiltration and Filtration Planter Box	Good	n/a	48	n/a	n/a
n/a = Not Applicable					

Table 4D-6. Runoff Curve Numbers

4D.5—Santa Barbara Urban Hydrograph (SBUH) Method

The SBUH method is an acceptable hydrograph method for flow control design. It involves a five step process. Methodology for steps one through four is described in Subsection 4D.3—Hydrograph Methods and Subsection 4D.4—Time of Concentration.

Determining runoff using the SBUH method requires the use of a computer model. Inputs to the model include:

(1). Basins Areas in acres.

(2). Precipitation for 24 hour storm events in inches.

(3). Soil Characteristics for CN.

(4). Travel time for basin in minutes.

Time of Concentration

SUBJECT	Costco Salem				
PROJECT NO.	2322.14429.01	**BY**	RHH	**DATE**	4/16/2018

		Basin 1	
SHEET FLOW			
INPUT		**VALUE**	
Surface Description	**Type**	**5**	
	Grass (short prairie)		
Manning's "n"	**0.15**		
Flow Length, L (<300 ft)	**250**	ft	
2-Yr 24 Hour Rainfall, P_2	**2.2**	in	
Land Slope, s	**0.020**	ft/ft	
OUTPUT			
Travel Time	0.41	hr	
SHALLOW CONCENTRATED FLOW			
INPUT	**VALUE**		
Surface Description	**Unpaved**		
Flow Length, L	**647**	ft	
Watercourse Slope*, s	**0.018**	ft/ft	
OUTPUT			
Average Velocity, V	2.16	ft/s	
Travel Time	0.083	hr	
CHANNEL FLOW			
INPUT	**VALUE**		
Cross Sectional Flow Area, a	**0**	ft^2	
Wetted Perimeter, P_w	**0**	ft	
Channel Slope, s	**0**	ft/ft	
Manning's "n"	**0.013**		
Flow Length, L	**0**	ft	
OUTPUT			
Average Velocity	0.00	ft/s	
Hydraulic Radius, r = a / P_w	0.00	ft	
Travel Time	0.00	hr	
Watershed or Subarea T_c =	**0.49**	**hr**	
Watershed or Subarea T_c =	**30**	**minutes**	

Water Quality Swale

SUBJECT	Costco Salem - North Swale				
PROJECT NO.	14429.1	**BY**	KDL	**DATE**	4/16/2018
		CHECKED	RHH	**DATE**	4/16/2018

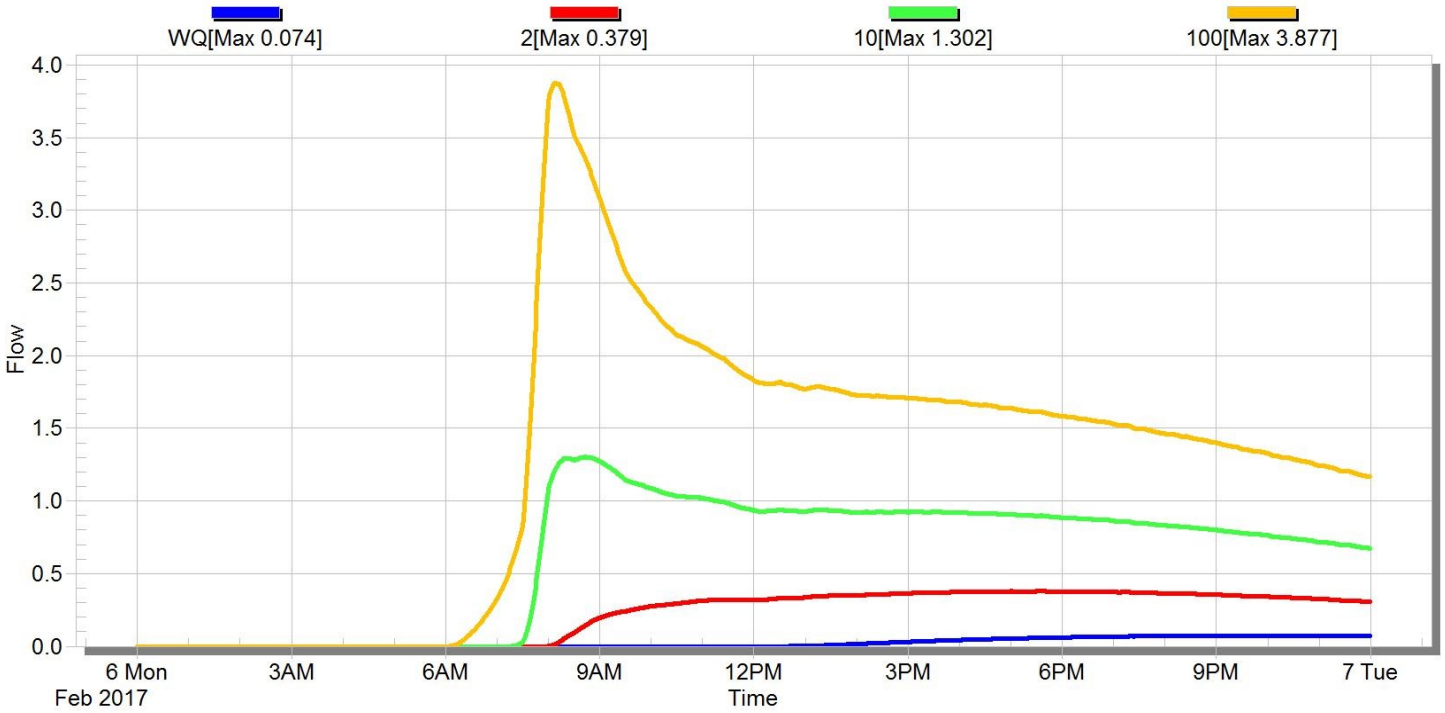
Swale Characteristics:			
Input	**Description**		**Value**
V	Max Velocity		**0.9** ft/s
A	Impervious area		**388,120** ft^2
S	Slope of channel (0.005 ft/ft minimum)		**0.016** ft/ft
Y	Assumed water depth to begin analysis (0.5 ft max)		**0.33** ft
n	Roughness factor	**1** Grass	**0.25**
B	Swale width at base		**21** ft
Z	Side Slopes		**3** H:1V
t	Minimum treatment time (min)		**9.0** min
Water Quality Flow			
Output	**Description**		**Value**
vol	Water quality volume		**NA** ft^3
Q	Flow		**2.53** cfs
Y	Depth of water		**0.33** ft
W	Width of water surface in swale		**22.98** ft
V	Velocity		**0.35** ft/s
L	Length of swale		**188.3** ft

Water Quality Swale

SUBJECT	Costco Salem - South Swale				
PROJECT NO.	14429.1	**BY**	KDL	**DATE**	4/16/2018
		CHECKED	RHH	**DATE**	4/16/2018

Swale Characteristics:			
Input	**Description**		**Value**
V	Max Velocity		**0.9** ft/s
A	Impervious area		**270,950** ft^2
S	Slope of channel (0.005 ft/ft minimum)		**0.015** ft/ft
Y	Assumed water depth to begin analysis (0.5 ft max)		**0.33** ft
n	Roughness factor	**1** Grass	**0.25**
B	Swale width at base		**15** ft
Z	Side Slopes		**3** H:1V
t	Minimum treatment time (min)		**9.0** min
Water Quality Flow			
Output	**Description**		**Value**
vol	Water quality volume		**NA** ft^3
Q	Flow		**1.74** cfs
Y	Depth of water		**0.33** ft
W	Width of water surface in swale		**16.96** ft
V	Velocity		**0.33** ft/s
L	Length of swale		**179.2** ft

PRE-DEVELOPED HYDROGRAPH



POST-DEVELOPED HYDROGRAPH