Appendix E

Preliminary Stormwater Management Report

Milwaukie Bay Park

Preliminary Stormwater Management Report

Prepared to Support Land Use Application

Submitted by:

Property Owner / Site Address

North Clackamas Parks & Recreation District

Heather Koch – Project Manager
Email: hkoch@ncprd.com
Phone: 971-337-6867

Site Address - Milwaukie Bay Park
11211 SE McLoughlin Blvd
Milwaukie, Oregon 97222

Engineer of Record

ZUCKER engineering & design

Adam Zucker, PE
4014 SE Ankeny Street
Portland, Oregon 97214

Email: adam@zuckerenegineering.com
Phone: 503-956-3473

June 2022

Certification and Statement

I hereby certify that this Preliminary Stormwater Management Report for Milwaukie Bay Park located at 11211 SE McLoughlin Blvd. has been prepared by me or under my supervision and meets minimum standards of the City of Milwaukie and normal standards of engineering practice. I hereby acknowledge and agree that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me.

Signed 6/19/22

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1.0 Project Overview and Description

Milwaukie Bay Park is located at the west end of downtown Milwaukie along the eastern bank of the Willamette River (illustrated in green) in the Vicinity Map (**Figure 1**) below. The project represents final phase of Milwaukie's waterfront development work at this site. The proposed project site is approximately 3.5 acres as shown in **Figure 2 – Existing Conditions** included in the **Appendix A**. The project is located within the Willamette River watershed.

Figure 1 – Project Vicinity Map

The existing stormwater basin identified on **Figure 2** appears to have been designed and built for the future park improvements on this site as well treat some runoff from the existing parking lot. It appears that the parking lot design was changed after the preparation of the *Milwaukie Riverfront Park – Stormwater Report* prepared by David Evans and Associates (DEA), in December 2009, and currently includes pervious pavement and doesn't appear to drain into the existing stormwater basin on the park site.

The proposed project involves demolishing all of the existing concrete and asphalt pathways within the work limits and to construct park improvements that include the following elements include:

- Playground
- New Trolley Trail
- Performance Stage
- Interactive Water Feature
- Entry Plaza
- Fire Pit
- Restroom Building
- Picnic Areas
- New Walkways

These proposed project features are shown on **Figure 3 – Proposed Conditions**

A summary of the Existing and Proposed impervious surfaces on the Site include the following:

Existing Impervious Areas (sq. ft.)	
Concrete Walkways	14,490
Asphalt Walkways	5,410
Total Existing Impervious Area:	19,990 sq. ft.

Proposed Impervious Area (sq. ft.)	
Restroom	277
Performance Stage	803
Water Feature	2,701
Entry Plaza	4,773
Picnic Areas	1,534
Drop-Off Area	2,302
Walks and Pathways	16,366
Total Proposed Impervious Area:	28,756 sq. ft.

The proposed Trolley Trail (12,525 sq. ft.) will be constructed with porous asphalt and the proposed playground area surfacing (2,448 sq. ft.) will be constructed with pervious materials.

2.0 Methodology

2.1 Infiltration Testing Results

The an evaluation of the subsurface soil conditions and site infiltration testing at the site was performed by Hart Crowser in their Report of *Preliminary Geotechnical Engineering Services* (dated September 5, 2018) and in their *Geotechnical Report Addendum #1* (dated May 20, 2022). The site was found to be blanketed with 1 to 3 feet of undocumented fill and infiltration rates were variable but generally poor. Six infiltration rate test were performed throughout the site. Five of them were taken at a (shallow) depth 2 to 3 feet and one taken at a depth of 10 feet below grade. Four of the five shallow infiltration tests had a measured infiltration rate of less than 1 inch per hour. The fifth shallow infiltration test, which was performed at the upper portion of the site near McLaughlin Boulevard had a measured infiltration rate of 13 inches per hour.

2.2 Design Approach

Given the variability of the subsurface conditions and the predominance of poorly infiltrating soils, the design team decided to incorporate stormwater treatment facilities that relies primarily on filtration (i.e. a grassy swale). Despite the anticipation of poorly infiltrating soils throughout the site, the design team believes that incorporation of permeable asphalt for the Trolley Trail is an appropriate approach for the site because,

1) The trolley trail is located within a portion of the site that exhibited good infiltration capacity.

2) The alignment of the trolley trail generally coincides with the location of sidewalk along SE McLoughlin Blvd. and roadway sidewalks area generally designed to shed towards the roadway.
3) The City of Milwaukie requires that all new site walkways and paths are constructed of permeable materials.

2.3 Treatment and Design Requirements

The City of Milwaukie has adopted the most current version of the City of Portland's Stormwater Management Manual (2020) for all stormwater design and operational and maintenance requirements.

Due to the site's proximity and direct conveyance into the Willamette River, the stormwater management manual does not require on-site quantity control (i.e. detention) and only requires treatment of the pollution reduction storm event (1.61-inch, 24-hour storm event).

2.4 Site versus Right-of-Way

For the purposed of this project, the entire work limit line for this project is designated as "on-site work", governed by the requirements of the City's Stormwater Management Manual. The existing right-of-ways for this site are located in atypical locations, as shown in **Figure 2**, and are in the process of being adjusted. Specifically, there is an extension of the SE Jefferson Street right-of-way through the site that is no longer current and the location of the Oregon Department of Transportation's right-of-way is at the back of curb north of SE Jefferson Street and is along the back of the existing Trolley Trail south of SE Jefferson Street.

2.5 Treatment Facility Types and Evaluation Approaches

This project includes a three types of stormwater treatment facilities,

- A Grassy Swale that treats a majority of the runoff from the site,
- A Stormwater Basin is the location of the existing stormwater facility on site, and
- Pervious Asphalt for the new Trolley Trail pathway.

The sizing of the Grassy Swale is based on the Performance Approach and utilizes a spreadsheet that calculates the same Santa Barbara Unit Hydrograph (SBUH) Type 1A, 24-hour storm distribution that is provided in the Appendix of the City of Portland's Stormwater Management Manual and a channel conveyance spreadsheet that incorporates the Mannings Equation.

The sizing of the Stormwater Basin is based on City of Portland's Presumptive Approach Calculator (PAC). The contributing drainage catchment for this facility is small enough that it can adequately store and infiltrate the design storm despite the poor infiltration rates (0.375 in/hour used for design).

The Trolley Trail will be based on standard design and specification for pervious asphalt.

The new asphalt and concrete for the Drop-Off Area (2,302 square feet) replaces 1,613 square feet that already drains into existing stormwater planters in the North Parking Lot. Zucker Engineering & Design will evaluate the sizing of the existing planters to determine if they are sized appropriately to manage

the addition 689 square feet of impervious area. Refer to **Figure 3 – Proposed Conditions**, for a location proposed stormwater treatment facilities.

3.0 Analysis

3.1 Drainage Catchment Areas

The site has been delineated into three catchments that correspond with each treatment facilities sized and evaluated for this report.

The *Northern Park* Basin (24,639 square feet of impervious surfaces) encompasses a majority of the park's impervious surfaces, including the restroom building, picnic areas, water feature, performance stage, entry plaza, and walkways. This basin drains into the proposed **Grassy Swale** stormwater feature.

The *Southern Fire Pit* Basin includes 1,815 square feet of the park walkways and drains into the proposed **Stormwater Basin** that is located where the existing stormwater basin is currently located.

The North Parking Basin (N1) includes 2,302 square feet of asphalt and concrete that drains into the existing parking lot stormwater planters. The proposed park improvements increase the impervious area draining into the existing stormwater planters by 689 square feet.

The proposed pervious asphalt Trolley Trail encompasses 12,525 square feet its areas is not included in the sizing of the proposed stormwater facilities.

3.2 Grassy Swale – Northern Park Basin

The design and sizing of the Grassy Swale was based on design guidelines outlined in Section 3.2.5.5 of City of Portland Stormwater Management Manual. Key requirements include:

- A maximum design velocity of 0.9 feet per second
- A minimum hydraulic residence time of 9 minutes
- A minimum length of 100 feet
- A design Mannings n value of 0.25
- A maximum flow depth of 4 inches

The proposed swale will not include a high-flow diversion for flows above the pollution reduction storm and must safely convey the 25-year storm event (peak 25-year, 5-minute intensity of 3.32 inches per hour), analyzed using the Rational Method. The swale design must also meet the following criteria:

- Have a minimum of 4 inches of freeboard above the water surface, and
- Have a maximum flow velocity less than 3 feet per second

The impervious surfaces in *North-Park* Basin were calculated to have a peak pollution reduction flow rate of **0.21 cubic feet per second (CFS)**. The spreadsheet calculation of this runoff rate is included in the **Appendix B**. The correspond Rational Method High flow runoff event is:

Rational Method = CIA = 0.9 x 3.32 x (24,639 / 43,560) = **1.70 cfs**

The proposed grassy swale is designed to have a 2-foot wide bottom width with 4:1 side slopes, a minimum 12-inch depth, and an average longitudinal slope of 2.7 percent. Based on this channel geometry, an inflow rate of 0.21 cfs, and an overall length of 165 feet, the corresponding hydraulic residence time is 9.0 minutes. The Trapezoidal Channel Hydraulic Spreadsheet included in the **Appendix B** includes flows, velocities, and residence times for varying flow depths. The spreadsheet indicates that during the high-flow event the maximum flow depth will be 8 inches and maximum velocity will be 0.5 feet per second. The swale is designed to be at least 12-inches deep and therefore meets the 4-inch freeboard requirement during the peak 25-year flow event.

3.3 Stormwater Basin – Southern Basin

A small portion of the park's drainage, about 1,815 square feet drains to into the re-graded Stormwater Basin. The stormwater basin will have a bottom area that is about 50 square feet, 3:1 side slopes, a 12-inch depth, and a 12-inch depth of drainage rock underneath the facility. Despite the anticipated poorly draining soils (0.375 in/hr for design), the size of the contributing drainage basin is small enough that the facility can adequately store and infiltrate the pollution reduction storm. A summary of the City of Portland's PAC report is included in the **Appendix C.**

3.4 Existing Planter – North Parking Lot Basin

This project impacts a portion of the existing parking lot that abuts the project site to the south with a new drop off area that increase the impervious area draining into the existing North Parking Lot Basins (N1 – as denoted in 2009 DEA Stormwater Report). According to the DEA report, the N1 drainage basin is 11, square feet and the associated treatment Planter has a treatment area of 1,057 square feet and depth of 10 inches. A copy of the original PAC calculations are included in the **Appendix C.** ZED re-created this drainage basin (plus 689 square feet) in the PAC and routed it through a similarly sized/designed Stormwater Planter. These new PAC calculations indicate that existing North Parking Lot Stormwater Basin has the treatment capacity to adequately handle the increased runoff. A copy of the new PAC calculations area included in the **Appendix C.**

4.0 Engineering Conclusions

It is the findings of this report that the proposed stormwater management facilities for Milwaukie Bay Park, as well as that alteration to the existing North Parking Lot drainage basin meet the treatment requirements of the City of Portland's 2020 Stormwater Management Manual. The site's proximity to the Willamette River precludes the need for on-site flow control and only requires management of the Pollution Reduction storm. Below is the summary of impervious area managed and type of treatment facility that is managing the runoff:

Drainage Basin	Impervious Area	Treatment Facility
Northern Park Basin	24,639 square feet	Grassy Swale
Southern Park (Fire Pit) Basin	1,815 square feet	Stormwater Basin
North Parking Lot (N1)	2,302 (689 new) square feet	Stormwater Planter (Existing)
Trolley Trail	12,525 square feet	Pervious Asphalt

The sizing of the Grassy Swale was based on the Performance Approach and residence time, flow depths, and flow velocities were evaluated based the principles of the Mannings Equations for a trapezoidal channel.

The sizing of the Stormwater Basin and existing Stormwater Planter were performed using the City of Portland's Presumptive Approach Calculator (PAC).

The generally poorly measured infiltration rates on the site lend themselves to filtering-type treatment facilities (ie Grassy Swales). However the relatively small size of the Southern Park basin makes the stormwater basin feasibly and the location of the Trolley Trail makes the proposed use of pervious asphalt more practical.

APPENDIX A

Figure 2 – Existing Conditions

Figure 3 – Proposed Conditions

Willamette River

CULVERT

PROJECT'S WORK LIMITS LINE

OUTFALL

STORMWATER BASIN

NORTH PARKING LOT

RIGHT-OF-WAY, TYP.

AREA DRAIN

ASPHALT PATH, TYP.

CONCRETE SIDEWALK

SE McLoughlin Blvd

SE Washington St

SE Jefferson St

SE Monroe St

SE Jackson St

ZUCKER engineering & design

80 0 80 160

SCALE: 1" = 80'

N

FIGURE 2
Existing Conditions

Preliminary Stormwater Management Plan
Milwaukie Bay Park

Willamette River

DRAINAGE BASIN BOUNDARY

GRASSY SWALE

CULVERT

PROJECT'S WORK LIMITS LINE

STAGE

STORMWATER BASIN

PARKING LOT DRAINAGE BASIN

NORTHERN DRAINAGE BASIN

NORTH PARKING LOT

SOUTHERN DRAINAGE BASIN

FIRE PIT

PLAYGROUND

PICNIC AREA

WATER FEATURE

PICNIC AREA

RESTROOM

ENTRY PLAZA

PERVIOUS ASPHALT

PERVIOUS ASPHALT

SE McLoughlin Blvd

SE Washington St

SE Jefferson St

SE Monroe St

SE Jackson St

ZUCKER engineering & design

80 0 80 160

SCALE: 1" = 80'

N

FIGURE 3
Proposed Conditions

Preliminary Stormwater Management Plan
Milwaukie Bay Park

APPENDIX B

Northern Park Basin – SBUH Spreadsheet

Trapezoidal Channel Hydraulic Using Mannings Equation

A SAMPLE HYDROGRAPH (SBUH METHOD) Pollution Reduction Stor

Based on the Design Storm Distribution from City of Portland's SWMM

Given: Project = Shute Park Hillsboro Oregon

Area = 0.57 acres

Pt = **1.61** Inches - Total 24-hr Rainfall for Design Storm

dt = 10 min.

Tc = 5 min. (Developed site conditions)

PERVIOUS Parcel		IMPERVIOUS Parcel			
Area =	0 acres	Area =	0.57 acres	Q - Peak	0.21 cfs
CN =	80	CN =	98	Volume	2867 ft^3
S =	2.50	S =	0.20		
0.2S =	0.50	0.2S =	0.04		
			24829.2		

Developed Conditions Runoff hydrograph

Column (3) = SCS Type IA Rainfall Distribution

Column (4) = Col. (3) x Pt = 10 year - 24 Hour Hyetograph at this location.

Column (5) = Accumulated Sum of Col. (4)

Column (6) = [If P <= 0.2S] = 0; Note, use PERVIOUS Area "S" value.

[If P > 0.2S] = (Col.(5) - 0.2S)^2/(Col.(5) + 0.8S); Using the PERVIOUS Area "S" value.

Column (7) = Col.(6) of Present Time Step - Col.(6) of Previous Time Step

Column (8) = Same method as for Col.(6), except use the IMPERVIOUS Area "S" value.

Column (9) = Col.(8) of the present time step - Col.(8) of the previous time step.

Column (10) = ((PERVIOUS area / Total area) x Col.(7)) + ((IMPERVIOUS area / Total area) x Col.(9))

Column (11) = (60.5 x Col.(10) x Total Area) / 10 (dt = 10 minutes)

Routing Constant, w = dt / (2Tc + dt) = 0.5000

Column (12) = Col.(12) of Previous Time Step + (w x [Col.(11) of Previous Time Step

+ Col.(11) of Present Time Step - (2 x Col.(12) of Previous Time Step)])

::

					Pervious Area		Impervious Area				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Time Increment	Time	Rainfall distribution	Incremental Rainfall	Accumulated Rainfall	Accumulated Runoff	Incremental Runoff	Accumulated Runoff	Incremental Runoff	Total Runoff	Instant hydrograph	design hydrograph
	min.	% of Pt	in.	in.	in.	in.	in.	in.	in.	cfs	cfs
1	10	0.0040	0.0064	0.0064	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00
2	20	0.0040	0.0064	0.0129	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00
3	30	0.0040	0.0064	0.0193	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00
4	40	0.0040	0.0064	0.0258	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00
5	50	0.0040	0.0064	0.0322	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00
6	60	0.0040	0.0064	0.0386	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00
7	70	0.0040	0.0064	0.0451	0.0000	0.0000	0.0001	0.0001	0.0001	0.00	0.00
8	80	0.0040	0.0064	0.0515	0.0000	0.0000	0.0005	0.0004	0.0004	0.00	0.00
9	90	0.0040	0.0064	0.0580	0.0000	0.0000	0.0013	0.0008	0.0008	0.00	0.00
10	100	0.0040	0.0064	0.0644	0.0000	0.0000	0.0024	0.0011	0.0011	0.00	0.00
11	110	0.0050	0.0081	0.0725	0.0000	0.0000	0.0042	0.0018	0.0018	0.01	0.01
12	120	0.0050	0.0081	0.0805	0.0000	0.0000	0.0065	0.0022	0.0022	0.01	0.01

13	130	0.0050	0.0081	0.0886	0.0000	0.0000	0.0090	0.0026	0.0026	0.01	0.01	
14	140	0.0050	0.0081	0.0966	0.0000	0.0000	0.0120	0.0029	0.0029	0.01	0.01	
15	150	0.0050	0.0081	0.1047	0.0000	0.0000	0.0152	0.0032	0.0032	0.01	0.01	
16	160	0.0050	0.0081	0.1127	0.0000	0.0000	0.0187	0.0035	0.0035	0.01	0.01	
17	170	0.0060	0.0097	0.1224	0.0000	0.0000	0.0233	0.0046	0.0046	0.02	0.01	
18	180	0.0060	0.0097	0.1320	0.0000	0.0000	0.0282	0.0049	0.0049	0.02	0.02	
19	190	0.0060	0.0097	0.1417	0.0000	0.0000	0.0334	0.0052	0.0052	0.02	0.02	
20	200	0.0060	0.0097	0.1513	0.0000	0.0000	0.0388	0.0055	0.0055	0.02	0.02	
21	210	0.0060	0.0097	0.1610	0.0000	0.0000	0.0445	0.0057	0.0057	0.02	0.02	
22	220	0.0060	0.0097	0.1707	0.0000	0.0000	0.0505	0.0059	0.0059	0.02	0.02	
23	230	0.0070	0.0113	0.1819	0.0000	0.0000	0.0577	0.0072	0.0072	0.02	0.02	
24	240	0.0070	0.0113	0.1932	0.0000	0.0000	0.0651	0.0075	0.0075	0.03	0.03	
25	250	0.0070	0.0113	0.2045	0.0000	0.0000	0.0728	0.0077	0.0077	0.03	0.03	
26	260	0.0070	0.0113	0.2157	0.0000	0.0000	0.0807	0.0079	0.0079	0.03	0.03	
27	270	0.0070	0.0113	0.2270	0.0000	0.0000	0.0888	0.0081	0.0081	0.03	0.03	
28	280	0.0070	0.0113	0.2383	0.0000	0.0000	0.0971	0.0083	0.0083	0.03	0.03	
29	290	0.0082	0.0132	0.2515	0.0000	0.0000	0.1070	0.0099	0.0099	0.03	0.03	
30	300	0.0082	0.0132	0.2647	0.0000	0.0000	0.1171	0.0101	0.0101	0.03	0.03	
31	310	0.0082	0.0132	0.2779	0.0000	0.0000	0.1274	0.0103	0.0103	0.04	0.04	
32	320	0.0082	0.0132	0.2911	0.0000	0.0000	0.1379	0.0105	0.0105	0.04	0.04	
33	330	0.0082	0.0132	0.3043	0.0000	0.0000	0.1485	0.0106	0.0106	0.04	0.04	
34	340	0.0082	0.0132	0.3175	0.0000	0.0000	0.1592	0.0108	0.0108	0.04	0.04	
35	350	0.0095	0.0153	0.3328	0.0000	0.0000	0.1719	0.0126	0.0126	0.04	0.04	
36	360	0.0095	0.0153	0.3481	0.0000	0.0000	0.1846	0.0128	0.0128	0.04	0.04	
37	370	0.0095	0.0153	0.3634	0.0000	0.0000	0.1976	0.0129	0.0129	0.04	0.04	
38	380	0.0095	0.0153	0.3787	0.0000	0.0000	0.2106	0.0131	0.0131	0.05	0.04	
39	390	0.0095	0.0153	0.3940	0.0000	0.0000	0.2238	0.0132	0.0132	0.05	0.05	
40	400	0.0095	0.0153	0.4093	0.0000	0.0000	0.2371	0.0133	0.0133	0.05	0.05	
41	410	0.0134	0.0216	0.4308	0.0000	0.0000	0.2560	0.0189	0.0189	0.07	0.06	
42	420	0.0134	0.0216	0.4524	0.0000	0.0000	0.2752	0.0191	0.0191	0.07	0.07	
43	430	0.0134	0.0216	0.4740	0.0000	0.0000	0.2944	0.0193	0.0193	0.07	0.07	
44	440	0.0180	0.0290	0.5030	0.0000	0.0000	0.3206	0.0261	0.0261	0.09	0.08	
45	450	0.0180	0.0290	0.5319	0.0004	0.0004	0.3470	0.0264	0.0264	0.09	0.09	
46	460	0.0340	0.0547	0.5867	0.0029	0.0025	0.3973	0.0504	0.0504	0.17	0.13	
47	470	0.0540	0.0869	0.6736	0.0113	0.0084	0.4785	0.0812	0.0812	0.28	0.23	
48	480	0.0270	0.0435	0.7171	0.0173	0.0061	0.5195	0.0410	0.0410	0.14	0.21	Q peak
49	490	0.0180	0.0290	0.7461	0.0221	0.0047	0.5470	0.0275	0.0275	0.09	0.12	
50	500	0.0134	0.0216	0.7676	0.0259	0.0038	0.5675	0.0205	0.0205	0.07	0.08	
51	510	0.0134	0.0216	0.7892	0.0300	0.0041	0.5881	0.0206	0.0206	0.07	0.07	
52	520	0.0134	0.0216	0.8108	0.0344	0.0044	0.6087	0.0206	0.0206	0.07	0.07	
53	530	0.0088	0.0142	0.8250	0.0374	0.0030	0.6222	0.0136	0.0136	0.05	0.06	
54	540	0.0088	0.0142	0.8391	0.0405	0.0031	0.6358	0.0136	0.0136	0.05	0.05	
55	550	0.0088	0.0142	0.8533	0.0437	0.0032	0.6494	0.0136	0.0136	0.05	0.05	
56	560	0.0088	0.0142	0.8675	0.0471	0.0033	0.6630	0.0136	0.0136	0.05	0.05	
57	570	0.0088	0.0142	0.8816	0.0505	0.0035	0.6766	0.0136	0.0136	0.05	0.05	
58	580	0.0088	0.0142	0.8958	0.0541	0.0036	0.6902	0.0136	0.0136	0.05	0.05	
59	590	0.0088	0.0142	0.9100	0.0578	0.0037	0.7039	0.0136	0.0136	0.05	0.05	
60	600	0.0088	0.0142	0.9241	0.0615	0.0038	0.7175	0.0137	0.0137	0.05	0.05	
61	610	0.0088	0.0142	0.9383	0.0654	0.0039	0.7312	0.0137	0.0137	0.05	0.05	

62	620	0.0088	0.0142	0.9525	0.0693	0.0040	0.7449	0.0137	0.0137	0.05	0.05
63	630	0.0088	0.0142	0.9666	0.0734	0.0041	0.7586	0.0137	0.0137	0.05	0.05
64	640	0.0088	0.0142	0.9808	0.0776	0.0042	0.7723	0.0137	0.0137	0.05	0.05
65	650	0.0072	0.0116	0.9924	0.0810	0.0035	0.7835	0.0112	0.0112	0.04	0.04
66	660	0.0072	0.0116	1.0040	0.0846	0.0035	0.7948	0.0112	0.0112	0.04	0.04
67	670	0.0072	0.0116	1.0156	0.0882	0.0036	0.8060	0.0112	0.0112	0.04	0.04
68	680	0.0072	0.0116	1.0272	0.0918	0.0037	0.8173	0.0112	0.0112	0.04	0.04
69	690	0.0072	0.0116	1.0388	0.0955	0.0037	0.8285	0.0113	0.0113	0.04	0.04
70	700	0.0072	0.0116	1.0504	0.0993	0.0038	0.8398	0.0113	0.0113	0.04	0.04
71	710	0.0072	0.0116	1.0620	0.1031	0.0038	0.8511	0.0113	0.0113	0.04	0.04
72	720	0.0072	0.0116	1.0735	0.1070	0.0039	0.8623	0.0113	0.0113	0.04	0.04
73	730	0.0072	0.0116	1.0851	0.1110	0.0040	0.8736	0.0113	0.0113	0.04	0.04
74	740	0.0072	0.0116	1.0967	0.1150	0.0040	0.8849	0.0113	0.0113	0.04	0.04
75	750	0.0072	0.0116	1.1083	0.1191	0.0041	0.8962	0.0113	0.0113	0.04	0.04
76	760	0.0072	0.0116	1.1199	0.1232	0.0041	0.9075	0.0113	0.0113	0.04	0.04
77	770	0.0057	0.0092	1.1291	0.1265	0.0033	0.9164	0.0089	0.0089	0.03	0.03
78	780	0.0057	0.0092	1.1383	0.1298	0.0033	0.9254	0.0089	0.0089	0.03	0.03
79	790	0.0057	0.0092	1.1474	0.1332	0.0034	0.9343	0.0090	0.0090	0.03	0.03
80	800	0.0057	0.0092	1.1566	0.1366	0.0034	0.9433	0.0090	0.0090	0.03	0.03
81	810	0.0057	0.0092	1.1658	0.1400	0.0034	0.9522	0.0090	0.0090	0.03	0.03
82	820	0.0057	0.0092	1.1750	0.1435	0.0035	0.9612	0.0090	0.0090	0.03	0.03
83	830	0.0057	0.0092	1.1842	0.1470	0.0035	0.9702	0.0090	0.0090	0.03	0.03
84	840	0.0057	0.0092	1.1933	0.1505	0.0035	0.9791	0.0090	0.0090	0.03	0.03
85	850	0.0057	0.0092	1.2025	0.1541	0.0036	0.9881	0.0090	0.0090	0.03	0.03
86	860	0.0057	0.0092	1.2117	0.1577	0.0036	0.9971	0.0090	0.0090	0.03	0.03
87	870	0.0057	0.0092	1.2209	0.1613	0.0036	1.0061	0.0090	0.0090	0.03	0.03
88	880	0.0057	0.0092	1.2300	0.1650	0.0037	1.0150	0.0090	0.0090	0.03	0.03
89	890	0.0050	0.0081	1.2381	0.1682	0.0032	1.0229	0.0079	0.0079	0.03	0.03
90	900	0.0050	0.0081	1.2461	0.1715	0.0033	1.0308	0.0079	0.0079	0.03	0.03
91	910	0.0050	0.0081	1.2542	0.1748	0.0033	1.0387	0.0079	0.0079	0.03	0.03
92	920	0.0050	0.0081	1.2622	0.1781	0.0033	1.0466	0.0079	0.0079	0.03	0.03
93	930	0.0050	0.0081	1.2703	0.1814	0.0033	1.0544	0.0079	0.0079	0.03	0.03
94	940	0.0050	0.0081	1.2783	0.1848	0.0034	1.0623	0.0079	0.0079	0.03	0.03
95	950	0.0050	0.0081	1.2864	0.1882	0.0034	1.0702	0.0079	0.0079	0.03	0.03
96	960	0.0050	0.0081	1.2944	0.1916	0.0034	1.0781	0.0079	0.0079	0.03	0.03
97	970	0.0050	0.0081	1.3025	0.1950	0.0034	1.0860	0.0079	0.0079	0.03	0.03
98	980	0.0050	0.0081	1.3105	0.1984	0.0034	1.0939	0.0079	0.0079	0.03	0.03
99	990	0.0050	0.0081	1.3186	0.2019	0.0035	1.1018	0.0079	0.0079	0.03	0.03
100	1000	0.0050	0.0081	1.3266	0.2054	0.0035	1.1097	0.0079	0.0079	0.03	0.03
101	1010	0.0040	0.0064	1.3331	0.2082	0.0028	1.1160	0.0063	0.0063	0.02	0.02
102	1020	0.0040	0.0064	1.3395	0.2110	0.0028	1.1223	0.0063	0.0063	0.02	0.02
103	1030	0.0040	0.0064	1.3460	0.2139	0.0028	1.1287	0.0063	0.0063	0.02	0.02
104	1040	0.0040	0.0064	1.3524	0.2167	0.0029	1.1350	0.0063	0.0063	0.02	0.02
105	1050	0.0040	0.0064	1.3588	0.2196	0.0029	1.1413	0.0063	0.0063	0.02	0.02
106	1060	0.0040	0.0064	1.3653	0.2225	0.0029	1.1476	0.0063	0.0063	0.02	0.02
107	1070	0.0040	0.0064	1.3717	0.2254	0.0029	1.1540	0.0063	0.0063	0.02	0.02
108	1080	0.0040	0.0064	1.3782	0.2283	0.0029	1.1603	0.0063	0.0063	0.02	0.02
109	1090	0.0040	0.0064	1.3846	0.2312	0.0029	1.1666	0.0063	0.0063	0.02	0.02
110	1100	0.0040	0.0064	1.3910	0.2341	0.0029	1.1729	0.0063	0.0063	0.02	0.02

111	1110	0.0040	0.0064	1.3975	0.2371	0.0029	1.1793	0.0063	0.0063	0.02	0.02
112	1120	0.0040	0.0064	1.4039	0.2400	0.0030	1.1856	0.0063	0.0063	0.02	0.02
113	1130	0.0040	0.0064	1.4104	0.2430	0.0030	1.1919	0.0063	0.0063	0.02	0.02
114	1140	0.0040	0.0064	1.4168	0.2460	0.0030	1.1983	0.0063	0.0063	0.02	0.02
115	1150	0.0040	0.0064	1.4232	0.2490	0.0030	1.2046	0.0063	0.0063	0.02	0.02
116	1160	0.0040	0.0064	1.4297	0.2520	0.0030	1.2109	0.0063	0.0063	0.02	0.02
117	1170	0.0040	0.0064	1.4361	0.2550	0.0030	1.2173	0.0063	0.0063	0.02	0.02
118	1180	0.0040	0.0064	1.4426	0.2581	0.0030	1.2236	0.0063	0.0063	0.02	0.02
119	1190	0.0040	0.0064	1.4490	0.2611	0.0031	1.2299	0.0063	0.0063	0.02	0.02
120	1200	0.0040	0.0064	1.4554	0.2642	0.0031	1.2363	0.0063	0.0063	0.02	0.02
121	1210	0.0040	0.0064	1.4619	0.2673	0.0031	1.2426	0.0063	0.0063	0.02	0.02
122	1220	0.0040	0.0064	1.4683	0.2703	0.0031	1.2489	0.0063	0.0063	0.02	0.02
123	1230	0.0040	0.0064	1.4748	0.2734	0.0031	1.2553	0.0063	0.0063	0.02	0.02
124	1240	0.0040	0.0064	1.4812	0.2766	0.0031	1.2616	0.0063	0.0063	0.02	0.02
125	1250	0.0040	0.0064	1.4876	0.2797	0.0031	1.2680	0.0063	0.0063	0.02	0.02
126	1260	0.0040	0.0064	1.4941	0.2828	0.0031	1.2743	0.0063	0.0063	0.02	0.02
127	1270	0.0040	0.0064	1.5005	0.2860	0.0031	1.2807	0.0063	0.0063	0.02	0.02
128	1280	0.0040	0.0064	1.5070	0.2891	0.0032	1.2870	0.0063	0.0063	0.02	0.02
129	1290	0.0040	0.0064	1.5134	0.2923	0.0032	1.2933	0.0063	0.0063	0.02	0.02
130	1300	0.0040	0.0064	1.5198	0.2955	0.0032	1.2997	0.0063	0.0063	0.02	0.02
131	1310	0.0040	0.0064	1.5263	0.2987	0.0032	1.3060	0.0063	0.0063	0.02	0.02
132	1320	0.0040	0.0064	1.5327	0.3019	0.0032	1.3124	0.0063	0.0063	0.02	0.02
133	1330	0.0040	0.0064	1.5392	0.3051	0.0032	1.3187	0.0063	0.0063	0.02	0.02
134	1340	0.0040	0.0064	1.5456	0.3083	0.0032	1.3251	0.0063	0.0063	0.02	0.02
135	1350	0.0040	0.0064	1.5520	0.3116	0.0032	1.3314	0.0063	0.0063	0.02	0.02
136	1360	0.0040	0.0064	1.5585	0.3148	0.0033	1.3378	0.0063	0.0063	0.02	0.02
137	1370	0.0040	0.0064	1.5649	0.3181	0.0033	1.3441	0.0063	0.0063	0.02	0.02
138	1380	0.0040	0.0064	1.5714	0.3214	0.0033	1.3505	0.0064	0.0064	0.02	0.02
139	1390	0.0040	0.0064	1.5778	0.3247	0.0033	1.3568	0.0064	0.0064	0.02	0.02
140	1400	0.0040	0.0064	1.5842	0.3280	0.0033	1.3632	0.0064	0.0064	0.02	0.02
141	1410	0.0040	0.0064	1.5907	0.3313	0.0033	1.3695	0.0064	0.0064	0.02	0.02
142	1420	0.0040	0.0064	1.5971	0.3346	0.0033	1.3759	0.0064	0.0064	0.02	0.02
143	1430	0.0040	0.0064	1.6036	0.3380	0.0033	1.3822	0.0064	0.0064	0.02	0.02
144	1440	0.0040	0.0064	1.6100	0.3413	0.0033	1.3886	0.0064	0.0064	0.02	0.02

Total Volume of Runoff = 2867 cu. ft.

(Found by summing this column and multiplying by 600. 600 is the conversion required to convert SUM(Q) in cfs to total volume in cubic feet as follows:

V = SUM(Q) x dt

(cu.ft.) = (cu.ft/s) x (10 min.) x (60 s/min.)

TRAPEZOIDAL CHANNEL HYDRAULICS
USING MANNING'S EQUATION

Milwaukie Bay Park - Grassy Swale Analysis

Water Depth (inches)	Water Depth (ft.)	Bottom Width (ft.)	Side Slope H/V	Channel Area (sq. ft.)	Wetted Perimeter (ft.)	Hydraulic Radius (ft.)	Manning's Coefficient (n)	Channel Slope (%)	Flow Rate (cfs)	Water Velocity (ft/s)	Top Width (ft.)	Froude Number	Length (ft.)	Residence Time (min.)	
1	0.08	2.00	4.00	0.19	2.69	0.07	0.250	2.7%	0.03	0.17	2.67	0.11	165	16.2	
2	0.17	2.00	4.00	0.44	3.37	0.13	0.250	2.7%	0.11	0.25	3.33	0.12	165	10.8	
2.8	0.23	2.00	4.00	0.68	3.92	0.17	0.250	2.7%	0.21	0.31	3.87	0.13	165	9.0	PR
3	0.25	2.00	4.00	0.75	4.06	0.18	0.250	2.7%	0.24	0.32	4.00	0.13	165	8.7	
4	0.33	2.00	4.00	1.11	4.75	0.23	0.250	2.7%	0.41	0.37	4.67	0.13	165	7.4	
5	0.42	2.00	4.00	1.53	5.44	0.28	0.250	2.7%	0.642	0.42	5.33	0.14	165	6.5	
6	0.50	2.00	4.00	2.00	6.12	0.33	0.250	2.7%	0.93	0.46	6.00	0.14	165	5.9	
8	0.67	2.00	4.00	3.11	7.50	0.41	0.250	2.7%	1.70	0.54	7.33	0.15	165	5.0	HF
10	0.83	2.00	4.00	4.44	8.87	0.50	0.250	2.7%	2.75	0.62	8.67	0.15	165	4.5	
12	1.00	2.00	4.00	6.00	10.25	0.59	0.250	2.7%	4.11	0.69	10.00	0.16	165	4.0	

PR = Pollution Reduction Storm - 1.61 inches per 24-hours (SBUH Type 1a Rainfall Distribution) = 0.207 cfs

HF = High Flow Event - 3.32 in/hr Rational Method Approach = 0.90 x 3.32 in/hr x 0.56 acres = 1.70 cfs

APPENDIX C

PAC Report for Stormwater Basin and Planter

Original PAC Report for Existing Storwmwater Planter in Basin N1

PAC Report

Project Details

Project Name	Permit No	Created
MBP		5/27/2022 12:06:48 AM
Project Address	**Designer**	**Last Modified**
SE McLoughlin Blvd	Adam Zucker	6/19/2022 12:27:10 AM
	Company	**Report Generated**
	Zucker Engineering & Design	6/18/2022 5:42:05 PM

Project Summary

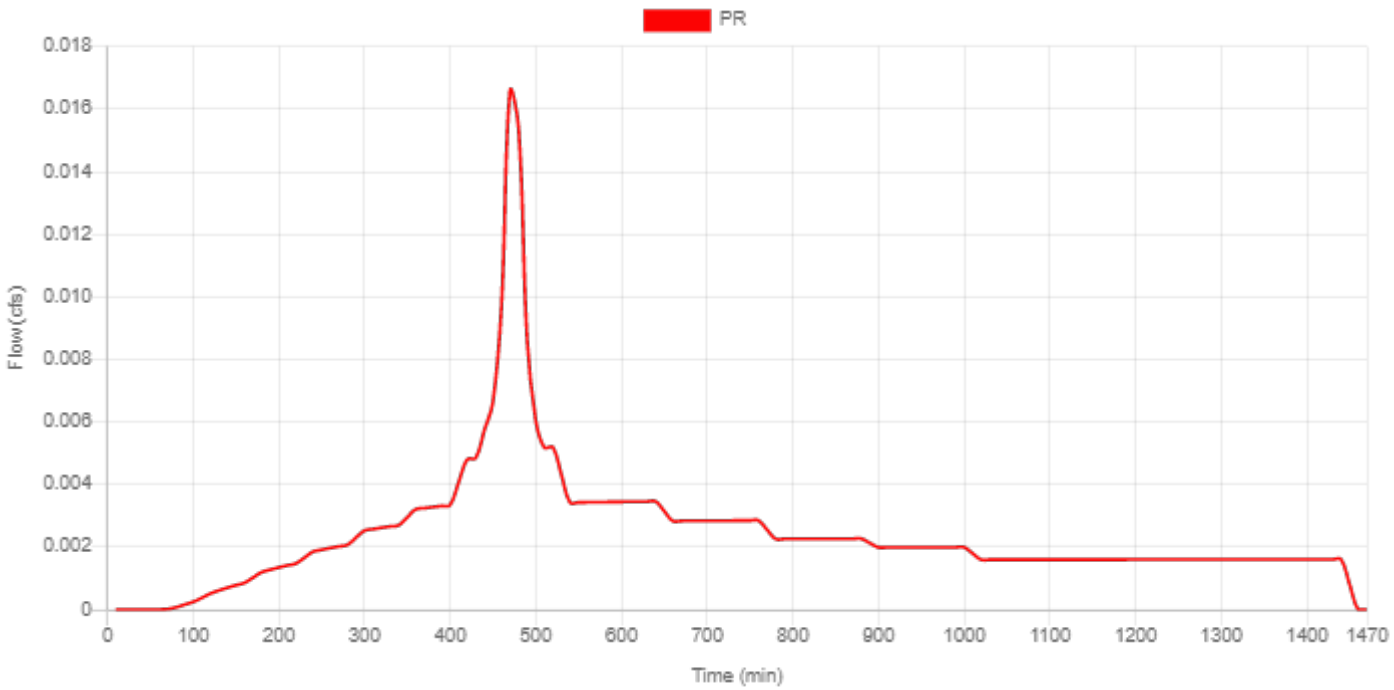
Catchment Name	Imper-vious Area (sq ft)	Native Soil Design Infilt-ration Rate (in/hr)	Level	Category	Config	Facility Area (excl. free board) (sq ft)	Facility Sizing Ratio (%)	PR Results	Infilt-ration Results	Flow Control Results
South - Fire Pit	1815	0.375	2A	Basin	B	140.00	7.71	Pass	NA	NA
North Parking Lot	12064	1	1	FlatPlanter	B	1057.00	8.76	Pass	Pass	NA

South - Fire Pit

Site Soils & Infiltration Testing	Infiltration Testing Procedure OpenPit Tested Native Soil Infiltration Rate 0.75 in/hr
Correction Factor	CF test 2
Design Infiltration Rates	Native Soil 0.375 in/hr Imported Blended Soil 6 in/hr
Catchment Information	Hierarchy Level 2A Hierarchy Description Offsite flow to the Willamette River, Columbia River, or Columbia Slough, or discharge to a storm-only pipe system or the Multnomah County Drainage District System (with capacity) that directly discharges to one of the three waterways named above. Pollution Reduction Requirement Filter the post-development stormwater runoff from the water quality storm event through the blended soil. Infiltration Requirement N/A Flow Control Requirement N/A Impervious Area 1815 sq ft 0.042 acre Pre-Development Time of Concentration (Tc pre) 10 min Post-Development Time of Concentration (Tc post) 5 min Pre-Development Curve Number (CN pre) 74 Post-Development Curve Number (CN post) 98

SBUH Results

Post-Development Runoff



	Pre - Development Rate and Volume		Post - Development Rate and Volume	
	Peak Rate (cfs)	**Total Volume (cf)**	**Peak Rate (cfs)**	**Total Volume (cf)**
PR	0.0006	28.2	0.0166	210

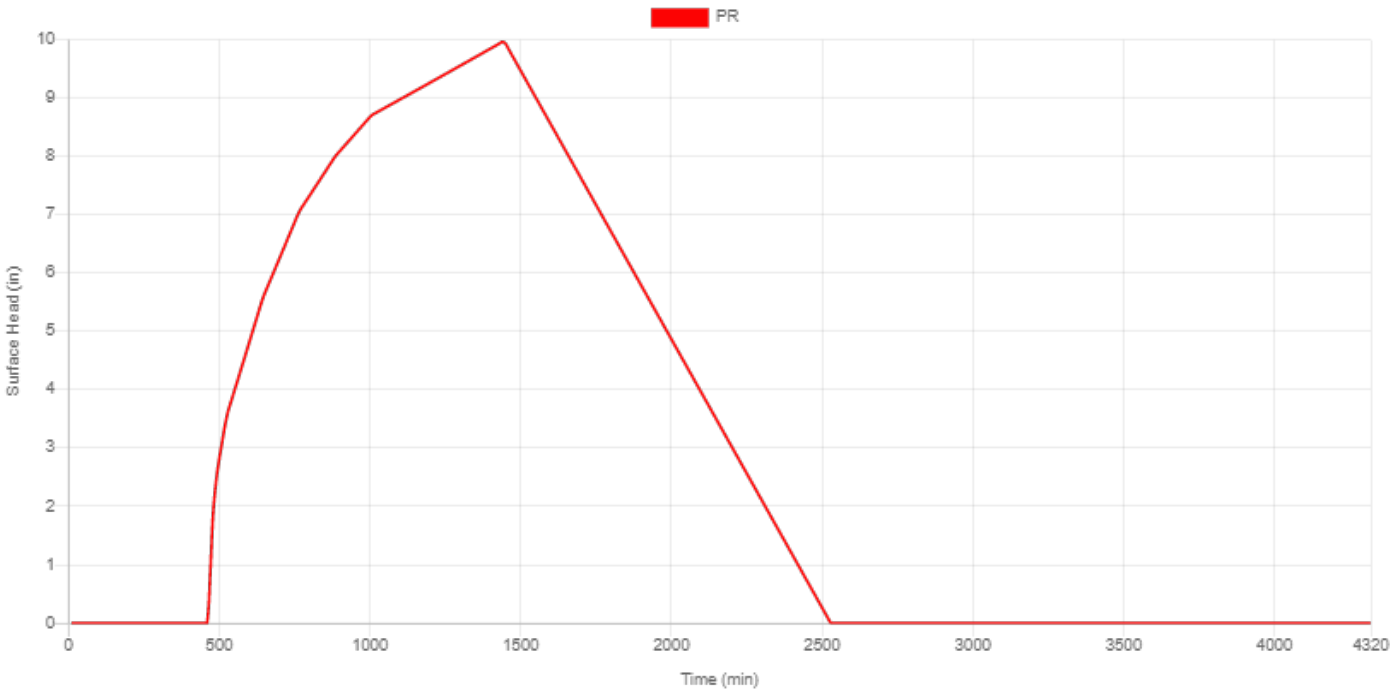
	Overflow		Underdrain Outflow		Infiltration	
	Peak Rate (cfs)	**Total Volume (cf)**	**Peak Rate (cfs)**	**Total Volume (cf)**	**Peak Rate (cfs)**	**Total Volume (cf)**
PR	0	0	0	0	0.001	210

Amoeba Basin

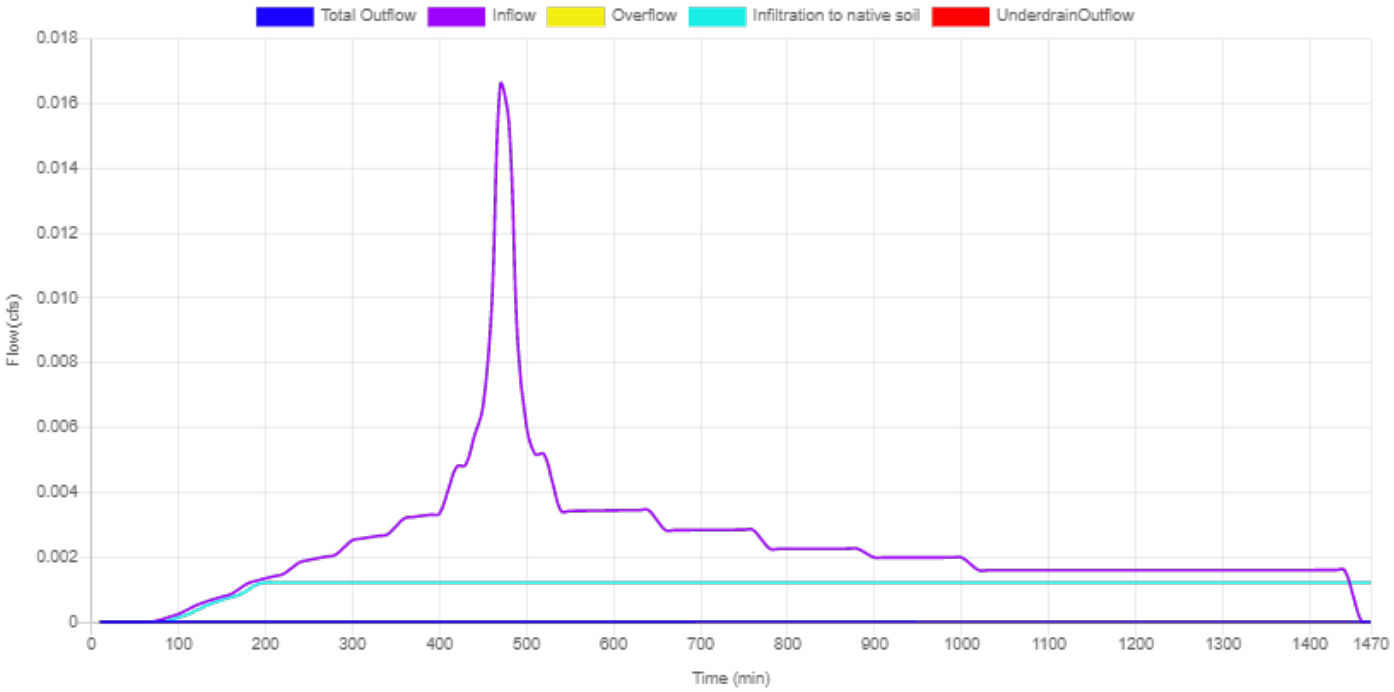
Site Soils & Infiltration Testing	Category Amoeba Basin Shape Amoeba Location Parcel Configuration B: Infiltration with Rock Storage[RS] **Above Grade Storage Data** Bottom Area 50 sq ft Bottom Perimeter Length 30.00 ft Side Slope 3.0 h:1v Freeboard Depth 18 in Overflow Height 12 in Total Depth of Blended Soil plus Rock 24 in Surface Storage Capacity at Overflow 95 cu ft Design Infiltration Rate to Soil Underlying the Facility 0.001 cfs Design Infiltration Rate for Imported Blended Soil in the Facility 0.016 cfs **Below Grade Storage Data** Catchment is too small for flow control? No Rock Area 50.00 sq ft Rock Width 8.00 ft Rock Storage Depth

	12.0 in Rock Porosity 0.3 Percent of Facility Base that Allows Infiltration 100 %
Facility Facts	Total Facility Area (excluding freeboard) 140.00 sq ft Sizing Ratio 7.71 %
Pollution Reduction Results	Pollution Reduction Score Pass Overflow Volume 0.00 cf Surface Capacity Used 83.05 %

Surface Head



Water Quality

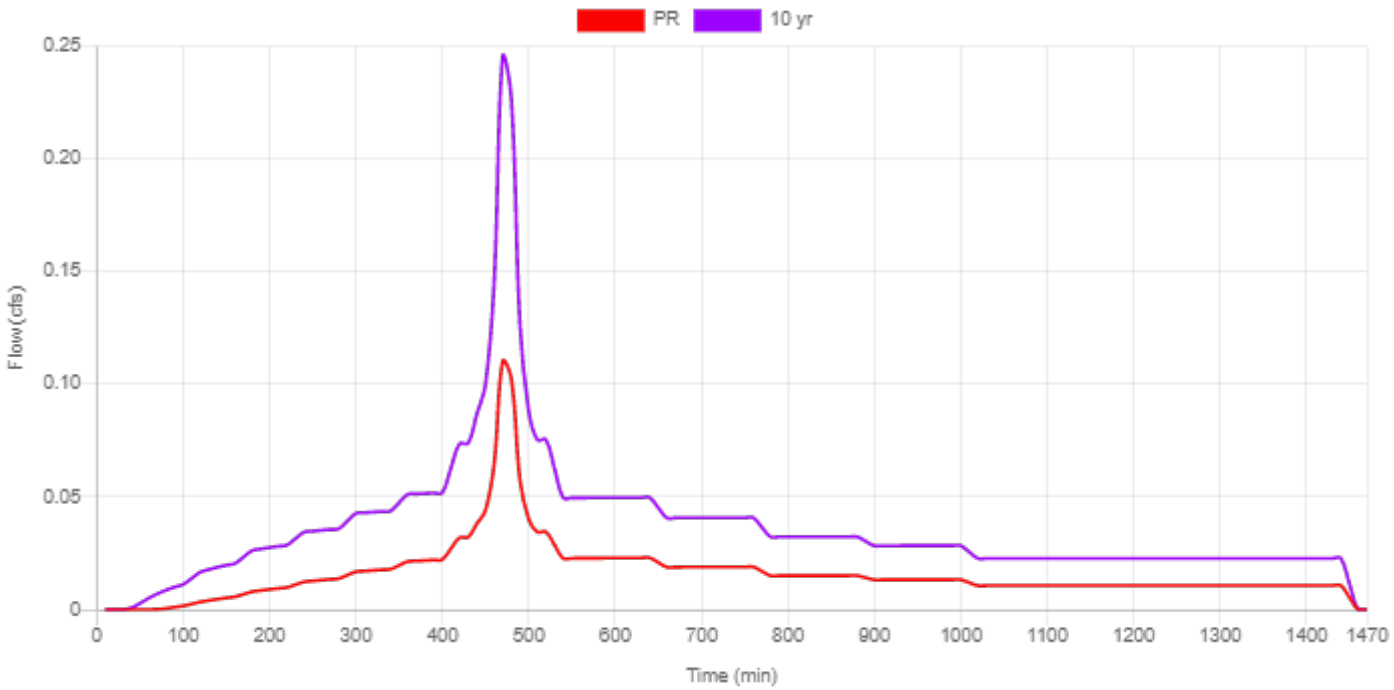


North Parking Lot

Site Soils & Infiltration Testing	Infiltration Testing Procedure Encased Tested Native Soil Infiltration Rate 2.00 in/hr
Correction Factor	CF test 2
Design Infiltration Rates	Native Soil 1 in/hr Imported Blended Soil 6 in/hr
Catchment Information	Hierarchy Level 1 Hierarchy Description On-site infiltration with a surface infiltration facility. Pollution Reduction Requirement Filter the post-development stormwater runoff from the water quality storm event through the blended soil. Infiltration Requirement Infiltrate the post-development stormwater runoff from the 10-year storm event. Flow Control Requirement N/A Impervious Area 12064 sq ft 0.277 acre Pre-Development Time of Concentration (Tc pre) 5 min Post-Development Time of Concentration (Tc post) 5 min Pre-Development Curve Number (CN pre) 74 Post-Development Curve Number (CN post) 98

SBUH Results

Post-Development Runoff



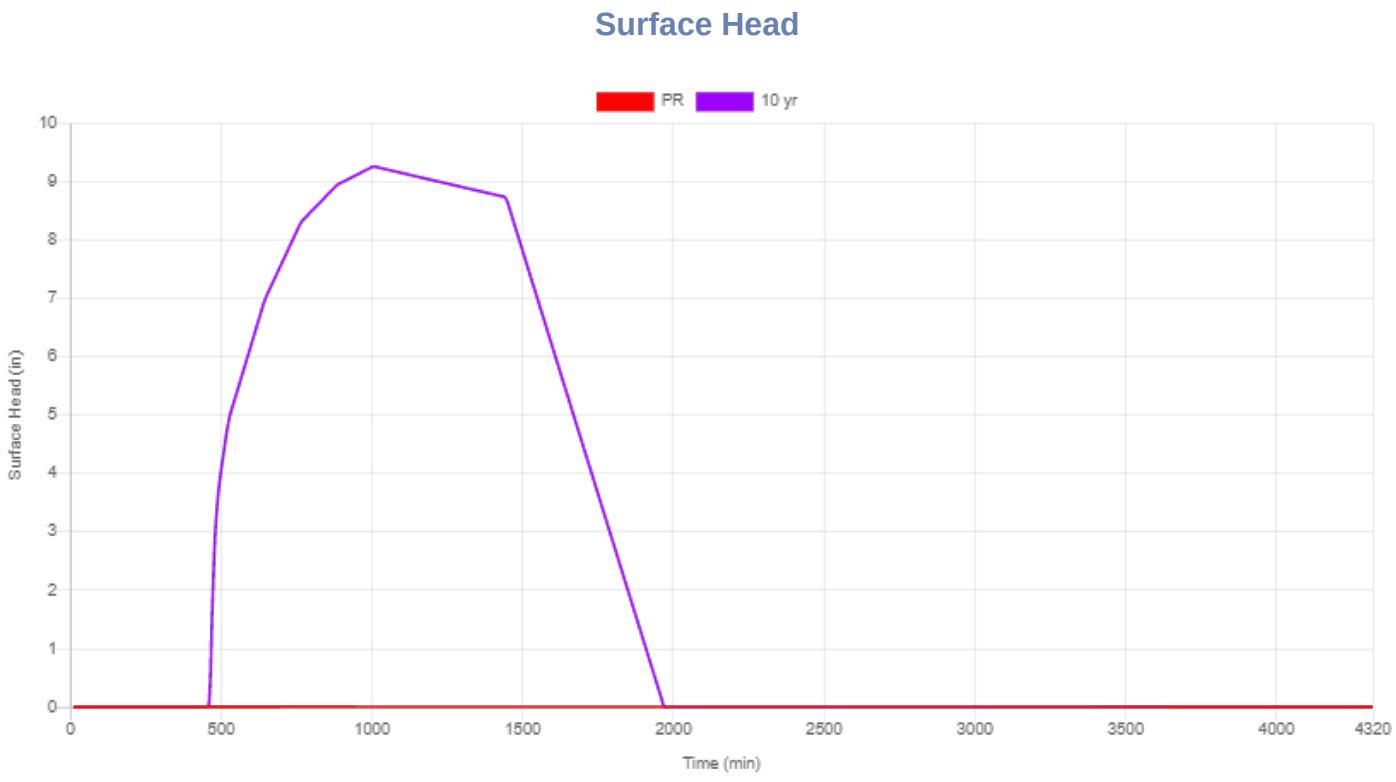
	Pre - Development Rate and Volume		Post - Development Rate and Volume	
	Peak Rate (cfs)	**Total Volume (cf)**	**Peak Rate (cfs)**	**Total Volume (cf)**
PR	0.004	187.2	0.1102	1396
10-Year	0.0681	1177.7	0.2455	3183.7

	Overflow		Underdrain Outflow		Infiltration	
	Peak Rate (cfs)	**Total Volume (cf)**	**Peak Rate (cfs)**	**Total Volume (cf)**	**Peak Rate (cfs)**	**Total Volume (cf)**
PR	0	0	0	0	0.024	1396
10-Year	0	0	0	0	0.024	3183.7

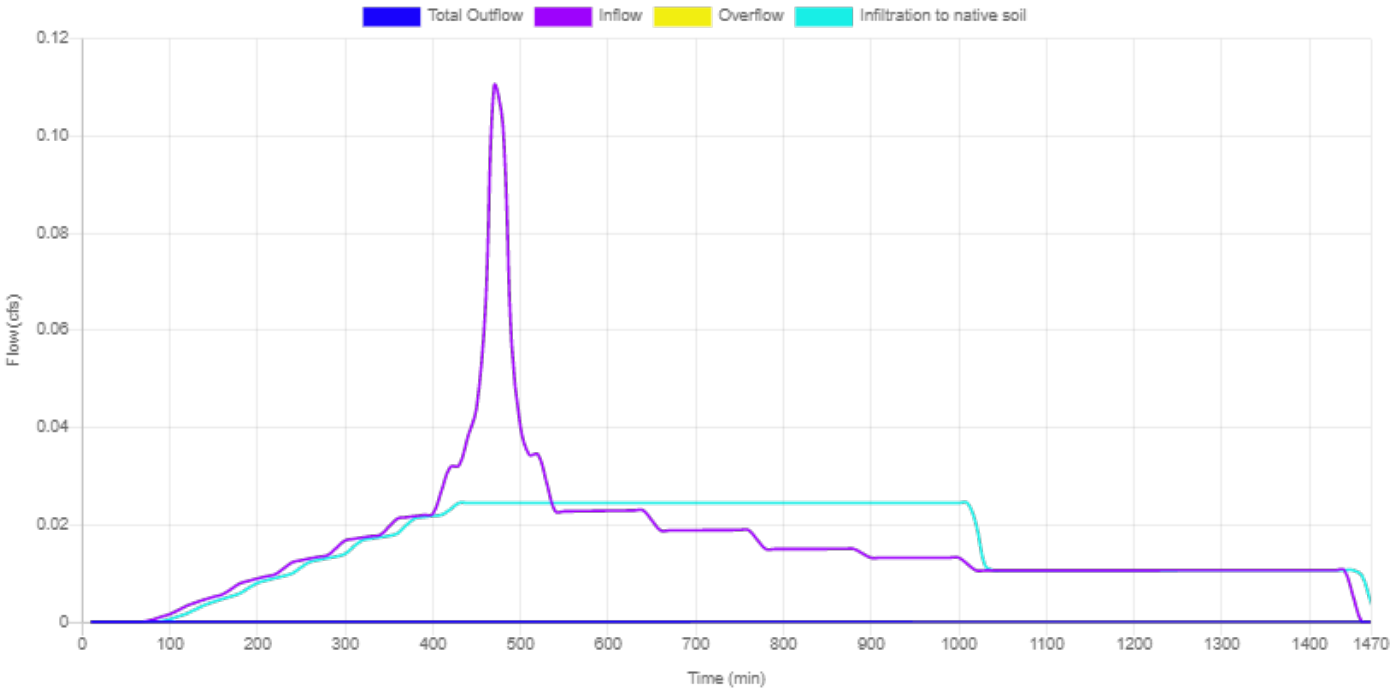
Flat Planter

Site Soils & Infiltration Testing	Category Flat Planter Shape Null Location Parcel Configuration B: Infiltration with Rock Storage[RS] **Above Grade Storage Data** Bottom Area 1057 sq ft Bottom Width 6.00 ft Overflow Height 10.3 in Total Depth of Blended Soil plus Rock 30 in Surface Storage Capacity at Overflow 907.26 cu ft Design Infiltration Rate to Soil Underlying the Facility 0.024 cfs Design Infiltration Rate for Imported Blended Soil in the Facility 0.147 cfs **Below Grade Storage Data** Catchment is too small for flow control? No Rock Area 994.00 sq ft Rock Width 6.00 ft Rock Storage Depth 12.0 in Rock Porosity 0.3 Percent of Facility Base that Allows Infiltration

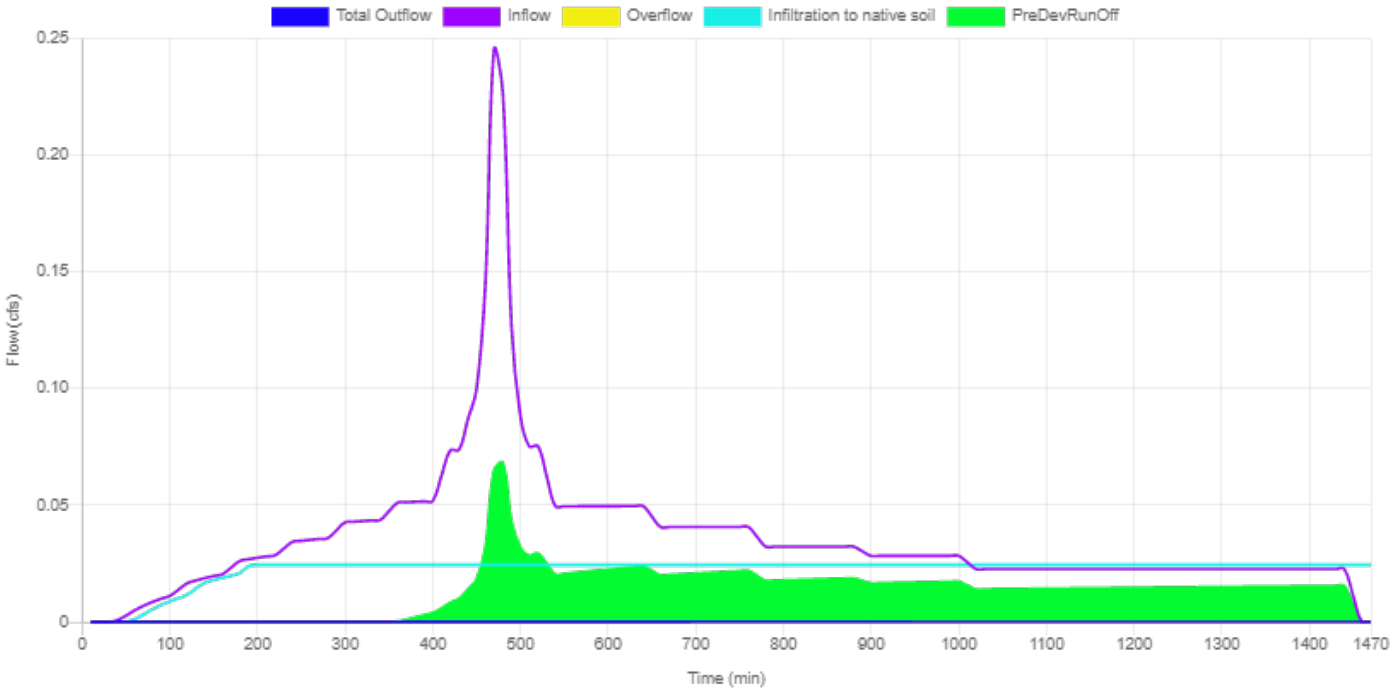
	100 %
Facility Facts	Total Facility Area (excluding freeboard) 1057.00 sq ft Sizing Ratio 8.76 %
Pollution Reduction Results	Pollution Reduction Score Pass Overflow Volume 0.00 cf Surface Capacity Used 0.00 %
Infiltration Results	Infiltration Score Pass Overflow Volume 0.00 cf Surface Capacity Used 89.96 %



Water Quality



10-Year



Presumptive Approach Calculator ver. 1.1

Catchment Data

Catchment ID: N1
Date: 03/15/09
Permit Number: 0

Run Time: 5/14/2009 11:42:05 AM

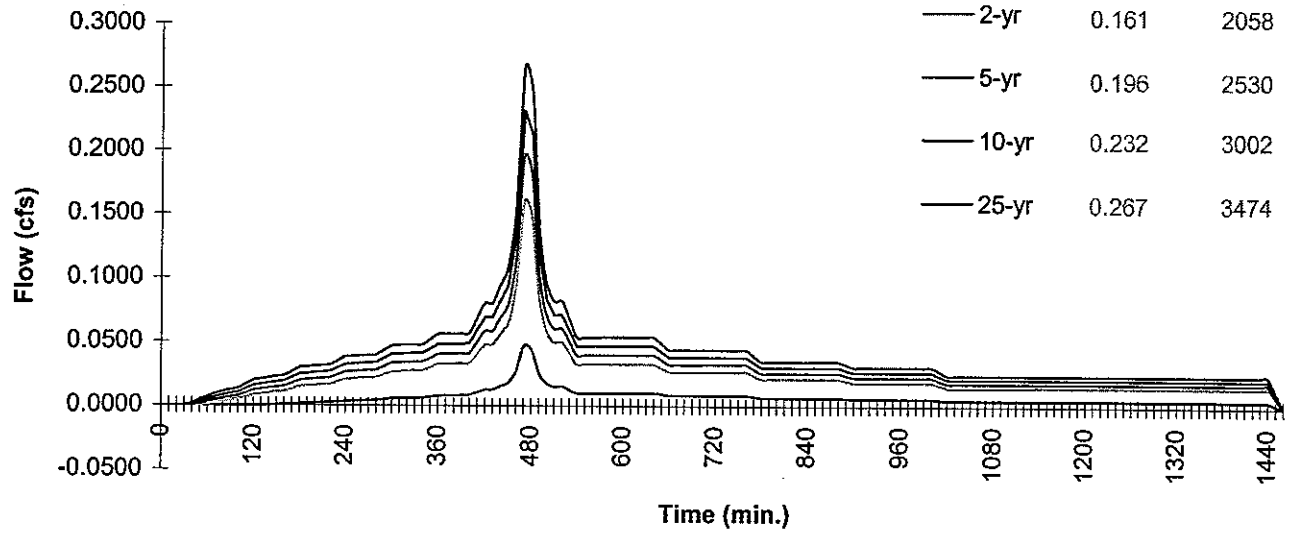
Project Name: Milwaukie Park - Lower No. Parking Ca
Project Address: -
Milwaukie, OR
Designer: SDH
Company: David Evans and Associates, Inc.

Drainage Catchment Information		
Catchment ID	N1	
	Catchment Area	
Impervious Area	11,375	SF
Impervious Area	0.26	ac
Impervious Area Curve Number, CN_{imp}	98	
Time of Concentration, Tc, minutes	5	min.
Site Soils & Infiltration Testing Data		
Infiltration Testing Procedure:	Open Pit Falling Head	
Native Soil Field Tested Infiltration Rate (I_{test}):	2	in/hr
Bottom of Facility Meets Required Separation From High Groundwater Per BES SWMM Section 1.4:	Yes	
Correction Factor Component		
CF_{test} (ranges from 1 to 3)	2	
Design Infiltration Rates		
I_{dsgn} for Native (I_{test} / CF_{test}):	1.00	in/hr
I_{dsgn} for Imported Growing Medium:	2.00	in/hr

Execute SBUH Calculations

SBUH Results

	Peak Rate (cfs)	Volume (cf)
PR	0.047	594
2-yr	0.161	2058
5-yr	0.196	2530
10-yr	0.232	3002
25-yr	0.267	3474



Printed: 5/14/2009 11:45 AM

Presumptive Approach Calculator ver. 1.1

Catchment ID: N1

Run Time: 5/14/2009 11:42:05 AM

Project Name: Milwaukie Park - Lower No. Parking Catch **Catchment ID:** N1 **Date:** 3/15/2009

Instructions:

1. Identify which Stormwater Hierarchy Category the facility.
2. Select Facility Type.
3. Identify facility shape of surface facility to more accurately estimate surface volume, except for Swales and sloped planters that use the PAC Sloped Facility Worksheet to enter data.
4. Select type of facility configuration.
5. Complete data entry for all highlighted cells.

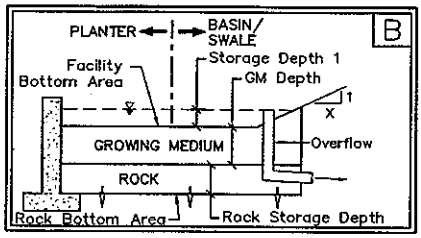
Catchment facility will meet Hierarchy Category: 1

Goal Summary:

Hierarchy Category	SWMM Requirement	RESULTS box below needs to display...		Facility configurations allowed
		Pollution Reduction as a	10-yr (aka disposal) as a	
1	On-site infiltration with a surface infiltration facility.	PASS	PASS	A or B

Facility Type = Planter (Sloped)

Facility Configuration: B



Refer to Sloped Facility Worksheet and enter Variable Parameters

Calculation Guide
Max. Rock Stor. Bottom Area
Per Swale Dims

DATA FOR ABOVE GRADE STORAGE COMPONENT

Infiltration Area = 1,057 sf
Surface Capacity Volume = 907.3 cf

Growing Medium Depth = 18 in
Freeboard Depth = N/A in

Surface Capacity at Depth 1 = 907 cf
GM Design Infiltration Rate = 2.00 in/hr
Infiltration Capacity = 0.049 cfs

BELOW GRADE STORAGE

Rock Storage Bottom Area = 994 sf
Rock Storage Depth = 12 in
Rock Void Ratio = 0.3

Rock Storage Capacity = 298 cf
Native Design Infiltration Rate = 1.00 in/hr
Infiltration Capacity = 0.023 cfs

RESULTS		Overflow Volume			
Pollution Reduction	PASS	0 CF	0%	Surf. Cap. Used	Run PAC
			10%	Rock Cap. Used	
10-yr	PASS	0 CF	98%	Surf. Cap. Used	
			100%	Rock Cap. Used	

FACILITY FACTS

Total Facility Area Including Freeboard = 1,228 SF
Sizing Ratio (Total Facility Area / Catchment Area) = 0.108

Current data has been exported:

Ramp_Lower_Park_Export.xls5/14/2009 11:45:23 AM

Presumptive Approach Calculator Ver 1.1

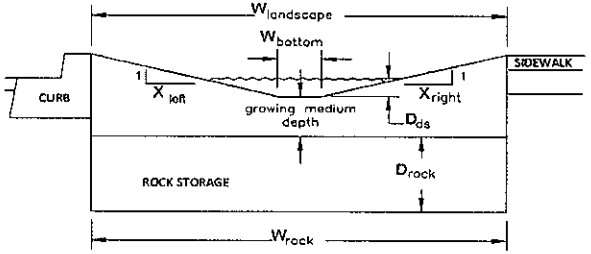
Instructions:

1. Refer to facility graphics and fill in all relevant facility parameters in the Data Entry table below. Data entry cells vary based on Facility Configuration selected on Facility Design Data tab.
2. Delete all facility parameters that may have been entered by the previous iteration that are no longer applicable.

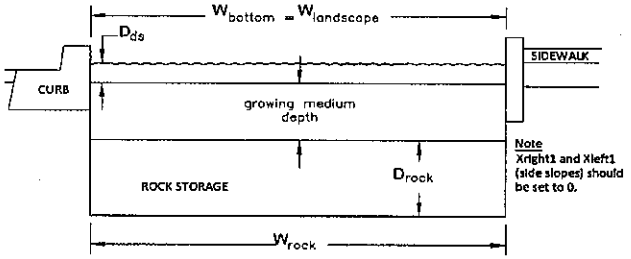
Run Time: 5/14/2009 11:42:05 AM

Project Name: Milwaukie Park - Lower No. Parking Catch **Date:** 3/15/2009 **Catchment ID:** N1

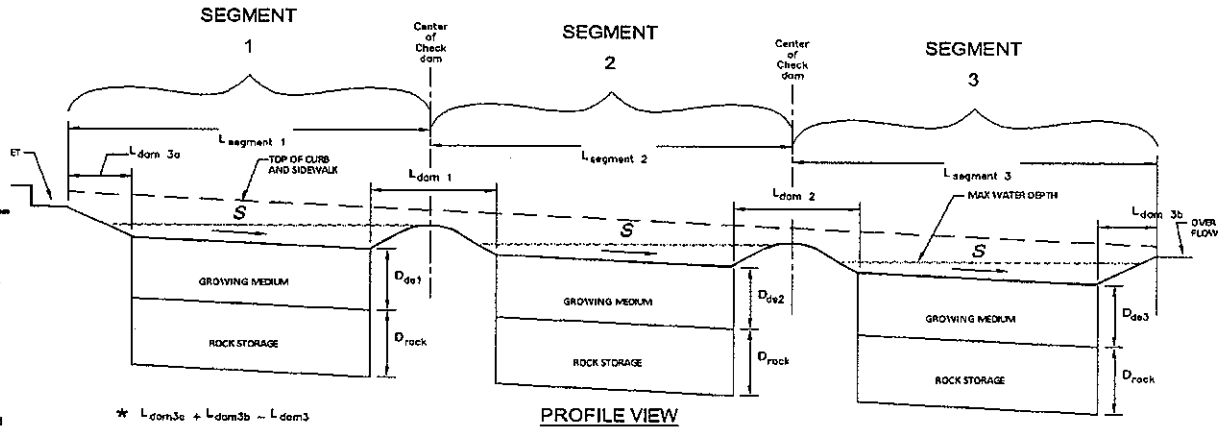
SWALE



SLOPED PLANTER



Note
Xright1 and Xleft1 (side slopes) should be set to 0.



Data Entry

Variable Description	Facility Segment	Length of facility segment	Downstream Check Dam Length	Longitudinal Facility Slope	Bottom Width	Side Slope Right	Side Slope Left	Downstream Depth	Landscape Width	Rock Storage Width	Rock Storage Depth	Rock Void Ratio
Unit		(ft)	(ft)	(ft/ft)	(ft)			(inches)	(ft)	(ft)	(inches)	
Variable Symbol		$L_{segment}$	L_{dam}	S	W_{bottom}	X_{right}:1	X_{left}:1	D_{ds}	$W_{landscape}$	W_{rock}	D_{rock}	v
1		20	3	0.015	7	0	0	12	7	7	12	0.3
2		20	2	0.015	7	0	0	12	7	7		
3		20	2	0.015	7	0	0	12	7	7		
4		20	2	0.015	7	0	0	12	7	7		
5		20	2	0.015	7	0	0	12	7	7		
6		20	2	0.015	7	0	0	12	7	7		
7		20	2	0.015	7	0	0	12	7	7		
8		20	3	0.015	7	0	0	12	7	7		
9												
10												

Error Messages

Worksheet Calculations