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Drainage Report for A New Building Addition for *Arlington Airport Administration and WSDOT Aviation Division*

Prepared for:
Rob Putnam
City of Arlington
18204 59th Drive NE
Arlington, WA 98223

Prepared by:
Derek I. Hann, E.I.T.

Reviewed by:
Michael E. Ryan, P.E.

August 12, 2008
Revised: February 12, 2009

hba DESIGN GROUP
land use planning + civil engineering

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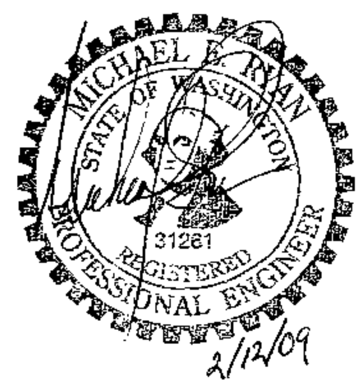

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SUMMARY

The new building addition for the Arlington Airport Administration and WSDOT Aviation Division proposes to construct a new building and sidewalk on a lot with an existing 1,398 SF office building and 37,500 SF of paved parking lot. The existing development will remain and the proposed construction will take place in an undeveloped portion of the lot adjacent to the existing building. The project site is located at 18204 59th Drive NE on the east side of the Arlington Airport approximately ½ mile north of 172nd St. NE. The site is currently developed and the only additional construction will be a 6,450 SF building, 2025 SF of sidewalk and approximately 2500 SF of landscaping and infiltrating rain garden.

Runoff from the proposed building and sidewalk, and runoff from the existing parking lot located on the east end of the property will be directed to an infiltrating rain garden located within a proposed landscaping strip between the building and walkway. All stormwater runoff from the proposed development will be treated and infiltrated into native soils within the proposed rain garden.

The proposed affected construction area will be approximately 0.25 acres. The proposed rain garden will infiltrate runoff from an area approximately 0.35 acres in size.

On June 27, 2008, HBA Design Group staff visited the site and observed existing drainage patterns, topography, and ground cover.

EXISTING CONDITIONS

The project site is currently developed with a 1,389 SF office building and approximately 37,500 SF of paved parking. The site accesses 59th Ave. on the east side of the property.

The site topography is flat with slopes ranging between 0 and 3% on average.

Stormwater runoff control for the southern parking lot is provided by catch basins connected to an underground pipe system. The parking lot on the northeast corner of the site drains west and is dispersed within the existing vegetation located in the center of the site near the existing building.

There are two existing trees on the east side of the existing building that will be removed prior to construction of the proposed building.

According to the *SCS Soil Survey of Snohomish County Area Washington* the onsite soils are composed of Lynnwood loamy sand, 0-3%, Soil Symbol #30. Lynnwood soils are deep and are classified as Hydrologic Group A which indicates a high rate of permeability.

A Geotechnical Engineering Evaluation of the soils on the site was prepared on August 8, 2008 by Nelson Geotechnical Associates, Inc. According to the report, groundwater was not encountered during exploration. Given the requirement for 3 FT of separation between the bottom of the infiltration system and the high water table, the Geotech has recommended a depth of 3 to 7 feet for the proposed infiltrating rain garden. Additionally the soils onsite appear to be composed of gray sand with gravel at exposed depths of 2.5 to 10 feet in the area of proposed infiltration. The Geotech has recommended a long term infiltration rate of 4.0 inches per hour for the native soils. (see Geotechnical Report)

DEVELOPED CONDITIONS

The proposed project includes the construction of a 6,450 SF building, 2,025 SF of walkway and approximately 2,500 SF of landscaped area. In addition, the proposed rain garden will collect and infiltrate approximately 4350 SF of existing parking lot.

Stormwater runoff from the proposed building and sidewalk will be directed to an infiltrating rain garden located within the proposed landscaped area. Roof drains will be directed to splash blocks within the landscape area and sheet flow to the proposed rain gardens. The sidewalks will be sloped to direct stormwater to the landscaped areas and into the rain gardens. Runoff from the existing parking lot on the northeast side of the property will drain west to the proposed sidewalk, flow through one of four proposed drain channels to be constructed within the proposed sidewalk and into the proposed rain garden.

The Western Washington Hydrology Method required by the 2005 Stormwater Management Manual for Western Washington was used to model the stormwater runoff from the site. The proposed project was modeled within the WWHM Version 3 software developed by Clear Creek Solutions.

The proposed infiltrating rain garden was modeled within the WWHM3 software as a gravel trench bed 140' long and 8' wide. The proposed rain garden will have approximately 0.5' of ponding depth and 2.5' of amended soils with a void capacity of approximately 40%. The total depth of the rain garden from existing grade will be 3' which is the most conservative infiltration system depth recommended by the Geotech.

The native infiltration rate for the soils beneath the proposed rain garden will be 4.0 inches per hour as recommended by the Geotech.

The proposed Engineered Soils mix for the rain garden infiltrates at a long term rate of 2.0 inches per hour. The 2 inch/hour infiltration rate is the controlling rate for the infiltration system and was used as the design infiltration rate in the WWHM3 analysis.

The WWHM3 software calculated that the proposed rain garden design would effectively infiltrate all stormwater runoff from the proposed development for all storms up to two consecutive 50-year storm events. (See calculation results in Appendix)

Water Quality

All available means to remove pollutants from stormwater flows are active in the proposed rain garden systems. The removal processes provided are as follows:

- Particulates will be physically strained out of the stormwater through the filtration process provided by the amended soils within the rain garden. Some filtration occurs as stormwater moves through the plants in the ponding area, but the amended soil is the primary filtering media. 90 percent of the particulates (6 to 41 microns) can be trapped by 18-inches of sand. Bioretention soils are typically high in sand content so this level of performance can be anticipated.

- Ions and molecules will be bound to electrostatic receptor sites on the filter media particles (amended soil) through the adsorption process. This process is the primary mechanism for removing soluble nutrients, metals, and organics that occur in storm flows as it percolates through the amended soils of the bioretention area. This process increases with increased organic matter, clay and a neutral to slightly high alkaline pH. The percolation of the stormwater initiates the adsorption and microbial action for pollutant removal.
- The vegetated soils allow the phytoremediation processes to occur. These processes include degradation, extraction by the plant, containment within the plant (assimilation) or a combination of these mechanisms. It has been shown through studies that vegetated soils are capable of more effective degradation, removal, and mineralization of total petroleum hydrocarbons (TPHs), polycyclic aromatic hydrocarbons (PAHs), pesticides, chlorinated solvents, and surfactants than non-vegetated soils.
- Thermal attenuation is provided which reduces stormwater temperature as storm flows move through subsurface soil layers.

The rain garden provides excellent water quality advantages. Section 6.1.4 of the *LID Technical Guidance Manual for Puget Sound* outlines in more detail the above listed water quality provisions provided in our proposed bioretention system.

UPSTREAM ANALYSIS

There are no offsite areas tributary to the project site's drainage. The proposed development will not change any upstream drainage course or pattern and no impact on upstream drainage is anticipated.

DOWNSTREAM ANALYSIS

Stormwater from the proposed development will be infiltrated and there will be no change to the down stream drainage courses or patterns, therefore no impact is anticipated to the downstream drainage.

APPENDIX

Soils Map & Information
Drainage Design Calculations
Operation & Maintenance Manual

Soils Map & Information

Soils Information

The following soils information is copied from a scanned version of the text of the original Soil Survey report of Snohomish County Area, Washington issued July 1983.
This information is available from the NRCS Washington state web site
www.wa.nrcs.usda.gov/index.html

30-Lynnwood loamy sand, 0 to 3 percent slopes.

This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. Areas generally are 10 to 30 acres in size, but a few areas are as much as 600 acres. The native vegetation is mainly conifers.

Elevation is 50 to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface is covered with a mat of leaves, needles, and twigs about 3 inches thick. The surface layer is grayish brown loamy sand about 1 inch thick. The upper part of the subsoil is dark brown loamy sand about 14 inches thick. The lower part is dark yellowish brown loamy sand about 14 inches thick. The substratum to a depth of 60
inches or more is grayish brown sand. In some areas the surface layer and subsoil are sandy loam.

Included in this unit are small areas of Everett, Indianola, Pastik, and Ragnar soils. Also included are Custer soils in basins
and soils that have slopes of more than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Lynnwood soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more.
Runoff is slow, and the hazard of water erosion is slight. This unit is used mainly as woodland and for urban development. It is also used for hay and pasture.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 158. On the basis of a 50-year site curve, the mean site index is 121. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 168 cubic feet per acre. Among the trees of limited extent are western hemlock and western redcedar. Among the common forest understory plants are western swordfern, brackenfern, deer fern, and red huckleberry.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road
construction is not readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. The droughtiness of the surface layer reduces
the survival of seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings.

The main limitation for hay and pasture is low available water capacity. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. In most years supplemental irrigation is needed.
Fertilizer is needed for optimum growth of grasses and legumes.

This unit is suited to use as homesites. The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems
are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

Cutbanks are not stable and are subject to caving in.

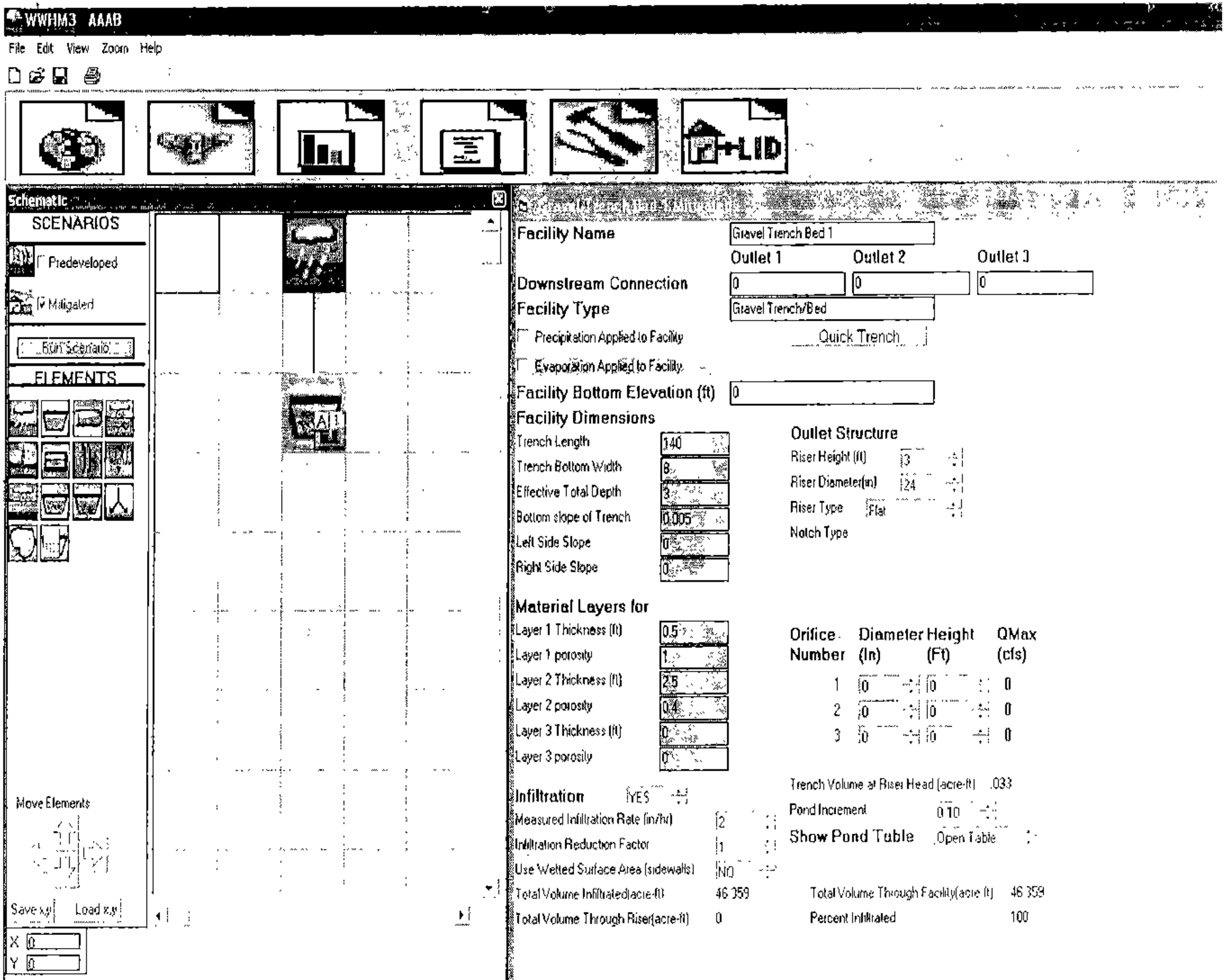
This map unit is in capability subclass IVs.

Soil Map–Snohomish County Area, Washington
(Arlington Airport Admin Building)

Map Unit Legend

Snohomish County Area, Washington (WA661)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
30	Lynnwood loamy sand, 0 to 3 percent slopes	28.1	100.0%
Totals for Area of Interest (AOI)		28.1	100.0%

Drainage Design Calculations



WWHM3 AAAB
File Edit View Zoom Help
Schematic
SCENARIOS
Predeveloped
Mitigated
Run Scenario
ELEMENTS
Move Elements
Save x,y
Load x,y
X 0
Y 0
Facility Name
Gravel Trench Bed 1
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Gravel Trench/Bed
Precipitation Applied to Facility
Quick Trench
Evaporation Applied to Facility
Facility Bottom Elevation (ft)
0
Facility Dimensions
Trench Length 140
Trench Bottom Width 8
Effective Total Depth 3
Bottom slope of Trench 0.005
Left Side Slope 0
Right Side Slope 0
Outlet Structure
Riser Height (ft) 3
Riser Diameter(in) 24
Riser Type Flat
Notch Type
Material Layers for
Layer 1 Thickness (ft) 0.5
Layer 1 porosity 1
Layer 2 Thickness (ft) 2.5
Layer 2 porosity 0.4
Layer 3 Thickness (ft) 0
Layer 3 porosity 0
Orifice Number
Diameter (In)
Height (Ft)
QMax (cfs)
1 0 0 0
2 0 0 0
3 0 0 0
Trench Volume at Riser Head (acre-ft) .033
Infiltration YES
Measured Infiltration Rate (in/hr) 2
Infiltration Reduction Factor 1
Use Wetted Surface Area (sidewalls) NO
Pond Increment 0.10
Show Pond Table
Open Table
Total Volume Infiltrated(acre-ft) 46.359
Total Volume Through Riser(acre-ft) 0
Total Volume Through Facility(acre-ft) 46.359
Percent Infiltrated 100

Western Washington Hydrology Model
PROJECT REPORT

Project Name: Arlington Airport Administration Building
Site Address: 18204 59th Drive NE
City : Arlington
Report Date : 2/5/2009
Gage : Everett
Data Start : 1948/10/01
Data End : 1997/09/30
Precip Scale: 1.20
WWHM3 Version: 3.0

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	Acres
A B, Forest, Flat	.35

Impervious Land Use	Acres

Element Flows To:

Surface	Interflow	Groundwater

Name : Gravel Trench Bed 1
Bottom Length: 140ft.
Bottom Width : 8ft.
Trench bottom slope 1: 0.005 To 1
Trench Left side slope 0: 0 To 1
Trench right side slope 2: 0 To 1
Material thickness of first layer : 0.5
Pour Space of material for first layer : 1
Material thickness of second layer : 2.5
Pour Space of material for second layer : 0.4
Material thickness of third layer : 0
Pour Space of material for third layer : 0
Infiltration On
Infiltration rate : 2
Infiltration saftey factor : 1
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 24 in.

Element Flows To:

Outlet 1 **Outlet 2**

Gravel Trench Bed Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.026	0.000	0.000	0.000
0.033	0.026	0.001	0.000	0.052
0.067	0.026	0.002	0.000	0.052
0.100	0.026	0.003	0.000	0.052
0.133	0.026	0.003	0.000	0.052
0.167	0.026	0.004	0.000	0.052
0.200	0.026	0.005	0.000	0.052
0.233	0.026	0.006	0.000	0.052
0.267	0.026	0.007	0.000	0.052
0.300	0.026	0.008	0.000	0.052
0.333	0.026	0.009	0.000	0.052
0.367	0.026	0.009	0.000	0.052
0.400	0.026	0.010	0.000	0.052
0.433	0.026	0.011	0.000	0.052
0.467	0.026	0.012	0.000	0.052
0.500	0.026	0.013	0.000	0.052
0.533	0.026	0.013	0.000	0.052
0.567	0.026	0.014	0.000	0.052
0.600	0.026	0.014	0.000	0.052
0.633	0.026	0.014	0.000	0.052
0.667	0.026	0.015	0.000	0.052
0.700	0.026	0.015	0.000	0.052
0.733	0.026	0.015	0.000	0.052
0.767	0.026	0.016	0.000	0.052
0.800	0.026	0.016	0.000	0.052
0.833	0.026	0.016	0.000	0.052
0.867	0.026	0.017	0.000	0.052
0.900	0.026	0.017	0.000	0.052
0.933	0.026	0.017	0.000	0.052
0.967	0.026	0.018	0.000	0.052
1.000	0.026	0.018	0.000	0.052
1.033	0.026	0.018	0.000	0.052
1.067	0.026	0.019	0.000	0.052
1.100	0.026	0.019	0.000	0.052
1.133	0.026	0.019	0.000	0.052
1.167	0.026	0.020	0.000	0.052
1.200	0.026	0.020	0.000	0.052
1.233	0.026	0.020	0.000	0.052
1.267	0.026	0.021	0.000	0.052
1.300	0.026	0.021	0.000	0.052
1.333	0.026	0.021	0.000	0.052
1.367	0.026	0.022	0.000	0.052
1.400	0.026	0.022	0.000	0.052
1.433	0.026	0.022	0.000	0.052
1.467	0.026	0.023	0.000	0.052
1.500	0.026	0.023	0.000	0.052
1.533	0.026	0.023	0.000	0.052
1.567	0.026	0.024	0.000	0.052
1.600	0.026	0.024	0.000	0.052

1.633	0.026	0.025	0.000	0.052
1.667	0.026	0.025	0.000	0.052
1.700	0.026	0.025	0.000	0.052
1.733	0.026	0.026	0.000	0.052
1.767	0.026	0.026	0.000	0.052
1.800	0.026	0.026	0.000	0.052
1.833	0.026	0.027	0.000	0.052
1.867	0.026	0.027	0.000	0.052
1.900	0.026	0.027	0.000	0.052
1.933	0.026	0.028	0.000	0.052
1.967	0.026	0.028	0.000	0.052
2.000	0.026	0.028	0.000	0.052
2.033	0.026	0.029	0.000	0.052
2.067	0.026	0.029	0.000	0.052
2.100	0.026	0.029	0.000	0.052
2.133	0.026	0.030	0.000	0.052
2.167	0.026	0.030	0.000	0.052
2.200	0.026	0.030	0.000	0.052
2.233	0.026	0.031	0.000	0.052
2.267	0.026	0.031	0.000	0.052
2.300	0.026	0.031	0.000	0.052
2.333	0.026	0.032	0.000	0.052
2.367	0.026	0.032	0.000	0.052
2.400	0.026	0.032	0.000	0.052
2.433	0.026	0.033	0.000	0.052
2.467	0.026	0.033	0.000	0.052
2.500	0.026	0.033	0.000	0.052
2.533	0.026	0.034	0.000	0.052
2.567	0.026	0.034	0.000	0.052
2.600	0.026	0.034	0.000	0.052
2.633	0.026	0.035	0.000	0.052
2.667	0.026	0.035	0.000	0.052
2.700	0.026	0.035	0.000	0.052
2.733	0.026	0.036	0.000	0.052
2.767	0.026	0.036	0.000	0.052
2.800	0.026	0.037	0.000	0.052
2.833	0.026	0.037	0.000	0.052
2.867	0.026	0.037	0.000	0.052
2.900	0.026	0.038	0.000	0.052
2.933	0.026	0.038	0.000	0.052
2.967	0.026	0.038	0.000	0.052
3.000	0.026	0.039	0.000	0.052

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
A B, Lawn, Flat	**.05**

Impervious Land Use	**Acres**
ROOF TOPS FLAT	**0.15**
SIDEWALKS FLAT	**0.05**
PARKING FLAT	**0.1**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Gravel Trench Bed 1,	Gravel Trench Bed 1,	

MITIGATED LAND USE

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.000071
5 year	0.000162
10 year	0.000265
25 year	0.000472
50 year	0.000704
100 year	0.001029

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.231233
5 year	0.312565
10 year	0.370779
25 year	0.449451
50 year	0.511867
100 year	0.577626

Yearly Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1950	0.000	0.000
1951	0.000	0.000
1952	0.000	0.000
1953	0.000	0.000
1954	0.000	0.000
1955	0.000	0.000
1956	0.001	0.000
1957	0.000	0.000
1958	0.000	0.000
1959	0.000	0.000
1960	0.000	0.000
1961	0.000	0.000
1962	0.000	0.000
1963	0.000	0.000
1964	0.000	0.000
1965	0.000	0.000
1966	0.000	0.000
1967	0.000	0.000
1968	0.000	0.000
1969	0.000	0.000
1970	0.000	0.000

1971	0.000	0.000
1972	0.000	0.000
1973	0.000	0.000
1974	0.000	0.000
1975	0.000	0.000
1976	0.000	0.000
1977	0.000	0.000
1978	0.000	0.000
1979	0.000	0.000
1980	0.000	0.000
1981	0.000	0.000
1982	0.000	0.000
1983	0.000	0.000
1984	0.000	0.000
1985	0.000	0.000
1986	0.000	0.000
1987	0.000	0.000
1988	0.000	0.000
1989	0.000	0.000
1990	0.000	0.000
1991	0.000	0.000
1992	0.000	0.000
1993	0.000	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.000	0.000
1997	0.001	0.000
1998	0.002	0.000

Ranked Yearly Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0016	0.0000
2	0.0009	0.0000
3	0.0009	0.0000
4	0.0004	0.0000
5	0.0004	0.0000
6	0.0003	0.0000
7	0.0003	0.0000
8	0.0002	0.0000
9	0.0002	0.0000
10	0.0001	0.0000
11	0.0001	0.0000
12	0.0001	0.0000
13	0.0001	0.0000
14	0.0001	0.0000
15	0.0001	0.0000
16	0.0001	0.0000
17	0.0001	0.0000
18	0.0001	0.0000
19	0.0001	0.0000
20	0.0001	0.0000
21	0.0001	0.0000
22	0.0001	0.0000
23	0.0001	0.0000
24	0.0000	0.0000
25	0.0000	0.0000

0.0002	38	0	0	Pass
0.0002	36	0	0	Pass
0.0002	36	0	0	Pass
0.0002	34	0	0	Pass
0.0002	33	0	0	Pass
0.0002	29	0	0	Pass
0.0002	27	0	0	Pass
0.0003	22	0	0	Pass
0.0003	20	0	0	Pass
0.0003	19	0	0	Pass
0.0003	19	0	0	Pass
0.0003	18	0	0	Pass
0.0003	18	0	0	Pass
0.0003	17	0	0	Pass
0.0003	17	0	0	Pass
0.0003	17	0	0	Pass
0.0003	17	0	0	Pass
0.0003	15	0	0	Pass
0.0003	15	0	0	Pass
0.0003	14	0	0	Pass
0.0003	14	0	0	Pass
0.0003	13	0	0	Pass
0.0004	13	0	0	Pass
0.0004	12	0	0	Pass
0.0004	11	0	0	Pass
0.0004	11	0	0	Pass
0.0004	11	0	0	Pass
0.0004	11	0	0	Pass
0.0004	11	0	0	Pass
0.0004	11	0	0	Pass
0.0004	11	0	0	Pass
0.0004	10	0	0	Pass
0.0004	10	0	0	Pass
0.0004	10	0	0	Pass
0.0004	10	0	0	Pass
0.0004	10	0	0	Pass
0.0004	9	0	0	Pass
0.0005	9	0	0	Pass
0.0005	9	0	0	Pass
0.0005	8	0	0	Pass
0.0005	8	0	0	Pass
0.0005	8	0	0	Pass
0.0005	8	0	0	Pass
0.0005	7	0	0	Pass
0.0005	7	0	0	Pass
0.0005	7	0	0	Pass
0.0005	6	0	0	Pass
0.0005	6	0	0	Pass
0.0005	6	0	0	Pass
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0.0005	6	0	0	Pass
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0.0006	6	0	0	Pass
0.0006	6	0	0	Pass

0.0006	6	0	0	Pass
0.0006	6	0	0	Pass
0.0006	6	0	0	Pass
0.0006	6	0	0	Pass
0.0006	6	0	0	Pass
0.0006	5	0	0	Pass
0.0006	5	0	0	Pass
0.0006	5	0	0	Pass
0.0006	4	0	0	Pass
0.0006	4	0	0	Pass
0.0007	4	0	0	Pass
0.0007	4	0	0	Pass
0.0007	4	0	0	Pass
0.0007	4	0	0	Pass
0.0007	3	0	0	Pass
0.0007	3	0	0	Pass
0.0007	3	0	0	Pass
0.0007	3	0	0	Pass

Operation and Maintenance Manual

No. 8 – Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.