City and Borough of Juneau

Manual of Stormwater Best Management Practices

August 2010

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ERRATA SHEET

The following updates to and errors in the June 2009 version are updated or corrected in this August 2010 version of the manual:

- Page C-4 and C-5, Design Procedure, changes to text detailing biofiltration swale design.
- Page D-3, Table D-1, the water quality design depth for the airport area should be 1.51 inches NOT 1.67 inches.
- Page D-3, Table D-1, a new method has been selected to transfer the water quality depth determined for the airport area to the downtown area resulting in a water quality depth of 1.92 inches NOT 3.03 inches
- Page D-3, Table D-1, a new method has been selected to determine water quality design intensities for the airport area and to transfer those water quality design intensities to the downtown area. This change in method resulted in new water quality design intensities for on-line and off-line BMPs for 10-minute and 30-minute time of concentrations for both the airport and downtown areas.
- Page D-5 and D-6, changes to text and equations describing method to determine water quality design depth for the downtown area.
- Page D-6 and D-7, changes to text and equations describing method to determine water quality design intensities for the airport and downtown areas.

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Text from the following documents has been used in the development of this manual without individual acknowledgment or footnotes:

Alaska Storm Water Guide, Alaska Department of Environmental Conservation, 2009

Alaska Highway Drainage Manual, Alaska Department of Transportation and Public Facilities, 1995

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, 2005

Stormwater Management Manual, City of Portland, 2008

Stormwater Management and Site Development Manual, Pierce County, Washington, 2008

Surface Water Design Manual, King County, Washington, 2009

Sources of figures, tables and photographs have been identified.

GLOSSARY AND ACRONYMS

Best Management Practices are methods that have been determined to be the most effective, practical means of preventing or reducing pollution from stormwater.

Impervious surface - A hard surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. Common impervious surfaces include roof tops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials or other surfaces which similarly impede the natural infiltration of stormwater.

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

Low Impact Development is a development approach to developing land and managing stormwater to imitate the natural hydrology (or movement of water) of the site.

Pollution generating impervious surfaces are impervious surfaces considered to be a significant source of pollutants in stormwater runoff. Such surfaces include those which are subject to: vehicular use (roads and parking lots); certain industrial activities; or storage of erodible or leachable materials, wastes, or chemicals, and which receive direct rainfall or the run-on or blow-in of rainfall.

Stormwater is runoff generated by land and impervious areas such as paved streets, parking lots, and building rooftops, during rainfall and snowmelt events.

API – American Petroleum Institute

BMP – Best Management Practice

CGP – Construction General Permit

CPS – Coalescing Plate Separator

EPA- Environmental Protection Agency

IPM – Integrated Pest Management

LID – Low Impact Development

MSGP – Multisector General Permit

NPDES – National Pollution Discharge Elimination System

PAH – Polycyclic Aromatic Hydrocarbon

TSS – Total Suspended Solids

SWPPP – Stormwater Pollution Prevention Plan

TMDL – Total Maximum Daily Load

UFC – Uniform Fire Code

  - Basic swales: water table must be minimum 2 feet below bottom of swale; site can be over-excavated in areas with impermeable or clay soils
  - Wet swales: no restrictions or need for underdrain; not appropriate for areas of highly infiltrative (gravelly, cobbly) soils
- Topsoil:
  - Permit infiltration but not be highly erosive: preferred sandy loam, loamy sand, loam soils
  - Composition: sand 35-60%, clay 10-25%, silt 30-55%, organics 20% (no animal waste)
  - Do not apply fertilizers, pesticides, or insecticides
- Vegetation:
  - Vegetation must be selected to accommodate expected high flow velocities
  - Vegetation must be established before introducing high flows (approximately 6 months)
  - Basic swales:
    - Vegetation and Seed mix: See vegetation recommendations below and Appendix E
    - Seed rate: 200 lbs per acre
  - Wet swales:
    - Vegetation: See vegetation recommendations below and Appendix E
    - Cover: use a combination of plugs, perennial seed, and annual seed to establish 100% cover in first year.
- The required setback is 2 feet from property lines, 10 feet from building foundations, and 50 feet from wetlands, rivers, streams and creeks, unless approved by the CBJ.

Design Procedure

The following is the procedure to be followed to design biofiltration swales:

1. Identify swale type (basic or wet)
2. Determine water quality design flow rate. Basic swales can be designed as either on-line or off-line facilities. Wet swales may be more appropriate as off-line facilities.
3. Establish longitudinal slope of swale and swale bottom width. Swales with longitudinal slopes less than 1% must be designed as wet swales.
4. Use Manning’s equation to calculate flow depth and find flow cross sectional area. Assume a Manning’s coefficient of 0.2 – 0.35 (approx 0.24 if mowed infrequently) for water quality flow rates and a Manning’s coefficient of 0.025-0.035 for high flow rates.
5. Compute flow velocity at design flow rate ($V = Q/A$, Q=design flow rate, A=cross sectional area of flow in swale)
6. Iteratively calculate channel length necessary to achieve hydraulic residence time of 9 minutes minimum ($L = 60Vt$, V = flow velocity, t = residence time of 9 minutes, 60 for conversion of seconds to minutes). If the stormwater does not enter at a single location, hydraulic residence time is calculated as the flow-weighted average.
7. If required length is not available on site, adjust slope and width of swale design.
8. Check maximum permissible velocity at 100-year flow rate.
9. Select vegetation appropriate to swale type.

- 12-15 inch tall riprap check dams are required for longitudinal swale slopes greater than 3%.
- Schedule 40 PVC perforated pipe, 6-inch diameter underdrains are required for basic swales with longitudinal slopes less than 1.5% or where poorly infiltrating soils will result in saturated soil conditions. Underdrains must infiltrate or drain freely to an acceptable discharge point.

Figure C-1 shows typical cross-sections for a biofiltration swale.

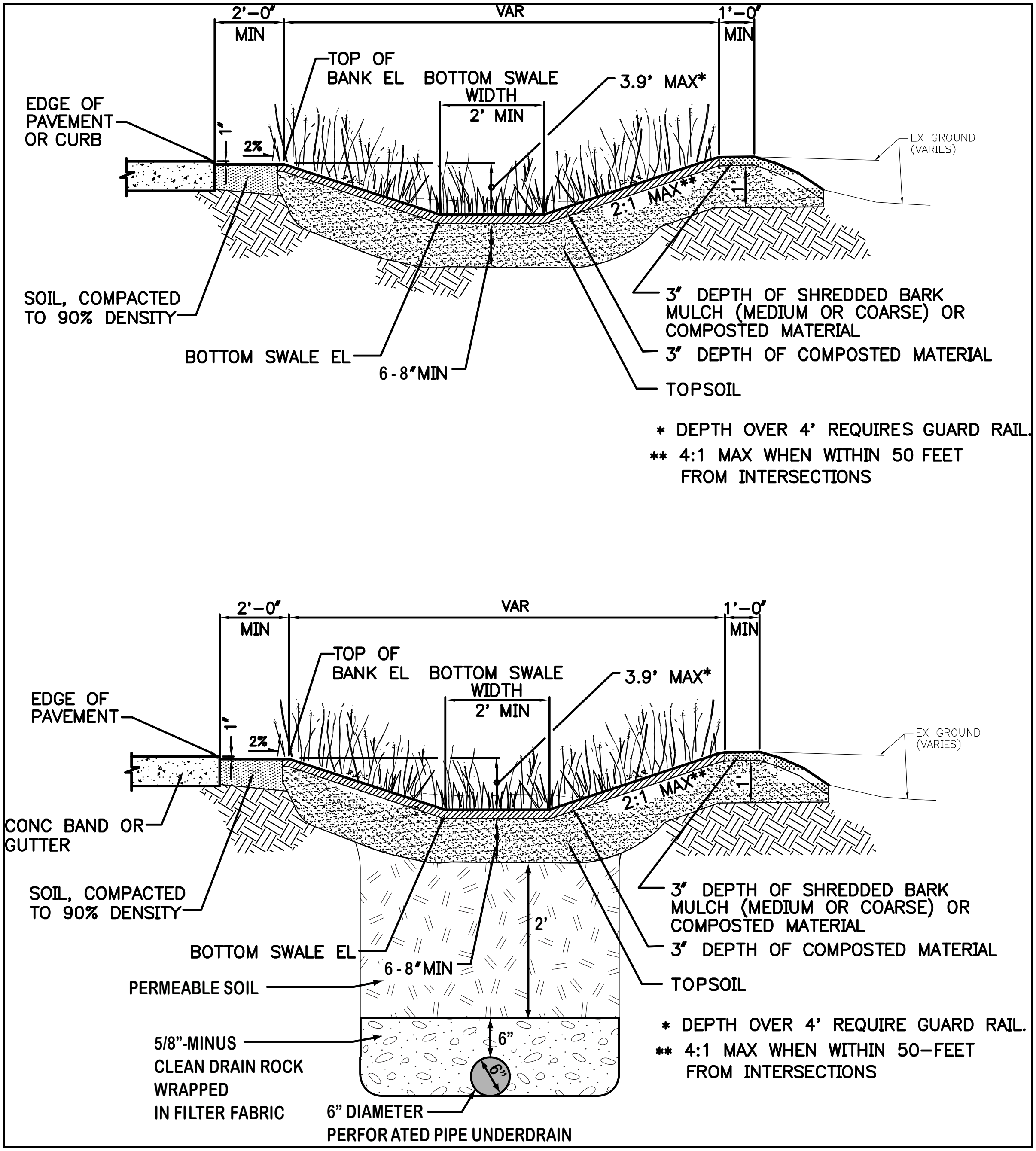

Figure C-1. Biofiltration Swale Sections

Development in the downtown zone (Downtown, Lemon Creek and Douglas) shall use rainfall parameters based on the downtown gage; areas in the airport zone (Mendenhall Valley and North Douglas) shall use rainfall parameters based on the airport gage. Although the upper Mendenhall Valley has a high precipitation, it is included in the airport area as subdividing the valley may be problematic. Hydrologic data for sizing infrastructure in CBJ outside the urbanized area will need to be determined by the developer.

Precipitation intensity and amounts in Juneau typically increase with higher elevation. More precipitation occurs as snowfall at higher elevations. All rainfall gages used in this manual and most development in the Juneau area are at or near sea level. Hydrologic data for sizing infrastructure above 500 feet will need to be determined by the developer.

Water Quality Volume and Flow Rates

Table D-1 shows the water quality design depths and intensities for the two hydrologic areas. These values shall be used to calculate the water quality design volume and rate for a particular site. The rationale and methodology used to set and determine these values, and the methodology to be used to calculate the water quality volume and flow rates for a particular site, are discussed later in this appendix

**TABLE D-1.
WATER QUALITY DESIGN DEPTHS AND INTENSITIES**

		Water Quality Design Intensities (inches/hour)			
		Online		Offline	
	Water Quality Design Depth (in)	Time of Concentration = 10 min	Time of Concentration = 30 min	Time of Concentration = 10 min	Time of Concentration = 30 min
Downtown Area	1.92	0.30	0.23	0.17	0.13
Airport Area	1.51	0.24	0.18	0.13	0.10

Table D-2 shows the 24-hour rainfall depths for different recurrence intervals for the two geographic areas selected for use by this manual. Table D-2 rainfall depths are based on the results several analyses of Juneau area rainfall data. The rainfall data and analyses are discussed later in this appendix. Full results of these analyses are shown as an attachment to this appendix.

**TABLE D-2.
RECURRENCE INTERVAL RAINFALL DEPTHS**

	24-hour Rainfall Depths (in)				
	2-year	5-year	10-year	25-year	100-year
Airport – Armstrong and Carlson 2003	2.01	2.41	2.67	3.00	5.19a
Downtown – McDonald 1990	2.83	3.56	4.02	4.57	5.35

a. National Weather Service, 1990s

WATER QUALITY STORM

Using event based rainfall-runoff models to size water quality treatment BMPs requires setting the magnitude or frequency of the water quality design event. Determining the water quality design event is both a statistical and economic exercise. During the year, rain and snow falls in numerous low volume low intensity events and a few larger higher intensity storms. The size of a water quality BMP sized either by volume or peak flow rate will determine how large a storm event the BMP can treat. Larger BMPs cost more to build and maintain and take up more space on a site. Therefore a balance must be reached between the amount of runoff a BMP can treat and the cost of the structure.

Municipalities have used different methods for setting the water quality treatment levels. These methods include: the 90% exceedance, 91% runoff using continuous simulation or the intensity or volume that would treat 90 percent of total precipitation (King County 2009, City of Portland 2008, DEC 2009). Some municipalities (City of Portland 2008) have justified the selection of the 90% exceedance by observing a significant "elbow" or increase in storm depths around the 90-percent exceedance in the plot of storm depth versus percent exceedance (see Figure D-3). This level represents the greatest "bang for the buck" in sizing BMPs as BMPs sized for a larger event will be significantly larger and have a decreasing return on volume of runoff treated. Monitoring data has shown King County's water quality treatment level achieves the treatment goal of 80% removal of total suspended sediment for most water quality BMPs.

Because Juneau does not have a distinct period of melt of accumulated winter snow and because snow accounts for a small percentage of total precipitation, water quality depths and intensities were based only on recorded precipitation.

Water Quality Design Depth

The water quality design depth for this manual was set at the 90% exceedence level of storm event precipitation depths using the following methodology.

Airport

Storm event precipitation depths were calculated using hourly precipitation data from the airport from 1998 to 2007. Storm events were defined as a rainfall period separated by an inter-event period of 12 hours with less than 0.05 inches of precipitation. Because water quality treatment BMPs typically treat runoff from impervious surfaces, the assumption used here—that the volume of precipitation equals the volume of runoff—is valid.

This method resulted in a 90% exceedence level storm precipitation depth of 1.51 inches for the airport. Figure D-3 shows the percent-exceedance plot for storm event precipitation depths based on data from the airport gauge.

Downtown

Because the downtown gage only recorded daily rainfall totals, this method was not possible with the downtown rain data. The water quality design depth for downtown was determined by assuming that the water quality design depths at the airport and downtown are proportional to the average annual rainfall totals at downtown and the airport. This method could be revised in future work, however additional data at a more frequent time interval may be required.

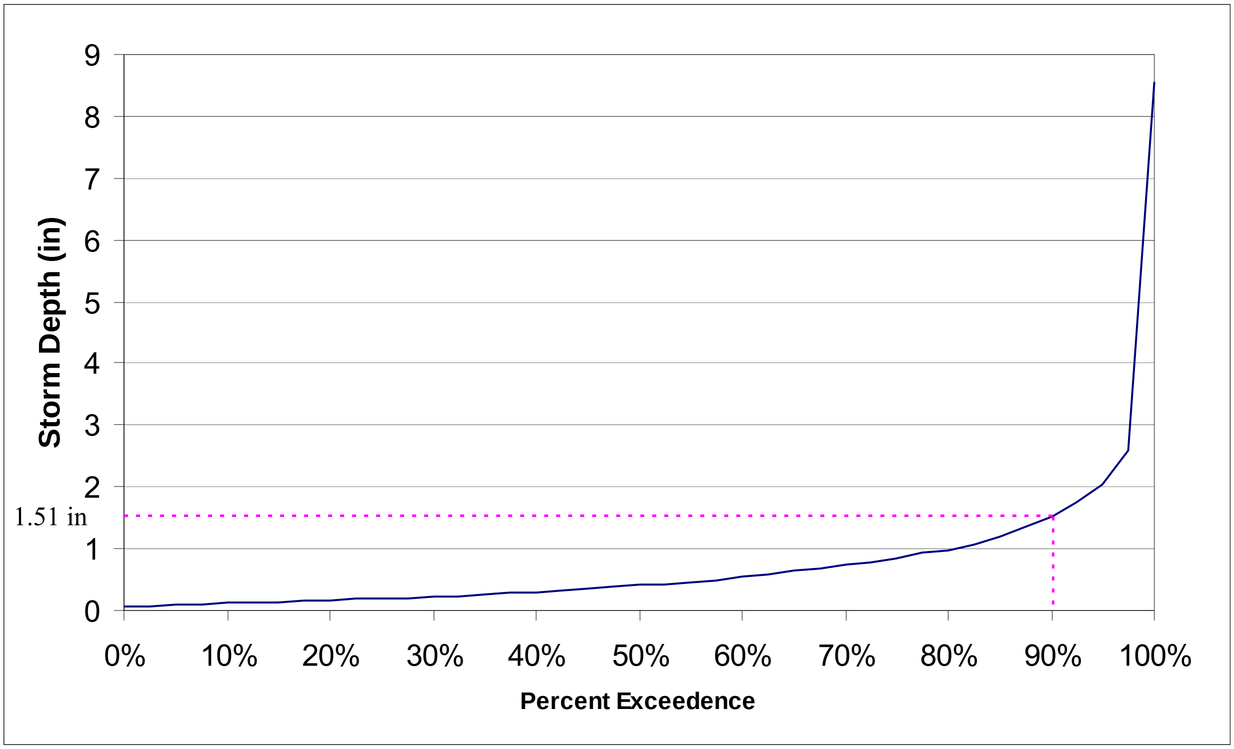

Figure D-3. Storm depth percent exceedance, Juneau Airport 1998-2007.

The ratio of the average annual rainfall totals at downtown and the airport was determined to be 1.27.

Ratio of average annual rainfall totals at downtown and the airport:

83.2 in (average annual precipitation depth —Downtown)/ 65.3 in. (average annual precipitation depth —Airport)

= 1.27 (ratio of downtown to airport average annual precipitation total)

This ratio was applied to the water quality design depth calculated for the airport gage. This resulted in a water quality storm depth of 1.92 inches for downtown:

1.27 (ratio of downtown to airport average annual precipitation total)$*$ 1.51 in (wq design depth—Airport)

= 1.92 in (wq design depth—Downtown)

Water Quality Design Intensity

The water quality design intensities for this manual were set at a level to treat 90% of total precipitation using the following method.

On-Line Facilities

The water quality design rate for on-line facilities assumes that flow rates below the water quality design rate are fully treated by the water quality treatment device. Flow rates higher than the design rate receive no treatment.

Off-Line Facilities

The water quality design rate for off-line facilities assumes that flow rates below the water quality design rate are fully treated by the water quality treatment device. For flows higher than the design rate, the portion of flow lower than the water quality treatment rate is fully treated, while the portion above the water quality flow rate receives no treatment. Because off-line facilities provide some treatment continuously during large events, the required water quality flow rate is lower than for on-line facilities.

Airport

Water quality design intensities were determined from the hourly rainfall data at the airport gage. Using the above assumptions, the intensity that resulted in treatment of 90 percent of total precipitation was 0.14 inches/hour for on-line facilities and 0.08 inches/hour for off-line facilities. Typical developments in Juneau have time of concentrations less than 30 minutes. The City of Portland conducted research on water quality rates determined from rainfall gauges with 5, 10 and 20 minute recording intervals. Ratios from this research were used to convert the hourly rainfall data results to an intensity of 0.24 inches/hour and 0.13 inches/hour for on-line and off-line facilities, respectively, for drainage areas with a time of concentration less than 10 minutes or less, and to 0.18 inches/hour and 0.10 inches/hour for on-line and off-line facilities, respectively, for basins with a time of concentration of 30 minutes.

Downtown

Because the downtown gage only recorded rainfall at a daily interval, this method was not possible for the downtown area. The following proposed method assumes that the 10- and 30-minute water quality intensities at the airport and downtown are proportional to the average annual rainfall totals at downtown and the airport. This methodology could be revised in future work; however, additional data at a more frequent time interval may be required.

The ratio of the downtown to airport average annual precipitation totals was calculated as 1.27. This ratio was applied to the 10- and 30-minute intensities calculated at the airport and resulted in a rates of 0.30 inches/hour and 0.17 inches/hour for on-line and off-line facilities, respectively, for drainage areas with a time of concentration of 10 minutes or less and rates of 0.23 inches/hour and 0.13 inches/hour for on-line and off-line facilities, respectively, for drainage areas with a time of concentration of 30 minutes.

10-minute time of concentration:

1.27 (ratio of downtown to airport average annual precipitation total) ∗ 0.24 in (wq design intensity (10-minute)—Airport-On-line)

= 0.30 in/hr (wq design intensity (10-minute)—Downtown-On-line)

30-minute time of concentration:

1.27 (ratio of downtown to airport average annual precipitation total) ∗ 0.18 in (wq design intensity (30-minute)—Airport-On-line)

= 0.23 in/hr (wq design intensity (30-minute)—Downtown-On-line)

Table D-1 shows the design depths and intensities to be used for the airport and downtown areas.