NPDES Phase II Municipal Stormwater Permit Requirements

NPDES Permit Appendix 1 – Development Core Elements 5, 6, 7

WASHINGTON STATE
DEPARTMENT OF ECOLOGY

EASTERN WASHINGTON NPDES II STORMWATER WORKSHOP

April 10, 2008
Core Element 5 – Runoff Treatment

Historically, urban stormwater flowed untreated into local waterways or was seeped into the ground.

NPDES II Permittees need to ensure that runoff from new development and re-development is treated before it is discharged to surface waters or groundwater.

Stormwater Treatment Levels

<table>
<thead>
<tr>
<th>Treatment Level</th>
<th>Treatment Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Treatment</td>
<td>80% TSS removal*</td>
</tr>
<tr>
<td>Oil Control</td>
<td>No sheen, Ave. 10 mg/l</td>
</tr>
<tr>
<td>Phosphorus Treatment</td>
<td>50% TP Removal**</td>
</tr>
<tr>
<td>Metals Treatment</td>
<td>Reduction in dissolved metals***</td>
</tr>
</tbody>
</table>

* For influent in 100-200 mg/l range
** For influent in 0.1-0.5 mg/l range
*** For assumed influent ranges: Cu 0.003-0.02 mg/l, Zn 0.02-0.3 mg/l

Chapter 5 of the E WA Manual Specifies Which BMPs, or Combination of BMPs, Provide What Level of Treatment
### Stormwater Treatment Types

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Treatment BMPs</th>
</tr>
</thead>
</table>
| Surface Infiltration and Bio-infiltration Treatment | • Infiltration ponds  
• Infiltration trenches  
• Infiltration swales  
• Bio-infiltration swales  
• Ecology Embankment |
| Biofiltration Treatment                             | • Biofiltration swales  
• Vegetated filter strip |
| Subsurface Infiltration                             | • Dry Wells (overlap with UIC & flow control)       |
| Wetpool/Wetpond and Dry Pond                        | • Basic Wetpond  
• Large Wetpond  
• Wetvaults  
• Stormwater Treatment Wetlands                      |

*Track approved BMPs and allowed uses on Ecology's Website  

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### Stormwater Treatment Types

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Treatment BMPs</th>
</tr>
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</table>
| Sand Filtration Treatment             | • Basic Sand Filter  
• Large Sand Filter  
• Sand Filter Vault  
• Linear Sand Filter                    |
| Evaporation Ponds                     | • Evaporation Ponds                                  |
| Oil and Water Separators              | • API (Baffle Type)  
• CP (Coalescing Plate Type)            |
| Dispersion                            | • Dispersion                                          |
| Emerging Technologies*                | • Media Filters  
• Amended Sand Filter  
• Catch Basin Inserts  
• Manufactured Storm Drain Structures  
• High Efficiency Street Sweeping       |

*Track approved BMPs and allowed uses on Ecology's Website  
Stormwater Treatment BMP Sizing

Recommended WQ Design Storm Analysis Process

- Design Storm Precipitation:
  - 6 mo – 3 hr
  - 6 mo – 24 hr
  - 6 mo – 24+ hr

- Precipitation Distribution:
  - Long Duration
  - Short Duration
  - SCS Type 1A
  - SCS Type II
  - Others

- Hydrologic Conditions:
  - Drainage Basins
  - Topography
  - Soils
  - Ground Cover
  - Conveyances
  - Antecedent Conditions

Runoff Analysis:
- Model or Spreadsheet

Site Hydrograph:
- Runoff Rates and Volumes

Stormwater Treatment BMP Sizing

“Default” Water Quality (WQ) Design Storms

- **WQ Design Volume**
  - Regional 24 hr+ Long Duration Storm Distribution with 6 Month Rainfall Depth

- **WQ Design Flow Rate**
  - Regional 3 hr Short Duration Storm Distribution with 6 Month Rainfall Depth

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Other Standard Methods Allowed – See SW Management Manual for EWA Chapt. 2 & 4
Stormwater Treatment BMP Sizing

Regional Design Storms

**WQ Design Volume**
Volume of Runoff Generated by the Second Portion of Precipitation for Long Duration Storm

**WQ Design Flow Rate**
Peak Discharge Generated by the Short Duration Storm

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**WQ Long Duration Storm Precipitation Amount**

\[ P_{wqs} = C_{wqs} (P_{2yr24hr}) \]

- **\( P_{wqs} \)** = 6-month, 24-hr precip. (in.)
- **\( C_{wqs} \)** = coefficient converting 2-year, 24-hr precip. to 6-mo. 24-hour precip.
- **\( P_{2yr24hr} \)** = Published 2-year, 24-hr precip. (in.)

**C\(_{24\text{hr-LDS}}\)** = Factor converting 24-hr precip. to long duration precip.

\[ C_{24\text{hr-LDS}} = \text{Factor converting 24-hr precip. to long duration precip.} \]

\[ P_{LDS} = C_{24\text{hr-LDS}} (P_{wqs}) \]

**Region #** | **Region Name** | **\( C_{wqs} \)** |
--- | --- | --- |
1 | East Slope Cascades | 0.70 |
2 | Central Basin | 0.66 |
3 | Okanogan, Spokane, Palouse | 0.69 |
4 | NE & Blue Mountains | 0.70 |
Stormwater Treatment BMP Sizing

WQ Short Duration (3 hr) Storm Precipitation Amount

\[ P_{\text{eds}} = 1.06 \times (C_{\text{eds}}) \times (P_{2\text{yr}2\text{hr}}) \]

- \( P_{\text{eds}} \): 6-month, 3-hr precip. (in.)
- \( C_{\text{eds}} \): coefficient converting 2-year, 2-hr precip. to x-year, 2-hour precip.
- \( P_{2\text{yr}2\text{hr}} \): Published 2-year, 2-hr precip. (in.)
- 1.06: conversion from 2 hr to 3 hr precip.

for all regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Mean Annual Precipitation (Inches)</th>
<th>6-Month</th>
<th>1-Year</th>
<th>10-Year</th>
<th>25-Year</th>
<th>50-Year</th>
<th>100-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 4</td>
<td>6-12</td>
<td>0.64</td>
<td>0.79</td>
<td>1.63</td>
<td>2.17</td>
<td>2.55</td>
<td>3.29</td>
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<tr>
<td></td>
<td>0-10</td>
<td>0.62</td>
<td>0.60</td>
<td>1.60</td>
<td>2.09</td>
<td>2.56</td>
<td>3.09</td>
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<tr>
<td></td>
<td>19-21</td>
<td>0.64</td>
<td>0.81</td>
<td>1.56</td>
<td>2.02</td>
<td>2.44</td>
<td>2.92</td>
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<tr>
<td></td>
<td>12-16</td>
<td>0.64</td>
<td>0.82</td>
<td>1.51</td>
<td>1.90</td>
<td>2.34</td>
<td>2.86</td>
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<tr>
<td></td>
<td>16-22</td>
<td>0.67</td>
<td>0.83</td>
<td>1.47</td>
<td>1.82</td>
<td>2.13</td>
<td>2.48</td>
</tr>
<tr>
<td></td>
<td>22-28</td>
<td>0.69</td>
<td>0.84</td>
<td>1.43</td>
<td>1.74</td>
<td>2.07</td>
<td>2.31</td>
</tr>
<tr>
<td></td>
<td>28-40</td>
<td>0.70</td>
<td>0.85</td>
<td>1.40</td>
<td>1.68</td>
<td>1.92</td>
<td>2.19</td>
</tr>
<tr>
<td></td>
<td>49-60</td>
<td>0.72</td>
<td>0.86</td>
<td>1.36</td>
<td>1.61</td>
<td>1.82</td>
<td>2.05</td>
</tr>
<tr>
<td></td>
<td>60-120</td>
<td>0.74</td>
<td>0.87</td>
<td>1.33</td>
<td>1.55</td>
<td>1.74</td>
<td>1.93</td>
</tr>
</tbody>
</table>
Stormwater Treatment and Flow Control BMP Sizing

Additional Considerations When Selecting, Sizing, and Applying BMPs in Eastern Washington

1. Cold climate considerations
2. Snow management activities
3. Snowmelt contribution to runoff
4. Antecedent moisture condition
5. Operation and maintenance requirements
6. Access and easement needs
7. Assurance of maintenance and repair

Example Of Treatment BMP Application

Example for Residential Subdivision

Infiltration Basin/Swale
Example Of Treatment BMP Application

Site Characteristics

1. 11.7 Acres
2. 48 SFR Lots w/ Connected Rooftops
3. 28 foot Street Section w/5 ft sidewalks
4. Closed Pipe Conveyance System
5. Type B Soils
6. Good Natural Infiltration -10 in/hr
7. General Drainage Pattern to North
8. Located in Yakima Area, Region 2
9. 2 yr, 24 hr Precip. = 1 inch
10. 6 mo, 24 hr Precip. = 0.66 inch

Example Of Treatment BMP Application

Multiple Sizing Criteria Allowed – We’ll use Hydrograph Method - Volume Based Sizing

1. Route WQ Storm hydrograph into assumed basin configuration, account for “outflow” due to infiltration for each time step.

2. Volume of basin needed to accommodate ponding without overflow drives the BMP design – iterate dimensions as needed given max. depth.

3. Flows above the WQ event may bypass or overflow from the basin.

4. Max Infiltration rate for WQ sizing = 2.4 in/hr (Per EWA Manual)
Desired Treatment BMP Configuration

**Ponding in basin**

**Infiltration**

**High flow overflow**

Amended Treatment Soil

Infiltration Capacity = Potential Outflow

Assumed Constant

Inflow (cfs)

Time (min)

Rqd. Basin Volume = \( \Sigma (\text{Inflow} - \text{Outflow}) \Delta T \)

Example Of Treatment BMP Application

**Drainage Basins**
Example Of Treatment BMP Application

Time of Concentration

Sheet Flow to Street
100 feet, 2% slope, n = 0.012 (asphalt)
Tt = 1.9 min

Shallow Flow To Catch Basin
150 feet, 2% slope, k = 27 (paved)
Calculate Velocity = 3.8 ft/sec
Tt = 0.7 min

Channel Flow in Pipe to Basin
700 LF, 2% slope, k = 21 (pipe)
Calculate Velocity = 3.0 ft/sec
Calculate Tt = 3.1 min

Tc = 1.9 + 0.7 + 3.1 = 5.7 minutes

Example Of Treatment BMP Application

Define Basin B Land Use and Curve Numbers

Developed Roads
1.64 acres, CN = 98 (impervious)

Developed Lots
6.5 acres, 36 lots = 7850 sf/lot, Impervious Footprint per lot: 2,000 SF buildings and 1,000 SF driveway (38%). Assume 100% directly connected to Roads.
ISA Connected to Roads = 2.5 acres, CN = 98
PGIS Connected to Roads = Driveways = 0.83 acres, CN = 98
NonPGIS Connected to Roads = Roofs = 1.67 acres, CN = 98
Remaining Area (Lawn) = 4 acres, CN = .61

Note: Residential Roof Runoff Does Not Need Treatment. Remove 1.67 acres of ISA From WQ Facility Sizing Calcs.
Example Of Treatment BMP Application

Regional Storm Runoff Hydrograph
Peak WQ Design Flow = 0.22 cfs
Total WQ Design Runoff Volume = 4180 cf

Assume Infiltration Basin Bottom 40 ft x 40 ft = 1600 sf
Infiltration Rate = 2.4 in/hr \(\times\) time 1600/(1/12)/(1/3600) = 0.09 cfs
Approx. Needed Volume = (0.22-0.09)(700-520)(60)/2 = 700 cf
Basin volume at 1 ft deep = 1600 cf \(\Rightarrow\) Can Reduce Basin Size
Example Of Treatment BMP Application
Partial LID Approach
Same Site Incorporating LID Features

1. 11.7 Acres
2. 48 SFR Lots w/Downspout Infiltration – Disconnects ISA
3. Permeable Pavers for Driveways – Reduces Curve Number (94)
4. Open swale conveyance between sidewalk and road
   – Increases Tc (6.4 min for Basin B)
   – Reduces Curve Number (89 but include 6 ft Swales in ROW on each side of road in area)

Repeat Calculations for Basin B

Example Of Treatment BMP Application
Partial LID Approach

<table>
<thead>
<tr>
<th></th>
<th>Traditional Design</th>
<th>LID Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc</td>
<td>5.7 min</td>
<td>6.3 min</td>
</tr>
<tr>
<td>Peak Flow</td>
<td>0.22 cfs</td>
<td>0.05 cfs</td>
</tr>
<tr>
<td>Water Quality Vol.</td>
<td>4,180 cu ft</td>
<td>1,600 cu ft</td>
</tr>
</tbody>
</table>

WQ Hydrographs LID Vs Non-LID

0.00 0.10 0.20 0.30
Flow rate (cfs)
0 200 400 600 800 1000 1200 1400 1600 1800
Time (minutes)
Core Element 6 – Flow Control

Historically, urban stormwater flowed un-detained into local waterways where it contributed to stream erosion, channel instability, increased flooding, and degraded habitat.

NPDES II Permittees need to ensure that runoff rates from new development and re-development does not cause stream erosion and downstream flooding.

Stormwater Flow Control BMPs

Infiltration = Preferred Approach

<table>
<thead>
<tr>
<th>Flow Control Type</th>
<th>Flow Control BMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detention Facilities</td>
<td>• Detention ponds</td>
</tr>
<tr>
<td></td>
<td>• Detention tanks</td>
</tr>
<tr>
<td></td>
<td>• Detention vaults</td>
</tr>
<tr>
<td>Infiltration Facilities</td>
<td>• Drywells</td>
</tr>
<tr>
<td></td>
<td>• Infiltration ponds/basins</td>
</tr>
<tr>
<td></td>
<td>• Infiltration trenches</td>
</tr>
<tr>
<td>Evaporation Ponds</td>
<td>• Evaporation ponds</td>
</tr>
<tr>
<td>Dispersion</td>
<td>• Concentrated flow dispersion</td>
</tr>
<tr>
<td></td>
<td>• Sheet flow dispersion</td>
</tr>
<tr>
<td></td>
<td>• Full dispersion</td>
</tr>
</tbody>
</table>

UIC Issues, Exemptions, Limitations
Stormwater Flow Control BMPs

Detention Tank

Infiltration Basin

Drywell

Flow Control Facility Sizing

Stream Protection Criteria

To protect stream morphology, projects shall limit the peak rate of runoff to 50% of the pre-developed or existing 2-year peak flow and maintain the pre-developed or existing 25-year peak runoff rate. Does not really address flood prone area issues.

Design Storms

The design storm to be used is the regional storm in Regions 1 and 4 or the Type IA storm in Regions 2 and 3. Existing conditions at the site are used for the analysis unless the local jurisdiction has imposed other requirements.
## Flow Control Facility Sizing

<table>
<thead>
<tr>
<th>Flow Control BMPs</th>
<th>Facility Sizing Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Detention ponds</td>
<td>Post project 2 yr discharge ½ of pre-project condition 2 yr discharge. Match pre-project</td>
</tr>
<tr>
<td>• Detention tanks</td>
<td>condition 25 yr peak discharge.</td>
</tr>
<tr>
<td>• Detention vaults</td>
<td></td>
</tr>
<tr>
<td>• Drywells</td>
<td>Infiltrate entire 10yr/25yr post project runoff volume. Drain down within 72 hrs after</td>
</tr>
<tr>
<td>• Infiltration ponds/basins</td>
<td>end of storm.</td>
</tr>
<tr>
<td>• Infiltration trenches</td>
<td></td>
</tr>
<tr>
<td>• Evaporation ponds</td>
<td>Maintain pond depth below limits based on a water budget method conducted for a 2 year</td>
</tr>
<tr>
<td></td>
<td>period. May sometimes include infiltration.</td>
</tr>
<tr>
<td>• Concentrated flow dispersion</td>
<td>Provide specified dispersion area (or width) per runoff area (or width). Varies depending</td>
</tr>
<tr>
<td>• Sheet flow dispersion</td>
<td>on site conditions.</td>
</tr>
<tr>
<td>• Full dispersion</td>
<td></td>
</tr>
</tbody>
</table>

## Example Of Flow Control BMP Application

**Example for Residential Subdivision**

**Infiltration Basin**
Example Of Flow Control BMP Application

Site Characteristics – same as Treatment BMP Site

1. 11.7 Acres
2. 48 SFR Lots w/ Connected Rooftops
3. 28 foot Street Section w/5 ft sidewalks
4. Closed Pipe Conveyance System
5. Type B Soils
6. Good Natural Infiltration -10 in/hr
7. General Drainage Pattern to North
8. Located in Yakima Area, Region 2
9. 2 yr, 24 hr Precip. = 1 inch
10. 25 yr, 24 hr Precip. = 1.7 inch

Example Of Flow Control BMP Application

Sizing Criteria – SCS Type 1A Hydrograph Method
Volume Based Sizing Similar to WQ BMP Example

1. Flows above the design event may overflow from the basin (after using freeboard).
2. Measured Native Infiltration Rate = 10 in/hr, Use safety factor of 2 to calculate long term rate and allow for some plugging.
3. Design infiltration rate = 5 in/hr (possibly lower if sod and grass)
4. Neglect WQ basin infiltration – could include by adding WQ basin inflit. capacity to FC basin inflit. Capacity during storage calcs.
5. Same drainage basins as WQ Example.
Example Of Flow Control BMP Application

Time of Concentration - Same as Treatment BMP Example

Sheet Flow to Street
100 feet, 2% slope, n = 0.012 (asphalt)
Tt = 1.9 min

Shallow Flow To Catch Basin
150 feet, 2% slope, k = 27 (paved)
Calculate Velocity = 3.8 ft/sec
Tt = 0.7 min

Channel Flow in Pipe to Basin
700 LF, 2% slope, k = 21 (pipe)
Calculate Velocity = 3.0 ft/sec
Calculate Tt = 3.1 min

Tc = 1.9 + 0.7 + 3.1 = 5.7 minutes
Example Of Flow Control BMP Application
Define Basin B Land Use and Curve Numbers

Pre-developed – not needed for use of infiltration.
8.14 acres, all pervious
CN = 51 (Sagebrush w/ grass understory)

Developed Roads
1.64 acres, CN = 98 (impervious)

Developed Lots
6.5 acres, 36 lots = 7850 sf/lot, Impervious Footprint per lot: 2,000 SF
buildings and 1,000 SF driveway (38%). Assume 100% directly connected
to Roads.
ISA Connected to Roads = 2.5 acres, CN = 98
Remaining Area (Lawn) = 4 acres, CN = .61

Example Of Flow Control BMP Application
Type 1A Storm Runoff Hydrograph
Peak FC Design Flow = 1.56 cfs
Total FC Storm Runoff Volume = 22,582 cf
Example Of Flow Control BMP Application

Assume Infiltration Pond Bottom 50 ft x 75 ft = 3750 sf
Infiltration Rate = 5 in/hr  → times 3750/(1/12)/(1/3600)  → 0.43 cfs
Approx. Needed Volume = (1.57-0.43)(537-425)(60)/2 = 3850 cf
Basin volume at 1.5 ft deep = 5625 cf
Draw down time = 18 in/5 in/hr = 3.6 hrs
→ Can Reduce Req Area or Depth

25 Yr Type 1A Storm Hydrograph

Example Of Flow Control BMP Application
Partial LID Approach
Incorporating Same LID Features as WQ Example
1. 11.7 Acres
2. 48 SFR Lots w/Downspout Infiltration – Disconnects ISA
3. Pervious Pavers for Driveways – Reduces Curve Number (94)
4. Open swale conveyance between sidewalk and road
   – Increases Tc (6.4 min for Basin B)
   – Reduces Curve Number (89 but include 6 ft Swales in ROW on each side of road in area)

Repeat Calculations for Basin B
Example Of Flow Control BMP Application
Partial LID Approach

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<thead>
<tr>
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<th>Traditional Design</th>
<th>LID Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc</td>
<td>5.7 min</td>
<td>6.3 min</td>
</tr>
<tr>
<td>Peak Flow</td>
<td>1.56 cfs</td>
<td>0.48 cfs</td>
</tr>
<tr>
<td>25 Yr. Vol.</td>
<td>22,582 cu ft</td>
<td>7940 cu ft</td>
</tr>
</tbody>
</table>

Core Element 7 – Operation and Maintenance

Stormwater treatment and flow control BMPs need proper operation and maintenance in order to function as intended. The resources spent designing and constructing a BMP is wasted unless ongoing operation and maintenance needs are addressed.

NPDES II Permittees need to ensure that BMP operation and maintenance needs will be addressed for public and private development and re-development projects.
Operation and Maintenance Plans

Requirements

Where structural BMPs are required, property owners shall operate and maintain the facilities in accordance with an Operation and Maintenance (O&M) plan that is prepared in accordance with the provisions in Chapters 5 and 6 of the Stormwater Management Manual for Eastern Washington (2004), or another technical stormwater manual approved by the Department.

The O&M plan shall:
1. Address expected maintenance needs for all proposed stormwater facilities and BMPs (See Chapters 5 & 6 of the E WA Manual);
2. Identify the party/parties responsible for maintenance and operation;
3. Address the long-term funding mechanism to support proper O&M;
4. Be retained onsite or within reasonable access to the site;
5. Be transferred with the property to the new owner;
6. For public facilities, be retained in the appropriate department.

A log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection.
Operation and Maintenance Plans

Generic O&M Plans – Streamline O&M Plan Preparation

Cities, Counties, and commercial and residential developers may develop generic O&M plans.

Generic plans must include checklists of actions and procedures for the operators, for BMPs that are commonly allowed by the local agencies.

Access for Operation and Maintenance

Ensuring Proper Perpetual Access to and Maintenance of Structural BMPs:

- Private Vs Public Easements
- Covenants/Restrictions
- Maintenance Agreements/Contracts
- Ensuring Enforcement of Easements
- Dedicated Tracts/Parcels
- Public Vs. Private Ownership of BMPs Serving Private Property

Many local governments are finding that assurance of O&M for some private facilities is difficult and contentious, therefore up front transfer of the BMP and property to public ownership (along with the O&M funding) is becoming more common.
Financing Operation and Maintenance

O&M Financing Methods
Larger issue for private facilities
Get dedicated funds up-front – where’s O&M $ when cash is tight?

- Bond
- Annuity
- Contract
- Homeowners Fees
- Others?

Discussion
Questions & Answers