Urban Water Quality Practices

Purpose of Best Management Practices (BMP) in urban hydrology is to mitigate the adverse impacts of development activity. The regulatory control for water quality practices are driven by national Pollution Discharge Elimination System (NPDES) requirements under the Clean Water Act amendments.

1. **Extended Detention Dry Ponds**: depressed basins that temporarily store a portion of the stormwater runoff following a storm event. The extended detention time of the stormwater provides an opportunity for urban pollutants carried by the flow to settle out.

2. **Wet Pond**: It is a retention pond and serves a dual purpose of controlling the volume of stormwater and treating the runoff for pollutant removal. They are designed to store a permanent pool during dry weather. This is accomplished through gravity settling, biological stabilization of solubles and infiltration.

3. **Infiltration trenches**: shallow excavation backfilled with coarse stone media. They form an underground reservoir which collects runoff and exfiltrates it to the subsoil. This will act to reduce peakflow and remove fine particulates and soluble pollutants.

4. **Infiltration basins**: similar to conventional ponds. However, the detained runoff is exfiltrated through permeable soils beneath the basin, removing both fine and soluble pollutants.

5. **Sand filters**: provide stormwater treatment where first flush runoff is strained through a sand bed before being returned to a stream or channel. They are generally used in urban areas and useful for groundwater protection where infiltration into soils is not feasible.

6. **Water quality inlets**: pre-cast storm drain inlets (oil and grit separators) that remove sediments, oil, and grease, and large particles from paved area runoff before it reaches storm drainage system or infiltration BMPs.

7. **Vegetative Practice**: Convey and filter runoff
   a. **Grassed swales**
   b. **Filter strips**
   c. **Wetlands**
   d. **Biofiltration swales**

8. **Temporary Erosion and Sediment Control Practices**: they are applied during the construction process. They are removed after final site stabilization.

9. **Porous pavement**: provides a quick transport of runoff from a paved surface to an underlying store reservoir.

General BMP selection guidance:
Factors involved:
- Set physical site condition
- Watershed area
- Stormwater and water quality objectives selection criteria table attached. Pollutant removal comparison for urban BMPs, see attached.

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Example local criteria (Virginia Performance Criteria)
- For drainage areas less than 2 ha (5 ac) BMPs must remove at least 15% of the total phosphorus pollutant load after development
- For drainage areas 2 ha or greater, BMPs must remove at least 40% of total phosphorus load after development
- The pre-development load shall be based on an equivalent average cores of 16% impervious or 0.5 kg/ha/yr.

Example

<table>
<thead>
<tr>
<th>% Impervious Property</th>
<th>Drainage area</th>
<th>&lt; 2 ha</th>
<th>&gt; 2 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 21</td>
<td>Vegetative filter strips</td>
<td>Extended detention, retention</td>
<td></td>
</tr>
<tr>
<td>22 – 37</td>
<td>1. modified grass swale</td>
<td>Extended detention, retention</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. extended detention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38-66</td>
<td>1. biofiltration swale</td>
<td>1. extended detention</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. modified extended detention</td>
<td>2. wetland</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. wetlands</td>
<td>3. infiltration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. infiltration</td>
<td>4. retention</td>
<td></td>
</tr>
</tbody>
</table>

Estimating Pollutant Loads:

\[
L = \frac{P R_v P_j C A}{98.6}
\]

- \( L \) = pollutant load kg
- \( P \) = rainfall depth over the desired time interval mm (0.9) ~ 10% according to Washington DC. Area are not effective in general for runoff.
- \( R_v \) = runoff coefficient
- \( P_j \) = correction factor for storms that produce no flow
- \( C \) = flow-weighted mean concentration of the pollutant in urban runoff mg/L
- \( A \) = area of development site ha
- 98.6 = unit conversion factor

\[
R_v = 0.05 + 0.009 \times I
\]

\( I \) = % of site imperviousness
C values from Table 10-4

<table>
<thead>
<tr>
<th>Example</th>
<th>Area of development site 20 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-development</td>
</tr>
<tr>
<td>P</td>
<td>890 mm</td>
</tr>
<tr>
<td>P_i</td>
<td>0.9</td>
</tr>
<tr>
<td>% Imp</td>
<td>2% (forest)</td>
</tr>
<tr>
<td>R_v</td>
<td>0.05 + 0.009 (2) = 0.07</td>
</tr>
<tr>
<td>C (Total N)</td>
<td>0.78 mg/L</td>
</tr>
<tr>
<td>C (Total P)</td>
<td>0.15 mg/L</td>
</tr>
<tr>
<td>C (Peak)</td>
<td></td>
</tr>
</tbody>
</table>

Find pre- and post-development storm loads
Pre-development: \[ L = PRPC_A/98.6 \]
Total N \[ = 890 (0.07)(0.9)(0.78)(20)/98.6 \]
\[ = 8.9 \text{ kg/yr} \]
Total phosphorus \[ = 890 (0.07)(0.9)(0.15)(20)/98.6 \]
\[ = 1.7 \text{ kg/L} \]

Post-development:
Total N \[ = 890 (0.46)(0.9)(0.26)(20)/98.6 \]
\[ = 19 \text{ kg/yr increase of 17.3} \]
Lead post \[ = 890 (0.46)(0.9)(0.018)(20)/98.6 \]
\[ = 1.3 \text{ kg/yr} \]