Introduction

• Environmental Flows
  • Definition
  • Concepts
  • Tools

• Water Quality
  • Clean Water Act
    • Impairments
    • Total Maximum Daily Loads (TMDLs)
Environmental flows can be defined as the quality, quantity and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems that provide multiple goods and services to people.

(Cummins et al., 2010)
Environmental flows (cont’d)

- Ecological integrity depends on maintaining quantity of flows and flow variability
  - Need right amount of water at right time
  - High/low flow indicators such as:
    - 7Q10: the lowest stream flow for seven consecutive days that would be expected to occur once in ten years
- Influences: impoundments, withdrawals...

Figure: (Richter, 2004)
Environmental flows (cont’d)

Linear Projection of Flow for the Potomac River at the USGS Point of Rocks Gage, MD.
Drainage area = 9,651 sq. mi.

(Cummins et al., 2010)
Environmental flows (cont’d)

(Cummins et al., 2010)
Environmental flows (cont’d)

Percent of Flow Approach

(Richter, 2004)
Environmental flows (cont’d)

West Virginia Water Withdrawal Guidance Tool (www.dep.wv.gov)
Environmental flows (cont’d)

West Virginia Water Withdrawal Guidance Tool

[Map of West Virginia with water withdrawal guidance tool]
Environmental flows (cont’d)

West Virginia Water Withdrawal Guidance Tool
Environmental flows (cont’d)

- Water use thresholds determined using the Tennant method, developed in 1976

- The Tennant method
  - assumes that some percentage of the mean flow is needed to maintain a healthy stream environment
  - environmental quality of different flows determined by the quality of the physical habitat provided (stream width, depth, and velocity)

  (Jowett, 1997)
Water quality

- **US Clean Water Act (1972) Goal**: "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters"

Source: EPA Office of Water
57% of WV rivers and streams assessed

Of those, 56% are impaired
### Water quality (cont’d)

#### WV Impairments

<table>
<thead>
<tr>
<th>Cause of Impairment Group</th>
<th>Size of Assessed Waters with Listed Causes of Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rivers and Streams (miles)</td>
</tr>
<tr>
<td>Ammonia</td>
<td>5.4</td>
</tr>
<tr>
<td>Cause unknown - impaired biota</td>
<td>5,152.1</td>
</tr>
<tr>
<td>Dioxins</td>
<td>359.2</td>
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<tr>
<td>Flow alteration(s)</td>
<td>44.3</td>
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<tr>
<td>Mercury</td>
<td>669.0</td>
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<tr>
<td>Metals (other than Mercury)</td>
<td>4,455.6</td>
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<tr>
<td>Nutrients</td>
<td>30.7</td>
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<tr>
<td>Organic enrichment/Oxygen depletion</td>
<td>23.4</td>
</tr>
<tr>
<td>Pathogens</td>
<td>4,152.8</td>
</tr>
<tr>
<td>pH/Acidity/Caustic conditions</td>
<td>1,378.1</td>
</tr>
<tr>
<td>Polychlorinated Biphenyls (PCBs)</td>
<td>1,056.4</td>
</tr>
<tr>
<td>Salinity/Total dissolved solids/Chlorides/Sulfates</td>
<td>21.6</td>
</tr>
<tr>
<td>Sediment</td>
<td>178.7</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td>Toxic inorganics</td>
<td>0.2</td>
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</tbody>
</table>
Water Quality (cont’d)

- A Total Maximum Daily Load (TMDLs) must be developed for each impaired water body.

- A TMDL is “a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.”

\[
\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}
\]

- “Waste Load Allocation”
  - Point sources

- “Load Allocation”
  - Non-point & background sources

- “Margin of Safety”
Water Quality (cont’d)

- TMDL process:
  - Identify pollutant of concern
  - Estimate waterbody loading capacity
  - Estimate pollutant loading from all sources (pt and nps)
  - Quantify pollutant reductions needed to meet water quality standards
  - Allocation (+ margin of safety) of pollutant load among the sources to meet water quality standards
  - Public review and comment
Water Quality (cont’d)

- WV TMDLs for selected pollutants
  - Cumulative since October 2005

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Number of TMDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>716</td>
</tr>
<tr>
<td>Aluminum</td>
<td>454</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>450</td>
</tr>
<tr>
<td>Manganese</td>
<td>397</td>
</tr>
<tr>
<td>pH</td>
<td>289</td>
</tr>
<tr>
<td>Sediment</td>
<td>83</td>
</tr>
<tr>
<td>Biological</td>
<td>80</td>
</tr>
<tr>
<td>Acid</td>
<td>27</td>
</tr>
<tr>
<td>Organic Enrichment</td>
<td>13</td>
</tr>
<tr>
<td>Selenium</td>
<td>13</td>
</tr>
<tr>
<td>Chloride</td>
<td>7</td>
</tr>
<tr>
<td>PCBs</td>
<td>7</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>6</td>
</tr>
</tbody>
</table>
Located in Kanawha County, 25mi. SE of Charleston

Listed since 1996 as impaired for metals and pH due to acid mine drainage from abandoned coal mines
TMDL example - Morris Creek, WV

- Morris Creek designated uses:
  - warm-water fishery
  - drinking water
  - contact recreation

- Morris Creek declared impaired due to lack of aquatic life and deposits of iron and aluminum on the streambed

Acid mine drainage in a tributary to Morris Creek
Source: EPA
TMDL example - Morris Creek, WV

TMDL results for Morris Creek to achieve water quality standards:

- aluminum reduction of 5,900 lbs/yr
- iron reduction of 8,007 lbs/yr
- manganese reduction of 4,444 lbs/yr

Source: TMDLs for selected streams in the Upper Kanawha Watershed Report
TMDL example - Morris Creek, WV

• Restoration efforts: anaerobic and aerobic wetlands, open limestone channels, and polishing ponds at four sites in the watershed

• Water quality improved immediately after treatment system installation

• Expected to be de-listed in 2010

• Treatment system maintenance ongoing

Limestone lined drainage channel
Source: EPA
# TMDL example - Morris Creek, WV

<table>
<thead>
<tr>
<th>Project site</th>
<th>pH level: pre/post treatment</th>
<th>Metal reductions achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Aluminum (lbs/yr)</td>
</tr>
<tr>
<td>Possum Hollow</td>
<td>3.5/6.7</td>
<td>390.55</td>
</tr>
<tr>
<td>Blacksnake Hollow</td>
<td>4.4/5.0</td>
<td>84.45</td>
</tr>
<tr>
<td>Lower Mainstem</td>
<td>4.0/6.3</td>
<td>1,759.3</td>
</tr>
<tr>
<td>Upper Mainstem</td>
<td>4.2/5.4</td>
<td>31,006.75</td>
</tr>
<tr>
<td><strong>Total Reductions</strong></td>
<td>--</td>
<td><strong>33,248</strong></td>
</tr>
<tr>
<td>TMDL Allocations</td>
<td>--</td>
<td>5,900</td>
</tr>
</tbody>
</table>

Source: EPA
Summary

• Environmental flows
  • Essential to maintaining ecosystem integrity in West Virginia
  • Assessment/protection methods: % of flow, WV water withdrawal guidance tool
  • ICPRB/TNC/CoE 2.5 yr project to quantify environmentally sustainable flows in the Potomac Basin (www.potomacrriver.org)

• Water quality
  • Regulated under the US Clean Water Act
  • 57% of WV rivers and streams assessed, 56% of which are impaired
  • TMDLs developed for many impaired waters, with some success stories, but more work remains
References