Resource Assessment

Presented by the Interstate Commission on the Potomac River Basin
Sponsored by the West Virginia Department of Environmental Protection
With funding from the American Reinvestment & Recovery Act

West Virginia Water Resources Training Workshops
Outline

- Water availability: why worry? who cares?
- Safe yield
- Watershed water budgets
- Risk-based approach
Why worry about availability?

- Forecasted population growth
- Industrial growth
- Contaminated sources
- Desire to extend public supply to self-served population

Derived from Cristiadi, 2009
Who worries about availability?

- **Individual water providers**
  - Municipalities, PSDs, self-served industries, ...
  - Focus on local resources - evaluate and develop
    - Wells
    - Streams
    - Impoundments (reservoirs or natural lakes)
  - Need technical evaluations of individual sources to determine safe yield of reservoir, best locations for wells, ...

- **Regional entities**
  - Counties, states, regional commissions
  - Focus on watersheds – surface water & ground water as a single resource
  - Planning based on use & availability by watershed
Safe Yield & WV Planning

- **West Virginia’s State Water Resources Management Plan**: the state shall develop “An inventory of the surface water resources of each region of this state, including an identification of the boundaries of significant watersheds and an estimate of the safe yield of such sources for consumptive and nonconsumptive uses during periods of normal conditions and drought.”
Watersheds
Definitions

- **Safe yield** (standard definition): the maximum sustainable withdrawal that can be made continuously from a water source
  - For surface water sources: based on historic flow data/drought of record
  - For wells: based on estimate of average ground water recharge
- **Consumptive use**: The amount of water withdrawn that is not returned to the same water body
  - Due to evaporation, incorporation into products or crops, consumptive by humans or livestock
- **Drought of record**: worst event for which hydrologic records exist
  - For Potomac & Ohio River basins: summer 1930 – spring 1931
  - In West Virginia in July-August, 1930, annual precip was 59% of average, 2-month precip was 48% of average
Safe Yield - Limitations of Standard Definition

• Need to add to qualification: “... while preserving the source’s aquatic habitat”

• Connotes “safety”, and gives no indication of risk
  – For surface water – results based on drought of record may be too conservative
  – For ground water – results based on annual may be not be conservative enough – misses risk of summertime low flows

• Doesn’t consider cumulative impact of consumptive use
Safe Yield - Simple Stream Example

• Happy Hollow, WV:
  – Currently uses 0.5 mgd
  – Projects demand of 0.8 mgd in 2030

• The municipal water source is Bubbly Brook, and USGS records show:
  – Annual mean flow = 15 cfs (15 cfs x 0.65 = 9.7 mgd)
  – August mean flow = 7 cfs ( 7 cfs x 0.65 = 4.5 mgd)
  – Lowest recorded flow was 1 cfs (1 x 0.65 = 0.65) mgd on Oct 15, 1930

• Safe yield analysis indicates that an additional water source must be developed

Bubbly Brook safe yield = 0.65 mgd
Safe Yield - Groundwater Example

Standard calculation based on annual average recharge:

- Use long-term record of daily stream flow
- Compute average annual baseflow using “hydrograph separation”
- Assumption: baseflow ~ recharge

Typical annual average recharge for Mid-Atlantic bedrock aquifer/stream systems:

8 inches/year ~ 600 gpd/acre*

*Caution: may not capture risk of seasonal low flows – see seasonal variability slide
Hydrographic Separation - Cheat River

Assumption: annual recharge ~ annual baseflow

 Estimates from USGS program “PART”
Surface Water & Ground Water - a Shared Resource

- Groundwater flow paths tend to mimic topography
- Recharge within a watershed is shared: available for well withdrawals & discharge to streams

Figure from USGS, Groundwater Atlas of the United States, at pubs.usgs.gov/ha/ha730/ch_g/G-text8.html
Watershed Water Budgets

- Precipitation
  - Groundwater recharge
    - Well withdrawals
    - Stream "baseflow"
  - Evapotranspiration
  - Storm runoff
    - Stream withdrawals
Watershed Water Budgets

- Especially important in fractured bedrock environments
- Surface water and ground water: a shared resource for diverse set of users:
  - Municipal, industrial, & agricultural well owners
  - Individual residential wells
  - Municipalities, industries, & farmers relying on surface water withdrawals
  - Aquatic ecosystems relying on adequate in-stream flow
- Takes into account total consumptive use within a watershed
- Possible to do seasonal as well as annual water budgets
Seasonal Variability

- In our region, stream baseflow and aquifer levels lowest in summertime
- Season water budgets better at capturing risk of summertime shortages
Example of Seasonal Estimates from Maryland Study

### Annual water budget
- Based on estimates of annual recharge
- Assumes no annual change in storage

### Seasonal water budget
- Based on estimates of recharge and recession
- Estimates seasonal changes in storage

<table>
<thead>
<tr>
<th>Station</th>
<th>Annual Recharge (gpd/acre) 1 in 20 year</th>
<th>Seasonal Summer recharge + summer storage (gpd/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median 1 in 10-year</td>
<td>1 in 20 year</td>
</tr>
<tr>
<td>Catoctin Creek (01637500)</td>
<td>350</td>
<td>210</td>
</tr>
<tr>
<td>Upper Monocacy River</td>
<td>230</td>
<td>120</td>
</tr>
<tr>
<td>(01639000)</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td>Big Pipe Creek (01639500)</td>
<td>350</td>
<td>460</td>
</tr>
<tr>
<td>Bennett Creek (01643500)</td>
<td>390</td>
<td>420</td>
</tr>
<tr>
<td></td>
<td></td>
<td>220</td>
</tr>
</tbody>
</table>
Risk-Based Approach

• Water suppliers want to minimize risk of shortages
• Zero risk?

Planning involves risk tradeoffs, whether explicit or not
Tradeoffs

• What’s the probability of different drought stages?

• Is there a drought management plan with conservation and water use restrictions?

• What are the impacts/costs of shortages?
Resources


• Canaan Valley Institute, http://www.canaanvi.org.