NGWA Informational Resources: Defining Managed Aquifer Recharge and Best Suggested Practices for Aquifer Storage and Recovery

Several techniques are employed to artificially recharge aquifers.

- Streamflow is directed to an artificial recharge basin, where water percolates downward to the underlying aquifer.
- A recharge well is used to pump treated wastewater into a deep, confined aquifer.
- Monitoring well showing water level in confined aquifer.

William M. Alley and Steven P. Musick
2014 GWPC Annual Forum
What is a “BSP?”

• “...those practices that have been shown to produce superior results; selected by a systematic process; and judged as exemplary, good, or successfully demonstrated.” – *The American Productivity and Quality Center*
What is a “BSP?”

- Consensus-driven document
- Good idea, good practice, or recognized best practice
  - NOT a standard, guideline, handbook, or position paper
  - NOT a technical specification
- General scope:
  - Audience any industry segment
  - If document is for contractors, usually used for private residential water wells
  - Nationally applied
- Helps protect limited resources
- Sets industry benchmarks
Who uses BSPs?

• Industry professionals
  – Drilling and water systems contractors
  – Scientists and engineers
  – Manufacturers and suppliers

• Regulatory agencies
  – Federal
  – State
  – Local
## Available NGWA BSPs

<table>
<thead>
<tr>
<th>Managing a Flowing Water Well</th>
<th>Reducing Problematic Concentrations of Nitrates in Residential Water Well Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing Problematic Concentrations of Hydrogen Sulfide in Residential Water Well Systems</td>
<td>Reducing Problematic Concentrations of Radon in Residential Water Well Systems</td>
</tr>
<tr>
<td>Reducing Problematic Concentrations of Arsenic in Residential Water Well Systems</td>
<td>Reducing Problematic Concentrations of Strontium in Residential Water Well Systems</td>
</tr>
<tr>
<td>Reducing Problematic Concentrations of Boron in Residential Water Well Systems</td>
<td>Reducing Problematic Concentrations of Uranium in Residential Water Well Systems</td>
</tr>
<tr>
<td>Reducing Problematic Concentrations of Fluoride in Residential Water Well Systems</td>
<td>Residential Well Cleaning</td>
</tr>
<tr>
<td>Reducing Problematic Concentrations of Iron and Manganese in Residential Water Well Systems</td>
<td>Water Well Systems for Fire Protection Services for Stand-Alone Housing Units of Four or Fewer</td>
</tr>
<tr>
<td>Reducing Problematic Concentrations of Microorganisms in Residential Water Well Systems</td>
<td>Water Well Systems Inspection</td>
</tr>
<tr>
<td>Emergency Residential Water Well Disinfection Following a Flooding Event</td>
<td>Reducing Problematic Concentrations of Perchlorate in Residential Water Well Systems</td>
</tr>
<tr>
<td>Reduce and Mitigate Problematic Concentrations of Methane in Residential Water Well Systems</td>
<td></td>
</tr>
</tbody>
</table>
## BSPs in development

<table>
<thead>
<tr>
<th>Topic</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationship Between Wells with Elevated Iron Levels and Arsenic</td>
<td>Well Development</td>
</tr>
<tr>
<td>Groundwater Sampling</td>
<td>Groundwater Testing</td>
</tr>
<tr>
<td>Safe Handling of Radioactive Wastes from Water Treatment Devices</td>
<td>Water Well and Pump System Operation and Maintenance</td>
</tr>
</tbody>
</table>
Development Process: Step by Step

**PHASE I: DRAFT**

- Admin writes “straw man”
- Task Group drafts BSP
- Editorial, tech, legal review
- Board approval of draft

**PHASE II: FINALIZATION**

- Public comment
- TG reviews and responds to comments
- Board approval of final BSP
What’s in a Name?

- Artificial recharge
- Managed aquifer recharge (MAR)
- Aquifer Storage and Recovery (ASR)
- Aquifer Storage Transfer and Recovery (ASTR)
- Soil aquifer treatment (SAT)
- Managed underground storage (MUS) of recoverable water
- Recharge basin (pond), spreading basin, infiltration basin, surface spreading
- Recharge well
- Vadose zone (dry) well
- Bank filtration
NGWA ASR BSP: Scope and Definitions

• ASR includes:
  – dual purpose well(s) for recharge and recovery, and
  – separate recharge and production wells
• Focus is on using potable source water
What’s contained within the BSP?

– ASR goals and challenges
– Planning and implementation
– System components
– Source water considerations
– Aquifer characteristics
– Drilling methods, well design and construction
– Monitoring
– System performance evaluation
– Regulatory and policy requirements
– Stakeholder involvement
– Case studies
– Information resources
– Disclaimer
Goals

• **Operational Goals**
  
  — *Recharge*
  
  • Recharge goals are hydrologic in nature. An aquifer must be sufficiently permeable in order to accept water by pumping, without over-pressuring the aquifer or affecting existing users.

  — *Storage*
  
  • Storage goals are driven by a specific use, such as human consumption or crop irrigation, and often a particular time frame (seasonal, long term, or short term to meet municipal system or emergency demands), or to optimize availability of permitted water rights. Aquifer transmissivity and gradient should be such that the recharged water will remain near the point of recharge so that it can be recovered later through the ASR well.

  — *Recovery*
  
  • Recovery augments water supply for droughts, system outages, and meeting peak or seasonal demands. Recovered water must be of a quality suitable for its intended use and be in compliance with all permit criteria.
• **Aquifer Restoration Goals**
  — Aquifer restoration goals may aim to decrease or prevent declining water levels, reduce subsidence, and/or improve water quality (e.g., saltwater intrusion prevention or dilution).

• **Public Water Supply Goals**
  — A primary goal of ASR is providing for public water supply needs, including drinking water.
  — Urban ASR systems can provide a local emergency water source for fire control or loss of water supply during storms or earthquakes in areas where above-ground storage is not feasible.

• **Environmental Benefit Goals**
  — Recovery and distribution of stored water for environmental benefits including maintenance of appropriate wetland hydration and surface-water flows.
Issues & Challenges

• Regulatory complexity as an obstacle in many cases where there are overlapping federal and state jurisdictions
• Financial and scientific challenges can limit the use of ASR for smaller water utilities
• Perception of higher ASR project costs than some alternatives
• Perceived need for protection of recharge water from other pumpers
• Chemical reactions of recharged water with aquifer materials
• Technical issues include the need for improved design, construction, and development of ASR wells, and maintenance of well efficiency by minimizing well clogging and addressing source water quality variability
• Federal policy - current challenges to constructing and operating ASR facilities in some areas arise from the potential or actual endangerment of underground sources of drinking water by the operation of ASR
Components of a ASR System

(Intentionally simplified for reference)
Phases of ASR system development

Adapted from Maliva and Missimer (2010).
ASR Evaluation

- Planning and implementation of ASR projects
- Source water considerations
- Aquifer characterization
- Drilling methods, well design, and construction
- Monitoring of ASR systems
Other Considerations

• Guidance on evaluating ASR system performance
• Regulatory and policy requirements
• Considerations for stakeholder involvement
• Reference for case study information
• Further resources for federal and state agency information
Who contributed?

- Michael Alferi, PG
- Allan Biddlecomb
- Kevin Frederick, PG
- Marvin Glotfelty, PG
- Yemia Hashimoto, CHG
- Robert Maliva, Ph.D.
- Jessica Rhoads, NGWA Coordinator
- Kenneth Minn, PE
- June Mirecki
- Steve Musick, PG
- Tim Parker, PG, CEG, CHG
- Marcus Trotta
- Sam Upchurch