Lessons Learned from Site Closure at the American Electric Power at the Mountaineer Product Validation Facility
The Monitoring Program at the AEP PVF Site was a Comprehensive, Integrated Program

The PVF project at the AEP Mountaineer Power Plant consisted of a 20 MW CO₂ Capture and Storage System

CO₂ Capture and Injection took place from October 2009 - May 2011

Well network of 2 injection wells and 3 reservoir monitoring wells

Injection into two reservoirs, the Rose Run Sandstone and the Copper Ridge Dolomite

Monitoring Goals & Requirements

Protection and monitoring of the USDW

Differential reservoir pressure monitoring

CO₂ plume assessment through modeling

Well network mechanical integrity and well condition maintenance

Program Approach

Local groundwater sampling and analysis

Downhole pressure / temp. data collection

Reservoir pressure data analysis

Frequent well observation/ maintenance surface & well
Groundwater Monitoring Wells surround the Deep Injection and Monitoring Wells.

Deep Monitoring Wells completed approx. 7,800 – 8,000 ft.

Injection Wells completed approx. 7,800 – 8,000 ft.
Given the near surface baseline data that you have collected how will you use these data to attribute a signal?

- Potential short term chemical changes possible from CO\textsubscript{2} invasion:
  - decreased pH caused by dissolution of CO\textsubscript{2}
  - potential dissolution of carbonate minerals by acidic fluids and corresponding increase in alkalinity
  - mineral dissolution producing an increase in TDS due to an increase in cations such as Ca\textsuperscript{+2} and Mg\textsuperscript{+2}
  - increased concentration of acid-soluble metals such as iron and manganese

- Isotopes were evaluated to distinguish injected CO\textsubscript{2} from other sources of CO\textsubscript{2}.

<table>
<thead>
<tr>
<th>Cations</th>
<th>Anions</th>
<th>Physical Parameters</th>
<th>Other\textsuperscript{(b)}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium, Sodium, Calcium, Magnesium, Iron, Manganese, Aluminum, Barium, Boron, Lithium\textsuperscript{(b)}, Strontium, Dissolved Silica</td>
<td>Chloride, Sulfate, Bromide, Fluoride</td>
<td>pH\textsuperscript{(a)} Alkalinity (Bicarbonate) Alkalinity (Carbonate) Total Dissolved Solids Specific gravity/ Density\textsuperscript{(b)} Dissolved Organic Carbon Specific conductance\textsuperscript{(a)} Temperature\textsuperscript{(a)} Turbidity\textsuperscript{(a)}</td>
<td>Stable hydrogen isotopes (D/H) Stable oxygen isotopes (\textsuperscript{18}O / \textsuperscript{16}O) Stable carbon isotopes (\textsuperscript{13}C/\textsuperscript{12}C) Dissolved CO\textsubscript{2}</td>
</tr>
</tbody>
</table>

\textsuperscript{(a)} Field parameter

\textsuperscript{(b)} Optional parameter, may be done at AEP’s discretion
Have you done a sensitivity analysis or any quantitative analysis on what a leakage signal would look like given your data set?

Stable carbon isotopes ($\delta^{13}C$) were measured to help detect invasion of injected CO$_2$.

Stable carbon isotope activities remained consistent in pre-injection, during-injection and post-injection monitoring events.

Variability exists between monitoring wells and sampling events.
Have you done a sensitivity analysis or any quantitative analysis on what a leakage signal would look like given your data set?

**Stable Oxygen and Hydrogen Isotopes**

- Stable oxygen and hydrogen isotopes were monitored in the groundwater and compared with deep brine pre-injection samples.
- Upward migration of deep brine from injection reservoirs could be discerned from stable isotope data through two component mixing models.
- Trends within groundwater data (evaporation trend, etc.) may be needed to explain analytical results.
- Anion/Cation tracking alone can show false positives.
What are your protocols for deciding that there is nothing in the monitoring data that justifies any action?

Highest Priority is to Meet the Permit Conditions of Non-Endangerment

- Requirements include verifying that the CO₂ plume has stabilized and is not endangering underground sources of drinking water (USDWs)
- The UIC permit includes monitoring for:
  - Semi annual groundwater monitoring
  - Monitoring for specific constituents and parameters within the groundwater samples
- Regulators alerts if “any monitoring or other information which indicated that any contaminant may cause endangerment to an USDW” – **no specific indicators are noted in the UIC permit as requiring formal reporting/alerts.**

Secondary Priority is to Determine Potential Causes and Impact of Changes

- Environmental surroundings may impact analytical results and be difficult to identify and/or isolate.
- Pre-injection data for 1-year prior to injection may not fully explain fluctuations in monitoring results.
- Qualitative goals and outlines of analysis to be performed was developed in the baseline monitoring plan, but **specific/quantitative analytical ranges to trigger investigation were not defined.**