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# **Coal Bed Methane-Produced Water: Management Options for Sustainable Development**

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- Independent Multidisciplinary Scientific Team
  - Walt Merschat, Geochem
  - Kimberley MacHardy, Geoscience
  - Tom Myers, Geohydrology
  - Jim Kuipers, Water Treatment, Cost and Sustainability Analysis
- Two Studies Published:
  - Coal Bed Methane-Produced Water: Management Options for Sustainable Development
  - Technology-Based Effluent Limitations for Coal Bed Methane Produced Wastewater Discharges in the Powder River Basin of Montana and Wyoming
- Studies released as Draft Reports with 60 day comment period August 26<sup>th</sup>
  - Available at : [www.northernplains.org](http://www.northernplains.org)  
[www.kuipersassoc.com](http://www.kuipersassoc.com)

# Disposal Options

- ReInjection into depleted or confined coal seam
- Injection or percolation into depleted or confined deep aquifer
- Injection or percolation into shallow aquifer
- Evaporation of stored water
- Land or crop application discharge
- Direct discharge to surface water
- Discharge to municipal or industrial use

# CBM-Produced Water Disposal, Benefits and Impacts

	Groundwater	Surface Water	Soils, Native Plants and Agriculture	Other
Disposal Method	<ul style="list-style-type: none"> <li>• ReInjection into coal aquifer</li> <li>• Injection into aquifer</li> <li>• Percolation into aquifer</li> </ul>	<ul style="list-style-type: none"> <li>• Direct discharge</li> <li>• Indirect discharge via groundwater</li> </ul>	<ul style="list-style-type: none"> <li>• Crop irrigation</li> <li>• Land application disposal</li> </ul>	<ul style="list-style-type: none"> <li>• Evaporation</li> <li>• To other uses</li> </ul>
Benefits	<ul style="list-style-type: none"> <li>• Aquifer recharge (shallow and deep aquifer)</li> </ul>	<ul style="list-style-type: none"> <li>• Improve surface flows</li> <li>• Increase water to downstream users</li> <li>• Constructed wetlands</li> </ul>	<ul style="list-style-type: none"> <li>• Increased irrigation water and crop yields</li> <li>• Increased native plant pasture</li> </ul>	<ul style="list-style-type: none"> <li>• Wildlife and livestock watering</li> <li>• Municipal</li> <li>• Recreation</li> <li>• Industrial</li> </ul>
Impacts	<ul style="list-style-type: none"> <li>• Aquifer depletion</li> <li>• Aquifer contamination</li> </ul>	<ul style="list-style-type: none"> <li>• Spring and seep dewatering</li> <li>• Surface water contamination</li> <li>• Surface water flow alteration</li> </ul>	<ul style="list-style-type: none"> <li>• Increased salinity and sodicity</li> <li>• Increased erosion</li> <li>• Reduced crop yields</li> <li>• Loss of native species</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of aquatic species</li> <li>• Reduced/altered wildlife habitat</li> <li>• Aesthetics</li> <li>• Recreation</li> </ul>

# Water Treatment Methods to Reduce Impacts

- Reverse Osmosis
- Nanofiltration
- Ion Exchange
- Capacitive Desalinization
- Freeze-Thaw Evaporation Process
- Electrodialysis Reversal
- Rapid Spray Evaporation
- Distillation
- Sulphur Generators
- Downhole Separation
  - Molecular Filters

# Regulatory Requirements Applicable to CBM Water Disposal

- The *Clean Water Act* regulates via National Pollution Discharge Elimination System (NPDES) permits
- NPDES permits should be based on Best Available Technology/Best Professional Judgment criteria
- Proposed NPDES BAT/BPJ criteria:
  - Tier 1      Zero Discharge
    - No discharge of contaminants to surface water by using reinjection, injection, and evaporation.
  - Tier 2      Effluent Limitations
    - Treatment prior to discharge that results in non-degradation of surface water
- Economic Impacts
  - At \$2.50 MCF impacts ROI by 1-10%
  - At higher gas prices impact is significantly less

# Defining Sustainable Development

- Either an activity is sustainable, or it is not.
- To *sustain* means “to maintain; keep in existence; keep going; prolong” (Webster’s 1962). However, human society is constantly in flux and change is inevitable.
- Sustainable development from an economics standpoint: “economic development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.”
- Sustainable development from a societal standpoint: “the kind of human activity that nourishes and perpetuates the historical fulfillment of the whole community of life on earth”

# Basis for Sustainable Development Evaluation

- **Seven Questions for Assessing Sustainability**

(Source: International Institute for Environment and Development and World Business Council for Sustainable Development, Breaking New Ground: Mining, Minerals, and Sustainable Development, 2002)

1. **Engagement.** Are engagement processes in place and working effectively?
2. **People.** Will people's well-being be maintained or improved?
3. **Environment.** Is the integrity of the environment assured over the long-term?
4. **Economy.** Is the economic viability of the project or operation assured, and will the economy of the community and beyond be better off as a result?
5. **Traditional and Non-Market Activities.** Are traditional and non-market activities in the community and surrounding area accounted for in a way that is acceptable to the local people?
6. **Institutional Arrangements and Governance.** Are rules, incentives, programs and capacities in place to address project or operational consequences?
7. **Synthesis and Continuous Learning.** Does a full synthesis show that the net result will be positive or negative in the long term, and will there be periodic reassessments?

# Sustainable Development

- Most Sustainable Practices

- ReInjection into aquifers depleted or otherwise affected by CBM production
- Injection or percolation into depleted aquifers with water treatment as required, protecting and/or enhancing water quality
- Crop, livestock, municipal or industrial use with water treatment and other mitigations as required, insuring against negative impacts
- Surface discharges with water treatment as required, resulting in improved stream flows with adequate mitigations against negative impacts

# Sustainable Development

- Least Sustainable Practices

- Evaporation of water resulting in loss of resource
- Injection or percolation into aquifers where water quality is deteriorated and negative hydrological impacts occur
- Land application that creates negative impacts on soils and water quality
- Direct discharges that degrade water quality and negatively impacts aquatic life, downstream users or result in loss of resource

# CBM-Produced Water Regulatory Recommendations

- Issuance of guidance for and production of technology-based limits for discharges.
- Requirement and enforcement of NPDES permits for surface water discharges and groundwater discharge permits.
- Changes in leasing procedures to coordinate production in a manner that encourages or requires systematic production to maximize reinjection and appropriate injection practices.

# CBM-Produced Water Industry Recommendations

- Improved openness and responsiveness to landowner and public concerns and willingness to take reasonable measures (such as monitoring).
- Investment into research and development of new technologies and into capital improvements for long-term benefits.

# CBM-Produced Water Public Engagement Recommendations

- Improved public access to and involvement in the governmental and industry processes that lead to CBM production and produced water disposal decisions.
- Opportunities need to be created and funded for public input and collaboration
  - with meaningful dialogue and participation
  - ensure that all aspects of CBM production are considered by the regulatory and industry sectors
  - include the impacted landowners and concerned public in the decision-making process

# CBM-Produced Water - Conclusions

- The present situation surrounding CBM production in many cases adversely affects the environment and communities that depend upon it.
- Current development is not likely to result in a high degree of sustainable development, and will most likely result in overall negative impacts over the short-term and, in particular, the long-term.
- If the issues identified are addressed consistent with the recommendations set forth in this study:
  - many or possibly nearly all negative impacts of CBM-produced water can be addressed
  - and improvement can be realized from a sustainable development standpoint