Project Progress Report 10/28/2005

Overview

This document contains the first semiannual report on the two year Produced Water Management and Beneficial Use project that is overseen by the Colorado Energy Research Institute (CERI) at Colorado School of Mines, Golden, Colorado. The fundamental logic of this project is the recognition that no single treatment can be applied to all co-produced water from Coal Bed Methane (CBM) operations. This project is focused on the Powder River Basin of Wyoming, but the management and treatment procedures can be exported to other CBM areas in the US. There are tow major challenges to disposal of CBM water. The significant variations in volumes of CBM co-produced water during gas production and the unique chemistry of the water makes simple disposal options difficult. In addition, potable water is a valuable resource in the western US and with proper treatment, this water could provide a long-term economic benefit to farmers and ranchers. Therefore, a variety of options will be developed and evaluated to provide CBM operators with the most cost-effective and environmentally sound practices for co-produced water.

The project has a total of ten tasks (1-10) with subcontractors from the Argonne National Laboratory, the Gas Technology Institute, University of Wyoming, Stanford University, Montana Tech, Pennsylvania State University and a private firm, PVES Inc. The report is divided in sections for each task. Please note that task 2 is the responsibility of Argonne National Laboratory in collaboration with the Gas Research Institute. As such, that task is funded separately through Argonne. Task 10 is also the responsibility of Argonne National Laboratory and is funded separately through Argonne. In both case (tasks 2 and 10), separate progress reports are filed directly with DOE by those PI's. Abbreviated progress reports from those tasks are included in this report.

Task 0 – Colorado Energy Research Institute

PI – Dag Nummdeal

Funding was established for this project starting April 29, 2005. All subcontracts were in place by June 2005. CERI has held two meetings with most or all the subcontractors attending to establish financial and reporting procedures, identify areas of potential collaboration between projects and facilitate collaboration between projects. CERi will also try and identify specific areas of research not presently included to add to this project in future funding cycles. CERI is actively seeking opportunities for publication of results (tech transfer), and trying to expand industry participation to provide additional input and support including access to more field areas, input on research to date and ongoing problems and challenges associated with produced water management.

Task 1 - Membrane Enhanced CBM Treatment, University of Wyoming
PI's – Michael Urynowicz and Andrew Johnson

A graduate student, Rich Pribyl, has begun working on the project. Intact cores from John Wheaton (MTU) have been received and being characterized. The experimental apparatus for testing the permeability of the coal is being developed and tested. The experimental setup and procedures for testing commercial membranes for separating methane from produced water have been established and initial testing of the membranes to establish the partitioning coefficient have been completed.

Task 2 - Electrodialysis Treatment of CBM Produced Water for Beneficial Use: Laboratory Evaluation Phase

Prepared by

Gas Technology Institute and Argonne National Laboratory

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Argonne FWP 49243

The overall objective of this effort Development of electrodialysis processing for reliable, low-cost treatment of produced waters for the purpose of brine volume reduction with the simultaneous generation of demineralized water that is suitable for beneficial use. The rationale for the work is to avoid the costly membrane fouling that has hindered the field operation of other demineralization processes (such as reverse osmosis).

To facilitate the project, Argonne and GTI executed an agreement the covers sharing of equipment, assignment of personnel across the organizations, and intellectual property rights.

Produced Water Sample Selection and Analysis

In the first 6 months of Task 2.0, the work has proceeded on schedule. Produced water samples were collected from four CBM production fields in the State of Wyoming where produced water management issues have the potential of affecting future energy development. Analyses included total dissolved solids, total suspended solids, specific conductance, total organic carbon, ammonia nitrogen, alkalinity, chloride, sulfate, pH, barium, calcium, magnesium, potassium, and sodium. Several samples were also measured for dissolved silica. Initial water compositional data from two Powder River Basin fields (near the Sheridan and Arvada regions of Wyoming) show that the CBM produced water in these areas are low in total dissolved solids (TDS < 1400 mg/l) with cations dominated by sodium levels at around 650 mg/l, anions dominated by bicarbonate with carbonate alkalinity at around 1200 mg/l as CaCO3, no oils and greases, virtually no BTEX, calcium and magnesium at low levels (< 13 mg/l) and SAR values above 40. Samples from two other CBM fields in Wyoming have been collected and analyzed; these samples indicate a produced water that is more than twice the concentration of the initial samples with (again) no oils, greases, and BTEX. The process of collecting information from the two host companies that own the four fields from which produced water was collected has been initiated; this information will provide insight into issues and management challenges presented by produced water and how growing water volumes potentially constrain the pace of energy development in CBM basins.

Produced Water Treatment

Based on the compositions of the produced water samples, a laboratory prototype system consisting of microfiltration with a 0.45 micron filter and an electrodialysis unit with a stack of 10 cell pairs and CMX and AMX membranes have been designed and constructed; the electrodialysis laboratory skid was fabricated by Ameridia Corporation. Following preparation of safety plans, mechanical shakedown and pretesting, the staff of Argonne and GTI initiated preliminary experimental runs using a low-TDS sodium chloride solution and a synthetic mixture that simulates the low-TDS CBM produced water collected from the Powder River Basin. The sodium chloride run was conducted to check the integrity of the ED stack unit and membranes as well as determining the limiting current density of the low-TDS solution. Initial runs indicate efficient separation and concentration of cations and anions from the feed CBM synthetic water into a concentrated brine consisting of sodium, bicarbonate and divalent calcium and magnesium. Running in batch mode, data was collected from the laboratory ED unit to elucidate voltage drop per cell pair versus ion removal relationships for CBM produced water which translates to overall power consumption. This data helps to determine energy costs in achieving various water quality targets that comply with certain beneficial use purposes. Preliminary results based on the conductivity data of a synthetic mixture consisting of 50 mg/L $CaCO_3$, 38 mg/L $MgCO_3$, 25 mg/L KCL and 1200 mg/L Na_2CO_3 shows a 95 % ion removal and a voltage drop per cell pair below 1.8. Tests in future months will include determinations of the fate of constituents of interest, including barium, silicon, and ammonia, through the ED unit. Tests will also strive to determine the effects of prolonged operation on membrane integrity as well as clean-in-place protocols.

Publications to Date

No presentations, no publications, no patent filings to date.

Plans for the Next Report Period

1. Present water quality and treatment metrics to vendors. We will request feedback and relevant equipment and performance information from these vendors. (GTI lead)

2. Coordinate with other project investigators to identify criteria for beneficial use water (joint),

3. Run synthetic and field samples in the ED system to determine desalting performance capabilities, and power and chemical requirements needed to achieve a targeted output stream for beneficial use (Argonne lead).

4. Coordinate with other project investigators for initial scoping to pilot the processes (joint).

Task 3 - Isotopic Tracing of Produced Coalbed Methane Water in the Powder River Basin, University of Wyoming

UW personnel:

Carol Frost, PI,
Liddi Brinck, PhD student,
Cat Campbell, MS student, and
Mike Meredith, radiogenic lab manager.

Official cost-share is 1 month of C. Frost's research time, which will be logged in Sept. Oct, and Nov. 2005. In addition, we have freed additional resources by Liddi Brinck's successful application for an EPA STAR fellowship. Now that she is supported by EPA we have been able to add Cat Campbell to the team and also provide partial support the lab manager who maintains the facility and provides training and oversight for Cat and Liddi.

Our progress has been of two types:

1. continued monitoring of the Beaver Creek and Coal Creek sites
2. planning and logistics for new aspects of the project

The project has supported 4 trips to Beaver Creek, 3 times for our 3-monthly monitoring and water sample collection, and once for to collect water and biomass for a stable isotope pilot project. The project has also supported 3 additional field visits to the Powder River basin to sample amendments, soil and biomass to evaluate 3 different potential sites for an amendment study planned by Liddi Brinck.

The project has covered approximately 75 Sr isotope ratio and concentration analyses from these collection trips and for analyses of water samples collected at Coal Creek by John Wheaton. (We share our water collections to cut down on duplicate visits and save money. The Coal Creek site requires a boat to get to some of the wells, which John can provide more easily than UW.)

We also paid for protein and mineral analyses of one landowner's hay in exchange for initial access and possible use as a study site.

Liddi Brinck is preparing a manuscript for her PhD qualifier exam and for submission to Ground Water on the results comparing on- and off-channel discharge of produced water at Beaver Creek and Coal Creek, respectively. We expect to submit this manuscript before the next report is due.

Liddi Brinck is finalizing plans for her Ca-cycling study on CBM-irrigated land to which amendments are applied. She expects to have baseline data at around the time the annual report is due. Cat Campbell is obtaining permissions and arranging to sample CBM wells that have been classified by the Stanford group on the basis of their gas and water production characteristics. She expects to have her initial Sr isotopic data prior to the next reporting date.

Task 4 – Geomechanics and the effectiveness of wellbore completion methods in coalbed methane water in the Powder River Basin,

PI - Mark Zoback, Stanford University

The goal of this study is to evaluate coalbed methane (CBM) wellbore completion methods to determine if there are ways to produce less CBM water, while still achieving adequate coal depressurization for CBM production. Water enhancement tests are used by operators in the Powder River Basin to better connect CBM wells to the natural coalbed fracture network, presumably enhancing water and gas production. Colmenares and Zoback (submitted) demonstrated that water enhancement tests caused hydraulic fractures to form. Through analysis of 550 water enhancement tests from CBM wells in the Powder River Basin, they found that about half of the wells with vertical hydraulic fractures were producing up to 45,000 bbl/mo of CBM water, and little, if any, methane. They hypothesized that in the wells producing large quantities of water, vertical hydraulic fractures had penetrated the overlying units, and that most of the water being produced was actually from the overlying formations.

We have obtained water enhancement tests from 198 CBM wells from Cordilleran Compliance Services, that supplement the tests previously available (Figure 1). An initial analysis of the 198 wells suggests that 87 were hydraulically fractured during the water enhancement process, and almost all of the fractures are vertical. An additional 42 wells have water enhancement tests with wellhead pressures close to zero, or below zero, for the entire length of pumping (Figure 2). What is unusual is that the flow rates for these tests are similar to *typical* water enhancement tests with wellhead pressures between 300 and 800 psi. We postulate that the magnitude of the least principal stress (S_3) for these low pressure tests must be below hydrostatic pressure, and therefore, any hydraulic fractures that have been created through water enhancement must be vertical. Moreover, as the least principal stress in these tests is sub-hydrostatic, so must be pore pressure. This has important implications for the potential to inject CBM waters.

Future work includes continued analysis (and quality control) of water enhancement tests that show that hydraulic fracturing has occurred; mapping out the occurrence (and degree) of sub-hydrostatic pore pressure in the basin, calculating the magnitude of S_3; comparing the orientation of the hydraulic fractures with water and gas production and evaluation of methods to determine why the state of stress (and pore pressure) in the basin is so variable.

Reference Cited: Colmenares, L.B. and M. D. Zoback, Hydraulic Fracturing and Wellbore Completion of Coalbed Methane (CBM) Wells in the Powder River Basin, Wyoming: Implications for Water and Gas Production, *(submitted AAPG Bulletin).*

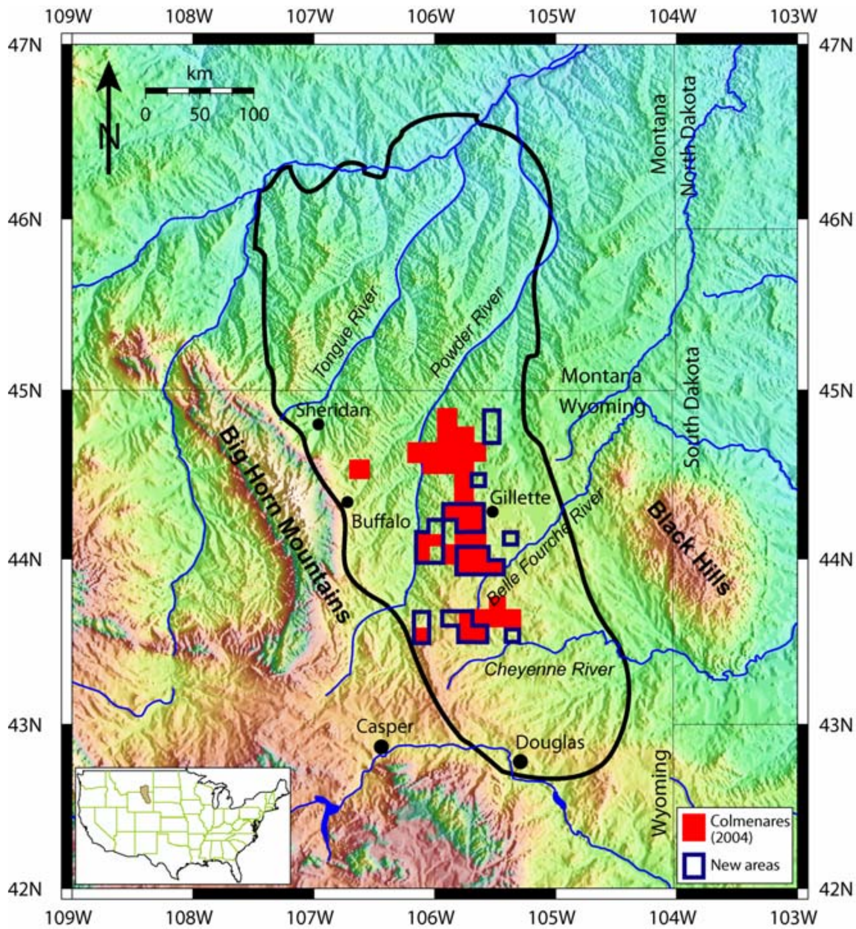

Figure 1: Map of the Powder River Basin showing the areas where Colmenares (2004) obtained water enhancement tests from CBM wells, and where our new water enhancement tests from CBM wells are located.

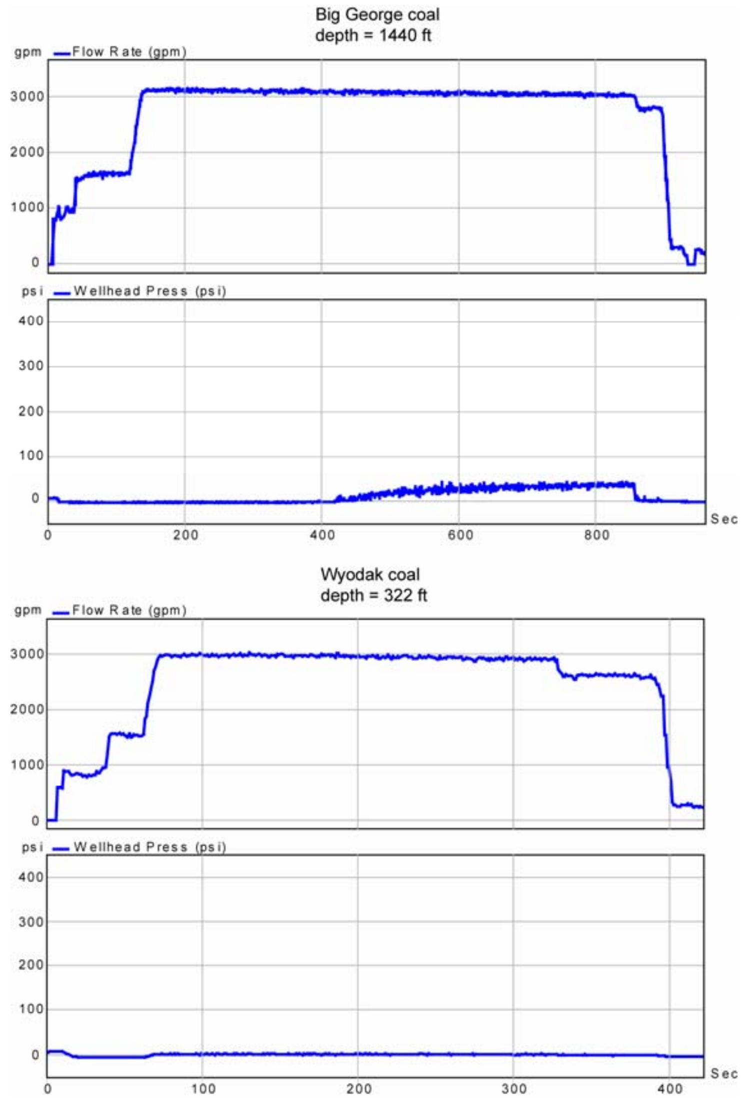

Figure 2: Two examples of water enhancement tests from CBM wells in the Powder River Basin with wellhead pressures close to zero.

Task 5 - Evaluating the Produced Water During CBM Extraction for Land Application in the PRB and Project management, PVES Inc.

PI – Terry Brown

The work is starting to move forward. The following activities are underway -

1. I am working with Energy Laboratories (lab facilities) to develop a usable method for determining cation exchange capacity of soils that contain calcite and gypsum, which tend to dissolve during the extraction process and result in poor data. The method modification has been developed and several samples have been analyzed using the mod-method. The results are currently being evaluated.

2. The fertility evaluation is underway. A site that has been irrigated for 2.5 years has been chosen for the study. Samples have been collected for analyses and soil has been collected to initiate a greenhouse study at Colorado State University. I have acquired space to conduct this work.

3. A site recently impacted with CBNG produced water has been chosen to show that impacted sites can be remediated at a reasonable cost. Samples have been collected for analysis and the Cooperator for this subtask - Continental Industries Inc. is making arrangements to acquire amendments, conduct the farming activities, and irrigate a portion of the site as in-kind costs.

4. Arrangements are being finalized with Marathon Oil to conduct the irrigation study at one of their irrigation pivots. I hope this is finalized in the next few weeks.

Task 6 - : Regional siting criteria for CBM infiltration ponds, Montana Technical University

This report covers the period from the project start (April 29, 2005) through October 30, 2005. The contract with Montana Tech was finalized in June, 2005, although some activities began before that date.

This project includes collection of field data and interpretation of those data. Field work and data collection occurred at 5 sites during this period. At the Coal Creek site, near Ucross, Wyoming, one new monitoring site was constructed during June, 2004 and has been added to the current regular monitoring field work. The site includes a shallow well to monitor ground-water flow to a spring. Samples from monitoring wells and the infiltration pond at Coal Creek were collected on a semi-annual basis as planned (March, 2005 and again in July, 2005). Water levels are measured at all wells and stream sites on an approximately monthly basis. A data logger and continuous recorders are utilized to measure meteorological parameters and stream flow. Along the Powder River near where it crosses from Wyoming in to Montana a new site was established during August, 2005 as part of this project. The site is a location where two historical flowing stock wells discharge sodium-bicarbonate water to small channels. This provides an opportunity to monitor the long-terms impacts of infiltration of sodium-bicarbonate water which is essentially identical to CBM-produced water. Water level measurements and water quality data have been collected. In Montana near the communities of Birney and Moorhead, two sites constructed prior to this project were monitored. These sites also provide data where historical flow of sodium-bicarbonate water, similar to CBM-produced water, interacts with surface and shallow materials. In addition to the wells and monitoring sites that are a direct part of this project, water-quality data were collected at wells across the Powder River Basin in Montana to further define anticipated CBM-production water quality. Though valuable for this project, expenses are not charged to this project.

Evaluation during the reporting period of existing and new data continues to improve our understanding of the hydrogeologic functions of CBM infiltration ponds. Grain size analysis data, originally thought to support a relationship between percent shale and rates of infiltration, now indicate little correlation. Rather, the sodium in the discharge water causes dispersion of the clays (even a very small percentage by weight) in the pond bottoms. This slows and eventually stops infiltration. Ground-water levels beneath and adjacent to ponds raises in response to infiltration and lowers as the pond bottoms seal. Total dissolved solids loads in the underlying and adjacent shallow aquifers increases, then decreases as available salts are flushed from the system and as water levels drop. Both water levels and water quality in ground-water systems affected by infiltrated CBM water are showing trends of returning toward baseline conditions with time, much as seen in coal mine spoils.

Task 7 - Controls on the Fate of CBM Waters and Impacts to Shallow Aquifer Quality, Pennsylvania University

PI – Demian Saffer

Activities on Task #7, "Controls on the fate of CBM Co-produced waters and impacts to shallow aquifer groundwater quality", have focused on two fronts: (1) maintaining and downloading data from remote hydrologic field data collection stations, and (2) calibration of numerical models using field data. To date, we have conducted several trips to the Beaver Creek and Coal Creek sites to download data from the weirs (Beaver Creek only), shallow aquifer/alluvial monitoring wells, and rain gauges. In September and October, 2005, the sites were shut down for the winter, to be reoccupied in Spring, 2006.

Initial analysis of the Beaver Creek water level data indicate a continuing trend of groundwater mounding beneath the stream channel. The rate of water level increase at both of the well sites has decreased compared with the first year deployment (funded by WRPF from July, 2003- July, 2004). The two well nests exhibited a water level increase of 2.6 ft and 3.3 ft from July 2003-2004, and rises of 0.9 ft and ~1.2 ft from July 2004-2005. Calculated infiltration rates for the study area are only available for part of the 2004-2005 period, because of a combination of instrument hardware problems (which are now rectified) and lack of information on CBM water production from the new operator in the watershed. As these data become available, a more detailed water budget can be developed "after the fact" for this time period. The partial dataset from 2004-2005 yields results consistent with those from 2003-2004, namely infiltration rates in the streambeds of 0.11-0.15 inches/hr and considerably lower infiltration rates in the ponds of ~0.01 inches/hr.

Our preliminary interpretation of the decreasing rate of groundwater mounding, in combination with apparent time-invariant infiltration rates is that lateral spreading of the mound beneath the streambed is occurring at a faster rate, because larger lateral head gradients have been generated. This hypothesis will be tested by future numerical modeling work.

Initial numerical modeling of infiltration and groundwater mounding are promising. Using data from slug tests to constrain aquifer properties, and a soils database for the Powder River Basin, models of infiltration honor existing data, namely: (a) average calculated infiltration rates, (b) constraints from Sr isotopic data on the timing for infiltrating water to reach the water table, and (c) observed groundwater mounding height. More detailed constraints on soil and aquifer properties, as well as additional modeling, will be required to more rigorously develop predictive and transferable tools for water management.

Task 8 - Perform Standardized Testing of CBM Water-Treatment Systems, Montana Technical University

This task is not scheduled to begin until Year 2 of this project.

Task 9 - Water Treatment by Injection, Montana Technical University

PI – David Lopez

Investigators: David A Lopez, Montana Bureau of Mines and Geology; Leo Heath, Petroleum Engineering Department, Montana Tech of the University of Montana

Project Term: One year; Phase one. It is hoped that Phase two can be funded in a following year for actual drilling, completing, equipping, and testing of an injection facility based on the research proposed here.

Purpose: To test the feasibility of disposal of produced water in shallow zones to preserve beneficial use by means of a pilot injection project.

Background: In the parts of the Powder River Basin produced water associated with Coal Bed Methane development is of quality sufficient for domestic and livestock use. But, it has a high SAR value making it unsuitable for irrigation use. Therefore, disposal methods can not include the discharge of large volumes of water to streams that are used for irrigation. Because of these restraints, water disposed by injection must be in zones shallow enough that can be tapped for later use in a cost-effective manner. It is not intended that injection be capable of handling the disposal of all the produced water, but to use the method in conjunction with other approved methods to develop an economically and environmentally feasible disposal system.

Procedure: Subtask 1. Geologic Research:
Accomplishments to date:

1. Generated data base for the project using PETRA software. Area compiled is all the Powder River Basin in Montana. Data includes: Township Range, and Section land grid data for the area from T9S to T3N and R37E to R51E in Montana; all oil and gas exploration data ('scout card data') for wells (3600 wells) in the same area; and raster image logs for all wells in the area.
2. Proposed target zones for injection are thick porous and permeable sands and non-producing coal beds in the Tongue River Member of the Fort Union Formation, which overlies the Lebo Shale Member. These shallow zones were chosen in order to preserve beneficial use of CBM-produced water. To reach this goal the Lebo Shale has been identified in all wells with available logs and a Lebo Structure map has been generated. Correlation of coal beds and 6 thick sandstones intervals above the Lebo has begun and is about 25% completed.

Subtask 2. Chemistry: Not yet begun.

Subtask 3. Petroleum Engineering:
Accomplishments to date:

1. Work to date has focused on a search of available methods and equipment for the down-hole separation of water from gas, and re-injection of the water into non-producing formations. Many journal articles, technical papers, patents, and new equipment applications have appeared in the petroleum industry during the past few years. This search is continuing with the objective of identifying appropriate methods to use with coal methane gas wells producing in the Powder River Basin area.

   The results of this search will provide methods for which engineering designs can be developed. Alternative disposal methods using conventional stand-alone injection well designs will be considered later.

   The search results and identification of feasible down/hole separation/re-injection methods are expected to be completed this quarter.

2. Contact has been made with companies in the industry that have reported successful re-injection in order to learn from their experience.

Task 10 - Ensuring that Technology Meshes with Regulatory Requirements, Argonne National Laboratory

PI – John Veil

I am already making separate monthly progress reports to Jesse Garcia

In any case, I did not receive my funding until some time last summer, 2005. There have been no requests for advice or consulting from any of the other researchers. I had planned to attend the team meeting in two weeks and give a brief overview on water regulatory topics, but my recovery from surgery in late August has gone slower than I planned. Therefore I will be giving my presentation by phone conference.

Here is my presentation. According to the schedule Dixie sent out a few weeks ago, my presentation is scheduled for 8:00 AM on Fri. I will be waiting in my office and will give the talk over the phone. The presentation includes a lot of slides but I can go through them quickly. Please let me know if you need anything else from me.

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Overview of Water Disposal Regulations

Produced Water Project Meeting
October 27-28, 2005
Colorado School of Mines
Golden, CO

John Veil

Environmental Sciences Division
Argonne National Laboratory

Contact Information

Topics for Discussion

- *U.S. national discharge and injection requirements for produced water*
- *The permitting process*
- *Applicability to CBM water*
- *Proposed changes to Montana regulations*

U.S. Regulatory System

Laws

- *Clean Water Act*
- *Safe Drinking Water Act*

Water Regulations

- *National Pollutant Discharge Elimination System (NPDES) program*
- *Effluent limitations guidelines (ELGs)*
- *Underground Injection Control (UIC) program*

Permits and Guidance

- *Environmental Protection Agency (EPA) regions and states issue NPDES and UIC permits*

Clean Water Act (CWA)

- *Federal Water Pollution Control Act of 1948*
  - 1972 amendments brought major overhaul of the law
  - 1977 and 1987 amendments strengthened programs
- *No point source discharges allowed to surface waters unless authorized by NPDES permit*
- *No discharges of toxics in toxic amounts*
- *Discharge limits must meet best available technology and also protect water quality*

Safe Drinking Water Act (SDWA)

SDWA – Continued

- *Regulates subsurface emplacement of waste*
  - Underground Injection Control Program (UIC)
- *Contains additional ground water protection programs*
  - Demonstration program to develop, implement, and assess critical aquifer protection areas (sole source aquifers)
  - Elective state program for protecting wellhead areas around public water system wells
- *Envisions protection of drinking water at the source*
  - Source Water Protection Programs

State vs. Federal Authority

- *Both CWA and SDWA are administered through regulatory programs*
  - Major regulatory programs can be delegated

•State can seek approval from the EPA for the day-to-day implementation and enforcement of programs
•Examples: NPDES, UIC
- When states do not have delegated authority, programs are administered by EPA regional offices

■ *State requirements can always be stricter than federal requirements unless barred by a state constitution*

State NPDES Program Authority

UIC Program Delegation

Major CWA Programs

NPDES Permits

EPA Headquarters Establishes National Effluent Limitations Guidelines (ELGs)

■ *performance-based controls*
■ *must consider:*
  - technologies that are already successfully in use
  - costs and economic impacts
  - non-water quality environmental impacts

Water Quality Standards

■ *Water quality standards (WQS) define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants*
■ *WQS consist of four basic elements:*
- (1) *designated uses* of the water body (e.g., recreation, water supply, aquatic life, agriculture),
- (2) *water quality criteria* to protect designated uses (numeric pollutant concentrations and narrative requirements),
- (3) an *antidegradation policy* to maintain and protect existing uses and high quality waters, and
- (4) *general policies* addressing implementation issues (e.g., low flows, variances, mixing zones).

Water Quality Standards (cont'd.)

■ *Every state must develop state-specific WQS that must be approved by the EPA*
- The EPA's recommended water quality criteria (WQC) provide technical guidance to states and tribes in adopting WQS

- WQC are developed for the protection of aquatic life as well as for human health
- The EPA's list contains 65 compounds and families of compounds; EPA continues to develop new water quality criteria for toxics, nutrients, microorganisms
  http://www.epa.gov/ost/standards/wqcriteria.html

■ *WQS are used to establish NPDES permit limits*
■ *WQS can serve as cleanup standards under CERCLA and RCRA*

Water Quality-Based Limits

■*States adopt numerical WQS for many pollutants*
■*States develop mixing zone policies that allow for dilution*
■*WQ-based limits are calculated by multiplying the WQS by the allowable dilution*
■*Permit limits must not cause exceedance of WQS outside of mixing zones*

Example of Permit Limit Calculation

1. Separately calculate technology-based limits and WQ-based limits.

2. Permit limit is the more stringent of the two.

	lead	*benzene*
Technology-based limit	200 ppb	1,000 ppb
WQ-based limit		
WQS	*5.6 ppb*	*700 ppb*
dilution	*20:1*	*20:1*
limit	*112 ppb*	*14,000 ppb*

Permit limit

Other NPDES Permit Conditions

- *Discharge rate*
- *Best management practices (BMP) plan*
- *Toxicity testing*
- *Ecological testing*
- *List of chemical additives*
- *Extra chemical monitoring*

EPA Oil and Gas Effluent Limitations Guidelines (ELGs) [40 CFR 435]

Onshore

Stripper *(<10bbl/day)*

Agricultural and wildlife use

Coastal

Offshore

Offshore and Coastal ELGs

- *Best Available Technology (BAT) for offshore produced water:*
  - Oil and grease limits before discharge
    - *29 mg/l monthly average*
    - *42 mg/l daily maximum*

- *BAT for coastal produced water*
  - zero discharge except in Cook Inlet, Alaska
  - Offshore limits are required there

ELGs for Wells Located Onshore

- *Onshore subcategory*
  - zero discharge
- *Stripper subcategory*
  - No national requirements
  - Jurisdiction left to state or EPA region
- *Agricultural and Wildlife Use subcategory*
  - produced water must have a use
    - Water must be of good enough quality for wildlife, livestock, or other agricultural use
    - Produced water must actually be put to that use
  - Oil and grease limit of 35 mg/l maximum

How Does This Relate to CBM Produced Water?

- ■ *During development of oil and gas industry ELGs, EPA did not envision or study CBM industry*
- ■ *Some parties suggest that oil and gas industry ELGs are not relevant to CBM water*
  - – CBM water is more like drainage from coal mines (regulated by coal mining ELGs at 40 CFR 434) than produced water from conventional oil and gas production
  - – CBM water could be regulated by BPJ

History of CBM Water Regulation

- ■ *Alabama fought the early battles*
  - – In the mid-1970s, CBM was produced for mine safety, not as a product
  - – During Arab oil embargo, natural gas prices rose, and coal companies tried to collect and sell the gas
  - – In early 1980s, Alabama producers petitioned EPA Region 4 for relief from oil and gas ELGs

•Being east of 98th meridian, Agricultural and Wildlife subcategory did not apply

  - – EPA agreed that, at least in Alabama, CBM water was not regulated by oil and gas ELGs

Permitting Practices in Alabama

- ■ *Alabama DEM originally issued NPDES permits based on coal ELGs and other water quality-based limits*

- ■ *As of 2002, permits contain:*
  - – Limits on pH, Fe, Mn, BOD, oil and grease, DO
  - – Monitoring for conductivity, chlorides, effluent toxicity
  - – Install diffuser
  - – BMP plan

Permitting Practices in Region 8

- ■ *WY, MT, and CO have NPDES primacy except for:*
  - – Tribal lands in all 3 states
  - – Federal facilities in CO

- ■ *WY and CO have elected to develop permits with limits based on BPJ and water quality protection*
  - – Did not use oil and gas/agricultural and wildlife use ELGs
  - – Do not have to demonstrate that water is being put to a beneficial use

UIC Program Objectives

■*The UIC program is designed to protect underground sources of drinking water (USDWs)*

UIC Program Definitions

UIC Well Classes

■*Class I wells are used for emplacing hazardous and nonhazardous fluids into isolated formations beneath the lowermost USDW*
■*Class II wells inject brines and other fluids associated with oil and gas production*
■*Class III wells inject fluids associated with solution mining of minerals*
■*Class IV wells, which involve the injection of hazardous or radioactive wastes into or above a USDW, are banned unless authorized under other statutes for ground water remediation*
■*Class V wells (those not included in Classes I through IV) inject nonhazardous fluids into or above a USDW (typically shallow, onsite disposal systems, e.g., floor and sink drains discharging directly or indirectly to ground water, dry wells, leach fields)*

UIC Program Requirements

- *The minimum requirements govern:*
  - Siting
  - Construction
  - Operation
  - Maintenance
  - Monitoring
  - Testing, and
  - Plugging and abandonment of the well
- *All injection wells require authorization under general rules or specific permits*
- *Finally, States may apply to have UIC Program primacy*

Proposed Changes to Montana Water Quality Regulations

- *Developed by Montana Board of Environmental Review*
  - Appointed panel
- *Changes are likely to significantly reduce the number and volume of CBM water discharges to Montana waters*
- *Public hearings:*
  - Nov 9 in Lame Deer, MT
  - Nov 10 in Miles City, MT
  - Dec 1 in Helena, MT

Proposed Changes

- *Discharges to Montana waters from CBM operations are prohibited as long as there are suitable shallow aquifers available for reinjection*
- *When such aquifers are not available, the proposal would require very rigorous discharge standards (see next page)*

NEW RULE VIII TREATMENT-BASED EFFLUENT LIMITATIONS

(1) If the department grants a waiver from the zero discharge requirement for all or a portion of the wastewater pursuant to [New Rules II and III], the amount of wastewater that obtains the waiver shall achieve the following minimum technology-based effluent limitations at the end of the pipe prior to discharge:

(a) calcium average concentration between 0.1 mg/L and 0.2 mg/L;

(b) magnesium average concentration between 0.1 mg/L and 0.6 mg/L;

(c) sodium average concentration of 10 mg/L;

(d) bicarbonate average concentration of 30 mg/L and instantaneous maximum concentration of 115 mg/L;

(e) sodium adsorption ratio instantaneous maximum of 0.5;

(f) electrical conductivity average concentration of 233 µmhos/cm;

(g) total dissolved solids average concentration of 170 mg/L;

(h) ammonia average concentration of 0.1 mg/L and instantaneous maximum concentration of 0.3 mg/L; and

(i) arsenic concentration of <0.0001 mg/L.

Additional Proposed Changes

- *Would require use of 7Q10 flow rather than a monthly flow when calculating compliance with state water quality standards for SAR and EC*
- *This has wider implications, since the Powder River flows from Wyoming into Montana, it may require Wyoming dischargers to reduce or eliminate their discharges in order to meet the new water quality standards at the state border*
- *A copy of the proposal can be found at:*

http://www.deq.state.mt.us/dir/legal/Notices/17-231pro.pdf