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1.0 Executive Summary

The *Final Environmental Impact Statement and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project* (FEIS) has identified impacts to soils and lands, and water resources that will occur due to extensive Coal Bed Methane (CBM) development. The Bureau of Land Management (BLM) has attempted to identify and evaluate mitigation measures to address water resource protection and reclamation of disturbed lands, but the present effort falls far short of ensuring that impacts will not occur that cause violations of state and federal water quality regulations, which will result in significant taxpayer liability for environmental cleanup.

The FEIS clearly acknowledges that impacts to soils and lands and water resources will occur. However, the environmental impacts from coal bed methane, while well known, have not been extensively described or studied. Based on my best professional judgment and expert opinions the following recommendations are made to the FEIS.

- The FEIS should be supplemented by an additional analysis that adequately describes and evaluates water disposal methods from the standpoint of BAT in compliance with the Clean Water Act and other applicable federal and state regulations.

- The state of Wyoming should complete the determination of BAT through the best professional judgment process or require technology based effluent limitations in their discharge permits in compliance with the Clean Water Act and other applicable federal and state regulations.

- Given the wide range of water treatment technologies for CBM produced waters with varying efficiencies and costs, which include reverse osmosis, nanofiltration, ion exchange, artificial wetlands, land application and many newly developing processes, the FEIS should have included additional information in the Alternatives and Environmental Consequences sections describing and evaluating the range of water treatment options.

- Given the cost effectiveness of water treatment technologies for CBM produced waters the FEIS should have included additional information in the Alternatives and Environmental Consequences sections describing and evaluating the cost effectiveness of water treatment options.

- The FEIS should either provide justification in the form of an actual evaluation of technological and economic feasibility of various water management and treatment methods, or should have included additional water management and treatment methods that have been proven feasible in other areas.

- The FEIS should have considered a combined Alternative 2A and Alternative 2B from a water management scenario in order to assess the benefits of a combined water treatment and infiltration alternative, and determined it to be the agency preferred alternative from a water management standpoint.

- The failure of the FEIS to recognize and address pollutants other than SAR and electroconductivity, and impacts other than to irrigated agriculture, is a major oversight that renders the FEIS' attempts to characterize the human and environmental impacts of CBM produced water incomplete. The FEIS should be supplemented to evaluate additional pollutants including barium, ammonia, fluoride, aluminum, lead, arsenic, total dissolved solids, manganese, iron, selenium, sulfate, zinc, and organic compounds.

- The FEIS and SWQA both fail to assess the impacts of infiltration to groundwater and subsequent transmission to surface water from pond infiltration, land application or injection because they assume no infiltration, which is not the actual case. The SWQA should be revised to run scenarios that show a reasonable degree of groundwater percolation based on actual experience from ponds, land application and reinjection, and their potential impact on surface water, and the FEIS should analyze the environmental consequences of those additional inputs.

- The FEIS and SWQA both fail to assess the site specific impacts of greater infiltration to groundwater and subsequent transmission to surface water from infiltration impoundments. The SWQA should be revised to run scenarios that show a reasonable degree of groundwater percolation and its potential impact on surface water (assuming up to 80% of percolation resurfacing and contributing to stream flows), and the FEIS should analyze the environmental consequences of those additional inputs.

- The NPDES permitting process should consider the additional inputs of CBM produced water from containment ponds, land application, reinjection, and infiltration impoundments and specify water treatment technologies as necessary to meet water quality standards. BLM failed to analyze how the NPDES program currently fails to consider the additional inputs of CBM produced water in its analysis of water impacts.

- Reclamation planning discussion should include identification of and evaluation of alternatives with respect to surface reclamation tasks such as resloping, grading, topsoil salvage and replacement, revegetation and monitoring. Discussion should also include specific measures to address areas of high salts or other contamination that could adversely affect surface revegetation or result in groundwater contamination.

- The FEIS in its present form does not address reclamation financial assurance provisions. The FEIS should be supplemented to provide a detailed explanation of reclamation financial assurance requirements, and provisions for each alternative. The FEIS should ensure that adequate financial assurance will be required for lands impacted by CBM.

- The FEIS should identify, describe and address interim reclamation measures to control surface water and limit erosion.

It is concluded that the approach taken by the FEIS to address impacts to water resources and soils and lands does not adequately or accurately describe the impacts or mitigation measures that will be necessary to ensure protection of the human and natural environment. The impacts to water quality have potentially been significantly underestimated due to limitations on pollutants considered and assumptions on infiltration from discharge areas. No coherent reclamation plan or information on financial assurance for areas disturbed by CBM development has been provided or considered in the FEIS. The only logical manner in which to address these concerns is for a supplemental environmental impact statement to be performed to address the gross inadequacies of the FEIS.

It is not surprising that the enormous task which has fallen on the agencies, to literally attempt to regulate an industry boom period, and adequately provide for address of human and environmental impacts, will require more effort to satisfactorily ensure compliance with the various federal and state regulations applicable to CBM development. That the resources will only become more valuable as time passes should serve as solace to the operators who recognize their corporate and ethical responsibility to ensure that the permitting process takes the time necessary to conduct a thorough and meaningful analysis based on facts.

2.0 Introduction

The following comments on the Final Environmental Impact Statement and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project (FEIS)1 have been prepared on behalf of the Wyoming Outdoor Council (WOC) and The Wilderness Society (TWS). The comments are based on review of the FEIS and supporting documents as referenced and professional expertise in environmental engineering and related matters.

The FEIS is intended to document and thoroughly study, disclose and evaluate the full range of reasonable alternatives of proceeding with a proposed action, including a hard look at all reasonable mitigation measures to lessen impacts to protect the human environment as a result of on-going and anticipated-future coal bed methane (CBM) and conventional oil and gas development in the Powder River Basin in the state of Wyoming. The FEIS presumes to assess the possible impacts of CBM development likely to occur through 2010, or over the next 10-year period.2 According to the FEIS, the Proposed Action would be completed around the end of 2020. In contrast to the Wyoming FEIS, the Montana FEIS analyzed the possible impacts of CBM method over the entire 20-year period during which the proposed action would occur, which is more consistent with typical NEPA process.

The reasonably foreseeable development scenarios examined in the FEIS range from a "moderate" level of 81,000 total CBM wells, with 50,000 wells drilled by 2010 to "high" scenario which projects 139,000 total CBM wells, with 80,000 drilled by 2010.3

The Wyoming Department of Environmental Quality (WDEQ) and U.S. Department of the Interior, Bureau of Land Management (BLM) are the primary regulatory agencies responsible for CBM and oil and gas permitting and enforcement. The BLM was the lead agency in preparing the FEIS, with the cooperation of WDEQ.

These comments are organized to address the issues of water quality impacts and other impacts to the environment that would occur in the event the preferred alternative were to be implemented as described in the FEIS. The comments are based on my professional qualifications in the areas of water quality, water management and treatment, land reclamation and financial assurance estimation. My professional qualifications are contained in the attached résumé (Exhibit 1), and the information provided is a true and correct statement of my qualifications, education and experience. I have over 25 years experience in the mining and environmental industry and 20 years professional experience as an engineer, manager and consultant in the mining and environmental industry. My recognized areas of expertise are mineral processing, project feasibility analysis and environmental matters including regulatory permitting, site assessment, wastewater treatment, reclamation/closure, and financial assurance. I am a professional engineer currently registered in Montana and Colorado.

Since 1989, I have testified as an expert witness in mining and environmental administrative and judicial legal matters in the states of Arizona, Montana, New Mexico and Utah. I have also provided written reports concerning water quality, wastewater treatment, permitting, reclamation and closure, and financial assurance for a variety of clients on federal appeals and hearings. I have been a primary responsible party in environmental planning and regulatory permitting and am familiar with the environmental practices employed by industry and the regulatory permitting processes in the western U.S. states. I have been a primarily responsible party in the feasibility and economics evaluations of numerous mining and environmental projects in the U.S. and abroad and am highly familiar with the economics practices employed by industry.

3.0 Discharge Water Treatment Clean Water Act Requirements

Some of the following discussion concerns state agencies and their duty under the CWA to address water handling methods and best professional judgment factors. BLM has the obligation to study and address these issues as well.4

Section 301(a) of the Clean Water Act (CWA) outlaws the discharge of pollutants from any person unless the discharge is in compliance with numerous requirements of the CWA.5 One of those requirements is that the discharge be permitted under Section 402.

Section 402(a)(1) allows the issuance of a permit for the discharge of pollutants upon the condition that such discharge will meet one of two conditions:

(A) all applicable requirements under section 1311, 1312, 1316, 1317, 1318, and 1343 of this title, or

(B) prior to the taking of necessary implementing actions relating to all such requirements, such conditions as the [Department] determines are necessary to carry out the provisions of this chapter.6

The CWA requires that all National Pollutant Discharge Elimination System (NPDES) permits include technology-based effluent limitations.7 Section 301(b)(2)(A) requires effluent limitations that "shall require the application of best available control technology economically achievable for such category or class, which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants."

There are two approaches for developing technology-based limits for industrial facilities like coal bed methane projects: (1) National effluent limitations guidelines (ELGs) and (2) in the absence of ELGs, limitations developed on a case-by-case basis using best professional judgment.8 The EPA did not consider CBM when it developed the ELGs for the Oil and Gas Point Source Category, 40 C.F.R. Part 435 and thus has not applied them to CBM facilities.

Therefore, according to 40 C.F.R. §125.3(c)(2), the agencies are required to develop technology-based effluent limitations for methane produced water using their best professional judgment. 40 C.F.R. §125.3(a) states that "[p]ermits shall contain the following technology-based treatment requirements . . ."9 Part 125.3(c) states that technology-based treatment requirements may be imposed through one of the following three methods: (1) application of EPA-promulgated national effluent limitations; (2) on a case-by-case basis under Section 402(a)(1) (commonly referred to as the best professional judgment process); or a combination of the two.

Using the best professional judgment process, the agencies should have determined the effluent limitations that represent the Best Available Technology (BAT) economically achievable for CBM discharges and required the most stringent one to be implemented. In exercising its best professional judgment, the agencies are required to consider the factors listed in Section 125.3(d) and shall consider: (i) the appropriate technology for the category or class of point sources of which the applicant is a member, based upon all available information; and (ii) any unique factors relating to the applicant. Part 125.3(d)(3) requires the permit writer, in exercising their best professional judgment, to consider the following factors: (1) the age of the equipment and facilities involved; (2) the process employed; (3) the engineering aspects of the application of various types of control technologies; (4) process changes; (5) non-water quality environmental impacts including energy requirements; (6) the costs of achieving such effluent reduction.10

The federal facilities portion of the Clean Water Act mandates that BLM, in allowing federal CBM wells to be drilled, abide by all federal, state, interstate and local requirements, including state water quality standards.11 Technically this a WDEQ responsibility, but in developing the full range of reasonable alternatives, these criteria provide guidelines for how BLM should have carried out its NEPA responsibilities in terms of cost, feasibility and possible application of these technologies to reduce water impacts. By failing to consider these issues in a supplemental draft EIS, BLM failed to take a hard look in developing a full range of reasonable alternatives that would serve to mitigate many of the impacts of the proposed action.

3.1. FEIS Analysis of BAT for CBM Discharge Water

The FEIS provides extremely limited discussion of water disposal methods. For example, Chapter 2 Alternatives describes Alternative 2b as emphasizing the use of passive and active treatment. Passive treatment is described as "water that is amended through passive methods to mee4t standards before discharge. An example of this method is passing the water over scoria to remove iron." Active treatment is described as "water that is amended through active treatment to meet standards before discharge. An example of this method is passing the water through a reverse osmosis system."12 However, at no point in the FEIS or otherwise referenced are water treatment methods, either passive or active, described in detail.

No examination of BAT appears to have taken place in support of the FEIS. No analysis of the six factors described above is provided for any of the water disposal methods described in the FEIS. Therefore, the FEIS does not contain any analysis of the economic and technological feasibility of the various treatment and disposal alternatives in the FEIS.

BLM failed to consider under its federal facilities obligation the BAT for water treatment options. The BATs are similar to the alternatives that BLM should have considered in the FEIS' analysis of the full range of reasonable alternatives to consider water treatment options that could lessen water impacts from CBM produced water discharges.

Recommendation: The FEIS should be supplemented by an additional analysis that adequately describes and evaluates water disposal methods from the standpoint of BAT in compliance with the Clean Water Act and other applicable federal and state regulations.

3.2. BAT for CBM Discharge Permits

The state of Wyoming has issued hundreds of National Pollutant Discharge Elimination System (NPDES) permits or methane discharges and the state of Montana has issued on MPDES permit for methane discharges and intends to issue a general MPDES permit for discharges into off-channel impoundments as part of this FEIS process. The states of Wyoming and Montana have not completed the determination of BAT through the best professional judgment process or required technology based effluent limitations in their discharge permits.

Recommendation: The state of Wyoming should complete the determination of BAT through the best professional judgment process or require technology based effluent limitations in their discharge permits in compliance with the Clean Water Act and other applicable federal and state regulations.

3.3. Water Disposal BAT for CBM Discharges

In the FEIS, Alternative 2a emphasizes use of infiltration impoundments to dispose of CBM produced water. In contrast, Alternative 2b emphasizes the use of passive and active treatment to dispose of CBM produced water.13 The agency has identified Alternative 2a as its preferred method for water management.

Despite repeated references to water management and treatment in the FEIS, there is no actual description provided as to the type or effectiveness of treatment that would be used, making it impossible to determine whether changes in surface water quality caused by the discharge of the effluent would comply with Wyoming water quality standards and downstream Montana water quality standards.

CBM Water Treatment

CBM produced water disposal has generally been performed by surface discharge to an impoundment followed by evaporation, commercial water hauling and handling, and in some cases discharged into surface water or land applied. In other cases it is used for beneficial purposes including livestock, irrigation, and for dust suppression. In some regions (i.e. San Juan Basin) re-injection is the most common method of produced water disposal. The capital costs for produced water disposal under these scenarios ranges from $10,000 (piping to surface discharge) to greater than $1.5 million (conversion of deep well to reinjection well). The costs are highly dependent on the particular disposal method as well as site-specific costs (mainly due to relative remoteness), and generally range from $1.25 to $300.00 per thousand gallons, with a median cost of around $30 per thousand gallons.14

As reported by Hodgson, water treatment for CBM discharges must address total dissolved solids (TDS), electrical conductivity, Sodium Adsorption Ratio (SAR) and elevated levels of certain metals and other ions.15 Water treatment technologies currently in use include membrane processes (reverse osmosis and nanofiltration).16 New technologies include capacitive desalination; freeze-thaw evaporation; and biological treatment.17 Other efforts are being made to use so called "natural" processes such as artificial wetlands and land application (including amended land application).18 The following sections describe each process, its effectiveness, and relative cost, which are summarized in Table 1.

Table 1
Comparison of Water Disposal Treatment Technologies
For Coal Bed Methane

Process	Effectiveness	Cost
Membrane Processes	High	Moderate
Ion Exchange	High	Moderate
Down-Hole Separation/Reinjection	Very High	High
Capacitive Desalination	High	Moderate
Freeze-Thaw Evaporation	High	Moderate
Artificial Wetlands	Low	Low
Land Application	Low to High	Low to Moderate

Membrane Processes

Reverse osmosis (RO) and nanofiltration (NF) are membrane technologies that can be applied to the treatment of various water sources for the production of relatively high purity (such as drinking water quality) water. Membrane technologies are water purification processes that take wastewater under pressure and sweep it along one side of a semi-permeable membrane, causing clean water to pass through and leaving behind a concentrated solution (brine). The brine solution is then either treated additionally (such as by evaporation) or hauled for disposal at alternative locations. RO employs a "tighter" membrane resulting in a higher degree of salt rejection than NF membranes achieve, therefore it is more efficient at removing dissolved solids, but because of the high pressures involved it is more expensive and prone to operational problems such as membrane scaling.

High-pressure RO membranes can effectively remove high TDS (mainly sodium, chloride and bicarbonate) found in CBM produced water. The advantages of RO are its high efficiency at removing undesirable contaminants, in most cases producing an effluent that meets drinking water standards. The disadvantages are the relatively high operating costs (due to the energy costs resulting from high pressure pumping). Recent innovations such as lower pressure RO membranes and "tight" nanofiltration membranes have proven successful at producing satisfactory effluent water quality at lower operating pressures than conventional RO, resulting in reduced operating costs.19 Typical RO treatment and disposal costs vary from $2 to $7 per thousand gallons.20

Ion Exchange

Ion exchange is a process that uses a reversible chemical reaction wherein an ion (an atom or molecule with an electrical charge) from solution is exchanged for a similarly charged ion attached to an immobile solid particle. In water deionization processes, the resins exchange hydrogen ions (H+) for the positively charged ions (such as sodium) and hydroxyl ions (OH-) for negatively charged sulfates and chlorides. Because the quantity of H+ and OH ions is balanced, the result of the ion exchange treatment is water that typically meets drinking water standards. It is comparable to RO in terms of treatment efficiency and cost.

New Processes

Down-Hole Gas/Water Separation with Re-Injection

Although perhaps not a water treatment process, down-hole gas/water separation, combined with re-injection, is perhaps the most advantageous way of dealing with CBM produced water. Although it is highly dependent on the suitability of a given CBM deposit, it is worthwhile to mention it as the likely BAT in at least some situations, as it prevents any form of surface discharge. Down-hole separation and disposal costs have been estimated at $20-$25 per thousand gallons.21

Capacitive Desalination

According to Welgemoed, Capacitive Deionization Technology (CDT) represents a breakthrough in desalination of brackish source water as compared to existing membrane and ion exchange technologies. Because the energy requirement is low, CDT could be an attractive alternative for remote areas that could utilize solar energy. Tests of CBM wastewater from the Powder River Basin showed a significant reduction in total dissolved solids (TDS) with estimated energy consumption of 2.25 kWh/1000 gallons for typical CBM wastewater. 22

Freeze-Thaw/Evaporation

According to Boysen, the Freeze/Thaw Evaporation (FTE) process for treatment of produced water was first developed in the 1990s. The freezing of water is a crystallization process that can be used to purify produced water. The FTE process couples of the processes of freezing and evaporation making them more economic and effective for treatment of produced water year-round. The inventors claim that "the reduced water treatment/disposal costs can result in increased production from economically marginal oil and gas resources."23 The treatment and disposal costs for the FTE process are estimated at $9 per thousand gallons.24

Biological Treatment

Biological treatment utilizes biological reactions to pretreat produced waters. Under one scenario anaerobic reactors would remove most organic material along with H2S (hydrogen sulfide). The wastewater then would undergo aerobic polishing for removal of remaining organic material prior to entering a membrane process. The process is most useful in situations where high organic matter and H2S are a consideration, and could result in a simple and cost-effective pre-treatment process.25

Other potential new processes applicable to CBM produced waters include electronic water purification, rapid spray evaporation, electrodialysis and carbon aerogel technology.26

Artificial Wetlands

Another approach that is being proposed for treatment of CBM produced water is the creation of artificial wetlands. Artificial wetlands rely on natural properties of plant and microbial life to treat CBM water. Issues with artificial wetlands treatment include pollutants, native plant suitability, area requirements, and regulatory aspects. Artificial wetland treatment has shown an ability to reduce hydrocarbon contamination, but not address total dissolved solids.27 Infiltration ponds are sometimes touted as artificial wetlands, however the benefits are typically casual at best and due to accumulation of salts and other pollutants may actually be an attractive hazard for wildlife.

Land Application

Land application of wastewater is a process which attempts to use agronomic uptake of water by crops or native vegetation to affect water treatment. Amelioration of pollutants by soils and groundwater is also sometimes claimed to affect water treatment. The actual extent to which land application actually treats wastewater depends on the pollutant(s), the land application practices, site specific characteristics (vegetation, soils, hydrology, and geology), and the whims of mother nature (storms and seasonal changes). For that reason the actual efficacy of land application varies from highly effective (nearly complete uptake) to poor (equivalent to shallow groundwater discharge).

The Wyoming FEIS for the Powder River Basin contains the following passage concerning LAD:

"The consideration of LAD as a beneficial use of CBM produced water can only be determined after an extensive evaluation of the land application operation has been completed. Many environmental factors must be assessed to determine both the potential risk and potential benefits for land application to be considered a viable option for disposal of discharge water. The best management practices for land application will be an evolving process as new research, data, and processes become available."28

This clearly shows that the relative variability in suitability and effectiveness of LAD is well recognized. In many applications LAD really doesn't constitute treatment as agronomic uptake and soil adsorption don't occur under various circumstances or conditions. In practicality LAD is a process that may just spread the pollution, and fail to provide any beneficial treatment.

According to DeJoia, soil amendments can be used to prevent soil degradation when land applying CBM produced water to irrigate grass crops. Produced water from the Powder River Basin exhibits relatively high TDS, bicarbonate concentrations and SARs, which creates problems when it is used for irrigation because it can impact crop growth and soil properties. Soil amendments, in the form of gypsum and sulfur, appeared to effectively control soil SAR (crop growth was not impacted). However, whether it affects soil properties is still uncertain.29

A number of hybrid water treatment and land application systems are used in the treatment of CBM produced water. For example, the Aqua SO2 process uses a combination of sulfurous acid to lower pH and remove bicarbonates and gypsum to lower SAR.30 The Harmon SO2 sulfur burner technology is similarly used to treat SAR, bicarbonates and pH for irrigation as well as livestock and other industrial uses.31

Water treatment could be used to mitigate any water quality concerns and combined with return of the water to appropriate aquifers (by reinjection if necessary) to restore groundwater hydrology would mitigate most of the concerns, more than any other option, related to potential groundwater and surface water impacts from CBM produced water, and should have been considered as an option in the FEIS.

Recommendation: Given the wide range of water treatment technologies for CBM produced waters with varying efficiencies and costs, which include reverse osmosis, nanofiltration, ion exchange, artificial wetlands, land application and many newly developing process, the FEIS should have included additional information in the Alternatives and Environmental Consequences sections describing and evaluating the range of water treatment options, and include an option which combines water treatment and re-injection.

3.4. Water Disposal Options Cost Effectiveness

It is a generally acknowledged fact that as the amount of produced water increases, the current CBM discharge permitting practices which primarily rely on the lowest cost methods, such as discharge to surface water, will change.32 The FEIS contains no discussion on the cost effectiveness of the various water treatment methods either today, or in the future.

Goerold conducted a financial analysis of four alternatives which are summarized in Table 2.33 Goerold's analysis shows that under present circumstances, the prevailing surface disposal and shallow injection methods allow CBM producers to obtain a profit of from 36-44% return on investment (ROI). The cost of technologies such as reverse osmosis allows CBM producers to still obtain a profit of 27% ROI and deep injection would allow 21-25% ROI. In all cases the producers would be able to obtain a reasonable profit, well above that of most other market sectors. Although Goerold's analysis was provided as comments to the Draft, the FEIS contains no response to those comments and fails to perform any type of economic analysis. The only information provided by the FEIS, assumes each well would generate from $792,000 to $1.3 million in revenue, and Alternative 1 is expected to contribute an estimated sales value discounted at 10% of nearly $21.8 billion (constant 2001 dollars) over the life of the project.34 The FEIS did not examine the actual profit margin and economic feasibility of Alternative 1 or any of the other Alternatives or to specific water treatment technologies.

Recommendation: Given the cost effectiveness of water treatment technologies for CBM produced waters and the range of water handling scenarios possible, the FEIS should have included additional information in the Alternatives and Environmental Consequences sections describing and evaluating the cost effectiveness of water treatment and handling options.

Return on Investment (ROI), Powder River Basin Northern Region
(from Goerold, 2002)

CBM Produced Water Disposal Method	Return on Investment	Net Present Value (@ 10% DROR)
Surface Disposal	44%	$158,000
Shallow Injection	36-38%	$138,000-$139,000
Reverse Osmosis and Shallow Injection	27%	$105,000
Deep Injection	21-25%	$71,000 - $96,000

4. Alternative Selection and Agency Preferred Alternative Rationale

The FEIS provides a number of responses to comments on the Draft regarding the narrow range of alternatives, and in particular water management and treatment alternatives, that were chosen for detailed analysis. Those arguments consisted of: injection and other alternative technologies not yet being proven as a feasible option for disposal of CBM produced water;35 and alternatives do not necessarily respond to the purpose and need of the proposed action.36 The FEIS makes the determination that "Only those water treatment methods that are technologically and economically feasible for use in the Project Area were analyzed ..."37

Nonetheless, the FEIS provides no actual description of evaluation showing how or on what basis or assumptions the determination of "technologically and economically feasible" was made. There is nothing site specific about the Project Area that should significantly affect the technical or economic feasibility of technologies that does not occur in other areas where those technologies are in use.

Recommendation: The FEIS should either provide justification in the form of an actual evaluation of technological and economic feasibility of various water management and treatment methods, or should have included additional water management and treatment methods that have been proven feasible in other areas.

The FEIS identifies Alternative 2A as the agency's preferred method for water management. Alternative 2A emphasizes use of infiltration impoundments to dispose of CBM produced water. In contrast, Alternative 2B emphasizes the use of passive and active treatment to dispose of CBM produced water.

According to the FEIS, the BLM prefers Alternative 2A's emphasis on infiltration to reduce or mitigate impacts to water for five reasons.38 The first reason relates to separate water management strategies for each sub-watershed aligning with WDEQ's current approach to permitting. This could similarly be accomplished by Alternative 2B. The second, third and fourth reasons all relate to minimizing the volume of water that is discharged downstream to surface waters, by maximizing infiltration. This could similarly be accomplished by Alternative

2B. The fifth reason states that Alternative 2A "Encourages treatment of produced water, where feasible and practicable" is illogical as Alternative 2B would actually encourage a much greater amount of treatment of produced water under the same scenarios.

Water treatment such as in Alternative 2B to improve CBM produced water quality would allow greater flexibility and ensure that WDEQ's current sub-watershed approach to permitting would result in meeting water standards in each sub-watershed. Following water treatment, the same approaches utilized to obtain the benefits of Alternative 2A in terms of minimizing discharges could be utilized with the additional water quality benefits provided by Alternative 2B. Clearly Alternative 2B would result in the same benefits as Alternative 2A, and provide additional benefits in terms of water quality.

Recommendation: The FEIS should have considered a combined Alternative 2A and Alternative 2B from a water management scenario in order to assess the benefits of a combined water treatment and infiltration alternative, and determined it to be the agency preferred alternative from a water management standpoint.

5. Surface Water Quality Impacts

According to the USGS, generally CBM produced waters contain sodium (Na), bicarbonate (HCO3), and chloride (Cl). CBM water is relatively low in sulfate (SO4). The TDS ranges from low (200 mg/L) to high (170,000 mg/L). It is believed that trace-element and volatile organic compound concentrations are commonly low (<1 mg/L). However, it should be noted that data is commonly limited to the major dissolved cations and anions, and information on trace metals and isotopic composition is said to be "sparse."39

The USGS acknowledges that the fate of CBM produced water is dependent on the composition of the water, and that "Important (underline added) composition information should include TDS (often equated to the amount of "salt" a water contains), pH, concentrations of dissolved metals and radium, and the type and amounts of dissolved organic constituents."40

The discussion in the FEIS of surface water impacts from CBM produced water discharges narrowly focuses on electroconductivity and SAR and the impacts of such changes on irrigation practices.41 The FEIS uses CBM produced water from the Fort Union Formation to characterize CBM water in the basin. However, it should be noted that for CBM produced water from the Fort Union Formation appears to be relatively good quality compared to the range of data found by the USGS, and it may not be representative of the water quality found in other formations in the basin.

The known range of TDS in the PRB ranges from approximately 500 to 2,800 mg/L. It is not reasonable to assume, as the FEIS does, that the Fort Union Formation CBM produced water quality can be accurately or meaningfully used to extrapolate CBM produced water quality from 51,000 wells, most of which will be in new formations and far from the Fort Union Formation. Extrapolation of limited data across an eight million acre project area is one of the critical flaws in the FEIS. The FEIS could have been improved by concentrating the baseline analysis on the Upper Powder River and Upper Belle-Fourche drainages, where approximately 63% of all new wells and facilities will be located. According to the FEIS, most of the new wells will be in largely untested formations where there is little data and water volumes will be higher than current wells.42 This further undermines the scientific credibility of the FEIS.

Various parameters of concern in methane produced water in addition to SAR and electroconductivity include barium, ammonia, fluoride, aluminum, lead, arsenic, total dissolved solids, manganese, iron, selenium, sulfate and zinc. The FEIS does not contain any significant discussion on CBM produced water with respect to parameters other than TDS, electroconductivity and SAR. It would be critical to know more about the characteristics of CBM produced water with respect to pH, dissolved metals and dissolved organic constituents in order to be able to assess their potential impacts.

The treatment methods mentioned in the previous section, such as reverse osmosis, have the potential to treat for and therefore address at least some of these other pollutants. The FEIS fails to assess the abilities and benefits of water treatment to address additional pollutants.

Recommendation: The failure of the FEIS to recognize and address pollutants other than SAR, TDS and electroconductivity, and impacts other than to irrigated agriculture, is a major oversight that renders the FEIS attempt to characterize the human and environmental impacts of CBM produced water incomplete. The FEIS should be supplemented to evaluate additional pollutants including barium, ammonia, fluoride, aluminum, lead, arsenic, total dissolved solids, manganese, iron, selenium, sulfate, zinc, and organic compounds.

6. Land application and Impoundments Discharges

The FEIS was revised to include the results of a Surface Water Quality Analysis (SWQA) examining surface water quality impacts associated with CBM development in the Powder River Basin. This document, the assumptions contained within it, and the analysis it provides are very important to the analysis of impacts to surface waters from CBM produced water discharges. It is absolutely critical to evaluating the cumulative impacts of Wyoming and Montana discharges when combined. That this document was not produced in time for incorporation into the DEIS in order to allow for public review and comment exists as a significant shortfall in the FEIS, and it should have been presented along with other information mentioned in these comments in a Supplemental EIS.

According to the SWQA conducted for the FEIS, the containment, LAD, and injection would not contribute to existing stream flows.43 Therefore, the analysis assumed that none, or 0% of the water that is contained in unlined ponds, land applied or injected will reach surface waters.

The assumption that 0% of the water under these circumstances would reach surface waters flies against conventional wisdom and experience. Even in projects that are designed for zero discharge to surface frequently can, and do result in discharges to surface water. For example, it is not uncommon in hardrock mining applications for solutions contained in engineered lined ponds, which are more intended to prevent leakage than typical unlined CBM produced water ponds, to leak, and in many cases for that leakage to reach groundwater and in some cases surface water. Similarly, injected water, if injected to shallow aquifers, can similarly result in discharges to surface water in gaining stream reaches. Experience with LAD discharges in numerous applications have all shown a propensity for surface water impacts far more commonly than is generally assumed.

As previously mentioned, land application of wastewater is a process which attempts to use agronomic uptake of water by crops or native vegetation to affect water treatment. The actual extent to which land application actually results in zero percolation through the soil/plant profile and into groundwater and subsequently potentially into surface water depends on the land application practices, site specific characteristics (vegetation, soils, hydrology, and geology), and the whims of mother nature (storms and seasonal changes). For that reason the actual efficacy of land application to result in zero discharge varies from highly effective (80% uptake or better) to poor (less than 20% uptake in some cases). In no cases, from a practical standpoint, does land application result in 100% reduction of percolation to groundwater and therefore no transmission to surface water.

Recommendation: The FEIS and SWQA both fail to assess the impacts of infiltration to groundwater and subsequent transmission to surface water from pond infiltration, land application or injection because they assume no infiltration, which is not the actual case. The SWQA should be revised to run scenarios that show a reasonable degree of groundwater percolation based on actual experience from ponds, land application and reinjection, and their potential impact on surface water, and the FEIS should analyze the environmental consequences of those additional inputs.

According to the SWQA conducted for the FEIS, the analysis assumed that 15% of the CBM produced water discharged to infiltration impoundments would resurface in-channel and contribute to existing stream flows. The SWQA provides no basis for this assumption, and practical experience shows that it has no basis. Infiltration ponds are typically intended to result in the percolation of over 90% (the remainder being lost to evaporation) of the discharged water to groundwater. The amount of groundwater that is then transmitted to surface water is site specific, but ranges from 100% to less than 10%, and is represented by gaining and losing stream reaches, in addition to the formation of seeps and springs (which are also surface waters protected by applicable water quality standards). The transmission from groundwater to surface water is site-specific and would depend on such factors as soils (saturated or unsaturated flow), geology (fracture flow), and hydrology (direction of flow and distance to surface water). The site specific factors affecting infiltration impoundments and the impacts to groundwater and surface water resources were not analyzed or even mentioned in a subwatershed by subwatershed analysis in the FEIS.

The FEIS states that it is not possible to predict the changes concentrations of parameters in the produced water caused by evaporation and concentration of metals and salts in the containment ponds. However, the FEIS is more than willing to make the assumption that all the water entering the containment ponds will either be held, evaporated, or infiltrate into the ground. Regardless of the amount of evaporation, the mass load of water contaminants entering the pond, and therefore being either discharged from the pond or remaining in it as salt deposits, is highly predictable. For that reason it is not necessary to predict the changes in concentration to predict the impact infiltration from containment ponds will have on groundwater. The FEIS should have recognized the feasibility of including data based on contaminant loads rather than concentration to address the impact of evaporation on water stored in containment ponds.

Recommendation: The FEIS and SWQA both fail to assess the site specific impacts of greater infiltration to groundwater and subsequent transmission to surface water from infiltration impoundments. The SWQA should be revised to run scenarios that show a reasonable degree of groundwater percolation and its potential impact on surface water (assuming up to 80% of percolation resurfacing and contributing to stream flows), and the FEIS should analyze the environmental consequences of those additional inputs.

Given that the assumptions about percolation from containment ponds, infiltration impoundments, LAD and re-injection into groundwater are potentially grossly inaccurate, the modeling that was done in the SWQA and relied upon by the FEIS to predict impacts on mainstem water quality and other water-related impacts does not reliably or accurately depict the potential outcomes of CBM produced water management.

As these additional inputs have the significant potential to result in CBM produced water degrading surface water quality the additional inputs from containment ponds, land application, reinjection, and infiltration impoundments should be considered. In the same manner, the need for and specification of water treatment technologies to meet water quality standards should also be considered.

Recommendation: The NPDES permitting process should consider the additional inputs of CBM produced water from containment ponds, land application, reinjection, and infiltration impoundments and specify water treatment technologies as necessary to meet non-degradation standards.

7. Reclamation Issues

Reclamation, and the accompanying issue of financial assurance, have become primary focal issues in the area of natural resource utilization. Experiences with the mining industry, which have cost state and federal taxpayers over $200 million dollars as a result of failure to adequately reclaim mine sites as characterized by the 1992 bankruptcy of Galactic Resources, owners of the Summitville Mine in Colorado, and 1998 bankruptcy of Pegasus Gold, and similar experiences in other industries, have shown that reclamation planning and financial assurance, to ensure that affected lands are reclaimed to a productive post-industrial use and that industry, not the taxpayer, pays the cost, are critical as a mitigation measure to any project which disturbs public and private lands and water resources.

The combined hardrock mining industry in Montana since 1980 has disturbed approximately 13,500 acres of land. The combined financial assurance is about $213,000,000 or about $16,000 per acre.44 By contrast, the Wyoming FEIS predicts that approximately 194,000 acres will be disturbed by CBM production related facilities.45 Presently $25,000 blanket bonds for all wells by an operator in a state (for federal minerals) are used to provide financial assurance for CBM produced water. The FEIS fails to address the adequacy of these blanket bonds to provide the necessary financial assurance as is discussed below.

Reclamation Planning

The limited information provided by the FEIS raises several additional issues that should be addressed. Examples include how a criteria of revegetation cover qualifies as revegetation success when plant diversity is also a key factor affected by reclamation and also indicative of revegetation success; and how failed reclamation efforts will be addressed. The FEIS does not address how the revegetation cover criteria and diversity will be measured? Other issues include the mitigation of areas of spills or salt contamination and the additional reclamation tasks and costs that could result from cleanup of those areas.

The FEIS does not include an adequate description of the baseline erosion, sediment, and total suspended solids levels in surface waters. It does not adequately quantify and predict the increases in such levels as a result of development, and it does not adequately describe and evaluate the effectiveness of various BMPs and other mitigation measures to minimize these impacts. It does not adequately evaluate the increased in sediment loads on aquatic life and other uses.

Recommendation: Reclamation planning should include identification of and evaluation of alternatives with respect to surface reclamation tasks such as resloping, grading, topsoil salvage and replacement, revegetation and monitoring. Discussion should also include specific measures to address areas of high salts or other contamination that could adversely affect surface revegetation or result in groundwater contamination. It should evaluate impacts from erosion and sedimentation on aquatic life and other uses.

Financial Assurance

The FEIS in a few places mentions "bonding" or financial assurance, but nowhere in the documents is it described or analyzed.46 Financial assurance is the establishment of surety bonds or other acceptable financial assurance to cover the full cost of reclaiming the impacts of CBM development to ensure that taxpayers do not unintentionally pay for those costs. The principle is well accepted as a responsible measure in both law and practice, and is considered a routine mitigation and is frequently cited in environmental assessments.

Experience in the hardrock mining industry suggests minimum costs of $2,000 per acre for surface reclamation of flat areas such as roads, and minimum costs $10,000 per acre for areas of ponds and similar disturbances which require additional tasks or materials.47 Based on 80,000 acres disturbance associated with areas of ponds or similar disturbances, and an additional 114,000 acres of roads and other flat areas, the total reclamation liability for CBM production in the state of Wyoming is estimated at approximately $1,028,000,000. This estimate alone should serve to validate the importance of addressing financial assurance in the FEIS.

It is important to note that the concept of walk-away reclamation has evaded the hardrock mining industry, and likely will become difficult for the CBM industry to achieve, at least from the standpoint of long-term revegetation success. It is likely that on-going efforts will be needed to ensure weed control and revegetation diversity and abundance to support post-CBM land use, including additional weed control and revegetation treatments in addition to monitoring. It is important to include the costs of conducting long-term operations and maintenance in support of reclamation as the ability of companies to sustain themselves as a viable entity over long periods of time are questionable.

Recommendation: The FEIS in its present form does not logically or adequately address reclamation financial assurance provisions. The FEIS should be supplemented to provide a detailed explanation of reclamation financial assurance requirements, and provisions for each alternative. The FEIS should ensure that adequate financial assurance will be required for lands impacted by CBM.

Interim Reclamation

The FEIS contains numerous references to interim reclamation, but does not provide any description of those measures.48 The FEIS should describe interim reclamation measures typically used to control surface water and limit erosion. These measures include surface water run-on prevention conveyances (berms and ditches), BMPs (such as silt fencing) and interim revegetation as well as other measures to address water quality and other concerns. Interim reclamation is a typical requirement at mine sites in Montana administered by BLM including such sites as the Zortman and Landusky Mine sites where interim reclamation has been necessary during the preparation of SEIS to prevent unnecessary or undue degradation.49

Recommendation: The FEIS should identify, describe and address interim reclamation measures to control surface water and limit erosion.

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