John Bredehoeft, Ph.D.

Subject: Comments—Wyoming & Montana Final Environmental Impact Statement on the development of Coal-Bed Methane

QUALIFICATIONS—John Bredehoeft, Ph.D.

In 1995 I established a consulting firm—The HYDRODYNAMICS Group. I devoted the previous 32 years to public service at the U.S. Geological Survey (USGS). My expertise is in water resources, especially groundwater; I worked on many aspects of water related problems. During my years at the USGS, I held both scientific research and high-level management positions. In 1994, I retired as a senior research geologist from the Water Resources Division of the USGS.

In the tradition of the USGS, I held positions in both research and high-level management. For five years in the 1970s, I managed the USGS National Water Research Program. In the early 1980s, I was the Regional Hydrologist, Western Region, where I supervised the Survey's water activities in the eight western states—Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon, and Washington. I taught one year as a visiting professor at the University of Illinois; and was a consulting professor at Stanford for 8 years, and at the University of California—Santa Cruz, and San Francisco State University for several years. I served on numerous national advisory committees for the National Research Council, the National Science Foundation, and the Department of Energy. I have published more than 100 scientific papers in established scientific journals.

I am a member of the U.S. National Academy of Engineering; I am also a Foreign Member of the Russian Academy of Natural Sciences. I received numerous honors and awards. My resume and bibliography are attached to the end of this document.

The following are my opinions.

IMPACTS ON GROUNDWATER

The most significant impact on the water resources of the Powder River Basin will be the impacts on deep wells and their owners. Thousands of deep water wells will have be abandoned and replaced with wells drilled to other aquifers. Many of the replacement wells will have water of poorer quality; much of the replacement groundwater will have to be treated. Hundreds, if not several thousand other deep wells will have to be reworked with pumps reset lower. These impacts entail significant costs, especially for the well owners. Well owners are not adequately protected by the proposed water well agreements.

It is feasible to mitigate the impacts of CBM production on the deep water wells. In many instances this will be expensive.

The Wyoming and Montana FEISs are deficient in addressing the problems posed by CBM development on the deep water wells currently producing in the Powder River Basin. Neither the impacts nor the cost of mitigating these impacts were adequately addressed.

Introduction

CBM development is underway in the Powder River Basin of Wyoming and Montana. There will be 51,000 CBM wells in Wyoming and another 26,000 in Montana drilled to extract methane from the Fort Union coals within the basin. The production will lower water levels within the Fort Union coal beds by more than 700 feet in Wyoming and up to 600 feet in Montana. The Powder River Basin will become one gigantic gas field with CBM wells almost everywhere. The gas production will produce a regional decline in water levels within the Fort Union across the basin. CBM production is projected to continue through the year 2017.

Coal beds contain methane; the coal beds in the undisturbed state are saturated with groundwater, often rather good quality groundwater. Most of the methane in the undisturbed state is adsorbed on the coal. The adsorbed methane can be released be reducing the fluid pressure; i.e. by reducing the groundwater pressure. One reduces the water pressure by pumping out the groundwater. As the water pressure goes down the methane is freed from the coal, and a combination of gas and water are produced.

The coal beds are not very porous; the porosity is thought to be 0.4 percent. However, the coal beds are reasonably permeable because of the fractures (*cleats)* within the coal. The coals often contain better quality water than the surrounding sand aquifers; in places the coal beds are the most permeable aquifers. For these reasons the coal beds are often the preferred aquifers for groundwater development.

The coal beds are generally immediately overlain and underlain by rocks of low permeability. When the water pressure in the coal bed is reduced significantly the coal bed becomes saturated with both gas and water. (Petroleum reservoir engineers now describe the system as a two-phase coal-bed reservoir in which both free gas and water coexist.) As some point gas can dominate the reservoir. As the fraction of gas dominates the coal-bed the water production declines. It is common to see coal-bed methane wells where the water production declines with time.

Development of CBM from the Fort Union coal beds conflicts with the use of the Fort Union coal beds as aquifers. In producing CBM one attempts to maximize the drawdown thereby releasing the maximum amount of methane from the coal. For a water well owner the CBM production maximizes the groundwater pumping lift making the well much less useful for water supply; it may also make what was a water well a water and gas well.

Groundwater Model Predictions

Wyoming used a groundwater model of the basin to make an analysis of the predicted drawdown caused by the CBM development. I found the Wyoming analysis to be both state of the art and convincing. The model is generally quite complete. Grid cells were 0.5 miles by 0.5 miles in size, a size that is more than adequate for the model. This means that given 80 acre spacing for the CBM wells there could be up to 4 CBM wells simulated per grid cell.

The objective of the groundwater model was to predict the regional impact over the basin. The fine detail of what happens at the local scale is lost in the regional model. No attempt was made to analyze local scale groundwater flow. BLM is straightforward in listing the limitations of the model. Even so, the model provides credible estimates of the regional impact of CBM development on the deep water levels within the basin.

The Wyoming model is calibrated to data from a limited set of observation wells. The highest concentration of wells is along the eastern flank of the basin in the area around Gillette and to the south, and along the Montana/Wyoming state line north of Sheridan. There are very little observation well data for the deeper portions of the basin.

The Wyoming model predicts the impact of full development in the Powder River Basin in Wyoming. It is true that the Wyoming model included only the Wyoming portion of the basin. The Wyoming model predicts a maximum drawdown in some areas of more than 700 feet—this seems reasonable. The Montana FEIS suggests a maximum drawdown of 600 feet. The Powder River Basin will become one giant regional gas field.

Given the Wyoming result the predicted drawdown for Montana seems reasonable. The Montana analysis is difficult to judge. The Montana FEIS is very incomplete in describing the details of the analyses, especially in comparison to the Wyoming FEIS. The Wyoming FEIS contained maps of the predicted declines in water levels in various formations for differing years in the future—for example years 2006, 2009, 2018, 2030, and 2060. There were no comparable maps in the Montana FEIS.

One of the important facets of the coal bed aquifers is the permeability of the claystones that overlie and underlie the coal measures. There are only two locations in the Marquiss Field in Campbell County, Wyoming where there are data on a 10-year water level decline within both the coal and the associated Wasatch sands. These are the only locations where the permeability of the claystones can be quantitatively estimated. This estimate is then applied to the model of the entire basin. More locations with similar data are desirable. The Montana FEIS does not indicate similar data in Montana. The claystone permeability estimated at the Marquiss Field is consistent with the long-term production of water from the CBM wells.

In the heart of the CBM development what once were good water wells may now become gas wells with greatly reduced water production. Many good water wells will have to be abandoned in the heart of the CBM productive areas. BLM made no attempt to estimate which wells, or the areas where wells will become gas wells.

IMPACTS OF CBM DEVELOPMENT ON WATER WELLS

As suggested above, both Wyoming and Montana used groundwater models to predict the decline in water levels (*drawdown)* within the Fort Union coal beds. Both models suggest very significant drawdown on a regional scale within the Powder River Basin—up to 600 feet in Montana, and up to more than 700 feet in Wyoming. As indicated above, the modeling appears to be quite reasonable. The predictions are probably a good measure of the expected regional drawdown.

Fort Union Water Wells

The groundwater models predict a regional decline in water levels within the Fort Union coal beds. In the center of the basin in Wyoming the predicted decline ranges from 400 to more than 700 feet at the peak of CBM production. This means that water levels in water wells producing from the Fort Union coal measures will undergo the same regional declines. The effect of the CBM production is to make one gigantic gas field that extends over much of the Powder River Basin.

The Wyoming FEIS (Table 3-7) suggests that there are somewhere between 2500 and 6500 wells producing from the Fort Union coal measures within the Wyoming portion of the Powder River Basin—it is hard to tell exactly how many wells because many wells are classified by the State Engineer as *"other"*. One can expect that many, if not most these wells will be seriously impacted. Some will undergo water level declines of several hundred feet. If water production continues some wells will become largely gas wells. A major portion of these wells will become unusable—either there is too much gas, or the water level decline is so great as to make further pumping too costly. BLM made no attempt in either Wyoming or Montana to conduct a Fort Union water well inventory.

In addition many flowing wells completed in the Fort Union Formation will stop flowing. The Montana FEIS (Map 3-5) indicates a density of water wells similar to that in Wyoming spread across the Powder River Basin in Montana.

Many of the Fort Union wells will have to be replaced with wells drilled to other deep aquifers. In many instances these other aquifers contain water of poorer quality. Some of the replacement groundwater will have to be treated to be useable. BLM make no attempt to assess the number of Fort Union water wells impacted by the CBM production, or the poorer quality replacement water, or the cost of mitigation.

Wasatch Water Wells (Hell Creek/Fox Hills Wells)

The Wyoming groundwater models indicate that the drawdown within the Wasatch Formation will be approximately 10% of drawdown in the Fort Union coal measures. Even though there is limited observational data to support this conclusion, the conclusion appears quite reasonable. The Fort Union coals are overlain and underlain by low permeability clay and shale layers that serve to isolate the coal measures from more permeable sands that both underlie and overlie the coals. The fact that water levels can

be lowered significantly in the coals indicates that they are isolated hydraulically. The low permeability layers above and below the coal are not totally impermeable; they leak water into the coal when the fluid pressure in the coal is reduced significantly. (Hydrogeologists refer to this groundwater flow as *leakage*.)

The Wyoming groundwater models predict 40 to 70 feet of regional water level decline over much of the basin in the Wasatch Formation caused by CBM production. The Wyoming FEIS (Table 3-7) indicates that there are from 3300 to 7000 Wasatch production water wells within the Powder River Basin. Many of these wells will be impacted by the regional decline in water levels. The yields of these wells will decline as the water levels drop. Some wells will require that the pump be set deeper because of the decline in water level. BLM made no attempt to do a water well inventory of Wasatch/Lower Hell Creek—Fox Hills deep wells.

The Wyoming modeling shows that there is a lag in time associated with the drawdown in the Wasatch Formations versus that in the Fort Union coals. The maximum drawdown in the Wasatch Formation is delayed by 5 to 10 years over the maximum drawdown in the Fort Union Formation. In other words, if the maximum drawdown in the Fort Union occurs in year 2017 the maximum drawdown in the Wasatch Formations will occur between 2025 and 2030 (see Figure 4-30 in the Wyoming FEIS).

This lag could pose problems for Wasatch well owners. The maximum impact of CBM production in the Wasatch Formation will probably occur after the majority of CBM wells are plugged and abandoned, and the CBM operators are gone.

While these impacts are not discussed in the Montana FEIS one can expect a similar impact on the deep completed in the Lower Hell Creek—Fox Hills aquifer in Montana. BLM made no attempt to assess the impacts on wells drilled to the Wasatch aquifer in Wyoming or wells drilled to the Lower Hell Creek—Fox Hills aquifer in Montana. Nor did BLM attempt to estimate the cost of mitigation to wells adversely impacted.

Assessment of Groundwater Impacts--FEIS

Both the Wyoming or Montana FEISs are deficient in addressing the impacts on existing deep water wells within the Powder River Basin. Wyoming had a table that lists the numbers of water wells that could be potentially impacted (Table 3-7) and a map of Fort Union water wells. Montana had a map of deep water wells that could be potentially impacted. However, there should have been:

1. An inventory of deep water wells—Fort Union, and Wasatch/Lower Hell Creek--Fox Hills.

2. An assessment of specific impacts based upon the model predicted drawdown and the location of deep wells—so many wells in each county or watershed to be abandoned and redrilled to other aquifers, so many wells to be reworked, pumps

lowered, new pumps set, etc. This could have been done based upon the model predictions, the current CBM experience, and the inventory of wells.

3. There is the issue of poorer quality replacement groundwater. Many replacement wells will be of poorer quality water. In order to use the replacement groundwater it will have to be treated. While the poorer quality replacement water is mentioned there is no assessment of the magnitude or the costs of this impact.

4. An economic assessment of what the well mitigation will cost. Let's assume 5000 wells are impacted with an average mitigation a cost of $10,000 per well, the total cost is $50,000,000—probably a low estimate. If this cost falls largely on the well owners, as the current laws seem to dictate, there will be many unhappy farmers and ranchers. The implication of both FEISs is that fixing well damages is a problem that will be arranged between the local CBM producers and the water well owners.

5. Finally there is the problem of impacts that linger beyond the plugging and abandonment of the CBM wells. The Wyoming modeling in particular shows that the maximum impact in the Wasatch Formation occurs approximately a decade later than the maximum drawdown in the Fort Union coals. There is no attempt to address the long-term impacts even though long-term impacts are predicted and discussed in the Wyoming FEIS.

Well Owner Protection

A *water well agreement* (Appendix G in the Wyoming FEIS) is proposed to mitigate problems with water wells caused by CBM development. There are a number of specific conditions of the agreement, of interest here are:

1. The agreement applies only to water wells that produce from the Fort Union coals. (Wasatch wells are not included in the agreement.)

2. The water well must be within the circle of influence of a producing (or shut-in) CBM well. The circle of influence (COI) is defined as 0.5 miles in radius. In other words, there must be an active CDM well within 0.5 miles of the water well in question.

3. The agreement expires when the CBM well for which the agreement applies is plugged and abandoned.

This agreement does not protect many well owners. First it applies only to Fort Union wells. Wasatch wells, even though the groundwater models predict that the drawdown in the Wasatch will be approximately 10% of the magnitude of drawdown in the Fort Union, are not included. The predicted regional drawdown in the Fort Union ranges up to 700 feet. The models suggest that the drawdown in the Wasatch will be up to 70 feet;

over much of the basin. These drawdowns are sufficient to adversely impact many Wasatch water wells. The same can be said for wells in the Lower Hell Creek—Fox Hills wells in Montana.

Secondly the groundwater models indicate that the drawdown caused by CBM development is regional in nature. In other words, the CBM development causes drawdown that extends across the basin—the entire Powder River Basin becomes one gigantic gas field. The groundwater models indicate that the drawdown is tied collectively to the entire development. However, damage to a water well, as defined by the water well agreement, is tied to the well within the circle of influence of a CBM well (or wells)—0.5 miles. There will be places in the CBM developed portion of the Powder River Basin where there is no operating CBM well within 0.5 miles, yet where the groundwater models predict a decline in the Fort Union water level of more than several hundred feet. In other words, there may be no active CBM well within 0.5 miles of an impacted water well; the impact is caused by the collective CBM development.

BLM in the Draft EIS suggested that *the maximum extent of the projected drawdown in the target coals, defined as drawdown of at least 10 feet, extends 10 to 12 miles beyond the areas of CBM delevelopment.* In view of this statement it seems totally unrealistic to restrict the circle of influence in the well agreement to 0.5 miles.

Many Fort Union water wells within the Powder River Basin will have to be abandoned. In Wyoming the obvious solution is to drill a water supply well into the overlying Wasatch sands. Comparable yields appear to be possible from the Wasatch sands. However, the quality of the Wasatch water is often not as good as that in the Fort Union. The Wyoming FEIS suggests 10% more total dissolved solids in the Wasatch groundwater; in many places 10% may be an underestimate of the degradation in water quality. There is no provision in the water well agreement to compensate well owners for degradation in their groundwater quality.

The Wyoming FEIS suggested that CBM production will be over by year 2017 (Figure 2-2). Water levels in the Fort Union Coal recover following the cessation of production. The modeling suggests that the drawdown in Fort Union water levels in year 2030 still ranges from 50 to more than 100 feet over much of the Wyoming portion of the Powder River Basin—10 to 15% of the maximum drawdown. By year 2060 the predicted drawdown in the Fort Union is 40 feet over much of the basin—something like 5 to 10% of the maximum drawdown remains. The agreement provides no relief once the CBM wells are plugged and abandoned even though impacts from the production persist.

The modeling also shows that the maximum drawdown in the Wasatch is delayed by about 10 years from the time of maximum drawdown in the Fort Union (Figure 4-30 in the Wyoming FEIS). This means that the maximum impact in Wasatch wells may occur a decade or so after production ceases in the Fort Union. This may be after most CBM wells are plugged and abandoned—the CBM operators will be gone.

A Montana water well agreement is not included in the Montana FEIS, although the references in the Montana FEIS suggest there may be a standard agreement similar to the one in Wyoming.

A Better Well Agreement

The *water well agreement* is inadequate for the reasons stated above and summarized here:

1. The groundwater models show significant declines caused by CBM production in the Wasatch Formations. Water wells in the Wasatch Formations are excluded from the agreement.

2. Groundwater modeling shows a regional drawdown across the basin caused by the CBM production. Not every water well impacted will have an active CBM production well within 0.5 miles.

3. Impacts may persist beyond the period where the majority of CBM wells are plugged and abandoned, especially in the Wasatch Formation.

4. Degradation in replacement water quality is not covered by the agreement.

BLM failed to address a method of funding the costs of mitigating water well impacts other than to suggest through the water well agreements that these costs will be the responsibility of the CBM operators. One potential solution is for BLM, and/or the states to create a water well fund that could be used to mitigate impacts where water wells are damaged by CBM production. This would eliminate the idea of a circle of influence of individual CBM wells and treat the problem as regional in nature. Money could be reserved in the fund to protect against problems that occur after the CBM wells are plugged and abandoned.

In lieu of a fund, I believe:

1. Wasatch wells and Hell Creek—Fox Hills Formation wells, and perhaps other deep wells (any well that can be demonstrated to have been impacted) should be included in the water well agreement;

2. the circle of influence of CBM wells should be increased to reflect the regional nature of the CBM drawdown;

3. there should be compensation of well owners when the groundwater from replacement wells requires additional water treatment; that compensation should cover both the cost of the treatment equipment and its operating costs;

4. there should be some mechanism created to mitigate the impacts of CBM production on water wells after the CBM wells are plugged and abandoned;

5. there should be a standard water well agreement for Montana similar to the Wyoming agreement if one does not exist;.

As suggested above, nowhere in either FEIS is there an attempt to estimate the number of Fort Union and other deep water wells that will be impacted adversely by the CBM production. Nor is there an attempt to estimate the cost of remediating impacted water wells. The FEISs are deficient in this regard.

Advice to Deep Well Owners

As things currently stand it seems probable that burden of proof in establishing that a deep well is adversely impacted by CBM production will fall to the well owner. BLM has made no attempt either to identify wells that will be potentially damaged by the CBM development, nor has BLM made any attempt to advise well owners of what information might prove helpful in establishing a claim of damages.

A prudent well owner should collect baseline information of each of his wells, especially deep wells that are likely to be impacted. This information should include: 1) a time history of static water levels, 2) a production test of limited duration, 3) a baseline chemical water analysis, 4) information about gas production from the well, 5) information about the energy consumption needed to pump the water (power records for the well). One probably needs an initial investigation by a qualified hydrogeologist to initiate the data collection. A minimum time for that investigation is a day per deep well at a cost of approximately $1000 including a routine water analysis. After an initial visit a farmer/rancher could probably continue the data collection for his well using procedures outlined by the hydrogeologist.

Groundwater Monitoring

It is my experience that people are reluctant to commit to long-term monitoring. They seem much more amenable to committing to a model analysis. Of course the usefulness of any analysis is dependent upon the available data. The Wyoming modeling indicates that the pressure in the Fort Union coal measures will return within 5% of their original values by the year 2060—95% recovery. Monitoring should be designed to capture the entire impact of the CBM development—drawdown and recovery. It is important to initiate a monitoring program that will continue to at least the year 2060.

The Montana FEIS contains a section on groundwater monitoring. The Montana monitoring suggests at least one monitoring well per township where CBM is produced. There is no similar discussion of the density of monitoring wells in the Wyoming FEIS.

In designing a monitoring network one must define what he/she is attempting to monitor. Let's assume the intent is to monitor the regional decline and recovery of water levels in the deep aquifers in the Powder River Basin in both Montana and Wyoming. The Wyoming FEIS used approximately 100 wells for the calibration of the model. This network left gaps in the data in the deeper portions of the basin. I suggest:

1. Deep observation well locations to be distributed more or less uniformly across the basin. There should be two observation wells at each monitoring loaction: 1) to the Fort Union coal measures, 2) a second observation well to the Wasatch aquifer in Wyoming (or Lower Hell Creek—Fox Hills aquifer in Montana). BLM appears to be committed to pairs of observation wells in Wyoming—as suggested above. Montana only discusses one monitoring well per township. Montana proposes to monitor these wells monthly, at least initially.

2. At 10% of the observation well sites one would like continuous monitoring of the water levels—digital data collected at 15-minute intervals.

3. A database of the water well records that is kept up to date and accessible on the Internet.

There is no discussion in either the Wyoming or Montana FEIS that discuss who will do the continued monitoring, or how it will be paid for. The support for the long-term monitoring will become problematic once the CBM wells are plugged and abandoned, and the CBM operators are gone. Even so the recovery in the deep water wells will go on until at least the year 2060. As suggested above, one needs to monitor both the drawdown and the recovery caused by the CBM production. BLM did not discuss the duration of the proposed monitoring.

Disposal of CBM Produced Groundwater in Evaporation Ponds

Evaporation ponds will produce minerals (salts) that will have to be disposed of once the CBM development is over. The quantity of minerals generated in the evaporation process is large. If one assumes the concentration of total dissolved solids in the CBM water is 3000 milligrams per liter (3000 parts per million) then there will be approximately 100 tons of minerals produced by each CBM well during its period of production. Disposal in evaporation ponds is a less favorable option since the disposal of the minerals will also be required. I could find no discussion of how minerals accumulated in evaporation ponds would be disposed of.

Disposal of CBM Produced Water in Impoundments

Preferred alternatives in both the Wyoming and Montana FEISs were selected to minimize water quality impacts on surface streams. This in turn means that the preferred alternatives will dispose of more water through local infiltration ponds.

In the Wyoming FEIS it is assumed that 15% of water infiltrated will reappear as base flow to local streams. This percent is entirely dependent on the local site conditions for the infiltration facilities. Both FEISs discuss permitting procedure for local facilities. There is no assurance that the permitting process will result in the 15% return to local streams—in actual fact the number may be larger. The 15% seems to be an arbitrary number based upon little, or no scientific information or empirical data.

The impact of local impoundments is very much dependent upon local conditions—local topography, local soils, local vegetation. In some instances the CBM water may be of poorer quality than the shallow groundwater. Some shallow groundwater may be degraded in quality.

Impoundments that dam up local streams pose potentially different problems It seems unlikely that the impoundments will be built on perennial streams where downstream users have water rights. The more probable scenario is that the impoundments will be created in topographic draws where there are intermittent streams. This may be the preferred site for an infiltration pond since it is cheaper to construct. The recharge can provide for prolonged low flow in associated intermittent streams. Where the impoundment is situated over an alluvial aquifer it is likely that the return flow to the local surface streams will be greater than the 15% estimate used in the Wyoming FEIS. An adverse impact occurs where the CBM water going into the impoundment is of poorer quality than the shallow groundwater, especially shallow groundwater in permeable alluvium.

An impoundment in a topographic draw is often subject to being overtopped by storm flow. If the impoundment contains poor quality CBM water, and/or accumulated minerals the storm water will transport these downstream away from the impoundment. Impoundments should be maintained with sufficient freeboard to capture at the very least the storm runoff from the expected annual storm. There is no indication that capturing runoff from the expected annual storm is considered in the design and operation of impoundments. BLM failed to address the potential adverse impacts impoundments on storm runoff in intermittent streams.

WYOMING VERSUS MONTANA FEIS

The Wyoming FEIS contains extensive information that one can use to judge the scientific work that supports the assessment of impacts. The relevant results are included in the document. For example, there are maps of the groundwater model predictions of drawdown across the Wyoming portion of the basin for the years 2006, 2009, 2018, 2030, and 2060. There are graphs showing how the Wyoming groundwater model was calibrated. There are graphs that show the predicted drawdown and recovery in selected water wells in Wyoming.

The Montana FEIS, while it refers to model studies and results, contains none of the expository information to judge either the predicted extent of the drawdown or its magnitude. The Montana FEIS is consistently deficient in laying out the data or the analyses that leads them to their assessment of impacts.

In comparison with the Wyoming FEIS the Montana FEIS document is significantly deficient in its completeness. Within the Powder River Basin the CBM production produces similar problems and concerns in the two states. One is left to make judgments on the impacts in Montana based upon the work displayed in the Wyoming FEIS. One is left guessing about the quality of the analyses in Montana.

The Montana FEIS deficient, especially when it is compared with the Wyoming FEIS.

SUMMARY

The preferred alternatives in both the Wyoming and Montana FEISs were selected to minimize the impact of CBM production on surface water, especially surface water quality. Ironically the impact on groundwater users could hardly be more dramatic and damaging. Production of CBM is in conflict with groundwater production from the Fort Union coal beds as explained above. Many water wells in the Fort Union beds will be severely impacted; many will have to be abandoned. Because the drawdowns are so large in the coal measures the water level declines will also be significant in the other deep aquifers. Deep water wells in the Wasatch and the Lower Hell Creek—Fox Hills aquifers will also be impacted. The impacts in the Wasatch and Lower Hell Creek—Fox Hills aquifers lag behind by 5 to 10 years the water levels changes in the Fort Union coal beds.

The principal water resource problem associated with CBM development is the impact on deep wells. The impacts on the deep wells were inadequately addressed in both FEISs. BLM made no effort to estimate the numbers of wells that will be impacted or the cost of mitigating the impacts. One is referred to a water well agreement in Wyoming that purports to protect well owners. The proposed mitigation for the deep wells is grossly inadequate as well as unfair. There are going to be many unhappy owners of deep wells. As the law now stands, the farmers/ranchers may bear much of the costs of the impacts of CBM development on deep water wells. That cost will be significant.

There is a water quality problem associated with disposing of the CBM produced water Much of the CBM water is high in SAR values, and/or high in EC values. Much of the CBM water is of poorer quality then the shallow groundwater. Even if the return flow to local drainages is only the 15% used for analysis there may be adverse impacts on the local vegetation; potential adverse impacts on the local vegetation is not addressed in the FEISs. The 15% value is highly dependent upon the local sites of infiltration ponds and impoundments. The local site permits may increase the 15% value significantly—it all depends upon the local site permits.

There should be a monitoring program designed to document the impact of CBM production on the deep aquifers of the Powder River Basin. If we are to see the total impact of the development (drawdown and recovery) the monitoring needs to be sustained into the later part of the 21st Century—at least to the year 2060. There will be pressure to discontinue the monitoring once the CBM wells are plugged and abandoned and the CBM operators are gone.

The Montana FEIS is incomplete; it does not include sufficient information from which to make judgments about the adequacy of the analyses of impacts. One is left assessing the impacts in Montana by inference to the impacts assessed in the Wyoming FEIS.