

John Monks, P.G. Comments on BLM's Draft EIS

Final Comments on Draft Environmental Impact Statement Related to Water Quality

23 May, 2002

Mr. Paul Beels
Project Manager
Bureau of Land Management
Buffalo Field Office
1425 Fort Street
Buffalo, WY 82834-2436

RE: Comments on Draft Environmental Impact Statement and Draft Planning Amendment for the Powder River Basin Oil and Gas Project

Dear Mr. Beels:

The Wyoming Outdoor Council, funded by the Hewlett Foundation, has retained me to review and comment on the hydrogeological portions of the Draft Environmental Impact Statement and Draft Planning Amendment for the Powder River Basin Oil and Gas Project WY-070-02-065 (DEIS). Most of the groundwater and surface water environmental consequences described in chapter 4 of the DEIS are based on predictions made by a numerical ground water model. My comments will address the hydrologic assumptions used in the numerical model, and the affects those assumptions have on the numerical model.

It is my professional opinion that the Draft Environmental Impact Statement and Draft Planning Amendment for the Powder River Basin Oil and Gas Project does not accurately disclose the environmental consequences of the proposed development. The assumptions used in the groundwater model result in an underestimate of the amount of CBM water that will be discharged to surface waters. The numerical groundwater model used in the DEIS does not adequately draw from existing data that describes hydrogeologic conditions in the basin. The numerical model used in the DEIS is a "regional" model, built to describe regional ground water flow, and calibrated to regional data that show general groundwater flow to the north. The hydrogeology of the area, however, is dominated by "local" groundwater flow systems. These local systems will determine the fate of discharged CBM water, but are not adequately represented by the model.

1. **OPINION:** The numerical model assumes that *all* CBM water disposed of by Surface Discharge that infiltrates alluvium will recharge ground water in the underlying bedrock formations. In my professional opinion, it is highly unlikely that this assumption will be met by conditions in the field. The assumption results in underestimating the amount of CBM water eventually discharging to surface water, and overestimating the amount of water recharging the Wasatch and Fort Union

Formations.

BASIS OF OPINION: The hydrogeology of alluvium in the Project Area is described in *Powder River Basin Oil and Gas EIS Technical Report – Groundwater Modeling* on page 2-1. The alluvium is recharged from surface infiltration and from discharge from underlying strata, and local groundwater movement in the alluvium is primarily along the drainage in a downstream direction. CBM water that is disposed of by Surface Discharge will recharge the alluvium and move along the drainage in a downstream direction, with some portion eventually discharging to surface water. USGS Water-Resources Investigation Report 85-4311 investigated recharge of shallow aquifers through ephemeral stream channels in northeastern Wyoming. This report concluded that surface water infiltrates the alluvium and causes water levels in the alluvial aquifer to rise. The report also concluded that *some* of the infiltrated water reaches bedrock aquifers, and that the remaining water probably is lost to evapotranspiration, horizontal down valley flow, and soil moisture in the unsaturated zone. The report found that in one of the stream reaches studied, recharge to the bedrock aquifer occurred, while in the other reach, no recharge to the bedrock aquifer occurred. USGS Water-Resources Investigation Report 85-4311 does not support the assumption that *all* CBM water disposed of by Surface Discharge will recharge ground water in the underlying bedrock formations. Recharge to Wasatch and Fort Union Formation bedrock aquifers from alluvial aquifers will likely be affected by the presence of clay at or near the base of the alluvium. USGS Water-Resources Investigation Report 89-4002 concluded that “*A thick blue clay or shale at the top of the bedrock is reported on many driller’s logs, and isolates the bedrock from the alluvium hydraulically...*”. A review of USGS Open-File Report 82-856 (*Ground-Water Data from Selected Wells in Alluvial Aquifers, Powder River Basin, Northeastern Wyoming*) reveals numerous descriptions of clay and/or shale at the base of the alluvium. The hydrogeologic data collected by the USGS clearly does not support the assumption that *all* CBM water disposed of by Surface Discharge that infiltrates alluvium will recharge ground water in the underlying bedrock formations. This assumption is also clearly not supported by evidence from ongoing CBM development in the project area.

2. **OPINION:** The numerical model assumes that *no* hydrologic connection exists between infiltration impoundments and downstream surface waters, and that *all* CBM water that infiltrates from infiltration impoundments recharges ground water, and does not reach surface waters. In my professional opinion, it is highly unlikely that this assumption will be met by conditions in the field. This assumption results in underestimating the amount of CBM water discharging to surface water, and overestimating the amount of water recharging the Wasatch and Fort Union Formations.

BASIS OF OPINION: Descriptions of and aquifer characteristics of the Wasatch and Fort Union Formations are found in Table 2-1 of *Powder River Basin Oil and Gas*

EIS Technical Report – Groundwater Modeling. Both formations contain discontinuous, lenticular sandstone layers separated by lower permeability claystones and siltstones. Both formations also contain coal beds. Hydraulic properties in these formations are heterogeneous and anisotropic. As a result, groundwater flow in the Wasatch and Fort Union Formations is dominated by local flow (EPA Region 8 Technical Memorandum, March 15, 2002). These local flow systems are illustrated in Figure 11 of USGS Water-Resources Investigation Report 85-4229 “Ground-Water Flow Systems in the Powder River Structural Basin, Wyoming and Montana”. This illustration shows discharge areas in topographic lows (stream valleys). The regional flow system depicted in this illustration is based on a paper by Freeze and Witherspoon (Water Resources Research, Vol. 3, No. 2, 1967, p. 623-634). This classic paper in hydrogeology analyzed the effect of water-table configuration and subsurface permeability variation on regional ground water flow. The paper concluded that local discharge areas could occur in minor topographic lows such as stream valleys, as is shown in Figure 11. The paper also concluded that discharge areas could occur at the surface above the pinch-out of a buried high permeability aquifer, such as the sandstone lenses that occur in the Wasatch and Fort Union Formations. The hydrogeologic conditions in the project area suggest that some portion of the CBM water that is discharged to bedrock aquifers via infiltration impoundments will discharge to the surface, either as springs or to stream valley alluvial aquifers and hydraulically connected downgradient surface waters.

3. **OPINION:** The numerical model assumes that *all* of the water used for land application will be used consumptively. In my professional opinion, it is highly unlikely that this assumption will be met by field conditions. This assumption results in underestimating the amount of CBM water discharging to surface water.

BASIS OF OPINION: Land application will likely be taking place on agricultural lands located in valley bottoms, adjacent to alluvial aquifers and stream channels. Conveyance losses are likely to occur as the CBM water is moved to the land application sites, particularly if existing irrigation ditches are used. The possibility also exists for the CBM water to be applied at the land application sites at rates exceeding the agronomic rate suitable for the crops and soils present at the site. CBM water could be applied directly to surface water by overspray from sprinkler systems.

4. **OPINION:** The DEIS assumes that there will be *no net recharge* to the Wasatch Sands or the coal zones in the Fort Union Formation from deep injection disposal of CBM water. In my professional opinion, it is unlikely that this assumption will be met by conditions in the field. This assumption results in underestimating the amount of CBM water discharging to surface water.

BASIS OF OPINION: *Powder River Basin Oil and Gas EIS Technical Report – Groundwater Modeling* states on page 2-11 that “The claystones underlying the upper Fort Union Formation coals act as a confining layer, providing partial isolation of the coals from underlying strata”. In order for there to be no net recharge to the Wasatch

sands or coal zones, the claystones would need to provide complete isolation of the coals from underlying strata. Complete hydrologic isolation of the coals from underlying strata, either locally or across the entire basin, is highly unlikely, and is not supported by existing data. The *Powder River Basin Oil and Gas EIS Technical Report – Groundwater Modeling* states: “The thickness and structure of the upper Fort Union Formation coal seams are significantly influenced by faulting that was believed to be active during deposition as well as after deposition of the coal forming materials (page 2-3)”. Faulting that affected the coal seams has probably also affected the underlying claystones, possibly enhancing the vertical permeability of the claystones near faults. The hydraulic connection between the coal seams and underlying formations may be enhanced locally by water supply wells screened through both the coal and underlying sands, deteriorating well casings, or poorly plugged exploratory boreholes or oil and gas wells. The assumption that injected water does not recharge the coal zones also assumes that there is no natural recharge to the coal zones from underlying rock formations. It also assumes that even when the heads in the coal zones are depressed by withdrawal of CBM water, no recharge to the coal zones from underlying, higher head formations will occur.

The assumption that no net recharge to the Wasatch Sands or the coal zones in the Fort Union Formation will result from deep injection disposal of CBM water is not likely to be met.

5. **OPINION:** Constant head cells and drain cells are used to model the interactions between perennial and intermittent streams and groundwater in the DEIS. It is my professional opinion that it may be more appropriate to model these groundwater - surface water interactions using the RIVER package in MODFLOW.

BASIS OF OPINION: By using drain cells to model the ephemeral streams, the flow of water is restricted to one direction - from aquifers to the streams. In constant head cells, water is free to move in both directions, from the aquifer to the stream, and from the stream to the aquifer. The RIVER Package in MODFLOW was built specifically for simulating the interactions between groundwater and perennial and intermittent streams and should be used.

6. **OPINION:** The model assumes that the partial isolation of the sand aquifers overlying the coal that has been documented by BLM monitoring at the Marquiss CBM project can be applied over the entire basin. In my professional opinion, it is unlikely that this assumption will be met by conditions in the field. This assumption results in underestimating the amount of CBM water discharging to surface water.

BASIS OF OPINION: The coal and sands probably are partially isolated over large areas of the Powder River basin. However, the partial isolation has most likely been compromised in places by wells screened through both formations, improperly plugged oil and gas wells or exploratory bore holes, and has almost certainly been

compromised by fracture zones associated with faults. Fractured areas in the Wasatch Formation may have vertical hydraulic conductivities that are significantly higher than the vertical hydraulic conductivities used in the model. If the partial isolation of the Wasatch sands from the coal beds has been compromised, either by poor well construction/abandonment or by naturally occurring fracture zones, the result would be underestimation of the amount of produced water from CBM development. The model would more conservatively predict drawdowns and volumes of produced water if the partial isolation were not presumed to exist everywhere.

Recommendations

1. Groundwater modeling should be conducted at a larger, watershed scale to more accurately predict the affects of CBM water disposal.
2. The interactions between groundwater and surface water in the model should be analyzed using the RIVER package for MODFLOW.
3. The groundwater model should be changed to more accurately portray the local flow systems that dominate groundwater flow in the project area.
4. Infiltration ponds should be located out of the alluvial deposits underlying floodplains and terraces and away from perennial, intermittent and ephemeral stream channels.
5. Infiltration ponds should be located in areas where the underlying bedrock formation is comprised of principally of sandstone. If infiltration ponds are constructed above low permeability siltstones and/or claystones, then the low permeability unit should be penetrated by discharge well(s) or fractured mechanically to enhance permeability.

Sincerely,

John Monks, P.G.

Hydrogeologist