Fidelity Exploration and Production
Badger Hills CBNG POD

Hydrology Technical Report

February, 2004

Prepared by:
Bureau of Land Management
Miles City Field Office
Miles City, MT

Contents

INTRODUCTION/AREA DESCRIPTION

Fidelity Exploration and Production Company (Fidelity) has obtained approval from the Montana Board of Oil and Gas Conservation (MBOGC) to expand the CX Field by approximately 5,500 acres. Fidelity proposes to develop coal bed natural gas (CBNG) resources in the expanded field by drilling 178 new wells. Of these 178 wells, 85 are federal minerals under the regulatory jurisdiction of the Bureau of Land Management (BLM). These 85 wells are to be finished in up to 5 separate coal seams at 18 different locations. The locations of these federal wells are listed in the Badger Hills Plan of Development (POD) Environmental Assessment (EA). The federal proposed wells underlie private surface. Additionally, one existing federal CBNG well would be connected for production. The approximate locations of these federal wells and the associated Fee and State wells are shown on Map 1 in the figures section of this report.

The proposed action for drilling operations is to drill separate vertical wells to test the Dietz 1, Dietz 2, Dietz 3, Monarch and Carney coal seams for commercial quantities of gas. These coal seams are all contained within the Tongue River Member of the Fort Union Formation. CBNG produced water would be used to drill to ~60'. Surface casing would be set at ~60' and cemented back to the surface. The wells would then be drilled to the top of the target coal seam (between 240 and 1218 feet deep) using CBNG produced water and weighting material. Production casing would be cemented from the top of the coal seam back to the surface using a one stage cementing program. The well would then be completed by drilling and under-reaming the coal. The wells would be completed for production if commercial quantities of CBNG are encountered. The wells would be plugged according to federal requirements when the wells are no longer needed.

All of these well sites are located in the Upper Tongue River 4th Order Watershed (10090101), and the Tongue River Upstream from the Tongue River Dam 5th Order Watershed (10090101060). These well locations either drain to the Tongue River via ephemeral drainages, drain directly to the Tongue River, or drain to the Tongue River via Badger Creek (See Map 1).

According to the climatic data provided by the MAPS Atlas website prepared by MSU Bozeman (http://stone.msu.montana.edu/ma6/basemap/viewer.htm) this area (MAPS cell 17540) receives an average of 12-14 inches of precipitation per year, and has the potential for 44 inches of evaporation (Penman Method).

Of the new well sites (fee, state and federal), 5 are located on Quaternary Alluvium, 26 are located on the Eocene Wasatch Formation, and 9 are located on the Paleocene Tongue River Member of the Fort Union Formation. The alluvium is composed of unconsolidated inter-bedded clay, silt, sand and gravels. The Wastach Formation is composed of poorly consolidated inter-bedded clay, silt, sand and gravel, with numerous coal beds near the base. The Tongue River Member of the Fort Union Formation is a poorly consolidated terrestrial deposit composed of interbedded clay, silt, sand, and coal. In places the surface of this unit is covered by “clinker” deposits, which form due to coal fires baking overlying clastic units. The baking of these units causes bright red porcelainite to be formed. Porcelainite is resistant to erosion, and therefore many of the ridge tops are capped with porcelainite (See Map 2) (Zelt et al., 1999).

ALTERNATIVES ANALYZED

Alternative A: No Action

In this Alternative there would not be any BLM approval action and none of the federal wells in the POD would be drilled, completed or produced; nor would any of the associated infrastructures that required BLM approval be installed or constructed in the Project area. However, 93 private

and state CBNG wells and their associated infrastructure would be installed to develop the CBNG resource in the Badger Hills Project area.

Water produced with CBNG in the Badger Hills POD would be made available for beneficial uses or discharged into the Tongue River upstream from the Tongue River Reservoir, in accordance with Fidelity's existing Montana Pollutant Discharge Elimination System (MPDES) permit. The water management plan under the No Action Alternative includes the following components:

- The water produced by the new state and fee wells in the Badger Hills POD will be managed in conjunction with the water being produced by the existing 246 CBNG wells in the CX field. The existing CX field wells are discharging at an average rate of 4 gallons per minute (gpm), while the maximum discharge of the new wells is anticipated to be 14 gpm. It is anticipated that the discharge from the new wells would decrease at a rate of 20% per year, while the discharge from the existing wells would decrease at a rate of 30% per year (Fidelity, 2003). Using these assumptions the combined total maximum water production would be approximately 2,257 gpm. The total water production rate after 5 years would be approximately 599 gpm.

- 4 discharge points to the Tongue River would be used. These discharges have been approved by Montana Department of Environmental Quality (MT-DEQ) under MPDES permit number MT 0030457. This permit allows for the discharge of up to 1,600 gpm (3.56 cfs) of CBNG produced water. The water balance calculations conducted for this analysis indicate that this full volume of discharge would be required for 3 months following the start of CBNG production in this POD under the No Action Alternative (See Appendix B). Discharge volumes would be below current levels (984 cfs) after 17 months. The 4 outfalls to be used for this project are identified in the MPDES permit as numbers 12, 13, 15, and 16. Of these, 12 and 13 are existing, while 15 and 16 would be new construction. These outfalls have been, or would be, installed in areas with low channel gradients to minimize erosional degradation. Additionally, each outfall structure would consist of a riprap pad surrounding the discharge pipe with a narrow riprap-lined trench sloping into the channel are to prevent erosion of the channel bank.

- 235 gpm of produced water would be piped to the Spring Creek coal mine to be used beneficially for dust suppression.

- 370 gpm of produced water would be piped to the East Decker coal mine to be used beneficially for dust suppression.

The MPDES discharge permit to the Tongue River, and the beneficial uses by the coal mines would be adequate to manage the produced water under the No Action Alternative (no federal wells). However, Fidelity has indicated that since these impoundments have already been designed and permitted by MBOGC, and the irrigation areas have already been investigated and irrigation plans developed, it is likely that this infrastructure would eventually be constructed and used to manage CBNG water from other Fidelity leases in the area. This infrastructure would not be constructed until a need for this water management capacity is realized (Icenogle, pers. com. 1/9/04). Due to economic considerations it is anticipated that discharge to surface water will be used for as long as possible until other infrastructure is needed. The impoundment and irrigation infrastructure needed includes the following:

- 3 new and one existing clay lined containment reservoirs would be used to store water. The design and construction criteria for these impoundments are discussed in Appendix D. Water

would enter these basins at a maximum rate of 1271 gpm. These reservoirs are identified in the POD Book as 34-3490, 44-3490, 22-3590, and 33-3390. The capacity of these reservoirs would be 109, 228.3, 122, and 4.14 acre-feet respectively. This would provide a total of 463 acre-feet of storage. Reservoir 23-0299 may be enlarged to 204.5 acre-feet depending on future needs. These impoundments would be reclaimed or left in place depending on surface owner preference.

- During the summer, the water stored in the containment reservoirs, and the produced water would be applied to 170 acres of cropland on the Seven Brothers Ranch, along Badger Creek and on a bench above the creek. Irrigation with this water would require that soil amendments be added to the soils to prevent dispersion of the soils. Monitoring of the irrigated sites would be conducted to ensure that sufficient amendments are being applied to prevent impacts to soils. Water application rates would not exceed the rate at which water could infiltrate through the least permeable soil horizon, and water application rates would be managed such that salts would be parked beneath the root zone.

3.4 miles of improved roads, 14 miles of 2 tracks, 1 existing compressor site, 3 new field compressor sites, one sales compressor, and the gas, water and electrical network needed for the State and Fee wells within the Badger Hills POD would be constructed. The disturbance that would result under the No Action Alternative is summarized in Table 1 below.

Table 1: Summary of Area Disturbed in Badger Hills POD Area – No Action

	units	# of Units	factor	acres
Long Term				
All Weather Roads	Miles	3.4	2.9	10
2-Track Roads	Miles	14	1.4	20
Field Compressors	number	3	2	6
Sales Compressor	number	1	4	4
Impoundments	acres	80	1	80
Discharge Points	number	4	0.25	1
Total Long Term				121
Short Term				
State Well Sites	sites	4	1	4
Fee Well Sites	sites	18	1	18
Federal Well Sites	sites	0	1	0
Gas/Water Flowlines (from wells)	miles	9	3.3	30
Produced Water Flowlines (to river)	miles	12.5	0.48	6
Arial Powerlines	miles	5.5	1.2	7
Buried Powerlines	miles	8	1.8	14
Total Short Term				79
TOTAL				200

Construction and reclamation activities would be conducted as described in the Surface Use Plan (SUP). This includes timely reclamation, revegetation with native weed free seed mixes, and following the Gold Book Standards for construction, where appropriate, to minimize environmental impacts.

Cumulative Actions:
The cumulative actions analyzed are those past, present or reasonably foreseeable future actions that may combine with the proposed action to create environmental impacts regardless of which agency or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

The following past, present and reasonably foreseeable actions are considered in this analysis:

- The existing CX Field CBNG Development (246 Wells)
- The proposed Fidelity infield drilling (36 Wells)
- CBNG development in Wyoming
- The proposed Yates Exploration CBNG Wells (14 Wells)
- The proposed Coal Creek POD (18 Wells)
- The existing Fidelity Scoria Pit
- The East Decker, West Decker, and Spring Creek Coal Mines

A summary of the potential for each of these projects to affect hydrological resources is provided in Table 2 below.

Table 2
Cumulative Actions and Potential to Affect Hydrological Resources

	Surface Water		Groundwater	
	Yes	No	Yes	No
CX Field	X		X	
CX Infield Drilling	X		X	
Wyoming CBNG		X	X	
Yates Exploration Wells		X		X
Coal Creek CBNG POD	X		X	
Scoria Pit		X		X
Coal Mines	X		X	

Additional discussion of each of these actions and their hydrologic significance is provided in Appendix A.

The existing CX Field and the proposed new infield wells will produce water which will combine with the Badger Hills produced water to make up the 1600 gpm of CBNG discharge to the Tongue River. These discharges have been approved by Montana Department of Environmental Quality (MT-DEQ) under MPDES permit number MT 0030457. This permit allows for the discharge of up to 1,600 gpm (3.56 cfs) of CBNG produced water.

The proposed Coal Creek POD plans to discharge treated CBNG water to the Tongue River below the Tongue River Dam. This treated discharge would be at a rate of 450 gpm (0.99 cfs), and the EC of the discharged water would be approximately 493 μS/cm and the SAR would be

approximately 0.03. Discharges from the coal mines are included in the reservoir component of the surface water model as an existing condition (See Appendix C).

The Badger Hills State and Fee wells, the CX Field, the CX infield drilling, the Wyoming CBNG located contiguous with the Badger Hills Project or within ~ 5 miles of the Badger Hills Project, the Coal Creek POD and the coal mines (Spring Creek, East Decker and West Decker) all have the potential to drawdown groundwater levels. For this reason all of these projects are included in the cumulative drawdown analysis.

Alternative B: Proposed Action

An outline of Fidelity's Proposed Action is provided below. For a more detailed description of the design features, construction practices and water management strategies associated with the proposed action please refer to the Master Surface Use Plan, Drilling Plan, and Water Management Plan in the Plan of Development (POD) and individual Applications for Permits to Drill (APDs) (Fidelity, 2003). Also see the subject POD and/or APDs for maps showing the proposed well locations and associated facilities. More general information on CBNG well drilling, production and standard practices is also available in the Final Montana Coal Bed Methane-Environmental Impact Statement (MT-CBM-FEIS; BLM, 2003).

85 federal wells would be drilled on 18 sites with up to 5 wells per site. The 92 State and Fee wells would also be installed and produced as outlined under the No Action Alternative. All wells capable of commercial production would be completed and produced. Approximately 1 acre at each well site would be disturbed by vehicle traffic, drilling and completion operations. 1 existing well would also be connected for production.

Vehicles would access the well sites by existing bladed roads, two track trails or across undisturbed range land along a designated route. Pipeline corridors would also be used as temporary roads for access to well sites. Culverts would be installed in drainage crossings if needed.

Water produced with CBNG would be made available for beneficial uses or discharged into the Tongue River in accordance with Fidelity's existing MPDES permit. The water management plan under the Proposed Alternative includes the following components:

- The water produced by the new federal Badger Hills wells will be managed in conjunction with the water being produced by the CX field and from the proposed 92 state and fee wells which are described under the No Action Alternative. It is anticipated that the discharge from the new federal wells will initially be 14 gpm, and will decrease at a rate of 20% per year. Using these assumptions the combined total maximum water production would be approximately 3,461 gpm. The total water production rate after 5 years would be approximately 1,000 gpm.

- 4 discharge points to the Tongue River would be used. These discharges have been approved by MT-DEQ under MPDES permit number MT 0030457 (most recently revised on 2/27/03). This permit allows for the discharge of up to 1,600 gpm of CBNG produced water. The water balance calculations conducted for this analysis indicate that this full volume of discharge would be required for 17 months following the start of CBNG production in this POD. Discharge volumes would be below current levels (984 cfs) after 22 months. The outfalls to the Tongue River would be as described under the No Action Alternative.

The beneficial uses of water for the coal mines, the impoundment construction, and the irrigation areas would be as described under the No Action Alternative.

The analysis of this alternative also includes the effects of BLM applied mitigation, which would be attached as conditions of approval (COAs) to the POD. For hydrology, these include the following:

- The Operator will install 2 monitoring wells within 50 feet of each impoundment. One well will be installed on each side of the impoundment. These wells will be screened from the lowest elevation in the impoundment to the anticipated high water mark. This is to monitor the effectiveness of the clay lining. These impoundments all have natural clay bottoms, therefore deeper monitoring is not needed. It is not anticipated that these wells will contain any water initially. These wells will be gauged monthly and reported to the BLM authorized officer annually unless water levels change by 1 foot or more, or if water is detected in a previously dry well. If such changes are observed, the BLM authorized officer must be notified within 5 business days, and a cause analysis conducted. If adverse monitoring results are recorded, discharge into these impoundments may need to be stopped, the water removed, and repairs conducted, prior to the reintroduction of produced water to these impoundments. Monitoring of these wells will continue for the life of the impoundment.

- The effluent limitations, other conditions, and self-monitoring requirements must be met as contained in Section I.B of MDEQ's DRAFT General Discharge Permit Coal Bed Methane Produced Water (see Appendix E of the Badger Hills Hydrology Technical Report). All reporting will be as described in the DRAFT General Discharge Permit, except that reports will be submitted to the BLM rather than to the MDEQ. If adverse monitoring results are recorded, discharge into these impoundments may need to be stopped until a modified Water Management Plan (WMP) which addresses the problem is developed and approved. These impoundments may be reclaimed of left in placed depending on surface owner preference. If the impoundments are removed, the land must be returned to its previous utility and stability.

- The operator will install one monitoring well approximately 300 feet topographically up-gradient and one monitoring well approximately 300 feet topographically down-gradient from the land application area along Badger Creek. These wells will be screened from 5 feet above to 10 feet below the existing alluvial groundwater table. One monitoring well will also be installed near the irrigation areas on the benches above Badger Creek, between the irrigation areas and the slope leading down to Badger Creek. These wells will be finished above the first major aquatard (shale > 1 ft thick), and shall not be greater than 25 feet in depth. Gauging and sampling of these wells will be conducted quarterly and reported to the BLM authorized officer annually until land application activities cease. Analysis will include EC, TDS, pH, and major ions (Na, Ca, Mg, K, HCO_3, SO_4, and Cl). If changes in groundwater levels of greater than 1 foot above baseline conditions (determined prior to initiation of irrigation) are recorded, if water is detected in a previously dry well, if EC increases by greater than 200 μS/cm above baseline EC, if the pH changes by 1 unit, or if the concentration of any other parameter changes by 20% or more, the BLM authorized officer must be notified within 5 business days, and a cause analysis conducted. Adverse monitoring results may require the cessation of land application until a revised WMP which addresses the problem is developed and approved.

4.4 miles of improved roads, 22 miles of 2 tracks, 4 field compressor sites, one sales compressor, and the gas, water and electrical network needed for the Badger Hills POD would be constructed. The disturbance that would result under the Proposed Action is summarized in Table 3 below.

Table 3 – Summary of Area Disturbed in Badger Hills
POD Area – Proposed Action

	units	# of Units	factor	acres
Long Term				
All Weather Roads	Miles	4.4	2.9	13
2-Track Roads	Miles	22	1.5	32
Field Compressors	number	4	2	8
Sales Compressor	number	1	4	4
Impoundments	acres	80	1	80
Discharge Points	number	4	0.25	1
Total Long Term				138
Short Term				
State Well Sites	sites	4	1	4
Fee Well Sites	sites	18	1	18
Federal Well Sites	sites	18	1	18
Gas/Water Flowlines (from wells)	miles	17	3.3	56
8-12" Gasline	miles	1	24	24
Produced Water Flowlines (to river)	miles	12.5	0.48	6
Arial Powerlines	miles	8	1.2	10
Buried Powerlines	miles	13.5	1.8	24
Total Short Term				160
TOTAL				298

Cumulative Actions:
The cumulative actions analyzed under this alternative are the same as those analyzed under the No Action Alternative and discussed in Appendix A.