2-1. Site Location and Layout (Section 2.1)

The applicant has not provided sufficient information regarding the site location and layout in section 2.1, to enable the staff to fully understand this topic and to support other reviews dependent on that understanding. Specifically, the following information should be provided:

a. the coordinates of the central processing plant and the distance to Casper and other major population centers;

Response:

Coordinates of the Central Processing Plant and distances to Casper and other major population centers was added to Section 2.1.

b. the total area within both the proposed license boundary and restricted area;

Response:

The total area within the proposed License boundary and restricted areas was added to Section 2.1.

c. a topographic map of the entire proposed licensed area; and

Response:

Figure 2.1-2 was revised to include the entire proposed license area.

d. a map of the main processing area showing the topography, site drainage, layout of and access to buildings, and proposed roads.

Response:

New Figure 2.1-3 was developed showing the main processing area showing the topography, site drainage, layout of and access to buildings, and proposed roads

2-2. Meteorology (Section 2.5)

The applicant has not provided sufficient information regarding the meteorological and atmospheric diffusion characteristics of the site in section 2.5. Specifically, the following information should be provided:

a. The applicant indicated that no onsite meteorological data was collected at the Moore Ranch site but instead, used meteorological data collected from Antelope Coal (ACC) and Glenrock Coal (GCC) to represent the Moore Ranch site. However, the applicant has not discussed its basis to assume that the data can be used to represent the Moore Ranch site without any data from the Moore Ranch site. Therefore, provide the justification to use the data from these two sites (ACC and GCC), without onsite meteorological data, to represent the Moore Ranch site.

Response:

The proposed project is situated in east-central Wyoming. It is encompassed by the area between the North Platte valley and the Montana border, generally referred to as the Powder River Basin (PRB). Due to uniformities in geography and climate, the PRB is treated by state and federal regulators as a single air quality control area.

As stated in the conclusion of the Climatology Report, the Antelope Mine (ACC) meteorology most nearly represents that of the Moore Ranch project site, and is therefore proposed as the source of meteorological data to be substituted for on-site monitoring. Data from the Glenrock Mine (GCC) was intended only to supplement ACC and to support the general conclusions made regarding local meteorology. To illustrate the similarities between Moore Ranch and ACC, several images from Google Earth are presented below. Figure 2.2a-1 shows an aerial view of the Moore Ranch area, and Figure 2.2a-2 shows a similar view of the ACC site (with meteorological station pinpointed). The ACC site has similar topographic features (Figure 2.2a-3) and is about 25 miles from the project site (Figure 2.2a-4). Both sites are characterized by mildly rolling hills covered with grass and sparse shrubs. The nearest mountain ranges are:

- the Bighorn Mountains, approximately 50 miles from the Moore Ranch project site and 75 miles from ACC
- the Black Hills, approximately 60 miles from ACC and 85 miles from the Moore Ranch
- the northern Laramie Range, approximately 50 miles south of Moore Ranch and 65 miles southwest of ACC

Due to these large distances, neither the ACC site nor the Moore Ranch site experiences significant wind channeling or shielding from any of the three mountain ranges. Also, there are no major bodies of water affecting the meteorology of these two sites. The ACC site is several hundred feet lower in elevation than Moore Ranch. Both, however, are situated on the southeasterly side of the hydrologic divide with a similar vertical relationship to the divide.

FIGURE 2.2a-1

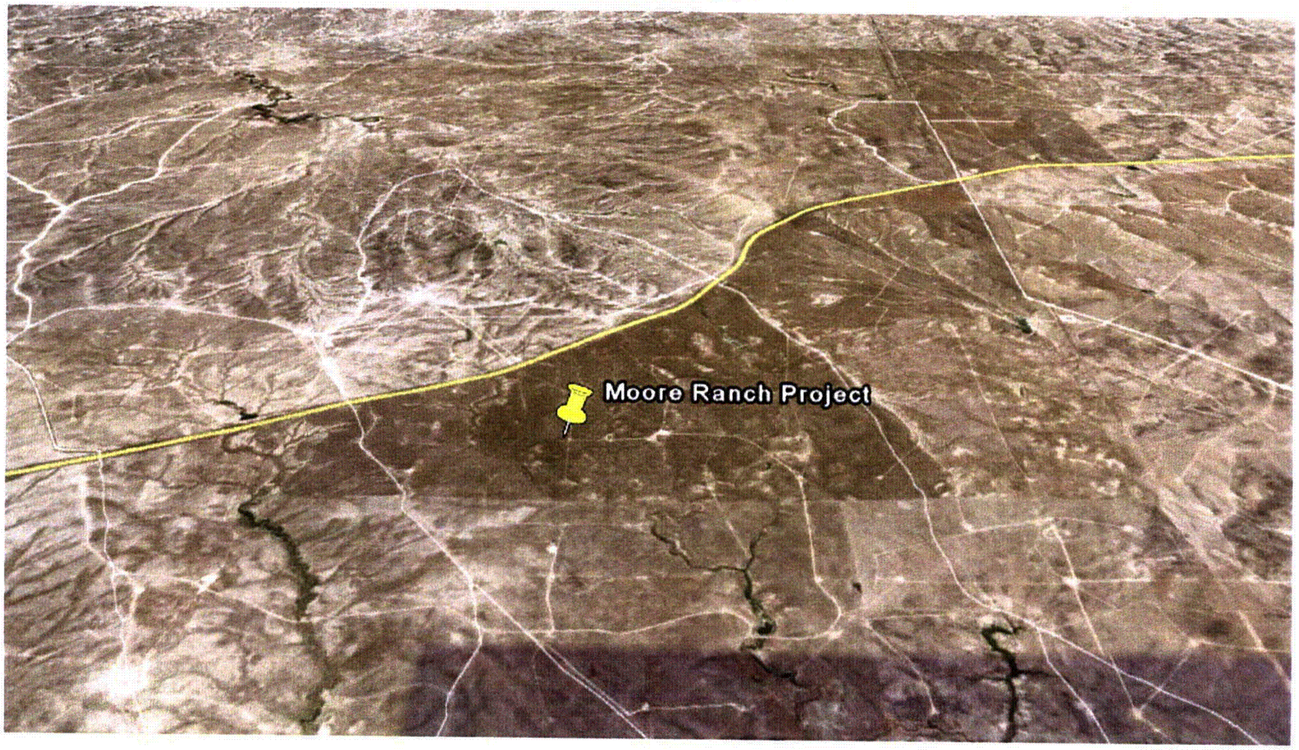


FIGURE 2.2a-2

FIGURE 2.2a-3

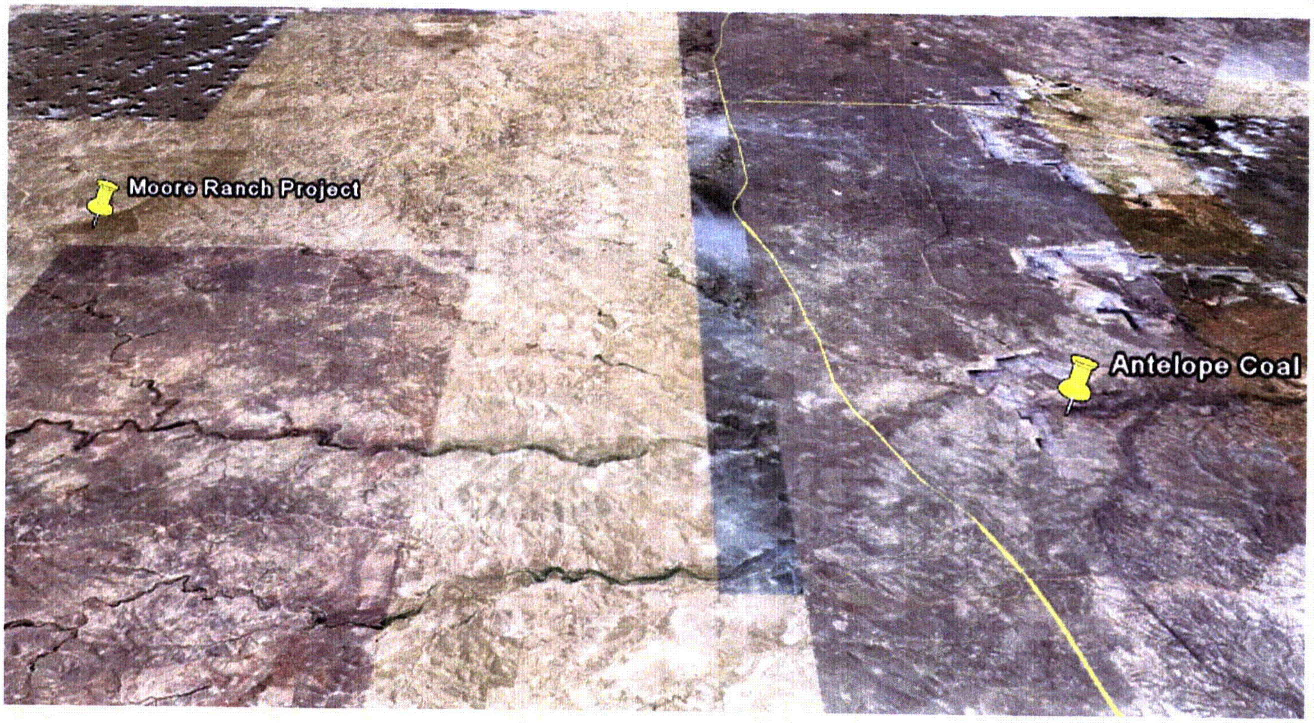
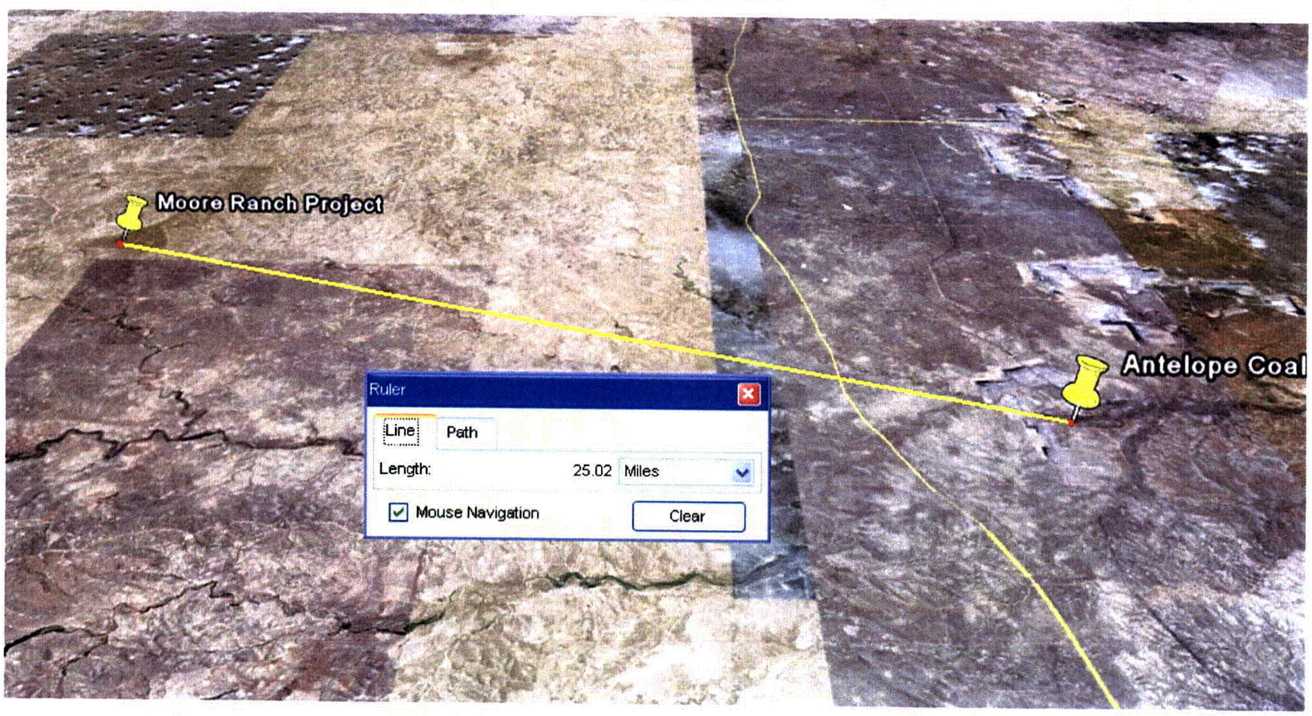


FIGURE 2.2a-4



Section 2.5 of the application was revised to include the above information.

2-2. Meteorology (Section 2.5) Cont.

b. The joint frequency data for each site (ACC and GCC) are shown in Table 2.5-9 and Table 2.5-10 of the Technical Report, respectively. However, the joint frequency data in Appendix E appears to be different from the data shown in Tables 2.5-9 and 2.5-10. Please explain the relationship between the joint frequency data from these tables (Table 2.5-9 and Table 2.5-10) and the joint frequency data in Appendix E of the Technical Report. Specifically, how was the joint frequency data generated in Appendix E and what time period does it represent? Also describe the instruments, locations and heights of the instruments, average inversion height, and annual average mixing layer heights.

Response:

The joint frequency distributions (JFD's) provided in Table 2.5-9 and Table 2.5-10 were taken from 10 years of meteorological data (1997-2006) at the ACC and GCC sites. The star distribution provided in Appendix E is from 5 years (2001-2006) of data at ACC. For all the JFD's, Pasquill stability classes were determined from the standard deviation of horizontal wind direction (sigma theta method).

Inversion and mixing heights were not presented in the original Climatology Report. The nearest upper-air data available from the National Weather Service are from Riverton, Wyoming or Rapid City, South Dakota. In both cases, the large distance from the southern PRB and the proximity to prominent mountain ranges make them ill suited to represent the Moore Ranch project site.

The Air Quality Division of the Wyoming Department of Environmental Quality (WDEQ-AQD) has provided statewide mixing heights to be used in dispersion modeling with the Industrial Source Complex (ISC3) model. These are based on the methods of Holsworth (1972) as applied to Lander, located in central Wyoming. For modeling purposes, the annual average mixing heights are assigned according to stability class as follows:

Class A	3,450 meters
Class B	2,300 meters
Class C	2,300 meters
Class D	2,300 meters
Class E	10,000 meters
Class F	10,000 meters

Stability classes E and F are given an arbitrarily high number to indicate the absence of a distinct boundary in the upper atmosphere.

In August of 2000, IML Air Science conducted Sound Detection and Ranging (SODAR) monitoring at the Black Thunder Mine, located approximately 20 miles north of the ACC site. The purpose of this monitoring was to support a comprehensive study of NO_x dispersion characteristics following overburden and coal blasting events. The SODAR instrument provided 3D wind speeds, wind directions, temperatures, temperature gradients, and other atmospheric parameters as a function of height above the ground.

The vertical range of the SODAR was 1,500 meters, with a sounding performed every 15 minutes. Each sounding resulted in a calculated "inversion height / mixing height" (the two terms are used interchangeably by the SODAR system supplier). For purposes of this response to NRC, these mixing heights were downloaded into a database and queried, with results shown in Table 2.2b-1. Morning and afternoon time intervals were taken from EPA modeling guidance.

TABLE 2.2b-1

Time Period (Filtered)	Number of Data Points	Average Mixing / Inversion Height
Morning (2 am – 6 am)	193	641 meters
Afternoon (12 pm – 4 pm)	152	1,052 meters

Since the SODAR definition of mixing height appears somewhat ambiguous, and these measurements were all from August, it is not known whether they would qualify as meteorological inputs to the MILDOS model.

Because of the extensive surface coal mining that has developed over the last 30 years, the PRB airshed is one of the most heavily monitored in the country. Coal production in the PRB grew from a few million tons in 1973 to over 400 million tons in 2006. The Clean Air Act and the Surface Mining Control and Reclamation Act of the 1970's prompted a parallel growth in ambient air quality monitoring throughout the PRB. This has led to over 100 particulate monitoring samplers and more than 20 meteorological monitoring towers, all configured to support air quality permitting, compliance and research objectives.

The monitoring programs at these sites meet the Wyoming Department of Environmental Quality requirements for land and air quality permit compliance. Methods used in collecting and validating these data adhere to EPA's "On-Site Meteorological Program Guidance For Regulatory Modeling Applications." Hourly average values for various parameters are generated by field instruments and recorded by continuous data loggers, all operated and maintained by IML Air Science. Data recovery has typically exceeded 95%. Depending on the mine, meteorological parameters logged include wind speed, wind direction, sigma theta, ambient temperature, barometric pressure, solar radiation and precipitation. All hourly data are downloaded to IML Air Science's relational database. The database software provides for quality assurance, invalidation of suspect or erroneous data, and various forms of data presentation.

Table 2.2b-1 lists the meteorological instruments employed at the Antelope (ACC) and Glenrock (GCC) mines. The coordinates and elevations of both sites are presented, along with instrument models, accuracy specifications, and instrument heights above the ground.

Section 2.5 of the application was revised to include the above information.

TABLE 2.2b-1

Antelope	10m tower	CR10X Data Logger		Lat: 43° 28' 08.92" Elev. 4,680 ft Long: -105° 20' 57.56"	
Parameter	**Instrument**	**Range**	**Accuracy**	**Threshold**	**Instrument Height**
Wind Speed	RM Young Wind Monitor AQ	0-112 mph	±0.4 mph or 1% of reading	0.9 mph	10 meters
Wind Dir	RM Young Wind Monitor AQ	0-360°	±3°	1.0 mph	10 meters
Temp	Fenwall Electronics Model 107	-35°- 50° C	±0.5° C @ given Range	--	2 meters
Precip	Met One 12" tip	Temp: -20° - 50° C	±0.5% @ 0.5 in/hr rate	--	1 meter
Bar Press	Vaisala PTB 101B	600 -1060 mb	±0.5 mb @ 20°C	--	2 meters
Glenrock	10m tower	CR10 Data Logger		Lat: 43° 03' 36" Elev. 4,910 ft Long: -105° 50' 24"	
Parameter	**Instrument**	**Range**	**Accuracy**	**Threshold**	**Instrument Height**
Wind Speed	RM Young Wind Monitor AQ	0-112 mph	±0.4 mph or 1% of reading	0.9 mph	10 meters
Wind Dir	RM Young Wind Monitor AQ	0-360°	±3°	1.0 mph	10 meters
Temp	Fenwall Electronics Model 107	-35°- 50° C	±0.5° C @ given Range	--	2 meters
Precip	Met One 8" tip	Temp: -20° - 50° C	±0.5% @ 0.5 in/hr rate	--	1 meter

2-2. Meteorology (Section 2.5) Cont.

c. Please discuss any bodies of water or special terrain features that may affect the meteorological conditions at the Moore Ranch Uranium Project site.

Response:

As mentioned above, there are no bodies of water or special terrain features that would alter the general meteorological conditions at either the Moore Ranch site or the ACC site. Nearby drainages support small, ephemeral streams. The maximum relief throughout this gently rolling terrain is a few hundred feet.

2-3. Geology and Seismology (Section 2.6)

The cross sections and some geologic descriptions provided in section 2.6 are insufficient to interpret the geology of the license area. Please provide the following:

a. All of the cross sections redrawn to a MSL datum with surface elevations clearly shown to ensure their proper interpretation with respect to site topography.

Response:

New Figures 2.6-2 through 2.6-13 have been developed to a MSL datum with surface elevations clearly shown. Section 2.6 has been revised to reflect new cross sections.

b. Where possible, develop cross sections using more and deeper boring logs to better define the presence or absence of overlying and underlying shales, and sandstones. At least one cross section should show the coal bed methane (CBM) production zone relative to the proposed mining zone.

Response:

New Figures 2.6-2 through 2.6-13 have been developed using more and deeper boring logs to better define the presence or absence of overlying and underlying shales, and sandstones, and showing the CBM production zone relative to the proposed mining zone. Section 2.6 has been revised to reflect new cross sections.

c. Where possible, the cross sections should also be lengthened past the edges of the well fields to at least the locations of the proposed monitoring well rings.

Response:

New Figures 2.6-2 through 2.6-13 Figures 2.6-14 through 2.6-24 (isopach maps) have been developed encompassing the entire License Area. Section 2.6 has been revised to reflect new cross sections and isopachs.

d. Redraw cross sections to show the "60 sand" which is located below the "68 sand" and the shale layer which separates them. Provide an isopach of the "60 sand" if possible.

Response:

New Figures 2.6-2 through 2.6-13 and Figures 2.6-14 through 2.6-24 (isopach maps) have been developed showing all sand units down to the CBM production area, including the 30, 40, 50, and 60 sands. Section 2.6 has been revised to reflect new cross sections and isopachs.

e. Provide more cross sections which show the two deeper sand zones, the "50 sand" and "40 sand", and isopachs if possible. These sands are noted on cross sections C-C' (one well log) and E-E' (three well logs), but their interpretation is questionable given the minimal number of logs used to define them.

Response:

New Figures 2.6-2 through 2.6-13 and Figures 2.6-14 through 2.6-24 (isopach maps) have been developed showing all sand units down to the CBM production area, including the 30, 40, 50, and 60 sands. Section 2.6 has been revised to reflect new cross sections and isopachs.

f. The isopach for the shale overlying the "70 sand" indicates it is missing across about 500 feet in Wellfield 3, just west of cross section B-B'. Please confirm this observation. If true, address the impact of its absence on hydrology and excursion monitoring of Wellfield 3 to determine if mining can be undertaken. (see also RAI 2-7.e.)

Response:

New cross sections and isopach maps were developed as described in the responses above using an increased number of data points. Figures 2.6-11 (cross section I-I'), 2.6-12 (cross section J-J'), and 2.6-15 are the new cross sections and isopach map showing the shale overlying the 70-sand in this area. As shown on these cross sections and isopach map, the overlying shale is continuous in this area.

In addition, water level data in the vicinity of Wellfield 3 (and for all of the baseline well nests) consistently show a 50 to 60 foot water level difference between the 70 and 72 Sands. Hydrographs illustrating the hydraulic relationship between the 70 and 72 Sands are attached (2.7.2-11a through 2.7.2-11d). Water level data used to develop the hydrographs are included in Table 2.7.2-2. The large difference in heads between the hydrostratigraphic units demonstrates a lack of hydraulic communication between them. Available data indicates the 72 Sand is a perched aquifer system. The uppermost portion of the 70 Sand is unsaturated across much of the site. This unsaturated zone between the 70 Sand and the 72 Sand hydrostratigraphic units provides a buffer that will prevent hydraulic communication between the sands during production and restoration activities. Furthermore, the production and restoration phases of the project will be operated under a net bleed (overpumpage), resulting in declining water levels within the 70 Sand that will further separate the 72 and 70 Sands hydraulically. Section 2.6 has been revised to reflect new cross sections and isopachs and Section 2.7.2 was revised to include information on the hydraulic relationship between the 72 and 70 sands and new Figures 2.7.2-11a through 2.7.2-11d were added to the end of Section 2.7.

2-4. Surface Water Hydrology (Section 2.7)

The analysis of the surface water hydrology in the proposed license area is currently insufficient to determine the potential for floods to disrupt the operation of the facility nor to interpret the impact of mining on water quality in and around the license area. Please provide the following:

a. Provide maps clearly showing the location, size and shape of surface water features within the proposed license area, including the area around the central plant facility. Provide maps showing areas inundated during major flood events.

Response:

Figure 2.8.5-2 shows the locations, size and shape of surface water features within the proposed license area, including the area around the central plant facility. These surface water features will be areas of inundation during major flood events caused from short term rapid runoff resulting from major precipitation or snow melt events. As can be see in Figure 2.8.5-2, the process facilities are located on the top of a high ridge and will not be inundated during major runoff events.

b. Provide maps which show the NPDES permitted CBM produced water discharge points in or surrounding the license area which discharge into surface water features including drainages.

Response:

Currently, three Wyoming Pollutant Discharge Elimination System (WYPDES) permits exist within or adjacent to the license area. The following table summarizes these permits.

Table 2-4.b WYPDES Permits in or near the Moore Ranch Project

WYPDES Permit	Facility Name	Operator
WY0040436	East Pine Tree Unit	Devon Energy Production Company
WY0051217	Palm Tree Project	Bill Barrett Corporation (BBC)
WY0055131	BBC Pine Tree Area	Bill Barrett Corporation (BBC)

Outfalls permitted under the three WYPDES permits are presented on Figure 2.7.-A1. The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

c. For each CBM produced water discharge point, provide NPDES permit volumes and water quality standards for discharge. Also describe the presence of structures or any other features which enhance groundwater infiltration at these CBM water discharge points.

Response:

Table 2-4.c provides the WYPDES effluent limitations for Devon's East Pine Tree Unit CBM Facility (WY0040436), Bill Barrett Corporation's (BBC) Palm Tree Project CBM Facility (WY0051217) and BBC Pine Tree Area Permit (WY0055131).

Table 2-4.c WYPDES Effluent Limitations for Permits in or near the Moore Ranch Project

Devon – East Pine Tree Unit (Outfalls 001-002, 004-015, 017-030)[1]	
Effluent Characteristic	**Daily Maximum**
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, mircromhos/cm	2000
Total Recoverable Arsenic, µg/L	2.4
Total Recoverable Barium, µg/L	1800
Total Dissolved Solids, mg/L	5000
Total Flow[4], MGD	0.68
BBC – Palm Tree Project (Outfalls 001 - 025)[2]	
Effluent Characteristic	**Daily Maximum**
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, mircromhos/cm	2000
Total Recoverable Arsenic, µg/L	3.0
Total Recoverable Barium, µg/L	1800
Total Flow[4], MGD	5.3
BBC – BBC Pine Tree Area (Outfalls 004 - 008)[3]	
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, micromhos/cm	2000
Total Recoverable Arsenic, µg/L	3.0
Total Recoverable Barium, µg/L	1800
Total Flow[4], MGD	1.02

[1] Devon's East Pine Tree Unit permit (WY0040436), effective August 30, 2007.
[2] BBC's Palm Tree Project permit (WY0051217), effective February 4, 2008.
[3] BBC's BBC Pine Tree Area permit (WT0055131), effective October 4, 2007.
[4] Total flow is for all outfalls permitted under each permit number, in million gallons per day.

Table 2-4.c1 provides a list of reservoirs permitted through the Wyoming State Engineers Office (WSEO) within the license area that may be impacted by CBNG produced water discharge. The reservoir locations are depicted on Figure 2.7.1-1

Table 2-4.c1 WSEO Permitted Reservoirs with the Moore Ranch License Area

SEO Permit No.	Qtr-Qtr	Section	Township	Range
P16543S	NWSW	1	41N	75W
P14042S	NWNE	25	42N	75W
P14041S	SESW	25	42N	75W
P14040S	SWSE	25	42N	75W
P14043S	NWNE	26	42N	75W
P14036S	SWSW	26	42N	75W
P14037S	NESE	27	42N	75W
P14038S	SWSE	35	42N	75W
P14039S	NWSE	36	42N	75W

The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

d. Provide provisions for erosion protection against the effects of flooding from drainages Wash No.1 and Upper and Lower Wash No. 2 which pass near or through planned wellfields. All berms, culverts, rock riprap, drainage or diversion channels are suggested to follow a design which meets the requirements of 10 CFR Part 40, Appendix A.

Response:

Several small dams and ponds exist within and downstream of the project that provide a level of control and storage of surface water. During normal runoff conditions, these ponds will contain all upgradient runoff. Many of these water features may contain higher levels of water after spring runoff or after large precipitation events but are generally reduced to small, isolated pools or are completely dry by the end of the summer. Relatively small amounts of surface discharge from coal-bed methane operations may also maintain small pools of water in these ponds during dry summer months.

Installation of Wellfield 2 monitor, injection, and production wells in main ephemeral stream channels will be avoided if possible. If it is necessary to install a well within the high water marks of a ephemeral channel, then adequate structural wellhead protection will be installed to protect the wells during potential flood conditions. Wellhead protection could include concrete berms, or reinforced steel/concrete well covers, etc. Properly sized culverts will be used for secondary access roads crossing across small drainages. Efforts will be made to construct secondary access roads to avoid crossing major drainages. However, if crossing a major drainage is required, then adequately sized culverts will be utilized and embankments will be protected from erosion using adequate best management practices (rip rap, rock, etc.) in accordance with WDEQ-LQD Rules and Regulations, Chapter 3. Culverts across significant drainages will be designed to pass the 25-year peak runoff event using head available at the entrance. The minimum culvert size of 18" will be utilized to divert drainage from roads or for crossing small drains or swayles. Crossings for major drainages will be constructed at or near right angles.

Section 2.7.1.4 was revised to include this information. Revisions to Section 2.7 will be submitted with the next RAI response package.

e. Discuss the potential for flooding of the area around the central plant facility and the provisions to protect critical equipment and components.

Response:

Figure 2.8.5-2 and 2.8.5-8 show surface water features within the Moore Ranch Project Area in relation to proposed facilities and wellfields. Figures 2.1-2 and 2.1-3 also show the facilities in relation to surrounding topography. The central processing area and wellfield are located well above any surface water features that would be inundated during flooding events, and also located in a manner that insignificant runon will occur from upgradient sources. Runoff in these areas will consist primarily of overland sheet flow. The central plant and facilities area will be graded and sloped to direct precipitation runoff away from building foundations in all directions to a storm water conveyance system. Potential runon will also be intercepted and directed around the central plant area. The stormwater conveyance system will be designed to meet the flow capacity of a 50-year runoff event. Due to the location of Wellfield 1 and the central plant area related to the surrounding topography, impacts from flooding are expected to be minimal.

The stream channel in Upper and Lower Wash No. 2 is located near the center portion of Wellfield 2. The previous hydrologic analysis conducted by Conoco determined representative channel cross sections for Upper and Lower Wash No. 2 and water crest heights for 100-year and 5-year floods (see Appendix B for previous hydrologic analysis conducted by Conoco. Channel cross sections for Upper Wash No. 2 in the vicinity of Wellfield 2 (approximately 650 feet upstream) show a channel inundation depth of approximately 2.9 feet at a velocity of 7.4 ft/second. As shown Figure 2.8.5-8, the channel widens somewhat through Wellfield 2, so the water depth and velocity in the channel during a 100-year flood through Wellfield 2 is anticipated to be less than 2.9 feet and 7.4 ft/second. However, due to the ephemeral nature of the drainages in the area, this channel is typically contains no flow.

Section 2.7.1.3 was added to Section 2.7 to include this information. Also, previous hydrologic analysis conducted by Conoco was added to Appendix B (Appendix B5).

2-5. Ground Water Hydrology – 72 sand aquifer (Section 2.7)

The applicant must provide a comprehensive description and explanation of the presence of the "72 sand aquifer" which appears to be an artificial perched aquifer created by coal bed methane (CBM) produced water discharge at the surface. If true, its compromised water quality may have implications for the operation of an ISL operation where it will be defined as both the surficial and overlying aquifer. Please provide the following:

a. EMC has identified the "72 sand" as the overlying aquifer. It is not clear to NRC if the "72 sand" aquifer is or has been historically present across the license area. Provide information on the presence or absence of this perched aquifer including the potentiometric surface in the "72 sand" over time as discussed in NUREG-1569.

Response:

Between 1979 and 1981 Conoco installed 35 piezometers in section 35, T42N, R75W and section 1, T41N, R75W as part of an evaluation of proposed mine tailings and evaporation pond sites. The piezometers were installed in discrete lithologic units (silts, sands, coals and alluvium) contained in the 72 sand aquifer. Two of these piezometers were completed near OMW-2 in sandy sections of the aquifer. The measured water elevations for both wells are similar to the elevations measured currently in the 72 sand. Data from the piezometers and monitor well OMW-2 are presented in Table 2-5.a. While saturated thickness levels are below those currently measured in OMW-2, this is likely a relict of completion methods versus quantity of water in the formation. Of the 35 piezometers completed for Conoco's Appendix D-6, only two lacked groundwater. EMC believes the presence of water in the 72 sand in 1979-1980 (some 21 years prior to CBNG development) indicates that the aquifer has been historically present in the area and is not the result of CBNG development. Additionally, stockwell P14682P, located in the SENW quarter of section 26, T42N, R75W and completed in the 72 sand aquifer has been a source of livestock water since the early sixties.

Table 2-5.a Shallow Tailings Area Piezometer Characteristics

Well/Piezometer I.D.	Total Depth	Depth to Water (Ft)	Saturated Thickness (Ft)	Static Water Elevation (Ft. AMSL)	Water Level Date
OMW-2	**78**	**67.62**	**10.38**	**5244.88**	**2/9/2007**
35N-6	**90**	**86.87**	**3.13**	**5236.5**	**5/15/1980**
35N-7C	**84**	**82.09**	**1.91**	**5229.3**	**5/15/1980**

Hydrographs of the 72 Sand baseline monitor wells indicate minimal change in the water level elevations within that hydrostratigraphic unit since the wells were installed in 2006 (Figure 2.7.2-6a). Water level data used to develop the hydrographs are included in Table 2.7.2-2. Saturated thickness of the 72 Sand ranges from 10 feet at OMW2 to over 50 feet at OMW1. Additional potentiometric maps of the 72 Sand have been prepared and are attached (Figure 2.7.2-6b through 2.7.2-6f). The figures illustrate that the potentiometric surface is relatively stable throughout the period of measurement (February 2007 through March 2008).

Section 2.7.2.5 was added to include the information on historic 72-sand conditions. Section 2.7.2 was revised and Figures 2.7.2-6a through 2.7.2-6f were added to include 72-Sand potentiometric surface information.

b. It is possible that the "72 sand" may have received infiltration of CBM produced water at WPDES permitted surface discharge points in the license area. Provide information on the possible infiltration of CBM produced water to the "72 sand" in the past or explain why no CBM produced water would have entered or will enter the "72 sand" from CBM WPDES discharge points on the surface.

Response:

As noted in the License Application, the groundwater within the 72 sands is of the calcium-sulfate type. Shallow groundwater monitoring associated with CBNG water storage facilities in the area also indicates calcium-sulfate type water under baseline conditions (WDEQ-WQD, Sheridan Office, 2008). Groundwater quality data from three monitor wells installed by methane producers in sections 4, 15 and 22 of T42N, R75W, are also of the calcium-sulfate type (MW4-2, MW23-15 and MW22-1). These three wells are under water table conditions and have not received any infiltration from water produced during coal-bed development because they were installed prior to the discharge of CBNG produced water. Based on elevation relationships, it is highly likely that the wells in sections 15 and 22 are installed in the 72 sand aquifer. Similarly, the groundwater encountered in piezometers 35N-6 and 35N-7C (Conoco, 1981) is of the calcium-sulfate type. Both of these piezometers were completed in sandy portions of the 72 sand aquifer.

Shallow aquifer systems which have received CBNG water typically display an evolution from calcium-sulfate to sodium-bicarbonate type (WDEQ-WQD, Sheridan Office, 2008). CBNG water within this area is of the sodium-bicarbonate type. Data from a monitor well (MWAL21-20-1) installed in a shallow alluvial system located in the NENW of section 20, T43N, R77W have been included on the attached Piper diagram. These data show the influence from infiltration of CBNG water as sodium and bicarbonate become the dominant ions in the shallow groundwater. The evolution from a calcium-sulfate based water type to sodium-bicarbonate occurred along with a decrease in total dissolved solids. Although groundwater in OMW-3 is somewhat atypical because of the significant presence of the bicarbonate ion, bicarbonate concentrations are far below those observed from nearby CBNG outfalls and the dominant cation remains calcium versus the prevalent sodium from CBNG discharges.

Comparison of the ambient water quality measured in the 72 sand to data from a system being altered by infiltration, indicates that the 72 sand has not received infiltration from nearby discharges. The potential for the water quality of the 72 sand to be impacted by infiltrating CBNG discharges was evaluated through a basic linear velocity analysis using conservative estimates to delineate; 1) minimum travel time for CBNG produced water to infiltrate from the surface through the overlying silts and clays to the top of the sandy portion of the 72 aquifer, and 2) minimum travel time between infiltration into the sandstone (either underlying an impoundment or recharge directly into a sandstone outcrop) to the closest monitoring point. The basic assumptions that were made lead to exceedingly conservative velocities and travel times (see attached Table 2-5.b). Fundamentally, utilizing conservative values for thickness, hydraulic conductivity and porosity it is theoretically possible for the 72 sand to receive water during the lifespan of the Moore Ranch Project. Infiltration into outcrops or subcrops of the 72 sand to where it could potentially reach monitoring locations is less likely, with travel times on the order of tens to hundreds of thousands of years.

Anecdotal evidence provided by the WDEQ-WQD for surface water facilities permitted to receive CBNG produced water provides few instances in which water infiltrating from the facilities has adversely impacted groundwater resources. Groundwater quality has been adversely affected and class of use has changed at only 16 out of 109 permitted impoundments due to infiltration from overlying reservoirs/infiltration pits. Typically, the class of use has changed due to increases in the concentrations of selenium, TDS or sulfate. These data represent nearly four years of data collection from 259 monitor wells installed at sites across the Powder River Basin. Based on the lack of change in groundwater chemistry in the 72 sand aquifer from 1980 to the present, there is no evidence to suggest that this aquifer is impacted.

Table 2-5.b Estimated Linear Travel Times to the 72 Sand Aquifer System

Unit	Thickness (ft)		Thickness (cm)	K (cm/sec)	Porosity (unitless)	(dh/dl)	Average Linear Velocity (cm/sec)	Average Linear Velocity (ft/day)	Travel Time (days)	Travel Time (years)
Overburden Siltstone	Minimum	30	914	1.0E-04	0.35	1	2.9E-04	0.810	37	0.1
		30	914	1.0E-05	0.35	1	2.9E-05	0.081	370	1.0
		30	914	1.0E-06	0.35	1	2.9E-06	0.008	3704	10.1
	Average	115	3505	1.0E-04	0.35	1	2.9E-04	0.810	142	0.4
		115	3505	1.0E-05	0.35	1	2.9E-05	0.081	1420	3.9
		115	3505	1.0E-06	0.35	1	2.9E-06	0.008	14199	38.9
	Maximum	200	6096	1.0E-04	0.35	1	2.9E-04	0.810	247	0.7
		200	6096	1.0E-05	0.35	1	2.9E-05	0.081	2469	6.8
		200	6096	1.0E-06	0.35	1	2.9E-06	0.008	24694	67.7

Unit	Distance to monitoring point (ft)	Distance (cm)	K (cm/sec)	Porosity (unitless)	(dh/dl)	Average Linear Velocity (cm/sec)	Average Linear Velocity (ft/day)	Travel Time (days)	Travel Time (years)
72 Sand	9151	2.8E+05	1.0E-06	0.25	0.004	1.6E-08	4.4E-05	2.1E+08	5.7E+05
	851	2.6E+04	1.0E-06	0.25	0.004	1.6E-08	4.4E-05	1.9E+07	5.3E+04

(Red) Indicates most conservative travel time and velocity estimate (thinnest overburden, highest K)
(Yellow) Indicates measured variables used in calculations. Values are from Conoco, 1981 and EMC, 2007
(Blue) Distance is measured from approximate sandstone outcrop on South Fork Ninemile Creek (NESE, S10, T41N, R75W) to monitor well OMW-4
(Orange) Distance is measured from outfall 020 EPTD to OMW-2 (area where overburden siltstone is thinnest)

The above information was included in Section 2.7 (Section 2.7.2.3).

c. If EMC determines the "72 sand" has received infiltration from CBM produced water discharge, it may influence the water quality in the "72 sand" at different locations which receive the infiltration. This could affect the evaluation of ISL operation impacts on surface water, surface spills and how to monitor excursions to the "72 sand" monitoring wells. Explain how EMC will monitor surface water, spill impacts and the "72 sand" to separate CBM impacts from ISL impacts including how excursion indicators be chosen and upper control limits will be determined or justify why it will not be a problem and the proposed indicators are sufficient.

Response:

As stated in the previous response, the 72-sand does not indicate impacts from nearby CBM discharges, which. As a result, the proposed indicators are sufficient.

2-6. Ground Water Hydrology – unconfined aquifer (Section 2.7)

The unconfined aquifer in the proposed "70 sand" production zone is a unique setting for an ISL operation. The unconfined aquifer setting presents an entirely different hydrogeologic flow regime which has implications for well field balancing, communication with monitoring wells and overlying and underlying aquifers, excursion monitoring /correction, lixiviant behavior and restoration. Please provide the following information:

a. Only one potentiometric surface was provided for the "70 sand." Provide the potentiometric surface in the "70 sand" over time as discussed in NUREG-1569.

Response:

Additional potentiometric surface maps have been prepared for the 70 Sand and are attached [Figures 2.7.2-5a through 2.7.2-5e]. The maps show a consistent hydraulic gradient toward the north throughout the period of measurement (February 2007 through March 2008) with the exception of the July 2007 potentiometric surface map. The potentiometric surface in July 2007 [Figure 2.7.2-5c], indicates a depression at baseline well MW8. Hydrographs have also been prepared for all of the baseline monitor wells completed within the 70 Sand that illustrate water level fluctuations since the wells were installed in 2006 [Figures 2.7.2-5f 2.7.2-5g]. Water level fluctuations are generally less than a few feet with the exception of monitor well MW8. MW8 showed a decrease of almost 20 feet in two measurements in July 2007 and then rebounded to previous levels. No direct cause has been identified for the decrease although it is suspected that the low water level is the result of slow recovery after purging the well prior to a sampling event. A potentiometric map was also constructed for the July 2007 data without including the MW8 measurement [Figure 2.7.2-5h]. The results of the mapping indicate that the depression around MW8 is localized and does not impact the other baseline wells. Water level data used to develop the potentiometric surface maps and the hydrographs are included in Table 2.7.2-2.

Section 2.7.2 was revised to reflect this information and new Figures 2.7.2-5a through 2.7.2-5h were added.

b. EMC states the "70 sand" is unconfined across the license area. However, EMC used a confined analysis method to evaluate all of the Conoco pump tests and EM 2007 pump tests in the "70 sand." Provide the details which show the confined analysis is an acceptable approach or revaluate the "70 sand" pump tests using an unconfined analysis to provide estimates of unconfined conductivity and specific yield for the "70 sand."

Response:

EMC did not analyze the data from the Conoco pump tests and only reported the results of the analyses performed by Conoco. The raw data from the Conoco pump tests were unavailable for additional analysis.

EMC conducted three pump tests in 2007 to evaluate aquifer properties of the 70 Sand. The data collected from the 2007 pump tests was suitable for general scoping purposes to determine if ISR methods could be successfully applied at the site. However, the data collected from the 2007 pump tests were not conducive to detailed analysis of aquifer properties because of the limited radius of influence and the strong impacts that barometric changes had on water level data during the tests.

In the test at well PW1, drawdown was observed at observation well MW1 located approximately 109 feet from the pumping well. However, that test was not run under a constant rate, making analysis of the data collected during the test more qualitative than quantitative.

During the MW2 pump test, drawdown was observed at well 1805, completed within the 70 Sand at a distance of 346 feet from the pumping well. That well has been re-analyzed using the Neuman method of analysis that is suitable for delayed yield response typical of unconfined aquifers. Results of the unconfined analysis of 1805 are attached (Figure 2.7.2-11).

The pump test that was performed at well MW3 resulted in no discernible drawdown at any of the monitor locations. The closest 70 Sand monitor well to the pumping well was over 1300 feet away.

EMC recently (2008) conducted a pump test designed to replicate operational conditions for the 70 Sand. A 5-spot pattern was installed within proposed Wellfield 2. The test included a central extraction well, four injectors spaced 100 feet apart, and several additional observation wells at distances of 10, 30, 40 and 70 feet from the extraction well. Boring logs and water level data confirmed that the wells included in the 5 Spot Pump Test were all within the unconfined portion of the 70 Sand. The initial phase of the test included only pumping from the extraction well. The pumping test was instrumented to allow continuous monitoring during all phases of the test. The data collected from the test was analyzed using a variety of analytical methods including Theis, Cooper-Jacob, Neuman (delayed yield) and Theis recovery. Results of the analyses indicate that the Neuman (delayed yield, unconfined conditions) method provided the best fit to the data. Furthermore, analytical results using the Neuman method were typically only 60 to 70 percent of the value determined using the standard Theis method. Data and analysis from the test are provided in a Appendix B2 (Technical Memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project" (Petrotek 2008a)) that is attached. The analytical results reported in that report are considered the most representative of site conditions and provide the basis for additional calculations and modeling pertaining to production and restoration operations. Adjustments to aquifer property data and calculations dependent on those aquifer properties will be made as that data becomes available throughout the project.

Section 2.7.2 was updated with this information (2008 Pump Test Results) and Appendix B2, Technical Memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project" (Petrotek 2008a) was added to Appendix B.

c. The EMC pump tests show very small drawdowns and lack of response in observation wells over the license area in the unconfined "70 sand" even when pumping rates were large over many days. These pump tests confirm the small drawdown may make it difficult to demonstrate communication across the production zone, with monitoring wells and isolation from the overlying and underlying aquifers. Explain how future pump tests will be designed for the "70 sand" to provide adequate hydrogeologic characterization of the wellfields given this small drawdown. This may include the use of more pump tests with observation wells on closer spacing.

Response:

Recently acquired field data from a 5 Spot Pump Test provides reliable and representative aquifer characterization of the 70 Sand. Data and analysis from the test are provided in the Technical Memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project" (Petrotek 2008a) that is attached. The results of the pump test were used to construct and validate numerical models that will be used to design future pumps tests that will adequately demonstrate hydraulic communication within the production zone. Results of the modeling indicate that multiple pumping tests will be required to demonstrate hydraulic communication across the production zone. A preliminary simulation of such a pump test and full description of the model development and model simulations is provided in the Appendix B4 report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008b).

Section 2.7.2 was revised to include this information.

d. EMC acknowledges that reduced drawdowns are occurring in the unconfined aquifer in the "70 sand" in response to pumping. NRC staff is concerned this will impact wellfield balancing, excursion prevention/correction and excursion monitoring. Explain how EMC will operate the well fields to address the impact of small drawdowns on operations and excursion prevention/control or justify why it is not an issue.

Response:

The recently completed 5-Spot Pump Test provided sufficient information to adequately characterize the 70 Sand aquifer system in an area where it is predominately under unconfined conditions. The aquifer characterization data has been incorporated into numerical models that will be used to assist in the design of wellfield development, production and restoration. The 5 Spot Pump Test demonstrated that the aquifer is very responsive to pumping. For example, during the first phase of the 5-Spot Pump Test with pumping occurring at a single extraction well at a rate of 21.7 gpm, drawdown of over 2 feet occurred at all wells within the test area within 1 day. The maximum distance from the pumping wells to the wells on the exterior of the pattern was 71 feet. Using parameters determined from the 5-Spot test (transmissivity of 300 ft^2/d, and a specific yield of 0.028), the calculated drawdown at a distance of 500 feet from the pumping well would be approximately 0.5 feet after 10 days of pumping at 22 gpm (Figure 2.7.2-12). The data indicate that a cone of influence could rapidly extended out to a monitor well ring 500 feet from the mined ore zone and that an excursion could be reversed within a relatively short period of time. Additional model simulations will be performed to further refine the methods that would be employed to recover an excursion and to determine the time frame that recovery could be accomplished.

Section 2.7.2 was updated with this information (2008 Pump Test Results) and Appendix B2, Technical Memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project" (Petrotek 2008a) was added to Appendix B.

e. NRC staff is concerned that lixiviant composition and flow could be impacted by the unconfined aquifer setting (e.g. added oxygen may evolve out of solution to create a gas and liquid phase in the ore body, which can lead to reduced permeability and preferential flow paths). Therefore, address in detail the implications to lixiviant composition and flow of the unconfined aquifer setting.

Response:

The key issue with respect to oxidant concentration and uranium recovery rates at Moore Ranch is related to the available hydrostatic head rather than the unconfined nature of the ore bearing aquifer. Energy Metals personnel are well aware of the modest available hydrostatic head at Moore Ranch and have taken this into consideration in developing the production profile presented in the application. As noted by the NRC staff, excessive injection of dissolved oxygen may result in creation of a free gas phase in the mining zone and could potentially create a restricted flow or gas locked reservoir. Such situations have previously been encountered in Texas and successfully resolved by personnel now employed by Energy Metals Corporation.

Oxygen injection is always restricted to the solubility of a pure oxygen phase in aqueous solutions (approximately 1 ppm oxygen per foot of available hydrostatic head). This insures that oxygen entering the host formation at the injection well is dissolved. In this regard, it must be noted that all injection wells are operated under a positive well head pressure. This pressure is limited and cannot exceed the ore zone fracture pressure by Wyoming regulations. Oxygen injection concentrations are controlled to the limitations of the individual well head surface pressure and oxygen solubility. Clearly, as lixiviant containing dissolved oxygen moves through the ore bearing aquifer, overburden or hydrostatic pressures will diminish. This is particularly true at and near the vicinity of recovery wells. During leaching operations, the active reaction zone where uranium leaching occurs moves away from the injection wells in initially a radial fashion and eventually along preferential flow paths. The general movement of this reaction zone is readily illustrated with traditional front tracking fluid flow models.

It is common and well accepted practice in commercial ISR operations to alter the direction of preferential flow between and among wells by changing the function of individual wells. That is, injection wells may be converted to recovery wells, recovery wells may be converted to injection, and selected wells may temporarily be shut in. Of course, the hydrologic cone of depression for the subject well field is maintained at all times even as the configuration of operating wells is altered. Within the industry, this process is known by various terms including well rotation, flip-flops, and other similar terms. In well fields with substantial hydrostatic heads, this process occurs late in the life of a well field. What will differ for situations such as that at Moore Ranch is that this process of altering flow paths and stream lines will occur early and, perhaps, often during the operating life of individual well patterns. Previous experience with limited hydrostatic heads has shown that the presence of free oxygen will be observed at recovery wells in advance of the onset of gas phase induced flow restrictions. Observation of the free gas phase is a useful basis for initiating rearrangement of operating well functionality which, in turn, allows for effective delivery of oxidation to unleached or slightly oxidized portions of the ore body. The only difference in operating strategy between Moore Ranch and other projects with confined, high hydrostatic head ore zones is that the timing of well rotations will be accelerated.

If a portion of the ore body does exhibit partial or even total gas blockage, experience at other projects has demonstrated the effectiveness of back flowing individual wells to remove the free gas and restore full liquid phase permeabilities. In this case, the backflow fluid would be added to other recovered fluids and sent to the ion exchange facility for uranium extraction and degassing prior to reinjection into the well field.

f. NRC staff is concerned that unconfined conditions may impact restoration if sweep can not be achieved in all zones in the "70 sand". Explain how EMC will ensure sweep of all zones in the unconfined aquifer during restoration or explain why it is not an issue.

Response:

The unconfined conditions present in the 70 Sand result in development of relatively steep drawdown cones during pumping that are of limited areal extent. Therefore the area of "dewatering" tends to be localized around the production well. Data collected during the 5-Spot Pump Test indicates that aquifer recovery occurs rapidly once an extraction well is shut in. Efficient groundwater sweep for both production and restoration can be accomplished by "pulsing" of extraction wells by cycling them on and off. The pulsing can be achieved by either switching groups of extraction wells on and off or by alternating between injection and extraction cycles within individual well patterns. Pulsing of wells will effectively resaturate portions of the aquifer that may have been temporarily dewatered by any individual extraction well. A model simulation illustrating this technique is attached. A description of the model development is provided in Appendix B2 in the technical memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project," Petrotek 2008a).

Section 6.1.3 was revised to include this information.

g. EMC has stated that recharge enters the "70 sand" one mile southeast of the license area. NRC is concerned that the influx of oxidized water entering the unconfined "70 sand" from the nearby recharge zone may impact the stability of the restoration if chemical or biological reductants are employed to achieve restoration. Explain how EMC will ensure stability in this case or why it is not an issue.

Response:

The pre-mining water quality has already been established through baseline sampling. The baseline water quality is considered representative of "steady state" conditions resulting from inflow of groundwater that is recharging the aquifer south of the site. In other words, groundwater moving across the site has already geochemically reacted with the aquifer matrix, resulting in the observed solutes at their current levels in the baseline samples. It is not known if the water recharging the aquifer to the south is still oxygenated by the time if flows through the License Area. While the uranium was deposited on the interface from oxidizing to reducing conditions, those deposits have not migrated to any measurable extent due to the inflow of oxic groundwater. There are currently no conditions that would cause an "influx" of oxidized groundwater beyond the typical recharge that exists in the current steady state conditions. Therefore, significant changes in the current oxidation-reduction front from upgradient oxic groundwater flow are not applicable and stability of restored areas will not be impacted.

2-7. Ground Water Hydrology – 70 sand aquifer communication with 68 sand (Section 2.7)

The confinement of the "70 sand" is in question based on the acknowledged absence of the underlying shale between the "70 sand" and "68 sand" in a large portion of Wellfield 2, the potential absence of the underlying shale in Wellfield 1, and the absence of overlying shale on the isopach just northwest of Wellfield 3.

a. Provide the potentiometric surface variability in the "68 sand" over time as discussed in NUREG 1569 and determine the vertical gradients between it and the "70 sand" over the license area.

Response:

Additional potentiometric surface maps have been prepared for the 68 Sand and are attached (Figures 2.7.2-7a through 2.7.2-7e). The maps show that the horizontal hydraulic gradient is consistently toward the northwest; however the magnitude of the gradient varies. Changes in the horizontal hydraulic gradient are predominately caused by large fluctuations in water levels that occur in 68 Sand monitor well UMW3. Additional monitoring of that well was performed by EMC and is described in detail in responses to comment 2-7.d. Hydrographs have been prepared for the baseline monitor wells showing water level changes over time for each well [Figure 2.7.7-7f]. With the exception of well UMW3, water levels remain relatively stable during the period of measurement (February 2007 through March 2008). Comparison of water levels in each of the nested well groups (MW1/UMW1 through MW4/UMW4) are shown on Figures 2.7.2-7g through 2.7.2-7j respectively. Water levels between the MW1/UMW1 and MW2/UMW2 well groups are very similar and no clear vertical hydraulic gradient predominates. The data are consistent with isopach data that indicate the absence of the underlying shale between the 70 and 68 Sands in the eastern portion of Wellfield 2 and therefore possible hydraulic communication between those units. At the MW4/UMW4 well group there is a distinct downward hydraulic gradient between the 70 and 68 Sands with water levels in the 70 Sand monitor wells consistently 8 to 10 feet greater than in the 68 Sand monitor wells. The hydraulic relationship between the 70 and 68 Sands at the MW3/UMW3 well pair is not clear because of the large fluctuations in water levels at UMW3, as described further under comment response 2-7.d. Water level data used to develop the potentiometric surface maps and the hydrographs are included in Table 2.7.2-2.

Section 2.7.2 was updated with this information and new Figures 2.7.2-7a through 2.7.7-7j and Table 2.7.2-2 were added to Section 2.7.

b. EMC states that in Wellfield 2, the "70 sand" and the "68 sand" coalesce in a large section. This is confirmed by isopachs, geological cross sections, and by pump tests. NRC staff is concerned that ISL operations in the "70 sand" in this wellfield will significantly impact the water quality in the "68 sand". Explain how EMC will prevent any excursions into the "68 sand" and monitor for excursions in the "68 sand" in Wellfield 2.

Response:

See Response to RAI 5-12(b) and 6-1(b).

c. EMC indicated that there is potential communication between the "70 sand" and underlying aquifer "68 sand" in the southern portion of Wellfield 1 as shown by the Conoco pump test. Either confirm if there is communication or provide evidence of no communication. If communication exists, explain how EMC will prevent and monitor for excursions in this location.

Response:

In 1977, Conoco pumped well 885 at a rate of 3.4 gpm for a period of 1 day (a total of 4,900 gallons). During the test, Conoco reported drawdown in an underlying monitoring well (887) of 0.76 feet. The underlying well was a reported to be a distance of 119 feet from the pumping well. Conoco stated in its report that the well seal was suspect. Drawdown was also measured at two other 70 Sand monitor wells, 886 and 888, reported to be 64 and 50 ft, respectively from the pumping well. The drawdown in those wells was reported as 0.74 and 1.95 ft, respectively. Note that the well locations reported in the Conoco Permit to Mine Application indicate that the distance from the pumping well to 887, 886 and 885 are actually 159, 161 and 12 feet respectively.

In an attempt to verify the hydraulic communication reported by Conoco, EMC conducted a pump test at well 885 on 6/4/08. Well 885 was pumped at a rate of approximately 15.6 gpm for a period of 20 hours (18,600 gallons). This test provided a significantly larger hydraulic stress to the 70 Sand than the Conoco test. The underlying monitor well (887) showed no response due to pumping of the production zone well (885). There was an unexplained and abrupt shift in the water level at well 887 halfway into the test. However, the shift does not appear to be related to the pumping test because it was a sharp instantaneous rise in water level of 0.1 feet approximately 11 hours into the test. No drawdown was observed during the duration of the test. Drawdown in well 885 was 17.4 feet at the end of the test. Drawdown at 70 Sand monitor well 888 at the end of the test was 2.6 ft. There was no drawdown indicated at location 886 during the test. A map showing the location of the pumping well and monitor wells and plots of the water level data collected during the test are attached. Based on the results of the test, EMC has demonstrated there is no communication between the 70 Sand and 68 Sand in the vicinity of the 885 monitor well.

Section 2.7.2 was updated with this information (2008 Pump Test Results) and Appendix B3, Technical Memorandum "885 Pump Test Description" (Petrotek 2008a) was added to Appendix B.

d. EMC describes an unexplained drawdown of 25 ft in UMW 3 in Wellfield 1 in the "68 sand" starting in Feb. 2007 and continuing until mid-August. NRC staff is concerned that there may be a nearby unidentified pumping well which is impacting the "68 sand," given the characteristics of this drawdown and recovery. Provide an explanation for this drawdown during this period.

Response:

The unexplained drawdown observed in the water levels of UMW-3 from February through July of 2007 does not correspond with production from nearby CBNG wells. Production from the six closest wells was ongoing through both drawdown and subsequent recovery of the water levels in UMW-3. Water production from the CBNG wells in March 2008 was more than 5,780 bbls/day (WOGCC, 2008), while the water levels in UMW-3 stabilized in February 2008. The majority of this has come from the 34S-1 (NENE, Section 34, T42N, R75W) and 35S-4 (NWNW, Section 35, T42N, R75W). Impacts to the monitor well due to CBNG production seems highly unlikely given this scenario.

EMC has continued monitoring of UMW3 to determine if the drawdown behavior is repeated or if a cause of the observed trend can be identified. Water level measurements were made at 15 minute intervals using a pressure transducer from 2/15/07 through 3/1/07, and 3/20/07 through 3/23/07, and then at 10 minute intervals from 5/8/08 through 7/1/08. A problem was identified with the transducer during the 2008 monitoring period, resulting in replacement of the instrument. Hand measurements were periodically made throughout the monitoring period. A hydrograph is attached that shows the water level elevation during the entire monitoring period (Figure 2.7.2-7k). In addition to the decline in water levels that was previously noted in the License Application (from February 2007 until August 2007) a large decrease in water level occurred in the well in October 2007. The decrease in water levels was in response to a sampling event in which the well was purged prior to sampling. Almost two months following the sampling event, water levels in the well were still almost 18 ft lower than the pre sample level. This slow recovery indicates that the 68 Sand in the vicinity of UMW3 has a relatively low transmissivity or that there is significant skin damage in the well. Discounting the equipment malfunction (which was identified when hand measurements indicated an error in the transducer measurement) the water level in UMW3 has been relatively stable since February 2008. The cause of the earlier declining trend in the well is unknown and was not replicated in other wells. EMC will continue periodic monitoring of well UMW-3 to identify continuing trends and potential causes of those trends in the well. Additionally, the underlying aquifer in the vicinity of UMW-3 will be closely monitoring during production of the 70 Sand in that area.

Section 2.7.2 was updated with this information and Figure 2.7.2-7k was added to the end of Section 2.7.

e. EMC shows that the overlying shale is missing on the isopach on the northwest side of Wellfield 3. NRC staff is concerned there will be communication between the "70 sand" and the overlying "72 sand" in this area during production operations. Determine whether there is communication of the "70 sand" with the "72 sand" where this overlying shale is missing. If you determine that there is communication, explain how EMC will prevent and monitor excursions into the overlying aquifer. If you determine that there is no communication, provide the basis for that conclusion.

Response:

See response to 2-3.f. Based on the available data, there does not appear to be hydraulic communication between the 70 and 72 Sands. There are consistently 50 to 60 foot differences between the 70 and 72 Sands in all four locations where well pairs screened in the 70 and 72 Sands are located.

2-8. Background Water Quality (Section 2.7)

The analysis of the surface water and ground water quality in the proposed license area is currently insufficient to interpret the impact of ISL recovery on water quality in and around the license area. Please provide the following:

a. EMC states that there are CBM discharge points in the license area. NRC is concerned that the baseline water quality in the surface water and overlying aquifer "72 sand" may have been and will be impacted by CBM produced water discharge. Provide the location, water quality, permitted volume and known volume of CBM produced water discharged to the surface within the license area and an estimate of how much has infiltrated to the "72 sand". Provide an estimate of the location, predicted water quality and volume of CBM discharge to the license area during future ISL operations.

Response:

Table 2-8.a provides a list of the discharge points located within the license area. These discharge points are also presented on Figure 2.7.-A1, as are a number of others outside of the license area.

Table 2-8.a CBNG WYPDES Permits and Outfall Locations Within or Upstream of the Moore Ranch Project

Company	Permit #	Outfall #	Qtr-Qtr	Sec	Twp	Rng	Latitude	Longitude
Devon	WY0040436	**001 EPTD**	**NWNE**	**25**	**T42N**	**R75W**	**43.59012**	**-105.81289**
		002 EPTD	**SENE**	**25**	**T42N**	**R75W**	**43.58458**	**-105.80856**
		004 EPTD	SESE	25	T42N	R75W	43.5806	-105.8100
		005 EPTD	SWSE	25	T42N	R75W	43.5769	-105.8122
		006 EPTD	NWNE	36	T42N	R75W	43.5719	-105.8117
		007 EPTD	SWNE	36	T42N	R75W	43.5694	-105.8122
		008 EPTD	SESE	36	T42N	R75W	43.5639	-105.8008
		009 EPTD	**NESW**	**24**	**T42N**	**R75W**	**43.59653**	**-105.81550**
		010 EPTD	SWSW	31	T42N	R74W	43.5626	-105.8043
		011 EPTD	NESW	34	T42N	R75W	43.5647	-105.8586
		012 EPTD	SWSE	34	T42N	R75W	43.5647	-105.8547
		017 EPTD	NESE	27	T42N	R75W	43.5814	-105.8465
		019 EPTD	NWNW	35	T42N	R75W	43.5743	-105.8430
		020 EPTD	SENW	35	T42N	R75W	43.5688	-105.8374
		021 EPTD	NESW	35	T42N	R75W	43.5657	-105.8259
		022 EPTD	SWSE	35	T42N	R75W	43.5628	-105.8345
		023 EPTD	SWSE	35	T42N	R75W	43.5623	-105.8345
		024 EPTD	**SWSE**	**23**	**T42N**	**R75W**	**43.59174**	**-105.83319**
		025 EPTD	SESE	26	T42N	R75W	43.5775	-105.8261
		026 EPTD	SWSW	25	T42N	R75W	43.5763	-105.8227
		027 EPTD	NENW	36	T42N	R75W	43.5738	-105.8176
		030	NENW	10	T41N	R75W	43.5442	-105.8581

		EPTD						
BBC	WY0051217	018	NWSW	1	T41N	R75W	43.55252	-105.82161
		020	SWSE	2	T41N	R75W	43.54840	-105.83423
		021	SWSW	2	T41N	R75W	43.54722	-105.84404
BBC	WY0055131	004	NWNE	9	T41N	R75W	43.54492	-105.87229
		005	NESE	28	T42N	R75W	43.58020	-105.86910
		006	SWSW	28	T42N	R75W	43.57640	-105.88350
		007	SWSE	31	T42N	R75W	43.56395	-105.91549
		008	NESW	33	T42N	R75W	43.56641	-105.87995

*Shading indicates outfalls that are upstream of Moore Ranch License Area

Discharge data and WYPDES permit limits for outfalls located within the license area are provided in the tables on the following pages. Data provided in response to comment 2-5.b indicates that infiltration to the 72 Sand has not occurred to date.

A conservative annual declination rate of 5% is assumed for future CBM discharge based on Devon's East Pine Tree Unit (WY0040436) historic data, as presented in the following table. All three WYPDES permits will up for renewal in early 2009 with an expiration date in 2014. Personal communications with permit holders indicates that the permits will not likely be renewed in 2014. Flow from Devon's WY0040436 outfalls is anticipated to be less than 0.006 MGD by 2013. Based on historic CBNG water discharge data within the license area, water quality will not vary significantly as CBNG water production declines.

Table 2-8.a1 Historic and Projected Discharge Rates at CBM Discharge Points (Devon – East Pine Tree Unit, WY0040436)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2012	2014
Maximum Flow (MGD)	0.1006	0.0694	0.0572	0.0302	0.0183	0.0111	0.0092	0.0120	0.0114	0.0108	0.0103	0.0093	0.0084
Average Flow (MGD)	0.0895	0.0615	0.0388	0.0243	0.0143	0.0078	0.0078	0.0082	0.0078	0.0074	0.0070	0.0063	0.0057
Annual Decline		36.0%	35.2%	11.1%	11.1%	17.4%	5.9%	5.9%	5.0%	5.0%	5.0%	5.0%	5.0%

Table 2-8.a2 BBC Pine Tree Area (WY0055131) Average Water Quality and Discharge Rates

PARAMETER	UNIT	PERMIT LIMIT[1]	OUTFALL				
			004	005	006	007	008
Total Flow (MGD) - MAX	MGD	1.02	0.0042	0.0261	0.0146	No Dis	No Dis
Total Flow (MGD) - AVG	MGD		0.0028	0.0197	0.0124	No Dis	No Dis
Bicarbonate	mg/L		952	1293	1126	No	No Dis

						Dis	
Dissolved Calcium	mg/L		74	82	73	No Dis	No Dis
Dissolved Magnesium	mg/L		26	33	34	No Dis	No Dis
Dissolved Sodium	mg/L		222	305	197	No Dis	No Dis
pH	SU	6.5-9.0	7.57	7.55	7.43	No Dis	No Dis
Sodium Adsorption Ratio	Calculated	10	5.7	7.6	6.0	No Dis	No Dis
Specific Conductance	micromhos/cm	2000	1350	1686	1415	No Dis	No Dis
Total Alkalinity	mg/L as CaCO3		780	1059	922	No Dis	No Dis
Chlorides	mg/L	46	10.3	6.9	6.8	No Dis	No Dis
Dissolved Iron	ug/L	1000	160	1257	570	No Dis	No Dis
Total Recoverable Arsenic	ug/L	3	0.67	1.73	1.60	No Dis	No Dis
Total Recoverable Barium	ug/L	1800	1050	2023	1157	No Dis	No Dis
Dissolved Cadmium	ug/L		0.1	ND	N/A	No Dis	No Dis
Dissolved Manganese	ug/L		97	104.5	84.5	No Dis	No Dis
Fluorides	mg/L		0.56	0.90	0.66	No Dis	No Dis
Potassium	mg/L		9	12.3	12.4	No Dis	No Dis
Sulfates	mg/L		2.6	3	7.5	No Dis	No Dis
Total Petroleum Hydrocarbons	mg/L		1	ND	ND	No Dis	No Dis
Total Radium 226	pCi/L		0.6	1.05	0.4	No Dis	No Dis

[1] – Data is provided for outfalls within and flowing through the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0051217 (total number outfalls is 25)
N/A - Was not monitored, No Dis – No discharge reported, ND – Reported as non-detect by laboratory

Table 2-8.a3 Devon East Pine Tree Unit (WY0040436) WYPDES Average Water Quality and Discharge Rates[1]

PARAMETER	UNIT	PERMIT LIMIT[2]	OUTFALL																			
			004	005	006	007	008	010	011	012	013	017	018	019	020	021	022	023	025	026	027	030
Flow - MAX	MGD	0.68	0.0443	0.0239	0.0109	0.0213	0.0256	0.0348	0.0283	0.0290	No Dis	0.0414	No Dis	0.0183	0.0086	0.0041	0.0066	No Dis	0.0130	0.0057	0.0032	0.0175
Flow - AVG	MGD		0.0367	0.0150	0.0096	0.0206	0.0232	0.0266	0.0217	0.0135	No Dis	0.0291	No Dis	0.0158	0.0076	0.0021	0.0044	No Dis	0.0108	0.0046	0.0021	0.0139
Alkalinity	mg/L		468	615	762	670	663	572	1217	995	No Dis	997	No Dis	602	702	498	434	No Dis	796	302	407	617
Total Recoverable Arsenic	ug/L	2.4	0.8	1.4	0.9	1.6	1.3	1.4	2.6	1.4	No Dis	5.6	No Dis	0.5	2.1	2.0	0.6	No Dis	0.6	1.6	1.1	1.8
Total Recoverable Barium	ug/L	1800	628	1032	1092	902	883	486	2476	1694	No Dis	1433	No Dis	577	925	600	421	No Dis	1153	296	360	980
Bicarbonate	mg/L		660	741	921	817	804	695	1471	1190	No Dis	1211	No Dis	723	828	605	517	No Dis	960	365	496	741
Calcium	mg/L		29	42	52	51	46	36	131	103	No Dis	88	No Dis	55	54	36	28	No Dis	68	17	26	59
Chlorides	mg/L	46	10	9	9	10	9	10	8	11	No Dis	5	No Dis	5	5	7	8	No Dis	6	9	No Dis	9
Dissolved Iron	ug/L	1000	189	482	1043	1089	60	671	380	174	No Dis	353	No Dis	467	351	1060	90	No Dis	498	892	905	0
Dissolved Cadmium	ug/L		N/A	N/A	N/A	N/A	N/A	N/A	0.6	0.6	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1820
Dissolved Manganese	ug/L		109	50	66	176	50	143	117	114	No Dis	77	No Dis	48	70	61	30	No Dis	88	119	74	57
Fluorides	mg/L		0.6	0.5	0.5	0.7	1.4	0.7	0.6	0.5	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.7
Magnesium	mg/L		8	9	16	11	13	9	44	29	No Dis	32	No Dis	16	14	8	6	No Dis	16	4	5	19
pH	SU	6.5 – 9.0	7.81	7.87	7.76	7.69	7.81	7.64	7.44	7.62	No Dis	7.55	No Dis	7.51	7.34	7.05	7.60	No Dis	7.16	7.66	7.22	7.84
Potassium	mg/L		5	6	7	7	7	6	15	11	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9
Sodium	mg/L		146	215	256	221	231	199	305	274	No Dis	298	No Dis	209	232	180	160	No Dis	255	117	153	178
Sodium Adsorption Ratio	Calculated	10	7.6	7.9	8.0	7.6	7.9	8.1	5.9	6.2	No Dis	7.0	No Dis	6.4	7.2	7.1	6.9	No Dis	7.2	6.7	7.2	5.1
Specific Conductance	umhos /cm	2000	859	1093	1348	1204	1175	1008	2068	1665	No Dis	1684	No Dis	1145	1186	912	798	No Dis	1316	585	735	1076
Sulfates	mg/L		13	2	4	3	2	2	5	2	No Dis	1	No Dis	40	1	1	8	No Dis	16	9	ND	2
Total Petroleum Hydrocarbons	mg/L		0.7	1.0	1.0	0.7	1.0	0.5	1.0	1.0	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.0
Total Radium 226	pCi/L		0.5	0.3	0.5	0.3	0.3	0.3	0.8	0.6	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5

[1] – Data is provided for outfalls within the license area.

[2] - Permit Limit set for all outfalls discharging under Permit WY0040436 (total number outfalls is 30)

Table 2-8.a4 BBC Palm Tree Project (WY0051217) Average Water Quality and Discharge Rates

PARAMETER	UNIT	PERMIT LIMIT[1]	OUTFALL		
			018	020	021
Total Flow (MGD) - MAX	MGD	5.3	0.0403	0.0079	0.0083
Total Flow (MGD) - AVG	MGD		0.0147	0.0079	0.0083
Bicarbonate	mg/L		723	744	674
Dissolved Calcium	me/L		5.72	7.89	11.78
Dissolved Magnesium	me/L		1.97	2.14	2.96
Dissolved Sodium	me/L		40.30	43.88	48.96
pH	SU	6.5-9.0	8.03	8.03	7.94
Sodium Adsorption Ratio	Calculated	10	7.9	7.4	6.4
Specific Conductance	micromhos/cm	2000	880	1052	967
Total Alkalinity	mg/L as CaCO3		449	615	555
Chlorides	mg/L	46	9	8	9
Dissolved Iron	ug/L	1000	1810	1514	2020
Dissolved Manganese	ug/L		63	119	66
Sulfates	mg/L		18	1	ND
Total Recoverable Arsenic	ug/L	3	0.8	1.0	1.6
Total Recoverable Barium	ug/L	1800	608	713	832
Total Petroleum Hydrocarbons	mg/L		ND	ND	ND
Total Radium 226	pCi/L		0.36	0.47	0.23

[1] – Data is provided for outfalls within and flowing through the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0051217 (total number outfalls is 25)
ND – Reported as non-detect by laboratory

The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

b. EMC states that surface water in the license area is impacted by CBM produced water discharge. NRC is concerned that the baseline surface water quality and surficial aquifer water quality have been affected CBM produced water. Explain how EMC can assess baseline surface water and surficial aquifer ground water quality when it is variably impacted by CBM discharge.

Response:

As detailed in response to comment 2-5.b, the surficial aquifer water quality does not indicate any impact from CBNG discharges at this time. The seasonal variability of surface water quality apparent during baseline characterization is largely due to the influence from Devon Energy's outfalls permitted under WY0040436. The lack of water at MRSW-10 and MRSW-11 indicates that Bill Barrett's discharges upstream infiltrate into the shallow alluvial system and do not directly contribute to surface hydrological features within the license area. Assessment of surface water quality in light of the contributions from CBNG water discharges present at or upstream of monitoring sites must account for the seasonal variability present in the area. Following permit renewals in late summer/early fall 2008, WYPDES permits WY0040436, WY0051217 and WY0055131 will be active into 2014.

The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

2-9. Air Particulate Monitoring (Section 2.9)

A total of four air particulate air sampling stations and 10 radon monitoring stations were identified in Figure 2.9-25. Background sampling station(s) are not identified in Figure 2.9-25. Regulatory Guide 4.14, Revision 1, April 1980, Table 1, (Type of Sample, Air), discusses three air sampling stations at or near the site boundaries, one air sampling station at or close to the nearest residence or occupiable offsite structure(s) (if within 10 km of the site), and one control air sampling station. Please describe the basis of the selection process for each air sampling location (particulate and radon) and how this comports with the guidance regarding location in Regulatory Guide 4.14 for the type of sample, i.e., air. Also, please identify or include a background or remote air sampling location.

Response:

Baseline radon monitoring station locations were selected prior to placement of air particulate monitoring stations. Air particulate station locations were slightly different from "associated" radon monitoring stations due to logistical issues related to the availability of hard line electrical power for long-term site monitoring. Although some of the radon stations do not exactly coincide with air particulate station locations, in each case there is one or more radon station reasonably close by each air particulate station. Specifically, radon station MR-1 is approximately 1,500 feet from air particulate station MRA-4; radon station MR-7 is approximately 575 feet from air particulate station MRA-2; radon station MR-6 is approximately 1,000 feet from air particulate station MRA-1; and radon station MR-5 is in the same location as air particulate station MRA-3.

There were no known residences within 10 km of the site so a fifth air particulate station was not considered applicable according to the protocols outlined in Table 1 of Regulatory Guide 4.14. Also, the control/background air particulate location was chosen to be on site rather than at a location "remote from the site". This is consistent with footnote (c) to Table 1 which states a need for the background location to be representative of site conditions. That footnote also states that the background air particulate station should be upwind of the site. Because of the large amount of area included within the boundaries of this ISR site, it seemed reasonable to place the background station within site boundaries, but at considerable distance upwind of operational areas (it is currently located at least 1 mile west/southwest of the plant location and wellfield areas). This also seemed to be a practical background location as it is readily accessible and hard line electrical power has limited availability in the area.

The control/background air particulate and radon monitoring stations are represented by ID numbers MRA-4 and MR-1 (as respectively shown in Fig. 2.9-25). Again, these locations are generally upwind of the plant location based on annual prevailing wind directions presented in the earlier response to comment 2.10 (d).

Regulatory Guide 4.14 calls for a minimum of 5 radon sampling stations, each located at the five recommended air particulate sampling stations. Because of the very large size of the site, 10 radon monitoring stations were used instead of the recommended 5 stations. Furthermore, each air particulate sampling station has at least 1 radon monitoring station in the general vicinity. Baseline Rn-222 results indicated a relatively minor degree of spatial variability in radon concentrations across the site. Because additional radon monitoring stations are placed in many locations around the site, any significant localized changes in conditions due to ISR operations should be detected and can be compared against pre-operational baseline data and where applicable, against data from the nearest air monitoring station or other stations.

2-10. Groundwater, Surface Water, Vegetation, and Food Sampling (Section 2.9)

The applicant has not provided sufficient information in section 2.9 regarding radiological sampling of the environs of the Moore Ranch site. Specifically, the following information should be provided

a. It is stated in section 2.9.8 that baseline groundwater sampling is conducted at eleven wells on a quarterly sampling basis. The wells are shown in Figure 2.9-34 of the Technical Report. Please identify which monitoring wells are considered up gradient and which monitoring wells are considered down gradient. Also, please identify or include a background or remote groundwater sampling location. Please include the dates when these groundwater samples were collected.

   Response:

   Section 2.7.2.2 (Figure 2.7.2-5) provides a description of the hydraulic gradient of the Moore Ranch Project Area. In general, groundwater flow direction for the wells shown on Figure 2.9-34 is predominantly to the north. Therefore, wells on south side of the proposed development areas are up gradient and those wells on the north side are down gradient. Dates of all groundwater sampling and results can be found on Tables 2.7.3-17 through 2.7.3-21. Section 2.9.8 was revised to include the above information on hydraulic gradient and reference to Section 2.7.3.

b. It states in Section 2.9.8.2 that parameters in suspended form were also evaluated but can be found in Section 2.9.2.7.2 of the Technical Report. This information could not be found, as there is no Section 2.9.2.7.2 in Volume II of the Technical Report. Please provide this information.

   Response:

   Information on surface water quality, including suspended radiological parameters, are included in Section 2.7.3. The reference in Section 2.9.8.2 was corrected

c. It is stated in Section 2.9.9.2 that suspended surface water samples were evaluated but all results were below analytical reporting limits and the data, reporting limits, and other details can be found in Section 2.7.1, but this information could not be found in that section. Please provide this information.

   Response:

   Information on surface water quality, including suspended radiological parameters, are included in Section 2.7.3. The reference in Section 2.9.8.2 was corrected

d. It is stated in section 2.9.10 that vegetation sampling was collected from three locations in April 2007. The sample locations are depicted in Figure 2.9.38 of the Technical Report. The samples were analyzed for natural uranium, Th-230, Ra-226, Po-210 and Pb-210. Please describe the basis of the selection process for each vegetation sampling location and how this meets the guidance regarding location in Regulatory Guide 4.14 for the type of sampling (i.e., vegetation).

Response:

Vegetation sampling locations were selected based on the Regulatory Guide 4.14 recommendation that locations be selected in three different grazing areas with "highest predicted airborne radionuclide concentration due to milling operations." Locations at Moore Ranch for vegetation sampling were selected to be just downwind of the plant area (to the NE, E, and SE of the plant area). Prevailing annual wind information is presented in Section 2.5 (prevailing winds are out of the west and southwest). Consideration was also given to choose areas with sufficient vegetation density that the volume of vegetation collected could be large enough to help meet specified analytical detection limits.

e. in Section 2.9.11, Food Sampling, it states, "Sampling of food items from the site such as meat from local grazing livestock is not planned at this time." Please explain why food sampling is not planned.

Response:

Baseline food sampling (e.g. livestock) was not conducted as radiological baseline parameters relevant to food chain dose pathways (e.g. soil, sediment, water, and forage vegetation) have been well characterized. Changes in these parameters due to site operations could be used to model corresponding radiological changes in food items such as meat or milk from agricultural livestock. Respective radionuclide transfer factors can be found in the literature (e.g. IAEA, 1994; Yu, 2001). Larger game animals such as deer or pronghorn have extensive ranges and are not confined to the site. Potential for bioaccumulation of radionuclides in these animals would be limited as they would likely derive only a small fraction of total sustenance from the site. Finally, the historical Conoco baseline study included food sampling data for various locally raised agricultural products as presented in the application (Table 2.9-19).

References:

International Atomic Energy Agency (IAEA). 1994. Handbook of parameter values for the prediction of radionuclide transfer in temperate environments. Technical reports series No. 364. International Union of Radioecologists and International Atomic Energy Agency, Vienna, Austria.

Yu, C., et al. 2001. User's manual for RESRAD, Version 6, ANL/EAD-4, Argonne national Laboratory, Argonne, IIll., July.

f. Please explain why fish samples were not collected.

Response:

No fish species are found on site as all water bodies are ephemeral in nature and do not contain sufficient water to support aquatic species.

3-1. ISL Leaching Process and Equipment (Section 3.1)

The applicant has not provided sufficient information regarding the ISL leaching process and equipment to enable the staff to fully understand this topic and to support other reviews dependent on that understanding. Specifically, the following information should be provided:

Response:

In addition to the responses to the RAIs listed below, EMC has made other revisions in Section 3. These revisions include:

- Wellfield 3 was combined into Wellfield 2 making one wellfield (Wellfield 2). Maps and schedules were revised to reflect this.
- Section 3 was also amended to include use of sodium hydroxide and/or ammonia in the precipitation circuit.

a. The number, design, operation, and monitoring of the wellfield headerhouses where fluids will be injected and recovered from well fields.

Header houses will be used to distribute injection fluid to injection wells and collect production solution from recovery wells. Each header house will be connected to two trunk lines, one for receiving injection fluid from the processing plant and one for conveying recovery fluids to the processing plant. The header house includes manifolds, valves, flow meters, pressure meters, booster pumps and oxygen for incorporation into the injection lixiviant, if and when required. Each header house will service approximately 40 to 60 wells (injection and recovery). Figure 3.1-3A illustrates a plan view of a typical headerhouse. Currently, approximately 8 headerhouses are planned to be constructed for Wellfield 1 and 11 are planned for Wellfield 2. Section 3.1.3 was revised to include the information above and new Figure 3.1-3A.

Injection well and production well flow rates and pressures are monitored at the headerhouse_in order that injection and production can be balanced for each pattern and the entire wellfield. The flow rate of each production and injection well is continuously monitored by monitoring individual electronic flow meters in each wellfield headerhouse. The pressure of each production and injection trunk line will be monitored at the headerhouse with electoronic pressure gauges. The flow meters and pressure gauges will be tied into the headerhouse control panel, which will be in communication with the central plant control room.

High and low pressure and flow alarms will be in place to alert wellfield and plant operators if specified ranges are exceeded in conjunction with automatic shutoff valves to stop flow if significant changes in flow or pressure occur.

Section 3.1.3.1 was revised to reflect the headerhouse monitoring activities described above.

b. An in-depth discussion of how the bleed will be adjusted to maintain an inward gradient in the atypical unconfined aquifer conditions in the "70 sand" production zone. The discussion should account for the reduced drawdown anticipated in the unconfined setting and for dewatering and mounding of fluids at the production/injection wells.

Response:

A numerical groundwater flow model has been developed based on site-derived information (top and bottom elevations of the hydrostratigraphic units, water level elevations, and aquifer properties) that replicates the unconfined conditions observed at the site. The numerical model was used to simulate aquifer response across the License Area during typical and proposed production and restoration phases of all wellfields. The results of those simulations are attached. Results of the model simulations indicated several feet of drawdown will occur across each wellfield during production at a one percent bleed. Particle tracking clearly shows an inward gradient toward the wellfield during wellfield production. Full description of the model development and model simulations is provided in the report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008b).

More detailed modeling will be performed at the wellfield scale to ensure that pumping rates at individual well patterns will maintain an overall inward gradient at all times during production of the wellfield.

Section 3.1.3 was updated to include this information.

c. Identify the locations for the underlying and overlying aquifer monitoring wells.

Response:

As described in Section 5.7.8.2, monitor wells will be installed within the overlying aquifer (72-Sand) and underlying aquifer (68-sand) at a density of one well per every four acres of pattern area. Final locations of these wells will be determined when final design of the wellfield and submitted with the wellfield package to WDEQ-LQD. Underlying monitoring in areas where the production sand and underlying sand coalesce is described in the response to RAI 6-1(b).

d. Present methods for timely detection and cleanup of leaks in the wellfield at wellheads and in surface and buried lines in the wellfield.

Response:

Each Mine Unit will have a number of headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells, along with main trunk lines, will have high and low flow alarm limits set in the header house. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures (e.g., failed fusion weld). EMC will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic (at a minimum of daily) inspections of each wellfield that is in service or in restoration.

Secion 3.1.3.1 was revised to include this description of timely leak detection.

e. Provide a description of the number, location, design, and capacity of deep disposal wells.

Three disposal wells are planned for the Moore Ranch Project. The location of these wells is shown on Figure 3.1-4A. These proposed wells will be permitted for a capacity of 125 gpm per well, giving a total of 375 gpm of disposal capacity. The estimated depth of the disposal wells and target zone is approximately 6,400 feet. Section 4.2.2 was updated to include this information.

f. Provide an explanation for how EMC will handle waste fluids should the disposal wells become inoperable short term or long term.

As shown in Figure 3.1-5, anticipated disposal during operations is approximately 40gpm and during restoration could be as high as 140 gpm. A minimum of Two disposal wells will be constructed for the first several years of operation (40 gpm) which will provide capacity of 125 gpm each. One well will handle all disposal flow from operations during this period. If a well becomes inoperable for a short time during maintenance or integrity testing, then the additional well will provide adequate disposal capacity. A third disposal well may be constructed to provide a backup well once restoration disposal flows commence. Section 4.2.2 was updated to include this information.

3-2. Central Processing Plant and Other Facilities – Equipment Used and Materials Processed (Section 3.2)

In addressing areas of the facility where fumes or gases may be generated, rather than just a reference to Section 7.3 of the application, which is focused on environmental impacts, the applicant should provide specific listing of each potential source of emission or release, the planned monitoring associated with the potential release, and the preventive/mitigative controls for the potential release.

Response:

A description of the areas in the proposed plant facility where radiological gases or air particulate could be generated is contained in Section 5.7 and are shown in Figure 5.7-1 as monitoring locations.

Other potential sources of non-radiological fumes or gases can result from use of process related chemicals. The potential sources of non-radiological fumes or gases are minimal in the ion exchange process area since the mining solutions contained in the process equipment are maintained under a positive pressure. The area within the plant facility with the greatest potential to generate non-radiological fumes or gases is the precipitation area. As described in Sections 3.1.4.4, 3.2.1.3, and 3.2.3.1, the primary chemicals used in the precipitation area are sulfuric or hydrochloric acid, hydrogen peroxide, and anhydrous ammonia. A description of the preventive/mitigative controls and monitoring for each of these potential chemical fumes is provided in the following list:

- Sulfuric or Hydrochloric Acid Fumes

  Sulfuric or hydrochloric acid fumes may be generated from leaks in acid piping and process tanks contained within the central plant precipitation area. Preventive/mitigation measures include construction of all storage tanks, piping, and associated appurtenances in accordance with current industry standards, all tanks are enclosed limiting the amount of vapors that can escape to the atmosphere, and daily shift inspections of plant and chemical storage facilities are conducted. Monitoring may be conducted using colorimetric tubes if it is believed that acid fumes may be present in an area.

  Typically, a Concentrated Acid Work Permit will be required for maintenance work on tanks, pipes, or equipment that contains or may contain concentrated acid or to the use of concentrated acid to prepare decontamination or cleaning solutions as required by site industrial safety procedures. Employees who may be exposed to concentrated sulfuric acid must wear chemical goggles and face shield, chemical suit, and acid resistant gloves. A respirator with an acid cartridge is necessary when fumes may be encountered. An emergency eyewash station will also be maintained near the precipitation area in case an employee comes into contact with sulfuric acid.

- Hydrogen Peroxide Fumes

Hydrogen peroxide fumes may be generated from leaks in piping and process tanks contained within the central plant precipitation area. Preventive/mitigation measures include construction of all storage tanks, and associated piping in accordance with current industry standards; all tanks are enclosed limiting the amount of vapors that can escape to the atmosphere; and daily shift inspections of plant and chemical storage facilities are conducted.

Hydrogen peroxide will be stored in bulk storage vessel located outside of the building away from any organics or other incompatible substance. Rubber gloves and face shield should be worn when there is any possibility of contact with this chemical. In the event of a spill, ample quantities of water will be used to dilute the spill. An emergency eyewash station will also be maintained near the precipitation area in case an employee comes into contact with hydrogen peroxide.

- Anhydrous Ammonia Fumes

Ammonia fumes may be generated from leaks in piping and process tanks contained within the central plant precipitation area (if used). Preventive/mitigation measures include construction of all storage tanks, and associated piping in accordance with current industry standards; all tanks are enclosed limiting the amount of vapors that can escape to the atmosphere; and daily shift inspections of plant and chemical storage facilities are conducted. If ammonia is used in the precipitation process, then continuous ammonia detectors will be placed in the precipitation area to monitor for any significant release of ammonia. The detectors will activate an alarm if determined allowable air concentrations of ammonia are detected. Monitoring may also be done with colorimetric tubes if it is believed that ammonia fumes may be present in an area.

If used, anhydrous ammonia will be piped from a bulk storage vessel located outside of the building. The chemical is stored as a liquid under pressure, but it immediately evaporates when the pressure is reduced to atmospheric. In situations where there is a possibility for the unexpected release of anhydrous ammonia, such as during work on ammonia lines, personnel shall wear a suitable respirator with appropriate canisters, chemical suit, gloves resistant to anhydrous ammonia, goggles, and a face shield. An emergency eyewash station will also be maintained near the precipitation and ammonia storage area in case an employee comes into contact with anhydrous ammonia.

If any of the potential fumes described above are detected, then building ventilation in the process equipment area will be accomplished by the use of an exhaust system that draws in fresh air and sweeps the plant air out to the atmosphere as described in Section 4.

In addition to the fumes described above in the plant area, the potential exists for buildup of carbon dioxide or oxygen gases may also occur in confined spaces such as headerhouses if carbon dioxide and oxygen lines are present. Procedures will require monitoring for these gases in confined spaces or basements where these gases may be present prior to employees conducting work in these areas.

Section 3.2.3.2 was added to Section 3 to include this information.

3-3. Instrumentation and Control (Section 3.3)

The applicant provides only a cursory commitment to have instrumentation and controls to monitor production, injection, and waste flows, and to have instrumentation to alarm for system leaks. The descriptions of the process instrumentation and controls and radiation safety monitoring instrumentation need to be more detailed and specific, including their minimum specifications and operating characteristics (alarms, interlocks, etc.). Additional information on backup systems, monitoring criteria, and yellowcake dryer instrumentation and control (with specific reference to 10 CFR Part 40, Appendix A, Criterion 8) needs to be included. The descriptions should focus on how the instrumentation and controls are adequate to identify quickly and remedy all potential processing problems that can increase exposures to radiological and chemical hazards.

Response:

Additional descriptions on instrumentation and controls are provided below.

Wellfield Operations/Ion Exchange Circuit

The wellfield and ion exchange circuits operate at a steady state, and deviations from the normal operating flow rates and pressure profiles (±10 percent or greater) are indicative of operating upsets. An automatic emergency shut down system consisting of pressure and flow rate switches will be provided for these circuits when normal operating parameters are exceeded. Instrumentation and control related to these circuits to accommodate emergency shutdown systems and alarms are listed below:

- Instrumentation will be provided to measure total production and injection flow and pressure on the main trunk lines at the Central Plant. Flows and pressures will be monitored continuously and will be displayed locally on the metering instrumentation and displayed at the facility control room. Automatic shutdown and alarms will be provided for deviations outside of established operating parameters.

- The individual well flows and pressures are adjusted and controlled within the headerhouses. Instrumentation will be provided to measure total production and injection flow and pressures into and out of the individual headerhouses. Flows and pressures will be monitored continuously and will be displayed locally on the metering instrumentation or headerhouse main display, and displayed at the facility control room. In addition, instrumentation will be provided to indicate the pressure and flow of the individual injection and production wells to record an alarm in the event of a change in flow that might indicate a leak or rupture in the system. Wellfield headerhouses will also be equipped with water sensors and alarms to detect the presence of liquids in the basement of wellfield headerhouses. Automatic shutoff valves and alarms will be provided for deviations outside of established operating parameters for the systems controlled within the headerhouse.

In the event of an automatic shutdown, an alarm notifies the operator of the situation.

Once the upset (broken piping, leaking vessels, etc.) is identified and corrective action taken, only then can the circuit be manually restarted. This type of control system provides the best protection against fluid spills to the environment by limiting the amount of fluid released and immediate notification to facility operators enhancing response to any upset conditions. Back-up for the automatic emergency shutdown systems are provided by local displays and controls for the metering instrumentation or headerhouse displays if systems controls or displays in the Central Plant should become temporarily unavailable.

Process Areas

In the process areas, tank levels are measured in chemical storage tanks as well as process tanks. Instrumentation will be installed to provide continuous monitoring of chemical and process tank levels. Other instrumentation may also be provided in process areas to provide continuous monitoring for rates and pressures of process fluids and chemicals and other in-line instrumentation used for process measurements. Readout from process area instrumentation will be displayed on the facility control room monitors and will be displayed locally on the metering instrumentation providing backup monitoring.

Alarms and automatic shutdown of systems (where needed) will be provided for deviations outside of established operating parameters. The alarms and automatic shutdown systems will provide the best protection against upset conditions of process fluids or chemicals by limiting the amount of fluids or chemicals released and immediate notification to facility operators enhancing response to any upset conditions. The continuous monitoring will also be used operate the plant process at maximum efficiency.

Yellowcake Drying Systems

Instrumentation and controls for the yellowcake drying system are described in detail in Section 4.1.2. The yellowcake drying facilities at the Moore Ranch Central Plant will be comprised of vacuum dryers. By design, vacuum dryers do not discharge any uranium when operating. The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures. The system will alarm if there is an indication that the emission control system is not performing within operational specifications. If the system is alarmed due to the emission control system, the operator will follow standard operating procedures to recover from the alarm condition, and the dryer will not be unloaded as part of routine operations, if currently loaded, or reloaded, if currently empty, until the emission control system is returned to service within specified operational conditions.

To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signal an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is checked and documented during dryer operations. In the event this system fails, the operator will perform and document checks of the differential pressure or vacuum every four (4) hours. Additionally, during routine operations, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations.

Readout from the yellowcake drying instrumentation will be displayed on the facility control room monitors providing continuous monitoring and will be displayed locally on the metering instrumentation providing backup monitoring for shift checks by the dryer operator. Checks must be made and logged at least hourly during drying operations and records will be retained for three years. The instrumentation and controls described above are adequate to determine if conditions are within the prescribed ranges to ensure that equipment is operating consistently near peak efficiency and provides immediate notification if conditions are not within the prescribed operating ranges, as required in 10 CFR 40, Appendix A, Criterion 8.

In accordance with 10 CFR 40, Appendix A, Criterion 8, effluent control devices will be operative at all times during drying and packaging operations. Drying and packaging operations will shutdown if effluent controls become inoperative. If instrumentation shows that equipment is not operating within the prescribed ranges, then corrective actions must be taken to restore proper operating conditions. If this cannot be done without shutdown and repairs, then drying operations must cease as soon as practicable. Operations will not be restarted after cessation due to abnormal performance until all needed corrective actions have been completed. Any cessation, corrective actions, and restarts of dryer operations will be reported to the NRC in writing within 10 days of the subsequent restart as required by 10 CFR 40, Appendix A, Criterion 8A. This reporting requirement does not apply to routine maintenance of dryer system components.

Process Waste Water Disposal

Process waste water will be disposed of through deep disposal wells as described earlier in this Section 3 and Section 4. The wells will be equipped with a high-level shutoff switch on the injection tubing to prevent operation of the pumps at pressures greater than the Limiting Surface Injection Pressure. In addition, the wells will be equipped with a low-pressure shut-down switch on the surface injection line that will deactivate the injection pump in the event of a surface leak. Finally, the wells will include a high/low pressure shutdown switch with a pressure sensor on the tubing/casing annulus. This switch will stop the injection pump in the event of either (1) a tubing leak or (2) a casing, packer, or wellhead leak.

This type of instrumentation and control system provides the best protection against process waste water spills to the environment by limiting the amount of fluid released and providing immediate notification to facility operators enhancing response to any upset conditions. Pressure monitoring in the tubing/casing annulus also provides immediate indicators of potential well integrity issues. Back-up for the automatic emergency shutdown systems are provided by local displays and controls for the metering instrumentation in the central plant and at the wellhead if systems controls or displays in the central plant control room should become temporarily unavailable. In addition, daily inspections of the disposal wells are conducted.

Radiological Monitoring Instrumentation

Radiological Monitoring Instrumentation

Handheld radiation detection instruments and portable samplers will be used to monitor radiological conditions at the central plant. Specifications/ for this equipment are discussed in further detail in Section 5. The location of monitoring points and monitoring frequency for in-plant radiation safety is also discussed in Section 5.

Section 3.3 was revised to include this information.