FSME

Fetter, Allen

From: Kock, Andrea
Sent: Wednesday, September 30, 2009 2:01 AM
To: Fetter, Allen
Cc: Bjornsen, Alan; Park, James
Subject: Comments on hydrology sections of Lost creek SEIS

Allen: I wanted to get you my comments on your hydrology sections since I know you only have this week to spend with us. I did review and I am going to fax my comments to 301-415-5369 in the morning. I have some notes on the first page of chapter 3 and last page of chapter 4 that aare not comments.

I have very few comments on chapter 3.

on chapter 4, my main comments are:
- ensuring that any mitigative measures have been committed to by the applicant, particularly if we are relying on them to make a conclusion
- please touch base with jon s on any independent review we have done on well drawdown
-on the drawdown issue, specify what the 15 surrounding wellw are used for. If they are not used or or only used for stock watering and if pumping can reduce the impacts, perhaps we should state that and then the impact would be moderate rather than moderate-large.
-specify one impact rather than a range

the rest you can review on the fax

D/44

4250 Hospitality Lane
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307-473-2600
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Casper ... Marriott

Fax

To: Allen Fetter		**From:** Andrea Kuck	
Fax: 301-415-5369		**Pages:** 21	
Phone: 202-579-8861		**Date:** 9/30/09	
Re:		**CC:**	

☐ Urgent ☒ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

3.5.2 Wetlands

Wetlands include "those areas inundated or saturated by surface or ground water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted to life in saturated soil conditions" (33 CFR Part 328.3). Wetlands are important resources that provide habitat for aquatic fauna and flora, filter sediments and toxicants, and provide floodwater attenuation. For purposes of this document, wetlands are relegated to vegetated surface waters.

As part of the Lost Creek application, an assessment was performed by the applicant to determine if any vegetated wetlands exist within the project site, and none were found. Crooked Well Reservoir is dry the majority of the year, and wetland vegetation has not been observed around this water feature.

The USACE regulates all "waters of the United States," the definition of which was recently influenced by the U.S. Supreme Court Decision *Rapanos v. United States*. Jurisdiction continues to be exerted for all traditional navigable waters, non-navigable tributaries of traditional navigable waters with relatively permanent flow, and wetlands directly abutting these systems. For systems that are isolated or tributaries that are not relatively permanent, the USACE requires a significant nexus determination to determine whether a particular waterbody is jurisdictional. A significant nexus determination is needed to evaluate whether the impact of a particular waterbody would result in more than a speculative or insubstantial effect on the chemical, physical, and biological integrity of a traditional navigable water.

Due to the fact that all of the channels are ephemeral and that the project site lies within a closed, isolated basin, no surface water features on the property connect to a tributary of a navigable waterbody. As such, no surface waters within the Lost Creek project area are considered waters of the U.S. under the jurisdictional authority of the USACE.

3.5.3 Groundwater

As indicated in the GEIS (Section 3.2.4.3), the Crooks Gap Uranium District, where the Lost Creek site is located, is part of the Wyoming West Milling Region (NRC, 2009). The Crooks Gap District lies with the Great Divide Basin, an endorheic (internally closed) drainage basin, that contains uranium bearing aquifers and encompasses 10,250 km^2 (3,959 mi^2). Hydrologic recharge areas are predominately along the topographically elevated margins of the basin, hence surface and groundwater flow is toward the center of the basin. As the Lost Creek project area is northeast of the basin center, groundwater flow at the site is towards the southwest. Regionally, the Great Divide Basin is part of the regional Upper Colorado River Basin aquifer system, a 51,800 km^2 (20,000 mi^2) system that also includes the Green River and Washakie structural basins of southwestern Wyoming (Whitehead, 1996).

The Colorado River Basin aquifer system was subdivided by Whitehead (1996) into five principal aquifers; the Laney aquifer (Tertiary), the Wasatch/Battle Spring-Fort Union aquifer (Lower Tertiary), the Mesa Verde Aquifer (Cretaceous - Mesozoic), and Upper and Lower Paleozoic aquifers. In the project area the stratigraphic units that host the Laney aquifer, the Green River Formation, are not present. As such, at the Lost Creek site, the shallowest Lower Tertiary aquifers consist of sandstone units within the Wasatch/Battle Spring and Fort Union Formations. These formations are up to 3,350 m (11,000 ft) thick in Sublette County, about 2,135 m (7,000 ft) thick near the center of the basin in south-central Wyoming and over 1,890 m (6,200 ft) thick in the project area. These uppermost aquifers serve as regional water supplies for drinking water and livestock, and also host a series of uranium-rich sedimentary units. While these aquifers are identified as the most important and most extensively distributed and accessible groundwater source in the study area by Collentine et al. (1981), the waters typically contain high levels of radionuclides (greater that EPA MCLs) within the basin and locally contain saline water where they are deeply buried. Below these Tertiary units is the Upper Cretaceous Lance/Fox Hills Formation that consists of very fine-grained sandstone, siltstone, and coal beds, which are not considered to be important aquifer units in the project area. Beneath this hydrologic system is a regionally continuous aquitard, the Upper Cretaceous Lewis Shale, which is between about 191 - 381 m (625 -1250 ft) thick in the project area. Due to its low permeability nature and significant thickness, the Lewis Shale is considered the base of the hydrogeologic sequence of interest within the Great Divide Basin. Units deeper than the Lewis Shale, the Mesa Verde aquifer system, the top of which is 2286 m (7500 ft) bgs in the project area, consists of interbedded sandstones and shales underlain by Permo-Triasssic confining units approximately 5486 m (18,000 ft) bgs. The Mesa Verde aquifer is generally too deep to economically develop for water supply or have elevated TDS concentration that renders them unsuitable for human consumption. Below the Permo-Triassic confining units the principal aquifers in Paleozoic rocks are the Tensleep Sandstone of Pennsylvanian and Permian age and the Madison Limestone of Devonian and Mississippian age. Sandstone, limestone, and dolomite beds of Pennsylvanian to Cambrian age also are water bearing. Because they are the most deeply buried and contain saline water almost everywhere, the Paleozoic aquifers are rarely used for water supply in southwestern Wyoming. Locally, however, where aquifer units crop out near structural highs along the basin margin (e.g., the Rawlins Uplift and Rock Springs Uplift), water is less saline and contains lower concentrations of radionuclides due to their proximity to the recharge areas and shorter residence time in the formations.

The Lost Creek Site is directly underlain by the Battle Spring Formation, the upper part of the shallow Lower Teritary aquifer system that extends to a depth of over 1,890 m (6,200 ft). The formation is interpreted to represent a major alluvial system, consisting of thick beds of very fine- to coarse-grained arkosic sandstones separated by various layers of mudstones and siltstones and finer grained beds, with conglomerate beds locally present. The multiple sandstone layers serve as the main water-bearing units and are typically under confined conditions between the finer grained units, but locally unconfined conditions exist. Regionally, the potentiometric surface within shallow aquifer units is usually within 61 m (200 ft) of the ground surface. Most wells drilled for livestock water supply in this unit are less than 305 m (1,000 ft) deep and draw water from the higher permeability sandstone units. Uranium mineralization in the Battle Spring Formation is associated with finer-grained sandstones and siltstones, which may contain minor organic matter in a few areas. This mineralization predominates in several horizons in the upper portion [top 213 m (700 ft)] of the Battle Spring Formation in the project area and its distribution described in more detail below.

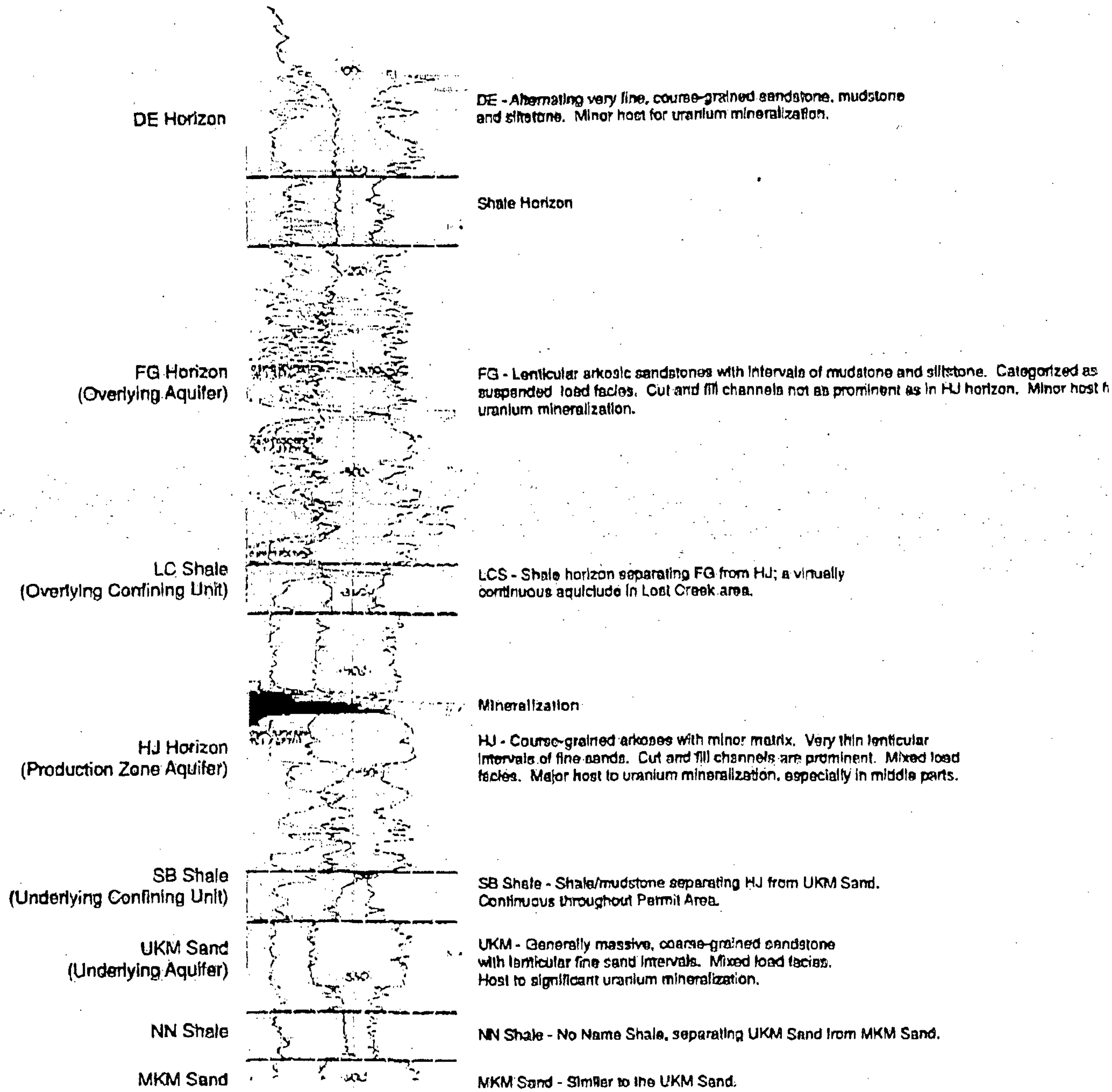

Figure 3-6: Site Hydrostratigraphic Units - Source: Modified from LCI Figure 3.5-10. Lost Creek ISR Project. U.S. NRC Source Material License Application, Environmental Report. October 2007 (Revised March 2008).

3.5.3.1 Uranium Bearing Aquifers

As discussed in Section 3.4.1, the top 213 m (700 ft) of the Battle Spring Formation was divided by the applicant into at least five horizons denoted from top to bottom as BC, DE, FG, HJ, and KM (see Figure 3-6). The primary uranium production zone for the Lost Creek project area is identified as the HJ Horizon. The HJ Horizon is subdivided into the Upper (UHJ), Middle (MHJ) and Lower (LHJ) Sands, which, based on pumping tests, appear to be hydraulically interconnected. As such, the applicant considers the combined HJ Sands as a single aquifer and has designated these sands as the production zone aquifer. The HJ sand units are bounded by areally extensive confining units identified as the Lost Creek Shale and the Sage Brush Shale, which respectively overlie and underlie the proposed production zone. The FG Horizon overlies the Lost Creek Shale and the KM occurs beneath the Sage Brush Shale. The Lower FG (LFG) sand has been designated by the applicant as the aquifer overlying the production zone, and the Upper KM (UKM) sand has been designated as the aquifer underlying the production zone. The UKM, however, is also identified as a potential future production zone. The shallowest occurrence of groundwater within the project area is within the DE Horizon, with the depth to water table varying from approximately 24 to 46 m (80 to 150 ft) below ground surface. The DE Horizon is separated from the FG Horizon below by an unnamed shale layer approximately 9 m (30 ft) thick.

Within the HJ Horizon the bulk of the uranium mineralization is present in the MHJ Sand. The total thickness of the HJ Horizon ranges from 30 to 49 m (100 to 160 ft), averaging approximately 36.5 m (120 ft). The top of the HJ Horizon ranges from approximately 91 to 137 m (300 to 450 ft) bgs within the project area. The upper, middle and lower sand units are generally separated by discontinuous thin clayey units that do not act as confining units to prevent groundwater movement vertically between the HJ Sands horizons (LCI, 2008a).

Monitoring wells have been completed in HJ Horizon, the overlying aquifers (DE and LFG) and the underlying aquifer (UKM). Water levels have been measured in these wells to assess the potentiometric surface, groundwater flow direction, and hydraulic gradient of these units. Water level data is available from 2006 and 2007 monitoring events as well as from historical data taken in 1982. Based on 2007 data taken from wells screened in the HJ Horizon approximately 30.5 m (100 ft) apart on each side on the Fault, the potentiometric surface on the north side of the Fault is 4.6 m (15 ft) higher than on the south side of the Fault. The difference between water levels on either side of the Fault suggests that the Fault is a barrier to groundwater flow. Pumping tests conducted on site seem to support this view. However, some hydraulic influence was noted across the Fault during these tests, indicating that while the Fault acts as a barrier to flow, it is not impervious to groundwater flow. Based on the potentiometric maps, groundwater is inferred to flow to the west-southwest, generally consistent with the regional flow system. The Fault may direct groundwater in a more westward direction than would be the case if the Fault were not present.

The horizon hydraulic gradient for the HJ Sand, determined from water level data from 1982, 2006, and 2007, ranged from 0.0034 to 0.0056 m/m (ft/ft) (3.4 to 5.6 m/km [18.0 to 29.6 ft/mi]). The potentiometric surfaces developed from water level data for the LFG Sand are similar to those developed for the HJ Horizon. However, the data for the UKM Sand indicate that the difference in hydraulic heads across the Fault does not appear as pronounced for the UKM sand as for the other shallow sands. However, this observation may be influenced the limited number of monitoring wells in the UKM Sand. Horizontal hydraulic gradients calculated for the UKM Sand from available water level data ranged from 0.0053 to 0.0063 m/m (ft/ft) (5.3 to 6.3 m/km [28 to 33.3 ft/mile]). The available water level data were also used to evaluate vertical gradients. The data indicate that vertical gradients range from 0.05 to 0.34 between the LFG, HJ, and UKM aquifers and consistently indicate decreasing hydraulic head with depth.

3.5.3.1.1 Hydrogeologic characteristics

Aquifer properties for the Battle Spring aquifers within the project area have been estimated from historic and recent pumping tests. Hydro-Search Inc. performed a hydrologic evaluation in 1982 to determine the feasibility of in situ production of the Conoco uranium ore body at Lost Creek. More recently in October 2006, several short-term single-well pumping tests and three longer multi-well pumping tests were performed (Hydro-Engineering, Inc., 2007). The range of transmissivity values for the HJ aquifer calculated from the data collected during the 2006 tests was from 4.1 to 37.2 m^2/day (44 to 400 ft^2/day [330 to 3,000 gallons per day/ft]). Although the 2006 testing was limited, none of the 2006 pumping tests of the HJ horizon indicates significant communication with the overlying or underlying aquifers. There was also no indication of hydraulic communication across the Fault in any of the 2006 pumping tests.

In June and July 2007, another long-term pumping test was conducted in the HJ aquifer at Well LC19M (Petrotek Engineering Corporation, 2007). While well LC19M had previously been tested during the 2006 pumping tests, the objectives of this test was to further develop aquifer characteristics of the HJ Horizon, to evaluate the hydraulic impacts of the Fault, and to demonstrate confinement of the production zone (HJ Horizon) aquifer. While LC19M is located on the north side of the Fault, HJ monitor wells were included on both sides of the Fault within distances likely to be impacted by the test were included as observation wells. The transmissivity calculated from five wells completed in the HJ aquifer on the north side of the Fault were similar, ranging from 2.8 to 7.0 m^2/day (30.0 to 75.5 ft^2/day) and averaging 6.3 m^2/day (68.3 ft^2/day). Storativity calculated from those wells range from 6.6×10^{-5} to 1.5×10^{-4} and averaged 1.1×10^{-4}.

In October 2007, an additional long-term pumping test was conducted in the HJ aquifer on the south side of the Fault in LC16M (LCI, 2008b). During the test, water levels were measured in monitoring wells in the HJ aquifer on both sides of the fault, as well as in the overlying and underlying aquifer on the south side of the Fault. The transmissivity calculated from five wells completed in the HJ aquifer on the south side of the Fault were similar, ranging from 5.6 to 9.3 m^2/day (60.3 to100.5 ft^2/day) and averaging 7.1 m^2/day (76.2 ft^2/day). Storativity calculated from those wells range from 3.5×10^{-5} to 9.1×10^{-4}.

The calculation of the transmissivity values in the two 2007 long-term pumping tests did not consider the effect of the fault, which limits groundwater flowing from the south in the first test and from the north in the second test, resulting in reduced estimates of transmissivity. As a result these transmissivities have been considered effective rather than actual transmissivities by the applicant. Actual transmissivities are likely to be larger than those calculated from the 2007 test data.

Minor responses to pumping were also observed across the Fault during both pumping tests. This response suggests that the Fault, while not entirely sealing, significantly impedes groundwater flow, even under considerable hydraulic stress. Small responses in water levels in the overlying and underlying aquifers were also observed during the both 2007 long-term pumping tests. While their cause is not clear, these responses suggest some hydraulic communication between the proposed production zone and the overlying and underlying aquifers.

3.5.3.1.2 Level of confinement

As discussed in Section 3.4.1, the HJ horizon is bounded above and below by areally extensive confining units identified as the Lost Creek Shale and the Sage Brush Shale, respectively. While these shales are extensive, large sections of the Sage Brush Shale are less than 3.4 m (10 ft) thick in the proposed project area, and several areas of the Lost Creek Shale are less than 3.4 m (10 ft) thick in the proposed project area. Data presented by the applicant indicate that in some locations within the mining units these confining units are only 1.5 m (5 ft) thick. These areas of thinning in the overlying and underlying confining layers suggest that there may be some hydraulic connection between the production aquifer and the overlying and underlying aquifers. These concerns are supported by the results of the 2007 pumping tests. Minor responses in the overlying and underlying aquifer were observed during these tests. A number of potential causes for these responses have been suggested in addition to leakage across the confining layers, including potential impacts from off-site pumping, leakage through abandoned boreholes, or communication across the Fault. However, the cause of these responses observed in the overlying and underlying aquifers during the 2007 pumping test have not been clearly identified. Thus, there remain some concerns regarding the degree of confinement of the HJ production aquifer. The applicant indicates that each mine unit would be subject to further extensive testing during the Mine Unit Test required before initiating solution extraction in each mine unit. This addition testing would employ a greater density of monitoring wells within the production zone aquifer and overlying aquifer on both sides of the fault. This additional hydrologic testing would provide better information regarding the cause of the drawdown response in overlying and underlying wells. These results would be provided in the Mine Unit Data Packages. Despite current uncertainties regarding confinement within the HJ horizon, the applicant has asserted that engineering practices are available to isolate the lixiviant form overlying and underlying aquifers. This is a [illegible] issue

3.5.3.1.3 Groundwater quality

Lost Creek ISR, LLC established the site pre-operational groundwater quality in the Lost Creek license area from well data collected by recent sampling in 2006 and 2007 and historical sampling performed by Conoco in the late 1970s and early 1980s. The recent data included four quarters of water sampling in fall and winter 2006 and spring and summer 2007. The groundwater quality was measured in three wells in the DE surficial aquifer, four wells in LFG overlying aquifer, six wells in HJ ore zone aquifer and four wells UKM underlying aquifer. The location of the wells is shown in Figure 3-7. The applicant presented the groundwater quality data for all four quarters for all wells in Table 2.7-13 of the TR. The groundwater quality parameters measured included all suggested analytes in Table 2.7.3-1 of the standard review plan except silver.

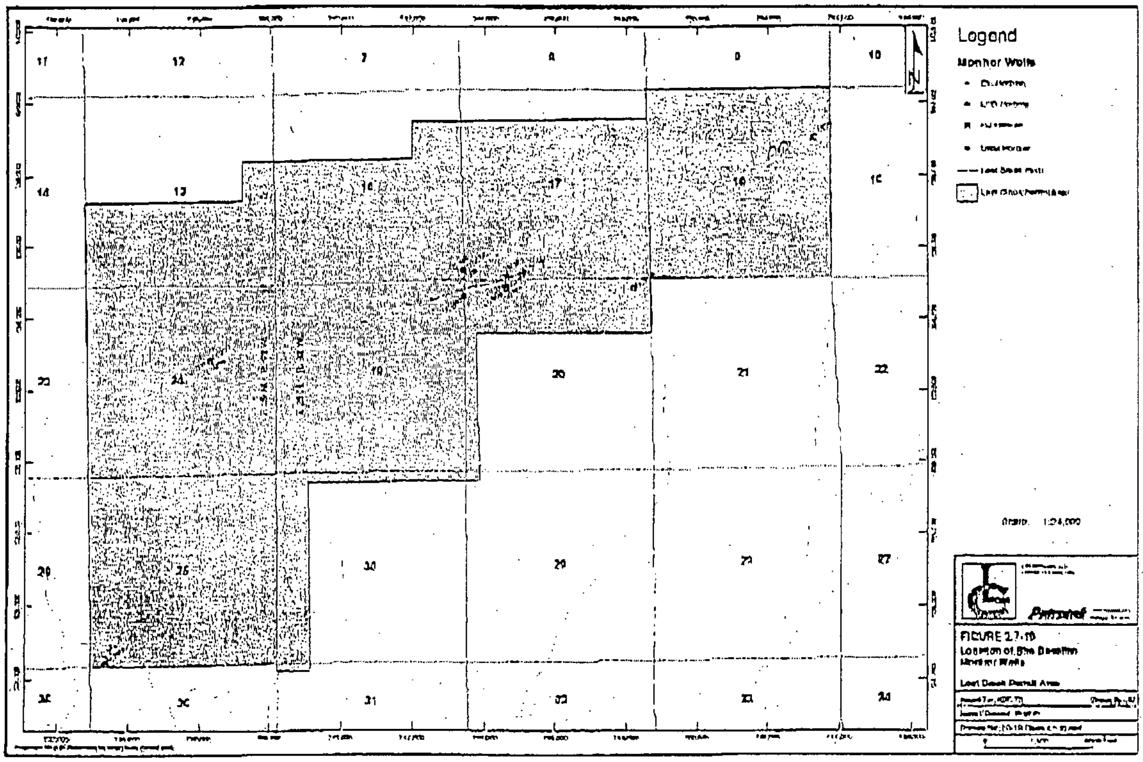

Figure 3-7: Location of wells in Lost Creek license area used to establish pre-operational groundwater quality.

NRC staff determined the average ground water quality in the Lost Creek license area from wells in the surficial DE aquifer, overlying LFG aquifer, HJ ore zone aquifer and UKM underlying aquifer from the data. The results are shown in Table 3.5.3-1. The table indicates that the average water quality in the surficial DE aquifer exceeded the WDEQ Class I, II and III and EPA primary drinking water standards for gross alpha, uranium, and combined Ra 226 and 228. These standards were exceeded in all wells for all quarters. One well, LC 31M in the far southwest corner of the license area exceeded the WDEQ Class I and EPA primary drinking water standards for sulfate and selenium for all four quarters. This well also had the highest values of uranium (1.4-2.1mg/l) and gross alpha (967-1430 pCi/L) of all wells at the site.

The average water quality in the LFG overlying aquifer also exceeded the WDEQ Class I, II, and III and EPA primary drinking water standards for gross alpha, uranium, and combined Ra 226 and 228 in all of the wells over all four quarters. These standards were exceeded in all wells for all quarters. The four wells across the license ranged from 0.251-0.546 mg/l uranium.

The average water quality in the HJ ore zone aquifer also exceeded the WDEQ Class I, II, and III and EPA primary drinking water standards for gross alpha and combined Ra 226 and 228 in

Water Quality Parameter	Lost Creek License Area			
	DE Surficial Aquifer	LFG Overlying Aquifer	HJ Ore zone Aquifer	UKM Underlying Aquifer
Bicarbonates as HCO3 (mg/l)	150	114	111	82
Carbonates as CO3(mg/l)	ND	2.5	3.5	27.8
Alkalinity (mg/l)	104.5	102.2	105.5	84.5
Chloride (mg/l)	6.3	5.3	5.5	5.5
Conductivity (umhos/cm)	566.8	463	485.9	558
Fluoride (mg/l)	0.3	0.21	0.21	0.20
pH (s.u.)	7.68-8.07	**7.32-8.57**	**7.85-9.51**	**7.66-11.6**
Total Dissolved Solids (mg/l)	347	296	311	297
Sulfate (mg/l)	135.7	121.5	131.9	117.6
Radium 226 (pCi/l)	**2.8**	**26.6**	**143.3**	**9.1**
Radium 228 (pCi/l)	**2.4**	**3.8**	**6.6**	**3.49**
Uranium (mg/l)	**0.74**	**0.41**	**0.17**	**0.031**
Gross Alpha (pCI/l)	**495.9**	**356**	**395.4**	**41.3**
Gross Beta (pCi/l)	157.7	107.9	117.5	23.1
Nitrogen, Ammonia as N (mg/l)	0.027	0.08	0.015	0.39
Nitrogen, Nitrate+Nitrite as N (mg/l)	0.7	0.6	ND	ND
Aluminum (mg/l)	ND	ND	ND	ND
Arsenic (mg/l)	0.003	0.003	0.006	0.006
Barium (mg/l)	ND	ND	ND	ND
Boron (mg/l)	ND	ND	ND	ND
Cadmium (mg/l)	ND	ND	ND	ND
Calcium (mg/l)	68.1	58.8	67.7	51.5
Chromium (mg/l)	ND	ND	ND	ND
Copper (mg/l)	ND	ND	ND	ND
Iron (mg/l)	0.21	**0.37**	0.09	0.12
Lead (mg/l)	ND	ND	ND	ND
Magnesium (mg/l)	4.3	3.31	3.65	2.45
Manganese (mg/l)	ND	ND	ND	ND
Mercury (mg/l)	ND	ND	ND	ND
Molybdenum (mg/l)	ND	ND	ND	ND
Nickel (mg/l)	ND	ND	ND	ND
Potassium (mg/l)	2.3	3.1	4.4	10.9
Selenium (mg/l)	**0.079**	0.024	0.002	0.002
Silica (mg/l)	15.6	14.1	14.9	14.4
Sodium (mg/l)	40.3	32.3	31.5	36.2
Vanadium (mg/l)	ND	ND	ND	ND
Zinc (mg/l)	ND	ND	ND	ND

Table 3.5.3-1: Average pre-operational baseline groundwater quality for the Lost Creek license area aquifers. Numbers in bold exceeded Wyoming Class I or EPA drinking water standards.

all but two of the wells over all four quarters. The exceptions were wells LCM27M and LCM28M, whose uranium concentrations were below the MCL of 0.03 mg/l; averaging 0.002 mg/l and 0.008 mg/l, respectively. Nonetheless, their gross alpha and combined Ra 226 and 228 values exceeded the aforementioned standards, which is consistent with the presence uranium ore bodies in the aquifer unit. Uranium concentrations in the waters from the other HJ sands monitoring wells had an average range of 0.065 to 0.552 mg/l, between 2 and 18 times the MCL for uranium. One well, LC 26M, in the eastern part of the license area, exceeded the WDEQ Class I and EPA secondary drinking water standards for sulfate and TDS.

The average water quality in the UKM underlying ore zone aquifer also exceeded the WDEQ Class I, II, and III and EPA primary drinking water standards for gross alpha and combined Ra 226 and 228 in all of the wells over all four quarters. Two of the wells, LC20M and LC24M, located in the ore zone area, also exceeded these standards for uranium.

The water quality data demonstrate that none of the aquifers tested near and within the ore zone in the Lost Creek license area meet WDEQ Class I, II, III or EPA primary drinking water standards for radionuclides. Nonetheless, for ISR operations to be conducted in an aquifer, it must be declared as an exempt aquifer under either State of Federal UIC regulations. An exempt aquifer is one that is not nor will ever be used for drinking water given its water quality. In Wyoming, the State has the authority to make this declaration. The water quality of the HJ sand production zone aquifer in the project area is Class VI under WDEQ standards, which means the groundwater can not be used for drinking, livestock or agricultural use as a consequence of its uranium and radium 226 concentrations. It would therefore be a candidate for an exempt aquifer declaration.

3.5.3.1.4 Current Groundwater uses

The applicant has identified the groundwater users within 3.2-km (2-mi) and 8-km (5-mi) radii of the project area using the WSEO Water Rights Database (WSEO, 2006) and correspondence with the BLM. The majority of the groundwater-use permitted in the vicinity of the project area is for monitoring or miscellaneous mining-related purposes, and do not represent consumptive use of groundwater. Many of these permits are associated with the Kennecott Sweetwater Mine, which the applicant indicates is in Reclamation. Within a 3.2-km (2-mi) radius of the project area, all water use permits are those of the BLM. Each of these permits is associated with a well that supplies a stock pond (or tank). In addition, there is a fourth BLM well supply; a stock pond for which no water-use permit was found. These wells are depicted on Figure 3.5-18 of the ER and are tabulated below.

Well Name/No.	Well Depth (ft)	Depth to Static Water (ft)	Aquifer Horizon
Eagle Nest Draw	370	269	FG
4451	900	104	KM
4475	280	unknown	FG
4777	220	unknown	FG

3.5.3.1 Uranium Bearing Aquifers

As discussed in Section 3.4.1, the top 213 m (700 ft) of the Battle Spring Formation was divided by the applicant into at least five horizons denoted from top to bottom as BC, DE, FG, HJ, and KM (see Figure 3-6). The primary uranium production zone for the Lost Creek project area is identified as the HJ Horizon. The HJ Horizon is subdivided into the Upper (UHJ), Middle (MHJ) and Lower (LHJ) Sands, which, based on pumping tests, appear to be hydraulically interconnected. As such, the applicant considers the combined HJ Sands as a single aquifer and has designated these sands as the production zone aquifer. The HJ sand units are bounded by areally extensive confining units identified as the Lost Creek Shale and the Sage Brush Shale, which respectively overlie and underlie the proposed production zone. The FG Horizon overlies the Lost Creek Shale and the KM occurs beneath the Sage Brush Shale. The Lower FG (LFG) sand has been designated by the applicant as the aquifer overlying the production zone, and the Upper KM (UKM) sand has been designated as the aquifer underlying the production zone. The UKM, however, is also identified as a potential future production zone. The shallowest occurrence of groundwater within the project area is within the DE Horizon, with the depth to water table varying from approximately 24 to 46 m (80 to 150 ft) below ground surface. The DE Horizon is separated from the FG Horizon below by an unnamed shale layer approximately 9 m (30 ft) thick.

Within the HJ Horizon the bulk of the uranium mineralization is present in the MHJ Sand. The total thickness of the HJ Horizon ranges from 30 to 49 m (100 to 160 ft), averaging approximately 36.5 m (120 ft). The top of the HJ Horizon ranges from approximately 91 to 137 m (300 to 450 ft) bgs within the project area. The upper, middle and lower sand units are generally separated by discontinuous thin clayey units that do not act as confining units to prevent groundwater movement vertically between the HJ Sands horizons (LCI, 2008a).

Monitoring wells have been completed in HJ Horizon, the overlying aquifers (DE and LFG) and the underlying aquifer (UKM). Water levels have been measured in these wells to assess the potentiometric surface, groundwater flow direction, and hydraulic gradient of these units. Water level data is available from 2006 and 2007 monitoring events as well as from historical data taken in 1982. Based on 2007 data taken from wells screened in the HJ Horizon approximately 30.5 m (100 ft) apart on each side on the Fault, the potentiometric surface on the north side of the Fault is 4.6 m (15 ft) higher than on the south side of the Fault. The difference between water levels on either side of the Fault suggests that the Fault is a barrier to groundwater flow. Pumping tests conducted on site seem to support this view. However, some hydraulic influence was noted across the Fault during these tests, indicating that while the Fault acts as a barrier to flow, it is not impervious to groundwater flow. Based on the potentiometric maps, groundwater is inferred to flow to the west-southwest, generally consistent with the regional flow system. The Fault may direct groundwater in a more westward direction than would be the case if the Fault were not present.

The horizon hydraulic gradient for the HJ Sand, determined from water level data from 1982, 2006, and 2007, ranged from 0.0034 to 0.0056 m/m (ft/ft) (3.4 to 5.6 m/km [18.0 to 29.6 ft/mi]). The potentiometric surfaces developed from water level data for the LFG Sand are similar to those developed for the HJ Horizon. However, the data for the UKM Sand indicate that the

Within an 8-km (5-mi) radius, the applicant has identified fifteen active domestic or stock wells (including the four stock wells indentified within a 3.2-km [2-mi] radius). Of these fifteen wells, the BLM has ten active or potentially active wells (and four associated stock ponds), located outside of the project area, but within an 8-km (5-mi) radius of impact around the project area boundary (LCI, 2008b). All of these wells are used for livestock watering. There are five other potentially active domestic or stock wells within the 8-km (5-mi) radius of the project area. Eight of the BLM wells are at or shallower than the proposed ISR depths in the HJ Horizon, while two are of unknown depth. Three of the non BLM wells are much deeper than the HJ Sand, although the specific screened interval of these wells is not known.

3.5.3.2 Surrounding Aquifers

As indicated above, the Wasatch/Battle Spring Formation, the Fort Union Formation, and the Lance Formation are all of Tertiary age. They are considered part of the Tertiary aquifer system, which has been identified as the most important source of groundwater in the study area. Although some stock wells are known to be present in the Lance Formation along the formation's outcrop areas along the border of the Great Divide Basin, the groundwater in Lance Formation is largely undeveloped. Similarly, the Fort Union aquifer is largely undeveloped and unknown as a source of groundwater supply except in areas where it occurs at shallow depth along the margins of the basin.

The most important aquifers within the Great Divide Basin are in the Wasatch and Battle Spring Formation. Most wells drilled for water supply in the Battle Spring Formation are less than 305 m (1,000 ft) deep. (Collentine et al., 1981) reports that wells completed in the Battle Spring aquifers typically yield 114 to 152 Lpm (30 to 40 gpm); but that yields as high as 568 Lpm (150 gpm) are possible. Water quality within the Battle Spring aquifer is generally good in the northeast portion of the basin with TDS levels usually less than 1,000 mg/L and frequently less than 200 mg/L. Sulfate levels are also generally low in the shallow aquifers of the Battle Spring aquifer. Notable exceptions to the relatively good water quality include waters with elevated radionuclides. The presence of high levels of uranium in Tertiary sediments and groundwater of the Great Divide Basin has been well documented.

Discuss how these are or are not connected with the production aquifer.

Fetter, Allen

From:	Kock, Andrea
Sent:	Wednesday, September 30, 2009 10:12 PM
To:	Fetter, Allen
Subject:	RE: Comments on lost creek groundwater sections

Thank you. Bill was very concerned that we were considering a large impact for drawdown. We discussed and while I am not opposed to such a conclusion, we need a good justification so one of the main issues is we need to fully explain the amount and use of wells that may be impacted by drawdown., If there are mitigative measures that could take place, the impact can be reduced.

-----Original Message-----
From: Fetter, Allen
Sent: Wednesday, September 30, 2009 6:00 PM
To: Kock, Andrea; Bjornsen, Alan; Park, James
Subject: Re: Comments on lost creek groundwater sections

Andrea,

I picked your fax up this morning and am modifying chapters 3 + 4 accordingly.

Allen

Sent from an NRC BlackBerry
Allen Fetter
301-832-4909

----- Original Message -----
From: Kock, Andrea
To: Fetter, Allen; Bjornsen, Alan; Park, James
Sent: Wed Sep 30 17:45:38 2009
Subject: Comments on lost creek groundwater sections

I faxed you written comments on chapter 3 and 4 groundwater sections this morning. I faxed to 301 4155369

Sent from NRC blackberry
Andrea Kock
202-579-8861