Wyoming Department of Environmental Quality
Land Quality Division
Uranium Recovery Program

STATE DECISION DOCUMENT
TECHNICAL REVIEW OF ANADARKO BEAR CREEK URANIUM COMPANY MILL SITE'S REQUEST TO ABANDON ALL MONITORING WELLS

PERMITTING REQUEST

By letter dated April 24th, 2019, Anadarko submitted a request to the Wyoming Department of Environmental Quality Land Quality Divisions (LQD) to abandon all monitoring wells located at the site in anticipation of the site transferring to the Department of Energy (DOE) for long-term maintenance.

SITE LOCATION

The Bear Creek disposal site is located in Converse County approximately 45 miles northeast of Casper and 37 miles north-northwest of Douglas, Wyoming (see Figure 1). The nearest town is Glenrock about 29 miles south-southwest of the site. The UMTRCA Title I Spook, Disposal Site is approximately 1 mile south of the Bear Creek Site (NRC 2016).

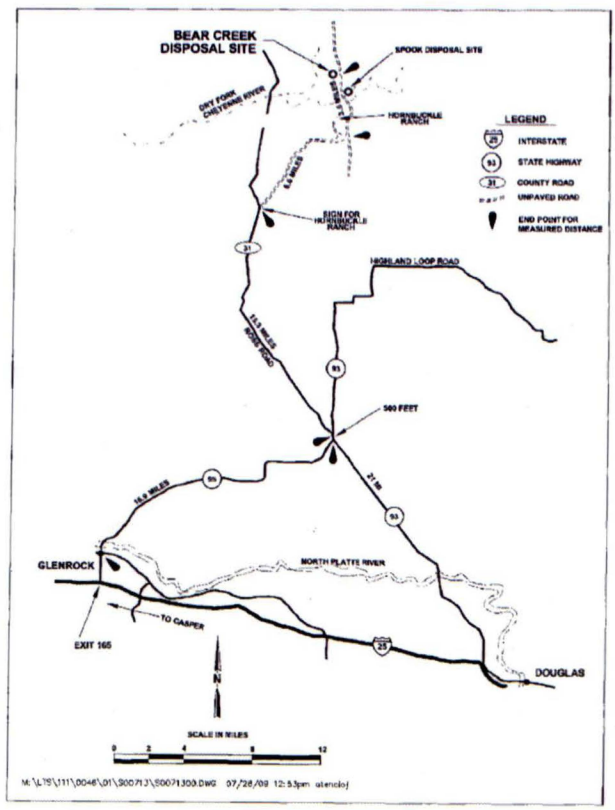

Figure 1 Site Location (DOE 2016)

SITE HISTORY

The Bear Creek uranium mill was owned and operated by Bear Creek Uranium Company (BCUC), which was a joint venture of Rocky Mountain Energy, the operating partner, and Southern California Edison. Company reorganization incorporated Rocky Mountain Energy into Union Pacific Railroad (UPR). Anadarko Petroleum Corporation (APC) acquired UPR in 2000 (NRC 2013).

Milling commenced in September 1977 under NRC license SUA-1310 and continued until January 20, 1986. The mill processed from the Bear Creek uranium mine, which consisted of five open pits near the mill. Ore in these pits were mined mostly from the Wasatch Formation at depths of 100 to 200 ft. below the surface. The milling process incorporated sulfuric acid leaching, sodium chlorate oxidant, liquid ion-exchange, solvent extraction and concentration, drying, and packaging. This process resulted in a tailings solution with a total dissolved solids concentration of approximately 20,000 milligrams per liter and a pH of 1.5 to 2.5 (UPR 1997). The primary constituents in the tailings solution were chloride and sulfate as well as trace metals from the ore. As a result of these operations, approximately 4.7 million tons of tailings were produced and discharged as a slurry into an adjacent above-grade tailings basin (UPR 1997). The mill and mill buildings were dismantled in 1988 and the tailings were reclaimed in place. All tailings and other contaminated materials were encapsulated in a 101-acre impoundment (DOE 2016).

The disposal site lies within an ephemeral drainage known as Lang Draw. Another ephemeral drainage referred to as the Northern Flow Path branches off from Lang Draw in the northern portion of the site. The tailings basin was installed in 1977 in Lang Draw and consisted of a zone-fill dam and a compacted soil-lined basin. Although state-of-the-art dam and liner construction techniques were used, BCUC anticipated that some seepage would occur and constructed a seepage catchment structure below (downgradient of) the tailings embankment to intercept the seepage and pump it back to the tailings basin. Surface seepage was first observed in 1978. Several wells were installed to determine groundwater contamination potential, and elevated chloride levels were observed (believed to be indicative of tailing seepage). Additional wells were completed as recovery wells and seepage recovery began in 1979. In 1985, the NRC required implementation of a groundwater detection monitoring program. Indicator parameters designated in the license were arsenic, selenium, and pH levels.

After 1986, an interim cover and three evaporation ponds were constructed on top of the tailings area. The evaporation ponds were part of a groundwater corrective action program (UPR 1999) that resulted in the evaporation of some 477 million gallons of water from within the disposal cell and the area below the embankment. The program ceased when lowered water levels in the cell, the area below the embankment, and in the recovery wells rendered it ineffective. The mill and adjacent solvent extraction building were decommissioned in 1988.

NRC concurred with the reclamation plan in 1984 and with modifications to the plan in 1986. Following the 10-year commitment to perform groundwater corrective actions, BCUC closed the tailings impoundment in December 1999. The NRC documented concurrence that the reclamation plan was implemented in 2001(NRC 2001). Additionally, the NRC documented

acceptance of the application for ACLs in 1997 (NRC 1997a), but requested a subsequent revision of the ACL after monitoring results showed that a point of exposure (POE) well had concentrations exceeding model predictions. The NRC subsequently approved a revised ACL application (APC 2011) and associated license amendment (NRC 2013).

SITE GEOLOGY/HYDROGEOLOGY

The Powder River Basin is the regional geologic and physiographic structure. The basin lies between the Black Hills on the east, the Bighorn Mountains on the west, and the Laramie Mountains, the Hartville uplift, and the Powder River lineament on the south (NRC 2013). The tailing basin is underlain by sandstone, shales, and lignites of the Wasatch Formation. The three sandstones of importance in the upper portion of the Wasatch include from shallower to deeper the K Sand, the N Sand, and the Ore Sand. The Ore Sand is separated from the shallower sands by claystone and siltstones (at least 50 ft.). Hydrogeological and water quality data collected throughout the area during the Bear Creek Operations indicates this material is an effective aquitard. In addition, there are not indications that mining activities have created communication through the aquitard in the potential area of impact of the tailing (WDEQ 1999). The Ore Sands are located 100 to 200 feet below the surface underneath the disposal site (NRC et al. 1977).

At the Bear Creek site, the K Sand ranges from 5 to 50 ft. in thickness in the vicinity of the tailings. The K Sand contains limited groundwater because it has been eroded along the Lang Draw, is of limited areal extent, and is generally found at elevations above the level of the tailings (NRC 2013a).

The N sands make up the uppermost water-bearing unit at the Bear Creek site in the area affected by tailings seepage. The N Sand ranges from 4 ft. to 40 ft. in thickness and is interlayered with fine-grained clay layers across portions of the site (Stoller 1997). Groundwater in these units reportedly occur in discrete zones of limited extent and is not continuous over large areas (Stoller 1997). Precipitation in the form of rain and snow is considered the primary form of recharge to the N Sand and alluvium in Lang Draw (UPR 1997)

Locally, seepage from the tailings impoundment saturated the alluvium and N Sand after milling commenced. The amount of water that originally resided in these units is unknown (UPR 1997). Results of characterization and monitoring indicated there were two flow paths associated with the seepage: The "Lang Draw" flow path on the west and the "Northern" flow path on the east (Figure 2). These two flow paths are separated by a facies change characterized by fining and thinning of the N Sand, which restricts groundwater flow through that zone. The flow paths define the seepage plume as two narrow lobes downgradient of the tailings impoundment (Stoller 1997).

The N sand is separated from the tailings by siltstones and clay stones beneath most of the tailings impoundment; the impoundment embankment was keyed into the underlying claystone at the downgradient side of the impoundment in an attempt to contain tailing seepage. However, installation of the northeast portion of the embankment stopped short of the claystone (APC 2011). This allowed for leakage from the impoundment into the N Sand and alluvium along the

Lang Draw flow path and into the N Sand along the Northern flow path. An additional source of contamination may have been from the recovery and monitoring wells located in the seepage catchment basin between the tailings embankment and seepage control dam. The casing in these wells were perforated from top to bottom and may have served as conduits for tailings fluids to the N Sand in Lang Draw when the pumps were not operating (APC 2011).

The N-Sand pinches out into claystones northeast of the tailings impoundment. In the Lang Draw area, the N Sand pinches out into the alluvium downgradient of the tailings impoundment (Stoller 1997). Any groundwater in the Lang Draw flow path discharges from the N Sand into the alluvium. There are no records of past water use associated with the alluvium and the N Sand in the vicinity of the Bear Creek Facility (a ½ mile beyond the LTCB) (APC 2011).

Groundwater development in the region has been mostly for stock water and, to a limited extent, domestic water. An environmental assessment completed by the BLM for the Hornbuckle area, which encompasses the Bear Creek site, inventoried groundwater use in the project area (BLM 2011). Forty-six permitted wells were identified: four of these were for domestic use, two were for domestic and livestock use, and the remainder were for livestock use Well depths ranged from 44 ft. to a maximum of 1000 ft. with an average of approximately 344 ft. Wells used for domestic purposes were all drilled to depths greater than 300 ft.

The N Sand in the site area is not hydraulically connected to a usable aquifer or any surface water resource. The alluvium in the vicinity of the site does not contain appreciable water and has been determined to not be a viable aquifer (Stoller 1997). Estimated yields for wells MW-108 and MW-109 (Figure 2) at the northern edge of the boundary are 0.01 gallons per minute (UPR 1997). Significant groundwater was not encountered in any of the boreholes along the Lang Draw during the 1997 drilling effort. NRC concluded that there was no viable aquifer at the site (NRC 2013). No groundwater seeps have been noted in Lang Draw from discharge of either the N Sand or alluvium by DOE or contractor personnel during site visits.

GROUNDWATER REMEDIATION

Seepage from the tailings impoundment was first observed in 1978 after several wells were installed to determine groundwater contamination potential. Elevated concentrations of chloride, an indicator of seepage, were detected in the new wells. In October 1979, several extraction wells were installed for recovering tailing seepage. Seepage was pumped back into the tailings impoundment (UPR 1997). In addition, a seepage control dam was constructed in 1979 about 600 ft. downstream of the tailings embankment, and a "pump back" recovery system was operated to return seepage to the tailings impoundment for evaporation.

Additional efforts included pumping the wells downgradient of the tailings embankment and installing wells in the tailings to dewater the tailings. This water was evaporated, through various enhanced evaporation systems, on top of the tailings.

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Figure 2 Well Locations (DOE 2016)

In 1985, NRC amended license SUA-1310 to formally require a groundwater detection monitoring program. Indicator parameters were arsenic, selenium, and pH, and threshold values were established for the point-of-compliance (POC) wells. NRC required a groundwater Corrective Action Plan (CAP), which BCUC implemented in 1986, and operated until 1996. The approximate extent of the contaminant plume was defined on the basis of a slightly acidic pH (UPR 1997).

The CAP was designed to recover contaminated groundwater and control and minimize the spread of tailing seepage. From the CAP inception through 1996, approximately 301,000,000 gallons of seepage water was recovered and pumped back into the tailings pond (UPR 1997). Clay capping of the tailings began in 1988 and continued until 1991. Subsequently, water from the recovery system was evaporated in clay-lined ponds on top of the tailings. This significantly improved the dewatering of the tailings impoundment.

The CAP was operated for more than 10 years and successfully reduced hazardous constituents levels with the exception of uranium, to less than the background standards established by the Bear Creeks byproduct material license, as measured at the POC location. The CAP pulled the acidic plume back to within and under the tailings impoundment area and reduced the saturated thickness of the alluvium, N Sand, and tailings. As a result of the characterization and monitoring efforts two flow paths associated with leakage from the tailings impoundment were delineated the Lang Draw and the Northern Flow Path. The flow paths resulted in two narrow lobes that eventually merge 3,000 feet down gradient from the tailings impoundment (UPR 1997)

Corrective actions were terminated when evaluations indicated that further remediation would have little or no effect on controlling movement of the acid front. Further groundwater recovery was also determined to be impracticable due to the reduction in saturated thickness of the units. An application for alternative concentration limit (ACL) was subsequently submitted and approved by the NRC (UPR 1997 and NRC 1997a).

ACLs were granted for uranium, combined Ra-226 and Ra-228, and nickel (Table 1). At the time the ACLs were established, all constituents except uranium were below the background concentrations at the POEs (originally designated as MW-14 and MW-43R). However, modeling suggested that the low pH plume associated with the tailings would eventually move downgradient to the POEs, and that elevated concentrations of uranium, radium, and nickel would move with the pH plume. Modeling was conducted to estimate the maximum concentration of these constituents expected at the POC and POE locations. The POE concentrations were determined to be protective and the maximum POC values were approved as the ACLs.

In preparation for transfer of the Bear Creek site to DOE, the NRC reviewed the licensee's groundwater monitoring results and found that observed concentrations at well MW-14 exceeded model predictions included in the 1997 ACL application by more than an order of magnitude. As a result, the NRC requested that the licensee submit a revision of the ACL (NRC 2010). The licensee evaluated the modeling approach and assumptions and revised the model predictions (APC 2011). The revised predictions aligned more closely with observed values. The licensee

indicated that ACL values did not require revision based on modeling results, but that the POE concentrations would be higher than originally projected.

The 2011 modeling results provided matched data in monitoring wells close to the tailings impoundment, but the simulated concentrations at two downgradient wells (MW-109 and MW-109) were significantly higher than those observed in the field. The NRC staff asked the licensee to recalibrate their model to better match observed concentrations in these two wells. A revised model, submitted in September 2012, focused on Lang Draw (Tetra Tech Geo 2012) and predicted increasing concentrations of chloride and sulfate from tailings-derived water in well MW-109 starting in the 2002. In addition, this modeling effort also indicated a slight increase in uranium concentrations in MW-109 starting in 2004 with a greater increase starting in 2040. Uranium concentrations are predicted to peak at approximately 277 pCi per liter in year 2057. Along the Northern flow path modeling was not completed, but well MW-111 shows concentrations of chloride and sulfate with slightly increasing trends that are likely due to tailings-derived waters.

By letter dated February 27, 2013, the NRC approved Anadarko application to eliminate License Condition No. 47 in essence terminating the groundwater monitoring program (NRC 2015). The NRC declared that the action was necessary prior to the transfer of the site to the U.S. Department of Energy Office of Legacy Management. It was concluded in the Safety Evaluation Report that no groundwater monitoring was necessary for the Bear Creek site since the only viable aquifer was greater than 400 feet below the surface, and there was no connection with the mill tailings. Additionally, by letter dated February 20, 2015 the NRC concluded that the remaining wells on site should be capped and abandoned based on the 2013 NRC decision and the fact that the Wyoming Department of Water Quality (WQD) had recently classified the N and K Sands around the Bear Creek site as industrial.

Table 1 Approved ACL for the Bear Creek Site and Predicted Concentration at POE (NRC 2013)

Constituent	ACLs	Background	Predicted at POE[a] (Lang Draw)	Predicted at POE[a] (Northern Flow Path)
Nickel (mg/L)	3.8	0.05	0.032	0.034
^{226}Ra and ^{228}Ra (pCi/L)	46	9.7	2.1	5.8
Uranium (pCi/L)	2038	98.7	277	75

Note:
[a] In APC (2011).
Abbreviations:
mg/L = milligrams per liter
pCi/L = picocuries per liter

Table 2 Field Data Samples 2012 (NRC 2013)

Constituent	Lang Draw					Northern Flow Path			
	MW-9	MW-12	MW-14	MW-108	MW-109	MW-43	MW-74	MW-110	MW-111
Nickel (mg/L)	0.029	0.042	0.135	0.018	0.006	0.02	0.074	0.014	0.006
^{226}Ra and ^{228}Ra (pCi/L)	1.79	3.23	2.77	3.33	1.28	6.2	6.6	11.5	1.13
Uranium (pCi/L)	250	408	452	131	52.2	38.6	14.6	2.3	16.7

Abbreviations:
mg/L = milligrams per liter
pCi/L = picocuries per liter

WDEQ INVOLVMENT

The Land Quality Division (LQD) terminated the Bear Creek mine site on May 22, 2009. The LQD continued however, to provide input on major decisions made by the NRC. In response to the 1997 ACL applications the LQD acknowledged that active restoration efforts were no longer necessary at the site as long as additional lands in Section 9 were included into the Long Term Surveillance Boundary (LTSB), additional sampling along the flow paths were instituted, non-radiological parameters such as sulfate and chloride were measured, and that there was a periodic review of well permits with the State Engineers Office (SEO) to review changes in water demands in the vicinity of the site. As a result of these comments the LTSB boundary was extended 1400 feet to the north and the installation of MW-108 and MW-109 along the Lang Draw and MW-110 and MW-111 along the Northern Flow Path were completed.

Additionally, the WDEQ through the joint efforts of land quality and water quality division commented on the draft Environmental Assessment related to the issuance of a license amendment on June 5, 2012. Several of the comments focused on whether Federal or State of Wyoming ground water quality standards should be met at the Point of Exposure (POE) wells located at the boundary of the Bear Creek property or for any ground water that flows off the property. The NRC responded pointing to an NRC Commission decision SRM-SECY-99-0277 stating that the "Commission has disapproved the staff's recommendation to formally adopt the current staff practice of acknowledging the concurrent jurisdiction of non-Agreement States over the non-radiological hazard of 11e.(2) byproduct material. The Commission has determined that NRC has exclusive jurisdiction over both radiological and non-radiological hazards of such material. The staff should ensure all affected states are aware of this decision." The WQD additionally commented on NRC February 27, 2013 letter approving Anadarko License amendment No. 51 request to remove license condition No.47 which provides for groundwater monitoring, to the effect that the WDEQ will consider the exceedance of any State of Wyoming groundwater protection standards by the NRC's plume as it migrates beyond the property as a violation of its rules and regulations and will proceed to enforce those rules and regulations accordingly.

On October 15, 2014 the Water Quality Division classified the upper Wasatch formation, the K and N Sands, to a depth of 160 feet as Class IV industrial for Sections 9 and 16 of Township 38 North Range 73 West, Converse County, Wyoming. The classification was based on pre-operational water quality in Well P9000 and P19942 (see Figure 3). Well P9000 mercury content was above Class III groundwater standards. Well P 19942 was high in sulfate and mercury. The

Ore Sands were not included in the classification and as the report details will not be impacted by the classification of the upper sands. The report states that the Ore Sand is separated from the upper sands by a seam of low-grade coal or lignite and a 40 to 100 foot thick siltstone/claystone unit. Additionally, groundwater samples taken from the different sands indicate different water chemistries, indicating a lack of mixing between the two sands.

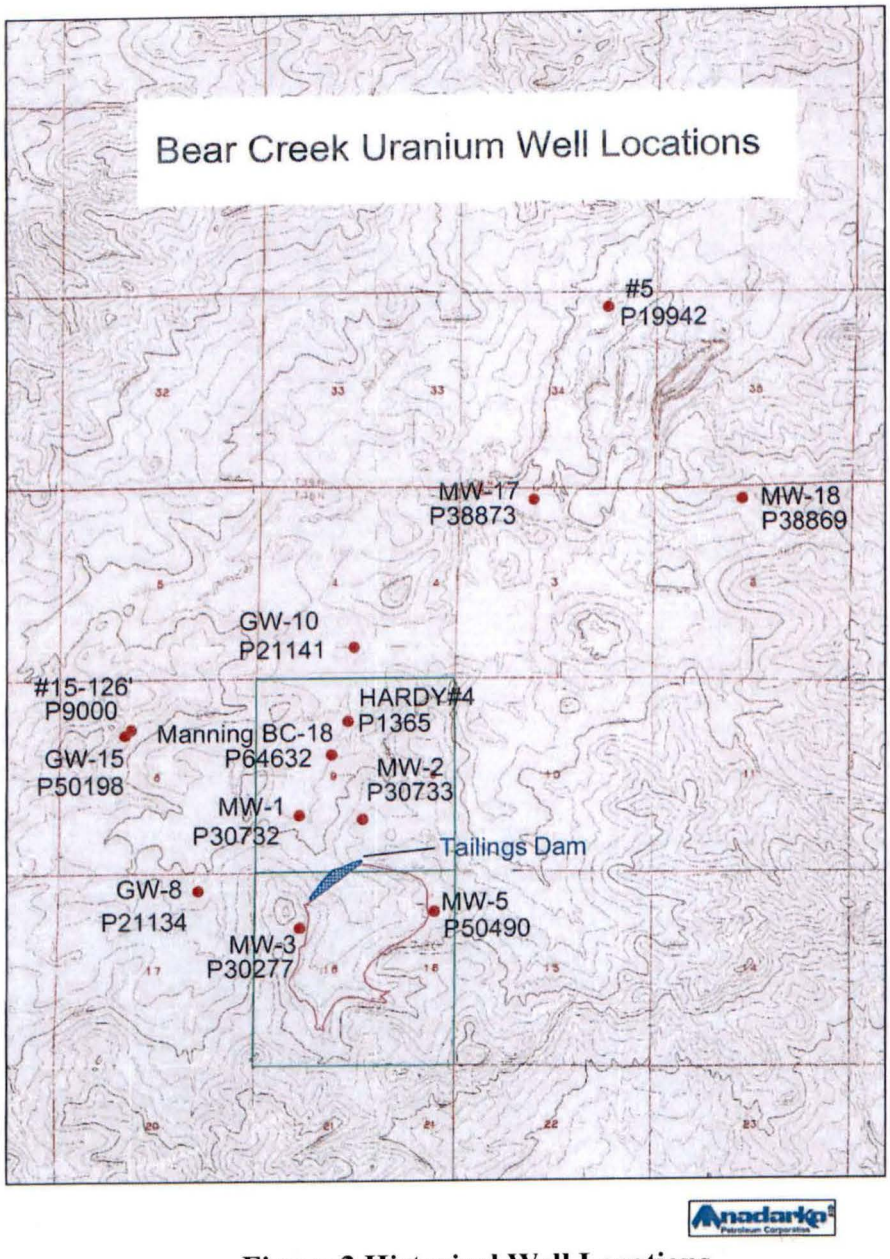

Figure 3 Historical Well Locations.

LQD ANALYSIS OF LICENSEE REQUEST

By letter dated February 27, 2013 the NRC approved Anadarko's application for eliminating License Condition No.47 that required a groundwater monitoring program (NRC 2015). This action was necessary prior to the transfer of the site to the US DOE. The Safety Evaluation Report (SER) for this action concluded that no groundwater monitoring was necessary since the only viable aquifer was greater than 400 feet below the surface, and there was no hydrological connection with the mill tailings. Additionally, on February 20, 2015, The NRC instructed Anadarko (NRC 2015) to plug and abandon existing monitoring wells based on the recent WDEQ classification of the N and K Sands as industrial.

Wyoming became an Agreement State on September 30, 2018, and NRC regulatory authority over the Bear Creek site was transferred to the Land Quality Division (LQD). Since the existing monitor wells were not abandoned as instructed in 2015, the LQD has undertaken the review to determine if abandonment of the existing monitoring well network is appropriate prior to transfer to the DOE for long term care and maintenance.

Prior to the transfer of licensees to the State the WDEQ and the NRC entered a Memorandum of Understanding (MOU) detailing the decommissioning activities that had been performed at the Title II sites that would be transferred to the State. The intent of the MOU was to delineate the existing decommissioning activities the State would need to act on and also delineate previous decommissioning activities the NRC had already ruled on. In evaluating the request by Anadarko, the LQD has no reason to open the already approved ACL and monitoring recommendations made by NRC as there is no additional evidence or reason to believe that these actions do not continue to be protective of human health and the environment. The review solely focuses on the abandonment of the monitoring well network prior to transfer to the DOE.
N and K Sand not a viable aquifer.

The NRC recommended abandonment of the monitoring network based on the claim that the only viable aquifer was 400 feet below the surface with no hydrological connection to the mill tailings. The surficial deposits, alluvium and the N Sand of concern are discontinuous in nature and partially eroded. The quantity of groundwater in these deposits varies spatially, and is further dependent upon the saturated thickness. The alluvium and N Sand contain "pockets" of water, however these units are not capable of yielding to wells with a sustainable quantity of water in the downgradient areas along Lang Draw and the Northern Flow Path beyond the proposed long-term surveillance boundary. Boreholes (T18-T23) completed in the vicinity of the property boundary indicate the alluvium and N Sand are less than 10 feet thick, and only a minor amount of groundwater was observed (Stoller, 1997). The alluvium and N Sand does not produce a significant amount of water to be classified as an aquifer. It is therefore not expected that water supplies for any use (e.g. domestic, livestock, etc.) will be installed in the downgradient vicinity of the site along the Lang and North Flow Path.

NRC's definition of an "aquifer" is: A geological formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs. Any saturated zone created by uranium or thorium recovery operations would not be considered an aquifer unless the zone is or potentially is (1) hydraulically interconnected to a natural aquifer, (2) capable of discharge to

surface water, (3) reasonably accessible because of migration beyond the vertical projection of the boundary of the land transferred for long-term government ownership and care in accordance with Criterion 11 of Appendix A to 10 CFR Part 40. NRC definition of groundwater is water below the land surface in a zone of saturation. For purposes of Appendix A to 10 CFR Part 40, groundwater is the water contained within an aquifer as defined above. The WDEQ defines an "Aquifer" as a zone, stratum or group of strata that can store and transmit water in sufficient quantities for a specific use.

Based on these definitions above the N and K Sands do not meet the definitions of an aquifer. Based on the information collected over the life of this site there is no history of the upper saturated zone of the Wasatch formation being used for domestic or livestock use within a half mile of the proposed long term care boundary. The estimated well yield for N- Sands for <.01 GPM based on MW-108 and MW-109 which would not be sufficient for daily residential or livestock wells. The area contains several existing stock water wells but they are completed to greater than 430 foot depths. These wells are separated from the N and K Sands by hundreds of feet of low permeable claystone. The wells provide water at 2-3 gallons per minute and are used primarily for livestock.

Industrial Classification

On October 15, 2014 the Water Quality Division classified the groundwater within the N and K Sands within Sections 9 and 16 as industrial to a depth of 160 feet (Attachment 1). The designation was based on ambient groundwater quality and the current use of the groundwater in the area. The effects of tailings seepage will not affect the classification or use of this groundwater in the area of Section 9 and 16.

Predicted Water Quality

In the evaluation of the ACL for the Bear Creek Site the NRC determined the estimated level of risk using the projected concentrations of uranium, combined radium, and nickel at the POE well MW-109 is on the order of 10^{-4}, similar to the background risk for the site. Additionally the ACL for the Site meet the requirements of 10 CFR 40 Appendix A Criterion 5B(6). Figures 4-7 show the predicted concentrations of Uranium, Radium, and nickel at the POE well.

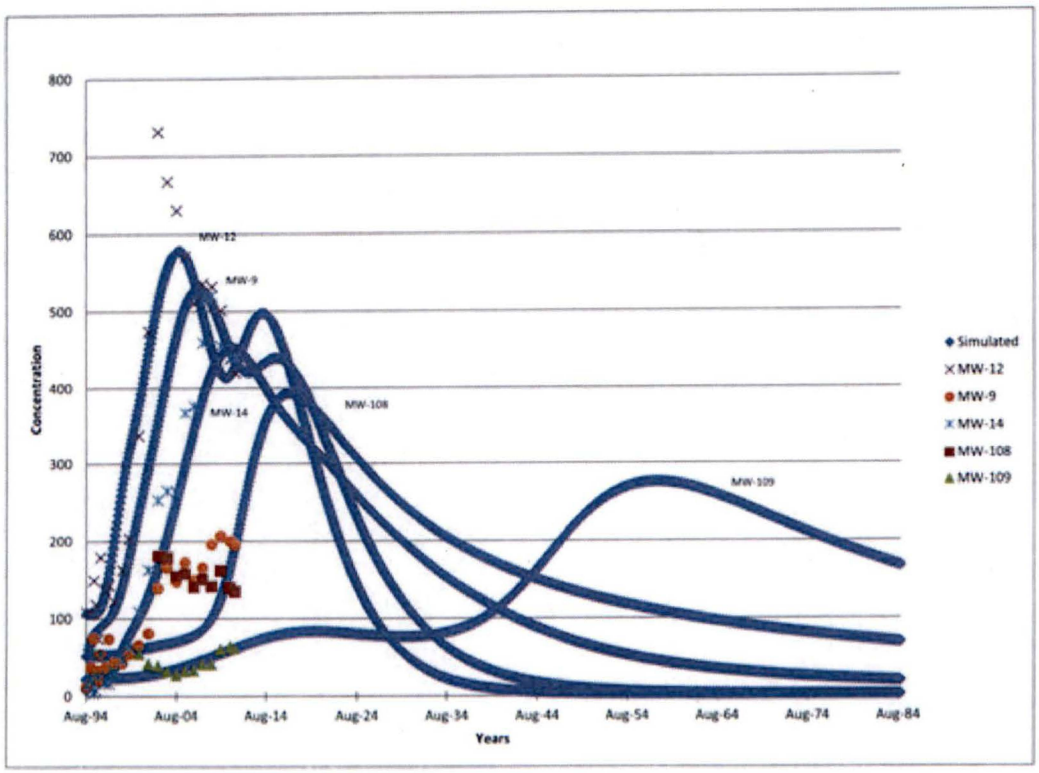

Figure 4 Predicted vs Measured Uranium Concentrations Along the Lang Draw Flow Path (NRC 2013)

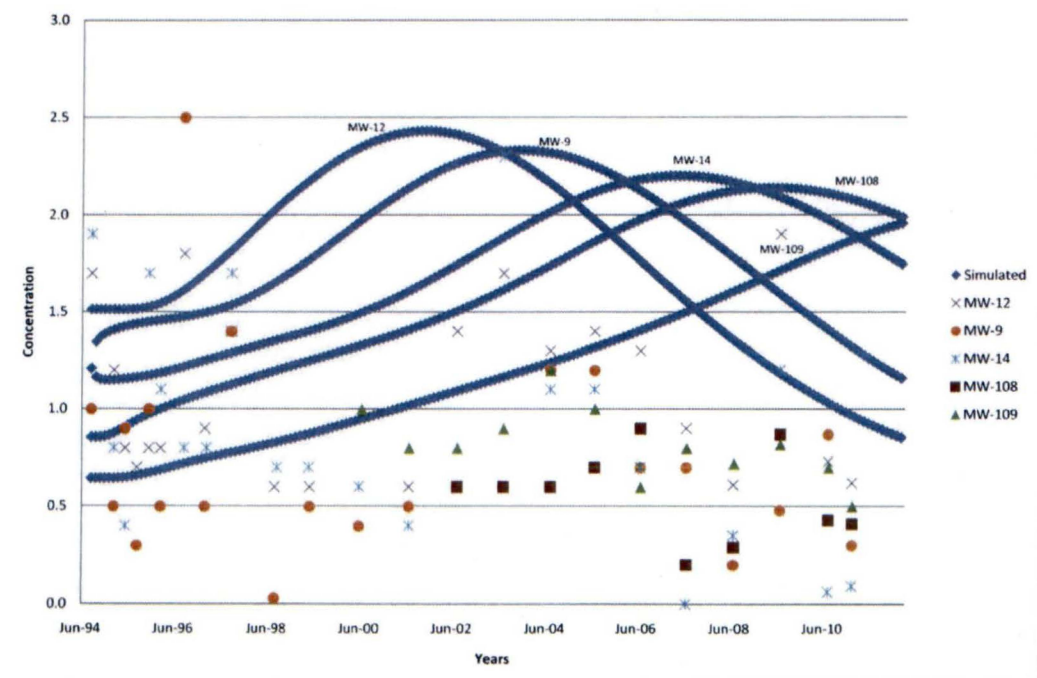

Figure 5 Predicted vs Measure Radium Concentrations Along the Lang Draw Flow Path (NRC 2013)

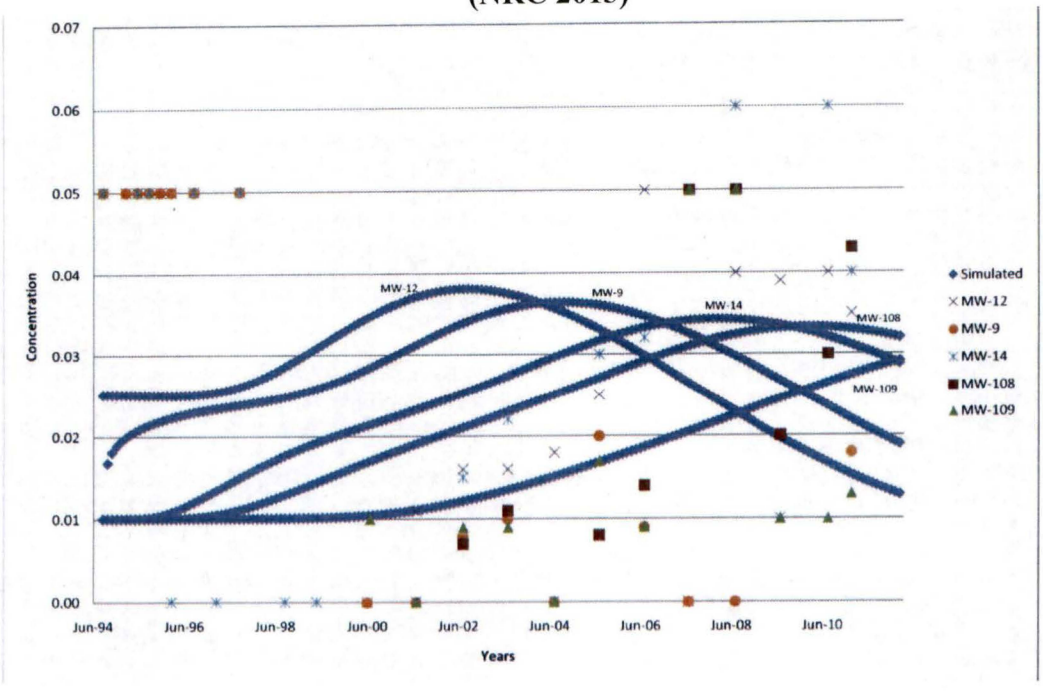

Figure 6 Predicted vs Measured Nickel Concentrations Along the Lang Draw Flow Path (NRC 2013)

The water quality data from 2002 through 2012 at the POE show that the measured values are lower than the predicted values. The data is tabulated in Attachment 2.

Conclusion

Based on the current and historic use of the N and K Sands, the quantity of groundwater in the N and K Sands, the classification of the N and K Sands as industrial up to 160 ft for Section 16 and 9 for Township 38 N. Range 73 W. , and the modeled results compared to actual observed data the LQD concurs with the NRC decision that no groundwater monitoring is necessary since the only viable aquifer is greater than 400 feet below the surface, and there is no connection with the mill tailings. As was instructed with the NRC letter dated February 15, 2015 the remaining monitoring wells should be capped and abandoned in accordance with Water Quality Regulations concerning well abandonment.

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ATTACHMENT 1

Water Quality Industrial Classification of N and K Sands to a Depth of 150 feet.

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

Matthew H. Mead, Governor

Todd Parfitt, Director

October 15, 2014

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1201Lake Robbins Drive,
The Woodlands, TX 77380

RE: Groundwater Classification, Bear Creek Uranium Company, Converse County, WY

Dear Mr. Nagel,

Enclosed, please find the Wyoming Department of Environmental Quality, Water Quality Division, Groundwater Section review of the groundwater classification of the Upper Wasatch formation underlying the Bear Creek Uranium facility in Converse County, Wyoming.

If you have any questions, please contact me directly at (307) 675-5640 or via email at Don.Fischer@wyo.gov.

Sincerely,

Don Fischer

Don Fischer, PG
North District Geologic Supervisor
WDEQ/Groundwater Section

2100 West 5th Street • SHERIDAN, WY 82801
(307) 673-9337 • FAX (307) 672-2213

GROUNDWATER POLLUTION CONTROL PROGRAM
OFFICIAL GROUNDWATER CLASSIFICATION

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION
2100 West 5th Street
Sheridan, WY 82801
Phone: 307-673-9337

Facility Name: Bear Creek Uranium Company

Applicant: Anadarko Petroleum Company,
1201Lake Robbins Drive,
The Woodlands, TX 77380
Attn: Mr. Harry Nagel, Minerals Manager
(832) 636.2732

Location: Section 9, 16, Township 38 North, Range 73 West

County: Converse County, WY

Type of Facility: Uranium Mill

Reason for Classification: Classification needed to determine aquifer restoration standards

Formation Containing Aquifer: Upper Wasatch

Consultant: N/A

Water Quality Division Permit Number: N/A (Land Quality Division Permit)

Report Received: 2/24/2014 (in Lander Office)

Reviewing Official: Don Fischer, PG 2852, North District Geologic Supervisor, Sheridan

Date of This Review: 10/9/2014

Action: Groundwater Classified by Ambient Quality as **Class IV (Industrial)** (details below)
K-Sand and N-Sand, Upper Wasatch Formation to 160 feet

Information Required/Information Submitted

(a) Classification of groundwaters of the State shall be based on the water quality standards of this chapter; excepting a Class I groundwater of the State shall be classified by ambient water quality and the technical practicability and economic reasonableness of treating ambient water quality to meet use suitability standards.

(b) Underground water quality shall be classified for an aquifer which is, or may be, affected by a subsurface discharge or other activity identified in Section 4(a) of these regulations.

The Bear Creek Uranium Company tailing disposal reservoir (WY SEO permit #P7707) commenced operation in September, 1977. The request for groundwater classification falls within Sections 9 &16, Township 38 North, Range 73 West, Converse County, Wyoming. Bear Creek Uranium is seeking groundwater classification for the upper Wasatch formation, referred to as the K-sand and N-sand, to a depth of 160 feet.

(c) Classification shall be made:

(1) Whenever there is pollution or threat of pollution to groundwater of the State, or;

(2) The physical, chemical, radiological or biological properties of any groundwater of the State are, or may be, altered by man's action.

Uranium mining activities at this impoundment has the potential to impact groundwater in the area beneath and adjacent to the pond. Groundwater is classified for restoration purposes.

(d) Classification shall be made for a water in a specified locally defined area by named and described aquifer or receiver. Any aquifer or receiver in its regional setting may have one or more classifications by defined area or areas.

(1) The name shall be a recognized geologic name whenever possible, and;

(2) The description shall include a lithologic description.

Pre-operation studies established that groundwater was present in two zones, the upper and lower Wasatch in Sections 9 and 16, T 38N, R 73W . The upper Wasatch, which contains the "K-sand" and "N-sand", are the zones that may be affected by drainage from the reservoir. The upper Wasatch contains interbedded sands, silts, and clays. The deposition was caused by large braided streams caused by the uplift of the Laramie Mountain range.

The lower Wasatch or "ore zone' should not be impacted. The upper and lower Wasatch formations are separated by a seam of low grade coal or lignite and a 40 to 100 feet thick siltstone/claystone unit. Analyses of groundwater samples taken from the upper and lower Wasatch demonstrates different water chemistries, indicating a lack of mixing between the two aquifers.

(e) The lateral and vertical limits of an aquifer or receiver, for purposes of classification, shall be based on existing water use, ambient water quality and geologic and hydrogeologic characteristics of the aquifer or of the receiver.

There are no existing up-gradient or lateral gradient water supply wells adjacent to the facility and completed in the upper Wasatch. The only permitted wells within one mile of the facility are monitor wells downgradient of the facility. There are no permitted domestic use wells within two miles of the facility.

The groundwater at the Bear Creek is based on ambient quality. Prior to Bear Creek becoming operational, wells were sampled to establish ambient water quality for classification purposes by the Colorado School of Mines Research Institute. Well P9000, completed in the Upper Wasatch in Sec 16, T 38N, R 73W revealed that many of the parameters fall within a Class III groundwater classification. (e.g., TDS= 2638 mg/L, gross alpha concentration = 14 pCi/L, sulfate = 1635 mg/L). However, mercury at 0.0001 mg/L exceeds the class III limit of 0.00005 mg/L, **therefore, the groundwater classification is Class IV** (industrial use).

Well P19942, completed into the Upper Wasatch in Sec 34, T 38N, R 73W had sulfate levels exceeding Class II groundwater standards and mercury exceeding Class III groundwater standards. **Therefore, the groundwater from Well 19942 is classified as a Class IV (industrial use) groundwater.**

(f) An underground water may be re-classified if new or additional data warrant re-classification.

END OF REVIEW

ATTACHMENT 2
Water Quality Date 2002 through 2012

MW-12 (POC for Lang Draw)*

	Ni (mg/L)	U-nat (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Th-230 (pCi/L)	SO_4 (mg/L)	pH	Conductivity
2002	0.011	731	1.4	ND	0.4	NR	6.4	NR
2003	0.016	667	1.7	ND	ND	NR	6.4	5800
2004	0.018	630	1.3	ND	ND	NR	6.6	6120
2005	0.025	571	1.4	1	0.2	NR	6.6	6115
2006	0.05	510	1.3	1	0.2	NR	6.6	6270
2007	0.05	536	0.9	1	0.2	NR	6.1	6200
2008	0.04	532	0.61	3.1	0.2	NR	6.2	6180
2009	0.039	501	1.9	2.9	0.65	2800	6.1	6190
2010	0.040	438	0.73	3.1	0.02	NR	6.3	6270
2011	0.035	420	0.62	2.4	-0.03	NR	NR	NR
2012	0.042	408	0.93	2.3	0.06	NR	NR	NR

*No Chloride value for this well
NR = not reported
ND = non detect

MW-14 (1997 POE for Lang Draw)

	Ni (mg/L)	U-nat (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Th-230 (pCi/L)	Cl (mg/L)	SO_4 (mg/L)	pH	Conductivity
2002	0.02	252.5	0.6	ND	ND	NR	NR	NR	NR
2003	0.02	264.7	2.3	ND	ND	NR	NR	6.8	5290
2004	ND	262.7	1.1	ND	ND	NR	NR	6.8	5150
2005	0.03	367.6	1.1	2.1	<0.2	NR	NR	6.7	5450
2006	0.03	376.4	0.7	1.9	<0.2	NR	NR	6.6	5470
2007	0.05	459.0	0.2	1	0.2	NR	NR	6.2	5450
2008	0.06	520.6	0.35	1.4	0.2	NR	NR	6.3	5500
2009	0.01	454.9	1.2	1	0.62	300	2000	6.3	5260
2010	0.06	438.7	0.06	0.6	0.08	NR	NR	6.3	5420
2011	0.04	439	0.09	0.08	0.1	NR	NR	NR	NR
2012	0.14	452	0.57	2.2	0.06	NR	NR	NR	NR

MW-109 (New POE for Lang Draw)

	Ni (mg/L)	U-nat (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Th-230 (pCi/L)	Cl (mg/L)	SO_4 (mg/L)	pH	Conductivity
2002	0.009	39	0.8	ND	ND	12.5	1800	7.1	3140
2003	0.009	32	0.9	ND	0.2	11.8	1770	7.0	3150
2004	ND	27	1.2	ND	ND	16	1860	7.1	3170
2005	0.017	32	1	ND	<0.2	20	1740	7.2	3130
2006	0.009	33	0.6	1	<0.2	25	1790	7.2	3250
2007	0.05	41	0.8	1	0.2	33	1920	6.6	3210
2008	0.05	41	0.72	3.4	0.2	31	1890	6.8	3080
2009	<0.01	60	0.82	1.3	0.07	52	1770	6.9	3050
2010	0.01	64	0.7	1.4	0.04	79	1890	7.0	3190
2011	0.013	61	0.5	1.3	-0.05	89	1900	7.0	2353
2012	0.006	52	0.58	0.7	0.004	103	1910	NR	NR

MW-74 (POC for Northern Flow Path)

	Ni (mg/L)	U-nat (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Th-230 (pCi/L)	Cl (mg/L)	SO_4 (mg/L)	pH	Conductivity
2002	0.01	103	2.8	4.6	4.1	250	3210	NR	NR
2003	0.01	60	2.3	ND	ND	250	2960	6.2	3860
2004	ND	53	1.8	ND	ND	260	3300	6.7	3970
2005	0.01	109	2.7	2.8	<0.2	235	3110	6.5	4190
2006	0.02	51	1.8	2.0	<0.2	220	3310	6.5	4170
2007	0.05	20	1.8	1.9	0.2	235	3380	5.8	4000
2008	0.05	16	2.2	5.3	0.2	235	3380	5.9	4020
2009	0.03	16	3.6	3.5	0.02	240	1800	5.8	3820
2010	0.17	16	2.4	3.4	0.05	NR	NR	5.8	3870
2011	0.04	15.4	1.8	4.0	-0.09	NR	NR	NR	NR
2012	0.07	14.6	2.6	4.0	0.05	NR	NR	NR	NR

MW-43 (1997 POE for Northern Flow Path)*

	Ni (mg/L)	U-nat (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Th-230 (pCi/L)	Cl (mg/L)	SO_4 (mg/L)	pH	Conductivity
2002	0.005	33.9	5.2	5.6	ND			NR	NR
2003	0.003	45.4	3.7	ND	0.2			6.5	4500
2004	ND	54.8	3.2	ND	0.2			6.7	4546
2005	0.001	42.9	3.8	2.8	<0.2			6.8	4440
2006	0.006	66.5	2.1	2	<0.2			6.7	4240
2007	0.05	20.3	3.2	1.9	0.04			6.5	3940
2008	0.05	26.0	2.2	5.3	ND			6.5	3880
2009	<0.01	29.1	3.2	3.5	ND			6.3	3830
2010	0.02	37.0	2.3	4.7	0.08			6.4	3820
2011	0.017	38.0	1.8	3.1	-0.07			NR	NR
2012	0.02	38.6	1.9	4.3	0.001			NR	NR

*No chloride or sulfate data for this well

MW-111 (New POE for Northern Flow Path)

	Ni (mg/L)	U-nat (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	Th-230 (pCi/L)	Cl (mg/L)	SO_4 (mg/L)	pH	Conductivity
2002	ND	18	1.1	ND	ND	60.1	525	7.0	1777
2003	0.002	11	1.7	ND	ND	75	730	7.4	1785
2004	ND	16	1	ND	ND	90	919	7.3	2150
2005	0.002	16	1.8	1.4	<0.2	886*	803	7.4	2170
2006	<0.005	15	1	1.6	0.2	98	978	7.4	2310
2007	0.05	16	0.2	1	0.2	109	2160	6.9	2390
2008	0.05	16	0.61	3.8	0.2	109	1100	7.0	2450
2009	0.01	16	1.1	1.9	0.02	101	1110	6.9	2500
2010	0.03	17	0.01	2.3	0.01	101	1200	6.9	2540
2011	0.004	17.6	0.042	1.4	-0.06	102	1190	6.8	2430
2012	0.006	16.7	0.53	0.6	0.03	116	1340	NR	NR

*Appears to be a reporting error