3.5.3 GROUNDWATER

Regional

As discussed in the GEIS (Section 3.3.4.3; NRC,2009a), the Northern Great Plains aquifer system is the major regional aquifer system in the Wyoming East Uranium Milling Region in which the Nichols Ranch and Hank ISRs are located. This regional aquifer system has been subdivided by Whitehead (1966) into five major aquifers. These aquifers, from the shallowest to the deepest, are the Lower Tertiary, Upper Cretaceous, Lower Cretaceous, Upper Paleozoic, and Lower Paleozoic aquifers. The Lower Tertiary aquifers consist of the sandstone beds with the Wasatch Formation and the Fort Union Formation. Both formations consist of alternating sandstone, siltstone, and claystone beds and containing lignite and subbituminous coal. Most water is stored in and flows through the more permeable sandstone beds. In the Powder River Basin, the Fort Union Formation and the Wasatch Formation are reported to be as thick as 1,095 and 305 m (3,600 and 1,000 ft), respectively. In the lower Tertiary aquifers, which include the ore horizons as described below, the regional flow direction is northward and northeastward from the recharge area in northeastern Wyoming. In Wyoming, the potentiometric surface of the Lower Tertiary aquifers is higher than the underlying Upper Cretaceous aquifers; consequently, groundwater moves vertically downward from the Lower Tertiary aquifers to the Upper Cretaceous units through the confining layer separating the two aquifers (NRC 2009).

Comment [a1]: Start with a summary of the information on the GEIS on the hydraulic properties of this region. If this information is from the GEIS, reference it

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Comment [a2]: Is there a more up to date reference?

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The Upper Cretaceous aquifer consists of sandstone beds interbedded with siltstone and claystone in the Lance and Hell Creek Formations and the Fox Hill Sandstone. The Fox Hills Sandstone is one of the most continuous water-yielding formations in the Northern Great Plains aquifer system. The Upper Cretaceous aquifers are separated from the Lower Cretaceous aquifers by several thick confining units. The Pierre Shale, the Lewis Shale, and the Steele Shale are the regionally thickest and most extensive confining units. The lower Cretaceous aquifers are the most widespread aquifers in the Northern Great Plain aquifer system and contain several sandstones. However, the lower Cretaceous aquifers contain little freshwater. The water becomes saline in the deep parts of the Powder River Basin. The Paleozoic aquifers cover a larger area, but they are deeply buried in most places and contain little freshwater.

Local

As previously discussed in Section xxx of this SEIS, the Wasatch Formation outcrops in the study area and represents most of the surficial deposits in the area except for limited Quaternary deposits within surface drainages. Extensive alluvial deposits are present in the project area along Cottonwood Creek. The sandstone beds within the Wasatch Formation comprise the shallowest aquifers within the project area. There are commonly multiple water-bearing sands within the Wasatch Formation. Due to their higher permeability, these water-bearing sands provide the primary sources for groundwater withdrawal. Groundwater within the Wasatch aquifers is typically under confined (artesian) conditions, although locally unconfined conditions exist. Well yields from the Wasatch in the southern part of the Powder River Basin

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where the site is located are reported to be as high as 1,900 Lpm (500 gpm). In the vicinity of the Pumpkin Buttes, the Wasatch Formation is known to be 480 m (1,575 ft) thick (Sharp and Gibbons, 1964).

As discussed in Section xxx, the applicant has identified a series of sand layers in the upper portion of Wasatch Formation present in the project area and have labeled these layers from the shallowest to the deepest as the H, G, F, C, B, A, and 1 Sands. The sands are considered aquifers in the project area. The intervening shales that separate these sands are considered aquitards due to their hydraulic properties (i.e., low permeability) and have been identified by the overlying and underlying sands. For example, the shale separating the H and G Sands has been labeled the HG Aquitard (see Section xxx of this SEIS). A schematic of the typical aquifer and aquitard sequence in the project area is shown in Figure xx. While generally present throughout the project area, the nature and extent of these sands differ somewhat across the project area from the Nichols Ranch Unit to the Hank Unit. In addition, depth and expression of these sands at the ground surface is influenced by the topographical relief of the project area. The production aquifer at the Nichols Ranch Unit is the A Sand, while the production aquifer at the Hank Unit is the F Sand. The geologic nature and extent of the specific sands and aquitards identified in the project area is discussed further in Section xx of this SEIS.

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Comment [pxm23]: I never hurts to state the obvious.

The depth at which groundwater is first encountered across the site varies and depends on surface topography. The specific sand that acts as the surficial aquifer similarly varies across the project area depending on the outcropping of these sands and the surface topography. Limited groundwater level data is available to define depth to shallow groundwater across the Nichols Ranch Unit area, and additional wells are planned to better define shallow groundwater levels in this area. However, based on available data and extrapolation of sand units across the site, the applicant has depicted the depth to shallow groundwater and the sand layer acting as the surficial aquifer in the Nichols Ranch Unit area on Figure 2-21a of the TR. In the southern portion of the Nichols Ranch Unit area, shallow groundwater is first encountered in the Cottonwood alluvium and has been shown to within 3 m (10 ft) of the ground surface. Moving north from the Cottonwood alluvium, shallow groundwater is first encountered in the F aquifer at depths ranging from 15 to 30 m (50 to 100 ft). However, in the northernmost portion of the Nichols Ranch Unit area, the G sand is likely to be the shallow aquifer, with depth to groundwater ranging between 30 to 50 m (100 to 150 ft). Groundwater flow in the F and G Sands is projected to be in a westerly direction, most likely a result of the local topography. .

Comment [Pm4]: DSER indicates 100 to 150 feet

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Depth to shallow groundwater at the Hank Unit Area is similarly uncertain, and the installation of additional wells are planned to identify shallow water levels in the Hank Unit area. However, the applicant has indicated that the H Sand should be the surficial aquifer in this area, with depth to groundwater ranging between 15 m (50 ft) in the low lying areas to the west of the Hank Unit area to 61 m (200 ft) along the eastern border of the Hank Unit area (Figure 2-21b of the TR). Groundwater flow in the H Sand at the Hank Unit is expected to flow in a westerly direction. The Willow and Dry Willow Creek alluvial materials in the Hank Unit area are not expected to contain water except during short periods of time after runoff events.

Groundwater in the surficial aquifers is likely unconfined, although there may be portions of these aquifers that are locally confined. Those sands that underlie the surficial aquifer, particularly at depth, are generally confined.

Uranium Bearing Aquifer

The principle uranium bearing aquifer at the Nichols Ranch Unit is the A Sand (Figure xx). As indicated in Section 3.4.1, the A Sand is 18 to 30 m (60 to 100 ft) thick and is located 91 m to 213 m (300 to 700 ft) below the surface at the Nichols Ranch Unit. The A Sand is thickest to the northeast and thins to the southwest and is fine to coarse grained. Groundwater in the A Sand is confined. The A Sand is underlain by the A1 Aquitard and the 1 Sand. The 1 Sand has been identified as the aquifer production aquifer. The A1 Aquitard is comprised of mudstones and carbonaceous shale with occasional thin lenses of poorly developed coal. This unit ranges in thickness from 6 to 11 m (20 to 35 ft). The underlying 1 Sand is variable in thickness, ranging from 3 to 26 m (10 to 85 ft) in thickness, and occurs at depths of 171 to 216 m (560 to 710 ft) bgs. The sand is very fine to coarse grained.

The A Sand is overlain by the BA Aquitard and the B Sand. The B Sand has been identified as the aquifer overlying the production aquifer. The BA aquitard varies from 7.6 to 27 m (25 to 90 ft) in this area, thickening to the northwest and thinning to the southeast. This unit consists of mudstones and thin discontinuous light gray siltstones. The BA Aquitard has been shown to extend across the site from the Nichols Ranch Unit to the Hank Unit, where it is 24 m (80 ft) thick and is composed mainly of mudstones. The B Sand ranges in thickness from 30 to 183 m (100 to 600 ft) at the Nichols Ranch Unit. This unit is fine to coarse grained. The body of the B sand is occasionally separated by lenses of mudstone, siltstone, and carbonaceous shale. Some of these mudstone splits exceed 8 m (25 ft) in thickness and may extend for thousands of feet. The B Sand is very extensive and has been correlated across the gap between the Nichols Ranch and Hank Units.

The principle uranium ore zone sand member at the Hank Unit is the F Sand, which is approximately 23 m (75 ft) thick and 61 to 183 m (200 to 600 ft) bgs in this portion of the project area. The water levels in the F sand fall below the base of the overlying G-F aquitard in the northern portion of the Hank Unit and slightly above in the southern portion. The F sand is therefore both an unconfined and slightly confined aquifer across the Hank Unit. The F Sand is underlain by the FC Aquitard and the C Sand. The C Sand has been designated the aquifer underlying the production zone in areas where it is present. The C Sand at the Hank Unit is 1.5 to 6.1 m (5 to 20 ft) thick, discontinuous, and is composed of fine and very fine grained sand. The C sand is not always present below the F Sand at the Hank Unit. At these locations the B Sand is the sand unit underlying the production sand. The FC aquitard is composed of mudstones, siltstones, gray carbonaceous shales, and poorly developed coal. The aquitard ranges in thickness from 14 to 24 m (45 to 110 ft), depending on the presence of the C Sand. Where the C Sand is not present, it merges with the CB aquitard overlying the B Sand.

Comment [Pm5]: I borrowed this language from the DSER. Even though it's unconfined, I think it's important to note that there is an aquitard above the F Sand.

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Water levels have been measured in wells installed in the project area to define the direction and gradient of groundwater movement. The location of wells installed at the Nichols Ranch and Hank Unit are shown in Figures 3-7 and 3-8, respectively. While wells have been installed in many of the identified sand aquifers, these wells have been concentrated in the production zones at the Nichols Ranch and Hank Units. Based on these water level measurements, a potentiometric map has been presented for the A Sand at the Nichols Ranch Unit (Figure 2-19 of the TR). This potentiometric map indicates that groundwater in the A Sand is flowing to the northwest with an average gradient of 0.0033. Based on this gradient, and effective porosity of 0.05, and an average hydraulic conductivity of 0.15 m/day (0.5 ft/day), the average rate of groundwater flow is estimated to be 0.01 m/day (0.033 ft/day). A similar potentiometric map has been presented for the F Sand across both the Nichols Ranch and Hank units (Figure 2-20 of the TR). This map indicates that water in the F Sand is flowing west with an average gradient of 0.005. Based on this gradient, an effective porosity of 0.05, and an average hydraulic conductivity of 0.18 m/day (0.6 ft/day), the average rate of groundwater flow in the F aquifer across the project area is estimated to be 0.018 m/day (0.06 ft/day). Similar gradients and flow directions have been observed in the B and C Sand aquifers as in the A and F Sand aquifers. The shallow sands in the Hank Unit Area are more likely to be affected by local topographical changes than the deeper sands. Water level data for the G Sand in the Hank area show a much steeper groundwater gradient.

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3.5.3.1.1 Hydrogeologic Characteristics

Comment [a6]: This paragraph seems to provide information that is not necessary. Explain why this information is important to environmental impacts or remove it

Comment [Pm7]: John, I think we should delete this paragraph, plus the "may" and "could" in the last couple of lines could open up a can of worms.

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From the TR "The Nichols Ranch and Hank Unit ore zones have uranium mineralization composed of amorphous uranium oxide, sooty pitchblende, and coffinite. The uranium is deposited upon individual detrital sand grains and within authigenic clays in the void spaces. The host sandstones are composed of quartz, feldspar, accessory biotite and muscovite mica, and locally occurring carbon fragments. Grain size ranges from very fine-grained sand to conglomerate. The sandstones are weakly to moderately cemented and friable. Pyrite and calcite are associated with the sands in the reduced facies. Hematite or limonite stain from pyrite, are common oxidation products in the oxidized facies. Montmorillonite and kaolinite clays from oxidized feldspars are also present in the oxidized facies. Figure **2-13** (see map pocket) details a typical stratigraphic coluimn of the Nichols Ranch ISR Project area." Page TR-41 *Using a geochemical speciation code, it may be possible to constrain water- rock interactions of the ore-bearing zones. This information could be used to address the reactivity of minerals under ambient conditions. Consequently, constraints could be placed on the geochemical aspects of the hydrologic system during restoration and decommissioning.* ¶

The hydraulic properties of the production aquifers as well as the associated underlying and overlying aquifers have been evaluated in the project area using both multi-well pumping tests and single tests. Aquifer testing was previously conducted between 1978 and 1979 by Cleveland-Cliffs and Uranerz. In preparation for the current application, additional aquifer testing was conducted by Uranerz in 2006 and 2007. A summary of the aquifer properties estimated for the Nichols Ranch Unit using the results of these aquifer tests is presented in Table 2-12 of the TR. The hydraulic conductivity of the A Sand at the Nichols Ranch Units was found to vary from 0.55 to slightly more than 21.3 cm/day (0.018 to slightly greater than 0.7 ft/day). A value of 15.2 cm/day (0.5 ft/day) was thought by the applicant to best represent the A Sand. A single-well test for the B Sand aquifer indicated that the hydraulic conductivity of 11.3 cm/day (0.37 ft/day) for this sand. Two single-well tests for the 1 Sand resulted in hydraulic conductivities of 5.5 and 7.9 cm/day (0.18 and 0.26 ft/day) for this sand. A single-well test in the F sand yielded a higher hydraulic conductivity of 110 cm/day (3.6 ft/day).

A summary of the aquifer properties estimated for the Hank Unit using the results of the multi-well pumping test and single-well tests in this area is presented in Table 2-13 of the TR. The hydraulic properties of the F Sand at the Hank Unit were found to vary greatly. The hydraulic conductivities of this unit were found to vary from a low of 4.3 cm/day to a high of 287 cm/day (0.14 to 9.4 ft/day). A hydraulic conductivity of 18.3 cm/day (0.6 ft/day) is thought by the applicant to best represent the majority of the F sand. The water-level in the ore zone at the Hank unit is near the top of the sand and therefore the F Sand is not fully saturated. Accordingly, the F Sand aquifer is an unconfined aquifer. The primary storage property for an unconfined aquifer is specific yield. The applicant has estimated that a specific yield of 0.05 best represents the F Sand in this area. Test results from two G Sand wells yielded hydraulic conductivity measurements for this sand of 0.15 and 0.67 cm/day (0.005 and 0.022 ft/day). A single measurement in the C Sand indicated a hydraulic conductivity value of 0.76 cm/day (0.025 ft/day). Two single well tests in the B Sand yielded hydraulic conductivity measurements of 11.6 and 67.1 cm/day (0.38 and 2.2 ft/day).

3.5.3.1.2 Level of Confinement

Vertical permeabilities of the aquitards in the Powder River Basin have been defined at numerous locations, including just north of the Hank Unit during the permitting of the PRI North Butte. These permeabilities have been measured using multi-well pumping tests and a variety of analytical methods. These permeabilities have also been determined using laboratory measurements. The applicant reports that data and analysis presented in the PRI North Butte application indicated that the vertical permeability for the aquitard separating the F and C sands was 0.004 cm/day (1.1 x 10^{-4} ft/day). A second multi-well test at the North Butte site indicated that the aquitard permeability between the A Sand and the 1 Sand was 0.004 cm/day (1.2 x 10^{-4} ft/day). Laboratory measurements of permeabilities of samples from two aquitards were submitted for the North Butte site. These permeabilities varied from 54.9 to 0.001 cm/day (1.8 ft/day to 3.7 x 10^{-5} ft/day). These data were considered sufficient to demonstrate the confinement of the uranium-bearing sands at the project area. Aquifer confinement would be further verified at each of the wellfields during the required wellfield multi-well pumping tests. These data would be submitted as part of the Wellfield data packages and would be reviewed and approved by the NRC before each wellfield would begin operation.

3.5.3.1.3 Groundwater Quality

In Wyoming, the quality of groundwater is measured against either US EPA Drinking Water Standards (40 CFR 142 and 143) which establish Maximum Contaminant Levels (MCLs) for specific chemical constituents or Wyoming Ground Water Quality standards. The Wyoming standards are based on ambient water quality and are divided into three Classes: Class 1 is defined as suitable for domestic use, Class II is defined as suitable for agriculture, Class III is defined as suitable for livestock, Class IV is defined as suitable for industrial use, and Class Special (A) is defined as suitable for fish and aquatic life (WDEQ, 2005).

Groundwater quality at the project area has been defined by sampling numerous wells in many of the aquifers identified in the area. The resulting groundwater quality data has been summarized in Table 2-14 of the TR and is presented below. The data in this summary has been grouped for the A Sand, the F Sand, the B and C Sands, the G and H Sands, and the 1 Sand. Included in this summary table are US EPA Drinking Water Standards (40 CFR 142 and 143) and Wyoming Class 1, Domestic Ground Water Quality standards.

The groundwater quality summary data indicates that the A Sand water has very low TDS (less than 500 mg/L), with major components being sodium, sulfate, and bicarbonate. Uranium concentrations in A Sand groundwater varied between detection and 0.027 mg/L. Radium-226 concentrations varied between detection and 36.3 picocuries (pCi) per liter. Typically, uranium-bearing aquifers, particularly in the ore-zone, exhibit uranium and radium-226 levels exceeding their respective EPA MCLs (Section 3.3.4.3.3; NRC 2009?). The relatively low concentrations found in the A Sand in the area of Nichols Ranch and Hank Unit appear to be related to the length of the well screens (ranging from 69 to 110 feet in length) which extend over the entire A Sand and are not limited to the ore zone. This would lead to dilution of the samples with water from outside the ore zone.

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Comment [Pm8]: Good point John. I got these values from the well specs table in the TR.

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Groundwater quality data for the F Sand indicated that average TDS concentrations were greater than 1,000 mg/L. Sodium, calcium, bicarbonate, and sulfate are the major dissolved constituents in this water. Uranium concentrations were measured in this ore-bearing sand at an average of 0.16 mg/L, with a maximum concentration of 5.25 mg/L. Radium concentrations as high as 562 pCi/L were also measured, with an average value of 43 pCi/L. Consequently, the F Sand does not meet the Wyoming Class I, II, or III groundwater quality standards and exceeds the EPA MCL for uranium.

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Water quality for the B and C Sands were grouped together by the applicant. These sands lie between the two production zones and are connected in some areas. TDS in these aquifers averaged 793 mg/L with the major constituents being sodium, bicarbonate, and sulfate. Uranium concentrations in these aquifers averaged 0.059 mg/L, with a maximum of 2.16 mg/L. Radium concentrations in the B and C aquifers average 16 pCi/L. with a maximum measured concentration of 128 pCi/L. Consequently, the B and C Sands do not meet the Wyoming Class I, II, or III groundwater quality standards and exceeds the EPA MCL for uranium.

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Water quality for the H and G Sands were grouped together by the applicant. TDS in these aquifers averaged 427 mg/L with the major constituents being sodium, bicarbonate, and sulfate. Uranium concentrations in these aquifers were generally low, averaging 0.004 mg/L. Radium concentrations in the H and G aquifers average 0.44 pCi/L with a maximum measured concentration of 1.9 pCi/L. Uranium concentrations averaged 0;059 mg/L. As a result, the H and G Sands meet the Wyoming Class II groundwater quality standards and is suitable for agriculture.

Water quality for the 1 Sand is also of good water quality. TDS in this aquifer averaged 232 mg/L with the major constituents being sodium, bicarbonate, and sulfate. Uranium concentrations in this aquifer was very low, averaging 0.00015 mg/L. Radium concentrations in average 0.1 pCi/L. Consequently, the 1 Sand meets the Wyoming Class I groundwater quality standards.

Water Quality Parameter	Nichols Ranch Unit License Area			
	"B and C sand" Overlying Aquifer	"A sand" Ore zone Aquifer	"1 sand" Underlying Aquifer	Water Quality Standards*
Bicarbonates as HCO3 (mg/l)	120.65	138.86	233.75	
Carbonates as CO3(mg/l)	3.43	4.41	15.75	
Chloride (mg/l)	53.22	8.06	5.00	250
Conductivity (umhos/cm)	1162.68	564.13	411.5	
Fluoride (mg/l)	0.174	0.24	0.65	2.0 – 4.0
pH (s.u.)	8.15	8.48	8.63	6.5 – 8.5
Total Dissolved Solids (mg/l)	**797.11**	333.14	232.0	500
Sulfate (mg/l)	**466.24**	135.05	1.5	250
Radium 226 (pCi/l)	**15.44**	**5.02**	0.1	5.0
Nitrogen, Ammonia as N (mg/l)	**0.627**	0.09	0.07	*0.5*
Nitrogen, Nitrate+Nitrite as N (mg/l)	0.069	0.05	0.05	10

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Aluminum (mg/l)	0.095	0.05	0.05	0.05 to 0.2
Arsenic (mg/l)	0.002	0.0	0.0005	0.01
Barium (mg/l)	0.052	0.05	0.05	2.0
Boron (mg/l)	0.110	0.08	0.05	
Cadmium (mg/l)	0.004	0.0	0.0025	0.005
Calcium (mg/l)	53.22	7.61	3.75	
Chromium (mg/l)	0.016	0.02	0.025	0.1 (total)
Copper (mg/l)	0.012	0.01	0.005	1.0
Iron (mg/l)	0.109	0.07	0.015	0.3
Lead (mg/l)	0.01	0.01	0.005	*0.015*
Magnesium (mg/l)	10.94	0.57	0.50	
Manganese (mg/l)	0.025	0.01	0.005	0.05
Mercury (mg/l)	0.001	0.0	0.0005	0.002
Molybdenum (mg/l)	0.069	0.07	0.05	
Nickel (mg/l)	0.02	0.02	0.025	0.1
Potassium (mg/l)	6.89	2.23	2.25	
Selenium (mg/l)	0.0	0.0	0.0005	0.05
Sodium (mg/l)	189.49	113.62	99.5	
Uranium (mg/l)	**0.06**	0.01	0.00015	0.03
Vanadium (mg/l)	0.05	0.05	0.05	
Zinc (mg/l)	0.23	0.01	0.005	5.0

EPA Drinking Water Standards - 10 CFR Part 141 and 143

Wyoming Water Quality, Rules and Regulations, Chapter 8, Class 1, Domestic Ground Water

Bolded values exceed either EPA or Wyoming Class 1 Groundwater Standards

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Comment [Pm9]: I don't think the other SEISs are using gw quality tables (I know Fetter's is not). I think we can delete the tables, hit the high spots in the section, and reference the TR.

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Ground water compositions are listed in the tables below. ¶
A Sand Well: MN-1, MN-2, MN-3, MN-4, MN-5, MN-6 and DW-4L ... [1]

Water Quality Parameters	Hank Unit License Area			
	"G sand" Overlying Aquifer	"F sand" Ore Zone Aquifer	"B and C sand" Underlying Aquifer	Water Quality Standards*
Bicarbonates as HCO3 (mg/l)	151.1	171.43	120.65	
Carbonates as CO3(mg/l)	8.8	0.63	3.43	
Chloride (mg/l)	7.6	5.53	53.22	250
Conductivity (umhos/cm)	804.9	1426.96	1162.68	
Fluoride (mg/l)	0.2486	0.15	0.174	2.0 – 4.0
pH (s.u.)	8.4	7.82	8.15	6.5 – 8.5
Total Dissolved Solids (mg/l)	**504.4**	**1020.95**	**797.11**	500
Sulfate (mg/l)	243.1	**597.33**	**466.24**	250
Radium 226 (pCi/l)	0.73	**44.6**	**15.44**	5.0
Nitrogen, Ammonia as N (mg/l)	0.103	0.05	**0.627**	*0.5*
Nitrogen, Nitrate+Nitrite as N (mg/l)	0.05	0.05	0.069	10

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Aluminum (mg/l)	**0.425**	**0.05**	0.095	0.05 to 0.2
Arsenic (mg/l)	0.0033	0.0068	0.002	0.01
Barium (mg/l)	0.055357	0.05	0.052	2.0
Boron (mg/l)	0.24643	0.08	0.110	
Cadmium (mg/l)	0.00329	0.0034	0.004	0.005
Calcium (mg/l)	48.6	99.77	53.22	
Chromium (mg/l)	0.0221	0.02	0.016	0.1 (total)
Copper (mg/l)	0.00714	0.02	0.012	1.0
Iron (mg/l)	**0.499**	**0.30**	0.109	0.3
Lead (mg/l)	**0.0231**	0.01	0.01	*0.015*
Magnesium (mg/l)	9.8	24.37	10.94	
Manganese (mg/l)	**0.051**	**0.07**	0.025	0.05
Mercury (mg/l)	0.00047	0.0005	0.001	0.002
Molybdenum (mg/l)	0.05	0.05	0.069	
Nickel (mg/l)	0.0232	0.02	0.02	0.1
Potassium (mg/l)	6.0	7.12	6.89	
Selenium (mg/l)	0.0026	0.02	0.00	0.05
Sodium (mg/l)	110.9	185.73	189.49	
Uranium (mg/l)	0.009475	**0.15**	**0.06**	0.03
Vanadium (mg/l)	0.0363	0.05	0.05	
Zinc (mg/l)	0.021	0.02	0.23	5.0

EPA Drinking Water Standards - 10 CFR Part 141 and 143
Wyoming Water Quality, Rules and Regulations, Chapter 8, Class 1, Domestic Ground Water
Bolded values exceed either EPA or Wyoming Class 1 Groundwater Standards

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F Sand Wells: DW-4U, HANK 1, DRY WILLOW #1, WC-MN1, BR-B, C #1, SS1-F, URZHF-1, URZHF-5 and URZNF-3 ... [2]

Comment [pxm210]: Since one potential impact of the proposed activites is to current gw users, I think we need a little more depth in this section. Closest downgradient users, which aquifer(s) are they withdrawing water, relationship to production zones, etc.

Addressed

3.5.3.1.4 Current Groundwater Uses

The applicant has contacted the WSEO to identify all permitted wells within the project unit area and within a 4.8-km (3-mi) radius of each unit. Numerous wells have been identified in these surveys, including wells associated with mining and aquifer monitoring, stock watering wells, and domestic wells. The survey indicates that excluding the monitoring and mining related wells, most wells are used for livestock watering through the use of windmills or electric well pumps. The depth of these wells generally ranges between 30 and 305 m (100 and 1,000 ft). A number of the identified wells are noted to have sufficient hydraulic heads to allow the wells to discharge to the surface without pumping (flowing wells). In the proposed project area, wells that are completed in the ore bearing zone will be abandoned per Wyoming regulations/guidance or will be used as monitoring wells if deemed appropriate (i.e., proper screen interval).

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All the permitted wells identified within the Nichols Ranch Unit and within a three-mile radius of the unit are presented in Tables D6G.1-1 and D6G.1-2 of the TR, respectively. Inspection of these data for wells with depths of between 300 to 700 feet below ground surface (i.e., potentially screened within the A Sand) indicates available ground water head averages around 446 feet. The survey has identified nine existing wells within the Nichols Ranch Unit excluding aquifer testing or monitoring wells. All of these wells are used for stock watering. The review of

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these wells conducted by the applicant indicates that several of these wells are completed in the ore-bearing sands and would need to be abandoned or converted to monitoring wells. The survey also indicates three domestic wells within three miles of the Nichols Ranch proposed well fields. Two of the wells (Doughstick and Garden Well) are approximately 2.25 miles southeast and up-gradient of the proposed well fields, while Dry Fork #1 is about 1.25 miles southwest and cross-gradient from the proposed well fields.

All of the permitted wells identified within the Hank Unit and within a three-mile radius are presented in Tables D6G.2-1 and D6G.2-2 of the TR, respectively. Inspection of these data for wells with depths of between 200 to 600 feet below ground surface (i.e., potentially screened within the F Sand) indicates available ground water head averages around 246 feet. Six permitted wells were identified within 0.8 km (0.5 mi) of the Hank Unit area. All of these are used for stock watering. Several of these wells appear to be completed in the F Sand, while other wells are screened through multiple sands including the C, B, and A Sands. Several of these wells would need to be abandoned or converted to monitoring wells. The survey also indicates three domestic wells within three miles of the Hank Unit. A domestic well was identified 1 km (0.6 mi) north of the northern boundary of the Hank Unit. This well (BR-T) is reported to be completed in the B Sand below the westward flowing production zone (F Sand) at the Hank Unit. The other two domestic wells (Doughstick and Garden Well, same as above) are approximately 3 miles southwest and cross-gradient from the proposed well fields.

3.5.3.2 Surrounding Aquifers

As indicated in the GEIS (Section 3.3.4.3.4), the Wasatch Formation and the Fort Union Formation are important aquifers for water supplies on a regional scale. The Fox Hill Sandstone is one of the most continuous water-yielding formations in the Northern Great Plans aquifer system. Except at outcrop areas, the Paleozoic aquifers are not usually used for water production, because they are either deeply buried or contain saline water.

Based on the survey of water wells within a 4.8-km (3-mi) radius of the site, water supply wells are generally completed within a 305 m (1,000 ft) of the ground surface in the sands of the Wasatch Formation. The Fort Union Formation is not extensively used because sufficient yields of groundwater are available from the overlying Wasatch.

Deep well injection has been proposed for the disposal of RO brines. Typically, deep well injection in the Powder River Basin, occurs in the Upper Cretaceous Lance Formation (e.g., Christensen Ranch) several thousand feet below the Lower Tertiary production zones. The applicant has indicated that it will apply for an Underground Injection Control (UIC) permit through WDEQ. As required, the disposal well will be completed (i.e., screened) in an approved subsurface formation(s) and will be operated according to the permit requirements.

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Deleted: The survey has identified nine existing wells within the Nichols Ranch Unit excluding aquifer testing or monitoring wells. All of these wells are used for stock watering. The review of these wells conducted by the applicant indicates that several of these wells are completed in the ore-bearing sands and would need to be abandoned or converted to monitoring wells. ¶
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Deleted: The applicant indicates that arrangements have also been made to address these impacts with the owners of these wells through confidential agreements.

Comment [pxm211]: Not only in another unit, but cross-gradient to the ambient flow in the F Sand.

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Excluding mining and monitoring wells, more than forty-five wells have been identified within a 4.8-km (3-mi) radius of both the Nichols Ranch Unit and the Hank Unit. Most of these wells have been identified as stock watering wells, although several domestic wells have been identified within three miles of the proposed mining units. ¶

Comment [pxm212]: I have found nothing with respect to which aquifer/unit Uranerz intends to deep well inject. Unless we come up with it, I'm proposing this language.

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Reference

NRC, 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities. NUREG-1910. Vol. 1 and 2. June 2009.

Uranerz, 2007a. Nichols Ranch ISR project U.S.N.R.C. Source Material License Application, Volume III, Environmental Report. November 2007. Casper, Wyoming. Accession No. ML080090338.

Uranerz, 2007a. Nichols Ranch ISR project U.S.N.R.C. Source Material License Application, Volume I, Technical Report. November 2007. Casper, Wyoming. Accession No. ML080080609.

Wyoming Department of Environmental Quality (2005), Water Quality Rules and Regulations, Chapter 8, Quality Standards for Wyoming Groundwaters, April 27.

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Ground[Pm1] water compositions are listed in the tables below.

A Sand Well: MN-1, MN-2, MN-3, MN-4, MN-5, MN-6 and DW-4L				
Constituent	Mean (mg/L)	Maximum (mg/L)	Minimum (mg/L)	EPA (and NEPA) Drinking water standard
Ca	7.61	11	5.3	
Cl	8.06	16	4	250
CO3	4.41	24	0.5	
HCO3	138.86	156	80	
K	2.23	5.7	1.7	
Mg	0.57	1	0.4	
Na	113.62	130	84	
SO4	135.03	183	85	250
Temp	15.43	20	13.6	
TDS	333.14	370	289	500
Cond	564.13	643	489	
Cond(f)	574.23	720	507	
pH	8.48	8.74	7.41	6.5-8.5
pH(f)	8.42	9.5	7.26	
Fe	0.07	0.65	0.005	
Mn	0.01	0.03	0.005	
NH3	0.09	0.57	0.02	
NO3 + NO2	0.05	0.05	0.05	10
F	0.24	0.3	0.1	4.0 or 2.0
Al	0.05	0.05	0.05	
As	0.00	0.009	0.0005	0.05
Ba	0.05	0.05	0.05	2.0
Cr	0.02	0.025	0.005	0.05
Cu	0.01	0.005	0.005	1.0
B	0.08	0.5	0.05	
Cd	0.00	0.005	0.0025	0.01
Hg	0.00	0.0007	0.0002	0.002
Mo	0.07	0.5	0.05	
Ni	0.02	0.025	0.005	0.1
Pb	0.01	0.08	5e-4	0.05
Se	0.00	0.0015	0.0005	0.05
Unat	0.01	0.027	0.00015	
V	0.05	0.05	0.05	
Zn	0.01	0.04	0.005	5.0
Ra226*	5.02	36.3	0.1	5.0
Ra226(e)*	0.66	3	0.2	5.0

* pCi/L

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F Sand Wells: DW-4U, HANK 1, DRY WILLOW #1, WC-MN1, BR-B, C #1, SS1-F, URZHF-1, URZHF-5 and URZNF-3				
Constituent	Mean (mg/L)	Maximum (mg/L)	Minimum (mg/L)	EPA (and NEPA)

				Drinking water standard
Ca	101.02	293	44	
Cl	5.56	33	0.5	250
CO3	0.65	4.3	0.5	
HCO3	173.86	421	45	
K	7.29	14	5	
Mg	25.04	96	10	
Na	182.17	245	94	
SO4	592.11	981	418	250
Temp	12.00	17.1	9	
TDS	1019.09	1860	710	500
Cond	1411.04	1880	994	
Cond(f)	1530.24	3370	995	
pH	7.80	8.5	7.16	6.5-8.5
pH(f)	7.74	10.4	6.7	
Fe	0.34	3.9	0.005	
Mn	0.06	0.26	0.005	
NH3	0.05	0.13	0.005	
NO3 + NO2	0.05	0.05	0.05	10
F	0.14	0.5	0.01	4.0 or 2.0
Al	0.05	0.4	0.005	
As	0.0017	0.015	0.0005	0.05
Ba	0.05	0.05	0.015	2.0
Cr	0.02	0.03	0.005	0.05
Cu	0.01	0.08	0.005	1.0
B	0.08	0.5	0.005	
Cd	0.0035	0.014	0.001	0.01
Hg	0.0005	0.0013	0.0002	0.002
Mo	0.05	0.05	0.05	
Ni	0.02	0.025	0.005	0.1
Pb	0.01	0.05	5e-4	0.05
Se	0.02	0.574	0.0005	0.05
Unat	0.16	5.25	0.0005	
V	0.05	0.05	0.025	
Zn	0.02	0.32	0.005	5.0
Ra226	43.14	562	0.1	5.0
Ra226(e)	2.0	7.2	0.2	5.0

B and C Sand Wells: BR-Q, BR-T, DW-4M, F, Brown #1, Brown #5, NBHW-13, SS1-M, SS1-U, URZNB-1, URZHC-2, URZHB-6				
Constituent	Mean (mg/L)	Maximum (mg/L)	Minimum (mg/L)	EPA (and NEPA) Drinking water standard

Ca	51.27	103	5	
Cl	7.60	80	1	250
CO3	3.58	26	0.5	
HCO3	120.62	242	26	
K	6.86	41	3	
Mg	10.80	22	0.5	
Na	190.57	250	85	
SO4	462.93	620	121	250
Temp	13.08	18	3	
TDS	793.53	966	278	500
Cond	1155.11	1450	537	
Cond(f)	1224.79	2100	535	
pH	8.17	9.63	7.16	6.5-8.5
pH(f)	8.12	10.07	6.84	
Fe	0.102	1	0.005	
Mn	0.024	0.09	0.005	
NH3	0.648	26	0.02	
NO3 + NO2	0.050	0.05	0.05	10
F	0.179	0.88	0.01	4.0 or 2.0
Al	0.089	0.7	0.025	
As	0.002	0.007	0.0005	0.05
Ba	0.052	0.15	0.015	2.0
Cr	0.016	0.025	0.003	0.05
Cu	0.012	0.2	0.005	1.0
B	0.112	0.7	0.005	
Cd	0.004	0.02	0.0005	0.01
Hg	0.001	0.0043	5e-5	0.002
Mo	0.070	0.5	0.05	
Ni	0.019	0.07	0.005	0.1
Pb	0.010	0.13	5e-4	0.05
Se	0.002	0.025	0.0005	0.05
Unat	0.059	2.16	0.00015	
V	0.047	0.2	0.003	
Zn	0.241	3.19	0.005	5.0
Ra226	16.022	128	0.1	5.0
Ra226(e)	1.711	9	0.2	5.0

G and H Sand Wells: BR-F, BR-H, BR-1				
Constituent	Mean (mg/L)	Maximum (mg/L)	Minimum (mg/L)	EPA (and NEPA) Drinking water

				standard
Ca	40.5	78	8	
Cl	8.2	27	3	250
CO3	10.1	48	0.5	
HCO3	157.0	270	13	
K	5.7	13	2	
Mg	7.2	16	0.5	
Na	101.6	190	8	
SO4	187.5	400	9	250
Temp	11.6	14.8	7.9	
TDS	427.8	696	225	500
Cond	691.3	1080	400	
Cond(f)	726.2	1886	380	
pH	8.5	10.9	7.1	6.5-8.5
pH(f)	8.6	10.24	7.06	
Fe	0.57	2.16	0.015	
Mn	0.06	0.22	0.005	
NH3	0.11	0.66	0.025	
NO3 + NO2	0.05	0.05	0.05	10
F	0.26	0.4	0.1	4.0 or 2.0
Al	0.49	1.6	0.05	
As	0.003	0.007	0.0005	0.05
Ba	0.06	0.25	0.025	2.0
Cr	0.02	0.025	0.005	0.05
Cu	0.01	0.01	0.005	1.0
B	0.28	1	0.05	
Cd	0.003	0.005	0.001	0.01
Hg	0.0005	0.0005	0.0001	0.002
Mo	0.05	0.05	0.05	
Ni	0.02	0.025	0.02	0.1
Pb	0.03	0.117	5e-4	0.05
Se	0.003	0.005	0.0005	0.05
Unat	0.004	0.018	0.00015	
V	0.03	0.05	0.003	
Zn	0.02	0.1	0.005	5.0
Ra226	0.44	1.9	0.1	5.0
Ra226(e)	0.29	0.6	0.2	5.0

1 Sand Well: URZN1-2				
	Mean (mg/L)	Maximum (mg/L)	Minimum (mg/L)	EPA (and NEPA) Drinking water standard
Ca	3.75	4	3	

Cl	5.00	6	4	250
CO3	15.75	24	12	
HCO3	233.75	246	209	
K	2.25	3	2	
Mg	0.50	0.5	0.5	
Na	99.50	104	92	
SO4	1.50	2	1	250
Temp	15.20	16.3	14.1	
TDS	232.00	248	204	500
Cond	411.50	425	393	
Cond(f)	416.00	421	409	
pH	8.63	9.39	7.07	6.5-8.5
pH(f)	8.94	9.15	8.78	
Fe	0.015	0.015	0.015	
Mn	0.005	0.005	0.005	
NH3	0.07	0.09	0.05	
NO3 + NO2	0.05	0.05	0.05	10
F	0.65	0.7	0.05	4.0 or 2.0
Al	0.05	0.05	0.05	
As	0.0005	0.0005	0.0005	0.05
Ba	0.05	0.05	0.05	2.0
Cr	0.025	0.025	0.025	0.05
Cu	0.005	0.005	0.005	1.0
B	0.05	0.05	0.05	
Cd	0.0025	0.0025	0.0025	0.01
Hg	0.0005	0.0005	0.0005	0.002
Mo	0.05	0.05	0.05	
Ni	0.025	0.025	0.025	0.1
Pb	5e-4	5e-4	5e-4	0.05
Se	0.0005	0.0005	0.0005	0.05
Unat	0.0015	0.0015	0.0015	
V	0.05	0.05	0.05	
Zn	0.005	0.005	0.005	5.0
Ra226	0.1	0.1	0.1	5.0
Ra226(e)	0.2	0.2	0.2	5.0