U.S. EPA Region 8

Underground Injection Control Program

AQUIFER EXEMPTION RECORD OF DECISION

This Record of Decision provides EPA's aquifer exemption (AE) decision, background information concerning the AE request, and the basis for the AE decision requested by Powertech (USA) Inc. for the Dewey-Burdock uranium in-situ recovery (ISR) site in Custer and Fall River Counties in South Dakota.

Primacy Agency: EPA Region 8 Direct Implementation Program under Section 1422 of the Safe Drinking Water Act (SDWA) for the State of South Dakota

Date of AE Request: January 2013

Major or Minor (Substantial or Non-Substantial) Approval: **Minor (Non-Substantial)**

While the action before EPA is not a state program revision, but rather an approval of an AE in a federally-administered program, the process is treated similarly and requires EPA to determine whether the AE approval is major or minor (i.e. substantial or non-substantial). The process is discussed in the Preamble of 49 Fed. Reg. 40098, 40108 (September 2, 1983); see also 49 Fed. Reg. 20138, 20143 (May 11, 1984). The review and/or approval process differs depending on whether EPA treats the decision as a major or minor program revision. EPA has determined this AE decision is minor, or non-substantial, because it is associated with the issuance of a site-specific UIC Class III permit action, not a state-wide programmatic change or a revision with implications for the national UIC program. The decision to treat this AE as a minor, non-substantial program revision is also consistent with the corresponding state program revision process detailed in EPA Guidance#34: *Guidance for Review and Approval of State Underground Injection Control (UIC) Programs and Revisions to Approved State Programs*. Guidance 34 explains that the determination as to whether a program revision is substantial or non-substantial is made on a case-by-case basis, and with the exception of AEs associated with certain Class I wells or exemptions not related to action on a permit, AE requests are typically treated as non-substantial program revisions.

Operator: Powertech (USA) Inc. (Powertech)

Well/Project Name: Dewey-Burdock Uranium In-Situ Recovery Project

Well/Project Permit Number: EPA Permit No. SD31231-00000

Well/Project Location: Portions of Sections 20, 21, 27, 28, 29, 30, 31, 32, 33, 34 and 35 of Township 6S, Range 1E and portions of Sections 1, 2, 3, 4, 5, 10, 11, 12, 14 and 15 of Township 7S, Range 1E

County: Custer and Fall River **State**: SD

Well Class /Type: Class III uranium in-situ recovery

BACKGROUND

The purpose of this AE is for the injection of lixiviant into the uranium-bearing portions of the Inyan Kara Group aquifers for ISR of uranium. Powertech requested this AE as part of a UIC Area Permit Application for the Class III injection wells that will be used for the injection of lixiviant. The proposed Dewey-Burdock uranium ISR site is located southwest of the Black Hills in South Dakota on the South Dakota-Wyoming state line in southwest Custer and northwest Fall River Counties as shown in Figure 1. The site is located approximately 13 miles northwest of Edgemont, SD and 46 miles west of the western border of the Pine Ridge Reservation.

EPA developed a Fact Sheet for the draft Class III Area Permit that provides more detailed information about the Dewey-Burdock Project and the draft Class III Area Permit requirements. Information about changes EPA made to Class III Area Permit requirements from the 2019 draft to the final versions are discussed in the document entitled *EPA Region 8 Underground Injection Control (UIC) Program Response to Public Comments.*

The ISR process involves the injection of lixiviant, consisting of injection interval groundwater with added oxygen and carbon dioxide, into uranium ore deposits targeted by 14 proposed wellfields. Powertech anticipates the construction of approximately 1,461 Class III injection wells and 869 production wells over the life of the project. The lixiviant is pumped into the uranium deposit through the injection wells and mobilizes uranium from the ore deposits. Production wells pump the uranium-bearing lixiviant out of the ground. The uranium-bearing lixiviant flows via pipeline from the wellfield to a processing unit where ion exchange resin columns remove the uranium from solution. The barren lixiviant is pumped from the processing unit back to the ISR wellfield where oxygen and carbon dioxide are added before injection back into uranium ore deposits through the wellfield injection wells.

Figure 2 shows the Dewey-Burdock Project Area outlined by the black Project Boundary. The Project Area is divided into the Dewey and Burdock Areas identified in Figure 2. Each ISR wellfield has a perimeter ring of monitoring wells completed in the injection zone around each wellfield as shown in Figure 2. Each perimeter monitoring well ring will be located about 400 feet from the injection and production wells completed in the ore deposits. The color of the ore deposits and the perimeter monitoring well rings indicates where the ore deposits occur vertically in the Inyan Kara Group aquifers shown in the stratigraphic column in Figure 3.

DESCRIPTION OF APPROVED AE

Exempted Aquifers

The aquifers approved for exemption are the Inyan Kara Group aquifers: the Fall River Formation and the Lakota Formation, Chilson Sandstone Member, shown in Figure 3. EPA approved the exemption of Inyan Kara aquifers 1,020 feet from the currently defined ore deposit boundaries for Burdock Wellfields 1 through 5 and 9 as shown by the purple-dashed line in Figure 2. EPA also approved the exemption of Inyan Kara aquifers 520 feet from the currently defined ore deposit boundaries for Burdock Wellfield 10 and Dewey Wellfields 1 through 4 as represented by the green dashed line in Figure 2. EPA did not approve the requested exemption of Inyan Kara aquifers for Burdock Wellfields 6, 7 and 8 because Powertech must provide the Director with an analysis of the amenability of the mining zone to the proposed ISR mining method per § 144.7(c)(1) and Class III Area Permit Part II, Section G.

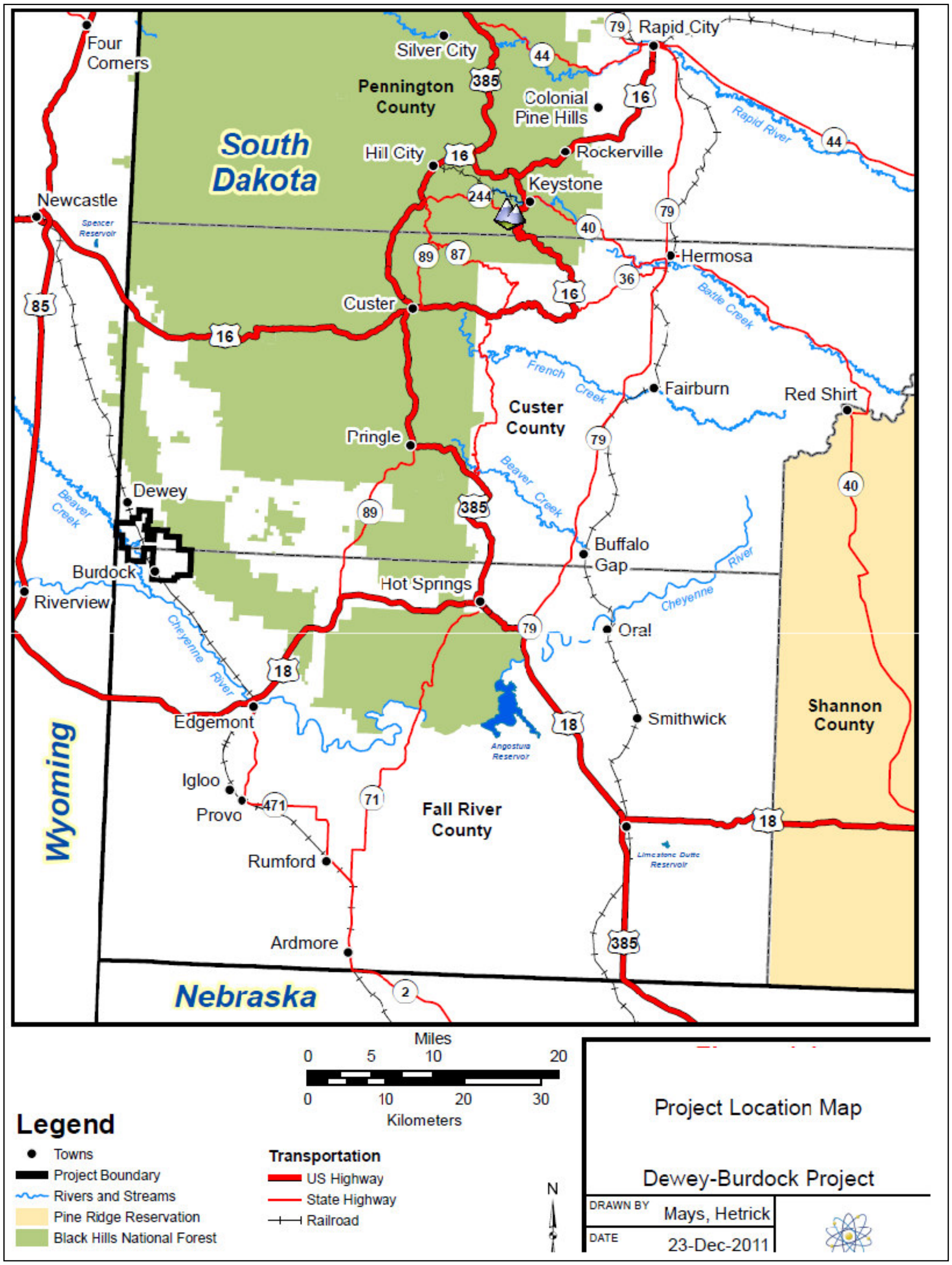

Figure 1. Dewey-Burdock Project location

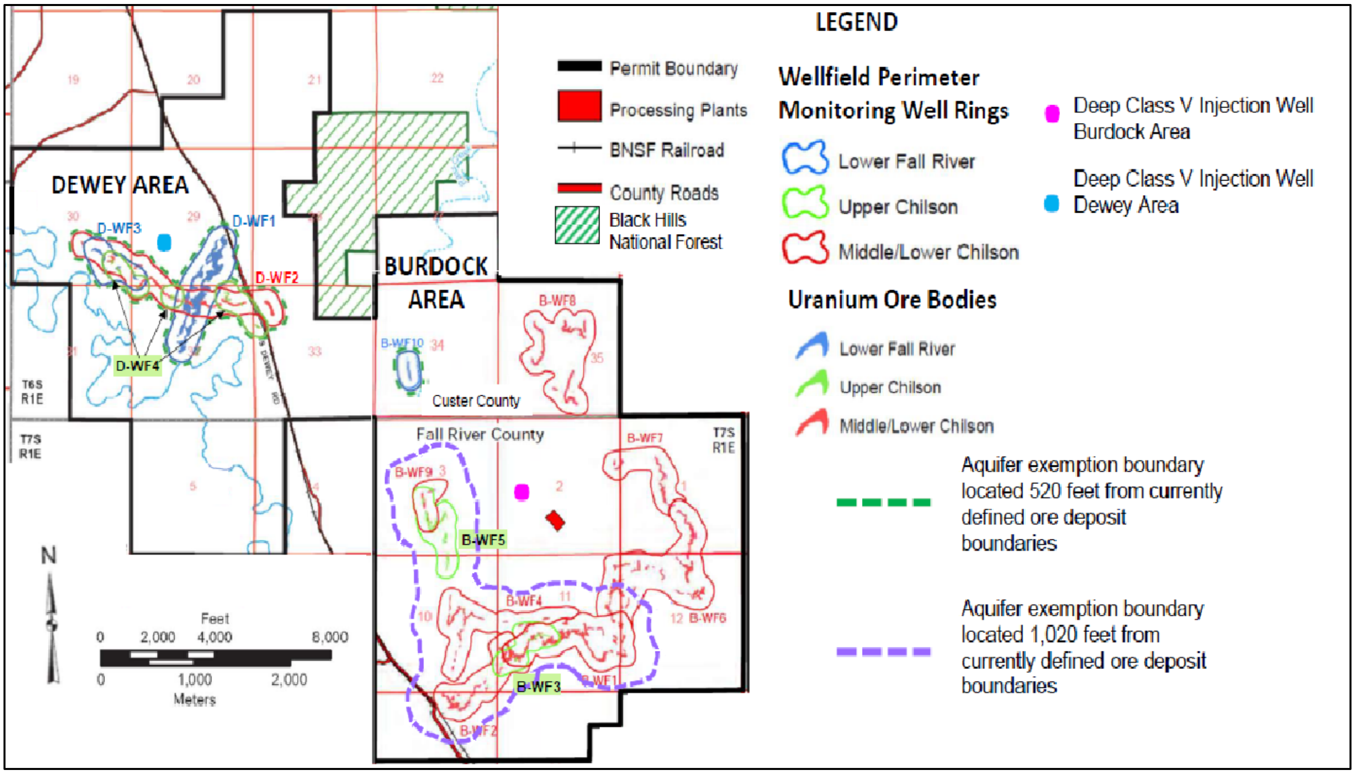

Figure 2. Areas of the Inyan Kara Group aquifers approved by this Record of Decision.

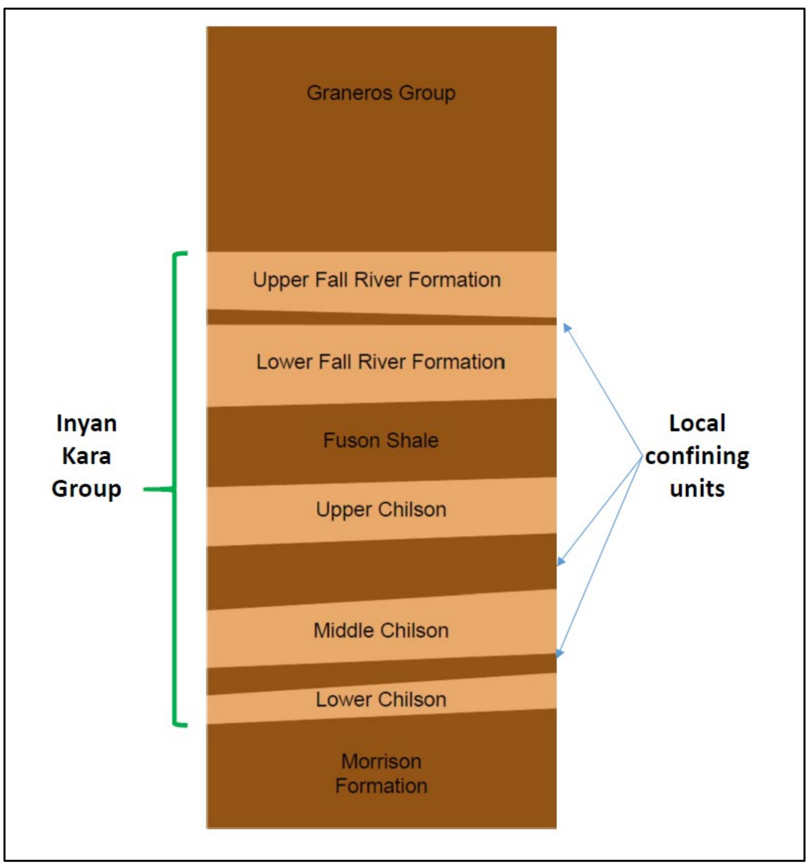

Figure 3. Stratigraphic column of the Inyan Kara Group, major confining zones, and the local confining units.

Water Quality – Total Dissolved Solids (TDS) (mg/L) mg/L

Fall River Formation of the Inyan Kara Group TDS Range: 773.85 -2,250.00 mg/L; mean TDS=1,275.01 mg/L, based on the summary of groundwater quality analyses in Appendix N of the Class III Permit Application.

Chilson Sandstone unit of the Lakota Formation of the Inyan Kara Group TDS Range: 708.33 mg/L-2,358.33 mg/L; mean TDS=1,263.38 mg/L, based on the summary of groundwater quality analyses in Appendix N of the Class III Permit Application.

Depth and Thickness of Aquifers

In the Dewey-Burdock Project Area, the geologic strata dip gently to the southwest at 2 to 6 degrees; therefore, the depth to the top and bottom of the Inyan Kara Group aquifers varies across the Project Area. Table 1 presents an average depth of the Inyan Kara Group units in the Dewey and the Burdock Areas.

Table 1. Depth below ground surface to the top and bottom of the Inyan Kara Group units

Formation Name	**Burdock Area**			**Dewey Area**		
	Top (feet)	**Base (feet)**	**Thickness (feet)**	**Top (feet)**	**Base (feet)**	**Thickness (feet)**
Inyan Kara Group	190	425	235	525	760	235
Fall River Formation	190	315	125	525	650	125
Lakota Formation	315	425	110	650	760	110
Fuson Shale	315	355	40	650	690	40
Chilson Sandstone	355	425	70	690	760	70

The vertical extent of the Inyan Kara Group proposed for exemption includes the entire vertical interval which is confined above and below by low permeability shale confining zones as shown in Figure 3.

Areal Extent of Exempted Area

The areal extent of the approved AE is approximately 1,970 acres and includes the areas shown in Figure 2.

The AE area Powertech proposed included the location of commercially producible uranium ore plus a calculated distance of 120 feet beyond the perimeter monitoring well ring for each wellfield. The horizontal extent of the AE area Powertech requested includes all currently identified potential Class III ISR wellfield areas, the perimeter monitoring well rings located 400 feet from the wellfield areas, and an additional area 120 feet outside of the perimeter monitoring well rings. As described in the September 2011 memorandum *Calculation of the Proposed Aquifer Exemption Distance beyond the Monitor Ring: Dewey-Burdock ISR Uranium Project, South Dakota*[1], this area is derived from a science-based

[1] Technical Memorandum to J. Mays, R. Blubaugh - Powertech Uranium, from: Hal Demuth – Petrotek "Calculation of the Proposed Aquifer Exemption Distance beyond the Monitor Ring: Dewey-Burdock ISR Uranium Project, South Dakota" September 12, 2011, included as Appendix M of the Class III Permit Application.

calculation using site-specific properties of the injection interval aquifers and considers the distance that a potential excursion could travel prior to being detected and recovered. The maximum distance that a potential excursion could travel before detection (ΔT) is approximately 47 feet based on the geometry of the monitoring well rings. The estimated distance of potential excursion migration between initial detection and implementation of excursion recovery (Δd) is 24 feet based on a Darcy calculation using a hydraulic gradient representative of a wellfield imbalance that could cause an excursion. The dispersion factor (DF) is estimated as 10% of the total travel distance or 47 feet. The science-based calculation of 118 feet beyond the wellfield perimeter monitoring well ring was rounded up to 120 feet for ease of surveying and plotting on maps. A distance of 120 feet provides a reasonable extension beyond the monitoring ring boundary to enable uranium recovery while remaining protective of the USDWs located outside the exempted portions. For a more detailed explanation of the method Powertech used to determine the horizontal extent of the AE areas, see Appendix M of the Class III Permit Application.

Summary of Proposed AE Boundaries in the 2017 and 2019 Proposed AE RODs

Powertech proposed this AE area before understanding that the Class III Area Permit would require verification that no ISR contaminants will cross the downgradient AE boundary after groundwater restoration and wellfield closure. In comments submitted to EPA on the 2017 draft Class III Area Permit, Powertech reminded EPA that the 2008 Class III Permit Application included a proposed AE boundary located 1,600 feet from potential wellfield patterns of injection and recovery wells and requested that EPA reconsider the larger AE area for each wellfield. EPA had evaluated the 2008 proposed AE boundary along with the 2010 *Updated Technical Report on the Dewey-Burdock Uranium Project Custer and Fall River Counties South Dakota* (Bush, 2010) but was not able to distinguish indicated and measured mineral resources (the demonstrated commercially ore deposits) from the inferred mineral resources (identified but not verified for commercial producibility) on the 2008 proposed aquifer exemption boundary map. EPA was not able to conclude that the 2008 proposed AE boundary was tied to the commercially producible ore areas as discussed in the 2010 updated technical report.

After considering an appropriate distance required for natural attenuation of potentially elevated ISR contaminants within the injection zone aquifer and the fact that the wellfield area may increase after delineation drilling has identified the ore deposit boundaries in better detail, EPA proposed approving up to ¼ mile (1,320 feet) from the currently identified ore deposit boundaries in the second draft AE ROD. The final AE boundary would be determined after delineation drilling identified ore deposit boundary in better detail thus directly tying the final AE boundary to commercially producible ore deposits. However, because this approach delayed EPA approval of the final AE boundary until after delineation drilling, it was later deemed impractical.

Justification for Final AE Boundary

In attempting to determine the extent to which the AE boundary would be expanded by delineation drilling, EPA reviewed the 2020 *Technical Report Preliminary Economic Assessment Dewey-Burdock Uranium ISR Project South Dakota, USA* (Graves and Cutler, 2019, NI 43-10, Effective date: December 3, 2019, Report Date: January 17, 2020). EPA previously reviewed earlier Preliminary Economic Assessment technical reports: Bush, 2010; SRK Consulting, 2012 and Graves and Cutler, 2015. Over time, Powertech's documentation of indicated and measured reserves within the proposed wellfield area expanded. Based on Figure 16.3 of Graves and Cutler, 2019, EPA concluded that there was adequate documentation of indicated and measured reserves to justify expanding the AE boundary 500 feet from the proposed AE boundary for Burdock Wellfields 1 through 5 and 9. Figure 16.3 shows that ore delineation has expanded in the Dewey Wellfields along the trend of the roll front deposits; however, there was not enough documentation to justify expanding the AE boundary around the entire perimeter of the Dewey Area Wellfields. After reviewing the uncertainties with the amenability of the ISR mining method in Burdock Wellfields 6, 7 and 8, EPA determined it prudent to delay approval of exempting Inyan Kara aquifers in these areas until Powertech submitted the information required in Part II, Section G of the Class III Area Permit.

Confining Zone(s)

Table 2 lists the major confining zones and their minimum and maximum thicknesses at wellfield locations within the Dewey-Burdock Project Area. The thickness values for the upper and lower confining zones for each of the exempted aquifers are based on logs from drillholes located throughout the Dewey-Burdock Project Area. These overlying and underlying confining zones are comprised of shale.

Table 2. Major confining zones

Injection Interval	Confining Zone Formation Name	Minimum Thickness (ft)	Maximum Thickness (ft)
Fall River Sandstone	Upper Confining Zone: Graneros Group	280	550
	Lower Confining Zone: Fuson Shale	20	80
Chilson Sandstone	Upper Confining Zone: Fuson Shale	20	80
	Lower Confining Zone: Morrison Formation	60	140

There are also operational confining units for each wellfield consisting of unnamed shale units separating the Upper and Lower Fall River Formation and the Upper, Middle and Lower Chilson Sandstone, as shown in Figure 3. The wellfield pump tests required under Part II, Sections C, D and F of the Class III Area Permit will verify the ability of these local confining units to direct the injected lixiviant to flow through the ore deposit in the intended injection interval.

Injectate Characteristics

The Class III Area Permit allows the following types of fluids to be injected into the Class III injection wells:

1. During the ISR process, the injection fluid is limited to ISR lixiviant consisting of wellfield groundwater with carbon dioxide and oxygen added.
2. During the groundwater restoration phase, the injectate will be limited to permeate from reverse osmosis (RO) treatment of groundwater extracted from the post-ISR wellfields, clean makeup water or groundwater recirculated within the wellfield.
3. Chemical reductant may be injected for the purposes of aquifer remediation after the Director confirms approval through authorization by rule.

BASIS FOR DECISION

Underground Sources of Drinking Water (USDWs)

UIC regulations found at 40 CFR § 144.3 defines an underground source of drinking water (USDW) as an aquifer or its portion:
(a) (1) Which supplies any public water system; or
(2) Which contains a sufficient quantity of ground water to supply a public water system; and
(i) Currently supplies drinking water for human consumption; or
(ii) Contains fewer than 10,000 mg/L total dissolved solids; and
(b) Which is not an exempted aquifer.

The Inyan Kara Group aquifers qualify as USDWs at this project site because the groundwater has a TDS concentration below 10,000 mg/L and contains a sufficient quantity of water to supply a public water system. The TDS concentrations of groundwater samples from different locations within the Fall River Formation and Chilson Sandstone aquifers are included in Appendix N of the Class III Permit Application. The TDS of the Fall River aquifer ranges between 773.85 mg/L-2,250.00 mg/L, with the mean TDS being 1,275.01 mg/L[2]. The TDS of the Chilson Sandstone aquifer of the Inyan Kara Group Lakota Formation ranges between 708.33 mg/L-2,358.33 mg/L with the mean TDS being 1,263.38 mg/L[3]. The TDS content and the capacity to produce a large enough volume of groundwater to supply a public water supply qualify Inyan Kara aquifers as USDWs; therefore, an AE is required to inject under a Class III permit.

Regulatory Criteria under which the exemption is approved

EPA reviewed the information provided by Powertech to demonstrate the proposed AE area meets the regulatory criteria discussed below. Based on the information reviewed, EPA has determined that that the following regulatory criteria are met.

40 CFR § 146.4(a) *It does not currently serve as a source of drinking water*

Powertech reviewed historic records from Silver King Mines, Inc. and the Tennessee Valley Authority (TVA), conducted searches in the South Dakota Water Well database, the South Dakota Water Rights database and the Wyoming State Engineer's database and performed field investigations in order to compile an inventory of wells within approximately 2 km (1.2 miles) of the Dewey-Burdock Project Boundary. Figure 4 shows the locations of the 19 domestic wells identified within 2 km (1.2 miles) of the Project Boundary. A list of the complete well inventory is included in Appendix A of the Class III Permit Application. More detailed information on the well inventory and historic records searched is contained in Appendix B of the Class III Permit Application. EPA determined that 2km (1.2 miles) from the Dewey-Burdock Project Boundary is an adequate distance for the well-search investigation because, as discussed later in greater detail, the capture zone for drinking water wells located outside the Project Boundary, but within the area 2 km (1.2 miles) from the Dewey-Burdock Project Boundary, did not intersect the AE boundary. This distance is greater than the minimum ¼ mile buffer zone from the AE boundary discussed in EPA Guidance #34.

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[2] Class III Permit Application Appendix N, p. N-7
[3] Class III Permit Application Appendix N, p. N-11.

Private Drinking Water Wells Inside the AE Boundary

Powertech identified one private drinking water well, well 16, inside the proposed AE boundary that previously used Inyan Kara groundwater for drinking water. Well ID 16 is located within the proposed AE boundary for Burdock Wellfields 6 and 7. Because EPA is not approving exemption of Inyan Kara aquifers for Burdock Wellfields 6 and 7 at this time, well 16 is not an issue for this AE decision. There are no other private drinking water wells inside the AE Boundary at the Dewey-Burdock Project Site.

Nearby Drinking Water Wells Outside the AE Boundary

When considering the capture zone for a well, it is also possible for water within the AE area to serve as a current source of drinking water for wells outside the AE boundary. In this case, EPA looked for wells as far as 2 km (1.2 miles) beyond the Project Boundary. Based on the information available and the calculations performed, this was determined to be an appropriate distance. The technical analysis, described in detail below, demonstrated that water within the AE boundary is not a current source of drinking water for any existing wells.

Including well 16, Figure 4 shows 19 drinking water wells located within 2 km (1.2 miles) of the Dewey-Burdock Project Boundary that are being used, or have been used, for drinking water. Ten of these wells are located outside the Dewey-Burdock Project Boundary. Nine wells (including well 16) are located inside the Project Boundary.

Capture Zone Analysis

A capture zone analysis (CZA) was performed for 11 of the 19 private drinking water wells to evaluate whether any of these existing wells could draw groundwater from within the proposed AE area during the life of the well. CZA, in the context of this document, refers to the determination of the portion of the aquifer from which a well draws groundwater.

Of the ten wells located outside the Project Boundary, six wells are located upgradient or crossgradient relative to the direction of groundwater flow and the Project Boundary. As discussed in the *Technical Memorandum*, no CZA was performed for these six well wells.

No CZA was performed for two of the nine wells inside the Project Boundary. Well 703 is completed in the Unkpapa Sandstone. The Unkpapa Sandstone is not part of the Inyan Kara Group, which contains the aquifers proposed for exemption. The Unkpapa Sandstone is located stratigraphically below and hydrologically separated from the Inyan Kara aquifers by the Morrison Formation lower confining zone. Because this well is not drawing groundwater from the any of the aquifers proposed for exemption, no CZA was needed for this well. Well 16 is located within the AE boundary and is drawing groundwater from the portion of the aquifer proposed for exemption. Because well 16 is already known to draw water from inside the proposed AE boundary, no CZA was performed for this well.

The wells for which a CZA was performed include four wells located outside of and downgradient from the Project Boundary and seven wells located inside the Project Boundary, but outside the proposed AE area.

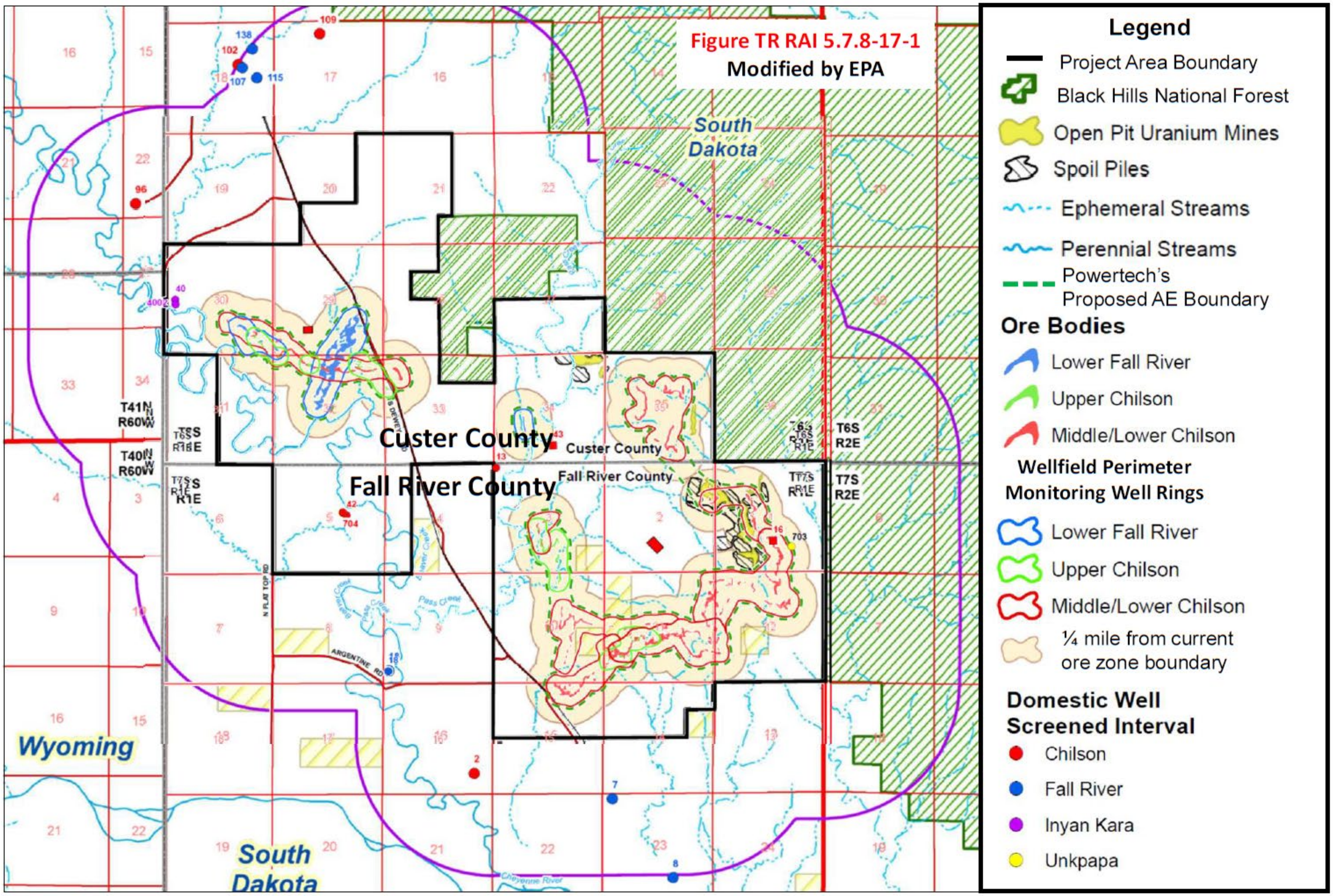


Figure 4. Map of the nineteen private drinking water wells located within approximately 2 km (1.2 miles) of the Dewey-Burdock Project Boundary

Capture Zone Equations

The CZA was based on two equations: one equation calculates the upgradient extent of the Zone of Contribution from a well pumping water from an aquifer with a sloping potentiometric surface and the second equation calculates the width of the capture zone. For a discussion of the first equation, see Section 4.4.3 of EPA *Ground Water and Wellhead Protection Handbook.*[4] For a discussion of the second equation see Figure 4-10 from EPA *Ground Water and Wellhead Protection Handbook.* Table 3 summarizes the information from the capture zone calculations for each well. Appendix A of this document includes the equations and input values for the CZA for each well in Table 3.

In performing the calculations, the following assumptions were made: 1) the drinking water well is constantly pumping and 2) the life of the well from its construction date through 2017 was used for the pumping interval. The assumption that the well is continuously pumping results in a very conservative approach for the areal extent of the capture zone, because this is the maximum amount of time the well could pump and domestic wells are generally not pumped continuously. The capture zone for a well that is continuously pumping is constantly growing larger over time. The capture zone for a well that is pumping intermittently expands while the well is pumping but decreases during the time the well is not pumping and the aquifer potentiometric surface is recovering. As a result, the capture zone for a continuously pumping well is much larger than for a well that is intermittently pumping.

Flow Rates Used in the Capture Zone Equation

EPA evaluated two different scenarios for flow rate in the CZA equations. No records are available on actual domestic use pumping rates for the 11 private wells. Therefore, in the first scenario, EPA used the information available on the 2017 EPA Water Sense website for residential water use (last visited October 19, 2020). The website estimates that the average American family of four uses 400 gallons of water per day. On average, approximately 70% of that water is used indoors, with the bathroom being the largest consumer (a toilet alone can use 27%). The largest family in the Dewey-Burdock area consisted of 10 people, so EPA increased the estimated water usage for each household with a private well to 1,000 gallons per day (gpd), which would be the expected usage for a household consisting of 10 people. An estimated flow of 1,000 gpd is a conservative overestimation for drinking water usage, because it includes 30% expected for outdoor usage and the remaining 70% includes other indoor uses such as laundry, bathing and toilet use.

For the second scenario, EPA used information available in well records or historic TVA records for flow rates from some of the wells that flowed naturally to the ground surface. These flow rates represent the maximum flow volume the well is capable of producing without pumping. For those wells for which no record of flow rate was available, EPA used the maximum value allowed by the South Dakota Department of Environment and Natural Resources for a private well without a water rights permit.[5] This flow rate is 18 gallons per minute (gpm) or 25,920 gpd and represents continuous flow of these wells 24 hours a day. These flow rate values are extreme and greatly overestimate the flow rates expected for a well serving a single-family residence. EPA performed calculations using historic flow rates, if available, 25,920 gpd if no historic flow rate was available and a flow rate of 1,000 gpd for each

[4] Ground Water and Wellhead Protection Handbook, EPA/625/R-94/001, September, 1994

[5] Because none of these wells have a water rights permit, this is the maximum amount they are allowed to pump.

capture zone calculation. Tables A-1 and A-2 in Appendix A of this document show the flow rates used as the input values for each well for which a CZA was performed. The calculations, input values and final results are included in Excel spreadsheets *CaptureZoneCalculations_2017.xlxs* and *CaptureZoneCalculations_1000gpd_2017.xlxs* included in the Administrative Record for the Dewey-Burdock permitting and AE actions.

Wells 40 and 4002 are located so closely together, for the purposes of the CZA these two wells treated as one well, flowing at the combined rate of both wells. Similarly, wells 42 and 704 treated as one well flowing at the combined rate of both wells.

Table 3 shows the results of the capture zone analyses. Calculations using the more realistic, but still conservative flow rate of 1,000 gpd did not result in any capture zones crossing an AE boundary. Under the second scenario, using the historic flow rate of 12 gpm (17,280 gpd) for well 41 (Chilson completion) resulted in a capture zone that extended upgradient 236 ft into the proposed AE area of Dewey wellfields 2 and 4 assuming the well is pumping continuously through 2017. The well has not been used for drinking water since at least 2006 when Powertech performed its well survey.

Three wells, 43, 40 and 4002 are located cross-gradient from the AE area. For these wells, the width of the capture zone was calculated to determine if the capture zone is wide enough to intersect an AE boundary. Because wells 40 and 4002 are located so closely together, they were treated as one well with a flow rate equal to the sum of the flow rates of both wells for the purposes of calculating both the width and upgradient extent of the capture zone. As explained in more detail in Appendix A of this document, the capture zone for wells 40 and 4002 is not wide enough to intersect the AE boundary.

Under the second flow rate scenario, using the State Water Rights Program's maximum well flow rate before a water rights permit is needed of 25,920 gpd for well 43 resulted in a capture zone so wide it encompassed all of Burdock wellfield 10 and extended 1,273 feet into the proposed AE area of Burdock wellfield 8. EPA determined that the flow rates used to calculate the second scenario are a large overestimation of the actual private well flow rates and are not reasonable. Additional calculations were performed for Well 43 to determine the maximum flow rate that would not result in the capture zone crossing an AE boundary. Well 43 could continuously pump up to 4,650 gpd before the width of its capture zone extended crossgradient to reach the AE boundary of Burdock wellfield 10. This pumping rate is greater than 10 times the estimated usage of a family of four discussed above. Because Well 43 is no longer associated with a residence and is not currently being used for drinking water, EPA decided that it was reasonable to conclude the capture zone for Well 43 is not using groundwater inside the AE area.

There are no public water system wells, including municipal wells, utilizing the Inyan Kara aquifers downgradient of the Dewey-Burdock Project Area. The municipal wells owned by the City of Edgemont, which is approximately 13 miles downgradient and to the southeast of the Project Area, are completed in the Madison Formation. Reverse osmosis treatment of Inyan Kara groundwater is necessary to decrease sulfate concentration below the secondary drinking water standards to make it palatable for human consumption. The City of Edgemont chose to drill an additional 2,400 feet to complete wells in the Madison Formation instead of using Inyan Kara groundwater for the public water supply.

Well #	Calculated distances (ft) using well flow rates in Tables 2 and 5		Calculated distances (ft) using 1,000 Gallons per Day		Distance from AE Boundaries (ft)
	Maximum Upgradient Capture Zone Extent	Maximum Width of the Capture Zone	Maximum Upgradient Capture Zone Extent	Maximum Width of the Capture Zone	
2	2,140’	3,655’	1,160’	141’	4,600’ downgradient from B-WF2
7	566’	2,460’	394’	402’	4,750’ crossgradient from B-WF2
8	5,492’	1,244’	5,269’	340’	9,625’ crossgradient from B-WF2
13	959’	299’	914’	207’	1,750’ downgradient from B-WF8
18	1,269’	3,917’	889’	340’	7,880’ downgradient from B-WF4
40	1,340’	2,074’	739’	144’	2,187.5’ crossgradient from D-WF2
41 (Fall River)	1,247’	1,076’	795’	62’	2,750’ downgradient from D-WF 3 3,300’ crossgradient from D-WF1
41 (Chilson)	3,236’	310’	2,924’	18’	3,000’ downgradient from D-WFs 2&4 3,300’ crossgradient from D-WF1
42	2,854’	909’	2,224’	35’	4,800’ downgradient from D-WF4
43	1,147’	4,873’	449’	188’	3,600 crossgradient from B-WF8 875’ crossgradient from B-WF10
704	2,854’	909’	2,224’	35’	4,800’ downgradient from D-WF4
4002	1,340’	2,074’	739’	144’	2,125’ crossgradient from D-WF2

Table 3. Summary of Capture Zone Analysis for the Eleven Drinking Water Wells in and near the Dewey-Burdock Project Site.

Based on the above results, EPA has concluded that the portions of the Inyan Kara aquifers proposed for exemption do not currently serve as a source of drinking water.

Impacts of Expansion of AE Boundary on Private Well Capture Zones

The expansion of the AE boundary for Burdock Wellfields 1 through 5 and 9 does not encroach upon any private well capture zones calculated by the EPA capture zone analysis. If wellfield delineation drilling indicates additional expansion of any of the AE areas is warranted, Powertech must submit an AE request for the additional area. Part II, Section B.1.d.i of the Class III Area Permit requires Powertech to perform a new capture zone analysis for potentially impacted private wells if the expanded AE area encroaches upon a private well capture zone calculated by EPA. Powertech has the option of using a computer flow model with the capability of simulating a more realistic aquifer potentiometric surface impact from intermittent pumping of a private well. This approach would identify a more realistic capture zone that takes into consideration potentiometric surface rebound during the non-pumping phases of private well use. If the AE boundary encroaches on a capture zone after it has been recalculated using the more realistic flow model, Powertech is not authorized to expand the wellfield near the location of the private well capture zone.

40 CFR § 146.4(b)(1)

It cannot now and will not in the future serve as a source of drinking water because:

> *It is mineral, hydrocarbon, or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.*

Powertech provided information to EPA to support the conclusion that the proposed AE area within the Inyan Kara aquifers cannot now and will not in the future serve as a source of drinking water by demonstrating in the Class III permit application for the uranium ISR operation that the portion of the aquifer proposed for exemption contains minerals in a quantity and location that is expected to be commercially producible.

40 CFR § 144.7(c)(1) requires a UIC Class III Permit Application that "necessitates an aquifer exemption under 40 CFR §146.4(b)(1), to furnish the data necessary to demonstrate that the aquifer is expected to be mineral or hydrocarbon producing. Information contained in the mining plan for the proposed project, such as a map and general description of the mining zone, general information on the mineralogy and geochemistry of the mining zone, analysis of the amenability of the mining zone to the proposed mining method, and a time-table of planned development of the mining zone" should be considered by the UIC Director.

Commercial Producibility

The commercial producibility of uranium from the Dewey-Burdock Project has been most recently demonstrated in the 2020 *Technical Report Preliminary Economic Assessment Dewey-Burdock Uranium ISR Project South Dakota, USA*. This document is published on SEDAR (System for Electronic Document Analysis and Retrieval) and is compliant with the National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI 43-101) of the British Columbia Securities Commission. This document was completed for Powertech by consultants for the purpose of independent confirmation of resource calculations as well as the technical and economic viability of uranium recovery by ISR methods at the Dewey-Burdock Project. The average thickness of the uranium ore deposits targeted by the wellfields is 4.6 feet and the average grade is 0.21% U_3O_8 in the project area. Within the project area, Powertech has identified 14 wellfields that will be designed around economically viable uranium roll-front deposits occurring within the Fall River Formation and the Chilson Sandstone. The information in the report is based on the information from approximately 5,932 drillhole logs in and around the Dewey-Burdock Project Area. The TVA drilled and logged 5,823 exploratory drillholes to define the horizontal and vertical locations of the ore deposits; Powertech drilled and logged an additional 109 exploratory drillholes. The locations of the drillholes are listed in Appendix C of the Class III Permit Application.

Powertech provided cross-sections based on the drillhole logs for each wellfield showing the thickness of the Inyan Kara aquifers, confining zones and overlying formations and the locations of the ore deposits. The drillhole logs are included in the cross-sections. These cross-sections are shown in Plates 6.13 through 6.21 of the UIC Class III Permit Application. Plate 6.12 is the cross-section index showing a map with the locations of the cross-sections through each wellfield.

Demonstration of Amenability of Mining Method

To demonstrate the amenability of the mining zone to the proposed ISR mining method, Powertech performed aquifer pump tests in the Dewey and Burdock areas and referred to pump tests performed by the TVA during the 1980s in the Fall River Formation and the Chilson Sandstone. The Powertech Dewey Area pumping well was completed in the Fall River Formation and the Powertech Burdock Area pumping well was completed in the Chilson Formation. The measurement of water levels in observation wells completed in the pumped aquifers confirmed that during all three pump tests a cone of depression formed in the pumped aquifer. The presence of a cone of depression verifies that hydraulic control of injection interval fluids is able to be maintained in wellfields in both Inyan Kara aquifers and demonstrates the amenability of the proposed ISR mining method. The UIC Class III Area Permit requires Powertech to perform similar pump tests for each wellfield to verify that hydraulic control of injection interval fluids is able to be maintained at each wellfield.

The thickness of the Inyan Kara Group averages approximately 350 feet within the project area. Within the proposed AE boundary, the Inyan Kara Group has the geologic and hydrologic features that make it a suitable host rock for the recovery of uranium using ISR methods as detailed Chapter 2 of the NRC *Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities* (2009): (1) the deposit geometry is generally horizontal and of sufficient size and lateral continuity to economically extract uranium; (2) the sandstone host rock is permeable enough to allow the ISR solutions to access and interact with the uranium mineralization; and (3) the major confining zones (Graneros Group, Fuson Shale and Morrison Formation) plus local confining zones within the Fall River and Chilson aquifers, will prevent ISR solution from migrating vertically into overlying or underlying aquifers.

The potentiometric surface of the Inyan Kara aquifers in the area of Burdock Wellfields 6, 7 and 8 falls below the top of the Fall River Formation and in some areas below the top of the Chilson Sandstone. The aquifers are only partially saturated in these areas, which is not the ideal situation for ISR operations. ISR operations work most efficiently under conditions of full saturation of the injection zone aquifer. In order for excursion monitoring of overlying aquifers to be effective, these aquifers must also be fully saturated. Because of the uncertainty caused by partially saturated conditions in the areas of Burdock Wellfields 6, 7 and 8, Part II, Section G.3 of Class III Area Permit requires Powertech to perform additional wellfield pump testing, and possibly flow modeling, to demonstrate the amenability of the Inyan Kara aquifers to the ISR process before approving the AE for these areas.

Geochemistry and Mineralogy of the Mining Zone

There are three distinct geochemical zones in the proposed exemption areas of the ore-bearing aquifers within Dewey-Burdock project area: 1) the reduced zone, 2) the oxidized zone and 3) the ore deposit zone.

The reduced zone is located downgradient of the uranium ore deposits and represents the original character of the Inyan Kara sandstones before uranium mineralization occurred. The reduced sandstones are grey in color, pyritic and/or carbonaceous. Organic material consists of carbonized wood fragments and interstitial plant material. Pyrite is abundant within the host sandstones and present as very small cubic crystals or as very fine-grained aggregates. Marcasite is also present as nodular masses in the sandstones. The pyrite contains trace amounts of transition metals (Cu, Ni, Zn, Mo and Se). Plagioclase and potassium feldspar clasts are chemically unaltered. Calcite is sparse, averaging only 0.15% except for localized areas of calcite cementing. A heavy mineral suite (ranging from trace to 3%) of tourmaline, ilmenite, apatite, zircon and garnet is typical of those found in quartz sandstones.

The oxidized zone occurs upgradient of the uranium ore deposit and is characterized by the presence of iron oxides and oxyhydroxides resulting in a brown, pink, orange or red staining of host sandstones. The oxidized zone marks the progression of the downgradient movement of mineralizing solutions through the host sandstones. Within the oxidized zone, pyrite has been altered and is present as hematite or goethite sand grain coatings, clastic particles or as pseudomorphs after the original pyrite crystal shape. Goethite is considered to be metastable and is found near the oxidation/reduction boundary, while the more stable hematite is found greater distances upgradient from the ore deposit zone. The heavy mineral leucoxene – a white titanium oxide – is also present as a pseudomorph of ilmenite. All organic material has been destroyed in the oxidized zone. The oxidizing solutions left dissolution etching on quartz grains and altered the feldspar minerals to clays.

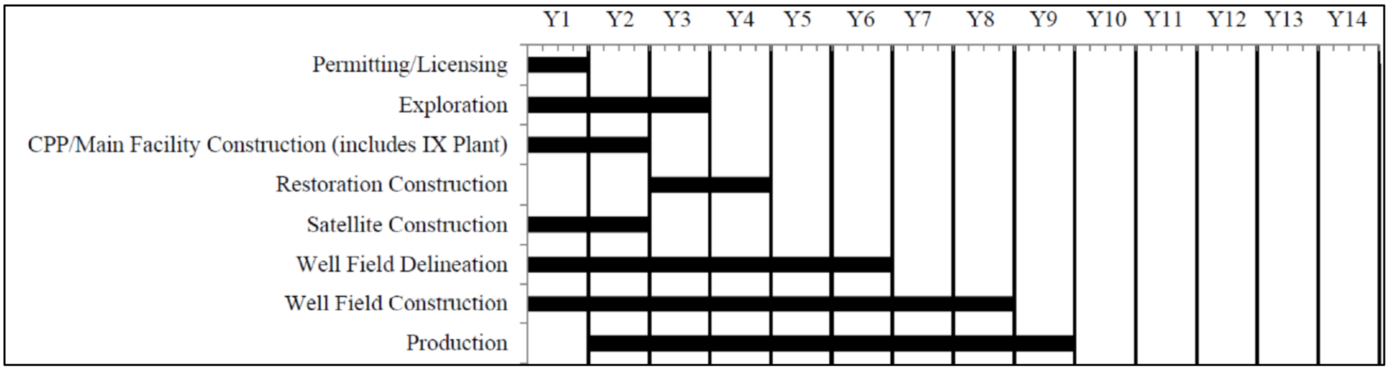
The ore deposit zone is located at the oxidation/reduction boundary where metals were precipitated when mineralizing solutions encountered an abrupt change from oxidizing conditions to reducing conditions as they moved downgradient within the aquifers. Sandstones in this zone are greenish-black, black, or dark grey in color. The primary uranium minerals are uraninite and coffinite, which occur within pore spaces in the sandstone, coat sand grains and form intergrowths with montroseite (VO(OH)) and pyrite. Other vanadium minerals (haggite and doloresite) are found adjacent to the uranium mineralization, extending up to 500 feet into the oxidized portion of the system. Overall, the V-U ratios can be as high as 1.5:1.

Transition metals removed from the oxidized zone by the mineralizing solutions were precipitated at or adjacent to the oxidation/reduction boundary. Native arsenic and selenium are found adjacent to the uranium, in the upgradient, oxidized boundary of the ore deposit filling pore spaces between quartz grains. Molybdenum occurs as the mineral jordisite adjacent to the uranium on the downgradient, reduced boundary of the ore deposit. The relatively low concentrations of transition metals indicate their source could have been internal to the Inyan Kara sediments rather than having been introduced from the source of the uranium and vanadium.

Project Timetable

The proposed timetable for project development is shown in Figure 5. Powertech anticipates that the Dewey-Burdock uranium ore deposits will be commercially producible for eight years.

Figure 5. Powertech's Timetable for Project Development



<u>ENSURING PROTECTION OF ADJACENT USDWs</u>

Demonstration that the Injection Zone Fluids Will Remain within the Exempted Portion

EPA guidance #34 states that if the exemption pertains to only a portion of an aquifer, a demonstration must be made that the waste will remain in the exempted portion. Such a demonstration should consider among other factors, the pressure in the injection zone, the waste volume, and injected waste characteristics (i.e., specific gravity, persistence, etc.) in the life of the facility. Given the nature of the ISR operation, waste fluids are not being injected into the exempted portion of the aquifer. The concern in the case of the ISR operation is whether contaminants from ISR activities will cross the AE boundary laterally or migrate vertically into USDWs. A number of factors, including NRC license requirements and Class III Area Permit requirements, led EPA to the conclusion that adjacent USDWs will not be impacted by ISR contaminants crossing the AE boundary laterally or migrating vertically.

The Class III Area Permit includes the following requirements:

- Injection interval confining zones will be evaluated during pre-ISR operation wellfield pump tests for their capacity to contain injection interval fluid vertically within the approved injection interval;
- Powertech must demonstrate the ability of the confining zones to contain injection interval fluids before EPA will issue an authorization to commence injection;
- Powertech must demonstrate the ability of the monitoring network to detect any movement of injection interval fluids out of the approved injection interval before EPA will issue an authorization to commence injection;
- Hydraulic control of the wellfield must be maintained by injecting a smaller volume of lixiviant into the wellfield injection interval than is pumped out. Hydraulic control will be verified by continuous monitoring of injection rate and volume and the measurement of water levels in the

wellfield perimeter monitoring well ring to verify a cone of depression.

- The extensive monitoring well network will verify both lateral and vertical containment of injection interval fluids. If any injection interval fluids begin to migrate out of the approved injection interval, the water level measurements in the monitoring well network will provide early detection to allow Powertech to implement timely corrective response actions to reverse the migration.
- The requirements to demonstrate initial mechanical integrity for all injection, production and monitoring wells and ongoing mechanical integrity tests for injection wells will prevent vertical migration of injection interval fluids through confining zones.
- Part IV, Section D of the Class III Area Permit requires Powertech to develop a wellfield closure plan for each wellfield that includes generating a geochemical model to evaluate the long-term stability of restored ISR contaminant concentrations to ensure that no ISR contaminants cross the AE boundary. As required under Part IV, Section B.5 of the Class III Area Permit, the geochemical model must be calibrated using site-specific groundwater and core data and analytical results from laboratory testing. If the model shows there is a high probability that a restored ISR contaminant concentration will rebound or increase in concentration above the Commission-approved background concentration, Powertech must conduct mitigation measures to stabilize that ISR contaminant.

Vertical confinement

Throughout most of the project area, the Inyan Kara Group is bounded above by shale units of the Graneros Group which serve as the uppermost confining zone for ISR operations. The depth to the top of the Inyan Kara Group ranges from approximately 0 feet where the Fall River Formation crops out in the eastern portion of the Burdock Area to 550 feet below ground surface in the Dewey Area. Analysis of a core sample from the Skull Creek Shale unit of the Graneros Group shows the vertical hydraulic conductivity to be very low: 5.3896E-09 cm/sec, compared with the vertical hydraulic conductivity of the Chilson Sandstone, 1.3474E-03 cm/sec or Fall River Formation sandstone, 4.7659E-04 cm/sec.

As shown in Figure 6, the Graneros Group shales are absent in the eastern portion of the Burdock Area where the Fall River Formation outcrops at the surface in the area shown in blue. Portions of Burdock Wellfields 6, 7 and 8 are located where the Fall River Formation outcrops and the Graneros Group shales are absent. However, these wellfields will be targeting ore in the Middle and Lower Chilson Sandstone shown in the cross-section of Figure 7. No wellfields will be targeting ore in the Fall River Formation where the overlying Graneros Group confining zone is absent. The Fuson Shale, which separates the Chilson Sandstone from the overlying Fall River Formation, acts as the upper confining zone for the Chilson Sandstone as shown in Figure 7.

Figure 7 shows a portion of cross-section B-B’ through Burdock wellfield 6. The complete cross-section B-B’ can be viewed in Plate 6.14 of the Class III Permit Application. Figure 7 shows the Fuson Shale upper confining zone for the Chilson Sandstone and the shale units separating the Upper, Middle and Lower Chilson. The average thickness of the Fuson Shale is about 50 feet thick in this area. The vertical hydraulic conductivity of the Fuson Shale measured in core sample ranges from 6.1595E-09 to 1.7555E-07 cm/sec.

Geologic cross-sections and logs submitted with the Class III Permit Application indicate that the Fuson is continuous throughout the Dewey-Burdock Project Area. EPA has reviewed the information that the Powertech provided in the Class III Permit Application and has determined that evidence indicates that except for the northeast corner of Section 1, T7S, R1E where it has been eroded away, the Fuson member of the Lakota formation is a continuous confining zone underlying the Fall River injection interval and overlying the Chilson Sandstone injection interval throughout the Dewey-Burdock Permit Area.

During the Burdock Area aquifer pump tests conducted in the Chilson Sandstone by Powertech and the TVA, there was a response in a monitoring well completed in the overlying Fall River indicating a localized hydraulic connection between the Fall River Formation and the Chilson Sandstone, possibly due to an improperly plugged historic exploration borehole or an old well such as the TVA well that is 10 inches in diameter and screened in both the Chilson and Fall River aquifers. The UIC Class III Area Permit requires thorough investigation of the overlying confining zone for each wellfield before EPA will authorize any injection activities. Section 5.0 of the Fact Sheet for the draft Class III Area Permit discusses the wellfield characterization requirements, including characterization of the confining zones for each wellfield. If a confining zone breach is caused by an improperly plugged historic exploratory drillhole or a well causes a pathway through a confining zone, the UIC Class III Area Permit requires Powertech to take corrective action to prevent the breach from resulting in the vertical migration of injection interval fluids out of the injection interval. The Fact Sheet for the draft Class III Area Permit contains more information about possible breaches in confining zones in Section 4.6 and a discussion of the required corrective action is found in Section 6.0.

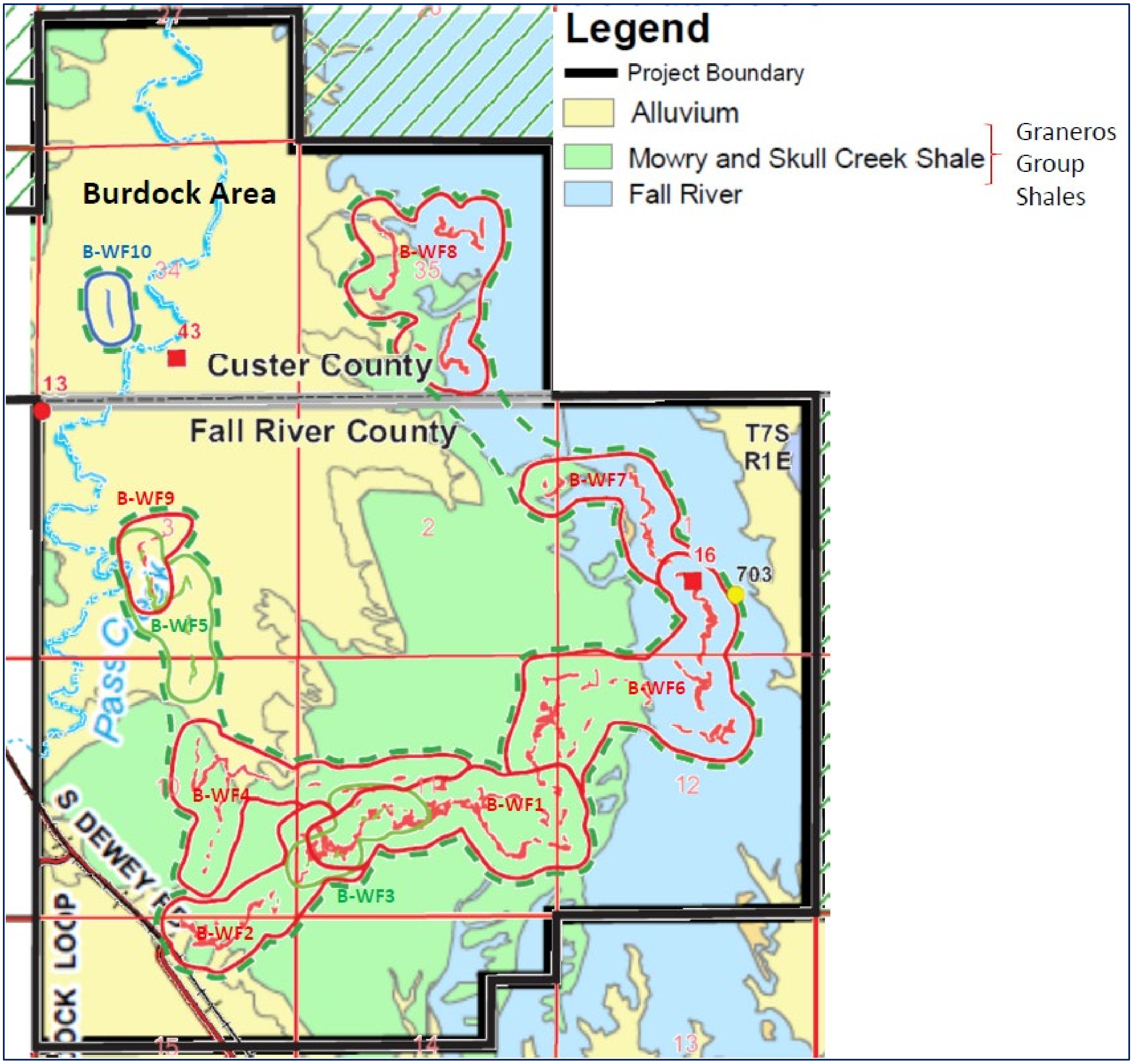


Figure 6. Map Showing Surface Geology of the Burdock Area and Burdock Area Wellfields.

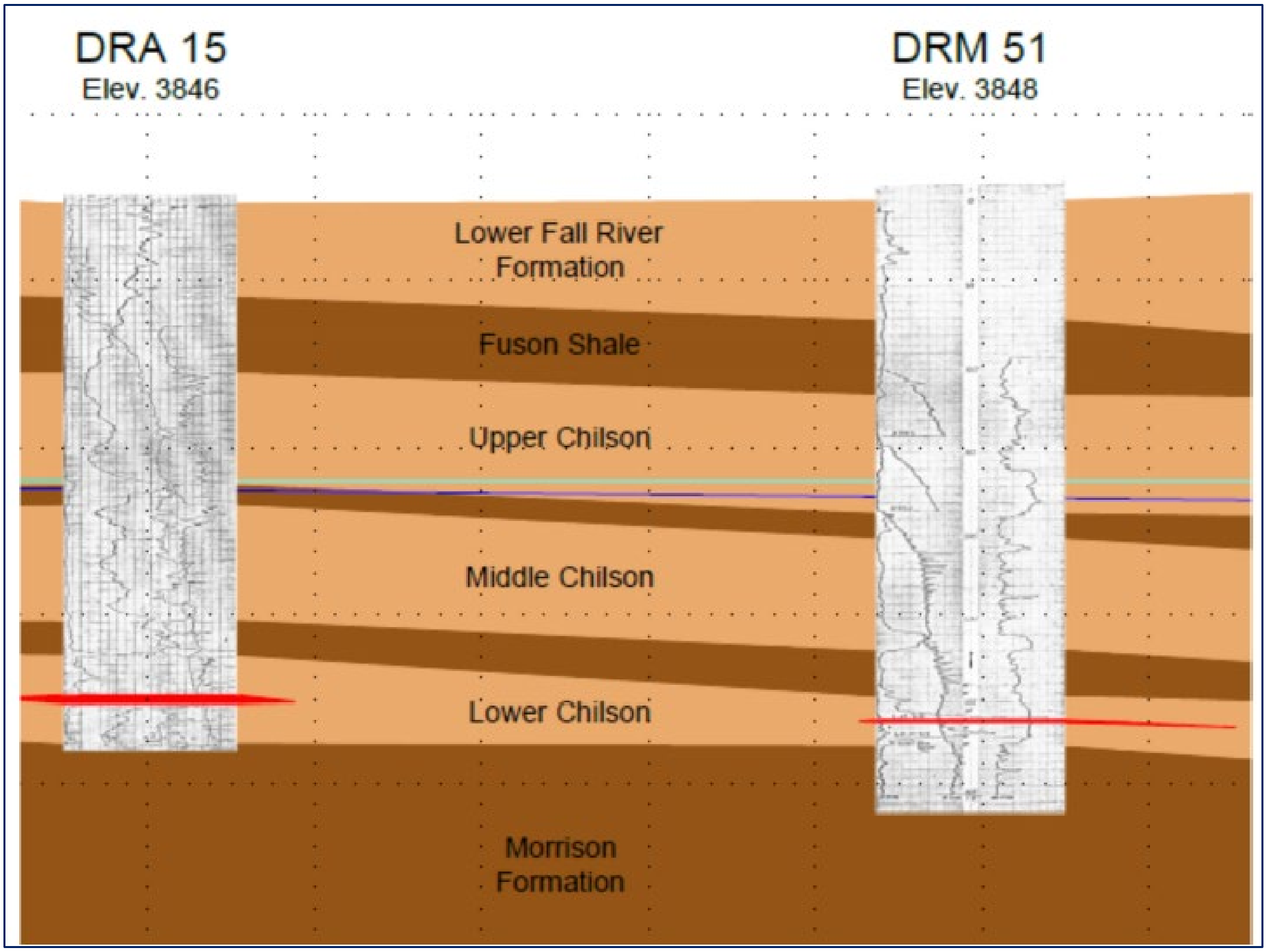


Figure 7. Portion of Cross-Section B-B' from Plate 6.14 of the UIC Class III Permit Application.

The Morrison Formation is the lower confining zone for the Inyan Kara Group. It is a low-permeability shale unit with a thickness of 60 to 140 feet at the Dewey-Burdock Project Site. Analyses of core samples from the Morrison Formation have shown the vertical permeability to be very low and range from 3.9 x 10-9 to 4.2 x 10-8 cm/sec.

To verify that no wellfield fluids migrate vertically out of the approved injection interval, non-injection interval monitoring wells will be completed within each wellfield in the overlying and underlying hydrogeologic units. Because the Morrison Formation is a thick and impermeable confining zone, the Class III Area Permit does not require monitoring of the aquifer underlying the Morrison Formation during wellfield operation or restoration. However, the Class III Area Permit requires at least one observation well below the Morrison Formation to be monitored during wellfield pump tests, to verify the integrity of the Morrison Formation as a confining zone in that area. Analytical results of groundwater samples collected from the overlying and underlying monitoring wells will provide baseline water quality data from which the compliance limits for the overlying and underlying aquifers will be established. These wells will be monitored during wellfield operation, post-ISR groundwater restoration and post-restoration monitoring to detect any potential vertical migration of ISR solutions out of the approved injection interval. EPA may require additional overlying or underlying monitoring wells beyond the minimum density specified in the Class III Area Permit to detect potential vertical excursions in areas where the integrity of a confining zone is in question.

The Class III Area Permit requires Powertech to demonstrate mechanical integrity for all wells installed, including injection, production and monitoring wells, to ensure that the cement-filled annulus between the well casing and drillhole wall does not contain any channels that could potentially allow migration of injection interval fluids out of the injection interval through confining zones.

Lateral Confinement

The Class III Area Permit requires Powertech to demonstrate and maintain hydraulic control of injection interval fluids during the uranium recovery process and post-ISR groundwater restoration. To accomplish this, the wellfield pumping rate must exceed the injection rate resulting in net extraction of injection interval fluids. Continuous monitoring of injection and production flow rates and volume is required for each wellfield to verify that these conditions are being met.

The net extraction of injection interval fluids creates a cone of depression within each wellfield indicating that an inward hydraulic gradient is pulling groundwater into the wellfield. The measurement of water levels in observation wells during the pump tests performed by both the TVA and Powertech demonstrate that a cone of depression formed in the pumped aquifer during the pump tests. The presence of a cone of depression verifies that hydraulic control of injection interval fluids is able to be maintained within Inyan Kara aquifers. The required monitoring of water levels in the wellfield perimeter monitoring well ring verifies that the cone of depression is being maintained during wellfield operations and post-ISR groundwater restoration.

A combination of monitoring and response actions required during the operational, post-ISR groundwater restoration and the post-restoration phases will assure that any effects from the ISR operations will remain within the exempted portion of the aquifers. As discussed in the following section, monitoring wells will be installed in and around each wellfield, up- and down-gradient and in overlying and underlying aquifers, to detect the potential migration of ISR solutions away from the approved injection interval.

Monitoring Requirements

The UIC Class III Area Permit requires Powertech to maintain hydraulic control of injection interval fluids within each wellfield at all times to prevent any horizontal movement of lixiviant out of the wellfield and includes a rigorous monitoring program to verify hydraulic control. For a more detailed discussion of the monitoring requirements, see Section 12 of the Fact Sheet for the Class III Area Permit.

A perimeter monitoring well ring will be completed in the ore zone injection interval aquifer around each wellfield. These wells will be used to verify the existence of the cone of depression through monitoring the water level in each well. A rise in water level detected in any well will signal an incipient loss of hydraulic control allowing it to be corrected before any lixiviant actually moves out of the approved injection interval. Groundwater sampling at the perimeter monitoring well ring will detect any potential horizontal migration of fluid outside the wellfield. Perimeter monitoring wells will be located no farther than 400 feet from the wellfield, evenly spaced with a maximum spacing of either 400 feet or a spacing that will ensure a 70 degree angle between adjacent perimeter monitoring wells and the nearest injection well as illustrated in Figure 8.

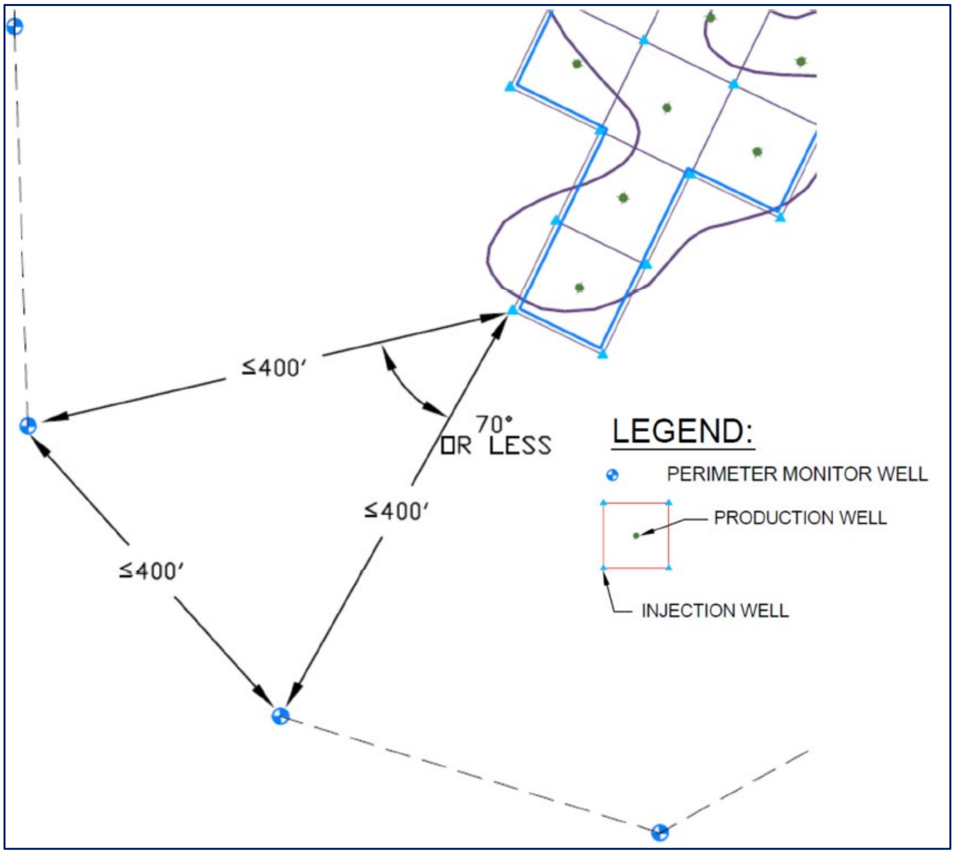


Figure 8. Spacing between Perimeter Monitoring Wells Will Be No Greater than 400 Feet or Close Enough to Ensure a 70º Angle between Adjacent Perimeter Monitoring Wells and the Nearest Injection Well

Non-injection zone monitoring wells will be completed in aquifers overlying the injection interval and, in some cases, below the injection interval. Groundwater sampling at these wells will detect any potential vertical migration of fluid outside the wellfield. These wells will be located every 4 acres in the first overlying aquifer and every 8 acres in other overlying aquifers. If the Morrison Formation is the lower confining zone, the Class III Area Permit does not require any monitoring wells in the underlying aquifer because Powertech has demonstrated the Morrison confining zone is thick and continuous across the Project Area. Wellfield aquifer pump tests will confirm the integrity of the Morrison Formation as a confining zone. In other underlying aquifers, monitoring wells will be placed every 4 acres.

Operational groundwater monitoring will be conducted to detect potential changes in groundwater quality in and around the project area as a result of ISR operations. The operational groundwater monitoring program will include domestic wells, stock wells and wells located hydrologically upgradient and downgradient of ISR operations. Wells to be included in the operational monitoring program include domestic wells within 2 km (1.2 miles) of the wellfield areas, stock wells within the Project Area, and additional monitoring wells within the project area in the alluvial, Fall River, Chilson and Unkpapa aquifers.

Monitoring within the wellfield during groundwater restoration will be conducted in accordance with the NRC license, which requires Powertech to conduct groundwater restoration after uranium recovery has been completed in a wellfield. Groundwater restoration must continue until ISR contaminant concentrations are at or below Commission-approved background or drinking water standards. If these concentrations cannot be achieved, then Powertech will submit to NRC an application for approval of an alternate concentration limit (ACL), which is an amendment to the license. NRC will not approve an ACL unless Powertech demonstrates the ACL is protective of human health and the environment.

The UIC Class III Area Permit does not have any groundwater restoration standards within the wellfield. Instead, the UIC Class III Area Permit requires the Permittee to demonstrate through geochemical modeling as part of a Wellfield Closure Plan that ISR contaminants will not cross the downgradient aquifer exemption boundary into the USDW. The UIC Class III Area Permit has groundwater permit limits for ISR contaminants that must be met at the AE boundary.

A post-restoration stability monitoring period will be conducted in accordance with the NRC license, After groundwater restoration is completed for a wellfield, Powertech must conduct post-restoration stability monitoring to determine that restored concentrations of ISR contaminants are chemically stable and will not rebound or increase in concentration over time. The NRC license requires that stability monitoring be conducted until the data show that the ISR contaminant concentrations for the most recent four consecutive quarters indicate no statistically significant increasing trend. If a constituent does not meet the stability criteria, Powertech must take appropriate actions to remedy the situation. Potential actions may include extending the stability monitoring period or returning the wellfield to a previous phase of active restoration until Powertech can demonstrate the chemical instability issue is resolved. If the analytical results from the stability period continue to meet the NRC license Commission-approved background, MCLs or ACLs and meet the stability criteria, Powertech will submit supporting documentation to NRC showing that the restoration parameters have remained at or below the restoration standards and request that the wellfield be declared restored.

The UIC Class III Area Permit contains requirements for monitoring during the post-restoration groundwater stabilization phase within a wellfield. The UIC Class III Area Permit require calibration of the wellfield geochemical model to groundwater and core data after this post-restoration groundwater stabilization phase has been completed.

OTHER CONSIDERATIONS

EPA evaluated the groundwater quality of the Inyan Kara aquifers within the area proposed for exemption and the likelihood that Inyan Kara groundwater within the AE boundary would be used for drinking water at some time in the future. Analytical results from the Inyan Kara aquifer groundwater samples are included in Appendices N and O of the Class III Permit Application. As stated earlier, the TDS of the Fall River Formation of the Inyan Kara Group ranges between 773.85 mg/L-2,250.00 mg/L, with a mean TDS of 1,275.01 mg/L; the TDS of the Chilson Sandstone unit of the Lakota Formation of the Inyan Kara Group ranges between 708.33 mg/L-2,358.33 mg/L, with a mean TDS of 1,263.38 mg/L. Inyan Kara groundwater requires treatment by reverse osmosis to decrease TDS, iron, manganese and sulfate concentration below the secondary drinking water standards before is it palatable for human consumption. In addition to these taste and odor concerns, Inyan Kara wells completed within the ore zone also have radium and gross alpha concentrations above MCLs and radon concentrations are high.

The water for the City of Edgemont, which is approximately 13 miles southeast of the Project Area, is supplied from municipal wells completed in the Madison Formation. Reverse osmosis is an expensive option for a public water system to use. Reverse osmosis treatment also generates a large volume of concentrated reject brine that would require disposal. The City of Edgemont chose to drill an additional 2,400 feet to complete wells in the Madison Formation instead of using Inyan Kara groundwater for the public water supply.

The land use in the Dewey-Burdock Project Area is mainly grazing for cattle ranches. It is unlikely that the population will increase in that area to a size that would support a public water system. According to www.census.com, the population of Edgemont has decreased since 2000: in the 2000 census, the population was 867; in 2010, it was 774; in 2015, the estimated population was 739. Based on this information, it is unlikely that the Inyan Kara groundwater within the AE boundary would be used in the future to supply drinking water.

CONCLUSION AND DECISION

Based on review of the information Powertech provided, EPA finds that exemption criteria 40 CFR § 146.4(a) and 146.4(b)(1) have been met. EPA approves the AE request as a minor/non-substantial program revision for the AE area shown in Figure 2.

DARCY OCONNOR Digitally signed by DARCY OCONNOR
Date: 2020.11.24 07:06:34 -07'00'

11/24/2020

Darcy O'Connor, Director
Water Division

Date

Appendix A
CZA Information

Equation number 4-7 in Section 4.4.3 Time of Travel with Sloping Regional Potentiometric Surface in the EPA *Ground Water and Wellhead Protection Handbook* was used to determine the upgradient extent of the capture zone.

Handbook — **EPA/625/R-94/001**
September 1994

Ground Water and Wellhead Protection

4.4.3 TOT With Sloping Regional Potentiometric Surface

$$t_x = n/Ki\,[r_x - (Q/2\pi Kbi)\ln\{1 + (2\pi Kbi/Q)r_x\}] \quad (4\text{-}7)$$

where
t_x = travel time from point x to a pumping well
n = porosity
r_x = distance over which ground water travels in T_x, r_x is positive (+) if the point is upgradient, and negative (–) is downgradient

Q = discharge
K = hydraulic conductivity
b = aquifer thickness
I = hydraulic gradient

Transmissivity (T) was used in the equation instead of hydraulic conductivity (K) and aquifer thickness (b).
Transmissivity T=Kb

Table A-1 shows the information on age and historic flow rate information for each well. As described in the ROD, if no information on the construction date of the well was available in historic records, the age of the oldest well was used. The older the well, the larger the capture zone. The two scenarios for flow rate are described earlier in this document.

Table A-2 shows all the values used for all variables in the capture zone equation. Table 3 shows the calculated upgradient extent of each capture zone using both scenarios for flow rate. Table 3 also shows the distance each well is located downgradient from an AE boundary. So as not to call into question the exact downgradient flow direction upgradient from each drinking water well, the distance to the closest AE boundary was used for comparison to the calculated extent of the capture zone included in Table 3. As discussed earlier, because wells 40 and 4002 are located so closely together, they were treated as one well with a flow rate equal to the sum of the flow rates of both wells for the purposes of calculating upgradient extent and the width of the capture zone. Similarly, because wells 42 and 704 are located so closely together, they were treated as one well with a flow rate equal to the sum of the flow rates of both wells for the purposes of calculating upgradient extent and the width of the capture zone.

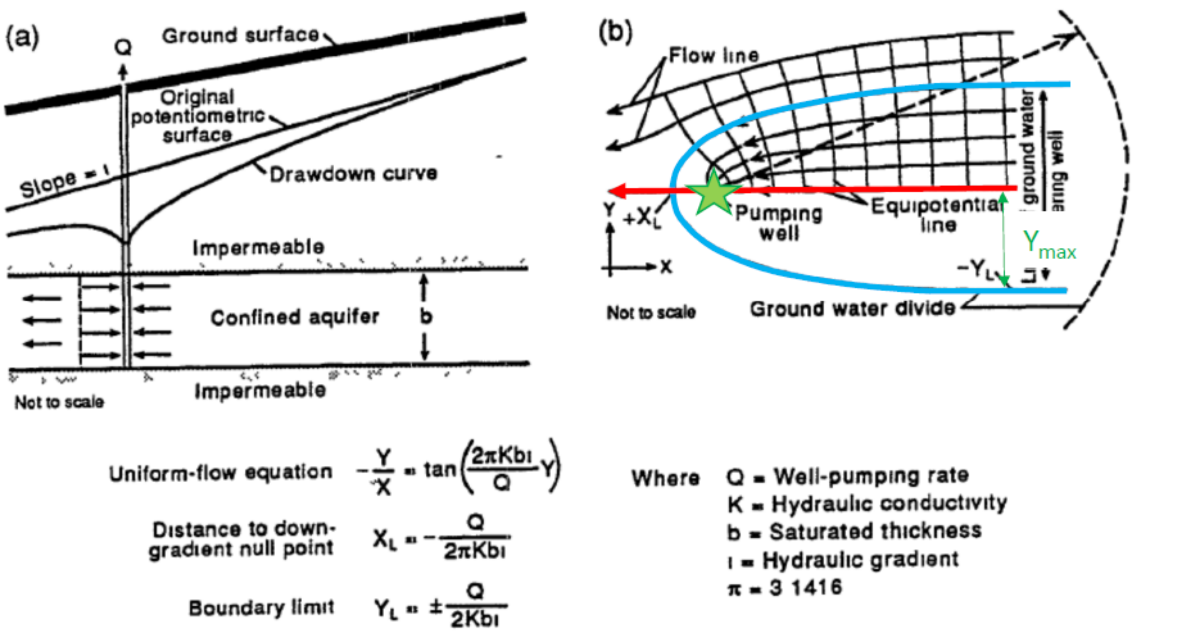
Well ID#	Sec,Township Range	Screened Interval & Project Site Area	Distance & Direction from Aquifer Exemption Boundary	Year Constructed/# Years & Days of Operation to 2017	Historic Values for Flow rate gpm
2	SESE Sec 16 T7S R1E	Chilson Burdock	4,600' downgradient from B-WF2	1930s, Use 1930 32,142 days	30 gpm which is greater than the SEO allows without water rights permit Use 18 gpm / 25,920 gpd
7	NWNW Sec 23 7S 1E	Fall River Burdock	4,750' crossgradient from B-WF2	Late 1950s, Use 1958 21,915 days	4.25 gpm 6,120 gpd
8	SWSE Sec 23 23 7S 1E	Fall River Burdock	9,625' crossgradient from B-WF2	Well repair form 1951. Casing had corroded away. Assume original well drilled in 1930 32,142 days	2.5 gpm 3,600 gpd
13	NWNW Sec 3 T7S R1E	Chilson Burdock	1,750' downgradient from B-WF10	1950s, Use 1950 24,837 days	Notice of well construction says well flows at 1 gpm, 1,440 gpd
18	SWSW Sec 9 T7S R1E	Fall River Burdock	7,880' downgradient from B-WF4	Late 1920s to early 1930s Use 1930 32,142 days	8 gpm 11,520 gpd
40	SWNW Sec 30 T6S R1E	Inyan Kara Dewey	2,187.5' crossgradient from D-WF2	1969 17,897.25 days	2 gpm 2,880 gpd
41	SWNE Sec 31 T6S R1E	Fall River Dewey	2,750' downgradient From D-WF3 3,300' crossgradient from D-WF1	No information Use 1930; 32,142 days	12 gpm 17,280 gpd
41	SWNE Sec 31 T6S R1E	Chilson Dewey	3,000' downgradient From D-WFs 2&4 3,300' crossgradient from D-WF1	No information Use 1930; 32,142 days	12 gpm 17,280 gpd
42	SWNE Sec 5 T7S 1E	Chilson Dewey	4,800' downgradient From D-WF4	1949 25,202.25 days	Flows 30 gpm, Use 18 gpm 25,920 gpd
43	SWSE Sec 34 T6S R1E	Chilson Burdock	3,600' crossgradient from B-WF8 875' crossgradient from B-WF10	No information Use 1930; 32,142 days	No info Use 18 gpm 25,920 gpd
704	SWNE Sec 5 T7S 1E	Chilson Dewey	4,800' downgradient From D-WF4	2008 3,652.5 days	No info Use 18 gpm 25,920 gpd
4002	NWSW Sec 30 T6S R1E	Inyan Kara Dewey	2,125' crossgradient from D-WF2	1940s Use 1940 28,489.5 days	No info Use 18 gpm 25,920 gpd

Table A-1. Well Location Information and the Values for Well Age and Flow Rate Used in the Capture Zone Equation.

Well ID#	Sec, Township Range	Screened Interval	Transmissivity (T) (ft^2/day)	Porosity (n) (%)	Hydraulic Gradient (i) (ft/ft)	Aquifer Thickness b (ft)	Age of well at end of 2017 (days)	Flow Rate (gpd)
2	SESE 16 T7S R1E	Chilson Burdock	150 & 190	0.296 & 0.319	0.00316	63	32,142	25,920 & 1,000
7	NWNW Sec 23 7S 1E	Fall River Burdock	54 & 255	0.29	0.00308	186	21,915	6,120 & 1,000
8	SWSE Sec 23 23 7S 1E	Fall River Burdock	54 & 255	0.29	0.00364	20	32,142	3,600 & 1,000
13	NWNW 3 T7S R1E	Chilson Burdock	150 & 190	0.296 & 0.319	0.00215	45	24,837	1,440 & 1,000
18	SWSW 9 T7S R1E	Fall River Burdock	54 & 255	0.29	0.00364	128	32,142	11,520 & 1,000
40	SWNW 30 T6S R1E	Inyan Kara Dewey	255	0.29	0.00364	150	17,897.25	2,880 & 1,000
41	SWNE Sec 31 T6S R1E	Fall River Dewey	255	0.29	0.00421	165	32,142	17,280 & 1,000
41	SWNE Sec 31 T6S R1E	Chilson Dewey	590	0.296 & 0.319	0.00631	140	32,142	17,280 & 1,000
42	SWNE 5 7S 1E	Chilson Dewey	590	0.296 & 0.319	0.00646	150	25,202.25	25,920 & 1,000
43	SWSE 34 T6S R1E	Chilson Burdock	150 & 190	0.296 & 0.319	0.00237	145	32,142	25,920 & 1,000
704	SWNE 5 7S 1E	Chilson Dewey	590	0.296 & 0.319	0.00646	150	3,652.50	25,920 & 1,000
4002	NWSW 30 T6S R1E	Inyan Kara Dewey	255	0.29	0.00364	150	28,489.5	25,920 & 1,000

Table A-2. The Input Values for All Variables in the Capture Zone Equation, Distance and Direction Each Well Is Located from nearest AE Boundary and the Calculated Extent of the Capture Zone.

To calculate the capture zone width, the boundary limit equation was used as shown below in Figure A-1 which is Figure 4-10 from the EPA *Ground Water and Wellhead Protection Handbook*. The groundwater divide shown as the blue line is the outer boundary of the capture zone for the well represented by the green star in the figure below. All groundwater outside the blue groundwater divide will flow past the well. All groundwater inside the blue groundwater divide will flow to the well. The groundwater divide is calculated using the uniform-flow equation shown in Figure 4-10. The boundary limit equation calculates the maximum width measured from the red capture zone centerline attained by groundwater divide. This maximum width is called Y_{max}. For the wells located cross-gradient from an AE boundary, wells 40, 4002 and 43, Y_{max}, must be calculated for the capture zone. For wells 40 and 4002, Y_{max} was smaller than the nearest AE boundary. As discussed earlier, because wells 40 and 4002 are located so closely together, Y_{max} was calculated using the combined flow rate of the two wells.



Transmissivity (T) was used in the equation instead of hydraulic conductivity (K) and aquifer thickness (b).
Transmissivity T=Kb

Figure A-1. Illustration of the Boundary Limit Equation used to Calculate the Maximum Width of the Well Capture Zone.

More detailed information on the CZA is provided in the *Technical Memorandum Documenting the Capture Zone Analysis for Eleven Private Drinking Water Wells in and near the Dewey-Burdock Uranium In-Situ Recovery Project Site Northwest of Edgemont, South Dakota* included in the Administrative Record for the Dewey-Burdock permitting and AE actions.