United States Nuclear Regulatory Commission Official Hearing Exhibit
In the Matter of: POWERTECH USA, INC. (Dewey-Burdock In Situ Uranium Recovery Facility)
ASLBP #: 10-898-02-MLA-BD01
Docket #: 04009075
Exhibit #: APP-016-D-00-BD01 Identified: 8/19/2014
Admitted: 8/19/2014 Withdrawn:
Rejected: Stricken:
Other:

Background Radiological Characteristics

The applicant has not provided sufficient information regarding background radiological characteristics. Background radiological characterization is necessary to determine whether the applicant's future operations will affect human health and the environment. Specifically, the staff is requesting the following information.

TR RAI 2.9-1

Regulatory Guide 4.14 provides criteria for determining air particulate sampling locations. NRC staff cannot locate the applicant's criteria for determining air particulate sampling locations in section 2.9 of the TR. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 2.9.3(1), provide the criteria used to establish air particulate sampling locations or indicate where this information can be found in the TR.

TR RAI 2.9-1 Response

Following is a discussion of the criteria used to establish air particulate sampling locations and a demonstration that the pre-operational air particulate sampling locations satisfy the recommendations of Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 2.9.3(1). The following discussion, figures and tables will be incorporated into Section 2.9 of the revised TR.

The criteria used to establish air particulate sampling locations include the following factors:

1) Average meteorological conditions such as wind speed, wind direction and atmospheric stability
2) Prevailing wind direction
3) Site boundaries nearest to proposed facility processing areas, land application areas, and well fields
4) Direction of nearest occupiable structure
5) Location of estimated maximum concentrations of radioactive materials
6) Location of existing features near or within the proposed license boundary, but unrelated to proposed site activities, that may impact background radiological conditions (e.g., railroads and historical surface mines)
7) Location of nearest multiple resident area or town

Factors 1-5 are identical to the air particulate sampler siting criteria contained in Regulatory Guide 4.14. Factors 6 and 7 were added to account for site-specific conditions. Table TR RAI 2.9-1-1 compares the air monitoring station locations suggested by Regulatory Guide 4.14 to those established for the site. The locations of the air monitoring stations are shown on Figure 2.9-8 (p. 2-325) of the TR and on Figure TR RAI 2.9-1-1.

Table TR RAI 2.9-1-2 shows the sum of predicted particulate radionuclide concentrations in air for all of the AMS locations and the southeast corner of the project boundary. The southeast corner of the project boundary was included in this evaluation because NRC staff questioned the absence of a pre-operational air particulate sampler at this location, which is in the downwind direction from the CPP.

The predicted airborne radionuclide concentrations were obtained from the MILDOS-AREA output contained in Appendix 7.3-A of the TR. As shown in Table TR RAI 2.9-1-2, AMS-02 has the highest predicted airborne radionuclide concentrations of the air monitoring locations followed by AMS-03 and AMS-01. Based on the April 7-8, 2011 meeting with NRC staff, Powertech understands that NRC staff do not disagree that AMS-02 and AMS-03 are acceptable boundary locations according to Regulatory Guide 4.14 recommendations. Additionally, the predicted air concentrations at AMS-01 are similar to the predicted airborne radionuclide concentrations at AMS-03 and are larger than the predicted airborne radionuclide concentrations at the southeast corner of the project boundary. Based on the provided information and supported by the updated annual wind rose shown in Figure TR RAI 2.9-1-1, Powertech believes that AMS-01 also meets the siting criteria contained in Regulatory Guide 4.14.

Four stations were initially sited consistent with factor 6 listed above. These included Stations AMS-01, AMS-05, AMS-06 and AMS-07. AMS-04 was placed in the town of Dewey because this is the closest area to the proposed license boundary that contains multiple residences. As discussed above, AMS-01 also meets the siting criteria contained in Regulatory Guide 4.14 for a site boundary monitoring location.

Table TR RAI 2.9-1-1: Regulatory Guide 4.14 Recommended Versus Pre-operational Air Monitoring Locations

Regulatory Guide 4.14 Recommendation	Dewey-Burdock Pre-operational Monitoring Locations
Three locations at or near the site boundary	Initially, AMS-01 was positioned to evaluate particulate emissions potentially resulting from disturbed areas associated with historical open-pit uranium mines to the west and northwest of this location. AMS-01 is also near the eastern boundary of the project area, approximately 3.2 km east-southeast of the proposed Burdock land application areas. Figure TR RAI 2.9-1-1 shows the location of AMS-01 relative to the Burdock land application areas. This figure also shows the predominant wind directions and the updated wind rose. The land application areas are the only expected source of potential routine airborne particulate emissions in the form of long-lived radionuclides. Winds from the northwest occur nearly 20% of the time as shown in Figure TR RAI 2.9-1-2. Additionally, the strongest winds are from the northwest as shown on the updated wind rose. AMS-01 is positioned near the eastern boundary of the project area and downwind from the only potential source of routine airborne particulate radionuclide emissions. Using the factors listed above, AMS-01 meets the criteria to establish an air particulate sampling location at this boundary location.

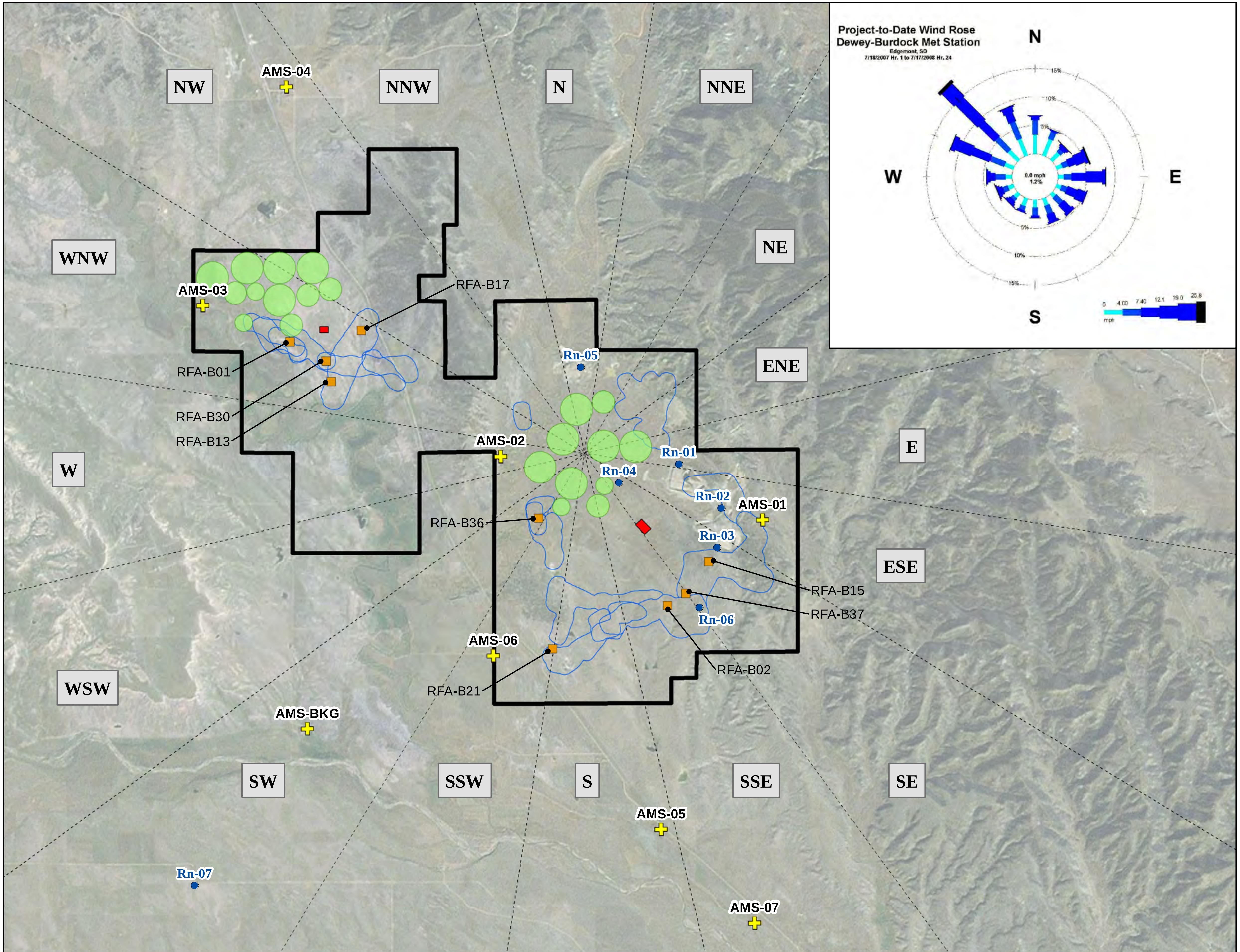
Table TR RAI 2.9-1-1: Regulatory Guide 4.14 Recommended Versus Pre-operational Air Monitoring Locations (Continued)

Regulatory Guide 4.14 Recommendation	Dewey-Burdock Pre-operational Monitoring Locations
Three locations at or near the site boundary	AMS-02 is near the project boundary in the center of the project area. It is approximately 3.5 km east-southeast of the proposed Satellite Facility and 2.5 km northwest of the proposed CPP. Winds from the southeast (including east-southeast and south-southeast) occur approximately 15% of the time as shown in Figure TR RAI 2.9-1-2. Winds from the northwest (including north-northwest and west–northwest) occur approximately 40% of the time. Additionally, the strongest winds are from the northwest as shown on the wind rose and in the joint frequency distribution tables contained in the response to TR RAI 2.5-3. AMS-02 is positioned in downwind direction from the proposed Satellite Facility and CPP. This is an ideal location to monitor potential airborne particulate radionuclide emissions from all potential facility-related sources.
	AMS-03 is near the northwest project boundary. It is approximately 2 km west of the proposed Satellite Facility and very near the Dewey land application areas. Winds from the east occur approximately 8% of the time, which is the fourth highest frequency when compared to other sectors from the 16 compass directions (refer to Figure TR RAI 2.9-1-2). Given the proximity of AMS-03 to the proposed Satellite Facility and the Dewey land application areas and the significant contribution of winds from the east and east-southeast, AMS-03 is ideally located to evaluate potential environmental impacts of airborne particulate radionuclide emissions.
If within 10 km of the site, an air sampler should be at or near the structure with the highest predicted airborne radionuclide concentration due to milling operations and at or near at least one structure in any area where predicted doses exceed 5% of the standards in 40 CFR Part 190.	Location AMS-02 is located within 10 km of the site, is adjacent to occupiable structures and is downwind of the CPP and Satellite Facility and land application areas. AMS-02 has the highest predicted airborne radionuclide concentrations during ISR operations for locations with occupiable structures in and around the project area, as determined by MILDOS-AREA.
A remote location that represents background conditions at the mill site.	AMS-BKG is approximately 7 km south of the proposed Satellite Facility and 6 km east-southeast of the proposed CPP. AMS-BKG is in one of the least prevalent wind directions from both the proposed Satellite Facility and the CPP. It is expected that this location would be unaffected by the proposed uranium recovery operations.

Table TR RAI 2.9-1-2: Predicted Airborne Radionuclide Concentrations at Dewey-Burdock AMS Locations

Location	U-nat (µCi/ml)	Th-230 (µCi/ml)	Ra-226 (µCi/ml)	Pb-210 (µCi/ml)	Total Concentration (µCi/ml)
AMS-02	1.18E-15	3.95E-16	2.37E-16	3.94E-17	1.86E-15
AMS-03	5.14E-16	1.71E-16	1.03E-16	1.71E-17	8.05E-16
AMS-01	4.67E-16	1.56E-16	9.35E-17	1.56E-17	7.32E-16
AMS-06	2.15E-16	7.18E-17	4.31E-17	7.17E-18	3.37E-16
AMS-04	1.46E-16	4.88E-17	2.93E-17	4.87E-18	2.29E-16
AMS-05	1.34E-16	4.45E-17	2.67E-17	4.44E-18	2.09E-16
AMS-07	1.03E-16	3.44E-17	2.06E-17	3.43E-18	1.62E-16
AMS-BKG	8.83E-17	2.95E-17	1.77E-17	2.94E-18	1.38E-16
Southeast Boundary	3.42E-16	1.14E-16	6.84E-17	1.14E-17	5.35E-16

µCi/ml = microCuries per milliliter



Legend

- Radon Track Etch Detector
- Land Application Area
- Air Monitoring Station
- Radon Flux Measurement
- Potential Well Field
- Project Boundary
- Processing Plants

TLDs and radon track etch detectors located at each air monitoring station

Feet: 0 | 2,500 | 5,000 | 10,000

Meters: 0 | 1,000 | 2,000 | 3,000

N

Figure TR RAI 2.9-1-1

Air Monitoring Station, Ambient Radon, and Radon Flux Measurement Locations Dewey-Burdock Project

DRAWN BY	C. Farr - ERG
DATE	21-Jun-2011
FILENAME	Figure TR RAI 2.9-1-1.mxd

POWERTECH (USA) INC.

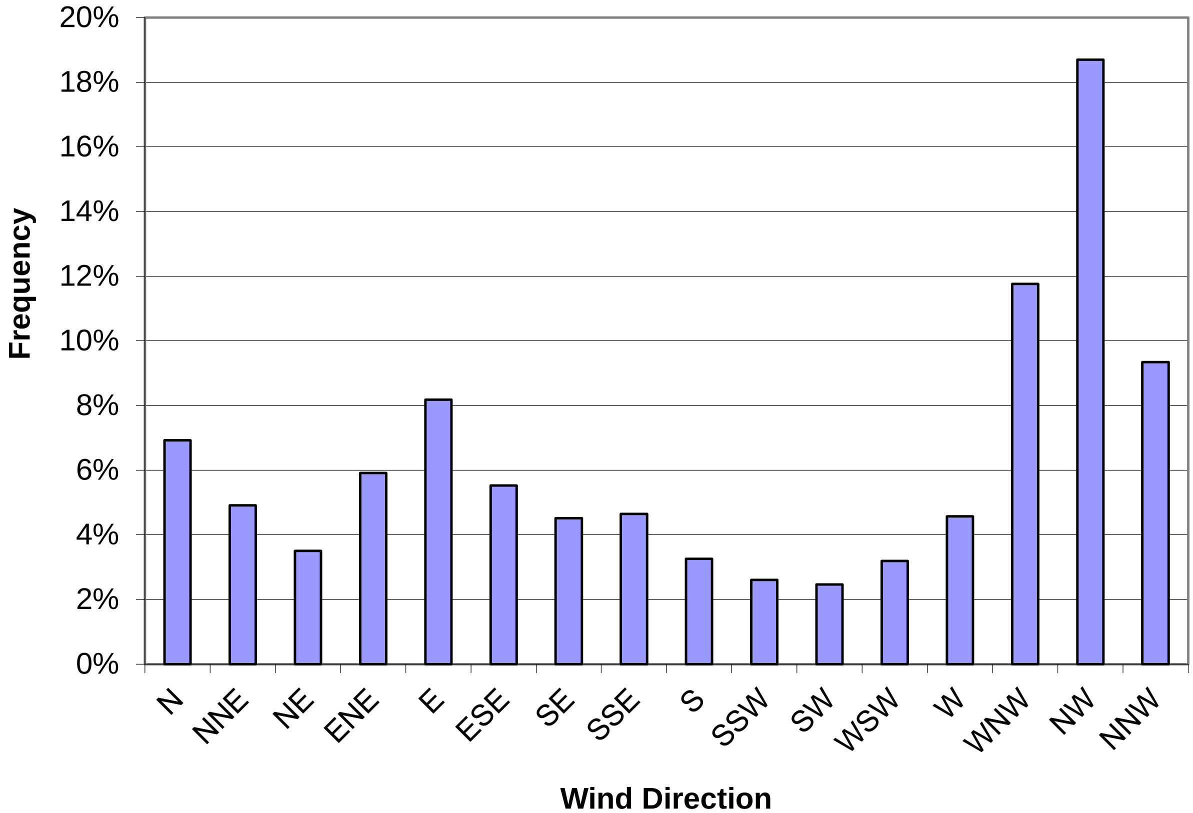


Figure TR RAI 2.9-1-2: Dewey-Burdock Wind Direction Distribution

TR RAI 2.9-2

Regulatory Guide 4.14 recommends that filters for continuous air samples be changed weekly or more often as required by dust loading. In Section 2.9.6.1 of the TR, the applicant stated that filters were collected approximately bi-weekly, prior to saturation. Please provide information (e.g., operating procedures, test results, etc.) on how the applicant determined filter saturation.

TR RAI 2.9-2 Response

Justification for the bi-weekly air particulate filter collection schedule is provided below. Based on the use of modern, automatic flow control air samplers, the recommendation in Regulatory Guide 4.14 to change filters weekly is obsolete. When Regulatory Guide 4.14 was issued, automatic flow control air samplers were unavailable, resulting in the need for weekly filter changes. As described in the response to TR RAI 2.9-3, use of automatic flow control air samplers and visual observations and flows recorded during each filter change confirmed that the bi-weekly filter changes did not result in any reduction in performance due to dust loading. Section 2.9.6 of the TR will be revised to incorporate the following information.

An approximately bi-weekly filter collection schedule was chosen based on the following:

1) As part of the baseline monitoring program, Powertech utilized brushless, automatic flow control hi-vol air samplers manufactured by Hi-Q Environmental Products Company (Model Number HVP-4200AFC). Each air sampler was equipped with a variable speed motor, controlled by a programmable logic controller (PLC). The PLC received input from a mass air flow sensor placed in the air flow path downstream of the filter paper. Any changes in the pre-set flow rate due to dust loading, barometric pressure or temperature were detected by the air flow sensor and the PLC compensated by adjusting the motor speed to maintain the pre-set flow rate.

2) Each air sampler was equipped with an air flow totalizer, which was recorded and reset during each filter change.

3) The Dewey-Burdock project area is in rural South Dakota. Given the site location coupled with the features of the samplers described above, it is not expected that total suspended particulate concentrations in air would interfere with air flow rates over a two-week period.

TR RAI 2.9-3

Regulatory Guide 4.14 recommends that individual procedures should be prepared and used for specific methods of calibrating all sampling and measuring equipment to ensure that the equipment will operate with adequate accuracy and stability over the range of intended use. For all air sampling equipment, please describe the procedures used by the applicant for the calibration of air sampling and measuring equipment consistent with Regulatory Guide 4.14 or indicate where this information can be found in the TR.

TR RAI 2.9-3 Response

The following text will be added to TR Section 2.9.6 to show that the manufacturer's instructions were followed regarding equipment calibration. The air particulate sampler manufacturer's operation and maintenance manual is provided as Appendix 2.9-B. This appendix is included with this RAI response package and also will be included with the revised TR.

Air Particulate Sampler Calibration Methods

The model number of the high-volume, air particulate samplers used during baseline monitoring for the Dewey-Burdock Project was HVP-4200AFC. The unit is manufactured by Hi-Q Environmental Products Company, San Diego, CA. The procedures to operate and maintain this equipment are described in the manufacturer's operations and maintenance manual (Hi-Q, 2006). This document is included as Appendix 2.9-B. The samplers were purchased new from the manufacturer and deployed on or near August 13, 2007. Although the operations and maintenance manual states that the units were calibrated before leaving the factory and that there was no need to calibrate before use, a calibration check was performed after initial installation using the procedures described in the operations and maintenance manual. The operations and maintenance manual also states that all air flow devices should be recalibrated at least once a year against a traceable standard. Since air monitoring was discontinued on August 13, 2008, one year after installation, recalibration was not deemed necessary.

The air particulate samplers were equipped with air flow totalizers, which were recorded and reset during each filter change. Qualitative checks of air particulate sampler operation were also performed during each filter change. No anomalous flow volumes or conditions were observed.

<u>TR RAI 2.9-4</u>

10 CFR 40, Appendix A, Criterion 7, requires that a preoperational monitoring program be conducted at least one full year prior to any major site construction. The applicant stated in Appendix 2.9-A of the TR that air particulate sampling was performed for 351 days. Consistent with 10 CFR 40, Appendix A, Criterion 7, and Regulatory Guide 4.14 provide justification for not sampling air particulates for one full year.

<u>TR RAI 2.9-4 Response</u>

The statement in Appendix 2.9-A that the air particulate sampling was performed for 351 days is incorrect. Appendix 2.9-A of the TR describes the monitoring period for particulate sampling as the beginning of Period 1 (August 13, 2007) to the end of Period 5 (August 13, 2008). Appendix 2.9-A of the TR will be revised to reflect that air particulate sampling was conducted continuously for 366 days (February 2008 contained 29 days), which is consistent with the recommendations in Regulatory Guide 4.14 and requirements in 10 CFR 40, Appendix A, Criterion 7.

TR RAI 2.9-5

Table 2.9-12 (Radionuclide Concentrations in Air) of the TR presents lower limit of detection LLD values for U-nat that are higher than what is recommended by Regulatory Guide 4.14. For those U-nat LLD values that are higher than the Regulatory Guide 4.14, value, please provide an analysis that the reported values are consistent with Regulatory Guide 4.14 or justification for providing alternate values.

TR RAI 2.9-5 Response

Note: Powertech identified that monitoring periods 1 through 5 in TR Table 2.9-12 do not correspond to monitoring periods 1 through 5 described in the text. Therefore, the airborne radionuclide concentration data in Tables 2.9-12 and 2.9-13 have been revised to the appropriate monitoring periods and concentrations. For the correct monitoring periods, refer to the response to TR RAI 2.9-7. The revised tables are included with this response and will be included in the revised TR.

Justification is provided below for U-nat LLD values for monitoring periods 1 and 2 that do not satisfy Regulatory Guide 4.14 guidance. U-nat LLD values met the Regulatory Guide 4.14 guidance for all other monitoring periods, and LLDs for all other radionuclide concentrations in air met the Regulatory Guide 4.14 guidance for all monitoring periods. The following discussion will be included in Section 2.9 of the revised TR.

U-nat LLD values greater than the Regulatory Guide 4.14 guidance can be justified by the use of the data, both currently and in the future. Currently the data are used to establish the pre-operational baseline condition of the airborne radionuclide concentrations in and around the project area. NUREG/CR-4007 states that "any measurement process must be capable of detecting the relevant radionuclides at levels well below those of concern to the public health and safety" (NRC, 1984). Regulatory Guide 4.14 states that one of its recommended siting criteria is to place an air particulate monitoring station at or near a structure with the highest predicted airborne radionuclide concentration due to milling operations and at or near at least one structure in any area where predicted doses exceed 5 percent of the standards in 40 CFR Part 190. A dose level of 5 percent of the standards in 40 CFR Part 190 is interpreted as being "well below those of concern to the public health and safety." On this basis Powertech proposes that an LLD for air particulate monitoring low enough to measure an airborne radionuclide concentration that would result in at least 5 percent of the standards in 40 CFR 190 would be acceptable.

The dose standards in 40 CFR 190 are an annual dose equivalent of 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of any member of the public as result of planned discharges of radioactive materials, radon and radon decay products excepted. For inhalation of natural uranium, the annual dose equivalent of 25 mrem to other organs of the body (the bone surface in the case of natural uranium) is the most restrictive limit. Equations 1 and 2 were used to

determine the concentration of natural uranium in air that would result in an annual dose equivalent of 1.25 mrem (5 percent of the standard) to a member of the public. The inhalation dose conversion factor (DCF) from Federal Guidance 11 (EPA, 1988) for Class D U-234 with the target organ of the bone surface was used, since it is the most restrictive of the three lung clearance classes for the three uranium isotopes contained in natural uranium.

$$C_{U-nat} = 1.25\ (mrem)\ x\ \frac{1}{DCF\ x\ BR\ x\ T x\ FO} \qquad \text{(Equation 1)}$$

Where

$C_{u\text{-}nat}$ = Natural uranium concentration (µCi/ml)

DCF = Inhalation dose conversion factor for U-234 contained in Federal Guidance Report 11 (EPA, 1988). Value equals 40,330 mrem/µCi.

BR = Breathing rate of 8.4 x 10^9 ml/year [Data Collection Handbook, (ANL, 1993)]

T = Time period of 1 year

FO = Shielding Factor for Inhalation Pathway = 0.45 as calculated using Equation 2 (Data Collection Handbook, ANL, 1993)

$$FO = (TF_1 x\ 1) + (TF_2 x\ 0.4) + (TF_3 x\ 0) \qquad \text{(Equation 2)}$$

Where

TF_1 = Fraction of time spent on site, outdoors (0.25) (Data Collection Handbook, ANL, 1993)

TF_2 = Fraction of time spent on site, indoors (0.5) (Data Collection Handbook, ANL, 1993)

TF_3 = Fraction of time spent off site (0.25) (Data Collection Handbook, ANL, 1993)

The result of this calculation shows that by using realistic assumptions, the natural uranium concentration in air needed to evaluate 5 percent of the most restrictive 40 CFR 190 standard is 8.2 x 10^{-15} µCi/ml. The highest LLD for air concentrations of natural uranium was 7.1 x 10^{-15} µCi/ml. This LLD is sensitive enough to evaluate the recommended siting criteria for air particulate monitoring at a location at or above 5 percent of the 40 CFR 190 standards. In addition, this dose level (1.25 mrem) is lower than the dose (5 mrem) resulting from the LLD recommendations for stack effluent samples contained in Section 5.0 of Regulatory Guide 4.14.

Table 2.9-12: Radionuclide Concentrations in Air

Location	Period	Concentration (µCi/ml)							% of Effluent Concentration				Lower Limit of Detection (µCi/ml)			
		U-nat	Th-230	Th-230 2σ Error	Ra-226	Ra-226 2σ Error	Pb-210	Pb-210 2σ Error	U-nat	Th-230	Ra-226	Pb-210	U-nat	Th-230	Ra-226	Pb-210
AMS-01	1	7.10E-15	1.70E-17	2.80E-17	5.30E-17	4.30E-17	2.40E-14	6.20E-16	0.24%	0.00%	0.01%	4.00%	7.10E-15	4.20E-18	4.80E-17	2.10E-17
	2	0.00E+00	1.60E-18	1.10E-17	7.20E-18	9.10E-18	4.10E-14	6.90E-16	0.00%	0.00%	0.00%	6.78%	1.60E-16	1.60E-18	1.60E-18	7.90E-18
	3	-1.30E-17	3.40E-18	1.00E-17	1.80E-17	1.70E-17	2.10E-14	3.50E-16	0.00%	0.00%	0.00%	3.54%	1.70E-18	1.70E-18	1.20E-17	2.10E-16
	4	2.40E-17	1.30E-17	9.80E-18	1.40E-17	9.70E-18	2.10E-14	4.90E-16	0.00%	0.00%	0.00%	3.51%	1.50E-18	1.50E-18	8.30E-18	4.20E-16
	5	-1.70E-17	6.50E-18	2.50E-17	-3.10E-17	2.70E-17	1.00E-14	6.50E-16	0.00%	0.00%	0.00%	1.74%	4.30E-18	4.30E-18	5.60E-17	6.70E-16
AMS-02	1	7.00E-15	4.10E-18	2.80E-17	-8.30E-18	2.90E-17	1.10E-14	4.50E-16	0.23%	0.00%	0.00%	1.85%	7.00E-15	4.10E-18	3.70E-17	2.10E-17
	2	0.00E+00	1.60E-17	1.10E-17	-2.30E-18	7.00E-18	2.00E-14	4.70E-16	0.00%	0.00%	0.00%	3.26%	1.50E-16	1.50E-18	1.50E-18	7.60E-18
	3	-2.00E-17	4.70E-18	1.10E-17	-8.60E-18	1.30E-17	8.90E-15	2.50E-16	0.00%	0.00%	0.00%	1.49%	1.60E-18	1.60E-18	1.10E-17	1.90E-16
	4	4.20E-18	0.00E+00	7.40E-18	-4.20E-18	7.40E-18	8.20E-15	4.20E-16	0.00%	0.00%	0.00%	1.37%	1.40E-18	1.40E-18	7.60E-18	3.90E-16
	5	-1.30E-17	0.00E+00	8.00E-18	-4.90E-17	2.30E-17	1.50E-14	6.50E-16	0.00%	0.00%	0.00%	2.44%	4.00E-18	4.00E-18	5.30E-17	6.20E-16
AMS-03	1	5.00E-15	-1.50E-18	2.00E-17	-5.90E-18	2.10E-17	1.20E-14	3.70E-16	0.17%	0.00%	0.00%	1.97%	5.00E-15	3.00E-18	2.70E-17	1.50E-17
	2	0.00E+00	9.30E-18	1.00E-17	5.40E-18	8.90E-18	1.30E-14	3.90E-16	0.00%	0.00%	0.00%	2.16%	1.60E-16	1.60E-18	1.60E-18	7.80E-18
	3	-3.00E-17	9.30E-18	1.20E-17	-1.40E-17	1.30E-17	9.20E-15	2.50E-16	0.00%	0.00%	0.00%	1.53%	1.50E-18	1.50E-18	1.20E-17	1.90E-16
	4	1.80E-17	8.90E-18	9.00E-18	9.60E-18	9.50E-18	8.00E-15	4.40E-16	0.00%	0.00%	0.00%	1.34%	1.50E-18	1.50E-18	8.90E-18	4.10E-16
	5	-1.60E-17	1.90E-17	9.70E-18	-3.20E-18	3.10E-17	1.20E-14	6.50E-16	0.00%	0.00%	0.00%	1.99%	4.20E-18	4.20E-18	5.00E-17	6.60E-16
AMS-04	1	5.00E-15	5.90E-18	2.50E-17	4.60E-17	2.90E-17	1.10E-14	3.70E-16	0.17%	0.00%	0.01%	1.89%	5.00E-15	3.00E-18	3.00E-17	1.50E-17
	2	0.00E+00	9.40E-18	1.10E-17	2.30E-18	8.30E-18	2.20E-14	5.10E-16	0.00%	0.00%	0.00%	3.66%	1.60E-16	1.60E-18	1.60E-18	7.80E-18
	3	-2.60E-17	2.50E-18	1.10E-17	-2.80E-17	1.20E-17	8.50E-15	2.60E-16	0.00%	0.00%	0.00%	1.42%	1.70E-18	1.70E-18	9.90E-18	2.00E-16
	4	1.90E-17	6.60E-18	9.00E-18	1.20E-17	9.50E-18	1.00E-14	4.60E-16	0.00%	0.00%	0.00%	1.74%	1.50E-18	1.50E-18	8.10E-18	4.10E-16
	5	-1.00E-18	2.70E-17	9.70E-18	-5.20E-18	3.30E-17	1.30E-14	6.70E-16	0.00%	0.00%	0.00%	2.23%	4.20E-18	4.20E-18	5.50E-17	6.60E-16
AMS-05	1	5.90E-15	2.60E-17	2.50E-17	-4.50E-17	2.40E-17	1.10E-14	5.30E-16	0.20%	0.00%	0.00%	1.82%	5.90E-15	3.50E-18	4.50E-17	1.70E-17
	2	0.00E+00	2.00E-17	1.40E-17	4.70E-17	1.30E-17	2.50E-14	2.60E-16	0.00%	0.00%	0.01%	4.09%	1.60E-16	1.50E-18	1.50E-18	7.70E-18
	3	1.00E-18	4.70E-18	1.10E-17	1.10E-17	1.50E-17	1.00E-14	4.40E-16	0.00%	0.00%	0.00%	1.66%	1.60E-18	1.60E-18	1.10E-17	1.90E-16
	4	2.50E-17	1.30E-17	9.20E-18	1.30E-17	9.00E-18	1.00E-14	6.30E-16	0.00%	0.00%	0.00%	1.74%	1.40E-18	1.40E-18	7.70E-18	3.90E-16
	5	2.40E-17	5.60E-17	9.50E-18	2.20E-17	3.40E-17	1.10E-14	0.00E+00	0.00%	0.00%	0.00%	1.85%	4.10E-18	4.10E-18	4.90E-17	6.40E-16

Table 2.9-12: Radionuclide Concentrations in Air (Continued)

Location	Period	Concentration (µCi/ml)							% of Effluent Concentration				Lower Limit of Detection (µCi/ml)			
		U-nat	Th-230	Th-230 2σ Error	Ra-226	Ra-226 2σ Error	Pb-210	Pb-210 2σ Error	U-nat	Th-230	Ra-226	Pb-210	U-nat	Th-230	Ra-226	Pb-210
AMS-06	1	5.0E-15	1.5E-18	2.0E-17	-3.9E-17	1.8E-17	1.4E-14	4.0E-16	0.17%	0.00%	0.00%	2.28%	5.0E-15	3.0E-18	3.1E-17	1.5E-17
	2	0.0E+00	1.4E-17	1.2E-17	2.3E-17	1.0E-17	2.1E-14	4.8E-16	0.00%	0.00%	0.00%	3.56%	1.5E-16	3.0E-18	1.5E-18	7.3E-18
	3	-1.4E-17	9.4E-18	1.2E-17	0.0E+00	1.4E-17	6.0E-15	2.2E-16	0.00%	0.00%	0.00%	0.99%	1.6E-18	3.0E-18	1.1E-17	1.9E-16
	4	1.5E-17	4.9E-18	9.1E-18	-4.9E-18	7.4E-18	9.5E-15	4.3E-16	0.00%	0.00%	0.00%	1.58%	1.4E-18	3.0E-18	8.3E-18	3.9E-16
	5	-2.6E-18	2.0E-17	9.1E-18	6.9E-18	3.3E-17	1.9E-14	6.9E-16	0.00%	0.00%	0.00%	3.25%	4.0E-18	3.0E-18	4.9E-17	6.2E-16
AMS-07	1	1.5E-14	2.0E-17	2.1E-17	-4.3E-18	2.5E-17	1.8E-14	4.4E-16	0.51%	0.00%	0.00%	3.03%	4.8E-15	2.8E-18	3.4E-17	1.4E-17
	2	0.0E+00	1.3E-17	1.2E-17	2.9E-17	1.0E-17	2.8E-14	5.3E-16	0.00%	0.00%	0.00%	4.62%	1.4E-16	1.4E-18	1.4E-18	6.9E-18
	3	-1.1E-17	6.3E-18	9.0E-18	-1.3E-17	1.1E-17	7.2E-15	2.2E-16	0.00%	0.00%	0.00%	1.19%	1.4E-18	1.4E-18	9.1E-18	1.7E-16
	4	2.0E-17	7.9E-18	8.1E-18	-6.6E-19	7.5E-18	1.3E-14	4.4E-16	0.00%	0.00%	0.00%	2.13%	1.3E-18	1.3E-18	7.3E-18	3.7E-16
	5	-9.2E-19	1.7E-17	8.5E-18	1.4E-17	3.0E-17	1.3E-14	5.9E-16	0.00%	0.00%	0.00%	2.10%	3.7E-18	3.7E-18	4.6E-17	5.8E-16
AMS-BKG	1	5.7E-15	3.0E-17	2.6E-17	5.0E-18	3.1E-17	1.4E-14	4.2E-16	0.19%	0.00%	0.00%	2.26%	5.7E-15	3.3E-18	4.0E-17	1.7E-17
	2	0.0E+00	-7.8E-19	9.4E-18	1.2E-17	9.5E-18	2.0E-14	4.8E-16	0.00%	0.00%	0.00%	3.29%	1.6E-16	1.6E-18	1.6E-18	7.8E-18
	3	1.6E-18	2.0E-17	1.3E-17	-5.6E-18	1.4E-17	8.3E-15	2.5E-16	0.00%	0.00%	0.00%	1.38%	1.6E-18	1.6E-18	1.2E-17	2.0E-16
	4	1.5E-17	1.4E-18	8.6E-18	2.1E-18	8.0E-18	1.3E-14	4.6E-16	0.00%	0.00%	0.00%	2.13%	1.4E-18	1.4E-18	8.5E-18	4.0E-16
	5	-8.1E-18	2.4E-17	9.3E-18	-1.7E-17	2.4E-17	1.2E-14	6.3E-16	0.00%	0.00%	0.00%	2.00%	4.0E-18	4.0E-18	4.0E-17	6.3E-16

Notes: The laboratory reported no blank assay data for Period 5. Blank assays in the sample concentration calculation were assumed to be 50 percent of the values for blanks reported for the previous period. The assumption is based on the relative, approximate run-time of the air samplers in both periods. No blank corrections were performed on uranium results for the first monitoring period since sample results were reported as non-detects.

Table 2.9-13: Summary of Radionuclide Concentrations in Air

Location	U-nat Concentration (µCi/ml)				Th-230 Concentration (µCi/ml)				Ra-226 Concentration (µCi/ml)				Pb-210 Concentration (µCi/ml)			
	Average	σ	Min	Max	Average	σ	Min	Max	Average	σ	Min	Max	Average	σ	Min	Max
AMS-01	1.4E-15	3.2E-15	-1.7E-17	7.1E-15	8.2E-18	6.4E-18	1.6E-18	1.7E-17	1.2E-17	3.0E-17	-3.1E-17	5.3E-17	2.3E-14	1.4E-17	9.1E-18	4.3E-17
AMS-02	1.4E-15	3.1E-15	-2.0E-17	7.0E-15	4.9E-18	6.5E-18	0.0E+00	1.6E-17	-1.4E-17	1.9E-17	-4.9E-17	-2.3E-18	1.3E-14	9.7E-18	7.0E-18	2.9E-17
AMS-03	1.0E-15	2.2E-15	-3.0E-17	5.0E-15	9.0E-18	7.2E-18	-1.5E-18	1.9E-17	-1.6E-18	9.3E-18	-1.4E-17	9.6E-18	1.1E-14	9.2E-18	8.9E-18	3.1E-17
AMS-04	1.0E-15	2.2E-15	-2.6E-17	5.0E-15	1.0E-17	9.8E-18	2.5E-18	2.7E-17	5.3E-18	2.7E-17	-2.8E-17	4.6E-17	1.3E-14	1.1E-17	8.3E-18	3.3E-17
AMS-05	1.2E-15	2.6E-15	0.0E+00	5.9E-15	2.4E-17	1.9E-17	4.7E-18	5.6E-17	9.6E-18	3.4E-17	-4.5E-17	4.7E-17	1.3E-14	1.0E-17	9.0E-18	3.4E-17
AMS-06	1.0E-15	2.3E-15	-1.4E-17	5.0E-15	9.9E-18	7.2E-18	1.5E-18	2.0E-17	-2.6E-18	2.3E-17	-3.9E-17	2.3E-17	1.4E-14	9.9E-18	7.4E-18	3.3E-17
AMS-07	3.1E-15	6.9E-15	-1.1E-17	1.5E-14	1.3E-17	5.7E-18	6.3E-18	2.0E-17	4.9E-18	1.7E-17	-1.3E-17	2.9E-17	1.6E-14	1.0E-17	7.5E-18	3.0E-17
AMS-BKG	1.1E-15	2.5E-15	-8.1E-18	5.7E-15	1.5E-17	1.4E-17	-7.8E-19	3.0E-17	-6.3E-19	1.1E-17	-1.7E-17	1.2E-17	1.3E-14	9.8E-18	8.0E-18	3.1E-17

TR RAI 2.9-6

In Section 2.9.6.1 of the TR, the applicant describes how laboratory data for air particulate monitoring results were converted from picocuries per filter composite to units of microcuries per milliliter. However, natural uranium (U-nat) results are reported as milligram per filter composite. Please demonstrate how the U-nat concentration in microcuries per milliliter was derived from the value in milligram per filter composite.

TR RAI 2.9-6 Response

The following describes the calculation used by Powertech to convert the laboratory reported air particulate uranium concentration to microcuries per milliliter. This information will be incorporated into the revised TR.

Uranium in air particulate was reported by the laboratory in milligrams per filter composite. The results were converted to microcuries per milliliter using the specific activity for natural uranium provided in Footnote 3 to 10 CFR Part 20, Appendix B and the following equation:

$$[\boldsymbol{U_{nat}}] = \frac{\boldsymbol{U_{nat}Result\ (mg) \times SA_{unat}(Ci/g) * 1x10^{6}\ \mu Ci/Ci}}{\boldsymbol{1000\ mg/g * V\ (ml)}}$$

Where:

$[U_{nat}]$	= Air concentration of natural uranium (µCi/ml)
SA_{unat}	= Specific activity of natural uranium (6.77 E-7 Ci/g)
U_{nat} Result	= Laboratory result for natural uranium in filter composite (mg)
V	= Volume of air sampled (ml)

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TR RAI 2.9-7

NRC staff notes that the air particulate monitoring collection time periods are not consistent in the main body of the TR (p. 2-358) and Appendix 2.9-A (Page 16) of the same report. Specifically, the beginning dates for period 1 and ending dates for period 2 are not the same. Please address this discrepancy in the collection dates.

TR RAI 2.9-7 Response

Section 2.9.6 of the TR incorrectly identified the air particulate monitoring collection periods used as part of the baseline monitoring program. The correct monitoring periods were presented in Appendix 2.9-A and include the following dates:

Period 1:	August 13, 2007 to October 2, 2008
Period 2:	October 2, 2007 to January 4, 2008
Period 3:	January 4, 2008 to April 1, 2008
Period 4:	April 1, 2008 to July 9, 2008
Period 5:	July 9, 2008 to August 13, 2008

Section 2.9.6 of the TR will be revised to reflect the correct monitoring dates.

<u>TR RAI 2.9-8</u>

NRC staff notes inconsistent language regarding the description of the monitoring duration. In the main body of the TR (p. 2-358) the applicant indicates "nearly continuously" while Appendix 2.9-A (p. 16) of the same report indicates "continuously" and "nearly continuously." Please address these inconsistencies in the description of the monitoring duration.

<u>TR RAI 2.9-8 Response</u>

The air monitoring stations were operated continuously with minimal down time due to filter changes, power outages, and other unforeseen disruptions in the power supply. This short period of down time is why the term "nearly continuously" was initially used. Section 2.9.6 and Appendix 2.9-A of the TR will be revised to correct the inconsistency by adding text to indicate that minor down times occurred due to filter changes, power outages, and other disruptions of the power supply. The word "nearly" will be removed from this context in Section 2.9.6 and Appendix 2.9-A of the TR.

TR RAI 2.9-9

On page 2-359 of the TR, the value listed for Th-230 is that of the derived airborne concentration from 10 CFR 20 Appendix B, Table 1, not the effluent concentration value as indicated. Please address this discrepancy.

TR RAI 2.9-9 Response

The effluent limit listed for thorium-230 on page 2-359 of the TR and page 17 of Appendix 2.9-A was mistakenly taken from 10 CFR 20, Appendix B, Table 1 rather than from 10 CFR 20, Appendix B, Table 2. The sentence in question from these pages will be revised as follows:

The most conservative effluent limits were applied to thorium-230 ($2*10^{-14}$ µCi/ml) and lead-210 ($6*10^{-13}$ µCi/ml).

<u>TR RAI 2.9-10</u>

Please clarify whether the "HV" designator in lab reports in Appendix 2.9-A of the TR (and Plate 2.5-1) are the same as "AMS" designators in Table 2.9-11 of the TR.

<u>TR RAI 2.9-10 Response</u>

The "HV" designators in the lab reports in Appendix 2.9-A of the TR and Plate 2.5-1 are the same as the "AMS" (Air Monitoring Station) designators in Table 2.9-11 of the TR. Notes will be added or the "HV" designations changed at the appropriate places in the revised TR to clear up any confusion, including Table 2.9-11, Appendix 2.9-A and Plate 2.5-1.

<u>TR RAI 2.9-11</u>

10 CFR 40, Appendix A, Criterion 7, requires that a preoperational monitoring program be conducted to provide complete baseline data on a milling site and its environs. Regulatory Guide 4.14 recommends collecting food samples 3 km from mill site. NUREG-1569, Section 2.2.2, recommends assessing land use 3.3 km from the site boundary. The applicant did not appear to assess land use at these distances in regards to food sampling. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criteria 2.2.3(1)(f) and 2.9.3(1), please provide an assessment of land use for food sampling.

<u>TR RAI 2.9-11 Response</u>

The following information will be incorporated into Section 2.9 of the revised TR

<u>Food Sampling</u>

Powertech's original assessment of land use for food sources resulted only in the identification of cattle grazed within 3.3 km of the project area. Powertech has since conducted additional investigations and determined that in addition to cattle, there are "free range" pigs and vegetable gardens within 3.3 km of the project area. Figure TR RAI 2.9-11-1 has been prepared to show the updated assessment of land use for food sources within 3.3 km of the project area. For additional information, please refer the responses to TR RAI 2.9-12 (vegetable gardens) and TR RAI 2.9-16 (cows and pigs).

Note that Figure TR RAI 2.9-11-1 does not depict game animals, since game animals observed in the vicinity of the project area have extensive ranges that are not confined to a particular area within the scale of Figure TR RAI 2.9-11-1.

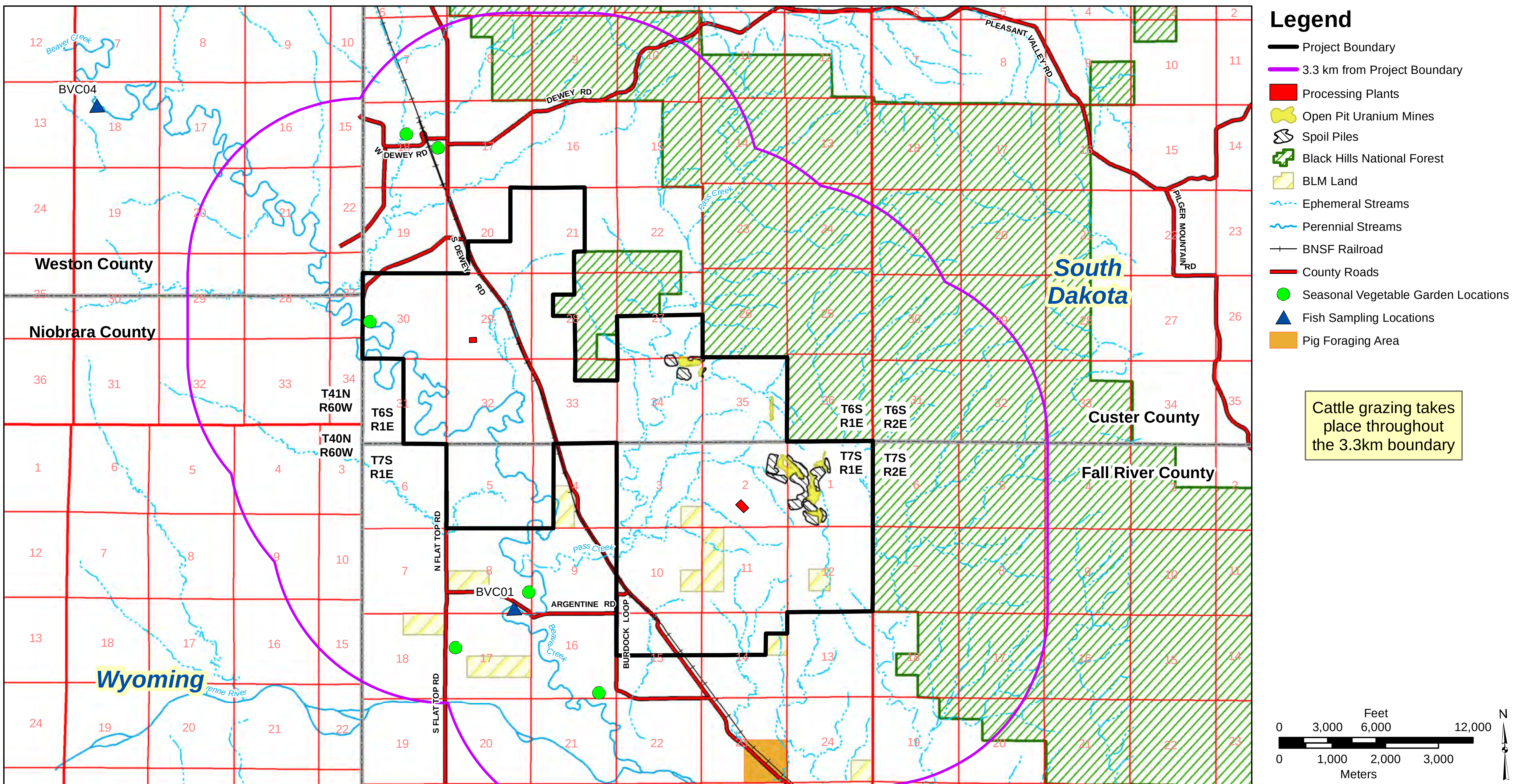

Figure TR RAI 2.9-11-1

Food Sources

Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	21-May-2011
FILENAME	Figure TR RAI 2.9-11-1.mxd

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TR RAI 2.9-12

Regulatory Guide 4.14 provides recommendations for the collection and analysis of crop samples raised within 3 km of the mill site. In Section 2.2.2 of the TR, the applicant only addressed crop production within the Permit Area. Consistent with Regulatory Guides 4.14 and 3.46, please provide the results of crop sample analyses or a justification for not collecting crop samples. In this response, please describe actions taken by the applicant to determine the agricultural use of adjacent lands, including vegetable gardens.

TR RAI 2.9-12 Response

The following information will be incorporated into Section 2.9 of the revised TR.

Powertech's original assessment of land use for food sources did not identify any vegetable gardens within 3.3 km of the project area. More recently, Powertech has determined that vegetable gardens are present in the town of Dewey and at one location within the project area as shown on Figure TR RAI 2.9-11-1 in the response to TR RAI 2.9-11. Due to the large sample size (> 10 lbs) typically required to satisfy Regulatory Guide 4.14 suggested LLDs for vegetation and the relatively small size of the vegetable gardens, Powertech is proposing the following alternate approach to sampling vegetables from local gardens.

Powertech proposes to sample vegetable garden soil rather than the vegetables themselves and then apply plant-to-soil concentration factors to estimate the radionuclide concentrations in vegetables. Methods and parameters contained in NUREG-5512 (NRC, 1992a) are proposed to estimate radionuclide concentrations in root and leafy vegetables based on soil radionuclide concentrations. Equation 1, obtained from Section 5 (Equation 5.5) of NUREG-5512, will be used to calculate vegetable concentration factors as follows:

$$C_{svhj} = 1000\left(ML_v + B_{JV}\right)W_v \ \{AC_{sj}, t_{gv}\}/C_{sj} \qquad \text{(Equation 1)}$$

Where:

C_{svhj} = concentration factor for radionuclide *j* in plant *v* at harvest from an initial unit concentration of parent radionuclide *i* in soil (pCi/kg wet-weight plant per pCi/g dry-weight soil)

B_{JV} = concentration factor for uptake of radionuclide *j* from the soil in plant *v* (pCi/kg dry-weight plant per pCi/g dry-weight soil)

ML_v = plant soil mass-loading factor for resuspension of soil to plant *v* (pCi/kg dry-weight plant per pCi/g dry-weight soil)

W_v = dry to wet-weight conversion factor (unitless)

$\{AC_{sj}, t_{gv}\}$ = decay operator notation used to develop the concentration of radionuclide *j* in soil at the end of the crop growing period t_{gv} (pCi/g dry-weight)

C_{sj} = concentration of radionuclide *j* in soil during the growing period (pCi/g dry-weight)

$C_{sj}(0)$ = initial concentration of radionuclide *j* in soil during the growing period (pCi/g dry-weight)

t_{gv} = growing period for food crop (d)

1000 = unit conversion factor (g/kg)

The radionuclides recommended for analysis in vegetation in Regulatory Guide 4.14 are natural uranium, thorium-230, radium-226, lead-210, and polonium-210. These radionuclides, with the exception of polonium-210, have long half-lives when compared to the growing season; therefore, the decay correction during the growing season can be ignored for these parameters. For polonium-210, the initial soil concentration and soil concentration during the growing season will be assumed identical. This assumption will allow simplification of Equation 1 to Equation 2.

$$C_{svhj} = 1000(ML_v + B_{JV})W_v \quad \text{(Equation 2)}$$

Table TR RAI 2.9-12-1 presents the parameters that will be used to estimate wet-weight vegetable concentrations from dry-weight soil concentrations.

Table TR RAI 2.9-12-1: Parameters that Will Be Used to Estimate Wet-Weight Vegetable Concentrations from Dry-Weight Soil Concentrations

Parameter	Parameter Description	Plant Type	Radionuclide	Value	Unit
ML_v	Mass loading factor	Root Vegetables	Parameter is not radionuclide specific.	0.1	pCi/kg dry-weight plant per pCi/g dry-weight soil
		Leafy Vegetables			
		Fruits			
B_{JV}	Concentration factor for root uptake	Root vegetables	Natural uranium	0.014	pCi/kg dry-weight plant per pCi/g dry-weight soil
			Thorium-230	0.00012	
			Radium-226	0.0032	
			Lead-210	0.0032	
			Polonium-210	0.009	
		Leafy Vegetables	Natural uranium	0.017	
			Thorium-230	0.0025	
			Radium-226	0.075	
			Lead-210	0.0058	
			Polonium-210	0.0025	
		Fruits	Natural uranium	0.004	
			Thorium-230	0.000085	
			Radium-226	0.0061	
			Lead-210	0.009	
			Polonium-210	0.0004	
W_v	Dry weight to wet weight conversion factor	Root Vegetables	Not radionuclide specific	0.2	Unitless
		Leafy Vegetables		0.25	
		Fruits		0.18	

<u>TR RAI 2.9-13</u>
In Section 2.2.2 of the TR, the applicant has identified livestock, poultry, and their products but did not analyze and sample them as recommended in Regulatory Guide 4.14 Section 1.1.3, "Vegetation, Food and Fish Samples." Consistent with Regulatory Guides 4.14 and 3.46, please analyze and provide results for appropriate food samples. In this response, please describe actions taken by the applicant to determine the agricultural use of adjacent lands.

<u>TR RAI 2.9-13 Response</u>
The revised TR Section 2.9 will include the following additional information.

Powertech has identified two types of livestock grazing within 3.3 km of the project area. They include free ranging pigs and cattle (refer to the response to TR RAI 2.9-11). While chickens also are present within 3 km of the project area, they are fed grains not originating from the project area and are not considered grazing animals. Therefore, Powertech does not propose to sample chickens.

Section 1.1.3 of Regulatory Guide 4.14 states:

"At least three samples should be collected at time of harvest or slaughter or removal of animals from grazing for each type of crop (including vegetable gardens) or livestock raised within three kilometers of the mill site."

Powertech's interpretation of Regulatory Guide 4.14 was to collect three samples from three of each type of animal. Therefore, three samples were originally collected from one locally grazed cow. Pursuant to NRC staff interpretation that three samples should be collected from each type of livestock, the following actions have been performed or will be performed prior to ISR operations:

- Samples from one additional cow have been analyzed for the recommended analytes in Regulatory Guide 4.14.
- Powertech commits to sampling one additional cow prior to ISR operations, bringing the total to three.
- Samples from one free ranging, locally grazed pig have been analyzed for the recommended analytes in Regulatory Guide 4.14.
- Powertech commits to sampling two additional pigs prior to ISR operations, bringing the total to three.

The results of all food samples available to date are shown in revised Table 2.9-19 provided below. The revised table also will be included in the revised TR.

Table 2.9-19: Baseline Radionuclide Concentrations in Local Food

Sample ID	Radionuclide	Parameter	Result
DBAT-01 (Meat sample from locally grazed cow, June 2008)	U-nat (µCi/kg)	Concentration	< 7.0E-06
		Error ± 2σ	-
		LLD	7.0E-06
	Ra-226 (µCi/kg)	Concentration	3.0E-06
		Error ± 2σ	2.0E-06
		LLD	3.0E-06
	Th-230 (µCi/kg)	Concentration	0.0
		Error ± 2σ	2.0E-05
		LLD	8.0E-06
	Pb-210 (µCi/kg)	Concentration	-7.0E-06
		Error ± 2σ	4.0E-05
		LLD	7.0E-06
	Po-210 (µCi/kg)	Concentration	8.0E-06
		Error ± 2σ	1.0E-04
		LLD	8.0E-06
DBAT-02 (Meat sample from locally grazed cow, June 2008)	U-nat (µCi/kg)	Concentration	ND
		Error ± 2σ	-
		LLD	7.0E-06
	Ra-226 (µCi/kg)	Concentration	6.0E-05
		Error ± 2σ	3.0E-05
		LLD	4.0E-05
	Th-230 (µCi/kg)	Concentration	0.0
		Error ± 2σ	1.4E-03
		LLD	1.0E-04
	Pb-210 (µCi/kg)	Concentration	2.0E-04
		Error ± 2σ	7.0E-04
		LLD	1.2E-03
	Po-210 (µCi/kg)	Concentration	0.0
		Error ± 2σ	1.2E-03
		LLD	1.0E-04
DBAT-03 (Liver sample from locally grazed cow, June 2008)	U-nat (µCi/kg)	Concentration	< 7.0E-06
		Error ± 2σ	-
		LLD	7.0E-06
	Ra-226 (µCi/kg)	Concentration	3.0E-06
		Error ± 2σ	1.0E-06
		LLD	2.0E-06
	Th-230 (µCi/kg)	Concentration	0.0
		Error ± 2σ	1.0E-04
		LLD	6.0E-06
	Pb-210 (µCi/kg)	Concentration	-7.0E-06
		Error ± 2σ	4.0E-05
		LLD	6.0E-05
	Po-210 (µCi/kg)	Concentration	2.0E-05
		Error ± 2σ	2.0E-04
		LLD	6.0E-06

Table 2.9-19: Baseline Radionuclide Concentrations in Local Food (Continued)

Sample ID	Radionuclide	Parameter	Result
Pork (April 2011)	U-nat (µCi/kg)	Concentration	8.1E-06
		Error ± 2σ	-
		LLD	2.0E-07
	Ra-226 (µCi/kg)	Concentration	7.9E-07
		Error ± 2σ	1.6E-07
		LLD	1.4E-07
	Th-230 (µCi/kg)	Concentration	-1.7E-05
		Error ± 2σ	4.4E-06
		LLD	7.2E-06
	Pb-210 (µCi/kg)	Concentration	-3.4E-07
		Error ± 2σ	1.0E-06
		LLD	1.7E-06
Beef (April 2011)	U-nat (µCi/kg)	Concentration	2.3E-06
		Error ± 2σ	-
		LLD	2.0E-07
	Ra-226 (µCi/kg)	Concentration	6.0E-07
		Error ± 2σ	1.5E-07
		LLD	1.4E-07
	Th-230 (µCi/kg)	Concentration	1.8E-06
		Error ± 2σ	2.6E-06
		LLD	4.9E-06
	Pb-210 (µCi/kg)	Concentration	1.1E-06
		Error ± 2σ	6.3E-07
		LLD	4.4E-07

Note: U-nat analyzed using ICP-MS; therefore, error estimate is not available.

TR RAI 2.9-14
In Section 2.2.2 and 2.8.5.4.2 (pages 2-267) of the TR, the applicant identified game animals (pronghorn, wild turkey, etc.) but these were not analyzed as recommended in Regulatory Guide 4.14. Consistent with Regulatory Guide 4.14, please provide results of game animal sample analyses or a justification for not collecting them.

TR RAI 2.9-14 Response
The following discussion will be provided in the revised TR.

Powertech interpreted Regulatory Guide 4.14 as requiring animal tissue sample analysis for livestock only, particularly in light of recently approved NRC license applications (e.g., Moore Ranch ISR Project, SUA-1596) that have not provided game animal tissue sample analyses. Specifically, Regulatory Guide 4.14 states, "At least three samples should be collected at time of harvest or slaughter or removal of animals from grazing for each type of crop (including vegetable gardens) or livestock raised within 3.3 km of the mill site." As additional justification, the migratory nature and relatively large home range of game animals observed in the area in relation to the size of the project area make it difficult to relate radionuclide concentrations to a particular site.

TR RAI 2.9-15
In Section 2.2.2 of the TR, the applicant stated that hunting is currently open to the public on 5,689 acres within the Permit Area. The applicant also stated that prior to commencement of operations all hunting will be prohibited within the Permit Boundary. However, the applicant has not addressed how the applicant will prohibit hunting on public lands. Please provide this information.

TR RAI 2.9-15 Response
The following clarifies current and future hunting access within the project area. This information will be included in Section 2.2.2 of the revised TR.

Recreational use in and around the Dewey-Burdock project area is limited primarily to large game hunting. Within the project area, hunting is currently open to the public on approximately 5,700 acres. Approximately 240 acres are public lands managed by the Bureau of Land Management (BLM). In addition, the South Dakota Department of Game, Fish and Parks (SDGF&P) leases around 3,000 acres annually of privately owned land that is designated as walk-in hunting areas (WIA). The number of acres designated as WIA can change from year to year, since participants enroll their lands annually.

The WIAs are on privately owned lands. The state WIA program compensates private landowners annually for use of the lands enrolled in the program. Landowners must renew their agreement with the State each year by May 1. Rules related to the program prohibit the firing of a firearm within 100 yards of a person or a structure. The landowner can terminate the program at any time with a written notice 30 days prior to termination and reimbursement of the annual compensation.

Prior to commencement of operations, Powertech will work with BLM, SDGF&P and private landowners to limit hunting within the project area to the extent practicable. Temporary fencing, signage, gates and other means of restricting public access will be installed in areas of active ISR operations such as well fields, processing plants and land application areas in order to protect the public, protect workers, prevent damage to facilities, and provide security.

According to 43 CFR 3802.4, the owner of a mining claim may restrict public recreational use of/or public access across claims or portions of claims that are actively used for prospecting, mining, or processing operations in the following situations:

1) Where public recreational use of a claim would endanger or materially interfere with legitimate mining pursuits; or
2) In cases where the mining operation is hazardous and could lead to personal injury. The claimant may protect his mining equipment and operations area with appropriate signs or other lawful means.

Radiation exposure to hunters is not likely to occur, since they would normally be at least 100 yards from buildings such as the CPP, Satellite Facility, and header houses. Consequently, the risk to a hunter in or near the project area from radiation sources would always be less than that to a worker.

<u>TR RAI 2.9-16</u>

The applicant collected three tissue samples, one liver and two meat samples, from one cow instead of one sample each from three different cows as recommended in Regulatory Guide 4.14. The applicant should provide the sample results of cows consistent with Regulatory Guide 4.14 or justification for not providing them.

<u>TR RAI 2.9-16 Response</u>

As described in the response to TR RAI 2.9-13, Powertech has collected additional samples from locally grazed cows and pigs and commits to sampling one additional cow and two additional pigs prior to ISR operations, bringing the total number of each animal sampled to three. This will meet the guidance in Regulatory Guide 4.14 for sampling livestock raised within 3.3 km of the project area.

TR RAI 2.9-17

Please address the following issues regarding Table 2.9-19 (page 2-378) of the TR and Table 10-1 in Appendix 2.9-A of the TR:

TR RAI 2.9-17(a)

a. ***Reporting format is not consistent with Regulatory Guide 4.14, Section 7.5.***

TR RAI 2.9-17(a) Response

Table 2.9-19 has been revised and is included with the response to TR RAI 2.9-13. Table 10-1 in Appendix 2.9-A will be similarly revised and included with the revised TR. However, the revisions included adding the additional beef and pork sample results and not modifying the format. The following discussion indicates why the reporting format of Table 2.9-19 and Table 10-1 in Appendix 2.9-A of the TR is consistent with Regulatory Guide 4.14, Section 7.5. This discussion will be incorporated into Section 2.9 of the revised TR.

Tables 2.9-19 of the TR and 10-1 in Appendix 2.9-A of the TR are in a format consistent with Regulatory Guide 4.14, Section 7.5 with the exception of data reported for natural uranium (U-nat), which cannot be reported in this format due to the quantification method used. U-nat concentrations in tissue were evaluated using EPA Method SW6020, which uses ICP-MS and is not a radiochemical method. The data were reported in units of mg/kg and subsequently converted to units of activity by using the specific activity for natural uranium of 6.77×10^{-4} µCi/mg. The "ND" values previously reported in the two tables referenced above should have been reported as < 7.0E-6 µCi/kg, which is the natural uranium reporting limit. This correction has been made in revised Table 2.9-19 and will be made to Table 10-1 in Appendix 2.9-A in the revised TR. Error estimates are not evaluated on an individual sample basis using EPA Method SW6020, which is why no error estimates are presented in Tables 2.9-19 of the TR and 10-1 in Appendix 2.9-A of the TR for individual samples. EPA Method SW6020 discusses controlling analytical error by evaluating laboratory control samples such as Matrix Spikes (MS) and Matrix Spike Duplicates (MSD) and establishing control limits for accuracy and precision. The data reported in the above mentioned tables met Energy Laboratories Inc. internal quality control measures.

TR RAI 2.9-17

Please address the following issues regarding Table 2.9-19 (page 2-378) of the TR and Table 10-1 in Appendix 2.9-A of the TR:

TR RAI 2.9-17(b)

b. ***Lower Levels of Detection (LLD) are significantly higher than Regulatory Guide 4.14, Section 5, Recommendations.***

TR RAI 2.9-17(b) Response

Powertech's health and safety based justification for alternatives to the LLDs recommended in Regulatory Guide 4.14, Section 5 for radionuclides in tissue samples is described below. This discussion will be incorporated into the revised TR.

The current use of the data in Table 2.9-19 of the TR and Table 10-1 in Appendix 2.9-A of the TR is to provide a pre-operational baseline concentration of radionuclides in beef tissue. Data contained in Table 2.9-19 of the TR and Table 10-1 in Appendix 2.9-A of the TR are not affected by the response to this RAI.

NUREG/CR-4007 (NRC, 1984) states that any measurement process must be capable of detecting the relevant radionuclides at levels well below those of concern to the public health and safety. Powertech is not aware of regulatory limits for radionuclides in food items to evaluate the appropriate sensitivity of the analytical methods used. For justification purposes herein, it was assumed that 10 percent of the total effective dose equivalent public dose limit of 100 mrem per year in 10 CFR 20 would be an appropriate comparison for food items.

Equation 1 was used to determine the concentration in food products, in this case beef, that would result in a dose equivalent of 10 percent of the public dose limit standard in 10 CFR 20. Table TR RAI 2.9-17b-1 shows the results of the radionuclide concentrations in beef that meet this criteria and the dose conversion factors used.

$$\boldsymbol{C_i = \frac{10\ mrem/yr}{IxDCF_i}} \qquad \text{(Equation 1)}$$

Where:

C_i = Concentration of radionuclide (i) in beef that would result in dose equivalent of 1.25 mrem/y (µCi/kg)

10 mrem = 10% of 10 CFR 20 public dose limit of 100 mrem/year (CEDE)

DCFi = Dose Conversion Factor for ingestion of radionuclide (i) (mrem/µCi) [Federal Guidance Report 11 (EPA, 1988)]

I = Beef intake rate for adult (27 kg/y) [Data Collection Handbook, (ANL, 1993)]

Table TR RAI 2.9-17b-1: Effective Dose Conversion Factors Used in and Results for Equation 1

Radionuclide	DCF (mrem/µCi)	Concentration (µCi/kg)
Natural uranium*	283	1.3×10^{-3}
Thorium-230	548	6.8×10^{-4}
Radium-226	1,325	2.8×10^{-4}
Lead-210	5,365	6.9×10^{-5}
Polonium-210	1,902	1.9×10^{-4}

* DCF for Uranium-234 was used since it is the most restrictive of the three uranium isotopes in natural uranium

Based on the justification above, LLDs for beef tissue should be below the concentrations presented in Table TR RAI 2.9-17b-1. A comparison of the baseline monitoring program results indicates that all but one LLD for beef tissue (Pb-210 in DBAT-02) was below the concentration values in the table. Powertech has submitted an additional beef sample for laboratory analysis and commits to sampling a third locally grazed cow prior to ISR operations. The goal will be to meet the LLDs contained in Regulatory Guide 4.14, but in no case will reported LLDs be greater than values contained in Table TR RAI 2.9-17b-1.

<u>TR RAI 2.9-17</u>

Please address the following issues regarding Table 2.9-19 (page 2-378) of the TR and Table 10-1 in Appendix 2.9-A of the TR:

<u>TR RAI 2.9-17(c)</u>

*c. **The LLDs for meat are substantially different from each other***

TR RAI 2.9-17(c) Response

The following information describes why the LLDs for the meat samples, collected as part of the baseline monitoring program, varied significantly. The information presented below will be incorporated into the revised TR.

The meat LLDs are substantially different from each other because of differences in matrix interference, sample size, and low radionuclide concentrations within the sample matrix. The potential for this result is acknowledged in NUREG/CR-4007, which states that “the critical (decision) level and detection limit (LLD) really do vary with the nature of the sample” and that “proper assessment of these quantities demands relevant information on each sample, unless the variations among samples are quite trivial” (NRC, 1984).

TR RAI 2.9-18

Please clarify what types of vegetation were included in the vegetation sampling and state whether this includes forage samples.

TR RAI 2.9-18 Response

TR Section 2.9 and/or 2.8.5.1 will be revised to indicate that grasses were the only type of forage sampled for radionuclide concentrations as described below.

Grass is the primary animal forage vegetation within the project area. Therefore, consistent with Regulatory Guide 4.14, grasses were the only type of forage vegetation sampled during background radiological characterization.

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<u>TR RAI 2.9-19</u>

In Section 2.8.5.6.1.2.1 of the TR, the applicant has identified grazing areas within the Permit Area, but it is not clear that they were analyzed as recommended by Regulatory Guide 4.14. Please clarify if identified grazing areas were analyzed as recommended by Regulatory Guide 4.14.

<u>TR RAI 2.9-19 Response</u>

Vegetation samples were collected from representative grazing areas in sectors near the air monitoring stations (AMS). These stations were placed in areas predicted to have the highest airborne concentrations due to ISR operations. This is consistent with Table 1 in Regulatory Guide 4.14, which indicates that radiological sampling will be conducted in grazing areas having the highest predicted air particulate concentrations during milling operations. TR Section 2.9 will be revised to indicate that vegetation samples were collected as recommended by Regulatory Guide 4.14.

TR RAI 2.9-20

On page 2-280 of the TR, the applicant states that fish sampling sites BVC04 and CHR05 can be identified on Plate 2.5-1. NRC staff could not locate these sites on Plate 2.5-1. However, these sites can be found on Figure 2.9-11 of the TR. Please correct this discrepancy in the TR.

TR RAI 2.9-20 Response

Sampling locations BVC04 and CHR05 are not within the scale of Plate 2.5-1. The TR will be revised to reference Figure 2.9-11 or another appropriate figure instead of Plate 2.5-1.

TR RAI 2.9-21

Section 1.1.3 of Regulatory Guide 4.14 recommends that fish (if any) samples should be collected semiannually from any bodies of water that may be subject to seepage or surface drainage from potentially contaminated areas. Please confirm whether the applicant ruled out the presence of fish in all impoundments, and, if not, please provide the results of fish samples from those impoundments

TR RAI 2.9-21 Response

TR Section 2.8.5.6.1, Aquatic Species and Habitats, will be modified to include the following.

Based on conversations with area landowners and the South Dakota Department of Game, Fish and Parks (SDGF&P), there are no known fish populations in any impoundments within the project area or in any impoundments outside of the project area but immediately downstream from proposed activities within the project area. Field verification of the presence or absence of fish was not made for the relatively small and often dry impoundments within and immediately downstream from the project area.

Powertech reviewed and discussed the fish sampling plan with SDGF&P. SDGF&P expressed far greater interest in the potential impacts to flowing water (i.e., Beaver Creek and the Cheyenne River) rather than ephemeral streams such as Pass Creek, ephemeral impoundments, or mine pits. Therefore, an alternative fish sampling program that did not include sampling impoundments was developed in cooperation with SDGF&P due to the ephemeral nature of most streams and impoundments within the project area and the absence of known fish populations in impoundments within the project area. Results of the fish sampling are summarized in revised Table 2.8-23, which accompanies this RAI response package and is discussed in the response to TR RAI RI-4(a).

TR RAI 2.9-22

In Section 2.9.2.1.1 GPS based gamma survey transects were spaced at approximately 500 m intervals in the main project area and 100 m in the surface mine area (Page 2-308). The 500 m spacing does not appear to comport with RG 4.14 or with recently published data by Whicker, et. al (2008). According to this study, 100 m spacing represents approximately 14% ground coverage. It is also recommended that areas of interest receive 25%-100% ground coverage. The typical vehicle spacing for this is reported as 20-30 m (35%-45% coverage). Please provide technical justification for the 500 m spacing used by the applicant.

TR RAI 2.9-22 Response

The following discussion will be incorporated into Section 2.9.2 (Baseline GPS-Based Gamma Survey) of the revised TR.

Regulatory Guide 4.14 recommends a total of 80 direct radiation measurements at 150 m (492 ft) intervals up to a distance of 1,500 m (4,921 ft) in eight directions from the center or 5 or more direct radiation measurements at the locations used for collection of particulate samples once prior to site construction. As an alternative to the Regulatory Guide 4.14 guidance, Powertech co-located TLDs with the air particulate samplers and collected additional direct radiation measurements (gamma-ray surveys) using ATVs as discussed below. The number of direct gamma measurements collected by Powertech (157,057) greatly exceeds the number recommended in Regulatory Guide 4.14 (80).

The gamma transect spacing was intentionally small when surveying suspected radiologically anomalous areas. A larger spacing (500 m) was used for areas not anticipated to be impacted by naturally occurring radioactive materials (NORM), and a smaller spacing (100 m) was used for known or potential NORM impacted areas. While this work was done prior to the cited publication, Powertech believes that the methods are similar to and consistent with that publication. Whicker et al. did not recommend transect spacing. They reported typical transect spacing that they used for certain situations (including surveys for cleanup). Powertech does not believe that the authors intended to establish a standard method. The measure of success for the gamma survey is determined by asking the questions: did the survey adequately determine the mean and variance of the exposure rates for areas within the site, and did it identify areas with highly varying exposure rates commonly referred to as anomalous areas? Powertech believes that the answer to both questions is yes.

The technical justification for the 500-meter transect spacing is based on the assumption that mineralized ore outcrops were not anticipated in areas where this transect spacing was used. Therefore, non-impacted areas were expected to be made up of large areas of different soil types or large fields having a unique history of fertilizer applications, if any. The characteristic sizes of these areas were expected to be large compared to 500 meters.

Data from the surveys were evaluated at the end of each day to determine whether the gamma count rates were consistent with the assumptions. Data anomalies were investigated and, where appropriate, the transect spacing and areal extent of the survey were changed to bound the anomaly. During the survey, an exposure-rate anomaly near a flowing artesian well was discovered and additional measurements were made to delineate the area. The data also showed that a region at the north end of the site had a slightly higher average exposure rate. However, an evaluation in the field indicated that the variance was not high and that this anomalous region was due to different geology. Also the gamma survey boundary was extended in the Surface Mine Area so that an anomaly on the original survey boundary could be bounded. These daily evaluations of the data and changes to the survey density were made to correct for small departures from the conditions that were assumed when developing the plans.

TR RAI 2.9-23

Consistent with Regulatory Guide 4.14, please describe the criteria, and basis for the criteria, used to determine the acceptability of the daily function tests performed on the sodium iodide detectors provided in Appendix 2.9-A of the TR. Using these criteria, please comment on the following specific examples and provide missing data where necessary.

Date	4410 Serial #	Efficiencies
9/14/07	PR118372	0.5% (6:50 am) 0.3% (8:20 pm different configuration)
9/14/07	PR198936	0.64% (6:50 am reported as 0.7%) 0.57% (8:30 pm)
7/18/08	PR198936	2nd daily function check not recorded

TR RAI 2.9-23 Response

Appendix 2.9-A of the TR will be revised to include a description of the criteria (including the basis for the criteria) used to evaluate the acceptability of the daily function tests as described below.

The detector systems used during the September 2007 gamma ray survey performed in a consistent manner each day throughout the survey period, as indicated by coefficients of variation (CVs) much lower than allowed under ANSI standards. Regulatory Guide 4.14 allows direct measurements to be made with "properly calibrated portable survey units." Since Regulatory Guide 4.14 does not provide acceptance criteria for function checks, Powertech used those provided in ANSI N323A-1997, Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments (ANSI, 1997). Section 4.8 of this standard states, "To ensure proper operation of the instrument between calibrations, each instrument (with the exception of neutron instruments and high-dose equivalent rate photon instruments) shall be checked with a source during operation at least daily or prior to each intermittent use, whichever is less frequent. If at any time the instrument response to the source differs from the reference reading by more than ±20% (for any photon instrument the reading should be at least ten times background), the instrument shall be returned to the calibration facility for calibration or for maintenance, repair, and recalibration, as required. Reference readings shall be obtained for each instrument when exposed to a source in a constant and reproducible manner, either at the time that the instrument is received in the field or before its first use." For the discussion that follows, it is assumed that ±20 percent is equivalent to a CV (CV = standard deviation/mean value) of 0.20/3 standard deviations = 0.067. This is the criterion used to evaluate the acceptability of daily function tests in accordance with ANSI N323A-1997.

The response changes for a normally functioning instrument used in the gamma survey occur primarily as a result of small changes in the high voltage of the digital rate meter. These changes may be induced by large changes in the temperature but are normally smaller than the allowable 20 percent change

mentioned above. These changes are not source or count-rate dependent and thus they affect the background count rates as well as the count rate from a source. It unfortunately took four days before problems with the function check method were identified and rectified (September 13-17, 2007). The detectors were function-checked while mounted on the ATVs with the source placed on the ground. Larger deviations than normal in the net count rates resulted primarily from changes in the detector height from tire pressure changes and possibly due to the suspension systems of the ATVs. The procedure was changed on September 18, 2007 by removing the detectors and placing them at a fixed distance from the source, resulting in a CV = 0.02 for the 14 measurements taken during the last 7 days for both detector systems. No measurements were outside of the ±20 percent limit (i.e., 0.067).

During the initial four-day period when the various procedures were applied in conducting the function checks, the data support that the morning checks differed by less than 20 percent from the checks made at the end of the day. Unfortunately, the function check for PR118372 at the end of the day on September 14, 2007 was not performed the same distance from the source as the function check at the beginning of the day, thus making a comparison impossible.

As stated above, performance changes in the detector systems will be reflected in changes in the background readings. The background count rates are less dependent on detector placement and therefore, in this case, may be used to evaluate whether the detectors were functioning properly each day. An analysis of the background count rate data taken the first four days of the survey shows that the detector systems have similar means, with CVs of 0.05 and 0.04. Background data for the last seven days of the survey were almost identical with the means differing by less than 3 percent from those during the first four days, with CVs of 0.04 for each detector system. All data were within ±20 percent of the mean. Therefore, one can conclude that the detector systems used during September 2007 performed in a consistent manner each day throughout the survey period, with CVs much lower than allowed under ANSI N323A-1997.

To address the question regarding the missing function check data for July 18, 2008, a review of the field log books shows that the survey instruments were function-checked in the morning but not used on that day. No follow-up function check was performed nor needed.

TR RAI 2.9-24

Regulatory Guide 4.14 recommends that direct radiation measurements be made at sites chosen for air particulate samples. As discussed in RAI # 1 in this section, the applicant has not provided sufficient information to demonstrate that the placement of the air monitoring stations is consistent with RG 4.14. Therefore, there is not sufficient information to determine if the placement of TLDs at air monitoring stations is consistent with RG 4.14. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 2.9.3(1) provides the criteria used to establish TLD monitoring locations or indicate where this information can be found in the TR.

TR RAI 2.9-24 Response

As stated in the response to TR RAI 2.9-1, the criteria used to establish air particulate sampling locations, and consequently the TLD monitoring locations, include the following factors:

1) Average meteorological conditions such as wind speed, wind direction and atmospheric stability
2) Prevailing wind direction
3) Site boundaries nearest to proposed facility processing areas, land application areas, and well fields
4) Direction of nearest occupiable structure
5) Location of estimated maximum concentrations of radioactive materials
6) Location of existing features near or within the proposed license boundary, but unrelated to proposed site activities, that may impact background radiological conditions (e.g., railroads and historic surface mines)
7) Location of nearest multiple resident area or town

The response to TR RAI 2.9-1 concludes that the locations of air monitoring stations meet the siting criteria recommended in Regulatory Guide 4.14. On this basis the TLD monitoring locations also meet the siting criteria recommended in Regulatory Guide 4.14.

<u>TR RAI 2.9-25</u>

NRC staff could not locate the laboratory reports for TLD results in the TR. Please provide this information or indicate where these can be found in the application.

<u>TR RAI 2.9-25 Response</u>

The analytical reports for the TLDs were mistakenly omitted from Appendix 2.9-A of the TR. The analytical reports are provided as Appendix 2.9-C, a copy of which is included with this RAI response package. Included at the beginning of Appendix 2.9-C is an index sheet listing the TLD analytical reports by sample location and monitoring period. Appendix 2.9-C also will be included with the revised TR.

TR RAI 2.9-26

Section 2.9.5.2.1 of the TR states that AMS-01 was monitored for 303 days. However, Table 2.9-10 in the TR and Table 9-1 in Appendix 2.9-A of the TR indicate that this station was monitored for only approximately 164 days. Please clarify and provide documentation for the monitoring period for AMS-01.

TR RAI 2.9-26 Response

TR Section 2.9.5 and TR Appendix 2.9-A will be revised to correct the monitoring period for AMS-01 as described below.

The TLD monitoring period for AMS-01 was 164 days, not 303 days as previously indicated in TR Section 2.9.5.2.1 and Table 9-1 of Appendix 2.9-A. The documentation for the AMS-01 monitoring period is included in Appendix 2.9-C.

TR RAI 2.9-27

As the examples in the table below demonstrate, the ambient gamma dose rates provided in Table 2.9-10 in the TR indicate a significantly higher dose rate during the third time period (5/17/08 – 7/17/08) compared to the other measuring periods.

Station	Dose rates (mrem/day)	
	2nd Measurement Period	3rd Measurement Period
AMS-01	0.36	0.96
AMS-06	0.35	0.85
AMS-BKG	0.39	0.975

TR RAI 2.9-27(a)

a. Please provide justification that a TLD monitoring period for less than one full year is consistent with 10 CFR 40, Appendix A, Criterion 7. Specifically, please demonstrate that complete baseline data, including expected variations in gamma dose rates, has been provided in accordance with 10 CFR 40, Appendix A, Criterion 7, and as recommended by Regulatory Guide 4.14.

TR RAI 2.9-27(a) Response

Section 1.1.5 of Regulatory Guide 4.14 recommends that gamma exposure rate measurements be made at the sites chosen for air particulate samples and gives examples of how these measurements can be made (e.g., TLDs, properly calibrated portable survey instruments, or pressurized ionization chambers). However, Regulatory Guide 4.14 gives no recommendation regarding the frequency or duration of these measurements. Table 1 of Regulatory Guide 4.14 recommends the gamma exposure rate measurement frequency to be once prior to construction, with no specific recommendation on measurement duration. If Regulatory Guide 4.14 is the acceptance criteria for Criterion 7 of 10 CFR 40, then the baseline gamma exposure rate measurement requirement has been met.

Powertech believes that the 11-month TLD monitoring period provides a good measure of the expected baseline annual external dose equivalent rates. In addition, baseline gamma survey data have been collected across the project area using a GPS-based survey system. These baseline gamma-ray survey data are considered the most useful baseline exposure rate data since the gamma emission rates are mapped for the entire project area.

The TLD results as revised (see discussion in the response to TR RAI 2.9-27(b)) compare favorably with the baseline direct gamma-ray survey data for the project area when expressed in exposure rate units, microRoentgen per hour (µR/h). The average exposure rate from the project area gamma survey was reported in the TR as 10.9 µR/h. Since one Roentgen is approximately equal to one rem, 10.9 µR/h can be expressed as approximately 96 mrem/year. This is close to the 109 mrem/year average for the four monitoring locations reported in revised TR Table 2.9-10 provided in the response to TR RAI 2.9-27(b). A

discussion of the expected variations of the gamma exposure rate is provided in the response to TR RAI 2.9-27(b).

TR RAI 2.9-27

As the examples in the table below demonstrate, the ambient gamma dose rates provided in Table 2.9-10 in the TR indicate a significantly higher dose rate during the third time period (5/17/08 – 7/17/08) compared to the other measuring periods.

Station	Dose rates (mrem/day)	
	2nd Measurement Period	3rd Measurement Period
AMS-01	0.36	0.96
AMS-06	0.35	0.85
AMS-BKG	0.39	0.975

TR RAI 2.9-27(b)

b. Referring to the above table, please update the discussion on ambient gamma dose rate monitoring, taking into account the variability of the data and the lack of data collected over an entire year.

TR RAI 2.9-27(b) Response

Powertech has re-evaluated the gamma dose rate data obtained from TLDs and corrected some entry errors. During this re-evaluation, it was discovered that the dose equivalent rates had not considered the dose that occurred during transit and while waiting to be deployed or processed. Based on the re-evaluation, the dose equivalent rates were adjusted downward, by assuming that the dose rate for a TLD when not deployed was equal to the dose rate during deployment. This assumption is believed to be reasonable since all TLDs were deployed at locations believed to be background for the project area. Since the third monitoring period was the shortest, this adjustment significantly reduced the previously reported dose equivalent rates for this period compared to the other periods. Errors were also discovered regarding the monitoring dates in Period 1, which should have been reported as beginning on 8/15/07 rather than 9/18/07.

Tables 2.9-10 and 9-1 below present the individual exposure rates for periods for which data are available. The missing data occurred because the TLDs were not retrievable due to theft or, more likely, damage/interference by cattle. Experience at other sites has shown that cattle are attracted to the plastic protective covers of the TLDs and tend to chew on them, resulting in TLD damage. Where data are available, there is good agreement between the relative dose equivalent rates per period for all stations. Calculations show that the average rates are 0.30, 0.26, and 0.36 mrem/day for the first, second, and third measurement periods. While variations with time in cosmic radiation occur in an unpredictable manner, variations in the terrestrial component are known to occur and depend primarily on the amount of soil moisture, vegetation cover, and snow cover. All of these factors attenuate gamma-ray emissions and reduce the dose equivalent rate. The first two monitoring periods cover fall, winter and spring while the third period is in the summer. It is reasonable to assume that the higher

average dose equivalent rates for summer are a result of lower soil moisture and no snow cover. While late summer storms can produce relatively high rainfall events, they are generally of short duration and do not greatly affect average soil moisture. It seems reasonable that the average daily dose rate for the unmonitored 29-day period could best be approximated by that of the third monitoring period. The projected annual dose equivalent at each monitoring station was calculated where the data are complete by assuming that the 29-day period had the same average dose equivalent rate as the respective third monitoring period. Section 2.9.5.2.1 of the TR and Sections 9.2 and 11.0 of Appendix 2.9-A will be revised as follows.

Revisions to Section 2.9 of the Technical Report

2.9.5.2.1 Ambient Gamma Dose Rate Monitoring

Ambient exposure rates were determined for three periods using TLDs supplied and analyzed by Landauer, Inc. The monitoring periods were: August 15, 2007 to February 4, 2008, February 4 to May 17, 2008, and May 17 to July 17, 2008. The 29-day period between July 17 and August 15 that would complete the year was not monitored.

The TLDs were deployed at each of the eight AMS locations. Duplicates were deployed at AMS-01 and the background location (AMS-BKG). Five of the nine TLDs deployed in the August 2007 to February 2008 period were lost, presumably by way of cattle disturbance. Two additional TLDs were lost from subsequent deployments, presumably as a result of cattle in the area.

The ambient gamma dose rate monitoring results are listed in Table 2.9-10. All reported dose equivalents were converted to an adjusted dose rate by dividing by the time between the shipment of the dosimeters to the site and the time that the dosimeters were processed by the vendor. In order to obtain an estimate of the annual dose equivalent rate, the average daily dose rate for the 29-day period (July 17, 2008-August 15, 2008) which was not monitored was assumed equal to the May 17, 2008 to July 17, 2008 period. This is reasonable since terrestrial dose rates for a location primarily depend on soil moisture and snow and vegetation cover. For locations where TLDs were missing, no attempt was made to obtain an annual projected dose equivalent. The results for the TLDs reported in millirem per year (mrem/yr) ambient dose equivalents are as follows:

- AMS-04: 112 mrem/yr
- AMS-05: 91 mrem/yr
- AMS-07: 109 mrem/yr
- AMS-BKG: 123 mrem/yr

The range of exposure rates (91 to 123 mrem/yr) and average (109 mrem/yr) are similar to average worldwide exposures to natural radiation sources comprised of cosmic radiation, cosmogenic radionuclides, and external terrestrial radiation reported in the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report to the General Assembly, Sources and Effects of Ionizing Radiation, Annex. The typical ranges of average worldwide exposures reported in this reference document are from 60 to 160 mrem/yr.

The TLD results compare favorably with the baseline direct gamma-ray survey data for the site reported in Section 2.9.2.1.1 when expressed in exposure rate units (µR/h) as reported in Section 2.9.2.2.2, where the average exposure rate was reported as 10.9 microRoentgen/h (µR/h). Since a Roentgen is approximately equal to a rem, 10.9 µR/h can be expressed as 96 mrem/yr. This is very close to the 109 mrem/y average for the four monitoring locations.

Table TR RAI 2.9-10: Ambient Gamma Dose Rates

Location	Starting Date	End Date	Dose (mrem)	Adjusted Dose Rate (mrem/day)[b]	Projected Annual Dose (mrem)
AMS-01	8/15/07	2/4/08	-	NC	NC
	2/4/08	5/17/08	37.2[a]	0.260	
	5/17/08	7/17/08	57.7[a]	0.412	
AMS-02	8/16/07	2/4/08	-	NC	NC
	2/4/08	5/17/08	-	NC	
	5/17/08	7/17/08	54.0	0.386	
AMS-03	8/15/07	2/4/08	-	NC	NC
	2/4/08	5/17/08	38.6	0.270	
	5/17/08	7/17/08	-	NC	
AMS-04	8/15/07	2/4/08	62.4	0.297	112
	2/4/08	5/17/08	36.1	0.252	
	5/17/08	7/17/08	54.3	0.388	
AMS-05	8/15/07	2/4/08	50.6	0.241	91
	2/4/08	5/17/08	36.7	0.257	
	5/17/08	7/17/08	36.4	0.260	
AMS-06	8/15/07	2/4/08	-	NC	NC
	2/4/08	5/17/08	36.9	0.258	
	5/17/08	7/17/08	51.1	0.365	
AMS-07	8/15/07	2/4/08	73.7	0.351	109
	2/4/08	5/17/08	35.5	0.248	
	5/17/08	7/17/08	36.1	0.258	
AMS-BKG	8/15/07	2/4/08	68.8[a]	0.328	123
	2/4/08	5/17/08	40.5[a]	0.283	
	5/17/08	7/17/08	58.5[a]	0.418	

Notes:

[a] Result is average of measurement plus duplicate.

[b] Dose rate adjusted by dividing the reported dose by the time from vendor shipment of dosimeters to site and the time dosimeters were processed.

NC = Not Calculated due to missing data

Revisions to Section 9 of Appendix 2.9-A

9.2 Ambient Exposure Rates Determined using Thermoluminescent Detectors

Ambient exposure rates were determined for three periods using TLDs supplied and analyzed by Landauer, Inc. The monitoring periods were: August 15, 2007 to February 4, 2008, February 4 to May 17, 2008, and May 17 to July 17, 2008. The 29-day period between July 17 and August 15 that would complete the year was not monitored.

The TLDs were deployed at each of the eight AMS locations. Duplicates were deployed at AMS-01 and the background location (AMS-BKG). Five of the nine TLDs deployed in the August 2007 to February 2008 period were lost, presumably by way of cattle disturbance. Two additional TLDs were lost from subsequent deployments, presumably as a result of cattle in the area.

The ambient gamma dose rate monitoring results are listed in Table 9-1. All reported dose equivalents were converted to an adjusted dose rate by dividing by the time between the shipment of the dosimeters to the site and the time that the dosimeters were processed by the vendor. In order to obtain an estimate of the annual dose equivalent rate, the average daily dose rate for the 29-day period (July 17, 2008-August 15, 2008) which was not monitored was assumed equal to the May 17, 2008 to July 17, 2008 period. This is reasonable since terrestrial dose rates for a location primarily depend on soil moisture and snow and vegetation cover. For locations where TLDs were missing, no attempt was made to obtain an annual projected dose equivalent. The results for the TLDs reported in millirem per year (mrem/yr) ambient dose equivalents are as follows:

- AMS-04: 112 mrem/yr
- AMS-05: 91 mrem/yr
- AMS-07: 109 mrem/yr
- AMS-BKG: 123 mrem/yr

The range of exposure rates (91 to 123 mrem/yr) and average (109 mrem/yr) are similar to average worldwide exposures to natural radiation sources comprised of comic radiation, cosmogenic radionuclides, and external terrestrial radiation reported in the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report to the General Assembly, Sources and Effects of Ionizing Radiation, Annex. The typical ranges of average worldwide exposures reported in this reference document are to 60 to 160 mrem/yr.

The TLD results compare favorably with the baseline direct gamma-ray survey data reported in Section 3 when expressed in exposure rate units (µR/h) as reported in Section 9.1, where the average exposure rate was reported as 10.9 microRoentgen/h (µR/h). Since a Roentgen is approximately equal to a rem, 10.9 µR/h can be expressed as 96 mrem/year. This is very close to the 109 mrem/yr average for the four monitoring locations reported above.

Table TR RAI 9-1: Ambient Gamma Dose Rates using TLDs

Location	Starting Date	End Date	Dose (mrem)	Adjusted Dose Rate (mrem/day)[b]	Projected Annual Dose (mrem)
AMS-01	8/15/07	2/4/08	-	NC	NC
	2/4/08	5/17/08	37.2[a]	0.260	
	5/17/08	7/17/08	57.7[a]	0.412	
AMS-02	8/16/07	2/4/08	-	NC	NC
	2/4/08	5/17/08	-	NC	
	5/17/08	7/17/08	54.0	0.386	
AMS-03	8/15/07	2/4/08	-	NC	NC
	2/4/08	5/17/08	38.6	0.270	
	5/17/08	7/17/08	-	NC	
AMS-04	8/15/07	2/4/08	62.4	0.297	112
	2/4/08	5/17/08	36.1	0.252	
	5/17/08	7/17/08	54.3	0.388	
AMS-05	8/15/07	2/4/08	50.6	0.241	91
	2/4/08	5/17/08	36.7	0.257	
	5/17/08	7/17/08	36.4	0.260	
AMS-06	8/15/07	2/4/08	-	NC	NC
	2/4/08	5/17/08	36.9	0.58	
	5/17/08	7/17/08	51.1	0.365	
AMS-07	8/15/07	2/4/08	73.7	0.351	109
	2/4/08	5/17/08	35.5	0.248	
	5/17/08	7/17/08	36.1	0.258	
AMS-BKG	8/15/07	2/4/08	68.8[a]	0.328	123
	2/4/08	5/17/08	40.5[a]	0.283	
	5/17/08	7/17/08	58.5[a]	0.418	

Notes:

[a] Result is average of measurement plus duplicate.

[b] Dose rate adjusted by dividing the reported dose by the time from vendor shipment of dosimeters to site and the time dosimeters were processed.

NC = Not Calculated due to missing data

Revisions to Section 11.0 of Appendix 2.9-A

The last bullet in Section 11.0 of Appendix 2.9-A will be revised as follows:

- Baseline ambient exposure rates, as determined using TLDs, range from 91 to 123 mrem/yr.

TR RAI 2.9-27

As the examples in the table below demonstrate, the ambient gamma dose rates provided in Table 2.9-10 in the TR indicate a significantly higher dose rate during the third time period (5/17/08 – 7/17/08) compared to the other measuring periods.

Station	Dose rates (mrem/day)	
	2nd Measurement Period	3rd Measurement Period
AMS-01	0.36	0.96
AMS-06	0.35	0.85
AMS-BKG	0.39	0.975

TR RAI 2.9-27(c)

c. In Section 2.9.2.1.1 of the TR, it is stated that the applicant collected GPS-based gamma dose rate data during two different time periods: September 2007 and July 2008. Additional data was collected for the land application area from July 17-19, 2008. These time periods appear to have potentially significantly different background gamma dose rate attributes. It appears that the applicant combined the data from these different time periods without accounting for the variations in background. Please address the following:

i) It is not clear which areas were surveyed during the July 14-16, 2008 timeframe. Please provide information on precisely which locations were surveyed and the corresponding dates.
ii) Considering the variations in expected gamma dose rates during different times of the year, please explain how the statistics for the GPS-based gamma ray surveys are affected by combining these different time periods. In your response, address the test for normality (and other types of distributions) of the data, transformations of the data, the identification of outliers, and the test for variance of the Main Permit Area, the anomalous north area and the Surface Mine Area.
iii) Considering the variations in expected gamma dose rates during the year, please explain how these variations will be taken into account when performing post reclamation and decommissioning radiological surveys to ensure appropriate action levels are established (e.g., that contamination above regulatory limits is detected).

TR RAI 2.9-27(c) Response

The following discussion will be incorporated into the revised TR.

i: The initial GPS-based gamma survey was performed in the Main Permit Area and Surface Mine Area using 500-meter and 100-meter transect spacing, respectively, from September 13-27, 2007. The boundary of the Main Permit Area was later extended to the southwest. Refer to revised TR Figure 2.9-6 provided with the response to TR RAI 2.9-32(b) for the locations of the Main Permit Area and Surface Mine Area. The 500-meter survey lines were extended south to this new boundary by mobilizing to the site and conducting the survey on July 14, 2008. Work continued from July 17-19, 2008, where additional data within the Land Application Areas were obtained to comply with the desire to have data on 100-meter transect spacing therein. Transects at a spacing of 100 meters were added within the previously determined 500-meter transects within the Land Application Areas only. Land Application

Areas are depicted on revised Exhibit 3.1-2. Tables 2.9-10 of the TR and 9-1 in Appendix 2.9-A indicate the locations of gamma-ray surveys. TR Section 2.9 and Appendix 2.9-A will be revised to clarify the locations and dates of the gamma-ray surveys, including providing figures that differentiate 2007 and 2008 survey data points using different colors.

ii: The first issue to address is whether the data from 2007 and 2008 may be combined because of possible different background count rates. A search for overlapping 2007/2008 areas was completed, concentrating on overlap areas considered free of anomalies. Ten areas of overlapping data (within 3 feet) were identified and corresponding count rates were recorded and compared, as shown in Table TR RAI 2.9-27c-1. The results confirm that the survey instruments produced count rates that were similar, with a mean ratio of the two count rates of 1.01 and a maximum difference of any two data points of 15 percent. An Anderson-Darling test was done to see if the differences of the paired data were of a normal distribution. The results of the Anderson-Darling test for normality yielded a p-value of 0.093 (cannot reject normal distribution hypothesis). Then a paired t-test was performed to determine whether the differences were significantly different from 0. The results of the paired t-test were a p-value of 0.787 (cannot reject zero-difference hypothesis), an average difference of 84 cpm, and a 95% confidence interval on the average difference of (-603 cpm, 772 cpm). In summary, the two data sets are not statistically different from one another and combining the data sets has no impact on the statistics when summarizing the gamma count rate in and around the project area.

Table TR RAI 2.9-27c-1: Data Pairs from 2007 and 2008 Gamma Surveys

Location	2007 Count Rate (cpm)	2008 Count Rate (cpm)	Ratio 2007:2008
1	12,721	14,985	0.85
2	12,060	11,309	1.07
3	12,186	11,299	1.08
4	11,958	11,562	1.03
5	15,016	15,074	1.00
6	13,358	13,752	0.97
7	13,829	13,970	0.99
8	12,685	12,207	1.04
9	15,788	14,633	1.08
10	12,979	12,945	1.00
		Mean	1.01

A significant effort was made to match the instrument responses to background radiation and radiation sources prior to deployment for the 2007 survey. In preparing for the 2008 survey, the instrument performances were again matched to one another and to the performances of the instruments used in 2007. Since the instrument responses in background areas were the same for the 2007 and 2008

surveys, Powertech concludes that the background radiation was very similar for the two surveys and that merging the data was appropriate.

A statistical evaluation of the total data set and sets of data corresponding to defined areas was presented in the Baseline Radiological Report (TR Appendix 2.9-A), including tests for normality and log transforms. All frequency distributions were found to be nonparametric, and conventional approaches were used to describe these distributions. Powertech does not believe that a test of variance of the three defined areas would add meaningful information to the discussion regarding the Main Permit Area, the anomalous north area, and the Surface Mine Area since the anomalous north area and the Surface Mine Area were evident as different from the remainder of the Main Permit Area, based on historical use and geological features.

iii: 10 CFR Part 40, Appendix A, Criterion 6(6) decommissioning regulations limit the radionuclide concentrations in soil. Compliance with the cleanup criteria is based on laboratory analysis of soil samples. While it is true that gamma-ray action levels are used to identify anomalies, the accuracy of the action levels is known to be limited, due to changes in background count rates, vertical distribution and aerial extent of radionuclides, soil moisture, and other factors. Experience has shown that results of gamma surveys cannot be reliably interpreted if done when there is excessive soil moisture. This limitation in itself reduces the variation in background count rates during cleanup operations. Action levels are conservatively set and periodically revaluated during cleanup, especially when known changes may influence gamma-ray emissions. The confidence lines of correlations such as in those shown in Figures 5-1 and 5-2 in TR Appendix 2.9-A are useful in establishing conservative gamma-ray action levels. Normally the application of these conservatively chosen action levels results in cleanup to near background levels, in accordance with NRC's ALARA policy.

<u>TR RAI 2.9-28</u>

In Section 2.9.5.2.1 of the TR, the applicant excludes AMS-02 when discussing exposure rates. Please provide justification for excluding this data point.

<u>TR RAI 2.9-28 Response</u>

Section 2.9.5.2.1 of the TR will be revised based on re-evaluation of the TLD data as indicated in the response to TR RAI 2.9-27 (a-c). External dose equivalent rate data for AMS-02 was included in this re-evaluation. TLDs at the stations AMS-01, AMS-02, AMS-03, and AMS-06 were eaten or otherwise removed by cattle or humans for one or more of the monitoring periods. In re-evaluating the data, it was decided not to attempt to compute an annual average dose equivalent rate for these stations. Instead Powertech relied on the extensive set of exposure rate data predicted from the GPS-based gamma surveys. The gamma-ray count rates were converted to exposure rates by developing a correlation with data from a pressurized ionization chamber (PIC). Using the project area-wide (excluding the Surface Mine Area) average predicted exposure rate (10.9 μR/hr) from the correlation, an annual dose equivalent rate was calculated for the project area (10.9*8,760 hrs/yr/1,000 = 96 mrem). As indicated in the revisions to TR Section 2.9.5.2.1 provided with the response to TR RAI 2.9-27(b), the annual gamma dose rate for the project area (96 mrem) agrees well with the 109 mrem annual measured dose equivalent rate from the TLD data at the four monitoring stations where the data sets are complete.

External dose equivalent rate data from TLDs at Monitoring Stations AMS-04, AMS-05, AMS-07, and AMS-BKG are considered complete. As described in the response to TR RAI 2.9-27(b), the annual average dose equivalent rates for these four stations range from 91 to 123 mrem and average 109 mrem. These stations are located to the north, southwest, and south of the project area, not near the historical surface mining area or other known elevated exposure rate anomalies.

TR RAI 2.9-29

In Section 2.9.5.2.1 of the TR, the applicant presents the projected dose for AMS-03. It appears that the reported dose underestimates the true dose due to the fact that data was only collected during what appears to be the minimum dose rate time period. Provide technical justification that the projected dose for AMS-03 is a valid estimate of the actual dose at this monitoring station.

TR RAI 2.9-29 Response

Section 2.9.5.2.1 of the TR will be revised based on re-evaluation of the TLD data as indicated in the response to TR RAI 2.9-27 (a-c). External dose equivalent rate data for AMS-03 was included in this re-evaluation. TLDs at the stations AMS-01, AMS-02, AMS-03, and AMS-06 were eaten or otherwise removed by cattle or humans for one or more of the monitoring periods. In re-evaluating the data, it was decided not to attempt to compute an annual average dose equivalent rate for these stations. Instead Powertech relied on the extensive set of exposure rate data predicted from the GPS-based gamma surveys. The gamma-ray count rates were converted to exposure rates by developing a correlation with data from a pressurized ionization chamber (PIC). Using the project area-wide (excluding the Surface Mine Area) average predicted exposure rate (10.9 μR/hr) from the correlation, an annual dose equivalent rate was calculated for the project area (10.9*8,760 hrs/yr/1,000= 96 mrem). As indicated in the revisions to TR Section 2.9.5.2.1 provided with the response to TR RAI 2.9-27(b), the annual gamma dose rate for the project area (96 mrem) agrees well with the 109 mrem annual measured dose equivalent rate from the TLD data at the four monitoring stations where the data sets are complete.

External dose equivalent rate data from TLDs at Monitoring Stations AMS-04, AMS-05, AMS-07, and AMS-BKG are considered complete. As described in the response to TR RAI 2.9-27(b), the annual average dose equivalent rates for these four stations ranges from 91 to 123 mrem and averages 109 mrem. These stations are located to the north, southwest, and south of the project area, not near the historical surface mining area or other known elevated exposure rate anomalies.

<u>TR RAI 2.9-30</u>

In Section 2.9.2.2.1 of the TR and Section 3.2 of Appendix 2.9-A of the TR, the applicant discusses outliers in the gamma-ray count rate data. Regarding the identification of outliers, NRC staff has consulted the statistical reference cited by the applicant (Ott and Longnecker 2001) and has not found justification for using the interquartile range (IQR) method as a sole means of proving outliers. According to Ott and Longnecker (2001, p. 86), "…the IQR does not provide sufficient useful information about a single set of measurements, but can be quite useful when comparing the variabilities of two or more data sets." This approach is consistent with other statistical sources (e.g., NIST 2006). Further, in their discussion of boxplots, Ott and Longnecker (2001, p. 100) recommend carefully examining and checking the extreme values of the measurement. Lastly, NIST (2006) discusses nonnormal distributions that may be expected to have extreme values at larger rates than for a normal distribution. One example is the Cauchy distribution. Please provide the following:

<u>TR RAI 2.9-30(a)</u>

- ***a. Documentation for all statistical analyses (histograms, data transformations, etc.) performed on the GPS-based gamma surveys, including outputs from statistical software packages, or indicate where these can be found in the application.***

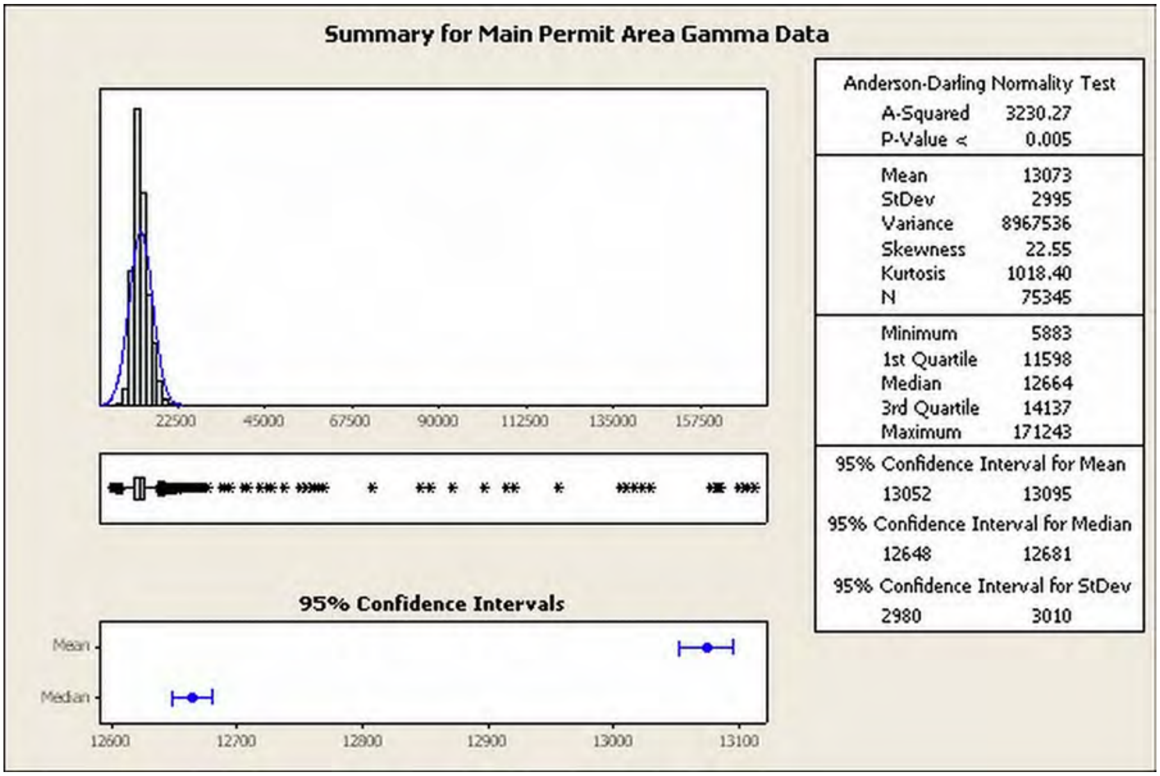
<u>TR RAI 2.9-30(a) Response</u>

The gamma data from the Main Permit Area, Surface Mine Area, and both land application areas (Dewey and Burdock) were analyzed separately with the statistical software package Minitab, version 15.1.1.0. TR Section 2.9.2 and Appendix 2.9 of the TR will be revised to incorporate the following output graphs from Minitab. Refer to the response to TR RAI 2.9-35(a) for additional explanation of the statistical methods.

<u>Main Permit Area</u>

The gamma data from the Main Permit Area were tested for a normal distribution. Figure TR RAI 2.9-30a-1 displays the results of the test as well as a histogram and statistical summary of the data. The p-value demonstrates that the gamma data from the Main Permit Area are not normally distributed.

Figure TR RAI 2.9-30a-1: Summary of Statistics and Normality Test of Gamma Data from the Main Permit Area (in cpm).



The data were then tested for lognormal and exponential distributions. Figures TR RAI 2.9-30a-2 and TR RAI 2.9-30a-3 show the results of the tests for lognormal and exponential distributions, along with their respective probability plots. The p-values demonstrate that the data are not lognormally or exponentially distributed.

Figure TR RAI 2.9-30a-2: Statistical Results and Probability Plot of the Test for Lognormal Distribution on Gamma Data from the Main Permit Area.

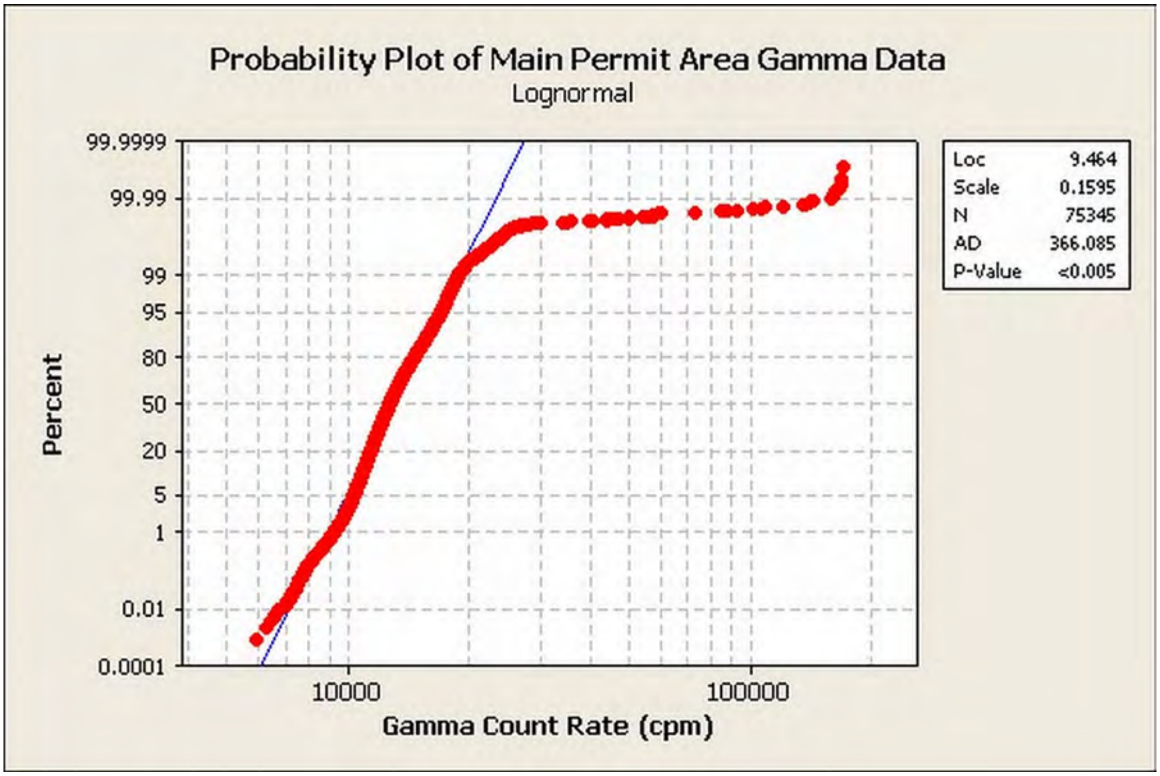
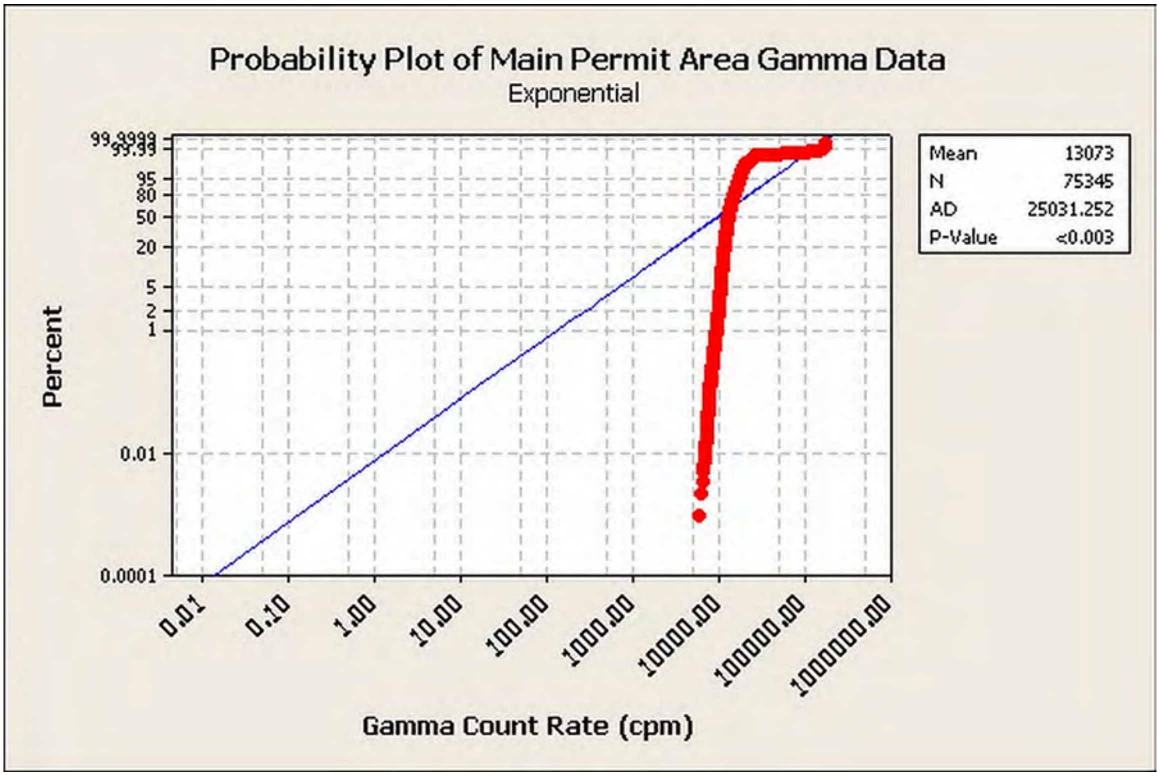
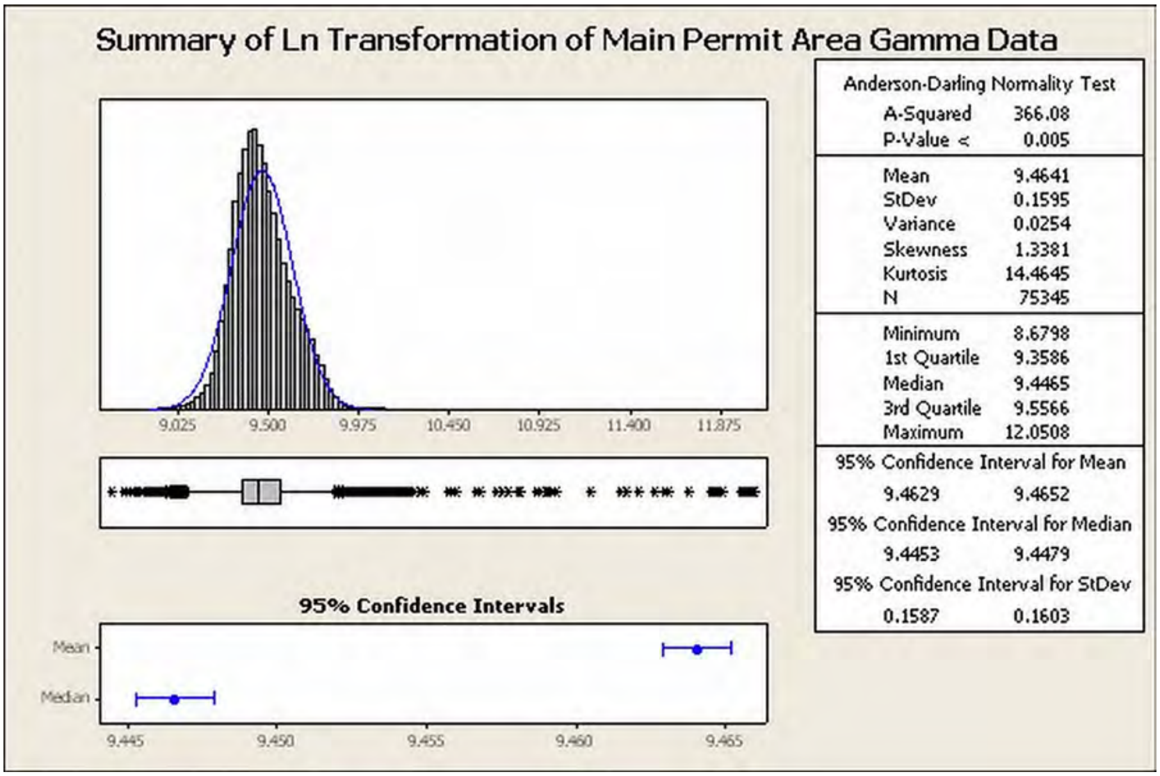


Figure TR RAI 2.9-30a-3: Statistical Results and Probability Plot of the Test for Exponential Distribution on Gamma Data from the Main Permit Area.



Each value in the set of data was transformed by taking its natural logarithm and the transformed data set was tested for a normal distribution. Figure TR RAI 2.9-30a-4 displays the results of the test as well as a histogram and statistical summary of the transformed data. The test shows that the transformed data are not normally distributed.

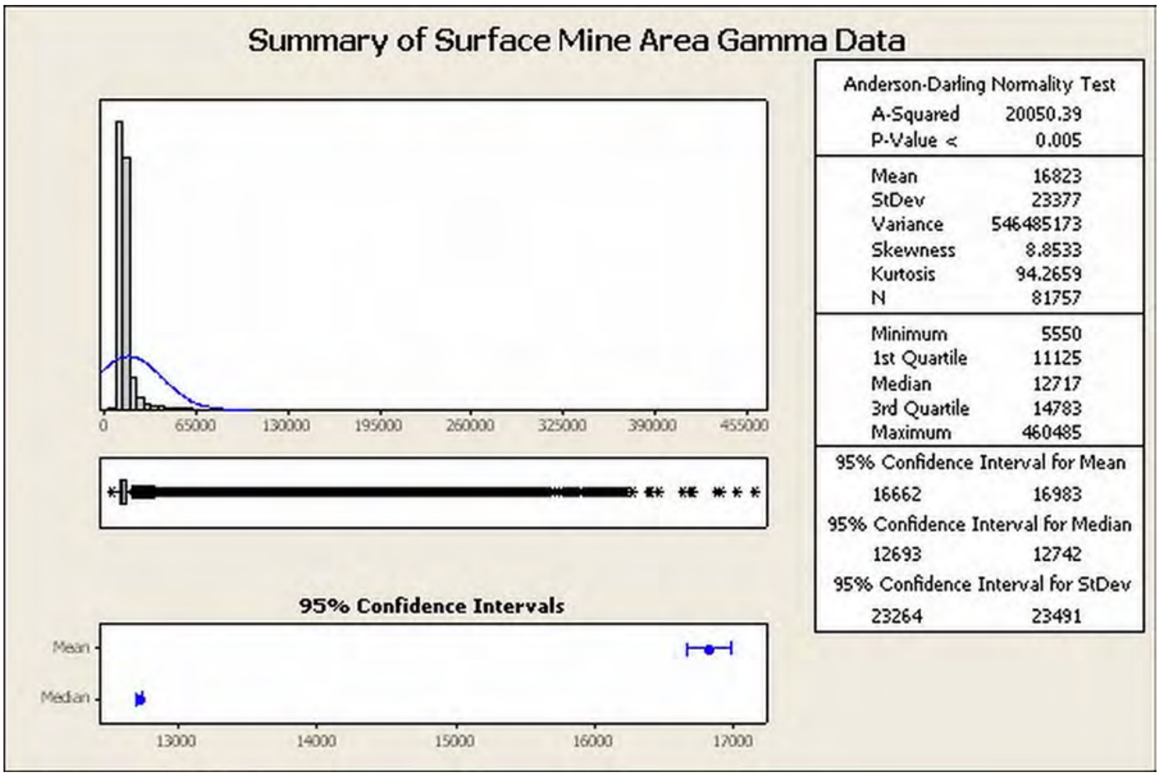
Figure TR RAI 2.9-30a-4: Summary of Statistics and Normality Test of Transformed Gamma Data from the Main Permit Area.



Surface Mine Area

The gamma data from the Surface Mine Area was tested for a normal distribution. Figure TR RAI 2.9-30a-5 displays the results of the test as well as a histogram and statistical summary of the data. The test shows that the gamma data for the Surface Mine Area are not normally distributed.

Figure TR RAI 2.9-30a-5: Summary of Statistics and Normality Test of Gamma Data from the Surface Mine Area (in cpm).



The data were then tested for lognormal and exponential distributions Figures TR RAI 2.9-30a-6 and TR RAI 2.9-30a-7 show the statistical results and probability plots of the tests for lognormal and exponential distributions. The p-values show that the gamma data from the Surface Mine Area are not lognormally or exponentially distributed.

Figure TR RAI 2.9-30a-6: Statistical Results and Probability Plot of the Test for Lognormal Distribution on Gamma Data from the Surface Mine Area.

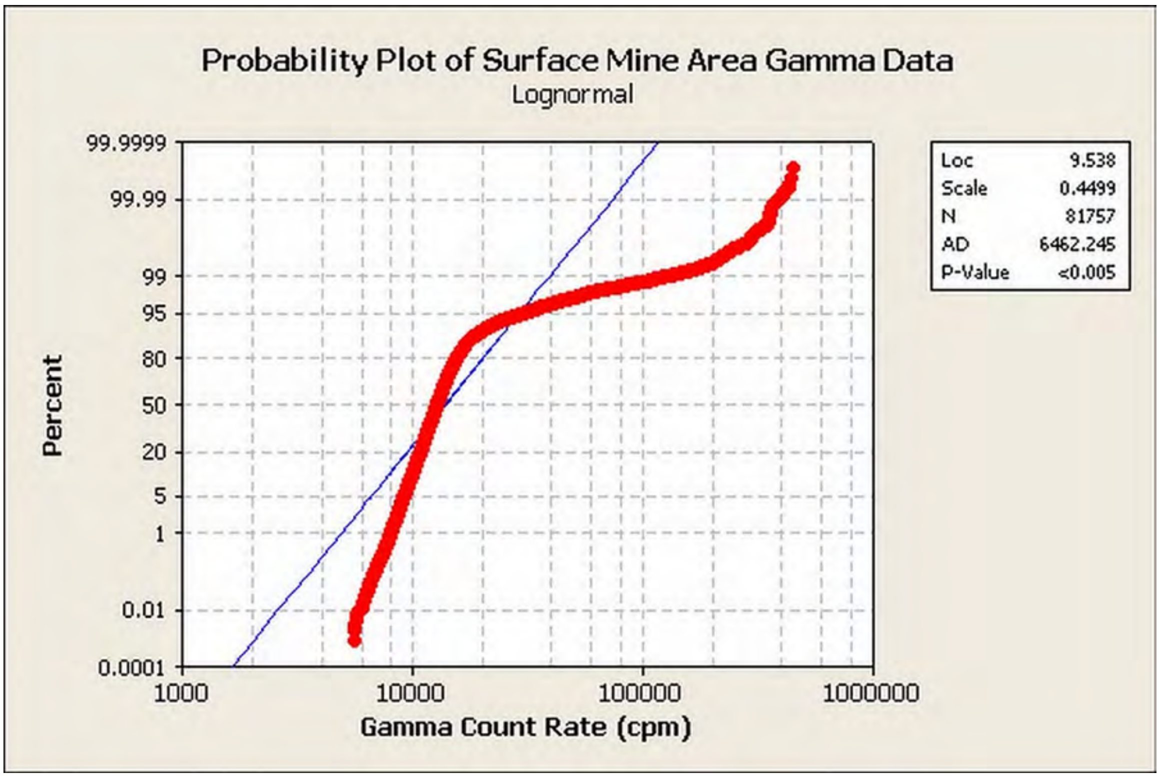
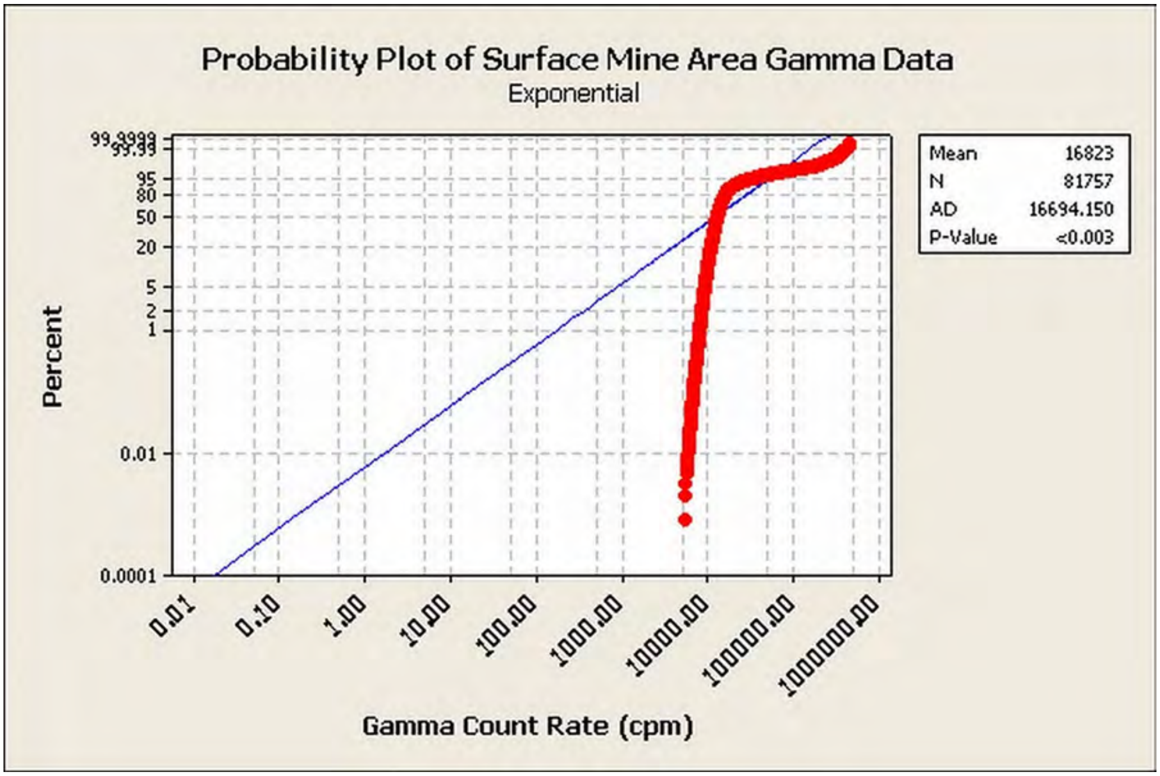
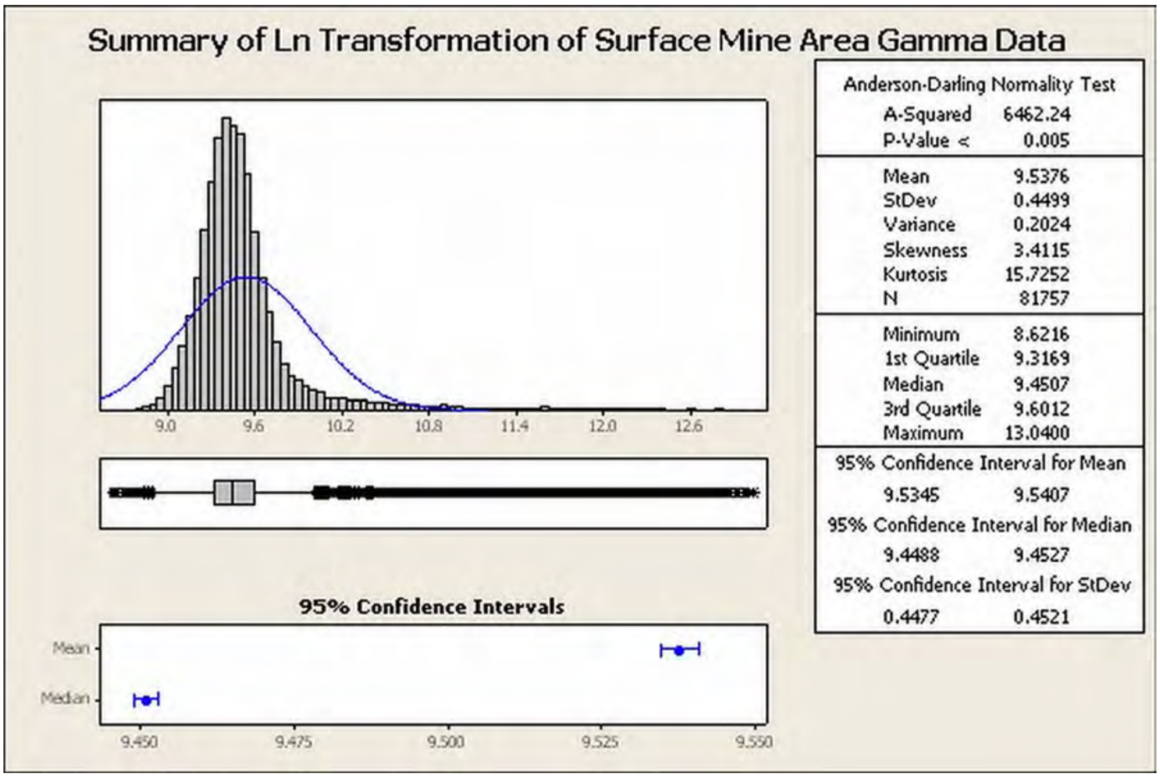


Figure TR RAI 2.9-30a-7: Statistical Results and Probability Plot of the Test for Exponential Distribution on Gamma Data from the Surface Mine Area.



Each value in the set of data was transformed by taking its natural logarithm and the transformed data were tested for a normal distribution. Figure TR RAI 2.9-30a-8 displays the results of the test as well as a histogram and statistical summary of the transformed data. The normality test shows that the transformed gamma data from the Surface Mine Area are not normally distributed.

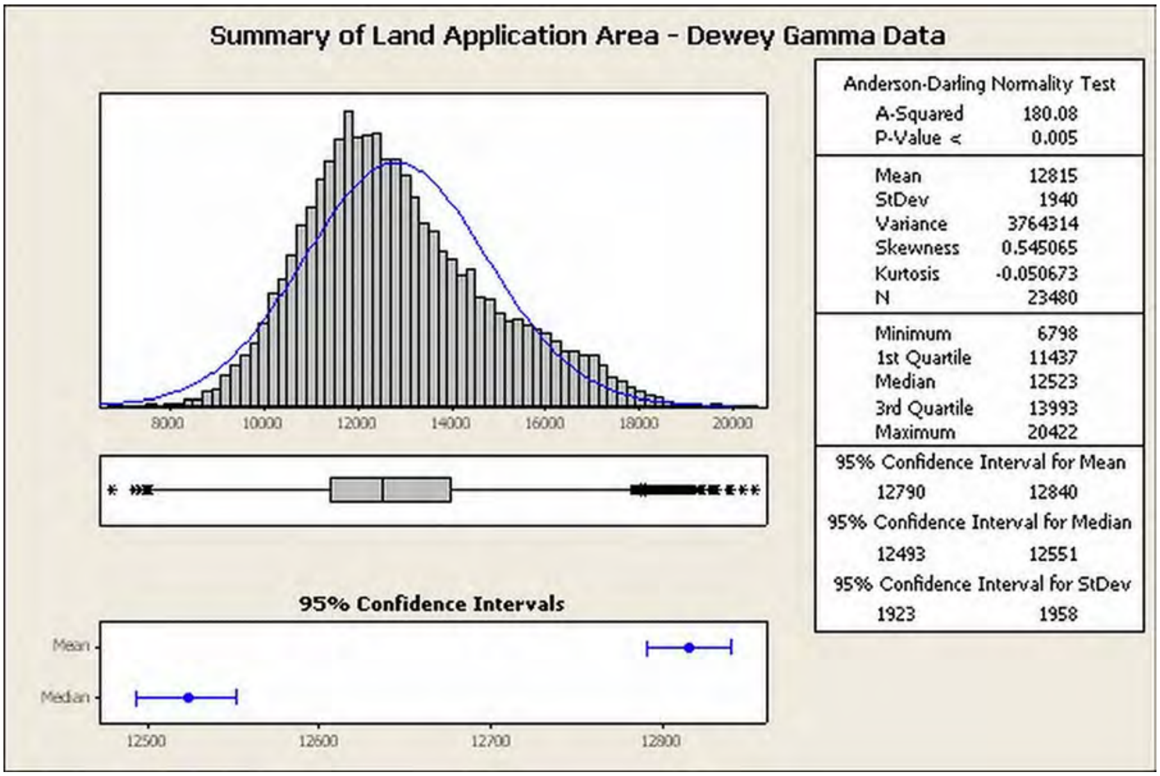
Figure TR RAI 2.9-30a-8: Summary of Statistics and Normality Test of Transformed Gamma Data from the Surface Mine Area.



Dewey Land Application Area

The gamma data from the Dewey Land Application Area was tested for a normal distribution. Figure TR RAI 2.9-30a-9 displays the results of the test as well as a histogram of the data. The normality test shows that the data are not normally distributed.

Figure TR RAI 2.9-30a-9: Summary of statistics and normality test of gamma data from the Dewey Land Application Area (in cpm).



The data were then tested for lognormal and exponential distributions. Figures TR RAI 2.9-30a-10 and TR RAI 2.9-30a-11 show the statistical results and probability plots of the tests for lognormal and exponential distributions. These figures show that the data are not lognormally or exponentially distributed.

Figure TR RAI 2.9-30a-10: Statistical Results and Probability Plot of the Test for Lognormal Distribution on Gamma Data from the Dewey Land Application Area.

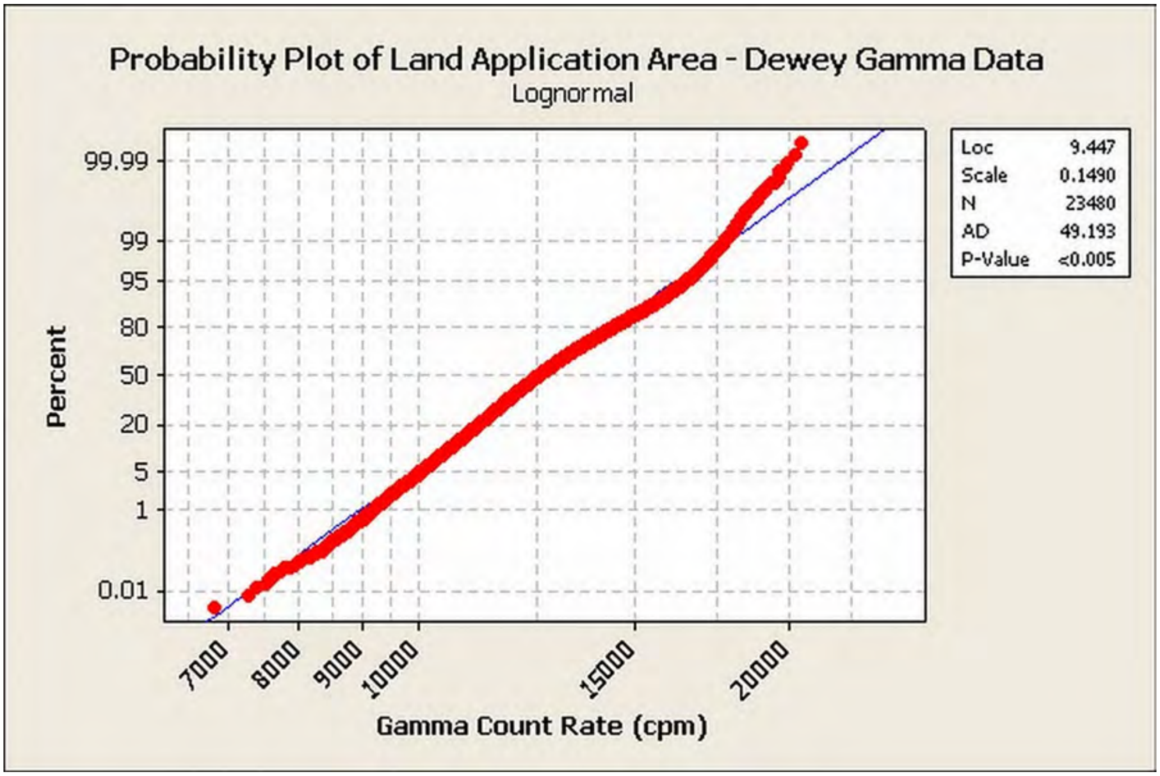


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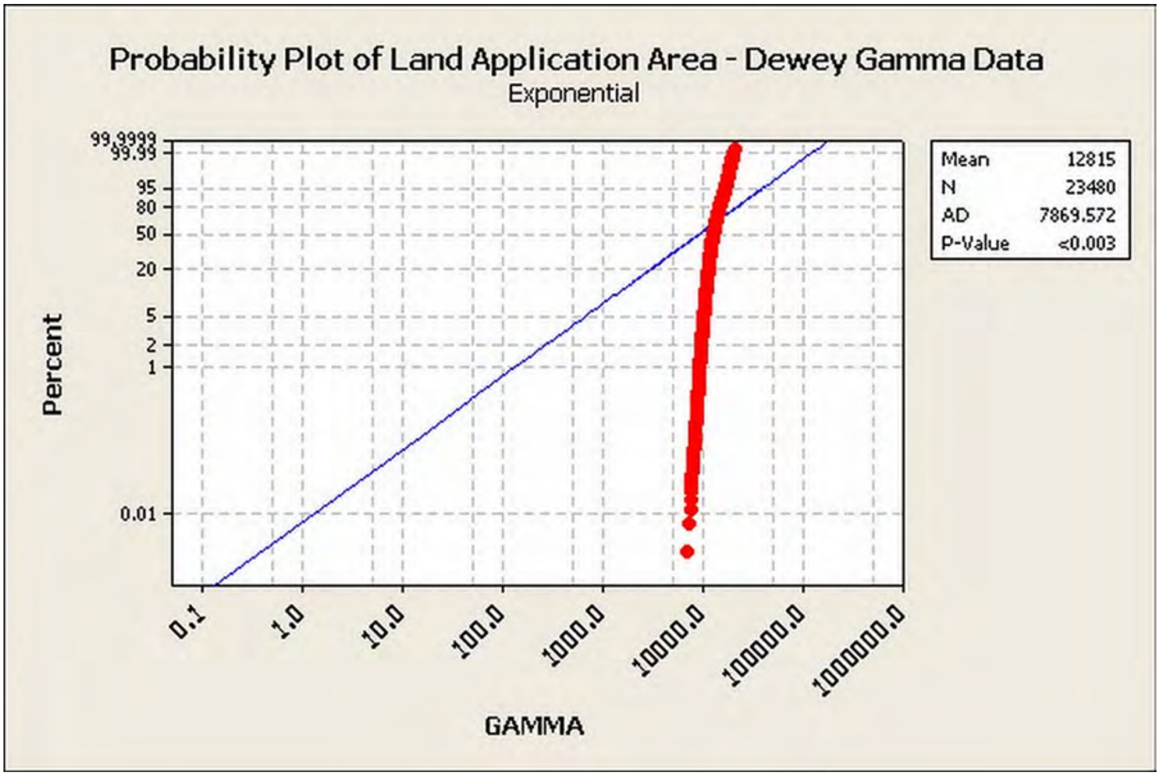
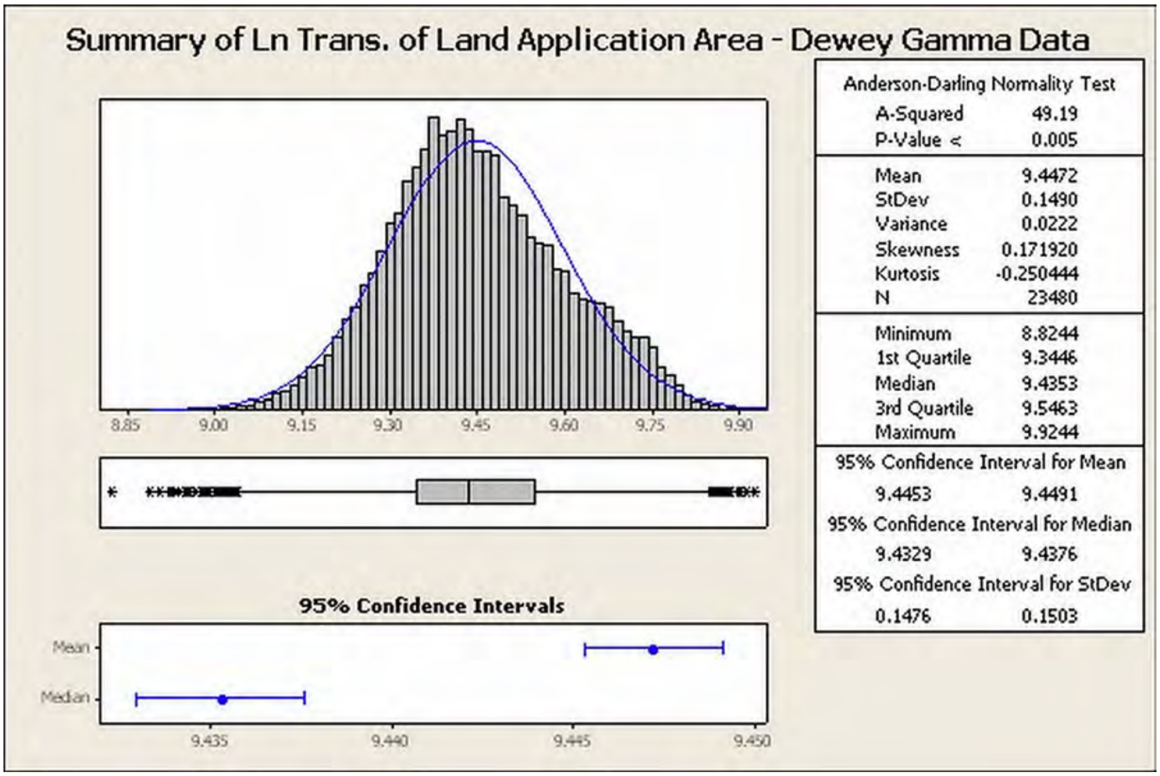
Figure TR RAI 2.9-30a-11: Statistical Results and Probability Plot of the Test for Exponential Distribution on Gamma Data from the Dewey Land Application Area.



Each value in the set of data was transformed by taking its natural logarithm and the transformed data were tested for a normal distribution. Figure TR RAI 2.9-30a-12 displays the results of the test as well as a histogram and statistical summary of the transformed data. This figure shows that the transformed data are not normally distributed.

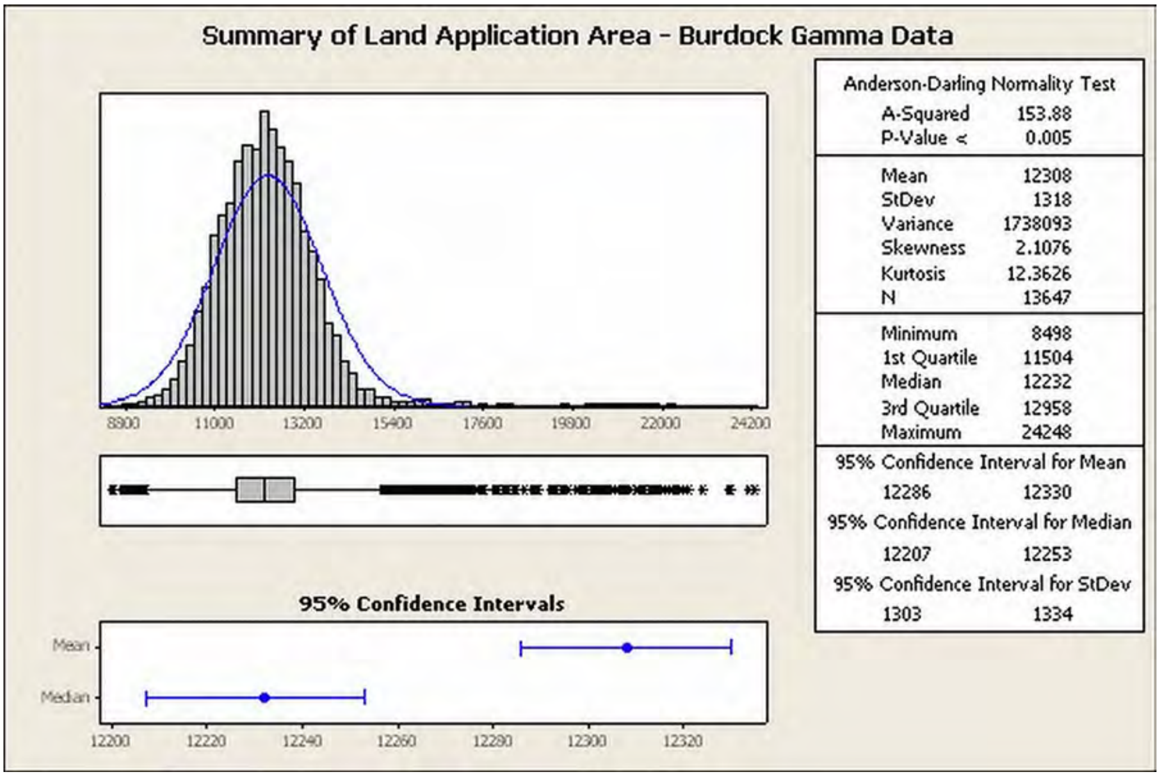
Figure TR RAI 2.9-30a-12: Summary of Statistics and Normality Test of Transformed Gamma Data from the Dewey Land Application Area.



Burdock Land Application Area

The gamma data from Burdock Land Application Area were tested for a normal distribution. Figure TR RAI 2.9-30a-13 displays the results of the test as well as a histogram and statistical summary of the data. This figure shows that the data are not normally distributed.

Figure TR RAI 2.9-30a-13: Summary of Statistics and Normality Test of Gamma Data from the Burdock Land Application Area (in cpm).



The data were then tested for lognormal and exponential distributions. Figures TR RAI 2.9-30a-14 and TR RAI 2.9-30a-15 show the results of the tests for lognormal and exponential distributions along with their respective probability plots. These figures show that the data are not lognormally or exponentially distributed.

Figure TR RAI 2.9-30a-14: Statistical Results and Probability Plot of the Test for Lognormal Distribution on Gamma Data from the Burdock Land Application Area.

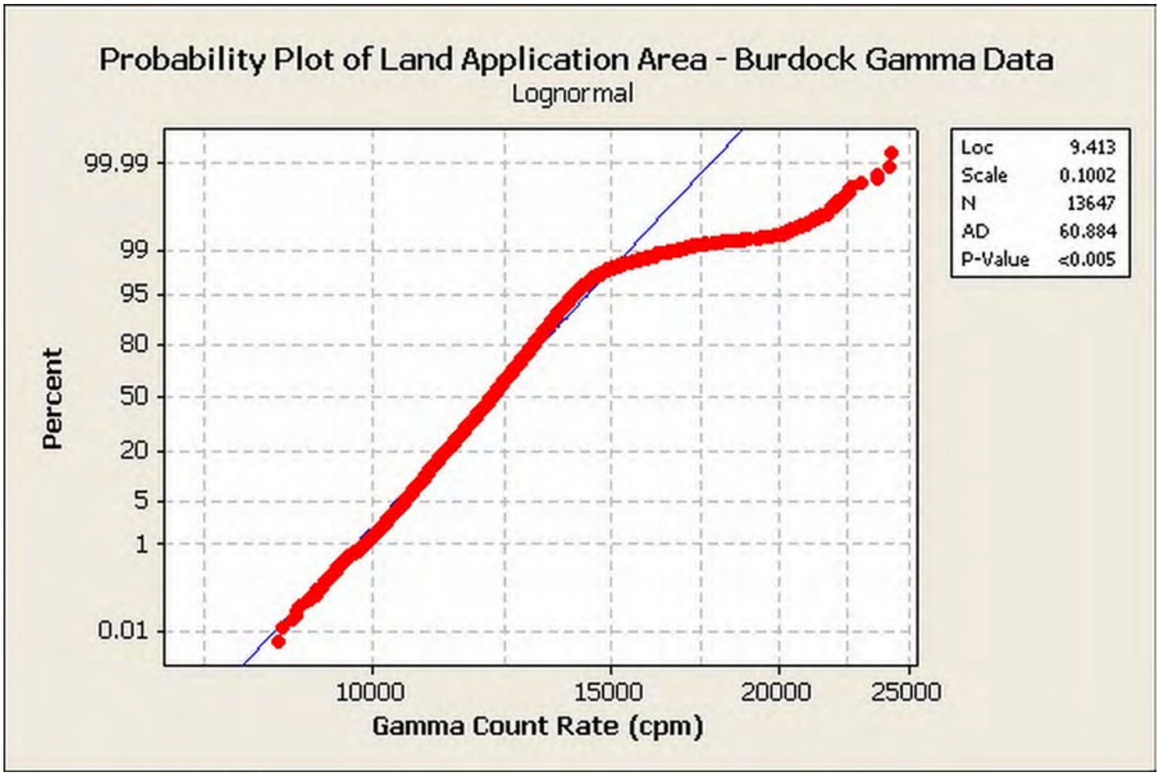
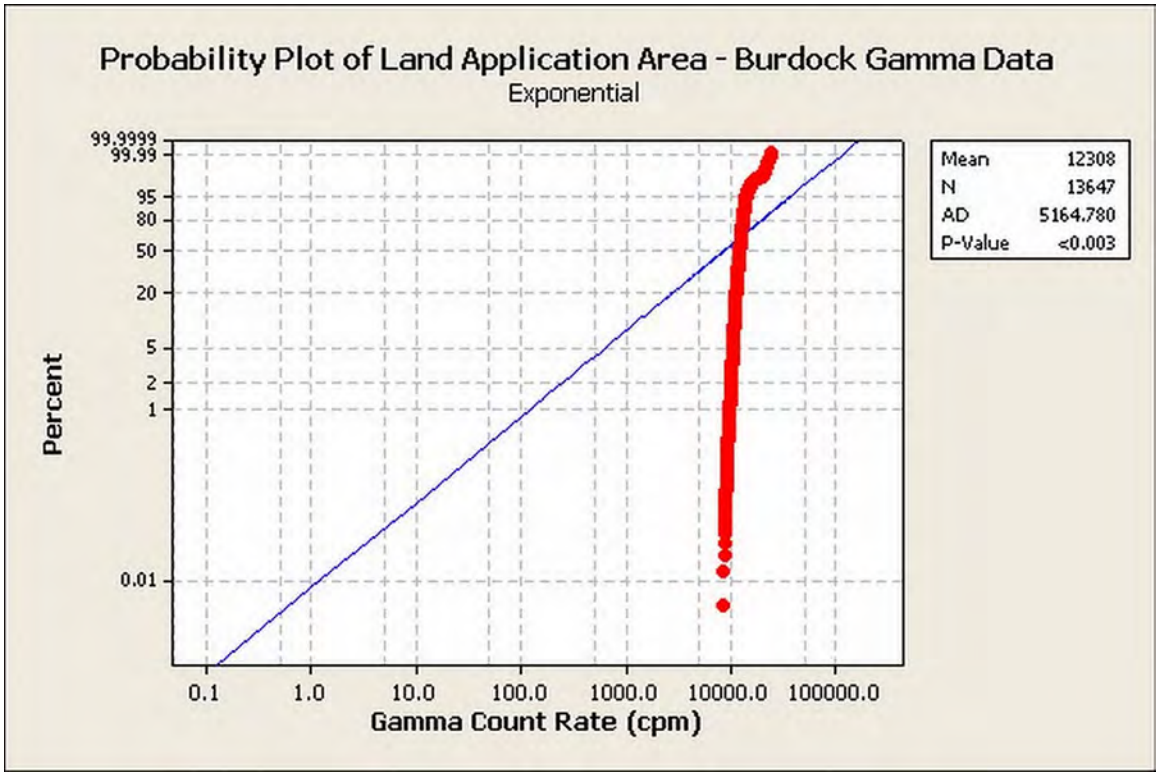
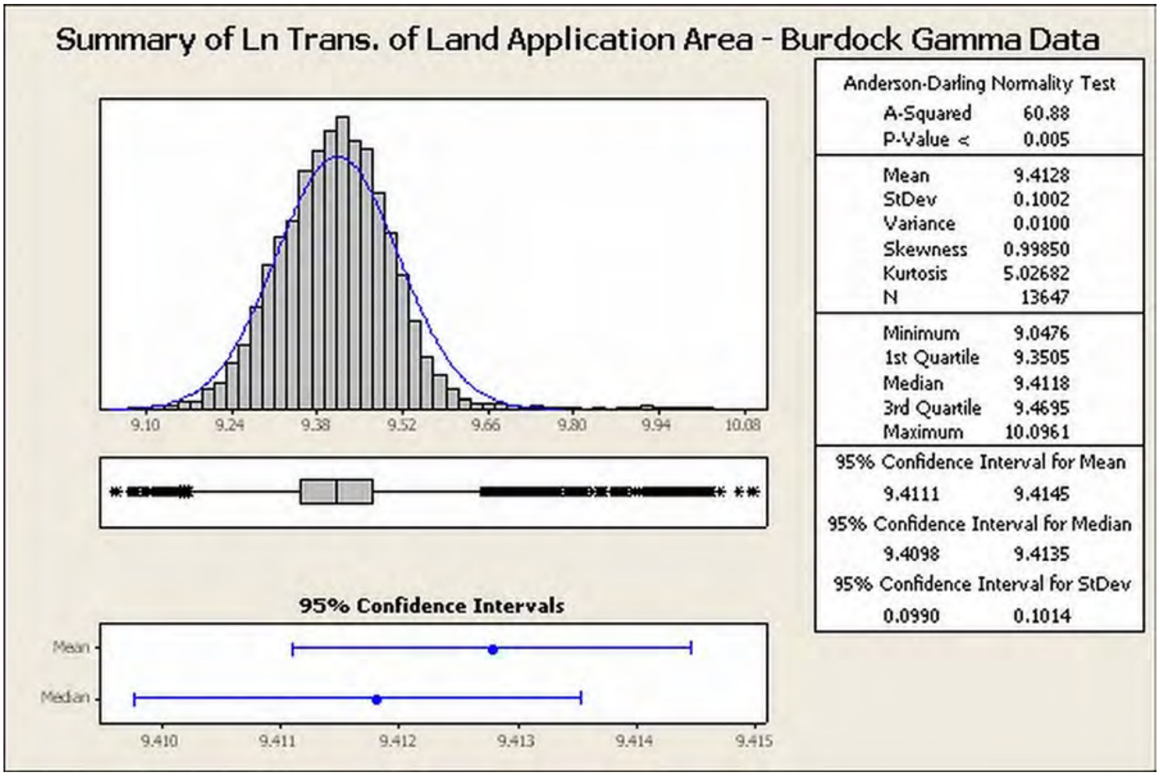


Figure TR RAI 2.9-30a-15: Statistical Results and Probability Plot of the Test for Exponential Distribution on Gamma Data from the Burdock Land Application Area.



Each value in the set of data was transformed by taking its natural logarithm and the transformed data were tested for a normal distribution. Figure TR RAI 2.9-30a-16 displays the results of the test as well as a histogram and statistical summary of the transformed data. The figure shows that the transformed data are not normally distributed.

Figure TR RAI 2.9-30a-16: Summary of Statistics and Normality Test of Transformed Gamma Data from the Burdock Land Application Area.



TR RAI 2.9-30

In Section 2.9.2.2.1 of the TR and Section 3.2 of Appendix 2.9-A of the TR, the applicant discusses outliers in the gamma-ray count rate data. Regarding the identification of outliers, NRC staff has consulted the statistical reference cited by the applicant (Ott and Longnecker 2001) and has not found justification for using the interquartile range (IQR) method as a sole means of proving outliers. According to Ott and Longnecker (2001, p. 86), "…the IQR does not provide sufficient useful information about a single set of measurements, but can be quite useful when comparing the variabilities of two or more data sets." This approach is consistent with other statistical sources (e.g., NIST 2006). Further, in their discussion of boxplots, Ott and Longnecker (2001, p. 100) recommend carefully examining and checking the extreme values of the measurement. Lastly, NIST (2006) discusses nonnormal distributions that may be expected to have extreme values at larger rates than for a normal distribution. One example is the Cauchy distribution. Please provide the following:

TR RAI 2.9-30(b)

b. Justification for utilizing the IQR as the sole means of proving outliers.

TR RAI 2.9-30(b) Response

Several tools were used to identify potential outliers, including histograms, distribution tests, and probability plots. Support for the use of box plots and IQRs to screen outliers is found in Chapter 12 of *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (EPA, 2009). In any case, it is important to clarify that potential outliers were identified for informational purposes (e.g., to determine whether the data sets could be described by various distributions without the potential outliers included). The potential outliers defined using the IQR method were not removed or discounted in the statistical analysis of the GPS gamma data. For additional information, refer to the response to TR RAI 2.9-38(b). This information will be included in Section 2.9 of the revised TR.

TR RAI 2.9-31

In Section 2.9.2.2.1 of the TR and Section 3.2 of Appendix 2.9-A of the TR, the applicant discusses outliers in the gamma-ray count rate data. Please provide the following information:

- ***a. Discuss how these outliers were treated in the statistical analysis of gamma ray count rates.***

- ***b. If outliers were rejected from the final data set, please describe any investigations performed by the applicant to determine the cause of the outlying observations. Specifically, the applicant should demonstrate that the outlying data is either an extreme manifestation of the random variability inherent in the data or that it is the result of gross deviation from prescribed experimental procedure or error in calculating or recording the numerical value (ASTM 2002).***

TR RAI 2.9-31(a) Response

The outliers in the GPS gamma data were treated like the other GPS gamma data in the statistical analysis. The outliers were not rejected or otherwise discounted.

TR RAI 2.9-31(b) Response

None of the outliers were rejected from the final data set.

This will be clarified in the revised TR.

<u>TR RAI 2.9-32</u>
Please provide the following information related to the predicted site-wide exposure rates discussed in Section 2.9.2.2.2 of the TR:

<u>TR RAI 2.9-32(a)</u>
a. Input parameters to, and results obtained from, ArcView GIS.

<u>TR RAI 2.9-32(a) Response</u>
TR Section 2.9.2 (Results of Cross-Calibration of Sodium Iodide Detectors and High-Pressure Ionization Chamber) will be revised to include the following.

ArcView GIS was used to map gamma survey data. The input parameters to ArcView GIS were gross gamma-ray count rates, in counts per minute (cpm), measured using matched sodium iodide detectors and recorded during the GPS-based survey. The results obtained from ArcView GIS were the predicted exposure rates, in µR/hr, calculated using the equation given in TR Section 2.9.2.2.2:

Exposure Rate = 0.0007 x Gamma Count Rate + 2.02

Using a minimum count rate cutoff of 5,500 cpm and the maximum observed gamma count rate of 460,485 cpm, the minimum and maximum exposure rates of 5.9 to 324 µR/hr were calculated.

<u>TR RAI 2.9-32</u>

Please provide the following information related to the predicted site-wide exposure rates discussed in Section 2.9.2.2.2 of the TR:

<u>TR RAI 2.9-32(b)</u>

b. A description of the ArcView GIS interpolation scheme used, including the parameters to control how the scheme is applied.

TR RAI 2.9-32(b) Response

TR Figure 2.9-6 was intended for informational purposes only, to qualitatively evaluate the relative spatial distribution of exposure rates across the project area. No interpolation of the data was performed other than to group the data by category using ArcView GIS. The grid block exposure rates presented on Figure 2.9-6 reflected the average of all predicted exposure rates, as calculated from the gross gamma-ray count rates that fell spatially within each 700 x 700-foot grid block boundary. With a 500-meter gamma survey transect spacing used throughout most of the site, approximately 40 percent of the grid blocks have no gamma readings (a null value when calculating the exposure rate). The GIS analysis of these grid blocks interpreted no gamma-ray count rates as a zero value instead of a null value, which resulted in the incorrect display of a zero value. No interpolation or other method to spatially predict gamma exposure rate within the project area was used.

This will be clarified in the revised TR. Figure 2.9-6 of the TR has been revised and Figure 9-3 of Appendix 2.9-A will be revised to only show exposure rate estimates from points where gamma survey data were collected. The revised Figure 2.9-6 is provided below.

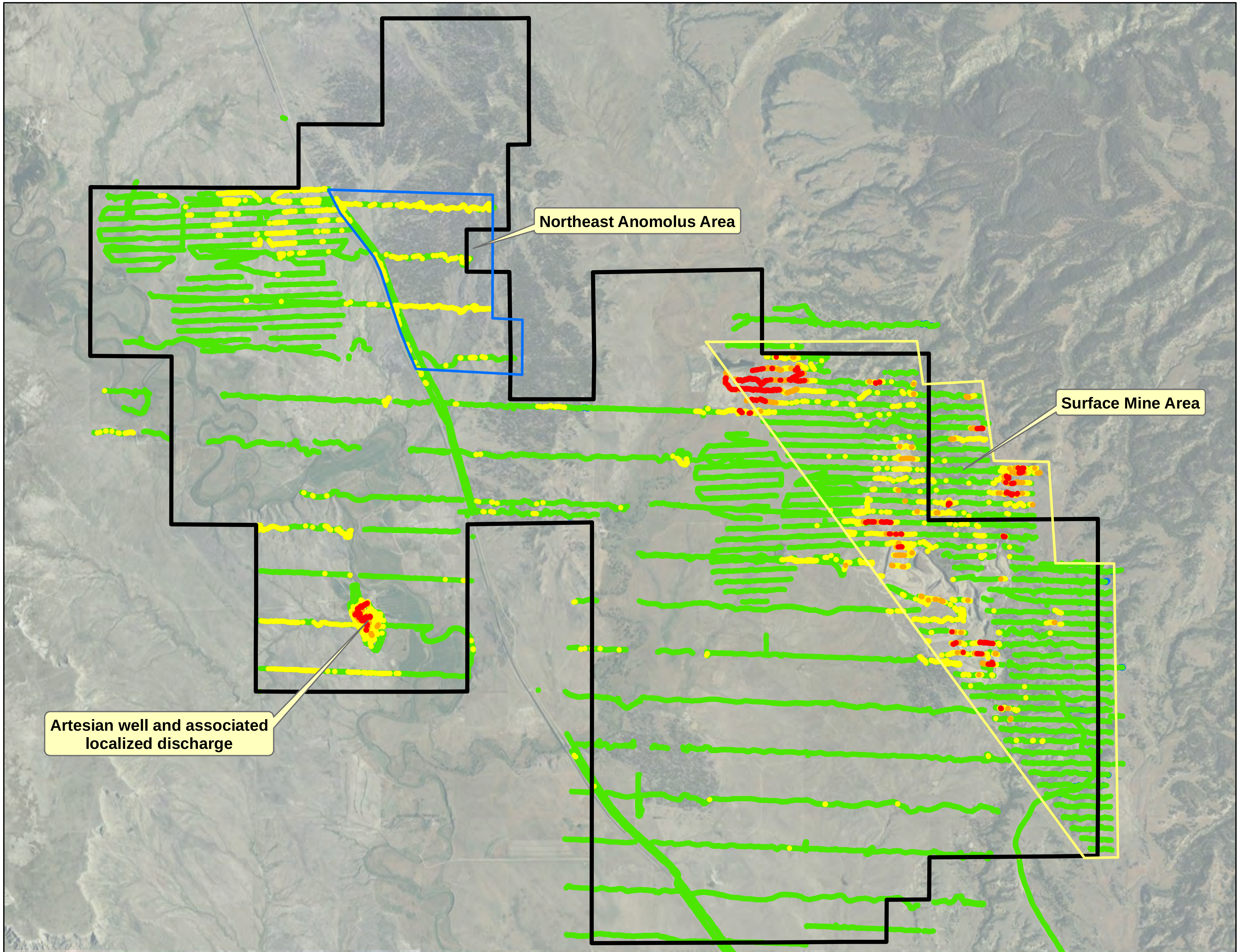


Figure 2.9-6

Baseline GPS-Based
Gamma-Ray Count Rates
Correlated Exposure Rates
Dewey-Burdock Project

DRAWN BY	C. Farr - ERG
DATE	14-Jun-2011
FILENAME	Figure 2.9-6.mxd

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TR RAI 2.9-32

Please provide the following information related to the predicted site-wide exposure rates discussed in Section 2.9.2.2.2 of the TR:

TR RAI 2.9-32(c)

c. Error estimates of the data presented in Figure 2.9-6, Predicted Site-Wide Exposure Rates, Grid Block Averages, in the TR.

TR RAI-2.9-32(c) Response

The error estimates associated with the data on updated Figure 2.9-6 are based on the linear regression correlation of the gamma count rate data and PIC measurements. The 95 percent confidence interval of the regression line is shown in Figure TR RAI 2.9-32c-1 below. For predicted exposure rates near the median gamma count rate, the upper and lower 95 percent confidence limits are within 35% of the predicted value.

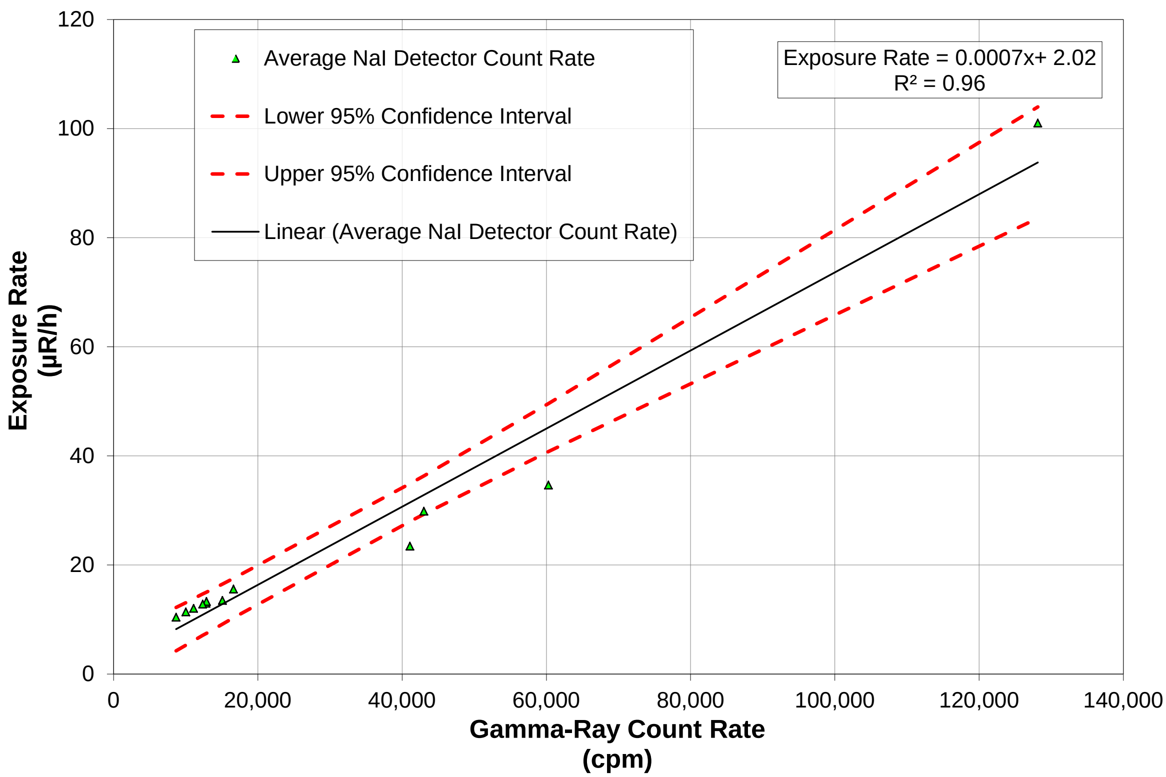

Figure TR RAI 2.9-32c-1: Linear Regression of Gamma Count Rate Data and PIC Measurements, Including the 95% Confidence Interval

<u>TR RAI 2.9-33</u>

Regulatory Guide 4.14 recommends an LLD of 2E-7 µCi/g for Pb-210 in soil. However, in Sections 2.9.3.2.1 of the TR and 4.6.2 of Appendix 2.9-A of the TR, the applicant reported that the LLD for Pb-210 in the LAN (land application area north (Dewey)) and LAS (land application south (Burdock)) soil samples ranged from 1.9E-6 to 3.8E-6 µCi/g. The applicant also reported that all values were below their LLDs. The applicant recognized that guidance was not followed but did not provide a justification for the different LLDs. Please demonstrate that the reported data is consistent with Regulatory Guide 4.14 or justification for a higher LLD for Pb-210 in soil.

<u>TR RAI 2.9-33 Response</u>

The following provides justification for reporting Pb-210 LLDs above the recommended Regulatory Guide 4.14 LLDs. The following information will be incorporated into the revised TR.

The median Pb-210 concentration for surface soils (0-5 cm and 0-15 cm depths), excluding land application samples (LAN and LAS), was 1.5 E-6 µCi/g. In these areas, the Pb-210 LLD was 1.0E-7, which is consistent with the Regulatory Guide 4.14 LLD for Pb-210 in soil. The median Pb-210 soil concentration for surface soil in the land application areas was 1.1 E-6 µCi/g. In the land application areas, the LLD ranged from 1.9E-6 to 3.8E-6. Since the median Pb-210 concentrations were similar between the two data sets, Powertech considers the reported Pb-210 soil concentrations within the land application areas as representative of background regardless of the reported sample-specific LLD values.

TR RAI 2.9-34

Regarding soil sample collection, the applicant stated in Section 2.9.3.1.1 of the TR that NUREG-1569 suggests the collection of samples at 0 to 15 cm. The applicant recognized the 0 to 5 cm collection depth specified in Regulatory Guide 4.14 and chose to collect surface soil samples at 0 to 15 cm. However, NUREG-1569 (Acceptance Criterion 2.9.3(2)) recommends that soil sampling be conducted at both a 5-cm (2-inch) depth as described in Regulatory Guide 4.14 and 15-cm (6-inch) for background decommissioning data. Please provide data that is consistent with Regulatory Guide 4.14 and NUREG-1569 or justification for an alternate methodology.

TR RAI 2.9-34 Response

The following provides justification for an alternate soil sampling method than that specified in Regulatory Guide 4.14. Section 2.9.3 of the TR will be revised to including the following information.

Section 2.9.3.1.1 of the TR describes the general soil sampling strategy used for the baseline soil sampling but does not clearly identify that soil samples from a 0-5 cm depth were collected at the AMS (Air Monitoring Station) locations. The samples from the AMS locations were analyzed for natural uranium, Th-230, Ra-226, and Pb-210. The locations of the AMS samples were consistent with the recommendations in Regulatory Guide 4.14 as described in the response to TR RAI 2.9-1. Powertech will revise TR Table 2.9-5, which presents the radionuclide concentrations in soil for all soil samples. The revisions to the table are described in the response to TR RAI RI-4(c).

As part of the baseline monitoring program Powertech focused the soil investigation on the 0-15 cm depth intervals and limited soil sampling of the 0-5 cm depth interval to the AMS locations. The rationale for this approach includes the following items:

1) The 0-5 cm depth interval is more sensitive to aerial deposition of radionuclides than the 0-15 cm depth interval, and it therefore makes sense to sample the more sensitive depth interval at the AMS locations.
2) The 0-5 cm depth interval sampling at the AMS locations will be part of the operational monitoring program, thus operational monitoring data can be compared to baseline monitoring data at consistent depth intervals.
3) The Ra-226 soil cleanup standards contained in 10 CFR 40, Appendix A is defined as 5 pCi/g above background for a depth interval of 0-15 cm.
4) An emphasis on the depth interval applicable to the Ra-226 cleanup standard was used since this standard requires a well-defined pre-operational characterization of background radiological conditions in soil from a depth of 0-15 cm.

The box plot in Figure TR RAI 2.9-34-1 demonstrates that the median Ra-226 concentrations in the 0-5 cm and 0-15 cm soil depth interval are similar. Collecting additional 0-5 cm depth interval soil samples and analyzing for Ra-226 would not provide additional information.

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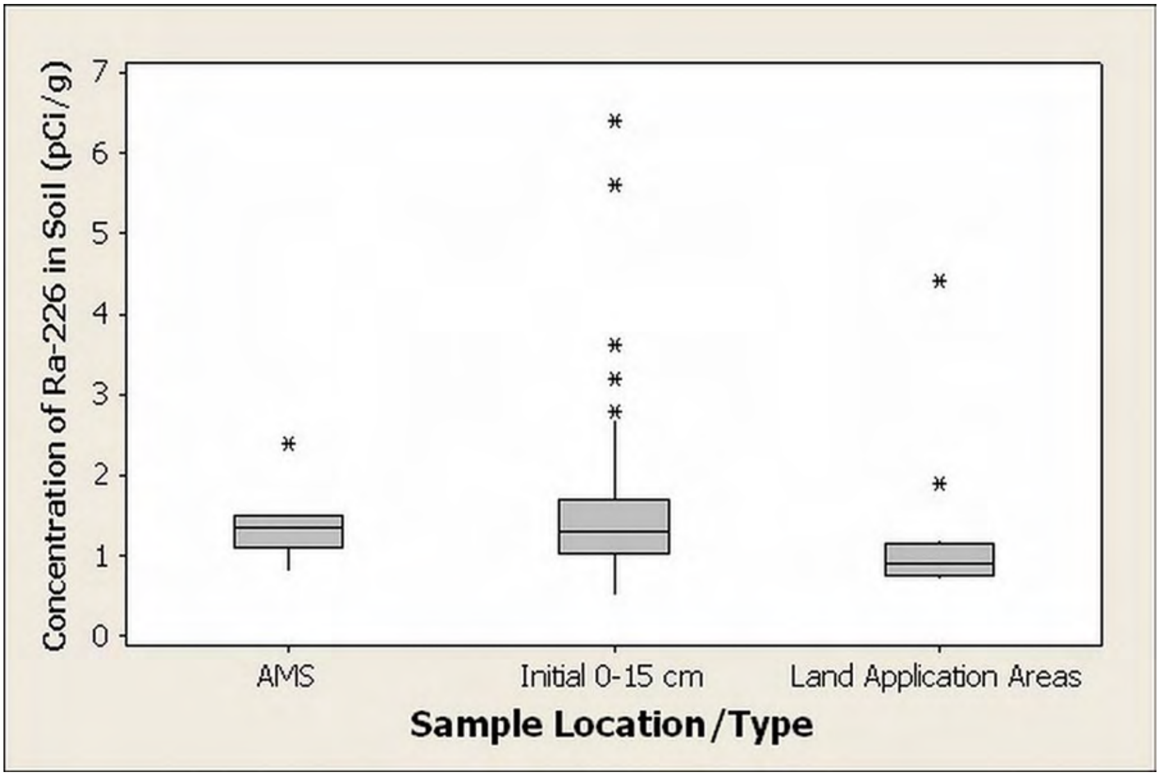
Figure TR RAI 2.9-34-1: Box and Whisker Plot of Ra-226 Concentrations in Surface Soil at Depths of 0-5 cm (AMS), 0-15 cm (Initial 0-15 cm), and 0-15 cm (Land Application Areas).



<u>TR RAI 2.9-35</u>

Regarding the Ra-226 soil sampling results, please provide the following information:

<u>TR RAI 2.9-35(a)</u>

a. ***Documentation for all statistical analyses (histograms, data transformations, calculated p-values, etc.) performed on the Ra-226 soil sampling results, including outputs from statistical software packages, or indicate where these can be found in the application.***

<u>TR RAI 2.9-35(a) Response</u>

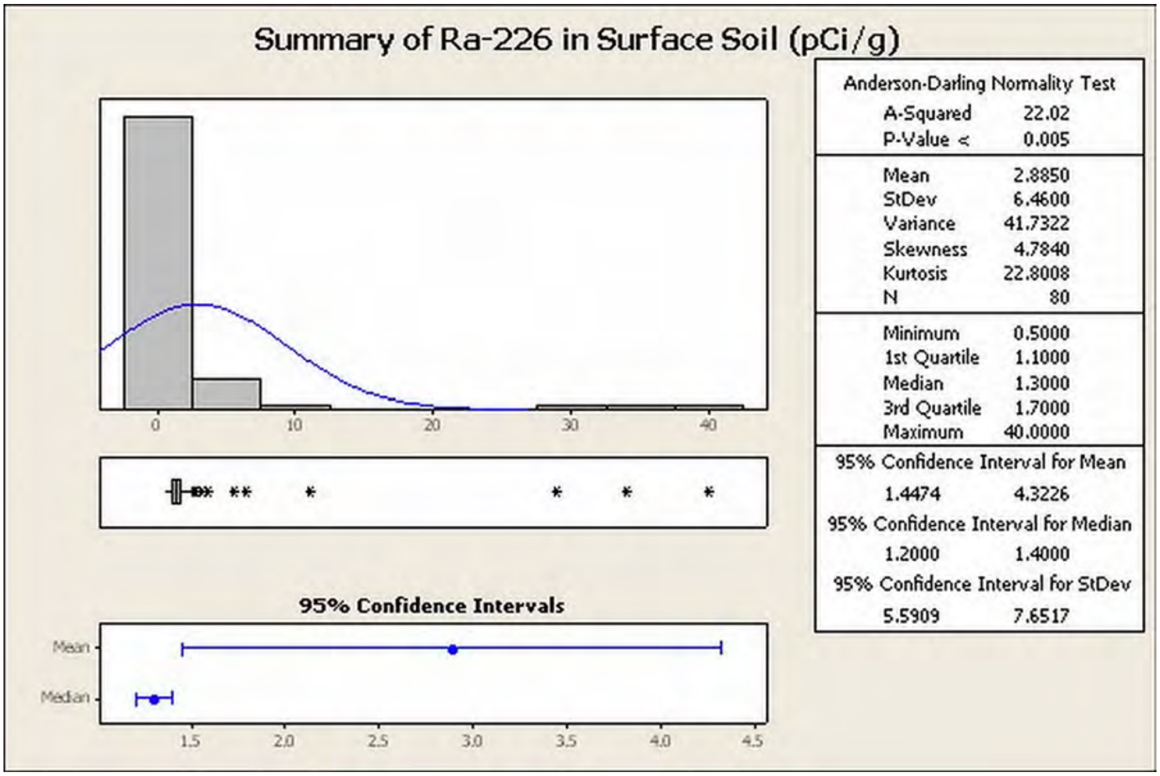
The Ra-226 soil sampling results were analyzed with the statistical software package Minitab, version 15.1.1.0. TR Section 2.9.3 will be revised to include the following output from Minitab and presentation of statistical analyses.

<u>First Set of 80 Soil Sampling Locations</u>

The Ra-226 soil sampling results from the first set of 80 locations were first tested for a normal distribution. Figure TR RAI 2.9-35a-1 displays the results of the test as well as a histogram and statistical summary of the data.

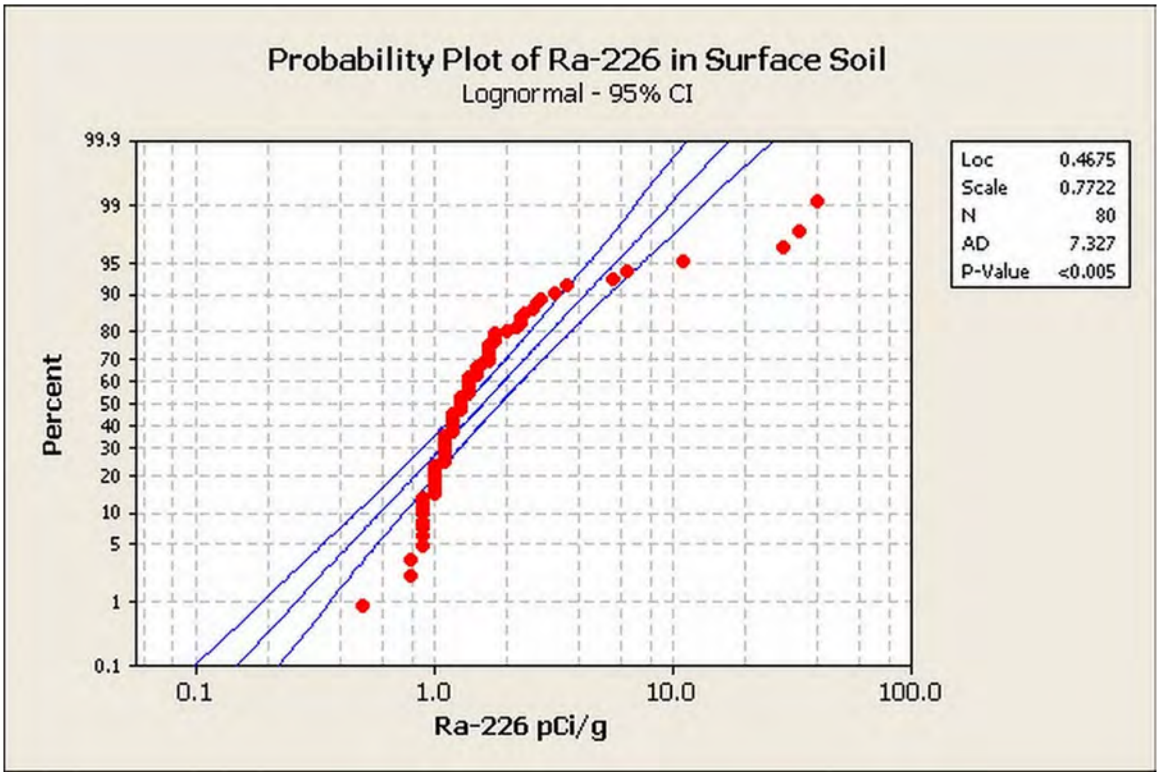
In order to test the Ra-226 sample results for a normal distribution, the Anderson-Darling normality test was performed in Minitab. Figure TR RAI 2.9-35a-1 presents the results of the Anderson-Darling normality test. The p-values from the normality test indicate the distribution is not normal.

Figure TR RAI 2.9-35a-1: Summary of Statistics and Normality Test of Ra-226 Soil Sampling Results in the First Set of 80 Locations (in cpm).



The data were then tested for a lognormal distribution. Figure TR RAI 2.9-35a-2 shows the statistical test results and probability plot. The p-values from the lognormal test indicate that the data are not lognormally distributed.

Figure TR RAI 2.9-35a-2: Statistical Results and Probability Plot of the Test for Lognormal Distribution of Ra-226 Soil Sampling Results in the First Set of 80 Locations.



Surface Mine Area

The Ra-226 soil sampling results from the Surface Mine Area were tested for normal and lognormal distributions. Figure TR RAI 2.9-35a-3 displays the results of the normality test as well as a histogram and statistical summary of the data. The p-values from the normality test indicate that the data are not normally distributed.

Figure TR RAI 2.9-35a-3: Summary of Statistics and Normality Test of the Ra-226 Soil Sampling Results from the Surface Mine Area.

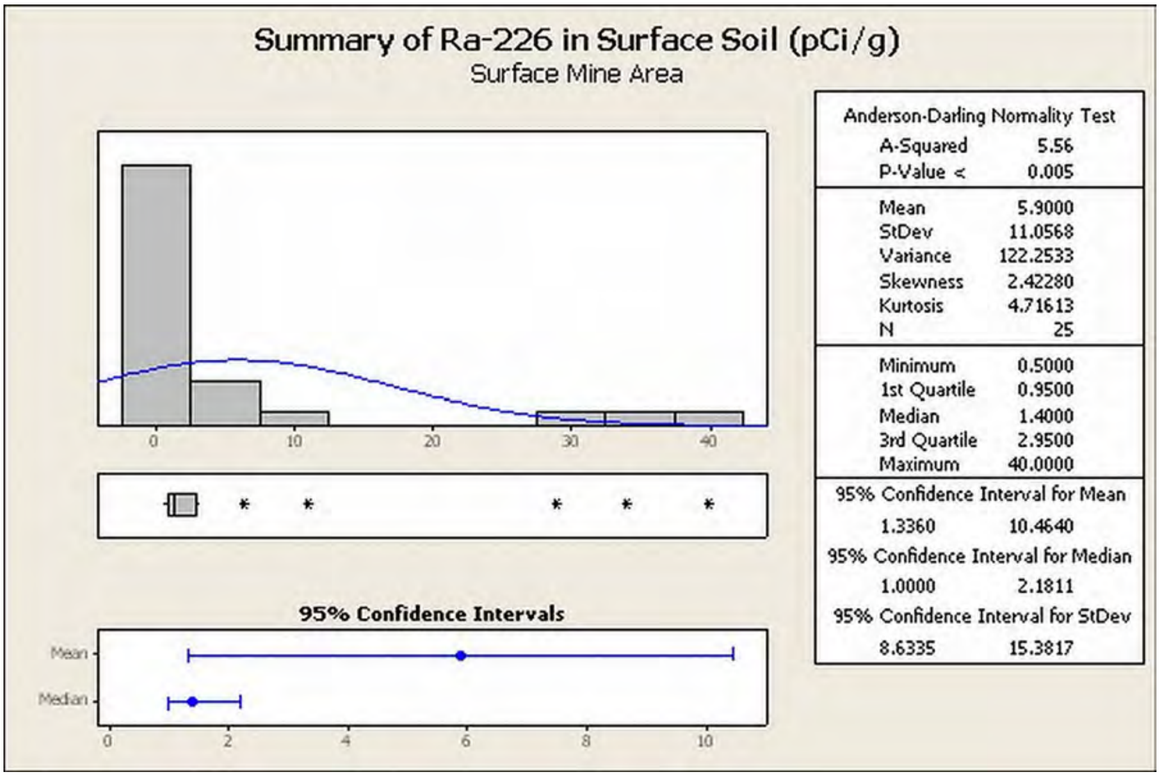


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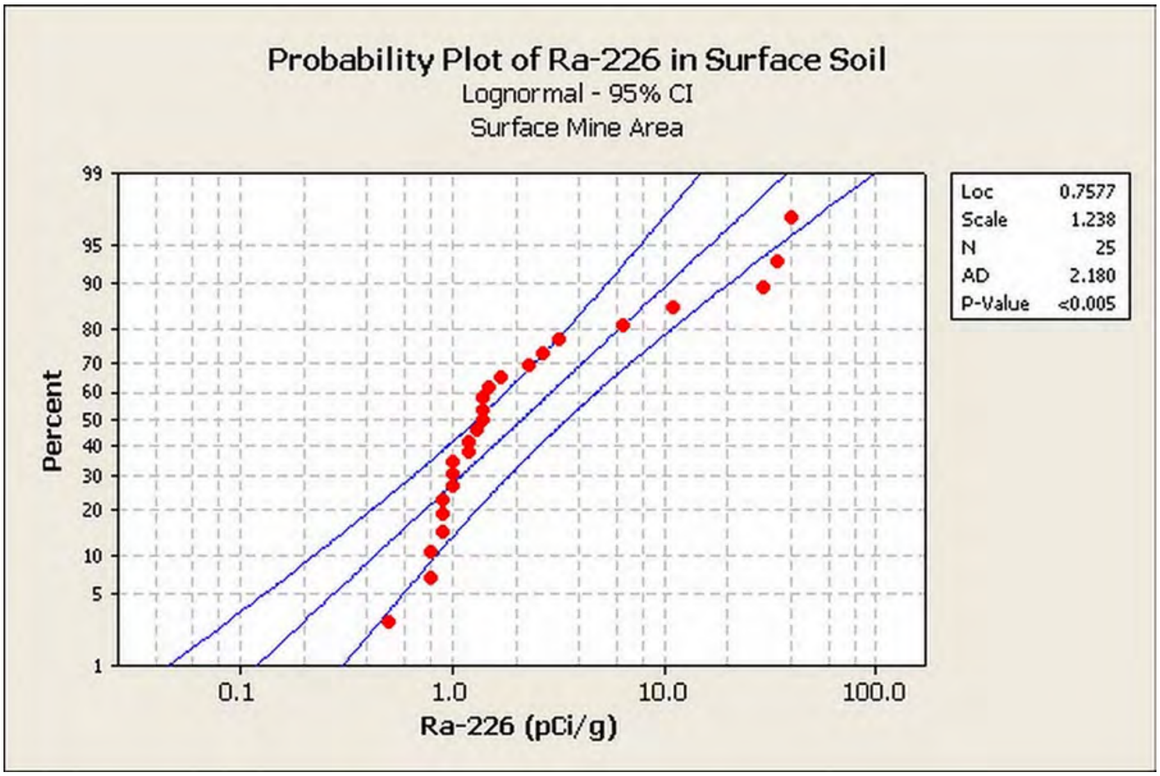
Figure TR RAI 2.9-35a-4 shows the statistical results and probability plot of the test for a lognormal distribution for the Surface Mine Area. The p-values from the lognormal test indicate that the data are not lognormally distributed.

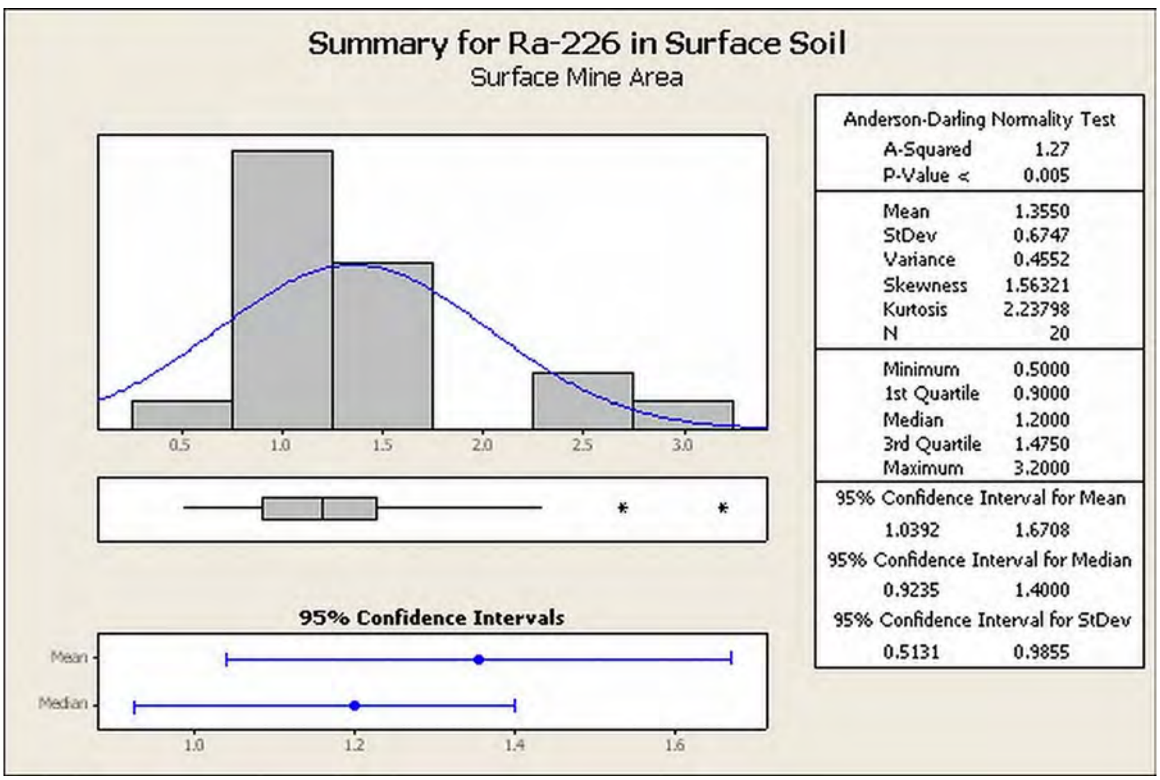
Figure TR RAI 2.9-35a-4: Statistical Results and Probability Plot of the Test for Lognormal Distribution of Ra-226 Soil Sampling Results from the Surface Mine Area.



The box plot in Figure TR RAI 2.9-35a-3 shows five potential outliers (identified with "*"). The box plot marks any data beyond the range (Q1 – 1.5*IQR, Q3 + 1.5*IQR) as potential outliers. IQR stands for the "interquartile range" and is calculated as the difference between the 3rd and 1st quartiles. The five potential outlier sample locations were biased, based on an evaluation of the gamma survey results, and intended to capture the upper limit of radium-226 soil concentrations.

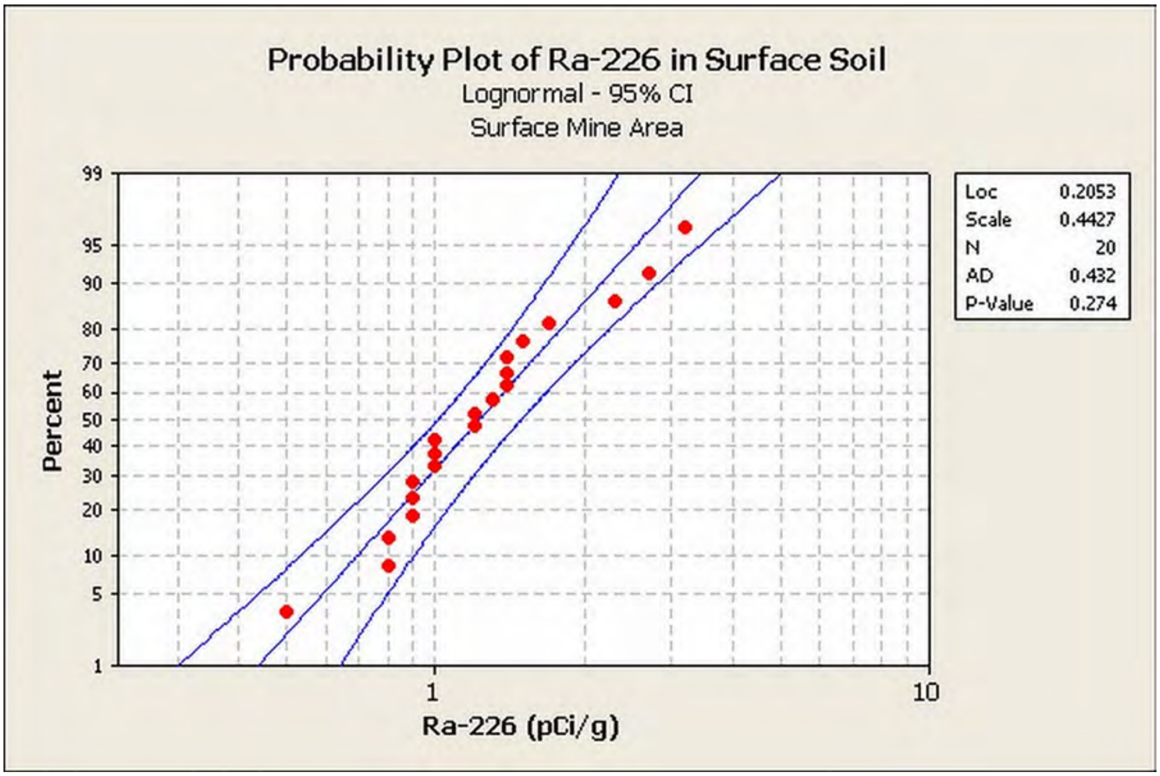
The test for a normal distribution was repeated with the potential outliers removed from the data set. Figure TR RAI 2.9-35a-5 displays the results of the test as well as a histogram and statistical summary of the data. Although the histogram more closely resembles a normally distributed data set, the p-values from the Anderson-Darling normality test indicate that the data without outliers are not normally distributed.

Figure TR RAI 2.9-35a-5: Summary of Statistics and Normality Test of the Ra-226 Soil Sampling Results from the Surface Mine Area, with Five Potential Outliers Removed.



The data without potential outliers were then tested for a lognormal distribution. Figure TR RAI 2.9-35a-6 shows the statistical results and probability plot of the test for a lognormal distribution. In this case, the p-value indicates that the data with the five potential outliers removed are adequately described by a lognormal distribution.

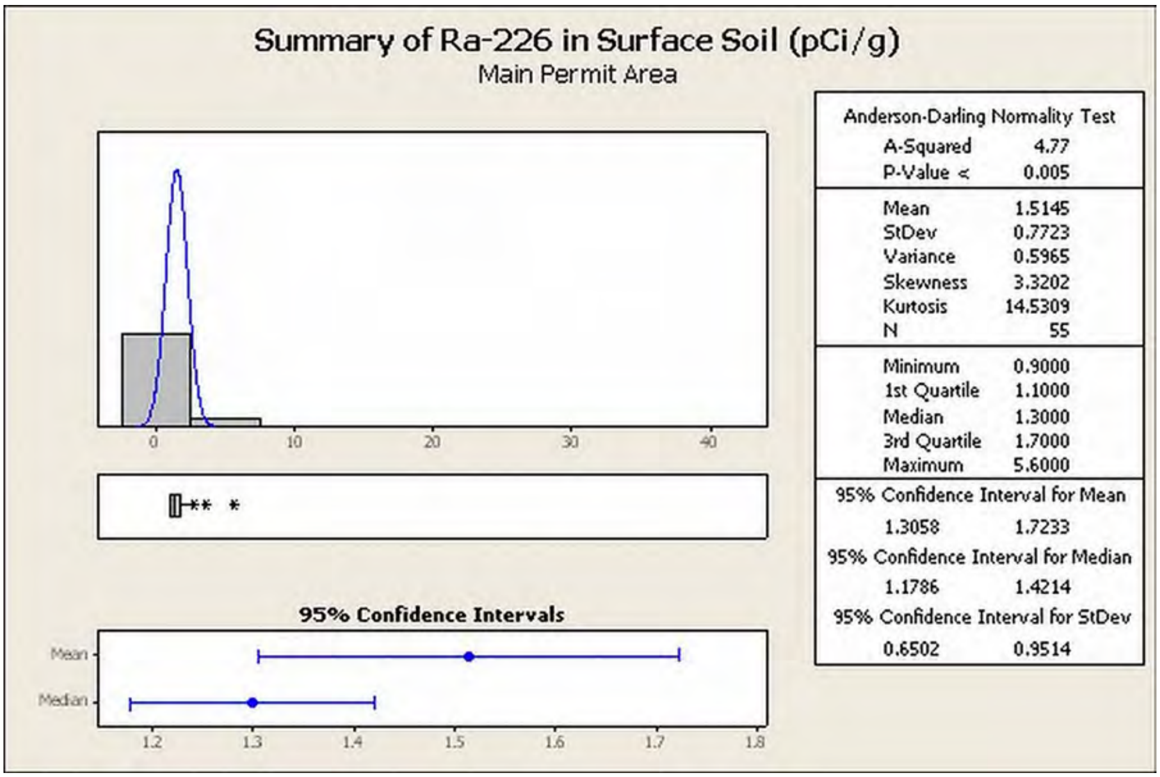
Figure TR RAI 2.9-35a-6: Statistical Results and Probability Plot of the Test for Lognormal Distribution of the Ra-226 Soil Sampling Results from the Surface Mine Area, with Five Potential Outliers Removed.



Main Permit Area

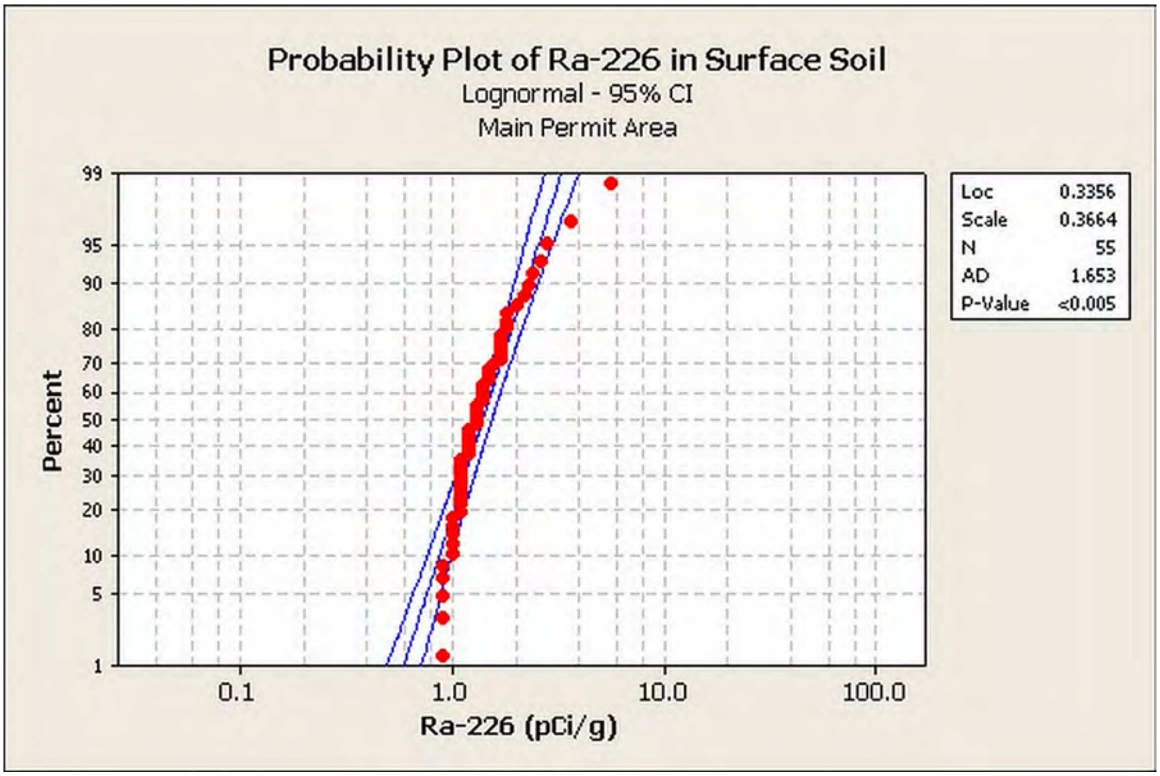
The Ra-226 soil sampling results from the Main Permit Area were tested for normal and lognormal distributions. Figure TR RAI 2.9-35a-7 displays the results of the normality test as well as a histogram and statistical summary of the data. The p-values from the Anderson-Darling normality test indicate that the data are not normally distributed.

Figure TR RAI 2.9-35a-7: Summary of Statistics and Normality Test of the Ra-226 Soil Sampling Results from the Main Permit Area.



The data were then tested for a lognormal distribution. Figure TR RAI 2.9-35a-8 shows the results of the statistical test and probability plot for a lognormal distribution. The p-values from the lognormal test indicate that the data are not lognormally distributed.

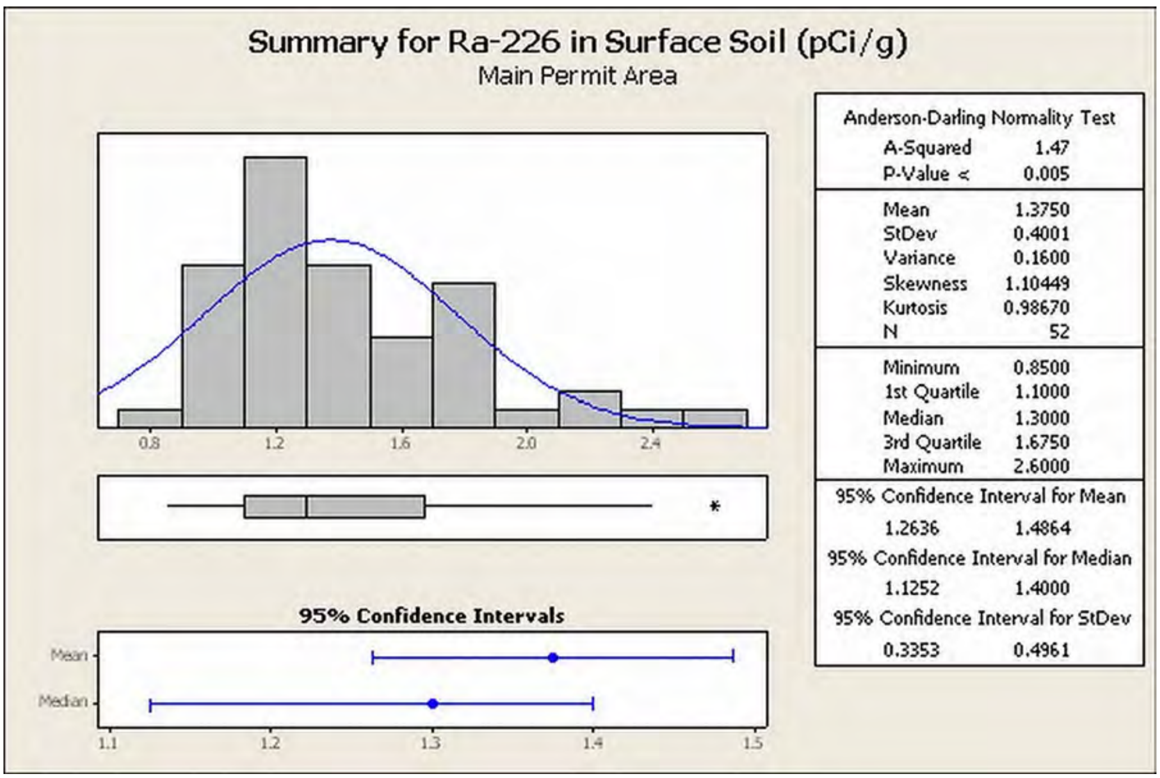
Figure TR RAI 2.9-35a-8: Statistical Results and Probability Plot of the Test for Lognormal Distribution of the Ra-226 Soil Sampling Results from the Main Permit Area.



The box plot in Figure TR RAI 2.9-35a-7 shows three potential outliers (defined with *). The box plot marks any data beyond the range (Q1 – 1.5*IQR, Q3 + 1.5*IQR) as potential outliers. No errors were found associated with these potential outliers. The three potential outliers make up about 5 percent of the entire data set, therefore it was determined that the relatively high values of the potential outliers were due to random measurement variability.

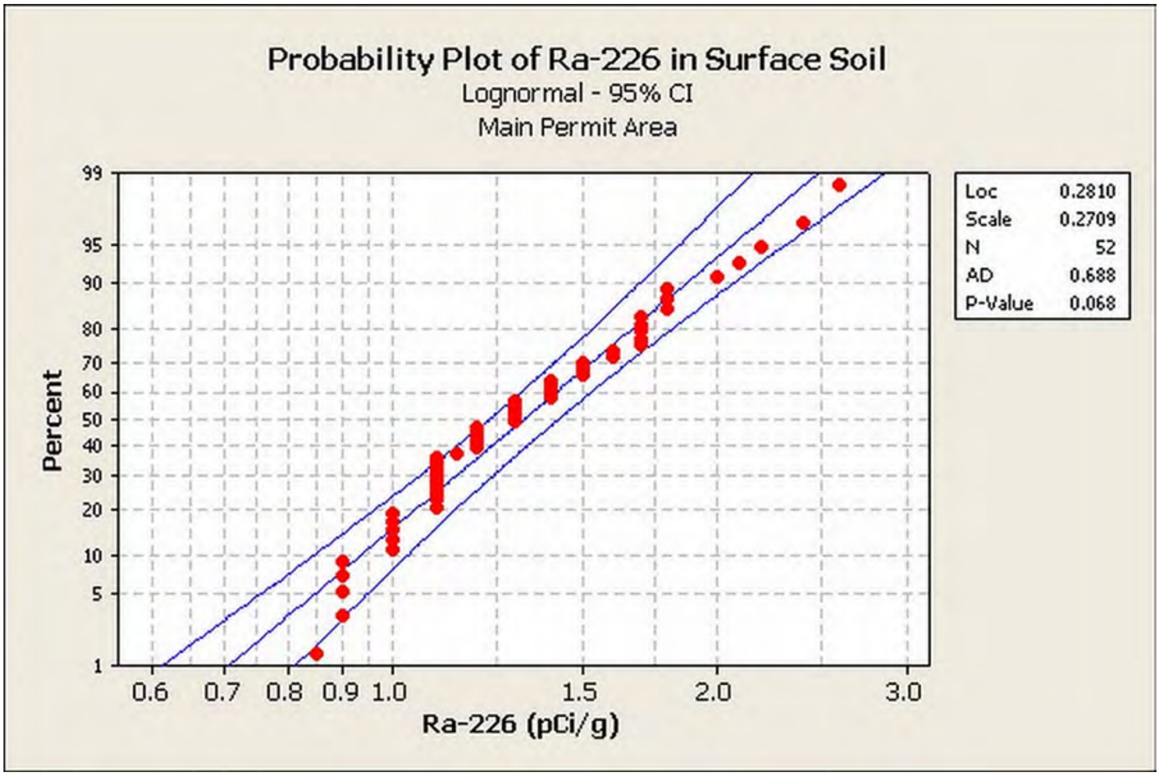
The test for a normal distribution was repeated with the outliers removed from the data set. Figure TR RAI 2.9-35a-9 displays the results of the test as well as a histogram and statistical summary of the data. The p-value from the normality test indicates that the Ra-226 soil sampling results from the Main Permit Area with potential outliers removed is not normally distributed.

Figure TR RAI 2.9-35a-9: Summary of Statistics and Normality Test of the Ra-226 Soil Sampling Results from the Main Permit Area, with Three Potential Outliers Removed.



The data were then tested for a lognormal distribution. Figure TR RAI 2.9-35a-10 shows the statistical results and probability plot of the test for a lognormal distribution. The p-value from the lognormal test indicates that the data are adequately described by a lognormal distribution.

Figure TR RAI 2.9-35a-10: Statistical Results and Probability Plot of the Test for Lognormal Distribution of the Ra-226 Soil Sampling Results from the Main Permit Area.



North Section of Main Permit Area and Land Application Areas

The Ra-226 soil sampling results from the north section of the Main Permit Area and the Land Application Areas were not analyzed statistically.

<u>TR RAI 2.9-35</u>

Regarding the Ra-226 soil sampling results, please provide the following information:

Justification for utilizing the IQR as the sole means of proving outliers. See related RAI regarding Direct Radiation given above for further explanation.

<u>TR RAI 2.9-35(b) Response</u>

The following discussion will be incorporated into the revised TR.

Several methods were considered to evaluate outliers, including histograms, distribution tests, and probability plots, prior to the decision to use IQRs. The set of the data from the Main Permit Area was initially found to be non-parametric (i.e., does not follow a normal, lognormal or other commonly used distribution that can be described with parameters). The IQR was used to help identify any potential outliers non-parametrically. The usefulness of using box plots to non-parametrically screen for data outliers is discussed in Chapter 12 of *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (EPA, 2009). As described on pg. 12-5 of this guidance, “Box plots…provide an alternate method to perform outlier screening, one not dependent on normality of the underlying measurement population. Instead of looking for points inconsistent with a linear pattern on a probability plot, the box plot flags as possible outliers values that are located in either or both of the *extreme tails* of the sample.”

TR RAI 2.9-35

Regarding the Ra-226 soil sampling results, please provide the following information:

TR RAI 2.9-35(c)

c. ***For outliers that were rejected from the final data set; please describe any investigations performed by the applicant to determine the cause of the outlying observations. Specifically, the applicant should demonstrate that the outlying data is either an extreme manifestation of the random variability inherent in the data, or that it is the result of gross deviation from prescribed experimental procedure or error in calculating or recording the numerical value (ASTM 2002).***

TR RAI 2.9-35(c) Response

The following discussion and tables will be incorporated into the revised TR.

The five potential outlier locations in the data from the Surface Mine Area were biased, based on an evaluation of the gamma survey results, and were intended to capture the upper limit of radium-226 soil concentrations in the area. Because the sample locations were intentionally biased toward higher radium-226 concentrations, it is not surprising that they would be outliers compared to the remaining data set. The box plot analysis (see Figure TR RAI 2.9-35a-3) identified five samples within the Surface Mine Area as being outliers. At the request of the NRC staff, ASTM Standard E178-08, Standard Practice for Dealing with Outlying Observations (ASTM, 2002), was also used to evaluate whether the outliers identified using the box plot analysis are also outliers using the methods described within. Prior to presenting the test data contained in ASTM E178-08, three important points should be mentioned:

1) ASTM E178-08 discusses rejecting observations based on judgment provided a physical reason is known or discovered for the outlier. Statistical test for these outliers may be used but is not required to support a judgment that a physical reason actually exists for the outlier.
2) The criteria for outliers within ASTM E178-08 are based on an assumed underlying normal distribution.
3) When data are not normally or approximately normally distributed, the probabilities associated with the tests will be different (ASTM E178-08).

In the case of the five outliers in the Surface Mine Area, physical properties (the proximity of the historical open-pit uranium mines) for the higher values were known. This physical property was the reason samples were collected at these locations. Table TR RAI 2.9-35c-1 provides the statistical analysis based on methods described in Section 6 of ASTM E178-08.

Table TR RAI 2.9-35c-1 supports the decision to consider the sample results as outliers based on judgment and the outlier screening using box plots. Consistent with ASTM E178-09, these observations

were recognized as likely being from a different population than the other sample values and were not used in describing the central tendency of the data or other data analysis.

Table TR RAI 2.9-35c-1: Outlier Test for Surface Soil Samples Collected in Surface Mine Area

Potential Outlier Sample ID	Sample Ra-226 Concentration (pCi/g)	N	Mean Ra-226 Concentration (pCi/g)	Standard Deviation (pCi/g)	‡Test Statistic	†Critical Value (upper 1%)	Outlier (Yes/No)
SMA-B27	40.00	25	5.90	11.00	3.10	3.009	Yes
SMA-B30	34.00	24	4.84	8.65	3.37	2.987	Yes
SMA-B29	29.00	23	3.20	6.08	4.24	2.963	Yes
SMA-B26	11.00	22	2.02	2.36	3.81	2.939	Yes
SMA-B28	6.40	21	1.60	1.28	3.75	2.912	Yes

† Critical values obtained from Table 1 of ASTM E178-08
‡ Test Statistic

Potential outliers in the data obtained in the Main Permit Area were not attributed to any known or discovered physical property. The samples were identified as potential outliers using box plots. Table TR RAI 2.9-35c-2 provides the statistical analysis for outliers for these three samples based on methods described in Section 6 of ASTM E178-08. Two of the three samples identified as outliers using box plots were also identified as outliers using the ASTM method. The outlier data in the case of the Main Permit Area are probably extreme manifestations of the random variability inherent in the data and should be retained and processed in the same manner as the other observations in the sample (ASTM E178-08). These data were only excluded from the other data processing when attempting to fit a parametric distribution to the data, in this case a lognormal distribution. These data were included when describing the median radium-226 concentration (1.3 pCi/g) for the Main Permit Area and excluded when calculating the geometric mean (1.3 pCi/g) for the same area. The estimate of the central tendency of the data using non-parametric (outliers were included in estimate) and parametric (outliers were excluded in estimate) estimates are the same.

Table TR RAI 2.9-35c-2: Outlier Test for Surface Soil Samples Collected in Main Permit Area

Potential Outlier Sample ID	Sample Ra-226 Concentration (pCi/g)	N	Mean Ra-226 Concentration (pCi/g)	Standard Deviation (pCi/g)	‡Test Statistic	†Critical Value (upper 1%)	Outlier (Yes/No)
RFA-B21A	5.60	55	1.51	0.77	5.31	3.376	Yes
RFA-B23	3.60	54	1.44	0.54	4.00	3.368	Yes
NEA-R05	2.80	53	1.40	0.45	3.11	3.361	No

† Critical values obtained from Table 1 of ASTM E178-08
‡ Test Statistic

TR RAI 2.9-36

Regarding the soil sampling strategy described in section 2.9.3.1.1 of the TR, please provide input parameters to, and results obtained from, Visual Sampling Plan.

TR RAI 2.9-36 Response

TR Section 2.9.3 will be revised to describe input parameters to, and results obtained from, Visual Sampling Plan (VSP) version 5.0. For the Main Permit Area and Surface Mine Area, the input to VSP consisted of shape files of the proposed license boundary and Surface Mine Area and the number of samples (75) for the Main Permit Area and Surface Mine Area. Refer to Figure 2.9-6, provided with the response to TR RAI 2.9-32(b), for the locations of the Main Permit Area (designated as "Proposed Action Area") and the Surface Mine Area. For the Land Application Areas, the input to VSP consisted of shape files of the land application areas and the number of samples (17) for the land application areas. Land Application Areas are shown on Exhibit 3.1-2. The results obtained from VSP consisted of coordinates for soil samples in the Main Permit Area and Land Application Areas. These locations are shown on Figures 2.9-9 and 2.9-10.

TR RAI 2.9-37

The following questions pertain to the analytical methods described in 2.9.3.1.1 of the TR:

TR RAI 2.9-37(a)

a. ***Consistent with Regulatory Guide 4.14, please provide the references for procedures used to convert the soil samples to a water matrix in order for the Environmental Protection Agency (EPA) drinking water testing methods to be used.***

TR RAI 2.9-37(a) Response

Section 2.9.3 of the TR will be revised to indicate the laboratory method for soil digestion. EPA Method 3050B, "Acid Digestion of Sediments, Sludges, and Soils," was used to convert the soil into an aqueous matrix (EPA, 1996). This procedure is provided with this RAI response package as Appendix 2.9-D, which will also be included with the revised TR.

<u>TR RAI 2.9-37(b)</u>

The following questions pertain to the analytical methods described in 2.9.3.1.1 of the TR:

b. NRC staff cannot verify that analytical method 909.0M is included in the EPA document Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA-600/4-80-032), 1980. Consistent with Regulatory Guide 4.14, please indicate where this analytical method can be found in the EPA document and a justification for its use.

<u>TR RAI 2.9-37(b) Response</u>

EPA Method 909, "Determination of Lead-210 in Drinking Water," was selected by the contract laboratory, Energy Laboratories, Inc., as the preferred test method. A copy of EPA Method 909 (EPA, 1982), is provided as Appendix 2.9-E to this RAI response package and will be included with the revised TR.

Although EPA method 909 was developed by EPA personnel and can be found on the EPA test method website (http://www.epa.gov/ne/info/testmethods), EPA Method 909 is not an EPA-approved procedure. Powertech understands that EPA does not have an approved procedure for lead-210 in water or soil. The TR incorrectly stated that EPA Method 909 is contained in *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA-600/4-80-032, EPA, 1980). TR Section 2.9.3 will be updated to correct this statement.

<u>TR RAI 2.9-37(c)</u>

The following questions pertain to the analytical methods described in 2.9.3.1.1 of the TR:

c. ***The applicant indicates that Method 6020A of EPA Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods (SW-846) was used for analyzing natural uranium in soil samples. Section 1.2 of Method 6020A of SW-846 does not specifically list uranium as an acceptable analyte for inductively coupled plasma-mass spectrometry (ICP-MS). Consistent with Regulatory Guide 4.14, please provide the demonstration of performance discussed in Section 1.3 of Method 6020A of SW-846 as it applies to uranium in the matrix evaluated.***

<u>TR RAI 2.9-37(c) Response</u>

The following information will be included in Section 2.9.3.1.1 of the revised TR. Consistent with Regulatory Guide 4.14, a laboratory performance evaluation for uranium in a soil matrix using EPA Method 6020A has been provided as 2.9-F. The performance evaluation was performed by RTC Corp. (A2LA Accreditation No. 2122.01) for the accreditation provided by the American Association for Laboratory Accreditation (A2LA). The performance evaluation is for the period July 30 through September 12, 2008, which is the time period during which the soil samples from the land application areas were analyzed. The initial 80 soil samples were analyzed in late 2007. The evaluation indicates that Method 6020A is used by the laboratory for analysis of uranium in soil and that it provides an acceptably accurate measurement of uranium in a soil matrix.

TR RAI 2.9-37(d)

The following questions pertain to the analytical methods described in 2.9.3.1.1 of the TR:

d. ***Laboratory analytical reports for Ra-226 soil sample analyses are located in Appendix 2.9-A of the TR. It is not clear what type of gamma analysis was performed on the soil samples to determine the Ra-226 concentration. For example, the testing method for sample R07100004-003 (SMA-B03) is annotated as "Gross Gamma" on the Analytical Summary Report, but the results are listed as "Ra-226 Gamma" on the Laboratory Analytical Report. Consistent with Regulatory Guide 4.14, please provide laboratory documentation that specifies the photopeak energies used to determine the Ra-226 activity of the soil samples as reported in the Laboratory Analytical Report.***

TR RAI 2.9-37(d) Response

Clarification from the contract laboratory, Energy Laboratories, Inc., on the testing method used for Ra-226 soil sample analyses, is provided in Appendix 2.9-G. The type of gamma analysis performed on the soil samples to determine the Ra-226 concentrations was closed-can gamma analysis in a 3-in can filled with 150 to 200 grams of soil. The soil is dried, ground, split, canned and taped in accordance with EPA Method 901.1. The Ra-226 concentrations were determined by measuring the 609 keV peak from bismuth-214. Appendix 2.9-G is included with this RAI response package and also will be included with the revised TR.

<u>TR RAI 2.9-38</u>
The following questions pertain to deriving the gamma-ray count rate-soil Ra-226 correlation:

<u>TR RAI 2.9-38(a)</u>
Considering the variations in expected gamma dose rates during different times of the year, please explain how combining gamma surveys performed at different times during the year affect the statistics for deriving the gamma ray count rate-soil Ra-226 correlation and the predicted Ra-226 concentrations over the permit area.

<u>TR RAI 2.9-38(a) Response</u>
It is well documented that high soil moisture and snow cover are the two most influential factors that contribute to reducing the exposure rate from radionuclides in the soil (NRC, 1980 and NRC, 2003b).

The use of a correlation to predict the Ra-226 in soil requires that all data, including the gamma survey and correlation data, be collected under similar soil moisture conditions. All data were gathered in fair weather during the late summers of 2007 and 2008 under similar soil moisture conditions. No effect on the gamma ray count rate-soil Ra-266 correlation is expected nor was one observed.

TR Section 2.9.2 (Baseline GPS-Based Gamma Surveys) will be revised to incorporate the preceding discussion and include the following statement.

"All data were gathered in fair weather during the late summers of 2007 and 2008 under similar soil moisture conditions."

TR RAI 2.9-38
The following questions pertain to deriving the gamma-ray count rate-soil Ra-226 correlation:

TR RAI 2.9-38(b)

b. In Section 2.9.2.2.3, the applicant stated that the linear regression formula for the gamma-ray count rate-soil Ra-226 correlation, after removing five outliers, is Radium-226 = 1.9*10-4 x Gamma-Ray Count Rate – 1.04, where the radium-226 concentration is in pCi/g and the gamma-ray count rate is in gross cpm. The applicant also stated in Section 5 of Appendix 2.9-A of the TR that this model has an R2 (coefficient of determination) value of 0.43, denoting a poor fit. NRC staff agrees with this assessment. In addition, work done by the authors previously cited by the applicant (Ott and Longnecker 2001) indicate that, based on this model, the gamma count rate is not a good indicator of Ra-226 concentration in soil. Please provide justification for utilizing a regression model that exhibits such a "poor fit" to predict Ra-226 concentrations in the Permit area.

TR RAI 2.9-38(b) Response

The following discussion, tables and figures will be added to Section 2.9.2 of the revised TR.

Linear regression modeling was used to provide a correlation between the concentration of Ra-226 in soil and the gamma count rate. This is standard industry practice. For decades the uranium industry decommissioning programs have relied on gamma count rate/Ra-226 correlations to identify land areas with Ra-226 contaminated soils requiring removal.

Two linear regression models were developed. The equations and descriptive statistics for each model are shown in Table TR RAI 2.9-38b-1. Equation 1 was developed using all soil data, while Equation 2 was developed using the same data but with five outliers excluded. The R^2 value for Equation 1 is higher than Equation 2. While the higher R^2 value often indicates a better fit, in this case Equation 2 better represents the concentrations of Ra-226 in soil as described below.

Plots of residuals (actual data minus predicted values from the equations) for both equations show increasing deviation with increasing gamma count rate. This is demonstrated in Figures TR RAI 2.9-38b-1 and TR RAI 2.9-38b-2. This increasing deviation violates the assumption of constant variance that is used in linear regression. Therefore, the use of R^2 as a measure of the adequacy of a model is not appropriate.

Equation 2 (the linear regression model with five outliers excluded) was selected based on an evaluation of results of data analysis that compare the two linear regression models using two distinct equations, which indicated that the selected equation produced the best fit of data. Instead of using the R^2 value, the model predictions were directly compared to the data by examining the median and quartiles. The median and quartiles predicted by Equation 2 are very close to the median and quartiles of the data and

are much closer than the median and quartiles of Equation 1. Therefore, Equation 2 was used to predict concentrations of Ra-226 in soil.

Table TR RAI 2.9-38b-1: Predicted Radium-226 Concentrations From Two Linear Regression Models Compared to Actual Data

Linear Regression Model Equation	Soil Data	R^2	Gamma Count Rate (All) (cpm)	Predicted Ra-226 Soil Concentration (pCi/g)
1) [Ra-226] = -0.87 + 0.0002*GCR	All	0.75	Median (12,687)	1.7
			1st Quartile (11,395)	1.4
			3rd Quartile (14,437)	2.0
2) [Ra-226] = -1.04 + 0.000187*GCR	5 outliers removed	0.43	Median (12,687)	1.4
			1st Quartile (11,395)	1.1
			3rd Quartile (14,437)	1.7
Actual Soil Data	All	NA	Median	1.3
			1st Quartile	1.1
			3rd Quartile	1.7
GCR = gamma count rate				

Figure TR RAI 2.9-38b-1: Plot of Residuals versus Gamma Count Rate for the Linear Regression Equation 1

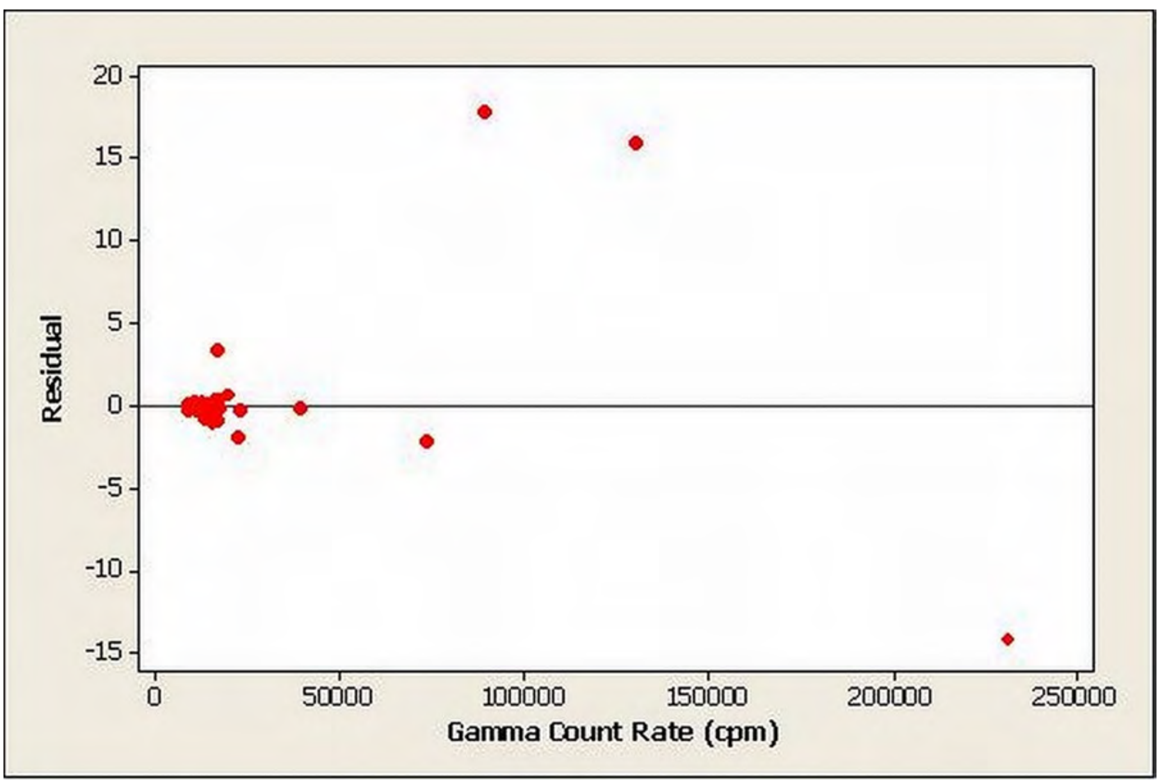
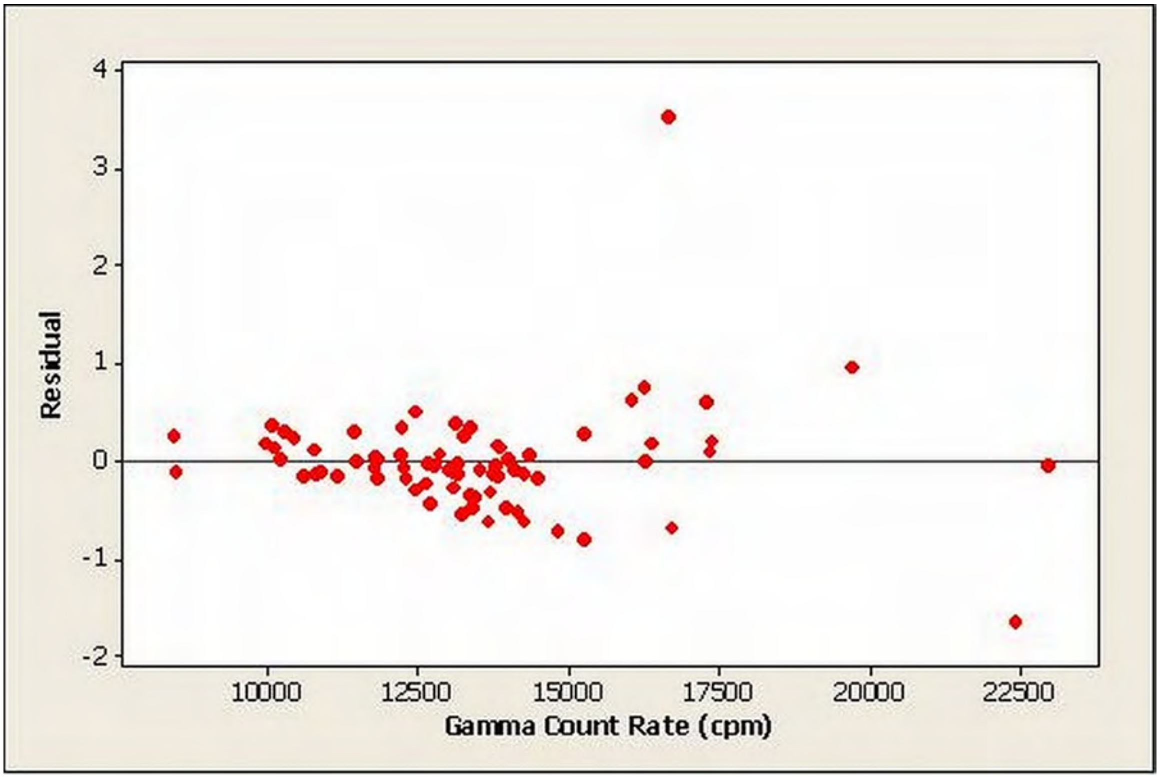


Figure TR RAI 2.9-38b-2: Plot of Residuals versus Gamma Count Rate for the Linear Regression Equation 2



TR RAI 2.9-39
The following questions pertain to the gamma/Ra-226 correlation grids discussed in Section 2.9.2.1.3 of the TR:

TR RAI 2.9-39(a)

a. ***Please provide input parameters and results obtained from Arc View GIS.***

TR RAI 2.9-39(a) Response

Please refer to the responses to TR RAI 2.9-32(a) and (b). The same methods used to develop site-wide exposure rates were used to develop site-wide Ra-226 concentration estimates. TR Section 2.9.2 will be revised to include the following.

ArcView GIS was used to map the predicted site-wide Ra-226 concentrations. The input parameters to ArcView GIS were gross gamma-ray count rates, in counts per minute (cpm), measured using matched sodium iodide detectors and recorded during the GPS-based survey. The results obtained from ArcView GIS were the predicted Ra-226 concentrations, in pCi/g, calculated using the equation given in TR Section 2.9.2.2.3:

$$\text{Ra-226 Concentration} = 1.9*10^{-4} \times \text{Gamma-Ray Count Rate} - 1.04$$

TR RAI 2.9-39

The following questions pertain to the gamma/Ra-226 correlation grids discussed in Section 2.9.2.1.3 of the TR:

TR RAI 2.9-39(b)

b. Please provide a description of the Arc View GIS interpolation scheme used, including the parameters to control how the scheme is applied.

TR RAI 2.9-39(b) Response

Figure 2.9-7 was intended for informational purposes only, to qualitatively evaluate the relative spatial distribution of Ra-226 concentrations in soil across the project area. No interpolation of the data was performed other than to group the data by category using ArcView GIS. The grid block Ra-226 concentrations presented on Figure 2.9-7 reflected the average of all predicted Ra-226 concentrations, as calculated from the gross gamma-ray count rates that fell within each 700 x 700-foot grid block boundary. With a 500-meter gamma survey transect spacing used throughout most of the site, approximately 40 percent of the grid blocks have no gamma readings (a null value when calculating the Ra-226 concentrations). The GIS analysis of these grid blocks interpreted no gamma-ray count rates as a zero value instead of a null value, which resulted in the incorrect display of a zero value. No interpolation or other method to spatially predict Ra-226 concentrations within the project area was used.

This will be clarified in the revised TR.

Figure 2.9-7 of the TR and Figure 9-3 of Appendix 2.9-A have been revised to only show Ra-226 concentration in soil exposure rate estimates from points where gamma survey data were collected. Revised Figure 2.9-7 is included below and will be incorporated into the revised TR.

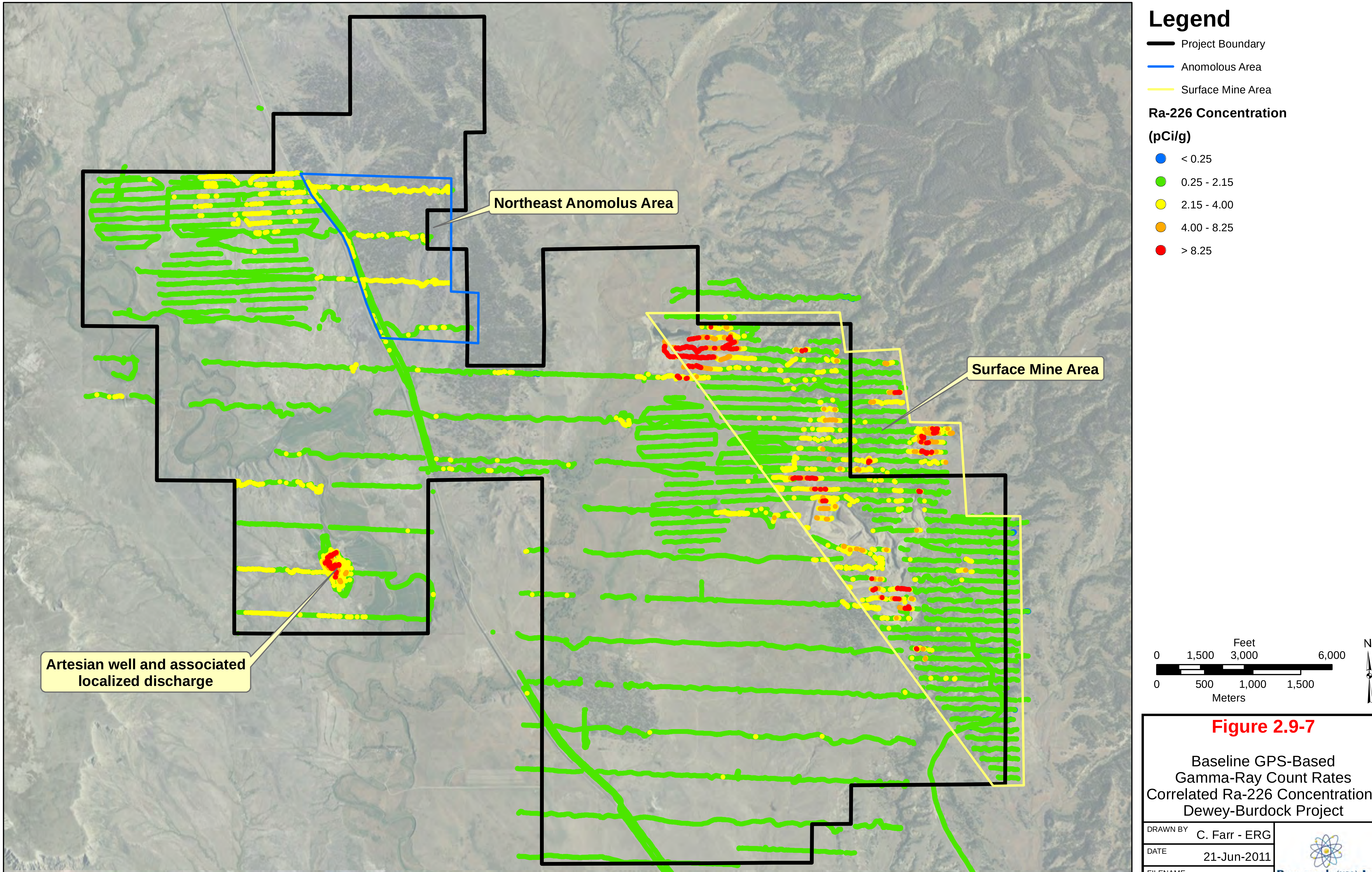


Figure 2.9-7

Baseline GPS-Based
Gamma-Ray Count Rates
Correlated Ra-226 Concentrations
Dewey-Burdock Project

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DATE	21-Jun-2011
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Powertech (USA) Inc.

<u>TR RAI 2.9-39</u>

The following questions pertain to the gamma/Ra-226 correlation grids discussed in Section 2.9.2.1.3 of the TR:

<u>TR RAI 2.9-39(c)</u>

c. ***Please provide error estimates of the data presented in Figure 2.9-7, Predicted Site-Wide Radium-226 Concentrations, Grid Block Averages, in the TR. In the response, include a discussion of the various sources of error (e.g., seasonal variability in gamma dose rates, using a regression model with an R^2 (coefficient of determination) value of 0.43, etc.)***

<u>TR RAI 2.9-39(c) Response</u>

Regarding error estimates for the data presented in Figure 2.9-7, please refer to the responses to TR RAI 2.9-32 (c) and TR RAI 2.9-38(a) and (b). Figure 2.9-7 will be revised and the interpolation eliminated. The error associated with the predicted values is coupled with the error of the regression line. A 95% confidence interval for the regression line used to predict radium-226 concentration is shown in Figure 5-2 of Appendix 2.9-A. The 95% confidence interval across the range of typical gamma count rates spans approximately 2 pCi/g. Provided future gamma count rates are collected using similar instrumentation and during a similar seasonal period as the existing data, little seasonal variability would be introduced. If soil moisture conditions are much different when collecting future gamma count rate data, new correlations to radium-226 concentrations in soil will be established for the specific condition.

<u>TR RAI 2.9-40</u>

In Section 2.9.3 of the TR, the applicant describes its soil sampling program. Figures 2.9-9 and 2.9-10 of the TR provide sampling locations from the main Permit Area and land application areas respectively. Table 2.9-5 of the TR provides radionuclide concentrations for all soil samples. Comparing the aforementioned soil sampling data with Supplemental Exhibit 3.1-2, Proposed Facilities and Well Fields Land Application Option, NRC staff has the following questions to understand site-wide radiological variations in areas expected to be impacted by operations and evaluating compliance with 10 CFR 40, Appendix A, Criterion 7.

<u>TR RAI 2.9-40(a)</u>

a. ***Please demonstrate that a sufficient number of samples have been obtained in the Dewey area. It appears that very few radium samples have been obtained in the proposed area of the satellite processing plant and wellfield that could be impacted by operations. It also appears that no uranium or Th-230 samples were obtained in areas that could be impacted by operations.***

<u>TR RAI 2.9-40(b)</u>

b. ***Please demonstrate that a sufficient number of samples have been obtained in the Burdock area. While the applicant took more total samples in this area, it is not clear how many are in the area expected to be impacted by the central processing plant and the wellfield. In addition, it appears that very few uranium and Th-230 samples were obtained in these areas.***

<u>Clarification:</u>

Prior to addressing the specific RAIs above, it is important to review and clarify the soil sampling strategy used at the Dewey-Burdock Project. This strategy was presented to the NRC staff during public meetings on August 22, 2007 and on April 29, 2008; no deficiencies regarding this strategy were communicated to Powertech by the NRC staff as a result of these presentations. The general soil sampling strategy is described in Section 2.9.3 of the TR, but the following key points are emphasized.

1) The Dewey-Burdock project area was treated as one "milling site," not as two separate "milling sites." For pre-operational baseline characterization, Powertech contends that this is appropriate, since one continuous license area is proposed and the locations of well fields, processing facilities, and land application areas within that license area are arbitrary when evaluating the average pre-operational radiological conditions.
2) The radial pattern sample point distribution recommended in Regulatory Guide 4.14 was not used due to the configuration of proposed ISR facilities. Most soil sample locations were based on a combination of random and biased sampling. Random sampling was intended to evaluate the central tendency (mean or median) of the radionuclide concentrations in soil, while the biased sampling was focused on defining the range of radionuclide concentrations in soil, within the project area. The gamma survey data were used to help locate the bias sampling locations. An exception to this method was that soil samples were collected at air particulate monitoring locations, consistent with Regulatory Guide 4.14.

3) Initially, the total number of biased and random samples was 80. Regulatory Guide 4.14 recommends 40 radially spaced samples from a depth interval of 0-5 cm, while NUREG-1569 recommends an additional 40 soil samples from a depth interval of 0-15 cm co-located with the 0-5 cm sample locations. In addition to the 40 radially spaced soil samples, Regulatory Guide 4.14 recommends soil sampling (0-5 cm depth interval) from the air particulate monitoring locations. An additional 17 random soil sample locations were later added in the proposed land application areas.
4) The approach was to focus the baseline soil investigation on the 0-15 cm depth intervals and limit soil sampling of the 0-5 cm depth interval to the air particulate monitoring locations, while keeping the total number of samples greater than or equal to those recommended by Regulatory Guide 4.14 and NUREG-1569 the same, which is 80 samples. The rationale for this approach includes the following items:

   a. The 0-5 cm depth interval is more sensitive to aerial deposition of radionuclides than the 0-15 cm depth interval, and it therefore makes sense to sample the more sensitive depth interval where air particulate monitoring is taking place.

   b. The 0-5 cm depth interval sampling at air particulate monitoring stations will be part of the operational monitoring program, thus operational monitoring data can be compared to baseline monitoring data at consistent depth intervals.

   c. The radium-226 soil cleanup standard contained in 10 CFR 40, Appendix A is defined as 5 pCi/g above background for a depth interval of 0-15 cm.

   d. An emphasis on the depth interval applicable to the radium-226 cleanup standard was used since this standard requires a well-defined pre-operational characterization of background radiological conditions in soil from a depth of 0-15 cm.

5) Consistent with Regulatory Guide 4.14 recommendations, all soil samples were analyzed for radium-226, while 10% of the soil samples were also analyzed for natural uranium, thorium-230 and lead-210. All soil samples collected at the air particulate monitoring locations were analyzed for natural uranium, thorium-230, radium-226, and lead-210.

The preceding discussion and the information in the following response, including the figures and tables and commitment for (or results of, depending on timing) additional sampling will be incorporated into the revised TR.

TR RAI 2.9-40(a) and (b) Response

The following discussion provides justification for the number of samples collected in the Dewey and Burdock portions of the project area. Powertech acknowledges that there was a difference in sample density between the Dewey and Burdock portions of the project area and commits to collecting additional soil samples in the Dewey area prior to ISR operations.

Dewey Area

Table TR RAI 2.9-40-1 describes the samples collected in the Dewey portion of the project area. These samples include random and biased locations within the general Dewey area as well as the Dewey land application area. The sample locations were focused on the roll-front areas, land application areas and in an area exhibiting higher gamma readings in the north and northeast part of the Dewey area. Sample locations have been plotted on Exhibit 3.2-1 to show their relationship to proposed process-related features.

Table TR RAI 2.9-40-1: Dewey Area Soil Samples

Sample ID	Depth (cm)	Analytes
MPA-R01	0-15	Radium-226
NEA-R01	0-15	Full List
NEA-R02	0-15	Radium-226
NEA-R03	0-15	Radium-226
NEA-R04	0-15	Radium-226
NEA-R05	0-15	Radium-226
RFA-B01	0-15, 15-30, 30-100	Full List
RFA-B03	0-15	Radium-226
RFA-B06	0-15	Radium-226
RFA-B10	0-15	Radium-226
RFA-B13	0-15, 15-30, 30-100	Radium-226
RFA-B14	0-15cm	Radium-226
RFA-B17	0-15, 15-30, 30-100	Radium-226
RFA-B18	0-15	Radium-226
RFA-B23	0-15	Radim-226
RFA-B25	0-15	Full List
RFA-B28	0-15	Radium-226
RFA-B30	0-15, 15-30, 30-100	Radium-226
RFA-B41	0-15	Radium-226
RFA-B43	0-15	Radium-226
RFA-B45	0-15	Radium-226
LAN-001	0-15, 15-30, 30-100	Full List
LAN-002	0-15, 15-30, 30-100	Full List
LAN-003	0-15, 15-30, 30-100	Full List
LAN-004	0-15, 15-30, 30-100	Full List
LAN-005	0-15, 15-30, 30-100	Full List
LAN-006	0-15, 15-30, 30-100	Full List
LAN-007	0-15, 15-30, 30-100	Full List
LAN-008	0-15, 15-25 , Refusal at 25	Full List
LAN-009	0-15, 15-30, 30-100	Full List
LAN-010	0-15, 15-30, 30-100	Full List

Note: “Full List” includes natural uranium, radium-226, thorium-230 and lead-210.

<u>Burdock Area</u>

Table TR RAI 2.9-40-2 describes the samples collected in the Burdock portion of the project area. These samples include random and biased locations within the Burdock area. The sample locations were focused on the roll-front areas and land application areas. Sample locations have been plotted on Exhibit 3.2-1 to show their relationship to proposed process-related features.

TR RAI 2.9-40(a) and (b) specifically ask to demonstrate adequate sample numbers in the Dewey and Burdock areas independently. Since the pre-operational soil sampling strategy treated the entire project area as one "mill site" as discussed above, Powertech proposes to evaluate adequate sample numbers for the entire project area, not sub-areas as the RAI requests. Nevertheless, Powertech acknowledges that there was a difference in sample densities between the Dewey and Burdock portions of the project area and commits to additional soil sampling in the Dewey area as described below.

Powertech chose to use methods contained in NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination" (NRC, 1992b) to evaluate the sample number adequacy. The land application area sample results (sample ID designations LAS and LAN) were not used in the evaluation, since they were not part of the initial 80 soil samples. NUREG/CR-5849 describes a method to determine an adequate sample size (N), where t is the t-statistic, r is the relative fractional error, and cv is the coefficient of variation.

$$N > \left(\frac{t}{r}cv\right)^2$$

A 95% confidence level with the degrees of freedom approaching infinity yields a t-statistic of 1.645. Figure TR RAI 2.9-40-1 shows the plot of this equation for a relative fraction error of 10 and 20 percent for various values of coefficient of variation.

The mean and standard deviation of the radium-226 concentrations in the 55 samples collected in the Main Permit Area are 1.51 and 0.77 pCi/g, respectively. The coefficient of variation for the samples is 0.77/1.51=0.5. Inspection of the plot in Figure TR RAI 2.9-40-1 indicates that about 20 and 70 samples are sufficient to estimate the mean radium-226 concentration to within 20 and 10 percent, respectively. The collection of 55 samples is acceptably within this range. The addition of 18 land application samples exceeds this range. Based on this evaluation, Powertech concluded that an adequate number of soil samples were collected to describe the mean radium-226 concentration in the entire project area to within 10 percent.

Table TR RAI 2.9-40-2: Burdock Area Soil Samples

Sample ID	Depth (cm)	Analytes
MPA-R02	0-15	Radium-226
MPA-R03	0-15	Full List
MPA-R04	0-15	Radium-226
MPA-R05	0-15	Radium-226
MPA-B01	0-15	Radium-226
MPA-B02	0-15	Radium-226
MPA-B03	0-15	Radium-226
RFA-B02	0-15, 15-30, 30-100	Radium-226
RFA-B04	0-15	Radium-226
RFA-B07	0-15	Radium-226
RFA-B08	0-15	Radium-226
RFA-B09	0-15	Radium-226
RFA-B11	0-15	Full List
RFA-B12	0-15	Radium-226
RFA-B15	0-15, 15-30, 30-100	Radium-226
RFA-B16	0-15	Radium-226
RFA-B19	0-15	Radium-226
RFA-B20	0-15	Full List
RFA-B21	0-15, 15-30, 30-100	Radium-226
RFA-B22	0-15	Radium-226
RFA-B24	0-15	Radium-226
RFA-B26	0-15	Radium-226
RFA-B27	0-15	Radium-226
RFA-B29	0-15	Radium-226
RFA-B31	0-15	Radium-226
RFA-B33	0-15	Radium-226
RFA-B34	0-15	Radium-226
RFA-B35	0-15	Radium-226
RFA-B36	0-15, 15-30, 30-100	Radium-226
RFA-B37	0-15, 15-30, 30-100	Radium-226
RFA-B38	0-15	Radium-226
RFA-B39	0-15	Radium-226
RFA-B40	0-15	Full List
RFA-B44	0-15	Radium-226
LAS-001	0-15, 15-30, 30-100	Full List
LAS-002	0-15, 15-30, 30-100	Full List
LAS-003	0-15, 15-30, 30-100	Full List
LAS-004	0-15, 15-30, 30-100	Full List
LAS-005	0-15, 15-30, 30-100	Full List
LAS-006	0-15, 15-30, 30-100	Full List
LAS-007	0-15, 15-30, 30-100	Full List

Note: “Full List” includes natural uranium, radium-226, thorium-230 and lead-210.

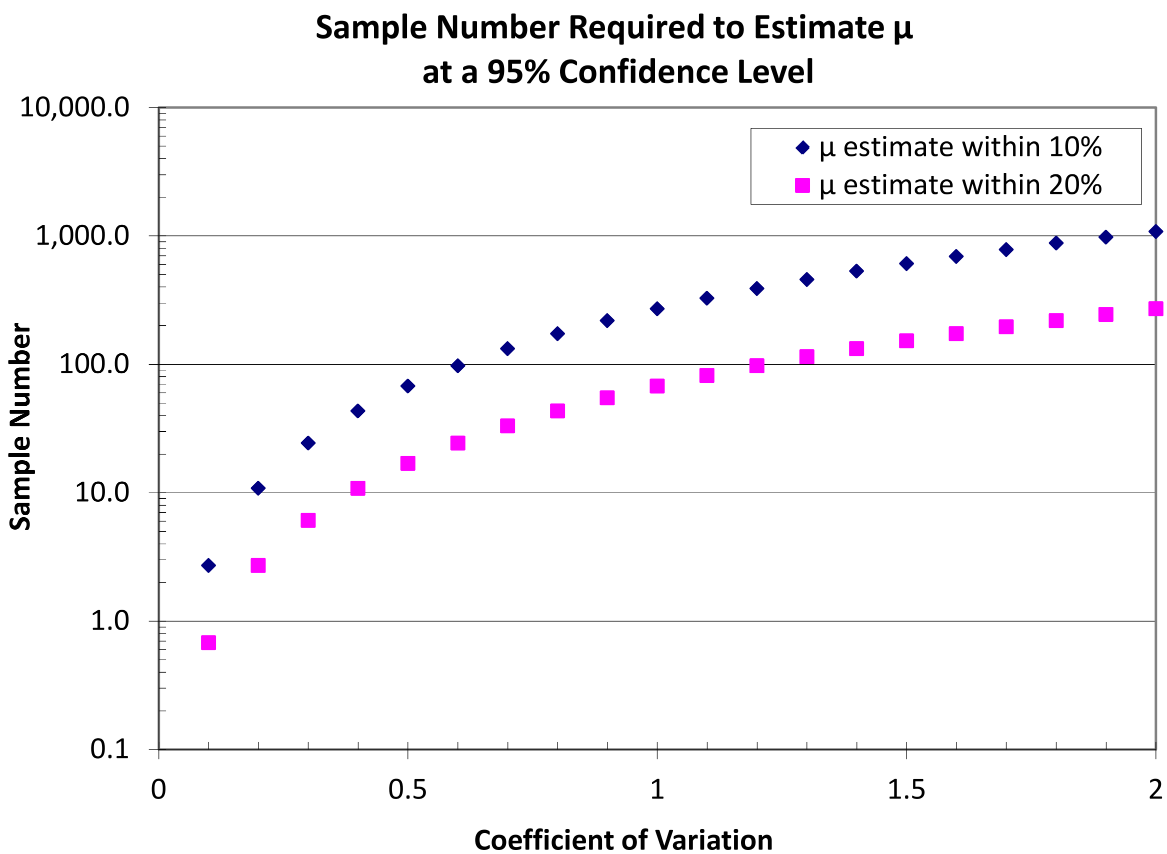

Figure TR RAI 2.9-40-1: Adequate Sample Size as a Function of the Coefficient of Variation

<u>Commitment to Collect Additional Soil Samples</u>

Powertech acknowledges a difference in sample density (number of samples per unit area) between the Burdock and Dewey areas. The Burdock area has a higher sample density, which the NRC staff has stated is probably sufficient for the pre-operational baseline sampling program. Powertech commits to collecting 15 more surface soil samples (0-15 cm) in the Dewey area. The proposed locations of these additional samples are shown in Figure TR RAI 2.9-40-2. The samples will be analyzed for parameters consistent with the recommendations of Regulatory Guide 4.14, including the suggested LLDs. This additional sampling will result in equal sample densities for the Dewey and Burdock portions of the project areas.

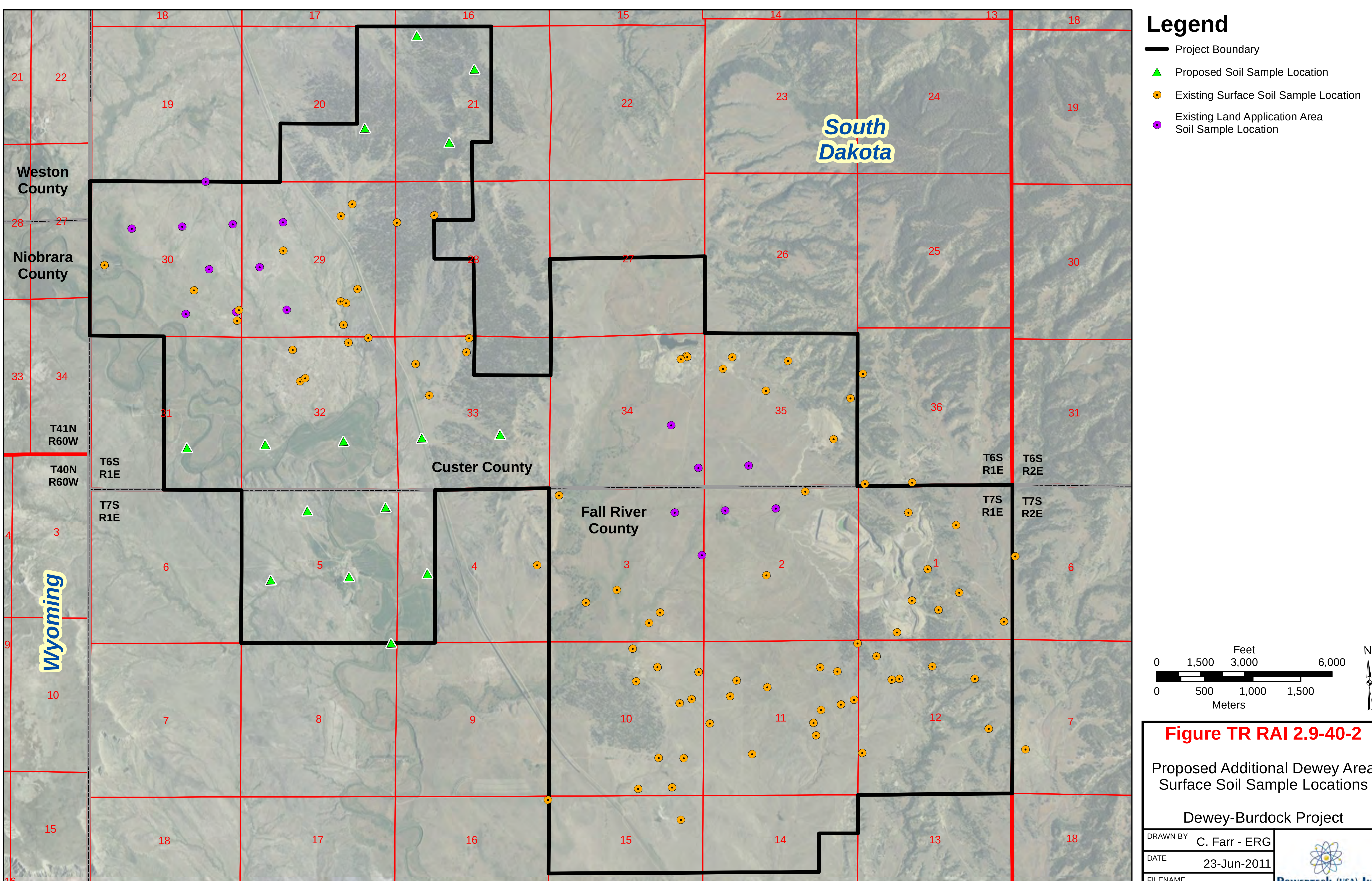

Figure TR RAI 2.9-40-2

Proposed Additional Dewey Area Surface Soil Sample Locations

Dewey-Burdock Project

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DATE 23-Jun-2011

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Powertech (USA) Inc.

TR RAI 2.9-40

In Section 2.9.3 of the TR, the applicant describes its soil sampling program. Figures 2.9-9 and 2.9-10 of the TR provide sampling locations from the main Permit Area and land application areas respectively. Table 2.9-5 of the TR provides radionuclide concentrations for all soil samples. Comparing the aforementioned soil sampling data with Supplemental Exhibit 3.1-2, Proposed Facilities and Well Fields Land Application Option, NRC staff has the following questions to understand site-wide radiological variations in areas expected to be impacted by operations and evaluating compliance with 10 CFR 40, Appendix A, Criterion 7.

TR RAI 2.9-40(c)

c. ***There appears to be no soil sampling data for the area between Dewey and Burdock. Please demonstrate that sufficient information has been obtained on the background soil levels to characterize expected transportation routes between these areas.***

TR RAI 2.9-40(c) Response

The commitment to collect additional soil samples in the response to TR RAI 2.9-40(a) and (b) will result in additional data for the portion of the project area between the Dewey and Burdock areas, as well as the Dewey area.

This information, including the commitment for (or results of, depending on timing) additional sampling will be incorporated into the revised TR.

TR RAI 2.9-41

NRC Staff notes that in section 2.9.4.3 (page 2-349) the applicant refers to PSC02 as the downstream location of Pass Creek. This is not consistent with Table 2.7-20 (page 2-185) that refers to PSC02 as the upstream location of Pass Creek. Please address this inconsistency.

TR RAI 2.9-41 Response

The TR incorrectly identified the site ID associated with the downstream site on Pass Creek. As presented in Table 2.7-20 of the TR, the previous upstream site on Pass Creek is identified as PSC02, while the downstream site was denoted as PSC01. Section 2.9.4.3 of the TR will be revised to incorporate the following:

"Radionuclide concentrations in sediment at downstream locations on Pass Creek (PSC01) and the Cheyenne River (CHR05) are elevated compared to upstream locations for the same surface water bodies, indicating potential impacts from mineralized areas on and adjacent to the site."

It is important to note that Powertech proposes to relocate upstream and downstream surface water and sediment sampling locations on Beaver Creek and Pass Creek. As described in the response to TR RAI 2.9-43(b), Powertech proposes to relocate the pre-operational and operational sampling locations to coincide with the proposed license boundary.

<u>TR RAI 2.9-42</u>

The staff could not locate laboratory reports for sediment samples. Please provide these reports or specify where these can be found in the application.

<u>TR RAI 2.9-42 Response</u>

Analytical results for the sediment sampling completed as part of the baseline monitoring program are provided in Appendix 2.9-H, which is included with this response package. A summary of radionuclide concentration in sediment samples is provided in Appendix 2.9-K. Both appendices will be included with the revised TR.

<u>TR RAI 2.9-43</u>

10 CFR 40, Appendix A, Criterion 7, requires a preoperational monitoring program to provide complete baseline data on a milling site and its environs. RG 4.14 provides guidance on surface water sampling, including impoundments and surface waters passing through the mill site. Regarding the applicant's preoperational surface water monitoring program, please address the following issues.

For these issues, the applicant should analyze all surface water features in accordance with Regulatory Guide 4.14 criteria, including offsite water features that could be impacted from operations, or provide a justification for an alternate methodology that complies with 10 CFR 40, Appendix A, Criterion 7.

<u>TR RAI 2.9-43(a)</u>

In Section 2.7.3.1 of the TR, the applicant identified 48 surface water impoundments. In Section 2.7.3.1 of the TR the applicant stated that it chose surface water sampling locations based on Regulatory Guide 4.14. However, the applicant only sampled a "representative" number of impoundments resulting in including only 11 impoundments in its preoperational surface water monitoring program as shown on Table 2.7-20 of the TR.

<u>TR RAI 2.9-43(a) Response</u>

The following describes the surface water impoundment monitoring that was completed as part of the baseline monitoring program. For additional information on the inconsistency regarding the number of impoundments included in the monitoring program, please refer to the response to TR RAI 2.7-18. The following information will be incorporated into the revised TR.

A summary of impoundment sampling for the baseline surface water monitoring program is provided in Table TR RAI 2.9-43a-1. The table details all of the 40 impoundments that were identified during the 2007 field survey. During the baseline monitoring program, 11 of the 40 impoundments were visited on a quarterly basis. Table TR RAI 2.9-43a-1 illustrates which of these impoundments were sampled during each quarterly sampling event or provides a reason why a sample could not be collected. Water quality and radionuclide results for each impoundment are provided in Appendix 2.7-C, and 2.9-I, respectively. These appendices are included with this RAI response package and will be included with the revised TR.

Powertech has re-evaluated all of the impoundments within and surrounding the project area, including the impoundments identified during the 2007 field survey. The location of each impoundment in relation to proposed activity was used to determine whether the impoundment would be included in the operational monitoring program. Table TR RAI 2.9-43a-1 lists all of the impoundments and identifies which impoundments are located down-gradient (i.e., potentially subject to surface runoff) from proposed activity or within potential well field areas. The table also denotes the 24 impoundments proposed for operational monitoring, including 2 Darrow pits not included in the baseline monitoring program. Justification for the impoundments not proposed for operational monitoring is provided in the table and is typically due to the impoundment not being located downstream of all proposed activities.

Powertech proposes to visit all 24 of the impoundments proposed for operational monitoring four times (including the initial samples) prior to ISR operations to satisfy the Regulatory Guide 4.14 pre-operational monitoring recommendation. Water samples will be collected, when available, and analyzed for constituents listed in Table 2.7-22 of the TR, which is consistent with Table 2.7.3-1 of NUREG-1569 and Table 1 of Regulatory Guide 4.14.

Impoundments proposed to be included in the operational surface water monitoring program are depicted on Exhibit 5.7-1, which is included with this response package and will be included with the revised TR.

Table TR RAI 2.9-43a-1: Impoundment Pre-Operational Sampling Summary and Impoundments Proposed for Operational Monitoring

Site	Type/Name	Baseline Sampling				Down-Gradient of Proposed Activity*	Proposed for Operational Monitoring	Justification for Not Including in Operational Monitoring Program
		3Q07	4Q07	1Q08	2Q08			
Sub01	Stock Pond	1	1	**X**	**X**	No		Not down-gradient and outside of project area
Sub02	Triangle Mine Pit	**X**	**X**	**X**	**X**	No	**Yes**	
Sub03	Mine Dam	1	**X**	1	**X**	Yes	**Yes**	
Sub04	Stock Pond	1	**X**	1	**X**	Yes	**Yes**	
Sub05	Mine Dam	1	1	1	1	Yes	**Yes**	
Sub06	Darrow Mine Pit Northwest	**X**	**X**	**X**	**X**	Yes	**Yes**	
Sub07	Stock Dam	**X**	**X**	**X**	**X**	Yes	**Yes**	
Sub08	Stock Pond	**X**	**X**	**X**	**X**	Yes	**Yes**	
Sub09	Stock Pond	1	1	**X**	**X**	Yes	**Yes**	
Sub10	Stock Pond		1	**X**	**X**	Yes	**Yes**	
Sub11	Stock Pond	**X**	**X**	**X**	**X**	Yes	**Yes**	
Sub20	Stock Pond					Yes	**Yes**	
Sub21	Stock Pond					Yes	**Yes**	
Sub22	Stock Pond					Yes	**Yes**	
Sub23	Stock Pond					No		Not an impoundment, infrequent, small pool of water due to inadequate storm water control at county road crossing
Sub24	Stock Pond			**X**		No		Outside of project area, not located in a project area drainage
Sub25	Stock Pond					No		Outside of project area, not down-gradient
Sub26	Stock Pond					No		Outside of project area, not down-gradient
Sub27	Stock Pond					Yes		Outside of project area, downstream of Sub28
Sub28	Stock Pond					Yes		Outside of project area, downstream of Sub08 and Sub09 with no proposed activity between Sub 08 or Sub09 and Sub28

Table TR RAI 2.9-43a-1: Impoundment Pre-Operational Sampling Summary and Impoundments Proposed for Operational Monitoring (Cont.)

Site	Type/Name	Baseline Sampling				Down-Gradient of Proposed Activity*	Proposed for Operational Monitoring	Justification for Not Including in the Operational Monitoring Program
		3Q07	4Q07	1Q08	2Q08			
Sub29	Stock Pond					Yes	**Yes**	
Sub30	Stock Pond					Yes	**Yes**	
Sub31	Stock Pond					Yes	**Yes**	
Sub32	Stock Pond					Yes	**Yes**	
Sub33	Stock Pond					Yes	**Yes**	
Sub34	Stock Pond					Yes	**Yes**	
Sub35	Stock Pond					Yes	**Yes**	
Sub36	Stock Pond					Yes	**Yes**	
Sub37	Stock Pond					Yes		Downstream of Sub36
Sub38	Stock Pond					No		Outside of project area, not down-gradient
Sub39	Stock Pond					No		Not down-gradient
Sub40	Darrow Mine Pit Southeast					Yes	**Yes**	
Sub41	Stock Pond					Yes		Only down-gradient of potential perimeter monitor wells
Sub42	Stock Pond					No		Not down-gradient
Sub43	Stock Pond					No		Not down-gradient
Sub44	Stock Pond					No		
Sub45	Stock Pond					No		Outside of project area, not down-gradient
Sub46	Stock Pond					No		Outside of project area, not down-gradient
Sub47	Stock Pond					No		Outside of project area, not down-gradient
Sub48	Stock Pond					No		Outside of project area, not down-gradient
Sub49	Darrow Mine Pit	Not Included in 2007 Field Survey				Yes	**Yes**	
Sub50	Darrow Mine Pit	Not Included in 2007 Field Survey				Yes	**Yes**	

* Potentially subject to surface runoff from Satellite Facility, CPP, ponds, potential land application areas, pipelines, or potential well field areas.

Notes: **X** – Sample collected

1-2 – No sample collected due to:

1 – Impoundment was dry during quarterly visit

2 – Impoundment was covered in ice during quarterly visit

TR RAI 2.9-43

10 CFR 40, Appendix A, Criterion 7, requires a preoperational monitoring program to provide complete baseline data on a milling site and its environs. RG 4.14 provides guidance on surface water sampling, including impoundments and surface waters passing through the mill site. Regarding the applicant's preoperational surface water monitoring program, please address the following issues.

For these issues, the applicant should analyze all surface water features in accordance with Regulatory Guide 4.14 criteria, including offsite water features that could be impacted from operations, or provide a justification for an alternate methodology that complies with 10 CFR 40, Appendix A, Criterion 7.

TR RAI 2.9-43(b)

b. It appears that the applicant also used this "representative" approach with other surface water features as well. For example, grid 14 on Plate 2.5-1 appears to have three separate drainages exiting the Permit Area, yet they were not sampled.

TR RAI 2.9-43(b) Response

The following describes the stream monitoring that was completed as part of the baseline monitoring program and proposes additional stream monitoring sites in response to this RAI. The following information will be incorporated into the revised TR.

As stated in Section 2.7 of the TR, as part of the baseline monitoring program stream sampling sites were established on Beaver Creek, Pass Creek, the Cheyenne River, Bennett Canyon, and unnamed tributaries. The baseline monitoring program included monthly visits to each site. Grab samples were collected from the sites on Beaver Creek and the Cheyenne River, when available, while automated samplers were installed at the sites on Pass Creek, Bennett Canyon and an unnamed tributary south of the project area. Table TR RAI 2.9-43b-1 provides a baseline stream sampling summary. The table includes the eight stream monitoring sites and illustrates which sites were sampled during each monthly sampling event or provides a reason why a sample could not be collected.

Water quality and radionuclide results for each stream sampling site are provided in Appendix 2.7-C and 2.9-I, respectively. These appendices are included with this RAI response package and will be included in the revised TR.

The stream sampling sites were evaluated against guidance in Regulatory Guide 4.14 to establish an operational monitoring program. Table TR RAI 2.9-43b-2 provides a list of the stream sampling sites proposed for operational monitoring. The table proposes a total of 10 stream sampling sites including 6 new sites, as depicted on Exhibit 5.7-1. Four sites (BVC01, BVC04, PSC01, and PSC02) used for baseline monitoring will be replaced with operational monitoring sites that better meet the guidance in Regulatory Guide 4.14 as follows:

- BVC11 will be located where Beaver Creek exits the project area. This monitoring location will replace BVC01, which was approximately 2 stream miles further downstream, below the confluence with Pass Creek.
- BVC14 will be located where Beaver Creek enters the project area. This monitoring location will replace BVC04, which was approximately 12 stream miles upstream from the project area.
- PSC11 will be located where Pass Creek exits the project area. This monitoring location will replace PSC01, which was approximately 2 stream miles upstream from the PSC11 location, within the project area.
- PSC12 will be located where Pass Creek enters the project area. This monitoring location will replace PSC02, which was about 2 stream miles upstream from the project area

Prior to ISR operations, Powertech proposes to sample each site monthly (including the initial samples) for 12 consecutive months in accordance with Regulatory Guide 4.14 pre-operational monitoring recommendations. Grab samples will be collected from sites BVC11, BVC14, CHR01, and CHR05. Passive samplers will be installed at the remaining sites to collect samples during ephemeral flow events. Water samples will be analyzed for constituents listed in Table 2.7-22 of the TR, which is consistent with Table 2.7.3-1 of NUREG-1569 and Table 1 of Regulatory Guide 4.14.

Table TR RAI 2.9-43b-1: Baseline Stream Sampling Summary

Site	Type/Name	Sample Type	Jul-2007	Aug-2007	Sept-2007	Oct-2007	Nov-2007	Dec-2007	Jan-2008	Feb-2008	Mar-2008	Apr-2008	May-2008	Jun-2008
BVC01	Beaver Creek Downstream	Grab	**X**	**X**	**X**	**X**	**X**	**X**	**X**	1	**X**	**X**	**X**	**X**
BVC04	Beaver Creek Upstream	Grab	**X**	**X**	**X**	**X**	**X**	**X**	**X**	1	**X**	**X**	**X**	**X**
CHR01	Cheyenne River Upstream	Grab	**X**	2	**X**	**X**	**X**	1	3	3	**X**	**X**	**X**	**X**
CHR05	Cheyenne River Downstream	Grab	**X**	2	**X**	**X**	**X**	**X**	1	**X**	**X**	**X**	**X**	**X**
PSC01	Pass Creek Downstream	Passive Sampler	**X**	4	4	4	4	4	4	4	4	4	4	**X**
PSC02	Pass Creek Upstream	Passive Sampler	**X**	4	4	4	4	4	4	4	4	4	4	**X**
BEN01	Bennett Canyon	Passive Sampler	3	4	4	4	4	4	4	4	4	4	4	4
UNT01	Unnamed Tributary	Passive Sampler	3	4	4	4	4	4	4	4	4	4	4	**X**

Notes:

X – sample collected

1-3 – no sample collected due to:

1 – Ice

2 – August 2007 sample collected September 5, 2007

3 – Dry

4 – Passive sampler did not indicate precipitation event

Table TR RAI 2.9-43b-2: Proposed Operational Stream Sampling Locations

Site ID	Name	Sample Type	Location in NAD 27, South Dakota State Plane South (feet)	
			Northing	Easting
BVC11	Beaver Creek Downstream	Grab	433,638	1,022,546
BVC14	Beaver Creek Upstream	Grab	446,829	1,012,976
CHR01	Cheyenne River Upstream	Grab	423,009	1,016,699
CHR05	Cheyenne River Downstream	Grab	405,925	1,047,227
PSC11	Pass Creek Downstream	Passive sampler	431,452	1,028,064
PSC12	Pass Creek Upstream	Passive sampler	446,470	1,031,222
BEN01	Bennett Canyon	Passive sampler	416,196	1,047,473
UNT01	Unnamed Tributary	Passive sampler	422,482	1,039,166
UNT02	Unnamed Tributary	Passive sampler	424,478	1,035,236
UNT03	Unnamed Tributary	Passive sampler	425,438	1,029,910

<u>TR RAI 2.9-44</u>

The NRC staff could not locate BVC04, CHR05, and BEN01 on Plate 2.5-1 of the TR as stated by the applicant, but they are listed in Table 2.7-20. Please provide the locations of the above monitoring stations on Plate 2.5-1 of the TR or correct the text to incorporate the correct reference.

<u>TR RAI 2.9-44 Response</u>

Sampling locations BVC04, CHR05, and BEN01 are not within the scale of Plate 2.5-1. The TR will be revised to reference Figure 2.9-11 or another appropriate figure instead of Plate 2.5-1.

<u>TR RAI 2.9-45</u>
The staff could not locate PSC01 on Plate 2.5-1 of the TR. However there is a PS-1 sampling location. Please verify whether these two monitoring stations are the same or not.

<u>TR RAI 2.9-45 Response</u>

PSC01 and PS-1 are two separate monitoring sites. Site PSC01, located in Section 3, T7S, R1E, was sampled as part of the baseline surface water monitoring program.

Site PS-1, located in Section 9, T7S, R1E, was not part of the baseline monitoring program. The site was used by DENR as part of the Cheyenne River Total Maximum Daily Load (TMDL) project. This site does not pertain to this project and should not have been included on Plate 2.5-1. A revised Plate 2.5-1 will be included with the revised TR.

<u>TR RAI 2.9-46</u>

Regulatory Guide 4.14 recommends sampling at the site boundary or at a location immediately downstream of the area of potential influence. BVC01 (Beaver Creek downstream) and UNT01 (Unnamed Tributary) do not appear to comport with this recommendation. Please demonstrate that these sampling sites are consistent with Regulatory Guide 4.14.

<u>TR RAI 2.9-46 Response</u>

Powertech agrees that these two sites do not comport with the Regulatory Guide 4.14 recommendation for site boundary locations. Site BVC01 will be relocated as discussed below and monitored for 12 months prior to ISR operations. Justification for site UNT01 is provided below on the basis that this site is the nearest downstream location from the proposed license boundary that is conducive to passive sampler installation and operation.

The following describes the locations used for sites BVC01 and UNT01 during the baseline monitoring and provides details on the proposed relocation of site BVC01. For additional information on stream monitoring completed as part of the baseline monitoring program and the proposed operational surface water monitoring, please refer to the response to TR RAI 2.9-43(b). The following information will be incorporated into the revised TR.

As part of the baseline surface water monitoring program, Powertech established and sampled eight sites, including BVC01 and UNT01. BVC01 was downstream of the confluence of Beaver Creek and Pass Creek. Following the evaluation of sites for the operational surface water monitoring program, Powertech proposes to relocate BVC01 to the site boundary as discussed in the response to TR RAI 2.9-43(b). After license issuance but prior to ISR operations, Powertech proposes to sample the relocated BVC01, which will be called BVC11, monthly for 12 consecutive months in accordance with Regulatory Guide 4.14 pre-operational monitoring recommendations.

UNT01 was established for the baseline surface water monitoring program to characterize surface waters downstream from proposed activities in the eastern portion of the project area. Due to steepness of the valley walls, the site could not be located at the proposed license boundary. Instead UNT01 was installed downstream at an accessible location, which was more conducive to passive sampler installation and operation. Powertech proposes that this site is justified since it is near the proposed license boundary and there are no major intervening tributaries between the proposed license boundary and UNT01.

TR RAI 2.9-47

The NRC staff did not find data for Pb-210 and Po-210 (Appendix 2.7-F) for sampling locations PSC01 and UNT01. Please provide the data or a justification of why the current data set is consistent with Regulatory Guide 4.14.

TR RAI 2.9-47 Response

The following describes the baseline monitoring conducted at sites PSC01 and UNT01. Revised surface water quality and radionuclide summary tables are provided in revised Appendix 2.7-C and 2.9-I, respectively, a copy of which are included with this response package. Laboratory analytical reports are provided in Appendix 2.7-F. For a summary of the sampling conducted at the sites, please refer to Table TR RAI 2.9-43b-1 in the response to TR RAI 2.9-43(b). The following information will be incorporated into the revised TR.

Passive samplers were installed at sites PSC01 and UNT01 as part of the baseline monitoring program. The samplers were set up to automatically collect a sample in the event of an ephemeral flow event. During baseline monitoring two samples were collected from site PSC01 and one sample was collected from site UNT01. Of the three samples, only one of the PSC01 samples (July 2008) was analyzed for Pb-210 and Po-210. The laboratory results for dissolved and suspended Pb-210 were 2.2 ± 4.5 pCi/L and 0.9 ± 7.0 pCi/L. The results for dissolved and suspended Po-210 were 0.7 ± 0.70 pCi/L and 0.3 ± 0.33 pCi/L. All results were below the laboratory minimum detectable concentration (MDC). Refer to the response to TR RAI 2.9-50 for a summary of all surface water radiological sampling results.

An evaluation of water quality for all of the stream monitoring sites was completed for Pb-210 and Po-210 concentrations. The following summarizes the results:

- Pb-210, dissolved: 17 of the 24 samples were below the laboratory MDC. The highest concentration, 26 ± 2.6 pCi/L, was measured at site BVC04 in December 2007.
- Pb-210, suspended: 20 of the 24 samples were below the laboratory MDC. Site CHR05 measured the highest concentration of 22 ± 3.6 pCi/L in January 2008.
- Po-210, dissolved: 14 of the 24 samples were below the laboratory MDC. The highest concentration, 3 ± 1.7 pCi/L, was measured at site BVC04 in October 2007.
- Po-210, suspended: 13 of the 24 samples were below the laboratory MDC. Site CHR01 measured the highest concentration of 4.1 ± 3.2 pCi/L in May 2008.

TR RAI 2.9-48

The NRC staff noted missing monthly data for Ra-226, Th-230 and uranium for sampling location BVC01. Provide data for Ra-226, Th-230 and uranium for sampling location BVC01 or a justification of why the data set is consistent with RG 4.14

TR RAI 2.9-48 Response

The following describes the baseline monitoring conducted at site BVC01. Revised surface water quality and radionuclide summary tables, including the missing information for site BVC01, are provided in revised Appendix 2.7-C and 2.9-I, respectively, copies of which are included with this RAI response package. Laboratory analytical reports are provided in Appendix 2.7-F. For a summary of the sampling conducted at the site, please refer to Table TR RAI 2.9-43b-1 in the response to TR RAI 2.9-43(b). The following information will be incorporated into the revised TR.

As part of the baseline monitoring program, surface water station BVC01 was visited monthly from July 2007 to June 2008. Water samples were collected from the site each month except February 2008, when the site was ice covered. The following summarizes the samples and results.

- Ra-226, dissolved: Nine samples were analyzed. The results show the concentrations were less than the MDC in seven of the samples. The highest concentration was 2 ± 0.4 pCi/L.
- Ra-226, suspended: Nine samples were analyzed for Ra-226, suspended. Only two samples measured concentrations above the MDC. The highest concentration was 3.1 ± 1.6 pCi/L.
- Th-230, dissolved: Nine samples were analyzed only one measured a concentration above the MDC: 0.3 ± 0.3 pCi/L.
- Th-230, suspended: Five of the nine samples analyzed were equal to or less than the MDC. The highest concentration of 3.4 ± 1.1 pCi/L was measured in May 2008.
- Uranium, dissolved: Nine samples were analyzed. The average concentration for the samples was 0.0124 mg/L, with the highest concentration of 0.0269 mg/L measured in March 2008.
- Uranium, total: All 11 samples were analyzed for total uranium. The average concentration for the samples was 0.0121 mg/L.

TR RAI 2.9-49

NRC staff could not locate quarterly or semiannual sample results for several of the impoundments. Examples by impoundment locations are given below.

SUB01 - missing quarterly samples for Ra-226, Th-230 and uranium, missing semiannual samples for Pb-210, Po-210.
SUB03 - missing quarterly samples for Ra-226, Th-230 and uranium.
SUB04 - missing quarterly samples for Ra-226, Th-230 and uranium.
SUB05 - missing all sampling data.
SUB06 - missing quarterly sample for Ra-226 (dissolved).
SUB08 - missing quarterly samples for Ra-226 (dissolved).
SUB09 - missing quarterly samples for Ra-226, Th-230 and uranium, missing semiannual data for Po-21, Pb-210.
SUB10 - missing quarterly samples for Ra-226, Th-230 and uranium, missing semiannual data for Po-21 , Pb-210.
SUB11 - missing quarterly samples for Ra-226 (dissolved).

Please review all data submitted for impoundments and provide missing data or a justification of why the current data set is consistent with Regulatory Guide 4.14.

TR RAI 2.9-49 Response

The following describes the baseline impoundment monitoring conducted at the Dewey-Burdock Project. Please refer to Table TR RAI 2.9-43a-1 in the response to TR RAI 2.9-43(a) for a summary of impoundment sampling conducted as part of the baseline monitoring program. Revised surface water quality and radionuclide summary tables are provided in revised Appendix 2.7-C and 2.9-I, respectively, copies of which are included with this RAI response package. Laboratory analytical reports are provided in Appendix 2.7-F. The following information will be incorporated into the revised TR.

As part of the baseline monitoring program 11 impoundments (Sub01 through Sub11) were visited on a quarterly basis between July 2007 and June 2008. When water was available, water samples were collected from each impoundment and analyzed for the constituents listed in Table 2.7-22 of the TR. The following summarizes the sampling conducted and radionuclide analytical results for the nine impoundments referenced in the RAI (SUB01, SUB03, SUB04, SUB05, SUB06, SUB08, SUB09, SUB10, and SUB11).

Sub01

Sub01 was visited in September 2007, November 2007, March 2008, and June 2008. In September 2007 and November 2007 the impoundment was dry and no samples were collected, thus explaining the two missing quarterly samples. Quarterly samples collected in March and June 2008 were analyzed for Ra-226, Th-230 and uranium, as recommended by Regulatory Guide 4.14. Since Po-210 and Pb-210 were on the semiannual analysis schedule rather than quarterly per recommendations in Regulatory Guide 4.14, the constituents were not analyzed in the March 2008 water sample. Both Po-210 and Pb-210 were

analyzed in the water sample collected in June 2008. Since Sub01 is not located downstream from proposed activities or within the project area (as described in Table TR RAI 2.9-43a-1), no operational monitoring is proposed at this impoundment.

Sub03

Sub03 was visited in September 2007, November 2007, February 2008, March 2008, and June 2008. The impoundment was dry in September 2007, February 2008, and March 2008 and no samples were collected, thus explaining the two missing quarterly samples. Quarterly samples collected in November 2007 and June 2008 were analyzed for Ra-226, Th-230 and uranium, as recommended by Regulatory Guide 4.14. Sub03 will be included in the operational monitoring program.

Sub04

Sub04 was visited in September 2007, November 2007, February 2008, March 2008, and June 2008. The impoundment was dry in September 2007, February 2008, and March 2008 and no samples were collected at those times. Quarterly samples collected in November 2007 and June 2008 were analyzed for Ra-226, Th-230 and uranium, as recommended by Regulatory Guide 4.14. During operations Sub04 will be included in the operational monitoring program.

Sub05

Sub05 is a detention pond below the Darrow surface mines and was visited quarterly. During each monitoring site visit the impoundment was dry and no samples were collected. As described in Table TR RAI 2.9-43a-1, Sub05 will be included in the operational monitoring program.

Sub06

The surface water quality summary tables have been corrected to show that Ra-226 (dissolved) was analyzed during all four quarters.

Sub08

The revised surface water quality and radionuclide summary tables in Appendix 2.7-C and 2.9-I show that Ra-226 (dissolved) was analyzed during all four quarters.

Sub09

Sub09 was visited in September 2007, November 2007, March 2008, and June 2008. The impoundment was dry in September 2007 and November 2007 and no samples were collected at those times. Quarterly samples collected in March 2008 and June 2008 were analyzed for Ra-226, Th-230 and uranium, as recommended by Regulatory Guide 4.14. Since Po-210 and Pb-210 were on the semiannual analysis schedule rather than quarterly per recommendations in Regulatory Guide 4.14, the constituents were not analyzed in the March 2008 water sample. Both Po-210 and Pb-210 were analyzed in the water sample collected in June 2008. Sub09 will be included in the operational monitoring program.

Sub10

Sub10 was visited in September 2007, November 2007, March 2008, and June 2008. The impoundment was dry in September 2007 and November 2007 and no samples were collected at those times. Quarterly samples collected in March 2008 and June 2008 were analyzed for Ra-226, Th-230 and uranium, as recommended by Regulatory Guide 4.14. Since Po-210 and Pb-210 were on the semiannual analysis schedule rather than quarterly per recommendations in Regulatory Guide 4.14, the constituents were not analyzed in the March 2008 water sample. Both Po-210 and Pb-210 were analyzed in the water sample collected in June 2008. Sub10 will be monitored as part of the operational surface water monitoring program.

Sub11

The revised surface water quality and radionuclide summary tables in Appendix 2.7-C and 2.9-I show that Ra-226 (dissolved) was analyzed during all four quarters.

TR RAI 2.9-50

Consistent with Regulatory Guide 4.14, provide the value of the Lower Limit of Detection (LLD) along with a description of the calculation of the LLD for surface water measurements.

TR RAI 2.9-50 Response

Revised summary tables of the baseline radiological surface water quality are provided in Appendix 2.9-I. The revised tables include the error and LLD, where available (refer to the response to TR RAI RI-4(b)), and other information to meet the guidance detailed in Table 2.9.3-1 of NUREG-1569 and Regulatory Guide 4.14. Laboratory results are provided in revised Appendix 2.7-F, which is included with this RAI response package and will be included with the revised TR. The tables in Appendix 2.9-I will be incorporated into the revised TR.

The following description of how the MDC is used in place of the LLD will be incorporated into the revised TR.

The lower limit of detection (LLD) is defined in MARLAP (2004) as the following: "(1) The smallest concentration of radioactive material in a sample that will yield a net count, above the measurement process (MP) blank, that will be detected with at least 95 percent probability with no greater than a 5 percent probability of falsely concluding that a blank observation represents a real signal (NRC, 1984). (2) An estimated detection limit that is related to the characteristics of the counting instrument (EPA, 1980)."

The calculation referenced in several NRC documents for LLD is generally in the form:

$$LLD = \frac{4.66 \times \sigma_b}{2.22 \times E \times M \times R \times I}$$

Where:

LLD	=	Lower limit of detection as an a priori determination
σ_b	=	Standard deviation of the instrument background count rate (counts/min)
M	=	The sample weight (g) or volume (L)
E	=	Instrument efficiency for alpha or beta
R	=	Yield for the individual radionuclide as determined by tracer or carrier
I	=	Ingrowth factor
2.22	=	Conversion for dpm to pCi

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Process and Equipment

TR RAI 3.1-1

The applicant provides only a general commitment to have instrumentation, alarms and controls to monitor production, injection and waste flows. Description of the instrumentation, alarms and controls are inadequate to allow the staff to understand how the applicant will ensure safe operations and timely detection of releases or spills. Please provide a more in-depth description of the instrumentation, alarms and controls to ensure timely detection of any unanticipated release or spill, and frequency of inspection of these and other items included in spill prevention SOP(s).

TR RAI 3.1-1 Response

The following discussion provides additional details of the proposed instrumentation, controls, and alarms which will allow for safe operation and timely detection of potential releases or spills. This information will be included in Section 3.2.12 (Instrumentation and Control) of the revised TR.

Powertech will install automated control and data recording systems at the Dewey Satellite Facility and the Burdock CPP which will provide centralized monitoring and control of the process variables including the flows and pressures of production, injection, and waste streams. The systems will include alarms and automatic shutoffs to detect and control a potential release or spill.

Pressure and flow sensors will be installed, for the purpose of leak detection, on the main trunklines that connect the CPP and Satellite Facility to the well fields. In addition, flow rates of each production well and each injection well will be automatically measured. Measurements will be collected and transmitted to both the CPP and Satellite Facility control systems. Should pressures or flows fluctuate outside of normal operating ranges, alarms will provide immediate warning to operators which will result in a timely response and appropriate corrective action.

Both external and internal shutdown controls will be installed at each header house to provide for operator safety and spill control. The external and internal shutdown controls are designed for automatic and remote shutdown of each header house. In the event of a header house shutdown, an alarm will occur and the flows of all injection and production wells in that header house will be automatically stopped. The alarm will activate a blinking light on the outside of the header house and will cause an alarm signal to be sent to the CPP and Satellite Facility control rooms.

An external header house shutdown will activate an electrical disconnect switch located on the outside of the header house or at the transformer pole which will shut down all electrical power to the header house. This will mitigate potential electrical hazards while de-energizing the header house and operating equipment. The production pumps will be de-energized which will result in flow stopping from all production wells. A control valve that will close when de-energized will be used on the injection header, which will stop the flow to all injection wells.

Internal shutdown controls will not involve de-energization of the header house but will result in the same alarm condition and shutdown of flow to all production and injection wells feeding the header house.

Each header house will also include a sump equipped with a water level sensor so that if a leak occurs, and the water level approaches a preset level, the sensors will cause an automatic shutdown of the header house. A pressure switch will be installed on the injection header to ensure that fluid pressures do not exceed the mechanical integrity test pressures of the injection wells served by that header house. If the injection pressure reaches the maximum set value in the pressure switch, an automatic header house shutdown will occur. Downhole pressure transducers will be installed in all monitor wells for the measurement of potentiometric head. These instruments will alert operators to any significant change in the water levels within the monitor wells to provide an early warning of a potential lixiviant excursion. Operators may then follow standard operating procedures to make adjustments to well field production and/or injection flow rates to avoid an excursion due to any unbalanced flow condition in a well field.

If an excursion or pipeline leak were to occur, procedures will be in place to address and correct it. Well field operators will conduct daily visual inspections of well field facilities, including header houses and all visible pipes, connections, and fittings. Operating flow rates and pressures of all injection wells, production wells, and associated buried piping systems will also be monitored and recorded on a daily basis. The CPP and Satellite Facility control rooms will both receive the pressure and flow data transmitted from the well fields, trunklines, and header houses. This information will provide the plant operators access to instantaneous data on well field operating conditions, enabling them to respond appropriately to unexpected or upset conditions, and allow them to direct well field operators to specific locations where immediate attention is needed.

TR RAI 3.1-2

The applicant reports that the depth to mineralized zones primarily in the eastern portions of the proposed licensed area may be less than 100 feet with a saturated thickness significantly less. Operations performed under unconfined conditions and/or limited potentiometric head differ from those performed under confined conditions. The applicant has not provided sufficient information to allow the staff to assess the manner in which ISR under unconfined conditions or limited potentiometric head will affect operations. Please provide information that demonstrates the effects of such hydraulic conditions on the proposed operations.

TR RAI 3.1-2 Response

The following discussion will be incorporated into the revised TR.

The only instance where hydrologically unconfined (partially saturated) conditions exist within an area that Powertech proposes for ISR operations occurs in the eastern portion of the project area. Powertech does not plan to conduct ISR operations in the Fall River on the eastern edge of the project area (in the vicinity of the Triangle or Darrow pits), where the Fall River is geologically and hydrologically unconfined (partially saturated). However, Powertech proposes to conduct ISR operations in the underlying Chilson, which is confined above by the Fuson Shale and below by the Morrison Formation. Although the Chilson is not fully saturated near the eastern edge of the project boundary, the mineralization occurs near the base of the formation. As a result, any ISR operations will occur within the portion of the Chilson with available head sufficient for fluid control.

Within the project area, the Fall River Formation rises in elevation to the northeast. It subcrops on the eastern edge of the project area in the vicinity of the Darrow pits and crops out to the east in Bennett Canyon. In this area, the upper confining layer, namely the Graneros Group, is absent and the Fall River is geologically unconfined. Depending on location within this general area, the Fall River is partially saturated and the saturated thickness can be substantially less than 100 feet.

Similarly, the Chilson Member rises in elevation to the northeast and subcrops beneath the alluvium in Bennett Canyon. The potentiometric surface elevation for the Chilson is projected to be below the top of the formation on the eastern edge of the project area. Only in this limited area, the Chilson, although geologically confined by the overlying Fuson Shale, is partially saturated (i.e., the water table is below the top the formation). The projected limits for the fully saturated and partially saturated portions of the Fall River and the Chilson are shown on Figures TR RAI P&R-5-2 and TR RAI P&R-5-3, respectively. These figures are included with the response to TR RAI P&R-5 and also will be provided in the revised TR.

Geologic cross section B-B' (Exhibit 2.7-1b) has been updated to show the potentiometric surfaces as well as the interbedded shales and siltstones within the Fall River and Chilson. The cross section depicts the location of the mineralization in the Chilson in relation to the Chilson potentiometric surface. Near the eastern portion of the project area the potentiometric surface is nearly 100 feet higher than the

mineralization. Locally occurring shale units may serve to further confine the mineralization within the Chilson. As such, Powertech does not anticipate that ISR operations will occur where there is less than 50 feet of potentiometric head over the ore body.

After license issuance but prior to well field development, delineation drilling and well field pumping tests will be conducted to fully characterize the existing geologic and hydrogeologic conditions and to confirm sufficient head (>50 feet) is available to perform normal ISR operations. As an integral component of the characterization activities, a detailed evaluation will be made, based on actual site conditions, regarding the application of ISR under partially saturated conditions should it be necessary. Partially saturated conditions, if encountered, would be similar in many respects to what has been licensed at Moore Ranch and would be addressed similarly with modeling.

TR RAI 3.1-3

The applicant's general schedule did not provide a timetable for restoration of individual well fields. This detailed information as well as other information such as the requirement for NRC notification of the termination of principal activities or an alternate schedule, needs to be included in the TR consistent with Section 3.1.1 (4) of NUREG-1569 and in accordance with requirements of 10 CFR 40.42. Please address this comment.

TR RAI 3.1-3 Response

Powertech's proposed schedule of operations, showing a timetable for restoration of individual well fields, is included in the response to TR RAI 6.1-11. Powertech will notify the NRC in writing, in accordance with 10 CFR 40.42, within 60 days of the cessation of recovery operations in any individual well field. Should restoration efforts indicate a period longer than 24 months is necessary for groundwater restoration of a particular well field, Powertech will request NRC approval for an alternate schedule in accordance with 10 CFR 40.42.

This commitment will be included in Section 6.1 of the revised TR.

TR RAI 3.1-4

Experience with existing ISR facilities has shown that a facility may delay restoration after the end of production. However, during any restoration delay, the hydraulic control for a well field must be maintained. Therefore, please include information regarding the manner in which hydraulic control will be maintained throughout the life of a well field, from the first injection of lixiviant to the end of restoration.

TR RAI 3.1-4 Response

The following discussion will be incorporated into the revised TR.

Powertech will maintain hydraulic control of each well field from the first injection of lixiviant through the end of aquifer restoration. During uranium recovery, the groundwater removal rate in each well field will exceed the lixiviant injection rate, creating a cone of depression within each well field. During aquifer restoration, the groundwater removal rate in each well field will exceed the injection rate of permeate and clean makeup water from the Madison Formation. If there are any delays between uranium recovery and aquifer restoration, production wells will continue to be operated as needed to maintain water levels within the perimeter monitor rings below baseline conditions. This activity may be intermittent or continuous.

Verification of hydraulic control will be performed through water level measurements in perimeter monitor wells. Water levels will be measured continuously using pressure transducers and recorded at a frequency appropriate to confirm hydraulic well field control. Other standard operating procedures to monitor and control well field operations are described in the response to TR RAI 3.1-1.

TR RAI 3.1-5

On Page 3-14, the applicant uses the term "leachate" in lieu of "lixiviant." Please include a definition of leachate if it is to be used in the TR.

TR RAI 3.1-5 Response

TR Section 3.1.3 will be revised to replace the term “leachate” with “lixiviant.”

TR RAI 3.1-6

On Supplemental Exhibit 3.1-1, it is difficult to distinguish several features including the black lines (Fault or PAA Boundary) or blue Lines (Perennial and Ephemeral Streams). Please modify the exhibit accordingly.

TR RAI 3.1-6 Response

Supplemental Exhibit 3.1-1 has been replaced with Exhibit 3.1-1 to provide a clearer distinction between features by the use of line type and color. The revised exhibit is included with this RAI response package and will be included with the revised TR.

TR RAI 3.1-7
The total pond area, as shown on Supplemental Exhibit 3.1-2, is 84 acres and the total land application area is 720 acres. The pond area is similar in extent to that discussed in the narrative; however, the land application area differs from the 875 acres discussed in the narrative. Please clarify this apparent discrepancy.

TR RAI 3.1-7 Response
The following information will be provided in the revised TR to clarify this apparent discrepancy.

The total pond area proposed for the land application option is approximately 71 acres. The land application system will occupy around 760 acres; however, only 630 acres will typically be used at one time. The rest will be on standby. These values are based on the most current design of the land application system. TR Section 3.1.5 (Pond Design and Land Application) and Section 4.2 (Liquid Waste) will be updated with the current design information. The current pond and land application designs are described below.

Pond Designs

The land application disposal option will include the following ponds:

- **Two (2) Radium Settling Ponds** - one near each land application area (Dewey and Burdock). Each pond will have an operating capacity of 39.4 acre-feet. Radium settling ponds for the land application disposal option were designed such that a single pond has sufficient capacity for radium removal of the entire project-wide wastewater stream at the maximum expected production bleed of 3% while maintaining a minimum retention time of 14.1 days.
- **Two (2) Spare Ponds** - one at each area. Each pond will have an operating capacity of 39.4 acre-feet. The spare ponds will be designed with the same dimensions and liner system as the radium settling ponds so that they can be used as either spare radium settling ponds or spare Central Plant Ponds.
- **Two (2) Outlet Ponds** - one at each area. Each pond will have an operating capacity of 4.9 acre-feet. The outlet ponds will be designed to temporarily store treated water from the radium settling ponds and provide extra capacity for the radium settling ponds during large precipitation events.
- **Eight (8) Storage Ponds** - four at each area. Each pond will have an operating capacity of 63.8 acre-feet. The storage ponds will be used to store treated water during the winter months when no liquid waste disposal by land application systems is available. The total storage required at each area was obtained using the SPAW model, which is discussed in more detail in the Pond Design Report (Supplemental Report, Appendix B) and in the response to TR RAI P&R-14(b).
- **Two (2) Spare Storage Ponds** - one at each area. Each pond will have an operating capacity of 63.8 acre-feet. The spare storage ponds will be designed with the same dimensions and liner system as the storage ponds so that they can be used in the event of an upset condition.

- **One (1) Central Plant Pond** - located at the Burdock CPP, with an operating capacity of 36.2 acre-feet. The storage capacity design for the Central Plant Pond allows for over 18 months of CPP liquid waste storage, which will be required during initial uranium recovery operations when no groundwater sweep water is available to blend with CPP liquid waste. Additional discussion of the Central Plant Pond capacity is included in the response to TR RAI P&R-14(g).

The deep disposal well liquid waste disposal option will include the following ponds:

- **Two (2) Radium Settling Ponds** - one at each area. Each pond will have an operating capacity of 15.9 acre-feet. Radium settling ponds for the DDW option were designed such that a single pond has sufficient capacity for radium removal of the entire project-wide liquid waste stream at the maximum expected production bleed of 3% while maintaining a minimum retention time of 12.7 days.
- **Two (2) Spare Ponds** - one at each area. Each pond will have an operating capacity of 15.9 acre-feet. The spare ponds will be designed with the same dimensions and liner system as the radium settling ponds so that they can be used as either spare radium settling ponds or spare Central Plant Ponds.
- **Two (2) Outlet Ponds** - one at each area. Each pond will have an operating capacity of 5.1 acre-feet. The outlet ponds will be designed to temporarily store treated water from the radium settling ponds and provide extra capacity for the radium settling ponds during large precipitation events.
- **Two (2) Surge Ponds** - one at each area. Each pond will have an operating capacity of 8.4 acre-feet. The surge ponds will provide surge capacity for treated liquid waste flowing out of the radium settling ponds. They have been sized to accommodate 7 days of water production.
- **One (1) Central Plant Pond** - located at the Burdock CPP, with an operating capacity of 15.9 acre-feet.

All ponds have been designed to accommodate the design flows of liquid waste plus the precipitation from the 100-year precipitation event, while maintaining 3 feet of freeboard.

Land Application Design

Two general land application areas are proposed for liquid waste disposal within the project area, one near the Dewey satellite facility and one near the Burdock CPP. Each land application area will have 315 acres of irrigated area along with 65 acres of auxiliary area on standby. The required land application area was estimated from the disposal capacity obtained using the SPAW (Soil-Plant-Atmosphere-Water) model, which was developed by the USDA to simulate the daily hydrologic budget for agricultural landscapes. The inputs to the model include climatic data, soil profile information, and crop growth information. Additional information on the SPAW model, as well as the model inputs and outputs, is included in the Pond Design Report (Supplemental Report, Appendix B).

TR RAI 3.1-8

On Supplemental Exhibit 3.1-4, various land application areas overlap outlines of two future mine units. Please confirm the location of the land application areas. If the land application areas overlap proposed well fields, please provide further information regarding the manner in which both the well field and land application areas will be operated.

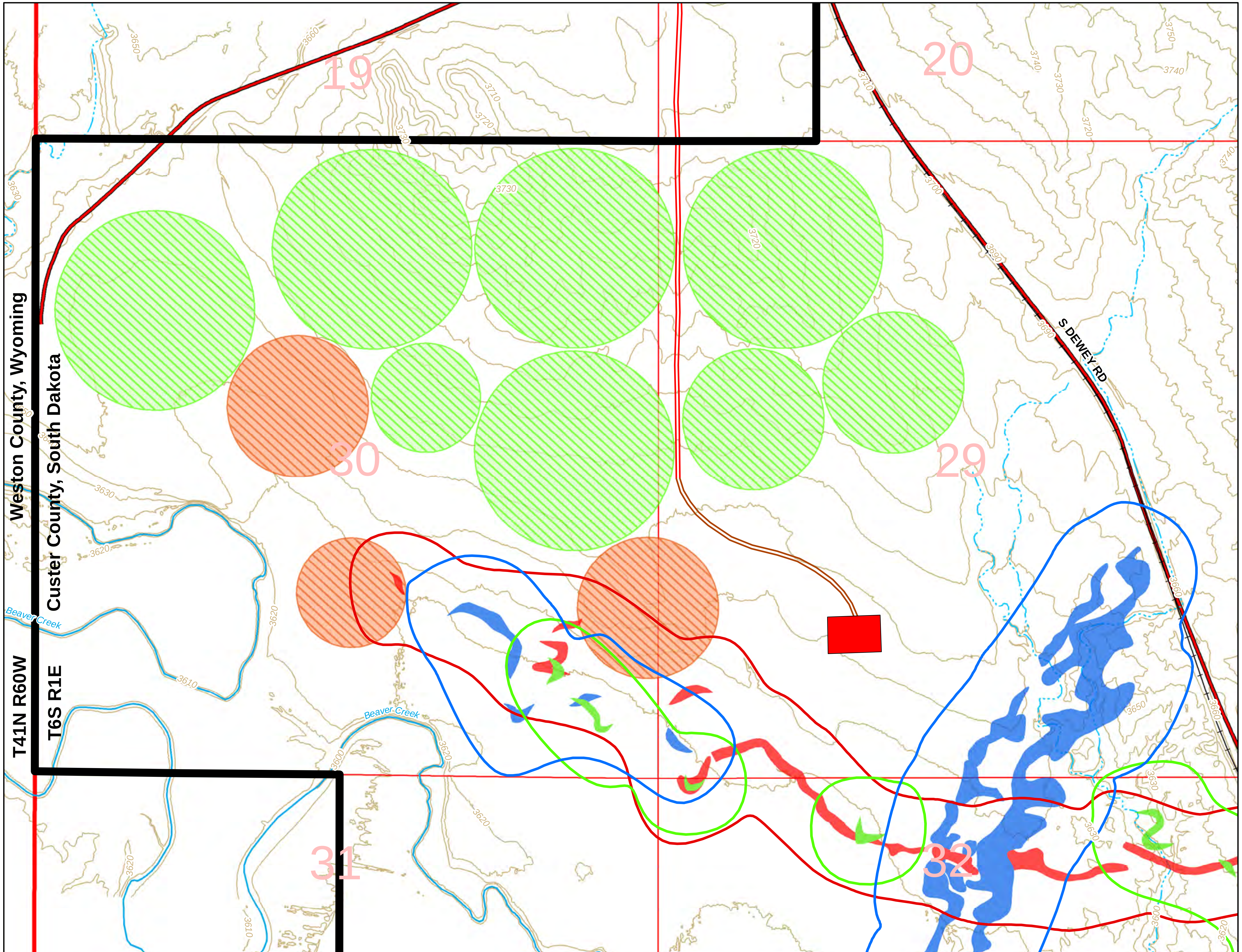
TR RAI 3.1-8 Response

The following information will be included in the revised TR.

The locations of the proposed land application areas in relation to potential well field areas are depicted on revised Figures TR RAI 3.1-8-1 and 3.1-8-2, which are included below and also will be included in the revised TR. Figure TR RAI 3.1-8-1 shows minimal overlap between Dewey land application areas and potential well field areas. The only land application areas that potentially will overlap with well fields are designated for standby operation. These standby areas will serve as contingency areas and generally will not be used at the same time as the underlying well fields.

Figure TR RAI 3.1-8-2 shows that there is also limited potential overlap between Burdock land application areas and potential well field areas. In this case overlap will likely be limited to perimeter monitor wells.

Although overlap between active land application areas and potential well field areas will be limited, there may be times that production, injection and monitor wells are operated within active land application areas. Powertech will design and construct the well fields and land application systems to avoid any potential conflicts and minimize potential risks. The irrigation nozzles will be suspended above the well head covers, and wells and fences will be positioned to avoid the center pivot wheel pathways. Injection, production and monitor wells will have sealed well heads to prevent entry of the land application water. The well heads will also have sufficient aboveground casing to ensure that surface water cannot enter the wells. Injection and production pipelines will be buried and will not conflict with land application systems. Perimeter monitor wells will have pressure transducers that will allow remote monitoring of water levels. If necessary, discharge piping and pressure transducer cable will be installed from the monitor wells to remote sampling locations outside of the land application area. This would allow Powertech personnel to measure water levels and sample monitor wells without traveling through active land application areas. Inspections of well field components will be conducted routinely as discussed in the response to TR RAI 3.1-1.



Legend

- Project Boundary
- Existing Roads Used for Access
- Access Roads
- Processing Plants
- Ephemeral Streams
- Perennial Streams
- BNSF Railroad
- County Roads
- Land Application
- Standby Land Application

Potential Well Field Areas

- Fall River
- Upper Chilson
- Middle/Lower Chilson

Ore Bodies

- Lower Fall River
- Upper Chilson
- Middle/Lower Chilson

Feet: 0, 400, 800, 1,600

Meters: 0, 200, 400

N

Figure TR RAI 3.1-8-1

Detail 1 of Potential Well Field Areas, Facilities and Land Application Sites Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	23-Jun-2011
FILENAME	Figure TR RAI 3.1-8-1.mxd

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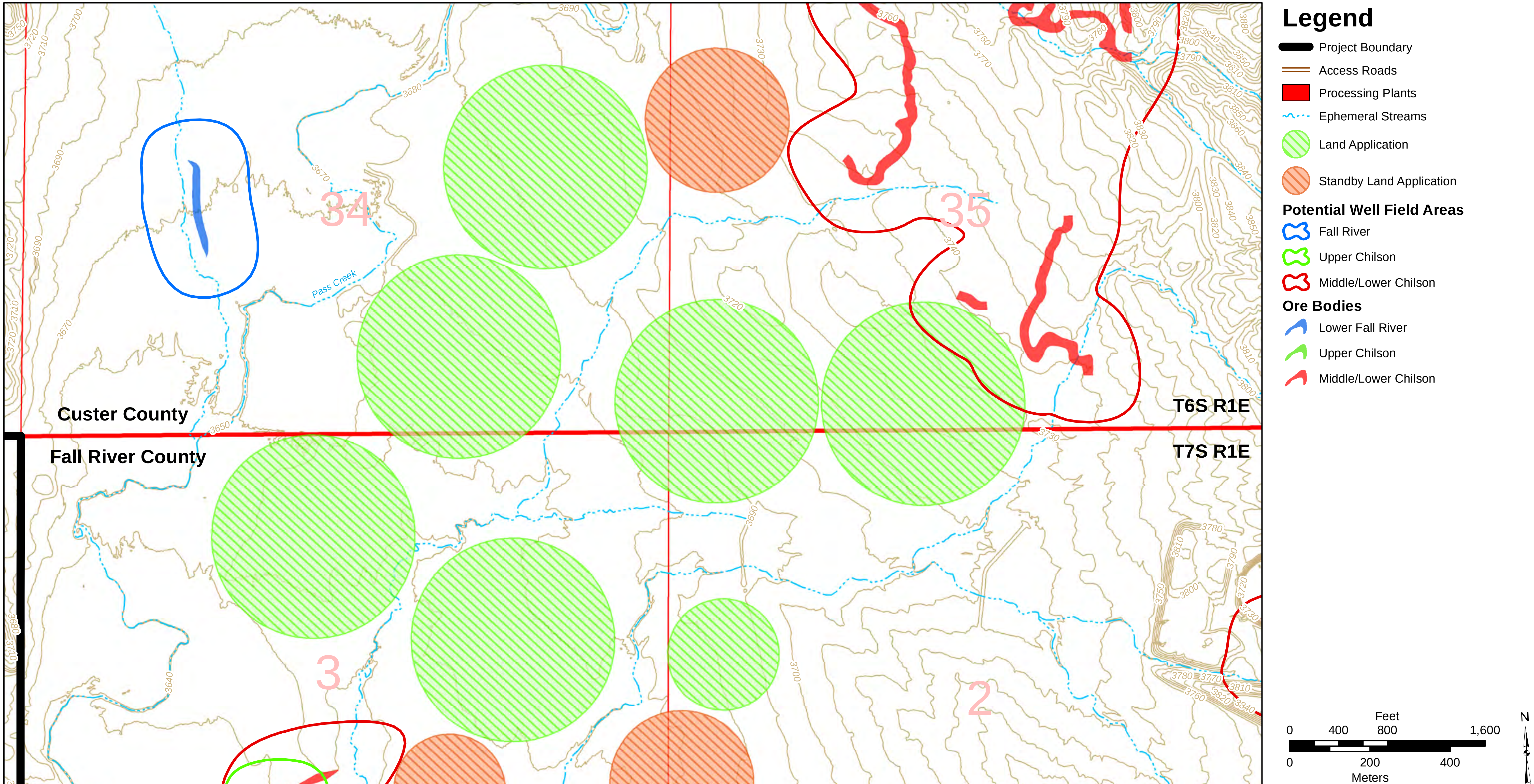

Figure TR RAI 3.1-8-2

Detail 2 of Potential Well Field Areas, Facilities and Land Application Sites
Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	23-Jun-2011
FILENAME	Figure TR RAI 3.1-8-2.mxd

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TR RAI 3.1-9

The application did not include a water balance diagram consistent with the guidance in Section 3.1.2 of NUREG-1569. Please provide a water balance diagram.

TR RAI 3.1-9 Response

The response to TR RAI P&R-14(c) presents typical water balances for uranium recovery, aquifer restoration, and concurrent uranium recovery and aquifer restoration. The water balances encompass the entire system, including the well fields, Satellite Facility, CPP and liquid waste disposal systems, in accordance with guidance in NUREG-1569, Section 3.1.2. The response also includes a discussion on liquid waste disposal capacities. That information will be incorporated into the revised TR.

Gaseous and Airborne Particulates

TR RAI 4.1-1

In Section 4.1.1, the applicant states that exhausting radon gas outside the plant minimizes employee airborne exposure. Please evaluate the following scenarios under your As Low As Is Reasonably Achievable (ALARA) program that will address the requirements of 10 CFR 40, Appendix A, Criterion 8, and 10 CFR 20.1101(b) and the recommendations in NUREG-1569, Acceptance Criterion 4.1.3(5).

TR RAI 4.1-1(a)

a. ***Please provide an analysis that includes exposure to employees in areas outside the plant***

TR RAI 4.1-1(a) Response

Please refer to the response to TR RAI 5.7.7-13 for the results of the modeled Total Effective Dose Equivalent (TEDE) in and around the project area. This analysis and the following discussion will be included in the revised TR.

The isodose lines presented in Figure TR RAI 5.7.7-13-1 are based on the updated MILDOS-AREA modeling results and are based on continuous occupancy. The highest predicted dose is approximately 6 mrem per year. Assuming a worker is in this area for 2,000 hours per year, the expected annual occupational dose from gaseous and particulate releases would be less than 2 mrem per year.

The analysis presented in the response to TR RAI 5.7.7-13 is based on the use of best professional practices to ensure effluent limits are ALARA, including use of pressurized, downflow IX columns, modern vacuum dryer, building ventilation, and extensive control, alarm, and monitoring systems. This will ensure that ISR operations are conducted so that all airborne effluent releases, occupational doses, and doses to members of the public are reduced to levels that are ALARA in accordance with 10 CFR Part 40, Appendix A, Criterion 8, 10 CFR 20.1101(b) and NUREG-1569, Acceptance Criterion 4.1.3(5).

The analysis presented in the response to TR RAI 5.7.7-13 is also in agreement with NUREG-1910 (NRC, 2009), which states, “Doses for the various ISL facilities…are at least a factor of three below the regulatory limit and most are less than that. Based on operational history and dose-modeling results, doses at operating ISL facilities in different regions are not likely to exceed regulatory limits, and overall potential radiological impacts from ISL operations would be SMALL” (pg. 4.3-33). NUREG-1910 also provides information regarding typical employee exposure to radon decay products. For one ISR facility monitored over a 13-year period, maximum employee exposure to radon decay products ranged from 0.213 to 0.643 working-level months, or from 2.5 to 16 percent of the occupational exposure limit of 4 working-level months. NUREG-1910 concludes, “Because these average and maximum exposure levels range from 2.5 to 16 percent of the occupational exposure limit of 4 working-level months, doses from normal radon releases would be expected to have a SMALL impact on the workers” (pg. 4.2-55).

TR RAI 4.1-1

In Section 4.1.1, the applicant states that exhausting radon gas outside the plant minimizes employee airborne exposure. Please evaluate the following scenarios under your As Low As Is Reasonably Achievable (ALARA) program that will address the requirements of 10 CFR 40, Appendix A, Criterion 8, and 10 CFR 20.1101(b) and the recommendations in NUREG-1569, Acceptance Criterion 4.1.3(5).

TR RAI 4.1-1(b)

b. ***During favorable weather conditions how will open doorways and convection vents affect radon effluent airflow and employee exposure both inside and outside the plant?***

TR RAI 4.1-1(b) Response

The following information will be incorporated into the revised TR.

During favorable weather conditions, open doorways and convection vents may change release points and air patterns of radon slightly, but the amount of radon released will remain the same. The concentration of radon gas being emitted under this scenario is expected to be lower compared to radon that is collected in the ventilation system and transported via duct work to an external release point. During plant operation, measurements will be made of radon emission from the plant ventilation system as well as measurements of radon decay products exposure at occupied areas in and around the plant. With these data, analyses of exposure to employees and radon effluent airflow will be conducted to determine if exposure is ALARA. In addition, a radon decay products concentration action level will be established. If the action level is exceeded, an analysis will be conducted to determine if the radon and radon decay products concentration and potential employee exposures are ALARA. Powertech will implement changes if and when necessary to ensure levels are ALARA. Results of monitoring obtained during initial plant operation will be used to adjust monitoring programs and upgrade ventilation and/or other effluent control equipment as necessary.

Powertech will implement these monitoring programs to provide sufficient information to demonstrate that radon effluent and worker exposure to radon decay products will be maintained at levels that are ALARA in accordance with the requirements in 10 CFR Part 40, Appendix A, Criterion 8 and 10 CFR § 20.1101(b) and the recommendation in NUREG-1569, Acceptance Criterion 4.1.3(5).

<u>TR RAI 4.1-2</u>

In Section 4.1.2.2 of the TR, the applicant describes the discharge for the yellowcake drying and packaging system but does not specify where this effluent will discharge. Please specify the discharge location(s) for the yellowcake drying and packaging system.

<u>TR RAI 4.1-2 Response</u>

The following information will be incorporated into the revised TR.

There are three discharge locations associated with the yellowcake drying and packaging system. These include: i) the yellowcake discharge valve located directly below the dryer, through which drums are filled with yellowcake, ii) the condensed water vapor that is removed from the condenser and recycled to the yellowcake thickener, and iii) very small amounts of air that are drawn through the vacuum pump and are exhausted into the dryer room of the CPP. The system of treating gases emanating from the dryer chamber with bag house filters and water condenser is designed to capture virtually all particles from the vapor stream leaving the dryer (NUREG-1910, pg. 2-25). Furthermore, NUREG-1569, Section 7.3.1.2.2 states, “When a vacuum dryer is used for yellowcake, then dust emissions from drying may also be assumed to be negligible.”

<u>TR RAI 4.1-3</u>

Regulatory Guide 8.30 recommends performing ventilation surveys on a routine basis. Please provide details of a ventilation survey program consistent with Regulatory Guide 8.30 or justification for an alternate program.

<u>TR RAI 4.1-3 Response</u>

The following information will be incorporated into the revised TR.

Consistent with Regulatory Guide 8.30, a ventilation survey will be conducted daily in areas with airborne radioactivity. The survey will be performed by the radiation safety staff during a daily walk through of the facility. Surveys will consist of operational checks of ventilation systems, to ensure they are operating effectively. Whenever equipment or procedures in the CPP or the Satellite Facility are changed in a manner that affects ventilation, the radiation safety staff will conduct a ventilation rate survey using an anemometer or pitot tube to ensure that the ventilation system is operating effectively.

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<u>TR RAI 4.1-4</u>

Consistent with Regulatory Guide 8.31 and NUREG 1569, Acceptance Criterion 4.1.3(5), demonstrate that radon exhaust vent will be located in a way that ensures compliance with the requirements of 10 CFR 20.1302

<u>TR RAI 4.1-4 Response</u>

The following discussion will be included in the revised TR.

Section 7.3 of the TR describes methods used to estimate potential radiological impacts resulting from planned activities to members of the public near the proposed facility. The CPP will be located near the center of the proposed license area, and the radon exhaust point will be located on or near the CPP roof. Based on use of modern ISR equipment, engineering controls such as building ventilation, and routine sampling and monitoring described below, radon effluent and worker exposure to radon decay products will be maintained at levels that are ALARA. The highest predicted Total Effective Dose Equivalent (TEDE) to a resident is 2.21 mrem per year, which is in compliance with the requirements of 10 CFR §20.1302.

To ensure effluents are ALARA, as described in Section 4.1.1, Powertech has committed to use sealed, pressurized, downflow IX vessels to limit routine radon-222 emissions from the CPP or Satellite Facility to resin transfer operations only. The radon emissions from the resin transfer operation will be exhausted using a dedicated ventilation system and released via a primary release point on or near the roof of the facility. The primary release point will be located away from building intakes to prevent introducing exhausted radon back into the facility. The normal HVAC system will also aid in reducing radon-222 and decay product concentrations within the facility. Potential release points as well as general air in the plant will be routinely sampled for radon and decay products to assure concentration levels are maintained ALARA. Results of monitoring obtained during initial plant operation will be used to adjust monitoring programs and upgrade ventilation and/or other effluent control equipment as necessary.

TR RAI 4.1-5

Consistent with NUREG-1569, Acceptance Criterion 4.1.3(4), evaluate the applicant's effluent control systems under accident conditions and identify any health and safety impacts of system failures and identify contingencies for such occurrences.

TR RAI 4.1-5 Response

The following discussion will be incorporated into the revised TR to satisfy NUREG-1569, Acceptance Criterion 4.1.3(4).

The accident scenarios with potential to occur at the facility are those typical of other ISR facilities. These scenarios have been evaluated in NUREG/CR-6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees (NRC, 2001) and are discussed below. Three primary engineering controls that will exist at the site include 1) downflow pressurized IX columns, 2) building ventilation, and 3) use of a modern vacuum yellowcake dryer. Also included in the engineering controls will be alarms to indicate suboptimal operating conditions of the effluent control systems and concrete curbs and sumps to contain any process spills. Administrative controls such as training for emergency scenarios will be in place to provide appropriate worker protection in the event the effluent control systems fail under an emergency situation. In brief, the engineering controls coupled with appropriate administrative controls will mitigate any potential health and safety impacts of system failures at the facility.

NRC has evaluated likely accident scenarios and the associated radiological consequences for a typical ISR facility. This analysis is contained in NUREG/CR-6733. A series of potential accident scenarios which could occur in the CPP or Satellite Facility area were evaluated and included the following:

- Yellowcake thickener failure and spill
- Radon release in enclosed process areas
- Pregnant lixiviant and loaded resin spills
- Yellowcake dryer hazard analysis

The estimated radiological consequence resulting from these accidents ranged from no significant radiological exposures, in the case of the thickener failure and pregnant lixiviant/loaded resin spill, to a significant radiological exposure which could result in doses to workers exceeding those allowed in 10 CFR Part 20. Due to the short term nature of the above scenarios and assuming spills and releases are mitigated promptly, no scenario was expected to result in a significant estimated radiological dose to members of the public.

Given the accident scenarios described above, if effluent controls are operable during and while responding to the accident, they will reduce the potential radiological consequence to the workers

involved in the response by reducing airborne radionuclide concentrations. If the effluent controls are not operable because of the accident, this reduction in airborne radionuclide concentrations would not occur and administrative controls and personal protective equipment would play a larger role in minimizing worker doses.

During an accident, administrative controls will be in place such as standard operating procedures for spill response and cleanup, programs for radiation and occupational monitoring, and training for workers in radiological health and emergency response. Administrative controls coupled with proper use of personal protective equipment (PPE) such as respirators are the best tools to reduce worker doses and will be provided.

Other approaches to mitigate system failures that may result in exceeding exposure limits include but are not necessarily limited to the following:

1) A team of responders, trained for radiation health and emergency response, will be available. Specific training will include: response monitoring, PPE use and response to fires, large lixiviant spills or ion-exchange system failure.
2) Powertech will train local emergency response personnel in the potential hazards present within the project area.
3) A yellowcake thickener failure and spill would result in the immediate evacuation of normal operating personnel within the spill area and cleanup of the saturated product prior to drying. Employees performing the cleanup would utilize the appropriate PPE to minimize exposure to any product that may dry during cleanup. Yellowcake residue that may remain within the thickener area would be washed into a sump, thus mitigating the potential for exposure to employees.
4) Radon release into an enclosed area would result in an immediate evacuation within the release area of normal operating personnel, manual shutdown of the release point (if automated shutoff system failed) and promotion of ventilation within the area manually (if automated ventilation system failed). Employees performing manual shutdown within the area of the release would utilize the appropriate PPE (such as atmosphere-supplying respirators designed to protect against gases) to minimize exposure to radon and radon decay products. Radon samples would be taken and if above normal working levels, workers would remain evacuated and only return to normal duties within the release area upon re-establishment of normal working levels.
5) A pregnant lixiviant spill would be mitigated in a manner consistent with the location and degree of spill. Normal operating employees within the spill area would be evacuated. Response personnel would utilize the appropriate PPE to protect against radon and radon decay products exposure as discussed above and cleanup would result.
6) A yellowcake dryer upset response would be dictated by the severity of the upset. Mitigation response may include a combination of additional site-specific response actions such as:

- Workers, including the spill response team, will have access to respiratory equipment in the yellowcake dryer area.
- All practicable measures will be taken to control emissions at the source. The operator will reduce exposure to airborne effluent releases by implementing emission controls (such as wetting) and institutional controls (such as extending the area of upset so as to exclude any personnel not responding to the upset).
- Siting of the CPP near the center of the proposed license area will serve to protect against off-site exposures in the event of a yellowcake dryer upset.
- Individual dose standards will be strictly implemented to assure exposures are limited and reduced to the maximum extent reasonably achievable and to limit contamination to the designated upset area.
- All drying and packaging operations will terminate until cleanup is complete, the area has been cleared for potential exposure, and equipment has been restored to proper operating conditions and efficiencies.
- Cessations, corrective actions and restarts will be reported to the NRC within 10 days of the upset or off-normal performance.

Management Control Program

TR RAI 5.2-1

In Section 5.2.6 of the TR, the applicant discusses its reporting program to satisfy 10 CFR 20.2202. However, it does not appear that the applicant addressed other reporting requirements in 10 CFR 20, Subpart M, as recommended in NUREG-1569, Acceptance Criterion 5.2.3(1). For example, 10 CFR 20.2203(a)(2) addresses reporting requirements for doses found to be in excess of regulatory limits. In addition, 10 CFR 40.60(b)(3) addresses medical treatment at a "medical" facility, not "outside" facility as stated in Section 5.2.6 of the TR. Please provide a reporting program that is consistent with NUREG-1569, Acceptance Criterion 5.2.3(1).

TR RAI 5.2-1 Response

TR Section 5.2.6 (Reporting) will be revised to include the following:

Consistent with NUREG-1569, Acceptance Criterion 5.2.3(1), Powertech commits to the development of written operating procedures within the management control program to address reporting requirements in 10 CFR Part 20, Subpart M and 10 CFR §40.60. These include appropriate reporting requirements listed in Regulatory Guide 10.1, Compilation of Reporting Requirements for Persons Subject to NRC Regulations (NRC, 1981). Specific reporting requirements include, but are not limited to, the following:

- Reports of theft or loss of licensed material (10 CFR §20.2201),
- Notification of incidents (10 CFR §20.2202),
- Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the constraints or limits (10 CFR §20.2203),
- Reports of planned special exposures (10 CFR §20.2204),
- Reports to individuals of exceeding dose limits (10 CFR §20.2205),
- Reporting requirements under 10 CFR §40.60,
- Reporting requirements under 10 CFR §40.64,
- Effluent monitoring reporting requirements (10 CFR §40.65), and
- Requirements for advance notice of export shipments of natural uranium (10 CFR §40.66).

Specific incident reporting requirements under 10 CFR §40.60 include notifying the NRC within 24 hours of any of the following events:

- An unplanned contamination event that involves a quantity of licensed material greater than 5 times the lowest annual limit on intake or requires restricted access to the contaminated area, by workers or the public, for more than 24 hours.

- Equipment necessary for control of radioactive material or radiation fails and there is no adequate redundancy/substitute.

- An event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body.

- An unplanned fire or explosion affecting the integrity of either a container of licensed material containing a quantity greater than 5 times the lowest annual limit on intake or the licensed material itself.

Powertech will prepare the written operating procedures describing reporting requirements after license issuance but prior to ISR operations.

TR RAI 5.2-2
Consistent with NUREG-1569, Acceptance Criteria 5.2.3(13), please include a Land Use Survey in your discussion of the information required to be submitted annually to NRC.

TR RAI 5.2-2 Response
The following commitment will be added to Section 5.2.6 of the revised TR.

In accordance with NUREG-1569, Acceptance Criterion 5.2.3(13), Powertech will include a Land Use Survey describing any changes to the land use within the license boundary or with 3.3 km of the license boundary in the information submitted annually to NRC.

<u>TR RAI 5.2-3</u>

Consistent with NUREG-1569, Acceptance Criteria 5.2.3(6), please include a commitment to administer a cultural resources inventory before engaging in any development activity not previously assessed by NRC, and that any disturbances associated with such development will be completed in compliance with the National Historic Preservation Act, the Archeological Resources Protection Act, and their implementing regulations.

<u>TR RAI 5.2-3 Response</u>

TR Section 5.2 will be revised to include the following commitment.

Powertech will administer a historic and cultural resources inventory before engaging in any development activity not previously assessed by NRC or any cooperating agency. Any disturbances to be associated with such development will be addressed in compliance with the National Historic Preservation Act (NHPA), the Archeological Resources Protection Act, and their implementing regulations. Any disturbances also will be addressed in compliance with Powertech's Memorandum of Agreement (MOA) with the South Dakota State Archeologist and any future MOAs developed by Powertech or NRC under the NHPA. Powertech executed the MOA with the South Dakota State Archeologist in September 2008. The MOA, which was provided to the NRC as Appendix 4.10-B to the ER, establishes procedures to avoid or mitigate potential effects on archaeological and historic sites pursuant to South Dakota statutes 45-6D-14 and 45-6B.

Powertech will immediately cease any work resulting in the discovery of previously unknown cultural artifacts to ensure that no unapproved disturbance occurs. Powertech will notify appropriate authorities per any license conditions and will not go forward without appropriate approvals from NRC or other agencies as appropriate. Any such artifacts will be inventoried and evaluated, and no further disturbance will occur until authorization to proceed has been received. Powertech recognizes that the NHPA environment is not static, but rather is ongoing up to and through final license termination.

TR RAI 5.2-4

On page 5-7 of the TR it is stated that "Records of inspections of tailings piles and waste retention systems" will be maintained. Please clarify if there will be tailings piles on the site.

TR RAI 5.2-4 Response

There will be no tailings piles within the Dewey-Burdock project area as there are no tailings generated at ISR facilities and no on-site disposal is permitted at such facilities per the NRC's policy directive implementing 10 CFR Part 40, Appendix A, Criterion 2. TR Section 5.2.5 will be revised to remove the reference to records of inspections of tailings piles.

Management and Audit Program

TR RAI 5.3-1

ALARA requirements relevant to ISR facilities are codified in 10 CFR 20.1101 and 10 CFR 40, Appendix A, Criterion 8. Please address the following issues related to the applicant's ALARA program.

TR RAI 5.3-1(a)

a. ***10 CFR 20.1101(b) specifically addresses dose to members of the public. In Section 5.3.4 of the TR, the applicant does not discuss ALARA measures as it applies to members of the public. Consistent with the regulatory citations above and Regulatory Guide 8.37, please provide additional discussion on the applicant's ALARA program. This discussion should address ALARA goals and reviews related to members of the public.***

TR RAI 5.3-1(a) Response

The following information will be incorporated into revised Section 5.3.4 of the TR.

Goal of the Radiation Protection Program:

Powertech will develop, document and implement a radiation protection program commensurate with the scope and extent of the licensed activities that will ensure compliance with the provisions in 10 CFR § 20.1101. The radiation protection program will include implementing procedures and conducting operations in such a manner as to reduce airborne effluent releases to levels that are ALARA. The program's primary function will be to ensure doses to workers and members of the public are ALARA. A summary of the means by which this goal will be accomplished is described below.

Institutional Controls:

Management and Audit Program

The management and audit program will function to ensure vigilance toward the protection of human health and the environment. The management and audit program will be designed to provide quality assurance based upon reviews and evaluations of the effectiveness of radiation protection provided for workers and members of the public (MOP). Specifically, the semiannual effluent report required by 10 CFR § 40.65 will specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation, and such other information as the NRC may require to estimate maximum potential annual radiation doses to the public resulting from effluent releases.

Powertech's goal of the radiation protection program is to ensure doses to workers and the MOP are ALARA, consistent with 10 CFR § 20.1101(b).

Inspections and Audits Performed to Ensure ALARA Goal

- Accident reports and corrective action plans

- Effluent monitoring programs and air emissions restriction plan
- Emergency plans
- Radiation exposure records and monitoring program
- Security of licensed materials on site
- Retention system program and reports
- Transportation of licensed material
- Environmental monitoring program
- Inspection and documentation of equipment operation to ensure the equipment is operating consistently near peak efficiency. This includes drying and packaging operations
- Other institutional controls that will be utilized to prevent and minimize the potential for exposure to MOP including the remoteness of the project area and restriction of land and groundwater use

Engineering Controls:

Constraint on Radioactive Effluents to Air: Powertech will establish a plan to restrict air emissions of radioactive material to the environment, excluding radon-222 and decay products, to ensure that the individual MOP likely to receive the highest dose will not be expected to receive a total effective dose equivalent (TEDE) in excess of 10 mrem (0.1 mSv) per year from these emissions. If an over exposure does occur, Powertech will promptly report the incident according to 10 CFR § 20.2203 and implement corrective action and preventative measures against recurrence.

Effluent Control and Monitoring: This program will establish the control and monitoring system utilized for the facility and ensure monitoring locations are optimized for the intended function. The monitoring system will be utilized to assess the worker and MOP exposures. The system will be designed in a manner that is appropriate for the types of effluent(s) generated at the facility. Adequate ventilation systems will be installed, maintained and monitored to ensure exposures are ALARA.

Waste Storage Program: Powertech will develop and implement a waste storage system that will ensure that the design and installation is conducted in such a manner as to assure any dose that may result is ALARA. A monitoring program will be established for the waste storage system that will ensure the ponds are operated and maintained in a manner that prevents the movement of waste(s) to undesirable areas. Contingency plans will be built into the program to address all reasonable system failures.

Additional engineering controls that will be utilized to minimize the potential for exposure to MOP include locating the CPP near the center of the proposed license area, optimizing the number of well

fields in operation at one time, fencing, signage, physical access controls, and groundwater monitoring systems.

The implementation of institutional and engineering controls will ensure to the extent practicable that the TEDE to individual members of the public from the licensed operation does not exceed 0.010 rem/yr (10 mrem/yr).

Public Exposure at ISR Facilities:

According to NUREG-1910 (pg. 3.2-81), the TEDE to the average U.S. resident from natural background and man-made sources is 360 mrem/yr. NRC's regulations in 10 CFR Part 20 specify annual dose limits to MOP of 1 mSv (100 mrem) TEDE (above background). The potential for exposure of MOP to TEDE greater than the annual dose limits from an ISR facility is very remote. As described in pg. 4.2-55 of NUREG-1910, "Because of the distance to offsite receptors, radiological doses from normal operations are expected to have a SMALL impact on the general public." Further, the Generic Environmental Report in Support of the Nuclear Regulatory Commission's Generic Environmental Impact Statement for In Situ Uranium Recovery Facilities (NMA, 2007) concludes, "With respect to ISR operations, the potential impacts from radiation dose are, by orders of magnitude, lower than those posed by conventional mining/milling.

"Many of the dose pathways relevant to conventional mining/milling, such as ore removal, hauling, ore storage, mill tailings, and wind-blown particulates are not present, and therefore do not pose any risk, at ISR facilities, since no ore or waste rock is brought to the surface and there are no tailings associated with ISR activities. Thus, it is anticipated that the potential doses to actual members of the public who live near ISR facilities will be significantly lower, on the order of 1 mrem/year which equates to NCRP's negligible individual risk level (NIRL). Thus, it is highly unlikely that an ISR worker, much less a member of the public [even one who works occasionally within the project area], will receive a dose in excess of 10 CFR § 20.1301 regulatory limits."

TR RAI 5.3-1

ALARA requirements relevant to ISR facilities are codified in 10 CFR 20.1101 and 10 CFR 40, Appendix A, Criterion 8. Please address the following issues related 10 the applicant's ALARA program.

TR RAI 5.3-1(b)

b. ***Consistent with Regulatory Guides 8.10 and 8.31, please provide additional information on the applicant's occupational exposure ALARA program. The discussion should evaluate its proposed management and audit program and specifically address those items in Section 1.1, Licensee Management, of Regulatory Guide 8.31 and regulatory position C(1) of Regulatory Guide 8.10 that are not currently addressed in the application.***

TR RAI 5.3-1(b) Response

The following information will be included in Section 5.3 of the revised TR. Please also see response TR RAI 5.3-1(a) for more information on the proposed management and audit program and institutional and engineering controls that will be implemented to protect human health.

Licensee management items in Regulatory Guide 8.31, Section 1.1 are listed below followed by the appropriate TR section where each commitment is made within the respective discussion of the applicable program and/or management schema described.

1) A strong commitment to and continuing support for the development and implementation of the radiation protection and ALARA program.
   Addressed in: TR Section 5.0, pg. 5-1, first paragraph.

2) Information and policy statements to employees, contractors, and visitors.
   Addressed in: TR Section 5.5, pp. 5-12 through 5-14.

3) A periodic management audit program that reviews procedural and operational efforts to maintain exposures ALARA.
   Addressed in: TR Section 5.3, beginning on pg. 5-9, with the updates indicated in the response to TR RAI 5.3-1(a).

4) Continuing management evaluation of the radiation safety (health physics) program, its staff, and its allocation of adequate space and money.
   Addressed in: TR Section 5.0, pg. 5-1 first paragraph and TR Section 5.3, beginning on pg. 5-9.

5) Appropriate briefings and training in radiation safety, including ALARA concepts for all uranium employees in the facility and, when appropriate, for contractors and visitors.
   Addressed in: TR Section 5.5, beginning pg. 5-12; TR Section 3.3, beginning pg. 3-59; TR Section 4.2.3, pg. 4-28; TR Section 5.3.4, pg. 5-11; and TR Section 5.4, pg. 5-12.

Powertech is confident that the information contained within the application is in line with the general operating philosophies acceptable to the NRC staff as described in Regulatory Guide 8.10. The application strongly supports the management's commitment to maintaining exposures ALARA and reducing exposures when possible. This is demonstrated throughout the TR, including the following sections: 4.1.1 Radon; 4.1.2.2 Atmospheric Discharges from the Yellowcake Drying and Packaging

System; 5.0 Operations; 5.1 Corporate Organization and Administrative Procedures; 5.1.5 Radiation Safety Officer; 5.2 Management Control Program; 5.3 Management and Audit Program; 5.3.4 Annual Radiation Protection and ALARA Program Audit; 5.5.1 Initial Training; 5.7 Radiation Safety Controls and Monitoring; 6.3.2 Preliminary Radiological Surveys and Contamination Control; 6.4.1.3 Uranium Chemical Toxicity Assessment; and 6.4.3 Surface Soil Cleanup Verification and Sampling Plans.

Radiation Safety Training

TR RAI 5.5-1

Consistent with Regulatory Guide 8.13 and NUREG-1569, Acceptance Criteria 5.5.3(2), please provide the applicant's specific policy on declared pregnant women.

TR RAI 5.5-1 Response

TR Section 5.5 will be revised to include Powertech's policy on declared pregnant women as follows:

Prenatal and Fetal Exposure Policy

To ensure that the radiation dose to an embryo/fetus during the entire pregnancy of a declared pregnant worker does not present a health threat and is maintained ALARA, Powertech will take the following steps:

1) Advise all female workers of child-bearing age at the time of employment that if they are pregnant or become pregnant during their employment, they can voluntarily declare their pregnancy to Powertech to limit radiation exposure to their unborn child. Powertech will provide copies of this policy to all female employees.
2) Powertech encourages pregnant women to declare their pregnancy in order to protect the embryo/fetus.
3) In addition to providing instruction in accordance with §19.12 of 10 CFR Part 19, provide to all female employees instruction specified by NRC's Regulatory Guide 8.13, specifically concerning biological risks to the embryo/fetus exposed to radiation, the dose limit for the embryo/fetus and suggestions for reducing radiation exposure.
4) Limit the exposure to the unborn child from occupational exposure of the expectant mother to 500 millirems for the entire pregnancy, if the pregnancy has been declared by the mother.
5) Avoid assigning job duties that could result in substantial variations in the rate of exposure.

TR RAI 5.5-2

Consistent with Regulatory Guide 8.31 and NUREG-1569, Acceptance Criteria 5.5.3(1), please provide a proposed training program that includes non-radiological hazards for workers.

TR RAI 5.5-2 Response

TR Section 5.5 will be revised to include a commitment and program description for training on identification of, standards for, and health and safety procedures for nonradiological hazards. The training will be based on OSHA regulations and will address occupational safety (ergonomics, drug and alcohol abuse in the work place, hazardous material handling, confined spaces, etc.) general safety (hazard recognition, security, etc.), and job-specific categories of training for employees whose job function includes construction, electrical work, hazardous materials handling, or operation of machinery.

TR RAI 5.5-3
Consistent with Regulatory Guide 3.46, please provide a copy of the proposed written radiological safety instructions in conformance with 10 CFR 19.12.

TR RAI 5.5-3 Response
TR Section 5.5 will be revised to include the following summary of the written radiological safety instructions, which will be provided as Appendix 5.5-A in the revised TR.

Appendix 5.5-A (Proposed Written Radiological Safety Instruction to Workers) will be added to the revised TR and will state the following:

Instruction to Workers:

(a) All individuals who in the course of employment are likely to receive in a year an occupational dose in excess of 100 mrem shall be:

(1) Kept informed of the storage, transfer, or use of radiation and/or radioactive material;

(2) Instructed in the health protection concerns associated with exposure to radiation and/or radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed;

(3) Instructed in, and required to observe, to the extent within the workers control, the applicable provisions of NRC regulations and licenses for the protection of personnel from exposure to radiation and/or radioactive material;

(4) Instructed of their responsibility to report promptly to Powertech any condition which may lead to or cause a violation of NRC regulations and licenses or unnecessary exposure to radiation and/or radioactive material;

(5) Instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation and/or radioactive material; and

(6) Advised as to the radiation exposure reports which workers may request pursuant to 10 CFR § 19.13.

(b) In determining those individuals subject to the requirements of item (a), Powertech will take into consideration assigned activities during routine and non-routine situations involving exposure to radiation and/or radioactive material which can reasonably be expected to occur during the life of the licensed facility. The extent of these instructions will be commensurate with potential radiological health protection concerns present in the work place.

External Radiation Exposure Monitoring Program

TR RAI 5.7.2-1

10 CFR 20.1501(a)(2)(i) states that the licensee shall make or cause to be made surveys that are reasonable under the circumstances to evaluate the magnitude and extent of radiation levels. In section 5.7.2 of the TR, the applicant has not discussed the potential situation when the dose exceeds 5 mrem in 1 hour at 30 cm from a radiation source, or any surface that the radiation penetrates, and whether it will have sufficient instrumentation to measure gamma dose rates in excess of 5 mrem per hour. Consistent with Regulatory Guide 3.46 and NUREG-1569, Acceptance Criterion 5.7.2.3(3), provide a description of survey instrumentation sufficient to measure expected gamma dose rates during operation.

TR RAI 5.7.2-1 Response

TR Section 5.7 will be revised to include descriptions of the survey equipment used to measure expected gamma dose rates during operation, in potential situations where the dose may exceed 5 mrem in 1 hour at 30 cm, and the sensitivity of the equipment used. The revision will include the information provided below.

The typical gamma exposure rates during operation are expected to range from background up to 1,000 µR per hour. The gamma dose rates will be estimated by assuming 1 µR per hour is equivalent to 1 µrem per hour. There may be rare occasions where the gamma dose rate may approach 5 mrem per hour. The instrument to be used for most gamma surveys is the Ludlum 19 or equivalent. The typical operating specifications for this instrument are shown in Table TR RAI 5.7.2-1-1. This instrument can measure dose rates up to 5 mrem/hr. If gamma dose rates larger than 5 mrem/hr are evident, a Ludlum model 44-38 or equivalent type of detector coupled with an appropriate rate meter will be used. The typical operating specifications for the Ludlum model 44-38 are shown in Table TR RAI 5.7.2-1-1. The Ludlum 44-38 can also be used when performing beta surveys where appropriate in and around the process area. Both instruments will be on site and available for use by properly trained staff during operations.

Table TR RAI 5.7.2-1-1: Ludlum 19 and Ludlum 44-38 Operating Specifications.

Instrument Model	Instrument Type	Radiation Type	Measurement Range	Sensitivity
Ludlum Model 19	Sodium Iodide (Tl) scintillometer (1 in x 1 in)	Gamma	0 – 5,000 µR/hr	175 cpm per µR/hr (Cs-137)
Ludlum Model 44-38	Geiger-Mueller (GM), halogen quenched	Gamma and beta	Up to 50 mR/hr	1,200 cpm per mR/hr (Cs-137) with window closed

TR RAI 5.7.2-2

Regulatory Guide 8.30 recommends establishing action levels for gamma dose rates and dosimeter results. Consistent with Regulatory Guide 8.30, please provide these action levels or justification for an alternate program.

TR RAI 5.7.2-2 Response

TR Section 5.7.2 will be revised to include the following discussion on action levels for gamma dose rates and dosimeter results.

Action levels for gamma radiation dose rates are as follows:

1) Areas with gamma exposure rate measurements above 0.25 mR/hr will require individuals working in and around the area to wear personal dosimeters. An evaluation regarding the cause of the exposure rate will be conducted and steps will be taken to keep exposure rates ALARA.
2) Areas with gamma exposure rate measurements above 5 mR/hr will be posted as Radiation Areas. An evaluation regarding the cause of the exposure rate will be conducted and steps will be taken to reduce the exposure rate.

In addition, once typical operational gamma dose rate levels have been established, additional administrative action levels may be established as deemed appropriate by the RSO and as reviewed by the SERP.

For dosimeter results, the following action levels will apply:

1) Measured individual worker external whole body deep radiation doses above 125 mrem per calendar quarter or 500 mrem per calendar year will result in investigations as to the cause of the dosimeter result, and steps will be taken to keep radiation doses ALARA.
2) Measured individual worker shallow-doses (skin) above 1,250 mrem per calendar quarter or 5,000 mrem per calendar year will also result in investigations as to cause and procedures to mitigate.
3) Measured individual worker external whole body radiation deep doses above 312 mrem per calendar quarter or 1,250 mrem per calendar year will result in work restrictions for the affected workers until an investigation has determined that cumulative internal and external EDEs for the year are unlikely to exceed 5 rem, and that the doses are ALARA.

<u>TR RAI 5.7.2-3</u>

Consistent with NUREG-1569, Acceptance Criterion 5.7.2.3(2) and Regulatory Guide 8.34, discuss the applicant's employee monitoring program as it relates to individuals entering a high radiation area.

<u>TR RAI 5.7.2-3 Response</u>

TR Section 5.7.2 will be revised to include Powertech's employee monitoring program as it relates to individuals entering high radiation areas, as discussed below.

A high radiation area is defined in 10 CFR Part 20 as "an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or 30 centimeters from any surface that the radiation penetrates." The existence of such a high radiation area within an ISR facility is highly unlikely due to the nature of the radioactive materials involved. However, in the unlikely event an individual had to enter a high radiation area, the work would be conducted under a Radiation Work Permit, which characterizes the radiological hazards and identifies controls, both engineering and administrative, and PPE to keep radiation doses to levels that are ALARA. The individual would be monitored with a personal monitoring device and equipped with a calibrated rate meter and appropriate detector. Any work performed within the area would be limited and performed in such a manner as to maintain doses to levels that are ALARA. In accordance with Subpart G §20.1601, Powertech will have qualified staff (e.g., RSO, RSTs) present and prepared to implement and utilize monitoring devices and the controls deemed applicable to the specific circumstances and area in order to control access and exposure.

TR RAI 5.7.2-4

Regulatory Guide 3.46 recommends indicating the number and category of personnel that will be included in the external radiation monitoring program. Please provide this information or justification for not including it in the application.

TR RAI 5.7.2-4 Response

TR Section 5.7 will be revised to indicate the category and number of personnel included in the external radiation monitoring program based on the following discussion.

OSL dosimeters will be utilized quarterly for assessing the external dose for individuals who may potentially exceed 10 percent of the annual occupational limit (10 CFR 20.1201(a)). Powertech may monitor other workers, although not required, for occupational exposures during the first year of operations, or any other period deemed necessary, to ensure that all workers are receiving less than 10 percent of the 5 rem annual limit. After the periodic evaluation, monitoring may be reduced or eliminated at some locations. This decision would be at the discretion of the RSO and the SERP. The number and category (based on the organizational chart shown on TR Figure 5.1.2) of personnel that will be included in the external radiation monitoring program are as follows:

Category	**Number of Employees***
Construction Superintendent	31
Production Superintendent	43
Radiation Safety Officer	9
Total	83

*Includes category supervisor and all personnel working under each category supervisor

TR RAI 5.7.2-5

Section 5.7.2.1 refers to Figure 5.7-1 for the locations of fixed radiation exposure measurements at the Dewey-Burdock facility. However, Figure 5.7-1 depicts the proposed operational environmental monitoring sites. Please provide the correct figure reference(s).

TR RAI 5.7.2-5 Response

TR Section 5.7.2 will be revised to include corrected figure references (TR Figures 5.7-2 through 5.7-5) for the locations of the radiation exposure measurements. The text and Figures 5.7-2 through 5.7-5 will be revised to indicate that these are measurement locations, not fixed radiation monitoring points.

In-Plant Airborne Radiation Monitoring Program

TR RAI 5.7.3-1

In Section 5.7.3.1 of the TR, the applicant described proposed radon monitoring locations based upon expected radon decay product concentrations. Figures 5.7-6 to 5.7-9 show these locations at the satellite and central processing facilities. However, it is not clear if/how the applicant will evaluate if these proposed locations remain appropriate once operations have started and throughout the operational lifetime of the facilities. Regulatory guides 3.46, 8.25, and 8.30 provide recommendations regarding the location of air samplers. Please address the following in regards to radon decay product monitoring:

TR RAI 5.7.3-1(a)

a. ***Consistent with Regulatory Guide 8.25, please describe how airflow patterns will be established within the facilities and will they be verified throughout the operational lifetime of the facilities.***

TR RAI 5.7.3-1(a) Response

Section 5.7.3 of the revised TR will include the following discussion.

Airflow patterns in the facilities will be determined based on location of air inlets and exhausts relative to sources of airborne radioactive materials. Neutrally buoyant markers may be used to determine airflow patterns. Airflow patterns for workers will also be observed and monitored. If any worker areas are altered in size or location the air flow will be re-evaluated in those areas. If there is any reason to suspect a change in flow or pattern due to process or equipment changes, the area will be evaluated for airflow pattern changes, and sampling locations will be changed accordingly. Radon decay product samples will be collected at a height of 3 to 6 feet between the source and the area occupied by the workers.

TR RAI 5.7.3-1

In Section 5.7.3.1 of the TR, the applicant described proposed radon monitoring locations based upon expected radon decay product concentrations. Figures 5.7-6 to 5.7-9 show these locations at the satellite and central processing facilities. However, it is not clear if/how the applicant will evaluate if these proposed locations remain appropriate once operations have started and throughout the operational lifetime of the facilities. Regulatory guides 3.46, 8.25, and 8.30 provide recommendations regarding the location of air samplers. Please address the following in regards to radon decay product monitoring:

TR RAI 5.7.3-1(b)

b. ***Consistent with Regulatory Guide 8.25, please describe how air sampling locations will be evaluated over time to confirm that their locations are still appropriate.***

TR RAI 5.7.3-1(b) Response

The response to TR RAI 5.7.3-1(a) has been revised to address this RAI as well.

<u>TR RAI 5.7.3-1</u>

In Section 5.7.3.1 of the TR, the applicant described proposed radon monitoring locations based upon expected radon decay product concentrations. Figures 5.7-6 to 5.7-9 show these locations at the satellite and central processing facilities. However, it is not clear if/how the applicant will evaluate if these proposed locations remain appropriate once operations have started and throughout the operational lifetime of the facilities. Regulatory guides 3.46, 8.25, and 8.30 provide recommendations regarding the location of air samplers. Please address the following in regards to radon decay product monitoring:

<u>TR RAI 5.7.3-1(c)</u>

c. ***Consistent with Regulatory Guide 8.30, please provide a description of your air sampling program during the first year of operations to ensure that the proposed program adequately provides measurements of the concentrations representative of the concentrations to which workers are exposed.***

<u>TR RAI 5.7.3-1(c) Response</u>

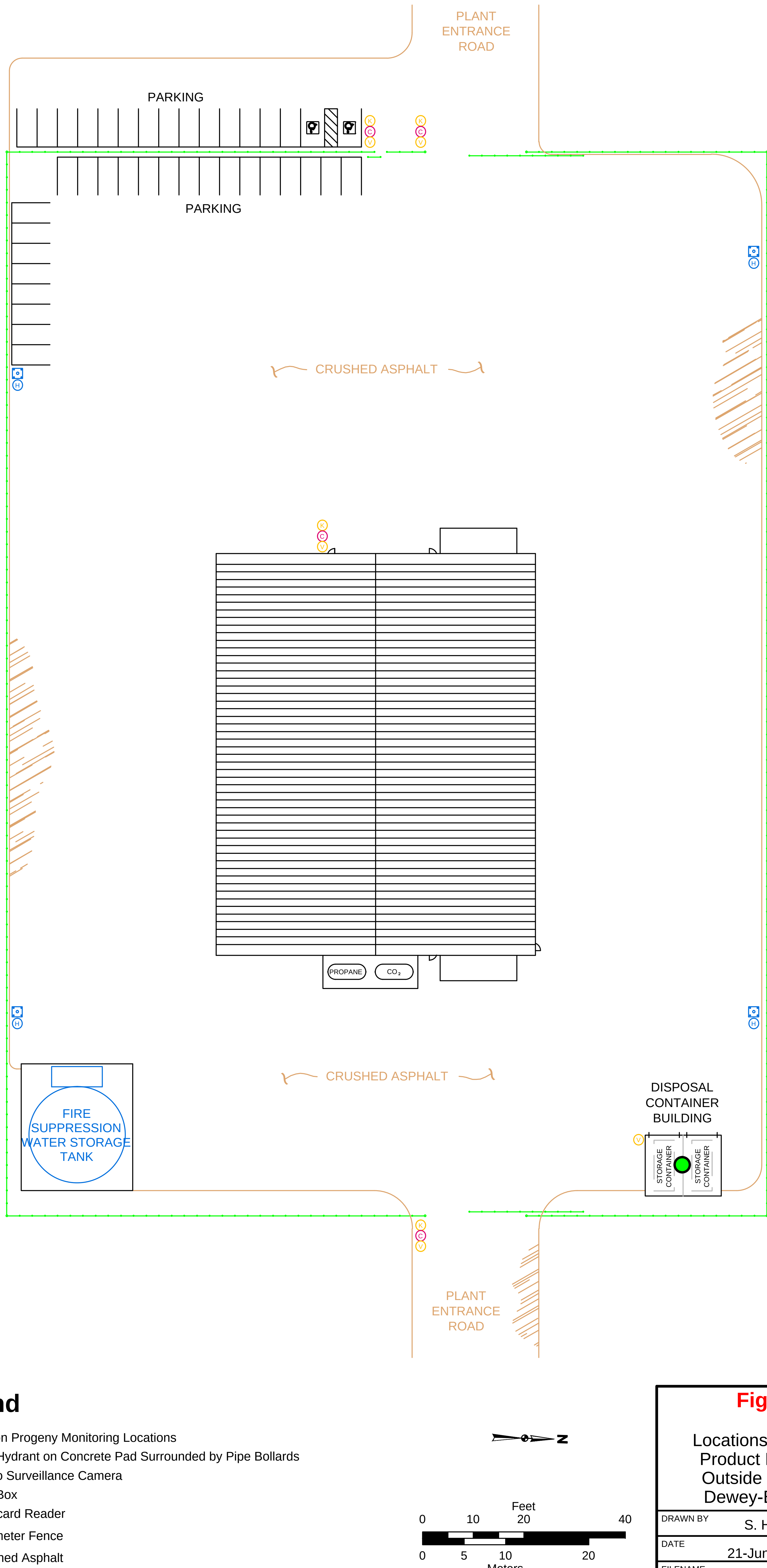
Section 5.7.3 of the revised TR will include the following discussion.

According to Regulatory Guide 8.30, measurements of radon decay products are a better measure for worker dose than measurements of radon. Therefore, measurements of radon decay products will be made in the facility.

Powertech will conduct an airborne radiation monitoring program at the project facility that is consistent with the recommendations contained in Regulatory Guide 8.30. The monitoring program will consist of monitoring radon decay products as well as airborne particulate monitoring. During the first year of operation an extensive air particulate program will be implemented in order to evaluate and determine area concentrations of key particulates to which workers may be exposed.

Working level (WL) measurements for radon decay products will be made on a monthly basis in areas where radon decay product concentrations are likely to exceed the LLD of 0.03 WL as described in Regulatory Guide 8.30. TR Figures 5.7-6 to 5.7-9 present the monitoring locations where radon decay products could possibly exceed 0.03 WL. These figures have been updated to reflect the current facility designs and are included below. Additionally, areas where the radon decay product concentration exceeds 0.08 WL, as indicated by the monthly WL measurements, will be measured for radon decay products on a weekly basis. For these areas, investigations will be conducted to determine the source and corrective action will be taken if determined necessary by the RSO. If four consecutive weekly measurements in an area show the concentration of radon decay products to be at or below 0.08 WL, then the frequency of measurements in that area will return to monthly. Areas proximal to radon sources that do not exhibit radon decay product concentrations above 0.03 WL, as indicated by monthly WL measurements, will have WL measurement frequency reduced to quarterly. The time, date, and

state of operation of the equipment in the vicinity of the measurement will be recorded. Areas that do not exhibit radon decay product concentrations above 0.03 WL but are proximal to radon sources will be evaluated on a quarterly basis. In addition, areas where workers routinely work and may be exposed to radon decay products will be evaluated at the discretion of the RSO.



Legend

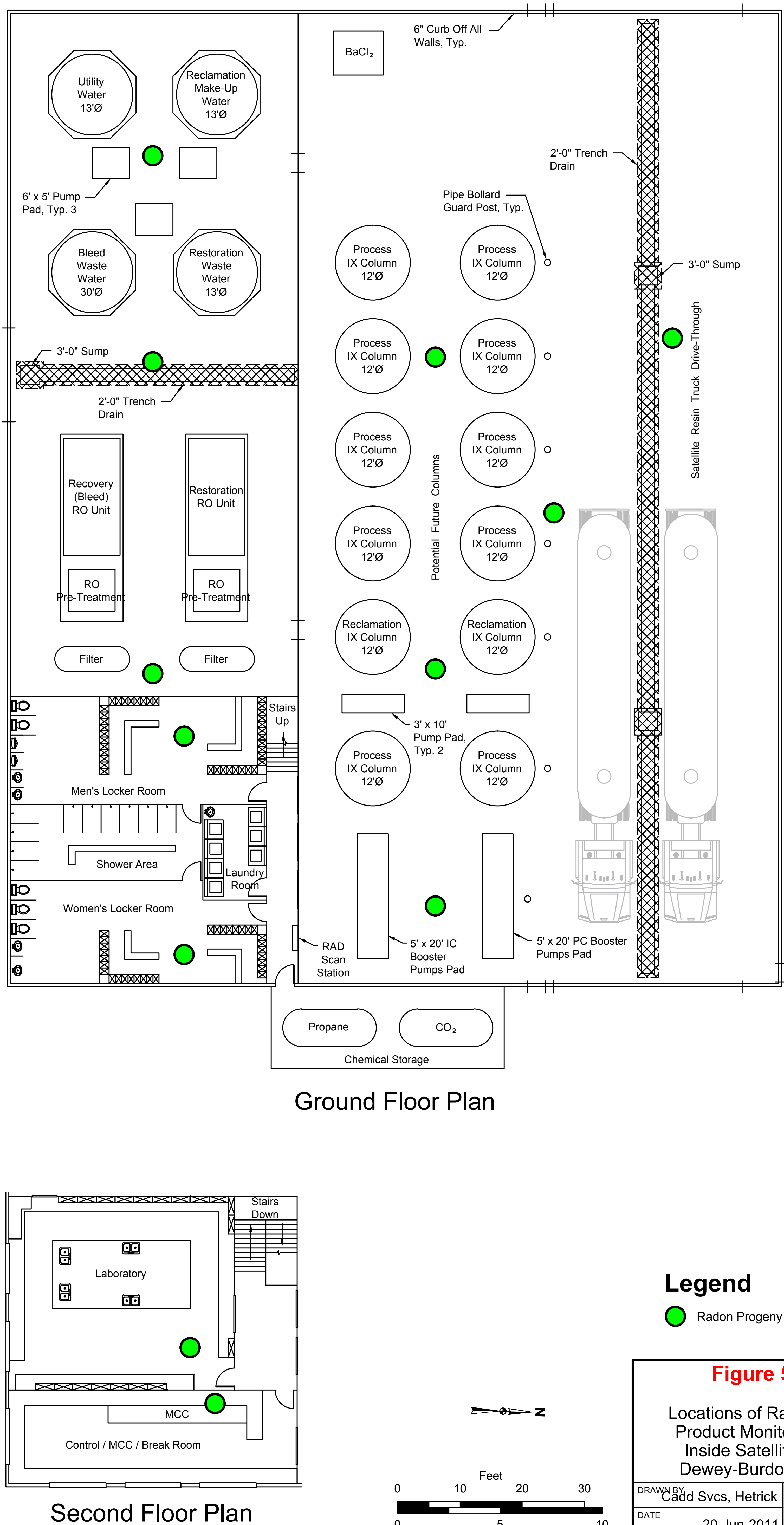
- Radon Progeny Monitoring Locations
- Fire Hydrant on Concrete Pad Surrounded by Pipe Bollards
- Video Surveillance Camera
- Call Box
- Key-card Reader
- Perimeter Fence
- Crushed Asphalt

Figure 5.7-6

Locations of Radon Decay Product Monitoring Sites Outside Satellite Facility Dewey-Burdock Project

DRAWN BY	S. Hetrick
DATE	21-Jun-2011
FILENAME	Figure 5.7-6.dwg

POWERTECH (USA) INC.



Legend

Radon Progeny Monitoring Locations

Figure 5.7-7

Locations of Radon Decay Product Monitoring Sites Inside Satellite Facility Dewey-Burdock Project

DRAWN BY	Cadd Svcs, Hetrick
DATE	20-Jun-2011
FILENAME	Figure 5.7-7.dwg

POWERTECH (USA) INC.

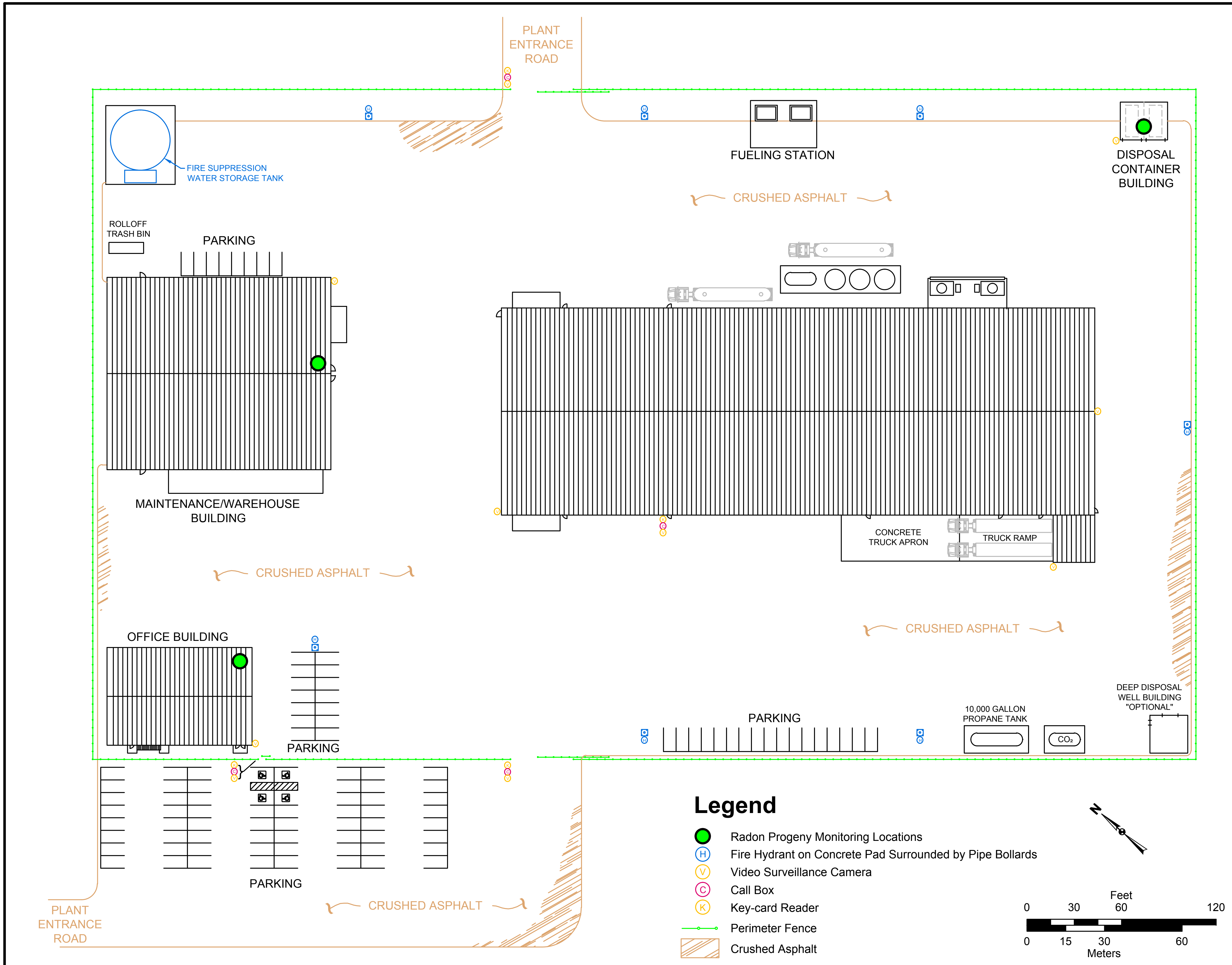
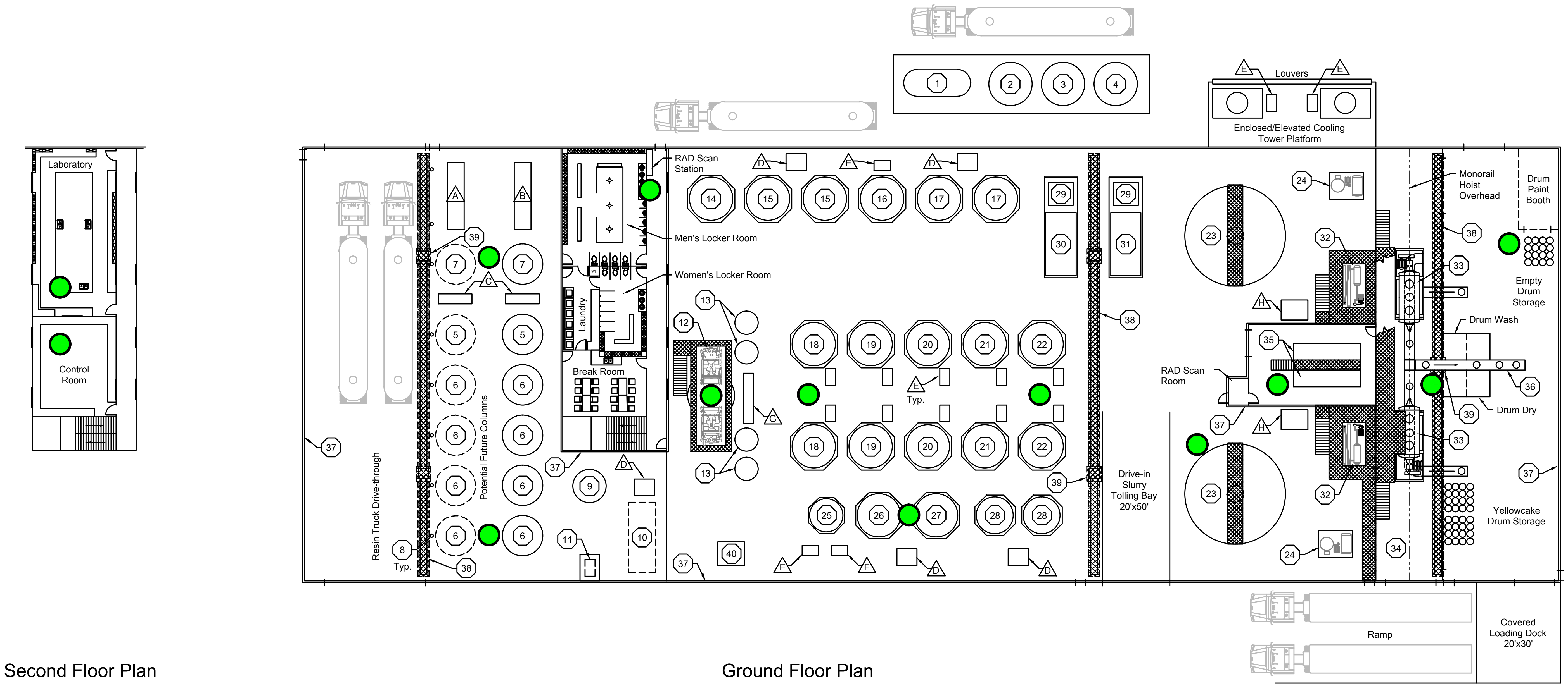


Figure 5.7-8

Location of Radon Decay Product Monitoring Sites Outside Central Processing Facility
Dewey-Burdock Project

DRAWN BY	S. Hetrick
DATE	20-Jun-2011
FILENAME	Figure 5.7-8.dwg

POWERTECH (USA) INC.



Key Notes

1. CO_2
2. NaOH
3. H_2SO_4
4. H_2O_2
5. Reclamation IX Column 12'Ø
6. Process IX Column 12'Ø
7. Bleed IX Column 12'Ø
8. Pipe Bollard Guard Post
9. Resin Transfer Water 10'Ø
10. Resin Supersack Storage
11. Standby Generator in Sound Insulated Room
12. Shaker Screens with Shaker Overflow Collection Tank Below
13. Elution Column 7'Ø
14. Reclamation Make-up Water 13'Ø
15. NaCl 13'Ø
16. Na_2CO_3 13'Ø
17. Utility Water 13'Ø
18. Fresh Eluant 13'Ø
19. Lean Eluant 13'Ø
20. Intermediate Eluant 13'Ø
21. Rich Eluant 13'Ø
22. Precipitation 13'Ø
23. 30'Ø Thickener, 5'Ø Shear Tank Below
24. Hot Oil Boiler
25. Potable Water 10'Ø
26. High TDS Wastewater Tank 13'Ø
27. Low TDS Wastewater Tank 13'Ø
28. Solids Removal Tank 11'Ø
29. RO Pre-treatment
30. Recovery RO Unit
31. Restoration RO Unit
32. Elevated Condenser/Vacuum Pump Skid 7'x13'
33. Vacuum Dryer 8'x24'
34. Dryer Room 20'x130'
35. Filter Press and Transfer Pump 5'x20'
36. Drum Conveyor
37. 6" Curb Off All Walls, Typ.
38. 2'-0" Trench Drain, Typ.
39. 3'-0" Sump, Typ.
40. Barium Chloride Storage

Housekeeping Pads

- A 5'x20' - PC Booster Pumps
- B 5'x20' - IC Booster Pumps
- C 3'x10' - Pump
- D 6'x5' - Pump
- E 3'x5' - Pump
- F 3'x5' - Disinfectant
- G 3'x15' - Pump
- H 6'x8' - Pump

Feet: 0 15 30 60
Meters: 0 5 10 20

Legend

● Radon Progeny Monitoring Locations

Figure 5.7-9

Locations of Radon Decay Product Monitoring Sites Inside Central Processing Facility Dewey-Burdock Project

DRAWN BY	Cadd Svcs, Hetrick
DATE	20-Jun-2011
FILENAME	Figure 5.7-9.dwg

Powertech (USA) Inc.

TR RAI 5.7.3-2

Consistent with NUREG-1569, Acceptance Criterion 5.7.3.3(2) and Regulatory Guide 8.30, specify the LLD for radon daughter measurements.

TR RAI 5.7.3-2 Response

The TR will be revised to indicate that the LLD for radon decay product measurements will be 0.03 WL, as described in Regulatory Guide 8.30, Section 2.3.

<u>TR RAI 5.7.3-3</u>

In Section 5.7.3.2 of the TR, the applicant described the proposed airborne particulate monitoring program. Regulatory Guides 3.46, 8.25, and 8.30 provide recommendations regarding the location of air samplers. Please address the following in regards to airborne particulate monitoring:

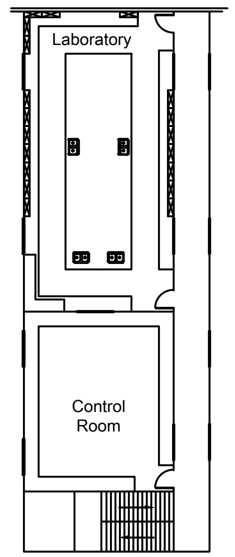
<u>TR RAI 5.7.3-3(a)</u>

a. ***Consistent with NUREG-1569, Acceptance Criterion 5.7.3(1), please provide facility drawings that depict the facility layout and the location of samplers for airborne particulates.***

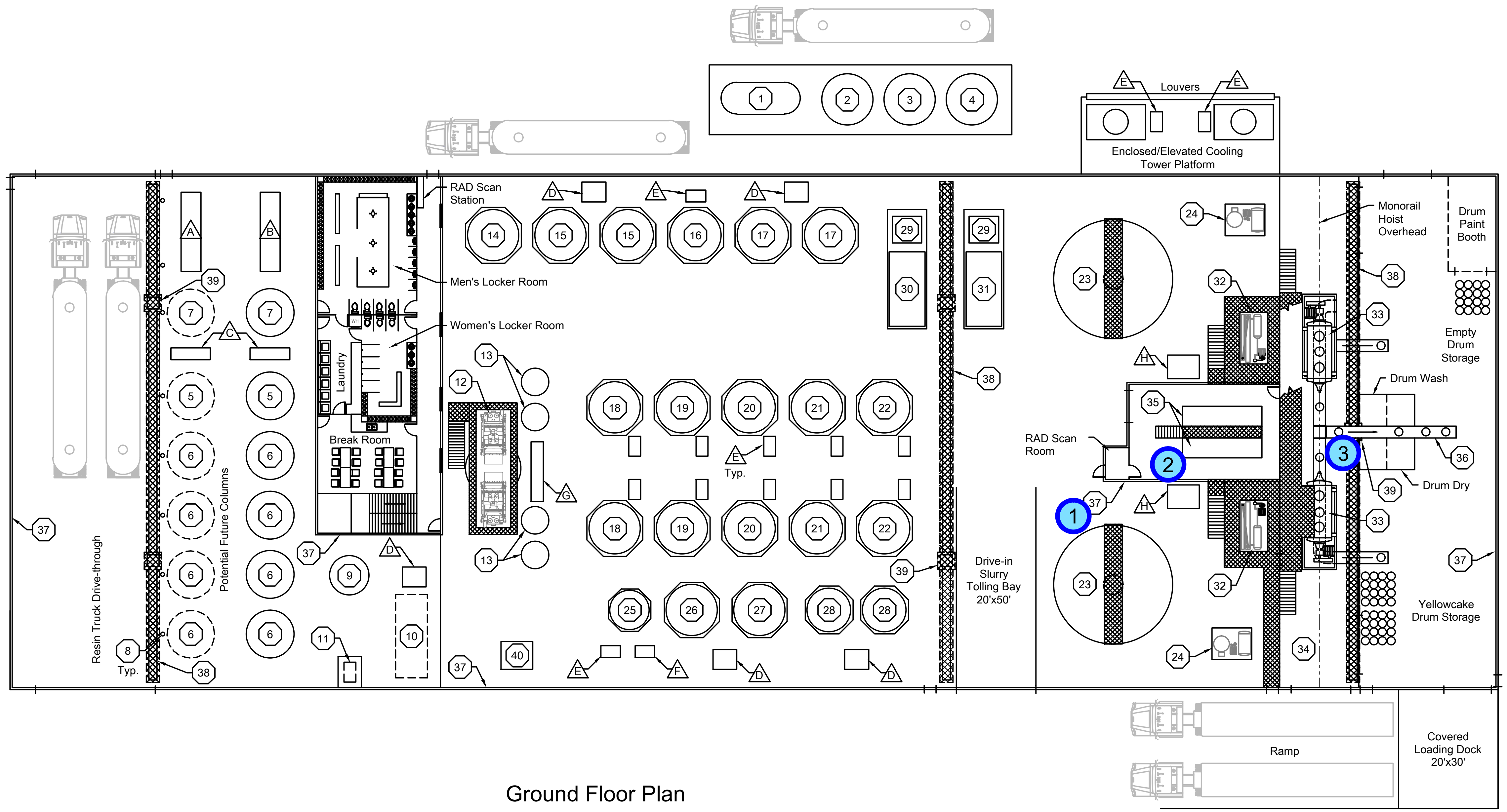
<u>TR RAI 5.7.3-3(a) Response</u>

The following information will be added to Section 5.7.3.2 of the revised TR.

Static monitoring stations for airborne radionuclide areas within the CPP are shown on Figure TR RAI 5.7.3-3a-1. For non-airborne radioactivity areas within the CPP, Powertech will conduct monthly and weekly monitoring for in-plant airborne radionuclides via breathing zone monitoring devices assigned to workers performing specific routine tasks on a random basis. No static monitoring stations for non-airborne radioactivity areas will occur unless required by a Radiation Work Permit (RWP). Non-routine task monitoring requirements will be documented in an RWP.



Second Floor Plan



Ground Floor Plan

Key Notes

1. CO_2
2. NaOH
3. H_2SO_4
4. H_2O_2
5. Reclamation IX Column 12'Ø
6. Process IX Column 12'Ø
7. Bleed IX Column 12'Ø
8. Pipe Bollard Guard Post
9. Resin Transfer Water 10'Ø
10. Resin Supersack Storage
11. Standby Generator in Sound Insulated Room
12. Shaker Screens with Shaker Overflow Collection Tank Below
13. Elution Column 7'Ø
14. Reclamation Make-up Water 13'Ø
15. NaCl 13'Ø
16. Na_2CO_3 13'Ø
17. Utility Water 13'Ø
18. Fresh Eluant 13'Ø
19. Lean Eluant 13'Ø
20. Intermediate Eluant 13'Ø
21. Rich Eluant 13'Ø
22. Precipitation 13'Ø
23. 30'Ø Thickener, 5'Ø Shear Tank Below
24. Hot Oil Boiler
25. Potable Water 10'Ø
26. High TDS Wastewater Tank 13'Ø
27. Low TDS Wastewater Tank 13'Ø
28. Solids Removal Tank 11'Ø
29. RO Pre-treatment
30. Recovery RO Unit
31. Restoration RO Unit
32. Elevated Condenser/Vacuum Pump Skid 7'x13'
33. Vacuum Dryer 8'x24'
34. Dryer Room 20'x130'
35. Filter Press and Transfer Pump 5'x20'
36. Drum Conveyor
37. 6" Curb Off All Walls, Typ.
38. 2'-0" Trench Drain, Typ.
39. 3'-0" Sump, Typ.
40. Barium Chloride Storage

Housekeeping Pads

- A: 5'x20' - PC Booster Pumps
- B: 5'x20' - IC Booster Pumps
- C: 3'x10' - Pump
- D: 6'x5' - Pump
- E: 3'x5' - Pump
- F: 3'x5' - Disinfectant
- G: 3'x15' - Pump
- H: 6'x8' - Pump

Feet: 0, 15, 30, 60
Meters: 0, 5, 10, 20

1. Precipitation Area
2. Filter Press Room
3. Dryer and Packaging Area

Figure TR RAI 5.7.3-3a-1

Proposed Quarterly Air Particulate Sampling Locations

Dewey-Burdock Project

DRAWN BY	Cadd Svcs, Hetrick
DATE	10-Jun-2011
FILENAME	Figure TR RAI 5.7.3-3a-1.dwg

POWERTECH (USA) INC.

TR RAI 5.7.3-3

In Section 5.7.3.2 of the TR, the applicant described the proposed airborne particulate monitoring program. Regulatory Guides 3.46, 8.25, and 8.30 provide recommendations regarding the location of air samplers. Please address the following in regards to airborne particulate monitoring:

TR RAI 5.7.3-3(b)

b. Consistent with Regulatory Guide 8.25, please describe how airflow patterns will be established within the facilities and will they be verified throughout the operational lifetime of the facilities?

TR RAI 5.7.3-3(b) Response

The description of airflow pattern determination and verification throughout the operational lifetime of the facilities is provided in the response to TR RAI 5.7.3-1(a).

<u>TR RAI 5.7.3-3</u>

In Section 5.7.3.2 of the TR, the applicant described the proposed airborne particulate monitoring program. Regulatory Guides 3.46, 8.25, and 8.30 provide recommendations regarding the location of air samplers. Please address the following in regards to airborne particulate monitoring:

<u>TR RAI 5.7.3-3(c)</u>

c. ***Consistent with Regulatory Guide 8.25, please describe how air sampling locations will be evaluated over time to confirm that their locations are still appropriate.***

<u>TR RAI 5.7.3-3(c) Response</u>

The following describes how Powertech will evaluate the air sampling locations throughout the life of the facility to ensure worker safety. Please refer to the responses to TR RAI 5.7.3-1(a) and TR RAI 5.7.3-3(b) for methods used to determine airflow patterns. The following information will be incorporated into the revised TR.

Fixed-location sampler locations will be evaluated annually to confirm that their locations are still appropriate. Included in this evaluation will be the assessment of air flow patterns including potential seasonal variations, changes in worker and equipment locations, and changes in process. Breathing zone samples (lapel samples) for specific tasks are presumed to be representative without further assessment provided the intake of the lapel sampler is within one foot of the worker's head.

<u>TR RAI 5.7.3-3</u>

In Section 5.7.3.2 of the TR, the applicant described the proposed airborne particulate monitoring program. Regulatory Guides 3.46, 8.25, and 8.30 provide recommendations regarding the location of air samplers. Please address the following in regards to airborne particulate monitoring:

<u>TR RAI 5.7.3-3(d)</u>

d. ***Consistent with Regulatory Guide 8.30, please provide a description of the applicant's air sampling program during the first year of operations to ensure that the proposed program adequately provides measurements of the concentrations representative of the concentrations to which workers are exposed.***

<u>TR RAI 5.7.3-3(d) Response</u>

The following describes the air sampling program Powertech will implement during the first year of operation. The information presented below will be incorporated in Section 5.7.3 of the TR. Please also refer to the response TR RAI 5.7.3-1(c).

Powertech will conduct an airborne radiation monitoring program at the project facility that is consistent with the recommendations contained in Regulatory Guide 8.30. The monitoring program will consist of monitoring radon decay products as well as airborne particulate monitoring. During the first year of operation an extensive air particulate program will be implemented in order to evaluate and determine area concentrations of key particulates to which workers may be exposed. Since no conventional ore processing is conducted at an ISR facility, the program will be designed to measure areas where workers may theoretically be exposed to radiological and non-radiological particulates during the daily work routines specific to ISR operations. Breathing zone and particulate monitoring programs are proposed in areas of the CPP where yellowcake is present (Figure TR RAI 5.7.3-3a-1). Upon analyzing the results from the air particulate measurements, determinations will be made as to the assurance that process and engineering controls are maintaining the concentrations to which workers may be exposed ALARA. Other precautions will be considered based on the data from the primary monitoring program, such as access control to some areas, restrictions on working time within specific areas, and the use of PPE for respiratory protection.

TR RAI 5.7.3-3

In Section 5.7.3.2 of the TR, the applicant described the proposed airborne particulate monitoring program. Regulatory Guides 3.46, 8.25, and 8.30 provide recommendations regarding the location of air samplers. Please address the following in regards to airborne particulate monitoring:

TR RAI 5.7.3-3(e)

*e. **Consistent with Regulatory Guide 8.30, please provide a description of the applicant's air sampling program for areas not designated as airborne radioactivity areas.***

TR RAI 5.7.3-3(e) Response

The following describes the air sampling program proposed by Powertech for areas not designated as airborne radioactivity areas. The following information will be incorporated into Section 5.7.3.2 of the revised TR.

Consistent with Regulatory Guide 8.30, Powertech will implement an air sampling program for areas in the process facility not designated as airborne radioactivity areas. The air sampling program will include quarterly radon decay product grab samples and monthly uranium grab samples. With respect to airborne particulate monitoring, a demonstration that the volume of air sampled is accurately known will be performed via one monthly sample for 30 minutes, or 5-minute weekly grab samples via a high-volume air sampler running at 30 cfm. Powertech reserves the right to incorporate one or both of these methods into air sampling procedures depending on which method may be most appropriate for a given space not designated as an airborne radioactivity area.

TR RAI 5.7.3-4

In Section 5.7.3.2 of the TR, the applicant proposed a formula for calculating the lower limit of detection (LLD) for particulate air samples based on the formula for minimum detectable activity (MDA) in Regulatory Guide 8.25. However, recommendations for LLD are specified in Regulatory Guide 8.30 and are based on a different formula (see Appendix B of Regulatory Guide 8.30). Please provide an LLD formula that is consistent with Regulatory Guide 8.30 or a technical justification for an alternate methodology.

TR RAI 5.7.3-4 Response

The following information will be incorporated into Section 5.7.3.2 of the revised TR.

The technical justification for using the LLD equation in Regulatory Guide 8.25, rather than LLD specified in Regulatory Guide 8.30, is contained in NUREG-1400, Air Sampling in the Workplace (NRC, 1993a), as discussed below.

Regulatory Guide 8.30 uses the following formula to calculate LLD.

$$LLD = \frac{3 + 4.65S_b}{3.7 \times 10^4 EVYe^{-\lambda t}} \qquad \text{(Equation 1)}$$

where:

LLD =	the lower limit of detection (µCi/ml)
S_b =	the standard deviation of background count rate (counts per second)
3.7×10^4 =	the conversion from disintegrations per second to µCi
E =	the counting efficiency (counts per disintegration)
V =	the sample volume (ml)
Y =	the fractional radiochemical yield if applicable
λ =	the decay constant for the particular radionuclide
t =	the elapsed time between sample collection and counting(s)

When performing gross alpha counts on a filter for natural uranium, all counts above background are assumed to be from natural uranium. Thus, the Y variable in the above equation is not applicable and the exponential term in the denominator goes to 1 due to the long effective half life of natural uranium. Equation 1 can then be simplified to the following:

$$LLD = \frac{3 + 4.65S_b}{3.7 \times 10^4 EV} \qquad \text{(Equation 2)}$$

S_b is the standard deviation of background count rate (counts per second) and is calculated using Equation 3.

$$S_b = \frac{\sqrt{R_b T_s \left(1 + \frac{T_s}{T_b}\right)}}{T_s} \qquad \text{(Equation 3)}$$

where:

S_b =	the standard deviation of background count rate (counts per second)
T_s =	the gross counting time or sample counting time (s)
T_b =	the background counting time (s)
R_b =	the background count rate

The equation proposed in the application to calculate LLD for uranium concentrations in air is shown as Equation 4.

$$LLD = \frac{2.71 + 3.29\sqrt{R_b T_s \left(1 + \frac{T_s}{T_b}\right)}}{VEKT_s} \qquad \text{(Equation 4)}$$

where:

LLD =	the lower limit of detection (µCi/ml)
T_s =	the gross counting time or sample counting time (s)
T_b =	the background counting time (s)
R_b =	the background count rate
K =	the conversion from disintegrations per second to µCi (3.7×10^4)
E =	the counting efficiency (counts per disintegration)
V =	the sample volume (ml)

Substituting the variable S_b for the standard deviation of background count rate into Equation 4 yields Equation 5 below.

$$LLD = \frac{2.71 + 3.29 S_b}{KEV} \qquad \text{(Equation 5)}$$

A special case of S_b where the background counting time (T_s) equals the sample counting time (T_b) results in the following relationship (Equation 6) for S_b:

$$S_b = \frac{\sqrt{R_b T_s}}{T_s}\sqrt{2} = 1.41\,\frac{\sqrt{R_b T_s}}{T_s} \qquad \text{(Equation 6)}$$

Substituting Equation 6 into Equation 5 results in Equation 7

$$LLD = \frac{2.71 + 4.65\sqrt{R_b T_s}}{VEKT_s} \qquad \text{(Equation 7)}$$

A more rigorous formulation for extreme low-level counting using the exact Poisson distribution was given in Currie, 1972. Here, 2.71 (the Poisson-Normal approximation) is replaced by the exact Poisson value of 3.

Using this value, Equation 7 becomes:

$$LLD = \frac{3 + 4.65\sqrt{R_b T_s}}{VEKT_s} \qquad \text{(Equation 8)}$$

Powertech proposes to use Equation 8 in the simplified case where the background counting time is equal to the sample counting time if the exact Poisson distribution is used. The effect of using 2.71 versus 3 on the LLD is small and both are appropriate in estimating the LLD for air concentrations. Equation 8 is similar to Equation 2 (the simplified Regulatory Guide 8.30 equation) in form; however, Equation 8 accurately addresses S_b.

TR RAI 5.7.3-5

Regulatory Guide 8.30 recommends establishing an action level for each sampling location that will result in an investigation of the cause of the elevated concentration. Consistent with Regulatory Guide 8.30, please provide action level for each sampling location or justification for an alternate program.

TR RAI 5.7.3-5 Response

The following describes the action levels proposed by Powertech for each sampling location as part of the airborne radiation monitoring program. The following information will be incorporated into the revised TR.

A facility action level of 25% of the DAC for particulate radionuclides and 0.08 WL for radon-222 decay products will be established. If an airborne radionuclide sample exceeds the action level for radioparticulates or radon-222, the RSO will investigate the cause and increase the sampling frequency as appropriate until airborne radionuclide concentration levels do not exceed the action level. An administrative action level will be set at 130 DAC-hours for exposure to radioparticulates and/or radon decay products for any calendar quarter. If the action level is exceeded, the RSO will initiate an investigation into the cause of the occurrence, determine any corrective actions that will reduce future exposures, and document the corrective actions taken. Results of the investigation will be reported to management and the SERP and will be available for NRC inspection. The results of the bioassay program also will be used to evaluate the adequacy of the respiratory protection program at the facility. An abnormally high urinalysis will be investigated to determine the cause of the high result and if the exposure records adequately reflect that such an exposure may have actually occurred.

TR RAI 5.7.3-6

In Sections 4.1.2 and 5.7.3.2 of the TR, the applicant states that yellowcake produced at the facility should be considered "soluble" with respect to occupational radiation exposure based on footnotes in 10 CFR 20, Appendix B. NRC staff is unaware of any footnotes making this statement. This terminology is outdated and is no longer relevant to 10 CFR 20, Appendix B, occupational radiation exposure limits. It also appears to be inconsistent with NRC guidance given at the November 2009 uranium recovery workshop held in Denver, CO (ML09351 0162). In regards to the applicant's airborne particulate monitoring program, please provide the following information:

TR RAI 5.7.3-6(a)

*a. **Provide a specific reference in 10 CFR 20 that describes hydrogen peroxide precipitated yellowcake as "soluble" for radiation protection purposes.***

TR RAI 5.7.3-6(a) Response

The following discussion will be included in Section 5.7.3 of the revised TR.

There is no specific reference in 10 CFR 20 that describes hydrogen peroxide precipitated yellowcake as "soluble" for radiation protection purposes. Footnote 3 to 10 CFR 20, Appendix B, Table 1 addresses soluble mixtures of U-238, U-234, and U-235. Regulatory Guide 8.30, Section 2.2 suggests that "yellowcake dried at low temperature, which is predominantly composed of ammonium diuranate, or in the new processes uranyl peroxide, both are more soluble in body fluids than yellowcake dried at higher temperature; and a relatively large fraction is rapidly transferred to kidney tissues." Regulatory Guide 8.30 suggests that uranyl peroxide (i.e., hydrogen peroxide precipitated yellowcake) is soluble. Therefore, Powertech proposes that footnote 3 to 10 CFR Part 20, Appendix B, Table 1 applies to uranyl peroxide.

<u>TR RAI 5.7.3-6</u>

In Sections 4.1.2 and 5.7.3.2 of the TR, the applicant states that yellowcake produced at the facility should be considered "soluble" with respect to occupational radiation exposure based on footnotes in 10 CFR 20, Appendix B. NRC staff is unaware of any footnotes making this statement. This terminology is outdated and is no longer relevant to 10 CFR 20, Appendix B, occupational radiation exposure limits. It also appears to be inconsistent with NRC guidance given at the November 2009 uranium recovery workshop held in Denver, CO (ML093510162). In regards to the applicant's airborne particulate monitoring program, please provide the following information:

<u>TR RAI 5.7.3-6(b)</u>

b. Regarding the determination of the inhalation classification of yellowcake produced at the Dewey-Burdock facility, provide an air particulate monitoring program consistent with guidance given at the November 2009 uranium recovery workshop held in Denver, CO (ML093510162) or a technical justification for an alternate methodology.

<u>TR RAI 5.7.3-6(b) Response</u>

The following information will be included in Section 5.7.3 of the revised TR.

Consistent with the NRC staff guidance presented at the November 2009 uranium recovery workshop in Denver, CO, Powertech will consider hydrogen peroxide precipitated yellowcake dried at < 400° C as a Class W compound for radiation protection purposes until either the solubility class specific to the product produced in the process has been measured or the specific process has been shown to be comparable to similar processes for which the solubility class of the product has been measured.

<u>TR RAI 5.7.3-7</u>

In Section 5.7.3.2 of the TR, the applicant described its monitoring program for determining compliance with 10 CFR 20.1201(e) (weekly soluble uranium intake). However, it is not clear how the applicant's ALARA program will be applied to this limit. Please provide the ALARA goal for uranium intake.

<u>TR RAI 5.7.3-7 Response</u>

The following information will be incorporated into Section 5.7.3 of the revised TR.

The primary ALARA goal for uranium intake will initially be set to less than 25% of the DAC values presented in 10 CFR Part 20, Appendix B, Table 1. In addition, Powertech will establish a corollary ALARA goal to limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity (see footnote 3 to 10 CFR Part 20, Appendix B, Table 1). After review of the first ALARA audit, modifications determined to be necessary to the facilities, procedures or ALARA program will be developed and implemented in order to further reduce exposures.

<u>TR RAI 5.7.3-8</u>

The applicant did not demonstrate that respiratory protection will be routinely used for operations within drying and packaging areas and did not identify the criteria for determining when respirators will be required for special jobs or emergency situations. Consistent with NUREG-1569, Acceptance Criterion 5.7.3(6), please evaluate the applicant's respiratory program and provide this information.

<u>TR RAI 5.7.3-8 Response</u>

This information will be incorporated into the revised TR, Section 5.7.3.

PPE in the form of respiratory protective equipment will be mandatory for workers in areas where the use of process and engineering controls may not be adequate to maintain regulated exposure levels to airborne radioactive and/or toxic materials. This protection program will be carried out in accordance with Regulatory Guide 8.15 and Regulatory Guide 8.31 and will be administered by the RSO. The work areas that may have the potential for overexposure are limited to the drying and packaging areas under normal operating conditions.

Criteria for determining when respirators will be required for special job situations or a credible emergency are summarized here. The use of respiratory protection devices will be contemplated only after other measures to limit intake have been considered (10 CFR § 20.1701). If the ALARA evaluation determines process and/or engineering controls are not practicable, Powertech will increase monitoring and limit intake by controlling access and exposure time; if it is determined the use of respirators will optimize the sum of internal dose and other potential risk, use of a respirator will be implemented in order to keep TEDE ALARA in conformance with Regulatory Guide 8.15. The level of detail addressed during a TEDE ALARA evaluation will be dictated by the potential radiological and physical risk that may be associated with the special job or emergency.

Exposure Calculations

TR RAI 5.7.4-1

In Section 5.7.4.2 of the TR, the applicant has not provided sufficient information regarding the internal dose calculation. Please provide the following information:

TR RAI 5.7.4-1(a)

a. ***Consistent with Regulatory Guide 3.46 and NUREG-1569, Acceptance Criterion 5.7.4.3(1), provide methodologies to calculate the intake of natural uranium by personnel in work areas where airborne radioactive materials could exist.***

TR RAI 5.7.4-1(a) Response

The following information will be added to Section 5.7.4 of the revised TR.

The potential intake due to inhalation of natural uranium by personnel in work areas where airborne radioactive materials could exist will be determined using the following formula:

$$I_u = BR \sum_{i=1}^{n} X_i \times t_i \times \frac{1}{PF}$$

Where:

I_u	=	Intake of natural uranium for the monitoring period (µg or µCi)
X_i	=	The average air concentration of natural uranium in breathing zone during exposure period (i) (µg or µCi per milliliter)
BR	=	Breathing rate of the worker (2.0×10^4 milliliters per minute)
t_i	=	Time of exposure period (i)(minutes)
PF	=	The protection factor based on type of respiratory protection
N	=	Number of exposure periods during monitoring period

<u>TR RAI 5.7.4-1</u>
In Section 5.7.4.2 of the TR, the applicant has not provided sufficient information regarding the internal dose calculation. Please provide the following information:

<u>TR RAI 5.7.4-1(b)</u>

b. ***Consistent with Regulatory Guide 3.46 and NUREG-1569, Acceptance Criterion 5.7.4.3(5), provide exposure calculations for natural uranium for routine operations, non-routine operations, maintenance, and cleanup activities that are consistent with NRC Regulatory Guides 8.30 and 8.34.***

TR RAI 5.7.4-1(b) Response
The following information will be incorporated into Section 5.7.4 of the revised TR.

Section 5.7.4.1 of the TR commits to performing calculations of the committed effective dose equivalents (CEDEs) using one of two methods described in Regulatory Guide 8.30, Section C-3. These two methods are described as follows.

Method 1: Use of Stochastic Inhalation ALIs from 10 CFR Part 20

The CEDE for each radionuclide may be calculated using the estimated radionuclide intake, by Equation 2 of Regulatory Guide 8.30 as follows:

$$H_{i,E} = \frac{5I_i}{ALI_{i,E}}$$ Equation 2 from RG 8.30

where:

$H_{i,E}$ = CEDE from radionuclide i (rem)

I_i = Intake of radionuclide i by inhalation during the calendar year (µCi). (If multiple intakes occurred during the year, is the sum of all intakes)

$ALI_{i,E}$ = Value of the stochastic inhalation ALI (based on the CEDE) from Column 2 in 10 CFR Part 20, Appendix B, Table 1 (µCi)

5 = CEDE from intake of 1 ALI (rem). The intake of natural uranium will be determined using the equation listed above in the response to TR RAI 5.7.4-1(a).

If intakes of more than one radionuclide occur, the CEDE will be the sum of the CEDEs for all radionuclides. The intake of natural uranium will be determined using the equation listed in the response to TR RAI 5.7.4-1(a).

Method 2: Use of DACs from 10 CFR Part 20

The CEDE also may be calculated from exposures expressed in terms of DAC-hours. Equation 4 of Regulatory Guide 8.30 demonstrates how the CEDE may be calculated from exposures expressed in terms of DAC-hours.

$$H_{i,E} = \frac{5C_i t}{2000\,DAC_{stoc,i}}$$ Equation 4 from Regulatory Guide 8.30

where:

$H_{i,E}$ = CEDE from radionuclide i (rems)

C_i = The airborne concentration of radionuclide i to which the worker is exposed (µCi/ml)

t = The duration of the exposure (hours)

2000 = The number of hours in a work year

5 = CEDE from annual intake of 1 ALI or 2000 DAC-hours (rems)

Exposures to airborne natural uranium will be compared to the stochastic ALI or DAC for the "W" class of natural uranium from Table 1 of 10 CFR 20, Appendix B until the actual lung clearance class of the product has been determined.

These methods will be used in non-routine operations, maintenance, and cleanup activities as well as during routine activities where appropriate. For non-routine operations involving an accident scenario, the worker breathing rate assumed in each of the above methods may not be appropriate. If at some point in time alternate methods to evaluate exposure to natural uranium not contained in Regulatory Guides 8.30 or 8.34 are determined to be more appropriate or applicable, these methods will be submitted to the NRC for review and approval prior to use.

TR RAI 5.7.4-1

In Section 5.7.4.2 of the TR, the applicant has not provided sufficient information regarding the internal dose calculation. Please provide the following information:

TR RAI 5.7.4-1(c)

c. ***Consistent with NUREG-1569, Acceptance Criterion 5.7.4.3(6), discuss parameters used in exposure calculations for radon daughters and natural uranium to ensure they are representative of conditions at the site by taking in to account the maximum production capacity.***

TR RAI 5.7.4-1(c) Response

The following information will be incorporated into Section 5.7.4 of the revised TR.

Consistent with NUREG-1569, Acceptance Criterion 5.7.4.3(6), the parameters used to evaluate inhalation exposure to radon-222 decay products and to natural uranium will be representative of site conditions as they relate to the maximum production capacity. The calculations will incorporate occupancy time and average airborne concentrations; consequently, both full- and part-time employees (if any) will be considered in these exposure calculations.

TR RAI 5.7.4-2

In Section 5.7.4.2 of the TR, the applicant did not appear to address the possibility of various radionuclides that may be present in air. According to 10 CFR 20.1204(f), if the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture must be the most restrictive DAC of any radionuclide in the mixture. Please demonstrate how exposure calculations will take into account the possibility of a mixture of radionuclides in air.

TR RAI 5.7.4-2 Response

The following information will be incorporated into the revised TR Section 5.7.4.

Based on industry experience, it is expected that there will only be natural uranium in air, not a mixture of radionuclides. Air samples will be analyzed using gross alpha measurements and, potentially, supported via alpha spectroscopy. Knowing the concentrations of long-lived alpha emitting radionuclides for various processes, no unknown mixtures of radionuclides in air are expected.

If encountered, exposure calculations will account for mixtures in air using the unity rule as follows:

$$\frac{C_{Th-230}}{DAC_{Th-230}} + \frac{C_{U-nat}}{DAC_{U-nat}} + \frac{C_{Ra-226}}{DAC_{Ra-226}} > 1$$

Where:
C = airborne concentration, µCi/ml
DAC = derived air concentration, µCi/ml

The DAC for the mixture will be exceeded if the sum of fractions exceeds unity. If a condition occurs where the radionuclide and mixture of radionuclides are unknown, the DAC for Th-230(W) will be assumed since this is the most restrictive.

TR RAI 5.7.4-3

According to 10 CFR 20.1201(e), in addition to the annual dose limits the licensee shall limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity. The applicant has mentioned this in the TR but still needs to describe how it will monitor and keep records of this requirement.

TR RAI 5.7.4-3 Response

The following information will be incorporated into the revised TR Section 5.7.4.

Analysis of air filters using gross alpha and alpha spectroscopy methods will yield known concentrations of uranium, 100 percent of which will be converted to mass using the natural uranium specific activity of 677 µCi/g.

The TR states in Section 5.7.3.2, "the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 8E-3 (SA) µCi-hr/ml, where SA is the specific activity of the uranium inhaled."

When the limit in footnote 3 to 10 CFR 20, Appendix B, Table 1 is divided by 40 hours and the specific activity of natural uranium (677 µCi/g) is taken into account, the 40-hr time-weighted average uranium concentration limit is 1×10^{-10} µCi/mL. Assuming all the uranium sampled is soluble, this limit is consistent with the soluble uranium intake limit of 10 mg/week specified in 10 CFR § 20.1201.2(e). Therefore, the soluble uranium intake (in mg/week) can be calculated from the airborne uranium concentrations to which the worker was exposed.

All measurements and calculations will be done and recorded using standard operating procedures. Typically, airborne particulate concentrations are recorded on an airborne particulate monitoring form, which includes lapel or air particulate sampling flow rates and time of operation, gross alpha measurements, and associated calculations.

Records will be maintained as described in TR Section 5.2.5.

TR RAI 5.7.4-4

NUREG-1569, Acceptance Criterion 5.7.4.3(4) recommends that guidance for prenatal radiation exposure be consistent with Regulatory Guide 8.13. Please provide a description of the applicant's prenatal radiation exposure program that is consistent with Regulatory Guide 8.13.

TR RAI 5.7.4-4 Response

The following information will be included in the revised TR.

Regulatory Guide 8.13, Instruction Concerning Prenatal Radiation Exposure (NRC, 1999) provides information to pregnant women and other personnel to help them make decisions regarding radiation exposure during pregnancy, and also provides the definition of a “declared pregnant woman” as stated in Section A of the document. Consistent with Regulatory Guide 8.13, Powertech, in TR Section 5.5.1, commits to providing this information to workers as appropriate. Section 5.7.4 of the TR specifically addresses exposure calculations and will be revised to incorporate this information and clarify that the guidance for prenatal radiation exposure will be consistent with Regulatory Guide 8.13. The information below describes some of the specific information that will be included within Powertech’s prenatal radiation exposure program consistent with Regulatory Guide 8.13.

- In order for a pregnant worker to take advantage of the lower exposure limit and dose monitoring provisions specified in 10 CFR Part 20, the woman must declare her pregnancy in writing to the licensee.
- The woman’s immediate supervisor should receive the written declaration of pregnancy.
- Once a woman has declared a pregnancy in writing , the applicant has the obligation to take steps, including potentially changing the woman’s job function, in order to keep doses to the embryo/fetus below regulatory limits contained in 10 CFR § 20.1208 and to levels that are ALARA.
- The RSO is to be consulted if the declared pregnant worker needs additional information.
- The calculations of embryo/fetus doses will be done according the NRC Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus."

<u>TR RAI 5.7.4-5</u>
NUREG-1569, Acceptance Criterion 5.7.4.3(8) recommends that all reporting and record keeping of worker doses is done in conformance with Regulatory Guide 8.7 and 10 CFR 20.2103. Please provide a description of the applicant's reporting and record keeping of worker doses that is consistent with Regulatory Guide 8.7 and in conformance with 10 CFR 20.2103 or provide the location for this information in the TR.

<u>TR RAI 5.7.4-5 Response</u>

The following is a description of the reporting and recordkeeping of worker doses and will be included in the revised TR.

Records showing the results of surveys and calibrations will be maintained for a minimum of three years after the record is made.

Records of all dose assessments, including surveys, measurements, bioassays and calculations used in the dose assessments, will be maintained through license termination in accordance with recommendations in Regulatory Guide 8.7 and in formats necessary to demonstrate compliance with 10 CFR § 20.2102, 20.2103, 20.2106, and 20.2110.

TR RAI 5.7.4-6

NUREG-1569, Acceptance Criterion 5.7.4.3(7) recommends providing an estimate of airborne uranium concentrations that addresses the maximum production capacity requested in the application and the anticipated efficiencies of airborne particulate control systems discussed in the TR. The staff is unable able to locate this information within the TR; therefore, please provide it to the staff.

TR RAI 5.7.4-6 Response

The following information will be inserted into the revised TR

It is estimated that airborne uranium concentrations will be well below 25 percent of the derived air concentrations in 10 CFR Part 20 when the plant is at maximum production capacity. This estimate is supported by Section 2.8.4 of NUREG/CR-6733, which states:

"The vacuum dryer has an efficiency in excess of 99 percent for removal of uranium particulates prior to release to the atmosphere. The particles that result from the control system are returned to the drying chamber, thus recovering any uranium particulates. This particulate control system captures virtually all escaping particles."

Bioassay Program

TR RAI 5.7.5-1

In Section 5.7.5 of the TR, the applicant has not specified the inhalation class for the airborne uranium that will be used to evaluate the bioassay program. Regulatory Guide 8.22 recommends that for exposures to Class W or Y materials alone, in vivo lung counts or alternate sampling times and action levels should be considered. Without a technical justification of the inhalation class for the uranium that could be encountered during operations, NRC staff cannot conclude that performing urinalysis alone is consistent with Regulatory Guide 8.22. Please provide a technical justification for relying on urinalysis as a primary bioassay technique.

TR RAI 5.7.5-1 Response

The justification for relying on urinalysis as a primary bioassay technique is provided as follows. This information will be included in Section 5.7.5 of the revised TR.

Two bioassay techniques are considered in Regulatory Guide 8.22: urinalysis and in-vivo lung measurements. Regulatory Guide 8.22 discusses two triggers for in-vivo lung measurements: 1) when air monitoring or exposure calculations call for in vivo measurement, and 2) when urinalysis results call for in vivo measurements.

The first trigger is when air sampling results indicate an exposure exceeding that resulting from exposure to the more insoluble component of yellowcake at an average airborne concentration of 10^{-10} µCi/ml in a period of 1 calendar quarter. In the response to TR RAI 5.7.3-6, Powertech has agreed to consider the dried yellowcake produced at the Dewey-Burdock Project as Class W natural uranium for radiation protection purposes until determined otherwise. The DAC for Class W natural uranium is 3×10^{-10} µCi/ml. The action level for airborne radionuclide concentrations measured minimally on a weekly basis is 25% of the DAC, or in the case of Class W natural uranium an airborne concentration of 7.5×10^{-11} µCi/ml. Since controls will be implemented to mitigate airborne concentrations at the established action level, airborne natural uranium concentrations exceeding the air monitoring trigger for in-vivo measurement are unlikely.

Since quarterly average airborne natural uranium (Class W) concentrations are unlikely to exceed the in-vivo lung measurement trigger, urinalysis should be used as the primary bioassay technique. However, in-vivo lung measurement would be considered on a case-by-case basis if urinalysis results indicate that it would be appropriate.

TR RAI 5.7.5-2

Consistent with Regulatory Guide 8.9 and NUREG-1569, Acceptance Criterion 5.7.5.3(1), please demonstrate the manner in which an uptake will be converted to a dose assigned to the individual for compliance with 10 CFR 20 Subpart C.

TR RAI 5.7.5-2 Response

The following information will be incorporated into the revised TR.

The dose from the intake will be estimated by multiplying the estimated intake by the appropriate dose conversion contained in Federal Guidance Report No. 11 (EPA, 1988).

Intakes of uranium will be estimated using the methods described in Regulatory Guide 8.9 (NRC, 1993b). The methods used below apply to the inhalation pathway since it is by the far the most important pathway for potential worker exposure. The following equation will be used to estimate intakes for urine samples collected over a 24-hour period:

$$I = \frac{A(t)}{IRF(t)}$$ Equation 1 (Regulatory Guide 8.9)

where:

- I = Estimate of intake with units the same as A(t)
- A(t) = Numerical value of the bioassay measurement obtained at time t (µCi)
- IRF(t) = Intake retention fraction corresponding to type of measurement for time t after estimated time of intake

The IRF(t) for Class D and Class W, given a 30-day urine bioassay monitoring interval, is 4.7E-3 and 1.3 E-3, respectively (ICRP, 1988).

If the total urine sample is not collected over a 24-hour period, the following formulas will be used to estimate the intake:

$$\Delta A_i = C_i E_i \, (t_i - t_{i-1})$$ Equation 2

$$A_t = \Delta A_1 + \Delta A_2 + \ldots \Delta A_i$$ Equation 3

where:

- ΔA_i = Amount of uranium in sample (µCi)
- i = The sequence number of the sample
- C_i = The uranium concentration in urine of sample i (µCi/L)
- E = Daily urine excretion rate (1.4 and 1.0 L/d for standard man and standard woman, respectively)
- t_i = time (d) after intake that sample i is collected
- A_i = Total amount (mg) excreted up to time t

Using the calculated A_i, the worker intake can be estimated using Equation 1 and the IRF(t) given above.

TR RAI 5.7.5-3

Consistent with NUREG-1569, Acceptance Criterion 5.7.5.3(2), and Regulatory Guide 3.46, the number and category of personnel involved in the bioassay program should be identified in the application. Please provide this information or indicate where it can be found in the application.

TR RAI 5.7.5-3 Response

TR Section 5.7.5 (Bioassay Program) will be revised to indicate the employees to be included in the bioassay program as follows:

Each employee that has the potential to ingest or inhale yellowcake will give a urine sample on a monthly basis. At a minimum, mechanics/general maintenance workers (7 employees), dryer operators (2 employees), and CPP operators (8 employees) will be sampled on a monthly basis (17 total employees).

TR RAI 5.7.5-4

Consistent with Regulatory Guide 8.22 and NUREG-1569, Acceptance Criterion 5.7.5.3(1), the applicant should specify the actions that will be taken when positive bioassay results are confirmed.

TR RAI 5.7.5-4 Response

TR Section 5.7.5 (Bioassay Program) will be revised to include the following:

The following corrective actions, which are consistent with Table 1 in Regulatory Guide 8.22, will be taken if positive bioassay results are confirmed. If a monthly urinalysis is less than 15 µg/L uranium, no action will be taken. If the monthly urinalysis is 15 to 35 µg/L uranium, the cause of the elevated uranium will be identified and corrected. A determination will be made as to the potential for other workers' exposure and bioassays conducted as necessary. Work assignment limitations and/or respiratory protection will be considered. Uranium effluent controls will be also be reviewed for possible improvements. If the amount of uranium detected in a monthly urinalysis is greater than 35 µg/L, and has been confirmed in two consecutive specimens, then the actions mentioned above will be taken. Additionally, the urine specimen will be tested for albuminuria, and an in vivo count may be obtained. Work restrictions will be considered for affected employees until urinary concentrations are below 15 µg/L uranium and laboratory tests for albuminuria are negative. Further uranium effluent controls or respiratory protection requirements will also be considered. NRC will be notified as required.

TR RAI 5.7.5-5

NUREG-1569, Acceptance Criterion 5.7.5.3(5) recommends that all reporting and record keeping be done in conformance with 10 CFR 20, Subpart L and Subpart M. Please provide a description of the applicant's reporting and record keeping that is in conformance with 10 CFR Subpart L and Subpart M or provide the location in the TR where this can be found.

TR RAI 5.7.5-5 Response

TR Section 5.7.5 (Bioassay Program) will be revised to include the following.

Consistent with Acceptance Criterion 5.7.6.3(5) of NUREG-1569, Powertech will conduct record keeping and reporting for the bioassay program in accordance with 10 CFR Part 20, Subparts L and M. Records of all dose assessments will be maintained through license termination. All bioassay results, including negative (i.e., < action level of 15 µg/l) results, will be retained in employee personnel files. For results confirmed in excess of action levels, an internal dose assessment will be performed including information obtained from follow-up actions and investigations including follow-up bioassay results, if applicable. Powertech will submit a written report to NRC within 30 days after confirmation of results in excess of action levels. The report will contain estimates of each individual's dose, the levels of radiation and concentrations of radioactive material involved, the cause of the elevated exposures, dose rates or concentrations, and corrective steps taken or planned to ensure against a recurrence. Please see TR Section 5.2.5 and 5.2.6 for additional information regarding the reporting and record keeping functions proposed by Powertech.

Contamination Control Program

TR RAI 5.7.6-1

In Sections 5.7.2.3 and 5.7.6.3 of the TR, the applicant addressed beta-gamma monitoring but did not address beta-gamma contamination monitoring for personnel. Please provide details on limits and action levels for personnel with beta-gamma contamination.

TR RAI 5.7.6-1 Response

TR Section 5.7.6 will be revised to include the following text:

Section 5.7.6.2 of the TR discusses surveys of personnel exiting restricted areas and describes the action level for alpha contamination on clothing and skin as being any detectable contamination above background. Since any beta–gamma contamination at a uranium ISR facility must be associated with alpha emitting nuclides, no special monitoring or survey for beta–gamma emitters is required. The lack of detectable alpha contamination assures no beta–gamma contamination.

TR RAI 5.7.6-2

In Section 5.7.6.2 of the TR, the applicant refers to personnel contamination as "surface" contamination. Please clarify that personnel will be monitored for skin and clothing contamination.

TR RAI 5.7.6-2 Response

To clarify, personnel exiting restricted areas with potential removable surface contamination will be monitored for skin and clothing contamination in order to prevent the spread of contamination to unrestricted areas and to keep doses ALARA. This will be made clear in Section 5.7.6.2 of the revised TR.

TR RAI 5.7.6-3

In Section 5.7.6.2 of the TR, the applicant states those actions to be followed for personnel with skin and clothing contamination levels detected above background. Please provide information on who will conduct skin decontaminations and who will verify that background levels have been achieved after contamination has been detected.

TR RAI 5.7.6-3 Response

TR Section 5.7.6 will be revised to include the following text:

The individual(s) with skin contamination will conduct self-decontamination if physically able to do so. If necessary, the RSO, the Radiation Safety Technician (RST) or a qualified and trained radiation worker will conduct the skin decontamination and verify that background levels have been achieved. The RSO will verify that correct procedures were followed and follow up with an investigation, if appropriate.

TR RAI 5.7.6-4

In Section 5.7.6 of the TR, the applicant states that work will be restricted in areas where "uranium work" is performed with surface contamination levels above those specified. Please clarify whether areas will be classified as restricted based on surface contamination levels alone or if certain types of work will dictate what constitutes a restricted area. If it is the type of work, please specify what constitutes "uranium work."

TR RAI 5.7.6-4 Response

TR Section 5.7.6 will be revised to include the following discussion regarding classification of restricted areas. The type of work being performed will not dictate what constitutes a restricted area. The term “uranium work” will no longer be used.

The contamination control program will address potential contamination spreading from restricted areas (process areas as well as general plant areas), from personnel working in those areas, and from equipment and PPE used in those areas. Areas will be classified as restricted based on the potential for risks to workers from exposure to radiation and radioactive materials (10 CFR Part 20). This potential for risks from radiation exposure encompasses airborne radiation as well as radioactive materials on surfaces.

TR RAI 5.7.6-5

The applicant addressed beta-gamma contamination monitoring for equipment but did not address beta-gamma contamination monitoring for area surveys. Please provide details on limits and action levels for areas with beta-gamma contamination.

TR RAI 5.7.6-5 Response

TR Section 5.7.6 will be revised to include the following information.

The limits established for alpha and beta-gamma radiation shall apply independently where surface contamination by both alpha and beta-gamma radiation exists. Beta contamination surveys will be performed in those areas of operations that involve direct handling of large quantities of aged yellowcake. Unrestricted area surveys (areas where food is allowed, change rooms, and offices) will be conducted weekly. The total beta-gamma contamination limit for these surveys will be 1,000 dpm/ 100 cm^2. After facilities have been built, each area will be monitored and a background level established. After background has been established, the action levels for each area will be determined. The beta-gamma surveys for contamination within controlled areas (e.g., well fields) will be conducted monthly; the limit for these surveys will be 1,000 dpm/100 cm^2.

Powertech (USA) Inc.

TR RAI 5.7.6-6

Consistent with Regulatory Guide 8.31, specify the staff that will perform the surveys of items leaving the restricted areas.

TR RAI 5.7.6-6 Response

TR Section 5.7.6 will be revised to include the following text:

Radiation surveys of material leaving the restricted areas will be conducted by the RSO, the RST, or a qualified and trained radiation worker under the supervision of the RSO.

TR RAI 5.7.6-7

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(5), please describe the applicant's reporting and record keeping program related to its contamination control program or indicate where this can be found in the application.

TR RAI 5.7.6-7 Response

TR Section 5.7.6 will be revised to include the following:

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(5), Powertech will record and maintain contamination control program information and data as required by 10 CFR Part 20, Subpart L. The records will be retained for 3 years after the records are made. Powertech will immediately report any event involving source and byproduct materials possessed by Powertech that may have caused or threatens to cause any of the conditions listed in 10 CFR § 20.2202. Powertech will submit a written report to NRC within 30 days after confirmation of any of the reportable events listed in 10 CFR § 20.2203. The report will describe the extent of exposure of individuals to radiation and radioactive material and other information as described in 10 CFR § 20.2203. Please refer to TR Section 5.2.5 and 5.2.6.

<u>TR RAI 5.7.6-8</u>

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(6), please describe the applicant's approach for applying covering material to contaminated surfaces.

<u>TR RAI 5.7.6-8 Response</u>

TR Section 5.7.6 will be revised to include the following:

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(6), Powertech will make a reasonable effort to minimize any radioactive contamination before the use of any covering. Radioactivity on equipment or other surfaces will not be covered with paint, plating, or other covering material unless contamination levels, as determined by a radioactivity survey and properly documented, are below the limits specified in Enclosure 2 to Policy and Guidance Directive FC-83-23, as updated (NRC, May 28, 2010, pg. 41, Section 6.3, Item #2).

TR RAI 5.7.6-9

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(7), please describe the applicant's procedures for determining the radioactivity of interior surfaces of pipes, drain lines, duct work or similar items.

TR RAI 5.7.6-9 Response

TR Section 5.7.6 will be revised to include the following:

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(7), the radioactivity of the interior surfaces of pipes, drain lines, or duct work used to convey radionuclides will be determined by making radioactivity measurements at all accessible traps, drains and other appropriate access points that would likely be representative of the radioactivity on the interior of the pipes, drain lines or duct work. If a representative surface cannot be accessed, the pipe, drain line, duct work used to convey radioactive material or similar item will be considered contaminated and not released for unrestricted use from the site.

Airborne Effluent and Environmental Monitoring Program

TR RAI 5.7.7-1

In its discussion of radon stacks in Section 4.1.1 of the TR, the applicant stated that it will routinely sample potential release points for radon daughters to assure that concentrations of radon and daughters are maintained ALARA. Please address the following issues related to this statement.

TR RAI 5.7.7-1(a)

a. ***Please describe the frequency of sampling of radon stacks.***

TR RAI 5.7.7-1(a) Response

The following information will be included within the revised TR to clarify sampling of radon release points.

There will be no stacks at the Dewey-Burdock Project. There will be release points (e.g., vents) that will be sampled quarterly.

TR RAI 5.7.7-1

In its discussion of radon stacks in Section 4.1.1 of the TR, the applicant stated that it will routinely sample potential release points for radon daughters to assure that concentrations of radon and daughters are maintained ALARA Please address the following issues related to this statement.

TR RAI 5.7.7-1(b)

b. ***Consistent with Regulatory Guides 8.31 and 8.37 and NUREG-1569, Acceptance Criterion 4.1.3(5), please discuss the manner in which concentrations of radon and daughters will be determined to be ALARA under the applicant's radiation protection program.***

TR RAI 5.7.7-1(b) Response

The following information will be included in revised TR Section 5.7.7.

Operating philosophies in Regulatory Guide 8.10 will be implemented to determine that concentrations of radon and decay products will be maintained ALARA. Administratively, action levels of 25% of the DAC for airborne radionuclides will be established. Exceedances of the action levels will trigger an investigation to evaluate the performance of existing controls and potentially implement new controls to mitigate airborne radionuclide concentrations.

Additionally, Section 4.1.1 states that results of monitoring obtained during initial plant operations will be used to adjust monitoring programs and upgrade ventilation and/or other effluent control equipment as necessary.

Monitoring results will also be evaluated in routine audits conducted by the RSO and third parties. Included in these audits will be an evaluation of spatial and temporal trends for these monitoring results. These audits provide another opportunity to evaluate whether concentrations of radon and decay products are ALARA.

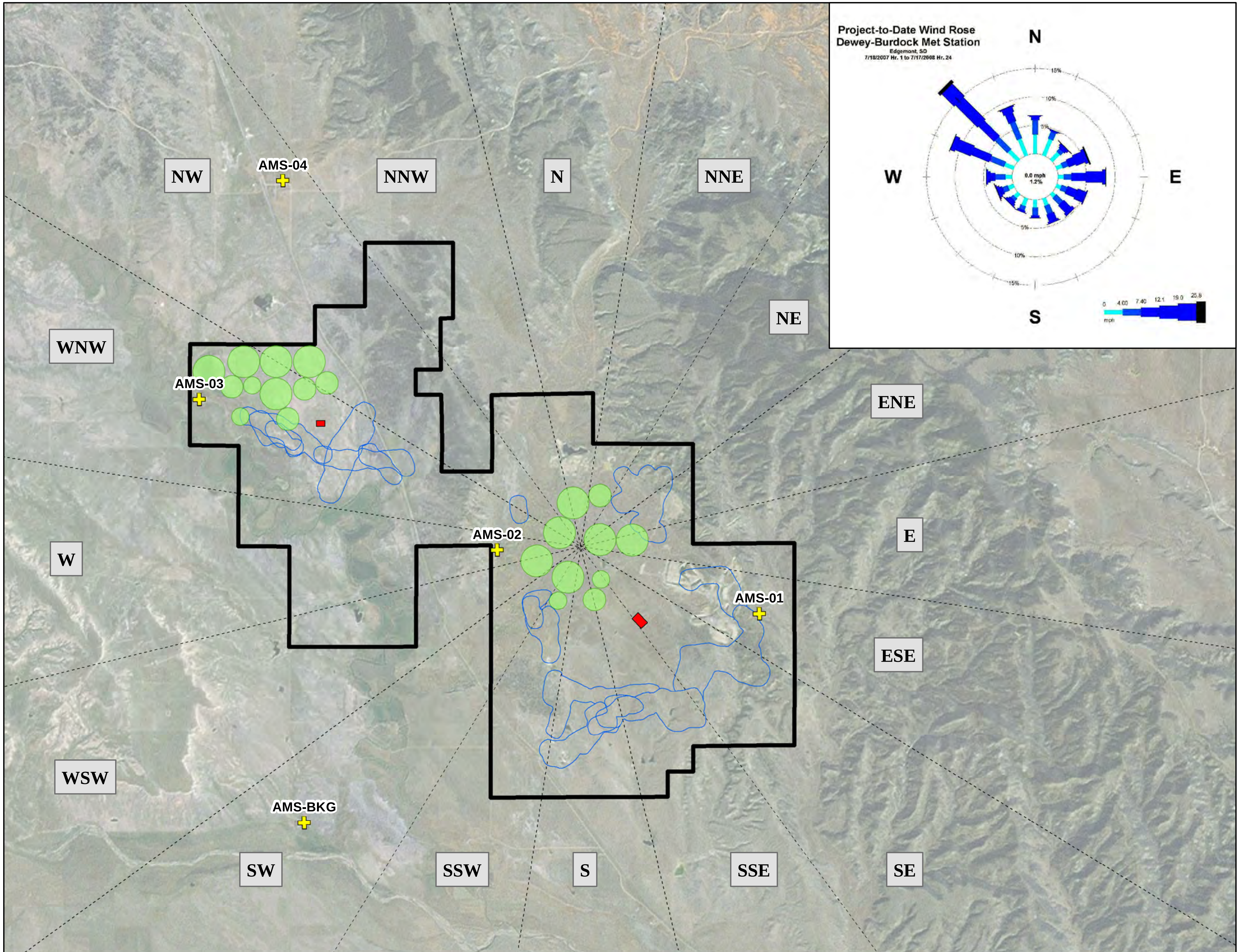
Throughout the application Powertech demonstrates through commitments for implementing management controls, engineering controls, radiation safety training, radon monitoring and sampling, and auditing programs that there are multiple methods by which concentrations of radon and radon decay products will be determined to be ALARA.

TR RAI 5.7.7-2

The applicant shows the air particulate sampling locations in Figure 5.7-10 of the TR. As discussed in previous comments (See Sections 2.5 and 2.9), the applicant did not provide an annual wind rose or address the criteria in Regulatory Guide 4.14 relating to air sampling locations. Please provide sufficient data for NRC staff to evaluate the placement of operational air particulate and radon sampling stations.

TR RAI 5.7.7-2 Response

The response to TR RAI 2.9-1 provides information regarding placement of pre-operational and proposed operational air particulate and radon sampling stations as they apply to recommendations in Regulatory Guide 4.14. Proposed operational air monitoring locations (air particulate and radon-222 track-etch detectors) are shown on Figure TR RAI 5.7.7-2-1 below. This figure includes an updated annual wind rose as requested. The five proposed operational monitoring locations are the same as the corresponding pre-operational monitoring locations.



Legend

- Land Application Area
- Air Monitoring Station
- Potential Well Field Area
- Project Boundary
- Processing Plants

High volume air particulate, TLDs and radon track etch detectors located at each air monitoring station

Feet
0 2,500 5,000 10,000
0 1,000 2,000 3,000
Meters
N

Figure TR RAI 5.7.7-2-1

Operational Air Monitoring Locations

Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	15-Jun-2011
FILENAME	Figure TR RAI 5.7.7-2-1.mxd

POWERTECH (USA) INC.

TR RAI 5.7.7-3

In Section 5.7.7.1 of the TR, the applicant stated that the filters from air samplers operating continuously will be analyzed quarterly for natural uranium, thorium-230, radium-226, and lead-210. Regulatory Guide 4.14 recommends a weekly filter change, or more frequently as required by dust loading and analysis of quarterly composite of the weekly sample. Please explain the manner in which the applicant's air sampling procedures are consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1).

TR RAI 5.7.7-3 Response

Section 5.7.7.1 of the TR will be revised as shown below to include justification for the filter change schedule proposed for the operational monitoring program. For additional information refer to the response to TR RAI 2.9-2.

Powertech will change filters from the operational air samplers bi-weekly or more frequently if required for dust loading. The operational air particulate samplers will be brushless, automatic flow control hi-vol air samplers similar to those used during pre-operational monitoring. Each air sampler will be equipped with a variable speed motor, controlled by a programmable logic controller (PLC). The PLC will receive input from a mass air flow sensor placed in the air flow path downstream of the filter paper. Any changes in the pre-set flow rate due to dust loading, barometric pressure or temperature will be detected by the air flow sensor. The PLC will compensate for the change by adjusting the motor speed to maintain the pre-set flow rate.

Air samplers will also be equipped with air flow totalizers, which will be recorded and reset during each filter change. Based on the use of modern, automatic flow control air samplers, the recommendation in Regulatory Guide 4.14 to change filters weekly is obsolete. When Regulatory Guide 4.14 was issued, automatic flow control air samplers were unavailable, resulting in the need for weekly filter changes. As described in the response to TR RAI 2.9-3, use of automatic flow control air samplers along with visual observations and flows recorded during each filter change confirmed that the bi-weekly filter changes was sufficiently frequent to avoid reduction in performance due to dust loading during pre-operational monitoring. Similarly, Powertech will monitor air sampler performance during operational monitoring and change filters bi-weekly or more frequently if required for dust loading.

<u>TR RAI 5.7.7-4</u>

Consistent with Regulatory Guide 4.14, operational air sampling locations should be the same as those for preoperational air samples. Please provide information that confirms that placement of operational air sampling locations is consistent with Regulatory Guide 4.14 or justification for an alternate methodology.

<u>TR RAI 5.7.7-4 Response</u>

The response to TR RAI 2.9-1 provides information regarding placement of pre-operational air particulate sampling stations as they apply to Regulatory Guide 4.14. In summary, Powertech believes that the placement of pre-operational air monitoring stations is consistent with recommendations contained in Regulatory Guide 4.14. The five operational air monitoring stations (AMS-01, AMS-02, AMS-03, AMS-04, and AMS-BKG) are a subset of the pre-operational monitoring stations as recommended by Regulatory Guide 4.14 and NUREG-1569. This allows for the comparison of operational data with pre-operational data. Since the five operational air monitoring locations are the same as pre-operational air sampling locations, Powertech also believes the placement of operational air monitoring stations is consistent with Regulatory Guide 4.14.

TR RAI 5.7.7-5

Regulatory Guide 4.14, Table 2, suggests that radon sampling be conducted at five or more locations using the same locations as stated for air particulate sampling. Please provide information that confirms that placement of operational air sampling locations is consistent with Regulatory Guide 4.14 or justification for an alternate methodology.

TR RAI 5.7.7-5 Response

The response to TR RAI 2.9-1 provides information regarding placement of pre-operational air particulate sampling stations as they apply to Regulatory Guide 4.14. In summary, Powertech believes that the placement of pre-operational air monitoring stations is consistent with recommendations contained in Regulatory Guide 4.14. Consequently, since the five operational air monitoring locations are the same as preoperational air sampling locations, Powertech also believes the placement of operational air monitoring stations and radon sampling stations is consistent with Regulatory Guide 4.14.

TR RAI 5.7.7-6

In Section 5.7.7.1 of the TR, the applicant stated passive track-etch detectors will be deployed at each station for monitoring radon-222 on a quarterly basis. Regulatory Guide 4.14 recommends analysis for Rn-222 on a monthly basis. Please explain the manner in which the applicant's radon sampling procedures are consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1).

TR RAI 5.7.7-6 Response

Powertech will sample for radon-222 using passive track-etch detectors located at each air monitoring station on a monthly basis, which is consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1). This commitment will be included in Section 5.7.7 of the revised TR.

TR RAI 5.7.7-7

Figure 5.7-10 does not indicate locations of radon monitors. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(2), please provide this information.

TR RAI 5.7.7-7 Response

Radon-222 monitors (i.e., track-etch detectors) will be co-located with the air particulate monitoring stations. Figure TR RAI 5.7.7-2-1 in the response to TR RAI 5.7.7-2 depicts the operational air monitoring locations.

TR RAI 5.7.7-8

As discussed above, NRC staff does not have enough data to fully evaluate the placement of the air particulate samplers consistent with Regulatory Guide 4.14. Since Regulatory Guide 4.14 recommends annual soil sampling at the air monitoring station locations, staff is requesting additional information to evaluate the proposed soil sampling locations described in 5.7.7.3 of the TR. Please provide information that confirms that placement of operational air sampling locations is consistent with Regulatory Guide 4.14 or justification for an alternate methodology.

TR RAI 5.7.7-8 Response

The response to TR RAI 2.9-1 provides information regarding placement of pre-operational air particulate sampling stations as they apply to Regulatory Guide 4.14. In summary, Powertech believes that the placement of pre-operational air monitoring stations is consistent with recommendations contained in Regulatory Guide 4.14. Consequently, since the five operational air monitoring locations depicted on Figure TR RAI 5.7.7-2-1 are the same as pre-operational air sampling locations depicted on Figure TR RAI 2.9-1-1, Powertech also believes the placement of operational air monitoring stations and associated soil sampling locations is consistent with Regulatory Guide 4.14.

<u>TR RAI 5.7.7-9</u>

Regulatory Guide 4.14 provides recommendations for collecting and analyzing sediment samples during operations. The applicant did not discuss sediment sampling during operations in Section 5.7.7 of the TR. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1), provide an operational sediment sampling program or justification of an alternate methodology.

<u>TR RAI 5.7.7-9 Response</u>

The following describes the operational sediment monitoring program proposed by Powertech, which will be incorporated into Section 5.7.7 of the revised TR.

During operations, Powertech will conduct annual sediment sampling at the surface water locations proposed for monitoring. Table TR RAI 2.9-43a-1 in the response to TR RAI 2.9-43(a) provides the locations of the 24 impoundments proposed for operational monitoring, and Table TR RAI 2.9-43b-2 presents the stream sampling sites proposed for operational monitoring. All samples will be analyzed for natural uranium, Th-230, Ra-226, and Pb-210, which is consistent with Table 2 of Regulatory Guide 4.14.

Powertech (USA) Inc.

<u>TR RAI 5.7.7-10</u>

Regulatory Guide 4.14 provides recommendations for collecting and analyzing food samples during operations. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1), the applicant should evaluate baseline radionuclide concentrations in local food within 3 km of the site. See related issues in Section 2.9 of this RAI. Please address the following issues.

<u>TR RAI 5.7.7-10(a)</u>

a. ***The applicant has identified fish, livestock, poultry, and their products, but has not adequately analyzed the need for collecting and analyzing these food sources.***

<u>TR RAI 5.7.7-10(a) Response</u>

TR Section 5.7.7.2 (Biota Monitoring) will be revised to include the following.

Powertech commits to collecting livestock samples annually, consistent with guidance contained in Regulatory Guide 4.14. Regulatory Guide 4.14 focuses animal food sampling on grazing animals and fish. Poultry are not grazing animals. Fish will be collected semiannually provided they exist in water bodies that may be subject to seepage or surface drainage from potentially contaminated areas. Livestock and fish samples will be collected and analyzed for uranium (natural), thorium-230, radium-226, lead-210 and polonium-210.

Powertech commits to livestock sampling and analysis during the first year of operations for comparison to baseline. These annual grab samples taken at the time of harvest or slaughter will be analyzed for natural uranium, radium-226, thorium-230, lead-210 and polonium-210. Livestock samples will include cattle, pigs and other livestock present at the time of sampling; number and type will depend upon availability. Currently, cattle and pigs are the only livestock within the 3.3 km area. If the presence of other livestock is found during the annual land use survey, Powertech will seek the livestock owner's approval to collect tissue samples at the time of slaughter.

If the analysis of livestock tissue supported by the annual MILDOS-AREA modeling indicates grazing animals demonstrate no significant exposure pathway, Powertech will modify the monitoring program appropriately and submit to the NRC for approval. This is in accordance with Regulatory Guide 4.14, Table 2, footnote "o," which states, "Vegetation or forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway (an exposure pathway should be considered important if the predicted dose to an individual would exceed 5% of the applicable radiation protection standard)."

Powertech does not propose to sample poultry. While chickens also are currently present within 3.3 km of the project area, they are fed grains not originating from the project area and are not considered grazing animals.

Fish species with the potential for human consumption (green sunfish and channel catfish) have been recorded in the area will be sampled semiannually, if present in water bodies potentially affected by contamination.

TR RAI 5.7.7-10

Regulatory Guide 4.14 provides recommendations for collecting and analyzing food samples during operations. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1), the applicant should evaluate baseline radionuclide concentrations in local food within 3 km of the site. See related issues in Section 2.9 of this RAI. Please address the following issues.

TR RAI 5.7.7-10(b)

- ***b. The applicant has identified game animals (pronghorn, wild turkey, etc.) but has not adequately analyzed the need for collecting and analyzing these food sources.***

TR RAI 5.7.7-10(b) Response

Powertech believes it has adequately analyzed the need for collecting and analyzing game animals, and has concluded that there is no significant basis for such sample collection and analysis. See response to TR RAI 2.9-14 for additional information. Powertech does not propose to sample wild game due to the precedent from recently approved NRC license applications (e.g., Moore Ranch) that have not provided game animal tissue sample analyses due to the migratory nature and relatively large home range of game animals in relation to the size of the project area. These animals would not be a significant pathway to man, which Regulatory Guide 4.14 lists as a criterion for sampling in the operational monitoring program. This will be confirmed through annual MILDOS-AREA modeling.

<u>TR RAI 5.7.7-10</u>
Regulatory Guide 4.14 provides recommendations for collecting and analyzing food samples during operations. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1), the applicant should evaluate baseline radionuclide concentrations in local food within 3 km of the site. See related issues in Section 2.9 of this RAI. Please address the following issues.

<u>TR RAI 5.7.7-10(c)</u>

c. ***The applicant has not adequately analyzed the need for collecting and analyzing crops including local vegetable gardens.***

<u>TR RAI 5.7.7-10(c) Response</u>
The operational monitoring program in the revised TR will be updated to include the following information.

Based on MILDOS-AREA results that show the total effective dose equivalent (TEDE) from all pathways is less than 5% of the applicable radiation protection standard (the modeled dose to potential maximally exposed member of the public is approximately 3 mrem/year), the ingestion pathway from crops would not likely exceed 5% of the applicable radiation protection standard. If the pre-operational garden vegetable soil sample results described in the response to TR 2.9-12 supported by MILDOS-AREA modeling demonstrate no significant exposure pathway, Powertech will not sample crops, including vegetable gardens, as part of the operational monitoring program. This approach is consistent with the recommendations contained in Regulatory Guide 4.14.

TR RAI 5.7.7-11

In Section 5.7.7.2 of the TR, the applicant stated that samples of vegetation will be collected three times during the grazing season at each air monitoring station presented on Figure 5.7-10. Regulatory Guide 4.14 provides recommendations on where to sample for vegetation. Consistent with Regulatory Guide 4.14 and NUREG-1569. Acceptance Criterion 5.7.7.3(1), provide sufficient information for NRC staff to evaluate the adequacy of vegetation sampling locations.

TR RAI 5.7.7-11 Response

Powertech believes the placement of vegetation sampling locations is consistent with the recommendations of Regulatory Guide 4.14. Section 5.7.7.2 of the TR commits to sampling vegetation three times during the grazing season at each air monitoring station presented on Figure 5.7-10. These air monitoring locations are located in three different sectors having the highest predicted airborne radionuclide concentrations due to milling operations, which is a siting criterion for the air monitoring stations. Powertech has provided justification regarding the placement of these air monitoring stations as they apply to recommendations in Regulatory Guide 4.14 in the response to TR RAI 2.9-1. The operational monitoring program in the revised TR will be updated to include the following information.

Based on MILDOS-AREA results that show the total effective dose equivalent (TEDE) from all pathways is less than 5% of the applicable radiation protection standard (the modeled dose to potential maximally exposed member of the public is approximately 3 mrem/year), Powertech does not believe that the ingestion pathways from grazing animals is a potentially significant pathway exceeding 5% of the applicable radiation protection standard. However, Powertech will sample vegetation during the first year of operations for comparison to baseline data. If analysis and MILDOS-AREA determine that there is not a significant pathway, Powertech will propose to modify the monitoring plan to not include the sampling of vegetation or forage as part of the operational monitoring program. This is consistent with the recommendations contained in Regulatory Guide 4.14.

TR RAI 5.7.7-12

Regulatory Guide 4.14 provides recommendations for an operational direct radiation monitoring program. The applicant did not address an operational direct radiation monitoring program in section 5.7.7 of the TR. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1), provide an operational direct radiation monitoring program or provide justification for an alternate methodology.

TR RAI 5.7.7-12 Response

The following describes the operational direct radiation monitoring program proposed by Powertech. This information will be incorporated into the revised TR.

Consistent with recommendations contained in Regulatory Guide 4.14, thermoluminescent dosimeters (TLDs) or equivalent dosimeters will be co-located with the air particulate samplers. Powertech will utilize environmental, low-level TLDs provided by a National Voluntary Laboratory Accreditation Program (NVLAP) approved provider. The dosimeters will be exchanged quarterly. The results will be used to assess quarterly gamma exposure rates at each of the sites.

TR RAI 5.7.7-13

It is not clear from the applicant's description of its airborne effluent and environmental monitoring program the manner in which it will account for and verify, by surveys and/or monitoring, the occupational dose (gaseous and particulate) received throughout the entire Permit Area. Please provide an airborne effluent and environmental monitoring program that complies with 10 CFR 20.1501.

TR RAI 5.7.7-13 Response

TR Section 5.7 will be revised to include the following information.

Consistent with the requirements of 10 CFR §20.1501, Figure TR RAI 5.7.7-13-1 presents the results of modeling the annual total effective dose equivalent (TEDE) above background in and around the project area. The analysis was performed using MILDOS-AREA as a predictive model to estimate doses at regularly spaced (1 X 1-km grid spacing) arbitrary receptors within and around the project area using the same input parameters and source terms described in Section 7.3 of the TR, which will be revised to reflect the updated MILDOS-AREA results. Appendix 7.3-C to this response package includes the updated MILDOS-AREA input parameters as requested by NRC staff. Isodose contour lines were developed using kriging interpolation methods based on the results of the MILDOS-AREA modeling of the arbitrary receptors.

The isodose lines shown on Figure TR RAI 5.7.7-13-1 are adult doses based on continuous occupancy. The highest predicted dose is around 6 mrem/year southeast of the Dewey portion of the project area. Assuming a worker is in this area for 2,000 hours per year, the expected annual occupational dose from gaseous and particulate releases would be less than 2 mrem/year. If a worker not associated with the Dewey-Burdock Project (i.e., a member of the public) were to work the entire year within the project area, no public dose limits will be exceeded.

This analysis is in agreement with NUREG-1910 (NRC, 2009), which states, "Doses for the various ISL facilities…are at least a factor of three below the regulatory limit and most are less than that. Based on operational history and dose-modeling results, doses at operating ISL facilities in different regions are not likely to exceed regulatory limits, and overall potential radiological impacts from ISL operations would be SMALL" (pg. 4.3-33). Figure TR RAI 5.7.7-13-1 supports the expectation that the areas with the highest potential for occupational doses occur within the confined structures of the facility where gaseous and particulate emissions potentially could concentrate.

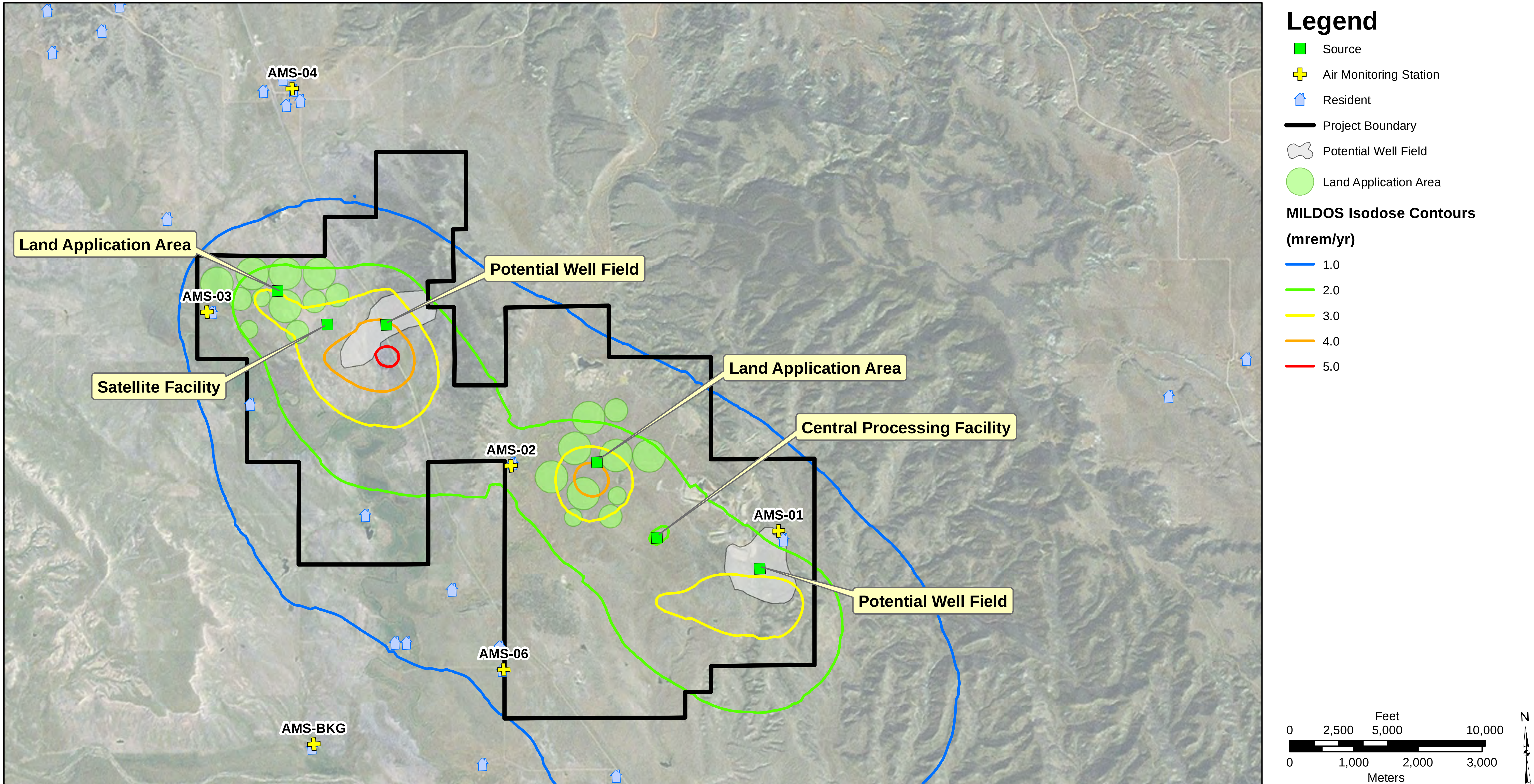


Figure TR RAI 5.7.7-13-1

MILDOS Isodose Lines

Dewey-Burdock Project

DRAWN BY C. Farr - ERG

DATE 20-Jun-2011

FILENAME Figure TR RAI 5.7.7-13-1.mxd

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TR RAI 5.7.7-14

Consistent with 10 CFR 20.1302 and NUREG-1736, it is not clear that the applicant has evaluated the member(s) of the public likely to receive the highest exposure from licensed operations. Please provide an airborne effluent and environmental monitoring program that complies with 10 CFR 20.1302.

TR RAI 5.7.7-14 Response

Consistent with the requirements of 10 CFR §20.1501, Figure TR RAI 5.7.7-13-1 presents the results of modeling the annual total effective dose equivalent (TEDE) in and around the project area. The analysis was performed using MILDOS-AREA as a predictive model to estimate doses at regularly spaced (1 X 1-km grid spacing) arbitrary receptors within and around the project area using the same input parameters and source terms described in Appendix 7.3-C. Isodose contour lines were developed using kriging interpolation methods based on the results of the MILDOS-AREA modeling of the arbitrary receptors.

The isodose lines shown on Figure TR RAI 5.7.7-13-1 are adult doses based on continuous occupancy. The highest predicted dose is around 6 mrem/year southeast of the Dewey portion of the project area. Assuming a member of the public uses this area for recreation or other purposes for 2 weeks per year, the expected annual public dose from gaseous and particulate releases would be less than 1 mrem/year. It is likely that any member of the public working or otherwise using the land within the permit area would be there for a small fraction of time compared to a resident potentially living within the permit area (please refer to the response to TR RAI 5.7.7-13). Consequently, the member of the public likely to receive the highest dose from the licensed operation would be a resident living near the facility continuously during the year. The residence closest to and downwind from the facility is shown on Figure TR RAI 2.9-1-1 as AMS-02. The predicted TEDE at this location ranges from 2.21 mrem/year for an adult to 4.5 mrem/per year for an infant. The AMS-02 location is included in the proposed environmental monitoring program for radon-222, air particulate, and exposure rate monitoring.

TR RAI 5.7.7-15

The applicant did not discuss how radon progeny will be factored into analyzing potential public dose from operations. Concentration values given in 10 CFR 20, Appendix S, Table 2, are based on radionuclide concentrations inhaled or ingested. The radon progeny, if present, will be the principal contributor to radiation dose in most practical radon exposure situations and need to be considered in any dose assessment. Please provide a description of the applicant's monitoring program that will account for public exposure to radon daughters.

TR RAI 5.7.7-15 Response

TR Section 5.7 will be revised to include the following information.

The primary method to account for public exposure to radon decay products is to evaluate the dose from radon and its decay products at receptor locations in and around the project area using environmental monitoring data and Equation 1 below.

$$\boldsymbol{CEDE = DCF \times C_{net} \sum_i OF_i \times EF_i} \qquad \text{(Equation 1)}$$

Where:

- CEDE = Annual committed effective dose equivalent from radon-222 (mrem/yr).
- C_{net} = Net annual average radon-222 concentration (annual average concentration at location minus annual average concentration at background location) (pCi/L).
- OF_i = Occupancy factor for location or conditions; in above equation will usually be 1 unless different equilibrium factors for indoor and outdoor radon-222 exposures are used.
- EF_i = Radon-222 decay products equilibrium fraction; will assume indoor and outdoor fraction of 0.5. May adjust outdoor fraction based on MILDOS-AREA modeling.
- DCF = Dose Conversion Factor of 500 mrem/pCi L^{-1} at 100% equilibrium (from 10 CFR 20, Appendix B, Table 2).

The member of the public likely to receive the highest dose from licensed operations is a resident at air monitoring station AMS-02. Locations of operational air monitoring stations are shown on Figure TR RAI 5.7.7-2-1 in the response to TR RAI 5.7.7-2. Passive track-etch detectors will be deployed at each operational monitoring station for monitoring radon-222 on a quarterly basis.

The above method is a conservative approximation of dose from radon-222. Given the difficulty in measuring low-level radon-222 concentrations resulting from site activities within the varying background radon-222 concentrations in and around the project area, an alternate approach to the above method may be used as needed. The alternate approach would be to model the dose to the receptor of concern using MILDOS-AREA. Inputs into MILDOS-AREA will be the location and strength of source terms based on estimated airborne releases reported as required by 10 CFR § 40.65, the site-specific meteorological data updated as needed for the current year, and receptor location.

TR RAI 5.7.7-16
10 CFR 40.65 requires a report that specifies the quantity of each of the principal radionuclides released to unrestricted areas. It is not clear from the applicant's description of its airborne effluent and environmental monitoring program how it will account for and verify, by surveys and/or monitoring, the quantity of these radionuclides from all point and diffuse sources (e.g., uranium escaping the central processing plant) from its operations.

TR RAI 5.7.7-16 Response
TR Section 5.7 will be revised with the following information:

The airborne release of radon (the principal radionuclide potentially released) from process operations will be estimated using the methods described in TR Section 7.3 and in Regulatory Guide 3.59, Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (NRC, 1987). Important parameters used to estimate the airborne releases will be monitored as part of routine process performance parameters. These parameters include but are not limited to the following:

- Average production lixiviant flow rate
- Average restoration flow rate
- Average bleed rate
- Radium-226 concentration of pregnant lixiviant
- Uranium concentration of pregnant lixiviant
- Number of operating days
- Land application rate
- Radionuclide concentration of land application solutions
- Radionuclide soil concentrations of land application areas
- Identification of potential point and diffuse source locations.

Although potential airborne uranium emissions to unrestricted areas are not expected, performance of the vacuum dryer and emission control systems for the dryer will be monitored as part of typical process performance parameters.

The results of airborne radionuclide release surveys, including location and strength (i.e., quantity of each radionuclide in Ci/yr) of point and diffuse airborne emissions, based on important parameter monitoring will be reported in the semiannual effluent reports required by 10 CFR § 40.65.

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TR RAI 5.7.7-17

The applicant stated that the LLD for biota and surface soil monitoring will be consistent with the recommendations in Regulatory Guide 4.14 unless matrix interferences prohibit attainment of these values. Regulatory Guide 4.14 allows for alternate proposals to the preoperational and operational monitoring programs, as long as the two programs remain compatible. Please provide more information regarding the proposed LLD for biota and surface soil monitoring that demonstrate that these values will be consistent with Regulatory Guide 4.14 and that the preoperational and operational monitoring programs will remain compatible.

TR RAI 5.7.7-17 Response

The following information will be included in the revised TR.

Powertech will develop, implement and maintain monitoring and quality assurance/quality control programs that ensure consistency for purposes of comparison of data results within and between phases of pre-operation, operations and restoration and reclamation activities where applicable. Alternate LLDs for some biota sampling have been proposed. Powertech commits to attaining the LLDs in Regulatory Guide 4.14 or, at a minimum, these alternate LLDs, if agreed to by the NRC as part of this RAI response package, in the operational monitoring phase of the project if appropriate. Alternate LLDs for soil monitoring have not been proposed and soil LLDs contained in Regulatory Guide 4.14 will be attained to remain consistent with pre-operational samples. Powertech commits to utilizing well trained field personnel and to working closely with contract laboratory personnel in order to ensure LLDs are consistent with NRC guidance in Regulatory Guide 4.14.

Groundwater and Surface Water Monitoring Programs

TR RAI 5.7.8-1

Regulatory Guide 4.14 recommends the surface water samples be analyzed for dissolved and suspended natural uranium, Ra-226, Th-230, Pb-210 and Po-210. Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1), provide an operational surface water sampling and analysis program that addresses these analyses or technical justification for an alternate program.

TR RAI 5.7.8-1 Response

The following describes the operational surface water sampling and analysis program that will be implemented by Powertech. For additional information on the impoundments and stream sampling monitoring sites included in the surface water operational monitoring program, please refer to the responses to TR RAI 2.9-43(a) and TR RAI 2.9-43(b), respectively. The following information will be incorporated into the revised TR.

Operational surface water monitoring will include quarterly monitoring of all surface impoundments located down-gradient (i.e., potentially subject to surface runoff) from proposed activity and surface waters passing through the site or located down-gradient of proposed activity. As illustrated in Table TR RAI 2.9-43a-1 and Table TR RAI 2.9-43b-2, Powertech proposes to monitor 24 impoundments and 10 stream sampling sites as part of the operational monitoring. Samples collected from the sites will be analyzed for dissolved and suspended natural uranium, Ra-226, Th-230, Pb-210 and Po-210, which is consistent with Regulatory Guide 4.14 recommendations. Sampling methodology is described in the response to TR RAI 5.7.8-19.

<u>TR RAI 5.7.8-2</u>

In 10 CFR 40, Appendix A, Criterion 7, NRC requires an operational monitoring program that can be used to evaluate environmental impacts of operation and to detect potential long-term effects, among other things. Regulatory Guide 4.14 provides guidance on surface water sampling, including impoundments and surface waters passing through the mill site. In Section 2.7.3.1 of the TR the applicant identified 48 surface water impoundments.

However, in Section 5.7.8 of the TR, the applicant identified only 11 impoundments in its operational surface water monitoring program as shown on Figure 5.7-10 of the TR. In addition, the applicant has not identified sampling locations for Beaver Creek which passes through the mill site. The applicant should analyze all surface water features in accordance with Regulatory Guide 4.14 criteria, including offsite water features that could be impacted from operations, or provide a justification for an alternate methodology that complies with 10 CFR 40, Appendix A, Criterion 7.

<u>TR RAI 5.7.8-2 Response</u>

The following describes the operational surface water monitoring program proposed by Powertech For additional information on the impoundments and stream sampling monitoring sites included in the surface water operational monitoring program, please refer to the responses to TR RAI 2.9-43(a) and TR RAI 2.9-43(b), respectively. In addition, the response to TR RAI 5.7.8-1 provides a description of the operational monitoring sampling and analysis program. The following information will be incorporated into the revised TR.

During ISR operations, 24 impoundments and 10 stream sampling sites, depicted on Exhibit 5.7-I, will be monitored as part of the operational monitoring program. As described in the response to TR RAI 2.9-43(a), impoundments within and surrounding the project area were evaluated based on location in relation to proposed activity (i.e., down-gradient of proposed well field, CPP, etc.). Table TR RAI 2.9-43a-1 lists all of the impoundments identified during the 2007 field survey and includes two additional impoundments associated with the Darrow Mine pits. The table also illustrates the impoundments that are proposed for operational monitoring and provides justification for impoundments not included. All 24 impoundments identified for operational monitoring will be visited on a quarterly basis throughout construction and operation. Grab samples collected from the impoundments will be analyzed for dissolved and suspended natural uranium, Ra-226, Th-230, Pb-210 and Po-210. In the event that a sample cannot be collected from an impoundment during the quarterly visit, the reason will be stated on a field sheet and reported accordingly.

A total of 10 stream sampling sites are proposed for operational monitoring. To meet the recommendations of Regulatory Guide 4.14, Powertech is proposing six sites not previously included in the baseline monitoring program. During baseline monitoring sites on Beaver Creek (BVC01 and BVC04) and Pass Creek (PSC01 and PSC02) were not located on the site boundary and therefore will be omitted from the operational monitoring program. Powertech will establish a new upstream and downstream

site on both Beaver Creek and Pass Creek as well as two additional sites on unnamed tributaries in the southeast portion of the project area. Details for each of the proposed stream sampling sites are provided in Table TR RAI 2.9-43b-2. Grab samples will be collected quarterly from the sites on Beaver Creek (BVC11 and BVC14) and the Cheyenne River (CHR01 and CHR05), while passive samplers (single-stage samplers) will be installed at all other stream sampling sites between the months of April and October. All water samples collected from the sites will be analyzed for dissolved and suspended uranium, Ra-226, Th-230, Pb-210, and Po-210.

<u>TR RAI 5.7.8-3</u>

Table 2.7.3-1 in NUREG 1569 provides a list of acceptable constituents for monitoring at in situ recovery facilities. Alternatively, applicants may propose a list of constituents that is tailored to a particular location. In such cases, sufficient technical bases must be provided to demonstrate the acceptability of the selected constituent list." With respect to the list of RAIs, the staff requests the following information.

<u>TR RAI 5.7.8-3(a)</u>

a. Table 6.1.1 in the TR provided a proposed list of baseline water quality parameters for well fields. NRC staff notes this list did not include constituents consistent with the above-referenced Table 2.7.3-1. Please provide justification for excluding constituents listed in Table 2.7.3-1 from the proposed baseline sampling, consistent with the guidelines in Section 5.7.8.3 of NUREG-1569.

<u>TR RAI 5.7.8-3(a) Response</u>

TR Table 6.1-1 has been revised to include all analytes listed in Table 2.7.3-1 of NUREG-1569, and is included in the response to TR RAI 6.1-3. The revised table will also be included in the revised TR.

TR RAI 5.7.8-3

Table 2.7.3-1 in NUREG-1569 provides a list of acceptable constituents for monitoring at in situ recovery facilities. Alternatively, applicants may propose a list of constituents that is tailored to a particular location. In such cases, sufficient technical bases must be provided to demonstrate the acceptability of the selected constituent list." With respect to the list of RAIs, the staff requests the following information.

TR RAI 5.7.8-3(b)

b. Consistent with Section 5.8.7.3 of NUREG-1569, the applicant did not include information on the statistical methods that would be employed to establish baseline or background levels. For example, the applicant did not define whether or not the baseline levels for the production zone will be based on a well field average or well-by-well basis, methods to identify and exclude outliers, or other methods that may be appropriate for establishing background levels in all aquifers. The staff cannot determine if the applicant will be able to appropriately define baseline levels for a well field without this information. Please provide the above-referenced information.

TR RAI 5.7.8-3(b) Response

The following discussion will be incorporated into the revised TR.

Within each well field a subset of wells that will later serve as production wells will be identified for baseline water quality sampling. These subsets of wells will include at least one (1) well per four (4) acres of well field pattern area, or six (6) wells, whichever is greater. These wells will be sampled four times for baseline characterization, with a minimum of fourteen (14) days between sample events. The samples will be analyzed for all parameters identified in revised Table 6.1-1, which is included with the response to TR RAI 6.1-3.

Prior to calculating baseline water quality statistics, the analytical results will be examined for differences between the hydrogeologic units within each well field. Methods used to determine whether differences exist include visual screening, such as the use of trilinear diagrams and statistical analysis such as the Student’s t-test. If heterogeneity exists, then baseline water quality will be established for each hydrogeologic unit. If no statistically significant differences in water quality are present, then baseline water quality will be established for the entire production zone of the well field.

Outliers, which are anomalously high or low values relative to the other values, will be removed by quality control checks including visual screening and statistical analysis. Specifically, an outlier will be defined as a value outside of the mean value, plus or minus three (3) standard deviations, of all values of that parameter within the hydrogeologic zone. The mean value and standard deviation used to identify outliers will be calculated for the entire data set within the hydrogeologic zone minus the suspected outlier. Outliers will be examined for potential data transcription or other identifiable errors and

corrected if possible. If they cannot be corrected, outliers will be removed from the data set prior to calculating baseline water quality.

After grouping the analytical data into hydrogeologic units and removing outliers, if necessary, Powertech will calculate the baseline water quality as the arithmetic average for each sample parameter. The target restoration goals (TRGs) will be established as a function of the average baseline water quality and the variability in each parameter according to statistical methods approved by NRC.

<u>TR RAI 5.7.8-4</u>

In addition to the uncertainty that staff noted in the last RAI within the Hydrology Section, NRC staff is uncertain of the potential for operations to create or enhance a potential migration of constituents of concern from mine pit areas at or near well fields in the license area to the underlying Fall River aquifer. Please demonstrate whether this scenario may potentially occur and if so, please clarify whether the well field groundwater monitor locations will provide satisfactory coverage of the Fall River water-bearing zone beneath appropriate areas at or near the mine pit areas. This information is necessary for staff to understand the potential impacts of the operations on water resources and to assess the manner in which the Dewey-Burdock operations will be protective of human health and the environment.

<u>TR RAI 5.7.8-4 Response</u>

The following information will be incorporated into the revised TR.

Powertech does not plan ISR operations in ore bodies in the Fall River in the vicinity of the Darrow and Triangle pits. The former Darrow and Triangle open-pit mines and associated underground workings in the eastern portion of the project area extracted ore from the Fall River Formation. These open-pit mines and underground workings did not penetrate the underlying Fuson Shale. The Fuson Shale physically and hydraulically separates the Fall River from the underlying Chilson Member of the Lakota Formation across the entire project area (see response to TR RAI P&R-2).

Powertech is proposing to conduct ISR operations within the Chilson in this area. The Chilson is confined above by the Fuson Shale, which is a subunit of the thicker Fuson Member of the Lakota, and below by the Morrison Formation. The Fuson Shale consists of a sequence of nearly impermeable shales, clays, and mudstones, 20 feet or more thick.

Because of the physical and hydraulic separation of the Chilson from the overlying Fall River Formation, ISR operations in the Chilson will not affect the Fall River or create or enhance migration of constituents of concern from the open-pit or underground mines.

The potential effects of ISR operations in the Chilson on the overlying Fall River Formation will be evaluated further as part of the planned delineation drilling and well field-scale pumping tests prior to the development of each potential well field. Powertech is also in the process of developing a groundwater model that will help evaluate any potential for interaction between the old mining operations and the Fall River. Powertech also commits to the installation and operational monitoring of Fall River, Chilson, and alluvial monitor wells between the open-pit mines and potential well field areas. For additional information, refer to the response to TR RAI 5.7.8-17.

TR RAI 5.7.8-5

Section 5.7.8.3 of NUREG-1569 suggests that for large well fields, it may not be practical to sample one production/injection well per acre. However, baseline sampling should not occur at a density less than one per 4 acres." Section 3.2 of the TR Supplement states, "A minimum of eight baseline water quality wells will be installed in the ore zone in the planned well field area." The staff is not certain that this statement is consistent with current guidance. Please clarify that the sampling densities are consistent with the NRC's guidance or provide additional justification for an alternate density.

TR RAI 5.7.8-5 Response

The following describes the baseline sampling density proposed by Powertech and will be incorporated into the revised TR.

Within each production well field a subset of wells to be utilized as production wells will be identified for baseline water quality sampling with the intention of following guidance in Section 5.7.8.3 of NUREG-1569. The subset of these wells will consist of at least one well per 4 acres of well field pattern area or six wells, whichever is greater. Should the pattern area be 6 acres or less, the maximum density will be one well per acre and a subset of less than six wells may be used. Please also refer to the response to TR RAI 5.7.8-3(b).

<u>TR RAI 5.7.8-6</u>

Section 5.7.8.3 of NUREG-1569 states, "Baseline sampling programs should provide enough data to adequately evaluate natural spatial and temporal variations in pre-operational water quality. At least four independent sets of samples should be collected, with adequate time between sets to represent any pre-operational temporal variations." Consistent with Section 5.7.8.3 of NUREG-1569, please specify the number of baseline sample sets that will be collected and the time between sets to represent any pre-operational temporal variations.

<u>TR RAI 5.7.8-6 Response</u>

The following describes the baseline sampling frequency proposed by Powertech to adequately evaluate natural spatial and temporal variations in pre-operational water quality. The following information will be incorporated into the revised TR.

Powertech will sample all wells identified for baseline water quality sampling. Baseline sampling will consist of four sample events with a minimum of fourteen (14) days between consecutive samplings. All samples will be analyzed for constituents listed in TR Table 6.1-1, which is included in the response to TR RAI 6.1-3.

<u>TR RAI 5.7.8-7</u>

In Section 5.2.7 of the TR Supplement, the applicant states "Powertech (USA)'s management has always used Chlorides, Sulfate and Uranium as Upper Control Limit Parameters. Sometimes Total Dissolved Solids is used. Powertech (USA) also uses pressure measurements in the monitor wells to detect the potential for excursions. These parameters were selected for the following reasons."

<u>TR RAI 5.7.8-7(a)</u>

a. Please clearly specify excursion indicator constituents proposed for the Dewey-Burdock site.

<u>TR RAI 5.7.8-7(a) Response</u>

Following is a description of the excursion indicators proposed by Powertech for the Dewey-Burdock Project. This information will be incorporated into the revised TR.

Following characterization of well field baseline water quality, UCLs will be established for constituents that provide early indication of a potential excursion. The constituents proposed for use as UCLs are chloride, conductivity and total alkalinity. Chloride is proposed as an excursion indicator because concentrations in the lixiviant are increased by the IX process. In addition, chloride is highly mobile in groundwater and is not influenced by pH changes or oxidation-reduction reactions. Conductivity is proposed as an excursion indicator because it provides an overall indication of changes in groundwater quality and is more easily measured than TDS. Total alkalinity was chosen since concentrations of bicarbonate are increased during ISR operations.

<u>TR RAI 5.7.8-7</u>

In Section 5.2.7 of the TR Supplement, the applicant states "Powertech (USA)'s management has always used Chlorides, Sulfate and Uranium as Upper Control Limit Parameters. Sometimes Total Dissolved Solids is used. Powertech (USA) also uses pressure measurements in the monitor wells to detect the potential for excursions. These parameters were selected for the following reasons."

<u>TR RAI 5.7.8-7(b)</u>

b. ***Section 5.2.7.2 of the TR Supplement states, "Since there is always pyrite (iron sulfide, a reduced mineral) present in uranium roll front deposits (it is the reason the uranium is there), an increase in sulfate means that there is oxygenated water moving in sufficient volume to change the sulfate levels." The staff notes that the oxygenated portion of the Iixiviant tends to be consumed relatively quickly. Therefore, it is unclear if sulfate will sufficiently serve the early warning function that UCL parameters should.***

<u>TR RAI 5.7.8-7(b) Response</u>

The TR will be revised to reflect that sulfate is no longer proposed as an excursion indicator. As stated in the response to TR RAI 5.7.8-7(a), Powertech proposes to use chloride, conductivity and total alkalinity as excursion indicators.

TR RAI 5.7.8-7

In Section 5.2.7 of the TR Supplement, the applicant states "Powertech (USA)'s management has always used Chlorides, Sulfate and Uranium as Upper Control Limit Parameters. Sometimes Total Dissolved Solids is used. Powertech (USA) also uses pressure measurements in the monitor wells to detect the potential for excursions. These parameters were selected for the following reasons."

TR RAI 5.7.8-7(c)

c. ***Section 5.2.7.4 of the TR Supplement states, "Total Dissolved Solids (TDS) indicates the increase primarily in chlorides and sulfates when it is used as a UCL. ... Powertech's opinion that total dissolved solids is not sufficiently specific to be useful." The applicant's statement appears to imply that total dissolved solids may not be a good excursion indicator. Staff notes that conductivity, which is correlated to total dissolved solids, is generally considered to be a good excursion indicator (Staub, 1986; Deutsch, 1985). Please for provide site-specific justification for the use of total dissolved solids or its related parameter, conductivity at the project site.***

TR RAI 5.7.8-7(c) Response

The TR will be revised to reflect that TDS is no longer proposed as an excursion indicator. As stated in the response to TR RAI 5.7.8-7(a), conductivity will be used as an excursion indicator because it provides an overall indication of changes in groundwater quality. Conductivity and TDS are strongly correlated, and conductivity provides an excellent indicator of changes in TDS while being easier to measure than TDS. Conductivity is therefore a better excursion parameter to rapidly detect changes in dissolved constituent concentrations.

<u>TR RAI-5.7.8-7</u>

In Section 5.2.7 of the TR Supplement, the applicant states "Powertech (USA)'s management has always used Chlorides, Sulfate and Uranium as Upper Control Limit Parameters. Sometimes Total Dissolved Solids is used. Powertech (USA) also uses pressure measurements in the monitor wells to detect the potential for excursions. These parameters were selected for the following reasons."

<u>TR RAI-5.7.8-7(d)</u>

d. ***Section 5.2.7.3 of the TR Supplement states, "The uranium is selected because it is a uranium mine and this is the primary change that is made to the groundwater that is an adverse change. The uranium is not very mobile as it is insoluble in the reduced state and must be oxidized to be soluble and must have the correct pH at any oxidation level as well as sufficient carbonate ion in solution." The applicant's statement appears to imply that uranium may not be a good excursion indicator. Please further evaluate the use of uranium as an excursion indicator constituent. Consistent with Section 5.8.7.3 of NUREG 1569, this evaluation should consider that excursion indicator constituents are intended to provide early warning that leaching solutions are moving away from the well fields and that groundwater outside the monitor well ring may be threatened. Please provide information that addresses the above-referenced comments.***

<u>TR RAI 5.7.8-7(d) Response</u>

The TR will be revised to reflect that uranium is no longer proposed as an excursion indicator. As stated in the response to TR RAI 5.7.8-7(a), Powertech proposes to use chloride, conductivity and total alkalinity as excursion indicators. These constituents will provide early warning in the event that lixiviant moves away from the well field indicating that groundwater outside the monitor well ring may be threatened.

<u>TR RAI 5.7.8-8</u>

Section 2.7.8.3 of NUREG 1569 states, "Upper control limits for a specific excursion indicator should be determined on a statistical basis to account for likely spatial and temporal concentration variations within the mineralized zone.... " NRC staff notes that the application does not provide this information. Consistent with Section 2.7.8.3 of NUREG 1569, please describe the method that will be used to establish upper control limits.

<u>TR RAI-5.7.8-8 Response</u>

The following describes the method Powertech will use to establish UCLs. The baseline sampling procedures to establish UCLs will be similar to the method described in the response to TR RAI 5.7.8-3 (b). As described in the response to TR RAI 5.7.8-7, the constituents proposed as excursion indicators include chloride, conductivity and total alkalinity. The following information will be incorporated into the revised TR.

All monitor wells will be sampled four times for baseline characterization, with a minimum of fourteen (14) days between sample events. The water level in each monitor well also be recorded during each sampling event. All samples will be analyzed for the parameters listed in Table 6.1-1, which is included with the response to TR RAI 6.1-3.

Prior to calculating UCLs, the analytical results will be examined for differences. As described in the response to TR RAI 5.7.8-3(b), methods used to determine whether differences exist include visual screening, such as the use of trilinear diagrams and statistical analysis such as the Student's t-test. If heterogeneity exists, then the UCL for a particular monitor well will be established for that well. If no statistically significant differences in water quality are present, then the UCLs will be established to represent the entire production zone of the well field.

Outliers, which are anomalously high or low values relative to the other values, will be removed by quality control checks including visual screening and statistical analysis. Specifically, an outlier will be defined as a value outside of the mean value plus or minus 3 standard deviations of all values of that parameter within the same zone. The mean value and standard deviation used to identify outliers will be calculated for the entire data set within the same zone minus the suspected outlier. Data values identified as outliers will not be included in the computation of statistical parameters used for determining the UCLs. Outliers will be examined for potential data transcription or other identifiable errors and corrected if possible. If they cannot be corrected, outliers will be removed from the data set prior to calculating baseline water quality.

UCLs for each monitor well will be set at the baseline mean concentration of the individual unit or zone being monitored plus five (5) standard deviations for each excursion indicator. Because some aquifers exhibit low chloride concentration with a narrow statistical distribution, for chloride only the greater of

the mean plus five standard deviations or the mean plus 15 mg/L will be used as the UCL. This is consistent with NUREG-1569, Section 5.7.8.3(2).

TR RAI 5.7.8-9

On page 3-8 of the TR. the applicant states that the perimeter wells will be screened across the "entire mineralized zone" and for internal monitoring wells, across the overlying or underlying aquifers where the greatest potential for vertical excursions may occur. The proposed screening of the perimeter monitoring wells is consistent with guidance in NUREG-1569 (page 5-42); however, guidance in NUREG-1569 also indicates that the applicant should describe the process for determining the screened horizon. The staff is uncertain of the rationale and details that the applicant will use for determining screened horizon or well placement. For example, the staff is unclear whether the entire mineralized zone means horizons within the Lakota or Fall River aquifers (e.g., F11, F12 or F13) or the entire aquifer. The applicant should provide justification for screening a monitor well across the entire overlying or underlying aquifer. Finally, the applicant does not define how the "greatest potential for an excursion" is to be determined. Please provide information that addresses the above-referenced comments.

TR RAI 5.7.8-9 Response

The following information will be incorporated into the revised TR.

Consistent with NUREG-1569 (page 5-42), the perimeter monitor wells will be screened across the entire thickness of the production zone, which will be determined following completion of delineation drilling for each well field. In all cases, the screens will fully penetrate the hydrogeologic unit to be monitored, i.e., spanning the entire interval between the overlying and underlying confining beds. As described in the response to TR RAI P&R-2, the Fuson Shale is pervasive throughout the project area and forms a confining unit between the Fall River and Chilson. No monitor well will be screened across the Fuson Shale and into the Fall River and Chilson.

In some areas, multiple ore bodies are vertically stacked within the Fall River or Chilson. The perimeter production zone monitor wells will be screened across the full thickness of the hydrogeological unit (Fall River or Chilson, but not both), and these multiple ore bodies treated as a single production zone for the purpose of determining the horizontal distance between the production zone and the monitor well ring. This approach will be utilized when there are no substantial confining layers between ore bodies within the hydrogeologic unit (Fall River or Chilson) and when the hydrogeologic unit containing the multiple ore bodies behaves as a single hydraulically connected unit. An example of this type of monitoring approach is shown in Figure TR RAI 5.7.8-12-1 in the response to TR RAI 5.7.8-12.

In the case where a localized confining unit (other than the Fuson Shale) is present between stacked ore bodies within one of the primary hydrogeologic units (Fall River or Chilson), the monitoring approach may be modified such that perimeter monitor wells are screened only within the portion of the hydrogeologic unit in which the ore body is located. An example of this approach is described as follows. Based on characterization to date, the Chilson has been subdivided into three subunits: Upper Chilson, Middle Chilson, and Lower Chilson. In some cases, a low-permeability unit separates the Upper Chilson

from the Middle and Lower Chilson. This relationship is shown on the cross sections submitted in response to TR RAI P&R-1 (Exhibits 2.7-1a through 2.7-1h and 2.7-1j). If it is demonstrated that the localized confining unit provides hydraulic separation between the Upper Chilson and the lower units of the Chilson, then monitor wells will be located and designed to monitor these zones separately as shown on Figures TR RAI 5.7.8-12-2 and TR RAI 5.7.8-12-4, which are provided with the response to TR RAI 5.7.8-12. Using this approach, if the ore body were located within the Upper Chilson unit, the perimeter monitor wells would only be screened across the Upper Chilson.

The screened intervals for the perimeter monitor wells will be further justified by demonstrating responses to pumping during the well field-scale pumping tests (see response to TR RAI 5.7.8-14). Numerical modeling will also be conducted to further evaluate the likely magnitude of the response in the perimeter monitor wells to ISR operations.

The internal, non-production zone monitor wells will be screened across the entire overlying and underlying aquifer to avoid missing an excursion (defined as when a monitor well sample contains more than two of the excursion indicators at the UCL level, in accordance with NUREG-1910, Supplement 1, pg. 4-2a) occurring above or below the screened interval.

The “greatest potential for excursion” is defined as those locations where an excursion has the greatest potential to occur based on the hydrogeologic data obtained and analyzed during development of the detailed well field package. This could include, for example, areas of higher permeability, pronounced anisotropy (varying hydrologic parameters measured in varying directions), and similar features that could create a preferential flow path for ISR fluids. At a minimum, monitor wells will be installed in the overlying aquifer at a density of one well per 4 acres of area under well pattern and in the underlying aquifer at a density of one well per 4 acres per the guidance provided in NUREG-1569. In assessing the potential for a vertical excursion to occur, the following criteria will be applied for installing overlying and underlying monitor wells within the pattern:

- Areas which may be associated with leakage around the injection well casing.
- Areas where the confining unit may be uncharacteristically thin.
- Areas which may be associated with leakage through improperly abandoned boreholes.
- Areas identified during hydrologic testing as having hydraulic communication with the overlying or underlying aquifer.

By properly designing and pump testing each well field and its associated monitor well network, including specifically addressing those areas having the greatest potential for excursions, Powertech will minimize the risk of excursions and minimize the potential impacts resulting from excursions. By routinely sampling monitor wells for changes in water level and concentrations of the highly mobile and

conservative excursion parameters of chloride, total alkalinity and conductivity, Powertech will ensure that any potential excursions are identified and corrected quickly. As described on page B-75 of the Moore Ranch Final SEIS (NUREG-1910, Supplement 1, Appendix B), "An excursion is defined as an event where a monitoring well in overlying, underlying, or perimeter well ring detects an increase in specific water quality indicators, usually chloride, alkalinity and conductivity, which may signal that fluids are moving out from the wellfield…The perimeter monitoring wells are located in a buffer region surrounding the wellfield within the exempted portion of the aquifer. These wells are specifically located in this buffer zone to detect and correct an excursion before it reaches a USDW…To date, no excursion from an NRC-licensed ISR facility has contaminated a USDW."

TR RAI 5.7.8-10

On Page 3-14 of the Technical Report, the applicant proposes for the perimeter monitoring ring to be 400 feet from the production well field, with a minimum spacing of 400 feet between wells of a spacing that ensures a 70 degree angle. The applicant references three NUREG guidance documents on the proposed spacing but does not justify the spacing based on site-specific hydrogeological and geochemical conditions. Please provide the appropriate justification.

TR RAI 5.7.8-10 Response

The following information will be incorporated into the revised TR.

Powertech proposes that the perimeter production zone monitoring ring be located at a maximum distance of 400 feet from the pattern area. This proposed maximum distance is based on and consistent with standard monitoring practices at operating ISR facilities. As indicated in NUREG-1569, Acceptance Criterion 5.7.8.3(3), "Previously approved *in situ* leach excursion monitoring systems used monitor wells as far as 180 m [600 ft] and as near as 75 m [250 ft] from the well field edge…The licensee should be afforded some discretion in determining the appropriate distance of excursion monitor wells from the well field, but should provide justification for distances greater than about 150 m [500 ft]." The proposed maximum distance also is supported by site-specific data and evaluation through numerical groundwater modeling.

Within the project area, the Fall River and Chilson hydrogeologic units have been extensively characterized, both historically by TVA and more recently by Powertech. Numerous monitor wells have been installed for determination of the potentiometric surfaces. Pumping tests conducted by TVA (Appendix 2.7-K to this response package) and by Powertech (TR Appendix 2.7-B) have provided site-specific aquifer properties for the Fall River and Chilson. Data derived from the hydrologic testing have been incorporated into numerical models to evaluate well field scale issues related to ISR operations, including monitor ring spacing and excursion control.

Additional numerical modeling will be performed to evaluate well spacing and control of potential excursions for the proposed Chilson well fields. The aquifer properties of the Chilson are similar to those of the Fall River, based on pumping tests conducted by TVA and Powertech. Therefore, results of the modeling for the Chilson well fields are anticipated to be similar to those already completed for the Fall River well fields.

In support of the proposed perimeter monitor ring spacing, numerical modeling has been undertaken to evaluate groundwater conditions related to ISR at the Dewey-Burdock Project (Appendix 6.6-B). The results from the rigorous numerical simulations demonstrate that the proposed maximum spacing of 400 feet is adequate to detect an excursion and that the excursion can be controlled. Petrotek Engineering Corporation's 2010 report, "Numerical Modeling of Groundwater Conditions Related to In-

Situ Recovery at the Dewey-Burdock Uranium Project, South Dakota," is included in this RAI response package as Appendix 6.6-B. This appendix will also be included with the revised TR.

The model simulations are based on the site-specific hydrogeological conditions and aquifer properties determined for the Dewey well field area from the 2008 pumping test in the Lower Fall River (TR Appendix 2.7-B). The result from the 2008 pumping test indicated the average transmissivity to be 255 ft^2/day with an average storativity 4.6 x 10^{-5}. Assuming a 75-foot thickness for the Lower Fall River, the hydraulic conductivity is calculated to be 3.4 ft/day. Total porosity of the Lower Fall River was estimated, based on analysis of core samples, to be 29 percent. These values were the initial values used in the model calibration. Using the site-specific aquifer properties and the observed hydraulic gradient of 0.006 ft/ft, the average groundwater flow velocity was calculated to be 0.07 ft/day, or 26 ft/yr.

Assuming the anticipated production rates to be approximately 20 gpm per well pattern, with a net bleed of approximately 1 percent, the model simulations were conducted to evaluate well field-scale issues related to ISR production. The horizontal well field flare was determined to be 1.19 and the 400-foot well spacing demonstrated through modeling to be adequate to detect a potential excursion at this distance. Model simulations were also used to demonstrate that hydraulic control of the simulated excursion can be established by changing well field operational rates to reverse the hydraulic gradient at a distance of 400 feet and change the direction of groundwater travel back to the well field.

Powertech (USA) Inc.

TR RAI 5.7.8-11

Exhibit 3.1-6 and Exhibit 3.1-7 of the TR Supplement show perimeter monitoring wells farther than 400 feet from several of the proposed production areas. For example, the perimeter monitoring wells shown in Exhibit 3.1-7 are approximately 400 feet from the proposed production in the L2 horizon, but up to approximately 1,400 feet from the proposed production at the L3 horizon. Please justify the variation in well spacings.

TR RAI 5.7.8-11 Response

The following information will be incorporated into the revised TR.

The L2 and L3 ore bodies are within the Lower Chilson sand unit and are separated vertically by approximately 10 feet. Although the L2 and L3 ore horizons will be produced with separated systems of injection and recovery wells, they will be treated as a single production zone for monitoring purposes. There is no evidence that a laterally continuous shale of clay confining unit is present between the L2 and L3 ore bodies that would restrict hydraulic communication between these ore bodies, so they are considered together as one hydrologic unit . The perimeter monitor well ring will be located within 400 feet horizontally from the larger production zone. The monitoring wells in that perimeter monitor ring encompassing the L2 and L3 ore horizons will be screened across the full thickness of the Lower Chilson sand unit, which is estimated to average approximately 65 feet thick.

It is anticipated that ISR operations for these “stacked” roll front deposits will be conducted concurrently. Therefore, monitoring of the entire Lower Chilson sand unit is appropriate to ensure that any potential excursion is detected.

TR RAI 5.7.8-12

On Page 3-16 of the Technical Report, the applicant states that additional wells will be completed in any aquifers overlying the first aquifer overlying the production zone. However, the applicant does not provide the methods to be used to determine what constitutes an overlying aquifer. Please provide the methods to be used to determine what constitutes an overlying aquifer.

TR RAI 5.7.8-12 Response

The following discussion and figures will be added to Section 3.1.3.1 of the TR.

The term "overlying aquifer" refers to any hydrogeologic unit(s) above the production zone and separated by a confining layer. The terms "overlying aquifer" and "overlying hydrogeologic unit" are used interchangeably when describing well field operations in the project area. There may be more than one overlying hydrogeologic unit in a given well field, depending on the specific production zone and local geology. The presence or absence of local confining beds and the location of the production zone within the Fall River or Chilson will determine the number of overlying hydrogeologic units. At times, an alluvial unit may exist at the surface above the well field. This alluvial unit will be treated as an overlying hydrogeologic unit and monitored appropriately.

Monitor wells completed in the first overlying hydrogeologic unit will be designated with the prefix MO and will have a density of at least one well per 4 acres of well field pattern area. Subsequent overlying hydrogeologic units will have designations MO2, MO3, etc. and will have a density of at least one well per 8 acres of well field pattern area. Monitor wells completed in the first underlying hydrogeologic unit will be named with the prefix MU and will have a density of one well per 4 acres of pattern area. Only the first underlying hydrogeologic unit will be monitored (see response to TR RAI 5.7.8-13).

The generalized monitoring scheme for the Fall River and Chilson is presented in Figure TR RAI 5.7.8-12-1, General Monitor Well Configuration. This approach will be used when there are no substantial confining layers between ore bodies within the hydrogeologic unit (Fall River or Chilson).

At times local confining units within the Fall River and Chilson may be utilized in the monitoring scheme. The presence or absence of these will be confirmed with delineation drilling and mapped in more detail in the process of development of each well field hydrogeologic data package. The monitoring system also will be specified in each hydrogeologic data package. Should sufficient confining units be mapped after more detailed delineation drilling, the following describes how the well fields would be monitored. The following information represents a conceptual description of monitor well design for the initial Burdock and Dewey well fields.

Figure TR RAI 5.7.8-12-2 shows the anticipated monitor well configuration for Burdock Well Fields 1 and 3. For B-WF1 the production will be from the Lower Chilson and the overlying hydrogeologic units will consist of the Middle and Upper Chilson and the Lower and Upper Fall River. Since the production zone

in B-WF1 is anticipated to be in the lowermost Chilson hydrogeologic unit, which is underlain by the Morrison Formation, no monitoring is proposed in the underlying hydrogeologic unit (Unkpapa). Please refer to the response to TR RAI 2.7-16 for additional explanation. The Middle Chilson, being the first overlying hydrogeologic unit, will be monitored at a density of one well per 4 acres with monitor wells designated MO. Monitor wells will be completed in the Upper Chilson, the Lower Fall River, and the Upper Fall River at a density of one well per 8 acres in each unit. These wells will be designated MO2 (Upper Chilson), MO3 (Lower Fall River) and MO4 (Upper Fall River). For B-WF3, the production zone will be the Upper Chilson, the first overlying hydrogeologic unit will be the Lower Fall River (monitor wells at one per 4 acres and designation MO) and the second overlying unit will be the Upper Fall River (monitor wells at one per 8 acres and designation MO2). For B-WF3 the Middle Chilson will be the underlying hydrogeologic unit and will be monitored at a density of one well per 4 acres of pattern with designation MU.

Figure TR RAI 5.7.8-12-3 depicts the type log for B-WF1. This type log illustrates the various hydrogeologic units that Powertech anticipates monitoring in B-WF1 as described above.

Figure TR RAI 5.7.8-12-4 shows the anticipated monitoring well configuration for the initial Dewey well fields. For D-WF1 the production zone will be the Lower Fall River, the MO zone (with monitoring at one well per 4 acres) will be the Upper Fall River, and there will be no additional overlying hydrogeologic units. The MU zone (with monitoring at one well per 4 acres) will be the Upper Chilson. Similar conventions are shown for D-WF2 and D-WF3.

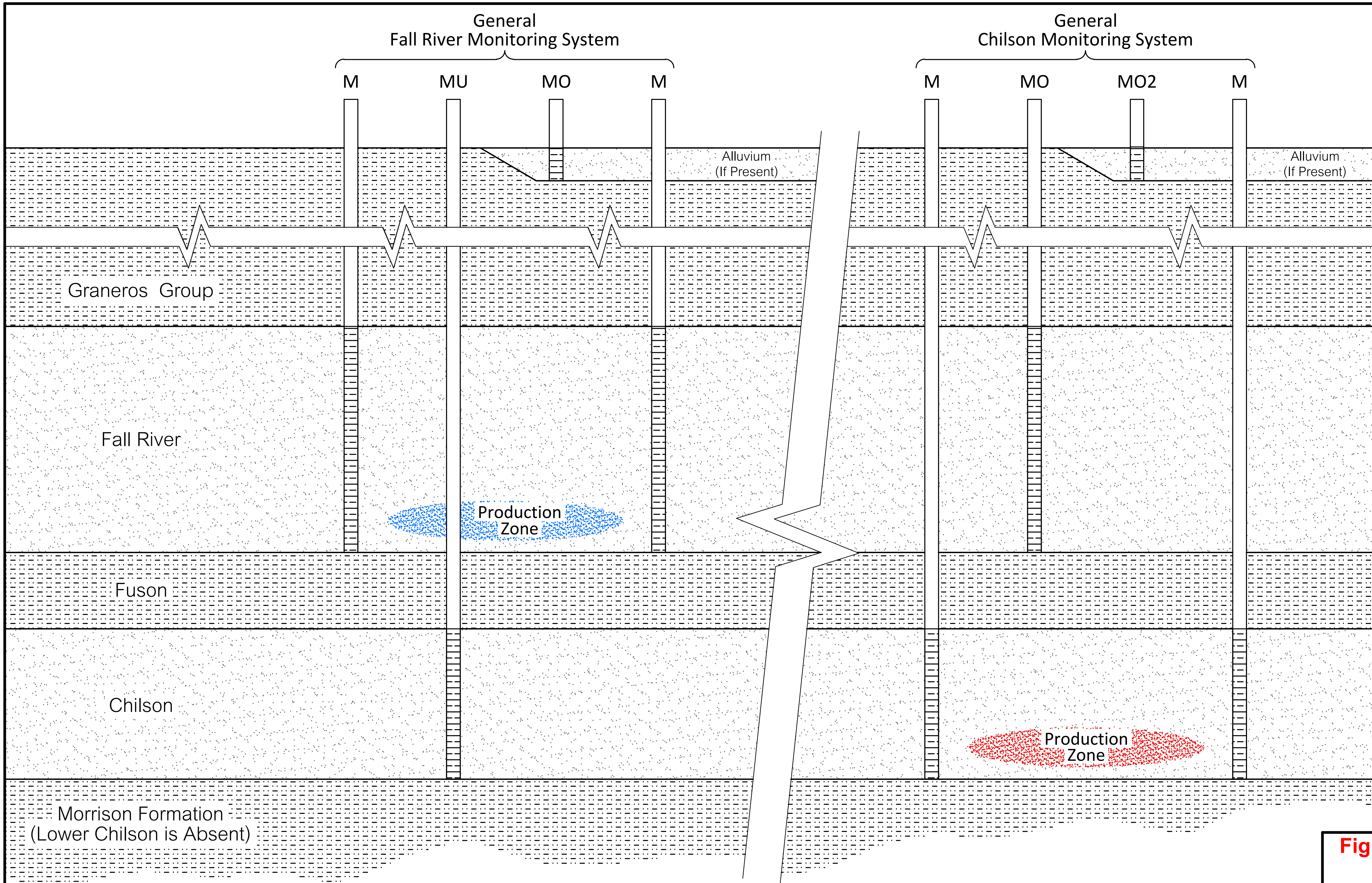
Figure TR RAI 5.7.8-12-4 depicts the type log for D-WF1. This type log depicts the various hydrogeologic units that Powertech anticipates monitoring as described above.

In some cases, the production zone of one well field will be in the immediately overlying hydrogeologic unit of another well field. Monitoring for all hydrogeologic units will be continued in the same fashion as described above with the exception that the overlying monitor wells will be excluded from the production zone of an immediately overlying well field. This will only occur inside the perimeter well ring of the overlying well field.

As an example, Figure TR RAI 5.7.8-12-2 shows the monitoring configuration of a production zone in the Upper Chilson in the Burdock area, B-WF3. When this well field is developed, there could be some MO2 wells in the Upper Chilson associated with a previous well field developed in the Lower Chilson within its perimeter monitor ring. When injection is started, use of these former MO2 wells for monitoring will cease. However, all other monitor wells for the Upper Fall River, Lower Fall River, Upper Chilson, and Middle Chilson associated with B-WF1 will remain in use.

In places where there is no confining layer between the Middle and Lower Chilson and they become a single hydrogeologic unit, then these will be treated as one unit for purposes of monitoring. If they are separate units within the entire area of the perimeter monitor ring of the well field, then they will be treated as separate hydrogeologic units and monitored separately.

During the ongoing well field development, the monitor well designations may change. However, the density of monitor wells in the overlying hydrogeologic units will remain as discussed above. Development of each well field monitoring system will be included in the hydrogeologic data packages prepared during the detailed design of each well field.



M - Monitor Ring in Production Sand
MU - Monitor Underlying Sand
MO - Monitor Overlying Sand (1 per 4 acres)
MO2 - Monitor Overlying Sand (1 per 8 acres)

Production Zone Legend
Fall River
Chilson

Figure TR RAI 5.7.8-12-1

General Monitor Well Configuration

Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	20-Jun-2011
FILENAME	Figure TR RAI 5.7.8-12-1.dwg

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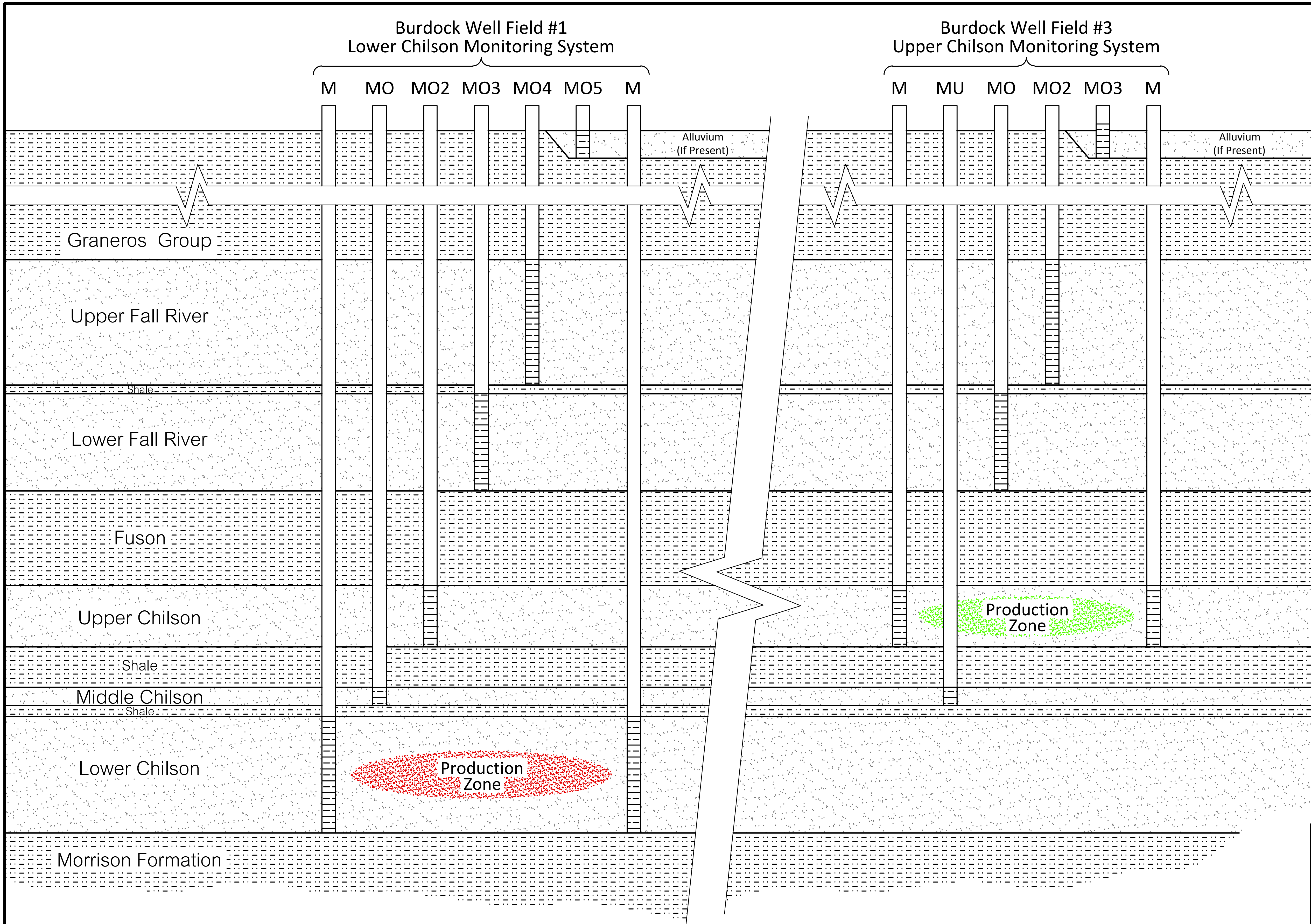

M - Monitor Ring in Production Sand
MU - Monitor Underlying Sand
MO - Monitor Overlying Sand (1 per 4 acres)
MO2, MO3, MO4, MO5 - Monitor Overlying Sand (1 per 8 acres)

Production Zone Legend
- Upper Chilson
- Lower Chilson

Figure TR RAI 5.7.8-12-2

Anticipated Burdock Monitor Well Configuration

Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	20-Jun-2011
FILENAME	Figure TR RAI 5.7.8-12-2.dwg

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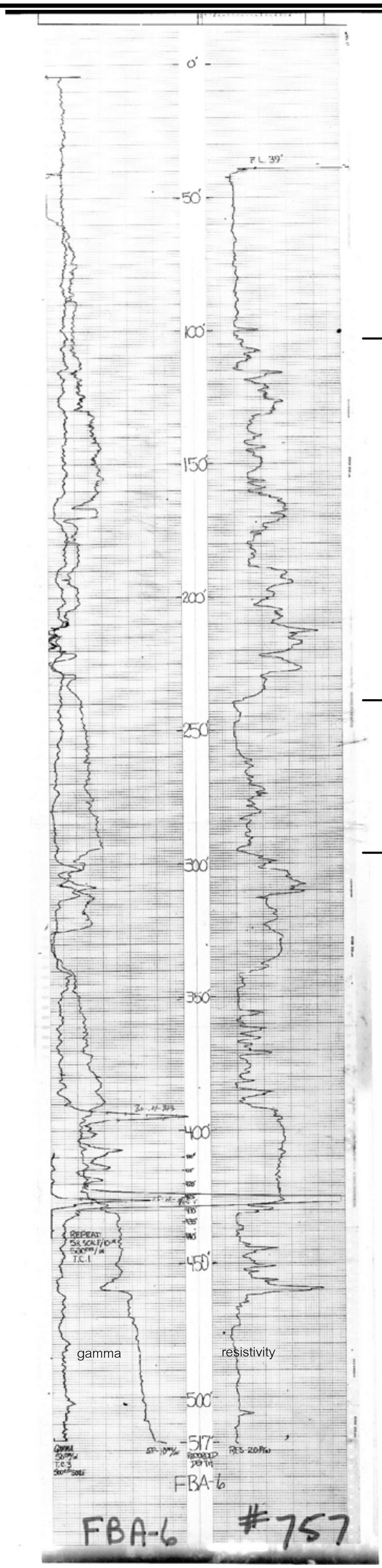

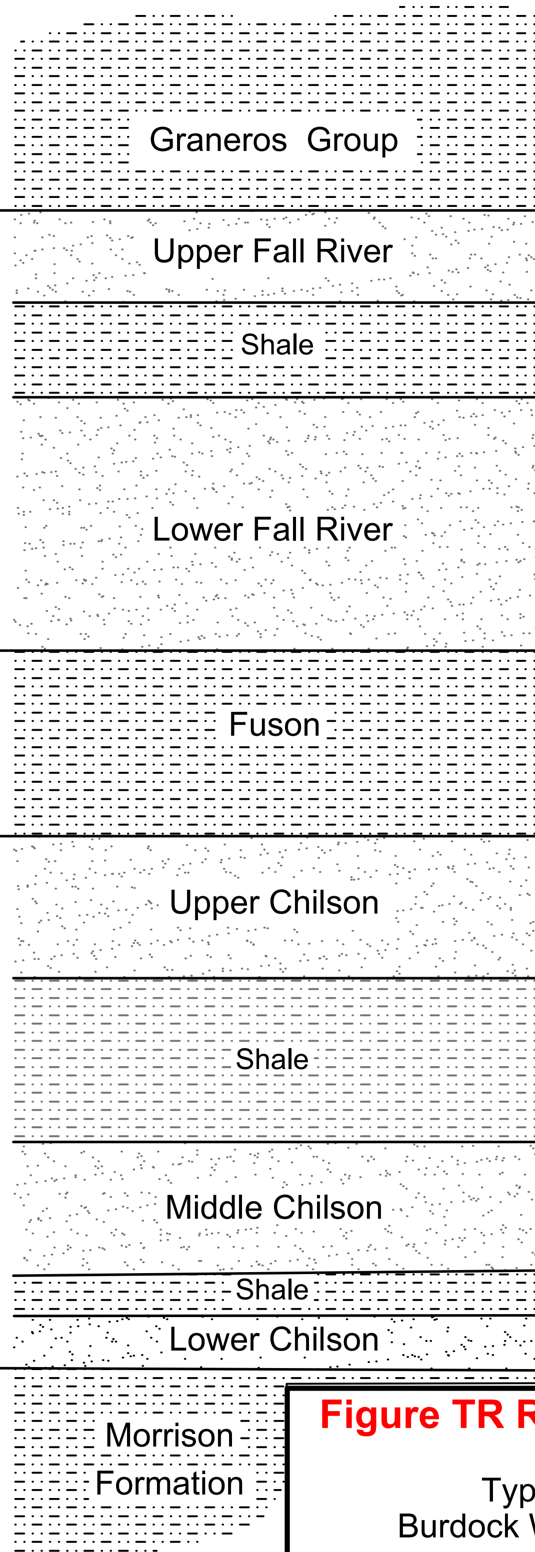

Figure TR RAI 5.7.8-12-3

Type Log
Burdock Well Field 1

Dewey-Burdock Project

DRAWN BY	Mays, Lichnovsky
DATE	20-Jun-2011
FILENAME	Figure TR RAI 5.7.8-12-3.dwg

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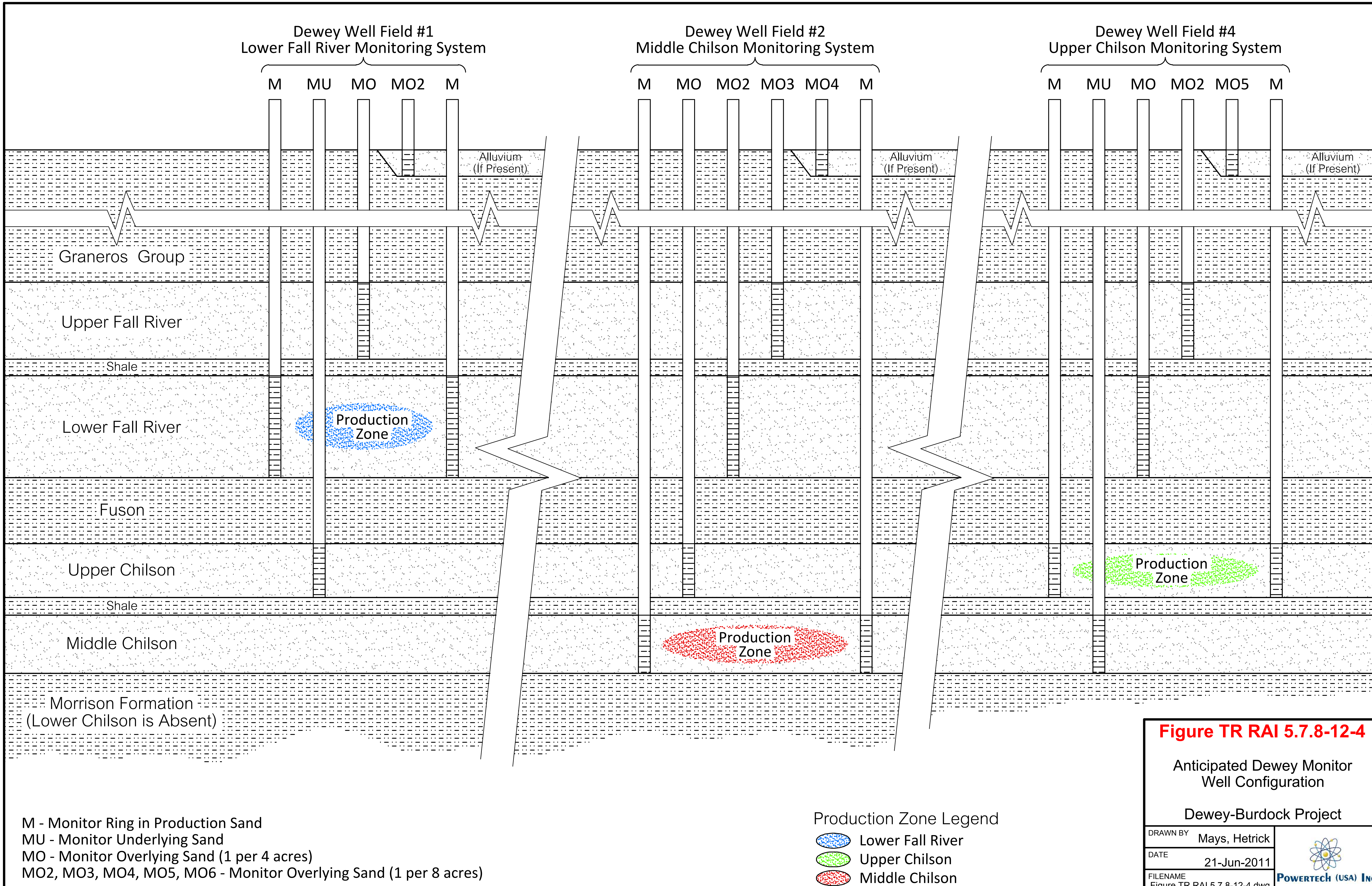
Dewey Well Field #1
Lower Fall River Monitoring System
M MU MO MO2 M
Dewey Well Field #2
Middle Chilson Monitoring System
M MO MO2 MO3 MO4 M
Dewey Well Field #4
Upper Chilson Monitoring System
M MU MO MO2 MO5 M
Alluvium (If Present)
Graneros Group
Upper Fall River
Shale
Lower Fall River
Production Zone
Fuson
Upper Chilson
Shale
Middle Chilson
Morrison Formation
(Lower Chilson is Absent)
M - Monitor Ring in Production Sand
MU - Monitor Underlying Sand
MO - Monitor Overlying Sand (1 per 4 acres)
MO2, MO3, MO4, MO5, MO6 - Monitor Overlying Sand (1 per 8 acres)
Production Zone Legend
Lower Fall River
Upper Chilson
Middle Chilson
Figure TR RAI 5.7.8-12-4
Anticipated Dewey Monitor Well Configuration
Dewey-Burdock Project
DRAWN BY Mays, Hetrick
DATE 21-Jun-2011
FILENAME Figure TR RAI 5.7.8-12-4.dwg
Powertech (USA) Inc.

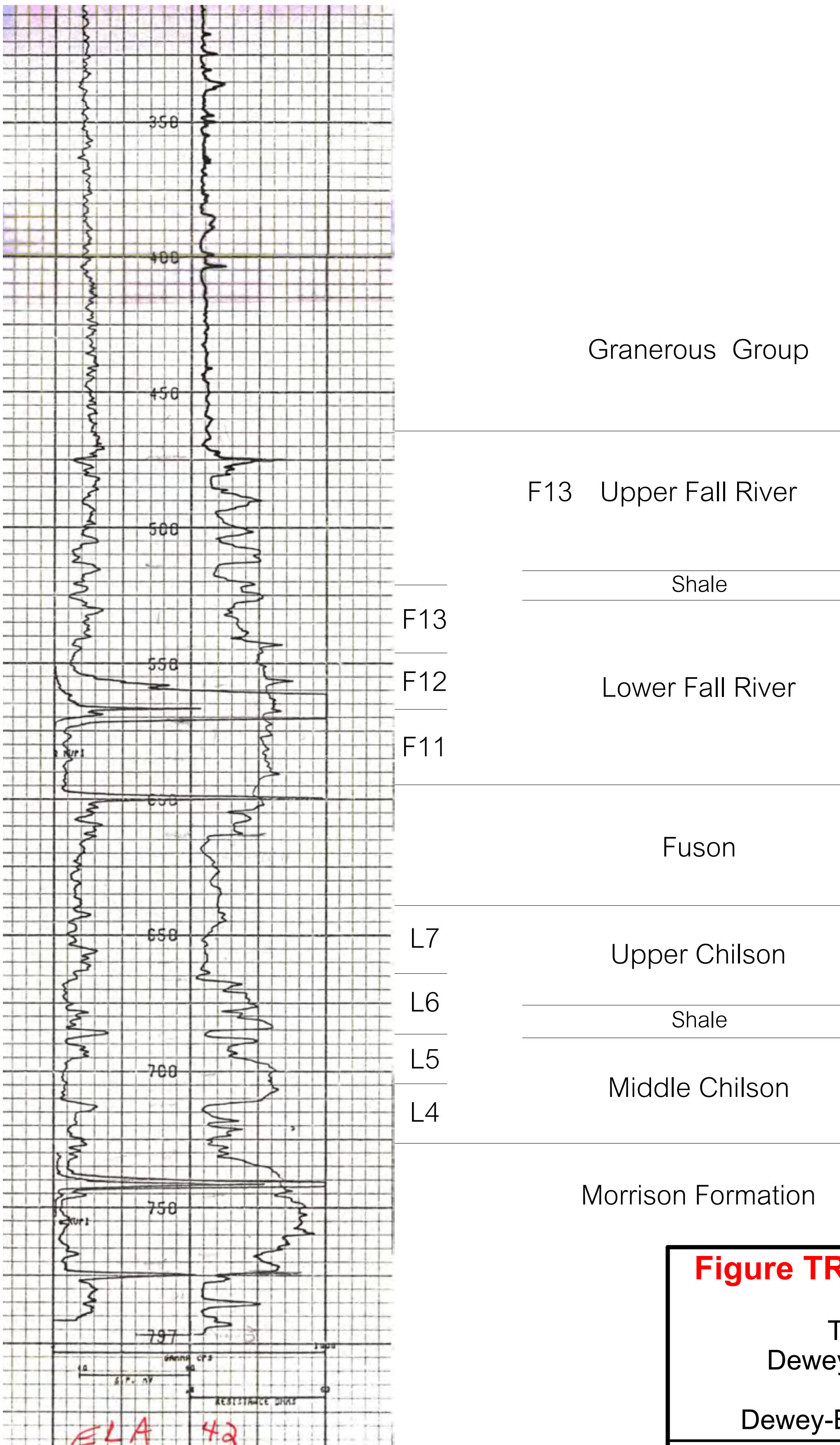

Figure TR RAI 5.7.8-12-5

Type Log
Dewey Well Field 1

Dewey-Burdock Project

DRAWN BY Bonner,Lichnovsky	Powertech (USA) Inc.
DATE 21-Jun-2011	
FILENAME Figure TR RAI 5.7.8-12-5.dwg	

<u>TR RAI 5.7.8-13</u>

On Page 3-16 of the Technical Report, the applicant indicates that monitoring wells will be completed in the underlying aquifer at a minimum of one well per four acres, but further states that wells will not be completed below the Lakota Formation due to the thickness and relatively impermeable nature of the underlying Morrison Formation. These statements appear to be contradictory in nature, unless the Lakota is considered to be the lower aquifer for a specific well field. Please provide clarification of the proposed monitoring of the lower aquifer, in particular, areas in which the applicant does not propose any monitoring wells in the lower aquifer.

<u>TR RAI 5.7.8-13 Response</u>

The proposed location of underlying non-production zone monitor wells is depicted in detail in Figures TR RAI 5.7.8-12-1, TR RAI 5.7.8-12-2 and TR RAI 5.7.8-12-4 in the response to TR RAI 5.7.8-12. Underlying wells are named with the prefix MU and are installed only in the first hydrogeologic unit below the production zone. The proposed density of the wells is one MU well per 4 acres of pattern area.

There will be some instances where a producing well field will be in the underlying hydrogeologic unit of an overlying well field. In these instances, MU wells associated with the overlying well field will not be installed within the perimeter monitor ring of the underlying well field. However, these MU wells will be installed directly below the overlying well field pattern area which is vertically outside of the perimeter monitor ring of the underlying well field.

In cases where the production zone is in the lower most hydrogeologic unit and is bounded below by the Morrison, no underlying non-production zone MU wells will be installed. An example of this is provided in Figure TR RAI 5.7.8-12-2, where the production zone for B-WF1 is in the Lower Chilson. Another example is shown in Figure TR RAI 5.7.8-12-4, where D-WF2 is in the Middle Chilson and there is no Lower Chilson.

<u>TR RAI 5.7.8-14</u>

NRC staff notes that Section 3.1 of the TR and Section 3.0 of the TR Supplement provides limited information concerning wellfield test procedures. NUREG-1569, Section 5.7.8.3 states, "The applicant establishes wellfield test procedures. Once a wellfield is installed, it should be tested to establish that the production and injection wells are hydraulically connected to the perimeter horizontal excursion monitor wells and are hydraulically isolated from the vertical excursion monitor wells. Such testing will serve to confirm the performance of the monitoring system and will verify the validity of the site conceptual model reviewed in Section 2 of this standard review plan. The reviewer should verify that well field test approaches have sound technical bases. Test approaches typically consist of a pumping test that subjects the well field to a sustained maximum withdrawal rate while monitoring the perimeter and vertical excursion wells for drawdown. The test should continue until the effects of pumping can be clearly seen via drawdown in the perimeter monitor wells. Typically, about 0.3 m [1 ft] of drawdown in the perimeter monitor wells will verify hydraulic connection, but the amount may vary because of the distance from the pumping wells, pumping rates, and hydraulic conductivity. To investigate vertical confinement or hydraulic isolation between the production zone and upper and lower aquifers, water levels in upper or lower aquifers may also be monitored during the pumping tests." Consistent with NUREG 1569, Section 5.7.8.3, please further describe wellfield test procedures that will be used.

<u>TR RAI 5.7.8-14 Response</u>

The following pump testing procedures will be used to establish that the production and injection wells are hydraulically connected to the perimeter production zone monitor wells, that the production and injection wells are hydraulically isolated from non-production zone vertical monitor wells, and to detect potentially improperly plugged wells or exploration holes. The following information will be included in the revised TR.

Pump Testing Design

An extensive pump test program will be designed and implemented prior to operation of each well field to evaluate the hydrogeology and assess the ability to operate the well field. Prior to pump testing several important well field development steps will be completed:

1) Delineation drilling at a spacing approximately equivalent to well field pattern size. As standard procedure, all delineation holes will be plugged and abandoned after drilling.
2) Detailed mapping of the ore bodies targeted for ISR operations and the lithology of overlying and underlying sand units and aquitards.
3) Revision of the conceptual geology and hydrogeology including definition of aquitards and sand units to be produced or monitored.
4) Design of the production and injection wells including well locations and screened intervals.
5) Design of the monitor well system based on production and injection well locations and refined conceptual geology and hydrogeology.
6) Specification of all monitor well locations and screened intervals.

7) Installation of all monitor wells and production wells used during pump testing.
8) Plugging and abandoning all water supply wells within ¼ mile of the well field or that have been determined through preliminary evaluation to be potentially impacted by ISR operations or to impact ISR operations.

Pump Testing Procedures

The entire monitoring system for the well field will be monitored during the pumping test, including but not necessarily limited to the following wells:

1) Pumping wells,
2) Monitor wells within the production zone (at a minimum density of 1 per 4 acres),
3) Perimeter production zone monitor wells,
4) Monitor wells in the immediately overlying non-production zone sand unit (at a minimum density of 1 per 4 acres),
5) Monitor wells in each subsequently overlying non-production zone sand unit (at a minimum density of 1 per 8 acres),
6) Monitor wells in the alluvium, if present (at a minimum density of 1 per 8 acres),
7) Monitor wells in the immediately underlying non-production zone sand unit, if the production zone does not occur immediately above the Morrison Formation (at a minimum density of 1 per 4 acres),
8) Any additional wells installed for investigating other hydrogeologic features, and
9) Any other wells within proximity to the well field that have been identified as having the potential to impact or be impacted by ISR operations.

All monitoring system wells will be monitored using downhole data logging pressure transducers, which will be corrected for variations in barometric pressure.

Prior to testing, static potentiometric water levels will be measured in every well in the monitoring system. These data will be used to map the preoperational potentiometric surface for each unit including alluvium, where present. Because of the high density of wells and artesian conditions at the site, any leakage across aquitards due to improperly plugged boreholes or wells will typically become apparent while preparing potentiometric surface maps. Four water samples will be collected from each monitor well and analyzed for the parameters in Table 6.1-1. The water quality will be evaluated to identify any potential areas of leakage across aquitards due to improperly plugged boreholes or wells.

Pump testing will involve inducing stress on the production zone sand unit by operating pumping wells. The goal of the test will be to cause drawdown in the production zone extending to all perimeter monitor wells. More than one pumping well may be required to create drawdown in all perimeter monitor wells. Pump testing will create a cone of depression across the well field area to test the

confinement between the production zone and the overlying and underlying sand units and alluvium, if present. The presence or lack of response in vertical monitor wells will be used for evaluation of confinement between these units and for identification of leakage due to anomalies such as improperly plugged boreholes. If leakage is present, the relative responses in the overlying, underlying, and/or alluvial monitor wells will indicate the proximity and direction towards the source of leakage.

If saturated alluvium is present within the well field, alluvial monitor wells will be installed and monitored above the production zone and within an appropriate distance from the well field. The water level in the alluvium will be mapped prior to testing and monitored during pump testing. If the potentiometric surface of the production zone unit rises above the base of the alluvium, pump testing will create sufficient drawdown to lower the production zone unit potentiometric surface below the lowest elevation of the alluvium in the well field. If there are anomalous conditions that cause communication between the production zone and alluvium such as an improperly plugged borehole, these conditions will be identified through responses in the alluvial monitor wells.

The pumping test duration will be sufficient to create a suitable response in the perimeter monitor wells. Typically, this will be a minimum drawdown of 1 foot in each perimeter monitor well. If hydrogeologic conditions dictate, less response may be justified.

The flow rate of the pumping test will be greater than or equal to the maximum well field bleed or the maximum expected flow rate of a single production well, whichever is greater.

Measurements during pump testing will include instantaneous and totalized flow, continuous pressure transducer measurements, barometric pressure, and time. A step rate test will be performed initially. There will be an initial stabilization phase with no flow, a stress period of constant flow, and a recovery period with no flow. During the entire test downhole pressure transducers will collect data in each monitor well.

Pump Test Evaluation

Evaluation of pump test data will address the following:

- Demonstration of hydraulic connection across the production zone and between the production and injection wells and all perimeter monitor wells.
- Confirmation that all monitor wells can suitably detect an excursion.
- Verification of the geologic conceptual model for the well field.
- Evaluation of the vertical confinement and hydraulic isolation between the production zone and overlying and underlying units.
- Demonstration that solutions can be controlled with a typical well field bleed.

- Calculation of the hydraulic conductivity, storativity, and transmissivity of the production zone sand unit.
- Evaluation of anisotropy within the production zone sand unit.
- Calculation of anticipated drawdown during ISR operation at typical bleed rates.
- Detection of potentially improperly plugged wells or exploration boreholes.

Well Field Hydrogeologic Data Packages

Pumping test data and results will be included in the Well Field Hydrogeologic Data Packages. Upon completion of field data collection and laboratory analysis, the Well Field Hydrogeologic Data Package will be assembled and submitted for review by the Safety and Environmental Review Panel (SERP) for evaluation. The SERP evaluation will determine whether the results of the hydrologic testing and the planned ISR operations are consistent with standard operating procedures and technical requirements stated in the source and byproduct material license. The evaluation will include review of the potential impacts to human health and environment. If anomalous conditions are present or the SERP evaluation indicates potential to impact human health or the environment, the Well Field Hydrogeologic Data Package will be submitted to NRC for review and approval. Otherwise, the Well Field Hydrogeologic Data Package and written SERP evaluation will be maintained at the site and available for NRC review.

A Well Field Hydrogeologic Data Package will contain the following:

1) A description of the proposed well field (location, extent, etc.).
2) Map(s) showing the proposed production and injection well patterns and locations of all monitor wells.
3) Geologic cross sections and cross section location maps.
4) Isopach maps of the production zone sand and overlying and underlying confining units.
5) Discussion of how pump testing was performed, including well completion reports.
6) Discussion of the results and conclusions of the pump testing, including pump testing raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and, when appropriate, directional transmissivity data and graphs.
7) Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns.
8) Baseline water quality information including proposed UCLs for monitor wells and target restoration goals (TRGs).
9) Any other information pertinent to the proposed well field area tested will be included and discussed.

<u>TR RAI 5.7.8-15</u>

Consistent with NUREG-1569, NRC staff notes that the excursion monitoring program does not contain the monitoring frequency and the criteria for determining when an excursion has occurred. NUREG-1569 states, "The applicant defines operational approaches for the monitoring program. The monitoring program must indicate which wells will be monitored for excursion indicators, the monitoring frequency, and the criteria for determining when an excursion has occurred. An acceptable excursion monitoring program should indicate that all monitor wells will be sampled for excursion indicators at least every 2 weeks during in situ recovery operations. An excursion is deemed to have occurred if two or more excursion indicators in any monitor well exceed their upper control limits. A verification sample must be taken within 48 hours after results of the first analyses were received. If the second sample does not indicate that upper control limits were exceeded, a third sample must be taken within 48 hours after the second set of sampling data was acquired. If neither the second nor the third sample indicates that upper control limits are exceeded, the first sample is considered in error, and the well is removed from excursion status. If either the second or third sample contains indicators above upper control limits, an excursion is confirmed, the well is placed in excursion status, and corrective action must be initiated." Please provide the above-referenced information.

<u>TR RAI 5.7.8-15 Response</u>

The following information will be included in the revised TR.

All monitor wells will be sampled for excursion indicators at least twice per month during ISR operations.

The monitoring program for excursion detection has been designed to comply with NRC guidance of NUREG-1569, Acceptance Criterion 5.7.8.3(5) (NRC, 2003a). An excursion will be deemed to have occurred if two or more excursion indicators in any monitor well exceed their upper control limits (UCLs). A verification sample will be taken within 48 hours after results of the first analyses are received. If the results of the verification sampling are not complete within 30 days of the initial sampling event, then the excursion will be considered confirmed for the purpose of meeting the reporting requirements described below. If the excursion is not confirmed by the verification sample, a third sample will be taken within 48 hours after the second set of sampling data are received. If neither the second nor the third sample confirms the excursion by two indicators exceeding their UCLs, the first sample will be considered to have been in error, and the well will be removed from excursion status. If either the second or third sample exhibits two or more indicators above their UCLs, an excursion will be confirmed, the well will be placed on confirmed excursion status, and corrective action will be initiated.

TR RAI 5.7.8-16

NRC staff notes that corrective action and notification plans were not provided consistent with Section 5.7.8.3 of NUREG -569, which states, "The excursion monitoring operational procedures must also include corrective action and notification plans in the event of an excursion...." Please provide the above referenced information.

TR RAI 5.7.8-16 Response

The following information will be included in the revised TR.

Corrective action to retrieve an excursion will include adjusting the flow rates of the pumping and injection wells to increase the aquifer bleed in the area of the excursion. The sampling frequency will be increased to weekly. The NRC will be notified within 24 hours by telephone and within 7 days in writing from the time an excursion is verified. A written report describing the excursion event, corrective actions taken and the corrective action results will be submitted to NRC within 60 days of the excursion confirmation.

If wells are still on excursion status when the report is submitted, the report will also contain a schedule for submittal of future reports describing the excursion event, corrective actions taken, and results obtained. In accordance with NUREG-1569, p. 5-44, if an excursion is not corrected within 60 days of confirmation, Powertech will terminate injection of lixiviant into the affected portion of the well field until the excursion is retrieved, or provide an increase to the reclamation financial assurance obligation in an amount that is agreeable to NRC and that would cover the expected full cost of correcting and cleaning up the excursion. The financial assurance increase will remain in force until the excursion is corrected. The written 60-day excursion report will state and justify which course of action will be followed. If wells are still on excursion status at the time the 60-day report is submitted to NRC, and the financial assurance option is chosen, the well field restoration financial assurance obligation will be adjusted upward. To calculate the increase in financial assurance for horizontal excursions, it will be assumed that the entire thickness of the confined operating horizon between the well field and the monitor well(s) on excursion contains lixiviant. The width of the excursion is assumed to be the distance between the monitor wells on excursion status plus one monitor well spacing distance on either side of the excursion. When the excursion is corrected, the additional financial assurance obligations resulting from the excursion will be removed.

<u>TR RAI 5.7.8-17</u>

Section 5.7.8 of the TR states, "Quarterly samples will be collected from drinking water and livestock wells, included in the groundwater sampling sites as shown in Figure 5.7-10." This statement implies there are more proposed well sampling locations than what is shown in Figure 5.7-8. NRC staff notes that numerous Inyan Kara wells in Appendix 2.2-A are close to well fields within the license boundary and are not included in Figure 5.7-10. Please specify all water well sampling locations.

<u>TR RAI 5.7.8-17 Response</u>

The following describes the operational groundwater monitoring program proposed by Powertech. For a list of the water supply wells within 2 km of the project area, please refer to the response to TR RAI P&R-10. The following information will also be incorporated into the revised TR.

The operational groundwater monitoring program will include domestic wells, stock wells and wells located hydrologically upgradient and downgradient of proposed activity. Powertech proposes an alternate operational groundwater monitoring program to what is recommended in Regulatory Guide 4.14. The proposed operational monitoring program is designed to provide a comprehensive baseline evaluation of water supply wells located within 2 km of the proposed license boundary. This is a conservative approach, since the minimum search radius in Regulatory Guide 4.14 guidance is 2 km from the "proposed tailings area," which could be interpreted as the monitor well ring. Wells proposed for operational monitoring include domestic wells within 2 km of the project area, stock wells within the project area, and additional monitor wells in the alluvium, Fall River, Chilson and Unkpapa.

Prior to operations all domestic and stock wells within 2 km of the project area will be sampled to establish baseline water quality. A complete list of the wells is provided the response to TR RAI P&R-10. As discussed in Section 2.7 of the TR, Powertech has already monitored many of the wells included in the list as part of the baseline monitoring program. To meet the recommendations of Regulatory Guide 4.14, Powertech will ensure that all domestic and stock wells within 2 km of the project area are monitored quarterly for one year prior to operation (including monitoring already completed). All samples will be analyzed for constituents listed in Table 6.1-1 in the response to TR RAI 6.1-3, which meets the criteria listed in NUREG-1569 and Regulatory Guide 4.14.

<u>Operational Groundwater Monitoring - Domestic Wells</u>

Prior to operations, all domestic wells within the project area will be removed from private use. Depending on the well construction, location and screen interval, Powertech may continue to use the well for monitoring or plug and abandon the well. Plugging and abandonment procedures are described in the response to TR RAI P&R-9 and well replacement procedures are described in the response to TR RAI P&R-10.

During operations, Powertech will monitor all domestic wells within 2 km of the project boundary. Samples will be collected annually and analyzed for the constituents listed in Table 6.1-1 in the response to TR RAI 6.1-3.

Operational Groundwater Monitoring - Stock Wells

During the design of each well field, all nearby stock wells will be evaluated for the potential to be adversely affected by ISR operations or to adversely affect ISR operations. At a minimum, all stock wells within ¼ mile of well fields will be removed from private use prior to operation of nearby well fields. Depending on the well construction, location and screen interval, Powertech may continue to use the well for monitoring or plug and abandon the well. Plugging and abandonment procedures are described in the response to TR RAI P&R-9 and well replacement procedures are described in the response to TR RAI P&R-10.

During operation, Powertech will monitor all stock wells within the project area. Samples will be collected quarterly and analyzed for water level and the three excursion indicators of chloride, total alkalinity, and conductivity.

Operational Groundwater Monitoring - Monitor Wells

As recommended in Regulatory Guide 4.14, Powertech will monitor wells located hydrologically upgradient and downgradient of proposed activity as part of the operational groundwater monitoring program. A list of the monitor wells proposed for operational monitoring is provided in Table TR RAI 5.7.8-17-1. Monitor wells proposed for operational monitoring are depicted on Figures TR RAI 5.7.8-17-1, -2, -3, -4, -5, and -6.

The monitor wells will be monitored quarterly and analyzed for constituents listed in the revised Table 6.1-1.

Monitoring conducted as part of the pre-operational and operational monitoring program will be conditional upon land owner access and suitable conditions allowing proper collection of a sample. If access is not available during the time of monitoring, a second attempt will be made to collect a sample during the monitoring period. If a well cannot be accessed continually, Powertech will propose an alternate monitoring location or remove the well from the operational groundwater monitoring program.

Table TR RAI 5.7.8-17-1: Monitor Wells Proposed for Operational Monitoring

Well ID	Qtr-Qtr	Section	Township	Range	Relative Position
Alluvium					
676	SESW	34	6S	1E	Downgradient of Land App.
677	SWSW	27	6S	1E	Downgradient
678	SWNE	4	7S	1E	Downgradient
679	NESW	9	7S	1E	Upgradient
707	SWNE	34	6S	1E	Downgradient of Triangle Pit
708	SESW	3	7S	1E	Downgradient of Land App.
709	SENW	15	7S	1E	Downgradient of Well Field
Proposed	NWNW	20	6S	1E	Upgradient
Proposed	NENE	31	6S	1E	Downgradient of Well Field
Proposed	NWSE	32	6S	1E	Downgradient of Well Field
Proposed	NWNW	20	6S	1E	Downgradient of Land App.
Fall River					
631	SWSW	23	6S	1E	Upgradient
681	NWNE	32	6S	1E	Production Zone
688	NESW	11	7S	1E	Overlying Production Zone
694	NWNW	15	7S	1E	Upgradient
695	SESE	32	6S	1E	Downgradient
698	SENW	2	7S	1E	Downgradient
706	NENE	21	6S	1E	Upgradient
Proposed	SWNE	34	6S	1E	Downgradient of Triangle Pit
Proposed	NWSE	2	7S	1E	Downgradient of Darrow Pit
Chilson					
43	SWSE	34	6S	1E	Downgradient of Triangle Pit
680	NESW	11	7S	1E	Production Zone
689	NENW	32	6S	1E	Production Zone
696	NWNW	15	7S	1E	Downgradient
697	SESE	32	6S	1E	Downgradient
705	NENE	21	6S	1E	Upgradient
3026	SESE	12	7S	1E	Upgradient
Proposed	SWSE	2	7S	1E	Downgradient of Darrow Pit
Unkpapa					
690	NESW	11	7S	1E	
693	NENW	32	6S	1E	
703	SWSE	1	7S	1E	

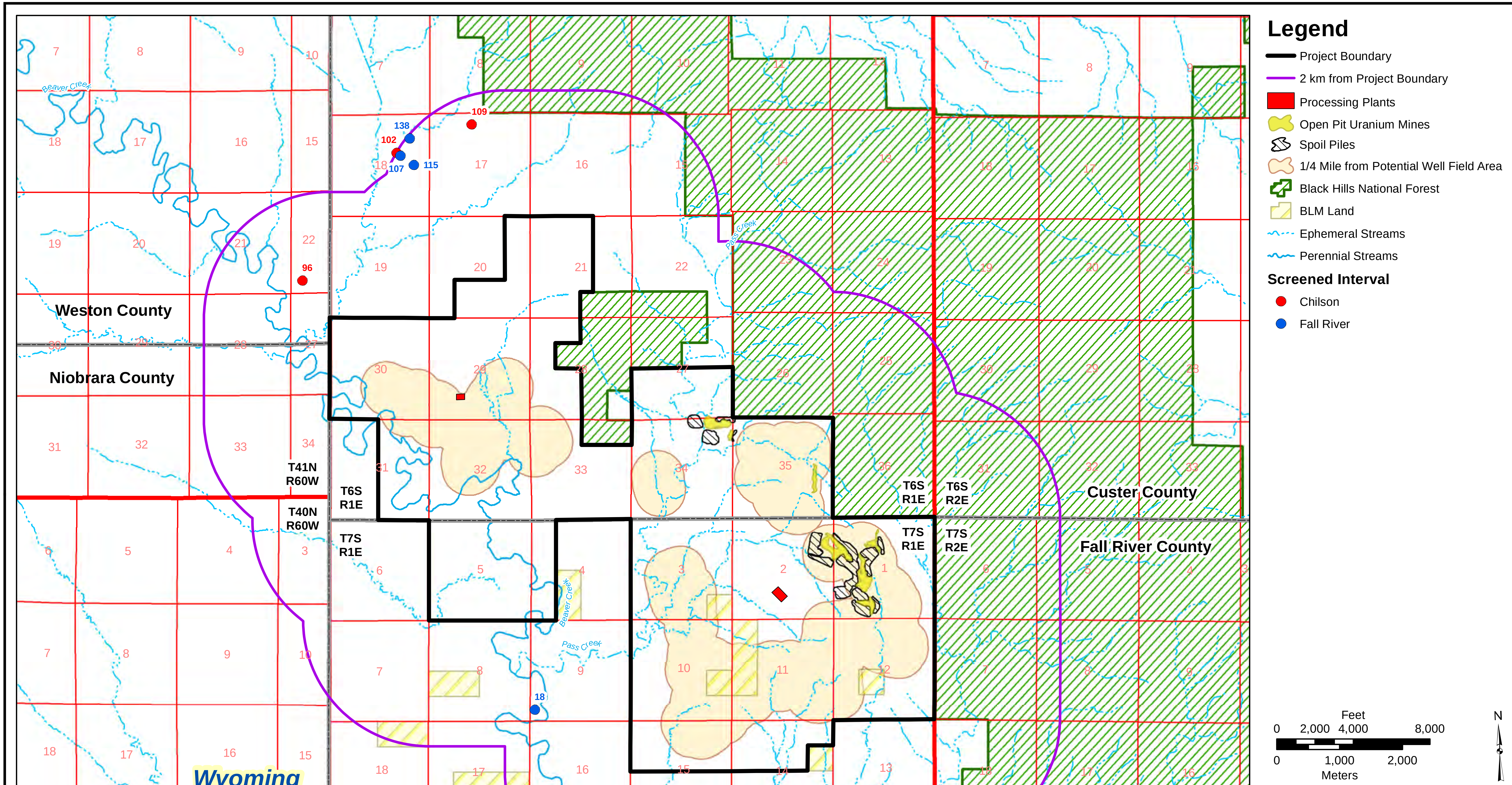

Figure TR RAI 5.7.8-17-1

Domestic Wells Operational Monitoring Locations

Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	21-Jun-2011
FILENAME	Figure TR RAI 5.7.8-17-1.mxd

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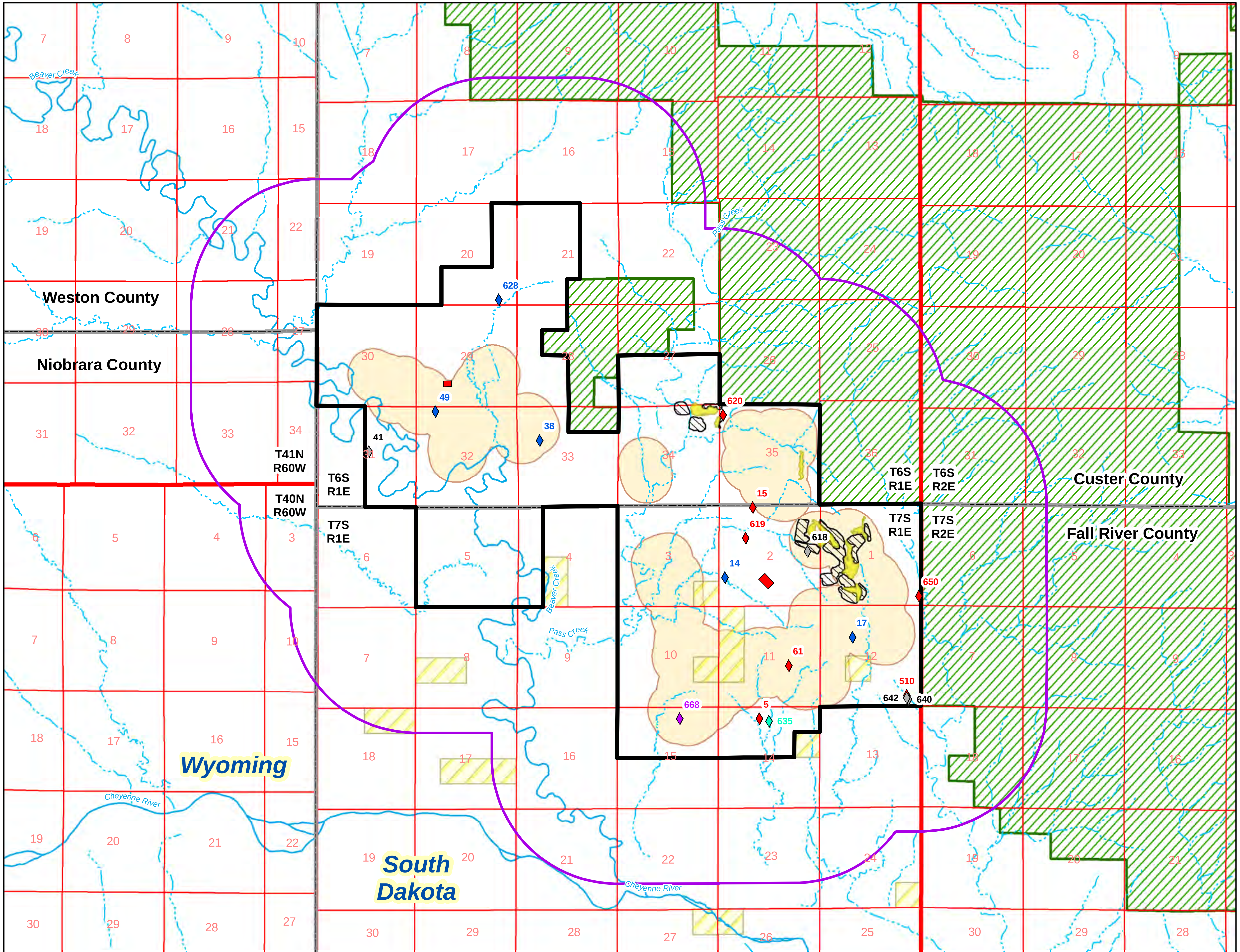


Figure TR RAI 5.7.8-17-2

Stock Wells Operational Monitoring Locations

Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	23-Jun-2011
FILENAME	Figure TR RAI 5.7.8-17-2.mxd

POWERTECH (USA) INC.

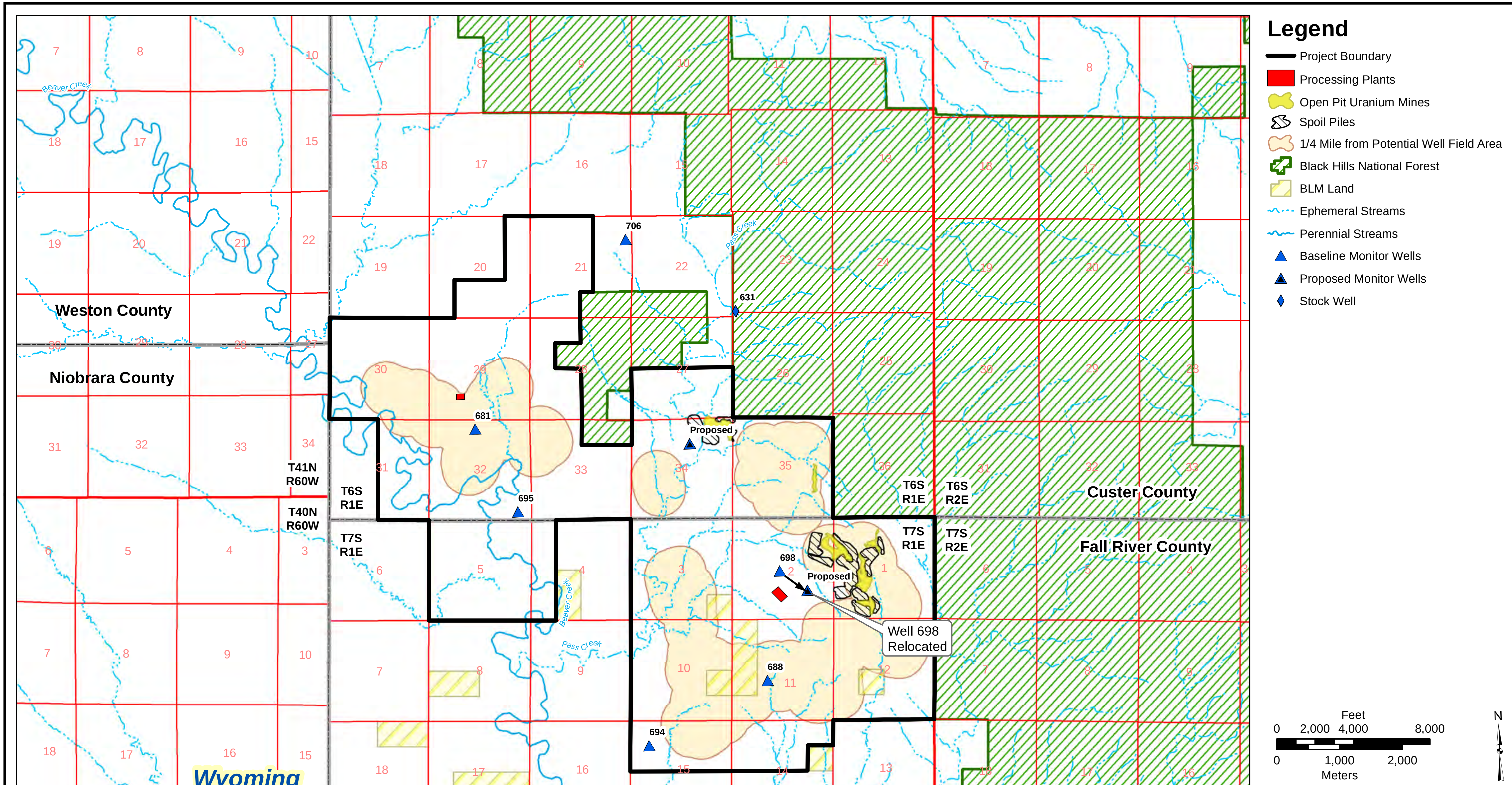


Figure TR RAI 5.7.8-17-3

Fall River Wells Operational Monitoring Locations

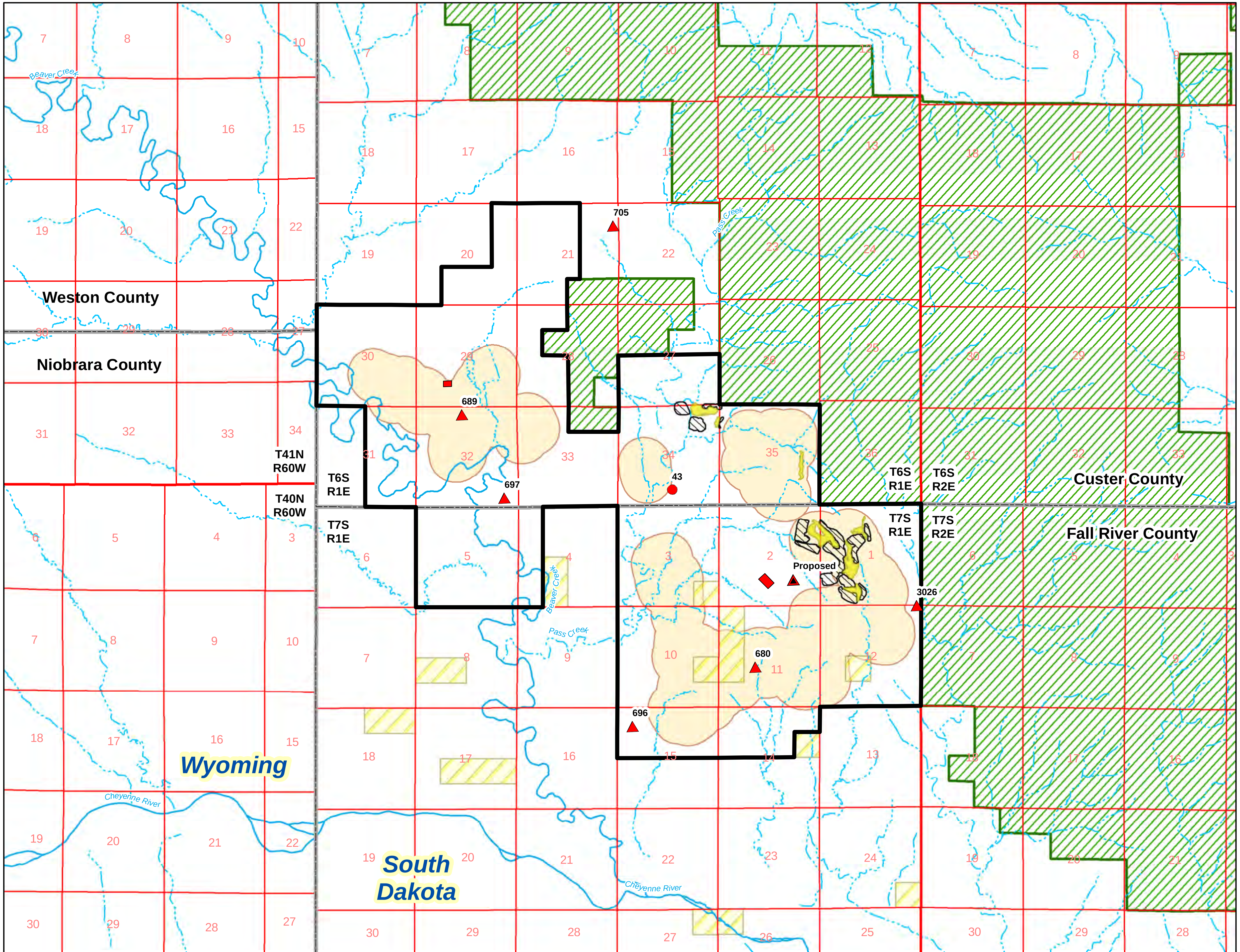
Dewey-Burdock Project

DRAWN BY Mays, Hetrick

DATE 21-Jun-2011

FILENAME Figure TR RAI 5.7.8-17-3.mxd

POWERTECH (USA) INC.



Legend

- Project Boundary
- Processing Plants
- Open Pit Uranium Mines
- Spoil Piles
- 1/4 Mile from Potential Well Field Area
- Black Hills National Forest
- BLM Land
- Ephemeral Streams
- Perennial Streams
- Proposed Monitor Well
- Monitor Wells
- Domestic to be Converted to Monitor

Feet
0 2,000 4,000 8,000
0 1,000 2,000
Meters
N

Figure TR RAI 5.7.8-17-4

Chilson Wells Operational Monitoring Locations

Dewey-Burdock Project

DRAWN BY	Mays, Hetrick
DATE	21-Jun-2011
FILENAME	Figure TR RAI 5.7.8-17-4.mxd

POWERTECH (USA) INC.

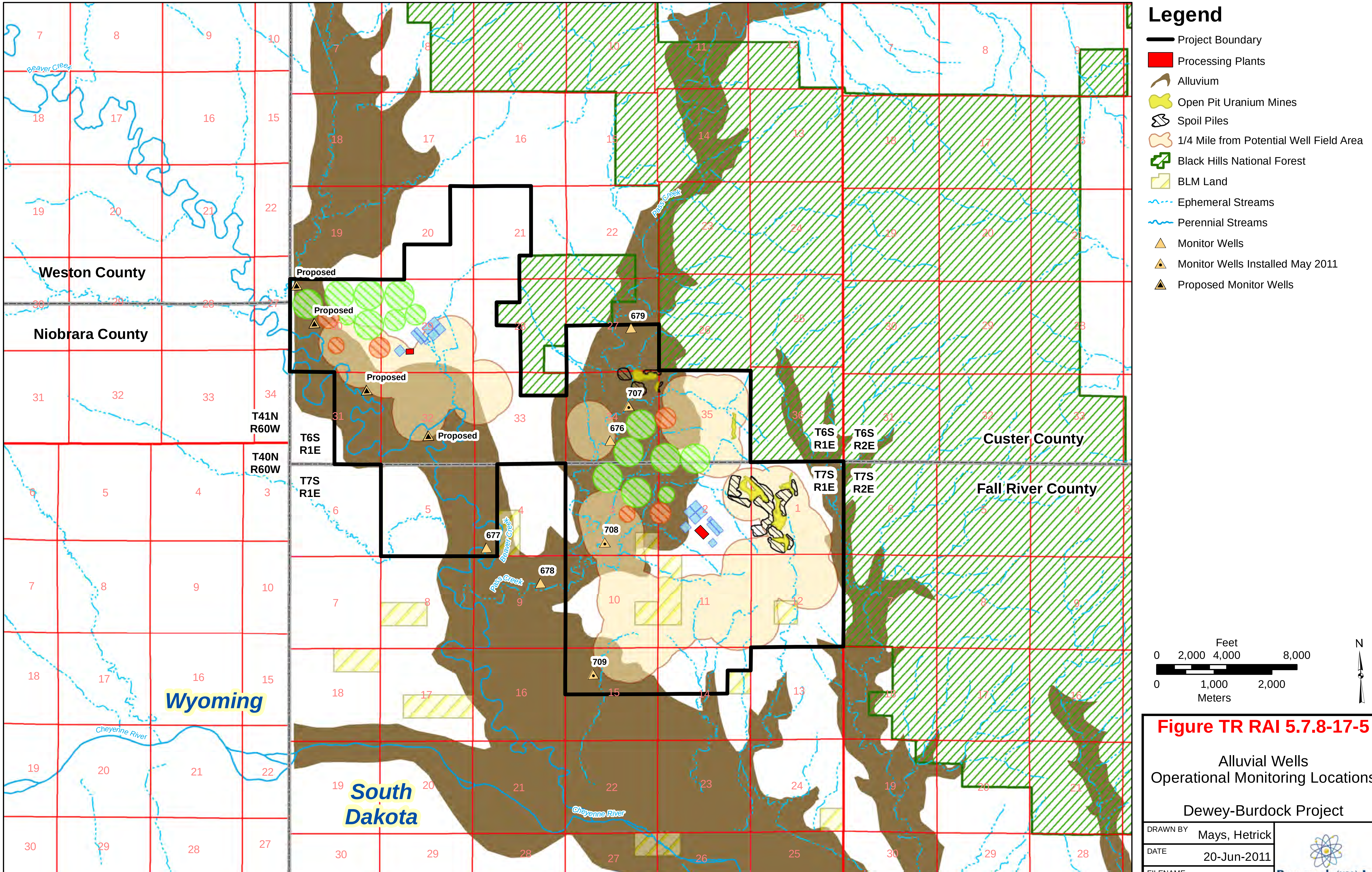


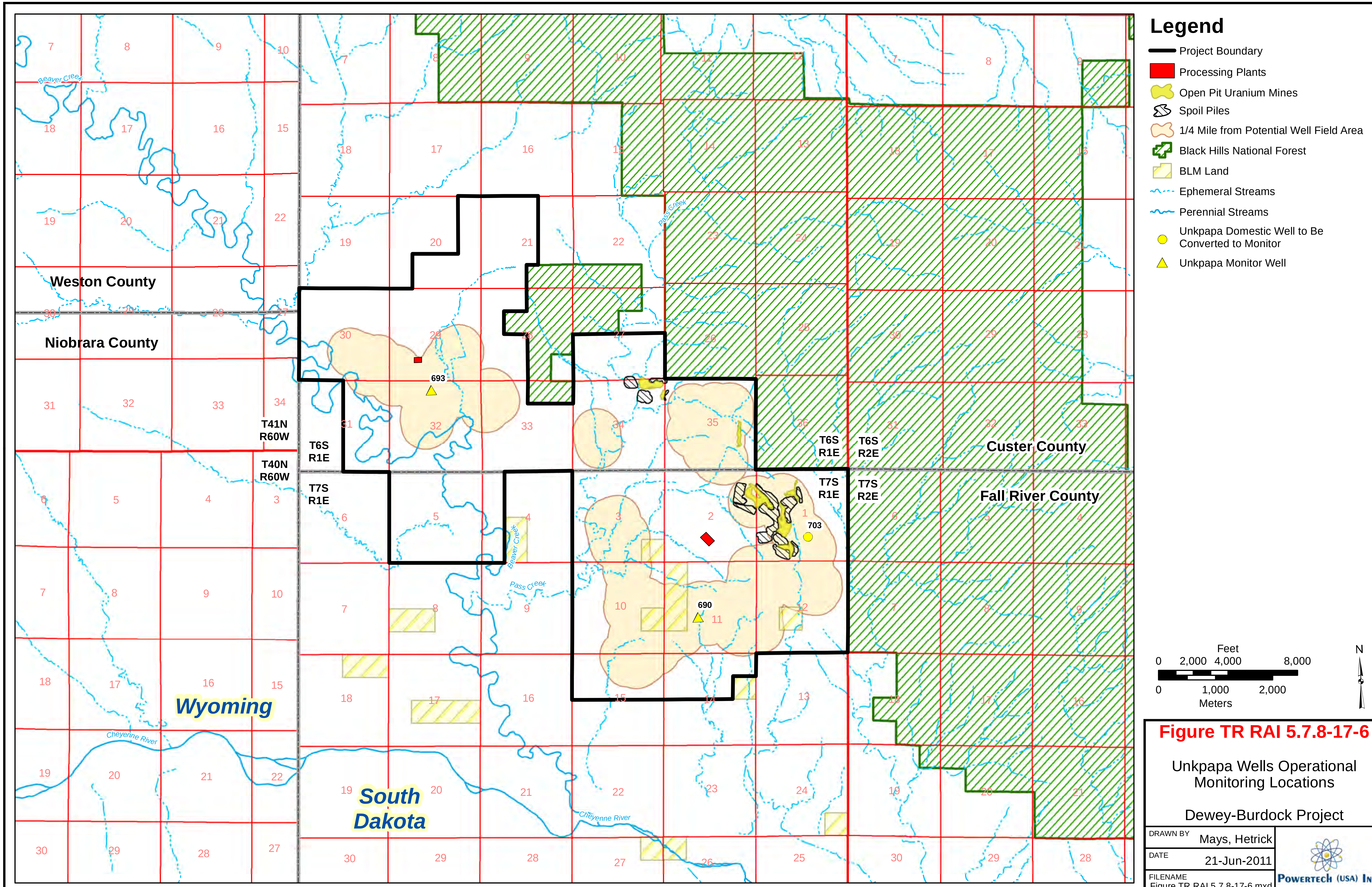
Figure TR RAI 5.7.8-17-5

Alluvial Wells
Operational Monitoring Locations

Dewey-Burdock Project

DRAWN BY Mays, Hetrick
DATE 20-Jun-2011
FILENAME Figure TR RAI 5.7.8-17-15.mxd

Powertech (USA) Inc.


Legend
Project Boundary
Processing Plants
Open Pit Uranium Mines
Spoil Piles
1/4 Mile from Potential Well Field Area
Black Hills National Forest
BLM Land
Ephemeral Streams
Perennial Streams
Unkpapa Domestic Well to Be Converted to Monitor
Unkpapa Monitor Well
Weston County
Niobrara County
Custer County
Fall River County
Wyoming
South Dakota
T41N R60W
T40N R60W
T6S R1E
T7S R1E
T6S R2E
T7S R2E
693
703
690
Beaver Creek
Pass Creek
Cheyenne River
Feet
0 2,000 4,000 8,000
0 1,000 2,000
Meters
N
Figure TR RAI 5.7.8-17-6
Unkpapa Wells Operational Monitoring Locations
Dewey-Burdock Project
DRAWN BY Mays, Hetrick
DATE 21-Jun-2011
FILENAME Figure TR RAI 5.7.8-17-6.mxd
POWERTECH (USA) INC.

Powertech (USA) Inc.

<u>TR RAI 5.7.8-18</u>

Section 5.7.8.3 of NUREG 1569 states, "Any surface-water body that lies within the proposed license boundary should be sampled at upstream and downstream locations, both before and during operations. The pre-operational data should be collected on a seasonal basis for a minimum of 1 year before* in situ *leach operations."

<u>TR RAI 5.7.8-18(a)</u>

a. ***NRC staff notes that surface water sampling locations indicated in Section 5.7.8 and Figure 5.7-10 of the TR do not include an upstream location for Beaver Creek and a downstream location for Pass Creek where it exits the site. Consistent with Section 5.7.8.3 of NUREG 1569, please include the above-referenced surface water sampling locations.***

<u>TR RAI 5.7.8-18(a) Response</u>

The following information will be incorporated into the revised TR.

Please refer to the response to TR RAI 5.7.8-2, which describes the operational surface water monitoring program as it has been revised to respond to these RAIs. Exhibit 5.7-I shows the revised operational surface water sampling sites.

TR RAI 5.7.8-18

Section 5.7.8.3 of NUREG 1569 states, "Any surface-water body that lies within the proposed license boundary should be sampled at upstream and downstream locations, both before and during operations. The pre-operational data should be collected on a seasonal basis for a minimum of 1 year before **in situ** ***leach operations."***

TR RAI 5.7.8-18(b)

b. ***NRC staff notes that the application did not include a commitment to collecting pre-operational data on a seasonal basis for a minimum of 1 year before in situ recovery operations. Consistent with Section 5.7.8.3 of NUREG 1569, please commit to collecting pre-operational data on a seasonal basis for a minimum of 1 year before in situ recovery operations.***

TR RAI 5.7.8-18(b) Response

Please refer to the responses to TR RAI 2.9-43(a) and TR RAI 2.9-43(b), which describe the monitoring Powertech will complete prior to ISR operations to satisfy Regulatory Guide 4.14 and NUREG-1569 recommendations. The following will be incorporated into the revised TR.

Powertech commits to monitor 24 impoundments and 10 stream sampling sites as part of the operational surface water monitoring program. Each of the impoundments will be visited four times (including baseline samples already completed) prior to ISR operations to assess baseline water quality. Stream sampling sites on Beaver Creek (BVC11 and BVC14) and the Cheyenne River (CHR01 and CHR05) will be visited monthly for a 12-month period (including baseline samples already collected) prior to ISR operations. In addition, passive samplers will be installed at the six remaining stream sampling sites, which are located on ephemeral drainages, to automatically sample during flow events. Water samples will be analyzed for constituents listed in Table 2.7-22 of the TR, which includes the parameters listed in Table 2.7.3-1 of NUREG-1569 and Table 1 of Regulatory Guide 4.14.

TR RAI 5.7.8-19

NRC staff notes that the application does not provide a description of proposed surface water and water well sampling methods and parameters that will be measured and analytically analyzed in surface water samples and water well samples. Please provide this information. This information is necessary for staff to assess the manner in which the Dewey-Burdock project activities will be protective of human health and the environment.

TR RAI 5.7.8-19 Response

Following is a description of the sampling methods and parameters to be analyzed in the operational surface and groundwater monitoring program. This information will be incorporated into the revised TR. For a description of the proposed sample locations and sample frequency in the operational surface water monitoring program, refer to the responses to TR RAI 5.7.8-1, TR RAI 5.7.8-2 and TR RAI 2.9-43(b). Information on proposed sample locations and sample frequency for the operational groundwater monitoring program is found in the response to TR RAI 5.7.8-17.

Operational Surface Water Sampling Methods and Parameters

Impoundments will be sampled by collecting grab samples. Prior to sampling, the sampler will conduct a visual survey of the impoundment to identify an appropriate sample location. This will include an area free of ice or floating debris and with sufficient water depth to permit sample collection without disturbing sediments. If necessary, a clean, long-handled dip sampler will be used. Typically the sample location will be near the impoundment embankment where the water is deepest. Grab samples will be collected in clean sample containers provided by the contract laboratory. Water will be obtained by filling the containers from the top 10 cm (4 in) of the water column. Samples will be field-preserved where required. The sample containers will be kept cool (less than 4°C) until delivery to the contract laboratory.

Streams will be sampled by grab sampling or with automatic samplers. Perennial stream sampling locations include those on Beaver Creek and the Cheyenne River. These will be sampled by collecting grab samples as described above. Passive samplers (single-stage samplers) will be installed at all other stream sampling sites from April through October. These will automatically collect samples when the flow rate in the channel reaches a field-adjustable minimum depth threshold. Following the runoff event the water will be manually transferred from the temporary sample container to clean sample bottles and submitted to the contract laboratory for analysis.

Representative water of that collected in the grab samples will be analyzed in the field for pH, conductivity and temperature. Impoundment and stream samples will be analyzed for the parameters presented in Table TR RAI 5.7.8-19-1.

Table TR RAI 5.7.8-19-1: Operational Surface Water Monitoring Parameter List and Analytical Methods

Parameter	Units	Analytical Method
Uranium, dissolved	mg/L	E200.8
Uranium, suspended	mg/L	E200.8
Ra-226, dissolved	pCi/L	E903.0
Ra-226, suspended	pCi/L	E903.0
Th-230, dissolved	pCi/L	E907.0
Th-230, suspended	pCi/L	E907.0
Pb-210, dissolved	pCi/L	E909.0M
Pb-210, suspended	pCi/L	E909.0M
Po-210, dissolved	pCi/L	RMO-3008
Po-210, suspended	pCi/L	RMO-3008

Operational Groundwater Sampling Methods and Parameters

Groundwater sampling methods will be the same as the methods utilized for baseline characterization. Static water level will be measured before sample collection when access is available. Measurement techniques will include pressure transducers, a portable electronic water level meter, or an ultrasonic water level sensor. For flowing artesian wells, the shut-in pressure will be measured, where access is available, using a 15 or 30 psi NIST pressure gauge. Prior to measuring the pressure, the well will be shut in and the pressure allowed to stabilize before recording the hydrostatic pressure.

Three casing volumes will be purged prior to sample collection where possible, except that flowing artesian wells will be assumed to contain representative formation water without purging. In all cases, field parameters will be measured and recorded and samples will not be collected until field pH, conductivity and temperature have stabilized. The criterion used to assess stability will be three consecutive measurements of each of the field parameters with values for each parameter within 10%.

All groundwater samples will be collected in clean sample containers and field preserved, where required. The sample containers will be kept cool (less than 4°C) until delivery to the contract laboratory.

Groundwater sampling parameters are described in the response to TR RAI 5.7.8-17. During operation, all domestic wells within the project area and all stock wells within ¼ mile of well fields will be removed from use. Domestic wells within 2 km of the project area will be sampled annually for the parameters in Table 6.1-1 (see response to TR RAI 6.1-3). Stock wells within the project area will be sampled quarterly for chloride, total alkalinity and conductivity.

Quality Assurance

TR RAI 5.7.9

The applicant stated that it will establish a quality assurance program at the facility consistent with the recommendations contained in Regulatory Guide 4.15. However, the applicant did not provide sufficient details of its proposed quality assurance program to allow NRC staff to evaluate the applicant's program. Consistent with Regulatory Guides 3.46, 4.14 and 4.15, and NUREG-1569, Acceptance Criteria 5.7.9.3(1) and 5.7.9.3(2), provide adequate details of the applicant's quality assurance program to allow NRC staff to evaluate the applicant's quality assurance program for its effluent and environmental programs.

TR RAI 5.7.9 Response

The following information will be incorporated into Section 5.7.9 of the revised TR.

After license issuance but prior to operations, Powertech will prepare a Quality Assurance Project Plan (QAPP) in accordance with Regulatory Guide 4.15. The outline for the QAPP is provided in Figure TR RAI P&R-16-1 of the response to TR RAI P&R-16.

Plans and Schedules for Groundwater Restoration

TR RAI 6.1-1

The specific language in the TR of* "consistent with the pre-operational baseline conditions" *and a secondary goal of* "pre-operational ... class *of* use" *is not consistent with NRC regulatory requirements. The regulatory requirements, as documented in RIS-09-05, are Commission-approved background levels, MCLs or ACLs as specified in Criterion 58(5) of Appendix A of 10 CFR Part 40. The primary goals for restoration of the production zone aquifer should be either background levels or MCLS; the secondary goal may be ACLs. However, an application for ACLs must be approved by the Commission. Guidance for preparing an application for ACLs to the Commission is found in various documents (e.g., NUREG-1724, NUREG-1620 and NUREG-1757) but an application must demonstrate that the best management activities have been conducted and that the ACLs are protective of human health and the environment by demonstrating that the levels at the boundary of the exempted aquifer meet the background levels or MCLs. Please revise the language in the TR to be consistent with the above guidance and regulatory requirements.

TR RAI 6.1-1 Response

The TR will be revised to include the following language:

The groundwater restoration program for all well fields will be conducted pursuant to 10 CFR Part 40, Appendix A, Criterion 5, which sets forth groundwater quality standards for uranium milling facilities. Currently, Criterion 5 states that groundwater quality at such facilities shall have primary goals of baseline (background) or an MCL, whichever is higher, or an ACL. Powertech recognizes that an ACL is a site-specific, constituent-specific, risk-based standard that demonstrates that maintaining groundwater quality at the requested level at a designated point of compliance (POC) will be adequately protective of human health and the environment at the point of exposure (POE) and that groundwater quality outside the boundary of the aquifer exemption approved by EPA would meet background (baseline) levels or MCLs. Powertech understands that satisfaction of prior class-of-use can be proposed as a factor in demonstrating justification for an ACL.

Powertech understands that, in the event that the primary goal of groundwater restoration (i.e., baseline or an MCL, whichever is higher) cannot be met after engaging in all practicable (reasonably achievable) efforts, it will be required to submit an ACL application to NRC staff in accordance with its regulatory rights under 10 CFR Part 40, Appendix A, Criterion 5(B)(5). Powertech understands that any ACL application will be in the form of a license amendment application that addresses, at a minimum, all of the relevant factors in 10 CFR Part 40, Appendix A, Criterion 5B(6), including but not limited to:

(a) Potential adverse effects on ground-water quality, considering—

(i) The physical and chemical characteristics of the waste in the licensed site including its potential for migration;

(ii) The hydrogeological characteristics of the facility and surrounding land;

(iii) The quantity of ground water and the direction of ground-water flow;

(iv) The proximity and withdrawal rates of ground-water users;

(v) The current and future uses of ground water in the area;

(vi) The existing quality of ground water, including other sources of contamination and their cumulative impact on the ground-water quality;

(vii) The potential for health risks caused by human exposure to waste constituents;

(viii) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents;

(ix) The persistence and permanence of the potential adverse effects.

(b) Potential adverse effects on hydraulically-connected surface water quality, considering—

(i) The volume and physical and chemical characteristics of the waste in the licensed site;

(ii) The hydrogeological characteristics of the facility and surrounding land;

(iii) The quantity and quality of ground water, and the direction of ground-water flow;

(iv) The patterns of rainfall in the region;

(v) The proximity of the licensed site to surface waters;

(vi) The current and future uses of surface waters in the area and any water quality standards established for those surface waters;

(vii) The existing quality of surface water including other sources of contamination and the cumulative impact on surface water quality;

(viii) The potential for health risks caused by human exposure to waste constituents;

(ix) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and

(x) The persistence and permanence of the potential adverse effects.

Powertech intends to follow any and all relevant NRC guidance and policy in effect at the time that an ACL would be requested, including the NRC staff Technical Position on Alternate Concentration Limits for Title II Uranium Mills (NRC, 1996), which is the most current ACL guidance available to date.

TR RAI 6.1-2

In the TR, the applicant indicated the target restoration goals (TRGs) will be based on a statistical analysis following ASTM standard 06312 (ASTM, 2001). The reference should be ASTM 06312-98 (Re-approved 2005).) Please address this comment.

TR RAI 6.1-2 Response

The corrected citation is: ASTM D-6312-98 (Re-approved 2005), "Standard Guide for Developing Appropriate Statistical Approaches for Groundwater Detection Monitoring Programs." Powertech will remove this citation in Section 6.1 of the revised TR. As noted in the response to TR RAI 5.7.8-3(b), baseline water quality will be calculated as the arithmetic average for each sample parameter. The target restoration goals (TRGs) will be established as a function of the average baseline water quality and the variability in each parameter according to statistical methods approved by NRC.

TR RAI 6.1-3

Table 6.1-1 of the TR provided a list of baseline water quality parameters and methods that will be used for establishing groundwater TRGs. Within the references for the table, NRC staff requests clarification of the passage "methods that will be used for establishing groundwater TRGs." This reference is to the laboratory analytical methods to be used to determine the concentration of a constituent and not a specific method (e.g., statistical average) for establishing TRGs based on the analytical data. In addition, the footnote in Table 6.1-1 suggests that the parameter list is derived from NUREG-1910. However, a similar table is not identified in NUREG-1910. Staff notes that the list of parameters in Table 6.1-1 is a subset of those recommended in NUREG-1569. Please correct the references in Table 6.1-1 and provide rationale or justification for excluding those other parameters listed in NUREG-1569.

TR RAI 6.1-3 Response

TR Table 6.1-1 was revised as indicated below to include all analytes listed in Table 2.7.3-1 of NUREG-1569. The last column of Table 6.1-1 lists the analytical method that will be used to determine each water quality parameter.

Refer to the response for TR RAI 5.7.8-3(b) for a description of the method that will be used to establish TRGs.

Table TR RAI 6.1-1: Baseline Water Quality Parameter List

Test Analyte/Parameter*	Units	Analytical Method
Physical Properties		
pH ♯	pH units	A4500-H B
Total Dissolved Solids (TDS) +	mg/L	A2540 C
Conductivity	µmhos/cm	A2510 B
Common Elements and Ions		
Alkalinity (as $CaCO_3$)	mg/L	A2320 B
Bicarbonate Alkalinity (as $CaCO_3$)	mg/L	A2320 B (as HCO_3)
Calcium	mg/L	E200.7
Carbonate Alkalinity (as $CaCO_3$)	mg/L	A2320 B
Chloride, Cl	mg/L	A4500-Cl B; E300.0
Magnesium, Mg	mg/L	E200.7
Nitrate, NO_3^- (as Nitrogen)	mg/L	E300.0
Potassium, K	mg/L	E200.7
Sodium, Na	mg/L	E200.7
Sulfate, SO_4	mg/L	A4500-SO4 E; E300.0
Trace and Minor Elements		
Arsenic, As	mg/L	E200.8
Barium, Ba	mg/L	E200.8
Boron, B	mg/L	E200.7
Cadmium, Cd	mg/L	E200.8
Chromium, Cr	mg/L	E200.8
Copper, Cu	mg/L	E200.8
Fluoride, F	mg/L	E300.0
Iron, Fe	mg/L	E200.7
Lead, Pb	mg/L	E200.8
Manganese, Mn	mg/L	E200.8
Mercury, Hg	mg/L	E200.8
Molybdenum, Mo	mg/L	E200.8
Nickel, Ni	mg/L	E200.8
Selenium, Se	mg/L	E200.8, A3114 B
Silver, Ag	mg/L	E200.8
Uranium, U	mg/L	E200.7, E200.8
Vanadium, V	mg/L	E200.7, E200.8
Zinc, Zn	mg/L	E200.8
Radiological Parameters		
Gross Alpha††	pCi/L	E900.0
Gross Beta	pCi/L	E900.0
Radium, Ra-226§	pCi/L	E903.0

*Analyte list based on NUREG-1569, Table 2.7.3-1. As noted on pg. 6 of NUREG-1569, Powertech may provide the rationale for the exclusion of water quality indicators/ parameters in a license application or amendment request if operational experience or site-specific data demonstrate that concentrations of constituents such as radium-228 are not significantly affected by ISR operations.

♯ Field and Laboratory

\+ Laboratory only

††Excluding radon, radium, and uranium

§ If initial analysis indicates presence of Th-232, then Ra-228 will be considered within the baseline sampling program or an alternative may be proposed.

<u>TR RAI 6.1-4</u>

The applicant provided a brief discussion of the restoration methods to be used but the discussion is too general and contains several confusing references. The discussion lacks details on the proposed specific restoration methods to be used and how those methods* affect *the aquifer. The applicant needs to provide a more in-depth discussion on the proposed methods to be used in clear terms. For example, the applicant needs to define "injection sweep method" in more commonly accepted terms (e.g. groundwater transfer, groundwater sweep, groundwater treatment or groundwater recirculation). The methods should be described in sufficient detail for staff to review (i.e., for groundwater treatment, staff needs to consider the volume of waste, clean makeup water, pore volumes and timing). If groundwater treatment is the only restoration method, then the applicant needs to discuss how flaring will be captured by using this method only. Please address this comment.

<u>TR RAI 6.1-4 Response</u>

Powertech proposes two options for aquifer restoration, depending on the method of liquid waste disposal (refer to response to TR RAI P&R-14(b) for a description of the liquid waste disposal options). The following discussion describes the two aquifer restoration options and replaces outdated information in the TR and SR. For example, the term “injection sweep method” is no longer used. Section 6.1 of the TR will be revised to incorporate the following information.

Aquifer Restoration Methods

During aquifer restoration, Powertech will restore groundwater quality consistent with the groundwater protection standards contained in 10 CFR 40, Appendix A, Criterion 5(B)(5) on a parameter-by-parameter basis using best practicable technology. The technology selected will depend on the liquid waste disposal option as described below. In the deep disposal well liquid waste disposal option, RO treatment with permeate injection will be the primary restoration method. If land application is used to dispose liquid waste, then groundwater sweep with injection of clean makeup water from the Madison Formation will be used to restore the aquifer. In either case, Powertech proposes to remove at least six (6) pore volumes during aquifer restoration. Additional information about the typical aquifer restoration flow rates is found in the water balance provided in response to TR RAI P&R-14(c).

<u>Deep Disposal Well Option</u>

In the deep disposal well liquid waste disposal option, the primary method of aquifer restoration will be RO treatment with permeate injection. In this method, water will be pumped from one or more well fields to the CPP or Satellite Facility for treatment. Treatment will begin with removal of uranium and other dissolved species in IX columns. The water will then pass through the restoration RO unit, which will remove over 90% of dissolved constituents using high pressure RO membranes. The treated effluent, or permeate, will be returned to the well field(s) for injection. The RO reject, or brine, will

undergo radium removal in radium settling ponds and will then be disposed in one or more deep disposal wells.

The RO units will operate at a recovery rate of approximately 70%. Therefore, about 70% of the water that is withdrawn from the well fields and passed through the restoration RO unit will be recovered as nearly pure water, or permeate. In order to avoid excessive restoration bleed and consumptive use of Fall River and Chilson groundwater, permeate will be supplemented with clean makeup water from Madison Formation water supply wells. Permeate and Madison Formation water will be reinjected into the well field(s) at an amount slightly less than the amount withdrawn from the well field(s). This will be done to maintain a slight restoration bleed, which will maintain hydraulic control of the well field(s) throughout active aquifer restoration. The restoration bleed will typically be 1% of the restoration flow rate unless groundwater sweep is used in conjunction with RO treatment with permeate injection, in which case the restoration bleed will average approximately 17%. Refer to the “Optional Groundwater Sweep” discussion below.

Land Application Option

In the land application liquid waste disposal option, the primary method of aquifer restoration will be groundwater sweep with Madison Formation water injection. This method begins the same as the method described above for RO treatment with permeate injection; water is pumped to the CPP or Satellite Facility for removal of uranium and other dissolved species in IX columns. The partially treated water will undergo radium removal in radium settling ponds and will then be disposed in the land application system. Powertech refers to this portion of the aquifer restoration method as “groundwater sweep,” since none of the water recovered from the Fall River or Chilson will be reinjected into the well field(s).

RO will not be used if there are no deep disposal wells available to accept the RO brine. Instead, clean makeup water from the Madison Formation will be injected into the well field(s) at a flow rate sufficient to maintain the restoration bleed. As before, the restoration bleed will typically be 1% of the restoration flow rate unless the optional groundwater sweep method is used as described below.

The water quality of the Madison Formation is expected to be equal to or better than the baseline ore zone water quality, and injection of Madison Formation water will therefore be similar to injection of permeate under the deep disposal well option.

Optional Groundwater Sweep

Although a 1% restoration bleed will be adequate to maintain hydraulic control of well fields undergoing active aquifer restoration, additional bleed may be required at times. For example, additional restoration bleed may be used to recover flare of lixiviant outside of the well field pattern area. In addition to the restoration methods described above, Powertech may withdraw up to one (1) pore volume of water through groundwater sweep over the course of aquifer restoration. This will result in an average restoration bleed of approximately 17% as described in the response to TR RAI P&R-14(c).

Flare Control and Capture

Flaring will be controlled by maintaining balanced well fields and adequate production bleed during uranium recovery. Flaring will be captured by maintaining adequate restoration bleed. If necessary, the restoration bleed may be increased to provide up to one (1) pore volume of groundwater sweep as discussed above. The results of an analytical drawdown potential impact analysis for the Inyan Kara under aquifer restoration with and without one (1) pore volume of groundwater sweep are provided in new Appendix 6.1-A, which is included with this response package and will be included with the revised TR.

<u>TR RAI 6.1-5</u>

The applicant reported expected concentrations for baseline, post-mining, postrestoration and stabilization based on the Crow Butte analog. The applicant indicated that the initial restoration concentrations will be similar to those seen during production but will decline throughout the groundwater treatment process and **"further *via* the natural restoration process (NUREG/CR-3136. 1983)".** ***The staff suggests that reference to NUREG-3136 be clarified. The reference may be interpreted as NRC-sanctioned restoration method of natural flushing (i.e., restoration is accomplished by discontinued active pumping and allowing groundwater to flow under natural conditions). This is not a NRC-approved method. In fact, the staff will require a statement that the applicant will maintain hydraulic control at all well fields (negative or inward pressure gradient) at all times during production and restoration until stabilization period. Please address this comment.***

<u>TR RAI 6.1-5 Response</u>

The reference to NUREG/CR-3136 will be removed and the following discussion will be incorporated into Section 6.1.3 of the revised TR.

Powertech will maintain hydraulic control of each well field from the first injection of lixiviant through the end of active aquifer restoration. During uranium recovery, the groundwater removal rate in each well field will exceed the lixiviant injection rate, creating a cone of depression within the well field. During aquifer restoration, the groundwater removal rate in each well field will exceed the injection rate of permeate and clean makeup water from the Madison Formation. If there are any delays between uranium recovery and aquifer restoration, production wells will continue to be operated as needed to maintain water levels within the perimeter monitor rings below baseline conditions. This activity may be intermittent or continuous.

Verification of hydraulic control will be performed through water level measurements in perimeter monitor wells. Water levels will be measured continuously using pressure transducers and recorded at a frequency appropriate to confirm hydraulic well field control.

TR RAI 6.1-6

The applicant's preferred restoration method is solely groundwater treatment by reverse osmosis with deep well disposal of the brine. This method is preferred due to lower groundwater consumptive use and minimum land disturbance. The applicant needs to discuss the effectiveness of this method and provide appropriate analogues demonstrating the effectiveness of groundwater treatment as the sole restoration process. Please address this comment.

TR RAI 6.1-6 Response

The preferred aquifer restoration method is RO treatment with permeate injection. This is the aquifer restoration method that will be used if deep disposal wells are used to dispose liquid waste. As described in Section 2.5.3 of the ISR GEIS (NUREG-1910), this method of aquifer restoration is responsible for returning "total dissolved solids, trace metal concentrations, and aquifer pH to baseline values." RO treatment with permeate injection has proven effective at achieving successful aquifer restoration as described below. This discussion will be incorporated into Section 6.1 of the revised TR.

> *"Results of the effectiveness of groundwater sweep (or lack of it) were clearly demonstrated in the Christensen Ranch Wellfield Restoration report (CRWR) (COGEMA 2008). Example plots from that report of mean well field water quality at the end of mining, groundwater sweep, RO and stabilization monitoring… indicate minimal improvement following groundwater sweep at MU3 and MU5 and an actual increase [in dissolved constituents] at MU6. Following application of RO, the TDS values at MU5 and MU6 decreased to levels below the target Restoration Goal. Uranium increased in MU5 and MU6 following groundwater sweep…and then was significantly lowered during RO. Approximately 1.8, 4.8 and 1.5 PVs of groundwater were removed from MU3, MU5 and MU6, respectively, during groundwater sweep. This water removal was totally consumptive by design, in that none of it was returned to the aquifer.*
>
> *"Based on the results, minimal benefit, if any, was derived from [the groundwater sweep] phase of restoration. Eliminating groundwater sweep, an unnecessary, ineffective and consumptive step in the restoration process, will reduce the number of PVs required to reach restoration goals.*
>
> *"Terminating RO once water quality has stabilized will minimize the consumptive use of groundwater and reduce the number of PVs of treatment."* (Uranium One, 2008)

The following analogues demonstrate the effectiveness of RO treatment with permeate injection as an effective aquifer restoration technology:

The Ruth R & D Project was a Wyoming pilot test conducted by Uranerz USA, Inc. in the early 1980s. The ore body represented a typical roll front type deposit with the target ore zone approximately 500 feet below ground surface. Groundwater restoration began in February 1984. Groundwater sweep was initially the primary restoration method, but it was terminated due to excessive water consumption. Groundwater restoration continued using RO treatment with permeate injection. By September 1984,

TDS was successfully lowered, but the concentrations of a few metals remained above target restoration goals. A reductant phase was initiated in November 1984 and continued for six weeks. This combination of treatment was deemed successful, and by the end of December 1984 restoration activities were terminated. At the end of the stability period, regulatory agencies deemed the water quality was stable and aquifer restoration efforts by Uranerz were successful. (Catchpole and Kuchelka, 1993)

The Crow Butte R&D Project also used RO treatment with permeate injection to achieve successful aquifer restoration. According to Catchpole and Kuchelka (1993), RO treatment with permeate injection "restored the quality of the groundwater in the mined out well field to a level acceptable to the agencies and, following the successful completion of the six month stability monitoring period, the agencies deemed that Ferret Exploration Company of Nebraska had demonstrated the capability of restoring an aquifer affected by ISR mining operations."

The Bison Basin Commercial ISL Uranium Mine is another example of a successful restoration project using RO treatment with permeate injection. According to Catchpole and Kuchelka (1993), "This action returned all water quality parameters to levels acceptable to the regulatory agencies and, following the successful completion of a 12 month stability monitoring period, the aquifer was deemed restored. The Bison Basin case represented the first successful aquifer restoration of a commercial sized ISL well field in the United States."

As described in the response to TR RAI 6.1-4, clean makeup water from the Madison Formation will be used to supplement permeate and maintain the restoration bleed in the deep disposal well option. In the land application option, all of the water reinjected into the well fields during active aquifer restoration will come from the Madison Formation. The water quality of the Madison Formation is expected to be equal to or better than the baseline ore zone water quality, and injection of Madison Formation water will therefore be similar to injection of permeate under the deep disposal well option.

Refer to the response to TR RAI 6.1-4 for a discussion of the optional groundwater sweep that Powertech may use with either the deep disposal well or land application options. In order to recover flare of lixiviant outside the well field pattern area, up to one (1) pore volume of groundwater sweep may be employed over the course of aquifer restoration.

TR RAI 6.1-7

The application did not include estimates on the pore volume for a well field, porosity or flare factors. The staff needs this information to evaluate the financial assurance calculations and the proposed schedule and water balance for the restoration process. Please provide this information for staff to review.

TR RAI 6.1-7 Response

Revised TR Appendix 6.6-A, which is included with this RAI response package and will be included with the revised TR, contains the requested estimates for pore volume, porosity and flare factors. The following discussion summarizes Powertech's proposed calculations of these parameters for financial assurance calculations, schedule and water balance. This information will be included in Section 6.1 of the revised TR.

Pore Volume Calculations and Restoration Pore Volumes

The formulas for determining the pore volume and the volume of restoration composite (RC) to be withdrawn during aquifer restoration are as follows:

Pore volume = (well field pattern area) x (thickness) x (porosity) x (flare factor)

RC volume = (pore volume) x (number of pore volumes for aquifer restoration)

The thickness is the average thickness of the mineralized zones as determined by down-hole radiological logging. The average thickness in the Dewey-Burdock project area is 4.6 feet.

The porosity of the ore zone within the project area was determined by laboratory analysis of core samples. Based on 11 measurements of ore zone porosity from core samples of the Fall River and Chilson host sands, the average porosity of the ore zone sands within the project area is 0.30.

The proposed flare factor is 1.44, accounting for both horizontal and vertical flare of lixiviant during ISR operations. Support for the flare factor is contained in the numerical groundwater modeling results presented in TR Appendix 6.6-B, "Numerical Modeling of Groundwater Conditions Related to In situ Recovery at the Dewey-Burdock Uranium Project, South Dakota," which is provided with this RAI response package. Appendix 6.6-B describes how horizontal flare from a modeled balanced well field was determined to be 1.19. Vertical flare is expected to be similar to or less than the horizontal flare since the horizontal conductivity is greater than vertical conductivity. An overall flare factor of 1.44 is supported by the numerical modeling results presented in Appendix 6.6-B.

The flare factor and number of pore volumes required for aquifer restoration are both a function of the properties of the particular sandstone formations and ore deposits, as well as the operational factors of

aquifer bleed rates, the balancing of pattern flow rates, the use of RO during aquifer restoration and the timeliness of beginning aquifer restoration operations following cessation of recovery operations. For the Dewey-Burdock Project, the values of the flare factor and the number of pore volumes removed for aquifer restoration are comparable to those that have been recently approved for other ISR facilities and are consistent with the best practicable technology for aquifer restoration.

The overall (horizontal and vertical) flare factor for ISR uranium projects has varied from 1.44 at Irigaray/Christensen Ranch (COGEMA, 2008 and COGEMA, 2005) to 1.95 at Churchrock/Crownpoint (HRI, 2001). The overall well field flare factor for the Dewey-Burdock Project is estimated to be 1.44, which is equal to the flare factor in approved license applications at ISR facilities located nearby in the State of Wyoming and is supported by numerical groundwater modeling.

The number of pore volumes, including flare, of groundwater to be removed to achieve aquifer restoration is estimated to be 6.0. This figure is consistent with the best practicable technology that includes the following operational practices:

(i) Daily balancing of injection and extraction flow rates during production. This flow rate balancing is designed to ensure that a proper aquifer bleed is maintained both at the well field level and also within each 5-spot pattern within the well field.
(ii) Timeliness of beginning restoration operations. For any particular well field, aquifer restoration operations will begin as soon as is reasonably possible following the cessation of recovery operations.
(iii) Maintenance of aquifer bleeds. Hydraulic control of well fields through the net withdrawal of the aquifer bleed stream will be continuously maintained from the beginning of recovery operations until the end of active aquifer restoration.

While the number of pore volumes required for aquifer restoration has historically proven to have been significantly higher for some of the early ISR uranium projects, the methods and timing of restoration likely contributed to these larger numbers. The following information was obtained from the Moore Ranch license application (Uranium One, 2008)

> *"The average number of PVs extracted and treated/reinjected/or disposed was 13.6 for Irigaray and 12.4 for Christensen … Circumstances at both those ISR projects resulted in increased PVs to achieve restoration goals including the following:*
>
> - *Production and restoration were not conducted sequentially, and were plagued with extended periods of shut-in and standby, with delays of up to several years in some cases;*
> - *Groundwater sweep, the initial phase of restoration, was often largely ineffective and in some cases may have exacerbated the problem; and*

- *RO was continued in some well fields after it was apparent that little improvement in water quality was occurring.*

> *"Restoration was not performed immediately following the completion of production, and in some cases, there were long periods of inactivity during the production and restoration phases. At Irigaray, production was interrupted for a period of almost six years in MU1 through MU5 … Similarly, there was a three-year break in production in MU6 through MU9, when the operation was in standby status. Restoration did not commence at MUl through MU3 until a year after production had ended. At MU4 and MU5, restoration operations did not begin until two years following production. Restoration commenced shortly after the end of production at MU6 through MU9. However the project was on standby status between the completion of groundwater sweep and the beginning of the RO phase of production, resulting in a break of one to two years, depending on the MU. Restoration was initiated sooner after the end of production at Christensen Ranch, with the exception of MU3 and MU4. However, there were periods of standby between groundwater sweep and RO treatment/injection of up to a year. These delays between and during production and restoration operations most likely increased the number of PVs required to complete aquifer restoration."*

For the financial assurance calculations, the pore volume affected in the first year of production is estimated to be approximately 13 million gallons, corresponding to an active well field area of approximately 20 acres. The restoration composite, or volume of groundwater to be extracted during groundwater restoration, is estimated to be approximately 78 million gallons. Calculations are presented in Appendix 6.6-A (attached).

<u>TR RAI 6.1-8</u>

The applicant reported that because lixiviant injection was discontinued during restoration, the groundwater quality will continually improve and the potential for an excursion is greatly reduced. The applicant proposed to monitor the water quality indicators in Table 6.1-1 and water levels once every 60 days in the monitor ring wells, and monitoring wells in the overlying and underlying aquifers. The applicant proposed to contact NRC if wells cannot be monitored within 65 days of the last sampling event. Staff notes that this monitoring plan is for excursion monitoring and not restoration monitoring. The excursion monitoring program should continue during restoration similar to that conducted during operations but will accept a frequency of monitoring greater than once every two weeks. However, should the levels indicate an excursion status for a well during restoration, the applicant must document corrective actions to be undertaken. Please address this comment.

<u>TR RAI 6.1-8 Response</u>

Section 6.1.7 of the revised TR will incorporate the following.

During active aquifer restoration, monitoring wells will be sampled every 60 days and analyzed for the indicator UCL parameters. If the concentration of two of the three excursion indicators exceeds the UCL concentrations during a sampling event, a subsequent sample will be taken within 24 hours and analyzed for the excursion indicators. If the confirmatory sample results are not complete within 30 days then for reporting purposes (described below) the excursion is considered confirmed. If the second sample does not confirm an excursion a third sample will be taken within 48 hours. If two or more excursion indicators of either the second or third samples exceed the UCL concentrations for the excursion indicators, the well in question will be placed on excursion status and corrective action will be taken. The first sample will be considered an error if neither the second nor third sample confirm the first sample results.

<u>Corrective Action and Monitoring</u>

Corrective actions following the confirmation of an excursion will include: sampling frequency will be increased to weekly; pumping rates of production wells in the area of the excursion will increase; the net bleed will be increased; individual wells will be pumped to enhance recovery of ISR solutions; and an excursion report will be prepared for NRC. If actions taken are not effective at retrieving the excursion within 60 days, Powertech will suspend injecting lixiviant into the production zone adjacent to the excursion until the excursion is retrieved and the UCL parameters are not exceeded.

<u>Notification</u>

In the event of an excursion Powertech will notify the NRC within 24 hours by telephone or email, and in writing within 30 days, and begin corrective actions.

TR RAI 6.1-9

The applicant did not propose a monitoring program to document the effectiveness of the restoration program. The monitoring program should include a detailed description of the monitoring of the mining zone during restoration, including sampling density, parameters, and frequency to substantiate that it will be able to closely monitor and optimize their restoration strategy or to determine whether or not any flare or hot spots have been effectively captured during the restoration process. Please address this comment.

TR RAI 6.1-9 Response

The following procedures will be used to document the effectiveness of the aquifer restoration program. This information will be incorporated into Section 6.1 of the revised TR.

Powertech will implement an active aquifer restoration monitoring program to document the progress of aquifer restoration. During active aquifer restoration, each well field will be monitored on a frequency sufficient to determine the success of aquifer restoration, optimize the efficiency of aquifer restoration and determine if any areas of the well field need additional attention. At the beginning of aquifer restoration, water level will be measured and groundwater analyzed for all parameters listed in Table 6.1-1 for the subset of production zone sampling wells used in baseline. Thereafter, samples will be collected and analyzed for all or selected parameters as needed.

The success of aquifer restoration will be demonstrated during the well field stabilization period.

The results of the active restoration monitoring will be used to evaluate potential areas of flare or hot spots. If potential flare or hot spots are identified, appropriate corrective measures will be taken. These may include adjusting the flows in the area, changing wells from injection to production or vice-versa, or adjusting the restoration bleed in specific areas. Additional information on statistical methods used to identify hot spots is provided in the response to TR RAI 6.1-10.

TR RAI 6.1-10

The applicant proposed a minimum six month stability monitoring program to demonstrate that the restoration goal has been maintained. The monitoring program includes sampling groundwater at the monitoring ring wells, one every two months for chloride, total alkalinity and conductivity and at the production wells at the beginning, middle and end of the stability parameters for the indicator parameters listed in Table 6.1-1. The applicant proposed to contact NRC if any well cannot be monitored within 65 days of the last sampling event. The staff has determined that this monitoring program is inconsistent with NUREG-1569. The monitoring program should consist of four quarterly events using a full suite of parameters for each sampling event. Furthermore, the applicant needs to discuss statistical methods to be used to determine whether or not a trend is observed or hot spots exist. Please address this comment.

TR RAI 6.1-10 Response

The following information will be incorporated into Section 6.1 of the revised TR.

A groundwater stability monitoring period will be implemented to show that the restoration goal has been adequately maintained. The stability monitoring period will consist of twelve (12) months with quarterly sampling. Over the 12-month minimum stability monitoring period, there will be at least five (5) sample events, including one at the beginning of the stability monitoring period and following each of the following four quarters. The criteria to establish restoration stability will be based on well field averages for water quality, except that hot spots will be evaluated based on the results from individual wells.

During the restoration stability period, the following monitoring program will be utilized:

Monitoring wells in the perimeter ring and those wells in the overlying and underlying aquifers will continue to be sampled once every 60 days for the UCL indicator parameters of chloride, total alkalinity (or bicarbonate), and conductivity. The NRC will be contacted if any of the wells cannot be sampled within 65 days of the last sampling event due to unforeseen conditions such as snowstorms, flooding, or equipment malfunctions.

Quarterly, the production-zone wells that were sampled to determine well field baseline will be sampled and analyzed for the water quality parameters listed in Table 6.1-1. The criteria to establish successful stability will be that, for each sampling event, the mean constituent concentration of each water quality parameter meets the target restoration goal established for that parameter from baseline sampling, as described in TR RAI 5.7.8-3(b).

Linear regression analysis will be performed on each monitored constituent measured in the production zone baseline wells. This statistical method will assist in determining if the concentration of a given constituent exhibits a significantly increasing trend during the stability period. If a constituent exhibits a

strongly increasing trend, or in the case of pH a strongly increasing or decreasing trend, Powertech will take action to resolve the situation. The action taken will depend on the constituent and the status of the restored groundwater system. Due to the complexity of the aqueous geochemical groundwater systems involved, these statistical techniques will not be relied on as the sole determinant when evaluating the effectiveness of groundwater restoration. Therefore, Powertech will consider which constituent(s) shows an increasing trend in concentration and base the decision on further action on the status of the production zone groundwater geochemistry. These actions may include extending the stability period or returning the well field to a previous phase of active restoration to resolve the issue. The phase of active restoration that will be used will be determined by the constituent and the process required to bring it to stability.

If the analytical results from the stability period continue to meet the target restoration goals and do not exhibit significant increasing trends, then Powertech will submit supporting documentation to the regulatory agencies showing that the restoration parameters have remained at or below the restoration standards and will request that the well field be declared restored.

For one or two parameters, localized, elevated concentrations above the restoration criteria may remain in the production zone following restoration. These isolated, residual elevated concentrations are referred to as "hot spots." The primary indicator of a hot spot for a specific constituent or parameter will be the mean production zone concentration plus two standard deviations. For pH, the indication of a hot spot will be plus or minus two standard deviations. If a constituent or parameter at a production zone baseline sampling well exceeds that criterion during the stability period, the location of the well will be identified as a hot spot. Once a hot spot is identified, additional evaluation will be conducted to determine potential impacts that such a hot spot could have on water quality outside of the exempted aquifer. The additional evaluation may include collection of additional water samples, analysis of added parameters, trend analysis, or flow and transport modeling. Based on the results of the evaluation, additional stability monitoring or restoration may be conducted as needed to ensure the protection of water quality outside the exempted aquifer. If hot spots are sufficiently demonstrated not to have the potential to affect water quality outside of the exempted aquifer and the restoration criteria are otherwise met without increasing trends, then no additional action will be taken and Powertech will submit supporting documentation to the regulatory agencies showing that the restoration parameters have remained at or below the restoration standards and will request that the well field be declared restored.

TR RAI 6.1-11

The applicant included a Gant-type chart to depict the proposed restoration schedule in the application. The schedule is based on the entire project rather than individual mine units or well fields. The proposed restoration period encompasses an eight-year time-frame starting at year five. The restoration period overlaps the production, stability monitoring and well field decommissioning elements of the schedule. Also note that should the restoration schedule exceed 24 months for a well field, the applicant will have to request NRC approval of that schedule as an alternate schedule. Please address this comment.

TR RAI 6.1-11 Response

The revised well field schedule is shown in attached Figure 6.1-1. This figure will be included in the revised TR along with the following commitment.

As illustrated on Figure 6.1-1, it is expected that the aquifer restoration phase for each well field will be completed in less than two years. In the event that an alternate schedule is needed for restoration of a particular well field, Powertech will request NRC approval for the modification as an alternate schedule in accordance with 10 CFR 40.42.

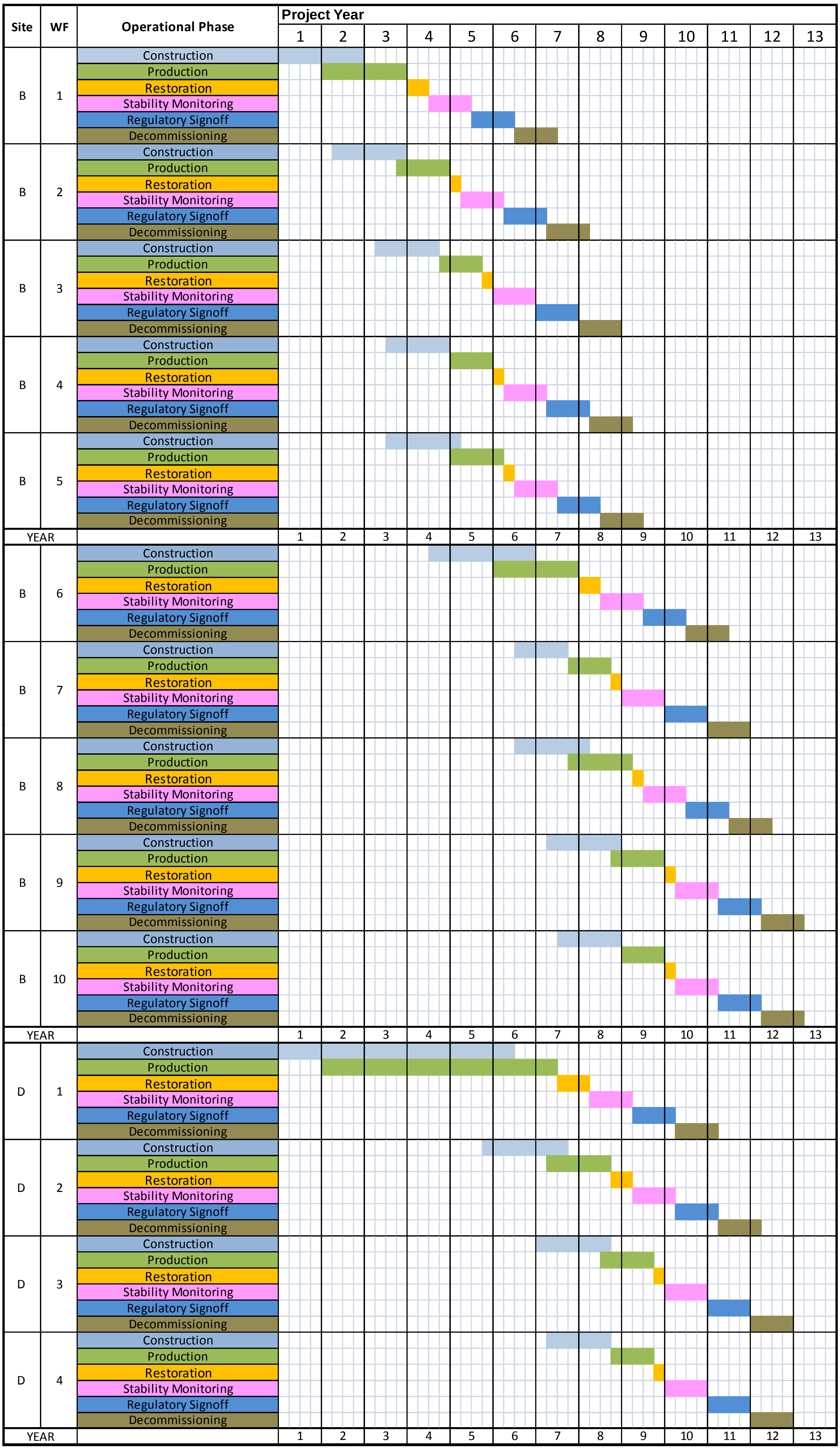


Figure 6.1-1

Schedule for Proposed Well Field Operations

Dewey-Burdock Project

DRAWN BY	J. Munro
DATE	21-Jun-2011
FILENAME	Figure 6.1-1.mxd

POWERTECH (USA) INC.

Plans for Reclaiming Disturbed Lands

TR RAI 6.2-1

Consistent with NUREG-1569, Acceptance Criteria 6.2.3(2), 6.2.3(8) and 6.2.3(9), the applicant should provide additional discussion of the land cleanup program, including:

TR RAI 6.2-1(a)

a. ***The areas that will be focused on during the surveys such as well field surfaces, areas around structures in process and storage areas, on-site transportation routes, historical spill areas, retention ponds, and areas near the deep disposal wells.***

TR RAI 6.2-1(a) Response

TR Section 6.3.2 (Preliminary Radiological Surveys and Contamination Control) will be revised to include the following text:

Consistent with NUREG-1569, 6.2.1 Areas of Review, Powertech will provide the NRC and SD DENR with maps and data that document the post-operational condition. The areas that will receive particular attention during the pre-reclamation surveys include diversion ditches, surface impoundment areas, well fields (particularly those areas where spills or leaks may have occurred), process structures, storage areas, on-site transportation routes for contaminated material and equipment, and areas associated with liquid waste disposal.

TR RAI 6.2-1

Consistent with NUREG-1569, Acceptance Criteria 6.2.3(2), 6.2.3(8) and 6.2.3(9), the applicant should provide additional discussion of the land cleanup program, including:

TR RAI 6.2-1(b)

b. ***Plans for decommissioning non-radiological hazardous constituents as required by 10 CFR Part 40, Appendix A, Criterion 6 (7),***

TR RAI 6.2-1(b) Response

TR Section 6.3 will be revised to include a new section (Plans for Decommissioning Non-Radiological Hazardous Constituents), which would include the following information. Please also see responses to ER RAIs WM-3, WM-4 and WM-6.2, which also address the decommissioning and disposal of non-radiological materials and constituents.

Consistent with NUREG-1569 and 10 CFR Part 40, Appendix A, Criterion 6(7), Powertech will ensure that non-radiological hazards are addressed in the planning and implementation processes of decommissioning and closure. TR Section 1.10 includes a discussion of non-radiological wastes and their disposition at closure. Non-radiological cleanup concerns related to the land application option are addressed in TR Section 7.3.3.8.2.

Any non-radiological hazardous waste that is determined to be 11e.(2) byproduct material will be disposed of offsite at a licensed 11e.(2) waste disposal site in accordance with NRC's directive in 10 CFR Part 40, Appendix A, Criterion 2. Any non-radiological hazardous waste that is not 11e.(2) byproduct material will be disposed offsite at a permitted hazardous waste disposal facility. As described in TR Section 1.10, potentially hazardous liquid wastes such as used oil, hydraulic fluid, cleaners, solvents and degreasers will be recycled or disposed offsite at an appropriately permitted hazardous or solid waste disposal facility. In addition, as described in TR Section 7.3.3.8.2, residual non-radiological metal concentrations in land application areas are not expected to exceed their respective EPA soil screening levels (SSLs). Powertech will include more details on decommissioning non-radiological hazardous constituents in its final decommissioning plan, which will be submitted 12 months prior to any planned reclamation.

<u>TR RAI 6.2-1</u>
Consistent with NUREG-1569, Acceptance Criteria 6.2.3(2), 6.2.3(8) and 6.2.3(9), the applicant should provide additional discussion of the land cleanup program, including:

<u>TR RAI 6.2-1(c)</u>

c. ***Demonstration that the actual quality assurance and quality control program will address all aspects of decommissioning.***

<u>TR RAI 6.2-1(c) Response</u>
The following information will be included in the revised TR.

Powertech will develop a quality assurance and quality control program that will address all aspects of decommissioning. The outline of the Quality Assurance Project Plan is found in Figure TR RAI P&R-16-1 in the response to TR RAI P&R-16. The program will address all aspects of decommissioning and will be designed to ensure that the project area is closed in a manner that permits release for unrestricted (i.e., any) use.

Powertech commits to preparing a QAPP in accordance with Regulatory Guide 4.15 prior to operations.

<u>TR RAI 6.2-2</u>

As discussed in Section 2.9 of this RAI, the applicant has not sufficiently demonstrated that background radiological conditions have been established within the Permit Area. In addition, the applicant has not sufficiently demonstrated the correlation of gamma surveys with Ra-226 (or other radionuclides) concentrations in soil. In Section 6.2.1 of the TR, the applicant stated that baseline soils, vegetation, and radiological data will be used as a guide in evaluating the final reclamation. The following questions pertain to pre-reclamation surveys and planned cleanup activities.

<u>TR RAI 6.2-2(a)</u>

a. ***Consistent with NUREG-1569, Acceptance Criterion 6.2.3(2), please identify instruments and techniques that will be used in the pre-reclamation radiological survey program to identify areas of the site that need to be cleaned up to comply with NRC concentration limits.***

<u>TR RAI 6.2-2(a) Response</u>

Section 6.2 of the TR will be revised to incorporate the following information.

The instruments and techniques for pre-reclamation radiological surveys to identify areas of the site that need to be cleaned up to comply with NRC concentration limits will be the same or similar to those used to survey the project area for pre-operational radiological conditions. The instruments used for the pre-operational survey are described in Section 2.9 of the TR and include unshielded Ludlum Model 44-10 2" x 2" sodium iodide (NaI) detectors coupled to Ludlum Model 2221 rate meter/scalers (set in rate meter mode) and a Trimble Pro XRS GPS receiver with Trimble TSCe data logger.

The techniques to be used during the pre-reclamation radiological survey include putting special emphasis on those areas with the highest potential for surface contamination, including diversion ditches, surface impoundment areas, well fields (particularly those areas where potential spills or leaks may have occurred), process structures, storage areas, on-site transportation routes for contaminated material and equipment, and areas associated with liquid waste disposal. Powertech will also consider results from operational monitoring and any other information that provides insight to areas with the greatest potential to be contaminated. Powertech will use a sampling grid of 100 m^2 for soil and other specifications to ensure that radium and other radionuclides will not exceed the standards in 10 CFR Part 40, Appendix A, Criterion 6(6). Guidance for sample size and other techniques provided in NUREG-1575 will be used as reference for the pre-reclamation radiological survey.

<u>TR RAI 6.2-2</u>

As discussed in Section 2.9 of this RAI, the applicant has not sufficiently demonstrated that background radiological conditions have been established within the Permit Area. In addition, the applicant has not sufficiently demonstrated the correlation of gamma surveys with Ra-226 (or other radionuclides) concentrations in soil. In Section 6.2.1 of the TR, the applicant stated that baseline soils, vegetation, and radiological data will be used as a guide in evaluating the final reclamation. The following questions pertain to pre-reclamation surveys and planned cleanup activities.

<u>TR RAI 6.2-2(b)</u>

b. Consistent with NUREG-1569, Acceptance Criterion 6.2.3(3), please describe how pre-reclamation survey results will be used to identify candidate areas for cleanup operations.

<u>TR RAI 6.2-2(b) Response</u>

The following information will be included in Section 6.2 of the revised TR.

Consistent with NUREG-1569, Acceptance Criterion 6.2.3(3), Powertech will use the pre-reclamation survey results to identify candidate areas for cleanup operations. The following general procedures for interpretation of the pre-reclamation survey results will be used to identify areas for cleanup operations:

1) Pursuant to 10 CFR Part 40, Appendix A, Criterion 6(6), the radium-226 content in soils, averaged over areas of 100 m^2, will not exceed the background concentration by more than (i) 5 pCi/g of Ra-226 averaged over the first 15 cm (5.9 in) below the surface, and (ii) 15 pCi/g of radium-226 averaged over 15 cm thick layers more than 15 cm below the surface.

2) The background radionuclide concentrations have been determined using appropriate methods as described in TR Section 2.9 and the responses to Section 2.9 RAIs contained herein. There are two areas within the project area where the gamma survey recorded levels higher than the majority of the project area. These are the surface mine area in the northeast portion of the project area and a naturally anomalous area in the northern portion of the project area. These areas may warrant a different background concentration. Should Powertech determine that use of a different background radionuclide concentration is warranted, it will propose one with its final decommissioning plan.

3) For areas that meet the radium cleanup criteria, but that still have elevated thorium-230 levels, Powertech proposes to provide in its final decommissioning plan an acceptable cleanup criterion for thorium-230, one that when combined with residual concentrations of radium-226, would result in the radium concentration (both radium residual and from thorium decay) that would meet the radium cleanup standard in 1,000 years.

4) Likewise, Powertech will propose acceptable criteria for uranium in soil, such as those found in Appendix E of NUREG-1569.

5) Lastly, the survey method for cleanup operations will be designed to provide 95% confidence that any residual radionuclides on the project area will be identified and cleaned up. Powertech will apply appropriate statistical tests for analysis of survey data.

Removal and Disposal of Structures, Waste Material, and Equipment

TR RAI 6.3-1

It appears that the bullet at the top of page 6-23 should read, "Not salvageable and contaminated below release limits ..." Please clarify this point.

TR RAI 6.3-1 Response

The reviewer is correct.

TR Section 6.3 will be corrected to read as follows:

- Not salvageable and contaminated below release limits (offsite disposal at a permitted facility)

TR RAI 6.3-2

In Section 6.3.1 of the TR, the applicant references Regulatory Guide 1.86 as the criteria for surface contamination release limits. However, Regulatory Guide 1.86 is for use by nuclear power reactors, while Enclosure 2 to Policy and Guidance Directive FC-83-23 (as updated) is used as the criteria for surface contamination release limits by materials licensees. Please provide the correct reference in the TR.

TR RAI 6.3-2 Response

TR Section 6.3 will be revised to omit the reference to Regulatory Guide 1.86 as follows:

Powertech will use surface contamination release limits contained in Enclosure 2 to Policy and Guidance Directive FC-82-23 (as updated) to release material and equipment that has potentially come into contact with licensed material.

Surface contamination release limits for surfaces on structures intended for unrestricted release following decommissioning are subject to Criterion 6(6) of Appendix A to 10 CFR 40. Acceptable dose-based surface contamination release limits will be established using the RESRAD-Build model or an equivalent model and will be provided in the final Decommissioning Plan, which will be submitted 12 months prior to any planned decommissioning.

TR RAI 6.3-3

In Section 6.3.2, the applicant describes how materials with potential surface contamination will be treated. Please provide a description of how materials such as concrete exposed to

TR RAI 6.3-3 Response

TR Section 6.3 will be revised to include the following:

Concrete slabs will be surveyed and if found to contain radionuclides in excess of the release limits, an attempt will be made to decontaminate the concrete slab(s). If after a second survey radionuclides are in excess of the release limits, the concrete will be broken up and disposed of at a licensed 11e.(2) disposal site. If the survey results indicate that the concrete is not contaminated above release limits, it may be disposed in an appropriately permitted landfill, used for fill elsewhere, or left in place for use by the landowner.

POWERTECH (USA) INC.

Methodologies for Conducting Post Reclamation and Decommissioning Radiological Surveys

TR RAI 6.4-1

Consistent with NUREG-1569, Acceptance Criterion 6.4.3(1), please describe the manner in which areas that meet the Ra-226 cleanup criteria but still have elevated Th-230 levels will be addressed.

TR RAI 6.4-1 Response

TR Section 6.4.3 (Surface Soil Cleanup Verification and Sampling Plans) will be revised to include the following information.

Powertech will comply with the cleanup standard of Criterion 6(6) of 10 CFR Part 40, Appendix A: 11e.(2) byproduct material containing concentrations of radionuclides other than radium in soil, and surface activity on remaining structures, will not result in a TEDE exceeding the dose from cleanup of radium-contaminated soil to the above standard (benchmark dose), and will be at levels which are ALARA. If more than one residual radionuclide is present in the same 100 m^2 area, the sum of the ratios for each radionuclide of concentration present to the concentration limit will not exceed 1 (unity).

In areas that meet the Ra-226 cleanup criteria post-reclamation but that still have elevated Th-230 levels, Powertech will propose an acceptable protocol for Th-230 cleanup. Powertech, in its final decommissioning plan, which will be submitted 12 months prior to any planned reclamation, will propose a concentration for Th-230 that, when combined with the residual concentration (residual thorium and products from thorium decay) that would be present in 1,000 years, meets the radium cleanup standard. In addition, Powertech will consider other potentially acceptable criteria before selecting and proposing a final cleanup criterion for Th-230 in the decommissioning plan.

<u>TR RAI 6.4-2</u>

As discussed in Section 2.9 of this RAI, it does not appear that the applicant has sufficiently demonstrated that background radiological conditions have been established within the Permit Area. Consistent with NUREG-1569, Acceptance Criterion 6.4.3(2), please demonstrate that the applicant has sufficiently determined background radionuclide concentrations as described in Section 2.9 of NUREG-1569.

<u>TR RAI 6.4-2 Response</u>

In accordance with NUREG-1569, Acceptance Criterion 6.4.3(2), Powertech has or will have (as demonstrated by the commitments in these RAI responses) determined background radionuclide concentrations throughout the project area prior to commencement of operations. Please refer to the responses to the RAIs contained in Section 2.9 for information sufficient to demonstrate that background radiological conditions have been or will have been established within the project area before operations commence. In particular, the responses to TR RAI 2.9-30 through 2.9-40 demonstrate the adequacy of the baseline gamma ray surveys and soil sampling and provide commitments to collect additional soil samples prior to commencing operations.

TR RAI 6.4-3

In Section 6.4.1.2 of the TR, the formula for the unity rule appears with the uranium soil standard formula. It appears that this should be moved to the next paragraph. Please clarify this point.

TR RAI 6.4-3 Response

TR Section 6.4 will be revised to move the formula for the unity rule as shown below.

The U-nat limit is applied to soil cleanup with the Ra-226 limit using the unity rule. To determine whether an area exceeds the cleanup standards, the standards are applied according to the following formula:

$$\left(\frac{\text{Soil Uranium Concentration}}{\text{Soil Uranium Limit}}\right)+\left(\frac{\text{Soil Radium Concentration}}{\text{Soil Radium Limit}}\right)<1$$

<u>TR RAI 6.4-4</u>

In Section 6.4.3 of the TR, the applicant stated that it will evaluate compliance with cleanup criteria in terms of soil concentrations that will be supplemented by field gamma surveys. The applicant will conduct final GPS-based gamma surveys in affected areas and buffer zones. The staff cannot evaluate the comprehensiveness of the soil cleanup verification and sampling plan. Please define more specifically what constitutes affected areas.

<u>TR RAI 6.4-4 Response</u>

TR Section 6.4.3 (Surface Soil Cleanup Verification and Sampling Plans) will be revised to include the following additional information:

Affected areas are those areas that have greater potential to be impacted by uranium solutions, dried uranium product (yellowcake) or liquid or solid waste streams that contain uranium or other radionuclides associated with uranium recovery operations. The areas that are most likely to be considered affected areas include diversion ditches, surface impoundment areas, well fields (particularly those areas where potential spills or leaks may have occurred), process structures, storage areas, on-site transportation routes for contaminated material and equipment, and areas associated with liquid waste disposal.

TR RAI 6.4-5

The applicant has not provided assurance that the survey method for verification of soil cleanup is designed to provide 95% confidence that the soil units meet the cleanup guidelines. The staff cannot evaluate the effectiveness of the cleanup based on the information provided. Consistent with NUREG-1569, Acceptance Criterion 6.4.3(5), please clarify that the survey method for verification of soil cleanup will be designed to provide 95-percent confidence that the survey units will meet the cleanup guidelines.

TR RAI 6.4-5 Response

TR Section 6.4.3 (Surface Soil Cleanup Verification and Sampling Plans) will be revised to include the following commitment:

Consistent with NUREG-1569, Acceptance Criterion 6.4.3(5), the survey method for verification of soil cleanup will be designed to provide 95% confidence that the survey units will meet the cleanup guidelines.

<u>TR RAI 6.4-6</u>

In Sections 6.4.2 and 6.4.3 of the TR, the applicant states that it will utilize gamma ray measurements to determine compliance with soil cleanup criteria. However, as discussed in Section 2.9 of this RAI, it does not appear that the applicant has demonstrated the feasibility of relating gamma ray measurements to radium or any other radionuclides. Consistent with NUREG-1569, Acceptance Criteria 6.4.3(1), 6.4.3(3) and 6.4.3(5), please demonstrate that the applicant's methodology for gamma ray surveys for excavation control monitoring and final status surveys will provide 95-percent confidence that the survey units will meet the cleanup guidelines.

<u>TR RAI 6.4-6 Response</u>

With its response to TR RAI 2.9-38 (a-b), and others in this response package, Powertech has demonstrated the feasibility of relating gamma ray measurements to Ra-226 concentrations in soil within the project area. Please see the response to TR RAI 6.2-2 (a-b) for further information.

TR Section 6.4 will be revised to include the following commitment:

At least 12 months prior to commencing reclamation, Powertech will submit a decommissioning plan that will contain descriptions of methodology for both pre- and post-reclamation gamma ray surveys. The gamma ray surveys for excavation control monitoring and final cleanup status will be designed to be consistent with NUREG-1569, Acceptance Criteria 6.4.3(1), 6.4.3(3) and 6.4.3(5), including the use of a methodology for gamma-ray surveys for excavation control monitoring and final status surveys that will provide 95% confidence that the survey units will meet the cleanup guidelines.

<u>TR RAI 6.4-7</u>

Consistent with 10 CFR 40, Appendix A, Criterion 6(6), please discuss how byproduct material containing concentrations of radionuclides other than radium in soil, and surface activity on remaining structures will not result in a total effective dose equivalent (TEDE) exceeding the dose from cleanup of the radium contaminated soil to the benchmark dose and will be at levels which are ALARA. This discussion should describe how the radium benchmark dose will be applied to the surface activity on remaining structures.

<u>TR RAI 6.4-7 Response</u>

TR Section 6.4.3 (Surface Soil Cleanup Verification and Sampling Plans) will be revised to include the following:

A calculation of the potential peak annual total effective dose equivalent (TEDE) within 1,000 years to the average member of the critical group that would result from applying the radium standard (not including radon) on the site will be submitted to NRC for approval. Details will be provided in the decommissioning plan to be submitted for review at least 12 months prior to decommissioning activities. A key component of the plan would be that 11e.(2) byproduct material containing concentrations of radionuclides, other than radium in soil, and surface activity on remaining structures, must not result in a TEDE exceeding the dose from cleanup of radium contaminated soil to the radium benchmark dose, and must be at levels which are ALARA. Powertech is aware that the use of decommissioning plans with radium benchmark doses which exceed 100 mrem/yr, before application of ALARA, requires the approval of the Commission after consideration of the recommendation of the NRC staff.

TR RAI 6.4-8

The applicant stated that the QAPP will contain recommendations in NRC Regulatory Guide 8.15. The correct reference appears to be Regulatory Guide 4.15. Please address this discrepancy.

TR RAI 6.4-8 Response

TR Section 6.4.4 (Quality Assurance) will be corrected to include the correct reference to Regulatory Guide 4.15 as follows:

Prior to operations, Powertech will prepare a Quality Assurance Project Plan (QAPP) in accordance with Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) - Effluent Streams and the Environment.

Environmental Effects

The applicant has not provided sufficient information regarding the manner in which it will monitor for, remediate, and prevent accidents. Please provide the following information:

TR RAI 7.0-1
Consistent with Regulatory Guide 3.46 and NUREG-1569, Acceptance Criteria 7.5.3(1) and 7.5.3(2), please address preventive measures, consequences from, and actions and equipment used to stop, a major pipe or tank rupture in the facility. In the discussion, please provide the manner in which major piping/tank ruptures will be stopped and also the capacity of the sumps/bermed areas.

TR RAI 7.0-1 Response
TR Section 7.5 (Potential Effects of Accidents) will be revised to include the following information. For additional information, refer to the response to TR RAI P&R-14(j).

Major Pipe or Tank Ruptures in the CPP or Satellite Facility

a. Preventative measures: Facilities will be designed and operated according to 40 CFR Part 68. In addition, Powertech will comply with 40 CFR Part 355 in disclosing the reportable quantities of sulfuric acid, hydrochloric acid and sodium hydroxide, the only chemicals used in the project area that are expected to be present in quantities greater than the minimum reportable amounts. Preventative measures will also include routine inspection, installation of safety devices to prevent over pressurization or excessive level, use of tanks and vessels that meet applicable ASME and/or ASTM codes, and proper engineering design of tanks and supporting structures, foundations, and footings.

b. Consequences: The rupture of a major pipe or tank within either the CPP or Satellite Facility would result in the release of process liquids onto the floor of the facility. The spilled material would be contained by concrete curbs and would flow to the trench drains and sumps (equipped with level alarms), where it would be pumped to the appropriate tank or disposal system. Alternatively, the spilled material will be transferred from the sumps to the Central Plant Pond for reprocessing prior to eventual disposal.

c. Actions used to stop chemical accidents: Personnel will be trained in the hazards associated with process chemicals and solutions present at each facility and the proper procedure to follow in the clean-up of a spill of the materials within the plant facilities. In particular, for tank ruptures, operators will be trained to use personal protective equipment and to close valves on any pipelines connected to the ruptured tank. In the case of a pipe rupture, personnel will be trained to shut down pumps and close valves in order to isolate the section of pipe containing the rupture from other parts of the process. Powertech will also train local emergency response personnel in the potential hazards associated with the facility.

Capacities of Sumps and Curbed Areas

The CPP and Satellite Facility will be designed with trench drains, sumps, and a concrete curb at the perimeter of the floor designed to contain the contents of the largest vessel in the facility. For the CPP,

the largest liquid-containing vessel is the yellowcake thickener, which will have an operating volume of 5,000 ft^3. For the Satellite Facility, the largest liquid-containing vessel will be the utility water tank, with a volume of 2,139 ft^3. For both facilities, a containment curb along the perimeter wall of each building slab with internal trench drains and sumps will be designed to contain a spill of at least 200% of the largest liquid-containing tank or vessel volume in each facility. Sumps and sump pumps will be operable for the removal of spilled materials to waste holding tanks or the Central Plant Pond and ultimately to the liquid waste disposal system. For additional information on the capacities of curbed areas, refer to the response to TR RAI P&R-14(j).

TR RAI 7.0-2

Consistent with Regulatory Guide 3.46 and NUREG-1569, Acceptance Criterion 7.5.3(2), please address any site specific preventive and mitigating measures for potential chemical accidents.

TR RAI 7.0-2 Response

Personnel will be trained in the hazards associated with process chemicals and solutions present at each facility and the proper procedures to follow in the clean-up of a spill of the materials within the plant facilities. In particular, for tank ruptures, operators will be trained to use personal protective equipment and to close valves on any pipelines connected to the ruptured tank. In the case of a pipe rupture, personnel will be trained to shut down pumps and close valves in order to isolate the section of pipe containing the rupture from other parts of the process. Powertech will also train local emergency response personnel in the potential hazards associated with the facility.

Please refer to response to TR RAI MI-1(a), which identifies chemicals used in uranium processing that have the potential to impact radiological safety. That response, which provides information that will be incorporated into the revised TR, describes site specific measures that will be taken by Powertech to prevent and mitigate potential chemical accidents. Hydrogen peroxide, acid and sodium hydroxide will be stored in tanks meeting all manufacturer's recommendations. The storage tanks will be outside the CPP and will each have secondary containment basins capable of storing at least 110% of the largest tank volume.

Please also refer to the response to TR RAI 7.0-1, which describes preventative and mitigating measures for potential chemical accidents. Additional measures that address site-specific conditions are described below. The following information will be incorporated into the revised TR, Section 7.5.

Freezing temperatures

Outdoor winter temperatures at the project area will at times be below freezing. All tanks and pipelines that contain fluids subject to freezing will be heat traced to maintain the contents above the freezing point of the material. Header houses, valve vaults, and well head covers will contain electric heaters to prevent freezing temperatures from occurring in these structures.

Windstorms and winter storms

All facilities, including buildings, storage tanks, and well head covers, will be designed and constructed to withstand the highest wind velocities that are reasonably expected to occur within the project area. During winter months, storms with high winds and snowfall may cause blizzard conditions, but these events do not present a higher potential for chemical accidents. Delivery of chemicals will be delayed until safe driving conditions exist. Care will be taken not to let the amount of chemicals on hand be reduced to levels that make it urgent to obtain more chemicals.

<u>TR RAI 7.0-3</u>
Consistent with Regulatory Guide 3.46 and NUREG-1569, Acceptance Criteria 7.5.3(1), 7.5.3(2) and 7.5.3(3), please provide a discussion on accident consequences, including preventive and mitigating measures for fires and explosions at the Dewey-Burdock facility. In the discussion, include the potential for wildfires.

<u>TR RAI 7.0-3 Response</u>
TR Section 7.5 will be revised to incorporate the following discussion on accident consequences.

<u>Accident Consequences – Fires and Explosions</u>

An explosion, although unlikely, could result from: a prematurely sealed drum of yellowcake, in a dryer, from the use of propane in the thermal fluid heater or space heaters, or from the mixing of oxygen gas with combustible materials. Of these, an explosion from the drum of yellowcake has the greatest potential to impact radiological safety of the workers. An explosion in a sealed drum would be contained within the dryer room. Powertech will develop a standard operating procedure for measuring the temperature in yellowcake drums prior to drum sealing.

According to the NRC, multiple hearth dryers pose a greater hazard than the vacuum dryers that will be used by Powertech (NUREG-1910). Multiple hearth dryers operate at higher temperatures and may be directly fed with gas. The vacuum dryers proposed for the Dewey-Burdock Project operate at lower temperatures and are not directly fed by gas. They therefore pose less of a hazard for explosion. In the unlikely event of an unmitigated explosion accident of a yellowcake dryer, doses to the workers could have a MODERATE impact depending on the type of accident, but exposure to the general public would result in a dose below the 10 CFR Part 20 public dose limit, resulting in only a SMALL impact to the public (NUREG-1910, pg. 4.2-56).

<u>Preventative and Mitigation Measures – Fires and Explosions</u>

As noted in TR Section 3.2.8, the design criteria for chemical storage and feeding systems includes applicable sections of the International Building Code, International Fire Code, OSHA regulations, RCRA regulations, and Homeland Security regulations. Propane fired heating devices will be installed to meet applicable NFPA/FM safety standards. Additional measures for preventing fires and explosions within process facilities include:

- As noted in TR Section 3.2.8.6, the oxygen tanks will be located a safe distance from the CPP and other storage tanks and will be designed to meet industry standards of NFPA-50.
- Cleaning of equipment for oxygen storage and conveyance systems will follow the standards specified in CGA G-4.1.

- Powertech will develop emergency response procedures for oxygen accidents. All employees who may be exposed to hazards associated with oxygen will be properly trained with regard to the hazards, accident prevention and mitigation, and emergency response procedures.
- Header houses will be equipped with fans to provide continuous ventilation in order to prevent buildup of oxygen.
- The oxygen lines to each header house will be equipped with automatic low pressure shut-off valves to minimize the delivery of oxygen through a broken pipe or a valve stuck in the open position, which could potentially supply oxygen to a fire.
- Procedures will be in place for confined space work or hot work for monitoring of oxygen build-up prior to start of work.
- Fire extinguishers will be placed at accessible locations in all buildings and vehicles for quick response and training will be provided for appropriate personnel in use of fire extinguishers.
- Powertech personnel and local emergency responders will receive training for responding to a fire or explosion.
- The CPP facilities are designed to contain and reduce the exposures to individuals in the event of an accident. Emergency response procedures would be implemented and employees would be directed as to what actions to perform in the event of an accident. For instance, a respiratory protection program will be in place and will be executed as necessary for worker protection during accident assessment and cleanup phases. In addition to the above mentioned protections other safeguards and mitigatory protocols are always in place during operation of a CPP facility. For example, a bioassay program for worker safety and contamination control programs involving personnel survey, clothing survey and equipment survey before release to unrestricted areas are common practices workers are subject to on a regular basis. These types of protocols are also utilized to assess if an accidental exposure took place during the course of an unintentional incident.

Preventative and Mitigating Measures – Wildfire

In order to protect facilities from wildfires, all facility buildings will be located within an area that is maintained in a vegetation-free state by the use of a crushed aggregate or asphalt surface and by appropriate weed-control measures. The creation of this buffer zone is expected to prevent fire from damaging equipment that could lead to a chemical accident by acting as a firebreak.

Within the well fields, vegetation will be controlled around each header house and around each well head cover to reduce the amount of combustible material adjacent to these structures. In the event of an approaching wildfire, operators will be trained to shut down well field operations and, if necessary, to evacuate facilities until the danger to personnel has passed. Damage, if any, will be assessed and remediated prior to re-starting operations.

Powertech will maintain firefighting equipment on site and will provide training for local emergency response personnel in the specific hazards present in the project area.

The emergency response plan will include descriptions of the following provisions of 29 CFR Part 1910:

- Notification and evacuation procedures
- Personal protective equipment
- General firefighting safety rules
- Reporting procedures
- Electrical and gas emergencies

TR RAI 7.0-4

Based on NUREG/CR-6733, the applicant concluded that the most significant risk from natural events at the proposed Dewey-Burdock facility is a tornado that dispersed yellowcake. However, the applicant did not address emergency procedures including notification of personnel of potential severe weather, evacuation procedures, damage inspection and reporting, and cleanup and mitigation of spills. Please address these issues.

TR RAI 7.0-4 Response

The following discussion will be incorporated into the revised TR.

The NRC determined that in the event of a tornado strike, chemical storage tanks could fail resulting in the release of chemicals. NUREG-0706 analyzed the risk from a tornado strike, which determined that ISR facilities were not designed to withstand tornado strength winds and assumed that an inventory of 45,000 kg of yellowcake was present on-site and that 15 percent (11,400 kg) or 26 55-gallon drums of the yellowcake was dispersed by the tornado. The model assumes that all the yellowcake was in a respirable form and was carried by the tornado to the project site boundary. According to the model, the maximum 50-yr dose to an individual's lungs would be 8.3×10^{-7} rem and would be located approximately 2.5 miles from the mill. NUREG-6733/CR concluded that the risk of a tornado strike on an ISR facility was very low and that no design or operational changes were necessary to mitigate the potential risks, but that it was important to locate chemical storage tanks far enough from each other to prevent contact of reactive chemicals in the event of an accident. Considering the relative remoteness of the proposed Dewey-Burdock Project, the potential consequences of a tornado strike would be considerably less than if the facilities were in a more populated area.

Nevertheless, there are risks to workers that must be addressed. Powertech will prepare and have available onsite for NRC inspectors an Emergency Response Plan that will contain emergency procedures to be followed in the event of severe weather or other emergencies. Included in the plan will be procedures for notification of personnel, evacuation procedures, damage inspection and reporting. It will also address cleanup and mitigation of spills that may result from severe weather. In advance of preparing the Emergency Response Plan, Powertech offers the following discussion on these issues.

Initially, Powertech will provide adequate training to its employees and visitors regarding communication systems used at the facilities. In the event of a report of a tornado sighting in the vicinity of the facility, the RSO, RST and/or Safety Engineer will ensure that the proper alarm (preset signal) has been sounded at both the Burdock and Dewey facilities. Additionally, all supervisors will be personally contacted via phone or radio and advised of the emergency. The supervisors and radiation safety staff will direct the employees' evacuation to one or more previously-specified nearby locations. Once it is safe to access the facilities, supervisory staff and radiation safety staff will begin the process of assessing potential damage to the facilities, including header houses and well heads. This process would

include radiological surveys and assessment of potential non-radiological hazards as well. NRC, DENR, BLM and other regulatory agencies as appropriate would be notified and advised of the damage, if any was observed. After consultation with the regulatory agencies the cleanup and mitigation efforts would commence.

POWERTECH (USA) INC.

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