Management Control Program 5.2

TR RAI--5.2-1

Please provide a reporting program that is consistent with NUREG-1569, Acceptance Criterion 5.2.3(1).

Response TR RAI-5.2-1

See TR_RAI-Response and Replacement Pages; Section 5.2 "Management Control Program"

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.

Response TR RAI--5.2-2

See TR_RAI-Response and Replacement Pages; Section 5.2 "Reporting".

TR RAI-5.2-3

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.

Response TR RAI-5.2-3

See TR_RAI-Response and Replacement Pages; Section 5.2 "Management Control Program"

TR RAI-5.2-4

Please clarify if there will be tailings piles on the site.

Response TR RAI-5.2-4

Tailings piles will not be present on the site. See TR_RAI-Response and Replacement Pages; Section 5.2-4 concerning TR Section 5.2.5 "Record Keeping".

POWERTECH (USA) INC.

Response: TR RAI-5.2-1

TR Section 5.2

Management Control Program

Reporting Program Consistant with NUREG 1569

ensure that equipment and laboratory facilities are adequate for monitoring and evaluating the relative attainment of the ALARA objective. The RSO will develop, review, approve and enact changes in the program so that protection against uranium and its progeny and the ALARA principle are maintained during the operation of the facility. These changes include new equipment, process changes, and changes in the operating procedures.

The RSO will also have the authority to enforce regulations and administrative policies that affect the program and can raise issues concerning safety to Mine Manager and the Vice President of Environment, Health, and Safety as shown in Figures 5.1-1 and 5.1-2. A mine manager will not possess the authority to unilaterally override the RSO's decision to suspend, postpone or modify an activity. The RSO will possess the authority to enforce regulations and administrative policies that may affect any aspect of the radiological protection program. The RSO will also be a member of the SERP described in Section 5.2.3 and will meet the qualifications outlined in NRC guidance.

The RSO reports directly to the Vice President of Environment, Health, and Safety.

5.2 Management Control Program

This section describes administrative controls within the Powertech (USA) organization that are intended to ensure the facility is operated in a manner that is protective of human health and the environment, including the principle of ALARA. Powertech (USA)'s Management Control Program will ensure that all applicable procedures concerning evaluations of the consequences of a spill or incident against 10 CFR Part 20, Subpart M and 10 CFR 40.60 reporting criteria are met. Powertech (USA) has committed to procedures to avoid or mitigate potential effects on archaeological and historic sites. This commitment is incorporated by reference in ER Appendix 4.10B.

5.2.1 Routine Activities

All routine activities involving handling, processing, or storing of radioactive material at the Dewey-Burdock facility will be documented by written standard operating procedures (SOPs). In addition, written SOPs will be established for health physics monitoring, sampling, analysis, and instrument calibration. These SOPs involving radioactive material handling will incorporate pertinent radiation safety practices.

POWERTECH (USA) INC.

Response: TR RAI-5.2-2

TR Section 5.2.6

Reporting

Discussion on Annual Landuse Information

- Create a possibility of an accident unlike what is evaluated in the license application (as updated)
- Create a possibility of a malfunction of a structure, system, or control unlike what is evaluated in this license application (as updated)
- Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report or the environmental assessment or technical evaluation reports or other analyses and evaluations for license amendments

Records of the evaluations made by the SERP will be made. These records will provide the basis for determining if the implementations of the changes do not require a license amendment pursuant to 10 CFR 40.44. Any change approved by the SERP will be documented in writing by showing the affected operating procedure, facility, and/or test and experiment before and after the change along with the date of the change. Even though Powertech (USA) is a newly formed corporation, it possesses more than 200 years of technical experience with ISL operations. The SERP will evaluate each well field package as it is developed. Due to the fact that Powertech (USA) is seeking a performance based license from the NRC, the SERP will submit the first well field package to the NRC for review and evaluation.

The SERP will have the authority to raise issues regarding the health and safety of the workers, general public, and/or the environment due to the operation of the facility to the Mine Manager and the Vice President of Environment, Health, and Safety.

An annual report will be prepared which describes actions taken by the SERP including changes to operating procedures, the facility, or tests and experiments that involve safety or the environment enacted since the previous report was issued. The report will also document the reason for each change, whether the change required a license amendment, and the basis for determination.

5.2.4 Radioactive Material Postings

In order to be exempted from the requirements of 20 CFR 1902(e), all entrances to the facility will be conspicuously posted with the following statement: "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

5.2.5 Record Keeping

All records will be maintained as hard copy originals or stored electronically.

The following information will be permanently maintained both on-site and at an off-site location until license termination:

- Records of on-site radioactive waste disposal.
- Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.
- Records of spills, excursions, facility stoppages, contamination events, and unusual occurrences.
- Records of inspections of waste retention systems. (no tailings at this facility)
- Records of the occupational monitoring described in Section 5.7.
- Information related to the radiological characterization of the facility.
- Drawing and photographs of structures, equipment, restricted areas, wellfields, and storage areas with radioactive materials and all of their modifications.

Additionally, records of survey and calibrations will be maintained for at least 3 years.

All records will be stored in manner to prevent record loss from fire, flood, or other unforeseen events beyond the control of Powertech (USA). All records will be legible throughout the retention period described above.

5.2.6 Reporting

Consistent with 10 CFR 20.2202, Powertech (USA) will notify the NRC within 4 hours of any event that could cause a release of licensed material or an exposure to radiation or radioactive materials exceeding the regulatory limits.

The NRC will be notified within 24 hours of any event that causes:

- An unplanned contamination event, involving licensed material greater than 5 times the lowest annual limit of intake, requiring longer than 24 hours to correct/clean up.
- Equipment necessary for control of radioactive material or radiation fails and there is no adequate redundancy/substitute.
- Medical treatment of an individual with removable contamination at an offsite medical facility.

The following information will be permanently maintained both on-site and at an off-site location until license termination:

- Records of on-site radioactive waste disposal.
- Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.
- Records of spills, excursions, facility stoppages, contamination events, and unusual occurrences.
- Records of inspections of waste retention systems. (no tailings at this facility)
- Records of the occupational monitoring described in Section 5.7.
- Information related to the radiological characterization of the facility.
- Drawing and photographs of structures, equipment, restricted areas, wellfields, and storage areas with radioactive materials and all of their modifications.

Additionally, records of survey and calibrations will be maintained for at least 3 years.

All records will be stored in manner to prevent record loss from fire, flood, or other unforeseen events beyond the control of Powertech (USA). All records will be legible throughout the retention period described above.

5.2.6 Reporting

Consistent with 10 CFR 20.2202, Powertech (USA) will notify the NRC within 4 hours of any event that could cause a release of licensed material or an exposure to radiation or radioactive materials exceeding the regulatory limits.

The NRC will be notified within 24 hours of any event that causes:

- An unplanned contamination event, involving licensed material greater than 5 times the lowest annual limit of intake, requiring longer than 24 hours to correct/clean up.
- Equipment necessary for control of radioactive material or radiation fails and there is no adequate redundancy/substitute.
- Medical treatment of an individual with removable contamination at an offsite medical facility.

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

The NRC will be notified within 48 hours of any event in which spills, evaporation pond leaks, or excursions of source material and process chemicals occurred.

A written report will be made and sent to the NRC Headquarters Manager within 30 days of each event listed above. That report will contain details about the event including the conditions leading up to the event, corrective measures taken, and their results.

The following reports will be submitted to the NRC at the indicated frequency:

- Annually, a SERP report as described in Section 5.2.3.
- Semiannually, an effluent and environmental monitoring report as required by 10 CFR 40.65.
- Annually, the ALARA audit report detailed in Section 5.3.3.
- Annually, the land use survey report
- Annually, summary of monitoring data detailed in Section 5.7 and any corrective actions resulting from SERP actions, inspections described in Section 5.3 or reporting triggers described above.

5.3 Management and Audit Program

This section describes management and audit programs Powertech (USA) will use to periodically evaluate compliance with and effectiveness of the radiation protection, operational monitoring, and environmental programs at the facility. A series of health physics inspections and audits of the radiation protection and ALARA programs will be conducted.

The company's primary goal of the radiation protection program is to ensure doses to workers and the members of the public are ALARA, according to the requirements in 10 CFR 20.1101(b) which states: "The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA)." The Management and Audit Program is designed to provide quality assurance based upon reviews and evaluations of the effectiveness of radiation protection provided for workers and members of

Powertech (USA) Inc.

Response: TR RAI-5.2-3

TR Section 5.2

Management Control Program

Cultural Resources Inventory Prior to Development Activity

POWERTECH (USA) INC.

Response: TR RAI-5.2-4

TR Section 5.2.5

Record Keeping

Tailings Piles are not present at the ISL Facility

Management and Audit Program 5.3

TR RAI- 5.3-1
Please address the following issues related 10 the applicant's ALARA program.

(a) Consistent with the regulatory citations above and Regulatory Guide 8.37, please provide additional discussion on the applicant's ALARA program.

(b) 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.

Response TR RAI-5.3-1(a)
See TR_RAI-Response and Replacement Pages; Section 5.3 "Management and Audit Program".

Response TR RAI-5.3-1(b)
Licensee Management Items in RG-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 pg.5-13

3. A periodic management audit program that reviews procedural and operational efforts to maintain exposures ALARA;
Addressed in: TR_Section 5.3 begin on pg . 5-9

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; TR_Section 5.3 begin 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 5.5.4 pg. 5-15; TR_Section 5.5 pg.5-13; TR_Section 3.3 begin pg. 3-59; TR_Section 4.2.3 pg. 4-28; TR_Section 5.3.4 pg. 5-11; TR_Section 5.4 pg. 5-12

Powertech (USA) believes the information contained within the application is in line with the general operating philosophies acceptable to the NRC staff as described in RG-8.10. The application strongly supports the management's commitment to maintaining exposures ALARA and reducing exposures when possible. Refer to the following TR_Sections: 4.1.1 Radon; 4.1.2.2 Atmospheric Discharges from the Yellowcake Draying 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; 6.4.3 Surface Soil Cleanup Verification and Sampling Plans.

POWERTECH (USA) INC.

Response: TR RAI-5.3-1(a)

TR Section 5.3

Management and Audit Program

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

The NRC will be notified within 48 hours of any event in which spills, evaporation pond leaks, or excursions of source material and process chemicals occurred.

A written report will be made and sent to the NRC Headquarters Manager within 30 days of each event listed above. That report will contain details about the event including the conditions leading up to the event, corrective measures taken, and their results.

The following reports will be submitted to the NRC at the indicated frequency:

- Annually, a SERP report as described in Section 5.2.3.
- Semiannually, an effluent and environmental monitoring report as required by 10 CFR 40.65.
- Annually, the ALARA audit report detailed in Section 5.3.3.
- Annually, the land use survey report
- Annually, summary of monitoring data detailed in Section 5.7 and any corrective actions resulting from SERP actions, inspections described in Section 5.3 or reporting triggers described above.

5.3 Management and Audit Program

This section describes management and audit programs Powertech (USA) will use to periodically evaluate compliance with and effectiveness of the radiation protection, operational monitoring, and environmental programs at the facility. A series of health physics inspections and audits of the radiation protection and ALARA programs will be conducted.

The company's primary goal of the radiation protection program is to ensure doses to workers and the members of the public are ALARA, according to the requirements in 10 CFR 20.1101(b) which states: "The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA)." The Management and Audit Program is designed to provide quality assurance based upon reviews and evaluations of the effectiveness of radiation protection provided for workers and members of the public. For more information regarding exposures to members of the public see TR Section 2.9.6.

5.3.1 Health Physics Inspections – Daily

The RSO or an RSO designee will conduct a daily visual inspection of all work and storage areas in the facility. The purpose of these inspections is to determine if good radiation practices are being implemented properly, including minimization of contamination through proper housekeeping and cleanup, SOPs are being followed, and if issues identified in prior inspections have been addressed and corrected. See section 5.4 for radiation staff qualifications.

5.3.2 Health Physics Inspections – Weekly

Once a week, the RSO and Mine Manager will perform an inspection of all facility areas. The purpose of these inspections is to examine the general radiation control practices and observe the required changes in procedure and equipment.

Procedural deviation or other issues potentially affecting facility compliance, health and safety, or environmental impacts found during the inspections will be recorded in an inspection logbook or equivalent tracking system along with the date of the inspection and the signature of the inspector. These entries will be kept on file for at least a year. The RSO will discuss the problems with members of management that have the authority and responsibility to rectify them.

Additionally, the RSO will review the shift logs and daily work-orders, on a regular basis, where there was potential of exposing employees. The RSO will determine if each action was authorized in writing by a person with the proper authority (the RSO or someone designated by the RSO).

5.3.3 Health Physics Reviews – Monthly

At least monthly, the RSO will review the results of daily and weekly inspections, including a review of all monitoring and exposure data for the month. The RSO will then write a report summarizing the significant worker protection activities for the month. The report will summarize the most recent personnel exposure data, bioassays, and time-weighted calculations for the month along with the pertinent radiation survey records for the month.

Radiation Safety Training 5.5

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.

Response TR RAI-5.5-1

See section TR_Sections 5.5.1, 5.7.2.2 and 5.7.4.3. The training program (consistant with RG 8.13) for declared pregnant workers is outlined in the above mentioned sections of the TR.

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 nonradiological hazards for workers.

Response TR RAI-5.5-2

Regulatory Guide 8.31_Section 2.5 and NUREG-1569, Acceptance Criteria 5.5.3(1) both address risks of exposure to radiation, the applicant has addressed these components of the training program in TR_Section 5.5.1. TR_Section 5.5.3 Visitor Training addresses radiological and nonradiological training for visitors. TR_Section 5.5.4 Contractor Training addresses type of training appropriate for the work that will be performed by the contractor. See also TR_Section 3.3 (Subparts H and Z). TR_Section 7.2.5.4 commits the applicant to "rigorous safety training". TR_Section 7.5.1 includes by reference NUREG-1910 other training that could be implemented. Also, for language regarding a proposed non radiological hazard training program see TR_RAI-Response and Replacement Pages; Section 5.5-2 applicable to TR Section 5.5 "Initial Training".

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.

Response TR RAI-5.5-3

See TR_RAI-Response and Replacement Pages; Section 5.5 For **TR Appendix 5.5-A "Proposed Written Radiological Safety Instructions".**

POWERTECH (USA) INC.

Response: TR RAI-5.5-1 and 5.7.4-4

TR Section 5.7.2.2 and 5.7.4.3

Employee Monitoring and Prenatal and Fetal Exposure

5.7.2.2 Employee Monitoring

Pursuant to 10 CFR 20.1502, employees working at the facility will be monitored for external radiation exposure if they have the potential to receive 10 percent of an applicable limit in a year. Monitoring requirements will be determined in accordance with guidance found in NRC Regulatory Guide 8.34.

The applicable adult worker radiation dose limits are as follows:

- 5 rem deep-dose equivalent (DDE)
- 15 rems lens dose equivalent (LDE)
- 50 rems shallow-dose equivalent to the skin (SDE)
- 50 rems shallow-dose equivalent to any extremity

Applicable limits for minors working at the facility are 10 percent of the adult limits listed above.

Applicable limits for declared pregnant workers are the same as adult workers with the exception of the DDE wich is 10 percent of the adult limit for the period of gestation.

Employee participation in the external radiation monitoring program include those working in the following departments: Environmental, Health and Safety; Construction and Production; number of personnel are estimated at 90 participants at program start. See Figure 5.1-2 for personnel who may be included into the external radiation monitoring program.

Employees not monitored that have a change in exposure potential such that they may receive 10 percent of an applicable dose listed above in one year will be monitored. Conversely, monitored employees can be eliminated from the external radiation monitoring program provided they no longer have the potential to receive 10 percent of the applicable doses listed above in one year.

Personnel monitoring for external radiation will be done by issuing dosimeters to personnel who may potentially exceed 10 percent of the annual occupational limit (10 CFR 20.1201(a)). Powertech (USA) may monitor other workers, although not required, for occupational exposures during the first year of operations to ensure that all workers are receiving less than 10 percent of the 5 rem annual limit; after the first year evaluation, monitoring may be reduced or eliminated at some locations. This decision would be at the discretion of the RSO. TLDs or OSLs will also be utilized as dose area monitors. The dosimeters will have a sensitivity of 1 mrem and will be issued by a company currently holding personal dosimeter accreditation by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The dosimeters will be exchanged monthly for worker with declared pregnancies and quarterly for all other radiation workers.

High Radiation Area: Any accessible area in which an individual could receive a dose equivalent exceeding 100 mrem in 1 hour at 30 cm (1 ft) from the source or from any surface the radiation penetrates. The existence of a high radiation area occurring within an ISL facility is unlikely.

However unlikely the occurrence may be, if it were necessary for an individual to enter a high radiation area, 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 only permit the minimum exposure.

The licensee is aware of 10 CFR Subpart G §20.1601 and would have qualified staff 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.

All external doses received by monitored personnel above 10 percent of the above limits will be reported on NRC Form 5 or in a format which contains all the information listed on NRC Form 5.

5.7.2.2.1 Administrative Action Levels

Consistent with RG 8.30 action levels for worker protection will be established for the necessary work area(s), work activities, constituent(s), and for employee exposure and or contamination, dose rate and quarterly dose. If action an action level is exceeded, the RSO will conduct an investigation into the specific occurrence and take corrective action, when appropriate. The exceedance should be documented along with any corrective action that occurred and any preventative measures employed. If any limits or constraints specified in Subpart M of 10 CFR Part 20 and §40.60 are exceeded the NRC will be notified by the licensee as soon as possible. The records of such events will be kept by the licensee until license termination. An example of how action levels will be determined is summarized below.

5.7.4.2 Radon Decay Production Exposure

The amount of radon decay products exposure an employee received in a year will be calculated using the following equation:

$$E_{rd} = \frac{1}{170} \sum_{i=1}^{n} \frac{C_i \times t_i}{PF_i} \qquad \text{Equation 5.3}$$

where E_{rd} is the exposure to radon decay products in working level months (WLM) the employee received in a year, C_i is the average concentration, or working level (WL), of radon decay products of each exposure, t_i is the time of each exposure in hours, PF_i is the respiratory protection factor of each exposure, and n is the number of exposures the employee had during the year.

According to 10 CFR 20 Appendix B, 4 WLM equates to 5 rem CEDE.

5.7.4.3 Prenatal and Fetal Exposure

The dose to the embryo and fetus is calculated as the sum of the deep-dose equivalent of the declared pregnant worker and the dose to the embryo/fetus from radionuclides in the embryo/fetus and the declared pregnant worker. The calculations will be done according the NRC Regulatory Guide 8.36 *"Radiation Dose to the Embryo/Fetus"*.

5.7.5 Bioassay Program

A urinalysis bioassay program will be established at the facility in order to detect employee intakes of uranium. The program will be consistent with the recommendations contained in NRC Regulatory Guide 8.22 "*Bioassays at Uranium Mills*" (RG 8.22). All employees that will handle yellowcake will give a urine sample prior to starting employment and upon termination of employment. During operation of the facility, each employee that has the potential to ingest or inhale yellowcake will give a urine sample on a monthly basis.

Additionally, urine samples will be collected from workers who were exposed to airborne yellowcake suspected of exceeding the 40-hr weekly limit of 1 x 10^{-10} μCi / mL.

All urine samples will be analyzed for uranium content by a contract laboratory that can achieve a minimum sensitivity of 5 μg/L. The results of the analyses will be documented. Action levels for urinalysis will be established based upon Table 1 in RG 8.22.

POWERTECH (USA) INC.

Response: TR RAI-5.5-3

TR Appendix 5.5-A

Proposed Written Radiological Safety Instructions

Appendix 5.5-A: Proposed Written Radiological Safety Instructions

§ 19.12 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 (1 mSv) shall be--

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

(2) Instructed in the health protection problems 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 Commission 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 the licensee any condition which may lead to or cause a violation of Commission 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 § 19.13.

(b) In determining those individuals subject to the requirements of paragraph (a) of this section, licensees must take into consideration assigned activities during normal and abnormal situations involving exposure to radiation and/or radioactive material which can reasonably be expected to occur during the life of a licensed facility. The extent of these instructions must be commensurate with potential radiological health protection problems present in the work place.

External Radiation Exposure Monitoring Program 5.7.2

TR RAI-5.7.2-1
Provide a description of survey instrumentation sufficient to measure expected gamma dose rates during operation.

Response TR RAI-5.7.2-1
According to NUREG 1569; Acceptance Criterion 5.7.2.3(3) applies to the proposed external radiation monitors appropriate to the facility operation. It is the applicant's understanding, the NRC's request is specific to Radiation Area: Any accessible area in which an individual could receive a dose equivalent exceeding 5 mrem in 1 hour at 30 cm (1 ft) from the source or from any surface the radiation penetrates. It is unlikely an area exceeding 5 rem in 1 hour at 30 cm would occur within an ISL facility. This type of survey is not deemed "reasonable" under normal operating circumstances.

The applicant refers the reviewer to **TR_Section 5.7.2.3 "External Radiation Surveys"** with regards to description of instrumentation, sensitivity, calibration, frequency, etc.

Also See TR_RAI-Response and Replacement Pages; Section 5.7.2-1 for information concerning OSL dosimeters in TR Section 5.7.2.2 "Employee Monitoring".

TR RAI-5.7.2-2
Consistent with Regulatory Guide 8.30, please provide these action levels or justification for an alternate program.

Response TR RAI-5.7.2-2
See TR_RAI-Response and Replacement Pages; Section 5.7.2-2 for additional information on administrative action levels for TR Section 5.7.2.2.1.

TR RAI-5.7.2-3
Discuss the applicant's employee monitoring program as it relates to individuals entering a high radiation area.

Response TR RAI-5.7.2-3
See TR_RAI-Response and Replacement Pages; Section 5.7.2-3 for additional information in TR Section 5.7.2.2 "Employee Monitoring".

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.

Response TR RAI-5.7.2-4

See TR_RAI-Response and Replacement Pages; Section 5.7.2-4 concerning the categories and quantity of personnel that may be included in the external radiation monitoring program (TR Section 5.7.2.2 text insertion). Please refer to Figure 5.1-2: Facility Organizational Structure also for categories and numbers of individuals whom may be monitored within the first year of operation.

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).

Response TR RAI-5.7.2-5

TR_Section 5.7.2.3 External Radiation Surveys provides the proposed locations of exposure rate monitors inside and outside the facilities. See Figures 5.7-2 through 5.7-5 of the above mentioned section of the TR.

POWERTECH (USA) INC.

Response: TR RAI-5.7.2-1

TR Section 5.7.2.3

External Radiation Surveys

Gamma action levels are usually determined after fluctuations of normal operating levels have been established. The action level is usually set just higher than the fluctuation of normal operating levels. The action levels may vary based on background levels; distance from source; type of shielding available within the work area and type of work. All of which will be considered in the development of gamma dose action levels. See section 5.7.4 for more information on dose assessment.

A facility action level of 25% of the DAC for soluble natural uranium and 0.08 WL for radon-222 with daughters present will be established. If an airborne uranium sample exceeds the action level for soluble uranium or radon-222, the RSO will investigate the cause and increase the sampling frequency to weekly until the radon daughter concentration levels do not exceed the action level. An administrative action level will be set at 130 DAC-hours for exposure to insoluble uranium, and/or radon daughters 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.

An action level for urinalysis will be establishd utilizing RG 8.22 Table 1. 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 both to determine the cause of the high result, and determine if the exposure records adequately reflect such an exposure occurred.

5.7.2.3 External Radiation Surveys

Shortly after the facility becomes operational, at least 20 gamma radiation measurements will be taken in order to characterize the radiation levels at the facility, as stated in RG 8.30. The locations where these measurements will be performed are depicted on Figures 5.7-2 through 5.7-5. Based on these measurements, areas where a person may receive a dose of 5 mrem in 1 hour at 30 cm (1 foot) from a radiation source or radiation-emitting surface will be posted as a "Radiation Area" as required in 10 CFR 20.1902(a). For areas with radiation levels less than those defined for a radiation area, follow-up measurements will be performed semiannually to evaluate potential impacts of changing process conditions on facility radiation levels.

Areas posted as "radiation areas" will be investigated to determine the source of radiation and will be surveyed for gamma radiation on a quarterly basis as described in RG 8.30. Methods to reduce radiation levels using engineering controls, process adjustments, or maintenance practices will be evaluated once the source of radiation is determined

The instrumentation used in the external gamma radiation surveys will be portable, battery operated and will have a sensitivity of at least 0.1 milliroentgens per hour (mR/hr) and be able to measure radiation levels as high as 5 mR/hr.

The instrumentation will be calibrated according to the manufacturer's instructions or at least once a year. Operational checks on the instruments will be performed before each daily use. The instruments will be operated according to manufacturer's recommendation.

Since yellowcake will be generated at the facility, there is a potential hazard from external beta radiation. Specifically, operations requiring direct handling of aged yellowcake may lead to significant exposures to the skin. Therefore, a beta survey will be conducted at or near surfaces for each operation requiring direct handling of yellowcake. A beta survey will also be conducted when the equipment or operating procedures are changed in a way that may affect the exposure of the worker to beta radiation. These surveys will also be used in determining the level of personal protective equipment (PPE) required for the operations.

The instrumentation to be used in the beta surveys will be portable, have a sufficient efficiency for detecting beta radiation, and have a low efficiency for detecting gamma radiation. An example is a Ludlum Model 44-9 Pancake G-M Detector coupled with an appropriate ratemeter/scaler.

Beta doses will be determined using one of two ways. One method uses the information acquired during the beta radiation surveys. Average beta radiation fluence rates can be estimated, assuming all net counts are beta radiation from the yellowcake. The estimated average particle fluence rates, along with the amount of time spent on each operation by each worker and the average energy of beta radiation emitted from yellowcake can be used to determine the amount of radiation dose to the skin of the workers from beta radiation. The other method to determine beta radiation doses involve using Figures 1 and 2 from RG 8.30.

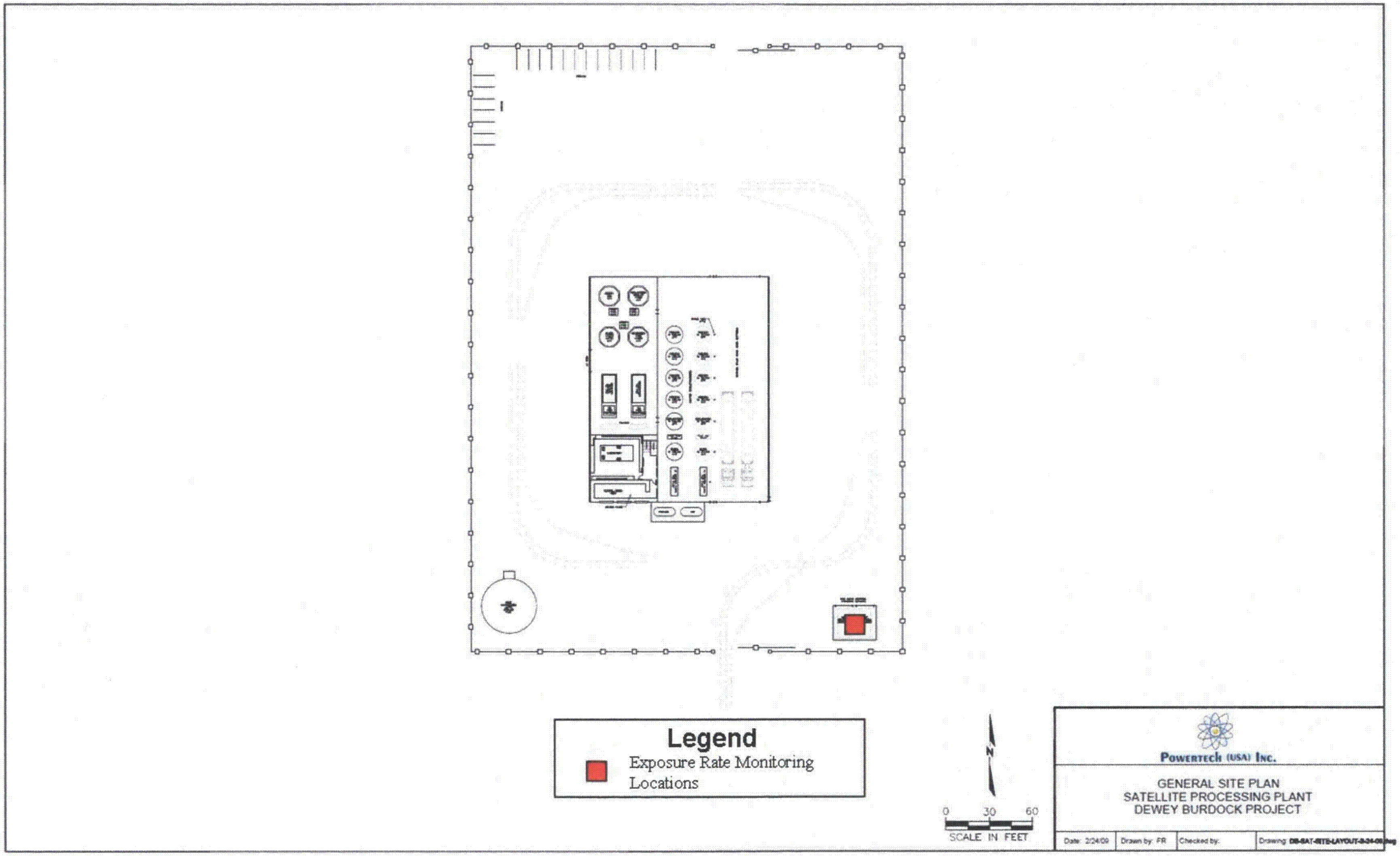


Figure 5.7-2: Locations of Exposure Rate Monitors on-site of Satellite Facility, Outside the Satellite Facility

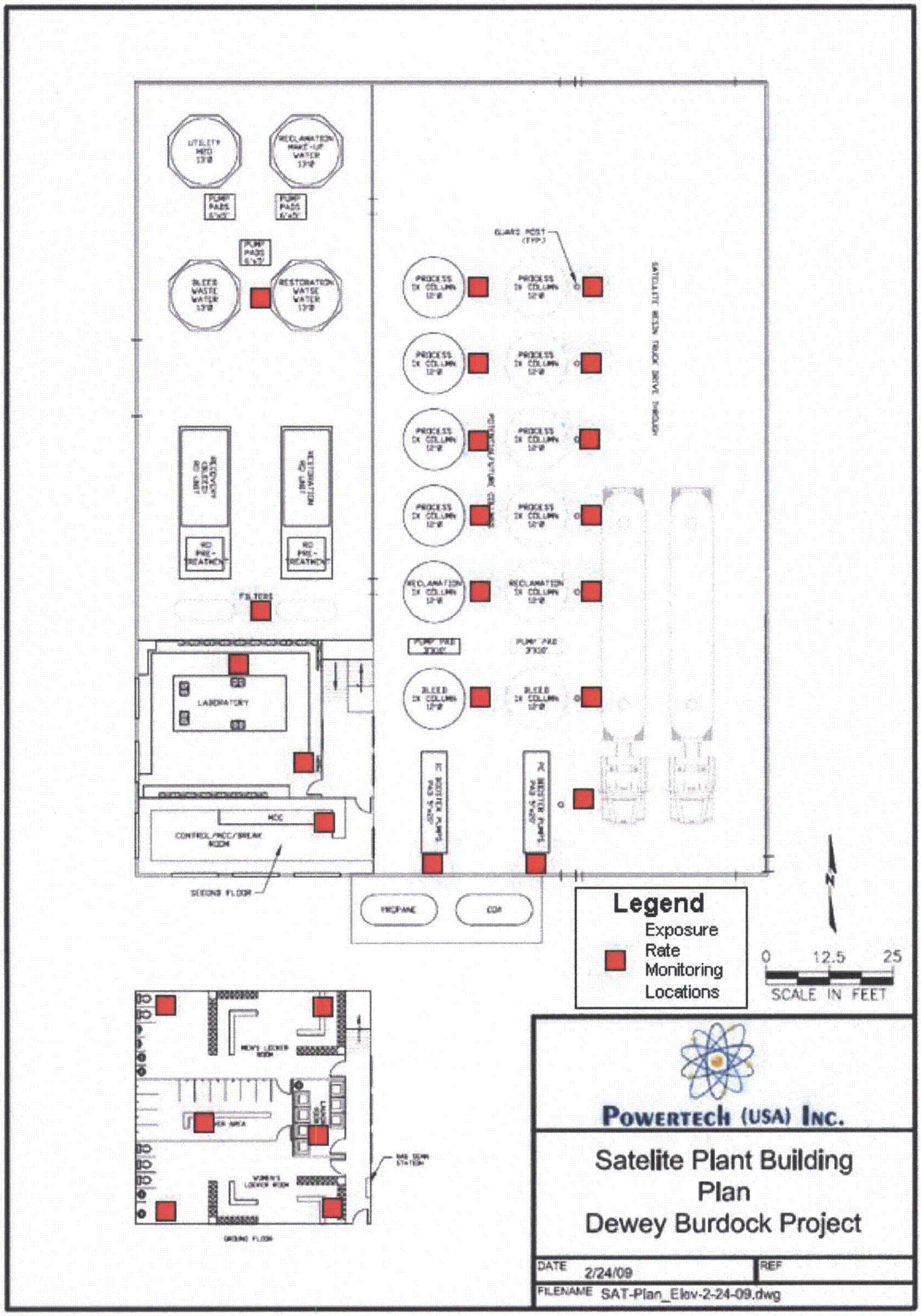


Figure 5.7-3: Locations of Exposure Rate Monitors Inside Satellite Facility

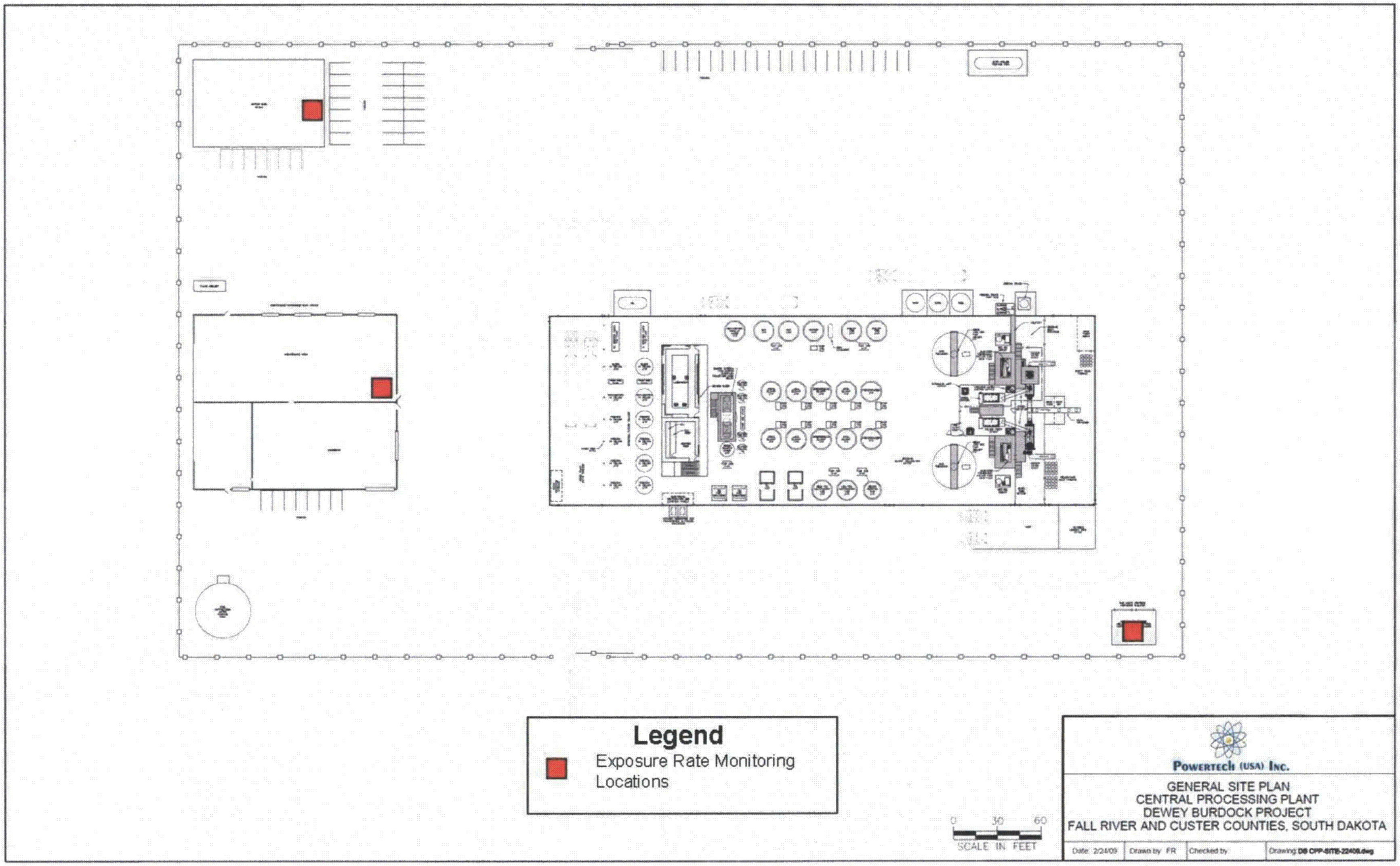


Figure 5.7-4: Locations of Exposure Rate Monitors on-site of Central Processing Plant, Outside the Central Processing Plant

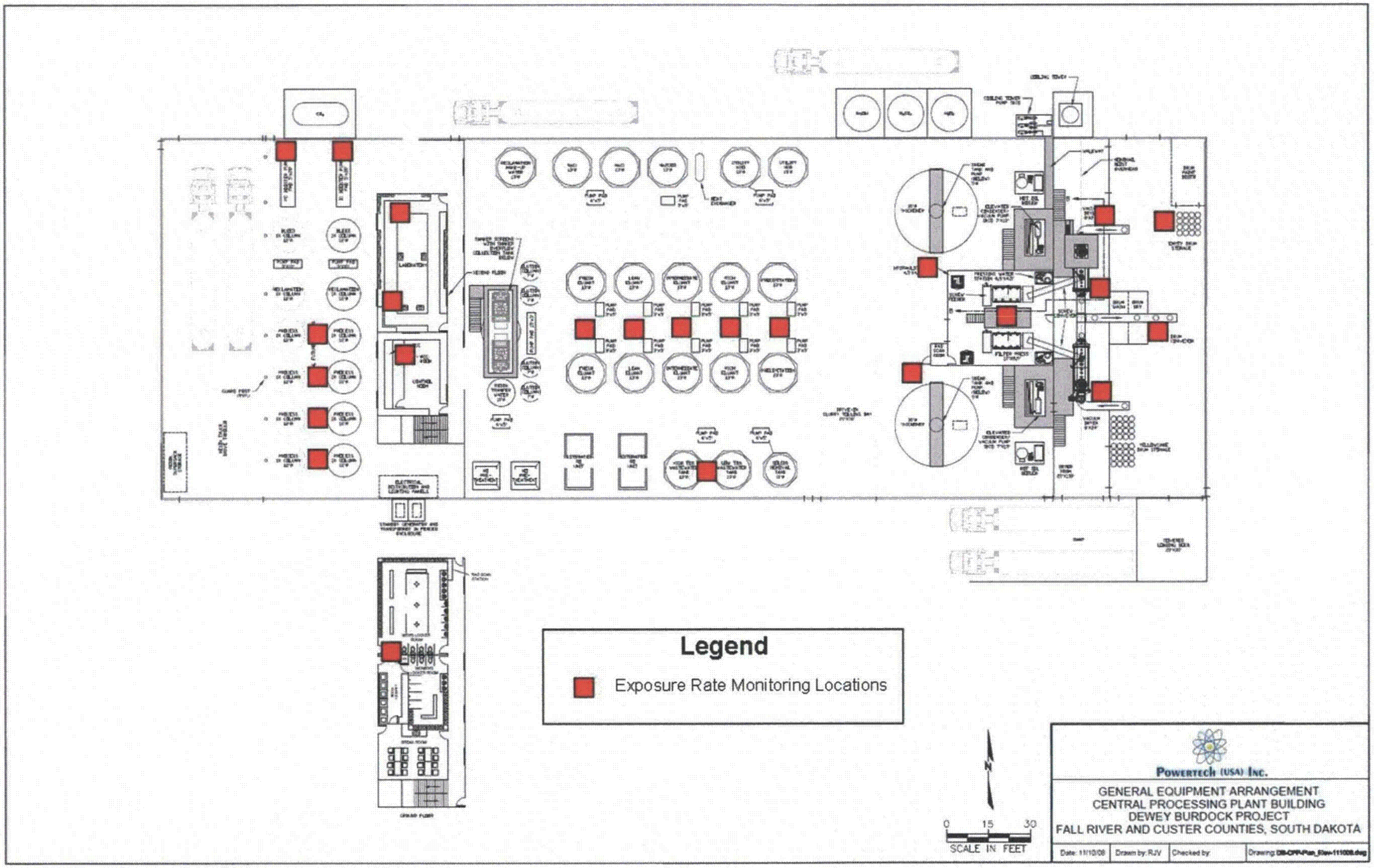


Figure 5.7-5: Locations of Exposure Rate Monitors in Central Processing Plant

In-Plant Airborne Radiation Monitoring Program 5.7.3

TR RAI-5.7.3-1

Please address the following in regards to radon decay product monitoring:

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.

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.

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.

Response TR RAI-5.7.3-1(a)

See TR_RAI-Response and Replacement Pages; Section 5.7.3-1(a) for additional information concerning determining air flow patterns within work areas in TR Section 5.7.3 "Airborne Radiation Monitoring Program".

Response TR RAI-5.7.3-1(b)

See TR_RAI-Response and Replacement Pages; Section 5.7.3-1(b).

Response TR RAI-5.7.3-1(c)

See TR_RAI-Response and Replacement Pages; Section 5.7.3-1(c); For more information see TR Section 5.7.3.

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.

Response TR RAI-5.7.3-2

See TR_RAI-Response and Replacement Pages; Section 5.7.3-2 for requested information inserted into TR Section 5.7.3.2 and TR Section 4.1.1.

TR RAI-5.7.3-3

Please address the following in regards to airborne particulate monitoring:

a. please provide facility drawings that depict the facility layout and the location of samplers for airborne particulates.

b. please describe how airflow patterns will be established within the facilities and will they be verified throughout the operational lifetime of the facilities?

c. please describe how air sampling locations will be evaluated over time to confirm that their locations are still appropriate.

d. 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.
e. please provide a description of the applicant's air sampling program for areas not designated as airborne radioactivity areas.

Response TR RAI-5.7.3-3(a)
See TR Section 5.7.3.2 Airborne Particulate Monitoring paragraph 5.

Response TR RAI-5.7.3-3(b)
See Response TR_RAI-5.7.3-1(a.)

Response TR RAI-5.7.3-3(c)
Response TR_RAI-5.7.3-3(c) for additional information in TR Section 5.7.3.2. "Airborne Particulate Monitoring".

Response TR RAI-5.7.3-3(d)
See Response TR_RAI-5.7.3-3(d) for additional information in TR Section 5.7.3.2 and Figure 5.7-10 "Air Particulate Sampling Locations".

Response TR RAI-5.7.3-3(e)
See Response TR_RAI-5.7.3-3(e) for additional information in TR Section 5.7.3.2 concerning accuracy of air volume sampled.

TR RAI-5.7.3-4
Please provide an LLD formula that is consistent with Regulatory Guide 8.30 or a technical justification for an alternate methodology.

Response TR RAI-5.7.3-4
The technical justification for using the LLD equation based on Regulatory Guide 8.25 is contained in NUREG 1400 "Air Sampling in the Workplace" (USNRC, 1993).

We believe the equation in Regulatory Guide 8.30 is incorrect as will be shown below.

Regulatory Guide 8.30 uses the following formula to calculate LLD.

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

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

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. The Equation 1 can then be simplified to the following:

$$LLD = \frac{3 + 4.65S_b}{3.7x10^4\ EV} \quad \textbf{(Equation 2)}$$

S_b is the standard deviation of background count rate (counts per second) and is calculated using Equation 3.0.

$$S_b = \frac{\sqrt{R_b T_S \left(1 + \frac{T_S}{T_b}\right)}}{T_S} \quad \textbf{(Equation 3)}$$

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 in Equation 4.

$$S_b = \frac{2.71 + 3.29\sqrt{R_b T_S \left(1 + \frac{T_S}{T_b}\right)}}{VEKT_S} \quad \textbf{(Equation 4)}$$

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
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.

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

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:

$$S_b = \frac{\sqrt{R_b T_S}}{T_S}\sqrt{2} \text{ or } 1.41\frac{\sqrt{R_b T_S}}{T_S} \quad \text{(Equation 6)}$$

Substituting Equation 6 into Equation 5 results in Equation 7

$$LLD = \frac{2.71 + 4.65\sqrt{R_b T_S}}{VEKT_S} \quad \text{(Equation 7)}$$

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:

$$LLD = \frac{3 + 4.65\sqrt{R_b T_S}}{VEKT_S} \quad \text{(Equation 8)}$$

We believe Equation 8 should be used 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 we believe either is appropriate in estimating the LLD for air concentrations. Equation 8 is similar to Equation 2 (the simplified Regulatory Guide 8.30 equation) in form but accurately addresses S_b while Equation 2 does not accurately address S_b.

References for 5.7.3-4

NRC 1993. NUREG 1400, *Air Sampling in the Workplace, Final Report.* September

L.A Currie, *The Measurement of Environmental Levels of Rare Gas Nuclides and the Treatment of Very Low-Level Counting Data.* IEEE Trans. Nucl. Sci. NS19 (1), 119-126 (1972)

TR RAI-5.7.3-5

Consistent with Regulatory Guide 8.30, please provide action for each sampling location or justification for an alternate program.

Response TR RAI-5.7.3-5

See TR_RAI Response 5.7.2-2 additional information for TR Section 5.7.2.2.1 "Administrative Action Levels".

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:

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

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.

Response TR RAI-5.7.3-6(a)

(a). Clarification: TR_Section 4.1.2 is referring to uranyl peroxide (yellowcake) as soluble in body fluids with respect to drying temperature during processing. TR_Section 5.7.3.2 basically quotes the current regulation ISL licensees are bound to comply with.

Although aspects of solubility were discussed within a power point presented at the November 2009 uranium workshop, there is no specific action items listed in ML093510816 concerning the occupational radiation exposure limits. There are specific areas of concern identified for contamination (items 3 and 4); the action by the NRC was a determination that RG 8.30 would be the standard until it is revised in dealing with contamination control limits and personnel contamination limits. It seems only logical that applicants would follow this same guidance in RG 8.30 (in areas where document is correct) regarding occupational radiation exposure until RG 8.30 is revised, vetted, and approved by the Commission. In addition, there are many TR_RAIs that specifically request that responses are consistent with RG 8.30 regarding the in-plant airborne radiation monitoring program (see TR_RAIs in section 5.7.3).

The applicant refers the reviewer to RG 8.30 Section 2.2 "new process uranyl peroxide" or UO_4 as described in TR_Section 3.2.5. This discussion relates to yellowcake dried at low temperatures of less than 400 °C (this includes uranyl peroxide) being more soluble in body fluids than yellowcake dried at higher temperatures. "For purposes of compliance with 10 CFR Part 20, yellowcake undried or dried at low temperature should be classified as soluble" (RG 8.30; section 2.2). With that stated and referenced the applicant would direct the reviewer's attention to the footnotes referred to in 10 CFR Part 20 Appendix B. This part of the regulation is presented in TR_RAI-Response and Replacement Pages; Section 5.7.3-6(a) for the reviewer's convenience. This approach is also consistent with recent applications; three examples are provided below:

- Lost Creek Project; *(ML090080451)*
- Uranium One (ML0820527)
- Uranerz Energy Corporation (ML102650539)

The regulatory reference that provides for the determination of soluble mixtures in air is 10 CFR Part 20 Appendix B, Footnote 3 (attached) is also referenced in § 20.1201(e). The reviewer gives no justification for the statement "This terminology is outdated and is no longer relevant to 10 CFR 20, Appendix B, occupational radiation exposure limits". The referenced footnotes are an extension of 10 CFR PART 20 Appendix B.

Powertech (USA) is bound by the law to comply with 10 CFR Part 20 and BMPs; in conjunction the applicant utilized RG 8.30 as guidance due to the following facts: 10 CFR Part 20 is the active regulation by which the standards for protection against ionizing radiation resulting from ISL activities under licenses issued by the NRC. These regulations are issued under the Atomic Energy Act which ISL operators are obligated to comply with. RG 8.30 was written and vetted through the public and commission processes in order to provide industry with methods and techniques acceptable to the NRC. RG 8.30 represent the most current guidance that has been through the complete evaluating and vetting processes and have Commission Approval.

Response TR RAI-5.7.3-6(b)

See TR_Section 5.7.4.1 "Internal Exposure" intake or concentration of radioactive material in air will be compared to the ALI or the DAC value regarding a solubility classification "D" specified in 10 CFR Part 20 Appendix B (Table1 Occupational Values).

TR RAI-5.7.3-7
Please provide the ALARA goal for uranium intake.

Response TR RAI-5.7.3-7
See TR_RAI-Response and Replacement Pages; Section 5.7.3-7 for additional information concerning primary ALARA goal for uranium intake.

TR RAI-5.7.3-8
Consistent with NUREG-1569, Acceptance Criterion 5.7.3(6), please evaluate the applicant's respiratory program and provide this information.

Response TR RAI-5.7.3-8
PPE in the form of respiratory protective equipment will be mandatory for workers in areas where safeguards 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 RG 8.15 and RG 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.

POWERTECH (USA) INC.

Response: TR RAI-5.7.3-1(a) and (b)

TR Section 5.7.3

Airborne Radiation Monitoring Program

And

TR Section 4.1

Air Flow Patterns addressed

in Gaseous and Airborne Particlates

5.7.3 Airborne Radiation Monitoring Program

Powertech (USA) will conduct an airborne radiation monitoring program at the project facility which is consistent with the recommendations contained in RG 8.30. The facility will not process ore. However, the facility will precipitate, dry (at low temperatures), and package yellowcake. Therefore, the monitoring program will consist of monitoring radon decay products, as well as airborne particulate monitoring. To ensure that measurements of radon and radon progeny are representative of worker exposures, areas where workers are present often and for extended periods of time will be monitored. The process is described in TR_Section 5.7.3.1.

Air flow patterns will be determined based on location of air inlets and air exhausts relative to sources of airborne radioactive materials; neutrally buoyant markers may be utilized to determine air patterns. Air flow patterns for worker areas 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, the area will be evaluated for air flow pattern changes. Radon detectors will be placed near a height of 3 to 6 feet between the source and the area occupied by the workers.

5.7.3.1 Monitoring of Radon and Radon Decay Products

According to RG 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.

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 0.03 WL as described in RG 8.30. Figures 5.7-6 to 5.7-9 present the monitoring locations where radon decay products are most likely to exceed 0.03 WL. 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 daughters 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.

The measurements will be performed by collecting samples on filter paper with a low-volume air sampler and analyzing the filter paper with an alpha counter using the Modified Kusnetz method described in ANSI N13.8-1973 or an equivalent method. The air sampler and alpha counter will be calibrated at the manufacturers' suggest time interval.

POWERTECH (USA) INC.

Response: TR RAI-5.7.3-1(c)

TR Section 5.7.3.2

Airborne Radiation Monitoring Program

5.7.3.2 Airborne Particulate Monitoring

Since there will be no ore grinding at the facility, no monitoring of airborne uranium ore dust will be necessary. However, airborne yellowcake will be monitored at the facility. The facility will be drying yellowcake under low temperature (approximately 450°F). No stack monitoring will be required for this proposed action. According to the footnotes of 10 CFR 20 Appendix B, yellowcake dried under low temperature should be considered soluble.

The limiting factor for health considerations for soluble uranium is chemical toxicity and not radiation dose. According to the footnotes for the radionuclide tables in 10 CFR Part 20 Appendix B, "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." Also in the foot notes, the specific activity for natural uranium is 6.77E-7 Ci/g.

When the limit in the footnotes is divided by 40 hours and the specific activity of natural uranium is taken into account, the 40-hr time-weighted average uranium concentration limit is 1×10^{-10} μCi / mL. This limit is consistent with the soluble uranium intake limit of 10 mg/week specified in 10 CFR 20.1201.2(e).

Areas meeting one of two criteria will be designated as airborne radioactivity areas. The first criterion is airborne yellowcake concentrations greater than 1×10^{-10} μCi / mL. The second criterion is potential for personnel to be exposed to 25 percent of that concentration, averaged over the number of hours exposed in a week (as recommended in RG 8.30).

In lieu of weekly 30 minute grab samples specified in RG 8.30, weekly low volume breathing zone samples will be taken from representative workers in airborne radioactivity areas. Breathing zone samples provide a better estimate of airborne particulate concentrations to which workers are exposed, resulting in a more representative estimate of actual intakes. The sensitivity of this method shall be at least 1×10^{-11} μCi / mL.

Breathing zone samples will be taken during non-routine operations with potential for a worker to receive exposure to airborne yellowcake above 1×10^{-10} μCi / mL. The monitoring type and frequency for non-routine tasks will be described in the job-specific RWP as described in Section 5.2.2. The breathing zone samples will be evaluated quarterly to confirm that specified working locations being monitored remain at acceptable working levels.

All air samples will be analyzed for uranium within two working days after sample collection. The lower limit of detection (LLD) of all analyses of air samples will be no greater than 1 x 10^{-11} µCi / mL. The calculation of LLDs for measuring concentration of uranium in air is derived from the method to calculate minimum detectable activity (MDA) shown in NRC Regulatory Guide 8.25 "*Air Sampling in the Workplace*".

The calculation of MDAs is shown in Equation 5.1.

$$MDA = \frac{2.71 + 3.29[R_b T_s (1 + T_s/T_b)]^{1/2}}{EKT_s} \qquad \text{Equation 5.1}$$

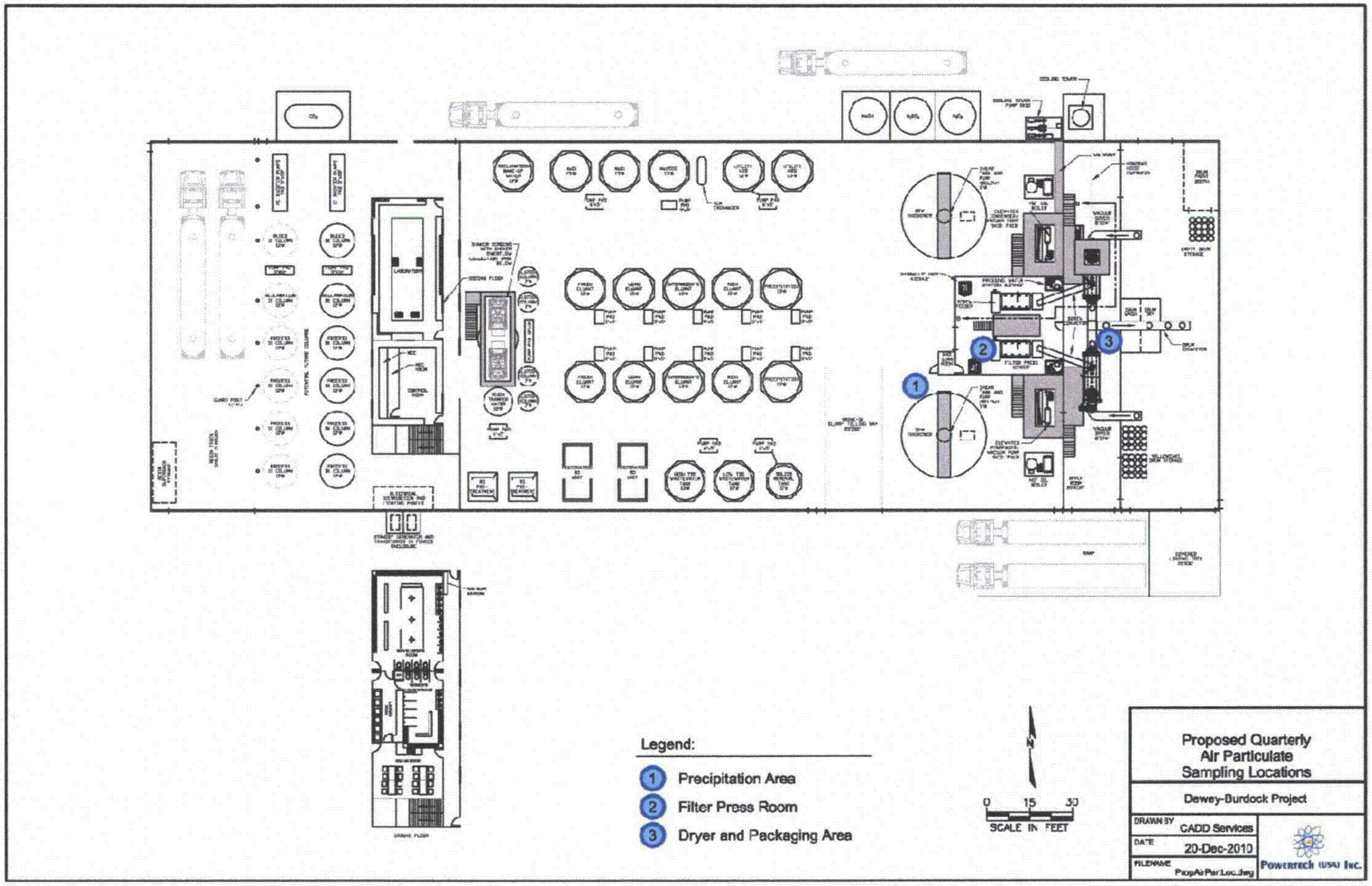
Where R_b is the background count rate (counts per minute), T_s is the counting time of the sample (minutes), T_b is the counting time of background (minutes), E is the filter efficiency, and K is the calibration factor to convert activity into count rate (counts per minute per microcurie). Therefore, the units of the calculated MDAs are microcuries. In order to yield LLD, the MDA will be divided by the volume of air sampled as shown in Equation 5.2.

$$LLD = \frac{2.71 + 3.29[R_b T_s (1 + T_s/T_b)]^{1/2}}{VEKT_s} \qquad \text{Equation 5.2}$$

Where V is the volume of air sampled (milliliters).

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 that workers may be exposed to. Due to the fact there is no ore processing conducted at an ISL facility, the program will be designed to measure areas where workers may be exposed to radiological and non-radiological particulates during the daily work routine specific to ISL operations. Breathing zone and hi-vol monitoring programs are proposed in areas of the CPP where yellowcake is present (Figure 5.7-10). Upon analyzing the results from the air particulate measurements, determinations will be made as to the assurance that process and engineering controls set in place are controlling the concentrations workers may be exposed to. 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 a specific area, and the use of PPE for respiratory protection. As stated in TR_Section 5.7.3 and reiterated here: "Powertech (USA) will conduct an airborne radiation monitoring program at the project facility which is consistent with the recommendations contained in RG 8.30".

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 five minute weekly grab samples via a high-volume air sampler running at 30 cfm. The applicant 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.


Legend:
1 Precipitation Area
2 Filter Press Room
3 Dryer and Packaging Area
0 15 30
SCALE IN FEET
Proposed Quarterly Air Particulate Sampling Locations
Dewey-Burdock Project
DRAWN BY CADD Services
DATE 20-Dec-2010
POWERTECH (USA) INC.

POWERTECH (USA) INC.

Response: TR RAI-5.7.3-6(b)

TR Section 5.7.4.1

Internal Exposure

5.7.3.3 Respiratory Protection

The respiratory protection program at the facility will be conducted in accordance with NRC Regulatory Guide 8.15, Revision 1, "*Acceptable Programs for Respiratory Protection*" and NRC Regulatory Guide 8.31 "*Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable*", Section 2.7 and 10 CFR 20 subpart H. PPE in the form of respiratory protective equipment will be mandatory for workers in areas where safeguards may not be adequate to maintain regulated exposure levels to airborne radioactive and/or toxic materials. This protection program 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. Written procedures will address use categories such as: Routine use, Special use; this may include work performed under an RWP. Emergency respirator use procedures will be addressed within the respiratory protection program operating procedures; emergencies may include for example recovery of personnel in an area where air is restricted or air quality has been compromised or not assessed previously to the situation occurance or the area becomes IDLH due to a nonradiological hazard.

5.7.4 Exposure Calculations

In accordance with 10 CFR 20.1202, the total effective dose equivalent for all radiation workers will be determined by summing the DDE from external radiation and the committed effective dose equivalent (CEDE) from internal radiation.

5.7.4.1 Internal Exposure

CEDEs due to inhalation of yellowcake will be determined by either using the stochastic annual limits of intake (ALIs) listed in Table 1 of 10 CFR 20 or using the derived air concentrations (DACs) listed in the same table. Applicable dose limits are identified in 10 CFR 20.1201(a)(1)(ii). In addition to these limits, 10 CFR 20.1201(e) establishes a limit for the intake of soluble uranium of 10 milligrams per week, based on chemical toxicity to the kidney.

The calculation of the committed effective dose equivalents, using either method, will be performed according with RG 8.30, Section C. These calculations will also be supported by the facility's bioassay program described in Section 5.7.5.

Referencesfor Sections 2.9 and 5.7.4

ANSI, 1997. ANSI N323A-1997, Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments. Institute of Electrical and Electronics Engineers.

EPA, 1982. Determination of Lead-210 in Drinking Water. Environmental Monitoring and Support Laboratory. March.

EPA, 1996. Test Methods for Evaluating Solid Waste (SW-846), Revision 2. December.

Hi-Q, 2006. "HVP-4200AFC Brushless Automatic Flow Control Outdoor Hi-Vol Air Sampler for Continuous Use." Hi-Q Environmental Products, December.

Krejci, K., T. Dewey and L. Olson. 2009. "Antilocapra americana" (On-line), Animal Diversity Web. Accessed August 05, 2010 at: http://animaldiversity.ummz.umich.edu/site/accounts/information/Antilocapra_americana.html.

NRC, 1992. NUREG/CR-5849, Manual for Conducting Radiological Surveys in Support of License Termination, Draft for Public Comment. Environmental Survey and Site Assessment Program, Energy/Environmental Systems Division, Oak Ridge Associated Universities.

NRC, 1999. Regulatory Guide 8.13, Revision 3, Instruction Concerning Prenatal Radiation Exposure. June.

NRC, 2001. NUREG/CR-6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees. September.

NRC, 2003. NUREG 1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Final Report. June

POWERTECH (USA) INC.

Response: TR RAI-5.7.6-3

TR Section 5.7.6.2

Personnel

Unrestricted area surveys will be conducted once a week (areas where food is allowed, change rooms, and offices). The total beta/gamma contamination limit for these surveys is 1000 dpm/100cm^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 (i.e. well fields) will be conducted once per month; the limit for these surveys is 1000 dpm/100cm^2.

5.7.6.2 Personnel

Personnel working in restricted areas as described in Section 5.7.6.1 will wear protective clothing to mitigate the potential for skin contamination.

Personnel exiting restricted areas with removable surface contamination will self survey for surface contamination in order to prevent the spread of contamination to unrestricted areas. Personnel with areas of skin measured to be above background will conduct 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. Clothing measured to have alpha contamination above background will be laundered or properly disposed. Soles of shoes reading higher than background alpha levels will be washed and scrubbed until they are no longer above that value.

Most uranium recovery (UR) facility workers receive external gamma radiation doses of less than 1 rem per year (RG 8.30). With ISL facilities there is no ore and no crushing and grinding circuits to pose a risk of exposure to beta-gamma radiation from those sources. The most likely sources of beta-gamma radiation are radium removal and yellowcake storage where uranium may be stored long enough to allow the buildup of the thorium-234 and protactinium-234. Since it will be a new facility, a gamma radiation survey will be performed shortly after commencement of operations at Dewey-Burdock. If the survey reveals any areas accessible to personnel where the gamma exposure rates are high enough that a major portion of the body of an individual could receive a dose in excess of 0.005 rem in an hour at 12 inches from the source, or from any surface that the radiation penetrates, the area will be designated a "radiation area," as defined in 10 CFR 20.1003. "Few UR facilities will have radiation dose rates this high, but such dose rates have been found where radium-226 builds up in part of the circuit."(RG 8.30)

Personnel monitoring (exposure rate surveys) for beta-gamma radiation and recording of monitoring results would be required for any individual likely to exceed 10 percent of the radiation dose limits for occupationally exposed adults (10CFR20.1201). As recommended in RG 8.30, if the situation were to exist, beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake would be conducted. Beta dose rates would be measured very close to the surface (within 10 cm) a distance that would represent beta exposure rate to hands and skin. If contamination is detected on personnel, the decontamination procedure would be performed and verification would be made and documented in the same process described for alpha monitoring of personnel. Each survey of personnel leaving a restricted area and the subsequent decontamination will be documented.

Additionally, random surveys of personnel by a member of the radiation protection staff will be conducted quarterly to ensure that the contamination control program is performing satisfactorily.

5.7.6.3 Equipment

Equipment leaving restricted areas with removable contamination will undergo decontamination followed by a survey for removable contamination in order to prevent the spread of contamination to unrestricted areas. The surveys will be for alpha radiation and beta-gamma radiation. Equipment found to have average radiation levels at or below 5,000 dpm alpha (or beta-gamma) per 100 cm^2 (averaged over no more than 1 m^2), removable contamination at or below 1,000 dpm alpha (or beta-gamma) per 100 cm^2, and spots (areas 100 cm^2 or smaller) at or below 15,000 dpm alpha (or beta-gamma) per 100 cm^2 will be cleared for unrestricted use. Equipment that exceeds the contamination limits will undergo further decontamination until the contamination is below the limits or until decontamination yields no reduction in contamination. Equipment with contamination above any of the limits after attempts of decontamination will be properly disposed. Each survey of equipment leaving a restricted area and the subsequent decontamination will be documented.

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(7), the radioactivity of the interior surfaces of pipes, drain lines, or duct work 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.

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(6), the applicant will make a reasonable effort to minimize any radioactive contamination before the use of any covering. The applicant will not cover radioactivity on equipment or other surfaces 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, P.41, Section 6.3, Item #2).

POWERTECH (USA) INC.

Response: TR RAI-5.7.6-4

TR Section 5.7.6.1

Areas

5.7.6 Contamination Control Program

Powertech (USA) will conduct a contamination control program at the project facilities consistent with recommendations contained in RG 8.30. The purpose of the program is to prevent contamination from spreading to unrestricted areas and needlessly exposing people to radiation. The program will address potential contamination spreading from areas where uranium work is performed, from personnel working in those areas, and from equipment and respirators used in those areas. The program will also address the survey equipment used to locate contamination. The ALARA goal for contamination control is to reduce the residual contamination on personnel and equipment to be released from the controlled area to as low as reasonably achievable.

Radiation surveys of material leaving the restricted areas will be conducted by the Radiation Safety Officer (RSO), the Radiation Safety Technician (RST), or a qualified and trained radiation worker under the supervision of the RSO.

5.7.6.1 Areas

Areas where uranium work is performed with surface contamination above 5,000 dpm alpha per 100 cm^2 (averaged over no more than 1 m^2), spots of contamination above 15,000 dpm alpha per 100 cm^2 (averaged over no more than 100 cm^2), or removable contamination above 1,000 dpm alpha per 100 cm^2 will be restricted.

To meet the ALARA concept, surfaces in restricted areas exposed to the air will be limited to having surface contamination of 220,000 dpm alpha per 100 cm^2.

Unrestricted areas will be spot checked weekly for removable surface contamination. If a spot check finds an area of removable surface contamination above background in an unrestricted area, that area will be cleaned and resurveyed for removable surface contamination.

Areas will be classified as restricted based on the potential for undue risks to workers from exposure to radiation and radioactive materials (10 CFR Part 20). This potential for undue risks from radiation exposure encompasses airborne radiation as well as radioactive materials on surfaces, as it is unusual to find one without the other. The type of work being performed does not dictate what constitutes a restricted area. "Uranium work" is simply a generic term for work at the facility. For further discussion regarding restricted area, see the response to TR RAI 2.9-1.

Beta contamination surveys would be performed in those areas of operations that involve direct handling of large quantities of aged yellowcake (refer to Response TR_RAI-CCP-5.7.6-1).

Unrestricted area surveys will be conducted once a week (areas where food is allowed, change rooms, and offices). The total beta/gamma contamination limit for these surveys is 1000 dpm/100cm^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 (i.e. well fields) will be conducted once per month; the limit for these surveys is 1000 dpm/100cm^2.

5.7.6.2 Personnel

Personnel working in restricted areas as described in Section 5.7.6.1 will wear protective clothing to mitigate the potential for skin contamination.

Personnel exiting restricted areas with removable surface contamination will self survey for surface contamination in order to prevent the spread of contamination to unrestricted areas. Personnel with areas of skin measured to be above background will conduct 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. Clothing measured to have alpha contamination above background will be laundered or properly disposed. Soles of shoes reading higher than background alpha levels will be washed and scrubbed until they are no longer above that value.

Most uranium recovery (UR) facility workers receive external gamma radiation doses of less than 1 rem per year (RG 8.30). With ISL facilities there is no ore and no crushing and grinding circuits to pose a risk of exposure to beta-gamma radiation from those sources. The most likely sources of beta-gamma radiation are radium removal and yellowcake storage where uranium may be stored long enough to allow the buildup of the thorium-234 and protactinium-234. Since it will be a new facility, a gamma radiation survey will be performed shortly after commencement of operations at Dewey-Burdock. If the survey reveals any areas accessible to personnel where the gamma exposure rates are high enough that a major portion of the body of an individual could receive a dose in excess of 0.005 rem in an hour at 12 inches from the source, or from any surface that the radiation penetrates, the area will be designated a "radiation area," as defined in 10 CFR 20.1003. "Few UR facilities will have radiation dose rates this high, but such dose rates have been found where radium-226 builds up in part of the circuit."(RG 8.30)

Personnel monitoring (exposure rate surveys) for beta-gamma radiation and recording of monitoring results would be required for any individual likely to exceed 10 percent of the radiation dose limits for occupationally exposed adults (10CFR20.1201). As recommended in RG 8.30, if the situation were to exist, beta surveys of specific operations that involve direct

POWERTECH (USA) INC.

Response: TR RAI-5.7.3-6(a)

TR Section 5.7.3.2

Attachments

Footnote to Part 20 Appendix B
And
Section 2.2 from RG-8.30

U.S.NRC

Footnotes

[1]"Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material.

[2] These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do not include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute 1E-7 µCi/ml for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits. (See § 20.1203.)

[3] For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see § 20.1201(e)). If the percent by weight (enrichment) of U-235 is not greater than 5, the concentration value for a 40-hour workweek is 0.2 milligrams uranium per cubic meter of air average. For any enrichment, 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. The specific activity for natural uranium is 6.77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

SA = 3.6E-7 curies/gram U for U-depleted

SA = [0.4 + 0.38 (enrichment) + 0.0034 $(\text{enrichment})^2$] E-6 , enrichment ≥ 0.72

where enrichment is the percentage by weight of U-235, expressed as percent.

NOTE:

1. 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 shall be the most restrictive DAC of any radionuclide in the mixture.
2. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentrations for the mixture are the lowest values specified in this appendix for any radionuclide that is not known to be absent from the mixture; or

	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
	Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	Monthly Average Concentration (uCi/ml)
	Oral Ingestion	Inhalation		Air (uCi/ml)	Water (uCi/ml)	
Radionuclide		ALI	DAC			

	ALI (µCi)	(µCi)	(µCi/ml)			
If it is known that Ac-227-D and Cm-250-W are not present	-	7E-4	3E-13	-	-	-
If, in addition, it is known that Ac-227-W,Y, Th-229-W,Y, Th-230-W, Th-232-W,Y, Pa-231-W,Y, Np-237-W, Pu-239-W, Pu-240-W, Pu-242-W, Am-241-W, Am-242m-W, Am-243-W, Cm-245-W, Cm-246-W, Cm-247-W, Cm-248-W, Bk-247-W, Cf-249-W, and Cf-251-W are not present	-	7E-3	3E-12	-	-	-
If, in addition, it is known that Sm-146-W, Sm-147-W, Gd-148-D,W, Gd-152-D,W, Th-228-W,Y, Th-230-Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, Np-236-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-Y, Pu-240-Y, Pu-242-Y, Pu-244-W,Y, Cm-243-W, Cm-244-W, Cf-248-W, Cf-249-Y, Cf-250-W,Y, Cf-251-Y, Cf-252-W,Y, and Cf-254-W,Y are not present	-	7E-2	3E-11	-	-	-
If, in addition, it is known that Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-Y, Es-254-W, Fm-257-W, and Md-258-W are not present	-	7E-1	3E-10	-	-	-
If, in addition, it is known that Si-32-Y, Ti-44-Y, Fe-60-D, Sr-90-Y, Zr-93-D, Cd-113m-D, Cd-113-D, In-115-D,W, La-138-D, Lu-176-W, Hf-178m-D,W, Hf-182-D,W, Bi-210m-D, Ra-224-W, Ra-228-W, Ac-226-D,W,Y, Pa-230-W,Y, U-233-D,W, U-234-D,W, U-235-D,W, U-236-D,W, U-238-D,W, Pu-241-Y, Bk-249-W, Cf-253-W,Y, and Es-253-W are not present	-	7E+0	3E-9	-	-	-
If it is known that Ac-227-D,W,Y, Th-229-W,Y, Th 232-W,Y, Pa-231-W,Y, Cm-248-W, and Cm-250-W are not present	-	-	-	1E-14	-	-
If, in addition, it is known that Sm-146-W, Gd-148-D,W, Gd-152-D, Th-228-W,Y, Th-230-W,Y,U-232-Y, U233-Y, U-235-Y, u-236-Y, U238-Y, U-Nat-Y, Mp-236-W, Mp-237-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-W,Y, Pu-240-W,Y, Pu-242-W,Y, Pu-244-W,Y, Am-241-W, Am-242m-W, Am-243-W, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y are not present	-	-	-	1E-13	-	-
If, in addition, it is known that Sm-147-W, Gd-152-W, Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, U-Nat-W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-W,Y, Es-254-W, Fm-257-W, and Md-258-W are not present	-	-	-	1E-12	-	-
If, in addition it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Sm-147, Gd-148, Gd-152, Hg-194 (organic), Bi-210m, Ra-223, Ra-224, Ra-225, Ac-225, Th-228,	-	-	-	-	1E-6	1E-5

Th-230, U-233, U-234, U-235, U-236, U-238, U-Nat, Cm-242, Cf-248, Es-254, Fm-257, and Md-258 are not present						

3. If a mixture of radionuclides consists of uranium and its daughters in ore dust (10 µm AMAD particle distribution assumed) prior to chemical separation of the uranium from the ore, the following values may beused for the DAC of the mixture: 6E-11 µCi of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11 µCi of natural uranium per milliliter of air; or 45 micrograms of natural uranium per cubic meter of air.
4. If the identity and concentration of each radionuclide in a mixture are known, the limiting values should be derived as follows: determine, for each radionuclide in the mixture, the ratio between the concentration present in the mixture and the concentration otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all of the radionuclides in the mixture may not exceed "1" (i.e., "unity").

Example: If radionuclides "A," "B," and "C" are present in concentrations C_A, C_B, and C_C, and if the applicable DACs are DAC_A, DAC_B, and DAC_C, respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} < 1$$

Sample analysis should usually be completed within two working days after sample collection. Unusual results should be reported promptly to the Radiation Safety Officer (RSO).[2]

Intake and exposure calculations for ore dust are discussed in Regulatory Position 3 of this guide.

2.2 Surveys for Airborne Yellowcake

It is generally accepted that uranium dissolved in the lung or absorbed by the gastrointestinal tract enters the bloodstream and is distributed to various body organs. The rate of dissolution for yellowcake appears to depend on its temperature history during processing. 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 (Refs. 9 to 11). If the intake of such yellowcake is controlled to protect the kidney from the chemical toxicity of uranium, radiological protection criteria for natural uranium will also be satisfied. For purposes of compliance with 10 CFR Part 20, yellowcake undried or dried at low temperature should be classified as soluble.

Yellowcake dried at high temperature is a mixture of compounds that contains a major portion of more insoluble uranium oxides. Radiation dose to the lung and other organs is the limiting consideration rather than chemical toxicity; this is primarily due to the large insoluble component. For compliance purposes, yellowcake dried at 400°C (752°F) and above should be classified as insoluble (Refs. 12 and 13).

Thus, surveys for airborne yellowcake are necessary to demonstrate compliance with the occupational dose limits in 10 CFR 20.1201. Surveys are also necessary to establish the boundaries of airborne radioactivity areas and to determine whether surveillance, limitation on working times, provisions of respiratory equipment, or other precautions should be considered in compliance with 10 CFR 20.1701 and 20.1702.

The recommended survey program for yellowcake uses a combination of general air sampling and breathing zone sampling during routine and nonroutine operations that may involve considerable intake, such as those that require a radiation work permit (RWP).

Grab samples for yellowcake with a duration of 30 minutes should be performed weekly in airborne radioactivity areas and monthly in areas not designated as airborne radioactivity areas. As an alternative, weekly grab samples of 5 minutes duration using a high-volume sampler (roughly 30 cfm) are acceptable in areas that are not airborne radioactivity areas instead of monthly 30-minute samples as long as the licensee can demonstrate that the volume of air sampled is accurately known.

Breathing zone sampling for specific jobs should be used to monitor intakes of individual workers doing special high-exposure jobs if the special jobs are likely to involve more than 12

---

[2] The title "Radiation Safety Officer" is used by many licensees and, in this guide, means the person responsible for conducting health physics survey programs; other titles are equally acceptable.

Exposure Calculations 5.7.4

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:

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.

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.

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.

Response TR RAI-5.7.4-1a

If the intake due to inhalation of natural uranium by personnel in work areas where airborne radioactive materials could exist is needed, it 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

Response TR_RAI-**5.7.4-1b**

RG 3.46, Section 5.7.4 suggests describing the proposed procedure to determine the intake of radioactive materials by personnel in work areas where airborne radioactive materials could exist. This includes those exposures incurred during appropriate routine activities, non-routine operations, maintenance, and cleanup activities. The acceptance criteria in NUREG-1569 (Section 5.7.4.3 (2)) for exposure calculations for natural uranium are consistent with RG 8.30, Section C-3. 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 RG 8.30, Section C. These two methods are described as follows:

Method 1: Use of Stochastic Inhalation ALIs from 10 CFR 20

The CEDE for each radionuclide may be calculated using the estimated radionuclide intake, by Equation 2 of RG 8.30 as follows:

$$H_{i,E} = \frac{5I_i}{ALI_{i,E}} \qquad \text{Equation 2}$$

where:
$H_{i,E}$ = CEDE from radionuclide i (rems)
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 of Table 1 in Appendix B to Part 20 (μCi)
5 = CEDE from intake of 1 ALI (rems) The intake of natural uranium will be determined using the equation listed above in response (a).

Method 2: Use of DACs from 10 CFR 20

The CEDE may be calculated from exposures expressed in terms of DAC-hours. Equation 4 of RG 8.30 demonstrates how the committed effective dose equivalent may be calculated from exposures expressed in terms of DAC-hours.

$$H_{i,E} = \frac{5 C_i t}{2000 DAC_{stoc,i}} \qquad \text{Equation 4}$$

where

$H_{i,E}$ = Committed effective dose equivalent from radionuclide i (rems)
C_i = The airborne concentration of radionuclide i to which the worker is exposed (microcuries/ml)
t = The duration of the exposure (hours)
2000 = The number of hours in a work year
5 = Committed effective dose equivalent 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 "D" class of natural uranium from Table 1 of 10 CFR 20, Appendix B.

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. Alternate methods to evaluate exposure to natural uranium not contained in RGs 8.30 or 8.34 will be submitted to the NRC for review and approval prior to use.

Response TR RAI-5.7.4-1c

The parameters used to evaluate inhalation exposure to radon-222 decay products described in Section 5.7.4.2 of the TR and to natural uranium described above are representative of the conditions of the site as they relate to the maximum production capacity.

TR RAI-5.7.4-2

Please demonstrate how exposure calculations will take into account the possibility of a mixture of radionuclides in air

Response TR RAI-5.7.4-2

Considering the anticipated concentrations in air, we expect to have only natural uranium in air, not a mixture of radionuclides. Air samples will be analyzed in general using gross alpha measurements and potentially via alpha spectroscopy. Knowing the concentrations of long-lived alpha emitting radionuclides for various processes, we expect there to be no unknown mixtures of radionuclides in air.

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.

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.

Response TR RAI-5.7.4-3

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 as follows.

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 the footnotes is divided by 40 hours and the specific activity of natural uranium (6.77E-7 Ci/g) is taken into account, the 40-hr time-weighted average uranium concentration limit is 1 x 10^{-10}µCi/mL. This limit is consistent with the soluble uranium intake limit of 10 mg/week specified in 10 CFR 20.1201.2(e).

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 high-volume air sampling flow rates and time of operation, gross alpha measurements, and associated calculations,

Records will be maintained in accordance with TR Section 5.2.5.

TR RAI-5.7.4-4
Please provide a description of the applicant's prenatal radiation exposure program that is consistent with Regulatory Guide 8.13.

Response TR RAI-5.7.4-4
RG 8.13, Revision 3, *Instruction Concerning Prenatal Radiation Exposure* (NRC, 1999) is intended to provide information to pregnant women, and other personnel, to help them make decisions regarding radiation exposure during pregnancy, as stated in Section A of the document. Section 5.5.1 of the TR commits to providing this information to workers as appropriate. Section 5.7.4 of the TR specifically addresses exposure calculations. It is unclear what information contained in RG 8.13 is applicable to this section.

TR RAI-5.7.4-5
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.

Response TR RAI-5.7.4-5
Section 5.2.6 of the TR conforms to the requirements of 10 CFR §20.2103.

In addition, Section 5.7.2.2 states that external doses received by monitored personnel above 10 percent of the applicable limits will be reported on NRC Form 5 or in a format which contains all the information listed on NRC Form 5. This same commitment is not specifically mentioned in the internal dose reporting but is intended.

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.

Response TR RAI-5.7.4-6

The estimate of the airborne uranium concentrations either within a facility or at locations outside of the facility is directly related to the efficiency of the airborne particulate control systems. Section 4.1.2.1 of the TR describes the control systems for the significant sources of airborne particulates at the facility and concludes that uranium will not be discharged. The NRC concluded similarly in Section 2.2.3 of NUREG/CR-6733 for a typical ISR facility (NRC, 2001).

Section 2.8.4 of NUREG/CR-6733 also states that historic occupational air sampling results from ISR facilities indicate that airborne radiation levels are well below 25 percent of the derived air concentration for uranium. We assume this is for Class D natural uranium.

Section 2.8.5 of NUREG/CR-6733 also states that results from environmental monitoring programs are far below regulatory limits. It is expected that this proposed ISR facility would operate within these expected parameters.

Referencesfor Sections 2.9 and 5.7.4

ANSI, 1997. ANSI N323A-1997, Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments. Institute of Electrical and Electronics Engineers.

EPA, 1982. Determination of Lead-210 in Drinking Water. Environmental Monitoring and Support Laboratory. March.

EPA, 1996. Test Methods for Evaluating Solid Waste (SW-846), Revision 2. December.

Hi-Q, 2006. "HVP-4200AFC Brushless Automatic Flow Control Outdoor Hi-Vol Air Sampler for Continuous Use." Hi-Q Environmental Products, December.

Krejci, K., T. Dewey and L. Olson. 2009. "Antilocapra americana" (On-line), Animal Diversity Web. Accessed August 05, 2010 at: http://animaldiversity.ummz.umich.edu/site/accounts/information/Antilocapra_americana.html.

NRC, 1992. NUREG/CR-5849, Manual for Conducting Radiological Surveys in Support of License Termination, Draft for Public Comment. Environmental Survey and Site Assessment Program, Energy/Environmental Systems Division, Oak Ridge Associated Universities.

NRC, 1999. Regulatory Guide 8.13, Revision 3, Instruction Concerning Prenatal Radiation Exposure. June.

NRC, 2001. NUREG/CR-6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees. September.

NRC, 2003. NUREG 1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Final Report. June

POWERTECH (USA) INC.

Bioassay Program 5.7.5

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.

Response TR_RAI-5.7.5-1

TR RAI-5.7.5-2 The applicant's response to TR_RAI 5.7.3-6(a) establishes that yellowcake dried at low temperatures (less than 400°C) is considered to be soluble. Regulatory Guide 8.22 states, "Urinalysis should be performed to monitor exposures to uranium in ore dust as well as in yellowcake as they clear from the kidney before elimination renders them undetectable. It also says that in vivo thorax measurements should be made to detect the presence of the more insoluble yellowcake and uranium in ore dust when air sampling results indicate an exposure exceeding that resulting from exposure to such materials at an average concentration of 10^{-10} µCi/mL in one calendar quarter. Thus, with the solubility established, the key technical prerequisite for monitoring uranium uptake using urinalysis, the applicant believes it's proposed use of urinalysis as a primary bioassay technique to be justified.

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

Response TR_RAI-5.7.5-2

Section 2.3 of Regulatory Guide 8.9 - Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program, Revision 1, July 1993, provides guidance for determining uranium uptake. Section 4.3 of RG 8.9 discusses intake retention and excretion fractions for calculating intakes. Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses" contains additional guidance on determining doses based on calculated intakes once the intake is determined. Reg Guide 8.34 also contains an example of the calculation of occupational doses based on intake.

TR RAI-5.7.5-3

Consistent with NUREG-1569, Acceptance Criterion 5.7.5.3(2), and Regulatory Guide 3.46, their 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.

Response TR RAI-5.7.5-3

Consistent with NUREG-1569, Acceptance Criterion 5.7.5.3(2) and Regulatory Guide 3.46, the applicant provided the number and category of its projected facility workers on the Organizational Structure Figure 5.1-2. Specific to the bioassay program would be the mechanics and general maintenance workers (7) and the dryer operators (2), for a total of 9 personnel.

TR RAI-5.7.5-4

Response TR_RAI-5.7. 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.

Response TR RAI-5.7.5-4

Consistent with Regulatory Guide 8.22, the applicant will follow the corrective actions outlined on Table 1 of Regulatory Guide 8.22. 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 will be considered, and respiratory protection will be considered as appropriate. Uranium confinement controls will be also be considered 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 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 ug/L uranium and laboratory tests for albuminuria are negative. Further uranium confinement 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 5.7.6.3(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.

Response TR RAI-5.7.5-5

Consistent with Acceptance Criterion 5.7.6.3(5) of NUREG-1569, the applicant will conduct its record keeping and reporting in accordance with 10 CFR 20 Subparts L and M. The applicant describes its record keeping and reporting program in TR Sections 5.2.5 and 5.2.6. Additionally, the applicant has provided additional discussion regarding record keeping and reporting in the Responses to TR RAI 5.2-1, TR RAI 5.7.4-5 and TR RAI 5.7.6-7

Contamination Control Program 5.7.6

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.

Response TR RAI-5.7.6-1
Most uranium recovery (UR) facility workers receive external gamma radiation doses of less than 1 rem per year (RG 8.30). With ISL facilities there is no ore and no crushing and grinding circuits to pose a risk of exposure to beta-gamma radiation from those sources. The most likely sources of beta-gamma radiation are radium removal and yellowcake storage where uranium may be stored long enough to allow the buildup of the thorium-234 and protactinium-234. Since it will be a new facility, a gamma radiation survey will be performed shortly after commencement of operations at Dewey-Burdock. If the survey reveals any areas accessible to personnel where the gamma exposure rates are high enough that a major portion of the body of an individual could receive a dose in excess of 0.005 rem in an hour at 12 inches from the source, or from any surface that the radiation penetrates, the area will be designated a "radiation area," as defined in 10 CFR 20.1003. "Few UR facilities will have radiation dose rates this high, but such dose rates have been found where radium-226 builds up in part of the circuit."(RG 8.30)

Personnel monitoring (exposure rate surveys) for beta-gamma radiation and recording of monitoring results would be required for any individual likely to exceed 10 percent of the radiation dose limits for occupationally exposed adults (10CFR20.1201). As recommended in RG 8.30, if the situation were to exist, beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake would be conducted. Beta dose rates would be measured very close to the surface (within 10 cm) a distance that would represent beta exposure rate to hands and skin. If contamination is detected on personnel, the decontamination procedure would be performed and verification would be made and documented in the same process described for alpha monitoring of personnel.

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.

Response TR RAI-5.7.6-2
The statements in TR Section 5.7.6.2 clearly indicate that personnel will be monitored for skin and clothing contamination.

TR RAI-5.7.6-3
Please provide information on who will conduct skin decontaminations and who will verify that background levels have been achieved after contamination has been detected.

Response TR RAI-5.7.6-3
See TR_RAI-Response and Replacement Pages; Section 5.7.6.2 "Personnel"

TR RAI- 5.7.6-4
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."

Response TR RAI-5.7.6-4
See TR_RAI-Response and Replacement Pages; Section 5.7.6.1 "Areas"

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.

Response TR RAI-5.7.6-5
See TR_RAI-Response and Replacement Pages; Section 5.7.6.1 "Areas"

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.

Response TR RAI-5.7.6-6
See TR_RAI-Response and Replacement Pages; Section 5.7.6 "Contamination Control Program"

TR RAI-5.7.6-7
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.

Response TR RAI-5.7.6-7
See TR_RAI-Response and Replacement Pages; Section 5.7.6.6 "Reporting and Recordkeeping for Surface Contamination Program"

TR RAI-5.7.6-8
Please describe the applicant's approach for applying covering material to contaminated surfaces.

Response TR RAI-5.7.6-8
See TR_RAI-Response and Replacement Pages; Section 5.7.6.3 Equipment

TR RAI-5.7.6-9
Please describe the applicant's procedures for determining the radioactivity of interior surfaces of pipes, drain lines, duct work or similar items.
Response TR RAI-5.7.6-9
See TR_RAI-Response and Replacement Pages; Section 5.7.6.3 Equipment

POWERTECH (USA) INC.

Response: TR RAI-5.7.6-7

TR Section 5.7.6.6

Reporting and Recordkeeping for Surface Contamination Program

5.7.6.4 Respirators

Respirator hoods and face pieces will be surveyed for removable surface contamination before each reuse. Any pieces that have removable surface contamination above background will be decontaminated or replaced. Each survey of respirator hoods and face pieces and the subsequent replacement will be documented.

5.7.6.5 Survey Instrumentation

For tests of removable alpha contamination, swipes or wipes will be used and then counted with an alpha detector designed for sample counting. The same method will be used for testing for removable beta-gamma radiation except the counting will be done with a beta-gamma detector designed for sample counting.

For other measurements for surface contamination, a battery-operated portable alpha detector will be used to directly measure the surface for alpha contamination and a battery-operated portable beta-gamma detector will be used to directly measure the surface for beta-gamma contamination.

In each scenario, the alpha detector used will be able to detect alpha radiation ranging from 100 to 220,000 dpm per 100 cm^2 and the beta-gamma detector used will be able to detect beta-gamma radiation ranging from 1,000 to 15,000 dpm per 100 cm^2.

The instrumentation will be calibrated according to the manufacturer's specifications annually or at the manufacturer's recommended interval, whichever is more frequent.

5.7.6.6 Reporting and Recordkeeping for Surface Contamination Program

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(5), Powertech (USA) will record and maintain information and data as required by 10 CFR Part 20, Subpart L and Subpart M. Recordkeeping and Reporting functions are addressed in the following TR Sections: 5.2.5; 5.2.6 (pp.5-7 to 5-9). In addition, recordkeeping and reporting are addressed in TR Section 5.3 and 5.3.4 (p. 5-10). As contamination control is a primary focus of the radiation protection program, reporting and record keeping for this purpose are considered inherent to the overall radiation protection effort. However, in order to avoid confusion, the applicant will follow the protocols specified in 10 CFR Part 20, §2101, General Provisions. These are:

- Use the units of curie, rad, rem (including multiples and subdivisions)
- Show units of all quantities on records

- Use the International System of units (SI) in addition to the units of curie, rad and rem, as necessary for shipment manifests
- Make clear distinction among the quantities for dose entered on records, i.e., TEDE, lens dose equivalent, CEDE, shallow or deep dose equivalent

5.7.7 Airborne Effluent and Environmental Monitoring Program

Powertech (USA) will conduct an airborne effluent and environmental monitoring program during operations consistent with recommendations in NRC Regulatory Guide 4.14 "*Radiological Effluent and Environmental Monitoring at Uranium Mills*" (RG 4.14). The program will consist of sampling air, water, vegetation, livestock, and surface soil.

5.7.7.1 Air Monitoring

Locations of air monitoring stations are shown in Figure 5.7-10. The filters from air samplers operating continuously will be analyzed quarterly for natural uranium, thorium-230, radium-226, and lead-210. Samplers will have sensors to measure total air flow within a sampling period. Passive track-etch detectors will be deployed at each station for monitoring radon-222 on a quarterly basis. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14.

Additionally, effluents from the yellowcake dryer and packaging roof vents will be sampled quarterly. The grab samples will be isokinetic in nature and will be analyzed for natural uranium, thorium-230, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with recommendations of RG 4.14.

This section has described the use of the available technology for detection of radon and radon progeny. The passive track-etch detectors will be utilized during operational environmental monitoring. At least four of the AMS stations utilized for baseline characterization will be selected for operational monitoring; this meets the suggested monitoring in RG 4.14 (upwind, downwind, nearest neighbor, and control). The four AMS stations will be equipped with a track-etch detector; see figure 5.7-11 below. The track-etch detectors are designed to measure the average radon concentration at the particular location for the period of deployment. The alpha-track detector is designed with a radiosensitive element that records alpha particle emissions from natural radioactive decay of radon. The values reported will provide the basis for calculating the average radon concentration; these detectors are not fitted with a thoron proof filter, therefore, radon progeny is also detected.

POWERTECH (USA) INC.

Response: TR RAI-5.7.6-8

TR Section 5.7.6.3

Equipment

handling of large quantities of aged yellowcake would be conducted. Beta dose rates would be measured very close to the surface (within 10 cm) a distance that would represent beta exposure rate to hands and skin. If contamination is detected on personnel, the decontamination procedure would be performed and verification would be made and documented in the same process described for alpha monitoring of personnel. Each survey of personnel leaving a restricted area and the subsequent decontamination will be documented.

Additionally, random surveys of personnel by a member of the radiation protection staff will be conducted quarterly to ensure that the contamination control program is performing satisfactorily.

5.7.6.3 Equipment

Equipment leaving restricted areas with removable contamination will undergo decontamination followed by a survey for removable contamination in order to prevent the spread of contamination to unrestricted areas. The surveys will be for alpha radiation and beta-gamma radiation. Equipment found to have average radiation levels at or below 5,000 dpm alpha (or beta-gamma) per 100 cm^2 (averaged over no more than 1 m^2), removable contamination at or below 1,000 dpm alpha (or beta-gamma) per 100 cm^2, and spots (areas 100 cm^2 or smaller) at or below 15,000 dpm alpha (or beta-gamma) per 100 cm^2 will be cleared for unrestricted use. Equipment that exceeds the contamination limits will undergo further decontamination until the contamination is below the limits or until decontamination yields no reduction in contamination. Equipment with contamination above any of the limits after attempts of decontamination will be properly disposed. Each survey of equipment leaving a restricted area and the subsequent decontamination will be documented.

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(7), the radioactivity of the interior surfaces of pipes, drain lines, or duct work 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.

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(6), the applicant will make a reasonable effort to minimize any radioactive contamination before the use of any covering. The applicant will not cover radioactivity on equipment or other surfaces 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, P.41, Section 6.3, Item #2).

Airborne Effluent and Environmental Monitoring Program 5.7.7

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.

a. Please describe the frequency of sampling of radon stacks

b. Please discuss the manner in which concentrations of radon and daughters will be determined to be ALARA under the applicant's radiation protection program.

Response TR RAI-5.7.7-1(a)

Refer to TR Section 4.1.1 points of release (e.g., stacks, roof vents)"will be sampled quarterly".

Response TR RAI-5.7.7-1(b)

1. Operating philosophies in RG 8.10 will be implemented
2. Refer to TR Section 4.1 "Gaseous and Airborne Particulates" where it discusses airborne effluent and environmental monitoring programs that are in line with RG 8.30
3. Refer to TR Section 4.1.1 "Radon" and Section 5.7.3.1 "Monitoring of Radon and Radon Decay Products" where Working Level measurements for decay product is discussed
4. Refer to TR Section 5.0 for a detailed description of the radon and radon products monitoring program
5. Refer to TR Section 5.7.1 "Effluent Control Techniques" where sampling of emissions of concern are discussed
6. Refer to TR Section 5.7.4.2 "Radon Decay Production Exposure" discuss how the exposure calculations will be performed

Throughout the application Powertech (USA) demonstrates through commitments of implementing management controls, engineering controls, radiation safety training, radon monitoring and sampling, and auditing programs, there are several avenues involved in which concentrations of radon and radon progeny will be determined to be ALARA. The auditing programs such as the ALARA audit will ensure that Powertech (USA) utilizes the above means to upgrade the protocols in order to keep the facility radon and progeny exposures ALARA.

TR RAI-5.7.7-2
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.

Response TR RAI-5.7.7-2
See Response to: TR_RAI -2.9-1 and Appendix 2.5-D of the TR

TR RAI-5.7.7-3
Please explain the manner in which the applicant's air sampling procedures are consistent with Regulatory Guide 4.14 and NUREG1569, Acceptance Criterion 5.7.7.3(1).

Response TR RAI-5.7.7-3
See also, Response to: TR_RAI-2.9-2 for determining the frequency of filter collection and why the airborne sampling procedures are not only consistent with RG 4.14, but exceed the guidance. If the dust load is large enough that flow rates cannot be adjusted to compensate appropriately, the filters will be changed out more frequently during high dust loading periods. During low dust loading filters will be replaced less frequently. Regardless of frequency (weekly or bi-weekly) the samples will be sent into the laboratory for analysis as a quarterly composite.

TR RAI-5.7.7-4
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.

Response TR RAI-5.7.7-4
See Response to: TR_RAI-2.9-1 and TR Section 5.7.7.1 "Air Monitoring" where locations of air monitoring stations and analysis are discussed relevant to RG4.14.

TR RAI-5.7.7-5
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.

Response TR RAI-5.7.7-5
See Response to: TR_RAI-2.9-1 and TR Section 5.7.7.1 "Air Monitoring"

TR RAI-5.7.7-6
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).

Response TR RAI-5.7.7-6
RG 4.14 states "Samples should be collected continuously, or for at least one week per month, for analysis of radon-222. The sampling locations should be the same as those for the continuous air particulate samples". RG 4.14, Section 2.1 is not applicable to the content of this response, therefore is not addressed.

The applicant's Rn-22 monitoring exceeds the 4.14 guidance due to the following:

Radon-222 sampling resulted in 18 averages from 71 individual readings collected at 18 separate locations. Statistically speaking, this exceeds the RG 4.14, Section 1.1 minimum recommendation of 12 individual samples collected at 3 locations. The track etch detectors measure average radon concentrations in air over the measurement period, minimum recommended deployment time for monitoring ambient concentrations of radon is 90 days by the manufacturer . If high concentrations of radon were expected to be observed at or near the site, the detectors would have been deployed for shorter time periods. For a general overview and a list of EPA, NRC accepted radiation detectors (including the alpha track detector) and their applications see Appendix H of NUREG-1575, Rev.1.

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.

Response TR RAI-5.7.7-7

As quoted above radon monitors should be located at the particulate air monitoring locations; therefore the RG 4.14 locations are depicted in Figure 5.6-10 with a green square indicating locations for the Hi-Vol Air Sampling Sites or in other terms the particulate air monitoring stations. All 16 radon monitoring locations are depicted on Figure 2.9-8. The 16 radon monitoring locations are also depicted within the TR_Appendix 2.9-A "Baseline Radiological Report" in figure 4-1.

TR RAI-5.7.7-8

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.

Response TR RAI-5.7.7-8

See Table 2.9-1; item (F) for soil sampling locations consistent with RG 4.14. Also see Plate 2.5-1 for all soil sampling locations within the AOR. Quantity of soil sampling locations exceeds the recommendations of RG 4.14 due to the extensive wildlife study conducted by BKS Environmental.

TR RAI-5.7.7-9

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.

Response TR RAI-5.7.7-9

See TR_RAI-Response and Replacement Pages, Section 5.7.7-9 for additional information provided in TR Section 5.7.7.3 "Surface Soil and Sediment Monitoring". See also Figure 5.7-11 in TR Section 5.7.7/1 "Air Monitoring".

TR RAI-5.7.7-10
Consistent with Regulatory Guide 4.14 and NUREG1569, 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(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.

Response TR_RAI-5.7.7-10(a)
See responses TR_RAI-2.9-11 through 2.9-14 and TR_RAI-2.9-21. First year operational vegetation, food and fish sampling program will meet or exceed the applicable guidance in Section 2.1.4 of RG 4.14. Vegetation, food and fish collected will be analyzed for uranium (natural), thorium-230, radium-226, lead-210 and polonium-210. Vegetation of forage sampling will be carried out if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway (e.g., exceeds 5% of the applicable radiation protection standard) (RG 4.14).

TR RAI-5.7.7-10(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.

Response TR_RAI-5.7.7-10(b)
See response TR_RAI-2.9-14.

TR RAI-5.7.7-10(c)
The applicant has not adequately analyzed the need for collecting and analyzing crops .including local vegetable gardens.

Response TR_RAI-5.7.7-10(c)
See response TR_RAI-2.9-12

TR RAI-5.7.7-11
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.

Response TR_RAI-5.7.7-11
Forage vegetation when sampled will be collected in grazing areas in three different sectors having the highest predicted airborne radionuclide concentration due to milling operations.

TR RAI-5.7.7-12
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.

Response TR RAI-5.7.7-12

During operations the direct radiation monitoring plan will include the use of Environmental TLDs or properly calibrated portable survey instruments, monitoring the chosen air-particulate locations on a quarterly basis.

TR RAI-5.7.7-13

Please provide an airborne effluent and environmental monitoring program that complies with 10 CFR 20.1501.

Response TR RAI-5.7.7-13

The applicant proposes to account for and verify occupational dose within the licensed areas by implementation of the following:

- TR Section 4.0 Describes the airborne monitoring program consistent with RG 8.30 and 10 CFR 20.1501
- TR Section 5.7 (in total) describes the active and passive methods to ensure (account for and verify) occupational and public doses will be ALARA.
- Responses to TR_RAIs – 2.9
- Responses to TR_RAIs – 5.7.7

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.

Response TR RAI-5.7.7-14

Clarification: The applicant has thoroughly evaluated potential receptors within the PAA by utilizing site-specific radionuclide release estimates, meteorological and population data, and other parameters to model, via MILDOS-AREA, the potential radiological impacts to human and environmental receptors (e.g. air and soil). The estimated radiological impacts resulting from routine site operational activities will be compared to applicable public dose limits as well as naturally occurring background levels.

A description of the "Potential Radiological Effects" to both the environment and humans are in Section 7.3 of the TR. Potential exposure pathways are discussed in TR Section 7.3.1; also for the reviewer's consideration are the Appendices 7.3-A and 7.3-B (MILDOS-AREA SIMULATION FOR LAND APPLICATION and MILDOS SIMULATION FOR WASTE DISPOSAL WELL). Also, see Figure 7.3-1 for a depiction of human exposure pathways that were evaluated.

See also TR Section 7.3.3 for a description of how the total effective dose equivalent (TEDE) to nearby residents in the region and at the facility boundaries was estimated using MILDOS-AREA. The parameters used to estimate releases are provided in Table 7.3-1.

For source term estimate evaluation of natural Uranium, Pb-210, Ra-226, Th-230and see TR Section 7.3.3.1; see section 7.3.3.2 for discussion on evaluations of source term estimates for Rn-222.

The receptors and their respective locations utilized in the evaluation are presented in TR Section 7.3.3.3.

TR Section 7.3.3.6 describes the predicted TEDE to the population from one year of operation at the PAA.

See TR Section 7.3.3.8 for a discussion on the evaluation and results of RESRAD Version 6.4 model. This model was used to calculate the maximum annual dose rate from the land application processes (Radiological and Non-radiological). This program was developed by Argon National Laboratory to (in part) calculate radiation dose to an on-site resident (a maximally exposed individual or a member of a critical population group.

There is no indication from the evaluation that any member of the public would receive 0.1 rem/yr (100 mrem). In fact the data indicate the highest TEDE to be 0.012 rem/yr (12 mrem) located at the Boundary - SF – NNW (TR Table 7.3-5 provided in Replacement Pages).

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 B, 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.

Response TR RAI-5.7.7-15

See TR_RAI-Response and Replacement Pages; Section 5.7.7.1 "Air Monitoring".

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.

Response TR RAI-5.7.7-16

The environmental monitoring concerning the release of radon (the principal radionuclide potentially released) from process operations will be estimated using the source term method described in TR Section 7.3 and in "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (RG 3.59). The results will be reported in the semi-annual effluent reports required by 10 CFR § 40.65. See Figures 5.7-6 to 5.7-9 for radon monitoring locations from point and diffuse sources.

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.

Response TR RAI-5.7.7-17

Other than atypical matrix interferences, The LLD values should be consistent with recommended values in RG 4.14. The statement serves only as a caveat with regards to sampling and analysis limitations. Since the LLD is a function of sample volume, counting efficiency, radiochemical yield, etc., infrequently for example, there may be circumstances where the minimum volume or mass is not attainable due to natural occurring circumstances (i.e. drought, or flooding event) beyond the control of the operator. The ability to analyze for the radionuclide of concern may be inhibited given the presence of another radionuclide in high concentrations within the sample i.e., U-235 in high concentrations inhibiting the analysis of Ra -226.

POWERTECH (USA) INC.

Response: TR RAI-5.7.7-2

Appendix 2.5-D

METEOROLOGICAL CHARACTERIZATION OF THE DEWEY-BURDOCK URANIUM PROJECT AREA FALL RIVER AND CUSTER COUNTIES, SOUTH DAKOTA

POWERTECH (USA) INC.

Response: TR RAI-5.7.7-9

TR Section 5.7.7.3

Surface Soil and Sediment Monitoring

Sampling Program

Additionally, effluents from the yellowcake dryer and packaging stacks will be sampled quarterly. The grab samples will be isokinetic in nature and will be analyzed for natural uranium, thorium-230, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with recommendations of RG 4.14.

5.7.7.2 Biota Monitoring

Samples of vegetation will be collected three times during the grazing season at each air monitoring station presented on Figure 5.7-10. At least three samples of livestock will be collected once a year, shortly after slaughter. The samples of vegetation and livestock will be analyzed for radium-226 and lead-210. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14 unless matrix interferences prohibit attainment of these low detection limit goals.

5.7.7.3 Surface Soil and Sediment Monitoring

Samples of surface soil (0-5 cm) will be collected annually at each of the air monitoring stations shown in Figure 5.7-10. The samples will be analyzed for natural uranium, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14 unless matrix interferences prohibit attainment of these low detection limit goals.

The first year stream sediment sampling plan will include four sediment sampling locations providing deep wells are utilized. The following describes the locations and depicts the proposed stream sediment monitoring locations in Figure 5.7-11 and coordinates in Table 5.7-1. The locations will be sampled annually and analyzed for natural uranium, thorium-230, radium-226, lead-210 and polonium-210. If a major precipitation event occurs, sediment sampling will be conducted in addition to the annual sampling regimen. In the case of an extended period of low flow sediment sampling will be conducted in addition to the annual sampling regimen.
The following Stream Sampling Locations for Deep Well Scenario:

1. PSC02-Upstream of potential influence
2. PSC01-Downstream of potential influence
3. BVC01-Downstream of potential influence
4. CHR-BVC-Confluence-Downstream of potential influence

The following Stream Sampling Locations for Land Application Scenario:

1. PSC02-Upstream of potential influence
2. PSC01 – Downstream of potential influence (relocated south of current location for detection of potential runoff)
3. BVC01-Downstream of potential influence
4. CHR-BVC-Confluence-Downstream of potential influence

Table: 5.7-1 Proposed Operational Stream Sediment Sampling Locations

Proposed Operational Sediment Sampling Locations NAD 27, South Dakota State Plane South (feet)		
Station Name	**X Coordinate**	**Y Coordinate**
PSC02	1,034,322.75675	452,562.56253
LA-01	1,022,349.06810	442,052.29287
Onsite	1,028,583.77446	431,913.05462
BVC01	1,021,472.23291	428,715.22046
CHR/BVC	1,029,024.34117	418,291.51034
PSC02	1,034,322.75675	452,562.56253

5.7.8 Groundwater and Surface-Water Monitoring Programs

There are three phases of groundwater and surface water monitoring:

1. Pre-operational (site-wide characterization)
2. Operational (includes well field baseline)
3. Restoration (includes restoration and stability)

Pre-operational is conducted as part of site characterization addressed within Section 2.0 of this report. This section addresses the groundwater and surface water monitoring during production/operational phase of the proposed project. Section 6.0 addresses the restoration phase.

Surface water sampling methods and locations will be comparable to the methods utilized for baseline characterization (Figure 5.7-11) ; see TR Section 2.7.3.1.1 "Sample Collection and Analysis Methods". See Table 6.1-1 for analytes and analytical methods.

Response: TR RAI-5.7.7-14

TR Section 5.7.7.3

Table 7.3-5
Land Application: Maximum Estimated Total Effective Dose Equivalents (TEDE) to Receptors Near the Project Site

Table 7.3-5: Land Application: Maximum Estimated Total Effective Dose Equivalents (TEDE) to Receptors Near the Project Site

Receptor	Distance from Main Plant (km)	40 CFR part 190 TEDE (mrem y^{-1})	Total TEDE (mrem y^{-1})
Boundary - CPP - N	2.82	1.20	2.32
Boundary - CPP - NNE	2.96	0.864	1.79
Boundary - CPP - NE	1.65	1.89	3.43
Boundary - CPP - ENE	2.83	1.06	2.17
Boundary - CPP - E	2.60	1.42	3.23
Boundary - CPP - ESE	2.71	1.49	5.11
Boundary - CPP - SE	3.02	1.59	5.39
Boundary - CPP - SSE	2.41	2.09	5.36
Boundary - CPP - S	2.87	2.13	4.59
Boundary - CPP - SSW	3.04	2.33	4.17
Boundary - CPP - SW	3.44	1.29	2.86
Boundary - CPP - WSW	2.54	1.76	3.65
Boundary - CPP - W	2.32	1.98	4.16
Boundary - CPP - WNW	2.45	2.30	4.59
Boundary - CPP - NW	2.45	2.15	4.72
Boundary - CPP - NNW	3.96	1.21	2.31
Boundary - SF - N	7.22	1.37	2.62
Boundary - SF - NNE	6.74	1.06	2.24
Boundary - SF - NE	6.25	0.727	1.52
Boundary - SF - ENE	5.23	1.79	3.54
Boundary - SF - E	4.54	1.90	4.30
Boundary - SF - ESE	4.03	2.23	6.08
Boundary - SF - SE	3.10	2.25	5.22
Boundary - SF - SSE	3.55	1.51	3.96
Boundary - SF - S	4.92	1.01	2.82
Boundary - SF - SSW	5.86	1.52	3.16
Boundary - SF - SW	6.61	1.41	2.59
Boundary - SF - WSW	6.89	2.23	3.38
Boundary - SF - W	7.81	1.08	1.85
Boundary - SF - WNW	8.15	1.23	1.90
Boundary - SF - NW	7.81	3.63	4.55
Boundary - SF - NNW	7.14	10.8	12.5
Resident - Daniels Ranch	2.13	1.64	3.43
Resident - Spencer Ranch*	2.34	2.32	4.48
Resident - BC Ranch	7.66	1.23	2.06
Resident - Puttman Ranch	8.88	0.596	1.25
Resident - Burdock School	2.98	1.86	3.56
Resident - Heck Ranch	6.61	0.771	2.27
Resident - Englebert Ranch	4.84	0.978	2.74
Town - Edgemont	21.61	0.200	0.572

*Resident – Spencer; No Longer Occupied

POWERTECH (USA) INC.

Response: TR RAI-5.7.7-15

TR Section 5.7.7.1

Monitoring Program to Account for Public Exposure to Radon Progeny

- Use the units of curie, rad, rem (including multiples and subdivisions)
- Show units of all quantities on records
- Use the International System of units (SI) in addition to the units of curie, rad and rem, as necessary for shipment manifests
- Make clear distinction among the quantities for dose entered on records, i.e., TEDE, lens dose equivalent, CEDE, shallow or deep dose equivalent.

5.7.7 Airborne Effluent and Environmental Monitoring Program

Powertech (USA) will conduct an airborne effluent and environmental monitoring program during operations consistent with recommendations in NRC Regulatory Guide 4.14 "*Radiological Effluent and Environmental Monitoring at Uranium Mills*" (RG 4.14). The program will consist of sampling air, water, vegetation, livestock, and surface soil.

5.7.7.1 Air Monitoring

Locations of air monitoring stations are shown in Figure 5.7-10. The filters from air samplers operating continuously will be analyzed quarterly for natural uranium, thorium-230, radium-226, and lead-210. Samplers will have sensors to measure total air flow within a sampling period. Passive track-etch detectors will be deployed at each station for monitoring radon-222 on a quarterly basis. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14.

Additionally, effluents from the yellowcake dryer and packaging roof vents will be sampled quarterly. The grab samples will be isokinetic in nature and will be analyzed for natural uranium, thorium-230, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with recommendations of RG 4.14.

This section has described the use of the available technology for detection of radon and radon progeny. The passive track-etch detectors will be utilized during operational environmental monitoring. At least four of the AMS stations utilized for baseline characterization will be selected for operational monitoring; this meets the suggested monitoring in RG 4.14 (upwind, downwind, nearest neighbor, and control). The four AMS stations will be equipped with a track-etch detector; see figure 5.7-11 below. The track-etch detectors are designed to measure the average radon concentration at the particular location for the period of deployment. The alpha-track detector is designed with a radiosensitive element that records alpha particle emissions from natural radioactive decay of radon. The values reported will provide the basis for calculating the average radon concentration; these detectors are not fitted with a thoron proof filter, therefore, radon progeny is also detected.

The committed effective dose equivalent (CEDE) is quantifiable (to account for public exposure) by utilizing the following equation:

$$\text{CEDE (mrem/yr)} = \frac{0.2\ \text{pCi/L}\left(\frac{\text{WL}}{100\ \text{pCi/L}}\right)(8760\ \text{hrs/yr})(0.7)(500\ \text{mrem/WLM})}{170\ \text{hrs/mo}} = 36\ \text{mrem/yr}$$

where:

0.2 pCi/L represent the recommended LLD (RG 4.14, 1980)

0.7 represents the assumed outdoor radon equilibrium ratio (NRCP Report No. 78, 1984)

500 mrem/WLM (ICRP 65, 1994)

36 mrem/yr represents the LLD measured by the current available technology

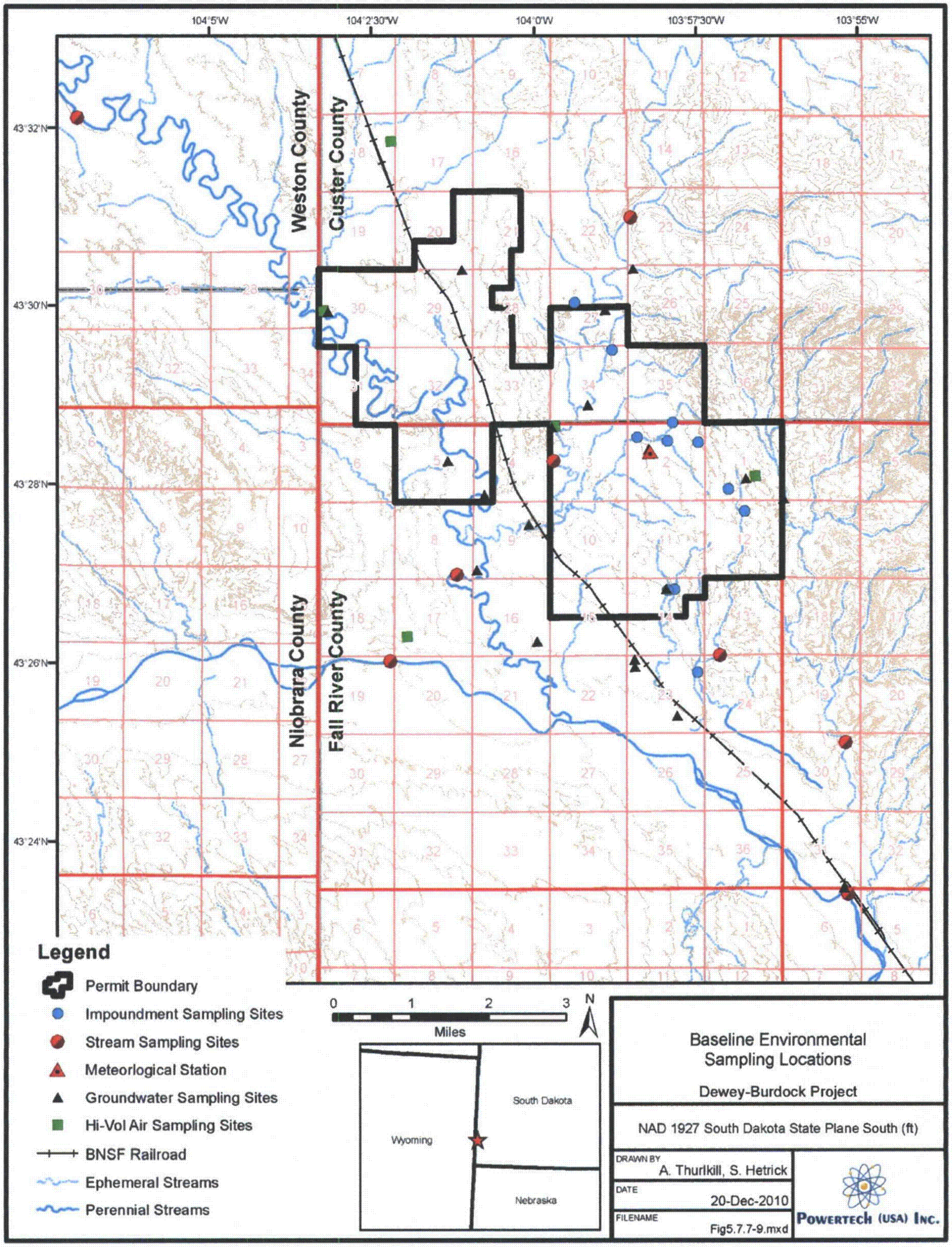


Figure 5.7-11: Operational Environmental Monitoring Sites

Additionally, effluents from the yellowcake dryer and packaging stacks will be sampled quarterly. The grab samples will be isokinetic in nature and will be analyzed for natural uranium, thorium-230, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with recommendations of RG 4.14.

5.7.7.2 Biota Monitoring

Samples of vegetation will be collected three times during the grazing season at each air monitoring station presented on Figure 5.7-10. At least three samples of livestock will be collected once a year, shortly after slaughter. The samples of vegetation and livestock will be analyzed for radium-226 and lead-210. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14 unless matrix interferences prohibit attainment of these low detection limit goals.

5.7.7.3 Surface Soil and Sediment Monitoring

Samples of surface soil (0-5 cm) will be collected annually at each of the air monitoring stations shown in Figure 5.7-10. The samples will be analyzed for natural uranium, radium-226, and lead-210. The maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14 unless matrix interferences prohibit attainment of these low detection limit goals.

The first year stream sediment sampling plan will include four sediment sampling locations providing deep wells are utilized. The following describes the locations and depicts the proposed stream sediment monitoring locations in Figure 5.7-11 and coordinates in Table 5.7-1. The locations will be sampled annually and analyzed for natural uranium, thorium-230, radium-226, lead-210 and polonium-210. If a major precipitation event occurs, sediment sampling will be conducted in addition to the annual sampling regimen. In the case of an extended period of low flow sediment sampling will be conducted in addition to the annual sampling regimen.
The following Stream Sampling Locations for Deep Well Scenario:

1. PSC02-Upstream of potential influence
2. PSC01-Downstream of potential influence
3. BVC01-Downstream of potential influence
4. CHR-BVC-Confluence-Downstream of potential influence

The following Stream Sampling Locations for Land Application Scenario:

Ground-Water and Surface-Water Monitoring Programs 5.7.8

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.

Response TR RAI-5.7.8-1

It is the applicant's understanding from NUREG-1569, Acceptance Criteria 5.7.7.3 – 3, the airborne effluent and environmental monitoring program includes: radon in air, air particulates, surface soils, subsurface soils, vegetation, direct radiation, and sediment in accordance with RG 4.14.

The applicant referenced, among other NRC guidance, NUREG-1569, Section 5.7.8 for developing the groundwater and surface water monitoring program in section 5.7.8 of the TR report. NUREG 1569 section mentioned above describes: Areas of review, procedures and acceptance criteria for groundwater and surface water monitoring programs beginning on page 5-36. Please refer to paragraph 1 of Areas of Review 5.7.8.1 where it states "This standard review plan section deals specifically with monitoring ground-water and surface-water quality during the production or operational phase of *in situ* leach activities".

TR RAI-5.7.8-2

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.

Response TR RAI-5.7.8-2

With regard to the first part of this TR_RAI please refer to the following responses: TR_RAI-2.7-18 and Response TR_RAI-2.9-43a

The applicant has further analyzed all surface water features in accordance with 4.14 and 10 CFR, Appendix A, Criterion 7. As a result the applicant is presenting Figure TR_RAI 5.7.7-8 (See TR_RAI-Response and Replacement Pages; Section 5.7.8) in support of a modified surface water and sediment monitoring plan. The locations are proposed for the construction phase and first year of operations. The proposed locations are based on some existing monitoring locations developed during site characterization to the extent the locations meet the stated objectives in CFR 10, Appendix A, Criterion 7. To further comply, three new stations have been added (LA-01, Onsite, and CHR/BVC). Station PSC01 has been replaced with the "Onsite" station located at the confluence of Pass Creek and ephemeral drainages near the project boundary. The applicant believes this to be compendious of a more detailed program that will be summarized quarterly and submitted to NRC semiannually pursuant to § 40.65 of 10 CFR. The reviewer is directed to Response TR_RAI-5.7.7-9 for map and coordinates of all surface water locations.

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.

a. Table 6.1.1 in the TR provided a proposed list of baseline water quality parameters for wellfields. 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.

b. Consistent with Section 5.8.7.3 of NUREG-1569, the applicant did not include information on the statistic 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 wellfield 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 wellfield without this information. Please provide the above-referenced information.

Response TR RAI-5.7.8-3(a)

See ER_Response RAI EMM-1; pg 68 under the "Environmental Measurements and Monitoring" section.

Response TR RAI-5.7.8-3(b)

See TR_RAI-Response and Replacement Pages, Section 5.7.8-3(b) for requested information in TR Section 5.7.8 "Groundwater and Surface-Water Monitoring Programs".

TR RAI-5.7.8-4

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 wellfields in the license area to the underlying Fall River aquifer.

Response TR RAI-5.7.8-4

The applicant is uncertain of the relevance of TR_RAI 2.7-23 (the last RAI within the Hydrology Section), however concerning the staff's uncertainty regarding potential of operations to cause or enhance a potential migration of constituents of concern from mine pit area(s) at or near the well fields within the Fall River aquifer, the reviewer is directed to Response: TR_RAI-P&R-5 also see TR_RAI Response 2.7-10.

TR RAI-5.7.8-5

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.

Response TR RAI-5.7.8-5

Each well field will be delineated, designed and presented within individual well field packages to both the NRC and the SD DENR; upon design, density of monitoring wells will be defined for each individual well field based upon the analysis of the individual characteristics such as, mining zone location and whether there is an upper aquifer and a lower aquifer and consideration of the confinement status in the particular area of mining. These are just a few of the individual characteristic considered at the time of developing a well field package for submittal. With that stated, reviewer is directed to Response TR_RAI-5.7.8-3(b).

TR RAI-5.7.8-6

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.

Response TR RAI-5.7.8-6

See Response TR_RAI-5.7.8-3(b).

TR RAI-5.7.8-7

In Section 5.2.7 of the TR Supplement, the applicant states "Powertech's management has always used Chlorides, Sulfate and Uranium as Upper Control Limit Parameters. Sometimes Total Dissolved Solids is used. Powertech also uses pressure measurements in the monitor wells to detect the potential for excursions. These parameters were selected for the following reasons."

a. Please clearly specify excursion indicator constituents proposed for the Dewey-Burdock site.
b. The staff notes that the oxygenated portion of the lixiviant tends to be consumed relatively quickly. Therefore, it is unclear if sulfate will sufficiently serve the early warning function that UCL parameters should.
c. Please for provide site-specific justification for the use of total dissolved solids or its related parameter, conductivity at the project site.
d. 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.

Response TR RAI-5.7.8-7(a)

See TR_RAI-Response and Replacement Pages; Section 3.1.3.1.3 "Selection of Upper Control Limit (UCL) Parameters"

Response TR RAI-5.7.8-7(b)

Sulfate will not be proposed as a UCL parameter as this constituent is known to increase across the Dewey-Burdock PAA.

Response TR RAI-5.7.8-7(c)

Lixiviant mixtures typically contain higher TDS than native groundwater and therefore have a higher specific conductivity. For this reason conductivity is very useful for detecting potential excursions early.

Response TR RAI-5.7.8-7(d)

The applicant does not propose to use uranium as a UCL parameter for detection of potential excursions. Chloride, conductivity and total alkalinity are sufficient to monitor for potential excursions.

TR RAI-5.7.8-8

"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. Consistent with Section 2.7.8.3 of NUREG 1569, please describe the method that will be used to establish upper control limits.

Response TR RAI-5.7.8-8

See TR_RAI-Response TR_RAI-5.7.8-3(b) for additional information provided for TR Section 5.7.8.1.1 "Statistical Approach"

TR RAI-5.7.8-9

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 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.

Response TR RAI-5.7.8-9

See TR_RAI-Response and Replacement Pages, 5.7.8-9 for additonal information in TR Section 5.7.1.3 Spill Provision Plans (Subsurface Releases).

TR RAI-5.7.8-10

The applicant proposes 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. Please provide the appropriate justification.

Response TR RAI-5.7.8-10

See TR_RAI-Response and Replacement Pages; Section 3.1.3.1.2 "Production Monitoring Wells".

TR RAI-5.7.8-11

The TR Supplement show perimeter monitoring wells farther than 400 feet from several of the proposed production areas. Please justify the variation in well spacings.

Response TR RAI-5.7.8-11

Both the L2 and L3 ore bodies exist within the Lower Chilson sand unit. Vertical separation between these ore bodies is relatively minor of approximately 10 ft as shown in cross sections presented in Exhibits 2.7-1a through 2.7-1j.

The monitor ring that encompasses both the L2 and L3 is screened across the full thickness of the Lower Chilson sand unit which has an estimated average thickness of 65 ft. Even though L2 and L3 ore horizons are produced with separate systems of wells they are treated as a single production zone for monitoring purposes. The monitor ring is a maximum of 400 ft horizontally from this single production zone.

TR RAI-5.7.8-12

Please provide the methods to be used to determine what constitutes an overlying aquifer.

Response TR RAI-5.7.8-12

See TR_RAI-Response and Replacement Pages; TR Section 3.1.3.1.1 "Non-Production Monitoring Wells".

TR RAI-5.7.8-13

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.

Response TR RAI-5.7.8-13

The proposed location of underlying non-produciton zone wells is depicted in detail in Figure B and Figure D. Underlying wells are named with the prefix MU. Underlying wells are installed only in the first hydrogeologic unit beow the production zone hydrogeologic unit and separated by an aquitard. The proposed density of the wells is 1 MU well per four 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 patterns area which are vertically outside of the perimeter monitor ring of the underlying well field.

Only in case where the proeduciton zone is in the lower most hydrogeologic unit and bounded below by the Morrison no underlying non-production zone MU wells will be installed. An example of this is provide in Figure B, where Burdock Well field #1 is in the Lower Chilson formation. Another example is shown in figure D, where Dewey Well field #2 in the Middle Chilson formation.

TR RAI-5.7.8-14

Consistent with NUREG 1569, Section 5.7.8.3, please further describe wellfield test procedures that will be used.

Response TR RAI-5.7.8-14

See TR_RAI- Response to 5.7.8-9 for additional information in TR Section 5.7.1.3 Spill Provision Plans (Subsurface Releases).

TR RAI-5.7.8-15

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. Please provide excursion monitoring program consistent with NUREG-1569.

Response TR RAI-5.7.8-15

See TR_RAI-Response 5.7.8-9 for requested information for TR Section 5.7.8.2 "Excursion Verification and Corrective Action".

TR RAI-5.7.8-16

NRC Staff notes corrective action and notification plans were not provided

Response TR RAI-5.7.8-16

See TR_RAI-Response 5.7.8-9 for requested information for TR Sections 5.7.8.2.2 "Corrective Action and Monitoring" and 5.7.8.2.3 "Notification".

TR RAI-5.7.8-17

Please specify all water well sampling locations.

Response TR RAI-5.7.8-17

All well sampling locations are depicted on Figure 5.7-10 now replaced with Figure TR_RAI 5.7.7-9. These depict the same wells sampled on a quarterly basis for baseline characterization in Figure 2.7-19. Drinking water and livestock wells are used within the text as descriptive use terms only, for the designated group of wells represented on Figure 5.7-10 as "Groundwater Sampling Sites". With regard to the Inyan Kara wells, if deemed to interfere with operations the well will be plugged and abandoned, however, the well(s) in question, may be utilized during operations within the well field.

The application identifies the referenced Figure 5.7-8 as *"Locations of Radon Decay Product (Radon) Monitors on-site of Central Processing Facility, Outside the Central Processing Facility"*. The applicant does not understand the relevance of the statement and associated Figure 5.7-8 reference.

TR RAI-5.7.8-18

Surface water sampling before and during operations according to Section 5.7.8.3 of NUREG 1569; provide the following:

a. Upstream location for Beaver Creek and downstream location for Pass Creek where it exits the site

b. Commitment to collecting pre-operational data on a seasonal basis for a minimum of 1 year before in situ recovery operations.

Response TR RAI-5.7.8-18(a)

See TR_RAI-Response Response 5.7.8-9 for (Figure 5.7-11) the scale of the map has been adjusted to depict all surface water sampling locations upstream of PAA and downstream of PAA.

Response TR RAI-5.7.8-18(b)

The applicant has fulfilled this commitment by completing the pre-operational (baseline characterization) data collection. Monthly samples at perennial, intermittent, and ephemeral streams and quarterly samples at selected impoundments have been collected for 1 year upstream, downstream, and within proposed mining and facility locations. The information is provided within the Environmental and Technical Reports submitted to the NRC in support of acquiring a source material license.

If the reviewer is referring to operational baseline data collection, see TR_RAI-Response and Replacement Pages; Section 5.7.8 "Groundwater and Surface-Water Monitoring Programs".

The applicant will conduct well field hydrologic and water chemistry testing, sampling, and analysis before in situ leach operations begin to establish a basis for comparing operational monitoring data. These evaluations at the well field scale will enable the operator to determine well field operational safety, determine proper location for monitoring wells, verify the locations and modify in necessary; planning and implementation of the groundwater restoration phase.

Operational sampling and analysis methodology will be carried out similar to the pre-operational sampling and analysis. See TR_RAI-Response and Replacement Pages; Section 5.7.8 "Groundwater and Surface-Water Monitoring Programs".

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.

Response TR RAI-5.7.8-19

See TR_RAI-Response and Replacement Pages; Response 5.7.8-9 for TR Section 5.7.8-19 "Groundwater and Surface water Monitoring Programs".

POWERTECH (USA) INC.

Response: TR RAI-5.7.8-3(b)

TR Section 5.7.8

Groundwater and Surface water Monitoring Programs

Baseline Levels Defined

1. PSC02-Upstream of potential influence

2. PSC01 – Downstream of potential influence (relocated south of current location for detection of potential runoff)

3. BVC01-Downstream of potential influence

4. CHR-BVC-Confluence-Downstream of potential influence

Table: 5.7-1 Proposed Operational Stream Sediment Sampling Locations

Proposed Operational Sediment Sampling Locations NAD 27, South Dakota State Plane South (feet)		
Station Name	**X Coordinate**	**Y Coordinate**
PSC02	1,034,322.75675	452,562.56253
LA-01	1,022,349.06810	442,052.29287
Onsite	1,028,583.77446	431,913.05462
BVC01	1,021,472.23291	428,715.22046
CHR/BVC	1,029,024.34117	418,291.51034
PSC02	1,034,322.75675	452,562.56253

5.7.8 Groundwater and Surface-Water Monitoring Programs

There are three phases of groundwater and surface water monitoring:

1. Pre-operational (site-wide characterization)

2. Operational (includes well field baseline)

3. Restoration (includes restoration and stability)

Pre-operational is conducted as part of site characterization addressed within Section 2.0 of this report. This section addresses the groundwater and surface water monitoring during production/operational phase of the proposed project. Section 6.0 addresses the restoration phase.

Surface water sampling methods and locations will be comparable to the methods utilized for baseline characterization (Figure 5.7-11) ; see TR Section 2.7.3.1.1 "Sample Collection and Analysis Methods". See Table 6.1-1 for analytes and analytical methods.

Groundwater sampling methods will be comparable to the methods utilized for baseline characterization. Static water level measured before collection; when possible pressure of free flowing wells were measured with a 15 or 30 psi NIST pressure gauge; the well was shut in and pressure allowed to stabilized before reading was recorded. Wells with subsurface water levels were measured with an electric water level tape.

Three casing volumes were purged (or until formation flow was induced) and the temperature, pH and conductivity were stabilized before collection of the groundwater sample. Free flowing wells were assumed to represent formation water; a spot check of stabilization parameters was recorded at the time of sample collection (TR Section 2.7.4 References).

Acceptable analysis methods will be performed during operational monitoring as in baseline characterization; see TR Table 2.7-22 and Table 2.7-30.

5.7.8.1 Approach Used to Establish Baseline

Within each production well field a subset of wells to be utilized as production wells will be identified for baseline water quality sampling. The subset of these wells will consist of at least one (1) well per four (4) acres of mine unit, except if the total number of such monitor wells in a wellfield is less than six (6) then additional wells may be added to the subset to attain either a representative subset of six (6) wells or a maximum well density of 1 well per acre, whichever is less.

The perimeter monitor wells are completed in the same geologic formation as the mineralized ore zone, but around the perimeter of the production well fields spaced 400 feet outside the production well field and evenly spaced around the perimeter of the well field with a minimum spacing either 400 feet or the spacing that will ensure a 70 degree angle between adjacent production zone monitor wells and the nearest injection well (NUREG/CR-6733; NUREG-1910, 2008; NUREG-1569).

Internal, non-production zone monitoring wells will be installed at spacing densities of one (1) overlying monitor well per four (4) acres and one (1) underlying monitor well per eight (8) acres, unless specific wellfield properties call for a higher monitor well spacing density. For more information on layout and design of monitoring wells, see TR Section 3.1.3.

The subset of production-zone wells identified for baseline sampling described in TR Section 3.1.3 will be sampled four times for baseline characterization prior to production operations with a minimum of fourteen (14) days between consecutive samplings. The first and second sampling events will include analyses for all groundwater parameters identified in Table 6.1-1. The third and fourth sampling events will be analyzed for a reduced list of parameters as defined by the results of the previous sample events; if certain elements are not detected during the first and second sampling events, then those elements will not be analyzed during the third and fourth sample events. All monitor wells will also be sampled during the four baseline sampling events and analyzed for the excursion indicator parameters; the water level in the monitor wells will also be recorded at each sampling event.

5.7.8.1.1 ***Statistical Approach***

The subset of production-zone wells identified for baseline sampling described in TR Section 3.1.3 will be sampled four times for baseline characterization prior to production operations with a minimum of fourteen (14) days between consecutive samplings. The first and second sampling events will include analyses for all groundwater parameters identified in Table 6.1-1. The third and fourth sampling events will be analyzed for a reduced list of parameters as defined by the results of the previous sample events; if certain elements are not detected during the first and second sampling events, then those elements will not be analyzed during the third and fourth sample events. All monitor wells will also be sampled during the four baseline sampling events and analyzed for the UCL indicator parameters; the water level in the monitor wells will also be recorded at each sampling event.

The collective well field data from the baseline sampling will be separated by hydrogeologic unit and examined for spatial heterogeneity; this will normally result in at least four separate zones of wells among those wells so sampled: i) Production-zone wells located within the ore body to be mined that will be used to determine the restoration target values (RTV) for the production zone aquifer, ii) monitoring ring wells, iii) overlying zone wells, if any, and iv) underlying zone wells in the underlying aquifer.

Upper control limits for each monitoring zone will be set at the baseline mean concentration plus five standard deviations for each excursion indicator. However, some aquifers exhibit low chloride concentration with a narrow statistical distribution; therefore, chloride, the greater of the mean plus five standard deviations or the mean plus 15 mg/L will be used as the upper control limit. (NRC, 2003, §5.7.8.3(2))

The collective data within each zone will then be examined for possible outliers on a parameter by parameter basis. An outlier is a single non-repeating value that lies far above or below the rest of the sample values for that parameter. Outliers will be corrected if possible, as for example if the outlier was a result of a transcription or other identifiable error. A data value will be deemed to be an outlier and removed from the data if it lies outside of the mean value, plus or minus three standard deviations, of all values of that parameter within the zone or sub-zone, where said mean and standard deviation are computed without using the suspected outlier.

Following removal of outliers, if any, the data within each zone or sub-zone will be analyzed by statistical methods to determine the restoration target values (RTVs) and upper control limits for excursion detection, as appropriate to that zone or sub-zone.

The RTVs for each parameter in a production zone will follow standardized methods of statistical process control (ASTM, 2007) E2587-07e1) such that successful restoration with respect to that parameter for a given restoration sampling event shall require that the mean and range values of the parameter shall lie between the lower control limit and the upper control limit established for that parameter.

Environmental groundwater samples will be collected monthly for the first year of operation and quarterly thereafter at the groundwater monitoring well locations as shown in Figure 5.7-10. Quarterly samples will be collected from drinking water and livestock wells, included in the groundwater sampling sites as shown in Figure 5.7-10. Upstream and downstream surface water sampling (including passive sampling on Pass Creek) will be conducted monthly at the sampling locations shown in Figure 5.7-10. Surface impoundments will be sampled on a quarterly basis at the locations shown in Figure 5.7-10.

5.7.8.2 Excursion Verification and Corrective Action

5.7.8.2.1 Verification

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 sample results 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 or third sample confirm the first sample results.

5.7.8.2.2 ***Corrective Action and Monitoring***

Sampling frequency will be increased to weekly, pumping rates of production wells in the area of the excursion will increase, the net bleed, pump individual wells to enhance recovery of mining solutions, and prepare an excursion report for NRC. If these actions 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.

5.7.8.2.3 Notification

In the event of an excursion Powertech will notify the NRC within 24 hours by telephone or email, and in writing with 30 days, and begin corrective actions.

Refer to ER Section 6.2.2.4.1 for more information regarding confinement for vertical excursions.

5.7.9 Quality Assurance Program

Powertech (USA) will establish a quality assurance program at the facility consistent with the recommendations contained in NRC Regulatory Guide 4.15 "*Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) -- Effluent Streams and the Environment*" (RG 4.15). The purpose of the program is to ensure that all radiological and nonradiological measurements that support the radiological monitoring program are reasonably valid and of a defined quality. These programs are needed (1) to identify deficiencies in the sampling and measurement processes and report them to those responsible for these operations so that licensees may take corrective action and (2) to obtain some measure of confidence in the results of the monitoring programs to assure the regulatory agencies and the public that the results are valid.

The quality assurance program will contain the following RG 4.15 elements:

- The organizational structure, responsibilities, and qualifications of both the management and the operational personnel.
- Specification and qualifications of personnel.
- The SOPs used in the monitoring programs.

POWERTECH (USA) INC.

Response: TR RAI-5.7.8-9

TR Section 5.7.1.3

Spill Provision Plans

(Subsurface Releases)

Groundwater treatment involves the use of process equipment to lower ion concentration of the water in the production zone. Brine water is produced during this activity and is disposed of via waste disposal well. Chemical reducing agents may also be employed during this phase of treatment.

Facility sanitary waste will be relatively small in quantity and will be treated in an appropriately sized septic system with sanitary drain field.

5.7.1.3 Spill Provision Plans

Procedures to address potential spills will be the responsibility of the radiation safety department; engineers and operations supervisors will assist in development of procedures. The SERP will review the procedure for effectiveness. Procedures developed will implement appropriate protocol to handle potential spills of radioactive materials. Nine responsibilities comprise basic activities:

- Resources and manpower assigned.
- Material and Inventory.
- Identification of potential spill sources.
- Spill reporting and visual inspection program established.
- Review of past spill incidents.
- Coordination among all departments for containment of spills.
- Emergency response protocol established.
- Program implementation, review and updating.
- New construction and changes in process relative to prevention and control of spills will be reviewed.

There are two types of spills that may result from an in situ operation:

Surface Releases

Potential surface releases may be the result of a tank failure, ruptured pipe, or transportation incident.

Failure of a process vessel will be contained within the CPP via berms and directed into a sump (equipped with a level alarm) that will allow the solution to be transported to appropriate tank or disposal system.

Likelihood of multiple tank failures

No reference information could be located that cited numerical probabilities or likelihoods of vessel failures at ISL facilities, whether such failures involve single or multiple tanks. A 1994 thickener accident at the Irigaray ISL facility resulted in about 20 percent of the thickener content being spilled inside and outside of the processing building (NUREG/CR-6733)

Measures for preventing tank failures

See TR Section 7.5.1, the provisions of 40 CFR, Part 68, and others, will be followed to prevent tank failures.

Methods of containing tank failures

Both the central processing plant and the satellite facility are equipped with trench drains and sumps, with pumps, to collect spills of process fluids from leaks or tank failures. The facility floors will be sloped toward these trench drains and sumps. Spilled or leaked fluids will be transferred to the waste tanks, from which it can be directed to wastewater treatment and disposal. If a spill occurs in the recovery area, the spilled fluid could also be returned to the process circuit for re-working, or stored temporarily in the central plant pond.

Capacity of the curbed areas.

In addition to the sump system, both the CPP and the satellite facility buildings will be designed with a concrete containment curb around the perimeter of the building. The height of the concrete containment curb will be such that the curbed area will contain the volume of the largest tank located in the facility. Any of the spills located within the curbed foundation areas will be considered contained spills. For the CPP, the largest tank is the thickener vessel, of which there are two. It is estimated that, considering the volume of trench drains, sumps and the curbed area of only the elution/precip/dewatering process areas, but excluding the IX , dryer and packaging portions of the central processing plant, a containment curb of less than 3-inches will be sufficient to contain the entire contents of a thickener vessel. The two thickeners are spaced far enough apart to prevent a failed thickener to fall into, and cause the failure of, the other thickener vessel. For other vessels, even in the unlikely event of the failure of multiple tanks, the containment curb will be large enough to contain the contents of multiple vessels.

Piping system leaks is the most common source of surface releases that occur at an in situ facility. Generally these spills are small due to engineering controls set up to detect changes in pressure within the piping systems. Operators are alerted via an alarm system when pressure changes occur. Well field piping systems are constructed of PVC or high density polyethylene (HDPE) materials with butt welded joints or the equivalent. All pipelines will be pressure tested at operating pressures before put online. No additional stress is placed on the buried pipes so it is improbable a break would occur. The underground portions of the pipes are protected from vehicles and exposed pipes only occur at the wellheads and header houses. Trunkline flows and wellhead pressures will be monitored for process control. Spill response is specifically addressed in the Emergency Response Procedures (Energy Metals Corporation, U.S, 2007).

Spills related to transportation will be addressed in Powertech's (USA) Emergency Response Action Plan. Specific actions involving response to a radioactive materials shipment will include instructions for appropriate packaging, documentation, driver emergency and accident response procedures and cleanup and recovery protocol.

Subsurface Releases

Potential subsurface releases such as a well excursion may result in the migration of process fluids.

Monitoring wells will be set up around the well field for detection of any leach fluids that may potentially migrate away from the production zone due to an imbalance in well field pressure. The monitoring well detection system is a proven method historically among ISL operations. Powertech (USA) proposes to locate a ring of monitoring wells no farther than 400 feet from the well field.

These monitoring wells will be screened in the same zone as the production well. The screen interval for perimeter production zone monitor wells will be the entire hydrologeologic unit.

There will be additional wells monitoring the aquifers above and potentially below the ore-bearing aquifer. Similarly, overlying and underlying wells will be screen across the entire hydrogeologic unit which either overlies or underlies the production zone hydrogeologic unit.

These screened intervals are determined by mapping of the these hydrogeologic units and the aquitards between them after delineation drilling of each well field. This mapping and monitor well design will be presented in a hydrologeologic package for each well field for review prior to operation. In all cases, screens will be installed to be fully penetrating the hydrogeologic unit to be monitored; in other words, fully screened across the entire hydrogeologic unit between the aquitards above and below which confine it.

Sampling of monitoring wells will occur on a weekly or bi-weekly basis. Recovery and monitoring work in conjunction, as a coordinated effluent control system, and has proven effective in early detection of recovery fluids for a number of reasons:

- Close proximity of monitoring wells to well field
- Low flow of production wells
- Cone of depression created from production bleed

The overall effect of the system makes non-detection highly unlikely.

Effluent controls for preventing migration of recovery solutions to overlying and underlying aquifers consist of:

- Plugging and Abandonment of all (historical or recent) exploration holes that may have potential to interfere with operations and/or restoration activities.
- Conducting Mechanical Integrity Tests (MITs) on each well before it is put on line.
- Sampling the monitoring wells located within the overlying and underlying aquifers on a frequent schedule.

Well Field Test Procedures

Once the monitoring system for a well field is installed, a pump test or tests will be conducted to establish the hydrogeologic connection of the perimeter monitor ring and the production zone or zones within it. It will also be used to determine the extent of hydrogeologic isolation between overlying and underlying hydrogeologic units. At a minimum, pump tests will be conducted by pumping of a single well centrally within the production zone such that a significant response can be measured in the perimeter monitoring ring. This response is typically expected to be a minimum of 1 foot of drawdown in the perimeter production zone monitor ring; though, if necessary a small estimate of response will be justified a significant based upon site specific conditions. Multiple pump tests may be necessary if the well field encompasses a large distance across and if sufficient hydrogeologic response cannot be obtained across the full extent of the proposed perimeter production zone monitoring ring in a single test. The flow rate of the pump test will be well field specific and based upon the expected maximum withdrawal rates based equivalent to the maximum production bleed rate of that well field. Intent of the test will be characterization of the hydrogeologic properties and demonstration confinement (or lack of) in the production zone hydrogeologic unit. Response will also be measured in non-production zone monitor wells in the first hydrogeologic unit immediately overlying and first hydrogeologic unit immediately underlying the production zone hydrogeologic unit. For purposes of gathering baseline water quality data and confirmation of hydrogeological conditions, pump testing will be conducted with full monitoring system in place. Pump testing is completed for the review in Well field Hydrogeologic Data packages presented for each well field, with the results and conclusions of the hydrogeologic response of the monitoring system included.

Upon completion of all field data collection, the Well field Hydrogeologic Data Package is assembled and submitted to NRC and DENR for review. In accordance with NRC Performance Based Licensing requirements, the Well field Hydrologic Data Package is reviewed by a Safety and Environmental Review Panel (SERP) to ensure that the results of the hydrologic testing and the planned mining activities are consistent with technical requirements and do not conflict with any requirement stated in NRC regulations or in the NRC license. A written SERP evaluation will evaluate safety and environmental concerns and demonstrate compliance with applicable NRC license requirements. The written SERP evaluation will be maintained at the site.

The Wellfield Hydrologic Data Package contains the following:

1. A description of the proposed mine unit (location, extent, etc.).
2. A map(s) showing the proposed production patterns and locations of all monitor wells.
3. Geologic cross-sections and cross-section location maps.
4. Isopach maps of the Production Zone sand, overlying confining unit and underlying confining unit.
5. Discussion of how the hydrologic test was preformed, including well completion reports.
6. Discussion of the results and conclusions of the hydrologic test including pump test 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 average production zone/restoration target values.

9. Any other information pertinent to the area tested will be included and discussed.

These controls work together to prevent and detect production fluid migration. Plugging exploration holes prevents connection of the ore-bearing aquifer to overlying and underlying aquifers. The EPA UIC requirement of MITs assures proper well construction and is the first line of defense for maintaining appropriate pressure without leakage. Sampling the monitor wells will enable early detection of any production solutions should an excursion occur.

Sediment or erosion of existing soils has the potential to lead to a release of undesirable elements in addition to the aforementioned spills. The greatest likely hood of this type of release may occur during the construction phase of the project. Two types of Best Management Practices (BMPs) will be employed to minimize the effects of runoff during precipitation events. One type is erosion prevention practices and the second type is sediment control practices.

Erosion Prevention Practices utilize ground covers that prevent different types of erosion from occurring. Ground covers include but are not limited to:

- Vegetation
- Riprap
- Mulch
- Blankets

Sediment control practices prevent soil particles that are being carried in storm water from leaving the site. These types of controls may consist of:

- Silt fence
- Sediment traps
- Sediment basins
- Vegetative cover

Leaving as much of the vegetation in place for as much of the construction period as possible will reduce the potential for a precipitation event to cause significant erosion and soil loss on-site. Utilizing erosion prevention and sediment controls in combination will prevent sediment loss during a major precipitation event. In addition to the above mentioned controls, engineering design and administrative controls will also minimize and control erosion and runoff. Should a pipeline failure coincide with a precipitation event, there is potential for a release. Relative soil saturation beneath the leak area would be a determining factor to what extent the material would be able to be absorbed. In any event with rapid detection and quick spill response a pipeline failure and migration of solutions due to runoff would be minimal.

5.7.1.4 Contaminated Equipment

Solid wastes generated by this project that are contaminated with process related material consist of materials such as rags, contaminated personal protective equipment, trash, packing material, worn or replaced parts from equipment, piping, sediments removed from process pumps and vessels . Radioactive solid waste that has a contamination level requiring controlled disposal will be isolated in drums or other suitable containers and disposed in a NRC licensed facility or as otherwise approved by the NRC. The combined operations at the SF and CPP will generate between approximately 100 to 300 yd^3 of radioactive contaminated waste each year. During final decommissioning of the CPP facilities and SFs, the volume of solid waste will increase. During final decommissioning of the CPP facilities and SFs, the volume will increase.

5.7.2 External Radiation Monitoring Program

Powertech (USA) will monitor external radiation exposure at the Dewey-Burdock facility. The monitoring will be done in three ways: continuous measurements at fixed locations, employee monitoring, and period work area surveys. The external radiation monitoring program will be

Quality Assurance 5.7.9

TR RAI-5.7.9

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.

Response TR RAI-5.7.9

See Response to P&R-16(3).

Plans and Schedules for Groundwater Restoration 6.1

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... Please revise the language in the TR to be consistent with the above guidance and regulatory requirements.

Response TR RAI-6.1-1

It is important to note that Powertech (USA) (USA) has committed to the standards consistent with Criterion 5B(5) of Appendix A to 10 CFR Part 40. The RIS-09-05 states that the OGC agrees with EPA's interpretation of 40 CFR Part 192 that was adopted by the NRC concerning groundwater restoration criteria, in that 5B(5) conforms to the groundwater standards agreed upon by both EPA and the NRC concerning MCL's and ACLs if established. Therefore, the applicant's commitment to the standards described in 5B(5) is consistent with guidance and regulatory requirements.

See TR_RAI Responses TR_RAI-Response and Replacement Pages in Section 6.1 revised language for "Groundwater Restoration Criteria". The applicant agrees that while the class of use is not a NRC regulatory requirement, it seems to fit within the philosophy and guidance of the NRC, Criterion 5B(6) of Appendix A of 10 CFR Par 40 and the SD DENR regulations. Please refer to NUREG/CR-6870, 2007 and NUREG/CR-6733, 2001, where the following statements appear:

"The applicant may therefore propose returning the water quality to its pre-operational class of use (e.g., drinking water, livestock, agricultural, or limited use) as a secondary restoration standard" (Nureg-1569, 2003).

"...the U.S. Nuclear Regulatory Commission (NRC) requires licensees to ensure that sufficient funds are maintained by the licensee for restoration of the site to *initial conditions* following cessation of in-situ leach mining operations" (NUREG/CR-6870, 2007). This statement appears in direct reference to groundwater restoration.

"At the end of the groundwater recirculation phase, aquifer water is monitored according to a schedule accepted by the regulatory authority to ensure that baseline or class-of-use conditions have been restored and that no impact on adjacent aquifers has occurred" (NUREG/CR-6870, 2007) .

"The long-term trends in the concentrations of these elements are important in establishing whether the groundwater restoration activities have been adequate to ensure the stability of the aquifer water quality and the class of use required by regulatory authorities" (NUREG/CR-6870, 2007).

"The final phase of aquifer restoration is stabilization. During this period, aquifer water is typically monitored by quarterly sampling to ensure that baseline or preextraction class-of-use conditions have been permanently restored and that there is no impact on any adjacent nonexempt aquifer. Aquifer restoration is reinitiated if determined to be necessary as a result of stabilization monitoring" (NUREG/CR-6733, 2001).

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 6312 (ASTM, 2001). The reference should be ASTM 6312-98 (Re-approved 2005).) Please address this comment.

Response TR RAI-6.1-2
See TR_RAI-Response and Replacement Pages; Section 6.1.1 "Groundwater Restoration Criteria". The ASTM standard has been changed to: ASTM Standard D 6312-98 (Re-approved 2005);

TR RAI-6.1-3
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. Please correct the references in Table 6.1-1 and provide rationale or justification for excluding those other parameters listed in NUREG-1569.

Response TR RAI-6.1-3
Clarification of the passage "methods that will be used for establishing TRGs" would include reference to above TR_RAI 6.1-2 where the reviewer acknowledges the applicant's intention to utilize statistical analysis in ASTM 6312-98. This is clearly stated in TR Section 6.1.1. Laboratory analytical methods listed in Table 6.1-1 are provided for the reviewer's information concerning methods applied to constituent analytics.

See TR_RAI Responses TR_RAI-Response and Replacement Pages; Section 6.1. The language for Table 6.1-1 footnote has been changed from using the term *adapted* to: "Table modified from parameter list in Table 2.7.3-1 of USNRC (2003) Standard Review Plan for In Situ Leach Uranium Extraction License Applications." See TR_RAI-Response and Replacement Pages; Section 6.1.1 "Groundwater Restoration Criteria".

Regarding justification for excluding those other parameter listed in NUREG-1569; please see Response TR_RAI-5.7.8-3(a).

<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 applicant needs to provide a more in-depth discussion on the proposed methods to be used in clear terms. The applicant needs to define "injection sweep method" in more commonly accepted terms (e.g. groundwater transfer, groundwater sweep, and 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.

<u>Response TR RAI-6.1-4</u>
See TR_RAI-Response and Replacement Pages, Section 6.1-4; TR Section 6.1.3 "Groundwater Restoration Methods". The applicant provides an in-depth discussion on the proposed restoration methods to be used at the proposed Dewey-Burdock Project in

<u>TR RAI-6.1-5</u>
TR-RAI-6.1-5: Clarify reference to NUREG/CR-3136, 1983 and provide statement of hydraulic control at all well fields at all times during production and restoration until the stabilization period.

<u>Response TR RAI-6.1-5</u>

The reference to NUREG/CR-3136 has been removed; see TR_RAI-Response and Replacement Pages; Section 6.1-5 for Section TR Section 6.1.3 "Groundwater restoration Methods".

<u>TR RAI-6.1-6</u>
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.

<u>Response TR RAI-6.1-6</u>

See TR_RAI-Response and Replacement Pages; Section 6.1.6.1 "Effectiveness of Groundwater Treatment Method"

<u>TR RAI-6.1-7</u>
The application did not include estimates on the pore volume for a wellfield, 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.

<u>Response TR RAI-6.1-7</u>
See TR_RAI-Response and Replacement Pages; Section 6.1-7 for information concerning the above request in TR Section 6.6.1 "Estimates of Pore Volume for a Well Field, Porosity and Flare Factors".

TR RAI-6.1-8

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.

Response TR RAI-6.1-8

See TR_RAI-Response and Replacement Pages; 6.1-8 for additional information in TR Sections 5.7.8-15, 16 and 6.1-9. TR Section 6.1.7.1.2 "Monitoring During Aquifer Restoration".

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 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.

Response TR RAI-6.1-9

See TR_RAI-Response and Replacement Pages; Sections 3.1.3 "Monitoring well Layout and Design" and 6.1.7.1 "Monitoring During Active Restoration".

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 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.

Response TR RAI-6.1-10

According to Nureg-1569 – 6.1.3(5) Acceptance Criteria the applicant meets the following criteria for stability monitoring:

- specify the length of time that stability monitoring will be conducted
- the number of wells to be monitored
- the chemical indicators to be monitored
- the monitoring frequency

All designated monitor wells must be sampled for all monitored constituents.
See TR_RAI-Response and Replacement Pages; Section 6.1.7.2 "Restoration Stability Monitoring" for additional information on proposed stability monitoring program.

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 wellfields. The proposed restoration period encompasses an eight-year time-frame starting at year five. The restoration period overlaps the production, stability monitoring and wellfield decommissioning elements of the schedule. Also note that should the restoration schedule exceed 24 months for a wellfield, the applicant will have to request NRC approval of that schedule as an alternate schedule. Please address this comment.

Response TR RAI-6.1-11

See TR_RAI-Response and Replacement Pages; Section 6.1.4 "Restoration Schedule" Figure 6.1.1 (Revised) Schedule for Proposed Well Field Operations.

6.0 Groundwater Quality Restoration, Surface Reclamation, and Facility Decommissioning

6.1 Plans and Schedules for Groundwater Quality Restoration

Groundwater restoration, reclamation of disturbed land and decommissioning of the well fields, plant and associated facilities will be conducted in a manner that will protect human health and the environment. The methods for achieving this objective are discussed in the following sections.

6.1.1 Groundwater Restoration Criteria

Groundwater restoration at the proposed project site will be performed pursuant to NRC requirements to protect underground sources of drinking water (USDW) adjacent to the site. Prior to recovery, a Class III Underground Injection Control (UIC) Permit that includes an aquifer exemption from the EPA must be issued. This exemption will be based on historical and existing water quality, the demonstration that the ore zone is commercially producible and that the ore zone has not historically nor will it now or in the future be an underground source of drinking water.

The primary goal of groundwater restoration at the site will be to return groundwater quality within the production zone of a well field consistent with ARSD 74:55:01:45.01 groundwater restoration table; the restoration values will be based upon pre-operational baseline water quality conditions or to standards consistent with NRC's application of Criterion 5B(5) of Appendix A to 10 CFR Part 40.

In the event that Powertech (USA), based upon the application of best practicable technology, is unable to restore such groundwater consistent with preoperational baseline water quality conditions, the secondary goal would fall under ARSD 74:55:01:45.01 provisions for establishing alternate restoration values based on the following considerations:

1. To not exceed the applicable maximum allowable concentrations in South Dakota ground water quality standards listed in § 74:54:01:04;

2. To not exceed the health advisory levels or secondary drinking water regulations set by the U.S. Environmental Protection Agency for other parameters not listed in Table 1 and Table 2 of § 74:54:01:04; and

3. To not exceed values based on an appropriate statistical method for any parameters not listed in South Dakota ground water quality standards or in U.S. Environmental Protection Agency health advisory lists or secondary drinking water regulations.

Modification of the restoration table shall be done in accordance with ARSD 74:55:01:58.01 and provisions of 10 CFR Part 40 in 5B(5) and 5B(6) regarding alternate concentration limit(s). Implementation of the proposed alternate concentration limit(s) and modification(s) to compliance groundwater monitoring program will be presented to the SD DENR and the NRC for review.

South Dakota rules and regulations described above provide for alternate restoration values based upon justification that include providing all available water quality data for the restoration unit in question within a submitted amendment to the permit. Determinations include use for which the groundwater was suitable at baseline quality levels. Powertech (USA) believes the ARSD standards are appropriate criteria to demonstrate adequate restoration of an exempted aquifer.

Prior to operation, the baseline groundwater quality will be determined through the sampling and analysis of water quality indicator constituents in wells screened in the mineralized zone(s) across each well field. Target restoration goals (TRG) will be established for each constituent. The target restoration goal (TRG) for each monitored constituent will be the mean value as determined from a statistical analysis of the preoperational baseline sampling data. Powertech (USA) will attempt to meet the TRG established for each constituent during the groundwater restoration process. Table 6.1-1 provided below lists the baseline water quality parameters and the methods that will be used for establishing groundwater TRG:

Table 6.1-1: Baseline Water Quality Parameters

Test Analyte/Parameter	Units	Method
BULK PROPERTIES		
pH	pH Units	A4500-H B
Total Dissolved Solids (TDS)	mg/L	A1030 E[1], A2540 C
Conductivity	µmhos/cm	A2510B
CATIONS/ANIONS		
Chloride	mg/L	E300.0
Sulfate	mg/L	E300.0
Total Alkalinity (as $CaCO_3$)	mg/L	A2320 B
TRACE METALS		
Arsenic, As	mg/L	E200.8
Iron, Fe	mg/L	E200.7
Lead, Pb	mg/L	E200.8
Manganese, Mn	mg/L	E200.8
Strontium	mg/L	E200.8
Uranium, U	mg/L	E200.8
Vanadium	mg/L	E200.7, E200.8
RADIONUCLIDES		
Gross Alpha=Alpha Particles	pCi/L	E900.0
Gross Beta=Beta Particles and Photons	mRem/Year	E900.0
Radium-226	pCi/L	E903.0
Radon-222	pCi/L	D5072-92

Table modified from parameter list in Table 2.7.3-1 of USNRC (2003) Standard Review Plan for Ins Situ Leach Uranium Extraction License Applications.
Notes: mg/L = milligrams per liter
µmhos/cm = micromhos per centimeter
pCi/L = picocuries per liter
All metals analyses are for dissolved metals

Powertech (USA) will consult with DENR concerning the specific groundwater suite of constituents prior to well field baseline evaluation. In the event that secondary groundwater restoration standards may need to be considered for specific constituents, Powertech (USA) will provide data and justification for restoring groundwater water quality to pre-operational class of use.

6.1.2 Estimate of Post-Production Groundwater Quality

In order to estimate post-production water quality from ISL operations at the site, Powertech (USA) has reviewed operational restoration water quality data from six ISL operations in the western United States. These sites include:

- Irigaray/Christensen Ranch (Wyoming)

- Crownpoint (New Mexico)
- Crow Butte (Nebraska)
- Bison Basin (Wyoming)
- Smith Ranch/Highland (Wyoming)
- Ruth (Wyoming)

Based on this review, the Crow Butte site was selected for the estimate because of the proximity and similar geologic conditions to the project site, available water quality data, reasonable pore volume estimates to achieve restoration and overall restoration success. The water quality data for the Crow Butte site is extensive with baseline, post-production, post-restoration, and stabilization period data. Baseline water quality, post-production water quality, post-restoration average water quality and stabilization period average water quality data are provided in Table 6.1-2 for the Crow Butte Mine Unit No.1. Powertech (USA) may expect similar baseline and post-production water quality results at the project site. The results of the restoration at the Crow Butte site are discussed in Section 6.1.5.

Table 6.1-2: Crow Butte Post Mining Water Quality Data Summary

Parameter	Baseline Water Quality	Post-Mining Water Quality	Post-Restoration Average Water Quality	Stabilization Period Average Water Quality
BULK PROPERTIES				
Specific Cond.	1947	5752	1620	1787
pH	8.5	7.35	7.95	8.18
TDS	1170.2	3728	967	1094
CATIONS/ANIONS				
Alkalinity	293	875	321	347
Chloride	204	583	124	139
Sulfate	356.2	1128	287	331
TRACE METALS				
Manganese	0.11	0.075	0.01	0.02
Arsenic	0.002	0.021	0.024	0.017
Iron	0.044	0.078	<0.05	0.09
Lead	0.031	<0.05	<0.05	<0.01
Uranium	0.092	12.2	0.963	1.73
Vanadium	0.066	0.96	0.26	0.11
RADIONUCLIDES				
Radium-226	229.7	786	246.7	303

Notes: All units in mg/L except for pH (standard units), radium (pCi/L), and specific conductivity (μmhos/cm).

6.1.3 Groundwater Restoration Methods

For ISL operations, a common commercial groundwater restoration program consists of a restoration stage and a monitoring stage (stabilization phase). During restoration, groundwater will continue to be pumped from the well field, using a subset of wells that, during the production phase, functioned as either injection or production wells. The groundwater produced by these restoration wells, "restoration composite" (RC), will contain uranium and other constituents released during uranium production as well as residual lixiviant. Initial concentrations of these substances will be similar to those seen during production, but will decline gradually throughout the aquifer restoration phase until the restoration targets are achieved and the well field enters the stabilization phase.

Hydraulic control of the groundwater in a well field will begin with the first injection of lixiviant that marks the initiation of the production phase of operations. Hydraulic control will be continuously maintained at all times from the initiation of production operations until the beginning of the stabilization period following aquifer restoration in that well field. Hydraulic control will be accomplished by maintaining a cone of depression around each well field; this will be accomplished by pumping of production wells or where well field withdrawal flow rate will be greater than the well field injection flow rate , creating a well field bleed stream. The bleed stream flow rate (the difference between withdrawal and injection flow rates) is expected to be between 0.5-3% of the well field withdrawal flow rate.

Restoration will consist of the removal of six pore volumes, measured as RC flow. The net aquifer withdrawal, regardless of the restoration method used, is expected to average one percent (1%) of the nominal 500 gpm RC flow rate.

During aquifer restoration operations, and regardless of the particular method utilized for conducting aquifer restoration operations, all RC will be treated to remove contaminants as described in TR Section 6.1.9.

The aquifer restoration method to be utilized depends on the selection of waste water disposal method:

- If Class V disposal wells are selected for the disposal of wastewater, then reverse osmosis (RO) technology will be utilized and the method for aquifer restoration will be the "groundwater treatment" method.
- If land application is the selected method of waste water disposal, then RO technology will not be utilized and the "groundwater sweep" method will be utilized.
- If a combination of both deep disposal wells and land application is utilized for disposal of wastewater, then a combination of both aquifer restoration methods will be utilized.

During aquifer restoration operations, a subset of the total number of well field patterns in a well field will be selected for active restoration operations. During active restoration, RC will be withdrawn from each pattern at a typical flow rate of 20 gpm The number of patterns in active restoration at any time is limited by the total RC flow rate that can be withdrawn and processed. Following the completion of the restoration phase in any pattern, the flow of restoration composite utilized in that pattern will be shifted to another pattern, and this process will continue until groundwater restoration has been completed for all patterns in that well field. Well field patterns not in active restoration, i.e. not yet restored or previously restored, will be maintained under hydraulic control until the well field has successfully met the restoration goals for that well field and the stabilization phase for that well field has begun.

In order to minimize drawdown, Madison aquifer water will be injected as makeup water into well fields undergoing aquifer restoration operations. The amount of Madison aquifer water to be injected during aquifer restoration operations depends on the selection of aquifer restoration method. The use of Madison water is expected to accelerate restoration of the affected aquifer for both the "groundwater treatment" method and the "groundwater sweep" method. The water quality of the Madison is expected to be equivalent to, or better than the baseline conditions of the Inyan Kara aquifer. Madison wells will be drilled within the permit license boundary.

The revised restoration schedule appears in TR Section 6.1.5 (Figure 6.1-1) indicating that restoration may potentially be completed within 24 months for any given well field. For information on water balance during restoration, see TRSection 3.0.

6.1.3.1 Groundwater Treatment

In the groundwater treatment method, RC is treated by reverse osmosis and the RO reject stream is treated to remove radium and then disposed in Class V injection wells. The RO permeate stream, along with clean makeup water from the Madison aquifer, is reinjected into the well field undergoing restoration operations.

6.1.3.2 Groundwater Sweep

In the groundwater sweep method, the RC stream is treated to remove radium and disposed by land application, as described in TR Section 6.1.9. Clean makeup water from the Madison aquifer is injected into the well field undergoing restoration operations. In a groundwater sweep, the removal of groundwater causes native groundwater to flow into the ore body, thereby flushing the contaminants from areas that have been affected by the horizontal spreading of the lixiviant, including the flare.

6.1.3.3 Alternate aquifer bleed option

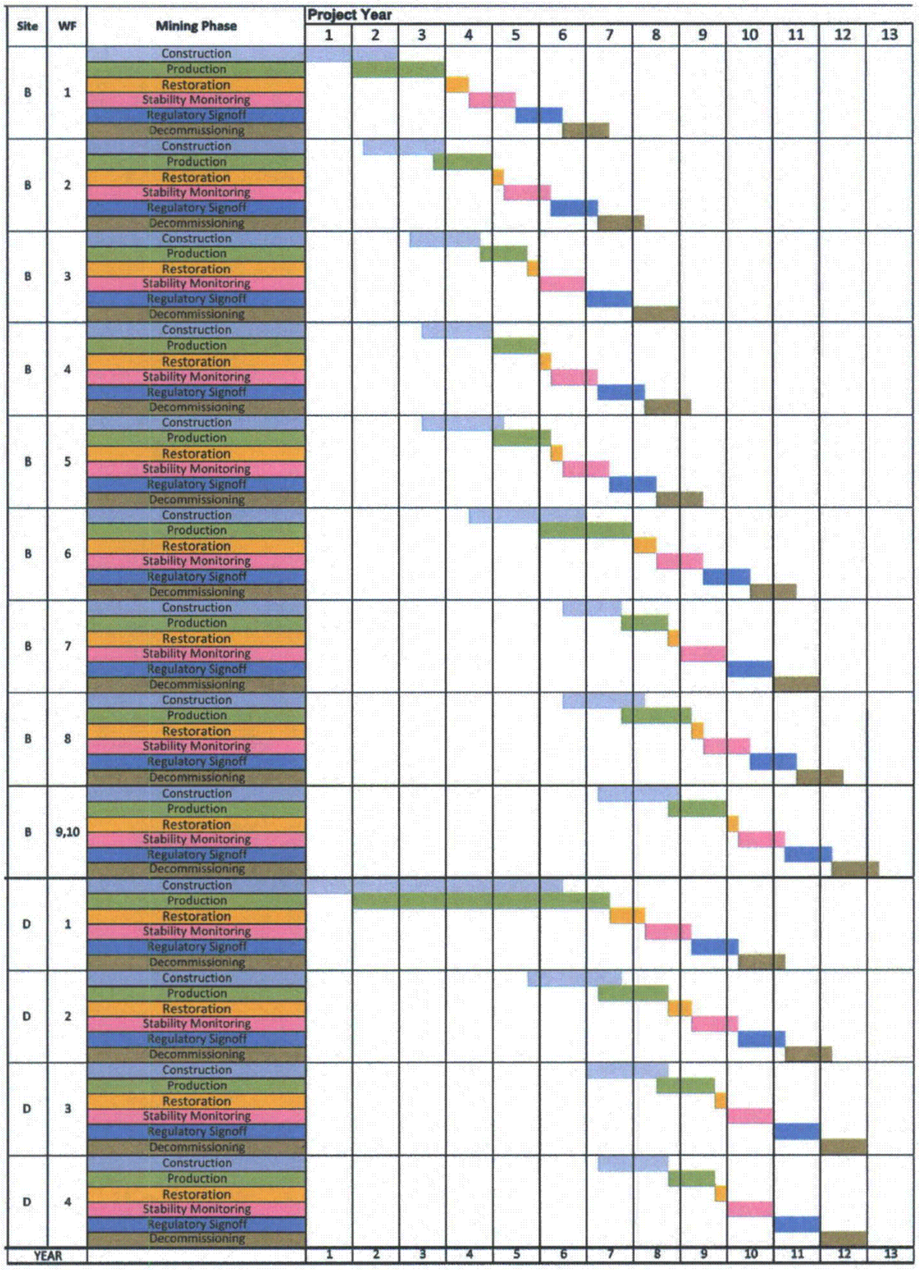
An alternate to the 1% aquifer bleed is also considered wherein a net aquifer withdrawal of up to one (1) pore volume of groundwater may be utilized to pull back flare. The net mean aquifer withdrawal rates under this alternate bleed option are expected to be less than 60 gpm from the Lakota aquifer and less than 40 gpm from the Fall River aquifer. The impacts to aquifer drawdown of these withdrawal rates is addressed in Appendix 6.1-A "Analytical Drawdown Impact Analysis of the Inyan Kara Aquifer Dewey-Burdock Uranium Project, Fall River and Custer Counties, South Dakota" (RESPEC, 2010)

6.1.4 Restoration Schedule

The proposed project restoration schedule, Figure 6.1-1, shows the estimated schedule for restoration. This is a preliminary schedule based on current knowledge of the area, and is based on completion of the production activities for both the Dewey and Burdock sites. As the project is developed, the restoration schedule will be further refined.

The PA is expected to involve fourteen well fields, with ten well fields at the Burdock site and four well fields at the Dewey site. A schedule of all phases of well field operations has been prepared that shows the expected duration of production, restoration, stability monitoring, regulatory approvals and decommissioning. The schedule is based on the expected flow rates during recovery and restoration operations, as well as on the estimated physical properties of the mineralized zones where ISL operations will occur. The well field schedule of aquifer restoration operations assumes that six pore volumes of restoration composite will be withdrawn during restoration with a flare factor of 1.44. The revised well field schedule is shown in Figure 6.1-1. As illustrated on this figure, it is expected that the aquifer restoration phase for each well field will be completed in less than two years. Should restoration efforts indicate a period longer than 24 months are necessary for restoration of a particular well field, Powertech (USA) will request NRC approval for the modification as an alternate schedule.

POWERTECH (USA) INC.



Schedule for Proposed Well Field Operations

Dewey-Burdock Project

DRAWN BY J. Munro

DATE 20-Dec-2010

FILENAME WellFieldOps.dwg

POWERTECH (USA) INC.

6.1.5 Effectiveness of Ground Water Restoration Techniques

The groundwater restoration methods described in this application have been successfully applied at other uranium ISL facilities in the US, including Irigaray/Christensen Ranch in Wyoming and Crow Butte in Nebraska.

6.1.5.1 Irigaray/Christensen Ranch

The Irigaray/Christensen Ranch ISL sites are located in the Powder River Basin approximately 50 miles to the southeast of Buffalo, Wyoming (USEPA, 2008). The ore mineralization occurs as a roll-front deposit in the Eocene Wasatch Formation.

Reverse osmosis was used to treat well field bleed water for use in restoration. Water quality of the Irigaray ore zone after production was measured by sampling each of the designated restoration wells and comparing results to baseline water quality data. Most of the 30 parameter concentrations in the post-production data exceeded the baseline means. Several of these parameters did not meet Restoration Target Values (RTV) established for the site (EMC, 2007).

Groundwater restoration results at the Irigaray/Christensen Ranch site were approved by the NRC and WDEQ following commercial operations and groundwater restoration at well fields 1 through 9. Post-production water quality in the nine production units was described above. Restoration water quality data were not available for this report. After restoration, twenty-seven of twenty-nine constituents were restored below the restoration target values as approved by the WDEQ using 9.5 to 18.4 pore volumes (USNRC, 2008). Bicarbonate and manganese were the only constituents that exceeded baseline ranges. However, WDEQ ruled that these constituents met the criteria of pre-production class of use. Therefore, the WDEQ determined that post restoration groundwater conditions did not significantly differ from the background water quality and groundwater, as a whole, had been returned to its pre-production class of use. In 2006, the NRC concurred with WDEQ's determination that groundwater restoration was complete at the site.

6.1.5.2 Crow Butte

The Crow Butte ISL site is located in Dawes County Nebraska just southeast of the town of Crawford (Collins and Knode, 1984). Roll-front ore deposits are concentrated in the Basal Chadron Sandstone, which is a member of the Paleocene White River Group. Coffinite is the major uranium mineral associated with the deposit. Matrices minerals include quartz, feldspar, mafic minerals, pyrite, and clays.

Restoration of commercial Mine Unit No. 1 took approximately five years after beginning in 1994 (USNRC, 2007b). The restoration process consisted of groundwater transfer (0.89 pore volumes), groundwater sweep (0.09 pore volumes), groundwater treatment with IX (26.62 pore volumes), groundwater treatment with reverse osmosis (6.02 pore volumes) and well field recirculation (2.85 pore volumes). Thus, a total 36.47 pore volumes was processed in the restoration steps listed above (Crow Butte Resources, 2000). The NRC originally denied restoration approval for Mine Unit No. 1 due to concentrations of ammonium, iron, radium-226, selenium, total dissolved solids, and uranium that showed increasing trends during the six-month stability monitoring period. Therefore, the NRC requested additional stability monitoring for these parameters which was performed and submitted by Crow Butte Resources (Crow Butte Resources, 2001). The NRC then approved the restoration of Mine Unit No. 1 in 2003 (USNRC, 2007b).

The NRC approved the completion of groundwater restoration program for Well field No. 2 after the removal of approximately 19 pore volumes and recirculation of approximately 16.4 pore volumes (USNRC, 2007b).

6.1.6 Environmental Effects of Groundwater Restoration

Based on the success of groundwater restoration at other ISL facilities, Powertech (USA) expects that the proposed groundwater restoration techniques will be successful at returning the production zones within the PAA to restoration target values. The purpose of restoring the groundwater to these indicator parameters is to protect USDWs adjacent the aquifer exemption boundary. Powertech (USA) believes that by using proven best practicable technology for groundwater restoration combined with federal and state regulatory requirements will ensure that potential impacts to groundwater quality outside the production zone are mitigated.

The preferred method of restoration consists of using the groundwater treatment method with RO reject brines being disposed in a Class V disposal well located in the Minnelusa aquifer within the permit boundary. This method minimizes the amount of groundwater that will be consumed during restoration, and minimizes the surface disturbance to land within the permit boundary. It further eliminates the need for additional processing facilities, beyond RO, to concentrate and remove radium and other contaminants prior to land application. Disposal of wastewater in deep disposal wells is the best practicable technology and is the standard method used at most ISL uranium mines. The alternate method of land application would consume more groundwater since none of the restoration water would be recycled to the well field, but would be used in a once-through process leading to land application.

The proposed restoration methods will consume groundwater. Groundwater recovered during groundwater restoration is typically disposed of directly in the wastewater system. Consumption of groundwater is an unavoidable consequence of groundwater treatment; potential impacts and water usage during operations is discussed in more detail in Section 7.2.5.1.

6.1.6.1 Effectiveness of Groundwater Treatment Method

The preferred aquifer restoration method is groundwater treatment by reverse osmosis with deep well disposal of the RO reject brine. In this method of aquifer restoration, the removal of restoration composite is balanced by the flow of makeup water from three distinct sources: i) the flow of native (Inyan Kara) groundwater into the well field; ii) the reinjection of RO permeate; and, iii) the injection of Madison aquifer reclamation water. Historical record below indicates the groundwater treatment method is preferred and effective.

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 wellfield water quality at the end of mining, groundwater sweep, RO and stabilization monitoring are attached. Plots of TDS for MU3, MU5 and MU6 (Figures 5-7, 5-8 and 5-7, from the respective Mine Unit Data Packages of the CRWR), indicate minimal improvement following groundwater sweep at MU3 and MU5 and an actual increase 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 (Figures 5-12 and 5-13 from the respective Mine Unit Data Packages of the CRWR), 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 this 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. In some cases, RO was continued longer than necessary or at least longer than any improvements to water quality were occurring. A review of the uranium and conductivity trend plots from the Irigaray recovery wells during restoration (included in the Irigaray Mine Wellfield Restoration Report (COGEMA 2004) show this to be the case. Figures 4-4 through 4-7 from the Irigaray report show that RO was often continued for several PVs beyond the point that water quality had stabilized. The additional PVs of RO resulted in no direct benefit to aquifer water quality and only resulted in consumptive use of the groundwater resources. RO typically results in disposal of approximately 20 percent of the recovered groundwater with reinjection of the remaining 80 percent following treatment.

Terminating RO once water quality has stabilized will minimize the consumptive use of groundwater and reduce the number of PVs of treatment. (Uranium One, 2009)

Groundwater treatment via reverse osmosis is well documented as an effective technology:

Ruth R & D Project was a Wyoming pilot test conducted by Uranerz U.S.A., Inc. in the early 1980s. The ore body represented a typical roll front type deposit with uranium below surface ~ 160 meters. Groundwater restoration began in February of 1984. Groundwater sweep started out as the primary restoration method and was terminated due to water consumption issues. The groundwater restoration was accomplished by utilizing reverse osmosis technology. By September 1984 end, TDS was successfully lowered a few heavy metals needed to be reduced in concentration after the seven months of restoration efforts. A reductant phase was initiated in November of 1984 and continued for duration of 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 a success (Catchpole and Kuchelka, 1993).

See also the discussion of how the Crow Butte R&D Project utilized RO and "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 ISL mining operations" (Catchpole and Kuchelka, 1993).

Bison Basin Commercial ISL Uranium Mine is another example of a successful restoration project utilizing RO technology. "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" (Catchpole and Kuchelka, 1993).

SD DENR demonstrates the state's views on reverse osmosis technology by incorporation of a point system classification for water treatment plants into their administrative rules whereby, a water treatment plant can be awarded "Fifteen points where equipment is provided for treatment of the water by reverse osmosis..."(ARSD 74:21:02:61). ARSD 74:21:02:60 indicates "Fifteen points if reverse osmosis ... is provided as advanced waste treatment".

LAC Minerals (USA), LLC (Richmond Hill Mine), treated about 4.7 million gallons with a reverse osmosis unit and discharged by the end of the 2002. Ground water impacted by acid mine drainage prior to mine reclamation is steadily improving. Monitoring wells generally show decreasing trends in sulfate and metal concentrations and increasing pH. Biological assessments of a creek below the mine show that the stream remains healthy and supports a viable cold water fishery (SD DENR, 2002).

In a Board of minerals and Environment meeting in January 2009, it is important to note that Wharf Resources (USA) Inc. water treatment process included the use of reverse osmosis to account for removal of metals. It is recorded within the meeting minutes that "use of the reverse osmosis unit also made the (surety) calculation more conservative" with regard "Mining Issues" put before the Board (SD Board of Minerals and Environment, 2009).

6.1.7 Groundwater Restoration Monitoring

6.1.7.1 Monitoring During Active Restoration

During aquifer restoration phase of operations, the mined zone will be monitored on a frequency sufficient to determine the success of restoration, optimize the efficiency of restoration and determine if any areas of the well field need additional attention. At the beginning of 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.

6.1.7.1.1 Criteria to Establish the Success of Aquifer Restoration

The primary goal of the groundwater restoration phase will be to return the groundwater quality of the production zone, on a well field average, to the preoperational (baseline) water quality conditions using Best Practicable Technology (BPT). The PA will attempt to return the concentrations of the monitored water quality indicator constituents of Table 6.1-1 to within the baseline range of statistical variability for each constituent (NRC, 2003: §6.1.3(3)). Within the production zone, the water quality parameters will be evaluated on measurements made on groundwater samples drawn from the same subsets of wells that were sampled for the determination of baseline conditions. Success of restoration will therefore be evaluated on well field zone-wide values, on a parameter by parameter basis. Restoration shall be demonstrated in accordance with NUREG-1569 Section 6.

In some instances, residual elevated concentrations may remain following restoration. These residual elevated concentrations, also known as 'hot spots,' will be identified by an individual sampling well concentration that exceeds the wellfield mean concentration by three (3) standard deviations. If a hot spot is identified using this criterion, 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, but is not limited to, trend analysis, solute transport modeling, collection of extra water samples, or analysis of added parameters to assess post-restoration redox conditions. Based on the results of the analysis, additional restoration would be conducted as needed to ensure the protection of water quality outside the exempted aquifer.

6.1.7.1.2 Monitoring During Aquifer Restoration

During restoration, lixiviant injection is discontinued and the quality of the groundwater is constantly being improved. As a result, the possibility of elevated UCLs is greatly reduced. The monitor ring wells, overlying aquifer wells, and underlying aquifer wells will be sampled once every 60 days and analyzed for the indicator parameters of chloride, total alkalinity (or bicarbonate), and conductivity. Water levels at these wells are also obtained prior to sampling. The NRC will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event due to unforeseen conditions such as snowstorms, flooding, and equipment malfunctions.

In the event that UCL(s) are exceeded within a well, corrective actions will be taken, as described in TR Section 3.1.3.1.2, and the sampling frequency in that well will be increased to bi-weekly.

6.1.7.2 Restoration Stability Monitoring

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. The criteria to establish restoration stability will be based on well field averages for water quality.

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 two months for the UCL indicator parameters of chloride, total alkalinity (or bicarbonate), and conductivity. In the event UCL are exceeded during stability monitoring, the well field will, as soon as reasonably possible, be returned to aquifer restoration status, with corrective actions to be taken to reduce the UCL concentration as described in TR Section 3.1.3.1.2.1. 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, and 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 will meet the target restoration goal established for that parameter from baseline sampling, as described in TR Section 6.1.1 or a secondary RTV based on restoring the water to class of use (NUREG-1569; §6.1.3(4)(b), 2003). In addition, the mean and range data from successive tests will be examined for statistical evidence of an oscillating or increasing concentration trend. If either oscillating or increasing trends are confirmed, an evaluation of the cause will be conducted and corrective actions will be taken.

6.1.8 Well Plugging and Abandonment

Well Replacement

Plugging and abandonment procedures are applicable to any well determined to need replacement. Well replacement determination is based upon whether or not the well: i) poses a risk for aquifer contamination (determined via water quality analysis results and well field delineation pump test(s)), ii) poses a safety risk for humans and/or animals (determined by physical condition), iii) potentially could interfere with control of a well field (determined via well field delineation pump test(s)), and iv) if the integrity of the well is compromised and will not pass testing requirements (determined by MIT). If wells are located that require plugging and abandonment the steps below will be utilized to protect public health and the environment.

Prior to plugging, each well will undergo mechanical integrity testing (MIT) to demonstrate the integrity of casing and cement that will be left in the ground after closure. Alternatively, cementing records or other evidence (such as cement bond logs) will be used to show that an adequate quantity of cement is present to prevent upward fluid movement within the borehole outside of the casing. If it cannot be verified that a well casing is grouted properly, an effort will be made to plug the annulus from the bottom of the annulus to the ground surface, using the same materials required for plugging the inside of the casing as described below.

Wells will be opened and debris and downhole equipment such as the tubing, pumps and screens will be removed to prevent obstacles from interfering with plugging operations. The wellhead and casing will be removed to three (3) feet below ground surface. A tremie pipe will be used to add grout to wells that are more than 40 feet deep.

Injection, extraction and monitoring wells that are completed into a confined aquifer or multiple aquifers will be plugged with bentonite grout provided the weight of the bentonite grout column will be sufficient to overcome the bottom hole pressure. If bentonite grout will not be sufficient, cement grout will be placed from the bottom of the well to within eight (8) feet of the ground surface. Cement grout will be placed from eight (8) feet below ground surface to within three (3) feet of the ground surface. The top three (3) feet of the well will be backfilled with native material and reclaimed. If a tremie pipe cannot be lowered inside the well-casing for grout placement a tight connection will be made to the top of the casing in order to pump a sufficient volume of cement grout down to fill the well, under pressure. Bentonite grout will not be used if the tight connection method is used. Figure 6.1-3 shows a generalized schematic of a plugged and abandoned well completed into a confined aquifer or multiple aquifers.

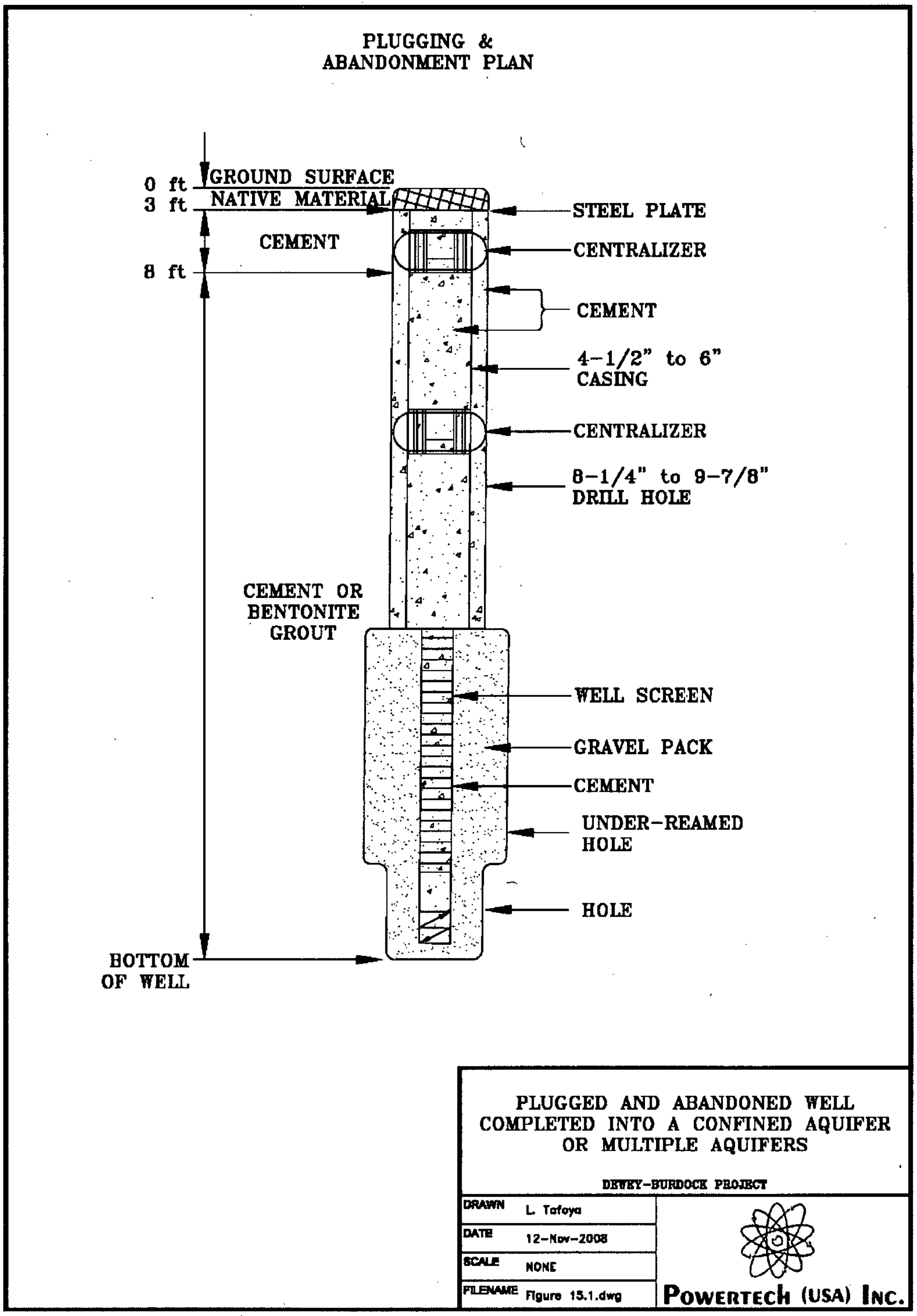


Figure 6.1-1: Plugged and Abandoned Well Completed into a Confined Aquifer or Multiple Aquifers

Wells completed into an unconfined aquifer where a single aquifer is encountered will be backfilled with clean sand or gravel to the top of the aquifer. Above the aquifer, clay, bentonite grout, or cement grout will be used for plugging to within at least 3 feet of the ground surface. If clay is used as the backfill material, a minimum of 2-feet of dry bentonite, bentonite grout, or cement grout will be placed at the top of the aquifer. The top 3-feet of the casing or hole, if not filled with clay, bentonite grout, or cement grout will be backfilled with native material and reclaimed. Figure 6.1-4 shows a generalized schematic of a plugged and abandoned well completed into an unconfined aquifer.

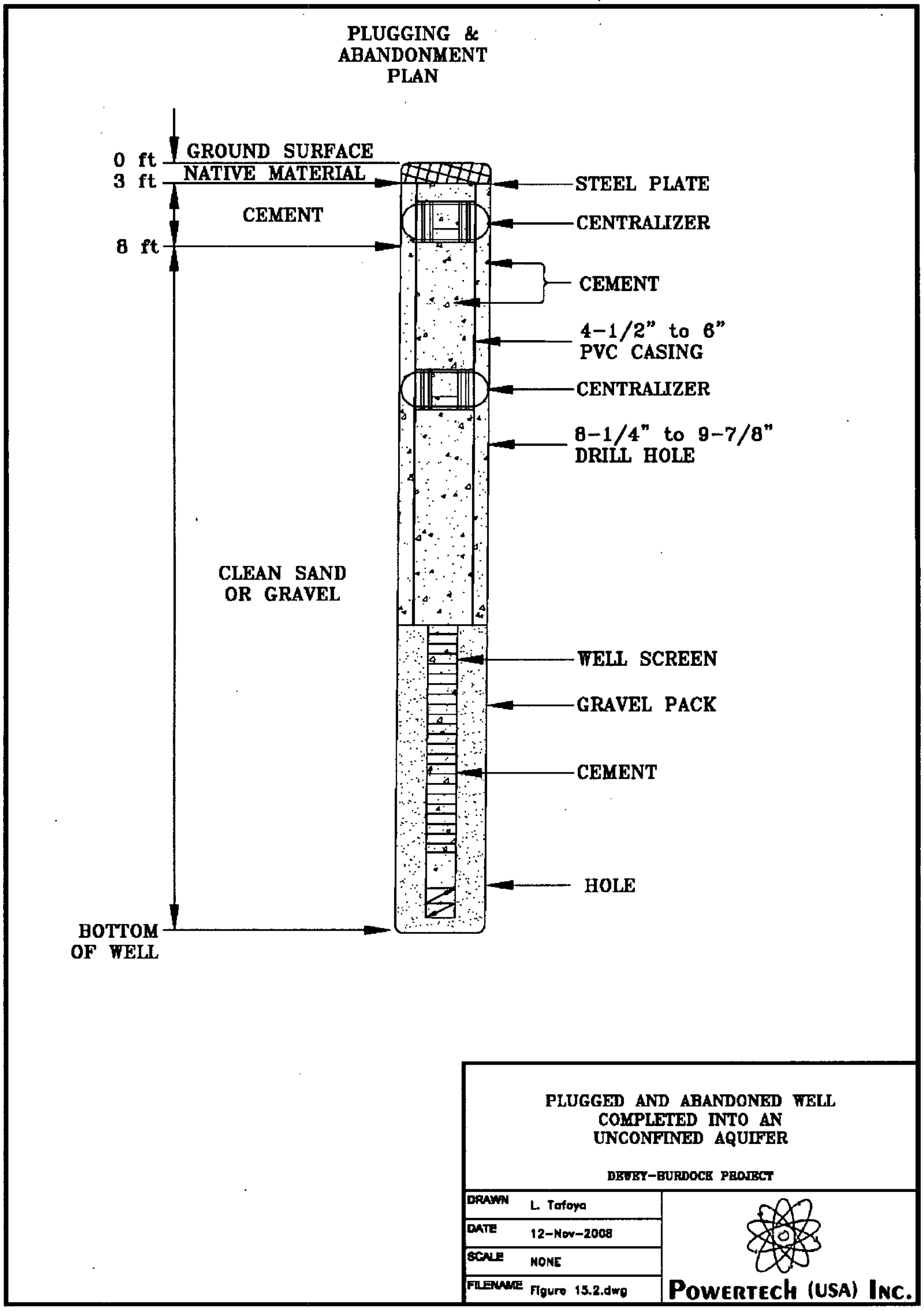


Figure 6.1-2: Schematic of Plugged and Abandoned Well in an Unconfined Aquifer

Bentonite grout, composed of commercially manufactured sodium bentonite material specifically formulated for well casings, will be mixed according to manufacturer's recommendations and will contain a minimum of 20 percent solids by weight and have a minimum slurry density of 9.4 pounds per gallon. Cement plugs will consist of neat cement grout prepared in the same manner as used for well construction. Specifically, cement grout will be composed of high sulfate resistant Portland cement using no more than 6 gallons of clean water for each 94-pound sack of cement to yield a slurry weight of approximately 13 pounds per gallon. Water used to make the cement grout will not contain oil or other organic material. Cement grout may contain as much as 2 pounds of bentonite per 94-pound bag of cement. Up to 7 gallons of clean water may be added when 2 pounds of bentonite are added per 94-pound bag of cement.

Grout will be allowed to set for approximately 24 hours in the borehole. If the grout settles less than 40 feet below ground surface the top of the well will be sealed with additional grouting material as described above. If the grout settles more than 40 feet below ground surface, additional grout will be introduced on top of settled grout through a tremie pipe.

A steel plate will be placed on top of the sealing mixture with the permit number, date of plugging and well identification number clearly displayed. The tag will be affixed to the top of the plug at a minimum depth of 2 feet below ground surface. The locations of the abandoned wells will be identified by recording the boundaries of each well field and the location of the monitor well ring around each well field as a deed notice with the appropriate county.

Wells in which water is not encountered or only low-permeability formations such as clays, shales, or till are encountered will be backfilled with material free of contamination. In order to restore the natural conditions as much as possible, the fill will have a permeability less than or equal to the permeability of the formations encountered.

6.1.9 Restoration Wastewater Disposal

As noted earlier, the method selected for wastewater disposal will determine the method of groundwater restoration. The preferred disposal option is to dispose of wastewater by injection into Class V disposal wells completed within the Minnelusa or Deadwood formation(s) (SR Section 4.2). If disposal wells are either unavailable or have insufficient capacity, then the land application method of wastewater disposal will be utilized either alone or in parallel with the deep disposal well option. Wastewater to be disposed of includes RO reject water, barren restoration water, production bleed streams, waste resin transfer water, CPP wastewater including spent elution brines and wash-down water, well field development wastewater including pump test water and well development and maintenance wastewater.

The wastewater disposal options and the associated treatment are depicted in Figure 6.1-5 where the stream identifiers I and N are consistent with the identifiers on the water balance diagram provided in Figure 3.1-7. A separate surge pond (not shown) will be available at each site with a deep disposal well option for the temporary storage of wastewater that is barren of uranium and other metals, but contains radium that will be removed in the radium removal ponds. For the land application disposal option, the storage ponds will provide surge capacity. As indicated in the project water balance in Figure 6.1-5 the flow rate of wastewater will depend on the choice of wastewater disposal option, as well as on the actual aquifer bleed rates during both recovery and restoration operations. The final design may entail both deep well disposal and land application systems if the completed Class V disposal wells have insufficient disposal capacity.

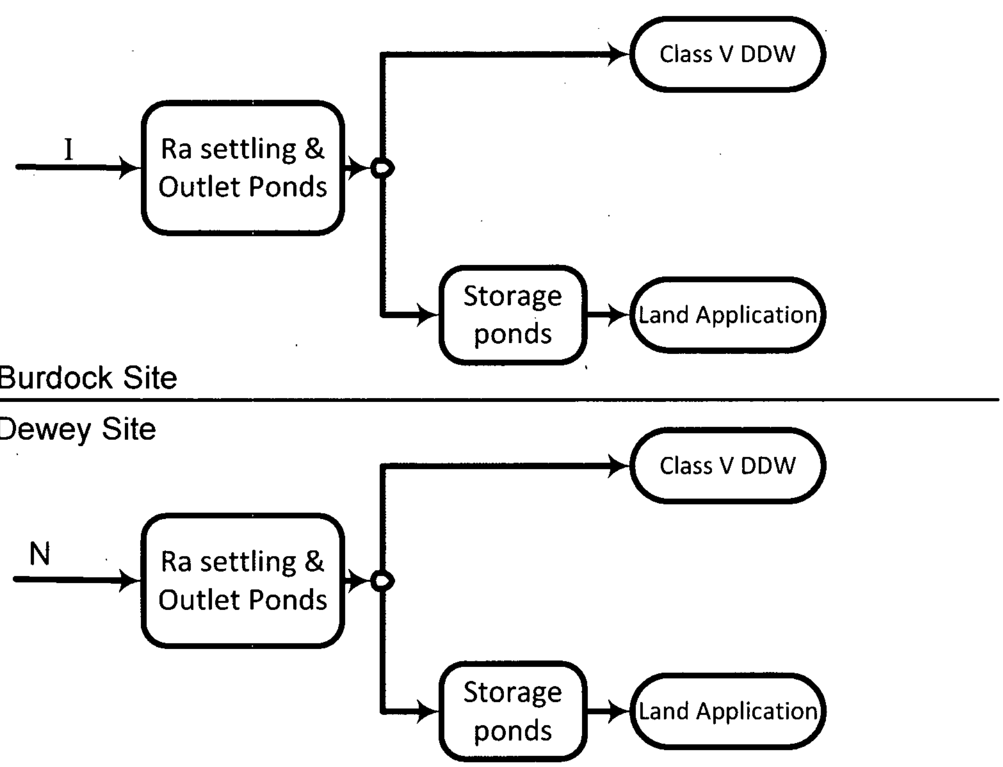


Figure 6.1-3: Project Wastewater Disposal Options and Associated Treatment

Regardless of the option chosen for wastewater disposal, groundwater removed during aquifer restoration operations will first be treated to remove uranium and other dissolved species by ion exchange, the purified effluent of which forms the barren restoration composite (BRC). With the deep disposal well option, the BRC exiting the ion exchange step is treated by RO; the resulting RO reject brine, after subsequent removal of radium, will be suitable for injection via the disposal wells; with the land application option, the entire BRC stream will be treated to remove radium and disposed of by applying it to the surface of the ground for evaporation and possible agricultural irrigation.

With the deep disposal well option, Class V disposal wells will be located within the permit license boundary and therefore within the state of South Dakota. A restoration flow diagram with the deep disposal well option is shown on TR Figure 6.1-4. The proposed locations of the first four disposal wells are shown on Figure TR_RAI-P&R-13-1. Two of these first four wells will be located in the vicinity of the Burdock Central Processing plant and two will be in the vicinity of the Dewey Satellite Facility. The two wells at each site will consist of one well completed in the Deadwood formation and one well completed in the Minnelusa formation. The proposed tentative locations for wells 1-4 are listed below. The locations of subsequent wells are yet to be determined.

Site 1: NE ¼ of NW ¼ of SW ¼ of Section 2, T7S, R1E
DW No. 1: Lat: -103.971938654 Long: 43.469772181
DW No. 2: Lat: -103.971859557 Long: 43.4696483743

Site 2: SE ¼ of NW ¼ of SW ¼ of Section 29, T6S, R1E
DW No. 3: Lat: -104.031570321 Long: 43.4971737527
DW No. 4: Lat: -104.031436264 Long: 43.4970792287

In the land application method of wastewater disposal, wastewater will not be treated by RO and will flow directly from ion exchange treatment to the radium removal treatment, followed by seasonal storage if necessary, and then application to the land via center pivot irrigation systems as described in TR Section 4.2.2.1.

Radium will be removed from wastewater streams by precipitation with barium chloride. A small amount of barium chloride solution will be mixed with the wastewater. The naturally occurring sulfate within the wastewater will chemically bond with the barium and radium, causing barium sulfate and radium sulfate to co-precipitate. If sulfate levels are low, sulfate ions may be added prior to the barium addition step by the injection of an ammonium sulfate solution. The wastewater stream will then be directed to a radium settling pond where the insoluble precipitate will settle out. The supernatant water from the pond will be suitable for injection in the Class V disposal wells or for land application via a number of center-pivot irrigation sprinkler systems as described in TR Section 3.1.6 and TRS Section 4.3. The radium-bearing pond sludge will accumulate in the ponds and will periodically be removed for disposal at an NRC approved facility for 11e.(2) byproduct materials. A restoration flow diagram with land application is shown on TR Figure 6.1-5.

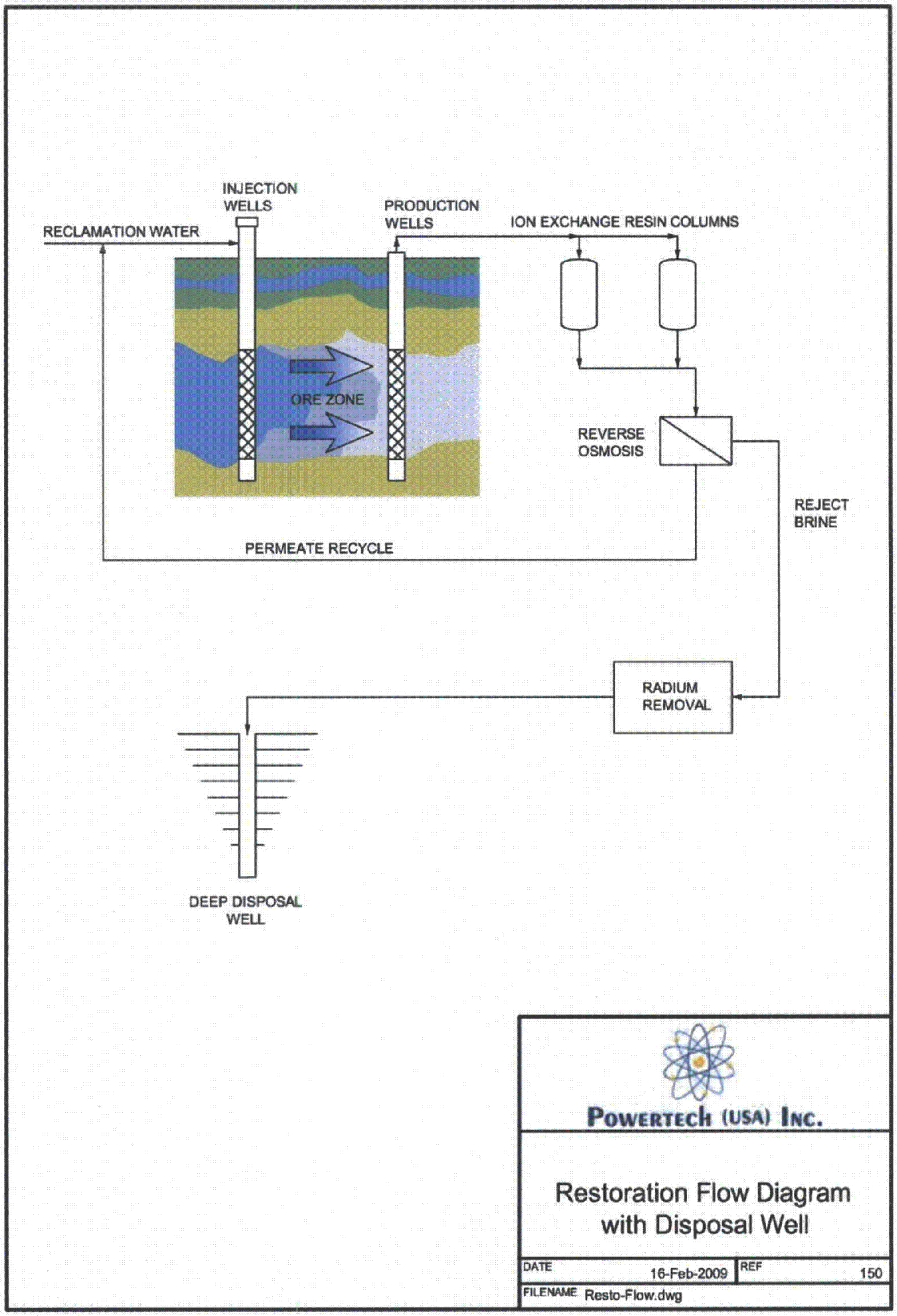


Figure 6.1-4: Restoration Flow Diagram with Disposal Well

Powertech (USA) Inc.

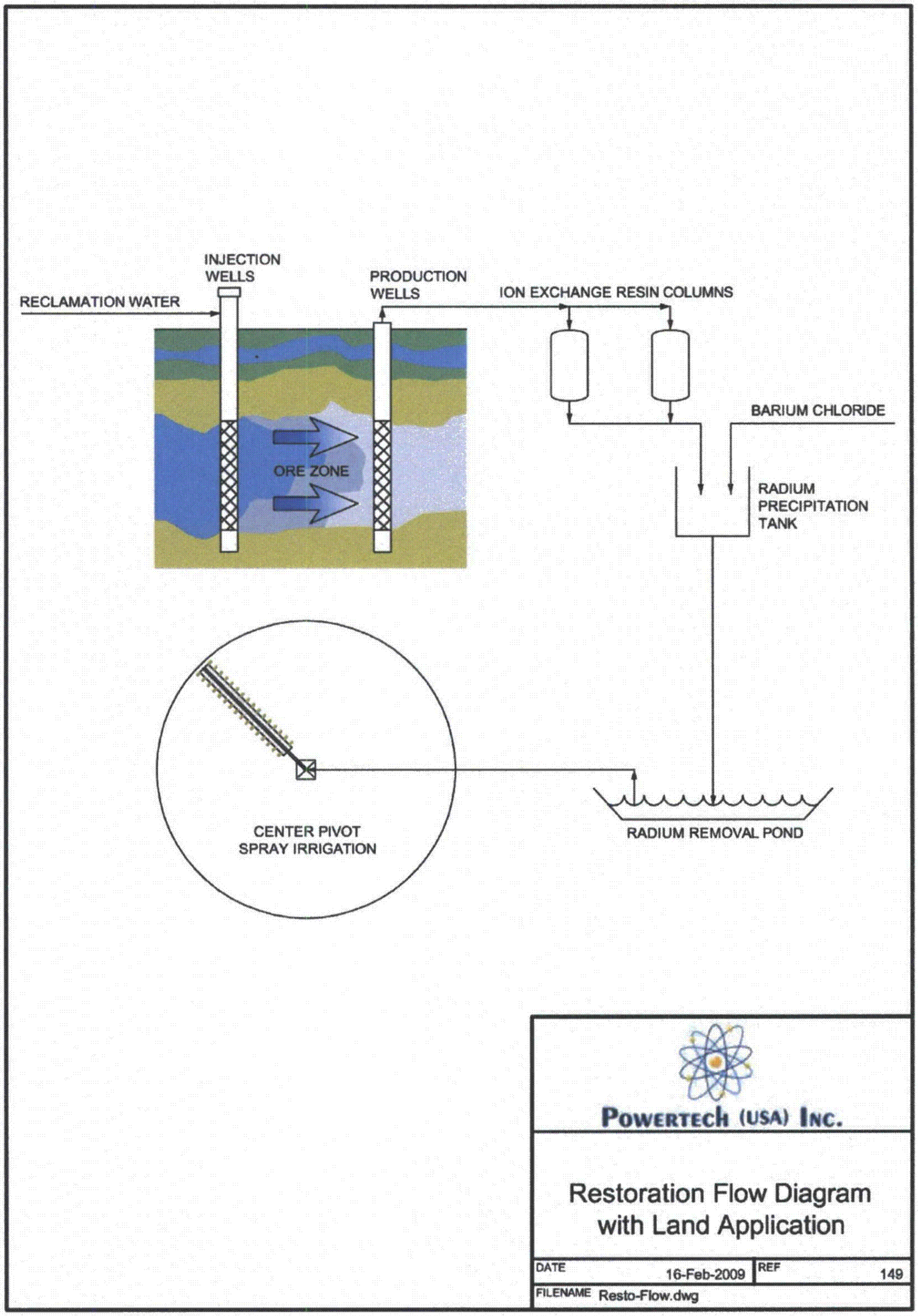


Figure 6.1-5: Restoration Flow Diagram with Land Application

ANALYTICAL DRAWDOWN IMPACT ANALYSIS OF THE INYAN KARA AQUIFER DEWEY-BURDOCK URANIUM PROJECT, FALL RIVER AND CUSTER COUNTIES, SOUTH DAKOTA

Topical Report RSI-2174

prepared for

Powertech (USA) Inc.
310 2nd Avenue
Edgemont, South Dakota 57735

November 2010

RESPEC
CONSULTING & SERVICES

ANALYTICAL DRAWDOWN IMPACT ANALYSIS OF THE INYAN KARA AQUIFER DEWEY-BURDOCK URANIUM PROJECT, FALL RIVER AND CUSTER COUNTIES, SOUTH DAKOTA

Topical Report RSI-2174

by

Crystal M. Hocking

RESPEC
P.O. Box 725
Rapid City, South Dakota 57709

prepared for

Powertech (USA) Inc.
310 2nd Avenue
Edgemont, South Dakota 57735

November 2010

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Calculations were conducted to estimate the drawdown impacts to the Inyan Kara Aquifer in the vicinity of the Dewey-Burdock in situ recovery project. These analytical calculations were prepared to supplement existing drawdown calculations.

This report is organized to optimize available information and understanding of the potential drawdown impacts. Chapter 2.0 provides information on the methods used to predict drawdown. Chapters 3.0 and 4.0 provide results of calculations for the Lakota Aquifer and the Fall River Aquifer, respectively. Conclusions are provided in Chapter 5.0 with references in Chapter 6.0. Information contained in other interrelated reports are referenced as appropriate.

2.0 DRAWDOWN PREDICTION METHODS

2.1 PREDICTION APPLICATIONS

Drawdown predictions for both the Lakota and Fall River Aquifers were calculated using two different applications, all using the Theis analytical solution for confined aquifers. Assumptions of the Theis solution (as presented in Powertech [2009a]) include:

- The aquifer is homogeneous and isotropic.
- The aquifer is confined with uniform thickness and has an infinite extent.
- No recharge to the aquifer occurs.
- The pumping well is fully penetrating and receives water from the full thickness of the formation.
- All water removed from the well comes from aquifer storage which is released instantaneously when the head is lowered.
- The piezometric surface is horizontal before pumping.
- The well is pumped at a constant rate.
- The pumping well diameter is small so wellbore storage is negligible.

Using both applications, drawdown was predicted at 22 Inyan Kara wells, 11 in each the Lakota and Fall River Aquifers. The locations of these wells are presented in Appendix A. These wells were chosen for their spatial distribution across the project site with special emphasis on selecting domestic water supply wells. Additional information about these wells is available in Appendix 2.2-A of the NRC Technical Report (TR) [Powertech, 2009b].

2.1.1 <u>Application 1</u>

The first application used in this study involves a simple calculation of drawdown using the Theis equation in a spreadsheet developed by the U.S. Geological Survey (USGS) [Halford and Kuniansky, 2002]; this method was used in the drawdown calculations provided to the Nuclear Regulatory Commission (NRC) in the Environmental Report (ER) Section 4.6.2.6 [Powertech, 2009a]. As in the ER, the outcrop was assumed to be a straight-line barrier boundary and was modeled with "image" pumping wells. The location of this barrier boundary is slightly shifted and rotated from the original calculations to best represent the outcrop locations across the site. Original outcrop boundaries follow more closely just the outcrop at the north end of the project area. The locations of the outcrop barrier boundaries are shown in Figures A-1 and A-2 in Appendix A. The Lakota boundary in this study is about 3,400 feet east of the Fall River boundary, compared to a 4,000-foot offset in the calculation used in the ER Section 4.6.2.6 [Powertech, 2009a].

This spreadsheet application was used for the purpose of mimicking the process used in drawdown estimates already presented in the NRC permit application. However, this method of analysis is limited and time consuming. The spreadsheet is not capable of rapidly predicting drawdown versus time curves in situations where multiple barrier boundaries and multiple pumping wells are present. For this reason, a second predictive application was chosen.

2.1.2 Application 2

The second application involved predicting drawdown using Theis' equation in **AQTESOLV**, Version 4.0 [HydroSOLVE, 2006], a software program used for analysis of aquifer tests. Final calculations in **AQTESOLV** used the same input information with the exception that both the outcrop and the Dewey Fault served as barrier boundaries. Most available hydrogeologic information indicates that the Dewey Fault acts as a barrier boundary to groundwater flow in the Inyan Kara Aquifers (Boggs [1983]; Powertech [2009b]). As a result of the fault boundary, predicted drawdown values would be more representative of actual conditions. Note that for this study, the barrier boundary along the Dewey Fault had to be rotated a few degrees from the exact fault orientation as **AQTESOLV** requires two barrier boundaries be orthogonal to one another.

2.2 AQUIFER PROPERTIES

Aquifer properties used in these calculations mirror those used in the ER. Transmissivity and storativity values were derived from aquifer tests conducted in 1979, 1982, and 2008. Values used in this analysis are provided in Table 2-1. These values represent the median (2008 tests) and average (1979 and 1982 tests) properties obtained from multiple observation wells; for a complete description of these tests and associated aquifer properties please refer to Tennessee Valley Authority (TVA) reports [Boggs and Jenkins, 1980], Boggs, 1983, and Powertech, 2009b]. Applications 1 and 2 calculate estimated drawdown using each of these aquifer property scenarios at pumping rates of 20 gallons per minute (gpm). Application 2 calculations done with higher pumping rates used only aquifer properties listed under Scenario 1 and 5 (Table 2-1), as these values are believed to be the most representative of the aquifer in proximity of proposed mining operations.

2.3 PUMPING RATES

Based on water consumption estimates, 99 percent of Inyan Kara water usage near Burdock will be derived from the Lakota Aquifer (Table 2-2). Near Dewey, about 75 percent of the Inyan Kara water usage will be derived from the Fall River Aquifer. For simplification, it is assumed that all pumping in the Lakota Aquifer occurs at the site of the May 2008 pump tests at the Burdock site, and pumping in the Fall River Aquifer occurs at the site of the May 2008 pump tests at the Dewey site. As a result of this simplifying assumption, predicted drawdown values for Lakota Aquifer wells may be slightly lower than expected, while predicted impacts to Fall River Aquifer wells will be conservatively higher.

Table 2-1. Transmissivity and Storativity Values Used in Drawdown Predictions

Scenario No.	Date/Conductor	Transmissivity (ft^2/day)	Storativity (ft/ft)
Lakota Aquifer Tests			
1	1979–TVA	190	1.8×10^{-4}
2	1982–TVA	590	1.0×10^{-4}
3	2008–Powertech	150	1.2×10^{-4}
Fall River Aquifer Tests			
4	1979–TVA	54	1.4×10^{-5}
5	2008–Powertech	255	4.6×10^{-5}

Table 2-2. Relative Quantities of Water by Site and Aquifer

Item	Units	Lakota		Fall River		Total	
		Value	%	Value	%	Value	%
Based on Number of Production Wells (PWs)							
Burdock	PWs	880	98.9	10	1.1	890	100.0
Dewey	PWs	153	27.9	395	72.1	548	100.0
Project Total	**PWs**	**1,033**	**71.8**	**405**	**28.2**	**1,438**	**100.0**
Average Water Usage							
Burdock			**99.0**		**1.0**		**100.0**
Dewey			**25.3**		**74.7**		**100.0**

In the AQTESOLV application, real-world coordinates for observation wells were used as input. To represent the initial well fields, a single pumping well was also used in this application; however, actual operating procedures will involve the extraction from a number of evenly distributed wells over the entire area of a wellfield (about 2,000 to 3,000 acres). In an effort to determine the effect that a single pumping well versus the multiple wells in a wellfield would have on drawdown values, a calculation was also ran where ten randomly placed wells would pump a total of 20 gpm. Preliminary data indicate that drawdown results at nearby domestic wells are at such a distance that the use of a single pumping well is sufficient to model a well field (Figure 2-1). Values for single versus multiple pumped wells were typically ± 0.3 feet. Note this simplifying assumption would not be adequate to determine drawdown in or within close proximity of an active well field.

RSI-1853-10-073

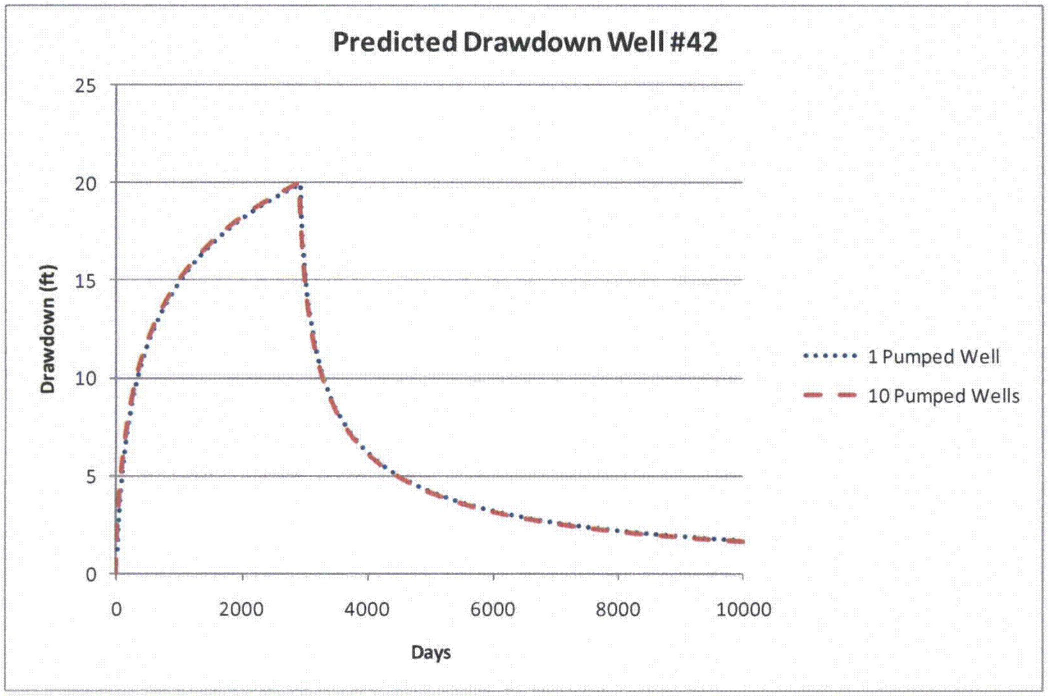


Figure 2-1. Comparison of Predicted Drawdown With One Versus Ten Pumped Wells in a Wellfield.

For calculations described under Application 1, the median bleed case of 1 percent of 2,000 gpm (20 gpm) was used. For Application 2 impact calculations, the bleed case was varied. For the Lakota Aquifer, impact calculations in this study were prepared for wellfield pumping rates of 20, 60, and 120 gpm cases. For the Fall River Aquifer, calculations were prepared for pumping rates of 20, 40, and 60 gpm.

Calculations for Application 1 were done for an active pumping period of 8 years. Application 2 calculations are performed for an active pumping period of 8, 14, and 20 years. It is anticipated that active mining will occur for 8 to 14 years. A time frame of 20 years was also included as restoration activities may be ongoing until that time as well as the fact that water rights permits are assigned on a 20-year basis. If operations were to continue longer than 20 years, drawdown impacts would need to be reevaluated in the future.

3.0 LAKOTA AQUIFER DRAWDOWN PREDICTIONS

3.1 APPLICATION 1

Drawdown estimates for 11 Lakota aquifer wells in the Dewey-Burdock area, based on the Theis spreadsheet analysis, are presented in Table B-1 of Appendix B. Distances from the pumping well range from 6,765 feet (Well # 619) to 32,075 feet (Well # 96).

Predicted drawdown values are greatest at wells closest to the pumping well and for the scenario using the 2008 pumping test aquifer properties (highest transmissivity). The highest drawdown value predicted at the end of 8 years of pumping is 18.3 feet (Well #16). The furthest well (# 96) has a maximum predicted drawdown of 7.6 feet.

In the ER Section 4.6.2.6, drawdown was predicted for only the nearest Lakota domestic well (# 13) at 8 years' time and using Application 1. Comparisons of results from the ER Section 4.6.2.6 [Powertech, 2009a] to results from this analysis are provided in Table 3-1. Results from this investigation are within about 10 percent of those from the previous investigation. Deviations are the result of differences in placement of the barrier boundary (outcrop) line. This comparison demonstrates that these drawdown predictions are consistent with those derived from previous investigations.

Table 3-1. Well # 13 Drawdown Comparison of Results in Environmental Report (ER) Versus Current Investigation

Test	ER	Current Investigation
1979	9.5 ft	10.4 ft
1982	4.9 ft	5.1 ft
2008	12.6 ft	13.9 ft

3.2 APPLICATION 2

A single drawdown-versus-time plot was generated for each set of aquifer properties using a 20 gpm pumping rate and period of 8 years (Figures C-1 to C-3 of Appendix C). The maximum drawdown values for all wells (other than the pumping well) are between 5 and 25 feet at 8 years of pumping 20 gpm.

The maximum predicted drawdown values for each of the selected wells at the specified time intervals and pumping rates are provided in Appendix D. Generally, predicted drawdown values increase with increases to the pumping rate and increased time of pumping. The maximum predicted drawdown values for the Lakota Aquifer occur after 20 years of pumping 120 gpm and are between 97 and 130 feet (Appendix D).

The most noticeable drawdown differences between applications are observed at wells closest to the Dewey Fault, notably Wells # 96 and # 615. The maximum drawdown observed on the **AQTESOLV** plots at these two wells in particular is about double the value calculated by Application 1. For example, the drawdown calculated using Application 1 with the 1979 aquifer test properties is 5.5 feet compared to about 10.1 feet. These differences indicate the simulation of the Dewey Fault as a barrier boundary does impact drawdown predictions, primarily increasing predicted drawdown at wells closest to the fault.

3.3 APPLICATION COMPARISON

For comparison of Applications 1 and 2, drawdown from three wells from each the Lakota and Fall River Aquifers were calculated using both the USGS spreadsheet and **AQTESOLV** (with and without the Dewey-Fault as a barrier boundary). The comparison results are all for a pumping rate of 20 gpm for a period of 8 years. Comparison graphs provided in Appendix E indicate that the USGS spreadsheet and **AQTESOLV** solution, both without the fault boundary, are nearly identical, as expected. Under similar pumping conditions and aquifer properties, predicted drawdown values from this calculation method are typically 25 to 100 percent greater than those determined from Application 1 (see Appendix E). Wells furthest from the fault show the least difference in drawdown, while wells closest to the fault have the greatest difference.

4.0 FALL RIVER AQUIFER PREDICTIONS

4.1 APPLICATION 1

Drawdown estimates for 11 Fall River Aquifer wells in the Dewey-Burdock area, based on the Theis spreadsheet analysis, are presented in Table B-2 of Appendix B. Distances from the pumping well range from 4,870 feet (Well # 695) to 29,710 feet (Well # 8).

Predicted drawdown values are greatest at wells closest to the pumping well and for the scenario using the 1979 pumping test aquifer properties (highest transmissivity). The highest drawdown value of 58.6 feet is predicted to occur at Well 695 after 8 years of pumping. The furthest well (# 8) has a maximum predicted drawdown of 35.6 feet.

In the ER, drawdown was predicted for only the nearest domestic well (# 18). Comparisons of results from the ER to results from this analysis are provided in Table 4-1. Results from this investigation are within about 10 percent of those from the previous investigation. Deviations are the result of differences in placement of the barrier boundary (outcrop) line. This comparison demonstrates that these drawdown predictions are consistent with those derived from previous investigations [Powertech, 2009b].

Table 4-1. Well # 18 Drawdown Comparison of Results in Environmental Report Versus Current Investigation

Test Year	ER	Current Investigation
1979	42.8 ft	43.8 ft
2008	9.9 ft	10.1 ft

4.2 APPLICATION 2

A single drawdown-versus-time plot was generated for each set of aquifer properties using a 20 gpm pumping rate and period of 8 years (Figures C-4 and C-5 of Appendix C). The maximum drawdown values for all wells (other than the pumping well), at a pumping rate of 20 gpm for a period of 8 years, are between 50 and 100 feet using the 1979 aquifer test properties and between 10 and 22 feet using the 2008 aquifer test properties. The significant range in predicted drawdown is the result of heterogeneities in the Dewey-Burdock area. It is important to note that the 1979 test was conducted near Burdock while the 2008 test was conducted near Dewey, the site of the first proposed mine units. For this reason, the drawdown results using aquifer properties from the 2008 Fall River test are more representative of anticipated results from mining in that area.

The maximum predicted drawdown values for each of the selected wells at the specified time intervals and pumping rates are provided in Appendix D. Generally, predicted drawdown values increase with increases to the pumping rate and increased time of pumping. The maximum predicted drawdown values for the Fall River Aquifer occur after 20 years of pumping 60 gpm and are between 55 and 80 feet (Appendix D).

Predicted drawdown values from the **AQTESOLV** calculation are typically 50 to 100 percent greater to those determined from Application 1 (see Appendix D). Unlike the calculations conducted for a Lakota wellfield near Burdock, the Fall River wellfield is much closer to the Dewey Fault barrier boundary, and hence, the effects of that boundary are much more apparent and play a greater role in increasing the amount of drawdown. Drawdown at wells closest to the fault are impacted the greatest by the fault boundary. Well # 622, for instance, is the closest well to the fault. Although Well # 622 is almost twice the distance from the pumping well as Well # 695, in less than a year's time and continuing through 8 years of pumping, it has a slightly greater drawdown than Well # 695 (Figure C-4 and Figure C-5 in Appendix C).

5.0 SUMMARY AND CONCLUSIONS

Analytical drawdown calculations were conducted using aquifer property values obtained from different aquifer pump tests. Predictions made from the USGS spreadsheet and in AQTESOLV with the use of only the outcrop boundary are comparable to previous calculations and indicate this study was conducted similarly. However, results from the AQTESOLV analysis indicate that the Dewey Fault barrier boundary does have significant impacts on drawdown calculations for wells in the project vicinity.

According to criteria for granting a water permit as set forth in South Dakota Codified Law) SDCL 46-2A-9, a proposed diversion will be approved only if it can be developed without unlawfully impairing existing rights. Existing Inyan Kara water rights (of which there are none in the immediate project area or vicinity) and domestic wells are protected from adverse impacts per rules SDCL 4:02:04 and 74:02:05; these rules provide that an adverse impact or impairment is one such that it inhibits the wells ability to produce water independent of artesian pressure. In other words, if water levels in the Inyan Kara Aquifer decline and the pump level can be lowered to below the top of the aquifer and still have the ability to produce water, the well is not considered impaired. In accordance with SDCL 46-1-4 and board-adopted findings, an increase in operating cost or decrease in production is not considered an adverse impact.

The maximum predicted drawdown within the Lakota Aquifer (Scenario 1 aquifer properties) occurs after 20 years of pumping 120 gpm with drawdown values between 77 and 130 feet. The maximum predicted drawdown within the Fall River Aquifer (Scenario 5 aquifer properties) occurs after 20 years of pumping 60 gpm with drawdown values between 55 and 80 feet. At the locality of existing wells, a maximum decrease of potentiometric head of 130 feet would not lower the water table below the top of the aquifer, and hence, these predicted drawdown values indicate any existing water use would not be lawfully impaired.

6.0 REFERENCES

Boggs, J. M. and A. M. Jenkins, 1980. *Analysis of Aquifer Tests Conducted at the Proposed Burdock Uranium Mine Site, Burdock, South Dakota*, Report No. WR28-1-520-109, prepared by the Tennessee Valley Authority.

Boggs, J. M., 1983. *Hydrogeologic Investigations at Proposed Uranium Mine Near Dewey, South Dakota*, Report No. WR28-520-128, prepared by the Tennessee Valley Authority.

Halford, K. J. and E. L. Kuniansky, 2002. *Documentation of Spreadsheets for the Analysis of Aquifer-test and Slug-test Data*, U.S. Geological Survey Open File Report 02-197.

HydroSolve, Inc., 2006. *AQTESOLV*, prepared by HydroSolve, Inc., Reston, VA.

Powertech, 2009a. *Dewey-Burdock Project Application for NRC Uranium Recovery License Fall River and Custer Counties, South Dakota*, environmental report, prepared by Powertech (USA) Inc., Denver, CO, for U.S. Nuclear Regulatory Commission, Rockville, MD.

Powertech, 2009b. *Dewey-Burdock Project Application for NRC Uranium Recovery License Fall River and Custer Counties, South Dakota*, technical report, prepared by Powertech (USA) Inc., Denver, CO, for U.S. Nuclear Regulatory Commission, Rockville, MD.

APPENDIX A

MAPS

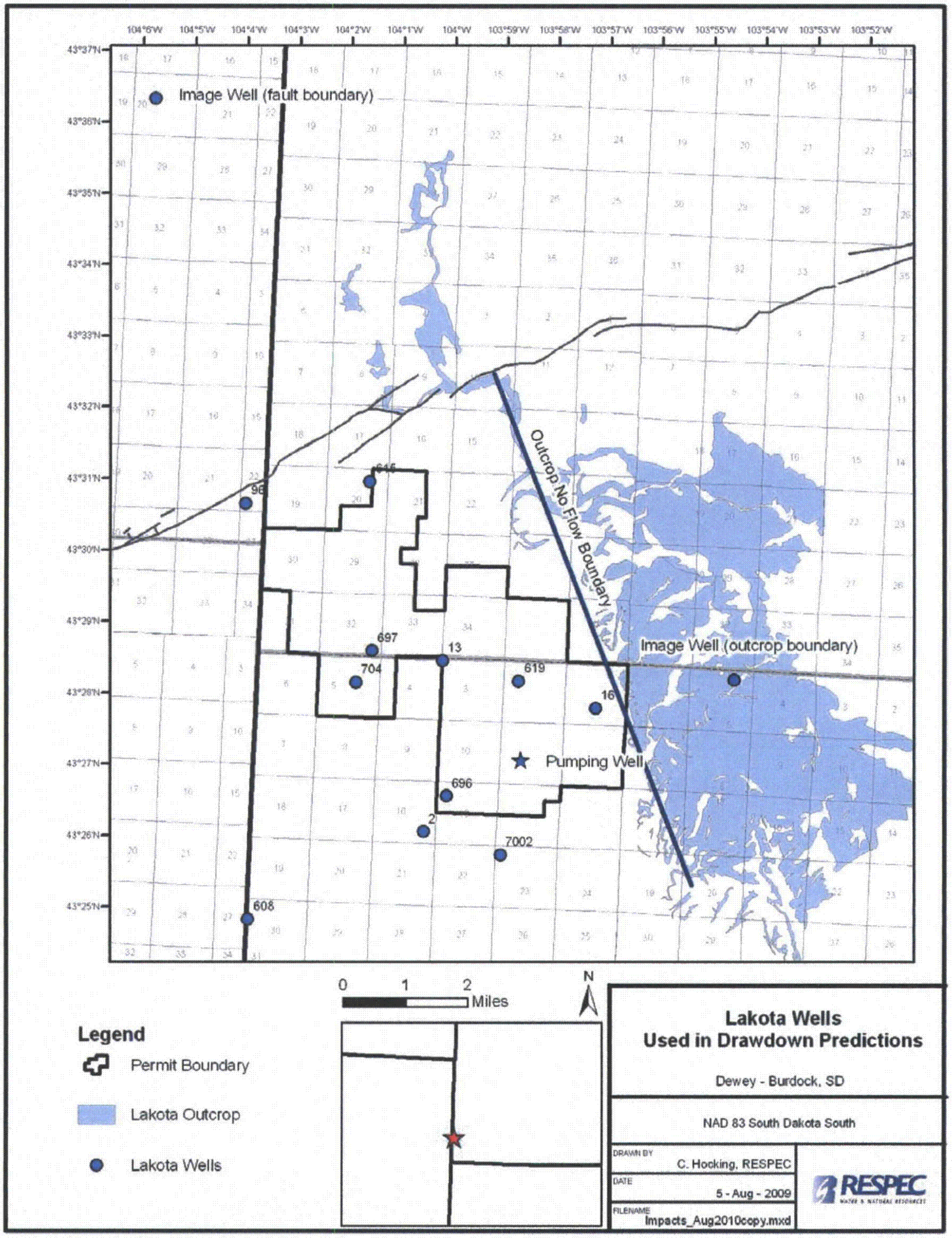


Figure A-1. Location of Lakota Wells Used in Drawdown Predictions.

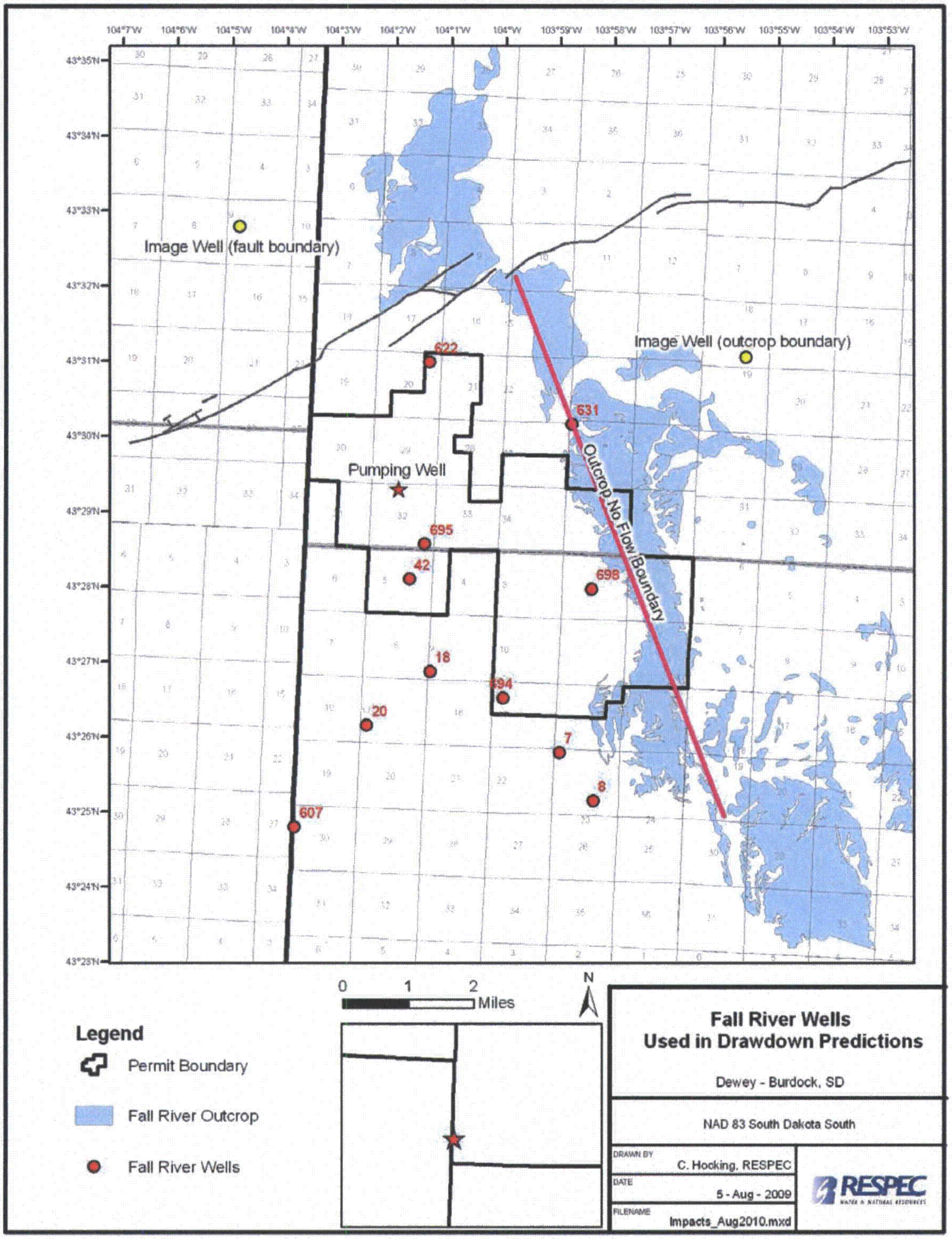


Figure A-2. Location of Fall River Wells Used in Drawdown Predictions.

APPENDIX B

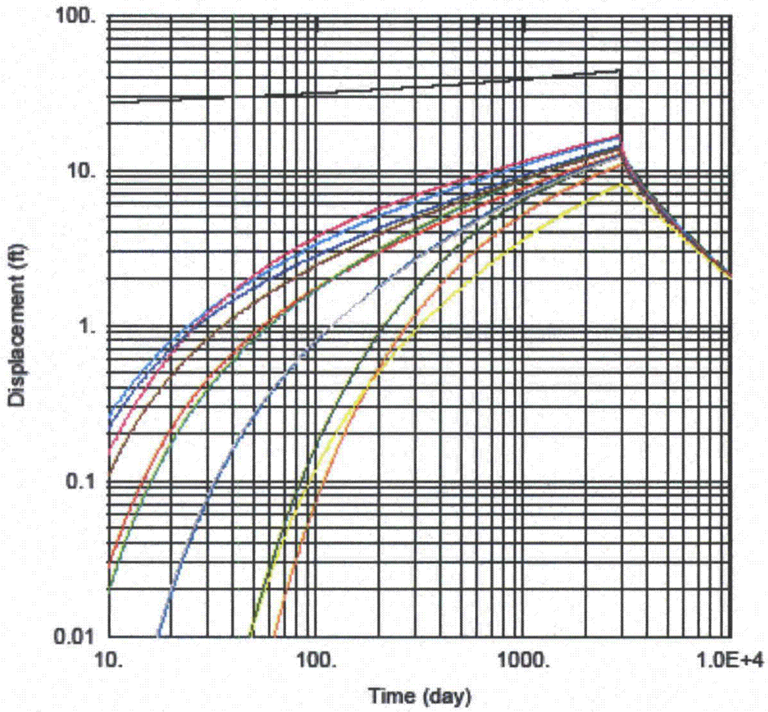
APPLICATION 1: U.S. GEOLOGICAL SURVEY SPREADSHEET DRAWDOWN PREDICTIONS

Table B-1. Burdock Well Field (Lakota Aquifer) Drawdown Estimates for Select Wells (All Values in Feet)

Scenario		Well No.										
		2	13	16	96	608	615	619	696	697	705	7002
1	1 yr	4.3	4.4	7.4	0.9	1.2	1.5	6.6	5.6	3.0	2.9	5.3
	2 yrs	6.1	6.3	9.5	2.0	2.4	2.9	8.7	7.5	4.7	4.6	7.2
	3 yrs	7.2	7.4	10.8	2.9	3.3	3.9	9.9	8.7	5.8	5.7	8.4
	4 yrs	8.1	8.3	11.7	3.6	4.0	4.7	10.8	9.6	6.6	6.5	9.3
	5 yrs	8.8	9.0	12.4	4.2	4.6	5.3	11.5	10.3	7.3	7.2	10.0
	6 yrs	9.3	9.5	13.0	4.7	5.1	5.8	12.1	10.8	7.8	7.7	10.6
	7 yrs	9.8	10.0	13.5	5.1	5.5	6.2	12.6	11.3	8.3	8.2	11.0
	8 yrs	10.2	10.4	13.9	5.5	5.9	6.6	13.0	11.7	8.7	8.6	11.4
2	1 yr	2.9	3.0	4.1	1.4	1.6	1.8	3.8	3.4	2.4	2.4	3.3
	2 yrs	3.6	3.7	4.8	2.1	2.2	2.5	4.5	4.1	3.1	3.1	4.0
	3 yrs	4.0	4.1	5.2	2.5	2.6	2.9	5.0	4.5	3.5	3.5	4.4
	4 yrs	4.3	4.4	5.5	2.8	2.9	3.2	5.2	4.8	3.8	3.8	4.7
	5 yrs	4.6	4.6	5.8	3.0	3.1	3.4	5.5	5.1	4.1	4.0	5.0
	6 yrs	4.7	4.8	6.0	3.2	3.3	3.6	5.7	5.2	4.3	4.2	5.2
	7 yrs	4.9	5.0	6.1	3.3	3.5	3.7	5.8	5.4	4.4	4.4	5.3
	8 yrs	5.0	5.1	6.3	3.5	3.6	3.9	6.0	5.5	4.5	4.5	5.5
3	1 yr	5.9	6.1	10.0	1.4	1.8	2.2	9.0	7.7	4.2	4.2	7.3
	2 yrs	8.3	8.5	12.7	3.0	3.5	4.2	11.7	10.2	6.5	6.4	9.8
	3 yrs	9.8	10.1	14.3	4.2	4.7	5.5	13.2	11.7	7.9	7.8	11.3
	4 yrs	10.9	11.2	15.5	5.1	5.6	6.5	14.4	12.8	9.0	8.9	12.4
	5 yrs	11.8	12.0	16.4	5.9	6.4	7.3	15.3	13.7	9.9	9.8	13.3
	6 yrs	12.5	12.7	17.1	6.5	7.1	8.0	16.0	14.4	10.6	10.5	14.0
	7 yrs	13.1	13.4	17.8	7.1	7.6	8.5	16.6	15.0	11.2	11.1	14.6
	8 yrs	13.6	13.9	18.3	7.6	8.1	9.1	17.2	15.5	11.7	11.6	15.2

APPENDIX C

APPLICATION 2: AQTESOLV DRAWDOWN CURVES BY AQUIFER PROPERTY SCENARIO (20 GALLONS PER MINUTE PUMPING RATE)



WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
BurdockLAK	1003477	429969

Observation Wells

Well Name	X (ft)	Y (ft)
BurdockLAK	1003477	429969
2	995123	423923
96	980028	451854
615	990571	453709
697	990748	439347
705	989365	436648
13	996759	438470
619	1003265	436729
16	1009828	434447
696	997086	426946
7002	1001731	421931
608	980229	416455

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

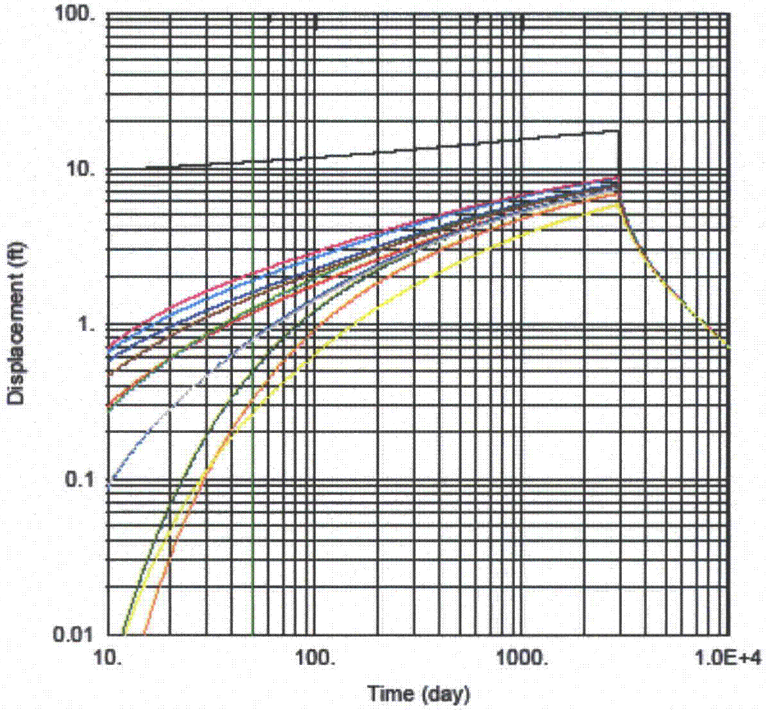
T = 190. ft^2/day

S = 0.00018

Kz/Kr = 1.

b = 100. ft

Figure C-1. Lakota Aquifer Drawdown Predictions for Nearby Wells Based on Aquifer Properties From Scenario 1 (1979 TVA Pump Test).



WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
BurdockLAK	1003477	429969

Observation Wells

Well Name	X (ft)	Y (ft)
▫ BurdockLAK	1003477	429969
▫ 2	995123	423923
▫ 96	980028	451854
▫ 615	990571	453709
▫ 697	990748	439347
▫ 705	989365	436648
▫ 13	996759	438470
▫ 619	1003265	436729
▫ 16	1009828	434447
▫ 696	997086	426946
▫ 7002	1001731	421931
▫ 608	980229	416455

SOLUTION

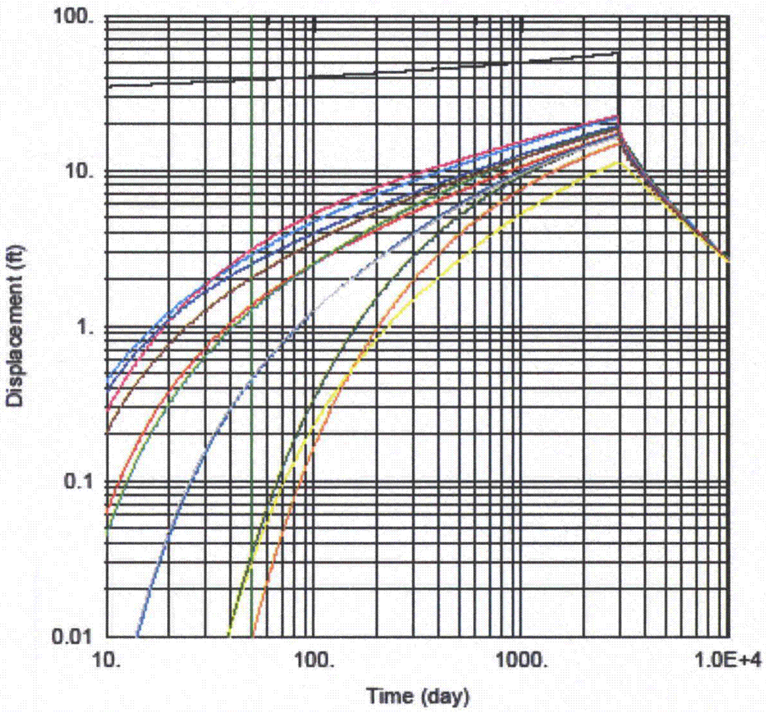
Aquifer Model: Confined

T = 590. ft^2/day
Kz/Kr = 1.

Solution Method: Theis

S = 0.0001
b = 100. ft

Figure C-2. Lakota Aquifer Drawdown Predictions for Nearby Wells Based on Aquifer Properties From Scenario 2 (1982 TVA Pump Test).



WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
BurdockLAK	1003477	429969

Observation Wells

Well Name	X (ft)	Y (ft)
BurdockLAK	1003477	429969
2	995123	423923
96	980028	451854
615	990571	453709
697	990748	439347
705	989365	436648
13	996759	438470
619	1003265	436729
16	1009828	434447
696	997086	426946
7002	1001731	421931
608	980229	416455

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

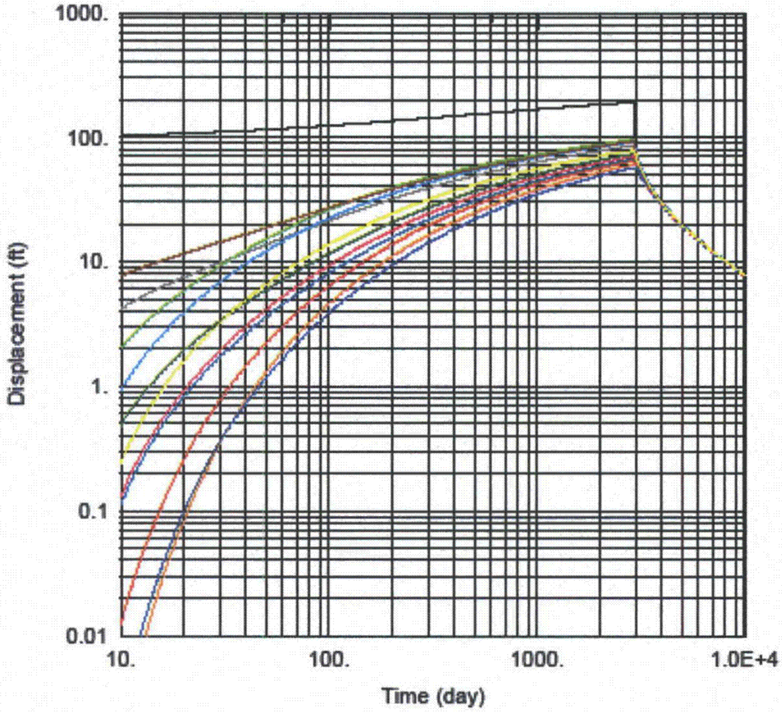
T = 150. ft²/day

S = 0.00012

Kz/Kr = 1.

b = 100. ft

Figure C-3. Lakota Aquifer Drawdown Predictions for Nearby Wells Based on Aquifer Properties From Scenario 3 (2008 Powertech Pump Test).



WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
DeweyFR	988728	443725

Observation Wells

Well Name	X (ft)	Y (ft)
DeweyFR	988728	443725
7	1001703	422417
8	1004451	418515
18	991211	428960
20	986071	424628
42	989543	436481
607	980219	416378
622	991175	454034
631	1002734	448993
694	997116	426836
695	990783	439313
698	1004308	435651

SOLUTION

Aquifer Model: Confined

T = 54. ft^2/day

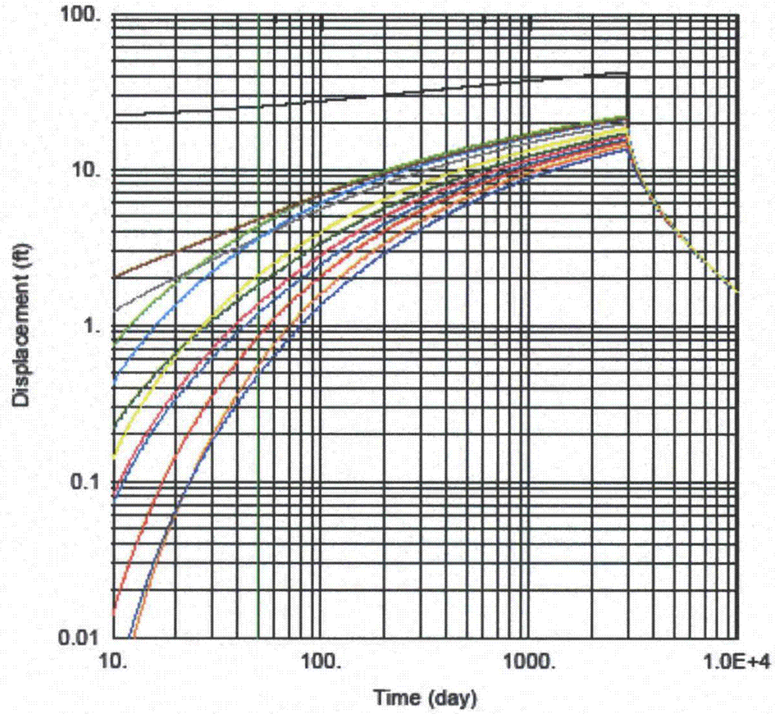
Kz/Kr = 1.

Solution Method: Theis

S = 1.4E-5

b = 100. ft

Figure C-4. Fall River Aquifer Drawdown Predictions for Nearby Wells Based on Aquifer Properties From Scenario 4 (1979 TVA Pump Test).



WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
DeweyFR	988728	443725

Observation Wells

Well Name	X (ft)	Y (ft)
DeweyFR	988728	443725
7	1001703	422417
8	1004451	418515
18	991211	428960
20	986071	424628
42	989543	436481
607	980219	416378
622	991175	454034
631	1002734	448993
694	997116	426836
695	990783	439313
698	1004308	435651

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 255. ft^2/day

S = 4.6E-5

Kz/Kr = 1.

b = 100. ft

Figure C-5. Fall River Aquifer Drawdown Predictions for Nearby Wells Based on Aquifer Properties From Scenario 5 (2008 Powertech Pump Test).

APPENDIX D

APPLICATION VARIABLE RATE AND DURATION DRAWDOWN PREDICTIONS

Table D-1. Burdock Well Field Drawdown Estimates for Select Lakota Aquifer Wells Using Scenario 1 Aquifer Properties (All Values in Feet)

Rate	Year	Well No.										
		2	13	16	96	608	615	619	696	697	705	7002
20	8	12.6	14.1	16.8	10.7	7.9	12.1	16.3	14.4	12.4	12.1	13.7
	14	15.8	17.4	20.1	13.9	10.8	15.5	19.6	17.5	15.7	15.3	16.8
	20	17.9	19.6	22.2	16.1	12.9	17.7	21.7	19.6	17.9	17.5	18.9
60	8	37.9	42.4	50.5	32.0	23.7	36.4	48.9	43.1	37.3	36.3	41.1
	14	47.3	52.2	60.2	41.8	32.5	46.4	58.7	52.6	47.1	46.0	50.4
	20	53.6	58.7	66.6	48.3	38.6	53.0	65.2	58.9	53.6	52.4	56.6
120	8	75.9	84.8	100.9	64.0	47.5	72.7	97.8	86.2	74.6	72.6	82.1
	14	94.6	104.4	120.3	83.6	65.0	92.8	117.4	105.2	94.2	92.0	100.7
	20	107.1	117.4	133.2	96.6	77.1	106.0	130.3	117.8	107.1	104.9	113.2

Table D-2. Dewey Well Field Drawdown Estimates for Select Fall River Aquifer Wells Using Scenario 5 Aquifer Properties (All Values in Feet)

Rate	Year	Well No.										
		7	8	18	20	42	607	622	631	694	695	698
20	8	15.2	14.3	17.1	15.7	19.9	13.5	22.1	21.2	16.5	21.4	18.3
	14	17.9	16.9	19.8	18.4	22.6	16.2	24.8	23.9	19.1	24.1	20.9
	20	19.6	18.6	21.5	20.0	24.3	17.8	26.5	25.6	20.8	25.8	22.6
40	8	30.5	28.6	34.3	31.4	39.9	27.1	44.3	42.4	32.9	42.9	36.6
	14	35.8	33.9	39.6	36.7	45.2	32.3	49.6	47.8	38.2	48.2	41.9
	20	39.1	37.2	43.0	40.1	48.6	35.7	53.0	51.2	41.6	51.6	45.3
60	8	45.7	42.9	51.4	47.2	59.8	40.6	66.4	63.6	49.4	64.3	54.9
	14	53.6	50.8	59.4	55.1	67.8	48.5	74.4	71.6	57.3	72.3	62.8
	20	58.7	55.8	64.4	60.1	72.9	53.5	79.5	76.8	62.4	77.4	67.9

APPENDIX E

APPLICATION 1 AND 2 COMPARISONS
(20 GALLONS PER MINUTE PUMPING RATE)

RSI-1853-10-081

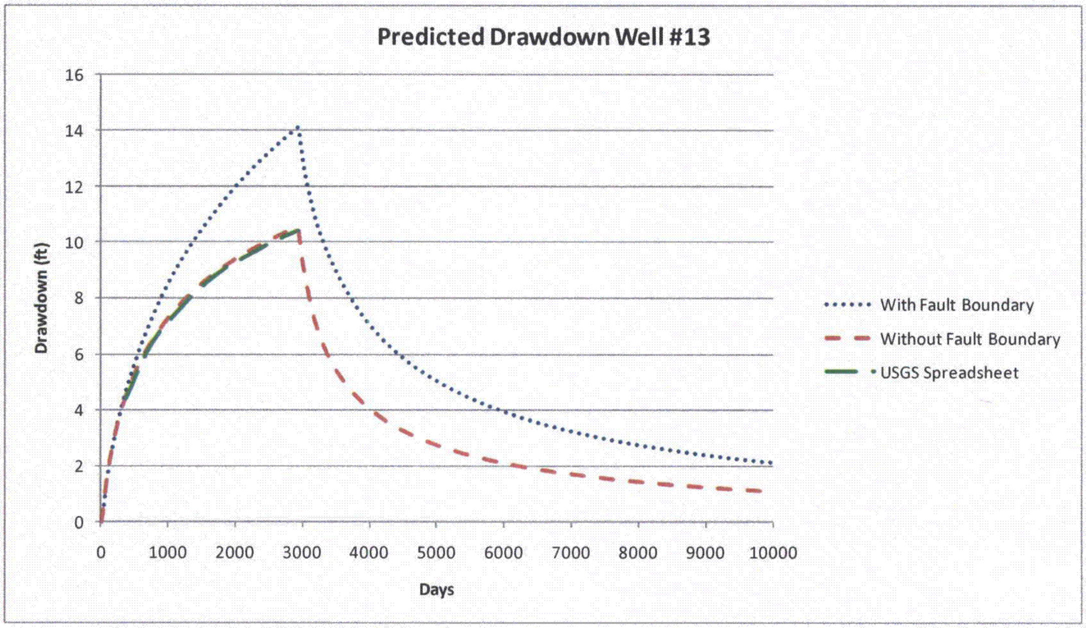


Figure E-1. Application Drawdown Comparison for Well # 13. Lakota Aquifer properties same as Scenario 1.

RSI-1853-10-082

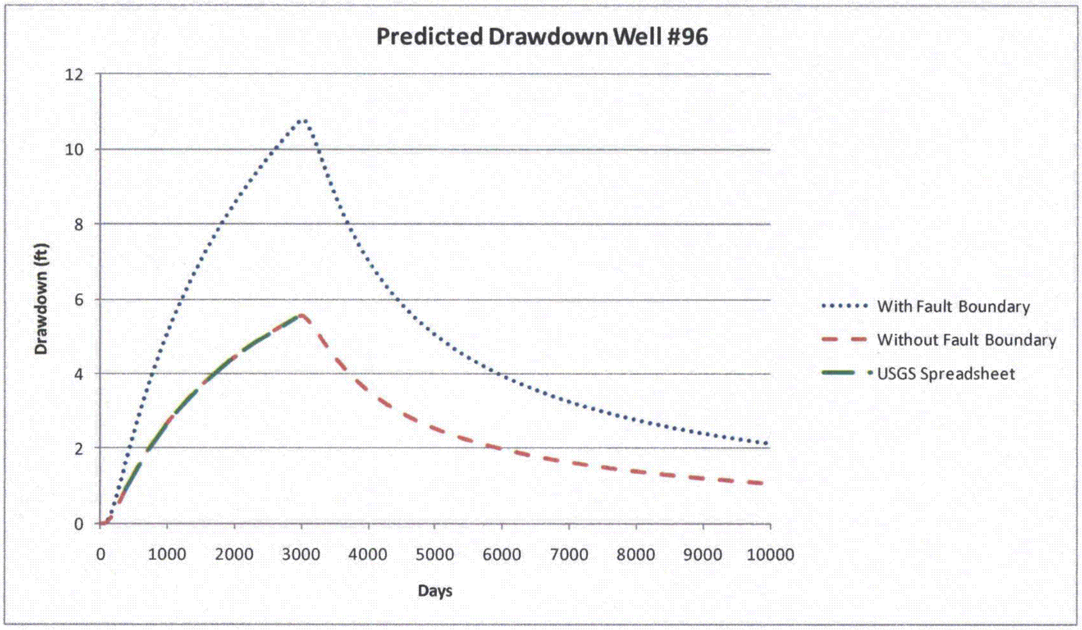


Figure E-2. Application Drawdown Comparison for Well # 96. Lakota Aquifer properties same as Scenario 1.

RSI-1853-10-083

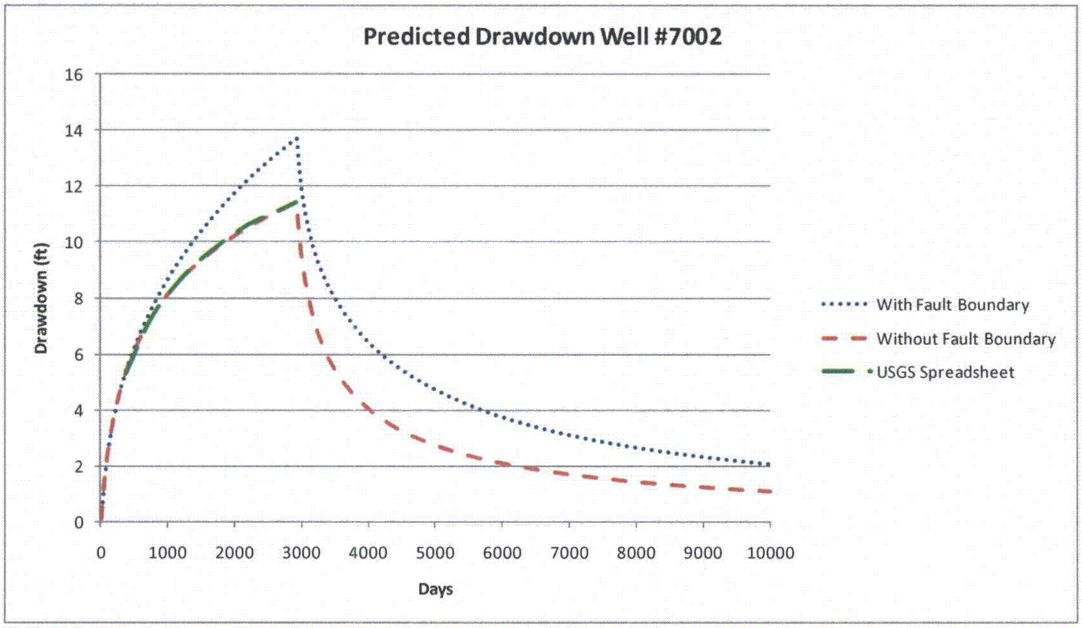


Figure E-3. Application Drawdown Comparison for Well # 7002. Lakota Aquifer properties same as Scenario 1.

RSI-1853-10-084

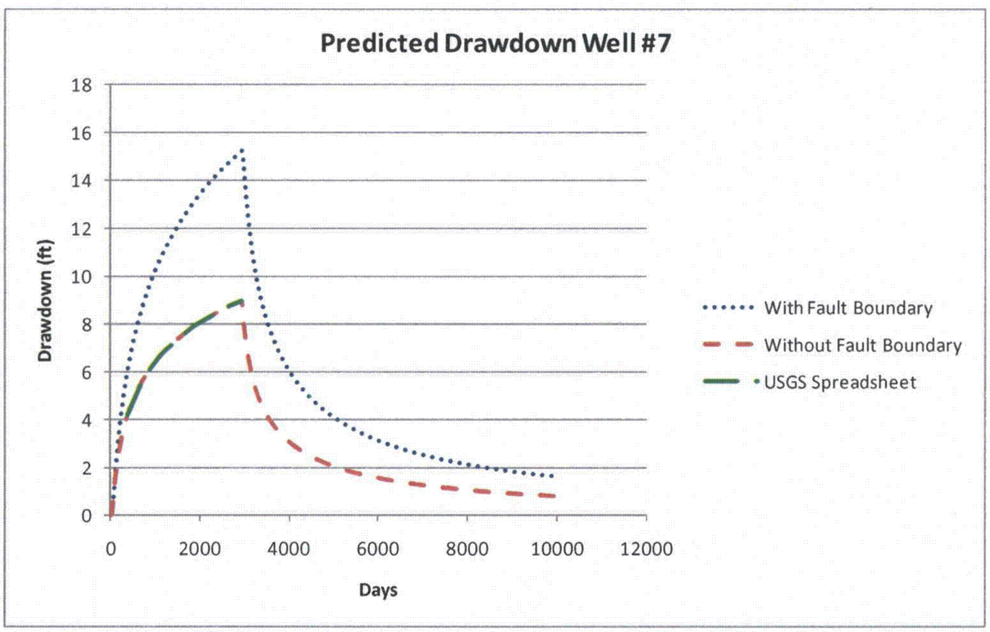


Figure E-4. Application Drawdown Comparison for Well # 7. Fall River Aquifer properties same as Scenario 5.

RSI-1853-10-085

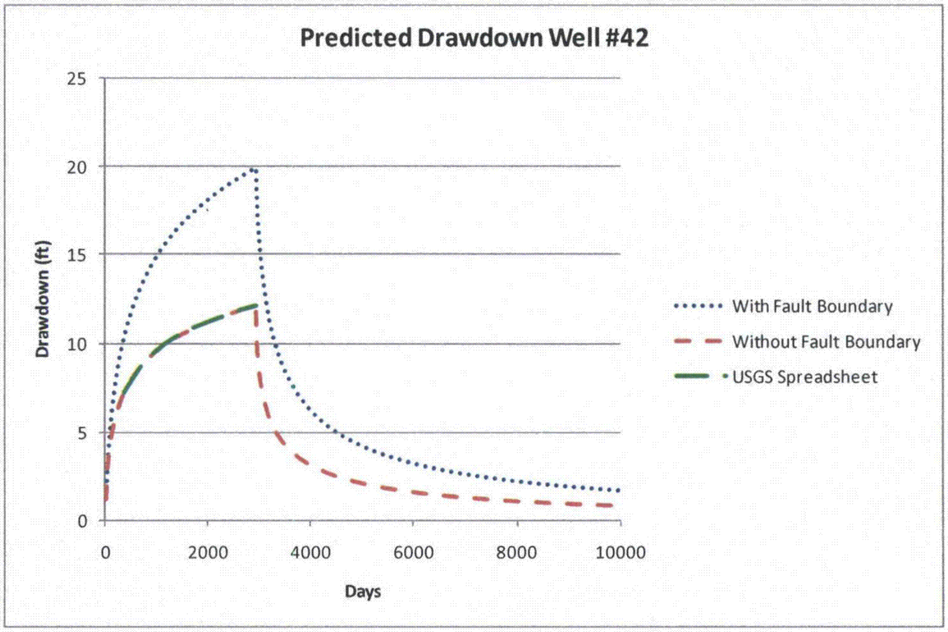


Figure E-5. Application Drawdown Comparison for Well # 42. Fall River Aquifer properties same as Scenario 5.

RSI-1853-10-086

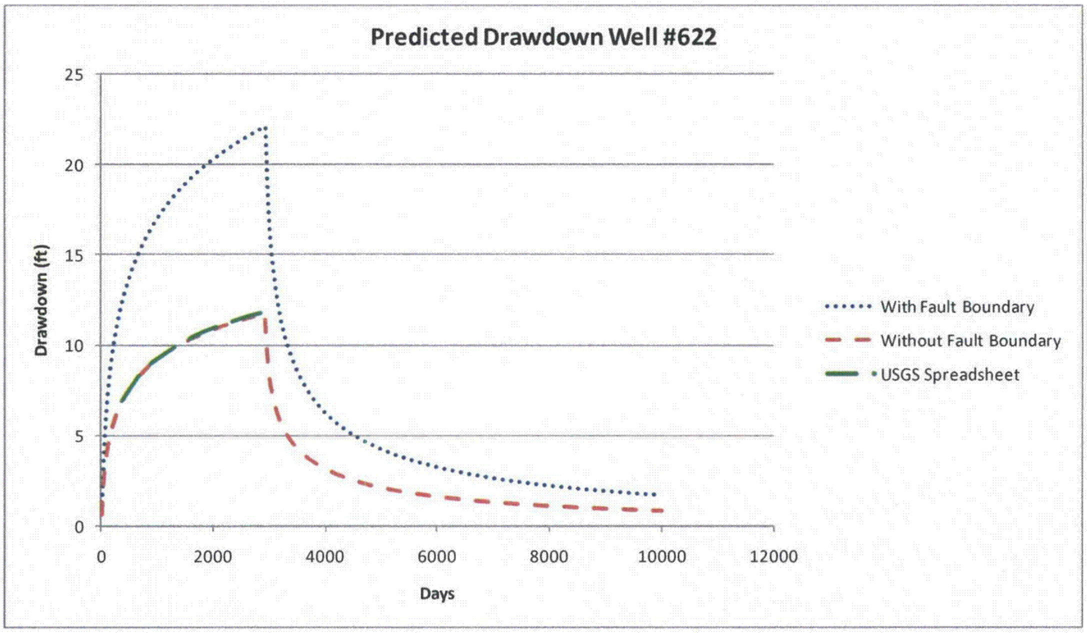


Figure E-6. Application Drawdown Comparison for Well # 622. Fall River Aquifer properties same as Scenario 5.

Plans for Reclaiming Disturbed Lands 6.2

TR RAI-6.2-1
The applicant should provide additional discussion of the land cleanup program, including:

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***

b. Plans for decommissioning non-radiological hazardous constituents as required by 10 CFR Part 40, Appendix A, Criterion 6 (7).

c. Demonstration that the actual quality assurance and quality control program will address all aspects of decommissioning.

Response TR RAI-6.2-1(a)
Consistent with NUREG-1569, 6.2.1 Areas of Review, the licensee will provide the NRC with maps and data that document the post-operational condition. The areas that will receive the primary focus during the pre-reclamation surveys are well field surfaces - particularly those areas where they may have been historical spills, areas and structures around process facilities, process related storage areas and structures, on-site transportation routes, retention ponds, diversion ditches, and areas near the deep disposal wells. If land application is used as the liquid disposal method, the irrigated areas will be focus areas as well. Sampling methods provided in NUREG-1575 will be used to verify that cleanup criteria have been met.
Also, See TR_RAI-Response and Replacement Pages; Section P&R-16(1) and refer to TR Section 6.4.1 "Cleanup Criteria".

Response: TR RAI-6.2-1(b)
Consistent with NUREG-1569 and 10CFR Part 40, Appendix A, Criterion 6(7), the applicant 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. Also, for the land application option, non-radiological cleanup concerns are addressed in TR Section 7.3.3.8.2. Further, responses to ER RAIs WM-3, WM-4, and WM-6.2 also address the decommissioning and disposal of non-radiological materials and constituents.

Response: TR RAI-6.2-1(c)
The actual quality assurance and quality control program will be finalized after issuance of the license. The applicant is committed to developing a quality assurance and control program that will address all aspects of decommissioning. The proposed outline of that program is found in applicant's response to TR_RAI-P&R-16-3, specifically Figure TR_RAI_P&R-16. Item 8, Sampling and Analysis, will address non-radiological as well as radiological parameters. The program will be designed to ensure that the project

area is closed in a manner that eliminates or minimizes the need for further maintenance to the extent necessary to prevent threats to human health and the environment.

TR RAI-6.2-2

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.

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.

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.

Response: TR RAI-6.2-2(a)

See TR_RAI Replacement Pages; Section 6.2 Plans and Schedules for Reclaiming Disturbed Lands

Response: TR RAI-6.2-2(b)

See TR_RAI Replacement Pages; Section 6.2 Plans and Schedules for Reclaiming Disturbed Lands

6.2 Plans and Schedules for Reclaiming Disturbed Lands

6.2.1 Introduction

During operations (i.e. pre-reclamation), the applicant plans to use identical or similar instruments and techniques to identify areas of the site that need to be cleaned up to comply with NRC concentration limits as was used to survey the PAA for background radiological conditions. The instruments used for the background survey are described in Section 2.9 of the TR and includes unshielded Ludlum Model 44-10 2"x 2" sodium iodide (NaI) detectors coupled to Ludlum Model 2221 ratemeter/scalers (set in ratemeter mode) and a Trimble Pro XRS GPS Receiver with Trimble TSCe Datalogger. The techniques to be used during the pre-reclamation radiological survey include putting special emphasis on those areas that are likely to be contaminated, such as diversion ditches, surface impoundments, well field surfaces, and in process and storage areas. The applicant will also consider results from operational monitoring and any other information that provides insights to areas of expected contamination. Additionally, the applicant will use a sampling grid of 100 m^2 for soil. Guidance for sample size and other techniques provided in NUREG-1575 will be used as reference for the pre-reclamation radiological survey.

Consistent with NUREG-1569, Acceptance Criterion 6.2.3(3) the applicant 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 m2, will not exceed the background concentration by more than (i) 5 picocuries per gram (pCi/g) 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. There are two areas of the PAA where the gamma survey recorded levels higher than the majority of the PAA. These are the old abandoned surface mine area in the NE portion of the PAA and a naturally anomalous area in the northern portion of the PAA. These areas may warrant a different background concentration. Should the applicant determine that use of a different background radionuclide concentration is warranted, it will propose one with its final reclamation plan.

3. For areas that meet the radium cleanup criteria, but still have elevated thorium-230 levels, the applicant proposes to provide in its final reclamation 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, the applicant 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 PAA will be identified and cleaned up. The applicant will apply appropriate statistical tests for analysis of survey data that are described in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (NRC, 2000).

At the completion of the project, all disturbed lands will be returned to their pre-production land use of livestock grazing and wildlife habitat. The objective of the surface reclamation effort is to return the disturbed lands to equal or better condition than pre-production. All buildings and structures will be decontaminated to regulatory standards and demolished and trucked to an approved disposal facility. Baseline soils, vegetation, and radiological data will be used as a guide in evaluating the final reclamation. A final decommissioning plan will be submitted to the NRC for review and approval at least 12 months prior to the planned decommissioning of a well field or PAA.

6.2.2 Surface Disturbance

Due to the nature of ISL production, minimal and intermittent surface disturbance will be associated with the project, and will be mainly associated with the CPP, maintenance and office areas. Additional intermittent disturbance occurs in the well fields, which includes well drilling, pipe installations, and road construction; however, disturbances associated with the well field impact a relatively small area and have short-term impacts.

Surface disturbances associated with the construction of the CPP, office and maintenance buildings, and well field header houses will be for the life of those activities. Topsoil will be stripped and stockpiled from these areas prior to construction. Disturbances associated with the well field drilling and pipeline installation are limited and will be reclaimed as soon as possible after these components are completed. Surface disturbance associated with the development of access roads will occur at the project site; topsoil will be stripped from the road areas and stockpiled prior to construction.

While, the PAA encompasses 10,580 acres, the land potentially disturbed by the PAA will be approximately 68 acres (facilities, piping, ponds, well fields and roads) the year proceeding operation. The disturbed area during the life of the project (production to restoration) is estimated to increase over time to a maximum of 108 acres. If the maximum area for land application of treated wastewater is included in the footprint of the PAA, then approximately a maximum additional 355 acres would be affected by the PAA for most of the project life. The maximum potential disturbance at any given time is expected to be 463 acres.

6.2.3 Topsoil Handling and Replacement

Topsoil will be salvaged from any building sites, permanent storage areas, access roads, and chemical storage areas prior to construction in accordance with SD DENR requirements. Typical earth moving equipment such as rubber tired scrapers and front end loaders will be used for topsoil stripping. In the well field, topsoil removal will be limited to headerhouse locations and access roads. A total of an estimated 13 acres of topsoil will be stripped, stockpiled, and replaced during the life of the project.

Salvaged topsoil will be stored in designated topsoil stockpiles. These stockpiles will be located such that losses from wind erosion are minimized. Additionally, topsoil stockpiles will not be located in any drainage channels or other locations that could lead to a loss of material. Berms will be constructed around the perimeter of stockpiles and the stockpile will be seeded with an approved seed mix to help minimize sediment runoff. Additionally, all topsoil piles will be identified with highly visible signs per SD DENR requirements.

During excavations of mud pits associated with well construction, exploration drilling, and delineation drilling activities, topsoil is separated from the subsoil with a backhoe. First the topsoil is removed and placed at a separate location and then the subsoil is removed and deposited next to the mud pit. Usually within 30 days of the initial excavation use of the mud pit is complete; the subsoil is redeposited in the mud pit followed by the replacing of topsoil. Pipeline ditch construction follows a similar procedure storing topsoil and subsoil separately and depositing the topsoil on the subsoil after the ditch has been backfilled.

6.2.4 Final Contouring

Due to the nature of ISL production, there will be very few construction activities that will require any major contouring during reclamation. Surface disturbances that do occur will be contoured to blend in with the natural terrain. Since no major changes in the topography will result from the proposed action, a final contour map has not been included.

6.2.5 Revegetation Practices

Revegetation practices will be conducted in accordance with NRC and DENR regulations and the methods outlined in the SD DENR mining permit. In order to help reduce wind and water erosion, topsoil stockpiles and other various disturbances in the well field area will be seeded throughout the PAA. Per SD DENR regulations, the seed mix will be chosen to be compatible with the post-production land use. The local conservation district, landowners and the SD DENR will be consulted when selecting the seed mix.

A reference area may be used to measure the success of reclamation. The reference area will be selected in a location that will not be affected by future production and is representative of the post-production land use. It will be managed such that there are no significant changes in cover, productivity, species diversity and composition of the vegetation.

Seeding may be done with a rangeland drill or with a broadcast seeder where practical. After topsoil preparation is completed affected lands will be seeded during the first normal period of favorable planting conditions unless an alternative plan has been approved. Any gullies or rills that would preclude the successful establishment of vegetation or achievement of the post-production land use will be removed or stabilized as part of the revegetation and reclamation process.

Removal and Disposal of Structures, Waste Material, and Equipment 6.3

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.

Response: TR RAI-6.3-1
The language in the above referenced statement has been change to: "Salvageable and meet release limits (releasable) for unrestricted use" in order to clarify the intent of the statement. See TR_RAI-Response and Replacement Pages; Section 6.3.3 "Removal of Process Building and Equipment".

TR RAI-6.3-2
Please provide the correct reference for surface contamination release limits in the TR.

Response: TR RAI-6.3-2
The reference Enclosure 2 to Policy and Guidance Directive FC-83-23 has been added to TR_RAI-Response and Replacement Pages; Section 6.3.1 "Establishment of Surface Contamination Limits".

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

Response: TR RAI-6.3-3
While the request is incomplete, the applicant assumes the RAI is a request for a description of how the applicant will treat and/or dispose of materials such as concrete exposed to radionuclides. As stated in the RAI, TR Sections 6.3.2 and 6.3.3 present a description of how materials with potential surface contamination will be treated. Apparently the reviewer did not understand that the term "slabs" meant concrete slabs. Therefore, the description in 6.3.2 also applies to concrete exposed to radionuclides. In summary, the concrete slabs will be monitored, and if deemed to be contaminated in excess of the release limits, the concrete will be broken up and removed for disposal at a licensed 11e. (2) disposal facility. If concentrations are below release limits, the concrete will be disposed of at a permitted landfill site. Alternatively, if the concrete slab is not contaminated and the landowner desires to use it for his own purposes, the concrete slab may be left in place. The details of final decontamination and decommissioning will be addressed in a plan to be provided to NRC for its review at least 12 months prior to planned decommissioning.

6.3 Procedures for Removing and Disposing of Structures and Equipment

The procedures for removing and disposing of structures and equipment include the establishment of surface contamination limits, preliminary radiological surveys of process building surfaces, equipment and piping systems; strategic cleanup and removal of process building materials and equipment, sorting materials according to contamination levels and salvageability, and preparing materials for transport and offsite use or disposal. Although not mentioned hereafter, the procedures also apply to tools and other equipment, such as backhoes.

All decommissioning activities will be done in accordance with the NRC license, Titles 10 and 49 of the CFR, and other applicable regulatory requirements.

6.3.1 Establishment of Surface Contamination Limits

Surface contamination release limits will be adopted from those published in Enclosure 2 to Policy and Guidance Directive FC-83-23, or modeled using RESRAD Build, or equivalent. Powertech (USA) will select the methods by which surface contamination limits will be developed at a later date.

6.3.2 Preliminary Radiological Surveys and Contamination Control

Powertech (USA) will develop one or more characterization plans that it will follow to demonstrate compliance with the surface contamination limits for building materials, systems, and equipment. The characterization plan(s) will include guidance and SOPs to conduct the preliminary surveys and control contamination.

Areas within buildings showing evidence of possible penetration of process solutions will be evaluated for possible subsurface contamination. If building materials, slabs and soils beneath the slabs are not contaminated, the buildings shall be released for unrestricted use, provided the building surfaces meet the release criteria and radiological monitoring requirements of the characterization and verification plans. Otherwise, the buildings will be demolished, the slabs removed, and the underlying soils removed (if contaminated). All materials contaminated above release limits will be prepared for offsite disposal at a licensed disposal facility. Contamination control will be addressed using operational SOPs, in conjunction with radiological surveys.

6.3.3 Removal of Process Building and Equipment

Powertech (USA) will develop plans for the strategic removal of process building and equipment, based on inventory, the results of the radiological surveys, decontamination options and available methods, reuse/disposal pathways, and information obtained during the effort. To the extent possible, Powertech (USA) intends to decontaminate salvageable equipment for unrestricted release. Decontamination methods may include a combination of washing, high pressure sprays, or steam cleaning. Cleaned surfaces will be air-dried prior to radiological monitoring. The ALARA principle applies to decommissioning activities. As such, surface contamination will be reduced to levels as far below applicable limits as practical.

Powertech (USA) will document the results of radiological surveys for all building materials, systems, and equipment. These items will be sorted as follows:

- Salvageable and contaminated above release limits (not releasable but potentially disposable or transferrable)
- Salvageable and meet the release limits (releasable) for unrestricted use
- Not salvageable and contaminated above release limits (offsite disposal at a facility licensed to accept 11e.(2) byproduct material)
- Not salvageable and contaminated above release limits (offsite disposal at a permitted facility)

In the first case, the item may be transferred to another NRC or Agreement State licensee. If it cannot be transferred or decontaminated to be released for unrestricted use, it will be disposed of at a licensed disposal facility. In all cases, Powertech (USA) will strictly maintain an inventory of all process building and equipment and the results of radiological surveys.

6.3.3.1 Building Materials, Equipment and Piping to be Released for Unrestricted Use

Powertech (USA) will develop an approved standard operating procedure for release of items to unrestricted use and thoroughly document all items eligible for release to unrestricted use. To the extent possible, releasable items having a salvageable value will be sold on the industrial market. Releasable items having no net salvageable value will be sent to a municipal landfill.

Powertech (USA) commits to prepare plans for performing radioactivity measurements on the interior surfaces of pipes, drain lines, and ductwork, and include them in its decommissioning and decontamination plan (D&D Plan). Such plans will include measurements at all traps and other access points where contamination is likely to be representative of system-wide contamination. Additionally, in its D&D Plan, Powertech (USA) will assume that all premises, equipment, or scrap likely to be contaminated in excess of limits, but that cannot be measured, is contaminated in excess of limits and will be treated accordingly.

6.3.3.2 Preparation for Disposal at a Licensed Facility

All materials and plant equipment unsuitable for unrestricted release will be prepared for offsite disposal at a licensed facility. Building materials, tools, and equipment destined for offsite disposal will be prepared for transportation and disposal in accordance with 49 CFR and other applicable requirements.

6.3.4 Waste Transportation and Disposal

Waste transportation will be performed in accordance with 49 CFR and all other applicable regulations. Offsite shipments will be properly prepared, in terms of packaging, marking and labeling, dose rate measurements, shipping papers, and emergency contact information. Offsite disposal will be conducted in accordance with disposal facility licensing requirements, including waste characterization and profiling.

Powertech (USA) will maintain a strict inventory of materials sent for disposal in a municipal landfill, i.e., those that are both non-salvageable and meet the requirements of unrestricted release. In all cases, Powertech (USA) will couple the ultimate destinations of all items to its origin, date of generation, and the results of radiological surveys.

Methodologies for Conducting Post Reclamation and Decommissioning Radiological Surveys 6.4

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.

Response: TR RAI-6.4-1

See TR_RAI Replacement Pages; Section 6.2-2(b) number 3 in the list provided for insertion into TR Section 6.2.1.

TR RAI-6.4-2

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.

Response: TR RAI-6.4-2

Powertech (USA) believes it has sufficiently demonstrated that background radiological conditions have been established within the Permit Area. See TR_RAI Replacement Pages; Section 2.9 for the issues addressed that were raised by NRC staff. The information provided is sufficient to demonstrate that background radiological conditions have been established within the Permit Area.

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.

Response: TR RAI-6.4-3

In TR Section 6.4.1.2 "Determination of Natural Uranium Soil Standard", the formula for the unity rule has been reformatted to reflect the proper context. See TR_RAI-Response and Replacement Pages for Section 6.4-3.

TR RAI-6.4-4

The staff cannot evaluate the comprehensiveness of the soil cleanup verification and sampling plan. Please define more specifically what constitutes affected areas.

Response: TR RAI-6.4-4

Affected areas are those areas that are potentially more likely to be impacted by uranium solutions, dried uranium product (yellowcake) and liquid or solid waste streams that contain uranium or other radionuclides associated with uranium recovery operations. See TR_RAI-Response and Replacement Pages; Section 6.4.3 "Surface Soil Cleanup Verification and Sampling Plans" for a description of the areas that are potentially most likely to be considered affected areas.

TR RAI-6.4-5

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.

Response: TR RAI-6.4-5

Consistent with NUREG-1569, Acceptance Criterion 6.4.3(5), See TR_RAI-Response and Replacement Pages; Section 6.2.2(b) number 5 in list provided.

TR RAI-6.4-6

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.

Response: TR RAI-6.4-6

As stated in its response to RAI 2.9-38 (a-b) in this response package, the applicant believes it has sufficiently demonstrated the feasibility of relating gamma ray measurements to radium-226 concentrations in soil at the proposed Dewey-Burdock Project. At least 12 months prior to commencing reclamation, the applicant will submit a reclamation 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), as previously stated in this response package in the response to RAI 6.2-2 (a-b).

TR RAI-6.4-7

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.

Response: TR RAI-6.4-7

See TR_RAI-Response and Replacement Pages Section 6.4.1.1.1 "Radium Benchmark Dose Applied to Surface Activity on Structures".

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.

Response: TR RAI-6.4-8

The correct reference in this particular instance is Regulatory Guide 4.15. See TR_RAI-Response and Replacement Pages; Section 6.4.4 "Quality Assurance".

6.4 Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys

6.4.1 Cleanup Criteria

The post-operation (pre-reclamation) radiological survey will consist of an integrated area gamma survey and sampling of soils for confirmation of whether cleanup action is required and to what extent. The areas that will receive particular attention are those that are expected to have higher levels of contamination than surrounding areas, and 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. In the case where land application is used for disposal of waste water, the irrigated areas and associated retention structures would also receive particular attention. If the deep disposal well method is used for waste water disposal, the areas around the disposal wells also would receive close attention.

Surface soils will be cleaned up in accordance with requirements contained in 10 CFR Part 40, Appendix A, including considerations of ALARA goals and the chemical toxicity of Uranium. On April 12, 1999, the U.S. NRC issued a Final Rule (64 FR 17506) that requires the use of the existing soil radium standard to derive a dose criterion for the cleanup of byproduct material. The amendment to Criterion 6 (6) of 10 CFR Part 40, Appendix A was effective on June 11, 1999. This "benchmark approach" requires that NRC licensees model the site-specific dose from the existing radium standard and then use that dose to determine the allowable quantity of other radionuclides that would result in a similar dose to the average member of the critical group. These determinations must then be submitted to NRC with the site reclamation plan or included in license applications. This report documents the modeling and assumptions made by Powertech (USA) to derive a standard for U-nat in soil for the proposed project ISL facility.

Concurrent with publication of the Final Rule, NRC published draft guidance (64 FR 17690) for performing the benchmark dose modeling required to implement the final rule. Final guidance (NRC, 2003) was published as Appendix E to the Standard Review Plan for *In Situ* Leach License Applications (NUREG-1569). This guidance discusses acceptable models and input parameters. This guidance from the RESRAD Users Manual (ANL, 2001), the Data Collection Handbook (ANL, 1993) and site-specific parameters were used in the modeling as discussed in the following sections.

6.4.1.1 Determination of Radium Benchmark Dose

RESRAD Version 6.4 computer code (RESRAD) was used to model the ISL site and calculate the maximum annual dose rate from the current radium cleanup standard.

The following supporting documentation for determination of the radium benchmark dose and the natural uranium soil standard (explained in Section 6.4.1.2) is attached in the Appendix 6.4-A (Radium Benchmark Dose Assessment, ERG, Inc., Oct., 2008):

- The RESRAD Data Input Basis (Attachment 1 of Appendix 6.4-A) provides a summary of the modeling performed with RESRAD and the values that were used for the input parameters. A sensitivity analysis was performed for parameters which are important to the major component dose pathways and for which no site specific data was available.
- Selected graphs produced with RESRAD that present the results of the sensitivity analysis performed on the input parameters are attached (Attachment 2 of Appendix 6.4-A).
- A full printout of the final RESRAD modeling results for the resident farmer scenario with the chosen input values is attached (Attachment 3.0 and 3.1 of Appendix 6.4-A). The printout provides the modeled maximum annual dose for calculated times for the 1,000-year time span and provides a breakdown of the fraction of dose due to each pathway.
- Graphs produced with RESRAD that present the modeling results for the maximum dose during the 1,000 year time span for radium-226 and natural uranium. A series of graphs depicting the summed dose for all pathways and the component pathways that contributes to the total dose are attached (Attachment 4.0 and 4.1 of Appendix 6.4-A).

The maximum dose from Ra-226 contaminated soil at the 5 pCi/g above background cleanup standard, as determined by RESRAD, for the residential farmer scenario was 38.1 mrem/yr. This dose was based upon the 5 pCi/g surface (0 to 6-inch) Ra-226 standard and was noted at time, t = 0 years. The two major dose pathways were external exposure and plant ingestion (water independent). For these two pathways, a sensitivity analysis was performed for important parameters for which no site specific information was available. The 38.1 mrem/yr dose from radium is the level at which the natural uranium radiological end point soil standard will be based as described in the following section.

6.4.1.1.1 Radium Benchmark Dose Applied to Surface Activity on Structures

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 radium contaminated soil to the radium benchmark dose, and will be at levels which are ALARA. If more than one residual radionuclide is present in the same 100-square-meter area (soil or structure), the sum of the ratios for each radionuclide of concentration present to the concentration limit will not exceed "1" (unity). A calculation of the potential peak annual TEDE within 1000 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 and reclamation plans to be submitted for review at least 12 months prior to decommissioning activities. The applicant is aware that the use of decommissioning plans with radium benchmark doses which may exceed 100 mrem/yr, before application of ALARA, requires the approval of the Commission after consideration of the recommendation of the NRC staff.

6.4.1.2 Determination of Natural Uranium Soil Standard

RESRAD was used to determine the concentration of natural uranium (U-nat) in soil distinguishable from background that would result in a maximum dose of 38.1 mrem/yr. The method involved modeling the dose from a set concentration of U-nat in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable U-nat concentration in soil.

For ease of calculations, a preset concentration of 100 pCi/g U-nat was used for modeling the dose. The fractions used were 49.2 percent (or pCi/g) U-234, 48.6 percent (or pCi/g) U-238 and 2.2 percent (or pCi/g) U-235. The distribution coefficients that were selected for each radionuclide were RESRAD default values. All other input parameters were the same as those used in the Ra-226 benchmark modeling.

Using a U-nat concentration in soil of 100 pCi/g, RESRAD determined a maximum dose of 7.1 mrem/yr. at time, t = 0 years. The printout of the RESRAD data summary is provided in Attachment 3.1 of Appendix 6.4-A and the dose figures generated with RESRAD are provided in

$$\text{Uranium Limit} = \left(\frac{100\ \text{pCi/g U - nat}}{7.1\ \text{mrem/yr U - nat dose}}\right) \text{x } 38.1\ \text{mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = 537\ \text{pCi/g U - nat}$$

Attachment 4.1 of Appendix 6.4-A.

To determine the uranium soil standard, the following formula was used:

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:

$$\left(\frac{\text{Soil Uranium Concentration}}{\text{Soil Uranium Limit}}\right) + \left(\frac{\text{Soil Radium Concentration}}{\text{Soil Radium Limit}}\right) < 1$$

This approach will be used at the ISL site to determine the radiological impact on the environment from releases of source and byproduct materials.

6.4.1.3 Uranium Chemical Toxicity Assessment

The chemical toxicity effects from uranium exposure are evaluated by assuming the same exposure scenario as that used for the radiation dose assessment. In the benchmark dose assessment for the resident farmer scenario, it was assumed that the diet consisted of 25 percent of the meat, fruits, and vegetables grown at the site. No intake of contaminated food through the aquatic or milk pathways was considered probable. Also, the model showed that the contamination would not affect the groundwater quality. Therefore, the same model will be used in assessing the chemical toxicity. The intake from eating meat was shown to be negligible compared to the plant pathway and therefore is not shown here. This is confirmed by the results of the RESRAD calculations shown in Attachment 3.1 of Appendix 6.4-A and the figures generated with RESRAD shown in Attachment 4.1 of Appendix 6.4-A.

The method and parameters for estimating the human intake of uranium from ingestion are taken from NUREG/CR-5512 Vol. 1 (NRC, 1992). The uptake of uranium in food is a product of the uranium concentration in soil and the soil-to-plant conversion factor. The annual intake in humans is then calculated by multiplying the annual consumption by the uranium concentration in the food. Since the soil-plant conversion factor is based on a dry weight, the annual consumption must be adjusted to a dry-weight basis by multiplying by the dry-weight to wet-weight ratio. Parameters for these calculations are given in Section 6.5.9 of the NUREG/CR-5512 Vol. 1 (NRC, 1992). Table 6.4-1 provides the parameters used in these calculation and results for leafy vegetables, other vegetables, and fruit. Annual intakes of 14 kg/year and 97 kg/year were assumed for leafy vegetables and other vegetables and fruit, respectively. Consistent with Attachment 3.1 of Appendix 6.4-A dose calculations, it was assumed that 25 percent of the food was grown on the site. It was also assumed that the uranium concentration in the garden or orchard was 537 pCi/g. This corresponds to the uranium Benchmark Concentration for surface soils. Using a conversion factor for U-nat of 1 mg = 677 pCi, then 537 pCi/g is equivalent to 793 mg/kg. The human intake shown in the first column of Table 6.4-1 is equal to the product of the parameters given in the subsequent columns. Table 6.4-1 shows that the total annual uranium intake from all food sources from the site is 52.4 mg/yr.

The two-compartment model of uranium toxicity in the kidney from oral ingestion was used (ICRP, 1995) to predict the burden of uranium in the kidney following chronic uranium ingestion. This model allows for the distribution of the two forms of uranium in the blood, and consists of a kidney with two compartments, as well as several other compartments for uranium distribution, storage and elimination including the skeleton, liver, red blood cells (macrophages) and other soft tissues.

Table 6.4-1: Annual Intake of Uranium from Ingestion

Food Source	Human Intake (mg/yr)	Soil Concentration (mg/kg)	Soil to Plant Ratio (mg/kg plant to mg/kg soil)	Annual Consumption (kg)	Dry Weight Wet Weight Ratio
Leafy Vegetables	9.4	793	1.7E-2	3.5	0.2
Other Vegetables	36.1	793	1.4E-2	13	0.25
Fruit	6.9	793	4.0E-3	12	0.18
Total	52.4				

The total burden to the kidney is the sum of the two compartments. The mathematical representation for the kidney burden of uranium at steady state can be derived as follows (ICRP, 1995):

$$Q_P = \frac{IR \times f_1}{\lambda_P \left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pk} - f_{pk1}\right)}$$

Where:

Q_P = uranium burden in the plasma, μg

IR = dietary consumption rate, mg U/d

f_1 = fractional transfer of uranium from GI tract to blood, unitless

f_{ps} = fractional transfer of uranium from plasma to skeleton, unitless

f_{pr} = fractional transfer of uranium from plasma to red blood cells, unitless

f_{pl} = fractional transfer of uranium from plasma to liver, unitless

f_{pt} = fractional transfer of uranium from plasma to soft tissue, unitless

f_{pk1} = fractional transfer of uranium from plasma to kidney, compartment 1, unitless

λ_p = biological retention constant in the plasma, d^{-1}

The burden in kidney compartment 1 is:

$$Q_{k1} = \lambda_P \times Q_P \times \frac{f_{pk1}}{\lambda_{k1}}$$

Where:

Q_{k1} = uranium burden in kidney compartment 1, mg

λ_{k1} = biological retention constant of uranium in kidney compartment 1, d^{-1}

Similarly, for compartment 2 in the kidney, the burden is:

$$Q_{k2} = \lambda_P \times Q_P \times \frac{f_{pk2}}{\lambda_{k2}}$$

Where:

Q_{k2} = uranium burden in kidney compartment 2, μg;

λ_{k2} = biological retention constant of uranium in kidney compartment 2, d^{-1};

f_{pk2} = fractional transfer of uranium from plasma to kidney compartment 2, unitless.

The total burden to the kidney is then the sum of the two compartments is:

$$Q_{k1} + Q_{k2} = \frac{IR \times f_1}{\left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pt} - f_{pk1}\right)} \times \left(\frac{f_{pk1}}{\lambda_{k1}} + \frac{f_{pk2}}{\lambda_{k2}}\right)$$

The parameter input values for the two-compartment kidney model include the daily intake of uranium estimated for residents at this site, and the ICRP69 values recommended by the ICRP as listed below (ICRP, 1995). The daily uranium intake rate was estimated to be 0.14 mg/day (52.4 mg/year) from ingestion while residing at this site.

IR = 0.14 mg/day

f_1 = 0.02

f_{ps} = 0.105

f_{pr} = 0.007

f_{pl} = 0.0105

f_{pt} = 0.347

f_{pk1} = 0.00035

f_{pk2} = 0.084

λ_{k1} = ln(2)/(5 yrs*365 days/yr)

λ_{k2} = ln(2)/7 days

where ln(2) = 0.693…

Given a daily uranium intake of 0.14 mg/day at this site and the above equation, the calculated uranium in the kidneys is 0.0093 mg U, or a concentration of 0.032 µg U/g kidney. This is 3.2 percent of the 1.0 µg U/g value that has generally been understood to protect the kidney from the toxic effects of uranium. Some researchers have suggested that mild effects may be observable at levels as low as 0.1 µg U/g of kidney tissue. Using 0.1 µg U/g as a criterion, then the intake is 32 percent of the level where mild effects may be observable.

The EPA evaluated the chemical toxicity data and found that mild proteinuria has been observed at drinking water levels between 20 and 100 µg/liter. Assuming water intake of 2 liters/day, this corresponds to an intake of 0.04 to 0.2 mg/day. Using animal data and a conservative factor of 100, the EPA arrived at a 30 µg/liter limit for use as a National Primary Drinking Water Standard (Federal Register/Vol.65, No.236/ December 7, 2000). This is equivalent to an intake of 0.06 mg/day for the average individual. Naturally, since large diverse populations are potentially exposed to drinking water sources regulated using these standards, the EPA is very conservative in developing limits.

This analysis indicates that a soil limit of 537 pCi/g of U-nat would result in an intake of approximately 0.14 mg/day. Using the most conservative daily limit corresponding to the National Primary Drinking Water standard, a soil limit of 230 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day. Therefore exposure to soils containing 230 pCi/g of natural uranium should not result in chemical toxicity effects. Since the roots of a fruit tree would penetrate to a considerable depth, limiting subsurface uranium concentrations to 230 pCi/g will be considered.

The ALARA principle requires an evaluation of, considering a cost benefit analysis and socio-economic impacts, the practicality of lowering established or derived soil cleanup levels. For gamma-emitting radionuclides, the cost and potential impacts becomes excessively high as soil concentrations, thus the gamma emission rates, become indistinguishable from background.

Cleanup of uranium mill sites has demonstrated that conservatively derived gamma action levels coupled with appropriate field survey and sampling procedures result in radium-226 soil concentrations near background levels. The presents of radium-226 and natural uranium in a mixture will tend to drive the cleanup to lower radium-226 concentrations. The ALARA principle is met by choosing conservatively derived gamma actions levels, thus no ALARA goals for radium-226 need to be established.

Powertech (USA) proposes and ALARA goal of limiting the natural uranium concentration in the top 15 cm soil layer to 150 pCi/g averaged over the impacted areas. Subsurface soil (greater than 15 cm) natural uranium concentrations should be limited to 230 pCi/g averaged over the impacted area based on chemical toxicity.

6.4.2 Excavation Control Monitoring

The purpose of excavation control monitoring will be to guide the removal of contaminated material to the point where it is highly probable that an area meets the cleanup criteria.

Gamma surveys will be relied on to guide soil remediation efforts. The surveys will be done over the extents of affected and buffer areas. The surveys will identify soil contamination that exceeds the cleanup criteria and will be used to guide the cleanup efforts. After cleanup, the surveys will be used, in conjunction with surface soil sample analyses, to verify cleanup to the site cleanup criteria.

Two methods are proposed for conducting site gamma surveys, the first is the use of the GPS-based radiological survey system and the second is the use of the equivalent conventional method using a Ludlum 2221 rate-meter/scaler and Model 44-10 detector.

Since the methods differ only by data recording and management, there will be no apparent differences in the accuracy of the results.

Gamma Action Level

A gamma action level, defined as a gamma count-rate level corresponding to the soil cleanup criterion, is used in the interpretation of the data. Normally the action level is conservatively developed to allow only a five percent error rate of exceeding the cleanup criteria at the 95 percent confidence level. The gamma action level may change as contaminated soil and associated gamma "shine" is removed. Thus, several action levels may be established. A particular action level will correspond to a gamma-ray count rate that conservatively predicts that the radium-226 in soil may be above the cleanup criterion. In addition, one action level will be required where radium-226 is the principal contaminant, such as in the well fields. Another action level will be required for areas affected by uranium releases, such as in plant areas.

The methods to determine gamma action levels will be determined prior to decommissioning.

For areas exhibiting contamination below the top 6 inches, excavation control monitoring will be done using the same detector deployed to determine the action level. Subsurface excavation control monitoring will consider the appropriate action level, adjusting for geometry factors.

After the remediation, the area will be resurveyed and the new data added to the database. Remediation will continue in areas not meeting action levels. This iterative procedure will be applied until all areas are determined to meet the action levels.

6.4.3 Surface Soil Cleanup Verification and Sampling Plans

In general, a combination of 10 CFR 40 Appendix A, MARSSIM-like, or other applicable approaches, including considerations of ALARA and the chemical toxicity of uranium, will be used for verification surveys (final status surveys) using the Data Quality Objectives (DQOs) established in a QAPP. Compliance with cleanup criteria will be evaluated in terms of soil concentrations, which will be supplemented by field surveys employing gamma-ray measurements. A final gamma survey of the affected area and buffer zone will be performed using the GPS-based equipment or conventional equipment.

The areas that are potentially most likely to be considered affected areas include well field surfaces - particularly those areas where they may have been historical spills, areas and structures around process facilities, process related storage areas and structures, on-site transportation routes, retention ponds, diversion ditches, and areas near the deep disposal wells. If land application is used as the liquid disposal method, the irrigated areas may be affected areas as well.

6.4.4 Quality Assurance

Powertech (USA) will prepare a QAPP that establishes the quality assurance and control measures for field measurement, sample collection, and laboratory analysis for all decommissioning activities. The QAPP will also establish performance criteria for field and laboratory data precision, accuracy, completeness, and representativeness. The QAPP will contain recommendations in NRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)-Effluent Streams and the Environment* (NRC, 2007).

Powertech (USA) management will check all aspects of data collection and input to verify that procedures are being followed. The collection and handling of samples from the plant decommissioning, soil cleanup, and other radiological cleanup areas will be reviewed and approved by management. Laboratory results for these samples will be evaluated and validated to requirements in the QAPP. Other aspects of the reclamation including adherence to the SOPs and adherence to the decommissioning plan will be evaluated periodically by Powertech (USA) management. The construction process will be monitored to confirm that appropriate physical and radiological safety procedures are followed. Excavation processes will be monitored to ensure that contaminated materials are not handled carelessly and that any spillage is collected and contained. The conveyance of contaminated materials through the site, e.g., to stockpiling areas, will be monitored to prevent dispersal of these materials in the environment. Construction and sampling activities will be documented and reviewed throughout the reclamation process.

6.5 Decommissioning Health Physics and Radiation Safety

The health physics and radiation safety program for decommissioning will ensure that occupational radiation exposure levels will be kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee will be on site during any decommissioning activities where a potential radiation exposure hazard exists. In general, the radiation safety program discussed in Section 5 will be used as the basis for development of the decommissioning health physics program. Health physics surveys conducted during decommissioning will be guided by applicable sections of Regulatory Guide 8.30 or other applicable standards at the time.

6.5.1 Records and Reporting Procedures

At the conclusion of site decommissioning and surface reclamation, a report containing all applicable documentation will be submitted to the NRC. Records of all contaminated materials transported to a licensed disposal site will be maintained for five years, or as otherwise required by applicable regulations at the time of decommissioning.

6.6 Financial Assurance

In compliance 10 CFR Part 40 Appendix A criteria and NUREG-1569 and 1757, Powertech (USA) commits to provide the required financial surety in the form of an irrevocable letter of credit (ILOC), but reserves its option to combine the ILOC with other surety mechanisms acceptable to the NRC prior to operation. This surety will cover the cost of reclamation including the costs of groundwater restoration, the cost of decommissioning, dismantling and disposal of all buildings and other facilities, and the reclamation and revegetation of affected areas for the project. Table 6.6-1 provides summaries of closure cost estimates for the land application and waste disposal well options. Detailed cost tables are provided in Appendix 6.6-A. The costs presented in these tables reflect prices as of 2009-2010. In accordance with NRC requirements, an updated Annual Surety Estimate Revision will be submitted each year adjusting the surety instrument to reflect existing operations and those planned for construction or operation in the following year. After review and approval of the Annual Surety Estimate Revision by the NRC, Powertech (USA) will revise the surety instrument to reflect the updated amount. Powertech (USA) agrees to update its decommissioning cost estimate for the selected option in current dollars just prior to licensing.

In addition to adjusting the surety value annually, the applicant agrees to:

1. automatically extend the surety if the NRC has not approved the proposed revision 30 days prior to the expiration date of the existing surety;

2. revise the surety arrangement within 90 days of NRC approval of any revised closure (decommissioning) plan if the revised cost estimate exceeds the amount of the existing financial surety;

3. submit for NRC review an updated surety to cover any planned expansion or operational change not included in the annual surety update at least 90 days prior to beginning associated construction; and

4. provide the NRC copies of surety related information submitted to the State of South Dakota and/or the U.S. Environmental Protection Agency, including a copy of the State's surety review or the final surety arrangement.

The surety estimate assumes only minimal capital equipment acquisitions will be required for restoration, since the equipment for the production phase operations would be utilized for aquifer restoration and yellowcake processing during the restoration and reclamation phase. The costs of elution and yellowcake processing have been computed as being proportional to the estimated quantity of yellowcake to be produced during the aquifer restoration operations.

The PA expects to have an agreement for disposal of 11e. (2) byproduct materials at the White Mesa mill disposal site located near Blanding, Utah. A list of detailed assumptions and cost factors are included in the tables in revised Appendix 6.6-A.

Table 6.6-1: Summary of Financial Assurance Amounts

No.		Financial Assurance- Dewey-Burdock Project Description	Details in Table(s):	Disposal Option: Disposal wells	Land application
1		Facility Decommissioning			
	A	Salvageable Equipment	9	$ 242,000	$ 242,000
	B	Non-salvageable bldg. & equipment disposal	9,13	$ 670,280	$ 1,046,780
	C	Byproduct disposal	6	$ 483,794	$ 494,535
	D	Restore contaminated areas	9	$ 570,300	$ 709,100
2		O&M- GW restoration and stability			
	A	Method: Groundwater treatment	O&M	$ 885,873	
	B	Method: Groundwater Sweep with Madison Injection	O&M		$ 543,700
3		Well field reclamation			$ -
	A	Well plugging & closure	8, 14	$ 751,300	$ 751,300
	B	Remove surface equipment & reclaim	9	$ 975,050	$ 975,050
4		Radiological Survey and Env. Monitoring	10	$ 832,939	$ 847,039
5		Project Management Costs & Miscellaneous	12	$ 968,700	$ 968,700
6		Labor, 35% overhead+ 10% contactor profit	11	$ 1,337,000	$ 1,337,000
7		Contingency @ 15%		$ 1,157,585	$ 1,187,281
Total Surety amount				$ 8,874,822	$ 9,102,485

6.6.1 Estimates of Pore Volume for a Well Field, Porosity and Flare Factors

Powertech proposes use of a flare factor of 1.44 and the restoration estimate of 6 pore volumes of groundwater for its financial assurance. Basis for the flare factor is found in TR Appendix 6.6-B "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Dewey-Burdock Uranium Project, South Dakota" (Petrotek, 2010).

Pore volume and volume required for restoration

Eleven measurements of ore-zone porosity have been made on cores removed from the Lakota and Fall River formation sands. The average of these porosity measurements is 0.30, which is assumed to be the average porosity of the mineralized sands within the project. The mean thickness of the mineralized zones was determined by down-hole radiologic logging to be 4.6 ft.

The formulas for determining the pore volume, including flare, and the volume of restoration composite (RC) to be withdrawn during aquifer restoration operations are as follow:

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 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 recovery operations and the timeliness of beginning aquifer restoration operations following cessation of recovery operations (Appendix 6.6-B). The total volume of restoration composite withdrawn during aquifer restoration operations is directly proportional to both the flare factor and the number of pore volumes to be withdrawn; thus, there exists a continuum of paired values of the flare factor and the number of restoration pore volumes that produce the same total volume of restoration composite removed during aquifer restoration operations (HRI, 2001). 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 in situ recovery sites and that are consistent with the best practicable technology for aquifer restoration.

The overall (volumetric) flare factor for ISR uranium recovery projects has varied from 1.44 at Irigaray/Christianson Ranch (Reference) to 1.95 at Churchrock/Crownpoint (Reference). 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 permit applications at ISL facilities located nearby in the State of Wyoming. A detailed discussion is provided in Appendix 6.6-B.

The number of pore volumes, including flare, of groundwater to be removed to affect 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 five-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 completion of the stability monitoring period following aquifer restoration.

(iv) The use of RO technology. The use of RO with the deep disposal well option of wastewater disposal during the recovery operations, will remove dissolved solids concurrent with the recovery of uranium, effectively conducting a portion of the aquifer restoration operations during the recovery phase of operations.

While the number of pore volumes required for aquifer restoration has historically proven to have been significantly higher for some of the early ISL operations, the methods and timing of restoration likely contributed to these larger numbers as has been documented as follows:

... 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 wellfields 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 [Figure 6.1-A (1)]. Similarly, there was a three-year break in production inMU6 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. (Uranium One, 2009).

For the financial assurance calculations, the pore volume affected in the first year of production is estimated to be 13 million gallons corresponding to an active well field area of 20 acres. The volume of groundwater to be extracted during groundwater restoration is estimated to be 78 million gallons.

6.7 References

ANL, 1993, "*Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil*", Environmental Assessment Division, Argonne National Laboratory, ANL/EAIS-8, Argonne, Illinois.

Code of Federal Regulations, 10 CFR 40, "Appendix A, Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content".

ERG, Inc., 2008, "*Radium Benchmark Dose Assessment for Dewey-Burdock Uranium In-situ Recovery Facility*", Environmental Restoration Group, Inc., Albuquerque, NM.

HRI, 2001: Hydro Resources Inc. "*Reply of Hydro Resources, Inc. ("HRI") to Intervenors' Response to HRI's Cost Estimate for Decommissioning and Restoration Action Plan,*" Docket No. 40-8698-ML; ASLBP No. 95-706-01-Ml, 1/22/2001.

ICRP, 1995, ICRP Publication 69 – "*Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 3 Ingestion Dose Coefficients*", International Commission on Radiation Protection, Tarrytown, New York.

NRC (1983), "*Aquifer Restoration at In-Situ Leach Uranium Mines: Evidence for Natural Restoration Processes*", NUREG/CR-3136, Washington DC: USNRC. April 1983.

NRC, 1992, "*Residual Radioactive Contamination from Decommissioning*," U.S. Nuclear Regulatory Commission, NUREG/CRR-5512 (PNL-7994) Vol. 1, Washington, DC.

NRC, 2003, "*Standard Review Plan for In situ Leach Uranium Extraction License Applications*", Division of Fuel Cycle Safety and Safeguards, Office of Nuclear Material Safety and Safeguards, U. S. Nuclear Regulatory Commission, NUREG-1569, Washington, DC.

NRCS, 2007, "*2003 Annual National Resources Inventory*", Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, DC.

TVA, 1979, "*Draft Environmental Statement – Edgemont Uranium Mine*", Tennessee Valley Authority, Knoxville, Tennessee.

Uranium One, 2009: Additional Information Requested for the Moore Ranch in situ Uranium Recovery Project License Application (TAC JU01 1), "*Safety Evaluation Report Open Issues,*" Dec. 4, 2009

USGS, 2004, "*Estimated Use of Water in the United States in 2000*", U.S. Geological Survey, U.S. Department of the Interior, USGS Circular 1268, Reston, Virginia.

NUMERICAL MODELING OF GROUNDWATER CONDITIONS RELATED TO INSITU RECOVERY AT THE DEWEY-BURDOCK URANIUM PROJECT, SOUTH DAKOTA

Introduction

Powertech (USA) Inc., has submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for a Source Materials License (SML) to conduct in-situ recovery (ISR) of uranium from the Dewey-Burdock Project in South Dakota (Powertech, 2009). Wellfield-scale modeling simulations were conducted in response to the Request for Additional Information (RAI) from NRC presented to Powertech in a correspondences dated May 19, 2010 and May 28, 2010. The target ore zone at the Dewey site is the lower Fall River Formation, and this is the aquifer represented in these hydrological modeling simulations. Ore is also present in the Lakota Formation to the south at the Burdock site area, but flow in this aquifer is not simulated.

The following lists the specific RAIs presented by NRC that are addressed in this report (references to pore volume are not addressed in this report):

Correspondence dated May 19, 2010, entitled "Summary of April 8, 2010, Teleconference Addressing Technical Issues, Powertech (USA), Inc., Proposed Dewey-Burdock In-Situ Recovery Facility (TAC No. J00606)".

- Section III (Miscellaneous Issues), #4(d): *The applicant includes a flare factor of 1.5 in its calculation of restoration costs. In addition ground water restoration costs are based on treatment of 10 pore volumes. Provide justification for the flare factor and for using 10 pore volumes total.*

Correspondence dated May 28, 2010, entitled "Request for Additional Information, Powertech (USA), Inc., Proposed Dewey-Burdock In Situ Recovery Facility (TAC No. J00606)".

- Section 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 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.*
- Section 6.1, #7: *The application did not include estimates on the pore volume for a wellfield, 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.*

A numerical groundwater flow model was developed to evaluate wellfield-scale issues related to ISR production at the site. This report describes the development of the numerical model and summarizes the results of numerical simulations used to address NRC concerns regarding ISR operations at the site.

Models and simulations presented in this report are not intended to fully characterize the regional groundwater flow system and are based on data currently available. It is noted that there are hydrologic complexities to the site and surrounding area, such as aquifer heterogeneities and recharge and fault boundaries that may require further characterization. This modeling exercise is provided for the analysis of wellfield flare and demonstrating hydraulic control at the monitor well ring. The modeling presented in this report is site specific and is not intended to represent the regional groundwater flow system.

Purpose and Objectives

The numerical groundwater flow model was developed to support Powertech in planning and operation of the ISR project. The numerical model was used to assess impacts of ISR mining on lower Fall River Formation in the Dewey area of the proposed Dewey-Burdock Uranium Project. Model simulations were developed to:

- Evaluate the wellfield balance and net bleed at the proposed F-13 wellfield.
- Estimate wellfield flare during mining operations.
- Demonstrate that proposed monitor well spacing is adequate to detect any potential excursions, specifically by simulating an excursion out of the wellfield.
- Demonstrate that hydraulic control of the simulated excursion can be established by changing injection/extraction rates and altering groundwater flow direction at the perimeter monitor well ring.

The model was developed to allow adequate discretization within the wellfields such that the impacts of individual wells can be discerned.

Conceptual Model

Description of the geology and hydrogeology of the Permit Area can be found in the SML application (Powertech, 2009). Based on that document and hydrologic testing conducted in 2008 (Knight Piesold, 2008), a conceptual hydrologic model for the Dewey area at the Dewey-Burdock Project is summarized below.

The aquifer being simulated is the lower Fall River Formation, which is the proposed uranium production zone at the Dewey area. The total thickness of the Fall River Formation is approximately 165 feet in the area. There are three distinct ore zones of about 10 to 15 feet thick within the lower Fall River sandstone interval. This sandstone at the base of the Fall River is approximately 75 feet thick, and dips to the south-southwest at approximately 0.01 ft/ft. This interval of the lower Fall River Formation is the aquifer that was modeled in the following simulations.

The Fall River Formation is a confined aquifer system at the Dewey area, with a hydraulic gradient generally following the dipping beds to the south-southwest. Measured gradients in the Dewey area are locally as high as 0.01 ft/ft, but generally are closer to an average of 0.006 ft/ft (Knight Piesold, 2008). A hydraulic gradient of 0.006 ft/ft is utilized for all baseline (non-pumping) conditions around the simulated wellfield. There is also a vertical-upward hydraulic gradient of approximately 0.2 ft/ft measured between well screens in the lower sandstone versus the upper sandstone in the Fall River Formation. For the purposes of these simulations that focus on hydraulic behavior within the monitoring well ring, this vertical gradient was not considered, nor was potential leakage from or into overlying and underlying layers.

Results of hydrologic testing conducted in 2008 (Knight Piesold, 2008) provided the basis for aquifer parameters values used in the modeling. Results of testing in the Dewey area in the lower Fall River indicate an average transmissivity of 255 ft^2/day and average storativity of 4.6 x 10^{-5}. Based on an assumed 75-foot thickness of the lower Fall River, the hydraulic conductivity is calculated as 3.4 ft/day. Total porosity of the lower Fall River was estimated at 29 percent, based on analysis of core samples. These values were the initial values used in the model calibration simulations. The initial values were modified during model calibration.

Average groundwater velocity under the stated aquifer conditions of hydraulic conductivity of 3.4 ft/d, hydraulic gradient of 0.006 ft/ft and porosity of 29 percent is 0.07 ft/d, or 26 ft/yr.

Anticipated production rates were assumed to be approximately 20 gallons per minute (gpm) per well pattern, with a net bleed (overproduction) of approximately 1%. Figure 1 shows the wellfield layout that was modeled in the Dewey area.

Model Code

Three-dimensional analysis of groundwater flow in the lower Fall River aquifer system was performed with the finite difference groundwater flow model (MODFLOW), developed by the U.S. Geological Survey (USGS) (McDonald 1988, 1996). MODFLOW was selected for simulating groundwater flow at the Dewey site because it is capable of a wide array of boundary conditions, in addition to being a public domain code that is well accepted in the scientific community. MODFLOW can be used to simulate transient or steady-state saturated groundwater flow in one, two, or three dimensions. The code simulates groundwater flow using a block-centered, finite-difference approach. Modeled aquifers can be simulated as unconfined, confined, or a combination of thereof.

Advective transport was evaluated using MODPATH, Version 3, developed by the USGS (Pollock, 1994). MODPATH's particle-tracking code was utilized because it is compatible with model outputs from the MODFLOW groundwater flow model and is suitable for flowpath analysis of steady-state or transient simulations, and is a widely accepted public domain code. MODPATH utilizes the output head files from MODFLOW to calculate particle velocity changes over time in three dimensions.

MODPATH was used to provide computations of groundwater seepage velocities and groundwater flow directions at the site.

The pre/post-processor Groundwater Vistas (Environmental Simulations, Version 5, 2007) was used to assist with input of model parameters and output of model results. Groundwater Vistas serves as a direct interface with MODFLOW and MODPATH. Groundwater Vistas provides an extensive set of tools for developing, modifying and calibrating numerical models and allows for ease of transition between the groundwater flow and particle tracking codes. Full description of the Groundwater Vistas program is provided in the Users Guide to Groundwater Vistas 5 (Environmental Simulations, Inc., 2007).

Model Domain and Grid

The model encompasses an area of approximately 1,530 square miles and is shown on Figure 2. The model domain is aligned to the prevailing potentiometric gradient to the southwest (model is oriented 26 degrees east of north) and the model grid is centered over the F-13 wellfield. Northeast-southwest dimensions are 206,840 feet (39.2 miles), and northwest-southeast dimensions are 206,562.5 feet (39.1 miles).

The model grid was designed to provide adequate spatial resolution within the wellfield area in order to simulate response of the aquifer to typical extraction and injection rates anticipated at the Dewey area in the lower Fall River Formation. The model grid was extended a considerable distance from the wellfield boundaries to minimize potential impacts of exterior boundary conditions on the model solution in the area of interest.

Cell dimensions within the area of the proposed wellfield are 17.5 feet by 17.5 feet. Cell dimensions are gradually increased to a size of 1,500 feet by 1,500 feet near the edges of the model. The model consists of 476 rows and 291 columns, and contains 138,516 active cells.

Model Boundary Conditions

Boundary conditions imposed on a numerical model define the external geometry of the groundwater flow system being studied. Boundary conditions assigned in the model were determined from available reported potentiometric conditions (Knight Piesold, 2008). Descriptions of the types of boundary conditions that can be implemented with the MODFLOW code are found in McDonald and Harbaugh (1988).

This numerical model was designed for a conceptual evaluation of wellfield flare and near-wellfield groundwater movement, and is not a rigorous conceptualization of the potential heterogeneities and hydrogeologic boundaries present in the larger regional groundwater flow system.

Boundary conditions used to represent hydrologic conditions at the Dewey site include general-head boundaries (GHB) and wells (extraction and injection). The locations of the GHB conditions within the model are illustrated in Figure 2. Discussion of the placement and values for these boundary conditions is provided below. The placement and values for the well boundary conditions are described under the simulation discussion.

The GHB was used in the Dewey Area model to account for inflow and outflow from the model domain on all sides. GHBs were assigned along the edges of the model domain by extrapolating available potentiometric data (Knight Piesold, 2008), including observed water level elevations and observed hydraulic gradients. GHBs were used because the groundwater elevation at those boundaries can change in response to simulated stresses. In the Dewey wellfield model, GHBs were assigned to all four sides of the model. The values of head assigned to the GHBs ranged from 4,269 feet above mean sea level (ft amsl) along the north edge of the model and 3,036 ft amsl, along the south edge. The values of head assigned to the GHBs on the west and east sides of the model vary linearly between assigned heads at the north and south boundaries of the model. This configuration represents a hydraulic gradient of 0.006 ft/ft to the southwest, consistent with water levels and hydraulic gradients observed in the lower Fall River monitor wells.

The wellfield configuration includes a series of 5-spot well patterns with an extraction well located in the center, surrounded by four injection wells. Each well pattern is approximately 70 feet on a side. Figure 1 presents the wellfield layout of injection and extraction wells, and the perimeter monitor well ring. Extraction and injection rates applied to the wells are described under the simulation discussions of this report.

The model domain was extended a suitable distance from the location of the proposed production wellfield to minimize perimeter boundary effects on the interior of the model where the hydraulic stresses were applied.

Aquifer Properties

Input parameters used in the model to simulate aquifer properties are consistent with site-derived data, including the following:

- Top and bottom elevations of the lower Fall River sandstone, of approximately 3,066 feet above mean sea level (ft amsl) and 2,991 ft amsl at the southwest corner of the modeled wellfield
- Saturated thickness of 75 feet
- Hydraulic gradient of 0.006 ft/ft
- Hydraulic conductivity of 3.4 ft/day and storativity of 4.6 x 10^{-5}, based on hydrologic testing (to be modified by model calibration)
- Porosity of 29%, based on core analysis

For the purposes of a wellfield-scale model simulating ISR production, the additional geologic and hydrogeologic complexities that are present in the Dewey area were not included, owing to the lack of data. The wellfield is located on a homoclinal limb of the Fall River Formation, but the aquifer is represented as an extension of the stratigraphic dip observed near the wellfield. Thus, the observed top of the lower Fall River sandstone is extended to the model boundaries at a dip of 0.01 ft/ft, though limited local data and regional mapping indicates that the degree of dip in both the up-dip and down-dip directions decreases.

Static water level conditions within the model domain are similarly presented. Utilizing a potentiometric elevation of 3,654 ft amsl at the southwest corner of the wellfield, an average measured gradient of 0.006 ft/ft is extended to the edges of the model boundaries.

A hydrologic test conducted in 2008 (Knight Piesold, 2008) in the Dewey area included a pump test at well DB-07-32-03C for 3.08 days, at a constant rate of 30.2 gpm. The median reported aquifer transmissivity (T) for the lower Fall River (estimated thickness of 75 feet) was approximately 255 ft^2/day, which corresponds to a hydraulic conductivity of 3.4 ft/day. Median storativity (S) was determined to be 4.6 x 10^{-5}. These two values (T = 3.4 ft/day; S = 4.6 x 10^{-5}) represent starting aquifer input values for the wellfield model calibration to the results of testing.

No attempt was made to calibrate the model to natural background potentiometric conditions because of limited data.

Modeled Aquifer Response versus 2008 Hydrologic Testing

The groundwater model was calibrated to the 2008 pump test conducted in the Dewey area (Knight Piesold, 2008). The pumping well (DB-07-32-03C) is completed in a portion of the lower Fall River (ore zone), and three observation wells completed to the ore zone were monitored. The pumping well and two closest observation wells are located within or near the wellfield. Overlying and underlying wells were also monitored, but because the model is a single layer, the overlying and underlying data was not utilized in the calibration.

The pumping well was simulated at a constant rate of 30.2 gpm for 3.08 days. The initial condition was the previously described potentiometric surface with a hydraulic gradient of 0.006 ft/ft. Simulated drawdown at the three observation wells was compared to the pump test results and hydraulic conductivity and storativity values were varied in the model input to attempt a best fit to the limited hydrologic data. No attempt was made to compare the results of the pumping well drawdown at the end of the test, due to the lack of data regarding well efficiency at this well.

The following table briefly summarizes the results of the 2008 testing:

Well	Type	Radial Distance to Pumping Well (ft)	Observed Drawdown at End of Pumping (ft)
DB 07-32-3C	Pumping	0	44.8
DB 07-32-05	Observation	265	13.0
DB 07-32-4C	Observation	467	9.8
DB 07-29-7	Observation	2,400	1.5

During calibration, model input parameters for K and S were varied from the average reported aquifer parameters (K = 3.4 ft/day, S = 4.6 x 10^{-5}, Knight Piesold [2008]). Table 1 summarizes the calculated residual values (difference between observed versus model results of drawdown), and shows that a K value of 3.1 ft/day and S value of 4 x 10^{-5} provides the best match to observed drawdowns. The model output at the distal observation well (DB 07-29-7, 2,400 ft distant) overpredicts drawdown in all simulated cases. The purpose of the modeling simulations are to simulate flow at a wellfield scale and within the monitoring well ring (spaced 400 feet from the ore body wellfield patterns, therefore the drawdown fit at the two closest wells was weighed more heavily in the choice of aquifer parameters for the wellfield model (see Table 1). Based on this approach, a conductivity of 3.1 ft/day and storativity of 4 x 10^{-5} were determined to best fit the limited hydrologic data available. Figure 3 presents the simulated drawdown versus observed drawdown.

Dewey Wellfield Balance and Determination of Flare

The wellfield balance and flare determination simulation was conducted to (1) attempt to balance injection and production volumes within the wellfield while minimizing excursion potential and (2) track groundwater particle pathways that illustrate the horizontal flare around the wellfield. The following wellfield simulation was run for a period of two years, and flare was evaluated at the end of this time frame.

Input parameters for the modeled aquifer are a K value equal to 3.1 ft/day and S equal to 4 x 10^{-5}. Total wellfield overproduction (bleed) in this simulation is 1.0%. Balancing was conducted by starting with an idealized wellfield balance, with each extraction well producing at 20 gpm. Each injection well rate is defined by the number of neighboring extraction wells. An interior injection well surrounded by four extraction wells and injects at a rate of 19.8 gpm (1.0% bleed). For an exterior injection well adjacent to three extraction wells, the injection rate is 75% of an interior well, and 50% and 25% for an injection well adjacent to two and one extraction wells, respectively.

Totál production at the 104 extraction wells is 2080 gpm, equivalent to 20 gpm per well. Total injection at the 160 injection wells is 2059.2 gpm, ranging in rate from 3.2 gpm to 20.8 gpm. Figure 4 presents the modeled wellfield, with posted extraction and injection volumes at each of the 264 wells.

Particle tracking by MODPATH was implemented utilizing multiple particles originating in the model cell of each of the exterior injection wells. Figure 5 presents the particle flowpaths of the balanced wellfield at 1.0% bleed, and the perimeter of the particle traces were traced. Horizontal flare is calculated by taking the ratio of the flare perimeter and boundary of the injection wells. Horizontal flare was minimized by adjusting injection rates at specific wells while maintaining the overall balance at a 1% bleed. Horizontal flare is calculated at 1.19 by dividing the area of particle traces by the exterior boundary of the wellfield. Vertical flare cannot be evaluated in the single-layer model that was utilized in this simulation, but it is expected that the magnitude of vertical flare is similar, or less, in scale to horizontal flare. Due to the vertical anisotropy likely present in the sand layers (i.e., horizontal conductivity is greater than vertical conductivity) and the presence of overlying and underlying confining layers, it is likely that flare in the vertical dimension is less than in the horizontal. Therefore, a total flare value of 1.4 is reasonable and appropriate for the Dewey wellfield.

Simulated Regional Drawdown and Wellfield Potentiometric Levels

Regional drawdown was evaluated based on the results of the two-year operational simulation conducted in the wellfield flare evaluation. Based on the model results, regional drawdown impacts of 5 feet and 1 foot are approximately 14,000 ft (2.7 mi) and 68,000 ft (12.9 mi), respectively (see Figure 6). Figures 7 and 8 present the modeled potentiometric surface of the ore zone near the wellfield and modeled drawdown near the wellfield, respectively.

For model verification, an analytical Theis equation is used to compare the radius of drawdown from the wellfield. Using the Theis solution in a spreadsheet produced by the USGS (Halford and Kuniansky, 2002), a pumping rate of 20.8 gpm (i.e., 2080 gpm – 2059.2 gpm) over a two-year period is used. Results of this calculation indicate that the radius of 5-foot and 1-foot of drawdown is approximately 16,000 feet and 80,000 feet, respectively, which compares well to the results of the modeling simulations.

The wellfield model simulates a homogeneous and isotropic aquifer, without any potential hydrogeologic boundaries (e.g., recharge and/or fault boundaries). The presence of potential boundaries at some distance from the wellfield, or heterogeneity within the wellfield could increase or decrease the overall drawdown within the wellfield area, and may require changes in the overall wellfield balance, but is not expected to significantly alter flow within the wellfield.

Dewey Wellfield Simulated Excursion

In order to assess the proposed 400 foot monitoring well spacing (i.e., wells spaced approximately 400 feet distant from the wellfield, and laterally spaced 400 feet apart in the monitor well ring), an excursion was simulated to illustrate that the spacing is adequate to detect a potential excursion that might occur.

To simulate the excursion, the extraction well at the extreme southwest corner of the wellfield was turned off, with all remaining injection and extraction wells operating at the same rates evaluated in the 1% bleed wellfield flare simulation. This location in the wellfield was utilized because the downgradient and southern portion of the wellfield would be most susceptible to particles exiting the hydraulic sink of the wellfield and traveling southwest with the regional groundwater gradient. Particles to track the flow of injectate from the wellfield during the simulated excursion were placed at the three downgradient injection wells.

Figure 9 presents the particle paths originating from the "out of balance" corner of the wellfield. Figure 10 presents the simulated potentiometric surface at this time near the wellfield. Groundwater flow vectors at the end of the excursion simulation are presented in Figure 11 and illustrate that groundwater flow in the southern area near the monitoring wells is dominantly to the south, in the direction of regional hydraulic gradient. As can be observed from Figure 9, the modeled excursion would eventually intersect the perimeter monitor wells. Therefore, the proposed 400 foot monitoring well spacing is adequate to detect any potential excursion.

Dewey Wellfield Simulated Excursion Recovery

To demonstrate that any potential excursion to the monitoring well ring can be hydraulically controlled, the previously simulated excursion was recovered by adjusting wellfield production/injection. Injection rates at the three downgradient injection wells were set to zero, and the two downgradient extraction wells were adjusted to pump at a rate of 24 gpm each.

Figure 12 presents the potentiometric surface near the simulated excursion at approximately one hour after the recovery was initiated. As can be seen in this figure and contrasted with the potentiometric levels during the excursion (see Figure 10), a local gradient from the southernmost monitor well back to the wellfield is induced. Figure 13 illustrates the velocity vectors of groundwater flow at the same time, which has been reversed and modeled groundwater flow at the area of the simulated excursion is moving back towards the wellfield.

The previously simulated excursion, where a single extraction well was turned off, was run for an additional 30 days, and particles just inside the perimeter monitor well boundary at the downgradient side of the wellfield were tracked. At the end of the 30 days, the excursion recovery was initiated and particles representing the downgradient extent of the simulated excursion were tracked for a period of 60 days. Figure 14 illustrates the simulated groundwater flowpaths immediately adjacent to the monitor well for this scenario, as well as illustrating that the excursion recovery scenario is adequate to reverse the hydraulic gradient and reverse the direction of groundwater flow at a distance of 400 ft, and pull the simulated excursion back inside the perimeter boundary. This figure also provides an indication of the scale of simulated groundwater travel times, as groundwater migrates only approximately 3 ft in the 30 day simulated excursion scenario, and a similar distance for the 60 day recovery. Differences in velocity at this location during the excursion and subsequent recovery are because the induced hydraulic gradient during recovery is lower than the regional gradient that was simulated during the out-of-balance wellfield excursion.

In order to assess the validity of this simulation, an analytical Theis solution for a confined aquifer was utilized. The excursion recovery represents an additional 28 gpm of production (24 gpm at one well previously not operating, and the other well increased from 20 gpm to 24 gpm) and a deduction of approximately 16 gpm (see Figure 4 for posted injection rates), a net pumping rate of 44 gpm. At a distance of 400 ft from the pumping well, the drawdown at one hour is estimated to be approximately 4 feet. Therefore, the Theis solution verifies the results of the modeling simulation that indicate the local gradient can be influenced at a distance of 400 ft. This relatively rapid response at this distance is due to that fact that the lower Fall River is a relatively low-storage system (based on hydrologic testing).

Summary

Numerical modeling was conducted to evaluate wellfield-scale issues related to ISR production at the Dewey-Burdock Project. Wellfield flare was determined and the proposed 400 foot well spacing was demonstrated through modeling to be adequate to detect a potential excursion at this distance. Model simulations also demonstrated that hydraulic control of the simulated excursion can be established by changing wellfield operational rates at this distance away from the wellfield.

Horizontal flare from a balanced wellfield operating at a 1% net bleed was determined to be 1.19. Vertical flare was not evaluated, but considering a similar scale of flare in this direction, total wellfield flare is estimated at approximately 1.4.

An excursion was simulated by varying the wellfield balance, and particle pathways representing the flow of injectate indicate that the 400 foot monitoring well spacing is adequate to detect the excursion away from the wellfield. The recovery of a potential excursion was also demonstrated by varying the wellfield balance to reverse the hydraulic gradient at this distance and change the direction of travel of groundwater back towards the wellfield.

List of Tables

List of Figures

References

Environmental Simulations, Inc. 2005. Guide to Using Groundwater Vistas, Version 5. pp 372. Prepared by Environmental Simulations, Inc., Reinholds, VA.

Knight Piesold, 2008. Powertech (USA) Inc., Dewey-Burdock Project, 2008 Pumping Tests: Results and Analysis. Prepared for Powertech (USA), November 2008.

McDonald, M.G., and A.W. Harbaugh. 1988. *MODFLOW, A Modular Three-Dimensional Finite Difference Flow Model*. Techniques of Water-Resources Investigations, Book 6, Chapter A1. U.S. Geological Survey.

McDonald, M.G., and A.W. Harbaugh. 1996. *User's documents for MODFLOW-96, an update to the U.S. Geological Survey modular finite difference ground-water flow model*. Open File Report 96-485. U.S. Geological Survey.

Powertech (USA) Inc., 2009. Dewey-Burdock Project Application for NRC Uranium Recovery License, Fall River and Custer Counties, South Dakota, Technical Report (separate cover) & Environmental Report (separate cover). February 2009.

Table 1. Dewey Wellfield Model, Calibration of Model to 2008 Hydrologic Testing

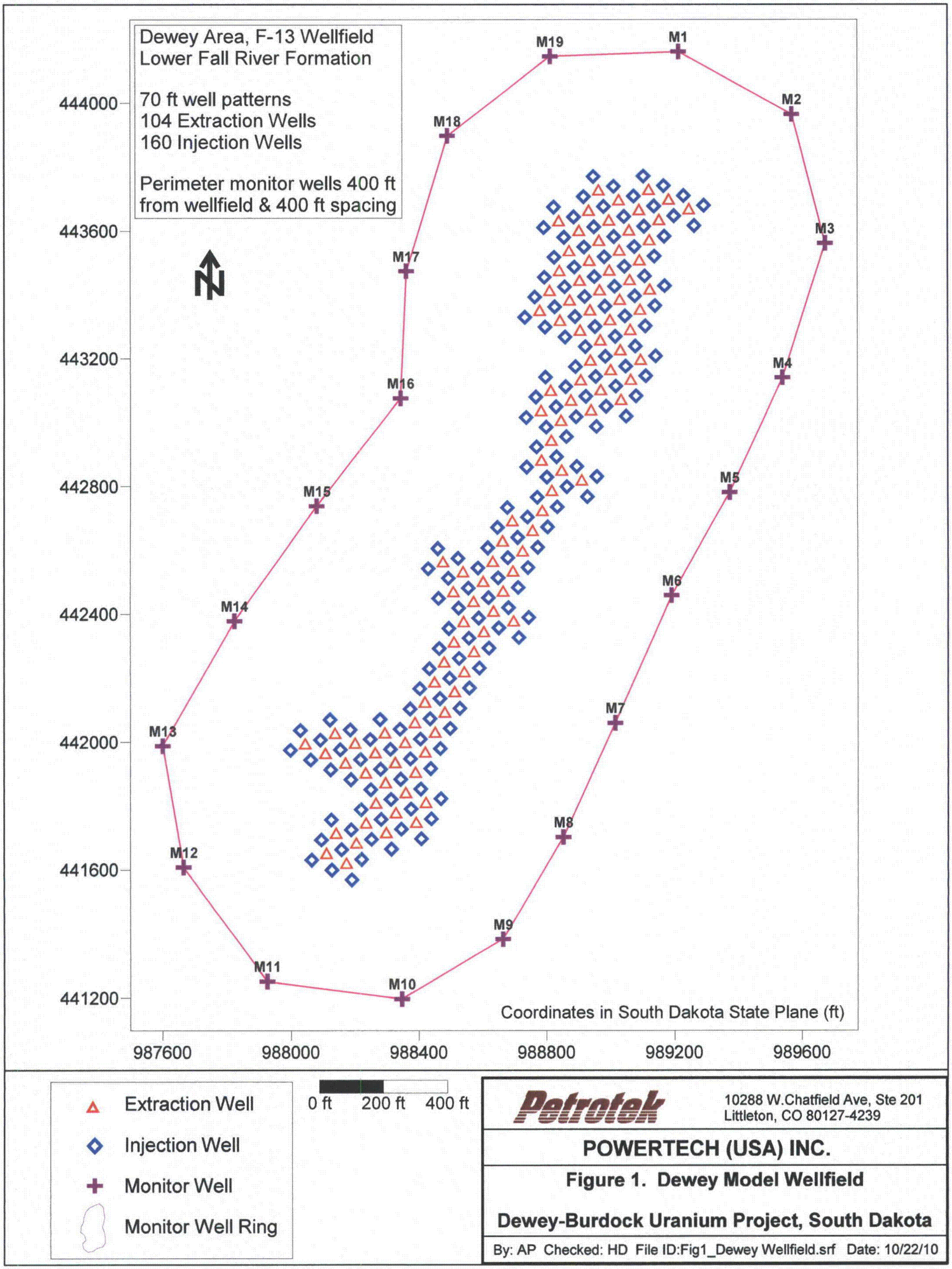
	Drawdown Residual* (DB 07-32-05) (265 ft from PW)	Drawdown Residual* (DB 07-32-04C) (467 ft from PW)	Drawdown Residual* (DB 07-29-7) (2,400 ft from PW)	Residual Sum of Squares, 2 Closest Wells[1]
K = 3.1 ft/day				
S=3e-5	-0.34	-1.11	-3.03	1.35
S=4e-5	**0.23**	**-0.53**	**-2.5**	**0.33**
S=5e-5	0.68	-0.09	-2.09	0.47
S=6e-5	1.04	0.28	-1.77	1.16
K = 3.2 ft/day				
S=3e-5	0.01	-0.83	-2.94	0.69
S=4e-5	0.57	-0.37	-2.43	0.46
S=5e-5	1	0.16	-2.03	1.03
S=6e-5	1.35	0.51	-1.72	2.08
K = 3.4 ft/day				
S=3e-5	0.67	-0.31	-2.79	0.55
S=4e-5	1.19	0.21	-2.3	1.46
S=5e-5	1.6	0.62	-1.93	2.94
S=6e-5	1.93	0.95	-1.63	4.63
K = 3.6 ft/day				
S=4e-5	1.75	0.65	-2.18	3.49
S=5e-5	2.13	1.03	-1.83	5.60
S=6e-5	2.45	1.34	-1.54	7.80

Notes:

* - A positive sign indicates underprediction of drawdown; negative sign indicates model output drawdown more than observed drawdown.

1 - Calibration based on evaluation at two closest monitoring wells, as indicated in text.

Bold indicates best fit utilized for wellfield model simulations.



Petrotek

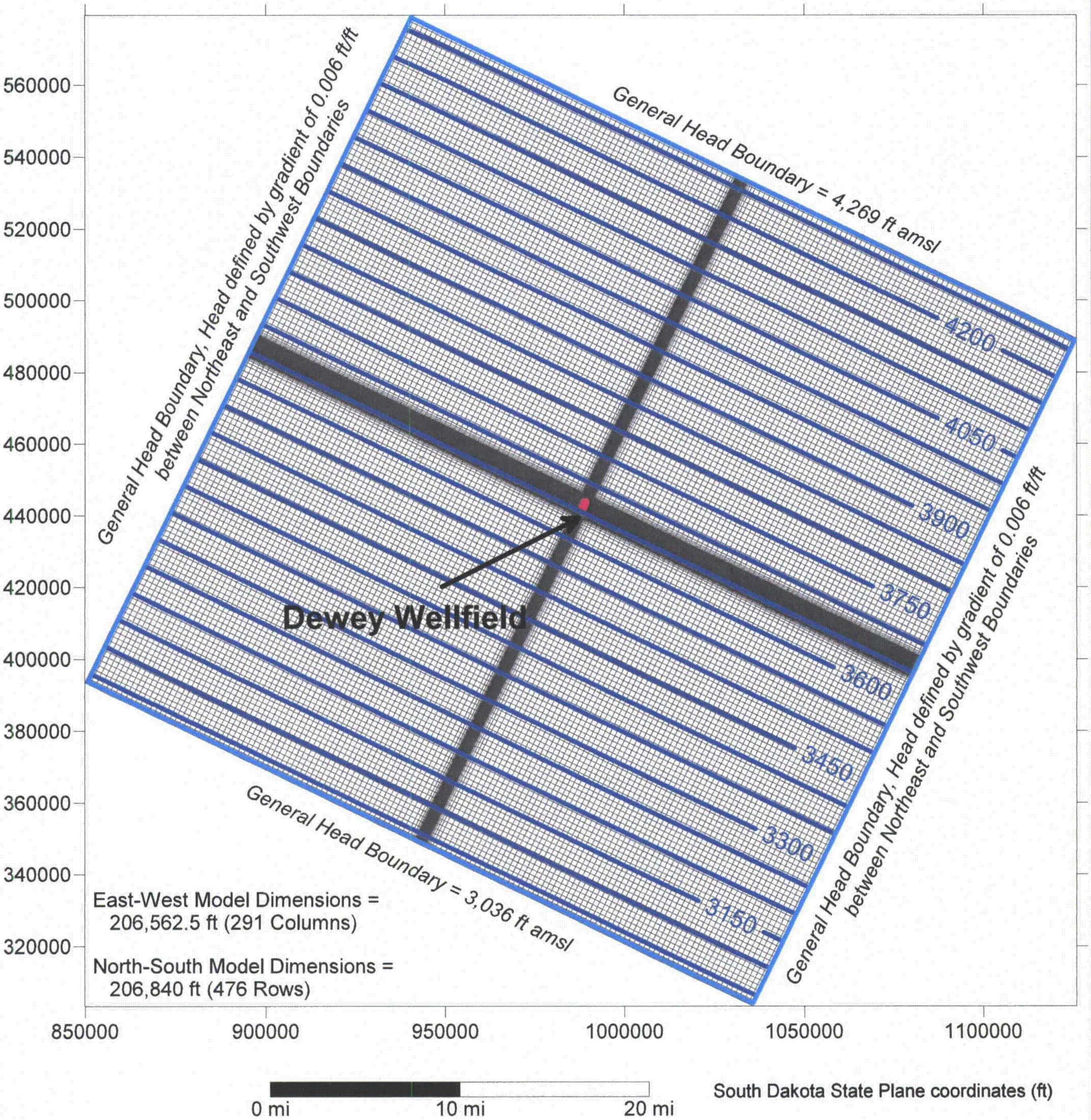
10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 1. Dewey Model Wellfield

Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig1_Dewey Wellfield.srf Date: 10/22/10



Monitor Well Ring

General Head Boundary

Static Potentiometric Surface (ft amsl)
Contour interval = 50 feet

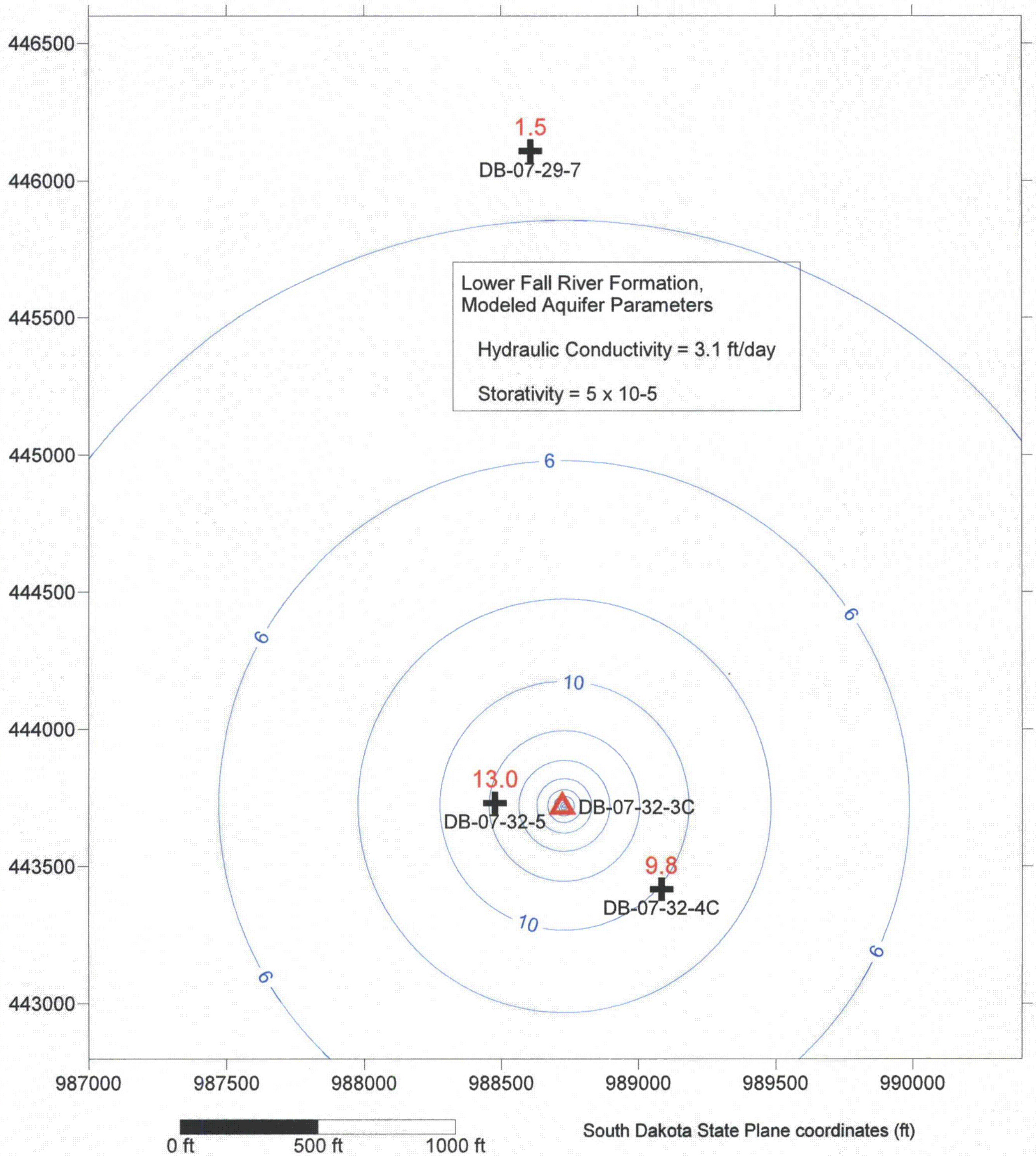
Petrotek

10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 2. Model Domain, Boundary Conditions, Background Potentiometric Surface Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig2_Dewey WF Model.srf Date: 10/22/10



Pumping Well

Observation Well

13.0 Observed Drawdown (ft)

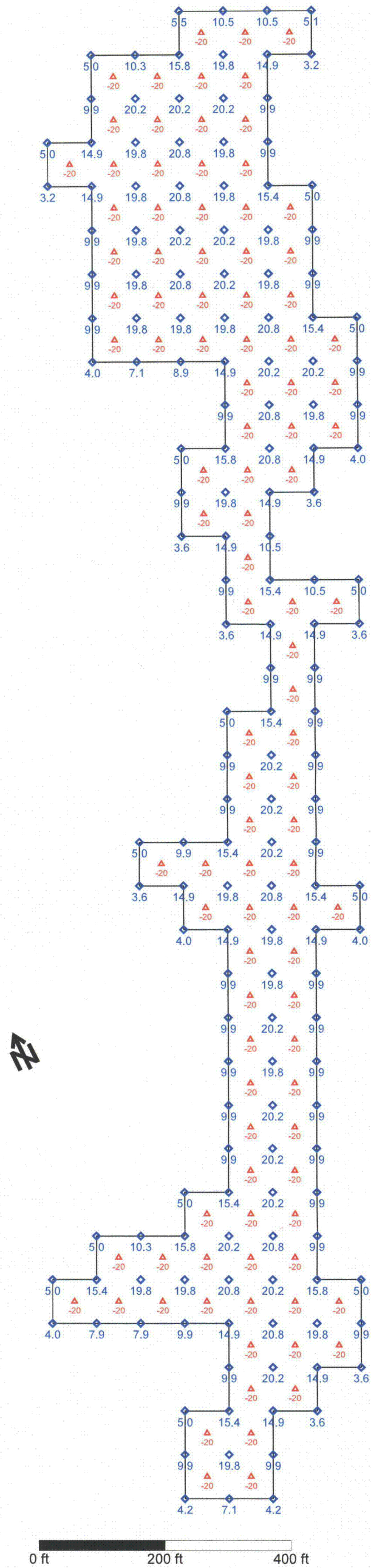
Simulated Drawdown
Contour Interval = 2 foot

Petrotek
10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 3. Dewey Area 2008 Pump Test Calibration Results
Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig3_PT Calibration.srf Date: 10/22/10



Note:
Dewey F-13 Wellfield balanced and simulated for a period of 2 years, at 1% bleed.

△ Extraction Well

◇ Injection Well

-20 Extraction Well Pump Rate (gpm)

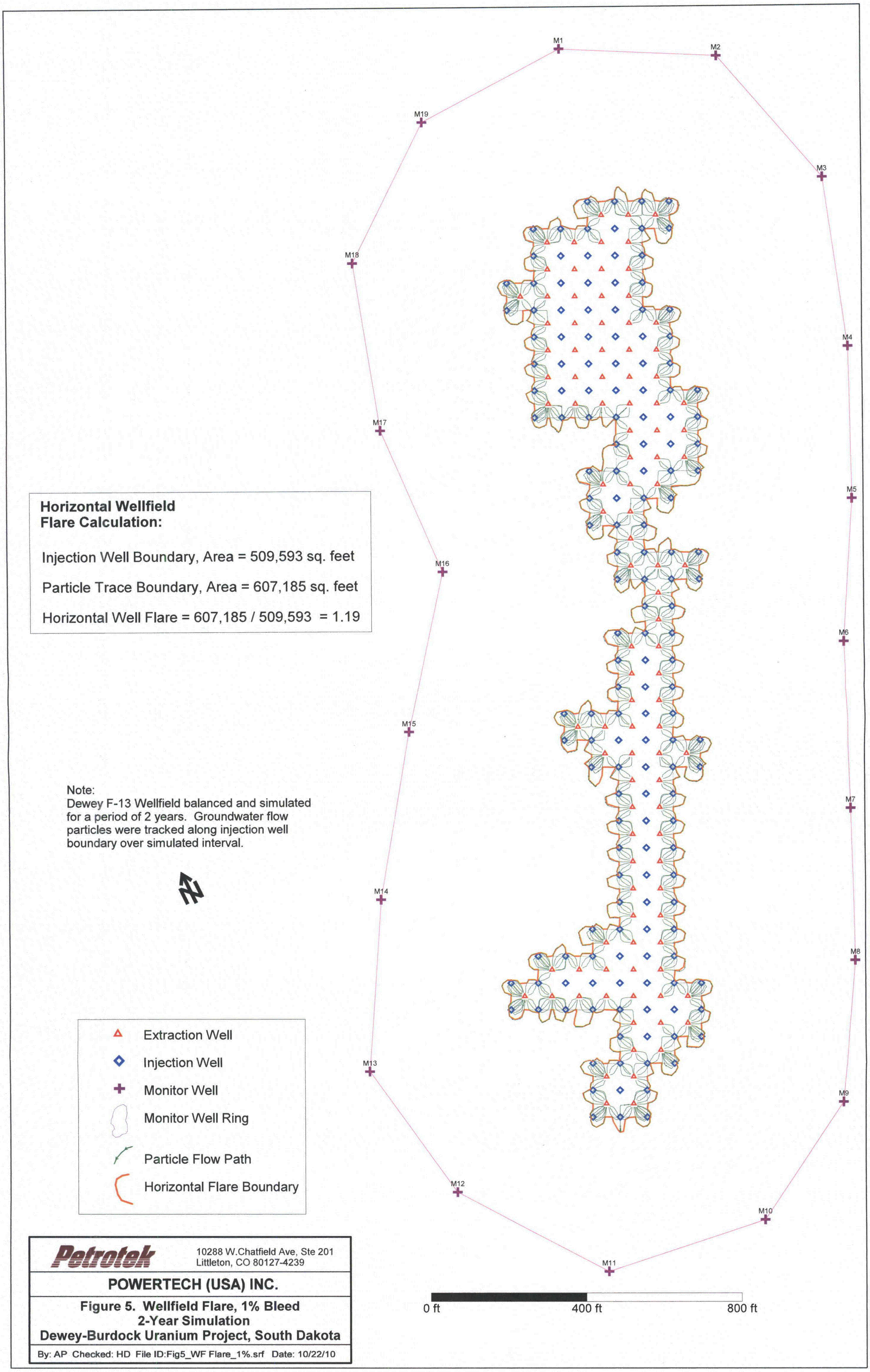
5.0 Injection Well Pump Rate (gpm)

Petrotek
10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 4. Balanced Wellfield Rates, 1% Bleed
2-Year Simulation
Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig4_1% Bleed Rates.srf Date: 10/22/10

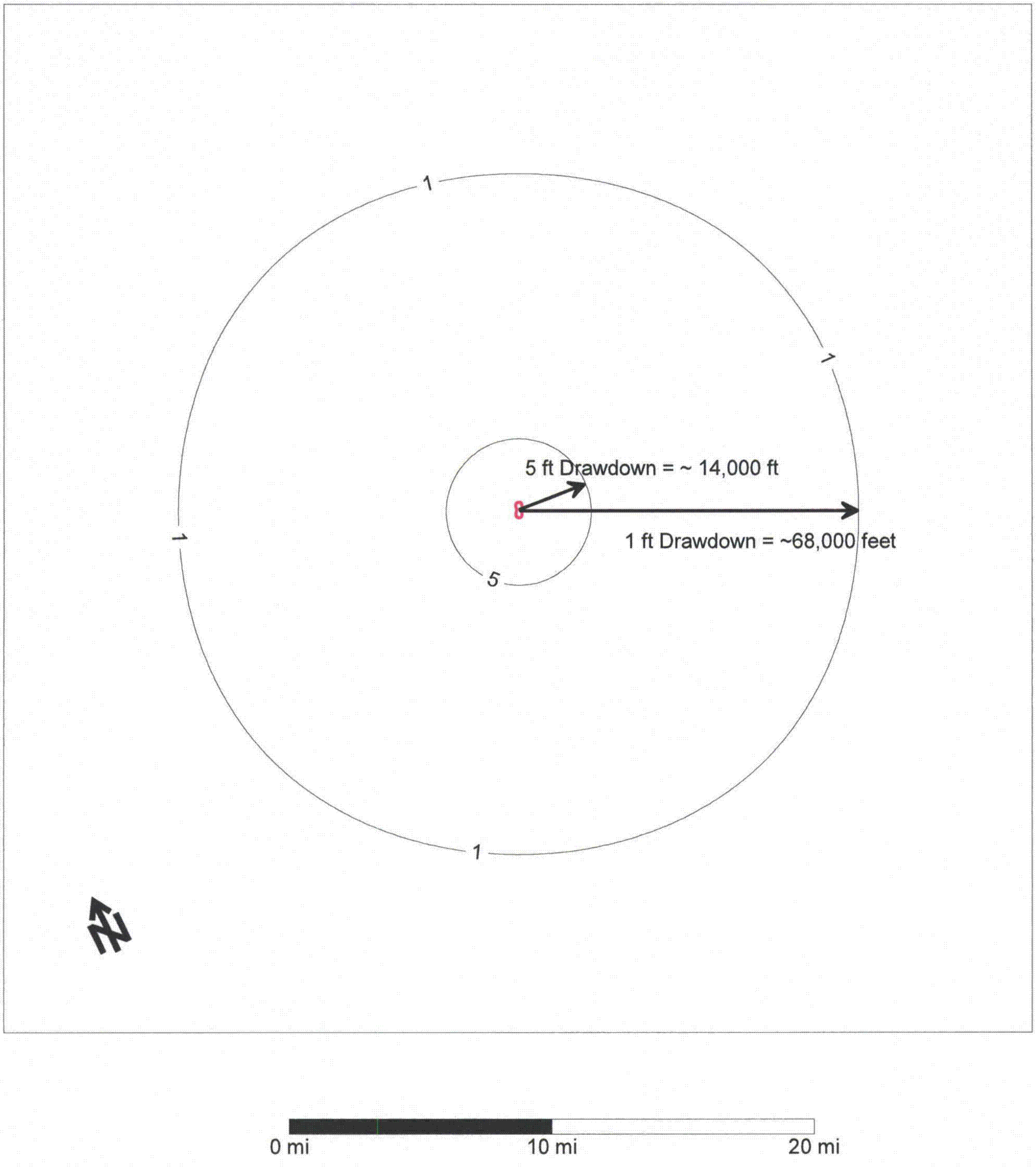


Petrotek 10288 W.Chatfield Ave, Ste 201 Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 5. Wellfield Flare, 1% Bleed
2-Year Simulation
Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig5_WF Flare_1%.srf Date: 10/22/10



Monitor Well Ring

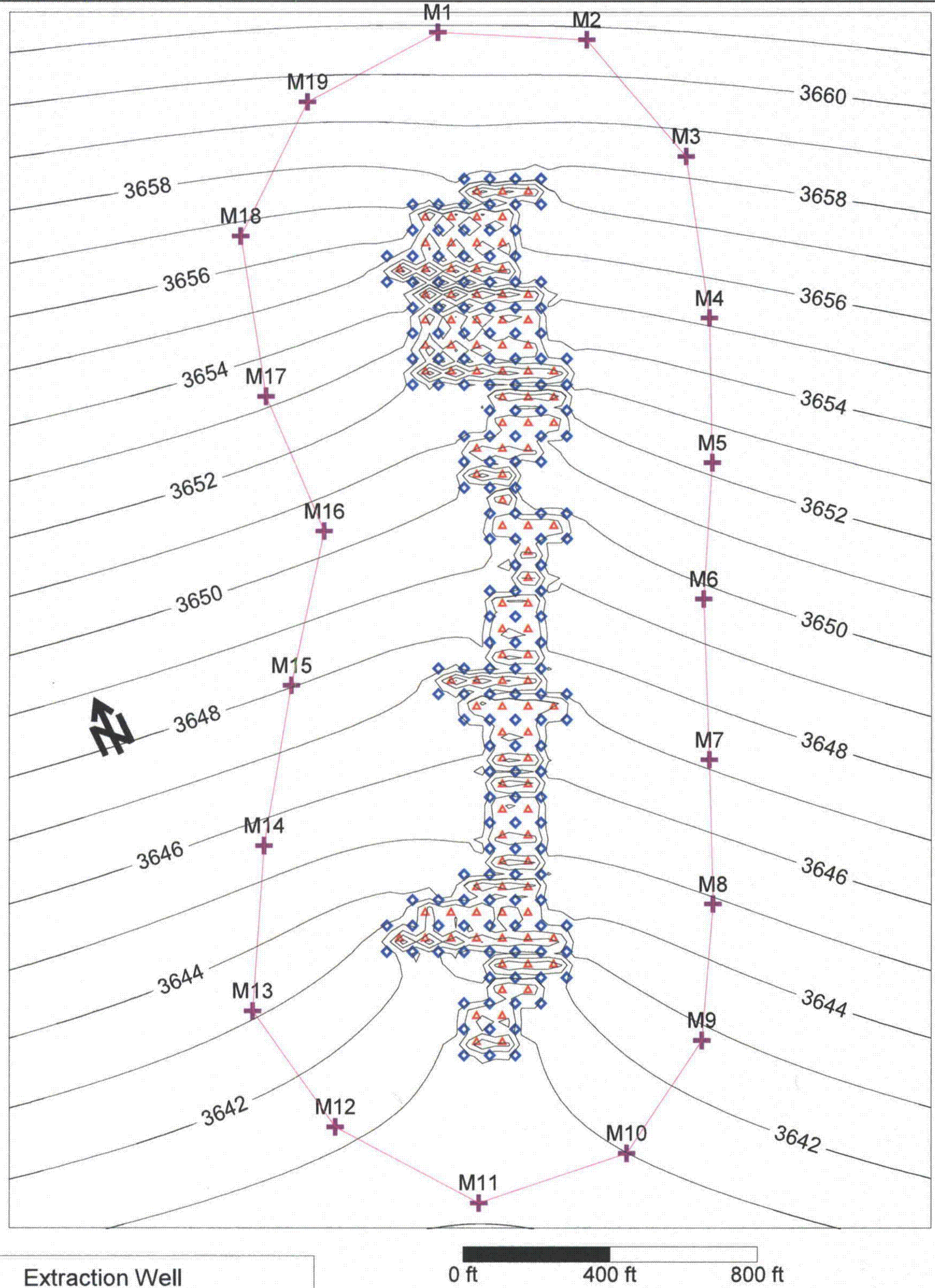
Drawdown Contour (ft)

Petrotek 10288 W.Chatfield Ave, Ste 201 Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 6. Simulated Regional Drawdown, 1% Bleed 2-Year Simulation Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig6_RegionalDDN.srf Date: 10/22/10



Extraction Well
Injection Well
Monitor Well
Monitor Well Ring
Simulated Head (ft amsl)
Contour Interval = 1 foot

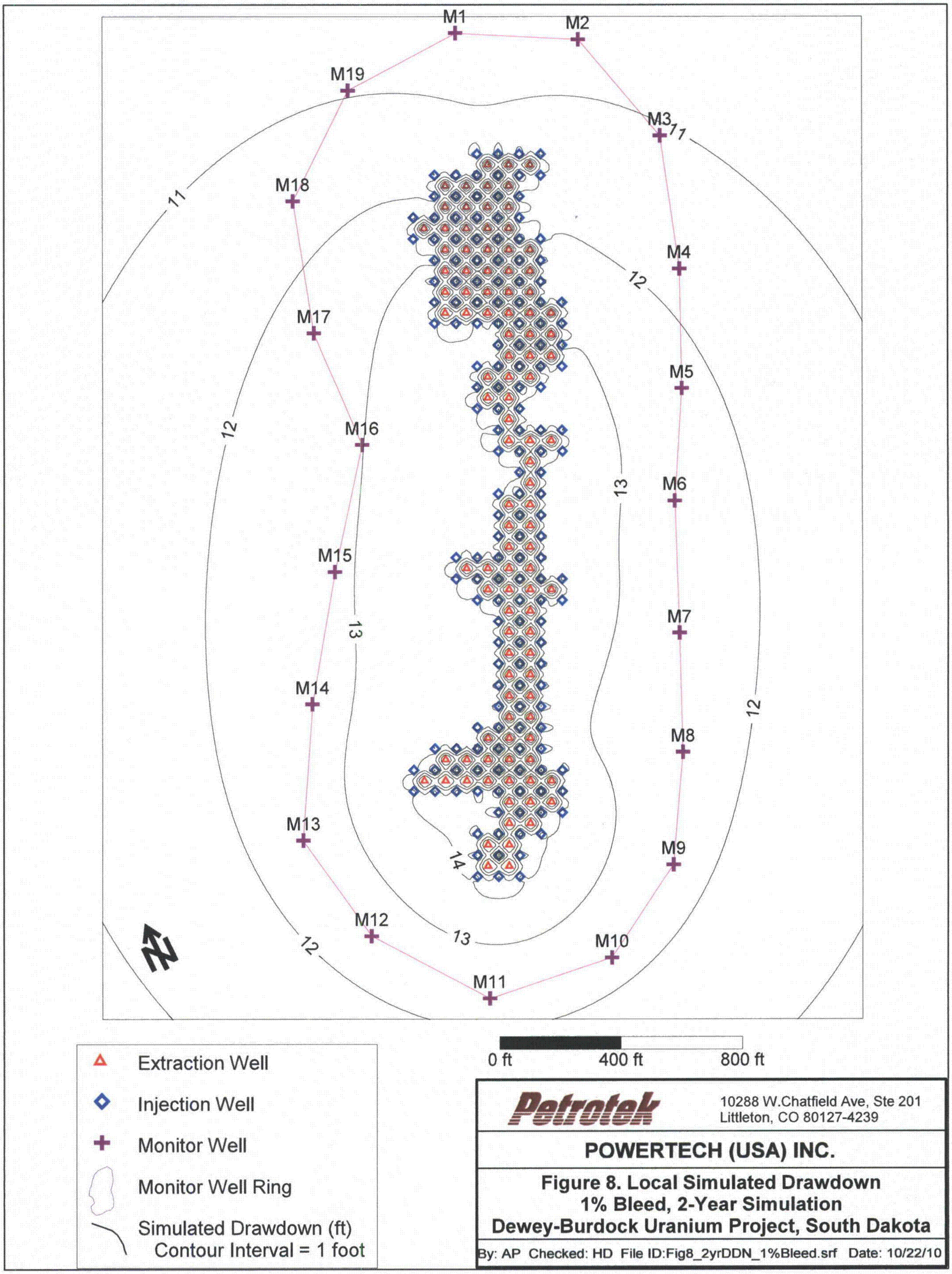
Petrotek

10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 7. Local Potentiometric Surface
1% Bleed, 2-Year Simulation
Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig7_2yrHead_1%Bleed.srf Date: 10/22/1(



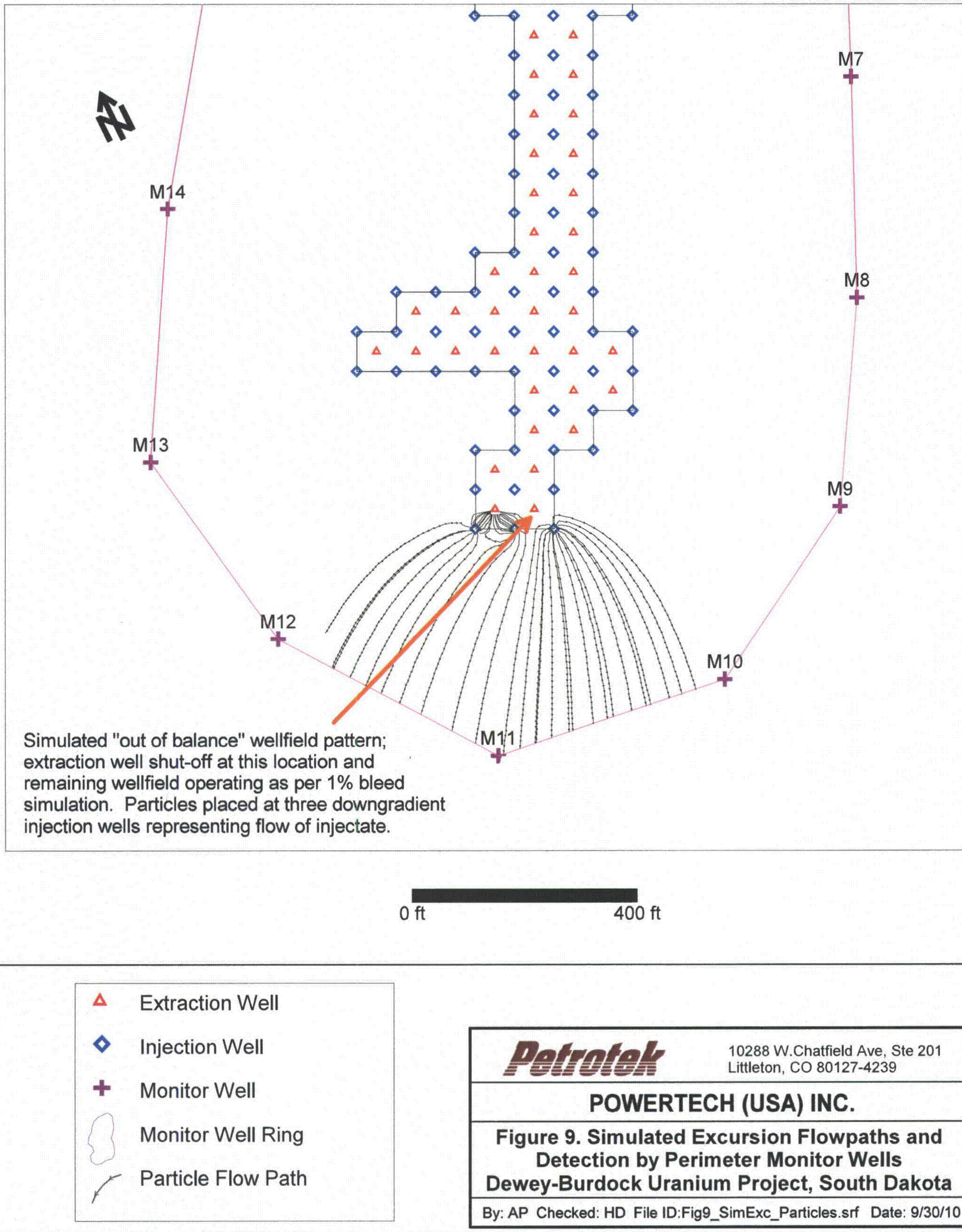
Petrotek

10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 8. Local Simulated Drawdown
1% Bleed, 2-Year Simulation
Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig8_2yrDDN_1%Bleed.srf Date: 10/22/10

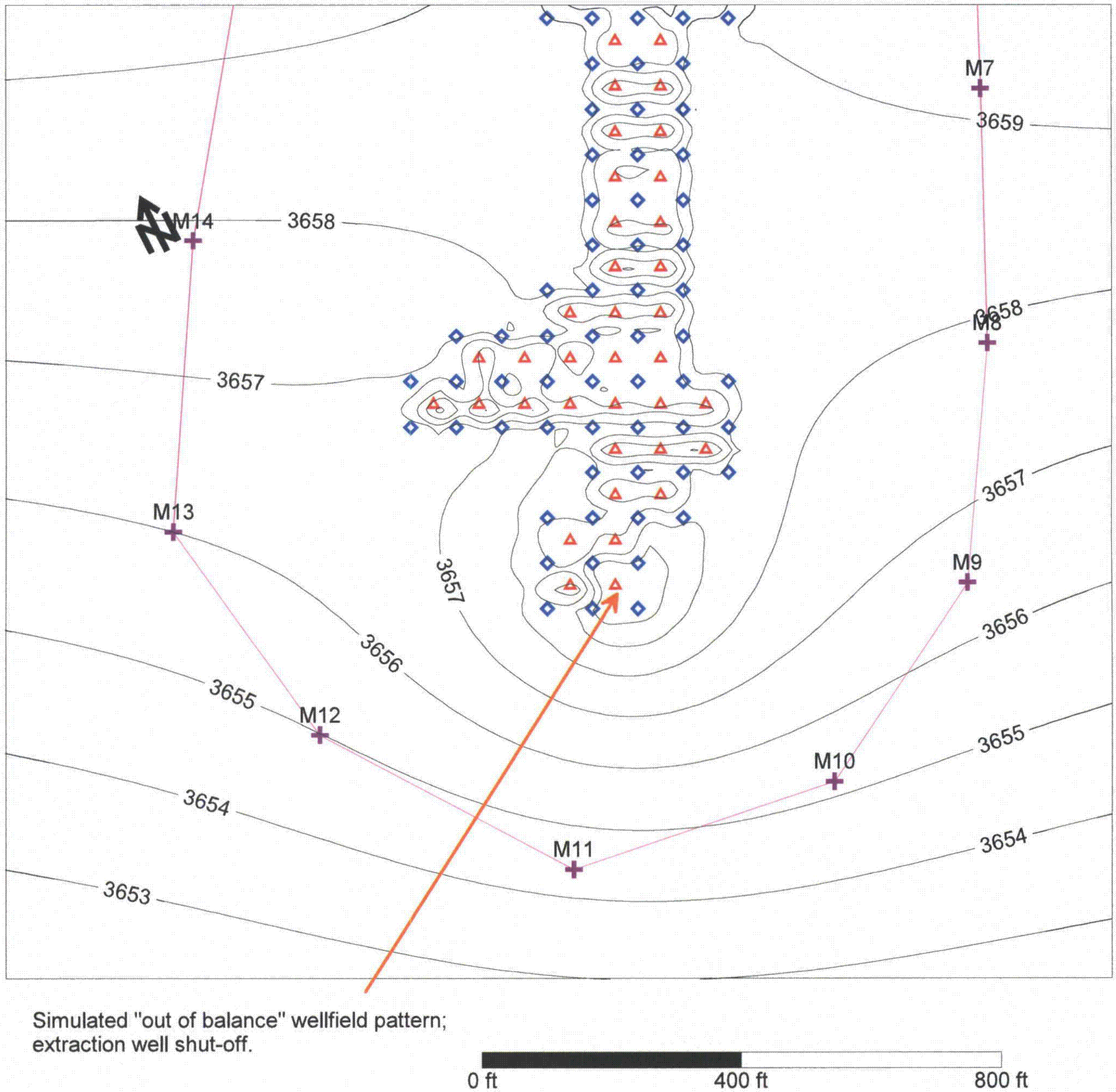


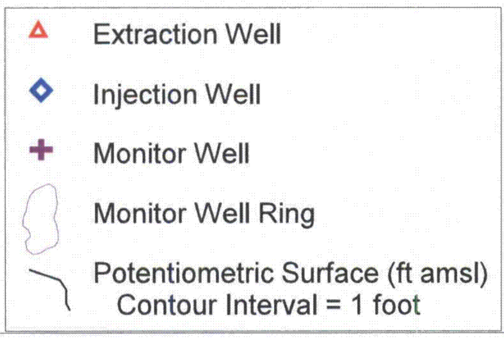
Petrotek
10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 9. Simulated Excursion Flowpaths and Detection by Perimeter Monitor Wells Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig9_SimExc_Particles.srf Date: 9/30/10



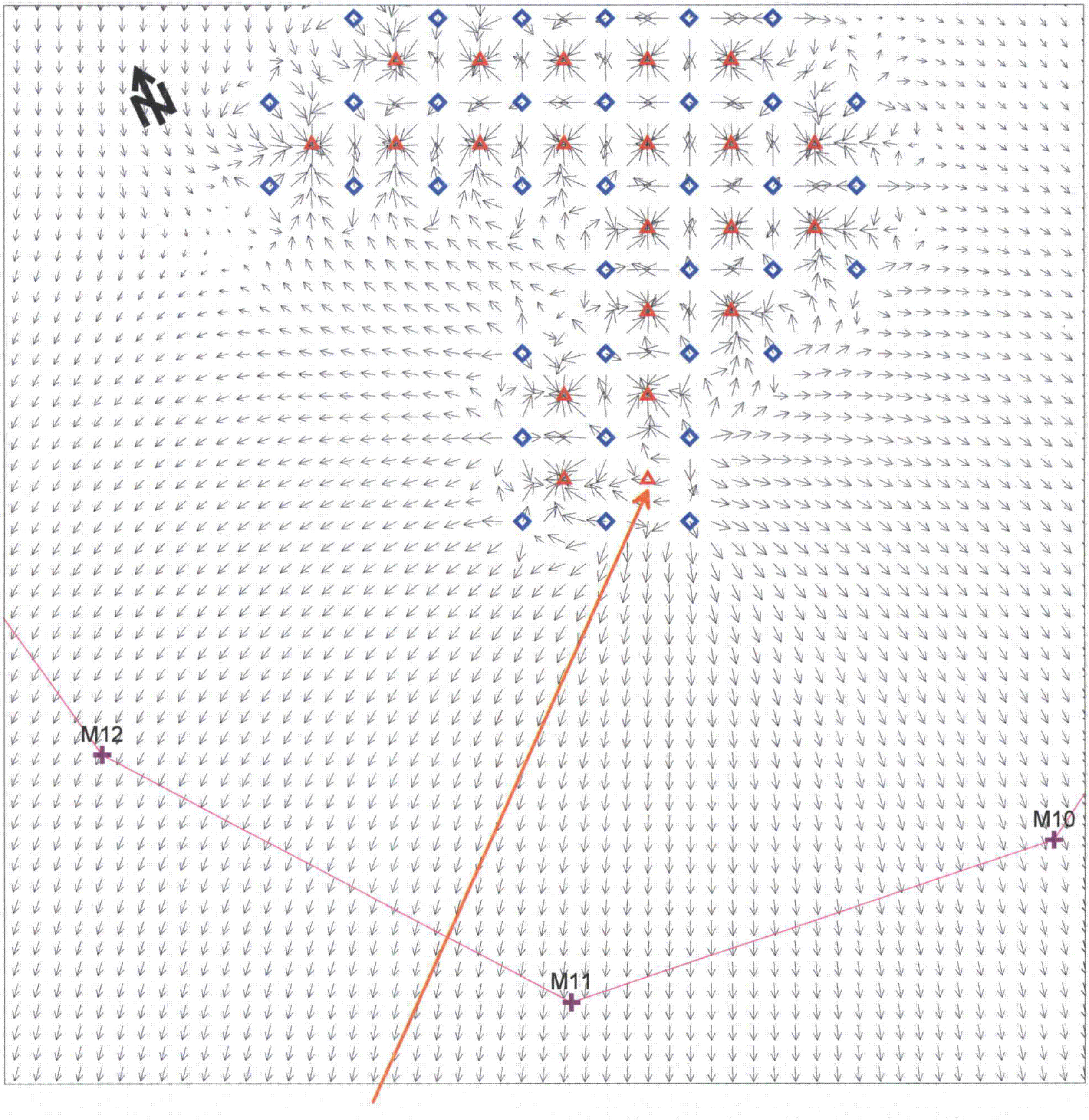


Petrotek
10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 10. Potentiometric Surface, Simulated Excursion
Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig10_SimExc_Head.srf Date: 10/22/10



Simulated "out of balance" wellfield pattern; extraction well shut-off.

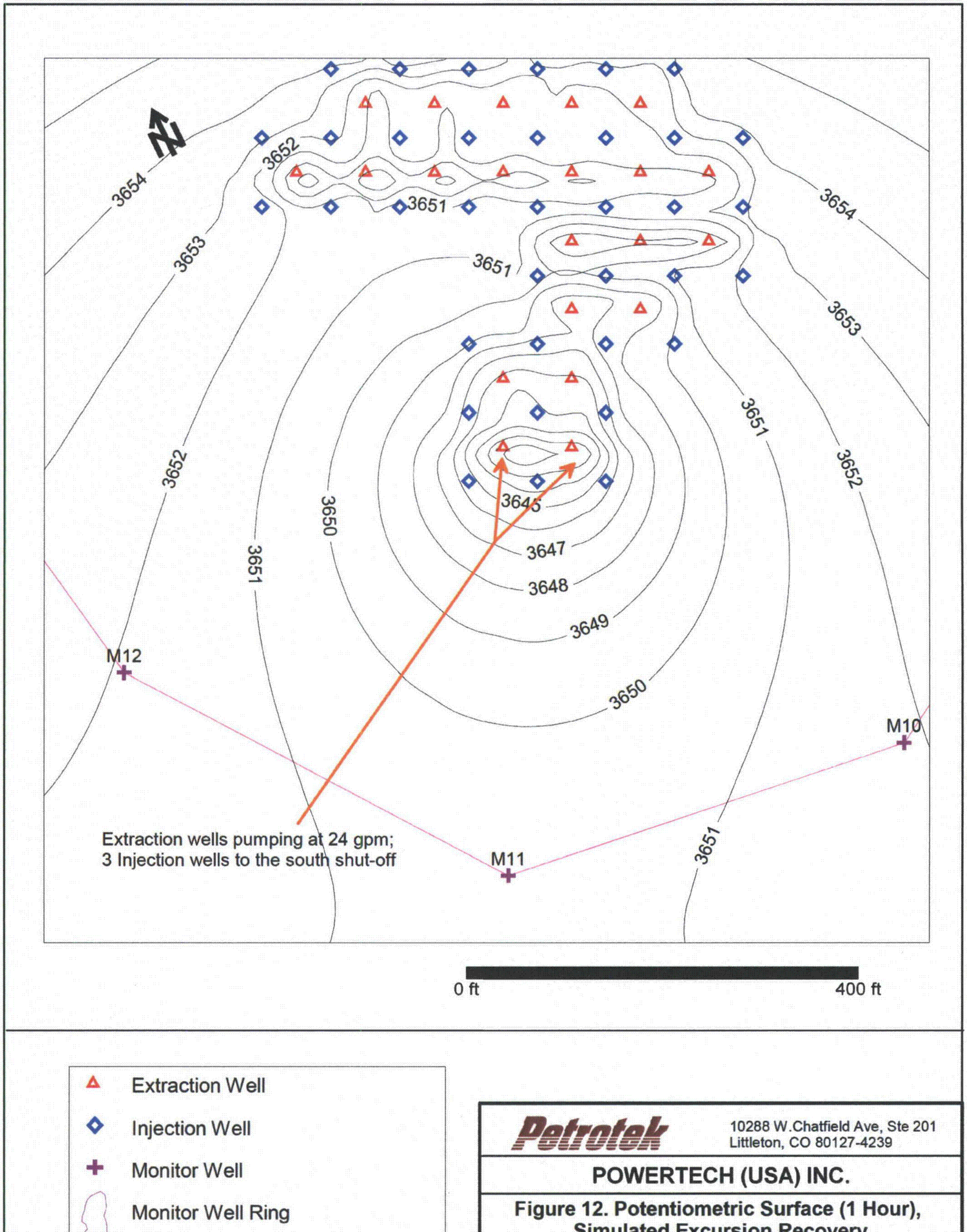
△	Extraction Well
◇	Injection Well
+	Monitor Well
	Monitor Well Ring
↓	Groundwater Flow Velocity Vector

Petrotek 10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 11. Velocity Vectors, Simulated Excursion Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig11_SimExc_Vectors.srf Date: 10/22/10

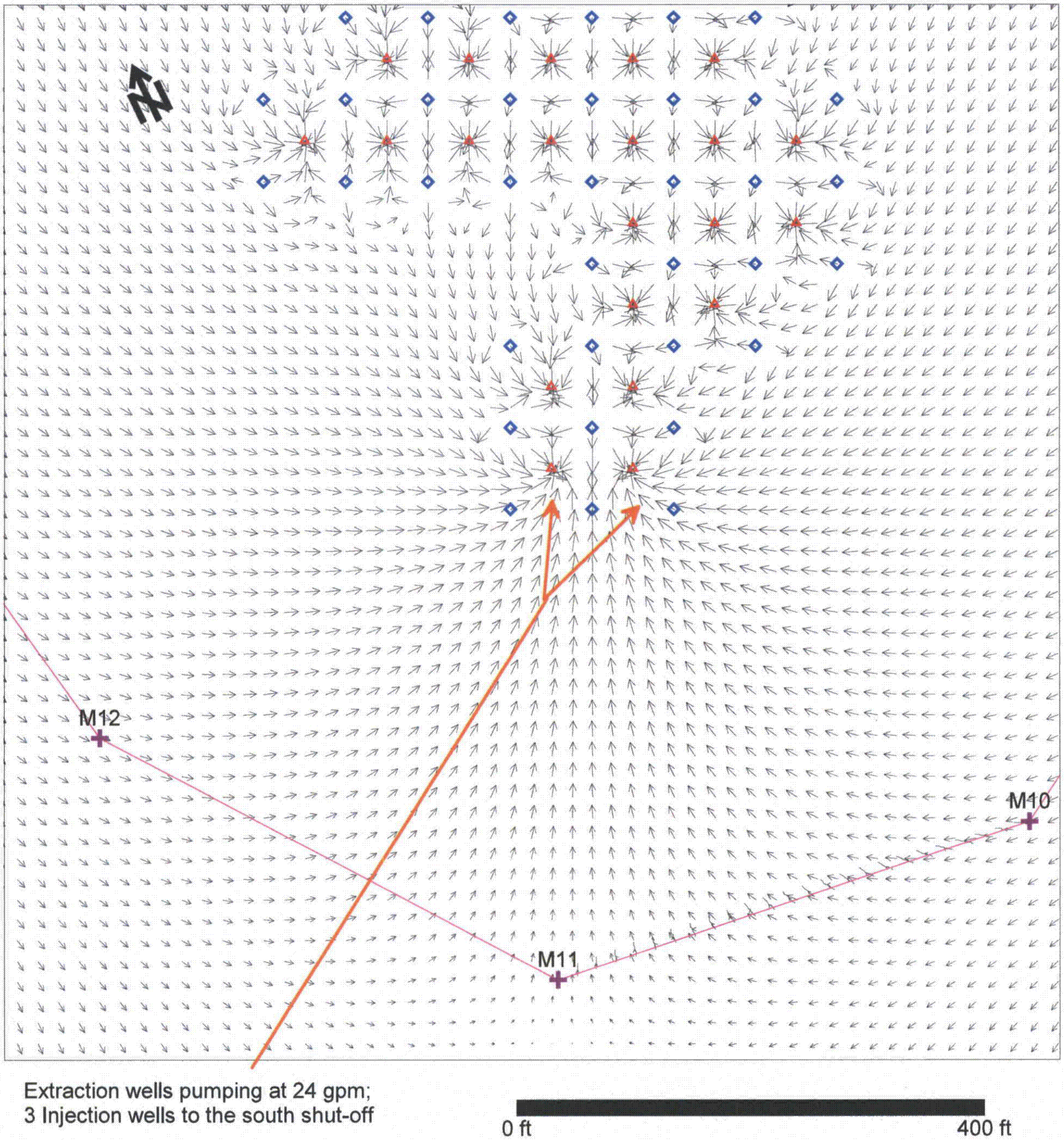


Petrotek
10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 12. Potentiometric Surface (1 Hour), Simulated Excursion Recovery Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig12_Recovery_Head.srf Date: 10/22/10



Extraction Well

Injection Well

Monitor Well

Monitor Well Ring

Groundwater Flow Velocity Vector

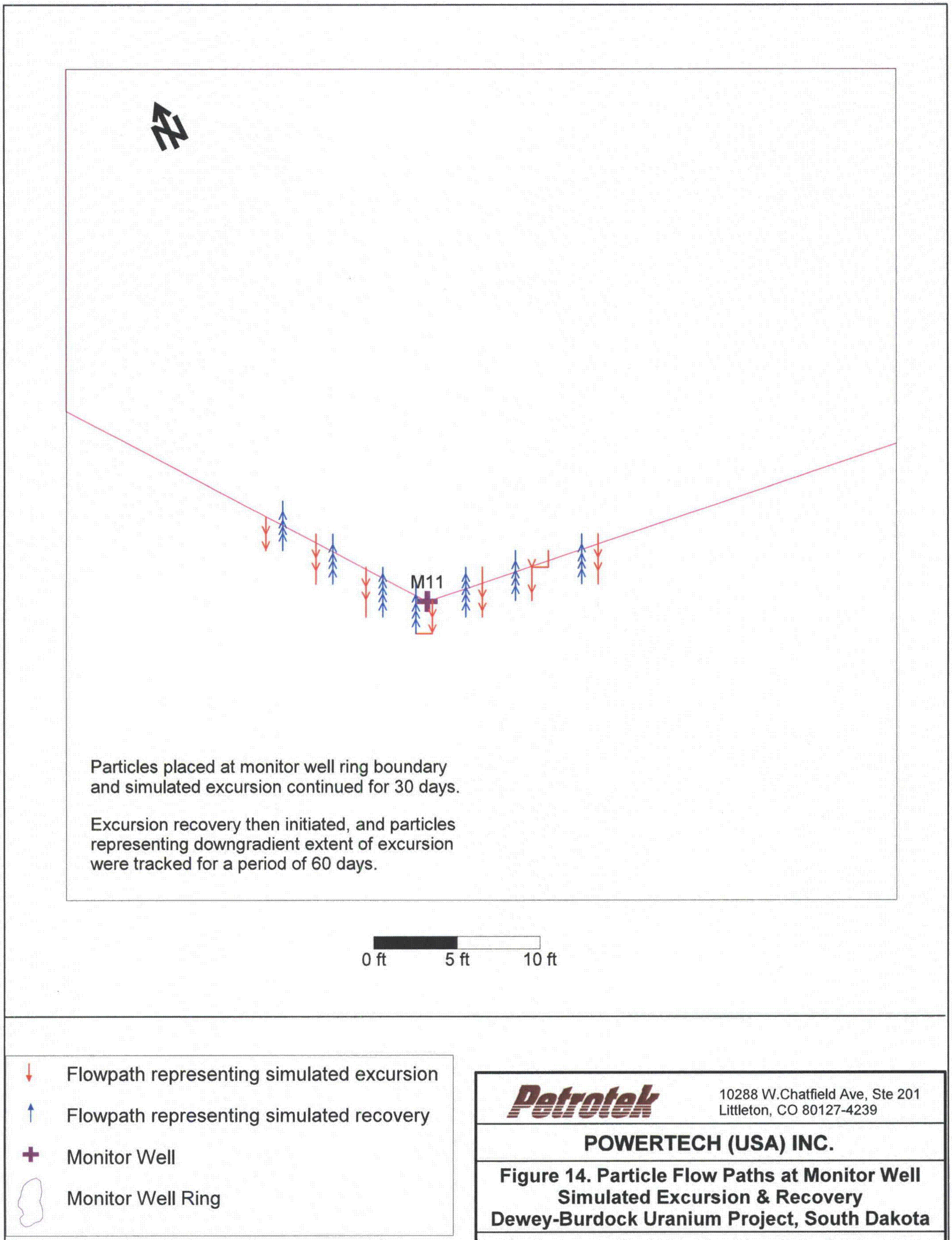
Petrotek

10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 13. Velocity Vectors (1 Hour), Simulated Excursion Recovery Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig13_Recovery_Vector.srf Date: 10/22/10



Petrotek

10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

POWERTECH (USA) INC.

Figure 14. Particle Flow Paths at Monitor Well Simulated Excursion & Recovery Dewey-Burdock Uranium Project, South Dakota

By: AP Checked: HD File ID:Fig14_Exc&RecovPath.srf Date: 10/22/10

Environmental Effects 7.0

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-7-1

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.

Response: TR RAI-7-1

See TR_RAI-Response and Replacement Pages, Section 7.0-1 for additional information in TR Section 7.5.2 "Potential Chemical Risks" concerning the following preventative and mitigation measures information:

- Major pipe or tank ruptures in the CPP or Satellite facility
- Capacities of sumps and bermed areas

TR RAI-7-2

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.

Response: TR RAI-7-2

See TR_RAI 7.0-1 and 7.0-3; also see ER Section 4.14.1.1."Potential Chemical Impacts and ER Section 5.4, 5.12; TR Section 4.2.1.4. 4.2.3.1, 4.2.3.2, 4.3, 5.4, and TR_RAI-Response and Replacement Pages; Section 7.5.2 "Potential Chemical Risks".

TR RAI-7-3

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.

Response: TR RAI-7-3

See TR_RAI-Response and Replacement Pages, 7.0-3 for additional information provided in TR Section 7.5.1 "Consequences, Preventative and Mitigation Measures of a Potential Fire or Explosion" for information regarding:

- Accident Consequences - Explosions
- Preventative and Mitigation Measures
- Preventative and mitigating measures-Wildfire

TR RAI-7-4

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.

Response: TR RAI-7-4

See TR_RAI-Response and Replacement Pages, Section 7.0-4 for additional informaiton in TR Section 7.5.6 "Potential Natural Disaster Risk".

POWERTECH (USA) INC.

Response: TR RAI-7.0-1 and 7.0-2

TR Section 7.5.2

Potential Chemical Risks

Preventative and Mitigation Measures

Preventative and mitigating measures-Wildfire

In order to protect facilities from wildfires, all facility building 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 if necessary. The creation of this buffer zone is expected to prevent any significant damage to equipment that could cause a chemical accident by acting as a firebreak if needed.

Within the well fields, vegetation will be removed, mowed or sprayed 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.

The emergency response plan will include descriptions of the following provisions of 29 CFR Part 1910:

- Notification and evacuation procedures
- Personal protective equipment
- General fire fighting safety rules
- Reporting procedures
- Electrical and gas emergencies

7.5.2 Potential Chemical Risks

In general, most ISL facilities utilize hazardous chemicals during the extraction process, to process wastewater, and during restoration of groundwater quality. Several hazardous chemicals will be used in the project ISL process. Bulk hazardous chemicals will be stored on-site in areas at a distance that will pose no significant hazard to the public or workers' health and safety. Powertech (USA) will have strict standard operating procedures regarding receiving, storing, handling, and disposal of hazardous chemicals to ensure the safety of the public and workers. Industrial safety aspects associated with the use of these hazardous chemicals will be regulated by several agencies including the EPA, SD DENR and OSHA.

Risk assessments completed by the NRC in NUREG-6733 for ISL facilities focused on indirect interactions between the chemicals used in ISL mining and other substances and the potential of operational hazards to workers. Powertech will, via engineering design and implementation of safety standards utilized in the chemical process industry, ensure that risk from chemical events are lower or at what is considered acceptable for the industry. The radiological risks are minimal when considering specific chemicals that would directly interact with radionuclides to cause a hazardous event (NUREG/CR-6733, 2001). Therefore, engineering controls and implementation of the appropriate design, operating practices, codes and standards will serve to prevent a chemical event from impacting a radiological event. Acceptable safeguards will be implemented to ensure that if the two types of events were to impact one another the result would be small and quickly addressed by trained staff.

The largest potential health and safety impact would result from an accidental release of these chemicals. Releases of these chemicals at levels greater than the reportable quantity level under the Community Right to Know Act (40 CFR 355) will be reported to the National Response Center, US EPA, SD DENR, and NRC. Specific quantities or uses of chemicals that require certain controls, procedures, or safety measures are defined by statutes:

- 29 CFR Part 1910.119 and 1910.120
- 40 CFR Part 68, 302.4, and 355

Compliance with these necessary requirements will reduce the likelihood of a release. Offsite potential impacts would be SMALL, while impacts to workers involved in response clean up could receive MODERATE impacts that would be mitigated by implementing procedures and training requirements (NUREG-1910, 2008).

Restoration activities will at times overlap with some operational activities such as operation of well fields, wastewater treatment, and disposal. The potential occupational health and safety impacts are expected to be less than operational impacts due to the absence of some operational activity, such as yellowcake drying operations and IX.

Further information on preventative measures, consequences and action implemented in the case of a major pipe rupture in the CPP or SF is provided in the following paragraphs.

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, the applicant will comply with 40 CFR Part 355 in disclosing the reportable quantities of sulfuric acid and sodium hydroxide, the only chemicals used in the facilities that are expected to be present in quantities greater than the minimum reportable amounts. Also, see TR Section 4.2.3.2 "Central Processing Plant."

b. Consequences: The rupture of a major pipe or tank within either the CPP or Satellite facility may result in the release of process liquids onto the floor of the facility. The spilled material would be directed to the trench drains and sumps, from which it could be pumped to the wastewater tanks and ultimately to disposal. Alternatively, the spilled materials could be transferred to the central plant pond for possible reprocessing prior to eventual disposal. No air-dried material would be present due to a leak from a pipe or tank and, consequently, no airborne radionuclides to be inhaled by the operators.

Preventative and Mitigative Measures

Because outdoor winter temperatures at the PAA will be below freezing, all tanks and pipelines that will contain fluids and are located outside the facilities will be heat traced to maintain the contents above the freezing point of the material. In particular, the sulfuric acid and sodium hydroxide (caustic) pipelines and tanks will fall into this category. Freezing of the sulfuric acid or caustic pipelines would prevent flow in those lines, but would not likely lead to a pipe or tank rupture. Pipelines between the facilities and the well fields, as well as pipelines within well fields, will be buried to a depth below the frost line in order to prevent freezing of the aqueous solutions within those lines. Header houses, valve vaults, and wellhead covers will contain electric heaters in order to prevent freezing temperatures from occurring in these structures.

<u>Windstorm/winter storm</u>

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 in the within the PAA. During winter months, winter storms with high winds and snowfall may cause blizzard conditions, but these events do not present a higher potential for 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 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.

Capacities of sumps and bermed areas

The central plant and satellite facilities are 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 central plant, the largest vessel is the yellowcake thickener, which has an operating volume of 5,050 ft^3. For the satellite facility, the largest vessel is the utility water tank with a volume of 16,000 gallons, or approximately 2,140 ft^3. For Both facilities, a containment curb along the perimeter wall of each slab with internal trench drains and sumps is sufficient to contain a spill of 150% of the largest tank 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 wastewater disposal system. See also, TR Sections 3.2.8 "Chemical Storage and Feeding Systems and TR 5.7.1.3 "Spill Provision Plans."

7.5.3 Potential Groundwater Contamination Risks

Horizontal and vertical lixiviant excursions have the potential to contaminate the groundwater in the production aquifer or the overlying or underlying aquifers.

7.5.3.1 Potential Recovery Solution Excursions

Potential groundwater quality impacts from leach fluid excursions are discussed in detail in Section 7.2.5.3. Leach fluid excursions have the potential to contaminate adjacent non-exempt aquifers with constituents that have been mobilized during the ISL process. There are two types of excursions: vertical and horizontal. A vertical excursion is movement of solution into overlying or underlying aquifers. A horizontal excursion is a lateral movement of leach fluids outside the production zone of the orebody aquifer.

The potential impacts of horizontal and vertical excursion could be significant. Monitoring wells will be installed within and around the production zone to ensure timely detection of horizontal excursions. Monitoring wells will be installed in the overlying and underlying aquifers to ensure timely detection of vertical excursions.

7.5.4 Potential Well Field Spill Risks

The failure of a process pipeline within the well field could result in the discharge of pregnant or barren lixiviant to the surface. In order to minimize the amount of process fluid that is lost should a failure occur, high and low pressure alarms and shutoffs as well as flowmeters will be

POWERTECH (USA) INC.

Response: TR RAI-7.0-3

TR Section 7.5.1

Consequences, Preventative and Mitigation Measures

Fires and Explosions

Powertech (USA) is currently considering two scenarios for liquid effluent disposal. The first involves management of well field "bleed" water and well field restoration water on-site using evaporation ponds and land application. The second scenario involves management of well field "bleed" water, well field restoration brine water, and CPP brine water in a waste disposal wells. As the project moves forward, the feasibilities of either scenarios or some combination of two scenarios will be evaluated and a determination will be made based on effectiveness, implementability, and cost.

7.5 Potential Effects of Accidents

The NRC has determined that the effects of all accidents that are the most probable to occur at an ISL facility are minor, provided that effective emergency procedures exist and are utilized in the event of an accident, and that personnel are properly trained to handle the situations. When compared with conventional underground and open pit mining methods, accidents associated with ISL uranium production typically have far less severe consequences. An assessment of potential accidents are discussed in the following sections.

7.5.1 Consequences, Preventative and Mitigation Measures of a Potential Fire or Explosion

Accident Consequences - Explosions

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 greater potential to impact radiological safety of the workers. An explosion in a sealed drum would be contained within the dryer room. According to the NRC, multiple hearth dryers posed a greater hazard than vacuum dryers. Multiple hearth dryers operate at higher temperatures and may be directly fed with gas. The vacuum dryers proposed in this application operate at lower temperatures and are not directly fed by gas therefore posing 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 (NRC, 2009, § 4.2-56).

Preventative and Mitigation Measures

As noted in TR Section 3.2.8, 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.

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 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.
- Header houses will be ventilated by continuously in order to prevent any buildup of oxygen.
- The oxygen lines to each header house will be equipped with low pressure shut-off valves to minimize the delivery of 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.
- Personnel will receive training for responding to a fire or explosion.

The CPP facilities are designed to contain and reduce the exposures to individual 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, respiratory protection program in place and executed as necessary as part of the worker protection during 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, 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 protocol 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 building 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 if necessary. The creation of this buffer zone is expected to prevent any significant damage to equipment that could cause a chemical accident by acting as a firebreak if needed.

Within the well fields, vegetation will be removed, mowed or sprayed 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.

The emergency response plan will include descriptions of the following provisions of 29 CFR Part 1910:

- Notification and evacuation procedures
- Personal protective equipment
- General fire fighting safety rules
- Reporting procedures
- Electrical and gas emergencies

7.5.2 Potential Chemical Risks

In general, most ISL facilities utilize hazardous chemicals during the extraction process, to process wastewater, and during restoration of groundwater quality. Several hazardous chemicals will be used in the project ISL process. Bulk hazardous chemicals will be stored on-site in areas at a distance that will pose no significant hazard to the public or workers' health and safety. Powertech (USA) will have strict standard operating procedures regarding receiving, storing, handling, and disposal of hazardous chemicals to ensure the safety of the public and workers. Industrial safety aspects associated with the use of these hazardous chemicals will be regulated by several agencies including the EPA, SD DENR and OSHA.

Risk assessments completed by the NRC in NUREG-6733 for ISL facilities focused on indirect interactions between the chemicals used in ISL mining and other substances and the potential of operational hazards to workers. Powertech will, via engineering design and implementation of safety standards utilized in the chemical process industry, ensure that risk from chemical events are lower or at what is considered acceptable for the industry. The radiological risks are minimal

POWERTECH (USA) INC.

Response: TR RAI-7.0-4

TR Section 7.5.6

Potential Natural Disaster Risk

7.5.5.4 Potential Accidents Involving Radioactive Wastes

The disposal of all solid 11e.(2) byproduct waste generated during operations will be transported to an appropriately licensed disposal facility. Most of the solid waste shipping will occur during the site reclamation and decommissioning stage. The probability of an accident while transporting 11e.(2) waste for any given trip is similar to the probability discussed in Section 7.5.4.1. The potential risks, however, for exposure are less because 11e.(2) waste is generally less radioactive than dried yellowcake and much of the waste will consists of solid material that in the event of an accident would be easy to contain. All applicable DOT shipping regulations and requirements will be followed before and during shipment of 11e.(2) wastes to prevent a possible transportation accident.

7.5.6 Potential Natural Disaster Risk

NUREG/CR 6733 evaluates potential risks associated with ISL facilities for the release of radioactive materials or hazardous chemicals due to the effects of an earthquake or tornado strike. 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 ISL 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's site boundary. According to the model, the maximum 50-yr. dose to an individual's lung would be 8.3×10^{-7} rem and located approximately 2.5 miles from the mill. NUREG-6733/CR concluded that the risk of a tornado strike on an ISL 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 risks from a tornado strike would be considerably less than if the facilities were in a more populated area.

The NRC determined that the radiological consequences of materials released and dispersed due to earthquake damage at an ISL facility were no greater than for a tornado strike. NUREG-0706 determined that mitigation of earthquake damage could be attained following adequate design criteria. NUREG/CR-6733 concluded that risk from earthquakes is very low at uranium ISL facilities and that no design or operational changes were required to mitigate the risk, 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.

Nevertheless, there are risks to workers that must be addressed. The applicant 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, the applicant offers the following discussion on these issues.

Initially, the applicant 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 either the Edgemont or Hot Springs office, whichever is appropriate. If there is not enough time to evacuate, employees and others onsite would be directed to the conference room of the office building. Once it is safe to access the facilities, supervisory staff and radiation safety staff will begin the process of assessing damage to the facilities, including header houses and wellheads. This process would include radiological surveys and assessment of 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. It is worth noting that the authors of NUREG/CR-6733 state, "The authors conclude that tornado risk is very low at uranium ISL facilities and that no design or operational changes are required to mitigate this risk."

7.6 Potential Economic and Social Effects of Construction and Operation

The following section highlights potential socioeconomic impacts of the project to Custer and Fall River Counties. A cost benefit analysis for the project is presented in section 9.0.

7.6.1 Construction

Assuming a peak workforce of about 86 payrolled employees, the influx of workers is expected to result in a small to moderate impact in Custer and Fall River Counties because of the short