APPENDIX 6.6-A

Restoration Action Plan

POWERTECH (USA) INC.

Powertech (USA) Inc.
Dewey-Burdock Project
RESTORATION ACTION PLAN
License No: SUA-1600
July 2014

POWERTECH (USA) INC.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 RAP Composition 1
1.2 Programmatic Agreement Coordination 3
1.3 Financial Assurance Mechanism 3
1.4 Cost Details for Restoration and Reclamation Activities 4
2.0 AQUIFER RESTORATION 4
2.1 Introduction 4
2.2 Groundwater Restoration Criteria 5
2.3 Deep Disposal Well Option 6
2.4 Land Application Option 6
2.5 Combined Liquid Waste Disposal Option 7
2.6 Optional Groundwater Sweep 7
2.7 Pore Volume Calculations and Restoration Pore Volumes 8
2.8 Monitoring the Progress of Active Restoration 9
2.9 Restoration Stability Monitoring 10
3.0 FACILITIES DECOMMISSIONING AND RECLAMATION 12
3.1 Establishment of Surface Contamination Limits 12
3.2 Pre-Reclamation Radiological Surveys 12
3.3 Removal of Process Buildings and Equipment 14
3.4 Plans for Decommissioning Non-Radiological Constituents 15
3.5 Ponds 16
3.6 Surface Soil Cleanup Verification and Sampling Plans 16
3.7 Grading, Topsoil Replacement and Revegetation 17
3.8 Stream Channel Reclamation 17
4.0 WELL FIELD RECLAMATION 18
4.1 Well Plugging and Abandonment 18
5.0 RADIOLOGICAL SURVEY AND ENVIRONMENTAL MONITORING 19
6.0 REFERENCES 20

TABLE OF CONTENTS (Continued)

LIST OF ATTACHMENTS

Attachment RAP-1	Financial Assurance Mechanism
Attachment RAP-2	Financial Assurance Cost Estimate
Attachment RAP-3	Financial Assurance-Related Correspondence with Other Regulatory Agencies
Attachment RAP-4	Estimate of the Duration of Groundwater Restoration based on Current Experiences at Licensed ISR Facilities
Attachment RAP-5	Determination of Thorium-230 Soil Standard

RESTORATION ACTION PLAN

1.0 INTRODUCTION

This Restoration Action Plan (RAP) is submitted in support of Powertech (USA) Inc.'s (Powertech (USA)'s) Dewey-Burdock *in situ* recovery (ISR) uranium project located near Edgemont, South Dakota. Powertech (USA) is submitting this RAP as a stand-alone document to comply with license conditions (LCs) 9.5 and 12.23 of Powertech (USA)'s materials license No. SUA-1600. This RAP is necessary to provide NRC staff with decommissioning and decontamination (D&D) procedures and related financial assurance cost estimates in one document. Preparation of this RAP is in accordance with NRC's requirements as defined in 10 CFR Part 40, Appendix A, Criterion 9.

1.1 RAP Composition

The composition of this RAP follows that of Strata Energy's RAP for the Ross ISR Project, which was designed to closely follow the RAP for Hydro Resources, Inc.'s Crownpoint Uranium Project. This RAP addresses D&D activities planned throughout the life of the project, while the financial assurance estimate in Attachment RAP-2 only covers the activities planned during the first year of license possession, specifically during the time period July 1, 2014 through June 30, 2015. D&D activities planned throughout the life of the project include:

- Aquifer restoration
- D&D of the processing facilities, other facility buildings and ponds
- D&D of wastewater disposal systems, including deep disposal wells and appurtenances and/or land application systems
- D&D of well field infrastructure, including pipelines, header houses and production, injection and monitor wells
- Disposal of all wastes off site, including 11e.(2) byproduct material
- Surface reclamation, grading and revegetation
- Necessary environmental monitoring, including groundwater monitoring
- Stability monitoring following groundwater restoration
- Pre- and post-decommissioning surveying and sampling
- Removal of environmental monitoring stations

- Any other site activities required to return the Dewey-Burdock Project site to unrestricted use

The financial assurance cost estimate in Attachment RAP-2 includes costs for all D&D activities at the project site except for plugging and abandoning Class III injection wells and Class V deep disposal wells. In accordance with LC 9.5, a separate financial assurance instrument will be maintained in favor of the U.S. Environmental Protection Agency (EPA) for these specific activities. It also includes costs for items that do not have a direct nexus to radiological health and safety such as access road reclamation. Inclusion of these items in the financial assurance estimate is based on the assumption that NRC and the South Dakota Department of Environment and Natural Resources (SD DENR) will enter into an agreement such as a memorandum of understanding by which NRC will hold the state's portion of the financial assurance instrument.

Powertech (USA) will update the financial assurance estimate and associated financial assurance instrument annually, in response to changes in closure or decommissioning plans, and as necessitated by changes in the facility and its operations in accordance with Criterion 9, LC 9.5 and NUREG-1569 acceptance criterion 6.5.3(7). Powertech (USA) will extend the financial assurance for an additional year if the NRC has not approved a proposed revision within 30 days prior to the financial assurance expiration date in accordance with NUREG-1569 acceptance criterion 6.5.3(8). Powertech (USA) also agrees to revise the financial assurance arrangement within 3 months of the NRC approval of a revised closure (decommissioning) plan if estimated costs exceed the amount of the existing financial assurance in accordance with NUREG-1569 acceptance criterion 6.5.3(9). Further, an updated financial assurance estimate will be submitted for NRC approval to cover any planned expansion or operational change not included in the annual financial assurance update at least 90 days prior to beginning associated construction in accordance with NUREG-1569 acceptance criterion 6.5.3(11). Section 1.3 describes Powertech (USA)'s commitment to provide NRC with copies of financial assurance-related correspondence with the SD DENR and other agencies. Powertech (USA) commits that, where the financial assurance is authorized to be held by the State of South Dakota or another agency, the financial assurance covers all appropriate costs in accordance with NUREG-1569 acceptance criterion 6.5.3(12).

Powertech (USA)'s submittal presented herein employs assumptions that are based on best professional judgment given the data currently available. Annual reviews will provide the iterative format by which NRC can continually update the financial assurance amount based on work completed at the site and newly available information.

1.2 Programmatic Agreement Coordination

LC 9.8 requires compliance with the terms and conditions of the approved Programmatic Agreement (PA) for the protection of historic properties identified during the Section 106 Process. Stipulation 5(e) of the PA requires Powertech (USA) to submit an annual Plan of Activities. It states, "In conjunction with the submission of their Plan of Activities, which detail construction and operations activities for each year, Powertech will submit one or more draft treatment plans based on input provided by all consulting parties." The RAP and the annual updates thereto will be the mechanism for providing the Plan of Activities. In future years the Plan of Activities will be accompanied by one or more draft treatment plans for NRC and BLM review and approval. Draft treatment plan(s) could not be developed for the initial year of license possession, since Powertech (USA) has not received the location information for the potentially affected tribal sites. Treatment plan(s) will be developed after receipt and evaluation of the site location information for all eligible and unevaluated sites potentially affected by construction and operation activities.

1.3 Financial Assurance Mechanism

The financial assurance mechanism to be used by Powertech (USA) will be provided in Attachment RAP-1 at least 90 days prior to commencing operations as required by LC 9.5. Powertech (USA) commits to supplying a financial assurance mechanism in a form and in an amount approved by NRC staff in accordance with 10 CFR Part 40, Appendix A, Criterion 9. Powertech (USA) is required to supply financial assurance cost estimates for NRC staff approval based on best available information, including contractor and material costs, using standard industry practices (Hydro Resources, Inc., 51 NRC 227, May 25, 2000).

Copies of financial assurance-related correspondence submitted to the EPA, the Bureau of Land Management and/or the SD DENR will be provided in future updates to this RAP in Attachment RAP-3 along with copies of each agency's financial assurance review and the final approved financial assurance arrangement. Powertech (USA) also will provide copies of approved financial assurance arrangements with these agencies to NRC staff as they are received by Powertech (USA).

1.4 Cost Details for Restoration and Reclamation Activities

Attachment RAP-2 contains tables showing the detailed financial assurance cost estimate for facilities that are planned to be constructed during the first year of license possession, specifically July 1, 2014 through June 30, 2015. During this time period Powertech (USA) plans to construct certain facilities as described below, but no lixiviant injection will take place. The information in Attachment RAP-2 is designed to be sufficiently descriptive for the NRC staff to determine the acceptability of Powertech (USA)'s proposed cost figures and is based on the estimated costs for an independent contractor to perform the decommissioning and reclamation work in accordance with 10 CFR Part 40, Appendix A, Criterion 9. The financial assurance estimate generally follows the outline presented in Appendix C of NUREG-1569.

Attachment RAP-2 contains detailed descriptions of the construction activities planned during the time period covered by the initial financial assurance estimate. These are summarized as follows:

- Construction of a portion of the Burdock central processing plant (CPP) including ion exchange columns, chemical storage facilities, resin loading facilities, laboratory and control room
- Construction of four lined ponds near the Burdock CPP
- Installation of one deep disposal well and associated piping
- Installation of a Madison water supply well and associated piping
- Construction of a portion of the initial Burdock well field and associated piping and header houses
- Construction of access roads, power lines, a stormwater diversion channel around the facility and other miscellaneous infrastructure such as fencing, environmental monitoring stations, etc.

2.0 AQUIFER RESTORATION

2.1 Introduction

Aquifer restoration will involve the following phases of work:

- Active aquifer restoration
- Monitoring the progress of active restoration
- Stability monitoring
- Providing the aquifer restoration and stability monitoring results for regulatory approval

Attachment RAP-4 provides an estimate of the duration of aquifer restoration based on current experiences at licensed ISR facilities in accordance with LC 9.5.

During aquifer restoration, Powertech (USA) will restore groundwater quality consistent with the groundwater protection standards contained in 10 CFR 40, Appendix A, Criterion 5(B)(5) on a parameter-by-parameter basis using best practicable technology. The technology selected will depend on the liquid waste disposal option as described below. In the deep disposal well liquid waste disposal option, RO treatment with permeate injection will be the primary restoration method. If land application is used to dispose liquid waste, then groundwater sweep with injection of clean makeup water from the Madison Formation will be used to restore the aquifer. In either case, Powertech (USA) will remove six (6) pore volumes during aquifer restoration.

2.2 Groundwater Restoration Criteria

The groundwater restoration program for all well fields will be conducted pursuant to 10 CFR Part 40, Appendix A, Criterion 5, which sets forth groundwater quality standards for uranium milling facilities. Currently, Criterion 5 states that groundwater quality at such facilities shall have primary goals of Commission-approved background (CAB) or an MCL, whichever is higher, or an ACL. Powertech (USA) recognizes that an ACL is a site-specific, constituent-specific, risk-based standard that demonstrates that maintaining groundwater quality at the requested level at a designated point of compliance (POC) will be adequately protective of human health and the environment at the point of exposure (POE) and that groundwater quality outside the boundary of the aquifer exemption approved by EPA would meet CAB concentrations or MCLs. Powertech (USA) understands that satisfaction of prior class-of-use can be proposed as a factor in demonstrating justification for an ACL.

Powertech (USA) understands that, in the event that the primary goal of groundwater restoration (i.e., CAB or an MCL, whichever is higher) cannot be met after engaging in all practicable (reasonably achievable) efforts, it will be required to submit an ACL application to NRC staff in accordance with its regulatory rights under 10 CFR Part 40, Appendix A, Criterion 5(B)(5). Powertech (USA) understands that any ACL application will be in the form of a license amendment application that addresses, at a minimum, all of the relevant factors in 10 CFR Part 40, Appendix A, Criterion 5B(6), which are described in TR Section 6.1.1.

2.3 Deep Disposal Well Option

In the deep disposal well liquid waste disposal option, the primary method of aquifer restoration will be RO treatment with permeate injection. In this method, water will be pumped from one or more well fields to the CPP or Satellite Facility for treatment. Treatment will begin with removal of uranium and other dissolved species in IX columns. The water will then pass through the restoration RO unit, which will remove over 90% of dissolved constituents using high pressure RO membranes. The treated effluent, or permeate, will be returned to the well field(s) for injection. The RO reject, or brine, will undergo radium removal in radium settling ponds and will then be disposed in one or more deep disposal well(s).

The RO units will operate at a recovery rate of approximately 70%. Therefore, about 70% of the water that is withdrawn from the well fields and passed through the restoration RO unit will be recovered as nearly pure water, or permeate. In order to avoid excessive restoration bleed and consumptive use of Fall River and Chilson groundwater, permeate will be supplemented with clean makeup water from Madison Formation water supply wells. Permeate and Madison Formation water will be reinjected into the well field(s) at an amount slightly less than the amount withdrawn from the well field(s). This will be done to maintain a slight restoration bleed, which will maintain hydraulic control of the well field(s) throughout active aquifer restoration. The restoration bleed will typically be 1% of the restoration flow rate unless groundwater sweep is used in conjunction with RO treatment with permeate injection, in which case the restoration bleed will average approximately 17%. Refer to the “Optional Groundwater Sweep” discussion in Section 2.6.

2.4 Land Application Option

In the land application liquid waste disposal option, the primary method of aquifer restoration will be groundwater sweep with Madison Formation water injection. This method will begin the same as the method described above for RO treatment with permeate injection; water will be pumped to the CPP or Satellite Facility for removal of uranium and other dissolved species in IX columns. The partially treated water will undergo radium removal in radium settling ponds and will then be disposed in the land application system. Powertech (USA) refers to this portion of the aquifer restoration method as "groundwater sweep," since none of the water recovered from the Fall River or Chilson will be reinjected into the well field(s).

RO will not be used if there are no deep disposal wells available to accept the RO brine. Instead, clean makeup water from the Madison Formation will be injected into the well field(s) at a flow rate sufficient to maintain the restoration bleed. As before, the restoration bleed will typically be 1% of the restoration flow rate unless the optional groundwater sweep method is used as described in Section 2.6.

The water quality of the Madison Formation is expected to be equal to or better than the baseline ore zone water quality, and injection of Madison Formation water will therefore be similar to injection of permeate under the deep disposal well option.

2.5 Combined Liquid Waste Disposal Option

If Class V DDWs are constructed but lack sufficient capacity to dispose of the entire liquid waste stream, Powertech (USA) will combine the use of DDWs and land application. In this option land application facilities will be constructed and used on an as-needed basis depending on the DDW capacity. The financial assurance cost estimate for this option will depend on the DDW capacity and will be prepared prior to construction of the combined liquid waste disposal system.

2.6 Optional Groundwater Sweep

Although a 1% restoration bleed will be adequate to maintain hydraulic control of well fields undergoing active aquifer restoration, additional bleed may be required at times. For example, additional restoration bleed may be used to recover flare of lixiviant outside of the well field pattern area. In addition to the restoration methods described above, Powertech (USA) may withdraw up to one (1) pore volume of water through groundwater sweep over the course of aquifer restoration. This will result in an average restoration bleed of approximately 17%.

2.7 Pore Volume Calculations and Restoration Pore Volumes

The formulas for determining the pore volume and the volume of restoration composite (RC) to be withdrawn during aquifer restoration are as follows:

Pore volume = (well field pattern area) x (thickness) x (porosity) x (flare factor)

RC volume = (pore volume) x (number of pore volumes for aquifer restoration)

The average thickness in the Dewey-Burdock project area is 4.6 feet. Pore volumes will be calculated based on the actual screen lengths of injection and production wells and not by the ore zone thickness as required by LC 9.5.

The porosity of the ore zone within the project area was determined by laboratory analysis of core samples. Based on 11 measurements of ore zone porosity from core samples of the Fall River and Chilson host sands, the average porosity of the ore zone sands within the project area is 0.30.

The flare factor is 1.44, accounting for both horizontal and vertical flare of lixiviant during ISR operations. Support for the flare factor is contained in the numerical groundwater modeling results presented in TR Appendix 6.6-B, "Numerical Modeling of Groundwater Conditions Related to In situ Recovery." TR Appendix 6.6-B describes how horizontal flare from a modeled balanced well field was determined to be 1.19. Vertical flare is expected to be similar to or less than the horizontal flare since the horizontal conductivity is greater than vertical conductivity. An overall flare factor of 1.44 is supported by the numerical modeling results presented in TR Appendix 6.6-B.

The flare factor and number of pore volumes required for aquifer restoration are both a function of the properties of the particular sandstone formations and ore deposits, as well as the operational factors of aquifer bleed rates, the balancing of pattern flow rates, the use of RO during aquifer restoration and the timeliness of beginning aquifer restoration operations following cessation of recovery operations. For the Dewey-Burdock Project, the values of the flare factor and the number of pore volumes removed for aquifer restoration are comparable to those that have been recently approved for other ISR facilities and are consistent with the best practicable technology for aquifer restoration.

The overall (horizontal and vertical) flare factor for ISR uranium projects has varied from 1.44 at Irigaray/Christensen Ranch (COGEMA, 2008 and COGEMA, 2005) to 1.95 at Churchrock/Crownpoint (HRI, 2001). The overall well field flare factor for the Dewey-Burdock Project is estimated to be 1.44, which is equal to the flare factor in approved license applications at ISR facilities located nearby in the State of Wyoming and is supported by numerical groundwater modeling.

The number of pore volumes, including flare, of groundwater to be removed to achieve aquifer restoration is estimated to be 6.0. This figure is consistent with the best practicable technology that includes the following operational practices:

(i) Daily balancing of injection and extraction flow rates during production. This flow rate balancing is designed to ensure that a proper aquifer bleed is maintained both at the well field level and also within each 5-spot pattern within the well field.

(ii) Timeliness of beginning restoration operations. For any particular well field, aquifer restoration operations will begin as soon as is reasonably possible following the cessation of recovery operations.

(iii) Maintenance of aquifer bleeds. Hydraulic control of well fields through the net withdrawal of the aquifer bleed stream will be continuously maintained from the beginning of recovery operations until the end of active aquifer restoration.

Powertech (USA) will adjust the financial assurance budget for aquifer restoration during each annual update review to reflect experience gained from actual operation as well as to add commitments for new well fields to be put into ISR operations. NRC staff will be able to verify the availability of the restoration equipment during routine inspections.

2.8 Monitoring the Progress of Active Restoration

Powertech (USA) will implement an active aquifer restoration monitoring program to document the progress of aquifer restoration. During active aquifer restoration, each well field will be monitored on a frequency sufficient to determine the success of aquifer restoration, optimize the efficiency of aquifer restoration and determine if any areas of the well field need additional attention. At the beginning of aquifer restoration, water levels will be measured and groundwater analyzed for all parameters listed in TR Table 6.1-1 for the subset of production zone sampling wells used in baseline. Thereafter, samples will be collected and analyzed for all or selected parameters as needed.

The success of aquifer restoration will be demonstrated during the well field stabilization period.

The results of the active restoration monitoring will be used to evaluate potential areas of flare or hot spots. If potential flare or hot spots are identified, appropriate corrective measures will be taken. These may include adjusting the flows in the area, changing wells from injection to production or vice-versa, or adjusting the restoration bleed in specific areas. Additional information on statistical methods used to identify hot spots is provided in TR Section 6.1.8.2.

2.9 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. Over the 12-month minimum stability monitoring period, there will be at least five (5) sample events, including one at the beginning of the stability monitoring period and following each of the following four quarters. The criteria to establish restoration stability will be based on well field averages or upper confidence limits computed using EPA's ProUCL 4.0 or other standard and acceptable statistical software 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 60 days for the UCL indicator parameters of chloride, total alkalinity (or bicarbonate), and conductivity. The NRC staff will be contacted if any of the wells cannot be sampled within 65 days of the last sampling event due to unforeseen conditions such as snowstorms, flooding, or equipment malfunctions.

Quarterly, the production-zone wells that were sampled to determine well field CAB will be sampled and analyzed for the water quality parameters listed in TR Table 6.1-1. The criteria to establish successful stability will be that, for each sampling event, the constituent concentration of each water quality parameter meets the target restoration goal (CAB or MCL) established for that parameter from CAB sampling, as described in TR Section 5.7.8.3.

Statistical analysis will be performed on each monitored constituent measured in the production zone CAB wells. The statistical analysis will assist in determining if the concentration of a given constituent exhibits a significantly increasing trend during the stability period. If a constituent exhibits a statistically significant increasing (SSI) trend, or in the case of pH an SSI or statistically significant decreasing trend, Powertech (USA) will take action to resolve the situation. The action taken will depend on the constituent and the status of the restored groundwater system. Due to the complexity of the aqueous geochemical groundwater systems involved, these statistical techniques will not be relied on as the sole determinant when evaluating the effectiveness of groundwater restoration. Therefore, Powertech (USA) will consider which constituent(s) shows an SSI trend in concentration and base the decision on further action on the status of the production zone groundwater geochemistry. These actions may include extending the stability period or returning the well field to a previous phase of active restoration to resolve the issue. The phase of active restoration that will be used will be determined by the constituent and the process required to bring it to stability.

If the analytical results from the stability period continue to meet the target restoration goals and do not exhibit SSI trends, then Powertech (USA) will submit supporting documentation to the regulatory agencies showing that the restoration parameters have remained at or below the restoration standards and will request that the well field be declared restored.

For one or two parameters, localized, elevated concentrations above the restoration criteria may remain in the production zone following restoration. These isolated, residual elevated concentrations are referred to as “hot spots.” Statistical analysis using outlier tests will be used to identify potential hot spots. Once a hot spot is identified, additional evaluation will be conducted to determine potential impacts that such a hot spot could have on water quality outside of the exempted aquifer. The additional evaluation may include collection of additional water samples, analysis of added parameters, trend analysis, or flow and transport modeling. Based on the results of the evaluation, additional stability monitoring or restoration may be conducted as needed to ensure the protection of water quality outside the exempted aquifer. If hot spots are sufficiently demonstrated not to have the potential to affect water quality outside of the exempted aquifer and the restoration criteria are otherwise met without increasing trends, then no additional action will be taken and Powertech (USA) will submit supporting documentation to the regulatory agencies showing that the restoration parameters have remained at or below the restoration standards and will request that the well field be declared restored.

3.0 FACILITIES DECOMMISSIONING AND RECLAMATION

Following well field restoration, stability monitoring, and regulatory signoff, when it is certain that the water treatment equipment is no longer needed, reclamation can begin on the surface facilities. 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.

3.1 Establishment of Surface Contamination Limits

Powertech (USA) will use surface contamination release limits contained in Enclosure 2 to Policy and Guidance Directive FC-82-23 (as updated) to release material and equipment that has potentially come into contact with licensed material. Beta surface contamination release limits will be included to account for the emission of beta particles from beta-emitting radionuclides in the uranium-238 decay series (e.g., thorium-234 and protactinium-234). The release limits for alpha and beta emitting radionuclides will be applied independently.

Surface contamination release limits for surfaces on structures intended for unrestricted release following decommissioning are subject to Criterion 6(6) of Appendix A to 10 CFR 40. Acceptable dose-based surface contamination release limits will be established using the RESRAD-Build model or an equivalent model and will be provided in the final Decommissioning Plan, which will be submitted 12 months prior to any planned decommissioning. In the Decommissioning Plan, Powertech (USA) will assume that all structures, 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.

3.2 Pre-Reclamation Radiological Surveys

Consistent with NUREG-1569, Acceptance Criterion 6.2.3(2), Powertech (USA) will implement a pre-reclamation radiological survey program to identify areas for cleanup operations. The instruments and techniques for pre-reclamation radiological surveys to identify areas of the site that need to be cleaned up to comply with NRC concentration limits will be the same or similar to those used to survey the project area for pre-operational radiological conditions. The instruments used for the pre-operational survey are described in TR Section 2.9 and include unshielded Ludlum Model 44-10 2" x 2" sodium iodide (NaI) detectors coupled to Ludlum Model 2221 rate meter/scalers (set in rate meter mode) and a Trimble Pro XRS GPS receiver with Trimble TSCe data logger.

Consistent with NUREG-1569, 6.2.1 Areas of Review, Powertech (USA) will provide the NRC staff and SD DENR with maps and data that document the pre-reclamation condition. The techniques to be used during the pre-reclamation radiological survey include putting special emphasis on those areas with the highest potential for surface contamination, including diversion ditches, surface impoundment areas, well fields (particularly those areas where potential spills or leaks may have occurred), process structures, storage areas, on-site transportation routes for contaminated material and equipment, and areas associated with liquid waste disposal. Powertech (USA) will also consider results from operational monitoring and any other information that provides insight to areas with the greatest potential to be contaminated. Powertech (USA) will use a sampling grid of 100 m^2 for soil and other specifications to ensure that radium and other radionuclides will not exceed the standards in 10 CFR Part 40, Appendix A, Criterion 6(6). Guidance for sample size and other techniques provided in NUREG-1575 will be used as reference for the pre-reclamation radiological survey.

The following general procedures for interpretation of the pre-reclamation survey results will be used to identify areas for cleanup operations:

1) Pursuant to 10 CFR Part 40, Appendix A, Criterion 6(6), the radium-226 content in soils, averaged over areas of 100 m^2, will not exceed the background concentration by more than (i) 5 pCi/g of Ra-226 averaged over the first 15 cm (5.9 in) below the surface, and (ii) 15 pCi/g of radium-226 averaged over 15 cm thick layers more than 15 cm below the surface.
2) The background radionuclide concentrations have been determined using appropriate methods as described in TR Section 2.9. There are two areas within the project area where the gamma survey recorded levels higher than the majority of the project area. These are the surface mine area in the northeast portion of the project area and a naturally anomalous area in the northern portion of the project area. These areas may warrant a different background concentration. Should Powertech (USA) determine that use of a

different background radionuclide concentration is warranted, it will propose one with its final decommissioning plan.

3) Attachment RAP-5 presents the modeling and assumptions used to derive a standard for thorium-230 in soil. The thorium-230 soil standard is 165 pCi/g.
4) TR Section 6.4.1.2 presents the modeling and assumptions used to derive a standard for natural uranium in soil. The natural uranium soil standard is 537 pCi/g.
5) Lastly, the survey method for cleanup operations, derived from MARSSIM, will be designed to provide 95% confidence that any residual radionuclides on the project area will be identified and cleaned up. Powertech (USA) will apply appropriate statistical tests for analysis of survey data.

3.3 Removal of Process Buildings 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. This will include the use of an approved standard operating procedure (SOP) for release of items to unrestricted use and thoroughly documenting all items eligible for release to unrestricted use. This SOP will incorporate methods described in Section 6.6 and 6.7 of NUREG-1575, Rev 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," including equations to calculate Minimum Detectable Concentrations (MDCs) and Scan MDCs to ensure the equipment being used has adequate detection sensitivity to make decisions regarding release. 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 contaminated below 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), and

- Not salvageable and contaminated below 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.

All structures will be decontaminated, if necessary, and moved to a new location and salvaged or disposed at an appropriately licensed solid waste facility. Concrete slabs will be surveyed and if found to contain radionuclides in excess of the release limits, an attempt will be made to decontaminate the concrete slab(s). If after a second survey radionuclides are in excess of the release limits, the concrete will be broken up and disposed of at a licensed 11e.(2) disposal site. If the survey results indicate that the concrete is not contaminated above release limits, it may be disposed in an appropriately permitted landfill, used for fill elsewhere, or left in place for use by the landowner.

3.4 Plans for Decommissioning Non-Radiological Constituents

Consistent with NUREG-1569 and 10 CFR Part 40, Appendix A, Criterion 6(7), Powertech (USA) will ensure that non-radiological hazards are addressed in the planning and implementation processes of decommissioning and closure. TR Section 1.10 includes a discussion of non-radiological wastes and their disposition at closure. Non-radiological cleanup concerns related to the land application option are addressed in TR Section 7.3.3.8.2.

Any non-radiological hazardous waste that is determined to be 11e.(2) byproduct material will be disposed of offsite at a licensed 11e.(2) waste disposal site in accordance with NRC's directive in 10 CFR Part 40, Appendix A, Criterion 2. Any non-radiological hazardous waste that is not 11e.(2) byproduct material will be disposed offsite at a permitted hazardous waste disposal facility. As described in TR Section 1.10, potentially hazardous liquid wastes such as used oil, hydraulic fluid, cleaners, solvents and degreasers will be recycled or disposed offsite at an appropriately permitted hazardous or solid waste disposal facility. In addition, as described in TR Section 7.3.3.8.2, residual non-radiological metal concentrations in land application areas are not expected to exceed their respective EPA soil screening levels (SSLs). Powertech (USA) will include more details on decommissioning non-radiological hazardous constituents in its final decommissioning plan, which will be submitted 12 months prior to any planned reclamation.

3.5 Ponds

Work required to reclaim the ponds will include wastewater disposal and removal of the pond liners and leak detection systems, along with any residual brine residue or pond sludge, to an appropriately permitted disposal site. Regrading will be conducted to approximate original topography, topsoil will be replaced and disturbed areas will be revegetated. Estimates of the quantities and the unit prices used to estimate the reclamation costs are provided in Attachment RAP-2.

3.6 Surface Soil Cleanup Verification and Sampling Plans

Powertech (USA) will comply with the cleanup standard of Criterion 6(6) of 10 CFR Part 40, Appendix A: 11e.(2) byproduct material containing concentrations of radionuclides other than radium in soil, and surface activity on remaining structures, will not result in a Total Effective Dose Equivalent (TEDE) exceeding the dose from cleanup of radium-contaminated soil to the above standard (benchmark dose), and will be at levels which are ALARA. If more than one residual radionuclide is present in the same 100 m^2 area, the sum of the ratios for each radionuclide of concentration present to the concentration limit will not exceed 1 (unity).

In areas that meet the Ra-226 cleanup criteria post-reclamation but that still have elevated Th-230 levels, Powertech (USA) will compare the sampling results with the Th-230 soil cleanup standard included in Attachment RAP-5.

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. Affected areas are those areas that have greater potential to be impacted by uranium solutions, dried uranium product (yellowcake) or liquid or solid waste streams that contain uranium or other radionuclides associated with uranium recovery operations. The areas that are most likely to be considered affected areas include diversion ditches, surface impoundment areas, well fields (particularly those areas where potential spills or leaks may have occurred), process structures, storage areas, on-site transportation routes for contaminated material and equipment, and areas associated with liquid waste disposal. Consistent with NUREG-1569, Acceptance Criterion 6.4.3(5), the survey method for verification of soil cleanup will be designed to provide 95% confidence that the survey units will meet the cleanup guidelines.

A calculation of the potential peak annual total effective dose equivalent (TEDE) within 1,000 years to the average member of the critical group that would result from applying the radium standard (not including radon) on the site will be submitted to NRC for approval. Details will be provided in the decommissioning plan to be submitted for review at least 12 months prior to decommissioning activities. A key component of the plan would be that 11e.(2) byproduct material containing concentrations of radionuclides, other than radium in soil, and surface activity on remaining structures, must not result in a TEDE exceeding the dose from cleanup of radium contaminated soil to the radium benchmark dose, and must be at levels which are ALARA. Powertech (USA) is aware that the use of decommissioning plans with radium benchmark doses which exceed 100 mrem/yr, before application of ALARA, requires the approval of the Commission after consideration of the recommendation of the NRC staff.

3.7 Grading, Topsoil Replacement and Revegetation

Disturbed areas will be regraded, topsoil replaced, and revegetated according to SD DENR requirements. The seed mixture selected will be compatible with the SD DENR-approved post-reclamation land use.

3.8 Stream Channel Reclamation

Powertech (USA) does not plan to disturb intermittent or perennial stream channels, including the only intermittent stream channel in the license area (Pass Creek) and the only perennial stream channel in the license area (Beaver Creek). Although one or more plant-to-plant pipelines may be constructed across Pass Creek, it is anticipated that these would be bored underneath the creek and would not disturb the intermittent stream channel. The only instances where ephemeral stream channels are anticipated to be disturbed are the installation of pipelines, access roads, sediment ponds, and diversion channels.

Pipelines and access roads will cross ephemeral stream channels perpendicular to the flow direction as practicable to minimize disturbance. Interim revegetation will be used to stabilize disturbed areas that are scheduled to be re-disturbed during final site decommissioning. The stream channel geometry will not be affected by access road and pipeline crossings, and these areas will have topsoil replaced and will be revegetated according to SD DENR requirements.

During the reclamation of diversion channels and sediment ponds, spoil that was stockpiled during construction will be replaced in lifts and compacted as necessary to match the original topography. Dikes or berms placed in the original stream channel will be removed and the stream channel geometry restored to approximately original condition. Topsoil that was stockpiled during construction will be redistributed over the disturbed area and graded to blend with the adjacent topography as required by SD DENR. Following topsoil replacement, disturbed areas will be revegetated according to SD DENR requirements.

4.0 WELL FIELD RECLAMATION

Decommissioning and reclamation of the well fields will include removal of the header houses and all pipes and utilities connecting the wells to the header houses and the CPP or SF, disposing of these materials in an appropriately permitted landfill or licensed 11e.(2) byproduct disposal site as appropriate, and reclaiming the surface as described for the other surface facilities.

4.1 Well Plugging and Abandonment

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.

Powertech (USA) will plug all wells with bentonite or cement grout. The weight and composition of the grout will be sufficient to control artesian conditions and meet the well abandonment standards of the State of South Dakota, including Chapter 74:02:04:67 (Requirements for Plugging Wells or Test Holes Completed into Confined Aquifers or Encountering More than One Aquifer) of the South Dakota Administrative Rules. Cementing will be completed from total depth to surface using a drill pipe. Records will be kept of each well cemented including at a minimum the following information:

- well ID, total depth, and location,
- driller, company, or person doing the cementing work,
- total volume of cement placed down hole, and
- viscosity and density of the slurry used.

Powertech (USA) will remove surface casing and set a cement plug to a depth 6 ft below the ground surface on each well or borehole plugged and abandoned.

5.0 RADIOLOGICAL SURVEY AND ENVIRONMENTAL MONITORING

Gamma surveys will be relied on to guide soil remediation efforts. At least 12 months prior to commencing reclamation, Powertech (USA) will submit a decommissioning plan that will contain descriptions of methodology for both pre- and post-reclamation gamma ray surveys. The gamma ray surveys for excavation control monitoring and final cleanup status will be designed to be consistent with NUREG-1569, Acceptance Criteria 6.4.3(1), 6.4.3(3) and 6.4.3(5), including the use of a methodology for gamma-ray surveys for excavation control monitoring and final status surveys that will provide 95% confidence that the survey units will meet the cleanup guidelines.

The pre-decommissioning radiological survey will consist of an integrated area gamma survey and confirmation soil sampling and analysis to verify that the required cleanup standard(s) are met. The areas that will receive particular attention are those that are expected to have higher readings 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, and on-site transportation routes for contaminated material and equipment. Areas associated with liquid waste disposal will also receive close attention. 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. Gamma surveys and action levels are discussed in more detail in TR Section 6.4.2.

6.0 REFERENCES

COGEMA, 2008, Wellfield Restoration Report, Christensen Ranch Project, Prepared by COGEMA Mining, Inc. and Petrotek Engineering Corporation, March 5, 2008, NRC ADAMS Accession No. ML081060131.

_____, 2005, Response to LQD/DEQ January 10, 2005 Comments and Irigaray Wellfield Restoration Report, TFN 4 1/170, Prepared by COGEMA Mining, Inc., Petrotek Engineering Corporation, and Resource Technologies Group, May 4, 2005, NRC ADAMS Accession No. ML053270037.

Hydro Resources, Inc. (HRI), 2001, Church Rock Section 17 Restoration Action Plan, Prepared by Hydro Resources, Inc. July 23, 2001, NRC ADAMS Accession No. ML012070171.

Attachment RAP-1

Financial Assurance Mechanism

Attachment RAP-2

Financial Assurance Cost Estimate

Executive Summary	RAP 2-iii
Financial Assurance Estimate Cost Calculations	
Summary of Costs	RAP 2-1
Assumptions	RAP 2-2
Equipment Demolition and Disposal	RAP 2-3
Facility Building Demolition and Disposal	RAP 2-6
Well Field Building Demolition and Disposal	RAP 2-9
Facility Reclamation	RAP 2-11
Well Field Reclamation	RAP 2-14
Well Abandonment	RAP 2-19
Miscellaneous Reclamation	RAP 2-20
Unit Cost Table	RAP 2-22
Compound Unit Cost Calculations	
UC-GEO - Geosythetic Liner/Geonet Demolition	RAP 2-25
UC-MAIN - Main Pipeline Removal, Pipe Chipping, Valve Vault Removal	RAP 2-26
UC-MIT - Mechanical Integrity Testing	RAP 2-28
UC-ROAD - Road Reclamation	RAP 2-29
UC-SURF REC - Surface Reclamation	RAP 2-31
UC-T&D - Transportation and Disposal	RAP 2-32
UC-WA - Well Abandonment	RAP 2-34
UC-WFPIPE - Well Field Pipeline Removal	RAP 2-36
Cost References	
EQUIP-1	RAP 2-38
EQUIP-2	RAP 2-39
EQUIP-3	RAP 2-40
EQUIP-4	RAP 2-41
LF-1	RAP 2-42
TRANS-1	RAP 2-43
WA-1	RAP 2-44
WA-2	RAP 2-45
Map to Accompany Initial Financial Assurance Estimate	In Pocket

Dewey-Burdock Project
Financial Assurance Cost Estimate
Executive Summary

This financial assurance cost estimate details costs required to reclaim facilities planned to be constructed during the first year of license possession, specifically during the time period July 1, 2014 through June 30, 2015. During this time, Powertech (USA) plans to construct most of the facilities required to operate the first well field in the Burdock portion of the license area; however, no lixiviant injection is planned. Powertech (USA) also plans to construct the infrastructure required to utilize the preferred liquid waste disposal option, which is underground injection of treated wastewater in one or more deep disposal wells (DDWs) permitted through EPA.

A map showing the approximate locations of the facilities anticipated to be constructed during the initial financial assurance period is provided with this attachment. The map is provided to generally identify where facilities are planned (e.g., the initial well field location in the Burdock area), but the locations of all facilities are approximate and subject to change. In some cases, the quantities used in the financial assurance estimate are higher than the quantities shown on the map. For example, the number of well field patterns depicted on the map is 52, which would correspond to 52 production wells, while the number of production wells in the financial assurance estimate is 60. The higher number was used to provide flexibility during construction. Also, not all facilities are depicted on the map. For instance, the overlying monitor wells are not shown, since their locations have not yet been determined.

This financial assurance cost estimate includes costs for all D&D activities at the project site except for plugging and abandoning Class III injection wells and Class V DDWs. In accordance with LC 9.5, a separate financial assurance instrument will be maintained in favor of EPA for these specific activities. It also includes costs for items that do not have a direct nexus to radiological health and safety such as access road reclamation. Inclusion of these items in the financial assurance estimate is based on the assumption that NRC and the SD DENR will enter into an agreement such as a memorandum of understanding by which NRC will hold the state's portion of the financial assurance instrument. Excluding plugging and abandoning Class III and V wells, the estimated cost to return the license area to a condition that will permit release for unrestricted use is **$1.62 million.**

This financial assurance cost estimate includes the following cost categories:

- Facility Decommissioning
- Groundwater Restoration and Well Plugging
- Radiological Survey and Environmental Monitoring
- Project Management Costs and Miscellaneous
- Labor and Equipment Overhead, Contractor Profits
- Contingency

The financial assurance cost estimate includes four components: cost calculation sheets for each D&D category, a unit cost table that provides references for all unit costs used in the estimate, compound unit cost calculation sheets, and unit cost references. Unit costs listed in the unit cost table are either simple or compound unit costs. Simple unit costs were obtained directly from a reference or vendor quote, e.g., equipment rental. Compound unit costs are calculated based on one or more simple unit costs, e.g., pipeline removal. The unit cost table specifies whether each unit cost is a simple or compound cost and, if compound, lists the applicable compound unit cost sheet.

Unit costs were obtained from vendor quotes, 2014 RSMeans® cost data, regulatory guidance including Wyoming Department of Environmental Quality's Guideline 12 (WDEQ, 2014), and from other operating ISR and industrial facilities. Assumptions used in this estimate are based on recent professional experience of general construction activities as well as construction and reclamation at other ISR facilities. Cost references are provided in the unit cost table. The cost basis, assumptions, calculations, and cost references associated with the major D&D activities are discussed below.

All unit costs are expressed in current (2014) dollars and include contractor overhead and profit. They are based on the estimated costs for an independent contractor to perform the decommissioning and reclamation work in accordance with 10 CFR Part 40, Appendix A, Criterion 9. Project management and contingency costs have been included as recommended by NUREG-1569 Appendix C.

FACILITY DECOMMISSIONING

Facility decommissioning will include the following activities:

- CPP removal and disposal, including building, equipment and concrete floor, footers and containment curb; also including facility pad and stormwater diversion
- Well field reclamation, including removing and disposing header houses, valve vaults and piping
- Pond reclamation
- Access road reclamation

Since uranium recovery operations will not commence during the time period covered by this financial assurance estimate, no costs for radiological decontamination, radiological surveying, or disposal of 11e.(2) byproduct material are included.

Buildings and Equipment

Only a portion of the CPP building and equipment will be constructed during the initial financial assurance period, including six ion exchange vessels, a resin transfer water tank, truck loading facilities and the portion of the CPP building housing this equipment. Referencing TR Figure 3.2-4, the planned portion of the CPP building to be constructed includes the western portion of the building up to and including the locker rooms.

The cost estimate assumes that buildings and equipment will be demolished and disposed at the Custer-Fall River Regional Landfill (regional landfill) in Edgemont, with salvageable portions hauled to a re-use/recycle facility located in Rapid City. In addition to the CPP, buildings anticipated to require removal include two header houses in the initial Burdock well field. Concrete slabs, footers, foundations and containment curbs will be demolished and disposed at the regional landfill.

The cost estimate assumes that equipment within the CPP and header houses will be demolished and disposed at the regional landfill, with a portion hauled to a re-use/recycle facility. This is a conservative estimate, since the unused equipment likely could be sold to another facility for a net salvage value.

Facility Reclamation

Facility reclamation will include reclaiming the facility pad, facility access road (primary access road) and removing pipelines to the Class V DDW and Madison water supply well. It also will include reclaiming the facility stormwater diversion channel and ponds. Powertech (USA) plans to construct the radium settling pond, spare radium settling pond, outlet pond, and surge pond during the initial financial assurance period. Reclamation of the ponds will include removal, demolition, and disposal of the liner and leak detection systems at the regional landfill. As previously stated, no uranium recovery operations are planned in the first year, and therefore no solids removal or disposal of 11e.(2) byproduct material will be required.

Well Field Reclamation

Well Field reclamation includes removing and disposing pipelines between the CPP and header houses and piping within the well field. The financial assurance cost estimate includes the cost of chipping HDPE pipe to reduce the volume requiring disposal and transporting the chipped pipe to the regional landfill. It also accounts for removing and disposing down-hole equipment (well pumps, pipe and power cable) in the wells. Costs are provided for reclaiming well field access roads and light-use roads used to access monitor wells and environmental monitoring locations. Costs also are included for surface reclamation and revegetation of disturbed well field areas.

GROUNDWATER RESTORATION AND WELL PLUGGING

Since no lixiviant injection will occur during the initial financial assurance period, groundwater restoration will not be required. Well plugging and abandonment cost calculations are provided for production wells and monitor wells. Costs are not included for Class III injection wells or the single planned Class V DDW, since financial assurance for these wells will be maintained in favor of EPA. The financial assurance estimate is based on the installation of 60 production wells and 40 monitor wells during the initial financial assurance period. A Madison water supply well is planned during the initial financial assurance period, but it is assumed that it will be transferred to the landowner upon site decommissioning. Prior to abandonment, production, injection, and monitor wells will undergo mechanical integrity testing (MIT) to demonstrate the integrity of the casing and cement that will be left in the ground. All production, injection, and monitor wells will be cemented from the total depth to the surface with cement grout. In addition, surface facilities will be removed and a surface plug will be installed.

PROJECT MANAGEMENT COSTS AND MISCELLANEOUS

Project management costs include 5% of the overall project cost for mobilization/demobilization and 5% for general project management. According to WDEQ (2014), the total of these percentages typically ranges from 8 to 15 percent. WDEQ states that it is presently using 10%.

Costs for miscellaneous items not covered in other sections are provided in this section of the financial assurance cost estimate. Miscellaneous costs include CPP area and well field fence demolition, overhead power line removal, sediment control structure removal, environmental monitoring station reclamation, and reclamation performance sampling costs. Reclamation performance sampling is required by the South Dakota Department of Environment and Natural Resources (SD DENR) to ensure that reclaimed lands meet the post-mining land use for livestock grazing. Sampling will consist of annual vegetation surveys for cover and species composition. SD DENR requires that the reclaimed lands withstand 2 years of grazing. Annual surveys for 3 years were included in the cost estimate to allow for surveys to commence during the year in which reclamation is completed.

LABOR AND EQUIPMENT OVERHEAD AND CONTRACTOR PROFITS

Unit costs for labor and equipment used in this estimate include costs for overhead and profit. The percentages for overhead and profit, if known, are included in the unit cost table.

PROJECT CONTINGENCY

A project contingency of 15% of the project cost was included in accordance with NUREG-1569 acceptance criterion 6.5.3(10).

REFERENCES:

WDEQ (Wyoming Department of Environmental Quality), 2014, Guideline 12, Standard Reclamation Performance Bond Format and Cost Calculation Methods, March 2014. Available from the Internet as of 27 June 2014: http://deq.state.wy.us/lqd/guidelines.asp.

Powertech (USA) Inc.

Summary of Costs
Dewey-Burdock Project
Powertech (USA), Inc.

Financial Assurance Cost Estimate Summary

Cost Description	Cost ($)	Reference Worksheet
I. FACILITY DECOMMISSIONING		
Equipment Removal and Disposal Cost	$75,131	EQUIPMENT
Facility Building Demolition and Disposal Cost	$371,768	FACILITY BUILDINGS
Well Field Building Demolition and Disposal Cost	$44,085	WELL FIELD BUILDINGS
Facility Reclamation	$265,943	FACILITY RECLAMATION
Well Field Reclamation	$226,736	WELL FIELD RECLAMATION
Total:	**$983,663**	
II. GROUNDWATER RESTORATION AND WELL PLUGGING		
Groundwater Restoration	$0	
Well Abandonment	$212,787	WELL ABANDONMENT
Total:	**$212,787**	
III. RADIOLOGICAL SURVEY AND ENVIRONMENTAL MONITORING		
Radiological Survey	$0	
Total:	**$0**	
IV. PROJECT MANAGEMENT COSTS AND MISCELLANEOUS		
Miscellaneous Reclamation	$80,259	MISC. RECLAMATION
Labor	$0	
Mobilization/Demobilization @ 5% of Project Cost	$63,835	
Project Management @ 5% of Project Cost	$67,027	
Total:	**$211,122**	
V. LABOR AND EQUIPMENT OVERHEAD, CONTRACTOR PROFITS		
Labor and Equipment Overhead and Profit Included in Unit Costs	$0	
Total:	**$0**	
VI. CONTINGENCY		
Contingency @ 15% of Project Cost	$211,136	
Total:	**$211,136**	
VII. ADJUSTMENTS TO SURETY AMOUNTS		
Inflation	$0	
Process/Reclamation Plan Changes	$0	
Total:	**$0**	

TOTAL FINANCIAL ASSURANCE AMOUNT	**$1,618,707**
FOR ESTIMATE	**$1,620,000**

Powertech (USA) Inc.

Assumptions
Dewey-Burdock Project
Powertech (USA), Inc.

Assumptions	**Burdock**	**Source**
Restoration and Production Operating Assumptions		
Restoration Flow Rate (gpm)		
Restoration Operating Days (days/yr)		
Pore Volumes (PV) Required for Restoration		
Average Restoration Bleed (%)		
Average Area per Pattern (sf)	10,000	1st Year Development Plan
Ratio of Pattern Area/Ore Zone Area	1.04	1st Year Development Plan
Average Ratio of Inj./Prod Wells		
Production Wells per Header House		
	B-WF1	**Source**
PV Assumptions		
Well Field Area (sf)	520,000	
Well Field Area (acres)	11.94	Calculated
Affected Ore Zone Area (sf)		No lixiviant injected in 1st year
Avg. Screen Length (ft)		License Condition 9.5
Porosity		RAP Sec. 2.6
Flare Factor		RAP Sec. 2.6
Affected Pore Volume (cf)		
Affected Pore Volume (Kgal)		
Restoration Parameters		
Restoration Composite (RC) Volume (Kgal)		No restoration in 1st year
Total RC Volume per Facility (Kgal)		Calculated
Calculated Restoration Duration (months)		Restoration composite volume divided by restoration flow rate
Minimum Assumed Restoration Duration (months)		Based on current experience at licensed ISR facilities
Total Restoration Duration per Facility (months)		Calculated
Stability Monitoring Duration (months)		License Condition 10.6
Number of Patterns per Well Field	52	1st Year Development Plan
Number of Wells per Well Field		
Production Wells	60	1st Year Development Plan
Injection Wells	110	1st Year Development Plan
Perimeter Monitor Wells	30	1st Year Development Plan
Internal (Overlying/Underlying) Monitor Wells		
Immediately Overlying Monitor Wells	4	1st Year Development Plan
Subsequent Overlying Monitor Wells	6	1st Year Development Plan
Underlying Monitor Wells	0	1st Year Development Plan; none required since initial well field is in Lower Chilson
Total Internal Monitor Wells	10	Calculated
Baseline Monitor Wells	0	Baseline monitor wells accounted for in production well count, see TR p. 5-45p
Number of Wells per Well Field	210	Calculated
Total Number of Wells per Facility	210	Calculated
Average Well Depth (ft)	450	1st Year Development Plan
Number of Header Houses per Well Field	2	1st Year Development Plan
Number of Header Houses per Facility	2	Calculated

Not applicable to initial financial assurance estimate
Input value

Equipment Demolition and Disposal	Burdock	Source or Unit Cost Name
I. Equipment Demolition and Loading Cost		
A. Equipment Inventory		
1. Process Equipment		
IX Columns: 12-ft Diameter, 15-ft High		
Number of Tanks	6	1st Year Development Plan
Volume per Tank (cf)	1,700	Calculated
Total Volume (cf)	10,200	Calculated
Elution Columns: 7-ft Diameter, 15-ft High		
Number of Tanks	-	1st Year Development Plan
Volume per Tank (cf)	580	Calculated
Total Volume (cf)	-	Calculated
Process Tanks: 13-ft Diameter, 16-ft High		
Number of Tanks	-	1st Year Development Plan
Volume per Tank (cf)	2,130	Calculated
Total Volume (cf)	-	Calculated
Solids Removal Tanks: 11-ft Diameter, 16-ft High		
Number of Tanks	-	1st Year Development Plan
Volume per Tank (cf)	1,520	Calculated
Total Volume (cf)	-	Calculated
Water Tanks: 10-ft Diameter, 16-ft High		
Number of Tanks	1	1st Year Development Plan
Volume per Tank (cf)	1,260	Calculated
Total Volume (cf)	1,260	Calculated
Shaker Screens: 10-ft x 7-ft x 5-ft		
Number of Screens	-	1st Year Development Plan
Volume per Screen (cf)	350	Calculated
Total Volume (cf)	-	Calculated
RO Units		
Number of Units	-	1st Year Development Plan
Volume per Unit (cf)	400	Calculated
Total Volume (cf)	-	Calculated
Thickeners: 30-ft Diameter		
Number of Units	-	1st Year Development Plan
Volume per Unit (cf)	10,600	Calculated
Total Volume (cf)	-	Calculated
Screw Conveyors and Filter Presses		
Number of Units	-	1st Year Development Plan
Volume per Unit (cf)	2,100	Calculated
Total Volume (cf)	-	Calculated
Dryer: 8-ft x 24-ft x 6-ft and Appurtenances		
Number of Units	-	1st Year Development Plan
Volume per Unit (cf)	1,400	Calculated
Total Volume (cf)	-	Calculated
Drum Handling/Cleaning/Painting System		
Number of Units	-	1st Year Development Plan
Volume per Unit (cf)	4,500	Calculated
Total Volume (cf)	-	Calculated
Process Pumps		
Number of Pumps	25	1st Year Development Plan
Volume per Pump (cf)	16	Calculated
Total Volume (cf)	400	Calculated
Process Equipment Total Volume (cf)	**11,860**	
2. Other Equipment		
Fuel Storage Tanks (15,000 gal)		
Number of Tanks	-	1st Year Development Plan
Volume per Tank (cf)	2,005	Calculated

Equipment Demolition and Disposal	Burdock	Source or Unit Cost Name
Total Volume (cf)	-	Calculated
Outdoor Chemical Storage Tanks (20,000 gal)		
Number of Tanks	-	1st Year Development Plan
Volume per Tank (cf)	2,680	Calculated
Total Volume (cf)	-	Calculated
Fire Suppression Tank (240,000 gal)		
Number of Tanks	1	1st Year Development Plan
Volume per Tank (cf)	32,100	Calculated
Total Volume (cf)	32,100	Calculated
Other Equipment Total Volume (cf)	**32,100**	
Total Equipment Volume (cf)	**43,960**	
B. Equipment Demolition and Loading Cost		
1. Demolition and Loading Equipment		
Daily Output (cf/day)	2,500	Estimate
Demolition and Loading Duration (days)	18	Calculated
Demolition and Loading Unit Cost ($/day)	$1,575.00	Equipment Demolition and Loading
Demolition and Loading Equipment Cost	$28,350.00	
2. Demolition and Loading Labor		
Number of Persons	2	Estimate
Demolition and Loading Duration (days)	18	Calculated
Demolition and Loading Duration (hours)	144	Assuming 8 hr work day
Demolition and Loading Labor Cost ($/hr)	$49.48	Labor - Laborer
Demolition and Loading Labor Cost	$14,250.24	Calculated
TOTAL EQUIPMENT DEMOLITION AND LOADING COST	**$42,600.24**	
II. Equipment Decontamination Cost		
Ratio of Surface Area:Volume for Equipment		Estimate based on typical for process tankage
Surface Area of Contaminated Equipment (sf)		Calculated
Radiological Decontamination Unit Cost ($/sf)		Radiological Decontamination
Equipment Decontamination Cost		
TOTAL EQUIPMENT DECONTAMINATION COST	**$0.00**	No radiological contamination in 1st year
III. Equipment Transportation and Disposal Cost		
Demolished Equipment Volume Reduction	50%	Estimate
Demolished Volume of Equipment (cf)	21,980	Calculated
A. Re-use/Recycle Facility Transportation and Disposal		
Salvage Percentage	50%	Estimate
Salvage Volume (cf)	10,990	Calculated
Re-use/Recycle Fac. Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Re-use/Recycle Facility Transportation and Disposal Cost	$11,979.10	
B. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of demolished, non-salvaged volume
Volume to Landfill (cf)	10,990	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.87	Landfill Trans. and Disposal - Const. Debris/Equipment
Landfill Transportation and Disposal Cost	$20,551.30	
C. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of demolished, non-salvaged volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)		11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Transportation and Disposal Cost	$0.00	
TOTAL EQUIPMENT TRANSPORTATION AND DISPOSAL COST	**$32,530.40**	

Equipment Demolition and Disposal	Burdock	Source or Unit Cost Name
IV. Health and Safety Cost		
Radiation Safety Equipment		Radiation Safety Equipment - Decom.
TOTAL HEALTH AND SAFETY COST	**$0.00**	

TOTAL EQUIPMENT DEMOLITION AND DISPOSAL COST	**$75,131**

Facility Building Demolition and Disposal	**CPP**	**Source or Unit Cost Name**
Building Dimensions		
First Story		
Length (ft)	108	TR Figures 3.2-4 and 3.2-5
Width (ft)	130	TR Figures 3.2-4 and 3.2-5
Height (ft)	20	Estimate
Second Story		
Length (ft)	32	TR Figures 3.2-4 and 3.2-5
Width (ft)	92	TR Figures 3.2-4 and 3.2-5
Height (ft)	20	Estimate
I. Building Decontamination Cost		
A. Wall Decontamination		
Wall Area to Be Decontaminated (sf)		
Radiological Decontamination Unit Cost ($/sf)		Radiological Decontamination
Wall Decontamination Cost	$0.00	No radiological contamination in 1st year
B. Concrete Floor Decontamination		
Floor Area to be Decontaminated (sf)		
Radiological Decontamination Unit Cost ($/sf)		Radiological Decontamination
Concrete Floor Decontamination Cost	$0.00	No radiological contamination in 1st year
TOTAL BUILDING DECONTAMINATION COST	**$0.00**	
II. Building Demolition Cost		
A. Building		
Volume of Building (cf)	339,680	Calculated
Building Demolition Unit Cost ($/cf)	$0.19	Building Demolition
Building Demolition Cost	$64,539.20	
B. Concrete Floor		
Area of Concrete Floor (sf)	14,040	Calculated
Concrete Floor Demolition Unit Cost ($/sf)	$8.45	Concrete Floor Demolition
Concrete Floor Demolition Cost	$118,638.00	
C. Concrete Footer		
Length of Concrete Footer (ft)	476	Calculated
Concrete Footer Demolition Unit Cost ($/ft)	$29.00	Concrete Footer Demolition
Concrete Footer Demolition Cost	$13,804.00	
D. Concrete Containment Curb		
Length of Concrete Containment Curb (ft)	476	Calculated
Concrete Containment Curb Demolition Unit Cost ($/ft)	$6.80	Concrete Containment Curb Demolition
Concrete Containment Curb Demolition Cost	$3,236.80	
TOTAL BUILDING DEMOLITION COST	**$200,218.00**	
III. Building Transportation and Disposal Cost		
A. Building		
Volume of Building (cf)	339,680	Calculated
Demolished Building Volume Reduction	75%	Estimate
Demolished Volume of Building (cf)	84,920	Calculated
1. Re-use/Recycle Facility Transportation and Disposal		
Salvage Percentage	50%	Estimate
Salvage Volume (cf)	42,460	Calculated
Re-use/Recycle Fac. Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Re-use/Recycle Facility Trans. and Disposal Cost	$46,281.40	
2. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of demolished, non-salvaged volume
Volume to Landfill (cf)	42,460	Calculated

Facility Building Demolition and Disposal	CPP	Source or Unit Cost Name
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.87	Landfill Trans. and Disposal - Const. Debris/Equipment
Landfill Transportation and Disposal Cost	$79,400.20	
3. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of demolished, non-salvaged volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Trans. and Disposal Cost	$0.00	
Subtotal Building Transportation and Disposal Cost	$125,681.60	
B. Concrete Floor		
Area of Concrete Floor (cf)	14,040	Calculated
Thickness of Concrete Floor (ft)	0.5	Estimate
Demolished Concrete Swell Factor (%)	30%	Estimate
Volume of Concrete Floor (cf)	9,126	Calculated
1. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of demolished volume
Volume to Landfill (cf)	9,126	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$3.53	Landfill Trans. and Disposal - Concrete
Landfill Transportation and Disposal Cost	$32,214.78	
2. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of demolished volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Trans. and Disposal Cost	$0.00	
Subtotal Concrete Floor Transportation and Disposal Cost	$32,214.78	
C. Concrete Footer		
Length of Concrete Footer (ft)	476	Calculated
Width of Concrete Footer (ft)	2	Estimate
Depth of Concrete Footer (ft)	3	Estimate
Demolished Concrete Swell Factor (%)	30%	Estimate
Volume of Concrete Footer (cf)	3,713	Calculated
1. Landfill Transportation and Disposal		
Percentage to Landfill	100%	Estimate
Volume to Landfill (cf)	3,713	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$3.53	Landfill Trans. and Disposal - Concrete
Landfill Transportation and Disposal Cost	$13,106.89	
D. Concrete Containment Curb		
Length of Concrete Containment Curb (ft)	476	Calculated
Height of Concrete Containment Curb (ft)	0.5	TR Figure 3.2-4
Width of Concrete Containment Curb (ft)	0.5	Estimate
Demolished Concrete Swell Factor (%)	30%	Estimate
Volume of Concrete Containment Curb (cf)	155	Calculated
1. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of demolished volume
Volume to Landfill (cf)	155	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$3.53	Landfill Trans. and Disposal - Concrete
Landfill Transportation and Disposal Cost	$547.15	
2. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of demolished volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Trans. and Disposal Cost	$0.00	
Subtotal Concrete Curb Transportation and Disposal Cost	$547.15	
TOTAL BUILDING TRANSPORTATION AND DISPOSAL COST	**$171,550.42**	

Facility Building Demolition and Disposal	CPP	Source or Unit Cost Name
IV. Health and Safety Cost		
Radiation Safety Equipment	$0	Included in equipment demolition and disposal cost
TOTAL HEALTH AND SAFETY COST	**$0**	

TOTAL FACILITY BUILDING DEMOLITION AND DISPOSAL COST	**$371,768**

Well Field Building Demolition and Disposal	Burdock B-WF1	Source or Unit Cost Name
I. Wellhead Covers		
Number of Wellhead Covers	210	See Sheet ASSUMPTIONS
Wellhead Cover Length (ft)	3	Estimate
Wellhead Cover Width (ft)	3	Estimate
Wellhead Cover Height (ft)	3	Estimate
A. Decontamination		
Area to Be Decontaminated (sf)		Calculated
Radiological Decontamination Unit Cost ($/sf)		Radiological Decontamination
Wellhead Cover Decontamination Cost	$0.00	No radiological contamination in 1st year
B. Demolition		
Wellhead Cover Demolition Unit Cost ($/ea)	$29.50	Wellhead Cover Demolition
Wellhead Cover Demolition Cost	$6,195.00	
C. Transportation and Disposal		
Demolished Cover Volume Reduction %	75%	Estimate
Demolished Volume of Wellhead Covers (cf)	1,418	Calculated
1. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of demolished volume
Volume to Landfill (cf)	1,417.50	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.87	Landfill Trans. and Disposal - Const. Debris/Equipment
Landfill Transportation and Disposal Cost	$2,650.73	
2. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of demolished volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)		11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Transportation and Disposal Cost	$0.00	
Subtotal Wellhead Cover Transportation and Disposal	$2,650.73	
TOTAL WELLHEAD COVER REMOVAL AND DISPOSAL COST	**$8,845.73**	
II. Header Houses		
Header House Length (ft)	40	TR Plate 3.1-6
Header House Width (ft)	10	TR Plate 3.1-6
Header House Height (ft)	8	TR Plate 3.1-6
Number of Header Houses	2	See Sheet ASSUMPTIONS
A. Decontamination		
1. Wall Decontamination		
Wall Area to Be Decontaminated (sf)		Calculated
Radiological Decontamination Unit Cost ($/sf)		Radiological Decontamination
Wall Decontamination Cost	$0.00	No radiological contamination in 1st year
2. Concrete Foundation Decontamination		
Foundation Area to be Decontaminated (sf)		Calculated
Radiological Decontamination Unit Cost ($/sf)		Radiological Decontamination
Concrete Foundation Decontamination Cost	$0.00	No radiological contamination in 1st year
Subtotal Header House Decontamination Cost	$0.00	
B. Demolition		
1. Building		
Building Volume (cf)	6,400	Calculated
Building Demolition Unit Cost ($/cf)	$0.19	Building Demolition
Building Demolition Cost	$1,216.00	
2. Concrete Foundation		
Depth of Concrete Foundation (ft)	4	Estimate

Well Field Building Demolition and Disposal	B-WF1	Source or Unit Cost Name
Area of Concrete Foundation (sf)	1,600	Calculated
Concrete Foundation Demolition Unit Cost ($/sf)	$17.49	Concrete Foundation Demolition
Concrete Foundation Demolition Cost	$27,984.00	
Subtotal Header House Demolition Cost	$29,200.00	
C. Transportation and Disposal		
1. Building		
Building Volume (cf)	6,400	Calculated
Demolished Building Volume Reduction %	75%	Estimate
Demolished Volume of Building (cf)	1,600	Calculated
a. Re-use/Recycle Facility Transportation and Disposal		
Salvage Percentage	50%	Estimate
Salvage Volume (cf)	800	Calculated
Re-use/Recycle Fac. Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Re-use/Recycle Facility Transportation and Disposal Cost	$872.00	
b. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of demolished, non-salvaged volume
Volume to Landfill (cf)	800	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.87	Landfill Trans. and Disposal - Const. Debris/Equipment
Landfill Transportation and Disposal Cost	$1,496.00	
c. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of demolished, non-salvaged volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Transportation and Disposal Cost	$0.00	
Subtotal Building Transportation and Disposal Cost	$2,368.00	
2. Concrete Foundation		
Area of Concrete Foundation (sf)	1,600	Calculated
Thickness of Concrete Foundation (ft)	0.5	Estimate
Demolished Concrete Swell Factor (%)	30%	Estimate
Volume of Concrete Foundation (cf)	1,040	Calculated
a. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of demolished volume
Volume to Landfill (cf)	1,040	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$3.53	Landfill Trans. and Disposal - Concrete
Landfill Transportation and Disposal Cost	$3,671.20	
b. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of demolished volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Transportation and Disposal Cost	$0.00	
Subtotal Concrete Foundation Trans. and Disposal Cost	$3,671.20	
Subtotal Header House Transportation and Disposal	$6,039.20	
TOTAL HEADER HOUSE DEMOLITION AND DISPOSAL COST	**$35,239.20**	

TOTAL WELL FIELD BUILDING DEMOLITION AND DISPOSAL COST	**$44,085**

Facility Reclamation	Burdock	Source or Unit Cost Name
I. Facility Pad Reclamation		
Pad Area (sf)	314,929	TR Figure 3.2-2
Pad Area (acre)	7.23	Calculated
Pad Reclamation Unit Cost ($/acre)	$3,795.97	Facility Pad/Staging Area Reclamation
TOTAL FACILITY PAD RECLAMATION COST	**$27,444.86**	
II. Facility Access Road Reclamation		
A. Road Reclamation		
Length of Facility Access Roads (ft)	10,387	1st Year Development Plan
Facility Access Road Reclamation Unit Cost ($/1,000 ft)	$3,384.10	Road Reclamation - Facility Access
Facility Access Road Reclamation Cost	$35,150.65	
B. Culvert Removal		
Length of Facility Access Road Culverts (ft)	525	1st Year Development Plan
Culvert Removal Unit Cost ($/20 ft)	$187.81	Culvert Removal
Facility Access Road Culvert Removal Cost	$4,930.01	
TOTAL FACILITY ACCESS ROAD RECLAMATION COST	**$40,080.66**	
III. Facility Pipeline Reclamation		
Wastewater Pipeline Length (ft)	1,195	1st Year Development Plan
DDW Pipeline Length (ft)	2,410	1st Year Development Plan
Madison Well Pipeline Length (ft)	2,945	1st Year Development Plan
A. Pipeline Removal		
Length of HDPE Pipe Trench (ft)	3,605	Calculated; Madison well pipeline included with trunkline cost
Main Pipeline Removal Unit Cost ($/ft of trench)	$1.31	Main Pipeline Removal
Pipeline Removal Cost	$4,723.00	
B. Pipe Chipping		
Length of HDPE Pipe (ft)	6,550	Calculated
Pipe Chipping Unit Cost ($/ft of pipe)	$0.48	Pipe Chipping
Pipeline Chipping Cost	$3,144.00	
C. Pipeline Transportation and Disposal		
Wastewater Pipeline Pipe Diameter (in)	10	1st Year Development Plan
Wastewater Pipeline Pipe Material Volume (cf)	262	Calculated assuming PE4710 SDR 11
DDW Pipeline Pipe Diameter (in)	6	1st Year Development Plan
DDW Pipeline Pipe Material Volume (cf)	201	Calculated assuming PE4710 SDR 11
Madison Well Pipeline Pipe Diameter (in)	8	1st Year Development Plan
Madison Well Pipeline Pipe Material Volume (cf)	416	Calculated assuming PE4710 SDR 11
Total Pipe Material Volume (cf)	879	Calculated
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	1,143	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Pipeline Transportation and Disposal Cost	$1,520.19	
D. Revegetation		
Width of Disturbed Trench Corridor (ft)	12	Typical
Area of Disturbed Trench Corridor (acres)	0.99	Calculated
Revegetation Unit Cost ($/acre)	$1,192.00	Revegetation
Revegetation Cost	$1,180.08	
TOTAL FACILITY PIPELINE RECLAMATION COST	**$10,567.27**	
IV. Pond Reclamation		
80-mil Primary Liner Surface Area (sf)	418,190	1st Year Development Plan; assumes all ponds will have dual synthetic liners
60-mil Secondary Liner Surface Area (sf)	418,190	1st Year Development Plan; assumes all ponds will have dual synthetic liners
Geonet (200-mil) Surface Area (sf)	418,190	1st Year Development Plan; assumes all ponds will have dual synthetic liners
Clay Liner Surface Area (sf)	418,190	1st Year Development Plan

Facility Reclamation	Burdock	Source or Unit Cost Name
Clay Liner Thickness (ft)	1	TR Appendix 3.1-A, assume left in place
A. Liner/Geonet Demolition		
Geosynthetic Liner/Geonet Area (sf)	418,190	Calculated as total pond area; assumes 80-mil liner, geonet, and 60-mil liner removed as a whole
Geosynthetic Liner/Geonet Demolition Unit Cost ($/sf)	$0.06	Geosynthetic Liner/Geonet Demolition
Geosynthetic Liner/Geonet Demolition Cost	$25,091.40	
B. Liner/Geonet Transportation and Disposal		
80-mil Liner Thickness (ft)	0.00667	
80-mil Liner Volume (cf)	2,789	Calculated
60-mil Liner Thickness (ft)	0.00500	
60-mil Liner Volume (cf)	2,091	Calculated
Geonet (200-mil) Thickness (ft)	0.01667	
Geonet Volume (cf)	6,971	Calculated
1. 80-mil Liner Transportation and Disposal		
Demolished Liner Swell Factor (%)	25%	Estimate
Volume to Landfill (cf)	3,486	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$4,636.38	
2. 60-mil Liner Transportation and Disposal		
Demolished Liner Swell Factor (%)	25%	Estimate
Volume to Landfill (cf)	2,614	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$3,476.62	
3. Geonet Transportation and Disposal		
Demolished Geonet Swell Factor (%)	25%	Estimate
Volume to Landfill (cf)	8,714	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$11,589.62	
Subtotal Liner/Geonet Transportation and Disposal Cost	$19,702.62	
C. Pond Regrading		
Total Pond Capacity (acre-ft)	45.3	TR Appendix 3.1-A
Pond Regrading Volume (cy)	36,542	Volume estimated as 50% of pond capacity
Regrading Unit Cost ($/cy)	$1.49	Topsoil/Borrow Placement
Pond Regrading Cost	$54,447.58	
D. Pond Topsoil Application		
Disturbance Area (sf)	536,400	TR Appendix 3.1-A
Topsoil Thickness (ft)	0.5	Estimate
Topsoil Volume (cy)	9,933	Calculated
Topsoil Application Unit Cost ($/cy)	$1.49	Topsoil/Borrow Placement
Pond Topsoil Application Cost	$14,800.17	
E. Pond Revegetation		
Disturbance Area (acre)	12.31	Calculated
Revegetation Unit Cost ($/acre)	$1,192.00	Revegetation
Pond Revegetation Cost	$14,673.52	
F. Radium Precipitate Disposal		
Restoration Composite Volume Treated (Kgal)		No restoration in 1st year
Radium Settlement Chemical Concentration (mg/L)		Process calculations
Radium Precipitate Percent Solids		Process calculations
Radium Precipitate Specific Gravity		Process calculations
Volume of Radium Precipitate (cy)		Calculated
1. Radium Precipitate Removal and Loading		
Removal and Loading Unit Cost ($/cy)		Load Trucks or Containers
Radium Precipitate Removal and Loading Cost	$0.00	No radium precipitate in 1st year

Facility Reclamation	Burdock	Source or Unit Cost Name
2. Radium Precipitate Transportation and Disposal		
Volume to 11e.(2) Disposal Facility (cf)	[redacted]	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Trans. and Disposal Cost	$0.00	No radium precipitate in 1st year
Subtotal Radium Precipitate Disposal Cost	$0.00	
G. Reclamation Soil Sampling		
Number of Samples	0	1st Year Development Plan
Sample Unit Cost ($/sample)	[redacted]	Soil Analysis - Reclamation
Reclamation Soil Sampling Cost	$0.00	
TOTAL POND RECLAMATION COST	**$128,715.29**	
VI. Land Application Reclamation		
A. Pivot Removal		Assume no net salvage value
Number of Pivots	[redacted]	No land application planned in 1st year
Pivot Removal Unit Cost ($/pivot)	[redacted]	Land Application Equipment Removal
Pivot Removal Cost	[redacted]	
B. Reclamation Soil Sampling		
Number of Samples	[redacted]	1st Year Development Plan
Sample Unit Cost ($/sample)	[redacted]	Soil Analysis - Reclamation
Reclamation Soil Sampling Cost	[redacted]	
TOTAL LAND APPLICATION RECLAMATION COST	**$0.00**	
VII. Facility Diversion Reclamation		
Facility Diversion Cut Volume (cy)	33,820	AutoCAD volume; conceptual design
Facility Diversion Disturbance Area (acres)	3.5	AutoCAD area; conceptual design
A. Diversion Backfill		
Backfill Unit Cost ($/cy)	$1.49	Topsoil/Borrow Placement
Diversion Backfill Cost	$50,391.80	
B. Diversion Grading		
Grading Unit Cost ($/acre)	$104.37	Grading
Diversion Grading Cost	$365.30	
C. Diversion Topsoil Replacement		
Diversion Topsoil Thickness (ft)	0.5	Estimate
Diversion Topsoil Volume (cy)	2,823	Calculated
Topsoil Replacement Unit Cost ($/acre)	$1.49	Topsoil/Borrow Placement
Diversion Topsoil Replacement Cost	$4,206.27	
D. Diversion Revegetation		
Revegetation Unit Cost ($/acre)	$1,192.00	Revegetation
Diversion Revegetation Cost	$4,172.00	
TOTAL FACILITY DIVERSION RECLAMATION COST	**$59,135.37**	

TOTAL FACILITY RECLAMATION COST	**$265,943**

Well Field Reclamation	**Burdock** **B-WF1**	**Source or Unit Cost Name**
I. Well and Header House Piping Removal and Disposal		
A. Header House Piping		
Number of Header Houses	2	See Sheet ASSUMPTIONS
1. Pipe Chipping		
Length of Piping per Header House (ft)	600	Estimate
Total Length of Piping (ft)	1,200	Calculated
Pipe Chipping Unit Cost ($/ft of pipe)	$0.48	Pipe Chipping
Piping Chipping Cost	$576.00	
2. Piping Transportation and Disposal		
Pipe Diameter (in)	2	Average piping diameter, estimate
Pipe Material Volume (cf)	6	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	8	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Piping Transportation and Disposal Cost	$10.64	
Subtotal Header House Piping Cost	$586.64	
B. Individual Well Pipelines		
Number of Production/Injection Wells	170	See Sheet ASSUMPTIONS
Average Length of Pipeline per Well (ft)	400	1st Year Development Plan
1. Pipeline Removal		
Total Length of Pipe (ft)	68,000	Calculated
Well Field Pipeline Removal Unit Cost ($/ft of Pipe)	$0.54	Well Field Pipeline Removal
Pipeline Removal Cost	$36,720.00	
2. Pipe Chipping		
Total Length of Piping (ft)	68,000	Calculated
Pipe Chipping Unit Cost ($/ft of pipe)	$0.48	Pipe Chipping
Pipeline Chipping Cost	$32,640.00	
3. Pipeline Transportation and Disposal		
Pipe Diameter (in)	1	1st Year Development Plan
Pipe Material Volume (cf)	224	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	291	Calculated
a. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of chipped volume
Volume to Landfill (cf)	291	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$387.03	
b. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of chipped volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Transportation and Disposal Cost	$0.00	
Subtotal Pipeline Transportation and Disposal Cost	$387.03	
Subtotal Individual Well Pipelines Cost	$69,747.03	
C. Downhole Well Piping		
Number of Production Wells	60	See Sheet ASSUMPTIONS
Number of Injection Wells	110	See Sheet ASSUMPTIONS
Average Well Depth(ft)	450	See Sheet ASSUMPTIONS
1. Piping Removal		
Piping Removal Cost	$0	Included in well abandonment cost

Well Field Reclamation	B-WF1	Source or Unit Cost Name
2. Pipe Chipping		
Total Length of Piping (ft)	76,500	Calculated
Pipe Chipping Unit Cost ($/ft of pipe)	$0.48	Pipe Chipping
Piping Chipping Cost	$36,720.00	
3. Piping Transportation and Disposal		
a. Production Wells		
Total Production Well Piping Length (ft)	27,000	Calculated
Pipe Diameter (in)	2	TR Figure 3.1-5
Pipe Material Volume (cf)	289	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	376	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Production Well Piping Transportation and Disposal Cost	$500.08	
b. Injection Wells		
Total Injection Well Piping Length (ft)	49,500	Calculated
Average Pipe Diameter (in)	1.25	TR Figure 3.1-4
Pipe Material Volume (cf)	259	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	337	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Injection Well Piping Transportation and Disposal Cost	$448.21	
Subtotal Piping Transportation and Disposal Cost	$948.29	
Subtotal Downhole Piping Disposal Cost	$37,668.29	
TOTAL WELL AND HEADER HOUSE PIPING COST	**$108,001.96**	
II. Well Pumps and Wire Removal and Disposal		
A. Pumps		
1. Pump Removal		
Pump Removal Cost	$0	Included in well abandonment cost
2. Pump Transportation and Disposal		
Number of Pumps	60	Number of production wells
Average Volume per Pump (cf)	0.5	Estimate
Total Pump Volume (cf)	30	Calculated
Re-use/Recycle Fac. Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Pump Transportation and Disposal Cost	$32.70	
Subtotal Pump Removal and Disposal Cost	$32.70	
B. Pump Wiring		
1. Wiring Removal		
Wiring Removal Cost	$0	Included in well abandonment cost
2. Wiring Transportation and Disposal		
Total Length of Wiring (ft)	27,000	Number of production wells x average well depth
Volume of Wire per Foot of Length (cf/ft)	0.002	Estimate
Total Wire Volume (cf)	54	Calculated
Re-use/Recycle Fac. Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Pump Wiring Transportation and Disposal Cost	$58.86	
Subtotal Pump Wiring Removal and Disposal Cost	$58.86	
TOTAL WELL PUMPS AND WIRE COST	**$91.56**	
III. Well Field Pattern Area Reclamation		
Pattern Area (sf)	520,000	See Sheet ASSUMPTIONS

Well Field Reclamation	B-WF1	Source or Unit Cost Name
Pattern Area (acres)	11.94	Calculated
Revegetation Unit Cost ($/acre)	$1,192.00	Revegetation
TOTAL WELL FIELD PATTERN AREA RECLAMATION	**$14,232.48**	
IV. HDPE Trunkline Removal and Disposal		
CPP/SF to Valve Vaults		
18" Trunkline Length per Pipe (ft)	6,660	1st Year Development Plan - prod./inj. lines
Number of Pipes	2	TR Plate 3.1-5
8" Trunkline Length per Pipe (ft)	6,660	1st Year Development Plan - cleanout/spare lines
Number of Pipes	2	TR Plate 3.1-5
2" Trunkline Length per Pipe (ft)	6,660	1st Year Development Plan - carbon dioxide line
Number of Pipes	1	TR Plate 3.1-5
Valve Vaults to Header Houses		
3" Trunkline Length per Pipe (ft)	175	1st Year Development Plan - prod./inj./cleanout/spare lines
Number of Pipes	8	TR Plate 3.1-5
1.5" Trunkline Length per Pipe (ft)	175	1st Year Development Plan - carbon dioxide line
Number of Pipes	2	TR Plate 3.1-5
A. Trunkline Removal		
Length of Trunkline Trench (ft)	7,010	Calculated
Main Pipeline Removal Unit Cost ($/ft of trench)	$1.31	Main Pipeline Removal
Trunkline Removal Cost	$9,183.10	
B. Pipe Chipping		
Total Length of Piping (ft)	35,050	Calculated
Pipe Chipping Unit Cost ($/ft of pipe)	$0.48	Pipe Chipping
Pipeline Chipping Cost	$16,824.00	
C. Trunkline Transportation and Disposal		
1. 18" HDPE Trunkline		
Pipe Material Volume (cf)	8,196	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	10,655	Calculated
a. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of chipped volume
Volume to Landfill (cf)	10,655	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$14,171.15	
b. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of chipped volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Transportation and Disposal Cost	$0.00	
Subtotal 18" HDPE Trunkline Transportation and Disposal Cost	$14,171.15	
2. 8" HDPE Trunkline		
Pipe Material Volume (cf)	1,882	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	2,447	Calculated
a. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of chipped volume
Volume to Landfill (cf)	2,447	Calculated

Well Field Reclamation	**B-WF1**	**Source or Unit Cost Name**
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$3,254.51	
b. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of chipped volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Transportation and Disposal Cost	$0.00	
Subtotal 8" HDPE Trunkline Transportation and Disposal Cost	$3,254.51	
3. 2" HDPE Trunkline		
Pipe Material Volume (cf)	71	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	92	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$122.36	
4. 3" HDPE Trunkline		
Pipe Material Volume (cf)	33	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	43	Calculated
a. Landfill Transportation and Disposal		
Percentage to Landfill	100%	100% of chipped volume
Volume to Landfill (cf)	43	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$57.19	
b. 11e.(2) Disposal Facility Transportation and Disposal		
Percentage to 11e.(2) Disposal Facility	0%	0% of chipped volume
Volume to 11e.(2) Disposal Facility (cf)	-	Calculated
11e.(2) Transportation and Disposal Unit Cost ($/cf)	[redacted]	11e.(2) Transportation and Disposal
11e.(2) Disposal Facility Transportation and Disposal Cost	$0.00	
Subtotal 3" HDPE Trunkline Transportation and Disposal Cost	$57.19	
5. 1.5" HDPE Trunkline		
Pipe Material Volume (cf)	2	Calculated assuming PE4710 SDR 11
Chipped Pipe Swell Factor (%)	30%	Estimate
Chipped Pipe Volume (cf)	3	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$1.33	Landfill Trans. and Disposal - Pipe/Liner
Landfill Transportation and Disposal Cost	$3.99	
Subtotal Trunkline Transportation and Disposal Cost	$17,609.20	
TOTAL HDPE TRUNKLINE COST	**$43,616.30**	
V. Stainless Steel (SS) Pipeline Removal and Disposal		
O2 Tank to Valve Vaults		
2" SS Length per Pipe (ft)	1,425	1st Year Development Plan - oxygen line
Number of Pipes	1	TR Plate 3.1-5 and TR Figure 3.2-7
Valve Vaults to Header Houses		
1.5" SS Length per Pipe (ft)	175	1st Year Development Plan - oxygen line
Number of Pipes	2	TR Plate 3.1-5
A. SS Pipeline Removal		
SS Pipeline Removal Cost	$0	Included in HDPE trunkline removal cost

Well Field Reclamation	B-WF1	Source or Unit Cost Name
B. SS Pipeline Transportation and Disposal		
Pipe Material Volume (cf)	18	Calculated assuming SCH 80 Pipe
Demolished Pipe Swell Factor (%)	50%	Estimate
Demolished Pipe Volume (cf)	27	Calculated
Re-use/Recycle Facility Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Re-use/Recycle Facility Transportation and Disposal Cost	$29.43	
TOTAL SS PIPELINE COST	**$29.43**	
VI. Valve Vault Reclamation		
Number of Valve Vaults	3	1st Year Development Plan
A. Valve Vault Removal		
Valve Vault Removal Unit Cost ($/vault)	$ 983.92	Valve Vault Removal
Valve Vault Removal Cost	$2,951.76	
B. Valve Vault Transportation and Disposal		
1. Steel Culvert Transportation and Disposal		
Steel Culvert Unit Volume (cf)	1,232	Calculated assuming 14' O.D. x 8' depth
Total Steel Culvert Volume (cf)	3,696	
Re-use/Recycle Fac. Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Re-use/Recycle Facility Transportation and Disposal Cost	$4,028.64	
2. Concrete Floor		
Unit Area of Concrete Floor (sf)	154	Calculated assuming 14' O.D.
Thickness of Concrete Floor (ft)	0.5	Estimate
Total Volume of Concrete Floor (cf)	231	
Demolished Concrete Swell Factor (%)	30%	Estimate
Volume of Concrete Floor (cf)	300	Calculated
Landfill Transportation and Disposal Unit Cost ($/cf)	$3.53	Landfill Trans. and Disposal - Concrete
Landfill Transportation and Disposal Cost	$1,059.00	
Subtotal Valve Vault Transportation and Disposal Cost	$5,087.64	
TOTAL VALVE VAULT RECLAMATION COST	**$8,039.40**	
VII. Well Field Access Road Reclamation		
A. Road Reclamation		
Length of Well Field Access Roads (ft)	11,416	1st Year Development Plan
Well Field Access Road Reclamation Unit Cost ($/1,000 ft)	$1,902.66	Road Reclamation - Well Field Access
Well Field Access Road Reclamation Cost	$21,720.77	
B. Culvert Removal		
Length of Well Field Access Road Culverts (ft)	371	1st Year Development Plan
Culvert Removal Unit Cost ($/20 ft)	$187.81	Culvert Removal
Well Field Access Road Culvert Removal Cost	$3,483.88	
TOTAL WELL FIELD ACCESS ROAD RECLAMATION COST	**$25,204.64**	
VIII. Light Use Road Reclamation		
Length of Light Use Roads (ft)	23,590	1st Year Development Plan
Light Use Road Reclamation Unit Cost ($/1,000 ft)	$236.50	Road Reclamation - Light Use
TOTAL LIGHT USE ROAD RECLAMATION COST	**$5,579.04**	
IX. Staging Area Reclamation		
Staging Area Area (sf)	251,600	1st Year Development Plan
Staging Area Area (acre)	5.78	
Staging Area Reclamation Unit Cost ($/acre)	$3,795.97	Facility Pad/Staging Area Reclamation
TOTAL STAGING AREA RECLAMATION COST	**$21,940.71**	

TOTAL WELL FIELD RECLAMATION COST	**$226,736**

Well Abandonment	Burdock	Source or Unit Cost Name
Average Well Depth (ft)	450	See Sheet ASSUMPTIONS
Well Field	**B-WF1**	**Source or Unit Cost Name**
Number of Production Wells	60	See Sheet ASSUMPTIONS
Number of Injection Wells	110	See Sheet ASSUMPTIONS
Number of Monitoring Wells	40	See Sheet ASSUMPTIONS
Total Number of Wells Abandoned	100	Calculated; Class III injection well financial assurance to be maintained in favor of EPA
I. Mechanical Integrity Testing (MIT) Cost		
MIT Unit Cost ($/well)	$349.42	MIT
TOTAL MIT COST	**$73,378.20**	Based on the total number of wells
II. Well Abandonment (Well Fields)		
Well Abandonment Unit Cost ($/well)	$1,394.08	Well Abandonment (Burdock)
TOTAL WELL FIELD ABANDONMENT COST	**$139,408.49**	Excluding Class III injection wells
III. Deep Disposal Well Abandonment		
Number of Deep Disposal Wells	1	1st Year Development Plan
Deep Disposal Well Abandonment Unit Cost ($/well)	[redacted]	Deep Disposal Well Abandonment; Class V DDW financial assurance to be maintained in favor of EPA
TOTAL DEEP DISPOSAL WELL ABANDONMENT COST	[redacted]	
TOTAL WELL ABANDONMENT COST	**$212,787**	

Miscellaneous Reclamation	Dewey/ Burdock	Source or Unit Cost Name
I. Fence Removal and Disposal		
A. Chain-link Fence Removal		
1. Chain-link Fence Removal and Disposal		
Length around CPP (ft)	2,240	TR Figure 3.2-2
Length around Surge Pond (ft)	1,360	1st Year Development Plan
Length around Radium Settling Ponds (ft)	2,840	1st Year Development Plan
Total Length of Chain-link Fence (ft)	6,440	Calculated
Chain-link Fence Removal Unit Cost ($/ft)	$4.22	Chain-link Fence Removal
Chain-link Fence Removal Cost	$27,176.80	
2. Chain-link Fence Transportation and Disposal		
Unit Volume of Chain-link Fence (cf/ft)	0.33	Estimate
Total Volume of Chain-link Fence (cf)	2,125	Calculated
Re-use/Recycle Fac. Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Chain-link Fence Transportation and Disposal Cost	$2,316.25	
Subtotal Chain Link Fence Removal and Disposal	$29,493.05	
B. Barbed Wire Fence Removal and Disposal		
1. Barbed Wire Fence Removal		
Length in Well Fields (ft)	7,180	1st Year Development Plan
Barbed Wire Fence Removal Unit Cost ($/ft)	$0.38	Barbed Wire Fence Removal
Barbed Wire Fence Removal Cost	$2,728.40	
2. Barbed Wire Fence Transportation and Disposal		
Unit Volume of Barbed Wire Fence (cf/ft)	0.003	Estimate, assumes posts are disposed or salvaged on-site
Total Volume of Barbed Wire Fence (cf)	22	Calculated
Re-use/Recycle Fac. Trans. and Disposal Unit Cost ($/cf)	$1.09	Re-use/Recycle Fac. Trans. and Disposal
Barbed Wire Fence Transportation and Disposal Cost	$23.98	
Subtotal Barbed Wire Fence Removal and Disposal	$2,752.38	
TOTAL FENCE REMOVAL AND DISPOSAL COST	**$32,245.43**	
II. Overhead Power Line Removal and Disposal		
Length of Overhead Power Lines (ft)	41,700	1st Year Development Plan
Overhead Power Lines Removal and Disposal Unit Cost ($/ft)	$0.00	Overhead Power Line Removal and Disposal
TOTAL OVERHEAD POWER LINE REMOVAL AND DISPOSAL COST	**$0.00**	
III. Sediment Control Structure Removal and Disposal		
Sediment Control Structure Removal and Disposal Cost	$10,000.00	Sediment Control Structure Removal and Disposal
TOTAL SEDIMENT CONTROL REMOVAL AND DISPOSAL COST	**$10,000.00**	
IV. Environmental Monitoring Station Reclamation		
A. MET Station Demolition and Removal		
Number of MET Stations	1	1st Year Development Plan
MET Station Demolition and Removal Unit Cost ($/station)	$1,369.06	Met Station Demo. and Removal
MET Station Reclamation Cost	$1,369.06	
B. Surface Water Station Demolition and Removal		
Number of Surface Water Stations	6	TR Table 5.7.8-2; passive samplers
Surface Water Station Demo. and Removal Unit Cost ($/station)	$3,607.42	Surface Water Station Demo. and Removal
Surface Water Station Reclamation Cost	$21,644.52	
TOTAL ENVIRONMENTAL MON. STATION RECLAMATION COST	**$23,013.58**	
V. Reclamation Performance Sampling		
Duration of Reclamation Performance Sampling (yr)	3	Large Scale Mine Permit Application, Appendix 6.4-D

Miscellaneous Reclamation	Dewey/ Burdock	Source or Unit Cost Name
Reclamation Performance Sampling Unit Cost ($/yr)	$5,000.00	Reclamation Performance Sampling
TOTAL RECLAMATION PERFORMANCE SAMPLING COST	**$15,000.00**	

TOTAL MISCELLANEOUS RECLAMATION COST	**$80,259**

Unit Cost Table
Dewey-Burdock Project
Powertech (USA), Inc.

Unit Cost Table

Description	Unit Cost	Unit	Source	Notes	Unit Cost Type (Sheet Name)	Cost Reference Sheet
11e.(2) Disposal	[redacted]	cy	[redacted]	[redacted]	[redacted]	[redacted]
11e.(2) Transportation and Disposal	[redacted]	cf	[redacted]	[redacted]	[redacted]	[redacted]
Backhoe Fuel	$ 11.60	hr	Caterpillar O&O Manual	Cat 420 backhoe, medium use, fuel consumption = 2.9 gal/hr, fuel at $4/gal	Simple	EQUIP-1
Backhoe Rental	$ 1,060.00	week	Wyoming Rents, LLC	Backhoe 4x4 E-stick	Simple	EQUIP-2
Barbed Wire Fence Removal	$ 0.38	ft	WYDOT 2013 Weighted Average Bid Prices		Simple	
Building Demolition	$ 0.19	cf	RSMeans 2014; 02 41 16.13.0100	Reduced 50% for lack of interior walls per RSMeans 2014; 02 41 16.13.0750	Simple	
Cementer	$ 500.00	day	Cost from Northwestern Wyoming Well Driller		Simple	
Chain-link Fence Removal	$ 4.22	ft	RSMeans 2014; 02 41 13.60.1700		Simple	
Chemical - Barium Chloride	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - Biocide	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - Corrosion Inhibitor	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - DDW Scale Inhibitor	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - Hydrogen Peroxide	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - Oxygen Scavenger	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - Sodium Carbonate	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - Sodium Chloride	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - Sodium Hydroxide	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chemical - Sulfuric Acid	[redacted]	lb	[redacted]	[redacted]	[redacted]	[redacted]
Chipper	$ 855.00	week	RSMeans 2014; 01 54 33 20.0550		Simple	
Concrete Containment Curb Demolition	$ 6.80	ft	RSMeans 2014; 02 41 13.17.6100		Simple	
Concrete Floor Demolition	$ 8.45	sf	RSMeans 2014; 02 41 16.17.0440		Simple	
Concrete Footer Demolition	$ 29.00	ft	RSMeans 2014; 02 41 16.17.1140	Assumed 3' Wide, 2' Thick	Simple	
Concrete Foundation Demolition	$ 17.49	sf	RSMeans 2014; 02 41 16.17.2400			
Culvert Removal	$ 187.81	20 ft	WDEQ Guideline No. 12 App. J	Includes additional 25% overhead and 10% profit	Simple	
Deep Disposal Well Abandonment	[redacted]	ea	[redacted]	[redacted]	[redacted]	[redacted]
Deep Disposal Well Maintenance and Repair	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Deep Disposal Well	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Electricity	[redacted]	kWh	[redacted]	[redacted]	[redacted]	[redacted]
Electricity - CPP Area	[redacted]	month	[redacted]	[redacted]	[redacted]	[redacted]
Electricity - Header House	[redacted]	month	[redacted]	[redacted]	[redacted]	[redacted]
Electricity - Satellite	[redacted]	month	[redacted]	[redacted]	[redacted]	[redacted]
Electricity - Well Head	[redacted]	month	[redacted]	[redacted]	[redacted]	[redacted]
Equipment Demolition and Loading	$ 1,575.00	day	RSMeans 2014; 02 42 10.20.9010	Hydraulic Crane and Crew	Simple	
Facility Pad/Staging Area Reclamation	$ 3,795.97	acre			Compound (UC-SURF REC)	
Gamma Survey Mob./Demob	[redacted]	Lump Sum	[redacted]	[redacted]	[redacted]	[redacted]
Gamma Survey Reporting	[redacted]	Lump Sum	[redacted]	[redacted]	[redacted]	[redacted]
Gamma Survey Transects	[redacted]	acre	[redacted]	[redacted]	[redacted]	[redacted]
Geosynthetic Liner/Geonet Demolition	$ 0.06	sf			Compound (UC-GEO)	
Grading	$ 104.37	acre	WDEQ Guideline No. 12 App. G	Includes additional 25% overhead and 10% profit	Simple	
Gravel	[redacted]	cy	[redacted]	[redacted]	[redacted]	[redacted]
Gravel Removal	$ 1.49	cy	WDEQ Guideline No. 12 App. C	Scraper, Level Ground, 500-ft Haul, Includes additional 25% overhead and 10% profit	Simple	
IX Resin Transfer	[redacted]	Resin Trans.	[redacted]	[redacted]	[redacted]	[redacted]

Unit Cost Table
Dewey-Burdock Project
Powertech (USA), Inc.

Description	Unit Cost	Unit	Source	Notes	Unit Cost Type (Sheet Name)	Cost Reference Sheet
Labor - Equipment Operator	$ 66.02	hr	RSMeans 2014, Crews	Equipment Operator (medium), includes 25% overhead and 10% profit	Simple	
Labor - Lab Technician	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Labor - Laborer	$ 49.48	hr	RSMeans 2014, Crews	Includes 25% overhead and 10% profit	Simple	
Labor - Radiation Safety Officer	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Labor - Restoration Engineer	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Labor - Restoration Operator	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Labor - Restoration Superintendent	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Land Application - Burdock	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Land Application - Dewey	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Land Application Equipment Removal	[redacted]	pivot	[redacted]	[redacted]	[redacted]	[redacted]
Land Application Repair and Maintenance	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Landfill Disposal	$ 45.00	ton	Custer Fall River Landfill	From Website Accessed 2014	Simple	LF-1
Landfill Trans. and Disposal - Concrete	$ 3.53	cf			Compound (UC-T&D)	
Landfill Trans. and Disposal - Const. Debris/Equipment	$ 1.87	cf			Compound (UC-T&D)	
Landfill Trans. and Disposal - Pipe/Liner	$ 1.33	cf			Compound (UC-T&D)	
Load Trucks or Containers	[redacted]	cy	[redacted]	[redacted]	[redacted]	[redacted]
Loader Fuel	$ 7.60	hr	Caterpillar O&O Manual	Cat 930 loader, medium use, fuel consumption = 1.9 gal/hr, fuel at $4/gal	Simple	EQUIP-3
Loader Rental	$ 2,200.00	week	Wyoming Rents, LLC	Cat 930	Simple	EQUIP-2
Main Pipeline Removal	$ 1.31	ft			Compound (UC-MAIN)	
Maintenance - HH Equipment	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance - HH Flow Meter	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance - HH Pressure Gauge/Switch	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance - Pipelines	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance - Process Hardware	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance - Prod./Inj. Well	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance - Well Pumps	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Maintenance - Wireless Telemetry and Security	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
Met Station Demo. and Removal	$ 1,369.06	ea	WDEQ Guideline No. 12 App. O	Includes 25% overhead and 10% profit	Simple	
Met Station Monitoring and Sampling	[redacted]	yr	[redacted]	[redacted]	[redacted]	[redacted]
MIT	$ 349.42	well			Compound (UC-MIT)	
MIT Unit	$ 750.00	week	2013 ISR Facility Rental Cost		Simple	
Overhead Power Line Removal and Disposal	$ -	ft	WDEQ Guideline No. 12 App. H	Assumes removed at no charge by power company	Simple	
Pickup Truck/Pulling Unit	$ 40.46	hr	WDEQ Guideline No. 12, Table D-1	Gas, Includes 25% overhead and 10% profit	Simple	
Pipe Chipping	$ 0.48	ft			Compound (UC-MAIN)	
Propane	[redacted]	gal	[redacted]	[redacted]	[redacted]	[redacted]
Propane - CPP Area	[redacted]	month	[redacted]	[redacted]	[redacted]	[redacted]
Propane - Satellite	[redacted]	month	[redacted]	[redacted]	[redacted]	[redacted]
Pumping from Madison	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Pumping from Well Fields	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Pumping to Well Fields	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Radiation Safety Equipment - Decom.	[redacted]	Lump Sum	[redacted]	[redacted]	[redacted]	[redacted]
Radiological Decontamination	[redacted]	sf	[redacted]	[redacted]	[redacted]	[redacted]
Radium Treatment	[redacted]	1,000 gal	[redacted]	[redacted]	[redacted]	[redacted]
Radon Analysis	[redacted]	ea	[redacted]	[redacted]	[redacted]	[redacted]
Reclamation Performance Sampling	$ 5,000.00	yr	WWC Engineering Estimate	Annual Vegetation Sampling	Simple	
Re-use/Recycle Fac. Trans. and Disposal	$ 1.09	cf			Compound (UC-T&D)	

POWERTECH (USA) INC.

Unit Cost Table
Dewey-Burdock Project
Powertech (USA), Inc.

Description	Unit Cost	Unit	Source	Notes	Unit Cost Type (Sheet Name)	Cost Reference Sheet
Revegetation	$ 1,192.00	acre	From construction project in northeastern Wyoming	Inflated from 2010 dollars using Bureau of Labor Statistics CPI inflation calculator	Simple	
Ripping	$ 1,695.20	acre	WDEQ Guideline No. 12 App. I1	Includes 25% overhead and 10% profit	Simple	
RO Electricity		1,000 gal				
RO Membrane Replacement		1,000 gal				
RO Operation		1,000 gal				
RO Pretreatment		1,000 gal				
Road Maintenance - Facility Access		1,000 ft				
Road Maintenance - Well Field Access		1,000 ft				
Road Reclamation - Facility Access	$ 3,384.10	1,000 ft			Compound (UC-ROAD)	
Road Reclamation - Light Use	$ 236.50	1,000 ft			Compound (UC-ROAD)	
Road Reclamation - Well Field Access	$ 1,902.66	1,000 ft			Compound (UC-ROAD)	
Scarification	$ 95.73	acre	WDEQ Guideline No. 12 App. P	Includes 25% overhead and 10% profit	Simple	
Sediment Control Structure Removal and Disposal	$ 10,000.00	Lump Sum	WWC Engineering Estimate		Simple	
Soil Analysis - AMS Surface		ea				
Soil Analysis - Land App.		ea				
Soil Analysis - Reclamation		ea				
Surface Water Station Demo. and Removal	$ 3,607.42	ea	WDEQ Guideline No. 12 App. N	Includes 25% overhead and 10% profit	Simple	
Tissue Analysis - Fish		ea				
Tissue Analysis - Livestock		ea				
Tissue Analysis - Prairie Dog		ea				
Topsoil/Borrow Placement	$ 1.49	cy	WDEQ Guideline No. 12 App. C	Scraper, Level Ground, 500-ft Haul, Includes additional 25% overhead and 10% profit	Simple	
Trackhoe Fuel	$ 16.00	hr	Caterpillar O&O Manual	Cat 320 excavator, medium use, fuel consumption = 4.0 gal/hr, fuel at $4/gal	Simple	EQUIP-4
Trackhoe Rental	$ 2,600.00	week	Wyoming Rents, LLC	Cat 320	Simple	EQUIP-2
Trans. to Landfill or Re-use/Recy (Loaded)	$ 3.74	mile	Powertech Estimate		Simple	TRANS-1
Trans. to Landfill or Re-use/Recy (Unloaded)	$ 3.02	mile	Powertech Estimate		Simple	TRANS-1
Trans. to NRC Facility (Loaded)		mile				
Trans. to NRC Facility (Unloaded)		mile				
Valve Vault Removal	$ 983.92	ea			Compound (UC-MAIN)	
Vegetation Analysis - Land App.		ea				
Water Analysis - Active Restoration		ea				
Water Analysis - Excursion Sample		ea				
Water Analysis - Full Suite		ea				
Water Analysis - Land App. Catchment Area		ea				
Water Analysis - Land App. Effluent Monthly		ea				
Water Analysis - Land App. Effluent Volume Based		ea				
Water Analysis - Land App. Monitor Well		ea				
Water Analysis - Surface Water		ea				
Well Abandonment (Burdock)	$ 1,394.08	well			Compound (UC-WA)	
Well Abandonment (Dewey)		well				
Well Field Pipeline Removal	$ 0.54	ft			Compound (UC-WFPIPE)	
Wellhead Cover Demolition	$ 29.50	ea	RSMeans 2014; 02 41 13.88.0900		Simple	

References:
- RSMeans 2014 Site Work and Landscape Cost Data
- WDEQ Guideline No. 12, updated March 2014, http://deq.state.wy.us/lqd/Guidelines.asp

UC-GEO
Dewey-Burdock Project
Powertech (USA), Inc.

GEOSYNTHETIC LINER/GEONET DEMOLITION

Assumptions:	Rate	Unit	Source or Unit Cost Name
1. Loader Rental:	$ 2,200	/week	Loader Rental
2. Production for Demolition and Loading with Loader:	30,000	sf/day	Estimate, assumes primary liner, geonet, and secondary liner removed as a whole
3. Daily Operating Schedule:	8	hr/day	Estimate
4. Weekly Operating Schedule:	5	days/week	Estimate
5. Loader Fuel Cost:	$ 7.60	/hr	Loader Fuel
6. Loader Operator:	$ 66.02	/hr	Labor - Equipment Operator
7. Liner Demolition Labor:	$ 49.48	/hr	Labor - Laborer
8. Liner Demolition Labor, # Workers:	2	workers	Estimate

Geosynthetic Liner/Geonet Demolition Cost per Square Foot of Liner

Equipment

Loader

$ 2,200.00 / week X 1 week / 5 days X 1 day / 30,000 sf =$ 0.015

Fuel

$ $ 7.60 / hour X 8 hr / 1 day X 1 day / 30,000 sf =$ 0.002

Labor

Loader Operation

$ 66.02 / man hr X 8 man hr / 1 day X 1 day / 30,000 sf =$ 0.018

Liner Demolition and Loading

$ 49.48 / man hr X 8 man hr / 1 day X 2 workers X

1 day / ##### sf =$ 0.026

GEOSYNTHETIC LINER/GEONET DEMOLITION COST PER SQUARE FOOT OF LINER =$ 0.06

UC-MAIN
Dewey-Burdock Project
Powertech (USA), Inc.

MAIN PIPELINE REMOVAL, PIPE CHIPPING, AND VALVE VAULT REMOVAL

Assumptions:	Rate	Unit	Source or Unit Cost Name
1. Trackhoe Rental:	$ 2,600	/week	Trackhoe Rental
2. Production for Trenching, Pipeline Extraction and Backfilling with Trackhoe:	1,500	ft/day	Estimate
3. Daily Operating Schedule:	8	hr/day	Estimate
4. Weekly Operating Schedule:	5	days/week	Estimate
5. Trackhoe Fuel Cost:	$ 16.00	/hr	Trackhoe Fuel
6. Trackhoe Operator:	$ 66.02	/hr	Labor - Equipment Operator
7. Laborer Labor:	$ 49.48	/hr	Labor - Laborer
8. Pipeline Extraction Labor, # Workers:	2	workers	Estimate
9. Chipper Rental:	$ 855.00	/week	Chipper
10. Production for Pipe Chipping:	2,000	ft/day	Estimate
11. Pipe Chipping Labor, # Workers:	2	workers	Estimate
12. Production for Valve Vault Removal:	2	vaults/day	Estimate

Main Pipeline Removal Cost per Foot of Trench

Equipment

Trackhoe

$$\frac{\$\ 2{,}600}{\text{week}} \times \frac{1\ \text{week}}{5\ \text{days}} \times \frac{1\ \text{day}}{1{,}500\ \text{ft}} = \$\ 0.347$$

Fuel

$$\frac{\$\ 16.00}{\text{hour}} \times \frac{8\ \text{hr}}{1\ \text{day}} \times \frac{1\ \text{day}}{1{,}500\ \text{ft}} = \$\ 0.085$$

Labor

Trackhoe Operation

$$\frac{\$\ 66.02}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{1\ \text{day}}{1{,}500\ \text{ft}} = \$\ 0.352$$

Laborer

$$\frac{\$\ 49.48}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{2\ \text{workers}}{\text{day}} \times \frac{1\ \text{day}}{1{,}500\ \text{ft}} = \$\ 0.528$$

MAIN PIPELINE REMOVAL COST PER FOOT OF TRENCH =$ 1.31

UC-MAIN
Dewey-Burdock Project
Powertech (USA), Inc.

Pipeline Chipping Cost per ft of Pipe

Equipment

Pipe Chipper

$$\frac{\$\ 855.00}{\text{week}} \times \frac{1\ \text{week}}{5\ \text{day}} \times \frac{1\ \text{day}}{2{,}000\ \text{ft}} = \$\ 0.086$$

Labor

Laborer

$$\frac{\$\ 49.48}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{2\ \text{workers}}{} \times \frac{1\ \text{day}}{2{,}000\ \text{ft}} = \$\ 0.396$$

PIPE CHIPPING COST PER FOOT OF PIPE =$ 0.48

Valve Vault Removal Cost per Vault

Equipment

Trackhoe

$$\frac{\$\ 2{,}600}{\text{week}} \times \frac{1\ \text{week}}{5\ \text{days}} \times \frac{1\ \text{day}}{2\ \text{vaults}} = \$\ 260.00$$

Fuel

$$\frac{\$\ 16.00}{\text{hour}} \times \frac{8\ \text{hr}}{1\ \text{day}} \times \frac{1\ \text{day}}{2\ \text{vaults}} = \$\ 64.00$$

Labor

Trackhoe Operation

$$\frac{\$\ 66.02}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{1\ \text{day}}{2\ \text{vaults}} = \$\ 264.08$$

Laborer

$$\frac{\$\ 49.48}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{2\ \text{workers}}{} \times \frac{1\ \text{day}}{2\ \text{vaults}} = \$\ 395.84$$

VALVE VAULT REMOVAL COST PER VAULT =$ 983.92

UC-MIT
Dewey-Burdock Project
Powertech (USA), Inc.

MECHANICAL INTEGRITY TESTING (MIT)

Assumptions:	Rate	Unit	Source or Unit Cost Name
1. Pulling Unit Cost:	$ 40.46	/hr	Pickup Truck/Pulling Unit
2. Daily Operating Schedule:	8	hr/day	Estimate
3. Weekly Operating Schedule:	5	days/week	Estimate
4. Production for Removing and Resetting Pump and MIT Testing:	4	wells/day	RSMeans 2014; 33 21 13.10.1400
5. MIT Unit Rental:	$ 750.00	/week	MIT Unit
6. Production for MIT Testing:	4	wells/day	Estimate
7. Pulling Unit/MIT Operator Labor:	$ 66.02	/hr	Labor - Equipment Operator
8. Laborer Labor	$ 49.48	/hr	Labor - Laborer

Mechanical Integrity Testing Cost per Well

Equipment

Pulling Unit

$$\frac{\$\ 40.46}{\text{hour}} \times \frac{8\ \text{hours}}{1\ \text{day}} \times \frac{1\ \text{day}}{4\ \text{wells}} = \$\ 80.92$$

MIT Unit

$$\frac{\$\ 750.00}{\text{week}} \times \frac{8\ \text{week}}{5\ \text{day}} \times \frac{1\ \text{day}}{4\ \text{wells}} = \$\ 37.50$$

Labor

Pulling Unit/MIT Unit Operation

Operator

$$\frac{\$\ 66.02}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{1\ \text{day}}{4\ \text{wells}} = \$\ 132.04$$

Laborer

$$\frac{\$\ 49.48}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{1\ \text{day}}{4\ \text{wells}} = \$\ 98.96$$

TOTAL MIT COST PER WELL **=$ 349.42**

UC-ROAD
Dewey-Burdock Project
Powertech (USA), Inc.

ROAD RECLAMATION

Assumptions:	Rate	Unit	Source or Unit Cost Name
1. Facility Access Road Width:	32	ft	Estimate
2. Well Field Access Road Width:	15	ft	Estimate
3. Light Use Road Width:	8	ft	Estimate
4. Gravel Road Base Depth:	0.5	ft	Estimate
5. Gravel Removal Cost[1]:	$ 1.49	/cy	Gravel Removal
6. Scarification Cost:	$ 95.73	/acre	Scarification
7. Grading Cost:	$ 104.37	/acre	Grading
8. Facility Access Road Disturbed Width:	42	ft	Estimate
9. Well Field Access Road Disturbed Width:	25	ft	Estimate
10. Topsoil Replacement Depth:	0.5	ft	Estimate
11. Topsoil Replacement Cost:	$ 1.49	/cy	Topsoil/Borrow Placement
12. Revegetation Cost:	$ 1,192.00	/acre	Revegetation

[1] Assumes crushed asphalt/gravel provided to county at no net salvage value.

Road Reclamation Cost per 1,000 Feet of Road

Facility Access Roads

Gravel Road Base Removal Cost per 1,000 ft of Road

1000 ft X 32 ft-wide X 0.5 ft-depth X (1 cy / 27 cf) X ($ 1.49 / cy) =$ 882.96

Scarification Cost per 1,000 ft of Road

1000 ft X 42 ft-wide X (1 acre / 43,560 sf) X ($ 95.73 / acre) =$ 92.30

Grading Cost per 1,000 ft of Road

1000 ft X 42 ft-wide X (1 acre / 43,560 sf) X ($ 104.37 / acre) =$ 100.63

Topsoil Replacement Cost per 1,000 ft of Road

1000 ft X 42 ft-wide X 0.5 ft-depth X (1 cy / 27 cf) X ($ 1.49 / cy) =$ 1,158.89

Revegetation Cost per 1,000 ft of Road

1000 ft X 42 ft-wide X (1 acre / 43,560 sf) X ($ 1,192 / acre) =$ 1,149.31

FACILITY ACCESS ROAD RECLAMATION COST PER 1,000 FEET OF ROAD =$ 3,384.10

UC-ROAD
Dewey-Burdock Project
Powertech (USA), Inc.

Well Field Access Roads

Gravel Road Base Removal Cost per 1,000 ft of Road

1000 ft	X	15 ft-wide	X	0.5 ft-depth	X	1 cy / 27 cf	X	$ 1.49 / cy	=$	413.89

Scarification Cost per 1,000 ft of Road

1000 ft	X	25 ft-wide	X	1 acre / 43,560 sf	X	$ 95.73 / acre	=$	54.94

Grading Cost per 1,000 ft of Road

1000 ft	X	25 ft-wide	X	1 acre / 43,560 sf	X	$ 104.37 / acre	=$	59.90

Topsoil Replacement Cost per 1,000 ft of Road

1000 ft	X	25 ft-wide	X	0.5 ft-depth	X	1 cy / 27 cf	X	$ 1.49 / cy	=$	689.81

Revegetation Cost per 1,000 ft of Road

1000 ft	X	25 ft-wide	X	1 acre / 43,560 sf	X	$ 1,192 / acre	=$	684.11

WELL FIELD ACCESS ROAD RECLAMATION COST PER 1,000 FEET OF ROAD =$ 1,902.66

Light Use Roads

Scarification Cost per 1,000 ft of Road

1000 ft	X	8 ft-wide	X	1 acre / 43,560 sf	X	$ 95.73 / acre	=$	17.58

Revegetation Cost per 1,000 ft of Road

1000 ft	X	8 ft-wide	X	1 acre / 43,560 sf	X	$ 1,192 / acre	=$	218.92

LIGHT USE ROAD RECLAMATION COST PER 1,000 FEET OF ROAD =$ 236.50

UC-SURF REC
Dewey-Burdock Project
Powertech (USA), Inc.

SURFACE RECLAMATION

Assumptions:	**Rate**	**Unit**	**Source or Unit Cost Name**
1. Crushed Asphalt/Gravel Depth:	0.5	ft	Estimate
2. Crushed Asphalt/Gravel Removal Cost[1]:	$ 1.49	/cy	Gravel Removal
3. Scarification Cost:	$ 95.73	/acre	Scarification
4. Grading Cost:	$ 104.37	/acre	Grading
5. Topsoil Replacement Depth:	0.5	ft	Estimate
6. Topsoil/Borrow Replacement Cost:	$ 1.49	/cy	Topsoil/Borrow Placement
7. Revegetation Cost:	$ 1,192.00	/acre	Revegetation

[1] Assumes crushed asphalt/gravel provided to county at no net salvage value.

Facility Pad/Staging Area Reclamation Cost per Acre

Crushed Asphalt/Gravel Removal Cost per Acre

1 acre X 0.5 ft-depth X (43,560 sf / 1 acre) X (1 cy / 27 cf) X ($ 1.49 / cy) =$ 1,201.93

Scarification Cost per Acre =$ 95.73

Grading Cost per Acre =$ 104.37

Topsoil Replacement Cost per Acre

1 acre X 0.5 ft-depth X (43,560 sf / 1 acre) X (1 cy / 27 cf) X ($ 1.49 / cy) =$ 1,201.93

Revegetation Cost per Acre =$ 1,192.00

FACILITY PAD RECLAMATION COST PER ACRE =$ 3,795.97

UC-T&D
Dewey-Burdock Project
Powertech (USA), Inc.

TRANSPORTATION AND DISPOSAL

Assumptions:	Rate	Unit	Source or Unit Cost Name
1. Distance from Site to Regional Landfill at Edgemont, SD:	16	miles	Actual travel distance
2. Distance from Site to Re-use/recycling Facility at Rapid City, SD:	87	miles	Actual travel distance
3. Distance from Site to 11e.(2) Disposal Facility at White Mesa, UT:	[redacted]	miles	Actual travel distance
4. Transport to Landfill or Re-use/recycle Facility Cost (Loaded):	$ 3.74	/mile	Trans. to Landfill or Re-use/Recy (loaded)
5. Transport to Landfill or Re-use/recycle Facility Cost (Unloaded):	$ 3.02	/mile	Trans. to Landfill or Re-use/Recy (unloaded)
6. Transport to NRC Licensed Facility Cost (Loaded):	[redacted]	/mile	Trans. to NRC Facility (loaded)
7. Transport to NRC Licensed Facility Cost (Unloaded):	[redacted]	/mile	Trans. to NRC Facility (unloaded)
8. Construction Debris/Equipment Density:	2,000	lb/cy	Typical
9. Pipe/liner Density:	1,350	lb/cy	Typical
10. Concrete Density:	4,000	lb/cy	Typical
11. Regional Landfill Disposal Fee:	$ 45	/ton	Landfill Disposal
12. Re-use/recycle Facility Disposal Fee:	$ -	/ton	Assumed $0 for salvage value
13. 11e.(2) Disposal Facility Disposal Fee:	[redacted]	cy	11e.(2) Disposal
14. Dump Truck Size (landfill/re-use/recycle):	20	cy	Process calculations
15. Shipping Container Size (11e.(2)):	[redacted]	cy	Process calculations

Landfill Transportation and Disposal

Transportation

16 miles X $ 3.74 / loaded mile + 16 miles X $ 3.02 / unloaded X 1 Truck / 20 cy = $ 5.41 /cy

Disposal

Construction Debris/Equipment

2000 lb / cy X 1 ton / 2000 lb X $ 45 / ton = $ 45.00 /cy

Pipe/Liner

1350 lb / cy X 1 ton / 2000 lb X $ 45 / ton = $ 30.38 /cy

Concrete

4000 lb / cy X 1 ton / 2000 lb X $ 45 / ton = $ 90.00 /cy

Total Transportation and Disposal: Construction Debris/Equipment

Transportation Cost		Disposal Cost	Total
$ 5.41 /cy	+	$ 45.00 /cy	= $ 50.41 /cy

LANDFILL TRANS. AND DISPOSAL - CONST. DEBRIS/EQUIPMENT = $ 1.87 /cf

Total Transportation and Disposal: Pipe/Liner

Transportation Cost		Disposal Cost	Total
$ 5.41 /cy	+	$ 30.38 /cy	= $ 35.78 /cy

LANDFILL TRANS. AND DISPOSAL - PIPE/LINER = $ 1.33 /cf

Total Transportation and Disposal: Concrete

Transportation Cost		Disposal Cost	Total
$ 5.41 /cy	+	$ 90.00 /cy	= $ 95.41 /cy

LANDFILL TRANS. AND DISPOSAL - CONCRETE = $ 3.53 /cf

Re-use/Recycle Facility Transportation and Disposal

Transportation

87 miles X ($ 3.74 / loaded mile) + 87 miles X ($ 3.02 / unloaded) X (1 Truck / 20 cy) = $ 29.41 /cy

Disposal

All Materials

= $ 0 /cy

Total Transportation and Disposal: All Materials

Transportation Cost		Disposal Cost	Total
$ 29.41 /cy	+	$ - /cy	= $ 29.41 /cy

REUSE/RECYCLE FAC. TRANS. AND DISPOSAL = $ 1.09 /cf

11e.(2) Transportation and Disposal

Transportation

[redacted] miles X ($ [redacted] / loaded mile) + [redacted] miles X ($ [redacted] / unloaded) X (1 container / [redacted] cy) = $ [redacted] /cy

Disposal

All Materials

= $ [redacted] /cy

Total Transportation and Disposal: All Materials

Transportation Cost		Disposal Cost	Total
[redacted] /cy	+	[redacted] /cy	= $ [redacted] /cy

11e.(2) TRANSPORTATION AND DISPOSAL = $ [redacted] /cf

Powertech (USA) Inc.

WELL ABANDONMENT

Assumptions:	Rate	Unit	Source or Unit Cost Name
1. Equipment and Labor Cost:	$ 1,036.18	/well	Vendor quote, see reference WA-1, inflated from 2012 dollars using BLS CPI inflation calculator
2. Cement Storage Pig Rental:	$ 647.61	/week	Vendor quote, see reference WA-2, inflated from 2012 dollars using BLS CPI inflation calculator
3. Production for Well Abandonment:	16	wells/week	Vendor quote, see reference WA-1
4. Well Volume per Foot:	0.131	cf/ft	Calculated based on 4.9" casing inside diameter
5. Cement Grout Sack Weight:	94	lbs	Typical
6. Cement Grout Sack Yield:	1.27	cf/sack	Typical
7. Cement Grout Cost:	$ 145.50	/ton	Vendor quote, see reference WA-2, inflated from 2012 dollars using BLS CPI inflation calculator
8. Average Well Depth (Dewey)	[redacted]	ft	1st Year Development Plan
9. Average Well Depth (Burdock)	450	ft	1st Year Development Plan

Well Abandonment Cost per Well

Fixed Costs

Equipment and Labor Cost per Well =$ 1036.18

Cement Storage Pig Rental Cost per Well

$ 648 / week X 1 week / 16 wells =$ 40.48

Total Fixed Cost per Well =$ 1076.66

Variable Costs

Cement Grout per 100 Feet of Well

100 feet X 0.131 cf / 1 ft-well X 94 lbs / 1 sack X

1 sack / 1.27 cf X 1 ton / 2000 lbs X $ 145.50 / ton =$ 70.54

Total Variable Cost per Well =$ 70.54

Total Well Abandonment Cost per Well

Dewey: [redacted] ft-depth / well X Variable: $ [redacted] / 100 ft + Fixed: $ [redacted] / well

TOTAL WELL ABANDONMENT COST PER WELL (DEWEY) =$ [redacted]

Burdock		Variable		Fixed
450 ft-depth / well	X	$ 70.54 / 100 ft	+	$ 1076.66 / well

TOTAL WELL ABANDONMENT COST PER WELL (BURDOCK) **=$ 1,394.08**

WELL FIELD PIPELINE REMOVAL

Assumptions:	Rate	Unit	Source or Unit Cost Name
1. Backhoe Rental:	$ 1,060	/week	Backhoe Rental
2. Production for Trenching, Pipeline Extraction, and Backfilling with Backhoe:	3,000	ft/day	Estimate, assumes portion of piping in common trench
3. Daily Operating Schedule:	8	hr/day	Estimate
4. Weekly Operating Schedule:	5	days/week	Estimate
5. Backhoe Fuel Cost:	$ 11.60	/hr	Backhoe Fuel
6. Backhoe Operator:	$ 66.02	/hr	Labor - Equipment Operator
7. Pipeline Extraction Labor:	$ 49.48	/hr	Labor - Laborer
8. Pipeline Extraction Labor, # Workers:	2	workers	Estimate

Well Field Pipeline Removal Cost per Foot of Pipe

Equipment

Backhoe

$\frac{\$\ 1060.00}{\text{week}} \times \frac{1\ \text{week}}{5\ \text{days}} \times \frac{1\ \text{days}}{3000\ \text{ft}}$ =$ 0.071

Fuel

$\frac{\$\ \$\ 11.60}{\text{hour}} \times \frac{8\ \text{hr}}{1\ \text{day}} \times \frac{1\ \text{days}}{3000\ \text{ft}}$ =$ 0.031

Labor

Backhoe Operation

$\frac{\$\ 66.02}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{1\ \text{days}}{3000\ \text{ft}}$ =$ 0.176

Pipeline Extraction

$\frac{\$\ 49.48}{\text{man hr}} \times \frac{8\ \text{man hr}}{1\ \text{day}} \times \frac{2\ \text{workers}}{} \times \frac{1\ \text{day}}{3000\ \text{ft}}$ =$ 0.264

WELL FIELD PIPELINE REMOVAL COST PER FOOT OF PIPE =$ 0.54

Cost References

WHEEL TRACTOR-SCRAPERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
613G Tier 3	15.0-19.0	**4.0-5.0**	21.0-25.0	**5.5-6.5**	27.5-34.0	**7.3-9.0**
621G Tier 3	26.3-37.6	**6.9-9.9**	37.6-48.8	**9.9-12.9**	48.8-60.1	**12.9-15.9**
623G Tier 3	30.1-41.3	**8.0-10.9**	41.3-52.6	**10.9-13.9**	52.6-66.1	**13.9-17.5**
627G Tier 3	40.2-59.9	**10.6-15.8**	59.9-79.5	**15.8-21.0**	79.5-104.7	**21.0-27.7**
631G Tier 3	33.9-48.5	**9.0-12.8**	48.5-63.0	**12.8-16.6**	63.0-77.5	**16.6-20.5**
637G Tier 3	48.8-72.4	**12.9-19.1**	72.4-95.9	**19.1-25.3**	95.9-125.3	**25.3-33.1**
657G Tier 3	66.3-98.6	**17.6-26.1**	98.6-130.9	**26.1-34.6**	130.9-163.3	**34.6-43.1**

Typical Application Description
(relative to work application)

Low — Level or favorable grades on good haul roads and low rolling resistance. Easy-loading materials, partial loads. No impact. Average use, but with considerable idling.

Medium — Adverse and favorable grades with varying loading and haul road conditions. Long and short hauls, near full. Some impact. Typical road building use.

High — Rough haul roads. Loading heavy clay, continuous high total resistance conditions with steady cycling. Overloading. High impact conditions, such as loading ripped rock.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

BACKHOE LOADERS

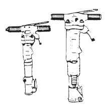
Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
416D (NA)	6.4-8.3	**1.7-2.2**	8.3-10.2	**2.2-2.7**	10.2-12.1	**2.7-3.2**
416D (T)	7.6-9.5	**2.0-2.5**	9.5-11.4	**2.5-3.0**	11.4-13.2	**3.0-3.5**
416E	7.6-9.5	**2.0-2.5**	9.5-11.4	**2.5-3.0**	11.4-13.2	**3.0-3.5**
420E (T)	7.0	**1.8**	11.0	**2.9**	18.1	**4.8**
422E (T)	6.4-8.3	**1.7-2.2**	8.3-10.2	**2.2-2.7**	10.2-12.1	**2.7-3.2**
424D (NA)	6.4-8.3	**1.7-2.2**	8.3-10.2	**2.2-2.7**	10.2-12.1	**2.7-3.2**
428E (T)	7.6-9.5	**2.0-2.5**	9.5-11.4	**2.5-3.0**	11.4-13.2	**3.0-3.5**
430E (T)	7.7	**2.0**	12.8	**3.4**	20.4	**5.4**
432E (T)	8.1-10.0	**2.1-2.6**	10.0-11.9	**2.6-3.1**	11.9-14.2	**3.1-3.8**
434E (T)	8.1-10.0	**2.1-2.6**	10.0-11.9	**2.6-3.1**	11.9-14.2	**3.1-3.8**
438D	8.9-11.2	**2.4-3.0**	11.2-13.1	**3.0-3.5**	13.1-15.3	**3.5-4.0**
442E (T)	8.9-11.2	**2.4-3.0**	11.2-13.1	**3.0-3.5**	13.1-15.3	**3.5-4.0**
444E (T)	8.9-11.2	**2.4-3.0**	11.2-13.1	**3.0-3.5**	13.1-15.3	**3.5-4.0**
446D (T)	10.6-12.9	**2.8-3.4**	12.9-15.1	**3.4-4.0**	15.1-17.4	**4.0-4.6**
450E	17.0	**4.5**	17.0	**4.5**	21.9	**5.8**

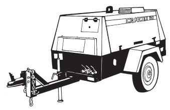
NA = Naturally Aspirated
T = Turbocharged

WYOMING RENTS, L.L.C. • 1-800-RENT CAT

AIR COMPRESSORS

	DAY	WEEK	4 WEEKS
Portable(Electric) 4 CFM	60.00	240.00	600.00
Portable(Electric) 7.2 CFM	65.00	260.00	660.00
Portable(Gas) 11.4 CFM	65.00	260.00	660.00
Towable (Diesel) 185 CFM	140.00	560.00	1550.00
Towable (Diesel) 210 CFM	150.00	600.00	1650.00
Towable (Diesel) 225 CFM	160.00	640.00	1750.00
Towable (Diesel) 375 CFM	170.00	680.00	1850.00





AIR TOOLS & ACCESSORIES

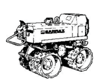
	DAY	WEEK	4 WEEKS
Chipping Hammer	40.00	160.00	420.00
35 lb. Paving Breaker	55.00	220.00	580.00
60 lb. Paving Breaker	60.00	240.00	660.00
60 lb. Paving Breaker (Electric)	80.00	320.00	900.00
90 lb. Paving Breaker	65.00	260.00	720.00
40 lb. Rock Drill	60.00	240.00	660.00
Air Tamper (Pogo Stick)	55.00	220.00	580.00
Hoses		(Call on Pricing)	

AIR NAILERS & STAPLERS

	DAY	WEEK	4 WEEKS
Brad Nailer	45.00	180.00	495.00
Finish Nailer	45.00	180.00	495.00
Framing Nailer	55.00	220.00	605.00
Roofing Nailer	45.00	180.00	495.00
Roofing Stapler	32.00	128.00	384.00
Stapler (Narrow Crown)	35.00	140.00	350.00
Stapler (Wide Crown)	35.00	140.00	350.00

COMPACTION EQUIPMENT

	DAY	WEEK	4 WEEKS
Jumping Jack	90.00	360.00	980.00
Rammer (Trench)	90.00	360.00	980.00
Vibratory Plate	90.00	360.00	980.00
Reversible Plate	120.00	480.00	1200.00
Hydraulic Plate for Backhoe	190.00	760.00	2100.00
Rammax Roller- Remote Control	240.00	960.00	2600.00
36″ Riding Dble Drum- Smooth	200.00	800.00	2200.00
48″ Roller Dble Drum-Smooth	320.00	1280.00	3200.00
CAT CS323 50″ Sgl Drum- Smooth	330.00	1320.00	3800.00
CAT CS433 66″ Sgl Drum- Smooth	420.00	1680.00	5000.00
CAT CS563 84′ Sgl Drum-Smooth	550.00	2200.00	6600.00
Pad kit for CS 323, 433, 563		(Call on pricing)	



CONCRETE DRILLS & SAWS

	DAY	WEEK	4 WEEKS
Core Drill	100.00	400.00	1000.00
Electric or Gas hand-held Saw	90.00	360.00	1080.00
Walkbehind Saw 13Hp 18″	110.00	440.00	1200.00
Green Concrete Saw	75.00	300.00	850.00
Tilesaw	70.00	280.00	800.00
Bricksaw	55.00	220.00	660.00
Roto Hammers and bits		(Call on pricing)	
Diamond Blades		(Call on pricing)	
Core Bits		(Call on pricing)	

DRYWALL & AIRLESS PAINT SPRAYERS

	DAY	WEEK	4 WEEKS
Texture Machine	60.00	240.00	720.00
Sheet Rock Jack	45.00	180.00	450.00
Misc. Drywall & Painting Tools		(Call on Pricing)	
Airless Paint Sprayer (Electric)	100.00	400.00	1100.00

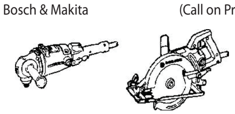
EARTH MOVING EQUIPMENT

	DAY	WEEK	4 WEEKS
Backhoe 4x4 E-stick	265.00	1060.00	2750.00
D5C Dozer w/ripper	530.00	2120.00	5300.00
D6M Dozer w/ripper	715.00	2860.00	8200.00
930 Loader	550.00	2200.00	5300.00
IT14 Loader	385.00	1540.00	3850.00
IT24 Loader	495.00	1980.00	4400.00
IT28 Loader	525.00	2100.00	5100.00
IT38 Loader	575.00	2300.00	5900.00
Walk Behind Skid Steer	165.00	660.00	1800.00
Skid Steer Cat 216	175.00	700.00	1700.00
Skid Steer Cat 226	190.00	760.00	1850.00
Skid Steer Cat 236	210.00	840.00	2000.00
Skid Steer Cat 242/246	220.00	880.00	2200.00
Skid Steer Cat 272	240.00	920.00	2600.00
Mini-Grader	300.00	1200.00	3600.00
140 Motor Grader	725.00	2900.00	8300.00
301.5 Mini Excavator	190.00	760.00	2280.00
302.5 Mini Excavator	220.00	880.00	2450.00
303.5 Mini Excavator	245.00	980.00	2850.00
304.5 Mini Excavator	265.00	1060.00	3200.00
315 Excavator	575.00	2300.00	5200.00
319 Excavator	650.00	2520.00	6600.00
320 Excavator	630.00	2600.00	6800.00
20HP Tractor 4x4 w/bucket	180.00	720.00	2000.00
30HP Tractor 4x4 w/bucket	190.00	760.00	2200.00

Call on Pricing for Attachments
Pallet Forks ▫Post Hole Auger ▫Buckets ▫Tiller ▫Snow Blower ▫ Rock Bucket ▫Hydraulic Plate Compactor ▫Demolition Hammer ▫Thumb and more.

ELECTRIC HAND TOOLS

	DAY	WEEK	4 WEEKS
Milwaukee, Bosch & Makita		(Call on Pricing)	

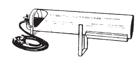


GENERATORS - LIGHT TOWERS

	DAY	WEEK	4 WEEKS
2500 W	55.00	220.00	660.00
3600 W	60.00	240.00	720.00
6000 W	70.00	280.00	840.00
9700 W	80.00	320.00	960.00
25 KVA	115.00	460.00	1380.00
45 KVA	135.00	540.00	1620.00
70 KVA	150.00	600.00	1800.00
100 KVA	190.00	760.00	2280.00
125 KVA	220.00	880.00	2640.00
Light towers	125.00	500.00	1500.00
Detour Light	70.00	280.00	800.00

HEATERS

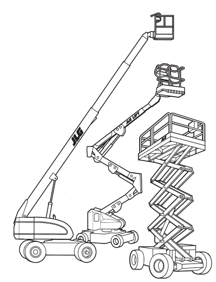
	DAY	WEEK	4 WEEKS
150,000 BTU Diesel	50.00	200.00	550.00
150,000 BTU Propane	45.00	180.00	540.00
350,000 BTU Diesel	60.00	240.00	720.00
Towable Heater 600,000 BTU Diesel	300.00	1200.00	3600.00
Towable Heater 1,000,000,BTU Diesel	480.00	1920.00	5760.00



MANLIFTS

	DAY	WEEK	4 WEEKS
50′ Towable Manlift	190.00	760.00	2280.00
19′ Electric Scissor Lift	110.00	440.00	1200.00
26′ Electric Scissor Lift	125.00	500.00	1380.00
32′ Electric Scissor Lift	140.00	560.00	1560.00
26′ RT Scissor Lift 4x4	155.00	620.00	1680.00
40′ RT Scissor Lift 4x4	230.00	920.00	2500.00
45′ “Z” Boom 4x4 w/Jib	265.00	1060.00	3100.00
60′ “Z” Boom 4x4 w/Jib	350.00	1400.00	3900.00
65′ Straight/ “Z” Boom 4x4 w/Jib	385.00	1540.00	4300.00
85′ Straight Boom 4x4 w/Jib	740.00	3000.00	8900.00
125′ Straight Boom 4x4	1100.00	4400.00	13,200.00
135′ Straight/ ″Z″ Boom 4x4	1200.00	4800.00	14,000.00

All heights are platform heights.



MATERIAL & FORKLIFTS

	DAY	WEEK	4 WEEKS
6000 lb. Ware house Fork Lift	170.00	680.00	2040.00
6000 lb. RT 2wd Fork Lift	200.00	800.00	2200.00
8000 lb. RT 4x4 Fork Lift	240.00	960.00	2650.00
5500 lb. 18′ Telehndler 4x4	250.00	1000.00	3000.00
8000 lb. 40′ Telehandler 4x4	330.00	1320.00	3300.00
10,000 lb. 44′ Telehandler 4X4	350.00	1400.00	3650.00
10,000 lb. 54′ Telehandler 4X4	370.00	1480.00	3800.00
11,000 lb. 44′ Telehandler 4x4	370.00	1480.00	3800.00

PRESSURE WASHERS

	DAY	WEEK	4 WEEKS
Cold Water 3000 psi	90.00	360.00	990.00
Hot Water 3500 psi	150.00	600.00	1800.00
Towable Hot Water w/Tank	185.00	740.00	2220.00

PUMPS

	DAY	WEEK	4 WEEKS
2″ Submersible	45.00	180.00	540.00
2″ HP Centrifugal	50.00	200.00	600.00
2″ Trash	75.00	300.00	900.00
3″ Trash	90.00	360.00	1080.00
4″ Trash	100.00	400.00	1200.00
6″ Trash	130.00	520.00	1560.00
Hoses		(Call on Pricing)	

TRAILERS

	DAY	WEEK	4 WEEKS
Gooseneck or Bumper pull		(Call on sizes and weights)	
Flatbed, Horse & Cargo			

WELDING

	DAY	WEEK	4 WEEKS
225 amp (Gas)	70.00	280.00	725.00
300 amp Towable (Diesel)	90.00	360.00	790.00
500 amp Towable (Diesel)	100.00	400.00	890.00
Cutting Torch Set	65.00	260.00	780.00

MISCELLANEOUS

	DAY	WEEK	4 WEEKS
Trencher (2.5′ walkbehind)	220.00	880.00	2640.00
Trencher (3′ walkbehind)	235.00	940.00	2820.00
4′ Ride on Trencher	495.00	1980.00	5940.00
Walk Behind Skid Steer	165.00	660.00	1800.00
1 Man Post Hole Auger	105.00	420.00	1100.00
2 Man Post Hole Auger	85.00	340.00	1020.00
Stump Grinder	250.00	1000.00	3000.00
Hillman Rollers (8 ton)	40.00	160.00	480.00
Hillman Rollers (60 ton)	90.00	360.00	950.00
Chipper 6″	165.00	660.00	1980.00
Chipper 9″	190.00	760.00	2280.00

CASPER 307-473-7300 CHEYENNE 307-775-7500 GILLETTE 307-682-1362 RAWLINS 307-324-2075 RIVERTON 307-857-2802 ROCK SPRINGS 307-382-3300 SHERIDAN 307-673-0026

WHEEL LOADERS AND INTEGRATED TOOLCARRIERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
904H	4.4-6.3	**1.16-1.66**	6.3-8.2	**1.66-2.17**	8.2-10.1	**2.17-2.67**
906H	3.8	**1.01**	7.6	**2.01**	11.4	**3.02**
907H	3.8	**1.01**	7.6	**2.01**	11.4	**3.02**
908H	4.3	**1.14**	8.6	**2.28**	12.9	**3.42**
914G, IT14G	5.0-6.5	**1.0-2.0**	8.0-10.5	**2.0-2.5**	11.5-13.0	**3.0-3.5**
924H, 924Hz	3.5-5.8	**0.9-1.5**	5.8-8.1	**1.5-2.1**	8.1-15.0	**2.1-3.9**
928H, 928Hz	3.8-6.2	**1.0-1.6**	6.2-8.5	**1.6-2.2**	8.5-15.4	**2.2-4.0**
930H	3.8-6.2	**1.0-1.6**	6.2-8.5	**1.6-2.2**	8.5-15.4	**2.2-4.0**
938H, IT38H*	5.2-7.8	**1.4-2.0**	7.8-10.4	**2.0-2.7**	10.4-15.0	**2.7-4.0**
950H*	7.9-11.4	**2.1-3.0**	11.4-14.7	**3.0-3.9**	14.7-18.5	**3.9-4.9**
962H, IT62H*	9.4-12.0	**2.5-3.2**	12.0-15.1	**3.2-4.0**	15.1-19.2	**4.0-5.1**
966H*	9.1-13.4	**2.4-3.5**	13.4-16.9	**3.5-4.5**	16.9-20.5	**4.5-5.4**
972H*	12.3-17.1	**3.3-4.5**	17.1-21.0	**4.5-5.5**	21.0-25.5	**5.5-6.7**
980H*	15.6-20.6	**4.1-5.4**	20.6-26.0	**5.4-6.9**	26.0-32.9	**6.9-8.7**
988H	28.0-40.1	**7.4-10.6**	40.1-52.6	**10.6-13.9**	52.6-65.1	**13.9-17.2**
990H	42.0-58.3	**11.1-15.4**	58.3-75.0	**15.4-19.8**	75.0-91.6	**19.8-24.2**
992K	53.0-75.7	**14.0-20.0**	75.7-98.4	**20.0-26.0**	98.4-121.0	**26.0-32.0**
993K	61.3-87.4	**16.2-23.1**	87.4-113.6	**23.1-30.0**	113.6-140.0	**30.0-37.0**
994F	87.0-123.0	**23.0-32.5**	123.0-160.0	**32.5-42.2**	160.0-197.0	**42.2-52.0**

*The Medium Wheel Loader (i.e. 938H to 980H) hourly fuel rates are taken directly from customer machines registered on Product Link worldwide. Data from the top and bottom 5% of these customer machines has been excluded from the tables because it varies widely (15-60% from the extremes shown) and therefore is not considered representative of what the remaining 90% of customers experience. Hourly fuel consumption for the 90% of machines in the tables also varies depending upon geographical region, load factor variation between models, etc. Cat machines are often used in more demanding applications which can account for differences between competitive models used in lighter duty applications. Consult your local Cat dealer for ways to more accurately estimate hourly fuel consumption for specific applications.

EXCAVATORS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
301.5	2.1-2.5	**0.55-0.66**	2.5-2.9	**0.66-0.77**	2.9-3.3	**0.77-0.87**
301.6C	0.9-1.4	**0.24-0.35**	1.4-1.8	**0.35-0.47**	1.8-2.3	**0.47-0.59**
301.8C	0.9-1.4	**0.24-0.35**	1.4-1.8	**0.35-0.47**	1.8-2.3	**0.47-0.59**
302.5C	1.2-1.8	**0.31-0.47**	1.8-2.4	**0.47-0.62**	2.4-3.0	**0.62-0.78**
303 CR/SR	3.4-4.0	**0.89-1.07**	4.0-4.7	**1.07-1.24**	4.7-5.4	**1.2-1.42**
304 CR	4.0-4.8	**1.06-1.28**	4.8-5.6	**1.28-1.49**	5.6-6.4	**1.49-1.7**
305 CR/SR	4.7-5.7	**1.24-1.49**	5.7-6.6	**1.49-1.74**	6.6-7.5	**1.74-1.99**
307D	2.5-3.7	**0.7-1.0**	3.7-4.9	**1.0-1.3**	4.9-6.2	**1.3-1.6**
308D CR	2.5-3.7	**0.7-1.0**	3.7-4.9	**1.0-1.3**	4.9-6.2	**1.3-1.6**
311D RR (Tier 3)	3.5-6.5	**0.9-1.7**	6.5-9.5	**1.7-2.5**	9.5-12.8	**2.5-3.4**
312D (Tier 3)	4.0-7.5	**1.1-2.0**	7.5-11.5	**2.0-3.0**	11.5-15.2	**3.0-4.0**
314D CR (Tier 3)	4.0-7.5	**1.1-2.0**	7.5-11.5	**2.0-3.0**	11.5-15.2	**3.0-4.0**
315D (Tier 3)	5.0-9.5	**1.3-2.5**	9.5-14.5	**2.5-3.8**	14.5-19.2	**3.8-5.1**
319D (Tier 3)	5.5-10.5	**1.5-2.8**	10.5-15.5	**2.8-4.1**	15.5-21.0	**4.1-5.5**
320D (STD Tier 3)	6.0-12.0	**1.6-3.2**	12.0-18.0	**3.2-4.8**	18.0-24.0	**4.8-6.3**
320D (HHP Tier 3)	6.5-12.5	**1.7-3.3**	12.5-18.5	**3.3-4.9**	18.5-24.8	**4.9-6.6**
321D CR (STD Tier 3)	6.0-12.0	**1.6-3.2**	12.0-18.0	**3.2-4.8**	18.0-24.0	**4.8-6.3**
321D CR (HHP Tier 3)	6.5-12.5	**1.7-3.3**	12.5-18.5	**3.3-4.9**	18.5-24.8	**4.9-6.6**
323D (Tier 3)	6.5-12.5	**1.7-3.3**	12.5-18.5	**3.3-4.9**	18.5-24.8	**4.9-6.6**
324D (STD Tier 3)	7.0-14.0	**1.8-3.7**	14.0-21.0	**3.7-5.5**	21.0-28.0	**5.5-7.4**
324D (HHP Tier 3)	8.0-16.0	**2.1-4.2**	16.0-24.0	**4.2-6.3**	24.0-32.0	**6.3-8.5**
324D (STD Tier 2)	6.5-13.5	**1.7-3.6**	13.5-20.0	**3.6-5.3**	20.0-26.6	**5.3-7.0**
324D (HHP Tier 2)	7.5-15.5	**2.0-4.1**	15.5-23.0	**4.1-6.1**	23.0-30.4	**6.1-8.0**
328D CR (Tier 3)	8.5-17.5	**2.2-4.6**	17.5-26.0	**4.6-6.9**	26.0-34.5	**6.9-9.1**
329D (STD Tier 3)	8.0-16.0	**2.1-4.2**	16.0-24.0	**4.2-6.3**	24.0-32.0	**6.3-8.5**
329D (HHP Tier 3)	8.5-17.5	**2.2-4.6**	17.5-26.0	**4.6-6.9**	26.0-34.5	**6.9-9.1**
329D (STD Tier 2)	7.5-15.5	**2.0-4.1**	15.5-23.0	**4.1-6.1**	23.0-30.5	**6.1-8.1**
329D (HHP Tier 2)	8.5-16.5	**2.2-4.4**	16.5-24.5	**4.4-6.5**	24.5-33.0	**6.5-8.7**
336D (Tier 3)	11.5-23.0	**3.0-6.1**	23.0-34.5	**6.1-9.1**	34.5-45.5	**9.1-12.0**
336D (Tier 2)	11.0-21.5	**2.9-5.7**	21.5-32.5	**5.7-8.6**	32.5-43.5	**8.6-11.5**
345D (Tier 3)	15.5-30.5	**4.1-8.1**	30.5-45.6	**8.1-12.0**	45.6-61.0	**12.0-16.1**
345D (Tier 2)	14.5-29.0	**3.8-7.7**	29.0-43.3	**7.7-11.4**	43.3-58.0	**11.4-15.3**
365C (Tier 3)	16.5-33.0	**4.4-8.7**	33.0-49.2	**8.7-13.0**	49.2-65.5	**13.0-17.3**
365C (Tier 2)	15.5-31.0	**4.1-8.2**	31.0-46.7	**8.2-12.3**	46.7-62.5	**12.3-16.5**
374D (Tier 3)	19.0-37.5	**5.0-9.9**	37.5-56.4	**9.9-14.9**	56.4-75.5	**14.9-19.9**
374D (Tier 2)	18.0-35.5	**4.8-9.4**	35.5-53.6	**9.4-14.2**	53.6-71.5	**14.2-18.9**
385C (Tier 3)	20.5-41.0	**5.4-10.8**	41.1-61.0	**10.8-16.1**	61.0-81.5	**16.1-21.5**
385C (Tier 2)	19.5-39.0	**5.2-10.3**	39.0-58.0	**10.3-15.3**	58.0-77.5	**15.3-20.5**
M313D	8.0-12.0	**2.1-3.2**	12.0-16.0	**3.2-4.2**	16.0-19.0	**4.2-5.0**
M315D	9.0-13.0	**2.4-3.4**	13.0-18.0	**3.4-4.8**	18.0-21.0	**4.8-5.5**
M316D	8.0-12.0	**2.1-3.2**	12.0-17.0	**3.2-4.5**	17.0-20.0	**4.5-5.3**
M318D	9.0-13.0	**2.4-3.4**	13.0-18.0	**3.4-4.8**	18.0-22.0	**4.8-5.8**
M322D	11.0-17.0	**2.9-4.5**	17.0-23.0	**4.5-6.1**	23.0-26.0	**6.0-6.9**
M325C MH*	12.9-15.9	**3.4-4.2**	20.8-23.8	**5.5-6.3**	23.8-27.6	**6.3-7.3**
M325C L MH*	14.0-19.0	**3.7-5.0**	23.0-27.0	**6.1-7.1**	27.0-32.0	**7.1-8.5**
W330B MH*	19.0-24.0	**5.0-6.3**	29.0-33.0	**7.7-8.7**	34.0-39.0	**9.0-10.3**
W345B MH*	25.0-30.0	**6.6-7.9**	38.0-42.0	**10.0-11.1**	45.0-50.0	**11.9-13.2**

*If the application of these machines is to be used for scrap handling, the LOW hourly fuel consumption rate would typically apply.
NOTE: Fuel consumption rates for 320D through 385C include machine at idle per load factor definition.

28470 Lookout Rd.
Edgemont, SD 57735

For driving directions please click Google Map

Hours of Operation
7:30am-3:30pm Monday-Friday
Must present weight ticket upon arrival
(605) 890-0561

Landfill Managed by:

Barker Concrete & Construction, Inc
Ph. (605)662-7760
fax (605) 662-7761
bconcrete@gwtc.net

Rates for 2011

- **Yearly Permit Fee - $10**
  Required to use facility
  Must present weight ticket upon arrival
  No dumping without permit
  No dumping without attendant
  All loads MUST be tarped

Material Fees

- **Construction**
  Minimum $15 under 500#
  $45/ton over 500#
- **Rubble (non-construction)**
  Minimum $15 under 500#
  $45/ton over 500#
- **Household**
  Solid Waste Pickup Load under 500# $15
  (includes weight ticket cost & tax)
  Solid Waste $52/ton over 500#
- **White Goods**
  $10/unit - must be freon free
  $18/unit - not freon free
- **Contaminated Soil**
  Call ahead. Load must be approved by State DENR
- **Tires**
  Passenger $4 (15" or smaller)
  Pickup/Truck $10 (16" -20"
  Tractor $20 (20" or larger)
  Motorcycle $2

Weight Scales and Payments

Ranchers Feed
301 1st Ave
Edgemont, SD 57735

Custer - Fall River Regional Waste Management District
P. O. Box 11
Edgemont, South Dakota
57735-0809

Design by Alley Cat Productions

TRANS-1

Waste Transportation Cost Calculation			
Item	**Units**	**Design Value**	**Source/Notes**
Capacity of 1 truckload	CY	20	Typ. 20 CY rolloff containers
Fuel cost	$/gal	3.796	http://www.truckmiles.com/FuelPrices.asp for South Dakota as of 6/13/2014
Maintenance costs per mile	$/mi	0.26	MN DOT, 2003, adjusted (x1.30) to Dec. 2014 prices
Driver	$/hr	55.70	RSMeans 2014, Crews, Truck Driver (light), Includes 25% overhead and 10% profit
Average speed	mi/hr	45	Estimated
Driver cost per mile	$/mi	1.24	Calculated
Fuel mileage, loaded	mi/gal	1.7	Estimated
Cost per loaded mile	$/mi	3.74	Calculated
Fuel mileage, unloaded	mi/gal	2.5	Estimated
Cost per unloaded mile	$/mi	3.02	Calculated
Round trip cost per 1-way distance	$/mi	6.76	Calculated

Well Plugging and Abandonment Bid Request

Location: Powertech USA, Dewey-Burdock Project
13 miles northwest of Edgemont, South Dakota on Dewey Road

Description of work: ***Bid is for total job of 100 wells.***

Remove down hole pipe (2" coiled polyethylene). Install tremie pipe to total depth. Mix and pump grout filling well casing to surface. Remove tremie pipe. Cut and remove casing 4 feet below surface. Cover with cement plug. Back fill and compact back to grade. All labor, materials and equipment to be provided on location by the contractor.

Casing: 5" PVC, SDR 17 approx. 4.91" Inside Diameter

Average depth: 550 feet (casing volume approx. 15 bbl)

Plugging Material: Cement grout or bentonite grout as per ARSD 74:02:04:67
Cemented from total depth to surface, possible artesian conditions

VENDOR (name and address): Davis Drilling
P.O. Box 2302, Gillette, WY 82717

Item	Estimate
Plugging materials	$ See note below

Description of materials: Class C Cement (bulk)

Equipment	$ Included

Types and quantity of equipment to be supplied:
20 bbl cement tank, 5X8 Duplex Pump Coil Tubing Unit

Labor	$ Included

Crew description: 3 Man

Other	$ 1,000 per well

Explanation of Other: $1000.00 per well, Powertech provides the cement

Estimate Completion Time: 3-4 wells per day **Total Estimate: $** 100,000.00

Prepared by: Stan Davis Dated:

Stan Davis

WA-2

Jim Munro

From: jfinnegan@gcc.com
Sent: Friday, February 10, 2012 5:01 PM
To: jmunro@harneypeakresources.com
Subject: type V cement estimate for Edgemont, SD

Categories: Harney Peak Resources

Hello Jim,

I'm following up on our conversation from earlier this morning regarding a budget number for you to use on a project you are looking into at Edgemont, SD.

Assumptions:

2,000 tons of type V sulfate resistant cement
$125.00 per ton FOB our cement plant in Rapid City (2012 dollars)
$15.42 freight rate (which includes a current fuel surcharge of 27%)
for a delivered cost at job of **$140.42**
$625 per week for a storage pig
plus incidentals such as mobilization and demobilization of pig and fuel to power the blower.

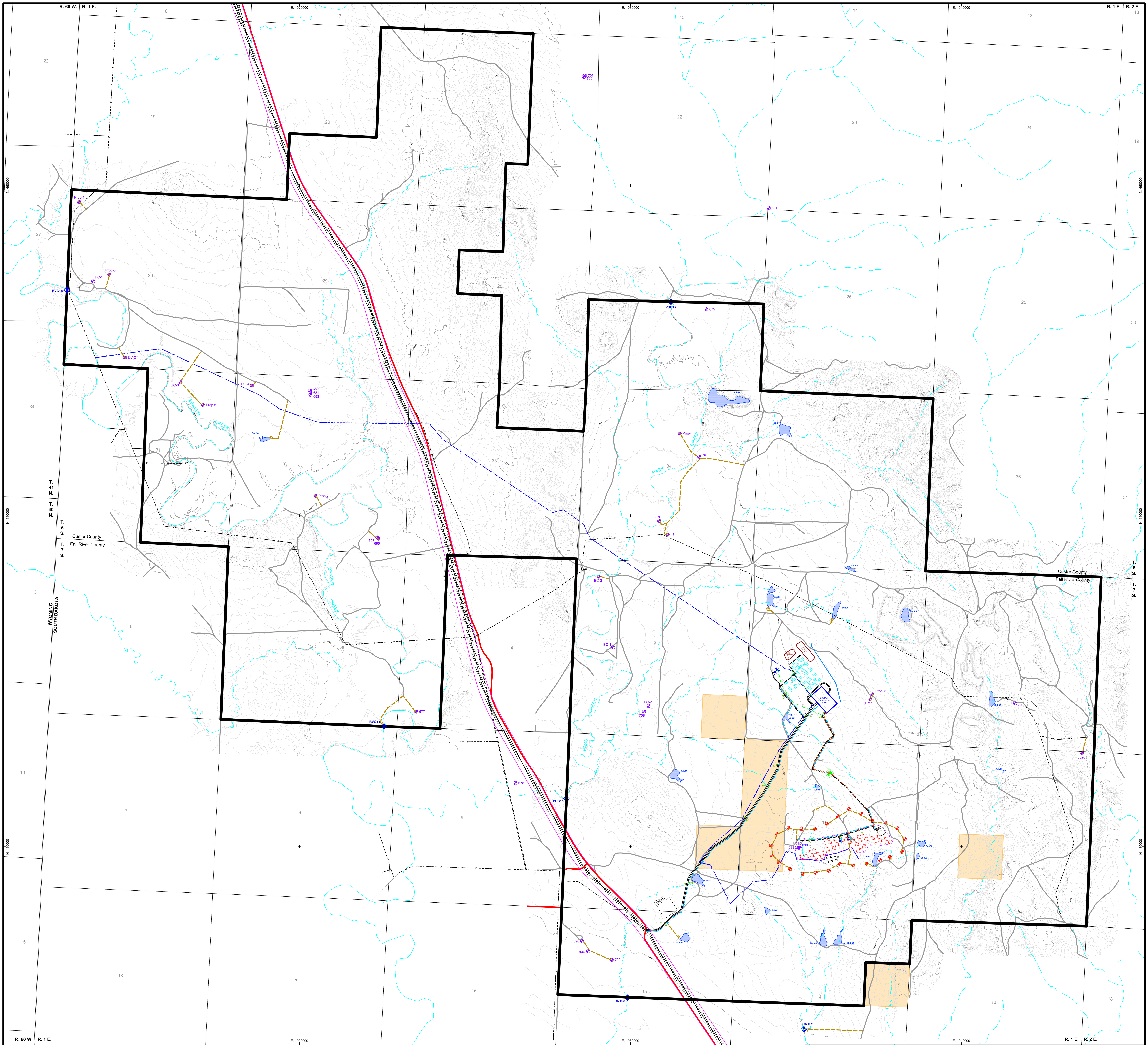
This is an estimate for if I was to quote the job today for work in 2012
If you think the work would go in 2013, it would be a safe assumption to add 5% to the above estimate.

If you or a sub need a firm quote from me, please call me at: 303-453-9196. I am the sales manager for the company and am currently covering the vacant Rapid City position until I get someone hired.
Thank you for contacting us.

Thanks,

Joe Finnegan
GCC of America
130 Rampart Way, Suite 205
Denver, CO 80230
Office: 303-739-5900

visit our website at www.gccusa.com



LEGEND

- LICENSE BOUNDARY
- COUNTY ROAD
- EXISTING ROAD
- PROPOSED PRIMARY ACCESS ROAD
- PROPOSED SECONDARY ACCESS ROAD
- PROPOSED LIGHT USE ROAD
- RAILROAD
- APPROXIMATE RAILROAD RIGHT-OF-WAY
- PERENNIAL STREAM CHANNEL
- EPHEMERAL OR INTERMITTENT STREAM CHANNEL
- PROPOSED ROAD DITCH
- PROPOSED DIVERSION
- MAIN PIPELINE
- SECONDARY PIPELINE
- MADISON WELL PIPELINE
- WASTEWATER PIPELINE
- PROPOSED OVERHEAD POWER
- EXISTING BLACK HILLS ELECTRIC
- PROPOSED WELL FIELD FENCE
- PROPOSED CULVERT
- INITIAL ISR WELL FIELD AREA
- FACILITY POND
- HEADER HOUSE
- BLM LANDS
- STAGING AREA
- MONITOR WELL
- PERIMETER MONITOR WELL
- MADISON WELL
- DEEP DISPOSAL WELL
- STREAM MONITORING LOCATION
- EXISTING IMPOUNDMENT TO BE MONITORED

C.I. = 10'
Feet 0 250 500 1000 1500 2000
Meters 0 125 250 500

CONSULTANT
WWC ENGINEERING

REF

CHECK SCALES
If this bar does not measure 1 inch this map is not at its original scale
36" x 36"

REVISIONS

#	DRAWN	CHECKED	APPROVED	DATE

SIGNATURE OF PREPARER

PLOT DATE
DATE 3-JULY-2014
DRAWN VENTLING
PDF FILE K:\Sheridan□owertech\14028\DWGS_SD-S\Basemap_1K.pdf
PREPARER
CAD FILE K:\Sheridan□owertech\14028\DWGS_SD-S\Basemap_1k.dwg

POWERTECH (USA) INC.

Map to Accompany Initial Financial Assurance Estimate

Dewey-Burdock Project

COORDS NAD 27, South Dakota State Plane South (feet)

K:\Sheridan□owertech\14028\DWGS_SD-S\Basemap_1k.dwg 7/3/2014 8:40:57 AM rod ventling

Attachment RAP-3

Financial Assurance-Related Correspondence with Other Regulatory Agencies

Attachment RAP-4

Estimate of the Duration of Groundwater Restoration based on Current Experiences at Licensed ISR Facilities

ESTIMATE OF THE DURATION OF GROUNDWATER RESTORATION

In accordance with LC 9.5 of SUA-1600, this attachment provides "a reasonable estimate for the duration of groundwater restoration based on current experiences at licensed ISR facilities." This attachment summarizes the duration of groundwater restoration at the Uranium Resources, Inc. (URI) Kingsville Dome and Rosita projects in Texas using publicly available information. Following is a description of the aquifer restoration methods and duration at these facilities and an evaluation of the applicability of these analogs to the Dewey-Burdock Project.

Criteria used to evaluate the applicability of analogs include the number of PVs treated and injected (compared to 6 at Dewey-Burdock; refer to RAP Sec. 2.7), the relative volume of a single PV (compared to approximately 6 million gallons [MG] for a typical well field at Dewey-Burdock; refer to Table 6-1 in TR Appendix 6.1-A), the RO system capacity (compared to 500 gpm at Dewey-Burdock; refer to TR Sec. 4.2.2.4.2, revised January 2014) and the deep disposal well capacity (compared to up to 300 gpm at Dewey-Burdock; refer to TR Sec. 4.2.2.2 revised January 2014).

The URI Kingsville Dome and Rosita projects are deemed to be representative analogs for the Dewey-Burdock Project based on the groundwater restoration method, which was limited primarily to RO treatment with permeate injection, and the number of PVs. Groundwater sweep was used initially in most or all of the production area authorizations (PAAs); however, its use was limited due to water consumption, and RO treatment with permeate injection was relied on to achieve aquifer restoration goals. Table 1 summarizes the Kingsville Dome and Rosita restoration data.

Active groundwater restoration at Kingsville Dome varied from 0.7 to 5.9 years in the 10 well fields in PAA1 and PAA2. Well fields 4 and 7 are considered the most representative of the Dewey-Burdock Project based on similar PVs of 13.5 and 12.7 MG, respectively. Although these are approximately twice the typical PV at the Dewey-Burdock Project, they are significantly lower than the remaining Kingsville Dome well field PVs. The number of PVs treated at Kingsville Dome well fields 4 and 7, at 7.2 and 5.0, respectively, are also very close to the 6 PVs committed to by Powertech (USA) for the Dewey-Burdock Project. The duration of groundwater restoration at Kingsville Dome well fields 4 and 7 ranged from 8 to 9 months.

Table 1. Groundwater Restoration Methods and Duration at URI Kingsville Dome and Rosita Projects

Facility Name	Well Field	PV (mgal)	Disposal Capacity (gpm)	Restoration Phase	Start Date	End Date	PVs	Source
KVD - PAA1	WF 1	36.97	200	RO	Dec-99	Jul-02	8.6	URI Kingsville Dome ISR Project Request to Cease Restoration and Begin Stability Sampling in PAA UR02827-011
				TOTAL	**2.6 yrs**		**8.6**	
KVD - PAA1	WF 2	20.65	200	RO	Mar-01	Dec-04	6.2	
				TOTAL	**3.8 yrs**		**6.2**	
KVD - PAA1	WF 3	31.47	200	RO	Dec-99	Apr-03	7.4	
				TOTAL	**3.3 yrs**		**7.4**	
KVD - PAA1	WF 7	12.67	200	RO	Jan-01	Sep-01	5.0	
				TOTAL	**0.7 yr**		**5.0**	
KVD - PAA2	WF 4	13.5	200	RO	Feb-04	Dec-04	7.2	URI Kingsville Dome ISR Project Request to Cease Restoration and Begin Stability Sampling in PAA UR02827-021
				TOTAL	**0.8 yr**		**7.2**	
KVD - PAA2	WF 5	46.1	200	RO	Jan-02	Dec-07	8.7	
				TOTAL	**5.9 yrs**		**8.7**	
KVD - PAA2	WF 6	36.8	200	RO	Apr-07	Dec-09	6.5	
				TOTAL	**2.7 yrs**		**6.5**	
KVD - PAA2	WF 8	16.7	200	RO	Oct-04	Oct-07	2.7	
				TOTAL	**3 yrs**		**2.7**	
KVD - PAA2	WFs 11&12	33.33	200	RO	May-09	Oct-10	6.5	
				TOTAL	**1.4 yrs**		**6.5**	
Rosita - PAA2	WF 3	21.1	200	RO	Mar-03	Mar-06	8.9	URI Rosita ISR Project Technical Report for a Restoration Table Amendment for PAA UR02880-021
				TOTAL	**3 yrs**		**8.9**	
Rosita - PAA2	WF 4	28.2	200	RO	May-01	May-02	4.3	
				TOTAL	**1 yr**		**4.3**	
Rosita - PAA2	WF 5	13.3	200	RO	Dec-01	Nov-02	7.3	
				TOTAL	**0.9 yr**		**7.3**	
Rosita - PAA2	WF 6	7.1	200	RO	Sep-02	Apr-03	6.7	
				TOTAL	**0.6 yr**		**6.7**	

Active groundwater restoration at the Rosita Project varied from 0.6 to 3.0 years in the four well fields in PAA2. Well field 6 is considered the most representative of a typical Dewey-Burdock Project well field based on its PV of 7.1 MG and the number of PVs of RO treatment with permeate injection (6.7). It required 7 months of active groundwater restoration. Based on the duration of groundwater restoration at this and the two most representative Kingsville Dome well fields, a reasonable estimate for the duration of groundwater restoration for a typical well field at the Dewey-Burdock Project is 6 to 12 months.

Other ISR facilities were considered as potential analogs in this analysis, including the Crow Butte Project in Nebraska and the Smith Ranch/Highland, Christensen Ranch and Irigaray projects in Wyoming. However, these facilities are not appropriate analogs since these operations have not necessarily focused on production operations with restoration as the final goal. In addition, there have been significant advances in restoration technology. This is demonstrated in Crow Butte Resources' (CBR's) latest efforts using a Model-Based Restoration Plan (MBRP) (CBR, 2013). In its correspondence, CBR states that restorations using this method would require between 3 and 6 pore volumes, which is less than the historical number of PVs at Crow Butte. Furthermore, the restoration phase of these facilities has been used as a time to experiment with various methods. For example, Cameco stated in its Mine Unit B restoration report that it took time during the RO phase to develop procedures to replace hydrogen sulfide with sodium sulfide (Cameco, 2009). Cameco also experimented with bioremediation during the RO phase and discovered that RO permeate was the most effective way to add the nutrients used during the bioremediation procedure.

Considering advances in restoration analysis and technology, Powertech (USA) has determined that it can complete well field groundwater restoration using 6 pore volumes. As stated in the RAP, to ensure the best practicable technology Powertech (USA) will implement the following operational practices:

(i) Daily balancing of injection and extraction flow rates during production. This flow rate balancing is designed to ensure that a proper aquifer bleed is maintained both at the well field level and also within each 5-spot pattern within the well field.

(ii) Timeliness of beginning restoration operations. For any particular well field, aquifer restoration operations will begin as soon as is reasonably possible following the cessation of recovery operations.

(iii) Maintenance of aquifer bleeds. Hydraulic control of well fields through the net withdrawal of the aquifer bleed stream will be continuously maintained from the beginning of recovery operations until the end of active aquifer restoration.

In addition, Powertech (USA) has committed to installing groundwater restoration equipment sized to accommodate a 500-gpm restoration flow rate, which is relatively large compared to many historically operated ISR facilities. This coupled with adequate wastewater disposal capacity, including two options for wastewater disposal, will help ensure that groundwater restoration can be carried out in a timely manner. Powertech (USA) also intends to use personnel experienced in groundwater restoration and modern flow management techniques to expedite restoration.

Similar operational practices have been used by URI at the Kingsville Dome and Rosita projects with groundwater restoration achieved in approximately 6 to 12 months for similarly sized well fields. Therefore, a reasonable estimate for the duration of groundwater restoration, based on current expenses at licensed ISR facilities, is 6 to 12 months for a typical Dewey-Burdock Project well field.

REFERENCES

Cameco Resources, 2009, Smith Ranch-Highland Operation Mine Unit B Ground Water Submittal, including Restoration Report, Correspondence, Stability Report, and Final Approval – WDEQ, June 26, 2009, NRC ADAMS Accession No. ML091831100.

Crow Butte Resources, Inc. (CBR), 2013, Mine Unit 2 Restoration Status, May 9, 2013, NRC ADAMS Accession No. ML13149A386.

URI (Uranium Resources, Inc.), n.d., URI Kingsville Dome ISR Project, Request to Cease Restoration and Begin Stability Sampling in Production Area Authorization UR02827-011.

_____, n.d., URI Kingsville Dome ISR Project, Request to Cease Restoration and Begin Stability Sampling in Production Area Authorization UR02827-021.

_____, n.d., URI Rosita ISR Project Technical Report for a Restoration Table Amendment for Production Area Authorization UR02880-021.

Attachment RAP-5

Determination of Thorium-230 Soil Standard

DETERMINATION OF THORIUM-230 SOIL STANDARD

In accordance with LC 12.23 of SUA-1600, this attachment provides soil cleanup criteria for Th-230 based on the radium benchmark dose method.

RESRAD was used to determine the concentration of Th-230 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 Th-230 in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable Th-230 concentration in soil.

For ease of calculations, a preset concentration of 100 pCi/g Th-230 was used for modeling the dose. 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 Th-230 concentration in soil of 100 pCi/g, RESRAD determined a maximum dose of 23.1 mrem/yr. at time, t = 120 years. The time of the maximum dose is a result of ingrowth of Ra-226 over time. This evaluation will conservatively assume that the maximum dose from thorium occurs at the same time as the maximum dose for Ra-226 (t=0). The printout of the RESRAD data summary is provided below.

To determine theTh-230 soil standard, the following formula was used:

$$\text{Th - 230 Limit} = \left(\frac{100 \text{ pCi/g Th - 230}}{23.1 \text{ mrem/yr Th - 230 dose}} \right) \text{x } 38.1 \text{ mrem/yr radium benchmark dose}$$

$$\text{Th - 230 Limit} = 165 \text{ pCi/g Th - 230}$$

Summary : Dewey Burdock
File   : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 3
Summary of Pathway Selections 7
Contaminated Zone and Total Dose Summary 8
Total Dose Components
Time = 0.000E+00 9
Time = 1.000E+00 10
Time = 3.000E+00 11
Time = 1.000E+01 12
Time = 3.000E+01 13
Time = 1.000E+02 14
Time = 3.000E+02 15
Time = 1.000E+03 16
Dose/Source Ratios Summed Over All Pathways 17
Single Radionuclide Soil Guidelines 17
Dose Per Nuclide Summed Over All Pathways 18
Soil Concentration Per Nuclide 18

1RESRAD, Version 6.5   T½ Limit = 180 days   06/05/2014 12:28 Page   2
Summary : Dewey Burdock
File   : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

0

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(1)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(2)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(3)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(4)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(5)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(6)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(7)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(8)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(9)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(10)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(11)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(12)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(1)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(2)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(3)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(1)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(2)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(3)
D-34	Food transfer factors:			
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(1,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(1,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(1,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(2,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(3,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(2,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(3,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(3,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

1RESRAD, Version 6.5   T½ Limit = 180 days   06/05/2014 12:28 Page   3
Summary : Dewey Burdock
File   : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Site-Specific Parameter Summary

0

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Th-230	1.000E+02	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Th-230	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.260E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	7.000E-04	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	5.384E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.000E-34	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.990E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	7.120E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.990E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.200E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	3.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	5.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.300E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	2.640E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.400E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.974E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	4.260E-02	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	7.030E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	1.322E+03	2.500E+02	---	UW

Summary : Dewey Burdock
File : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	1.520E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	2.610E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.200E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	9.200E-02	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	3.280E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	1.140E+01	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.030E-02	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.585E-08	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.746E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.919E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	5.500E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	0.000E+00	5.000E-01	---	FR9
R018	Contamination fraction of plant food	2.500E-01	-1	---	FPLANT
R018	Contamination fraction of meat	2.500E-01	-1	---	FMEAT
R018	Contamination fraction of milk	0.000E+00	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI

```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/05/2014  12:28  Page   6
 Summary : Dewey Burdock
 File    : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD
```

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	3.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	0.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	4.020E-01	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	3.660E-01	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL

1RESRAD, Version 6.5 T½ Limit = 180 days 06/05/2014 12:28 Page 7
Summary : Dewey Burdock
File : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Site-Specific Parameter Summary (continued)

0

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

1RESRAD, Version 6.5   T½ Limit = 180 days   06/05/2014 12:28 Page   8
Summary : Dewey Burdock
File   : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Contaminated Zone Dimensions

Area: 10000.00 square meters
Thickness: 0.15 meters
Cover Depth: 0.00 meters

Initial Soil Concentrations, pCi/g

Th-230   1.000E+02

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	4.728E+00	4.958E+00	5.421E+00	7.060E+00	1.169E+01	2.248E+01	0.000E+00	0.000E+00
M(t):	1.891E-01	1.983E-01	2.168E-01	2.824E-01	4.676E-01	8.991E-01	0.000E+00	0.000E+00

0Maximum TDOSE(t): 2.313E+01 mrem/yr   at t =   119.8 ± 0.2 years
0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.198E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-230	1.533E+01	0.6628	7.981E-01	0.0345	0.000E+00	0.0000	5.698E+00	0.2464	2.347E-01	0.0101	0.000E+00	0.0000	1.066E+00	0.0461
Total	1.533E+01	0.6628	7.981E-01	0.0345	0.000E+00	0.0000	5.698E+00	0.2464	2.347E-01	0.0101	0.000E+00	0.0000	1.066E+00	0.0461

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.198E+02 years
0 Water Dependent Pathways

Radio-Nuclide Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.313E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.313E+01	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Th-230	1.584E-01	0.0335	1.810E+00	0.3829	0.000E+00	0.0000	1.216E+00	0.2571	4.668E-02	0.0099	0.000E+00	0.0000	1.497E+00	0.3167
Total	1.584E-01	0.0335	1.810E+00	0.3829	0.000E+00	0.0000	1.216E+00	0.2571	4.668E-02	0.0099	0.000E+00	0.0000	1.497E+00	0.3167

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.728E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.728E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.5   T½ Limit = 180 days   06/05/2014 12:28 Page 10
Summary : Dewey Burdock
File   : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-230	3.543E-01	0.0715	1.802E+00	0.3634	0.000E+00	0.0000	1.261E+00	0.2544	4.822E-02	0.0097	0.000E+00	0.0000	1.492E+00	0.3010
Total	3.543E-01	0.0715	1.802E+00	0.3634	0.000E+00	0.0000	1.261E+00	0.2544	4.822E-02	0.0097	0.000E+00	0.0000	1.492E+00	0.3010

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Dependent Pathways

0 Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.958E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.958E+00	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Th-230	7.439E-01	0.1372	1.785E+00	0.3293	0.000E+00	0.0000	1.358E+00	0.2505	5.160E-02	0.0095	0.000E+00	0.0000	1.483E+00	0.2735
Total	7.439E-01	0.1372	1.785E+00	0.3293	0.000E+00	0.0000	1.358E+00	0.2505	5.160E-02	0.0095	0.000E+00	0.0000	1.483E+00	0.2735

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

0 Water Dependent Pathways

0 Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.421E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.421E+00	1.0000

0*Sum of all water independent and dependent pathways.

```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/05/2014  12:28  Page  12
 Summary : Dewey Burdock
 File    : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD
```

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Th-230	2.081E+00	0.2948	1.726E+00	0.2444	0.000E+00	0.0000	1.733E+00	0.2455	6.549E-02	0.0093	0.000E+00	0.0000	1.455E+00	0.2060
Total	2.081E+00	0.2948	1.726E+00	0.2444	0.000E+00	0.0000	1.733E+00	0.2455	6.549E-02	0.0093	0.000E+00	0.0000	1.455E+00	0.2060

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

0 Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.060E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.060E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.5   T½ Limit = 180 days   06/05/2014 12:28 Page 13
Summary : Dewey Burdock
File   : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Th-230	5.659E+00	0.4841	1.557E+00	0.1332	0.000E+00	0.0000	2.953E+00	0.2526	1.143E-01	0.0098	0.000E+00	0.0000	1.406E+00	0.1203
Total	5.659E+00	0.4841	1.557E+00	0.1332	0.000E+00	0.0000	2.953E+00	0.2526	1.143E-01	0.0098	0.000E+00	0.0000	1.406E+00	0.1203

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Dependent Pathways

Radio- Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.169E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.169E+01	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

0 Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Th-230	1.436E+01	0.6387	9.657E-01	0.0430	0.000E+00	0.0000	5.730E+00	0.2549	2.344E-01	0.0104	0.000E+00	0.0000	1.191E+00	0.0530
Total	1.436E+01	0.6387	9.657E-01	0.0430	0.000E+00	0.0000	5.730E+00	0.2549	2.344E-01	0.0104	0.000E+00	0.0000	1.191E+00	0.0530

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

0 Water Dependent Pathways

Radio- Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.248E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.248E+01	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.5 T½ Limit = 180 days 06/05/2014 12:28 Page 15
Summary : Dewey Burdock
File : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.5   T½ Limit = 180 days   06/05/2014 12:28 Page 17
Summary : Dewey Burdock
File   : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0 Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Th-230	Th-230	1.000E+00	4.605E-02	4.583E-02	4.541E-02	4.392E-02	3.965E-02	2.471E-02	0.000E+00	0.000E+00
Th-230	Ra-226+D	1.000E+00	1.230E-03	3.713E-03	8.645E-03	2.548E-02	6.974E-02	1.706E-01	0.000E+00	0.000E+00
Th-230	Pb-210+D	1.000E+00	5.240E-06	3.218E-05	1.552E-04	1.207E-03	7.502E-03	2.948E-02	0.000E+00	0.000E+00
Th-230	ΣDSR(j)		4.728E-02	4.958E-02	5.421E-02	7.060E-02	1.169E-01	2.248E-01	0.000E+00	0.000E+00

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Th-230	5.287E+02	5.042E+02	4.612E+02	3.541E+02	2.139E+02	1.112E+02	*2.018E+10	*2.018E+10

*At specific activity limit
0

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose =   119.8 ± 0.2 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Th-230	1.000E+02	119.8 ± 0.2	2.313E-01	1.081E+02	2.313E-01	1.081E+02

1RESRAD, Version 6.5 T½ Limit = 180 days 06/05/2014 12:28 Page 18
Summary : Dewey Burdock
File : X:\PROJECT_DATA\KNIGHTPIESOLD\DEWEYBURDOCK\RESRAD\DBTHORIUMBENCHMARK.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Th-230	Th-230	1.000E+00	4.605E+00	4.583E+00	4.541E+00	4.392E+00	3.965E+00	2.471E+00	0.000E+00	0.000E+00
0Ra-226	Th-230	1.000E+00	1.230E-01	3.713E-01	8.645E-01	2.548E+00	6.974E+00	1.706E+01	0.000E+00	0.000E+00
0Pb-210	Th-230	1.000E+00	5.240E-04	3.218E-03	1.552E-02	1.207E-01	7.502E-01	2.948E+00	0.000E+00	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Th-230	Th-230	1.000E+00	1.000E+02	1.000E+02	1.000E+02	9.999E+01	9.997E+01	9.991E+01	9.973E+01	9.910E+01
0Ra-226	Th-230	1.000E+00	0.000E+00	4.331E-02	1.299E-01	4.322E-01	1.290E+00	4.230E+00	1.210E+01	3.436E+01
0Pb-210	Th-230	1.000E+00	0.000E+00	6.662E-04	5.872E-03	6.076E-02	4.520E-01	2.942E+00	1.087E+01	3.346E+01

THF(i) is the thread fraction of the parent nuclide.
0RESCALC.EXE execution time = 2.78 seconds