POWERTECH (USA) INC.

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Admitted:	8/19/2014	Withdrawn:	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

APPENDIX 2.7-L

Class V UIC Application

UIC PERMIT APPLICATION

Class V Non-Hazardous Injection Wells

Powertech (USA) Inc.

Dewey-Burdock Project

Custer and Fall River Counties, South Dakota

EPA Permit # TBD

March 2010

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USEPA PERMIT FORMS

1.0 PERMIT APPLICATION AND INTRODUCTION

Through the submittal of this application, Powertech (USA) Inc. [Powertech], requests an Area Permit and authorization from the US Environmental Protection Agency (USEPA) to install and operate four to eight non-hazardous Class V disposal wells located at the Dewey-Burdock Project, pursuant to the applicable Underground Injection Control (UIC) regulations. The number of wells is to be determined and is dependent upon well capacity. Powertech requests authorization to inject a total of 300 gallons per minute (gpm) in a maximum of eight Class V disposal wells. These wells are to be located in Custer and Fall River Counties, South Dakota, within the limits of the proposed Class V permit area within the Dewey-Burdock Project boundary. Proposed locations for the first four wells are shown on Figure B-2. The Project is located approximately 13 miles north-northwest of Edgemont, South Dakota, and straddles the area between northern Fall River and southern Custer County line. The project boundary encompasses approximately 10,580 acres (4,282 ha) of mostly private land on either side of County Road 6463 and includes portions of Sections 1-5, 10-12, 14 and 15, Township 7 South, Range 1 East and Sections 20, 21, 27, 28, 29 and 30-35, Township 6 South, Range 1 East. Approximately 240 acres (~2%) (97.1 ha) are under the control of the Bureau of Land Management (BLM) located in portions of Sections 3, 10, 11, and 12. A map identifying the general project location is included as Figure 1.

A completed copy of USEPA UIC 7520-6, "Underground Injection Control Permit Application" for the wells is included in this application, and required attachments to this form are also included in this document. In this application, the initial four planned wells are referred to individually as Dewey-Burdock Disposal Well Nos. 1, 2, 3, and 4, (DW Nos. 1, 2, 3, and 4) or collectively with additional disposal wells as the Dewey-Burdock Disposal Wells. All depths discussed in this application are below ground surface (bgs) unless otherwise noted.

The proposed Powertech facility in South Dakota will operate between four and eight Class V Non-Hazardous Disposal Wells for underground injection of fluids from an in-situ leach (ISL) uranium mining project. Fresh water aquifers in the vicinity of the wells are to be protected by casing and cement. Injected fluids will be delivered to the Minnelusa and Deadwood Formations in separate wells under positive pressure injection through tubing and a packer. The wells are to have one cemented long string protective casing extending into the injection interval. The wellbores are to be perforated completions within the injection interval. The annulus area between the protective casings and injection tubing strings will be filled with inhibited fresh water. Annulus pressure will be continuously monitored to detect any potential leaks in the tubing or casing strings and annulus pressures will be maintained at more than 100 psi above the tubing pressure.

Relevant administrative data regarding the permit are summarized as follows.

Applicant:	Powertech (USA) Inc.
State:	South Dakota
Counties:	Custer and Fall River
Facility Address:	310 2nd Avenue Edgemont, SD 57735
Mailing Address:	5575 DTC Parkway, Suite 140, Greenwood Village, CO 80111
Location of Planned Wells:	Site 1: NE ¼ of NW ¼ of SW ¼ of Section 2, T7S, R1E DW No. 1: Lat: -103.971938654 Long: 43.469772181 DW No. 2: Lat: -103.971859557 Long: 43.4696483743 Site 2: SE ¼ of NW ¼ of SW ¼ of Section 29, T6S, R1E DW No. 3: Lat: -104.031570321 Long: 43.4971737527 DW No. 4: Lat: -104.031436264 Long: 43.4970792287

Location of Additional Wells:	To be determined
USEPA ID Nos.:	Dewey-Burdock Disposal Well Nos. 1, 2, 3, 4, and additional wells- TBD
Contact:	Mr. Richard Blubaugh, Vice President

OMB No. 2040-0042 Approval Expires 12/31/2011

EPA

United States Environmental Protection Agency

Underground Injection Control Permit Application

(Collected under the authority of the Safe Drinking Water Act. Sections 1421, 1422, 40 CFR 144)

I. EPA ID Number		T/A	C
U			

Read Attached Instructions Before Starting

For Official Use Only

Application approved mo day year	Date received mo day year	Permit Number	Well ID	FINDS Number

II. Owner Name and Address			III. Operator Name and Address		
Owner Name: Powertech (USA) Inc.			Owner Name: Powertech (USA) Inc.		
Street Address: 5575 DTC Parkway, Suite 140		Phone Number: (303) 790-7528	Street Address: 5575 DTC Parkway, Suite 140		Phone Number: (303) 790-7528
City: Greenwood Village	State: CO	ZIP CODE: 80111	City: Greenwood Village	State: CO	ZIP CODE: 80111

IV. Commercial Facility	V. Ownership	VI. Legal Contact	VII. SIC Codes
☐ Yes ☒ No	☒ Private ☐ Federal ☐ Other	☒ Owner ☐ Operator	SIC: 1094 NAISC: 212291

VIII. Well Status *(Mark "x")*

☐ A Operating	Date Started mo day year	☐ B. Modification/Conversion	☒ C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

☐ A. Individual ☒ B. Area	Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
	0	4 - 8	Dewey-Burdock

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
Other	N/A	Class V, permitted under 40 CFR 144.12	4 - 8

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude			Longitude			Township and Range							
Deg	Min	Sec	Deg	Min	Sec	Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
103	59	43	43	28	55	34	6S	1E	SW	93.0	W	1403	S

XII. Indian Lands (Mark 'x')

☐ Yes
☒ No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

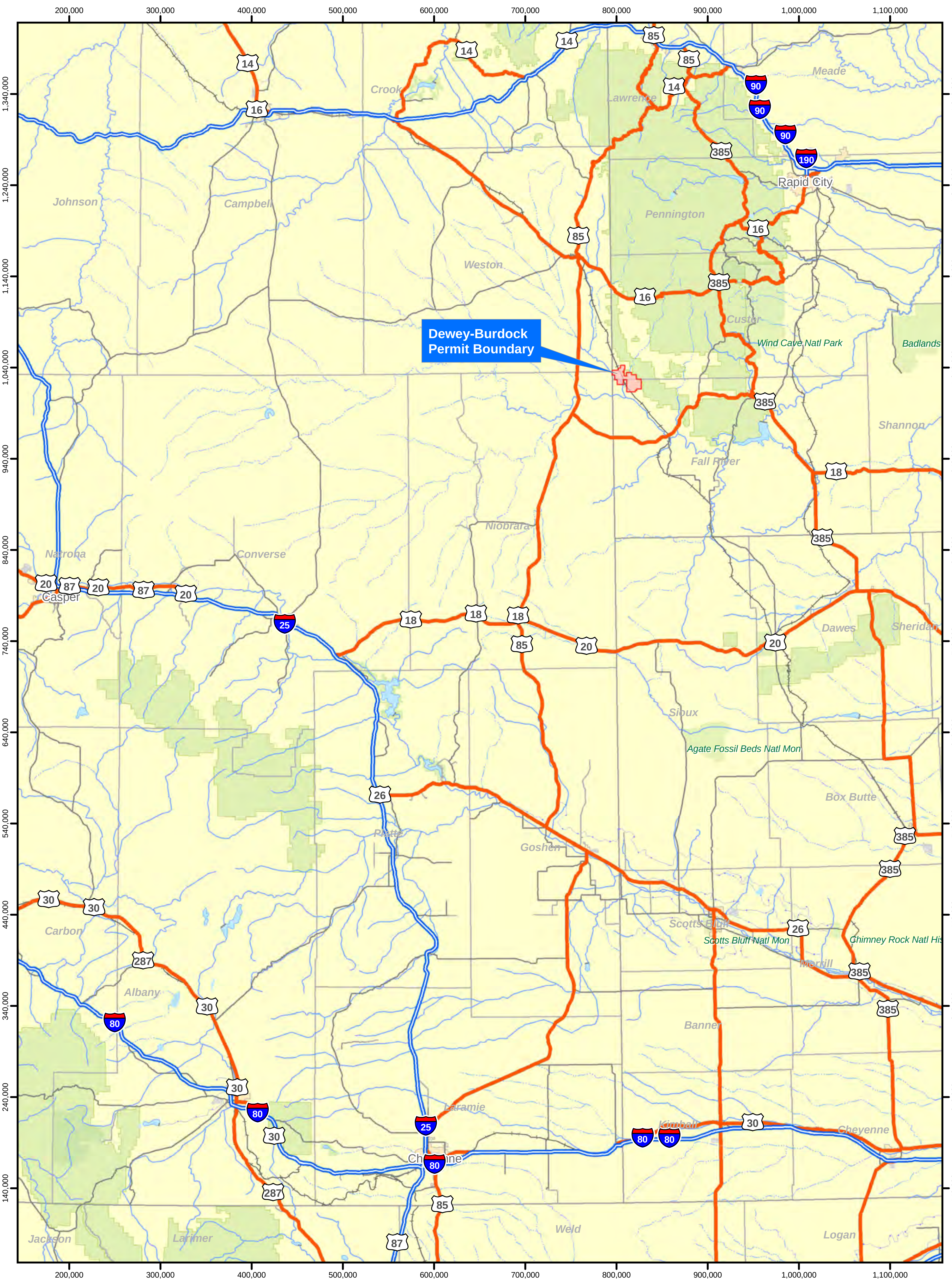
For Classes I, II, III, (and other classes) complete and submit on a separate sheet(s) Attachments A--U (pp 2-6) as appropriate. Attach maps where required. List attachments by letter which are applicable and are included with your application.

XIV. Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possiblity of fine and imprisonment. (Ref. 40 CFR 144.32)

A. Name and Title *(Type or Print)*	B. Phone No. *(Area Code and No.)*
Richard Blubaugh, Vice President - Environmental	(303) 790-7528
C. Signature	D. Date Signed

EPA Form 7520-6 (Rev. 12-08)



Legend

Dewey-Burdock Permit Boundary

N

0 10 20 30 40 Miles

POWERTECH (USA) INC.

Figure 1
Site Location Map

2010 Dewey-Burdock Class V Permit

Scale: 1:1,250,000	Date: March 2010	
2010_DB_Class_V_Fig_01.mxd	By: JLM	Checked: HD

Petrotek

10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com

2.0 USEPA FORM 7520-6 PERMIT APPLICATION ATTACHMENTS

2.A AREA OF REVIEW METHODS

Give the methods and, if appropriate, the calculations used to determine the size of the area of review (fixed radius or equation). The area of review shall be a fixed radius of ¼-mile from the well bore unless the use of an equation is approved in advance by the Director.

RESPONSE

In the meeting held on November 24, 2009, EPA Region 8 instructed Powertech to generally follow Class I standards and approach for this application. As such, the radius of investigation used in this permit request has been based on standard practices applied historically to Class I wells in Region 8. Under Section 146.6 of the UIC regulations (40CFR), the area of review (AOR) for a non-hazardous Class I injection well is defined as either the calculated zone of endangering influence or a fixed radius of not less than one-fourth mile.

The South Dakota Department of Environment and Natural Resources (DENR) has guidance for Class V wells but does not require separate state approval for Class V well installation. The guidelines for Class V wells are outlined in a letter received from DENR which is included as Appendix A.

The critical pressure rise, cone-of-influence (COI), radius of fluid displacement (ROFD) calculations for this permit application are based on the formation parameters derived from the correlation of three separate type logs. The location of these wells is shown on Figure A-1. Type Log #1 (Figure A-2) is from the Earl Darrow #1 (T7S, R1E, Sec 2) which penetrates the top of the Minnelusa and is located within the Dewey-Burdock Project boundary near the well locations of DW Nos. 1 and 2. Type Log #2 (Figure A-3) is from the Lance-Nelson Estate #1 (T7S, R1E, Sec 21) which penetrates the top of the Madison and is located just south of the project boundary. Type Log #3 (Figure A-4), from the #1 West Mule Creek (T39, R61W, Sec 2), penetrates to the top of the Precambrian and is located in eastern Wyoming to the southwest of the Project. This is the closest log available that penetrates the Deadwood Formation. Additionally, tops for shallow formations from the logs of various uranium exploration wells within the Project boundary were used in conjunction with the type logs to determine surface elevation and formation depths at each well site.

DW Nos. 1 and 2 target the Minnelusa and Deadwood Formations, respectively, and are located near the main plant site (Site 1). DW Nos. 3 and 4 target the Minnelusa and Deadwood, respectively, and will be located at Site 2. While formation parameters are expected to be similar at each site, formations are expected to occur at greater depth at Site 2 due to geologic structure. Separate critical pressure rise and COI calculations for the Minnelusa and Deadwood at each site are included in this application and are presented in Tables A-1 through A-4. In addition, ROFD calculations for the Minnelusa and Deadwood are presented in Tables A-5 and A-6, respectively.

Because the calculated ROFD and COI are significantly smaller than the statutory minimum, a fixed radius of 1,320' (¼ mile) has been used for evaluation of all artificial penetrations for Class V injection into the Minnelusa Formation for DW Nos. 1 and 3. Based on COI calculations, a radius of 1,355' has been used for evaluation of all artificial penetrations for Class V injection into the Deadwood Formation for DW Nos. 2 and 4. The Class V permit area has been conservatively defined by applying the maximum calculated AOR of 1,355' as an offset from the Dewey-Burdock Project boundary and the oil and gas wells permitted within that boundary.

In the event that additional disposal wells are required to inject the requested 300 gpm, similar AORs are expected for subsequent Dewey-Burdock Disposal Wells located within the proposed Class V permit area. The input parameters used to calculate the AORs are based on formation parameters derived from limited data and will be verified during the drilling, testing, and completion process. If the input parameters that have been used are found to yield projections that are insufficiently conservative, the AORs will be recalculated.

The COI for injection is defined as that area around a well within which increased injection zone pressures caused by injection could be sufficient to drive fluids into an underground source of drinking water (USDW). The pathway for this theoretical fluid movement is assumed to be a hypothetical, open abandoned well, which penetrates the confining zone for injection. Information used in the following calculations has been estimated from available geophysical well logs and will be verified through formation testing during the drilling process.

Critical Pressure Rise

For this permit application, three critical pressure rise calculations are required at each site. One is applied for the rise from the Minnelusa to the Unkpapa/Sundance, one for the rise from the Minnelusa to the Madison, and one for the rise from the Deadwood to the Madison.

To calculate the COI, a value must first be assigned for the pressure increase in the injection interval that would be sufficient to cause injection zone brine to rise in a hypothetical open pathway to the base of the lowermost USDW. This applies individually to the rise from the Minnelusa (injection zone) to the Unkpapa/Sundance (USDW) and for rise from the Deadwood (injection zone) to the Madison (USDW). The COI will also be applied to the transfer of injection zone brine from the base of the effective Minnelusa in a hypothetical open pathway down to the top of the Madison Formation. This critical pressure rise, Pc, is assigned as indicated in Figure A-5.

The pressure required at the top of the injection interval to support injection zone brine in the configuration indicated is, in psi units:

$$P = 0.433\ [y_B D_B + y_w(D_w - L)]$$

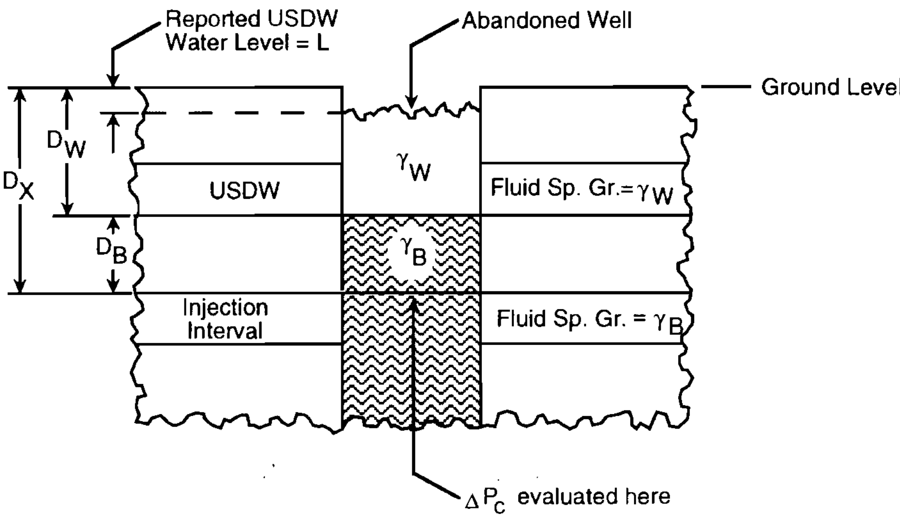
where: $D_B = D_x - D_w$

and the pressure rise is then:

$$Pc = 0.433\ [y_B D_B + y_w(D_w - L)] - Po$$

where Po is the original, pre-injection value for pressure at the top of the injection interval expressed in psi units.

FIGURE A-5 CRITICAL PRESSURE RISE



MINNELUSA TO UNKPAPA/SUNDANCE AND MINNELUSA TO MADISON FOR DW NO. 1 – SITE 1

Minnelusa – Unkpapa/Sundance

Original pressure in the Minnelusa has been calculated based on a depth to water of 1,415' above top of the Minnelusa from USGS potentiometric maps (Figure D-14, Driscoll et al., 2002). For the estimated top of the injection interval of 1,615' (See Response F, Table F-2), a gradient of 0.433 psi/ft * 1.008 (SG of approximately 15,000 mg/l TDS brine) yields a pressure of 617.6 psi at the top of the Minnelusa (1,615'). The same gradient applied to the effective base of the Injection Zone at 2,205 yields a pressure 875.1 psi. The effective base refers to the lowermost zone of effective porosity in the Minnelusa that will be targeted for injection in DW No. 1 as discussed in Section 2.F of this document.

In assigning the critical pressure rise and calculating the cone-of-influence (Tables A-1 and A-3) at this site, the base of the overlying USDW, the Unkpapa/Sundance, is assigned as 920', as discussed in Response 2.D of this document. The potentiometric surface of Unkpapa/Sundance near the Dewey-Burdock Project is projected to be approximately 29 feet above ground surface (Figure D-14a, Powertech 2008). Therefore, in these calculations, it is assumed that the water table in the Unkpapa/Sundance is at approximately 589 feet above the top of the formation. The result is a calculated critical pressure rise for Minnelusa to Unkpapa/Sundance of 97.1 psi (Table A-1).

The values in Table A-1 were used in the pressure rise equation to compute the critical pressure rise for Minnelusa to Unkpapa/Sundance as follows:

$$Pc = 0.433[1.008(1{,}615-920) + 1.001(920-(-29))] - 617.6 \text{ psi}$$

or:

$$Pc = 97.1 \text{ psi}$$

Minnelusa - Madison

The top of the underlying USDW is the Madison Formation at 2,765' as discussed in Response 2.D of this document. Original pressure in the Madison has been calculated based on an artesian aquifer condition with a water level of approximately 200' above ground surface. This head is based on historical water well data for the City of Edgemont water wells completed in the Madison Formation (Appendix D). Based on an estimated shut-in pressure of 150 psi and a minimum surface elevation of 3,450', the potentiometric surface of the Madison at Edgemont is 3,745' (345' above ground surface). It is noted that surface elevation at Edgemont wells may be as high as 3,650'. Given the elevation increase of approximately 100' to 300' from Edgemont to the Dewey-Burdock Project, it is reasonable to assume a potentiometric level of approximately 3,900' AMSL (~200' above ground surface) at Dewey-Burdock. USGS potentiometric maps for this formation are regional and based on little (if any) local data (Figure D-10, Driscoll et al., 2002). The result is a calculated critical pressure rise for the Minnelusa to Madison of 165.6 psi (Table A-1). It is noted that formation parameters have been estimated from available data and will be verified through formation testing during the drilling process.

The values in Table A-1 were used in the pressure rise equation to compute the critical pressure rise for Minnelusa to top of Madison as follows:

$$Pc = 0.433[1.008(2{,}205-2{,}765) + 1.001(2{,}765-(-200))] - 875.1 \text{ psi}$$

or:

$$Pc = 165.6 \text{ psi}$$

Cone-of-Influence

Based on the calculated value for the critical pressure rise, the cone-of-influence can be calculated for DW No.1 over a ten-year period of injection. At DW No. 1 there is projected to be a 13.2' cone-of-influence for continuous injection at a rate of 75 gpm (2,571 bwpd) in the Minnelusa Formation (Table A-2). This is the value at which pressure at distance intersects the critical pressure rise of 97.1 psi from the Minnelusa to the Unkpapa/Sundance (Figure A-6). Since the critical pressure rise for the Minnelusa to the over-pressured Madison is never intersected, even at the well bore, there is no COI and no potential exists for contamination of the Madison. As such, the fixed radius of 1,320' (¼ mile) will be used for the Minnelusa Formation at Site 1. Pressure rise has been evaluated in an infinite acting reservoir with a line source well using the log-approximation of the radial flow diffusivity equation (Lee, 1982).

$$dP = -70.6\ Bq\mu\ /kh * \ln\left([\ 1{,}688\ \phi\ \mu c_t r^2\ /kt\ ] - 2s \right)$$

where the values listed in Table A-3 have been assigned based on site-specific information.

Calculations for pressure rise due to ten years of injection have been based on a rate of 75 gpm. Well capacities will be verified during the drilling, testing, and completion process.

MINNELUSA TO UNKPAPA/SUNDANCE AND MINNELUSA TO MADISON FOR DW NO. 3 – SITE 2

Minnelusa – Unkpapa/Sundance

Original pressure in the Minnelusa has been calculated based on a depth to water of 1,750' above the top of the Minnelusa from USGS potentiometric maps (Figure D-14, Driscoll et al., 2002). For the estimated top of the injection interval of 1,950' (See Response F, Table F-2), a gradient of 0.433

psi/ft * 1.008 (SG of approximately 15,000 mg/l TDS brine) yields a pressure of 763.8 psi at the top of the Minnelusa. The same gradient applied to the effective base of the Injection Zone at 2,540 yields a pressure 1,021.3 psi. (Table A-2).The effective base refers to the lowermost porous zone that will be targeted for injection as discussed in Section 2.F of this document.

In assigning the critical pressure rise and calculating the cone-of-influence (Tables A-2 and A-3) at this site, the base of the overlying USDW, the Unkpapa/Sundance, is assigned as 1,255', as discussed in Response 2.D of this document. The lowest potentiometric surface near the Dewey-Burdock Project is projected to be approximately 29 feet above ground surface (Figure D-14a, Powertech 2008). Therefore, in these calculations, it is assumed that the water table in the Unkpapa/Sundance is at approximately 924' above the top of the formation. The result is a calculated critical pressure rise for Minnelusa to Unkpapa/Sundance of 96.1 psi (Table A-2).

The values in Table A-2 were used in the pressure rise equation to compute the critical pressure rise for Minnelusa to Unkpapa/Sundance as follows:

$$Pc = 0.433[1.008(1{,}950-1{,}255) + 1.001(1{,}255-(-29))] - 763.8 \text{ psi}$$

or:

$$Pc = 96.1 \text{ psi}$$

<u>Minnelusa - Madison</u>

The top of the underlying USDW is the Madison Formation at 3,100' as discussed in Response 2.D of this document. Original pressure in the Madison has been calculated based on an artesian aquifer condition with a water level of approximately 200' above ground surface. This head is based on historical water well data for the City of Edgemont water wells completed in the Madison Formation (Appendix D). Based on an estimated shut-in pressure of 150 psi and a minimum surface elevation of 3,450', the potentiometric surface of the Madison at Edgemont is 3,745' (345' above ground surface). It is noted that surface elevation at Edgemont wells may be as high as 3,650'. Given the elevation increase of approximately 100' to 300' from Edgemont to the Dewey-Burdock Project, it is reasonable to assume a potentiometric level of approximately 3,900' AMSL (~200' above ground surface) at Dewey-Burdock. USGS potentiometric maps for this formation are regional and based on little (if any) local data (Figure D-10, Driscoll et al., 2002). The result is a calculated critical pressure rise for the Minnelusa to Madison of 164.6 psi (Table A-2). It is noted that formation parameters have been estimated from available data and will be verified through formation testing during the drilling process.

The values in Table A-2 were used in the pressure rise equation to compute the critical pressure rise for Minnelusa to Madison as follows:

$$Pc = 0.433[1.008(2{,}540-3{,}100) + 1.001(3{,}100-(-200))] - 1{,}021.3 \text{ psi}$$

or:

$$Pc = 164.6 \text{ psi}$$

Cone-of-Influence

Based on the calculated value for the critical pressure rise, the cone-of-influence can be calculated for DW No. 3 over a ten-year period of injection. At DW No. 3, there is projected to be a 14.4' cone-of-influence for continuous injection at a rate of 75 gpm (2,571 bwpd) in the Minnelusa Formation (Table A-3). This is the value at which pressure at distance intersects the critical pressure rise of 96.1 psi from the Minnelusa to the Unkpapa/Sundance (Figure A-6). Since the critical pressure rise for the Minnelusa to the over-pressured Madison is never intersected, even at the well bore, there is

no COI and no potential exists for contamination of the Madison. As such, the fixed radius of 1,320' (1/4 mile) will be used. Pressure rise has been evaluated in an infinite acting reservoir with a line source well using the log-approximation of the radial flow diffusivity equation (Lee, 1982).

$$dP = -70.6\ Bq\mu /kh * \ln ([1{,}688\ \phi\ \mu c_t r^2 /kt] - 2s)$$

where the values listed in Table A-3 have been assigned based on site-specific information.

Calculations for pressure rise due to ten years of injection have been based on a rate of 75 gpm. Well capacities will be verified during the drilling, testing, and completion process.

DEADWOOD TO MADISON FOR DW NO. 2 – SITE 1

Original pressure in the Deadwood has been calculated based on an estimated formation fluid level of 2,900' above the top of the Deadwood. For the estimated top of the injection interval of 3,100' (See Response F, Table F-2), a gradient of 0.433 psi/ft * 1.008 (SG of 15,000 mg/l TDS brine) yields a pressure of 1,265.7 psi at the top of the Deadwood.

In assigning the critical pressure rise and calculating the cone-of-influence (Tables A-1 and A-4) at this site, the base of the overlying USDW, the Madison Formation, is assigned as 3,060', as discussed in Response 2.D of this document. Original pressure in the Madison has been calculated based on an artesian aquifer condition with a water level of approximately 200' above ground surface. This head is based on historical water well data for the City of Edgemont water wells completed in the Madison Formation (Appendix D). Based on an estimated shut-in pressure of 150 psi and a minimum surface elevation of 3,450', the potentiometric surface of the Madison at Edgemont is 3,745' (345' above ground surface). It is noted that surface elevation at Edgemont wells may be as high as 3,650'. Given the elevation increase of approximately 100' to 300' from Edgemont to the Dewey-Burdock Project, it is reasonable to assume a potentiometric level of approximately 3,900' AMSL (~200' above ground surface) at Dewey-Burdock. USGS potentiometric maps for this formation are regional and based on little (if any) local data (Figure D-10, Driscoll et al., 2002). The result is a calculated critical pressure rise for the Minnelusa to Madison of 164.7 psi (Table A-1). It is noted that formation parameters have been estimated from available data and will be verified through formation testing during the drilling process.

The values in Table A-1 were used in the pressure rise equation to compute the critical pressure rise for Deadwood to Madison as follows:

$$Pc = 0.433[1.008(3{,}100-3{,}060) + 1.001(3{,}060-(-200))] - 1{,}265.7 \text{ psi}$$

or:

$$Pc = 164.7 \text{ psi}$$

Cone-of-Influence

Based on the calculated value for the critical pressure rise, the cone-of-influence can be calculated for the DW No. 2 over a ten-year period of injection. At DW No. 2, there is projected to be a 1,210' cone-of-influence for continuous injection at a rate of 75 gpm (2,571 bwpd) in the Deadwood Formation (Table A-4). This is the value at which pressure at distance intersects the critical pressure rise of 164.7 psi from the Deadwood to the Madison (Figure A-7). Pressure rise has been evaluated in an infinite acting reservoir with a line source well using the log-approximation of the radial flow diffusivity equation (Lee, 1982).

$$dP = -70.6\ Bq\mu /kh * \ln ([1{,}688\ \phi\ \mu c_t r^2 /kt] - 2s)$$

where the values listed in Table A-4 have been assigned based on site-specific information.

Calculations for pressure rise due to ten years of injection have been based on a rate of 75 gpm. Well capacities will be verified during the drilling, testing, and completion process.

DEADWOOD TO MADISON FOR DW NO. 4 – SITE 2

Original pressure in the Deadwood has been calculated based on an estimated formation fluid level of 3,235' above the top of the Deadwood. For the estimated top of the injection interval of 3,435' (See Response F), a gradient of 0.433 psi/ft * 1.008 (SG of 15,000 mg/l TDS brine) yields a pressure of 1,412.0 psi at the top of the Deadwood.

In assigning the critical pressure rise and calculating the cone-of-influence (Tables A-2 and a-4) at this site, the base of the overlying USDW, the Madison Formation, is assigned as 3,395', as discussed in Response 2.D of this document. Original pressure in the Madison has been calculated based on an artesian aquifer condition with a water level of approximately 200' above ground surface. This head is based on historical water well data for the City of Edgemont water wells completed in the Madison Formation (Appendix D). Based on an estimated shut-in pressure of 150 psi and a minimum surface elevation of 3,450', the potentiometric surface of the Madison at Edgemont is 3,745' (345' above ground surface). It is noted that surface elevation at Edgemont wells may be as high as 3,650'. Given the elevation increase of approximately 100' to 300' from Edgemont to the Dewey-Burdock Project, it is reasonable to assume a potentiometric level of approximately 3,900' AMSL (~200' above ground surface) at Dewey-Burdock. USGS potentiometric maps for this formation are regional and based on little (if any) local data (Figure D-10, Driscoll et al., 2002). The result is a calculated critical pressure rise for the Minnelusa to Madison of 163.7 psi (Table A-2). It is noted that formation parameters have been estimated from available data and will be verified through formation testing during the drilling process.

The values in Table A-2 were used in the pressure rise equation to compute the critical pressure rise for Deadwood to Madison as follows:

$$Pc = 0.433[1.008(3{,}435-3{,}395) + 1.001(3{,}395-(-200))] - 1{,}412.0 \text{ psi}$$

or:

$$Pc = 163.7 \text{ psi}$$

Cone-of-Influence

Based on the calculated value for the critical pressure rise, the cone-of-influence can be calculated for the DW No. 2 over a ten-year period of injection. At DW No. 4, there is projected to be a 1,242' cone-of-influence for continuous injection at a rate of 75 gpm (2,571 bwpd) in the Deadwood Formation (Table A-4). This is the value at which pressure at distance intersects the critical pressure rise of 163.7 psi from the Deadwood to the Madison (Figure A-7). Pressure rise has been evaluated in an infinite acting reservoir with a line source well using the log-approximation of the radial flow diffusivity equation (Lee, 1982).

$$dP = -70.6\ Bq\mu / kh * \ln ([1{,}688\ \phi\ \mu c_t r^2 / kt] - 2s)$$

where the values listed in Table A-4 have been assigned based on site-specific information.

Calculations for pressure rise due to ten years of injection have been based on a rate of 75 gpm. Well capacities will be verified during the drilling, testing, and completion process.

Radius of Fluid Displacement

Minnelusa

The same formation parameters for each formation that were used in the COI calculations were used to calculate the ROFD. Using a porosity of 21% and an effective thickness of 164', the calculated ROFD is 698' after 10 years of constant rate injection at 75 gpm. The effect of an estimated hydraulic gradient of 10 ft/mile alters the maximum ROFD by 8.12' which yields a total calculated ROFD of approximately 706' (Table A-5). The ROFD in the Minnelusa is presented on Figure B-2.

Deadwood

Using a porosity of 11% and an effective thickness of 85', the calculated ROFD is 1,339' after 10 years of constant rate injection at 75 gpm. The effect of an estimated hydraulic gradient of 10 ft/mile alters the maximum ROFD by 15.50' which yields a total calculated ROFD of approximately 1,355' (Table A-6). The ROFD in the Deadwood is presented on Figure B-2a.

Final AORs

The calculated COIs for DW Nos. 1, 2, 3, and 4 are 13.2', 1,210', 14.4', and 1,242', respectively. The distances for DW Nos. 1 and 3 are less than the calculated ROFDs for the Minnelusa (706') and less than a fixed radius of ¼ mile or 1,320'. As such, a radius of 1,320' has been used for evaluation of all artificial penetrations for Class V injection into the Minnelusa Formation for DW No. 1 and DW No. 3 (Figure B-2).

The calculated COIs for DW Nos. 2 and 4 are less than the calculated ROFDs for the Deadwood (1,355') and greater than a fixed radius of ¼ mile or 1,320'. As such, a radius of 1,355' has been used for DW No. 2 and DW No. 4 for evaluation of all artificial penetrations for Class V injection into the Deadwood Formation (Figure B-2a). Figure B-2b presents the final AORs of the four planned wells relative to the Class V permit area and oil and gas wells near the project. The Class V permit area is defined conservatively by applying the maximum calculated AOR of 1,355' as an offset from the Dewey-Burdock Project boundary and the oil and gas wells permitted within that boundary.

The input parameters used to calculate the AORs are based on formation parameters derived from limited data and will be verified during the drilling, testing, and completion process. If the input parameters that have been used are found to yield projections that are insufficiently conservative, the AORs will be recalculated.

Pressure Rise at the Dewey Fault

The Dewey Fault shown on Figure B-2b is located in excess of 4,000' to the northwest of the nearest corner of the proposed Class V permit area. While some authors have mapped it as dipping to the southeast, it is shown at the same location relative to the Dewey-Burdock Project at surface and at depth (Figures D-1, D-8, D-10, D-14, and D-15). As such, it is more likely a near vertical fault in proximity to the site. The pressure rise at a distance of 4,000' due to injection in the Minnelusa would be approximately 34 psi. This is less than the calculated critical pressure rise of 96.1 psi (Minnelusa to Unkpapa/Sundance) and 164.6 psi (Minnelusa to Madison). The pressure rise at a distance of 4,000' due to injection into the Deadwood would be approximately 119 psi. This is less than the calculated critical pressure rise of 163.7 psi necessary to transmit fluid from the Deadwood to the Madison along any hypothetical open pathway. It can thus be concluded that the Dewey Fault could not act as a conduit for fluid to rise to a USDW due to injection into the Minnelusa or

Deadwood in the vicinity of the proposed Class V permit area.

TABLE A-1 Critical Pressure Rise - Site 1

Pc=0.433(YbDb+Yw(Dw-L))-Po				Inj. Zone DTW (ft;bgs)	Yb (Inj. Z)	Confining Zone Db (feet; bgs)	SG of USDW Yw (USDW)	Top Inj. Zone Dx (feet; bgs)	Base/Top Inj. Zone Dw (feet; bgs)	USDW DTW L (feet; bgs)	Inj. Zone Po (psi)
Minnelusa to Unkpapa/Sundance				200	1.008	695	1.001	1615	920	-29	617.6
Pc =	97.1	psi									
Minnelusa to Madison				200	1.008	-560	1.001	2205	2765	-200	875.1
Pc =	165.6	psi									
Deadwood to Madison				200	1.008	40	1.001	3100	3060	-200	1,265.7
Pc =	164.7	psi									

Po calculated based on a depth to water of 1,400' above top of Minnelusa; fluid gradient of Minnelusa and Deadwood = 0.433 psi/ft x 1.008 (SG)

TABLE A-2 Critical Pressure Rise - Site 2

Pc=0.433(YbDb+Yw(Dw-L))-Po			Inj. Zone DTW (ft;bgs)	Yb (Inj. Z)	Confining Zone Db (feet; bgs)	SG of USDW Yw (USDW)	Top Inj. Zone Dx (feet; bgs)	Base/Top Inj. Zone Dw (feet; bgs)	USDW DTW L (feet; bgs)	Inj. Zone Po (psi)
Minnelusa to Unkpapa/Sundance			200	1.008	695	1.001	1950	1255	-29	763.8
Pc =	96.1	psi								
Minnelusa to Madison			200	1.008	-560	1.001	2540	3100	-200	1,021.3
Pc =	164.6	psi								
Deadwood to Madison			200	1.008	40	1.001	3435	3395	-200	1,412.0
Pc =	163.7	psi								

Po calculated based on a depth to water of 1,400' above top of Minnelusa; fluid gradient of Minnelusa and Deadwood = 0.433 psi/ft x 1.008 (SG)

TABLE A-3 Calculated Pressure Rise vs. Distance (Diffusivity Equation) - Minnelusa Formation

Injection Rate (gpm) 75

Based on Equation 1.11 (Lee, 1982; P. 5)

dp = -70.6(qBu/kh)[ln(1,688.388*por*u*ct*rw^2/kt)-2s]

Where

dp =	pressure differential	Solve	psi
q =	flowrate (STB/d)	2,571.43	bbl/d
B =	formation volume factor (RB/STB)	1.01	RB/STB
u =	viscosity (cp)	0.74	cp
k =	permeability (md)	150	md
h =	reservior thickness (feet)	164	feet
por =	formation effective porosity (percent)	0.21	fraction
ct =	total matrix and fluid compressibility (1/psi)	6.50E-06	psi-1
rw =	radius (feet)	Variable	feet
t =	injection time (hours)	87660.0	hours = 10.00 years
s =	skin factor (units)	0.0	

Term 1 -70.6(qBu/kh)

Term 2 (por*u*ct*rw^2/kt)

Injection Rate (gpm) = 75

dp = Term 1 * ln(1688.388*Term 2)

	Radius (ft)	Term 1	Term 2	[ln (term 2) - 2s]	dp (psi)	
rw	0.26042	-5.51566	5.2098E-15	-25.45671	140.4	Minn-Madison NO COI At 165.6 (DW No. 1) or 164.6 (DW No. 3)
no skin	0.5	-5.51566	1.9205E-14	-24.15208	133.2	
	1	-5.51566	7.6820E-14	-22.76579	125.6	
	5	-5.51566	1.9205E-12	-19.54691	107.8	
	13.2	-5.51566	1.3385E-11	-17.60535	97.1	Minn-Unkpapa/Sundance Pc=97.1 psi (DW No. 1)
	14.4	-5.51566	1.5929E-11	-17.43133	96.1	Minn-Unkpapa/Sundance Pc=96.1 psi (DW No. 3)
	22.6	-5.51566	3.9236E-11	-16.52989	91.2	
	25	-5.51566	4.8012E-11	-16.32804	90.1	
	35	-5.51566	9.4104E-11	-15.65509	86.3	
	48.5	-5.51566	1.8070E-10	-15.00266	82.7	
	50.5	-5.51566	1.9591E-10	-14.92184	82.3	
	75	-5.51566	4.3211E-10	-14.13081	77.9	

TABLE A-3 Calculated Pressure Rise vs. Distance (Diffusivity Equation) - Minnelusa Formation

100	-5.51566	7.6820E-10	-13.55545	74.8
125	-5.51566	1.2003E-09	-13.10916	72.3
150	-5.51566	1.7284E-09	-12.74452	70.3
172	-5.51566	2.2726E-09	-12.47080	68.8
200	-5.51566	3.0728E-09	-12.16915	67.1
225	-5.51566	3.8890E-09	-11.93359	65.8
250	-5.51566	4.8012E-09	-11.72287	64.7
275	-5.51566	5.8095E-09	-11.53225	63.6
300	-5.51566	6.9138E-09	-11.35822	62.6
325	-5.51566	8.1141E-09	-11.19814	61.8
350	-5.51566	9.4104E-09	-11.04992	60.9
375	-5.51566	1.0803E-08	-10.91194	60.2
400	-5.51566	1.2291E-08	-10.78286	59.5
425	-5.51566	1.3876E-08	-10.66161	58.8
450	-5.51566	1.5556E-08	-10.54729	58.2
500	-5.51566	1.9205E-08	-10.33657	57.0
625	-5.51566	3.0008E-08	-9.89028	54.6
750	-5.51566	4.3211E-08	-9.52564	52.5
1000	-5.51566	7.6820E-08	-8.95028	49.4
1250	-5.51566	1.2003E-07	-8.50399	46.9
1500	-5.51566	1.7284E-07	-8.13935	44.9
1830	-5.51566	2.5726E-07	-7.74165	42.7
2020	-5.51566	3.1345E-07	-7.54408	41.6
2250	-5.51566	3.8890E-07	-7.32842	40.4
2400	-5.51566	4.4248E-07	-7.19934	39.7
3000	-5.51566	6.9138E-07	-6.75305	37.2
3500	-5.51566	9.4104E-07	-6.44475	35.5
4000	-5.51566	1.2291E-06	-6.17769	34.1
4500	-5.51566	1.5556E-06	-5.94212	32.8
5280	-5.51566	2.1416E-06	-5.62243	31.0
6000	-5.51566	2.7655E-06	-5.36676	29.6
6600	-5.51566	3.3463E-06	-5.17614	28.5
6700	-5.51566	3.4484E-06	-5.14606	28.4
6800	-5.51566	3.5521E-06	-5.11643	28.2
6900	-5.51566	3.6574E-06	-5.08723	28.1
7000	-5.51566	3.7642E-06	-5.05846	27.9
7100	-5.51566	3.8725E-06	-5.03009	27.7
7200	-5.51566	3.9823E-06	-5.00212	27.6
7300	-5.51566	4.0937E-06	-4.97453	27.4
7400	-5.51566	4.2066E-06	-4.94732	27.3
7500	-5.51566	4.3211E-06	-4.92047	27.1
7600	-5.51566	4.4371E-06	-4.89398	27.0
7700	-5.51566	4.5546E-06	-4.86784	26.8
7800	-5.51566	4.6737E-06	-4.84203	26.7
7900	-5.51566	4.7943E-06	-4.81655	26.6
8000	-5.51566	4.9164E-06	-4.79139	26.4

TABLE A-3 Calculated Pressure Rise vs. Distance (Diffusivity Equation) - Minnelusa Formation

8100	-5.51566	5.0401E-06	-4.76655	26.3
8200	-5.51566	5.1653E-06	-4.74201	26.2
8300	-5.51566	5.2921E-06	-4.71777	26.0
8400	-5.51566	5.4204E-06	-4.69381	25.9
8500	-5.51566	5.5502E-06	-4.67015	25.8
9000	-5.51566	6.2224E-06	-4.55583	25.1
10000	-5.51566	7.6820E-06	-4.34511	24.0
10560	-5.51566	8.5664E-06	-4.23613	23.4
11000	-5.51566	9.2952E-06	-4.15449	22.9

TABLE A-4 Calculated Pressure Rise vs. Distance (Diffusivity Equation) - Deadwood Formation

Injection Rate (gpm) 75

Based on Equation 1.11 (Lee, 1982; P. 5)

dp = -70.6(qBu/kh)[ln(1,688.388*por*u*ct*rw^2/kt)-2s]

Where

dp =	pressure differential	Solve	psi
q =	flowrate (STB/d)	2,571.43	bbl/d
B =	formation volume factor (RB/STB)	1.01	RB/STB
u =	viscosity (cp)	0.67	cp
k =	permeability (md)	75	md
h =	reservior thickness (feet)	85	feet
por =	formation effective porosity (percent)	0.11	fraction
ct =	total matrix and fluid compressibility (1/psi)	7.00E-06	psi-1
rw =	radius (feet)	Variable	feet
t =	injection time (hours)	87660.0	hours = 10.00 years
s =	skin factor (units)	0.0	

Term 1 -70.6(qBu/kh)

Term 2 (por*u*ct*rw^2/kt)

Injection Rate (gpm) 75

dp = Term 1 * ln(1688.388*Term 2)

	Radius (ft)	Term 1	Term 2	[ln (term 2) - 2s]	dp (psi)
rw	0.26042	-19.27060	5.3217E-15	-25.43545	490.2
no skin	0.5	-19.27060	1.9617E-14	-24.13083	465.0
	1	-19.27060	7.8470E-14	-22.74453	438.3
	5	-19.27060	1.9617E-12	-19.52566	376.3
	10	-19.27060	7.8470E-12	-18.13936	349.6
	15	-19.27060	1.7656E-11	-17.32843	333.9
	22.6	-19.27060	4.0079E-11	-16.50863	318.1
	25	-19.27060	4.9044E-11	-16.30678	314.2
	35	-19.27060	9.6126E-11	-15.63384	301.3

TABLE A-4 Calculated Pressure Rise vs. Distance (Diffusivity Equation) - Deadwood Formation

48.5	-19.27060	1.8458E-10	-14.98140	288.7	
50.5	-19.27060	2.0012E-10	-14.90059	287.1	
75	-19.27060	4.4139E-10	-14.10956	271.9	
100	-19.27060	7.8470E-10	-13.53419	260.8	
125	-19.27060	1.2261E-09	-13.08790	252.2	
150	-19.27060	1.7656E-09	-12.72326	245.2	
172	-19.27060	2.3215E-09	-12.44954	239.9	
200	-19.27060	3.1388E-09	-12.14790	234.1	
225	-19.27060	3.9725E-09	-11.91233	229.6	
250	-19.27060	4.9044E-09	-11.70161	225.5	
275	-19.27060	5.9343E-09	-11.51099	221.8	
300	-19.27060	7.0623E-09	-11.33697	218.5	
325	-19.27060	8.2884E-09	-11.17688	215.4	
350	-19.27060	9.6126E-09	-11.02867	212.5	
375	-19.27060	1.1035E-08	-10.89068	209.9	
400	-19.27060	1.2555E-08	-10.76160	207.4	
425	-19.27060	1.4174E-08	-10.64035	205.0	
450	-19.27060	1.5890E-08	-10.52604	202.8	
500	-19.27060	1.9617E-08	-10.31532	198.8	
625	-19.27060	3.0652E-08	-9.86903	190.2	
715	-19.27060	4.0116E-08	-9.59997	185.0	
1000	-19.27060	7.8470E-08	-8.92902	172.1	
1210	-19.27060	1.1489E-07	-8.54778	164.7	Deadwood-Madison Pc=164.7 psi at DW No. 2
1242	-19.27060	1.2104E-07	-8.49558	163.7	Deadwood-Madison Pc=163.7 psi at DW No. 4
1750	-19.27060	2.4031E-07	-7.80979	150.5	
2000	-19.27060	3.1388E-07	-7.54273	145.4	
2124	-19.27060	3.5401E-07	-7.42242	143.0	
2180	-19.27060	3.7292E-07	-7.37037	142.0	
3000	-19.27060	7.0623E-07	-6.73180	129.7	
3500	-19.27060	9.6126E-07	-6.42350	123.8	
4000	-19.27060	1.2555E-06	-6.15643	118.6	
4500	-19.27060	1.5890E-06	-5.92087	114.1	
5280	-19.27060	2.1876E-06	-5.60117	107.9	
6000	-19.27060	2.8249E-06	-5.34550	103.0	
6600	-19.27060	3.4181E-06	-5.15488	99.3	
6700	-19.27060	3.5225E-06	-5.12481	98.8	
6800	-19.27060	3.6284E-06	-5.09518	98.2	
6900	-19.27060	3.7359E-06	-5.06598	97.6	
7000	-19.27060	3.8450E-06	-5.03720	97.1	
7100	-19.27060	3.9557E-06	-5.00883	96.5	
7200	-19.27060	4.0679E-06	-4.98086	96.0	
7300	-19.27060	4.1817E-06	-4.95327	95.5	
7400	-19.27060	4.2970E-06	-4.92606	94.9	

TABLE A-4 Calculated Pressure Rise vs. Distance (Diffusivity Equation) - Deadwood Formation

7500	-19.27060	4.4139E-06	-4.89922	94.4
7600	-19.27060	4.5324E-06	-4.87273	93.9
7700	-19.27060	4.6525E-06	-4.84658	93.4
7800	-19.27060	4.7741E-06	-4.82077	92.9
7900	-19.27060	4.8973E-06	-4.79530	92.4
8000	-19.27060	5.0221E-06	-4.77014	91.9
8100	-19.27060	5.1484E-06	-4.74529	91.4
8200	-19.27060	5.2763E-06	-4.72075	91.0
8300	-19.27060	5.4058E-06	-4.69651	90.5
8400	-19.27060	5.5368E-06	-4.67256	90.0
8500	-19.27060	5.6694E-06	-4.64889	89.6
9000	-19.27060	6.3561E-06	-4.53457	87.4
10000	-19.27060	7.8470E-06	-4.32385	83.3
10560	-19.27060	8.7505E-06	-4.21488	81.2
11000	-19.27060	9.4949E-06	-4.13323	79.6

Table A-5 Radius of Fluid Displacement Calculation - Minnelusa Formation

Porosity = 0.21
Formation Thickness = 164 ft
Injection Rate = 75 gpm

r = radius of fluid displacement   Q = injection volume (ft^3)

r = (Q/((pi)*h*porosity))^0.5

Elapsed Time (yrs)	Qt (ft3)	r (ft)	r (miles)
1	5,270,055	221	0.04
5	26,350,275	493	0.09
10	52,700,550	698	0.13

EFFECT OF REGIONAL HYDRAULIC GRADIENT

ASSUME: Regional gradient = 0.0001 ft/ft (10 ft/mile)

Linear velocity (vl):
vl = (KI)/porosity where I = hydraulic gradient
K = 4.670 ft/d

Hyd. Gradient Displacement = (vl)*(time)

Elapsed Time (yrs)	Injection Displacement Ri (ft)	Hyd. Grad. Displ. Rg (ft)	Total Fluid Displacment Rt (ft)
1	221	0.81	221.51
5	493	4.06	497.56
10	698	8.12	706.03

NOTE: The additional displacement due to the regional hydraulic gradient is independent of injection rate.

Table A-6 Radius of Fluid Displacement Calculation - Deadwood Formation

Porosity = 0.11
Formation Thickness = 85 ft
Injection Rate = 75 gpm

r = radius of fluid displacement   Q = injection volume (ft^3)

r = (Q/((pi)*h*porosity))^0.5

Elapsed Time (yrs)	Qt (ft3)	r (ft)	r (miles)
1	5,270,055	424	0.08
5	26,350,275	947	0.18
10	52,700,550	1339	0.25

EFFECT OF REGIONAL HYDRAULIC GRADIENT

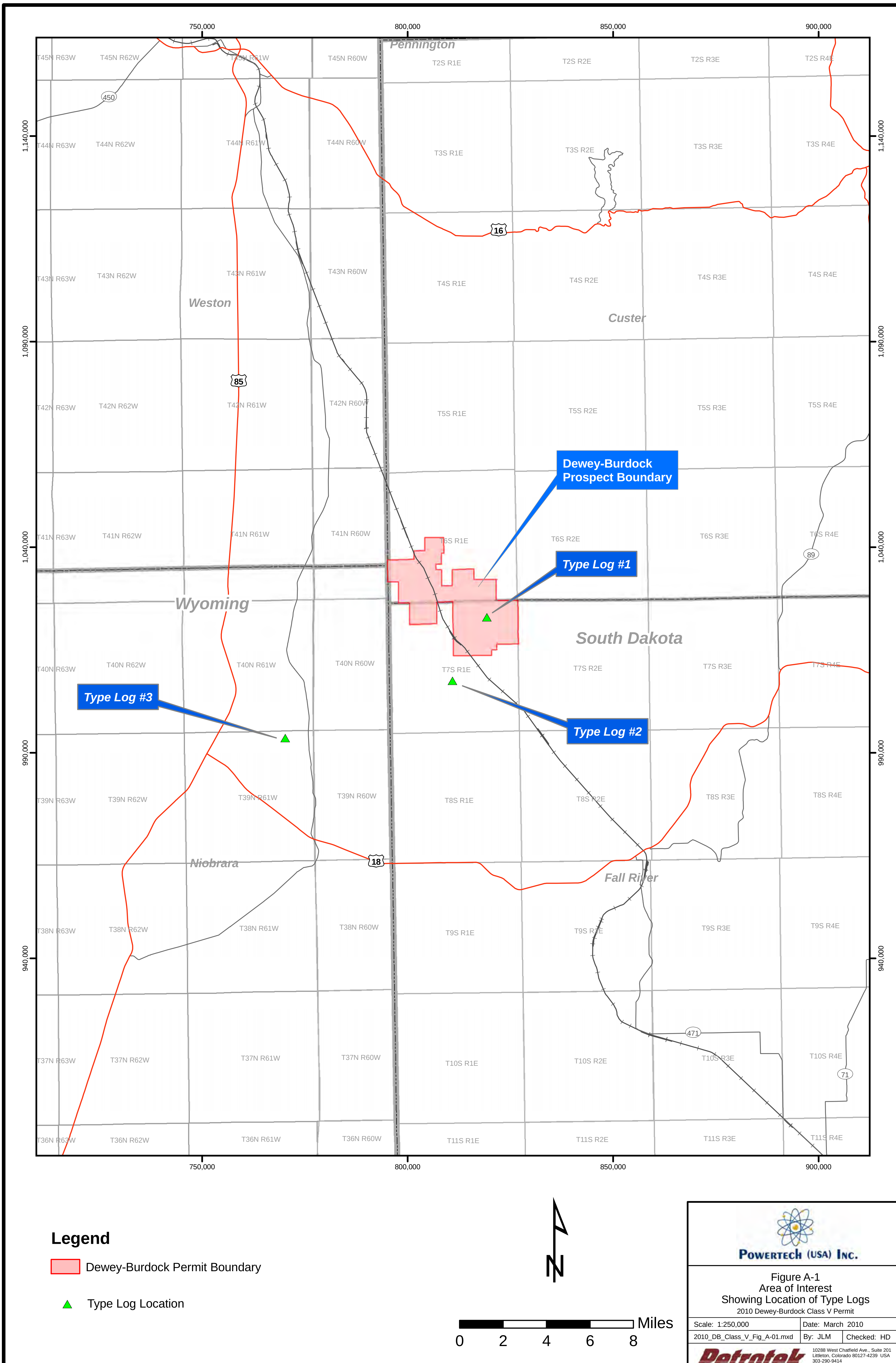
ASSUME: Regional gradient = 0.0001 ft/ft (10 ft/mile)

Linear velocity (vl):
vl = (KI)/porosity where I = hydraulic gradient
K = 4.670 ft/d

Hyd. Gradient Displacement = (vl)*(time)

Elapsed Time (yrs)	Injection Displacement Ri (ft)	Hyd. Grad. Displ. Rg (ft)	Total Fluid Displacment Rt (ft)
1	424	1.55	425.12
5	947	7.75	954.88
10	1339	15.50	1354.95

NOTE: The additional displacement due to the regional hydraulic gradient is independent of injection rate.


Pennington
Weston
Custer
Wyoming
South Dakota
Niobrara
Fall River
Dewey-Burdock Prospect Boundary
Type Log #1
Type Log #2
Type Log #3
750,000
800,000
850,000
900,000
1,140,000
1,090,000
1,040,000
990,000
940,000
Legend
Dewey-Burdock Permit Boundary
Type Log Location
N
Miles
0
2
4
6
8
POWERTECH (USA) INC.
Figure A-1
Area of Interest
Showing Location of Type Logs
2010 Dewey-Burdock Class V Permit
Scale: 1:250,000
Date: March 2010
2010_DB_Class_V_Fig_A-01.mxd
By: JLM
Checked: HD
Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com

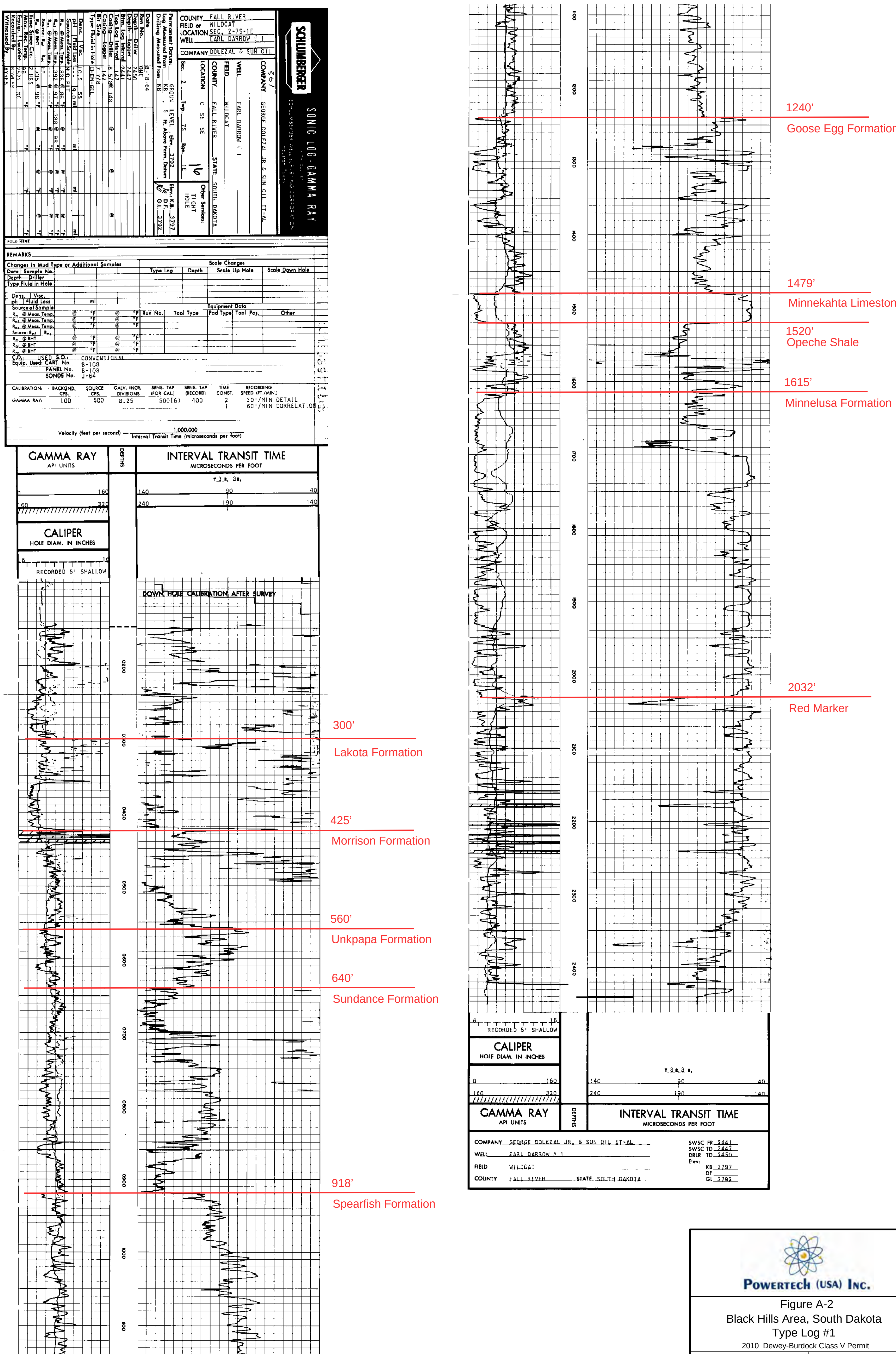


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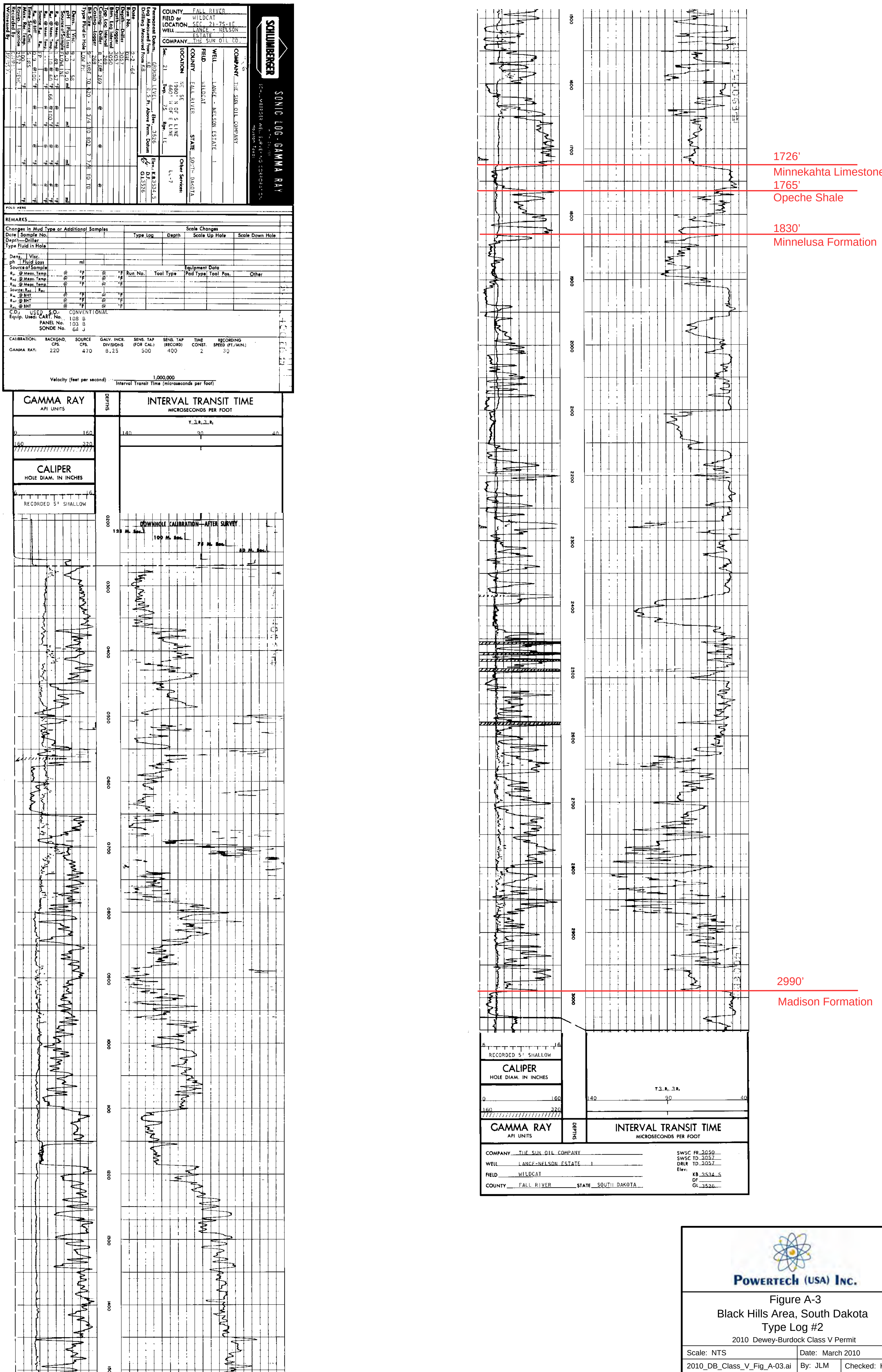
Figure A-2
Black Hills Area, South Dakota
Type Log #1
2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010
2010_DB_Class_V_Fig_A-02.ai	By: JLM / Checked: HD

Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com



POWERTECH (USA) INC.

Figure A-3
Black Hills Area, South Dakota
Type Log #2
2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010
2010_DB_Class_V_Fig_A-03.ai	By: JLM / Checked: HD

Petrotek
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Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com

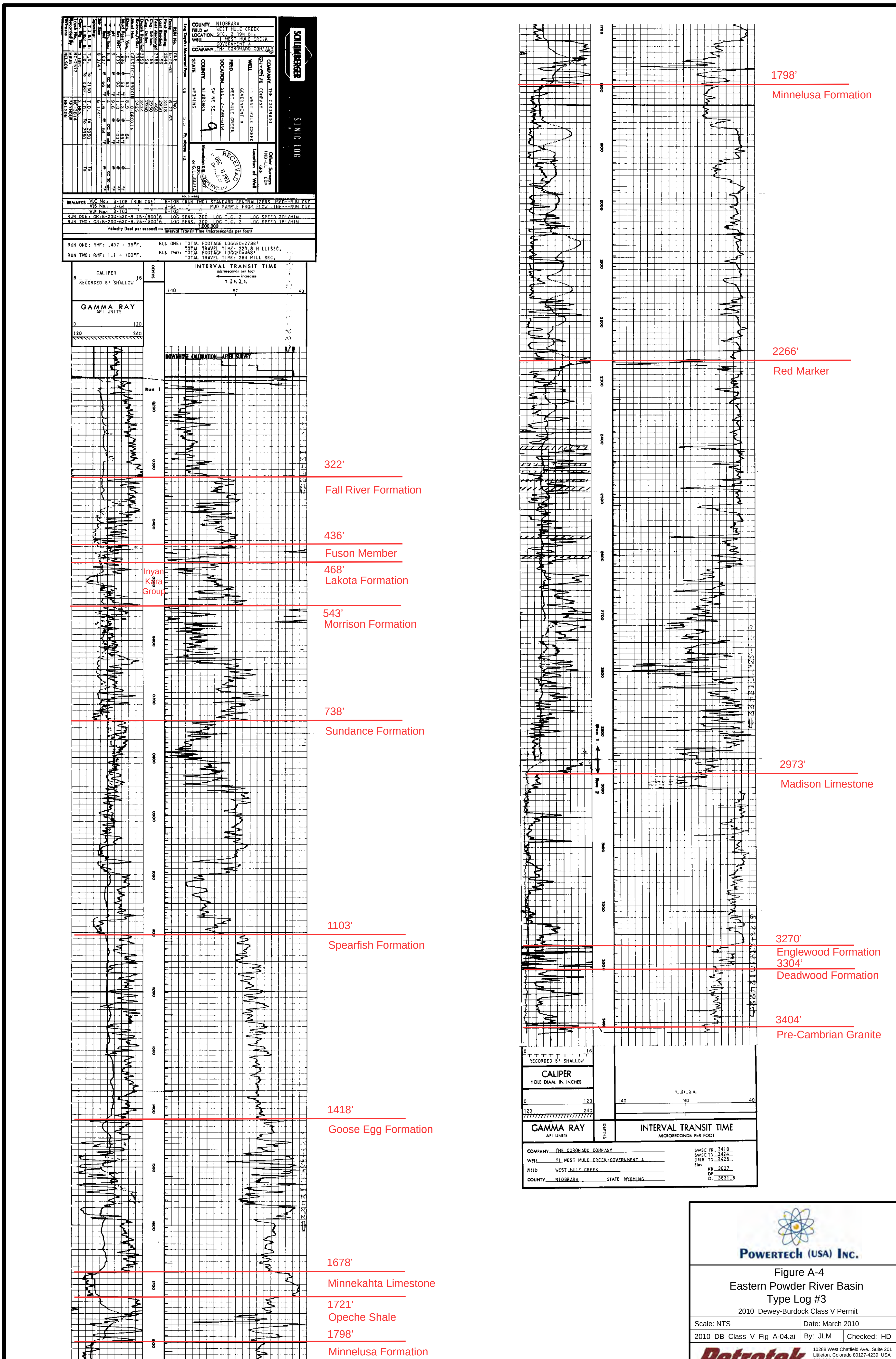

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Figure A-4
Eastern Powder River Basin
Type Log #3
2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010	
2010_DB_Class_V_Fig_A-04.ai	By: JLM	Checked: HD

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Littleton, Colorado 80127-4239 USA
303-290-9414
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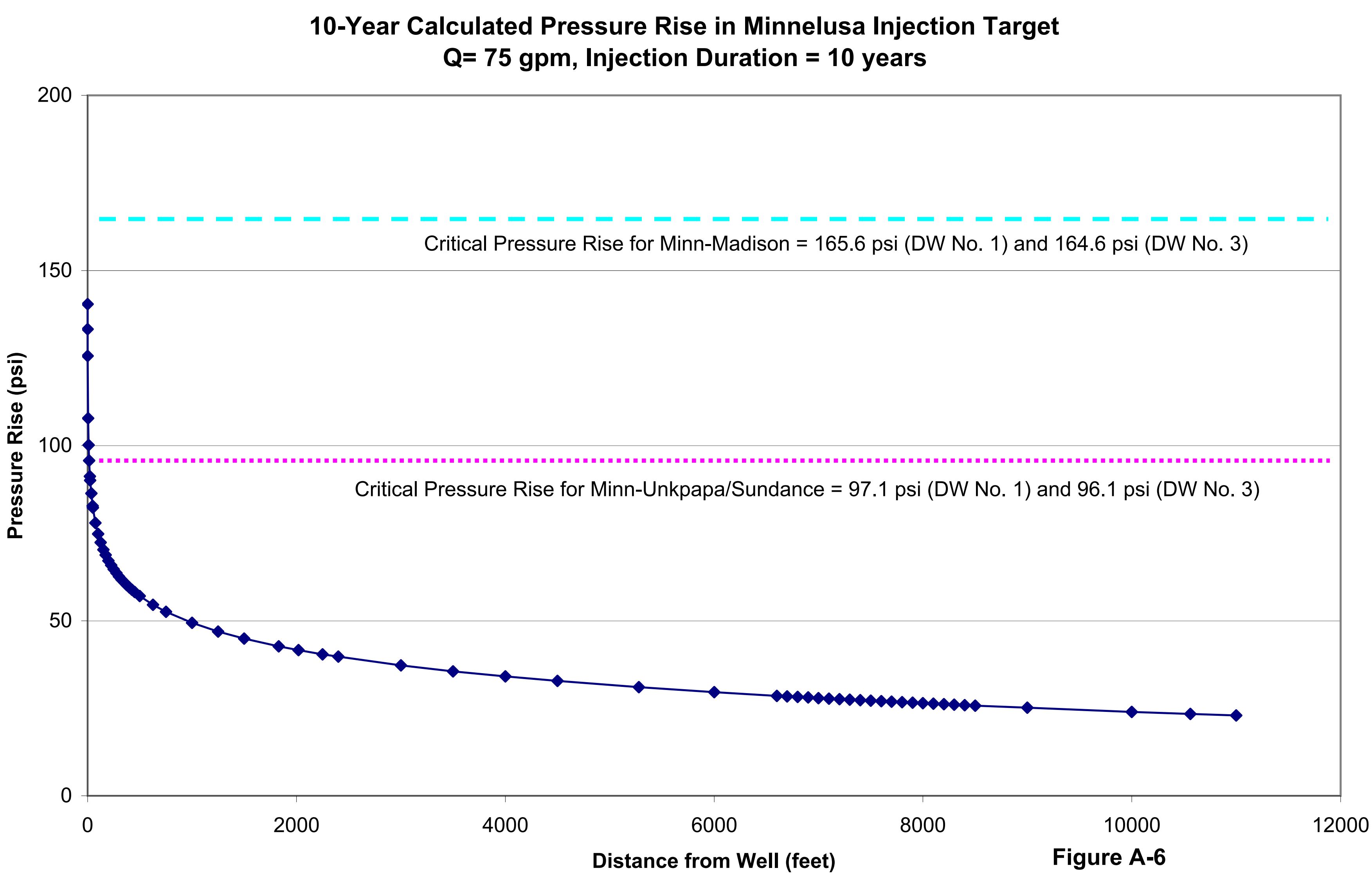

10-Year Calculated Pressure Rise in Minnelusa Injection Target
Q= 75 gpm, Injection Duration = 10 years
Critical Pressure Rise for Minn-Madison = 165.6 psi (DW No. 1) and 164.6 psi (DW No. 3)
Critical Pressure Rise for Minn-Unkpapa/Sundance = 97.1 psi (DW No. 1) and 96.1 psi (DW No. 3)
Pressure Rise (psi)
200
150
100
50
0
0
2000
4000
6000
8000
10000
12000
Distance from Well (feet)

Figure A-6

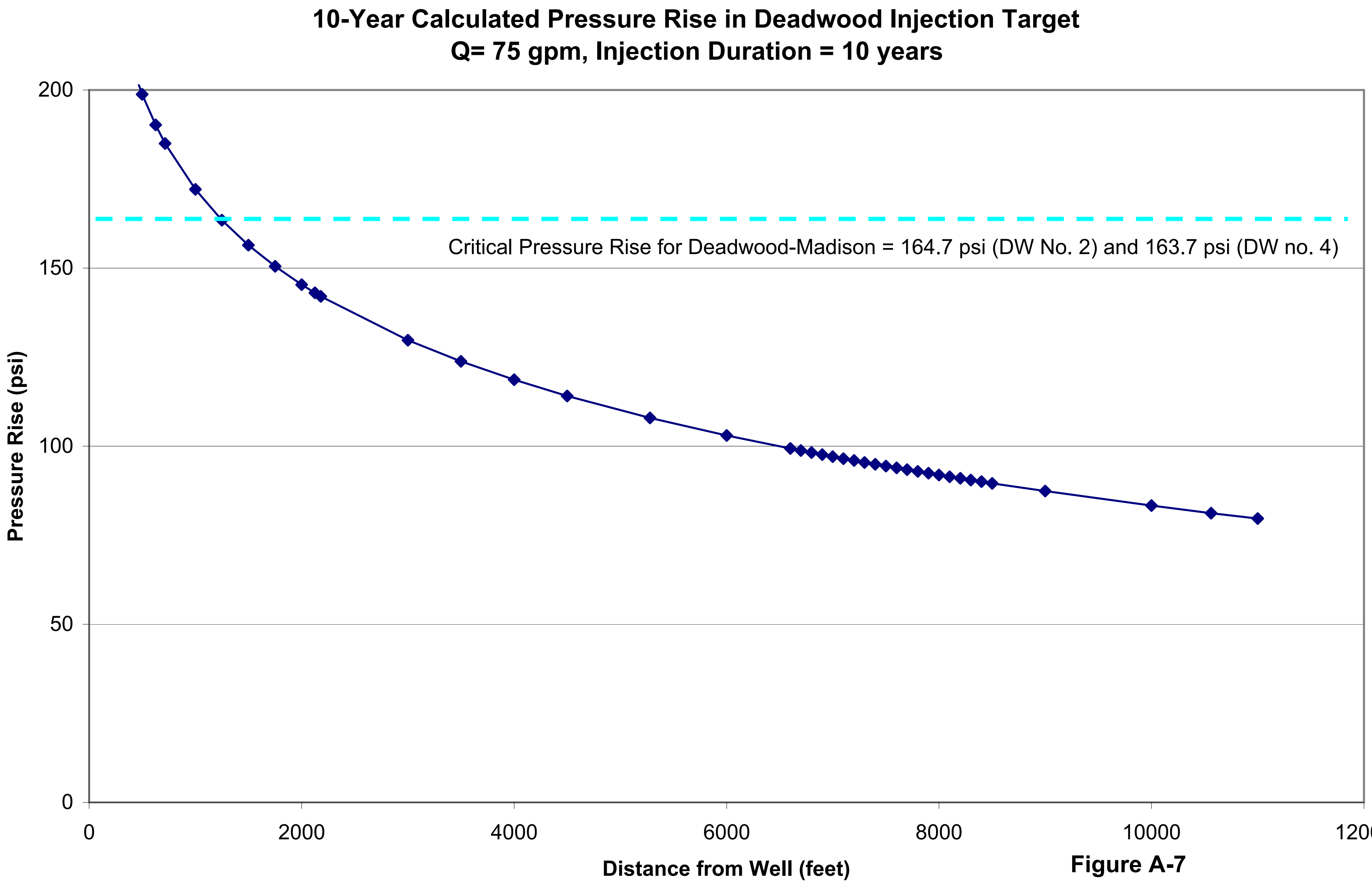

10-Year Calculated Pressure Rise in Deadwood Injection Target
Q= 75 gpm, Injection Duration = 10 years
Critical Pressure Rise for Deadwood-Madison = 164.7 psi (DW No. 2) and 163.7 psi (DW no. 4)
Pressure Rise (psi)
200
150
100
50
0
0
2000
4000
6000
8000
10000
12000
Distance from Well (feet)

Figure A-7

2.B MAPS OF WELLS IN AREA AND AREA OF REVIEW

Submit a topographic map, extending one mile beyond the property boundaries, showing the injection well(s) or project area for which a permit is sought and the applicable area of review. The map must show all intake and discharge structures and all hazardous waste, treatment, storage, or disposal facilities. If the application is for an area permit, the map should show the distribution manifold (if applicable) applying injection fluid to all wells in the area, including all system monitoring points. Within the area of review, the map must show the following:

The number, or name, and location of all producing well, injection well, abandoned well, dry holes, surface bodies of water, springs, mines (surface and subsurface), quarries, and other pertinent surface features, including residences and roads, and faults, if known or suspected. In addition, the map must identify those well, springs, other surface water bodies, and drinking water wells located within one-quarter mile of the facility property boundary. Only information of public record is required to be included on this map.

RESPONSE

Maps based on available public records have been prepared and submitted in this Response as summaries of the required data.

Topographic Map

A copy of the USGS Topographic map available with the outline of the Dewey-Burdock Project boundary superimposed on the map is included as Figure B-1. In addition, the map shows the location of all known surface bodies of water, springs, mines, quarries, residencies and roads.

Artificial Penetrations

There are two artificial penetrations identified in the areas of review surrounding Site 1 and one in the areas of review surrounding Site 2. Figures B-2 and B-2a show the artificial penetrations within the AORs for DW Nos. 1 through 4 for the Minnelusa and the Deadwood, respectively.

Figure B-2b, a map generated using regional data provided by the state of South Dakota, shows the Proposed Class V permit area, the location of the required AORs for four of the proposed Dewey-Burdock Disposal Wells, and the locations of surrounding oil and gas wells. Figure B-2c presents the location of all known water wells within the proposed Class V permit area.

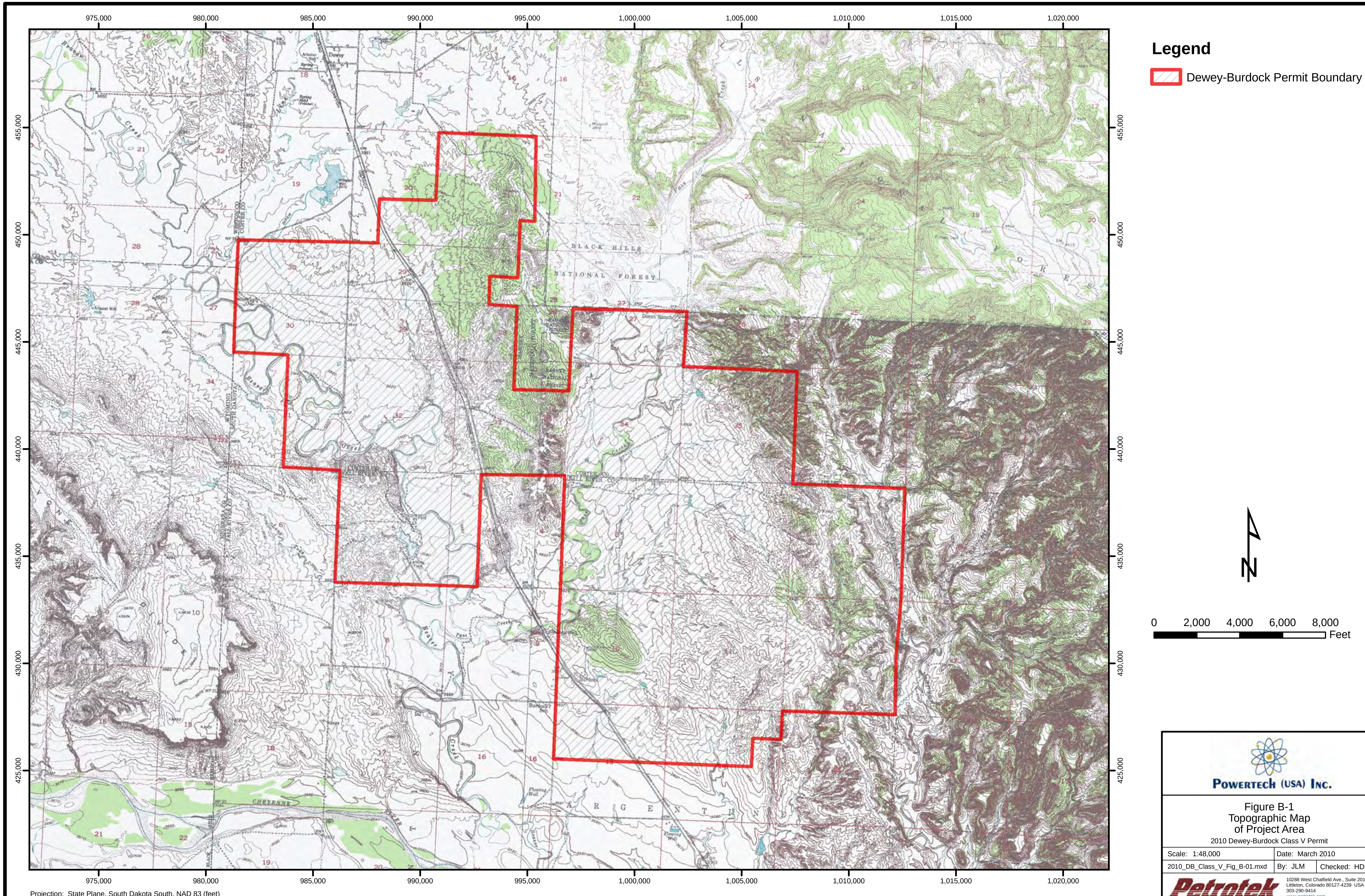
Table C-1 is a tabulation of the known water wells located within the Class V permit area. The deepest formation penetrated by any of these wells is the Unkpapa/Sundance. Due to the absence of wells within the Class V permit area that penetrate the injection zones, there is little potential for causing any endangerment to a USDW.

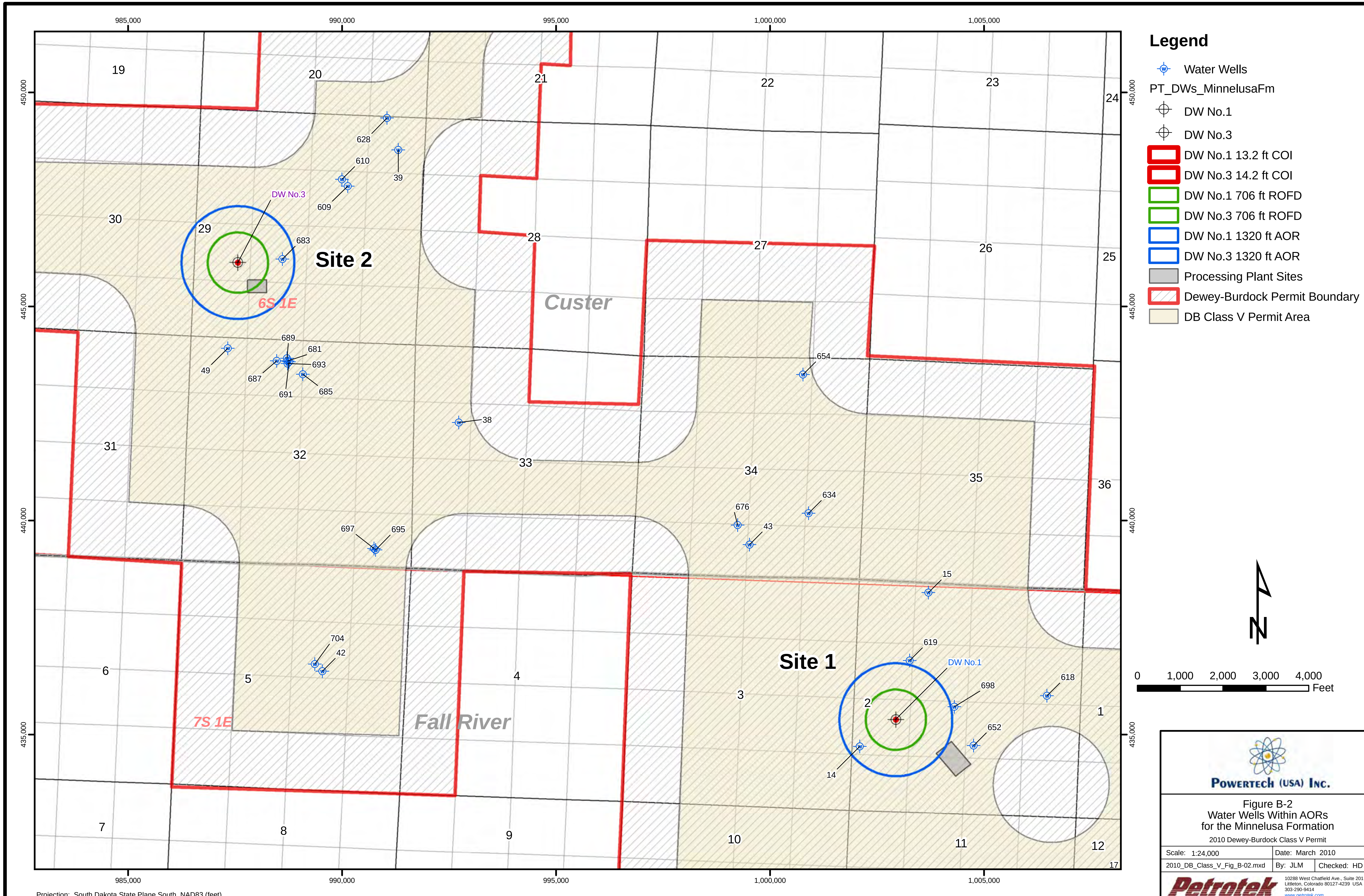
Table C-2 is a tabulation of the three oil and gas wells permitted within the Dewey-Burdock Project area. The plugging records for these well are included as Appendix B. According to the records obtained from DENR, each of the wells is plugged to a sufficient depth so as not to allow transmission of fluids from the targeted injection zones to overlying USDWs. Note that none of these wells are located within the proposed Class V permit area. As such, they will not be encompassed in any prospective AORs of proposed Dewey-Burdock Disposal Wells.

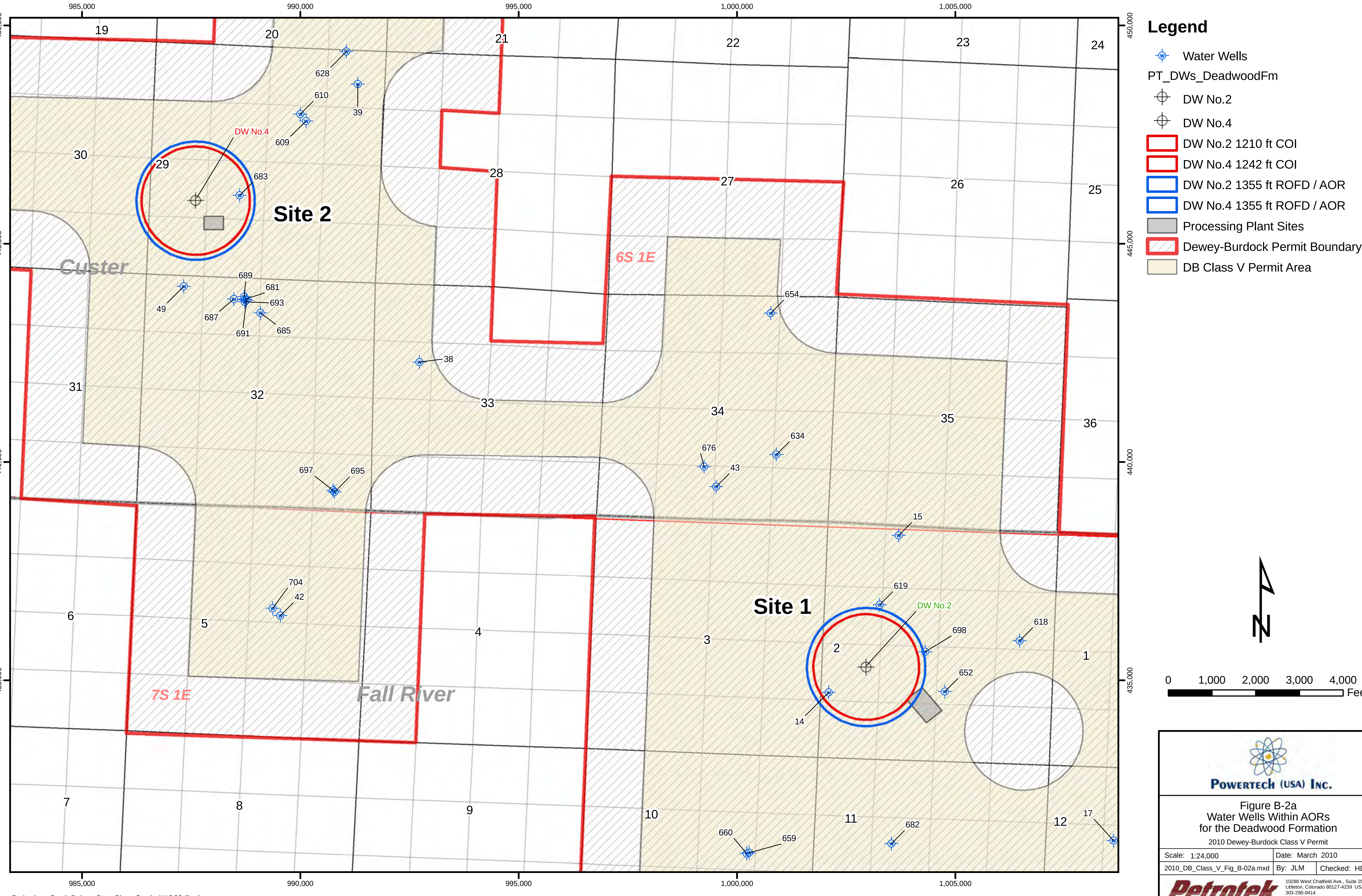
Property Ownership and Public Notice

Figure B-3 shows the surface property owners in the Dewey-Burdock Project area and Figure B-4 shows the mineral ownership within the Dewey-Burdock Project boundary.

For the purpose of public notice, newspaper service is available from several publishers in the area including the closest paper to the proposed facility, the Edgemont Herald Tribune.


Legend
Dewey-Burdock Permit Boundary
0 2,000 4,000 6,000 8,000
Feet
N
BLACK HILLS
NATIONAL FOREST
Projection: State Plane, South Dakota South, NAD 83 (feet)
POWERTECH (USA) INC.
Figure B-1
Topographic Map
of Project Area
2010 Dewey-Burdock Class V Permit
Scale: 1:48,000
Date: March 2010
2010_DB_Class_V_Fig_B-01.mxd
By: JLM
Checked: HD
Petrotek


Legend
Water Wells
PT_DWs_MinnelusaFm
DW No.1
DW No.3
DW No.1 13.2 ft COI
DW No.3 14.2 ft COI
DW No.1 706 ft ROFD
DW No.3 706 ft ROFD
DW No.1 1320 ft AOR
DW No.3 1320 ft AOR
Processing Plant Sites
Dewey-Burdock Permit Boundary
DB Class V Permit Area
Site 2
Site 1
Custer
Fall River
6S 1E
7S 1E
DW No.3
DW No.1
985,000
990,000
995,000
1,000,000
1,005,000
450,000
445,000
440,000
435,000
0 1,000 2,000 3,000 4,000
Feet
N
POWERTECH (USA) INC.
Figure B-2
Water Wells Within AORs
for the Minnelusa Formation
2010 Dewey-Burdock Class V Permit
Scale: 1:24,000
Date: March 2010
2010_DB_Class_V_Fig_B-02.mxd
By: JLM
Checked: HD
Petrotek
Projection: South Dakota State Plane South, NAD83 (feet)

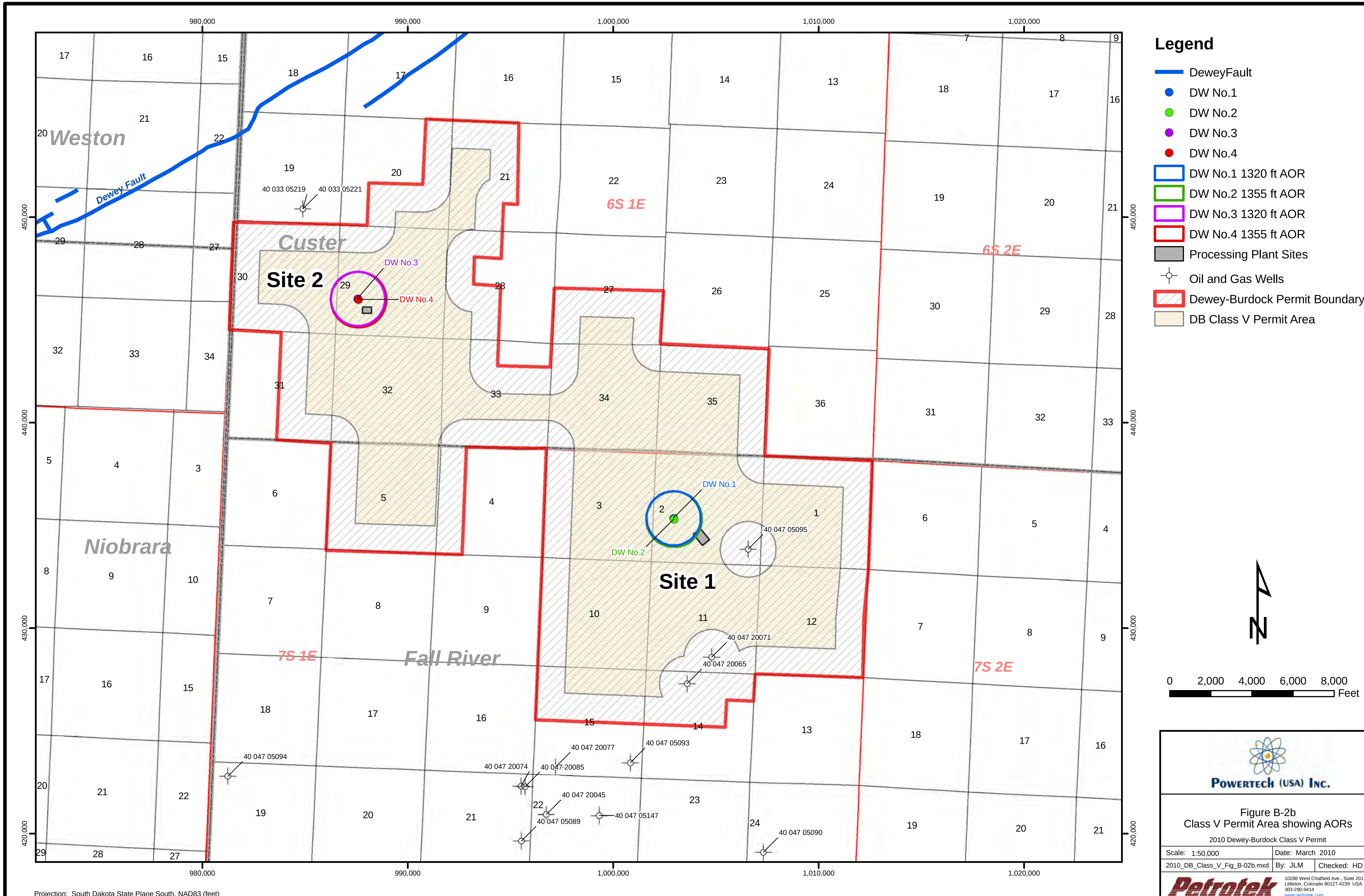


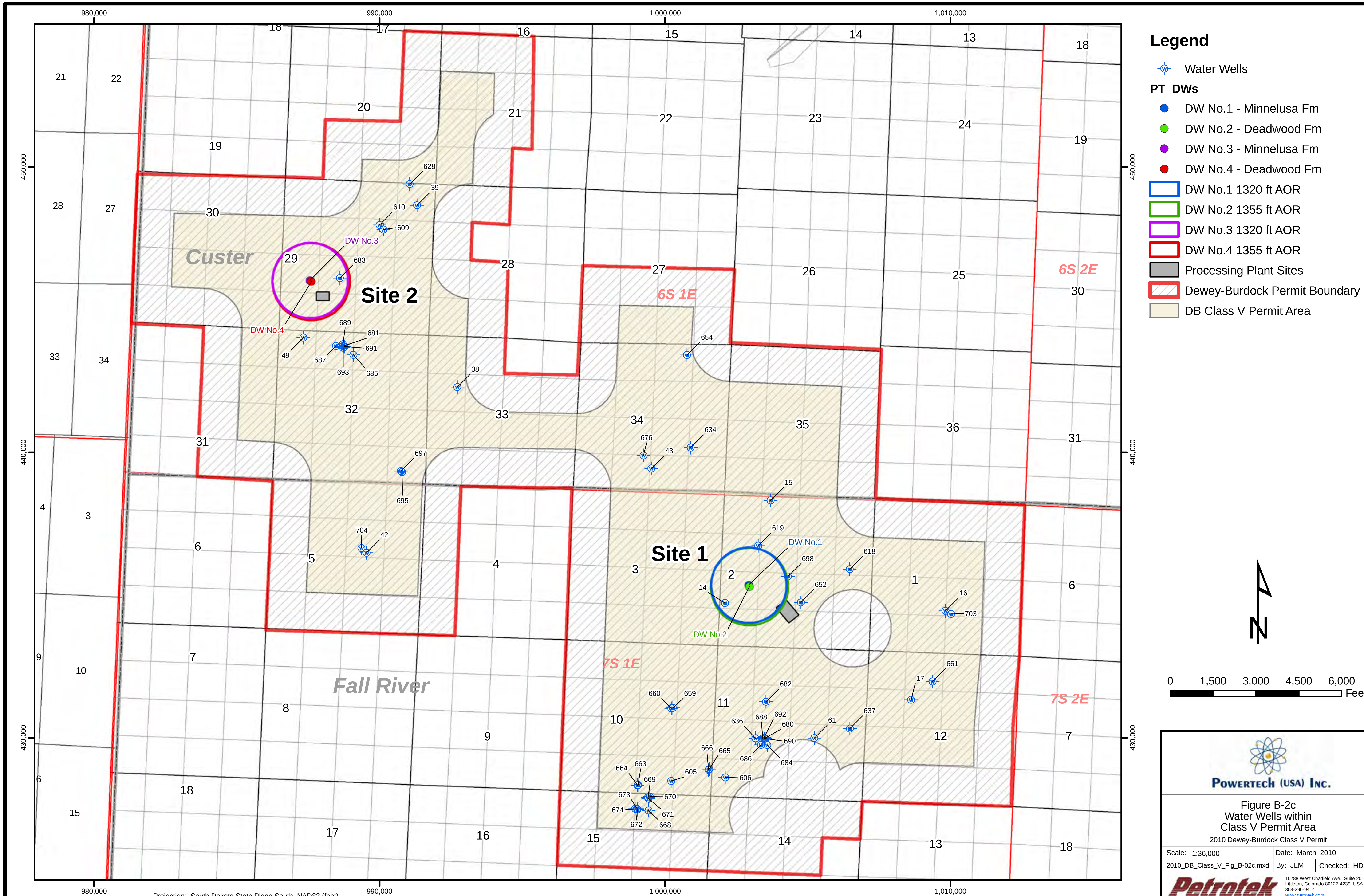
POWERTECH (USA) INC.

Figure B-2a
Water Wells Within AORs
for the Deadwood Formation
2010 Dewey-Burdock Class V Permit

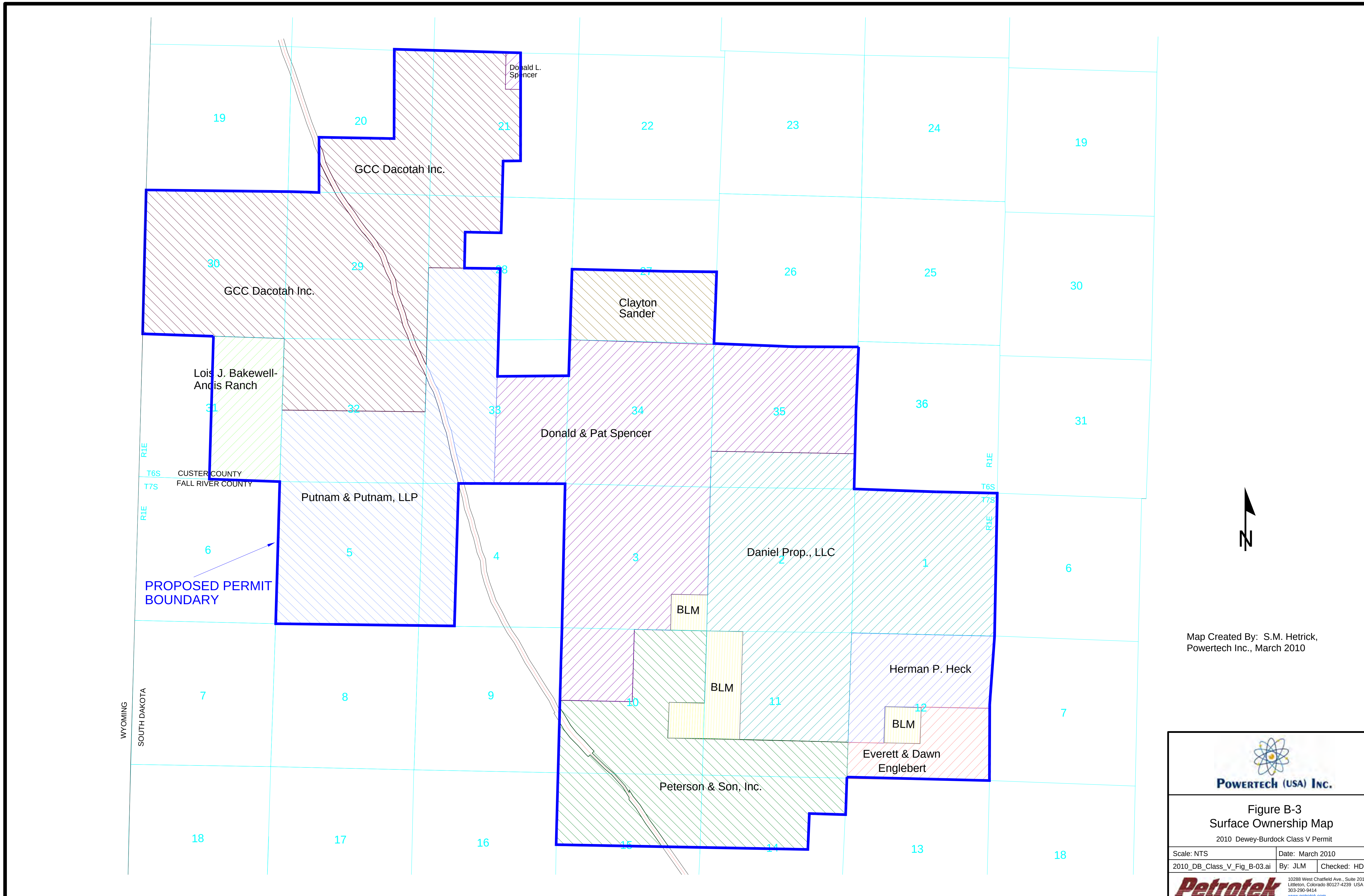
Scale: 1:24,000	Date: March 2010	
2010_DB_Class_V_Fig_B-02a.mxd	By: JLM	Checked: HD

Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com

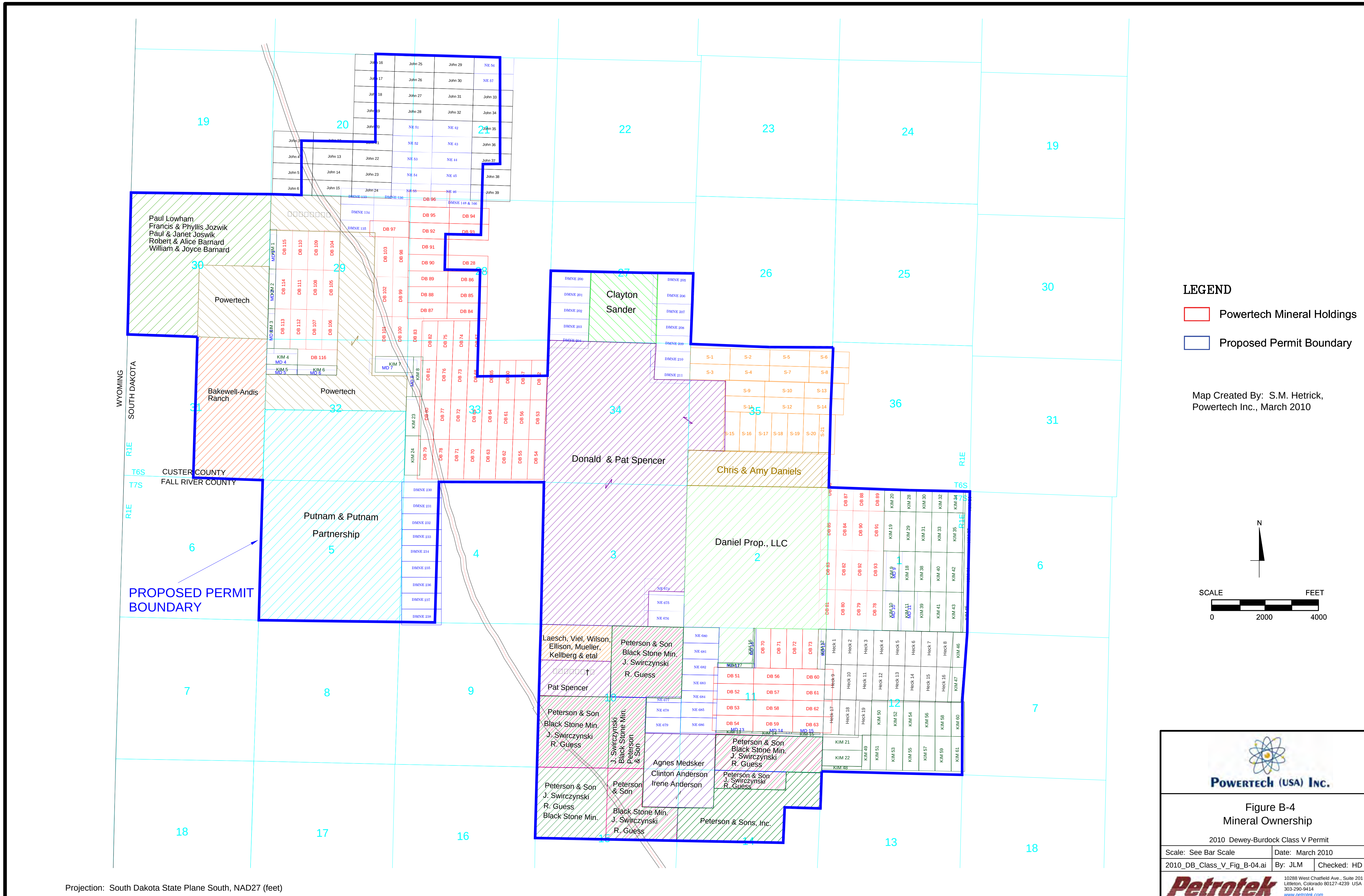

Legend
DeweyFault
DW No.1
DW No.2
DW No.3
DW No.4
DW No.1 1320 ft AOR
DW No.2 1355 ft AOR
DW No.3 1320 ft AOR
DW No.4 1355 ft AOR
Processing Plant Sites
Oil and Gas Wells
Dewey-Burdock Permit Boundary
DB Class V Permit Area
Weston
Custer
Niobrara
Fall River
Dewey Fault
Site 1
Site 2
6S 1E
6S 2E
7S 1E
7S 2E
DW No.1
DW No.2
DW No.3
DW No.4
40 033 05219
40 033 05221
40 047 05095
40 047 20071
40 047 20065
40 047 05094
40 047 20077
40 047 05093
40 047 20074
40 047-20085
40 047 20045
40 047 05089
40 047 05147
40 047 05090
980,000
990,000
1,000,000
1,010,000
1,020,000
450,000
440,000
430,000
420,000
N
0 2,000 4,000 6,000 8,000
Feet
Projection: South Dakota State Plane South, NAD83 (feet)
POWERTECH (USA) INC.
Figure B-2b
Class V Permit Area showing AORs
2010 Dewey-Burdock Class V Permit
Scale: 1:50,000
Date: March 2010
2010_DB_Class_V_Fig_B-02b.mxd
By: JLM
Checked: HD
Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com



Legend
Water Wells
PT_DWs
DW No.1 - Minnelusa Fm
DW No.2 - Deadwood Fm
DW No.3 - Minnelusa Fm
DW No.4 - Deadwood Fm
DW No.1 1320 ft AOR
DW No.2 1355 ft AOR
DW No.3 1320 ft AOR
DW No.4 1355 ft AOR
Processing Plant Sites
Dewey-Burdock Permit Boundary
DB Class V Permit Area
Site 1
Site 2
Custer
Fall River
6S 1E
6S 2E
7S 1E
7S 2E
0 1,500 3,000 4,500 6,000 Feet
Projection: South Dakota State Plane South, NAD83 (feet)
POWERTECH (USA) INC.
Figure B-2c
Water Wells within
Class V Permit Area
2010 Dewey-Burdock Class V Permit
Scale: 1:36,000
Date: March 2010
2010_DB_Class_V_Fig_B-02c.mxd
By: JLM
Checked: HD
Petrotek



GCC Dacotah Inc.
GCC Dacotah Inc.
Donald L. Spencer
Clayton Sander
Lois J. Bakewell-Andis Ranch
Donald & Pat Spencer
Putnam & Putnam, LLP
Daniel Prop., LLC
BLM
BLM
BLM
Herman P. Heck
Everett & Dawn Englebert
Peterson & Son, Inc.
PROPOSED PERMIT BOUNDARY
CUSTER COUNTY
FALL RIVER COUNTY
WYOMING
SOUTH DAKOTA
T6S
T7S
R1E
19
20
21
22
23
24
19
30
29
28
27
26
25
30
31
32
33
34
35
36
31
6
5
4
3
2
1
6
7
8
9
10
11
12
7
18
17
16
15
14
13
18
N
Map Created By: S.M. Hetrick, Powertech Inc., March 2010
Powertech (USA) Inc.
Figure B-3
Surface Ownership Map
2010 Dewey-Burdock Class V Permit
Scale: NTS
Date: March 2010
2010_DB_Class_V_Fig_B-03.ai
By: JLM
Checked: HD
Petrotek


LEGEND
Powertech Mineral Holdings
Proposed Permit Boundary
Map Created By: S.M. Hetrick, Powertech Inc., March 2010
PROPOSED PERMIT BOUNDARY
WYOMING
SOUTH DAKOTA
CUSTER COUNTY
FALL RIVER COUNTY
T6S
T7S
R1E
Paul Lowham
Francis & Phyllis Jozwik
Paul & Janet Joswik
Robert & Alice Barnard
William & Joyce Barnard
Powertech
Bakewell-Andis Ranch
Putnam & Putnam Partnership
Clayton Sander
Donald & Pat Spencer
Chris & Amy Daniels
Daniel Prop., LLC
Laesch, Viel, Wilson, Ellison, Mueller, Kellberg & etal
Pat Spencer
Peterson & Son
Black Stone Min.
J. Swirczynski
R. Guess
Agnes Medsker
Clinton Anderson
Irene Anderson
Peterson & Sons, Inc.
SCALE
FEET
0
2000
4000
N
Projection: South Dakota State Plane South, NAD27 (feet)
POWERTECH (USA) INC.
Figure B-4
Mineral Ownership
2010 Dewey-Burdock Class V Permit
Scale: See Bar Scale
Date: March 2010
2010_DB_Class_V_Fig_B-04.ai
By: JLM
Checked: HD
Petrotek
10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
www.petrotek.com

2.C CORRECTIVE ACTION PLAN AND WELL DATA

Submit a tabulation of data reasonably available from public records or otherwise known to the applicant on all wells within the area of review, including those on the map required in Attachment B, which penetrate the proposed injection zone. Such data shall include the following:

A description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Director may require. In the case of a new injection well, include the corrective action proposed to be taken by the applicant under 40 CFR 144.55.

RESPONSE

Corrective Action

A corrective action plan is not required for any of the artificial penetrations within the AORs of the proposed Dewey-Burdock wells or the Class V permit area because there are no artificial penetrations to the injection zone within the Class V permit area. If a corrective action plan for any neighboring well becomes necessary in the future, it will be developed according to appropriate regulatory standards and guidelines.

The corrective action plan which would be proposed by Powertech should the potential for fluid migration to occur through the confining layer develop via any future well likely would include the following:

1. The impacted Dewey-Burdock Project Disposal Well will be shut-in.
2. The USEPA, Region 8 UIC Section and the SD DENR will be notified.
3. Following well shut-in, liquid 11e2 waste will be shipped to alternative permitted facilities for off-site treatment and/or disposal as necessary.
4. A contingency plan will be prepared as follows:
    a. Locate well and identify present operator or owner, if any.
    b. Identify mode of failure.
    c. Prepare remedial plan outlining course of action.
    d. The remedial plan will be submitted to the USEPA, Region 8 and SD DENR for approval.
    e. Upon authorization, the remedial plan will be implemented.

Water Wells within AORs

Table C-1 is a tabulation of the known artificial penetrations (water wells) located within the Class V permit area. The deepest formation penetrated by any of these wells is the Unkpapa/Sundance. Due to the absence of wells within the Class V permit area that penetrate either of the targeted injection zones, there is no potential from artificial penetrations for causing any endangerment to a USDW.

Area of Review Oil and Gas Well Data

Table C-2 is a tabulation of the three oil and gas wells permitted within the Dewey-Burdock Project area that are outside the assigned AORs. The plugging records for these wells are included as Appendix B. Plugging records obtained from DENR indicate that each of the wells is plugged to a sufficient depth so as not to allow transmission of fluids from the targeted injection zones to overlying USDWs. Note that none of these wells are located within the proposed Class V permit area. As such, they will not be encompassed in any prospective future AORs of proposed additional Dewey-Burdock Disposal Wells.

TABLE C-1 Known Water Wells Within Class V Permit Area

Well ID	Well Depth (ft)	Formation	Abandoned	Depth to Water (ft)
605	Unknown	Inyan Kara	no	Unknown
606	Unknown	Lakota	yes	0
42	600	Lakota	no	-10
61	525	Lakota	unknown	Unknown
16	330	Lakota	no	158
618	Unknown	Unknown	no	Unknown
15	495	Lakota	yes	0
634	Unknown	Unknown	yes	Unknown
43	350	Lakota	yes	Unknown
14	470	Lakota	unknown	-1
636	Unknown	Unknown	yes	Unknown
637	Unknown	Unknown	no	Unknown
17	156	Fall River	no	Unknown
39	Unknown	Unknown	unknown	Unknown
652	280	Inyan Kara	yes	Unknown
654	Unknown	Inyan Kara	yes	Unknown
659	Unknown	Fall River	yes	Unknown
660	Unknown	Lakota	yes	Unknown
661	Unknown	Lakota	unknown	Unknown
663	550	Lakota	unknown	Unknown
664	360	Fall River	unknown	Unknown
665	252	Fall River	unknown	Unknown
666	441	Lakota	unknown	Unknown
669	550	Lakota	unknown	Unknown
670	395	Fuson	unknown	Unknown
671	350	Fall River	unknown	Unknown
672	376	Fall River	unknown	Unknown
673	440	Fuson	unknown	Unknown
674	570	Lakota	unknown	Unknown
676	23	Alluvial	no	Unknown
683	650	Fall River	no	5
687	608	Fall River	no	Unknown
685	595	Fall River	no	Unknown
682	460	Lakota	no	Unknown
686	428	Lakota	no	Unknown
684	423	Lakota	no	Unknown
690	623	Unkpapa/Sundance	no	-29
692	327	Lakota	no	Unknown
38	494	Lakota	no	-14
609	1000	Lakota	no	7
610	Unknown	Fall River	no	Unknown
619	280	Lakota	no	19
628	Unknown	Inyan Kara	no	Unknown
668	574	Inyan Kara	no	Unknown
698	205	Fall River	no	Unknown
704	955	Unkpapa/Sundance	no	Unknown
703	525	Unkpapa/Sundance	no	Unknown
695	508	Fall River	no	Unknown

TABLE C-1 Known Water Wells Within Class V Permit Area

Well ID	Well Depth (ft)	Formation	Abandoned	Depth to Water (ft)
697	682	Lakota	no	Unknown
691	505	Fall River	no	Unknown
693	910	Unkpapa/Sundance	no	-138
689	730	Lakota	no	-59
681	600	Fall River	no	-13
49	600	Fall River	no	Unknown
688	255	Fall River	no	37
680	436	Lakota	no	39

Source: 2009 Powertech Dewey-Burdock NRC Application

TABLE C-2 Oil and Gas Wells Within Project Area

Well API	Name	Well Depth (ft)	Formation	Well Status
40-047-05095	Earl Darrow #1	2,450	Minnelusa	Plugged and Abandonded
40-047-20071	#34-11 Peterson	2,250	Minnelusa	Plugged and Abandonded
40-047-20065	Lenore Peterson #21-14	2,266	Minnelusa	Plugged back to 850'

2.D MAPS AND CROSS SECTIONS OF USDWs

Submit maps and cross sections indicating the vertical limits of all underground sources of drinking water within the area of review (both vertical and lateral limits for Class I), their position relative to the injection formation and the direction of water movement, where known, in every underground source of drinking water which may be affected by the proposed injection activities.

RESPONSE

The major bedrock aquifers in the Black Hills area include the Deadwood, Madison, Minnelusa, Minnekahta, and Inyan Kara (Carter et al, 2003). These aquifers are regionally extensive in areas surrounding the Black Hills as shown on Figure D-1 (Driscoll et al., 2002). A regional east-west geologic cross section across the Black Hills Uplift is shown on Figure D-2. The location of the cross section A-A' is indicated on Figure D-1. Ground-water flow in the regional aquifer system in the Paleozoic aquifer units (i.e., Deadwood, Madison, Minnelusa, and Minnekahta Formations) is generally interpreted to be radially outward from the outcrops surrounding the Black Hills (Figure D-3). Groundwater recharge from the Black Hills area comingles with groundwater in the Powder River Basin to the west and then migrates northeastward into the Williston Basin where it eventually discharges at lower elevations to the land surface in eastern North Dakota and along the outcrop of the Canadian Shield in Canada.

Only two of these major aquifers, the Madison and Inyan Kara, are considered to be USDWs within the AORs of the Dewey-Burdock Disposal Wells. As discussed below, the Deadwood, Minnelusa, and Minnekahta do not supply water wells in the Dewey-Burdock area and are not considered to be USDWs locally. Further, due to local total dissolved solids (TDS) concentrations in excess of 10,000 mg/l, (shown Table D-1 from the USGS Produced Waters Database [http://energy.cr.usgs.gov/prov/prodwat/data2.htm]), the Minnelusa is not a USDW.

Minor aquifers in the area include the Sundance formation (Driscoll et al., 2002). While some authors differentiate geologically between the Sundance and overlying Unkpapa Formation, they are thought to be hydrogeologically connected and are referred to as the Unkpapa/Sundance in this document. Further, the Unkpapa/Sundance is considered to be the lower-most USDW above the Madison below the Dewey-Burdock Project area.

<u>Deadwood Formation</u>

The Cambrian-age Deadwood Formation consists of massive to thinly-bedded, brown to light-gray sandstone; greenish glauconitic shale; dolomite; and flat-pebble limestone conglomerate. Sandstone with conglomerate occurs locally at the base of the formation. The Deadwood ranges in thickness from 0 to 500 feet (Carter et al., 2003) in the area. Generally, groundwater flow in the Cambrian-Ordovician aquifer system is from the high-altitude recharge areas on the top of the Black Hills radially outward (Figure D-4). Regionally the Deadwood is confined by the Precambrian basement (Williamson and Carter, 2001). It overlies the Precambrian basement and granite wash (where present) and outcrops approximately 20 miles to the northeast of the Dewey-Burdock Project (Figure D-1). As stated previously, the Deadwood is not considered to be a local USDW. Based on available data, there are no known water wells supplied by the Deadwood Formation in the Dewey-Burdock Project area. There are no water quality data available in the area, but it is suspected that water quality declines with depth and distance down-gradient from the recharge at the outcrop. As a result, it is likely that the Deadwood contains dissolved solids in excess of 10,000 mg/l below Sites 1 and 2 and will not meet the USEPA criteria for a USDW. An isopach map of the Deadwood is included as Figure D-5.

Madison Formation

The Mississippian Madison aquifer is contained within the limestones, siltstones, sandstones, and dolomite of the Madison Limestone or Group. Generally, water in the Madison is confined except in outcrop areas and can frequently demonstrate artesian conditions. Groundwater flow in this aquifer system generally is from the recharge areas radially outward from the Black Hills (Figure D-6). Water in the Madison is typically fresh only near the recharge areas, becoming slightly saline to saline as it moves down-gradient (Figure D-7). In the deeper parts of the Williston Basin, the water is a brine with dissolved solids concentrations greater than 300,000 mg/L (Driscoll et al., 2002). Local water quality for the Madison is summarized by analysis of the Edgemont city wells and is presented in Table D-1. Structure contour and isopach maps of the Madison are included as Figures D-8 and D-9, respectively. A potentiometric surface map of the Madison Formation is presented as Figure D-10.

Minnelusa Formation

The Pennsylvanian- and Permian-age Minnelusa Formation consists of yellow to red, cross-stratified sandstone, limestone, dolomite, and shale. The Minnelusa Aquifer occurs primarily in sandstone and anhydrite beds in the upper part of the formation (Williamson and Carter, 2001). Water in this aquifer moves from recharge areas radially outward from the Black Hills and to the northeast to discharge areas in eastern South Dakota (Figure D-6). It is confined above by the Opeche Shale and below by layers of lower permeability in the Minnelusa Formation.

The Minnelusa is referred to as an aquifer but is an oil and gas producer in the Dewey-Burdock area. Table D-2 and Figure D-11 present local water quality data from the USGS Produced Waters Database for the Minnelusa Formation that shows TDS concentrations in excess of 10,000 mg/l in the Dewey-Burdock area. In addition, this formation does not supply water to any local water wells. As such, it is not considered to be a USDW in the Dewey-Burdock area. Structure contour and isopach maps of the Minnelusa are included as Figures D-12 and D-13, respectively. A potentiometric surface map of the Minnelusa Formation is presented as Figure D-14.

It has been postulated that in the vicinity of the Black Hills, there may be communication between the Madison and Minnelusa Formations and even communication from the Minnelusa to the surface via breccia pipes. However, this communication is thought to occur near the outcrop in areas where these formations are near surface. These areas are located well to the north and east of the Project area and up-gradient in the system. Evidence of regional isolation is the contrast between water quality in the Madison and Minnelusa. There is no evidence to suggest that there is communication between these formations locally.

Minnekahta Formation

The Permian-age Minnekahta Limestone is a thin to medium-bedded, fine-grained, purple to gray laminated limestone, which ranges in thickness from 25 to 65 feet (Driscoll et al., 2002). The Minnekahta is considered a major aquifer in parts of the Black Hills area but does not supply any known water wells locally.

Unkpapa/Sundance Formation

The Sundance Formation consists of greenish-gray shale with thin limestone lenses; glauconitic sandstone, with red sandstone near the middle of the formation. The Sundance ranges from 250 to 450 feet thick (Carter et al., 2003). The Unkpapa Sandstone is a massive fine-grained sandstone, 0 to 225 feet thick (Carter et al., 2003). A potentiometric surface map of the Unkpapa is presented as

figure D-14a. The Unkpapa/Sundance is considered a minor aquifer in the area. Local water quality data from wells located within the Dewey-Burdock Project are presented in Table D-3.

Inyan Kara Group

Several sandstone units compose the lower Cretaceous aquifer, which is known as the Inyan Kara aquifer in South Dakota. These units are the Lakota and Fall River Formations and the Lakota is divided into the Chilson, Minnewaste, and Fuson Members. Some authors include the Minnewaste Limestone Member regionally, but it is not present below the project area. Generally, water in the Inyan Kara is confined by several thick shale layers of the Graneros Group (including the Skull Creek Shale), except in outcrop areas around structural uplifts, such as the Black Hills Uplift. Regionally, groundwater in the Inyan Kara moves from high-altitude recharge areas to discharge areas in eastern North Dakota and South Dakota. Although the aquifer is wide-spread, it contains little fresh water except in small areas in central and south-central Montana and north and east of the Black Hills uplift. Water in the Inyan Kara is saline in the deeper parts of the Williston and Powder River Basins (Driscoll et al., 2002). Table D-4 presents local water quality data from wells located within the Dewey-Burdock Project. A structure contour map of the Inyan Kara is included as Figure D-15. Isopach maps of each of the units that compose the Inyan Kara are included as Figures D-16, D-17, and D-18. A potentiometric surface map of the Fall River Aquifer is presented as Figure D-19.

Figure D-20 is a cross-section location map that shows A - A' (Figure D-21) and B - B' (Figure D-22) which show the vertical extent of the USDWs across the project area. The lowermost formations (Madison, Englewood, and Deadwood) are not shown due to the lack of deep well logs.

TABLE D-1 Local Water Quality Data - Madison Formation

Summary of Madison well data, Edgemont city water														
		Well ID	BNR/TVA	well 2	well 4	well 5	TVA	well 2	well 4	well 5	Mean	Minimum	Maximum	Std. Dev
		Sample Date	11/6/2002	11/6/2002	11/6/2002	11/6/2002	5/23/2000	5/23/2000	5/23/2000	5/23/2000				
Component		**units**												
Physical properties														
Conductivity	Cond.	umhos/cm	1154	1671	1785	2140	1300	1700	1800	2300	1731.3	1154.0	2300.0	382.1
Hardness			406	503	528	580	410	460	500	560	493.4	406.0	580.0	64.3
pH	pH		7.81	7.7	7.73	7.66	7.15	7.23	7.26	7.37	7.5	7.2	7.8	0.3
TDS	TDS	mg/L	726	1047	1101	1333	690	980	940	1000	977.1	690.0	1333.0	205.0
TSS	TSS	mg/L												
Turbidity	Turbidity	NTU												
Acidity	Acidity													
Alkalinity	CaCO3		188	181	182	180	170	160	160	170	173.9	160.0	188.0	10.5
Carbonate	CO3	mg/L												
Bicarbonate	HCO3	mg/L	229	221	222	220	210	200	200	210	214.0	200.0	229.0	10.7
Chloride	Cl	mg/L	185	255	300	385	150	250	270	360	269.4	150.0	385.0	79.7
Cyanide	CN	mg/L												
Flouride	F	mg/L	0.843	1.1	1.07	1.32	0.9	1.05	1.03	1.2	1.1	0.8	1.3	0.2
Nitrogen, Ammonia	NH3	mg/L												
Nitrogen, Nitrate	NO3	mg/L	0.211	0.086	0.063	<.05	0.15	0.16	0.16	<.1	0.1	0.1	0.2	0.1
Nitrogen, Nitrite	NO2	mg/L					<.01	<.01	<.01	<.01		0.0	0.0	
Sulfate	SO4	mg/L	211	295	309	353	210	300	340	390	301.0	210.0	390.0	64.0
Metals														
Aluminum	Al	mg/L												
Arsenic	As	mg/L	0.006	0.01	0.01	0.008					0.0085	0.0	0.0	0.0019
Calcium	Ca	mg/L	115	150	156	175	100	120	130	140	135.8	100.0	175.0	24.4
Iron	Fe	mg/L	0.05	0.091	<.05	2.53	<0.05	0.09	<.05	2.6	1.1	0.1	2.6	1.4
Magnesium	Mg	mg/L	28.8	31.1	33.7	34.8	30	32	35	36	32.7	28.8	36.0	2.6
Manganese	Mn	mg/L	0.05	0.05	<.05	<.05	<.03	<.03	<.03	0.05	0.05	0.1	0.1	0.00
Mercury	Hg	mg/L												
Lead	Pb	mg/L												
Molybdenum	Mo	mg/L												
Potassium	K	mg/L	10.6	17.3	17.9	23	12	19	20	24	18.0	10.6	24.0	4.7
Selenium	Se	mg/L												
Sodium	Na	mg/L	86.9	161	174	228	88	150	170	200	157.2	86.9	228.0	49.4

Source: Summary of Madison well data, Edgemont city water http://www.sdgs.usd.edu/other/db.html

TABLE D-2 Local Water Quality Data - Minnelusa Formation

API Number	Location					County	Formation Sampled	Sample Method	Test Interval		TDS (mg/L)
	Section	Township	Range	Latitude	Longitude				Top (feet)	Bottom (feet)	
4003305005	34	6S	2E	43.48664	-103.86925	Custer	Minnelusa	DST	1,338	1,375	18,814
4003305010	34	6S	2E	43.48814	-103.86781	Custer	Minnelusa	Production	1,368	1,388	13,512
4003305010	34	6S	2E	43.48814	-103.86781	Custer	Minnelusa	Wellhead	1,356	--	7,740
4003305015	34	6S	2E	43.49021	-103.86926	Custer	Minnelusa	Separator	713	--	7,429
4003305035	30	5S	2E	43.58112	-103.93146	Custer	Minnelusa	Bailer	845	851	4,288
4004705067	15	9S	2E	43.26232	-103.87392	Fall River	Minnelusa	DST	2,692	2,707	24,823
4004705067	15	9S	2E	43.26232	-103.87392	Fall River	Minnelusa	DST	2,692	2,707	24,422
4004705067	15	9S	2E	43.26232	-103.87392	Fall River	Minnelusa	WLT	2,230	2,234	9,803
4004705089	21	7S	1E	43.42595	-103.99711	Fall River	Minnelusa	DST	2,390	2,400	21,391
4004705089	21	7S	1E	43.42595	-103.99711	Fall River	Minnelusa	DST	2,390	2,400	17,279
4004705089	21	7S	1E	43.42595	-103.99711	Fall River	Minnelusa	DST	2,390	2,400	16,652
4004705092	21	7S	2E	43.42964	-103.88318	Fall River	Minnelusa	Unknown	1,415	1,418	10,183
40000185	34	6S	2E	43.48480	-103.86630	Custer	Minnelusa	Separator	713	--	7,427
40000183	34	6S	2E	43.48480	-103.86630	Custer	Minnelusa	Separator	680	--	6,968

Notes:
-- - Data not provided.
Shading indicates duplicate samples.
Source: USGS Produced waters Database; http://energy.cr.usgs.gov/prov/prodwat/data.htm

TABLE D-3 Local Water Quality Data - Unkpapa/Sundance Formation

	Well #635			
Analyte	**9/26/07 18:08**	**11/27/07 8:25**	**2/10/08 14:55**	**4/29/08 19:00**
A/C Balance (± 5) (%)	-1.14	-0.831	-0.25	3.52
Alkalinity-Total as CaCO3 (mg/L)	124	118	120	118
Aluminum-Dissolved (mg/L)	<0.1	<0.1	<0.1	<0.1
Ammonia (mg/L)	0.1	0.4	0.5	0.5
Anions (meq/L)	30.4	31.6	33.7	32.8
Antimony-Total (mg/L)			<0.003	<0.003
Arsenic-Dissolved (mg/L)	<0.001	<0.001	<0.001	<0.001
Arsenic-Total (mg/L)			<0.001	0.001
Barium-Dissolved (mg/L)	<0.1	<0.1	<0.1	<0.1
Barium-Total (mg/L)			<0.1	<0.1
Beryllium-Total (mg/L)			<0.001	<0.001
Bicarbonate as HCO3 (mg/L)	151	144	146	144
Boron-Dissolved (mg/L)	0.4	0.4	0.5	0.4
Boron-Total (mg/L)			0.5	0.4
Cadmium-Dissolved (mg/L)	<0.005	<0.005	<0.005	<0.005
Cadmium-Total (mg/L)			<0.005	<0.005
Calcium-Dissolved (mg/L)	110	120	132	136
Carbonate as CO3 (mg/L)	<5	<5	<5	<5
Cations (meq/L)	29.8	31.1	33.5	35.2
Chloride (mg/L)	24	23	26	20
Chromium-Dissolved (mg/L)	<0.05	<0.05	<0.05	<0.05
Chromium-Total (mg/L)			<0.05	<0.05
Conductivity @ 25 C (umhos/cm)	2890	2830	2950	2810
Copper-Dissolved (mg/L)	<0.01	<0.01	<0.01	<0.01
Copper-Total (mg/L)			<0.01	<0.01
Fluoride (mg/L)	0.3	0.3	0.4	0.4
Gross Alpha-Dissolved (pCi/L)	2.5	4.4	14.8	13.2
Gross Beta-Dissolved (pCi/L)	4.3	6.3	10	-8
Gross Gamma-Dissolved (pCi/L)	960	1000	91	
Iron-Dissolved (mg/L)	<0.03	<0.03	<0.03	<0.03
Iron-Total (mg/L)			1.11	1.08
Lead 210-Dissolved (pCi/L)	<1	1.7	<1	
Lead 210-Suspended (pCi/L)	<1	5.1	<1	-9.6
Lead 210-Total (pCi/L)	<1			
Lead-Dissolved (mg/L)	<0.001	0.003	<0.001	<0.001
Lead-Total (mg/L)			<0.001	<0.001
Magnesium-Dissolved (mg/L)	44.3	49	52.3	54.1
Manganese-Dissolved (mg/L)	0.06	0.07	0.06	0.06
Manganese-Total (mg/L)			0.06	0.05
Mercury-Dissolved (mg/L)	<0.001	<0.001	<0.001	<0.001
Mercury-Total (mg/L)	<0.0002	<0.001	<0.001	<0.001
Molybdenum-Dissolved (mg/L)	<0.1	<0.1	<0.1	<0.1
Molybdenum-Total (mg/L)			0.01	<0.1
Nickel-Dissolved (mg/L)	<0.05	<0.05	<0.05	<0.05
Nickel-Total (mg/L)			<0.05	<0.05
Nitrogen, Nitrate as N (mg/L)	<0.1	<0.1	<0.1	<0.05
Nitrogen, Nitrite as N (mg/L)	<0.1	<0.1	<0.1	<0.05
Oxidation-Reduction Potential (mV)		270	129.4	180
pH	7.72	7.64	7.91	8.2
Polonium 210-Dissolved (pCi/L)	<1	1.9	<1	1.1
Polonium 210-Suspended (pCi/L)	<1	<1	<1	
Polonium 210-Total (pCi/L)	<1			
Potassium-Dissolved (mg/L)	7.8	8.3	8.2	7.3
Radium 226-Dissolved (pCi/L)	1.6	0.8	1.3	
Radium 226-Suspended (pCi/L)	0.8	<0.2	0.6	0.3
Radium 226-Total (pCi/L)	2.4			

TABLE D-3 Local Water Quality Data - Unkpapa/Sundance Formation

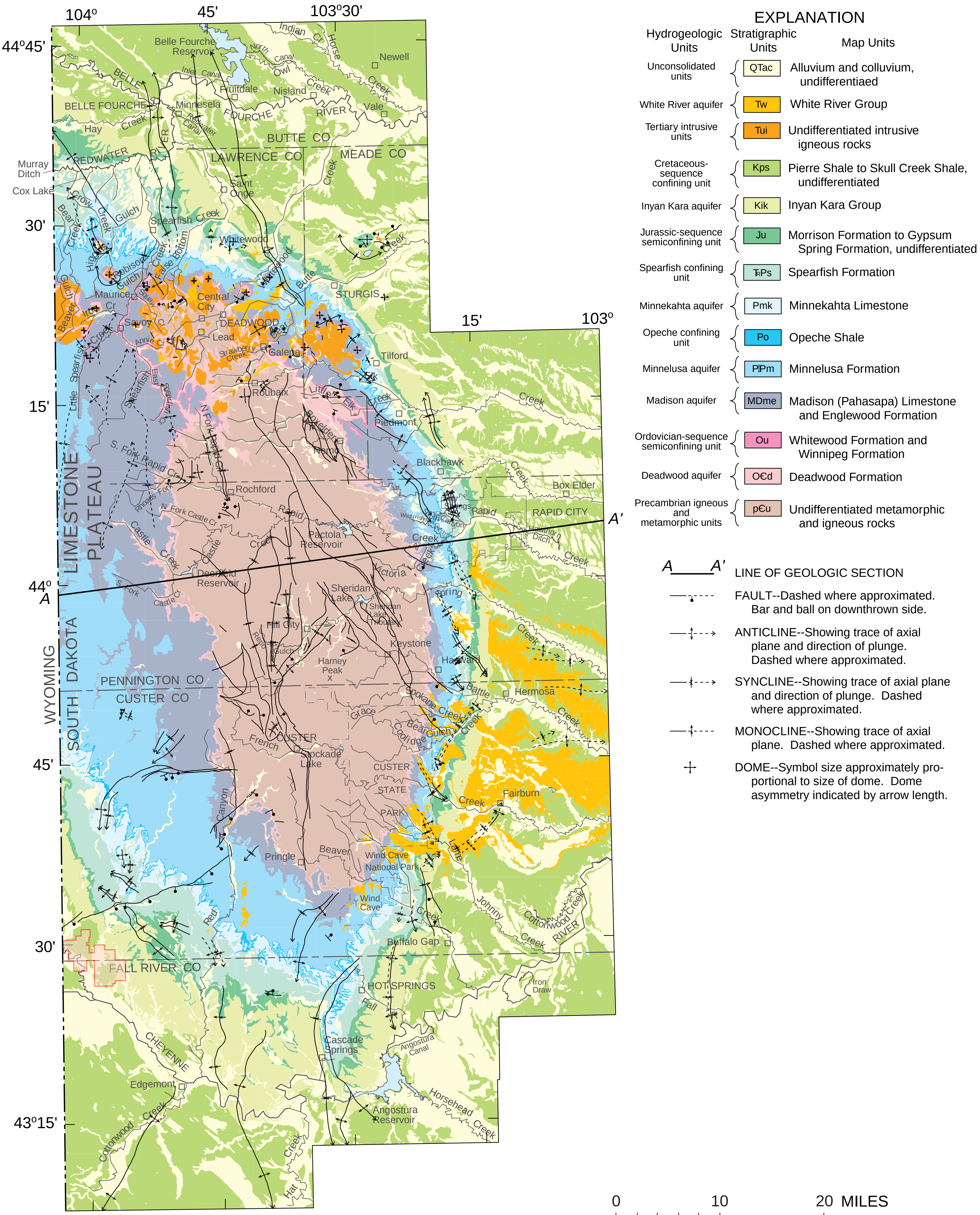
Well #635				
Analyte	**9/26/07 18:08**	**11/27/07 8:25**	**2/10/08 14:55**	**4/29/08 19:00**
Radon 222-Total (pCi/L)		902	806	1070
Selenium-Dissolved (mg/L)	0.001	<0.001	<0.001	<0.001
Selenium-IV-Dissolved (mg/L)		0.001	<0.001	<0.001
Selenium-Total (mg/L)			<0.001	0.001
Selenium-VI-Dissolved (mg/L)		<0.001	<0.001	<0.001
Silica-Dissolved (mg/L)	8.6	9	10	4.9
Silver-Dissolved (mg/L)	<0.005	<0.005	<0.005	<0.005
Silver-Total (mg/L)			<0.005	<0.005
Sodium Adsorption Ratio (SAR) (meq/L)		9.3	9.6	10
Sodium-Dissolved (mg/L)	470	480	515	545
Solids-Total Dissolved Calculated (mg/L)	2040	2120	2270	2280
Solids-Total Dissolved TDS @ 180 C (mg/L)	2200	2300	2300	2200
Strontium-Total (mg.L)			4.2	4.6
Sulfate (mg/L)	1500	1370	1470	1430
TDS Balance (0.80 - 1.20) (dec.%)	1.09	1.08	1.03	0.98
Thallium-Total (mg/L)			<0.001	<0.001
Thorium 230-Dissolved (pCi/L)	<0.2	<0.2	<0.2	0.2
Thorium 230-Suspended (pCi/L)	<0.2	<0.2	<0.2	0.1
Thorium 230-Total (pCi/L)	<0.2			
Thorium 232-Dissolved (pCi/L)	<0.005	<0.005	<0.005	<0.005
Uranium-Dissolved (mg/L)	0.002	0.002	0.0021	0.0017
Uranium-Suspended (mg/L)	<0.0003	<0.0003	<0.0003	<0.0003
Uranium-Total (mg/L)	0.002		0.0021	0.0017
Vanadium-Dissolved (mg/L)	<0.1	<0.1	<0.1	<0.1
Zinc-Dissolved (mg/L)	<0.01	0.02	<0.01	<0.01
Zinc-Total (mg/L)			<0.01	<0.01

Source: Powertech 2008 Class III UIC Permit Application, Appendix F

TABLE D-4 Local Water Quality Data - Inyan Kara Group (Lakota and Fall River Formations)

		Mean			Minimum			Maximum		
	Well	Powertech	TVA	RPD	Powertech	TVA	RPD	Powertech	TVA	RPD
Alkalinity as CaCO3, mg/L	2	181	219	19%	88	200	78%	214	242	12%
	7	171	181	6%	170	171	1%	176	191	8%
	8	166	178	7%	156	166	6%	178	194	9%
	13	159	173	8%	142	160	12%	170	196	14%
	16	153	152	1%	148	144	3%	160	157	2%
	18	179	196	9%	172	180	5%	184	238	26%
	42	178	188	5%	174	179	3%	180	204	13%
	4002	140	158	12%	138	144	4%	144	202	34%
	7002	261	261	0%	250	210	17%	280	300	7%
Conductivity, uS/cm	2	2285	1547	39%	1500	1450	3%	4400	1750	86%
	7	1542	1338	14%	1440	1325	8%	1650	1350	20%
	8	1450	1385	5%	1420	1285	10%	1560	1450	7%
	13	1292	1274	1%	1140	1100	4%	1420	1400	1%
	16	1063	1162	9%	925	1150	22%	1260	1175	7%
	18	1412	1379	2%	1330	1300	2%	1470	1420	3%
	42	1408	1353	4%	1310	1200	9%	1510	1400	8%
	4002	1220	1161	5%	1130	1100	3%	1340	1195	11%
	7002	2328	2339	0%	2200	1925	13%	2480	2500	1%
pH	2	7.91	7.7	3%	7.85	7.16	9%	7.94	8.2	3%
	7	8.11	8.5	5%	8.05	8.3	3%	8.17	8.7	6%
	8	7.95	7.87	1%	7.93	7.59	4%	7.97	8.5	6%
	13	7.9	7.76	2%	7.75	7.48	4%	8.05	8.1	1%
	16	7.46	7.34	2%	7.38	7.31	1%	7.57	7.39	2%
	18	8.08	7.94	2%	8.02	7.69	4%	8.11	8.4	4%
	42	8.02	7.94	1%	7.95	7.67	4%	8.08	8.4	4%
	4002	7.83	7.75	1%	7.65	7.51	2%	8.02	8.5	6%
	7002	7.36	7.44	1%	7.22	7.14	1%	7.56	8	6%
Total Dissolved Solids	2	1750	1043	51%	1100	1004	9%	3600	1113	106%
	7	999	1081	8%	896	1058	17%	1050	1104	5%
	8	1000	965	4%	940	860	9%	1100	1130	3%
	13	878	886	1%	850	792	7%	890	1006	12%
	16	814	846	4%	760	796	5%	940	894	5%
	18	958	909	5%	940	520	58%	990	1118	12%
	42	950	939	1%	930	888	5%	980	1033	5%
	4002	818	773	6%	790	740	7%	850	805	5%
	7002	1875	1843	2%	1800	1690	6%	1900	1970	4%
RPD (Relative Percent Difference) = The absolute difference divided by the average.										

Source: Table 2.7-45: Comparison of Statistics for Selected Constituents between Historic TVA Data and current Powertech Data (2009 Powertech NRC Application)



Base modified from U.S. Geological Survey digital data, 1:100,000
Rapid City, Office of City Engineer map, 1:18,000, 1996
Universal Transverse Mercator projection, zone 13

Legend

Dewey-Burdock Permit Boundary

From:
Water-Resources Investigations Report 01-4194
by Joyce E. Williamson and Janet M. Carter, 2001

POWERTECH (USA) INC.

Figure D-1
Distribution of Hydrogeologic Units
in the Black Hills Area

2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_Fig_D-01.ai	By: JLM	Checked: HD

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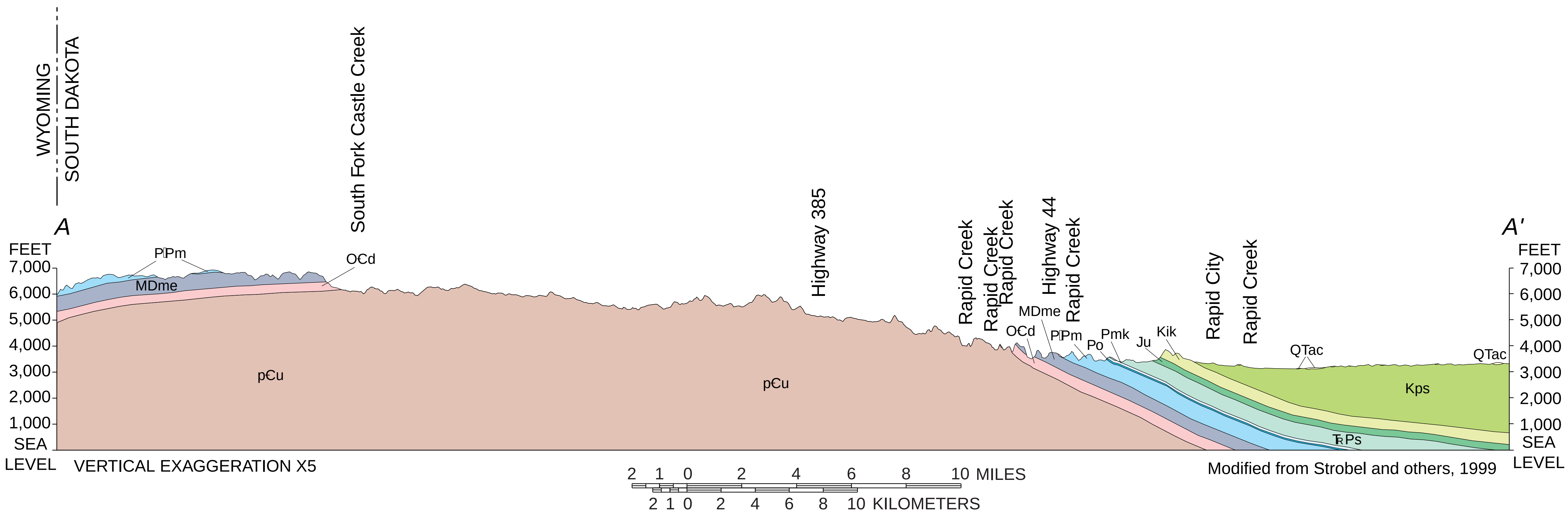

EXPLANATION

Hydrogeologic Units	Stratigraphic Units	Map Units
Unconsolidated units	QTac	Alluvium and colluvium, undifferentiaed
White River aquifer	Tw	White River Group
Tertiary intrusive units	Tui	Undifferentiated intrusive igneous rocks
Cretaceous-sequence confining unit	Kps	Pierre Shale to Skull Creek Shale, undifferentiated
Inyan Kara aquifer	Kik	Inyan Kara Group
Jurassic-sequence semiconfining unit	Ju	Morrison Formation to Gypsum Spring Formation, undifferentiated
Spearfish confining unit	TRPs	Spearfish Formation
Minnekahta aquifer	Pmk	Minnekahta Limestone
Opeche confining unit	Po	Opeche Shale
Minnelusa aquifer	PIPm	Minnelusa Formation
Madison aquifer	MDme	Madison (Pahasapa) Limestone and Englewood Formation
Ordovician-sequence semiconfining unit	Ou	Whitewood Formation and Winnipeg Formation
Deadwood aquifer	OꞒd	Deadwood Formation
Precambrian igneous and metamorphic units	pꞒu	Undifferentiated metamorphic and igneous rocks

From:
Water-Resources Investigations Report 01-4194
(after Stobel et al., 1999, Modified by Driscoll et al., 2002)

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Figure D-2
Generalized East-West Geologic Cross Section through Black Hills Uplift (A-A')
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-2.ai	By: JLM	Checked: HD

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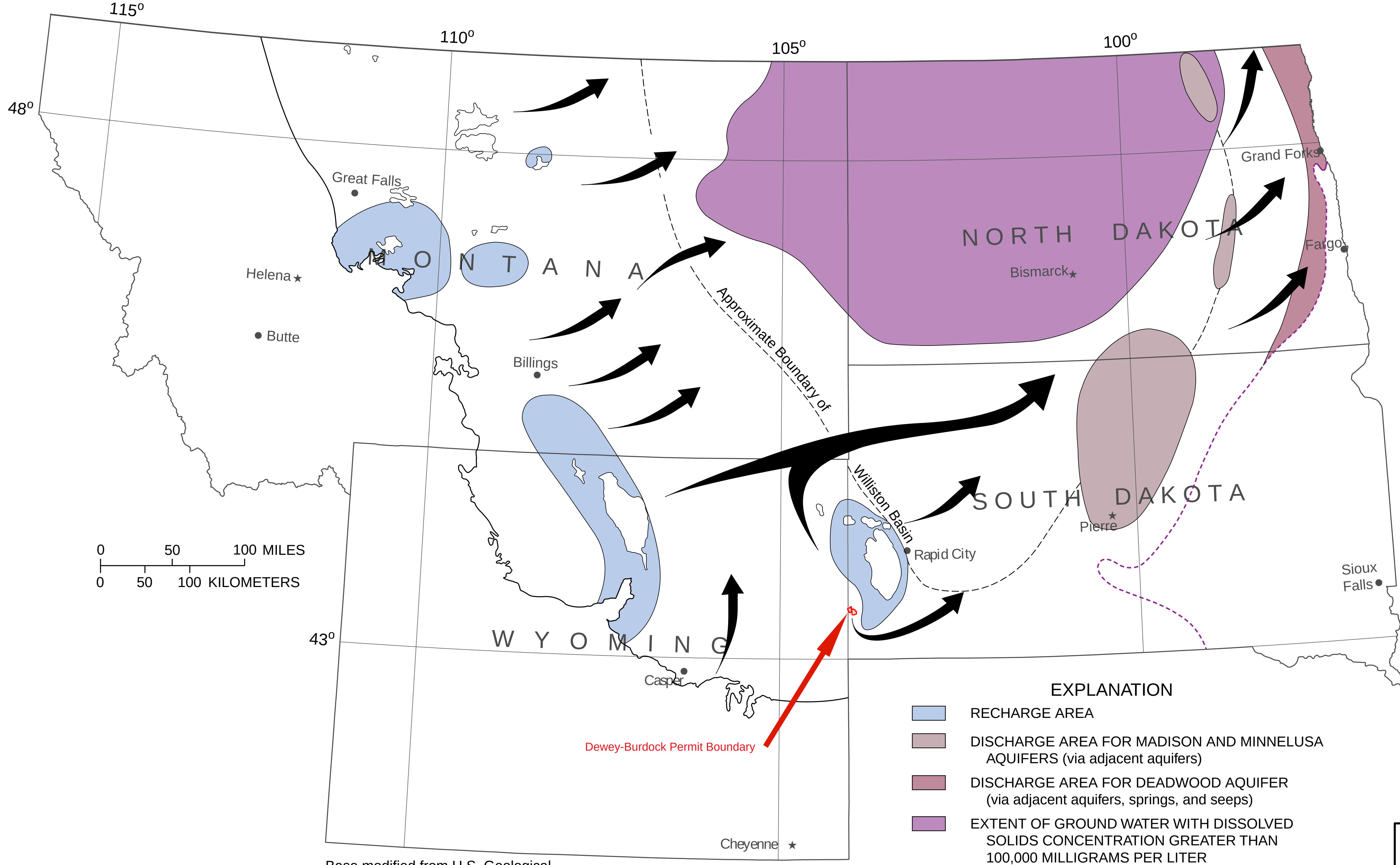

Base modified from U.S. Geological Survey digital data, 1:2,000,000, 1972

EXPLANATION

RECHARGE AREA

DISCHARGE AREA FOR MADISON AND MINNELUSA AQUIFERS (via adjacent aquifers)

DISCHARGE AREA FOR DEADWOOD AQUIFER (via adjacent aquifers, springs, and seeps)

EXTENT OF GROUND WATER WITH DISSOLVED SOLIDS CONCENTRATION GREATER THAN 100,000 MILLIGRAMS PER LITER

EASTERN LIMIT OF DEADWOOD AQUIFER--Dashed where approximately located

DIRECTION OF GROUND-WATER FLOW

From:
Water-Resources Investigations Report 02-4094
(after Downey and Dinwiddie, 1988,
modified by Driscoll et al., 2002)

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Figure D-3
General Direction of Groundwater Flow in Regional Aquifer System within Paleozoic Aquifer Units
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-03.ai	By: JLM	Checked: HD

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