ADDENDUM 4-A

SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING REPORT

Subsurface Exploration and Geotechnical Engineering Report

Prepared for:

AUC LLC
1536 Cole Boulevard, suite 330
Lakewood, CO 80401

Reno Creek Project
Campbell County, Wyoming

July 9, 2012

16216-CX

Prepared by:

INBERG-MILLER ENGINEERS
1120 East "C" Street
Casper, WY 82601

July 9, 2012 16216-CX

PDF PAGES EMAILED: lhuffman@auc-llc.com
ORIGINAL MAILED

Mr. Leland Huffman
AUC LLC
1536 Cole Boulevard, Suite 330
Lakewood, CO 80401

RE: SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING REPORT
RENO CREEK PROJECT
CAMPBELL COUNTY, WYOMING

Dear Mr. Huffman:

Enclosed are the original and one PDF copy of our Subsurface Exploration and Geotechnical Engineering report for the above-referenced project. The work described in this report has been completed in accordance with our Service Agreement dated May 31, 2012.

It has been a pleasure participating in this project. We are available to provide additional services at your request. Services we could provide include:

- additional field exploration
- environmental assessment
- surveying
- construction materials testing
- observation of excavations and earthwork

If you have any questions or comments, please contact us at 307-577-0806.

Sincerely,

INBERG-MILLER ENGINEERS

Ben Hauser, P.E., G.I.T.
Geotechnical Engineer

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Enclosures as stated

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SUMMARY

Based on information obtained from our subsurface exploration and laboratory testing of recovered samples, it is our opinion that the site is suitable for construction of the proposed Reno Creek Project, subject to considerations for site preparation and foundations described in this report. Our field exploration included 15 test borings to maximum depths of 21.5 feet. Soils encountered include sandy clay and sand overlying weathered sedimentary bedrock. Groundwater was not observed within the borings during drilling observations.

Laboratory test results indicate the claystone bedrock underlying the proposed site at variable elevations exhibits potential for an increase in volume with associated swell pressures with an increase in moisture content. Swell pressures on the order of 1,800 to 2,400 psf were observed. Consequently, a deep foundation system consisting of drilled piers and grade beams is considered appropriate to support all wall and roof loads of the proposed buildings and major equipment.

We understand that the final site-grading plan has not been completed as of the date of this report. It is possible that a more cost effective foundation system could be considered for the site, depending on the geology and/or fill thicknesses that are expected to be exposed at final grade. Therefore, alternative foundation systems, including but not limited to conventional continuous and spread footing bearing on improved subgrades, post-tensioned slabs-on-grade, and helical piers could be considered as alternatives at your request, and at additional cost.

SCOPE OF SERVICES

The purpose of this study was to explore subsurface conditions at the site of the proposed Reno Creek Project, and to provide geotechnical recommendations for design and construction. Specific recommendations and information are provided about foundation types, bearing capacity, groundwater conditions, consolidation-swell potential of foundation soils, earthwork, and other pertinent foundation and construction requirements.

PROJECT INFORMATION

Project information was provided by Leland Huffman with AUC LLC. We understand the project will consist of constructing a processing facility for in-situ uranium mining. The proposed project consists of a central processing plant, administration and shop building, and one pond with the potential to expand to a second pond.

Detailed information on the structural loads was not available at the time this report was prepared. However, based on information provided, we assume that the proposed buildings will have low to moderate loads. These assumptions include maximum wall loads on the order of three kips per linear foot and maximum isolated columns loads on the order of 60 kips. Some recommendations provided in this report will not be appropriate for buildings with loads in excess of those described above.

It is important to note that we have assumed that some minor grading will be required, and cut and fill depths will be less than 3 feet. If cuts and fills in excess of these assumptions are planned, we should be provided plans and our recommendations should be reviewed for conformance with the planned site configuration. The importance of understanding the final grading plan as a consideration in determining an appropriate foundation type as it relates to the geology exposed at final grade cannot be over-emphasized.

FIELD EXPLORATION

The fieldwork was performed using a CME 85 truck-mounted drilling rig at the site on June 13-14, 2012. Fifteen test borings were advanced to depths of 11.5 to 21.5 feet. Drilling was performed using 4-inch diameter solid flight augers. The augers are withdrawn at each sample depth to allow sampling tools access to the bottom of the hole for sampling undisturbed soils.

Drilling and field sampling were performed according to the following standard specifications:

1. "Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling," ASTM D6151.

2. Sampling with a 2-inch O.D., split-barrel (split-spoon) sampler per ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils." 92 such tests were performed. Standard penetration test blow counts were obtained by driving a 2.0-inch-diameter split-spoon sampler into the soil using an automatic hammer that drops a 140-pound hammer a distance of 30 inches. The SPT N-value is the blow count for 12 inches of sampler penetration. N-values are correlated to soil relative density, hardness, strength and a variety of other parameters.

3. Sampling with a 2.5-inch I.D., thick-wall, ring-lined, split-barrel, drive sampler per ASTM D3550. Seven such samples were obtained.

The soil samples were field classified by the geologist and geotechnical engineer, sealed in containers to prevent loss of moisture, and returned to our laboratory. A field log was prepared for each boring during drilling.

Test boring locations were located by surveyors who determined location and elevation using survey instruments.

LABORATORY TESTING PROGRAM

Upon return to the office, samples were classified visually in accordance with ASTM D2488. In order to better classify the recovered samples and determine their engineering properties, the following laboratory soil tests were performed:

		TESTS
1.	Moisture Content (ASTM D2216)	92
2.	Atterberg Limits (ASTM D4318)	9
3.	Sieve Analysis (#4 to #200) (ASTM C136 and C117)	9
4.	Water Soluble Sulfate	3
5.	Consolidation-Swell Test (ASTM D2435)	4

A final log for each boring was prepared containing the work method, samples recovered, and a description of soils encountered. The sieve analyses and consolidation-swell tests are presented graphically in Appendix C. All other test results are arrayed on the final logs bound into Appendix B.

SITE CONDITIONS

The site is located approximately 1/4 mile northwest of the intersection of Clarkelen Road and WY Highway 387. The site is vegetated with sparse native grass and sage brush. The topography at the site is relatively flat to moderately steep. A site location map, site observation sheet, and test boring location plan in Appendix A describe the site in more detail.

SUBSOIL CONDITIONS

The subsoil classified in the 15 test borings performed at the site generally consists of unconsolidated sandy clay and sand overlying weathered to competent sedimentary bedrock. Due to the variable nature of the soil strata and geology at the site the soil descriptions below are for a general overview only and the boring logs should reviewed for specific soils conditions in each area.

The topsoil consists of 0 to 4 inches of sandy clay. The organic content of the soils appears to be low.

Over the approximate interval of 0 to 10 feet, sandy clay was encountered. Laboratory testing indicates minus number 200 sieve fractions of 55 percent to 90 percent and plasticity indexes of 13 to 43 percent indicating low to medium high plasticity. Standard Penetration Test blow counts (N-values) indicate that the soil is in a firm to hard condition.

Over the approximate interval of 10 to 20 feet, sedimentary bedrock with variable amounts of weathering was encountered. The weathering ranged from nearly complete (hard or dense soil) to severely weathered.

Consolidation-swell tests are summarized in the following table. Testing was performed on relatively undisturbed, drive-tube samples using one-dimensional test equipment. Samples were placed into the equipment at native moisture content and loaded to a nominal vertical confining pressure of 1,000 psf prior to wetting. Following wetting, the vertical confining pressure was increased incrementally to a maximum vertical pressure of 8,000 psf and then reduced incrementally to determine a rebound curve. The test results indicate that the claystone has moderate swell pressure when wetted.

SAMPLE			TEST RESULTS		
Soil Description	Boring No.	Depth (Feet)	Volumetric Swell (%)	Swell Pressure (psf)	Compression Index, Cc
Claystone	1	7.5	1.23	1,800	0.218
Claystone	4	10	0.81	2,400	0.069
Very Fine Sand	6	5	-0.10	N/A	0.104
Claystone	7	10	-	N/A	0.116

GROUNDWATER CONDITIONS

Groundwater was not observed in any of the test borings during drilling operations. Groundwater observations were made in each test boring at the completion of drilling. This information, along with cave-in depths of the drill holes, is recorded on the final logs in Appendix B. Test borings were backfilled at the completion of the field work for practical and safety reasons. Therefore no subsequent readings were performed.

We have noted groundwater occurrences within claystone on numerous occasions at other sites with similar geology. Typically, the groundwater is observed within discontinuous fractures of the claystone bedrock. Groundwater could be present at this site within the fractures based on our observation of iron oxide staining within them even though no groundwater was observed.

In addition, groundwater conditions could change with seasonal or long-term changes in climatic conditions and post-construction changes in irrigation and surface water runoff. Generally, developed sites have a significantly greater volume of water available to percolate into the ground due to irrigation and storm water runoff from hard surfaces. Localized, perched groundwater tables may develop above clay layers or bedrock or within the foundation backfill zone.

RECOMMENDATIONS

EARTHWORK

1. Prior to construction on the site, all vegetation and organic surface matter should be stripped from the surface. Based on the test borings, it appears that stripping depths of approximately 0 to 4 inches may be required.

2. Demolition of existing structures and utilities (if any) must include complete removal of below grade concrete and old fill.

3. After excavation to desired site grades (including any overexcavation required), and prior to placing fill or erection of forms for foundations and slabs, we recommend the site surface be compacted. This compaction densifies the native subgrade and soils loosened by excavation. This compaction effort should be performed in the presence of the geotechnical engineer so that soft or loose zones can be properly identified and improved. Alternatively, the geotechnical engineer can observe proof rolling with a heavily loaded wheeled vehicle. If loose or soft zones are encountered that do not improve with repeated compaction, they should be removed and replaced with properly compacted, approved fill, as described in Item 5 below.

4. Fill material requirements are provided in the following table:

Use	Fill Material
Beneath structures	Structural fill meeting Envelope A
Beneath Slabs	
Bottom of slab to 6 inches	WYDOT Grading W aggregate base
Deeper than 6 inches below slab	Structural fill meeting Envelope A or supported on piers
Road and pavement subgrades	Scarified and compacted native soil
Trench backfill	Native site soils or Structural fill meeting Envelope A
General site fill in landscaped areas	Native site soils

Native and fill soils should be free of debris and particles larger than 6 inches in diameter.

5. Imported fill specifications are provided below:

Structural Fill Envelope A	
Sieve	Percent Finer
1½"	100
#4	50-100
#8	30-90
#30	15-75
#50	10-60
#200	0-20
Liquid Limit < 40, PI < 15	

WYDOT Grading W Crushed Aggregate Base	
Sieve	Percent Finer
1½"	100
1"	90-100
½"	60-85
#4	45-65
#8	33-53
#200	3-12
Liquid Limit < 25, PI < 3	

6. Fill should be placed in horizontal lifts not exceeding 8 inches in loose thickness and compacted at moisture contents ranging from 4 percent below to 2 percent above the optimum moisture content for engineered fill and <u>optimum moisture content to 2 percent above for native site soils</u>. The contractor's equipment and procedures should produce a uniformly mixed and compacted lift. In-place density and water content of each lift of fill materials should be tested and approved.

The following table is our recommended soil compaction requirement for earthwork. All compaction requirements are based on Standard Proctor maximum dry density (ASTM D698).

	Minimum % Compaction
<u>Native Subgrade</u>	
Scarified and compacted subgrade soils beneath footings, slabs-on-grade, pavement, and structural fill	95
<u>Fill Soils</u>	
Beneath foundations	95
Beneath slabs-on-grade	95
Beneath pavements	95
Embankments and backfill in non-structural areas	90

6. If construction takes place during cold weather, care should be taken to prevent construction on frozen soils. In addition, fill materials should not contain snow and/or ice and should not be placed in a frozen condition.

FOUNDATIONS

Drilled pier foundations are intended to transfer structural loads through potentially swelling surficial soils to a competent underlying stratum beneath the zone of anticipated moisture change. The embedment depth of the pier into the bedrock is intended to provide both resistance to gravity loads and resistance to uplift forces from swelling soils surrounding the top portion of the pier. The load capacity of the pier is provided by the bottom surface of the pier bearing on bedrock and by friction

between bedrock and sidewalls of the piers. Resistance to uplift is provided by friction between the bedrock and sidewalls of the piers over the length of piers beneath the zone of moisture change.

Building column loads are transferred from the columns to a single pier or a group of drilled piers connected by a concrete cap. Wall loads are transferred to grade beams, which are supported by the piers. Grade beams are normally underlain by a void space created by a cardboard void form to prevent uplift pressures on the walls from swelling soils.

1. Structural loads for the proposed structures may be founded on straight-shaft, reinforced concrete, cast-in-place drilled piers and grade beams to support all wall and roof loads. Grade beams should be designed to span between pier locations while carrying the imposed loads.

2. Piers should be founded with a five-foot minimum penetration into an acceptable, sedimentary, bedrock stratum defined as having a minimum N-Value of 50 blows per foot. A minimum pier diameter of 18 inches is recommended to allow proper cleaning and observation of the pier hole. Structures bearing on drilled piers, founded as described above, may experience up to 0.5 inches of total vertical settlement and up to 0.25 inches of differential vertical settlement.

3. Design parameters for drilled piers are provided in the following table.

Layer	Allowable End Bearing	Allowable Skin Friction – Compression (psf)	Allowable Skin Friction – Tension (psf)
A-Sandy clay/Clayey Sand	N.A.	100	N.A.
B-weathered claystone and sandstone	20,000	1,000	500

The allowable skin and end bearing capacities are based on considerations of soil type and strength and incorporate an approximate factor of safety of two. Refer to the test boring logs for applicable layer depth/thickness information at specific locations.

4. Drilled piers are frequently required to resist lateral forces. Laterally loaded piers are analyzed using software that models deflection, shear, bending moment, and soil response with respect to depth in nonlinear soils. In our experience, LPile by Ensoft, Inc is the most common analyses tool. The following table lists LPILE input parameters for a generalized soil profile of the site.

Layer	A	B
LPILE Material Type[a]	3	7
Total Unit Weight (pcf)[b]	120	125
Friction Angle (deg)	-	-
Undrained Cohesion c (psi)	20	-
Unconfined Compressive Strength (psi)	40	300
Static Soil Modulus, k (pci)	1000	-
Young's Modulus, (psi)	-	70,000
Strain, k_m	-	0.0003
Rock Quality Designation (RQD %)	-	0

a. LPILE material types: 1-soft clay, 2-stiff clay with free water, 3-stiff clay w/o free water, 4-sand, 5-strong rock, 6-silt, 7-weak rock
b. LPILE requires an effective unit weight for soil. Below the water table Effective Unit Weight = Total unit weight – 62.4 pcf.

5. Drilled piers should be spaced a minimum of four pier diameters apart (measured center to center) in order to be considered as acting independently and not as a group. If piers are spaced closer than four pier diameters apart, individual pier capacities are reduced according to a rational formula.

6. The foundation driller should be equipped with appropriate drilling equipment, and be prepared for any difficulties resulting from drilling into hard sedimentary bedrock deposits as well as for sloughing of overlying cohesionless fine sandy soils. We anticipate that casing may be required in some pier excavations.

7. We do not anticipate that free groundwater will be encountered in the pier excavations within the proposed foundation excavation depths. However, the contractor should be prepared to dewater and/or case pier excavations if it becomes necessary. Concrete should not be poured into a pier excavation in which more than two inches of standing water is present without the geotechnical engineer's review of proposed procedures and equipment. It will sometimes be necessary to pump concrete to the bottom of the pier hole and fill the hole with concrete while maintaining the discharge end of the pump hose below the concrete/water interface. The purpose of this procedure is to minimize the mixing of fresh concrete and groundwater.

8. All loose soils and cuttings that accumulate in the bottom of the pier excavation should be removed prior to concrete placement. The importance of achieving clean pier excavation bottoms prior to concrete placement cannot be overemphasized.

9. Once drilling and cleaning is complete, the pier excavations should be observed by the geotechnical engineer, or his representative. If any additional drilling, cleaning, and/or dewatering are recommended by the geotechnical engineer, it should be performed prior to concrete placement. If pier excavations cannot be cleaned to the satisfaction of the geotechnical engineer, or his representative, the recommended allowable end bearing pressures may no longer be valid at those foundation locations.

10. Once drilling, cleaning, and/or dewatering of the excavations are sufficiently complete according to Item 8 above, concrete should be placed immediately.

11. Cast-in-place concrete piers should fill the entire hole. Falling concrete should be directed so that it does not come in contact with the sidewall of the excavation and so that it has minimal contact with reinforcing steel. Concrete may need to be placed with a tremie or concrete pump.

12. Concrete placed in pier excavations should have a slump of 6 to 8 inches, while at the same time maintaining minimum 28-day strength requirements. The concrete piers should fill the entire hole. If casing is used, it should be left in place until it has been filled with a sufficient head of concrete to prevent water infiltration, soil sloughing or creation of voids when it is withdrawn.

13. A 6-inch air void should be provided beneath all grade beams and pier caps to prevent uplift loads on the structure from swelling soils.

    Air voids beneath grade beams and pier caps can be provided by using commercially-available, collapsible, cardboard forms, "J voids", or "Sure-void." Consequently, grade beams and pier caps should be designed to carry all loads imposed upon each span between pier foundations.

14. The top portion of all piers should not be allowed to have "mushroom" tops. The contractor shall provide forms or sono-tube casing that match pier diameters for the top two feet (minimum) of piers if the top diameter of piers at the ground surface increases six inches or more due to loose soil sloughing.

LATERAL EARTH PRESSURES

1. Lateral load parameters are provided in the following table. All of the parameters assume the structure and soils are above the water table. The following parameters do not include a factor of safety. A minimum factor of safety of 2.0 is recommended for horizontal loading.

	Native sandy clay	Grading A Fill
Active Lateral Soil Pressure – for structures that can deflect without restraint by other structures. (equivalent fluid unit weight, pcf)	70	40
At-Rest Lateral Soil Pressure - for structures which have significant restraint against deflection. (equivalent fluid unit weight, pcf)	90	60
Passive Lateral Soil Pressure – resistance of soil abutting a structure. (equivalent fluid unit weight, pcf)	200	400
Coefficient of Friction between foundation and underlying soil	0.33	0.5
Soil Density, wet soil (pcf)	120	135

2. Where possible, foundations should be backfilled and compacted evenly on all sides to prevent horizontal movement. Foundation walls should be adequately braced prior to backfilling. Fill placed against retaining walls or basement walls should be carefully compacted with appropriate equipment to prevent excessive lateral pressures that may displace or damage the structure.

3. Surcharge loads, on the uphill side of the wall, due to ground slope, soil stockpiles, equipment, and structures, may significantly increase lateral forces on the wall and need to be fully evaluated.

4. Drains should be installed behind retaining walls or other confined areas where surface precipitation and runoff water can collect. Drains should be designed to prevent the build-up of hydrostatic pressures behind the retaining structures due to trapped water.

FLOOR SLABS

We understand that uranium-processing facilities are typically constructed in a manner such that the floors slab and stem walls are interconnected to serve as a containment area within the plant. Consequently, the floor slab system is sensitive to heave and cracking. We have included two options for a floor slab system within the processing plant. We anticipate the office will be much less sensitive to up heave; therefore, the floor slab can be supported on structural fill.

Structural fill support

1. The processing plant floor slab should be supported on a minimum of 36 inches of structural fill meeting the material and compaction requirements outlined in the Earthwork section above.

2. The office floor slab should be supported on a minimum of 24 inches of structural fill meeting the material and compaction requirements outlined in the Earthwork section above.

3. The top 6 inches of this fill (immediately beneath the floor slab) should be crushed aggregate base course (WYDOT Grading W) to provide a stable construction surface and to provide uniform slab support. The base course will not provide an effective capillary break of moisture rise to the slab.

4. For structural design of slabs-on-grade constructed as recommended in Item 1 above, a modulus of subgrade reaction, k, of 225 pci may be used.

Drilled pier supported structural slab

If a cost analysis determines additional drilled piers to be more efficient than hauling select fill to the remote location, then the floor slab can be supported on drilled piers. If the slab is supported on piers, a minimum 6-inch void should be constructed below the slab to prevent uplift.

Regardless of the pre-construction soil-moisture content, there is a potential for problematic infiltration of moisture upwards through the slab-on-grade floor. In this semi-arid climate, the moisture content of soil beneath buildings generally increases following construction. This is due to the reduction of evapotranspiration from the ground surface and the concentration of water around the building from irrigation and runoff from hard surfaces. Post-construction moisture infiltration through the slab may result in damage to flooring materials or may support growth of mold or other biologic materials in areas of poor ventilation. Installation of a moisture barrier beneath the slab should be considered by the building design professionals in light of the long-term service requirements for the building.

GENERAL

1. The measured water-soluble sulfate contents of 0 to greater than 2,000 ppm indicates that the soils are variable but can be very reactive with portland cement. According to American Concrete Institute (ACI) and Portland Cement Association (PCA) guidelines, concrete mixes should use Type V or equivalent cement and be formulated with a water/cementitious material ratio of less than 0.45.

   Sulfate attack is a chemical reaction between sulfates (SO4) and the cement, and can result in extensive cracking and disintegration of the concrete. Sulfate attack on concrete can occur

where soil and groundwater have high concentrations of sulfate and measures have not been taken to employ a sulfate resistant concrete mix.

2. Percolation tests were performed on six test holes within the planned drained field. Performing six tests allows the designer to use the average percolation rate for the drain field rather than the minimum. The average percolation rate was determined to be 2.41 minutes per inch of drop. The percolation rates ranged from 2.0 minutes per inch to 3.5 minutes per inch.

3. Rainwater discharge from the building roofs, parking, and drive areas should be directed toward collection points and disposed of away from the building and pavement in an adequate and efficient manner.

4. In order to promote drainage away from the building, we recommend that final exterior grades slope away from the building at a slope of 5 percent for a minimum distance of 10 feet.

5. In order to reduce the presence of moisture near the structure, landscaping should utilize plants and vegetation adjacent to the building that do not require much irrigation. Furthermore, sprinkler heads should not be placed closer than 10 feet from the structure.

6. In accordance with the International Building Code (IBC), 2003 Edition, Table 1615.1.1, we recommend site Class C for determination of design spectral response acceleration parameters per IBC. This class is based on Standard Penetration Resistance blow count numbers (N-values) per ASTM D1586 and the assumption that the subsurface soil conditions encountered in the test borings can be projected deeper into the earth to describe the average soil conditions for the top 100 feet. Class C describes the average soil properties for the top 100 feet as very dense soil and soft rock (Standard Penetration Test blow count, N > 50 or unconfined shear strength > 2,000 psf).

Inberg-Miller Engineers should review final plans and specifications in order to determine whether the intent of our recommendations has been properly implemented. In addition, we should be retained as the geotechnical engineer and construction materials testing agency to provide the following services:

a) Observe excavations to determine if subsurface conditions revealed are consistent with those discovered in the exploration.

b) Identify if the proper bearing stratum is exposed at proposed foundation excavation depths.

c) Observe that foundation excavations are properly prepared, cleaned, and dewatered prior to concrete placement.

d) Test compaction of subgrades and fills.

e) Perform field and laboratory testing of concrete and other materials as required by project specification and/or building code.

f) Observe drilled pier construction to identify suitable bearing strata and to observe pier construction including cleaning of pier bottoms and concrete placement.

CONSTRUCTION CONSIDERATIONS

No major difficulties are anticipated for conventional equipment during earthwork construction at the proposed site. We do not anticipate that groundwater will be encountered at the proposed foundation depths during construction. However, excavations should be protected from surface water run-off, whenever possible. Water accumulation within excavations should be promptly removed. If excavation bottoms become wet, excavation of soils beyond the minimum required depth may be necessary to provide a firm base for fill placement.

In all borings, drilling in sedimentary bedrock was difficult at times. Consequently, difficult pier drilling is expected in these strata during foundation installation operations. In addition, sloughing of the upper overburden will likely occur in pier excavations. The drilling contractor should be prepared to case all pier excavations full-depth and dewater holes in order to achieve recommended depths. Regardless of the pier drilling conditions, the importance of achieving adequate foundation stratum penetration for the capacities provided cannot be overemphasized. The pier-drilling subcontractor should be prepared with the appropriate equipment (adequate size and torque) to construct the foundations as recommended. Since the foundation construction is early in the sequence of events, which must take place to facilitate the construction schedule, the importance of retaining a qualified foundation drilling subcontractor for the project cannot be overemphasized. We recommend specific clauses be included in the project specifications requiring the foundation-drilling subcontractor to collect whatever additional information the foundation drilling subcontractor deems necessary to provide an informed bid.

Excavations should be sloped, benched, shored, or made safe for entry by use of trench boxes as required by the standards of 29 CFR Part 1926. As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance equal to the slope height, from the crest of the slope. The contractor is solely responsible for designing and constructing stable excavations. Furthermore, the contractor's "responsible person" should continuously evaluate the soil exposed in the excavations, the geometry of the excavation slopes, and the protective equipment and procedures employed by his forces. For the sole purpose of project planning, we recommend that sandy clay to depths of approximately 10 feet be considered an OSHA Type A soil. Excavations, including utility trenches, extending to depths of greater than 20 feet are required to have side slopes, trench boxes, or shoring designed by a professional engineer.

CLOSURE

This report has been prepared for the exclusive use of our client, AUC LLC, for evaluation of the site, design, and construction planning purposes of the described project. All information referenced in the Table of Contents, as well as any future written documents that address comments or questions regarding this report, constitute the "entire report". Inberg-Miller Engineers' conclusions, opinions, and recommendations are based on the entire report. This report may contain insufficient information for applications other than those herein described. Our scope of services was specifically designed for and limited to the specific purpose of providing geotechnical recommendations for the design of the proposed Reno Creek project. Consequently, this report may contain insufficient information for applications other than those herein described.

The scope of services for this project does not include any environmental or biological assessment of the site. If requested, we would be pleased to assist you with developing a scope of services for environmental assessment for the subject site. Wherever structures are in contact with soil, there is potential that soil moisture may penetrate the building and provide an opportunity for mold growth. While this report identifies soil moisture/groundwater conditions and may provide geotechnical recommendations for drainage and construction, the design of drains, water proof/resistant building elements, equipment to remove moisture from the building, or additional measures to prevent the growth of mold are beyond the scope of our geotechnical services. Implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent the growth of mold in or on the proposed building.

We appreciate participating in your project. We can offer services under a separate contract to provide environmental engineering services, review final plans and specifications, perform construction surveying, field and laboratory construction materials testing, and observe excavations, as may be required. Please call us at 307-577-0806 if you have any questions regarding this report.

INBERG-MILLER ENGINEERS

Ben Hauser, P.E., G.I.T.
Geotechnical Engineer

REVIEWED BY:

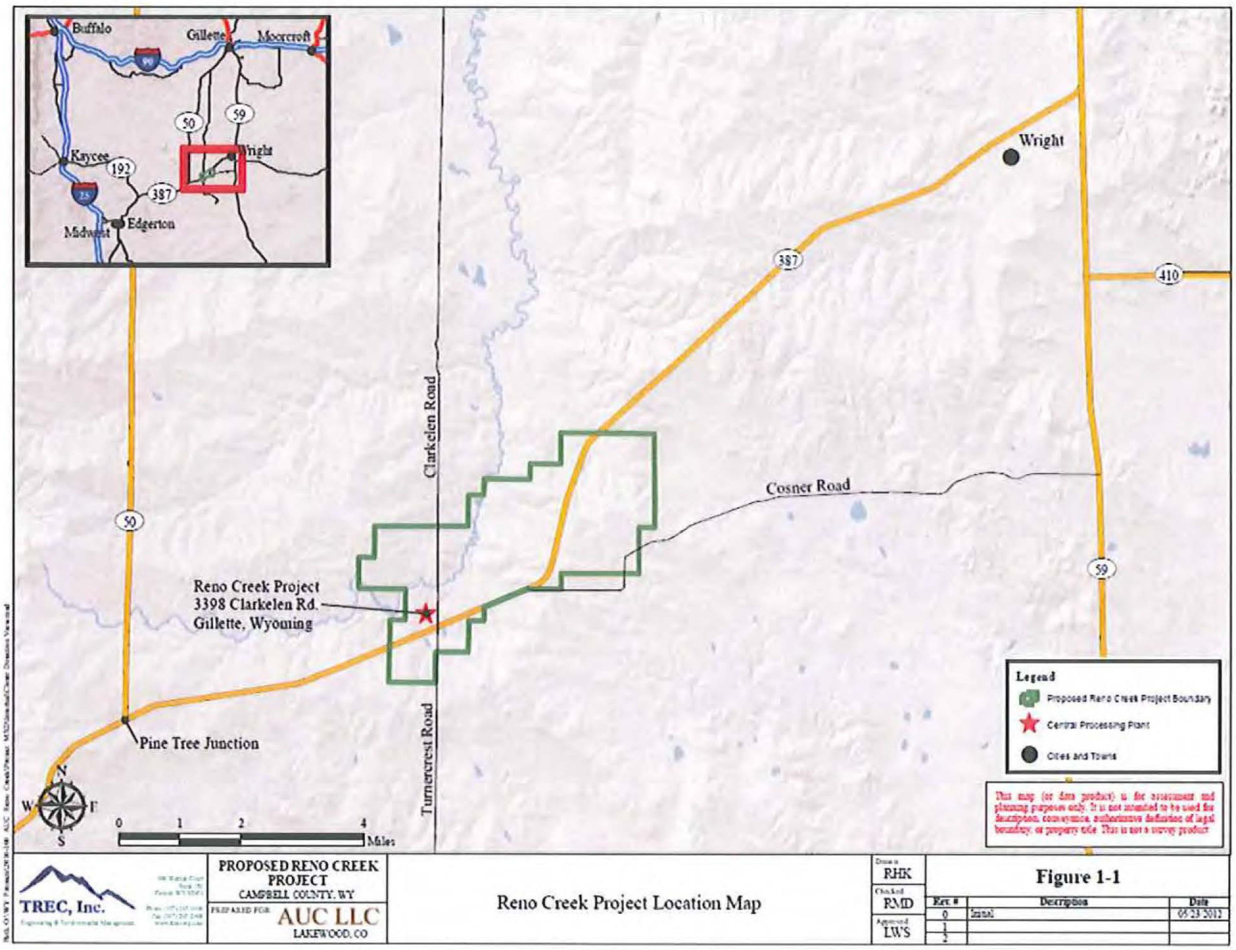
Derek J. Baker, P.E., P.G.
Geological Engineer

BH:llm\16216\Geotech\16216 CX rpt

Professional Engineer (Civil)
BEN HAUSER
13592
Date 7/9/12
WYOMING

APPENDIX A

Site Location Map

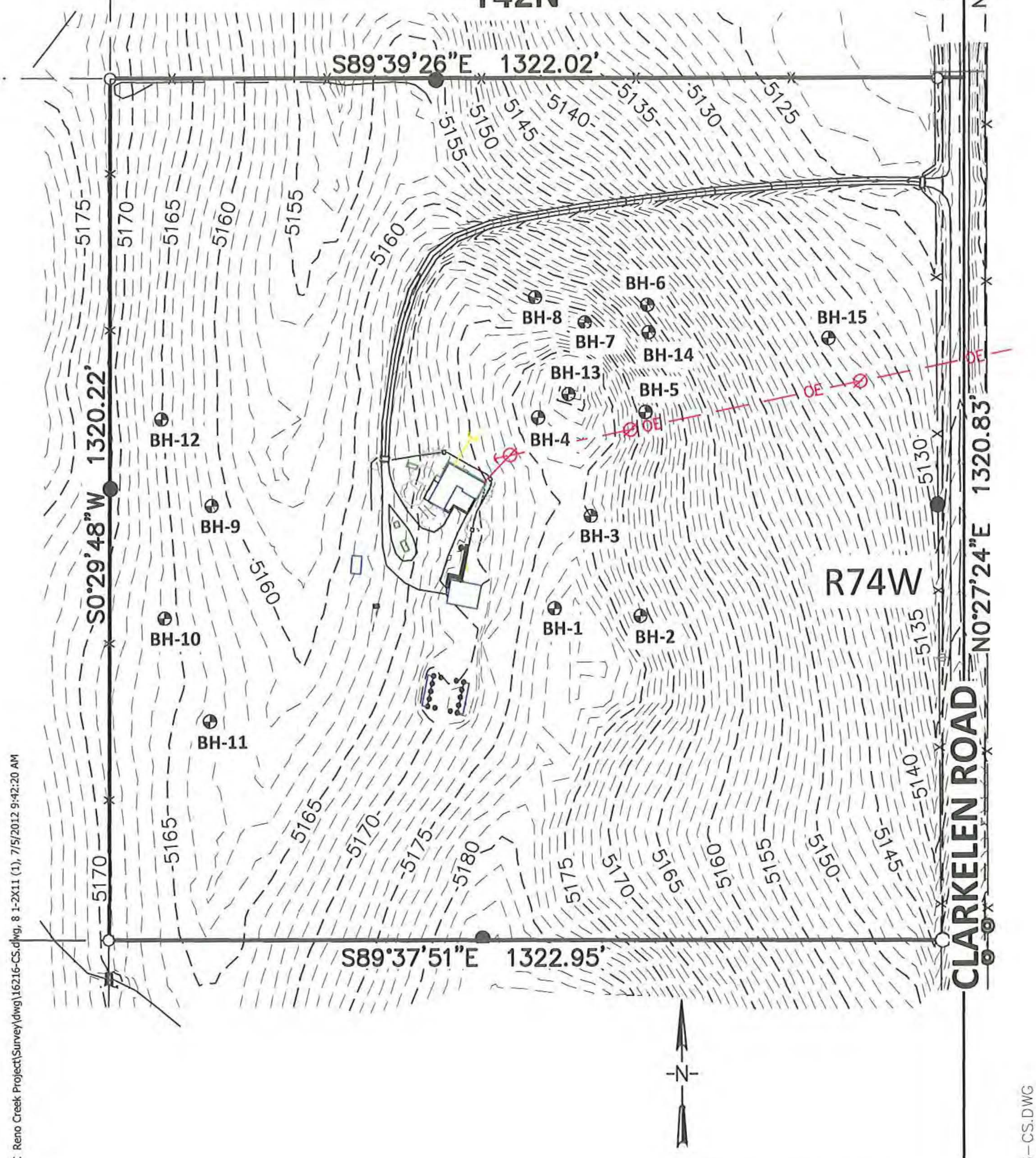


Source: TREC, Inc.

Site Observations

1.	Location of Site:	Approximately 1/4 mile northwest of the Clarkelen Road and WY Highway 387 intersection
2.	County/state:	Campbell County, Wyoming
3.	Slope of Ground Surface:	6H to 1V at the steepest location
4.	Downhill Direction:	The CPP is proposed for the top of a hill so all directions are down
5.	Est. Change of Surface Elevation:	Total across site 55 feet
6.	Bodies of Water Nearby:	None
7.	Topsoil Type:	Sandy clay
8.	Vegetation:	Sparse grass and sage brush
9.	Rock Outcrops:	Claystone outcrop noted between CPP and office
10.	Est. Depth to Bedrock:	Surface to approximately 20+ feet
11.	Artificial Fills:	None noted
12.	Type and Depth:	N/A
13.	Nearby Land Features:	None noted
14.	Present Site Improvements:	Currently a residence and welding shop occupy a portion of the site
15.	Buried Utilities On Site:	Water, septic, possibly gas
16.	Nearby Buildings:	Shop, shed, house
17.	Cond. of Nearby Foundations:	Good
18.	Cond. of Nearby Driveways/Walks:	Fair
19.	Buried Obstructions Encountered:	None
20.	History of Land Use:	Rangeland and industrial
21.	Existing Drainage Features:	Natural
22.	Overhead Utilities Crossing Site:	Electric
23.	Geologic Description of Site:	Completely weathered sediments to severely weathered bedrock of the tertiary Wasatch formation.

BORING LOCATION MAP



INBERG-MILLER ENGINEERS

124 East Main Street Riverton, WY 82501 307-856-8136	1120 East C Street Casper, WY 82601 307-577-0806	350 Parsley Boulevard Cheyenne, WY 82007 307-635-6827	428 Alan Road Powell, WY 82435 307-754-7170	193 West Flaming Gorge Way Green River, WY 82935 307-875-4394

SCALE	HORZ 1"=200'	VERT
DRN. MDH	BK: 1135	JOB NO. 16216-CS
CHK. BH	PAGE: 11+	DATE: 7/5/12

FILE: 16216-CS.DWG

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APPENDIX B

INBERG-MILLER ENGINEERS
IME
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B1

Project: Reno Creek
Location: WY State Plane 1145655, 518277
Job No.: 16216-CX
Client: AUC LLC

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION	GRAPHIC	SAMPLE TYPE RECOVERY	N BLOWS PER Ft	Qp (TSF)	% GRAVEL	% SAND	% -200	WATER CONTENT (PL, LL)	OTHER TESTS AND NOTES
		Surface Elevation (Ft): 5177.6			0 50 100					0 20 40 60	
	0	Hard, dry, light brown, sandy CLAY			30					9	
5175		2.5' Iron oxide staining			33		5	9	86	PL–LL	CL LL= 44 PL= 18 PI= 26
	5	5.5									WSS=1000-2000 ppm
		Hard, moist, reddish-brown, sandy CLAY, some iron oxide & gypsum			50/4					9	
5170					19					17	
	10										
		11' Grades to severly weathered CLAYSTONE with interbedded SILTSTONE			68					13	
5165											
	15				41					11	
5160											
	20	20.5									
		Dry, light-brown, fine SAND (Moderately weathered SANDSTONE) 21.5			50/3					6	
5155											

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

- ☒ Standard Penetration Test
- ☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 20.9

INBERG-MILLER ENGINEERS — IME — QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B2

Project: Reno Creek
Location: WY State Plane 1145642, 518410
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5171.3

Depth (ft)	Soil Description
0	Stiff to hard, dry, brown to reddish brown, sandy CLAY
	3' Some gypsum
	11.5' Thin <1" fine SAND layer
15.5	Medium dense, dry, light-brown, fine SAND
16.5	Hard, dry, brown, CLAY (severely weathered CLAYSTONE with iron oxide staining and fractures)
21.5	Thin 1" fine SANDSTONE layer

Elevation scale: 5170, 5165, 5160, 5155, 5150. Depth scale: 0, 5, 10, 15, 20.

Sample Type	N Blows per Ft	Water Content (%)	Other Tests and Notes
Standard Penetration Test	14	8	
Standard Penetration Test	15	9	
Drive Sampler	26	12	
Standard Penetration Test	58	7	LL= 68 PL= 25 PI= 44
Standard Penetration Test	34	13	Some organics
Standard Penetration Test	18	9	Some organics
Standard Penetration Test	63	11	

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

- Standard Penetration Test
- Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 21.9

INBERG-MILLER ENGINEERS — IME — QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B3

Project: Reno Creek
Location: WY State Plane 1145795, 518334
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5175.0

Elevation	Depth (ft)	Soil Description	Graphic	Sample Type / Recovery	N Blows per Ft	Qp (TSF)	% Gravel	% Sand	% -200	Water Content (PL, LL)	Other Tests and Notes
5175	0	Stiff to hard, dry, brown, sandy CLAY	Clay								
				Standard Penetration Test	12					6	
				Standard Penetration Test	11					9	
5170	5										
				Standard Penetration Test	31					9	
				Drive Sampler	35					6	
5165	10	10' Grades gray and hard (severely weathered CLAYSTONE with iron oxide staining on fractured surfaces some gypsum)		Standard Penetration Test	44		0	17	83	10	CH LL= 50 PL= 18 PI= 32
5160	15	15' Grades reddish-brown to dark-brown		Standard Penetration Test	61					22	Some organics
	19.5	Dry, light-gray SILTSTONE	Siltstone								Hard drilling
5155	20			Standard Penetration Test	50/3					8	
	21.5										
5150											

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

- ☒ Standard Penetration Test
- ☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 20.0

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B4

Project: Reno Creek
Location: WY State Plane 1145947, 518254
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5177.7

Elevation	Depth (ft)	Soil Description	Graphic	Sample Type / Recovery	N Blows per Ft (0–100)	Qp (TSF)	% Gravel	% Sand	% -200	Water Content (PL × LL) (0–60)	Other Tests and Notes
5177.7	0–10	Very stiff to hard, dry, brown, sandy CLAY		Standard Penetration Test	19, 16, 35, 43					9, 10, 13, 9	
	10–20.5	Hard, dry, gray to reddish brown, sandy CLAY (severely weathered organic rich CLAYSTONE)		Drive Sampler; Standard Penetration Test	50/3, 50					10, 16, 13	
	20.5–21	Dry, light-brown, very fine SAND									
	21–21.5	Moist, gray CLAYSTONE									

Elevation scale: 5175, 5170, 5165, 5160, 5155. Depth scale: 0, 5, 10, 15, 20.

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES
- ☒ Standard Penetration Test
- ☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 21.7

INBERG-MILLER ENGINEERS — IME — QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B5

Project: Reno Creek
Location: WY State Plane 1145954, 518421
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5168.0

Depth to bottom of layer (ft)	Soil Description
8	Stiff to hard, dry, brown, sandy CLAY
9	Dense, moist, brown, very fine SAND
14	Hard, moist, reddish-brown and gray CLAY (very severely weathered CLAYSTONE with iron oxide staining on fractures)
21.5	Dry, light-brown, very fine SAND (severely weathered SANDSTONE)

Columns: Elevation | Depth (ft) | Soil Description | Graphic | Sample Type Recovery | N Blows per Ft (0 50 100) | Qp (TSF) | % Gravel | % Sand | % -200 | Water Content (PL, LL) (0 20 40 60) | Other Tests and Notes

Sample	Sample Type	N Blows per Ft	Water Content (%)
1	Standard Penetration Test	10	7
2	Standard Penetration Test	30	8
3	Standard Penetration Test	42	13
4	Standard Penetration Test	30	12
5	Standard Penetration Test	32	28
6	Standard Penetration Test	85	10
7	Standard Penetration Test	51	7

Other Tests and Notes: WSS=<2000 ppm (at 8 ft)

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling (ft)	None

Depth to Cave In (Ft): 21.9

INBERG-MILLER ENGINEERS — Quality Solutions Through Teamwork

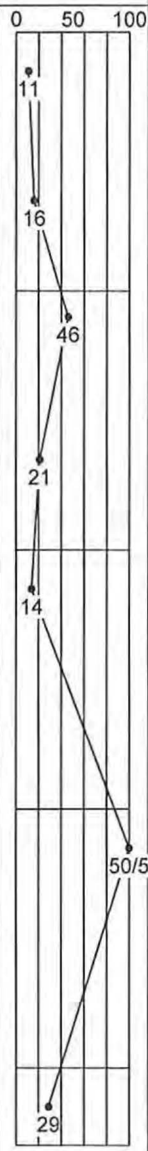
TEST BORING B6

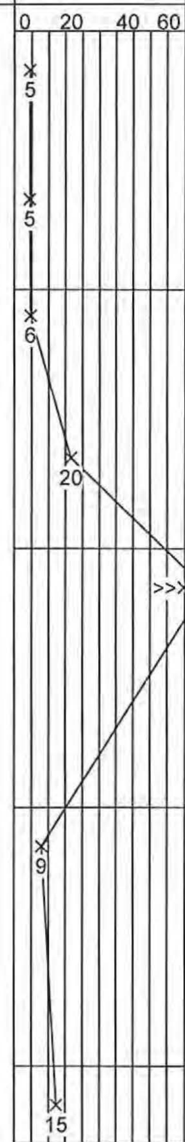
Project: Reno Creek
Location: WY State Plane 1146119, 518424
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5154.3

Elevation	Depth (ft)	Soil Description
5154.3	0 – 4	Stiff to very stiff, dry, brown, sandy CLAY
5150	4 – 8.5	Medium dense to dense, brown, moist, very fine SAND
5145	8.5 – 12	Very stiff, dry, brown, CLAY with iron oxide staining and some organics Lignite
5140	12 – 16	Dense, dry, light-brown, very fine SAND
5135	16 – 21.5	Hard, moist, gray, CLAY (severely weathered CLAYSTONE with iron oxide staining on fractures)

Columns: Elevation; Depth (ft); Soil Description; Graphic; Sample Type / Recovery; N Blows per Ft; Qp (TSF); % Gravel; % Sand; % -200; Water Content (PL, LL); Other Tests and Notes

N Blows per Ft


Water Content


Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

- ☒ Standard Penetration Test
- ☐ Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 21.5

INBERG-MILLER ENGINEERS — Quality Solutions Through Teamwork

TEST BORING B7

Project: Reno Creek
Location: WY State Plane 1146092, 518327
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5167.4

Elevation	Depth (ft)	Soil Description	Graphic	Sample Type / Recovery	N Blows per Ft	Qp (TSF)	% Gravel	% Sand	% -200	Water Content	Other Tests and Notes
	0	Firm to hard, dry to moist, brown, sandy CLAY		SPT	7					7	
5165				SPT	16					13	
	5			SPT	36					11	
5160				SPT	54					15	
	10	9' Grades reddish brown (severely weathered CLAYSTONE with iron oxide staining on fractures)		Drive Sampler	30					19	
5155	13	Very dense, dry, light-brown, very fine SAND (severely weathered SANDSTONE)									
	15			SPT	70					15	
5150	18	Hard, moist, gray and brown CLAY with some fine SAND (severely weathered CLAYSTONE)									
	20			SPT	50		0	11	89	14	CL LL= 48 PL= 21 PI= 26
	21.5										
5145											

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

- Standard Penetration Test
- Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 21.0

Inberg-Miller Engineers — Quality Solutions Through Teamwork

TEST BORING B8

Project: Reno Creek
Location: WY State Plane 1146131, 518250
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5164.8

Elevation	Depth (ft)	Soil Description
5164.8	0 – 13	Stiff to hard, dry, brown, sandy CLAY. 10' Grades to gray (severely weathered CLAYSTONE)
	13 – 21.5	Very dense, dry, light-brown, fine SAND (severely weathered SANDSTONE with interbedded CLAYSTONE)
	21.5	

Sample Type	N Blows per Ft	Water Content (%)
Standard Penetration Test	12	4
Standard Penetration Test	25	7
Standard Penetration Test	35	11
Standard Penetration Test	47	14
Standard Penetration Test	54	14
Standard Penetration Test	52	11
Standard Penetration Test	49	12

Columns: Elevation; Depth (ft); Soil Description; Graphic; Sample Type Recovery; N Blows per Ft (0, 50, 100); Qp (TSF); % Gravel; % Sand; % -200; Water Content (PL, LL) (0, 20, 40, 60); Other Tests and Notes

Elevation scale: 5160, 5155, 5150, 5145, 5140. Depth scale: 0, 5, 10, 15, 20.

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	ETG,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 21.9

NEW BORING LOG 16216-CX AUC RENO CREEK.GPJ INB_MLLR 6-23-10.GDT 7/9/12

TEST BORING B9

INBERG-MILLER ENGINEERS — Quality Solutions Through Teamwork

Project: Reno Creek
Location: WY State Plane 1145815, 517746
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5161.1

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION	SAMPLE TYPE	N BLOWS PER Ft	Qp (TSF)	% GRAVEL	% SAND	% -200	WATER CONTENT	PL	LL	OTHER TESTS AND NOTES
	0	Stiff, dry, brown, sandy CLAY										
5160			SPT	17					6			
			SPT	11					7			
5155	5		SPT	18		0	22	78	5	Δ	Δ	CL LL= 39 PL= 21 PI= 18
		7.5' Grades very fine clayey SAND	SPT	27					9			
5150	10	10' Grades gray	SPT	34					10			
	14	Very stiff, moist, dark-brown, CLAY with lignite										
5145	15		SPT	28					12			
5140	20		SPT	28					37			
	21.5											

Remarks:

Date Begun:	6/13/12
Date Completed:	6/13/12
Termination Depth (ft):	21.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 21.3

INBERG-MILLER ENGINEERS
QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B10

Project: Reno Creek
Location: WY State Plane 1145643, 517672
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5165.7

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION	SAMPLE TYPE	N BLOWS PER Ft	Qp (TSF)	% GRAVEL	% SAND	% -200	WATER CONTENT	OTHER TESTS AND NOTES
5165	0–7	Stiff, moist, dark-brown, sandy CLAY	SPT	16					6	
			SPT	12					5	
5160			SPT	40					4	
	7	Hard, moist, gray CLAY (iron oxide staining)	SPT	35		0	10	90	13	CH LL= 68 PL= 25 PI= 44
5155	10	10' Grades to include lignite	Drive Sampler	20					42	
5150	15	15' Grades to (severely weathered CLAYSTONE)	SPT	50/5					19	
5145	20–21.5		SPT	51					17	

Remarks:

Date Begun: 6/14/12
Date Completed: 6/14/12
Termination Depth (ft): 21.5
Crew: BH,BWH,JLH
Rig: CME-85
Method: Solid-Stem Auger
Benchmark/Datum (Ft):

SAMPLE TYPES
- Standard Penetration Test
- Drive Sampler, 2.41-I.D.

WATER LEVEL OBSERVATIONS
- While Drilling (ft): None
- End of Drilling(ft): None

Depth to Cave In (Ft): 21.0

INBERG-MILLER ENGINEERS — IME — Quality Solutions Through Teamwork

TEST BORING B11

Project: Reno Creek
Location: WY State Plane 1145485, 517741
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5163.5

Elevation	Depth (ft)	Soil Description	Graphic	Sample Type / Recovery	N Blows per Ft	Qp (TSF)	% Gravel	% Sand	% -200	Water Content (%)	Other Tests and Notes
	0	Stiff, dry, brown, sandy CLAY									
				SPT	11					6	
5160				SPT	17		0	24	76	5	CL LL= 49 PL= 18 PI= 30
	4.5	Very stiff to hard, moist, gray CLAY									
				SPT	21					12	
5155				SPT	28					13	
	10			SPT	58					8	
5150	15			SPT	42					6	
5145	20			SPT	14					18	
	21.5	21.5' Grades to lignite									
5140											

Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	21.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 21

INBERG-MILLER ENGINEERS — QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B12

Project: Reno Creek
Location: WY State Plane 1145948, 517669
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5165.0

ELEVATION	DEPTH (ft)	SOIL DESCRIPTION	GRAPHIC	SAMPLE TYPE RECOVERY	N BLOWS PER Ft	Qp (TSF)	% GRAVEL	% SAND	% -200	WATER CONTENT	OTHER TESTS AND NOTES
5165	0	Stiff, dark-brown, sandy CLAY									
				☒	12					7	
				☒	11					6	
5160	5										
				☒	20		0	42	58	6	CL LL= 36 PL= 10 PI= 26
		Grades more clay and less sand									
				☒	14					12	
		Grades more sand and less clay									
5155	10										
				☒	25		0	46	54	7	CL LL= 31 PL= 18 PI= 14
5150	15										
				☒	46					11	
	18	Hard, moist, dark-brown, CLAY with lignite									
5145	20										
				☒	29					18	
	21.5										
5140											

N BLOWS PER Ft scale: 0, 50, 100. WATER CONTENT scale: 0, 20, 40, 60 (× water content; PL △—△ LL).

Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	21.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

▽ While Drilling (ft)	None
▼ End of Drilling(ft)	None

Depth to Cave In (Ft): 21.5

INBERG-MILLER ENGINEERS — QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B13

Project: Reno Creek
Location: WY State Plane 1145983, 518301
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5181.4

Elevation	Depth (ft)	Soil Description	Graphic	Sample Type / Recovery	N Blows per Ft	Qp (TSF)	% Gravel	% Sand	% -200	Water Content (PL / LL)	Other Tests and Notes
5181.4	0										
	5–11.5	Hard, moist, olive CLAY (severely weathered CLAYSTONE)		SPT	64 (at ~5.5 ft)					11	
				SPT	79 (at ~10.5 ft)					12	
	11.5	(bottom of boring)									

Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	11.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling (ft)	None

Depth to Cave In (Ft): 11.5

INBERG-MILLER ENGINEERS — IME — QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B14

Project: Reno Creek
Location: WY State Plane 1146077, 518426
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5157.4

Elevation	Depth (ft)	Soil Description	Graphic	Sample Type / Recovery	N Blows per Ft	Water Content (%)	Other Tests and Notes
	0–2.5	Stiff, dark-brown, sandy CLAY		SPT	11	5	
5155	2.5–9.5	Medium dense to very dense, dry, tan, very fine SAND		SPT	12	7	
				SPT	38	6	WSS=0-50 ppm
5150				SPT	57	10	
	9.5–19	Hard, slight-moist, dark-brown CLAY with lignite		SPT	40	15	
5145							
				SPT	42	49	
5140							
	19–21.5	Very dense, dry, tan, very fine SAND (severely weathered SANDSTONE)		SPT	50/3	11	
5135							

Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	21.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None

Depth to Cave In (Ft): 21

INBERG-MILLER ENGINEERS — QUALITY SOLUTIONS THROUGH TEAMWORK

TEST BORING B15

Project: Reno Creek
Location: WY State Plane 1146066, 518704
Job No.: 16216-CX
Client: AUC LLC

Surface Elevation (Ft): 5133.6

Elevation	Depth (ft)	Soil Description	Sample Type	N Blows per Ft	Qp (TSF)	% Gravel	% Sand	% -200	Water Content (%)	Other Tests and Notes
	0	Stiff, moist, tan, sandy CLAY								
			SPT	5					5	
5130	5		SPT	21		0	19	81	9	CL LL= 42 PL= 18 PI= 24
5125	10		SPT	18					11	
5120	14	Medium dense, moist, brown, clayey SAND								
	15		SPT	20					9	
	16.5	(Termination)								
5115	20									
5110										

Remarks:

Date Begun:	6/14/12
Date Completed:	6/14/12
Termination Depth (ft):	16.5
Crew:	BH,BWH,JLH
Rig:	CME-85
Method:	Solid-Stem Auger
Benchmark/Datum (Ft):	

SAMPLE TYPES

☒ Standard Penetration Test

WATER LEVEL OBSERVATIONS

While Drilling (ft)	None
End of Drilling(ft)	None
	None
Depth to Cave In (Ft):	16

GENERAL NOTES - LOG OF TEST BORING/TEST PIT

DESCRIPTIVE SOIL CLASSIFICATION

Grain Size Terminology

Soil Fraction		Particle Size	U.S. Standard Sieve Size
Boulders		Larger than 12"	Larger than 12"
Cobbles		3" to 12"	3" to 12"
Gravel:	Coarse	3/4" to 3"	3/4" to 3"
	Fine	4.76mm to ¾"	#4 to ¾"
Sand:	Coarse	2.00mm to 4.76mm	#10 to #4
	Medium	0.42mm to 2.00mm	#40 to #10
	Fine	0.074mm to 0.42mm	#200 to #40
Silt		0.005mm to 0.074mm	Smaller than #200
Clay		Smaller than 0.005mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay

Relative Density

Term	"N" Value*
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Consistency

Term	q_u-tons/sq. ft.
Very Soft	0.0 to 0.25
Soft	0.25 to 0.5
Firm	0.5 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

*Note: The penetration number, N, is the summation of blows required to effect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140-pound weight falling 30", and is seated to a depth of 6" before commencing the standard penetration test.

DESCRIPTIVE ROCK CLASSIFICATION

Engineering Hardness Description of Rock

(not to be confused with MOH's scale for minerals)

Very Soft	Can be carved with a knife. Can be excavated readily with point of pick. Pieces one inch or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Medium Soft	Can be grooved or gouged 1/16-inch deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-inch-maximum size by hard blows of the point of a geologist's pick.
Medium Hard	Can be scratched with knife or pick. Gouges or grooves to ¼-inch deep. Can be excavated by hard blow of a geologist's pick. Hand specimens can be detached by moderate blow.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.

NOMENCLATURE

Drilling and Sampling

SS -- Split Barrel (spoon) Sampler

N -- Standard Penetration Test Number, blows/foot*

ST -- Thin-walled Tube (Shelby Tube) Sampler

DC -- Thick-wall, ring lined, drive sampler

C -- Coring

DP -- Direct Push Sampler

CS -- Continuous Sampler (used in conjunction with hollow stem auger drilling)

D -- Disturbed Sample (auger cuttings, air/wash rotary cuttings, backhoe, shovel, etc.)

Laboratory Tests

USCS -- Unified Soil Classification System (soil type)

W -- Water Content (%)

LL -- Liquid Limit (%)

PL -- Plastic Limit (%)

PI -- Plasticity Index (LL-PL) (%)

q_u -- Unconfined Strength, TSF

q_p -- Penetrometer Reading (estimate of unconfined strength), TSF

γ_m -- Moist Unit Weight, PCF

γ_d -- Dry Unit Weight, PCF

WSS -- Water Soluble Sulfate (%)

Φ -- Angle of Internal Friction (degrees)

c -- Soil Cohesion, TSF

SG -- Specific gravity of soil solids

S -- Degree of Saturation (%)

e -- Void Ratio

n -- Porosity

k -- Permeability (cm/sec)

Water Level Measurement

▼ -- Water Level at Time Shown

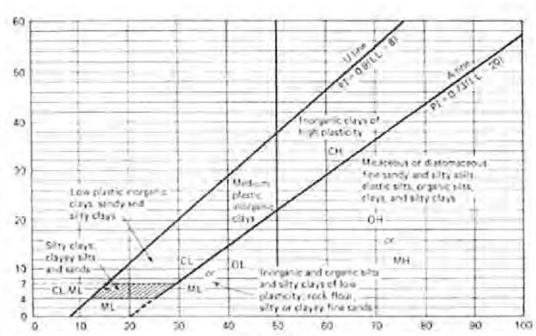
Note: Water level measurements shown on the boring logs represent conditions at the time indicated, and may not reflect static levels, especially in cohesive soils. The available water level information is given at the bottom of each log.

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D2487-69 and D2488-69
(Unified Soil Classification System)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-Grained Soils (More than half of material is larger than No. 200 sieve size)	**Gravels** (More than half of coarse fraction is larger than No. 4 sieve size)	**Clean Gravels** (Little or no fines)	GW		Well graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 % GW,GP, SW, SP; More than 12% GM, GC, SM, SC	$C_u = \frac{D_{60}}{D_{10}}$ *greater than* 4; $C_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$ *between* 1 & 3	
			GP		Poorly Graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels w/ Fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	**Clean Sands** (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ *greater than* 6; $C_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$ *between* 1 & 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands w/ Fines (Appreciable mount of fines)	SM[a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
Fine-Grained Soils (More than half material is smaller than No. 200 sieve size)	**Silts and Clays** (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	**Plasticity Chart** (see below)		
			CL		Inorganic clays of low to medium plasticity, gravelly, clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic Soils		P_t		Peat and other highly organic soils			

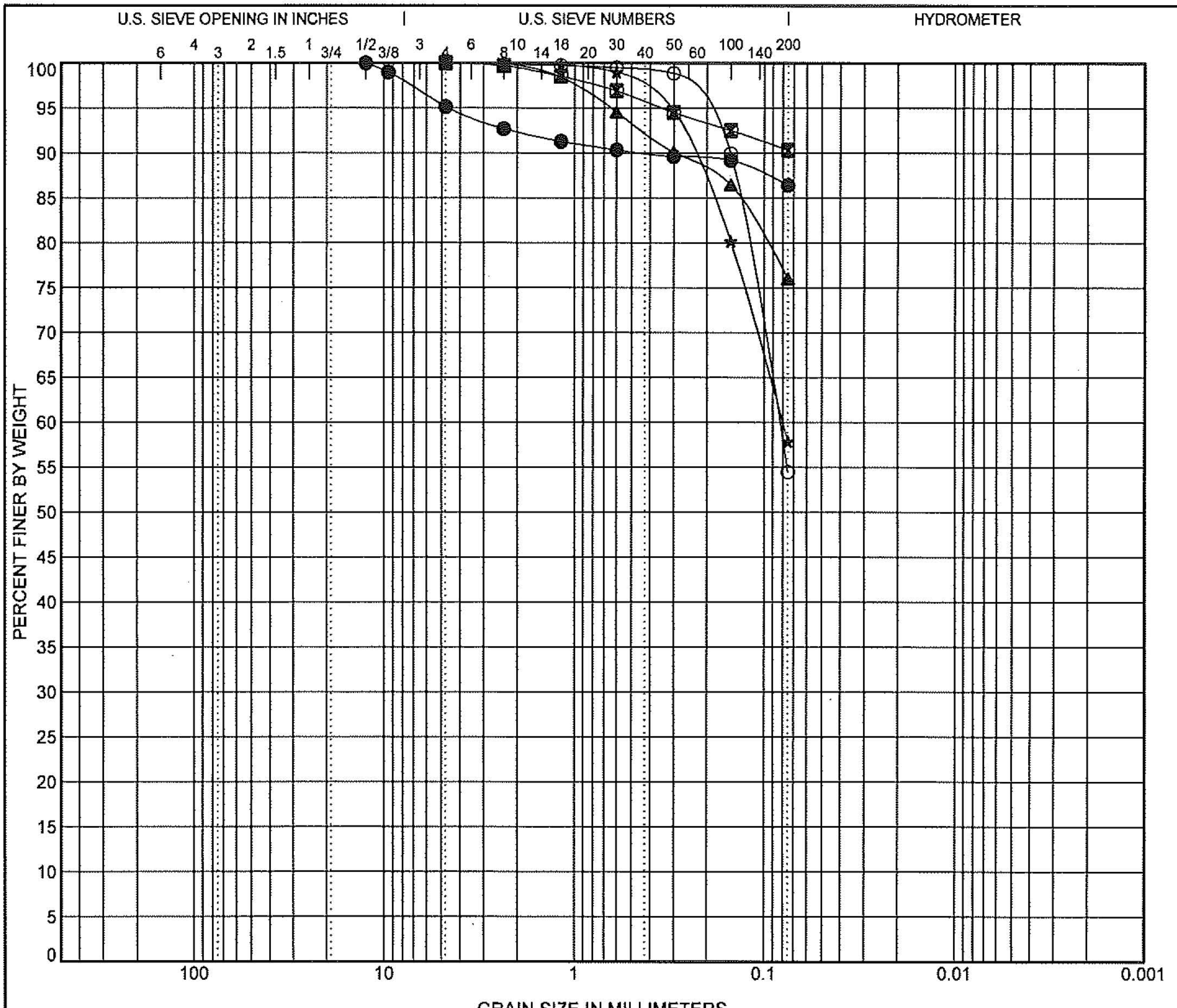
Plasticity Chart



[a] Division of GM and SM groups into subdivision of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

APPENDIX C



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B1	2.5	**LEAN CLAY(CL)**	44	18	26		
⊠	B10	7.5	**FAT CLAY(CH)**	68	25	43		
▲	B11	2.5	**LEAN CLAY with SAND(CL)**	49	18	31		
★	B12	5.0	**SANDY LEAN CLAY(CL)**	36	10	26		
⊙	B12	10.0	**SANDY LEAN CLAY(CL)**	31	18	13		

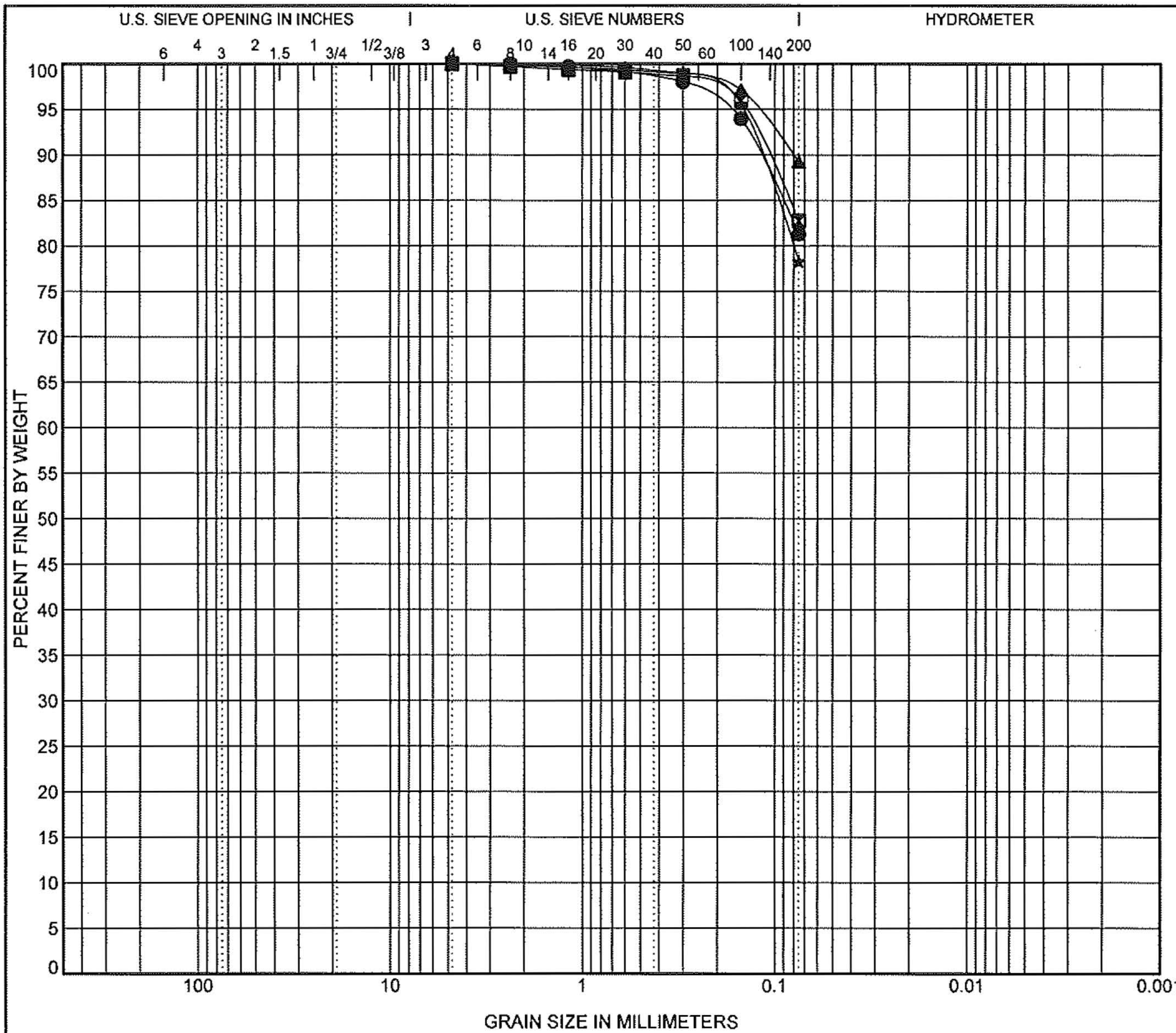
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B1	2.5	12.5				4.8	8.7	86.5	
⊠	B10	7.5	4.75				0.0	9.7	90.3	
▲	B11	2.5	4.75				0.0	24.0	76.0	
★	B12	5.0	4.75	0.08			0.0	42.1	57.9	
⊙	B12	10.0	4.75	0.084			0.0	45.5	54.5	

PROJECT: Reno Creek
JOB NO.: 16216-CX
CLIENT: AUC LLC
TEST METHOD: ASTM D422

PARTICLE SIZE ANALYSES

US_GRAIN_SIZE 16216-CX AUC RENO CREEK.GPJ US_LAB.GDT 7/9/12

INBERG-MILLER ENGINEERS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B15**	**5.0**	**LEAN CLAY with SAND(CL)**	**42**	**18**	**24**		
⊠	**B3**	**10.0**	**FAT CLAY with SAND(CH)**	**50**	**18**	**32**		
▲	**B7**	**20.0**	**LEAN CLAY(CL)**	**48**	**21**	**27**		
★	**B9**	**5.0**	**LEAN CLAY with SAND(CL)**	**39**	**21**	**18**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B15**	**5.0**	**4.75**				**0.0**	**18.7**	**81.3**	
⊠	**B3**	**10.0**	**4.75**				**0.0**	**17.2**	**82.8**	
▲	**B7**	**20.0**	**4.75**				**0.0**	**10.8**	**89.2**	
★	**B9**	**5.0**	**4.75**				**0.0**	**21.7**	**78.3**	

PROJECT: Reno Creek
JOB NO.: 16216-CX
CLIENT: AUC LLC
TEST METHOD: ASTM D422

PARTICLE SIZE ANALYSES

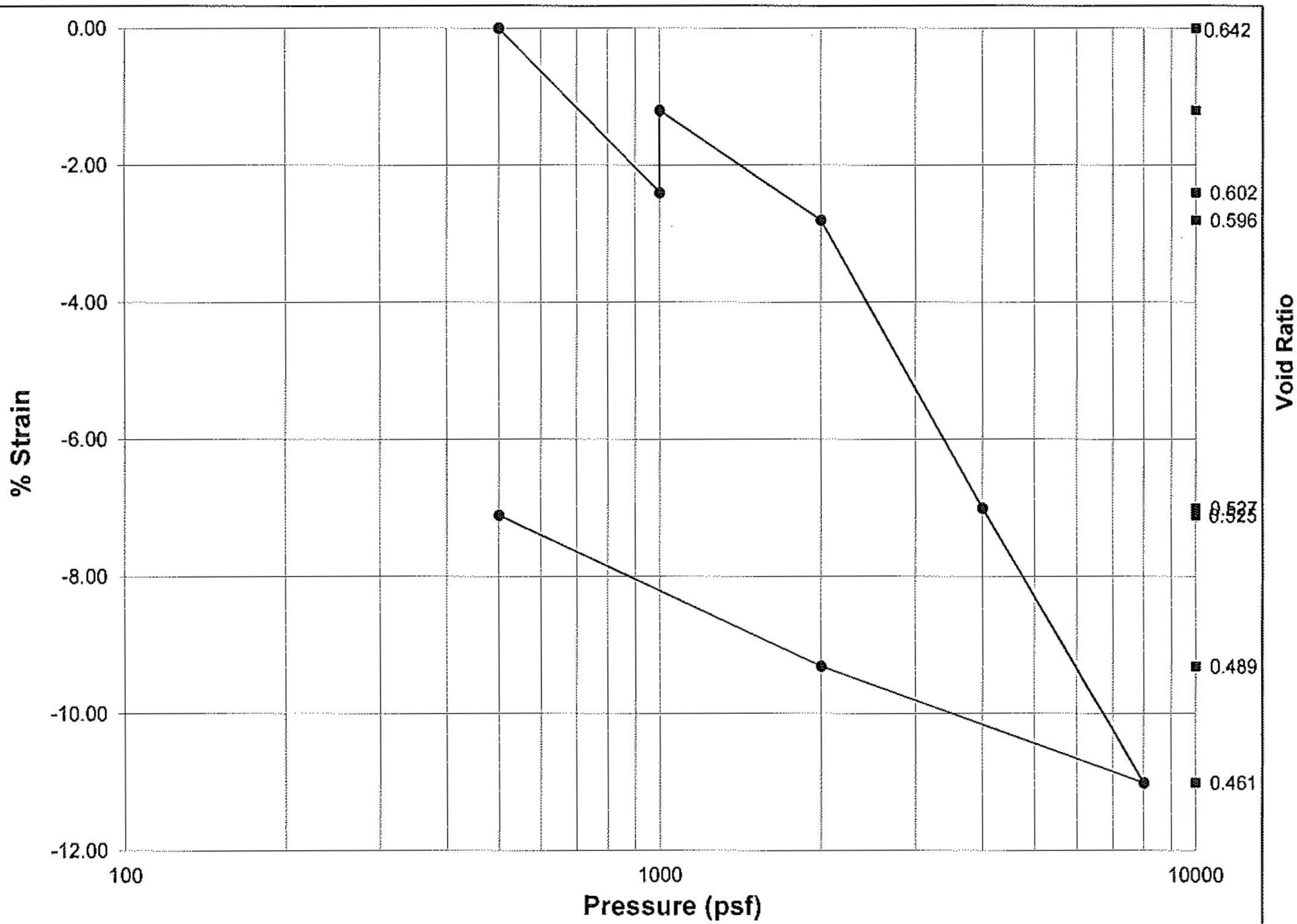
US_GRAIN_SIZE 16216-CX AUC RENO CREEK.GPJ US_LAB.GDT 7/9/12

INBERG-MILLER ENGINEERS

CONSOLIDATION-SWELL TEST

ASTM D2435

Project:	Reno Creek Project	Client:	AUC LLC
Job No:	16216-CX	Test Date:	6/1/12
Boring No:	1	Depth (ft):	7.5



Soil Description: Claystone

Liquid Limit (%):

Plastic Limit (%):

Plasticity Index (%):

	Initial	Final
Moisture Content:	12.0%	22.0%
Saturation:	51%	108%
Wet Density (pcf):	114.9	132.5
Dry Density (pcf):	102.6	108.6

Specimen Diameter:	2.4125	in.
Specimen Height:	1.00	in.
Overburden Pressure (Po):	860	psf
Preconsolidation Pressure (Pp):	2700	psf
Overconsolidation Ratio: (OCR = pp/po)	3.1	
Comp. Index (Cc):	0.218	
Consol. Index (Cr):	0.002	

Swell Pressure: 1800 psf

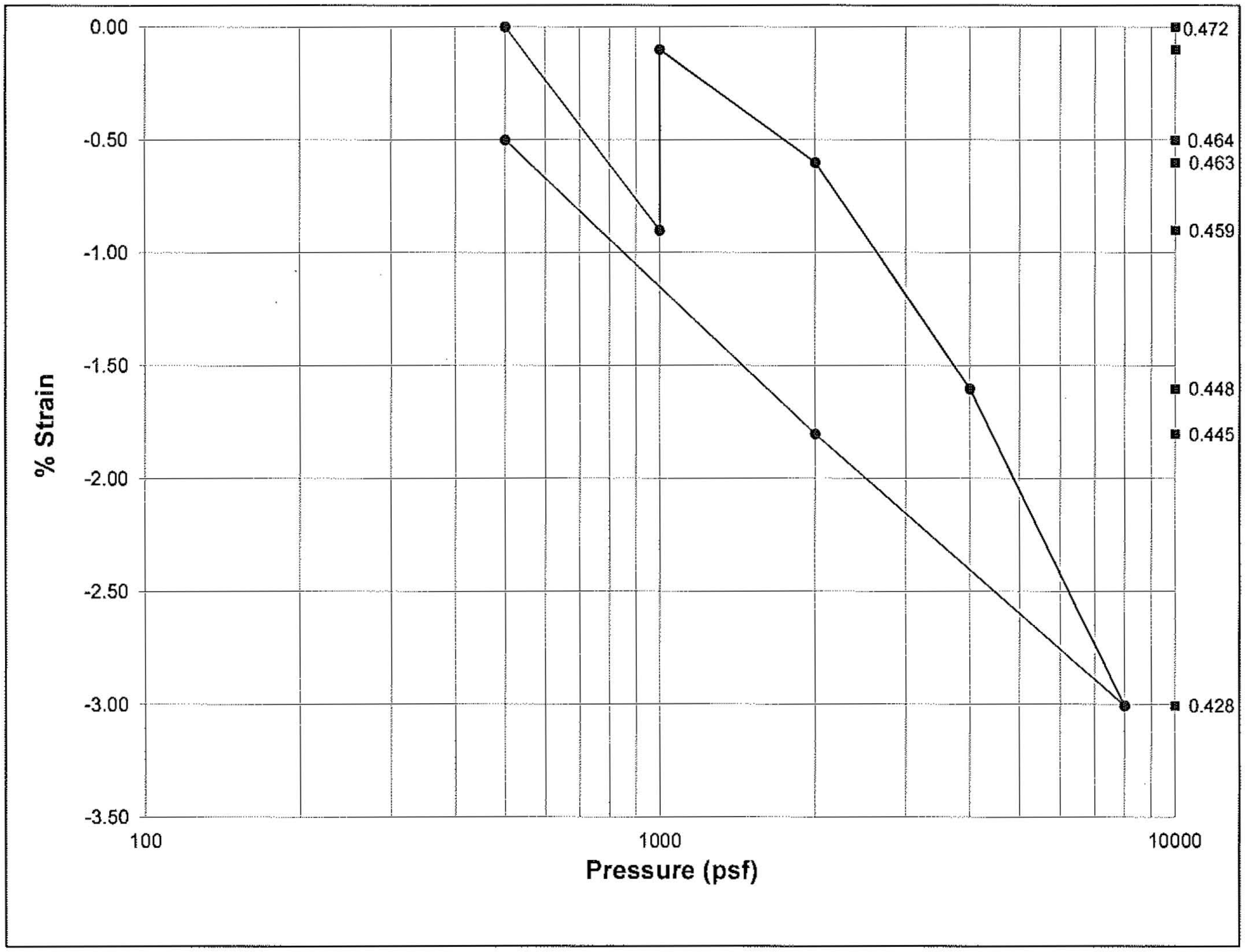
Percent Swell or Collapse*: 1.23% (- indicates collapse) Pressure when wetted: 1000 psf

INBERG-MILLER ENGINEERS

CONSOLIDATION-SWELL TEST

ASTM D2435

Project:	Reno Creek Project	Client:	AUC LLC
Job No:	16216-CX	Test Date:	6/15/12
Boring No:	4	Depth (ft):	10



Soil Description: Claystone

Liquid Limit (%):

Plastic Limit (%):

Plasticity Index (%):

	Initial	Final
Moisture Content:	10.6%	16.5%
Saturation:	61%	100%
Wet Density (pcf):	126.6	135.5
Dry Density (pcf):	114.5	116.3

Specimen Diameter:	2.4075	in.
Specimen Height:	1.00	in.
Overburden Pressure (Po):	1265	psf
Preconsolidation Pressure (Pp):	3300	psf
Overconsolidation Ratio: (OCR = pp/po)	2.6	
Comp. Index (Cc):	0.069	
Consol. Index (Cr):	0.018	

Swell Pressure: 2400 psf

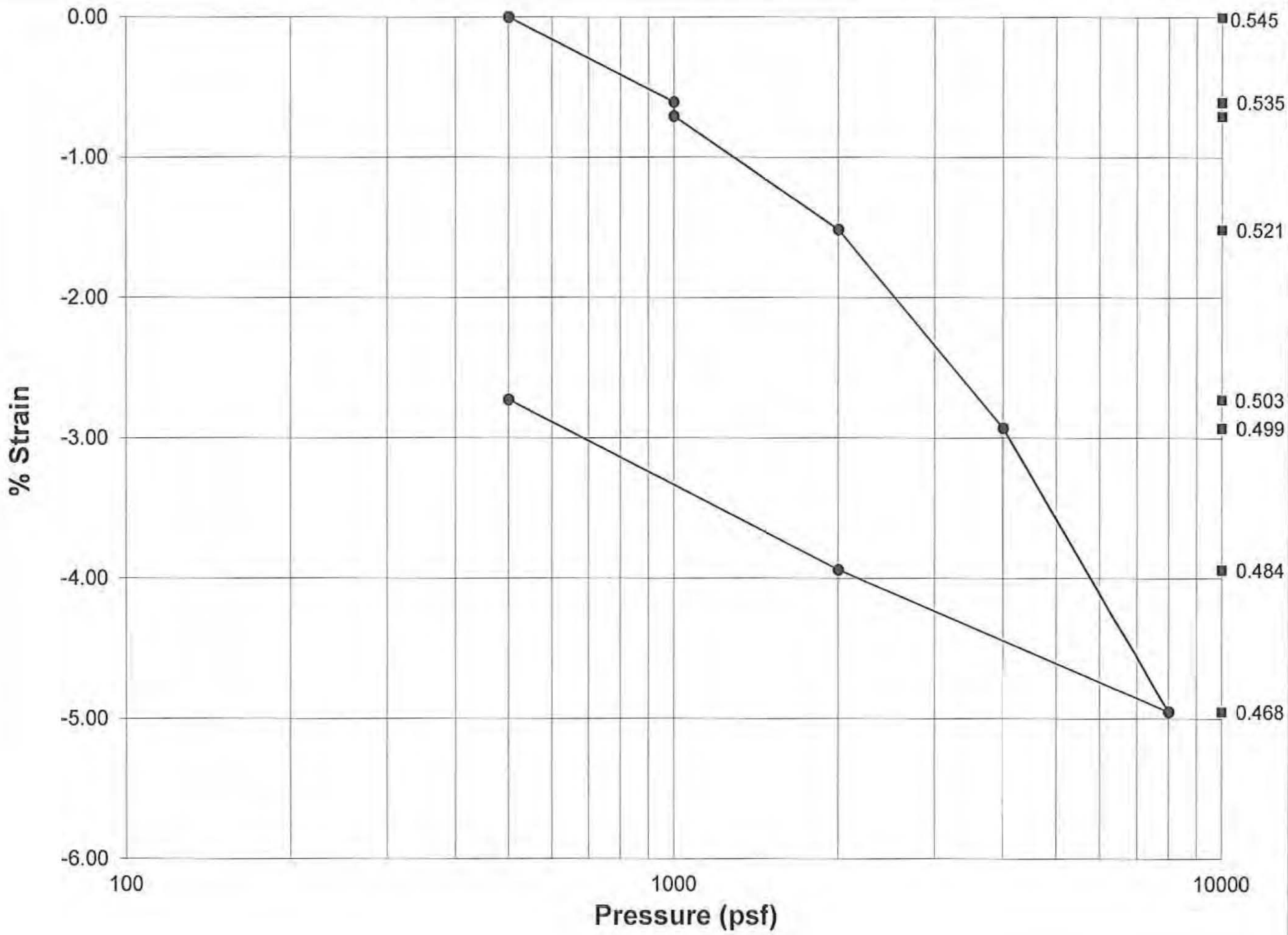
Percent Swell or Collapse*: 0.81% (- indicates collapse) Pressure when wetted: 1000 psf

INBERG-MILLER ENGINEERS

CONSOLIDATION-SWELL TEST

ASTM D2435

Project:	Reno Creek Project	Client:	AUC LLC
Job No:	16216-CX	Test Date:	6/15/12
Boring No:	6	Depth (ft):	5



Soil Description: Very Fine Sand

Specimen Diameter:	2.41	in.
Specimen Height:	0.99	in.
Overburden Pressure (Po):	550	psf
Preconsolidation Pressure (Pp):	3000	psf
Overconsolidation Ratio: (OCR = pp/po)	5.5	
Comp. Index (Cc):	0.104	
Consol. Index (Cr):	0.003	

Liquid Limit (%):

Plastic Limit (%):

Plasticity Index (%):

	Initial	Final
Moisture Content:	2.0%	22.2%
Saturation:	10%	97%
Wet Density (pcf):	110.4	126.6
Dry Density (pcf):	108.3	103.5

Swell Pressure: psf

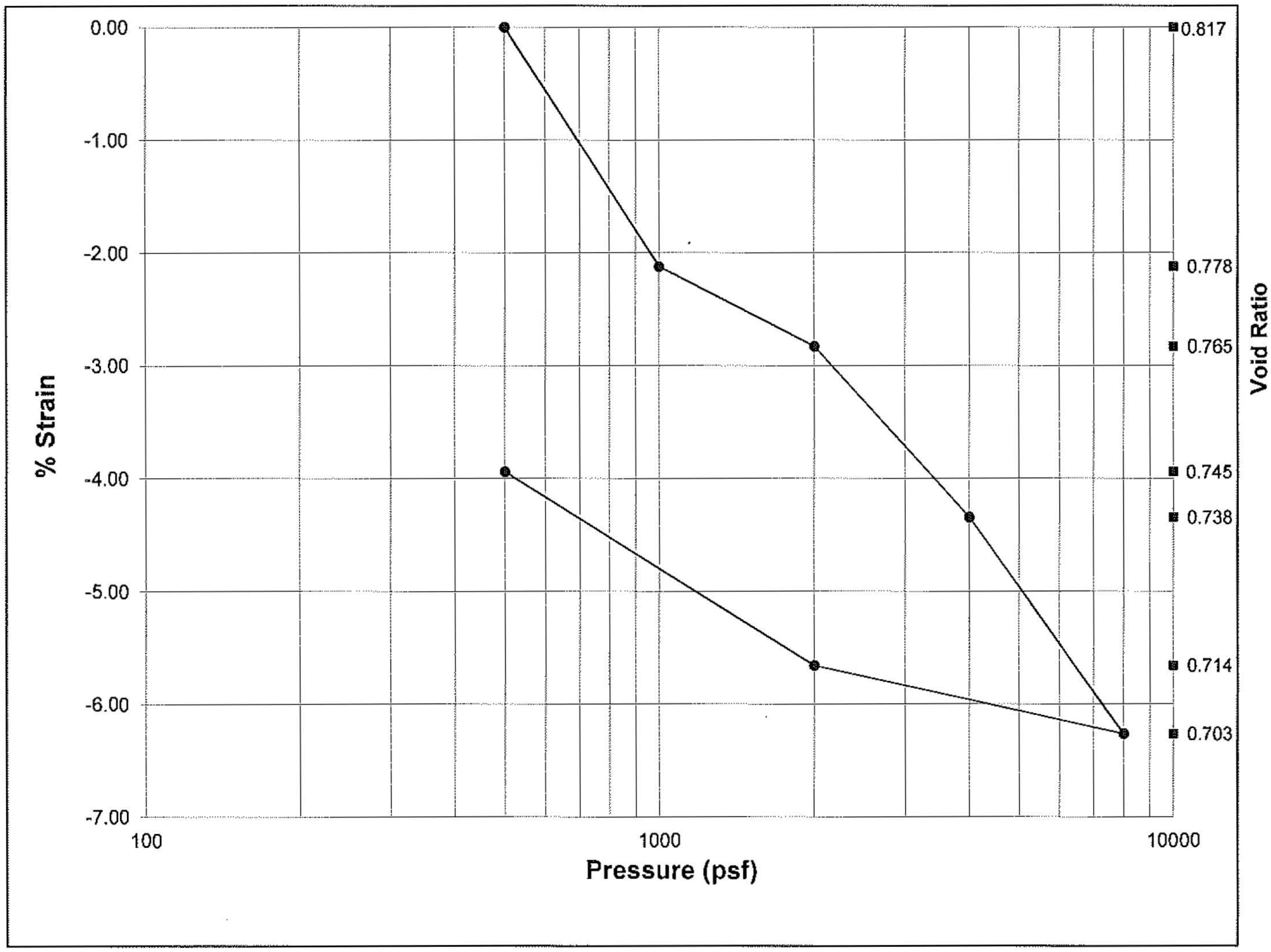
Percent Swell or Collapse*: -0.10% (- indicates collapse) Pressure when wetted: 1000 psf

INBERG-MILLER ENGINEERS

CONSOLIDATION-SWELL TEST

ASTM D2435

Project:	Reno Creek Project	Client:	AUC LLC
Job No:	16216-CX	Test Date:	6/15/12
Boring No:	7	Depth (ft):	10



Soil Description:	Claystone		Specimen Diameter:	2.41	in.
			Specimen Height:	0.99	in.
Liquid Limit (%):			Overburden Pressure (Po):	1175	psf
Plastic Limit (%):			Preconsolidation Pressure (Pp):	3300	psf
Plasticity Index (%):			Overconsolidation Ratio: (OCR = pp/po)	2.8	
	Initial	Final			
Moisture Content:	28.0%	66.9%	Comp. Index (Cc):	0.116	
Saturation:	92%	150%	Consol. Index (Cr):	0.008	
Wet Density (pcf):	117.8	127.3			
Dry Density (pcf):	92.1	76.3			

Swell Pressure: psf

Percent Swell or Collapse*: (- indicates collapse) Pressure when wetted: 1000 psf

INBERG-MILLER ENGINEERS

APPENDIX D

LIMITATIONS AND USE OF THIS REPORT

This report has been prepared by Inberg-Miller Engineers, hereinafter referred to as "IME", to evaluate this property for the intended use described herein. If any changes of the facility are planned with respect to the design vertical position or horizontal location as outlined herein, we recommend that the changes be reviewed, and the conclusions and recommendations of this report be modified in writing by IME.

The analyses and recommendations submitted in this report are our opinions based on the data obtained, and subsurface conditions noted from the field exploration. The locations of the exploration are illustrated on the accompanying map and diagram. Any variations that may occur between, beyond, or below the depths of test borings or test pits, are not presented in this report because these areas were not specifically explored. Excavations during the construction phases may reveal variations from subsurface conditions identified in our exploration. The nature and extent of such variations may not become evident until excavation and construction begins. If variations appear evident during construction, we advise a re-evaluation of the recommendations in this report. After performing additional on-site observations, we can provide an addendum to our recommendations noting the characteristics of any variations.

IME is responsible for the conclusions and opinions contained in this report based on the supplied data relative only to the specific project and location outlined in this report. If conclusions or recommendations are made by others, IME should be given an opportunity to review and comment on such conclusions or recommendations in writing, prior to the completion of the project design phase.

It is recommended that IME be provided the opportunity to review final designs, plans, and specifications using the conclusions of this report, in order to determine whether any change in concept may have any effect on the validity of the recommendations contained in this document. If IME is accorded the privilege of this review, IME can assist in avoiding misinterpretation or misapplication of these recommendations if changes have been made as compared with IME's understanding of either the project or design content. Review of the final design, plans, and specifications will be noted in writing by IME upon client's request, and will become a part of this report.

Standards are referenced by designated letters/numbers in several locations within this report. These standards were identified for the sole purpose of informing the reader what test methods were followed by IME during the execution of IME's scope of services. Anyone who reads, references, or relies on this report for any purpose whatsoever is hereby advised that IME has applied professional judgment in determining the extent to which IME complied with any given standard identified in this report or any other instrument of IME's professional service. Unless otherwise indicated, such compliance referred to as "general compliance," specifically excluded consideration of any standard listed as a reference in the text of those standards IME has cited. Questions about general compliance – i.e., which elements of a cited standard were followed and to what extent, should be directed to IME.

IME has performed exploration, laboratory, and engineering services sufficient to provide geotechnical information that is adequate for either the preliminary planning or the design phase of the project, as

stated herein. IME's scope of services was developed and agreed to specifically for this purpose. Consequently, this report may be insufficient for other purposes. For example, this report may be insufficient for the contractor or his subcontractors to prepare an accurate bid for the construction phase of the project. The client, owner, potential contractors, and subcontractors are advised that it is specifically the contractor's and subcontractor's obligation and responsibility during the bidding process to collect whatever additional information they deem necessary to prepare an accurate bid. The contractor's and subcontractor's bid should include selection of personnel, equipment, bits, etc. that are necessary to complete the project according to the project specifications, on schedule, within budget, and without change orders resulting from unforeseen geologic conditions.

Variations in soil conditions may be encountered during construction. To permit correlation between soil data in this report and the actual soil conditions encountered during construction, we recommend that IME be retained to perform construction observations of the earthwork and foundation phases of the work. It is recommended that IME be retained to observe all areas where fills are to be placed, and test and approve each class of fill material to be used according to the recommendations for compacted fill presented in this report. IME can provide specific assistance in evaluating construction compliance with the design concepts, specifications, or recommendations if IME has been retained to perform continuous on-site observations and materials testing during construction.

The presence of IME's field representative, if such services are requested by the client, will be for the sole purpose of providing record observations and field materials testing. We recommend the contractor be solely responsible for supervision, management, or direction of the actual work of the contractor, his employees, or agents. The contractor for this project should be so advised. The contractor should also be informed that neither the presence of our field representative or the observation and testing by our firm shall excuse him in any way for defects discovered in his work. It is understood that IME will not be responsible for job or site safety on this project.

This report has been prepared in accordance with generally accepted geotechnical engineering practices, and makes no warranties, either expressed or implied. The services performed by IME in preparing this report have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, express or implied, and no warranty or guarantee is included or intended in this report. The report has not been prepared for other uses or parties other than those specifically named, or for uses or applications other than those enumerated herein. The report may contain insufficient or inaccurate information for other purposes, applications, building sites, or other uses.

SAMPLE AND DATA COLLECTION INFORMATION

Field-sampling techniques were employed in this exploration to obtain the data presented in the Final Logs and Report generally in accordance with ASTM D420, D1452, D1586 (where applicable), and D1587 (where applicable).

The drilling method utilized in most test borings is a dry-process, machine rotary auger type that advances hollow steel pipe surrounded by attached steel auger flights in 5-foot lengths. This method creates a continuously cased test hole that prevents the boring from caving in above each level of substrata to be tested. Sampling tools were lowered inside the hollow shaft for testing in the undisturbed soils below the lead auger. In some test borings, as appropriate to advance to the desired depth, air or wash rotary drilling methods were utilized. Air or wash rotary drilling methods allow for the extraction of rock core samples.

Samples were brought to the surface, examined by an IME field representative, and sealed in containers (or sealed in the tubes) to prevent a significant loss of moisture. They were returned to our laboratory for final classification per ASTM D2487 methods. Some samples were subjected to field or laboratory tests as described in the text of this report.

Groundwater observations were made with cloth-tape measurements in the open drill holes by IME field personnel at the times and dates stated on the Final Logs. Recorded groundwater levels may not reflect equilibrium groundwater conditions due to relatively low permeability of some soils. It must also be noted that fluctuations may occur in the groundwater level due to variations in precipitation, temperature, nearby site improvements, nearby drainage features, underdrainage, wells, severity of winter frosts, overburden weights, and the permeability of the subsoil. Because variations may be expected, final designs and construction planning should allow for the need to temporarily or permanently dewater excavations or subsoil.

A Final Log of each test pit or boring was prepared by IME. Each Final Log contains IME's interpretation of field conditions or changes in substrata between recovered samples based on the field data received, along with the laboratory test data obtained following the field work or on subsequent site observations. The final logs were prepared by assembling and analyzing field and laboratory data. Therefore, the Final Logs contain both factual and interpretive information. IME's opinions are based on the Final Logs.

The Final Logs list boring methods, sampling methods, approximate depths sampled, amounts of recovery in sampling tools (where applicable), indications of the presence of subsoil types, and groundwater observations and measurements. Results of some laboratory tests are arrayed on the Final Logs at the appropriate depths below grade. The horizontal lines on the Final Logs designate the interface between successive layers (strata) and represent approximate boundaries. The transition between strata may be gradual.

We caution that the Final Logs alone do not constitute the report, and as such they should not be excerpted from the other appendix exhibits or from any of the written text. Without the written report, it is possible to misinterpret the meaning of the information reported on the Final Logs. If the report is

reproduced for reference purposes, the entire numbered report and appendix exhibits should be bound together as a separate document, or as a section of a specification booklet, including all drawings, maps, etc.

Pocket penetration tests taken in the field, or on samples examined in the laboratory are listed on the Final Logs in a column marked "qp". These tests were performed only to approximate unconfined strength and consistency when making comparisons between successive layers of cohesive soil. It is not recommended that the listed values be used to determine allowable bearing capacities. Bearing capacities of soil is determined by IME using test methods as described in the text of the report.

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

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ADDENDUM 4-B
UIC CLASS I DEEP DISPOSAL WELL PERMIT APPLICATION

Reno Creek ISR Project

Application For
Wyoming Underground Injection Control Permit
For Class I Non-Hazardous Injection Wells

AUC, LLC

Geologist and Engineer Signatures

I, John DeJoia, hereby certify that I am a Professional Geologist licensed as required by the provisions of W.S. 33-41-101 through W.S. 33-41-121 and that all geological work performed in relation to this technical document was performed by me or under my direct supervision.

IN WITNESS WHEREOF, I have here under set my hand and affixed my seal.

____

John DeJoia, P.G.
Geologist

I, Thomas G. Michel, hereby certify that I am a Professional Engineer licensed as required by the provisions of W.S. 33-29-105 through W.S. 33-29-113 and that this technical document was prepared by me or under my direct supervision.

IN WITNESS WHEREOF, I have here under set my hand and affixed my seal.

____

Thomas G. Michel, P.E.
Hydrologist

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Acronyms and Abbreviations

µmhos	micromhos or microsiemens
AOR	Area Of Review
°C	degrees Celsius
BGS	below ground surface
BHC	borehole compensated
BHP	bottom hole pressure
BKB	below kelly bushing
BPM	barrels per minute
CBL	cement bond log
CBM	coal bed methane
cc	cubic centimeter
cfs	cubic feet per second
cm	centimeter
cu. ft.	cubic feet
DIL	dual induction log
DST	drill stem test
EPA	Environmental Protection Agency
°F	degrees Fahrenheit
FC	float collar
FDC	formation density/caliper
ft	foot (feet)
gm	gram
gpm	gallons per minute
HH	hydrostatic head
IES	induction-electrical survey
ISR	in-situ recovery
l	liter
lb	pound
mg	milligrams
MIT	mechanical integrity test
MSL	mean sea level
O.D.	outside diameter
pCi	picocuries
PRB	Powder River Basin
psi	pounds per square inch
psig	pounds per square inch guage
RCRA	Resource Conservation and Recovery Act
RO	reverse osmosis
ROW	right-of-way
QA/QC	quality assurance/quality control
sec	seconds
sx	sacks
T.D.	total depth
TDS	total dissolved solids

Acronyms and Abbreviations (continued)

UIC	Underground Injection Control
USDW	Underground Source of Drinking Water
USGS	United States Geological Survey
WDEQ	Wyoming Department of Environmental Quality
WOGCC	Wyoming Oil and Gas Conservation Commission
WQD	Water Quality Division
WY	Wyoming

1. INTRODUCTION AND PERMIT APPLICATION

1.1 Introduction

This document is an application for four Class I Injection Wells at AUC, LLC (AUC's) Reno Creek in-situ recovery (ISR) uranium processing location. Two of the wells in this application were permitted by Power Resources, Inc. under UIC 98-092 in June of 1998.

AUC is a limited liability company organized in the state of Delaware with two members: American Uranium Corporation (American) and Strathmore Resources (US) LLC (Strathmore). Strathmore currently owns 100% of AUC and is the operator for AUC. Jim Crouch, Strathmore's Vice President of Wyoming Operations serves as AUC's general manager. American has an option to acquire up to a 60% interest in AUC. As part of the initial contributions, Strathmore has agreed to transfer certain of its uranium mining claims, state leases, and private leases to AUC. Strathmore is currently in the process of making those transfers. References to property ownership in this application may designate AUC or Strathmore as the legal owner, depending on what stage the transfer is at. American's initial contribution to AUC consists of a thirty three million dollar ($33,000,000.00) investment, which must be paid by January 3, 2014 and entitles it the 60% interest in AUC.

The original permit application was purchased by American on April 15, 2008 on behalf of AUC. Strathmore signed the financial responsibility requirements for the transfer of a Class I Well later that month. The transfer form was approved by the Wyoming Department of Environmental Quality (WDEQ) and Water Quality Division (WQD) Administrator the following month, in May, 2008. The original permit application for UIC 98-092 is included as Attachment I and the subsequent transfer documents and financial form are included as Attachment II of this submittal.

Of the four wells included in this application, two wells were permitted under UIC 98-092. Two additional wells are included in this permit as a mechanism for insuring adequate injectivity and to allow siting of individual wells adjacent to additional processing facilities. This application for a Class I Injection Well permit is based on the existing UIC 98-092 permit and utilizes supporting information presented therein. As stated previously, the permit application for UIC 98-092 is included as Attachment I of this submittal and will hereafter be referenced as UIC 98-092. Figure 1 presents a general location map for the project area.

The proposed disposal of uranium ISR mining-related fluids remains fundamentally unchanged from the previous submittal. One or more of the planned injection wells will be used for disposal of fluids generated by the solution mining operation. These fluids fall under the Bevill Exclusion to the Resource Conservation and Recovery Act of 1976 (RCRA) as described in 40 CFR 261.4(b)(7). The Reno Creek project area has been explored and partially developed since the 1970's. There was a pilot research and development (R&D) ISR test operation conducted in the late 1970's and early 1980's, but the site development has not progressed beyond the evaluation and testing phase. AUC has acquired mineral rights for identified uranium ore bodies in the area and is in the process of obtaining ISR mining permits for the project. The planned operation includes construction and operation of an ISR solution processing plant. The processing plant will receive solution from one or more operating well fields within the project area at a rate of up to 4000 gallons per minute (gpm).

The Class I well(s) will serve as the primary disposal for the well field bleed stream and other process fluids generated during mining and restoration phases.

Because the Reno Creek ISR project has not yet been developed to the point of constructing a permanent processing plant, the status of the two wells permitted under UIC 98-092 has not changed since the permit was issued in 1998. The first well is designated as well IW-1 and is located in the SW ¼ of the SE ¼ of Section 31, T43N, R73W at a latitude of 43° 39' 2" and a longitude of 105° 40' 17". This well will be installed as an injection well conversion of an existing plugged and abandoned oil well designated as Sinadin #1. Well IW-1 has remained undisturbed in a plugged and abandoned condition since 1977. Construction/conversion of the well will occur prior to usage for fluid disposal. The second well is designated as well IW-2 and will be drilled in the NE ¼ of Section 33, T43N, R73W. In the UIC 98-092 permit, the proposed location of well IW-2 was in the NE ¼ of Section 29, T43N, R73W coincident with the planned location of the satellite ISR processing plant proposed by the property holders in 1998. However, the proposed location of the AUC ISR plant facilities is in Section 33, T43N, R73W, and the proposed location of well IW-2 has been adjusted accordingly. The impact on the planned installation and completion of well IW-2 is nominal. The distance between wells IW-1 and IW-2 is basically unchanged at approximately two (2) miles. The differential in land surface elevation between the previous and current proposed locations for well IW-2 is less than 25 feet, and the expected stratigraphy is essentially unchanged from the UIC 98-092 application submittal.

The two additional proposed wells are designated as IW-3 and IW-4. These wells will be installed if required to provide necessary injection capacity. Well IW-3 is located in the NE ¼ of Section 34, T43N, R73W. Well IW-4 is located in the NW ¼ of Section 27, T43N, R73W. Both wells are sited proximate to identified ore bodies and potential satellite plant locations, and are expected to have the same stratigraphy and well completions as wells IW-1 and IW-2. Figure 2 presents the proposed location of wells IW-1 through IW-4. The anticipated construction sequence for the wells is:

1) Well IW-2 constructed adjacent to the preferred plant location and the first proposed well field.
2) Well IW-3 constructed in Section 34 unless geophysical logging of well IW-2 indicates that the receiver hydraulic properties are less promising than those at the existing well proposed for conversion to Well IW-1. If this is the case, Well IW-1 will be converted prior to drilling of Well IW-3.
3) Well IW-1 converted/constructed using the plugged and abandoned Sinadin #1 well.
4) Well IW-4 constructed adjacent to a major well field in Section 27.

The sequence of well construction may be altered to accommodate changes in plant, facilities or mining unit development. At least one well will be constructed, but subsequent well construction will be dependent on the performance of the previously installed wells and the required injection rate.

The fluid disposed in the well will include waste and process waters from the uranium ISR process plant and will originally be produced from Wasatch and/or Ft. Union Formations. The fluid will be disposed in the Cretaceous Teapot and Parkman sandstones at depths of approximately 7,450 to 8,390 feet Below Ground Surface (BGS).

The operator of the Reno Creek ISR uranium mining project will be AUC, LLC. The mailing address of the operator is:

AUC, LLC
2420 Watt Court
Riverton, WY 82501

Riverton Phone: 307-856-8080

The preliminary disposal wellhead pressure is limited to a maximum of 1087 pounds per square inch (psi) with a cumulative daily injection volume not to exceed that equivalent to a continuous rate of 115 gpm for each well. Details of the well construction such as perforated intervals are preliminary estimates and are subject to adjustment during well installation. Likewise, the maximum wellhead pressure will be recalculated following testing of the well.

1.2 UIC-1-I Form

(A paper copy of the UIC-1-I permit application form is enclosed in the attached map holder at the end of this section.)

1.3 Class I Well Justification

Sections 2 and 4 of this document describe geologic and hydrologic conditions that support this application for Class I injection well permits. A Class I well is one in which the receiver zone is located below the lowest viable Underground Source of Drinking Water (USDW). Moreover, the receiver zone must be hydrologically isolated from overlying USDWs. Multiple criteria are used to evaluate the suitability of the proposed receiver zone for the Class I well. These factors include: water quality within the receiver interval, presence of hydrocarbons within the receiver interval, hydraulic properties of the receiver interval, presence of USDWs above the receiver interval, nature and thickness of materials separating the receiver interval from identified USDWs above the receiver, and nature of strata or aquifers below the receiver interval. Sections 1.3.1 through 1.3.5 present summary analyses of these criteria.

1.3.1 Nature of Receiver Interval

The receiver interval consists of the Cretaceous Teapot and Parkman sandstones at depths of approximately 7,450 to 8,390 feet BGS. The more permeable sandstones occur within thick intervals of shale, and the Teapot sandstone is overlain by the Lewis shale. Water samples from nearby producing oil wells completed within the Parkman have a total dissolved solids (TDS) concentration of greater than 10,000 mg/l. The producing oil wells are within two (2) miles of the central mining area and well IW-1 will be a conversion of an existing oil and gas exploration hole. Hence, the available information indicates that water within the receiver interval will: have a TDS concentration in excess of 10,000 mg/l, have constituent (e.g. chloride and barium) concentrations that render it generally unusable, and have significant hydrocarbon concentrations that also make the water unusable. As indicated in UIC 98-092, this leads to the characterization of the water in the receiver zone as a Class VI ground water according to criteria and standards presented in Chapter 8 of the WDEQ-WQD rules and regulations.

1.3.2 Receiver Isolation From Overlying Aquifers

The receiver interval is overlain by the Lewis Shale (see Sections 2 and 4 of this application). The Lewis shale is low-permeability marine shale with a thickness of approximately 850 feet (including the Teckla sandstone) at the site. As indicated in Section 2, roughly one-half of the Lewis Shale is true shale, and this should provide isolation of the receiver zone from overlying aquifers. The Fox Hills sandstone and Lance Formation overlie the Lewis Shale. The Fort Union and Wasatch Formations overlie the Lance Formation. The strata from the Fox Hills sandstone through the Wasatch Formation have the potential to be a USDW.

1.3.3 USDWs Above Receiver

The Wasatch, Fort Union, and Lance Formations and the Fox Hills sandstone have the potential to be characterized as USDWs in the vicinity of the mine. There is large degree of heterogeneity in the nature of the strata, and there are coal intervals within the Wasatch and Fort Union Formations, so there is likely considerable variability in the water quality. Water quality samples from sands and sandstones in the Wasatch indicate generally good water quality (see UIC 98-092), although there are elevated concentrations of radionuclides in mineralized intervals within the project area. For the purposes of this application, all strata above the Lewis Shale are considered to be potential USDWs.

1.3.4 Receiver Isolation From Underlying Strata

The receiver interval is underlain by the Steele Shale (see Sections 2 and 4 of this application). The Steele shale is low-permeability marine shale member within the massive Cody Shale. There are also sandstone members (e.g Sussex and Shannon) within the Steele/Cody Shale. The thickness and limited permeability of the Steele Shale provides virtually complete isolation of the receiver interval from underlying strata. The remaining stratigraphic sequence below the Parkman is shown in Figures 2-2 and 2-3 of UIC 98-092. The majority of the material between the receiver interval and the Madison Limestone is indicated to be shale in Figure 2-3 of UIC 98-092.

1.3.5 Hydrogeology of Strata Below the Receiver

The Madison Limestone, which is below the Parkman receiver interval at large depth, is considered an interval of interest at the project site. The Madison Limestone exists over the Powder River Basin and the structure generally conforms to that of the basin. The basin configuration results in a large depth to the limestone in the central area of the basin with a tapering of the depth to the limestone on the periphery of the basin. The reduced depth to the limestone and the proximity to recharge areas results in the Madison Limestone potentially serving as a USDW on the periphery of the Powder River Basin as well as other areas in the state. However, the great depth to the Madison Limestone near the project site and the large distance from recharge areas makes it very unlikely that the Madison Limestone can be characterized as a viable USDW in the central part of the Powder River Basin.

Section 4.2 and associated subsections include information and discussion of the hydrogeology of strata between the Parkman receiver interval and the Madison Limestone. Because the Madison Limestone is at great depth (estimated at 15,000 feet or more BGS) at the project site, there are no wells or borings that penetrate to the limestone. Many available drilling records typically extend only to the target oil and gas production intervals in the area that include the Parkman, Sussex, Shannon and Turner intervals at depths of less than 11,000 feet BGS in the project vicinity.

Although there is limited drilling data for the deeper strata below the Shannon sandstone extending to and including the Madison Limestone, there are several characteristics and properties in the deeper strata that make it very unlikely that these strata contain a viable USDW. Further discussion of these characteristics and properties is included in Section 4.2 and is summarized herein. The large depth to these strata dramatically increases the drilling cost and difficulty which raises economic considerations for installation and operation of a drinking water supply from these deep strata. The cost of installation of well in the Madison Limestone is likely two to three times greater than the cost of installation of a similar Parkman well. Also, the large overburden load with increasing depth tends to reduce permeability and the increased pressures and temperatures will likely result in very poor formation water quality.

Available water quality data for the deep strata are presented in Section 4.2.2. The indicated water quality as measured by TDS concentration is poor for the stratigraphic sequence between the receiver interval and the Madison Limestone. TDS concentrations ranging up to approximately 33,000 mg/l may be present in ground water in theses deep strata. There is no representative water quality data for the Madison Limestone at the site and the only estimates of TDS concentration are projections from samples taken at great distance from the site. As cited in Section 4.2.2, the projected TDS concentration of water from the Madison Limestone at the site is 2,500 mg/l. Actual TDS is likely much larger, but even water with a TDS concentration of 2,500 mg/l would require treatment (likely reverse osmosis) prior to utilization as drinking water. A reverse osmosis system produces a brine stream at a rate of approximately 25% of the well production rate, and this brine stream would then require disposal. In short, a water supply well completed to the Madison Limestone at the project site would be expensive and would penetrate several thousand feet of deep strata wherein the typical water would likely be Class VI ground water according to WDEQ-WQD criteria. Even with a very optimistic expectation of the water quality in the Madison Limestone, the water would still require treatment and this would likely produce an additional brine stream requiring disposal.

With increasing depth below the receiver interval, the ground water temperature also increases. References cited in Section 4.2.3 indicate that water temperature in the Madison Limestone is expected to be 100 to 130ºC (212 to 266ºF). This makes the water potentially suitable for geothermal use which is a possible aquifer exemption criterion. These temperatures and the resulting impacts on water quality are also generally incompatible with characterization of the aquifer as a USDW because the high temperature and pressure conditions are expected to result in dramatically increased mineral solubilization.

Although the Madison Limestone is correctly designated as a USDW in other areas, this designation is not appropriate for the project area because of factors that are related to the large depth to the limestone. The large depth is an obvious economic consideration for the installation and operation of a water supply well, but the depth also contributes to high temperatures and deteriorating water quality that make it extremely unlikely that water produced from the limestone in the project area could plausibly be used for drinking water. The limited potential well yield is also expected to preclude utilization of the Madison Limestone as a USDW. As described in Section 4.3, an application for injection wells in a similar setting by Power Resources Inc. contains a thorough discussion of likely Madison well yields for the area that indicates potential yields are far too small to justify any consideration of production of potable water.

2. RECEIVING ZONES AND CONFINING LAYERS

Reno Creek injection wells IW-1, IW-2, IW-3 and IW-4 will be completed in two deep horizons. The target injection zones are the Teapot and Parkman sandstones. The Teckla sandstone is located above the Teapot sandstone and is separated from the Teapot by a large thickness of the Lewis shale. The Teckla sandstone will not be used as a target injection zone. The two target injection members and the overlying Teckla are sandstone intervals within Cretaceous marine sediments of the Lewis and Mesaverde Formations. UIC 98-092 contains a thorough description of the geology of the target injection zones and confining layers in Sections 2.3 through 2.5 of Attachment I as well Figures 2-2 through 2-6 of Attachment I. Structure contour maps for the Teapot and Parkman formations are included in Plates 2-1 and 2-2 of UIC 98-092 (see Attachment I). The geology presented in UIC 98-092 is summarized in the following discussion.

The estimated thickness of the Teckla member at the well locations is 216 feet with the anticipated top of the member at the IW-1 site at 7164 feet BKB. The member is characterized by marine fine-grained sandstone, siltstone, and shale. Geophysical logs indicate the likely presence of a more permeable interval of the sandstone from 7265 feet to 7375 feet BGS. Although this interval may have sufficient injectivity to justify inclusion as an injection zone, it is not included as a target injection zone in order to provide more vertical separation between injection intervals and overlying aquifers. A cross section location map and two cross sections are presented in Figures 2-4 through 2-6 of UIC 98-092. The available density porosity log for well IW-1 indicates typical density porosity values of 8% to 10% in the Teckla sandstone interval. The stratigraphy and depths to formation tops for well IW-2, IW-3 and IW-4 are expected to be similar to those of the IW-1 site. Figure 4 presents an additional cross section C-C' and cross section location map. Based on cross sections A-A' and B-B' in Figures 2-5 and 2-6 of UIC 98-092, and cross section C-C' in Figure 4, the structural top of the Teckla member is very similar to that of the Teapot and is located 400 to 500 feet above the top of the Teapot member.

The estimated thickness of the Teapot member at the well locations is 173 feet with the anticipated top of the member at the IW-1 site at 7582 feet Below Kelly Bushing (BKB). The member is characterized by marine, coarsening-upward sandstone. The more permeable interval of the sandstone is anticipated to be 7582 feet to 7720 feet BGS. The available density porosity log for well IW-1 indicates typical density porosity values of 6% to 18% in the potential Teapot injection zone.

The estimated thickness of the Parkman member at the well locations is 520 feet with the anticipated top of the member at the IW-1 site at 7870 feet BKB. The member is characterized by marine, coarsening-upward sandstone and siltstone similar to the Teapot member. The more permeable interval of the Parkman sandstone is anticipated to be 7870 feet to 8040 feet BKB. The available density porosity log for well IW-1 indicates typical density porosity values of 6% to 18% in the potential Parkman injection zone.

The upper confining layer is the Lewis Shale. The estimated thickness of the Lewis Shale above the Teckla sandstone at the proposed IW-1 well location is 520 feet and it separates the Teckla from the Fox Hills sandstone. Below the Teckla sandstone, the Lewis Shale separates the Teapot sandstone from the Teckla sandstone. The Lewis Shale is described as a marine fine-grained sandstone,

siltstone, and shale, and the total thickness of the Lewis Shale including the Teckla is approximately 850 feet at the IW-1 location. Roughly one-half of the Lewis is a true shale. Although there are no available measurements of permeability in the Lewis Shale, a very low vertical permeability is expected for shale. The available density porosity log for Sinadin #1 indicates typical porosities of 4% to approximately 6% in the Lewis Shale for a thickness of at least 300 feet above the Teckla sandstone. The remaining interval of Lewis Shale above the Teckla was not included in the available geophysical log. There is also a 100 foot thick interval of shale between the Teckla and Teapot sandstones with similarly small indicated porosity.

The lower confining layer consists of the Cody (Steele) Shale (approximately 525 feet thick at Sinadin #1) Marine shales have very low permeabilities, making them good seal facies. The available density porosity log for Sinadin #1 indicates typical porosities of 4% to approximately 6% in the majority of the lower interval of what was classified as the Parkman Sandstone in UIC 98-092. There is an interval of approximately 20 feet near the base of identified Parkman with slightly greater indicated porosity, and this interval will also be included as an injection zone to increase injection exposure through the Parkman.

2.1 Receiving Zone Properties

The physical and hydraulic properties of the Teapot and Parkman receiving zones are presented in Table 2-1 of UIC 98-092. These properties were used in determining the area of review (AOR) in UIC 98-092 and were evaluated for calculation of the updated AOR in Section 5.

The properties of the Teapot receiving zone (see Table 2-1 of UIC 98-092) include a gross thickness of 173 feet, an average porosity of 15% for porosity greater than 8%, and an average permeability of 4.7 millidarcy as calculated using Timur's (1968) equation using an irreducible water saturation of 66%. Based on the density-porosity log for Sinadin #1 (IW-1), the more permeable interval is from 7580 to 7720 feet BKB. There is a 40 foot thick higher porosity interval immediately above the specified top of the Teapot that will also be included in the Teapot perforation interval. The estimated initial reservoir pressure from offset Drill Stem Test (DST) data is 2825 psi at the midpoint of the perforations (7636 feet BKB in Table 2-1 of UIC 98-092).

The properties of the Parkman receiving zone (see Table 2-1 of UIC 98-092) include a gross thickness of 520 feet, an average porosity of 17% for porosity greater than 8%, and an average permeability of 8.1 millidarcy as calculated using Timur's (1968) equation using an irreducible water saturation of 66%. Based on the density-porosity log for Sinadin #1 (IW-1), the more permeable interval is from 7870 to 8040 feet BKB. The estimated initial reservoir pressure from offset DST data is 2940 psi at the midpoint of the perforations (7947 feet BKB in Table 2-1 of UIC 98-092).

2.2 Proposed Well Completion Zone Conditions

The proposed well(s) will be completed in sandstone intervals in the Mesaverde Formation. Three perforated intervals totaling 470 to 510 feet are anticipated for the proposed wells. At well IW-1, the perforated interval is approximately 58% of the 855 feet interval between the top of the planned upper perforated zone and the base of the lower perforated zone. Of the proposed 500 foot perforated interval at well IW-1, approximately 310 feet are considered the effective injection zone based on indications of sandstone (in the API gamma, SP, and/or Resistivity logs) with a density porosity of

8% or greater in the available geophysical logs. This indicates that a significant portion of the receiver zone is comprised of shale, siltstone, and low-porosity sandstone.

2.2.1 Updates of Receiver Properties for AOR Calculation

Physical and hydraulic properties of the receiving zone are utilized in the calculation of the AOR (see Section 4.0 of UIC 98-092). Critical properties include effective thickness, permeability, and porosity. The gross thickness of the receiving intervals in the Teapot and Parkman were used in calculation AOR in UIC 98-092. A review of the density-porosity log for Sinadin #1 (well IW-1) indicates that only a portion of the gross interval thickness has sufficient porosity (and by implication, permeability) to function as an effective receiver zone. For the purposes of defining an "effective" receiver thickness, the two receiver intervals were reduced to zones where the typical indicated porosity is greater than 6%. For the Teapot, this zone is from 7580 to 7720 feet BKB (140 feet thickness). For the Parkman, this zone is from 7870 to 8040 feet BKB (170 feet thickness). Total receiver thickness included in the AOR calculation is thus 310 feet. Anticipated perforated zone thickness will be 470 to 510 feet in three or more intervals. The perforated zone will be expanded beyond the higher porosity intervals as indicated in geophysical logs to ensure contact with most porous intervals and to add contact through the remainder of the Parkman.

The average permeability for the Parkman and Teapot receiver intervals was estimated as 6.7 millidarcy (md) using Timur's (1968) method (Section 2-4 and Table 2-1 of UIC 98-092). This value was a composite from estimates of 8.1 md and 4.7 md permeability for the Parkman and Teapot, respectively. Available records from the Wyoming Oil and Gas Commission (WOGC) were reviewed for permeability data. There is core permeability (horizontal) data available for a significant interval in the Parkman sandstone in a handful of wells in the area. The Larson 31-32 well is located in section 32 of T45N, R74W and had an average permeability of 6.87 md and an average porosity of 15.7% for 120 feet of core. The average permeability for the most permeable 100 foot interval of core was 8.23 md with a corresponding porosity of 16.8%. The Marquiss 32-31 well is located in Section 31 of T44N, R73W and had an average permeability of 3.85 md and an average porosity of 14.8% for 102 feet of core. When the data was restricted to the most permeable 80 foot interval, the permeability increased to 4.89 md and the porosity increased to 16.4%. The Gilbertz #1 well is located in Section 30 of T45N, R74W and had an average permeability of 20.56 md and an average porosity of 14.9% for 135.5 feet of core. Within this cored interval, there was a 56.5 foot thick interval with an average permeability of 42.31 md. The Ickes #1 well is located in Section 31 of T43N, R73W and had an average permeability of 9.37 md and an average porosity of 12.9% for 36 feet of core. When the data was restricted to the most permeable 29 foot interval, the permeability increased to 11.6 md and the porosity increased to 14.4%. No core permeability records were found in nearby wells for the Teapot or Teckla sandstone intervals.

The preceding core permeability data summary indicates that the estimate of 6.7 md for the composite Teapot and Parkman is reasonable. The range of measured permeabilities for the Parkman encompasses the estimate used in the AOR calculation, and since the Parkman represents the largest thickness in the receiver zone, its hydraulic properties are considered the most critical. Likewise, the measured porosities from the core samples are reasonably consistent with the values presented in Table 2-1 of UIC 98-092 (17% and 15% for the Parkman and Teapot, respectively). However, a conservatively small porosity of 11% was selected from density porosity logs of Sinadin #1 for use in the AOR calculation.

3. WELLS PENETRATING RECEIVER

There are no wells that penetrate the proposed receivers within the area of review for the four UIC wells. Figure 3 presents the existing wells within the project and surrounding area. Additional information including the plugging and abandonment is included in Appendix A.

4. GEOLOGIC CONDITIONS

The regional and local geology is discussed in detail in UIC 98-092. This discussion is referenced, summarized and presented in part in Section 4.1. Section 4.2 presents additional information on the geologic and hydrologic conditions for formations below the target injection zone in the Upper Cretaceous strata.

4.1 Regional Hydrogeologic Setting

The Reno Creek ISR project area is located in the central Powder River Basin (PRB) with a sedimentary strata thickness of approximately 16,000 feet in the project area (cited from Feathers et al, 1981 in UIC 98-092). Figures 2-1, 2-2 and 2-3 of UIC 98-092 present a geologic map, generalized stratigraphy, and a generalized cross section for the Powder River Basin, respectively. Section 2.1 of UIC 98-092 presents a detailed discussion of the hydrogeologic setting for the region.

The Quarternary deposits consist of alluvium, terrace deposits and eolian sands. The thickness of Quarternary deposits vary with surface topography and may be absent or indistinguishable from the underlying Tertiary strata. Tertiary strata in the project area consist primarily of the Wasatch Formation (Eocene) and Ft. Union Formation (Paleocene). The uranium ore bearing sandstones are within the Wasatch Formation. The Wasatch and Ft. Union Formation strata consist of an interbedded sequence of fluvial-continental sandstones, siltstones, claystones, and coals.

The target injection interval is within the Upper Cretaceous strata and specifically within sandstone members of the Mesaverde Formation with potential limited extension into the lower Lewis Formation at the top of the Teapot sandstone. Upper Cretaceous strata consist primarily of shales and sandstones extending from the uppermost Lance Formation to the Frontier Formation. The Mesaverde Formation includes the Teapot and Parkman sandstone members, but is primarily marine shale. The Lewis Shale is directly above the Mesaverde Formation, and includes the Teckla sandstone. The Cody Shale underlying the Mesaverde Formation is a thick marine shale with two identified sandstone members (Sussex and Shannon) in the project area. In addition to changes in the geology across the PRB, there are also some changes in naming convention for formations and strata in an east-west direction across the PRB (see Figures 2-2 and 2-3 of UIC 98-092), and these naming differences first occur in the Upper Cretaceous layers. As an example, the Steele Shale member of the Cody Shale on the western side of the PRB is designated as the Pierre Shale on the eastern side of the PRB.

The Lower Cretaceous strata are primarily shale with sandstone members or intervals. The presence of numerous sandstone and shale sequences with the Upper and Lower Cretaceous strata has resulted

in sealing of petroleum in several reservoirs within the PRB (UIC 98-092). These same shale and sandstone sequences also provide hydraulic isolation of the target sandstone receiver intervals.

The entire receiver zone is marine with a consistent correlation of strata over the area of review. Cross sections are presented in Figures 2-5 and 2-6 of UIC 98-092 and an additional cross section is presented in Figure 4.

4.2 Hydrogeologic Setting Beneath the Parkman Sandstone

As cited in the previous section, the estimated thickness of sedimentary strata at the Reno Creek site is approximately 16,000 feet. An evaluation of the strata underlying the target injection zone was undertaken to confirm that there was no potential for injection well impacts on viable USDW's. In order to evaluate hydrogeologic conditions beneath the Parkman Sandstone, information was compiled from a variety of sources including: United States Geological Survey (USGS) Professional Paper 1402-A "The Regional Aquifer System Underlying the Northern Great Plains in Parts of Montana, North Dakota, South Dakota, and Wyoming –Summary" by J.S Downey and G.A. Dinwiddie (1988); USGS Professional Paper 1402-E "Geohydrology of Bedrock Aquifers in the Northern Great Plains of Montana, North Dakota, South Dakota , and Wyoming" by J.S Downey (1986); USGS Professional Paper 1402-F "Geochemistry of Water in Aquifers and Confining Units of the Northern great Plains in Parts of Montana, North Dakota, South Dakota, and Wyoming" by J.F Busby, B.A. Kimball,J.S Downey and K.D. Peter (1995); USGS Professional Paper 1273-G "Geohydrology of the Madison and Associated Aquifers in Parts of Montana, North Dakota, South Dakota, and Wyoming" by J.S Downey (1984); and records from the Wyoming Oil and Gas Conservation Commission (WOGCC). Selected excerpts from these records and reports are included in Appendix H.

4.2.1 Deep Geologic Setting

The target injection zone includes the Teapot and Parkman sandstones within the Upper Cretaceous Measaverde Formation (see Plate 2 of USGS Professional Paper 1402-A in Appendix H). The following discussion of Cretaceous through Mississippian lithologic sequence is based primarily on Plates 1 and 2 of USGS Professional Paper 1402-A which are included as Figures H-1 and H-2 of Appendix H. Underlying the Parkman is the Cody Shale (alternately designated as the Steele Shale) which has the Sussex, Shannon, and Fishtooth sandstone members. Figure 4 presents a geologic cross section indicating that the interval of Steele Shale between the Parkman and Sussex sandstones is approximately 600 feet thick in the Reno Creek area. The Parkman, Sussex, and Shannon sandstones are oil and gas producing intervals in the area according to WOGCC records. The remaining strata within the Upper Cretaceous include the Niobrara Member of the Cody Shale and the Frontier Formation. The Lower Cretaceous consists of the Mowry Shale, Muddy Sandstone, Skull Creek or Thermopolis Shale, Fall River Sandstone equivalent, Fuson Formation equivalent, and Lakota Formation.

The Jurassic geologic sequence consists of the Morrison Formation, upper and lower parts of the Sundance Formation, and Gypsum Spring Formation. There is a minor discrepancy between Plates 1 and 2 of USGS Professional Paper 1402-A in that Plate 1 indicates the Piper Formation is present in the Middle Jurassic series, while Plate 2 indicates the Gypsum Spring Formation is present at the base of the Middle Jurassic sequence. The geologic sequence presented in Plate 2 is listed as being located in the western Powder River Basin, while Plate 1 indicates the sequence is for the more

general Powder River Basin, so there may be a change in naming convention with the minor difference in stratigraphic column location.

The Permian age strata consist of the Goose Egg Formation with no remaining Triassic age material between the Jurassic and Permian age materials. The Pennsylvanian age material includes Tensleep Sandstone and Amsden Formation, or alternately, the Minnelusa Formation. The Mississippian age material includes the Madison Limestone.

4.2.2 Expected Deep Formation Water Quality

USGS reports and WOGCC records were reviewed to evaluate water quality in the target receiver zone and underlying strata. Water quality within the receiver intervals was evaluated in UIC 98-092 and is also described in Section 7.1 and presented in Appendix D. Water quality was measured in samples taken from oil wells that are producing from the Parkman Sandstone just north of the planned injection well sites. The TDS concentration of these samples ranged from 12,130 to 13,840 mg/l.

Water quality data in strata beneath the oil production zones (e.g. Parkman, Sussex, Shannon sandstones) is relatively scarce because there is little incentive to drill beyond target oil and gas production intervals. Wyoming Oil and Gas Conservation Commission (WOGCC) records did provide a water quality sample for the 29-1 Cosner Fee well which is located in Section 29 of T43N, R72W, or approximately five miles east of the central ISR project site. The sample was listed as taken from the Frontier Formation in 1995, and had a TDS concentration of 33,918 mg/l. The Frontier Formation is at the base of the Upper Cretaceous interval, and is separated from the Parkman Sandstone by a significant interval of Cody/Steele Shale. Based on WOGCC records, the sample was likely taken from an interval at a depth of slightly over 10,000 feet BGS, and this is separated from the base of the Parkman by an interval of over 2,300 feet.

USGS reports were also reviewed for relevant water quality information. These reports included USGS Professional Papers 1402-F, 1273-G, 1402-E, and 1402-A as authored by Busby, J.F. et al (1995), Downey J.S., (1984), Downey, J.S, (1986) and Downey, J.S., and G.A. Dinwiddie (1988), respectively. Selected figures from these reports are included as Figures H-1 through H-14 of Appendix H. Further references to this information in this report will be according to the Appendix H Figure designation for simplicity. In the maps included as Figures H-3 through H-12 of Appendix H, the labeled town of Midwest in central Wyoming represents the most convenient reference point for locating the project site. The Reno Creek project site is approximately 23 miles east and 11 miles north of the town of Midwest.

Figure H-8 presents estimates of TDS in what is described as the Lower Cretaceous aquifer for the northern Great Plains area. The Lower Cretaceous aquifer includes the Muddy Sandstone through the Lakota Formation according to Figure H-2. These formations are expected to be 3,380 feet or more below the Parkman Sandstone based on lithology at the 29-1 Cosner Fee well. The USGS estimates the TDS concentration as being greater than 10,000 mg/l and approaching 20,000 mg/l. in these strata. This is supported by Figure H-14 which presented TDS iso-concentration contours for the same strata designated as the Inyan Kara aquifer.

Figure H-7 presents estimates of TDS in the Jurassic or Triassic age formations for the northern Great Plains area. The Jurassic age strata at the project site are expected to include the Morrison, Sundance, and Gypsum Springs or Piper Formations. These formations are expected to be 3,700 feet or more below the Parkman Sandstone based on lithology at the 29-1 Cosner Fee well. The USGS estimates the TDS concentration as being greater than 10,000 mg/l and approaching 20,000 mg/l in these strata.

Figure H-6 presents estimates of TDS in what is described as the Pennsylvanian aquifer for the northern Great Plains area. The Pennsylvanian aquifer includes the Tensleep Sandstone and Amsden Formation or Minnelusa Formation according to Figure H-1. There are no known deep penetrations that reach the Pennsylvanian aquifer in the project area, so the interval between the Parkman Sandstone and the Tensleep Sandstone/Minnelusa Formation is not known. The USGS estimates the TDS concentration as being greater than 5,000 and likely approaching 20,000 mg/l in these strata.

Figure H-5 presents estimates of TDS in what is described as the Madison aquifer for the northern Great Plains area. The Madison aquifer includes the Madison Limestone according to Figure H-1. There are no known deep penetrations that reach the Madison Limestone in the project area, so the interval between the Parkman Sandstone and the Madison Limestone is not known. The USGS estimates the TDS concentration at 2,500 mg/l. in the Madison Limestone. However, the TDS contours in northeastern Wyoming as shown in Figure H-5 (Figure 36 of USGS Professional Paper 1402-E) are based upon known recharge areas and available samples on the perimeter of the Powder River Basin where the depth to the Madison Limestone is much smaller than it is at the project site. Hence, the estimated TDS concentration at the project site is an extrapolation of data from wells much closer to the known aquifer recharge areas. The actual Madison Limestone water quality at the project site is not known, but there is a strong likelihood that water quality will deteriorate with increasing distance from the recharge areas.

4.2.3 Expected Deep Formation Water Temperature

USGS reports include water temperature data and estimates for aquifers from the Createaceous to Mississippian strata. Relevant figures from these USGS reports have been included in Appendix H and, as in the preceding section, will be referenced by Appendix H figure designation for simplicity.

Figure H-12 presents estimates of water temperature in the Upper Cretaceous aquifer which, according to Figure H-2, includes the Lance Formation and Fox Hills Sandstone and extends through the Teapot and Parkman sandstones and down to the Frontier Formation. Both the Lance Formation and Fox Hills Sandstone are above the receiver zones and are separated from the Teapot Sandstone by a significant thickness (750 feet or more) of Lewis Shale. The USGS estimates the water temperature at approximately 20 to 30ºC (68 to 86ºF) in the Upper Cretaceous aquifer at the project site.

Figure H-11 presents estimates of water temperature in the Lower Cretaceous aquifer which includes the Muddy Sandstone through the Lakota Formation according to Figure H-2. These formations are expected to be 3,380 feet or more below the Parkman Sandstone based on lithology at the 29-1 Cosner Fee well. The USGS estimates the water temperature at approximately 60 to 100ºC (140 to 212ºF) in the Lower Cretaceous aquifer at the project site.

Figure H-10 presents estimates of water temperature in the Madison aquifer which includes the Madison Limestone. The USGS estimates the water temperature at approximately 100 to 130ºC (212 to 266ºF) in the Madison aquifer at the project site. Figure H-13 presents a similar estimate of Madison Limestone water temperature. With increasing solubility at elevated temperature, the dissolved mineral concentration in water at this temperature is likely to be significantly larger than in cooler and shallower areas of the Madison aquifer.

4.2.4 Expected Deep Formation Vertical Head Gradients

USGS reports include estimated potentiometric surfaces for deep aquifer systems. These potentiometric surfaces were used to evaluate vertical gradients between the receiver zone and underlying formations. Figure H-3 indicates that the water level altitude (or water level elevation) in the Madison aquifer is approximately 3,900 feet above mean sea level (MSL) at the project site. Figure H-4 indicates that the water level altitude in the Pennsylvanian aquifer is approximately 5,000 feet above MSL at the project site. However, there is a relatively steep gradient in this area shown on Figure H-4, so the actual water level altitude in the Pennsylvanian aquifer at the cite may differ slightly from this estimate. The cited USGS reports do not include a potentiometric surface for the Lower Cretaceous aquifer, but do present a simulated surface (USGS Professional Paper 1402-E, Figure 45) that indicates an approximate water level altitude of 4,600 feet above MSL at the project site. For informational purposes, the expected water level altitude in the Upper Cretaceous aquifer as shown in Figure H-9 is approximately 4,800 feet above MSL.

For the three pertinent aquifer systems (Lower Cretaceous, Pennsylvanian, and Madison), the USGS reports indicate that the highest water level altitude occurs in the Pennsylvanian aquifer which is in the middle of the sequence, The estimated water level altitude in both the overlying Lower Cretaceous and underlying Madison aquifers is lower than it is in the Pennsylvanian aquifer. The combination of water level altitude estimates for the sequence of aquifers indicates that there likely is a significant upward gradient from the Pennsylvanian aquifer to the receiver zone which is between the designated Upper and Lower Cretaceous aquifers. Below the Pennsylvanian aquifer, there is a significant downward gradient to the Madison aquifer. Hence, vertical flow will be from the Pennsylvanian aquifer up to the Upper and Lower Cretaceous aquifers, and down to the Madison aquifer.

4.3 Deep Formation Hydrology

The combination of water quality, water temperature, and potentiometric surface data leads to the conclusion that strata beneath the receiver interval do not include a viable USDW. Although the Madison Limestone is a USDW at other sites where it is at a much smaller depth and is much closer to recharge areas, the water quality in the Madison Limestone would be expected to deteriorate dramatically with increasing travel distance from recharge areas and with increasing ground water temperature. The depth to the Madison aquifer at the project site is not known, but based upon lithology from the perimeter of the Powder River Basin, the depth is expected to be 15,000 feet or more BGS.

With the increasing overburden load at these depths, the expected aquifer transmissivity, potential well yields, and corresponding ground water movement rates would likely be very small. Power Resources Inc. (PRI) submitted a detailed discussion of anticipated porosity, permeability and well yield for the Madison Limestone in their application for injection wells designated as UIC 09-054.

This discussion was included as Appendix L in the 09-054 Smith Ranch Highland Uranium Project Injection Well Application. The discussion focused on the very small indicated Madison porosity in a geophysical log from the No. 1 Hornbeck well located in Section 16 of T36N, R74W or approximately 33 miles south of the Reno Creek site. The geologic setting for this well is generally similar to that at the Reno Creek site and the location within the central area of the Powder River Basin makes the PRI analysis relevant to the Reno Creek site. As with the Reno Creek site, the depth to the Madison Limestone at the No. 1 Hornbeck site is very large (slightly over 16,500 feet BGS).

The PRI analysis presented documentation that the average porosity of the Madison Limestone at the No. 1 Hornbeck site was approximately 1.5 percent. Using a record of production data and an analysis of production interval porosity and permeability from the Elk Basin Field in the Big Horn Basin, PRI also estimated a permeability of 0.0005 millidarcy for the Madison at the No. 1 Hornbeck site. They then estimated the potential yield for the Madison aquifer at the No. 1 Hornbeck site at 0.055 gpm, which is dramatically smaller than a suitable yield for a USDW.

The very small anticipated permeability and potential well yield also translates to very small ground water movement rates. With slower ground water movement rates, the residence time of the ground water increases and the TDS concentration typically increases. The combination of increasing distance from recharge zones, slower ground water movement rates, and high ground water temperatures typically results in poor water quality.

The water quality and water temperature for strata between the receiver interval and the Madison Limestone precludes the use of these aquifers as USDWs. There is relatively poor water quality (TDS concentration of 10,000 mg/l or more) for virtually all of the aquifers below the Parkman Sandstone receiver, and there is also significant oil production from intervals in and below the Parkman Sandstone. Since there is documented poor water quality for aquifers between the receiver zones and the Madison Limestone, and no available water quality data for the Madison Limestone, the presence of better water quality in the Madison would also indicate that there is no significant vertically downward migration of poor quality water from overlying zones to the Madison.

5. AREA OF REVIEW

The radius of the Area of Review (AOR) for the Reno Creek Disposal Well(s) was determined to be 1699 feet according to the radius of the cone of influence calculation. The location of plant facilities, pipeline routing, power supply lines, etc. is subject to some minor adjustment to accommodate surface topography, existing roads, rights-of-way (ROW), coal bed methane (CBM) infrastructure, etc., and to satisfy landowner concerns. Therefore, the planned location is presented as the center of a circle within which the well location may be adjusted to address previously cited concerns. An expanded AOR is evaluated by adding the calculated radius of the cone of influence to the radius of the circle enclosing potential well locations. The radius of the resulting expanded AOR is 2000 feet which is the sum of a calculated radius of the cone of influence of 1699 feet and the well location adjustment circle radius of 301 feet. This allows minor adjustment of the well location while still providing notification of affected parties within the affected AOR. The calculated radius of the cone of influence was larger than the calculated volumetric fillup radius and the default minimum radius of 1320 feet and thus was the controlling radius for the AOR. The one exception to the expanded AOR is well IW-1 where the location is fixed and the calculated AOR of 1699 feet applies. Figure 5 shows the circular area and the effective AOR bounded by a line to the quarter of the quarter section for each proposed injection well location.

5.1 Radius of the Cone of Influence

The calculation of the radius of the cone of influence for each injection well is based on the hydraulic conditions and properties of the receiver zones, hydraulic conditions in the nearest underground source of drinking water (USDW), injection rate and duration of injection. The method of calculation is presented in Guidance Document Number 1, Permitting of Class I Injection Wells provided by the Underground Injection Control (UIC) Program, Wyoming Department of Environmental Quality – Water Quality Division (WDEQ-WQD). The calculation presented in UIC 98-092 was used as the basis for determining the radius of the cone of influence with updates to the calculation inputs as described in the following discussion. The radius of the cone of influence for twenty years of water disposal injection into the Teapot and Parkman, members in the Reno Creek Disposal Well(s) is shown by the following calculations:

$$r = \sqrt{\frac{(2.25)(KHt)}{S(10)^x}}$$

$$x = \left[\frac{W}{G} - B\right]\left[\frac{4\pi KH}{2.3Q}\right]$$

$$K = Ki \times \left({}^{\rho g}\!/_{\mu} \right) \times 2835 \frac{ft/day}{cm/\sec}$$

Where:
- r = Radius of the cone of influence of an injection well (ft)
- K = Hydraulic conductivity of the injection zone (ft/day)
- Ki = Injection zone permeability (cm^2)
- ρ = Density of injected water (gm/cc)

g	=	Acceleration of gravity (cm/sec^2)
μ	=	Viscosity of water (gm/cm·sec or poise)
H	=	Thickness of injection zone (ft)
t	=	Time of injection (days)
S	=	Storage coefficient (dimensionless) = H x 10^{-6}
W	=	Hydrostatic head of the Underground Source of Drinking Water (USDW) Referenced to the base of the receiver (ft)
G	=	Specific gravity of water in the injection zone (dimensionless)
B	=	Original hydrostatic head of the receiver (ft)
Q	=	Injection rate (ft^3/day)

Data:

Ki	=	0.0067 darcy, from UIC 98-092 as calculated by Timur's (1968) method
ρ	=	0.999099 gm/cc
g	=	980 cm/sec^2
μ	=	0.011404 gm/cm·sec or poise
H	=	310 ft
t	=	20 years or 7300 days
S	=	4.20 x 10^{-4}
W	=	8390 ft.
G	=	1.00464
B	=	2940 psi ÷(1.00464 x 0.433 psi/ft) = 6758 ft.
Q	=	115 gpm or 22,139 ft^3/day

Calculations:

Ki	=	0.0067 darcy x 9.87 x 10^{-9} cm^2/darcy
	=	6.61 x 10^{-11} cm^2
K	=	{Ki x 1.0 x 980 cm/sec^2 ÷ 0.011404 gm/cm·sec} x 2835 $\frac{ft/day}{cm/\sec}$
	=	0.0161 ft/day
W/G	=	(8390 ft./1.00464) = 8351 ft.
B	=	6758 ft. (cited as resulting from offset DST data in UIC 98-092)

The current hydrostatic head (HH) of the USDW, W, is greater than the HH of the receiver, B. The group W/G – B = 1593 feet and the x exponent in the radius of influence is greater than zero. The following calculations illustrate the determination of the radius of influence:

$$x = (1593)\frac{(4\pi)(0.0161)(310)}{(2.3)(22139)}$$

$$x = 1.962$$

$$r = \sqrt{\frac{2.25 \times 0.0161\, x 310 \times 7300}{310 \times 10^{-6} \times (10^{1.962})}}$$

r = 1699 feet (0.32 miles)

The input parameters for this calculation were updated or derived from UIC 98-092 in the following manner:

Ki	-	Cited value from UIC 98-092 is 0.0067 darcies as calculated by Timur's (1968) equation. This value was used for the AOR calculation.
H	-	Adjusted from 693 feet in UIC 98-092 to 310 feet in the preceding calculation to reflect a more conservative estimate of the effective injection zone.
K	-	Calculated from permeability and fluid properties for injectate. Value of 0.0161 ft/day is unchanged from UIC 98-092.
ρ	-	The density of the injected water (0.999099 gm/cc) was unchanged from the UIC 98-092. The density of water changes slightly with temperature and TDS concentration, but is relatively constant within the expected ranges for the injectate.
g	-	Acceleration of gravity (980 cm/sec^2) is unchanged.
Q	-	Projected injection rate is 115 gpm/well. This is increased from 57 gpm/well in UIC 98-092.
S	-	Storage coefficient is calculated as H x 1E-06 or 3.1 E-04.
t	-	Time of injection is unchanged from 20 years or 7300 days.
W	-	Estimated hydrostatic head of lowermost drinking water source measured from the base of the injection zone is unchanged from the UIC 98-092 estimate of 8390 feet.
B	-	Original hydrostatic head of injection zone measured from the base of the injection zone is changed slightly from the UIC 98-092 value of 6790 feet to 6758 feet. The change is a result of a small fluid specific gravity adjustment for the well fluid in offset DST data from the Sinadin #1 well.
G	-	Specific gravity of the fluid in the injection zone is unchanged from the UIC 98-092 value of 1.00464 which was estimated for water with a TDS of 13,000 mg/l.

The radius of the Area of Review is a function of the injection rate because the HH of the USDW is greater than the HH in the receiver.

5.2 Volumetric Fillup Calculation

The calculation of the radius of volumetric fillup for twenty years of water disposal injection at 115 gpm into the proposed Reno Creek disposal well(s) is presented as:

$$R = \sqrt{\frac{Qt}{\pi H \phi}}$$

Where:	R	=	Radius of volumetric fillup (ft)
	Q	=	Average injection rate (ft^3/day)
	t	=	Time of Injection (days)
	H	=	Thickness of injection zone (ft)
	φ	=	Porosity expressed as a pure decimal

Data:	Q	=	115 gpm or 22,139 ft^3/day
	t	=	20 years or 7300 days
	H	=	310 feet
	φ	=	0.11

Calculations:

$$R = \sqrt{\frac{22{,}139 \times 7300}{\pi \times 310 \times 0.11}}$$

$$R = 1228 \ feet$$

The radius of volumetric fillup after 20 years of future injection into the planned Reno Creek disposal wells is 1228 feet.

5.3 Fixed Area of Review

The calculated area of review exceeds the minimum fixed AOR of ¼ mile. The calculated AOR based on the cone of influence calculation (1699 feet radius) is the controlling area for the purposes of this calculation.

6. SURFACE AND MINERAL OWNERSHIP AND WATER RIGHTS

6.1 Surface Ownership

The surface ownership of land within the well AORs is presented in Figure 6. Appendix B provides a description of the surface ownership within each AOR by ¼ ¼ of each section. The AOR circles do not overlap, but some ¼ ¼ sections are common to two AORs. The IW-1, IW-2 and IW-3 well locations are on property owned and administered by the Leavitt family, with whom AUC currently has a relationship that allows access upon request. The proposed ISR plant location is also adjacent to well IW-2 on the Leavitt property, so the installation of well IW-2 will be preceded by substantial facilities construction in the immediate vicinity. Because other ISR mine facilities on the Leavitt property will necessarily be authorized and/or installed prior to installation of the injection wells, landowner agreements for installation of wells IW-1, IW-2, and IW-3 will be incorporated into a broader agreement that authorizes construction of the ISR plant and installation of other ISR mine facilities that surround or are adjacent to the proposed injection well locations.

Injection well IW-4 is located on property owned and administered by the Groves family, and is adjacent to an identified uranium ore body planned for future ISR mining by AUC. AUC does not presently have an access agreement for the property. Well IW-4 is incorporated as a contingency well location and will only be installed if there is development of the adjacent ISR mining unit that is also located on the Groves property. As with the other injection wells, the landowner agreement for installation of well IW-4 will be incorporated in a broader agreement that includes authorization for ISR mining in the area.

6.2 Mineral Ownership

The mineral ownership of land within the AORs is presented in Figure 7. Strathmore has ownership of the uranium resource within the permit boundary. Appendix B presents the mineral ownership within the AOR by ¼ ¼ of each section.

6.3 Oil and Gas Leaseholder

The oil and gas ownership is presented in Figure 8. The oil and gas leases within the AOR are presented in Figure 9. Appendix B presents the oil and gas ownership and leases within the AOR by ¼ ¼ of each section.

6.4 Water Rights

The permitted ground and surface water rights within the well AORs are presented in Figure 10. Wells with a use of monitoring are not included, but wells or surface water rights within a ¼ ¼ of a section that is all or partly within an injection well AOR are presented . The permit number is posted within the designated ¼ ¼ of each section. Appendix C presents a tabulation of permitted ground and surface water rights within the AORs by ¼ ¼ or lot number for each section. There are two surface water permits (P16331S and P16030S) in the tabulation in Appendix C that are located according to lot number. Additionally, surface water permit P17057S (SE NW of Sec 6, T42N, R73W) is located outside of the AOR of Well IW-1, but is on a drainage that flows through the AOR.

7. WATER QUALITY INFORMATION

7.1 Analysis of Water Within the Receiver

The anticipated water quality in the receiver is presented in Section 5.1.a and Tables 5-1 through 5-5 of UIC 98-092. Water quality samples were taken from three producing oil wells in the vicinity that are completed in the Parkman. The TDS concentration of these samples ranged from 12,130 to 13,840 mg/l. Additionally, available water quality data within a ten mile radius from Section 32 of T43N, R73W, was tabulated for the Teapot and Parkman sandstones in Tables 5-4 and 5-5 of UIC 98-092. These tables are reproduced in Appendix D.

7.2 Analysis of Water from any Usable Aquifer

Numerous samples of water have been taken from strata above the base of the Fox Hills sandstone and representative results are included in Appendix D and in UIC 98-092. The base of the Fox Hills sandstone is considered the base of the usable aquifer zone. Water quality within the Wasatch and Ft. Union formations is generally good with TDS concentration significantly less than 10,000 mg/l. However, naturally high activities (>15 pCi/l) of radionuclides such as Radium-226 and Thorium-230 are common in uranium mineralization zones of the Wasatch and Ft. Union Formations.

8. DESCRIPTION OF DISCHARGE

The fluid to be injected in the Reno Creek Water Disposal Well(s) is a blended stream resulting from several wastewater sources from the well field, ground water restoration and the brine concentrate discharge from the reverse osmosis (RO) units. The fluid is exempt from RCRA regulation under the Bevill Amendment listed in 40 CFR 261.4(b)(7). The proportion of these water sources in the injectate stream will change over the life of the project as individual well fields are developed, operated, and transitioned to restoration.

The potential or anticipated sources of disposal fluids include:

- wash down waters from the Reno Creek Plant
- ion exchange screening wash waters
- yellowcake wash waters
- ion exchange circuit/well field bleed waters
- brine discharge from the reverse osmosis units during ground water restoration
- Elution fluid from Reno Creek Central Plant (emergency situations only)

The ion exchange circuit/well field bleed water is the uranium leaching fluid which consists of ground water fortified with dissolved oxygen, carbon dioxide, sodium bicarbonate and/or other lixiviant enhancements. Reverse osmosis units may be used to reduce volume of bleed water injectate.

A tabulation of injection fluid properties for several uranium ISR projects and the proposed injection fluids is included in Table 1. This table is replicated from Table 6-1 of UIC 98-092 and includes a wide range of anticipated injectate water composition for the Reno Creek ISR project. The

properties of the injectate are likely to vary over the course of the project. Initially, the injectate will likely include various plant wash waters and the well field bleed waters. The well field bleed waters will constitute the majority of the injectate while the quantities of wash water will typically be incidental to the injectate stream. If it is necessary to reduce the volume of injectate, the well field bleed waters may be processed through a RO unit. The brine from the RO will then be included in the injectate while the high quality RO product water will be utilized for other purposes. In contrast to the direct well field bleed stream, constituent concentrations (particularly major ions) in the RO brine will be very large and may approach the projected concentrations for the Reno Creek Project Eluant as presented in Table 1.

As the project matures, the composition of the injectate will change. When well field restoration begins, the injectate will likely include waters produced during ground water sweep operations. Initially, these waters will be similar in quality to the well field bleed. Because there are multiple well fields planned for the project area, there will likely be simultaneous ISR mining operations and well field restoration operations during the project life. During this period, the injectate may include the plant operations wash water, well field bleed water, ground water restoration water, and RO brine water. It is anticipated that the eluant or the RO brine will contain the largest concentrations of major constituents for the injectate. The design fluid composition for the Reno Creek Project in Table 1 incorporates a range that will include the eluant or RO brine fluids.

Table 1. UIC 98-092 Class I Injection Well Waste Water Composition

	Irigarary Project			Highland Project		URI Rosita Project			Reno Creek Project		
Constituent	Bleed	Eluant	RO Brine	Projected	Design	Bleed	Eluant	Composite	Bleed	Eluant	Design
Calcium	82		95-115	50	50	600		1210	330		50-1000
Magnesium	46		40-55	25	25	123		224	50		50-100
Sodium	750		870-1500	8000	31700	687	30000	4650	350	30000	30000
Potassium	11		0	50	50	34		96	0		50
Bicarbonate	689		650-800		0	558	8000	1125	340	8000	1000-8000
Sulfate	684	6889		4000	5797	1150	20000	2820	1130	20000	7000-20000
Chloride	578	19553	1200-2000	35000	53440	1174	25000	7460	240	25000	20000-35000
Nitrate	5.1	0.22				0.11		0.26			
TDS	2426	40381		50000	93300	3840	50000	17500		50000	50000
Conductivity (μmhos/cm)	4515	55796	5350-8440			5750		24000			
pH (Standard Units)	7.83	7.78	7.8-7.9	6	6	7.51	8.7	7.7		8.7	6.0-9.0
Aluminum	<0.1										
Arsenic	<0.001					0.014		0.039			0.01
Barium	<0.1				<0.01				0.1		0.01
Cadmium	<0.1				<0.0001	0.0001		0.0007	<0.01		0.0001
Chromium	<0.05								<0.1		0.1
Copper	<0.01				0.12						
Fluoride	<0.05				0	0.7		2.2			0
Iron					0.57	0.04		0.05			0.1
Mercury	<0.001					0.0001		0.0001	<0.001		0.0001
Manganese	<0.01					0.37		0.82			0.01
Molybdenum	<0.1				<0.1	0.43		2.9			0.01
Lead	<0.05				<0.001	0.001		0.001	<0.1		0.001
Nickel	<0.05				<0.01				<0.05		0.05
Selenium	0.314					0.006		0.022	1		1
Vanadium	<0.1										
Zinc	<0.01	0.08			0.02						0.01
Uranium	0.74	91	10-43	5	5.51	1.53		10.3	2		5-10
Radium (pCi/l)	0.4	52		100	314			574	5		300-500

All units in mg/l, except as noted

Following the beginning of operation of the disposal well, routine sampling of the composite disposal fluid will be performed and the samples will be analyzed to provide a periodic detailed description of the fluid.

9. DESCRIPTION OF THE WELLS

The planned sequence of well construction is described in Section 1.1. It is anticipated that well IW-2 will be constructed first with the remaining installation sequence and scheduling subject to adjustment based on the performance of well IW-2. The planned drilling and construction of wells IW-2, IW-3 and IW-4 will be very similar and many of the installation procedures are common as described in the following sections. Well IW-1 will be installed as a conversion of the existing plugged and abandoned Sinadin #1 well and the completion and installation approach will necessarily differ from that of the other three wells.

9.1 Description and Schematic of Well IW-1

Well IW-1 will be completed in the Teapot and Parkman members of the Mesaverde Formation.

Tasks and procedures associated with drilling and completing the well will be similar to those presented in Appendix E. A schematic of the completed well is provided in Figure 11.

The perforation intervals shown in Figure 11 reflect the target zones selected from existing logs of Sinadin #1 well. Minor adjustments in perforation intervals may be made after completion of additional logging. The proposed well is designed to cement the long string from total depth of approximately 8,400 feet to the surface.

9.2 Records of Well IW-1

Existing geophysical logs will be supplemented by additional geophysical logging during construction of the Reno Creek Disposal Well IW-1. Perforation intervals and daily drilling records will also be provided when available. Results of well testing including mechanical integrity testing, pressure testing, and step injection testing will be provided as soon as possible after completion of the testing.

9.3 Description and Schematic of Wells IW-2, IW-3, and IW-4

The Reno Creek Disposal Well(s) will be completed in the Teapot and Parkman members of the Mesaverde Formation. The following plans and specifications related to the drilling and completion of this well are preliminary. They represent AUC's current preferred approach to the task. They are, however, subject to final revision and refinement when the actual work is authorized.

Tasks and procedures associated with drilling and completing the well will be similar to those presented in Appendix E. Prognoses for the drilling of the Reno Creek Disposal Wells are also provided in Appendix E. Schematic for the completed wells IW-2, IW-3, and IW-4 are provided in Figure 12, Figure 13 and Figure 14, respectively. The perforation intervals shown in Figures 12, 13 and 14 are only illustrative. Actual targets will be selected at the time of perforating based on

geophysical logs obtained from the well. The proposed well is designed to cement the long string from total depths ranging from 8,200 feet to 8,350 feet to the surface.

9.4 Records of Well IW-2, IW-3 and IW-4

Numerous geophysical logs will be provided when available for the Reno Creek Disposal Well(s). Perforation intervals and daily drilling records will also be provided when available. Results of well testing including mechanical integrity testing, pressure testing, and step injection testing will be provided as soon as possible after completion of the testing.

10. OPERATING CONDITIONS

10.1 Operating Data

The average daily injection rate will not exceed 115 gpm for each of the Reno Creek Disposal Wells. The Reno Creek ISR project is currently in the permitting stage, and no firm schedule has been established for constructing or operating the injection well(s).

The fracture pressure of the receiver was based on calculations provided in Section 8 of UIC 98-092 and is calculated as follows:

$$P = F \times D$$

where: P = Fracture pressure of the receiver, in psig
F = Fracture gradient, in psi/ft
D = Depth to the bottom of the receiver, in ft

In UIC 98-092, the calculation was made to the base of the Teapot sandstone at a depth of 7,755 feet to the base of the receiver. The indicated fracture gradient of the Teapot in UIC 98-092 was 0.7 psi/foot. A minor change in the base of the receiver formation was made to reflect the bottom of the anticipated perforated zone in the Teapot at 7,735 feet with a resulting fracture pressure of:

$$P = F \times D = 0.7 \times 7735 = 5415 \text{ psig}$$

This fracture pressure differs only slightly from the value of 5,429 psi as calculated in UIC 98-092. In order to extend the fracture pressure estimate to encompass a wider range of potential fracture pressures for the three planned perforated zones, a calculation was also made for the base of the receiver in the lower perforated zone in the Parkman at a depth of 8,390 feet. Cited fracture gradients for other Class I injection wells in the general area range from 0.55 to 0.63. Using a fracture gradient of 0.55 for the Parkman, the resulting fracture pressure is:

$$P = F \times D = 0.55 \times 8390 = 4615 \text{ psig}$$

Based on the preceding calculations, the more conservative estimate of fracture pressure is 4615 psig.

The hydrostatic head at the base of the Parkman perforated zone with fluid at the land surface is calculated as follows:

$$H = G \times D \times .433 = 1.03 \times 8390 \times .433 = 3742 \text{ psig}$$

where: H = Hydrostatic head at the bottom of the receiver, in psig
G = Specific gravity of the injection fluid
D = Depth to the bottom of the receiver, in ft

The specific gravity of the injection fluid was conservatively estimated for a high TDS fluid.

The friction loss in the tubing was calculated as follows:

T = 4.5 psi/100 ft x 74.5 = 335 psig (Halliburton friction pressure Charts, 2.441" diameter, 2.74 BPM, packer @ 7450').

Perforation pressure loss (L) was assumed to be negligible.

The surface injection pressure was calculated as follows:

S = (P – H + T + L) x (0.90) psig = (4615 – 3742 + 335 + 0) x (0.90) = 1087 psig

After completion of the well, a step injection pressure test will be conducted. The test results, the calculated fracture pressure, and the recalculated maximum surface injection pressure will be provided.

10.2 Proposed Stimulation Program

The proposed stimulation program includes the following items for initial and periodic stimulation:

1. A packer and bridge plug will be used to isolate each receiver formation and each receiver formation will be acidized with hydrochloric acid. Hydraulically fracture using proppant with the amount of frac fluid and proppant designed for a propped fracture half-length of approximately 200 feet. Temperature logs and/or gamma ray logs run in conjunction with radioactive frac sand will be used to determine fracture height.

2. For periodic stimulation, pump approximately 15,000 gallons of 15% HCL into the perforation zone. A pump truck with be used to remove any acid soluble materials in the perforation tunnels or in the near-wellbore formation.

10.3 Schematic of Water Disposal Surface Equipment

A schematic drawing of surface equipment is shown in Figure 15. This schematic shows the proposed tanks, filters and pumps used to deliver the disposal water to the well.

10.4 Injection Procedures

Operation of the injection system may be conducted on either a semi-continuous or a batch basis. Once sufficient waste water is accumulated in the storage tank (Figure 15), the water is pumped through filter housing, polishing filter housing, and through buried high density polyethylene piping which terminates at the suction manifolds of the disposal well pump. Well IW-2 will be located in close proximity to the plant and it is possible that the transfer pipeline will be enclosed above ground. The pump boosts the fluid pressure to that required for injection into the receiver intervals. The injection pressure, as measured at the wellhead, is limited to 200 psig less than the formation's estimated fracture pressure. Prior to reaching the disposal well pumps, a properly selected corrosion or scale inhibitor may be added to the wastewater to minimize the potential for downhole corrosion or scaling.

10.5 Description of Recording Devices

AUC will monitor and continuously record the injection rate. Pressure monitors will be installed on the injection tubing and on the well annulus. Continuous recording of these pressures will be provided. Complete specifications of the recording devices will be provided upon request when the devices are purchased. With this design, leakage in either the casing or the tubing will be detected and the injection well will be shut down automatically. Useable water quality in the area will be monitored by the required well field monitor wells associated with the ISR uranium operations.

10.6 Methods and Procedures Used for Inspection and Failure Detection

The injection pressure will be measured and recorded at all times. Should the pressure reach 90% of the maximum allowable injection pressure, a relief valve will automatically open and the disposal well pump will be shut down. If there are repeated occurrences of relief valve opening, the threshold relief pressure may be adjusted, but will not exceed 99% of the maximum allowable injection pressure. The annulus pressure will also be continuously measured and recorded.

The flow rate from the polishing filter (Figure 15) is measured, recorded and compared against the flow rate measured at the wellhead during injection. A deviation of greater than 3% between the two measurements will be investigated to determine if there is leakage from the buried or enclosed pipeline to the injection well.

10.7 Information About Staffing

The Reno Creek ISR project is currently in the permitting phase and there are no on-site facilities. Prior to construction of the injection well(s), AUC will provide documentation of on-site facilities, staffing, organization, and assigned responsibilities. Operation and maintenance of the injection disposal well will be under the direction of the Reno Creek Plant Supervisor. On-site personnel will include a Radiation Safety Officer. Personnel responsible for operating and monitoring the disposal well will be trained in all tasks necessary to safely and correctly operate the disposal well pumps, valves, recording devices, and scale/corrosion inhibitor systems.

11. MONITORING PLAN

11.1 Plan of Analysis of Injected Water

Following the approval to inject, a composite sample will be collected of the waste stream and analyzed for the parameters noted below, on a quarterly basis or when process changes occur that will significantly alter the characteristics of the waste stream.

Radium-226 (pCi/l)	pH (standard units)
Uranium, natural (mg/l)	Sulfate (mg/l)
Chloride (mg/l)	Bicarbonate (mg/l)
Carbonate (mg/l)	Conductivity (µ/cm)
Total Dissolved Solids (mg/l)	Ammonia, NH_3 as N (mg/l)

The records of monitoring will be reported quarterly and will include:

a. The date, exact place, and time of sampling;
b. The name(s) of individuals performing the sampling;
c. The date(s) of analysis;
d. Name(s) of individuals performing analysis;
e. Analytical procedures or methods used;
f. The results of the analysis.

The samples will be collected before the high pressure injection pump and will be representative of the waste being injected. The results of the analyses will be furnished to the Division within 30 days following the end of each calendar quarter.

The constituents will be analyzed using approved methods as described and in accordance with Wyoming Water Quality Rules and Regulations Chapter VIII, Section 7.

Other items which will be monitored include the continuous measurement and recording of injection and annulus pressures. Additionally, the injection zone pressure will be determined and a pressure falloff curve will be developed on an annual basis.

11.2 Monitor Wells

Useable water quality in the area will be monitored by the required well field monitor wells associated with the ISR uranium operations.

11.3 Monitoring Plan

All information and records of the monitoring plan will be reported as outlined in Section 16 of this application. All records will be retained for a minimum of three (3) years following well closure and with the records delivered to the Division, upon Administrator request, at the conclusion of the retention period.

11.4 Quality Assurance Plan

The Quality Assurance Program will incorporate and utilize the appropriate techniques outlined in the Environmental Protection Agency's (EPA's) manual "RCRA Groundwater Monitoring Technical Enforcement Guidance Document" including using guidelines for sampling and preservation established in 40 CFR §136. The program will incorporate the appropriate field and laboratory quality assurance and control procedures including splitting of samples between laboratories, submittal of blanks, maintenance and calibration of equipment, use of standards, and chain of custody records. Analysis of all samples will be performed in accordance with Chapter VIII, Water Quality Rules and Regulations, Section 7 and 8.

12. WELL ABANDONMENT

At the present time, minimum Plugging & Abandonment (P & A) requirements are to squeeze cement through the existing perforations using a cement retainer, place approximately 50 feet of cement on top of the retainer, set a 250 foot stabilizer plug mid-way in the casing, cut off the casing near the surface and place a dry hole marker in a 10 sack cement plug at the surface. A more detailed abandonment procedure is described in Section 10 of UIC 98-092. The procedure in Section 10.1.a of UIC 98-092 was used as a guideline, and well abandonment volumes and costs were estimated based on the well IW-1completion with the assumption of perforations extending to include the Teckla sandstone. This expands the cemented interval and adds a measure of conservatism to the abandonment cost estimates. Appendix F includes a prepared bid with costing for cementing abandonment of well IW-1. At the time of abandonment, there will be minor changes reflecting actual perforation intervals and installed casing depth.

When wastewater disposal operations cease and the well is no longer necessary, the well(s) will be plugged and abandoned according to the previous description and the rules of the Wyoming Oil and Gas Conservation Commission in effect at the time of abandonment.

Additional costs for decommissioning and abandonment of the Class I injection wells are included in Appendix G. These costs include removal and disposal of surface equipment and structures, removal of pipelines, and surface reclamation of the site and pipeline corridors.

13. FINANCIAL SURETY

The current decommissioning and abandonment cost estimate for a single injection well is $126,300. At the time of well construction, a specific abandonment cost estimate will be developed for each well that is installed. Because the Class I injection well(s) will not be installed until after a significant portion of the ISR operations facilities have been constructed or installed, the financial surety for the injection well abandonment and closure will be included as an increase in the surety instrument for the ISR mining operations. AUC will provide a Financial Surety Bond to the WDEQ using an approved surety arrangement prior to the commencement of well construction activities.

14. MECHANICAL INTEGRITY

Mechanical integrity will be demonstrated before subsurface injection commences, and at least once every five (5) years thereafter during the life of the well. The well will be deemed to have mechanical integrity if there is no measurable leak in the casing, tubing, or packer; and there is no indication of movement of injected fluid into an underground source of usable water through vertical channels adjacent to the well bore. The absence of leaks will be determined by an acceptable pressure test. The absence of vertical fluid movement will be determined by the results and interpretation of appropriate geophysical logs(s), such as a cement bond, temperature, noise or other log, or combination of logs; or another technique acceptable to the Administrator. The results of the

replaced 3/26/10 [initials]

initial mechanical integrity testing will be submitted and approved before subsurface injection will commence.

15. SIGNATURE REQUIREMENTS

Pursuant to the provision of Chapter XIII, Section 5(b) (xiv), the permit application has been signed by Jim Crouch, Manager, AUC, LLC.

16. REPORTING REQUIREMENTS

16.1 Quarterly Reporting

AUC will submit quarterly reports within 30 days after the end of each calendar quarter signed by a duly authorized representative.

The quarterly report will contain:

1) The maximum and minimum daily injection pressure (not an average pressure) as well as maximum and minimum daily injection volume for each month within the quarter, and the dates that these maximums and minimums were reached. The accumulated total volume of waste injected for each month and the accumulated total volume injected to date.
2) The maximum and minimum daily annulus pressures, date(s) of occurrence of minimum and maximum, and a well operating log for that day.
3) Chemical analyses of waste fluid as listed in Section 11.
4) Total water disposal volumes and a list of facilities that produced the water.
5) A discussion of any non-compliance, mechanical integrity test (MIT), or significant event during the quarter.
6) The average maximum injection pressure and annulus pressure for each month calculated by averaging the maximum pressures for each day.
7) The average injection rate calculated by dividing the total waste injected by the total hours of operation.

16.2 Annual Report

The Annual Report shall consist of the 4th Quarter Report along with a summary of the year's operation. This summary shall include the maximum injected volume for the year and the date on which it was reached as well as the total volume of waste fluid injected. The Annual Report shall include significant events for the year such as Mechanical Integrity Tests, and any noncompliance with permit conditions.

17. REFERENCES

Busby, J.F., B.A. Kimball, J.S Downey and K.D. Peter 1995, Geochemistry of Water in Aquifers and Confining Units of the Northern great Plains in Parts of Montana, North Dakota, South Dakota, and Wyoming, U.S. Geological Survey Professional Paper 1402-F

Downey, J.S, 1984, Geohydrology of the Madison and Associated Aquifers in Parts of Montana, North Dakota, South Dakota, and Wyoming, U.S. Geological Survey Professional Paper 1273-G

Downey, J.S, 1986, Geohydrology of Bedrock Aquifers in the Northern Great Plains of Montana, North Dakota, South Dakota , and Wyoming, U.S. Geological Survey Professional Paper 1402-E

Downey, J.S., and G.A. Dinwiddie , 1988, The Regional Aquifer System Underlying the Northern Great Plains in Parts of Montana, North Dakota, South Dakota, and Wyoming –Summary, U.S. Geological Survey Professional Paper 1402-A

Timur; A., 1968, "An Investigation of Permeability, Porosity and Residual Water Saturation Relationships for Sandstone Reservoirs", Transaction SPWLA, June 1968.

Figure 1. Location Map for Project Area

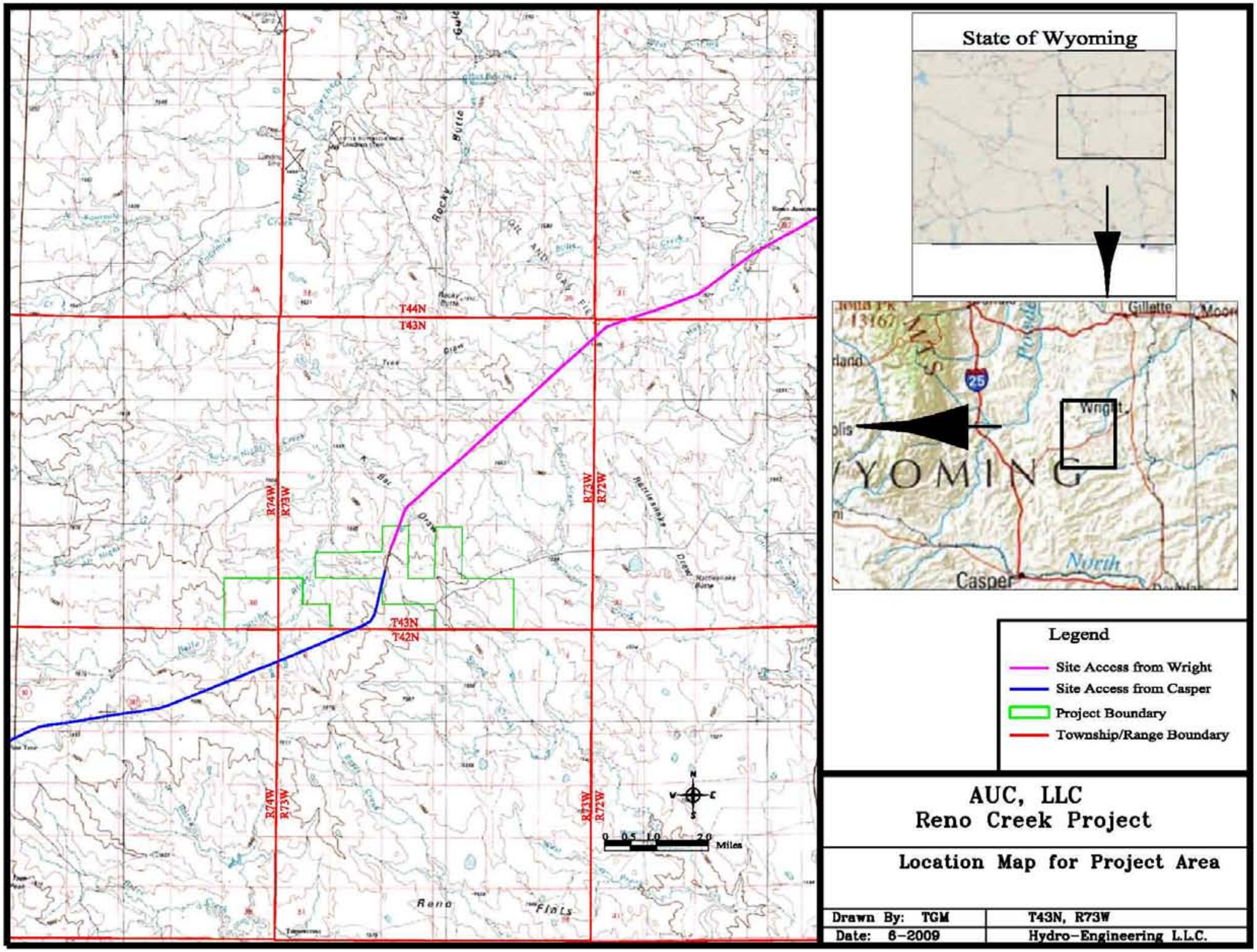


Figure 2. Location of Proposed Class I Injection Wells

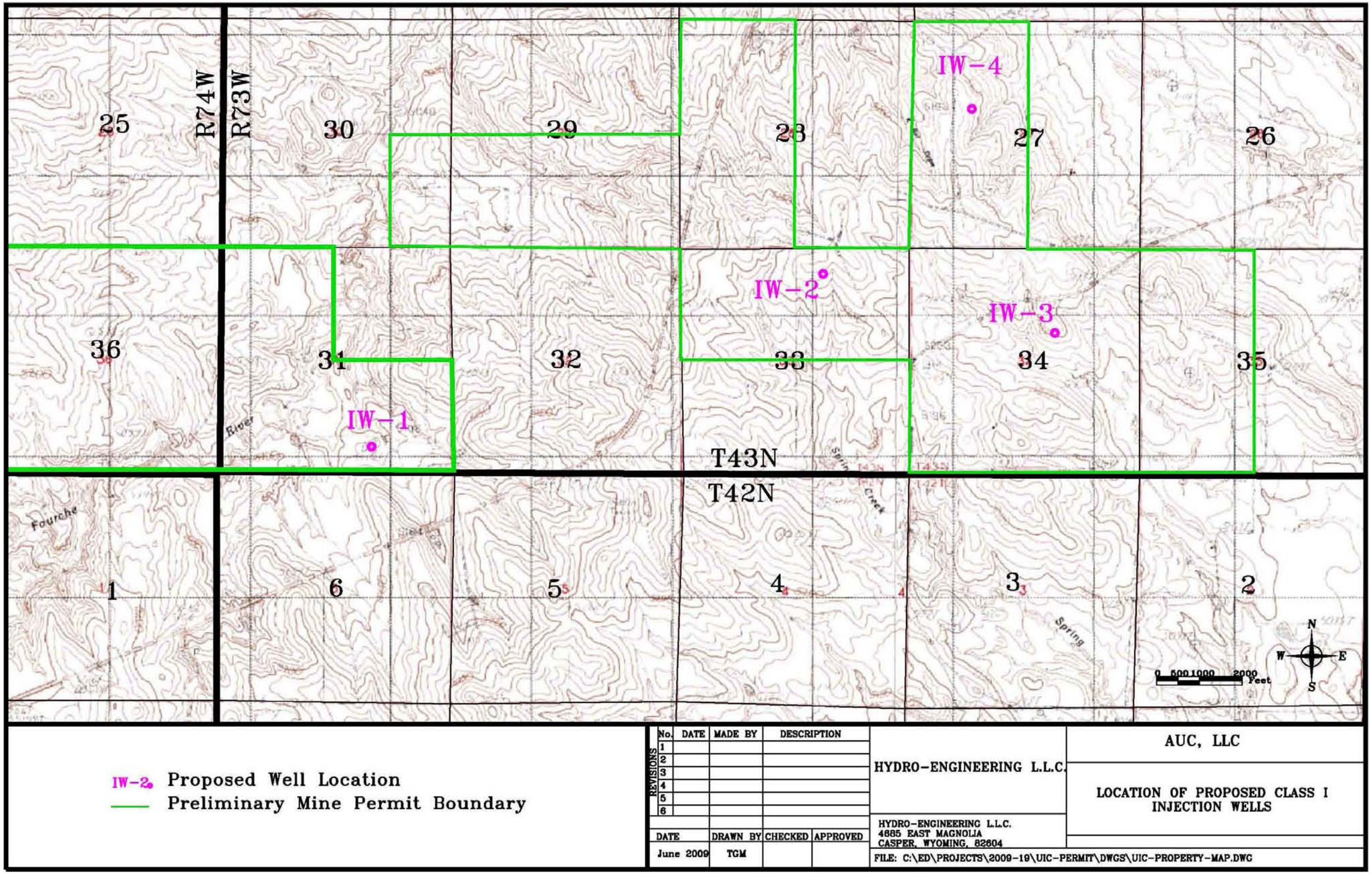


Figure 3. Existing Wells Within the Project Area

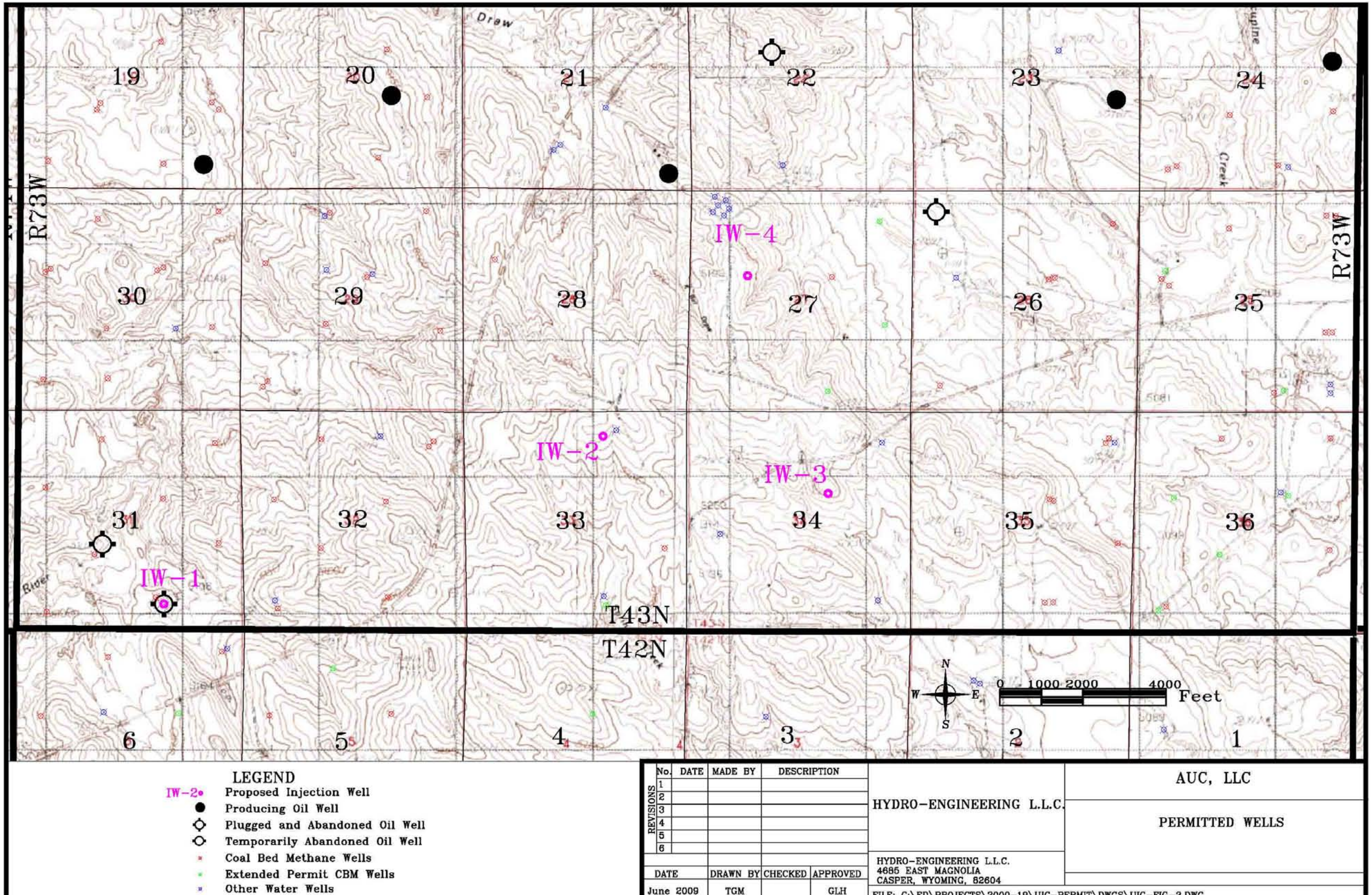


Figure 4. Geologic Cross Section Through Project Area

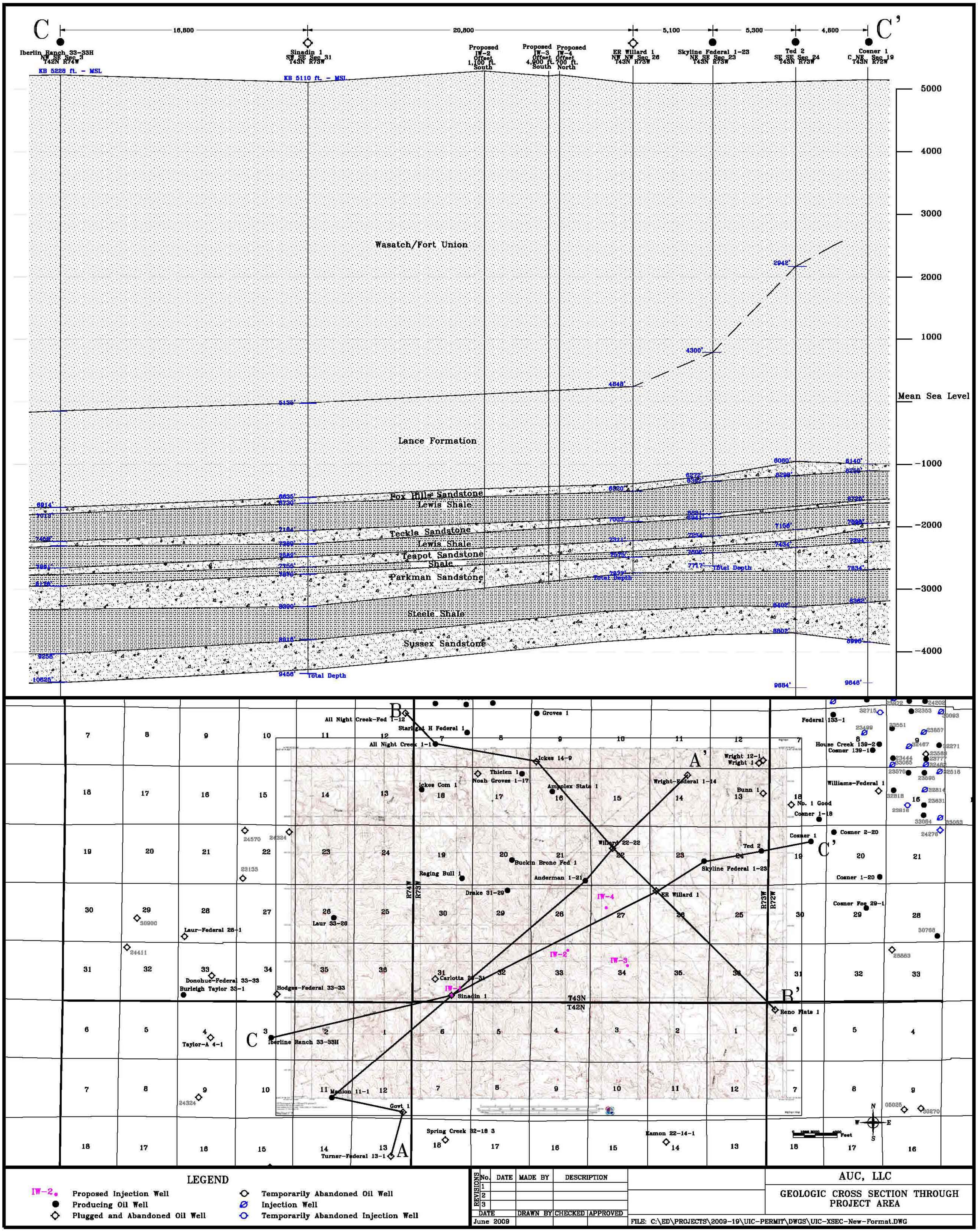


Figure 5. Injection Well Areas of Review

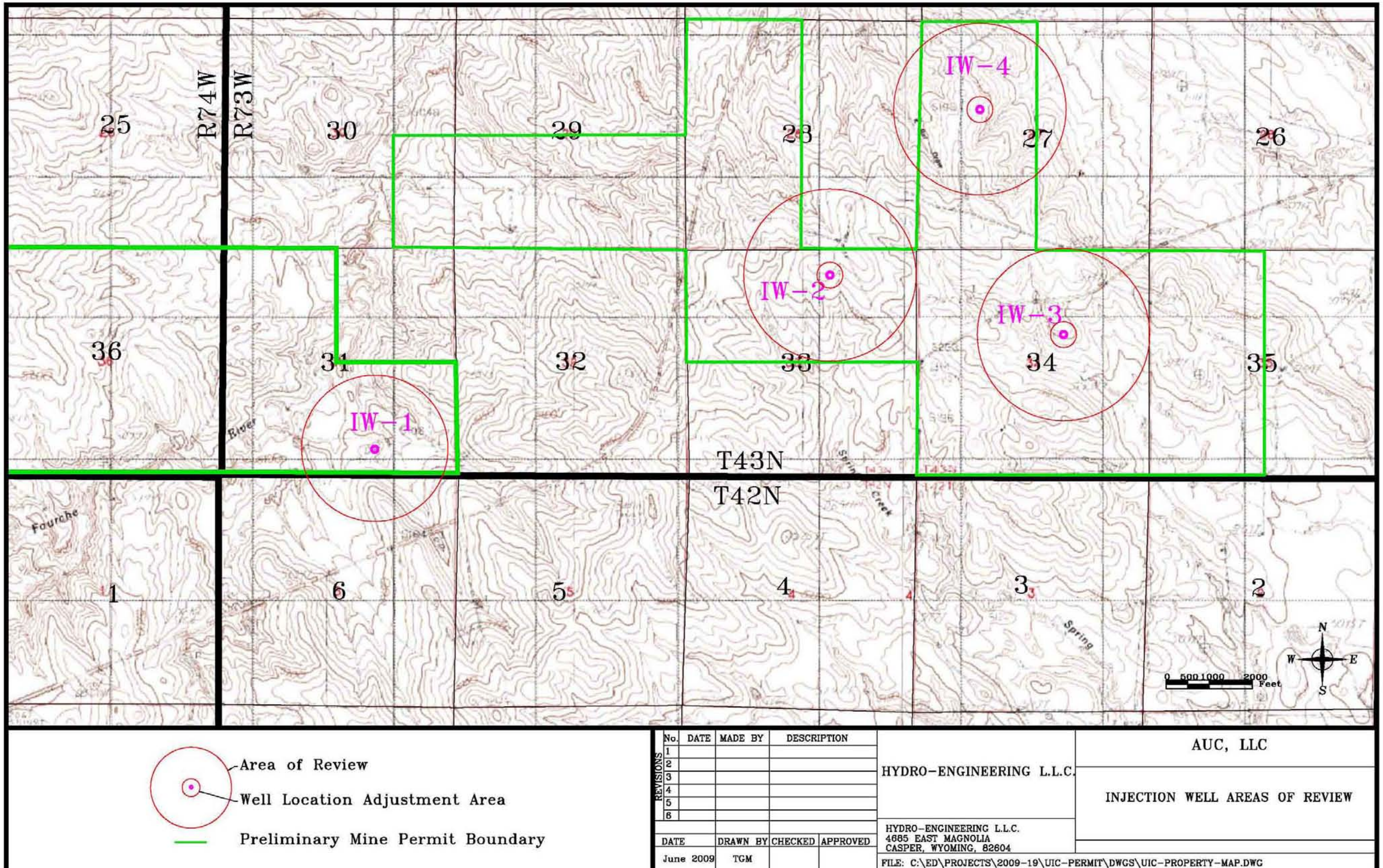


Figure 6. Surface Land Ownership

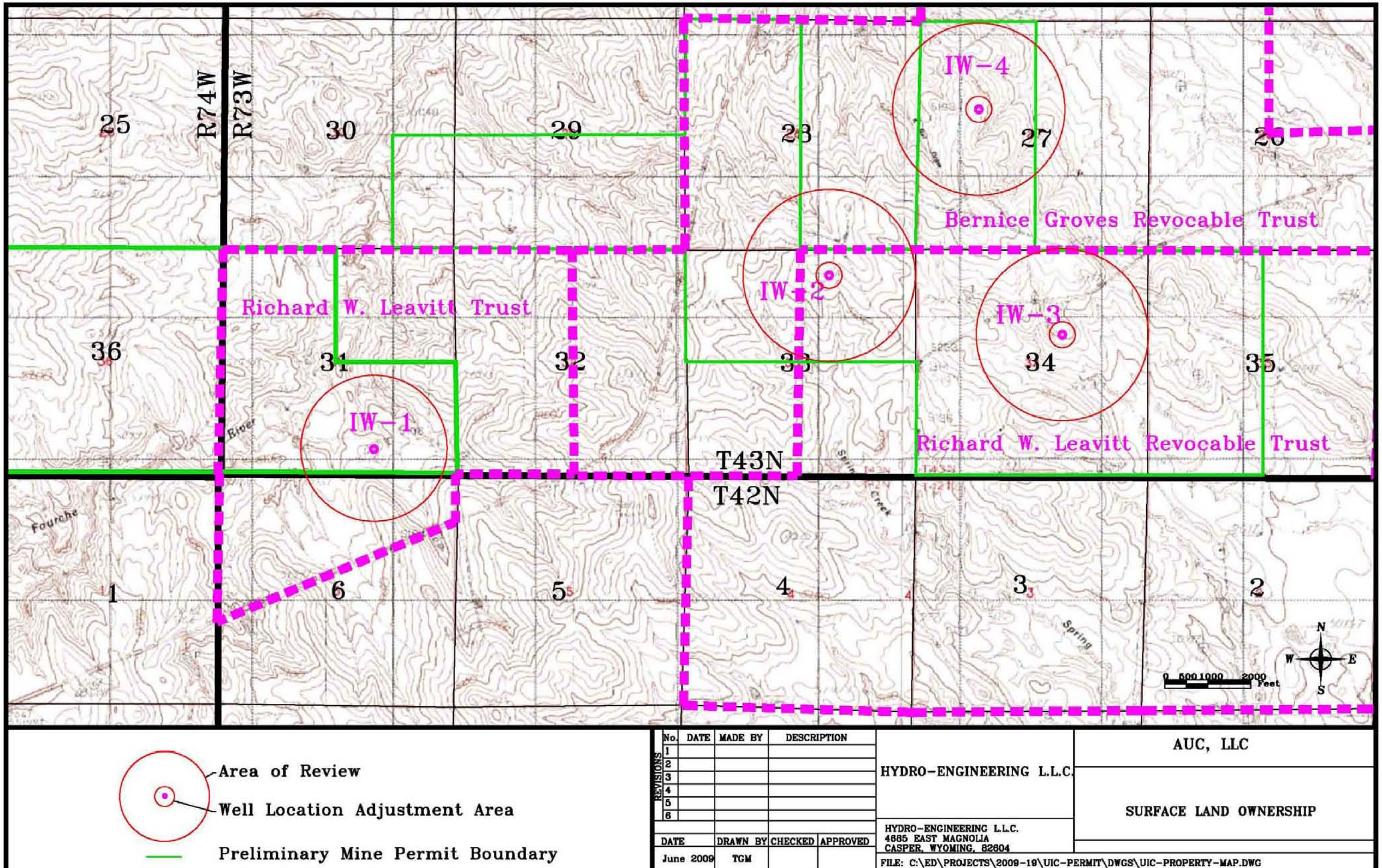


Figure 7. Mineral Ownership

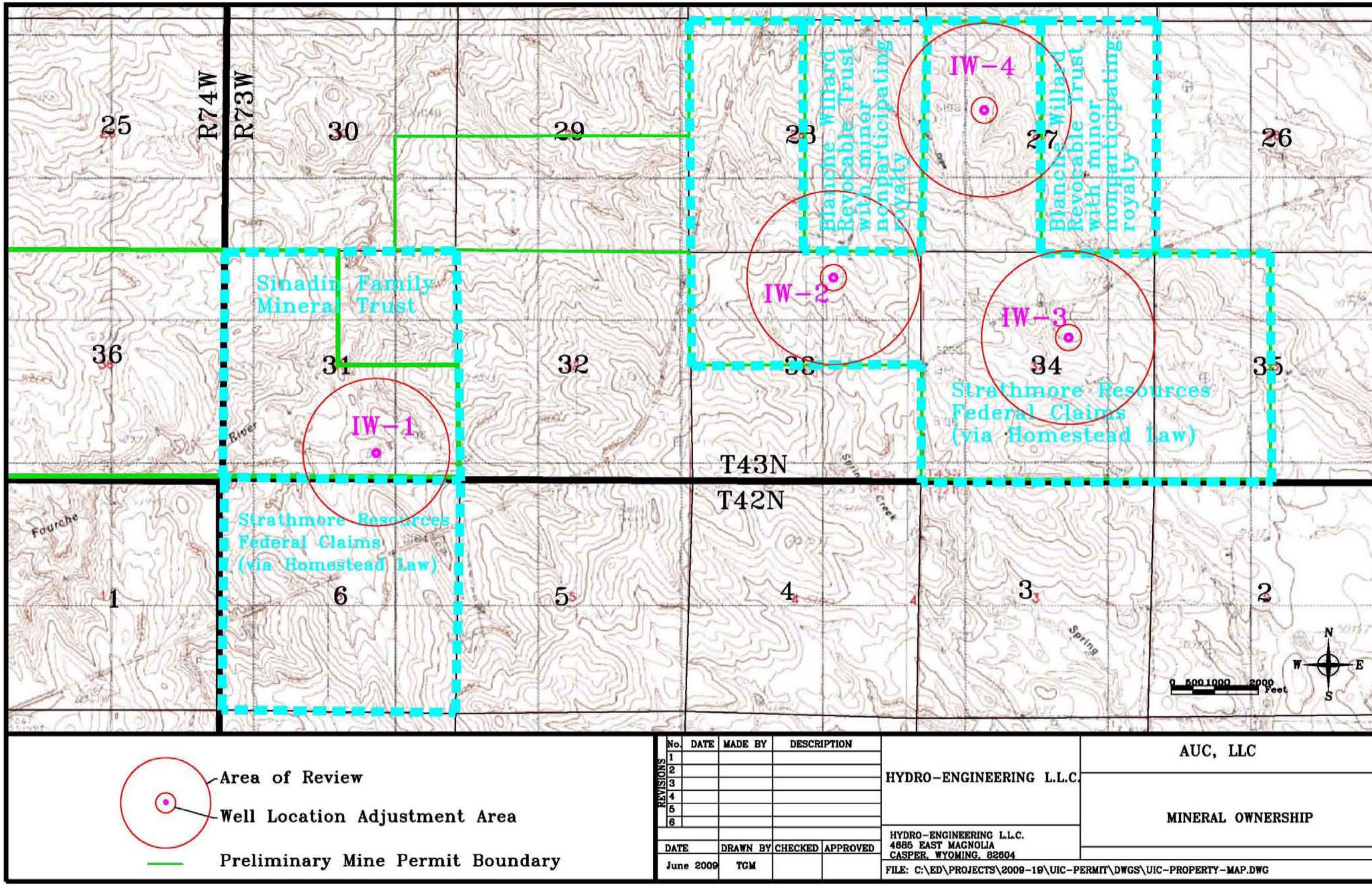


Figure 8. Oil and Gas Ownership

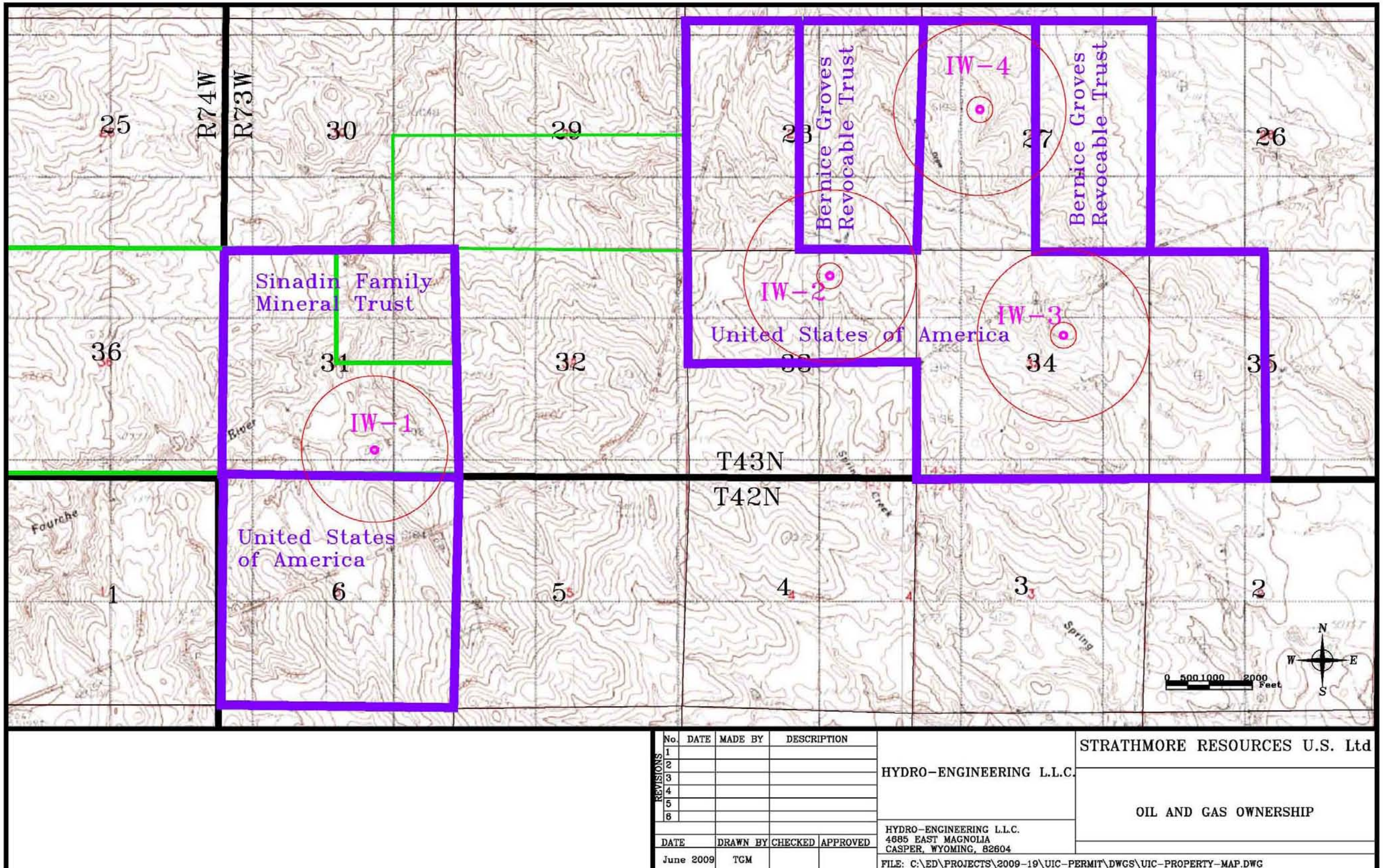


Figure 9. Oil and Gas Leaseholder

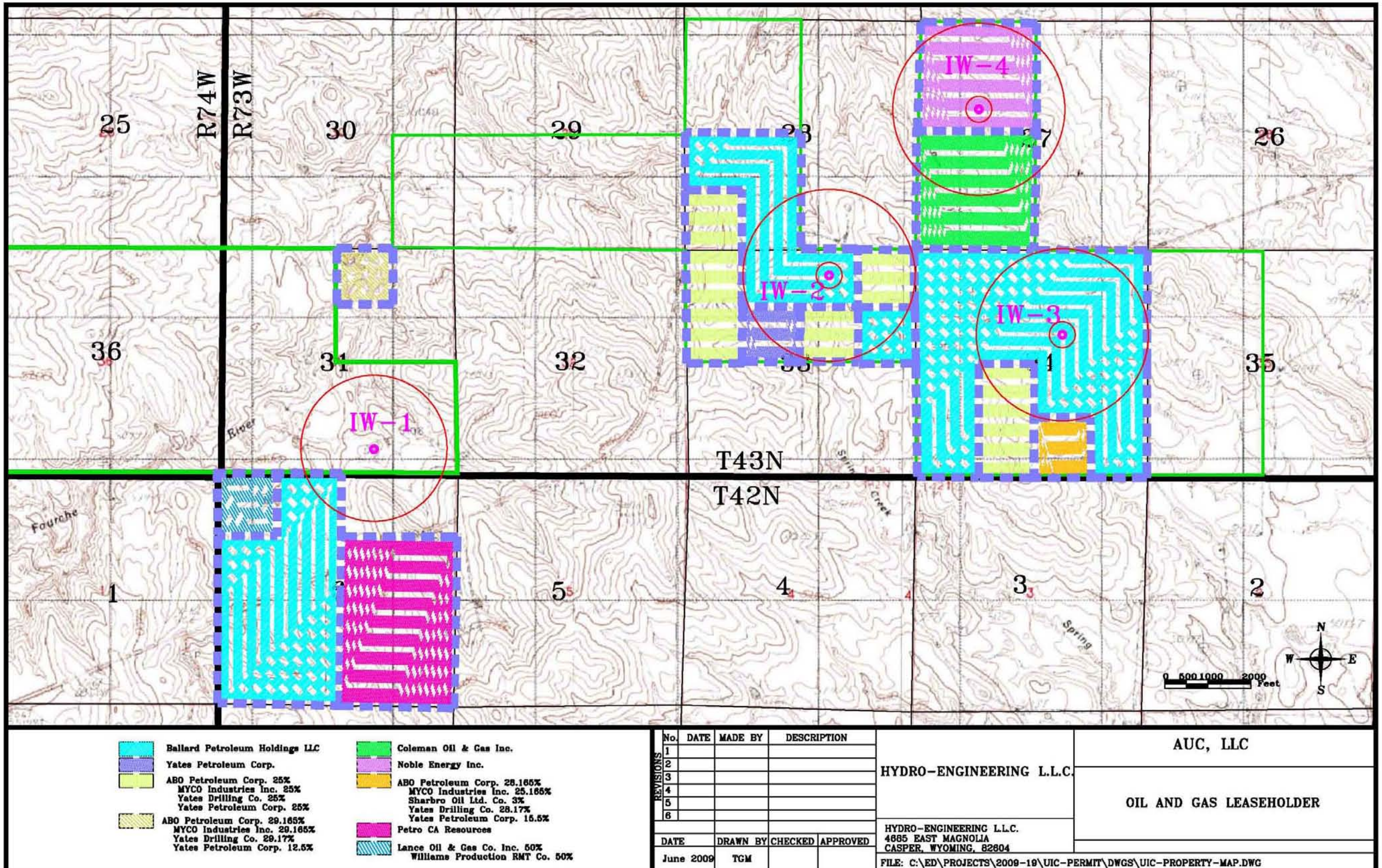


Figure 10. Permitted Ground and Surface Water Rights

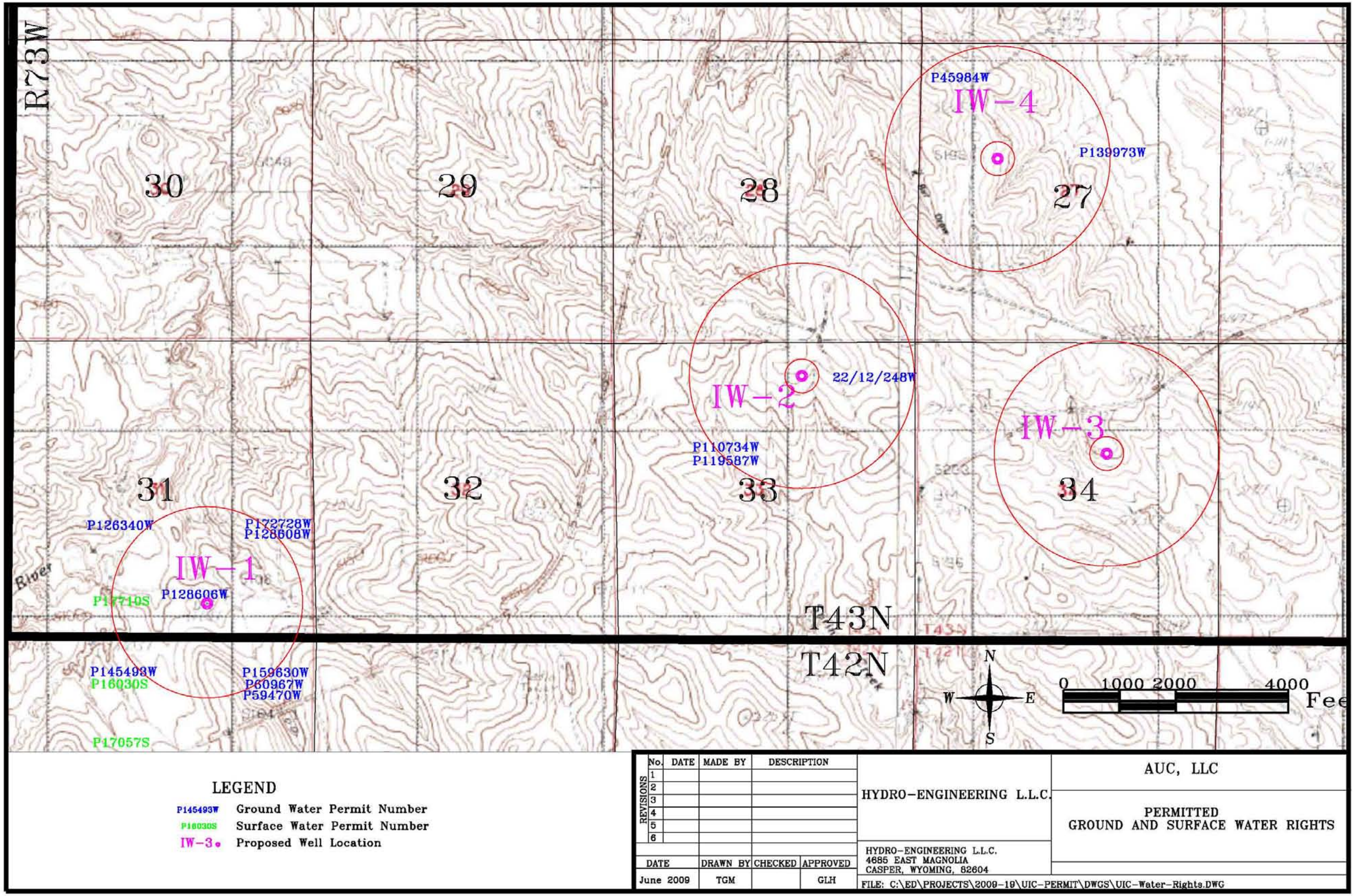


Figure 11. IW-1 Class I Injection Well Completion

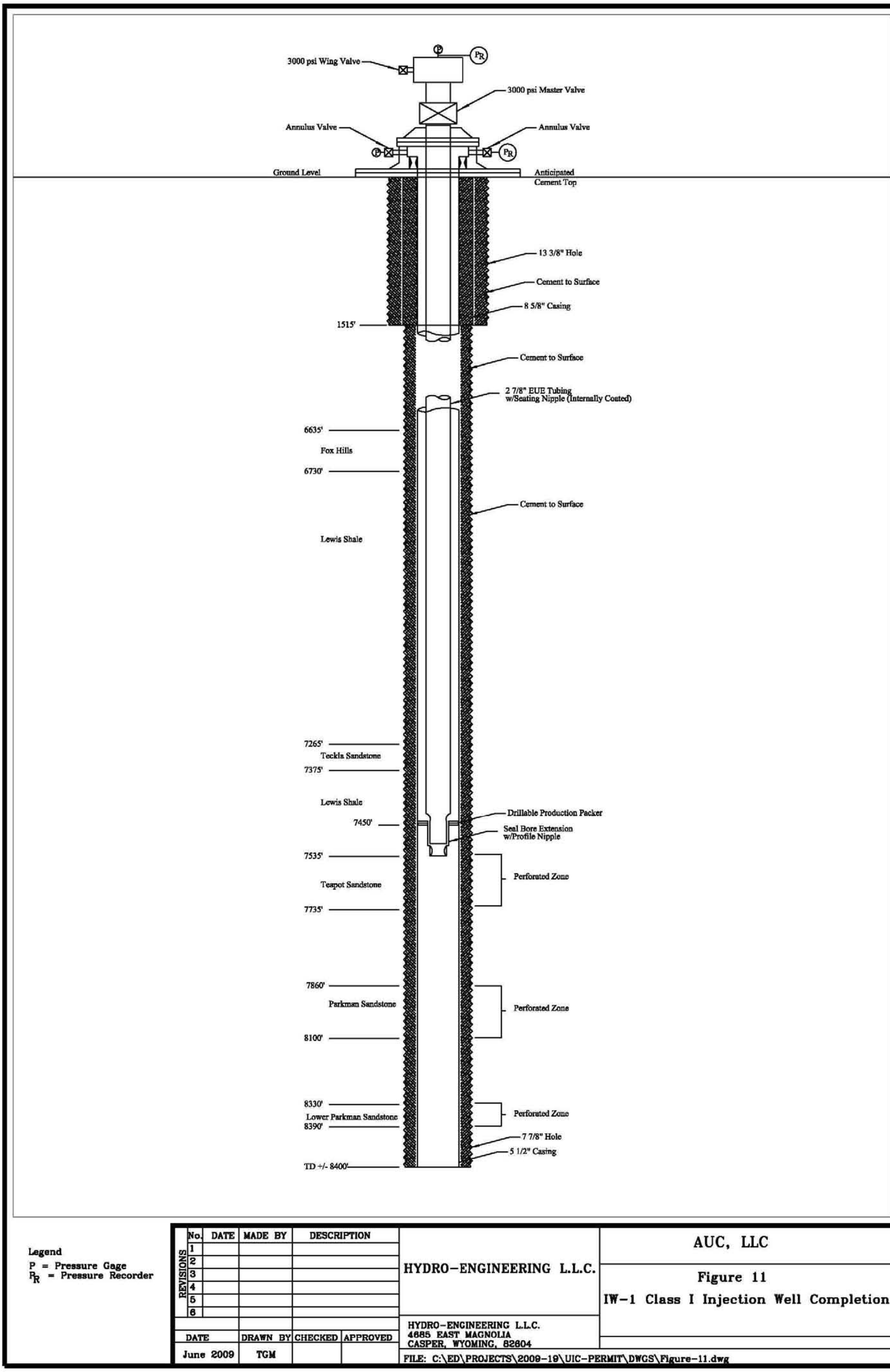


Figure 12. Proposed IW-2 Class I Injection Well Completion

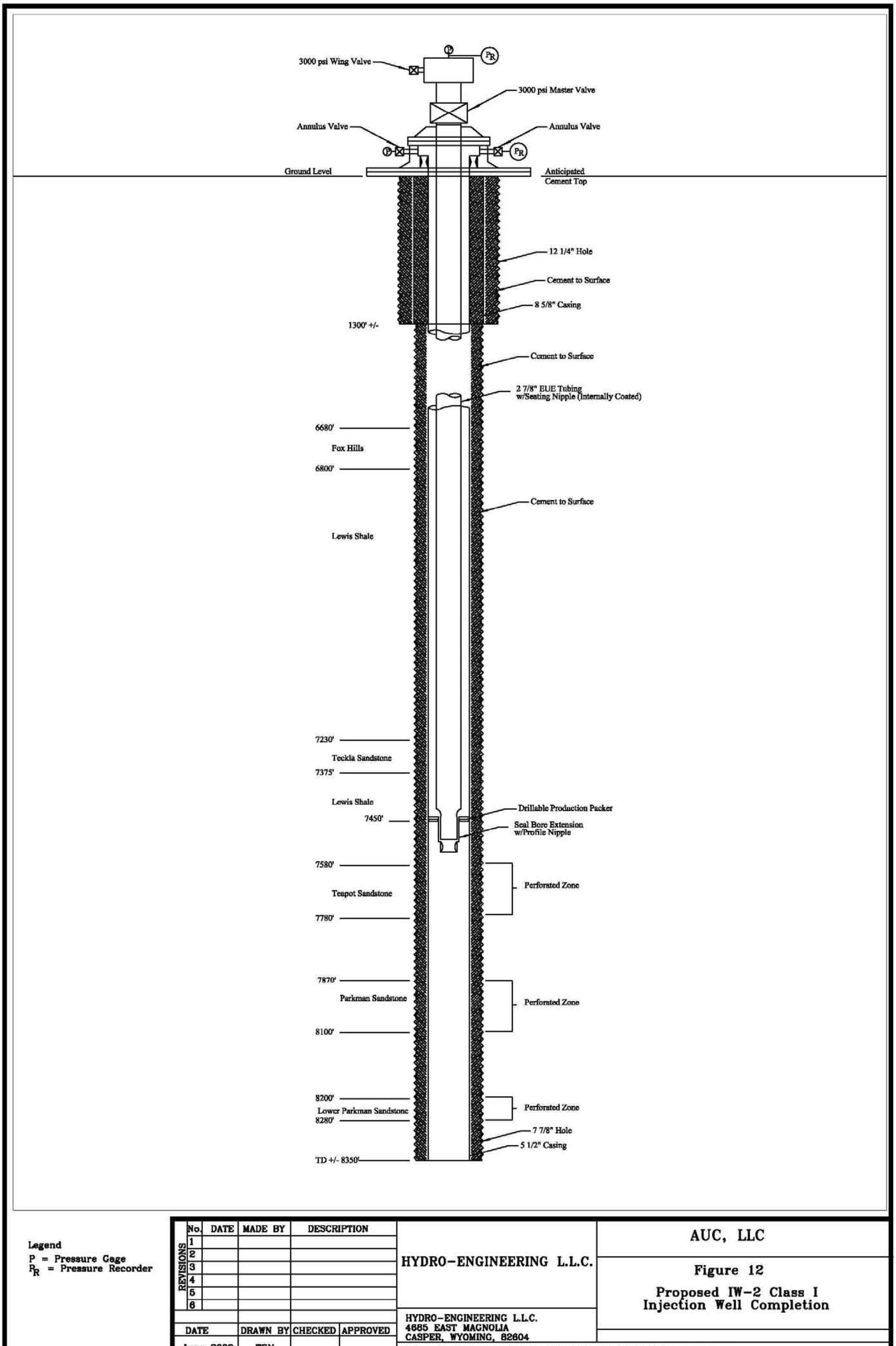


Figure 13. Proposed IW-3 Class I Injection Well Completion

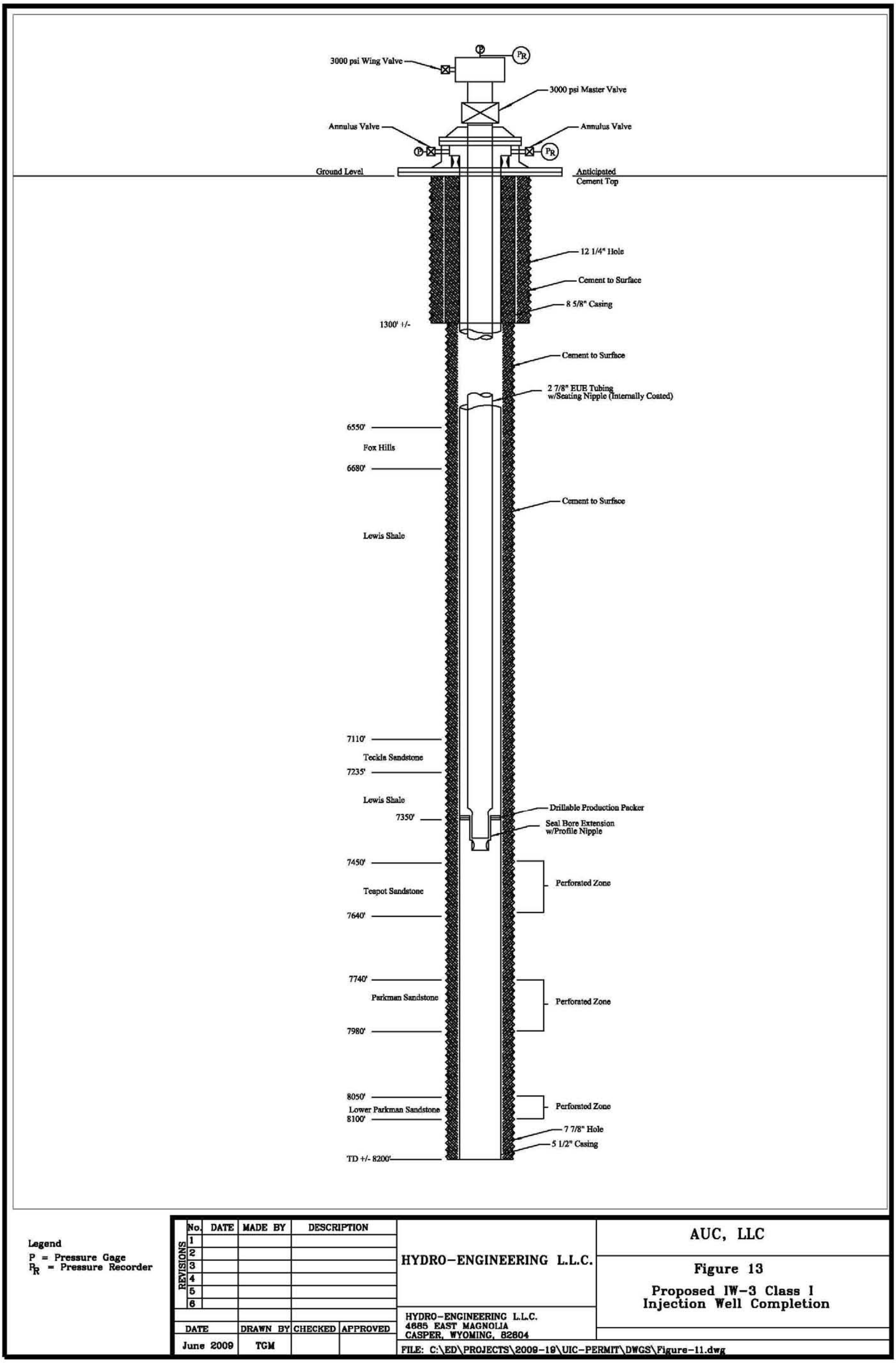


Figure 14. Proposed IW-4 Class I Injection Well Completion

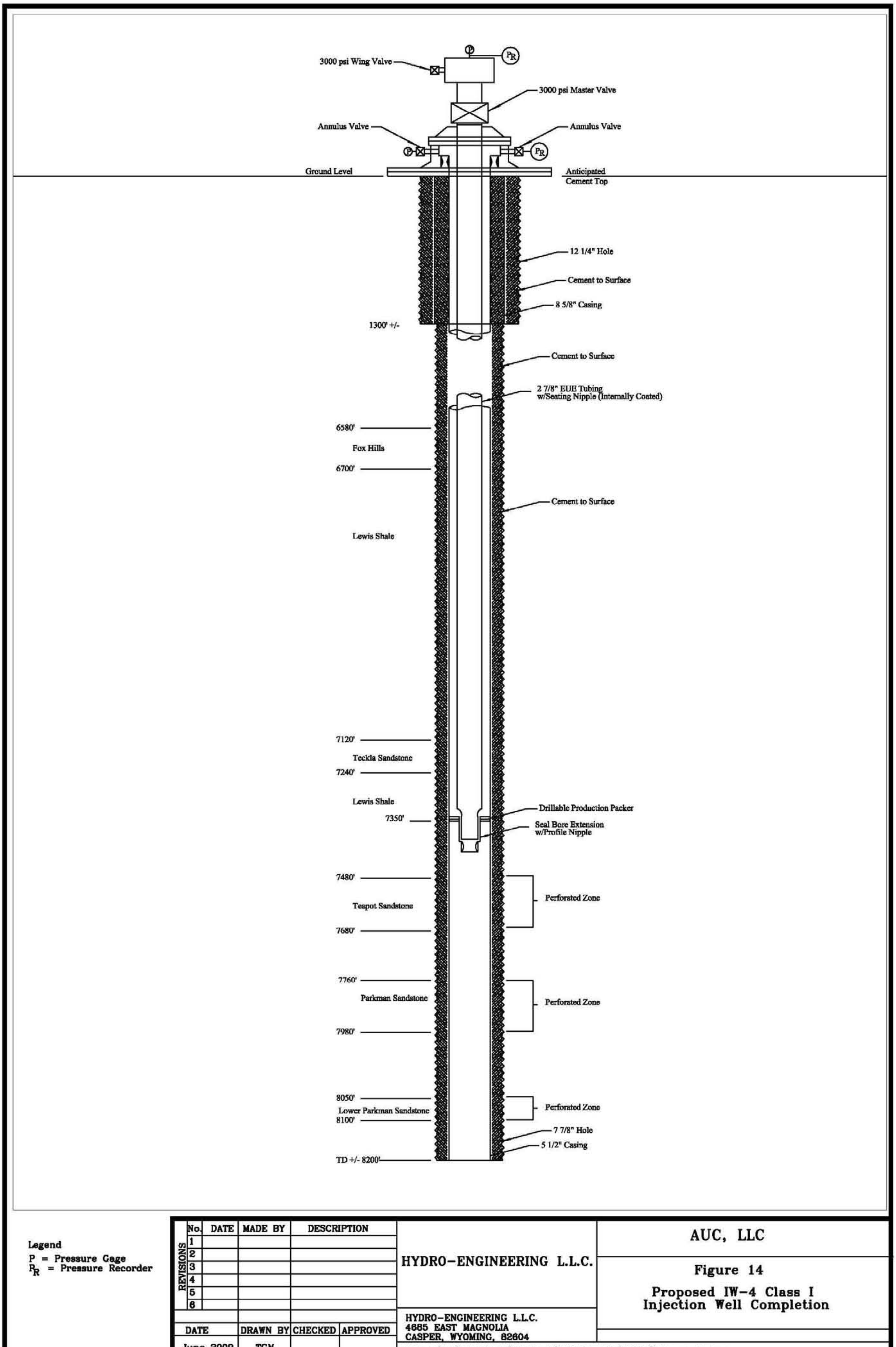
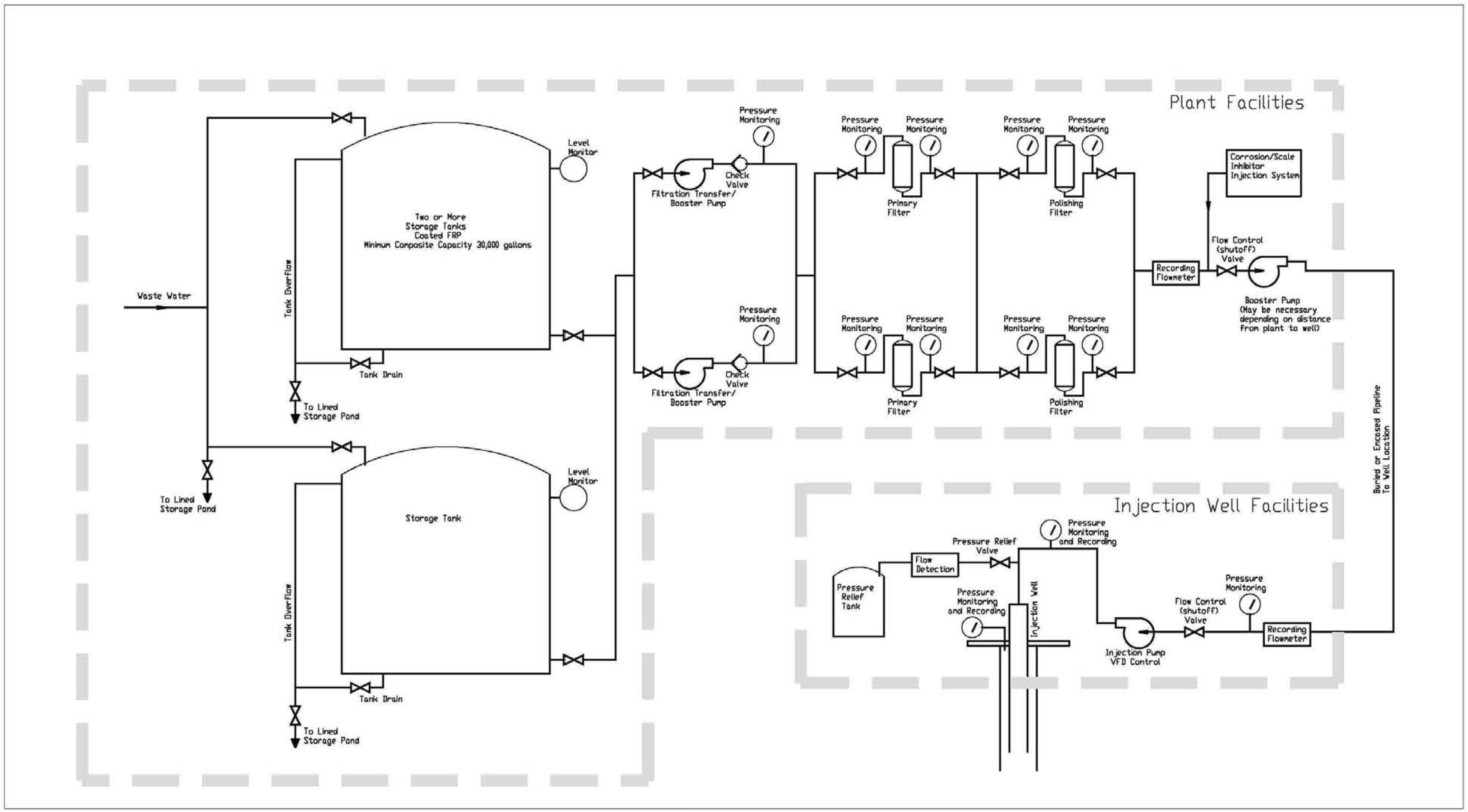


Figure 15. Surface Injection Equipment



Note: Flow and pressure monitoring, recording, and control will typically be done with electronic instruments and actuators. Electronic measurement devices (transducers and transmitters) and valve actuation or pump control units will be connected to a programmable logic controller.

REVISIONS No.	DATE	MADE BY	DESCRIPTION
1			
2			
3			
4			
5			
6			

DATE	DRAWN BY	CHECKED	APPROVED
June 2009	TGM		GLH

HYDRO-ENGINEERING L.L.C.

HYDRO-ENGINEERING L.L.C.
4685 EAST MAGNOLIA
CASPER, WYOMING, 82604

AUC, LLC

SURFACE INJECTION EQUIPMENT

FILE: C:\ED\PROJECTS\2009-19\UIC-PERMIT\DWGS\Figure-15.DWG

Appendix A. Wells Penetrating Receiver

There are no wells penetrating the receiver within the AOR of the four wells. There are both producing oil wells and plugged and abandoned wells within a mile of planned well locations. The following listing includes Wyoming Oil and Gas Conservation Commission records for wells within Sections 20 thru 23 and Sections 26 thru 35 of T43N, R73W. The Wyoming Oil and Gas Conservation Commission records do not indicate the presence of wells within Sections 1 thru 6 of T42N, R73W, Section 1 of T42N, R74W, or Section 36 of T43N, R74W.

List of Appendix A Figures

Figure A-1. WOGCC Completion Report For E R Willard 1

STATE OF WYOMING
OIL AND GAS CONSERVATION COMMISSION
Office of State Oil and Gas
Supervisor

01/23/2009

Lease No.	
Unit No.	
Lease Name	E R WILLARD
Api No.	49-005-05026
County	CAMPBELL
Well Name	E R WILLARD 1
Operator	ARROWHEAD EXPLORATION CO
Field	WC

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude	Well Class	Minerals	Elevation	Elevation KB
660 FNL & 660 FWL	NW NW	26	43 NORTH	73 WEST	43.67609	105.60095	O	FEDERAL	0	5093 KB

Bottom Hole	First Prod	Well Status	Form 2 Status
		PA 08/29/1958	

Total Depth	Plug Back Depth	Bottom Formation	Permitted Formation	Apd Received	Apd Approved	Spud Date	TD Reached	Completed
7887	0	PARKMAN			08/10/1958	08/10/1958		08/29/1958

Verbal To Plug and Abandon:	Notice of Intent To Abandon:	Hole Size:	Csg Size: 8 5/8	Csg Depth: 300
Subsequent Report Of Abandonment:	Plug and Abandonment Date:	Hole Size:	Csg Size:	Csg Depth: 0
Ip Oil Bbls:	Ip Gas Mcf:	Ip Water Bbls:		
Cumulative Production:	Oil Bbls: / Gas Mcf:	Water Bbls:		
Logs Ran:		Form 2 Filed:		

Geolgical Formation	Depth
LEWIS,SH	6520
TEAPOT,MBR (PARKMAN SS)	7311
PARKMAN,SS	7575

Figure A-2. WOGCC Completion Report For Anderman 1-21

01/23/2009

STATE OF WYOMING

OIL AND GAS CONSERVATION COMMISSION

Office of State Oil and Gas Supervisor

Lease No.	PATENTED
Unit No.	
Lease Name	ANDERMAN
Api No.	49-005-24167
County	CAMPBELL
Well Name	ANDERMAN 1-21
Operator	EXCO RESOURCES INC
Field	K-BAR

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude
570 FSL & 705 FEL	SE SE	21	43 NORTH	73 WEST	43.67978	105.62658

Bottom Hole

Well Class	Minerals	Elevation	Elevation KB
O	FEE	0	5202

First Prod	Well Status	Form 2 Status
04/23/1976	PO 04/23/1976	PR 11/2008

Total Depth	Plug Back Depth	Bottom Formation	Permited Formation	Apd Received	Apd Approved	Spud Date	TD Reached	Completed
8868	0	SUSSEX	PARKMAN		02/11/1976	02/11/1976		05/20/1976

Verbal To Plug and Abandon	Notice of Intent To Abandon	Hole Size	Csg Size 5 1/2	Csg Depth 7997
Subsequent Report Of Abandonment	Plug and Abandonment Date	Hole Size	Csg Size 8 5/8	Csg Depth 512

Ip Oil Bbls	Ip Gas Mcf	Ip Water Bbls
90		102

Cumulative Production	Oil Bbls	Gas Mcf	Water Bbls
Jan 1978 To Nov 2008	90,945	0	59,708

Logs Ran

Form 2 Filed: PARKMAN

Top Perfs	Bottom Perfs	Holes/Ft	Size	Purpose	Type	Prod Interval Top	Prod Interval Bot	Formation
7771	7814							

Form Date	Submission	Action
1994/11/14	FORM 4A	SEVERANCE TAX REDUCTION

Geolgical Formation	Depth
TECKLA,SAND MBR (LEWIS SH)	7168
TEAPOT,MBR (PARKMAN SS)	7493
PARKMAN,SS	7733
SUSSEX,SS	8723

http://wogcc.state.wy.us/QuickLook.cfm?nAPI=524167 1/23/2009

Figure A-3. WOGCC Completion Report For Skyline Federal 1-23

01/23/2009

STATE OF WYOMING
OIL AND GAS CONSERVATION COMMISSION
Office of State Oil and Gas Supervisor

Lease No.	WYW5331
Unit No.	
Lease Name	SKYLINE FEDERAL
Api No.	49-005-24260
County	CAMPBELL
Well Name	SKYLINE FEDERAL 1-23
Operator	MARLIN OIL COMPANY LLC
Field	K-BAR

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude
1980 FSL & 660 FEL	NE SE	23	43 NORTH	73 WEST	43.68327	105.58565

Bottom Hole:

Well Class	Minerals	Elevation	Elevation KB
O	FEDERAL	5080	5090

First Prod	Well Status	Form 2 Status
08/14/1976	PO 12/31/1986	PR 09/2008

Total Depth	Plug Back Depth	Bottom Formation	Permited Formation	Apd Received	Apd Approved
7717	0	PARKMAN	PARKMAN		06/13/1976

Spud Date	TD Reached	Completed
06/13/1976		08/15/1976

Verbal To Plug and Abandon	Notice of Intent To Abandon

Subsequent Report Of Abandonment	Plug and Abandonment Date

Hole Size	Csg Size	Csg Depth
	5 1/2	7717
	8 5/8	1460

Ip Oil Bbls	Ip Gas Mcf	Ip Water Bbls
43	40	160

Cumulative Production	Oil Bbls	Gas Mcf	Water Bbls
Jan 1978 To Sep 2008	54,376	45,369	111,704

Logs Ran:

Form 2 Filed: PARKMAN

Top Perfs	Bottom Perfs	Holes/Ft	Size	Purpose	Type	Prod Interval Top	Prod Interval Bot	Formation
7506	7576							

Geolgical Formation	Depth
WASATCH,FM	0
FORT UNION,FM	1060
LANCE,FM	4300
FOX HILLS,FM	6272
LEWIS,SH	6362
TEAPOT,MBR (PARKMAN SS)	7234
PARKMAN,SS	7505
PARKMAN,SS	7505

Figure A-4. WOGCC Completion Report For Sinadin 1

01/23/2009

STATE OF WYOMING

OIL AND GAS CONSERVATION COMMISSION

Office of State Oil and Gas Supervisor

Field	Value
Lease No.	FEE
Unit No.	
Lease Name	SINADIN
Api No.	49-005-24704
County	CAMPBELL
Well Name	SINADIN 1
Field	WC

Operator: **BP AMERICA PRODUCTION COMPANY**

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude	Well Class	Minerals	Elevation	Elevation KB
660 FSL & 1982 FEL	SW SE	31	43 NORTH	73 WEST	43.65058	105.67147	O	FEE	0	5110

Bottom Hole	First Prod	Well Status	Form 2 Status
		PA 07/27/1977	

Total Depth	Plug Back Depth	Bottom Formation	Permitted Formation	Apd Received	Apd Approved	Spud Date	TD Reached	Completed
9456	0	SHANNON			06/26/1977	06/26/1977		07/27/1977

Verbal To Plug and Abandon	Notice of Intent To Abandon	Hole Size	Csg Size	Csg Depth
			18	30

Subsequent Report Of Abandonment	Plug and Abandonment Date	Hole Size	Csg Size	Csg Depth
			8 5/8	1515

Ip Oil Bbls	Ip Gas Mcf	Ip Water Bbls

Cumulative Production	Oil Bbls	Gas Mcf	Water Bbls

Logs Ran	Form 2 Filed

Geolgical Formation	Depth
TECKLA,SAND MBR (LEWIS SH)	7164
TEAPOT,MBR (PARKMAN SS)	7582
PARKMAN,SS	7886
SUSSEX,SS	8915
SHANNON,SS MBR (CODY SH)	9365

http://wogcc.state.wy.us/QuickLook.cfm?nAPI=524704 1/23/2009

Figure A-5. WOGCC Completion Report For Willard 22-22

01/23/2009

STATE OF WYOMING

OIL AND GAS CONSERVATION COMMISSION

Office of State Oil and Gas Supervisor

Lease No.	
Unit No.	
Lease Name	WILLARD
Api No.	49-005-29105
County	CAMPBELL
Well Name	WILLARD 22-22
Field	K-BAR

Operator: TRUE OIL LLC

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude
1935 FNL & 1825 FL	SE NW	22	43 NORTH	73 WEST	43.68731	105.61056

Bottom Hole:

Well Class	Minerals	Elevation	Elevation KB
O	FEE	5254GR	5268 KB

First Prod	Well Status	Form 2 Status
	PA 06/11/1996	

Total Depth	Plug Back Depth	Bottom Formation	Permited Formation	Apd Received	Apd Approved
12090	0	MORRISON	DAKOTA	06/16/1987	06/18/1987

Spud Date	TD Reached	Completed
08/08/1987		09/07/1987

Verbal To Plug and Abandon	09/05/1987
Notice of Intent To Abandon	09/22/1987
Subsequent Report Of Abandonment	06/11/1995
PA Date	09/05/1987
Ip Oil Bbls	
Ip Gas Mcf	
Ip Water Bbls	
Cumulative Production	
Oil Bbls	
Gas Mcf	
Water Bbls	
Logs Ran	
Form 2 Filed	

Hole Size	Csg Size	Csg Depth
	9 5/8	1598
		0

Form Date	Submission	Action
1987/09/22	SUBSEQUENT REPORT	PLUG AND ABANDON
1987/09/05	NOTICE OF INTENT	VERBAL PLUG AND ABANDON

Geolgical Formation	Depth	
FOX HILLS,FM	6530	
LEWIS,SH	6605	
TECKLA,SAND MBR (LEWIS SH)	7112	
TEAPOT,MBR (PARKMAN SS)	7518	
PARKMAN,SS	7784	
STEELE	8244	
SUSSEX,SS	8754	
SHANNON,SS MBR (CODY SH)	9405	
NIOBRARA,FM	10078	
CARLILE	10495	
TURNER,SANDY MBR (CARLILE SH)	10667	
FRONTIER,FM	11168	
MOWRY,MBR (SH)	11500	
MUDDY,FM	11673	
SKULL CREEK,SH	11736	
DAKOTA,FM	11878	
FUSON	11918	
LAKOTA,FM (INYAN KARA GP)	11952	
MORRISON,FM	12024	

http://wogcc.state.wy.us/QuickLook.cfm?nAPI=529105 1/23/2009

Figure A-6. WOGCC Completion Report For Carlotta 23-31

01/23/2009

STATE OF WYOMING

OIL AND GAS CONSERVATION COMMISSION

Office of State Oil and Gas Supervisor

Lease No.	FEE
Unit No.	
Lease Name	CARLOTTA
Api No.	49-005-29240
County	CAMPBELL
Well Name	CARLOTTA 23-31
Operator	ENCANA OIL AND GAS USA INC
Field	WC

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude	Well Class	Minerals	Elevation	Elevation KB
2105 FSL & 1955 FWL	NE SW	31	43 NORTH	73 WEST	43.65451	105.67728	O	FEE	5087	5103
Bottom Hole							First Prod	Well Status: PA 04/24/1996	Form 2 Status	

Total Depth	Plug Back Depth	Bottom Formation	Permited Formation	Apd Received	Apd Approved	Spud Date	TD Reached	Completed
13800	0	MINNELUSA		10/26/1987	10/27/1987	11/14/1987		12/13/1987

Verbal To Plug and Abandon: 09/02/1990	Notice of Intent To Abandon: 04/24/1996	Hole Size	Csg Size: 9 5/8	Csg Depth: 2014
Subsequent Report Of Abandonment: 04/24/1996	PA Date: 09/02/1990	Hole Size	Csg Size: 7	Csg Depth: 10782
Ip Oil Bbls	Ip Gas Mcf	Ip Water Bbls		
Cumulative Production	Oil Bbls / Gas Mcf	Water Bbls		
Logs Ran: DST #1 (On File), DST #2-MIS (On File)		Form 2 Filed		

Form Date	Submission	Action
2000/05/17	FINAL ABANDONMENT NOTICE	PLUG AND ABANDON
1996/04/24	NOTICE OF INTENT	PLUG AND ABANDON
1996/04/24	SUBSEQUENT REPORT	PLUG AND ABANDON
1996/04/10	SUBSEQUENT REPORT	WROTE NIA & SRA-RE-ENRTY
1990/09/02	NOTICE OF INTENT	VERBAL PLUG AND ABANDON
1990/09/02	SUBSEQUENT REPORT	VERBAL FOR RE-ENTRY

Geolgical Formation	Depth	
FOX HILLS,FM	6606	
LEWIS,SH	6710	
TECKLA,SAND MBR (LEWIS SH)	7146	
TEAPOT,MBR (PARKMAN SS)	7566	
PARKMAN,SS	7842	
STEELE,SH	8363	
ARDMORE,BENTONITE BEDS(CODY SH	8870	
SUSSEX,SS	8890	
SHANNON,SS MBR (CODY SH)	9290	
NIOBRARA,FM	10230	
CARLILE,MBR (CODY SH)	10644	
FRONTIER,FM	10832	
MOWRY,MBR (SH)	11670	
MUDDY,FM	11850	
SKULL CREEK,SH	11888	
DAKOTA,FM	11998	
FUSON,FM (INYAN KARA GP)	12098	
LAKOTA,FM (INYAN KARA GP)	12130	

Figure A-7. WOGCC Completion Report For Buckin Bronc Fed 1

Well Files Page 1 of 1

01/23/2009

STATE OF WYOMING

OIL AND GAS CONSERVATION COMMISSION

Office of State Oil and Gas Supervisor

Lease No.	Unit No.	Lease Name	Api No.	County	Well Name	Field
WYW138127		BUCKIN BRONC FED	49-005-37518	CAMPBELL	BUCKIN BRONC FED 1	WC

Operator **YATES PETROLEUM CORPORATION**

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude	Well Class	Minerals	Elevation	Elevation KB
2385 FSL & 2196 FEL	NW SE	20	43 NORTH	73 WEST	43.68517	105.65214	O	FEDERAL	5158	0

Bottom Hole	First Prod	Well Status	Form 2 Status
	03/19/2000	PO 06/02/2005	PR 11/2008

Total Depth	Plug Back Depth	Bottom Formation	Permitted Formation	Apd Received	Apd Approved	Spud Date	TD Reached	Completed
12114	11210	LAKOTA		11/01/1999	11/16/1999	11/15/1999	12/20/1999	12/07/2000

Verbal To Plug and Abandon	Notice of Intent To Abandon	Hole Size	Csg Size	Csg Depth
		12 1/4	9 5/8	1525

Subsequent Report Of Abandonment	Plug and Abandonment Date	Hole Size	Csg Size	Csg Depth
		8 3/4	7	11407

Ip Oil Bbls	Ip Gas Mcf	Ip Water Bbls
106		18

Cumulative Production	Oil Bbls	Gas Mcf	Water Bbls
Mar 2000 To Nov 2008	81,850	34,600	86,956

Logs Ran	Form 2 Filed
DRILL STEM (On File), DIGITAL ACOUSTILOG GAMMA RAY C (On File), HIGH DEFINITION INDUCTION GAMM (On File), DENSILOG-C-NEUTRON GAMMA RAY (On File), CORE ANALYSIS (On File), GAS-MUD (On File), CEMENT BOND GAMMA RAY (On File), CORE ANALYSIS (On File), GEOLOGICAL REPORT (On File), HIGH DEFINITION INDUCTION GAMM (On File), DENSILOG-C-NEUTRON GAMMA RAY (On File), DIGITAL ACOUSTILOG GAMMA RAY C (On File)	PARKMAN-TURNER, PARKMAN

Top Perfs	Bottom Perfs	Holes/Ft	Size	Purpose	Type	Prod Interval Top	Prod Interval Bot	Formation
7768	7777		.32			7768	7777	PARKMAN
10711	10718		.42			10711	10718	TURNER

Form Date	Submission	Action
2005/06/08	SUBSEQUENT REPORT-SIGNED	RELEASE RBP & COMMINGLE
2004/11/11	SUBSEQUENT REPORT-SIGNED	PRODUCTION (START/RESUME)
2001/03/29	SUBSEQUENT REPORT	PERFORATE AND FRAC-1-11-00
2001/03/01	SUBSEQUENT REPORT	PRODUCTION (START/RESUME)
2001/03/01	SUBSEQUENT REPORT	PUT PRKM/TURNER BACK TOGETHER
2001/03/01	SUBSEQUENT REPORT	TEST PARKMAN PERFS-10/4/00
2001/03/01	SUBSEQUENT REPORT	SPUD AND CASING
2001/03/01	SUBSEQUENT REPORT	TD & PLUG BACK-11-15-99
2001/03/01	SUBSEQUENT REPORT	TD & PLUGBACK-12-20-00
2000/05/16	APPLICATION	COMINGLE
2000/03/03	APPLICATION	EXCEPTION LOCATION
2000/02/21	SUBSEQUENT REPORT	CHANGE WELL NAME & OPERATOR
2000/02/15	SUBSEQUENT REPORT	COMPLETION & NI-CHNG OF OP
1999/11/16	SUBSEQUENT REPORT	SPUD WELL
1999/11/15	NOTICE OF INTENT	SPUD WELL

http://wogcc.state.wy.us/QuickLook.cfm?nAPI=537518 1/23/2009

Figure A-8. WOGCC Completion Report For Ted 2

01/23/2009

STATE OF WYOMING

OIL AND GAS CONSERVATION COMMISSION

Office of State Oil and Gas Supervisor

Field	Value
Lease No.	
Unit No.	
Lease Name	TED
Api No.	49-005-39686
County	CAMPBELL
Well Name	TED 2
Field	K-BAR

Operator: YATES PETROLEUM CORPORATION

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude
2160 FNL & 840 FEL	SE NE	24	43 NORTH	73 WEST	43.6869	105.5661

Bottom Hole

Well Class	Minerals	Elevation	Elevation KB
O	FEE	5099	0

First Prod	Well Status	Form 2 Status
05/12/2000	PG 04/17/2001	PR 11/2008

Total Depth	Plug Back Depth	Bottom Formation	Permited Formation	Apd Received	Apd Approved
10450	10406	TURNER	TURNER	02/08/2000	02/25/2000

Spud Date	TD Reached	Completed
03/09/2000	03/24/2000	05/10/2000

Verbal To Plug and Abandon | Notice of Intent To Abandon

Subsequent Report Of Abandonment | Plug and Abandonment Date

Hole Size	Csg Size	Csg Depth
24	16	69
12 1/4	8 5/8	1575
7 7/8	5 1/2	10450

Ip Oil Bbls	Ip Gas Mcf	Ip Water Bbls
50		28

Cumulative Production	Oil Bbls	Gas Mcf	Water Bbls
May 2000 To Nov 2008	23,581	20,400	22,645

Logs Ran: DUAL INDUCTION FOCUSED 2-ARM C (On File), DENSILOG-C-NEUTRON 2ARM CALIPE (On File)

Form 2 Filed: PARKMAN-TURNER

Top Perfs	Bottom Perfs	Holes/Ft	Size	Purpose	Type	Prod Interval Top	Prod Interval Bot	Formation
7458	7468	4		120 DEG PHSG		7458	7468	PARKMAN
10237	10243	6		60 DEG PHSG		10237	10243	TURNER

Top Treated Interval	Bottom Treated Interval	Date	Treatment
7458	7468	//	FRAC W/26,124 GALS VISTAR 20 IT AND 81,200# 20/40 OTTAWA SAND
10237	10243	//	FRAC W/59,800 GALS VIKING ID-30 BORATE GEL AND 165,000# 16/30 PR-6000 RESIN COATED SAND

Form Date	Submission	Action
2001/04/06	SUBSEQUENT REPORT	PRODUCTION CASING
2001/04/06	SUBSEQUENT REPORT	PERFFORATE AND FRAC
2001/04/04	SUBSEQUENT REPORT	PRODUCTION (START/RESUME)
2000/05/16	APPLICATION	COMINGLE
2000/03/20	SUBSEQUENT REPORT	SPUD WELL
2000/03/17	NOTICE OF INTENT	BOP TEST
2000/03/17	SUBSEQUENT REPORT	BOP TEST & DRILL STEM TEST
2000/03/14	NOTICE OF INTENT	SPUD WELL

Figure A-9. WOGCC Completion Report For Raging Bull 1

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01/23/2009

STATE OF WYOMING

OIL AND GAS CONSERVATION COMMISSION

Office of State Oil and Gas Supervisor

Field	Value
Lease No.	
Unit No.	
Lease Name	RAGING BULL
Api No.	49-005-45589
County	CAMPBELL
Well Name	RAGING BULL 1
Field	WC

Operator: **YATES PETROLEUM CORPORATION**

	Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude
Surface Location	660 FSL & 860 FEL	SE SE	19	43 NORTH	73 WEST	43.67997	105.66802
Bottom Hole	660 FNL & 1980 FEL	NW NE	19	43 NORTH	73 WEST	43.69112	-105.6722

Well Class	Minerals	Elevation	Elevation KB
O	FEE	5074.5	5093

First Prod	Well Status	Form 2 Status
11/13/2003	PO 11/24/2003	FL 11/2008

Total Depth	Plug Back Depth	Bottom Formation	Permitted Formation	Apd Received	Apd Approved
10690	10204	TURNER	TURNER	08/13/2002	08/14/2002

Spud Date	TD Reached	Completed
08/11/2003		11/23/2003

Verbal To Plug and Abandon	Notice of Intent To Abandon

Subsequent Report Of Abandonment	Plug and Abandonment Date

Hole Size	Csg Size	Csg Depth
12 1/4	9 5/8	1540
8 3/4	7	10972

Ip Oil Bbls	Ip Gas Mcf	Ip Water Bbls
27		202

Cumulative Production	Oil Bbls	Gas Mcf	Water Bbls
Sep 2003 To ?	40,411	15,845	35,564

Logs Ran	Form 2 Filed
HIGH DEFINITION INDUCTION GAMM (On File), DENSILOG-C-NEUTRON GAMMA RAY (On File)	TURNER, PARKMAN

Top Perfs	Bottom Perfs	Holes/Ft	Size	Purpose	Type	Prod Interval Top	Prod Interval Bot	Formation
7738	7741	18		PRODUCTION		7738	7741	PARKMAN

Top Treated Interval	Bottom Treated Interval	Date	Treatment
7700	7702	11/23/2003	
7738	7741	11/23/2003	FRAC W/14,740G VIKING D30 X-LINKED BORATE GEL AND 33,400# 20/40 OTTAWA SAND
7800	7802	11/23/2003	PERF SQUEEZE HOLES W/100SX

Form Date	Submission	Action
2009/01/09	SUBSEQUENT REPORT	BILL CORRECTION
2003/11/24	NOTICE OF INTENT	WELL NAME CHANGE - SIGNED
2003/10/14	SUBSEQUENT REPORT	FRACTURE TREAT-SIGNED
2003/09/15	SUBSEQUENT REPORT	RECOMPLETE-SIGNED
2003/07/23	NOTICE OF INTENT	RECOMPLETE -SIGNED
2003/06/03	NOTICE OF INTENT	RECOMPLETE-SIGNED
2003/02/26	SUBSEQUENT REPORT	DIRECTIONAL DRILLING-SIGNED
2002/11/19	SUBSEQUENT REPORT	SET PRODUCTION CASING
2002/10/14	SUBSEQUENT REPORT	SET SURFACE CASING
2002/10/04	SUBSEQUENT REPORT	CORRECTED LOCATION
2002/09/26	SUBSEQUENT REPORT	SEE SUNDRY
2002/07/31	APPLICATION	CHAPTER 3, SECTION 25
2001/04/27	APPLICATION	CHAPTER 3, SEC 2 & 25

http://wogcc.state.wy.us/QuickLook.cfm?nAPI=545589 1/23/2009

Figure A-10. WOGCC Completion Report For E R Willard

Well Files — Page 1 of 1

01/23/2009 STATE OF WYOMING OIL AND GAS CONSERVATION COMMISSION Office of State Oil and Gas Supervisor	Lease No.
	Unit No.
	Lease Name: DRAKE
	Api No.: 49-005-56671
	County: CAMPBELL
	Well Name: DRAKE 31-29
Operator: BALLARD PETROLEUM HOLDINGS LLC	Field: K-BAR

Surface Location	Qtr-Qtr	Section	Township	Range	Latitude	Longitude	Well Class	Minerals	Elevation	Elevation KB
575 FNL & 2096 FEL	NW NE	29	43 NORTH	73 WEST	43.67658	105.65272	O	FEE	5157	0

Bottom Hole	First Prod	Well Status	Form 2 Status
	12/16/2006	PO 03/25/2008	PR 11/2008

Total Depth	Plug Back Depth	Bottom Formation	Permited Formation	Apd Received	Apd Approved	Spud Date	TD Reached	Completed
8076	8030	STEEL	PARKMAN	10/31/2005	11/23/2005	08/14/2006	08/25/2006	11/14/2006

		Hole Size	Csg Size	Csg Depth
Verbal To Plug and Abandon	Notice of Intent To Abandon	7 7/8	5 1/2	8075
Subsequent Report Of Abandonment	Plug and Abandonment Date	12 1/4	8 5/8	1328
		7 7/8		

Ip Oil Bbls	Ip Gas Mcf	Ip Water Bbls
50		90

Cumulative Production	Oil Bbls	Gas Mcf	Water Bbls
Dec 2006 To Nov 2008	4,849	0	18,455

Logs Ran	Form 2 Filed
	PARKMAN

Top Perfs	Bottom Perfs	Holes/Ft	Size	Purpose	Type	Prod Interval Top	Prod Interval Bot	Formation
7860	62	4	.46	PRODUCTION		7860	7862	PARKMAN STONE
7865	80	4	.46	PRODUCTION		7862	7880	PARKMAN STONE

Top Treated Interval	Bottom Treated Interval	Date	Treatment
		//	BORE-GEL 6 FLUID. ISIP=1536#, 5MIN=164#, 10 MIN= 56# 15MIN=VAC.
7860	7880	//	34500# OF 20/40 SAND FRAC JOB, PUMPED AT 11.5 BPM AVG, 2505 PSI AVG, IN 391 BBLS OF

Form Date	Submission	Action
2008/03/25	SUBSEQUENT REPORT	PRODUCTION (START/RESUME)
2008/02/06	NOTICE OF INTENT	START/RESUME PRODUCTION
2007/09/14	SUBSEQUENT REPORT	FRACTURE TREAT
2007/09/14	SUBSEQUENT REPORT	SHUT IN
2007/02/15	NOTICE OF INTENT	FRACTURE TREAT
2006/12/20	SUBSEQUENT REPORT	PRODUCTION (START/RESUME)
2006/09/08	SUBSEQUENT REPORT	REPORT CORRECT ELEV

Geolgical Formation	Depth
TECKLA	71
FOX HILLS	6580
LEWIS	6702
TEAPOT	7506
PARKMAN	7820
STEEL	7890

http://wogcc.state.wy.us/QuickLook.cfm?nAPI=556671 1/23/2009

Appendix B. Surface and Mineral Ownership, Leaseholders and Right-of-Way Owner

OWNERS OF OIL AND GAS LEASES WITHIN THE AREA OF REVIEW:

IW-1:	T43N, R73W, Section 31: SE ¼, E ½ SW ¼	Costilla Energy Inc./Ballard Petroleum LLC
	T42N, R73W, NE ¼ NW ¼	Costilla Energy Inc./Ballard Petroleum LLC
	T42N, R73W, Section 6: N ½ NE ¼	M.J. Harvey, Jr.
IW-2:	T43N, R73W, Section 29: NE ¼, E ½ NW ¼	Costilla Energy Inc./Ballard Petroleum LLC
	T43N, R73W, Section 20: S ½ SE ¼	Costilla Energy Inc./Ballard Petroleum LLC

OWNERS OF SURFACE RIGHTS WITHIN THE AREA OF REVIEW:

IW-1

Section 31, T43N, R73W, 6th PM, Section 6 PT, T42N, R73W, 6th PM

Richard W. Leavitt Trust
%Wells Fargo Real Estate
1740 Broadway Street C7300-07E
Denver, CO 80274

IW-2

Section 33: NW/4, Sec 28 S/2, T43N, R73W, 6th PM

Bernice Groves Revocable Trust
PO Box 408
Wright, WY 82732-0408

Section 33: NE/4, T43N, R73W, 6th PM

Richard W. Leavitt Revocable Trust
%Wells Fargo Real Estate
1740 Broadway Street C7300-07E
Denver, CO 80274

IW-3

Section 34: All, T43N, R73W, 6th PM

Richard W. Leavitt Revocable Trust
%Wells Fargo Real Estate
1740 Broadway Street C7300-07E
Denver, CO 80274

IW-4

Section 27: All, Sec 28: E/2

Bernice Groves Revocable Trust
PO Box 408
Wright, WY 82732-0408

OWNER OF RECORD FOR ANY OTHER PROPERTY RIGHT WITHIN THE AREA OF REVIEW:

Mineral Ownership:

IW-1

Section 31, T43N, R73W, 6th PM

Sinadin Family Mineral Trust* 100% (except coal)
% Dorothy Reichmuth, Trustee
1531 S. 77th Street
Lincoln, NE 68506

* Subject to the following obligation to share equally all income therefrom with the following life estates:

Milton Austin
1115 S. Elm
Denver, CO 80222

Nila Fern Sherard Harnden

PO Box 521
Manteca, CA 95336-0521

Everett Sherard
1553 North 1st Avenue
Upland, CA 91786

Coal Ownership:
United States of America 100%
Bureau of Land Management
Wyoming State Office
PO Box 1828
2515 Warren Avenue
Cheyenne, WY 82003

Section 6 – PT (area of review), T42N, R73W, 6th PM
Unpatented Mining Claims No. BFR-5, BFR-7, BFR-9, BFR-11, BFR-13, BFR-15, BFR-17

IW-2

Section 33: N/2, Sec 28 W/2, T43N, R73W, 6th PM
Federal Claims (via Homestead Law) held by:
Strathmore Resources
2420 Watt Court
Riverton, WY 82501

Sec 28: E/2, T43N, R73W, 6th PM
Blanche Willard Revocable Trust (Bernice and Edra) 100% . Subject to:
3.125% Nonparticipating Royalty – Drake Family LLC
3.125% Nonparticipating Royalty – Bernice Groves Revocable Trust
PO Box 408
Wright, WY 82732-0408
Sec 28: W/2, T43N, R73W, 6th PM
Federal Claims (via Homestead Law) held by:
Strathmore Resources
2420 Watt Court
Riverton, WY 82501

IW-3

Section 34: All, T43N, R73W, 6th PM
Federal Claims (via Homestead Law) held by:
Strathmore Resources
2420 Watt Court
Riverton, WY 82501

IW-4

Sec 27: W/2, T43N, R73W, 6th PM
Federal Claims (via Homestead Law) held by:
Strathmore Resources
2420 Watt Court
Riverton, WY 82501

Sec 27: E/2 and Sec 28: E/2, T43N, R73W, 6th PM

Blanche Willard Revocable Trust (Bernice and Edra) 100% . Subject to:

3.125% Nonparticipating Royalty – Drake Family LLC

3.125% Nonparticipating Royalty – Bernice Groves Revocable Trust

PO Box 408
Wright, WY 82732-0408

NMC Lease

United States of America 100%
Bureau of Land Management
Wyoming State Office
PO Box 1828
2515 Warren Avenue
Cheyenne, WY 82003

*****

Coal Ownership:

United States of America
Bureau of Land Management 100%
Wyoming State Office
PO Box 1828
2515 Warren Avenue
Cheyenne, WY 82003

Mineral leases:

Sinadin Family Mineral Trust – Energy Fuels, Ltd.
Sec 31: Lots 1, 2, 3, 4, E1/2NE1/4, SW1/4NE1/4, E1/2W1/2, SE1/4

Appendix C. Permitted Water Rights Inventory

Appropriation	Township	Range	Section	Quarter	Qtrqtr	Lots	HeadGate-Outlet-Well	Status	Supply type	Adj Uses	SW Permit Uses	SW Permit Facility name	SW Permit Applicant	SW Permit Priority	SW Permit Amount	SW Permit Unit	SW Permit Source	Gw Permit Uses	GW Permit Facility Name	GW Permit Applicant
P45984W	43N	73W	27	6	NWNW		X	PUW	ORI									MIS	RENO RANCH ISL P 1	ROCKY MOUNTAIN ENERGY COMPANY
P139973W	43N	73W	27	3	SWNE		X	GSE	ORI									STO,CBM	PICKETT CS FEE #2	YATES PETROLEUM CORP.
P128606W	43N	73W	31	15	SWSE		X	GST	ORI									CBM	LEAVITT TRUST 34-31-4373	WILLIAMS PRODUCTION RMT, COMPANY
P172728W	43N	73W	31	13	NESE		X	GSI	ORI									CBM,MIS	COSNER #43-24 C	BIG BASIN PETROLEUM, LLC
P16331S	43N	73W	31	0		L18	X	UNA	STR		STO	Leavitt 24-31-4373 Stock Reservoir	Richard Leavitt Trust-Wells Fargo** Williams Production RMT Co.	6/15/2004	5.08	ACFT	Sawbuck Draw			
P126340W	43N	73W	31	9	NESW		X	GST	ORI									CBM	ANCU LEAVITT TRUST 23-31-4373	WILLIAMS PRODUCTION RMT, COMPANY
P128608W	43N	73W	31	13	NESE			GST	ORI									CBM	LEAVITT TRUST 43-31-4373	WILLIAMS PRODUCTION RMT, COMPANY
P17710S	43N	73W	31	16	SESE		X	UNA	STR	STO	STO	Leavitt 44-31-4373 Stock Reservoir	Richard Leavitt Trust	1/30/2006	0.6	ACFT	Radio Draw			
22/12/248W	43N	73W	33	1	NENE		X	UNA	ORI											
P110734W	43N	73W	33	8	SENW				ORI									IND,MIS	House Creek 79-2	DEVON ENERGY PRODUCTION COMPANY L.P.
P119587W	43N	73W	33	8	SENW			UNA	ORI									IND	HCSU MIDDLE PLANT	DEVON ENERGY CORP. (NEVADA)
P17057S	43N	73W	33	8	SENW		X	UNA	STR		STO	Groves 22-33-4373	Bernice Groves	7/22/2005	0.22	ACFT	Spring Creek			
P145493W	42N	73W	6	5	NENW	L10	X	GST	ORI									CBM	ANCU 21-6-4273	WILLIAMS PRODUCTION RMT COMPANY
P16030S	42N	73W	6	0		L10	X	UNA	STR		STO	Leavitt 21-6-4273 Stock Reservoir	Richard Leavitt Trust** Williams Production RMT Co.	6/15/2004	1.5	ACFT	Lettuce Draw			
P59470W	42N	73W	6	1	NENE		X	PUW	ORI									MIS	FORGEY #1	INC. RUSSELL FORGEY CONSTRUCTION COMPANY
P60967W	42N	73W	6	1	NENE		X	PUW	ORI									MIS	FORGEY - #1	INC. RUSSELL FORGEY CONSTRUCTION COMPANY
P159630W	42N	73W	6	1	NENE		X	GSI	ORI									STO,CBM	LEAVITT TRUST FEDERAL 41-6-4273	WILLIAMS PRODUCTION RMT COMPANY

Appendix D. Water Quality Data

Figure D-1. UIC 98-092 Water Quality Table 5-1

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.

1105 WEST FIRST STREET • GILLETTE, WY 82716 • PHONE (307) 686-7175
FAX (307) 682-4625

TABLE 5-1

LABORATORY REPORT

TO: Energy Fuels Nuclear
ADDRESS: 6765 S. Highway 59
Gillette, WY 82718

LAB NO.: G94-7240
DATE: 4-15-94

WATER ANALYSIS

Manx Oil
Skyline 1-23
Tank Bottom at Load Line
Sampled 3-25-94
Submitted 3-25-94

CONSTITUENT	mg/l
Calcium	32
Magnesium	9
Sodium	5,560
Potassium	18
Carbonate	0
Bicarbonate	2,460
Sulfate	15
Chloride	6,910
Ammonia	1.23
Fluoride	4.80
Barium	9.70
Iron	6.78
Manganese	0.09
Strontium	8.52
Phosphate	1.5
Total Dissolved Solids @ 180°C	13,786
Total Suspended Solids @ 105°C	46
Specific Conductance @ 25°C	21,950 μmhos/cm
pH	7.80 S.U.

Figure D-2. UIC 98-092 Water Quality Table 5-2

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.
1105 WEST FIRST STREET • GILLETTE, WY 82716 • PHONE (307) 686-7175
FAX (307) 682-4625

TABLE 5-2

LABORATORY REPORT

TO: Energy Fuels Nuclear
ADDRESS: 6765 S. Highway 59
Gillette, WY 82718

LAB NO.: G94-7241
DATE: 4-15-94

WATER ANALYSIS

DNR Oil & Gas
All Night Creek Fed 1-7
Treater Site Glass
Sampled 3-25-94
Submitted 3-25-94

CONSTITUENT	mg/l
Calcium	29
Magnesium	6
Sodium	4,548
Potassium	23
Carbonate	0
Bicarbonate	2,110
Sulfate	5
Chloride	6,248
Ammonia	3.56
Fluoride	3.50
Barium	7.19
Iron	1.09
Manganese	0.06
Strontium	7.33
Phosphate	<0.5
Total Dissolved Solids @ 180°C	12,130
Total Suspended Solids @ 105°C	34
Specific Conductance @ 25°C	18,960 μmhos/cm
pH	8.11 S.U.

Figure D-3. UIC 98-092 Water Quality Table 5-3

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.

1105 WEST FIRST STREET • GILLETTE, WY 82716 • PHONE (307) 686-7175
FAX (307) 682-4625

TABLE 5-3

LABORATORY REPORT

TO: Energy Fuels Nuclear
ADDRESS: 6765 S. Highway 59
Gillette, WY 82718

LAB NO.: G94-7242
DATE: 4-15-94

WATER ANALYSIS

Central Resources
Anderman 1-21
Flow Line @ Treater
Sampled 3-25-94
Submitted 3-25-94

CONSTITUENT	mg/l
Calcium	15
Magnesium	5
Sodium	5,490
Potassium	29
Carbonate	0
Bicarbonate	2,300
Sulfate	24
Chloride	7,300
Ammonia	4.52
Fluoride	3.10
Barium	8.72
Iron	11.6
Manganese	0.63
Strontium	7.64
Phosphate	<0.5
Total Dissolved Solids @ 180°C	13,840
Total Suspended Solids @ 105°C	144
Specific Conductance @ 25°C	22,060 μmhos/cm
pH	8.32 S.U.

Figure D-4. UIC 98-092 Water Quality Table 5-4

TABLE 5-4

WATER QUALITY DATA FOR THE TEAPOT SANDSTONE

Location					Depth (feet)	Equivalent NaCl (ppm)	Data Source
T (N)	R (W)	Sec.	¼	¼			
39	72	4	NE	NE	7,380-7,406	5,023	PI
35	70	2				19,133	Hall
34	70	24				20,207	Hall

Data Source: Hall Halliburton (Kundert,1994).

PI Petroleum Information, 1985. Rocky Mountain Formation Water Resistivities Catalog.

Figure D-5. UIC 98-092 Water Quality Table 5-5

TABLE 5-5
WATER QUALITY DATA FOR THE PARKMAN SANDSTONE

Location					Depth (feet)	Equivalent NaCl (ppm)	TDS (mg/l)	Data Source
T (N)	R (W)	Sec.	¼	¼				
44	73	5			7,144-7,304	7,586	7,745*	PI
43	73	7	NE	SW	7,653-7,690	--	12,130	EFNI**
43	73	9	SW	SW	7,666-7,740	13,366	13,647*	PI
43	73	21	SE	SE	7,771-7,814	--	13,840	EFNI**
43	73	23	NE	SE	7,506-7,576	--	13,786	EFNI**
42	74	24	SW	NW	8,130-8,155	9,616	9,818*	PI
42	73	11	SW	SE	8,038-8,070	5,821	5,943*	PI
42	74	24	SW	NW	8,130-8,155	9,616	9,818*	PI
41	73	17					12,292	Hall

Data Source: Hall Halliburton (Kundert-1994).

PI Petroleum Information, 1985. Rocky Mountain Formation Water Resistivities Catalog.

* Estimated by Hydro-Search, Inc. from equivalent NaCl/TDS ratios for Parkman SS based on chemical analysis data in Powder River Basin.

** Chemical Analysis Data, Samples taken @ surface by Energy Fuels Nuclear Inc. (EFNI) from currently active Parkman oil producers.

TABLE 5-6
WATER QUALITY DATA FROM THE SOLUTION MINING PRODUCTION, INJECTION AND MONITOR WELLS (WASATCH FORMATION)

Well	Location*	Sample Date	Depth Drilled (feet)	TDS (mg/l)
Project Wells				
RI1	1090916 366496	930624	380	705
RI2	1093887 368844	930624	438	1340
RI3	1096336 373133	930622	400	1180
RI4	1097986 376492	930622	405	931
RI5	1095673 379417	930629	460	1339
RI6	1092287 378192	930629	490	1385
RI7	1088861 378118	930630	330	569
RI15U	1091190 377780	930819	245	381
RI24U	1098019 376479	930819	146	568
RI25U	1090965 366494	930819	116	1685
RI30U	1094256 370479	930819	160	1579
RI42C	1091360 378900	931007	400	1339
MP-08	1094105 373754	931007	460	589

Figure D-6. UIC 98-092 Water Quality Table 5-6

Figure D-7. UIC 98-092 Water Quality Table 5-6a

TABLE 5-6a
WATER QUALITY DATA FROM REGIONAL WELLS
(WASATCH FORMATION)

Well	Location*	Sample Date	Depth Drilled (feet)	TDS (mg/l)
Regional Wells				
	41721 dd	761130		2900
	41734 aa	761130		1640
	427220 cd	761130		2720
	427220 cd2	761130		5180
McClure Well	42732 ba2	761130	200	1510
Hi-Way Well	42735 ba	820727	350	775
Deep Well #2a	42738 ca	761130	450	1680
RI - 9	427310 cb	930630	360	2354
	427320 ac	761130		1220
RI - 10	427323 bc	820718	270	1350
	427327 ac	790725		785
RI - 11	427327 ad	820719	185	975
	427331 dc	761130		412
	427336 bb	761130		575

Figure D-8. UIC 98-092 Water Quality Table 5-6a (continued)

TABLE 5-6a (Continued)
WATER QUALITY DATA FROM REGIONAL WELLS
(WASATCH FORMATION)

Well	Location*	Sample Date	Depth Drilled (feet)	TDS (mg/l)
Regional Wells				
Red Well	427412 db	761130	234	2210
Cosner #10	437230 dc	761130	55	797
	437236 ac	761130		3330
	43731 db	820727		825
Willard #6	437310 dc	761130	105	688
Underwood #8	437325 bc	761130	350	276
	437326 bb	761130		2220
Willard #5	437328 ab	761130	80	1100
Willard #3	437332 ab	761130		1960
	437425 da	761130		404

*Location — Project Wells: State Plane Coordinates - Northing Easting
Regional Wells: TN, RW, Section, Descending Quarter Sections
ac = NE 160 acres
SW 40 acres

Figure D-9. UIC 98-092 Water Quality Table 5-7

TABLE 5-7

WATER QUALITY DATA - ORE SAND AND UPPER AQUIFER WELLS

Ore Sand Wells: ***RI-1, 2, 3, 4, 5, 6, 7, 9, 42***

Upper Aquifer Wells: ***RI-24U, RI-25U, RI-30U***

Constituent*	ORE SAND		UPPER AQUIFER	
	Mean	Two Std Dev I	Mean	Two Std Dev I
Ca	134	214	173	262
Mg	32.7	62.4	44.2	78.4
Na	186	140	106	96
K	8.16	5.94	5.20	5.16
Cl	14.0	16.4	12.1	19
SULFATE	666	794	564	846
BICARBONAT	201	304	276	200
CARBONATE	4.75	19.35	2.31	13.08
pH (std units)	8.09	2.06	7.79	1.5
pHf (std units)	7.29	1.04	6.95	1.08
COND(umhos)	1539	1038	1434	1458
CONDf(unhos)	1228	942	1080	1180
TDS	1217	1162	1101	1232
HARD	507	874	--	--
NO_2	.037	.092	.070	.102
ALK	175	242	241	150
Al	.139	.406	ND	ND
As	.005	.014	.001	.002
Ba	.044	.094	ND	ND
B	.148	.590	ND	ND
Cd	.002	.004	ND	ND
Cr	ND	ND	ND	ND
Cu	ND	ND	ND	ND
F	0.192	.438	.449	.930
Fe	.558	1.854	.498	1.462
Pb	ND	ND	ND	ND
Mn	.115	.240	.217	.400
Hg	ND	ND	ND	ND
Mo	ND	ND	ND	ND
Ni	ND	ND	ND	ND
NH_3	.111	.266	.270	.256
NO_3	.301	1.852	.086	.206

Figure D-10. UIC 98-092 Water Quality Table 5-7 (continued)

TABLE 5-7

WATER QUALITY DATA - ORE SAND AND UPPER AQUIFER WELLS

Ore Sand Wells: *RI-1, 2, 3, 4, 5, 6, 7, 9, 42*

Upper Aquifer Wells: *RI-24U, RI-25U, RI-30U*

Constituent*	ORE SAND		UPPER AQUIFER	
	Mean	Two Std Dev I	Mean	Two Std Dev I
Se	.004	.01	.001	.002
Ag	ND	ND	ND	ND
V	ND	ND	ND	ND
Zn	.048	.16	.029	.046
U	.031	.112	.022	.064
Ra226 (pCi/l)	51.9	158	1.46	1.52
Th230 (pCi/l)	1.41	2.66	--	--
SiO_2	4.21	11.14	15.0	5.8
Eh (mv)	180	142	--	--

*All units are mg/l except as noted.

Figure D-11. UIC 98-092 Water Quality Tables 5-8 and 5-9

TABLE 5-8

WATER QUALITY DATA FOR THE WASATCH FORMATION

Location			Depth (feet)	TDS (mg/l)
T (N)	R (W)	Sec.		
44	73	35	205	1,070
44	72	15	145	2,660
43	72	11	160	2,700
43	72	11	240	1,780
43	72	16	345	1,790
43	72	18	261	1,030
43	72	21	550	367
42	74	6	225	941

Data Source: USGS United States Geological Survey, Chemical Analysis Data (Hodson, et.al. - 1971).

TABLE 5-9

WATER QUALITY DATA FOR THE FORT UNION FORMATION

Location			Depth (feet)	TDS (mg/l)
T (N)	R (W)	Sec.		
43	72	11	485	314

Data Source: USGS United States Geological Survey, Chemical Analysis Data (Hodson, et.al. - 1971).

Appendix E. Drilling Prognoses for Disposal Wells

The well history and drilling prognoses in this section were derived primarily from the UIC 98-092 permit application. Much of the information presented is duplicated from Section 7 of UIC 98-092. More recent drilling prognoses from other well installations in the area were also reviewed for changes in installation requirements.

Well History for IW-1

Well History of Sinadin #1, Existing Well to be converted to Class 1 Non-Hazardous Injection Well. The primary objective of this well was the Shannon Sandstone. No coring and/or Dill Stem Testing (DST) were done. The well was plugged with 8 open hole cement plugs and also plugged at the surface on 7/29/77. There is a minor conflict in the records for surface elevation at the well site with a recorded surface elevation ranging from 5110 feet above MSL to 5118 feet above MSL. This minor discrepancy does not appreciably affect the anticipated completion.

Operator:	Amoco Production
Well:	Sinadin #1
Location:	SW ¼, SE ¼, Section 31, T43N R73W, 660' FSL, 1982'FEL
County:	Campbell Co., WY
Spud Date:	June 26, 1977
Completion Date:	July 27, 1977
Type of Completion:	Cased hole/perforated
Elevation:	5118' GL (Est.)
Total Depth:	9,456'
Electric Logs:	Induction-Laterolog 1,504'-9,450' 7/27/77
	Borehole Compensated 1,504'-9,445' 7/27/77 Sonic Log
	Compensated Formation 6,800'-9,455' 7/27/77 Density Log (Logged by Schlumberger)
Bottom Formation:	Steele Shale
Well Status:	Dry and abandoned (D&A)

Dry/P&A (7/29/77):

Plug #1 35 Sx Class "G" @ 9,415'
Plug #2 35 Sx Class "G" @ 8,965'
Plug #3 35 Sx Class "G" @ 7,918'
Plug #4 35 Sx Class "G" @ 7,632'
Plug #5 35 Sx Class "G" @ 7,214'
Plug #6 50 Sx Class "G" @ 6,750'
Plug #7 35 Sx Class "G" @ 4,100'
Plug #8 60 Sx Class "G" @ 1,600'
Plug #9 10 Sx Class "G" @ Surface

Note: Plugs #1 and #2 will be left in place during recompletion as an injection well.

Drilling Prognosis for IW-1

Operator:	AUC, LLC
Well:	IW-1
Location:	SW ¼, SE ¼, Section 31, T43N R73W, 660' FSL, 1982'FEL
County:	Campbell Co., WY
Elevation:	5118' GL (Est.)

Estimated Formation Tops (depth in feet from ground surface):

Tertiary	Surface
Fox Hills	6635'
Lewis	6730'
Teckla ss	7255'
Teapot ss	7535'
Parkman ss	7860'
Lower Parkman ss	8330'
T.D.	9456'

Hole Size:

13 3/8" to 1,515'
7 7/8" 1,515' to T.D.

Casing/Tubing Program:

Conductor: 0' - 30', 18" casing - Existing

Surface Casing:
0 - 1,515'-8 5/8", 24#/ft. in a 13 3/8" Hole – Existing casing cemented to surface

Production Casing:

Interval	Net '	Specifications
0' – 6,000'	6,000'	5 1/2", 17#/ft., K-55
6,000' – 8,400'	2,400'	5 1/2", 17#/ft., N-80
Totals	8,400'	

Injection Tubing:
2 7/8" 6.5# J-55 at ± 7,450'

Injection Packer:
5 ½" x 2 7/8" carbon steel packer with 20 feet of tailpipe @ ± 7,450'

Annular Fluid:
Inhibited brine/fresh water.

Cementing Program:

Conductor: 2 cubic yard of cement - existing

Surface Casing: Cemented to surface with 1120 sx Class G cement - existing

Production Casing:

1st Stage Cement:

245 sx Premium
Yield: 1.20 cu.ft/sx
Density: 15.60 lb/gal
Water Ratio: 5.27 gal/sx `

2nd Stage Cement

Lead:
555 sx Light Cement
Yield: 2.26 cu.ft/sx
Density: 11.80 lb/gal
Water Ratio: 13.00 gal/sx

Tail:
180 sx Light Cement
Yield: 1.20 cu.ft/sx
Density: 15.60 lb/gal
Water Ratio: 5.28 gal/sx

Cement Stage Collar: ± 7,000 feet

Open Hole Logging Program:

Utilize logs obtained during drilling of Sinadin #1 on 7/27/77

Induction-Latero log 1,504'-9,450' Schlumberger
BHC Sonic Log 1,504'-9,445' Schlumberger
FDC Log 6,800'-9,445' Schlumberger

Cased Hole Logs:

Production Casing:

Cement Bond Log (CBL) 0'-8,400'
Baseline Temperature Survey 0'-8,400'
Electromagnetic Casing Inspection Log 0'-8,400'
Radioactive Tracer Survey 0'-8,400'

Formation Evaluation:

Quartz Crystal BHP 0'-8,400'
Static Survey and Pressure Fall off

Core: None

DST's: Proposed – DST's for Teapot and Parkman injection zones.

Mud Logging Unit: None

Samples:

Representative formation water samples will be collected (if possible) during DST's for the Teapot and Parkman Sandstones. After recovery, samples will be sent to a qualified laboratory for analysis. All sampling procedures will follow WDEQ guidelines for sampling methods/protocols, QA/QC, chain of custody, etc.

Proposed Completion Procedure:

The following is a step-by-step description of what will be required, at minimum, to convert the existing dry and abandoned well (Sinadin #1) into a disposal well (IW-1):

1. Notify the Wyoming Department of Environmental Quality (WDEQ) of workover start-up schedule.
2. Move in and rig-up workover rig and peripheral equipment.
3. Install blowout prevention and equipment that conforms with Section 23 of Chapter 3 of the Wyoming Oil and Gas Conservation Commission Rules. Proposed equipment is as follows:
   - Rotating Head
   - Annular Preventer
   - Blind Rams (4.5")
   - Pipe Rams
   - Drilling Spool with 2-3" outlets
   - Casing Head
   - Kill line equipped with 2-2" x 5,000 psi valves and 1-2" x 5,000 psi check valve minimum
   - Choke line equipped with 2-3" 5,000 psi valves
   - Choke manifold equipped with 2-3" 5,000 psi valves, 4-3" 5,000 psi wing outlet valves, a remote operated choke, a manual choke, 2-3" x 5,000 psi valves downstream of the remote chokes, 2-3" x 5,000 psi valves downstream of the manual choke and pressure gauge. Bypass line from flare line to mud gas separator line.
   - Upper Kelly cock with handle available on floor
   - Full opening internal blowout preventer or drill pipe safety valve to fit all connections
   - Minimum 5,000 psi working pressure rating for equipment

The well has an existing 8 5/8" 24# surface casing at 1515 feet in 13 3/8" hole and is cemented to the surface.

4. Pick up 7 7/8" bit and go in hole with same. Drill out the cement plugs at surface, 1600 feet, 4100 feet, 6750 feet, 7214 feet, 7632 feet, and 7918 feet. Leave the existing bottom two cement plugs at 8965 feet and 9415 feet in place.
5. Cleanout drilling mud and debris in hole to below the Parkman Sandstone at approximately 8400 feet.
6. Evaluate existing open hole logs.

7. Run Drill Stem Tests (DSTs) for the Teapot and Parkman injection zones and collect fluid samples from each of the zones. Evaluate DST data.
8. Circulate and condition mud prior to running the 5 ½” protection casing.
9. Notify WDEQ of 5 ½” long string casing cementing and cased hole logging schedules.
10. Run 5 ½” production casing as per described casing program.
11. Cement production casing as per described cementing program.
12. Go in hole with 4 ¾” bit and clean out to the top of the 5 ½” float collar (FC). Pressure test the 5 ½” casing per WDEQ-WQD requirements.
13. Circulate mud out of the hole with clean brine.
14. Run cement bond and electromagnetic casing inspection/electronic caliper logs over the length of the 5 ½” casing extending from the FC back to the surface.
15. Perforate the Teapot and Parkman formation selectively.
16. Perform step-rate injection test/falloff to evaluate potential performance. Include spinner survey and quartz crystal bottom-hole pressure gauge to determine flow distribution and performance.
17. Notify WDEQ of radioactive tracer logging schedule.
18. Run radioactive tracer survey to demonstrate mechanical integrity.
19. Stimulate if required.
20. Run packer with 20 feet of 2 7/8” tailpipe on work string and set packer at approximately 7450 feet.
21. Go in hole with 2 7/8” O.D. 6.5 #J-55 injection string and seal assembly.
22. Space out 2 7/8” injection tubing.
23. Circulate corrosion inhibiter fluid down annulus side.
24. Latch injection string into packer and install wellhead.
25. Notify WDEQ of annulus pressure test.
26. Pressure test annulus as per WDEQ to demonstrate mechanical integrity.
27. Rig down and move out.
28. Prepare final report.

Drilling Prognoses for IW-2, IW-3 and IW-4

The drilling prognoses for proposed injection wells IW-2, IW-3 and IW-4 are very similar and are included within this section. The prognoses were developed from that of well IW-1 as included in UIC 98-092 with some modification to accommodate site specific conditions. The location of each of these three proposed well can be changed to within a 301 foot radius of the proposed location as described in Section 5. This results in a range of potential surface elevations of up to 55 feet and the corresponding potential changes in depth to formation tops. Hence, the cited depths are subject to changes of several tens of feet due to variable surface elevation in addition to the potential depth changes resulting from the differential between projected and actual geologic structure. Where possible, the well construction procedures, depths and completion techniques are presented in a common format within these prognoses.

Well IW-2 Location and Structure Information

Operator:	AUC, LLC
Well:	IW-2
Location:	NW ¼ , NE ¼, Section 33, T43N R73W
County:	Campbell Co., WY
Elevation:	5275' GL (Est.)

Estimated Formation Tops (depth in feet from ground surface):

Tertiary	Surface
Fox Hills	6680'
Lewis	6800'
Teckla ss	7220'
Teapot ss	7600'
Parkman ss	7880'
Lower Parkman ss	8200'
T.D.	± 8,350'

Well IW-3 Location and Structure Information

Operator:	AUC, LLC
Well:	IW-3
Location:	SW ¼ , NE ¼, Section 34, T43N R73W
County:	Campbell Co., WY
Elevation:	5200' GL (Est.)

Estimated Formation Tops (depth in feet from ground surface):

Tertiary	Surface
Fox Hills	6550'
Lewis	6680'
Teckla ss	7100'
Teapot ss	7480'
Parkman ss	7750'
Lower Parkman ss	8050'
T.D.	± 8,200'

<u>Well IW-4 Location and Structure Information</u>

Operator:	AUC, LLC
Well:	IW-4
Location:	NW ¼, Section 27, T43N R73W
County:	Campbell Co., WY
Elevation:	5220' GL (Est.)

Estimated Formation Tops (depth in feet from ground surface):

Tertiary	Surface
Fox Hills	6580'
Lewis	6700'
Teckla ss	7120'
Teapot ss	7500'
Parkman ss	7770'
Lower Parkman ss	8050'
T.D.	± 8,200'

<u>Wells IW-2, IW-3, and IW-4 Installation</u>

The following installation and completion information generally applies for wells IW-2, IW-3 and IW-4. Volume calculations (e.g. cementing program) are based upon the projected completion of well IW-2, and will differ slightly for wells IW-3 and IW-4. The proposed cementing program from UIC 98-092 was used as the basis for cementing program included below, with some modification for differing hole sizes and depths.

Hole Size:

12 ¼ " to 1300'

7 7/8" 1300' to T.D.

Casing/Tubing Program:

<u>Conductor:</u>

0' - 50'-16" O.D., 65 lb/ft, H-40 or equivalent in 20" hole.

<u>Surface Casing:</u>

0 - 1300'-8 5/8" O.D., 24 lb/ft, K-55 or equivalent in 12 ¼ " hole.

<u>Production Casing:</u>

Interval	Net '	Specifications
0' – 6,000'	6,000'	5 ½ ", 17 lb/ft., J/K-55
6,000' – T.D.	2,200' to 2,350'	5 ½ ", 17 lb/ft., N-80
Totals	8,200' to 8,350'	

<u>Injection String:</u>

2 7/8" 6.5# J-55 at ± 7,450'

Injection Packer:
5 ½” x 2 7/8” carbon steel packer with 20 feet of tailpipe @ ± 7,450’

Annular Fluid:
Inhibited brine/fresh water.

Cementing Program:
Check water quality and compatibility for all cement slurries.

Conductor:
± 50 feet to surface cemented with ± 2 cubic yards

Surface Casing:
± 1300 feet to surface cemented
(310 sx. light premium – lead and 310 sx. premium – tail, approx. 100% excess)

Production Casing:

1st Stage Cement: (T.D. to 7000’ plus 20%)
235 sx Premium
Yield: 1.20 cu.ft/sx
Density: 15.60 lb/gal
Water Ratio: 5.27 gal/sx

2nd Stage Cement: (7000’ to surface plus 20%)
Lead:
560 sx Light Cement
Yield: 2.26 cu.ft/sx
Density: 11.80 lb/gal
Water Ratio: 13.00 gal/sx

Tail:
185 sx Light Cement
Yield: 1.20 cu.ft/sx
Density: 15.60 lb/gal
Water Ratio: 5.28 gal/sx

Cement Stage Collar: ± 7,000 feet

Cement volumes will be recalculated after caliper logging.

Open Hole Logging Program:
Surface Interval:
12 ¼ ” hole, 0’-1300’

Induction Electric (IES) Caliper

Production/Injection Interval:

7 7/8” hole 1300’- TD
Dual Induction (DIL)
Gamma Ray/Neutron Caliper
Formation Density Compensated
Other logs (e.g. CNL, SFL) at the discretion of operator

Cased Hole Logs:

Surface Casing:

Temperature Log 0’-1300’

Production Casing:

Cement Bond Log (CBL) 0’- T.D.
Baseline Temperature Survey 0’- T.D.
Electromagnetic Casing Inspection Log 0’- T.D.
Radioactive Tracer Survey 0’- T.D.

Formation Evaluation:

Quartz Crystal BHP 0’- T.D. minus 100’
Static Survey and Pressure Fall off
Spinner Survey 0’- T.D.

Core:

Two – 30’x3” full hole cores may be collected in well IW-2; one each from within the following formations.

Formation	IW-2 Top/Bottom
Teapot Formation	± 7,600 – 7,770
Parkman Formation	± 7,880 – 8,280

After recovery, the cores are to be sent to a qualified laboratory for a minimum analysis of:

1. Permeability – vertical and horizontal
2. Porosity – total
3. Saturation – water, gas and oil
4. Lithologic description

Coring in wells IW-3 and IW-4 will be at the discretion of the operator.

DST’s: Proposed DST’s in Teapot and Parkman sandstone receiver zones.

Mud Logging Unit: None

Samples:

Representative formation water samples will be collected during DST's for the Teapot and Parkman Sandstones. After recovery, samples will be sent to a qualified laboratory for analysis. All sampling procedures will follow WDEQ guidelines for sampling methods/protocols, QA/QC, chain of custody, etc.

Proposed Completion Procedure:

The following is a step-by-step description required, at minimum, to drill and install wells IW-2, IW-3 and IW-4:

1. Notify the Wyoming Department of Environmental Quality (WDEQ) of start-up schedule.
2. Move in and rig up drilling rig and peripheral equipment.
3. Install 16" O.D., 65lb/ft., H-40, or equivalent, conductor casing into bedrock @ ±50 feet.
4. Drill 12 ¼ " surface hole to a depth of ± 1300".
5. Upon reaching surface casing depth of 1300' ±, condition mud and run open hole logs as per logging program.
6. Circulate and condition mud/open hole prior to running surface casing.
7. Notify WDEQ of surface casing cement and temperature logging schedule.
8. Run ± 1300' of 8 5/8", 24 lb/ft, K-55 surface casing.
9. Cement surface casing back to surface as per the attached cement program.
10. Wait on cement as per cement company recommendation prior to running temperature log
11. Cut off 16" and 8 5/8" at ground level and install blowout prevention and equipment that conforms with Section 23 of Chapter 3 of the Wyoming Oil and Gas Conservation Commission Rules. Proposed equipment is as follows:
    - Rotating Head
    - Annular Preventer
    - Blind Rams (4.5")
    - Pipe Rams
    - Drilling Spool with 2-3" outlets
    - Casing Head
    - Kill line equipped with 2-2" x 5,000 psi valves and 1-2" x 5,000 psi check valve minimum
    - Choke line equipped with 2-3" 5,000 psi valves
    - Choke manifold equipped with 2-3" 5,000 psi valves, 4-3" 5,000 psi wing outlet valves, a remote operated choke, a manual choke, 2-3" x 5,000 psi valves downstream of the remote chokes, 2-3" x 5,000 psi valves downstream of the manual choke and pressure gauge. Bypass line from flare line to mud gas separator line.
    - Upper Kelly cock with handle available on floor
    - Full opening internal blowout preventer or drill pipe safety valve to fit all connections
    - Minimum 5,000 psi working pressure rating for equipment
12. Pressure test the 8 5/8" casing as required by the WDEQ.
13. Pick up 7 7/8" bit and go in hole with same. Drill out float equipment.
14. Condition mud prior to drilling new formation.

15. Drill 7 7/8" hole to the top of the Teapot Sandstone (top estimated at 7,580'). Exact depth to be selected by geologist.
16. Attempt a 30' full-hole core of the Teapot Sandstone.
17. Ream cored interval and continue drilling 7 7/8" hole to the top of the Parkman Sandstone (top estimated at 7,870'). Exact depth to be selected by geologist.
18. Attempt a 30' full-hole core of the Parkman Sandstone. Evaluate core data.
19. Ream cored interval and continue drilling 7 7/8" hole to approximately 100' below the base of Parkman Sandstone (estimated at 8,350').
20. Run open hole logs as per attached logging program. Evaluate logs. Set a DST tool in the Parkman Sandstone. Perform a DST and collect a fluid sample of the Parkman. Evaluate DST data. DST test for Teapot may be conducted if electric logs show potentially favorable injection zones.
21. Circulate and condition mud prior to running production casing.
22. Notify WDEQ of surface casing cement and cased hole logging schedule.
23. Run 5 ½ " production casing as per descried casing program.
24. Cement production casing as per described cementing program.
25. Go in hole with 4 ¼" bit and clean out the top of the 5 ½ " float collar. Pressure test the 5 ½" production casing as per the WDEQ.
26. Circulate mud out of the hole with brine.
27. Run cement bond and electromagnetic casing inspection/electronic caliper logs over the length of the 5 ½" production casing extending from the float collar back to the surface.
28. Perforate the Teapot and Parkman formation selectively.
29. Perform step-rate injection test/falloff to evaluate potential well performance. Include spinner survey and quartz crystal bottom-hole pressure gauge to determine flow distribution and performance.
30. Notify WDEQ of radioactive tracer logging schedule.
31. Run radioactive tracer survey to demonstrate mechanical integrity.
32. Stimulate if required.
33. Run packer with 20 feet of 2 7/8" tailpipe on work string and set packer at approximately 7450 feet.
34. Go in hole with 2 7/8" O.D. 11.60 lb/ft K-55 carbon steel injection string and seal assembly.
35. Space out 2 7/8" injection tubing.
36. Circulate corrosion inhibiter fluid down annulus side.
37. Latch injection string into packer and install wellhead.
38. Notify WDEQ of annulus pressure test.
39. Pressure test annulus as per WDEQ to demonstrate mechanical integrity.
40. Rig down and move out.
41. Prepare final report.

Appendix F. Abandonment Cementing Estimate

The included document presents a proposed cementing procedure and cost estimate for well IW-1. At the time the cost estimate was prepared, the anticipated completion interval included perforations in the Teckla sandstone. The proposed completion intervals for wells IW-1, IW-2, IW-3, and IW-4 do not include the Teckla sandstone, so there is a conservatively large cemented interval included in the cost estimate.

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S M Stoller Corporation
105 Technology Dr Ste 190
Broomfield, Colorado 80021

Reno Creek IW-1

Campbell County, Wyoming
United States of America

PTA Cement Treatment

Prepared for: Mr. Geoff Asmus

January 21, 2009
Version: 1_187515

Submitted by:
Larry Staten
Halliburton
6900 Nugget Rd
Evansville, Wyoming 82636
307-473-8275

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Halliburton appreciates the opportunity to present this proposal and looks forward to being of service to you.

Foreword

Enclosed is our recommended procedure for plugging to abandon the referenced well. The information in this proposal includes well data, calculations, materials requirements, and cost estimates. This proposal is based on information from our field personnel and previous cementing services in the area.

Halliburton Energy Services recognizes the importance of meeting society's needs for health, safety, and protection of the environment. It is our intention to proactively work with employees, customers, the public, governments, and others to use natural resources in an environmentally sound manner while protecting the health, safety, and environmental processes while supplying high quality products and services to our customers.

We appreciate the opportunity to present this proposal for your consideration and we look forward to being of service to you. Our Services for your well will be coordinated through the Service Center listed below. If you require any additional information or additional designs, please feel free to contact me or one of our representatives listed below.

Prepared by: ____________________
Amber Barbarick
Senior Proposal Specialist

Submitted by: ____________________
Larry Staten
District Sales Manager

Service Location:	Gillette, WY	(307) 685-5160
Service Coordinator:	Robert Birkle	(307) 685-5160
District Operations Manager-Cement:	Calvin Alverado	(307) 473-8200
District Technical Manager:	Paul Rauzi	(307) 232-2007

Cementing Best Practices

1. Cement quality and weight: You must choose a cement slurry that is designed to solve the problems specific to each casing string.

2. Waiting time: You must hold the cement slurry in place and under pressure until it reaches its' initial set without disturbing it. A cement slurry is a time-dependent liquid and must be allowed to undergo a hydration reaction to produce a competent cement sheath. A fresh cement slurry can be worked (thickening or pump time) as long as it is in a plastic state and before going through its' transition phase. If the cement slurry is not allowed to transition without being disturbed, it may be subjected to changes in density, dilution, settling, water separation, and gas cutting that may lead to a lack of zonal isolation and possible bridging in the annulus.

3. Pipe movement: Pipe movement may be one of the single most influential factors in mud removal. Reciprocation and/or rotation mechanically breaks up gelled mud and changes the flow patterns in the annulus to improve displacement efficiency.

4. Mud properties (for cementing):

Rheology:

Plastic Viscosity (PV) < 15 centipoise (cp)
Yield Point (YP) < 10 lb/100 ft2
These properties should be reviewed with the Mud Engineer, Drilling Engineer, and Company Representative(s) to ensure no hole problems are created.

Gel Strength:

The 10-second/10-minute gel strength values should be such that the 10-second and 10-minute readings are close together or flat (i.e., 5/6). The 30-minute reading should be less than 20 lb/100 ft^2. Sufficient shear stress may not be achieved on a primary cement job to remove mud left in the hole if the mud were to develop more than 25 lb/100 ft^2 of gel strength.

Fluid Loss:

Decreasing the filtrate loss into a permeable zone enhances the creation of a thin, competent filter cake. A thin, competent filter cake created by a low fluid loss mud system is desirable over a thick, partially gelled filter cake. A mud system created with a low fluid loss will be more easily displaced. The fluid loss value should be < 15 cc's (ideal would be 5 cc's).

5. Circulation: Prior to cementing circulate full hole volume twice, or until well conditioned mud is being returned to the surface. There should be no cutting in the mud returns. An annular velocity of 260 feet per minute is optimum (SPE/IADC 18617), if possible.

6. Flow rate: Turbulent flow is the most desirable flow regime for mud removal. If turbulence cannot be achieved pump at as high a flow rate that can practically and safely be used to create the maximum flow energy. The highest mud removal is achieved when the maximum flow energy is obtained.

7. Pipe Centralization: Cement will take the path of least resistance; therefore, proper centralization is important to help prevent the casing from contacting the borehole wall. A minimum standoff of 70% should be targeted for optimum displacement efficiency.

8. Rat hole: A weighted viscous pill placed in the rat hole prior to cementing will minimize the risk of higher density cement mixing with lower density mud when the well is static.

9. Top and Bottom plugs: A top and bottom plug are recommended to be run on all primary casing jobs. The bottom plug should be run after the spacer and ahead of the first cement slurry.

10. Spacers and flushes: Spacers and/or flushes should be used to prevent contamination between the cement slurry and the drilling fluid. They are also used to clean the wellbore and aid with bonding. To determine the volume, either a minimum of 10 minutes contact time or 1000 ft. of annular fill, whichever is greater, is recommended.

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Job Information — *PTA*

Well Name: Reno Creek	Well #: IW-1
5 1/2" Production Casing	0 - 8400 ft (MD) 0 - 8400 ft (TVD)
Outer Diameter	5.500 in
Inner Diameter	4.892 in
Linear Weight	17 lbm/ft
Cement Plug	1615 ft (MD)
Cement Plug	50 ft (MD)
Cement Plug	7550 ft (MD)

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Job Recommendation *PTA*

Fluid Instructions

Fluid 1: Plug Cement			
Premium Cement		Fluid Weight	15.800 lbm/gal
94 lbm/sk	Premium Cement (Cement)	Slurry Yield:	1.150 ft^3/sk
0.2 %	HR-5 (Retarder)	Total Mixing Fluid:	5 Gal/sk
		Proposed Sacks:	385 sks
Fluid 2: Plug Cement			
Premium Cement		Fluid Weight	15.800 lbm/gal
94 lbm/sk	Premium Cement (Cement)	Slurry Yield:	1.150 ft^3/sk
2 %	Calcium Chloride (Additive Material)	Total Mixing Fluid:	5 Gal/sk
		Proposed Sacks:	25 sks
Fluid 3: Plug Cement			
Premium Cement		Fluid Weight	15.800 lbm/gal
94 lbm/sk	Premium Cement (Cement)	Slurry Yield:	1.150 ft^3/sk
2 %	Calcium Chloride (Additive Material)	Total Mixing Fluid:	5 Gal/sk
		Proposed Sacks:	25 sks

Detailed Pumping Schedule

Fluid #	Fluid Type	Fluid Name	Surface Density lbm/gal	Estimated Avg Rate bbl/min	Downhole Volume
1	Cement	Plug 1	15.8	3.0	385 sks
2	Cement	Plug 2	15.8	3.0	25 sks
3	Cement	Plug 3	15.8	3.0	25 sks

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Cost Estimate PTA

SAP Quote # 0

Mtrl Nbr	Description	Qty	U/M	Base Amt	Unit Price	Net Amt
7528	CMT PLUG TO ABANDON BOM	1	JOB			0.00
	Cementing Services and Equipment					
2	MILEAGE FOR CEMENTING CREW,ZI Number of Units	120 1	MI		5.76	331.78
1	ZI-MILEAGE FROM NEAREST HES BASE,/UNIT Number of Units	120 1	MI		9.79	563.90
16094	PLUG BACK/SPOT CEMENT OR MUD,ZI DEPTH FEET/METERS (FT/M)	1 8400 FT	EA		12,584.00	6,040.32
16092	ADDITIONAL HOURS (PUMPING EQUIPMENT), ZI HOURS	0 0	EA		1,071.00	0.00
141	RCM II W/ADC,/JOB,ZI NUMBER OF UNITS	1 1	JOB		1,990.00	955.20
132	PORT. DAS W/CEMWIN;ACQUIRE W/HES, ZI NUMBER OF DAYS	1 1	JOB		1,649.00	791.52
3	ZI-DERRICK CHARGE	0	EA		987.00	0.00
	SubTotal		**USD**			**8,682.72**
	Cementing Materials					
100003685	CLASS G / PREMIUM	385	SK		40.54	7,491.79
100005050	HR-5	73	LB		11.07	387.89
100003685	CLASS G / PREMIUM	25	SK		40.54	486.48
100005053	CALCIUM CHLORIDE HI TEST PLT	1	SK		251.00	120.48
100003685	CLASS G / PREMIUM	25	SK		40.54	486.48
100005053	CALCIUM CHLORIDE HI TEST PLT	1	SK		251.00	120.48
76400	ZI MILEAGE,CMT MTLS DEL/RET MIN NUMBER OF TONS	60 20.53	MI		3.35	1,980.73
3965	HANDLE&DUMP SVC CHRG, CMT&ADDITIVES,ZI NUMBER OF EACH	438 1	CF		5.49	1,154.22
	SubTotal		**USD**			**12,228.55**
	Cementing Surcharges					
7	ENVIRONMENTAL SURCHARGE,/JOB,ZI	1	LE		134.00	134.00
8	IRON SAFETY INSPECTION SURCHARGE /JOB ZI	1	LE		83.00	83.00
372867	Cmt PSL - DOT Vehicle Charge, CMT	3	EA		241.00	723.00
	SubTotal		**USD**			**940.00**
	Total	**USD**				**44,505.16**
	Discount	**USD**				**22,653.89**
	Discounted Total	**USD**				**21,851.27**

Primary Plant: Casper, WY, USA
Secondary Plant: Casper, WY, USA

Price Book Ref: 01 Western US
Price Date: 1/21/2009

Conditions

NOTE

The cost in this analysis is good for the materials and/or services outlined within and shall be valid for 30 days from the date of this proposal. In order to meet your needs under this proposal with a high quality of service and responsive timing, Halliburton will be allocating limited resources and committing valuable equipment and materials to your area of operations. Accordingly, the discounts reflected in this proposal are available only for materials and services awarded on a first-call basis. Alternate pricing may apply in the event that Halliburton is awarded work on any basis other than as a first-call provider.

The unit prices stated in the proposal are based on our current published prices. The projected equipment, personnel, and material needs are only estimates based on information about the work presently available to us. At the time the work is actually performed, conditions then existing may require an increase or decrease in the equipment, personnel, and/or material needs. Charges will be based upon unit prices in effect at the time the work is performed and the amount of equipment, personnel, and/or material actually utilized in the work. Taxes, if any, are not included. Applicable taxes, if any, will be added to the actual invoice.

It is understood and agreed between the parties that with the exception of the subject discounts, all services performed and equipment and materials sold are provided subject to Halliburton's General Terms and Conditions contained in our current price list, (which include LIMITATION OF LIABILITY and WARRANTY provisions), and pursuant to the applicable Halliburton Work Order Contract (whether or not executed by you), unless a Master Service and/or Sales Contract applicable to the services, equipment, or materials supplied exists between your company and Halliburton, in which case the negotiated Master Contract shall govern the relationship between the parties. A copy of the latest version of our General Terms and Conditions is available from your Halliburton representative or at: http://www.halliburton.com/hes/general_terms_conditions.pdf for your convenient review, and we would appreciate receiving any questions you may have about them. Should your company be interested in negotiating a Master Contract with Halliburton, our Law Department would be pleased to work with you to finalize a mutually agreeable contract. In this connection, it is also understood and agreed that Customer will continue to execute Halliburton usual field work orders and/or tickets customarily required by Halliburton in connection with the furnishing of said services, equipment, and materials.
Any terms and conditions contained in purchase orders or other documents issued by the customer shall be of no effect except to confirm the type and quantity of services, equipment, and materials to be supplied to the customer.
If customer does not have an approved open account with Halliburton or a mutually executed written contract with Halliburton, which dictates payment terms different than those set forth in this clause, all sums due are payable in cash at the time of performance of services or delivery of equipment, products, or materials. If customer has an approved open account, invoices are payable on the twentieth day after date of invoice.

Customer agrees to pay interest on any unpaid balance from the date payable until paid at the highest lawful contract rate applicable, but never to exceed 18% per annum. In the event Halliburton employs an attorney for collection of any account, customer agrees to pay attorney fees of 20% of the unpaid account, plus all collection and court costs.

Appendix G. Injection Well Abandonment Cost Estimate

The attached costing sheet presents a total well and ancillary structures abandonment cost estimate for a single injection well. The costing includes well abandonment based on well IW-1 and assumed a conservatively large perforation interval. The costing also includes reclamation of the well site and pipeline corridors and disposal of wastes generated during abandonment. The total estimated cost is $126,300.

replaced 3/26/10 [initials]

Figure G-1. Injection Well Abandonment Cost Estimate

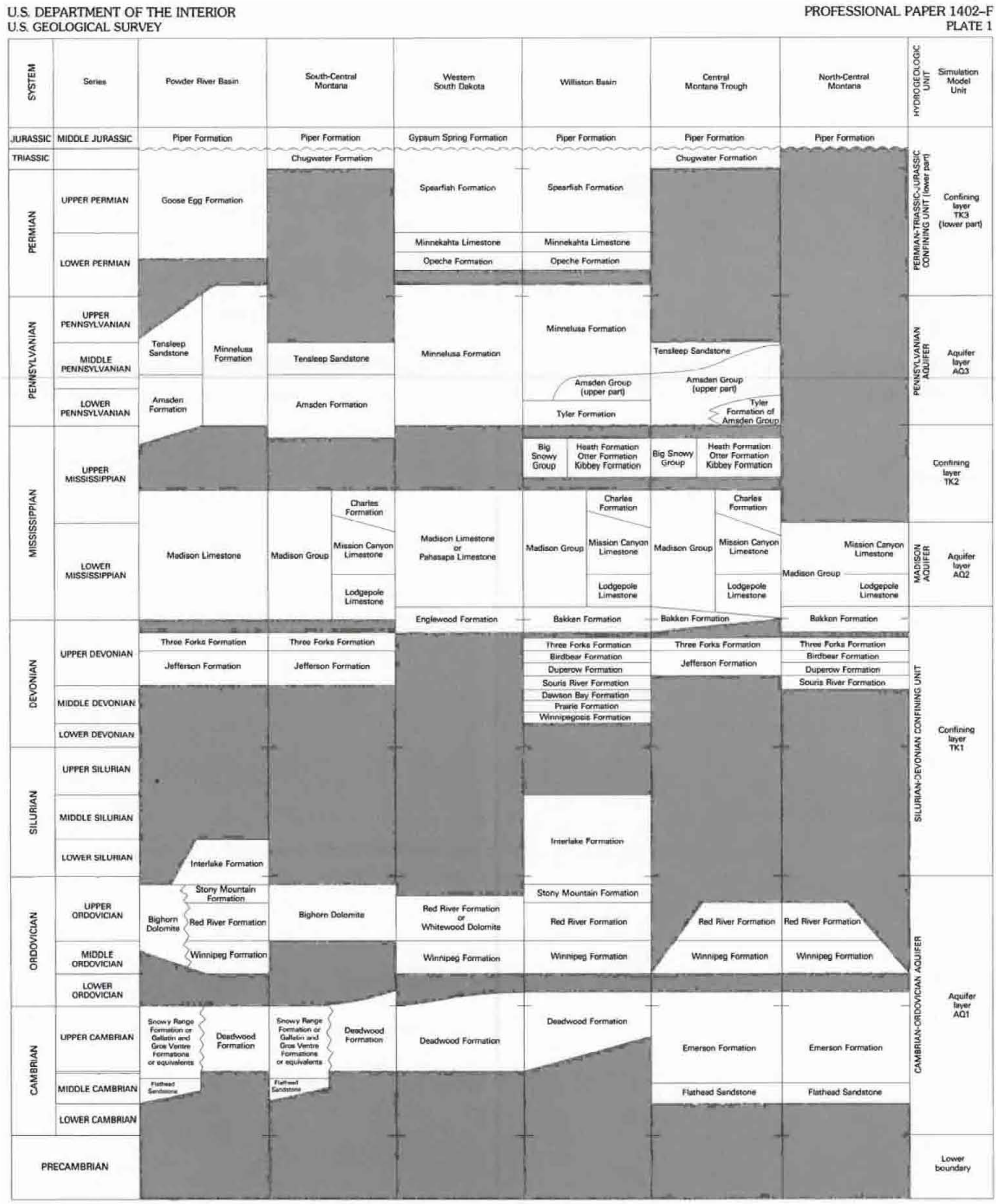
Item		Unit cost			Units	Total Cost	References
Well Plugging and Abandonment							
Cementing Services and Equipment							
Mileage for cementing crew						$ 332	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Mileage from nearest base						$ 564	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Plug back/spot cement or mud						$ 6,040	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
RCM II w/ADC						$ 955	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Port DAS W/CEMWIN; acquire w/HES						$ 792	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Cementing Materials							
Class G/Premium						$ 7,492	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
HR-5						$ 388	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Class G/Premium						$ 486	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Calcium Chloride H1 Test Pit						$ 120	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Class G/Premium						$ 486	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Calcium Chloride H1 Test Pit						$ 120	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Mileage, cement materials, return						$ 1,981	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Handling & dump service charge, cmt/addivs						$ 1,154	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Cementing surcharges							
Environmental surcharge						$ 134	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Iron safety inspection surcharge						$ 83	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
CMT PSL DOT Vehicle charge						$ 723	Abandonment cost estimate received from Halliburton, Evansville, WY, January 21, 2009
Rig and Associated Equipment							
Mob/Demob and Completion Rig Time						$ 28,000	Estimated from reviews of similar recent Class I well permit applications
Rental Tools and Equipment						$ 5,000	Estimated from reviews of similar recent Class I well permit applications
Wireline Work						$ 3,000	Estimated from reviews of similar recent Class I well permit applications
Fluids, Mud Additives, Water and Supplies						$ 10,000	Estimated from reviews of similar recent Class I well permit applications
Contract Services (welding, roustabout, etc.)						$ 3,000	Estimated from reviews of similar recent Class I well permit applications
Abandoment and Decommissioning Supervision and Support (Geologic and Engineering)						$ 4,000	Estimated from reviews of similar recent Class I well permit applications
Miscellaneous and Contingency						$ 8,000	Estimated from reviews of similar recent Class I well permit applications
						$ 80,851	
Surface Plant Removal							
Equipment Removal							
labor	$	23.85	per hour	foreman	24	$ 572	2008 Wyoming Heavy and Highway Prevailing Wages, laborer plus $5 per hour
	$	17.85	per hour	laborer	48	$ 857	2008 Wyoming Heavy and Highway Prevailing Wages
equipment rent	$	26.41	per hour	pickup	48	$ 1,268	WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
	$	17.29	per hour	boom truck	6	$ 104	Means 2009
Building Demolition							
decontamination							
labor	$	23.85	per hour	foreman	6	$ 143	2008 Wyoming Heavy and Highway Prevailing Wages, laborer plus $5 per hour
	$	17.85	per hour	laborer	6	$ 107	2008 Wyoming Heavy and Highway Prevailing Wages
equipment rent	$	26.41	per hour	pickup	6	$ 158	WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
	$	4.20	per hour	steam cleaner	6	$ 25	Means 2009
demolition	$	1.83	per ft^2	4 in walls	250	$ 458	Means 2009
	$	4.61	per ft^2	6 in slab	250	$ 1,153	WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
						$ 4,844	
Pipeline Removal (12,000 feet of 6 inch line)							
Excavation							
equipment	$	32.39	per hour	backhoe	178	$ 5,765	Means, 2009 for backhoe rate. Pipeline 5 feet deep, trench is 2 feet wide, 12,000 feet long - 4,444 yd3, excavation rate is 200 yards per day for 1/2 yd. backhoe, 22 days required or 178 hours
labor	$	22.09	per hour	operator	178	$ 3,932	2008 Wyoming Heavy and Highway Prevailing Wages
	$	17.85	per hour	laborer	178	$ 3,177	2008 Wyoming Heavy and Highway Prevailing Wages
Pipe Removal							
labor	$	23.85	per hour	foreman	24	$ 572	2008 Wyoming Heavy and Highway Prevailing Wages, laborer plus $5 per hour
	$	17.85	per hour	laborer	48	$ 857	2008 Wyoming Heavy and Highway Prevailing Wages
equipment rent	$	26.41	per hour	pickup	24	$ 634	WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
	$	17.29	per hour	boom truck	6	$ 104	Means 2009
Backfill Trench							
equipment rent	$	32.39	per hour	backhoe	89	$ 2,883	WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
labor	$	22.09	per hour	operator	89	$ 1,966	2008 Wyoming Heavy and Highway Prevailing Wages
	$	17.85	per hour	laborer	89	$ 1,589	2008 Wyoming Heavy and Highway Prevailing Wages
						$ 21,479	
Disposal of Waste							
Haulage for disposal							
uncontaminated	$	0.19	per ton-mile	building	12.3	$ 140	60 miles to Campbell County Landfill, Means 2009 has $3.39/mile for 18 ton load, or $0.19 per ton mile
	$	0.19	per ton-mile	concrete	8.3	$ 95	60 miles to Campbell County Landfill, Means 2009 has $3.39/mile for 18 ton load, or $0.19 per ton mile
contaminated	$	0.33	per ton-mile	pumps, etc.	2	$ 233	353 miles to Clean Harbors Deer Trail facility, Means 2009 has $5.95/mile for 18 ton load, or $0.331 per ton mile
	$	0.33	per ton-mile	pipes	43.6	$ 5,079	353 miles to Clean Harbors Deer Trail facility, Means 2009 has $5.95/mile for 18 ton load, or $0.331 per ton mile, volume of pipe = 12,000 x (0.25 feet)^2
	$	0.33	per ton-mile	concrete	0.9	$ 105	353 miles to Clean Harbors Deer Trail facility, Means 2009 has $5.95/mile for 18 ton load, or $0.331 per ton mile
Disposal							
uncontaminated	$	95.00	per ton	building	12.3	$ 1,169	WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
	$	95.00	per ton	concrete	8.3	$ 789	WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
contaminated	$	150.00	per ton	total from above	46.5	$ 6,975	Deer Trail disposal cost is $150/ton per Jack Kehoe, plant manager, verbal estimate, January 27, 2009 - assume 1 ton = 1 yd3
						$ 14,584	
Powerline Removal (no cost per Guideline 12)							WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
Fence Removal	$	0.50	per foot	fence	1200	$ 600	WYDEQ Guideline 12 - Standardized Reclamation Performance Bond Format and Cost Calculation Methods
						$ 600	
Reclamation and Revegetation							
	$	1.00	per yd^3	gravel removal	2167	$ 2,167	gravel volume = (12,000 ft x 12 ft x 0.25 ft / 27) + (300 ft x 300 ft x 0.25 ft / 27) = 1,333.3 + 833.3 = 2,167 yd^3, unit cost based on commercial rates for pick-up and haul
	$	59.41	per acre	scarifying	7.58	$ 450	scarifying area = (1,000 ft x 24 ft) + (300 ft x 300 ft) = 240,000 + 90,000 = 330,000 ft 2 = 7.58 acres, unit cost from WDEQ Guideline 12
	$	79.16	per acre	grading	7.58	$ 600	grinding and ripping area = (1,000 feet x 24 feet) + (300 feet x 300 feet) = 240,000 + 90,000 = 330,000 ft^2 = 7.58 acres, unit cost from WDEQ Guideline 12
	$	80.94	per acre	seed	7.58	$ 614	Unit costs from "Regional Cost Estimates for Reclamation practices on Arid and Semi-Arid Lands", DOE NNSA, 2002
	$	12.95	per acre	drill seeding labor/equipment	7.58	$ 98	Unit costs from "Regional Cost Estimates for Reclamation practices on Arid and Semi-Arid Lands", DOE NNSA, 2002
						$ 3,929	
					Total	**$ 126,287**	

replaced 3/26/10 [initials]

Appendix H. Deep Formation Hydrogeology

List of Appendix H Figures

Figure H-1. Plate 1 of USGS Professional Paper 1402-A

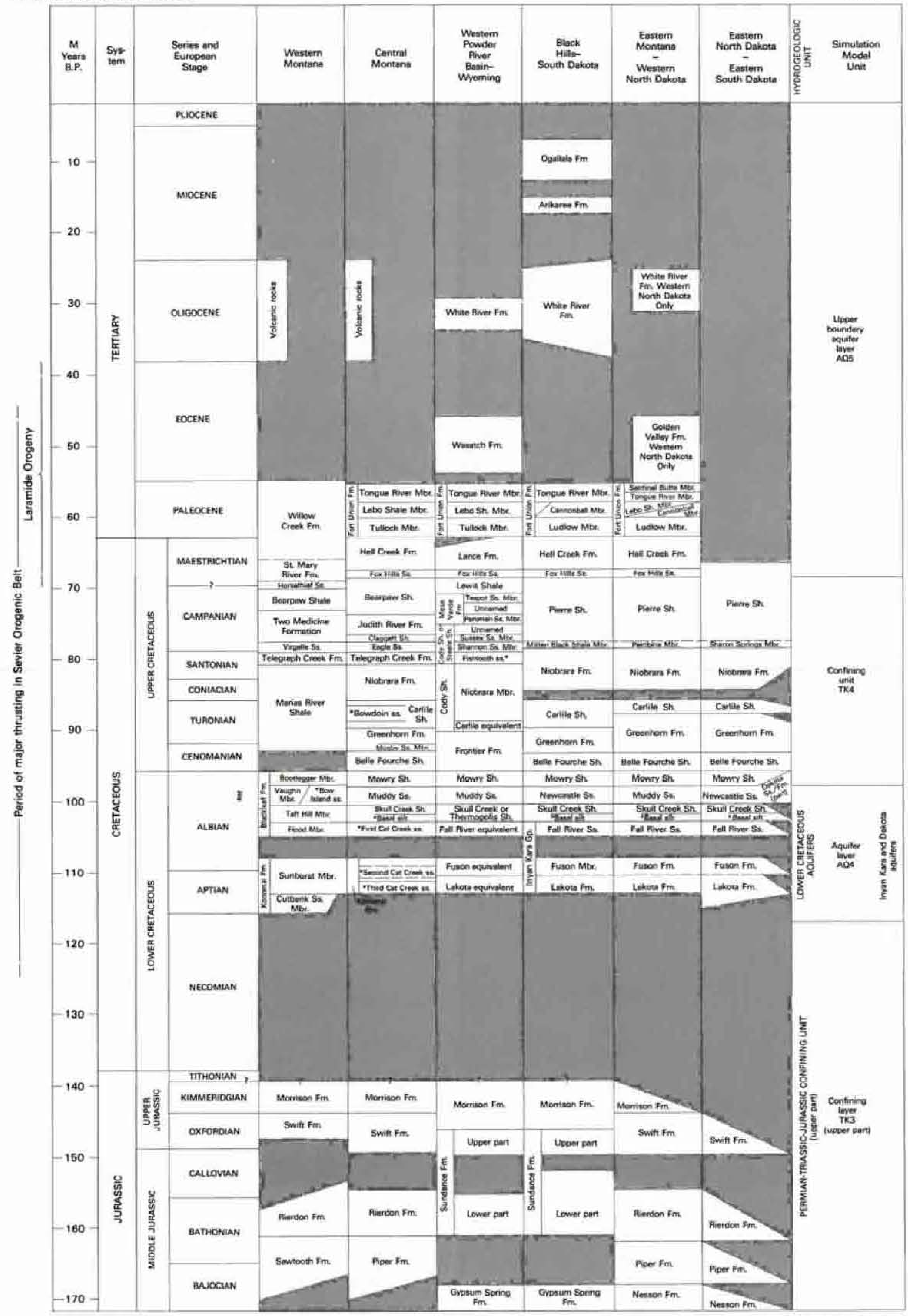


GENERALIZED GEOLOGIC CORRELATION CHART OF MESOZOIC AND PALEOZOIC ROCKS IN THE NORTHERN GREAT PLAINS

Figure H-2. Plate 2 of USGS Professional Paper 1402-A

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PROFESSIONAL PAPER 1402–F
PLATE 2



*Of informal or subsurface usage

Compiled by L.O. Anna, 1982. Modified from Balster (1971), Imlay (1980), and Rice (1976).

GENERALIZED GEOLOGIC CORRELATION CHART OF JURASSIC, CRETACEOUS (MESOZOIC), AND TERTIARY ROCKS IN THE NORTHERN GREAT PLAINS

Figure H-3. Figure 32 of USGS Professional Paper 1402-E

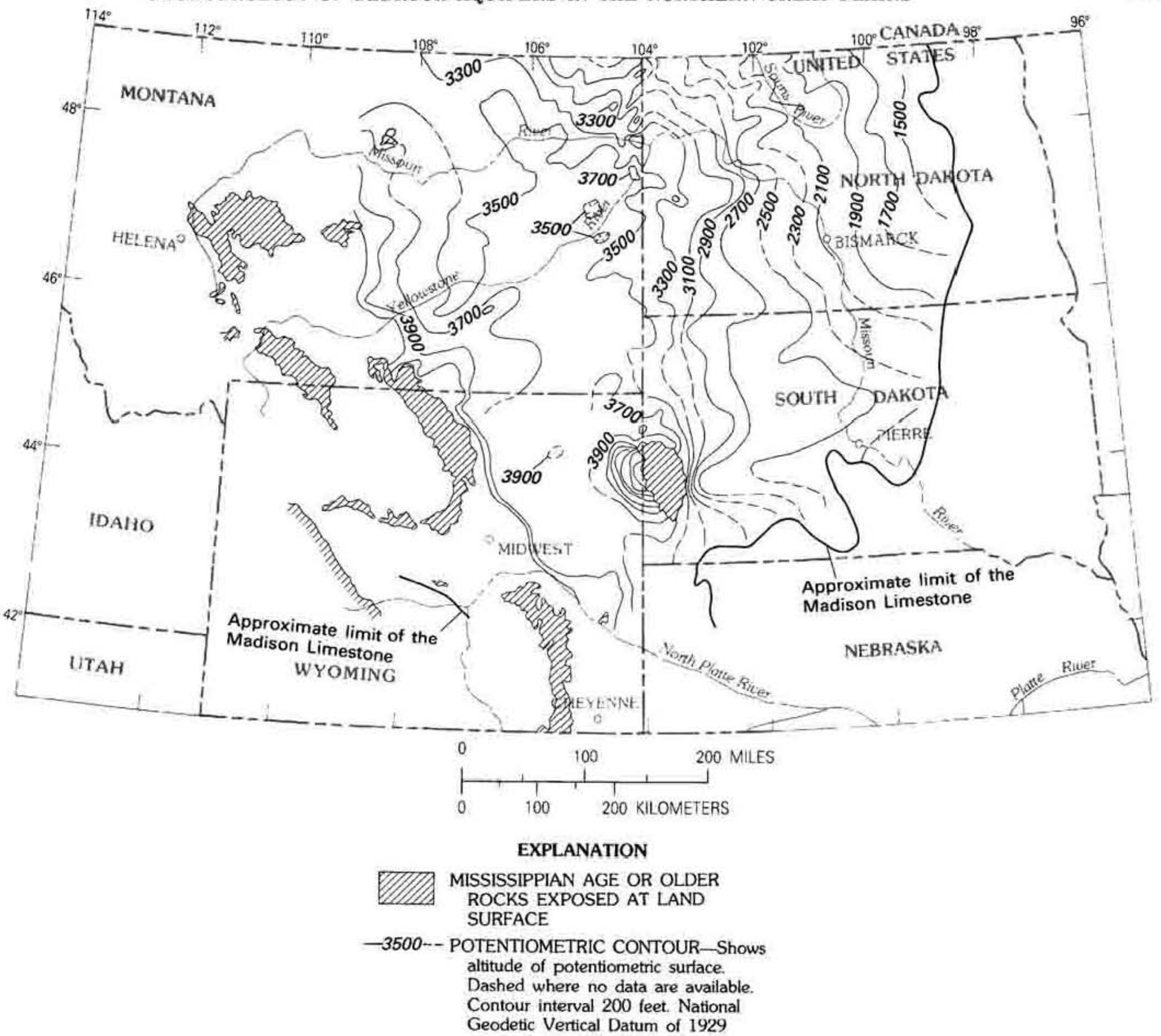


FIGURE 32.—Potentiometric surface of the Madison aquifer. Modified from Miller and Strausz (1980b).

the cone of depression. In addition, Busby, Lee, and Hanshaw (1983), in their analysis of geochemical data from the Midwest area, indicated that some leakage occurred from the overlying Pennsylvanian and Permian formations that was not considered by Konikow in his calculations, and so transmissivity of the Madison aquifer in the Midwest, Wyo., area may be less than 0.013 ft^2/s.

W. R. Miller (1976) states that data from DST's in Montana indicate that transmissivity of the Madison aquifer ranges from about $5x10^{-7}$ to $6x10^{-2}$ ft^2/s. However, Miller did not consider water viscosity changes with temperature in his calculations. The reliability of transmissivity values derived from DST's also is questionable because of inherent errors in the recording devices and the short shut-in times of most DST's.

On the basis of an analysis of data from step-drawdown tests performed at selected intervals in the Madison Limestone at Madison test well 3 (fig. 1), Blankennagel, Howells, and Miller (1981) reported a transmissivity range of from 0.037 to 0.052 ft^2/s, with an assumed storage coefficient of $2x10^{-6}$. The lower value of transmissivity appears to be associated with the upper part of the Madison aquifer at this location. The range in reported transmissivity values may be related to the significant variability of secondary porosity

Figure H-4. Figure 33 of USGS Professional Paper 1402-E

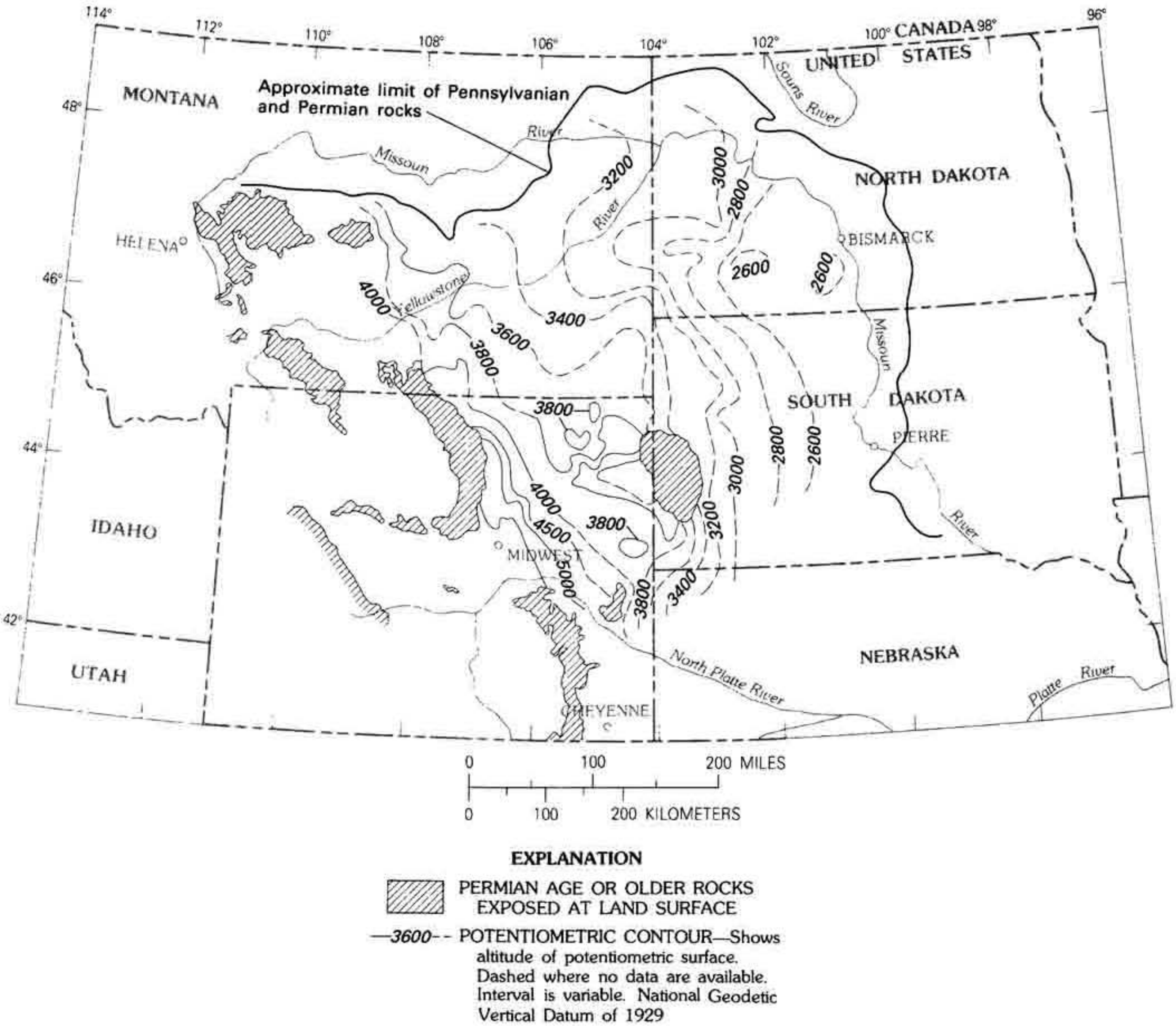


FIGURE 33.—Potentiometric surface of the Pennsylvanian aquifer. From W. R. Miller (written commun., 1980).

Figure H-5. Figure 36 of USGS Professional Paper 1402-E

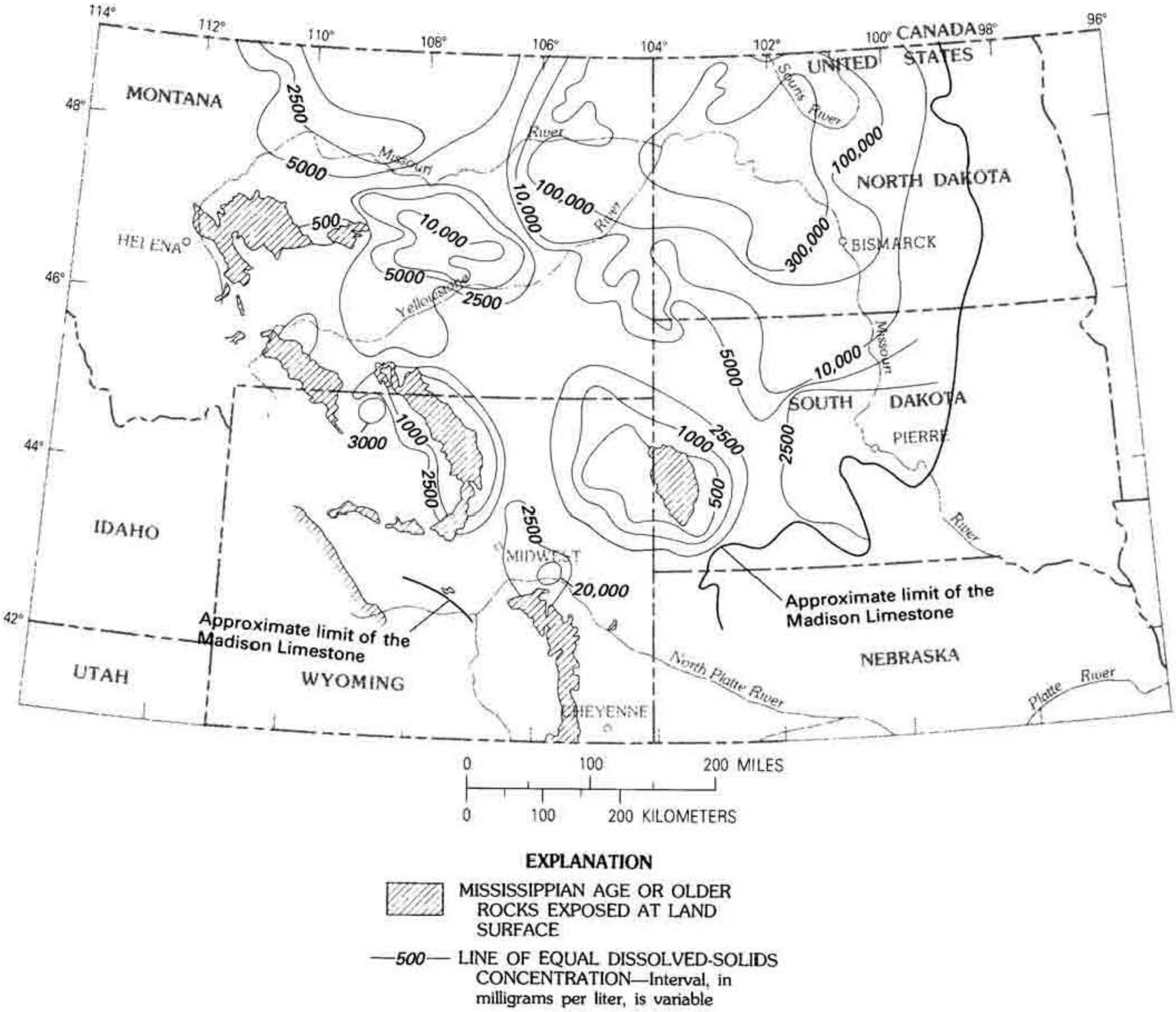


FIGURE 36.—Concentration of dissolved solids in water from the Madison aquifer. From J. F. Busby (written commun., 1981).

Figure H-6. Figure 37 of USGS Professional Paper 1402-E

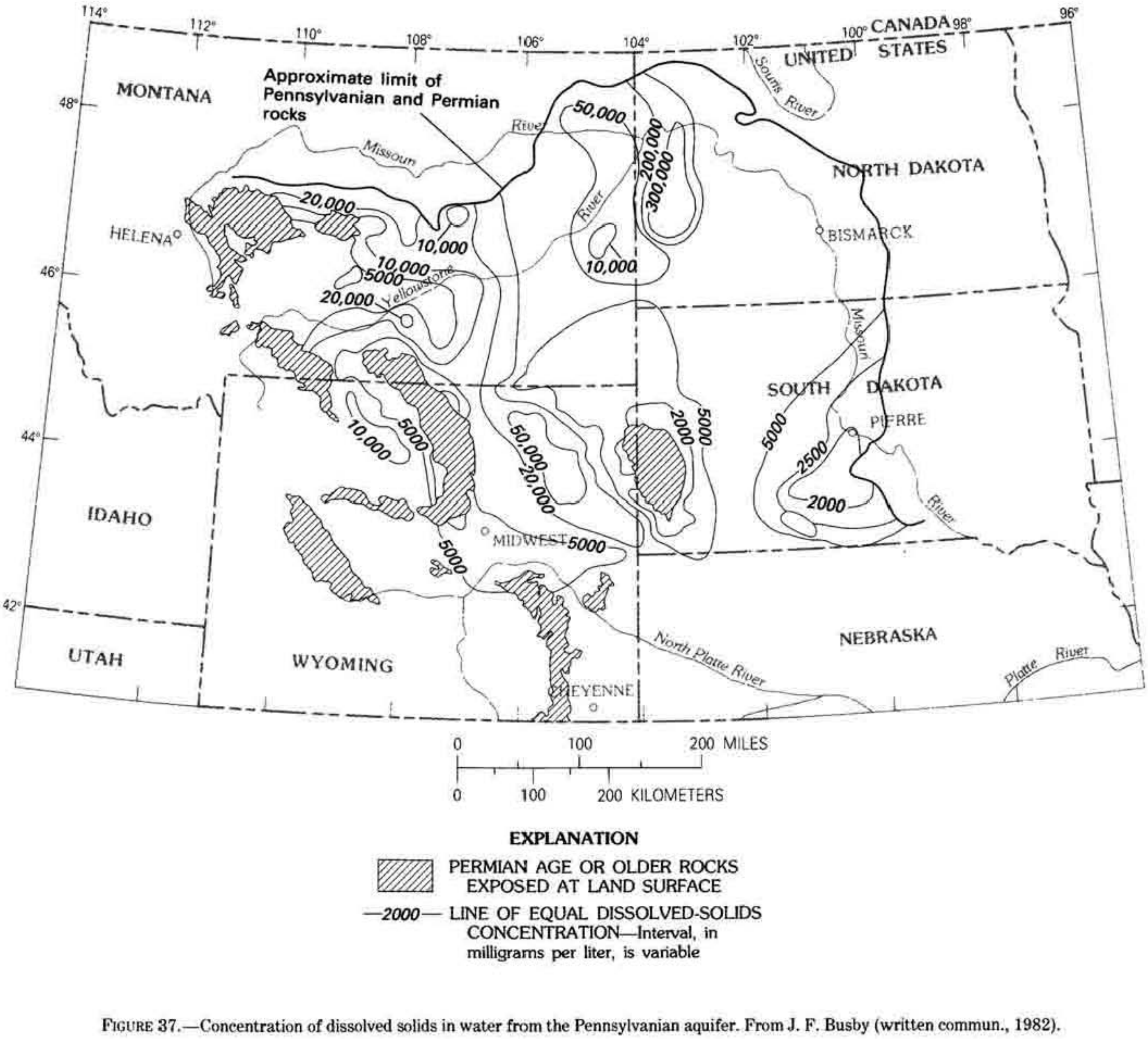


FIGURE 37.—Concentration of dissolved solids in water from the Pennsylvanian aquifer. From J. F. Busby (written commun., 1982).

Figure H-7. Figure 38 of USGS Professional Paper 1402-E

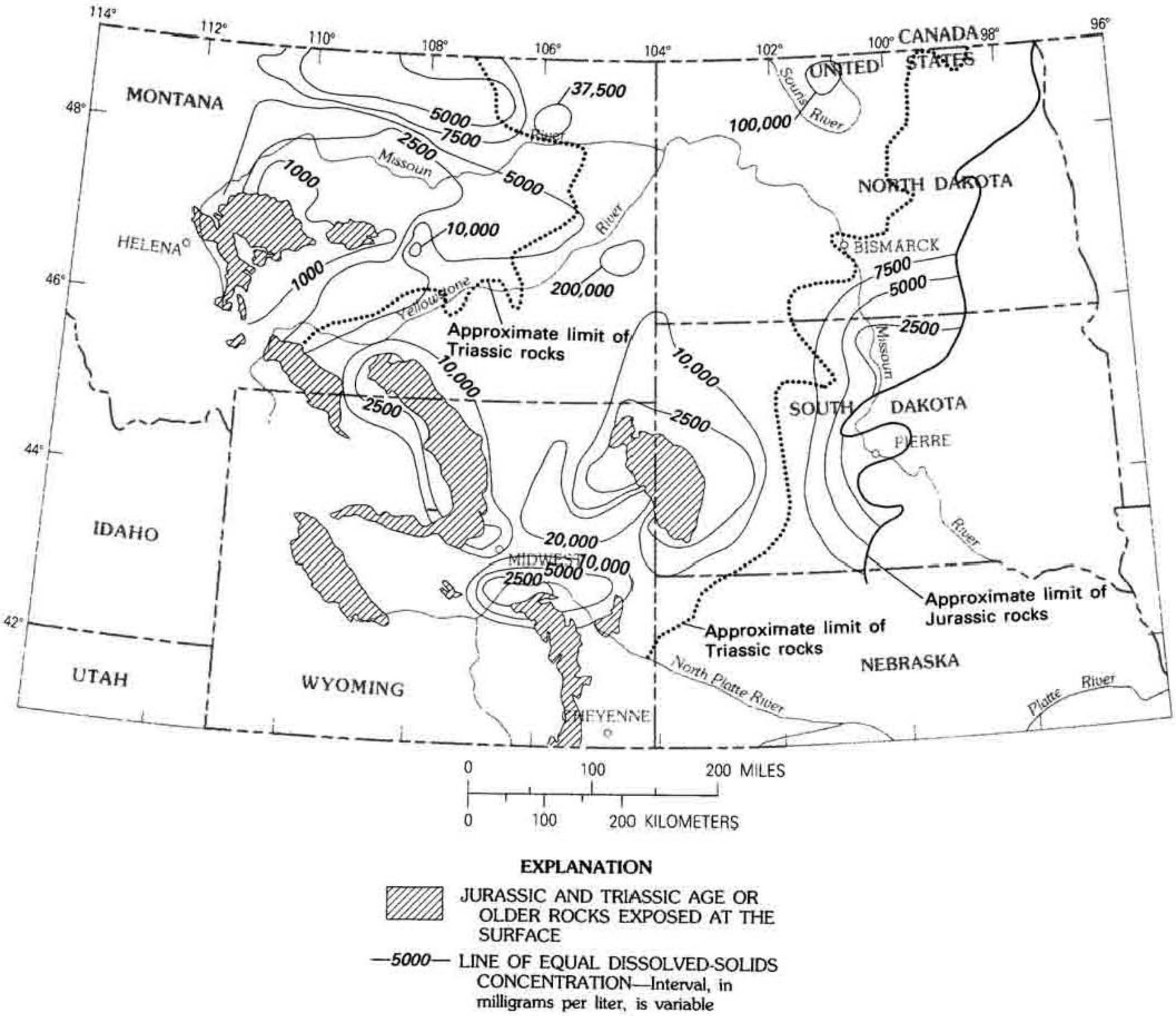


FIGURE 38.—Concentration of dissolved solids in water from the Triassic and Jurassic formations. From J. F. Busby (written commun., 1981).

Figure H-8. Figure 39 of USGS Professional Paper 1402-E

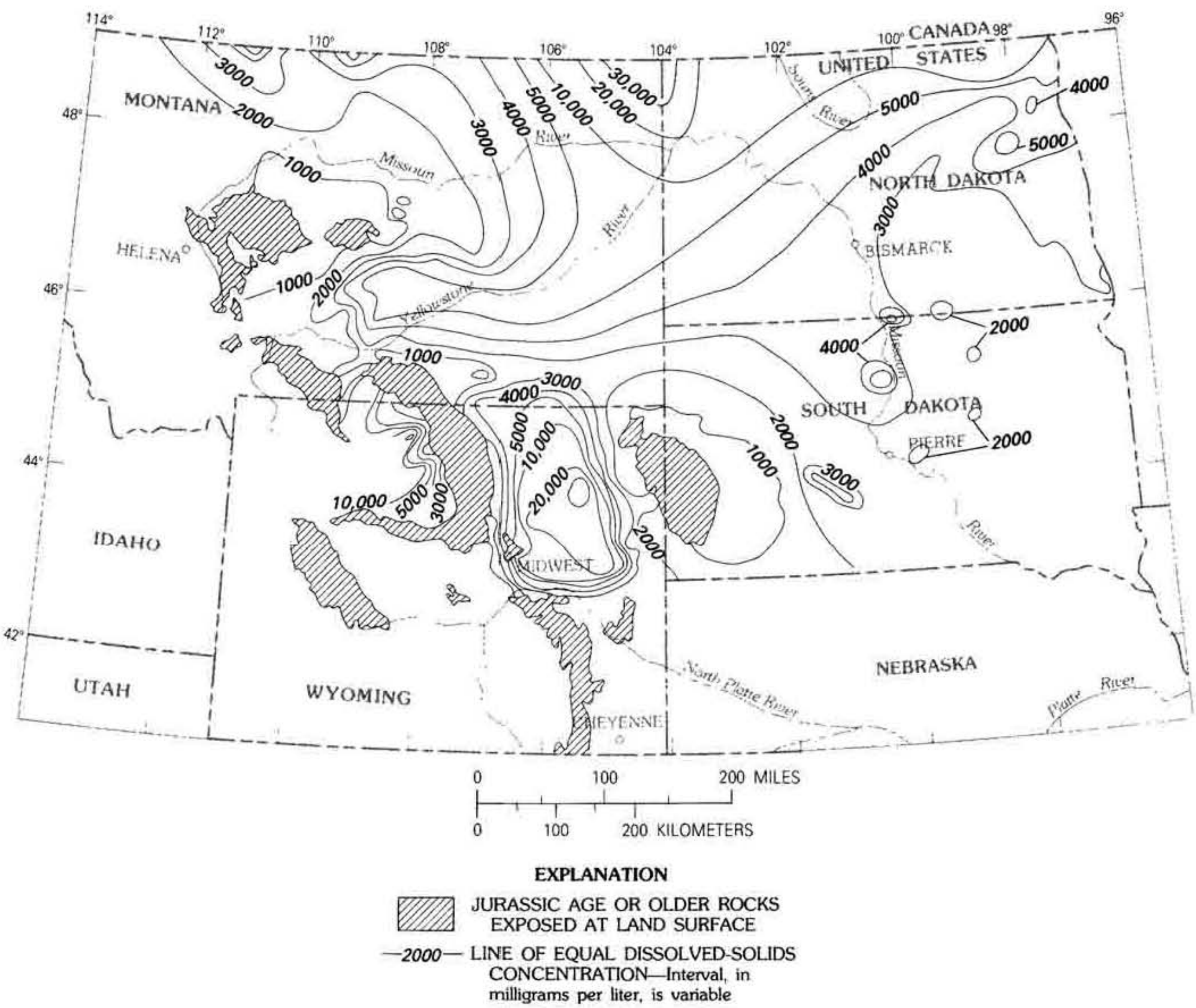
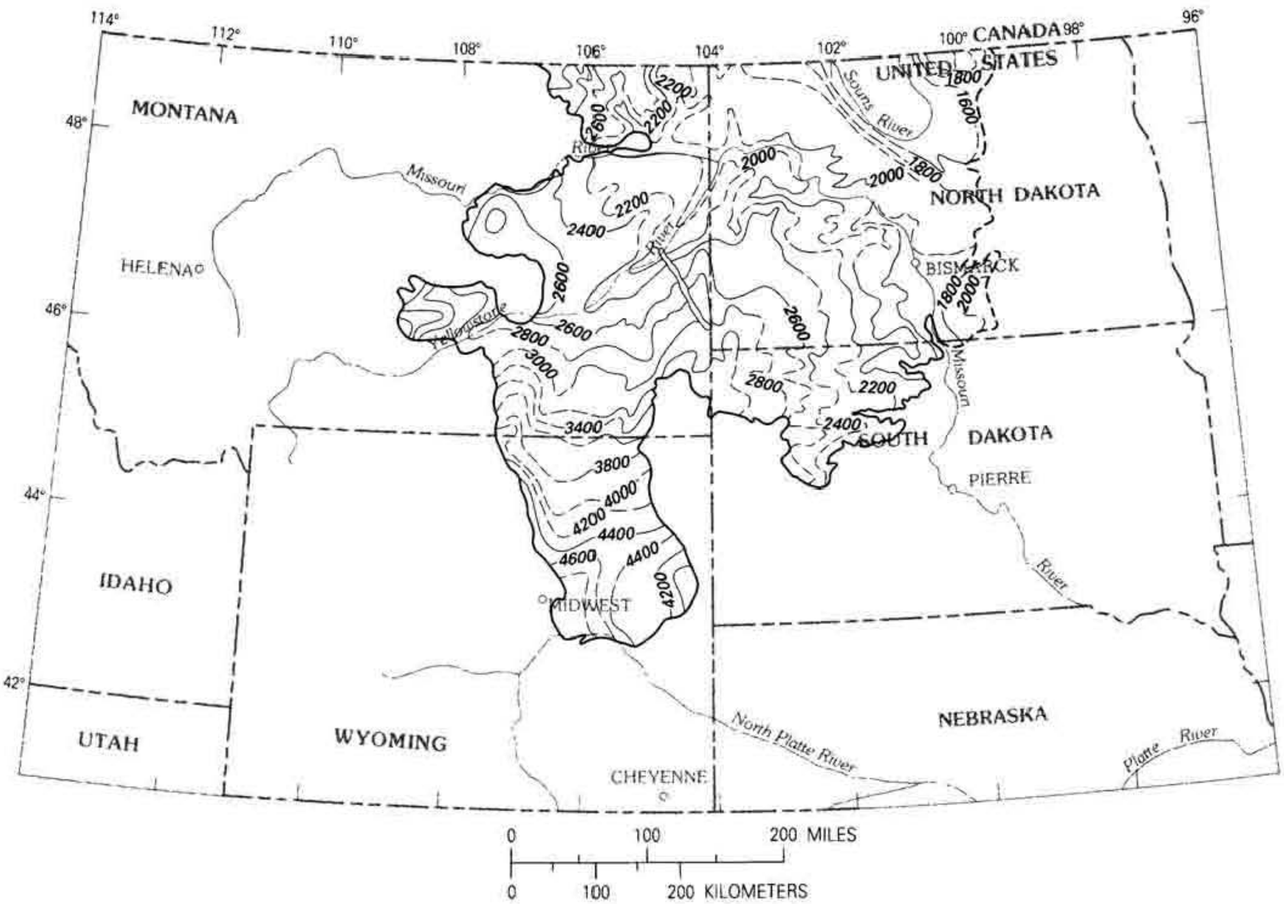


FIGURE 39.—Concentration of dissolved solids in water from the Lower Cretaceous aquifer. Modified from K. D. Peter (written commun., 1982).

Figure H-9. Figure 41 of USGS Professional Paper 1402-E



EXPLANATION

—1600 - - POTENTIOMETRIC CONTOUR—Shows altitude of potentiometric surface. Dashed where no data are available. Interval 200 feet. National Geodetic Vertical Datum of 1929

——— - - - LIMIT OF FOX HILLS SANDSTONE (LATE CRETACEOUS AGE)—Dashed where inferred

FIGURE 41.—Potentiometric surface of the Upper Cretaceous aquifer. From D. H. Lobmeyer (written commun., 1982).

Figure H-10. Figure 51 of USGS Professional Paper 1402-E

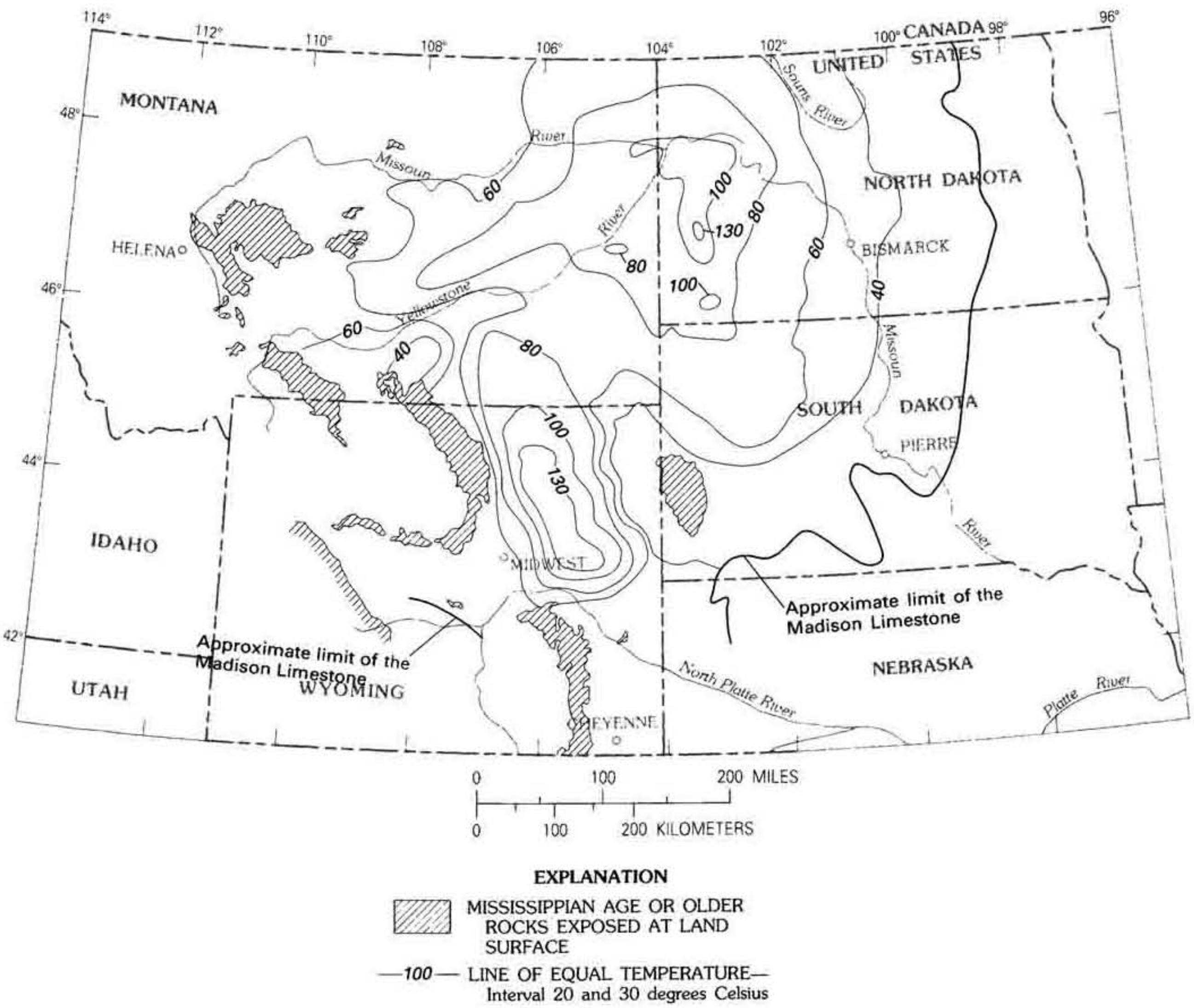


FIGURE 51.—Water temperatures in the Madison aquifer. Modified from MacCary (1981) and Head, Kilty, and Knottek (1979).

Figure H-11. Figure 52 of USGS Professional Paper 1402-E

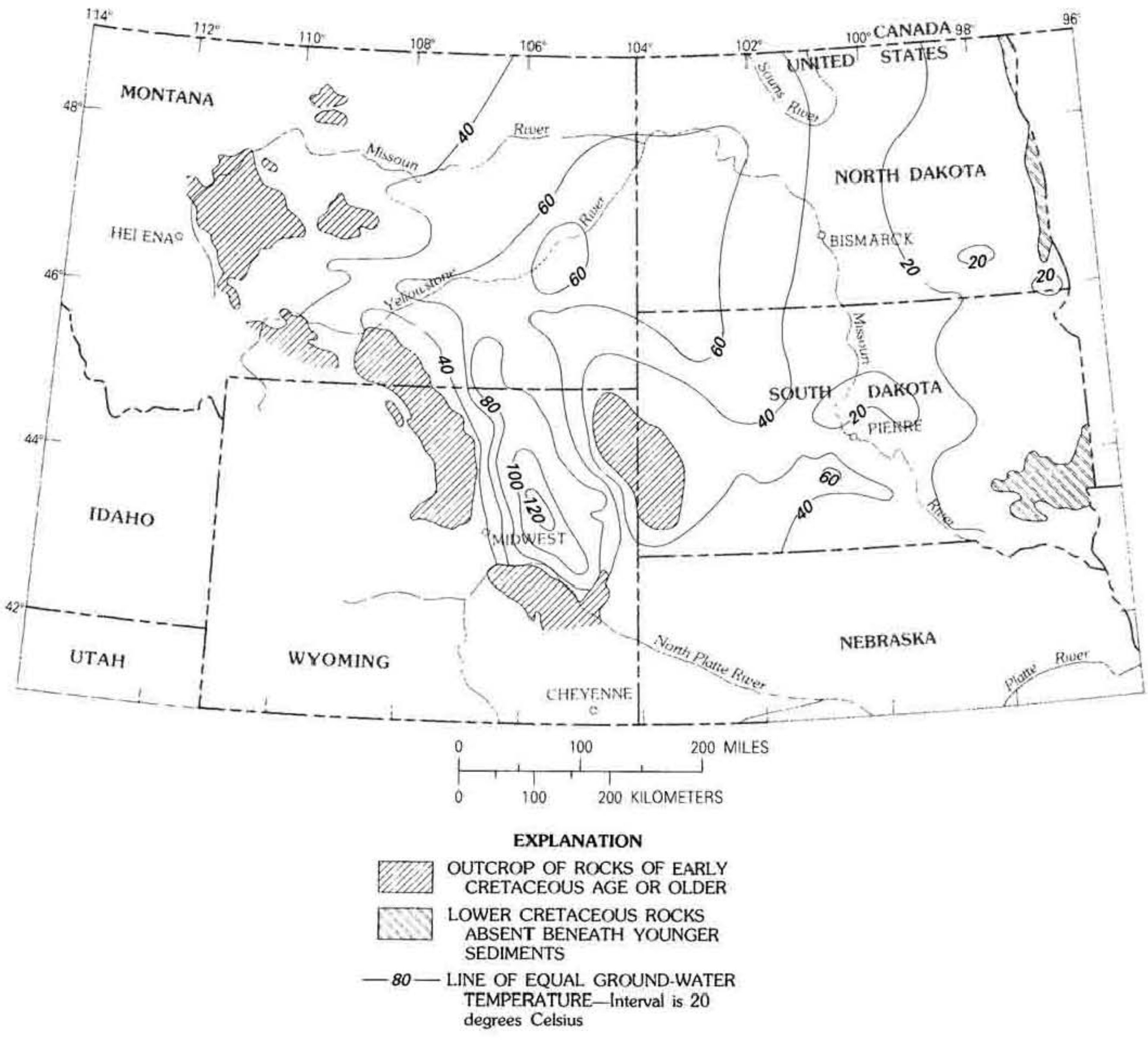


FIGURE 52.—Water temperatures in the Lower Cretaceous aquifer. Modified from D. H. Lobmeyer (written commun., 1982).

Figure H-12. Figure 53 of USGS Professional Paper 1402-E

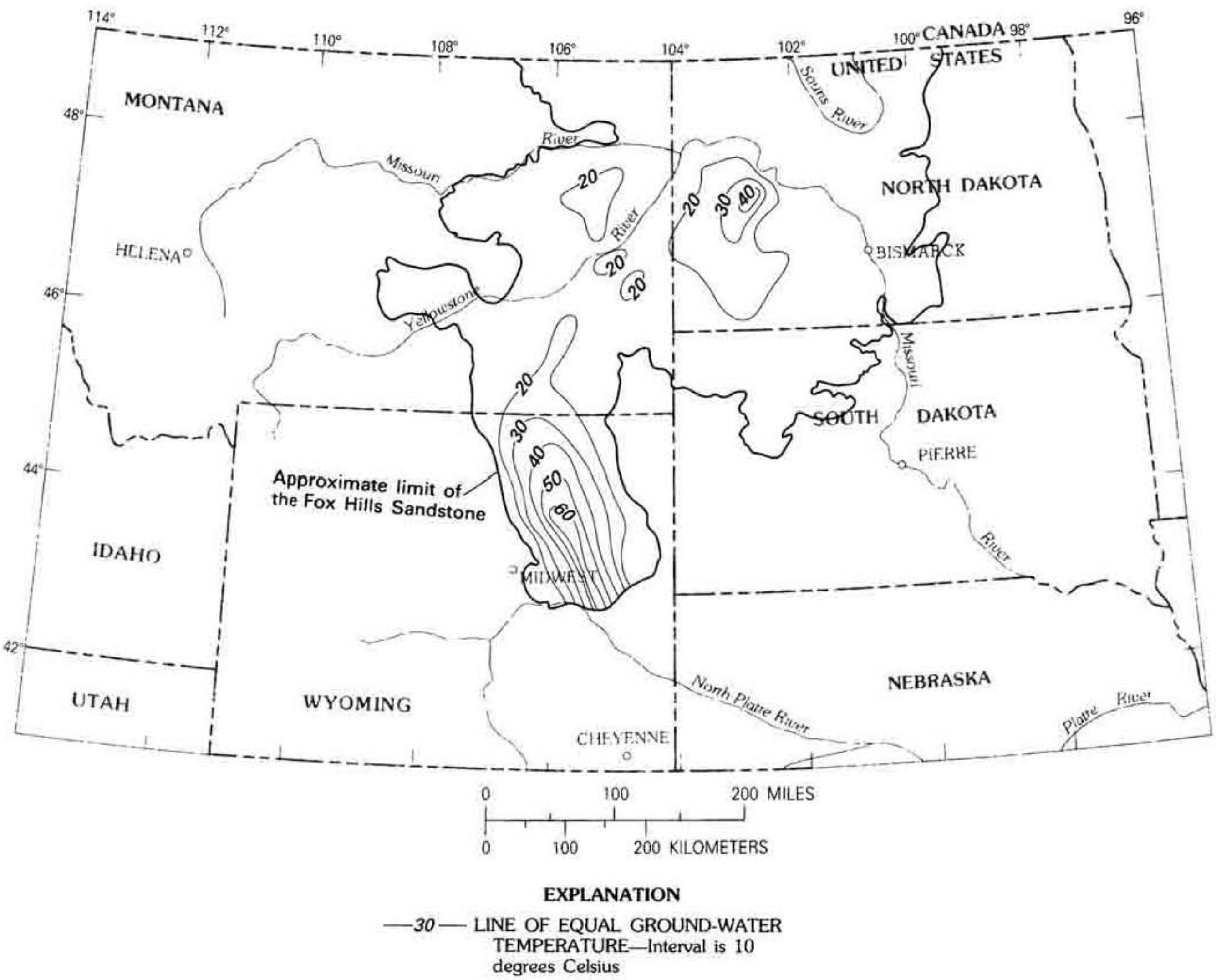


FIGURE 53.—Water temperatures in the Upper Cretaceous aquifer. Modified from D. H. Lobmeyer (written commun., 1982).

Figure H-13. Figures 32 and 33 of USGS Professional Paper 1273-G

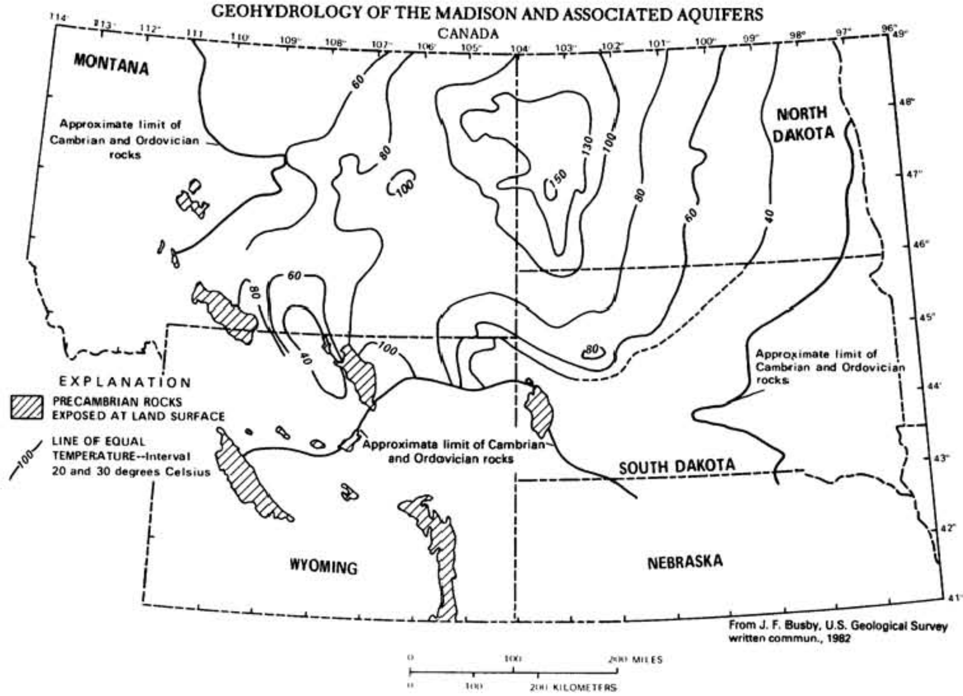


FIGURE 32. – Water temperture in the Cambrian-Ordovician aquifer.

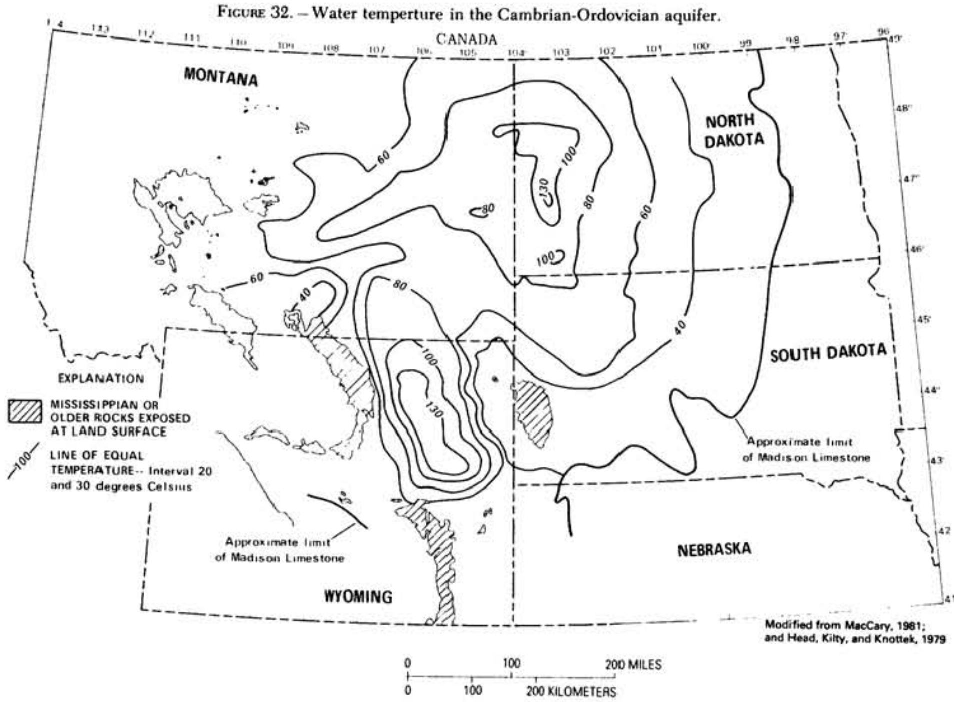


FIGURE 33. – Water temperature in the Madison aquifer.

Figure H-14. Figure 63 of USGS Professional Paper 1402-F

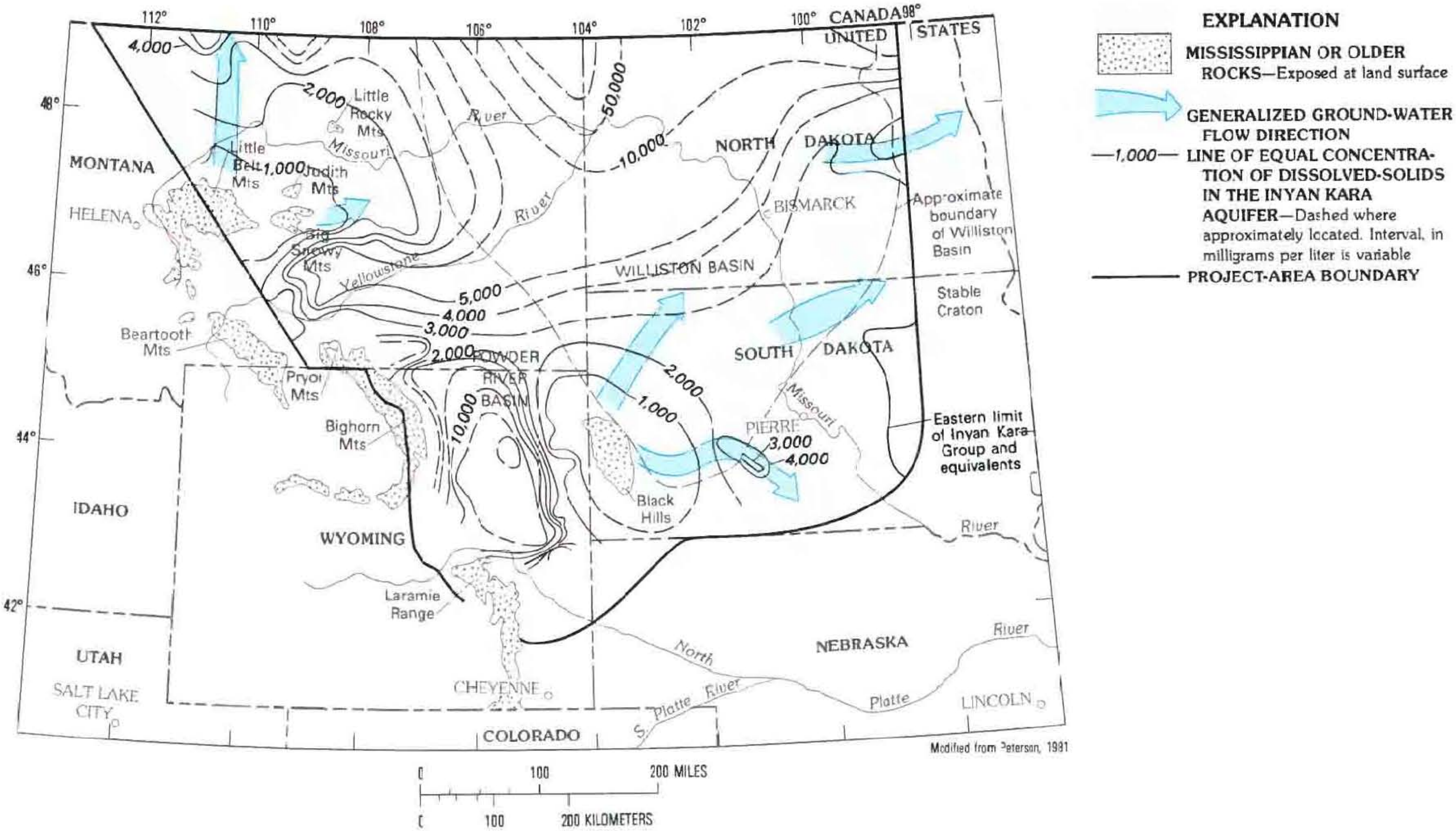


FIGURE 63.—Concentration of dissolved solids in water from the Inyan Kara aquifer in the northern Great Plains.

Attachment I. UIC 98-092 Permit

The enclosed CD includes an electronic copy of the UIC 98-092 permit in PDF format. Separate files are provided for each section and attachment of the UIC 98-092 permit and these are listed under generally self-explanatory files names. The following files are included on the CD:

Application-Maps.pdf	Includes the permit application form and associated maps.
Table-of-Contents.pdf	Includes the table of contents for the permit document.
Sec-1.pdf	Includes Section 1 of the permit document.
Sec-2.pdf	Includes Section 2 of the permit document.
Sec-3.pdf	Includes Section 3 of the permit document.
Sec-4.pdf	Includes Section 4 of the permit document.
Sec-5.pdf	Includes Section 5 of the permit document.
Sec-6.pdf	Includes Section 6 of the permit document.
Sec-7.pdf	Includes Section 7 of the permit document.
Sec-8.pdf	Includes Section 8 of the permit document.
Sec-9.pdf	Includes Section 9 of the permit document.
Sec-10.pdf	Includes Section 10 of the permit document.
Sec-11.pdf	Includes Section 11 of the permit document.
Sec-12.pdf	Includes Section 12 of the permit document.
Sec-13.pdf	Includes Section 13 of the permit document.
Attach-A.pdf	Includes Attachment A of the permit document.
Attach-B.pdf	Includes Attachment B of the permit document.
Attach-C.pdf	Includes Attachment C of the permit document.
Attach-D.pdf	Includes Attachment D of the permit document.
Attach-E.pdf	Includes Attachment E of the permit document.

Attachment II. Permit Transfer Documents and Financial Form

List of Attachment II Documents

Document II-1. Permit Transfer Application

UNDERGROUND INJECTION CONTROL PERMIT TRANSFER APPLICATION
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION

PART I (To be completed by current operator)

As present operator, Power Resources, Inc. (name) hereby applies to the Administrator to transfer operation of the facility or facilities authorized under UIC Permit # UIC 98-092

Stephen P. Collings
Printed name of person signing

Stephen P. Collings
Signature

President
Title

3-26-2008
Date

PART II (To be completed by proposed operator)

As proposed transferee, Strathmore Resources US Ltd, A Nevada Corporation 2420 Watt Ct, Riverton, WY 82501 (name and address) agrees to be bound by all of the terms and conditions of the permit described above. (In addition, for Class I facilities the potential transferee must complete the second page of this form to show financial responsibility). If this permit is presently out of compliance, the proposed transferee agrees to bring the operation into compliance according to the (schedule, agreement, letter, notice) attached and dated__/__/__

David Miller
Printed name of person signing

[signature]
Signed

CEO
Title

4/21/08
Date

APPROVAL FOR TRANSFER OF PERMIT

This transfer is approved effective on the later of the two dates below:

[signature]
Administrator/Water Quality Division

5/1/08
Date

[signature]
Director/Department of Environmental Quality

5/2/08
Date

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Document II-2. Permit Transfer Application (continued)

FINANCIAL RESPONSIBILITY REQUIREMENTS FOR TRANSFER OF CLASS I WELLS

PART III (To be completed by the company assuming responsibility)

NAME OF FACILITY Reno Creek Uranium Project

LOCATION (T, R, ¼ ¼ SEC, COUNTY) NW/4NE/4 Sec. 29-T43N, R73W
SW/4SE/4 Sec. 31-T43N, R73W

PERMIT NUMBER UIC 98-092

OPERATOR'S NAME AND ADDRESS STRATHMORE RESOURCES (US) LTD.
2420 WATT CT, RIVERTON, WY 82501

CERTIFICATION OF FINANCIAL RESPONSIBILITY

The above named operator(s) has adequate financial resources for dealing with the above identified UIC discharge (injection) well(s) and system(s) which either may be improperly abandoned or may otherwise cause pollution and contamination of groundwater sources, and with incomplete or inadequate groundwater pollution reduction or elimination.

Submitted with this document, as proof of adequate financial resources is (check and submit one of the following):

(✓) A copy of the latest annual corporation report to the Wyoming Secretary of State which shows nature and value of assets and copies or relevant instruments or statements which show liabilities, and accounts and goods as collateral; or

(✓) Balance sheet showing assets and liabilities, operator's equity and statements of operations for the most recent three years; or

( ) A surety bond or similar financial instrument in the amount determined by the Administrator.

SIGNATORIES REQUIREMENT FOR CERTIFICATION OF FINANCIAL RESPONSIBILITY

The certification shall be signed as follows:

For a corporation - by a principal executive officer of at least the level of vice-president.

For a partnership or sole proprietorship - by a general partner or the proprietor, respectively.

For a municipality, State, Federal, or other public agency - by either a principal executive officer or ranking elected official.

I certify under 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 possibility of fine and imprisonment.

David Miller — Printed name of person signing

CEO — Title

[signature] — Signature

4/21/08 — Date

Page 2

REV 13JAN2006 FORM UIC-4

Document II-3. Permit Bill of Sale

BILL OF SALE

Power Resources, Inc., a Wyoming Corporation, who's address is 141 Union Boulevard, Suite 330, Lakewood, Colorado 80228 ("Seller"), in consideration of $25,000.00 paid on behalf of AUC LLC* by ***American Uranium Corporation***, a Nevada Corporation, whose address is 600 17th Street, Suite 2800 South, Denver, Colorado 80202 ("Purchaser"), does hereby assign its Wyoming Department of Environmental Quality (WDEQ) Underground Injection Control Permit Number UIC 98-092 for Class I Injection Wells, dated June 4, 1998 (Attachment A).

The assignment of the Permit is made "as is" and done in accordance with the procedure required by WDEQ using the WDEQ "Underground Injection Control Permit Transfer Application" (Attachment B).

It is the sole responsibility of AUC LLC to timely file the renewal application and obtain the Permit extension. If for any reason AUC LLC's renewal of the Permit is not successful, it is agreed that the $25,000.00 is not refundable.

Please acknowledge that you are in agreement with these terms by counter-signing this Bill of Sale.

IN WITNESS WHEREOF, Seller and Purchaser have executed this Bill of Sale the ____ of April, 2008.

Power Resources, Inc.	American Uranium Corporation
By: William C Salisbury	By: Robert A Rich
Name: William C. Salisbury	Name: ROBERT A. RICH
Title: Director, Land & Evaluation	Title: PRESIDENT

**Note*: *AUC LLC is a Delaware Corporation with the following address: 2420 Watt Court, Riverton, WY 82501*