

TABLE OF CONTENTS – Detailed (continued)

MINE PERMIT VOLUME 2 of 5: Appendix D - Main Permit Area (D1 to D5) continued

D5	Geology.....	D5-1
D5.1	Regional Geology	D5-1
D5.1.1	Stratigraphy.....	D5-1
D5.1.2	Structure.....	D5-2
D5.2	Site Geology.....	D5-2
D5.2.1	Stratigraphy.....	D5-3
D5.2.2	Structure.....	D5-5
D5.2.3	Ore Mineralogy and Geochemistry.....	D5-6
D5.2.4	Exploration and Production Activities.....	D5-7
D5.2.4.1	Uranium	D5-7
D5.2.4.2	Other Minerals	D5-9
D5.3	Seismology.....	D5-9
D5.3.1	Historic Seismicity.....	D5-10
D5.3.1.1	Town of Bairoil Area	D5-10
D5.3.1.2	City of Rawlins Area	D5-10
D5.3.1.3	City of Rock Springs Area.....	D5-11
D5.3.1.4	City of Lander Area	D5-12
D5.3.1.5	City of Casper Area	D5-13
D5.3.2	Uniform Building Code	D5-13
D5.3.3	Deterministic Analysis of Active Fault Systems	D5-14
D5.3.4	Maximum Tectonic Province Earthquake “Floating Earthquake” Seismogenic Source	D5-15
D5.3.5	Short-Term Probabilistic Seismic Hazard Analysis	D5-15

MINE PERMIT VOLUME 3a of 5: Appendix D - Main Permit Area (D6)

D6	Hydrology	D6-1
D6.1	Surface Water.....	D6-1
D6.1.1	Drainage Characteristics	D6-1
D6.1.2	Surface Water Use	D6-3
D6.1.3	Surface Water Quality.....	D6-4
D6.2	Groundwater Occurrence.....	D6-6
D6.2.1	Regional Hydrogeology.....	D6-6
D6.2.1.1	Lewis Shale.....	D6-8
D6.2.1.2	Fox Hills Formation.....	D6-8
D6.2.1.3	Lance Formation	D6-8
D6.2.1.4	Fort Union Formation	D6-9
D6.2.1.5	Battle Spring Formation- Wasatch Formation.....	D6-9
D6.2.1.6	Undifferentiated Tertiary and Quaternary Sediments.....	D6-10

TABLE OF CONTENTS – Detailed (continued)

MINE PERMIT VOLUME 3a of 5: Appendix D - Main Permit Area (D6) continued

D6.2.2	Site Hydrogeology	D6-11
D6.2.2.1	Hydrostratigraphic Units.....	D6-11
D6.2.2.2	Potentiometric Surface, Groundwater Flow Direction and Hydraulic Gradient.....	D6-14
D6.2.2.3	Aquifer Properties.....	D6-16
D6.3	Groundwater Use	D6-22
D6.4	Groundwater Quality	D6-24
D6.4.1	Regional Groundwater Quality	D6-24
D6.4.2	Site Groundwater Quality	D6-27
D6.4.2.1	Groundwater Monitoring Network and Parameters....	D6-27
D6.4.2.2	Groundwater Quality Sampling Results	D6-28
D6.5	Hydrologic Conceptual Model.....	D6-33
D6.5.1	Regional Groundwater Conceptual Model	D6-33
D6.5.2	Site Groundwater Conceptual Model.....	D6-34
D6.5.2.1	Hydrostratigraphic Units.....	D6-34
D6.5.2.2	Potentiometric Surface and Hydraulic Gradients	D6-35
D6.5.2.3	Aquifer Properties.....	D6-37
D6.5.2.4	Water Quality.....	D6-37
D6.5.2.5	Summary	D6-38

MINE PERMIT VOLUME 3b of 5: Appendix D - Main Permit Area (D6)

No Text - See List of Attachments

MINE PERMIT VOLUME 4 of 5: Appendix D - Main Permit Area (D7 to D11) and Appendix D - East and West Roads

D7	Soils.....	D7-1
D7.1	Introduction.....	D7-1
D7.2	Methods.....	D7-1
D7.2.1	Review of Existing Literature.....	D7-1
D7.2.2	Soil Survey.....	D7-2
D7.2.3	Field Sampling.....	D7-3
D7.2.4	Laboratory Analysis.....	D7-3
D7.3	Results and Discussion	D7-3
D7.3.1	General characteristics	D7-3
D7.3.2	Soil Mapping Unit Interpretation.....	D7-4
D7.4	Topsoil Suitability.....	D7-5
D7.5	Topsoil Protection.....	D7-5
D7.6	Geotechnical Investigations.....	D7-6
D7.7	Historical Surface Disturbances.....	D7-6

Lost Creek Project
WDEQ-LQD Permit to Mine Application
Original Dec07; Rev5 Nov09

TABLE OF CONTENTS – Detailed (continued)

FIGURES

MINE PERMIT VOLUME 1 of 5: Adjudication Files – No Figures

MINE PERMIT VOLUME 2 of 5: Appendix D - Main Permit Area (D1 to D5)

D1 Land Use

Figure D1-1a General Location of the Permit Area

Figure D1-1b Aerial Photo of the Permit Area

Figure D1-2 Land Ownership

Figure D1-3 BLM Grazing Allotments

Figure D1-4 Nuclear Fuel Cycle Facilities and Mines within 50 Miles

Figure D1-5 Regional Transportation Network

Figure D1-6 Significant Population Centers within 50 Miles

D3 Archaeological and Paleontological Resources

(separate volume – requesting WDEQ confidentiality)

D4 Meteorology, Climatology, and Air Quality

Figure D4-1 Meteorological Stations within 50 Miles of the Permit Area

Figure D4-2 Monthly Total Precipitation in the Project Region

Figure D4-3a to m Wind Speed and Wind Direction at the Lost Soldier
Meteorological Station

Figure D4-4 Tornado Statistics by County

Figure D4-5 Air Particulate Sampling Locations

Figure D4-6 Passive Radiological Sampling Locations

D5 Geology

Figure D5-1 Regional Geologic Map

Figure D5-2a Geologic Cross Section Schematic of the Permit Area

Figure D5-2b General Stratigraphy of the Upper Battle Spring Formation

Figure D5-2c Stratigraphic Illustration of Battle Spring Aquifers and
Aquicludes

Figure D5-3 Historical Seismic Activities in Wyoming

Figure D5-4 UBC Seismic Zones

Figure D5-5 Active Fault Systems in the Vicinity of the Permit Area

Figure D5-6 500-Year Probabilistic Acceleration Map of Wyoming

TABLE OF CONTENTS – Detailed (continued)

PLATES

MINE PERMIT VOLUME 1 of 5: Adjudication Files

- Appendix A Surface and Mineral Rights within the Lost Creek Permit Area
 - Plate A-1 Surface Owners of Record within Lost Creek Permit Area
 - Plate A-2 Uranium Mineral Owners of Record within Lost Creek Permit Area
 - Plate A-3 Oil and Gas Mineral Owners of Record within Lost Creek Permit Area
- Appendix B Surface and Mineral Rights Adjacent to the Lost Creek Permit Area
 - Plate B-1 Surface Owners of Record within Half Mile Outside Permit Boundary
 - Plate B-2 Uranium Mineral Owners of Record within Half Mile Outside Permit Boundary
 - Plate B-3 Oil and Gas Mineral Owners of Record within Half Mile Outside Permit Boundary
- Appendix C Tabulation of Lands
 - Plate C-1 Legal Land Description
- Appendix E Right of Ways
 - Plate E-1 Location and Access

MINE PERMIT VOLUME 2 of 5: Appendix D - Main Permit Area (D1 to D5)

- D1 Land Use - No Plates
- D2 Brief History - No Plates
- D3 Archeological and Paleontological Resources - No Plates
- D4 Meteorology, Climatology, and Air Quality - No Plates
- D5 Geology
 - Plate D5-1a Geologic Cross Section A-A'
 - Plate D5-1b Geologic Cross Section B-C
 - Plate D5-1c Geologic Cross Section C-D
 - Plate D5-1d Geologic Cross Section D-E
 - Plate D5-1e Geologic Cross Sections F-F'
 - Plate D5-1f Geologic Cross Sections G-G'
 - Plate D5-1g Geologic Cross Sections H-H'
 - Plate D5-2a Lost Creek Shale Isopach Map
 - Plate D5-2b HJ Sand Isopach Map

TABLE OF CONTENTS – Detailed (continued)

PLATES (continued)

MINE PERMIT VOLUME 2 of 5: Appendix D - Main Permit Area (D1 to D5) (continued)

- D5 Geology
 Plate D5-2c Sagebrush Shale Isopach Map
 Plate D5-2d UKM Sand Isopach Map
 Plate D5-3 General Location Map - Geology

MINE PERMIT VOLUME 3a of 5: Appendix D - Main Permit Area (D6)

- D6 Hydrology
 Plate D6-1a Groundwater Permits within One-Half Mile of the Permit Area
 Plate D6-1b Groundwater Permits within Three Miles of the Permit Area

MINE PERMIT VOLUME 3b of 5: Appendix D - Main Permit Area (D6)

No Plates - See List of Attachments

MINE PERMIT VOLUME 4 of 5: Appendix D - Main Permit Area (D7 to D9) and Appendix D - East and West Roads

- D7 Soils
 Plate D7-1 Soil Survey Mapping Units
D8 Vegetation
 Plate D8-1 Vegetation
D9 Wildlife – No plates
D10 Background Radiological Characteristics - No Plates
D1 Wetlands - No Plates

MINE PERMIT VOLUME 5 of 5: Operations Plan and Reclamation Plan

- OP Operations Plan
 Plate OP-1 Site Layout
 Plate OP-2 Plant and Shop Detail
RP Groundwater Quality Restoration and Surface Reclamation
 No Plates

MINE UNIT VOLUMES - Separate Submittals

Notes on the Well Completion Logs in Attachment D6-3 (Page 1 of 2)

Well Completion:

For several wells, the log indicates there is an open hole (or 'rat hole') between the bottom of the screen and the total drilled depth (TD). If there is no record of the rat-hole having been backfilled, it can be assumed the hole below the screen is either open or caved naturally. As long as the TD is still within the target sand for the screened interval, the presence of an open or partially caved 'rat hole' is not of concern.

For a drill hole or well, the TD that is recorded in the LC ISR, LLC database is the total depth penetrated by the driller when drilling the 'pilot' hole and as recorded on the log header. At the time some of the wells were installed, the field geologists thought that the screen liner had to be landed *right on* the hole bottom. Therefore, it was common for the drillers, just prior to underreaming and screening, to clean out the hole to a depth a few feet deeper than the original TD (but still within the target sand), in case there was any caving into the hole. This results in a discrepancy regarding TD in some holes. The following table provides additional information on the discrepancies.

WELL #	Total Depth shown on the Well Completion Log (feet below surface)	True Total Depth (feet below surface)
HJMP-105	460	465
HJMU-101	535	539
HJMU-104	550	552
HJMU-107	855	Backplugged with grout 580-855
UKMO-101	488	490
UKMO-103	438	439
UKMP-101	575	577

In one of the DE wells (MB-1), the drilling may have penetrated the EF shale below the DE Sand. However, the EF shale is not a true confining shale because it splits in several areas. As is discussed elsewhere and illustrated in Cross Sections F-F', G-G' and H-H' (Plates D5-1e through D5-1g), the EF aquitard represents not a single ubiquitous shale, but a shaly, low permeability sequence which may contain multiple overlapping shales. In MB-01, the portion of the EF shale penetrated by the drill hole is underlain by an associated shaly interval which can be observed at depths of 307'-317' in the log for well MB-04. This shaly interval is associated with the EF aquitard sequence and serves as a supplementary overlying aquitard at the top of the FG Horizon.

Notes on the Well Completion Logs in Attachment D6-3 (Page 2 of 2)

Well Development:

All monitor wells were airlifted with the drill rig after placement of the screen. No additional efforts were made to develop wells with poor yield from airlifting for the following reasons:

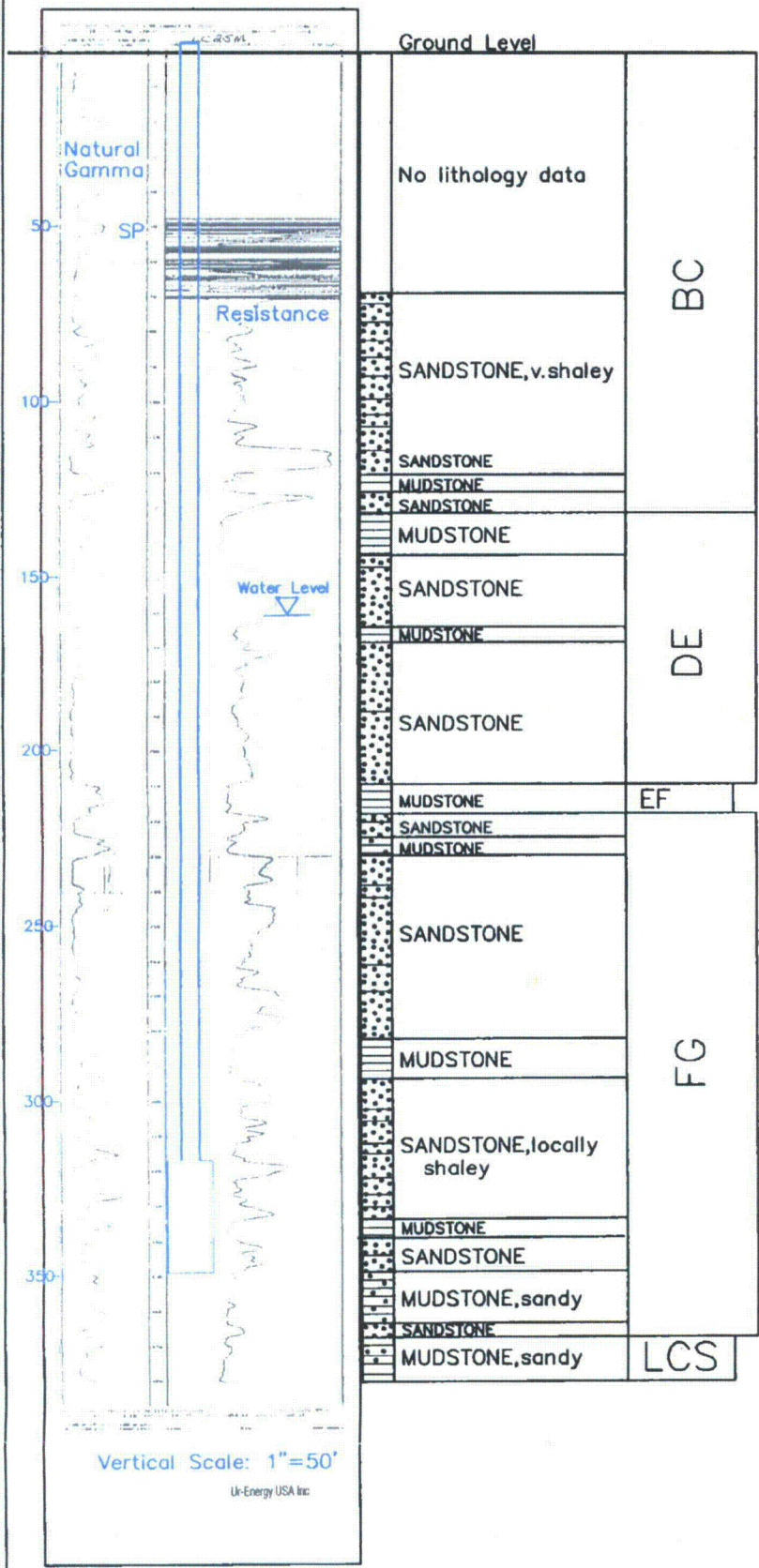
- Wells such as HJT-106, MB-7, MB-10 barely penetrated the static water table. Therefore, additional efforts to produce more water from these wells would be unproductive.
- Some wells are completed in shaly sands and therefore are expected to not yield additional flow.
- Some wells produced flow rates which were low, yet sufficient for the intended purposes.

Before sampling, each monitor well was swabbed to provide further development. Finally, wells were purged of at least three casing volume prior to collecting a baseline sample.

LC25M

LC25M

Lost Creek ISR, LLC
WELL COMPLETION REPORT



WELL # LC25M SEO # 175264 Date Drilled: 9-19-06

Location: E 743,397 / N 534,601 (NAD 27)

Ground Elev: 6935.00 Measure Point Elev: 6936.52

TD: 380 ft. Hole Dia.: 7-7/8"

CASED to: 316' Casing: PVC SDR17 ID: 4.5" OD: 5"

GROUT: Portland Cement – Type I/II
Pumped thru casing, displaced to surface with water

COMPLETION Aquifer: LFG Sand
Static Water Level: Depth 161' Elev: 6775' (avg.)

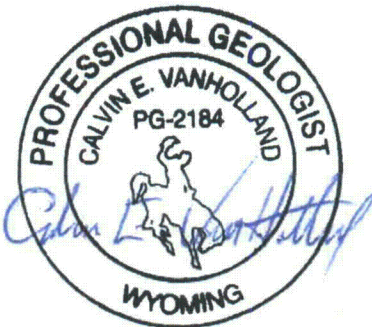
UNDERREAM: Blade Dia: 10-1/2"
Intervals: from 316' to 349' / length 33'
from _____ to _____ / length _____

OPEN-HOLE COMPLETION				
Description	Depth		Elev.	
	From	To	From	To
K-packer	N/A			
Open-hole	316'	349'	6620'	6587'

SCREEN SPECIFICATIONS:
Slot: _____ Composition N/A

FILTER PACKING:
Volume: _____ (bags)(ft³) Sand Specs. _____
Method: N/A

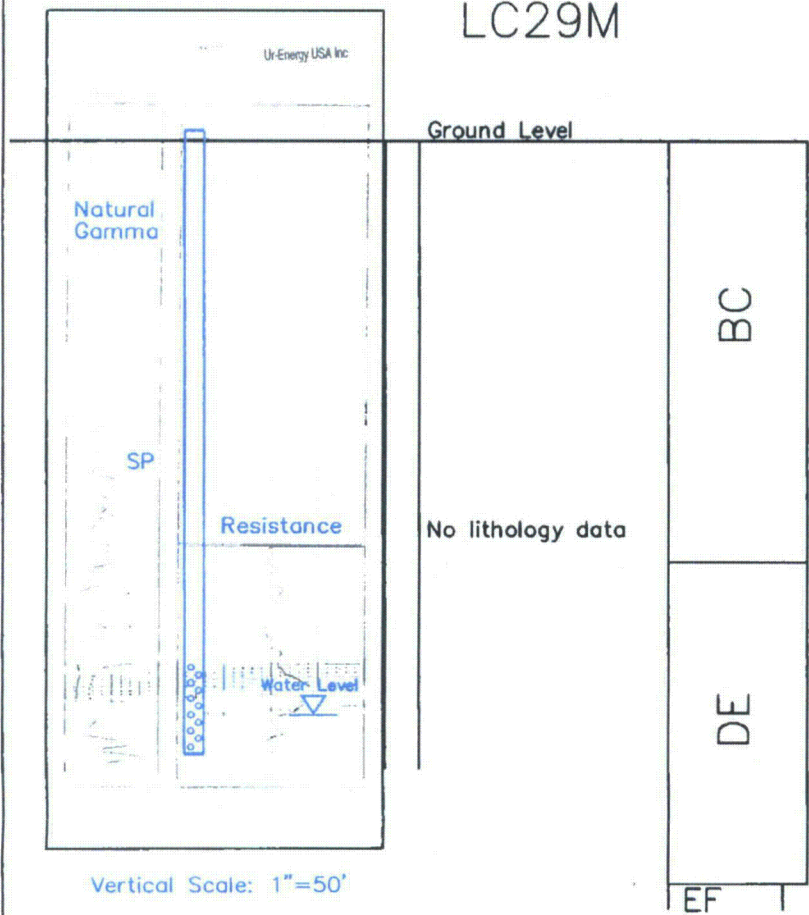
WELL STIMULATION: Method Airlift
Yield: Good / Moderate / Poor



LC25M

LC29M

Lost Creek ISR, LLC
WELL COMPLETION REPORT



WELL # LC29M SEO # 175260 Date Drilled: 8-30-06

Location: E 744,547 / N 534,837 (NAD 27)

Ground Elev: 6935.8' Measure Point Elev: 6937.55'

TD: 171 ft. Hole Dia.: 7-7/8"

CASED to: 140' Casing: PVC SDR17 ID: 4.5" OD: 5"

GROUT: Portland Cement – Type I/II
Pumped thru casing, displaced to surface with water

COMPLETION Aquifer: DE Sand
Static Water Level: Depth 155' Elev: 6783' (avg.)

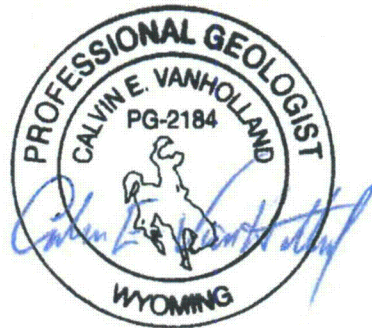
UNDERREAM: Blade Dia: N/A
Intervals: from _____ to _____ / length _____
from _____ to _____ / length _____

Description	Depth		Elev.		Length
	From	To	From	To	
<u>Perf. Casing</u>	<u>140'</u>	<u>164'</u>	<u>6796'</u>	<u>6772'</u>	<u>24'</u>
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

SCREEN SPECIFICATIONS:
Slot: _____ Composition N/A

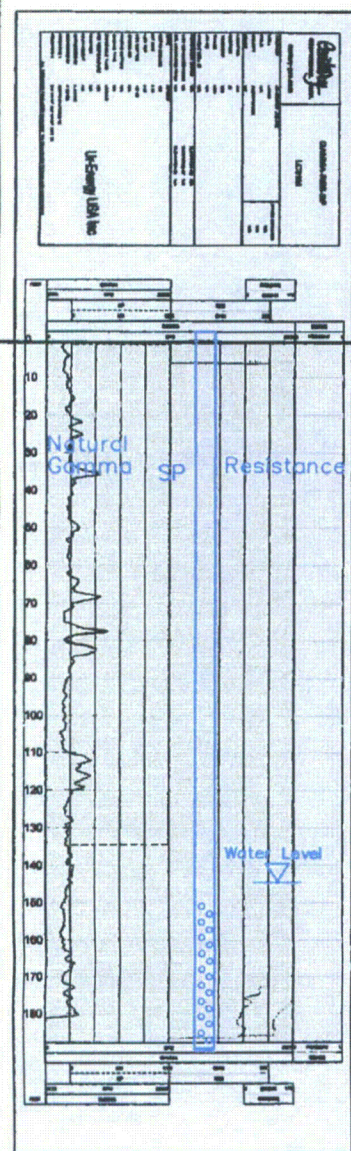
FILTER PACKING:
Volume: _____ (bags)(ft³) Sand Specs. _____
Method: N/A

WELL STIMULATION: Method Airlift
Yield: Good / Moderate / Poor



LC29M

LC31M



LC31M

Ground Level

No lithology data

BC

DE

EF

Lost Creek ISR, LLC

WELL COMPLETION REPORT

WELL # LC31M SEO # 175268 Date Drilled: 9-19-06

Location: E 733,380 / N 524,434 (NAD 27)

Ground Elev: 6804.1' Measure Point Elev: 6806.05'

TD: 191 ft. Hole Dia.: 7-7/8"

CASED to: 150' Casing: PVC SDR17 ID: 4.5" OD: 5"

GROUT: Portland Cement - Type I/II

Pumped thru casing, displaced to surface with water

COMPLETION Aquifer: DE Sand

Static Water Level: Depth 144' Elev: 6662' (avg.)

UNDERREAM: Blade Dia: N/A

Intervals: from to / length

from to / length

PERFORATED CASING COMPLETION:

Description	Depth		Elev.		Length
	From -	To	From -	To	
<u>Perf. Casing</u>	<u>150'</u>	<u>190'</u>	<u>6654'</u>	<u>6614'</u>	<u>40'</u>

SCREEN SPECIFICATIONS:

Slot: Composition N/A

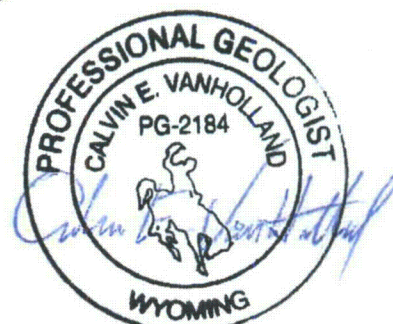
FILTER PACKING:

Volume: (bags)(ft³) Sand Specs.

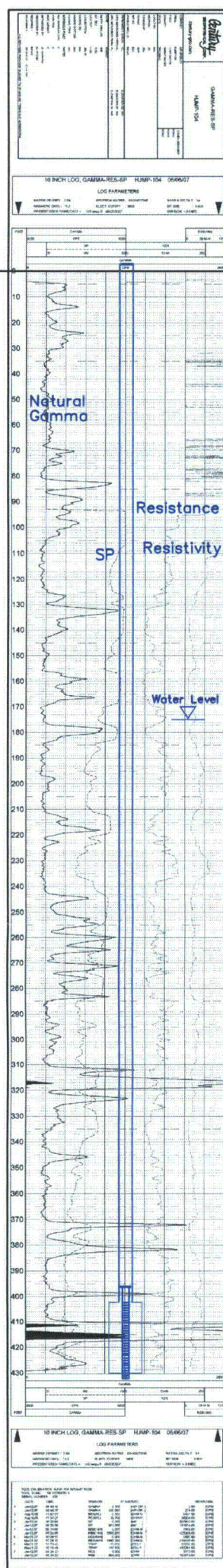
Method: N/A

WELL STIMULATION: Method Airlift

Yield: Good / Moderate / Poor



LC31M



Lost Creek ISR, LLC
WELL COMPLETION REPORT

WELL # HJMP-104 SEO # 179873 Date Drilled: 7-6-07

Location: E 742,886 / N 534,897 (NAD 27)

Ground Elev: 6939.04' Measure Point Elev: 6941.04'

TD: 432' Hole Dia.: 7-7/8"

CASED to: 402' Casing: PVC SDR17 ID: 4.5" OD: 5"

GROUT: Portland Cement – Type I/II
Pumped thru casing, displaced to surface with water

COMPLETION Aquifer: HJ Sand

Static Water Level: Depth 175' Elev: 6766' (avg.)

UNDERREAM: Blade Dia: 10.5"

Intervals: from 402' to 430' / length 28'
from _____ to _____ / length _____

SCREEN LINER ASSEMBLY

Description	Depth		Elev.		Length
	From	To	From	To	
K-packer		396'		6545'	
Screen	402'	432'	6539'	6509'	30'

SCREEN SPECIFICATIONS:

Slot: 0.030" Composition 3" PVC

FILTER PACKING:

Volume: _____ (bags)(ft³) Sand Specs. _____

Method: N/A

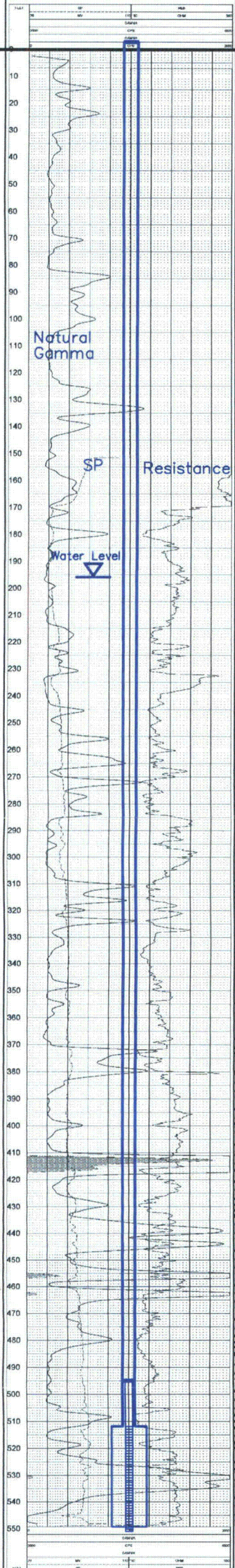
WELL STIMULATION: Method Airlift

Yield: Good / Moderate / Poor

HJMP-104

Company: **Century**
NAT GAMA-SP-RES
LOG NUMBER: **HJMU-104**
DATE: **08/07/07**

LOG PARAMETERS
WELL ID: **HJMU-104**
WELL TYPE: **W**
WELL STATUS: **1**
WELL DEPTH: **550**
WELL DIA: **7-7/8**
WELL Casing: **PVC SDR17**
WELL ID: **4.5**
WELL OD: **5**



NAT GAMA-SP-RES HJMU-104 08/07/07
LOG PARAMETERS
WELL ID: **HJMU-104**
WELL TYPE: **W**
WELL STATUS: **1**
WELL DEPTH: **550**
WELL DIA: **7-7/8**
WELL Casing: **PVC SDR17**
WELL ID: **4.5**
WELL OD: **5**

Depth	Gamma	SP
0	100	0
10	100	0
20	100	0
30	100	0
40	100	0
50	100	0
60	100	0
70	100	0
80	100	0
90	100	0
100	100	0
110	100	0
120	100	0
130	100	0
140	100	0
150	100	0
160	100	0
170	100	0
180	100	0
190	100	0
200	100	0
210	100	0
220	100	0
230	100	0
240	100	0
250	100	0
260	100	0
270	100	0
280	100	0
290	100	0
300	100	0
310	100	0
320	100	0
330	100	0
340	100	0
350	100	0
360	100	0
370	100	0
380	100	0
390	100	0
400	100	0
410	100	0
420	100	0
430	100	0
440	100	0
450	100	0
460	100	0
470	100	0
480	100	0
490	100	0
500	100	0
510	100	0
520	100	0
530	100	0
540	100	0
550	100	0

Vertical Scale: 1"=50'

HJMU-104

HJMU-104

Ground Level

No Lithology Log

MUDSTONE

SANDSTONE

MUDSTONE

SANDSTONE

MUDSTONE, sandy

SANDSTONE, shaley

MUDSTONE

SANDSTONE

MUDSTONE

SANDSTONE, shaley

MUDSTONE

SANDSTONE

MUDSTONE

SANDSTONE

MUDSTONE

SANDSTONE

MUDSTONE

SANDSTONE

BC

DE

EF

FG

ICS

HJ

SBS

KM

Lost Creek ISR, LLC

WELL COMPLETION REPORT

WELL # HJMU-104 SEO # 179872 Date Drilled: 8-7-07

Location: E 742891 / N 534907 (NAD 27)

Ground Elev: 6939.01' Measure Point Elev: 6940.51'

TD: 550' Hole Dia.: 7-7/8"

CASED to: 512' Casing: PVC SDR17 ID: 4.5" OD: 5"

GROUT: Portland Cement - Type I/II
Pumped thru casing, displaced to surface with water

COMPLETION Aquifer: UKM Sand

Static Water Level: Depth 196' Elev: 6745' (avg.)

UNDERREAM: Blade Dia: 10.5"

Intervals: from 512' to 550' / length 38'
from _____ to _____ / length _____

SCREEN LINER ASSEMBLY

Description	Depth	Elev.	Length
	From - To	From - To	
K-packer	495	6446'	
Screen	512' 552'	6429' 6389'	40'

SCREEN SPECIFICATIONS:

Slot: 0.030" Composition 3" PVC

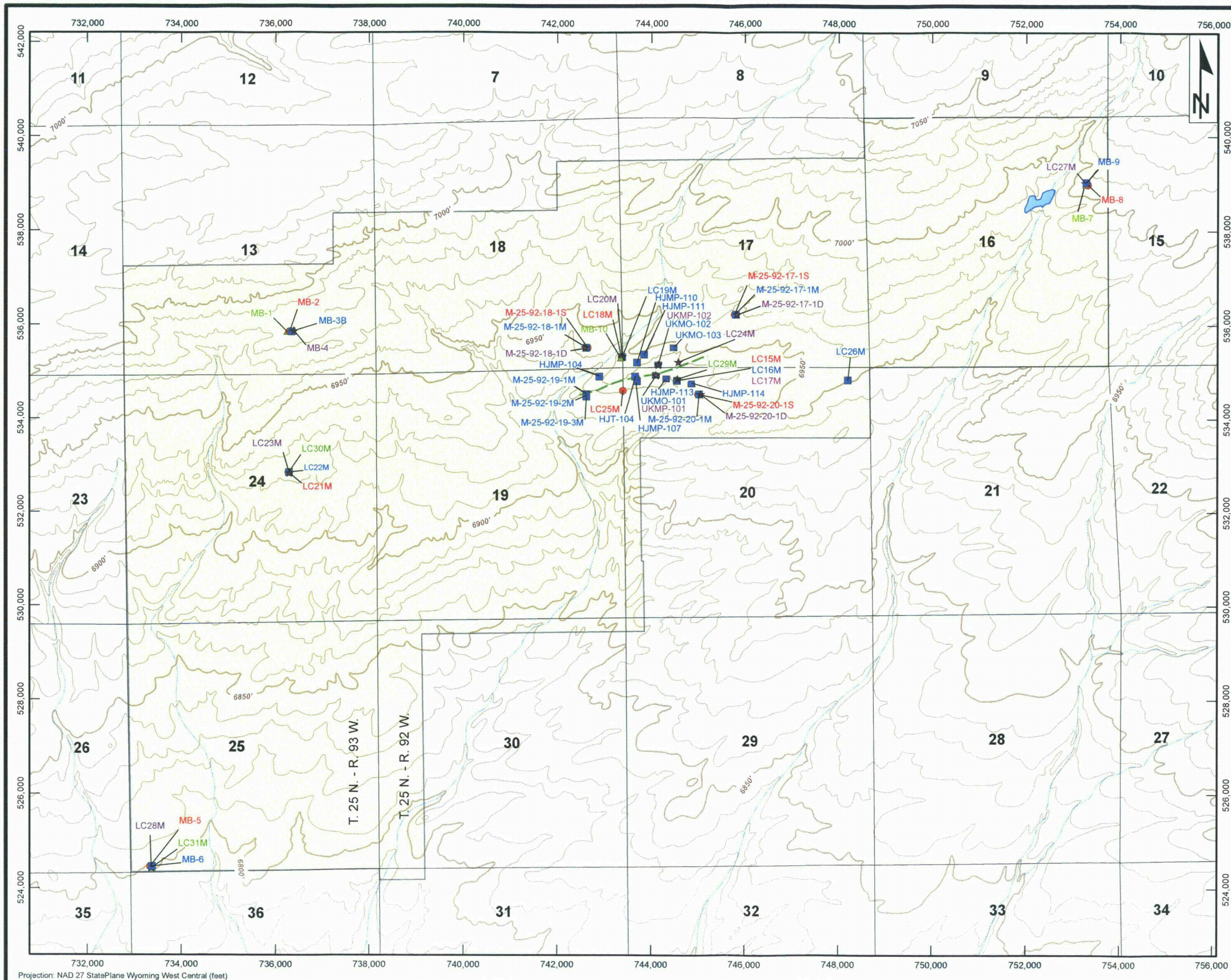
FILTER PACKING:

Volume: _____ (bags)(ft³) Sand Specs. _____

Method: N/A

WELL STIMULATION: Method Airlift

Yield: Good / Moderate / Poor



Legend

Monitor Wells

- ▲ DE Horizon
- LFG Horizon
- HJ Horizon
- ★ UKM Horizon
- Lost Creek Fault
- Lost Creek Permit Boundary

Notes:

- 1) Wells numbered as: 'M-Township-Range-Section-depth' (e.g., M-25-92-17-1S) were installed by Conoco-TexasGulf in the 1980s and subsequently abandoned.
- 2) All other wells shown on the map were installed as part of the Lost Creek Project for the LC16M and LC19M pump tests and baseline water quality sampling.
- 3) Plate D5-3 shows all the Lost Creek Project wells.

Scale: 1:24,000



Lost Creek ISR, LLC
Littleton, Colorado, USA

Petrotek www.petrotek.com
Littleton, CO USA

FIGURE D6-9 Location Map, Early Lost Creek Monitor Wells

Lost Creek Permit Area

Issued For: WDEQ-LQD 1.0 Drawn By: JM

Issued/ Revised: 04.06.09

Drawing No.: WDEQ_LQD_FIG_D6-9.mxd

0 2,000 4,000 Feet

TABLE OF CONTENTS

D11	Wetlands	D11-1
D11.1	Introduction	D11-1
D11.2	Methods	D11-1
D11.3	Results and Discussion	D11-2

FIGURES

- Figure D11-1 Potential Wetlands Delineated by the National Wetland Inventory
- Figure D11-2a Photos of Crooked Well Reservoir - April 2006
- Figure D11-2b Photos of Crooked Well Reservoir - April 2007
- Figure D11-2c Photos of Crooked Well Reservoir - April 2009
- Figure D11-3 Photos of Potential Wetland, per National Wetland Inventory, in T25N,
R93W, Section 24
- Figure D11-4 Photos of Potential Wetland, per National Wetland Inventory, T25N,
R92W, Section 21

D11 WETLANDS

D11.1 Introduction

The purpose of the wetland study is to evaluate the Permit Area for the presence of wetlands, and to describe cover and species compositions in any identified wetlands.

D11.2 Methods

Evaluation of potential wetland areas was initially conducted by reviewing aerial photographs of the Permit Area for topographic low areas and drainages. Other than the Crooked Well Reservoir, no potential wetland areas were identified from the aerial photographs. Three potential wetlands were identified using the GIS layers from the National Wetlands Inventory (NWI) database (National Wetlands Inventory, 2006) (**Figure D11-1**).

The potential wetland areas were visited in the field during the 2006 growing season and again in the spring of 2009. The sites were evaluated using the criteria listed in the US Army Corps of Engineers wetland delineation manual (Department of the Army, 1987). Two of the three locations were not wetlands as none of the criteria related to hydrology, soils, or vegetation were met. A more detailed evaluation of the vegetation at one potential location, the Crooked Well Reservoir, was done because of the potential for inundation of the area during some seasons.

Wetland vegetation delineation is based on the presence and abundance of obligate wetland plants, facultative wetland plants, facultative plants, facultative upland plants and obligate upland plants. The indicator status for wetland species has been developed by the US Fish and Wildlife Service, and a specific publication for Region 9 (which includes western Wyoming) is available (Reed, 1988). Specific categories include the following.

- Obligate Wetland Species: Under natural conditions, occur almost always (estimated probability greater than 99 percent) in wetlands.
- Facultative Wetland Species: Usually occur in wetlands (estimated probability 67 to 99 percent), but occasionally found in non-wetlands.
- Facultative Species: Equally likely to occur in wetlands or non-wetlands (estimated probability 34 to 66 percent).
- Facultative Upland Species: Usually occur in non-wetlands (estimated probability 67 to 99 percent), but occasionally found in wetlands (estimated probability 1 to 33 percent).

- Obligate Upland Species: Occur almost always (estimated probability greater than 99 percent) in non-wetlands under natural conditions in this region.

Had wetlands been identified during the April 2006 vegetation survey (Appendix D8) using indicator species, a point-intercept approach would have been used to sample species composition and cover. Areas that met the wetland determination criteria based on the field evaluations would have been delineated and mapped.

D11.3 Results and Discussion

All potential wetlands identified by aerial photo analysis and the National Wetlands Inventory were field-checked in April 2006 and again in April 2009. No wetlands were identified. The Permit Area consists almost entirely of upland environments dominated by big sagebrush (*Artemisia tridentata*). The Permit Area is dissected by several small ephemeral drainages, but none of these areas support wetlands. The channels are dominated by big sagebrush, which tends to have higher cover percentages and grow larger in the lowland areas. However, flow in the drainages is occasional, and none of the areas has the hydrology to support wetland vegetation. For nearly the entire growing season, the Permit Area has no standing surface water.

Of the three potential wetlands in the NWI, only one appeared to be a potential wetland based on initial field observations, specifically the Crooked Well Reservoir, located near the center of T25N, R92W, Section 16. This stock pond is an off-channel reservoir next to the Battle Spring Draw in the northeastern part of the Permit Area (**Figure D11-1**). However, based on more detailed field observations during the April 2006 vegetation survey (Appendix D8), surface water sampling (Appendix D6), and other site activities, this site is not a wetland under the 1987 ACOE criteria (hydrology, soils, and vegetation). Figures 11-2a, 2b, and 2c show the reservoir conditions in April of 2006, 2007, and 2009, respectively. Hydrology is the criteria most likely to be met in a given year; however, the variability and timing of precipitation do not result in inundation for at least five days during the growing season each year. There may be sufficient snowmelt for water to accumulate for five days in some years, but because of the variability in temperatures, snowmelt often occurs (and the reservoir dries) before the growing season starts in June (National Climatic Data Center, 2008). There may also be water present after an intense summer thunderstorm, but only at rare intervals from year to year. The bottom of the reservoir is composed of sand, silt, and clay, with no surficial evidence of extensive organic material or anaerobic conditions. The bottom of the reservoir is essentially bare, probably due in part to wind scour. Although there is no specific vegetation density requirement for wetlands, the density is a factor that should be taken into account (Department of the Army, 1987). Scattered small sagebrush and grasses are present

along the edges of the bare area, and these grade quickly to the more dense sagebrush community.

Of the other two potential wetlands identified in the NWI, one is off-channel and may have been an old turn-around off the east-west road in the northern portion of T25N, R93W, Section 24 (Figure D11-3). The other location is near a channel and just south of the Permit Area. It was apparently associated with the BLM Battle Spring Draw Well No. 4551 in the northern portion of T25N, R92W, Section 21. When the site was first visited in April 2006, and again in November 2007, the well was apparently not in use (Figure D11-4). However, when the site was visited in April 2009, the well had apparently been put back into service and a dirt 'tank' established (Figure D11-4).

Figure D11-2a **Photos of Crooked Well Reservoir**
T25N, R92W, Section 16
April 2006

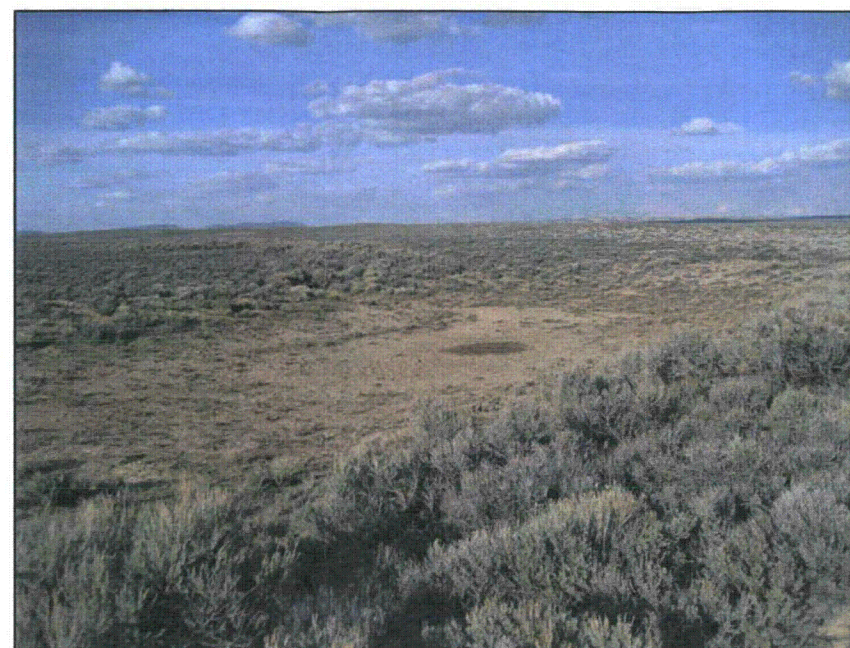


Looking southwest.

Figure D11-2b **Photos of Crooked Well Reservoir**
T25N, R92W, Section 16
April 2007



Looking southwest.



Looking north.



Looking north.



Looking north.



Looking north.

Figure D11-2c **Photos of Crooked Well Reservoir**
T25N, R92W, Section 16
April 2009



Looking north.



Looking east.



Looking west.



Looking south.

APPENDIX D REFERENCES (Page 11 of 21)

Mackey, Mike. 1997. *Black Gold: Patterns in the Development of Wyoming's Oil Industry*. Western History Publications, Powell.

Masursky H. 1962. Uranium bearing coal in the eastern part of the Red Desert area, Wyoming. Geological Survey (US). Bulletin No.1099-B.

Metcalf MD. 1987. Contributions to the prehistoric chronology of the Wyoming Basin. In: Perspectives on archaeological resources management in the Great Plains. Osborn AJ, Hassler RC, editors. Omaha (NE): I & O Publishing Company. p. 233-261.

Meyer R, Shields M, Green S, editors. 2005a. A GPS-based system for preliminary or remedial action gamma scanning. Proceedings of the American Nuclear Society: Decommissioning, decontamination, and reutilization and technology expo; 2005 August; Denver (CO).

Meyer R, Shields M, Green S, Johnson J, editors. 2005b. A GPS-based system for radium/uranium contamination gamma scanning. Uranium Mining and Hydrogeology IV. Broder J. Merkel, Andrea Hasche-Berger (Editors). Proceedings of the Uranium in the Environment Conference; 2005 Sep; Freiberg, Germany.

Miller. 2003. Peak flow characteristics of Wyoming streams. Geological Survey (US). Water Resources Rpt No. 03-4107.

Minnesota IMPLAN Group, Inc. 2003. Implan input/output model [Internet]. Available from: <http://www.implan.com>

Munn LC, Arneson CS. 1998. Soils of Wyoming: A digital statewide map at 1:500,000-scale. Agr. Expt. Sta. Rpt. B-1069. University of Wyoming, College of Agriculture, Laramie (WY).

Munn LC, Arneson CS. 1999. Soils of Wyoming: A digital statewide map at 1:100,000-scale. Agr. Expt. Sta. Rpt. B-1071. University of Wyoming, College of Agriculture, Laramie (WY).

Natfz DL. 1996. Geochemistry of selected aquifers in tertiary rocks of the Upper Colorado River Basin in Wyoming, Colorado and Utah. Geological Survey (US). Water Resources Investigation Report No. 95-4065.

National Climatic Data Center. 2008. Freeze/Frost Maps. Available from: <http://www.ncdc.noaa.gov/oa/climate/freezefrost/frostfreemaps.html>

APPENDIX D REFERENCES (Page 12 of 21)

National Council on Radiation Protection and Measurements. 1987. National Council on Radiation Protection and Measurements. Washington, D.C. Ionizing radiation exposure of the population of the United States. National Report No. 93.

National Park Service (US). 9 July 2004. National Natural Landmarks Guide: Wyoming. Available from:

http://www.nature.nps.gov/nnl/Registry/USA_Map/States/Wyoming/wyoming.cfm

Natural Resources Defense Council (US) Website. 2007. Available from: <http://www.nrdc.org/air/pollution/bt/WY.asp>

National Sustainable Agriculture Information Service (US). 2007. Sustainable Farming Association's Locally produced meat fact sheet series [Internet]. Available from: <http://attra.ncat.org/attra-pub/altmeat.html#producing>

National Wetlands Inventory Seamless Wetlands Data. 2006. Accessed April 2006. Available from: <http://wetlandsfws.er.usgs.gov/NWI/download.html>

Naugle DE, Doherty KE, Walker BL (Wildlife Biology Department, University of Montana, Missoula MT). 2006. Sage-Grouse habitat selection and energy development in the Powder River Basin. Completion Report.

Neidhardt PM, Nelson M, Metcalf T, Painter MW, Nelson P, Zier CJ (Centennial Archaeology, Inc., Fort Collins, CO). 2000. Final class III cultural resource inventory of the proposed Lost Creek 24-Inch and 12-Inch gathering system pipelines, Fremont and Sweetwater Counties, Wyoming. Prepared for ENSR Corporation and Merrick and Company.

Nuclear Information and Records Management Association. TG11-1998 (Ref. 23); TG15-1998 (Ref. 24); TG16-1998 (Ref. 25); TG21-1998 (Ref. 26).

Nuclear Regulatory Commission (US). 1980a. Office of Standards Development. Radiological effluent and environmental monitoring at uranium mills. Revision 1. Washington (DC). Regulatory Guide No. 4.14.

Nuclear Regulatory Commission (US). 1980b. Final generic EIS on uranium milling. Washington (DC). Project No. M-25.NUREG-0706. September 1980.

Nuclear Regulatory Commission (US). 1982. Office of Regulatory Research. Standard format and content of license applications, including environmental reports, for In Situ uranium solution mining. Washington (DC). Regulatory Guide No. 3.46.

APPENDIX D REFERENCES (Page 13 of 21)

Nuclear Regulatory Commission (US). 1983. Health physics surveys in uranium mills. Washington (DC). Regulatory Guide No. 8.30.

Nuclear Regulatory Commission (US). 1983. Health physics surveys in uranium mills. Washington (DC). Regulatory Guide No. 8.30.

Nuclear Regulatory Commission (US). 1983. Information relevant to ensuring that occupational exposures at uranium mills will be as low as reasonable achievable. Washington (DC). Regulatory Guide No. 8.31.

Nuclear Regulatory Commission (US). 1987. Bioassay at uranium mills. Washington (DC). Regulatory Guide No. 8.22.

Nuclear Regulatory Commission (US). 1991. Washington (DC). 10 CFR Part 40.44.

Nuclear Regulatory Commission (US). 1992. Monitoring criteria and methods to calculate occupational radiation doses. Washington (DC). Regulatory Guide No. 8.34.

Nuclear Regulatory Commission (US). 1995. Instruction concerning prenatal radiation exposure. Washington (DC). Regulatory Guide No. S.i3.

Nuclear Regulatory Commission (US). 1997. Final EIS to construct and operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico. Washington (DC). NUREG-1508. February.

Nuclear Regulatory Commission (US). 1999. Instructions Concerning Prenatal Radiation Exposure. Washington (DC). Regulatory Guide No. 8.13. June 1999. Available from: <http://www.nrc.gov/reading-rm/doc-collections/reg-guides/occupational-health/active/8-13/>

Nuclear Regulatory Commission (US). 2000. Multi-agency radiation survey and site investigation manual (MARSSIM). Revision 1. Washington (DC). NUREG 1575.

Nuclear Regulatory Commission (US). 2001. A baseline risk-informed performance-based approach for in-situ leach uranium extraction licenses. Washington (DC). NUREG/CR-6733. September 2001.

Nuclear Regulatory Commission (US). 2003. Office of Nuclear Material Safety and Safeguards. Standard review plan for In Situ leach uranium extraction license applications. Final Report. Washington (DC). NUREG 1569.

Nuclear Regulatory Commission (US). 2005. Washington (DC). NUREG-1600.

APPENDIX D REFERENCES (Page 14 of 21)

Nuclear Regulatory Commission (US). 2007a. Fuel Cycle Facilities. 25 June 2007. Available from: <http://www.nrc.gov/info-finder/materials/fuel-cycle/>

Nuclear Regulatory Commission (US). 2007b. § 20.1902 Posting requirements. Available from: <http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-1902.html>

Olendorf RR, Miller A, Lehman R. 1996. Suggested practices for raptor protection on power lines: the state of the art in 1996. Raptor Research Foundation.

Oles, L. 2007. Effectiveness of raptor perch deterrent devices on power poles for reducing secondary effects on prey species. Bureau of Land Management (US). Resource Note No. 84.

Oregon Climate Service Website. 2007a. The Oregon Climate Service at Oregon State University. 29 March 2007. Available from: <http://www.ocs.orst.edu/pub/maps/Precipitation/Total/States/WY/wy.gif>

Oregon Climate Service Website. 2007b. The Oregon Climate Service at Oregon State University. 29 March 2007. Available from: http://www.ocs.orst.edu/page_links/comparative_climate/wyoming/wyoming.html

Pochop, L., K. Warnaka, J. Borrelli and V. Hasfurther. 1985. Design Information for Evaporation Ponds in Wyoming. WWRC-85-21. Water Resources Data Systems Library Website. 29 March 2007. Available from: <http://library.wrds.uwyo.edu/wrp/85-21/85-21.html>

Poole E. 1984. Lost Creek and Conoco Uranium Projects, Sweetwater Co., Wyoming; In-house report: Texasgulf Minerals and Metals, Inc.: 33.

PRI. 1998. Gas Hills Project WDEW-LQD Permit to Mine Application. Power Resources Inc.

Reed, Jr., P. B. 1988. National list of plant species that occur in wetlands: Northwest, (Region 9). US Department of Interior, Fish and Wildlife Service Biol. Rept. 88 (26.9). 89 p.

Reeve AF. 1984. Environmental influences on male pronghorn home range and pronghorn behavior [dissertation]. [Laramie (WY)]: University of Wyoming.

Schiager KJ. 1972. Analysis of radiation exposures on or near uranium mill tailings piles. Radiation Data and Reports, Vol. 15, No. 7. Environmental Protection Agency (US), Office of Radiation Programs. July 1972.