Reno Creek ISL Project
Campbell County, Wyoming

Supportive Information for Wyoming Department of Environmental Quality Amendment to Mine Permit #479 and U.S. Nuclear Regulatory Commission Source Materials License

November, 1993
Energy Fuels Nuclear, Inc.

TABLE OF CONTENTS

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

Section | Page

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

Section | Page

TABLE OF CONTENTS
(Continued)

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS

RENO CREEK ISL PROJECT

FIGURES

TABLE OF CONTENTS

RENO CREEK ISL PROJECT

FIGURES

TABLE OF CONTENTS

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS

RENO CREEK ISL PROJECT

VOLUME I

TABLE OF CONTENTS

RENO CREEK ISL PROJECT

VOLUME I

VOLUME II

PLATES

VOLUME III

ATTACHMENTS

1. GENERAL PROJECT DESCRIPTION

1.1 PROJECT SUMMARY

The Reno Creek ISL Project is designed to mine uranium from roll front type deposits using in situ leach (ISL) solution mining technology. The project will be a commercial sized operation extracting some 400,000 pounds per year of uranium oxide (U_3O_8). The uranium will be loaded onto ion exchange resin at the proposed satellite plant building, and the loaded resin will be trucked off-site to another commercial uranium mining facility for further processing. ENERGY FUELS, *LTD.* controls the uranium mineral rights at the Reno Creek ISL Project. ENERGY FUELS NUCLEAR, INC. (EFNI) is operator and agent for ENERGY FUELS, *LTD.* and will be the holder of all permits for the project.

In the late 1970's and early 1980's Rocky Mountain Energy, the previous project owner, conducted a pilot R & D test operation at the Reno Creek site employing the same in situ leach technology planned for the commercial operation. For the pilot operation, sodium carbonate/bicarbonate was used as the lixiviant and hydrogen peroxide was used as the oxidant. The pilot operation was successful both in terms of extracting the uranium mineral and in restoring the quality of the groundwater following solution mining. Formal written acceptance of the groundwater restoration effort at the Reno Creek R & D project from the Wyoming Department of Environmental Quality (DEQ) and the U.S. Nuclear Regulatory Commission (NRC) is a matter of public record. The termination of Rocky Mountain Energy's source material license was granted on October 20, 1986.

The commercial Reno Creek ISL Project will utilize a satellite ion exchange plant, water treatment facilities, and surface irrigation for disposal of treated water. The existing pilot building constructed and used by Rocky Mountain Energy will be refurbished and used as a warehouse facility, thus reducing additional land disturbances required for the commercial project. The only other significant additional surface disturbance that will take place at the Reno Creek site for the commercial operation is the wellfield installation. EFNI projects starting commercial mining at the Reno Creek site in 1994. A list of the required permits and licenses required for the Reno Creek ISL Project is presented on Table 18.2.

1.2 PROJECT LOCATION

The Reno Creek ISL Project is located in southern Campbell County, Wyoming about 40 air miles south southwest of Gillette. Figure 1.1 is a general location map of the Reno Creek Project. The permit area includes portions or all of Sections 21, 22, 27, 28, 29, 30, 31, 33 and 34, Township 43 North, Range 73 West. The project site is located on private ranch lands which overlay a combination of United States and private minerals; no United States surface is located in the permit area. Access to the Reno Creek Project is via Wyoming State Highway 387, which passes through the project site approximately 10 miles southwest of Wright, Wyoming. Secondary access in the permit area is via local ranch roads and the existing gravel road to the old Rocky Mountain Energy pilot building. A complete legal description of the 3,613 acre commercial permit area is contained in Section 4.

1.3 PROJECT OWNERS

ENERGY FUELS NUCLEAR, INC. (EFNI) is a privately owned Colorado corporation. EFNI was incorporated in December, 1978 in Colorado. EFNI has a long history as a uranium producer, and during the 1980's was the largest U.S. producer. EFNI's principal uranium holdings include five underground uranium mines in northern Arizona and partial ownership of the White Mesa Mill in Blanding, Utah.

1.4 MINING OPERATIONS

1.4.1 WELLFIELD

Mine development at the Reno Creek ISL Project will advance sequentially along the roll front trends. The initial mining area, comprised of approximately fifty 5-spot patterns, will be in Section 29, T43N R73W, adjacent to the proposed satellite plant location. Upon reaching the design commercial production rate, total circulation of leaching solutions will be about 2,000 gallons per minute.

The mineralized or target sand for the solution mining operation at the Reno Creek site is referred to by EFNI as the lower unit of the Reno sand. The ore host sandstone is hydrogeologically confined in the western portion of the permit area, generally hydrologically unconfined east and south of

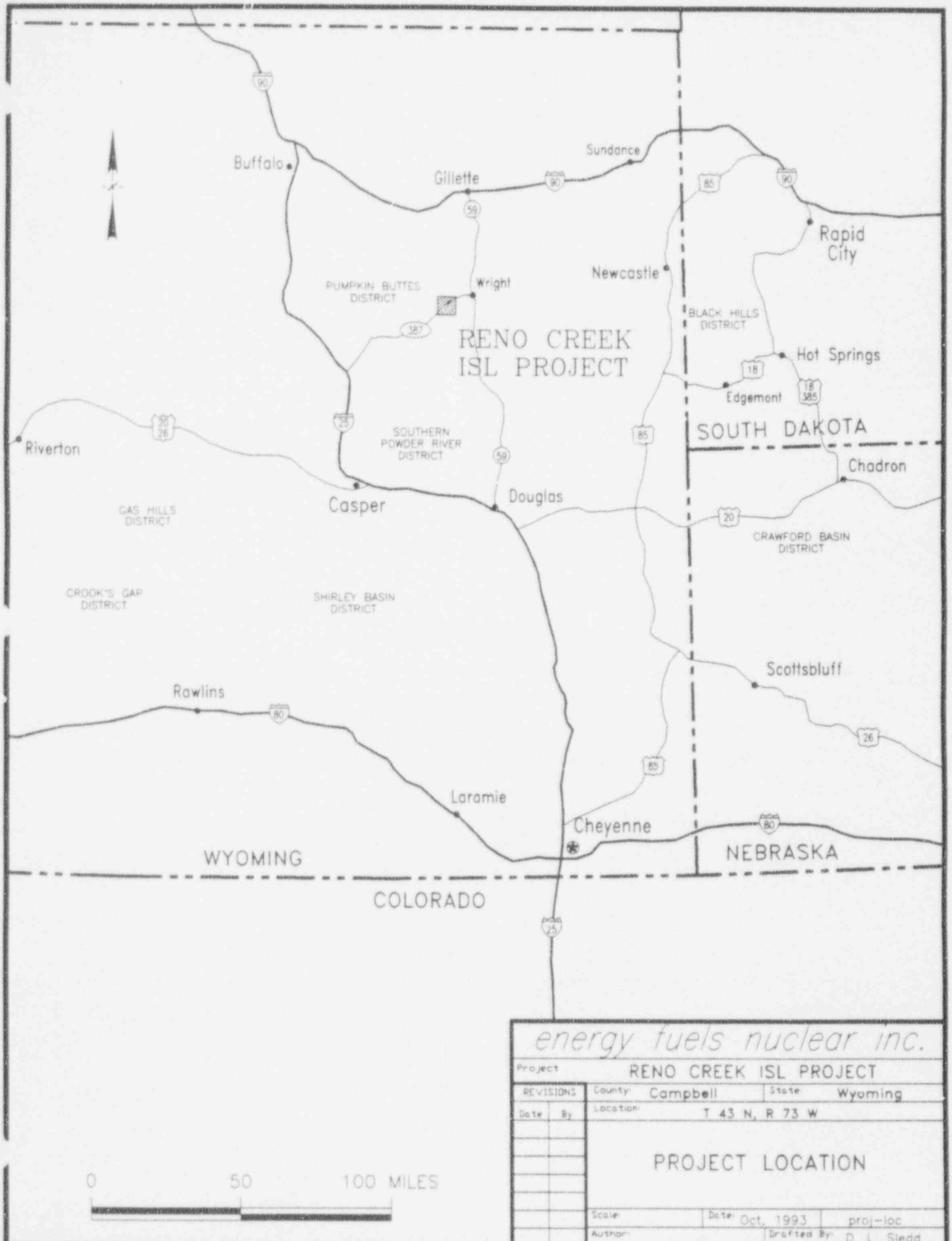

Buffalo
Gillette
Sundance
Rapid City
Newcastle
Wright
PUMPKIN BUTTES DISTRICT
RENO CREEK ISL PROJECT
BLACK HILLS DISTRICT
Hot Springs
Edgemont
SOUTH DAKOTA
Riverton
SOUTHERN POWDER RIVER DISTRICT
Chadron
Casper
Douglas
GAS HILLS DISTRICT
CRAWFORD BASIN DISTRICT
CROOK'S GAP DISTRICT
SHIRLEY BASIN DISTRICT
Scottsbluff
Rawlins
Laramie
Cheyenne
WYOMING
NEBRASKA
COLORADO
90
59
387
25
20 26
85
18
18 385
20
80
26
0 50 100 MILES
energy fuels nuclear inc.
Project RENO CREEK ISL PROJECT
REVISIONS
Date By
County: Campbell
State: Wyoming
Location: T 43 N, R 73 W
PROJECT LOCATION
Scale:
Date: Oct, 1993
proj-loc
Author:
Drafted By: D. L. Sledd

Figure: 1.1

Highway 387, and is flat lying with no known faulting. The method of well drilling and completion will involve casing the hole above the completion zone, cementing the annulus, underreaming the producing interval, installing a screened liner through the production zone, and gravel packing the annulus around the screen.

Perimeter *and* overlying monitor wells will be installed ~~in and around~~ *around and over* the wellfield to monitor containment of the leaching solutions. A slight over production of one to three percent of the total wellfield flow will keep ground water moving into the operating mining unit.

Following the extraction of the uranium from the ore body aquifer using solution mining techniques, the ground water affected by the mining operation will be restored to a quality of use equal to or better than the uses of water prior to operation. The techniques to be utilized for ground water restoration at the Reno Creek site will include ground water sweep to flush leaching solutions from the mining interval, followed by circulation and injection of water treated by reverse osmosis to achieve final ground water restoration.

1.4.2 PROCESSING PLANT

The Reno Creek processing facility is designed to operate as a satellite plant with only a uranium concentration (ion exchange) circuit and a leachate make-up circuit. The uranium loaded resin from the ion exchange circuit will be periodically trucked from the Reno Creek site to another Nuclear Regulatory Commission (NRC) licensed uranium facility for elution and further processing. Trailers and procedures consistent with current U.S. Department of Transportation regulations governing Low Specific Activity material will be used to transport the resin. The leaching solution or lixiviant will consist of a dilute carbonate/bicarbonate solution plus an oxidant.

Process equipment, with the exception of chemical storage vessels, will be located in the satellite building. A separate water treatment building will be used for treatment of wellfield purge (over production) and ground water sweep solutions and reverse osmosis brine to remove radium. The treated water will discharge to two lined settlement ponds to allow the radium solids to settle. Decanted water will pass to the irrigation storage reservoir prior to land application via a surface irrigation system, which will operate on a seasonal basis.

An office building will be provided for personnel space, analytical laboratory, and lunch and change room facilities.

1.5 RECLAMATION AND AQUIFER RESTORATION OPERATIONS

As mining advances and wellfields are depleted, reclamation of the land surface and restoration of the affected aquifer will take place. Reclamation and restoration activities will commence as soon as practicable once mining in a wellfield has terminated. The goal of reclamation will be to return all affected lands to their pre-mining use of livestock grazing and wildlife habitat~~, and the goal of restoration will be to return the water quality in the affected aquifer to acceptable regulatory standards~~.

EFNI will use best practicable technology as defined in W.S. 35-11-103(f)(i) to return the condition of ground water to background quality. If this cannot be achieved using best practicable technology, then affected ground water will, at a minimum, be returned to a quality equal to, and consistent with, uses for which the water was suitable prior to operations.

2. NAMES AND LAST KNOWN ADDRESSES OF OWNERS OF RECORD WITHIN THE PERMIT AMENDMENT AREA

The owners and interest holders of record in the following lists were obtained from the records of the Campbell County Clerk and Recorder, the Campbell County Assessor's Office, the Wyoming Office of the Bureau of Land Management, the Wyoming State Land Department, and by independent research. The ownership lists given below are divided into sections according to type of ownership or interest *and a new section 2.7 has been added to contain the consents received from the surface owners.* For reference, they are:

2.1 Surface Ownership

2.2 Surface Rights Granted by Surface Use Agreements or Grazing Leases

2.3 Surface Rights Granted by Rights of Way or Easements

2.4 Mineral Ownership (All Minerals, including Oil and Gas)

2.5 Oil and Gas Leasehold Interests
- 2.5.1 Federal Oil and Gas Leasehold Interests
- 2.5.2 Private Oil and Gas Leasehold Interests
- 2.5.3 Oil and Gas Wells
- 2.5.4 Overriding Royalty Interest Holders

2.6 Mineral Interests (other than Oil and Gas)
- 2.6.1 Mineral Leases
- 2.6.2 Mining Claims

2.7 Surface Owner Consents

2.1 SURFACE OWNERSHIP

Owners of the surface estate or any portion thereof are listed below with their corresponding land descriptions and a map key which refers to a map entitled "Surface Ownership Map" (Figure 2.1). All lands listed in this permit application that were deeded to the State Highway Commission for State Highway 387 are also listed in the section entitled "Surface Rights Granted by Rights of Way or Easements" and are shown on the map entitled "Rights of Ways" (Figure 2.3).

Surface Ownership	Land Description	Map Key
Bernice Groves P.O. Box 408 Wright, WY 82732-0408	T43N, R73W Sec. 22: SW/4 27: W/2 28: All 33: W/2	SA
The State Highway Commission of Wyoming Department of Transportation PO Box 1708 Cheyenne, WY 82003-1708 (for State Highway 387 conveyed by Warranty Deed)	T43N, R73W Portions of: Sec. 28: N/2NW/4, SW/4NW/4 W/2SW/4 33: NW/4NW/4	SA
(Heirs of Sinadin Estate, 1/5th to each) Ms. Terry Berquist 1003 Birch Douglas, WY 82633	T43N, R73W Sec. 31: All	SB
Nolan and Ann Diehl PO Box 334 Red Bluff, CA 96080		SB
Dorothy Reichmuth 1531 South 77th Street Lincoln, NE 68506		SB
Rev. Eugene Sullivan Box 2024 Sheridan, WY 82801		SB
Rev. Gerald Sullivan *PO Box 5720* *Cheyenne, WY 82003-5720* *(new address as of 1/31/94)*		SB

August G. Laur Trust *c/o August G. Laur and* *Lewella Laur, Co-Trustees* 245 E. Foote St. Buffalo, WY 82834	<u>T43N, R73W</u> Sec. 29: SW/4 30: E/2SE/4	SC
Lewella Laur Trust *c/o August G. Laur and* *Lewella Laur, Co-Trustees* 245 E. Foote St. Buffalo, WY 82834 *(title was conveyed into Trusts on August 24, 1993)*		SC
June M. Thielen-Stangler and John R. Thielen HCR 61 Box 5333 Danbury, Wisconsin 54873	<u>T43N, R73W</u> Sec. 21: S/2	SD
The State Highway Commission of Wyoming Department of Transportation PO Box 1708 Cheyenne, WY 82003-1708 (for State Highway 387 conveyed by Warranty Deed)	<u>T43N, R73W</u> Portions of: Sec. 21: NW/4SE/4, NE/4SW/4, SE/4SW/4	SD
Clayton and Cindy McGuire 42 Chalk Buttes Rd. Douglas, WY 82633 beginning 10/24/93: 1460 Hwy 59 PO Box 1070 Douglas, WY 82633	<u>T43N, R73W</u> Sec. 33: NE/4 34: W/2	SE
James E. and Edra June Drake 2501 E. Turney Phoenix, AZ 85016	<u>T43N, R73W</u> Sec. 29: N/2, SE/4	SF
The State Highway Commission of Wyoming Department of Transportation PO Box 1708 Cheyenne, WY 82003-1708 (for State Highway 387 conveyed by Warranty Deed)	<u>T43N, R73W</u> Portions of: Sec. 29: SE/4SE/4	SF

2.2 SURFACE RIGHTS GRANTED BY SURFACE USE AGREEMENTS OR GRAZING LEASES

The reference under the column entitled Map Key refers to the map entitled "Surface Agreements and Grazing Rights" (Figure 2.2). Note that the map includes areas without a map key reference where surface rights are granted under a mining or mineral lease. Mining leases were included on this map to make it clear that *Energy Fuels, Ltd.* has the right to the surface throughout the permit amendment area. However, the mining and mineral leases are listed under Section 2.6.1 below and are more fully identified on their corresponding map entitled "Mineral Lease and Claim Map" (Figure 2.6).

The following are recorded surface use agreements:

Grantor / Grantee	Land Description	Map Key
June M. Thielen-Stangler and John R. Thielen, Grantors *Energy Fuels, Ltd.*, Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (Thielen SOA)	T43N, R73W Sec. 21: S/2	S1
Bernice Groves, Grantor (successor) *Energy Fuels, Ltd.*, Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (split under Willard SOA)	T43N, R73W Sec. 27: W/2 28: W/2 33: NW/4	S2
James E. Drake et ux, Grantor (successor) *Energy Fuels, Ltd.*, Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (split under Willard SOA)	T43N, R73W Sec. 29: SE/4, N/2	S3

Dorothy Reichmuth, et al., Grantors (successors) *Energy Fuels, Ltd.,* Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (Sinadin SOA)	<u>T43N, R73W</u> Sec. 31: NW/4NE/4	S4
August G. and Lewella Laur, Grantor *Energy Fuels, Ltd.,* Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (Laur SOA)	<u>T43N, R73W</u> Sec. 29: SW/4 30: E/2SE/4	S5
Clayton and Cindy McGuire, Grantors (successors) *Energy Fuels, Ltd.,* Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (Underwood SOA)	<u>T43N, R73W</u> Sec. 33: NE/4 34: W/2	S6

Although no surface and/or grazing lease is recorded in the county records for the following, Robert Roush may be a surface lessee of lands currently leased under the Mining Lease between *Energy Fuels, Ltd.* and August and Lewella Laur on the following area:

Possible Lessee	Land Description	Map Key
Robert Roush 113 Todd Gillette, WY 82718	<u>T43N, R73W</u> Sec. 29: SW/4 30: E/2SE/4 (additional lands, if any, unknown)	none

Therefore, Robert Roush will be given notice of this permit application.

Although no surface and/or grazing lease is recorded in the county records for the following, Sunburst Ranch Co., Inc. may be a surface lessee of the same lands currently leased under one or more of the following: (i) the Mining Lease between *Energy Fuels, Ltd.* and Edward R. and Blanche Willard; (ii) the Mining Lease between *Energy Fuels, Ltd.* and Urban and Bernice Groves; and (iii) Surface Owners Agreement between *Energy Fuels, Ltd.* and Edward and Blanche Willard. All of such documents are listed in the appropriate sections of this Section 2. The exact lands that may be included in a surface and/or grazing lease between the surface owners and Sunburst Ranch Co., Inc. is unknown, but may include the following lands within the permit amendment area:

Possible Lessee	Land Description	Map Key
Sunburst Ranch Co., Inc. Box 408 Wright, WY 82732	T43N, R73W Sec. 22: SW/4 27: W/2 28: All 29: N/2, SE/4 33: W/2	none

Therefore, Sunburst Ranch Co., Inc. will be given notice of this permit application.

2.3 SURFACE RIGHTS GRANTED BY RIGHTS OF WAYS OR EASEMENTS

The documents which grant rights of ways and easements are listed below. The land description given with each is the general quarter section description to identify its location on the corresponding map entitled "Rights of Way" (Figure 2.3). Each complete right of way as shown on the map may have been obtained through several different conveyance documents from the different landowners within the area. Each map key reference refers only to that section of each right of way or easement that was conveyed through its corresponding document. Also note that the State Highway Department obtained rights of ways for State Highway 387, then later obtained deeds for the same highway. Both the right of way documents and deeds are listed for reference.

Type / Grantor / Grantee	Land Description	Map Key
Telephone Right of Way Easement Grantor: Edward R. Willard Grantee: The Mountain States Telephone and Telegraph Company 931 14th St. Denver, CO 80202	T43N, R73W Sec. 22: W/2SW/4 27: W/2W/2	R1
Warranty Deed (for State Highway 387) Grantor: Edward R. and Blanche Willard Grantee: The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T43N, R73W Sec. 28: N/2NW/4, W/2SW/4, SW/4NW/4 33: NW/4NW/4	R2
Road Right of Way Easement for State Highway 387 Grantor: L.J. and Emma M. Gilbert Grantee: State of Wyoming Department of Transportation	T43N, R73W Sec. 21: NW/4SE/4, SE/4SW/4, NE/4SW/4 29: SE/4SE/4	R3
Warranty Deed (for State Highway 387) Grantor: Urban H. and Bernice Groves Grantee: The State Highway Commission of Wyoming Department of Transportation	T43N, R73W Sec 29: SE/4SE/4	R4
Warranty Deed (for State Highway 387) Grantor: John B. and Irene H. Thielen Grantee: The State Highway Commission of Wyoming Department of Transportation	T43N, R73W Sec. 21: NW/4SE/4, SE/4SW/4, NE/4SW/4	R5
Snow Fence Right of Way Easement Grantor: Urban H. and Bernice Groves Grantee: State of Wyoming Department of Transportation	T43N, R73W Sec. 29: SE/4SE/4	R6

Road Right of Way Easement for State Highway 387 Grantor: John M. and Edith M. Paisley Grantee: State of Wyoming Department of Transportation	<u>T43N, R73W</u> Sec. 28: W/2W/2	R7
Telephone Right of Way Easement Grantor: Harry R. and Harriet Underwood Grantee: The Mountain States Telephone and Telegraph Company	<u>T43N, R73W</u> Sec. 33: SE/4NE/4 34: W/2NW/4	R8
Telephone Right of Way Easement Grantor: John B. Thielen Grantee: The Mountain States Telephone and Telagraph Company	<u>T43N, R73W</u> Sec. 21: NW/4SE/4, SW/4SW/4, E/2SW/4	R9
Snow Fence Right of Way Easement Grantor: Edward R. and Blanche Willard Grantee: Wyoming State Highway Dept.	<u>T43N, R73W</u> Sec. 28: W/2W/2	R10
Road Right of Way Easement for the Cosner County Road Grantor: Harry R. Underwood Grantee: Campbell County Road and Bridge Department 500 S. Gillette Ave. Gillette, WY 82716	<u>T43N, R73W</u> Sec. 34: NW/4NW/4, W/2SW/4, S/2NW/4	R11
Road Right of Way Easement for the Cosner County Road Grantor: Edward R. Willard Grantee: Campbell County Road and Bridge Department	<u>T43N, R73W</u> Sec. 33: S/2SW/4	R12

2.4 MINERAL OWNERSHIP (ALL MINERALS, INCLUDING OIL AND GAS)

The following lists all persons or entities who own the minerals in the lands within the permit amendment area. The map key refers to the map entitled "Mineral Ownership Map" (Figure 2.4).

Mineral Ownership	Percent Interest	Land Description	Map Key
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00	T43N, R73W Sec. 27: W/2 28: W/2 29: S/2 30: E/2SE/4 31: NW/4NE/4 33: N/2 34: W/2	MUSA
Arnold Royalty P.O. Box 1119 Lafollette, TN 37766	*3.1250 (except coal)	T43N, R73W Sec. 21: S/2	MA
Norma Craft Cannon Trust c/o First Union National Bank of North Carolina, Co-Trustee P.O. Box 467 Concord, N.C. 28026-0467	*6.2500 (except coal)		MA
Fortin Enterprises, Inc. P.O. Box 2416 Billings, MT 59103	5.4690 (except coal)		MA
Hancock Enterprises P.O. Box 2527 Billings, MT 59103	5.4690 (except coal)		MA
Dortha Ickes Trust 824 N.W. Spruce Ridge Dr. Stuart, FL 34994	25.0000 (except coal)		MA
Stanley Ickes Trust 824 N.W. Spruce Ridge Dr. Stuart, FL 34994	25.0000 (except coal)		MA

John R. Thielen, June M. Thielen-Stangler HCR 61 Box 5333 Danbury, WI 54873, and John T. Jones 352 Old Sundance Road Moorcroft, WY 82721	*25.0000 (except coal)		MA
Robert Foard Townsend Testamentary Trust c/o Robert Foard Townsend III, Trustee 217 W. Castano San Antonio, TX 78207	1.5620 (except coal)		MA
WGR, Inc. Suite 230 12200 N. Pecos St. Denver, CO 80234-3439	*3.1250 (except coal)		MA
	100.000		
Robert E. Kastner, et ux. 1809 E. L St. Torrington, WY 82240	5.000 1.000		MA

* The interest of Robert Kastner is not a true mineral ownership, but an interest in an advance royalty and production royalty payable to the mineral owners marked with an "*" above.

United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MA
Edward R. Willard *Estate* 410 W. 6th St. Gillette, WY 82716 *(Mr. Willard died in Sept. 1993)*	50.00 (except coal)	T43N, R73W Sec. 22: SW/4 28: E/2 33: SW/4	MB
Blanche Willard 410 W. 6th St. Gillette, WY 82716	50.00 (except coal		MB
	100.00		
United States of America *Bureau of Land Management* *Wyoming State Office*	*100.00* *(coal)*		*MB*

Arnold Royalty P.O. Box 1119 Lafollette, TN 37766	3.1250 (except coal)	<u>T43N, R73W</u> Sec. 29: N/2	MC
Urban and Bernice Groves P.O. Box 408 Wright, WY 82732-0408	10.0000 (except coal)		MC
Norma Craft Cannon Trust c/o First Union National Bank of North Carolina, Co-Trustee P.O. Box 467 Concord, NC 280267-0467	6.2500 (except coal)		MC
Fortin Enterprises, Inc. P.O. Box 2416 Billings, MT 59103	5.4690 (except coal)		MC
Hancock Enterprises P.O. Box 2527 Billings, MT 59103	5.4690 (except coal)		MC
Dortha Ickes Trust 824 N.W. Spruce Ridge Dr. Stuart, FL 34994	22.5000 (except coal)		MC
Stanley Ickes Trust 824 N.W. Spruce Ridge Dr. Stuart, FL 34994	22.5000 (except coal)		MC
June M. Thielen-Stangler, John R. Thielen HCR 61 Box 5333 Danbury, WI 54873 and John T. Jones 352 Old Sundance Road Moorcroft, WY 82721	20.000 (except coal)		MC
Robert Foard Townsend Testamentary Trust c/o Robert Foard Townsend III, Trustee 217 W. Castano San Antonio, TX 78209	1.5620 (except coal)		MC

WGR, Inc. Suite 230 12200 N. Pecos St. Denver, CO 80234-3439	3.1250 (except coal) ______ 100.0000		MC
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MC
Sinadin Family Mineral Trust c/o Dorothy Reichmuth, Trustee 1531 S. 77th St. Lincoln, NE 68506	**100.00 (except coal)	T43N, R73W Sec. 31: Lots 1, 2, 3, 4, E/2W/2, SE/4, E/2NE/4, SW/4NE/4	MD

**This ownership interest is subject to an obligation to share equally all income therefrom with the following people during their lifetime only (life estates). *EFNI was advised in February 1994 by the Trustee of the Sinadin Family Mineral Trust that Louise Frances Sherard Schlattman died in 1993. Accordingly, Mrs. Schlattman was removed from this list.*

Milton Austin 1115 S. Elm Denver, CO 80222			MD
Nila Fern Sherard Harnden P.O. Box 521 Manteca, CA 95336-0521			MD
Everett Sherard 1553 North 1st Ave. Upland, CA 91786			MD
Janiel Sherard Wilson 911 Corey St. Longmont, CO 80501			MD
United States of America Bureau of Land Management Wyoming State Office	*100.00 (coal)*		*MD*

2.5 OIL AND GAS LEASEHOLD INTERESTS

The following are lessees of oil and gas leases. The map key refers to the map entitled "Oil and Gas Leases" (Figure 2.5). There are no state lands and therefore no state oil and gas leases within the permit amendment area.

2.5.1 FEDERAL OIL AND GAS LEASEHOLD INTERESTS

Lessee	Serial Number	Land Description	Map Key
Samedan Oil Corp. 1660 Lincoln, Ste 3000 Denver, CO 80264	WYW-5331	T43N, R73W Sec. 27: NW/4	OA
Union Oil Company of California Box 3100 Midland, TX 79705	WYW-99023	T43N, R73W Sec. 27: SW/4	OB
Chorney Oil Company 555 17th St., Ste 1000 Denver, CO 80202-3910	WYW-96896	T43N, R73W Sec. 28: S/2NW/4, SE/4SW/4, N/2SW/4	OC
Anderman/Smith and Co. 1776 Lincoln, Ste 500 Denver, CO 80203		Sec. 33: NW/4NE/4, SE/4NE/4 Sec. 34: SW/4SW/4	OC
Apache Corporation 1700 Lincoln, Ste 1900 Denver, CO 80203-4519			OC
ABO Petro Corporation 105 S. 4th St. Artesia, NM 88210	WYW-114466	T43N, R73W Sec. 28: N/2NW/4	OD
Chorney Oil Company 555 17th St., Ste 1000 Denver, CO 80202-3910			OD
Lancaster Corporation 555 17th St., Ste 1000 Denver, CO 80202-3910			OD

Myco Industries Inc. 105 S. 4th St. Artesia, NM 88210			OD
Yates Drilling Company 105 S. 4th St. Artesia, NM 88210			OD
Yates Petroleum Corp. 105 S. 4th St. Artesia, NM 88210			OD
Union Oil Company of California Box 3100 Midland, TX 79705	WYW-98028	T43N, R73W Sec. 28: SW/4SW/4 33: W/2NW/4, NE/4NE/4, SW/4NE/4 34: E/2SW/4	OE
Presidio Exploration 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	WYW-122046	T43N, R73W Sec. 29: S/2 33: NE/4NW/4 34: NW/4, NW/4SW/4	OF
ABO Petro Corporation 105 S. 4th St. Artesia, NM 88210	WYW-117152	T43N, R73W Sec. 30: E/2SE/4	OG
Andover Partners Box 1715 Denver, CO 80201			OG
Joan Chorney 555 17th St., Ste 1000 Denver, CO 80202-3910			OG
Lancaster Corporation 555 17th St., Ste 1000 Denver, CO 80202-3910			OG
Myco Industries Inc. 105 S. 4th St. Artesia, NM 88210			OG

Yates Drilling Company 105 S. 4th St. Artesia, NM 88210		OG
Yates Petroleum Corp. 105 S. 4th St. Artesia, NM 88210		OG

2.5.2 PRIVATE OIL AND GAS LEASEHOLD INTERESTS

Lessee/Working Interest	Land Description	Map Key
A/D Holdings 400 Ogden St. Denver, CO 80218	T43N, R73W Sec. 21: S/2*** ****contains operating well (see 2.5.3)*	OH
Ainslie Perrault, Jr. 1612 S. Cincinnati Ave. Tulsa, OK 74119		OH
American Production Partnership Ltd. III 4500 Republic Bank Center 700 Louisiana Houston, TX 77002		OH
Anderman and Company 1776 Lincoln, Ste 500 Denver, CO 80203		OH
Ronald D. Boone 1670 Newport Denver, CO 80220		OH
Buccaneer Energy Company 1111 Fannin, Ste 1550 Houston, TX 77002		OH
Buttes Resources Company P.O. Box 5083 Denver, CO 80217 *(now known as Reunion Energy 2801 Post Oak Blvd, Ste 400 Houston, TX 77056)*		OH

[illegible] [illegible]ergy, Inc. Suite [illegible]50 North Central Plaza III 12801 N. Central Expressway Dallas, TX 75243	OH
DNR Oil and Gas, Inc. 730 17th St., Ste 200 Denver, CO 80202	OH
Evans Dunn 2121 S. Columbia, Ste 105 Tulsa, OK 74114 conveyed by order of the District Court, Sixth Judicial District, in the Estate of Evans Hall Dunn, Deceased: Life Estate: Nina Lane Dunn No address given 1/3 remainder interest each: George Dunn No address given Kathy Dunn Nydegger No address given Gerri Dunn Turner No address given	OH
Fred Dunn, Jr. 2121 S. Columbia, Ste 105 Tulsa, OK 74114	OH
John P. Ellbogen P.O. Box 1928 Casper, WY 82601	OH
Farmers Union Central Exchange, Inc. Box G St. Paul, MN 55101	OH
Ronald E. Hornig 1776 Lincoln St., Ste 500 Denver, CO 80203	OH

Hunt Oil Company
2900 First National Bank Bldg.
Dallas, TX 75202 — OH

J.A. LaFortune, Jr.
1924 S. Utica, Ste 1218
Tulsa, OK 74101 — OH

Joseph A. LaFortune Trust
2300 Fourth National Bldg.
Tulsa, OK 74119 — OH

Louisiana Land and
Exploration Company, The
1560 Broadway, Ste 1200
Denver, CO 80202 — OH

Joseph J. Morelli
1776 Lincoln St., Ste 500
Denver, CO 80203 — OH

Oneok Exploration Company
P.O. Box 871
Tulsa, OK 74101 — OH

Julian C. Pope
One W. Third St., Ste 1200
Tulsa, OK 74103 — OH

Riffe Petroleum Company
P.O. Box 25860
Tulsa, OK 74145 — OH

St. Mary Parish Land Company
1776 Lincoln St., Ste [illegible]0
Denver, CO 80202 — OH

Harold C. Stuart
P.O. Box 1349
Tulsa, OK 74104 — OH

Swift Energy Company
16825 Northchase Dr. Ste 400
Houston, TX 77060-6098 — OH

Viersen and Cochran c/o Sam K. Viersen, Jr. P.O. Box 280 Okmulgee, OK 74447		OH
Wilcox Exploration Company P.O. Box 4429 Tulsa, OK 74104		OH
H. Frank Wilcox III P.O. Box 4429 Tulsa, OK 74104		OH
Wollard Family Trust c/o Janes K. Wollard, et vir., Trustees 1616 Glenarm Pl., Ste 1230 Denver, CO 80202		OH
Wollard Family Trust c/o Janes K. Wollard, et vir., Trustees 2121-F S. Victor St. Aurora, CO 80014		OH
Apache Corporation 1700 Lincoln, Ste 1900 Denver, CO 80203-4519	<u>T43N, R73W</u> Sec. 22: SW/4 28: E/2 33: SW/4	OJ
Chorney Oil Company 555 17th St., Ste 1000 Denver, CO 80202-3910		OJ
Pathfinder Energy, Inc. P.O. Box 908 Powell, WY 82435		OJ
Wellstar Corporation 9704 State Highway 66 Platteville, CO 80651		OJ

Presidio Exploration, Inc. 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	T43N, R73W Sec. 29: N/2	OK
Presidio Exploration, Inc. 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	T43N, R73W Sec. 31: W/2, SE/4, S/2NE/4, NE/4NE/4	OL

2.5.3 OIL AND GAS WELLS

The following are all oil and gas wells identified through a search conducted by McKee Well History of Casper, Wyoming, and include both producing wells and abandoned wells. The map key refers to the map entitled "Oil and Gas Leases" (Figure 2.5).

Operator	Name	Location	Map Key
Buttes Resources Company P.O. Box 5083 Denver, CO 80217 (now known as Reunion Energy 2801 Post Oak Blvd, Ste 400 Houston, TX 77056)	Anderman No. 1-21 Producing	T43N, R73W Sec. 21: SE/4SE/4	OH
Presidio Exploration, Inc. 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	#23-31 Abandoned	T43N, R73W Sec. 31: NE/4SW/4	OL
Amoco Production Company P.O. Box 2520 Casper, WY 82602	Sinadin #1 Abandoned	T43N, R73W Sec. 31: SW/4SE/4	OL

2.5.4 OVERRIDING ROYALTY INTEREST HOLDERS

The following are holders of an overriding royalty interest under any one or more of the above-referenced leases. The map key refers to the map entitled "Oil and Gas Leases" (Figure 2.5).

ORRI Owner	Land Description	Map Key
Yvonne R. Phillips and Richard Phillips, et vir 219 W. Maple St. Deshler, OH 43516	T43N, R73W Sec. 21: S/2 Sec. 29: N/2	 OH OK
Aquaenco, Inc. P.O. Box 702571 Tulsa, OK 74170		OH OK
Marie Jeanne Darr no address listed		OH OK
Patricia J. Green no address listed		OH OK
Sharalyn R. Harr 6335 S. Logan Ct. Littleton, CO 80120		OH OK
Robert H. Hays P.O. Drawer A Gillette, WY 82716		OH OK
Janette M. Hutsell no address listed		OH OK
Larry J. Ickes and Judith A. Ickes, et ux. 6700 Milton Rd. Custar, OH 43511		OH OK
Lester B. Ickes and Brenda "Jill" Ickes, et ux. 170 La Cueva Las Alamos, NM 87544		OH OK
Robert E. Kastner, et ux. 1809 East L St. Torrington, WY 82240		OH OK

Ronald T. Mackey 1368 S. Robb Ct. Lakewood, CO 80226		OH OK
Dona M. Mohan no address listed		OH OK
Sam R. Ratcliff P.O. Box 697 Gillette, WY 82717		OH OK
Reato, Ltd. Box 4840 Casper, WY 82604		OH OK
Scope Exploration Inc. P.O. Box 702571 Tulsa, OK 74170		OH OK
Bill L. Tucker 1776 Lincoln St. Ste 506 Denver, CO 80203		OH OK
Prairie Petroleum 910 16th St., Ste. 610 Denver, CO 80202	<u>T43N, R73W</u> Sec. 22: SW/4 28: E/2 33: SW/4	OJ
Don C. Sullivan P.O. Box 1202 Gillette, WY 82716		OJ
McCullis Resources Co. 621 17th St., Ste 2155 Denver, CO 80293	<u>T43N, R73W</u> Sec. 31: W/2, SE/4, S/2NE/4, NE/4NE/4	OL
George G. Vaught, Jr. P.O. Box 13557 Denver, CO 80201		OL

ORRI Owner	Serial Number	Land Description			Map Key
TEMIN 1987 Partnership P.O. Box 1628 Ardmore, OK 73402	W-5331	T43N, R73W Sec.	 27:	 NW/4	OA
Diane M. Lukowicz 940 S. Josephine St. Denver, CO 80209	W-5331				OA
Lamar B. Roemer 530 S. University Blvd. Denver, CO 80220	W-5331				OA
Prairie Petroleum 910 16th St., Ste. 610 Denver, CO 80202	W-5331				OA
Robert M. Jenny 209 Newton St. Brookline, MA 02146	W-99023	T43N, R73W Sec.	 27:	 SW/4	OB
George H. Fentress P.O. Box 113 Wheat Ridge, CO 80034	W-96896	T43N, R73W Sec.	 28:	 S/2NW/4, N/2SW/4, SE/4SW/4	OC
Michael Gerace 1540 Chambers Dr. Boulder, CO 80303	W-96896		33: 34:	NW/4NE/4, SE/4NE/4 SW/4SW/4	OC
Dice Exploration Co. P.O. Box 73507 Houston, TX 77273	W-96896				OC
Jeanne O'Shaughnessy 4880 S. Franklin St. Englewood, CO 80110	W-98028	T43N, R73W Sec.	 28: 33: 34:	 SW/4SW/4 NE/4NE/4, SW/4NE/4, W/2NW/4 E/2SW/4	OE

2.6 MINERAL INTERESTS (OTHER THAN OIL AND GAS)

2.6.1 MINERAL LEASES

The following are leases for all minerals other than oil and gas. There were no leases identified in the records exclusively for coal or other leasable minerals other than oil and gas. The map key refers to the map entitled "Mineral Lease and Claim Map" (Figure 2.6).

Lessee	Land Description	Map Key
Energy Fuels, Ltd 1200 17th St., Ste 2500 Denver, CO 80202 (Sinadin ML)	T42N, R73W Sec. 31: Lots 1, 2, 3, 4, E/2NE/4, SW/4NE/4, E/2W/2, SE/4	L1
Energy Fuels, Ltd. 1200 17th St., Ste 2500 Denver, CO 80202 (Willard ML)	T43N, R73W Sec. 22: SW/4 28: E/2 33: SW/4	L2
Energy Fuels, Ltd. 1200 17th St., Ste 2500 Denver, CO 80202 (Romaker, Groves, Hancock MLs)	T43N, R73W Sec. 29: N/2	L3
Energy Fuels, Ltd. 1200 17th St., Ste 2500 Denver, CO 80202 (Romaker, Hancock MLs)	T43N, R73W Sec. 21: S/2	L4

2.6.2 MINING CLAIMS

The following are valid unpatented lode mining claims located within the permit amendment area. There are no valid placer, tunnel or millsite claims of record. The map key refers to the map entitled "Mineral Lease and Claim Map" (Figure 2.6) and the map identifies the claims by each named claim block or group. The claim groups listed below do not correspond line by line with the land description, but do fall within the total land area described.

Owner	Claim Groups	Land Description			Map Key
Energy Fuels, Ltd.	Stu 1-90	T43N, R73W			C1
1200 17th St., Ste 2500	Rand 1-4	Sec.	27:	W/2	
Denver, CO 80202	George 1-4	Sec.	28:	W/2	
	Stu 99-108	Sec.	29:	S/2	
	Stu 119-123	Sec.	30:	E/2SE/4	
	Stu 203-205	Sec.	31:	NW/4NE/4	
	Muff 4, 5, 7	Sec.	32:	NE/4	
	Shar 1-4	Sec.	33:	N/2	
		Sec.	34:	W/2	

2.7 SURFACE OWNER CONSENTS

Pursuant to W.S. Sec. 35-11-406(b)(xi) and (xii), the parties listed below, consisting of all of the resident or agricultural landowners within the permit amendment area, were provided with a copy of the mining plan and reclamation plan, together with a request for each party's consent.

Surface Owners:

	Surface Owner	T43N, R73W	
1.	Bernice Groves	Sec. 22:	SW¼
		Sec. 27:	W½
		Sec. 28:	All
		Sec. 33:	W½
2.	James E. and Edra June Drake	Sec. 29:	E½, NW¼
3.	August G. Laur Trust	Sec. 29:	SW¼
4.	Lewella Laur Trust c/o August G. and Lewella Laur, Co-Trustees	Sec. 30:	E½SE¼
5.	Dorothy Reichmuth	Sec. 31:	NW¼NE¼
6.	Ms. Terry Berquist		
7.	Nolan and Ann Diehl		
8.	Rev. Eugene Sullivan		
9.	Rev. Gerald Sullivan		
10.	Clayton and Cindy McGuire	Sec. 33:	NE¼
		Sec. 34:	W½
11.	State Highway Commission of Wyoming Department of Transportation	Portions of: Secs. 21, 28, 29, 33	

Ranchers who may "receive a significant portion of their income from such ranching operations." (See W.S. Sec. 35-11-406(b)(xi)(B)):

Robert Roush	Sec. 29:	SW/4
	Sec. 30:	E/2SE/4
Sunburst Ranch Co., Inc.	Sec. 22:	SW/4
	Sec. 27:	W/2
	Sec. 28:	All
	Sec. 29:	N/2, SE/4
	Sec. 33:	W/2

All consent forms received are attached hereto as pages 2-26 through 2-38.

SURFACE LANDOWNER'S CONSENT

I, **BERNICE GROVES**, CERTIFY that I hold surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

SW/4, Section 22, T. 43 N., R. 73 W., 6 P.M.
W/2, Section 27, T. 43 N., R. 73 W., 6 P.M.
ALL, Section 28, T. 43 N., R. 73 W., 6 P.M.
W/2, Section 33, T. 43 N., R. 73 W., 6 P.M.

I have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give my consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 18th day of February, 1994.

SURFACE LANDOWNER

Bernice Groves

BERNICE GROVES
P.O. Box 408
Wright, WY 82732-0408

Witness:

Patricia L. Litton

Gene E. Litton

SURFACE LANDOWNER'S CONSENT

WE, **JAMES E. AND EDRA JUNE DRAKE**, husband and wife, CERTIFY that we hold surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

N/2 & SE/4, Section 29, T. 43 N., R. 73 W., 6 P.M.

We have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give our consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 21 day of February, 1994.

SURFACE LANDOWNERS

James E. Drake
JAMES E. DRAKE

Edra J. Drake
EDRA JUNE DRAKE
2501 E. Turney
Phoenix, AZ 85016
Edra June Drake

Witness:

Hilda [illegible]

____

SURFACE LANDOWNER'S CONSENT

We, **AUGUST G. LAUR and LEWELLA LAUR**, Co-Trustees of the **AUGUST G. LAUR TRUST** dated the 22nd day of March, 1990 (herein called the "Trust"), CERTIFY that the Trust holds surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

SW/4, Section 29, T. 43 N., R. 73 W., 6 P.M.
E/2SE/4, Section 30, T. 43 N., R. 73 W., 6 P.M.

We have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give our consent on behalf of the Trust to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 24 day of February, 1994.

SURFACE LANDOWNER

AUGUST G. LAUR TRUST

By: August G. Laur
AUGUST G. LAUR, Co-Trustee

By: Lewella Laur.
LEWELLA LAUR, Co-Trustee

245 E. Foote
Buffalo, WY 82834

Witness:

Velma Atwood

E A Atwood

SURFACE LANDOWNER'S CONSENT

We, **AUGUST G. LAUR and LEWELLA LAUR**, Co-Trustees of the **LEWELLA LAUR TRUST** dated the 22nd day of March, 1990 (herein called the "Trust"), CERTIFY that the Trust holds surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

SW/4, Section 29, T. 43 N., R. 73 W., 6 P.M.

E/2SE/4, Section 30, T. 43 N., R. 73 W., 6 P.M.

We have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give our consent on behalf of the Trust to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 24 day of February, 1994.

SURFACE LANDOWNER

LEWELLA LAUR TRUST

By: August G. Laur
AUGUST G. LAUR, Co-Trustee

By: Lewella Laur
LEWELLA LAUR, Co-Trustee

245 E. Foote
Buffalo, WY 82834

Witness:

Velma Atwood

E. O. Atwood

SURFACE LANDOWNER'S CONSENT

I, **DOROTHY REICHMUTH**, CERTIFY that I hold surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

NW/4NE/4, Section 31, T. 43 N., R. 73 W., 6 P.M.

I have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give my consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 18 day of February, 1994.

SURFACE LANDOWNER

Dorothy Reichmuth

DOROTHY REICHMUTH
1531 South 77th Street
Lincoln, NE 68506

Witness:

Christine M Engle

SURFACE LANDOWNER'S CONSENT

I, **TERRY BERQUIST**, CERTIFY that I hold surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

NW/4NE/4, Section 31, T. 43 N., R. 73 W., 6 P.M.

I have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give my consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 21 day of February, 1994.

SURFACE LANDOWNER

X (resident unable to sign due to crippling of hands)

TERRY BERQUIST
1003 Birch
Douglas, WY 82633

Witness:

Jacqueline M. Wirtz

Lloyd W. [illegible]

SURFACE LANDOWNER'S CONSENT

We, **NOLAN AND ANN DIEHL**, husband and wife, CERTIFY that we hold surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

NW/4NE/4, Section 31, T. 43 N., R. 73 W., 6 P.M.

I have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give my consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 23 day of February, 1994.

SURFACE LANDOWNER

Nolan Diehl
NOLAN DIEHL

Ann Diehl
ANN DIEHL

PO Box 334
Red Bluff, CA 96080

Witness:

Kathleen L. Haley

SURFACE LANDOWNER'S CONSENT

I, **REV. EUGENE SULLIVAN**, CERTIFY that I hold surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

NW/4NE/4, Section 31, T. 43 N., R. 73 W., 6 P.M.

I have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give my consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 23 day of Feb., 1994.

SURFACE LANDOWNER

Rev Eugene Sullivan

REV. EUGENE SULLIVAN
Box 2024
Sheridan, WY 82801

Witness:

Doris Pierson
420 Airport Rd Sh 56

SURFACE LANDOWNER'S CONSENT

I, **REV. GERALD SULLIVAN**, CERTIFY that I hold surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

NW/4NE/4, Section 31, T. 43 N., R. 73 W., 6 P.M.

I have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give my consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 21 day of Feb., 1994.

SURFACE LANDOWNER

Rev. Gerald Sullivan

REV. GERALD SULLIVAN
PO Box 5720
Cheyenne, WY 82003-5720

Witness:

M. Eileen Uphoff

SURFACE LANDOWNER'S CONSENT

I, **CLAYTON AND CINDY MCGUIRE**, CERTIFY that we hold surface rights on certain lands on which Energy Fuels Nuclear, Inc. holds mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

NE/4, Section 33, T. 43 N., R. 73 W., 6 P.M.

W/2, Section 34, T. 43 N., R. 73 W., 6 P.M.

I have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give my consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 25 day of February, 1994.

SURFACE LANDOWNER

Clayton McGuire
CLAYTON MCGUIRE

Cindy McGuire
CINDY MCGUIRE

PO Box 1070
Douglas, WY 82633

Witness:

Carol A. Holloway

Colleen G. Hickman

11. *STATE HIGHWAY COMMISSION OF WYOMING*
DEPARTMENT OF TRANSPORTATION
SURFACE OWNER CONSENT

PENDING

CONSENT REQUESTED BUT NOT YET RECEIVED

WILL BE FURNISHED UPON RECEIPT

12. *ROBERT ROUSH SURFACE OWNER CONSENT*

PENDING

CONSENT REQUESTED BUT NOT YET RECEIVED

WILL BE FURNISHED UPON RECEIPT

SURFACE LANDOWNER'S CONSENT

I, Urban Groves (name), the Pres. (title of officer) of **SUNBURST RANCH CO., INC.** (herein called "Sunburst Ranch"), CERTIFY that Sunburst Ranch holds surface rights and/or grazing rights on certain lands on which Energy Fuels Nuclear, Inc. hold mineral estate rights, which lands are located in Campbell County, Wyoming, and are described as follows:

SW/4, Section 22, T. 43 N., R. 73 W., 6 P.M.
W/2, Section 27, T. 43 N., R. 73 W., 6 P.M.
ALL, Section 28, T. 43 N., R. 73 W., 6 P.M.
N/2 & SE/4, Section 29, T. 43 N., R. 73 W., 6 P.M.
W/2, Section 33, T. 43 N., R. 73 W., 6 P.M.

I have examined the mining plans and reclamation plan prepared by Energy Fuels Nuclear, Inc. in compliance with the WYOMING ENVIRONMENTAL QUALITY ACT of 1973 as amended, and do hereby approve said plans, and hereby give my consent to enter and carry out said mining and reclamation programs on said lands as proposed therein.

Dated this 18 day of Feb., 1994.

SURFACE LANDOWNER

SUNBURST RANCH CO., INC.
a Wyoming corporation

By: Sunburst Ranch Inc.
Name: Urban Groves
Title: Pres.

Witness:
Gene E Litton
Patricia L Litton

LEGEND
SH State of Wyoming
Note: This Map Refers to Both Appendix A and Appendix B
TODD RD
CLARKELEN RD
BOUNDARY OF PERMIT AREA
HWY 387
COSNER
SA
SB
SC
SD
SE
SF
SG
SH
SJ
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
1
6
5
4
3
FEET
energy fuels nuclear inc.
RENO CREEK ISL PROJECT
County Campbell
State Wyoming
T 42 & 43 N, R 73 W
SURFACE OWNERSHIP MAP
Scale 1"=2000
Date January 1997

Figure 2.1

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

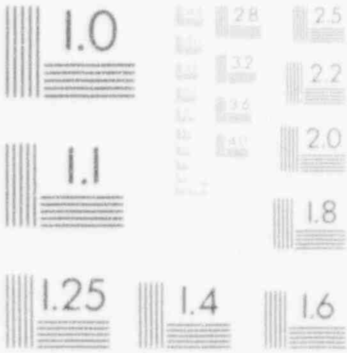
IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)



150mm

6"

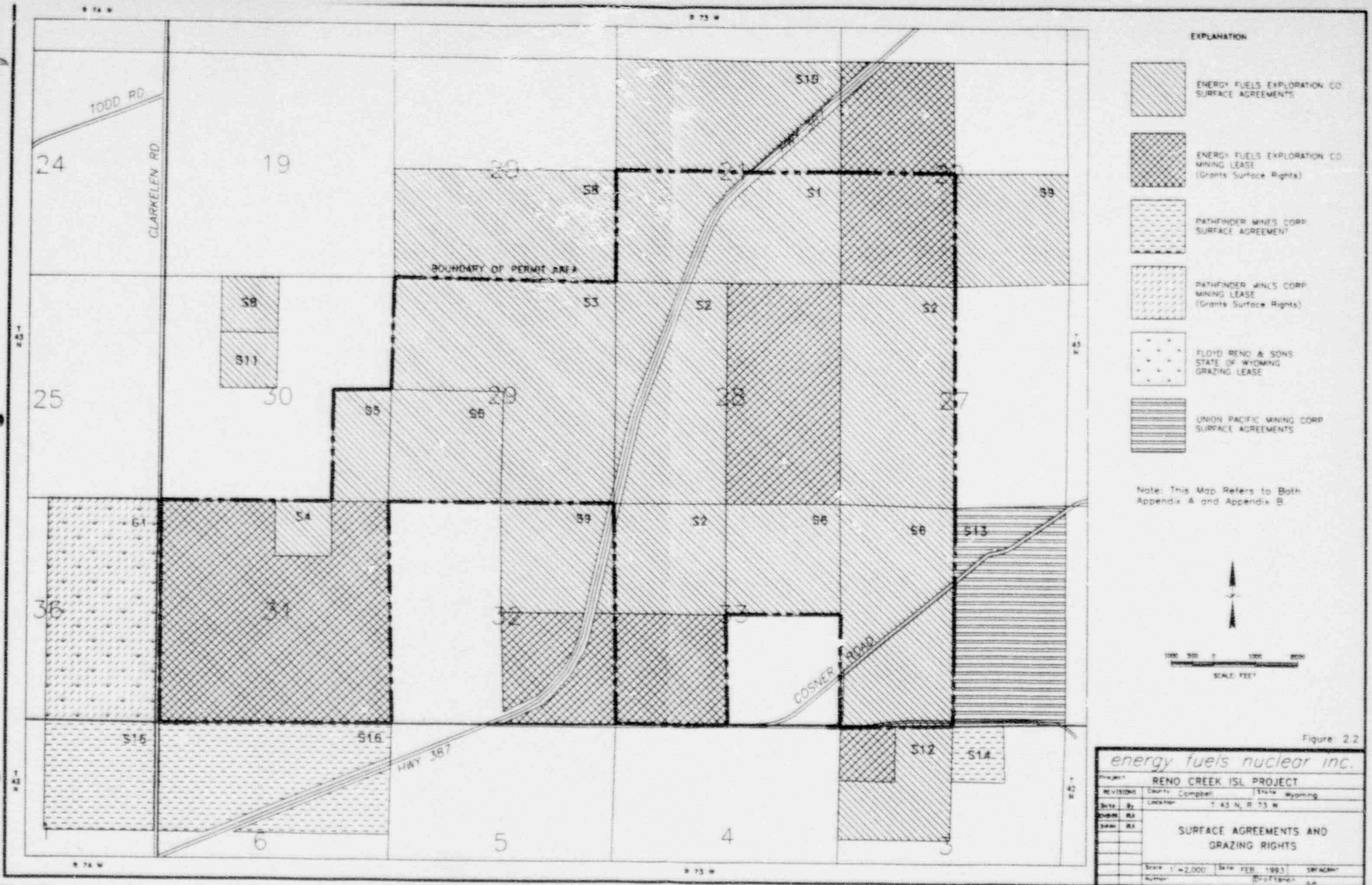
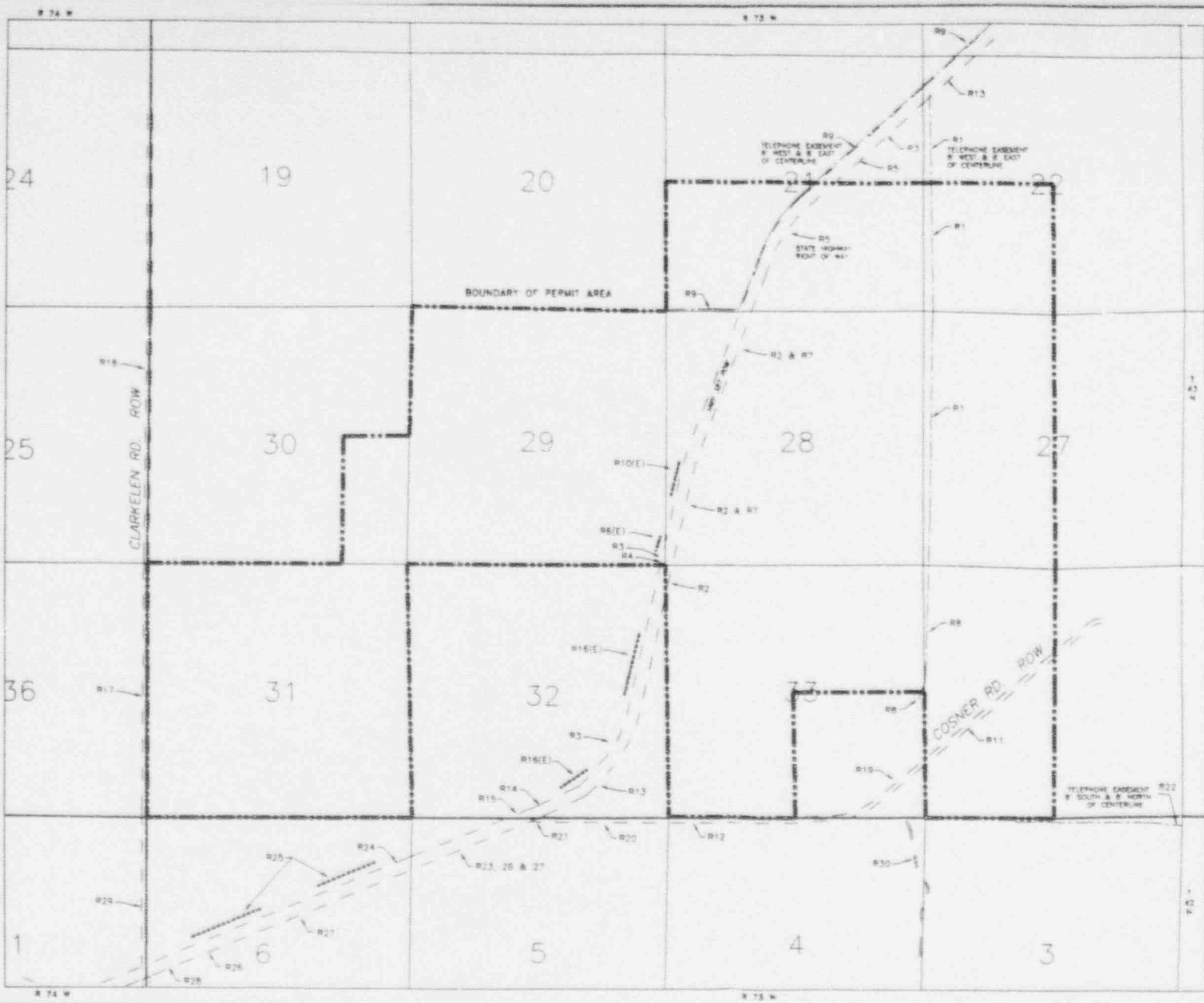

EXPLANATION
ENERGY FUELS EXPLORATION CO SURFACE AGREEMENTS
ENERGY FUELS EXPLORATION CO MINING LEASE (Grants Surface Rights)
PATHFINDER MINES CORP SURFACE AGREEMENT
PATHFINDER MINES CORP MINING LEASE (Grants Surface Rights)
FLOYD RENO & SONS STATE OF WYOMING GRAZING LEASE
UNION PACIFIC MINING CORP SURFACE AGREEMENTS
Note: This Map Refers to Both Appendix A and Appendix B.
SCALE: FEET
TODD RD
CLARKELEN RD
BOUNDARY OF PERMIT AREA
HWY 387
COSNER ROAD
24
19
25
30
29
28
27
36
31
32
33
6
5
4
3
S1
S2
S3
S4
S5
S6
S8
S9
S11
S12
S13
S14
S15
S16
S18
G1
energy fuels nuclear inc.
RENO CREEK ISL PROJECT
County Campbell
State Wyoming
Location T 43 N, R 73 W
SURFACE AGREEMENTS AND GRAZING RIGHTS
Scale 1"=2,000'
Date FEB. 1993

Figure: 2.2



LEGEND

= = =	HIGHWAY RIGHT OF WAYS
— · — · —	TELEPHONE COMPANY EASEMENTS
■ · · ■ · · ■	PERMIT AREA BOUNDARY
·········	SNOW FENCE RIGHT OF WAY EASEMENT (E) ESTIMATED LOCATION

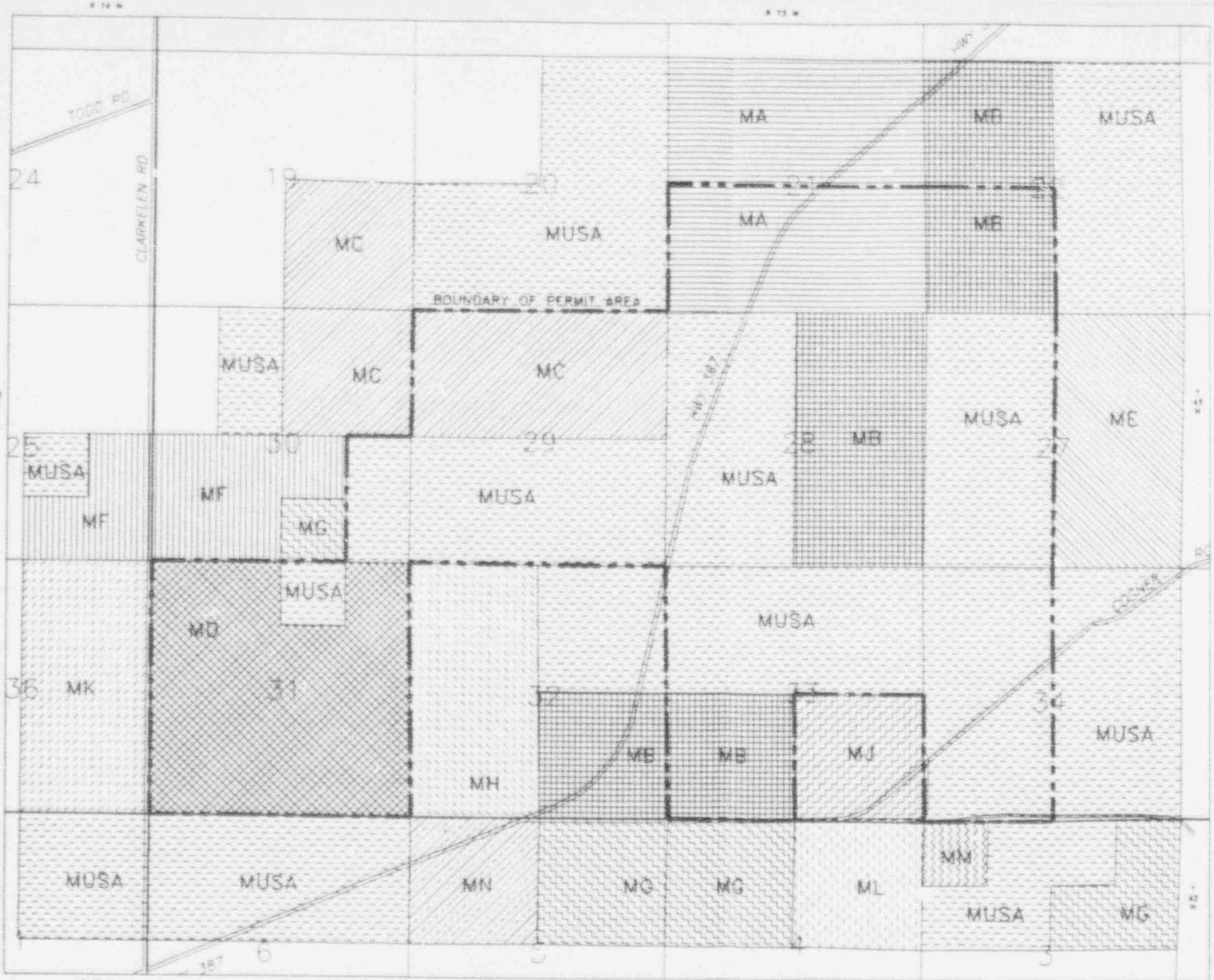
"R" Series Numbers Refer to Rights of Ways Listed in Both Appendix A and Appendix B

SCALE FEET

Figure 2.3

energy fuels nuclear inc.

Project	RENO CREEK PROJECT
County	Campbell
State	Wyoming
Location	T 43 N, R 73 W
	RIGHT OF WAYS
Scale	1"=2,000'
Date	FEB. 1983



Note: This Map Refers to Both Appendix A and Appendix B

SCALE FEET

Figure: 2.4

energy fuels nuclear inc.

Project	RENO CREEK PROJECT
County	Campbell
State	Wyoming
Location	T 42 & 43 N, R 73 W
Title	MINERAL OWNERSHIP MAP
Scale	1" = 2,000'
Date	Jan. 1993
Draftsman	D.L. Siems

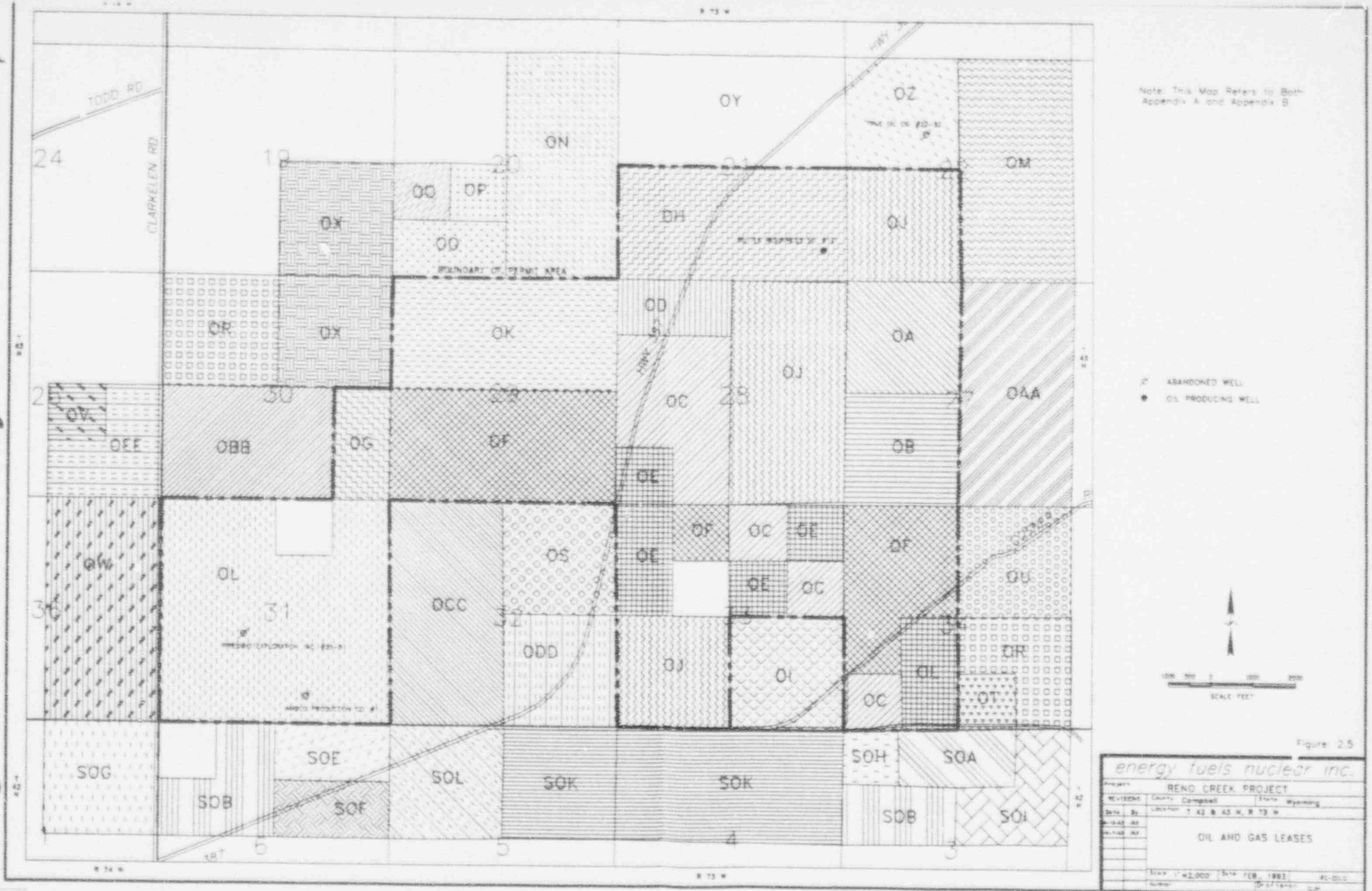
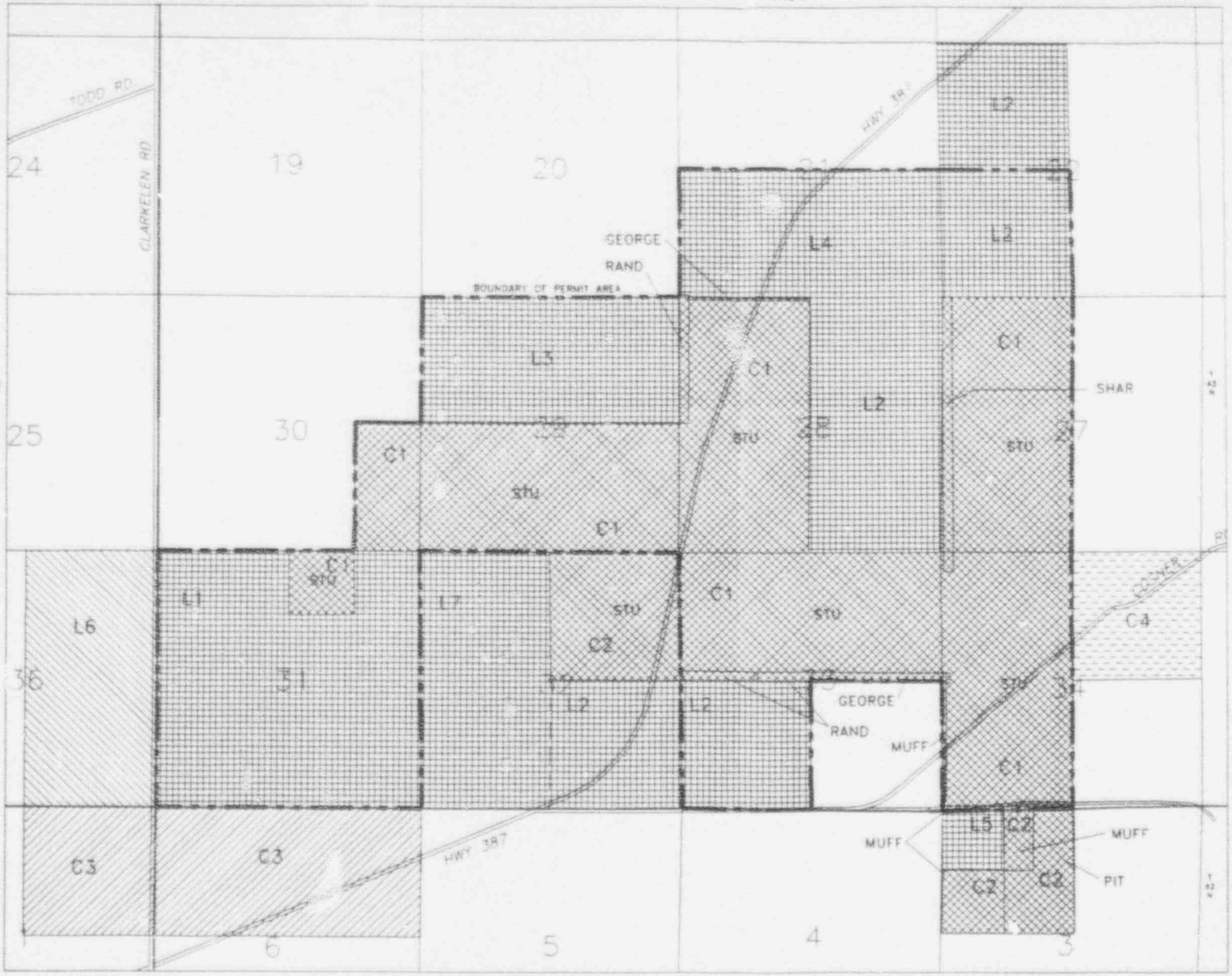

Note: This Map Refers to Both Appendix A and Appendix B
ABANDONED WELL
OIL PRODUCING WELL
SCALE FEET
TODD RD
CLARKELEN RD
BOUNDARY OF PERMIT AREA
OY
OZ
ON
OM
OQ
OP
OO
OX
DH
OJ
OR
OK
OD
OA
OAA
OV
OEE
OBB
OG
OF
OC
OB
OE
OW
OL
OCC
OS
ODD
OI
OU
DR
OT
SOG
SOB
SOE
SOF
SOL
SOK
SOH
SOA
SOI
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
1
6
5
4
3
energy fuels nuclear inc.
RENO CREEK PROJECT
County Campbell
State Wyoming
OIL AND GAS LEASES
FEB., 1983

Figure 2.5



EXPLANATION

- ENERGY FUELS EXPLORATION COMPANY MINERAL LEASES
- ENERGY FUELS EXPLORATION COMPANY MINERAL CLAIMS
- PATHFINDER MINES CORP MINERAL LEASE
- PATHFINDER MINES CORP MINERAL CLAIMS
- RME PARTNERS, L.P. MINERAL CLAIMS

Note: This Map Refers to Both Appendix A and Appendix B

SCALE FEET (1000 500 0 1000 2000)

Figure 2.6

energy fuels nuclear inc.

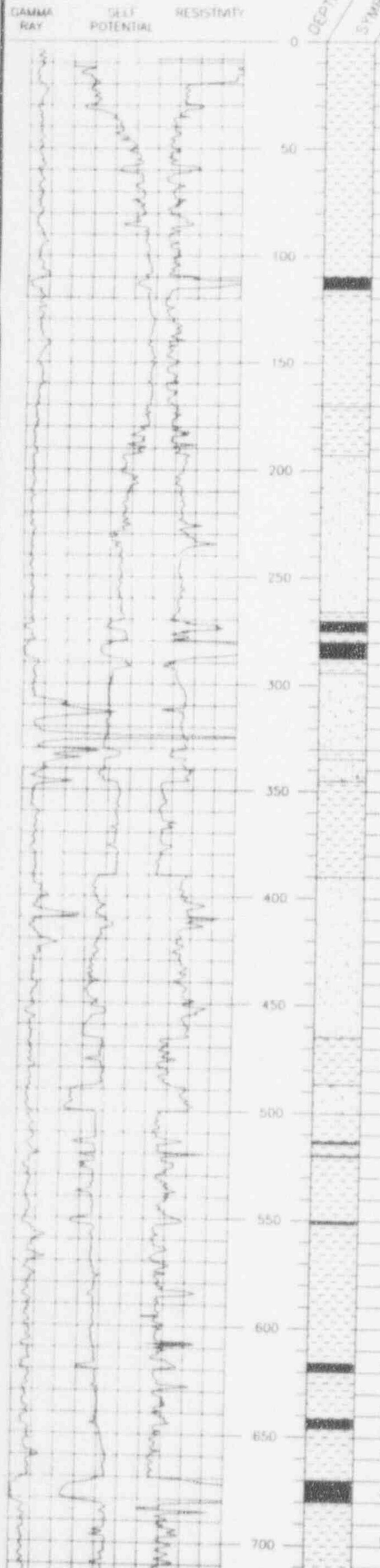
Project	RENO CREEK ISL PROJECT
County	Campbell
State	Wyoming
Location	T 43 N, R 73 W
	MINERAL LEASE & CLAIM MAP
Scale	1"=2,000
Date	FEB., 1993
	MINLEASE

2-44

RENO CREEK PROJECT

TYPE LOG DRILLHOLE RN-3937
SE NE SECTION 29, T43N, R73W

LOG SCALE: 1"=50'



LITHOLOGY	DESCRIPTION
CLAYSTONE	Surface oxidation 0' to 30' Dark yellow brown
CLAYSTONE	30' to 110' Medium gray to blue gray with occasional silty stringers Traces of carbonaceous material as interbedded, sooty trash
	110' to 114' Brown-black to black carbonaceous shale/lignite
CLAYSTONE	114' to 170' blue grey claystone
CLAYSTONE	170' to 193' Silty medium grey claystone
SANDSTONE	193' to 267' UPPER AQUIFER Medium to light gray sandstone, medium grained, good to moderate sorting, sub-angular, traces of fresh pyrite, traces of interbedded carbon trash
CLAYSTONE	267' to 270'
LIGNITE & CLAYSTONE	270' to 275' and 280' to 287' FELIX COAL Coal unit divided by medium gray claystone. Coal beds brown-black to black, vitreous, sub-bituminous. Claystone to 293'
SANDSTONE	293' to 345' UPPER ORE SAND Medium gray and light olive gray sandstone, medium grained, good to moderate sorting, sub-angular, traces of fresh pyrite, traces of in[illegible]bedded carbon trash, claystone at 330', oxidized below 310'
CLAYSTONE	345' to 390' Medium blue gray to dark gray
SANDSTONE	390' to 465' LOWER ORE SAND Medium gray sandstone, medium to coarse grained, moderate sorting, angular, traces of fresh pyrite, traces of interbedded carbon trash
CLAYSTONE	465' to 488' medium blue grey claystone
SANDSTONE	488' to 500' Medium gray sandstone, medium grained, good to moderate sorting sub-angular, traces of interbedded carbon trash
CLAYSTONE	500' to 615' Dark gray, medium gray to medium blue gray claystone. Lignitic stringers and traces of interbedded carbon trash Calcite stringers 580' to 585', 605' to 610'
LIGNITE	615' to 620' Lignite stringer
CLAYSTONE	
LIGNITE	620' to 670' Medium to dark gray claystone
CLAYSTONE	625' to 630' Calcite stringers
	642' to 645' Lignite stringers
COAL	670' to 680' COAL
CLAYSTONE	670' to T.D. Dark gray claystone 680' to 685' Calcite stringers

Figure 9.3

3. NAMES AND LAST KNOWN ADDRESSES OF OWNERS OF RECORD WITHIN ONE-HALF MILE OF THE PERMIT AMENDMENT AREA BOUNDARY

The owners and interest holders of record in the following lists were obtained from the records of the Campbell County Clerk and Recorder, the Campbell County Assessor's Office, the Wyoming Office of the Bureau of Land Management, the Wyoming State Land Department, and by independent research. The ownership lists given below are divided into sections according to type of ownership or interest *and new sections 3.7 and 3.8 have been added to contain the master mailing notification lists and proof of mailings*. For reference, they are:

- 3.1 Surface Ownership
- 3.2 Surface Rights Granted by Surface Use Agreements or Grazing Leases
- 3.3 Surface Rights Granted by Rights of Way or Easements
- 3.4 Mineral Ownership (All Minerals, including Oil and Gas)
- 3.5 Oil and Gas Leasehold Interests
  - 3.5.1 Federal Oil and Gas Leasehold Interests
  - 3.5.2 State Oil and Gas Leasehold Interests
  - 3.5.3 Private Oil and Gas Leasehold Interests
  - 3.5.4 Oil and Gas Wells
  - 3.5.5 Overriding Royalty Interest Holders
- 3.6 Mineral Interests (other than Oil and Gas)
  - 3.6.1 Mineral Leases
  - 3.6.2 Mining Claims
- *3.7 Master Mailing Notification List*
  - *3.7.1 Surface Owners Inside Permit Amendment Area*
  - *3.7.2 Surface Owners within 1/2 Mile of Permit Amendment Area*
  - *3.7.3 Operators of Oil and Gas Wells Inside Permit Amendment Area*
  - *3.7.4 Lessees of Oil and Gas Leases Inside Permit Amendment Area With No Operating Wells*
  - *3.7.5 Others With Surface Interests From Whom Surface Consents Were Sought*
  - *3.7.6 Consolidated, Alphabetical Mailing List*
- *3.8 Proof of Mailings*

3.1 SURFACE OWNERSHIP

Owners of the surface estate or any portion thereof are listed below with their corresponding land descriptions and a map key which refers to a map entitled "Surface Ownership Map" (Figure 2.1). All lands listed in this permit application that were deeded to the State Highway Commission for State Highway 387 are also listed in the section entitled "Surface Rights Granted by Rights of Way or Easements" and are shown on the map entitled "Rights of Ways" (Figure 2.3).

Surface Ownership	Land Description	Map Key
Bernice Groves P.O. Box 408 Wright, WY 82732-0408	T43N, R73W Sec: 22: N/2, SE/4 27: E/2 32: E/2	SA
The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708 (for State Highway 387 conveyed by Warranty Deed)	T43N, R73W (portions of) Sec. 22: NW/4NW/4 32: E/2NE/4, E/2SE/4, SW/4SE/4	SA
(Heirs of Sinadin Estate, 1/5th to each) Ms. Terry Berquist 1003 Birch Douglas, WY 82633	T43N, R73W Sec. 30: SE/4NW/4	SB
Nolan and Ann Diehl PO Box 334 Red Bluff, CA 96080	T42N, R74W Sec. 1: SE/4NE/4 T42N, R73W Sec. 6: Lot 4	SB
Dorothy Reichmuth 1531 S. 77th St. Lincoln, NE 68506		SB
Rev. Eugene Sullivan Box 2024 Sheridan, WY 82801		SB
Rev. Gerald Sullivan *PO Box 5720* *Cheyenne, WY 82003-5720*		SB

August G. Laur Trust 50% *c/o August G. and Lewella* *Laur, Co-Trustees* 245 E. Foote St. Buffalo, WY 82834	T43N, R73W Sec. 30: NW/4SE/4, SW/4 T43N, R74W Sec. 25: SE/4	SC
Lewella Laur Trust 50% *c/o August G. and Lewella* *Laur, Co-Trustees* 245 E. Foote St. Buffalo, WY 82834	T42N, R74W Sec. 1: W/2NE/4, NE/4NE/4	
June M. Thielen-Stangler and John R. Thielen HCR 61 Box 5333 Danbury, Wisconsin 54873	T43N, R73W Sec. 21: N/2	SD
The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708 (for State Highway 387 conveyed by Warranty Deed)	T43N, R73W (portions of) Sec. 21: S/2NE/4, NE/4NE/4	SD
Clayton and Cindy McGuire 42 Chalk Buttes Rd. Douglas, WY 82633 beginning 10/24/93: 1460 Hwy 59 PO Box 1070 Douglas, WY 82633	T43N, R73W Sec. 33: SE/4 34: E/2	SE
James E. and Edra June Drake 2501 E. Turney Phoenix, AZ 85016	T43N, R73W Sec. 19: SE/4 20: S/2, NE/4 30: NE/4, NE/4NW/4	SF

Justin Joe Reno P.O. Box 2529 Gillette, WY 82717 Subject to Option to Purchase with Right of First Refusal to: Bridle Bit Ranch Company 6546 Highway 59 Gillette, WY 82716	T43N, R73W Sec. 30: SW/4SE/4 32: W/2 T42N, R73W Sec. 3: N/2 4: N/2 5: Lots 3 and 4 lying north of Hwy 387 6: Lot 1 lying north of Hwy 387 Lots 2, 3, 5 SE/4NW/4 & SW/4NE/4 lying north of Hwy 387	SG
The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708 (for State Highway 387 conveyed by Warranty Deed)	T43N, R73W (portions of) Sec. 32: SE/4SW/4	SG
The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708 (for State Highway 387 conveyed by Warranty Deed)	T42N, R73W Sec. 5: Portion of Lots 3 and 4 6: Portion of Lot 5, SE/4NE/4, S/2NE/4	SG & SJ
State of Wyoming Commissioner of Public Lands 122 West 25th St. Herschler Bldg, 3 West Cheyenne, WY 82002-0600	T43N, R74W Sec. 36: E/2	SH

3.2 SURFACE RIGHTS GRANTED BY SURFACE USE AGREEMENTS OR GRAZING LEASES

The reference under the column entitled Map Key refers to the map entitled "Surface Agreements and Grazing Rights" (Figure 2.2). Note that the map includes areas without a map key reference where surface rights are granted under a mining or mineral lease. Mining leases were included on this map to make it clear that *Energy Fuels, Ltd.* has the right to the surface throughout the permit amendment area. The mining and mineral leases on lands within one-half mile of the permit amendment area boundary are listed under Section 3.6.1 below and are more fully identified on their corresponding map entitled "Mineral Lease and Claim Map" (Figure 2.6).

The following are recorded surface use agreements between private parties:

Grantor / Grantee	Land Description	Map Key
James E. and Edra Drake, Grantor (successor) *Energy Fuels, Ltd.*, Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (split under Willard SOA)	T43N, R73W Sec. 20: S/2 30: NE/4NW/4	S8
Bernice Groves, Grantor (successor) *Energy Fuels, Ltd.*, Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (split under Willard SOA)	T43N, R73W Sec. 22: SE/4 32: NE/4	S9
June M. Thielen-Stangler and John R. Thielen, Grantors (successors) *Energy Fuels, Ltd.*, Company, Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (Thielen SOA)	T43N, R73W Sec. 21: N/2	S10

Dorothy Reichmuth, et al., Grantors (successors) *Energy Fuels, Ltd.*, Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (Sinadin SOA)	T43N, R73W Sec. 30: SE/4NW/4	S11
Justin Joe Reno, Grantor (successor) *Energy Fuels, Ltd.*, Grantee 1200 17th St., Ste 2500 Denver, CO 80202 (Reno SOA)	T42N, R73W Sec. 3: Lot 3, S/2NW/4	S12
Clayton and Cindy McGuire, Grantors (successors) Union Pacific Mining Corporation, Grantee PO Box 7 Ft Worth, Texas 76101-0007 (Underwood SOA)	T43N, R73W Sec. 34: E/2	S13
Floyd C. Reno & Sons, Inc., Grantor Pathfinder Mines Corp., Grantee 7401 Wisconsin Ave. Bethesda, MD 20814-3416	T42N, R73W Sec. 3: Lot 2	S14
August G. Laur, Grantor Pathfinder Mines Corp., Grantee 7401 Wisconsin Ave. Bethesda, MD 20814-3416	T42N, R73W Sec. 1: Lots 1, 2 SW/4NE/4	S15

Floyd C. Reno & Sons, Inc., Grantor Pathfinder Mines Corp., Grantee 7401 Wisconsin Ave. Bethesda, MD 20814-3416	T42N, R73W Sec. 6: Lots 1, 2, 3 S/2N/2	S16
Justin Joe Reno, Grantor Pathfinder Mines Corp., Grantee 7401 Wisconsin Ave. Bethesda, MD 20814-3416	T42N, R73W Sec. 6: Lots 2, 3, 5 and those parts of Lots 1, 6, SW/4NE/4 and SE/4NW/4 lying north of Hwy 387	S16
Dorothy Reichmuth, Grantor Pathfinder Mines Corp., Grantee 7401 Wisconsin Ave. Bethesda, MD 20814-3416	T42N, R73W Sec. 6: Lot 4 T42N, R74W Sec. 1: SE/4NE/4	S16 S15

The following is a state surface use agreement:

Lessor / Lessee	Type/Lease No.	Land Description	Map Key
State of Wyoming, Lessor Floyd C. Reno & Sons, Inc., Lessee Box 704 Teckla Route Gillette, WY 82716	Grazing & Agricultural Lease #2-3965	T43N, R74W Sec. 36: E/2	G1

Although no surface and/or grazing lease is recorded in the county records for the following, Robert Roush may be a surface lessee of lands currently leased under the Mining Lease between *Energy Fuels, Ltd.* and August and Lewella Laur on the following areas which lie within one-half mile of the permit amendment area boundary:

Possible Lessee	Land Description	Map Key
Robert Roush 113 Todd Gillette, WY 82718	T43N, R73W Sec. 30: NW/4SE/4, SW/4 T43N, R74W Sec. 25: SE/4 T42N, R74W Sec. 1: N/2NE/4, SW/4NE/4 (additional lands, if any, unknown)	none

Therefore, Robert Roush will be given notice of this permit application.

Although no surface and/or grazing lease is recorded in the county records for the following, Sunburst Ranch Co., Inc. may be surface lessee of the same lands currently leased under one or more of the following: (i) the Mining Lease between *Energy Fuels, Ltd.* and Edward R. and Blanche Willard; (ii) the Mining Lease between *Energy Fuels, Ltd.* and Urban and Bernice Groves; and (iii) Surface Owners Agreement between *Energy Fuels, Ltd.* and Edward and Blanche Willard. All of such documents are listed in the appropriate sections of these appendices. The exact lands that may be included in a surface and/or grazing lease betwee the surface owners and Sunburst Ranch Co., Inc. is unknown, but may include the following lands within one-half mile of the permit amendment area boundary:

Possible Lessee	Land Description	Map Key
Sunburst Ranch Co., Inc. Box 408 Wright, WY 82732	T43N, R73W Sec. 19: SE/4 20: E/2, SW/4 22: SE/4, N/2 27: E/2 30: NE/4, NE/4NW/4	none

Therefore, Sunburst Ranch Co., Inc., will be given notice of this permit application.

3.3 SURFACE RIGHTS GRANTED BY RIGHTS OF WAYS OR EASEMENTS

The documents which granted rights of ways and easements are listed below. The land description given with each is the general quarter section description to help identify its location on the corresponding map entitled "Rights of Way" (Figure 2.3). Each complete right of way as shown on the map may have been obtained through several different conveyance documents from the different landowners within the area. Each map key reference refers only to that section of each right of way or easement that was conveyed through its corresponding document. Also note that the State Highway Department obtained rights of ways for State Highway 387, then later obtained deeds for the same highway. Both the right of way documents and deeds are listed for reference.

Type / Grantor / Grantee	Land Description	Map Key
Telephone Right of Way Easement Grantor: Edward R. Willard Grantee: The Mountain States Telephone and Telegraph Company 931 14th St. Denver, CO 80202	T43N, R73W Sec. 22: W/2NW/4	R1

Road Right of Way Easement for State Highway 387 Grantor: L.J. and Emma M. Gilbert Grantee: State of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T43N, R73W Sec. 21: S/2NE/4, NE/4NE/4	R3
Warranty Deed (for State Highway 387) Grantor: John B. and Irene H. Thielen Grantee: The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T43N, R73W Sec. 21: S/2NE/4, NE/4NE/4	R5
Telephone Right of Way Easement Grantor: John B. Thielen Grantee: The Mountain States Telephone and Telegraph Company 931 14th St. Denver, CO 80202	T43N, R73W Sec. 21: E/2NE/4, SW/4NE/4 22: NW/4NW/4	R9
Warranty Deed (for State Highway 387) Grantor: Edward R. and Blanche Willard Grantee: The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T43N, R73W Sec. 22: NW/4NW/4 32: E/2NE/4, E/2SE/4, SW/4SE/4	R13
Road Right of Way Easement for State Highway 387 Grantor: John M. and Edith M. Paisley Grantee: State of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T43N, R73W Sec. 22: NW/4NW/4 32: E/2E/2, SW/4SE/4	R13

Warranty Deed (for State Highway 387) Grantor: Justin Joe and Debra Kay Reno Grantee: The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	<u>T43N, R73W</u> Sec. 32: SE/4SW/4	R14
Road Right of Way Easement for State Highway 387 Grantor: C. H. Tucker Grantee: State of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	<u>T43N, R73W</u> Sec. 32: SE/4SW/4	R15
Telephone Right of Way Easement Grantor: Harry R. and Harriet Underwood Grantee: The Mountain States Telephone and Telegraph Company 931 14th St. Denver, CO 80202	<u>T43N, R73W</u> Sec. 33: E/2SE/4	R8
Snow Fence Right of Way Easement Grantor: Edward R. and Blanche Willard Grantee: Wyoming State Highway Dept. P.O. Box 1708 Cheyenne, WY 82003-1708	<u>T43N, R73W</u> Sec. 32: E/2E/2, SW/4SE/4	R16
Road Right of Way Easement for the Clarkelen County Road Grantor: State of Wyoming Grantee: Campbell County Road and Bridge Department 500 S. Gillette Ave. Gillette, WY 82716	<u>T43N, R74W</u> Sec. 36: E/2E/2	R17
Road Right of Way Easement for the Clarkelen County Road Grantor: August G. Laur Grantee: Campbell County Road and Bridge Department 500 S. Gillette Ave. Gillette, WY 82716	<u>T43N, R74W</u> Sec. 25: E/2SE/4 <u>T42N, R74W</u> Sec. 1: E/2NE/4NE/4	R18 R29

Road Right of Way Easement for the Clarkelen County Road Grantor: John L. Sinadin Grantee: Campbell County Road and Bridge Department 500 S. Gillette Ave. Gillette, WY 82716	<u>T42N, R74W</u> Sec. 1: E/2SE/4NE/4	R29
Road Right of Way Easement for the Cosner County Road Grantor: Harry R. Underwood Grantee: Campbell County Road and Bridge Department 500 S. Gillette Ave. Gillette, WY 82716	<u>T43N, R73W</u> Sec. 33: S/2SE/4 34: N/2NE/4	R19
Road Right of Way Easement for the Cosner County Road Grantor: Edward R. Willard Grantee: Campbell County Road and Bridge Department 500 S. Gillette Ave. Gillette, WY 82716	<u>T43N, R73W</u> Sec. 32: S/2SE/4	R20
Road Right of Way Easement for the Cosner County Road Grantor: Floyd C. Reno and Sons, Inc. Grantee: Campbell County Road and Bridge Department 500 S. Gillette Ave. Gillette, WY 82716	<u>T43N, R73W</u> Sec. 32: SE/4SW/4	R21
Telephone Right of Way Easement Grantor: Justin Joe Reno Grantee: The Mountain States Telephone and Telegraph Company 931 14th St. Denver, CO 80202	<u>T42N, R73W</u> Sec. 3: Lots 1 and 2	R22
Easement (private roadway right of way) Grantor: Justin Joe Reno Grantee: Bridle Bit Ranch Company 6546 Highway 59 Gillette, WY 82716	<u>T42N, R73W</u> Sec. 3: portion NW/4 4: portion NE/4	R30

Road Right of Way Easement for State Highway 387 Grantor: Blanche and Wm. J. O'Neill Grantee: State of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T42N, R73W Sec. 5: Lots 3 and 4 6: Lots 1 and 6, S/2N/2	R23 R24
Snow Fence Right of Way Easement Grantor: Justin Joe Reno Grantee: State of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T42N, R73W Sec. 6: Lots 1 and 5, SW/4NE/4, SE/4NW/4	R25
Warranty Deed for State Highway 387 Grantor: Justin Joe and Debra Kay Reno Grantee: The State Highway Commission of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T42N, R73W Sec. 5: Portion of Lots 3 and 4 6: Portion of Lot 5, SE/4NE/4, S/2NE/4	R26
Road Right of Way Easement for State Highway 387 Grantor: Floyd C. Reno & Sons, Inc. Grantee: State of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T42N, R73W Sec. 5: Lots 3 and 4 6: Lot 6, NE/4SW/4, SE/4NW/4, S/2NE/4	R27
Fence Right of Way Easement Grantor: Floyd C. Reno & Sons, Inc. Grantee: State of Wyoming Department of Transportation P.O. Box 1708 Cheyenne, WY 82003-1708	T42N, R73W Sec. 6: Lot 6	R28

3.4 MINERAL OWNERSHIP (ALL MINERALS, INCLUDING OIL AND GAS)

The following lists all persons or entities who own the minerals in the lands within one-half mile of the permit amendment area boundary. The map key refers to the map entitled "Mineral Ownership Map" (Figure 2.4).

Mineral Ownership	Percent Interest	Land Description	Map Key
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00	T43N, R73W Sec. 20: S/2, NE/4 22: E/2 30: E/2NW/4 32: NE/4 34: E/2 T43N, R74W Sec. 25: NW/4SE/4 T42N, R74W Sec. 1: NE/4 T42N, R73W Sec. 3: Lot 2 6: N/2	MUSA
Arnold Royalty P.O. Box 1119 Lafollette, TN 37766	3.125 (except coal)	T43N, R73W Sec. 21: N/2	MA
Norma Craft Cannon Trust c/o First Union National Bank of North Carolina, Co-Trustee P.O. Box 467 Concord, NC 28026-0467	6.250 (except coal)		MA
Fortin Enterprises, Inc. P.O. Box 2416 Billings, MT 59103	5.469 (except coal)		MA
Hancock Enterprises P.O. Box 2527 Billings, MT 59103	5.469 (except coal)		MA

Dortha Ickes Trust 824 N.W. Spruce Ridge Dr. Stuart, FL 34994	25.000 (except coal)		MA
Stanley Ickes Trust 824 N.W. Spruce Ridge Dr. Stuart, FL 34994	25.000 (except coal)		MA
John R. Thielen, June M. Thielen-Stangler and John T. Jones HCR 61 Box 5333 Danbury, Wisconsin 54873	25.00 (except coal)		MA
Robert Foard Townsend Testamentary Trust c/o Robert Foard Townsend III, Trustee 217 West Castano San Antonio, TX 78207	1.562 (except coal)		MA
WGR, Inc. Suite 230 12200 N. Pecos St. Denver, CO 80234-3439	3.125 (except coal) 100.000		MA
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MA
Edward R. Willard Estate 410 S. 6th St. Gillette, WY 82716	50.00 (except coal)	<u>T43N, R73W</u> Sec. 22: NW/4 32: SE/4	MB
Blanche Willard 410 S. 6th St. Gillette, WY 82716	50.00 (except coal) 100.00		MB

United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	*100.00 (coal)*		*MB*
Arnold Royalty P.O. Box 1119 Lafollette, TN 37766	3.125 (except coal)	<u>T43N, R73W</u> Sec. 19: SE/4 30: NE/4	MC
Norma Craft Cannon Trust c/o First Union National Bank of North Carolina, Co-Trustee P.O. Box 467 Concord, NC 28026-0467	6.250 (except coal)		MC
Fortin Enterprises, Inc. P.O. Box 2416 Billings, MT 59103	5.469 (except coal)		MC
Urban Groves, et ux. P.O. Box 408 Wright, WY 82732-0408	10.0000 (except coal)		MC
Hancock Enterprises P.O. Box 2527 Billings, MT 59103	5.469 (except coal)		MC
Dortha Ickes Trust 824 N.W. Spruce Ridge Dr. Stuart, FL 34994	22.500 (except coal)		MC
Stanley Ickes Trust 824 N.W. Spruce Ridge Dr. Stuart, FL 34994	22.500 (except coal)		MC
June M. Thielen-Stangler, John R. Thielen and John T. Jones HCR 61 Box 5333 Barnes, WI 54873	20.000 (except coal)		MC

Robert Foard Townsend Testamentary Trust c/o Robert Foard Townsend III, Trustee 217 W. Castano San Antonio, TX 78209	1.562 (except coal)		MC
WGR, Inc. Suite 230 12200 N. Pecos St. Denver, CO 80234-3439	3.125 (except coal)		MC
	100.000		
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MC
Edra June Drake 2501 E. Turney Phoenix, AZ 85016	50.00 (except oil and coal)	T43N, R73W Sec. 27: E/2	ME
Bernice Groves, et vir. P.O. Box 408 Wright, WY 82732-0408	50.00 (except oil and coal)		ME
	100.00		
Nebraska Children's Home Society 3549 Fontenelle Blvd. Omaha, NE 68104	50.00 (oil)		ME
Ned A. Pickett, et ux. 26501 Via Conchita Mission Viejo, CA 92675 leased by: Betty Wolff, formerly Betty W. Collins, formerly Betty W. Pickett 526 Alto St Santa Fe, NM 87501	50.00 (oil)		ME
	100.00		

United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		ME
August G. Laur Trust *c/o August G. and Lewella Laur, Co-Trustees* 245 E. Foote St. Buffalo, WY 82834	25.00 (except coal)	<u>T43N, R73W</u> Sec. 30: SW/4, NW/4SE/4	MF
		<u>T43N, R74W</u> Sec. 25: E/2SE/4, SW/4SE/4	MF
Lewella Laur Trust *c/o August G. and Lewella Laur, Co-Trustees* 245 E. Foote St. Buffalo, WY 82834	25.00 (except coal)		
J. K. Spittler Trust c/o John J. Spittler Route #1, Box 528 Norfolk, NE 68701	25.00 (except coal)		MF
Joseph Spittler 250 S. Ocean Blvd. 18C Boca Raton, FL 33432	25.00 (except coal)		
	100.00		
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MF

Adobe Oil and Gas Corporation 1100 Western Life Bldg. Midland, TX 79701	22.000 (except coal)	<u>T43N, R73W</u> Sec. 30: SW/4SE/4 <u>T42N, R73W</u> Sec. 3: Lot 1,	MG
Altrogge Resources Company 6901 E. Walsh Pl. Denver, CO 80224	1.5000 (except coal)	S/2NE/4 4: NW/4 5: NE/4	MG
W.E. Bakken 1445 Denver Club Bldg. Denver, CO 80202	0.7500 (except coal)		MG
Reeva E. Donoghue 3421 S. Race St. Denver, CO 80110	0.5625 (except coal)		MG
Larry J. Donoghue 11829 Broken Arrow Dr. Conifer, CO 80433	0.1875 (except coal)		MG
Harriet P. Reno, et al., Trustees P.O. Box 36 Gillette, WY 87216	25.0000 (except coal)		MG
Justin Joe Reno P.O. Box 2529 Gillette, WY 87217 Subject to recorded Option to Purchase with Right of First Refusal to: Bridle Bit Ranch Company 6546 Highway 59 Gillette, WY 82716	16.6700 (except coal)		MG
Mathew John Reno Box S-600 Gillette, WY 87216	16.6700 (except coal)		MG
Harriet Reno Underwood 6765 S. Hwy 59 Gillette, WY 87216	16.6700 (except coal & 4.1667 O&G to Killion)		MG
	100.0000		

B.K. Killion P.O. Box 3162 San Angelo, TX 76902	4.1667 (O&G from Harriet Reno Underwood)		MG
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MG
Coralie R. Clary 3821 Cosport Ct. Rapid City, SD 57701	4.1666 (except oil and coal)	<u>T43N, R73W</u> Sec. 32: W/2	MH
Betty I. Cox Rt. 1, Box 72C West, TX 76691	4.1666 (except oil and coal)		MH
Billy H. Mills 1058 Highlight Rd. Gillette, WY 82716	4.1666 (except oil and coal)		MH
Doris I. Mills 244 Alcott Rd. Gillette, WY 82716	25.000 (except oil and coal)		MH
Jody G. Mills 1304 Highlight Rd. Gillette, WY 82716	4.1666 (except oil and coal)		MH
Larry C. Mills 244 Alcott Rd. Gillette, WY 82716	4.1666 (except oil and coal)		MH
Tommy M. Mills 1009 Highlight Rd. Gillette, WY 82716	4.1666 (except oil and coal)		MH

Justin Joe Reno P.O. Box 2529 Gillette, WY 82717 Subject to recorded Option to Purchase with Right of First Refusal to: Bridle Bit Ranch Company 6546 Highway 59 Gillette, WY 82716	50.000 (except oil and coal)	MH
	100.0000	
Coralie R. Clary 3821 Cosport Ct. Rapid City, SD 57701	2.0833 (oil)	MH
Patricia J. Compton, et vir. P.O. Box 9522 Panama City Beach, FL 32401	25.000 (oil)	MH
Betty I. Cox Rt. 1, Box 72C West, TX 76691	2.0833 (oil)	MH
Drew Company, The Attn: Bill Drew 123 W. 1st St., Ste 800 Casper, WY 82601	12.500 (oil)	MH
John P. Ellbogen, et ux. P.O. Box 1928 Casper, WY 82602	12.5000 (oil)	MH
Billy H. Mills 1056 Highlight Rd. Gillette, WY 82716	2.0833 (oil)	MH
Doris I. Mills 244 Alcott Rd. Gillette, WY 82716	12.500 (oil)	MH
Jody G. Mills 1304 Highlight Rd. Gillette, WY 82716	2.0833 (oil)	MH

Larry C. Mills 244 Alcott Rd. Gillette, WY 82716	2.0833 (oil)		MH
Tommy M. Mills 1009 Highlight Rd. Gillette, WY 82716	2.0833 (oil)		MH
Justin Joe Reno P.O. Box 2529 Gillette, WY 82717 Subject to recorded Option to Purchase with Right of First Refusal to: Bridle Bit Ranch Company 6546 Highway 59 Gillette, WY 82716	25.000 (oil)		MH
	100.00		
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MH
Ted Cosner P.O. Box 690 Wright, WY 82732	25.00 (except coal)	<u>T43N, R73W</u> Sec. 33: SE/4	MJ
Marshall & Winston, Inc. P.O. Box 50880 Midland, TX 79702	2.500 (except coal)		MJ
Clayton McGuire et ux. 42 Chalk Buttes Rd. Douglas, WY 82633 beginning 10/24/93: 1460 Hwy 59 PO Box 1070 Douglas, WY 82633	22.50 (except coal)		MJ
Burton Keith Reno, Jr. P.O. Box 25039 Jackson, WY 83001	16.66 (except coal)		MJ

Nancy M. Reno Trust P.O. Box 458 Big Horn, WY 82833	16.66 (except coal)		MJ
William E. Reno Trust 425 Bowers Ute Rd. Gillette, WY 82716	16.66 (except coal) 100.00		MJ
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MJ
State of Wyoming Commissioner of Public Lands 122 W. 25th St. Herschler Bldg. 3 West Cheyenne, WY 82002-0600	100.00 (all)	T43N, R74W Sec: 36: E/2	MK
Ted Cosner P.O. Box 690 Wright, WY 82732	25.00 (except coal)	T42N, R73W Sec. 4: NE/4	ML
Marshall & Winston, Inc. P.O. Box 50880 Midland, TX 79702	2.500 (except coal)		ML
Clayton and Cindy McGuire 42 Chalk Buttes Rd. Douglas, WY 82633 beginning 10/24/93: 1460 Hwy 59 PO Box 1070 Douglas, WY 82633	22.500 (except coal)		ML
Nancy M. Reno Trust P.O. Box 458 Big Horn, WY 82833	25.00 (except coal)		ML

William E. Reno Trust 425 Bowers Ute Rd. Gillette, WY 82716	25.00 (except coal) 100.00		ML
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		ML
State of Wyoming Commissioner of Public Lands 122 West 25th St. Herschler Bldg, 3 West Cheyenne, WY 82002-0600	100.00 (except coal)	T42N, R73W Sec. 3: NW/4NW/4 (Lot 4)	MM
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		
Adobe Oil and Gas Corporation 1100 Western Life Bldg. Midland, TX 79701	11.000 (except coal)	T42N, R73W Sec. 5: NW/4	MN
Altrogge Resources Company 6901 E. Walsh Pl. Denver, CO 80224	0.7500 (except coal)		MN
W.E. Bakken 1445 Denver Club Bldg. Denver, CO 80202	0.3750 (except coal)		MN

Reeva E. Donoghue 3421 S. Race St. Denver, CO 80110	0.2812 (except coal)	MN
Larry J. Donoghue 11829 Broken Arrow Dr. Conifer, CO 80433	0.0938 (except coal)	MN
Zeda G. Dudley 2110 Lewis Billings, MT 59102	0.5882 (except coal)	MN
Raleigh Greene 5070 Del Mar Dr. Central Point, OR 97502	2.9412 (except coal)	MN
Reta R. Jager 890 East Gregory Road Central Point, OR 97501	0.5882 (except coal)	MN
Bernice B. Lewis 4440 W. Oden Bay Rd. Sandpoint, ID 83864	5.8824 (except coal)	MN
Louis S. Madrid 410 17th St., Ste 2050 Denver, CO 80202	29.4118 (except coal)	MN
Allen Nance 2401 North 51st Ave. Yakima, WA 98901	2.9412 (except coal)	MN
Justin Joe Reno P.O. Box 2529 Gillette, WY 82716 Subject to recorded Option to Purchase with Right of First Refusal to: Bridle Bit Ranch Company 6546 Highway 59 Gillette, WY 82716	8.3333 (except coal)	MN
Harriet P. Reno, et al., Trustees P.O. Box 36 Gillette, WY 82716	12.5000 (except coal)	MN

Mathew John Reno Box S-600 Gillette, WY 82716	8.3333 (except coal)	MN
Allen G. Sparks Hammond Trailer Park Westport, WA 98595	0.4902 (except coal)	MN
Howard B. Sparks 1335 Silverrado, Apt 771 Houston, TX 77077	0.4902 (except coal)	MN
Lyle Sparks Hammond Trailer Park Westport, WA 98595	0.4902 (except coal)	MN
Wanda N. Sparks Hammond Trailer Park Westport, WA 92595	1.4706 (except coal)	MN
Linda Stuart 106 S.E. 12th Altoona, IA 50009	0.4902 (except coal)	MN
Harriet Reno Underwood 6765 S. Hwy 59 Gillette, WY 82716	8.3333 (exc coal & 2.0883 O&G to Killion)	MN
Jerry L. Wall 7570 N.W. 16th Ankeny, IA 50021	0.4902 (except coal)	MN
Jimmy E. Wall 2819 S.E. 10th Des Moines, IA 50317	1.9607 (except coal)	MN
Max M. Wall 4353 Larson Way Salt Lake City, UT 84124	0.5882 (except coal)	MN
George N. Wall P.O. Box 62 Pavillion, WY 82523	0.5882 (except coal)	MN
Ardis R. Wilk 516 13th St. Rawlins, WY 82301	0.5882 (except coal)	MN
	100.00000	

B.K. Killion P.O. Box 3162 San Angelo, TX 76902	2.0833 (O&G from Harriet Reno Underwood)		MN
United States of America Bureau of Land Management Wyoming State Office P.O. Box 1828 2515 Warren Avenue Cheyenne, WY 82003	100.00 (coal)		MN

3.5 OIL AND GAS LEASEHOLD INTERESTS

The following are lessees of oil and gas leases. The map key refers to the map entitled "Oil and Gas Leases" (Figure 2.5).

3.5.1 FEDERAL OIL AND GAS LEASEHOLD INTERESTS

Lessee	Serial Number	Land Description	Map Key
Samedan Oil Corp. 1660 Lincoln, Ste 3000 Denver, CO 80264	WYW-5331	T43N, R73W Sec. 22: E/2	OM
ABO Petro Corporation 105 S. 4th St. Artesia, NM 88210	WYW-117152	T43N, R73W Sec. 20: E/2	ON
Andover Partners Box 1715 Denver, CO 80201			ON
Joan Chorney 555 17th St., Ste 1000 Denver, CO 80202-3910			ON

Lancaster Corporation 555 17th St., Ste 1000 Denver, CO 80202-3910			ON
Myco Industries Inc. 105 S. 4th St. Artesia, NM 88210			ON
Yates Drilling Company 105 S. 4th St. Artesia, NM 88210			ON
Yates Petroleum Corp. 105 S. 4th St. Artesia, NM 88210			ON
Yates Petroleum Corp. 105 S. 4th St. Artesia, NM 88210	WYW-114465	<u>T43N, R73W</u> Sec. 20: S/2SW/4	OO
Yates Drilling Company 105 S. 4th St. Artesia, NM 88210			OO
ABO Petro Corporation 105 S. 4th St. Artesia, NM 88210			OO
Myco Industries Inc. 105 S. 4th St. Artesia, NM 88210			OO
Chorney Oil Company 555 17th St., Ste 1000 Denver, CO 80202-3910			OO
Southland Royalty Co. 801 Cherry St. Ft. Worth, TX 76102	WYW-4064	<u>T43N, R73W</u> Sec. 20: NE/4SW/4	OP
Bird Oil Corporation 1801 California, Ste 4500 Denver, CO 80202			OP

Reading & Bates Petroleum 3200 Mid-Continent Tulsa, OK 74103			OP
Ann F. Hudson 616 Texas St. Fort Worth, TX 76102-4612	WYW-101413	<u>T43N, R73W</u> Sec. 20: NW/4SW/4	OQ
Anderman/Smith and Co. 1776 Lincoln, Ste 500 Denver, CO 80203	WYW-96896	<u>T43N, R73W</u> Sec. 30: Lots 1, 2, E/2NW/4 34: N/2SE/4, SE/4SE/4	OR
Chorney Oil Company 555 17th St., Ste 1000 Denver, CO 80202-3910			OR
Apache Corporation 1700 Lincoln, Ste 1900 Denver, CO 80203-4519			OR
Presidio Exploration 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	WYW-98029	<u>T43N, R73W</u> Sec. 32: NE/4	OS
Yates Petroleum Corp. 105 S. 4th St. Artesia, NM 88210	WYW-115198	<u>T43N, R73W</u> Sec. 34: SW/4SE/4	OT
Yates Drilling Company 105 S. 4th St. Artesia, NM 88210			OT
ABO Petro Corporation 105 S. 4th St. Artesia, NM 88210			OT
Myco Industries Inc. 105 S. 4th St. Artesia, NM 88210			OT
Seabrook Corporation 555 17th St., Ste 1000 Denver, CO 80202			OT

Presidio Exploration 5613 DTC Parkway, #800 Englewood, CO 80111-3035	WYW-122046	<u>T43N, R73W</u> Sec. 34: NE/4	OU
Dyco Petroleum Corp. 7130 S. Lewis, Ste 300 Tulsa, OK 74134	WYW-112943	<u>T43N, R74W</u> Sec. 25: NW/4SE/4	OV
John C. Oxley 1 W. 3rd St., Ste 1300 Tulsa, OK 74103			OV
Unit Petroleum Co. Box 702500 Tulsa, OK 74170			OV
Apache Corporation 1700 Lincoln, #1900 Denver, CO 80203-4519	WYW-111080	<u>T42N, R73W</u> Sec. 3: Lots 2, 3	SOA
M. J. Harvey, Jr. P.O. Box 12705 Dallas, TX 75225	WYW-127709	<u>T42N, R73W</u> Sec. 6: Lots 1, 2	SOE
Bonnie J. Brown 614 S. Greeley Hwy. Cheyenne, WY 82007-1855	WYW-99941	<u>T42N, R73W</u> Sec. 6: S/2NE/4	SOF
Presidio Exploration 5613 DTC Parkway, #800 Englewood, CO 80111			SOF
W.A. Moncrief, Jr. 9th at Commerce Fort Worth, TX 76102	WYW-95725	<u>T42N, R73W</u> Sec. 3: S/2NW/4 6: Lots 3, 5, SE/4NW/4	SOB

W.A. Moncrief, Jr. 9th at Commerce Fort Worth, TX 76102	WYW-119631	T42N, R74W Sec. 1: Lots 1, 2, S/2NE/4	SOG
W.A. Moncrief 9th at Commerce Fort Worth, TX 76102			SOG
Kerr McGee Corp. Box 25861 Oklahoma City, OK 73125			SOG

3.5.2 STATE OIL AND GAS LEASEHOLD INTERESTS

Lessee	Lease Number	Land Description	Map Key
Yates Petroleum Corp. 105 S. 4th St. Artesia, NM 88210	92-00134	T43N, R74W Sec. 36: E/2	OW
General Atlantic Resources, Inc. 410 17th St, Ste 1400 Denver, CO 80202	82-0083	T43N, R74W Sec. 36: E/2	OW
M. J. Harvey, Jr. Box 12705 Dallas, TX 75225	88-00373	T42N, R73W Sec. 3: Lot 4	SOH

3.5.3 PRIVATE OIL AND GAS LEASEHOLD INTERESTS

Lessee	Land Description	Map Key
Presidio Exploration, Inc. 5613 DTC Parkway, #800 Englewood, CO 80111-3035	T43N, R73W Sec. 19: SE/4 30: NE/4	OX
A/D Holdings 400 Ogden St. Denver, CO 80218	T43N, R73W Sec. 21: N/2	OY
Ainslie Perrault, Jr. 1812 S. Cincinnati Ave. Tulsa, OK 74119		OY
American Production Partnership Ltd. III 4500 Republic Bank Center 700 Louisiana Houston, TX 77002		OY
Anderman and Company 1776 Lincoln, Ste 500 Denver, CO 80203		OY
Ronald D. Boone 1670 Newport Denver, CO 80220		OY
Buccaneer Energy Company 1111 Fannin, Ste 1550 Houston, TX 77002		OY
Buttes Resources Company P.O. Box 5083 Denver, CO 80217 *(now known as Reunion Energy 2801 Post Oak Blvd, Ste 400 Houston, TX 77056)*		OY
Evans Dunn 2121 S. Columbia, Ste 105 Tulsa, OK 74114		OY

Fred Dunn, Jr. 2121 S. Columbia, Ste 105 Tulsa, OK 74114	OY
Eland Energy, Inc. Suite 1550 North Central Plaza III 12801 N. Central Expressway Dallas, TX 75243	OY
DNR Oil and Gas, Inc. 730 17th St., Ste 200 Denver, CO 80202	OY
John P. Ellbogen P.O. Box 1928 Casper, WY 82601	OY
Farmers Union Central Exchange, Inc. Box G St. Paul, MN 55101	OY
Ronald E. Hornig 1776 Lincoln St., Ste 500 Denver, CO 80203	OY
Hunt Oil Company 2900 First National Bank Bldg. Dallas, TX 75202	OY
J.A. LaFortune, Jr. 1924 S. Utica, Ste 1218 Tulsa, OK 74101	OY
Joseph A. LaFortune Trust 2300 Fourth National Bldg. Tulsa, OK 74119	OY
Louisiana Land and Exploration Company, The 1560 Broadway, Ste 1200 Denver, CO 80202	OY
Joseph J. Morelli 1776 Lincoln St., Ste 500 Denver, CO 80203	OY

Oneok Exploration Company
P.O. Box 871
Tulsa, OK 74101 OY

Julian C. Pope
One W. Third St., Ste 1200
Tulsa, OK 74103 OY

Riffe Petroleum Company
P.O. Box 25860
Tulsa, OK 74145 OY

St. Mary Parish Land Company
1776 Lincoln St., Ste 1100
Denver, CO 80202 OY

Harold C. Stuart
P.O. Box 1349
Tulsa, OK 74104 OY

Swift Energy Company
16825 Northchase Dr. Ste 400
Houston, TX 77060-6098 OY

Viersen and Cochran
c/o Sam K. Viersen, Jr.
P.O. Box 280
Okmulgee, OK 74447 OY

Wollard Family Trust
c/o Janes K. Wollard, et vir., Trustees
1616 Glenarm Pl., Ste 1230
Denver, CO 80202 OY

Wollard Family Trust
c/o Janes K. Wollard, et vir., Trustees
2121-F S. Victor St.
Aurora, CO 80014 OY

Wilcox Exploration Company
P.O. Box 4429
Tulsa, OK 74104 OY

H. Frank Wilcox III
P.O. Box 4429
Tulsa, OK 74104 OY

Andover Partners 1001 Fannin, Ste 2000 Houston, TX 77026	T43N, R73W Sec. 22: NW/4	OZ
Seabrook Corporation 555 17th St., Ste 1000 Denver, CO 80202		OZ
Yates Petroleum Corp. 105 S. 4th St. Artesia, NM 88210		OZ
L-K-E, Inc. P.O. Box 2001 Wichita Falls, TX 76307 also at P.O. Box 4224 Englewood, CO 80155	T43N, R73W Sec. 27: E/2	OAA
Presidio Exploration, Inc. 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	T43N, R73W Sec. 30: SW/4, W/2SE/4	OBB
Presidio Exploration, Inc. 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	T43N, R73W Sec. 32: W/2	OCC
Apache Corporation 1700 Lincoln, Ste 1900 Denver, CO 80203-4519	T43N, R73W Sec. 32: SE/4	ODD
Chorney Oil Company 555 17th St., Ste 1000 Denver, CO 80202-3910		ODD
Pathfinder Energy, Inc. P.O. Box 908 Powell, WY 82435		ODD
Wellstar Corporation 9704 State Highway 66 Platteville, CO 80651		ODD

Presidio Exploration, Inc. 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	T43N, R74W Sec. 25: S/2SE/4, NE/4SE/4	OEE
Presidio Exploration, Inc. 5613 DTC Parkway, Ste 800 Englewood, CO 80111-3035	T43N, R73W Sec. 33: SE/4	OI
The Louisiana Land and Exploration Company 1560 Broadway, Ste 1200 Denver, CO 80202	T42N, R73W Sec. 3: Lot 1, S/2NE/4	SOI
Presidio Exploration, Inc. 5613 DTC Parkway, #800 Englewood, CO 80111-3035	T42N, R73W Sec. 4: Lots 1, 2, 3, 4, S/2N/2 5: Lots 1, 2, S/2NE/4	SOK
Axem Energy Company 7800 E. Union, #1100 Denver, CO 80237	T42N, R73W Sec. 5: Lots 3, 4, S/2NW/4	SOL
Equity Oil Company 600 17th St., #2110 Denver, CO 80202		SOL
General Atlantic Resources Co. 410 17th St., Ste 1400 Denver, CO 80202		SOL
Great Western Drilling Co. P.O. Box 1659 Midland, TX 79702		SOL
Presidio Exploration, Inc. 5613 DTC Parkway, #800 Englewood, CO 80111		SOL

3.5.4 OIL AND GAS WELLS

The following are all oil and gas wells identified through a search conducted by McKee Well History of Casper, Wyoming, including both producing wells and abandoned wells. The map key refers to the map entitled "Oil and Gas Leases" (Figure 2.5).

Operator	Name	Location	Map Key
True Oil Co. PO Box 2360 Casper, WY 82602	#22-22 Abandoned	T43N, R73W Sec. 22: SE/4NW/4	OZ

3.5.5 OVERRIDING ROYALTY INTEREST HOLDERS

The following are holders of an overriding royalty interest under any one or more of the above-referenced leases. The map key refers to the map entitled "Oil and Gas Leases" (Figure 2.5).

ORRI Owner	Land Description	Map Key
Aquaenco, Inc. P.O. Box 702571 Tulsa, OK 74170	T43N, R73W Sec. 21: N/2	OY
Marie Jeanne Darr no address listed		OY
Patricia J. Green no address listed		OY
Sharalyn R. Harr 6335 S. Logan Ct. Littleton, CO 80120		OY
Janette M. Hutsell no address listed		OY

Lester B. Ickes and
Brenda "Jill" Ickes,
et ux.
170 La Cueva
Las Alamos, NM 87544 — OY

Larry J. Ickes and
Judith A. Ickes, et ux.
6700 Milton Rd.
Custar, OH 43511 — OY

Robert E. Kastner, et ux.
1809 East L St.
Torrington, WY 82240 — OY

Ronald T. Mackey
1368 S. Robb Ct.
Lakewood, CO 80226 — OY

Dona M. Mohan
no address listed — OY

Yvonne R. Phillips and
Richard Phillips, et vir
219 W. Maple St.
Deshler, OH 43516 — OY

Sam R. Ratcliff
P.O. Box 697
Gillette, WY 82717 — OY

Reato, Ltd.
Box 4840
Casper, WY 82604 — OY

Scope Exploration Inc.
P.O. Box 702571
Tulsa, OK 74170 — OY

Bill L. Tucker
1776 Lincoln St. Ste 506
Denver, CO 80203 — OY

Aquaenco, Inc. P.O. Box 702571 Tulsa, OK 74170	T43N, R73W Sec. 19: SE/4 30: NE/4	OX
Reato, Ltd. Box 4840 Casper, WY 82604		
Scope Exploration Inc. P.O. Box 702571 Tulsa, OK 74170		OX
Dan Connell P.O. Box 1336 Storm Lake, IA 50588	T43N, R73W Sec. 27: E/2	OAA
Joseph K. McMahon, Trustee of the K-A Trust P.O. Box 2569 Wichita Falls, TX 76307		OAA
McMahon-Bullington P.O. Box 2569 Wichita Falls, TX 76307		OAA
Edwin A. Tofte P.O. Box 1223 Williston, ND 58801		OAA
Harry R. Underwood 6765 S. Hwy 59 Gillette, WY 82716	T43N, R73W Sec. 30: SW/4SE/4 32: W/2	OBB OCC
Prairie Petroleum 910 16th St., Ste. 610 Denver, CO 80202	T43N, R73W Sec. 32: SE/4	ODD

ORRI Owner	Serial Number	Land Description	Map Key
Ann F. Hudson 616 Texas St. Ft. Worth, TX 76102-4610	W-101413	T43N, R73W Sec. 20: NW/4SW/4	OQ
Casper College Foundation 125 College Dr. Casper, WY 82601	W-4064	T43N, R73W Sec. 20: NE/4SW/4	OP
Reading & Bates Petroleum 3200 Mid-Continent Tulsa, OK 74103	W-4064		OP
Diane M. Lukowicz 940 S. Josephine St. Denver, CO 80209	W-5331	T43N, R73W Sec. 22: E/2	OM
Prairie Petroleum 910 16th St., Ste. 610 Denver, CO 80202	W-5331		OM
Lamar B. Roemer 530 S. University Blvd. Denver, CO 80220	W-5331		OM
TEMIN 1987 Partnership P.O. Box 1628 Ardmore, OK 73402	W-5331		OM

Dice Exploration Co. P.O. Box 73507 Houston, TX 77273	W-96896	T43N, R73W Sec. 30: NW/4 34: N/2SE/4, SE/4SE/4	OR
George H. Fentress P.O. Box 113 Wheat Ridge, CO 80034	W-96896		OR
Michael Gerace 1540 Chambers Dr. Boulder, CO 80303	W-96896		OR
Marion Bacil 40676 Ladero St. Fremont, CA 94539	W-98029	T43N, R73W Sec. 32: NE/4	OS
Dyco Petroleum Corp. 7130 S. Lewis, Ste 300 Tulsa, OK 74136	W-112943	T43N, R74W Sec. 25: NW/4SE/4	OV
Harry R. Underwood 6765 S. Hwy 59 Gillette, WY 82716		T42N, R73W Sec. 4: Lots 1, 2, 3, 4, S/2N/2	SOK
		5: Lots 1, 2, 3, 4, N/2	SOK & SOL
Gerald R. Grocock 226 County Rd. 65 Evergreen, CO 80439		T42N, R73W Sec. 5: Lots 3, 4, S/2NW/4	SOL
Sam D. Winegard 7086 E. Costilla Dr. Englewood, CO 80112-1106			SOL
Donald D. Wolf, Trustee for General Atlantic Employee Trust 410 17th St., Ste 1400 Denver, CO 80202			SOL

Rex L. Randolph P.O. Box 571 Casper, WY 82602	W-95725	<u>T42N, R73W</u> Sec. 3: 6:	S/2NW/4 Lots 3, 5, SE/4NW/4	SOB
Robert E. Park P.O. Box 2573 Casper, WY 82602	W-95725	<u>T42N, R73W</u> Sec. 6:	Lots 3, 5, SE/4NW/4	SOB
Bonnie J. Brown 614 S. Greeley Hwy. Cheyenne, WY 82007-1855	W-99941	<u>T42N, R73W</u> Sec. 6:	S/2NE/4	SOF
Robert L. Cranmer #4 Villa Appia 1919 Alameda De Las Pulgas San Mateo, CA 94403	W-119631	<u>T42N, R74W</u> Sec. 1:	Lots 1, 2, S/2NE/4	SOG
The Ogle Corporation P.O. Box 992 Casper, WY 82602	W-119631			SOG
H.O. English P.O. Box 1488 Casper, WY 82602	W-119631			SOG

3.6 MINERAL INTERESTS (OTHER THAN OIL AND GAS)

3.6.1 MINERAL LEASES

The following are leases for all minerals other than oil and gas. There were no leases identified in the records exclusively for coal or other leaseable minerals other than oil and gas. The map key refers to the map entitled "Mineral Lease and Claim Map" (Figure 2.6).

The following are state uranium and associated minerals leases:

Lessee	Lease Number	Land Description	Map Key
Energy Fuels, Ltd. 1200 17th St., Ste 2500 Denver, CO 80202	0-40410	T42N, R73W Sec. 3: NW/4N/4	L5
Pathfinder Mines Corp. 7401 Wisconsin Ave. Bethesda, MD 20814-3416	0-28624	T43N, R74W Sec. 36: E/2	L6

The following are mineral leases between private parties:

Lessee	Land Description	Map Key
Energy Fuels, Ltd. 1200 17th St., Ste 2500 Denver, CO 80202 (Willard ML)	T43N, R73W Sec. 22: NW/4 32: SE/4	L2
Energy Fuels, Ltd. 1200 17th St., Ste 2500 Denver, CO 80202 (Mills *50%* ML-other 50% not leased)	T43N, R73W Sec. 32: W/2	L7

3.6.2 MINING CLAIMS

The following are valid unpatented lode mining claims located within one-half mile of the permit amendment area boundary. There are no valid placer, tunnel or millsite claims oi record. The map key refers to the map entitled "Mineral Lease and Claim Map" (Figure 2.6) and the map identifes the claims by each named claim block or group.

Owner	Claim Groups	Land Description			Map Key
Energy Fuels, Ltd. 1200 17th St, Ste 2500 Denver, CO 80202	Muff 1-3,6 Pit 6-10	T42N, R73W Sec.	 3:	 E/2NW/4, SW/4NW/4	C2
Pathfinder Mines Corp. 7401 Wisconsin Ave. Bethesda, MD 20814-3416	Reno Claims Reno Strip Claims	T42N, R73W Sec. T42N, R74W Sec.	 6: 1:	 N/2 NE/4	C3
RME Partners, L.P. 9940 E. Costilla Ste B Englewood, CO 80112	Stu Claims	T43N, R73W Sec.	 34:	 NE/4	C4

3.7 MASTER MAILING NOTIFICATION LIST

3.7.1 SURFACE OWNERS INSIDE PERMIT AMENDMENT AREA

Ms. Terry Berquist

Nolan and Ann Diehl

James E. and Edra June Drake

Bernice Groves

Clayton and Cindy McGuire

August G. Laur Trust

Lewella Laur Trust

Dorothy Reichmuth

State Highway Commission of Wyoming, The Department of Transportation

Rev. Eugene Sullivan

Rev. Gerald Sullivan

June M. Thielen-Stangler and John R. Thielen

3.7.2 SURFACE OWNERS WITHIN ONE-HALF (1/2) MILE OF PERMIT AMENDMENT AREA BOUNDARY

Ms. Terry Berquist

Bridle Bit Ranch Company

Nolan and Ann Diehl

James E. and Edra June Drake

Bernice Groves

August G. Laur Trust

Lewella Laur Trust

Clayton and Cindy McGuire

Dorothy Reichmuth

Justin Joe Reno

State Highway Commission of Wyoming, The Department of Transportation

State of Wyoming Commissioner of Public Lands

Rev. Eugene Sullivan

Rev. Gerald Sullivan

June M. Thielen-Stangler and John R. Thielen

3.7.3 OPERATORS OF OIL AND GAS WELLS INSIDE PERMIT AMENDMENT AREA

Amoco Production Company (abandoned well)

Buttes Resources Company
Now known as Reunion Energy (operating well)

Presidio Exploration, Inc. (abandoned well)

3.7.4 LESSEES OF OIL AND GAS LEASES INSIDE PERMIT AMENDMENT AREA WITH NO OPERATING WELLS

ABO Petro Corporation

Anderman/Smith and Co.

Andover Partners

Apache Corporation

Joan Chorney

Chorney Oil Company

Lancaster Corporation

Myco Industries Inc.

Pathfinder Energy, Inc.

Presidio Exploration, Inc.

Samedan Oil Corp.

Union Oil Company of California

Wellstar Corporation

Yates Drilling Company

Yates Petroleum Corp.

3.7.5 OTHERS WITH SURFACE INTERESTS FROM WHOM SURFACE CONSENTS WERE SOUGHT

Robert Roush

Sunburst Ranch Co., Inc.

3.7.6 CONSOLIDATED, ALPHABETICAL MAILING LIST

1. *ABO Petro Corporation*
   105 S. 4th St.
   Artesia, NM 88210

2. *Amoco Production Company*
   P.O. Box 2520
   Casper, WY 82602

3. *Anderman/Smith and Co.*
   1776 Lincoln, Ste 500
   Denver, CO 80203

4. *Andover Partners*
   Box 1715
   Denver, CO 80201

5. *Apache Corporation*
   1700 Lincoln, Ste 1900
   Denver, CO 80203-4519

6. *Ms. Terry Berquist*
   1003 Birch
   Douglas, WY 82633

7. *Bridle Bit Ranch Company*
   6546 Highway 59
   Gillette, WY 82716

8. *Buttes Resources Company*
   Now known as Reunion Energy
   2801 Post Oak Blvd, Ste 400
   Houston, TX 77056

9. *Joan Chorney*
   555 17th St., Ste 1000
   Denver, CO 80202-3910

10. *Chorney Oil Company*
    555 17th St., Ste 1000
    Denver, CO 80202-3910

11. *Nolan and Ann Diehl*
    PO Box 334
    Red Bluff, CA 96080

12. *James E. and Edra June Drake*
2501 E. Turney
Phoenix, AZ 85016

13. *Bernice Groves*
P.O. Box 408
Wright, WY 82732-0408

14. *Lancaster Corporation*
555 17th St., Ste 1000
Denver, CO 80202-3910

15. *August G. Laur Trust c/o August G. Laur and Lewella Laur, Co-Trustees*
245 E. Foote St.
Buffalo, WY 82834

16. *Lewella Laur Trust c/o August G. Laur and Lewella Laur, Co-Trustees*
245 E. Foote St.
Buffalo, WY 82834

17. *Clayton and Cindy McGuire*
1460 Hwy 59
PO Box 1070
Douglas, WY 82633

18. *Myco Industries Inc.*
105 S. 4th St.
Artesia, NM 88210

19. *Pathfinder Energy, Inc.*
P.O. Box 908
Powell, WY 82435

20. *Presidio Exploration, Inc.*
5613 DTC Parkway, Ste 800
Englewood, CO 80111-3035

21. *Dorothy Reichmuth*
1531 South 77th Street
Lincoln, NE 68506

22. *Justin Joe Reno*
P.O. Box 2529
Gillette, WY 82717

23. *Robert Roush*
113 Todd
Gillette, WY 82718

24. *Samedan Oil Corp.*
1660 Lincoln, Ste 3000
Denver, CO 80264

25. *State Highway Commission of Wyoming, The*
Department of Transportation
PO Box 1708
Cheyenne, WY 82003-1708

26. *State of Wyoming*
Commissioner of Public Lands
122 West 25th St.
Herschler Bldg, 3 West
Cheyenne, WY 82002-0600

27. *Rev. Eugene Sullivan*
Box 2024
Sheridan, WY 82801

28. *Rev. Gerald Sullivan*
PO Box 5720
Cheyenne, WY 82003-5720

29. *Sunburst Ranch Co., Inc.*
Box 408
Wright, WY 82732

30. *June M. Thielen-Stangler*
and John R. Thielen
HCR 61 Box 5333
Danbury, Wisconsin 54873

31. *Union Oil Company of California*
Box 3100
Midland, TX 79705

32. *Wellstar Corporation*
9704 State Highway 66
Platteville, CO 80651

33. *Yates Drilling Company*
105 S. 4th St.
Artesia, NM 88210

34. *Yates Petroleum Corp.*
105 S. 4th St.
Artesia, NM 88210

3.8 PROOF OF MAILING

1. *ABO Petro Corporation*
   105 S. 4th St.
   Artesia, NM 88210

2. *Amoco Production Company*
   P.O. Box 2520
   Casper, WY 82602

3. *Anderman/Smith and Co.*
   1776 Lincoln, Ste 500
   Denver, CO 80203

4. *Andover Partners*
Box 1715
Denver, CO 80201

5. *Apache Corporation*
1700 Lincoln, Ste 1900
Denver, CO 80203-4519

6. *Ms. Terry Berquist*
1003 Birch
Douglas, WY 82633

7. *Bridle Bit Ranch Company*
6546 Highway 59
Gillette, WY 82716

8. *Buttes Resources Company*
Now known as Reunion Energy
2801 Post Oak Blvd, Ste 400
Houston, TX 77056

9. *Joan Chorney*
555 17th St., Ste 1000
Denver, CO 80202-3910

10. *Chorney Oil Company*
555 17th St., Ste 1000
Denver, CO 80202-3910

11. *Nolan and Ann Diehl*
PO Box 334
Red Bluff, CA 96080

12. *James E. and Edra June Drake*
2501 E. Turney
Phoenix, AZ 85016

13. *Bernice Groves*
P.O. Box 408
Wright, WY 82732-0408

14. *Lancaster Corporation*
555 17th St., Ste 1000
Denver, CO 80202-3910

15. *August G. Laur Trust*
c/o August G. Laur and
Lewella Laur, Co-Trustees
245 E. Foote St.
Buffalo, WY 82834

16. *Lewella Laur Trust*
c/o August G. Laur and
Lewella Laur, Co-Trustees
245 E. Foote St.
Buffalo, WY 82834

17. *Clayton and Cindy McGuire*
1460 Hwy 59
PO Box 1070
Douglas, WY 82633

18. *Myco Industries Inc.*
105 S. 4th St.
Artesia, NM 88210

19. *Pathfinder Energy, Inc.*
P.O. Box 908
Powell, WY 82435

20. *Presidio Exploration, Inc.*
5613 DTC Parkway, Ste 800
Englewood, CO 80111-3035

21. *Dorothy Reichmuth*
1531 South 77th Street
Lincoln, NE 68506

22. *Justin Joe Reno*
P.O. Box 2529
Gillette, WY 82717

23. *Robert Roush*
113 Todd
Gillette, WY 82718

24. *Samedan Oil Corp.*
1660 Lincoln, Ste 3000
Denver, CO 80264

25. *State Highway Commission of Wyoming, The*
Department of Transportation
PO Box 1708
Cheyenne, WY 82003-1708

26. *State of Wyoming*
Commissioner of Public Lands
122 West 25th St.
Herschler Bldg, 3 West
Cheyenne, WY 82002-0600

27. *Rev. Eugene Suliivan*
Box 2024
Sheridan, WY 82801

28. *Rev. Gerald Sullivan*
PO Box 5720
Cheyenne, WY 82003-5720

29. *Sunburst Ranch Co., Inc.*
Box 408
Wright, WY 82732

30. *June M. Thielen-Stangler*
and John R. Thielen
HCR 61 Box 5333
Danbury, Wisconsin 54873

31. *Union Oil Company of California*
Box 3100
Midland, TX 79705

32. *Wellstar Corporation*
9704 State Highway 66
Platteville, CO 80651

33. *Yates Drilling Company*
105 S. 4th St.
Artesia, NM 88210

34. *Yates Petroleum Corp.*
105 S. 4th St.
Artesia, NM 88210

This page intentionally left blank.

4. LEGAL DESCRIPTIONS

4.1 LANDS WITHIN PERMIT AMENDMENT AREA

The following is a tabulation of lands in the proposed permit amendment area by legal description with corresponding acreage.

Legal Description		Acres
Township 43 North, Range 73 West		
Section 21:	S½	320
Section 22:	SW¼	160
Section 27:	W½	320
Section 28:	All	640
Section 29:	All	640
Section 30:	E½SE¼	80
Section 31:	E½	320
	E½W½	160
	Lot 1	43.05
	Lot 2	43.26
	Lot 3	43.48
	Lot 4	43.69
Section 33:	W½	320
	NE¼	160
Section 34:	W½	320
	TOTAL	3,613.48

4.2 LANDS WITHIN PERMIT AMENDMENT BOUNDARY WHERE NO RIGHT TO MINE IS CLAIMED

There are no lands in the proposed permit amendment area where no right to mine is being claimed.

4.3 LANDS WITHIN EXISTING PERMITTED AREAS

The following is a tabulation of lands located under Permit 479 issued to Union Pacific Minerals, Inc. and assigned to Energy Fuels Exploration Company, which permit is being amended by this permit application:

4.3.1 MAIN PILOT PLANT SITE

Legal Description		Acres
S.W. corner Section 22, Township 43 North, Range 73 West is P.O.B.; thence due North 554' to PT1 thence due East 433' to PT2 thence S 36° 5' E 218' to PT3 thence due South 450' to PT4 thence due East 397' to PT5 then due South 652' to PT6 thence due West 280' to PT7 thence due South 403' to PT8 thence due West 198' to PT9 thence due North 403' to PT10 thence due West 505' to PT11 thence due South 90' to Pt12 thence due West 483' to PT13 thence due North 342' to PT14 thence N 32° 15' E 560' to PT15 thence due East 205' to P.O.B.		
	Section 22	6.773
	Section 27	16.909
	Section 28	8.068
		31.750

4.3.2 CONTINGENCY RESERVOIR AND ROAD

Legal Description	Acres
PT 8 from above is P.O.B. thence due South 274.45' to PT1 thence due East 478.05' to PT2 thence due South 650.00' to PT3 thence due West 530.00' to PT4 thence due North 650.00' to PT5 thence due East 31.95' to PT6 thence due North 274.45' to PT7 thence due East 20.00' to P.O.B.	
Section 27	7.57
TOTAL	39.320

4.4 LANDS LOCATED WITHIN OTHER PERMIT AREAS

There are no other permitted areas.

4.5 GEOLOGICAL SURVEY TOPOGRAPHIC MAP

An original geological survey topographic map outlining lands within the *original permit area and* proposed permit amendment area is attached hereto as Plate 4.1.

This page intentionally left blank.

5. LAND USE AND DEMOGRAPHY

5.1 LAND USE

The land within and immediately surrounding the proposed permit area is used primarily for grazing by domestic animals. The land is classified as agricultural land as defined in W.S. 35-11-103(e)(xxviii). Various wildlife species utilize the area. However, no crucial habitat to wildlife, as defined in W.S. 35-11-103(e)(xxx) has been identified within the proposed permit area (See Section 13, Wildlife Baseline Studies). From an economic standpoint, grazing of domestic animals is the most important current or past use of lands within or immediately adjacent to the proposed permit area. Wildlife utilization is an important, but secondary use of the land.

~~The main land use in the vicinity of the proposed Reno Creek project is cattle and sheep ranching. Mining is the major source of employment and income to the surrounding area.~~ The closest town (Wright, Wyoming) is primarily a residence community for the miners operating the surface coal mines located along the eastern flank of the Powder River Basin.

5.2 DEMOGRAPHY

The mining project itself lies on privately owned ~~grazing lands~~ *agricultural lands*. The closest resident (Justin Joe Reno residence) is located 4.2 kilometers east-south-east of the approximate location of the proposed uranium recovery plant. The closest population center with schools and town infrastructure is Wright, Wyoming located 17 kilometers to the northeast of the center of the production area.

Plate 18.2 provides an illustration of the area surrounding the Reno Creek project area and location of the nearest residents. Table 5.1 shows the population distribution surrounding the Reno Creek project area measured from a point in the center of the operations/wellfield area located in the NE 1/4, Section 29, T43N R73W. The population figures are based on the 1990 census or latest estimate for ranches and very small communities.

TABLE 5.1
POPULATION DISTRIBUTION

KILOMETERS	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1.0-2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0-3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0-4.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.0-5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.0-10.0	0	5	3[1]	0	7	1	0	0	0	0	0	0	0	8	0	0
10.0-20.0	6	3	1276[2]	0	4	0	3	5	2	0	0	0	0	0	0	3
20.0-30.0	7	7	33	33	10	11	11	10	10	10	9	21	22	14	14	14
30.0-40.0	24	32	42	32	10	11	10	0	0	0	0	0	0	14	14	51
40.0-50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.0-60.0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0
60.0-70.0	0	0	0	0	0	0	0	0	0	0	706	0	0	0	0	0
70.0-80.0	0	0	0	0	0	0	0	0	0	0	0	0	0	256	0	17635[3]

[1] Nearest resident
[2] Town of Wright, Wyoming
[3] Gillette, Wyoming

Table 5.1 Population Distribution

6. BRIEF HISTORY OF THE AREA

Frontier Archaeology of Worland, Wyoming, under contract to EFNI, provided an historical overview of the Powder River Basin. The historical overview is included in the Cultural Resource Inventory, Section 7.0.

7. ARCHAEOLOGY

Frontier Archaeology of Worland, Wyoming performed a cultural resource inventory covering 1546 acres within the Reno Creek permit area. The cultural resource inventory was performed in two parts and covers the area within the permit to be affected as part of the mining operation during the first five years of operation. This includes areas associated with the wellfields, process facilities and land application area.

Frontier Archaeology found no sites recommended for nomination to the National Register of Historic Places. No further archeological or historical work is considered necessary for those sites identified. However, if cultural remains are found during excavation/operations activities, the WDEQ and U.S. Bureau of Land Management will be notified prior to disturbance. *Site investigation will be performed if deemed necessary by the State of Wyoming or U.S. Bureau of Land Management.*

Copies of the cultural resource inventories have been provided to the U.S. Bureau of Land Management for review. Detailed supporting information describing each site has not been provided as part of this application, but can be made availabie on request.

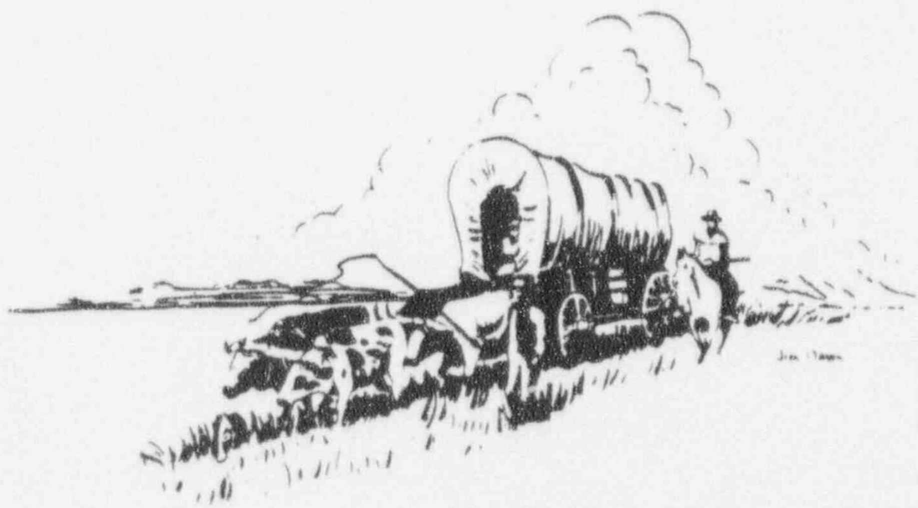
This page intentionally left blank.

CLASS III CULTURAL RESOURCE INVENTORY OF
ENERGY FUELS NUCLEAR, INC.
RENO CREEK PROJECT,
CAMPBELL COUNTY, WYOMING

by

Kelly Quick, James B. Tyler, and Robert G. Rosenberg

Project #FA93-25



June 1993

James M. Welch
Principal Investigator

FRONTIER ARCHAEOLOGY
P.O. Box 118
811 Big Horn Avenue
Worland, Wyoming 82401
(307) 347-8848

BLM Cultural Resource Use Permit #043-WY/NE-CO93

This page intentionally left blank.

ABSTRACT: A Class III cultural resource inventory was conducted of Energy Fuels Nuclear, Inc. Reno Creek Project. Eight prehistoric sites, four multi-component sites, and five historic sites, eight isolated prehistoric artifacts and two isolated historic artifacts were located by this inventory of the project area. None of these cultural resources is considered eligible for nomination to the National Register of Historic Places. No further archaeological or historical work is believed necessary. Cultural resource clearance is recommended for the project with no stipulations.

CLIENT: Energy Fuels Nuclear, Inc.

PROJECT: Reno Creek Project

LOCATION: BLM Casper District, Buffalo Resource Area
Private Surface Ownership, Federal Minerals Ownership
Portion of the W½ west of highway, Section 28; All, Section 29; E/SE, Section 30; NE¼, Section 31; T43N, R73W
Campbell County, Wyoming
USGS 7.5' Baker Spring, Wyoming Quadrangle
(Provisional Edition 1984)

PROJECT DESCRIPTION: Energy Fuels Nuclear, Inc. plans to construct uranium in-situ leach well fields and processing facilities. The project is situated on gentle to moderate slopes ranging from 1-17°. A minor to moderate amount of ground disturbance is expected to result from the project.

A total of 1,006 acres was inventoried for the project. All of this acreage is contained on privately owned surface land.

ENVIRONMENTAL SETTING: The project is situated within gently rolling plains in the southern half of the Powder River Basin. The basin is a structural and topographic depression about 250 miles long and more than 100 miles wide. It is characterized in the northern part by relatively high open rolling hills with 500 to 1,000 feet of topographic relief, and in the southern part by plains and tablelands with moderate relief of 300 to 500 feet. To the west are the Big Horn Mountains and to the east the Black Hills.

Specifically, the project area is situated in a region of minimal topographic relief. The terrain is characterized by low, rolling plains gently cut by the Belle Fourche River and its various ephemeral tributaries. The Belle Fourche River, which is also an ephemeral water source at this point, meanders in a northerly direction. The tributaries of the river generally run from the southeast to the northwest, forming northwest trending ridge lines.

The soils in this area are characteristically clay loam with greater amounts of sand in the hillier areas near eroding sandstone outcrops. The soil color is variable, ranging from tan to brown to greenish-brown to dark gray-brown. Sandstone bedrock outcrops also occur throughout the project area, with the rocks being part of the Eocene Wasatch Formation (Love and Christiansen 1985).

The region is characterized as an ecological transition zone between the true short grass plains to the east and the northern desert shrub to the west. Local vegetation communities, though dominated by short sagebrush, also contain numerous grass and forb species common to the shortgrass communities of the Great Plains. Within this context, the vegetation for the project area was found to be predominantly represented by various grasses and low sagebrush with few forbs. Some prickly pear and nipple cactus, and ground lichen were also present. Ground cover ranged from 20-75%, with the average coverage being about 50% of the surface.

Ranging in elevation from 5,050 to 5,280 feet above mean sea level within the cultural resource inventory area, the climate is typical of mid-latitude semi-arid regions characterized by low precipitation and high rates of evaporation. The fauna are typical of the Wyoming High Plains context. A detailed description is found in Babcock, Gallacher, and Amos (1982:2-9 through 2-11) and illustrates a somewhat diverse, but limited array of mammals, birds, and reptiles.

Previous surface disturbances noted within the project area include a paved state highway, two-track roads, fencelines, mineral test holes, erosion, and livestock grazing and trampling.

CULTURAL RESOURCE REVIEW: Prior to the fieldwork, a files search was requested from the Wyoming State Historic Preservation Office on March 19, 1993 (#10261). That agency reports no previous inventories or recorded cultural resources are known for the sections within which the project is located.

FIELDWORK: On April 1, 1993, Pat O'Brien marked project boundaries. On April 1-7 and April 12-17, Dave Day, Paul Nelson, Kelly Quick and James Tyler of Frontier Archaeology conducted an inventory of the project area shown on the attached map and described above, and recorded the prehistoric sites and isolated artifacts. On April 20-21, Bob Rosenberg of Rosenberg Historical Consultants recorded the historic sites and isolated artifacts. The project area was inventoried by a series of parallel pedestrian transects spaced 100 feet (30 meters) apart. The project was flagged and there was no snow cover at the time of the fieldwork. Seventeen subsurface tests were conducted in conjunction with this project and these are discussed in more detail in the Results section below. Original field notes and other data are retained at the Frontier Archaeology office in Worland, Wyoming.

RESULTS: For the purposes of this project, a site is operationally defined as two or more associated artifacts greater than 50 years of age, or one or more clearly definable features or structures greater than 50 years of age. Eight prehistoric sites, five historic sites, four multi-component sites, eight isolated prehistoric artifacts, and two isolated historic artifacts were located as a result of this inventory.

Site 48CA2764 - NW/SW/SE/SW/NW, SW/NW/SE/SW/NW, E/NE/SW/SW/NW, Section 29, T43N, R73W - The site consists of lithic debitage, three tools, and some fire-cracked rock. It is situated on an eroded slope of a low lying ridge in the Powder River Basin. Erosion has exposed outcrops of sandstone bedrock. The center of the site has approximately eight rows of cylindrical sandstone outcrops which are 40-70 meters long, 2-3 meters wide, 1-3 meters high and 3 meters apart on the average. These outcrops serve as wind blocks to level terraces lying between them. The site overlooks a northwest-southeast oriented ephemeral tributary of the Belle Fourche River. Surrounding the site are low lying, rolling plains dissected by ephemeral drainages. The soil consists of a light brown sand and silty sand eroded from the sandstone bedrock, with some colluvial reworking of the surface soils on the higher angle slope areas. Vegetation consists predominantly of short bunch grasses, with some low sagebrush, low forbs, prickly pear cactus, and ground lichen covering 25% of the ground surface. The site covers an area of 125 meters northwest-southeast by 75 meters northeast-southwest for a total of 7,360 square meters. The average density of cultural material is one artifact per

75 square meters.

All the lithic debitage and fire-cracked rock was located in eroded and deflated areas near the sandstone outcrops. The only concentration of lithic debitage was noted on the crest of the slope overlooking the rest of the site, with over 30 pieces of purple, medium-grained quartzite tertiary flakes and six pink fine grained quartzite tertiary flakes. This concentration may represent a tool manufacturing locale. The remainder of the site consists of 16 tertiary flakes and six secondary flakes knapped from various cherts and quartzites. No material type dominates the assemblage. Fire-cracked rock was scattered sparsely over the entire site and was usually found in close proximity to the lithics.

One uniface and two projectile points were observed on site. The uniface is made from a red, coarse-grained quartzite and exhibits use wear on one lateral edge. The two projectile points were collected from the site. One is a gold dendritic chert point base (FA93-25-3.1) exhibiting straight lateral edges, a slightly convex base, and large corner notches that form sharp points where they intersect with the lateral edges of the blade and the base. This is possibly a Late Plains Archaic point (2,500-1,500 B.P.). The other collected tool is a roughly worked red opaque chert projectile point (FA93-25-3.2). It exhibits small side notches, a straight base, and a small triangular shaped body. The edges are worked, however, there are no flaking scars within the center of the tool. The size and shape of the specimen is similar to Late Prehistoric points (1,500-200 B.P.).

Two shovel tests were excavated, each measuring about 30 x 30 cm. Shovel Test #1 was dug to 54 cm below the surface and exhibited light brown silty sand. Eroded sandstone bedrock was encountered at 54 cm. Shovel Test #2 was dug to 27 cm below the surface at which point the bedrock was encountered. Soils again consisted of light brown silty sand and no cultural material was observed in either tests. All soil was screened through ¼ inch mesh and the unit was backfilled upon completion.

Site 48CA2764 is considered not eligible for nomination to the National Register of Historic Places. It is datable and contains functionally diagnostic artifacts in the form of the two projectile points. However, there is no indication of stratified or buried *in situ* cultural deposits and the site has been subjected to considerable erosion. One small distribution of lithic debitage may represent an activity area, but there are no associated tools or discernible patterning of artifacts. Additionally, there is only a limited quantity and variety of cultural material at this locality. The site further gives no evidence of containing faunal or floral materials, exotic artifacts, or features. It appears to be little more than a short term campsite for a small number of individuals. This cultural resource has not yielded, nor is it likely to yield, information important in prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

<u>Site 48CA2765</u> - S/SW/SW/NW, NW/NE/NW/SW, SW/NE/NW/SW, NW/NW/SW, N/N/SW/NW/SW, Section 29, T43N, R73W, E/E/NE/NE/SE, Section 30, T43N, 73W - This is a multi-component site that sits on top of a prominent knoll above a large unnamed drainage which is to the northeast of the site. The vegetation cover ranges from 30-60% and averages about 50% of the ground surface. Vegetation consists primarily of low bunch grasses and low forbs with increasing amounts of sagebrush down the slope of the knoll. Prickly pear cactus is also present. Previous impacts to the site include livestock

grazing and trampling, mineral testing, fence construction, and slope wash erosion. The site covers a 330 x 255 meter area for a total of 84,150 square meters. The majority of the artifacts observed are on the north and east sides of the knoll.

The prehistoric component is an open campsite which consists of a low density of surface artifacts except for two small concentrations of lithics and fire-cracked rock. In addition to the concentrations, there is a site-wide sparse scatter of flakes, shatter, and fire-cracked rock. Five tools were located on the site consisting of two scrapers, two bifaces, and one retouched uniface flake. None of the tools were datable and only one, an orange/light brown chert scraper, was collected (FA93-25-4.1). The other scraper was an end scraper of maroon/purple chert. Of the two bifaces, one was a peach colored chert biface fragment, and the other a brown chert fragment. The uniface was a unifacially retouched pinkish white quartzite flake.

Concentration #1 contained 14 pieces of pink/purple to gray/purple quartzite fire-cracked rock, the maroon/purple end scraper, one tertiary chert flake, one piece of chert shatter, and one primary quartzite flake. Concentration #2 contained two pieces of quartzite fire-cracked rock, three tertiary quartzite flakes, and one tertiary basalt flake. The remainder of the lithic inventory at the site included one secondary basalt flake, one secondary quartzite flake, one tertiary quartzite flake, one primary chert flake, four secondary chert flakes, four tertiary chert flakes, and two pieces of chert shatter. No cores or tested cobbles were observed.

The historic component is extremely limited and consisted of only one tobacco can and a fallen metal pipe and its concrete base. This appears to be the remains of a plugged mineral test hole.

Two shovel tests were excavated, each measuring 30 x 30 cm. Both were placed above the eroded areas of the prehistoric artifact concentrations. Shovel Test #1 hit eroded sandstone bedrock at 29 cm; Shovel Test #2 hit the same surface at 42 cm below the surface. Soils were brown clay loam in test #2, and light brown sandy loam in test #1. Both tests were sterile and there appears to be very little potential for intact subsurface cultural remains. All soil was screened through ¼ inch mesh and each was backfilled upon completion.

Site 48CA2765 is considered not eligible for nomination to the National Register of Historic Places. The prehistoric component of the site is not datable and gives no evidence of containing stratified or buried *in situ* cultural deposits. There is no indication of multiple components, faunal or floral materials, exotic artifacts, or features. The five tools are of a non-diagnostic nature and the two concentrations appear to result from erosional processes. The historic component is extremely limited. It is not associated with events that have made a significant contribution to the broad patterns of our history; nor is it associated with the lives of persons significant in our past; nor does it embody the distinctive characteristics of a type, period, or method of construction that represents a significant entity. The site has not yielded, nor is it likely to yield, information important in history or prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2766 - NW/SW/SE/NW, Section 29, T43N, R73W - This is a prehistoric campsite situated on the end of a gentle ridge that is a high point in the area. The vegetation cover ranges from 20-75% and averages about 60% of the ground surface. Vegetation consists primarily of low bunch grasses, low forbs, sagebrush and prickly pear cactus. Previous impacts to the site include livestock grazing and trampling, slope wash erosion and a two track road. The site covers an area of 100 x 53 meters for a total of 5,300 square meters.

Cultural material observed includes nine pieces of scattered purple and pink/gray quartzite fire-cracked rock and four lithics. The lithics include one tertiary chert flake, one piece of quartzite shatter, one chert shatter, and one quartzite tertiary flake. A Late Prehistoric projectile point (1,500-200 B.P.) was also observed and collected (FA93-25-6.1). It is a small tan chert side-notched point. No concentrations of fire-cracked rock or evidence of intact hearths were seen.

One shovel test measuring 30 x 30 cm was excavated to 42 cm below the surface where eroded sandstone bedrock was struck. The soil in the shovel test was a light brown sandy loam. All soil was screened through ¼ inch mesh and the unit was backfilled upon completion. No cultural remains were recovered.

Site 48CA2766 is considered not eligible for nomination to the National Register of Historic Places. There is no indication of stratified or buried *in situ* cultural deposits. Additionally, there were no definable activity areas, multiple components, faunal or floral materials, exotic artifacts, or features present. While the site is datable by virtue of one projectile point, the low density and diversity of cultural materials and lack of the above described attributes make this Late Prehistoric period date of little consequence. The site has not yielded, nor is it likely to yield, information important in prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2767 - NE/NE/SW, Section 29, T43N, R73W - This site is a lithic scatter situated on the south slope of a gentle ridge near a small arroyo cut which empties into a larger drainage that eventually feeds into the Belle Fourche River. Vegetation consists of bunch grasses and a small amount of sagebrush and low forbs. The area is very overgrazed and the vegetation cover ranges from 30-60% and averages about 50% of the ground surface.

The observed cultural materials consist of a small surface cluster of lithics. These include one retouched uniface chert flake, one secondary chert flake, and one chert biface. All are within an 11 x 8 meter area, for a total of 88 square meters.

One 30 x 30 cm shovel test was excavated. This extended to a depth of 24 cm, at which point eroded sandstone bedrock was encountered. The soil in this unit was a light brown sandy loam. No cultural remains were recovered from the test. All soil was screened through ¼ inch mesh and the unit was backfilled upon completion.

Site 48CA2767 is considered not eligible for nomination to the National Register of Historic Places. The site is not datable and there is no indication of stratified or buried *in situ* cultural deposits. Additionally, there were no diagnostic artifacts, definable activity areas, multiple components, faunal or floral materials, exotic artifacts, or features present. The site has not yielded, nor is it likely to yield, information important in prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2768 - NE/NW/SW/NE/SE, SE/SW/NW/NE/SE, Section 30, T43N, R73W - This site is a sparse lithic scatter and open campsite situated on a small residual knoll overlooking the intermittent Belle Fourche River to the west and two ephemeral tributaries to the north and south. It is located in an area of low rolling plains gently cut by ephemeral drainages. The soil consists of a light brown sandy clay loam on a residual knoll. Sandstone outcrops of the Wasatch Formation were noted near the site. Low sagebrush, low forbs, short bunch grasses, prickly pear cactus and ground lichen cover approximately 65% of the ground surface. Livestock grazing and trampling and erosion are the impact agents, and the site is considered to be in good condition. It covers an area of 50 meters east to west by 85 meters north to south for a total of 3,335 square meters. The average density of cultural material is one artifact per 330 square meters.

Cultural material observed includes one quartzite tertiary flake, four chert tertiary flakes, one chert primary flake, and one quartzite tested cobble. One tool was noted on site, a gray mottled chert biface fragment (FA93-25-22.1) with finely worked serrated edges. One lateral edge exhibits a higher angle than the other, suggesting possible use as a knife. A concentration of over 20 pieces of fire-cracked rock was noted and roughly 15 pieces were scattered over the entire site. There was no evidence of charcoal, soil staining, or other hearth feature attributes associated with the concentration of burned stone.

One 30 x 30 cm shovel test was excavated to a depth of 20 cm below the present ground surface. The soil in the test consists of a brown clay loam. At 20 cm, decomposing bedrock was encountered and the test was discontinued. All soil was screened through ¼ inch mesh and no cultural material was recovered. The unit was backfilled upon completion.

Site 48CA2768 is considered not eligible for nomination to the National Register of Historic Places. The site is not datable and there is no indication of stratified or buried *in situ* cultural deposits. Additionally, there were no diagnostic artifacts, definable activity areas, multiple components, faunal or floral materials, exotic artifacts, or features present. The site has not yielded, nor is it likely to yield, information important in prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2769 - N/NW/SW/NE/SW, NE/SE/NW/SW, N/SE/SE/NW/SW, Section 29, T43N, R73W - This prehistoric campsite sits on the top and southwest side of a low gentle knoll in an area of rolling and undulating terrain. It is just south of a major drainage that runs northwest to the Belle Fourche River. The area is impacted by overgrazing and erosion. Vegetation consists of low bunch grasses and low forbs on the knoll top with sagebrush, in increasing amounts, down the side of the knoll. Ranging from 30-75% of the ground surface, the average vegetation cover is approximately 50%. The site measures 200 x 90 meters for a total area of 18,000 square meters.

Scattered lithics and five pieces of widely scattered fire-cracked rock were observed. No concentrations of fire-cracked rock or evidence of intact hearths were seen. The lithics include four tools and eight pieces of debitage. The tools consisted of two bifaces, one uniface, and one utilized flake. One biface is a red chert tertiary flake, worked bifacially along the distal end. The second biface is of a blood red chert with some utilization scars. The uniface is of an orange, red, and yellow chert. The utilized flakes is a secondary mottled gold/orange chert flake with some utilization scars, but has not been reworked. Recorded debitage consisted of four tertiary flakes of chert, two tertiary flakes of quartzite, one secondary flake of porcellanite and one secondary flake of chert.

A shovel test measuring 30 x 30 cm was excavated to a depth of 40 cm below ground surface. At this point eroded sandstone bedrock was encountered. The soil in the test was a dark brown sandy clay loam. All soil was screened through ¼ inch mesh and the unit was backfilled upon completion. No cultural remains were recovered from the test.

Site 48CA2769 is considered not eligible for nomination to the National Register of Historic Places. The site is not datable and there is no indication of stratified or buried *in situ* cultural deposits. Additionally, there were no definable activity areas, multiple components, faunal or floral materials, exotic artifacts, or features present. While several non-diagnostic tools were present, these can offer only the most generalized data in the context of the low density and diversity of cultural materials. The site has not yielded, nor is it likely to yield, information important in prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

<u>Site</u> <u>48CA2770</u> - SE/NE/SW, Section 29, T43N, R73W - This site consists of only two artifacts, one piece of quartzite shatter, and a Late Prehistoric (1,500-200 B.P.) corner-notched chert projectile point (FA93-25-27.1). The site is located on a relatively level area above the south side of a large drainage which runs west-northwest towards the Belle Fourche River. Vegetation is almost all low bunch grasses, with a few low forbs and cactus. The vegetation cover ranges from 40-60% and averages about 50% of the ground surface. The area is overgrazed and also impacted from sheet wash erosion. The site covers a 12 x 6 meter area for a total of 72 square meters.

One 30 x 30 cm shovel test was excavated to a depth of 14 cm below the ground surface, at which point eroding sandstone bedrock was encountered. The soil in the shovel test was a light brown sandy loam. All soil was screened through ¼ inch mesh and the unit was backfilled upon completion. No buried cultural material was found in this unit.

Site 48CA2770 is considered not eligible for nomination to the National Register of Historic Places. The site gives no indication of stratified or buried *in situ* cultural deposits. Additionally, there were no definable activity areas, multiple components, faunal or floral materials, exotic artifacts, or features present. While the located projectile point can date the site and be considered functionally diagnostic, this can offer only the most generalized data in the context of the low density and diversity of cultural materials. The site has not yielded, nor is it likely to yield, information important in prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2771 - NW/NW/NW/NW/SE, NE/NE/NE/SW, SE/SE/SE/NW, W/SW/SW/SW/NE, Section 31, T43N, R73W - This site is a lithic scatter and historic trash scatter. It is situated on top of a residual knoll overlooking ephemeral tributaries of the Belle Fourche River to the north, east, and west. The surrounding low relief, rolling topography is characterized by small mesas and knolls cut gently by ephemeral drainages. Vegetation consists of low sagebrush, short bunch grasses, low forbs, prickly pear and nipple cactus and ground lichen. A golden tan clay loam was noted in a residual context with minimal colluvial reworking of the surface soils on slope areas of higher angle. Mild erosion, a two-track road, and livestock grazing and trampling are the main impact agents to the site, leaving it in fair condition. The site measures an area of roughly 175 meters northwest to southeast by 250 meters southwest to northeast for a total of 34,444 square meters. Cultural material is present at an average density of one artifact per 1,375 square meters.

The prehistoric component of the site includes 21 pieces of lithic debitage made from various chert and, less commonly, gray quartzite and basalt. Tertiary flakes dominate the lithic assemblage and all stages of reduction are represented. One tested cobble was noted, however, no cores were observed. Thirteen pieces of fire-cracked rock were noted sparsely scattered over the entire site.

The historic component includes one hole and cap can, one removable lip can lid, and 14 pieces of sun-colored amethyst glass. The glass was in a small cluster and most probably came from the same vessel. The size and thickness of the glass fragments suggest a large jar. The presence of thick amethyst-colored glass with trapped air bubbles suggests a date of 1880-1925 (Rosenberg and Kvietok 1981:28) for the historic component of the site.

Three 30 x 30 cm shovel tests were excavated. Shovel Test #1 consisted of a hard packed clay loam to 20 cm below the surface, at which point the ground became too compacted for further excavation. Shovel Test #2 consisted of a moderately sorted clay loam to 50 cm below the surface. From 50-67 cm below the surface, a poorly sorted sandy loam with small gravels was encountered. Calcium carbonate was found at 67 cm below the surface and excavation was discontinued. Shovel Test #3 was similar to Shovel Test #2, with gravels and calcium carbonates encountered at 59 cm below the surface and at which point excavation was discontinued. No cultural material was recovered from any of the tests. All soil was screened through ¼ inch mesh and the units were backfilled upon completion.

Site 48CA2771 is considered not eligible for nomination to the National Register of Historic Places. The prehistoric component of the site is not datable and gives no evidence of containing stratified or buried *in situ* cultural deposits. There is no indication of functionally diagnostic artifacts, multiple components, faunal or floral materials, exotic artifacts, or features. The historic component is extremely limited. It is not associated with events that have made a significant contribution to the broad patterns of our history; nor is it associated with the lives of persons significant in our past; nor does it embody the distinctive characteristics of a type, period, or method of construction that represents a significant entity. The site has not yielded, nor is it likely to yield, information important in history or prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2772 - S/SW/SW/NE/NE, SE/SE/SE/NW/NE, Section 31, T43N, R73W - This site is a very sparse lithic scatter situated on a west facing slope in the Powder River Basin overlooking the Belle Fourche River. Sediments consist of a dark gray brown loam in a residual context with minimal colluvial reworking of the surface soils. Vegetation includes short bunch grasses, low sagebrush, prickly pear and nipple cactus, and ground lichen covering about 35% of the ground surface. The site is considered to be in good condition with erosion and livestock grazing and trampling as the main impact agents. It covers an area of 135 meters east-west by 50 meters north-south for a total of 5,299 square meters. The average density of cultural material is one artifact per 530 square meters.

Observed cultural material includes one point base (FA93-25-32.1) made from a gold chert, two red and white mottled chert tertiary flakes, and one mottled blue chert primary flake. The point base exhibits corner-notches with a short concave or notched base. These characteristics are similar to points dating to the Late Plains Archaic period (2,500-1,500 B.P.).

One 30 x 30 cm shovel test was excavated to a depth of 40 cm below the ground surface. The upper 15 cm consisted of a moderately sorted, moderately compacted brown loam. The strata from 15-40 cm consisted of a finely sorted, compacted light brown silt. At this level, deposits became too compacted for further excavation. All soil was screened through ¼ inch mesh and no cultural material was recovered. The unit was backfilled upon completion.

Site 48CA2772 is considered not eligible for nomination to the National Register of Historic Places. The site gives no indication of stratified or buried *in situ* cultural deposits. Additionally, there were no definable activity areas, multiple components, faunal or floral materials, exotic artifacts, or features present. While the located projectile point base can date the site and be considered functionally diagnostic, this can offer only the most generalized data in the context of the low density and diversity of cultural materials. The site has not yielded, nor is it likely to yield, information important in prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2773 - SE/SW/NW/NE/NE, NW/NE/SW/NE/NE, NE/NW/SW/NE/NE, Section 31, T43N, R73W - This is a multi-component site consisting of a lithic scatter with associated burned stone and one cluster of sun-colored amethyst glass. The site is situated on a flat plain directly above a cutbank of the Belle Fourche River. It is located in a region of moderate topographic relief characterized by ephemeral and intermittent drainages. Vegetation includes low sagebrush, short bunch grasses, prickly pear cactus, and ground lichen covering 45% of the ground surface. The soil consists of a green/brown loamy sand in a residual depositional context. Sandstone outcrops of the Eocene Wasatch formation were observed in the cutbank on the east side of the river. The site measures 115 meters northwest-southeast by 80 meters southwest-northeast for a total of 7,340 square meters. Cultural material is found at an average density of one artifact per 735 square meters. Impact agents to the site include a two-track road, erosion, and livestock grazing and trampling. The site is considered to be in good condition.

The prehistoric component includes three flakes: one gray quartzite tertiary flake, one red and black dendritic chert tertiary flake, and one gray quartzite tertiary flake with retouch on the distal edge, possibly an end scraper. One dendritic chert core and three pieces of fire-cracked rock were also noted.

The historic component is a small cluster of 20+ pieces of sun-colored amethyst glass dating from 1880 to 1925 (Rosenberg and Kvietok 1981:28). These glass fragments are very thick and have trapped air bubbles. The thickness, size, and shape of the glass fragments suggest a large decorative jar.

One 30 x 30 cm shovel test was excavated to a depth of 25 cm below the surface, at which point calcium carbonate was encountered and excavation was discontinued. The unit contained a compact loamy sand with light gravels throughout. No cultural material was recovered. All soil was screened through ¼ inch mesh and the unit was backfilled upon completion.

Site 48CA2773 is considered not eligible for nomination to the National Register of Historic Places. The prehistoric component of the site is not datable and gives no evidence of containing stratified or buried *in situ* cultural deposits. There is no indication of functionally diagnostic artifacts, multiple components, faunal or floral materials, exotic artifacts, or features. The historic component is extremely limited. It is not associated with events that have made a significant contribution to the broad patterns of our history; nor is it associated with the lives of persons significant in our past; nor does it embody the distinctive characteristics of a type, period, or method of construction that represents a significant entity. The site has not yielded, nor is it likely to yield, information important in history or prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2774 - C/NW/NE/NE, Section 31, T43N, R73W - This site is a lithic scatter. It covers a 28 x 13 meter area, for a total of 364 square meters. This cultural resource is located at the bottom of a gentle rounded ridge, facing the north-northwest and is 440 meters from the Belle Fourche River channel which lies to the west. Previous impacts to the site include slope wash erosion, a two-track road, and livestock grazing and trampling. The vegetation cover ranges from 40-60% and averages about 50% of the ground surface. The floral community is represented by bunch grasses, low forbs, and sparse sagebrush and cactus.

The observed artifact assemblage consists of two pieces of chert shatter, one primary chalcedony flake, and a hafted porcellanite biface (93-25-35.1). The biface is heavily weathered and has parallel oblique flaking. This type of flaking is frequently characteristic of the Paleo-Indian period, but no diagnostic attributes are present to make such an assertion. The edges show evidence of use, being heavily worn with striations parallel and diagonal to the blade which indicates that it was probably used as a crushing and cutting tool with some scraping.

One 30 x 30 cm shovel test was excavated to a depth of 28 cm below ground surface where eroded sandstone bedrock was encountered. The soil was a light brown sandy loam. All soil was screened through ¼ inch mesh and no cultural materials were recovered. The unit was backfilled upon completion.

Site 48CA2774 is considered not eligible for nomination to the National Register of Historic Places. The site is not datable and there is no indication of stratified or buried *in situ* cultural deposits. Additionally, there were no definable activity areas, multiple components, faunal or floral materials, exotic artifacts, or features present. While the culturally non-diagnostic biface was present, this can offer only the most generalized data in the context of the low density and diversity of cultural materials. The site has not yielded, nor is it likely to yield, information important in prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2775 - SW/SW/SE, Section 30, and NE/NW/NE, Section 31, T43N, R73W - This is a multi-component site with a prehistoric lithic scatter and a historic trash scatter. The site sits on a relatively level area immediately above the flood plain of the Belle Fourche river. There are bunch grasses on the west edge of the site with increasing amounts of sagebrush up the slope to the southeast. Some prickly pear cactus is also present. The vegetation cover ranges from 30-70% and averages 50% of the ground surface. The site is highly impacted by cattle grazing and trampling and erosion.

The prehistoric component covers a 182 x 57 meter area for a total of 10,374 square meters. The artifact assemblage consists of three flakes, one point fragment, two bifaces, and a rock cluster. The three flakes include two tertiary chert flakes and one secondary chert flake. Two of the three tools were collected: one Late Archaic period corner-notched point fragment (FA93-25-36.2) dating to 2,500-1,500 B.P., and a biface fragment (FA93-25-36.1) with the appearance of an Early Archaic period point though this is speculative. The uncollected biface was a pinkish-white chert tool midsection. In addition, there was a rock cluster on the site which could be either prehistoric or historic. It measures 0.8 meter in diameter and is made up of 13 sandstone rocks and rock fragments.

The historic component covers a smaller area of 90 x 43 meters for a total of 3,870 square meters. The historic artifacts include 32 pieces of sun-colored amethyst glass, one smashed hole-in-cap can, and one can lid. The amethyst-colored glass is generally diagnostic ca. 1880-1925 (Rosenberg and Kvietok, 1981).

Two 30 x 30 cm shovel tests were excavated, one to a depth of 35 cm and the other to a depth of 19 cm. Each was terminated at the point that eroding sandstone bedrock was encountered. The soil in both tests was a light brown silty clay loam. All soil was screened through ¼ inch mesh and each unit was backfilled upon completion. No cultural materials were recovered from either shovel test.

Site 48CA2775 is considered not eligible for nomination to the National Register of Historic Places. The prehistoric component of the site gives no evidence of containing stratified or buried *in situ* cultural deposits. There is no indication of definable activity areas, multiple components, faunal or floral materials, exotic artifacts, or features. While the located projectile point fragment can date the site and be considered functionally diagnostic, this can offer only the most generalized data in the context of the low density and diversity of cultural materials. The historic component is extremely limited. It is not associated with events that have made a significant contribution to the broad patterns of our history; nor is it associated with the lives of persons significant in our past; nor does it embody the distinctive characteristics of a type, period, or method of construction that represents a significant entity. The site has not yielded, nor is it likely to yield, information important in history or prehistory.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2776 - SE/NE/SW/SW/NW Section 28, T43N, R73W - A possible stock surveillance camp was found on the upper northwest slope of a ridge near the head of a shallow ephemeral drainage that trends northwest-southeast. The vegetation is sparse to moderate and consists of low sagebrush and prairie grasses. The soil is a desiccated tan sandy clay loam. The Belle Fourche River is located about 2,184 meters west of the site and is the nearest perennial water source. The site measures 46.5 meters northeast-southwest by 25.5 meters northwest-southeast for a total of 931 square meters.

The site contains a small scatter of opentop cans, single solder dot evaporated milk cans, clear bottle glass, and leather shoe fragments. Most of the cans were flattened and/or misshapen so that they could not be accurately measured for dating purposes. Opentop cans were in universal use by about 1922, and the single solder dot cans post-date 1900. The glass was from a ketchup bottle with a crown finish and exhibited automatic bottle technology (1904 to present).

Site 48CA2776 is considered not eligible for nomination to the National Register of Historic Places. The site appears to be associated with the early twentieth century sheep industry in the Powder River Basin. The context for agriculture (of which the sheep industry is a part) for the Eastern Powder River Basin has already been established and is included in *A Historical Synthesis of the Eastern Powder River Basin, Campbell and Converse Counties, Wyoming* (Rosenberg 1991). This site seems to fit the definition of a stock surveillance camp. Based on previous cultural resource surveys, the stock surveillance camp is the second most common historic period site type (18% of previously recorded sites) found in the Eastern Powder River Basin, after homestead/ranching sites (50%) (Rosenberg 1991:84,90). None of the previously recorded stock surveillance camps in this region has ever been found eligible for nomination to the National Register of Historic Places. This is a small site with a paucity of artifacts, and it lacks well-defined activity areas or signs of seasonal use over an extended period of time. There are no associated features with this site. The geographical information and date range are typical of this site type in this region (Rosenberg 1991:90-91). It appears that nearby highway and snowfence construction has also adversely affected the physical and environmental integrity of the site. Finally, there is very little likelihood of significant buried materials or deposits due to the thin soil deposition on this upper ridge slope.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2777 - NW/NW/NW/NW/SW, Section 28, and NE/NE/NE/NE/SE, Section 29, T43N, R73W - A stock surveillance camp was found on the crest of a northwest trending finger ridge of a larger ridge to the southeast, and north of a drainage area that eventually leads west into the Belle Fourche River drainage. The vegetation is sparse to moderate and consists of low sagebrush and prairie grasses. The soil is a desiccated tan sandy clay loam. The Belle Fourche River is located about 2,034 meters west of the site and is the nearest perennial water source. The site measures 30 meters east-west by 31.5 meters north-south for a total of 742 square meters.

The artifact assemblage includes two opentop cans, one single solder dot evaporated milk can, a beverage can with a church key opening, a wire apparatus that appears to be the frame to a feed bag (nose bag), small wood fragments, and round wire fragments. The best temporally diagnostic evidence was a measurable single solder dot evaporated milk can dating from 1917-1929. Opentop cans were in universal use by about 1922. However, the campsite may have been used more than once.

Site 48CA2777 is considered not eligible for nomination to the National Register of Historic Places. The site appears to be associated with the early twentieth century sheep industry in the Powder River Basin. The context for agriculture (of which the sheep industry is a part) for the Eastern Powder River Basin has already been established and is included in *A Historical Synthesis of the Eastern Powder River Basin, Campbell and Converse Counties, Wyoming* (Rosenberg 1991). This site appears to fit the definition of a stock surveillance camp. Based on previous cultural resource surveys, the stock surveillance camp is the second most common historic period site type (18% of previously recorded sites) found in the Eastern Powder River Basin, after homestead/ranching sites (50%) (Rosenberg 1991:84,90). None of the previously recorded stock surveillance camps in this region has ever been found eligible to the National Register of Historic Places. This is a small site with a paucity of artifacts, and it lacks well-defined activity areas or signs of seasonal use over an extended period of time. There are no associated features with this site. The geographical information and date range are typical of this site type in this region (Rosenberg 1991:90-91). Finally, there is very little likelihood of significant buried materials or deposits due to the thin soil deposition on the ridge crest.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

<u>Site</u> <u>48CA2778</u> - SE/SW/SE/NE, NE/NW/NE/SE, NW/SW/SE/SE/NE Section 29, T43N-R73W - A possible stock surveillance camp was found on the crest of a finger ridge of a larger ridge to the southwest, and north of an ephemeral drainage that trends west into the Belle Fourche River drainage. The vegetation is sparse to moderate and consists of low sagebrush and prairie grasses. The soil is a desiccated tan sandy clay loam. The Belle Fourche River is located about 1,734 meters west of the site and is the nearest perennial water source. The site measures 106.5 meters north-south by 27 meters east-west for a total of 2,557 square meters.

The artifact assemblage includes a scatter of opentop cans, single solder dot evaporated milk cans, hinged-lid tobacco cans, sardine cans, and a spice can. Opentop cans were in universal use by about 1922. The single solder dot evaporated milk cans post-date 1900, and the measurable can indicates a date range of 1920s-1930s. Upright hinged-lid tobacco cans post-date 1906. Other artifacts included round spikes, a centerfire rifle cartridge, and a black plastic electrical part. The configuration of the artifact scatter indicates that it may have existed prior to fence building. There are two-track roads running through the site and converging to the east of the site boundary.

Site 48CA2778 is considered not eligible for nomination to the National Register of Historic Places. The site appears to be associated with the early twentieth century sheep industry in the Powder River Basin. The context for agriculture (of which the sheep industry is a part) for the Eastern Powder River Basin has already been established and is included in *A Historical Synthesis of the Eastern Powder River Basin, Campbell and Converse Counties, Wyoming* (Rosenberg 1991). This site appears to fit the definition of a stock surveillance camp. Based on previous cultural resource surveys, the stock surveillance camp is the second most common historic period site type (18% of previously recorded sites) found in the Eastern Powder River Basin, after homestead/ranching sites (50%) (Rosenberg 1991:84, 90). None of the previously recorded stock surveillance camps in this region has ever been found eligible to the National Register of Historic Places. This is a small site with a paucity of artifacts, and it lacks well-defined activity areas or signs of seasonal use over an extended period of time. There are no associated features with this site. The geographical information and date range are typical of this site type in this region (Rosenberg 1991:90-91). Finally, there is very little likelihood of significant buried materials or deposits due to the thin soil deposition on the ridge crest.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2779 - NE/NE/SW/SW/NW Section 29, T43N-R73W - A possible stock surveillance camp was found on the southwest slope of a northwest-southeast trending ridge and northeast of an ephemeral drainage that leads northwest into the Belle Fourche River drainage. The vegetation is moderate and consists of low sagebrush and prairie grasses. The soil is a desiccated tan sandy clay loam. The Belle Fourche River is located about 510 meters west of the site and is the nearest perennial water source. The site measures 54 meters north-south by 25.5 meters east-west for a total of 1,081 square meters.

The artifact assemblage includes only one opentop can, four single solder dot evaporated milk cans, and one aluminum teartop beer can. The best temporally diagnostic evidence consisted of measurable single solder dot evaporated milk cans dating from 1917-1929. The aluminum teartop beer can was not introduced until 1963 and is probably unrelated to the sheepherder occupation.

Site 48CA2779 is considered not eligible for nomination to the National Register of Historic Places. The site appears to be associated with the early twentieth century sheep industry in the Powder River Basin. The context for agriculture (of which the sheep industry is a part) for the Eastern Powder River Basin has already been established and is included in *A Historical Synthesis of the Eastern Powder River Basin, Campbell and Converse Counties, Wyoming* (Rosenberg 1991). This site appears to fit the definition of a stock surveillance camp. Based on previous cultural resource surveys, the stock surveillance camp is the second most common historic period site type (18% of previously recorded sites) found in the Eastern Powder River Basin, after homestead/ranching sites (50%) (Rosenberg 1991:84,90). None of the previously recorded stock surveillance camps in this region has ever been found eligible to the National Register of Historic Places. This is a small site with a paucity of artifacts, and it lacks well-defined activity areas or signs of seasonal use over an extended period of time. There are no associated features with this site. The geographical information and date range are typical of this site type in this region (Rosenberg 1991:90-91). Finally, there is very little likelihood of significant buried materials or deposits due to the thin soil deposition on the ridge slope.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Site 48CA2780 - SE/SW/NW/NE, NW/SW/NW/NE, SW/SW/NW/NE Section 31, T43N-R73W - A possible stock surveillance camp was found within a nearly dry meander and cutbank of the Belle Fourche River. The vegetation is sparse and consists of low sagebrush and prairie grasses. The soil is a desiccated tan sandy silt loam. The Belle Fourche River is on-site. The site measures 63 meters northwest-southeast by 22.5 meters northeast-southwest for a total of 1,113 square meters.

The observed artifact assemblage consists of small amethyst and aqua-colored bottle glass fragments in the streambed and bank, a scattering of wood chips, and a complete whiskey bottle. The amethyst-colored glass is generally temporally diagnostic (ca. 1880-1925), and there were no diagnostic trademarks among the bottle fragments. The glass fragments are discolored and worn due to water and particle action in the streambed. The wood chips and whiskey bottle are probably more recent. The whiskey bottle exhibits automatic technology and has an embossed trademark on the base used by the Anchor-Hocking Glass Corp., Lancaster, Ohio, since 1938 (Toulouse 1971:47-48). The area is sheltered from the wind due to the high cutbank to the west and would generally offer some water to livestock. It is evident that both cattle and sheep have gathered here in large numbers from time to time for shelter and water due to the excessive droppings.

Site 48CA2780 is considered not eligible for nomination to the National Register of Historic Places. The site appears to be associated with the early twentieth century sheep industry in the Powder River Basin. The context for agriculture (of which the sheep industry is a part) for the Eastern Powder River Basin has already been established and is included in *A Historical Synthesis of the Eastern Powder River Basin, Campbell and Converse Counties, Wyoming* (Rosenberg 1991). This site appears to fit the definition of a stock surveillance camp. Based on previous cultural resource surveys, the stock surveillance camp is the second most common historic period site type (18% of previously recorded sites) found in the Eastern Powder River Basin, after homestead/ranching sites (50%) (Rosenberg 1991:84,90). None of the previously recorded stock surveillance camps in this region has ever been found eligible to the National Register of Historic Places. This is a small site with a paucity of artifacts, and it lacks well-defined activity areas. There are no associated features with this site. The geographical information and date range are typical of this site type in this region (Rosenberg 1991:90-91). Finally, the action of the river over the years has greatly eroded the site.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

Isolated Artifact FA93-25-IF-2 - SE/SW/SE/SW/NE, Section 29, T43N, R73W - This artifact is a butterscotch colored tertiary flake that is 1.5 cm in width. It is situated on top of a knoll within a region of undulating terrain. Surrounding vegetation consists of sagebrush, bunch grasses, and prickly pear cactus with an average ground cover of 60%. Soil in the region is a sandy clay loam. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact FA93-25-IF-12 - SW/NE/NE/NW/NE, Section 29, T43N, R73W - This artifact is a tertiary flake made of a gold chert with black inclusions. It measures 2.2 x 1.9 cm. The isolate is located on the slope of a small residual ridge in an area of low relief rolling plains gently cut by ephemeral drainages. Low sagebrush, stunted bunch grasses, prickly pear and nipple cactus, and ground lichen cover 60% of the ground surface. Soil consists of a greenish brown clay loam. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact FA93-25-IF-18 - NE/NW/NW/SW/SE, Section 29, T43N, R73W - This artifact is a butterscotch colored retouched uniface that is made from a primary chert flake. It is 2.5 cm in width. The isolate is located on a gradual slope on the south side of an unnamed drainage. Vegetation in the area includes sagebrush, bunch grasses, and low forbs covering 60% of the ground surface. The soil consists of a sandy clay loam. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact FA93-25-IF-23 - C/E/E/NE/SW, Section 29, T43N, R73W This artifact is a gray quartzite tertiary flake that measures 2.5 cm in width. It is located on a gradual slope on the north side of a northwest trending drainage. The vegetation includes bunch grasses, sagebrush, and low forbs, covering 70% of the ground surface. The soil consists of a light brown sandy clay loam. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact FA93-25-IF-25 - SW/NW/SE/NE/SE, Section 30, T43N, R73W - This artifact is a mottled red and white chert tertiary flake measuring 2 x 1.5 cm. It is located on the edge of a small northwest trending ephemeral drainage between two small residual ridges. The vegetation consists of low sagebrush, prickly pear cactus and bunch grasses covering approximately 80% of the ground surface. The soil is a brown clay loam. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact FA93-25-IF-26 - SE/SW/SW/NE/SE, Section 30, T43N, 73W - This artifact is a purple-brown tertiary quartzite flake that is 1.4 cm in width. It is located on the south slope of a small knoll. The knoll is just north of an unnamed drainage that flows northwest to the Belle Fourche River. The vegetation includes bunch grasses, sagebrush, and low forbs, covering 50% of the ground surface. The soil consists of a brown clay loam. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact FA93-25-IF-29 - NW/NE/NW/SE/SW, Section 29, T43N, R73W - This isolate is a gray opaque tertiary chert flake that is 2 cm in width. It is located near the western base of a small northwest trending ridge. The vegetation includes bunch grasses and sagebrush, covering 30% of the ground surface. The soil consists of a light brown, silty clay loam. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact FA93-25-IF-30 - NW/NW/NW/SE/SW, Section 29, T43N, R73W

- This artifact is a Late Archaic period projectile point with one corner and the tip broken off. The point is made from a light brown fine grained quartzite and is 2 cm in width and 2.5 cm in length. It is located in a region of flat terrain. The vegetation includes bunch grasses, sagebrush, and low forbs which cover 50% of the ground surface. The soil consists of light brown clay loam. The specimen was collected and will be curated at the University of Wyoming. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact RD93-8-IF-1 - NW/NW/SE/NE/NE Section 29, T43N, R73W - This artifact is a hole-in-top can that measures 4¼ inches in diameter by 4-3/4 inches in length. The can has a solder ring that is 2¼ inches in diameter. The can has lap side seams with heavy solder. It has a clean circular opening. Opentop or sanitary cans replaced hole-in-top cans in general use by about 1922. The can was found on the lower northeast slope of an ephemeral drainage that trends in a north-northwesterly direction. The soil is a desiccated tan sandy clay loam, and the vegetation consisted of low sagebrush and sparse prairie grasses. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

Isolated Artifact RD93-8-IF-2 - SE/NE/NE/NE Section 29, T43N, R73W - The isolate is a single solder dot evaporated milk can. The can measures 2-15/16 inches in diameter and 4-3/8 inches in length. It has a raised cap that is 1 inch in diameter and moderate, evenly applied solder. The can has a crimped side seam. It was opened using two punctures. The dimensions of the can indicate a manufacture date between 1915-1930. The can was located on the upper northwest slope of a ridge and east of an ephemeral drainage that trends in a north-northwesterly direction. The soil is a desiccated tan sandy clay loam, and the vegetation consisted of low sagebrush and sparse prairie grasses. The specimen was not collected. This isolate is not considered eligible for nomination to the National Register of Historic Places and a determination of no effect is recommended.

There is a high degree of confidence that the objectives of the inventory have been met. The probability of unlocated cultural resources existing within the project area is considered minimal. No further data needs are known for the current project.

RECOMMENDATIONS: Seventeen sites and 10 isolated artifacts were located by this inventory of the project area, none of which is considered eligible for nomination to the National Register of Historic Places. As such, a determination of no effect is recommended. No further archaeological or historical work is believed necessary. Cultural resource clearance is recommended for the project with no stipulations.

REFERENCES CITED:

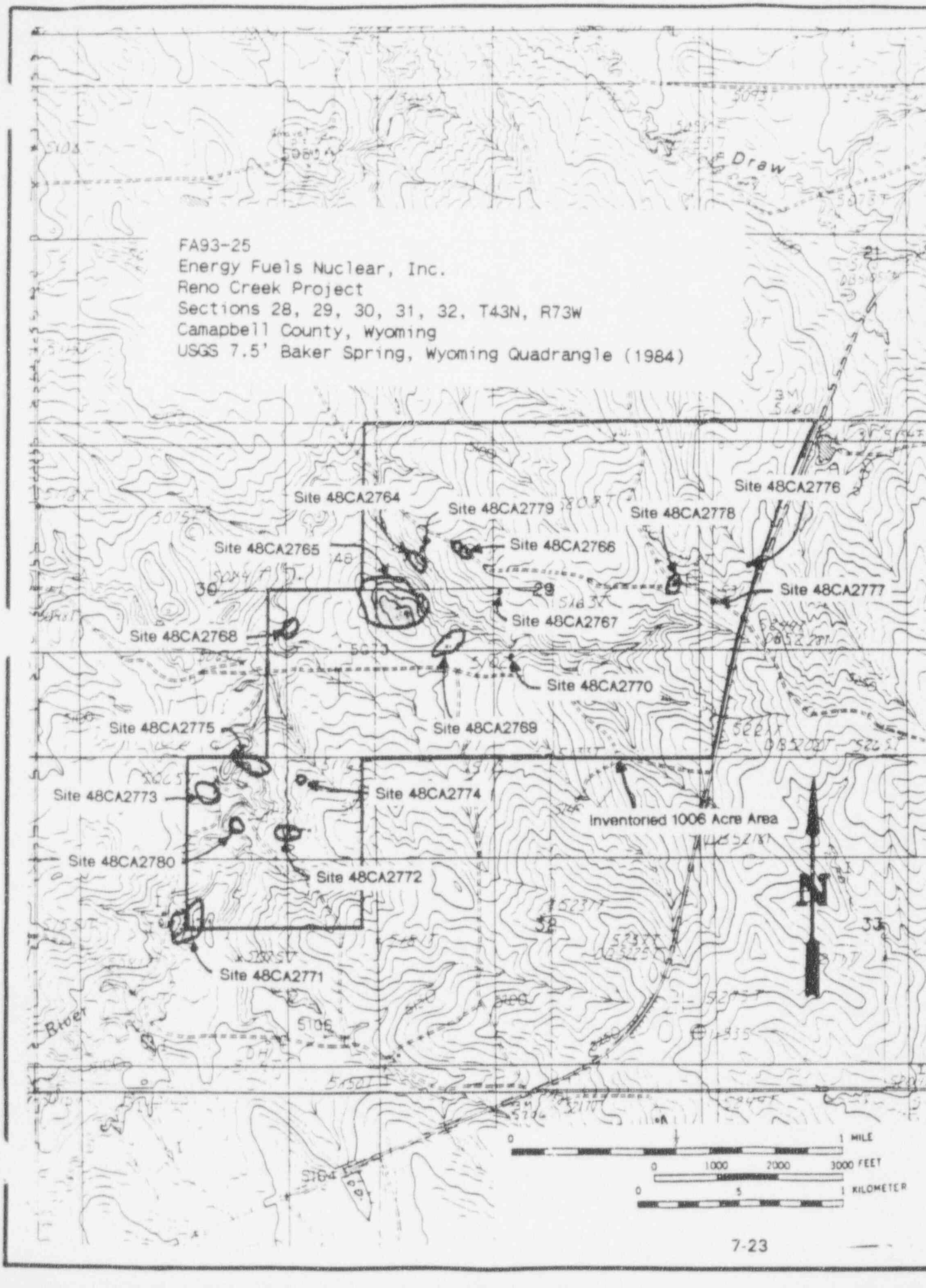
Babcock, William A., Daniel F. Gallacher, and Christine Amos
1982 *Historic Resources Inventory, Jacobs Ranch Mine, Campbell County Wyoming.* Appendix D-2. Historical Research Associates. Submitted to Kerr-McGee Coal Corporation, Oklahoma City, Oklahoma.

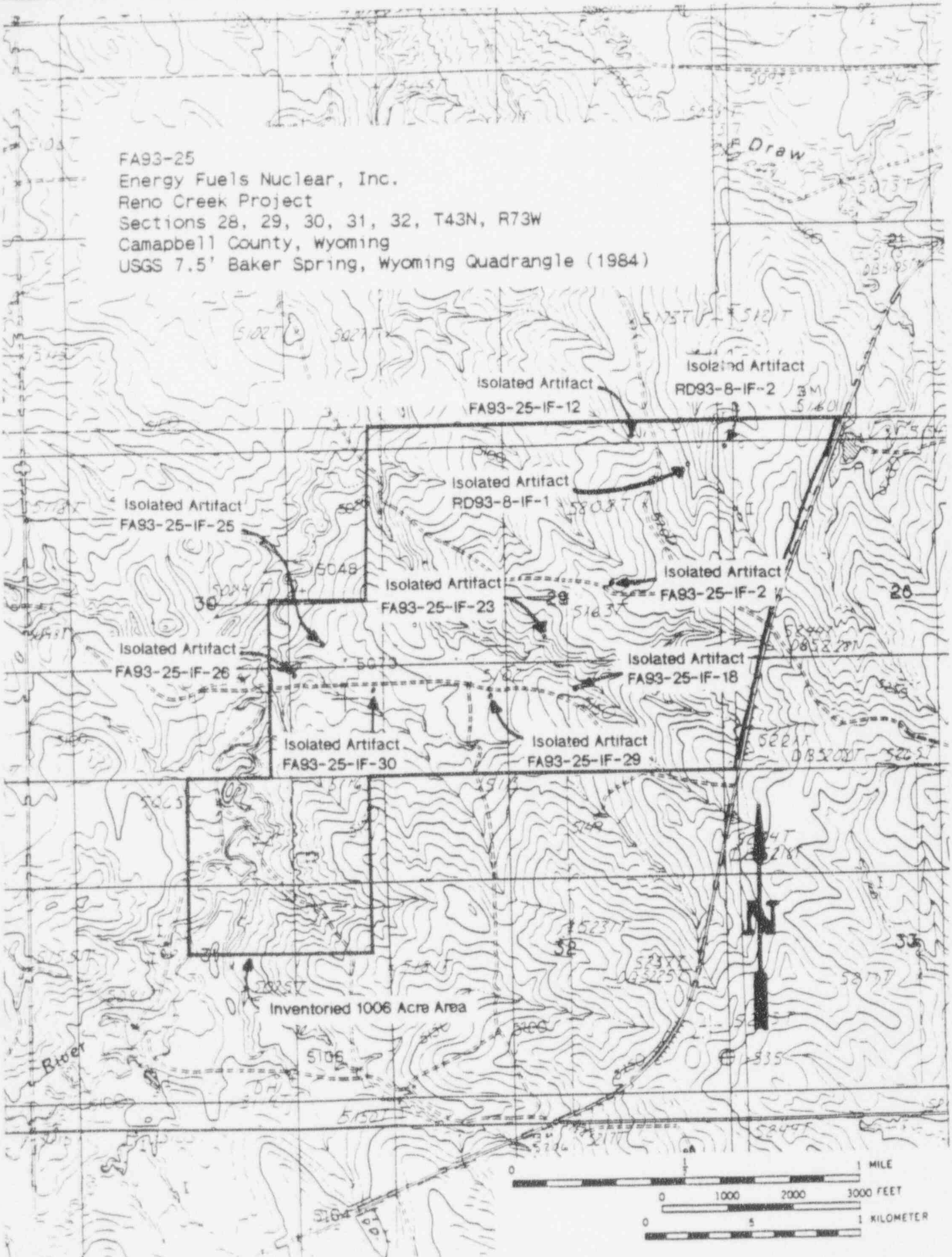
Love, J. D., and Ann Coe Christiansen
1985 *Geologic Map of Wyoming.* U.S. Geological Survey, Denver, Colorado.

Rosenberg, Robert G., and D. Peter Kvietok
1981 *A Guide to Historic Artifacts.* Privately printed, Cheyenne, Wyoming.

Rosenberg, Robert G.
1991 *A Historical Synthesis of the Eastern Powder River Basin, Campbell, and Converse Counties, Wyoming.* On file, Wyoming State Historic Preservation Office, Cheyenne, Wyoming.

Toulouse, Julian
1971 *Bottle Makers and Their Marks.* Thomas Nelson Inc., Camden, New Jersey.


FA93-25
Energy Fuels Nuclear, Inc.
Reno Creek Project
Sections 28, 29, 30, 31, 32, T43N, R73W
Camapbell County, Wyoming
USGS 7.5' Baker Spring, Wyoming Quadrangle (1984)
Draw
Site 48CA2764
Site 48CA2779
Site 48CA2778
Site 48CA2776
Site 48CA2765
Site 48CA2766
Site 48CA2777
Site 48CA2768
Site 48CA2767
Site 48CA2770
Site 48CA2775
Site 48CA2769
Site 48CA2773
Site 48CA2774
Inventoried 1006 Acre Area
Site 48CA2780
Site 48CA2772
Site 48CA2771
River
N
0
1 MILE
0 1000 2000 3000 FEET
0 .5 1 KILOMETER

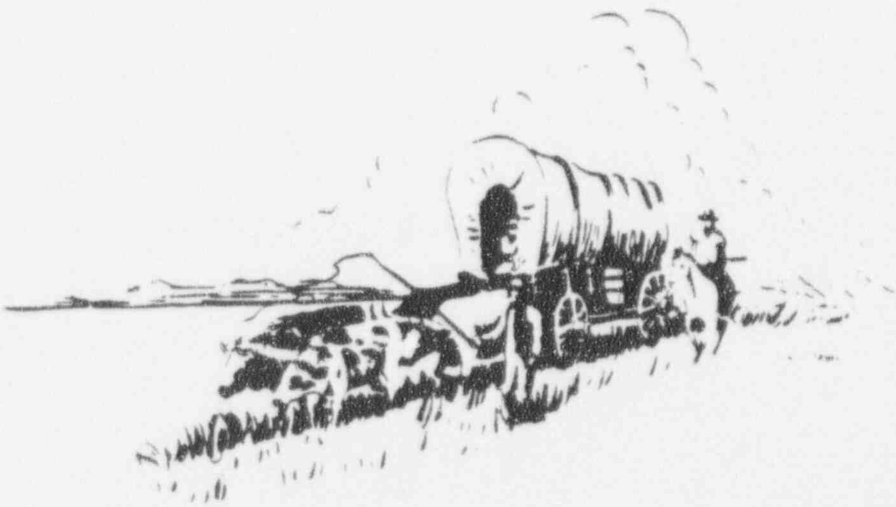

FA93-25
Energy Fuels Nuclear, Inc.
Reno Creek Project
Sections 28, 29, 30, 31, 32, T43N, R73W
Camapbell County, Wyoming
USGS 7.5' Baker Spring, Wyoming Quadrangle (1984)
Isolated Artifact
FA93-25-IF-12
Isolated Artifact
RD93-8-IF-2
Isolated Artifact
RD93-8-IF-1
Isolated Artifact
FA93-25-IF-25
Isolated Artifact
FA93-25-IF-2
Isolated Artifact
FA93-25-IF-23
Isolated Artifact
FA93-25-IF-26
Isolated Artifact
FA93-25-IF-18
Isolated Artifact
FA93-25-IF-30
Isolated Artifact
FA93-25-IF-29
Inventoried 1006 Acre Area
30
29
28
32
33
N
0
1/2
1 MILE
0
1000
2000
3000 FEET
0
5
1 KILOMETER

CLASS III CULTURAL RESOURCE INVENTORY OF ENERGY FUELS NUCLEAR, INC. RENO CREEK PROJECT ADDITION, CAMPBELL COUNTY, WYOMING

by

James E. Lieb and Robert G. Rosenberg

Project #FA93-151



September 1993

James M. Welch
Principal Investigator

FRONTIER ARCHAEOLOGY
P.O. Box 118
811 Big Horn Avenue
Worland, Wyoming 82401
(307) 347-8848

BLM Cultural Resource Use Permit #043-WY/NE-C093

This page intentionally left blank.

ABSTRACT: A Class III cultural resource inventory was conducted of Energy Fuels Nuclear, Inc. Reno Creek Project Addition. One multicomponent site was located, which consists of historic debris and one prehistoric artifact. This site is considered not eligible for nomination to the National Register of Historic Places. No further archaeological or historical work is believed necessary and cultural resource clearance is recommended for the project with no stipulations.

CLIENT: Energy Fuels Nuclear, Inc.

PROJECT: Reno Creek Project Addition

LOCATION: BLM Casper District, Buffalo Resource Area
Private Surface Ownership, Federal Minerals Ownership
N/NW (East of State Highway 387), Section 28, T43N, R73W
Private Surface Ownership, Federal Coal Ownership
S/S (East of State Highway 387), Section 21; N/NE, Section 28;
W/NW, SE¼ (East of State Highway 387), Section 32;
SW¼, Section 33; T43N, R73W
Campbell County, Wyoming
USGS 7.5' Baker Spring and Rattlesnake Draw,
Wyoming Quadrangles (1984)

PROJECT DESCRIPTION: Energy Fuels Nuclear, Inc. plans to construct uranium in-situ leach well fields and processing facilities. The project is situated on gentle to moderate slopes ranging from 1-17°. A minor to moderate amount of ground disturbance is expected to result from the project.

A total of 540 acres was inventoried for the project. All of this acreage is contained on privately owned surface land with federal coal /minerals.

ENVIRONMENTAL SETTING: The project is situated within gently rolling plains in the southern half of the Powder River Basin. The basin is a structural and topographic depression about 250 miles long and more than 100 miles wide. It is characterized in the northern part by relatively high open rolling hills with 500 to 1,000 feet of topographic relief, and in the southern part by plains and tablelands with moderate relief of 300 to 500 feet. The Big Horn Mountains lie to the west of the basin and the Black Hills lie to the east.

Specifically, the project is situated in a region of minimal topographic relief. The terrain is characterized by low, rolling plains gently cut by the Belle Fourche River and its various ephemeral tributaries. The Belle Fourche River, which is also an ephemeral water source at this point, meanders in a northerly direction. The tributaries of the river generally run from the southeast to the northwest, forming northwest trending ridge lines.

The soil in this area is characteristically a clay loam with greater amounts of sand in the hillier areas near eroding sandstone outcrops. Soil color is variable, ranging from tan to brown to greenish-brown to dark gray-brown. Sandstone bedrock outcrops also occur in the area, with the rocks being part of the Eocene Wasatch Formation (Love and Christiansen 1985).

The region is characterized as an ecological transition zone between the true short grass plains to the east and the northern desert shrub to the west. Local vegetation communities, though dominated by short sagebrush, also contain numerous grass and forb species common to the shortgrass communities of the Great Plains. Within this context, the vegetation for the project area was represented primarily by various grasses and low sagebrush with few forbs.

Some prickly pear and nipple cactus, and ground lichen were also present. Ground cover ranged from 20-75%, with the average coverage being about 50% of the surface.

Elevation across the project area ranges from 5,050 to 5,280 feet above mean sea level. The climate is typical of mid-latitude semi-arid regions characterized by low precipitation and high rates of evaporation. The faunae are typical of the Wyoming High Plains context. A detailed description is found in Babcock, Gallacher, and Amos (1982:2-9 through 2-11) and illustrates a somewhat diverse, but limited array of mammals, birds, and reptiles.

Previous ground disturbances noted within the project area include a paved highway, two-track roads, fencelines, an abandoned well pad, mineral test holes, erosion, and livestock grazing and trampling.

HISTORICAL OVERVIEW: Due to overlapping historical themes, this historical overview encompasses the wider region of the Powder River Basin.

The first European interest in Wyoming is represented by the trappers, who exploited this area for furs or traveled through it to reach other trapping grounds. In 1810, John Jacob Astor dispatched the Hunt Expedition to the mouth of the Columbia River to establish the headquarters for an envisioned chain of trading posts stretching from the Great Lakes to the Pacific Ocean. The expedition passed through northeastern Wyoming but stayed north of the project area and crossed the Big Horn Mountains. The Powder River Basin was not considered prime beaver country due to its aridity and lack of major year-round water courses, but was often described as an ideal "wintering over" place by the mountain men. Game was abundant and winters were mild in comparison to the high country.

Antonio Montero, an employee of Captain Bonneville, established a trading post on the lower Powder River in 1828, reportedly about 10 miles east of Kaycee. This post was abandoned in about 1836 or 1837 and was rediscovered by the Raynolds Expedition in 1859 (Markoff 1981:87; Schulte 1981:11; Wishart 1978:189). Otherwise, the era of the fur trade left few physical remnants likely to be found in the Powder River Basin.

The fur trade was based solely on the whims of fashion, and when beaver hats were replaced with silk hats, its decline was irreversible. However, the legacy of these early trapper-explorers was the geographic information necessary for the looming westward migration and for a more systematic exploration of the Trans-Mississippi West.

<u>Post-Fur Trade Exploration</u>: The Powder River Basin did not initially lure Euro-Americans for development or settlement. Its resources and attributes were subtle, best recognized and utilized by Native Americans. In fact, the area became a part of the last real stronghold of the Sioux, Cheyenne, and Arapaho and was the scene of pitched battles between the army and the Indians for domination of the region for nearly two decades.

The Oregon Trail followed the southern perimeter of the Powder River Basin along the North Platte River, which offered abundant water and forage. Although the great nineteenth century westward migration did not pass through the heart of the Powder River Basin, it did have an impact on the native populations of the region. Prior to the 1840s, contact with Europeans had been limited to small parties of trappers and traders. Emigrants stripped the country through which they passed of game and forage and disturbed game migration patterns. This extended period of mass migration through Indian country also increased the likelihood of hostile encounters and ultimate large scale conflict.

Prior to building an extensive system of forts, roads, and telegraph lines, the United States Army realized the need to reconnoiter the vast and unknown regions of the west. The Corps of Topographical Engineers was created in 1838 to perform this task (Goetzmann 1979:4). Two expeditions were particularly pertinent to the Powder River Basin--those of Lieutenant Kemble Warren in 1857 and Captain William F. Raynolds in 1859. Warren's mission was to determine the best route for a military road and to reconnoiter the Black Hills region. However, he was forced to turn back prematurely due to warnings of a large body of Dakota Indians. Raynolds conducted a follow-up expedition in 1859 to scout the Indians and explore four possible wagon roads. In October 1859, he sent a detachment under J. Hudson Snowden from his winter quarters on Deer Creek to explore the Powder River Basin to the north. Snowden reached Pumpkin Buttes, ascended the second butte and gave a vivid description of the country in all directions. However, he considered it "...totally unfit for the uses of a civilized being" (U.S., Congress, Senate 1868:157-161).

The Indian-Military Conflict: During the 1840s and 1850s, Euro-American and Indian contact within Wyoming's current boundaries was generally limited to the Oregon Trail corridor. Under the Fort Laramie Treaty Council of 1851, the Sioux assented to hunt north of the North Platte River, and all tribes agreed to leave the emigrant roads unmolested and to allow the establishment of military posts and roads in their territories (Larson 1978:14-15). Continued Anglo-Indian conflict to the south of the study area resulted in removal of the Cheyenne and Arapaho tribes in Colorado Territory to Indian Territory. To the north, the last stronghold of the Plains Indians gradually dwindled to the Powder River country and the Black Hills. Several factors soon led to open conflict in this region. In 1863, John M. Bozeman laid out a route to Virginia City, Montana, that cut through the heart of the Native American sanctuary. The Bozeman Trail branched off the main Oregon Trail near the future site of Fort Fetterman (near Douglas) and proceeded on a northwesterly course through the Powder River Basin, passing along the east flank of the Big Horn Mountains. Although several gold-seeking parties attempted to use this new route, the risks were high without military protection.

The Connor Expedition of 1865 was a three-pronged punitive campaign whose purpose was to penetrate the heart of Indian country in the Powder River Basin and the Black Hills. The expedition was a failure and nearly resulted in the loss of hundreds of soldiers due to an early blizzard. Connor did destroy a large Arapaho village at the battle of Tongue River on the site of Ranchester, Wyoming (Hafen and Hafen 1961:22-26).

While Connor's troops pursued this campaign, a civilian expedition protected by a military escort and under the direction of Colonel James A. Sawyers attempted to locate and build a wagon road across the northern Powder River Basin to Virginia City, Montana. In the vicinity of present-day Gillette, Wyoming, Sawyers was attacked by a large number of Sioux and Cheyenne Indians, and three members of his party were killed in a series of skirmishes. The party circled their wagons and dug riflepit defenses in two different locations (Rosenberg 1987:8-22). These sites have been located and tentatively identified as the Bonepile Riflepits and the Caballo Creek Riflepits.

The last major factor that precipitated the First Plains Indian War was the building of a system of forts along the Bozeman Trail in 1866. On December 21, 1866, Captain William J. Fetterman and his command of 81 men were surrounded and killed by a large force of Sioux Indians near Fort Phil Kearney. The Fetterman massacre was one of the major Indian victories over the military on the western frontier. This victory and the constant raids that effectively closed the Bozeman Trail led to the Fort Laramie Treaty of 1868, which conceded the region to the Indians as a hunting ground (Kappler 1904:774-775).

The peace was short-lived, as Custer's Black Hills expedition of 1874 discovered gold deposits and word soon spread of the mineral wealth of the Black Hills. This created a tide of emigration into the region that the federal government was powerless to prevent. It then attempted to buy the Black Hills, which the Indians refused to sell, considering them to be sacred. Finally, the Grant administration issued a proclamation requiring all Indians to report to their respective agencies or be subject to military action. The army first engaged in an unsuccessful winter campaign and then organized an invasion by three armies, which resulted in Custer's annihilation at the Little Big Horn on June 25, 1876. Several smaller engagements followed within Wyoming. On November 23, 1876, Colonel R.S. Mackenzie destroyed Dull Knife's Cheyenne village in the Big Horn Mountains west of present-day Kaycee (Utley 1973:275-76).

Although the 1876 campaigns did not result in any clear-cut military victories, the non-agency Indians had been fragmented and scattered, their ammunition and supplies exhausted. A government peace commission met in the fall of 1876 and drafted a treaty with some of the chiefs to cede the Black Hills and all lands west of them (Larson 1978:106). Thus, by the spring of 1877, northern Wyoming Territory had been cleared for White settlement, and most of the warring Indians were confined to formal reservations outside of Wyoming.

The Era of the Stockman: Although thousands of emigrants passed through Wyoming Territory on the Oregon Trail, there was very little interest in settling this forbidding land until (1) the more fertile areas to the west had been populated, and (2) the first transcontinental railroad was constructed through the southern portion of the territory in 1867-1868 allowing ready access to distant cattle markets. As a result of the abundance of free grasslands and the presence of the railroad, the era of the great Texas cattle drives commenced, and the Wyoming rangelands were soon populated with Texas cattle. At first the pioneer cattle ranches were located in southeastern Wyoming, but after a treaty with the Indians in 1876, the vast region north of the North Platte River was open for settlement, and the cattlemen soon moved their herds northward across the river. The pioneer Powder River Basin ranchers penetrated this unsettled region by following the major drainages and utilizing the Cheyenne-Deadwood Stage Road. To the west, ranches were clustered along the Bozeman Trail and the new town of Buffalo.

Among the earliest cattle outfits to establish operations in present-day Campbell County was the 4J Ranch, established by Johnathan Brown in 1875 and located about 18 miles southwest of Gillette. The 4J cattle roamed a vast range from Fort Laramie to Fort Fetterman. The T7 Ranch was established by Thomas N. Mathews in 1881 about 23 miles southeast of Gillette. The first organized cattle roundup in Campbell County took place in 1882, with the T7, G Bar M, T-S, CQ, OK, AK and the Six Half Circle taking part (LeCompte and Anderson 1982:D-2-72-73, 93-95, 98).

Open range cattle ranching on the Wyoming plains involved only a limited investment of capital and relied on the free short prairie grasses for feed. British and Scottish interests began investing in this seemingly "get rich quick" scheme and soon overpopulated the ranges with cattle. The Blizzard of 1886-1887 resulted in high cattle losses due to the open range system, under which no feed was grown or put aside for winter storms, and no shelter or water were provided. The hardest hit were the large cattle barons, including the British and Scottish investors. The Blizzard of 1886-1887 effectively ended the short-lived era of the cattle barons and open range management practices. The Wyoming cattle industry entered an extended period of decline and retrenchment. Cattlemen began to clear meadow land to grow hay crops for winter forage and to fence their lands for better livestock management.

The temporary decline of cattle ranching provided a foothold for the fledgling sheep industry in the Powder River Basin. However, the lack of rail transportation tended to delay its full development. The initial outlay for sheep ranching was estimated at one-third the cost of cattle ranching, and with a nearly unlimited public domain on which to graze, the sheepmen soon spread northward from southeastern Wyoming, stocking the range with sheep driven eastward from California and Oregon. The sheep thrived on the buffalo grass, bunch grass, native bluegrass, and various kinds of sagebrush, and required little water (Wentworth 1948:258-259; 308-309).

Jim Davis established one of the pioneer sheep bands north of the North Platte River in 1878 near Muskrat Canyon in the vicinity of Rawhide Buttes, and the Wilson brothers introduced sheep to the Lusk area in 1880 (Murray 1978:136). In 1883, D.A. Kingsbury drove a flock to Kelly Creek west of Kaycee and used the Big Horn Mountains for his summer range. George T. Beck located in the area shortly thereafter, and by 1884 had the largest flock in Sheridan and Johnson Counties. In the 1890s, Fred and Charles Waegle, George Kaltenbach, David and Richard Young, Long and Baldwin, James A. Dowling, and Barney Long all established sheep operations in Johnson County. The town of Buffalo became the center of the sheep ranching activity, and a regional sheep association was organized in 1899 (Wentworth 1948:325).

The sheep industry also gradually crept northward from the Laramie-Cheyenne area. In the late 1880s, John Morton, Al Myres, and George Powell were operating near Douglas. The establishment of their operation coincided with the arrival of the railroad. John Morton bought the G Bar M ranch in southern Campbell County in the late 1880s and began raising sheep there. At its peak, the Morton Sheep Company ran 35,000 sheep in Campbell County. Sheep operations were also conducted in the vicinity of Lusk by Henry Reed, Cal and John Hargrave, and Jacob Mills. The Willson Brothers ran sheep on the Niobrara River starting in 1887 and used the Laramie Peak area for a summer range.

The Elkhorn and Missouri Valley Railway (later Chicago and North Western) was built to Casper in 1888, and Casper soon became the main supply base for the sheep industry in that region. The town of Douglas, reached by rail in 1886, became a secondary shipping point (Wentworth 1948:322).

In 1891, the Burlington and Missouri Railroad (Chicago, Burlington and Quincy) was built westward through Newcastle from Nebraska. The new town of Gillette was founded, and the Powder River Basin at last had a rail connection to eastern markets. Such Campbell County outfits as the 4J ad the G Bar M ran up to 40,000 sheep in peak periods. John Allison herded sheep for R.R. Sellway on the Powder River in 1897-1898, and made Gillette his headquarters for supplies. Subsequently, Allison and Sellway became one of the large sheep companies in Campbell County. A.S. French ran sheep for the Blair Brothers west of Gillette near Felix on Wild Horse Creek in 1899. In 1900, Charles Lee and Ernest Spaeth bought the Preston Horse Ranch southeast of Gillette and went into the sheep business. William R. Wright ran sheep after 1902 in the southern part of the county; W.A. Appel ran sheep south of Gillette in 1903; he sold to W.R. Wright in 1905. By 1906, the Keelines were running 33,000 head of sheep. Many ranchers raised both sheep and cattle to allow for fluctuations in either market (Anderson and LeCompte 1982:D-2-81; Bragg 1978:15).

It was perhaps inevitable that the growing number of sheep on the range should result in conflicts with the already established cattlemen. Cattlemen believed that sheep cropped the range grasses too closely and contaminated the range, rendering it unfit for cattle. Differences in personality and image between the cowboy and the sheepherder contributed to the range wars. Conflicts followed a basic pattern--cattlemen would establish "deadlines" that the sheep operators were not permitted to cross. Inevitably these lines were violated, and the herder and his flock would sometimes be attacked. Such confrontations continued well into the twentieth century, with the killing of three sheepherders in the Ten Sleep country in 1909 (Mokler 1923:365). The violence gradually subsided as grazing restrictions on the public domain became more stringent and better regulated.

Since the Taylor Grazing Act of 1934, sheep in the Powder River Basin are generally run in fenced pastures without constant herder surveillance, and due to the great distances are not normally driven to high mountain areas for summer range. Despite the recent decline of the profitability of the sheep industry, Wyoming still derives a significant share of its agricultural income from sheep ranching, and the sheep industry played a major role in the settlement and economic development of the Powder River Basin.

<u>The Homesteader's Frontier</u>: The history of the homesteader's frontier in the second half of the nineteenth century is predicated on federal land policy and its underlying philosophy that settlement of the public domain was more important than revenue. It established the precedent of breaking up the public lands into small homesteads, thereby benefiting the largest number of people while reducing the hold of land speculators and those already holding sufficient land. The Homestead Act of 1862 went one step further and allowed a citizen to file upon and own basically free of charge up to 160 acres of "unappropriated public lands" (Robbins 1942:91).

Although this policy proved tenable east of the Mississippi River where rainfall was abundant, when homesteaders began taking up 160-acre homesteads on the semi-arid high western plains, they soon experienced the difficulties of succeeding on such a small parcel. As a result, the federal government attempted to adapt the homesteading laws with piecemeal legislation often more unrealistic than the Homestead Act itself, such as the Timber Culture Act of 1873 and the Desert Land Act of 1877. The result of these land acts was that the individual homesteader in the Powder River Basin could seldom legally acquire enough land to conduct a successful farming/ranching operation.

Homestead settlement in the Powder River Basin was retarded by a number of factors. Railroads did not penetrate most of northeastern Wyoming until the 1890s and the early 1900s. Secondly, the large cattle operators were already entrenched in the most favorable locations along the major drainages. Engaging in pastoral pursuits that were better suited to the environment, the cattle interests already controlled most of the available water sources and could prevent the small homesteader from making inroads into their vast cattle kingdoms. After the advent of cheap barbed wire in 1875, the homesteader could afford to fence his parcel, but the cattle rancher could in turn fence the public domain, which he did not own but claimed through custom and use. Furthermore, early homesteaders had chosen either to head for the fertile valleys of Oregon or California, or to cling to the eastern fringes of the Great Plains, areas less arid than the Powder River Basin country. Therefore, until the regions to the west and east were saturated, farmers had little incentive to brave the harsh climate, the cattle ranchers, or the Indians.

With some or all of these drawbacks facing the prospective settler, it is little wonder that homestead settlement developed so slowly in the Powder

River Basin. By the 1880s, however, conditions began to change in favor of the small homesteader. First, an act of Congress (February 25, 1885) forbade the fencing of the public domain by the cattlemen. Secondly, the General Land Office proceeded to crack down on fencing and land fraud violations and consequently stirred up the Eastern press against the cattlemen (Larson 1978:179-182). The Blizzard of 1886-1887 broke the hold of the cattle barons, and the weakening of the industry proved an opening for the homesteader. Furthermore, an cycle of increased rainfall in the arid region in the 1880s made farming briefly appear more attractive.

Success in early farming was based on the presence of sufficient water for irrigation. However, the Powder River Basin had few substantial year-round water sources. Such factors as the invention of wind mills, the use of James Oliver's chilled plow that could handle the tough prairie sod, and the introduction of hardy red winter wheat from the Crimea encouraged farmers to take up the vacant waterless lands of the plains. The final catalyst was a cycle of heavy rainfall in the 1880s, which convinced people that some fundamental shift in climate had occurred and resulted in the belief that "rain follows the plow" (Olson 1955:174). With the encouragement of the expanding railroads and their associated land companies, homesteaders began pouring onto the plains in the 1880s in an initial assault that lasted as long as the unusual wet weather pattern. However, the year 1894 brought the worst drought to the Plains until the 1930s. With the additional factor of the Financial Panic of 1893, abandoned homesteads dotted the western plains.

The Powder River Basin was largely unaffected by this initial homesteading effort. The large ranchers reigned supreme, with the exception of some early irrigated farming/ranching efforts north of Crazy Woman Creek near the Big Horn Mountains. These smaller operations provided products to the military and kept only small cattle herds (Murray 1980:69).

The next homesteading phase resulted from the Dry Land Farming movement of the late nineteenth and early twentieth centuries and proved to have a profound effect on settlement in the Powder River Basin. Coupled with increased immigration to the United States and the increasing scarcity of good cheap farming land, homesteaders turned to submarginal lands throughout Wyoming with these new farming techniques. The Campbell system of farming, developed by Hardy W. Campbell, had been used in Nebraska and Kansas. His theory was based on storing and conserving the natural rainfall by compressing the subsoil and keeping the topsoil loose by cultivation; it also entailed leaving parcels fallow and keeping the surface free of moisture-robbing vegetation (Dick 1975:356-357). The theory of dry farming was sound, and it is still practiced today in Wyoming. Nevertheless, a basic minimum amount of rainfall is necessary; below that amount, dry farming is not possible. Wyoming encouraged dry land settlement of its semi-arid lands through the Board of Immigration created in 1911. Newspapers extolled the virtues of dry land farming; the railroads conducted a well-organized advertising campaign on a nationwide basis to settle the regions through which they passed.

Wyoming's chief proponent of dry land farming was Frank W. Mondell, who later became mayor of Newcastle and a congressional representative. Mondell had practiced dry land farming techniques on his farm five miles northwest of Newcastle from 1889 to 1893. He wrote the 1909 Enlarged Homestead Act that allowed a homesteader to file on up to 320 acres and further encouraged farmers to immigrate to Wyoming. Despite droughts in 1910 and 1911, dry land farmers in Wyoming experienced good years in 1912 and 1913. However, these successful efforts were centered in southeastern Wyoming south of the North Platte River (Larson 1978:362).

The federal government also lured homesteaders to western lands by the

Stock Raising Homestead Act of 1916, which allowed an individual to file on up to 640 acres of land that the Secretary of the Interior had classified as "stock-raising lands." Such lands were suitable only for grazing and the raising of forage crops, did not have any timber, and could not be irrigated (Wyoming State Planning Board 1938:118).

Gillette and the Creation of Campbell County: The town of Gillette was created when the Chicago, Burlington, and Quincy Railroad built through the region in 1890-1891, attracted chiefly by coal deposits at Cambria and Sheridan. The Lincoln Townsite Company bought up four homesteads on the townsite, and the town was platted in July 1891. The first shipment of cattle from the region left Gillette on August 2 of the same year. Gillette continued to grow during the early years of the twentieth century and had a population of 448 in 1910. It became the county seat when Campbell County was created from portions of Crook and Weston counties in 1911. By the 1915 census, Gillette had grown to 505 people, and Campbell County had a population of 2,316. Most of the residents were engaged in farming and ranching, and no one was listed in mining. Only 7.4% of Campbell County residents were listed as foreign born (*Census of the State of Wyoming, 1905 and 1915*; Larson 1978:323; Markoff 1981:107-117). These statistics verify that the coal industry had not yet developed beyond small wagon and ranch mines. Commercial coal mining in the region did not begin until the Wyodak Mine was established in 1923. Large scale strip mining throughout the eastern Powder River Basin would not begin until the 1960s.

The most intensive period of homesteading activity in the Powder River Basin occurred in the late 1910s and early 1920s. Promotional efforts by the State and the railroads, the prosperous war years for agriculture in 1917 and 1918, and the Stock Raising Act of 1916 with its increased acreage (but lack of mineral rights) all contributed to this boom period. A large number of land filings consisted of existing farms and ranches expanding their holdings in an optimistic economic climate. However, an equally large number of homesteaders had been misled by promotional advertising and were not adequately prepared for the trying experiences that awaited them in the Powder River Basin. It soon became apparent to the would-be dry land farmer that he could not make a living by raising only crops. Some were initially successful in growing crops of wheat, oats, barley, and other small grains, along with hay, alfalfa, sweet clover, and other grasses for the increased number of cattle. A drought in 1919 was followed by a severe winter. The spring of 1920 saw market prices fall for cattle and sheep. Those homesteaders who were not ruined by the turn in events became small livestock ranchers and limited their farming to the growing of forage crops and family garden plots. Some were able to obtain cheap land as it was foreclosed or sold for taxes. During the 1920s, the size of homesteads in Wyoming nearly doubled and the number of homesteads decreased, indicating a shift to livestock raising (LeCompte and Anderson 1982:D-2-132-133).

For most of these small ranchers, irrigation was impossible due to the lack of year-round water sources. Availability of water was the major limiting factor for these early twentieth century homesteaders. The creeks and drainages were intermittent, and reliable springs were scarce. It was often necessary to dig a well 50 or more feet deep to strike water. Most homesteaders relied on a combination of water sources, employing wells and cisterns to hold rain water and snowmelt. It was also often necessary to haul water from distant year-round water sources.

The Great Depression: The End of the Homesteading Era: The high agricultural prices associated with increased demand during World War I caused many farmers and ranchers to use their profits to purchase more land, equipment, and seed. The Stock Raising Homestead Act of 1916 with its 640-acre parcel was ideal for this expansion by existing homesteaders. Unfortunately, agricultural prices began plummeting after 1920, and farmers preceded the rest of the nation into the Depression by using up their wartime profits on expansion instead of paying off their mortgages (Olson 1955:296).

Nevertheless, Campbell County farmers and ranchers fared better than most portions of Wyoming during this time period. Between 1919 and 1929 the amount of cropland tripled, sheep doubled, and cattle increased. Like many of its counterparts throughout the state, the Bank of Gillette failed in 1923. However, the farmers and ranchers of Campbell County who were able to survive the early 1920s experienced good years in the late 1920s (LeCompte and Anderson 1982:D-2-136-137).

This short reprieve was quickly followed by the Great Depression and a series of severe droughts in 1930, 1931, 1934, 1936, and 1939. Those small farmers and ranchers who were not ruined outright persevered but, no longer able to make a living from the land, became dependent on relief. Tax delinquency was therefore commonplace, and county governments had difficulty maintaining roads and administering the school system.

The Resettlement Administration created by Executive Order on April 30, 1935, began purchasing homesteads that were abandoned or operating at a loss on marginal lands. These lands were to be returned to their original status as grazing lands. Some of the residents on purchased lands were resettled on better lands to help them become self sufficient. These consisted of separate farms scattered throughout existing farm districts or settlements. A portion of these purchased lands were consolidated and formed the Thunder Basin National Grasslands, which now cover a large portion of Weston County, northeastern Converse County, southeastern Campbell County, and an isolated block in northeastern Campbell County. Campbell County has a total of 446,363 acres within the Grassland boundaries consisting of mixed federal, State, and private ownership. The Soil Conservation Service administered the Thunder Basin Project and was concerned chiefly with reclaiming the land that had been overgrazed and overcultivated during the dry land homesteading boom. Three grazing associations were established to administer grazing on the Grasslands, issue permits, and collect grazing fees. The Thunder Basin Grasslands were turned over to the Medicine Bow National Forest on January 1, 1954 (Resettlement Administration 1936:3, 121, 126; U.S. Forest Service 1965).

In 1934, the Taylor Grazing Act and two subsequent Executive Orders withdrew the remaining public domain from entry, thus virtually ending the homesteading era (except on certain reclamation projects). Its intent was "to stop injury to the public grazing lands by preventing overgrazing and soil deterioration, to provide for their orderly use, improvement, and development, to stabilize the livestock industry dependent upon the public range" (U.S. Statutes at Large, 73rd Congress, Vol. 48:1269).

The character of the Powder River Basin today reflects the fact that the federal government finally realized that this region and other large portions of Wyoming and the West were not suited to large-scale or even small subsistence farming. It was pastoral land, profitable if properly administered and regulated, and carrying a smaller number of larger operations, better suited to the demands of the land and climate.

CULTURAL RESOURCE REVIEW: Prior to the fieldwork, a file search was requested from the Wyoming State Historic Preservation Office on September 9, 1993 (#11965). That agency reports the following previous inventories and recorded cultural resources are known for the sections within which the project is located.

In 1993, Frontier Archaeology conducted a Class III cultural resource inventory for Energy Fuels Nuclear, Inc. of a proposed uranium in-situ leach well field and processing facilities. A total of 1,006 acres was inventoried for the project, which was located in the W½, Section 28; all of Section 29; E/SE, Section 30; and NE¼, Section 31; T43N, R73W. Two historic cultural resources were located as a result of this project.

Site 48CA2776 - SE/NE/SW/SW/NW Section 28, T43N, R73W - This site is a historic stockherding camp and is considered not eligible for nomination to the National Register of Historic Places. Since the site is located 0.23 mile from the proposed project, there will be no impact.

Site 48CA2777 - NW/NW/NW/SW Section 28, T43N, R73W - This site is also a historic stockherding camp and is considered not eligible for nomination to the National Register of Historic Places. This site occurs 0.38 mile from the proposed project and will not be impacted.

FIELDWORK: On September 9, 10, and 11, Sheryl Ann Hansen, James Lieb, and David Day conducted a Class III cultural resource inventory of the proposed project area as described above and indicated on the attached project map. The proposed project area was inventoried by a series of parallel, pedestrian transects spaced 100 feet (30 meters) apart, covering a total of 540 acres. The project was flagged and no snow cover was present at the time of the fieldwork. No subsurface tests were conducted in conjunction with this inventory. Original field notes and other data are retained at the Frontier Archaeology office in Worland, Wyoming.

RESULTS: For the purpose of this project, a site is operationally defined as two or more associated artifacts greater than 50 years of age, or one or more clearly definable features or structures greater than 50 years of age. One site was located by this inventory of the project area.

Site 48CA2798 - NW/NW/SW/SE Section 21, T43N, R73W - This is a multicomponent site consisting of a historic trash scatter and one prehistoric isolated artifact. The site is located on the western slope of a northwest-southeast trending finger ridge, adjacent to an intermittent drainage. Vegetation is moderate and consists of low sagebrush, prickly pear cactus, and sparse bunch grasses. Soils are a light tan silty sand. The Belle Fourche River is located about 2.08 miles to the northwest, and is the nearest perennial water source. The site measures 90 meters east-west and 65 meters north-south for a total of 5,850 square meters.

The artifact assemblage includes 19 tin can scraps, seven crushed sanitary cans, one crushed hole-in-top can, and one tertiary flake of red and tan mottled dendritic chert.

Site 48CA2798 is considered not eligible for nomination to the National Register of Historic Places. The historic component of this site appears to be a stock surveillance camp associated with the early twentieth century sheep industry in the Powder River Basin. The context for agriculture (of which the sheep industry is a part) for the Eastern Powder River Basin has already been established and is included in *A Historical Synthesis of the Eastern Powder River Basin, Campbell and Converse Counties, Wyoming* (Rosenberg 1991). Based on previous cultural resource surveys, the stock surveillance camp is the second most common historic period site type (18% of previously recorded sites) found in the Eastern Powder River Basin, after homestead/ranching sites (50%) (Rosenberg 1991:84,90). None of the previously recorded stock surveillance camps in this region have been found eligible for nomination to the National Register of Historic Places. This is a small site with few artifacts, and it lacks well-defined activity areas or signs of seasonal use over an extended period of time. There are no associated features with this site. The geographical information and date range are typical of this site type in this region (Rosenberg 1991:90-91). Finally, there is little likelihood of significant buried cultural material due to lack of soil deposition in the area.

The prehistoric component of site 48CA2798 consists of a single tertiary flake made of red and tan mottled dendritic chert. The function and time period of this artifact are unknown. By definition, this prehistoric isolated artifact is not considered eligible for nomination to the National Register of Historic Places.

It is not possible to determine at this time how the site might be impacted by the proposed project. However, given that it is not considered eligible for nomination to the National Register of Historic Places, a determination of no effect is recommended.

There is a high degree of confidence that the objectives of the inventory have been met. The probability of unlocated cultural resources existing within the project area is considered minimal. No further data needs are known for the current project.

RECOMMENDATIONS: One site was located as a result of this inventory of the project area which is considered not eligible for nomination to the National Register of Historic Places. As such, a determination of no effect is recommended. No further archaeological or historical work is believed necessary. Cultural resource clearance is recommended for the project with no stipulations.

This page intentionally left blank.

REFERENCES CITED:

Bragg, Bill
1978 *Campbell County: The Slumbering Giant.* Holiday Inn, Gillette, Wyoming.

Dick, Everett
1975 *Conquering the Great American Desert: Nebraska.* Nebraska State Historical Society, Lincoln.

Goetzmann, William H.
1979 *Exploration and Empire: The Explorer and the Scientist in the Winning of the American West.* Alfred A. Knopf, New York.

Hafen, LeRoy R. and Ann W. Hafen
1961 *Powder River Campaigns and Sawyer's Expedition of 1865.* A.H. Clark, Glendale, California.

Kappler, Charles J. (editor)
1904 Indian Affairs, Laws and Treaties. 58th Cong. 2nd Sess., Vol. 1, *Senate Doc. 319.* U.S. Government Printing Office, Washington, D.C.

Larson, T.A.
1978 *History of Wyoming.* University of Nebraska Press, Lincoln.

LeCompte, Janet and Jane L. Anderson
1982 *History of Northern Campbell County and the Rawhide Mine Permit Area, Wyoming.* Pioneer Archaeological Consultants, Longmont, Colorado. On file, Department of Environmental Quality, Land Quality Division, Cheyenne, Wyoming.

Love, J. D., and Ann Coe Christiansen
1985 *Geologic Map of Wyoming.* U.S. Geological Survey, Denver, Colorado.

Markoff, Dena S.
1981 *Cultural Resources of the Black Thunder Mine Permit Area, Southern Campbell County, Wyoming.* Western Cultural Resource Management, Inc., Boulder, Colorado. On file, Department of Environmental Quality, Land Quality Division, Cheyenne, Wyoming.

Mokler, Alfred J.
1923 *History of Natrona County, Wyoming, 1888-1922.* R.R. Donnelly and Sons Company, Chicago.

Murray, Robert A.
1978 *Class I Historic Resource Study, Vol. I. Narrative History.* On file, Bureau of Land Management, Casper District, Casper, Wyoming.

1980 *Multiple Use in the Big Horns: The Story of the Big Horn National Forest (3 Vols.).* Report prepared for and on file, Big Horn National Forest, Supervisor's Office, Sheridan, Wyoming.

Olson, James C.
1955 *History of Nebraska.* University of Nebraska Press, Lincoln.

Resettlement Administration
1936 *First Annual Report*. Resettlement Administration, U.S. Government Printing Office, Washington, D.C.

Robbins, Roy M.
1942 *Our Landed Heritage: The Public Domain, 1776-1936*. Princeton University Press, Princeton.

Rosenberg, Robert G.
1987 *Historical Investigations of the Sawyers Wagon Road Expeditions of 1865 and 1866 and Related Rifle Pits, Campbell County, Wyoming*. Report prepared for and on file, AMAX Coal Company, Gillette, Wyoming.

1991 *A Historical Synthesis of the Eastern Powder River Basin, Campbell and Converse Counties, Wyoming*. On file, Wyoming State Historic Preservation Office, Cheyenne, Wyoming.

Schulte, Steven C.
1981 *Class I Historic Cultural Resource Inventory for the Proposed Wycoalgas Project, Wyoming*. On file, Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming.

State of Wyoming
1905 *Census of the State of Wyoming*.
1915

Union Pacific Railroad
1909 *Dry Farming Congress* (pamphlet) Laramie: Wyoming Clipping File, Coe Library, University of Wyoming.

U.S., Congress, Senate
1868 Report on the Exploration of the Yellowstone and the Country Drained by that River (by William F. Raynolds). 40th Cong., 2nd Sess. *Sen. Exec. Doc. 77* (Serial 1317), U.S. Government Printing Office, Washington, D.C.

U.S. Forest Service
1965 *Multiple Use Management Plans: Thunder Basin*. On file, Medicine Bow National Forest, Supervisor's Office, Laramie, Wyoming.

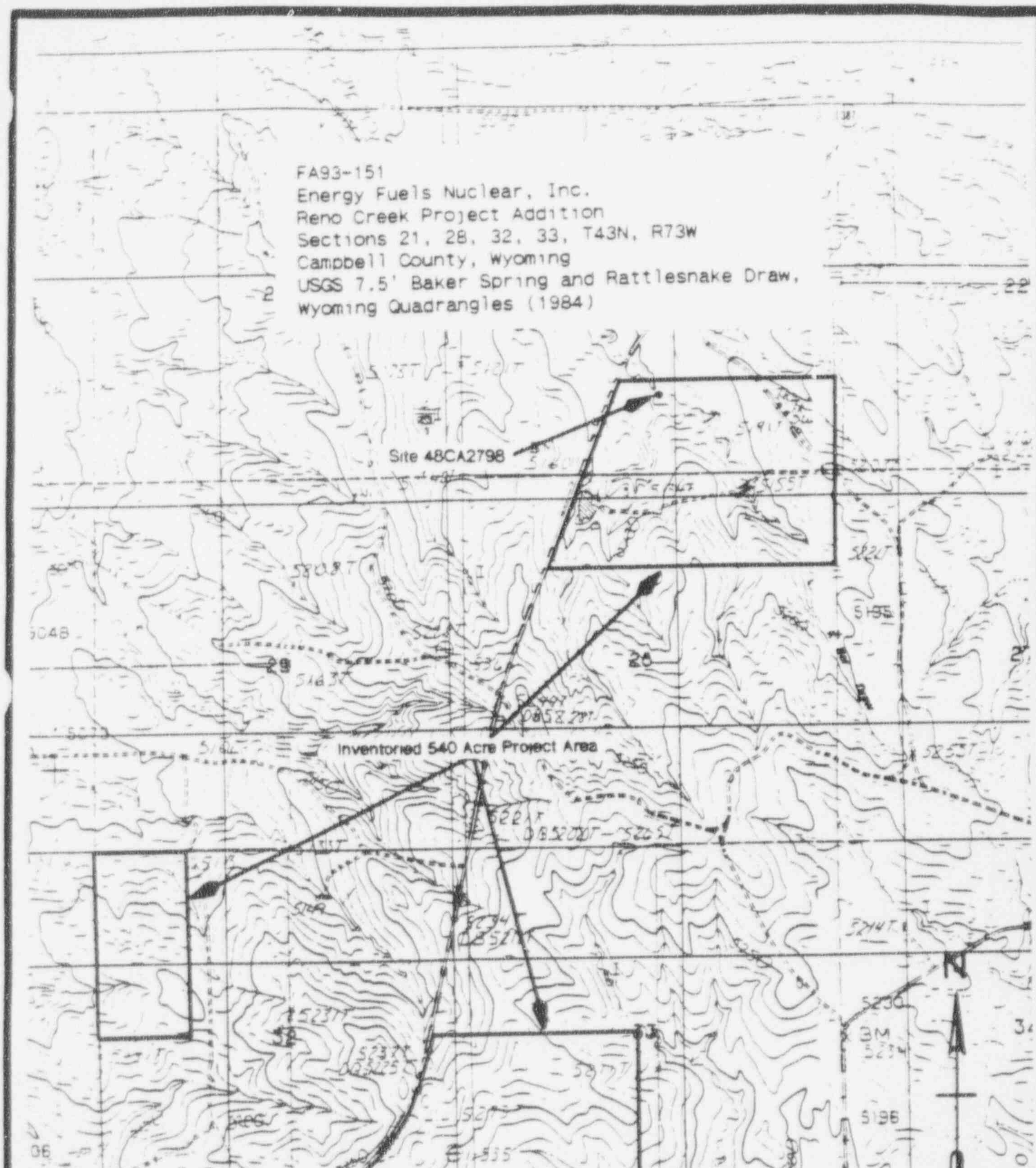
U.S. Statutes at Large, 1875-1877. Vol. 19:377.

Utley, Robert M.
1973 *Frontier Regulars: The United States Army and the Indian, 1866-1890*. The Macmillan Company, New York.

Wentworth, Edward N.
1948 *America's Sheep Trails*. Iowa State College Press, Ames, Iowa.

Wishart, David J.
1978 *The Fur Trade of the American West*. University of Nebraska Press, Lincoln.

Wyoming State Planning Board
1938 *Public Domain in Wyoming*. State Planning Board, Cheyenne.


FA93-151
Energy Fuels Nuclear, Inc.
Reno Creek Project Addition
Sections 21, 28, 32, 33, T43N, R73W
Campbell County, Wyoming
USGS 7.5' Baker Spring and Rattlesnake Draw, Wyoming Quadrangles (1984)
Site 48CA2798
Inventoried 540 Acre Project Area
N
0
1 MILE
0
1000
2000
3000 FEET
0
.5
1 KILOMETER
Radio Tower

This page intentionally left blank.

8. CLIMATOLOGY

8.1 DATA SOURCES

Climatological data was obtained from the Department of Agricultural Meteorology at the University of Nebraska in Lincoln. The data includes measurements taken at various weather stations around the Reno Creek area. These stations are located in Casper, Gillette, Kaycee and Midwest, Wyoming. Meteorological data from 1980 to 1990 was used for the Casper station while data from 1981 to 1991 was used for the Gillette, Kaycee and Midwest stations.

The Casper monitoring station is approximately 72 miles south-southwest of the Reno Creek site while the Gillette site is located approximately 45 miles north-northeast. The Kaycee monitoring station is located approximately 50 miles northwest and the Midwest monitoring station is located approximately 35 miles southwest.

After consultation with U.S. NRC staff, the Casper climatological data was selected as most representative of the Reno Creek project area for purposes of modeling airborne radon.

8.2 GENERAL CONDITIONS

Climatic conditions within the Reno Creek area can be classified as being semi-arid. Precipitation around the Reno Creek area varies from location to location. Most of the annual precipitation occurs during the growing season of the late spring and summer months and thunderstorms are common. Monthly snowfall amounts are relatively uniform from November through February, and slightly heavier during the spring months of March and April. Snow has occurred as early as September and as late as early June. Temperatures vary from highs during the summer of around 100° F to lows during the winter of -40° F.

8.3 PRECIPITATION

Precipitation within the Reno Creek area is variable. During 1982, Gillette received approximately 29.62 inches of rain while other stations around the area received 20.49 inches or less. During a dry year, 1988, Kaycee and Casper received 6.09 and 6.56 inches respectively, while Gillette and Midwest received over 12.00 inches of rain. Over the last 11 years, average annual precipitation amounts for the monitoring stations are: Casper 13.26 inches; Gillette 16.00 inches; Kaycee 12.34 inches and Midwest 11.51 inches.

Maximum snow fall amounts for the Casper station are presented in Table 8.1.

TABLE 8.1
Maximum Snow Fall Amounts (inches)
For Monthly and 24 Hour Period

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Year
Year	1980	1987	1983	1984	1980	1990	1990	1990	1982	1986	1983	1982	1982
Monthly	22.1	22.7	27.7	33.6	15.7	T	T	T	11.5	16.1	37.1	62.8	62.8
Year	1980	1990	1987	1985	1980	1990	1990	1990	1982	1986	1983	1982	1982
Hour (24)	7.6	9.8	9.2	9.8	8.1	T	T	T	6.8	13.3	14.3	31.1	31.1

Table 8.1 - Casper Average Snow Fall

Table 8.3, Table 8.4, Table 8.5 and Table 8.6 provide precipitation information for the past 11 years for the Casper, Gillette, Kaycee and Midwest stations.

8.4 RELATIVE HUMIDITY

Relative humidity is dependent on both the moisture content and the temperature of the air. Average monthly relative humidity data from 1990 for Casper is presented in Table 8.2. From these measurements, relative humidity in the morning is shown to average 70%, while the average is 41% for the afternoon. Yet, summer afternoons often exhibit relative humidity percentages in the 20's and 30's while winter afternoons exhibit humidity percentages in the 50's and 60's.

8.5 TEMPERATURE

Average annual temperatures for the four monitoring stations range from 42.5° to 49.9° F. The averages for each of the stations for the past 11 years are: Casper 45.7° F; Gillette 45.4° F; Kaycee 46.1° F and Midwest 47.4° F. Table 8.7, Table 8.8, Table 8.9 and Table 8.10 show temperature data for Casper, Gillette, Kaycee and Midwest respectively.

8.6 EVAPORATION

The closest site to the permit area where evaporation data is available is Gillette, Wyoming, approximately 45 miles north-northeast of the permit area. Data from Gillette indicates that an average total loss of 60 inches occurs from May to September. Net loss (evaporation minus precipitation) is 43 inches. July usually has the highest total evaporation loss, averaging approximately 9 to 10 inches.

8.7 SKY COVER

The sky cover data from the Casper station is presented in Table 8.[illegible] Data suggests that clear days are most prevalent during the summer months, while overcast da[illegible]ost prevalent during the winter months.

TABLE 8.2
Average Relative Humidity (%)
For 1990

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Year
Hour 05	66	66	78	81	82	68	75	74	67	62	59	62	70
Hour 11	51	51	52	50	41	32	34	30	32	39	48	54	43
Hour 17	51	48	46	49	41	26	28	28	27	38	53	55	41
Hour 23	65	64	74	76	70	59	61	58	51	62	58	51	63

Table 8.2 - 1990 Casper Relative Humidity

TABLE 8.3

Precipitation Data

Casper, Wyoming

Monthly Precipitation (inches) CASPER

Source: University of Nebraska Lincoln, Dept. of Meteorology

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1980	0.81	0.63	1.19	0.35	2.82	0.10	0.85	0.65	0.10	0.64	0.74	0.37	9.25
1981	0.46	0.23	0.77	1.56	3.51	0.37	1.27	0.50	0.23	0.76	0.75	0.43	10.84
1982	.041	0.33	0.60	1.25	2.10	4.15	1.92	0.88	3.4	1.18	0.55	3.71	20.48
1983	0.42	0.35	2.29	2.28	1.40	3.76	2.61	0.78	0.20	0.88	2.72	0.78	18.41
1984	1.19	0.48	1.59	2.23	1.33	1.34	2.26	0.25	0.50	0.71	.070	0.78	13.36
1985	0.79	0.61	0.52	1.25	1.37	1.32	1.57	0.09	1.09	0.46	1.56	1.05	11.68
1986	0.36	0.89	0.55	1.89	1.33	4.06	0.88	0.27	1.31	2.63	1.48	0.27	15.92
1987	1.42	1.42	1.43	0.35	1.40	0.70	1.93	1.80	0.59	0.55	0.77	0.63	12.99
1988	0.28	0.79	0.71	0.71	1.24	0.28	0.55	0.16	0.74	0.12	0.48	0.50	6.56
1989	0.16	1.37	0.49	0.72	2.77	1.95	0.28	1.00	3.22	1.17	0.34	0.31	13.78
1990	1.27	0.70	1.13	1.35	1.09	0.66	2.15	1.89	0.52	0.90	1.27	0.61	12.54

Table 8.3 - Monthly Precipitation, Casper

TABLE 8.4

Precipitation Data

Gillette, Wyoming

Monthly Precipitation (inches) GILLETTE

Source: University of Nebraska Lincoln, Dept. of Meteorology

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1981	0.28	0.57	1.27	0.48	4.54	1.38	2.82	2.32	0.27	0.93	0.25	0.67	15.78
1982	0.75	0.27	1.82	1.73	4.82	3.65	3.34	4.39	4.38	2.15	0.54	1.78	29.62
1983	0.27	0.25	1.35	1.30	2.30	1.27	0.38	1.92	0.40	2.35	1.35	1.01	14.15
1984	0.65	0.30	1.40	3.75	1.75	2.30	0.25	0.36	0.45	0.30	1.25	0.31	13.07
1985	0.33	0.02	0.54	0.76	3.24	2.62	2.15	0.90	1.91	0.10	1.12	0.38	14.07
1986	0.31	0.52	0.92	2.01	1.93	2.10	0.70	0.33	4.41	2.79	1.11	0.22	17.35
1987	0.14	0.99	0.87	0.24	3.76	2.94	2.91	2.10	1.16	0.74	0.43	0.52	16.50
1988	0.23	0.56	0.66	0.33	1.37	1.79	2.70	1.30	1.32	0.88	0.90	0.95	12.56
1989	0.07	0.34	0.95	1.25	4.07	2.29	1.16	0 .80	2.04	1.01	0.38	0.41	15.31
1990	0.28	0.26	0.68	2.55	1.17	0.82	2.28	2.35	0.80	0.75	0.37	0.05	12.72
1991	0.08	0.74	0.71	2.24	4.06	2.03	1.80	0.64	0.85	0.87	0.81	0.61	14.88

Table 8.4 - Monthly Precipitation - Gillette

TABLE 8.5 Precipitation Data Kaycee, Wyoming													
Monthly Precipitation (inches) KAYCEE Source: University of Nebraska Lincoln, Dept. of Agricultural Meteorology													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1981	0.30	0.33	1.25	0.52	4.91	1.13	1.12	0.84	0.37	0.81	0.46	0.55	12.69
1982	0.49	0.12	1.27	1.11	2.54	4.34	2.80	0.60	3.74	1.51	0.24	1.04	19.80
1983	0.12	0.11	0.90	0.95	2.23	1.87	0.57	1.58	0.20	1.73	1.29	0.89	12.44
1984	0.86	0.26	0.70	1.40	0.88	2.77	0.95	0.36	0.51	0.51	0.72	0.17	10.1
1985	0.45	0.42	0.67	1.11	3.40	1.30	0.41	0.12	1.66	0.36	1.04	0.28	11.22
1986	0.27	0.85	0.41	2.22	2.12	1.10	1.30	0.57	1.14			0.10	
1987	0.70	0.70	0.59	2.88	2.88	1.90	2.14	0.99	1.57	0.41	1.18	0.07	16.01
1988	0.18	0.21	0.54	0.90	1.15	0.49	0.56	0.25	0.83	0.23	0.41	0.34	6.09
1989	0.15	0.38	0.81	1.88	2.87	1.48		00.45	2.03	1.36	0.25	0.26	
1990	0.21	0.23	0.56	0.84	1.02	1.42	1.39	0.56	0.61	1.21	0.43	0.36	8.83
1991	0.20	0.25	0.91	2.66	3.58	2.52	1.05	0.29	1.42	0.61	0.29	0.14	13.92

Table 8.5 - Monthly Precipitation - Kaycee

TABLE 8.6 Precipitation Data Midwest, Wyoming													
Monthly Precipitation (inches) MIDWEST Source: University of Nebraska Lincoln, Dept. of Meteorology													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1981	0.36	0.48	1.34	0.73	4.58	0.24	2.27	0.38	0.56	0.95	0.65	0.38	12.92
1982	0.39	0.29	1.64	1.39			2.18	1.07	3.64	1.82			
1983										1.51	1.63	0.85	
1984	0.65	0.40	0.68	2.10	1.18	.067	1.40	0.22	0.21		0.15	0.21	
1985	0.29	0.48			1.08	1.94	1.33		1.13	0.70			
1986	0.02	0.13	1.23	1.41	1.44	2.82	0.04	0.00	0.15	2.68	00.79	0.73	
1987		1.50	2.27	0.14	3.01	3.46	2.57					0.95	
1988	0.30	0.50	0.09	0.04	0.90	0.74	0.11	0.37	1.94	1.44	0.69	0.41	12.17
1989	0.22	0.16	0.30	1.26	2.58	1.59	0.92	00.60	2.36	1.21	0.03	0.07	
1990	0.36	0.08	0.41	1.16	1.32	0.73	0.71	0.35	0.33	0.02	0.92	0.22	6.61
1991	0.08	0.61	1.09	3.69	2.67	1.02	1.11	0.27	0.48	0.21	0.60	0.25	14.34

Table 8.6 - Monthly Precipitation - Midwest

TABLE 8.7
Temperature Data
Casper, Wyoming

Average Monthly Temperature (F) CASPER

Source: University of Nebraska Lincoln, Dept. of Agricultural Meteorology

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1980	16.4	27.5	31.0	44.2	51.6	64.4	72.2	66.4	59.7	46.5	33.8	34.2	45.7
1981	31.0	29.9	38.0	48.3	51.4	64.3	71.8	69.2	62.0	44.4	39.0	27.3	48.10
1982	38.0	25.7	36.6	41.1	51.1	60.3	70.2	73.7	56.9	45.2	32.2	23.3	44.7
1983	31.5		36.3	38.0	48.4	50.4	71.2	74.8	60.2	49.7	31.2	10.9	45.3
1984	27.5	36.3	34.4	39.1	54.5	61.5	70.4	71.2	52.5	40.1	34.8	22.9	44.2
1985	19.7	34.4	33.3	45.5	55.3	61.3	71.6	66.7	53.4	45.3	20.3	21.3	42.5
1986	28.5	33.3	42.8	44.4	50.9	67.4	69.0	69.3	55.5	45.9	32.0	26.2	47.0
1987	28.4	42.8	32.4	49.7	57.5	64.8	70.7	66.2	58.7	46.7	35.5	23.8	46.5
1988	27.4	32.4	32.0	46.0	54.2	72.6	73.5	69.8	58.0	49.8	34.0	26.3	47.0
1989	11.9	32.0	35.6	44.9	54.0	61.2	73.4	69.0	48.2	46.3	37.3	24.1	45.2
1990	27.9	35.4	35.4	44.3	50.5	64.6	69.8	68.5	63.2	46.3	36.9	15.8	46.0
Avg. over 10 years	26.0	35.3	35.3	44.1	52.7	63.0	71.2	69.5	58.0	46.0	33.4	23.3	45.7

Table 8.7 - Temperature Data - Casper, Wyoming

TABLE 8.8 Temperature Data Gillette, Wyoming													
Average Monthly Temperature (F) GILLETTE Source: University of Nebraska Lincoln, Dept. of Agricultural Meteorology													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1981	31.4	29.9	38.0	48.3	51.4	64.3	71.8	69.2	62.0	44.4	39.0	27.3	48.1
1982	15.4	24.6	32.0	39.5	49.2	57.7	68.1	70.2	55.3	44.5	30.7	23.3	442.5
1983	30.6	34.6	36.5	39.7	49.0	62.0	72.8	76.3	59.8	49.7	32.9	7.30	45.9
1984	24.6	31.2	34.2	39.9	50.9	61.3	71.8	73.2	55.2	42.7	36.2	20.7	45.2
1985	18.8	21.6	34.4	48.7	57.4	60.9	72.5	67.3	54.3	46.1	17.1	20.6	43.3
1986	30.0	24.8	42.8	43.1	52.7	67.8	70.9	70.6	54.0	47.6	29.0	25.5	46.6
1987	25.5	30.8	31.8	49.5	58.2	64.3	69.3	63.8	57.9	445.4	37.1	25.2	46.6
1988	20.0	24.4	32.6	45.1	56.5	73.0	74.0	69.9	57.8	48.3	32.1	26.8	46.7
1989	25.2	11.2	30.8	42.9	52.2	60.7	73.2	69.6	56.8	45.8	34.7	18.9	43.5
1990	26.4	25.8	33.8	42.2	50.5	63.5	69.4	70.0	64.7	44.7	37.3	14.2	45.2
1991	17.0	34.7	35.8	41.5	52.4	63.5	70.4	72.3	58.9	42.8	28.3	27.8	45.5
Avg. over 10 years	22.4	26.7	34.8	43.7	52.8	63.5	71.3	70.2	57.9	45.6	32.2	21.6	45.4

Table 8.8 - Temperature Data - Gillette, Wyoming

TABLE 8.9

Temperature Data

Kaycee, Wyoming

Average Monthly Temperature (F) KAYCEE

Source: University of Nebraska Lincoln, Dept. of Agricultural Meteorology

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1981	32.3	29.7	38.6	49.0	52.9	63.6	73.3	69.5	61.8	46.0	39.7	27.0	58.6
1982	17.8	27.8	36.1	41.6	51.0	59.5	69.5	72.9	56.0	45.6	32.9	26.1	44.7
1983	32.2	33.7	37.7	39.9	49.5	62.2	71.3	74.1	59.9	50.2	33.1	8.5	46.0
1984	24.6	31.0	35.8	40.7	55.0	63.0	72.6	72.1	54.8	42.6	36.0	22.9	45.9
1985	16.4	22.9	34.8	47.7	57.1	63.0	71.6	67.5	53.4	45.9	16.7	20.9	43.2
1986	32.9	27.8	43.8	45.8	52.2	68.3		69.5	55.8			26.4	
1987	25.1	30.7	34.7	48.7	57.6	65.7	69.9	66.0	58.9	47.3	38.1	25.6	47.4
1988	21.2	27.6	34.4	45.6	56.2	72.8	74.5	70.3	57.6	49.3	33.4	26.5	47.5
1989	24.8	11.1	45.5	46.7	54.6	62.7		69.3	58.2	45.8	37.1	22.4	
1990	31.1	27.4	36.0	42.5	51.1	65.0	71.7	70.5	63.4	45.3	37.2	14.1	46.3
1991	16.8	36.4	36.3	41.4	52.3	65.6	70.6	70.7	57.7	43.0	28.2	28.4	45.6
Avg. over 10 years	25.0	27.6	36.7	44.5	53.5	64.7	71.1	70.2	57.9	46.1	33.2	22.6	46.1

Table 8.9 - Temperature Data - Kaycee, Wyoming

TABLE 8.10

Temperature Data

Midwest, Wyoming

Average Monthly Temperature (F) MIDWEST

Source: University of Nebraska Lincoln, Dept. of Agricultural Meteorology

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1981	33.3	31.1	39.7	20.9	54.0	66.1	73.6	70.2	63.8	47.0	40.6	29.0	49.9
1982	20.8	28.6	37.7	43.9			72.3	75.8	58.1	47.8			
1983										51.7	33.9	10.4	
1984	23.2	28.6	35.8	41.1	55.7	63.9	72.6	73.0	57.3		37.2	24.2	
1985	20.6	23.9	37.3		58.4	63.4	73.3		55.9	48.5	16.7	21.4	
1986	31.8	26.7	43.3	44.8	52.9	70.0	70.9	72.4	57.0	47.5	33.9	36.9	49.0
1987	27.7	33.8	35.7	53.2	61.6	67.3	71.5					24.7	
1988	20.0	28.5	33.4	46.4	56.0	73.5	74.8	69.1	56.9	50.7	33.0	26.0	47.4
1989	25.8	13.2	37.0	44.6	55.1	62.0	73.6	69.3	57.3	47.3	36.3	22.8	45.4
1990	31.8	28.6	37.2	43.3	52.0	64.9	70.3	70.7	63.8	45.8	35.5	11.6	46.3
1991	18.1	34.3	37.8	41.0	52.5	64.7	70.8	71.3	60.2	44.3	30.5	27.5	46.1
Avg. over 10 years	25.3	27.7	37.5	42.1	55.4	66.2	72.4	71.5	58.9	47.8	33.1	23.5	47.4

Table 8.10 - Temperature Data - Midwest, Wyoming

8.8 WIND

A wind rose for Casper, Wyoming is presented in Figure 8.1. As indicated, the predominant wind direction in the Casper area is from the southwest over 25% of the time. Calm winds prevail about 2.2% of the time.

TABLE 8.11												
Average Sky Cover(tenths) (sunrise - sunset)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
5.7	5.0	6.1	6.7	6.3	4.3	4.4	4.4	4.3	6.3	6.0	5.7	5.4

Table 8.11 Average Sky Cover - Casper

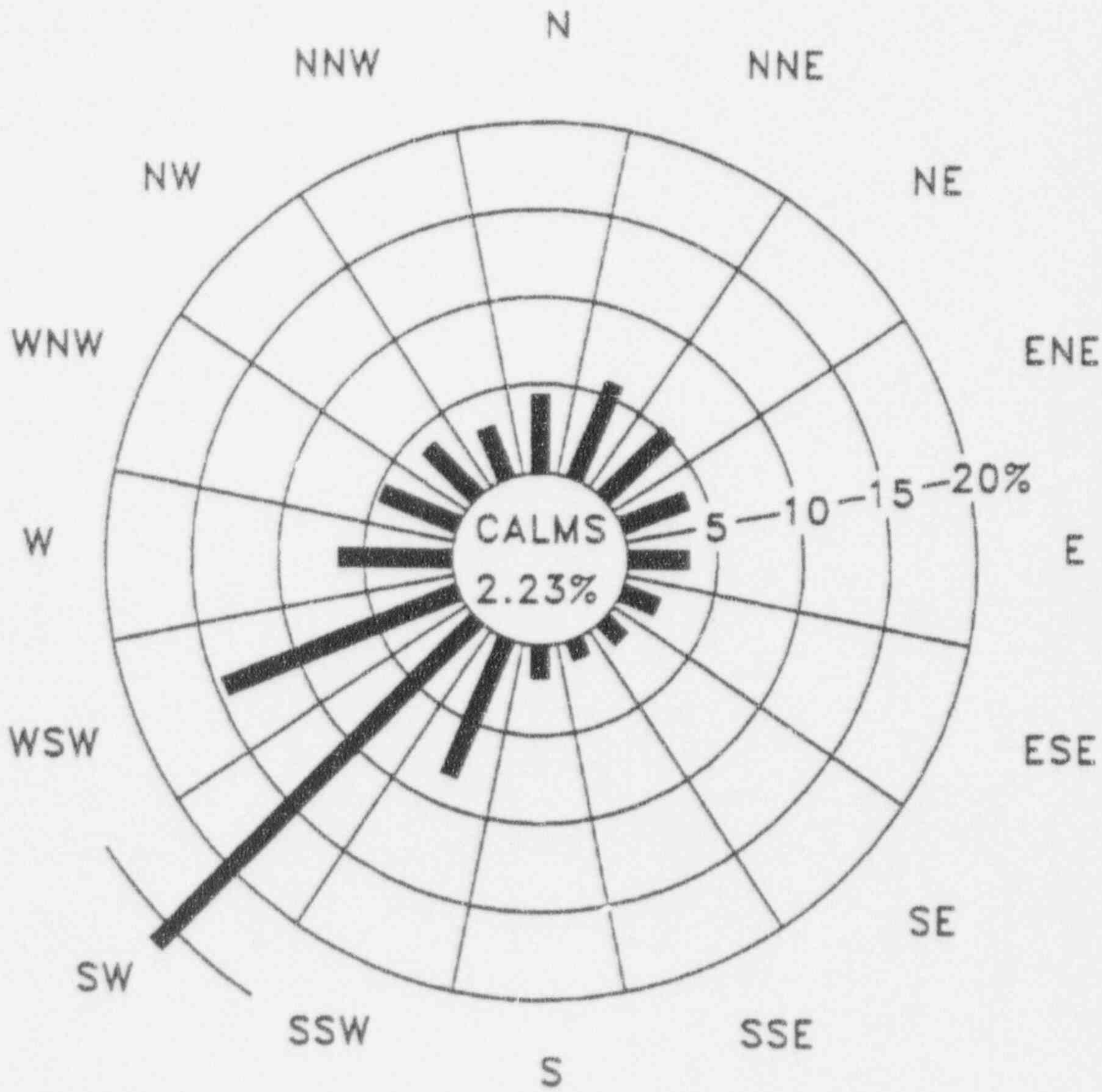


Figure 8.1 Wind Rose - Casper, Wyoming, 1985 through 1989

9. GEOLOGY AND TOPOGRAPHY

9.1 GENERAL GEOLOGIC DESCRIPTION

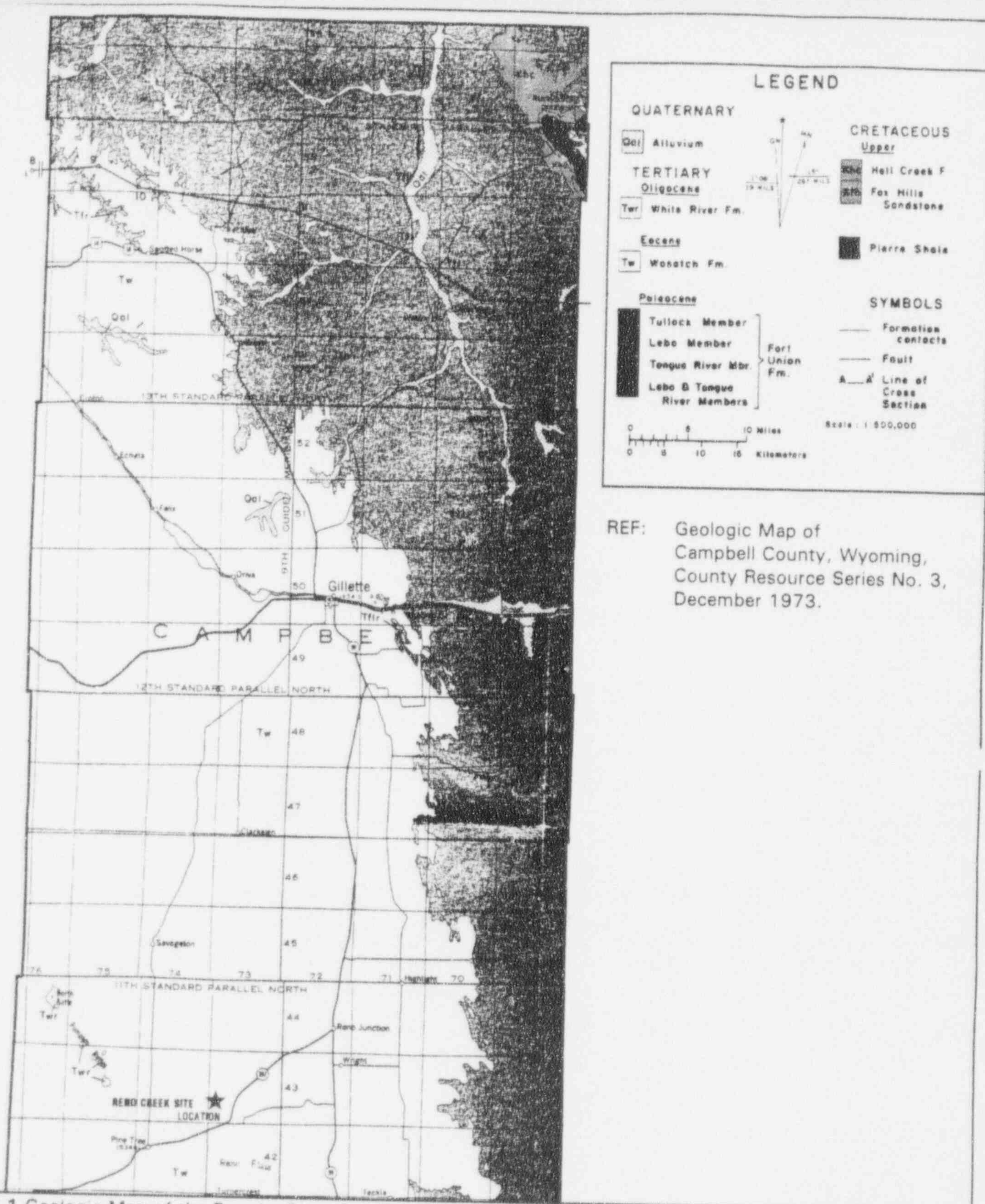
The Reno Creek project is located in the Pumpkin Buttes Uranium District of the Powder River Basin. The Powder River Basin is a large structural and topographic depression parallel to the Rocky Mountain axis. The Basin is bounded on the south by the Hartville Uplift and the Laramie Range, on the east by the Black Hills, and the Casper Arch and the Big Horn Mountains on the southwest and west. The Sheep Mountain Anticline in southeastern Montana forms the northern boundary of the Basin.

The Powder River Basin is an asymmetrical syncline with its axis closely paralleling the western margin. During sediment deposition, the line of greatest material accumulation shifted westward resulting in the asymmetry presently observed in the Basin. On the eastern flank of the Basin, sedimentary strata dip gently to the west at approximately 1/2 to 3 degrees. On the western flank, the strata dips more steeply (1/2 to 15 degrees) to the east toward the axis of the Basin. The Reno Creek ISL Project location within the Powder River Basin is shown in Figure 9.1.

The Reno Creek site is located in southern Campbell County and is about 10 miles southeast of Pumpkin Buttes. The host sand unit ranges from 120 to 150 feet thick, and the mining horizons range from 300 to 420 feet below the surface. Section 15.2 provides a geologic description of the Reno Creek ore deposit.

9.2 TOPOGRAPHY

The Reno Creek ISL Project permit area is typical of the high plains common throughout the Powder River Basin. Local topography is unremarkable with the only notable topographic features in the region being the Pumpkin Buttes several miles to the northwest of the project area. ~~Evaluations~~ *Elevations* range from a low of 5040 MSL, where the Belle Fourche River exits the property, to 5290 in the south of Section 28. Slopes are less than 10%, except in a few cut bank bluff locations adjacent to the Belle Fourche River channel.



REF: Geologic Map of Campbell County, Wyoming, County Resource Series No. 3, December 1973.

Figure 9.1 Geologic Map of the Powder River Basin

The drainage divide between the Belle Fourche River and the Cheyenne River passes through the Reno Creek permit area. The Belle Fourche headwater is a few miles west of the permit area, and the river channel passes southwest to northeast along the northwest side of the permit area.

Only two sizeable drainages occur within areas to be affected by mining activities in the permit area. K-Bar Draw originates in Section 27, passes through the northeast corner of Section 28 and exits the permit area through the middle of Section 21. K-Bar Draw is an ephemeral drainage that exhibits flow only during high precipitation events. The other significant drainage is west of Highway 387 and trends northwesterly from Section 32 across the southwest corner of Section 29. This unnamed drainage is also ephemeral and has a short channel length above its intersection with the Belle Fourche River channel.

On the Cheyenne River side of the drainage divide, the draws are gently sloping and broad with ~~more~~ small drainages flowing water only in response to high runoff events. Several unnamed ephemeral draws drain to the southeast into Spring Creek drainage and ultimately to the Cheyenne River. Access throughout the permit area is generally unlimited with only occasional small, steep-sided draws restricting field mobility. A description of surface hydrology considerations is given in Section 10.2.

9.3 STRATIGRAPHY

The Powder River Basin stratigraphy consists of a sedimentary sequence approaching 15,000 feet thick along the synclinal axis. These rocks range in age from Tertiary (3 to 70 million years ago) to Cambrian (500 to 570 million years ago). The Tertiary units were deposited in fluvial and lacustrine environments. The Tertiary fluvial systems had a general drainage direction from south to north. Source areas of the sediments were primarily located to the south and southwest. Present drainage systems still generally follow the Tertiary paleodrainage trends.

The rock types present in the Tertiary sediments are sandstones, siltstones, shales, and coal and lignite seams. Tertiary rock outcrops in the Powder River Basin are the Fort Union Formation (Paleocene), the Wasatch Formation (Eocene) and the White River Formation (Oligocene). The Reno Creek ISL Project is located within the Wasatch Formation as shown in Figure 9.2. The basement rocks of the Basin are sediments of Mesozoic and Paleozoic Age.

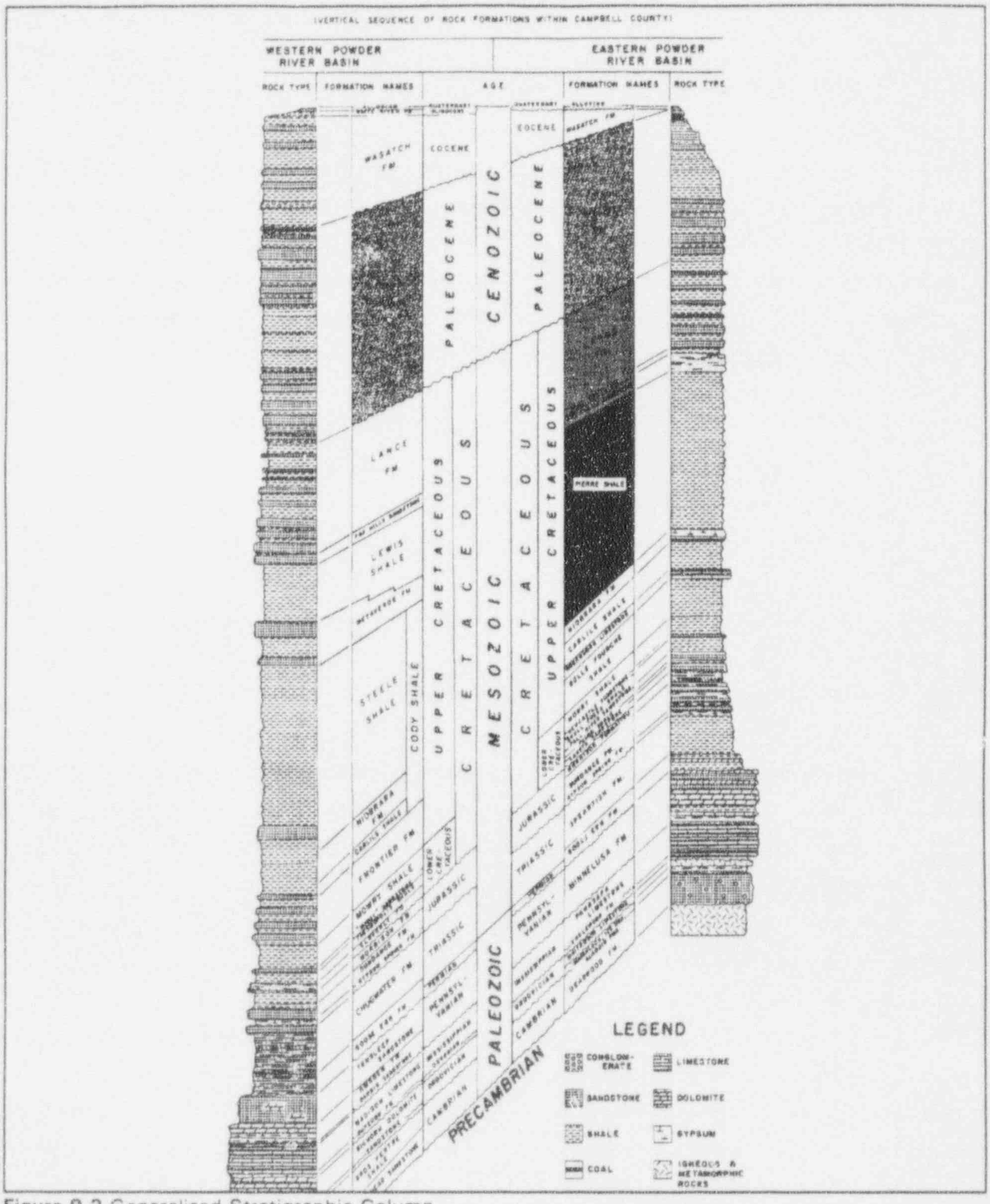


Figure 9.2 Generalized Stratigraphic Column

The Wasatch Formation consists of brown to gray claystone, siltstone and carbonaceous shales interbedded with buff sandstone lenses and coal beds. In the vicinity of the Pumpkin Buttes, the Wasatch Formation is a pink, tan and gray variegated sequence. The Wasatch Formation attains a maximum thickness of about 3,500 feet in the Powder River Basin. In the Pumpkin Buttes area, it is about 1,500 feet thick (Troyer et al., 1954).

In the Central Powder River Basin, the Wasatch can be divided into a lower siltstone unit, about 500 feet thick, a middle unit 200 to 300 feet thick containing numerous sandstone beds, and an upper siltstone unit (Troyer et al., 1954). The sandstone beds in the middle unit are commonly more than 120 feet thick, and can be several miles long and wide in the vicinity of the Pumpkin Buttes. These units are comprised of fine to coarse-grained, cross bedded, arkosic sandstone and conglomerate. The sandstone is often poorly cemented and contains calcareous lenses in places. The sandstone beds typically contain minor siltstone and claystone lenses, which are generally less than 25 feet thick.

9.4 STRATIGRAPHIC SECTION OF THE RENO CREEK AREA

The oxidation fronts in the sandstone units of the Wasatch Formation generally moved from the south and southwest towards the north on the west side of the Basin axis and from the south and southeast on the east side of the axis, once again toward the north, forming uranium enrichment zones. The host sand unit at the Reno Creek site is laterally extensive and thickens to the west, in the direction of the basin axis. The Reno Creek host unit exhibits the oxidation and reduction interfaces that are common to the roll front uranium deposits of the region.

Figure 9.3 is a type log of the Reno Creek project. As shown on the type log, EFNI has designated the following units to provide consistency in reference: Upper Aquifer, Felix Coal ~~(also Upper Aquitard),~~ *(contained within the Upper Aquitard)*, Upper Ore Sand, and Lower Ore Sand. The stratigraphy throughout the permit area varies somewhat (as is typical of fluvial/lacustrine systems). However, the host sand unit is present throughout the permit area. The marker bed used for stratigraphic correlation at Reno Creek is the Felix Coal, and it is has a distinctive double-spike kick on ~~electric logs~~ *the gamma ray, self-potential, and resistivity curves on the exploration geophysical logs (See Figure 9.3 and Plates 9.1 - 9.9). The double spike kick configuration is shown on the Type Log (Figure 9.3) at 270 to 287 feet depth.* The units above the Felix marker are sands, siltstones, claystones, shales and lignites.

The units are discontinuous and correlation of individual zones throughout the project area is not possible. The Ore Sand is continuous throughout the permit area, but its thickness is variable. A claystone unit in the middle of the Ore Sand is widespread in the permit area, but is not present at all sites in the permit area. The shale/claystone units at the base of the Ore Sand are pervasive throughout the project. Sand units below the Ore Sand are discontinuous and siltier and finer-grained than the Ore Sand.

Regional geologic cross sections, and the corresponding index map through the permit area, are presented in Plates 9.1 - 9.9.

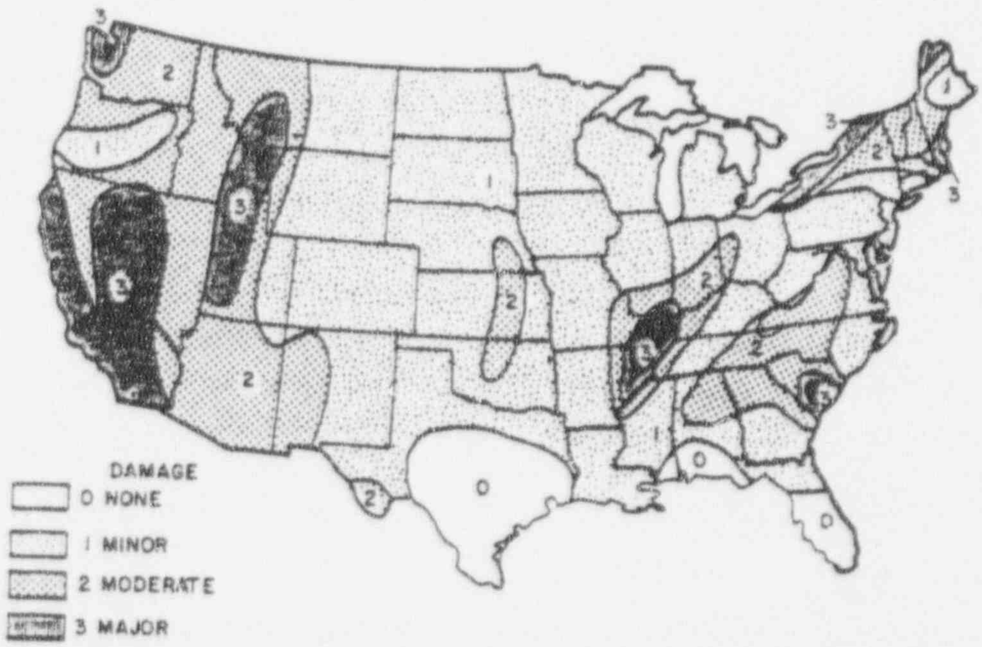
9.5 STRUCTURE

No evidence exists of structural instability at the Reno Creek project site. Evidence of faulting has not been observed in the field or through drill hole correlations (see *Permit Area Structural* Cross Sections, Plates 9.2 - 9.9). Variations in stratigraphy are attributable to facies changes and depositional dynamics rather than faulting.

9.6 SEISMICITY

The area of central Wyoming where the Reno Creek project is located lies in a relatively quiet seismic region. Although distant earthquakes may produce shocks strong enough to be felt in the Powder River Basin, the region is ranked as one of minor seismic risk, as shown in Figure 9.4. Few earthquakes capable of producing damage have originated in this region. The seismically active region closest to the project is the Intermountain Seismic Belt which extends in a northerly direction between Arizona and British Columbia. It is characterized by shallow earthquake foci between 10 and 25 miles in depth, and normal faulting. Part of this seismic belt extends along the Wyoming-Idaho border, more than 200 miles west of the project area, and is the most probable region for earthquakes that might be felt at the project.

A brief summary of earthquake history in the southern Powder River Basin and surrounding region includes the following notable observations:



Seismic risk map of the United States. Source: Modified from S. T. Algermissen, *United States Earthquakes*, U.S. Government Printing Office, Washington, D.C., 1968.

energy fuels nuclear inc.			
Project	RENO CREEK ISL PROJECT		
REVISIONS	County: Campbell	State: Wyoming	
Date / By	Location: T 43 N, R 73 W		
	Figure 9.4 - Seismic Risk Map of the United States		
	Scale: N/A	Date:	
	Author:	Drafted By: D. L. Sledd	

- *Very little damage has been attributed to earthquakes in the Powder River Basin area.*

- *Events prior to the 1970's were mainly around Lusk and were centered from Osage to Guernsey. Intensity values were in the IV to V range.*

- *In the 1970's and 1980's all events of significance were in the vicinity of Gillette and Kaycee. A magnitude 4.8 quake was recorded between Gillette and Kaycee in September 1976; no significant damage was reported. In May 1984 a magnitude 5.0 quake was centered 20 miles west of Gillette, and another event of 5.1 magnitude was located in the same general area three months later. These two magnitude 5 events were among the largest in the Powder River Basin in the last 100 years, but little damage was reported.*

- *The largest earthquake known in the region was felt, and moderate damage occurred, in Casper in November 1897. This event had an estimated intensity of VII.*

- *A number of quakes have occurred in northern Albany County near Esterbrook. A series of quakes occurred in 1983 and 1984, with the biggest event estimated at magnitude 5.5 in October, 1984.*

9.7 EXPLORATION HOLES

Throughout the history of the Reno Creek project, exploration and development drilling has taken place within as well as outside of the permit area. The current proposed permit area has approximately 1,772 drill holes within its perimeter.

To the best of EFNI's knowledge, holes drilled prior to 1979 were drilled with natural mud and bentonite, and a surface plug installed and buried. To the best of EFNI's knowledge, following 1979, all holes were plugged using methods in compliance with Wyoming Statute 35-11-404, which includes sealing and plugging of the drill holes. Appropriation of Groundwater Applications and Notices of Completion have been filed for all wells constructed by EFNI and its predecessors.

All existing wells have been located in the field and the well locations are shown on Plate 10.4-1. This map shows all existing, abandoned and cancelled well locations. A number of the wells were installed in the late 1970's and early 1980's by Rocky Mountain Energy in conjunction with its planned ISL program. Some of these existing wells have been selected for use as regional monitor wells in the current EFNI program. Section 10.5.4 describes the wells which have been selected for regional monitors.

Plate 9.10 is a drill hole location map showing exploration holes. Attachments 9.1 and 9.2 list all of the exploration holes and the corresponding state plane coordinates for all exploration holes within the permit area. Plate 9.10 does not have each hole numbered due to the density of drilling when presented at the map scale used herein. Rather than providing a large volume of drill hole maps, a single map has been used and a grid has been overlain on the map so that each hole or grid area can be identified by the grid designation. Attachments 9.1 *and 9.2* lists all drill holes and wells, in numerical sequence and also by grid sequence, so that specific holes or grids can be selected as required. Also provided is an explanation of the hole abandonment methods for drill holes as well as the well status for all wells within the permit area.

EFNI has state plane coordinate locations for all holes known to be drilled within the proposed permit area; the state plane coordinate locations are listed in Attachments 9.1 and 9.2. These locations, to the best of EFNI's knowledge, are actual surveyed locations and are not based on field approximations. Only two companies are known to have conducted drilling programs on the Reno Creek project; these companies are Rocky Mountain Energy (and its various predecessor and successor Union Pacific entities) and EFNI. Therefore the data base on holes actually drilled and the hole locations is believed to be complete and accurate. Relocation of old exploration holes, if necessary, should be possible with a high degree of accuracy.

10. HYDROLOGY OF THE RENO CREEK PERMIT AREA, CAMPBELL COUNTY, WYOMING (Appendix 10)

Prepared for:

ENERGY FUELS NUCLEAR, INC.

By:

HYDRO-ENGINEERING
4685 South Magnolia
Casper, Wyoming

FEBRUARY 1994

CARLETON S. BABB, P.G.
HYDROGEOLOGIST

GEORGE L. HOFFMAN, P.E.
HYDROLOGIST

THIS PAGE INTENTIONALLY LEFT BLANK

10. HYDROLOGY

10.1 GENERAL

Energy Fuels Nuclear, Inc. (EFNI) is applying for a permit for an in-situ uranium project in portions of sections 21, 22, 27, 28, 29, 30, 31, 33 and 34, T43N, R73W, Campbell County, Wyoming (Reno Creek Permit Area). The site location is approximately 10 miles southwest of the town of Wright, adjacent to Wyoming Highway 387. There are no major population centers within five miles of the project. Principal economic activities are oil and gas production and cattle and sheep ranching.

This Appendix discusses the hydrology of the permit area. Surface water is discussed in Section 10.2 and includes a delineation of drainage basins, peak and mean flows, and surface water quality. Section 10.3 covers ground water. Specific topics are: geologic setting, aquifer characteristics of the Ore Sand and Upper Aquifer, characteristics of the Upper and Lower Aquitards, ground water flow in the Ore Sand and the Upper Aquifer, and ground water quality.

Water rights are discussed in Section 10.4, including surface water, ground water, and potential impacts on existing water rights in the permit area. Hydrologic monitoring is discussed in Section 10.5 and includes topics on zone of control for Mining Unit 1, spacing of monitoring ring, and excursion retrieval. The zone of control sub-section includes drawdown estimates, wellfield simulation, and gradient reversal.

A list of hydrologic references is included as Section 10.6. Attachments 10A, 10B, and 10C are the UPR Pump Tests, EFNI Pump Tests, and the Aquifer Test Theory, respectively.

10.2 SURFACE WATER

10.2.1 AREA SURFACE WATER FLOW

The Reno Creek Permit Area is located on the divide between the Belle Fourche and Cheyenne Rivers which are tributaries to the Missouri River. The most significant drainage in the permit area is the Belle Fourche River, which flows NNE through the west end of the permit area. A drainage basin encompassing 26.3 square miles was delineated above a point on the Belle Fourche River one-half mile north (downstream) of the permit boundary. The reach of the Belle Fourche River along the west end of the permit area is 12,500' from an elevation of 5090' to 5040' (gradient = 21.1 feet/mile or 0.004 ft/ft).

The eastern half of the permit area contains the upper portions of three small drainage basins: Upper K-Bar Draw, Upper Spring Creek and unnamed. K-Bar Draw is tributary to the Belle Fourche River. The Spring Creek and unnamed basins are tributary to the Cheyenne River. The Belle Fourche ultimately joins the Cheyenne River in South Dakota. The respective reaches and gradients for these drainages are 7600', 111.1 feet/mile or 0.021 ft/ft flowing northwest; 3150', 84 feet/mile or 0.016 flowing southeast; 5000', 89.76 feet/mile or 0.017 ft/ft flowing southeast. The respective sizes of these drainage basins as defined in Plate 10.2-1 are 2.5, 2.1, and 0.7 square miles.

10.2.2 SURFACE WATER QUANTITY

All drainages in the permit area are either ephemeral or intermittent streams. The Belle Fourche River demonstrates the most persistent flow. Steamflow is directly related to the variable precipitation. The predominant source of surface water is from summer thunderstorms and spring snowmelt.

The nearest stream-gaging stations to the permit area are on the Belle Fourche River below Rattlesnake Creek and above Dry Creek (23.4 and 27.8 air miles NE of the site) and on the Cheyenne River near Dull Center (32 miles SE of the site). Flow data for these stations are presented in Table *10.2-1*. Estimated flows compare favorably with the observed flows. It should be noted that the more frequent peak flows are similar for each drainage while the Belle Fourche, with its larger drainage area, has the largest impact with the higher order events (Q_{100} = 5,000 CFS).

All the drainages carry zero flows part of the year, typically in the late summer and winter. However, thunderstorm activity can generate significant flows during spring and summer. Highest flows are typically in the spring, especially if thunderstorm events coincide with snowmelt. The periods of record for the gage stations are 4/76-9/81, 10/85-9/87, (Cheyenne/Dull Center), 10/75-4/83 (Belle Fourche/Rattlesnake), and 10/75-9/83 (Belle Fourche/Dry Creek).

Peak flows were estimated for each of the drainage basins for 2, 5, 10, 25, 50, and 100 year recurrence intervals. These data are presented in Table 10.2-2, along with the input data. Estimates for the Belle Fourche drainage basin were made utilizing the "Basin Characteristics Method" of LOWHAM, 1976. The Reno Creek permit area lies within LOWHAM's Region 3. Estimates for the other drainage basins were obtained by the "Basin Characteristics Method" of CRAIG and RANKL, 1978. Mean annual flows were also estimated (LOWHAM, 1976) for each drainage basin. The estimated mean annual flow for Upper K-Bar Draw, Upper Spring Creek, and unnamed drainages should be used with caution because their drainage areas are smaller than those used to develop the LOWHAM relationship.

10.2.3 SURFACE WATER QUALITY

USGS water quality data for the three gaging stations referenced in Section 10.2.2 indicate a sodium bicarbonate water type with pH ranging from 7.5 to 8.5. Major constituents and their respective concentration ranges in mg/l are: Ca (71-320), Mg (27-180), Na (67-440), K (5.9-18), SO_4 (320-2200), and Cl (6.8-32) *(Table 10.2-3)*. Periods of record for these data are the water years 1986-87, 1981-82, and 1982-83 for the Cheyenne and Belle Fourche stations, respectively.

Surface water samples were collected at three locations in the Reno Creek area by Rocky Mountain Energy in 1978 and analyzed by an independent laboratory. Sampling locations are shown on Plate 10.2-1 and the results of the chemical analyses are presented in Table 10.2-3. Stations SW#1 and

SW#2 are on the Belle Fourche drainage and SW#3 is on K-Bar Draw. The late summer constituent concentrations are generally higher than spring, with variations most likely attributed to the lack of surface runoff with the major source of water from ground water discharge to the stream. During low flow conditions, evaporation and transpiration can greatly affect the water quality by increasing constituent concentrations. The pH ranges from 7.3-8.3, TDS 74-2542 (mg/l), alkalinity 7-267 (mg/l $CaCO_3$), Ca 3-285, Mg 2-161, Na 8-160, Cl 7-18, SO_4 ND-1325, HCO_3 25-415. The high summer TDS values at SW-1 limit water use to livestock and wildlife consumption. The water quality at SW-2 and SW-3 is also suitable for agricultural use. *Surface waters meet the Wyoming DEQ livestock standards for trace metals. The* Ra_{226} *level of 5 pCi/l was exceeded July 29, 1978, at SW-2 (6.0) and May 15, 1978, at SW-3 (7.0).*

A reasonable comparison of surface water quality can be made between the three USGS gaging stations and the three sample sites near the permit area. The SO_4 values are higher at the gaging stations. It should be noted that these data are for different periods of record. *These data are presented in Table 10.2-3.*

TABLE 10.2-1. SUMMARY OF STREAM DISCHARGE DATA - BELLE FOURCHE AND CHEYENNE RIVERS

STATION	B.F./RATTLESNAKE	B.F./DRY CREEK	C./DULL CENTER
USGS STATION #	06425720	06425780	06365900
DRAINAGE AREA	495 mi^2 (1282 km^2)	594 mi^2 (1538 km^2)	1527 mi^2 (3955 km^2)
PERIOD OF RECORD	10/75 - 4/83	10/75 - 9/83	4/76 - 9/81 10/85 - 9/87
MAXIMUM DISCHARGE* (FT^3/SEC)	4100	5630	11,800
MAXIMUM GAGE (FT)	11.3	16.3	14
DATE OF MAXIMUM	5/18/78	5/18/78	5/18/78
MEAN DISCHARGE			
(FT^3/SEC)	2.51	4.37	17.9
(AC-FT/YR)	1820	3170	12,970

*DUE TO DAM FAILURE UPSTREAM

Reference: USGS Water Resources Data for Wyoming 1983, 1987.

TABLE 10.2-2. ESTIMATED PEAK AND MEAN ANNUAL FLOWS IN THE RENO CREEK AREA.

BASIN	METHOD	PEAK FLOWS, CFS Q2	Q5	Q10	Q25	Q50	Q100	MEAN ANNUAL FLOW, CFS[3]
BELLE FOURCHE	LOWHAM[1]	300	820	1400	2500	3600	5000	2.9
UPPER K-BAR DRAW	CRAIG & RANKL[2]	300	560	780	810	1100	1400	0.84
UPPER SPRING CREEK	CRAIG & RANKL[2]	350	610	790	1100	1400	1700	0.77
UNNAMED	CRAIG & RANKL[2]	150	260	360	460	610	740	0.43

[1] Region 3
[2] Basin Characteristics
[3] LOWHAM

INPUT PARAMETERS

BASIN	AREA sq. mi.	MAX. RELIEF ft.
BELLE FOURCHE	26.3	511
UPPER K-BAR DRAW	2.5	220
UPPER SPRING CREEK	2.1	160
UNNAMED	0.7	130

TABLE 10.2-3. SURFACE-WATER QUALITY DATA - revised 2/94.

SITE	DATE	DISCH	pH	Eh	COND	TDS	Ca	Mg	Na	SO4	HCO3	CO3	ALK	HARD	NO3
SW#1	780510	--	7.3	200	73	75	3.0	7.0	8.0	25	34	0	10.0	37	-0.10
	780513	--	7.6	230	76	74	4.0	5.0	8.0	28	25	0	7.0	31	-0.10
	780729	--	8.0	275	2000	2091	240	161	86	1050	415	0	12.0	1260	-0.10
	780921	--	7.9	225	2100	2542	285	161	140	1325	325	0	267	1370	--
SW#2	780511	--	8.3	185	950	818	133	58	20	420	187	19.0	67	571	-0.10
	780514	--	8.2	155	1020	1180	205	68	20	28	212	--	63	791	-0.10
	780729	--	7.5	340	310	214	240	20	11.0	-0.005	415	0	12.0	128	-0.10
SW#3	780511	--	7.9	165	985	725	130	25	52	350	210	0	62	428	-0.10
	780515	--	7.9	175	1150	1007	164	58	85	550	244	0	72	445	0.10
	780726	--	8.1	239	1720	1512	186	90	82	740	234	0	69	832	-0.10
	780729	--	7.7	345	195	132	21	2.0	12.0	2.0	102	0	7.0	60	-0.10
	780921	--	7.7	225	1630	1812	172	98	160	990	154	0	126	830	--
BF-RC	830303	0.94	8.5	--	1530	1160	130	55	140	690	--	--	140	550	-0.10
	830413	0.99	8.3	--	2750	2300	230	120	290	1400	--	--	222	1100	--
BF-DC	821026	0.61	--	--	--	--	--	--	--	--	--	--	--	--	--
	821206	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--
	830119	3.2	--	--	--	--	--	--	--	--	--	--	--	--	--
	830214	40	--	--	--	--	--	--	--	--	--	--	--	--	--
	830302	2.2	8.2	--	1280	860	100	42	120	490	--	--	142	420	0.10
	830413	1.5	8.3	--	2250	1690	170	87	240	1000	--	--	243	780	--
	830517	1.1	8.1	--	3100	2420	250	130	340	1500	--	--	273	1200	--
	830603	0.10	--	--	--	--	--	--	--	--	--	--	--	--	--
	830621	0.02	8.3	--	3800	3320	320	180	440	2200	--	--	225	1500	-0.10
	830708	-0.010	--	--	--	--	--	--	--	--	--	--	--	--	--
	830811	0.000	--	--	--	--	--	--	--	--	--	--	--	--	--
	830907	0.000	--	--	--	--	--	--	--	--	--	--	--	--	--
CR-DC	870105	0.26	7.9	--	3400	2600	280	130	330	1600	--	--	320	1200	0.10
	870212	3.1	8.0	--	2630	1800	230	92	230	1100	--	--	240	950	-0.10
	870305	121	8.0	--	950	640	72	30	81	360	--	--	130	300	0.20
	870403	20	8.3	--	2060	1500	190	75	190	880	--	--	240	780	-0.10
	870504	31	8.2	--	1290	940	110	47	120	550	--	--	140	470	0.20
	870518	37	7.9	--	930	620	78	31	67	370	--	--	86	320	0.30

TABLE 10.2-3. SURFACE-WATER QUALITY DATA - revised 2/94(continued).

SITE	DATE	DISCH	pH	Eh	COND	TDS	Ca	Mg	Na	SO4	HCO3	CO3	ALK	HARD	NO3
CR-DC	870527	45	8.0	--	840	560	71	27	68	320	--	--	88	290	0.20
	870625	2.6	8.2	--	2800	2000	210	91	250	1200	--	--	260	900	-0.10
	870723	0.11	8.1	--	3380	2700	320	130	370	1700	--	--	270	1300	-0.10
	870827	0.13	8.2	--	2720	2600	200	120	350	1700	--	--	290	990	-0.10

TABLE 10.2-3. SURFACE-WATER QUALITY DATA - revised 2/94(continued).

SITE	DATE	NO2	NH3	Al	As	Ba	B	Cd	Cr	Cu	F	Fe	Pb	Mn
SW#1	780510	0.02	0.12	0.70	-0.010	-0.03	0.25	-0.005	-0.010	-0.010	-0.10	0.42	-0.010	0.02
	780513	-0.010	0.15	0.24	-0.010	-0.03	0.26	-0.005	-0.010	-0.010	-0.10	0.02	-0.010	-0.010
	780729	-0.010	0.21	-0.05	0.010	-0.03	0.26	-0.005	-0.010	-0.010	0.36	0.09	-0.010	0.05
	780921	--	--	--	--	--	--	--	--	--	--	--	--	-0.010
SW#2	780511	-0.010	-0.10	0.15	-0.010	-0.03	0.28	-0.005	-0.010	-0.010	-0.10	-0.02	-0.010	0.010
	780514	-0.010	0.46	-0.05	-0.010	-0.03	0.10	-0.005	-0.010	-0.010	-0.10	0.36	-0.010	0.02
	780729	-0.910	0.21	-0.05	0.010	-0.03	0.26	-0.005	-0.010	-0.010	-0.10	0.94	-0.010	0.07
SW#3	780511	-0.010	-0.10	-0.05	-0.010	-0.03	0.54	-0.005	-0.010	-0.010	0.20	-0.02	-0.010	0.13
	780515	0.02	0.11	-0.05	-0.010	-0.03	0.03	-0.005	-0.010	-0.010	0.13	0.22	-0.010	0.21
	780726	-0.010	-0.10	-0.05	-0.010	-0.03	0.09	-0.005	-0.010	-0.010	0.40	0.05	-0.010	-0.010
	780729	-0.010	0.33	-0.05	0.02	-0.03	-1.0	-0.005	-0.010	-0.010	0.16	0.48	-0.010	0.09
	780921	--	--	--	--	--	--	--	--	--	--	--	--	0.08
BF-RC	830303	--	0.09	--	0.001	-1.0	0.05	-0.001	-0.010	0.001	0.30	0.03	-0.001	0.16
	830413	--	--	--	--	--	0.09	--	--	--	0.40	0.02	--	0.11
BF-DC	830302	--	0.14	--	0.001	-0.10	0.10	-0.001	-0.010	0.002	0.30	0.02	-0.001	0.18
	830413	--	--	--	--	--	0.21	--	--	--	0.50	0.02	--	0.42
	830517	--	--	--	--	--	0.19	--	--	--	0.50	0.03	--	0.40
	830621	--	0.06	--	-0.001	--	0.42	0.003	-0.010	0.004	0.50	0.07	0.002	0.55
CR-DC	870105	--	--	--	--	--	--	--	--	--	0.60	--	--	--
	870212	--	--	--	--	--	--	--	--	--	0.50	--	--	--
	870305	--	--	--	--	--	--	--	--	--	0.30	--	--	--
	870403	--	--	--	--	--	--	--	--	--	0.40	--	--	--
	870504	--	--	--	--	--	--	--	--	--	0.30	--	--	--
	870518	--	--	--	--	--	--	--	--	--	0.30	--	--	--
	870527	--	--	--	--	--	--	--	--	--	0.30	--	--	--
	870625	--	--	--	--	--	--	--	--	--	0.40	--	--	--
	870723	--	--	--	--	--	--	--	--	--	0.40	--	--	--
	870827	--	--	--	--	--	--	--	--	--	0.50	--	--	--

TABLE 10.2-3. SURFACE-WATER QUALITY DATA - revised 2/94(continued).

SITE	DATE	Hg	Mo	Ni	Se	SiO2	Ag	U	V	Zn	Ra226	Th230	Pb210	P
SW#1	780510	-0.001	-0.05	-0.02	-0.010	4.2	-0.010	0.01	-0.05	-0.010	2.8	-0.60	8.8	--
	780513	-0.001	-0.05	-0.02	-0.010	1.1	-0.010	-0.001	-0.05	-0.010	2.1	-0.60	5.0	--
	780729	-0.001	-0.05	--	0.010	-0.10	-0.010	0.007	-0.05	-0.010	1.2	-0.60	2.0	--
	780921	--	--	--	--	--	--	0.01	-0.05	--	1.4	-0.60	3.0	--
SW#2	780511	-0.001	-0.05	-0.02	-0.010	0.50	-0.010	0.03	-0.05	-0.010	1.8	-0.60	0.00	--
	780514	-0.001	-0.05	-0.02	0.010	0.50	-0.010	0.010	-0.05	-0.010	--	--	--	--
	780729	-0.001	-0.05	-0.02	0.010	-0.10	-0.010	0.001	-0.05	-0.010	6.0	-0.60	1.6	--
SW#3	780511	-0.001	-0.05	-0.02	-0.010	0.30	-0.010	0.001	-0.05	-0.010	-0.60	-0.60	12.0	--
	780515	-0.001	-0.05	-0.02	0.010	0.90	-0.010	0.003	-0.05	-0.010	7.0	-0.60	7.0	--
	780726	-0.001	-0.05	-0.02	-0.010	-0.10	-0.010	-0.001	-0.05	-0.010	-0.60	-0.60	0.60	--
	780729	-0.001	-0.05	-0.02	-0.010	-0.10	-0.010	-0.001	-0.05	-0.010	--	--	--	--
	780921	--	--	--	--	--	--	0.007	-0.05	--	0.80	-0.60	1.0	--
BF-RC	830303	-0.0	--	0.005	-0.001	-1.2	--	--	--	0.010	--	--	--	0.03
	830413	--	--	--	--	1.6	--	--	--	--	--	--	--	--
BF-DC	830302	0.0005	--	0.005	-0.001	2.8	--	--	--	0.010	--	--	--	0.02
	830413	--	--	--	--	2.3	--	--	--	--	--	--	--	--
	830517	--	--	--	--	1.4	--	--	--	--	--	--	--	--
	830621	0.0	--	0.010	0.001	1.9	--	--	--	0.03	--	--	--	0.03
CR-DC	870105	--	--	--	--	14.0	--	--	--	--	--	--	--	--
	870212	--	--	--	--	14.0	--	--	--	--	--	--	--	--
	870305	--	--	--	--	8.3	--	--	--	--	--	--	--	--
	870403	--	--	--	--	13.0	--	--	--	--	--	--	--	--
	870504	--	--	--	--	8.2	--	--	--	--	--	--	--	--
	870518	--	--	--	--	7.2	--	--	--	--	--	--	--	--
	870527	--	--	--	--	7.6	--	--	--	--	--	--	--	--
	870625	--	--	--	--	13.0	--	--	--	--	--	--	--	--
	870723	--	--	--	--	14.0	--	--	--	--	--	--	--	--
	870827	--	--	--	--	14.0	--	--	--	--	--	--	--	--

NOTES:

"-" sign before a value indicates that the value is less than the detection limit. Value shown is lower detection limit.

HARD = Hardness, in mg/l of CaCO3.

ALK = Alkalinity, in mg/l of CaCO3.

All values are in MG/L except as otherwise noted and the following:
COND = conductivity, in micromhos/cm @ 25 DEG C.
Eh = Eh, in millivolts.
pH = pH, in standard units.
Ra226 = Radium-226, in pci/l.
Th230 = Thorium-230, in pci/l.
Pb210 = Lead-210, in pci/l.

BF-RC = Belle Fourche/Rattlesnake Creek
BF-DC = Belle Fourche/Dry Creek
CR-DC = Cheyenne River/Dull Creek

10.3 GROUND WATER

10.3.1 REGIONAL GEOLOGIC SETTING

The Reno Creek permit area is located in the south-central Powder River Basin, ten miles southwest of *the town of Wright.* ~~Reno Junction.~~ Geologic structure in the permit area is relatively flat with gentle dips westward toward the basin axis. Dip calculations on the top of the Felix Coal, a good subsurface marker in the permit area, indicate westerly dips of 20 to 50 feet/mile (0.2 to 0.5°)(Plates 9.2-9.6). True dip is to the west-northwest. Outcrops in the permit area are primarily the Eocene Wasatch Formation, with some thin alluvial deposits in stream beds.

The Wasatch Formation in the permit area consists of north-trending channel sands, with widths of individual channels ranging from a few thousand feet up to several miles. Uranium occurs in epigenetic roll-front deposits in coarse to very coarse arkosic channel sands. Zones of interest include the Ore Sand, Upper Aquitard, Lower Aquitard, and Upper Aquifer. The top of the Ore Sand is at depths of 150 to 290 feet in the permit area and is massive on the western portion of the permit area due to stacked or coalesced channels. This massive unit is 160′ thick. The massive unit bifurcates into two sand bodies in the eastern portion of the permit area, thinning to a minimum of 50±′ (Structural Cross-sections, Plates 9.1-9.9). The mineralized zone in the Ore Sand has a thickness of approximately 15 to 20 feet (PRI Environmental, 1993). The Ore Sand is confined by an Upper and Lower Aquitard composed of low permeability siltstone, shales, mudstones, and thin coals. The top of the Upper Aquifer is encountered at depths of 20 to 180 feet in the permit area. It is up to 80′ thick and grades from a well developed sand in the western permit area to scattered, thin, low permeability sand lenses in the eastern permit area. This facies change occurs along a line trending NNW through the center of the permit area (Plate 10.3-2) with the poorly developed sand occurring east of the line.

10.3.2 AQUIFER CHARACTERISTICS

Table 10.3-1 presents the basic well information on EFNI wells in and near the Reno Creek permit area. A listing of wells *outside the permit area* in this region is presented in Table 10.3-2. This table contains the well depth, depth to water, and estimated yield. ~~The aquifer in which some of these wells are completed is the Upper Aquifer or the Ore Sand.~~ *Some of these wells are completed in the Upper Aquifer and some in the Ore Sand.* This specific aquifer identification was only *presented* ~~preformed~~ where sufficient information was available and is noted in Table 10.3-2 and on Plate 10.2-1. Plate 10.2-1 shows the locations of the regional wells and Plate 10.3-1 shows the permit well locations.

Hydro-Engineering (HYDRO) has re-analyzed the previous Rocky Mountain Energy (RME) pump tests. These are presented as Attachment 10A - RME Pump Tests. In addition, HYDRO conducted short, single-well pump tests on 11 project wells in June and August, 1993. These are presented as Attachment 10B - EFNI Pump Tests. Straight-line analyses were utilized in evaluating these data with the application of Neuman type curves to adjust the straight-line coefficient for unconfined aquifer conditions. A discussion of the aquifer test theory relevant to the analysis of these data are presented in Attachment 10C - Aquifer Test Theory. Both confined and unconfined conditions exist within the permit area.

Aquifer characteristics derived from the EFNI and RME pump tests are summarized in Table 10.3-3. *The net aquifer thickness reported in Table 10.3-3 is the effective aquifer thickness, adjusted for clay and silt interbeds and also for the screened interval. The sand thickness from Table 10.3-1 is gross sand, which is inclusive of clay and silt interbeds and not adjusted for the screened interval.* Ore Sand transmissivities ranged from 11.4 gal/day/ft (RI-7/EFNI) to 6490 gal/day/ft (RI-1/RME). *The Ore Sand may occur as a coalesced, massive unit or two sands (Upper and Lower Ore Sand) separated by 10 to 50 feet of siltstone and shale. In either case, both intervals were screened. Thus, in wells RI-1 through RI-9, where an Upper and Lower Ore Sand are present, both are included in the screened interval and contribute to the observed data.* The 11.4 transmissivity value for *RI-7* is an outlier (the next lowest value is 753) and is not thought to be representative of the Ore Sand in this area. This well may not be properly connected with the Ore Sand. Mean Ore Sand transmissivities were calculated from the

EFNI and RME data both separately and combined. These respective values are 1800, 1950, and 1920 gal/day/ft. Mean hydraulic conductivities for the Ore Sand are 1.8 ft/day or 0.52 darcy. The highest values for T and K are associated with the thicker portion of the aquifers. Storage coefficients or specific yields were calculated for tests in which observation wells were monitored (RME data). Values ranged from 1.3E-4 up to 0.11.

Table 10.3-3a is a comparison of Ore Sand transmissivity (T) values derived from EFNI (HYDRO) and RME pump tests. In some cases, RME conducted more than one pump test on a given well. In these cases, data for each test is shown. Values based on recovery data are indicated by parentheses. Aquifer type is also listed for each well. The EFNI and RME transmissivities generally agree *in order of magnitude. The variations in values for the same well can be attributed to differences in pump rates, length of test, and straight-line fit. The RME tests were conducted at higher pump rates for a longer period of time.* Values can be categorized in three ranges: high = 3000+ gal/day/ft; intermediate = 1000-3000 gal/day/ft; low = <1000 gal/day/ft. The high values are in wells with confined conditions (RI-1, RI-3) located in the western half of the permit area (Sections 29 and 31) where the Ore Sand is thicker and more massive. These wells are separated by an area of intermediate T (RI-2). The low range of T is exhibited by wells RI-4, RI-5, and RI-6, which are semi-confined or unconfined and located in the east half of the permit area where the Ore Sand bifurcates and thins.

Note the greatest variation in values is in wells having unconfined conditions. These are much more difficult to interpret. Some factors influencing the interpretation are the straight line fit, saturated thickness and change with time, well storage, discharge rate, and duration of test.

Higher transmissivities will be reflected in higher well yields while higher hydraulic conductivities result in higher groundwater velocities for an equal gradient. However, lower (intermediate) transmissivities can result in a more uniform sweep of injected fluids with less likelihood of channeling fluids through high permeability streaks.

The Upper Aquifer was tested in four of the EFNI pump tests. These data demonstrate the effects of the facies change from a thick, well-developed sand in the western permit area to a series of poorly-developed, thin, lenticular sands in the eastern permit area (Plate 10.3-2). RI-30U has a well-developed sand with a transmissivity of 1230 gal/day/ft. RI-15U and RI-24U have transmissivities of 13.4 and 1.8 gal/day/ft, respectively. Respective hydraulic conductivities for these three wells are 1.8, 0.06, and 0.02 ft/day (0.52, 0.02, 0.006 darcy).

10.3.3 CONFINING UNIT CHARACTERISTICS

The Ore Sand(s) are confined by an upper and lower aquitard. The Upper Aquitard is defined as the *clays and silts (both overlying and underlying) associated with the Felix Coal.* The "Felix Coal" is actually two coal seams separated by a clay layer as interpreted from electric logs and drill cuttings. An isopach map of this material (Plate 10.3-3) demonstrates a range of 20' to 75' with the thicker interval on the eastern portion of the mapped area. This area of thicker Upper Aquitard correlates well with the area in which the Upper Aquifer is poorly developed. Values of 20' or less indicate the Upper Aquitard is essentially limited to the ~~Felix Coal~~ shales overlying and interbedded with the Felix Coal. *A documented case of a coal seam having aquitard characteristics exists at the Ruby Ranch in-situ project, six miles WNW of Reno Creek. The MW-3 well is completed in the E lignite and was monitored during a single-well test. The coal is at a depth of 250 feet, comparable to the Felix Coal at Reno Creek. Transmissivity in the E lignite was determined to be <1 gal/day/ft and the resulting hydraulic conductivity 0.022 ft/day or 7.3 md.*

The Lower Aquitard consists of a thick transitional sequence of shales, silts, and clays; discontinuous, lenticular sand bodies; and thin, tightly cemented zones. The RN3932 drill hole on cross-section D-D', Plate 9.5, demonstrates the Lower Aquitard. Of the 253 foot interval from the base of the Ore Sand to the unnamed coal marker, 132', or 52.2%, consists of shale and tight silt, *reference Plates 9.2 through 9.9 (Permit Area Structural Cross-Sections). The sands occurring in this Lower Aquitard interval are finer grained and less permeable, as described in drill cuttings and observable on electric logs, than the Ore Sand. These fine-grained sands are laterally discontinuous, usually thin, and are distributed vertically throughout the aquitard interval.*

Laboratory vertical permeability (k) data for core intervals in the Upper and Lower Aquitards in EFNI RN3910C are presented in Table 10.3-7. *These analyses were performed by Core Laboratories, Western Atlas International, Casper, Wyoming.* This test hole was located in the E/2 of the NW/4 of section 29-T43N-R73W. *The Lower Aquitard cores were taken from an 11 foot thick shale and siltstone cored zone immediately below the Ore Sand.* The Lower Aquitard permeabilities are decreasing with depth. The value at 404.5' equates to 0.16 millidarcies (1.5E-7 cm/sec). The Upper Aquitard cores were taken in a silty interval, resulting in higher permeabilities ranging from 1.44 to 9.87 md (1.6E-6 to 1.1 E-5 cm/sec). The laboratory permeabilities were determined from sample plugs taken from the larger core. It was necessary to freeze the relatively unconsolidated core to obtain adequate samples for testing. The plugs were oven-dried and placed in a steady state permeameter. The permeability to air was determined by applying a pressure differential across the sample. Flow rate and permeability were then calculated. Adjusting the laboratory permeabilities from air to water results in a decrease of 21.7% The empirical relationship, $K_{water} = 0.783 K_{air}$, can be used for this purpose. The core samples were disturbed by: initial coring, handling, freezing, plugging, and drying. Therefore, it is very possible that the actual permeabilities to water in the aquitard are lower than the laboratory values.

Two additional Upper Aquitard core samples listed in Table 10.3-7 (221.9 ft and 223.8 ft) were recently analyzed by Huntingdon Chen-Northern, Inc. (H/C-N), Denver, Colorado. The analysis was run with water at a confining pressure of 85 psi to simulate the overburden pressure. The resulting permeabilities of 0.18 and 0.28 md (1.9E-7 and 3.0E-6 cm/sec) confirm that the Upper Aquitard possesses low vertical permeabilities to water under sub-surface conditions.

In a clastic depositional sequence, the true barriers to vertical migration are thin, horizontal clay, shale, or carbonaceous laminations and/or thin, horizontal tightly cemented layers. It is unlikely that handling would reduce such vertical permeabilities.

The two samples analyzed by H/C-N are felt to be the most representative of the Upper Aquitard properties.

10.3.4 GROUND WATER FLOW

Piezometric maps were constructed for the Ore Sand and the Upper Aquifer in the permit area (Plates 10.3-1 and 10.3-2). The Ore Sand map indicates ground water flow to the ENE with a gradient of 23.9 ft/mi or 0.0045 ft/ft. A ground water velocity of 0.09 ft/day (32.9 ft/yr) was calculated for the Ore Sand aquifer using the following input with the above gradient: average hydraulic conductivity (permeability) 2.0 ft/day and effective porosity 0.1. The Upper Aquifer has a complex ground water flow pattern in the permit area due to the east-west facies change discussed earlier in this report and a decreasing hydraulic gradient across the permit area. The west to east facies change in the Upper Aquifer has apparently resulted in two different hydrologic systems in the permit area. The groundwater flow in the western half of the permit area (well developed sand) is to the NW with a gradient of 21.6 ft/mi or 0.0041 ft/ft. A ground water velocity of 0.074 ft/day (27.0 ft/yr) was calculated for this area using a hydraulic conductivity of 1.8 ft/day and an effective porosity of 0.1. The eastern half of the permit area has ground water flow trending from W to NW with a gradient of 47.3 ft/mi or 0.0090 ft/ft. Ground water velocity for the poorly developed Upper Aquifer in this area is 0.0036 ft/day (1.3 ft/yr) using a hydraulic conductivity of 0.04 ft/day and effective porosity of 0.1.

Vertical flow in the adjacent aquitards is inferred to be downward from the head differences between the Upper Aquifer and the Ore Sand aquifer. Experience in the Powder River Basin supports the head in the Upper Aquitard being of similar magnitude but slightly less than the head in the Upper Aquifer. Therefore, the head in the Upper Aquitard is thought to be several tens of feet above the Ore Sand head (compare Plates 10.3-1 and 10.3-2).

10.3.5 GROUND WATER QUALITY

Groundwater quality data are presented for project wells having RI, M, OB, P, USM, LSM, and WW designations (excluding RI-10, RI-11, RI-37, & RI-41 which are included with the regional wells due to their locations) and regional wells [livestock, domestic, and construction wells] in Tables 10.3-5 and 10.3-6, respectively. Project wells are shown on Plate 10.3-1 and regional wells on Plate 10.2-1. An inventory of regional wells is presented in Table 10.3-2.

Woodward-Clyde Consultants conducted the initial sampling of wells and selected springs in the area in 1976. Specific field procedures are not known, but EPA-recommended preservation techniques were used. Field measurements included temperature, conductivity, pH, alkalinity, hardness, and chloride. These samples were analyzed by ACCU-Labs Research, Inc., Wheatridge, CO. Ground water samples collected by Hydro-Engineering in 1993 were placed in pre-rinsed containers. Guideline 8 preservation procedures were followed (filtered, HNO3,; filtered, none; raw; non-filtered, H2SO4; cooled to 4°C). Temperature, conductivity, and pH were monitored during pumping. Samples were taken after two to three casing volumes had been produced and field parameters were stable. These samples were analyzed by Energy Laboratories, Casper, WY, per Guideline 8 for major constituents, trace metals, and radionuclides.

The ground water quality data presented in Table 10.3-5 have been screened both visually and against a range of two standard deviations from the mean for outliers. These values are flagged in the table. The Ore Sand(s) and the Upper Aquifer were treated as separate populations. Although well RI-9 has high values flagged as outliers for many constituents, it is considered a valid member of the Ore Sand population. The data for this well are considered valid.

Project wells were sampled numerous times during 1978 and 1979. Additional sampling occurred on selected wells in 1982. Wells sampled during 1993 include RI-1 through RI-7, RI-9, RI-15U, RI-24U, RI-25U, RI-30U, RI-42C, and RI-43C. Upper Aquifer wells have a "U" suffix; other wells are completed in the Ore Sand. Constituent concentrations vary within the permit area with no significant trends evident, vertically or laterally. A review of the 1993 data for TDS and SO_4 in the Ore Sand reveals ranges of 569-2354 mg/l (TDS) and 40-1126 mg/l (SO_4) and respective means of 1126 and 700 mg/l. Similar values for the Upper Aquifer are 179-1745 mg/l (TDS) and 40-1042 mg/l (SO_4) with respective means of 1104 and 580 mg/l. The anomalously low constituent concentrations from well RI-15U are not thought to be representative of the Upper Aquifer. These values are much lower than other Upper Aquifer or Ore Sand wells and may indicate water from a shallower aquifer channeling downward behind casing in RI-15U or cross-flowing from another well or test hole. *The low constituent concentrations observed in RI-15U are most likely a function of a relatively short flow path from a recharge area just east of the permit area. It should be noted that this well is located on the east side* *of the permit area, where the Upper Aquifer consists of thin, poorly developed, low permeability sands. Subsequent sampling in this well indicates concentrations increasing towards values observed in other Upper Aquifer wells. The constituent concentrations observed thus far may not be representative of the actual water quality in this low-permeability well.*

HCO_3 values can vary. The relationships of HCO_3, CO_3, and pH for wells RI-1, RI-3, and RI-4 indicate the data are valid. Noting that these observed anomalies occur in the early well data, it is likely that these data represent early contamination from drilling and completion fluids. The 1993 values are interpreted as more representative of the present actual conditions.

A review of all the project well water quality data characterizes the ground water as generally hard and alkaline with high total dissolved solids, sulfates, and iron. The water generally meets DEQ standards for livestock consumption for all constituents EXCEPT Ra-226. Radium-226 values are highest in wells completed in the Ore Sand and exceed the livestock consumption standard of 5 pCi/l in ten of the fourteen Ore Sand wells for which radium data is available. Ranges of major constituent concentrations are: (all concentrations are in mg/l)

TDS (Ore Sand) 569-3307	HCO_3 0-578
TDS (Upper Aquifer) 179-1795	SO_4 1-1875
Ca 24-465	Cl 2.6-40
Mg 0-132	alkalinity 16-1370
K 2.1-52	hardness 46-1700
Na 20-605	

The regional wells were sampled by Woodward-Clyde Consultants for Rocky Mountain Energy Company in November 1976. These wells are completed in either the Ore Sand, Upper Aquifer , or sand stringers above the Upper Aquifer. Ground water from these wells is similar to that from the project wells. Major constituent concentration ranges are: (all concentrations are in mg/l)

TDS 412-5180	HCO_3 14-371
Ca 6.4-400	SO_4 22-2860
Mg 1.2-365	Cl non-detect.-19
K 1.7-32	alkalinity 10-348
Na 11-575	hardness 362-1700

All radium-226 levels were less than the DEQ ground water standard of 5 pCi/l. The highest Ra-226 value was 1.2 pCi/l at the Red Well, 1.8 miles SSW of the permit area. It is noteworthy that the Underwood #8 well (437325bc) has a Ra-226 value of 0.20, even though it is completed in the Ore Sand and is located 1.5 miles east of the permit area, downgradient with respect to ground water flow in the Ore Sand. This is evidence of natural attenuation processes actively restricting radionuclides to the immediate vicinity of the mineralized zones. The screened interval of a well also impacts the radium values by dilution in wells screened beyond the mineralization. *It is also important to note that the data for this well is vintage 1976.*

INSERT

FIGURE 10.3-1 (PAGE 23)

TABLE 10.3-1 (PAGE 24)

TABLE 10.3.2 (PAGES 25-26)

TABLE 10.3-3 (PAGE 27)

TABLE 10.3-3A (PAGE 28)

TABLE 10.3-4 (29-32)

TABLE 10.3-5 (PAGE 33-41)

TABLE 10.3-6 (PAGES 42-53)

TABLE 10.3-7 (PAGE 54)

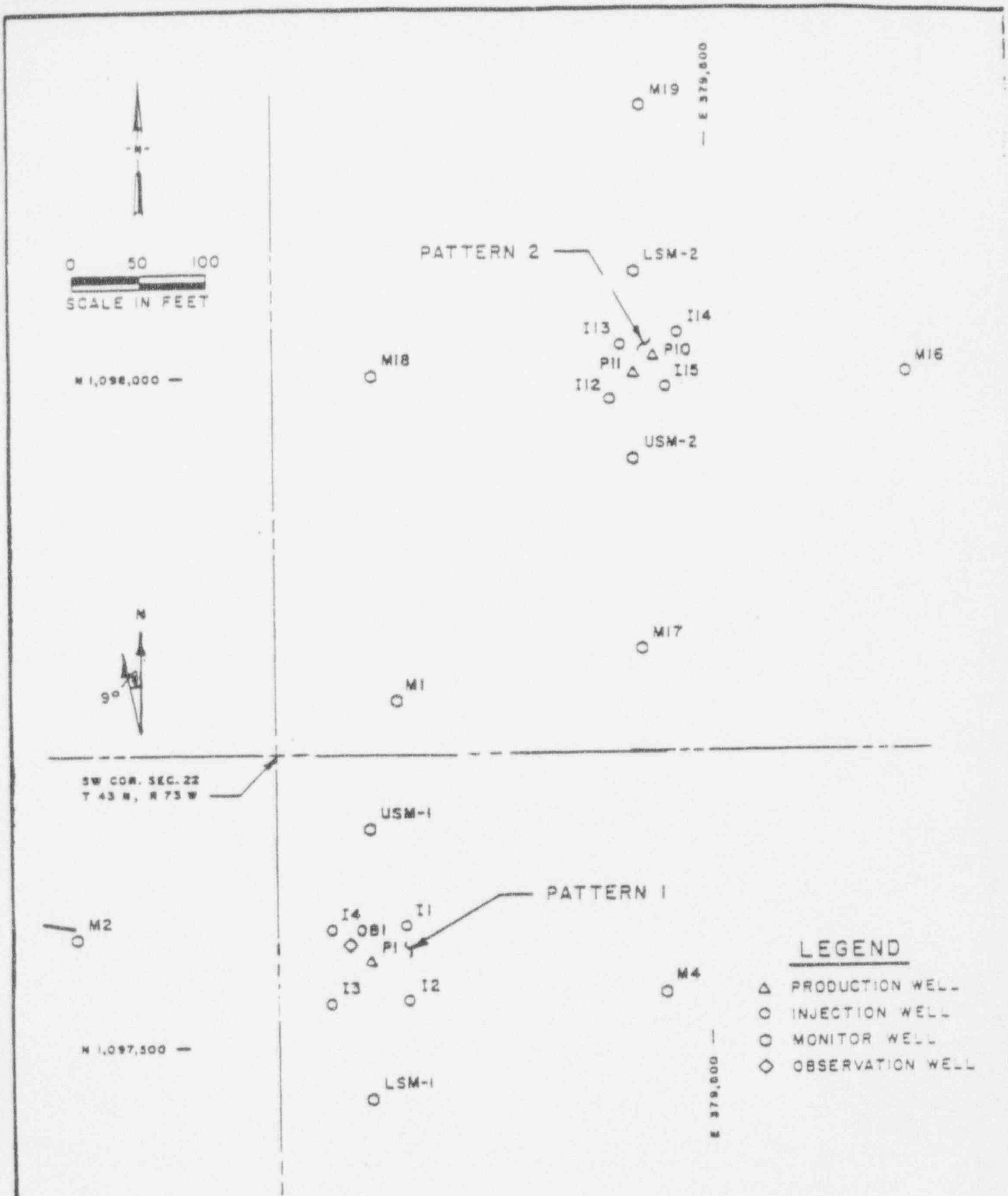


FIGURE 10.3-1.
WELL LOCATIONS
RME-PILOT PATTERNS
(after RME, 1981)

Reno Creek Permit No. 479 Amendment Application 11/25/93	10-24	Revised 2/94

TABLE 10.3-1. RENO CREEK BASIC WELL INFORMATION

WELL NUMBER	NORTHING	EASTING	GROUND ELEVATION (ft-msl)	DEPTH DRILLED (ft-lsd)	STICK UP ABOVE LSD (ft)	WELL DIAMETER (in)	MEASURED TOTAL DEPTH (ft-mp)	AQUIFER	TOP OF SAND ELEVATION (ft-msl)	BOTTOM OF SAND ELEVATION (ft-msl)	GROSS SAND THICKNESS (ft)	SCREENED INTERVAL (ft-lsd)	DEPTH TO WATER 6/93 (ft-mp)	STATIC WATER LEVEL ELEVATION (ft-msl)
RI-7	1088861	378118	5212.70	330.0	1.5	5	327.9	OS	4986	4874	112.0	190 - 330	249.64	4964.56
RI-12	1079463	369331	5325.20	460.0	0.5	5	--	OS	5013	4871	142.0	310 - 460	337.43	4988.27
RI-13	1088858	378035	5214.50	306.0	2.0	5	203.4 *	OS	4996	4897	99.0	206 - 306	--	--
RI-14	1084686	380986	5144.62	260.0	10.2	5	--	OS	4992	4899	93.0	152 - 245	--	--
RI-15U	1091190	377780	5268.35	245.0	0.8	5	244.4	UA	5057	5027	30.0	195 - 245	178.35	5090.80
RI-16	1391232	377802	5270.07	405.0	0.8	5	396.9	OS	4998	4876	122.0	315 - 395	--	--
RI-18	1092129	378098	5238.79	370.0	0.5	5	361.2	OS	5004	4877	127.0	280 - 363	293.14	4946.15
RI-21U	1099543	379038	5176.40	195.0	1.3	2	--	UA	5054	4981	73.0	137 - 195	105.34	5072.36
RI-22	1095715	379394	5215.72	380.0	1.5	2	400.3	OS	4981	4835	146.0	300 - 380	279.52	4937.70
RI-23U	1096338	373185	5169.74	208.0	1.7	2	--	UA	5039	4971	68.0	129 - 208	144.93	5026.51
RI-24U	1098019	376479	5125.42	146.0	0.8	5	138.4	UA	5011	4997	14.0	120 - 140	60.73	5065.49
RI-25U	1090965	366494	5073.03	116.0	1.7	2	113.1	UA	5047	4693	50.0	66 - 116	36.04	5038.69
RI-28	1094303	370512	5108.81	370.0	1.6	5	370.4	OS	4908	4743	165.0	213 - 370	141.58	4968.83
RI-30U	1094256	370476	5106.88	160.0	1.2	5	158.3	UA	5030	4948	82.0	79 - 158	80.57	5027.51
RI-32U	1092613	373191	5223.30	252.0	1.5	2	--	UA	5043	4974	69.0	182 - 250	181.45	5043.35
RI-33U	1098681	369197	5056.08	133.0	1.5	2	--	UA	5026	5113	86.5	59 - 133	40.88	5016.70
RI-34	1094273	370441	5101.20	360.0	0.8	5	347.7	OS	4910	4744	166.0	183 - 360	132.35	4969.65
RI-38U	1081926	368535	5272.81	228.0	1.4	5	--	UA	5113	5070	43.0	51 - 207	201.21	5073.00
RI-42	1091360	378900	5242.56	400.0	2.3	5	--	LOS	5142	5072	70.0	338 - 357	295.52	4949.34
RI-43	1094105	373754	5234.73	460.0	1.1	5	--	LOS	4870	4777	93.0	406 - 425	279.28	4956.55

NOTE:
* = BLOCKAGE AT THIS DEPTH
OS = ORE SAND
LOS = LOWER ORE SAND
UA = UPPER AQUIFER

ORE SAND WELLS ARE SCREENED IN BOTH UPPER AND LOWER ZONES, WHERE PRESENT.

Revised 2/94

TABLE 10.3-2. INVENTORY OF REGIONAL WELLS AND SPRINGS IN THE VICINITY OF THE RENO CREEK PROJECT - Revised 2/94.

				WATER LEVEL					
LOCATION T(N)-R(W)-SEC	OWNER AND/OR NAME	WYOMING WELL PERMIT NUMBER	AQUIFER	ELEV OF LAND SURF (ft-msl)	DEPTH OF WELL (ft)	DEPTH TO WATER (ft-ls)	DATE OF WATER LEVEL MEASUREMENT (mo-yr)	YIELD (gpm)	REMARKS*
42-72-6bd	Underwood #6	3921	Wasatch Fm.	5024	270	--	--	--	
42-72-18bb	Hard Water Spring Well	18855	Wasatch Fm.	5040	250	110	5-66	10	
42-73-1bb	Underwood #7	25460	Wasatch Fm.	5105	140	--	--	--	
42-73-1ca	West #1	3914	Wasatch Fm.	5100	248	160	6-65	10	
42-73-1dd	Underwood #9	25462	Wasatch Fm.	5110	120	--	--	--	
42-73-2ba	North McClure Well	18847	Upper Sd.	5115	100	30	6-60	20	
42-73-2ba2	McClure Well	18848	Ore Sd.	5120	200	100	3-61	15	WQ
42-73-5ba	Hi-way Well	18851	Ore Sd.	5210	350	110	9-51	5	WQ
42-73-6bd	O'Neil #1	33284	Ore Sd.	5150	254	90	5-76	5	
42-73-6dc	O'Neil #4a	17460	Ore Sd.	5200	276	130	8-73	30	
42-73-8ca	Deep Well #2a	18148	Wasatch Fm.	5240	450	180	7-51	5	WQ
42-73-10cb	RI-9	52564	Ore Sd.	5108	290	138	6-93	--	WQ
42-73-11cd	Hay Cock Well	18853	Wasatch Fm.	5100	275	115	7-57	15	
42-73-15ab	Reno #1	4726	Wasatch Fm.	5110	300	70	7-70	15	
42-73-23bc	RI-10	52565	L. Ore Sd.	5153	270	180	6-93	--	WQ
42-73-23bc2	RI-36	61879	U. Ore Sd.	5152	175	156	6-93	--	
42-73-23bc3	RI-37	61880	L. Ore Sd.	5151	275	186	6-93	--	WQ
42-73-27ad	RI-11	52566	L. Ore Sd.	5074	185	87	6-93	--	WQ
42-73-27ad2	RI-40	61883	Wasatch Fm.	5074	98	92	6-93	--	
42-73-27ad3	RI-41	61884	L. Ore Sd.	5075	179	93	6-93	--	WQ
42-74-1ab	Laur #7	19245	Above Upper Sd.	5150	120	80	1953	--	
42-74-3ca	Taylor #54-2	14680	Wasatch Fm.	5220	275	125	1948	--	
42-74-12db	Red Well	18852	Wasatch Fm.	5214	234	120	7-51	6	WQ
42-74-13ab	Turner #1	3827	Wasatch Fm.	5300	237	130	12-70	10	
42-74-23cb	Ralph #1	12243	Wasatch Fm.	5140	220	--	--	--	
42-74-36ac	Turner Crest #1	26304	Wasatch Fm.	5060	336	30	6-74	10	
43-72-5bd	Miller #1	1558	Wasatch Fm.	5020	230	30	10-66	--	
43-72-6bd	Ruby #1	1553	Wasatch Fm.	5140	225	40	10-66	--	
43-72-30ab	Patterson #4	2036	Wasatch Fm.	5000	200	60	12-72	--	
43-72-30dc	Cosner #10	2324	Wasatch Fm.	4990	55	25	12-68	--	WQ
43-73-1bd	Dobrenz #1	1556	Wasatch Fm.	5140	200	35	10-66	--	
43-73-1db	Highway #1	1560	Wasatch Fm.	5110	220	25	10-66	--	
43-73-1dd	House Well #1	1557	Wasatch Fm.	5110	205	35	10-66	--	
43-73-3db	Willard #7	2885	Wasatch Fm.	5160	50	18	10-42	5	
43-73-4dd	Willard #10	2888	Wasatch Fm.	5090	165	90	6-68	20	
43-73-4dd2	Willard #1	2902	Wasatch Fm.	5110	95	70	6-41	7	
43-73-9aa	Willard #9	2887	Wasatch Fm.	5080	152	110	4-64	20	
43-73-10dc	Willard #6	2884	Wasatch Fm.	5100	105	60	9-54	20	WQ
43-73-22cd	Willard #2	2880	Ore Sd.	5130	230	210	7-40	5	
43-73-23ac	Patterson #1	20033	Upper Sd.	5070	50	15	7-45	--	
43-73-24ab	Patterson #2	20034	Wasatch Fm.	5050	30	6	7-37	--	
43-73-24dc	Patterson #3	20035	Wasatch Fm.	5036	260	70	8-40	--	
43-73-25bc	Underwood #8	3923	Ore Sd.	5020	350	--	--	--	WQ
43-73-25dd	Cosner #10A	34004	Wasatch Fm.	--	200	65	6-76	25	
43-73-25dd2	Cosner #22	5329	Wasatch Fm.	5000	188	40	8-70	30	(WQ)
43-73-26bc	Willard #4	2882	Ore Sd.	5080	205	150	6-60	20	
43-73-28ab	Willard #5	2883	Upper Sd.	5160	80	60	8-62	6	WQ

TABLE 10.3-2. INVENTORY OF REGIONAL WELLS AND SPRINGS IN THE VICINITY OF THE RENO CREEK PROJECT - Revised 2/94.

LOCATION T(N)-R(W)-SEC	OWNER AND/OR NAME	WYOMING WELL PERMIT NUMBER	AQUIFER	WATER LEVEL: ELEV OF LAND SURF (ft-msl)	DEPTH OF WELL (ft)	DEPTH TO WATER (ft-ls)	DATE OF WATER LEVEL MEASUREMENT (mo-yr)	YIELD (gpm)	REMARKS*
43-73-30db	Laur #9	26955	Ore Sd.	5050	174	75	7-74	10	
43-73-32ab	Willard #3	2881	Upper Sd.	5150	90	65	6-43	10	WQ
43-73-32cc	Tucker Well	18841	Ore Sd.	5140	300	100	7-50	5	
43-73-33ab	Underwood #1	25454	Wasatch Fm.	5280	460	280	2-74	--	
43-73-33dc	Underwood #5	25458	Wasatch Fm.	5209	500	--	--	--	
43-73-34aa	Underwood #2	25455	Wasatch Fm.	5160	240	--	--	--	
43-73-34dd	Underwood #3	25456	Wasatch Fm.	5140	180	--	--	--	
43-73-34dd2	Underwood #18	25471	Wasatch Fm.	5140	180	--	--	--	
43-73-35aa	Patterson #5	20037	Upper Sd.	5085	200	50	1942	--	
43-73-36ac	Cosner #11	2325	Ore Sd.	5000	100	60	10-69	--	WQ
43-74-1db	Moore #2 (Griggs)	5429	Wasatch Fm.	5025	83	30	8-41	40	
43-74-10bd	Moore #5	5432	Wasatch Fm.	5160	290	150	7-58	5	
43-74-13cd	Baker Spring #1	7127	Wasatch Fm.	5037	10	0	11-76	--	
43-74-14ba	Todd #2	20072	Wasatch Fm.	5140	160	60	7-56	--	
43-74-16dd	SS #16	19247	Wasatch Fm.	5130	205	190	1950	--	
43-74-22ac	Todd #3	20073	Wasatch Fm.	5030	100	60	1950	--	
43-74-24bb	Baker Spring #2	5845	Wasatch Fm.	5086	6	0	11-76	--	WQ
43-74-25da	Laur #6	19244	Upper Sd.	5120	180	30	1953	--	WQ
43-74-26db	Laur #8	19246	Wasatch Fm.	5240	190	110	9-70	10	
43-74-28ad	Todd #1	2071	Wasatch Fm.	5180	100	40	1934	--	
43-74-28da	Todd #4	20074	Wasatch Fm.	5220	144	89	11-66	10	
43-74-35ba	Laur #3	19241	Wasatch Fm.	5230	120	90	1941	--	

* WQ = Water Analysis (Table 10.3-6)
Modified after Woodward-Clyde, 1976
(WQ) = Water Analysis filed with State Engineer; not included in this report.

TABLE 10.3-3. SUMMARY OF AQUIFER CHARACTERISTICS - Revised 2/94.

WELL NO.	NET AQUIFER THICKNESS (ft)	TRANSMISSIVITY LOG-LOG (gpd/ft)	SEMI-LOG (gpd/ft)	BEST VALUE	HYDRAULIC CONDUCTIVITY (ft/day)	(darcy)	S
EPRI TESTS							
RI-1	169	--	4780	4780	3.8	1.1	--
RI-2	121	--	1170	1170	1.3	0.37	--
RI-3	154	--	3720	3720	3.2	0.93	--
RI-4	124	--	1170	1170	1.3	0.37	--
RI-5	96	--	753	753	1.0	0.3	--
RI-6	67	--	812	812	1.6	0.46	--
RI-7	56	--	11.4	11.4	0.03	0.008	--
RI-9	120	--	2020	2020	2.3	0.65	--
RI-15U	30	--	13.4	13.4	0.06	0.02	--
RI-15U(2)	30	--					
RI-24U	13	--	1.8	1.8	0.02	0.005	--
RI-30U	80	--	1230	1230	2.1	0.67	--
RME TESTS							
OB-1 TEST	115	--	920	920	1.1	0.31	--
P-1	115	--	1030	1030	1.2	0.35	0.1
I-1	115	--	1680	1680	2.0	0.57	0.047
M-4	115	--	1680	1680	2.0	0.57	0.024
P-10 TEST	113	--	1900	1900	2.2	0.65	--
I-12	113	--	1810	1810	2.1	0.62	0.069
M-16	113	--	1770	1770	2.1	0.61	0.06
I-12 TEST	105	--	1310	1310	1.7	0.48	--
P-10	105	--	2020	2020	2.6	0.75	0.058
I-15	105	--	1810	1810	2.3	0.67	0.004
I-15 TEST	115	--	1510	1510	1.8	0.51	--
P-10	115	--	1190	1190	1.4	0.4	0.11
I-12	115	--	1840	1840	2.1	0.62	0.045
RI-5 TEST	96	--	864	864	0.79	0.23	--
RI-22	36	--	1520	1520	2.1	0.61	0.0026
RI-28 TEST	164	--	1550	1550	1.3	0.37	--
RI-34	164	--	1620	1620	1.3	0.38	1.3E-4
RI-1 (1st test)	169	--	6490	6490	5.1	1.5	--
RI-1 (2nd test)	169	--					--
RI-2 TEST	121	--	1410	1410	1.6	0.45	--
RI-3 (1st test)	154	--	3370	3370	2.9	0.86	--
RI-3 (2nd test)	154	--	3500	3500	3.0	0.86	--
RI-4 TEST	124	--	542	542	0.58	0.17	--
RI-5 TEST	96	--	1300	1300	1.8	0.52	--
RI-6 TEST	67	--	785	785	0.6	0.45	--
RI-7 TEST	56						
RI-8 TEST	--				--	--	--
RI-9 (1st test)	120	--	4910	4910	5.5	1.6	--
RI-9 (2nd test)	120	--	2920	2920	3.3	0.93	--
RI-28 TEST	164	--	1320	1320	1.1	0.31	--

TABLE 10.3-3a. COMPARISON OF ORE SAND AQUIFER CHARACTERISTICS DERIVED FROM EFNI (HYDRO) AND RME PUMP TESTS.

	TRANSMISSIVITY, GAL/DAY/FT		
WELL NO.	EFNI (HYDRO)	RME	AQUIFER TYPE
RI-1	4780	6490 (6080) 6000 (6190)	CONFINED
RI-2	1170	1410 (1170)	CONFINED
RI-3	3720	3370 (3430) 3500 (4400)	CONFINED
RI-4	1170 (880)	542 (561)	CONFINED
RI-5	753	1300 (1520)	UNCONFINED
RI-6	812	785 (826)	UNCONFINED
RI-9	2020	4910 (2920) 2560 (3010)	CONFINED

Note:
() = COMPUTED FROM RECOVERY DATA
ORE SAND = UPPER AND LOWER (SCREENED OVER BOTH INTERVALS)

Revised 2/94

TABLE 10.3-4. WATER-LEVEL DATA - PROJECT WELLS.

RI-1

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820612	107.38	4970.32
820614	107.40	4970.30
820622	107.90	4969.80
820707	108.17	4969.53
820723	108.25	4969.45
930622	102.09	4975.61
930819	102.56	4975.14

RI-2

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820707	139.95	4976.95
930624	137.36	4979.54
930819	[illegible]	4979.41

RI-3

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820610	215.68	4951.02
820612	215.62	4951.08
820613	215.53	4951.17
820617	216.35	4950.35
820619	215.76	4950.94
820622	215.93	4950.77
820707	216.08	4950.62
820723	216.30	4950.40
930622	210.69	4956.01
930819	210.97	4955.73

RI-4

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	214.86	4912.74
820619	205.13	4922.47
820622	205.05	4922.55
820707	204.98	4922.62
820711	205.01	4922.59
820723	205.59	4922.01
930622	189.80	4937.80
930819	190.62	4936.98

RI-5

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	282.70	4936.50
820622	282.68	4936.52
820708	282.64	4936.56
820723	283.15	4936.05
930624	281.24	4937.96
930629	282.12	4937.08
930819	281.40	4937.80

RI-6

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	323.82	4844.88
820622	323.87	4844.83
820707	323.93	4844.77
930624	321.36	4847.34
930629	321.24	4847.46
930819	321.52	4847.18

RI-7

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	258.55	4955.65
820707	258.75	4955.45
930629	249.64	4964.56
930819	250.33	4963.87

RI-9

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	139.22	4970.38
820707	138.25	4971.35
820709	138.40	4971.20
820723	138.11	4971.49
930630	137.79	4971.81

TABLE 10.3-4. WATER-LEVEL DATA - PROJECT WELLS (continued).

RI-10

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	179.91	4973.69
820616	179.00	4974.60
820618	179.20	4974.40
820707	179.22	4974.38
820718	179.28	4974.32
820719	179.47	4974.13
930625	179.93	4973.67

RI-11

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	87.57	4986.13
820707	89.63	4984.07
820718	87.98	4985.72
820719	88.06	4985.64
930630	87.38	4986.32

RI-12

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820707	341.50	4984.20
930630	337.44	4988.26

RI-13

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	246.82	4969.68
820707	246.80	4969.70
930819	193.53	5022.97

RI-14

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)

RI-16

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820611	323.77	4947.10
820613	323.44	4947.43
820622	323.57	4947.30
820707	323.59	4947.28
820711	323.58	4947.29

RI-18

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	295.97	4943.32
820622	296.10	4943.19
820707	296.16	4943.13
820723	296.56	4942.73
930819	293.14	4946.15

RI-22

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	229.65	4987.57
820622	281.71	4935.51
820708	280.92	4936.30
820723	281.39	4935.83
930624	279.52	4937.70
930819	279.70	4937.52

TABLE 10.3-4. WATER-LEVEL DATA - PROJECT WELLS (continued).

RI-28

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820620	145.38	4965.03
820707	145.72	4964.69
820713	145.68	4964.73
820714	145.60	4964.81
820716	147.65	4962.76
820723	146.42	4963.99
930624	141.58	4968.83
930819	141.57	4968.84

RI-34

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820707	137.46	4964.54
820713	137.44	4964.56
820714	137.30	4964.70
820716	139.19	4962.81
820723	137.70	4964.30
930624	132.35	4969.65
930819	132.44	4969.56

RI-36

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820714	136.07	5017.27
820715	145.78	5[illegible]7.56
820716	149.25	[illegible]4.09
820718	156.29	4997.[illegible]5
820719	153.63	4999.7[illegible]
930625	155.49	4997.85

RI-37

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820714	177.73	4973.66
820715	177.70	4973.69
820716	177.70	4973.69
820718	177.98	4973.41
820719	178.28	4973.11
820723	177.69	4973.70
930625	185.70	4965.69

RI-40

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820718	85.85	4989.30
820719	86.06	4989.09
930630	91.55	4983.60

RI-41

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820718	89.48	4986.97
820719	89.55	4986.90
820721	94.90	4981.55
930630	92.87	4983.58

RI-42

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
930625	295.52	4949.34
930819	295.54	4949.32

RI-43

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
930622	279.28	4956.55

TABLE 10.3-4. WATER-LEVEL DATA - PROJECT WELLS (continued).

RI-15U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820610	186.74	5082.41
820613	207.70	5061.45
820622	191.21	5077.94
820707	188.45	5080.70
820711	188.28	5080.87
930625	178.35	5090.80
930819	178.44	5090.71

RI-21U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	114.94	5062.76
820622	117.66	5060.04
820707	116.93	5060.77
820723	116.36	5061.34
930624	105.34	5072.36
930819	106.00	5071.70

RI-23U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820612	142.15	5029.29
820613	142.10	5029.34
820617	142.75	5028.69
820619	142.15	5029.29
820622	142.16	5029.28
820707	142.27	5029.17
820723	142.19	5029.25

RI-24U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820613	68.35	5057.87
820619	66.65	5059.57
820622	65.94	5060.28
820707	64.55	5061.67
820711	64.31	5061.91
820723	91.48	5034.74
930622	60.73	5065.49
930819	63.40	5062.82

RI-25U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820612	32.01	5039.72
820614	31.84	5039.89
820622	31.86	5039.87
820707	32.24	5039.49
820723	32.35	5039.38
930623	35.45	5036.28
930819	36.42	5035.31

RI-30U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820617	78.03	5030.05
820620	76.80	5031.28
820707	77.77	5030.31
820713	76.83	5031.25
820714	76.96	5031.12
820716	76.87	5031.21
820723	76.84	5031.24
930624	80.57	5027.51
930819	80.67	5027.41

RI-32U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820622	177.17	5047.63
820707	177.33	5047.47
820723	177.40	5047.40
930623	181.45	5043.35

RI-33U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820707	40.00	5887.64
820723	40.11	5887.53
930624	40.88	5886.76

RI-38U

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)
820716	186.45	4987.71
820716	188.17	4985.99
820722	197.14	4977.02
930630	201.21	4972.95

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)

DATE	WATER LEVEL (ft-MP)	WATER LEVEL ELEVATION (ft+MSL)

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94).

WELL	DATE	Ca	Mg	Na	K	Cl	SO4	HCO3	CO3	pH	pHf	COND	CONDf	TDS
RI1	790430	108	0	115	10.0	10.0	330	--	12.0	(11.5)	--	1535	--	792
	790512	88	17.0	240	11.0	34	690	5.0	24	9.7	--	1395	--	1118
	790518	96	0	136	9.0	12.0	422	--	5.0	(11.2)	--	1325	--	700
	790625	87	--	120	9.0	14.0	367	--	--	--	--	1130	--	704
	790719	86	0	135	9.0	10.0	432	0	14.0	(10.9)	--	1065	--	733
	827017	62	--	213	--	16.0	646	92	--	8.1	--	1220	--	1000
	930624	79	7.0	129	4.6	4.6	435	120	0	7.1	7.1	1058	790	705
RI2	780514	88	25	220	7.0	16.0	670	117	0	8.1	--	1355	--	1108
	790430	108	68	(20)	9.0	10.0	600	--	--	7.4	--	1580	--	1422
	790518	249	68	(11.0)	8.0	8.0	605	--	--	7.2	--	1595	--	1150
	790625	224	63	(35)	9.0	0.12	633	254	--	--	--	1495	--	1190
	790719	257	63	77	8.0	10.0	765	342	0	7.6	--	1525	--	1522
	930624	260	63	52	7.5	4.6	770	367	0	7.2	6.8	1684	1280	1340
RI3	780517	99	22	210	8.0	10.0	710	15.0	(34)	(9.4)	--	1220	--	1150
	780517	99	22	218	8.0	10.0	710	15.0	(34)	(9.4)	--	--	--	--
	790430	108	24	155	8.0	10.0	504	183	--	7.9	--	1325	--	1028
	790518	96	32	138	7.0	8.0	490	176	--	8.0	--	1355	--	885
	790625	96	27	150	7.0	10.0	517	161	--	--	--	1310	--	942
	790719	--	22	135	9.0	--	584	181	--	7.6	--	1320	--	1044
	930622	140	26	190	5.8	2.6	761	187	0	7.2	7.1	1604	1290	1180
RI4	780518	88	17.0	210	14.0	8.0	700	15.0	19.0	(9.7)	--	1410	--	1124
	780828	60	20	170	(22)	(42)	368	244	10.0	8.2	--	915	--	773
	790430	60	17.0	155	9.0	12.0	290	--	0	7.8	--	1105	--	700
	790517	66	--	153	7.0	12.0	324	244	0	8.2	--	--	--	730
	790625	60	15.0	160	8.0	14.0	326	239	--	--	--	1085	--	722
	790720	60	15.0	170	7.0	14.0	370	244	0	7.8	--	1045	--	815
	930622	67	39	178	4.0	(38)	503	181	0	7.2	7.1	1358	830	931
RI5	790423	96	27	220	8.0	12.0	650	134	--	7.9	--	1755	--	1095
	790511	108	20	256	7.0	12.0	--	107	0	7.9	--	1830	--	1230
	790625	100	22	245	8.0	16.0	715	117	--	--	--	1785	--	1220
	790720	104	22	280	8.0	14.0	840	107	0	7.9	--	1720	--	1344
	791006	103	28	332	9.0	12.0	950	122	0	7.9	--	1750	--	1494
	820708	93	--	263	--	20	708	105	--	7.6	--	1400	--	1475
	930629	103	22	277	5.1	10.9	826	107	0	6.9	7.1	1863	1450	1339

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94)(continued).

WELL	DATE	Ca	Mg	Na	K	Cl	SO4	HCO3	CO3	pH	pHf	COND	CONDf	TDS
RI6	780828	132	29	250	10.0	14.0	850	112	0	7.9	--	1450	--	1461
	790322	119	27	213	7.0	12.0	755	107	0	8.0	--	1610	--	1536
	790515	116	29	220	7.0	12.0	745	107	--	7.9	--	1845	--	1172
	790625	120	24	250	8.0	18.0	--	107	--	--	--	1845	--	1307
	790724	120	27	295	8.0	--	920	107	--	7.8	--	1775	--	1452
	930629	119	25	272	4.8	9.2	969	113	0	6.9	7.0	1911	1400	1385
RI7	790322	31	7.0	180	5.0	24	55	503	0	8.1	--	895	--	759
	790515	32	7.0	189	5.0	20	25	(566)	--	8.1	--	955	--	570
	790625	32	5.0	190	6.0	22	26	(561)	--	7.9	--	920	--	593
	790724	30	7.0	200	6.0	18.0	68	(556)	0	7.8	--	900	--	668
	930630	41	9.7	200	3.3	4.0	56	(578)	0	8.1	7.3	963	730	569
RI9	780824	244	60	240	(15.0)	14.0	1150	151	0	7.7	--	1775	--	1593
	790427	(457)	(127)	170	11.0	14.0	(1550)	342	--	7.4	--	(3140)	--	3307
	790516	(435)	(127)	160	10.0	15.0	(1560)	354	--	7.4	--	(3045)	--	2502
	790725	(465)	(132)	250	11.0	15.0	(1875)	354	0	7.3	--	(2920)	--	2921
	820709	343	--	211	--	(35)	1460	220	--	7.7	--	1960	--	2520
	930630	(381)	81	243	8.1	14.5	(1496)	212	0	7.1	7.0	(2745)	(2250)	2354
RI15D	930630	6.5	0.92	63	2.1	17.8	40	(60)	(18.5)	(9.7)	(8.2)	316	290	179
	930819	28	10.6	102	2.0	29	39	276	0	8.0	6.5	740	450	381
RI24D	820711	118	--	183	--	26	519	154	--	8.0	--	1120	--	960
	930622	69	12.0	154	3.4	6.6	233	375	0	7.4	6.5	885	650	689
	930819	34	7.7	163	4.0	1.9	148	388	0	7.8	7.0	1030	800	568
RI25D	930623	268	87	114	7.5	7.3	1004	295	0	7.4	6.9	2159	1680	1795
	930819	300	74	110	7.0	7.0	1018	277	0	7.3	6.8	2372	1650	1685
RI30D	820713	252	--	55	--	16.0	660	288	--	7.7	--	1395	--	1425
	930624	338	84	55	7.6	5.3	1042	328	0	7.2	6.8	2079	1620	1745
	930819	317	77	62	8.0	4.5	937	321	0	7.4	6.8	2247	1500	1579
RI42C	930107	114	22	287	6.8	9.2	891	107	0	8.2	7.9	1757	1400	1339
RI43C	930107	50	10.0	140	5.8	5.8	355	110	0	8.6	(8.5)	937	775	589

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94)(continued).

WELL	DATE	TEMP	P	PO4	HARD	HARDT	NO2	ALK	ALKT	Al	As	Ba	B	Cd
RI1	790430	--	--	--	270	--	-0.001	170	--	0.16	-0.005	0.06	-0.010	-0.002
	790512	--	--	--	290	--	-0.010	16.0	--	0.66	(-0.02)	-0.03	0.25	-0.005
	790518	--	--	--	--	--	-0.001	100	--	0.17	-0.005	-0.03	-0.010	-0.002
	790719	--	--	--	220	--	--	76	--	--	--	--	--	--
	930624	11.5	--	--	--	--	-0.10	98	--	-0.10	-0.001	-0.10	-0.10	-0.010
RI2	780514	--	--	--	323	--	-0.010	35	--	-0.05	0.010	-0.03	(1.5)	-0.005
	790430	--	--	--	870	--	0.005	280	--	0.43	-0.005	-0.03	0.02	-0.002
	790518	--	--	--	900	--	-0.001	342	--	0.010	-0.005	-0.03	-0.010	-0.002
	790719	--	--	--	900	--	--	280	--	--	--	--	--	--
	930624	11.0	--	--	--	--	-0.10	301	--	-0.10	-0.001	-0.10	-0.10	-0.010
RI3	780517	--	--	--	338	--	-0.010	25	--	0.20	0.010	-0.03	0.12	-0.002
	790430	--	--	--	350	--	-0.001	150	--	0.04	-0.005	-0.03	-0.010	-0.002
	790518	--	--	--	370	--	-0.001	144	--	0.010	-0.005	-0.03	-0.010	-0.002
	790719	--	--	--	370	--	--	148	--	--	--	--	--	--
	930622	13.0	--	--	--	--	-0.10	153	--	-0.10	-0.001	-0.10	-0.10	-0.010
RI4	780518	--	--	--	388	--	-0.010	16.0	--	-0.05	0.010	-0.03	0.45	-0.005
	780828	--	--	--	230	--	-0.010	200	--	-0.05	0.010	-0.03	0.07	-0.002
	790430	--	--	--	220	--	--	230	--	--	--	--	--	--
	790517	--	--	--	212	--	--	200	--	--	--	--	--	--
	790720	--	--	--	210	--	--	185	--	--	--	--	--	--
	930622	13.5	--	--	--	--	-0.10	148	--	-0.10	-0.001	-0.10	-0.10	-0.010
RI5	790423	--	--	--	351	--	--	110	--	--	--	--	--	--
	790511	--	--	--	350	--	--	88	--	--	--	--	--	--
	790720	--	--	--	350	--	--	88	--	--	--	--	--	--
	791006	--	--	--	372	--	-0.010	100	--	-0.05	-0.010	-0.05	(-1.0)	-0.002
	930629	14.0	--	--	--	--	-0.10	87	--	-0.10	-0.001	-0.10	-0.10	-0.010
RI6	780828	--	--	--	450	--	-0.010	92	--	-0.05	(0.03)	-0.03	0.05	-0.002
	790322	--	--	--	408	--	-0.001	88	--	0.05	-0.005	-0.03	-0.010	-0.002
	790515	--	--	--	410	--	-0.001	88	--	0.010	0.010	-0.03	0.59	-0.002
	790724	--	--	--	410	--	--	88	--	--	--	--	--	--
	930629	14.0	--	--	--	--	-0.10	92	--	-0.10	0.002	(-0.10)	-0.10	-0.010

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94)(continued).

WELL	DATE	TEMP	P	PO4	HARD	HARDT	NO2	ALK	ALKT	Al	As	Ba	B	Cd
RI7	790322	--	--	--	104	--	-0.001	412	--	0.45	-0.005	(0.17)	0.14	-0.002
	790515	--	--	--	108	--	-0.001	(464)	--	0.43	-0.005	(0.19)	-0.010	-0.002
	790724	--	--	--	104	--	--	(456)	--	--	--	--	--	--
	930630	17.0	--	--	--	--	-0.10	(474)	--	-0.10	-0.001	(0.16)	-0.10	-0.010
RI9	780824	--	--	--	800	--	-0.010	124	--	0.10	(0.02)	-0.03	-0.010	-0.002
	790427	--	--	--	1660	--	0.005	280	--	(0.79)	-0.005	0.04	0.02	-0.002
	790516	--	--	--	1680	--	-0.001	290	--	0.02	0.010	-0.03	0.09	-0.002
	790725	--	--	--	1700	--	--	290	--	--	--	--	--	--
	930630	12.6	--	--	--	--	-0.10	174	--	-0.10	-0.001	(-0.10)	0.10	-0.010
RI15U	930630	12.5	--	--	--	--	-0.10	77	--	-0.10	0.001	-0.10	0.10	-0.010
	930819	15.0	--	--	--	--	-0.010	226	--	-0.10	-0.001	-0.10	-0.10	-0.05
RI24U	930622	13.8	--	--	--	--	-0.10	307	--	-0.10	0.001	-0.10	-0.10	-0.010
	930819	11.0	--	--	--	--	0.13	318	--	-0.10	0.002	-0.10	-0.10	-0.05
RI25U	930623	10.5	--	--	--	--	-0.10	242	--	-0.10	-0.001	-0.10	-0.10	-0.010
	930819	11.7	--	--	--	--	-0.010	227	--	-0.10	-0.001	-0.10	-0.10	-0.05
RI30U	930624	10.5	--	--	--	--	-0.10	269	--	-0.10	-0.001	-0.10	-0.10	-0.010
	930819	11.0	--	--	--	--	-0.010	263	--	-0.10	-0.001	-0.10	-0.10	-0.05
RI42C	930107	15.0	--	--	--	--	-0.10	88	--	-0.10	-0.001	-0.10	0.10	-0.010
RI43C	930107	14.0	--	--	--	--	-0.10	90	--	-0.10	-0.001	-0.10	-0.10	-0.010

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94)(continued).

WELL	DATE	Cr	Crt	Co	Cu	F	Fe	Fet	Pb	Mn	Hg	Mo	Ni	NH3
RI1	790430	-0.010	--	--	-0.010	0.18	0.02	--	-0.010	0.010	-0.0005	-0.05	-0.02	0.12
	790512	-0.010	--	--	-0.010	-0.010	0.13	--	-0.010	-0.010	-0.001	-0.05	-0.02	-0.10
	790518	-0.010	--	--	-0.010	0.36	0.010	--	-0.010	0.010	-0.0005	-0.05	-0.02	0.15
	790625	--	--	--	--	--	0.26	--	--	0.08	--	--	--	--
	790719	--	--	--	--	--	0.19	--	--	0.010	--	--	--	--
	930624	-0.05	--	--	-0.010	-0.10	-0.05	--	-0.05	0.05	-0.001	-0.10	-0.05	-0.05
RI2	780514	-0.010	--	--	-0.010	-0.10	0.04	--	-0.010	0.06	-0.001	-0.05	-0.02	0.16
	790430	-0.010	--	--	-0.010	0.18	0.16	--	0.010	0.09	-0.0005	-0.05	-0.02	0.12
	790518	-0.010	--	--	-0.010	0.14	2.3	--	-0.010	0.23	-0.0005	-0.05	-0.02	0.30
	790625	--	--	--	--	--	1.6	--	--	0.14	--	--	--	--
	790719	--	--	--	--	--	1.7	--	--	0.20	--	--	--	--
	930624	-0.05	--	--	-0.010	-0.10	1.6	--	-0.05	0.13	-0.001	-0.10	-0.05	0.20
RI3	780517	-0.010	--	--	-0.010	-0.10	0.34	--	-0.010	-0.02	-0.001	-0.05	-0.02	(0.64)
	790430	-0.010	--	--	-0.010	0.18	0.02	--	-0.010	0.05	-0.005	-0.05	--	-0.001
	790518	-0.010	--	--	-0.010	0.22	0.03	--	-0.010	0.06	-0.0005	-0.05	-0.02	0.17
	790625	--	--	--	--	--	0.02	--	--	0.04	--	--	--	--
	790719	--	--	--	--	--	0.11	--	--	0.04	--	--	--	--
	930622	-0.05	--	--	-0.010	-0.10	0.14	--	-0.05	0.09	-0.001	-0.10	-0.05	-0.05
RI4	780518	-0.010	--	--	-0.010	-0.10	0.21	--	-0.010	0.000	-0.001	-0.05	-0.02	0.10
	780828	-0.010	--	--	-0.010	0.18	0.14	--	-0.02	0.05	-0.0005	-0.05	-0.02	-0.10
	790430	--	--	--	--	--	0.29	--	--	(0.54)	--	--	--	--
	790517	--	--	--	--	--	0.32	--	--	0.31	--	--	--	--
	790625	--	--	--	--	--	0.24	--	--	0.29	--	--	--	--
	790720	--	--	--	--	--	0.42	--	--	0.26	--	--	--	--
	930622	-0.05	--	--	-0.010	0.20	0.71	--	-0.05	(0.48)	-0.001	-0.10	-0.05	0.06
RI5	790423	--	--	--	--	--	(4.1)	--	--	0.15	--	--	--	--
	790511	--	--	--	--	--	0.010	--	--	0.04	--	--	--	--
	790625	--	--	--	--	--	(4.5)	--	--	0.26	--	--	--	--
	790720	--	--	--	--	--	0.14	--	--	0.06	--	--	--	--
	791006	-0.010	--	--	-0.010	0.07	0.14	--	-0.05	0.03	-0.001	-0.05	-0.04	-0.010
	930629	-0.05	--	--	-0.010	-0.10	-0.05	--	-0.05	0.10	-0.001	-0.10	-0.05	-0.05
RI6	780828	-0.010	--	--	-0.010	0.22	0.32	--	-0.02	0.05	-0.0005	-0.05	-0.02	-0.10

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94)(continued).

WELL	DATE	Cr	Crt	Co	Cu	F	Fe	Fet	Pb	Mn	Hg	Mo	Ni	NH3
RI6	790322	-0.010	--	--	-0.010	0.22	0.13	--	-0.010	0.09	-0.0005	-0.05	-0.02	-0.010
	790515	-0.010	--	--	-0.010	0.32	0.42	--	-0.010	0.08	-0.0005	-0.05	-0.02	0.14
	790625	--	--	--	--	--	1.5	--	--	0.14	--	--	--	--
	790724	--	--	--	--	--	0.33	--	--	0.05	--	--	--	--
	930629	-0.05	--	--	-0.010	-0.10	-0.05	--	-0.05	0.06	-0.001	-0.10	-0.05	-0.05
RI7	790322	-0.010	--	--	-0.010	(0.84)	0.54	--	-0.05	0.04	-0.0005	-0.05	-0.05	-0.010
	790515	-0.010	--	--	-0.010	(0.99)	0.94	--	-0.010	0.02	-0.0005	-0.05	-0.02	0.20
	790625	--	--	--	--	--	0.08	--	--	0.06	--	--	--	--
	790724	--	--	--	--	--	0.21	--	--	0.03	--	--	--	--
	930630	-0.05	--	--	-0.010	0.33	-0.05	--	-0.05	0.02	-0.001	-0.10	-0.05	-0.05
RI9	780824	-0.010	--	--	-0.010	0.18	0.20	--	-0.02	0.04	-0.0005	-0.05	-0.02	-0.10
	790427	-0.010	--	--	-0.010	-0.10	0.30	--	-0.010	0.27	-0.0005	-0.05	-0.02	-0.10
	790516	-0.010	--	--	-0.010	0.22	0.85	--	-0.010	0.32	-0.0005	-0.05	-0.02	0.36
	790725	--	--	--	--	--	0.68	--	--	0.18	--	--	--	--
	930630	-0.05	--	--	-0.010	-0.10	0.73	--	-0.05	0.19	-0.001	-0.10	-0.05	-0.05
RI15D	930630	-0.05	--	--	-0.010	1.1	-0.05	--	-0.05	-0.010	-0.001	-0.10	-0.05	0.26
	930819	-0.05	--	--	-0.010	1.0	-0.05	--	-0.05	0.010	-0.001	-0.10	-0.05	0.30
RI24D	930622	-0.05	--	--	-0.010	0.52	-0.05	--	-0.05	0.16	-0.001	-0.10	-0.05	0.10
	930819	-0.05	--	--	-0.010	0.70	-0.05	--	-0.05	0.15	-0.001	-0.10	-0.05	0.10
RI25D	930623	-0.05	--	--	-0.010	-0.10	-0.05	--	-0.05	0.48	-0.001	-0.10	-0.05	0.31
	930819	-0.05	--	--	-0.010	-0.10	0.71	--	-0.05	0.55	-0.001	-0.10	-0.05	0.50
RI30D	930624	-0.05	--	--	-0.010	-0.10	1.9	--	-0.05	0.16	-0.001	-0.10	-0.05	0.29
	930819	-0.05	--	--	-0.010	-0.10	1.2	--	-0.05	0.22	-0.001	-0.10	-0.05	0.30
RI42C	930107	-0.05	--	--	-0.010	0.10	0.10	--	-0.05	0.12	-0.001	-0.10	-0.05	0.12
RI43C	930107	-0.05	--	--	-0.010	0.11	-0.05	--	-0.05	0.010	-0.001	-0.10	-0.05	0.06

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94)(continued).

WELL	DATE	NO3	Se	Ag	V	Zn	U	Ra226	Th230	SiO2	DSSUM	OH	Be	Eh
RI1	790430	-0.05	-0.005	-0.010	-0.05	(0.26)	0.004	3.3	0.90	0.48	--	--	--	40
	790512	0.20	-0.010	-0.010	-0.05	-0.005	(0.25)	--	--	-0.10	--	--	--	130
	790518	0.08	-0.005	-0.010	-0.05	0.03	0.02	--	--	0.16	--	--	--	75
	790625	--	--	--	-0.05	--	0.003	--	--	--	--	--	--	46
	790719	--	--	--	-0.05	--	0.003	4.2	0.50	0.30	--	--	--	70
	827017	--	--	--	--	--	-0.001	--	--	--	--	--	--	--
	930624	-0.10	-0.001	--	-0.10	-0.010	0.02	3.3	--	12.4	--	--	--	--
RI2	780514	0.10	(0.02)	-0.010	-0.05	-0.005	0.006	--	--	-0.10	--	--	--	165
	790430	0.010	-0.005	-0.010	-0.05	0.11	0.004	3.5	0.90	0.90	--	--	--	150
	790518	0.06	-0.005	-0.010	-0.05	0.04	0.002	--	--	0.21	--	--	--	205
	790625	--	--	--	-0.05	--	0.002	--	--	--	--	--	--	230
	790719	--	--	--	-0.05	--	0.001	2.0	0.50	1.2	--	--	--	190
	930624	-0.10	-0.001	--	-0.10	0.02	-0.0003	1.1	--	(16.9)	--	--	--	--
RI3	780517	0.60	0.010	-0.010	-0.05	-0.005	(0.24)	--	--	1.3	--	--	--	110
	780517	--	--	--	--	--	--	--	--	--	1108	--	--	--
	790430	0.010	-0.005	-0.010	-0.05	(0.25)	0.01	8.7	0.90	0.55	--	--	--	145
	790518	-0.05	-0.005	-0.010	-0.05	0.03	0.02	--	--	0.12	--	--	--	195
	790625	--	--	--	-0.05	--	0.008	--	--	--	--	--	--	234
	790719	--	--	--	-0.05	--	0.01	7.7	0.90	0.75	--	--	--	180
	930622	-0.10	-0.001	--	-0.10	-0.010	0.02	9.5	--	(15.9)	--	--	--	--
RI4	780518	(5.0)	-0.010	-0.010	0.11	-0.005	(0.17)	--	--	-0.10	--	--	--	110
	780828	0.20	-0.005	-0.010	-0.05	-0.005	0.09	--	--	-0.10	--	--	--	248
	790430	--	--	--	--	--	0.02	--	--	--	--	--	--	140
	790517	--	--	--	--	--	0.04	--	--	--	--	--	--	--
	790625	--	--	--	-0.05	--	0.03	--	--	--	--	--	--	233
	790720	--	--	--	-0.05	--	0.03	99	--	1.2	--	--	--	--
	930622	-0.10	-0.001	--	-0.10	-0.010	0.03	32	--	9.3	--	--	--	--
RI5	790423	--	--	--	--	--	0.008	--	--	--	--	--	--	140
	790511	--	--	--	-0.05	--	0.010	--	--	--	--	--	--	250
	790625	--	--	--	-0.05	--	0.003	--	--	--	--	--	--	--
	790720	--	--	--	-0.05	--	0.008	18.5	1.1	0.30	--	--	--	185
	791006	-0.010	-0.010	-0.02	-0.05	-0.010	-0.001	--	--	10.3	--	--	--	330
	820708	--	--	--	--	--	-0.001	--	--	--	--	--	--	--
	930629	-0.10	-0.001	--	-0.10	0.05	0.006	13.6	--	(15.9)	--	--	--	--

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94)(continued).

WELL	DATE	NO3	Se	Ag	V	Zn	U	Ra226	Th230	SiO2	DSSUM	OH	Be	Eh
RI6	780828	-0.10	(0.02)	-0.010	-0.05	-0.005	(0.18)	--	--	-0.10	--	--	--	300
	790322	-0.05	-0.005	-0.010	-0.05	0.010	0.08	(240)	(4.8)	0.43	--	--	--	110
	790515	-0.05	-0.005	-0.010	-0.05	0.19	0.04	--	--	0.05	--	--	--	183
	790625	--	--	--	-0.05	--	0.05	--	--	--	--	--	--	242
	790724	--	--	--	-0.05	--	0.02	(224)	3.4	0.15	--	--	--	190
	930629	-0.10	0.001	--	-0.10	0.03	0.02	136	--	10.2	--	--	--	--
RI7	790322	-0.05	-0.005	-0.010	-0.05	-0.005	0.04	4.3	-0.50	9.3	--	--	--	105
	790515	1.1	-0.005	-0.010	-0.05	0.04	0.004	--	--	1.3	--	--	--	180
	790625	--	--	--	-0.05	--	0.010	--	--	--	--	--	--	233
	790724	--	--	--	-0.05	--	0.002	3.9	0.40	9.5	--	--	--	195
	930630	-0.10	-0.001	--	-0.10	-0.010	-0.0003	3.9	--	9.7	--	--	--	--
RI9	780824	-0.10	0.010	-0.010	-0.05	-0.005	0.01	--	--	-0.10	--	--	--	(350)
	790427	-0.05	-0.005	-0.010	-0.05	(0.25)	0.003	52	1.8	0.28	--	--	--	160
	790516	0.87	-0.005	0.09	-0.05	0.03	0.003	--	--	-0.10	--	--	--	205
	790725	--	--	--	-0.05	--	0.002	52	2.0	0.15	--	--	--	215
	820709	--	--	--	--	--	-0.001	--	--	--	--	--	--	--
	930630	-0.10	-0.001	--	-0.10	0.05	-0.0003	7.5	--	13.0	--	--	--	--
RI15U	930630	-0.10	-0.001	--	-0.10	-0.010	-0.0003	(-0.20)	--	13.2	--	--	--	--
	930819	-0.10	-0.001	--	-0.10	0.02	0.003	1.4	--	9.3	--	--	--	--
RI24D	820711	--	--	--	--	--	0.03	--	--	--	--	--	--	--
	930622	-0.10	-0.001	--	-0.10	0.02	0.10	1.6	--	17.7	--	--	--	--
	930819	(0.34)	0.002	--	-0.10	0.02	0.03	0.90	--	14.1	--	--	--	--
RI25D	930623	-0.10	-0.001	--	-0.10	0.04	0.05	2.1	--	14.3	--	--	--	--
	930819	-0.10	-0.001	--	-0.001	0.03	0.005	2.4	--	16.2	--	--	--	--
RI30D	820713	--	--	--	--	--	0.002	--	--	--	--	--	--	--
	930624	-0.10	-0.001	--	-0.10	0.02	-0.0003	1.1	--	17.2	--	--	--	--
	930819	-0.10	-0.001	--	-0.10	0.08	0.004	2.1	--	18.2	--	--	--	--
RI42C	930107	-0.10	0.009	--	-0.10	-0.010	0.007	(244)	--	11.0	--	--	--	--
RI43C	930107	-0.10	0.007	--	-0.10	-0.010	0.07	72	--	6.6	--	--	--	--

TABLE 10.3-5. GROUND-WATER QUALITY DATA - PROJECT WELLS (revised 2/94)(continued).

WELL	DATE	NO3	Se	Ag	V	Zn	U	Ra226	Th230	SiO2	DSSUM	OH	Be	Eh

NOTES:

"-" sign before a value indicates that the value is less than the detection limit. Value shown is lower detection limit.

An "f" subscript on a parameter indicates values were field measured.

HARD = Hardness, in mg/l of CaCO3.

ALK = Alkalinity, in mg/l of CaCO3.

DSSUM = Calculated sum of dissolved solids, in mg/l.

HARDT = Total Hardness, in mg/l.

ALKT = Total Alkalinity, in mg/l.

All values are in MG/L except as otherwise noted and the following:
TEMP = water temperature, in DEG C.
COND = conductivity, in micromhos/cm @ 25 DEG C.
Eh = Eh, in millivolts.
pH = pH, in standard units.
Ra226 = Radium-226, in pci/l.
Th230 = Thorium-230, in pci/l.

( ) = Outliers

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS.

WELL*	DATE	Ca	Mg	Na	K	Cl	SO4	HCO3	CO3	pH	COND	TEMP	TDS
41721dd	761130	330	180	255	6.6	17.0	1870	196	--	--	--	8.0	2900
41734aa	761130	220	48	200	6.4	9.0	1070	93	--	--	--	9.0	1640
427220cd	761130	340	135	250	8.2	15.0	1760	189	--	--	--	10.0	2720
427220cd2	761130	400	365	575	11.0	24	2860	425	--	--	--	6.0	5180
42732ba2	761130	270	76	56	8.0	2.0	860	300	--	--	--	10.0	1510
42735ba	820727	80	--	105	--	17.0	240	217	--	7.5	925	--	775
42738ca	761130	245	125	43	6.6	-1.0	992	296	--	--	--	12.0	1680
427310c	780824	244	60	240	15.0	14.0	1150	151	0	7.7	1775	--	1593
	790427	457	127	120	11.0	14.0	1550	342	--	7.4	3140	--	3307
	790516	435	127	160	10.0	15.0	1560	354	--	7.4	3045	--	2502
	790725	465	132	250	11.0	15.0	1875	354	0	7.3	2920	--	2921
	820709	343	--	211	--	35	1460	220	--	7.7	1960	--	2520
	930630	381	81	243	8.1	14.5	1498	212	0	7.1	2745	12.0	2354
427320ac	761130	225	53	54	7.5	11.0	684	249	--	--	--	10.0	1220
427323bc	790427	152	51	50	8.0	12.0	510	183	--	7.4	1440	--	1176
	790516	160	46	78	7.0	12.0	570	171	--	7.4	1390	--	950
	790724	172	44	100	8.0	16.0	665	161	0	7.6	1335	--	1065
427323bc	820718	107	--	98	--	20	497	160	--	7.6	1255	--	1350
427327ac	780825	110	48	47	8.0	10.0	360	224	0	7.7	840	--	803
	790427	126	56	15.0	8.0	10.0	356	232	--	7.4	1070	--	702

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	Ca	Mg	Na	K	Cl	SO4	HCO3	CO3	pH	COND	TEMP	TDS
427327ac	790516	144	54	6.0	7.0	10.0	360	234	0	7.2	1145	--	752
	790725	136	54	40	7.0	10.0	432	239	0	7.3	1020	--	785
427327ad	827019	110	--	45	--	21	289	238	--	7.1	920	--	975
427331dc	761130	81	25	18.0	4.9	3.0	115	296	--	--	--	10.0	412
427336bb	761130	84	31	52	4.9	5.0	278	215	--	--	--	10.0	575
427412db	761130	310	150	91	9.1	12.0	1440	171	--	--	--	10.0	2210
437230dc	761130	120	46	29	6.0	12.0	412	193	--	--	--	9.0	797
437236ac	761130	380	205	195	8.6	8.0	2080	14.0	--	--	--	9.0	3330
43731db	761103	135	55	31	6.4	-1.0	393	296	--	8.4	1100	10.0	815
	820727	58	--	158	--	19.0	380	143	--	7.8	1100	--	825
437310dc	761130	130	35	36	3.6	5.0	298	298	--	--	--	10.0	688
437325bc	761130	6.4	1.2	100	1.7	19.0	22	222	--	--	--	10.0	276
437326bb	761130	235	41	395	7.3	9.0	1500	62	--	--	--	10.0	2220
437328ab	761104	220	54	28	4.3	3.0	582	290	--	7.5	1400	9.0	1100
	761130	220	54	28	4.3	3.0	582	290	--	--	--	9.0	1100
437332ab	761104	345	110	66	8.0	9.0	1200	254	--	8.3	2300	9.0	1960
	761130	345	110	66	8.0	9.0	1200	254	--	--	--	9.0	1960

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	Ca	Mg	Na	K	Cl	SO4	HCO3	CO3	pH	COND	TEMP	TDS
437424bb	761130	146	69	155	32	14.0	642	371	--	--	--	6.0	--
437425da	761103	93	24	11.0	2.1	3.0	96	303	--	7.8	584	10.0	404
	761130	93	24	11.0	2.1	3.0	96	303	--	--	--	10.0	404
	780125	80	32	32	3.0	7.0	42	317	0	--	--	--	--

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	P	HARD	HARDT	NO2	ALK	ALKT	Al	As	Ba	B	Cd	Cr
41721dd	761130	--	1300	1600	--	160	190	--	--	--	--	--	--
41734aa	761130	--	--	835	--	76	85	0.10	0.010	-0.50	-0.10	0.02	--
427220cd	761130	--	1300	1470	--	154	205	--	--	--	--	--	--
427220cd2	761130	--	1700	2640	--	348	395	--	--	--	--	--	--
42732ba2	761130	--	--	1030	--	246	275	0.05	-0.010	-0.50	-0.10	0.004	--
42735ba	761130	--	--	--	--	--	--	--	--	--	--	--	--
42738ca	761130	--	--	1220	--	242	290	0.33	-0.010	-0.50	0.20	0.004	--
427310c	780824	--	800	--	-0.010	124	--	0.10	0.02	-0.03	-0.010	-0.002	-0.010
	790427	--	1660	--	0.005	280	--	0.79	-0.005	0.04	0.02	-0.002	-0.010
	790516	--	1680	--	-0.001	290	--	0.02	0.010	-0.03	0.09	-0.002	-0.010
	790725	--	1700	--	--	290	--	--	--	--	--	--	--
	930630	--	--	--	-0.16	174	--	-0.10	-0.001	-0.10	0.10	-0.010	-0.05
427320ac	761130	--	--	800	--	204	255	-0.05	-0.010	-0.50	0.10	0.004	--
427323bc	790427	--	590	--	-0.001	150	--	0.36	-0.005	0.03	-0.010	-0.002	-0.010
	790516	--	590	--	-0.001	140	--	0.02	-0.005	-0.03	0.02	-0.002	-0.010
	790724	--	610	--	--	132	--	--	--	--	--	--	--
427323bc	790427	--	--	--	--	--	--	--	--	--	--	--	--
427327ac	780825	--	470	--	-0.010	184	--	-0.05	-0.005	-0.03	-0.010	-0.002	-0.010
	790427	--	571	--	--	190	--	--	--	--	--	--	--
	790516	--	580	--	--	192	--	--	--	--	--	--	--

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	P	HARD	HARDT	NO2	ALK	ALKT	Al	As	Ba	B	Cd	Cr	
427327ac	790725	--	560	--	--	196	--	--	--	--	--	--	--	
427327ad	780825	--	--	--	--	--	--	--	--	--	--	--	--	
427331dc	761130	--	--	328	--	243	255	--	--	--	--	--	--	
427336bb	761130	--	--	368	--	176	170	-0.05	-0.010	-0.50	-0.10	0.002	--	
427412db	761130	--	--	1470	--	140	170	0.05	-0.010	-0.50	-0.10	0.004	--	
437230dc	761130	--	--	559	--	158	205	--	--	--	--	--	--	
437236ac	761130	--	--	1600	--	10.0	50	--	--	--	--	--	--	
43731db	761103	--	695	--	--	243	--	-0.05	-0.010	-0.50	0.10	0.002	-0.005	
437310dc	761130	--	--	423	--	244	305	-0.05	-0.010	--	-0.10	-0.50	0.002	--
437325bc	761130	--	--	30	--	182	205	-0.05	-0.010	-0.50	-0.10	0.002	--	
437326bb	761130	--	--	784	--	51	85	-0.05	-0.010	-0.50	-0.10	0.004	--	
437328ab	761104	--	423	--	--	244	--	0.10	-0.010	-0.50	-0.10	0.004	-0.005	
	761130	--	--	814	--	238	305	--	0.10	-0.010	-0.50	-0.10	0.004	--
437332ab	761104	--	1352	--	--	208	--	-0.05	-0.010	-0.50	-0.10	0.004	-0.005	
	761130	--	--	1350	--	208	255	-0.05	-0.010	-0.50	-0.10	0.004	--	
437424bb	761130	--	--	674	--	304	340	--	--	--	--	--	--	

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	P	HARD	HARDT	NO2	ALK	ALKT	Al	As	Ba	B	Cd	Cr
437425da	761103	--	362	--	--	248	--	-0.05	-0.010	-0.50	-0.10	0.002	-0.005
	761130	--	--	362	--	248	310	-0.05	0.010	-0.05	-0.10	0.002	--
	780125	-0.010	--	332	-0.010	--	--	-0.05	-0.010	-0.03	-0.010	-0.005	-0.010

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	Cut	Co	Cu	F	Fe	Fet	Pb	Mn	Hg	Mo	Ni	NH3
41721dd	761130	--	--	--	0.57	0.11	0.20	--	0.07	--	--	--	--
41734aa	761130	-0.005	0.02	0.02	0.29	0.11	32	0.52	0.45	-0.00	--	0.02	--
427220cd	761130	--	--	--	0.20	0.06	0.72	--	0.24	--	--	--	--
427220cd2	761130	--	--	--	0.34	0.13	1.6	--	0.14	--	--	--	--
42732ba2	761130	-0.005	0.010	0.02	-0.10	-0.03	0.32	0.04	0.23	-0.00	--	0.02	--
42735ba	781130	--	--	--	--	--	--	--	--	--	--	--	--
42738ca	761130	-0.005	0.010	0.005	-0.10	0.29	12.0	0.05	0.90	-0.00	--	--	0.010
427310c	780824	--	--	-0.010	0.18	0.29	--	-0.02	0.04	-0.0005	-0.05	-0.02	-0.10
	790427	--	--	-0.010	-0.10	0.30	--	-0.010	0.27	-0.0005	-0.05	-0.02	-0.10
	790516	--	--	-0.010	0.22	0.85	--	-0.010	0.32	-0.0005	-0.05	-0.02	0.36
	790725	--	--	--	--	0.68	--	--	0.18	--	--	--	--
	930630	--	--	-0.010	-0.10	0.73	--	-0.05	0.19	-0.001	-0.10	-0.05	-0.05
427320ac	761130	-0.005	0.010	0.010	0.14	0.06	2.7	0.04	0.08	-0.00	--	0.010	--
427323bc	790427	--	--	-0.010	-0.10	0.02	--	-0.010	-0.05	-0.0005	-0.05	-0.02	-0.10
	790516	--	--	-0.010	0.18	0.79	--	-0.010	0.23	-0.0005	-0.05	-0.02	0.17
	790724	--	--	--	--	0.61	--	--	0.11	--	--	--	--
427323bc	790427	--	--	--	--	--	--	--	--	--	--	--	--
427327ac	780825	--	--	-0.010	0.32	0.54	--	-0.02	0.15	-0.0005	-0.05	-0.02	-0.10
	790427	--	--	--	--	1.5	--	--	0.29	--	--	--	--
	790516	--	--	--	--	2.1	--	--	0.29	--	--	--	--

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	Cut	Co	Cu	F	Fe	Fet	Pb	Mn	Hg	Mo	Ni	NH3
427327ac	790725	--	--	--	--	1.6	--	--	0.23	--	--	--	--
427327ad	780825	--	--	--	--	--	--	--	--	--	--	--	--
427331dc	761130	--	--	--	-0.10	-0.03	1.6	--	0.04	--	--	--	--
427336bb	761130	-0.005	0.010	0.010	0.39	-0.03	0.88	0.03	0.36	-0.00	--	0.010	--
427412db	761130	-0.005	0.010	-0.005	-0.10	0.24	33	0.04	0.42	-0.00	--	0.010	--
437230dc	761130	--	--	--	0.54	0.03	0.10	--	0.010	--	--	--	--
437236ac	761130	--	--	--	0.57	165	155	--	4.1	--	--	--	--
43731db	761103	--	--	0.005	-0.10	0.30	--	0.03	0.13	-0.00	--	0.010	--
437310dc	761130	-0.005	0.010	-0.005	0.38	0.03	0.64	0.03	0.09	-0.00	--	0.010	--
437325bc	761130	-0.005	-0.005	-0.005	0.88	0.03	-0.20	-0.010	0.02	-0.00	--	-0.005	--
437326bb	761130	-0.005	0.02	0.005	0.10	0.03	0.55	0.40	0.28	-0.00	--	0.02	--
437328ab	761104	--	--	0.010	0.38	0.64	--	0.04	0.13	-0.00	--	0.010	--
	761130	-0.005	0.010	0.010	0.46	0.03	0.64	0.04	0.13	-0.00	--	0.010	--
437332ab	761104	--	--	0.010	0.10	0.80	--	0.04	0.36	-0.00	--	0.02	--
	761130	-0.005	0.010	0.010	0.10	0.07	0.80	0.04	0.36	-0.00	--	0.02	--
437424bb	761130	--	--	--	0.10	0.21	2.2	--	--	--	--	--	--

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	Cnt	Co	Cu	F	Fe	Fet	Pb	Mn	Hg	Mo	Ni	NH3
437425da	761103	--	--	0.005	0.30	0.49	--	0.03	0.05	-0.00	--	0.010	--
	761130	-0.005	0.010	0.005	0.30	-6.03	0.49	0.03	0.05	-0.00	--	0.010	--
	780125	--	-0.05	-0.010	0.36	0.07	0.50	-0.010	0.010	-0.001	-0.05	-0.05	-0.10

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	NO3	Se	Ag	V	Zn	U	Ra226	Th230	SiO2	DSSUM	Eh
41721dd	761130	--	--	--	--	--	0.02	--	--	11.0	2757	--
41734aa	761130	--	-0.005	0.002	-0.002	35	-0.002	0.40	0.10	--	1600	--
427220cd	761130	--	--	--	--	--	-0.002	--	--	3.0	2603	--
427220cd2	761130	--	--	--	--	--	0.04	--	--	6.0	4448	--
42732ba2	761130	--	-0.005	0.002	-0.002	1.0	-0.002	0.30	0.00	15.0	1422	--
42735ba	820727	--	--	--	--	--	0.09	--	--	--	--	--
42738ca	761130	--	-0.005	0.002	-0.002	0.08	0.01	0.70	0.00	10.0	1559	--
427310c	780824	-0.10	0.010	-0.010	-0.05	-0.005	0.01	--	--	-0.10	--	350
	790427	-0.05	-0.005	-0.010	-0.05	0.25	0.003	52	1.8	0.28	--	160
	790516	0.87	-0.005	0.09	-0.05	0.03	0.003	--	--	-0.10	--	205
	790725	--	--	--	-0.05	--	0.002	52	2.0	0.15	--	215
	820709	--	--	--	--	--	-0.001	--	--	--	--	--
	930630	-0.10	-0.001	--	-0.10	0.05	-0.0003	7.5	--	13.0	--	--
427320ac	761130	--	-0.005	-0.002	0.002	0.48	0.04	0.80	0.10	9.0	1159	--
427323bc	790427	-0.05	-0.005	-0.010	-0.05	0.03	0.03	--	--	0.17	874	155
	790516	-0.05	-0.005	0.000	-0.05	0.03	0.05	--	--	-0.10	958	215
	790724	--	--	--	-0.05	--	0.04	6.0	0.70	--	1086	205
427323bc	820718	--	--	--	--	--	0.08	--	--	--	--	--
427327ac	780825	-0.10	-0.005	-0.010	-0.05	-0.005	0.01	--	--	-0.10	695	345
	790427	--	--	--	--	--	0.59	--	--	--	687	170

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	NO3	Se	Ag	V	Zn	U	Ra226	Th230	SiO2	DSSOM	Eh
427327ac	790516	--	--	--	-0.05	--	0.70	--	--	--	698	275
	790725	--	--	--	-0.05	--	--	6.0	0.70	2.2	798	230
427327ad	827019	--	--	--	--	--	0.25	--	--	--	--	--
427331dc	761130	--	--	--	--	--	-0.002	--	--	12.0	395	--
427336bb	761130	--	-0.005	-0.002	-0.002	0.45	-0.002	0.20	0.00	14.0	562	--
427412db	761130	--	-0.005	0.004	-0.002	1.2	-0.002	1.2	0.30	8.0	2098	--
437230dc	761130	--	--	--	--	--	0.003	--	--	13.0	722	--
437236ac	761130	--	--	--	--	--	-0.002	--	--	8.0	2884	--
43731db	761103	--	-0.005	-0.002	-0.002	0.10	--	--	--	18.0	767	--
	820727	--	--	--	--	--	0.005	--	--	--	--	--
437310dc	761130	--	-0.005	-0.002	-0.002	0.90	0.006	0.30	0.10	16.0	657	--
437325bc	761130	--	-0.005	-0.002	-0.002	0.14	-0.002	0.20	0.30	8.0	261	--
437326bb	761130	--	-0.005	0.02	-0.002	0.29	-0.002	0.40	0.00	9.0	2218	--
437328ab	761104	--	-0.005	0.002	-0.002	0.11	--	0.50	0.00	10.0	1036	--
	761130	--	-0.005	0.002	-0.002	0.11	0.003	0.50	0.00	10.0	1036	--
437332ab	761104	--	-0.005	-0.004	-0.002	0.03	--	0.00	0.10	5.0	1865	--
	761130	--	-0.005	-0.004	-0.002	0.03	0.008	0.30	0.10	5.0	1865	--

TABLE 10.3-6. GROUND-WATER QUALITY DATA - REGIONAL WELLS(continued).

WELL*	DATE	NO3	Se	Ag	V	Zn	U	Ra226	Th230	SiO2	DSSUM	Eh
437424bb	761130	--	--	--	--	--	0.003	--	--	10.0	1238	--
437425da	761103	--	-0.002	-0.005	-0.002	0.14	0.002	--	--	10.0	381	--
	761130	--	-0.005	-0.002	-0.002	0.14	0.002	0.000	0.000	10.0	381	--
	780125	-0.10	-0.010	-0.010	-0.05	0.08	-0.001	--	--	--	354	--

NOTES:

"-" sign before a value indicates that the value is less than the detection limit. Value shown is lower detection limit.

HARD = Hardness, in mg/l of CaCO3.

ALK = Alkalinity, in mg/l of CaCO3.

DSSUM = Calculated sum of dissolved solids, in mg/l.

HARDT = Total Hardness, in mg/l.

ALKT = Total Alkalinity, in mg/l.

All values are in MG/L except as otherwise noted and the following:
TEMP = water temperature, in DEG C.
COND = conductivity, in micromhos/cm @ 25 DEG C.
Eh = Eh, in millivolts.
pH = pH, in standard units.
Ra226 = Radium-226, in pci/l.
Th230 = Thorium-230, in pci/l.

SOURCE: WOODWARD-CLYDE CONSULTANTS, 1976.

* Location - T_N, R_W, SECTION
descending quarter sections

b	a
c	d

ac = NE 160 acres
SW 40 acres

TABLE 10.3-7. SUMMARY OF LABORATORY AQUITARD PROPERTIES.

WELL	AQUITARD	DEPTH FT	VERTICAL PERMEABILITY MD	FT/DAY	CM/SEC
EFNI RN3910C	UPPER	221.0	5.01 @	1.6E-2	5.4E-6
	UPPER	221.9	0.18 **	5.4E-4	1.9E-7
	UPPER	222.0	9.50 @	2.9E-2	1.0E-5
	UPPER	223.0	9.55 @	2.9E-2	1.0E-5
	UPPER	223.3	1.44 @	4.4E-2	1.6E-6
	UPPER	223.8	0.28 **	8.5E-3	3.0E-6
	UPPER	225.0	9.87 @	3.0E-2	1.1E-5
	LOWER	394.5	0.95 @	2.9E-3	1.0E-6
	LOWER	396.3	1.44 *	4.4E-3	1.6E-6
	LOWER	398.5	0.69 @	2.1E-3	7.5E-7
	LOWER	400.0	1.12 @	3.4E-3	1.2E-6
	LOWER	402.5	0.19 @	5.8E-4	2.1E-7
	LOWER	404.5	0.16 @	4.9E-4	1.7E-7

* FRACTURED
** PERMEABILITY TO WATER @ 85 PSI
@ PERMEABILITY TO AIR

Revised 2/94

10.4 WATER RIGHTS

10.4.1 SURFACE WATER RIGHTS

A report from the Wyoming State Engineer's office indicates that there are no adjudicated or unadjudicated surface water rights within the permit amendment area, nor within one-half mile of the permit amendment boundary. Where ground water is transported to the surface for use in stock ponds and reservoirs, rights are granted under ground water appropriation permits (see Section 10.4.2 below).

10.4.2 GROUND WATER RIGHTS

10.4.2.1 ADJUDICATED WATER RIGHTS.

There are no adjudicated water rights within the permit amendment area, nor within one-half mile of the permit amendment area.

10.4.2.2 UNADJUDICATED WATER RIGHTS.

The following lists all unadjudicated water rights issued in the form of ground water appropriation permits by the Wyoming State Engineer's Office. Each entry below lists the permit number, the original applicant or owner and address, or subsequent owner if recorded with the State Engineer's Office, the type of well, well name and the general location of the well as taken from the Statement of Completion on file with the State. All permits on file have been listed and include active permits, abandoned permits and cancelled permits. Each permit is identified on a map entitled "Permitted Ground Water and Surface Water Map" (Figure 10.4-1). See the chart under 10.4.2.3 below for all completion and abandonment information available in the files of the Wyoming State Engineer's Office.

The list below is divided into two major sections: (i) wells within the permit amendment area, and (ii) wells within one-half (1/2) mile of the permit amendment boundary. Under each major section, wells are divided into two minor sections: (i) active or current permits; and (ii) cancelled or abandoned permits.

energy fuels nuclear inc.

RENO CREEK PROJECT

County: Campbell | State: Wyoming

Location: T 43 N, R 73 W

PERMITTED GROUNDWATER AND SURFACE WATER MAP

Scale 1"=2,000' | Date Aug. 1993

Draftsman: D.L. Sees

10-57

Figure 10.4-

10.4.2.2.1 ACTIVE PERMITS WITHIN PERMIT AMENDMENT AREA

Permit No./Owner of Record/Description	Land Description
Permit No. P61867W Union Pacific Minerals, Inc. PO Box 7 Ft Worth, Texas 76101-0007 Monitor Well: RI-21U	T43N, R73W Sec. 21: NE¼SE¼
Permit No. P52559W Rocky Mountain Energy Co. now known as Union Pacific Minerals, Inc. PO Box 7 Ft Worth, Texas 76101-0007 Monitor Well: RC BM 4 now RI-4	T43N, R73W Sec. 21: SW¼SE¼
Permit No. P61870W Union Pacific Minerals, Inc. (address given above) Monitor Well: RI-24U	T43N, R73W Sec. 21: SW¼SE¼
Permit No. P2880P Edward R. Willard 410 W 6th St Gillette, WY 82716 Stock Well: Willard #2	T43N, R73W Sec. 22: SE¼SW¼
Permit No. P52560W Rocky Mountain Energy Co. (address given above) Monitor Well: RC BM 5A now RI-5	T43N, R73W Sec. 27: SW¼NW¼
Permit No. P61868W Union Pacific Minerals, Inc. (address given above) Monitor Well: RI-22	T43N, R73W Sec. 27: SW¼NW¼
Permit No. P2883P Edward R. Willard (address given above) Stock Well: Willard #5	T43N, R73W Sec. 28: NW¼NE¼

Permit No.P90238W
Energy Fuels Nuclear, Inc.
1200 17 St Ste 2500
Denver CO 80202
Monitor Well: RI-43

T43N, R73W
Sec. 28: NW¼SW¼

Permit No. P92896W
Energy Fuels Nuclear, Inc.
(address given above)
Monitor Well: MP-8

T43N, R73W
Sec. 28: NW¼SW¼

Permit No. P61873W
Union Pacific Minerals Inc.
(address given above)
Monitor Well: RI-28

T43N, R73W
Sec. 29: NE¼SW¼

Permit No. P61874W
Union Pacific Minerals Inc.
(address given above)
Monitor Well: RI-30U

T43N, R73W
Sec. 29: NE¼SW¼

Permit No. P61877W
Union Pacific Minerals Inc.
(address given above)
Monitor Well: RI-34

T43N, R73W
Sec. 29: NE¼SW¼

Permit No. P61878W
Union Pacific Minerals Inc.
(address given above)
Monitor Well: RI-35L

T43N, R73W
Sec. 29: NE¼SW¼

Permit No. P92894W
Energy Fuels Nuclear, Inc.
(address given above)
Monitor Well: MP-1

T43N, R73W
Sec. 29: NE¼SW¼

Permit No. P92897W
Energy Fuels Nuclear, Inc.
(address given above)
Monitor Well: MU-1

T43N, R73W
Sec. 29: NE¼SW¼

Permit No. P52557W

Rocky Mountain Energy Co.	T43N, R73W
(address given above)	Sec. 29: NW¼SW¼
Monitor Well: RC BM 2 now RI-2	

Permit No. P52558W

Rocky Mountain Energy Co.	T43N, R73W
(address given above)	Sec. 29: SE¼NE¼
Monitor Well: RC BM 3 now RI-3	

Permit No. P61869W

Union Pacific Minerals Inc.	T43N, R73W
(address given above)	Sec. 29: SE¼NE¼
Monitor Well: RI-23U	

Permit No. P92895W

Energy Fuels Nuclear, Inc.	T43N, R73W
(address given above)	Sec. 29: SE¼NE¼
Monitor Well: MP-5	

Permit No. P61875W

Union Pacific Minerals Inc.	T43N, R73W
(address given above)	Sec. 29: SE¼SE¼
Monitor Well: RI-32U	

Permit No. P92898W

Energy Fuels Nuclear, Inc.	T43N, R73W
(address given above)	Sec. 29: SE¼NE¼
Monitor Well: MU-5	

Permit No. P52556W

Rocky Mountain Energy	T43N, R73W
(address given above)	Sec. 31: SW¼NE¼
Monitor Well: RC BM 1 now RI-1	

Permit No. P61871W

Union Pacific Minerals Inc.	T43N, R73W
(address given above)	Sec. 31: SW¼NE¼
Monitor Well: RI-25U	

Permit No. P61872W

Union Pacific Minerals Inc.	T43N, R73W
(address given above)	Sec. 31: SW¼NE¼
Monitor Well: RI-27L	

Permit No. P2881P
Edward R. Willard
(address given above)
Stock Well: Willard #3

T43N, R73W
Sec. 32: NW¼NE¼

Permit No. P18841P
Floyd C. Reno & Sons Inc.
Box S-600
Savageton Route
Gillette WY 82716
Stock Well: Tucker

T43N, R73W
Sec. 32: SW¼SW¼

Permit No. P52561W
Rocky Mountain Energy
(address given above)
Monitor Well: RC BM 6 now RI-6

T43N, R73W
Sec. 33: NE¼NE¼

Permit No. P61864W
Union Pacific Minerals Inc.
(address given above)
Monitor Well: RI-18

T43N, R73W
Sec. 33: NE¼NE¼

Permit No. P90237W
Energy Fuels Nuclear Inc.
(address given above)
Misc. Well: RI-42

T43N, R73W
Sec. 33: NE¼NE¼

Permit No. P61861W
Union Pacific Minerals Inc.
(address given above)
Monitor Well: RI-15U

T43N, R73W
Sec. 33: SE¼NE¼

Permit No. P61862W
Union Pacific Minerals Inc.
(address given above)
Monitor Well: RI-16

T43N, R73W
Sec. 33: SE¼NE¼

Permit No. P61863W
Union Pacific Minerals Inc.
(address given above)
Monitor Well: RI-17L

T43N, R73W
Sec. 33: SE¼NE¼

Permit No. P52563W

Rocky Mountain Energy Co.	T43N, R73W
(address given above)	Sec. 33: SW¼SW¼
Monitor Well: RC BM 8 now RI-8	

10.4.2.2.2 ABANDONED OR CANCELLED PERMITS WITHIN THE PERMIT AMENDMENT AREA

Permit No./Owner of Record/Description	Land Description
Permit No. P60142W (cancelled)	
Russell Forgey Construction Inc	T43N, R73W
PO Box 722	Sec. 21: NW¼SE¼
Casper, WY 82602	
Misc. Well: Forgey #4	
Permit No. P59471W (cancelled)	
Russell Forgey Construction Inc	T43N, R73W
(address given above)	Sec. 21: SE¼SW¼
Misc. Well: Forgey #2	
Permit No. P60143W (cancelled)	
Russell Forgey Construction Inc	T43N, R73W
(address given above)	Sec. 21: SE¼SW¼
Misc. Well: Forgey #3	
Permit No. P52549W (abandoned)	
Rocky Mountain Energy Co.	T43N, R73W
now known as Union	Sec. 22: SW¼SW¼
Pacific Minerals, Inc.	
(address given above)	
Industrial Well: ISL Pattern 2	
Permit No. P52550W (abandoned)	
Rocky Mountain Energy Co.	T43N, R73W
(address given above)	Sec. 22: SW¼SW¼
Misc. Monitor Well: ISL 2M-16	
Permit No. P52551W (abandoned)	
Rocky Mountain Energy Co.	T43N, R73W
(address given above)	Sec. 22: SW¼SW¼
Misc. Monitor Well: ISL 2M-17	

Permit No. P52552W (abandoned)
Rocky Mountain Energy Co.
(address given above)
Misc. Monitor Well: ISL 2M-18

T43N, R73W
Sec. 22: SW¼SW¼

Permit No. P52553W (abandoned)
Rocky Mountain Energy Co.
(address given above)
Misc. Monitor Well: ISL 2M-19

T43N, R73W
Sec. 22: SW¼SW¼

Permit No. P52554W (abandoned)
Rocky Mountain Energy Co.
(address given above)
Misc. Monitor Well: ISL 2 USM-20

T43N, R73W
Sec. 22: SW¼SW¼

Permit No. P52555W (abandoned)
Rocky Mountain Energy Co.
(address given above)
Misc. Monitor Well: ISL 2 LSM-21

T43N, R73W
Sec. 22: SW¼SW¼

Permit No. P45984W (cancelled)
Rocky Mountain Energy Co.
(address given above)
Misc. Well: Reno Ranch ISL P 1

T43N, R73W
Sec. 27: NW¼NW¼

Permit No. P45985W (abandoned)
Rocky Mountain Energy Co.
(address given above)
Monitor Well: Reno Ranch 1 SM 1

T43N, R73W
Sec. 27: NW¼NW¼

Permit No. P45986W (abandoned)
Rocky Mountain Energy Co.
(address given above)
Monitor Well: Reno Ranch 1 LM 1

T43N, R73W
Sec. 27: NW¼NW¼

Permit No. P45987W (abandoned)
Rocky Mountain Energy Co.
(address given above)
Monitor Well: Reno Ranch 1 M 4

T43N, R73W
Sec. 27: NW¼NW¼

Permit No. P45988W (abandoned)
Rocky Mountain Energy Co.
(address given above)
Monitor Well: Reno Ranch 1 M 3

T43N, R73W
Sec. 27: NW¼NW¼

Permit No. P45989W (abandoned) Rocky Mountain Energy Co. (address given above) Monitor Well: Reno Ranch 1 M 2	<u>T43N, R73W</u> Sec. 27: NW¼NW¼
Permit No. P45990W (abandoned) Rocky Mountain Energy Co. (address given above) Monitor Well: Reno Ranch 1 M 1	<u>T43N, R73W</u> Sec. 27: NW¼NW¼
Permit No. P25454W (abandoned) Harry R. and Harriet Underwood Meadowlark Farms Inc. 2705 Mont. Ave. Suite 350 Billings, MT 59103 Monitor Well: Underwood #1	<u>T43N, R73W</u> Sec. 33: NW¼NE¼
Permit No. P25457W (cancelled) Meadowlark Farms Inc. (address given above) Monitor Well: Underwood #4	<u>T43N, R73W</u> Sec. 34: NW¼SW¼

10.4.2.2.3 ACTIVE PERMITS WITHIN ONE-HALF MILE OF PERMIT AMENDMENT AREA BOUNDARY

Permit No./Owner of Record/Description	Land Description
Permit No. P52569W Rocky Mountain Energy Co. now known as Union Pacific Minerals, Inc. (address given above) Monitor Well: RC BM 14 now RI-14	<u>T42N, R73W</u> Sec. 3: SE¼NW¼
Permit No. P18851P Floyd C. Reno & Sons Box S-600 Savageton Route Gillette WY 82716 Stock Well: Hi Way	<u>T42N, T73W</u> Sec. 5: NE¼NW¼

Permit No. P33284W	
Harry B. Reno (deceased)	T42N, R73W
c/o Justin Joe Reno	Sec. 6: SE¼NW¼
Box 2529	
Gillette WY 82717	
Stock Well: O'Neil #1	
Permit No. P19245P	
August Laur	T42N, R74W
245 E Foote St	Sec. 1: NW¼NE¼
Buffalo WY 82834	
Stock Well: Laur #7	
Permit No. P61876W	
Union Pacific Minerals, Inc.	T43N, R73W
(address given above)	Sec. 20: SW¼SW¼
Monitor Well: RI-33U	
Permit No. P26955W	
August Laur	T43N, R73W
(address given above)	Sec. 30: NW¼SE¼
Stock Well: Laur #9	
Permit No. P52562W	
Union Pacific Minerals Inc.	T43N, R73W
(address given above)	Sec. 33: NE¼SE¼
Monitor Well: RC BM 7 now RI-7	
Permit No. P52568W	
Rocky Mountain Energy Co.	T43N, R73W
(address given above)	Sec. 33: NE¼SE¼
Monitor Well: RC BM 13 now RI-13	
Permit No. P19244P	
August Laur	T43N, R74W
(address given above)	Sec. 25: NE¼SE¼
Stock Well: Laur #6	

10.4.2.2.4 ABANDONED OR CANCELLED PERMITS WITHIN ONE-HALF MILE OF PERMIT AMENDMENT AREA BOUNDARY

Permit No./Owner of Record/Description	Land Description
Permit No. P59470W (cancelled) Russell Forgey Construction Inc PO Box 722 Casper, WY 82602 Misc. Well: Forgey #1 (not drilled under this permit)	T42N, R73W Sec. 6: NE¼NE¼
Permit No. P60967W (cancelled) Russell Forgey Construction Inc (address given above) Misc. Well: Forgey #1	T42N, R73W Sec. 6: NE¼NE¼
Permit No. P25458W (abandoned) Harry R. and Harriet Underwood and Meadowlark Farms Inc. 2705 Mont. Ave. Suite 350 Billings, MT 59103 Monitor Well: Underwood #5	T43N, R73W Sec. 33: SW¼SE¼
Permit No. P25455W (abandoned) Harry R. and Harriet Underwood Meadowlark Farms Inc. (address given above) Monitor Well: Underwood #2	T43N, R73W Sec. 34: NE¼NE¼
Permit No. P25456W (abandoned) Harry R. and Harriet Underwood Meadowlark Farms Inc. (address given above) Monitor Well: Underwood #3	T43N, R73W Sec. 34: SE¼SE¼

10.4.2.3 WELL COMPLETION INFORMATION

Permits are listed in numerical order

N or U = new or used
Y or N = yes or no
----- = not given (left blank on statement of completion)

Status:
- U = active or in use
- A = abandoned
- C = cancelled

Abandonment Information:
- UP = cemented from bottom of well to top of casing; after cement hardened, well casing was cut approximately 2 feet below ground surface; holes were capped and backfilled with excavated material to original ground surface and seeded.

Applicants or Owners:
- EFN = Energy Fuels Nuclear, Inc.
- Forgey = Russell Forgey Construction Co.
- Laur = August Laur
- Reno,F = Floyd J. Reno & Sons
- Reno,H = Harry B. Reno (deceased)
- RME = Rocky Mountain Energy Company (now known as Union Pacific Mineral, Inc.)
- Underwood = Harry and Harriet Underwood and Meadowlark Farms, Inc.
- UP = Union Pacific Minerals, Inc.
- Willard = Edward R. Willard (deceased)

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
02880	Willard No. 2	Willard No. 2	Willard	SESW S 22 43N 73W	Stock	230' 210'	-----	Y -----	Y -----	----- Cylinder Windmill 3 gals/min	N	-----	5150	U	n/a	no

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
02881	Willard No. 3	Willard No. 3	Willard	NWNE S 32 43N 73W	Stock	90' 65'	-----	Y -----	N -----	----- Cylinder Windmill 5 gals/min	N	-----	5240	U	n/a	no
02883	Willard No. 5	Willard No. 5	Willard	NWNE S 28 43N 73W	Stock	80' 60'	-----	Y -----	N -----	----- Cylinder Windmill 5 gals/min	N	-----	5170	U	n/a	no
18841	Tucker	Tucker	Reno,F	SWSW S 32 43N 73W	Stock	300' 100'	-----	N	N -----	----- ----- Windmill 5 gals/min	N	-----	-----	U	n/a	no
18851	Hi-way Well	Hi-way Well	Reno,F	NENW S 5 42N 73W	Stock	350' 110'	-----	Y -----	N -----	----- ----- Windmill 5-10 gals/min	N	-----	-----	U	n/a	no
19244	Laur #6	Laur #6	Laur	NESE S 25 43N 74W	Domes-tic & Stock	180' 30'	-----	N	N -----	----- ----- Windmill 2-1/2 gal/min	N	-----	-----	U	n/a	no
19245	Laur #7	Laur #7	Laur	NWNE S 1 42N 74W	Stock	120' 80'	-----	N	N -----	----- ----- Windmill -----	-----	-----	-----	U	n/a	no

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
25454	Under-wood #1	Under-wood #1	Under-wood	NWNE S 33 43N 73W	Misc	460' 280'	N	N	N N	----	N	460' "n/a" 4 3/4" 280' top to bottom ----	5290	A	no information in file except well plugged and abandoned plugged	no
25455	Under-wood #2	Under-wood #2	Under-wood	NENE S 34 43N 73W	Misc observe water table	240' "n/a"	N	N	N ----	----	N	240' "n/a" 5 1/8" "n/a" "n/a" to "n/a"	5160	A	no information in file except a letter says U-W-6 forms enclosed	no
25456	Under-wood #3	Under-wood #3	Under-wood	SESE S 34 43N 73W	Misc observe water table	180' "n/a"	N	N	N ----	----	N	180' "n/a" 4 3/4" "n/a" "n/a" to "n/a"	5140	A	no information in file except a letter says U-W-6 forms enclosed	no
25457	Under-wood #4	Under-wood #4	Under-wood	NWSW S 34 43N 73W	Misc observe water table	----	----	----	----	----	----	----	----	C	Not drilled	no

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
25458	Underwood #5	Underwood #5	Underwood	SWSE S 33 43N 73W	Misc observe water table	500' "n/a"	N	N	N ----	----	----	500' "n/a" 4-3/4" "n/a" "n/a" to "n/a"	5209	A	no information in file	no
26955	Laur #9	Laur #9	Laur	NWSE S 30 43N 73W	Stock	174' 75'	----	Y ----	Y Y	---- Cylinder Windmill 10 gals/min	N	----	----	U	n/a	no
33284	O'Neil #1	O'Neil #1	Reno,H	SENW S 6 42N 73W	Stock	254' 90'	N	N	N	---- ---- R.E.A. 1/3 HP 130' 5 gal/min	N	254' 257'(sic) 6-5/8" 90' ---- to ----	----	U	n/a	no
45984	Reno Ranch ISL P-1	P-1, I-1, I-2, I-3 and I-4	RME	NWNW S 27 43N 73W	Misc. 1 prod. well & 4 injec. wellsIls	413' 282'	N	N	N Y	Submersible Generator 7-1/2 HP 36 gal/min 360'	N	413' 413' 4" 165' 286-40' (sic)	5213	C	UP	yes, on fiche
45985	Reno Ranch 1 SM-1	LSM-1 then RI 1L	RME	NWNW S 27 43N 73W	Misc	215' 183'	Y ---- ---- 176'-215'	---- ----	---- ----	----	N	----	----	A	UP	yes, on fiche
45986	Reno Ranch 1 LM-1	USM-1 then RI 1U	RME	NWNW S 27 43N 73W	Misc	461' 296'	---- ---- ---- 415'-461'	---- ----	---- ----	----	N	----	----	A	UP	yes, on fiche
45987	Reno Ranch 1 M-4	M-4 then RI 4M	RME	NWNW S 27 43N 73W	Misc	383' 276'	Y ---- ---- 265-383'	---- ----	---- ----	----	N	N	----	A	UP	yes, on fiche

Permit No.	Original Well Name	Well Renamed or Current Nama	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
45988	Reno Ranch 1 M 3	M 3 then RI 3M	RME	NWNW S 27 43N 73W	Misc	407' 278.88'	Y ----- ----- 270-4C7'	-----	----- -----	"no more than 500 gals per observation"	-----	-----	-----	A	UP	yes, on fiche
45989	Reno Ranch 1 M 2	M 2 then RI 2M	RME	NWNW S 27 43N 73W	Misc	405' 272.65'	Y ----- ----- 249-405'	-----	----- -----	"no more than 500 gals per observation"	-----	-----	-----	A	UP	yes, on fiche
45990	Reno Ranch 1 M 1	M 1, then RI-1M	RME	NWNW S 27 43N 73W	Misc	386' 271.41'	Y ----- ----- 266-386'	-----	-----	"no more than 500 gals per observation"	-----	-----	-----	A	UP	yes, on fiche
52549	ISL Pattern 2 (P 10 P 11 I 12 I 13 I 14 I 15)	RI 10P RI 11P RI 12I RI 13I RI 14I RI 15I	RME	SWSW S 22 43N 73W	Indus-trial "In Situ Leach ing of Urani-um"g	420' 260'	N	N	----- Y -----	Grundfos Sumbersible Generator 7 1/2 HP 150' 40 gals/min gals/min	n/a	420' 400' 5" 244' 244-370'	5181.03	A	UP	
52550	ISL 2M-16	M 16 then RI 16M	RME	SWSW S 22 43N 73W	Misc Mon. Well	420' 260'	N	N	N -----	no pump installed	n/a	460' 420' 5" 259' 259-345'	5190.62	A	UP	
52551	ISL 2M-17	M 17 then RI 17M	RME	SWSW S 22 43N 73W	Misc Mon. Well	420' 260'	N	N	N -----	no pump installed	n/a	450' 420' 4.5" 266' 266-378'	5191.10	A	UP	

Permit No.	Original Well Name	Well Renamed or Current Namn	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r. Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
52552	ISL 2M 18	M 18 then RI 18M	RME	SWSW S 22 43N 73W	Misc Mon. Well	420' 260'	N	N	N -----	no pump installed	n/a	450' 420' 5" 251' 251-379'	5186.77	A	UP	
52553	ISL 2M 19	M 19 then RI 19M	RME	SWSW S 22 43N 73W	Misc Mon. Well	420' 260'	N	N	N -----	no pump installed	n/a	450' 450' ----- 256' 256-355'	5184.85	A	UP	
52554	ISL 2 USM 20	RI 20M	RME	SWSW S 22 43N 73W	Misc Mon. Well	190' 150'	N	N	N -----	no pump installed	n/a	190' 190' 5" 151' 151-190'	5183.3	A	UP	
52555	ISL 2 LSM 21	RI 21M	RME	SWSW S 22 43N 73W	Misc Mon. Well	440' 260'	N	N	N -----	no pump installed	n/a	----- 400' 5" 410' 410-440'	5181.0	A	UP	
52556	RC BM 1	RI-1	RME	SWNE S 31 43N 73W	Misc Base Mon. Well	320' 108'	Y ----- ----- 160-320'	N	N -----	no pump installed	n/a	320' 320' 5" 161' 161-315'	5076.30	U	n/a	yes, plus drilling data
52557	RC BM 2	RI-2	RME	NWSW S 29 43N 73W	Misc Base Mon. Well	380' 141'	Y ----- ----- 220-380'	N	N -----	no pump installed	n/a	380' 380' 5" 222' 222-369'	5115.60	U	n/a	yes, plus drilling data

Permit No.	Original Wall Nama	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
52558	RC BM 3	RI-3	RME	SENE S 29 43N 73W	Misc Base Mon. Well	400' 218'	Y ----- ----- 220-440'	N	N -----	no pump installed	n/a	415' 400' 5" 220' 220-393'	5165.30	U	n/a	yes, plus drilling data
52559	RC BM 4	RI-4	RME	SWSE S 21 43N 73W	Misc Base Mon.-Well	340' 195'	Y ----- ----- 220-340'	N	N -----	no pump installed	n/a	405' 340' 5" 212' 212-336'	5126.80	U	n/a	yes, plus drilling data
52560	RC BM 5A	RI-5	RME	SWNW S 27 43N 73W	Misc Base Mon. Well	410' 285'	Y ----- ----- 270-410'	N	N -----	no pump installed	n/a	455' 410' 5" 266' 266-380'	5217.70	U	n/a	yes, on fiche
52561	RC BM 6	RI-6	RME	NENE S 33 43N 73W	Misc Base Mon. Well	402.5' 325'	Y ----- ----- 280-400'	N	N -----	no pump installed	n/a	405' 400' ----- 296' 296-394	5267.6	U	n/a	yes, on fiche
52562	RC BM 7	RI-7	RME	NESE S 33 43N 73W	Misc Base Mon. Well	420' 260'	Y ----- ----- 190-330	N	N -----	no pump installed	n/a	420' 330' 5" 260' 260-338'	5212.70	U	n/a	yes, on fiche
52563	RC BM 8	RI-8	RME	SWSW S 33 43N 73W	Misc Base Mon. Well	430' 243'	Y ----- ----- 243-403'	N	N -----	no pump installed	n/a	430' 403' 5" 243' 243-395'	5235.0	U	n/a	no

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
52568	RC-BM 13	RI-13	RME	NESE S 33 43N 73W	Misc Base Mon. Well	306' 220'	Y ----- ----- 206-306'	N	N -----	no pump installed	n/a	306' 306' 5" 220' 218-317'	5214.5	U	n/a	yes, on fiche
52569	RC-BM 14	RI-14	RME	SENW S 3 42N 73W	Misc Base Mon. Well	260' 175'	Y ----- ----- 160-260'	N	N -----	no pump installed	n/a	260' 260' 5" 260' 152-245'	5144.62	U	n/a	yes, on fiche
59470	Forgey Number 1	Forgey Number 1	Forgey	NOT DRILLED										C	NOT DRILLED	
59471	Forgey Number 2	Forgey Number 2	Forgey	SESW S 2? 43N 73W	Misc Highway Const.	320' 220'	N	Y 3/8"	N N	Jaccuzzi Generator 7-1/2 HP 286' 33 gal/min	n/a	320' 320' 8" 220' 220-300'	-----	C	none in file	no
60142	Forgey Number 4	Forgey Number 4	Forgey	NWSE S 21 43N 73W	Misc Highway Const.	405' 220'	N	Y 3/8"	N N	Juccuzzi generator 10 HP 380' 90 gal/min	n/a	405' 380' 8" 220' 220-398'	-----	C	none in file	no
60143	Forgey Number 3	Forgey Number 3	Forgey	SESW S 21 43N 73W	Misc Highway Const.	320' 220'	N	Y 3/8"	N N	Jaccuzzi generator 7-1/2 HP 280' 33 gal/min	n/a	320' 320' 8" 220' 220-310	-----	C	none in file	no

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
60967	Forgey Number 1	replaced Forgey 1 not drilled	Forgey	NENE S 6 42N 73W	Misc High-way Const.	320' 220'	N	Y 3/8"	N N	Jaccuzzi generator 7-1/2 HP 300' 33 gal/min	n/a	320' 320' 8" 220' 220-310'	-----	C	none in file	no
61861	RI-15U	RI-15U	UP	SENE S 33 43N 73W	Misc Mon. Well	245' 188'	Y 4" ----- 205-235'	Y Coarse silica sand (4-8 mesh)	N Y 0-205'	n/a	n/a	245' 245' 5" 0-205' 4" 205-245' 188' 188-245+'	5268.35	U	n/a	no, but has drilling data
61862	RI-16	RI-16	UP	SENE S 33 43N 73W	Misc Mon. Well	405' 324'	Y 4" ----- 330-405'	Y Coarse silica sand (4-8 mesh)	Y Y 0-330'	n/a	n/a	405' 405' 5" 0-330' 4" 330-405' 188' 324-395'	5270.07	U	n/a	no, but has drilling data
61863	RI-17L	RI-17L	UP	SENE S 33 43N 73W	Misc Mon. Well	495' 326'	Y 4" ----- 414-495'	Y Coarse silica sand (4-8 mesh)	N Y 0-414'	n/a	n/a	495' 495' 5" 0-414' 4" 414-495' 188' 414-495+'	5268.64	U	n/a	no, but has drilling data
61864	RI-18	RI-18	UP	NENE S 33 43N 73W	Misc Mon. Well	370' 297'	Y 4" ----- 289-363'	Y Coarse silica sand (4-8 mesh)	N Y 0-289'	n/a	n/a	370' 363' 5" 0-289' 4" 289-363' 297' 297-361'	5238.79	U	n/a	

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
61867	RI-21U	RI-21U	UP	NESE S 21 43N 73W	Misc Mon Well	196' 116'	Y 2" 20 mill. 137-195'	Y Coarse silica sand (4-8 mesh)	N Y 0-137'	n/a	n/a	196' 195' 2" 135' 135-195 + '	5176.40	U	n/a	no, but has drilling data
61868	RI-22	RI-22	UP	SWNW S 27 43N 73W	Misc Mon. Well	380' 281'	Y 2" 20 mill. 300-380'	Y 1/4" pea gravel	N Y 0-200'	n/a	n/a	380' 380' 2" 281' 281-380 + '	5215.72	U	n/a	no, but has drilling data
61869	RI-23U	MU-5 (same hole renamed MU-5 under new permit 92898)	UP	SENE S 29 43N 73W	Misc Mon. Well	209' 141'	Y 2" ----- 129-208'	Y Coarse silica sand (4-8 mesh)	N Y 0-129'	n/a	n/a	209' 208' 2" 141' 141-209 + '	5169.7	U	n/a	no, but has drilling data
61870	RI-24U	RI-24U	UP	SWSE S 21 43N 73W	Misc Mon. Well	146' 92'	Y 5" ----- 120-140'	Y 1/4" pea gravel	N Y	n/a	n/a	146' 140' 5" 92' 92-146 + '	5125.4	U	n/a	no, but has drilling data
61871	RI-25U	RI-25U	UP	SWNE S 31 43N 73W	Misc Mon Well	166' 32'	Y 2" ----- 66-115'	Y Coarse silica sand (4-8 mesh)	N Y 0-66'	n/a	n/a	116' 115' 2" 32' 32-116 + '	5076.0	U	n/a	no, but has drilling data

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Wall Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
61872	RI 27L	RI 27L	UP	SWNE S 31 43N 73W	Misc Mon. Well	335' 108'	Y 2" ----- 335-355'	Y Coarse silica sand (4-8 mesh)	N Y 0-318'	n/a	n/a	355' 355' 2" 152' 326-355+'	5078.0	U	n/a	no, but has drilling data
61873	RI 28	RI 28	UP	NESW S 29 43N 73W	Misc Mon. Well	370' 146'	Y 4" ----- 218-370'	Y Coarse silica sand (4-8 mesh)	N Y 0-219'	n/a	n/a	370' 370' 5" 0-218' 4" 218-370' 77' 195-365'	5108.8	U	n/a	no, but has drilling data
61874	RI 30U	MU 1 (same hole re-named but under new permit 92897)m it	UP	NESW S 29 43N 73W	Misc Mon. Well	160' 77'	Y 5" ----- 79.2-158'	Y Coarse silica sand (4-8 mesh)	N Y 0-55'	n/a	n/a	160' 158' 5" 77' 77-160+'	5106.9	U	n/a	no, but has drilling data
61875	RI 32U	RI 32U	UP	SESE S 29 43N 73W	Misc Mon. Well	250' 177'	Y 2" ----- 182-250'	Y Coarse silica sand (4-8 mesh)	N Y 0-170'	n/a	n/a	252' 250' 2" 177' 177-252+'	5223.3	U	n/a	no, but has drilling data
61876	RI 33U	RI 33U	UP	SWSW S 20 43N 73W	Misc Mon. Well	133' 40'	Y 2" ----- 59-133'	Y Coarse silica sand (4-8 mesh)	N Y 0-48'	n/a	n/a	133' 133' 2" 40' 40-130'	5126.1	U	n/a	no, but has drilling data

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact's Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
61877	RI-34	RI-34	UP	NESW S 29 43N 73W	Misc Mon. Well	360' 138'	Y 4" ----- 192-360'	N	N Y 0-192'	n/a	n/a	360' 360' 5" 0-192' 4" 192-360' 77' 184-357'	5101.2	U	n/a	no, but has drilling data
61878	RI-35L	RI-35L	UP	NESW S 29 43N 73W	Misc Mon. Well	400' 143'	Y 4" ----- 371-397'	N	N Y 0-371'	n/a	n/a	400' 397' 5" 0-371' 4" 371-397' 77' 371-400+'	5098.7	U	n/a	no, but has drilling data
90237	RI-42	RI-42	EFN	NENE S 33 43N 73W	Misc Mon. Well	400' 296'	Y 3" 0.036 338-357.4	Y gravel 10/20	N -----	Grundfos Submersible generator 2 HP 328' "n/a" gal/min	n/a	400' 360.5' 5" rest left blank	5442.56	U	n/a	no
90238	RI-43	MP-8 (same hole, under new permit 92896)	EFN	NWSW S 28 43N 73W	Misc Mon. Well	460' 280'	Y 3" 0.036 406-425.4'	Y gravel 10/20	N -----	Grundfos Submersible generator 2 HP 328' "n/a" gal/min	n/a	460' 428.3' 5" rest left blank	5234.73	U	n/a	no
92894	MP-1	MP-1	EFN	NESW S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
92895	MP-5 (same hole as RI-3)	MP-5	EFN	SENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
92896	MP-8 (same hole as RI-43C)	MP-8	EFN	NWSW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		
92897	MU-1 (same hole as RI-30U)	MU-1	EFN	NESW S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
92898	MU-5 (same hole as RI-23U)	MU-5	EFN	SENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93094	MP-2	MP-2	EFN	SWNE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93095	MP-3	MP-3	EFN	SWNE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93095	MP-4	MP-4	EFN	SENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N *Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
93097	MP 6	MP 6	EFN	SENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93038	MP 7	MP 7	EFN	NESE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93099	MP 9	MP 9	EFN	NWSE S 29 43N 73W	Misc Pump Test & Mon. Well	Not Yet	completed							U		
93100	MU 2	MU 2	EFN	SWNE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93101	MU 3	MU 2	EFN	SWNE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93102	MU 4	MU 4	EFN	SENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		93103
MU 6	MU 6	EFN	SENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U			

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
93104	MU-7	MU-7	EFN	NESE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93105	MU-8	MU-8	EFN	NWSW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93106	M-1	M-1	EFN	NWSW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93107	M-2	M-2	EFN	NWSW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93108	M-3	M-3	EFN	NWSW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93109	M-4	M-4	EFN	SWSW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93110	M-5	M-5	EFN	SWSW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
93111	M-6	M-6	EFN	NESE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93112	M-7	M-7	EFN	NESE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
M-8	M-8	EFN	NESE S 29 43N 73W	Misc Mon. Well	Not Yet	complet ed							U			93113
93114	M-9	M-9	EFN	SWNE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93115	M-10	M-10	EFN	NWSE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93116	M-11	M-11	EFN	NWSE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93117	M-12	M-12	EFN	NWSE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93118	M-13	M-13	EFN	NESE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Ficha
93119	M-14	M-14	EFN	SESW S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93120	M-15	M-15	EFN	NESW S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93121	M-16	M-16	EFN	NESW S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93122	M-17	M-17	EFN	SENW S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93123	M-18	M-18	EFN	SENW S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93124	M-19	M-19	EFN	SWNE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93125	M-20	M-20	EFN	SWNE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93126	M-21	M-21	EFN	NWNE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
93127	M 22	M 22	EFN	SENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93128	M 23	M 23	EFN	NENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93129	M 24	M 24	EFN	NENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93130	M 25	M 25	EFN	NENE S 29 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93131	M 26	M 25	EFN	NWNW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93132	M 27	M 27	EFN	SWNW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		93133
93133	M 28	M 28	EFN	SWNW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		
93134	M 29	M 29	EFN	SWNW S 28 43N 73W	Misc Mon. Well	Not Yet	completed							U		

Permit No.	Original Well Name	Well Renamed or Current Name	Applicant or Owner	Location of Well Qrt Sec Section Twn/Rng	Type of Well	Total Well Depth Static Water Depth	Well Screen Y or N If yes, Diameter Slot size Set From/To	Gravel Packed Y or N If yes, size of gravel	Surface Casing Used Y or N Cemented in Place Y or N	Pump Info Manufact'r Type Source Power Horsepower Pump Depth Gals/Minute	Flowing Well Y or N	Log of Well Total Depth Comp. Depth Diameter First water Principal water top to bottom	Ground Elevation	Status A, C or U	Abandonment Information	Water Quality Data in File or on Fiche
93135	M-30	M-30	EFN	SWNW S 28 43N 73W	Misc. Mon. Well	Not Yet	completed							U		
93136	RI-44	RI-44	EFN	SESE S 20 43N 73W	Misc Water for monitor well drillingfling	Not Yet	completed							U		

Note: Permit Nos. 52549-52555 cover wells actually drilled in Section 22, T43N, R73W; however, typing errors on applications and statements of completion incorrectly list wells as being in the T42N. State records will be corrected upon verification of location of the wells by the State Engineer's Office.

10.4.3 POTENTIAL IMPACTS ON EXISTING WATER RIGHTS

Tributaries of the Belle Fourche, K-Bar Draw, and Spring Creek drainages are present in and near the site of the proposed plant and wellfield. Impact to these surface waters could occur if there was a release of high TDS fluids. Surface water will be monitored downstream of the permit area on these drainages. However, surface runoff is low in the permit area due to the low precipitation rate (mean annual = 12-15 inches) and high net evaporation rate (mean annual ≈ 42 inches). Sound operational and civil engineering practices will be utilized in handling process and waste fluids and controlling surface runoff. *Ponds will be lined, surrounded by embankments, and have a leak detection system.*

There are six active water wells within the permit area: Tucker, Willard #3, Willard #2 and #5, and two apparently unpermitted stock wells (windmills). There are an additional five such wells within 1/2 mile of the permit area: Laur #6, #7, #9, O'Neil #1, and Hi-Way. There are four other wells 1/2 to 3 miles east of the permit area that are completed in the Ore Sand. This is downgradient from the permit area. Area wells known to be completed in the Ore Sand are: Underwood #8, Cosner #1, McClure, Willard #2 and #4, Tucker, Hi-Way, O'Neil #1 and #4A, and Laur #7. These wells are listed in Table 10.3-2 and posted on Plate 10.2-1. The springs nearest the permit area are Baker Springs, 1.9 miles NW of the permit area and Hardwater Spring, 3.3 miles to the southeast. Relative to the Ore Sand piezometric surface, both springs are lateral to ground water flow and would not receive flow from the permit area. In addition, a review of Ore Sand heads versus spring elevations and an examination of aquitard facies between the Ore Sand and the surface on well logs indicates the springs to be hydrologically isolated from the Ore Sand.

Hydraulic heads in the Upper Aquifer are higher than in the Ore Sand in the permit area. Any flow or leakage would therefore be downward into the Ore Sand, *thus containing leaching fluids*. It is felt that the hydraulic containment of the project, both natural and induced by mining operations (see Section 10.5.1 'Zone of Control') and the proposed monitor ring will be adequate safeguards against excursions impacting ground water in the vicinity of the permit area. The primary impact to ground water at the site will be a drawdown of the water level in the Ore Sand during project operations. A quantitative evaluation of the drawdown can be found in Section 10.5 of this report. Following restoration of ground water quality and termination of operations, the ground water gradient and water levels are expected to return to their baseline conditions.

10.5 HYDROLOGIC MONITORING

Recommended Ore Sand monitor well spacing for the Reno Creek in-situ wellfield is presented in this section. It is recommended that horizontal excursion monitoring wells be located within the zone in the aquifer where the wellfield controls the ground water movement. The zone of control or gradient reversal is created by the bleed rate from the wellfield. The procedure presented in Hydro-Engineering (1989) predicting the drawdowns from the bleed rate, with an adjustment for the natural ground water gradient to determine if the wellfield controls the flow, was used. The wellfield controls the flow within the zone of ground water reversal.

The Ore Sand aquifer is confined in Mining Unit No. 1. The piezometric surface is 19' above the top of the Upper Ore Sand and 117' above the top of the Lower Ore Sand in this area. The Lower Ore Sand will be mined in Mining Unit No. 1. The injection/ recovery well profile (Figure 10.5-4) demonstrates a maximum drawdown of 17' at the recovery well. Therefore, the aquifer will always be in confined conditions in this area.

10.5.1 ZONE OF CONTROL FOR MINING UNIT 1

The placement of monitoring wells in the Ore Sand aquifer needs to be within the zone where the ground water flow is controlled by the operation of the mining unit. The bleed from the mining unit creates a zone around the mine where the head is lower than outside this zone. This reversal zone causes ground water in this area to flow to the mining unit and is called the "zone of control". The zone of control is the area of ground water reversal in the downgradient and two side gradient sides of the wellfield and also includes the upgradient side. The ground water flow direction at Reno Creek in Mining Unit 1 is N67°E. Therefore, at this site, the upgradient side is the southwest while the downgradient side is to the east and northeast. The bleed rate will only increase the gradient in the upgradient side toward the wellfield. Therefore, the flow in this side of the wellfield is controlled by the wellfield but also has the aid of the natural gradient. Hydro-Engineering (1989) presents a cross-section of the hydraulic gradient adjacent to a wellfield. The zone of reversal is shown downgradient of the wellfield where the ground water is flowing back to the wellfield. Beyond the zone of reversal, the ground water flow continued downgradient. The two side gradient areas are also within the reversal zone because flow prior to the bleed flows parallel to the wellfield. The ground water flow upgradient of the wellfield is still toward the wellfield during operation, but the gradient has increased. The zone of control includes the three reversal sides and the upgradient side.

Drawdowns at distances from the mining unit are first estimated by summing the individual drawdowns from 29 bleed rate locations. The drawdowns are adjusted for the natural ground water gradient to estimate the changes in the piezometric surface with distance from Mining Unit 1.

10.5.1.1 DRAWDOWN ESTIMATES

The appropriate ground water flow model for the Reno site is the Theis (1935), non-leaky confined aquifer model. The use of a partially penetrating well model is not necessary due to the length of time and relatively large distances where the drawdowns are needed. The following procedures are the same as those outlined in Hydro-Engineering (1989).

The WELFLO program presented in Walton (1989) was used to compute drawdowns from the Theis equation. The program has the advantage that it computes drawdowns along grid lines and therefore several lines of drawdowns are developed with one execution.

10.5.1.2 WELLFIELD SIMULATION

The total production from the recovery wells is slightly higher than the total injection rate. This difference is called the bleed rate and is planned to be between one and three percent of the total recovery rate for the Reno site. The bleed rate, not the recovery and injection rates, becomes the important rate with time. The zone of reversal was simulated with only the bleed rate for Mining Unit 1. Figure 10.5-1 shows the outer limits (dashed line) of a wellfield that is being simulated by 29 bleed points that are distributed over the Mine Unit to simulate the areal distribution. Each bleed point is simulating the bleed rate of several five spot patterns. Bleed points are shown on Figure 10.5-1 as a dot. The average total bleed rate of one percent for the 29 locations is 0.69 gpm for each point for a total recovery rate for this Mining Unit of 2000 gpm. The total bleed rate of 20 gpm for this simulation is applied uniformly over the wellfield area but could be applied unevenly if the wellfield was planned to operated with a non-uniform bleed.

The drawdown calculations for the example consist of 29 pumping (bleed) sites with drawdowns simulated over a 31 by 26 grid. Table 10.5-1 presents the list of input parameters that are initially listed with the output from the WELFLO program. The output listing does not list the first three inputs: enter 1 for printer, enter 1 for non-leaky condition, and enter 1 for fully penetrating wells. Table 10.5-1 presents the remainder of the input data. Table 10.5-2 presents the listing of the simulated drawdowns from the program output for the one percent bleed rate. The wellfield bleed locations are presented in Table 10.5-1 for each of the 29 stresses. The drawdowns east of the center of the wellfield are presented in the number 16 J row from 19 through 24 I columns. Figure 10.5-1 shows the grid used to calculate the drawdown adjacent to the Reno Mining Unit 1.

Average aquifer properties (transmissivity and storage coefficient) for the Reno pump tests in this area were used. Properties that are thought best representative of the area along the line of drawdowns used for the reversal determination should be used. *The simulation is for an area within the permit area where aquifer transmissivities are in the intermediate range.* A transmissivity of 1600 gal/day/ft and a storage coefficient of 0.00013 are thought to best represent the Ore Sand aquifer in this area. *The storage coefficient was obtained from observation well RI-34 (RME test-Figure 10A-18) and is a typical value for the Powder River Basin.*

10.5.1.3 GRADIENT REVERSAL

The pre-mine hydraulic gradient in the Ore Sand aquifer is integrated with the drawdown calculation to determine the zone in which the bleed has caused the gradient to be toward the wellfield. This zone is where the gradient has been reversed on the down-gradient sides of the wellfield. Monitoring in the

Ore Sand aquifer is recommended within the zone of control where the bleed controls the flow in the aquifer. The zone of control includes the upgradient side of the wellfield because the ground water flow in this area moves to the wellfield.

A pre-mine gradient of 0.0045 ft/ft means that more than 0.45 feet of additional drawdown is needed in the next closest drawdown node (100 foot spacing) for reversal to exist along drawdown lines that are downgradient and parallel to the ground water flow direction. The east side of the Reno wellfield is 23 degrees off of the ground water flow direction. Therefore, the drawdown difference required for a reversal off the east side of the wellfield is at least 0.41 feet (Cos 23° x 0.45). The angle between the lines of drawdowns on the north side of the wellfield and the flow direction is 67 degrees. The drawdown change required for a reversal in this direction is, therefore, anything above 0.18 feet (0.45 x Cos 67°). A gradient reversal was also evaluated to the northeast between nodes (18,9: 19,8: 20,7: 21,6). These nodes are 141 feet apart due to being offset by 100 feet in both directions. The change in gradient over 141 feet is 0.63 feet. The gradient is 22 degrees off of this N 45° E line and therefore, a change of 0.58 feet between nodes is needed for reversal along this line.

Table 10.5-2 presents the drawdown results for the one percent bleed. Reversal is only established on the northern one of these three lines. Table 10.5-3 gives the drawdown for the two percent bleed simulation while Figure 10.5-2 presents the drawdown changes along these three lines. This shows that reversal extends out to column 24 along row 16 and beyond row 1 along column 15. It also extends to node (20,7) to the northeast which is approximately 600 feet from the wellfield.

Table 10.5-4 presents the drawdowns for the three percent bleed simulation. As expected, reversals extend further for the three percent bleed.

10.5.2 RECOMMENDED SPACING OF MONITORING RING

Horizontal excursion monitoring wells are recommended to be placed within the area where the wellfield controls the ground water flow (zone of control). The spacing of the monitoring wells for the Reno Mining Unit #1 wellfield could be 600 feet in all directions of the wellfield and still be within the zone of control for the 2% bleed. A recommended spacing of 400 feet on all sides places the monitoring wells significantly inside the reversal zone. The spacing is close enough for early detection of excursions but well within the zone of control. A more detailed definition of aquifer properties in this area may show that a smaller bleed rate will be adequate for this Mining Unit if they are significantly different than those presently used.

The zone of reversal shows that horizontal containment is going to be much easier on the northwest side than the east, north, and northeast sides. Containment will also be even easier on the southwest side (upgradient) due to the aid of the natural gradient. Recommendations for spacing between monitoring wells are based on the areas most likely to have an excursion. Figure 10.5-3 shows the recommended spacing and the limits of the spacing on each side of the wellfield depending on the flow direction. A spacing between monitoring wells of 400 feet is recommended on the down-gradient side of the wellfield. Spacing on the side gradient sides of the wellfield, which has an angle of zero degrees, is recommended to be 600 feet. This spacing was selected as if this side gradient is slightly downgradient. Spacing between monitoring wells on the upgradient side of the wellfield is recommended to be 800 feet. This recommended spacing between monitoring wells is based on the fact that the upgradient side of the wellfield is much less likely to have an excursion as can be seen by the simulation of gradients.

10.5.3 EXCURSION RETRIEVAL

The 2% bleed wellfield simulated in section 10.5.1 was re-simulated at an increased bleed rate of 60 gpm (3%). The additional one percent increase in the bleed rate was simulated to occur in the five northeast nodes. Wells 22, 23, 24, 25, and 26 in Table 10.5-1 were the five bleed rates to be increased to 5.38 gpm for this simulation. Table 10.5-5 presents the drawdowns predicted from this simulation. A correction of 0.58 foot per 141 feet for the gradient is needed to obtain the change in head to the northeast. Therefore, the predicted gradients toward the wellfield after 60 days of increased rate is 0.0053 ft/ft for the 3% bleed rate. The average ground water movement rate back to the wellfield is estimated to be 0.106 ft/day. This movement rate will require a travel time of 94 days for the water to move ten feet back to the wellfield. The excursion is "controlled" at the beginning of the period because contaminated water is moving back toward the wellfield. The well on excursion status will most likely be off excursion prior to the end of the above stated period due to the hydrochemical nature of an excursion.

10.5.4 PERMIT MONITORING

Table 10.5-6 presents a list of proposed wells and two surface water sites for monitoring the hydrologic conditions in the area of the Reno Creek permit. A list of Ore Sand and Upper Aquifer wells are proposed to be monitored on a semi-annual basis for water level, pH, conductivity, and temperature. All major constituents, radium, iron, manganese, selenium, and uranium are also proposed to be monitored for these wells. Each of the sites would be monitored for at least four Guideline 8 analyses before going to this list. A second group of wells are proposed to be monitored only for water levels on an annual basis. Two surface water sites are proposed to monitor the surface water quality at the Reno Creek site. SW-2, which was sampled a few times, is downstream of the K-Bar drainage on the Belle Fourche River and is proposed to sample the downstream area. A new surface water site, SW-4, is proposed to be added downstream of Spring Creek. Plate 10.5-1 presents the hydrologic monitoring sites for the permit area wells and surface water sites. SW-2 is north of this map and is shown on Plate 10.2-2.

10.5.5 PREDICTED HEADS BETWEEN INJECTION AND RECOVERY WELLS

A 4 x 4 pattern was used to simulate the cumulative effects of water level changes between an injection and a recovery well. A four pattern wide area was used to simulate a typical width of a wellfield at Reno Creek. The simulation included the use of a row of five injection wells *and a column of five injection wells*. The square of 5 x 5 injection wells covers an area of 280'. All injection wells inside this square were also used in the simulation for a typical five spot pattern with 70' between the injectors and 70' between the recovery wells. All recovery wells inside the 280' square pattern of injectors were also used for additional recovery wells, one on each side of the square was used to make the number of recovery wells *20* with the 25 injectors. A recovery rate of 20 GPM was used for each of the 20 recovery wells. A 2% bleed rate, or 8 GPM, less total injection rate for an average injection rate of 15.68 GPM was used for the 25 injection wells.

WALTON (1989) WELFLO program was used to simulate the drawdowns for this wellfield. Table 10.5-7 presents the input parameters for the 5 x 5 injector pattern. Average aquifer properties of 1600 gal/day/ft and a storage coefficient of 0.00013 were used in the simulation. An operation period of 100 days was used to obtain heads that will become fairly static between the injector and recovery wells. The 25 injector wells are initially listed in the input table and followed by the input parameters for the 20 recovery wells. A grid location centered on the middle injector well as a grid of 0,0 was used in locating the recovery and injection wells. A pattern of drawdown was developed starting at the upper-left-most injector well at node 1,1 and developing drawdowns at each location, spaced five feet in both directions from this well. A 57 x 57 grid with five foot spacing was used to cover the 280' square well pattern. Therefore, injector nodes 1,1; 1,57; 57,1; and 57,57 are the four corner injector values for the predicted drawdowns. Table 10.5-8 presents the output of these drawdowns and shows that the maximum water level rises are adjacent to the corner injectors furthest from the four additional outside recovery wells. The nearest recovery well to the injector located at node 1,1 is located close to node 8,8. A profile of the water levels between this injector well and recovery well was developed and is presented in Figure 10.5-4. This water-level change profile shows that the head close to this injector well is approximately 6' with approximately 17' of water level drop close to the nearest recovery well. These head conditions between each injection and an adjacent recovery well will vary some but this figure shows the worst conditions for this well pattern.

The water-level changes in the Ore Sand aquifer adjacent to injection wells will only be a few feet above the static condition due to the overall drawdown in the vicinity. Water levels between the Upper Aquifer and the Ore Sand in the first mining area vary from 60' to 80' head difference with the larger head being in the Upper Aquifer. Therefore, the head conditions developed in the Ore Sand will not be large enough for flow to migrate from the Ore Sand into the Upper Aquifer. The only potential for solution movement into the Upper Aquifer will be through a cracked casing where the head inside the injection well is larger than the head in the Upper Aquifer.

THIS PAGE INTENTIONALLY LEFT BLANK

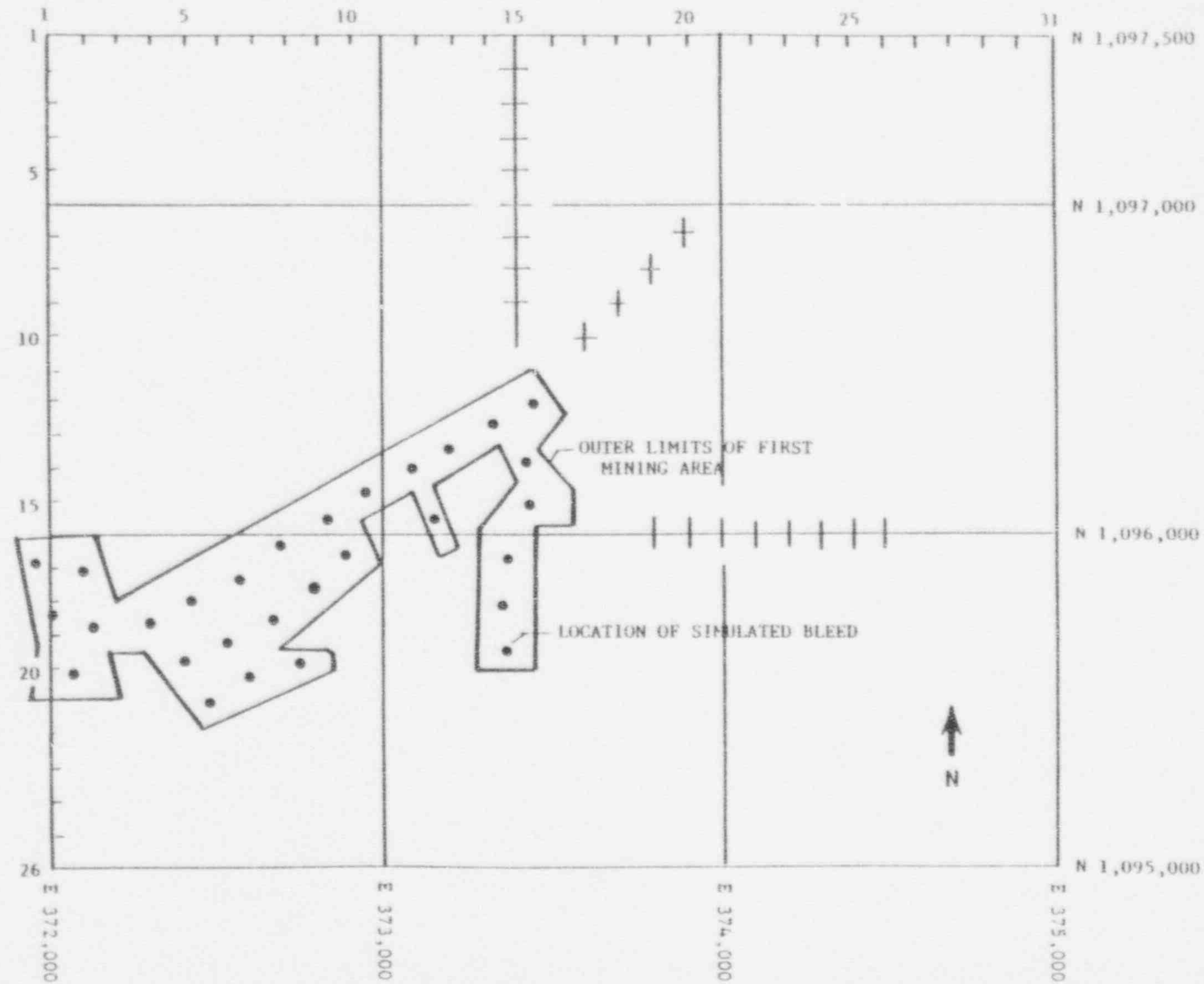


FIGURE 10.5-1. LOCATION OF WELL FIELD AND SIMULATED DRAWDOWN GRID.

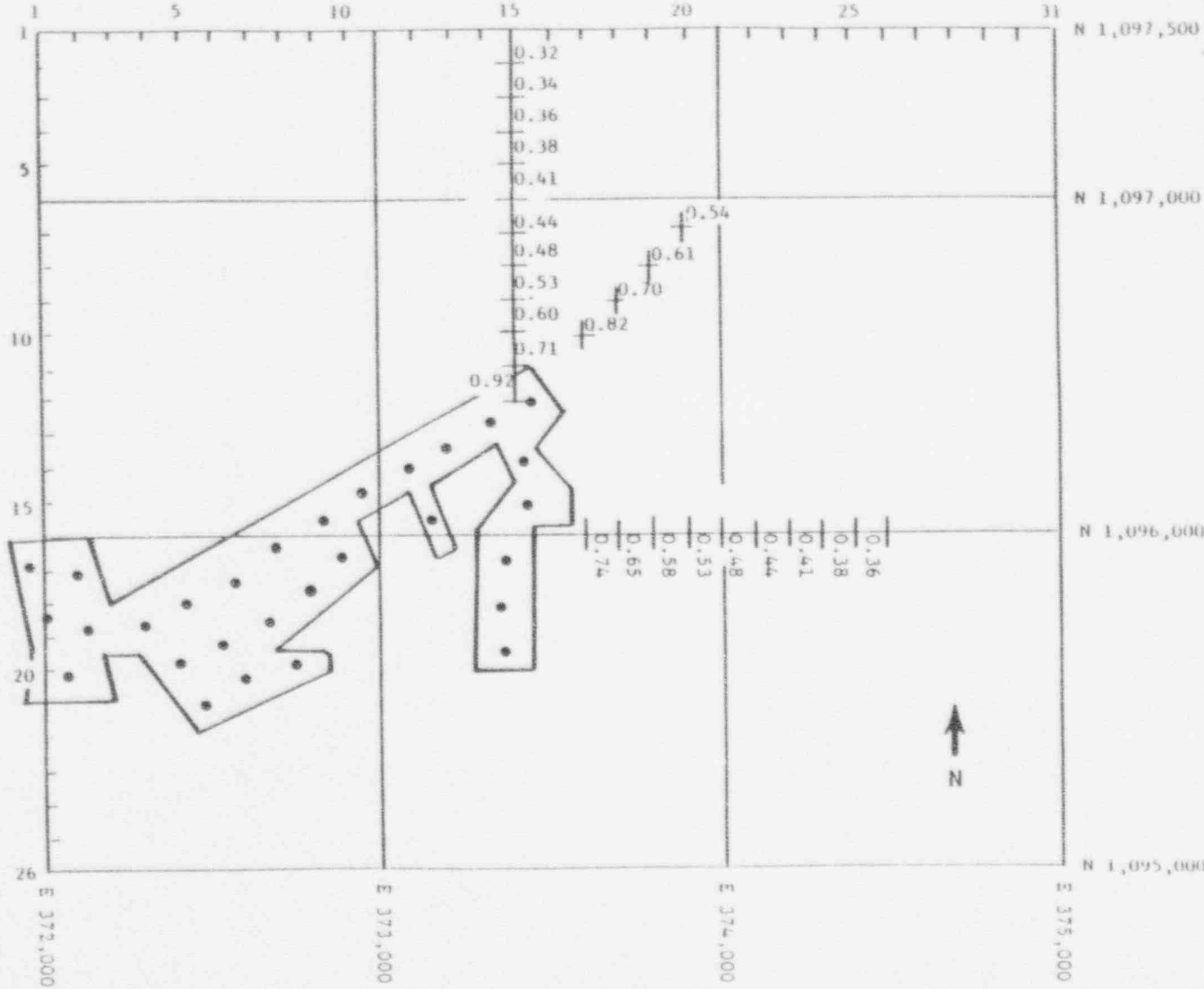


FIGURE 10.5-2. DRAWDOWN CHANGES ADJACENT TO MINING UNIT #1.

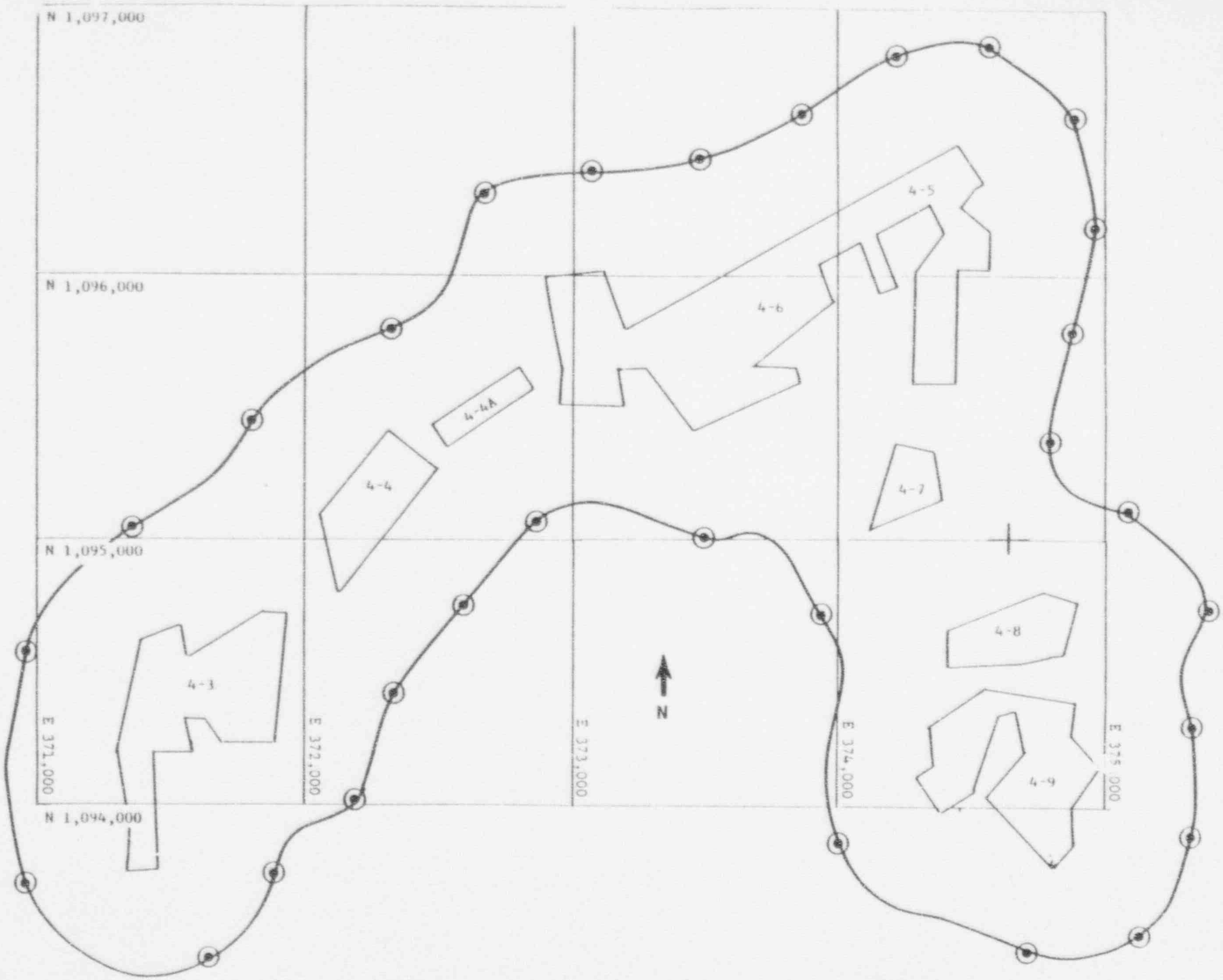


FIGURE 10.5-3. RECOMMENDED SPACING B' EEN MONITORING WELLS FOR MINING UNIT #1.

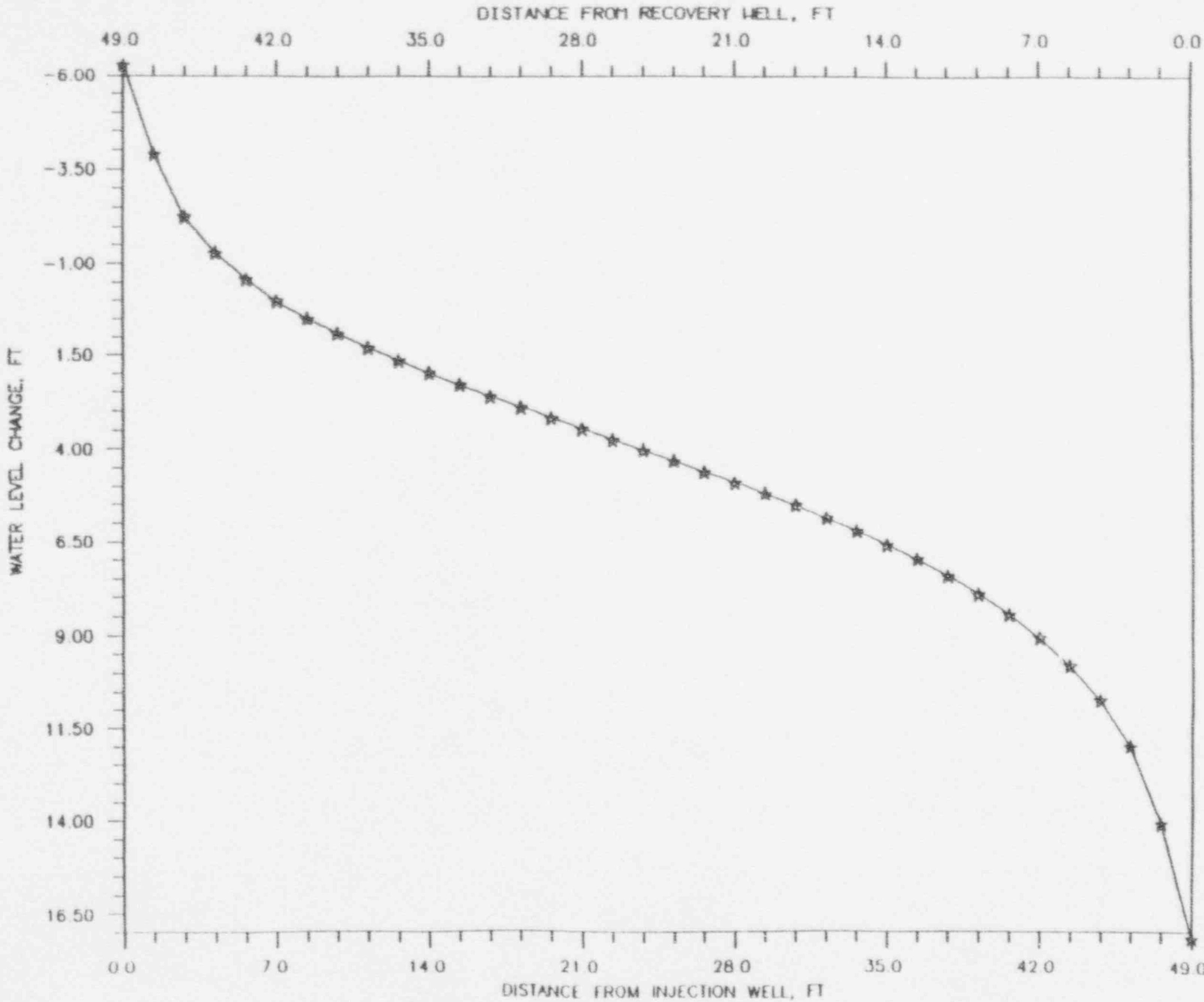


FIGURE 10.5-4. WATER LEVEL CHANGE ALONG A LINE BETWEEN INJECTION AND RECOVERY WELL.

TABLE 10.5-1. INPUT PARAMETERS FOR THE RENO MINING UNIT #1 SIMULATION.

RENO CREEK MINE UNIT ONE SIMS. T=1600 AND S=0.00013 365 days QBLEED=20GPM

GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days= 365.000
Number of grid columns= 31
Number of grid rows= 26
Grid spacing in ft= 100.00
X-coordinate of upper-left grid node in ft= 0.00
Y-coordinate of upper-left grid node in ft= 0.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29
Well number= 1
X-coordinate of well in ft= -50.00
Y-coordinate of well in ft= 1580.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29
Well number= 2
X-coordinate of well in ft= 0.00
Y-coordinate of well in ft= 1740.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29
Well number= 3
X-coordinate of well in ft= 50.00
Y-coordinate of well in ft= 1810.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29
Well number= 4
X-coordinate of well in ft= 90.00
Y-coordinate of well in ft= 1610.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000

TABLE 10.5-1. INPUT PARAMETERS FOR THE RENO MINING UNIT #1 SIMULATION (continued).

Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 5
X-coordinate of well in ft: 110.00
Y-coordinate of well in ft: 1780.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 6
X-coordinate of well in ft: 280.00
Y-coordinate of well in ft: 1760.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 7
X-coordinate of well in ft: 400.00
Y-coordinate of well in ft: 1700.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 8
X-coordinate of well in ft: 380.00
Y-coordinate of well in ft: 1880.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 9
X-coordinate of well in ft: 460.00
Y-coordinate of well in ft: 2000.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1

TABLE 10.5-1. INPUT PARAMETERS FOR THE RENO MINING UNIT #1 SIMULATION (continued).

Number of production, injection, and image wells
active during simulation period= 29
Well number= 10
X-coordinate of well in ft= 550.00
Y-coordinate of well in ft= 1640.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29
Well number= 11
X-coordinate of well in ft= 520.00
Y-coordinate of well in ft= 1820.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29
Well number= 12
X-coordinate of well in ft= 580.00
Y-coordinate of well in ft= 1910.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29
Well number= 13
X-coordinate of well in ft= 650.00
Y-coordinate of well in ft= 1740.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29
Well number= 14
X-coordinate of well in ft= 680.00
Y-coordinate of well in ft= 1700.00
Well discharge in gpm= 0.69
Duration of pump operation during simulation period
in days= 365.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 29

TABLE 10.5-1. INPUT PARAMETERS FOR THE RENO MINING UNIT #1 SIMULATION (continued).

Well number: 15
X-coordinate of well in ft: 730.00
Y-coordinate of well in ft: 1880.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 16
X-coordinate of well in ft: 760.00
Y-coordinate of well in ft: 1660.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 17
X-coordinate of well in ft: 810.00
Y-coordinate of well in ft: 1460.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 18
X-coordinate of well in ft: 870.00
Y-coordinate of well in ft: 1570.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 19
X-coordinate of well in ft: 940.00
Y-coordinate of well in ft: 1370.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 20
X-coordinate of well in ft: 1070.00

TABLE 10.5-1. INPUT PARAMETERS FOR THE RENO MINING UNIT #1 SIMULATION (continued).

Y-coordinate of well in ft: 1300.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 21
X-coordinate of well in ft: 1140.00
Y-coordinate of well in ft: 1450.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 22
X-coordinate of well in ft: 1180.00
Y-coordinate of well in ft: 1250.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 23
X-coordinate of well in ft: 1320.00
Y-coordinate of well in ft: 1160.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 24
X-coordinate of well in ft: 1430.00
Y-coordinate of well in ft: 1110.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 25
X-coordinate of well in ft: 1410.00
Y-coordinate of well in ft: 1280.00
Well discharge in gpm: 0.69

TABLE 10.5-1. INPUT PARAMETERS FOR THE RENO MINING UNIT #1 SIMULATION (continued).

Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 26
X-coordinate of well in ft: 1420.00
Y-coordinate of well in ft: 1420.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 27
X-coordinate of well in ft: 1360.00
Y-coordinate of well in ft: 1560.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 28
X-coordinate of well in ft: 1350.00
Y-coordinate of well in ft: 1710.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 29
Well number: 29
X-coordinate of well in ft: 1350.00
Y-coordinate of well in ft: 1850.00
Well discharge in gpm: 0.69
Duration of pump operation during simulation period
in days: 365.000
Well radius in ft: 0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft: 1600.00
Aquifer storativity as a decimal: 0.000130

TABLE 10.5-2. DRAWDOWN RESULTS FOR 1% BLEED RATE.

RENO CREEK MINE UNIT ONE SIMS. T=1600 AND S=0.00013 365 days QBLEED=20GPM

GENERAL DATA BASE:

Simulation period number= 1
Aquifer transmissivity in gpd/ft= 1600.00
Aquifer storativity as a decimal= 0.000130

NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS: 365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW	I-COLUMN																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	8.58	8.64	8.70	8.74	8.78	8.82	8.84	8.86	8.87	8.87	8.86	8.84	8.82	8.78	8.74	8.68	8.62	8.56
2	8.72	8.79	8.85	8.90	8.94	8.98	9.01	9.03	9.04	9.04	9.03	9.02	8.99	8.95	8.90	8.84	8.77	8.70
3	8.87	8.94	9.00	9.06	9.11	9.15	9.19	9.21	9.22	9.23	9.22	9.20	9.16	9.12	9.07	9.00	8.93	8.85
4	9.02	9.09	9.17	9.23	9.29	9.33	9.37	9.40	9.41	9.42	9.41	9.39	9.35	9.31	9.25	9.17	9.09	9.00
5	9.17	9.26	9.34	9.41	9.47	9.52	9.57	9.60	9.62	9.62	9.62	9.59	9.56	9.50	9.44	9.36	9.26	9.16
6	9.33	9.43	9.51	9.59	9.66	9.73	9.77	9.81	9.84	9.84	9.84	9.82	9.77	9.72	9.64	9.55	9.44	9.33
7	9.50	9.60	9.70	9.79	9.87	9.94	9.99	10.04	10.07	10.08	10.08	10.05	10.01	9.95	9.86	9.76	9.64	9.50
8	9.67	9.79	9.90	9.99	10.08	10.16	10.23	10.28	10.31	10.33	10.33	10.31	10.27	10.20	10.10	9.98	9.84	9.69
9	9.85	9.98	10.10	10.21	10.31	10.40	10.47	10.53	10.58	10.61	10.61	10.60	10.55	10.48	10.37	10.22	10.05	9.87
10	10.04	10.18	10.31	10.43	10.55	10.65	10.73	10.80	10.86	10.90	10.92	10.91	10.87	10.79	10.66	10.49	10.28	10.07
11	10.23	10.39	10.54	10.67	10.79	10.91	11.01	11.09	11.16	11.21	11.24	11.25	11.22	11.15	11.02	10.79	10.52	10.25
12	10.44	10.61	10.77	10.92	11.06	11.18	11.29	11.39	11.48	11.55	11.60	11.62	11.61	11.58	11.48	11.11	10.74	10.42
13	10.65	10.84	11.02	11.18	11.33	11.47	11.59	11.71	11.82	11.91	11.98	12.03	12.02	11.93	11.70	11.31	10.91	10.56
14	10.88	11.09	11.28	11.45	11.61	11.76	11.90	12.04	12.17	12.29	12.36	12.42	12.26	12.05	11.93	11.46	11.03	10.66
15	11.13	11.36	11.55	11.73	11.91	12.07	12.22	12.37	12.54	12.61	12.56	12.50	12.33	12.12	11.98	11.53	11.09	10.71
16	11.42	11.66	11.84	12.02	12.21	12.39	12.54	12.67	12.82	12.74	12.58	12.48	12.32	12.14	11.92	11.50	11.09	10.72
17	11.72	12.10	12.12	12.31	12.52	12.74	12.89	12.94	12.93	12.79	12.52	12.35	12.20	12.00	11.85	11.43	11.04	10.69
18	11.86	12.14	12.31	12.55	13.22	12.94	13.11	13.22	12.90	12.61	12.38	12.19	12.06	11.98	11.73	11.32	10.95	10.62
19	11.81	12.23	12.30	12.58	12.78	13.01	13.03	12.95	12.68	12.41	12.18	12.00	11.86	11.77	11.54	11.16	10.83	10.52
20	11.47	11.80	12.04	12.32	12.65	12.75	12.85	12.69	12.42	12.15	11.94	11.76	11.62	11.51	11.29	10.97	10.67	10.40
21	11.17	11.45	11.70	11.95	12.22	12.38	12.31	12.20	12.03	11.84	11.66	11.50	11.35	11.19	10.99	10.75	10.50	10.26
22	10.90	11.14	11.36	11.57	11.75	11.85	11.84	11.77	11.65	11.52	11.37	11.22	11.07	10.91	10.73	10.53	10.32	10.11
23	10.64	10.85	11.04	11.20	11.33	11.41	11.42	11.38	11.30	11.20	11.08	10.95	10.81	10.66	10.50	10.32	10.14	9.95
24	10.40	10.58	10.73	10.87	10.97	11.03	11.05	11.03	10.98	10.90	10.80	10.69	10.56	10.43	10.28	10.12	9.96	9.79
25	10.17	10.32	10.45	10.57	10.65	10.70	10.72	10.71	10.67	10.61	10.53	10.43	10.32	10.20	10.07	9.93	9.79	9.63
26	9.95	10.08	10.19	10.29	10.36	10.41	10.43	10.42	10.39	10.34	10.28	10.19	10.10	9.99	9.87	9.75	9.62	9.48

J-ROW	I-COLUMN																	
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	8.48	8.41	8.33	8.24	8.16	8.07	7.98	7.89	7.80	7.72	7.63	7.54	7.45					
2	8.62	8.53	8.45	8.36	8.26	8.17	8.07	7.98	7.88	7.79	7.70	7.61	7.52					
3	8.76	8.67	8.57	8.47	8.37	8.27	8.17	8.06	7.96	7.87	7.77	7.67	7.58					
4	8.90	8.80	8.69	8.59	8.48	8.37	8.26	8.15	8.04	7.94	7.84	7.74	7.64					
5	9.05	8.94	8.82	8.70	8.58	8.47	8.35	8.23	8.12	8.01	7.90	7.80	7.69					
6	9.21	9.08	8.95	8.82	8.69	8.56	8.44	8.32	8.20	8.08	7.97	7.86	7.75					
7	9.37	9.22	9.08	8.94	8.80	8.66	8.52	8.39	8.27	8.14	8.03	7.91	7.80					
8	9.53	9.37	9.21	9.05	8.90	8.75	8.61	8.47	8.34	8.21	8.08	7.96	7.85					
9	9.69	9.51	9.33	9.16	8.99	8.84	8.68	8.54	8.40	8.26	8.14	8.01	7.89					
10	9.85	9.65	9.45	9.26	9.09	8.92	8.76	8.60	8.46	8.32	8.18	8.05	7.93					
11	10.01	9.78	9.56	9.36	9.17	8.99	8.82	8.66	8.51	8.36	8.22	8.09	7.97					
12	10.14	9.89	9.66	9.44	9.24	9.05	8.87	8.71	8.55	8.40	8.26	8.12	8.00					
13	10.26	9.98	9.74	9.51	9.30	9.10	8.92	8.75	8.59	8.43	8.29	8.15	8.02					
14	10.34	10.05	9.79	9.56	9.34	9.14	8.95	8.78	8.61	8.46	8.31	8.17	8.04					
15	10.39	10.09	9.83	9.59	9.37	9.16	6.97	8.80	8.63	8.47	8.33	8.18	8.05					
16	10.40	10.10	9.84	9.60	9.38	9.17	8.98	8.81	8.64	8.48	8.33	8.19	8.06					
17	10.37	10.09	9.83	9.59	9.37	9.17	8.98	8.80	8.64	9.48	8.33	8.19	8.06					
18	10.32	10.05	9.80	9.57	9.35	9.15	8.97	8.79	8.63	8.47	8.32	8.18	8.05					
19	10.24	9.98	9.74	9.52	9.32	9.12	8.94	8.77	8.61	8.45	8.31	8.17	8.04					
20	10.14	9.90	9.68	9.46	9.27	9.08	8.90	8.74	8.58	8.43	8.29	8.15	8.02					
21	10.02	9.80	9.59	9.39	9.21	9.03	8.86	8.70	8.54	8.40	8.26	8.12	8.00					
22	9.90	9.69	9.50	9.31	9.13	8.96	8.00	8.65	8.50	8.36	8.22	8.09	7.97					
23	9.76	9.58	9.40	9.22	9.06	8.90	8.74	8.59	8.45	8.31	8.18	8.06	7.93					
24	9.62	9.45	9.29	9.13	8.97	8.82	8.67	8.53	8.39	8.26	8.14	8.01	7.90					
25	9.48	9.33	9.18	9.03	8.88	8.74	8.60	8.46	8.33	8.21	8.09	7.97	7.85					
26	9.34	9.20	9.06	8.92	8.79	8.65	8.52	8.39	8.27	8.15	8.03	7.92	7.81					

TABLE 10.5-3. DRAWDOWN RESULTS FOR 2% BLEED RATE.

RENO CREEK MINE UNIT ONE SIMS. T=1600 AND S=0.00013 365 days QBLEED=406PM

GENERAL DATA BASE:

Simulation period number= 1
Aquifer transmissivity in gpd/ft= 1600.00
Aquifer storativity as a decimal= 0.000130

NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS: 365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW	I-COLUMN																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	17.17	17.28	17.39	17.49	17.57	17.64	17.69	17.72	17.74	17.74	17.73	17.69	17.64	17.56	17.47	17.37	17.25	17.11
2	17.44	17.57	17.69	17.80	17.89	17.96	18.02	18.06	18.08	18.09	18.07	18.03	17.97	17.89	17.79	17.68	17.54	17.40
3	17.73	17.88	18.00	18.12	18.22	18.31	18.37	18.42	18.45	18.45	18.43	18.39	18.33	18.24	18.13	18.00	17.85	17.69
4	18.03	18.19	18.33	18.46	18.57	18.67	18.74	18.80	18.83	18.84	18.82	18.78	18.71	18.61	18.49	18.35	18.18	18.00
5	18.34	18.51	18.67	18.82	18.94	19.05	19.13	19.20	19.24	19.25	19.23	19.19	19.11	19.01	18.87	18.71	18.53	18.32
6	18.67	18.85	19.03	19.19	19.33	19.45	19.55	19.62	19.67	19.69	19.68	19.63	19.55	19.43	19.28	19.10	18.89	18.66
7	19.00	19.21	19.40	19.58	19.74	19.87	19.99	20.08	20.13	20.16	20.15	20.11	20.02	19.89	19.72	19.51	19.27	19.01
8	19.35	19.58	19.79	19.99	20.17	20.32	20.45	20.56	20.63	20.67	20.67	20.63	20.54	20.40	20.20	19.96	19.68	19.37
9	19.70	19.96	20.20	20.42	20.62	20.79	20.94	21.07	21.16	21.21	21.23	21.19	21.10	20.95	20.73	20.44	20.11	19.75
10	20.08	20.36	20.62	20.87	21.09	21.29	21.46	21.61	21.72	21.80	21.83	21.81	21.73	21.58	21.33	20.98	20.57	20.13
11	20.47	20.78	21.07	21.34	21.59	21.81	22.01	22.18	22.32	22.43	22.49	22.49	22.44	22.30	22.04	21.58	21.03	20.51
12	20.87	21.22	21.54	21.84	22.11	22.36	22.59	22.79	22.96	23.10	23.20	23.24	23.21	23.16	22.96	22.22	21.48	20.85
13	21.30	21.68	22.03	22.36	22.66	22.93	23.19	23.42	23.63	23.82	23.96	24.06	24.03	23.85	23.39	22.62	21.82	21.13
14	21.75	22.18	22.55	22.90	23.22	23.53	23.81	24.08	24.33	24.57	24.73	24.84	24.51	24.10	23.87	22.91	22.06	21.32
15	22.26	22.71	23.11	23.47	23.81	24.14	24.44	24.74	25.07	25.22	25.13	24.99	24.66	24.24	23.97	23.06	22.18	21.43
16	22.85	23.32	23.69	24.05	24.42	24.78	25.08	25.34	25.65	25.48	25.16	24.96	24.64	24.28	23.84	23.01	22.18	21.44
17	23.44	24.20	24.24	24.61	25.05	25.48	25.78	25.89	25.86	25.58	25.04	24.69	24.40	24.17	23.70	22.85	22.08	21.38
18	23.71	24.27	24.62	25.11	26.45	25.89	26.22	26.44	25.81	25.22	24.76	24.39	24.11	23.95	23.47	22.63	21.90	21.24
19	23.61	24.46	24.61	25.16	25.55	26.02	26.05	25.90	25.37	24.81	24.36	24.00	23.73	23.54	23.08	22.33	21.65	21.04
20	22.95	23.59	24.07	24.63	25.30	25.49	25.69	25.38	24.83	24.30	23.88	23.53	23.24	23.01	22.58	21.94	21.35	20.80
21	22.34	22.90	23.40	23.91	24.45	24.77	24.63	24.40	24.06	23.68	23.33	23.00	22.69	22.38	21.98	21.50	21.00	20.51
22	21.80	22.28	22.72	23.14	23.50	23.70	23.68	23.54	23.31	23.03	22.74	22.45	22.15	21.83	21.47	21.06	20.64	20.21
23	21.29	21.70	22.07	22.40	22.67	22.82	22.84	22.76	22.60	22.40	22.16	21.90	21.63	21.33	21.00	20.65	20.27	19.90
24	20.80	21.15	21.47	21.74	21.94	22.07	22.10	22.06	21.95	21.79	21.60	21.37	21.13	20.86	20.56	20.25	19.92	19.58
25	20.34	20.64	20.91	21.13	21.30	21.41	21.45	21.43	21.35	21.22	21.06	20.87	20.65	20.41	20.15	19.87	19.57	19.27
26	19.90	20.16	20.39	20.58	20.72	20.82	20.86	20.85	20.79	20.69	20.55	20.39	20.19	19.98	19.75	19.50	19.23	18.96

J-ROW	I-COLUMN																	
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	16.97	16.81	16.65	16.49	16.31	16.14	15.96	15.78	15.61	15.43	15.25	15.08	14.91					
2	17.24	17.07	16.89	16.71	16.52	16.34	16.15	15.96	15.77	15.58	15.40	15.21	15.03					
3	17.52	17.33	17.14	16.94	16.74	16.53	16.33	16.13	15.93	15.73	15.54	15.34	15.16					
4	17.80	17.60	17.39	17.17	16.95	16.73	16.52	16.30	16.09	15.88	15.67	15.47	15.27					
5	18.10	17.88	17.64	17.40	17.17	16.93	16.70	16.47	16.24	16.02	15.80	15.59	15.39					
6	18.41	18.16	17.90	17.64	17.38	17.13	16.88	16.63	16.39	16.16	15.93	15.71	15.50					
7	18.73	18.44	18.16	17.87	17.59	17.32	17.05	16.79	16.53	16.29	16.05	15.82	15.60					
8	19.05	18.73	18.41	18.10	17.80	17.50	17.21	16.94	16.67	16.41	16.17	15.93	15.70					
9	19.38	19.02	18.66	18.32	17.99	17.67	17.37	17.08	16.80	16.53	16.27	16.02	15.78					
10	19.71	19.29	18.90	18.53	18.17	17.83	17.51	17.20	16.91	16.63	16.36	16.11	15.86					
11	20.01	19.55	19.12	18.72	18.34	17.98	17.64	17.32	17.01	16.72	16.45	16.18	15.93					
12	20.29	19.78	19.31	18.88	18.48	18.10	17.75	17.42	17.10	16.80	16.52	16.25	15.99					
13	20.52	19.97	19.47	19.01	18.59	18.20	17.84	17.50	17.17	16.87	16.58	16.30	16.04					
14	20.68	20.10	19.59	19.11	18.68	18.28	17.91	17.56	17.23	16.92	16.62	16.34	16.08					
15	20.77	20.19	19.66	19.18	18.74	18.33	17.95	17.59	17.26	16.95	16.65	16.37	16.10					
16	20.79	20.21	19.68	19.20	18.76	18.35	17.97	17.61	17.28	16.96	16.67	16.38	16.11					
17	20.75	20.18	19.66	19.18	18.75	18.34	17.96	17.61	17.28	16.96	16.66	16.38	16.11					
18	20.64	20.10	19.59	19.13	18.70	18.31	17.93	17.58	17.25	16.94	16.65	16.37	16.10					
19	20.48	19.97	19.49	19.05	18.63	18.24	17.88	17.54	17.21	16.91	16.62	16.34	16.08					
20	20.28	19.80	19.35	18.93	18.53	18.16	17.81	17.47	17.16	16.86	16.57	16.30	16.04					
21	20.05	19.61	19.19	18.79	18.41	18.05	17.71	17.39	17.09	16.79	16.52	16.25	15.99					
22	19.79	19.39	19.00	18.63	18.27	17.93	17.61	17.30	17.00	16.72	16.45	16.19	15.94					
23	19.52	19.15	18.79	18.45	18.11	17.79	17.48	17.18	16.90	16.63	16.36	16.11	15.87					
24	19.24	18.91	18.58	18.25	17.94	17.64	17.35	17.06	16.79	16.53	16.27	16.03	15.79					
25	18.96	18.66	18.35	18.05	17.76	17.48	17.20	16.93	16.67	16.42	16.17	15.94	15.71					
26	18.68	18.40	18.12	17.85	17.57	17.31	17.04	16.79	16.54	16.30	16.07	15.84	15.62					

TABLE 10.5-4. DRAWDOWN RESULTS FOR 3% BLEED RATE.

RENO CREEK MINE UNIT ONE SIMS. T=1600 AND S=0.00013 365 days QBLEED=60GPM

GENERAL DATA BASE:

Simulation period number= 1
Aquifer transmissivity in gpd/ft= 1600.00
Aquifer storativity as a decimal= 0.000130

NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS: 365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW	I-COLUMN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	25.75	25.93	26.09	26.23	26.35	26.45	26.53	26.59	26.61	26.62	26.59	26.53	26.45	26.34	26.21	26.05	25.87	25.67
2	26.17	26.36	26.54	26.70	26.83	26.94	27.03	27.09	27.13	27.13	27.10	27.05	26.96	26.84	26.69	26.51	26.32	26.09
3	26.60	26.81	27.01	27.18	27.33	27.46	27.56	27.63	27.67	27.68	27.65	27.59	27.49	27.36	27.20	27.00	26.78	26.54
4	27.05	27.28	27.50	27.69	27.86	28.00	28.11	28.20	28.24	28.26	28.23	28.17	28.06	27.92	27.74	27.52	27.27	27.00
5	27.51	27.77	28.01	28.22	28.41	28.57	28.70	28.80	28.86	28.87	28.85	28.78	28.67	28.51	28.31	28.07	27.79	27.48
6	28.00	28.28	28.54	28.78	28.99	29.18	29.32	29.44	29.51	29.53	29.52	29.45	29.32	29.15	28.92	28.65	28.33	27.99
7	28.50	28.81	29.10	29.37	29.61	29.81	29.98	30.11	30.20	30.24	30.23	30.16	30.03	29.84	29.58	29.27	28.91	28.51
8	29.02	29.36	29.69	29.98	30.25	30.48	30.68	30.83	30.94	31.00	31.00	30.94	30.80	30.59	30.30	29.94	29.52	29.06
9	29.56	29.94	30.30	30.63	30.93	31.19	31.42	31.60	31.74	31.82	31.84	31.79	31.66	31.43	31.10	30.67	30.16	29.62
10	30.12	30.54	30.94	31.30	31.64	31.94	32.20	32.41	32.58	32.70	32.75	32.72	32.60	32.37	31.99	31.47	30.85	30.20
11	30.70	31.17	31.61	32.01	32.38	32.72	33.02	33.28	33.49	33.64	33.73	33.74	33.66	33.45	33.05	32.37	31.55	30.76
12	31.31	31.83	32.31	32.76	33.17	33.54	33.88	34.18	34.44	34.65	34.80	34.86	34.82	34.73	34.43	33.32	32.21	31.27
13	31.95	32.52	33.05	33.54	33.98	34.40	34.78	35.13	35.45	35.72	35.94	36.08	36.05	35.78	35.09	33.94	32.73	31.69
14	32.63	33.26	33.83	34.35	34.84	35.29	35.71	36.12	36.50	36.86	37.09	37.26	36.77	36.14	35.80	34.37	33.09	31.98
15	33.38	34.07	34.66	35.20	35.72	36.21	36.66	37.11	37.61	37.84	37.69	37.49	36.98	36.35	35.95	34.58	33.27	32.14
16	34.27	34.98	35.53	36.07	36.63	37.17	37.62	38.01	38.47	38.22	37.74	37.45	36.96	36.42	35.75	34.51	33.27	32.17
17	35.15	36.29	36.36	36.92	37.57	38.22	38.66	38.83	38.79	38.37	37.56	37.04	36.61	36.25	35.55	34.28	33.12	32.07
18	35.57	36.41	36.93	37.66	39.67	38.83	39.33	39.66	38.71	37.84	37.13	36.58	36.17	35.93	35.20	33.95	32.85	31.86
19	35.42	36.69	36.91	37.74	38.33	39.03	39.00	38.85	38.05	37.22	36.54	36.00	35.59	35.32	34.62	33.49	32.48	31.57
20	34.42	35.39	36.11	36.95	37.95	38.24	38.54	38.06	37.25	36.44	35.82	35.29	34.86	34.52	33.87	32.90	32.02	31.19
21	33.51	34.35	35.10	35.86	36.67	37.15	36.94	36.60	36.09	35.52	34.99	34.50	34.04	33.56	32.96	32.24	31.50	30.77
22	32.69	33.42	34.09	34.71	35.26	35.55	35.52	35.30	34.96	34.55	34.11	33.67	33.22	32.74	32.20	31.59	30.95	30.32
23	31.93	32.55	33.11	33.61	34.00	34.22	34.26	34.14	33.91	33.60	33.24	32.85	32.44	31.99	31.50	30.97	30.41	29.85
24	31.20	31.73	32.20	32.60	32.91	33.10	33.15	33.09	32.93	32.69	32.39	32.06	31.69	31.28	30.84	30.37	29.88	29.37
25	30.51	30.96	31.36	31.70	31.95	32.11	32.17	32.14	32.02	31.83	31.59	31.30	30.97	30.61	30.22	29.80	29.36	28.90
26	29.85	30.24	30.58	30.87	31.09	31.23	31.29	31.27	31.18	31.03	30.83	30.58	30.29	29.97	29.62	29.24	28.85	28.44

J-ROW	I-COLUMN 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	25.45	25.22	24.98	24.73	24.47	24.21	23.94	23.68	23.41	23.15	22.88	22.62	22.36					
2	25.86	25.60	25.34	25.07	24.79	24.50	24.22	23.94	23.65	23.37	23.10	22.82	22.55					
3	26.27	26.00	25.71	25.41	25.11	24.80	24.50	24.19	23.89	23.60	23.30	23.02	22.73					
4	26.71	26.40	26.08	25.76	25.43	25.10	24.77	24.45	24.13	23.82	23.51	23.21	22.91					
5	27.16	26.81	26.46	26.11	25.75	25.40	25.05	24.70	24.36	24.03	23.71	23.39	23.08					
6	27.62	27.24	26.85	26.46	26.07	25.69	25.31	24.95	24.59	24.24	23.90	23.57	23.25					
7	28.10	27.67	27.24	26.81	26.39	25.97	25.57	25.18	24.80	24.43	24.08	23.73	23.40					
8	28.58	28.10	27.62	27.15	26.69	26.25	25.82	25.41	25.01	24.62	24.25	23.89	23.54					
9	29.07	28.53	28.00	27.48	26.98	26.51	26.05	25.61	25.20	24.79	24.41	24.03	23.67					
10	29.56	28.94	28.35	27.79	27.26	26.75	26.27	25.81	25.37	24.95	24.55	24.16	23.79					
11	30.02	29.33	28.68	28.07	27.50	26.97	26.46	25.98	25.52	25.09	24.67	24.28	23.90					
12	30.43	29.67	28.97	28.32	27.72	27.15	26.62	26.12	25.65	25.20	24.78	24.37	23.99					
13	30.77	29.95	29.21	28.52	27.89	27.31	26.76	26.24	25.76	25.30	24.87	24.45	24.06					
14	31.07	30.16	29.38	28.67	28.02	27.42	26.86	26.33	25.84	25.37	24.93	24.51	24.11					
15	31.16	30.28	29.49	28.77	28.10	27.49	26.92	26.39	25.89	25.42	24.98	24.55	24.15					
16	31.19	30.31	29.52	28.80	28.14	27.52	26.95	26.42	25.92	25.44	25.00	24.57	24.17					
17	31.12	30.27	29.49	28.78	28.12	27.51	26.94	26.41	25.91	25.44	25.00	24.57	24.17					
18	30.96	30.14	29.39	28.70	28.06	27.46	26.90	26.38	25.88	25.41	24.97	24.55	24.15					
19	30.73	29.95	29.23	28.57	27.95	27.37	26.82	26.31	25.82	25.36	24.93	24.51	24.11					
20	30.42	29.70	29.03	28.39	27.80	27.24	26.71	26.21	25.74	25.29	24.86	24.45	24.06					
21	30.07	29.41	28.78	28.18	27.62	27.08	26.57	26.09	25.63	25.19	24.77	24.37	23.99					
22	29.69	29.08	28.50	27.94	27.40	26.89	26.41	25.94	25.50	25.07	24.67	24.28	23.90					
23	29.28	28.73	28.19	27.67	27.17	26.69	26.22	25.78	25.35	24.94	24.55	24.17	23.80					
24	28.87	28.36	27.87	27.38	26.91	26.46	26.02	25.59	25.18	24.79	24.41	24.04	23.69					
25	28.44	27.98	27.53	27.08	26.64	26.21	25.80	25.39	25.00	24.63	24.26	23.91	23.56					
26	28.02	27.60	27.18	26.77	26.36	25.96	25.57	25.18	24.81	24.45	24.10	23.76	23.43					

TABLE 10.5-5. DRAWDOWN RESULTS FOR 2% BLEED RATE WITH ADDITIONAL 20 GPM IN FIVE WELLS.

RENO CREEK MINE UNIT 1 SIMS. T=1600 AND S=0.00013 60 days 2% BLEED INCRE. 20GPM

GENERAL DATA BASE:

Simulation period number= 1
Aquifer transmissivity in gpd/ft= 1600.00
Aquifer storativity as a decimal= 0.000130

NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS: 60.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW	I-COLUMN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	18.02	18.25	18.47	18.68	18.87	19.05	19.21	19.34	19.45	19.53	19.58	19.59	19.58	19.52	19.44	19.31	19.16	18.97
2	18.40	18.65	18.89	19.12	19.34	19.53	19.71	19.86	19.98	20.08	20.14	20.16	20.15	20.09	19.99	19.86	19.68	19.47
3	18.79	19.06	19.33	19.58	19.82	20.04	20.23	20.41	20.55	20.66	20.74	20.77	20.76	20.70	20.59	20.44	20.24	20.01
4	19.19	19.49	19.78	20.05	20.32	20.56	20.79	20.98	21.15	21.29	21.38	21.42	21.42	21.35	21.24	21.06	20.84	20.57
5	19.59	19.92	20.23	20.54	20.83	21.11	21.36	21.59	21.79	21.95	22.07	22.13	22.13	22.07	21.94	21.74	21.48	21.17
6	20.01	20.36	20.70	21.04	21.37	21.67	21.96	22.23	22.47	22.66	22.81	22.90	22.92	22.85	22.70	22.47	22.17	21.80
7	20.42	20.81	21.19	21.56	21.91	22.26	22.59	22.90	23.18	23.42	23.61	23.74	23.78	23.72	23.56	23.28	22.92	22.48
8	20.85	21.26	21.67	22.08	22.48	22.86	23.24	23.60	23.93	24.23	24.49	24.66	24.75	24.71	24.52	24.19	23.74	23.21
9	21.27	21.72	22.17	22.61	23.05	23.48	23.90	24.32	24.72	25.09	25.42	25.69	25.84	25.84	25.63	25.21	24.64	23.97
10	21.70	22.19	22.67	23.15	23.63	24.10	24.58	25.05	25.53	25.99	26.43	26.81	27.09	27.10	26.97	26.41	25.62	24.76
11	22.13	22.66	23.18	23.69	24.21	24.73	25.26	25.79	26.34	26.91	27.48	28.05	28.53	28.83	28.69	27.84	26.65	25.52
12	22.57	23.13	23.68	24.24	24.79	25.35	25.92	26.52	27.14	27.81	28.55	29.35	30.13	30.92	31.21	29.41	27.58	26.18
13	23.01	23.61	24.20	24.78	25.36	25.96	26.57	27.21	27.90	28.66	29.54	30.64	31.79	32.36	31.86	30.10	28.18	26.62
14	23.46	24.10	24.72	25.32	25.93	26.55	27.18	27.86	28.59	29.40	30.27	31.37	32.10	32.06	32.66	30.37	28.40	26.81
15	23.95	24.62	25.25	25.86	26.48	27.12	27.76	28.45	29.22	29.90	30.41	30.97	31.31	31.47	32.04	30.12	28.24	26.73
16	24.50	25.19	25.78	26.39	27.03	27.60	28.30	28.92	29.63	29.90	30.07	30.39	30.55	30.62	30.47	29.24	27.75	26.43
17	25.05	26.01	26.27	26.88	27.56	28.27	28.86	29.30	29.61	29.71	29.56	29.59	29.64	29.66	29.27	28.24	27.09	25.97
18	25.27	26.02	26.57	27.28	28.06	28.55	29.15	29.65	29.32	29.04	28.80	28.80	28.76	28.76	28.30	27.35	26.39	25.43
19	25.10	26.13	26.47	27.23	27.94	28.54	28.81	28.90	28.62	28.32	28.11	27.97	77.07	27.79	27.34	26.51	25.67	24.84
20	24.36	25.17	25.83	26.58	27.45	27.85	28.26	28.16	27.83	27.51	27.28	27.10	26.94	26.78	26.36	25.66	24.95	24.24
21	23.66	74.38	25.05	25.73	26.46	26.96	27.01	26.97	26.81	26.61	26.41	26.22	26.01	25.74	25.35	24.83	24.24	23.62
22	23.03	23.66	24.26	24.83	25.37	25.73	25.87	25.89	25.82	25.69	25.53	25.34	25.12	24.84	24.48	24.04	23.55	23.07
23	22.42	22.97	23.49	23.97	24.30	24.60	24.85	24.91	24.89	24.81	24.60	24.51	24.29	24.03	23.70	23.32	22.89	22.43
24	21.83	22.31	22.76	23.17	23.51	23.76	23.93	24.01	24.02	23.96	23.86	23.71	23.51	23.27	22.98	22.64	22.27	21.86
25	21.27	21.69	22.08	22.43	22.72	22.94	23.10	23.19	23.21	23.17	23.09	22.96	22.78	22.57	22.31	22.01	21.67	21.31
26	20.73	21.10	21.44	21.74	22.00	22.20	22.34	22.43	22.46	22.43	22.37	22.25	22.10	21.90	21.67	21.40	21.11	20.79

J-ROW	I-COLUMN 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	18.76	18.53	18.28	18.02	17.74	17.46	17.17	16.88	16.59	16.31	16.02	15.74	15.46					
2	19.24	18.98	18.70	18.41	18.11	17.80	17.49	17.18	16.87	16.56	16.26	15.96	15.66					
3	19.74	19.45	19.14	18.82	18.48	18.15	17.81	17.47	17.14	16.81	16.49	16.17	15.86					
4	20.27	19.94	19.59	19.23	18.86	18.49	18.13	17.76	17.41	17.06	16.71	16.38	16.05					
5	20.82	20.44	20.05	19.65	19.24	18.84	18.44	18.05	17.67	17.29	16.93	16.58	16.24					
6	21.40	20.97	20.52	20.07	19.62	19.18	18.75	18.33	17.92	17.52	17.14	16.77	16.41					
7	22.01	21.51	21.00	20.49	20.00	19.51	19.04	18.59	18.16	17.74	17.34	16.95	16.57					
8	22.64	22.05	21.47	20.90	20.36	19.83	19.32	18.84	18.38	17.94	17.52	17.11	16.72					
9	23.28	22.59	21.93	21.30	20.69	20.12	19.58	19.07	18.58	18.12	17.68	17.26	16.86					
10	23.91	23.11	22.36	21.66	21.00	20.39	19.81	19.27	18.76	18.28	17.82	17.39	16.98					
11	24.50	23.50	22.74	21.97	21.27	20.62	20.01	19.44	18.91	18.42	17.94	17.50	17.07					
12	24.99	23.96	23.05	22.23	21.48	20.80	20.17	19.58	19.04	18.52	18.04	17.58	17.15					
13	25.33	24.23	23.26	22.41	21.63	20.93	20.28	19.68	19.12	18.60	18.11	17.65	17.21					
14	25.49	24.36	23.38	22.50	21.72	21.00	20.35	19.74	19.18	18.65	18.15	17.69	17.25					
15	25.46	24.35	23.30	22.52	21.73	21.02	20.36	19.76	19.19	18.66	18.17	17.70	17.26					
16	25.26	24.22	23.29	22.44	21.60	20.98	20.33	19.73	19.17	18.65	18.16	17.69	17.25					
17	24.93	23.97	23.10	22.30	21.56	20.80	20.25	19.67	19.12	18.60	18.11	17.66	17.22					
18	24.51	23.65	22.84	22.09	21.39	20.74	20.13	19.56	19.03	18.53	18.05	17.60	17.17					
19	24.03	23.26	22.52	21.83	21.17	20.56	19.98	19.43	18.91	18.42	17.96	17.52	17.10					
20	23.53	22.83	22.17	21.53	20.92	20.34	19.79	19.26	18.77	18.29	17.84	17.41	17.00					
21	23.00	22.39	21.78	21.20	20.63	20.09	19.57	19.07	18.60	18.14	17.71	17.29	16.90					
22	22.47	21.92	21.38	20.84	20.32	19.82	19.33	18.86	18.41	17.97	17.56	17.16	16.77					
23	21.95	21.46	20.97	20.48	20.00	19.53	19.07	18.63	18.20	17.79	17.39	17.00	16.63					
24	21.43	20.99	20.55	20.10	19.66	19.23	18.80	18.38	17.98	17.59	17.21	16.84	16.48					
25	20.93	20.54	20.13	19.73	19.32	18.92	18.52	18.13	17.75	17.37	17.01	16.66	16.32					
26	20.44	20.09	19.72	19.35	18.97	18.60	18.23	17.86	17.51	17.15	16.81	16.47	16.14					

TABLE 10.5-6. PERMIT HYDROLOGIC MONITORING.

SITE NO.	FREQUENCY	PARAMETERS
RI-1, RI-4 RI-42C, RI-23U, RI-25U, RI-30U	SEMI-ANNUAL	@ W.L., pH, Conductivity, Temperature, TDS, SO_4, Cl, HCO_3, Na, Mg, K, Ca, U, Ra226, Fe, Mn, Se
SW-2, SW-4	SEMI-ANNUAL	@ pH, Conductivity, Temperature, TSS, TDS, SO_4, Cl, HCO_3, Na, Mg, K, Ca, U, Ra226, Fe, Mn, Se
RI-2, RI-5, RI-6, RI-7, RI-12 RI-13, RI-16, RI-18, RI-15U RI-21U, RI-22, RI-24U, RI-32U RI-33U, RI-38U	ANNUAL	W.L.

@ = GUIDELINE 8 LIST TO BE USED FOR THE FIRST FOUR SAMPLES
SW-2 BELLE FOURCHE RIVER = 2MILES DOWNSTREAM OF K BAR DRAW
SW-4 SPRING CREEK

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN.

RENO CREEK 25 INJ-20 REC SIMS. 4X4 PATTERN T=1600 AND S=0.00013 100 days

GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days: 100.000
Number of grid columns: 57
Number of grid rows: 57
Grid spacing in ft: 5.00
X-coordinate of upper-left grid node in ft: -140.00
Y-coordinate of upper-left grid node in ft: -140.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 1
X-coordinate of well in ft: 0.00
Y-coordinate of well in ft: 0.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 2
X-coordinate of well in ft: -70.00
Y-coordinate of well in ft: 0.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 3
X-coordinate of well in ft: -140.00
Y-coordinate of well in ft: 0.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 4
X-coordinate of well in ft: 70.00
Y-coordinate of well in ft: 0.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN (continued).

Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 5
X-coordinate of well in ft= 140.00
Y-coordinate of well in ft= 0.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 6
X-coordinate of well in ft= -140.00
Y-coordinate of well in ft= -70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 7
X-coordinate of well in ft= -70.00
Y-coordinate of well in ft= -70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 8
X-coordinate of well in ft= 0.00
Y-coordinate of well in ft= -70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 9
X-coordinate of well in ft= 70.00
Y-coordinate of well in ft= -70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN (continued).

Number of production, injection, and image wells
active during simulation period= 45
Well number= 10
X-coordinate of well in ft= 140.00
Y-coordinate of well in ft= -70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 11
X-coordinate of well in ft= -140.00
Y-coordinate of well in ft= -140.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation p riod
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 12
X-coordinate of well in ft= -70.00
Y-coordinate of well in ft= -140.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 13
X-coordinate of well in ft= 0.00
Y-coordinate of well in ft= -140.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 14
X-coordinate of well in ft= 70.00
Y-coordinate of well in ft= -140.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN (continued).

Well number= 15
X-coordinate of well in ft= 140.00
Y-coordinate of well in ft= -140.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 16
X-coordinate of well in ft= -140.00
Y-coordinate of well in ft= 70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 17
X-coordinate of well in ft= -70.00
Y-coordinate of well in ft= 70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 18
X-coordinate of well in ft= 0.00
Y-coordinate of well in ft= 70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 19
X-coordinate of well in ft= 70.00
Y-coordinate of well in ft= 70.00
Well discharge in gpm= -15.68
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 20
X-coordinate of well in ft= 140.00

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN (continued).

Y-coordinate of well in ft: 70.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 21
X-coordinate of well in ft: -140.00
Y-coordinate of well in ft: 140.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 22
X-coordinate of well in ft: -70.00
Y-coordinate of well in ft: 140.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 23
X-coordinate of well in ft: 0.00
Y-coordinate of well in ft: 140.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 24
X-coordinate of well in ft: 70.00
Y-coordinate of well in ft: 140.00
Well discharge in gpm: -15.68
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 25
X-coordinate of well in ft: 140.00
Y-coordinate of well in ft: 140.00
Well discharge in gpm: -15.68

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN (continued).

Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 26
X-coordinate of well in ft: -105.00
Y-coordinate of well in ft: -105.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 27
X-coordinate of well in ft: -105.00
Y-coordinate of well in ft: -35.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 28
X-coordinate of well in ft: -105.00
Y-coordinate of well in ft: 35.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 29
X-coordinate of well in ft: -105.00
Y-coordinate of well in ft: 105.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 30
X-coordinate of well in ft: -35.00
Y-coordinate of well in ft: -105.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN (continued).

Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 31
X-coordinate of well in ft= -35.00
Y-coordinate of well in ft= -35.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 32
X-coordinate of well in ft= -35.00
Y-coordinate of well in ft= 35.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 33
X-coordinate of well in ft= -35.00
Y-coordinate of well in ft= 105.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 34
X-coordinate of well in ft= 35.00
Y-coordinate of well in ft= -105.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 35
X-coordinate of well in ft= 35.00
Y-coordinate of well in ft= -35.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN (continued).

Number of production, injection, and image wells
active during simulation period: 45
Well number: 36
X-coordinate of well in ft: 35.00
Y-coordinate of well in ft: 35.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 37
X-coordinate of well in ft: 35.00
Y-coordinate of well in ft: 105.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 38
X-coordinate of well in ft: 105.00
Y-coordinate of well in ft: -105.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 39
X-coordinate of well in ft: 105.00
Y-coordinate of well in ft: -35.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45
Well number: 40
X-coordinate of well in ft: 105.00
Y-coordinate of well in ft: 35.00
Well discharge in gpm: 20.00
Duration of pump operation during simulation period
in days: 100.000
Well radius in ft: 0.50
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 45

TABLE 10.5-7. INPUT PARAMETERS FOR SIMULATION OF A 4 X 4 RENO WELL PATTERN (continued).

Well number= 41
X-coordinate of well in ft= 105.00
Y-coordinate of well in ft= 105.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 42
X-coordinate of well in ft= 35.00
Y-coordinate of well in ft= -175.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 43
X-coordinate of well in ft= 175.00
Y-coordinate of well in ft= -35.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 44
X-coordinate of well in ft= -175.00
Y-coordinate of well in ft= 35.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 45
Well number= 45
X-coordinate of well in ft= -35.00
Y-coordinate of well in ft= 175.00
Well discharge in gpm= 20.00
Duration of pump operation during simulation period
in days= 100.000
Well radius in ft= 0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft= 1600.00
Aquifer storativity as a decimal= 0.000130

TABLE 10.5-8. DRAWDOWN RESULTS FOR THE 4 X 4 WELL PATTERN SIMULATION.

RENO CREEK 25 INJ-20 REC SIMS. 4X4 PATTERN T=1600 AND S=0.00013 100 days

GENERAL DATA BASE:

Simulation period number: 1
Aquifer transmissivity in gpd/ft: 1600.00
Aquifer storativity as a decimal: 0.000130

NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS: 100.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW	I-COLUMN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-6.29	-0.96	0.74	1.78	2.52	3.00	3.48	3.73	3.84	3.81	3.62	3.24	2.57	1.22	-3.76	1.59	3.31	4.37
2	-0.96	0.01	1.23	2.18	2.93	3.51	3.94	4.21	4.33	4.29	4.10	3.74	3.17	2.34	1.75	2.72	3.93	4.88
3	0.74	1.23	2.00	2.79	3.50	4.10	4.55	4.84	4.96	4.92	4.74	4.44	4.07	3.71	3.65	4.09	4.83	5.59
4	1.78	2.18	2.79	3.49	4.18	4.82	5.33	5.65	5.76	5.69	5.49	5.23	4.98	4.83	4.88	5.21	5.75	6.38
5	2.52	2.93	3.50	4.18	4.93	5.67	6.30	6.69	6.76	6.58	6.29	6.01	5.80	5.72	5.81	6.11	6.58	7.18
6	3.00	3.51	4.10	4.82	5.67	6.61	7.53	8.09	8.00	7.56	7.09	6.73	6.50	6.43	6.54	6.82	7.28	7.89
7	3.48	3.94	4.55	5.33	6.30	7.53	9.09	10.33	9.58	8.51	7.78	7.31	7.05	6.97	7.07	7.36	7.82	8.48
8	3.73	4.21	4.84	5.65	6.69	8.09	10.33	17.17	10.83	9.10	8.21	7.69	7.41	7.33	7.43	7.72	8.19	8.86
9	3.84	4.33	4.96	5.76	6.76	8.00	9.58	10.83	10.09	9.03	8.30	7.84	7.58	7.50	7.61	7.89	8.35	9.00
10	3.81	4.29	4.92	5.69	6.58	7.56	8.51	9.10	9.03	8.60	8.14	7.79	7.56	7.50	7.60	7.88	8.34	8.95
11	3.62	4.10	4.74	5.49	6.29	7.09	7.78	8.21	8.30	8.14	7.88	7.60	7.40	7.32	7.41	7.70	8.17	8.77
12	3.24	3.74	4.44	5.23	6.01	6.73	7.31	7.69	7.84	7.79	7.60	7.38	7.11	6.96	7.01	7.34	7.88	8.51
13	2.57	3.17	4.07	4.98	5.80	6.50	7.05	7.41	7.58	7.56	7.40	7.11	6.74	6.38	6.31	6.76	7.50	8.26
14	1.22	2.34	3.71	4.83	5.72	6.43	6.97	7.33	7.50	7.50	7.32	6.96	6.38	5.54	4.95	5.92	7.14	8.09
15	-3.76	1.75	3.65	4.88	5.81	6.54	7.07	7.43	7.61	7.60	7.41	7.01	6.31	4.95	-0.04	5.32	7.06	8.14
16	1.59	2.72	4.09	5.21	6.11	6.82	7.36	7.72	7.89	7.88	7.70	7.34	6.76	5.92	5.32	6.29	7.50	8.45
17	3.31	3.93	4.83	[illegible].75	6.58	7.28	7.82	8.19	8.36	8.34	8.17	7.88	7.50	7.14	7.06	7.50	8.23	8.98
18	4.37	4.88	5.59	6.38	7.18	7.89	8.48	8.86	9.00	8.95	8.77	8.51	8.26	8.09	8.14	8.45	8.98	9.59
19	5.13	5.62	6.27	7.[illegible]3	7.84	8.65	9.34	9.77	9.86	9.70	9.43	9.15	8.93	8.83	8.91	9.19	9.64	10.21
20	5.69	6.19	6.84	7.62	8.52	9.51	10.46	11.05	10.98	10.55	10.09	9.72	9.48	9.40	9.48	9.74	10.18	10.76
21	6.11	6.61	7.27	8.09	9.00	10.35	11.93	13.18	12.44	11.38	10.64	10.16	9.89	9.79	9.87	10.13	10.56	11.18
22	6.38	6.88	7.54	8.37	9.43	10.84	13.00	19.93	13.58	11.85	10.94	10.41	10.11	10.01	10.08	10.34	10.77	11.40
23	6.51	7.00	7.64	8.45	9.44	10.68	12.25	13.49	12.74	11.66	10.92	10.43	10.15	10.04	10.11	10.36	10.79	11.40
24	6.50	6.97	7.59	8.34	9.21	10.17	11.11	11.67	11.58	11.12	10.64	10.26	10.00	9.90	9.97	10.21	10.63	11.20
25	6.34	6.79	7.39	8.11	8.88	9.65	10.30	10.69	10.76	10.56	10.26	9.95	9.71	9.59	9.64	9.89	10.32	10.87
26	5.99	6.44	7.09	7.82	8.56	9.22	9.76	10.09	10.19	10.10	9.87	9.58	9.29	9.10	9.11	9.39	9.82	10.47
27	5.35	5.88	6.70	7.54	8.30	8.94	9.42	9.72	9.84	9.77	9.55	9.21	8.79	8.39	8.27	8.67	9.36	10.07
28	4.03	5.05	6.33	7.36	8.17	8.80	9.26	9.55	9.66	9.59	9.35	8.94	8.31	7.41	6.77	7.69	8.86	9.77
29	-0.91	4.47	6.25	7.37	8.20	8.83	9.28	9.56	9.66	9.58	9.33	8.87	8.11	6.69	1.65	6.96	8.64	9.67
30	4.47	5.44	6.67	7.65	8.43	9.03	9.47	9.74	9.83	9.75	9.50	9.07	8.43	7.53	6.87	7.78	8.95	9.84
31	6.21	6.64	7.37	8.13	8.82	9.40	9.84	10.10	10.18	10.09	9.84	9.48	9.03	8.61	8.48	8.86	9.53	10.23
32	7.27	7.55	8.07	8.69	9.33	9.92	10.38	10.65	10.71	10.57	10.30	9.98	9.65	9.43	9.41	9.67	10.14	10.70
33	8.00	8.24	8.67	9.24	9.89	10.55	11.12	11.44	11.43	11.18	10.82	10.47	10.19	10.03	10.04	10.26	10.66	11.17
34	8.50	8.72	9.13	9.71	10.44	11.28	12.10	12.58	12.41	11.88	11.34	10.90	10.59	10.44	10.47	10.67	11.05	11.58
35	8.79	9.01	9.42	10.03	10.86	11.97	13.41	14.55	13.71	12.56	11.74	11.19	10.84	10.69	10.71	10.91	11.29	11.86

TABLE 10.5-8. DRAWDOWN RESULTS FOR THE 4 X 4 WELL PATTERN SIMULATION (continued).

36	8.89	9.10	9.51	10.14	11.02	12.28	14.40	21.13	14.69	12.86	11.88	11.28	10.91	10.75	10.77	10.97	11.35	11.93
37	8.78	8.99	9.40	10.00	10.83	11.93	13.38	14.51	13.67	12.51	11.69	11.14	10.79	10.63	10.65	10.84	11.22	11.78
38	8.47	8.68	9.08	9.66	10.38	11.21	12.03	12.50	12.32	11.79	11.24	10.79	10.48	10.33	10.34	10.54	10.91	11.43
39	7.95	8.18	8.60	9.16	9.80	10.45	11.01	11.32	11.30	11.04	10.68	10.31	10.02	9.85	9.86	10.06	10.45	10.95
40	7.20	7.47	7.90	8.59	9.21	9.78	10.23	10.49	10.54	10.38	10.11	9.77	9.43	9.19	9.16	9.41	9.86	10.40
41	6.13	6.54	7.25	8.00	8.67	9.24	9.66	9.90	9.97	9.86	9.60	9.22	8.76	8.32	8.16	8.53	9.19	9.86
42	4.37	5.32	6.53	7.49	8.25	8.83	9.25	9.50	9.57	9.47	9.20	8.76	8.10	7.17	6.50	7.39	8.53	9.41
43	-1.03	4.33	6.09	7.18	7.99	8.59	9.02	9.28	9.36	9.26	8.98	8.50	7.72	6.28	1.22	6.50	8.16	9.16
44	3.90	4.90	6.15	7.14	7.92	8.53	8.97	9.23	9.31	9.22	8.96	8.52	7.87	6.95	6.28	7.17	8.32	9.19
45	5.20	5.70	6.49	7.30	8.03	8.63	9.08	9.36	9.45	9.35	9.11	8.75	8.30	7.87	7.72	8.10	8.76	9.43
46	5.83	6.24	6.85	7.55	8.25	8.88	9.38	9.68	9.76	9.64	9.38	9.06	8.75	8.52	8.50	8.76	9.22	9.77
47	6.17	6.57	7.13	7.81	8.54	9.27	9.88	10.24	10.27	10.05	9.72	9.38	9.11	8.96	8.98	9.20	9.60	10.11
48	6.31	6.73	7.30	8.01	8.84	9.75	10.65	11.18	11.05	10.56	10.05	9.64	9.35	9.22	9.26	9.47	9.86	10.38
49	6.31	6.74	7.33	8.08	9.03	10.22	11.74	12.95	12.16	11.05	10.27	9.76	9.45	9.31	9.36	9.57	9.97	10.54
50	6.16	6.60	7.20	7.97	8.97	10.33	12.52	19.33	12.95	11.18	10.24	9.68	9.36	9.23	9.28	9.50	9.90	10.49
51	5.87	6.31	6.90	7.65	8.59	9.79	11.32	12.52	11.74	10.65	9.88	9.38	9.08	8.97	9.02	9.25	9.66	10.23
52	5.45	5.87	6.43	7.14	7.97	8.89	9.79	10.33	10.22	9.75	9.27	8.88	8.63	8.53	8.59	8.83	9.24	9.78
53	4.87	5.27	5.83	6.50	7.24	7.97	8.59	8.97	9.03	8.84	8.54	8.25	8.03	7.92	7.99	8.25	8.67	9.21
54	4.11	4.51	5.12	5.81	6.50	7.14	7.65	7.97	8.08	8.01	7.81	7.55	7.30	7.14	7.18	7.49	8.00	8.59
55	3.05	3.54	4.32	5.12	5.83	6.43	6.90	7.20	7.33	7.30	7.13	6.85	6.49	6.15	6.09	6.53	7.25	7.98
56	1.33	2.31	3.54	4.51	5.27	5.87	6.31	6.60	6.74	6.73	6.57	6.24	5.70	4.90	4.33	5.32	6.54	7.47
57	-4.02	1.33	3.05	4.11	4.87	5.45	5.87	6.16	6.31	6.31	6.17	5.83	5.20	3.90	-1.03	4.37	6.13	7.20

J-ROW	I-COLUMN																	
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	5.13	5.69	6.11	6.38	6.51	6.50	6.34	5.99	5.35	4.03	-0.91	4.47	6.21	7.27	8.00	8.50	8.79	8.89
2	5.62	6.19	6.61	6.88	7.00	6.97	6.79	6.44	5.88	5.05	4.47	5.44	6.64	7.55	8.24	8.72	9.01	9.10
3	6.27	6.84	7.27	7.54	7.64	7.59	7.39	7.09	6.70	6.33	6.25	6.67	7.37	8.07	8.67	9.13	9.42	9.51
4	7.03	7.62	8.09	8.37	8.45	8.34	8.11	7.82	7.54	7.36	7.37	7.65	8.13	8.69	9.24	9.71	10.03	10.14
5	7.84	8.52	9.09	9.43	9.44	9.21	8.88	8.56	8.30	8.17	8.20	8.43	8.82	9.33	9.89	10.44	10.86	11.02
6	8.65	9.51	10.35	10.84	10.68	10.17	9.65	9.22	8.94	8.80	8.83	9.03	9.40	9.92	10.55	11.28	11.97	12.28
7	9.34	10.46	11.93	13.00	12.25	11.11	10.30	9.76	9.42	9.26	9.28	9.47	9.84	10.38	11.12	12.10	13.41	14.40
8	9.77	11.05	13.18	19.93	13.49	11.67	10.69	10.09	9.72	9.55	9.56	9.74	10.10	10.65	11.44	12.58	14.55	21.13
9	9.86	10.98	12.44	13.58	12.74	11.58	10.76	10.19	9.84	9.66	9.66	9.83	10.18	10.71	11.43	12.41	13.71	14.69
10	9.70	10.55	11.38	11.85	11.66	11.12	10.56	10.10	9.1[illegible]	9.59	9.58	9.75	10.09	10.57	11.18	11.88	12.56	12.86
11	9.43	10.09	10.64	10.94	10.92	10.64	10.26	9.87	9.55	9.35	9.33	9.50	9.84	10.30	10.82	11.34	11.74	11.88
12	9.15	9.72	10.16	10.41	10.43	10.26	9.95	9.58	9.21	8.94	8.87	9.07	9.48	9.98	10.47	10.90	11.19	11.28
13	8.93	9.48	9.89	10.11	10.15	10.00	9.71	9.29	8.79	8.31	8.11	8.43	9.03	9.65	10.19	10.59	10.84	10.91
14	8.83	9.40	9.79	10.01	10.04	9.90	9.59	9.10	8.39	7.41	6.69	7.53	8.61	9.43	10.03	10.44	10.69	10.75
15	8.91	9.48	9.87	10.08	10.11	9.97	9.64	9.11	8.27	6.77	1.65	6.87	8.48	9.41	10.04	10.47	10.71	10.77
16	9.19	9.74	10.13	10.34	10.36	10.21	9.89	9.39	8.67	7.69	6.96	7.78	8.86	9.67	10.26	10.67	10.91	10.97
17	9.64	10.18	10.56	10.77	10.79	10.63	10.32	9.88	9.36	8.86	8.64	8.95	9.53	10.14	10.66	11.05	11.29	11.35
18	10.21	10.76	11.18	11.40	11.40	11.20	10.87	10.47	10.07	9.77	9.67	9.84	10.23	10.70	11.17	11.58	11.86	11.93
19	10.84	11.48	12.00	12.27	12.21	11.90	11.48	11.06	10.70	10.46	10.39	10.53	10.84	11.26	11.76	12.25	12.63	12.75
20	11.48	12.29	13.06	13.51	13.29	12.70	12.08	11.58	11.20	10.97	10.91	11.03	11.32	11.77	12.34	13.01	13.66	13.94
21	12.00	13.08	14.49	15.59	14.69	13.47	12.59	11.97	11.55	11.31	11.25	11.36	11.66	12.13	12.81	13.75	15.02	15.97
22	12.27	13.51	15.59	22.28	15.78	13.89	12.84	12.16	11.72	11.47	11.41	11.52	11.82	12.31	13.03	14.13	16.06	22.61
23	12.21	13.29	14.69	15.78	14.87	13.65	12.78	12.13	11.70	11.45	11.39	11.49	11.78	12.25	12.92	13.86	15.12	16.06
24	11.90	12.70	13.47	13.89	13.65	13.05	12.42	11.90	11.50	11.26	11.19	11.29	11.57	12.00	12.56	13.22	13.86	14.13
25	11.48	12.09	12.59	12.84	12.76	12.42	11.98	11.53	11.15	10.89	10.81	10.92	11.21	11.62	12.09	12.56	12.92	13.03
26	11.06	11.58	11.97	12.16	12.13	11.90	11.53	11.10	10.68	10.34	10.22	10.36	10.72	11.17	11.62	12.00	12.25	12.31

TABLE 10.5-8. DRAWDOWN RESULTS FOR THE 4 X 4 WELL PATTERN SIMULATION (continued).

27	10.70	11.20	11.55	11.72	11.70	11.50	11.15	10.68	10.12	9.58	9.33	9.59	10.15	10.72	11.21	11.57	11.78	11.82
28	10.46	10.97	11.31	11.47	11.45	11.26	10.89	10.34	9.58	8.55	7.78	8.56	9.59	10.36	10.92	11.29	11.49	11.52
29	10.39	10.91	11.25	11.41	11.39	11.19	10.81	10.22	9.33	7.78	2.61	7.78	9.33	10.22	10.81	11.19	11.39	11.41
30	10.53	11.03	11.36	11.52	11.49	11.29	10.92	10.36	9.59	8.56	7.78	8.55	9.58	10.34	10.89	11.26	11.45	11.47
31	10.84	11.32	11.66	11.82	11.78	11.57	11.21	10.72	10.15	9.59	9.33	9.58	10.12	10.68	11.15	11.50	11.70	11.72
32	11.26	11.77	12.13	12.31	12.25	12.00	11.62	11.17	10.72	10.36	10.22	10.34	10.68	11.10	11.53	11.90	12.13	12.16
33	11.76	12.34	12.81	13.03	12.92	12.56	12.09	11.62	11.21	10.92	10.81	10.89	11.15	11.53	11.98	12.42	12.76	12.84
34	12.25	13.01	13.75	14.13	13.86	13.22	12.56	12.00	11.57	11.29	11.19	11.26	11.50	11.90	12.42	13.05	13.65	13.89
35	12.63	13.66	15.02	16.06	15.12	13.86	12.92	12.25	11.78	11.49	11.39	11.45	11.70	12.13	12.76	13.65	14.87	15.78
36	12.75	13.94	15.97	22.61	16.06	14.13	13.03	12.31	11.82	11.52	11.41	11.47	11.72	12.16	12.84	13.89	15.78	22.28
37	12.55	13.57	14.93	15.97	15.02	13.75	12.81	12.13	11.66	11.36	11.25	11.31	11.55	11.97	12.59	13.47	14.69	15.59
38	12.09	12.84	13.57	13.94	13.66	13.01	12.34	11.77	11.32	11.03	10.91	10.97	11.20	11.58	12.09	12.70	13.29	13.51
39	11.52	12.09	12.55	12.75	12.63	12.25	11.76	11.26	10.84	10.53	10.39	10.46	10.70	11.06	11.48	11.90	12.21	12.27
40	10.95	11.43	11.78	11.93	11.86	11.58	11.17	10.70	10.23	9.84	9.67	9.77	10.07	10.47	10.87	11.20	11.40	11.40
41	10.45	10.91	11.22	11.35	11.29	11.05	10.66	10.14	9.53	8.95	8.64	8.86	9.36	9.88	10.32	10.63	10.79	10.77
42	10.06	10.54	10.84	10.97	10.91	10.67	10.26	9.67	8.86	7.78	6.96	7.69	8.67	9.39	9.89	10.21	10.36	10.34
43	9.86	10.34	10.65	10.77	10.71	10.47	10.04	9.41	8.48	6.87	1.65	6.77	8.27	9.11	9.64	9.97	10.11	10.06
44	9.85	10.33	10.63	10.75	10.69	10.44	10.03	9.43	8.61	7.53	6.69	7.41	8.39	9.10	9.59	9.90	10.04	10.01
45	10.02	10.48	10.79	10.91	10.84	10.59	10.19	9.65	9.03	8.43	8.11	8.31	8.79	9.29	9.71	10.00	10.15	10.11
46	10.31	10.79	11.14	11.28	11.19	10.90	10.47	9.98	9.48	9.07	8.87	8.94	9.21	9.58	9.95	10.26	10.43	10.41
47	10.68	11.24	11.69	11.88	11.74	11.34	10.82	10.30	9.84	9.50	9.33	9.35	9.55	9.87	10.26	10.64	10.92	10.94
48	11.04	11.79	12.51	12.86	12.56	11.88	11.18	10.57	10.09	9.75	9.58	9.59	9.77	10.10	10.56	11.12	11.66	11.85
49	11.30	12.32	13.67	14.69	13.71	12.41	11.43	10.71	10.18	9.83	9.66	9.66	9.84	10.19	10.76	11.58	12.74	13.58
50	11.32	12.50	14.51	21.13	14.55	12.58	11.44	10.65	10.10	9.74	9.56	9.55	9.72	10.09	10.69	11.67	13.49	19.93
51	11.01	12.03	13.38	14.40	13.41	12.10	11.12	10.38	9.84	9.47	9.28	9.26	9.42	9.76	10.30	11.11	12.25	13.08
52	10.45	11.21	11.93	12.28	11.97	11.28	10.55	9.92	9.40	9.03	8.83	8.80	8.94	9.22	9.65	10.17	10.68	10.84
53	9.80	10.38	10.83	11.02	10.86	10.44	9.89	9.33	8.82	8.43	8.20	8.17	8.30	8.56	8.88	9.21	9.44	9.43
54	9.16	9.66	10.00	10.14	10.03	9.71	9.24	8.69	8.13	7.65	7.37	7.36	7.54	7.82	8.11	8.34	8.45	8.37
55	8.60	9.08	9.40	9.51	9.42	9.13	8.67	8.07	7.37	6.67	6.25	6.33	6.70	7.09	7.39	7.59	7.64	7.54
56	8.18	8.68	8.99	9.10	9.01	8.72	8.24	7.55	6.64	5.44	4.47	5.05	5.88	6.44	6.79	6.97	7.00	6.88
57	7.95	8.47	8.78	8.89	8.79	8.50	8.06	7.27	6.21	4.47	-0.91	4.03	5.35	5.99	6.34	6.50	6.51	6.38

J-ROW	I-COLUMN 37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
1	8.78	8.47	7.95	7.20	6.13	4.37	-1.03	3.90	5.20	5.83	6.17	6.31	6.31	6.16	5.87	5.45	4.87	4.11
2	8.99	8.68	8.18	7.47	6.54	5.32	4.33	4.90	5.70	6.24	6.57	6.73	6.74	6.60	6.31	5.87	5.27	4.51
3	9.40	9.06	8.60	7.98	7.25	6.53	6.09	6.15	6.49	6.85	7.13	7.30	7.33	7.20	6.98	6.43	5.83	5.12
4	10.00	9.66	9.16	8.59	8.09	7.49	7.18	7.14	7.30	7.55	7.81	8.01	8.08	7.97	7.65	7.14	6.50	5.81
5	10.83	10.38	9.80	9.21	8.67	8.25	7.99	7.92	8.03	8.25	8.54	8.84	9.03	8.97	8.59	7.97	7.24	6.50
6	11.93	11.21	10.45	9.78	9.24	8.83	8.59	8.53	8.63	8.88	9.27	9.75	10.22	10.33	9.79	8.89	7.97	7.14
7	13.38	12.03	11.01	10.23	9.68	9.25	9.02	8.97	9.08	9.38	9.88	10.65	11.74	12.52	11.32	9.79	8.59	7.65
8	14.51	12.50	11.32	10.49	9.90	9.50	9.28	9.23	9.36	9.68	10.24	11.18	12.95	19.33	12.52	10.33	8.97	7.97
9	13.67	12.32	11.30	10.54	9.97	9.57	9.36	9.31	9.45	9.76	10.27	11.05	12.16	12.95	11.74	10.22	9.03	8.08
10	12.51	11.79	11.04	10.38	9.86	9.47	9.26	9.22	9.35	9.64	10.05	10.56	11.05	11.18	10.65	9.75	8.84	8.01
11	11.69	11.24	10.68	10.11	9.60	9.20	8.98	8.96	9.11	9.38	9.72	10.05	10.27	10.24	9.88	9.27	8.54	7.81
12	11.14	10.79	10.31	9.77	9.22	8.76	8.50	8.52	8.75	9.06	9.38	9.64	9.76	9.68	9.38	8.88	8.25	7.55
13	10.79	10.48	10.02	9.43	8.76	8.10	7.72	7.87	8.30	8.75	9.11	9.35	9.45	9.38	9.08	8.63	8.03	7.30
14	10.63	10.33	9.85	9.19	8.32	7.17	6.28	6.95	7.87	8.52	8.96	9.22	9.31	9.23	8.97	8.53	7.92	7.14
15	10.65	10.34	9.86	9.16	8.16	6.50	1.22	6.28	7.72	8.50	8.98	9.26	9.36	9.28	9.02	8.59	7.99	7.18
16	10.84	10.54	10.06	9.41	8.53	7.39	6.50	7.17	8.10	8.76	9.20	9.47	9.57	9.50	9.25	8.83	8.25	7.49
17	11.22	10.91	10.45	9.86	9.19	8.53	8.16	8.32	8.76	9.22	9.60	9.86	9.97	9.90	9.66	9.24	8.67	8.20

TABLE 10.5-8. DRAWDOWN RESULTS FOR THE 4 X 4 WELL PATTERN SIMULATION (continued).

18	11.78	11.43	10.95	10.40	9.86	9.41	9.16	9.19	9.43	9.77	10.11	10.38	10.54	10.49	10.23	9.78	9.21	8.59
19	12.55	12.09	11.52	10.95	10.45	10.06	9.86	9.85	10.02	10.31	10.68	11.04	11.30	11.32	11.01	10.45	9.80	9.16
20	13.57	12.84	12.09	11.43	10.91	10.54	10.34	10.33	10.48	10.79	11.24	11.79	12.32	12.50	12.03	11.21	10.38	9.66
21	14.93	13.57	12.55	11.78	11.22	10.84	10.65	10.63	10.79	11.14	11.69	12.51	13.67	14.51	13.38	11.93	10.83	10.00
22	15.97	13.94	12.75	11.93	11.35	10.97	10.77	10.75	10.91	11.28	11.88	12.86	14.69	21.13	14.40	12.28	11.02	10.14
23	15.02	13.66	12.63	11.86	11.29	10.91	10.71	10.69	10.84	11.19	11.74	12.56	13.71	14.55	13.41	11.97	10.86	10.03
24	13.75	13.01	12.25	11.58	11.05	10.67	10.47	10.44	10.59	10.90	11.34	11.88	12.41	12.58	12.10	11.28	10.44	9.71
25	12.81	12.34	11.76	11.17	10.66	10.26	10.04	10.03	10.19	10.47	10.82	11.18	11.43	11.44	11.12	10.55	9.89	9.24
26	12.13	11.77	11.26	10.70	10.14	9.67	9.41	9.43	9.65	9.98	10.30	10.57	10.71	10.65	10.38	9.92	9.33	8.69
27	11.66	11.32	10.84	10.23	9.53	8.86	8.48	8.61	9.03	9.48	9.84	10.09	10.18	10.10	9.84	9.40	8.82	8.13
28	11.36	11.03	10.53	9.84	8.95	7.78	6.87	7.53	8.43	9.07	9.50	9.75	9.83	9.74	9.47	9.03	8.43	7.65
29	11.25	10.91	10.39	9.67	8.64	6.96	1.65	6.69	8.11	8.87	9.33	9.58	9.66	9.56	9.28	8.83	8.20	7.37
30	11.31	10.97	10.46	9.77	8.86	7.69	6.77	7.41	8.31	8.94	9.35	9.59	9.66	9.55	9.26	8.80	8.17	7.36
31	11.55	11.20	10.70	10.07	9.36	8.67	8.27	8.39	8.79	9.21	9.55	9.77	9.84	9.72	9.42	8.94	8.30	7.54
32	11.97	11.58	11.06	10.47	9.88	9.39	9.11	9.10	9.29	9.58	9.87	10.10	10.19	10.09	9.76	9.22	8.56	7.82
33	12.59	12.09	11.48	10.87	10.32	9.89	9.64	9.59	9.71	9.95	10.26	10.56	10.76	10.69	10.30	9.65	8.88	8.11
34	13.47	12.70	11.90	11.20	10.63	10.21	9.97	9.90	10.00	10.26	10.64	11.12	11.58	11.67	11.11	10.17	9.21	8.34
35	14.69	13.29	12.21	11.40	10.79	10.36	10.11	10.04	10.15	10.43	10.92	11.66	12.74	13.49	12.25	10.68	9.44	8.45
36	15.59	13.51	12.27	11.40	10.77	10.34	10.08	10.01	10.11	10.41	10.94	11.85	13.58	19.93	13.08	10.84	9.43	8.37
37	14.49	13.08	12.00	11.18	10.56	10.13	9.87	9.79	9.89	10.16	10.64	11.38	12.44	13.18	11.93	10.35	9.09	8.09
38	13.08	12.29	11.48	10.76	10.18	9.74	9.48	9.40	9.48	9.72	10.09	10.55	10.98	11.05	10.46	9.51	8.52	7.62
39	12.00	11.48	10.84	10.21	9.64	9.19	8.91	8.83	8.93	9.15	9.43	9.70	9.86	9.77	9.34	8.65	7.84	7.03
40	11.18	10.76	10.21	9.59	8.98	8.45	8.14	8.09	8.26	8.51	8.77	8.95	9.00	8.86	8.48	7.89	7.18	6.38
41	10.56	10.18	9.64	8.98	8.23	7.50	7.06	7.14	7.50	7.88	8.17	8.34	8.36	8.19	7.82	7.28	6.58	5.75
42	10.13	9.74	9.19	8.45	7.50	6.29	5.32	5.92	6.76	7.34	7.70	7.88	7.89	7.72	7.36	6.82	6.11	5.21
43	9.87	9.48	8.91	8.14	7.06	5.32	-0.04	4.95	6.31	7.01	7.41	7.60	7.61	7.43	7.07	6.54	5.81	4.88
44	9.79	9.40	8.83	8.09	7.14	5.92	4.95	5.54	6.38	6.96	7.32	7.50	7.50	7.33	6.97	6.43	5.72	4.83
45	9.89	9.48	8.93	8.26	7.50	6.76	6.31	6.38	6.74	7.11	7.40	7.56	7.58	7.41	7.05	6.50	5.80	4.98
46	10.16	9.72	9.15	8.51	7.88	7.34	7.01	6.96	7.11	7.36	7.60	7.79	7.84	7.69	7.31	6.73	6.01	5.23
47	10.64	10.09	9.43	8.77	8.17	7.70	7.41	7.32	7.40	7.60	7.88	8.14	8.30	8.21	7.78	7.09	6.29	5.49
48	11.38	10.55	9.70	8.95	8.34	7.88	7.60	7.50	7.56	7.79	8.14	8.60	9.03	9.10	8.51	7.56	6.58	5.69
49	12.44	10.98	9.86	9.00	8.35	7.89	7.61	7.50	7.58	7.84	8.30	9.03	10.09	10.83	9.58	8.00	6.76	5.76
50	13.18	11.05	9.77	8.86	8.19	7.72	7.43	7.33	7.41	7.69	8.21	9.10	10.83	17.17	10.33	8.09	6.69	5.65
51	11.93	10.46	9.34	8.48	7.82	7.36	7.07	6.97	7.05	7.31	7.78	8.51	9.58	10.33	9.09	7.53	6.30	5.33
52	10.35	9.51	8.65	7.89	7.28	6.82	6.54	6.43	6.50	6.73	7.09	7.56	8.00	8.09	7.53	6.61	5.67	4.82
53	9.09	8.52	7.84	7.18	6.58	6.11	5.81	5.72	5.80	6.01	6.29	6.58	6.76	6.69	6.30	5.67	4.93	4.18
54	8.09	7.62	7.03	6.38	5.75	5.21	4.88	4.83	4.98	5.23	5.49	5.69	5.76	5.65	5.33	4.82	4.18	3.49
55	7.27	6.84	6.27	5.59	4.83	4.09	3.65	3.71	4.07	4.44	4.74	4.92	4.96	4.84	4.55	4.10	3.50	2.79
56	6.61	6.19	5.62	4.88	3.93	2.72	1.75	2.34	3.17	3.74	4.10	4.29	4.33	4.21	3.94	3.51	2.93	2.18
57	6.11	5.69	5.13	4.37	3.31	1.59	-3.76	1.22	2.57	3.24	3.62	3.81	3.84	3.73	3.48	3.08	2.52	1.78

J-ROW	I-COLUMN																	
	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
1	3.05	1.33	-4.02															
2	3.54	2.31	1.33															
3	4.32	3.54	3.05															
4	5.12	4.51	4.11															
5	5.83	5.27	4.87															
6	6.43	5.87	5.45															
7	6.90	6.31	5.87															
8	7.20	6.60	6.16															

TABLE 10.5-8. DRAWDOWN RESULTS FOR THE 4 X 4 WELL PATTERN SIMULATION (continued).

9	7.33	6.74	6.31
10	7.30	6.73	6.31
11	7.13	6.57	6.17
12	6.85	6.24	5.83
13	6.49	5.70	5.20
14	6.15	4.90	3.90
15	6.09	4.33	-1.03
16	6.53	5.32	4.37
17	7.25	6.54	6.13
18	7.98	7.47	7.20
19	8.60	8.18	7.95
20	9.06	8.68	8.47
21	9.40	8.99	8.78
22	9.51	9.10	8.89
23	9.42	9.01	8.79
24	9.13	8.72	8.50
25	8.67	8.24	8.00
26	8.07	7.55	7.27
27	7.37	6.64	6.21
28	6.67	5.44	4.47
29	6.25	4.47	-0.91
30	6.33	5.05	4.03
31	6.70	5.88	5.35
32	7.09	6.44	5.99
33	7.39	6.79	6.34
34	7.59	6.97	6.50
35	7.64	7.00	6.51
36	7.54	6.88	6.38
37	7.27	6.61	6.11
38	6.84	6.19	5.69
39	6.27	5.62	5.13
40	5.59	4.88	4.37
41	4.83	3.93	3.31
42	4.09	2.72	1.59
43	3.65	1.75	-3.76
44	3.71	2.34	1.22
45	4.07	3.17	2.57
46	4.44	3.74	3.24
47	4.74	4.10	3.62
48	4.92	4.29	3.81
49	4.96	4.33	3.84
50	4.84	4.21	3.73
51	4.55	3.94	3.48
52	4.10	3.51	3.08
53	3.50	2.93	2.52
54	2.79	2.18	1.78
55	2.00	1.23	0.74
56	1.23	0.01	-0.96
57	0.74	-0.96	-6.29

10.6 HYDROLOGIC REFERENCES

Craig, G.S. and J.G. Rankl, 1977, Analysis of Runoff from Small Drainage Basins in Wyoming: USGS OF 77-727, 88 pp.

Dames & Moore, 1978, Reno Ranch R & D Literature Search for Rocky Mountain Energy Company: Consulting Report, 33 pp.

Hydro-Engineering, 1989, Guideline for Spacing Ore Sand Monitoring Wells Adjacent to an In-situ Well Field.

Lowham, H.W., 1976, Techniques for Estimating Flow Characteristics of Wyoming Streams: USGS - WRI 76-112, 83 pp.

PRI Environmental, Inc. 1993, EFNI Reno Creek Hydrologic & Geologic Investigations Report: Consulting Report for Energy Fuels Nuclear, Inc.

Rocky Mountain Energy, 1982, Hydrologic Integrity Evaluation of the Reno Creek project Area, V.II: Internal Report.

Theis, C.V., 1935, The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground water Storage: Transactions of the American Geophysical Union, V. 16, Part 2.

Walton, W.C., 1989, Analytical Ground water Modeling, Flow and Migration Containment: Lewis Publishers, Inc.

Water Resources Data for Wyoming, Water Years 1987, 1983: USGS Water-Data Reports.

Way, S.C., C.R. McKee and K. Shelburne, 1979, Hydrologic Evaluation of the Reno Creek Property for In-situ Uranium Recovery: In-situ Consulting, Consulting Report for Rocky Mountain Energy Company, 49 pp.

Woodward-Clyde, 1978, Water Quality/Geohydrology Data Acquisition for the Reno Ranch Project: Consulting Report for Rocky Mountain Energy Company.

11. SOILS ASSESSMENT

A soils inventory and assessment was performed during the summer of 1993 on all lands within the proposed permit area. The inventory was performed by BKS Environmental Associates of Gillette, Wyoming under contract to EFNI.

The Reno Creek project is an in situ uranium project, requiring excavation only to support the in situ recovery process. Major excavation activities include leveling and construction of an ion exchange recovery plant and parking area, construction of radium treatment ponds and irrigation reservoir and construction of main access roads. Minor excavation activities include the excavation of pipeline trenches, drilling related activities and surficial grading and leveling within wellfields. EFNI also proposes a land application area for wellfield solutions resulting in potential short term impacts to the soil resource.

In situ mining activities generally result in disturbances of the soil resource which are both relatively small in area/extent and/or disturbances that do not bury or disturb soils below several feet of the surface in disturbance areas. For these reasons, EFNI and the WDEQ-LQD agreed to focus the scope of baseline soils investigations on the identification of limiting factors to plant growth within the soils in those areas projected for disturbance.

11.1 INTRODUCTION

This report presents information on the soils occurring on the Reno Creek Project which is located approximately 10 miles southwest of Wright, Wyoming. The area has been previously surveyed, on a large scale, by the U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS) in 1979 and revised, in part, in 1992. The major objective of the 1993 assessment was to define the existing topsoil resource within the study area and determine the extent, availability, and suitability of soils material for use in reclamation. Prime farmland determination was made by the Gillette office of the SCS.

In addition to the mapping of the permit area and supporting information, backhoe pits were utilized in the proposed irrigation area to determine the baseline of various radiometric analyses. That information is summarized in this report also.

Soil analytical information is contained in Attachment 11.1.

11.2 METHODS

11.2.1 REVIEW OF EXISTING LITERATURE

The soils in this portion of Campbell County were studied and mapped to an Order 3 scale by the USDA, SCS in 1979. Although the soil survey has not been published, it is available in "open file form".

In addition to the previous SCS information, Appendix D-7 information from WDEQ permit volumes for nearby mine projects was reviewed. Pertinent information from the T3 permit for Jacobs Ranch Mine and the T5 permit for the Black Thunder Mine were reviewed prior to fieldwork.

11.2.2 1991 PROJECT PARTICIPANTS

BKS Environmental Associates, Inc. performed the 1993 soil survey field work and report preparation. All soil analysis was handled by Energy Laboratories of Billings, Montana.

11.2.3 SOIL SURVEY

Construction of the study area soil map was accomplished according to techniques and procedures of the National Cooperative Soil Survey. Guideline No. 1 (November, 1984) of the Wyoming Department of Environmental Quality, Land Quality Division was followed during all phases of the work.

A reconnaissance of the study area was used to familiarize field personnel with the area. Soil profiles were examined on a widely scattered basis according to physiographic configuration. Information derived from these profiles was compared with existing permit soil series descriptions and mapping unit descriptions, as well as SCS data, to determine which soils were likely to occur on specific landscape positions. SCS data for the study area was available throughout the field survey.

Following the reconnaissance survey, an Order 1-2 soil survey was conducted within the proposed actual disturbance. Order 3 SCS mapping units were verified outside the proposed actual disturbance. Soil boundaries were delineated in the field by exposing additional soil profiles to determine the nature and extent of soil series present on the study area. Soil map unit boundaries were delineated on a 1" = 500' topographic base map and were later transferred to a " = 1000' map for ease of comparison with other permit maps (refer to Plate 11.1).

Similar methodology was employed within the proposed irrigation area in Section 33. Existing SCS mapping units were verified at numerous locations.

11.2.4 FIELD SAMPLING

Soil series that had questionable reclamation potential were sampled and described by exposing the solum with a shovel and then sampling below this point with a hand auger. The physical and, where possible, chemical nature of each horizon within the sampled profile was described and recorded in the field. The sample location was noted on the field map. At least two quarts of sampled soil material were placed in clean, labeled, polyethylene plastic bags and kept cool and as dry as possible to limit chemical changes. Due to the timing of the sampling (i.e., early summer for the baseline assessment) and due to the cooler than normal temperatures during the radiometric sampling, ambient air temperatures were not considered excessive. Samples were kept out of direct sunlight and transported to the Gillette office of Energy Laboratories for shipment to the Billings office for analysis. In general, samples were taken to Energy Laboratories within one week of actual collection.

A total of 3 sites on the Reno Creek Project (outside the proposed irrigation area) were sampled for analysis and corresponding soil profile descriptions written. *They were saline phases of upland Zigweid; Kim and Forkword soil series. The samples were taken because of visual indications (evidence of saline conditions) of unsuitability for reclamation. All three samples were taken in bottomland locations along the Belle Forche River drainage. Therefore, chemical analysis should not be considereed representative of the usual quality or suitability of these soils for reclamation on upland sites.* Soil mapping unit designations and associated acreages are presented in Table 11.1. *Soil sample locations are shown on Plate 11.1.*

In addition, six *soil* series locations were sampled within the proposed ~~irrigation~~ *land application* area. *The locations were selected as representative of these soil series.* ~~These series included:~~ The sampled soul series were; Shingle, Forkwood (Ft. Collins), Theedle (Thedalund), Kishona (Kim), Cushman, and Zigweid. These six series comprised the major series encountered within that area.

TABLE 11.1
RENO CREEK PROJECT
TOPSOIL VOLUME SUMMARY
MAPPING UNIT

SYMBOL & NAME	COMPOSITION OF STUDY AREA ACRES	%	AVERAGE DEPTH OF SUITABLE MATERIALS[1] (FT)	AVERAGE DEPTH OF A+B HORIZON [2] (FT)	AREA TO BE STRIPPED OF A+B MATERIAL (ACRES)	SALVAGE VOLUME (ACRE - FT)	LIMITATIONS TO SUITABILIT'Y
807CD Bowbac - 6-15%	12.7	0.4	2.5	1.08	0.67	0.73	hig!. sand content
801AB Cambria - 0-6%	125.7	3.5	5.0	1.25	3.07	3.84	
800CD Cushman - 6-15%	153.6	4.3	2.5	1.08	0.06	0.06	paralithic <40" within Cushman
212B Cushman-Cambria - 0-6%	30.5	0.9	3.0	1.25	0.00	-	
345B Cushman-Theedle - 3-6%	97.7	2.7	2.5	1.25	0.00	-	
392CD Decolney-Hilard 6-15%	45.8	1.3	3.5	2.0	0.0	-	high sand content
Disturbed	6.3	0.2	0.0	<0.5[3]	0.0	-	
b45AB Forkwood-Cambria 0-6%	111.7	3.1	5.0	2.0	0.0	-	
410 Forkwood-Cambria 0-6%	189.1	5.3	5.0	1.75	0.23	0.4	
356B Forkwood-Cabria 0-6%	285.6	7.8	3.5	1.50	0.0	-	paralithic <40" within Cushman
331AB Forkwood-Ulm 0-6%	30.5	0.9	5.0	1.50	0.0	-	
EA62 Hiland 0.6%	15.2	0.4	4.0	1.50	10.50	15.76	high sand content
380AB Hiland-Bowbac 0-6%	195.5	5.4	3.5	2.0	0.00	-	high sand content
380CD Hiland-Bowbac 6-15%	54.6	1.5	3.5	1.5	0.00	-	high sand content
384AB Hiland-Vonalee 0-6%	21.6	0.7	3.5	1.5	0.00	-	high sand or shale content
802AB Kishona 0-6%	181.6	5.1	4.0	0.5	3.48	1.74	Alluviated shale & siltstone
417BD Shingle-Taluce 3-30%	5.1	0.1	1.0	0.75	0.00	-	high sand or shale content
158AB Kishona-Cambria-Zigweld 0.6%	529.3	14.6	4.0	1.25	0.17	0.21	alluviated shale & siltstone within Kishona & Zigweid
a79BD Parmleed 6-6%	3.8	0.1	2.5	1.25	0.00	-	high clay or salts
805CD Shingle 6-15%	63.5	1.8	1.0	<0.5	0.08	0.04	weathered shale
347CD Shingle-Theedle 6-30%	248.8	6.8	1.5	0.75	0.8	0.60	weathered shale
804CD Theedle 6-15%	198.0	5.5	2.5	0.67	5.48	3.67	paralithic <40"
177B Theedle-Kishona 3-9%	866.9	24.0	3.0	0.75	3.95	2.96	paralithic <40" within Theedle
395CD Turnercrest-Keeline-Taluce 6-30%	31.7	0.9	2.5	1.0	0.00	-	high sand content
418BD Terro-Vonalee 0.6%	50.8	1.4	2.5	0.75	0.00	-	
806CD Turnercrest 6-15%	6.3	0.2	2.5	1.0	0.00	-	paralithic <40"
803AB Zigweid 0.6%	38.1	1.1	3.5	0.5	0.00	-	alluviated shale & siltstone
Total	3600.0				28.49	29.99	

Reno Creek
Footnotes to Table 11.1

[1] Depth of suitability as defined in Table I-2, WDEQ-LQD Guideline #1 (11/84).
[2] Salvage of A and B horizons of soil only, as per discussions in Section 15.1.
[3] Disturbed profile depth estimated.

Table 11.1 Reno Creek Project Topsoil Volume Summary Mapping Unit

11.2.5 LABORATORY ANALYSIS

Upon receipt at the Billings office of Energy Laboratories, topsoil samples were logged into the computer system. Samples were placed into lined aluminum pans to dry in an oven at 80 degrees F. Clods were broken down into manageable pieces prior to determining coarse fragments. Coarse fragments were measured with a 10 mesh screen prior to grinding; the entire sample was then hand ground to pass 10 mesh. An approximate 20 ounce sub-sample was obtained through splitting with a series of riffle splitters and subsequently analyzed. A second sub-sample was maintained in storage at Energy Laboratories.

~~Actual~~ Laboratory analysis follows the methodology outlined in WDEQ, LQD Guideline 1 *(1984)*. ~~That~~ Methodology is found in ~~Addendum 2~~ *Attachment 11-1-2*, Energy Laboratory Analysis Methodology. In general, samples were analyzed within 30 days of receipt of the samples to limit any chemical changes.

Approximately 20 percent of the samples were run for duplicate analysis. All analytical data is found in ~~Addendum 5~~ *Attachment 11.1-6 and 11.1-7*, Summary of Soil Analytical Results.

The three bottomland samples selected because of suspect quality for reclamation purposes were analyzed for the following parameters.

pH (paste)	*Textural Analysis*
EC (extract)	*Organic matter*
Saturation %	*B*
Ca	*Se*
Mg	
Na	

Analysis results are found in Attachment 11.1-6.

The six sample locations within the proposed land application area were selected as representative of soil series in the land application area and were analyzed for the following parameters. Samples were selected from identifiable horizons and subunits.

pH (paste)	*Textural Analysis*
Saturation %	*Nitrate*
Electrical Conductivity (Extract)	
Ca	*Se*
Mg	*As*
Na	*B*
SAR	*Mo*

^{226}Ra
^{230}Th }Upper 5 feet
U-nat

11.3 RESULTS AND DISCUSSION

11.3.1 SOIL SURVEY - GENERAL

The soils occurring on the Reno Creek Project are typical of the semi-arid grasslands of the western United States. Due to prevailing climate and vegetation conditions, organic matter is accumulated slowly, and soils have developed with light-colored surfaces. Subsoil color is usually light brown or yellowish brown.

The greatest proportion of the upland soils of the study area are residual (i.e. developed in place) and are formed from weathered sedimentary bedrock, mostly sandstone and shale. Most developed soils reflect the character of the bedrock. Areas of sandy and medium-textured friable soils are underlain by sandstone and loamstone. Heavy clay soils are underlain by clayey shale. These soils vary widely in both depth and suitability of the material for topsoiling depending primarily on the parent material from which the soils have formed.

Smaller stream channels of the study area are characterized by alluvial soils such as the Kishona (formerly Kim) series. These soils are developed from a variety of material washed from the uplands and redeposited along the stream courses. The soils formed in alluvium reflect the character of the weathered, transported material. These soils often have a generally dark friable surface that contains a larger amount of organic matter than upland soils.

Larger stream channels of the study area are characterized by deeper haplargids such as Forkwood (formerly Fort Collins) series or Ulm series. These residual soils are developed in-place. There are also areas of alluvial soils such as Kishona. Depending upon the water regime in specific areas, all series may have saline phases associated with them.

Refer to ~~Addendum 3~~ *Attachment 11.1-3* for SCS soil series descriptions for those series encountered within the current permit area.

11.3.2 SOIL MAPPING UNIT INTERPRETATION

The 1993 mapping resulted in some additional mapping units due to the smaller scale of the Order 1 survey within the proposed disturbed area. However, no new series from the existing SCS mapping were encountered. Refer to ~~Addendum 4~~ *Attachment 11.1-4* for SCS soil mapping unit descriptions within the study area.

Mapping the larger drainages such as the Belle Fourche drainage is difficult due to past stream channel meandering and resultant deposition, as well as past and current agricultural water development and crested wheatgrass haylands. The C horizons are extremely variable and stratified in many locations. Individual series descriptions reflect this variability.

Sample numbers were based on verbal agreements between WDEQ-LQD and EFNI personnel. Only those areas of questionable reclamation quality material within the proposed disturbed area were sampled for chemical analysis. However, numerous pedons were exposed during initial mapping of the study.

A representative soil sample from each soil series identified within the plant area, irrigation reservoir or main access road will be sampled and analyzed for parameters found on Table I-2, WDEQ-LQD Guideline 1 (11-84). Analytical information will be used to determine suitability of the A+B horizon *for salvage and help define average depth. Analytical information will be provided to the WDEQ-LQD as shown as it is available in the spring of 1994. Soil sample locations will be shown on Plate 11.1.*

11.3.3 ANALYTICAL RESULTS

Lab analyses of the 1993 soil samples did not include percent very fine sands since the encountered soil series did not require very fine sands for delineation and since there was a limited number of samples. Field observations of fine sands, an indirect measure of the very fine sand portion within individual peds, if necessary, were used to determine series designation.

Refer to Addendum 6 and 7, in Attachment 11, for a complete collection of original laboratory data for the samples outside the proposed irrigation area and within the proposed irrigation area, respectively.

11.3.4 EVALUATION OF SOIL SUITABILITY AS A PLANT GROWTH MEDIUM

Within the study area, suitability of soil as a plant growth medium is limited by physical factors such as sandy or high clay textures or chemical factors such as high sodium adsorption ratio (SAR), high electrical conductivity (EC), or excess selenium. Many sampling intervals, specifically at depth, contained selenium of 0.1 ppm and high EC's and SAR's. Although the majority of pedon locations were not sampled for chemical analysis, marginal material is likely found in sandy upland ridge areas, clay upland breaks or broken topography, or lowland flats where salt accumulation may be a problem, specifically near the Belle Fourche River drainage. *Two suspected saline phases of soils limiting plant growth were sampled as part of baseline investigations. The analytical reports for these soils area found in Attachment 11.1-6. It is important to note that these soil phases are not representative of these soil series, but were selected as worst case.* Specific discussion of topsoil suitability by map unit is found in Addendum 4, Soil Mapping Unit Descriptions. Soil analytical information is found in ~~Addendum 6~~ *Attachment 11.1-6.*

Based on the analytical results of the soils within the proposed irrigation area, little or no chemical or physical problems exist within the soil series and the underlying paralithic or bedrock material. Only one sample, Shingle at 30-64", exhibited chemical characteristics in excess of WDEQ-LQD Guideline

#1 suitability criteria. The Shingle series exhibited selenium levels in excess of 0.1 ppm. Soil analytical information from the proposed irrigation area is found in ~~Addendum 7~~ *Attachment 11.1-7*.

Selenium is a naturally occurring element within the Reno Creek project although the analyzed data does not necessarily reflect that. It was generally not found within the analyzed samples of the proposed irrigation area but was found within the deeper horizons of the saline soils of the Belle Fourche River drainage. Selenium indicator plants are present within the drainages in the area and on upland ridge tops.

11.3.5 TOPSOIL VOLUME CALCULATIONS

Based on the initial review of current permit area soil series and study area field work with subsequent chemical analysis for questionable series, material suitable for use as topsoil were determined for the individual mapping units. Average suitability depths by mapping unit are shown in Table 11.1. Proposed disturbance acres are shown on Plate 11.1.

11.3.6 PRIME FARMLAND ASSESSMENT

No prime farmland was indicated within the study area based on a reconnaissance survey by the SCS, Gillette field office. Refer to ~~Addendum 1~~ *Attachment 11.1-1*, Correspondence, for the SCS letter of negative determination.

11.3.7 REFERENCES

~~Kerr McGee Coal Corporation. 1992. Black Thunder Mine Permit Application Appendix D-7, TFN 233-T5. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.~~

~~Thunder Basin Coal Company. 1992. Black Thunder Mine Permit Application Appendix D-7, TFN 233-T5. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.~~

1992. Black Thunder Mine. Renewal/Amendment Application for Permit No. 233-T4 (TFN 2 3/279). Appendix D-8. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.

1992. Jacobs Ranch Mine. Renewal/Amendment Application for Permit No. 271-T2 (TFN 2 6/288).

Appendix D-8. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.

U.S.D.A. Soil Conservation Service. 1979. Soil Survey of Northern Campbell County, Wyoming. Open file form.

U.S.D.A. Soil Conservation Service. 1992. Revisions of the 1979 Soil Survey of the LBA Tract, Northern Campbell County, Wyoming. Verbal Communication.

U.S.D.A. 1951. Soil Survey Manual. U.S. Dept. of Agric. Handbook 18, 503 pp. Government Printing Office.

U.S.D.A. 1975. Soil Taxonomy. U.S. Dept. of Agric. Handbook 436, 754 pp. Government Printing Office.

Wyoming Dept. of Environmental Quality, Land Quality Division. 1984. Guideline 1, Topsoil and Overburden *(1984)*.

12. VEGETATION (APPENDIX D-8)

12.1 INTRODUCTION

This report presents information on the vegetation occurring on the Reno Creek Project which is located approximately 10 miles southwest of Wright, Wyoming. The specific area has not been previously surveyed for the vegetation resource nor have any adjacent areas. The closest surveys were conducted for the Black Thunder Mine permit area and the Jacobs Ranch permit area approximately 25 miles east of the existing permit area. The major objective of the 1993 assessment was to define the baseline vegetation resource prior to any surface disturbance associated with a proposed in-situ mine.

The vegetation inventory of the proposed Reno Creek project area was performed by BKS Environmental Associates, Inc. of Gillette, Wyoming. The methodology used for the vegetation inventory is an alternate methodology from that described in Wyoming Department of Environmental Quality, Land Quality Division (WDEQ-LQD) ~~Rules and Regulations, Appendix A (March 1989)~~ *Guideline number 2 (March, 1986).* The current methodology *also* incorporates the elements discussed ~~and agreed upon~~ by Energy Fuels Nuclear, Inc. (EFNI) and WDEQ personnel. A general description of this methodology is set forth in a letter from the WDEQ-LQD to EFNI dated April 5, 1993.

In addition to the baseline mapping and sampling of the permit area, radiometric vegetation sampling was conducted within ~~a~~ *the* proposed ~~irrigation area~~ *land application area*. Information on that study is included *in Section 14.1*.

12.2 METHODOLOGY

Based on discussions between EFNI and WDEQ personnel, a telephone conversation with Brenda K. Schladweiler of BKS Environmental Associates, Inc., and WDEQ-LQD ~~Rules and Regulations~~ *Guideline number 2*, ~~Appendix A (March 1989)~~, the following methodology was ~~proposed~~ *executed*.

12.2.1 VEGETATIVE TYPE DETERMINATION AND MAPPING

All vegetation mapping units were transferred to topographic base maps (1" = 1000'). Native vegetation types were segregated by lifeform and dominant species differences resulting from soil, slope and general topographic position. Areas defined on photographic base maps were field checked during preliminary field mapping and later transferred to the topographic base map.

Mapping units, other than native vegetation types, included disturbed sites and agricultural. The disturbed sites were primarily comprised of oil and gas drilling exploration sites and major road disturbance. Disturbed sites included both seeded and non-seeded areas and were qualitatively described only. There is no specific delineation of roads which were too small to be mapped. Agricultural areas were recent disturbance by agricultural activities. Older agricultural disturbances, if not distinguishable from surrounding native areas, were included in the native types.

Mapping unit acreages were derived by planimetering the mapping units on the vegetation map. The permit acreage table was then constructed.

Photographs of native vegetation types (i.e.. Upland Grassland, Big Sagebrush, and Meadow) are included in Addendum 2 and photo locations illustrated on the vegetation map.

12.2.2 SPECIES COMPOSITION

Plant identification was confirmed by the Rocky Mountain Herbarium in Laramie, WY, if necessary. All scientific nomenclature followed current nomenclature in use at the Herbarium during 1993. Refer to Addendum 3, 1993 Species List.

Any encountered federally designated threatened and endangered species, state plants of concern, noxious weeds and primary selenium indicators were identified.

12.2.3 STUDY AREA SAMPLING DESIGN

~~All sampling procedures were designed according to the Wyoming Department of Environmental Quality, Land Quality Division, Rules and Regulations. Appendix A (March, 1989).~~

Sampling locations were randomly determined by placing a grid over the 1"-1000' vegetation map. The x-axis was generally east-west, while the y-axis generally ran north and south. Grid interval at the scale utilized was approximately 100 feet on the ground. Sampling location coordinates were randomly generated by the HP15C hand calculator. Sample point selection was repeated until the desired number of points for each vegetation type was attained. All sample locations are plotted on the vegetation map.

12.2.4 EXTENDED REFERENCE AREA ESTABLISHMENT

Due to the inherent difficulties in applying the traditional reference area concept or control area concept to an in-situ uranium project, the modified extended reference area concept was employed for the Reno Creek project. The entire proposed permit area was included in the original sample design. ~~Cover transects were distributed over the entire permit area. An approximate 400 foot buffer around the proposed disturbed area is considered the extended reference area.~~ Refer to Plate 12.1 for location *of the extended reference area.* The extended reference area contains the major vegetation types that would be disturbed by mining activity: Upland Grassland, Big Sagebrush, and Meadow.

Since the exact location of the proposed disturbed area was not know at the time of sampling, the entire permit area was included in the original design. The mean and standard deviations for total vegetation cover and total cover for those points found only within the EXREFA are as follows:

Vegetation Type	*N*	*Total Vegetation*		*Total Cover*	
		X	*S*	*X*	*S*
Upland Grassland	*4*	*55.5*	*8.39*	*73.5*	*9.98*
Big Sagebrush	*4*	*55.5*	*3.42*	*85.5*	*5.97*
Meadow	*8*	*74.25*	*11.78*	*93.5*	*4.99*

These values are very similar to those derived for the entire permit area study. It is Brenda Schladweiler's, of BKS Environmental Associates, Inc., professional opinion that the vegetation types within the permit area are generally homogenous and that those values derived from the permit-wide study are representative of the extended reference area.

12.2.5 EXTENDED REFERENCE AREA ~~SAMPLING DESIGN~~ *DESCRIPTION*

The extended reference area was included in the total 1993 study area. ~~Sampling locations were randomly determined as described earlier.~~ *No specific sampling program was applied to the extended reference area.*

12.2.6 TIME OF SAMPLING

All cover sampling occurred for all communities at various intervals through July and early August, 1993.

12.2.7 PLOT SIZE AND SHAPE

Cover plots consisted of 50 meter transects with readings taken every meter and summarized by transect within a specific vegetation type.

12.2.8 MEASUREMENTS

12.2.8.1 COLLECTION AND ANALYSIS OF COVER DATA

A ~~minimum of 15~~ *maximum of 50* transects for cover were sampled within each study area vegetation type. Statistical adequacy was not part of the original understanding with the WDEQ. However, at the time of sampling, additional samples were taken to insure ~~either~~ adequacy ~~or the maximum number allowed by WDEQ-LQD Rules and Regulations, Appendix A~~ *using the formula presented in Section 12.3.7.* All field sampling for cover occurred after July 1, 1993.

Sample locations for cover within the study area were chosen by randomly selecting points within a grid of the permit area. Grid intervals did not exceed 100 feet on the ground. Random sample location coordinates were plotted on a map and located in the field by pacing from a known location. Random numbers between 1 and 360 were generated to orient the transect. A compass was then used in the field to orient the transect to the nearest 1/8 of 360 degrees.

Sample hits were read at 1 meter intervals along the entire length of the 50 meter transect. First hit (50) readings constituted the absolute cover values for total vegetation and total cover. Additional hits at each meter mark were recorded separately and included ~~in~~ absolute cover values for individual species. This multiple hit information was used to compile the overall plant list for the extension areas and to qualitatively describe the canopy within each respective vegetation type. In addition, litter, rock, and bare ground percentages were recorded. Transects that exceeded designated vegetation boundaries were randomly reoriented to be within the sampled vegetation type. *Cover data was summarized using computer software RIMA version 2 (RIMA, 1988). Cover summary tables in RIMA produce relative cover and relative frequency values. These two values for an individual species are combined to form the Importance Value which in turn determines the rank for that species. The species with the highest Importance Value has the highest rank.*

12.2.8.2 COLLECTION AND ANALYSIS OF PRODUCTIVITY DATA

As per discussions between WDEQ-LQD and EFNI personnel summarized in a letter dated April 5, 1993, no production data was obtained.

12.2.8.3 COLLECTION AND ANALYSIS OF TREE AND SHRUB DENSITY DATA

As per discussions between WDEQ-LQD and EFNI personnel summarized in a letter dated April 5, 1993, no ~~tree or~~ shrub data was obtained. *No tree exist within the study area.*

12.2.9 PRIME FARMLAND ASSESSMENT

Agricultural areas, consisting of relic crested wheatgrass fields, were qualitatively described only.

12.2.10 WETLANDS INVENTORY

A Wetlands Inventory within the permit area will be performed in the spring of 1994. The Wetlands Inventory will be inserted in this section when available.

12.2.11 EVALUATING POST-MINING RECLAMATION SUCCESS

Reclaimed areas and the extended reference area will be sampled for two consecutive years prior to proposed bond release. Cover by transect will be the quantitative parameter used to indicate reclamation success. Quantitative information will be supplemented with: photographs; qualitative comparison of the reclamation seed mix and resulting cover information; landowner input; actual field trips to view the site with WDEQ personnel; and presentation of grazing history and sustainability.

The extended reference area and the reclaimed areas will not be statistically compared. Both will be sampled as separate entities. The extended reference area will be sampled as one unit. However, EFNI personnel will determine whether individual reclaimed area units will be sampled separately or combined for bond release purposes, based, in part, on timing of seeding and actual seed mix.

A minimum of 15 cover samples in the extended reference area will be sampled in any given year. A minimum of 15 samples within the reclaimed area will also be sampled at the same time. All samples will be randomly determined. The letter of understanding between the WDEQ and EFNI personnel dated April 5, 1993 is found in Addendum 1, Correspondence.

12.3 RESULTS

12.3.1 DESCRIPTION OF VEGETATION TYPES

Three native vegetation types occur within the study area. The better drained, gently rolling upland areas are characterized by Big Sagebrush and Upland Grassland. Areas in or adjacent to defined stream channels or minor drainages consist of the Meadow vegetation type.

Past agricultural activities have resulted in relic crested wheatgrass fields. These fields do not appear to be regularly mowed for hay.

Table 12.3.1 lists acreage for each vegetation mapping unit within the permit area.

Within the permit area, native vegetation types occur over 99 percent of the approximate 3600 acres. Big Sagebrush is the dominant native vegetation type (60.7 percent) followed by Upland Grassland (24.5 percent) and Meadow (13.8 percent). Agricultural communities, including relic crested wheatgrass fields, account for 0.3 percent of the permit area. Disturbed areas encompass 0.7 percent.

<u>Upland Grassland</u>

Within the study area, rolling upland terrain is characterized by a grassland vegetation type with limited shrub cover. This native vegetation type covers ~~880~~ *883* acres within the study area. Dominant perennial graminoids include western wheatgrass (*Agropyron smithii*), needle-and-thread (*Stipa comata*), and blue grama (*Bouteloua gracilis*). Some areas mapped as Upland Grassland are in transition to Big Sagebrush.

<u>Big Sagebrush</u>

Within the study area, the Big Sagebrush vegetation type occupies ~~2,185~~ *2,188* acres. Big Sagebrush (*Artemisia tridentata*) is generally dense with blue grama and western wheatgrass in the understory. Shrub growth is variable depending on soil type and moisture. Borderline Meadow areas were included in Big Sagebrush if the understory was less productive and more indicative of the Big Sagebrush type. In addition, some acres mapped as Big Sagebrush are in transition to Upland Grassland.

<u>Meadow</u>

Within the study area, topographic drainages support a variable Meadow grassland community with scattered shrubs that occupies ~~497~~ *500* acres. This vegetation type includes ephemeral drainage bottoms and upland terraces. The dominant shrub is silver sagebrush. Dominant perennial grasses include western wheatgrass, green needlegrass, thickspike wheatgrass, and slender wheatgrass

(*Agropyron trachycaulum*). Borderline Big Sagebrush areas were included in Meadow if the understory was sufficiently productive and more indicative of the Meadow type.

<u>Agricultural</u>

Within the study area, the Agricultural mapping unit occurs on ~~12~~ *15* acres. It consists primarily of relic crested wheatgrass fields. Within Campbell County, the percent cover of seeded species within haylands generally decreases with time. It is usually during this period of decline that haylands are reworked or left to convert to pasturelands. The crested wheatgrass fields, as mapped on the study area, are generally old and have not been reworked in the recent past.

<u>Disturbed</u>

Within the study area, the Disturbed mapping unit occurs on ~~26~~ *27* acres. It consists primarily of oil and gas drilling activity and major roads.

12.3.2 VEGETATION MAP

Study area vegetation types and sampling sites are outlined on Plate 12.1.

12.3.3 WEEDS, SELENIUM INDICATORS, ENDANGERED OR THREATENED SPECIES

Encountered species cited as "noxious" weeds in the Agricultural Experiment Station, University of Wyoming, 1979, Bulletin 498, <u>"Weeds of Wyoming"</u> include Canada thistle (*Cirsium arvense*), field bindweed (*Convolvulus arvensis*), quackgrass (*Agropyron repens*), and skeletonleaf bursage (*Ambrosia tomentosa*). Each has a low frequency with extremely limited cover.

Selenium indicator species identified during the 1993 survey were two-grooved milkvetch (*Astragalus bisulcatus*), stemmy goldenweed (*Haplopappus multicaulis*), and woody aster (*Xylorhiza glabriuscula*). These plants appear to be more prevalent in limited areas such as shallow upland soils in broken topography and deep major drainage soils as are located within the Belle Fourche River drainage. Selenium indicator plants are not overall significant contributors in terms of cover or production.

None of the plants identified on the study area appear on the U.S. Department of Interior's "Endangered and Threatened Species Plants", as published in the Federal Register. Legal coordinates for the permit area were run through the Wyoming Natural Diversity Database in Laramie, Wyoming, with no previous collections being found. Written correspondence with the Nature Conservancy is found in Addendum 1.

12.3.4 SPECIES COMPOSITION

Addendum 3 lists species of plants encountered during the 1993 sampling of the study area. This list is arranged by lifeform.

12.3.5 NATIVE VEGETATION TYPE COVER ANALYSIS

All native vegetation types were quantitatively sampled to determine composition and cover.

Upland Grassland

Absolute total vegetation cover (60.2 percent) was dominated by perennial graminoids. *Based on rank shown in Table 12.3,* major perennial species included needle-and-thread, blue grama, threadleaf sedge, western wheatgrass, prairie junegrass, and thickspike wheatgrass. Annual graminoids accounted for 0.3 percent absolute species cover. Shrubs, primarily big sagebrush, provided 5.0 percent absolute species cover. Halfshrubs, primarily fringed sagewort, contributed 0.5 percent absolute species cover. Seventeen perennial forbs provided 4.7 percent absolute species cover. Five annual forbs provided 1.0 percent absolute species cover. Succulents provided 0.6 percent absolute species cover. Bare soil and litter/rock percentages were 18.3 and 21.5 percent, respectively.

Utilizing the minimum sample number formula ~~outlined in WDEQ, LQD Rules and Regulations, Appendix A (March, 1989),~~ *presented in Section 12.3.7,* sample adequacy was attained for total vegetation cover and total cover. Based on sample data, five sample points were required to attain adequacy for total vegetation and total cover, respectively. Fifty points were actually sampled.

Refer to Table 12.3.2 for a summary of the Upland Grassland study area cover data. Refer to Table 12.3.6 for sample adequacy figures for Total Vegetation Cover and Total Cover.

Big Sagebrush

Absolute total vegetation cover (61.0 percent) was dominated by perennial graminoids. *Based on rank shown in Table 12.3.3,* major perennial species included needle-and-thread, western wheatgrass, blue grama, prairie junegrass, threadleaf sedge, and thickspike wheatgrass. Annual graminoids accounted for 1.0 percent absolute species cover. Shrubs, primarily big sagebrush, provided 20.4 percent absolute species cover. Halfshrubs, primarily fringed sage, contributed 0.2 percent absolute species cover. Eighteen perennial forbs provided 5.4 percent absolute species cover. Six annual forbs provided 2.1 percent absolute species cover. Succulents provided 0.5 percent absolute species cover. Bare soil and litter/rock percentages were 15.1 and 23.4, respectively.

Utilizing the minimum sample number formula outlined in ~~WDEQ, LQD Rules and Regulations, Appendix A (March, 1989),~~ *Section 12.3.7* sample adequacy was attained for total vegetation and total cover. Based on sample data, five sample points were required to attain adequacy for total vegetation and total cover, respectively. Fifty points were actually sampled.

Refer to Table 12.3.3 for a summary of the Big Sagebrush study area cover data. Refer to Table 12.3.6 for sample adequacy figures for Total Vegetation Cover and Total Cover.

Meadow

Absolute total vegetation cover (75.2 percent) was dominated by perennial graminoids. *Based on rank shown in Table 12.3.4,* major perennial species included western wheatgrass, green needlegrass, needle-and-thread, foxtail barley, slender wheatgrass, and prairie junegrass. Annual graminoids accounted for 3.6 percent absolute species cover. Four shrub species, primarily big sagebrush, provided 3.0 percent absolute species cover. Halfshrubs, primarily Gardner saltbush, contributed 0.2 percent absolute species cover. Thirty perennial forbs provided 13.0 percent absolute species cover. Thirteen annual or biennial forbs provided 4.8 percent absolute cover. Succulents provided 0.0 percent absolute species cover. Bare soil and litter/rock percentages were 6.0 and 18.8, respectively.

Utilizing the minimum sample number formula outlined in ~~WDEQ, LQD Rules and Regulations, Appendix A (March, 1989)~~ *Section 12.3.7*, sample adequacy was attained for total vegetation and total cover. Based on sample data, nine sample points were required to attain adequacy for total vegetation and total cover, respectively. Fifty points were actually sampled.

Refer to Table 12.3.4 for a summary of the Meadow study area cover data. Refer to Table 12.3.6 for sample adequacy figures for Total Vegetation Cover and Total Cover.

12.3.6 STOCK PONDS AND OTHER DISTURBED OR DEVELOPED SITES

Some small drainages within the study contain stock watering ponds. Such ponds generally have fluctuating water levels and are usually small. Ponds are generally full during the high precipitation and spring snowmelt periods. Water levels, however, drop during the hot, high evaporation summer months and low rainfall years.

The vegetation of ponds and aquatic areas is variable depending upon the physical site conditions and disturbance from sheep and cattle. The less disturbed ponds are characterized by a vegetational zonation produced by a moisture gradient.

Disturbed and developed areas occupy ~~26~~ *27* acres of the study area. Several small disturbed sites scattered over the study area are a result of past oil and gas exploration. These disturbed exploration sites have been seeded, primarily with crested wheatgrass mixes.

Annual weeds are present in reseeded areas, along roads, in relic agricultural fields, and in other disturbed sites of the study area. Common "weedy" species observed in these habitats include: goosefoot (*Chenopodium* spp.), wavyleaf thistle (*Cirsium undulatum*), Russian thistle (*Salsola australis*), fireweed summercypress (*Kochia scoparia*), prostrate knotweed (*Polygonum aviculare*), curlycup gumweed (*Grindelia squarrosa*), yellow salsify (*Tragapogon dubius*), cheatgrass brome (*Bromus tectorum*), Japanese brome (*Bromus japonicus*), tumbling hedgemustard (*Sisymbrium altissimum*), and numerous others.

12.3.7 SAMPLE ADEQUACY

Sample adequacy was tested for each of the study area vegetation types using the following formula:

$$n_{min} \geq \frac{2(sz)^2}{(dx)^2}$$

Where n_{min} = minimum number of sampled line transects needed to adequately represent a given vegetation type.
s = sample standard deviation,
z = the z statistic (see table below),
d = amount of reduction desired (see table below),
x = sample mean for cover and production,

z Statistic and d Table

	z	d
Cover	1.28	0.1

12.4 DISCUSSION

Sampled data for the 1993 assessment generally reflect atypical climatic factors. Sample year 1993 contained cooler than normal temperatures in May through July with above average precipitation. As a result, cover values are generally higher than normal for all lifeforms.

Table 12.3.1 Acreages of Each Vegetation Type within the Study Area.

Vegetation Type	Total Area (Acres)	Total %	Area Within Extended Reference Area (Acres)
Upland Grassland	883.0	24.5	49.2
Big Sagebrush	2188.0	60.7	262.0
Meadow	500.0	13.8	36.8
Agriculture	15.0	00.3	1.0
Disturbed	27.0	00.7	0.0
TOTAL	3613.0	100.0	349.0

Table 12.3.1 Acreages of Each Vegetation Type Within the Study Area

Table 12.3.2 1993 ENERGY FUELS UPLAND GRASSLAND COVER.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
COOL SEASON PERENNIAL GRASSES							
Agropyron dasystachyum	2.84	5.02	0 - 12	54.00	5.84	10.87	7
Agropyron smithii	3.80	6.72	0 - 28	64.00	6.93	13.64	4
Aristida longiseta	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Carex filifolia	8.68	15.35	0 - 28	90.00	9.74	25.09	3
Carex stenophylla	0.28	0.50	0 - 4	12.00	1.30	1.79	16
Koeleria macrantha	2.76	4.88	0 - 14	70.00	7.58	12.46	5
Poa canbyi	0.24	0.42	0 - 4	6.00	0.65	1.07	21
Poa fendleriana	0.24	0.42	0 - 4	6.00	0.65	1.07	21
Poa sandbergii	2.04	3.61	0 - 8	62.00	6.71	10.32	8
Stipa comata	12.72	22.49	2 - 38	100.00	10.82	33.31	1
Stipa viridula	0.44	0.78	0 - 6	18.00	1.95	2.73	15
Sub-total	34.08	60.25					
WARM SEASON PERENNIAL GRASSES							
Bouteloua gracilis	10.24	18.10	0 - 30	96.00	10.39	28.49	2
Calamovilfa longifolia	0.08	0.14	0 - 2	4.00	0.43	0.57	27
Sub-total	10.32	18.25					
ANNUAL GRASSES							
Bromus japonicus	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Bromus tectorum	0.12	0.21	0 - 2	6.00	0.65	0.86	24
Festuca octoflora	0.16	0.28	0 - 4	6.00	0.65	0.93	23
Sub-total	0.32	0.57					
PERENNIAL FORBS							
Allium textile	0.08	0.14	0 - 2	4.00	0.43	0.57	27
Arenaria hookeri	0.20	0.35	0 - 4	6.00	0.65	1.00	22
Astragalus mollissimus	0.08	0.14	0 - 2	4.00	0.43	0.57	27
Astragalus spatulatus	0.12	0.21	0 - 2	6.00	0.65	0.86	24
Comandra umbellata	0.04	0.07	0 - 2	2.00	0.22	0.29	28

Table 12.3.2(cont'd). 1993 ENERGY FUELS UPLAND GRASSLAND COVER.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
Gaura coccinea	0.08	0.14	0 - 2	4.00	0.43	0.57	27
Grindelia squarrosa	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Heterotheca villosa	0.20	0.35	0 - 4	8.00	0.87	1.22	19
Lupinus argenteus	0.44	0.78	0 - 10	8.00	0.87	1.64	17
Musineon divaricatum	0.16	0.28	0 - 2	8.00	0.87	1.15	20
Oenothera caespitosa	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Penstemon nitidus	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Phlox hoodii	1.56	2.76	0 - 8	46.00	4.98	7.74	9
Phlox multiflora	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Sphaeralcea coccinea	0.80	1.41	0 - 4	34.00	3.68	5.09	11
Taraxacum officinale	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Vicia americana	0.76	1.34	0 - 10	24.00	2.60	3.94	12
Sub-total	4.72	8.35					
ANNUAL AND BIENNIAL FORBS							
Alyssum desertorum	0.08	0.14	0 - 2	4.00	0.43	0.57	27
Camelina microcarpa	0.08	0.14	0 - 2	4.00	0.43	0.57	27
Lepidium densiflorum	0.16	0.28	0 - 6	4.00	0.43	0.72	25
Plagiobothrys scouleri	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Plantago patagonica	0.68	1.20	0 - 8	20.00	2.16	3.37	13
Sub-total	1.04	1.84					
SEMI-SHRUBS OR HALF-SHRUBS							
Artemisia frigida	0.28	0.50	0 - 4	10.00	1.08	1.58	18
Atriplex gardneri	0.12	0.21	0 - 4	4.00	0.43	0.65	26
Ceratoides lanata	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Gutierrezia sarothrae	0.04	0.07	0 - 2	2.00	0.22	0.29	28
Sub-total	0.48	0.85					
SHRUBS							
Artemisia pedatifida	1.36	2.40	0 - 8	36.00	3.90	6.30	10
Artemisia tridentata	3.68	6.51	0 - 24	54.00	5.84	12.35	6
Sub-total	5.04	8.91					

Table 12.3.2(cont'd). 1993 ENERGY FUELS UPLAND GRASSLAND COVER.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
CACTI AND SUCCULENTS							
Opuntia polyacantha	0.56	0.99	0 - 6	20.00	2.16	3.15	14
Sub-total	0.56	0.99					
SUM OF SPECIES COVER	56.56						
Lichens	0.14		0 - 0	100.00			
TOTAL VEGETATION	60.24 +/-	7.22					
LITTER/ROCK	21.48 +/-	6.22					
BARE SOIL	18.28 +/-	9.20					
TOTAL COVER	80.28 +/-	9.87					
Number of Species/sample	9.24						

Table 12.3.3 1993 ENERGY FUELS BIG SAGEBRUSH COVER.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
COOL SEASON PERENNIAL GRASSES							
Agropyron dasystachyum	2.64	4.29	0 - 14	50.00	5.32	9.61	8
Agropyron smithii	5.64	9.16	0 - 20	78.00	8.30	17.46	3
Carex filifolia	4.28	6.95	0 - 22	74.00	7.87	14.82	6
Carex stenophylla	0.12	0.19	0 - 2	6.00	0.64	0.83	21
Koeleria macrantha	4.24	6.89	0 - 18	76.00	8.09	14.97	5
Poa canbyi	0.40	0.65	0 - 2	20.00	2.13	2.78	15
Poa fendleriana	0.12	0.19	0 - 4	4.00	0.43	0.62	23
Poa sandbergii	0.72	1.17	0 - 6	26.00	2.77	3.94	13
Stipa comata	5.96	9.68	0 - 12	90.00	9.57	19.26	2
Stipa viridula	1.80	2.92	0 - 12	34.00	3.62	6.54	10
Sub-total	25.92	42.11					
WARM SEASON PERENNIAL GRASSES							
Bouteloua gracilis	5.64	9.16	0 - 22	76.00	8.09	17.25	4
Sub-total	5.64	9.16					
INTRODUCED PERENNIAL GRASSES							
Agropyron cristatum	0.28	0.45	0 - 12	4.00	0.43	0.88	20
Poa pratensis	0.12	0.19	0 - 2	6.00	0.64	0.83	21
Sub-total	0.40	0.65					
ANNUAL GRASSES							
Bromus japonicus	0.28	0.45	0 - 6	8.00	0.85	1.31	17
Bromus tectorum	0.56	0.91	0 - 12	10.00	1.06	1.97	16
Festuca octoflora	0.12	0.19	0 - 4	4.00	0.43	0.62	23
Sub-total	0.96	1.56					
PERENNIAL FORBS							
Achillea millefolium	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Antennaria rosea	0.08	0.13	0 - 2	4.00	0.43	0.56	24

Table 12.3.3(cont'd). 1993 ENERGY FUELS BIG SAGEBRUSH COVER.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
Arenaria hookeri	0.08	0.13	0 - 2	4.00	0.43	0.56	24
Artemisia ludoviciana	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Astragalus bisulcatus	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Astragalus spatulatus	0.20	0.32	0 - 4	8.00	0.85	1.18	18
Cerastium arvense	0.12	0.19	0 - 4	4.00	0.43	0.62	23
Gaura coccinea	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Heterotheca villosa	0.16	0.26	0 - 8	2.00	0.21	0.47	25
Lesquerella arenosa	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Lupinus argenteus	0.16	0.26	0 - 6	4.00	0.43	0.69	22
Machaeranthera tanacetifolia	0.12	0.19	0 - 2	6.00	0.64	0.83	21
Phlox hoodii	0.84	1.36	0 - 4	32.00	3.40	4.77	12
Polygonum douglasi	0.04	0.06	0 - 0	2.00	0.21	0.28	26
Psoralea argophylla	0.16	0.26	0 - 4	6.00	0.64	0.90	19
Sphaeralcea coccinea	0.76	1.23	0 - 4	34.00	3.62	4.85	11
Taraxacum officinale	0.12	0.19	0 - 2	6.00	0.64	0.83	21
Vicia americana	2.36	3.83	0 - 10	58.00	6.17	10.00	7
Sub-total	5.40	8.77					
ANNUAL AND BIENNIAL FORBS							
Descurainia pinnata	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Draba nemorosa	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Lupinus pusillus	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Microsteris gracilis	0.08	0.13	0 - 2	4.00	0.43	0.56	24
Plagiobothrys scouleri	0.08	0.13	0 - 2	4.00	0.43	0.56	24
Plantago patagonica	1.84	2.99	0 - 10	48.00	5.11	8.10	9
Sub-total	2.12	3.44					
SEMI-SHRUBS OR HALF-SHRUBS							
Artemisia frigida	0.12	0.19	0 - 2	6.00	0.64	0.83	21
Gutierrezia sarothrae	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Sub-total	0.16	0.26					

Table 12.3.3(cont'd). 1993 ENERGY FUELS BIG SAGEBRUSH COVER.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
SHRUBS							
Artemisia pedatifida	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Artemisia tridentata	20.40	33.14	6 - 46	100.00	10.64	43.78	1
Sub-total	20.44	33.20					
CACTI AND SUCCULENTS							
Opuntia fragilis	0.04	0.06	0 - 2	2.00	0.21	0.28	26
Opuntia polyacantha	0.48	0.78	0 - 4	20.00	2.13	2.91	14
Sub-total	0.52	0.84					
SUM OF SPECIES COVER	61.56						
Lichens	0.05		0 - 0	100.00			
TOTAL VEGETATION	61.00 +/- 7.13						
LITTER/ROCK	23.36 +/- 7.28						
BARE SOIL	15.12 +/- 9.44						
TOTAL COVER	84.16 +/- 9.36						
Number of Species/sample	9.40						

Table 12.3.4 1993 ENERGY FUELS MEADOW COVER.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
PERENNIAL GRASSES							
Bromus carinatus	0.08	0.08	0 - 4	2.00	0.17	0.26	47
Sub-total	0.08	0.08					
COOL SEASON PERENNIAL GRASSES							
Agropyron dasystachyum	1.76	1.83	0 - 12	40.00	3.47	5.30	9
Agropyron riparium	0.92	0.96	0 - 12	18.00	1.56	2.52	20
Agropyron smithii	36.48	37.97	4 - 82	100.00	8.68	46.65	1
Agropyron spicatum	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Agropyron trachycaulum	2.76	2.87	0 - 52	20.00	1.74	4.61	12
Carex filifolia	0.56	0.58	0 - 6	18.00	1.56	2.15	25
Carex praegracilis	0.68	0.71	0 - 18	10.00	0.87	1.58	32
Carex stenophylla	0.40	0.42	0 - 10	8.00	0.69	1.11	37
Distichlis spicata	0.84	0.87	0 - 24	4.00	0.35	1.22	35
Eleocharis palustris	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Elymus canadensis	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Hordeum jubatum	3.08	3.21	0 - 54	16.00	1.39	4.59	13
Juncus balticus	0.56	0.58	0 - 10	10.00	0.87	1.45	33
Koeleria macrantha	2.16	2.25	0 - 10	50.00	4.34	6.59	5
Poa ampla	0.16	0.17	0 - 2	8.00	0.69	0.86	39
Poa canbyi	0.08	0.08	0 - 2	4.00	0.35	0.43	44
Poa fendleriana	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Poa juncifolia	1.60	1.67	0 - 10	26.00	2.26	3.92	16
Poa sandbergii	1.16	1.21	0 - 8	42.00	3.65	4.85	10
Schedonnardus paniculatus	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Stipa comata	3.12	3.25	0 - 20	38.00	3.30	6.55	6
Stipa viridula	5.24	5.45	0 - 22	68.00	5.90	11.36	3
Sub-total	61.76	64.28					
WARM SEASON PERENNIAL GRASSES							
Bouteloua gracilis	1.00	1.04	0 - 8	30.00	2.60	3.64	17
Sub-total	1.00	1.04					

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
INTRODUCED PERENNIAL GRASSES							
Agropyron cristatum	1.52	1.58	0 - 22	20.00	1.74	3.32	19
Poa pratensis	7.00	7.29	0 - 64	58.00	5.03	12.32	2
Sub-total	8.52	8.87					
ANNUAL GRASSES							
Bromus japonicus	1.76	1.83	0 - 12	34.00	2.95	4.78	11
Bromus tectorum	1.72	1.79	0 - 12	30.00	2.60	4.39	14
Festuca octoflora	0.12	0.12	0 - 4	4.00	0.35	0.47	43
Sub-total	3.60	3.75					
PERENNIAL FORBS							
Achillea millefolium	0.16	0.17	0 - 2	8.00	0.69	0.86	39
Allium textile	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Ambrosia tomentosa	0.32	0.33	0 - 16	2.00	0.17	0.51	42
Antennaria rosea	0.08	0.08	0 - 4	2.00	0.17	0.26	47
Artemisia ludoviciana	1.16	1.21	0 - 12	32.00	2.78	3.99	15
Aster chilensis	0.12	0.12	0 - 4	4.00	0.35	0.47	43
Aster falcatus	0.20	0.21	0 - 6	26.00	2.26	2.47	23
Astragalus bisulcatus	0.12	0.12	0 - 6	2.00	0.17	0.30	46
Astragalus mollisimus	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Besseya wyomingensis	0.36	0.37	0 - 6	12.00	1.04	1.42	34
Cerastium arvense	0.48	0.50	0 - 8	16.00	1.39	1.89	28
Cirsium arvense	1.12	1.17	0 - 32	14.00	1.22	2.38	24
Comandra umbellata	0.08	0.08	0 - 2	4.00	0.35	0.43	44
Equisetum laevigatum	0.32	0.33	0 - 6	10.00	0.87	1.20	36
Gaura coccinea	0.68	0.71	0 - 16	14.00	1.22	1.92	27
Glycyrrhiza lepidota	0.08	0.08	0 - 4	2.00	0.17	0.26	47
Lomatium foeniculaceum	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Lomatium orientale	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Lupinus argenteus	0.40	0.42	0 - 6	14.00	1.22	1.63	31
Musineon divaricatum	0.04	0.04	0 - 2	2.00	0.17	0.22	48

Table 12.3.4(cont'd). 1993 ENERGY FUELS MEADOW COVER.

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
Phlox hoodii	0.08	0.08	0 - 2	4.00	0.35	0.43	44
Polygonum douglasi	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Psoralea argophylla	0.20	0.21	0 - 4	8.00	0.69	0.90	38
Rumex salicifolius	0.08	0.08	0 - 4	2.00	0.17	0.26	47
Solidago missouriensis	0.44	0.46	0 - 8	14.00	1.22	1.67	29
Solidago mollis	0.60	0.62	0 - 10	12.00	1.04	1.67	30
Sphaeralcea coccinea	0.64	0.67	0 - 8	16.00	1.39	2.05	26
Taraxacum officinale	3.20	3.33	0 - 28	44.00	3.82	7.15	4
Thermopsis rhombifolia	0.08	0.08	0 - 2	4.00	0.35	0.43	44
Tragopogon dubius	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Vicia americana	1.80	1.87	0 - 14	44.00	3.82	5.69	8
Sub-total	13.08	13.61					
ANNUAL AND BIENNIAL FORBS							
Alyssum desertorum	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Camelina microcarpa	0.56	0.58	0 - 6	22.00	1.91	2.49	22
Chenopodium album	0.08	0.08	0 - 4	2.00	0.17	0.26	47
Descurainia pinnata	0.16	0.17	0 - 2	8.00	0.69	0.86	39
Descurainia sophia	0.12	0.12	0 - 4	4.00	0.35	0.47	43
Lappula redowskii	0.16	0.17	0 - 2	8.00	0.69	0.86	39
Melilotus officinalis	1.64	1.71	0 - 32	22.00	1.91	3.62	18
Plagiobothrys scouleri	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Plantago patagonica	0.44	0.46	0 - 8	14.00	1.22	1.67	29
Sisymbrium altissimum	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Thlaspi arvense	1.40	1.46	0 - 26	12.00	1.04	2.50	21
Xanthium strumarium	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Sub-total	4.72	4.91					
SEMI-SHRUBS OR HALF-SHRUBS							
Artemisia frigida	0.08	0.08	0 - 2	4.00	0.35	0.43	44
Atriplex gardneri	0.16	0.17	0 - 4	6.00	0.52	0.69	40
Gutierrezia sarothrae	0.04	0.04	0 - 2	2.00	0.17	0.22	48
Sub-total	0.28	0.29					

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency (%)	I.V.	Rank
SHRUBS							
Artemisia cana	0.28	0.29	0 - 10	4.00	0.35	0.64	41
Artemisia tridentata	2.52	2.62	0 - 22	40.00	3.47	6.10	7
Atriplex canescens	0.16	0.17	0 - 8	2.00	0.17	0.34	45
Chrysothamnus nauseosus	0.08	0.08	0 - 4	2.00	0.17	0.26	47
Sub-total	3.04	3.16					
SUM OF SPECIES COVER	96.08						
Lichens	<0.01		0 - <1	100.00			
TOTAL VEGETATION	75.20 +/-	12.22					
LITTER/ROCK	18.80 +/-	9.99					
BARE SOIL	5.96 +/-	5.29					
TOTAL COVER	94.04 +/-	5.24					
Number of Species/sample	11.62						

Table 12.3.5. Summary of Percent Absolute Cover Data.

Vegetation Type	Total Veg	Litter/Rock	Bare Soil	Total Cover
Upland Grassland	60.24	21.48	18.28	80.28
Big Sagebrush	61.00	23.36	15.12	84.16
Meadow	75.20	18.80	5.96	94.04

NOTE: Numbers compiled from individual vegetation type cover summaries.

Table 12.3.5 Summary of Percent Absolute Cover Data

Table 12.3.6. Sample Adequacy of Derived Cover Data.

Sampled Area Vegetation Parameter	Vegetation Parameter (x + 1 S.D.)		Actual Sample Size	Computed Adequate Sample Size	Computed z-value	Confidence Level Achieved
Upland Grassland						
Total Veg Cover (%)	60.24	7.22	50	5	-	90.00
Total Cover (%)	80.28	9.87	50	5	-	90.00
Big Sagebrush						
Total Veg Cover (%)	61.00	7.13	50	5	-	90.00
Total Cover (%)	84.16	9.36	50	5	-	90.00
Meadow						
Total Veg Cover (%)	75.20	12.22	50	9	-	90.00
Total Cover (%)	94.04	5.29	50	9	-	90.00

12.5 REFERENCES ~~REFERENCES~~

Alley, H.P. and G.A. Lee. 1969. Weeds of Wyoming. University of Wyoming, Agricultural Experiment Station Bulletin 498. Laramie, Wyoming.

Beetle, A.A. 1970. Recommended Plant Names. University of Wyoming, Agricultural Experiment Station Research Journal 31. Laramie, Wyoming.

Beetle, A.A. 1977. Grasses of Wyoming. University of Wyoming, Agricultural Experiment Station Research Journal 39R. Laramie, Wyoming.

1992. Black Thunder Mine, Renewal/Amendment Application for Permit No. 233-T4 (TFN 2 3/279). Appendix D-8. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.

Dorn, R. 1988. Vascular Plants of Wyoming. Mountain West Publishing. Cheyenne, Wyoming. 340 p.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press.

1992. Jacobs Ranch Mine. Renewal/Amendment Application for Permit No. 271-T2 (TFN 2 6/288). Appendix D-8. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.

Kerr McGee Coal Corporation. 1992. Black Thunder Mine Permit Application Appendix D-8, TFN 233-T5. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.

Porter, C.L. 1964. Wyoming Trees. University of Wyoming, Agricultural Extension Service Circular 164R. Laramie, Wyoming.

~~Thunder Basin Coal Company. 1992. Black Thunder Mine Permit Application Appendix D-8, TFN 233-T5. Submitted to the Wyoming Department of Environmental Quality, Land Quality Division.~~

Western Society of Weed Science. 1991. Weeds of the West. Pioneer of Jackson Hole Publishing. 630 p.

Wyoming Dept. of Environmental Quality, Land Quality Division. Rules and Regulations Appendix A (March 1989).

Addendum 1

CORRESPONDENCE

The Nature Conservancy

Wyoming Natural Diversity Data Base
3165 University Station
Laramie, Wyoming 82071
(307) 766-3441

Sept. 7, 1993

Brenda Schladwieler
BKS Environmental
P.O. Box 3467
Gillette, WY 82717-3467

FAX: 682-0125

Dear Brenda,

I searched the database for occurrences of plants in Campbell Co.
in and around T43N R73W, as Brenda requested by phone last week. There were no occurrences retrieved. However, keep in mind that a database search such as this will indicate what species may or may not occur in the area, but it is not a substitute for a species survey. Adequate pre-project TES screening requires site surveys with collecting visits scheduled throughout the growing season for plants and throughout the year for animals.

Please be sure and complete a data request form and return it to me.

Sincerely,

Mary

Mary L. Neighbours
Information Manager

Addendum 2

PHOTOGRAPHS OF VEGETATION TYPES

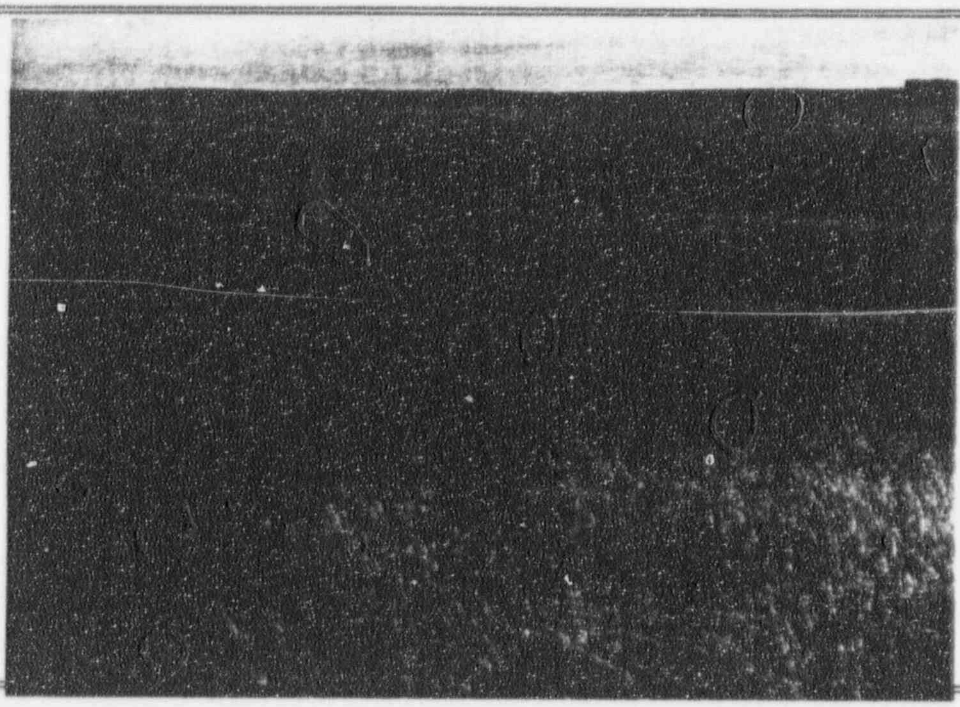


Photo 1. Upland Grassland

Photo 2. Big Sagebrush

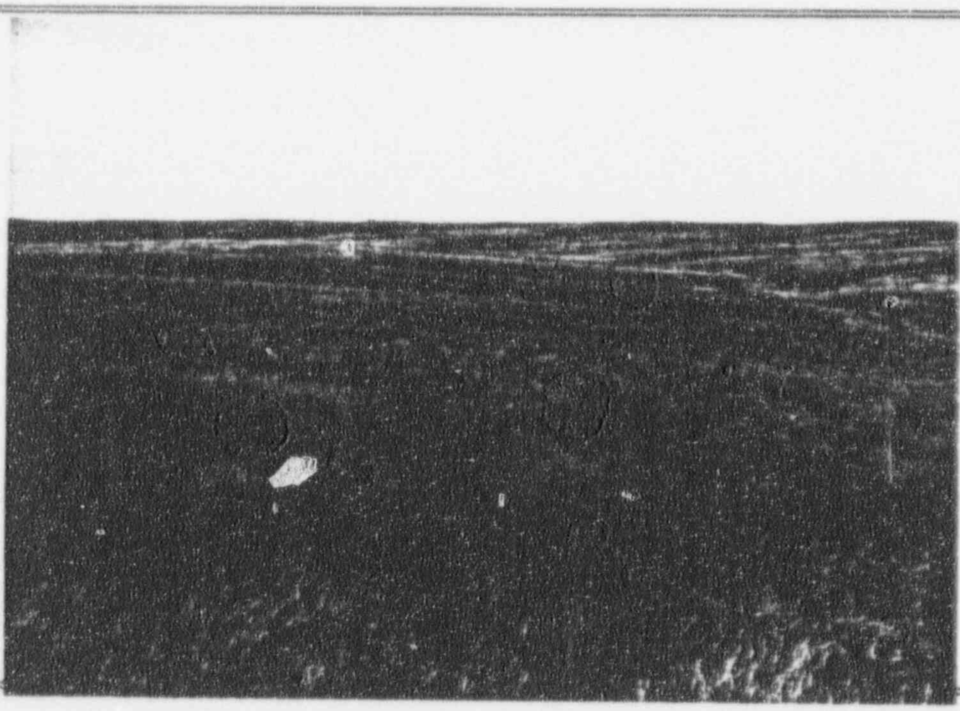
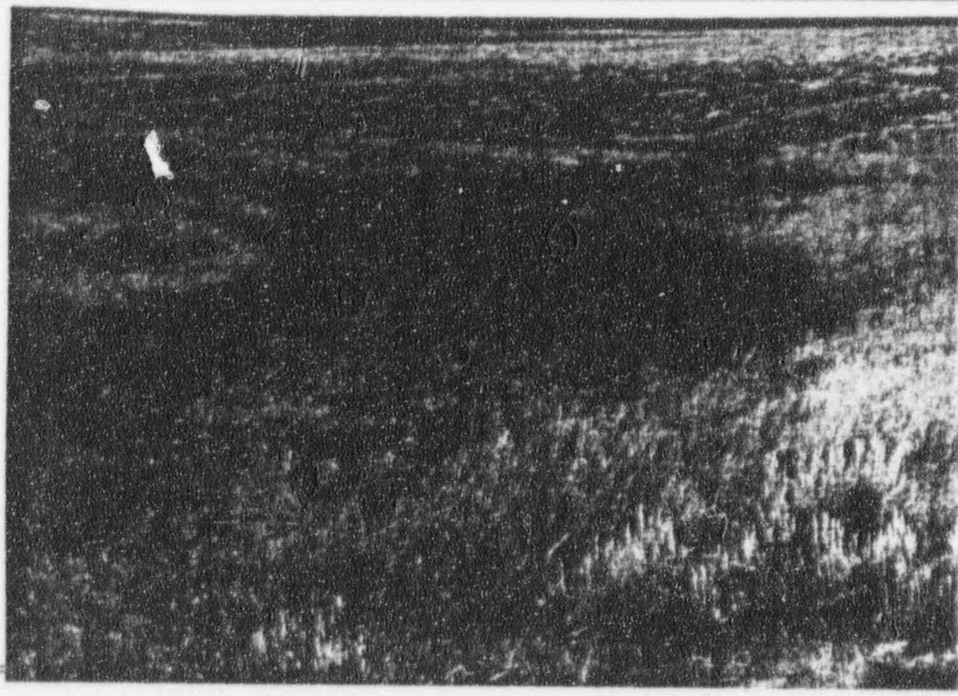


Photo 3. Meadow



Addendum 3

1993 PLANT SPECIES LIST

Addendum 3. LIST OF SPECIES OBSERVED DURING 1993 VEGETATION SAMPLING FOR RENO CREEK PROJECT.

Scientific Name	Common Name	Family Name
PERENNIAL GRASSES		
Bromus carinatus	California Brome	Poaceae
COOL SEASON PERENNIAL GRASSES		
Agropyron dasystachyum	Thickspike Wheat Grass	Gramineae
Agropyron riparian	Streambank Wheatgrass	Gramineae
Agropyron smithii	Western Wheatgrass	Gramineae
Agropyron spicatum	Bluebunch Wheatgrass	Gramineae
Agropyron trachycaulum	Slender Wheatgrass	Gramineae
Aristida longiseta	Red Three-awn	Gramineae
Carex filifolia	Threadleaf Sedge	Cyperaceae
Carex praegracilis	Sedge	Cyperaceae
Carex stenophylla	Sedge	Cyperaceae
Distichlis spicata	Inland Saltgrass	Gramineae
Eleocharis palustris	Creeping Spikerush	Gramineae
Elymus canadensis	Canada Wildrye	Gramineae
Hordeum jubatum	Foxtail Barley	Gramineae
Juncus balticus	Baltic Rush	Juncaceae
Koleria macrantha	Prairie Junegrass	Gramineae
Poa ampla	Big Bluegrass	Gramineae
Poa canbyi	Canby Bluegrass	Gramineae
Poa fendleriana	Mutton Bluegrass	Gramineae
Poa juncifolia	Alkali Bluegrass	Gramineae
Poa sandbergii	Sandberg Bluegrass	Gramineae
Schedonardus paniculatus	Tumblegrass	Gramineae
Stipa comata	Needle-and-thread Grass	Gramineae
Stipa viridula	Green Needle Grass	Gramineae
WARM SEASON PERENNIAL GRASSES		
Bouteloua gracilis	Blue Grama	Gramineae
Calamovilfa longifolia	Prairie Sandreed	Gramineae
INTRODUCED PERENNIAL GRASSES		
Agropyron cristatum	Crested Wheatgrass	Gramineae
Poa pratensis	Kentucky Bluegrass	Gramineae
ANNUAL GRASSES		
Bromus japonicus	Japanese Brome	Gramineae
Bromus tectorum	Cheatgrass	Gramineae
Festuca octoflora	Fescue	Gramineae

PERENNIAL F)RBS

Achillea millefolium	Common Yarrow	Asteraceae
Allium textile	Prairie Onion	Liliaceae
Ambrosia tomentosa	Ragweed	Compositae
Antennaria rosea	Pussytoes	Compositae
Arenaria hookeri	Hooker Sandwort	Caryophyllaceae
Artemisia ludoviciana	Louisiana Sagewort	Compositae
Aster chilensis	Pacific Aster	Compositae
Aster falcatus	White Aster	Compositae
Astragalus bisulcatus	Two-grooved Milkvetch	Leguminose
Astragalus mollisimus	Woolly Milkvetch	Leguminose
Astragalus spatulatus	Spoonleaf Milkvetch	Leguminosae
Besseya wyomingensis	Kittentails	Scrophulariaceae
Cerastium arvense	Mouse-ear Chickweed	Caryophyllaceae
Cirsium arvense	Canada Thistle	Compositae
Comandara umbellata	Bastard Toadflax	Santalaceae
Equisetum laevigatum	Smooth Horsetail	Equisetaceae
Gaura coccinea	Scarlet Gaura	Onagraceae
Glycyrrhiza lepidota	Wild Licorice	Leguminosae
Grindelia squarrosa	Curlycug Gumweed	Compositae
Heterotheca villosa	Golden Aster	Compositae
Lesquerella arenosa	Sand Bladderpod	Brassicaceae
Lomatium foeniculaceum	Biscuitroot	Umbelliferae
Lomatium orientale	Lomatium	Umbelliferae
Lupinus argenteus	Silvery Lupine	Leguminosae
Macaeranthera tanacetifolia	Tansy Aster	Compositae
Musineon divaricatum	Biscuitroot	Cruciferae
Oenothera caespitosa	Gumbo Lily	Onagraceae
Penstemon nitidus	Waxleaf Penstemon	Scrophulariaceae
Phlox hoodii	Hood's Phlox	Polemoniaceae
Phlox multiflora	Flowery Phlox	Polemoniaceae
Polygonum douglasi	Douglas Knotweed	Polygonaceae
Psoralea argophylla	Silverleaf Scurfpea	Leguminosae
Rumex salicifolius	Willowleaf Dock	Polygonaceae
Solidago missouriensis	Prairie Goldenrod	Compositae
Solidago mollis	Velvety Goldenrod	Compositae
Sphaeralcea coccinea	Scarlet Globe Mallow	Malvaceae
Taraxacum officinale	Common Dandelion	Compositae
Thermopsis rhombifolia	Golden Banner	Leguminosae
Tragopogon dubius	Yellow Salsify	Compositae
Vicia americana	American Vetch	Leguminosae

ANNUAL AND BIENNIAL FORBS

Alyssum destorum	Desert Alyssum	Cruciferae
Camelina microcarpa	Littleseed Falseflax	Cruciferae
Chenopodium album	Goosefoot	Chenopodiaceae
Descurainia pinnata	Pinnate Tansy Mustar	Cruciferae
Descurainia sophia	Flixweed Tansy Mustard	Cruciferae
Draba nemorosa	Yellow Draba	Cruciferae

Lappula redowskii	Stickseed	Boraginaceae
Lepidium densiflorum	Prairie Peppergrass	Cruciferae
Lupinus pusillus	Rusty Lupine	Leguminosae
Melilotus officinalis	Yellow Sweetclover	Leguminosae
Microsteris gracilis	Microsteris	Polemoniaceae
Plagiobothrys scouleri	Scouler Popcornflower	Boraginaceae
Plantago patagonica	Pursh's Plantain	Plantaginaceae
Sisymbrium altissimum	Thumblinig Hedge Mustard	Cruciferace
Thlaspi arvense	Field Pennycress	Cruciferace
Xanthium strumarium	Cocklebur	Compositae

SEMI-SHRUBS OR HALF-SHRUBS

Artemisia frigida	Fringed Sagewort	Compositae
Atriplex gardneri	Gardner Saltbrush	Chenopodiaceae
Ceratoides lanata	Winterfat	Chenopodiaceae
Gutierrezia sarothrae	Broom Snakeweed	Compositae

SHRUBS

Artemisia cana	Silver Sagebrush	Compositae
Artemisia pedatifida	Birdfoot Sagebrush	Compositae
Artemisia tridentata	Big Sagebrush	Compositae
Atriplex canescens	Four-wing Saltbush	Chenopodiaceae
Chrysothamnus nauseosus	Rubber Rabbitbrush	Compositae

CACTI AND SUCCULENTS

Opuntia fragilis	Brittle Pricklypear	Cactaceae
Opuntia polyacantha	Plains Pricklypear	Cactaceae

Addendum 4
COVER RAW DATA

Project Name : Energy Fuels
Vegetation Type : Native
Area Name : Upland Grassland
Vegetation Parameter : Cover
Number of Plots : 50

CATEGORY/SPECIES	RIMA TOTAL	RIMA MIN	RIMA MAX	Plot Number 1 / 26	2 / 27	3 / 28	4 / 29	5 / 30	6 / 31	7 / 32	8 / 33	9 / 34	10 / 35	11 / 36	12 / 37	13 / 38	14 / 39	15 / 40	16 / 41	17 / 42	18 / 43	19 / 44	20 / 45	21 / 46	22 / 47	23 / 48	24 / 49	25 / 50	MEAN	STANDARD DEVIATION
BARE GROUND	N/A	N/A	N/A	6.00	12.00	16.00	14.00	0.00	18.00	8.00	24.00	22.00	18.00	22.00	16.00	40.00	10.00	18.00	24.00	16.00	18.00	22.00	20.00	14.00	34.00	14.00	12.00	22.00	18.28	9.10
				26.00	10.00	10.00	28.00	26.00	10.00	6.00	26.00	12.00	40.00	24.00	10.00	12.00	34.00	12.00	4.00	10.00	24.00	12.00	12.00	28.00	34.00	32.00	16.00	16.00		
LITTER	N/A	N/A	N/A	24 30	16.00	20.00	28.00	26.00	24.00	22.00	20.00	28.00	22.00	12.00	26.00	10.00	24.00	24.00	24.00	20.00	14.00	14.00	28.00	28.00	14.00	26.00	24.00	22.00	20.60	6.48
				10.00	16.00	26.00	20.00	10.00	18.00	32.00	6.00	30.00	6.00	14.00	22.00	16.00	22.00	28.00	24.00	22.00	14.00	26.00	28.00	22.00	14.00	24.00	12.00	28.00		
ROCK	N/A	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.88	2.57
				0.00	0.00	0.00	0.00	6.00	12.00	0.00	4.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	2.00	0.00	8.00	0.00		
LICHEN	N/A	N/A	N/A	8.00	14.00	0.00	4.00	8.00	10.00	2.00	22.00	2.00	8.00	4.00	2.00	6.00	8.00	2.00	0.00	16.00	4.00	14.00	6.00	8.00	8.00	2.00	0.00	10.00	6.72	5.32
				8.00	18.00	8.00	12.00	4.00	0.00	4.00	12.00	12.00	4.00	0.00	6.00	6.00	4.00	2.00	6.00	2.00	2.00	16.00	16.00	2.00	2.00	4.00	4.00	14.00		
TOTAL VEGETATION	N/A	N/A	N/A	70.00	72.00	64.00	58.00	74.00	58.00	70.00	56.00	50.00	60.00	66.00	58.00	50.00	66.00	58.00	52.00	64.00	68.00	64.00	52.00	56.00	52.00	60.00	64.00	58.00	60.28	7.17
				64.00	74.00	64.00	52.00	58.00	60.00	62.00	64.00	58.00	54.00	62.00	68.00	62.00	44.00	60.00	72.00	68.00	62.00	62.00	60.00	50.00	50.00	44.00	64.00	56.00		
TOTAL COVER	N/A	N/A	N/A	94.00	88.00	84.00	86.00	50.00	[illegible]	[illegible]	76.00	78.00	82.00	78.00	84.00	60.00	76.00	82.00	76.00	84.00	82.00	78.00	80.00	86.00	66.00	86.00	88.00	78.00	80.32	9.80
				74.00	90.00	90.00	72.00	74.00	90.00	94.00	74.00	88.00	60.00	76.00	90.00	88.00	66.00	88.00	96.00	90.00	76.00	88.00	88.00	72.00	66.00	64.00	84.00	82.00		
COOL SEASON PERENNIAL GRASSES																														
Agropyron dasystachyum	142.00	0.00	12.00	2.00	12.00	6.00	4.00	6.00	6.00	0.00	4.00	0.00	0.00	0.00	2.00	0.00	4.00	12.00	2.00	6.00	0.00	10.00	2.00	0.00	6.00	0.00	0.00	0.00	2.84	3.49
				0.00	8.00	2.00	4.00	0.00	0.00	6.00	0.00	2.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	10.00	0.00	4.00	2.00	0.00	0.00	8.00	0.00	8.00		
Agropyron smithii	190.00	0.00	28.00	0.00	0.00	4.00	2.00	8.00	0.00	6.00	0.00	2.00	14.00	4.00	18.00	4.00	0.00	2.00	2.00	0.00	2.00	0.00	2.00	0.00	0.00	4.00	0.00	0.00	3.80	5.44
				6.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00	7.00	4.00	0.00	28.00	8.00	10.00	16.00	2.00	6.00	0.00	2.00	6.00	6.00	2.00	2.00	10.00	2.00		
Aristida longiseta	2.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Carex filifolia	434.00	0.00	28.00	6.00	6.00	0.00	4.00	0.00	4.00	22.00	2.00	12.00	0.00	6.00	2.00	8.00	2.00	2.00	2.00	12.00	24.00	0.00	2.00	8.00	10.00	26.00	20.00	14.00	8.68	7.09
				14.00	14.00	8.00	6.00	16.00	10.00	14.00	14.00	4.00	14.00	16.00	0.00	10.00	2.00	6.00	8.00	4.00	6.00	14.00	4.00	4.00	28.00	6.00	16.00	2.00		
Carex stenophylla	14.00	0.00	4.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.80
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Koeleria macra	138.00	0.00	14.00	6.00	4.00	0.00	0.00	0.00	2.00	14.00	2.00	2.00	2.00		0.00	2.00	0.00	10.00	6.00	4.00	0.00	4.00	8.01	0.00	2.00	0.00	2.00	0.00	*	2.94
				2.00	0.00	8.00	8.00	2.00	2.00	0.00	0.00	2.00	4.00		2.00	2.00	2.00	4.00	2.00	2.00	0.00	4.00	2.00	6.00	2.00	4.00	0.00	4.00		

Species				Values		
Poa canbyi	12.00	0.00	4.00	0.00 4.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 4.00 0.00 0.00 0.00 0.00 0.00 0.00	0.24	0.86
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00		
Poa fendleriana	12.00	0.00	4.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 4.00 0.00 0.00 0.00 0.00 0.00 4.00 0.00 0.00 0.00 0.00 0.00 4.00 0.00	0.24	0.95
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		
Poa sandbergii	102.00	0.00	8.00	0.00 0.00 4.00 0.00 2.00 4.00 0.00 2.00 0.00 4.00 2.00 6.00 0.00 2.00 4.00 0.00 2.00 4.00 0.00 0.00 0.00 0.00 0.00 2.00 2.00	2.04	1.98
				2.00 2.00 0.00 2.00 4.00 4.00 4.00 2.00 2.00 2.00 4.00 8.00 4.00 6.00 0.00 0.00 2.00 4.00 0.00 0.00 2.00 0.00 0.00 4.00 4.00		
Stipa comata	638.00	2.00	38.00	8.00 16.00 12.00 2.00 22.00 10.00 18.00 10.00 20.00 14.00 14.00 18.00 10.00 16.00 16.00 16.00 10.00 14.00 6.00 8.00 26.00 10.00 18.00 10.00 12.00	12.76	6.82
				8.00 14.00 4.00 2.00 14.00 18.00 18.00 12.00 18.00 6.00 18.00 12.00 12.00 4.00 6.00 38.00 12.00 26.00 4.00 2.00 10.00 18.00 6.00 14.00 6.00		
Stipa viridula	22.00	0.00	6.00	2.00 0.00 0.00 2.00 6.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00	0.44	1.08
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 2.00 0.00 0.00 2.00 0.00		
WARM SEASON PERENNIAL GRASSES						
Bouteloua gracilis	512.00	0.00	30.00	18.00 2.00 12.00 18.00 6.00 4.00 12.00 4.00 4.00 10.00 30.00 8.00 3.00 8.00 0.00 2.00 6.00 12.00 10.00 12.00 12.00 4.00 10.00 26.00 18.00	10.24	6.11
				14.00 10.00 16.00 6.00 10.00 18.00 14.00 10.00 8.00 4.00 14.00 6.00 12.00 8.00 14.00 10.00 4.00 16.00 12.00 16.00 10.00 2.00 4.00 10.00 6.00		
Calamovilfa longifolia	4.00	0.00	2.00	2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.08	0.39
				0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		
ANNUAL GRASSES						
Bromus japonicus	2.00	0.00	2.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.04	0.28
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		
Bromus tectorum	6.00	0.00	2.00	2.00 0.00 2.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.12	0.47
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0		
Festuca octoflora	8.00	0.00	4.00	0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.16	0.67
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 4.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		
PERENNIAL FORBS						
Allium textile	4.00	0.00	2.00	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.08	0.39
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		
Arenaria hookeri	10.00	0.00	4.00	0.00 0.00 4.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 4.00 0.00 0.00 0.00	0.20	0.82
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		
Astragalus mollissimus	4.00	0.00	2.00	0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 2.00 0.00 0.00	0.08	0.39
				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		

Astragalus spatulatus	6.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.47
				0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Comandra umbellata	2.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Gaura coccinea	4.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Grindelia squarrosa	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Heterotheca villosa	10.00	0.00	4.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.20	0.72
				0.00	0.00	4.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Lupinus argenteus	22.00	0.00	10.00	10.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.44	1.80
				0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Musineon divaricatum	8.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.16	0.54
				0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00		
Oenothera caespitosa	2.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Penstemon nitidus	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Phlox hoodii	78.00	0.00	8.00	0.00	2.00	0.00	2.00	0.00	4.00	0.00	8.00	2.00	0.00	6.00	0.00	6.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	1.56	2.12
				2.00	2.00	0.00	2.00	4.00	0.00	0.00	6.00	2.00	6.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	2.00	0.00	6.00	0.00	0.00	2.00	2.00	2.00		
Phlox multiflora	2.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Sphaeralcea coccinea	40.00	0.00	4.00	0.00	0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	2.00	0.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	1.20
				0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	2.00	2.00	0.00	2.00	0.00	0.00	2.00	4.00	2.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00		
Taraxacum officinale	2.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Vicia americana	38.00	0.00	10.00	0.00	0.00	2.00	0.00	0.00	4.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	2.00	0.76	1.69
				0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	10.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	4.00		
ANNUAL AND BIENNIAL FOB																														
Alyssum desertorum	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00		
Camelina microcarpa	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

Lepidium densiflorum	8.00	0.00	6.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.88
				0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Plagiobothrys scouleri	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Plantago patagonica	34.00	0.00	8.00	0.00	0.00	8.00	4.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.68	1.63
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	6.00	2.00	0.00	0.00	0.00	0.00		
HALF-SHRUBS																														
Artemisia frigida	14.00	0.00	4.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.28	0.90
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Atriplex gardneri	6.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.62
				2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Ceratoides lanata	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Gutierrezia sarothrae	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
FULL-SHRUBS																														
Artemisia pedatifida	66.00	0.00	8.00	0.00	2.00	0.00	0.00	0.00	4.00	0.00	0.00	4.00	2.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	2.00	0.00	0.00	0.00	1.32	2.02
				6.00	2.00	0.00	2.00	4.00	0.00	0.00	8.00	0.00	6.00	4.00	0.00	4.00	0.00	0.00	0.00	0.00	2.00	4.00	0.00	0.00	0.00	0.00	2.00	0.00		
Artemisia tridentata	184.00	0.00	24.00	4.00	6.00	14.00	12.00	4.00	10.00	0.00	2.00	0.00	0.00	0.00	0.00	10.00	24.00	6.00	18.00	0.00	4.00	10.00	6.00	0.00	0.00	0.00	0.00	0.00	3.68	5.33
				0.00	2.00	4.00	6.00	4.00	2.00	2.00	0.00	4.00	0.00	0.00	0.00	0.00	2.00	4.00	0.00	16.00	0.00	0.00	0.00	2.00	0.00	4.00	0.00	2.00		
CACTI AND SUCCULENTS																														
Opuntia polyacantha	28.00	0.00	6.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	2.00	0.00	0.56	1.27
				4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

Project Name : Energy Fuels
Vegetation Type : Native
Area Name : Big Sagebrush
Vegetation Parameter : Cover
Number of Plots : 50

CATEGORY/SPECIES	RIMA TOTAL	RIMA MIN	RIMA MAX	Plot Number 1 / 26	2 / 27	3 / 28	4 / 29	5 / 30	6 / 31	7 / 32	8 / 33	9 / 34	10 / 35	11 / 36	12 / 37	13 / 38	14 / 39	15 / 40	16 / 41	17 / 42	18 / 43	19 / 44	20 / 45	21 / 46	22 / 47	23 / 48	24 / 49	25 / 50	MEAN	STANDARD DEVIATION
BARE GROUND	N/A	N/A	N/A	8.00	36.00	8.00	26.00	8.00	4.00	18.00	8.00	32.00	14.00	18.00	8.00	26.00	10.00	4.00	24.00	0.00	22.00	22.00	18.00	12.00	26.00	14.00	18.00	0.00	15.56	9.14
				10.00	10.00	24.00	24.00	10.00	12.00	14.00	22.00	8.00	10.00	28.00	12.00	14.00	22.00	4.00	14.00	32.00	16.00	38.00	22.00	20.00	8.00	12.00	4.00	4.00		
LITTER	N/A	N/A	N/A	20.00	16.00	36.00	14.00	40.00	36.00	28.00	24.00	22.00	26.00	18.00	26.00	12.00	12.00	22.00	20.00	36.00	20.00	18.00	24.00	24.00	16.00	20.00	20.00	26.00	23.28	7.24
				22.00	28.00	26.00	20.00	30.00	30.00	28.00	10.00	30.00	28.00	18.00	34.00	24.00	20.00	30.00	26.00	12.00	30.00	12.00	12.00	22.00	16.00	18.00	28.00	34.00		
ROCK	N/A	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
LICHEN	N/A	N/A	N/A	0.00	4.00	0.00	2.00	8.00	2.00	0.00	0.00	0.00	12.00	0.00	6.00	8.00	0.00	16.00	0.00	6.00	2.00	6.00	0.00	2.00	0.00	2.00	2.00	6.00	2.68	3.41
				4.00	0.00	0.00	0.00	0.00	4.00	4.00	2.00	8.00	0.00	4.00	0.00	0.00	4.00	0.00	4.00	2.00	4.00	0.00	2.00	6.00	0.00	0.00	2.00	0.00		
TOTAL VEGETATION	N/A	N/A	N/A	72.00	48.00	56.00	60.00	52.00	60.00	54.00	68.00	46.00	60.00	64.00	66.00	62.00	78.00	74.00	56.00	64.00	58.00	60.00	58.00	64.00	58.00	66.00	62.00	74.00	61.00	7.06
				68.00	62.00	50.00	56.00	60.00	56.00	58.00	68.00	62.00	62.00	54.00	54.00	62.00	58.00	66.00	58.00	54.00	54.00	50.00	66.00	58.00	76.00	70.00	66.00	62.00		
TOTAL COVER	N/A	N/A	N/A	92.00	64.00	92.00	74.00	92.00	96.00	82.00	92.00	68.00	86.00	82.00	92.00	88.00	90.00	96.00	76.00	100.00	78.00	78.00	76.00	88.00	74.00	86.00	82.00	100.00	84.16	9.27
				90.00	90.00	76.00	76.00	90.00	88.00	86.00	78.00	70.00	90.00	72.09	88.00	86.00	78.00	96.00	86.00	68.00	84.00	62.00	78.00	80.00	92.00	88.00	96.00	96.00		
COOL SEASON PERENNIAL GRASSES																														
Agropyron dasystachyum	132.00	0.00	14.00	10.00	2.00	6.00	4.00	6.00	0.00	0.00	10.00	8.00	2.00	2.00	6.00	0.00	2.00	4.00	0.00	6.00	0.00	0.00	0.00	4.00	0.00	2.00	0.00	10.00	2.64	3.47
				0.00	0.00	2.00	0.00	2.00	0.00	4.00	0.00	6.00	0.00	4.00	0.00	2.00	0.00	6.00	0.00	0.00	8.00	0.00	0.00	14.00	0.00	0.00	0.00	0.00		
Agropyron smithii	282.00	0.00	20.00	2.00	4.00	20.00	2.00	2.00	0.00	10.00	2.00	2.00	0.00	0.00	0.00	4.00	10.00	6.00	12.00	6.00	6.00	2.00	6.00	0.00	14.00	0.00	14.00	4.00	5.64	5.48
				10.00	12.00	8.00	2.00	4.00	8.00	2.00	8.00	0.00	16.00	2.00	20.00	0.00	4.00	2.00	0.00	4.00	8.00	0.00	16.00	0.00	14.00	4.00	4.00	6.00		
Carex filifolia	214.00	0.00	22.00	4.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	4.00	2.00	8.00	6.00	2.00	6.00	4.00	2.00	8.00	4.00	4.00	2.00	2.00	0.00	6.00	4.00	4.28	4.78
				20.00	0.00	0.00	2.00	0.00	2.00	4.00	8.00	10.00	0.00	8.00	6.00	2.00	4.00	4.00	22.00	8.00	2.00	0.00	10.00	6.00	4.00	4.00	16.00	0.00		
Carex stenophylla	6.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.12	0.47
				0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Koeleria macrantha	212.00	0.00	18.00	2.00	8.00	6.00	12.00	4.00	0.00	6.00	10.00	2.00	0.00	14.00	8.00	8.00	8.00	0.00	0.00	2.00	2.00	2.00	0.00	18.00	4.00	0.00	2.00	6.00	4.24	3.83
				2.00	0.00	8.00	4.00	2.00	4.00	2.00	0.00	4.00	[illegible]	0.00	2.00	6.00	4.00	8.00	6.00	6.00	4.00	6.00	2.00	2.00	2.00	4.00	6.00	4.00		
Poa canbyi	20.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2	0.40	0.80
				0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	[illegible]	0.00	0.00	2.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	[illegible]		

Poa fendleriana	6.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.12	0.62
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00		
Poa sandbergii	36.00	0.00	6.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	4.00	0.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	0.72	1.37
				0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	2.00	2.00	2.00	0.00	4.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00		
Stipa comata	298.00	0.00	12.00	10.00	8.00	2.00	4.00	2.00	8.00	8.00	4.00	2.00	12.00	8.00	10.00	2.00	6.00	8.00	2.00	4.00	12.00	4.00	6.00	6.00	2.00	0.00	0.00	2.00	5.96	3.72
				6.00	0.00	2.00	2.00	10.00	4.00	12.00	10.00	10.00	4.00	8.00	2.00	10.00	12.00	8.00	4.00	12.00	6.00	4.00	8.00	2.00	6.00	12.00	10.00	2.00		
Stipa viridula	90.00	0.00	12.00	0.00	4.00	0.00	0.00	8.00	0.00	0.00	0.00	4.00	2.00	0.00	0.00	0.00	6.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	2.00	1.80	3.10
				4.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	4.00	0.00	10.00	0.00	0.00	0.00	6.00	0.00	2.00	0.00	12.00	0.00	0.00	0.00		
WARM SEASON PERENNIAL GRASSES																														
Bouteloua gracilis	282.00	0.00	22.00	4.00	0.00	8.00	6.00	14.00	22.00	10.00	0.00	0.00	4.00	0.00	6.00	8.00	8.00	20.00	6.00	16.00	10.00	14.00	2.00	6.00	0.00	2.00	2.00	8.00	5.64	5.57
				4.00	2.00	0.00	2.00	2.00	10.00	6.00	4.00	8.00	0.00	16.00	0.00	6.00	4.00	0.00	10.00	4.00	0.00	0.00	2.00	2.00	0.00	16.00	4.00	4.00		
INTRODUCED PERENNIAL GRASSES																														
Agropyron cristatum	14.00	0.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	1.70
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Poa pratensis	6.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.12	0.47
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00		
ANNUAL GRASSES																														
Bromus japonicus	14.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.28	1.06
				0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	4.00		
Bromus tectorum	28.00	0.00	12.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.56	2.04
				0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00		
Festuca octoflora	6.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.12	0.62
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00		
PERENNIAL FORBS																														
Achillea millefolium	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

Antennaria rosea	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.08	0.39
				0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Arenaria hookeri	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Artemisia ludoviciana	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00		
Astragalus bisulcatus	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Astragalus spatulatus	10.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.72
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00		
Cerastium arvense	6.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.62
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Gaura coccinea	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Heterotheca villosa	8.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.16	1.12
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Lesquerella arenosa	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Lupinus argenteus	8.00	0.00	6.00	6.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.88
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Machaeranthera tanacetifolia	6.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.47
				2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Phlox hoodii	42.00	0.00	4.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	4.00	2.00	0.00	0.00	0.00	2.00	0.00	0.84	1.33
				0.00	2.00	0.00	0.00	0.00	0.00	2.00	4.00	2.00	0.00	4.00	0.00	0.00	4.00	2.00	0.00	0.00	2.00	2.00	2.00	0.00	2.00	0.00	0.00	0.00		
Psoralea argophylla	8.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.67
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00		
Sphaeralcea coccinea	38.00	0.00	4.00	2.00	2.00	0.00	2.00	2.00	0.00	0.00	0.00	6.00	4.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	0.76	1.12
				2.00	2.00	0.00	0.00	2.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Taraxacum officinale	6.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.12	0.47
				0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Vicia americana	118.00	0.00	10.00	2.00	2.00	0.00	4.00	4.00	4.00	0.00	4.00	10.00	0.00	2.00	0.00	2.00	6.00	0.00	0.00	4.00	2.00	0.00	0.00	0.00	0.00	2.00	2.00	2.00	2.36	2.73
				6.00	2.00	0.00	2.00	8.00	0.00	2.00	0.00	2.00	10.00	0.00	0.00	6.00	0.00	6.00	0.00	0.00	6.00	0.00	2.00	0.00	6.00	0.00	6.00	2.00		

ANNUAL AND BIENNIAL FORBS

Descurainia pinn...	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.28

				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00		
Draba nemorosa	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Lupinus pusillus	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Plagiobothrys scouleri	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00		
Microsteris gracilis	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00		
Plantago patagonica	92.00	0.00	10.00	6.00	0.00	6.00	2.00	0.00	0.00	2.00	2.00	0.00	6.00	0.00	0.00	4.00	0.00	0.00	2.00	0.00	2.00	4.00	0.00	4.00	0.00	6.00	10.00	8.00	1.84	2.46
				0.00	2.00	0.00	0.00	2.00	2.00	2.00	4.00	2.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	4.00	0.00	0.00	0.00	0.00		
Polygonum douglasii	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00		
HALF-SHRUBS																														
Artemisia frigida	6.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.47
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Gutierrezia sarothrae	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00		
FULL-SHRUBS																														
Artemisia pedatifida	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Artemisia tridentata	1020.00	6.00	46.00	22.00	14.00	6.00	16.00	6.00	24.00	16.00	28.00	20.00	10.00	26.00	14.00	16.00	26.00	12.00	28.00	16.00	10.00	20.00	32.00	24.00	24.00	12.00	18.00	8.00	20.40	9.23
				16.00	30.00	30.00	46.00	32.00	24.00	12.00	24.00	6.00	16.00	6.00	20.00	20.00	14.00	24.00	12.00	12.00	12.00	32.00	24.00	18.00	36.00	26.00	16.00	34.00		
CACTI AND SUCCULENTS																														
Opuntia fragilis	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Opuntia polyacantha	24.00	0.00	4.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.48	1.02
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	0.00	2.00	0.00	0.00	0.00	2.00	4.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00		

Project Name :Energy Fuels
Vegetation Type :Native
Area Name :Meadow
Vegetation Parameter :Cover
Number of Plots :50

CATEGORY/SPECIES	RIMA TOTAL	RIMA MIN	RIMA MAX	1 / 26	2 / 27	3 / 28	4 / 29	5 / 30	6 / 31	7 / 32	8 / 33	9 / 34	10 / 35	11 / 36	12 / 37	13 / 38	14 / 39	15 / 40	16 / 41	17 / 42	18 / 43	19 / 44	20 / 45	21 / 46	22 / 47	23 / 48	24 / 49	25 / 50	MEAN	STANDARD DEVIATION
BARE GROUND	N/A	N/A	N/A	0.00	0.00	0.00	0.00	2.00	6.00	12.00	0.00	0.00	18.00	2.00	6.00	4.00	0.00	10.00	16.00	18.00	14.00	0.00	12.00	2.00	0.00	4.00	6.00	4.00	5.96	5.24
				10.00	10.00	12.00	14.00	4.00	4.00	2.00	4.00	0.00	8.00	10.00	16.00	2.00	6.00	6.00	6.00	4.00	6.00	10.00	4.00	2.00	0.00	12.00	6.00	4.00		
LITTER	N/A	N/A	N/A	12.00	2.00	16.00	6.00	16.00	28.00	18.00	0.00	20.00	4.00	44.00	26.00	16.00	40.00	22.00	10.00	26.00	26.00	20.00	18.00	14.00	2.00	10.00	32.00	22.00	18.80	9.89
				24.00	28.00	26.00	26.00	28.00	12.00	10.00	22.00	6.00	12.00	14.00	24.00	16.00	38.00	19.00	28.00	24.00	14.00	30.00	22.00	24.00	0.00	20.00	16.00	16.00		
LICHEN	N/A	N/A	N/A	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.44	1.22
				2.00	2.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	2.00	0.00	0.00		
TOTAL VEGETATION	N/A	N/A	N/A	84.00	98.00	84.00	94.00	82.00	66.00	70.00	100.00	80.00	78.00	54.00	68.00	80.00	60.00	68.00	74.00	56.00	60.00	80.00	70.00	84.00	98.00	86.00	62.00	74.00	75.20	12.09
				66.00	62.00	62.00	60.00	68.00	84.00	88.00	74.00	94.00	80.00	76.00	60.00	82.00	56.00	84.00	66.00	72.00	82.00	60.00	74.00	74.00	100.00	68.00	78.00	80.00		
TOTAL COVER	N/A	N/A	N/A	100.00	100.00	100.00	100.00	98.00	94.00	88.00	100.00	100.00	82.00	98.00	94.00	96.00	100.00	90.00	84.00	82.00	86.00	100.00	88.00	98.00	100.00	96.00	94.00	96.00	94.04	5.24
				90.00	90.00	88.00	86.00	96.00	96.00	98.00	96.00	100.00	92.00	90.00	84.00	98.00	94.00	94.00	94.00	96.00	94.00	90.00	96.00	98.00	100.00	88.00	94.00	96.00		
COOL SEASON PERENNIAL GRASSES																														
Agropyron dasystachyum	88.00	0.00	12.00	0.00	8.00	0.00	0.00	0.00	4.00	0.00	2.00	0.00	10.00	2.00	0.00	0.00	0.00	0.00	4.00	2.00	0.00	0.00	0.00	8.00	0.00	0.00	4.00	2.00	1.76	2.87
				2.00	0.00	0.00	2.00	0.00	6.00	6.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	12.00	0.00	0.00	0.00	0.00	2.00	6.00	2.00	0.00	0.00		
Agropyron riparian	46.00	0.00	12.00	6.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	10.00	0.00	4.00	0.92	2.47
				0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00	0.00	0.00		
Agropyron smithii	1824.00	4.00	82.00	38.00	20.00	70.00	82.00	70.00	40.00	48.00	60.00	34.00	32.00	32.00	46.00	54.00	18.00	32.00	26.00	30.00	4.00	64.00	20.00	32.00	6.00	24.00	28.00	30.00	36.48	18.21
				42.00	16.00	30.00	8.00	36.00	24.00	42.00	30.00	58.00	28.00	8.00	44.00	48.00	30.00	36.00	22.00	50.00	72.00	40.00	16.00	20.00	36.00	26.00	72.00	50.00		
Agropyron spicatum	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Agropyron trachycaulum	138.00	0.00	52.00	2.00	44.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	0.00	0.00	0.00	2.76	9.64
				0.00	0.00	6.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	0.00	0.00	0.00	0.00	4.00	2.00	8.00	0.00	0.00	0.00		
Carex filifolia	28.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	1.33
				0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	6.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00		
Carex praegracil	34.00	0.00	18.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	[illegible]	0.68	2.87
				0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00	0.00	0.00	[illegible]		

Carex stenophylla	20.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.40	1.65
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Distichlis spicata	42.00	0.00	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00	0.84	4.16
				0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.00	0.00	0.00	0.00	0.00		
Eleocharis palustris	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Elymus canadensis	2.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Juncus balticus	28.00	0.00	10.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.56	1.92
				0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00	0.00	0.00	0.00		
Hordeum jubatum	154.00	0.00	54.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.00	0.00	0.00	24.00	10.00	0.00	0.00	0.00	3.08	10.84
				0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	52.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	4.00	2.00	0.00	0.00	0.00	0.00		
Koeleria macrantha	108.00	0.00	10.00	4.00	4.00	10.00	2.00	8.00	4.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	4.00	2.00	0.00	4.00	0.00	0.00	0.00	0.00	2.00	2.00	2.16	2.77
				2.00	0.00	0.00	0.00	0.00	0.00	8.00	10.00	0.00	6.00	6.00	2.00	6.00	4.00	4.00	0.00	0.00	0.00	0.00	4.00	0.00	2.00	0.00	0.00	4.00		
Poa ampla	8.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.54
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00		
Poa canbyi	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Poa fendleriana	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00		
Poa juncifolia	80.00	0.00	10.00	8.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	10.00	0.00	2.00	1.60	3.10
				0.00	4.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	6.00	4.00	0.00	0.00	0.00	8.00	0.00	8.00	0.00	0.00		
Poa sandbergii	58.00	0.00	8.00	0.00	6.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	0.00	2.00	2.00	2.00	2.00	0.00	8.00	0.00	2.00	1.16	1.70
				0.00	2.00	2.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	4.00	2.00	0.00		
Schedonnardus paniculatus	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Stipa comata	156.00	0.00	20.00	4.00	0.00	2.00	0.00	0.00	0.00	4.00	0.00	0.00	16.00	6.00	0.00	6.00	4.00	20.00	0.00	0.00	0.00	0.00	12.00	0.00	0.00	18.00	4.00	0.00	3.12	5.28
				0.00	8.00	0.00	14.00	4.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	2.00	14.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	2.00		
Stipa viridula	262.00	0.00	22.00	4.00	18.00	8.00	10.00	12.00	2.00	6.00	20.00	0.00	16.00	0.00	2.00	8.00	0.00	0.00	6.00	0.00	0.00	2.00	4.00	0.00	4.00	0.00	8.00	2.00	5.24	6.00
				0.00	0.00	0.00	4.00	6.00	2.00	6.00	18.00	0.00	0.00	10.00	0.00	16.00	12.00	22.00	2.00	2.00	4.00	4.00	4.00	0.00	12.00	4.00	0.00	2.00		

WARM SEASON PERENNIAL
GRASSES

Bouteloua gracilis	50.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	6.00	0.00	4.00	0.00	2.00	0.00	0.00	4.00	0.00	0.00	0.00	4.00	0.00	0.00	1.00	1.80
				0.00	4.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	8.00	2.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00		

INTRODUCED PERENNIAL GRASSES																														
Agropyron cristatum	76.00	0.00	22.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	12.00	0.00	0.00	1.52	4.09
				0.00	12.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	22.00	0.00	0.00	10.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Poa pratensis	350.00	0.00	64.00	2.00	34.00	0.00	8.00	18.00	12.00	0.00	40.00	12.00	0.00	0.00	6.00	0.00	4.00	0.00	2.00	0.00	2.00	0.00	0.00	4.00	64.00	0.00	6.00	4.00	7.00	11.93
				0.00	0.00	12.00	0.00	0.00	20.00	10.00	2.00	0.00	0.00	0.00	2.00	14.00	0.00	4.00	10.00	2.00	0.00	4.00	12.00	6.00	26.00	0.00	0.00	8.00		
ANNUAL GRASSES																														
Bromus carinatus	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.56
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00		
Bromus japonicus	88.00	0.00	12.00	0.00	4.00	0.00	0.00	6.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	4.00	2.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	1.76	3.04
				8.00	0.00	0.00	0.00	6.00	4.00	0.00	0.00	0.00	2.00	4.00	0.00	0.00	0.00	12.00	10.00	10.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00		
Bromus tectorum	86.00	0.00	12.00	4.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	12.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	4.00	0.00	2.00	0.00	0.00	12.00	0.00	0.00	1.72	3.27
				6.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	4.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	10.00	4.00	0.00	0.00		
Festuca octoflora	6.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.62
				2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
PERENNIAL FORBS																														
Achillea millefolium	8.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.16	0.54
				0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Allium textile	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Ambrosia tomentosa	16.00	0.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	2.24
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Antennaria rosea	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.56
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Aster falcatus	10.00	0.00	6.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.92
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00		
Artemisia ludoviciana	58.00	0.00	12.00	0.00	4.00	0.00	0.00	2.00	0.00	0.00	12.00	2.00	0.00	0.00	0.00	2.00	10.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	1.16	2.37
				0.00	0.00	2.00	0.00	0.00	0.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	4.00	2.00	0.00	2.00	2.00	0.00		
Astragalus bisulcatus	6.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.12	0.84
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.C	)0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.C			

Astragalus chinensis	6.00	0.00	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.62
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Astragalus mollissimus	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Besseya wyomingensis	18.00	0.00	6.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.36	1.11
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	6.00	2.00		
Cerastium arvense	24.00	0.00	8.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	1.36
				0.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00		
Cirsium arvense	56.00	0.00	32.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00	0.00	0.00	0.00	1.12	4.77
				0.00	0.00	0.00	0.00	2.00	32.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	4.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Comandra umbellata	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Equisetum laevigatum	16.00	0.00	6.00	6.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.32	1.09
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	0.00	0.00		
Gaura coccinea	34.00	0.00	16.00	0.00	2.00	0.00	0.00	4.00	0.00	0.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	2.42
				0.00	0.00	0.00	0.00	0.00	4.00	2.00	0.00	0.00	4.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Glycyrrhiza lepidota	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.56
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Lomatium foeniculaceum	2.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Lomatium orientale	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Lupinus argenteus	20.00	0.00	6.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	2.00	4.00	0.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	1.13
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00		
Musineon divaricatum	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Phlox hoodii	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Psoralea argophylla	10.00	0.00	4.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.72
				0.00	0.00	0.00	2.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Rumex salicifolius	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.08	0.56
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Solidago missouriensis	22.00	0.00	8.00	0.00	2.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	4.00	2.00	0.00	2.00	0.44	1.34
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Solidago mollis	30.00	0.00	10.00	0.00	0.00	10.00	4.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.89
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	6.00		
Sphaeralcea coccinea	32.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	2.00	0.00	0.00	0.64	1.67
				0.00	2.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00		
Taraxacum officinale	160.00	0.00	28.00	0.00	0.00	2.00	0.00	4.00	2.00	0.00	6.00	28.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	2.00	2.00	6.00	0.00	4.00	0.00	0.00	4.00	2.00	3.20	5.80
				[illegible]	0.00	10.00	0.00	0.00	4.00	0.00	0.00	16.00	0.00	0.00	0.00	2.00	6.00	4.00	0.00	0.00	4.00	10.00	16.00	10.00	0.00	2.00	0.00	0.00		
Thermopsis rhombifolia	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00		
Tragopogon dubius	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Vicia americana	90.00	0.00	14.00	6.00	4.00	4.00	0.00	2.00	0.00	0.00	14.00	2.00	2.00	2.00	0.00	8.00	2.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	4.00	0.00	0.00	2.00	1.80	2.72

				4.00	0.00	0.00	0.00	2.00	0.00	8.00	0.00	0.00	4.00	2.00	0.00	4.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	4.00	2.00		
ANNUAL AND BIENNIAL FORBS																														
Alyssum desertorum	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Camelina microcarpa	28.00	0.00	6.00	0.00	2.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	2.00	0.56	1.20
				2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	4.00		
Chenopodium album	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.56
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00		
Descurainia pinnata	8.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.54
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Descurainia sophia	6.00	0.00	4.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.62
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00		
Lappula redowskii	8.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.54
				0.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00		
Melilotus officinalis	82.00	0.00	32.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.00	2.00	0.00	4.00	4.00	1.64	4.94
				0.00	0.00	0.00	0.00	0.00	8.00	0.00	12.00	0.00	0.00	0.00	0.00	4.00	0.00	4.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Plantago patagonica	22.00	0.00	8.00	0.[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	1.34
				0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00		
Plagiobothrys scouleri	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Polygonum douglasii	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Sisymbrium altissimum	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00		
Thlaspi arvense	70.00	0.00	26.00	0.00	8.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40	5.05
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	24.00	0.00	0.00	4.00		
Xanthium strumarium	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.28
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
HALF-SHRUBS																														
Artemisia frigida	4.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.39
				0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.0	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0[illegible]	[illegible]		
Atriplex gardne..	8.00	0.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0[illegible]	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	2.[illegible]	[illegible]	0.16	0.67

				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Gutierrezia sarothrae	2.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	[illegible]
				0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
FULL-SHRUBS																														
Artemisia cana	14.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	1.50
				0.00	0.00	0.00	10.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Artemisia tridentata	126.00	0.00	22.00	4.00	6.00	4.00	0.00	0.00	8.00	0.00	0.00	0.00	12.00	2.00	0.00	4.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	2.52	4.59
				10.00	2.00	0.00	4.00	0.00	0.00	4.00	2.00	0.00	22.00	18.00	0.00	8.00	2.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Atriplex canescens	8.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.16	1.12
				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Chrysothamnus nauseosus	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[illegible]	0.00	0.08	0.56
				0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

RENO CREEK PROJECT

1993 WILDLIFE BASELINE STUDIES

Prepared for:

Energy Fuels Nuclear, Inc.

One Tabor Center, Suite 2500

Denver, Colorado 80202

Prepared by:

Powder River Eagle Studies, Inc.

P.O. Box 2411

Gillette, Wyoming 82717-2411

September 1993

13. INTRODUCTION

Energy Fuels Nuclear, Inc. (EFNI) proposes to submit a permit application for an in-situ uranium mine in south-central Campbell County, Wyoming. The proposed mine site is referred to as the Reno Creek Project area. In anticipation of preparing a Wyoming state mining permit application, EFNI contracted Powder River Eagle Studies Inc. (PRES, wildlife consultants) to conduct a wildlife baseline study in the Reno Creek area in 1993.

~~The objective of the study was to map and describe habitats on the proposed permit area; and to collect both qualitative and quantitative data on vertebrate diversity, abundance, and habitat affinity on the area. Some surveys were extended to a larger perimeter around the proposed permit area.~~

~~Prior to finalizing wildlife inventory requirements for the Permit to Mine application, EFNI personnel met with Wyoming Department of Environmental Quality-Land Quality Division (WDEQ-LQD) staff in Sheridan, Wyoming. As a result of that meeting, it was determined that no passerine bird or small mammal inventories would be required. In 1993, field surveys were conducted for big game, upland game birds, nesting raptors, migratory birds of high federal interest (MBHFI), and threatened and endangered species.~~

The objective of the study was to map and describe habitats on the proposed permit area; and to collect both qualitative and quantitative data on vertebrate diversity, abundance, and habitat affinity on the area. some surveys were extended to a larger perimeter around the proposed permit area. In 1993, field surveys were conducted for big game, upland game birds, nesting raptors, migratory birds of high federal interest (MBHFI), and threatened and endangered species.

The study area is described below. Survey methods and results are presented by animal group. Descriptions of habitats found on the Reno Creek permit area are also given. All locations are for Township 43 North, Range 73 West, unless otherwise specified.

13.1 STUDY AREA

The Reno Creek Project area is in south-central Campbell County, in the southern Powder River Basin, approximately 10 miles west-southwest of Wright, Wyoming. The area is within the Wheatgrass-Needlegrass section of the Great Plains-Shortgrass Prairie Province as mapped by Bailey (1978). Annual precipitation is approximately 15 inches, three-quarters of which falls from April through September. The proposed permit area encompasses approximately 3613 acres, including all or part of Sections 21, 22, 27, 28, 29, 30, 31, 32, 33, and 34 (Plate 13.1).

Topography within the study area is characterized by rolling uplands dissected by shallow drainages. The permit area is near the origin of the Belle Fourche River. The (generally dry) channel of the Belle Fourche crosses the west side of the permit area from south to north. Most drainage on the area flows to the Belle Fourche, but the southeast corner of the area drains into Spring Creek and Porcupine Creek, and eventually into the Cheyenne River.

The area is crossed by various state and county roads. Wyoming State Highway 387 bisects the area from north to south. The Clarkelen Road borders the west side of the permit area, and the Cosner Road cuts across the southeast corner of the area. All land on the proposed permit area is privately owned. The land has been used primarily for livestock grazing, with some evidence of oil and gas exploration in the past.

13.2 METHODS

All 1993 field surveys were conducted or supervised by qualified biologists with at least thirteen years of experience in northeast Wyoming. Procedures and schedules recommended in the Handbook of Biological Techniques (Wyoming Game and Fish Department 1982) were followed as much as possible. Biologists used binoculars and spotting scopes to make observations. Standard field guides (Murie, 1954, Stebbins 1966, Burt and Grossenheider 1976, Baxter and Stone 1980, Clark and Stromberg 1987, and Peterson 1990) were used to identify animals.

13.2.1 BIG GAME

Three aerial surveys for big game, primarily pronghorn (Antilocapra americana), were conducted over the Reno Creek permit area and its two-mile perimeter (Map 1). Survey dates included: 23 February, 30 May, and 3 September 1993. The surveys were conducted from a highwing, light plane (Cessna172 or 206). For each flight, the 52.5-mi^2 survey area was covered by flying eight north-south transects spaced at 1-mile intervals over section lines. Each survey was started on the eastern-most transect and progressed to the west. During each survey, flight speed and altitude were approximately 90 miles per hour and 300 feet, respectively.

During each survey, two observers counted all big game animals within a 1/2-mile wide strip on either side of the flight path; the observers also scanned for raptors and mammalian predators. All sightings were recorded to the nearest quarter section, and the habitat type where animals were seen was noted.

13.2.2 UPLAND GAME BIRDS

Ground searches for sage grouse (Centrocercus urophasianus) leks were conducted on the proposed Reno Creek permit area and one-half mile perimeter on 15, 16, 19, and 26 April. Each morning search was begun at first light and lasted until approximately 1.5 hours after sunrise. Observers searched for displaying grouse while slowly driving state, county, and track roads in the survey area; and frequently stopping at vantage points to scan and listen for strutting birds.

Ground surveys for sage grouse broods were conducted on 29 July and 4 August 1993. On those days, field personnel walked drainages on the permit area looking for grouse and their sign (droppings, feathers, etc.).

13.2.3 NESTING RAPTORS

Raptor nest searches were conducted following guidelines recommended by Grier and Fyfe (1987) to prevent nest abandonment. Because many raptors are very sensitive to disturbance during the early stages of their breeding cycle, biologists avoided approaching nests on foot until June.

Initial searches on the proposed permit area were conducted on 15, 16, 19, and 26 April. After April, raptor surveys were conducted on the permit area and its one-mile perimeter. Nest searches in the larger survey area were conducted on 22 June, and 8 and 12 July 1993.

Nests were found by slowly driving roads in the area, and frequently stopping to scan for pairs or individual adult raptors. Once spotted, birds were observed until it could be determined if they had a nest in the area. Nests were also located by frequently stopping the vehicle and using a spotting scope to examine nesting substrates such as creek banks and rock outcrops. Nest locations were plotted on 1:24000 scale topographic maps.

13.2.4 MIGRATORY BIRDS OF HIGH FEDERAL INTEREST (MBHFI)

The U.S. Fish and Wildlife Service and WDEQ have expressed concern about 17 MBHFI in Campbell County. Biologists watched for MBHFI, and habitats that could support those species, on the proposed Reno Creek permit area and a one-half-mile perimeter during all field studies conducted in 1993.

13.2.5 THREATENED AND ENDANGERED SPECIES

Two threatened or endangered species could occur in the Reno Creek area as seasonal or permanent residents: bald eagles (Haliaeetus leucocephalus), and black-footed ferrets (Mustela nigripes). Field personnel looked for critical habitats on or near the Reno Creek area that could support threatened or endangered species while habitat mapping, and during all aerial surveys. Biologists also watched for threatened and endangered animals, including migrants such as peregrine falcons (Falco peregrinus), during the course of all field surveys.

13.3 RESULTS AND DISCUSSION

Appendix I lists all species that potentially occur in the area, and those which were observed in 1993. Wildlife habitats are described below. Data on big game, upland game birds, raptors, MBHFI, and threatened and endangered species follow.

13.3.1 HABITAT DESCRIPTIONS

Initial habitat mapping covered 3613 acres of the project area. There are three native habitat types on the Reno Creek area: sagebrush-grassland, grassland, and bottomland. The character of each of these native habitats has been influenced by man through range management practices. Two man-made habitats, seeded grassland and disturbed, occupy a very minor portion of the permit area. Habitats on the permit area are depicted on Plate 13.2; each habitat is described below in terms of extent, location, and characteristics. *There are no trees on the Reno Creek permit area.*

13.3.1.1 SAGEBRUSH-GRASSLAND

This is, by far, the most common habitat in the Reno Creek area, encompassing approximately 2387 acres. This habitat type includes a shrub-grass continuum--from grassland with moderate sagebrush cover, to shrublands so dense as to almost exclude any understory. In most areas, a grassy understory is present; the principal species are blue grama (Bouteloua gracilis), western wheatgrass (Agropyron smithii), and needle-and-thread grass (Stipa comata). Pricklypear cactus (Opuntia polyacantha) is found throughout sagebrush-grassland habitat. In some areas, crested wheatgrass (Agropyron cristatum) is the major grass species, where native land was interseeded, or where old hayfields have been reinvaded by shrubs. In all areas, big sagebrush (Artemisia tridentata) is the dominant shrub species.

13.3.1.2 GRASSLAND

Grassland habitat type, occupying approximately 885 acres, is interspersed with sagebrush-grassland throughout the permit area. This habitat is characterized by a mixture of short and mid-grass species, primarily blue grama, western wheatgrass, needle-and-thread grass, and prairie Junegrass (Koeleria macrantha). Pricklypear cactus is common in grassland. Big sagebrush is generally present in grassland habitat, but shrub cover is never dominant.

13.3.1.3 BOTTOMLAND

Bottomland habitat is found in a narrow band along the Belle Fourche River and the larger tributary draws on the permit area. It is a minor habitat, occupying only 278 acres. In all bottomland areas, the influence of water on vegetation is apparent. Bottomland supports a heavier growth of grasses and forbs than other habitats. Common species include western wheatgrass, Kentucky bluegrass (Poa pratensis), and foxtail barley (Hordeum jubatum). There are no trees along bottomland on the proposed permit area.

13.3.1.4 SEEDED GRASSLAND

Seeded grassland is the only agricultural habitat type on the permit area. It occurs where native ground was plowed or otherwise disturbed, and planted to grass; primarily crested wheatgrass. Both hayfields and revegetated oil and gas drilling sites fall within this classification. Seeded grassland occupies only 39 acres of the permit area.

13.3.1.5 DISTURBED

Disturbed land is characterized by bare ground or annual weeds, where native vegetation has been removed, and no revegetation has occurred. Wyoming Highway 387 is mapped as disturbed habitat where it crosses the permit area. Other disturbed areas--gravel and bladed roads, oilfield facilities, etc., were too small to map. Disturbed areas cover approximately 24 acres on the permit area.

13.3.2 BIG GAME

Pronghorn and mule deer (Odocoileus hemionus) are the only two big game species that occur in the vicinity of the Reno Creek area. No critical big game habitat is recognized by the Wyoming Game and Fish Department (WGFD) on or near the area. That part of the permit area lying north of Wyoming Highway 387 is classified by the WGFD as winter/yearlong pronghorn habitat. The area south of Highway 387 is classified as yearlong. All but a minuscule part of the permit area is classified as yearlong mule deer habitat (Approximately 40 acres in NW1/4 Section 31 is classified as "out").

13.3.2.1 PRONGHORN

Pronghorn are, by far, the most common big game species in the area. Pronghorn north of Highway 387 belong to the Pumpkin Buttes Herd Unit. In 1993, this unit was estimated to have a pre-hunt population of 25,000; well over the objective of 18,000 (pers. comm. Olin Oedekoven, WGFD). South of Highway 387 is the Bear Creek/Sage Creek Herd Unit. The 1993 pre-hunt population for this unit was approximately 23,000; slightly above the objective of 20,000. The 1993 post-hunt population is projected to be at objective (personal communication, Bill Helms, WGFD).

Pronghorn observations from the three aerial surveys of the Reno Creek area are depicted on Plate 13.1, and summarized in Table 13.1. The lowest count was the winter survey in February, when only

TABLE 13.1

1993 Reno Creek Wildlife Baseline

AERIAL SURVEY PRONGHORN DATA

Habitat	23 Feb	30 May	3 Sep
Sagebrush-grassland	173 (90%)	201 (72%)	287 (61%)
Grassland	19 (10%)	61 (22%)	72 (15%)
Bottomland	--	16 (6%)	91 (19%)
Seeded grassland	--	--	16 (3%)
Rough breaks	--	--	2 (<1%)
Disturbed	--	--	2 (<1%)
TOTAL	192	278	470
$\bar{x}$ Herd Size	21.3	3.7	6.0
Density[a]	3.7	5.3	9.0

[a]Based on the 52.5 mi^2 survey area that included permit area plus two-mile perimeter.

Table 13.1 1993 Aerial Survey Pronghorn Data

192 pronghorn (3.7/mi^2) were seen. More were observed during the spring survey in May, with 278 animals (5.3/mi^2) recorded. The highest count was made during the pre-hunt survey in September, when 470 pronghorn (6.0/mi^2) were seen.

Variations in the counts are probably not solely due to changes in abundance on the area. Overall visibility conditions were rated only fair to good during the winter survey. At that time, the northern two-thirds of the survey area had very good conditions with 100% snow cover, while the southern one-third of the area had very patchy conditions creating poor visibility. However, even with visibility less than optimal, it is believed that few pronghorn were on the survey area in February, and that numbers increased after winter.

Low winter numbers were probably not the result of winter mortality. Although cold temperatures and persistent snow combined to make winter 1992-1993 moderately severe, WGFD estimated no large winter mortality in the portions of the herd units that comprise the project area (pers. comm. O. Oedekoven). No pronghorn winter kills were observed on the permit area during the baseline study. Pronghorn probably concentrated elsewhere during winter, and filtered back onto the area in spring.

During the May and September counts the ground was clear, and visibility was considered good. Some, but not all, of the increase between the two counts can be attributed to fawn production. Pronghorn in this area may have a reproductive ratio of 90 fawns per 100 does, but reproduction in 1993 was poor. This may have been due to poor fawn viability following a winter that stressed pregnant does, or the extremely cool, wet spring which likely caused fawn losses. Few fawns were observed with pronghorn herds during this study.

It is also probable that the May count was lower because some pronghorn were missed due to the prevalence of lone animals and small herds. By late May winter groups have disbanded, and does ready to fawn seek seclusion. In early September herd sizes grow as bucks assemble their harems. Larger herds are more readily visible than single animals or small groups.

Distribution of pronghorn was similar during all three surveys. While animals were not absent from any part of the 52.5-mi^2 survey area, there appeared to be slight concentrations in the south and west, and a scarcity of observations in the northeast quarter of the area. This distribution does not appear to result from any natural or man-made obstacles. Highway 387 cuts diagonally through the middle of the survey area, from southwest to northeast, forming a barrier to antelope movement. However, no buildups or concentrations of animals along the highway were noted during any of the surveys (Plate 13.1).

Pronghorn habitat use changed with the seasons (Table 13.1). During the winter survey, 90% of the pronghorn seen were in sagebrush-grassland habitat. Given the prevalence of that habitat type in the area, that result is not surprising. Also, pronghorn typically favor sagebrush-grassland in winter (Sundstrom et al. 1973). The proportion of animals in sagebrush-grassland decreased with each survey. In spring, grassland use increased, and a few herds were observed in bottomland.

By September, a sizable percentage of sightings were in bottomland. This is typical for pronghorn in late summer.

13.3.2.2 MULE DEER

Few mule deer were observed during the aerial surveys, and few were recorded during groundwork on the project area. All mule deer sightings are listed in Table 13.2. Deer were seen throughout the year in small numbers, and were recorded in both uplands and bottomland drainages. With no trees, and a scarcity of abrupt topography, the permit area and its surroundings do not attract or support great numbers of deer.

TABLE 13.2

1993 Reno Creek Wildlife Baseline

MULE DEER OBSERVATIONS

Date	Buck	Doe	Fawn	Unclassified	Habitat[a]	1/4 1/4 Section	Twn (N)	Range (W)
2/23[b]				2	SBG	SE 6	42	73
2/23[b]				12	SBG	SW 11	42	74
2/23[b]				5	SBG	NE 11	42	74
4/15				12	SBG	NW NE 34	43	73
4/15				5	SBG	SE SE 27	43	73
4/16				3	SBG	SW SE 27	43	73
5/30[b]				1	SBG	NE 15	43	73
7/29	2				SBG	SE NW 31	43	73
7/29			2		BO	NE SW 29	43	73
7/29	1		1		BO	NW SW 29	43	73
7/29			1		BO	SE NW 29	43	73
7/29		1			BO	SW SE 30	43	73
8/4		2	2		BO	SW SW 29	43	73
8/4		1			BO	NW SE 30	43	73
9/3[b]				2	G	SW 34	43	73

[habitat] Codes:

SBG = sagebrush-grassland

BO = bottomland

G = grassland

[aerial] survey observation.

Table 13.2 1993 Mule Deer Observations

13.3.3 UPLAND GAME BIRDS

The habitat on the proposed permit area appears suitable for sage grouse breeding, loafing, and brood-rearing habitat. However, there was very little evidence of grouse using the area. No displaying grouse were found at any location on the proposed permit area during April lek searches. Also, no grouse droppings were found during the 32 hours that biologists spent walking through the area in spring.

During brood surveys, an adult female grouse with a single young was seen in a drainage just beyond the proposed permit boundary in NW/4 NW/4, Section 32; grouse scat was also found in that area. The only sign of grouse found on the permit area in summer was a scat pile in SW/4 NW/4, Section 29. Results of 1993 surveys indicate that the proposed permit area is not utilized by grouse to any significant extent.

No appropriate habitat exists in the area for turkeys (Meleagris gallopavo), sharp-tailed grouse (Tympanuchus phasianellus), or gray partridge (Perdix perdix).

13.3.4 NESTING RAPTORS

The absence of trees limits the potential for raptor nesting on the proposed Reno Creek permit area. During 1993, the only raptor nests found on the permit area were ferruginous hawk (Buteo regalis) ground nests. This species typically nests on the ground in Campbell County.

[redacted]

TABLE 13.3

1993 Reno Creek Wildlife Baseline

RAPTOR NESTS

Nest	Code	1/4	1/4	Sec	TWP	RNG	Status	Condition
FH1a*	G	NE	SW	31	43	73	Inactive	Good
FH1b*	G	NE	NW	31	43	73	Inactive	Good
FH1c*	G	NW	NE	31	43	73	Inactive	Good
FH1d	G	SW	SE	30	43	73	Inactive	Poor
FH2*	G	NE	SE	29	43	73	Inactive	Good
FH3a*	G	NE	NW	27	43	73	Inactive	Fair
FH3b	G	SW	NE	27	43	73	Inactive	Good
FH3c*	G	NE	SW	27	43	73	Inactive	Good
FH3d	G	SW	SE	27	4[illegible]	73	Inactive	Good
FH4	G	NE	NE	30	43	73	Active, Predated	Good
FH5a	G	NW	SW	20	43	73	Inactive	Poor
FH5b	G	SW	NW	20	43	73	Inactive	Poor
FH5c	G	NE	NE	19	43	73	Inactive	Good
FH5d	G	SW	SW	17	43	73	Inactive	Good
FH6a	G	SW	SE	36	43	74	Inactive	Poor
FH6b	G	NE	NW	1	42	74	Inactive	Good
FH6c	G	NW	NW	1	42	74	Inactive	Poor
FH6d	G	SE	NW	1	42	74	Inactive	Good
FH6e	G	SE	NW	1	42	74	Inactive	Poor
SH1	RO	NW	NW	5	42	73	Active, Predated	Good

Species Code:

FH = Ferruginous hawk

SH = Swainson's hawk

Nest Code:

G = Ground nest

RO = Russian olive

*Denotes nests on the Reno Creek permit area.

Table 13.3 1993 Raptor Nests

are on the proposed permit area; the remaining 13 nests are in the one-mile perimeter. Based on the spacing of the nests, it appears that there are potentially six ferruginous hawk breeding territories in the area. Two of the possible territories contain a single nest; there are four or five nests in the other four territories. Multiple nests are very common in ferruginous hawk territories in northeast Wyoming (PRES, unpub. data).

On 15 April, an adult ferruginous hawk was observed perched next to a nest on the permit area in NE/4 SW/4, Section 31 (FH1a, Plate 13.1); on 16 April, an adult was seen next to a nest near the permit boundary in NE/4 SW/4, Section 27 (FH3c, Plate 13.1). No eggs were laid in either FH1a or FH3c this year.

Young did hatch in a nest in the one-mile perimeter, in NE/4 NE/4, Section 30 (FH4, Plate 13.1), but they were apparently killed by a predator prior to fledgling. Numerous young ferruginous hawk feathers were found scattered around Nest FH4 on 8 July. None of the other nests in the perimeter appeared to be active this year.

Data gathered by PRES at numerous other study locations throughout Campbell County demonstrated that ferruginous hawk breeding was reduced throughout the area in 1993. The decrease in ferruginous hawk breeding this year was undoubtedly related to a significant decline in lagomorph (rabbit) abundance in the area. Reduced rabbit numbers in 1993 probably reflect a natural low in the rabbit population cycle. Also, the cold weather experienced during the winter of 1992-1993 may have contributed to reducing rabbit abundance this year.

A pair of Swainson's hawks (Buteo swainsoni) attempted to nest in a Russian olive tree (Elaeagnus angustifolia) just beyond the permit boundary in NW/4 NW/4, Section 5, T42N, R73W (SH1, Plate 13.1). Two eggs were in Nest SH1 on 22 June. That day, road construction workers were resurfacing Wyoming Highway 387 less than 200 feet from the nest tree. Despite the construction activity, the adults successfully hatched at least one young. The young, however, did not survive to fledgling. One dead young was found hanging from a limb of the nest tree on 12 July. The cause of death could not be determined.

13.3.5 MIGRATORY BIRDS OF HIGH FEDERAL INTEREST (MBHFI)

The potential occurrences of 17 species of MBHFI in the Reno Creek area are given in Table 13.4 Golden eagles (Aquila chrysaetos) were the only MBHFI recorded during the winter aerial survey; 16 eagles were seen on 23 February. Throughout the spring and summer golden eagles were seen flying over the permit area and one-mile perimeter. However, no evidence of eagles nesting in the area was found in 1993. In April, an old golden eagle carcass was found on the west side of the proposed permit area in Section 31. The bird had been dead for a long time and the cause of death could not be determined.

Three MBHFI--Richardson's merlin (Falco columbarius), prairie falcon (Falco mexicanus), and ferruginous hawk--were recorded on the area in April. A merlin and prairie falcon were each seen on just one occasion. The merlin was probably just passing through the area on migration. The prairie falcon may also have been migrating, or it could have been a resident of Campbell County. There are no suitable prairie falcon nesting sites on or near the Reno Creek permit area.

TABLE 13.4

1993 Reno Creek Wildlife Baseline

MBHFI STATUS IN NORTHEAST WYOMING AND

EXPECTED OCCURRENCE NEAR THE RENO CREEK PERMIT AREA

Species	Seasonal Status/ Breeding Records in NE Wyoming[1]	Expected Occurrence In Reno Creek Permit Area
White pelican	Summer/Nonbreeder	Rare
Double-crested cormorant	Summer/Breeder	Rare
Canvasback	Summer/One Record	Rare
Ferruginous Hawk	Summer/Breeder	Common
Golden eagle	Resident/Breeder	Common
Bald eagle	Winter/Nonbreeder	Uncommon in Winter
Osprey	Summer/Has Nested	Rare
Prairie falcon	Resident/Breeder	Uncommon
American peregrine falcon	Migrant/Historical	Rare
Richardson's merlin	Resident/Breeder	Rare
Whooping crane	Never Recorded	Very Rare
Sandhill crane	Migrant/Nonbreeder	Uncommon
Mountain plover	Summer/Breeder	Uncommon
Long-billed curlew	Summer/Possible Breeder	Rare
Burrowing Owl	Summer/Breeder	Uncommon
Lewis' woodpecker	Summer/Breeder	Rare
Dickcissel	Summer/Breeder	Rare

[1] Compiled from Oakleaf et al. (1992), includes Campbell and adjacent counties.

Table 13.4 1993 MBHFI Status in Northeast Wyoming

Ferruginous hawks were seen on numerous occasions throughout the spring and summer. The large number of ferruginous hawk ground nests found during raptor surveys indicates that this species regularly breeds in the Reno Creek area.

Nesting habitat for burrowing owls (Athene cunicularia) is present, in the form of badger (Taxidea taxus) holes, but no burrowing owls were observed in the area in 1993. No suitable nesting habitat for other raptor MBHFI exists on or near the area.

It is unlikely that any non-raptor MBHFI regularly use the area. Suitable staging or breeding habitats for non-raptor MBHFI do not exist to any significant extent on or near the proposed mine permit.

13.3.6 THREATENED AND ENDANGERED SPECIES

Bald eagles are relatively common winter visitors in northeast Wyoming. However, none were seen in the Reno Creek area during the 23 February aerial survey. No roosting habitat (wooded canyons or large tree groves) exists on or within one mile of the Reno Creek permit area. There are no unique food sources in that area that might attract wintering bald eagles.

Black-footed ferrets reside almost exclusively in prairie dog (Cynomys spp.) towns. No prairie dog towns exist within one mile of the area, and there are no historical records of ferrets in the vicinity.

13.4 IMPACT ASSESSMENT

It is unlikely the in-situ uranium mining will have any significant impact on wildlife resources in the vicinity of the Reno Creek permit area. Although well field drilling and maintenance activities may temporarily displace some animals, those actions will not result in large-scale or long-term surface disturbance. At any given time, activities associated with the mine will be limited to approximately 300 acres.

Only one raptor nest will potentially be impacted by activities associated with the mine. A storage reservoir may be constructed near a ferruginous hawk ground nest in NE/4 SE/4, Section 29 (Nest FH2, Plate 13.1). That nest was inactive in 1993, but was in good condition and might be used by hawks in the future. *Development of facilities, reservoirs, roads, and well fields at Reno Creek could potentially disturb a maximum of approximately 370 acres. In actuality only about 250 acres will be disturbed. Using the maximum disturbance acreage, approximately 266 acres of sagebrush-grassland, 73 acres of grassland, and 31 acres of bottomland might be affected by mine-related activities at Reno Creek.* ~~Disturbance to FH2 could be mitigated by relocating the nest to a similar site away from the mine facilities, or constructing one or two ferruginous hawk nesting platforms in isolated locations on the permit area.~~

LITERATURE C[illegible]

Bailey, R. G. 1[illegible]8. Ecoregions of the United States. U.S.D.A. For. Serv., Intermountain Region, Ogden, UT.

Baxter, G. T. and M. D. Stone. 1980. Amphibians and reptiles of Wyoming. Wyoming Game and Fish Dept. Bull. No. 16. 136pp.

Burt, W. H. and R. P. Grossenheider. 1976. A field guide to the mammals. Houghton Mifflin Company, Boston. 284pp.

Clark, T. W. and M. R. Stromberg. 1987. Mammals in Wyoming. Univ. of Kansas, Museum of Natural History, Lawrence, KS. 314pp.

Grier, J. W. and R. W. Fyfe. 1987. Preventing research and management disturbance. Pages 173-182 in B. A. Pendleton, B. A.

Millsap, K. W. Cline, and D. M. Bird, eds. Raptor management technique manual. Natl. Wildl. Fed., Washington, D. C.

Murie, O. J. 1954. A field guide to animal tracks. Houghton Mifflin Company, Boston. 374pp.

Oakleaf, B., B. Luce, S. Ritter, and A. Cerovski. 1992. Wyoming bird and mammal atlas. Wyoming Game and Fish Dept. Cheyenne. 170pp.

Peterson, R. T. 1990. A field guide to western birds. Houghton Mifflin Company, Boston. 309pp.

Stebbins, R. C. 1966. A field guide to western reptiles and amphibians. Houghton Mifflin Company, Boston.

Sundstrom, C., W. G. Hepworth, and K. L. Diem. 1973. Abundance, distribution, and food habits of pronghorn. Wyoming Game and Fish Commission, Bull. No. 12. Cheyenne. 51pp.

Wyoming Game and Fish Department. 1982. Handbook of biological techniques. WGFD, Cheyenne. 442pp.

13.5 POTENTIAL AND OBSERVED MAMMALIAN SPECIES LIST (APPENDIX I)

1993 Reno Creek Wildlife Baseline

POTENTIAL[1] AND OBSERVED MAMMALIAN SPECIES LIST

Common Name	Scientific Name
INSECTIVORES	
Masked shrew	Sorex cinereus
Vagrant shrew	Sorex vagrans
Merriam's shrew	Sorex merriami
BATS	
Little brown myotis	Myotis lucifugus
Keen's myotis	Myotis keeni
Long-eared myotis	Myotis evotis
Long-legged myotis	Myotis volans
Small-footed myotis	Myotis ciliolabrum
Silver-haired bat	Lasionycteris noctivagans
Big brown bat	Eptesicus fuscus
Hoary bat	Lasiurus cinereus
Townsend's bat	Plecotus townsendii
CARNIVORES	
Raccoon	Procyon lotor
Short-tailed weasel	Mustela erminea
Long-tailed weasel	Mustela frenata
Black-footed ferret	Mustela nigripes
Mink	Mustela vison
*Badger	Taxidea taxus
Spotted skunk	Spilogale putorius
*Striped skunk	Mephitis mephitis
*Coyote	Canis latrans
*Red fox	Vulpes vulpes
Swift fox	Vulpes velox
Gray fox	Urocyon cinereoargenteus
Bobcat	Felis rufus
RODENTS	
Black-tailed prairie dog	Cynomys ludovicianus
*Thirteen-lined ground squirrel	Spermophilus tridecemlineatus
Least chipmunk	Tamias minimus
Red squirrel	Tamiasciurus hudsonicus
*Northern pocket gopher	Thomomys talpoides
Plains pocket gopher	Geomys lutescens
Wyoming pocket mouse	Perognathus fasciatus
Silky pocket mouse	Perognathus flavus
Hispid pocket mouse	Perognathus hispidus
Ord's kangaroo rat	Dipodomys ordii
Beaver	Castor canadensis

1993 Reno Creek Wildlife Baseline

POTENTIAL AND OBSERVED MAMMALIAN SPECIES LIST (continued)

Common Name	Scientific Name
RODENTS (CONTINUED)	
Plains harvest mouse	*Reithrodontomys montanus*
Western harvest mouse	*Reithrodontomys megalotis*
Deer mouse	*Peromyscus maniculatus*
White-footed mouse	*Peromyscus leucopus*
Northern grasshopper mouse	*Onychomys leucogaster*
Bushy-tailed woodrat	*Neotoma cinerea*
Meadow vole	*Microtus pennsylvanicus*
Long-tailed vole	*Microtus longicaudus*
Prairie vole	*Microtus ochrogaster*
Sagebrush vole	*Lemmiscus curtatus*
Muskrat	*Ondatra zibethicus*
House mouse	*Mus musculus*
Meadow jumping mouse	*Zapus hudsonius*
Porcupine	*Erethizon dorsatum*
HARES AND RABBITS	
*White-tailed jackrabbit	*Lepus townsendii*
Black-tailed jackrabbit	*Lepus californicus*
Eastern cottontail	*Sylvilagus floridanus*
Mountain cottontail	*Sylvilagus nuttallii*
Desert cottontail	*Sylvilagus audubonii*
UNGULATES	
*Mule deer	*Odocoileus hemionus*
White-tailed deer	*Odocoileus virginianus*
Elk	*Cervus elaphus*
*Pronghorn	*Antilocapra* americana

POTENTIAL[2] AND OBSERVED AVIAN SPECIES LIST

Common Name	Scientific Name
LOONS	
Common loon	Gavia immer
GREBES	
Horned grebe	Podiceps auritus
Eared grebe	Podiceps nigricollis
Western grebe	Aechmophorus occidentalis
Pied-billed grebe	Podilymbus podiceps
PELICANS	
White pelican	Pelecanus erythrorhynchos
CORMORANTS	
Double-crested cormorant	Phalacrocorax auritus
HERONS	
*Great blue heron	Ardea herodias
Black-crowned night heron	Nycticorax nycticorax
American bittern	Botaurus lentiginosus
SWANS, GEESE, AND DUCKS	
Tundra swan	Olor columbianus
Canada goose	Branta canadensis
White-fronted goose	Anser albifrons
Snow goose	Chen caerulescens
*Mallard	Anas platyrhynchos
Gadwall	Anas strepera
*Pintail	Anas acuta
Green-winged teal	Anas crecca
Blue-winged teal	Anas discors
Cinnamon teal	Anas cyanoptera
*American wigeon	Anas americana
Northern shoveler	Anas clypeata
Wood duck	Aix sponsa
Redhead	Aythya americana
Ring-necked duck	Aythya collaris
Canvasback	Aythya valisineria
Greater scaup	Aythya marila
Lesser scaup	Aythya affinis
Common goldeneye	Bucephala clangula
Barrow's goldeneye	Bucephala islandica

POTENTIAL AND OBSERVED AVIAN SPECIES LIST (continued)

Common Name	Scientific Name
SWANS, GEESE, AND DUCKS (continued)	
Bufflehead	Bucephala albeola
Ruddy duck	Oxyura jamaicensis
Hooded merganser	Lophodytes cucullatus
Common merganser	Mergus merganser
Red-breasted merganser	Mergus serrator
DIURNAL RAPTORS	
*Turkey vulture	Cathartes aura
Northern goshawk	Accipiter gentilis
Sharp-shinned hawk	Accipiter striatus
Cooper's hawk	Accipiter cooperii
*Red-tailed hawk	Buteo jamaicensis
*Swainson's hawk	Buteo swainsoni
Rough-legged hawk	Buteo lagopus
*Ferruginous hawk	Buteo regalis
*Golden eagle	Aquila chrysaetos
Bald eagle	Haliaeetus leucocephalus
*Northern harrier	Circus cyaneus
Osprey	Pandion haliaetus
Gyrfalcon	Falco rusticolus
*Prairie falcon	Falco mexicanus
Peregrine falcon	Falco peregrinus
*Merlin	Falco columbarius
*American kestrel	Falco sparverius
GALLINACEOUS BIRDS	
Sharp-tailed grouse	Pedioecetus phasianellus
*Sage grouse	Centrocercus urophasianus
Ring-necked pheasant	Phasianus colchicus
Gray partridge	Perdix perdix
Wild turkey	Meleagris gallopavo
CRANES, RAILS, AND COOTS	
Sandhill crane	Grus canadensis
Virginia rail	Rallus limicola
Sora	Porzana carolina
American coot	Fulica americana

POTENTIAL AND OBSERVED AVIAN SPECIES LIST (continued)

Common Name	Scientific Name
SHOREBIRDS, GULLS, AND TERNS	
American avocet	Recurvirostra americana
Semipalmated plover	Charadrius semipalmatus
*Killdeer	Charadrius vociferus
Mountain plover	Charadrius montanus
Lesser golden plover	Pluvialis dominica
Black-bellied plover	Pluvialis squatarola
Hudsonian godwit	Limosa haemastica
Marbled godwit	Limosa fedoa
Whimbrel	Numenius phaeopus
Long-billed curlew	Numenius americanus
Upland sandpiper	Bartramia longicauda
Greater yellowlegs	Tringa melanoleuca
Lesser yellowlegs	Tringa flavipes
Solitary sandpiper	Tringa solitaria
Willet	Catoptrophorus semipalmatus
Spotted sandpiper	Actitis macularia
Wilson's phalarope	Steganopus tricolor
Northern phalarope	Lobipes lobatus
Common snipe	Capella gallinago
Short-billed dowitcher	Limnodromus griseus
Long-billed dowitcher	Limnodromus scolopaceus
Red knot	Calidris canutus
Sanderling	Calidris alba
Semipalmated sandpiper	Calidris pusilla
Western sandpiper	Calidris mauri
Least sandpiper	Calidris minutilla
White-rumped sandpiper	Calidris fuscicollis
Baird's sandpiper	Calidris bairdii
Pectoral sandpiper	Calidris melanotos
Stilt sandpiper	Micropalama himantopus
Herring gull	Larus argentatus
California gull	Larus californicus
Ring-billed gull	Larus delawarensis
Franklin's gull	Larus pipixcan
Bonaparte's gull	Larus philadelphia
Forster's tern	Sterna forsteri
Common tern	Sterna nirundo
Caspian tern	Sterna caspia
Black tern	Childonias niger
PIGEONS AND DOVES	
Rock dove	Columba livia
*Mourning dove	Zenaida macroura

POTENTIAL AND OBSERVED AVIAN SPECIES LIST (continued)

Common Name	Scientific Name
CUCKOOS	
Yellow-billed cuckoo	Coccyzus americanus
Black-billed cuckoo	Coccyzus erythropthalmus
OWLS	
Barn owl	Tyto alba
Screech owl	Otus asio
Great horned owl	Bubo virginianus
Snowy owl	Nyctea scandiaca
Burrowing owl	Athene cunicularia
Long-eared owl	Asio otus
Short-eared owl	Asio flammeus
Saw-whet owl	Aegolius acadicus
GOATSUCKERS	
Poor-will	Phalaenoptilus nuttallii
*Common nighthawk	Chordeiles minor
SWIFTS	
Chimney swift	Chaetura pelagica
White-throated swift	Aeronautes saxatalis
HUMMINGBIRDS	
Broad-tailed hummingbird	Selasphorus platycercus
Rufous hummingbird	Selasphorus rufus
KINGFISHERS	
Belted kingfisher	Megaceryle alcyon
WOODPECKERS	
*Common flicker	Colaptes auratus
Red-headed woodpecker	Melanerpes erythrocephalus
Lewis' woodpecker	Melanerpes lewis
Yellow-bellied sapsucker	Sphyrapicus varius
Williamson's sapsucker	Sphyrapicus thyroideus
Hairy woodpecker	Picoides villosus
Downy woodpecker	Picoides pubescens
Black-backed three-toed woodpecker	Picoides arcticus

POTENTIAL AND OBSERVED AVIAN SPECIES LIST (continued)

Common Name	Scientific Name
FLYCATCHERS	
*Eastern kingbird	Tyrannus tyrannus
*Western kingbird	Tyrannus verticalis
Cassin's kingbird	Tyrannus vociferans
Ash-throated flycatcher	Myiarchus cinerascens
Eastern phoebe	Sayornis phoebe
Say's phoebe	Sayornis saya
Willow flycatcher	Empidonax traillii
Least flycatcher	Empidonax minimus
Dusky flycatcher	Empidonax oberholseri
Western flycatcher	Empidonax difficilis
Western wood pewee	Contopus sordidulus
LARKS	
*Horned lark	Eremophila alpestris
SWALLOWS	
Violet-green swallow	Tachycineta thalassina
Tree swallow	Iridoprocne bicolor
Bank swallow	Riparia riparia
Rough-winged swallow	Stelgidopteryx ruficollis
Barn swallow	Hirundo rustica
Cliff swallow	Petrochelidon pyrrhonota
Purple martin	Progne subis
JAYS, MAGPIES, AND CROWS	
Gray jay	Perisoreus canadensis
Blue jay	Cyanocitta cristata
Black-billed magpie	Pica pica
Common raven	Corvus corax
Common crow	Corvus brachyrhynchos
Pinon jay	Gymnorhinus cyanocephalus
Clark's nutcracker	Nucifraga columbiana
CHICKADEES	
Black-capped chickadee	Parus atricapillus
Mountain chickadee	Parus gambeli
NUTHATCHES	
White-breasted nuthatch	Sitta carolinensis
Red-breasted nuthatch	Sitta canadensis
Pygmy nuthatch	Sitta pygmaea
Brown creeper	Certhia familiaris

POTENTIAL AND OBSERVED AVIAN SPECIES LIST (continued)

Common Name	Scientific Name
WRENS	
House wren	*Troglodytes aedon*
Rock wren	*Salpinctes obsoletus*
MIMIC THRUSHES	
Mockingbird	*Mimus polyglottos*
Gray catbird	*Dumetella carolinensis*
Brown thrasher	*Toxostoma rufum*
*Sage thrasher	*Oreoscoptes montanus*
THRUSHES	
American robin	*Turdus migratorius*
Hermit thrush	*Catharus guttatus*
Swainson's thrush	*Catharus ustulatus*
Veery	*Catharus fuscescens*
Eastern bluebird	*Sialia sialis*
Western bluebird	*Sialia mexicana*
Mountain bluebird	*Sialia currucoides*
Townsend's solitaire	*Myadestes townsendi*
KINGLETS	
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*Regulus calendula*
PIPITS	
Water pipit	*Anthus spinoletta*
Sprague's pipit	*Anthus spragueii*
WAXWINGS	
Bohemian waxwing	*Bombycilla garrulus*
Cedar waxwing	*Bombycilla cedrorum*
SHRIKES	
Northern shrike	*Lanius excubitor*
Loggerhead shrike	*Lanius ludovicianus*
STARLINGS	
Starling	*Sturnus vulgaris*

POTENTIAL AND OBSERVED AVIAN SPECIES LIST (continued)

Common Name	Scientific Name
VIREOS	
Solitary vireo	Vireo solitarius
Red-eyed vireo	Vireo olivaceus
Warbling vireo	Vireo gilvus
WARBLERS	
Black-and-white warbler	Mniotilta varia
Tennessee warbler	Vermivora peregrina
Orange-crowned warbler	Vermivora celata
Nashville warbler	Vermivora ruficapilla
Yellow warbler	Dendroica petechia
Magnolia warbler	Dendroica magnolia
Black-throated blue warbler	Dendroica caerulescens
Yellow-rumped warbler	Dendroica coronata
Townsend's warbler	Dendroica townsendi
Chestnut-sided warbler	Dendroica pensylvanica
Ovenbird	Seiurus aurocapillus
Northern waterthrush	Seiurus noveboracensis
Macgillivray's warbler	Oporornis tolmiei
Common yellowthroat	Geothlypis trichas
Yellow-breasted chat	Icteria virens
Hooded warbler	Wilsonia citrina
Wilson's warbler	Wilsonia pusilla
American redstart	Setophaga ruticilla
WEAVER FINCHES	
House sparrow	Passer domesticus
MEADOWLARKS, BLACKBIRDS, AND ORIOLES	
Bobolink	Dolichonyx oryzivorus
*Western meadowlark	Sturnella neglecta
Yellow-headed blackbird	Xanthocephalus xanthocephalus
Red-winged blackbird	Agelaius phoeniceus
Northern oriole	Icterus galbula
Rusty blackbird	Euphagus carolinus
*Brewer's blackbird	Euphagus cyanocephalus
Common grackle	Quiscalus quiscula
*Brown-headed cowbird	Molothrus ater
TANAGERS	
Western tanager	Piranga ludoviciana

1993 Reno Creek Wildlife Baseline

POTENTIAL AND OBSERVED AVIAN SPECIES LIST (continued)

Common Name	Scientific Name
GROSBEAKS, FINCHES, SPARROWS, AND BUNTINGS	
Rose-breasted grosbeak	Pheucticus ludovicianus
Black-headed grosbeak	Pheucticus melanocephalus
Indigo bunting	Passerina cyanea
Lazuli bunting	Passerina amoena
Dickcissel	Spiza americana
Evening grosbeak	Hesperiphona vespertina
Purple finch	Carpodacus purpureus
Cassin's finch	Carpodacus cassinii
House finch	Carpodacus mexicanus
Pine grosbeak	Pinicola enucleator
Gray-crowned rosy finch	Leucosticte tephrocotis
Black rosy finch	Leucosticte atrata
Common redpoll	Carduelis flammea
Pine siskin	Carduelis pinus
American goldfinch	Carduelis tristis
Red crossbill	Loxia curvirostra
Green-tailed towhee	Pipilo chlorurus
Rufous-sided towhee	Pipilo erythrophthalmus
*Lark bunting	Calamospiza melanocorys
Savannah sparrow	Passerculus sandwichensis
Grasshopper sparrow	Ammodramus savannarum
Baird's sparrow	Ammodramus bairdii
*Vesper sparrow	Pooecetes gramineus
*Lark sparrow	Chondestes grammacus
Sage sparrow	Amphispiza belli
Dark-eyed junco	Junco hyemalis
Gray-headed junco	Junco caniceps
Tree sparrow	Spizella arborea
Chipping sparrow	Spizella passerina
Clay-colored sparrow	Spizella pallida
*Brewer's sparrow	Spizella breweri
Field sparrow	Spizella pusilla
Harris' sparrow	Zonotrichia querula
*White-crowned sparrow	Zonotrichia leucophrys
White-throated sparrow	Zonotrichia albicollis
Fox sparrow	Passerella iliaca
Lincoln's sparrow	Melospiza lincolnii
*Song sparrow	Melospiza melodia
*McCown's longspur	Calcarius mccoownii
Lapland longspur	Calcarius lapponicus
Chestnut-collared longspur	Calcarius ornatus
Snow bunting	Plectrophenax nivalis

1993 Reno Creek Wildlife Baseline

POTENTIAL[1] AND OBSERVED AMPHIBIANS AND REPTILES SPECIES LIST

Common Name	Scientific Name
SALAMANDERS	
*Tiger salamander	Ambystoma tigrinum
FROGS AND TOADS	
Plains spadefoot	Scaphiopus bombifrons
Woodhouse's toad	Bufo woodhousei
Great plains toad	Bufo cognatus
*Boreal chorus frog	Pseudacris triseriata
Northern leopard frog	Rana pipiens
TURTLES	
Common snapping turtle	Chelydra serpentina
Western painted turtle	Chrysemys picta
Western spiny softshell	Trionyx spiniferus
LIZARDS	
Northern sagebrush lizard	Sceloporus graciosus
Eastern short-horned lizard	Phrynosoma douglassi
SNAKES	
Plains hognose snake	Heterodon nasicus
Eastern yellowbelly racer	Coluber constrictor
Bullsnake	Pituophis melanoleucas
Pale milk snake	Lampropeltis triangulum
Wandering garter snake	Thamnophis elegans
Western plains garter snake	Thamnophis radix
Red-sided garter	Thamnophis sirtalis
*Prairie rattlesnake	Crotalus viridis

POTENTIAL AND OBSERVED SPECIES LISTS

[1] Potential mammal list compiled from Clark and Stromberg (1987) and Oakleaf et al (1992).

[2] Potential avian list compiled from Oakleaf et al. (1992).

[3] Potential amphibian and reptile lists compiled from Baxter and Stone (1980).

* Denotes species observed on Reno Creek permit and surrounding area.

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

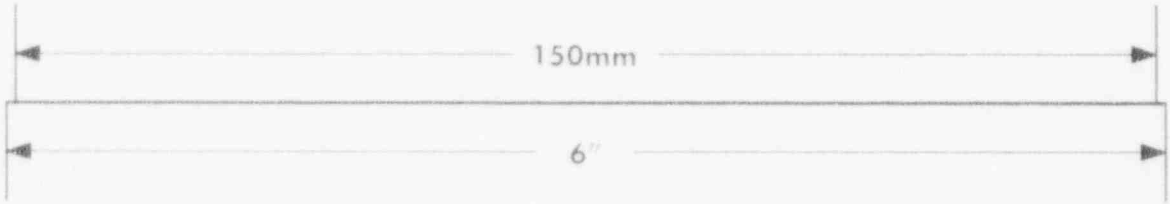
IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6″

1

IMAGE EVALUATION TEST TARGET (MT-3)



14. APPENDIX "D-10", PRE-MINING RADIOLOGICAL ASSESSMENT

14.1 ENVIRONMENTAL BASELINE RADIOLOGICAL DATA

Radiological environmental baseline information has been collected at the Reno Creek site following guidance found in the NRC Regulatory Guide 3.46 and WDEQ-LQD Guideline 6. Baseline sampling has been performed for selected radionuclides in soils, vegetation and groundwater. Additionally, a gamma radiation survey of the permit area and environmental thermoluminesent dosimeters were used to establish background gamma radiation levels. Landauer RadTrac alpha track radon detectors were used to determine background radon concentrations.

14.1.1 RADIONUCLIDE CONCENTRATION IN VEGETATION-1993 DATA COLLECTION

A total of six vegetation sampling locations were established within the permit area. The purpose of the vegetation sampling was to determine baseline concentrations of selected radionuclides and trace metals within plants. Vegetation was analyzed for the following radionuclides and trace metals.

Ra-226	Cu
Th-230	As
U-nat	Mo
	Se

Four vegetation sampling locations were established in the proposed irrigation area in the SW 1/4 of Section 31, T43N R73W. Two of each of these locations were within the Big Sagebrush and U, land Grassland vegetation types. These vegetation types comprise the types of vegetation covering the irrigation area. Two other sample locations were established; one near the existing warehouse building in Section 27 and another near the proposed process plant in Section 29. Plate 14.1 shows the sample locations. Table 14.1 shows sample results.

Vegetation was sampled in late August, 1993. Only the leafy portions of the plant were gathered for analysis. For purposes of baseline collection, vegetation was divided into life forms, i.e. shrubs, grasses and forbs. Approximately one half kilogram of vegetation was obtained from each life form

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.
P O BOX 3258 • CASPER WY 82602 • PHONE (307) 235-0515
254 NORTH CENTER, SUITE 100 • CASPER, WY 82601 • FAX (307) 234-1639

BASELINE VEGETATION SAMPLES - ENERGY FUELS NUCLEAR, INC. - BRUD CREEK PROJECT
Report Date: October 4, 1993

Lab No. Number/Prep.	Site I.D. Identification	Date Sampled	Radiochemical Constituent	Concentration uCi/kg as wet weight basis	Error Est. uCi/kg +/-	LLD* uCi/kg	Arsenic mg/kg **	Selenium mg/kg **	Copper mg/kg **	Molybdenum mg/kg **
93-36453	Production Area PF	09/01/93	Uranium-net	3.32E-06	NA	2 x 10-7	<0.20	<0.20	<1.90	<1.90
			Thorium 230	<1.33E-06	-	2 x 10-7				
			Radium 226	9.97E-06	2.66E-06	5 x 10-8				
93-36454	Production Area Shrubs	09/01/93	Uranium-net	1.70E-05	NA	2 x 10-7	<0.20	<0.20	1.98	<1.90
			Thorium 230	<5.01E-07	-	2 x 10-7				
			Radium 226	3.01E-06	1.00E-06	5 x 10-8				
93-36455	Production Area PG	09/01/93	Uranium-net	1.97E-05	NA	2 x 10-7	<0.20	<0.20	<1.90	<1.90
			Thorium 230	<5.40E-07	-	2 x 10-7				
			Radium 226	1.35E-05	1.89E-06	5 x 10-8				
93-36456	BS #1 PF		Uranium-net			2 x 10-7	<0.20	<0.20	<1.90	<1.90
			Thorium 230			2 x 10-7				
			Radium 226			5 x 10-8				
93-36457	BS #1 Shrubs		Uranium-net			2 x 10-7	<0.20	<0.20	2.18	<1.90
			Thorium 230			2 x 10-7				
			Radium 226			5 x 10-8				
93-36458	BS #1 PG		Uranium-net			2 x 10-7	<0.23	<0.23	<2.31	<2.31
			Thorium 230			2 x 10-7				
			Radium 226			5 x 10-8				
93-36459	BS #2 PF	09/01/93	Uranium-net	9.06E-06	NA	2 x 10-7	<0.20	<0.20	3.03	<2.02
			Thorium 230	7.96E-06	4.41E-06	2 x 10-7				
			Radium 226	1.84E-05	1.96E-06	5 x 10-8				
93-36460	BS #2 Shrubs	09/01/93	Uranium-net	1.01E-05	NA	2 x 10-7	<0.17	<0.17	4.76	<1.70
			Thorium 230	<2.21E-07	-	2 x 10-7				
			Radium 226	5.08E-06	7.73E-07	5 x 10-8				
93-36461	BS #2 PG	09/01/93	Uranium-net	5.62E-06	NA	2 x 10-7	<0.18	<0.18	<1.79	<1.79
			Thorium 230	<9.37E-07	-	2 x 10-7				
			Radium 226	7.96E-06	1.87E-06	5 x 10-8				
93-36462	UG #1 PF	09/01/93	Uranium-net			2 x 10-7	<0.20	1.15	<1.90	<1.90
			Thorium 230			2 x 10-7				
			Radium 226			5 x 10-8				
93-36463	UG #1 Shrubs	09/01/93	Uranium-net			2 x 10-7	<0.17	<0.17	3.69	<1.68
			Thorium 230			2 x 10-7				
			Radium 226			5 x 10-8				
93-36464	UG #1 PG	09/01/93	Uranium-net			2 x 10-7	<0.33	<0.33	3.28	<3.28
			Thorium 230			2 x 10-7				
			Radium 226			5 x 10-8				
93-36465	UG #2 PF	09/01/93	Uranium-net	1.23E-05	NA	2 x 10-7	<0.19	<0.19	2.82	<1.88
			Thorium 230	<4.64E-07	-	2 x 10-7				
			Radium 226	1.93E-05	1.86E-06	5 x 10-8				
93-36466	UG #2 (W3A) Shrubs	09/01/93	Uranium-net	1.16E-05	NA	2 x 10-7	<0.20	<0.20	3.15	<1.97
			Thorium 230	<3.67E-07	-	2 x 10-7				
			Radium 226	4.22E-06	9.18E-07	5 x 10-8				
93-36467	UG #2 (W3A) PG	09/01/93	Uranium-net	6.97E-06	NA	2 x 10-7	<0.23	<0.23	<2.26	<2.26
			Thorium 230	<8.72E-07	-	2 x 10-7				
			Radium 226	2.18E-05	3.05E-06	5 x 10-8				

COMPLETE ENVIRONMENTAL ANALYTICAL SERVICES

Table 14.1 1993 Analysis of Vegetation

ELI

BASELINE VEGETATION SAMPLES - ENERGY FUELS NUCLEAR, INC. - RENO CREEK PROJECT
Report Date: October 4, 1993

Lab No. Number/Prep.	Site I.D. Identification	Date Sampled	Radiochemical Constituent	Concentration uCi/kg as wet weight basis	Error Est. uCi/kg +/-	LLD* uCi/kg	Arsenic mg/kg **	Selenium mg/kg **	Copper mg/kg **	Molybdenum mg/kg **
93-36468	Reno Creek Build. PF	09/01/93	Uranium-nat	4.82E-06	NA	2 x 10-7	<0.20	<0.20	2.97	<1.98
			Thorium 230	<7.42E-07	-	2 x 10-7				
			Radium 226	2.23E-05	2.60E-06	5 x 10-8				
93-36469	Reno Creek Build. Sh^ubs	09/01/93	Uranium-nat	1.09E-06	NA	2 x 10-7	<0.23	<0.23	2.58	<2.35
			Thorium 230	<5.44E-07	-	2 x 10-7				
			Radium 226	4.89E-06	1.36E-06	5 x 10-8				
93-36470	Reno Creek Build. PG	09/01/93	Uranium-nat	<1.16E-06	NA	2 x 10-7	<0.36	<0.36	<3.63	<3.63
			Thorium 230	<1.16E-06	-	2 x 10-7				
			Radium 226	2.32E-05	3.48E-06	5 x 10-8				

Notes:
* Insufficient sample mass provided to obtain lower limit of detection as specified in Regulatory Guide 4.14.
** Metals were analyzed on a chemical digestion of sample. Detection limits vary due to the mass of the split sample.

REPORT APPROVED BY: *R.O. Lasling*
[illegible]

Table 14.1 Cont. 1993 Analysis of Vegetation at each sample location. The samples were collected from plants within a 20 square meter area. A steel fence post was used to mark the center of the sample location.

Radionuclide concentrations were determined through digestion of a weighed amount of air-dried plant material followed by gamma spectroscopy. Metal concentrations were determined through digestion of plant materials and atomic absorption techniques.

TABLE 14.2
Pre-1993
ANALYSIS OF VEGETATION

SAMPLE ID/GENUS	DATE OF SAMPLE	SAMPLE SITE	ANALYSIS RESULTS		
			^{226}Ra (1)	U-Nat	^{230}Th (1)
V-1/ Artemisia	9/25,26/76	E2	0.09 ± 0.66	<0.00005 (2)	0.05 ± 0.03
V-2/Agropyron	9/25,26/76	E7	0.06 ± 0.72	<0.00006 (2)	0.17 ± 0.05
V-3/Agropyron	9/25,26/76	E2	0.07 ± 0.08	<0.00006 (2)	0.09 ± 0.04
V-4/Koeleria	9/25,26/76	E9	0.06 ± 0.08	<0.00009 (2)	0.12 ± 0.05
V-5/Artemisia	9/25,26/76	E7	0.10 ± 0.08	<0.00005 (2)	0.16 ± 0.04
V-6/Artemisia	9/25,26/76	E9	0.16 ± 0.14	<0.00009 (2)	0.50 ± 0.09
P1/Koeleria	10/12,13/76	E10	0.12 ± 0.11	<0.1 (1)	0.00 ± 0.01
P2/Artemisia	10/12,13/76	E10	0.09 ± 0.05	0.1 (1)	0.00 ± 0.01
P3/Koeleria	10/12,13/76	E11	0.00 ± 0.01	<0.1 (1)	0.00 ± 0.01
P4/Artemisia	10/12,13/76	E11	0.03 ± 0.01	0.1 (1)	0.00 ± 0.01
P5/Koeleria	10/12,13/76	E12	0.14 ± 0.03	0.1 (1)	0.00 ± 0.01
P6/Artemisia	10/12,13/76	E12	0.00 ± 0.01	0.1 (1)	0.00 ± 0.01

(1) Reported in microcuries/kg
(2) Nat uranium reported as % uranium

Table 14.2 Pre-1993 Radionuclide Concentrations in Vegetation

14.1.2 CONCENTRATIONS IN VEGETATION-PRE-1993

Vegetation samples were collected by Woodward-Clyde Consultants (Woodward) under contract to Rocky Mountain Energy Company (RMEC) in 1976. Woodward sampled various species of plants including grasses and shrubs within the Reno Creek project area and in close proximity. The species analyzed, sample identification number and radionuclide concentrations are shown on Table 14.2. The sample locations are shown on Plate 14.1. Analysis was performed by Accu-Labs. The technique for determination of radionuclide concentrations is unknown, but was probably digestion of air-dried vegetation and gamma spectroscopy.

Vegetation samples V1 through V6 were collected on September 25 and 26, 1976. Samples P1 through P6 were collected October 12 and 13, 1976.

14.1.3 CONCENTRATIONS IN SOIL

Numerous soil samples were taken within the permit area to characterize baseline radiological concentrations and soil chemistry. Soil samples were collected for several different purposes as part of baseline data collection. The purpose for various samples sampling campaign is explained below.

Soil samples were collected as part of the soils assessment across the proposed permit area. These samples are principally for the purpose of defining the quality and quantity of topsoil in place on site. The samples were collected by soils series to refine and verify soil survey data provided by the Soil Conservation Service. The concentrations of the radionuclides Ra-226, Th-230 and U-nat were determined for a representative profile of each soil series. The results of the entire survey are discussed in Section 11.0 of this document.

Soil samples were also collected as part of a more intensive survey of the SW 1/4, Section 33, T43N, R73W. EFNI proposes to utilize this area for land application of wellfield bleed streams and groundwater restoration fluids. As support to the land application permit to be filed with the Wyoming DEQ, Water Quality Division, soil analysis was performed to a depth of 10 feet or more in the soil profile. The concentrations of Ra-226, Th-230 and U-nat were determined as part of this sampling program. Original analysis reports for radiochemical and chemical analysis are contained in Attachment 11.1.

Soil samples were collected as part of the gamma radiation survey performed within the proposed permit area. Ten soil samples were gathered from the top 15 centimeters of soils at gamma survey points. The samples were gathered to provide a comparison of gamma radiation levels to actual Ra-226 concentrations in the soil. Soil analytical results are discussed in Section 14.3 and Attachment 14.2.

Plate 14.1 shows sample locations for all baseline soil sampling chemical parameters.

14.1.4 CONCENTRATIONS IN SEDIMENT

The Belle Fourche River drainage bounds the project area to the north and west. Spring Creek, a tributary of the Cheyenne River, drains the southern and eastern portions of the permit area. Neither of these drainages are perennial in or near the proposed project area. Sediment was collected from a location within the Belle Fourche and Spring Creek ephemeral channels at the two locations shown on Plate 14.1. Samples were analyzed for Ra-226, Th-230, and U-nat. Results of the sediment sampling are included in Attachment 14.2.

14.1.5 GAMMA RADIATION SURVEY

A pre-operational survey of gamma radiation levels within the permit area was performed on July 20, 21 and August 3 and 11, 1993. Gamma radiation measurements were taken on a fixed grid basis across proposed operations areas. The fixed grid was at a spacing of one gamma radiation measurement per 100 square meters over most of the operations areas. Portions of the eastern one-third of the wellfield area was surveyed at a spacing of one measurement per 400 square meters. The density of measurement for gamma measurement was reduced in these areas when it became apparent that gamma radiation levels across the permit area showed very little variability. The proposed irrigation area for land application of wellfield solutions was surveyed at intervals of approximately 40,000 square meters (one measurement per 10 acres). Other locations within the permit area but outside of operations areas were surveyed at a spacing of approximately one measurement per 162,000 square meters (40 acres). Plate 14.1 shows gamma survey locations.

Operations areas include the following sites: projected wellfields encompassing the first five years of operation, process plant, radium settling pond, irrigation surge pond and the warehouse/storage area.

Soil samples were collected at nine locations within the gamma survey. Gamma radiation measurements were taken at each of these sites to confirm the relationship of the actual Ra-226 in surficial soil to gamma readings. Two other surficial soil samples were taken in surface stream bottoms north of the proposed wellfield locations. These samples are discussed in Section 14.1.4. All sample locations are designated on Plate 14.1.

The gamma survey was performed using two Ludlum Model 19 MicroR meters. Both meters were calibrated with a Ra-226 source within six months of the survey. Instruments and calibration information is described below.

Meter #1	Serial Number:	15601
	Date of Calibration:	June 14, 1993
Meter #2	Serial Number:	15613
	Date of Calibration:	June 1, 1993

A report summarizing analytical findings was prepared by Energy Laboratories and is included as Attachment 14.2

The concentration of Ra-226 and natural uranium are fairly uniform within operational units and the entire permit area. The average background dose rate to gamma radiation is between 12.6 and 14.1 microrem per hour. The average concentrations of Ra-226, Th-230 and U-natural in surficial soils are 1.21, 0.219 and 0.8375 pCi/gm respectively.

14.1.6 THERMOLUMINESCENT DOSIMETRY FOR DETERMINATION OF REGIONAL GAMMA RADIATION

Thermoluminescent dosimeters (TLD's) were established by both RMEC during their initial environmental collection effort and by EFNI. The purpose of the TLD's is to measure the environmental gamma radiation at various points surrounding the proposed permit area. The use of environmental TLD's allows a time averaged measure of gamma radiation. The TLD locations are shown on Plate 14.1.

The TLD's were established by RMEC in 1976. Two weather-proofed TLD's containing high sensitivity lithium fluoride chips were located at each monitor location. Information for the period December 1, 1976 to April 21, 1977 was obtained at five locations. RMEC reported the results as an average value for the two co-located TLD's. This information is presented on Table 14.3.

EFNI established TLD and radon monitoring stations in December of 1992. Seven locations in and around the project area were established as on-going monitoring sites. Only one of these stations (RAD-2) correspond to the original RMEC monitor locations. Three quarters of data have been collected from these pointc and is presented in Table 14.1.5. The TLD and radon monitor stations are shown on Plate 14.1. The monitoring of environmental gamma radiation levels is ongoing on a quarterly basis.

Table 14.3

Environmental Gamma Radiation as Determined by TLD (in mrem/Week)

Location	12/1/76 to 4/21/77	11/16/92 to [2] 04/29/93	04/01/93 to [2] 07/29/93	06/18/93 to [2] 11/02/93
RME-TLD-1 [1]	3.26			
RME-TLD-2 [1]	3.76			
RME-TLD-3 [1]	3.68			
RME-TLD-4 [1]	3.37			
RME-TLD-5 [1]	3.15			
RAD 1 (Badge 1007)	--	2.36	1.84	2.02
RAD 2 (Badge 1001)	--	2.49	Missing	1.96
RAD 3 (Badge 1002)	--	2.81	Missing	Missing
RAD 4 (Badge 1005)	--	2.68	1.81	2.08
RAD 5 (Badge 1003)	--	2.36	1.78	1.97
RAD 7 (Badge 1008)	--	2.54	Missing	2.03
Control (Badge 1000)	--	2.38	1.81	1.89

[1] Information collected by Rocky Mountain Energy. Average of two collocated TLD's.

[2] Based on elapsed time from annealing to reading.

Table 14.3 Environmental Gama Radiation as Determined by TLD (In mrem/Week)

14.1.7 CONCENTRATIONS OF RADIONUCLIDES IN GROUNDWATER

The water in the ore sand at the Reno Creek project site contains naturally elevated concentrations of radionuclides. A complete discussion of groundwater quality is contained in Section 10.3.5.

Two aquifers have the potential to be affected by in situ operations. They are designated on regional cross-sections, Plates 9.1 - 9.9, as the Ore Sand and Upper Aquifer.

The Ore Sand is the geologic unit within which leaching will take place. The Upper Aquifer unit is above the Ore Sand and is separated by a zone of low vertical and horizontal permeability. The Ore Sand and Upper Aquifer water quality will be monitored during production and restoration activities to assure containment of leach solutions.

As described in Section 10.3.5, Ore Sand water quality is generally hard and alkaline with high concentrations of total dissolved solids, sulfates and iron. Water quality analysis is summarized in Table 10.3.5. Radium 226 exceeded 5 pci/liter in ten of the fourteen wells sampled. Radium 226 concentrations ranged from 1.1 to 244 pci/liter measured as an average for each well. U-nat concentrations ranged from 0.001 to 1.1 mg/liter. Thorium-230 ranged from 0.45 to 4.1 pCi/liter.

Upper Aquifer quality is generally higher than the Ore Sand. Total dissolved solids ranged from 179 to 1585 mg/liter for the six upper sand wells. Radium-226 concentrations ranged from less than 0.20 to 2.1 pCi/liter. U-nat ranged from less than 0.0003 mg/liter to 0.15 mg/liter. Thorium-230 has not been sampled in the upper sand unit.

14.1.8 CONCENTRATIONS OF RADIONUCLIDES IN SURFACE WATER

As described in Section 10.2 of this document, no perennial streams exist within or in the vicinity of the permit area. The northern and western portions of the permit area are drained by the Belle Fourche River drainage and by Spring Creek to the south and east. Spring Creek is a tributary to the Cheyenne River. Limited sampling of the Belle Fourche River and K-Bar Draw (tributary to the Belle Fourche) was performed during high run off periods during 1978. However, no radionuclides were analyzed in these samples. No known anomalies of soils containing more than trace amounts of uranium or radium were detected in the gamma survey of the permit area. Furthermore, no known anomalies are present in the area. Therefore, it is believed that radionuclides will be very low in surface runoff in this area.

14.2 RADIOLOGICAL IMPACT ON BIOTA AND MAN

The potential pathways by which radiation could effect either the biota or man are limited to the possibilities discussed below.

Escape of wellfield solutions enriched in radionuclides to the groundwater system - Section 10.1 of this application addresses the groundwater setting and describes the parameters which influence the likelihood and extent of any uncontrolled release of wellfield solutions during mining and reclamation activities. Section 16.1.1 of this application describes the methods and procedures to be utilized to prevent and detect any uncontrolled release of wellfield solutions. In Section 16.1.1, EFNI commits to the restoration of groundwater to a use at least equal to its pre-mining use at the conclusion of mining. As a result of these procedures and commitments, long-term radiological impacts to the groundwater system will be negligible or non-existent.

Escape of process solutions to the surface environment - The possibility of the release of process solutions enriched in radionuclides to the surface environment has been addressed in Section 15, Mine Plan. Spills of wellfield solutions due to pipeline rupture are minimized through automatic switches which shut-down the effected portion of the wellfield, if a significant pressure drop or build-up is detected. Radium settling ponds are lined with impermeable HDPE material and a native clay liner as described in Section 15.9. Additionally, a leak detection system will be constructed to allow early detection of any failure of the liner system. The process building is completely surrounded by a concrete curb and equipped with a non-draining sump. The building curb will contain a volume exceeding the volume of the largest tank within the process building. As a result of the implementation of these control structures and systems, the possibility of uncontrolled releases of process solutions enriched in radionuclides has been minimized.

Airborne migration of radioactive particulates - Airborne particulates will not be generated by the Reno Creek operation. All processes are wet, and no precipitation and drying of uranium oxide will take place at the Reno Creek facility.

Airborne migration of radon gas and daughters - In order to quantify expected doses to humans and concentrations of radon and daughters at various points around the operation perimeter, the MILDOS-AREA (June, 1989) model was used. Assumptions and results of the model are presented in Section 18.0. Modeled dose to the nearest resident is well below dose limitations specified in 10 CFR 20. Also radon concentrations at the wellfield boundary and at the nearest residence are calculated to be below 10 CFR 20, Appendix B, Table 2 limits.

Accidents during transport of resin loaded with uranium - Organic resin loaded with uranium oxide to an average concentration of four pounds U_3O_8 per cubic foot of resin (7.55% U_3O_8 by weight) will be transported to a location off site for the elution, precipitation and drying of yellowcake. The potential for an accident resulting in the spill of loaded organic resin is a possibility. The resin will be wet throughout all phases of the handling and transporting cycle; therefore, even in the event of a spill, immediate releases due to blowing or scattering will be minimal until clean-up activities can be initiated. Emergency procedures will be developed prior to operations and submitted to the Nuclear Regulatory Commission for review and comment. Emergency procedures for response to a spill will become a part of the Standard Operating Procedures for the operation, subject to periodic review and update. Emergency procedures will ensure the prompt response and appropriate cleanup and decontamination of any transportation spills. Decontamination of an accident site will be facilitated by the fact that resin is solid and can be readily identified and excavated at the site.

14.2.1 RADON EXPOSURES TO THE SURROUNDING POPULATION

Energy Fuels Nuclear, Inc. placed high-sensitivity Rad-Trac outdoor radon detectors at locations within and surrounding the proposed permit area in December of 1992. Rad-Trac are sensitized chips covered with a selectively permeable material allowing only the infiltration of radon. The sensitized chip records alpha disintegrations from radon daughters. The chips have a minimum sensitivity of 6 pCi/l days.

Rad-Tracs were placed at the same location as environmental TLD's. Monitor locations are shown on Plate 14.1. Three quarters of radon information is currently available and is presented in Table 14.4. Monitoring is ongoing on a quarterly basis.

EFNI intends on establishing an additional radon monitoring site on the permit boundary at the southeast corner of Section 20, T43W, R92W. This point represents maximum potential dose at the controlled area boundary. Section 18.8.6 contains a complete discussion of exposures.

14.2.2 ATMOSPHERIC DISPERSION COMPUTER PROGRAM (MILDOS)

The MILDOS-AREA model predicts the concentrations of radionuclides at receptor points within and surrounding the permit area. Assumptions of the model and results are included in Section 18.8.

TABLE 14.4 ENVIRONMENTAL RADON CONCENTRATIONS				
		AVERAGE RADON CONC., PC;/1		
STATION ID#	LOCATION	12/05/92 TO 04/12/93	04/13/93 TO 07/14/93	07/14/93 TO 10/06/93
CONTROL		0.1	0.2	0.2
RAD - 1	Urban Groves Ranch house SE¼, Sec. 4, T43N, R73W	0.6	0.7	1.7
RAD - 2	Reno Creek Warehouse (RME Process Building) T43N, R73W	0.6	7.1	6.7
RAD - 3	Old Patterson Ranch house (Nearest residence) NW¼, Sec. 25, T43N, R73W	2.6	15.5[1]	1.9
RAD - 4	Upwind Boundary - Belle Fourche River SW¼, Sec. 6, T42N, R73W	0.8	0.7	1.4
RAD - 5	Justin Joe Reno Ranch house NW¼, Sec. 2, T42W, R73W	0.6	1.1	1.4
RAD - 7	South of Permit Area - 6 miles NW¼, Sec. 26, T42N, R73W	1.0	1.6	Missing

[1] Radon badge recovered on the ground probably erroneous data.

Table 14.4 Environmental Radon Concentrations

15. MINE PLAN

15.1 SITE LOCATION AND LAYOUT

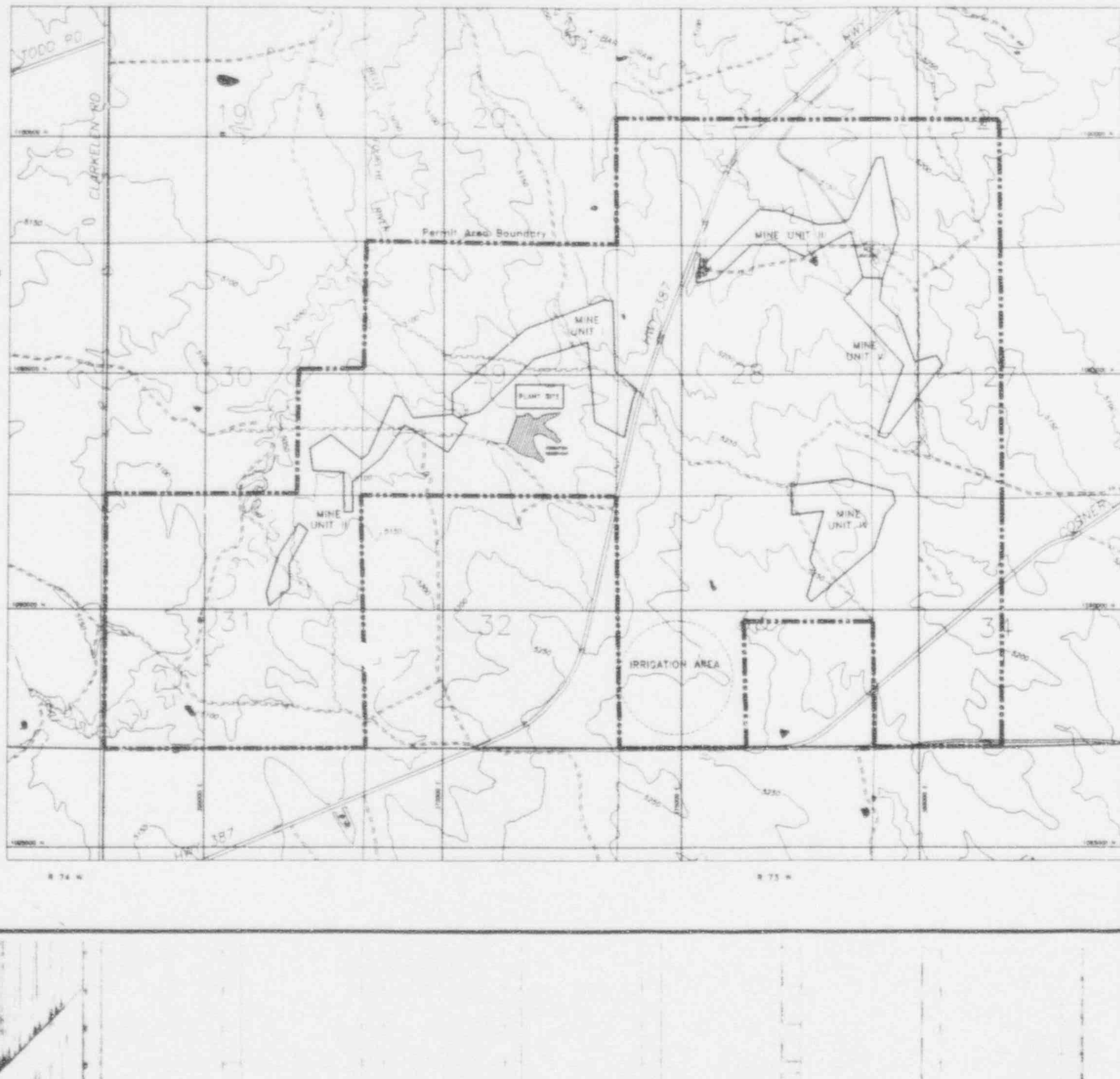
The Reno Creek ISL Project is located in southern Campbell County, Wyoming about 40 air miles south southwest of Gillette. Figure 1.1, Project Location, shows the general location of the Reno Creek ISL Project. The permit area includes portions of Sections 21, 22, 27, 28, 29, 30, 31, 33 and 34, Township 43 North, Range 73 West. Access to the Reno Creek ISL Project is via Wyoming State Highway 387 which cuts through the project located approximately ten miles southwest of Wright, Wyoming. Secondary access to the project is via local ranch roads and the existing gravel road to the Rocky Mountain Energy pilot plant building.

The 3,613 acre mine permit area lies in the Belle Fourche and Cheyenne River drainages with the drainage divide occurring along the southern and eastern portions of the permit area. Figure 15.1, Site Plan, shows the permit area boundary, the planned mining areas, the irrigation site and the proposed satellite plant and water treatment locations. The existing pilot plant building constructed and used by Rocky Mountain Energy will be used as a warehouse facility during commercial operation. Figure 15.2, Process Area Layout, shows more detail in the area of the processing plant and water treatment installations.

Access from the highway to the project site will be via a new gravel road, approximately one-half mile in length, to be constructed specifically for the commercial project. The warehouse facility will be accessed via the existing gravel road into the nearby oil well and pilot building.

15.2 ORE BODY DESCRIPTION

The mineralized sand is laterally extensive representing a major depositional event and is traceable for at least several miles to the north and west. The host sand outcrops several miles to the south of the permit area. The host sand is the thickest and most continuous sand unit in the permit area, and it ranges from 120 to 150 feet thick. Throughout much of its extent in the permit area, the Ore Sand is divided into upper and lower units by a shale/claystone that averages from 10 to 40 feet thick. The majority of the minable reserves occur in the Lower Ore Sand.

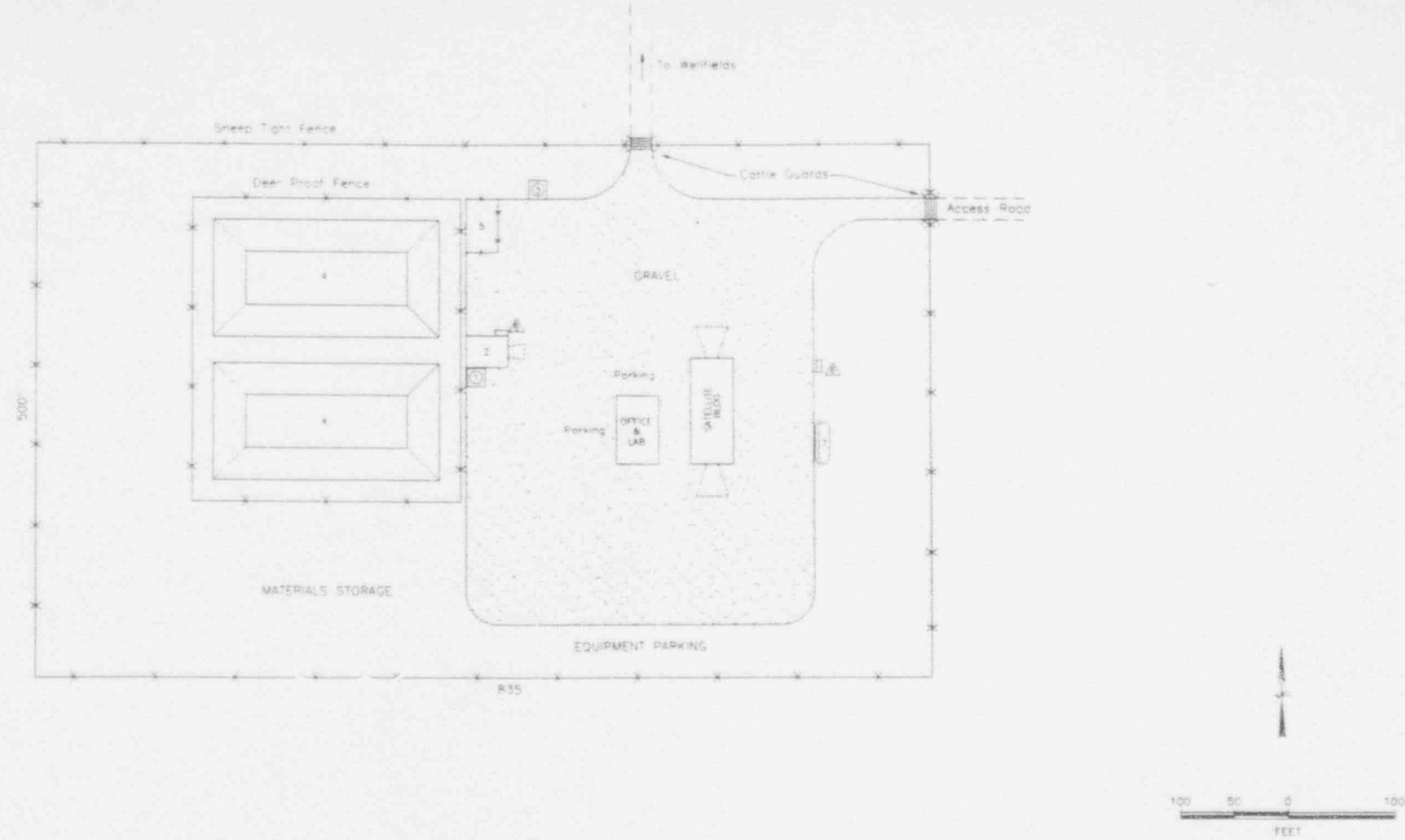


0 1000 2000 4000
FEET

energy fuels nuclear inc.

Project	RENO CREEK ISL PROJECT
County	Campbell
State	Wyoming
Location	T 43 N, R 73 W
	SITE PLAN
Scale	1"=2000'
Date	October 1993
Author	
Draftsman	D.L. Steed

Figure 15.1



LEGEND

1 Caustic Soda Storage Tank
2 Waste Water Treatment
3 Hydrochloric Acid Storage Tank
4 Lined Radium Removal Ponds
5 Gas, Diesel & Propane Storage Area
Electrical Transformer
7 Carbon Dioxide Storage Vessel

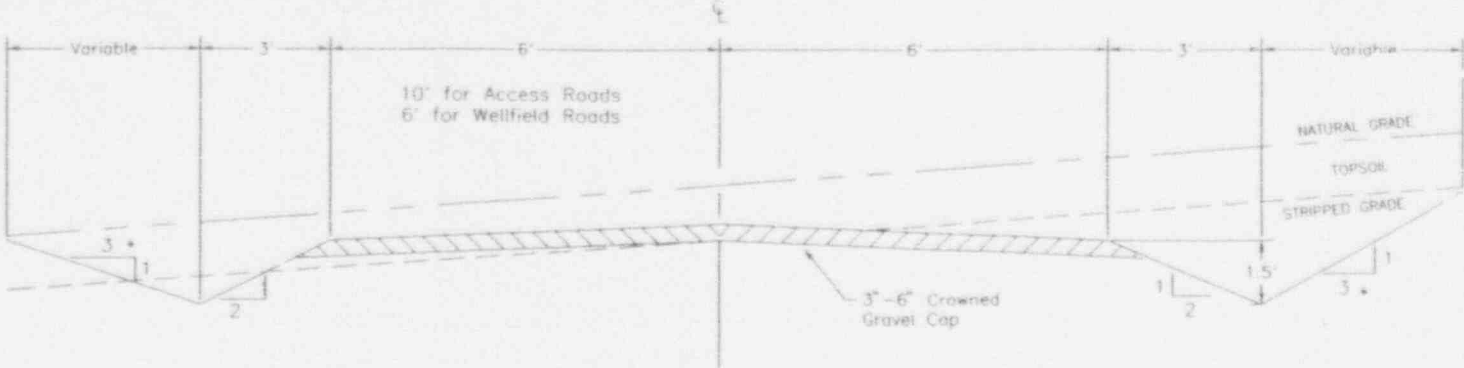
energy fuels nuclear inc.

Project: RENO CREEK
County: Campbell State: Wyoming
Location: T 43 N R 73 W

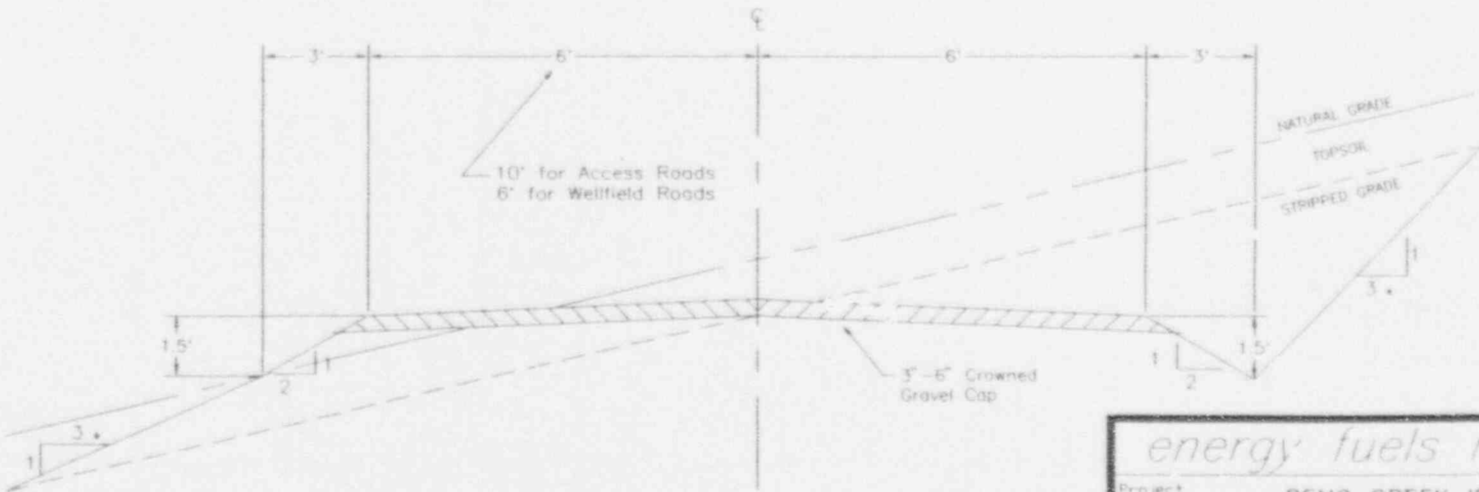
PROCESS AREA LAYOUT

Scale 1" = 100' Date July 1993 plant-lo
Draftsman D.L. Siepo

Figure 15.2



NEAR LEVEL GROUND



SIDE SLOPE

* Note: Slopes will range from 3:1 to 2:1

energy fuels nuclear inc.

Project	RENO CREEK ISL PROJECT		
REVISIONS	County: Campbell	State: Wyoming	
Date / By	Location: T 43 N, R 73 W		
	MINE ACCESS AND WELLFIELD ROADS TYPICAL PROFILES		
	Scale: N/A	Date October, 1993	road-x
	Author:	Draftsman:	

Figure: 15.3

Topsoil consisting of the A and B horizon material will be stripped from the main access road prior to construction.

~~The main access road to the plant area will be constructed of native subsoil materials and be capped by~~ *The main access road will then be surfaced with* three to six inches of gravel or scoria to provide an all-weather surface. Drainage along the road will be provided to keep the road base solid and to direct runoff into adjacent natural drainages. ~~Suitable soil~~ *Salvaged topsoil* will be removed from the road bed, stockpiled and then stabilized with grass cover using a temporary seed mixture. At the conclusion of all mining and restoration operations, the access road to the satellite plant will be reclaimed by picking up the gravel/scoria, ripping and discing the road bed, and reapplying the stored topsoil and reseeding. ~~The access road to the warehouse building will be left in place up to the active oil well and for use by local ranchers.~~ *The existing access road to the oil well will be left in place following mining and restoration activities. The section of access road to the warehouse building and the warehouse building and site will be reclaimed unless agreement is reached with the landowner to leave these installations in place.*

Secondary roads will be constructed along the wellfields to provide access for drill rigs, supplies, pump pulling units, mobile generators, maintenance vehicles, etc. The location of the planned wellfield roads is shown on Plate 15.1, Mine Plan. These secondary wellfield roads will be constructed in a manner to minimize land disturbance. The secondary wellfield roads will provide year round access to the wellfields. Construction of the wellfield access roads consists of removing and stockpiling A + B horizon material, followed by blading of the road surface. The road width will be approximately 12 feet. A layer of three to six inches of gravel, conglomerate or scoria material will be placed on top of the bladed surface to provide an all weather base. Figure 15.3 shows typical profiles to be used for secondary roads. The removed topsoil will be stockpiled and then stabilized with grass cover using the temporary seed mixture. At the conclusion of all mining and restoration operations in a mining unit, wellfield access roads no longer needed for operations will be reclaimed by picking up the gravel/scoria from the road bed, ripping, discing and reapplying the stored topsoil, mulching and seeding. A listing of soil series topsoil depths, acreages and volumes for all areas of topsoil removal is presented in Table 11.1.

Traffic on the mine access road and on the secondary gravel roads between wellfields will be subject to a 45 miles per hour posted speed limit to reduce the potential for collisions with wildlife.

The top of the host sands is bounded by a shale, shaley lignite, and lignite ~~unit locally termed the "Felix Coal" and is recognized by its distinctive response on electric logs. This unit comprises the overlying aquitard due to its dense, impermeable character.~~ *sequence and is referred to as the Upper Aquitard. Within the Upper Aquitard are two coal/lignite seams locally known as the "Felix Coal". The sequence of low permeability shales, claystones, and dense siltstones between the Ore Sand and the Upper Aquifer comprise the "Upper Aquitard".* Throughout the permit area, the ~~overlying aquitard~~ *Upper Aquitard* ranges from 20 to 50 feet thick, and in some places is massive shale and siltstone for more than 100 feet *(Ref. Plates 9.1 - 9.9., Permit Area Structural Cross Sections).*

Above the Felix unit is a locally discontinuous sand and siltstone sequence that is tapped locally by windmills for livestock water. The water level in this upper aquifer unit is approximately 60 feet above the water level in the ore sand, which further demonstrates the integrity of the Felix aquitard. The upper aquifer varies considerably in thickness across the permit area and is nonexistent in most of the eastern portions of the permit area.

Underlying the ore sand is a massive sequence of shale, claystone, siltstone, and occasional sand units. No continuous well-developed sand units are known to exist within the 200 to 300 foot interval below the bottom of the ore sand. In the project vicinity, no wells or windmills are known to be completed in any sand units underlying the ore sand. Water wells would not be expected to test lower horizons if the ore sand or upper aquifer yielded sufficient water for local ranching needs.

The ore body is a typical roll front type deposit. The oxidation-reduction zone trends essentially from the south to the north along the east side of the permit area. In the northeast corner of the permit area, the ore trend changes direction and generally tracks to the southwest. A complete description of the regional and local geology is presented in Section 9.

In the Reno Creek ore deposit, the uranium mineralization is present as amorphous uranium oxide. The host sandstones are composed of quartz, feldspars, and rock fragments with locally occurring carbon fragments. Grain size ranges from very fine-grained sand to small granules. The sandstone is weakly cemented and friable. Occasional occurrences of pyrite and calcite as cementing materials can be observed. Behind the roll front interface, the host sand is oxidized and generally appears tan or reddish brown/orange. Ahead of the roll front interface, the sand is gray with occasional fresh carbon fragments and minor pyrite.

15.3 IN SITU LEACH MINING METHOD

In Situ Leach (ISL) mining will be employed at the Reno Creek ISL Project. The applicability of this mining technology is demonstrated by the pilot test operated by Rocky Mountain Energy (RME) in 1980 and 1981, and by similarity to other ISL mines in the Powder River Basin of Wyoming.

The Reno Creek pilot test by RME operated a single 5-spot pattern employing a sodium bicarbonate lixiviant. The bicarbonate leach successfully demonstrated recovery of uranium, confinement and control of leaching solutions, and restoration of groundwater following mining. A copy of the RME Demonstrated Restoration Report is included as Attachment 15.1

The bicarbonate test began in October 1980 and restoration was concluded in April 1981. This was followed by a 12-month groundwater stabilization period. The test program culminated in regulatory sign off in March 1983 with approval of carbonate leaching for commercial operations at Reno Creek.

15.4 GENERAL DESCRIPTION OF OPERATIONS

The Reno Creek ISL Project commercial operation is planned to operate at a total flow rate of 2,000 gallons per minute (GPM) through the satellite plant. Nominal production is projected to average approximately 400,000 pounds of U_3O_8 annually. As a satellite project, operations at Reno Creek will include wellfield operations, uranium recovery on ion exchange resin in the satellite plant, water treatment of the wellfield purge stream and restoration brine, and surface irrigation of the treated water.

The Reno Creek uranium roll front deposits generally range from 300 to 420 feet deep. The host sandstone is continuous throughout the permit area as are the overlying and underlying aquitards. The Ore Sand is locally divided into Upper and Lower units by a claystone/shale that thins and disappears throughout the permit area. The upper and lower Ore Sand units are in hydrologic communication.

The Reno Creek site is rolling prairie grass and sage lands used exclusively for ranching and recreational hunting. No occupied residences exist within the permit area, and no grain crops are produced on lands within the permit area. ~~No past or current mining has taken place at Reno Creek.~~ *The only past uranium operation was a small (single pattern) in situ R&D test conducted by Rocky Mountain Energy in the 1980-1981 time frame, as described in paragraph 15.3.* One producing oil well exists within the permit area. The only building existing within the permit area is the aforementioned pilot plant building.

The site topography and drainage is influenced by the Belle Fourche-Cheyenne River drainage divide which passes through the permit area. The Belle Fourche River headwater is a few miles west of the permit area, and the river channel passes southwest to northeast along the northwest side of the permit area. No mining operations will take place in the active channel of the river, which only flows on a seasonal basis. Elevation of the site ranges from 5,040 to 5,290 feet above sea level.

The layout of the plant site and water treatment facility is shown on Figure 15.2 Process Area Layout. The existing building used by Rocky Mountain Energy during its pilot test will be used as a warehouse facility during operations. The pilot building has had all previously used equipment and materials removed and has been surveyed and released for unrestricted use. Figure 15.1, Site Plan, shows the overall project layout including the process area, mining units, irrigation storage reservoir and the surface irrigation site.

Fences will be constructed around the plant site, the irrigation reservoir, the irrigation area, and the wellfields. Fences will be Type I (Land Quality Division Guideline 10) to ensure that livestock, including sheep, cattle, and horses, are excluded from the operations areas. Fenced operations areas in the wellfields will generally follow the shape of the individual Mine Units as shown on Plate 15.1, but final location of fences will also consider access and facilitation of local ranching operations. None of the fencing planned for the project will be permanent.

Production is proposed on a continuous basis as wellfields are sequentially developed along the ore trends. Once mining is completed in a given wellfield and mining has advanced beyond the area of drawdown around an active mining area, restoration activities will be initiated. Restoration of groundwater in the mining areas will be accomplished by groundwater sweep to flush the mining zone followed by reverse osmosis treatment and re-injection of the treated water.

Four planned mining areas have been identified in the permit area. The limits of these mining areas will change slightly as mine development advances and the limits of the economic reserve areas are modified slightly based on close-spaced delineation drilling. A fifth prospective mining area has also been identified in the permit area; inclusion of the prospective area in the mine plan is contingent upon future verification of reserves. The general outline of *the* mining units are shown on Figure 15.1.

The ISL process is proposed to be similar to the techniques currently in use in operating ISL mines in Wyoming, Nebraska and Texas. The leaching solution will be groundwater that has been fortified with carbon dioxide and oxygen. Sodium bicarbonate or potassium hydroxide may also be added to the leaching solution to control pH.

Since Reno Creek will be operated as a satellite project, ion exchange resin that is loaded with recovered uranium will be trucked to an existing NRC licensed facility for resin processing and uranium recovery. Resin stripping, regeneration, uranium precipitation, and packaging will be performed off site. The satellite concept will allow the Reno Creek Project to operate with a full-time staff of six people on site. Support will be provided by EFNI's corporate staff, and certain maintenance and wellfield development activities will be performed on a contract basis.

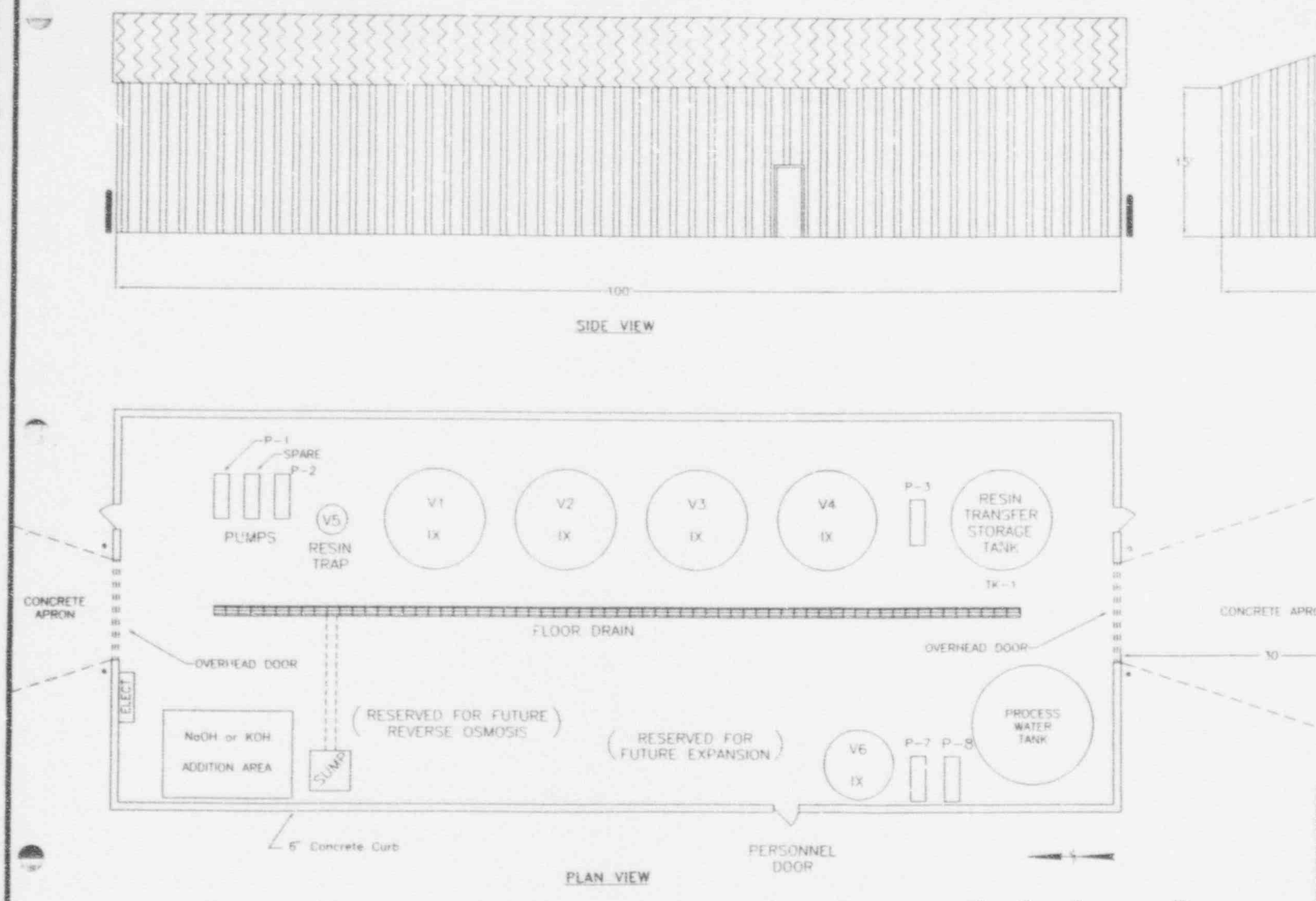
In addition to the plant and water treatment equipment at the satellite plant, other equipment used at the mine will include drill rigs, backhoes, trenching equipment, mobile generators, pump pulling units, supply trucks and trailers, maintenance vehicles, resin haulage trailers, and pickup trucks. The number of units employed will fluctuate as wellfields are added and operated throughout the project life.

The roll front deposits at Reno Creek host reserves adequate for approximately eight years of production at the design rate. Potential exists to expand the reserves through ongoing development drilling. The efficiency of mining reserves occurring in areas of low hydrostatic head will also impact the mine life of Reno Creek. Based on potential additions to the reserves, the mine life for these proposed permit area is presently not expected to exceed ten years.

ISL enjoys the benefit of minimal impact on other natural resources in the project area. Although lignite seams do occur within the permit area, these are thin, of poor quality, and too deep to be economically competitive, particularly in light of the enormous reserves of bituminous coal presently being exploited nearby in the Powder River Basin. ISL activities will not interfere with future opportunities to develop oil and gas reserves. Selection of drilling locations, location of access roads, and possible pipeline routes can easily be accommodated around the ISL operations since the areas of ISL activity are small. Temporary utilization of the surface and the groundwater resources within the wellfields are the major impacts to the local resources. Post mining reclamation and groundwater restoration will minimize the impacts of the mining operations.

15.5 ACCESS AND WELLFIELD ROADS

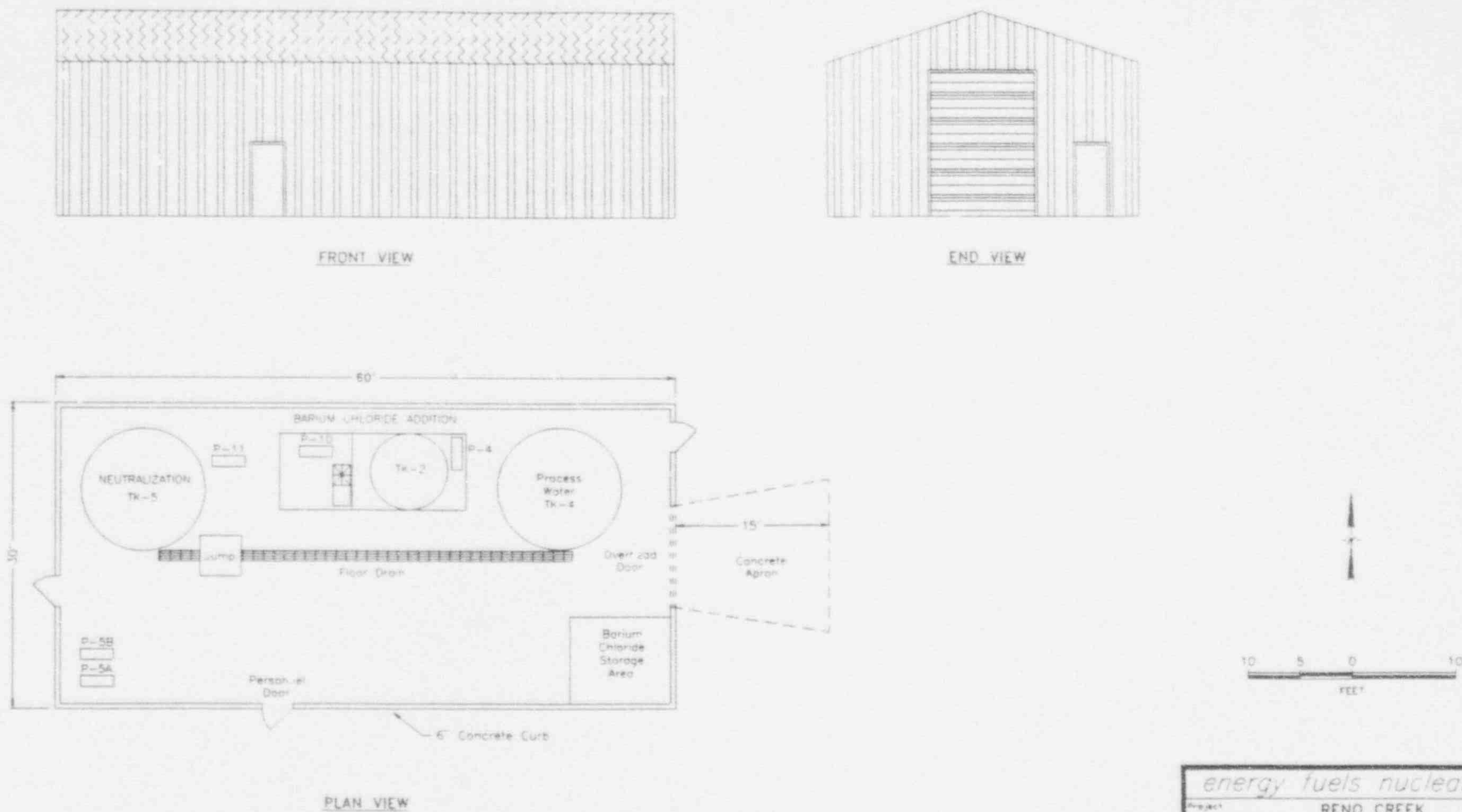
Access to the satellite plant will be from Highway 387 over a gravel surfaced road. The length of this road is less than one-half mile. *Access onto Highway 387 will be permitted through the Wyoming Department of Transportation by utilizing an M-3 Access Permit.* The short access road traverses gently sloping land. For this reason, cut, fill and grading requirements will be minimal. The road will have an operating width of approximately 20 feet. Figure 15.3 shows typical profiles through the access road. Access to the existing warehouse building will be via the existing, single lane gravel road which leads to the active oil well and the old pilot building. EFNI has an agreement in place to share maintenance of this road with the oil well owner. No modifications are planned for this road. This road will also serve as the primary access to Mine Units III, IV and V as shown on Plate 15.1, Mine Plan. Beyond the existing pilot plant location, the existing road is a two-track ranch trail. To minimize disturbance, ~~this trail will be upgraded to access Mine Units IV and V.~~ *the alignment of this existing trail will be followed for access to Mine Units IV and V. Topsoil horizons A and B will be stripped and stockpiled for any disturbances related to the upgrading, realignment, and construction of the access road.* In the event that Mine Unit V is developed, the alignment of the road will be modified, but the total length of improved road will be nearly identical for either scenario.



energy fuels nuclear inc.

Project	RENO CREEK
County	Campbell
State	Wyoming
Location	T 43 N, R 73 W
	SATELLITE BUILDING
Scale	1" = 10'
Date	July 1993
	sat-bldg
Author	
Draftsman	D. Stedo

Figure 15.9



energy fuels nuclear inc.

Project: RENO CREEK

County: Campbell — State: Wyoming

Location: T 43 N, R 73 W

WASTE WATER TREATMENT SYSTEM

Scale: 1"=10' — Date: July, 1993

Figure 15.12

Access to the wells within the wellfields will be provided by establishing a two track service road down every other row and connecting to the wellfield access road. These service roads will be unimproved and will receive very light use; therefore, topsoil will not be stripped from the wellfield service roads.

During drilling and wellfield construction, impact to the topsoil will be minimized by directing the field traffic to follow common routes. ~~Topsoil~~ *The A and B soil horizon material* from all drilling pits, pipelines and trenches will be piled *or windrowed* separately from the excavated subsoil material. After the pits and pipeline trenches are filled in, the topsoil will immediately be placed back on the excavated site. Further discussion of topsoil protection measures steps taken following wellfield construction is provided in Section 15.~~11~~ *12*, Topsoil Management Plan.

The Belle Fourche River channel is located along the western portion of the permit area (Figure 15.1 Site Plan and Plate 15.1 Mine Plan). The Belle Fourche channel will not be crossed by any wellfields, roads, pipelines, or other installations, as shown on Plate 15.1 Mine Plan. The Belle Fourche drainage is discussed in Section 10.2.

Only two sizeable drainages occur within areas to be affected by mining activities in the permit area. K-Bar Draw originates in Section 27, passes through the northeast corner of Section 28, and exits the permit area in the middle of Section 21. K-Bar Draw has a drainage length of less than one mile above the proposed wellfield areas in Section 28. K-Bar Draw is an ephemeral drainage that only collects run off water during high precipitation events. The other significant drainage is west of Highway 387 and trends northwesterly from Section 32 across the southwest corner of Section 29. This unnamed drainage is also ephemeral and has a drainage length of about one mile.

The K-Bar Draw drainage is presently crossed via an existing small earthen dam, which occasionally catches runoff for later use for stock watering. This crossing will be used to access the western limits of Mine Unit III.

The unnamed drainage in Section 29 is below the irrigation storage reservoir, but most runoff to this drainage will be diverted around the reservoir. *The diversion ditches are designed to handle the 100-year, 24-hour design storm event of 4.2 inches; the location of the diversion ditches is shown on Plate 15.1. The wellfield access road which crosses the drainage below the irrigation reservoir will have a* *low-water crossing. This crossing will be capable of handling a 25-year, 6-hour design event, as recommended by WDEQ Guideline 8, and will be a six inch thick layer of rock at least 1.3 inches in diameter. The location of the crossing is show on Plate 15.1.* ~~Therefore, a low-water crossing will be constructed where the wellfield access road crosses the drainage. This crossing will be lined with rock or coarse gravel to minimize erosion and sedimentation. All other drainages in the permit area are minor or captured by existing stock ponds (northwest corner Section 28).~~

15.6 WELLFIELD DESIGN AND OPERATION

The Reno Creek permit area encompasses five mining units. During installation of wellfields, reserves are expected to be expanded slightly as in-fill drilling is conducted. The limits of the presently proposed wellfields will be slightly modified as the precise limits of the reserves are defined; however, the general limits of mining are expected to be as depicted on Plate 15.1.

The description of wellfield configuration is based on EFNI's current understanding of the orebody. Adjustment in well spacing, mine unit configuration and mining schedule may be made as actual mining experience dictates. Both WDEQ and NRC will be notified of significant changes prior to implementation. The primary wellfield pattern design will be a five-spot configuration in either square or rectangular patterns with occasional triangular patterns along wellfield edges. Alternating line drives, staggered line drives or other configurations may be employed as conditions warrant.

In a five-spot pattern configuration, each production well is surrounded by four injection wells. Solutions enter the ore zone through the injectors and are recovered from the production well in the center of each pattern. In a large wellfield array of several patterns, some injection wells service four production wells and each production well is served by four injection wells. The spacing of wells within the patterns will vary from approximately 50 to 120 feet between injection and production wells, depending upon local geologic conditions and ore configuration.

Line drives will be used to exploit narrow portions of the ore body where five-spot patterns are impractical. Line drives consist of alternating injection and production wells aligned along a narrow ore trend. The offset placement of injectors and producers is a staggered line drive configuration. The spacing and distance between wells is dictated by the width of the ore.

Flow rates of each recovery well are expected to be between 10 and 30 gpm. The injection rate in each injection well will be 10 to 20 gpm. Injection pressures are expected to be low at Reno Creek, as evidenced in the pilot test, due to hydrostatic and hydrologic conditions. In any event, injection pressures will be kept below 100 psi.

Buried pipelines will be used to collect and distribute wellfield solutions during mining and restoration operations. Networks of small diameter lines will feed into larger trunklines connected to the satellite plant. Any pipeline crossings of Highway 387 will be covered by E-54 licenses, as required, from the Wyoming Department of Transportation.

15.7 WELL DRILLING AND COMPLETION

During the drilling of wellfields, all wells will be drilled and completed in a similar manner so that all wells can be used as either injection wells or production wells. This is done to allow any well to be switched from an injector to a producer or vice versa to efficiently leach an ore body and to have maximum beneficial use during restoration.

15.7.1 WELL COMPLETION METHODOLOGY

Wells will be drilled by rotary methods, with a pilot hole first being drilled through the expected ore bearing interval. Drill hole drift will be minimized by using drill collars and avoiding pull down. Following drilling to total depth, the hole will be circulated clean, and the drill string will be withdrawn so geophysical logging can be conducted. Drill hole logging will include:

1. Natural gamma for recognition and measurement of uranium bearing zones.
2. Resistance for lithologic identification.
3. Spontaneous potential for lithologic identification.
4. Deviation survey to measure drill hole drift.

Upon completion of geophysical logging, if the hole meets economic criteria and is acceptably straight, it will be reamed to a minimum diameter of 7 3/4 inches from surface to the top of the zone selected to be screened. After reaming, five-inch polyvinyl chloride (PVC) Schedule 40 casing will be cemented to the bottom of the reamed interval. The drill rig will pull off the hole while the cement sets.

The cementing of casing involves pumping ~~Class A~~ *Type II (Class B)* portland cement down the casing and displacing it up the annulus. The cement will have a weight of from 12 to 13 pounds per gallon and will include the addition of a minor amount of bentonite gel. A precalculated amount of cement will be pumped down the well and displaced with fresh water. If cement does not return to the surface during displacement, loose cement will be added from the surface to top off the cement column in the annulus.

If a pilot hole is logged and found not to meet economic criteria, it will be abandoned by filling it with plug gel. The hole will be capped approximately two feet below the surface with a precast concrete plug and marked and identified by a wooden stake on the surface.

After the cement in a completed well cures, the well is ready for completion. The standard completion methodology is under-reaming followed by either open hole completion or by gravel packing around the production screen. Cement will be drilled out of the bottom of the casing, and the hole will be cleaned through the completion interval. Next an under-reaming tool will be lowered on drill pipe to the desired location in the hole. Under-reaming involves the use of a specialized tool with spring loaded, pressure activated blades. The blades of the under-reamer remain in the folded position while being lowered into the well. When the desired interval is reached the tool is activated by engaging the mud pump on the drill rig which opens the blades. While the blades or cutting edges of the tool are opening, the rotary table on the rig turns the tool slowly. As pressure is increased from the mud pump the turning blades make contact with the well bore interior. Slowly increasing pump pressure forces the blades out farther until the maximum extension is reached and a 10½ or 14 inch diameter cavity is cut through the completion interval. The drill stem then stops rotation and the well is flushed to remove any remaining cuttings. The flushing is followed by a period of air lifting to bring fresh formation water through the exposed face, further cleaning it. At that time the pump pressure is relaxed and the spring tension on the cutting blades pulls them back into alignment within the under-reaming tool. The tool is then withdrawn from the well.

The production and injection wells will be completed by installing three-inch PVC wire wound well screen through the completion interval. This liner will be set by lowering it into the under-reamed hole on the drill string. The liner top assembly will remain inside the well casing and will isolate the liner annulus from the portion of hole above the liner assembly by employing two rubber K-Type well packers. Once the liner is set, coarse sand will be pumped into the annulus of the liner. This is the standard well completion technique for injection and production wells at Reno Creek.

Monitor wells will be drilled and cased in essentially the same manner as described for the injection and production wells. Based on past experience at Reno Creek, the monitor wells will most likely be completed as open hole completions rather than screened and gravel packed completions. Since the monitor wells will be subjected to less intensive pumping, open hole completions should be acceptable for monitoring purposes. In the event that a monitor exhibits evidence of open hole collapse or plugging, the well can be completed with a liner, but gravel-packing is not contemplated. Open hole integrity will be verified by probing of any open hole monitor wells prior to initiation of mining injection and recovery. The zones to be monitored and the proposed completion intervals are described in Section 16.1.

Figure 15.4, Figure 15.5 and Figure 15.6 are schematics of production, injection, and monitor well completions proposed for Reno Creek.

15.7.2 WELL DRILLING INTEGRITY LOGGING

After a well has been drilled, reamed, cased, and under-reamed, a well casing integrity log is run before setting the screened liner. The Mechanical Integrity Test Log (MIT) employs a single point resistivity survey. *The single point resistivity log will typically be run at a scale of one inch equal to ten feet vertically with a low range log sensitivity of 0 to 500 ohms.* This log verifies that the casing is intact and has not been damaged by tools run in and out of the hole and that cement occupies the annulus between the casing and the hole wall.

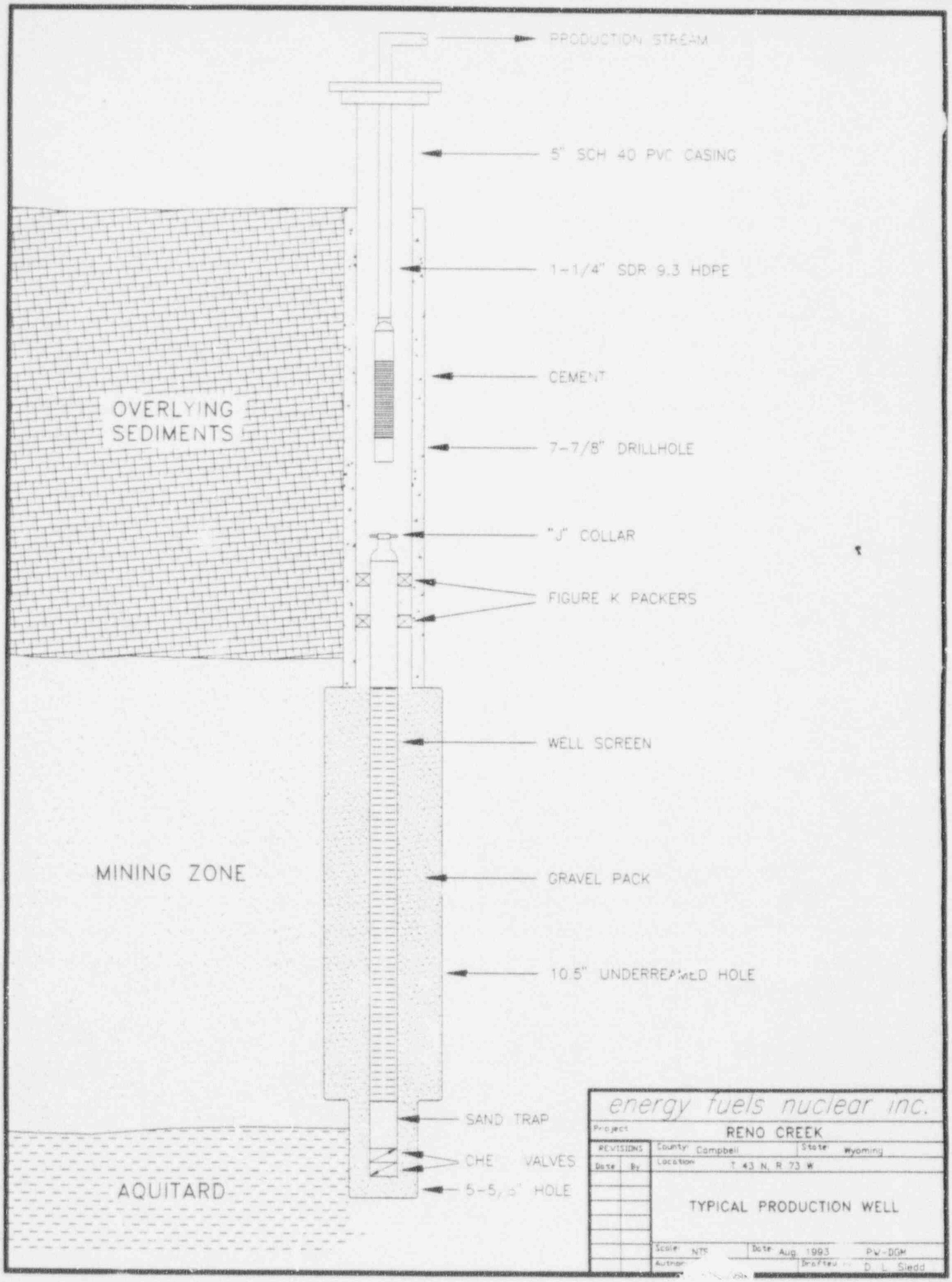
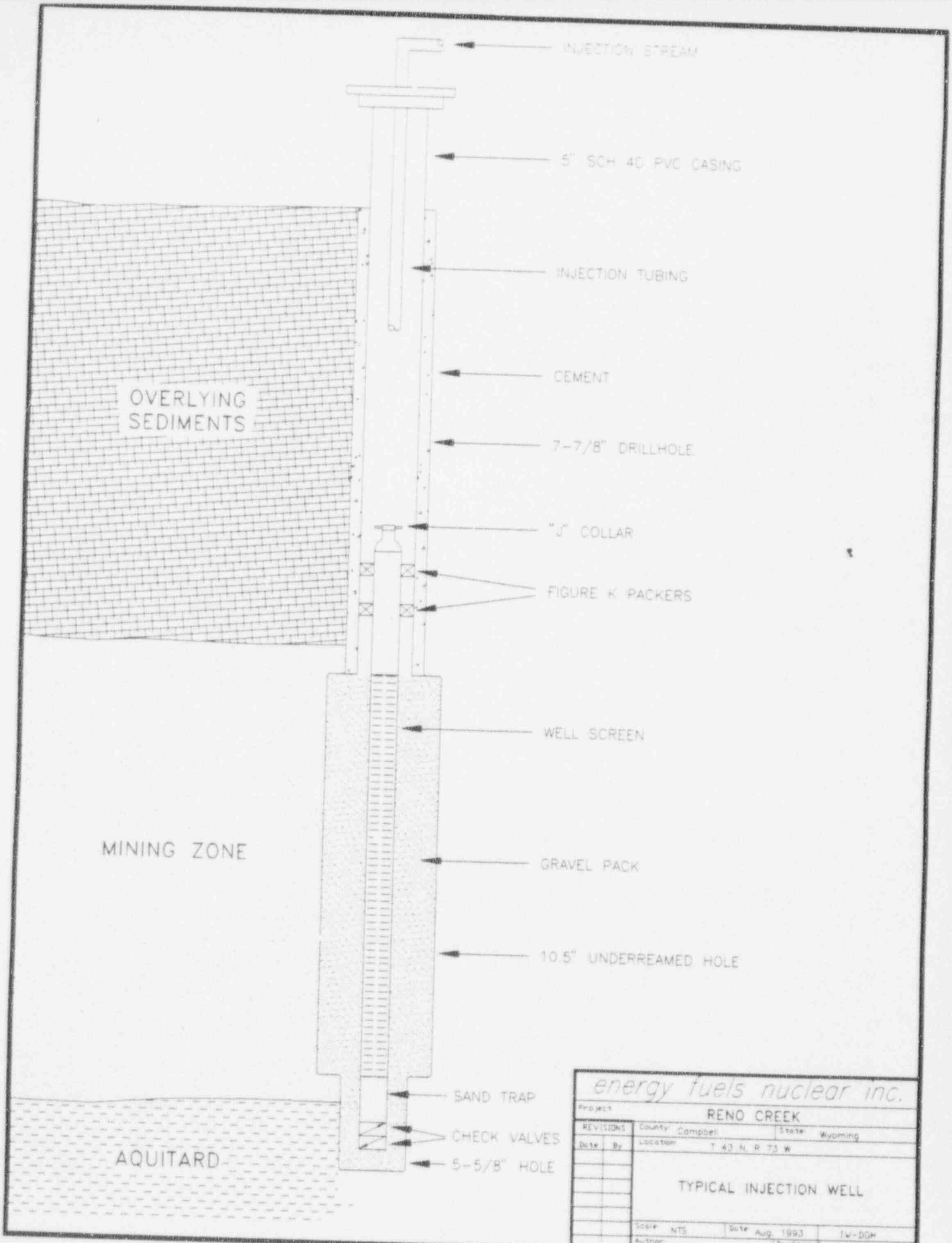

PRODUCTION STREAM
5" SCH 40 PVC CASING
1-1/4" SDR 9.3 HDPE
CEMENT
OVERLYING SEDIMENTS
7-7/8" DRILLHOLE
"J" COLLAR
FIGURE K PACKERS
WELL SCREEN
MINING ZONE
GRAVEL PACK
10.5" UNDERREAMED HOLE
SAND TRAP
VALVES
HOLE
AQUITARD
energy fuels nuclear inc.
Project
RENO CREEK
REVISIONS
Date
By
County: Campbell
State: Wyoming
Location: T 43 N, R 73 W
TYPICAL PRODUCTION WELL
Scale: NTS
Date: Aug 1993
PW-DGM
Author
Drafted: D. L. Sledd

Figure: 15.4



INJECTION STREAM
5" SCH 40 PVC CASING
INJECTION TUBING
CEMENT
7-7/8" DRILLHOLE
"J" COLLAR
FIGURE K PACKERS
WELL SCREEN
GRAVEL PACK
10.5" UNDERREAMED HOLE
SAND TRAP
CHECK VALVES
5-5/8" HOLE
OVERLYING SEDIMENTS
MINING ZONE
AQUITARD
energy fuels nuclear inc.
Project RENO CREEK
REVISIONS
Date By
County: Campbell
State: Wyoming
Location: T 43 N, R 73 W
TYPICAL INJECTION WELL
Scale NTS
Date Aug. 1993
IW-DGH
Author
Drafted By: D. L. Sledd

Figure: 15.5

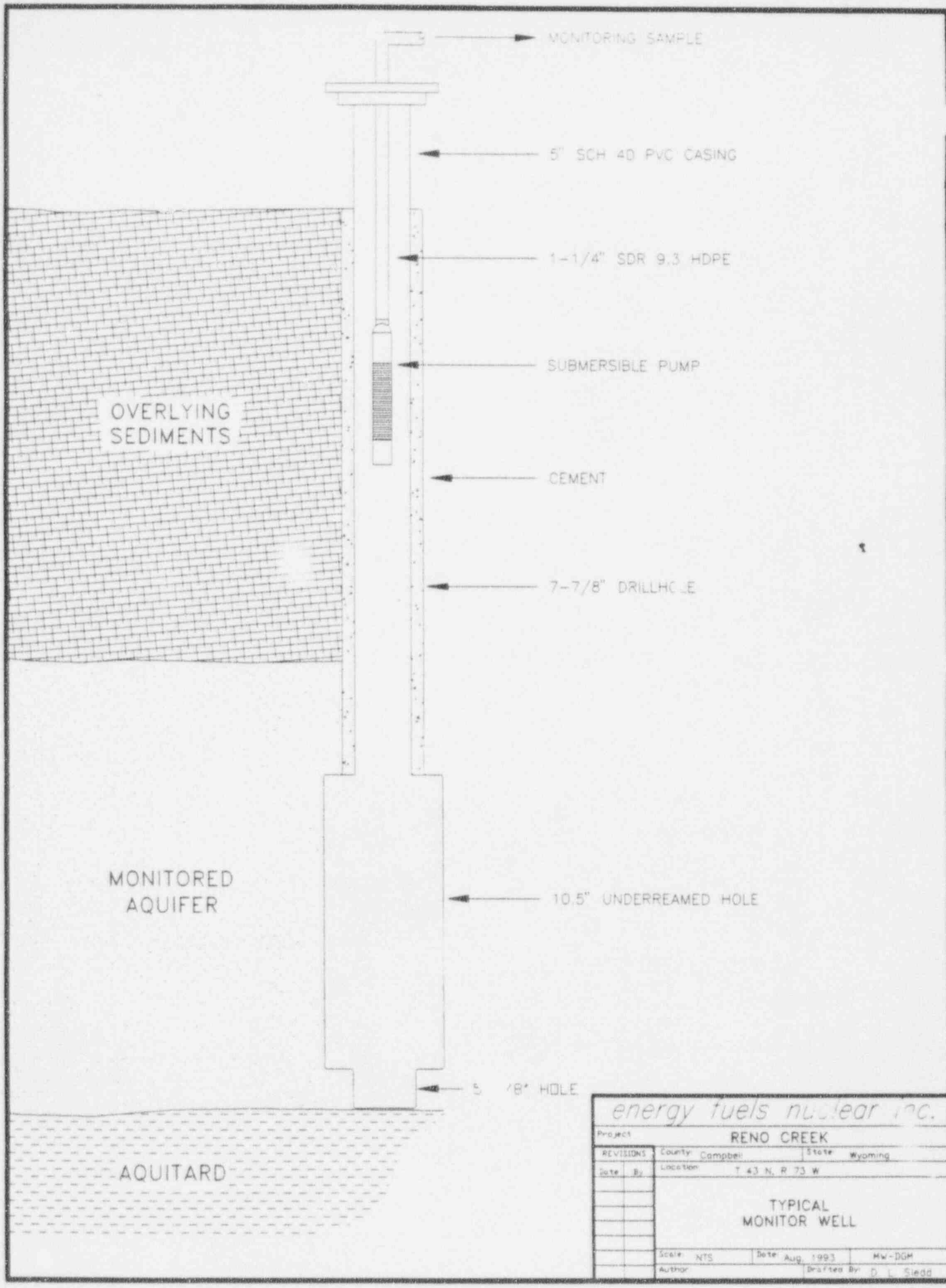

MONITORING SAMPLE
5" SCH 40 PVC CASING
1-1/4" SDR 9.3 HDPE
SUBMERSIBLE PUMP
OVERLYING SEDIMENTS
CEMENT
7-7/8"
MONITORED AQUIFER
10.5" UNDERREAMED HOLE
HOLE
AQUITARD
energy fuels
Project RENO CREEK
REVISIONS
Date By
County Campbell
State Wyoming
Location T 43 N, R 73 W
TYPICAL MONITOR WELL
Scale NTS
Date Aug. 1993
MW-DGM
Author
Drafted By D. L. Sledd

Figure: 15.6

Upon passing the MIT procedure, a well will have the screen installed and will be gravel-packed. If an MIT log shows evidence of casing failure or other difficulties, the hole will either be repaired and retested, or abandoned using the procedure in Section 17.3. All wells must pass the MIT procedure before they can be used in the solution mining process. Copies of MIT logs on all monitor, injection and production wells used in the mining process will be kept on the premises and will be available for inspection. The results of the integrity tests will be reported to regulatory agencies in accordance with Underground Injection Control program requirements.

15.8 RECOVERY PROCESS AND FACILITIES

15.8.1 PROCESS DESCRIPTION

The uranium in situ leaching process proposed for Reno Creek has been successfully tested and proven at the Rocky Mountain Energy pilot project and at other ISL mining projects in Wyoming and Texas. This process, involving dissolution of uranium minerals from the host rock consists of two steps. First the uranium must be oxidized from the tetravalent state to the hexavalent state with an oxidant such as gaseous oxygen. Second, a chemical compound, such as carbon dioxide, is used to complex the uranium in the solution. The uranium enriched solution is transferred from the production wells to the processing facility for extraction of uranium from the solution by using ion exchange resin.

The leaching solution, or lixiviant, is composed of native groundwater from the wellfield, fortified with the desired chemicals to achieve uranium solubilization and recovery. Barren lixiviant is injected with gaseous oxygen as a source of oxidant and carbon dioxide to convert existing carbonate ions to bicarbonate ions. The natural bicarbonate levels, if required, will be supplemented by the addition of sodium bicarbonate, sodium hydroxide or potassium hydroxide.

The network of injection and recovery wells in the wellfields will be utilized to circulate and recover the uranium-bearing lixiviant as it removes the uranium mineralization from the host formation. The uranium-bearing solution will be pumped directly to the satellite plant for uranium recovery, refortification, and return back to the wellfields. This cycle of circulation and uranium recovery will be continued until the formation is depleted of economically recoverable uranium.

The pregnant lixiviant from the wellfields will be passed through vessels containing a bed of ion exchange resin beads. This resin is selective to the uranium-bicarbonate complexed ion and removes the uranyl ions from the solution. When the resin is loaded with uranium, it will be removed from the vessel and processed to recover the uranium. Resin will be transferred to a resin hauling vehicle, the resin hauling vehicle will transport resin to an off site facility licensed for uranium recovery and the resin will be eluted with sulfuric acid to remove uranium. After removal of the uranium, the resin will be returned to an ion exchange vessel for continuation of the recovery process.

A one percent to three percent bleed stream of the total 2000 gpm flow will be taken from the lixiviant stream after it passes through ion exchange. This bleed stream is taken to ensure that more water is recovered than injected in the operating wellfields. This will maintain a net inflow of water into the mining area to reduce the potential for horizontal and vertical excursions. The bleed stream will be treated to remove radium prior to disposal by surface irrigation. This process is described further in the Waste Water Treatment System section.

15.8.2 LIXIVIANT COMPOSITION

The lixiviant for the in situ leaching process will be a dilute carbonate/bicarbonate aqueous solution. Oxygen will be added to oxidize the uranium underground. Carbon dioxide is added to lower pH and as the source of carbonate/bicarbonate.

Barren lixiviant, after uranium removal in ion exchange, will be refortified to the desired composition prior to reinjection in the wellfields. The expected maximum concentration of bicarbonate is 5,000 mg/l, and the pH range is expected to be between 4.0 and 8.0 units.

15.8.3 CHEMICAL REACTIONS

Oxidation of tetravalent uranium can be achieved by gaseous oxygen dissolved in water. Once oxidized, the uranium species is soluble and will complex with bicarbonate to form a compound that can be recovered as the lixiviant flows through the formation.

The chemical reactions for the alkaline leaching process are as follows:

Oxidation $2UO_2 + 1/2\ O_2 = 2UO_3$

Complexing $UO_3 + CO_3^{-2} + 2HCO_3^{-} = [UO_2(CO_3)_3]^{-4} + H_2O$

$UO_3 + 2\ HCO_3^{-} = [UO_2(CO_3)_2]^{-2} + H_2O$

The above alkaline leaching process for uranium is very selective. However, some mobilization of trace metals such as arsenic vanadium, selenium, etc., is possible if these minor constituents are present in the mining zone.

15.8.4 ABSORPTION CIRCUIT AND RESIN TRANSFER

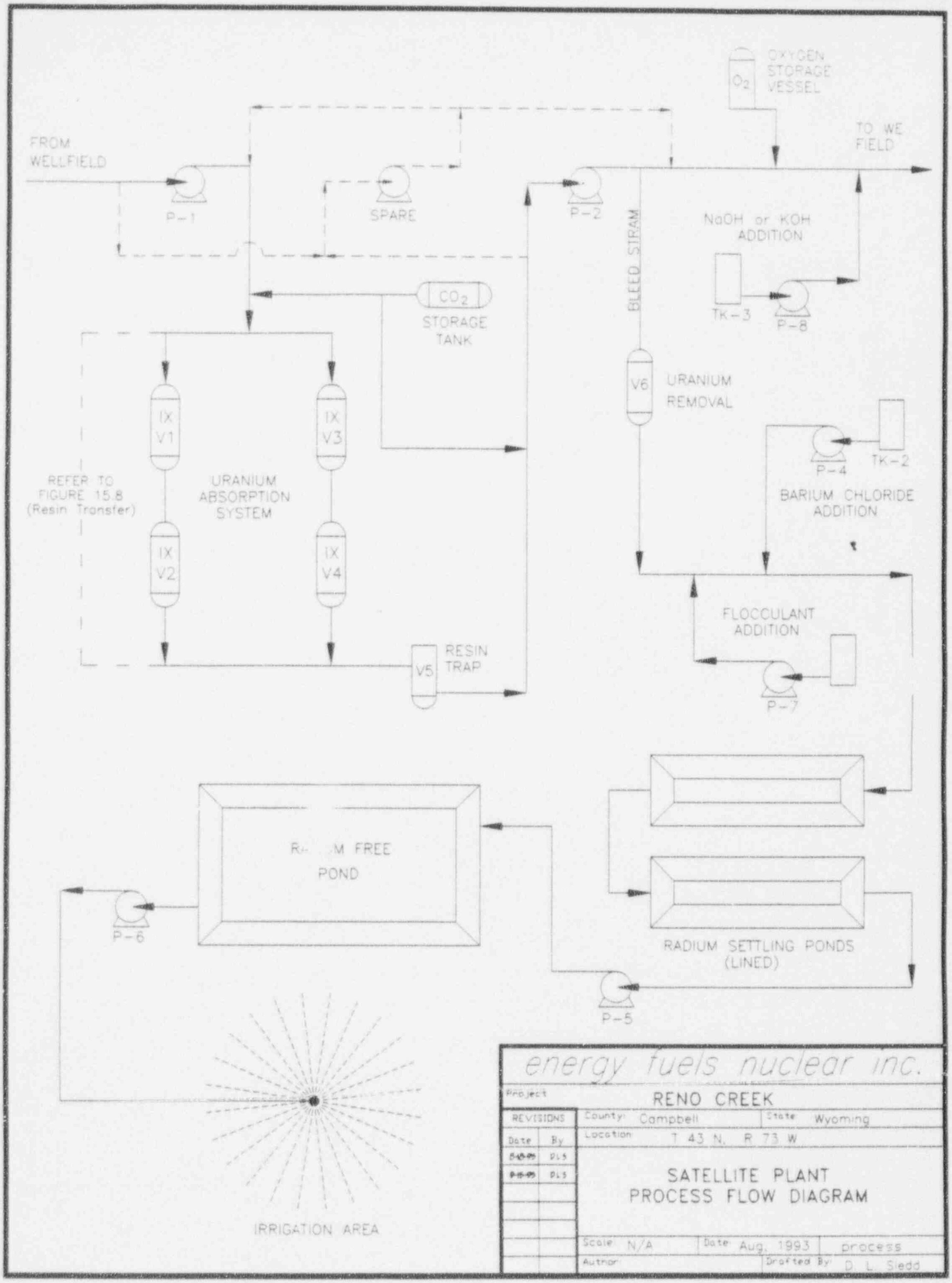
The Reno Creek ISL satellite plant will have a simplified solution circuit since only uranium absorption and resin transfer, for subsequent processing off site, will take place at the Project. The nominal design flow rate for the Reno Creek satellite facility is 2,000 gpm. Stripping of uranium from the ion exchange resin and precipitation of yellowcake will not take place at the Reno Creek facility. Figure 15.7, Satellite Plant Process Flow Diagram, shows the steps in the uranium recovery circuit.

Ion exchange resin will remove solubilized uranium from the pregnant lixiviant according to the following reactions:

$$[UO_2(CO_3)_3]^{-4} + 2R^{+2} = R_2[UO_2(CO_3)_3]^{-4}$$
$$[UO_2(CO_3)_2]^{-2} + R^{+2} = R[UO_2(CO_3)_2]^{-2}$$

Note: R denotes the resin.

The ion exchange circuit will be operated with resin columns in series to maximize uranium recovery. Once maximum uranium loading on the resin is achieved, the lead column will be taken off line so the resin can be removed from the column and stripped (uranium-free) resin can be loaded into the column to continue the recovery process.



OXYGEN STORAGE VESSEL
O_2
TO WE FIELD
FROM WELLFIELD
P-1
SPARE
P-2
BLEED STRAM
NaOH or KOH ADDITION
TK-3
P-8
CO_2
STORAGE TANK
V6
URANIUM REMOVAL
IX V1
IX V3
IX V2
IX V4
REFER TO FIGURE 15.8 (Resin Transfer)
URANIUM ABSORPTION SYSTEM
P-4
TK-2
BARIUM CHLORIDE ADDITION
FLOCCULANT ADDITION
V5
RESIN TRAP
P-7
POND
RADIUM SETTLING PONDS (LINED)
P-6
P-5
IRRIGATION AREA
energy fuels nuclear inc.
Project
RENO CREEK
REVISIONS
Date
By
DLS
DLS
County: Campbell
State Wyoming
Location T 43 N. R 73 W
SATELLITE PLANT
PROCESS FLOW DIAGRAM
Scale N/A
Date Aug. 1993
process
Author
Drafted By D. L. Siedd

Figure: 15.7

A resin transfer system will be utilized to move loaded and stripped resin between the ion exchange columns and the resin haulage trailers. The system will consist of a storage tank, pump and piping system as depicted on Figure 15.8, Resin Transfer System Flow Diagram. The system is a closed loop and the tank will be used to store water for the transfer until an actual transfer takes place. This tank will be located in the satellite building and will be vented through the roof. This will vent any released radon, oxygen or carbon dioxide gases to the outside of the building. Transfers will b onducted under pressure so the trailers or columns will not be open to the atmosphere.

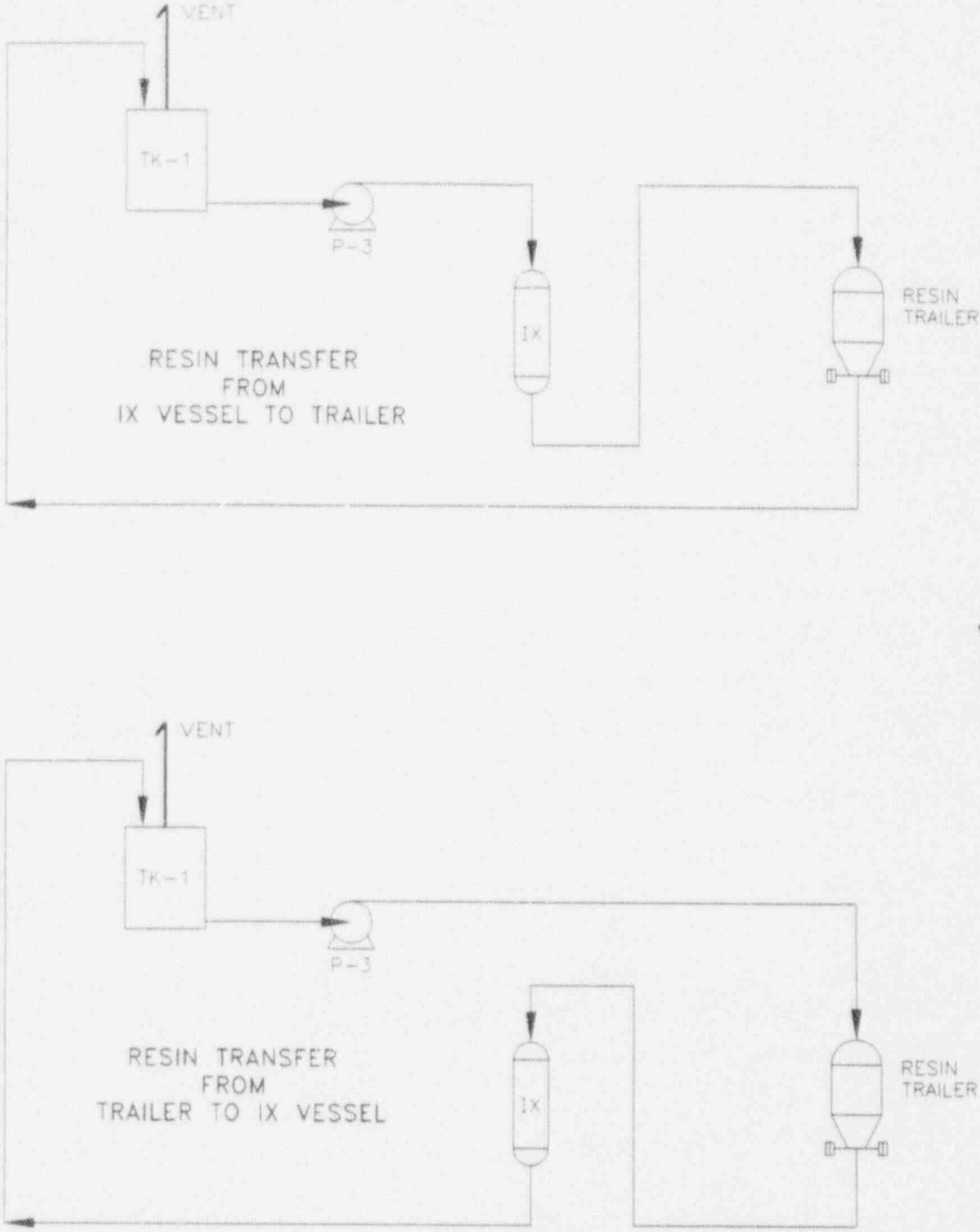
15.8.5 PLANT BUILDING AND FACILITIES

The Reno Creek ISL Project will employ four buildings. These are the satellite plant, the office/lab building, the water treatment building and the old Rocky Mountain Energy pilot building for a warehouse. The arrangement of the buildings and facilities at the satellite installation is shown on Figure 15.2, Process Area Layout.

The satellite plant building will be 100 feet by 40 feet with a 15 foot eave height. The building will be set on a concrete slab that has a six inch outside curb to contain any spills and to facilitate wash down. The floor will have a drain trench and sump to collect any spills or wash down water, which will be transferred to the waste water treatment system. *EFNI will inspect the slab frequently for open cracks, and cracks will be sealed to minimize potential for leaks through the slab.* Figure 15.9, Satellite Building Layout, shows the arrangement of the processing equipment within the satellite building.

The office and laboratory building will be adjacent to the satellite building. As shown on Figure 15.10, Office and Laboratory Building Plan View, this building will house the project offices, men and women's change facilities and the laboratory. This building will be 30 feet by 60 feet.

The waste water treatment building, as shown on Figure 15.2, Process Area Layout, will be adjacent to the radium removal ponds. This 60 foot by 30 foot building and the equipment it contains, are described in the Waste Water Treatment section.



energy fuels nuclear inc.			
Project: RENO CREEK			
REVISIONS	County: Campbell	State: Wyoming	
Date / By	Location: T 43 N, R 73 W		
8-10-93 / DLS	RESIN TRANSFER SYSTEM FLOW DIAGRAM		
	Scale: N/A	Date: July, 1993	resinsys
	Author:	Drafted By: D. L. Siedd	

Figure: 15.8

Other installations at the satellite facility include electrical transformers and substations, carbon dioxide tank, gas and fuel storage tanks and hydrochloric acid and caustic soda tanks for treatment of wells and neutralization of the treatment solutions.

The plant *and parking* areas will *be stripped of A and B horizon material.* ~~have all suitable topsoil stripped from traffic and parking areas.~~ The area will be *surfaced with* gravel~~ed~~ or ~~covered with~~ rock to provide a solid surface for traffic. The plant area will be fenced to prevent access by livestock and the radium removal ponds will have deer-proof fencing to prevent access by sharp hoofed animals in areas where the synthetic pond liners are exposed.

Electric power to the site will be provided by the local utility, *Tri-County Electric Association, Inc.* The line will be brought in to the site along Highway 387 from the current end of the line, *at the House Creek oil field,* approximately five miles to the northeast of the site. *The line is proposed to follow along the southeast side of Highway 387 to a point southeast of the plant site. Appropriate permits from the Wyoming Department of Transportation will be required for any powerline crossings over Highway 387. Any powerlines constructed in the future at Reno Creek will be specified to require raptor protection.*

15.8.6 PLANT EQUIPMENT, INSTRUMENTATION AND CONTROL

A list of the major components of the Reno Creek ISL plant is presented in Table 15.1. The plant will operate with automated controls to minimize operator coverage. Operating controls and limits will be set to control normal operations. The partially automated system will include alarms and shutoffs to prevent overflows or spills. System shutdown will be instantaneous when fault conditions are detected.

15.9 WASTE WATER TREATMENT SYSTEM

During the mining phase, the major waste stream generated will be the one to three percent bleed stream (20 to 60 gpm). A minor amount of liquids will be generated from plant wash down and from solutions used to flush and clean wells in the wellfield. In the groundwater restoration phase, the flow rate of waste solutions will be increased to approximately 200 gpm, thus making a maximum project total waste stream of approximately 260 gpm. These waste streams will be treated in the waste water

Table 15.1

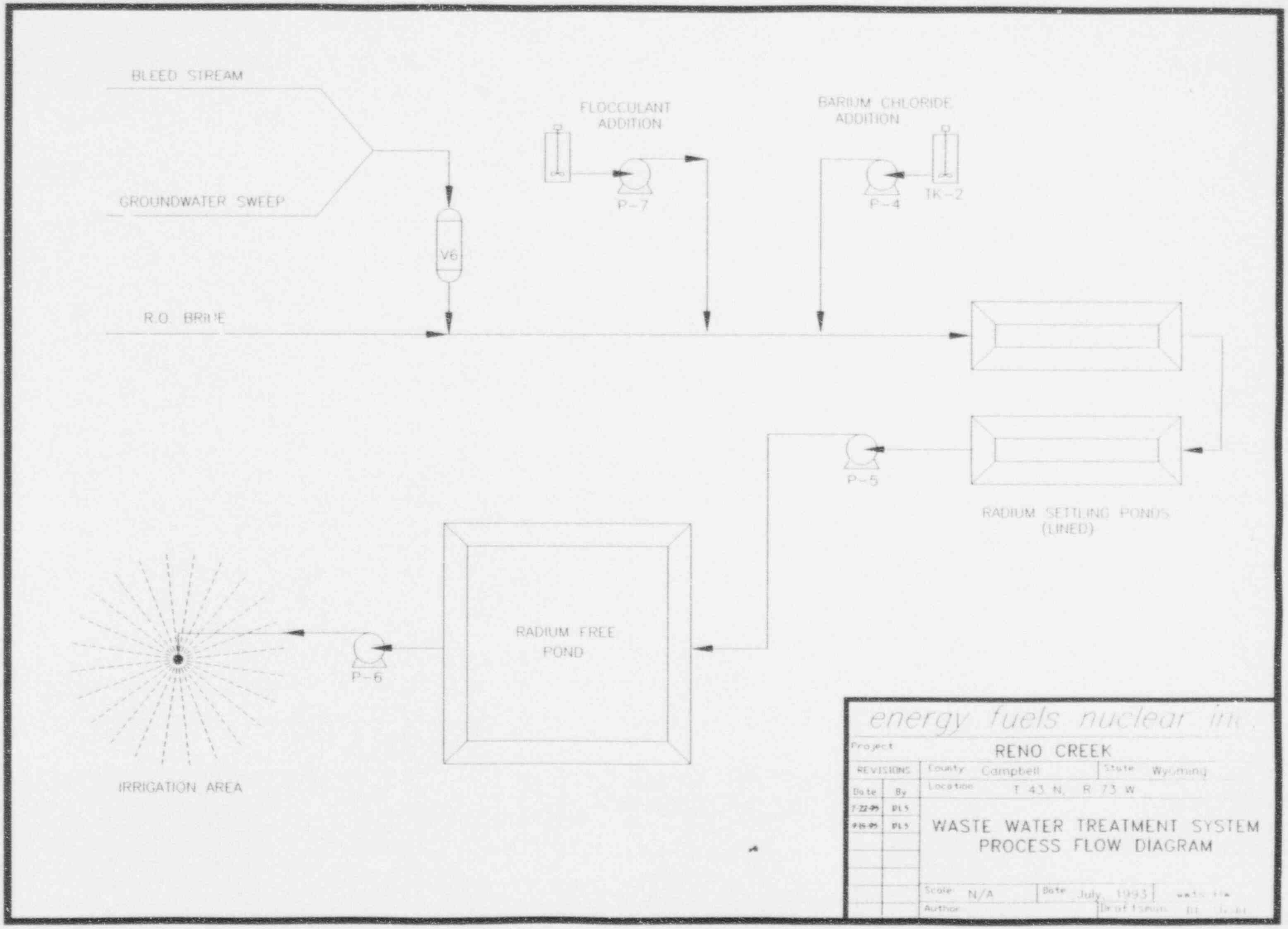
MAJOR EQUIPMENT LIST

Description	Size and Specification	Quantity
Ion Exchange Columns	10' diameter x 10'	4
Injection Pumps		3
Resin Transfer Water Storage	12' diameter x 12'	1
Process Water Tank (Satellite)	12' diameter x 12'	1
NaOH or KOH Make-up	12' diameter x 12'	1
Ion Exchange Column (Bleed)	6' diameter x 10'	1
Barium Chloride make-up	10' diameter x 12'	1
Process Water Tank (Water Treatment)	12' diameter x 12'	1
Neutralization Tank	12' diameter x 12'	1
Reverse Osmosis System	500 - 900 gpm	2 to 3
Caustic Soda Storage		1
Hydrochloric Acid Storage		1
Gasoline and diesel Storage		1 each
Carbon Dioxide Storage		1
Oxygen Storage		1

Table 15.1 Anticipated Major Equipment List

treatment system, as shown on Figure 15.11, Waste Water Treatment System Process Flow Diagram. This is a closed system and the waste stream will only come to ambient atmospheric conditions as it is discharged into the radium removal settling ponds.

The bleed stream from the normal production stream passes through a separate ion exchange column. This final pass through ion exchange is done to remove any residual uranium not removed in the primary ion exchange circuit. The bleed stream then passes to the water treatment building Figure 15.12, Waste Water Treatment System. Restoration water from groundwater sweep and brine from reverse osmosis treatment also follow the circuit as shown in Figure 15.11, Waste Water Treatment System Process Flow Diagram. After passing through the ion exchange column to remove residual uranium, the solution receives a flocculant prior to being treated with a barium chloride solution. The barium chloride solution is prepared in the waste water treatment building and is injected into the pipeline discharging to the first radium removal pond. Addition of barium chloride forms a radium precipitate.



BLEED STREAM
GROUNDWATER SWEEP
FLOCCULANT ADDITION
P-7
BARIUM CHLORIDE ADDITION
P-4
TK-2
V6
R.O. BRINE
P-5
RADIUM SETTLING PONDS (LINED)
RADIUM FREE POND
P-6
IRRIGATION AREA
energy fuels nuclear inc
Project
RENO CREEK
REVISIONS
County Campbell
State Wyoming
Date
By
Location T 43 N, R 73 W
WASTE WATER TREATMENT SYSTEM
PROCESS FLOW DIAGRAM
Scale N/A
Date July, 1993
Author
Draftsman

Figure 15.11

The solutions entering the radium removal ponds traverse slowly from the first pond to the second. This allows the radium solids to settle in the lined treatment ponds before the clean water is decanted from the second pond and transferred to the irrigation reservoir prior to land application by irrigation.

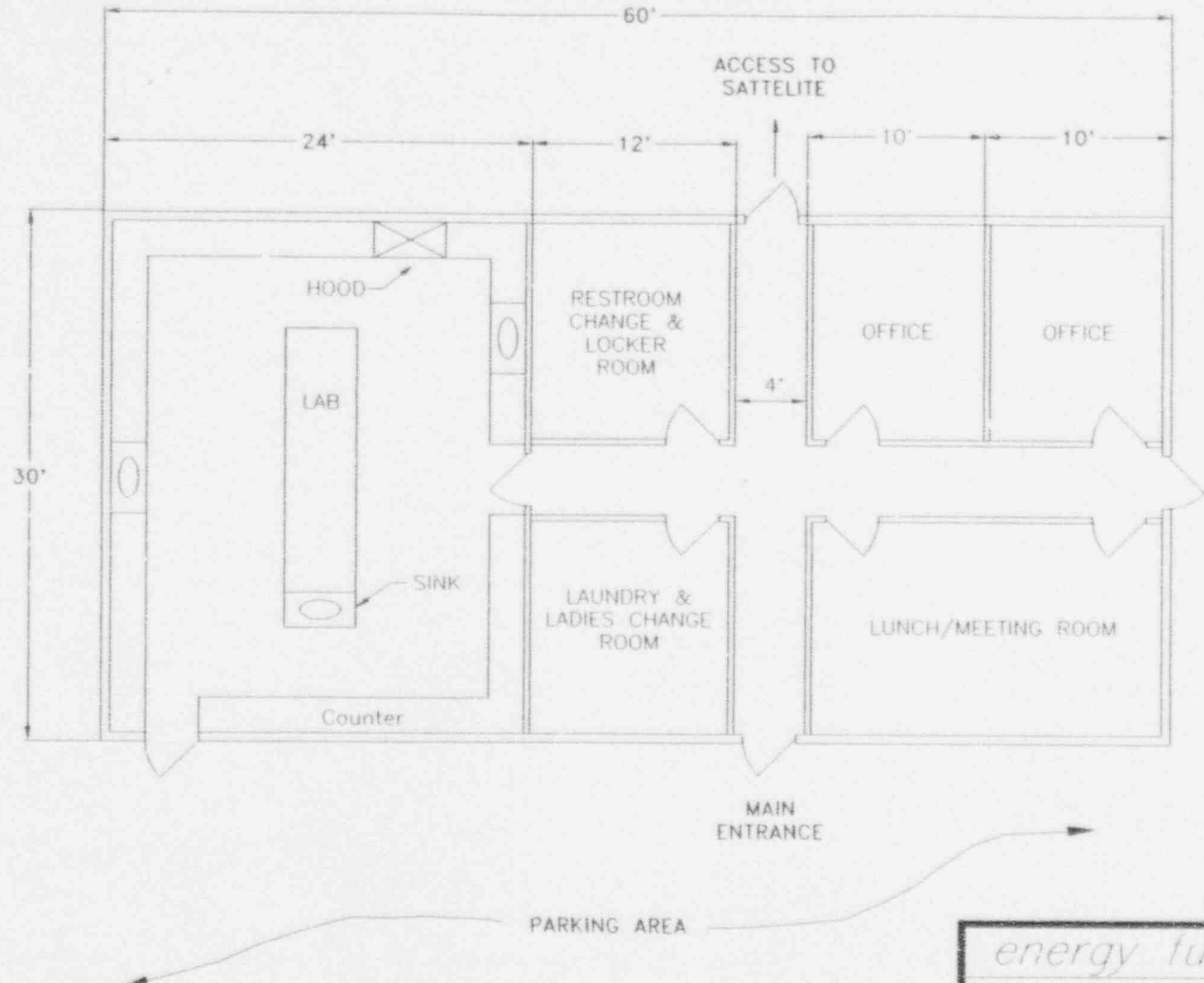
The radium removal ponds will be lined with 80 mil HDPE geomembrane. The geomembrane will be underlain by a leak detection and under drain collection system consisting of a sand blanket and collection piping. Beneath the leak detection system will be a minimum of one foot of reworked and compacted native clay, which will provide a secondary barrier in the unlikely event of a pond leak. Since the ponds will be kept full to properly operate the solid settling and water decontamination steps, opportunities for damage to the geomembrane liner are minimal.

The clay barrier beneath the leak detection system will be comprised of reworked in-place natural soils and weathered bedrock meeting liner fill gradation, moisture and compaction requirements. These requirements are: material will consist of finer inorganic soils with a 3/4-inch maximum rock size adjacent to the geomembrane liner material, a minimum of 30 per cent fines passing the No. 200 sieve size, and a minimum plasticity index of 10. Non-plastic soils with a minimum of 50 percent fines passing the No. 200 sieve size may also be acceptable. The material will be moisture conditioned to within two percent of optimum moisture content, placed in maximum 9-inch loose lifts, and compacted to a minimum 95 percent of maximum density (ASTM D-698). The clay barrier will be compacted to achieve a $1x10^{-7}$ *cm/sec permeability.*

Drawings and specifications for the radium removal ponds are included as Plate 15.2 . These drawings have been submitted for review and permitting by the State Engineer's Office.

The pipeline connecting the Irrigation Reservoir to the Irrigation Area is shown on Plate 15.1. This pipeline is proposed to be 8 inch HDPE laid on the surface. Since disturbances related to laying the pipeline and ongoing inspection and maintenance will be minimal, topsoil removal is not proposed for the pipeline route.

The irrigation reservoir has been designed in two phases. The initial phase is designed to store the water from only the bleed stream during mining prior to initiation of groundwater restoration. The second phase of the storage reservoir is designed to handle the combined flow (approximately 260 gpm maximum) from restoration activities and the bleed stream. The irrigation reservoir will not incorporate a geomembrane liner since the water it contains has already been treated for uranium and radium removal. The irrigation reservoir functions solely to store water to accommodate the seasonal land application by irrigation. Drawings and construction specifications for the irrigation reservoir are ~~included as~~ *shown on* Plate 15.3. ~~These drawings have been submitted for review and permitting by the State Engineer's Office.~~ *Details of the design and site investigation of the irrigation reservoir are included in the Application to Construct Waste Water Facilities submitted in December, 1993 to the WDEQ - Water Quality Division.*



energy fuels nuclear inc.

Project	RENO CREEK
County: Campbell	State: Wyoming
Location:	T 43 N, R 73 W
	OFFICE & LABORATORY BUILDING PLAN VIEW
Scale: 1" = 10'	Date: July, 1993
Author:	Draftsman: D.L. Stedd

REVISIONS	
Date	By
8-18-93	DLS

Figure: 15-10

SECTION 15.10 HAS BEEN

COMPLETELY REPLACED

BY THE FOLLOWING TEXT

Township 43 North, Range 73 West. Access to the Reno Creek ISL Project is via Wyoming State Highway 387 which passes through the project area. Secondary access to the project is via local ranch roads and the existing gravel road to the pilot plant building originally owned by Rocky Mountain Energy.

The 3,613 acre mine permit area lies in the Belle Fourche and Cheyenne River drainages with the drainage divide occurring along the southern and eastern portions of the permit area. Figure 15.1, Site Plan, shows the permit area boundary, the planned mining areas, the irrigation site and the proposed satellite plant and water treatment locations. The existing pilot plant building constructed and used by Rock. Mountain Energy will be used as a warehouse facility during commercial operation. Figure 15.11, Waste Water Treatment System Process Flow Diagram, shows a schematic of the process.

The plant site and irrigation reservoir are located in the SE¼ of Section 29, T43N, R73W. Two treatment ponds will be constructed to provide adequate retention time and settling of the radium solids formed when radium has reacted with barium chloride. The ponds are designed to operate in series with gravity discharge to the irrigation reservoir.

The proposed irrigation area is located in the SW¼ of Section 33, T43N, R73W. Slopes range from 0% to a maximum of 6% in the area to be irrigated. Average slope is approximately 4% across the irrigation area. The area can be described as rolling upland grass with big sagebrush vegetative communities on sandy loam, silty loam and clay loam soils. (Refer to Sections 11 and 12, Soils Inventory and Vegetation Inventory).

Ground water is first encountered at approximately 150 feet below the surface. Ground water contained in the Upper Aquifer is discontinuous and variable in water quality over all but the extreme western portion of the irrigation area. Yields from Upper Aquifer wells are low, typically yielding less than 3 gpm (Refer to Section 10, Hydrology).

Solutions will be land applied over a seven month period of the year, extending from May through November, depending on weather conditions.

15.10.2.2 URANIUM RECOVERY PROCESS DESCRIPTION

The uranium in situ leaching process proposed for Reno Creek has been successfully tested at the Rocky Mountain Energy pilot project and proven at other ISL mining projects in Wyoming and Texas. This process, involving dissolution of uranium minerals from the host rock consists of two steps. First, the uranium must be oxidized from the tetravalent state to the hexavalent state with an oxidant such as gaseous oxygen. Second, a chemical compound, such as carbon dioxide, is used to complex the uranium in the solution. The uranium enriched solution is transferred from the production wells to the processing facility for extraction of uranium from the solution by using ion exchange resin.

The leaching solution, or lixiviant, is composed of native groundwater from the wellfield, fortified with the desired chemicals to achieve uranium solubilization and recovery. Barren lixiviant is injected with gaseous oxygen as oxidant and carbon dioxide to convert existing carbonate ions to bicarbonate ions. The natural bicarbonate levels, if required, will be supplemented by the addition of sodium bicarbonate, sodium hydroxide or potassium hydroxide.

The network of injection and recovery wells in the wellfields will be utilized to circulate and recover the uranium bearing lixiviant as it removes the uranium mineralization from the host formation. The total design flow rate to the satellite plant is 2000 gpm. The uranium-bearing solution will be pumped directly to the satellite plant for uranium recovery, refortification, and return back to the wellfield. Refer to Figure 15.7, Satellite Plant Process Flow Diagram. This cycle of circulation and uranium recovery will be continued until the formation is depleted of economically recoverable uranium.

The pregnant lixiviant from the wellfields will be passed through vessels containing a bed of ion exchange resin. This resin is selective to the uranium-bicarbonate complexed ion and removes the uranyl ions from the solution. When the resin is loaded with uranium, it will be removed from the vessel and processed to recover the uranium. Resin will be transferred to a resin hauling vehicle. The resin hauling vehicle will transport resin to an off site facility licensed for uranium recovery. After removal of the uranium, the resin will be returned to an ion exchange vessel for reuse in the recovery process.

SECTION 15.10 HAS BEEN

COMPLETELY REPLACED

BY THE FOLLOWING TEXT

15.10 LAND APPLICATION PERMIT SUPPORTING INFORMATION

15.10.1 INTRODUCTION

Energy Fuels Nuclear, Inc. (EFNI) plans to construct and operate the Reno Creek in situ leach (ISL) uranium project located approximately 10 miles southwest of Wright, Wyoming. EFNI has applied for a Amendment to Mine Permit #479 through the Wyoming Department of Environmental Quality -Land Quality Division (WDEQ-LQD) and an Application for a Source Material License through the U.S. Nuclear Regulatory Commission (NRC). A complete description of the process and mine and processing facilities is provided in the Application for Amendment to Mine. This application is referred to as the LQD Amendment application in this Land Application Permit.

In addition to the Application for Amendment to Mine and Source Material License, EFNI submitted an Application for Permit to Construct Wastewater Facilities through the Wyoming Department of Environmental Quality - Water Quality Division (WDEQ-WQD) and the Wyoming State Engineers office. This application describes site investigation and design of ponds to be used for the treatment of excess wellfield solutions for radium and an irrigation reservoir.

As part of the mining and uranium recovery process, excess wellfield solutions are produced. After treatment for removal of radium and uranium, excess wellfield solutions will be disposed of in a manner which will not adversely impact the environment and is operationally feasible. Land application of excess wellfield solutions is proposed as the method of disposal by EFNI. This section describes the land application system, discusses environmental baseline information and environmental impacts associated with the project, and describes environmental monitoring of the operation.

15.10.2 FACILITIES AND PROCESS DESCRIPTION

15.10.2.1 SITE LOCATION AND LAYOUT

The Reno Creek ISL Project is located in southern Campbell County, Wyoming about 40 air miles south southwest of Gillette. Figure 1.1, Project Location, shows the general location of the Reno Creek ISL Project. The permit area includes portions of Sections 21, 22, 27, 28, 29, 30, 31, 33 and 34, Township 43 North, Range 73 West. Access to the Reno Creek ISL Project is via Wyoming State Highway 387 which passes through the project area. Secondary access to the project is via local ranch roads and the existing gravel road to the pilot plant building originally owned by Rocky Mountain Energy.

The 3,613 acre mine permit area lies in the Belle Fourche and Cheyenne River drainages with the drainage divide occurring along the southern and eastern portions of the permit area. Figure 15.1, Site Plan, shows the permit area boundary, the planned mining areas, the irrigation site and the proposed satellite plant and water treatment locations. The existing pilot plant building constructed and used by Rocky Mountain Energy will be used as a warehouse facility during commercial operation. Figure 15.11, Waste Water Treatment System Process Flow Diagram, shows a schematic of the process.

The plant site and irrigation reservoir are located in the SE¼ of Section 29, T43N, R73W. Two treatment ponds will be constructed to provide adequate retention time and settling of the radium solids formed when radium has reacted with barium chloride. The ponds are designed to operate in series with gravity discharge to the irrigation reservoir.

The proposed irrigation area is located in the SW¼ of Section 33, T43N, R73W. Slopes range from 0% to a maximum of 6% in the area to be irrigated. Average slope is approximately 4% across the irrigation area. The area can be described as rolling upland grass with big sagebrush vegetative communities on sandy loam, silty loam and clay loam soils. (Refer to Sections 11 and 12, Soils Inventory and Vegetation Inventory).

Ground water is first encountered at approximately 150 feet below the surface. Ground water contained in the Upper Aquifer is discontinuous and variable in water quality over all but the extreme western portion of the irrigation area. Yields from Upper Aquifer wells are low, typically yielding less than 3 gpm (Refer to Section 10, Hydrology).

Solutions will be land applied over a seven month period of the year, extending from May through November, depending on weather conditions.

15.10.2.2 URANIUM RECOVERY PROCESS DESCRIPTION

The uranium in situ leaching process proposed for Reno Creek has been successfully tested at the Rocky Mountain Energy pilot project and proven at other ISL mining projects in Wyoming and Texas. This process, involving dissolution of uranium minerals from the host rock consists of two steps. First, the uranium must be oxidized from the tetravalent state to the hexavalent state with an oxidant such as gaseous oxygen. Second, a chemical compound, such as carbon dioxide, is used to complex the uranium in the solution. The uranium enriched solution is transferred from the production wells to the processing facility for extraction of uranium from the solution by using ion exchange resin.

The leaching solution, or lixiviant, is composed of native groundwater from the wellfield, fortified with the desired chemicals to achieve uranium solubilization and recovery. Barren lixiviant is injected with gaseous oxygen as oxidant and carbon dioxide to convert existing carbonate ions to bicarbonate ions. The natural bicarbonate levels, if required, will be supplemented by the addition of sodium bicarbonate, sodium hydroxide or potassium hydroxide.

The network of injection and recovery wells in the wellfields will be utilized to circulate and recover the uranium bearing lixiviant as it removes the uranium mineralization from the host formation. The total design flow rate to the satellite plant is 2000 gpm. The uranium-bearing solution will be pumped directly to the satellite plant for uranium recovery, refortification, and return back to the wellfield. Refer to Figure 15.7, Satellite Plant Process Flow Diagram. This cycle of circulation and uranium recovery will be continued until the formation is depleted of economically recoverable uranium.

The pregnant lixiviant from the wellfields will be passed through vessels containing a bed of ion exchange resin. This resin is selective to the uranium-bicarbonate complexed ion and removes the uranyl ions from the solution. When the resin is loaded with uranium, it will be removed from the vessel and processed to recover the uranium. Resin will be transferred to a resin hauling vehicle. The resin hauling vehicle will transport resin to an off site facility licensed for uranium recovery. After removal of the uranium, the resin will be returned to an ion exchange vessel for reuse in the recovery process.

A one percent to three percent bleed stream (20 to 60 gpm) of the total flow will be taken from the lixiviant after it passes through ion exchange. This bleed stream is taken to ensure that more water is recovered than injected in the operating wellfields. This will maintain a net inflow of water into the mining area to reduce the potential for horizontal and vertical excursions. The bleed stream will be treated to remove radium prior to disposal by surface irrigation. This process is described further in the Waste Water Treatment section, Section 15.9.

15.10.2.3 WASTE WATER TREATMENT

During the mining phase, the major waste stream generated will be the one to three percent bleed stream (20 to 60 gpm). A minor amount of liquids will be generated from plant wash down and from solutions used to flush and clean wells in the wellfield. In the groundwater restoration phase, the flow rate of waste solutions will be increased to approximately 200 gpm, thus making a maximum project total waste stream of approximately 260 gpm. These waste streams will be treated in the waste water treatment system, as shown on Figure 15.11, Waste Water Treatment System Process Flow Diagram.

The bleed stream from the normal production flow passes through a separate ion exchange column. This final pass through ion exchange is performed to remove any residual uranium not removed in the primary ion exchange circuit. The bleed stream then passes to the water treatment building, Figure 15.12, Waste Water Treatment System. Restoration water from groundwater sweep and RO bleed from reverse osmosis treatment also flow through the circuit as shown in Figure 15.11, Waste Water Treatment System Process Flow Diagram. After passing through the ion exchange column to remove residual uranium, the solution is treated with a barium chloride solution. The barium chloride solution is prepared in the waste water treatment building and is injected into the pipeline discharging to the first radium removal pond. Addition of barium chloride forms a barium sulfate precipitate that then co-precipitates with radium.

The solutions entering the radium removal ponds traverse slowly from the first pond to the second. This allows the precipitate to settle in the lined treatment ponds before the treated water is decanted from the second pond and transferred to the irrigation reservoir prior to land application.

The radium removal ponds will be lined with 80-mil HDPE geomembrane. The geomembrane will be underlain by a leak detection and under drain collection system consisting of a sand blanket and collection piping. Beneath the leak detection system will be a minimum of one foot of reworked and compacted native clay, which will provide a secondary barrier in the unlikely event of a pond leak. Since the ponds will be kept full to properly operate the solid settling and water decontamination steps, opportunities for damage to the geomembrane liner are minimal.

The irrigation reservoir has been designed in two phases. The initial phase is designed to store solution from the bleed stream only. The second phase of the storage reservoir is designed to handle the combined flow (approximately 260 gpm maximum) from restoration activities and the bleed stream. The irrigation reservoir will not incorporate a geomembrane liner since the water it contains has already been treated for uranium and radium. The irrigation reservoir functions solely to store water to accommodate seasonal land application by irrigation. Drawings and construction specifications for the irrigation reservoir are included within the Application to Construct Wastewater Facilities, previously submitted to the WDEQ-WQD (December, 1993).

15.10.2.4 WASTE WATER STREAM DESCRIPTION

As described, solutions to be land applied will have three origins within the recovery and aquifer restoration process. A water balance for the wellfield and the irrigation reservoir is presented in Table 15.2. Table 15.2 shows the projected volumes of the various waste streams and the quantity of water produced, stored and land applied during the life of the project. Table 15.2 indicates the estimated average water quality for each waste stream. The waste streams are described below.

Bleed Stream from Producing Wells - A bleed stream from each wellfield is maintained to keep a slight negative pressure in the wellfield. This bleed stream will represent 1% to 3% of the total volume of solutions moving through the wellfield. This represents from 20 to 60 gpm. For purposes of this projection, EFNI has assumed a 2% bleed at a uranium oxide production rate of 400,000 pounds per year. The bleed stream will be taken throughout the eight years of production currently projected.

Groundwater Sweep Stream - Groundwater sweep wellfield solutions are projected in the third year of production. Groundwater sweep solutions are produced as part of the aquifer restoration process. Groundwater is pumped from the production zone, removing high TDS process solutions, drawing in surrounding unaffected formation waters and flushing the affected aquifer in the process. Quantities of water produced through groundwater sweep operations will range from 100 to 200 gpm at the design production rate of 400,000 pounds U_3O_8 per year. The duration of groundwater sweep operations assume removal of a volume equivalent to 4 pore volumes of the mine wellfield.

Reverse Osmosis Bleed Stream - Reverse osmosis (RO) treatment of groundwater will be utilized after groundwater sweep of the aquifer. Reverse osmosis treatment is projected to remove approximately 70% of the TDS from the feed streams to the RO equipment. The resulting treated groundwater will be reinjected into the former production zone. The reject water from the RO will be mixed with water resulting from groundwater sweep. The RO (bleed stream) is estimated at 50 to 100 gpm over the last 4.5 years of the mine life.

Table 15.2 Reno Creek Water Balance

TABLE 15.2

RENO CREEK WATER BALANCE

QUARTER		IRRIGATE % QUART	IRRIGATE RATE	PURGE RATE	GWS RATE	RO RATE	STORAGE RATE(GPM)	STORAGE (GAL)	STORAGE (A-ft)	STORAGE (GAL)	STORAGE (A-ft)	PRECIP (inches)	EVAP (inches)	MET CONT (GAL)	MET CONT (A-ft)	REQ'D (GAL)	REQ'D (A-ft)	TOTAL IRRIGATION AVAIL (AC/FT)
1	1 QUA,95	0	0	20.00	0	0	20	2592000	7.96	2592000	7.96	1.8	-3.2	-781989	-0.758	1810011	7.20	0.00
2	2 QUA	1	400	28.00	0	0	-372	-48211200	-147.96	0	0.00	5.4	-22.2	-16275149	-9.100	0	0.00	11.29
3	3 QUA	1	400	28.00	0	0	-372	-48211200	-147.96	0	0.00	3.4	-29.6	-13663088	-14.192	0	0.00	11.29
4	4 QUA	0.33	400	32.00	0	0	-100	-12960000	-39.78	0	0.00	1.8	-7.9	-1930536	-3.304	0	0.00	4.26
5	1 QUA,96	0	0	35.80	0	0	35.8	4613760	14.16	4813760	14.16	1.8	-3.2	-781989	-0.758	3831771	13.40	0.00
6	2 QUA	1	400	34.00	0	0	-366	-47433600	-145.58	0	0.00	5.4	-22.2	-16275149	-9.100	0	0.00	13.71
7	3 QUA	1	400	32.00	0	0	-368	-47692800	-146.37	0	0.00	3.4	-29.6	-13663088	-14.192	0	0.00	12.91
8	4 QUA	0.33	400	34.80	0	0	-97.2	-12597120	-38.66	0	0.00	1.8	-7.9	-1076593	-3.304	0	0.00	4.63
9	1 QUA,97	0	0	32.60	0	0	32.8	4250880	13.05	4250880	13.05	1.8	-3.2	-247087	-0.758	4003793	12.29	0.00
10	2 QUA	1	400	33.60	0	0	-366.4	-47485440	-145.74	0	0.00	5.4	-22.2	-2965042	-9.100	0	0.00	13.55
11	3 QUA	1	400	34.40	0	0	-365.6	-47381760	-145.42	0	0.00	3.4	-29.6	-4624054	-14.192	0	0.00	13.87
12	4 QUA	0.33	400	28.00	0	0	-104	-13478400	-41.37	0	0.00	1.8	-7.9	-1076593	-3.304	0	0.00	3.73
13	1 QUA,98	0	0	30.80	0	0	30.8	3991680	12.25	3991680	12.25	1.8	-3.2	-247087	-0.758	3744593	11.49	0.00
14	2 QUA	1	400	27.60	200	0	-172.4	-22343040	-68.57	0	0.00	5.4	-22.2	-2965042	-9.100	0	0.00	91.79
15	3 QUA	1	400	32.40	200	0	-167.6	-21720960	-66.66	0	0.00	3.4	-29.6	-4624054	-14.192	0	0.00	93.72
16	4 QUA	0.33	400	41.20	200	0	109.2	14152320	43.43	14152320	43.43	1.8	-7.9	-1076593	-3.304	13075727	40.13	32.10
17	1 QUA,99	0	0	41.60	200	0	241.6	31311360	96.10	45463680	139.53	1.8	-3.2	-380134	-0.758	45083546	138.77	0.00
18	2 QUA	1	400	40.00	200	0	-160	-20736000	-63.64	24727680	75.89	5.4	-22.2	-4561603	-9.100	20166077	66.79	96.79
19	3 QUA	1	400	34.40	100	101	-164.6	-21332160	-65.47	3395520	10.42	3.4	-29.6	-7113929	-14.192	0	0.00	94.93
20	4 QUA	0.33	400	29.20	101	101	99.2	12856320	39.46	16251840	49.88	1.8	-7.9	-1656296	-3.304	14595544	46.57	30.77
21	1 QUA,00	0	0	26.00	100	101	227	29419200	90.29	45671040	140.17	1.8	-3.2	-570200	-0.758	45100840	139.41	0.00
22	2 QUA	1	400	24.80	100	101	-174.2	-22576320	-69.29	23094720	70.88	5.4	-22.2	-6842405	-9.100	16252315	61.78	91.06
23	3 QUA	1	400	25.60	100	101	-173.4	-22472640	-68.97	622080	1.91	3.4	-29.6	-10670893	-14.192	0	0.00	91.38
24	4 QUA	0.33	400	25.60	129.5	70.1	93.2	12078720	37.07	12700800	38.98	1.8	-7.9	-1076593	-3.304	11624207	35.68	29.97
25	1 QUA,01	0	0	32.80	100	0	132.8	17210880	52.82	29911680	91.80	1.8	-3.2	-760287	-0.758	29151413	91.04	0.00
26	2 QUA	1	400	25.80	100	50	-224.4	-29082240	-89.26	829440	2.55	5.4	-22.2	-9123206	-9.100	0	0.00	70.82
27	3 QUA	1	400	17.20	100	50	-232.8	-30170880	-92.60	0	0.00	3.4	-29.6	-14227858	-14.192	0	0.00	67.43
28	4 QUA	0.33	400	11.20	70.5	50	-0.3	38880	-0.12	0	0.00	1.8	-7.9	-3312593	-3.304	0	0.00	17.53
29	1 QUA,02	0	0	6.40	200	101	307.4	39839040	122.27	39839040	122.27	1.8	-3.2	-950334	-0.758	38888706	121.51	0.00
30	2 QUA	1	400	4.40	150	101	-144.6	-18740160	-57.52	21098880	64.75	5.4	-22.2	-11404008	-9.100	9694872	55.65	103.00
31	3 QUA	1	400	2.40	150	87	-160.6	-20813760	-63.88	285120	0.88	3.4	-29.6	-17784822	-14.192	0	0.00	96.55
32	4 QUA	0.33	400	1.60	150	50	69.6	9020160	27.68	9305280	28.56	1.8	-7.9	-4140741	-3.304	5164539	25.25	26.83
33	1 QUA,03	0	0	0.00	100	100	200	25920000	79.55	35225280	108.11	1.8	-3.2	-950334	-0.758	34274946	107.35	0.00
34	2 QUA	1	400	0.00	100	100	-200	-25920000	-79.55	9305280	28.56	5.4	-22.2	-13684810	-9.100	0	19.46	80.66
35	3 QUA	1	400	0.00	112	90.1	-197.9	-25647840	-78.72	0	0.00	3.4	-29.6	-21341786	-14.192	0	0.00	81.50
36	4 QUA	0.33	400	0.00	107	0	-25	-3240000	-9.94	0	0.00	1.8	-7.9	-4968889	-3.304	0	0.00	14.24

Table 15.3 Estimated Water Quality From Three Sources

	Lixiviant with Use of $NaHCO_3$ - Process Bleed	Process Bleed without $NaHCO_3$	Mix of Process Bleed with Grw. Sweep
Ca (meq/l)	16.5	16.5	12.3
Mg (meq/l)	4.1	4.1	4.1
Na (meq/l)	39.1	15.2	28.7
K (meq/l)	0.0	0.0	0.0
Cl (meq/l)	6.8	6.8	4.1
SO_4 (meq/l)	11.9	23.6	23.6
HCO_3 (meq/l)	29.0	5.57	18.1
Se (mg/l)	0.085	0.085	0.085
Ra-226 (pCi/l)	5	5	5
U (mg/l)	2	2	2

15.10.2.5 ESTIMATED WATER QUALITY FOR WASTE STREAMS

Water quality of the three waste streams has been estimated to allow the prediction of environmental impacts due to land application activities. Water quality for two cases has been estimated.

15.10.2.5.1 WORST CASE

The following information and assumptions nave been used.

The Reno Creek Project Demonstrated Restoration Report prepared by Rocky Mountain Energy and submitted to the WDEQ and U.S. Nuclear Regulatory Commission in November of 1981 serves as a basis for the prediction of baseline water quality, water quality of the lixiviant during the leaching process and restored aquifer water quality. The Restoration Report includes observed water quality before, during and after in situ leaching. The pilot project performed by Rocky Mountain Energy utilized dissolved oxygen as an oxidant with the addition of sodium bicarbonate as a complexing agent for the uranium.

The decision to use sodium bicarbonate or not will be based on operational considerations. Therefore, EFNI has assumed use of sodium bicarbonate to reflect the worst case scenario. This report is included as Attachment 15.1. EFNI proposes to use dissolved oxygen as an oxidant, and hopes to eliminate the use of sodium bicarbonate. Thus, sodium concentrations in the pilot plant lixiviant are probably higher than will be experienced during proposed mining.

Knowledge of EFNI personnel based on the restoration of aquifers affected by in situ leaching of uranium in both Wyoming and Texas has been used to make assumptions pertaining to the performance of process and treatment technologies.

Concentration values for lixiviant found on Table 1 of the RME Restoration report, Attachment 15.1 are consistent with maximum values observed during the leaching process, and can therefore be considered conservative from the standpoint of assessing impacts on the environment.

Based on past experience with groundwater sweep efficiencies, it was assumed that 75% of constituents above the average baseline concentration would be removed through the sweep of four pore volumes through the production zone. It was further assumed that reverse osmosis treatment will be utilized sequentially with groundwater sweep. The remaining 25% of constituents above baseline will be removed through circulation of two pore volumes of treated water. The RO reject water (bleed) is assumed to be 35% of the total treated volume. The concentration of major ionic species not reported by Rocky Mountain Energy were calculated by balancing the charge balance of the various solutions.

These assumptions for water quality are considered adequate for calculating the concentrations of major cations and anions within the waste streams. However, trace metals such as selenium and boron were not reported in the Rocky Mountain Energy Restoration Report. Therefore, selenium and boron concentrations in the waste stream during leaching and restoration are unknown.

Concentrations of selenium and boron at other in situ leach operations in Wyoming and Texas, show selenium and boron concentrations are highly variable and dependent on site specific conditions. Uranium Resources, Inc. (URI) of Dallas, Texas provided water quality records for in situ projects in Wyoming and Texas that illustrate this point (Personal Communication, M. Pelizza). URI provided records of water quality for in situ leach projects that are under URI management. The selenium values during leaching range from a slight reduction in selenium concentration during leaching to an increase of 17 times the baseline value in one instance. The average increase for selenium using average wellfield concentrations from these 9 wellfields is 5.1 times the average baseline value. This comparison illustrates the difficulty of estimating selenium concentrations in leach solutions.

Due to the large variability in selenium concentrations and the lack of concentration information during leaching, an estimate of concentration during leaching has been made for illustration. The estimate is 5 times the concentration of the highest selenium concentration exhibited for baseline water quality in Rocky Mountain Energy's restoration report of 0.085 mg/l. This is considered a realistically conservative estimate. Given this concentration, and the projected total application rate of approximately 23 acre feet per acre over the life of the project, a total application rate of only 5.28 lbs per acre total selenium would be expected.

15.10.2.5.2 MOST LIKELY CASE

As indicated in Section 15.10.2.5.1, water quality for the Worst Case scenario was projected on the basis of analysis of wellfield solutions from the Rocky Mountain Energy (RME) Pilot project. The RME Pilot project used sodium bicarbonate to complex uranium. EFNI does not intend on using $NaHCO_3$ as a reagent. Therefore, water quality was also determined by taking water quality analysis from the RME Pilot plant and subtracting the amount of sodium and bicarbonate injected into the system during leaching. The average concentration of $NaHCO_3$ injected during leaching was 1.46 gm/liter. Total volume of injected solutions over the 73 day leaching period was 2,217,600 gallons (RME Final Restoration Report, 1981). Water quality for this scenario was generated using this information and a charge balance approach to adjusting other major cations and anions within wellfield solutions. The modeled effects of both water quality solutions on the soil and groundwater resources are presented in Section 15.10.2.5.10

15.10.2.6 IRRIGATION SYSTEM SPECIFICATIONS AND DESIGN

The irrigation system layout is illustrated on Plate 15.4 of this document. The irrigation rate of 500 GPM is planned and used in the design of the pipeline. An eight inch diameter SDR 13.5-HDPE pipe was selected for the pipeline. A total head of 250 feet (108 PSI) will be required at the pump of the sprinkler system. A lift head of 127 feet, operating pressure and friction losses equals this total head. Therefore, a pump with a total head of 275 feet at a pumping rate of 500 GPM was selected for this irrigation system.

An intake screen ten feet long and 12 inches in diameter was selected to prevent any large particle from entering the pump intakes. The pipeline is planned to be self draining with automatic or manual drains at three locations and air vent valves at the high points along the pipeline as shown on Plate 15.4. These drains are needed because the pipeline will be located above the land surface.

The sprinkler system is a Valmont Model 4271 center pivot sprinkler with 131 nozzles. Nozzles are the drop type nozzle designed to operate in the range of 26 to 21 PSI at the nozzle. The irrigated area shown on Plate 15.4 is 92.87 acres. The diameter and effective radius of irrigation is 1132 feet without use of an endgun nozzle.

The center pivot is equipped with a Valley C.A.M.S. programmable control panel. The programmable control panel will allow pre-planning for control of irrigation rates, location of application, and emergency shutdown in the event of pressure drop in the feed line.

15.10.2.7 IRRIGATION AREA PLANTINGS AND CULTURAL PRACTICES

EFNI proposes to augment the existing vegetative cover with salt tolerant species capable of sustaining an adequate vegetative cover during the life of the irrigation project. In order to ensure maximum vegetative cover, EFNI proposes to interseed with a mix of tall wheatgrass and barley. The interseeding will be accomplished using a Rangeland drill to ensure the placement of seed at approximately one inch below the surface. The irrigation area will initially be planted with 20 PLS tall wheatgrass and 20 PLS barley per acre.

15.10.3.0 DESCRIPTION OF THE IRRIGATION AREA

The proposed irrigation area is located in the SW 1/4, Section 33, T43N, R73W in Campbell County, Wyoming. The surface of the land is privately owned by Mrs. Bernice Groves of Gillette, Wyoming. A complete description of land and mineral ownership can be found in Section 2 through 4.

The center pivot of the sprinkler system will be located in the center of this 160 acres. The radius of the irrigator arm is 1132 feet, allowing a minimum 188 feet of buffer zone between irrigated land and the irrigation area boundary.

15.10.3.1 TOPOGRAPHY AND SURFACE DRAINAGE

The irrigation area lies between elevations of 5230 and 5280 MSL. The irrigation area has slopes ranging from 0% to 6% with an average slope of approximately 4% across the area. The entire irrigation area (93 acres) drains southwesterly to the Spring Creek drainage via two small drainages. Spring Creek is an ephemeral drainage which is tributary to the Cheyenne River in which perennial flows commence some 60 miles southeast of the southern boundary of the irrigation area. The extreme northwestern portion of the quarter section drains to the Upper Belle Fourche River drainage located approximately 1.7 miles to the northwest of the western irrigation area boundary. Although the irrigation area is within 1.7 miles to the Belle Fourche Drainage, it is ephemeral in the vicinity of the Reno Creek ISL project. Perennial water does not exist in the Belle Fourche River until a point approximately 20 miles north of the project area. None of the lands to receive irrigation waters will drain to the Belle Fourche River drainage. A more detailed description of the surface water resource is provided in Section 10.

The highest topographic point is within the irrigation area, (see Plate 15.4). Therefore, insignificant surface runoff from upslope areas will flow across the irrigation area.

15.10.3.2 SOILS

The soil resource in the irrigation area was extensively characterized for EFNI by BKS Environmental Associates of Gillette, Wyoming in the summer of 1993. BKS based their work on a 1979 unpublished U.S. Soil Conservation Survey (SCS) soil survey of the project area. The survey was field verified and partially revised to indicate actual field conditions. The full report and soils map is contained in Section 11.

The irrigation includes three soil mapping units. The mapping units are associations of soil series and are listed below.

Map Designation	Description
177B	Theedle-Kishona Loam
336B	Forkwood-Cushman Loam
410	Shingle-Taluse Loam

Six backhoe pits excavated to a depth of 6 feet or greater were used to chemically and physically characterize the soils for baseline purposes (one backhoe pit per soil series). Backhoe pits were used to expose the solum and samples were taken at recognizable horizonal boundaries within the soil. Complete soil series descriptions and analysis are contained in Section 11.

In general, the soils are shallow to moderate to very deep and well drained soils. Permeability of the soils is moderate, (BKS Environmental, 1993). Texture becomes finer and salinity and sodicity tend to increase with depth in the soil profile. Within the top 3 feet of soil material, the suitability limits for the soil set forth in the WDEQ-LQD Guideline #1 are meet. Paralithic material tends to contain higher salinity concentrations and does not always meet suitability criteria. Table 3.1 summarizes critical soil properties from an irrigation perspective.

Selenium concentrations in the soil were below detection limits (0.1 ppm) except for a single sample. This sample was equal to 0.1 ppm. The sample was below 30 inches in depth in the Shingle series. Thus, the irrigation area soils are low in selenium concentration.

Selected soil samples were also characterized for the radionuclides Radium-226, uranium and thorium 230. As expected given the naturally low background radioactivity in the area, radionuclides were generally below 1 pCi/gm for all radionuclides. The highest concentration detected was 2.5 pCi/gm for radium 226. The low concentrations of radionuclides in the soil are consistent with results of the radiological characterization presented in Section 14.

15.10.3.3 VEGETATION

BKS Environmental Associates performed a vegetation inventory of the entire Reno Creek ISL project area during the summer of 1993. The entire report with analytical results is contained in Section 12.

A presentation of radionuclide concentrations within vegetation is contained in Section 14.

The irrigation area was found to be comprised of two vegetative types; big sagebrush and upland grassland communities. A vegetation map and species list was developed

Table 15.4 Summary of Topsoil Characteristics for Soils Within Proposed Irrigation Area

MAP DESIGNATION	SOIL SERIES	DEPTH TO[1] PARALITHIC CONTACT	SOIL[2] TEXTURAL CLASS	PERMEABILITY[3] (in/hr)	AVAILABLE[3] WATER CAPACITY (in/hr)	SALINITY[2] dc/m	SAR[2]	SHRINK[3] SWELL POTENTION
Theedle-Kishona	Theedle	20-40'	Sil	Moderate (0.6 - 2.0)	0.16 - 2.0	<1	0 - 2	Low to Moderate
Theedle-Kishona (Kim)	Kishona (Kim)	42-60'	Cil	(0.6 - 2.0)	0.14 - 0.19	1	<1	Low to Moderate
Forkwood-Cushman	Forkwood	40-60'	Cil Sil	(0.8 - 2.0) (0.8 - 2.0)	0.17 - 0.20	1	3	Low to Moderate
Forkwood-Cushman	Cushman	20-40'	L Cil	(0.8 - 2.0)	0.17 - 0.19	<1	<1	Low to Moderate
Shingle-Taluse	Shingle	20	Cil	(0.6 - 2.0)	0.16 - 2.0	0 - 1	0 - 2	Low to Moderate

(1) Source - Soil survey performed by BKS Environmental

(2) Onsite analytical information

(3) SCS Soil Interpretive Records

for the project area, including the irrigation area. Percent cover and relative frequency by species was determined for each vegetation type.

Numerous grass and shrub species exist in the natural vegetative community which have moderate too high tolerance to salinity and sodicity. These species include western wheatgrass,inland saltgrass, alkali bluegrass, crested wheatgrass, four-wing saltbush, Gardiner saltbush and winterfat.

Several selenium indicator plants were identified on the project area. These included two-grooved milkvetch, stemmy goldenweed and woody aster. However, nowhere on the project area were large concentrations of these plants detected. When encountered, they were on shallow soils in broken topography or in fine textured, deep soils within the Belle Fourche River drainage channel.

Vegetation samples were taken at four locations within the bounds of the proposed irrigation area. Two of the these locations were within the big sagebrush and two within upland grass communities. Vegetation samples were taken for each life form (i.e. shrub, grass, or forb) at each location. Sample area was restricted to 20 square meters at each site. Vegetation samples were analyzed for total selenium, arsenic, copper and molybdenum concentrations through chemical digestion of the vegetation followed by atomic absorption spectrophotometry. Samples were bagged fresh in the field and sent to Energy Laboratories in Casper, Wyoming for immediate analysis. Radionuclide concentrations were determined by gamma spectroscopy.

Selenium was below detectable limits in all but one sample. This sample was 93-36462 (UG-#1) representing forbs in the upland grassland community, and contained 1.15 mg/kg selenium dry weight.

15.10.3.4 GROUNDWATER HYDROLOGY

The groundwater setting in the area is described in Section 10 of the LQD Amendment application. A summary of the most important hydrologic aspects of the area follows.

The Reno Creek land application area exists on the outcrop of the Wasatch formation. This formation consists of alternating layers of clays and sands. Plate 15.5 shows the alternating layers of clay and sand in the irrigation areas on cross-section 1-1' (see Plate 15.5 for location). This cross-section uses eight exploration logs in an west-east line across the irrigation area. The uppermost sand that has been defined in the permit area has been called the "Upper" sand. It exists above the mineralized zone and is approximately 150 feet below the land surface. When present, this is the first stratigraphic unit containing useable amounts of water. The mineralized zone is called the "Ore Sand" aquifer. These two units are typically separated by several tens of feet of mudstone which contains a coal bed (Felix) within the mudstone. The Upper Sand is very marginal or absent in the eastern half of the land application area. Plate 15.5 shows the Upper Sand pinching out on the east side of the irrigation area. West of this area, the Upper Sand is permeable and conveys useable amounts of water. Some sand stringers exist in the 150 feet above the Upper Sand. Typically, these sands are not continuous, but some do exist near the land surface in some of the western portions of the irrigation area.

As reported in Section 10 of the LQD Amendment application, transmissivities in the Upper Sand are much greater on the west side where the sand is well developed and are very low on the east side. Hydraulic conductivities for the Upper Sand are estimated to be 1.8 ft/day on the west side and 0.04 ft/day in the poorly developed portion on the east side of the application area. The Upper Sand on the east side of the application area acts more like the aquitards that exist above the Upper Sand. Groundwater flow on the western half of the land application area is to the northwest with an average gradient of 0.0041 ft/ft. Ground water is moving at a rate of 0.074 ft/day in the western half of the permit area.

The water quality in Upper Sand wells RI-15U, RI-24U, RI-25U, and RI-30U define the water quality of the Upper aquifer in the permit area. Water quality for these wells is presented in Table 10.3-5. Two of these Upper wells, RI-15U and RI-24U, are located east of the transmissive portion of the Upper Sand. These wells are located in the poorly developed portion of the Upper Sand and are not representative of the transmissive and useable portion of the Upper Sand. Water quality from wells RI-25U and RI-30U are representative of water quality in the transmissive portion of the Upper aquifer. Water quality from these two wells indicates a total dissolved solid (TDS) concentration that is approximately 1600 mg/l. This type of water quality is expected to be under the western half of the land application area. Any recharge from the land application area would enter the first useable aquifer in the western portion of Section 33.

Groundwater in the Upper Sand underlying the application area is expected to be classified as Class 3, Livestock. In the eastern half of the land application area, the first aquifer is the Ore Sand Aquifer. The water in the Ore Sand is also expected to be classified as a Class 3, Livestock due to sulfate and TDS concentrations.

15.10.3.5 EXISTING WATER RIGHTS

No surface water or groundwater rights other than monitor wells associated with the mining project exist within the SW 1/4 of Section 33. The closest groundwater rights to the irrigation area, not held by EFNI, are HiWay Well (NW¼ NE¼, Section 5, T42N, R73W) and Underwood #1 (NW¼ NE¼, Section 33, T43N, R73W). Locations are illustrated on Plate 10.2-1.

15.10.4 METEOROLOGY

A detailed description of meteorological conditions for the Reno Creek ISL Project area is given in Section 8.

For purposes of the Reno Creek Project water balance presented in Table 2.1, average precipitation has been assumed to be the 10 year average for the PRI Highland plant (12.4 inches/year) located approximately 60 miles southwest of the Reno Creek Project. Average pan evaporation was assumed to be 62.9 inches/year.

For purposes of modeling, crop requirements in soil and groundwater impact simulations used 10 year average precipitation data from Midwest, Wyoming reported in Section 8 of the LQD Amendment application. Evapotranspiration rates for Wyoming crops were taken from Trelease (1970).

15.10.5 PROJECT SCHEDULE

The project schedule and mine plan is presented in Section 15. Active ISL mining will take place for 8 years in four mining units. Irrigation is scheduled to continue an additional year after leaching activities cease, for a total of nine years of irrigation. Aquifer restoration activities will take place concurrently from year four to year nine of the operation.

15.10.6 IRRIGATION MANAGEMENT PRACTICES

The irrigation management practices were developed from knowledge of general irrigation practices and the results of leaching simulations included in Section 15.10.10. In order to maintain a soil condition which does not hamper plant growth, the leaching fraction must be maintained at an acceptable level.

15.10.6.1 SALINITY MANAGEMENT

15.10.6.1.1 CROP SELECTION

The potential crops for the irrigation area are salt-tolerant forage crops. Hansen et al. (1980) lists beardless wild rye, western wheat grass, and barley (hay) as tolerant crops in order of decreasing tolerance. Other potential crops of birdsfoot trefoil and tall fescue are described as moderately tolerant. Jensen (1983) lists tall wheatgrass and barley as salt tolerant, listing respective Electrical Conductivity (EC) thresholds as 8.0 and 7.5 (ds/m). Mallory (1981) lists the threshold soi extract EC (EC_e) for barley (forage or hay) as 6.0 mmhos/cm. Above this threshold, yield was expected to be reduced approximately 7.1% per unit increase in EC_e in mmhos/cm. This indicates that a combination of western wheat grass, tall wheatgrass and barley would be a good crop combination for this system. Only minor yield reductions would be expected.

15.10.6.1.2 LEACHING FRACTION

Simulations detailed in Section 15.10.10 indicate a minimum leaching fraction of 15 to 20% of the total irrigation depth (volume) is required to maintain the electrical conductivity of the soil root zone at an acceptable level. Acceptable level is assumed to be that level of soil salinity and sodicity that can sustain salt tolerant corps without significant crop reduction. The range of leaching fraction values is presented because prediction of the leaching fraction with the model incorporates uncertainties. An increased leaching fraction of approximately 25% of total irrigation depth will be used to balance available irrigation water and system design capacity.

A monitoring program is proposed to assure that the accumulation of critical constituents within the root zone does not adversely affect plant growth. This program includes measurements of major ion concentrations, sodium absorption ratio (SAR), EC_e and cation exchange capacity (CEC) at four depth intervals in the root zone within the irrigated area. The number of sampling locations will include two per discernible soil type in the irrigated area. These sampling locations will likely move with adjustments in the irrigated area described in the irrigation sequencing section. The sampling levels in the soil profile are 0.5, 1.0, 3.0 and 5.0 feet. This sampling will be performed annually, or more frequently if adverse effects on crops are observed.

Monitoring efforts will include soil moisture measurement at 2 foot increments to a depth of 6 ft. The method of measurement will be by porous cup tensiometer. *Nine sets of tensiometers will be located within the irrigation area.* ~~Two sets of tensiometers will be established in each soil type within the irrigation area.~~ Moisture measurements will be taken weekly in sectors of the irrigation area where solutions have been applied. Monitoring programs are described in more detail in Section 8.0.

15.10.6.1.3 IRRIGATION DEPTH

The optimized total annual irrigation depth used in the Section 15.10.10 simulation is 1035 mm (3.4 ft). This amount will be adjusted based on results of monitoring and weather conditions to compensate for changes in consumptive use, rainfall, etc. Irrigation depth is the depth of irrigation water to be applied per year per area. The area under irrigation will vary each year and is dependent on operational needs.

15.10.6.1.4 IRRIGATION SEQUENCING

EFNI is approaching the land application of wellfield solutions using well established irrigation management practices for waters relatively high in salinity with moderate sodium hazard. The sequencing of irrigation activities is an important component of irrigation management allowing the maintenance of an adequate leaching fraction.

Estimates of available irrigation water volumes are based on the fluids generated from a 400,000 lb. U_3O_8 annual production rate. The mining sequence and assumptions are described in detail in Section 15. Table 15.2 summarizes the water balance of wellfield solutions destined for irrigation. Given total irrigation depth of 1035 mm (3.4 feet) , the area which can be irrigated over the nine year operational sequence for each year is 19, 19, 93, 93, 93, 93, 93, 93, and 30 acres. These areas are listed sequentially from first to last. This irrigation sequencing is based on storage of the first year's water production for irrigation used in the second and third year of uranium production. There will also be an accumulation of stored water throughout mining and restoration operations which results in the final (ninth) year of irrigation. This final irrigation season will follow cessation of mining operations.

The irrigation simulations in Section 15.10.10 indicate that a lixiviant without added $NaHCO_3$ allows adequate capacity to accommodate irrigation through the life of the project without significantly degrading the soil resource.

To predict effects of irrigation, a Thedalund soil profile was modeled using projected depth of irrigation and water quality. SAR and EC remained at acceptable levels for the nine-year simulation. These simulations were performed using the wellfield bleed water over the nine year period instead of a blend of the waste streams described in Section 15.10.2.4. In reality, the irrigation water quality should improve dramatically after three years of irrigation and problems of SAR and EC buildup should be reduced. Therefore, this simulation uses conservative assumptions for modelling impacts of both salinity and sodicity.

Simulations assuming the use of $NaHCO_3$ in the lixiviant were also conducted. These were performed to illustrate model impacts on the soil and groundwater in the event $NaHCO_3$ is used in the leaching process. The simulations indicate SAR and EC buildup may limit the number of years of irrigation permissible in the proposed irrigation area to 5 years.

The remainder of this section is a discussion of the irrigation sequencing where SAR and EC buildup problems are expected to be limiting. This discussion of sequencing also applies to irrigations with lower Na and HCO_3 concentrations. However, sequencing is much less critical without the use of $NaHCO_3$. When the Na and HCO_3 concentrations in the irrigation water are reduced, the simulations indicate that buildup of SAR and EC of soil over nine years of operation is not expected to significantly degrade the soil resource.

Irrigation simulations indicate that representative soils for the area will likely reach a critical SAR in the root zone after roughly four years of irrigation if the $NaHCO_3$ is used as a lixiviant. If the irrigated area for the first two years of operation is approximately 19 acres, (roughly 20 degrees of pivot rotation), the root zone SAR may be allowed to increase to a point where restoration by amendment and tillage will be effective as a means of reducing SAR in the soil, if needed.

The modeling for a fine grained soil with moderate to high CEC indicates that approximately ~~8~~ 6 years of irrigation will result in an increase of SAR to ~~8~~ 6. Monitoring of soil SAR will provide the information needed to determine when and if irrigation should stop for a particular area. An SAR of ~~8~~ 6 gives an adequate margin of uncertainty assuring that significant degradation of the soils does not occur. averaged across ~~necessary through~~ the soil profile.

Adequate soil monitoring will detect local areas where increased SAR may result in reduced crop yield. These areas can be identified and removed from irrigation. If the area removed from irrigation is small, it will be possible to increase storage carryover to the final year of irrigation. A combination of soil amendment and the presence of less problematic conditions may allow continued use of the sprinkler system for the design operational period.

Uncertainties exist in the model and assumed water quality. Therefore, the predicted four-year life from the $NaHCO_3$ lixiviant of an irrigation area could easily vary in either direction. If the life is extended significantly, the single pivot system will be adequate for the nine-year operation life. If the capacity of the soil to receive salt is not adequate for the life of the project, EFNI proposes to move the center pivot sprinkler system directly to the north. This will give access to 92.87 acres of previously non-irrigated area. Two complete center pivot areas (approximately 186 acres) should be more than adequate for the nine-year life of the project even if the usable life of a particular area is dramatically reduced. Soil surveys indicate similar soil types are present in both areas and the response to irrigation should be very similar. The supply pipeline will only require minor rerouting if utilization of the second area becomes necessary. The area is within the proposed WDEQ-LQD permit area.

15.10.6.1.5 CROP MANAGEMENT FACTORS

Several crop management factors will be considered in the mitigation of salinity impacts on the crop. Seed placement will be a minor concern for areas that have not received any irrigation. Small grains and grasses will be planted at a depth of 1 inch.

15.10.6.1.6 SOIL PROFILE MODIFICATION

Soil amendments are a possible means of reducing SAR within the soil. In particular, additions of readily available calcium may reduce the rate of increase of SAR and allow restoration of soils in which SAR has risen beyond an acceptable level.

15.10.6.2 LAND GRADING

Land grading should only be necessary to allow the center pivot system to traverse depressions. Topography in the irrigation area is gently rolling, so that land grading will be minimal. Land grading may include forming an earthen bridge across some of the deeper channels beneath the center pivot towers. If wheel tracks become excessively deep, some periodic grading may be necessary to fill in the tracks.

15.10.6.3 IRRIGATION FREQUENCY

The design irrigation frequency is dependent on several factors, including crop consumptive use, limiting infiltration rate of the soil, land slope, and sprinkler configuration. Greater efficiency and larger leaching fractions usually result from less frequent, heavier irrigation applications. However, for soils with low to moderate infiltration rates such as that included in the modeling effort, increasing irrigation depth/application will result in increased runoff.

The target depth per irrigation is 33.4 mm or 1.31 inch. The estimated instantaneous application rate for the system with a 35 ft. sprinkler wetted diameter is 3.1 in/hr. This rate is relatively high, and if runoff is observed with a 1.31 inch application, the sprinkler speed and the irrigation frequency will be increased to avoid surface runoff. The modeling indicates a total of 31 irrigations is needed at this rate with a maximum frequency of one application every four days during peak usage periods. The irrigation scheduling is included in Section 15.10.10 as Tables C-1, C-2 but is subject to adjustment for precipitation and feedback from operation of the system. When consumptive use is at a maximum, the sprinkler system will be operated a percentage of time that is approximately equal to the percentage of the pivot under irrigation.

15.10.7 ENVIRONMENTAL IMPACTS

15.10.7.1 GENERAL

EFNI is proposing to irrigate an 93 acre area with a current land use of domestic stock grazing and wildlife use. EFNI proposes to change the land use from grazing to irrigated pasture for the life of the mining project. After land application activities cease, the irrigation area will be returned to native grasses and shrubs. The irrigation operation is the only cost effective means of disposing of relatively large volumes of wellfield solutions associated with the in situ leach operation.

15.10.7.2 SOILS

The soil resource has been described in Section 15.10.3.2 of this document and in more detail in Section 11 of the LQD Mine Amendment application.

15.10.7.2.1 SALINITY

The primary impact of land application of wellfield solutions is expected to be the short term increase in salinity of the soils within the irrigation area. A secondary concern related to salinity is increased sodicity of the soil.

In order to predict the effects of irrigation on the soil and groundwater resource, Hydro-Engineering, Inc. of Casper, Wyoming modeled soil chemistry using LEACHM (Wagenet and Hutson, 1989). LEACHM is a commonly used one dimensional numeric model used for the purpose of optimizing agricultural irrigation operations. The model allows the incorporation of plant growth, soil chemistry, irrigation water chemistry, and soil physical properties to predict effects on soil and groundwater. The assumptions and simulation results are included in this document as Section 15.10.10. The results of the simulations form the basis for irrigation management practices to be used to minimize environmental impacts. Environmental effects to the soil based on these simulations are discussed below.

Table C-3 illustrates the Sodium Adsorption Ratio (SAR) and electrical conductivity (EC in micromhos/cm) of soil extracts (EC-e) for two cases. Case 1 is a Worst Case scenario using the bleed stream from the wellfield operations with $NaHCO_3$. This simulation shows the soil within the top 1.1 meters maintaining a EC-e of between 5.6 and 7.0 dS/m over the 9 year life of the project. Maintenance of an adequate leaching fraction will help ensure that salinity levels within the soils do not exceed these levels.

Case II shows some accumulation of sodium but without reaching critical levels limiting plant growth.

At these EC-e levels, a reduction of yield for salt tolerant crops such as tall wheatgrass or barley is not expected (Jensen, 1983). However, less salt tolerant grass and forb species contained in the existing cover may show the effects of salt damage during irrigation. In order to assure the maintenance of an adequate vegetative cover, the irrigation area will be interseeded with salt tolerant tall wheatgrass and barley as described in Section 15.10.2.7.

15.10.7.2.2 SODICITY

As described in Section 2.4 of this document, the sodicity of wellfield solutions to be land applied is partially dependent on the process used during leaching of the ore body. Pilot testing (Rocky Mountain Energy, 1980) made use of $NaHCO_3$ as a chemical agent to enhance ease of uranium recovery. Relatively high bicarbonate concentrations in groundwater, may allow the elimination of $NaHCO_3$ as a reagent. Use of $NaHCO_3$ significantly increases the sodicity hazard associated with land application of solutions.

Table C-3 contained in Attachment C shows SAR projected for the top 1.1 meters of the soil using wellfield solutions with and without the addition of $NaHCO_3$.

For the worst case scenario, SAR will be 5 after five years. Average SAR's above *5* ~~6~~ in the soil could adversely effect soil structure and impact soil drainage (WDEQ-LQD Guideline 1), (U.S. Salinity Laboratory Staff, 1954). Therefore, monitoring of the upper 5 feet of the soil profile will be performed to ensure SAR does not move above *5* ~~6~~. If areas within the irrigation area show significant reduction in plant yield and/or are shown to have average SAR values through the profile values of over *5* ~~6~~, irrigation will be stopped in that area. ~~If the average SAR values within the irrigation approach 5, then land application activities will cease and soil reclamation activities will commence.~~

For the more likely scenario were $NaHCO_3$ is not utilized, SAR values are not expected to exceed five, but the same monitoring and restrictions are proposed for this scenario as well.

15.10.7.2.3 SOIL RECLAMATION

Reclamation of saline and sodic soils is a common agricultural problem. Reclamation of sodic soils can be accomplished through the leaching of the soil profile with low sodium waters and/or through the addition of amendments high in exchangeable cations such as calcium and magnesium.

In general, 80% of salts deposited in the soils can be leached below the root zone by applying a depth of water approximately equal to the depth of the soil to be leached (Reeve et al., 1955). Thus, four feet of water applied to the soil profile can be expected to remove 80% of soluble salts to a depth of approximately four feet.

Water quality during the last two years of leaching activities water quality is expected to be improving steadily with respect to dissolved constituents. Water quality will approach baseline as ground water sweep operations are completed on individual wellfields and the bleed stream from production activities stop. Water produced during groundwater sweep activities may be adequate for reclamation, if the need arrives. If it is not adequate to reduce the SAR to acceptable levels, then water produced from higher quality sources such as other groundwater wells in the area or water treated through RO technology will be applied to adequately reclaim soils exhibiting high sodium or high salts.

15.10.7.2.4 RADIONUCLIDES

The concentrations of natural uranium and ^{226}Ra within irrigation water have been estimated using knowledge of the performance of similar barium chloride treatment systems. Similar systems are common throughout the uranium industry. Radium-226 is expected to be reduced to 5 pCi/l on an average basis.

Natural uranium is expected to be reduced to an average of 2 mg/l in water discharged to the surface. Radium-226 and natural uranium allowable limits for discharge are specified in 10 CFR 20, Appendix B, Table 2 and are listed in Table 16.4 of the LQD Amendment application. EFNI's estimated average discharge concentrations are far less than specified.

For calculating soil loading over the life of the project, the average estimated concentration of solutions to be land applied, a total project application depth of 23 feet, and accumulation of the total amount of ^{226}Ra in the top six inches of soil was assumed.

On the basis of these assumptions, the following concentration would be expected within the top six inches of the land application area at the conclusion of mining activities:

0.2 pCi/gm ^{226}Ra Above Background

The ^{226}Ra concentration is well within the federal cleanup standard of 5 pCi/gm for unrestricted use within the top 15 cm of soil.

No current federal standard for natural uranium in soil exists. However, based on the assumption that all U-nat is accumulated in the top one foot of soil over the life of the project, a total activity of 25 pCi/gm above background is expected.

Monitoring of soil at the Power Resources Satellite #1 Facilities indicates that U-Nat does not accumulate significantly in surface soils, and therefore 25 pCi/gm is a very conservative estimate.

15.10.7.3 SELENIUM ACCUMULATION

The accumulation of selenium in the biosphere and its effects on the environment has been studied extensively since the 1940's. Even with the numerous investigations of selenium in the environment, many aspects of its behavior are still uncertain.

When considering the potential for toxic effects of selenium accumulation associated with the proposed land application area, it is important to put the activity in context. The proposed land application area is to be located on 93 acres of semi-arid grass and shrubland. The life of the project is finite (9 years) with a total application depth of approximately 23 feet. Concentrations of selenium within wellfield solutions are not expected to exceed 0.085 mg/l. The proposed facility is located at least 20 miles in any direction from a source of perennial surface water. Ground water underlying and downgradient of the land application area is limited in extent and is suitable only for livestock use. Many of the pathways for the bioaccumulation of selenium are not presented by this activity and location, and if much higher application rates of Se are assumed.

15.10.7.3.1 SELENIUM ACCUMULATION IN THE SOILS

The toxic effects of plants containing high concentrations of selenium on domestic animals has been documented by several investigators (Rosenfeld, 1964), (National Academy of Sciences, 1976). Effects include loss of hair and deformation of the hooves of animals. Selenium may also be the cause of blind staggers characterized by impairment or loss of vision in domestic animals. Lakin and Davidson (1973) estimated that selenium toxicities become evident in livestock grazing continuously on vegetation containing more than 4 ppm Se measured in dried vegetation. The National Research Council (1976) estimated 5 ppm as a level capable of causing chronic effects.

Selenium poisoning is normally caused by the ingestion of plants which have concentrated selenium in foliage. A three tiered system of classification of plants in relation to selenium accumulation is commonly used (Brown, 1982). Plants are classified as primary or secondary indicator plants or nonaccumulators. Primary indicators grow only on seleniferous soils and can accumulate selenium to several thousand parts per million dry weight in plant tissue. Secondary indicators are not restricted to seleniferous areas but can accumulate selenium up to a 1000 parts per million. Nonaccumulators seldom accumulate selenium to more than 30 ppm Se dry weight. Several species of primary indicator plants including members of the Astragalus genus were identified on the land application site. Several other secondary indicator plants including members of the Aster and Atriplex genus were also identified. However, these plants are not common and exist in spotty localized areas in deep, fine textured bottomland soils or shallow residual soils on ridges. Refer to Section 12 for further discussion.

The availability of selenium for uptake by plants is apparently determined primarily by the oxidation state of selenium in the soil. Selenium exists primarily in four oxidation states in the soil. They are selenide (-2), elemental selenium (0), selenite (+4), and selenate (+6). In general, the solubility and availability to uptake by plants increases as the oxidation number increases. The oxidation state in which selenium exists is generally related to the pH and Eh of the chemical environment. Increasing pH and Eh result in the predominance of the more oxidized forms of selenate and selenite. Reducing environments with lower pH and negative Eh's result in the predominance of elemental and selenide forms (Mikkelson, 1989). Thus, from a biological viewpoint, the total concentration of selenium in the soil is not as consequential as the form in which the selenium exists.

The mobility of selenium is also influenced by its oxidation state. At lower pH and Eh selenium forms tend to more readily adsorb to clays and are less mobile (Mayland et. al, 1990). In general, Se is similar to sulfur in its reaction within the soil and subsurface and is quite mobile in its oxidized forms (McNeal, 1989).

Irrigated solutions will be oxidizing in character and selenium will likely exist in their most available and mobile oxidation states. This has implications to selenium's effect on the environment. Based upon what is known about the behavior of selenium, long term accumulation of selenium in surficial soils appears unlikely. The mobility of the oxidized forms of selenium indicate that it is not likely to persist in surficial soils after applications cease. However during application, selenium will likely be in its most available form, raising the possibility of enhanced uptake by plants growing within the irrigation area.

Even without taking into account flushing and availability of selenium in the root zone, and assuming the total amount of selenium applied (0.085 mg/l) is accumulated in the surface one foot of soil, total concentration of selenium can be calculated to be less than 0.02 ppm at the conclusion of mining.

15.10.7.3.2 SELENIUM IMPACTS TO THE GROUNDWATER

As indicated in the above discussion, selenium is likely to be in its most mobile forms when applied to the surface environment. Selenate (+6) is reported to be weakly adsorbed to soil exchange sites (Hayes, 1987). Selenite (+4) was shown by Hayes to adsorb much more strongly in low pH environments. Therefore, it can be expected that selenium will move rapidly into the subsurface below the root zone. As the more oxidized forms of selenium move into a more reducing environment, reduction reactions can be expected to take place, reducing the solubility and bioavailability of selenium. In a related chemical phenomena, cation exchange of selenium for other cations attached to clay and organic matter in the subsurface can be expected.

15.10.7.4 GROUND WATER

A simulation with the LEACHM model was conducted for the profile to the top of the Upper Sand at an approximate depth of 144 feet. This simulation shows a cumulative drainage 810 mm over 30 years. An average rate of 27.0 mm over the 30 year simulation converts to an equivalent of 3.84 GPM for an average application area of 70 acres. Movement through the mudstone into the Upper aquifer is going to occur over a period of several tens of years. The movement of this water will also be spread horizontally in the mudstone as it moves downward. The Upper aquifer, over a width of 2500 feet, is estimated to be conveying 8.8 GPM. This is based on a transmissivity of 1230 gal/day/ft and a hydraulic gradient of 0.0041 ft/ft. The mixing of the 3.84 GPM would be with 8.8 GPM unaffected groundwater. A TDS of 1700 and 2150 mg/l, respectively, for the Upper aquifer and drainage water is expected. The irrigation leakage through the mudstone yields a mixed concentration of 1840 mg/l. Thus, only a small increase in concentration is expected in the Upper aquifer 30 years after the start of operation of the land application. Such an increase is within the range of natural variations expected in the aquifer water quality.

15.10.7.5 SURFACE WATER

The increase in the concentration of salts on the surface in the land application area will increase the salt concentration in surface water from runoff in this area after a larger precipitation event. The conductivity of the soil is expected to increase approximately 14 times based on the worst case simulation. It is difficult to estimate the concentration of surface runoff from the irrigation area when excess rainfall occurs. This will be highly dependent on the quantity of runoff. A rough estimate for concentration of runoff may be an equivalent increase in salt concentration in the surface water to the increase in conductivity on the soil which is a factor of 14. An increase by a factor of 14 for the typical surface water quality (300 mg/l) will produce a TDS of approximately 4,200 mg/l. The Upper Spring Creek drainage area of 2.1 square miles was defined in the mine permit. If the entire 93 acres of land application had available salts to be dissolved, and a runoff event occurred where the concentrations were 14 times higher, the resulting concentration would be 570 mg/l of TDS at the end of the Upper Spring Creek drainage. This assumes a runoff concentration of 300 mg/l of TDS for the remainder of Upper Spring Creek. This rough estimate shows that after a very short distance, the increase in concentration and surface water quality would be insignificant.

15.10.7.6 WILDLIFE

The primary short term impact of the land application on wildlife is expected to be the conversion of a 93 acre area from upland grass and big sagebrush vegetation community to an irrigated pasture. Composition and diversity of the vegetation will change in response to increased water availability, interseeding with salt tolerant species, and application of saline water.

At the conclusion of land application activities, the land application area will revert to its original land use. As described in Section 15.10.9, Reclamation, a reclamation plan will be developed based on the soil and vegetative conditions existing at that time. The ultimate goal of reclamation will be to restore the land to domestic grazing and wildlife use.

As discussed in Section 15.10.7.3, the effects of selenium are expected to be short-term. Increased selenium concentrations within the soil and in vegetation may occur. However, over the longer term selenium is expected to be flushed into the deeper unsaturated zone. Availability of selenium to vegetation is expected to diminish during the later stages of land application activities and reclamation.

In order to limit potential effects to big game wildlife species and domestic animals, the land application area will be fenced with five strand barbwire. Fencing can be expected to exclude domestic animals completely, but will not prevent mule deer and pronghorn antelope from entering the area. However, use of vegetation by wildlife within the land application area is not expected to be continuous. No water source exists in the land application area and therefore big game presence within the land application area is expected to be transient and impacts minimal.

Fortunately, the accumulation of selenium within aquatic systems is not a substantive impact of the land application activity. There are no wetlands and/or perennial water sources within the permit area or within at least a mile of the permit boundary. Therefore, many of the pathways to wildlife exposure and accumulation do not exist. Additionally, the land application activity has a defined time frame.

Long term contributions of selenium to the environment and aquatic systems normally associated with regional irrigation projects will not occur.

15.10.8 ENVIRONMENTAL MONITORING

Environmental monitoring will be performed for the following purposes:

Tensiometers to define migration of liquids in the soils to ensure the maintenance of an adequate leaching fraction.

Soils will be sampled and analyzed for chemical constituents. Soil chemistry will be determined to assure that soil salinity, sodicity, radionuclides and trace metal loading do not exceed accepted and the soil resource.

Shallow monitor wells to detect the presence and quality of groundwater originating from the irrigation site. Water quality information will serve as a means of verifying and calibrating projections for the migration of irrigated solutions within the unsaturated zone between the root zone and Upper Sand.

Monitor wells completed in the Upper sand well be monitored for water quality to determine any migration of irrigation solutions to the first aquifer of use and importance.

Vegetation will be collected and analyzed to determine the extent of uptake by plants within the land application area on an annual basis.

Monitor locations associated with the land application permit are illustrated on Plate 16.1.

The proposed monitoring program is summarized on Table 15.3.

15.10.8.1 SUBSURFACE MONITORING

EFNI has proposed a regional monitoring program for the Reno Creek ISL Project in Section 16. In addition to the proposed regional monitoring wells, EFNI is proposing to add monitoring points to quantify impacts of the land application operation. A description of the specific additions or revisions to the subsurface monitoring program follows. Approximate location of monitor locations is shown on Plate 16.1.

Shallow Tensiometers will be established at nine locations within the land application area. The porous cup tensiometers will be nested and will measure the saturation front at 2, 4 and 6 feet below the surface. Tensiometer measurements within the irrigation area will be recorded on a weekly basis. Only tensiometers within areas being actively irrigated will be monitored and recorded.

The purpose of monitoring the tensiometers is to assure the maintenance of an adequate leaching fraction. Two shallow monitor wells completed in unsaturated sands have been proposed. These wells will be completed in shallow sand layers located in the unsaturated zone below the irrigation area. Shallow monitor wells will be monitored on a semi-annual basis for the presence of water and the water quality parameters listed on Table 16.1. The wells will be completed in the manner described in Section 15. The purpose of shallow monitor wells will be to detect deep percolation of irrigation solutions (if present) and determine water quality.

In addition to the existing regional monitor network, EFNI proposes to complete one additional monitor well in the Upper Sand. This well will be located hydrologically down gradient (northwest) of the land application area. Since this is the first strata containing useable quantities of water, this well will be the point of compliance for the land application facility.

15.10.8.2 SURFACE WATER AND SEDIMENT MONITORING

A surface water and sediment monitoring program is presented in the LQD amendment application, Section 15. Two surface water and sediment stations have been proposed as part of this program, one station in the Belle Fourche River channel and one downstream from the land application area on Spring Creek. Water quality and sediment will be collected and sampled at these sites at least annually and more frequently if precipitation events allow. Samples will be analyzed for the set of parameters listed in Table 16.1 and 16.2.

The purpose of surface water and sediment sampling will be to determine impacts of surface runoff from the irrigation area.

15.10.8.3 SOIL SAMPLING

Soil sampling efforts will include adequate sampling points and depths to detect buildup of SAR, EC, trace metals, or radionuclides in the soil to unacceptable levels. The proposed soil sampling depths are 0.5 feet, 1.0 feet, 3.0 feet and 5 feet. For the initial 10 acre irrigated area, two sampling points are proposed. Sampling frequency is once per year and will occur in the fall after solution flux in the soil profile has declined. When the irrigated area is expanded, one sample per 5.2 acres will be added to the program. The anticipated maximum number of sample locations for the total irrigated area is 18, but will vary from year to year depending on the locations under irrigation. Locations of sample sites are subject to adjustment following detailed soil delineation at each site. Soil water detection sites will be the same as soil sampling sites.

Soil samples will be analyzed for the parameters listed in Table 16.2 of the LQD Amendment application. The purpose of soil sampling is to detect and quantify the effects of irrigation on soil chemistry.

15.10.8.4 VEGETATION SAMPLING

A vegetation sampling monitoring program is proposed in Section 16.4. As part of this program, vegetation will be collected at two sites within the land application area. At each site, shrubs, grasses and forbs will be collected annually during the growing season and analyzed for the parameters listed in Table 16.3.

The purpose of vegetation sampling is to determine uptake of trace elements such as Selenium or molybdenum that could be harmful to domestic animals or wildlife.

Table 15.5

Environmental Monitoring Summary

Monitoring Type	Frequency	Number of Locations	Parameters	Comments
Soil Moisture	Weekly during irrigation	Variable; 1 minimum and 9 maximum	Soil Capillary Pressure	Nested tensiometers at 2.0, 4.0, 6.0 feet
Shallow Monitoring Wells	Semi-annual	2	Water level and Chemistry (1)	Unsaturated Zone
Upper Sand	Semi-annual	1 + Regional Monitoring Wells	Water level and Chemistry (1)	Point of compliance
Surface Water & Sediment	Annual or more frequently if possible	2	Water Chemistry and Sediment Chemistry (1)(2)	Spring Creek and Belle Fourche drainages
Soils	Annually	Variable; 2 minimum - 18 maximum	Soil Chemistry (2)	Samples at three depths; 0.5 ft, 1 ft, 3.0 ft. and 5 feet
Vegetation	Annually	2 sites	Vegetation Chemistry (3)	Two sites - grasses, forbs and shrubs.

(1) Parameters listed on Table 16.1, LQD Amendment application
(2) Parameters listed on Table 16.2, LQD Amendment application
(3) Parameters listed on Table 16.3, LQD Amendment application

15.10.9 RECLAMATION

The ultimate goal of reclamation in the land application area is to return the area to its previous land use; wildlife use and grazing of domestic animals. EFNI has proposed a land application system with adequate environmental monitoring to detect potential effects on soils, vegetation, and water resources before they become significant environmental impacts. Therefore, it is likely that reclamation will simply consist of allowing the irrigated pasture to revert naturally to rangeland. However, if environmental effects do occur, EFNI will initiate remedial action. The means by which reclamation is accomplished will depend on soil and vegetation conditions at the time of reclamation. If salt affected soils are a problem in a portion of the land application area, several means of remediating problems exist. They include leaching the irrigation with fresh water relatively low in salts and sodium, adding calcium or organic amendments to the soil to cause cation exchange, and deep plowing.

If selenium is a problem in small areas, leaching with fresh water or addition of $CaSO_4$ to the soil have been successfully used in agricultural operations for removal or immobilization of selenate and selenite.

EFNI commits to the ongoing monitoring and development of appropriate reclamation measures as specific effects of the land application activity become evident.

15.10.10 IRRIGATION WATER AND SOIL MODELING

The operation of the irrigation system and changes in the soil chemistry were modeled using LEACHM, (Wagenet and Hutson, 1989) a water flow and leaching model. This model allows incorporation of plant growth, soil chemistry, irrigation water chemistry, precipitation chemistry and soil physical properties. The output of the model consists of predictions of water flux and concentrations of major ions within the soil profile over time. The water flux portion of the model is a finite difference solution of the one-dimensional form of the Richard's equation. Several options are available for the calculation of the soil water characteristic, and an empirical method based on particle size distribution was used for these simulations.

The inorganic chemical equilibria module used in the model is based on methods presented by Robbins et al. (1980a) and Robbins et al. (1980b). The reader is referred to Wagenet and Hutson (1989) for a discussion of algorithms and sources of activity coefficients, stability constants, etc.

15.10.10.1 MODEL INPUTS

The following is a description of model inputs used for simulation of the soil and water chemistry and soil water balance simulations.

15.10.10.1.1 SOIL PROFILE

Two soil profile thicknesses of 1.1 meter and 44 meter were used with 11 distinct layers of uniform thickness in each profile. The 1.1 meter thickness was used as a root zone model and the 44 meter thickness was used to predict the lag in appearance of drainage at depth. For the 1.1 meter thickness, the soil properties were those of a Thedalund soil with a root zone of 0.8 meter. For the 44 meter thickness, the root zone was a single layer of 4.4 meter and the Thedalund soil chemistry properties were carried all through the profile. As mentioned earlier, the purpose of this simulation was to estimate time to appearance of significant quantities of drainage at the bottom of the 44 meter profile, which represents the approximate contact with an Upper Sand.

The soil and soil solution chemistry module of the model is complex and many of the input parameters are estimates. The Thedalund soil was considered a typical soil profile in the irrigation area. Table C-1 presents the model input file for a typical root zone simulation, and Table C-2 presents the model input file for the 44 meter profile simulation. Both tables include the initial soil chemistry in terms of concentrations of constituents. In the absence of soil chemistry and properties information for the deeper surficial materials, the Thedalund soil properties were carried to the 44 meter depth with the exception of the hydraulic conductivity. Based on lithologic and geophysical logs for boreholes in the irrigation area, the hydraulic conductivity of the shales and mudstones underlaying the irrigation area was estimated to be 3 mm/day. In cases where concentrations or quantities of constituents were not known, such as quantities of individual exchangeable ions, the values were adjusted until reasonable correspondence between model predictions and measured values was achieved. As an example, the model predicts pH of the soil based on ion concentrations, and unknown values were adjusted until the predicted pH was reasonably close to the measured value.

15.10.10.1.2 PLANT GROWTH AND CONSUMPTIVE WATER USE

The anticipated crop for the irrigated area is salt-tolerant species such as Wheatgrass and barley. The root zone for these crops was estimated to be two feet, although this is dependent on many soil and crop management factors. Evapotranspiration rates for the crop were taken from Trelease et al. (1970) as an average of monthly values reported for Midwest, Wyoming and Gillette, Wyoming. Resulting weekly values of evapotranspiration (mm) are presented in Table C-1. The root development was assumed to be constant as would be the case with perennial grasses.

15.10.10.1.3 IRRIGATION AND PRECIPITATION.

Precipitation values were taken from a ten-year average for Midwest, Wyoming. With rounding and conversion to metric units, the precipitation used in modeling was 291.4 mm applied in 12 monthly inputs. Precipitation was considered to be free of significant ion concentrations.

Two irrigation water scenarios are considered. The first scenario results from use of a lixiviant with a relatively high $NaHCO_3$ concentration. This produces much poorer irrigation water quality over the life of the project. The second scenario uses a lixiviant without $NaHCO_3$ resulting in much better water quality. Irrigation water for the worst case situation was with the process bleed which will be used as the sole irrigation water source for the first two years of irrigation. In subsequent years, the irrigation water will consist of various combinations of process bleed, ground-water sweep and reverse osmosis RO bleed waters, and the general water quality should improve substantially. Based on anticipated quantities of water from each source, the water quality for years 3 through 9 was assumed to be a 1/3 process bleed, 2/3 ground-water sweep combination. The estimated concentrations of major ions in the irrigation water are as follows: Ca - 6.16 mmol/l, Mg - 2.06 mg/l, Na - 28.7 mmol/l, Cl - 4.12 mmol/l, SO4 - 11.77 mmol/l, and HCO_3 - 18.13 mmol/l.

The simulation with the $NaHCO_3$-free lixiviant used the following major ion concentrations: Ca - 8.23 mmol/l, Mg - 2.06 mmol/l, Na - 15.2 mmol/l, Cl - 6.77 mmol/l, SO4 - 11.77 mmol/l, and HCO_3 - 5.57 mmol/l. Irrigation over the nine-year operation period was simulated with the process bleed, which is a worst case scenario.

15.10.10.2 MODEL SIMULATIONS

A series of model runs were conducted to provide predictions of the soil chemistry, which would in turn allow analysis of irrigation management practices. The primary root zone simulation was conducted to optimize irrigation management. Alternative irrigation scenarios allowed optimization of irrigation frequency and application depth to produce an appropriate leaching fraction. In general, increases in total irrigation depth and reduced frequency of irrigation will result in a larger fraction of total water moving beyond the root zone. This fraction is referred to as the leaching fraction. A ground-water effects simulation with a profile thickness of 44 meters was conducted to examine effects of leaching through the unsaturated zone and impacts on ground water.

15.10.10.2.1 ROOT ZONE SIMULATION

The optimized root zone simulation was performed with irrigation application depths of 33.4 mm or 1.31 in. with total irrigation depth of 1035 mm or 40.7 inches. a simulation period of nine years was used and the leaching fraction was 25.4% of irrigation water and 20.0% of total precipitation plus irrigation. The simulation with $NaHCO_3$ in the lixiviant used nine years of irrigation with the combination water as discussed in section C.1.3. The low Na and HCO_3 concentration simulation results are also included in the table. Sulfate concentration, EC and SAR values for a point 250 mm from the surface are presented in Table C-3.

The EC_e of the soil is considered to be a good indicator of potential salinity problems. The slight changes in EC_e between the third and last year of operation are well within the expected accuracy of predictive modeling. The sulfate concentration exhibits behavior similar to the EC_e.

The SAR of the soil could be an area of concern, for the worst case scenario. Both the process bleed water and the combination irrigation water have relatively high concentrations of Na. Modeling indicates an accumulation of sodium at the surface which gradually propagates through the root zone. Unfortunately, increasing the volume of irrigation water tends to accelerate the accumulation of sodium, and thus increasing the leaching fraction may reduce the EC and simultaneously increase the SAR. Based on the SAR values at the 250 mm depth for the nine year simulation, it appears that the SAR may become critical in the root zone after 4 to 5 years of irrigation. The irrigation water with the lower Na and HCO_3 concentration produces much better results. EC values show a similar progression as earlier simulations. However the SAR value buildup is much slower and the SAR values in the root zone should not become critical over the nine-year irrigation schedule.

15.10.10.2.2 GROUND-WATER IMPACT SIMULATION

The ground-water impact simulation was for a period of 30 years and utilized a simplified irrigation and precipitation scheme. Total irrigation application was 1035 mm/year and application rates were 345 mm per application to reduce the total number of irrigations. A total of 300 mm precipitation was also used for the first eight years of simulation in three applications of 100 mm. Nine years of irrigation was simulated. For the remaining years, the crop was assumed to be eliminated and the precipitation was reduced to 120 mm per year to compensate for consumptive use by sparse vegetation. The model predicts a total of 0.810 meters of water will be lost to drainage through the 44 meter profile over a 30 year period. Essentially, the recharge due to irrigation has been delayed for at least 12 years and will likely be spread over a period of 12 years or more.

TABLE 15-6. SUMMARY OF RESULTS FROM ROOT ZONE LEACHING SIMULATIONS.

	SO4 Conc, mmol/l	EC_e, mS/cm	SAR
Case I - Worst Case			
9 YEAR SIMULATION - high Na & HCO_3 irrigation water			
End of Year 1	24.3	5.84	1.9
End of Year 2	23.7	5.39	2.4
End of Year 3	23.6	4.97	3.2
End of Year 4	24.0	5.26	4.2
End of Year 5	24.3	5.83	5.6
End of Year 6	24.9	6.09	6.9
End of Year 7	25.4	6.30	8.2
End of Year 8	25.7	6.45	9.3
End of Year 9	25.9	6.52	10.3
Case II - Likely Case			
9 YEAR SIMULATION - low Na & HCO_3 irrigation water			
End of Year 1	24.7	5.51	1.9
End of Year 2	26.0	5.76	1.9
End of Year 3	26.3	5.81	2.1
End of Year 4	26.3	5.82	2.4
End of Year 5	26.3	5.83	2.9
End of Year 6	26.3	5.84	3.3
End of Year 7	26.3	5.90	3.8
End of Year 8	26.3	5.95	4.2
End of Year 9	26.3	5.98	4.5

15.10.11 REFERENCES

Brown, T. H., 1991. Solubility, sorption, and redox relationships for selenium in reclaimed environments; a review of the literature. In U. S. Geological Survey Circular 1064. Proceedings of the 1990 Billings Land Reclamation Symposium on Selenium in Arid and Semiarid Environments, Western United States, U. S. Government Printing Office, Washington, D.C.

Hansen, V.E., O.W. Israelsen, and G.E. Stringham. 1980. Irrigation Principle and practices. John Wiley and Sons.

Hayes, K. F., Roe, A. L. Brown. 1987. In situ x-ray absorption study of surface complexes, Science, V. 238, p. 783-786

Jensen, M.E. 1983. Design and Operation of Farm Irrigation Systems. American Society of Agricultural Engineers, St. Joseph, Michigan

Mallory, R. 1981. Leaching requirements for salinity management vary according to crop. Irrigation Age, September, 1981, pp 53-54.

Mayland, H. F., L. P. Gough. 1989. Selenium mobility in soils and its absorption, translocation and metabolism in plants. In U. S. Geological Survey Circular 1064. Proceeding of the 1990 Billings Land Reclamation Symposium on Selenium in Arid and Semiarid Environments, Western United States, U. S. Government Printing Office, Washington, D.C.

Mays, Wallace M. 1992. Restoration of groundwater at three in situ uranium mines in Texas. Uranium in situ leaching, Proceeding of the Technical Meeting in Vienna, Oct 5-8, 1992. International Atomic Energy Agency, Vienna, Austria.

McNeal, James M., L. S. Balistrier. Geochemistry and occurrence of selenium; An overview, in Selenium in Agriculture and the Environment, Soil Science Society of America, SSSA Special Publication #23, Madison, Wisconsin.

Mikkelsen, R.L., A. L. Page. 1989. Selenium accumulation by agricultural crops. in Selenium in Agriculture and the Environment, Soil Science Society of America, Inc. SSSA Special Publication Number 23, Madison, Wisconsin.

National Research Council. 1976. Selenium; medical and biological effects of environmental pollutants. Committee on medical and biologic effects of environmental pollutants. Printing and publishing office, National Academy of Sciences, Washington, D.C.

Peliza, Mark. URI, Dallas, Texas. Personal Communication, December 9, 1993.

Robbins, C.W., J.J. Jurinak, and R.J. Wagenet. 1980a. Calculating cation exchange in a salt transport model. Soil Sci. Soc. Amer. J. 44:1195-1199.

Robbins, C.W. , Wagenet, R.J. and J.J. Jurinak. 1980b. A combined salt transport-chemical equilibrium model for calcareous and gypsiferous soils. Soil Sci. Soc. Amer. J. 44:1191-1194

Rocky Mountain Energy Company, Final Demonstrated Restoration Report, November, 1981.

Rosenfeld, Irene, O.A. Beath. 1964. Selenium; geobotany, biochemistry, toxicity and nutrition. Academic Press, Inc.

Trelease, F.J., P.J. Swartz, P.A. Rechard and R.P. Burman. 1970. Consumptive use of irrigation water in Wyoming. Wyoming Water Planning Rpt. No. 5. Water Resources Research Institute. University of Wyoming.

U.S. Salinity Laboratory Staff 1954. Diagnosis and improvement of saline and alkali souls. U.S. Department of Agriculture.

Wagenet, R.J. and J.L. Hutson. 1989. LEACHM: Leaching estimation and chemistry model. Department of Agronomy. Cornell University, Ithica, NY.

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION.

```
CHEMTEST  ATM-WATER-SALINITY-PLANT-INTERACTION
SIMULATION PERIODS (Data must be present for each item, even if it not used)
-----------------------------
Date type (US:1 UK:2)                   1
Starting date                      010120 Ending (date or day no.)        010121
Largest time interval (day) .1000E+00 Max.theta change/time st   .1000E-01
Read theta(1) or pot'l(2)               2 Calc.sel.coeff? 0:no 1:yes           1
No. of water applications              43 No. chemical applications            1
Cycles through data                     9 No. of crops                         3
K-Th-h from PSD:yes(1)no(0)             1 Trace 1(on) 0(off)                   0
No. of time steps/chemeq               40
-------------------------------------------------------------------------------
PROFILE DETAILS
-----------------------
Profile depth      (mm)         .1100E+04 Bottom boundary condition            2
Segment thickness (mm)          .1000E+03 :1 or 5,water table depth  .0000E+00
-------------------------------------------------------------------------------
FOR UNIFORM PROFILE: (Any non-zero value here will override those in the
table of hydrological characteristics below unless K-Th-h calc. from PSD).
Soil bulk density Mg/cu.m      .0000E+00 Air -entry value' kPa      -.0000E+00
Exponent in Campbell's eq      .0000E+00 Sat'd K values (mm/day)     .0000E+00
-------------------------------------------------------------------------------
FOR STEADY-STATE FLOW: (A non-zero water flux density will prevent calls to
the water flow subroutine, fix flux and theta and set ET to 0.
Steady state? y(1), n(0)               0
Water flux density (mm/d)      .1000e+03 Water content (theta)        .2500E+00
-------------------------------------------------------------------------------
CROP DATA
-----------
Plants present: 1 yes, 0 no             1 Wilting point (soil) kPa   -.1500E+04
Max(actual tran/potl tran)      .1100E+01 Min.root water pot'l(kpa) -.3000E+04
Roots: Const(1):growing(2)              1 Max.root water pot'l(kpa)  .0000E+00
Root length (not used)          .5000E+03 Root flow resistance term  .1050E+01
-------------------------------------------------------------------------------
DIFFUSION/DISPERSION
-------------------------
Molecular diffusion  | Do   .1200E+03 Dispersivity  (mm)            .1000E+03
coefficient (mm2/d)  | DIFA .1000E-02
(Bresler's eq.)      | DIFB .1000E+02
-------------------------------------------------------------------------------
NUMBER OF OUTPUT FILES                  2
  -- .OUT file --------                     ------ .SUM file ---------
                                          Summary print interval (d)           1
Node print frequency                    1 Three depth segments for the summary
Print options: 1, 2 or 3                2  file  (0's default to thirds of the
 1: Time intervals/print                1  profile)  (mm) :
 2: days/print                      365.0    Surface to [depth 1?]           000

 3: No. of prints (even)                4    Depth 1 to [depth 2?]           000
                                             Depth 2 to [depth 3?]           000
*******************************************************************************
*******************************************************************************
```

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION, continued.

TIMES AT WHICH *.OUT FILE IS DESIRED (if print option = 3)

Date or Day no.	Time of day (to nearest tenth)	Date or Day no.	Time of day (to nearest tenth)
011025	.2	011026	.6
010127	.5	010427	.0

****
****

INITIAL PROFILE DATA - SOLUBLE ANIONS AND pCO2

*****(HCO3 and CO3 will be determined by pCO2 and Ca levels)****

DEPTH SEGMENT	Cl	SO4	HCO3	PCO2
	mmol/l			atm.
1	1.24	0.44	1.44	.0030
2	1.15	4.15	1.15	.0030
3	1.15	4.15	1.15	.0030
4	1.15	4.15	1.15	.0030
5	1.15	4.15	1.15	.0030
6	1.15	4.15	1.15	.0030
7	1.15	4.15	1.15	.0030
8	30.60	15.00	39.00	.0030
9	30.60	15.00	39.00	.0030
10	30.60	15.00	39.00	.0030
11	30.60	15.00	39.00	.0030

****
****

INITIAL PROFILE DATA - SOLUBLE CATIONS, LIME AND GYPSUM

****

DEPTH SEGMENT	Ca	Mg	Na	K	Lime	Gypsum
	mmol/l				fraction	
1	1.41	0.59	0.60	0.10	.0050	.0000
2	1.18	1.05	3.59	0.10	.1000	.0000
3	1.18	1.05	3.59	0.10	.1000	.0000
4	1.18	1.05	3.59	0.10	.1000	.0000
5	1.18	1.05	3.59	0.10	.1000	.0000
6	1.18	1.05	3.59	0.10	.1000	.0000
7	1.18	1.05	3.59	0.10	.1000	.0000
8	15.70	21.90	30.10	0.10	.1000	.0000
9	15.70	21.90	30.10	0.10	.1000	.0000
10	15.70	21.90	30.10	0.10	.1000	.0000
11	15.70	21.90	30.10	0.10	.1000	.0000

****
****

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION, continued.

INITIAL PROFILE DATA - EXCHANGEABLE CATIONS, CEC AND pH

****

DEPTH SEGMENT	Ca	Mg	Na	K	CEC	pH
	meq/kg					
1	365.00	150.00	75.00	5.00	595.00	7.70
2	375.00	160.00	55.00	5.00	595.00	7.70
3	375.00	160.00	55.00	5.00	595.00	7.70
4	375.00	160.00	55.00	5.00	595.00	7.70
5	375.00	160.00	55.00	5.00	595.00	7.70
6	375.00	160.00	55.00	5.00	595.00	7.70
7	375.00	160.00	55.00	5.00	595.00	7.70
8	375.00	160.00	55.00	5.00	595.00	7.70
9	375.00	160.00	55.00	5.00	595.00	7.70
10	375.00	160.00	55.00	5.00	595.00	7.70
11	375.00	160.00	55.00	5.00	595.00	7.70

****

****

****

SELECTIVITY COEFFICIENTS

****

SEGMENT	Mg/Ca	Ca/Na	Ca/K	Mg/K	Mg/Na	K/Na
1	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
2	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
3	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
4	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
5	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
6	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
7	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
8	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
9	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
10	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
11	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01

****

****

Soil Layer no.	Particle size distribution Clay %	Silt %	Rho kg/dm3	Organic carbon %	Conductivity matching factor Hydr. cond. mm/d	Matric pot'l kPa
1	38.	42.	1.20	1.0	732.	0.
2	55.	35.	1.20	1.0	732.	0.
3	55.	35.	1.30	1.0	732.	0.
4	55.	35.	1.30	1.0	732.	0.
5	55.	35.	1.30	1.0	732.	0.
6	55.	35.	1.30	1.0	732.	0.
7	55.	35.	1.30	1.0	732.	0.
8	42.	53.	1.35	1.0	732.	0.
9	42.	53.	1.35	1.0	732.	0.
10	42.	53.	1.35	1.0	732.	0.
11	42.	53.	1.35	1.0	732.	0.

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION, continued.

Particle density kg/dm3:	Clay	Sand	Organic matter
	2.65	2.65	1.10

Soil layer no.	Starting values: Pot'l or Theta kPa		Hydrological Characteristics: AEV kPa	BCAM	KS mm/d	Root fraction (for const root distr)
1	-1515.0	0.0000	-.100E+01	3.00	1000.	0.100
2	-1515.0	0.0000	-.100E+01	3.50	1000.	0.150
3	-1515.0	0.0000	-.100E+01	4.00	1000.	0.200
4	-1515.0	0.0000	-.100E+01	4.50	1000.	0.200
5	-1515.0	0.0000	-.150E+01	5.00	1000.	0.150
6	-1515.0	0.0000	-.200E+01	5.50	1000.	0.100
7	-1515.0	0.0000	-.240E+01	6.00	1000.	0.050
8	-1515.0	0.0000	-.270E+01	6.40	1000.	0.050
9	-1515.0	0.0000	-.290E+01	6.70	1000.	0.000
10	-1515.0	0.0000	-.300E+01	7.00	1000.	0.000
11	-1515.0	0.0000	-.300E+01	7.00	1000.	0.000

CROP DATA

Crop no	Planting	Emergence	Maturity Root	Maturity Plant	Harvest	Rel. root depth	Crop cover frac	Plants per sq. m	Pan factor
	...........Date or Day no								
1	010120	040120	060120	060120	110120	1.00	0.8	2.000	1.00
2	010121	040121	060121	060121	110121	1.00	0.8	2.000	1.00
3	010122	040122	060122	060122	110122	1.00	0.8	2.000	1.00

RAIN/IRRIGATION AND WATER COMPOSITION

STARTING TIME Date or Day no.	Tenth of day	AMOUNT mm	RATE mm/d	Ca (Cl) mmol/l	Mg (SO4) mmol/l	Na (HCO3) mmol/l	K mmol/l
011520	.2	7.0	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
021520	.2	11.0	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
030120	.2	25.4	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041820	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
042020	.2	33.0	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
042820	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
050520	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION, continued.

050620	.2	52.0	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051120	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
051620	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
052120	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
052720	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
060120	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
060520	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
060620	.2	28.0	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
060920	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
061320	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
061720	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
062220	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
062720	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
070320	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
070620	.2	32.0	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
070920	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
071520	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
072220	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
072920	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
080620	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
081020	.2	10.0	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081420	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
082120	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
083020	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
090720	.2	33.4	300.0	6.160E+00	2.060E+00	2.870E+01	.000E+00
				4.120E+00	1.146E+01	1.813E+01	
091020	.2	32.0	300.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION, continued.

```
091520    .2    33.4   300.0   6.160E+00 2.060E+00 2.870E+01  .000E+00
                               4.120E+00 1.146E+01 1.813E+01
092320    .2    33.4   300.0   6.160E+00 2.060E+00 2.870E+01  .000E+00
                               4.120E+00 1.146E+01 1.813E+01
093120    .2    33.4   300.0   6.160E+00 2.060E+00 2.870E+01  .000E+00
                               4.120E+00 1.146E+01 1.813E+01
101020    .2    33.4   300.0   6.160E+00 2.060E+00 2.870E+01  .000E+00
                               4.120E+00 1.146E+01 1.813E+01
101520    .2    31.0   300.0   0.000E+00 0.000E+00 0.000E+00  .000E+00
                               0.000E+00 0.000E+00 0.000E+01
102020    .2    33.4   300.0   6.160E+00 2.060E+00 2.870E+01  .000E+00
                               4.120E+00 1.146E+01 1.813E+01
103020    .2    33.4   300.0   6.160E+00 2.060E+00 2.870E+01  .000E+00
                               4.120E+00 1.146E+01 1.813E+01
111020    .2    33.4   300.0   6.160E+00 2.060E+00 2.870E+01  .000E+00
                               4.120E+00 1.146E+01 1.813E+01
111520    .2    18.0   300.0   0.000E+00 0.000E+00 0.000E+00  .000E+00
                               0.000E+00 0.000E+00 0.000E+01
121320    .2    12.0   300.0   0.000E+00 0.000E+00 0.000E+00  .000E+00
                               0.000E+00 0.000E+00 0.000E+01
**************************************************************************
                     FERTILIZER APPLICATIONS
                     -----------------------
     TIME          Ca          Mg          Na          K
   Start of       (Cl)        (SO4)      (HCO3)
  day number               ---------mol/sq.m---------
  ----------     --.----     --.----     --.----     --.----
   010220        00.0000       .0000       .0000     00.0000
                 00.0000     00.0000       .0000
**************************************************************************
**************************************************************************
   POTENTIAL ET (WEEKLY TOTALS, mm) AND DEPTH TO WATER TABLE (mm)
--------------------------------------------------------------------------

--------------------------------------------------------------------------
      WEEK NO.     ET    WATER TABLE
      ----------------------------
        1         0.5      0.
        2         0.5      0.
        3         0.5      0.
        4         0.5      0.
        5         0.5      0.
        6         0.5      0.
        7         0.5      0.
        8         0.5      0.
        9         1.0      0.
       10         1.0      0.
       11         1.0      0.
       12         1.0      0.
       13        10.7      0.
       14        10.7      0.
       15        10.7      0.
       16        10.7      0.
```

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION, continued.

17	10.7	0.
18	25.1	0.
19	25.1	0.
20	25.1	0.
21	25.1	0.
22	35.5	0.
23	35.5	0.
24	35.5	0.
25	35.5	0.
26	35.5	0.
27	41.2	0.
28	41.2	0.
29	41.2	0.
30	41.2	0.
31	34.0	0.
32	34.0	0.
33	34.0	0.
34	34.0	0.
35	34.0	0.
36	21.0	0.
37	21.0	0.
38	21.0	0.
39	21.0	0.
40	21.0	0.
41	10.2	0.
42	10.2	0.
43	10.2	0.
44	10.2	0.
45	0.5	0.
46	0.5	0.
47	0.5	0.
48	0.5	0.
49	0.5	0.
50	0.5	0.
51	0.5	0.
52	0.5	0.
53	0.5	0.
1	0.5	0.
2	0.5	0.
3	0.5	0.
4	0.5	0.
5	0.5	0.
6	0.5	0.
7	0.5	0.
8	0.5	0.
9	1.0	0.
10	1.0	0.
11	1.0	0.
12	1.0	0.
13	10.7	0.
14	10.7	0.
15	10.7	0.

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION, continued.

16	10.7	0.
17	10.7	0.
18	25.1	0.
19	25.1	0.
20	25.1	0.
21	25.1	0.
22	35.5	0.
23	35.5	0.
24	35.5	0.
25	35.5	0.
26	35.5	0.
27	41.2	0.
28	41.2	0.
29	41.2	0.
30	41.2	0.
31	34.0	0.
32	34.0	0.
33	34.0	0.
34	34.0	0.
35	34.0	0.
36	21.0	0.
37	21.0	0.
38	21.0	0.
39	21.0	0.
40	21.0	0.
41	10.2	0.
42	10.2	0.
43	10.2	0.
44	10.2	0.
45	0.5	0.
46	0.5	0.
47	0.5	0.
48	0.5	0.
49	0.5	0.
50	0.5	0.
51	0.5	0.
52	0.5	0.
1	0.5	0.
2	0.5	0.
3	0.5	0.
4	0.5	0.
5	0.5	0.
6	0.5	0.
7	0.5	0.
8	0.5	0.
9	1.0	0.
10	1.0	0.
11	1.0	0.
12	1.0	0.
13	10.7	0.
14	10.7	0.
15	10.7	0.

TABLE C-1. TYPICAL LEACHM INPUT FILE FOR ROOT ZONE SIMULATION, continued.

16	10.7	0.
17	10.7	0.
18	25.1	0.
19	25.1	0.
20	25.1	0.
21	25.1	0.
22	35.5	0.
23	35.5	0.
24	35.5	0.
25	35.5	0.
26	35.5	0.
27	41.2	0.
28	41.2	0.
29	41.2	0.
30	41.2	0.
31	34.0	0.
32	34.0	0.
33	34.0	0.
34	34.0	0.
35	34.0	0.
36	21.0	0.
37	21.0	0.
38	21.0	0.
39	21.0	0.
40	21.0	0.
41	10.2	0.
42	10.2	0.
43	10.2	0.
44	10.2	0.
45	0.5	0.
46	0.5	0.
47	0.5	0.
48	0.5	0.
49	0.5	0.
50	0.5	0.
51	0.5	0.
52	0.5	0.

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE.

```
CHEMTEST  ATM-WATER-SALINITY-PLANT-INTERACTION
SIMULATION PERIODS (Data must be present for each item, even if it not used)
_______________________________
Date type (US:1 UK:2)                       1
Starting date                          010105 Ending (date or day no.)          010175
Largest time interval (day) .1000E+00 Max.theta change/time st        .1000E-01
Read theta(1) or pot'l(2)                   2 Calc.sel.coeff? 0:no 1:yes               1
No. of water applications                 117 No. chemical applications                1
Cycles through data                         1 No. of crops                             9
K-Th-h from PSD:yes(1)no(0)                 1 Trace 1(on) 0(off)                       1
No. of time steps/chemeq                   40
__________________________________________________________________________________
PROFILE DETAILS
_______________
Profile depth       (mm)       .4400E+05 Bottom boundary condition                 2
Segment thickness (mm)         .4000E+04 :1 or 5.water table depth        .0000E+00
__________________________________________________________________________________
FOR UNIFORM PROFILE: (Any non-zero value here will override those in the
table of hydrological characteristics below unless K-Th-h calc. from PSD).
Soil bulk density Mg/cu.m      .0000E+00 Air -entry value' kPa          -.0000E+00
Exponent in Campbell's eq      .0000E+00 Sat'd K values (mm/day)         .0000E+00
__________________________________________________________________________________
FOR STEADY-STATE FLOW: (A non-zero water flux density will prevent calls to
the water flow subroutine, fix flux and theta and set ET to 0.
Steady state? y(1), n(0)               0
Water flux density (mm/d)      .1000e+03 Water content (theta)           .2500E+00
__________________________________________________________________________________
CROP DATA
_________
Plants present: 1 yes, 0 no            1 Wilting point (soil) kPa       -.1500E+04
Max(actual tran/potl tran)     .1100E+01 Min.root water pot'l(kpa)      -.3000E+04
Roots: Const(1):growing(2)             1 Max.root water pot'l(kpa)       .0000E+00
Root length (not used)         .5000E+03 Root flow resistance term       .1050E+01
__________________________________________________________________________________
DIFFUSION/DISPERSION
____________________
Molecular diffusion   | Do    .1200E+03 Dispersivity  (mm)              .1000E+03
coefficient (mm2/d)   | DIFA .1000E-02
(Bresler's [illegible])       | DIFB .1000E+02
__________________________________________________________________________________
NUMBER OF OUTPUT FILES                  2
  — .OUT file ————                         ——— .SUM file ————
                                           Summary print interval (d)          1
Node print frequency                    1 Three depth segments for the summary
Print options: 1, 2 or 3                2  file  (0's default to thirds of the
 1: Time intervals/print                1  profile)  (mm) :
 2: days/print                      365.0    Surface to [depth 1?]           000

 3: No. of prints (even)                4    Depth 1 to [depth 2?]           000
                                             Depth 2 to [depth 3?]           000
**************************************************************************
**************************************************************************
```

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE, continued.

TIMES AT WHICH *.OUT FILE IS DESIRED (if print option = 3)

Date or Day no.	Time of day (to nearest tenth)	Date or Day no.	Time of day (to nearest tenth)
122688	.2	122988	.6
010189	.5	010489	.0

****
****

INITIAL PROFILE DATA - SOLUBLE ANIONS AND pCO2

*****(HCO3 and CO3 will be determined by pCO2 and Ca levels)****

DEPTH SEGMENT	Cl (mmol/l)	SO4 (mmol/l)	HCO3 (mmol/l)	PCO2 atm.
1	1.24	0.44	1.44	.0030
2	1.15	5.15	1.15	.0030
3	1.15	5.15	1.15	.0030
4	1.15	5.15	1.15	.0030
5	1.15	5.15	1.15	.0030
6	1.15	5.15	1.15	.0030
7	1.15	5.15	1.15	.0030
8	1.15	5.15	1.15	.0030
9	1.15	5.15	1.15	.0030
10	1.15	5.15	1.15	.0030
11	1.15	5.15	1.15	.0030

****
****

INITIAL PROFILE DATA - SOLUBLE CATIONS, LIME AND GYPSUM

****

DEPTH SEGMENT	Ca (mmol/l)	Mg (mmol/l)	Na (mmol/l)	K (mmol/l)	Lime (fraction)	Gypsum (fraction)
1	1.41	0.59	0.60	0.10	.0000	.0000
2	1.18	1.05	3.59	0.10	.0000	.0000
3	1.18	1.05	3.59	0.10	.0000	.0000
4	1.18	1.05	3.59	0.10	.0000	.0000
5	1.18	1.05	3.59	0.10	.0000	.0000
6	1.18	1.05	3.59	0.10	.0000	.0000
7	1.18	1.05	3.59	0.10	.0000	.0000
8	1.18	1.05	3.59	0.10	.0000	.0000
9	1.18	1.05	3.59	0.10	.0000	.0000
10	1.18	1.05	3.59	0.10	.0000	.0000
11	1.18	1.05	3.59	0.10	.0000	.0000

****
****

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE, continued.

INITIAL PROFILE DATA - EXCHANGEABLE CATIONS, CEC AND pH

****

DEPTH SEGMENT	Ca	Mg	Na	K	CEC	pH
	meq/kg					
1	365.00	150.00	75.00	5.00	595.00	7.70
2	375.00	160.00	55.00	5.00	595.00	7.70
3	375.00	160.00	55.00	5.00	595.00	7.70
4	375.00	160.00	55.00	5.00	595.00	7.70
5	375.00	160.00	55.00	5.00	595.00	7.70
6	375.00	160.00	55.00	5.00	595.00	7.70
7	375.00	160.00	55.00	5.00	595.00	7.70
8	375.00	160.00	55.00	5.00	595.00	7.70
9	375.00	160.00	55.00	5.00	595.00	7.70
10	375.00	160.00	55.00	5.00	595.00	7.70
11	375.00	160.00	55.00	5.00	595.00	7.70

****

****

****

SELECTIVITY COEFFICIENTS

****

SEGMENT	Mg/Ca	Ca/Na	Ca/K	Mg/K	Mg/Na	K/Na
1	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
2	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
3	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
4	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
5	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
6	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
7	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
8	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
9	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
10	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01
11	.000E+01	.000E+00	.000E+00	.000E+00	.000E+01	.000E+01

****

****

Soil Layer no.	Particle size distribution Clay %	Silt %	Rho kg/dm3	Organic carbon %	Conductiv: Hydr. cond. mm/d	matching factor Matric pot'l kPa
1	38.	42.	1.35	1.0	732.	0.
2	55.	35.	1.35	1.0	3.	0.
3	55.	35.	1.35	1.0	3.	0.
4	55.	35.	1.35	1.0	3.	0.
5	55.	35.	1.35	1.0	3.	0.
6	55.	35.	1.35	1.0	3.	0.
7	55.	35.	1.40	1.0	3.	0.
8	55.	35.	1.40	1.0	3.	0.
9	55.	35.	1.40	1.0	3.	0.
10	55.	35.	1.40	1.0	3.	0.
11	55.	35.	1.40	1.0	3.	0.

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE, continued.

Particle density kg/dm3: Clay 2.65 Sand 2.65 Organic matter 1.10

	Clay	Sand	Organic matter
Particle density kg/dm3:	2.65	2.65	1.10

****

Soil layer no.	Starting values Pot'l or Theta kPa		Hydrological Characteristics AEV kPa	BCAM	KS mm/d	Root fraction (for const root distr)
1	-715.0	0.0000	-.100E+01	3.00	732.	1.000
2	-715.0	0.0000	-.100E+01	3.50	3.	0.000
3	-715.0	0.0000	-.100E+01	4.00	3.	0.000
4	-715.0	0.0000	-.100E+01	4.50	3.	0.000
5	-715.0	0.0000	-.150E+01	5.00	3.	0.000
6	-715.0	0.0000	-.200E+01	5.50	3.	0.000
7	-715.0	0.0000	-.240E+01	6.00	3.	0.000
8	-715.0	0.0000	-.270E+01	6.40	3.	0.000
9	-715.0	0.0000	-.290E+01	6.70	3.	0.000
10	-715.0	0.0000	-.300E+01	7.00	3.	0.000
11	-715.0	0.0000	-.300E+01	7.00	3.	0.000

****

CROP DATA

Crop no	Planting	Emergence	Maturity Root	Maturity Plant	Harvest	Rel. root depth	Crop cover frac	Plants per sq. m	Pan factor
	...........Date or Day no								
1	010105	040105	060105	060105	110105	1.00	0.8	2.000	1.00
2	010106	040106	060106	060106	110106	1.00	0.8	2.000	1.00
3	010107	040107	060107	060107	110107	1.00	0.8	2.000	1.00
4	010108	040108	060108	060108	110108	1.00	0.8	2.000	1.00
5	010109	040109	060109	060109	110109	1.00	0.8	2.000	1.00
6	010110	040110	060110	060110	110110	1.00	0.8	2.000	1.00
7	010111	040111	060111	060111	110111	1.00	0.8	2.000	1.00
8	010112	040111	188111	188112	110112	1.00	0.8	2.000	1.00
9	010113	040113	060113	060113	110113	1.00	0.8	2.000	1.00

****

RAIN/IRRIGATION AND WATER COMPOSITION

STARTING TIME Date or Day no.	Tenth of day	AMOUNT mm	RATE mm/d	Ca (Cl) mmol/l	Mg (SO4)	Na (HCO3)	K
041005	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051005	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061005	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071005	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE, continued.

081005	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
090105	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
041006	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051006	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061006	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071006	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
081006	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
090106	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
041007	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051007	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061007	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071007	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
081007	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
091007	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
041008	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051008	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061008	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071008	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
081008	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
091008	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
041009	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051009	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061009	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071009	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
081009	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
091009	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE, continued.

041010	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051010	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061010	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071010	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
081010	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
091010	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
041011	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051011	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061011	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071011	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
081011	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
091011	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
041012	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051012	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061012	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071012	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
081012	.2	100.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
091012	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
041013	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
051013	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
061013	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
071013	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
081013	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
091013	.2	345.0	200.0	8.230E+00	2.060E+00	1.521E+01	.000E+00
				6.770E+00	1.177E+01	5.570E+00	
041014	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061014	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE, continued.

081014	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041015	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061015	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081015	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041016	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061016	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081016	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041017	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061017	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081017	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041018	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061018	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081018	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041019	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061019	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081019	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041020	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061020	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081020	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041021	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061021	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081021	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041022	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061022	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081022	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041023	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE, continued.

061023	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081023	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041024	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061024	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081024	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041025	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061025	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081025	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041026	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061026	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081026	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041027	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061027	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081027	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041028	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061028	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081028	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041029	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061029	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081029	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041030	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061030	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081030	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041031	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061031	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081031	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE, continued.

041032	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061032	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081032	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041033	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061033	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081033	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
041034	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
061034	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	
081034	.2	40.0	50.0	0.000E+00	0.000E+00	0.000E+00	.000E+00
				0.000E+00	0.000E+00	0.000E+01	

****

FERTILIZER APPLICATIONS

TIME Start of day number	Ca (Cl)	Mg (SO4)	Na (HCO3)	K
		mol/sq.m		
------	--.----	--.----	--.----	--.----
010296	00.0000	.0000	.0000	00.0000
	00.0000	00.0000	.0000	

****

****

POTENTIAL ET (WEEKLY TOTALS, mm) AND DEPTH TO WATER TABLE (mm)

WEEK NO.	ET	WATER TABLE
1	0.5	0.
2	0.5	0.
3	0.5	0.
4	0.5	0.
5	0.5	0.
6	0.5	0.
7	0.5	0.
8	0.5	0.
9	1.0	0.
10	1.0	0.
11	1.0	0.
12	1.0	0.
13	10.7	0.
14	10.7	0.
15	10.7	0.
16	10.7	0.
17	10.7	0.
18	25.1	0.

TABLE C-2. LEACHM INPUT FILE FOR 44 METER PROFILE. continued.

19	25.1	Ø.
20	25.1	Ø.
21	25.1	Ø.
22	35.5	Ø.
23	35.5	Ø.
24	35.5	Ø.
25	35.5	Ø.
26	35.5	Ø.
27	41.2	Ø.
28	41.2	Ø.
29	41.2	Ø.
30	41.2	Ø.
31	34.0	Ø.
32	34.0	Ø.
33	34.0	Ø.
34	34.0	Ø.
35	34.0	Ø.
36	21.0	Ø.
37	21.0	Ø.
38	21.0	Ø.
39	21.0	Ø.
40	21.0	Ø.
41	10.2	Ø.
42	10.2	Ø.
43	10.2	Ø.
44	10.2	Ø.
45	0.5	Ø.
46	0.5	Ø.
47	0.5	Ø.
48	0.5	Ø.
49	0.5	Ø.
50	0.5	Ø.
51	0.5	Ø.
52	0.5	Ø.
53	0.5	Ø.

* Potential ET values repreated for a 30 year period as above.

15.11 PROJECTED MINING SCHEDULE

The Reno Creek ISL Project presently includes four planned mining units. A fifth potential mining area exists within the permit area, but this area is not presently included in the mine schedule due to the undefined extent of the reserves in this possible mining area. The mine units are labelled Mine Units I through V as shown on Plate 15.1, Mine Plan. *Plate 15.1 Shows the proposed outlines of each of the Mine Units; included within these limits will be the wellfield patterns, roads, pipelines, etc. associated with mining operations. The entire operations areas shown on Plate 15.1 are not representations of wellfield patterns, but rather represent the expected areas of operations activities.*

The sequence of production and restoration for the first four units is presented in Table *15.7* ~~15.2~~ If sufficient reserves are developed for mining in Mine Unit V, this is expected to add approximately two years to the mine schedule.

Table 15.7
RENO CREEK ISL PROJECT
MINE AND RESTORATION SCHEDULE

Year	Mine Unit In Production	Mine Unit In Restoration	Mine Unit In Reclamation
1	I	-	-
2	I	-	-
3	I & II & III	-	-
4	I & II & III	-	-
5	III & IV	I & II	-
6	III & IV	I & II & III	-
7	IV	III	I
8	IV	III & IV	II
9	-	IV	III
10	-	-	IV

The schedule shows that both mining and restoration take place in the same year in some mine units. This is due to cessation of mining and start up of restoration within the same year. Multiple mine units are also shown to be in production at the same time. This is the result of transition from one wellfield area to the next as production begins to decline in the earlier mine unit. The mine units do not all have the same mine life and this also contributes to the need to have multiple mine units in production at a given time.

Prior to injection of lixiviant in a given mining unit, EFNI will submit a request for wellfield authorization to the Wyoming DEQ-Land Quality Division. The Wellfield Data Package will include, at a minimum, the following data:

1. *Results of a pump test to demonstrate that the perimeter ore zone monitor wells are in communication with the production unit mineralized zone wells.*

2. *Potentiometric surface maps for the mineralized portion of the ore sandstone and the overlying aquifer(s) as developed from pre-mining water levels.*

3. *Baseline water quality data and proposed monitor well upper control limits.*

4. *Location and completion details for monitor wells and ore zone baseline water quality wells.*

5. *Average production unit baseline water quality and proposed restoration target values. Production unit baseline data packages will be submitted as supplemental information to the permit in the form of a separate volume.*

~~Prior to injection of lixiviant in a given mining unit, EFNI will submit a request for wellfield authorization to the appropriate regulatory agencies. The request for wellfield authorization will include the baseline water quality data for the excursion monitor wells and the pre-mining baseline wells. The request will be supported by geologic cross sections to demonstrate the correlation of mining and monitor zones as well as the separation of the overlying aquifer from the mining zone. The location of monitoring and sampling wells will also be shown with the request.~~

Upon exhaustion of the reserves in a mining unit, groundwater restoration will commence by initiating groundwater sweep. Approximately four pore volumes of groundwater sweep is planned, which will be followed by two pore volumes of groundwater treated by reverse osmosis. The net groundwater withdrawal rate for either of these operations is not expected to exceed 200 gpm. Restoration operations are described in detail in Section 17.1 of this application. The proposed reclamation procedures for the wellfields and plant installations are also described in Section 17.2.

15.12 TOPSOIL MANAGEMENT PLAN

All areas disturbed by mining activities will be reclaimed to the pre-mining land use of livestock grazing and wildlife habitat.

In situ mining activities vary from conventional mining in the type and extent of disturbance to the soil. Reno Creek ISL surface activities include the construction of recovery facilities, mine access roads, secondary mine access roads, radium treatment ponds, and irrigation reservoir and land application facilities. Other activities that effect relatively small areas include pipeline burial and mud pit and drill site location excavation. None of these activities results in the generation of overburden and most activities leave all but surface soil material in place.

For these reasons, EFNI will manage topsoil in the following manner. The A and B horizon of the soil will be removed and stockpiled for use in reclamation ~~for activities such as construction~~ of access roads, radium treatment ponds, recovery facilities and the irrigation reservoir. The average depth of the A and B horizons is presented in Table 11.1, and projected salvage volumes given. ~~All topsoil stockpiles will be protected from erosion and seeded with the temporary seed mix listed in Section 17.2.~~

The A and B soil horizon material (topsoil) stored for use during project reclamation will be placed in piles with sloped sides to facilitate material placement and seeding and to minimize erosion. Topsoil stockpiles will be marked with "Topsoil Stockpile" signs. Topsoil stockpiles will be seeded with the temporary seed mix presented in Section 17.2, and seed will be broadcast sown or drilled depending on the size of the stockpile being seeded.

For mud pit, drilling site leveling and pipeline burial, the following procedure will be followed. The A and B horizons will be scraped off the disturbance area and windrowed *or piled* separately from subsoil materials. *Segregation of topsoil during well drilling and pipeline construction is achieved by placing the topsoil and excavated subsoil materials on opposite sides of the excavation. In the case of pipeline trenching, topsoil might be placed at a greater distance from the trench, but on the same side as the subsoil material, to avoid placing the topsoil where it might be scattered due to pipeline laying equipment and activities.* ~~At the conclusion of construction activities, topsoil will be replaced on the surface of the disturbance area.~~ *This topsoil handling activity is temporary since pipeline trenches and mud pits will be backfilled and topsoil replaced immediately upon completion of surface activities. These temporary or short term disturbances will not be seeded nor marked with "Topsoil Stockpile" signs.* For the land application area, all topsoil will be left in place with the natural vegetative cover left in place.

All land surface will be reclaimed as described in Section 17.2.

The estimated amount of topsoil to be stripped and stockpiled from all disturbance areas is 48,385 cubic yards.

15.12.1 IDENTIFICATION OF TOPSOIL FOR SALVAGE

Based upon the soil assessment performed on site, the interface between B and C horizons should be readily identifiable in the field. A pale brown blocky clay depositional area, which often contains carbonates, exists in the transitional zone between B and C horizons. The color change (brown to grayish) and textural change (loam to silty clay or clay loam) will be the primary means of identifying soil for salvage in the field. Field sampling using a hand auger will also be utilized as a means of identifying approximate depths of A/B material prior to stripping.

16. ENVIRONMENTAL MONITORING AND REPORTING

16.1 GROUNDWATER MONITORING

16.1.1 EXCURSION MONITORING

16.1.1.1 GENERAL DESCRIPTION

Groundwater quality will be monitored during operations using ~~upper~~ *overlying* aquifer wells (vertical excursion monitor wells) and ~~lower~~ Ore Sand wells (horizontal excursion monitor wells). No Lower Aquifer wells are proposed *when mining is taking place in the Lower Ore Sand.* This is because a continuous aquitard consisting of mudstones and shales lies below the Lower Ore Sand. No continuous water bearing strata lies within 50 feet of the Lower Ore Sand within the proposed mining area. *A technical justification for the number and location of monitor wells will be provided in each Wellfield Data Package described in Section 15.10.* Discussion of the hydrogeologic system in relation to mining and environmental protection is included in Section 10.

Horizontal excursion monitor wells will be completed within the same stratigraphic unit as the ore body. The horizontal excursion wells will be in hydrologic communication with the mineralized portion of the mining zone.

Vertical excursion monitoring wells will be completed in the *next overlying aquifer above the zone being mined.* ~~water bearing sand above the confining aquitard, and will not be in hydrologic communication with the stratigraphic unit in which the ore body lies.~~ *The designation of the mining zone, the next overlying aquifer, and the overlying aquitard is specific for each Mine Unit. The hydrologic properties of each monitored unit will be evaluated in designing the monitor well network, locating monitor wells, and developing the Wellfield Data Package for each Mine Unit. As an example, in Mine Unit I, all mining presently planned will be in the Lower Ore Sand. The Lower Ore Sand is separated from the Upper Ore Sand throughout Mine Unit I by a claystone/shale unit 20 to 50 feet thick. Vertical excursion monitoring will be proposed for the Upper Ore Sand in this case.* Vertical excursion monitoring wells will be constructed at a density of approximately 1 well per 3 acres, as recommended in WDEQ-LQD Guideline #4, *February, 1990.*

Ore sand baseline monitor wells will also be located at a minimum density of 1 well per 3 acres of wellfield.

The spacing of horizontal monitor wells is based on aquifer estimated transmissivity, estimated storage coefficient, leakage, wellfield size, gradient of the ~~lower~~ Ore Sand, and projected wellfield bleed rate. Monitor well spacing will be determined for each wellfield. For the ~~initial~~ *Mine Unit I* wellfield, spacing was calculated using the method set forth in Attachment II, WDEQ-LQD Guideline 4, February, 1990. A discussion of the basis for horizontal excursion well spacing is presented in Section 10.5. Generally, spacing of horizontal wells will be approximately 800 feet apart on the side hydrologically up-gradient of the wellfield and 400 feet apart on the down gradient side of the wellfield*, and the ring of wells will be 400 feet from the edge of the mining area.*

Prior to lixiviant injection into any mining unit, EFNI will perform multi-well pump tests to confirm the relationship of monitor wells to the hydrologic system and gather site specific water quality information. Results of the pump test will be submitted to the WDEQ-LQD for review and comment. Approval of the specific wellfield baseline water quality and aquifer testing procedures (Wellfield *Data* Package) is recognized as requisite before in situ leaching begins.

EFNI will monitor six regional monitor wells on a semi-annual basis. These regional wells are distributed geographically across the permit area, and include both ore sand and upper aquifer monitor wells. The purpose of monitoring regional monitoring wells is to document *regional* baseline water quality ~~across the permit area,~~ and detect any changes in water quality. Refer to Section 10.5.4 for a discussion of regional groundwater monitoring.

16.1.1.2 BASELINE GROUNDWATER QUALITY FOR DETECTION OF EXCURSIONS

As part of the baseline Wellfield *Data* Package, EFNI will establish groundwater quality for a specific wellfield. Samples will be gathered from all perimeter monitor wells, ~~lower~~ Ore Sand baseline wells and ~~upper~~ *overlying* aquifer wells.

Samples will be collected according to Quality Assurance/Quality Control recommendations presented in WDEQ-LQD Guideline 8 (WDEQ, 12/90). This document is included as Attachment 16.1.

A minimum of one duplicate, blank and standard per sample campaign will be analyzed with wellfield samples. Baseline groundwater quality will be established by sampling ~~three~~ *four* rounds of samples from the wellfield a minimum of ~~two~~ *one* week apart. The first two baseline groundwater samples will be analyzed for the parameters listed in Table 16.1. The third *and fourth* sample will be analyzed only for those analyses that have been detected in water in the first two samples. Water levels in each well will also be *recorded* ~~collected~~.

Baseline water quality will be considered the mean of the baseline water quality samples for the wellfield.

16.1.1.3 EXCURSION ~~MONITOR WELL~~ *PARAMETERS* MONITORED DURING MINING

Horizontal and vertical excursion wells will be sampled ~~twice per month~~ *once every 14 days*. The excursion wells will be sampled for indicator excursion parameters only. These indicators are listed below.

Electrical Conductivity (EC)
~~Sulfates~~ *Chlorides*
~~Bicarbonate plus carbonate~~ *Total Alkalinity as* $CaCO_3$

Unless an excursion is detected, results of ~~twice monthly~~ sampling will be submitted in a Semi-Annual Effluent Report to the WDEQ-LQD and the NRC.

16.1.1.4 ~~EXCURSION REPORTING AND CORRECTIVE ACTIONS~~ *UPPER CONTROL LIMITS*

The horizontal and vertical excursion monitor wells in the operating mining unit will be sampled *once every 14 days* ~~twice a month~~ and analyzed for the three excursion parameters stated in the previous section (Specific Conductivity, ~~Sulfates~~ *Chlorides* and *Alkalinity as* $CaCO_3$ ~~Carbonate plus Bicarbonate~~). The Upper Control Limit (UCL) for ~~specific~~ *electrical* conductivity and ~~carbonate plus bicarbonate~~ *total*

TABLE 16.1 Reno Creek Permit **Baseline Water Quality Parameters** **(Units: mg/l Unless Otherwise Noted)**	
Temperature, degrees C, Field	Aluminum
pH, Units, Field	Arsenic
pH, Units, Lab	Barium
Conductivity, umhos/cm, Field at 25 degrees C	Cadmium
Conductivity, umhos/cm, Lab at 25 degrees C	Chromium
TDS, Evaporated at 180 C	Copper
Sodium	Iron
Potassium	Lead
Calcium	Manganese
Magnesium	Mercury
Sulfate	Nickel
Chloride	Selenium
Carbonate	Zinc
Bicarbonate	Molybdenum
Ammonia	Uranium as U_3O_8
Nitrate	Vanadium as V_2O_5
Fluoride	Radium 226, pCi/1
Boron	

Table 16.1 Baseline Water Quality Parameters

alkalinity as $CaCO_3$ for a mining unit will be established by adding five standard deviations to the mean of the baseline values for each category of well within a wellfield (i.e., horizontal and ~~upper~~ *overlying* aquifer monitor wells).

Chloride is found in relatively small concentrations in Upper Aquifer and Ore Sand waters. In order to minimize false excursion indications due to natural variability or analytical variability, the UCL will be the arithmetic mean of chloride concentration within a class of wells in a wellfield plus five standard deviations of the mean or the arithmetic mean plus 15 mg/l, whichever is greater.

Outliers in the baseline data will be eliminated for use in determining UCL's using the following statistical method:

1. *UCL parameter water quality data will be treated as a group. For example, if 40 wells are sampled and analyzed three times each for chloride, the 120 samples will be treated as a group.*

2. *A tolerance test (See Miller and Freund, Probability and Statistics for Engineers, 1965, Section 15.5 Tolerance Limits) will be applied in which P=0.95, x is the mean of the group of samples, and S is the standard deviation of the group sampled.*

3. *Samples falling outside the tolerance limits, as defined by the above test will be considered anomalous outliers and will be eliminated from use in determining the UCL.*

4. *If all samples from an individual well are eliminated by the above process, discrete UCL values are determined separately for this well.*

To ensure that the UCL's determined from the baseline data are accurate, the monitoring data collected at the onset of the operational monitoring program (at least the first two samples) will be compared with the appropriate UCL's and baseline data. In the event that the data collected at the onset of the operational monitoring program shows that the baseline water quality data and UCL's are not consistent with previously determined baseline values and UCL's, additional baseline water quality data will be collected and alternative UCL's will be proposed to the regulatory agencies.

16.1.1.5 EXCURSION REPORTING PROCEDURE

A horizontal or vertical excursion monitor well will be declared in an excursion status if a routine sample analysis and a confirmation sample (or second confirmation sample) analysis show that at least two of the three excursion parameters exceed their UCL's. A confirmation sample will be collected within ~~48~~ *24* hours of receiving the results of a routine sampling event that indicates a possible excursion (i.e., two of the three parameters exceed their UCL's). If the first confirmation sample does not indicate an excursion, a second confirmation sample will be collected within ~~48~~ *24* hours of receiving the results of the first confirmation sample. *If both confirmation samples are below UCL's for two of the three excursion parameters, the first sample will be considered an error and no other action taken.*

The WDEQ/LQD and the NRC will be notified via telephone within 24 hours of confirming an excursion, and a written report on the incident will be mailed to the same two agencies within seven days of confirming the excursion. The known details of the excursion, including available monitor well data, will be presented in the written report along with information on the corrective action(s) that are being taken to correct the situation. Thereafter, a monthly report will be submitted to the NRC and the WDEQ/DEQ on the status of the excursion along with ~~all pertinent data~~ *a detailed description of mitigation activities.* ~~The~~ Monthly reports will continue until the monitor wells in excursion status are no longer in excursion. ~~status~~

During the period when a monitor well is in excursion status, the problem well will be sampled once *every seven days* ~~each week~~. The analytical data from the weekly sampling of the monitor well on excursion status will be included in a monthly excursion report.

Corrective actions in the event of an excursion will normally consist of the following in order of application (i.e., if step one is not successful, step two will be initiated, and so on):

1. Adjust the flow rate of the injection and recovery wells in the affected area so as to increase the rate of drawdown in the area adjacent to the detected excursion.

2. Cease injection of lixiviant in the affected area but continue the pumping of recovery wells;

2a. *In the event of a confirmed vertical excursion, injection in the area of the excursion will cease, and wells in the vicinity of the excursion will be tested for mechanical integrity. If no leaking wells are discovered, old exploration holes (those not plugged with abandonment gel) will be located, re-entered, circulated down to the mining zone, and plugged with abandonment gel.*

3. Drill and complete additional wells in the affected area and either produce water from or inject clean water into the new wells (only after consultation with the DEQ).

16.1.2 RESTORATION MONITORING

16.1.2.1 GENERAL DESCRIPTION

The monitoring of ground water quality for aquifer restoration purposes will be accomplished by utilizing restoration sampling wells (RSW's). The restoration sampling wells will be injection and/or recovery wells that have been designated. Baseline water quality will be determined for a mining unit prior to mining. Each RSW will be sampled during the restoration and post-restoration phases of the wellfield operation to evaluate the restoration effort. There will be one restoration sampling well for every three acres of wellfield. The planned locations of the restoration sampling wells for each wellfield will be submitted to the regulatory agencies as part of the wellfield authorization package.

16.1.2.2 BASELINE GROUNDWATER QUALITY FOR RESTORATION WITHIN A MINING UNIT

Baseline water quality in connection with *the* restoration monitoring program will be established by collecting ~~three~~ *four* rounds of samples from each RSW with a minimum of ~~two~~ *one* week between sampling events. Each sample will be analyzed for the parameters listed in Table 16.1 taken from LQD/DEQ Guideline 8 (WDEQ, 12/90). Samples will be collected after pumping at least two casing volumes from the well being sampled. The samples will be filtered and preserved in the field and transported to the commercial laboratory. Samples will be taken following sampling protocols recommended in WDEQ/LQD Guideline 8 (WQED, 12/90).

Outliers within the baseline data set will be determined using the procedure outlined in Section 16.1.1.5.

The required restoration baseline groundwater quality data for a given mining unit will be submitted to and agreed upon by the appropriate regulatory agencies prior to injecting chemicals into the groundwater. The baseline groundwater quality data for each mining unit will be forwarded to the LQD/DEQ and NRC as soon as it is received and compiled by EFNI as part of the wellfield authorization request. The procedure for establishing restoration criteria from the baseline data is discussed in Section 17.1.

16.1.2.3 POST MINING RESTORATION SAMPLING AND REPORTING

After mining operations have completely ceased in a mining unit, restoration activities will be initiated by collecting a round of samples from the restoration sampling wells. ~~and~~ *Samples will be* analyzed for parameters in Table 16.1. Any parameter that was not detected during baseline sampling will be deleted from the restoration period parameter list if it is ~~also~~ not detected at the start of restoration sampling. The restoration sampling wells will be sampled and analyzed for the above ~~derived~~ reduced parameter list. Results will be submitted every six months for restoration sampling wells.

Once the concentration levels of the above parameters meet ~~the~~ restoration goals, a final round of samples will be collected from the restoration sampling wells and analyzed for the parameters shown in Table 16.1 (After WDEQ/LQD Guideline 8). The data from the restoration period sampling will be submitted to ~~the regulatory agencies~~ *WDEQ and NRC* for the purpose of verifying *and agreeing* that aquifer restoration has been achieved. If restoration success is not confirmed by the water quality data, restoration operations will continue. If restoration is successful, *and this is agreed upon by the WDEQ and NRC, the stability period will commence in a designated wellfield or portion of a wellfield.* ~~the restoration sampling wells will be sampled once every 3 months for the next six months to assess the water quality stability of the restored ore body aquifer.~~

16.1.2.4 STABILITY SAMPLING AND WELLFIELD RELEASE

Pumping within the wellfield (or portion) will cease during the restoration period. RSW's will be sampled at the start of the stabilization period and every 60 days thereafter for six months.

The first and final round of stabilization samples will be analyzed for the full set of parameters listed in Table 16.1. Intermediate samples will be for the reduced set of parameters used during restoration.

Analysis results will be provided to the WDEQ and NRC after four stability samples have been taken. If stability has not been demonstrated by sample analysis, the stability period will either be extended or active restoration operations reinitiated. A wellfield, or portion thereof, will be judged restored if groundwater restoration goals have been met. The WDEQ and NRC will be given a minimum one month advance notice of the scheduled final stability period sampling to allow split sampling. ~~The stability period samples will be analyzed for the reduced list of parameters described above for the restoration period monthly sampling. That is, parameters that were not detected during baseline and post mining water quality sampling will be dropped from the stability period sampling list.~~ The water quality *analysis* from the *entire* stability period will be forwarded to the regulatory agencies in order to obtain final approval of the restoration effort. ~~Restoration water quality commitments are presented in Section 17.1.~~

16.1.3 RADIUM SETTLING POND LEAK DETECTION SYSTEM

The Reno Creek ISL Project will utilize two radium settling ponds and an irrigation surge pond located south of the plant building. Details of the ponds showing the location and design are presented in Figure 15.2 and Figure 15.3. *Further description of the radium settling ponds is provided in the Application for Permit to Construct Wastewater Facilities, Reno Creek ISL Project Treatment Ponds, submitted to WDEQ-WQD in December, 1993.*

The leak detection system for the ponds consists of a series of underlying perforated PVC pipes designed to route any liquid leaked from the ponds to the sumps. Inspection tubes run from the buried sumps to the top of the embankments.

The inspection tubes from each pond will be checked once a week ~~check~~ for the presence of liquid. ~~If a level of liquid is present that is equal to the level of fluid in the pond, it will be chemically analyzed to verify from its composition that liner failure has occurred. If the failure is confirmed,~~ *If more than five gallons of liquid can be evacuated from the leak detection system, the liquid will be analyzed for the parameters in Table 16.1. If the water within the sump is confirmed to be similar in quality to that in the treatment ponds,* an attempt will be made to repair the leak while the liquid remains in the pond. If this procedure is not successful, the liquid in the pond ~~with the failure~~ will be evacuated and the leak will be repaired.

The weekly check of the sumps for liquid will also include an inspection of the condition of the pond embankments and liners by an appropriately trained employee. Inspections will be documented in writing and kept on file at the Reno Creek ISL Project office.

16.2 SURFACE WATER AND SEDIMENT MONITORING

As described in Section 10.2, the Belle Fourche River drains the northern and western portions of the proposed project area. Spring Creek, a tributary to the Cheyenne River, drains the southern and eastern portions of the permit. Two surface monitor stations, SW-2 and SW-4 have been established. SW-2 is north of the permit area and downstream of operations on the Belle Fourche River. SW-4 is located south of the permit on the Spring Creek drainage. Locations of the monitoring stations are shown on Plate 10.2-2. Analysis will be for the parameters listed in Table 16.1.

During operations, the water quality at the two surface water stations will be sampled and analyzed once each year during spring or early summer. The parameter list for operational water quality sampling will be for those parameters listed on Table 16.1. Sediment samples will be collected at the same time as the water quality samples. The sediment samples will be analyzed for the list of parameters appearing on Table 16.2. Samples will be taken from the top 15 cm of material. The operational water quality and sediment data collected from SW #2 and SW #4 will be submitted in the WDEQ/LQD Annual Report and NRC Semi-Annual Effluent Report. The operational surface water and sediment monitoring program will commence with the start of construction, and end when surface reclamation and aquifer restoration have been completed.

TABLE 16.2 Parameters for Sediment Analysis (mg/kg Unless Otherwise Designated)	
pH (paste)	~~Cu~~
Electrical Conductivity (mmhos/cm)	~~Mo~~
Na	Se
Ca	~~V~~
Mg	~~Zn~~
~~As~~	U-Nat
~~Ba~~	^{226}Ra (pCi/gm)
~~Cd~~	^{230}Th (pCi/gm)
~~Cr~~	

Table 16.2 Parameters for Sediment and Soil Analysis

16.3 SOIL AND SEDIMENT SAMPLING DURING OPERATIONS

16.3.1 ~~RADIOLOGICAL~~ *SOIL SAMPLING IN PROCESS AREAS*

~~16.3.1.1 SOIL SAMPLING IN PROCESS AREAS~~

The baseline radiological soil and sediment sampling program and laboratory analysis results are presented in Section 14. Stream channel sediments will be sampled as described in Section 16.2.

No ongoing soil sampling of wellfield and process areas will be performed. Radiological characterization of process areas will be performed as part of the decommissioning and reclamation of the site at the conclusion of operations. Ground water restoration and surface reclamation may take place in a phased manner, as described in Section 15.11 of the Mine Plan.

16.3.2 SOIL SAMPLING IN THE LAND APPLICATION AREA

During operation of the Reno Creek project, wellfield solutions will be produced from ~~several~~ *three* sources. These sources are bleed from the wellfield during ISL recovery (approximately 2% of total wellfield production), and groundwater sweep and reverse osmosis brine solutions produced during aquifer restoration operations. All wellfield solutions to be land applied will be treated for removal of radium prior to application. These solutions will be land applied through surface irrigation. The projected land application system, quantity and quality of solutions produced and environmental impacts are discussed in Section 15.10, Land Application of Wellfield solutions, *and in the Application for Permit to Construct Wastewater Facilities for Land Application submitted to WDEQ January 28, 1994.*

As part of the land application operation monitoring system, soils receiving irrigated water will be sampled at ~~four~~ *18* locations within the land application area. *Six of the soil sample locations characterize the major soil types within the permit area. Discussion of these samples is found in Section 11. Chemical and radiochemical analysis is found in Attachment 11.1-7. An additional 12 sample points will be located and sampled prior to starting land application operations. The additional twelve samples will be analyzed for the parameters in Table 16.2.*

One sample will be taken at each of the following intervals:

0"- 6"
6"-12"
12"-36"
36"-60"

Plate 16.1 shows the locations of existing and proposed monitor points. ~~Each location corresponds to a soil mapping unit within the application area. Soil will be sampled in 15 centimeter increments to a depth of 75 centimeters at each of the monitor sites. Soil will be analyzed for the list of parameters contained in Table 16.2. Soil sample locations are identified on Figure 16.1.~~ Soil samples will be collected ~~twice~~ *once* per year *in the late fall*. Results will be reported in the WDEQ-LQD Annual Report and Semi-Annual Effluent Report to the NRC.

The land application area is drained by Spring Creek, a tributary to the Cheyenne River. Sediment and surface water sampling station SW-4 is directly down-gradient from the land application area on the Spring Creek drainage. Collection schedules for surface water and sediment samples at SW-4 is described in Section 16.2.

16.4 VEGETATION SAMPLING

Vegetation will be sampled annually at four locations within the permit area. Two of the locations are located outside of areas to be affected by mining (VEG-1,VEG-2). The other two locations are located within the land application area (VEG-3,VEG-4). Sample locations are shown on Figure 16.1. Vegetation samples will be collected once per year at all locations. Only herbaceous material will be collected at each site. The vegetation will be collected as forbs, grasses and shrubs and analyzed separately. Differentiation by life form should detect preferential uptake of radionuclides or metals contained in solutions applied to the land application area, if it occurs. Vegetation will be analyzed for the list of parameters listed in Table 16.3. The samples will be collected during the growing season of each year. Results will be reported in the WDEQ-LQD Annual Report and the Semi-Annual Effluent Report to the NRC.

TABLE 16.3
Parameters for Analysis
For Vegetation
(mg/kilogram Dry Weight unless Otherwise Specified)

As	U-Nat
Se	^{226}Ra (pCi/g)
Cu	^{230}Th (pCi/g)
Mo	

Table 16.3 Parameters for Analysis within Vegetation

16.5 WILDLIFE MONITORING

To assess the response of wildlife to operations at Reno Creek, wildlife monitoring will be conducted annually. Most procedures to be followed are presented below by animal group. Also included in this section is a discussion of the Raptor Mitigation Plan, and procedures for monitoring wildlife use of settling ponds.

BIG GAME

One winter aerial survey for big game will be completed between 1 January and 15 March. The survey area will include the Reno Creek permit area and a one-mile perimeter. Standard aerial survey techniques will be employed. If a single observer conducts the survey flight, transects will be spaced at 1/2-mile intervals; if there are two observers in the plane, transects will be spaced at 1-mile intervals. Flight speed and altitude will be approximately 85 mph and 300 feet, respectively. The survey will be completed in January, if snow cover is 100% over 90% of the area. The survey will be completed in February or March if snow cover is 100% over 90% of the area or if snow cover is less than 10% over 90% of the area. If, during a given year, prescribed snow conditions do not occur during the 1 January through 15 March period, no big game survey will be conducted that year. Data gathered during aerial surveys will include the location of each sighting, species, number of animals seen, activity, and habitat type. Results of the winter big game surveys will be presented in tabular form and on a map in annual reports submitted the WDEQ/LQD.

UPLAND GAMEBIRDS

All suitable habitat on the permit area and a one-mile perimeter will be searched for new leks each spring. Lek searches will be conducted from late March through early May. Ground surveys will be employed to search for leks. Each morning search will be started at first light and last until 1.5 hours after sunrise. A biologist will search for leks by slowly traversing county, mine, ranch, and oil field roads in the area. Frequent stops will be made at vantage points to scan and listen for strutting birds. There are no known sage grouse leks on or within one-mile of the Reno Creek permit area. If a lek becomes established, it will be monitored annually on three mornings. Attendance counts will be made between dawn and one-half hour after sunrise, from April through early May.

The results of all upland gamebird surveys will be reported annually to WDEQ-LQD. All lek locations, including inactive leks, will be shown on a report map. Lek attendance will be reported as number of males and number of females observed.

RAPTORS

Surveys for nesting raptors will conducted annually on the Reno Creek permit area and a one-mile perimeter. When monitoring known nests or searching for new nests, guidelines recommended by Grier and Fyfe (1987) will be followed to prevent nest abandonment or loss of eggs or young. Searches will be conducted in March and April for golden eagle and great horned owl nests. Searches for nests of hawks, falcons, and other owls will be conducted from mid-May through June.

Nests will be found by traversing the study area, primarily by vehicle, and looking for pairs or individual adult raptors. Once spotted, birds will be observed until it can be determined if they are breeding in the area. If their behavior does not provide conclusive evidence about breeding status, birds will be approached on foot. If that causes the birds to display nest defense behavior, the surrounding area will be thoroughly searched for a nest. Nests will also be located by using a spotting scope to examine nesting habitat such as creek banks and rimrocks.

Whenever a nest is found, its location will be plotted on a 1:24000 topographic map. The status of all nests will be recorded annually. The productivity of active nests will be determined prior to fledgling.

Nesting raptor data will be presented annually to WDEQ/LQD. Comparisons with previous years' data will be made, and a table documenting history of all nests during the most recent five-year period will be presented. All nest locations will be shown on a wildlife monitoring map.

RAPTOR MITIGATION PLAN

Although it is likely that activities associated with the Reno Creek project will encroach on just one ferruginous hawk (Buteo regalis) ground nest, a Raptor Mitigation Plan for the mine is being developed. The plan will discuss existing raptor nests, and potential conflicts between raptor nesting and development of the Reno Creek Project. Proposals to mitigate any impacts on nests will be presented. Procedures for coordinating mitigation activities with the U. S. Fish and Wildlife Service Ecological

Services (Cheyenne) and Law Enforcement (Denver) Offices will also be outlined. Upon completion, the mitigation plan will be submitted to the USFWS, Ecological Services Office, Cheyenne, for review and comment. Upon its acceptance by USFWS, a copy of the mitigation plan will be inserted into a specifically-designated section of the LQD permit.

THREATENED AND ENDANGERED SPECIES

All observations of threatened and endangered species, except migrating and wintering bald eagles or migrating peregrine falcons, on or within one mile of the permit area, will be promptly reported to WDEQ/LQD and USFWS, Helena, Montana.

Bald Eagles

There are no bald eagle roosts on or within one mile of the Reno Creek permit area. Suitable roost habitat is also lacking in that area. Consequently, it is unnecessary to conduct specific surveys for roosts.

Black-footed Ferrets

Currently, there are no prairie dog colonies on or within one mile of the Reno Creek permit area. Any prairie dog towns that become established in or within 0.25 miles of an area slated for development, will be surveyed for black-footed ferrets one year prior to disturbance. Ferret surveys will be led by an individual certified by the USFWS. Procedures described in the BLM Handbook on Methods for Locating Black-footed Ferrets (1984) and the most recent USFWS guidelines will be followed. Prior to conducting searches, the USFWS Regional Endangered Species Office will be contacted to verify procedures.

Results of each survey will be submitted to USFWS for review and clearance. A copy of the survey results will be sent to WDEQ/LQD for review. Copies of ferret survey reports and associated correspondence will be included in the annual report to LQD.

WILDLIFE USE OF RADIUM SETTLING PONDS

The shorelines of settling ponds constructed at Reno Creek will be monitored monthly to document wildlife use and to determine if any wildlife mortalities have occurred. Any dead or emaciated birds or *other wildlife will be collected, labelled, and frozen. The Wyoming Game and Fish Department District III Office, Sheridan, will be notified promptly.*

LITERATURE CITED

BLM. 1984. Handbook of Methods for Locating Black-footed Ferrets. Wyoming BLM Wildlife Technical Bulletin No. 1. U.S. BLM, Cheyenne, WY. 55pp.

Grier J. W. and R. W. Fyfe. 1987. Preventing research and management disturbance. Pages 173-182 in B. A. Giron Pendleton, B. A. Millsap, K. W. Cline, and D. M. Bird, eds. Raptor management techniques manual. Natl. Wildl. Fed., Washington, DC.

~~A wildlife baseline study and inventory was prepared by Powder River Eagle Studies of Gillette, Wyoming and is presented in Section ?. The impact assessment based on field studies concludes that the project will have insignificant impacts on wildlife in the area. Six ferruginous hawk nests were identified within the permit area, however. One of these is located near the proposed affected area and may be impacted. This nest is located in the NE 1/4 SE 1/4, Section 29, T93N R73W. Energy Fuels Nuclear, Inc. will consult with the U.S. Fish and Wildlife Service to develop an acceptable mitigation plan for this nest prior to disturbance.~~

~~Energy Fuels Nuclear, Inc. will perform an annual raptor survey of the permit area and the area within 1 mile of current operations to identify occupied nests. No additional monitoring for wildlife is proposed because of the minimal impact the operation is expected to have on wildlife.~~

16.6 RADIOLOGICAL MONITORING

Environmental baseline studies characterizing natural radiation in the environment in the vicinity if the Reno Creek project are presented in Section 14 of this document. The radiological monitoring program carried out during operations is designed to detect increases in radiation due to uranium recovery activities at the Reno Creek project.

16.6.1 ENVIRONMENTAL THERMOLUMINESCENT DOSIMETRY

Environmental thermoluminescent dosimetry will continue at the site at the seven locations established for purposes of determining background gamma radiation. An additional monitoring station will be established downwind from the ion exchange facility prior to the commencement of recovery operations. TLD's will be collected on a quarterly basis. Results of the TLD analysis will be reported to the NRC in the Semi-Annual Effluent Report. Monitoring of gamma radiation will continue as long as recovery or aquifer restoration activities continue. The locations of environmental TLD monitoring sites are illustrated on ~~Figure~~ *Plate* 16.1 *and Plate 14.1*.

16.6.2 ATMOSPHERIC RADON-222 MONITORING

Atmospheric radon concentrations will be monitored using high sensitivity Rad-Trac cups containing sensitized chips allowing the determination of average radon concentrations. The monitoring sites will be at the same locations used for determination of baseline atmospheric concentrations of radon. An additional monitoring station will be established downwind from the ion exchange facility prior to the commencement of recovery operations. Monitoring of atmospheric radon concentrations will continue as long as recovery or aquifer restoration activities continue. The locations of Rad Trac monitor sites are illustrated on ~~Figure~~ *Plate* 16.1 *and Plate 14.1*.

16.7 LIQUID EFFLUENT MONITORING ASSOCIATED WITH LAND APPLICATION

16.7.1 POND AND IRRIGATION MONITORING

Energy Fuels Nuclear, Inc. proposes to land apply the solutions associated with the wellfield bleed during operation and groundwater sweep and reverse osmosis brine during restoration activities. Solutions will be treated to minimize concentrations of radium and uranium prior to land application.

The treatment process and facilities for radium are described in Section 15.12 of the Mine Plan. Uranium will be removed through passage of wellfield solutions through ion exchange columns. Radium will be precipitated with barium chloride and allowed to settle in the radium treatment ponds ~~and passed to an~~ *and the treated water will be decanted to the* irrigation reservoir prior to application. EFNI is limited to effluent release criteria for radionuclides listed in 10 CFR 20, Appendix B, Table 2, "Effluent Concentrations". If limits listed in Table 16.4 are exceeded, the NRC and WDEQ will be notified within 24 hours. Corrective action will be determined by EFNI in consultation with both agencies.

TABLE 16.4 Radionuclides Limits	
Radionuclide	Allowable Limit (Daily, Weekly, Yearly)
^{226}Ra	6 E 10^{-7} $\mu Ci/ml$
U-Nat	3 E 10^{-6} $\mu Ci/ml$

Table 16.4 Radionuclides Monitoring

EFNI will monitor for the radionuclides at the frequency listed on Table 16.4. Liquid effluent sampling point locations are illustrated on ~~Figure~~ *Plate* 16.1. Samples will be taken at the outfall of the final radium settling ponds (LF-1), and at the intake to the irrigation system located on the southeastern edge of the irrigation reservoir (LF-2). EFNI will sample LF-1 on a quarterly basis. LF-2 will be sampled and analyzed for radionuclides on a monthly basis, when the irrigation system is being used. LF-2 will be sampled and analyzed for the list of parameters listed on Table 16.1 on a quarterly basis.

Additionally, EFNI will keep a weekly record of the total number of gallons discharged through the irrigation system. This will be accomplished through the use of a totalizing meter within the water line to the irrigation system. The location of irrigation water application will be recorded as well. Location information will be recorded as the degrees within the circle irrigation pattern within which water was applied. Using this information a quarterly record of volume, location and average concentrations of monitored constituents will be generated. This information will be submitted to the WDEQ-LQD in the Annual Report and to the NRC in the Semi-Annual Effluent Report.

16.7.2 SHALLOW SOIL TENSIOMETERS

~~Two shall ground water~~ *Nine soil* tensiometers will be established in the land application area. The purpose of the shallow ~~wells~~ *tensiometers* will be to detect the presence of soil water below the root zone to maintain a leaching fraction of 20%. The ~~monitor wells~~ *tensiometers* will be completed to a depth of 6 feet. The tensiometers will be monitored on a weekly basis *for those areas under irrigation.* ~~and~~ Results *will be* reported in the Semi Annual Effluent Report to the NRC and Annual Report to the WDEQ.

16.7.3 UNSATURATED ZONE MONITOR WELLS

Two shallow monitor wells will be completed into unsaturated sands underlying the land application area. The unsaturated zone monitor wells will be located within the perimeter of the land application area in approximate locations shown on Plate 16.1. Shallow monitoring wells will be monitored for the presence of liquids on a semi-annual basis. If liquids are detected in the unsaturated zone monitor wells, the liquid will be analyzed for parameters in Table 16.1. Monitoring information will be submitted to WDEQ and NRC as part of the Semi-Annual Effluent Report.

16.8 SETTLING POND LEAK DETECTION SYSTEM

The design drawings and a description of the radium settling ponds ~~is~~ *are* provided in Section 15.9 and Plates 15.2 of this document. Two settling ponds and two leak detection systems will be constructed. Monitoring will take place once each week to detect any fluids within the leak detection sump. If *more than five gallons of* liquids are present in the leak detection sump, a determination of the quantity and quality of water within the sump will be made. If it is determined through chemical analysis of the liquids that liquids are pond solutions, the WDEQ and NRC will be notified within 24 hours of this confirmation. Necessary corrective action to repair the leak in the pond will be determined by EFNI in consultation with the regulatory agencies.

17. RESTORATION AND RECLAMATION PLAN

The objective of ground water restoration is to return, by employing best practicable technology, all affected ground water *within wellfields to average baseline water quality. If this cannot be achieved, affected waters will be returned to a quality consistent with premining ground water use categories.* ~~including affected water within the production zone to a condition such that its quality of use is equal to or better than, and consistent with, the uses for which the water was suitable prior to the operation.~~

The objective of surface reclamation is to restore the land to a condition equal to or greater than the previous highest use of the land.

The estimated costs associated with restoration, decommissioning and reclamation of the site are presented in detail in Section 17.4. The following narrative presents the basic assumptions upon which the restoration and reclamation estimate is based. Detailed assumptions are included as part of Section 17.4.

17.1 GROUND WATER RESTORATION SEQUENCE AND TIMING

Ground water restoration activities will commence immediately after production activities have concluded within a mining unit. Ground water restoration activities are planned to include the sequential use of ground water sweep and reverse osmosis to restore ground water quality. A projected schedule of mining, restoration and reclamation activities is provided in Table 15.3 contained in the Mine Plan section.

17.1.1 GROUND WATER QUALITY CLASSIFICATION

Characterization of ambient ground water quality has been performed for wells completed in the ore zone and the aquifer (when present) above the ore zone (Upper Aquifer). A summary and discussion of the results of ground water sampling is included in Section 10.3.5, Ground water Quality. Although considerable variability exists within the Ore Sand, water quality can be characterized as an alkaline water high in total dissolved solids and sulfates. Water within the Ore Sand has concentrations of radium ranging from an average per monitor well of 2.2 to 244 pCi/l. The overall average for the ten project monitor wells sampled for radium-226 is 62.1 pCi/liter (refer to Table 10.3-5). This average exceeds livestock water quality (Wyoming Class III water) within the ore zone. For parameters other than Ra-226, the ore zone water quality falls within Wyoming Class III suitability criteria. Ore zone water average sulfate concentrations exceed agricultural use (Class II) criteria in 21 of 23 project wells sampled for sulfate. For the above reasons, ground water within the projected mining zones at the Reno Creek project is expected to be classified as Class IV (a) industrial use water.

Upper Aquifer waters generally contain less Total Dissolved Solids and sulfates than the Ore Sand and do not exhibit Ra-226 concentrations over agricultural and domestic limitations. Therefore, Upper Aquifer water is expected to be classified as Wyoming Class III (Livestock) water because average sulfate concentrations exceed agricultural and domestic classifications.

17.1.2 RESTORATION - RESEARCH AND DEVELOPMENT

In 1980 and 1981, Rocky Mountain Energy (RME) performed a research and development pilot project at the Reno Creek Project site. Rocky Mountain Energy used the same mining process proposed by EFNI for the commercial scale Reno Creek in situ mine. Rocky Mountain Energy restored ground water within the research and development mining pattern to acceptable limits under both WDEQ and NRC criteria. Restoration was performed in generally the same manner as proposed by EFNI except that reverse osmosis technology was not utilized during pilot restoration activities. A copy of the RME Final Restoration Report is included in this document as Attachment 15.1.

17.1.3 RESTORATION DURING COMMERCIAL OPERATIONS

The concentrations of many dissolved constituents in wellfield ground water will be increased over baseline concentrations during operations and immediately after production activities have ceased. Review of the Final Restoration Report prepared by RME for the research and development project at the Reno Creek site provides a description of restoration activities performed during pilot testing. Increases in the concentration of five chemical constituents (U-nat, HCO3, Ca, Cl, and Electrical

Conductivity) are graphically represented in this report. Other constituents such as Na, Fe, other trace metals and radium-226 can be expected to increase as well.

EFNI will commence activities to restore the quality of ground water affected by production activities within a mining unit immediately upon cessation of production activities. Table 15.3, contained within the Mine Plan section, describes the project sequence of mining and restoration activities associated with the Reno Creek project. Restoration activities will consist of the following:

> After production activities have ceased in a mining unit, restoration will commence using ground water sweep of the former production zone. Ground water sweep is simply the withdrawal of ground water from the affected zone in order to remove contaminated water and draw fresh water from the surrounding formation into the affected zone. The process of drawing fresh water into the production zone also results in exchange of cations and anions from rock within the formation and the subsequent removal of cations. Water quality will be monitored frequently during ground water sweep to track the reduction of elevated constituents in the ground water. When the rate of reduction of constituents slows significantly, reverse osmosis technology will be implemented to remove remaining elevated constituents. Reverse osmosis may be implemented before a mining unit has completed ground water sweep in order to reduce restoration time.
>
> Reverse osmosis technology forces water through a semi-permeable membrane at high pressure. A major portion of the dissolved constituents in the ground water are retained on the upstream side of the membrane. The solute laden solution is then removed and pumped to the radium treatment ponds prior to land application. The process results in a dramatic reduction (more than 50%) in dissolved contaminants in the permeate recirculated through the wellfield. Reverse osmosis will continue until dissolved substances within the recirculated solution are returned to concentrations consistent with a water use equal to or greater than the use before mining. Using best practicable technology, the concentration of most dissolved constituents will be returned to background concentrations for the water within the wellfield. *Consideration will be given, and if appropriate, corresponding proposals will be made to the*

appropriate regulatory agencies, to employ alternative methods, including use of reductants if warranted, to complete restoration, notably to aid in reduction of trace metals. If, after implementation and use of best practicable technology, the average baseline concentrations within a mining unit cannot be achieved, then at a minimum affected waters will be returned to a quality consistent with the water use category. Background concentration of a constituent is defined as the arithmetic average of the pre-mining concentration of a dissolved constituent for ~~all~~ *restoration sampling* wells within the mining unit during designated baseline sampling. ~~plus three standard deviations of the mean.~~

After restoration activities have brought the concentrations of dissolved constituents down to the values described above, a final round of samples will be taken from designated restoration sampling wells to demonstrate the success of the restoration program. A[illegible] point, restoration activities will cease.

For each mining unit, a stabilization period of six months will follow restoration activities. A round of samples will be taken every ~~month~~ *60 days* for designated restoration parameters. *The WDEQ and NRC will be given at least one month notice of the final sampling round to allow for collection of split samples.* At the end of the six month monitoring period, the analytical information will be summarized and evaluated [illegible]tically to determine if any upward trends in concentrations of dissolved constituents exists. If no upward trend can be discerned, a report will be prepared requesting concurrence from the WDEQ and NRC on the success of restoration activities. Upon receiving notice of concurrence from both agencies, wells will be plugged and sealed in accordance with WDEQ standards and the surface reclaimed.

17.2 SURFACE RECLAMATION

17.2.1 POST-MINING LAND USE

The pre-mining land use in the Reno Creek project area is *agricultural land used for* grazing by domestic animals. *Utilization by wildlife is an important but secondary use of the land.* ~~and wildlife use.~~ The land will be returned to a condition suitable for *agricultural land.* ~~grazing and wildlife usage.~~ Process buildings and the irrigation reservoir may remain if the land owner, at the time of reclamation, wishes to assume ownership. For purposes of the reclamation plan, it has been assumed that all buildings and earthen structures will be removed, and the land returned to approximate pre-mining contours, and drainage patterns re-established.

17.2.2 CONTOURING PLAN

Areas requiring recontouring will be *in the* operations areas. Operations areas include the process plant and associated parking lot and outbuildings, major access roads, radium treatment ponds and the irrigation reservoir. These facilities are illustrated on Plate 15.1. After the conclusion of mining *and restoration,* all operations areas will be recontoured to the approximate land configuration prior to mining. Specifically, the following actions will be taken:

> Subsoil material forming on the bottom of the irrigation reservoir will be sampled and analyzed for soil suitability parameters contained in Table I of the WDEQ-LQD Guideline #1 (11/84). In addition to parameters within Table I, Radium-226 and U-nat concentrations will be determined for compliance with decommissioning criteria. If subsoil exceeds any of the chemical parameters (excluding textural) on Table I, the most feasible means to reduce chemical concentrations of any constituent to acceptable levels will be evaluated and implemented. If concentrations of radionuclides are exceeded, subsoil material will be excavated and disposed of at a facility licensed to receive by-product materials. The reservoir dam will be removed and used as part of the cover material for the reclamation of the irrigation reservoir. Then, topsoil salvaged during construction will be evenly distributed over the area previously covered with water.
>
> Residues within the radium treatment ponds will be removed from the ponds prior to recontouring. The radium treatment ponds drain to a lined sump to facilitate the washing and removal of solids and semi-solids. *Pond residues will be hauled from the site and disposed at a facility licensed to receive radioactive wastes, such as the White Mesa Mill near Blanding, Utah.* After removal of solids from the radium ponds, the

HDPE liner will be removed and disposed of off site, and the underlying compacted earth liner and leak detection systems sampled and tested for radiological contaminants (Ra-226 and U-nat). If the compacted earth liner is contaminated with radionuclides over the limits acceptable for release of the site for unrestricted use, contaminated materials will be removed and disposed of at a licensed facility. Portions of the compacted earth liner not contaminated with radionuclides will be ripped and buried in place. All pipes, liner and other debris determined to exceed criteria for release for unrestricted use will be excavated and disposed of in a facility licensed for receiving radioactive materials. The pond areas will then be recontoured and topsoil salvaged during construction spread evenly over the recontoured areas.

Concrete foundations associated with the process building will be broken. Subsoil and concrete will be sampled for radionuclides in accordance with NRC standards governing decommissioning. *Contaminated materials will be disposed in a facility licensed to receive radioactive wastes. Uncontaminated materials will be disposed in a licensed landfill.* ~~and disposed of either in a facility licenced to receive radioactive wastes or in a below-grade excavation on site.~~

Gravel surfaced parking areas and roads will be surveyed for radiological contamination. Subsoil materials found to contain concentrations of radionuclides in excess of decommissioning standards will be excavated and disposed of at a facility licensed to receive radioactive materials. After removal of contaminated materials, the gravel from the parking area will be scraped up and buried in the radium treatment pond excavation or other approved location on site.

Recontouring and reclamation of any wetlands identified in the wetlands inventory will be performed in a manner consistent with a Wetlands Mitigation Plan. The wetlands Inventory will be performed during the spring of 1994 and provided to the WDEQ as part of Section 13. The criteria for determining the presence of the wetlands will be the 1987 Corp of Engineers Technical Report Y-87-1.

17.2.3 WELLFIELD AND PLANT DISMANTLING

At the conclusion of the aquifer restoration stabilization period in a mining unit, wellfield piping and controls will be removed. Wells will be plugged and sealed according to standard procedures described in Section 17.3. Wellfield equipment will be handled in one of the following ways:

> Equipment will be monitored to determine the levels of total and fixed alpha and beta radiation. Decontamination procedures will be implemented to remove surface contaminants, as necessary. If equipment meets NRC criteria for release for unrestricted use, equipment will either be removed from the site for use at another facility or will be disposed of in *an offsite landfill.* ~~an on site solid waste facility.~~
>
> Equipment which does not meet NRC criteria for unrestricted use will be either transferred to another facility licensed for the production of source material or disposed of at a facility licensed for the disposal of radioactive waste.

All equipment will be removed from the process building and disposed of as described above. The process building itself will be dismantled, decontaminated and disposed of in the same manner.

17.2.4 REVEGETATION PRACTICES

17.2.4.1 TEMPORARY STABILIZATION OF DISTURBED LANDS

EFNI will utilize a temporary stabilization procedure for areas where re-disturbance of the area will occur one or more times before the end of mining. These areas include topsoil stockpiles and monitor well locations. The purpose of temporary stabilization is to stabilize the land surface and minimize soil erosion during mining activities.

Temporary stabilization will consist of the discing of disturbed areas, followed by the broadcast application of approximately 13 PLS thickspike wheatgrass and 13 PLS western wheatgrass per acre. After application of the seed, areas will be lightly raked using a harrow or hand implement. Temporary stabilization activities will take place in the fall or spring of the year when frost is not in the ground.

17.2.4.2 FINAL REVEGETATION PROCEDURES

Areas to be recontoured will be prepared for reclamation as discussed in Section 17.2.2. Other operations areas such as wellfields and secondary wellfield roads where topsoil has been left in place will be ripped and/or disced prior to seeding. After loosening the soil, areas will be seeded using the seed mix presented in Table 17.1. Seed will be applied at a rate of 15 PLS per acre and will be placed with a grass drill. If broadcast seeding is utilized, the rate of application will be doubled. The seed mix is made up of diverse grasses of both cool and warm season growth adapted to loamy and to sandy soil conditions. The grasses are all desirable forage species. No shrub species have been included in the reclamation mix because of the relatively small disturbance area *(maximum 250 acres)* associated

TABLE 17.1
FINAL RECLAMATION SEED MIX

COMMON NAMES	SCIENTIFIC NAMES	PLS/ACRES
Western wheatgrass	Agropyron smithii	3
Bluebunch wheatgrass	Agropyron spicatum	3
Thickspike wheatgrass	Agropyron dasystachyum	3
Prairie sandreed	Calamovilfa longifolia	2
Indian ricegrass	Oryzopsis hymenoides	2
~~Needle and thread~~	~~Stipa cometa~~	~~2~~
Green needle grass	*Stipa vitidula*	*2*
Total		15

Table 17.1

with mining activities which are surrounded by lands with significant big sagebrush growth. *Written* *consent forms from land owners acknowledging EFNI's intent not to include shrub species in the seed mix are contained in Attachment 17.2.*

Seeding activities will be conducted in the spring or fall when no frost is in the ground. Areas seeded as described above will be fenced and protected from grazing of domestic animals until it appears the cover can sustain grazing pressure. ~~The wellfield fence~~ *Reclaimed area fences* will be constructed using the Type I design described in WDEQ-LQD Guideline 10 (8/79).

17.2.4.3 SEEDING SURFACE OWNER CONSENT FORMS

Consent to reseed areas with a grass species mix only, and not a shrub species mix, have been sought from all of the owners of the surface estate within the permit area and from those who may have surface use rights within the permit area. A list of the parties from whom such consents were sought and each consent form received is attached to this application as Attachment 17.2.

17.2.5 EVALUATION OF RECLAMATION SUCCESS

17.2.5.1 RECLAMATION GOALS AND COMMITMENTS

The goal of reclamation is to return the land to a condition equal to or greater than its *pre-mining land uses.* ~~previous use.~~ The *pre-mining* ~~previous~~ use of the land at the Reno Creek project is ~~grazing for~~ *agricultural land used by* domestic animals and wildlife. The pre-mining vegetation is described in Section 12. EFNI will seek to accomplish the following more specific goals, *paraphrased from chapter III, Section d, Wyoming 1993 Non-Coal Rules and Regulations.*

Restore wildlife habitat commensurate with or superior to pre-mining habitat.

Establish a self renewing vegetative cover with species adapted to local soil and climatic conditions.

Establish a reclaimed vegetative cover equal to or greater than pre-mining cover measured in percent.

Establish *total* ground cover on reclaimed lands equal to or greater than the pre-mining ground cover measured in percent.

Establish a vegetative community that is equal to or greater than pre-mining *herbaceous* productivity.

Establish species diversity and species composition on reclaimed lands which support the post mining land use *under grazing pressure comparable to pre-mining grazing conditions*.

Stabilize the reclaimed area to minimize erosion *and retain soil moisture*.

17.2.5.2 PROCEDURES FOR EVALUATION OF RECLAMATION SUCCESS

EFNI proposes an alternate method for determining reclamation success, pursuant to Wyoming Land Quality Non-Coal Rules and Regulations, Chapter III, 2(d)(vi). The proposed alternate success standard fulfills the intent of the reclamation goals and objectives of the Wyoming Non-Coal Rules and Regulations, Chapter III, Section 2a(i), (ii) and (iii)

In order to evaluate the success of reclamation in accomplishing these goals, EFNI proposes *an alternate method* ~~the establishment of procedures~~ specific to the nature and types of disturbance associated with in situ mining. Revegetation evaluation procedures different than those for conventional mining are justified for several reasons. In situ mining normally results in disturbances smaller in areal extent than most conventional mining. Disturbances tend to extend over long areas compared to the width of disturbance. Also, in situ mining does not involve the deep excavation of soils and overburden to extract minerals and results in a less profound alteration of the soils available for reclamation on site. *Plate 15.1, Mine Plan shows the maximum extent of projected disturbance within wellfields. Only a portion of these areas will actually be disturbed as a result of wellfield construction.*

~~The following specific procedures are proposed for evaluation of reclamation success:~~

Extended reference areas (ERA) will be designated adjacent to disturbance areas. ERA's will surround disturbance areas as a halo and will contain the three vegetative mapping units identified in Section 12. The area around disturbance areas will be approximately 400 feet in width. ~~Projected~~ *The maximum extent of* disturbance areas and ERA are shown on Plate 12.1. In the event mining unit boundaries change from projected configurations, the ERA *boundaries* will be agreed upon by the WDEQ and EFNI. *Clear agreement on the boundaries of the ERA will be obtained prior to sampling and comparison of reclamation areas for bond release.* ~~through the Annual Report process.~~

At the time of final evaluation of reclamation success and bond release, vegetation will be sampled in reclaimed areas and ERA for percent cover by vegetative form and percent ground cover. The reclaimed area will be sampled and evaluated as one unit. A minimum of fifteen randomly selected point transects will be located in the reclaimed area and within the ERA in each of the two years of evaluation prior to bond release. Cover measurements will be used as background for evaluation of reclamation success. The cover information will be compiled and submitted in table form. The table will include the mean percent cover, relative percent cover, range of cover values, percent frequency and relative frequency for both the reclamation area and the ERA. This format has been utilized in the baseline vegetation inventory contained in Section 12. Cover information will not be used for a statistical comparison with baseline.

An inventory of plant species present within reclaimed areas and the ERA will be compiled as an aid in evaluating species diversity. A statement of grazing activity on site will be provided each year during at least the two years just prior to the evaluation for bond release. The statement will be included in the annual report and will include the approximate number of domestic animals grazing within a reclamation area, the type of animal, and the time period in which the animals grazed in the area, including the time of year. This information will be used by the WDEQ to determine the ability of the grazed area to sustain grazing. Photographic documentation will be provided to the WDEQ which supports adequate reclamation of the disturbed area.

EFNI will make a concerted effort to obtain the written approval of all land owners stating that in their opinion the land has been adequately reclaimed. All landowners will have the opportunity to participate in the field evaluation carried out by the WDEQ to determine reclamation adequacy. The field evaluation of reclamation adequacy will be subjective, based on non-quantitative evaluations of final bond release standards.

17.3 WELL ABANDONMENT PROCEDURE

EFNI will abandon all cased wells in accordance with WDEQ Water Quality Regulations. All production, injection and monitor wells will be plugged upon finalization of ground water restoration and stabilization. *Abandonment will consist of placing cement or high solids abandonment mud or abandonment pellets across and 50 feet above the completion interval in a well. Cement or high solids abandonment mud or abandonment pellets will also be placed in the upper 30 feet of wells. The 30-foot plug will either be suspended in a manner acceptable to the WDEQ and NRC or the interval between the completion zone plug and the surface plug will be filled with inert, non-toxic material (such as sand, gravel, scoria, etc.).* ~~Well plugging will involve preparing a slurry of cement and bentonite which weighs approximately 13 pounds per gallon, and pumping the slurry into the well casing. The weight of the cement will displace the water in the well and will fill the well bore with slurry. The casing will be filled to within two to four feet of the ground surface.~~ The well casing will be cut off at least two feet below the ground surface, and soil will be placed over the cemented casing.

If a hole is drilled in a wellfield, and is determined to be unacceptable or improperly located to be completed as a well, the hole will be plugged to the surface with high solids abandonment mud. A pre-cast concrete plug will be set in the top of the hole, at least two feet below the surface, and the remaining area will be filled with dirt. The hole location will be marked for possible future location; hole markers will be removed during final surface reclamation.

17.4 RECLAMATION BOND ESTIMATE

Estimates of ground water restoration and surface reclamation costs for the Reno Creek ISL Project are presented for two time periods. The restoration and reclamation cost has been estimated for the first year of activity and for all activity through the fifth year of the project.

The following assumptions are incorporated into the cost estimation:

1. The existing bond for the former Rocky Mountain Energy pilot building and site will be combined with the new bond so that there is only one bond for the project.

2. The one year cost estimate assumes that the operator abandons the site at the end of the first twelve months after commencement of project construction, and the regulatory agencies have to hire contractors to perform the decommissioning work. The five year cost estimate assumes site abandonment at the end of the fifth year of project operation.

3. The installed equipment on site at the end of the first and fifth years of operation is available for the contractor to use in performing the aquifer restoration and surface reclamation activities. This equipment includes the tanks, pipelines, pumps, electrical panels and distribution system, ponds, irrigator and buildings.

4. The cost estimates include decontamination of the main satellite plant building and the water treatment building. Decontamination for unrestricted use and transfer of the buildings to the landowner might be possible, as has been done at other ISL projects, but the estimate assumes demolition and reclamation.

5. After the first year of operation only about 13 acres of Mining Unit I will contain injection and recovery wells and a total of 336 wells will exist at the site. (Refer to Plate 15.1)

6. After five years of operation, a total of approximately 46 acres of operated wellfields will exist.

The cost estimates are presented in two segments for both the one year and the five year cases. The first segment is a general narrative description of the restoration and reclamation activities and a cost summary. The second segment is worksheets that detail the cost components and provides references for the cost parameters.

The cost estimates are presented in the following categories:

1. Ground water Restoration
2. Wellfield Abandonment & Reclamation
3. Plant Facilities Reclamation
4. Water Treatment Ponds & Irrigation Reservoir Reclamation
5. Other Structures and Facilities

17.4.1 BOND ESTIMATE - YEAR ONE

The first year of activity under the project permits and licenses will be to construct the satellite plant and water treatment facilities and to install and operate the initial wellfield. The first twelve months of project development will include about four months of construction, wellfield installation and startup activities. This will be followed by operation of the first 50-pattern mining block and construction of the second 50-pattern mining block approximately 6 months after the first block. As shown in the Worksheet, the actual number of patterns for the first 12 months is 116 which accounts for early shutdown of patterns in the first mining block.

The following numbered items correspond to the numbered items on the Bond Estimate Worksheet found in ~~*Appendix*~~ *Attachment* 17.1. The assumption and cost estimation parameters are elaborated and a cost summary for each component is presented in the text. ~~Cost calculation details are provided in the Bond Estimate Worksheet found in Attachment 17.1.~~

17.4.1.1 GROUND WATER RESTORATION

As previously mentioned, 116 patterns are assumed to be constructed by the end of the first year. The second group of patterns, following the first 50 patterns, may have only operated for a short time period, or perhaps not at all, depending on the productivity of the first 50 patterns. As a conservative assumption for this cost estimation it is assumed that all 116 patterns will undergo full restoration (i.e. 4 pore volumes of ground water sweep and 2 pore volumes of reverse osmosis treatment).

Pore Volume Parameters: 116 patterns, 4900 ft^2/pattern, 17 feet thick, 28% porosity.

Pore Volume = 20,237,768 gallons

Ground water Sweep Phase: 4 pore volumes, 250 gpm total withdrawal, 56 days/pore volume, 224 days total.

Reverse Osmosis Phase: 2 pore volumes, 500 gpm circulation rate, 28 days/pore volume, 56 days total.

Irrigation Operations: 400 gpm seasonal rate, 211 days to apply restoration solutions.

Stabilization Sampling: 6 monthly samples, 5 designated wells on the basis of 1 well per 3 acres of wellfield.

1.A	Ground water Sweep Phase	
	Electrical Cost	$4,019
	Chemical Cost	$7,993
	Labor Cost	$74,400
	Others Costs	$18,667
	Subtotal Ground water Sweep	$105,079
1.B	Reverse Osmosis Phase	
	Electrical Cost	$14,764
	Chemical Cost	$8,126
	Labor Cost	$19,200
	Others Costs	$4,667
	Subtotal Ground water Sweep	$46,757

1.C	Irrigation Operations	
	Electrical Cost	$4,598
1.D	Stabilization Sampling	
	Labor Cost	$300
	Analytical Cost	$4,500
	Total	$4,800
1.E	Equipment Cost	
	Pick-Up Truck	$5,000
	Pick-Up Truck with Pump Unit	$10,000
	Pump Reel	$5,000
	Cementer	$5,000
	Laboratory Equipment	$5,000
	500 gpm Reverse Osmosis	$250,000
	Total	$280,000

Ground water RESTORATION TOTAL COST = $441,234

17.4.1.2 WELLFIELD ABANDONMENT AND RECLAMATION

Plugging and abandonment of all pattern and monitor wells will be undertaken following ground water restoration and stabilization. The total number of wells to be abandoned is 166 production wells, 174 injection wells, 46 monitor wells in the initial mine unit, and 34 remaining regional monitor wells that are either not included in the initial monitor well network or have not been previously plugged and abandoned.

Well plugging includes the labor and materials costs to fill the well casings with cement slurry and cut off the casing.

Wellfield reclamation includes removal of header houses (piping manifold structures), removal of buried collection and distribution piping, removal of the electric supply lines, reclamation of wellfield access roads, removal of fences, and revegetation of disturbed areas within the active wellfield areas.

2.A	Well Plugging	
	Labor Cost	$18,500
	Materials Cost	$42,269
	Total	$60,769
2.B	Building Removal	
	Decontamination	
	Labor Cost	$1,250
	Equipment Rental	$513
	Demolition	$2,720
	Haul	$550
	Disposal	$312
	Total	$5,345
2.C	Buried Pipe Removal	
	Excavate	$12,146
	Removal & Loading - Labor Cost	$2,800
	Equipment Rental	$739
	Backfilling	$1,560
	Haul	$1,050
	Disposal	$800
	Total	$19,095
2.D	Electrical Removal	
	Cable Removal Labor Cost	$1080
	Starter Removal Labor Cost	$900
	Power Disconnect Labor Cost	$360
	Pole Removal Labor Cost	$360
	Equipment Rental	$910
	Haul	$22
	Disposal	$12
	Total	$3,644
2.E	Wellfield Road Reclamation	
	Gravel Removal	$343
	Ripping & Grading	$420
	Topsoil Replacement	$1,145
	Total	$1,908
2.F	Fence Removal	
	Fence Removal	$13,780
2.G	Revegetation	
	Ground Preparation	$1,818
	Seed	$850
	Seeding	$680
	Total	$3,348

WELLFIELD ABANDONMENT AND RECLAMATION COST = $107,888

17.4.1.3 PLANT FACILITIES RECLAMATION

Reclamation of the plant and facilities areas includes the satellite plant, water treatment building, radium removal ponds, and the irrigation reservoir. Reclamation of the old pilot plant building and site is also included in this category. Activity estimates include building decontamination, demolition, removal of fences and graveled areas, segregation and disposal of contaminated and uncontaminated wastes, regrading, topsoiling and revegetation.

3.A.1 Satellite Building Removal				
	Decontamination			
		Labor Cost		$2,200
		Equipment Rental		$530
	Demolition			$10,200
	Haul			$770
	Disposal			$375
			Total	$14,075
3.A.2 Tanks, Piping and Pumps				
	Decontamination			
		Labor Cost		$8,800
		Equipment Rental		$2,410
		Materials		$250
	Demolish & Load			
		Labor Cost		$12,880
		Equipment Rental		$3,752
	Haul			$1,086
	Disposal			$706
			Total	$29,883
3.A.3 Satellite Electrical				
		Labor Cost		$1,900
		Equipment Rental		$670
		Haul		$110
		Disposal		$9
			Total	$2,689
3.A.4 Satellite Foundations				
	Decontamination			
		Labor Cost		$1,320
		Equipment Rental		$246
		Materials		$450
	Demolition			$6,850
	Haul			$1,956
	Disposal			$1,384
			Total	$12,206

3.B.1	Water Treatment Building Removal		
	Decontamination		
		Labor Cost	$880
		Equipment Cost	$164
	Demolition		$3,672
	Haul		$330
	Disposal		$183
		Total	$5,229
3.B.2	Tanks, Piping and Pumps		
	Decontamination		
		Labor Cost	$3,080
		Equipment Rental	$843
	Demolish & Load		
		Labor Cost	$4,600
		Equipment Rental	$1,340
	Haul		$336
	Disposal		$211
		Total	$10,410
3.B.3	Water Treatment Electrical		
		Labor Cost	$1140
		Equipment Rental	$402
		Haul	$110
		Disposal	$6
		Total	$1,658
3.B.4	Water Treatment Foundations		
	Decontamination		
		Labor Cost	$880
		Equipment Rental	$164
		Materials	$150
	Demolition		$2,672
	Haul		$745
	Disposal		$529
		Total	$5,139
3.C.	Office Building Removal		
		Gutting	$5,166
		Demolition	$3,060
		Haul	$330
		Dispose	$165
		Total	$8,721
3.D.	Fence Removal		
		Fence Removal	$2,830

3.E. Plant Site Reclamation		
	Gravel Removal	$722
	Ripping & Grading	$450
	Replace Topsoil	$1,806
	Seed	$150
	Seeding	$120
	Total	$3,248
3.F Reclaim Warehouse and Site		
	Resin Disposal	$10,283
	Building Removal	$16,821
	Haul	$990
	Disposal	$363
	Fence Removal	$5,910
	Gravel Removal	$563
	Ripping and Grading	$218
	Replace Topsoil	$469
	Seed	$73
	Seeding	$58
	Miscellaneous	$205
	Total	$35,952

Note: Regional monitor well plugging included with Wellfield Abandonment and Reclamation.

17.4.1.4 WATER TREATMENT PONDS AND IRRIGATION RESERVOIR

The water treatment ponds for radium removal and the irrigation reservoir will be removed and reclaimed at project closure. This will entail removal of sludge from the treatment ponds, removal of the pond liners and leak detection systems, backfilling and recontouring, and revegetation of the site.

The irrigation reservoir will be reclaimed by removing ditches and diversions and removing the dam by distributing the dam material back into the pond basin. Topsoiling and revegetation will be undertaken on all disturbed areas with the reservoir site.

4.A	Water Treatment Ponds			
		Fence Removal		$1,037
		Sludge & Liner Removal		
			Labor Cost	$2,880
			Equipment Rental	$1,971
		Leak Detection Removal		
			Labor Cost	$960
			Equipment Rental	$657
		Radiation Surveys		
			Labor Cost	$240
			Analyses	$500
		Backfilling		
			Equipment Rental	$9,720
		Reclamation		
			Topsoil	$2,420
			Seed	$200
			Seeding	$160
		Haul		$24,833
		Disposal		$18,920
			Total	$64,497
4.B	Irrigation Reservoir			
		Ditch & Diversion Removal		
			Equipment Rental	$1,775
		Remove Dam		
			Equipment Rental	$37,625
		Reclamation		
			Topsoil	$12,370
			Seed	$1,000
			Seeding	$800
			Total	$53,570

17.4.1.5 OTHER STRUCTURES AND FACILITIES

Removal and reclamation of trunk lines and the access road is included upon project closure. The irrigation area reclamation includes removal of the irrigation equipment and reclamation of the runoff catchments. Miscellaneous expenses are estimated for final closure activities during surface reclamation. A monthly estimate is provided, which is an extension of the monthly costs for utilities, fuels, laboratory supplies, etc. that was included with the restoration phase.

5.A Trunklines		
	Excavation	
	Equipment Rental	$4,731
	Remove & Decontaminate	
	Labor Cost	$5,320
	Equipment Cost	$2,689
	Materials	$618
	Backfilling	
	Equipment Cost	$365
	Haul	$8,755
	Dispose	$6,450
	Seed	$50
	Seeding	$40
	Total	$29,018

5.B Powerlines - Tri County Electric keeps service line.

5.C Access Road		
	Gravel Removal	$435
	Ripping & Grading	$195
	Replace Topsoil	$542
	Seed	$65
	Seeding	$52
	Total	$1,289
5.D Irrigation Site		
	Remove Irrigator	$2,124
	Grading	$1,630
	Seed	$250
	Seeding	$200
	Total	$4,204
5.E Miscellaneous		
	Miscellaneous	$10,000

BOND ESTIMATE SUMMARY - YEAR ONE

Ground water Restoration	
Ground water Sweep Phase	$105,079
Reverse Osmosis Phase	$46,757
Irrigation	$4,598
Stabilization Sampling	$4,800
Equipment Costs	$280,000
Total	$441,234
Wellfield Abandonment and Reclamation	
Well plugging	$60,769
Surface Reclamation	$47,120
Total	$107,888
Plant Facilities Reclamation	
Satellite Building	$58,854
Water Treatment Building	$22,437
Office Building	$8,721
Surface Reclamation	$6,078
Warehouse Removal and Reclamation	$35,952
Total	$132,041
Water Treatment Ponds and Irrigation Reservoir	
Water Treatment Ponds	$64,498
Irrigation Reservoir	$53,570
Total	$118,067
Other Structures and Facilities	
Trunklines	$29,018
Access Road	$1,289
Irrigation Site	$4,204
Miscellaneous	$10,000
Total	$44,510
Subtotal	* $843,740
Contingency - 15%	$126,561
Contractors, Profit, Overhead, Mobilization - 10%	$84,374
Project Design & Document Preparation - 2%	$16,875
Insurance, Accounting, Monitoring - 2.5%	$21,094
Subtotal	$248,903
TOTAL - YEAR ONE	* $1,092,644

* **Totals contain rounding adjustments**

17.4.2 BOND ESTIMATE - YEAR FIVE

At the end of the fifth year of activity at the Reno Creek Project, all plant and facilities will be operating at capacity, mining will have advanced into the first three mining units, wellfields will be under construction in the fourth mining unit, and restoration will be in progress in the first mining unit. The total number of patterns installed is estimated to be 489, and 449 of these are estimated to have been put into production .

As was presented in the bond estimation for the end of the first year, the following numbered items correspond to the numbered items on the Bond Calculation Worksheet Attachment 17.1. A cost summary is presented in the text, and cost calculation details are provided in the worksheet.

17.4.2.1 GROUND WATER RESTORATION

A total of 489 patterns are estimated to have been installed by the end of the fifth year; 449 of these are estimated to have actually had lixiviant circulated in them. The estimated total volumes of ground water for restoration, based on 4 pore volumes of ground water sweep followed by 2 pore volumes of reverse osmosis treatment, are as follows:

Pore Volume Parameters: 449 patterns, 4,900 ft^2/pattern, 17 ft thick, 28% porosity, pore volume = 78,334,121 gallons.

Ground water Sweep Phase: 4 pore volumes, 250 gpm total withdrawal, 868 days total.

Reverse Osmosis Phase: 2 pore volumes, 500 gpm circulation rate, 218 days total.

Irrigation Operations: 400 gpm seasonal rate, 817 days to apply restoration solutions.

Stabilization Sampling: 6 monthly samples, 17 designated wells on the basis of 1 well per 3 acres of wellfield.

1.A	Ground Water Sweep Phase	
	Electrical Cost	$15,574
	Chemical Cost	$30,939
	Labor Cost	$289,200
	Others Costs	$72,333
	Subtotal Ground water Sweep	$408,047
1.B	Reverse Osmosis Phase	
	Electrical Cost	$57,474
	Chemical Cost	$31,450
	Labor Cost	$73,200
	Others Costs	$18,167
	Subtotal Ground water Sweep	$180,290
1.C	Irrigation Operations	
	Electrical Cost	$17,804
1.D	Stabilization Sampling	
	Labor Cost	$1,020
	Analytical Cost	$15,300
	Total	$16,320
1.E	Equipment Cost	
	Pick-Up Truck	$10,000
	Pick-Up Truck with Pump Unit	$15,000
	Pump Reel	$5,000
	Cementer	$5,000
	Laboratory Equipment	$5,000
	500 gpm Reverse Osmosis	$250,000
	Total	$290,000

GROUND WATER RESTORATION TOTAL COST = $912,461

17.4.2.2 WELLFIELD ABANDONMENT AND RECLAMATION

Plugging and abandonment of all pattern and monitor wells will be undertaken following ground water restoration and stabilization. The total number of wells to be abandoned is 489 production wells, 735 injection wells, 98 monitor wells, and 34 remaining regional monitor wells that are either not included in the monitor well network or have not been previously plugged and abandoned.

Well plugging includes the labor and materials costs to fill the well casings with cement slurry and cut off the casing.

Wellfield reclamation includes removal of header houses (piping manifold structures), removal of buried collection and distribution piping, removal of the electric supply lines, reclamation of wellfield access roads, removal of fences, and revegetation of disturbed areas within the active wellfield areas.

2.A	Well Plugging			
			Labor Cost	$67,800
			Materials Cost	$154,909
			Total	$222,709
2.B	Building Removal			
		Decontamination		
			Labor Cost	$2,500
			Equipment Rental	$1,025
		Demolition		$5,440
		Haul		$1,100
		Disposal		$624
			Total	$10,689
2.C	Buried Pipe Removal			
			Excavate	$51,204
			Removal & Loading - Labor Cost	$12,000
			Equipment - Rental	$3,168
			Backfilling	$6,607
			Haul	$4,410
			Disposal	$3,360
			Total	$80,749
2.D	Electrical Removal			
			Cable Removal Labor Cost	$4,320
			Starter Removal Labor Cost	$3,780
			Power Disconnect Labor Cost	$720
			Pole Removal Labor Cost	$900
			Equipment Rental	$2,736
			Haul	$110
			Disposal	$46
			Total	$12,612
2.E	Wellfield Road Reclamation			
			Gravel Removal	$1,825
			Ripping & Grading	$2,265
			Topsoil Replacement	$6,084
			Total	$10,174
2.F	Fence Removal			
			Fence Removal	$54,140

2.G Revegetation		
	Ground Preparation	$7,691
	Seed	$3,760
	Seeding	$3,008
	Total	$14,459

WELLFIELD ABANDONMENT AND RECLAMATION COST = $405,531

17.4.2.3 PLANT FACILITIES RECLAMATION

Reclamation of the plant and facilities areas includes the satellite plant, water treatment building, radium removal ponds, and the irrigation reservoir. Reclamation of the old pilot plant building and site is also included in this category. Activities estimates include building decontamination, demolition, removal of fences and graveled areas, segregation and disposal of contaminated and uncontaminated wastes, regrading, topsoiling and revegetation.

3.A.1 Satellite Building Removal		
	Decontamination	
	Labor Cost	$2,200
	Equipment Rental	$530
	Demolition	$10,200
	Haul	$770
	Disposal	$375
	Total	$14,075

3.A.2 Tanks, Piping and Pumps		
	Decontamination	
	Labor Cost	$8,800
	Equipment Rental	$2,410
	Materials	$250
	Demolish & Load	
	Labor Cost	$12,880
	Equipment Rental	$3,752
	Haul	$1,086
	Disposal	$706
	Total	$29,883

3.A.3 Satellite Electrical		
	Labor Cost	$1,900
	Equipment Rental	$670
	Haul	$110
	Disposal	$9
	Total	$2,689
3.A.4 Satellite Foundations		
	Decontamination	
	Labor Cost	$1,320
	Equipment Rental	$246
	Materials	$450
	Demolition	$6,850
	Haul	$1,956
	Disposal	$1,384
	Total	$12,206
3.B.1 Water Treatment Building Removal		
	Decontamination	
	Labor Cost	$880
	Equipment Cost	$164
	Demolition	$3,672
	Haul	$330
	Disposal	$183
	Total	$5,229
3.B.2 Tanks, Piping and Pumps		
	Decontamination	
	Labor Cost	$3,080
	Equipment Rental	$843
	Demolish & Load	
	Labor Cost	$4,600
	Equipment Rental	$1,340
	Haul	$336
	Disposal	$211
	Total	$10,410
3.B.3 Water Treatment Electrical		
	Labor Cost	$1140
	Equipment Rental	$402
	Haul	$110
	Disposal	$6
	Total	$1,658

3.B.4 Water Treatment Foundations		
	Decontamination	
	Labor Cost	$880
	Equipment Rental	$164
	Materials	$150
	Demolition	$2,672
	Haul	$745
	Disposal	$529
	Total	$5,139
3.C. Office Building Removal		
	Gutting	$5,166
	Demolition	$3,060
	Haul	$330
	Dispose	$165
	Total	$8,721
3.D. Fence Removal		
	Fence Removal	$2,830
3.E. Plant Site Reclamation		
	Gravel Removal	$722
	Ripping & Grading	$450
	Replace Topsoil	$1,806
	Seed	$150
	Seeding	$120
	Total	$3,248
3.F Reclaim Warehouse and Site		
	Resin Disposal	$10,283
	Building Removal	$16,821
	Haul	$990
	Disposal	$363
	Fence Removal	$5,910
	Gravel Removal	$563
	Ripping and Grading	$218
	Replace Topsoil	$469
	Seed	$73
	Seeding	$58
	Miscellaneous	$205
	Total	$35,952

Note: Regional monitor well plugging included with Wellfield Abandonment and Reclamation.

17.4.2.4 WATER TREATMENT PONDS AND IRRIGATION RESERVOIR

The water treatment ponds for radium removal and the irrigation reservoir will be removed and reclaimed at project closure. This will entail removal of sludge from the treatment ponds, removal of the pond liners and leak detection systems, backfilling and recontouring, and revegetation of the site.

The irrigation reservoir will be reclaimed by removing ditches and diversions and removing the dam by distributing the dam material back into the pond basin. Topsoiling and revegetation will be undertaken on all disturbed areas with the reservoir site.

4.A	Water Treatment Ponds			
		Fence Removal		$1,037
		Sludge & Liner Removal		
			Labor Cost	$2,880
			Equipment Rental	$1,971
		Leak Detection Removal		
			Labor Cost	$960
			Equipment Rental	$657
		Radiation Surveys		
			Labor Cost	$240
			Analyses	$500
		Backfilling		
			Equipment Rental	$9,720
		Reclamation		
			Topsoil	$2,420
			Seed	$200
			Seeding	$160
		Haul		$24,833
		Disposal		$18,920
			Total	$64,497
4.B	Irrigation Reservoir			
		Ditch & Diversion Removal		
			Equipment Rental	$1,775
		Remove Dam		
			Equipment Rental	$79,726
		Reclamation		
			Topsoil	$19,705
			Seed	$1,375
			Seeding	$1,100
			Total	$103,856

17.4.2.5 OTHER STRUCTURES AND FACILITIES

Removal and reclamation of trunk lines and the access road is included upon project closure. The irrigation area reclamation includes removal of the irrigation equipment and reclamation of the runoff catchments. Miscellaneous expenses are estimated for final closure activities during surface reclamation. A monthly estimate is provided, which is an extension of the monthly costs for utilities, fuels, laboratory supplies, etc. that was included with the restoration phase.

5.A Trunklines

Excavation	
Equipment Rental	$24,388
Remove & Decontaminate	
Labor Cost	$26,600
Equipment Cost	$13,446
Materials	$3,186
Backfilling	
Equipment Cost	$1,825
Haul	$43,966
Dispose	$33,218
Seed	$200
Seeding	$160
Total	$146,988

5.B Powerlines - Tri County Electric keeps service line.

5.C Access Road

Gravel Removal	$435
Ripping & Grading	$195
Replace Topsoil	$542
Seed	$65
Seeding	$52
Total	$1,289

5.D Irrigation Site

Remove Irrigator	$2,124
Grading	$1,630
Seed	$250
Seeding	$200
Total	$4,204

5.E Miscellaneous

Miscellaneous	$20,000

BOND ESTIMATE SUMMARY - YEAR FIVE

Ground water Restoration	
Ground water Sweep Phase	$408,047
Reverse Osmosis Phase	$180,290
Irrigation	$17,804
Stabilization Sampling	$16,320
Equipment Costs	$290,000
Total	$912,461
Wellfield Abandonment and Reclamation	
Well plugging	$222,709
Surface Reclamation	$182,822
Total	$405,531
Plant Facilities Reclamation	
Satellite Building	$58,853
Water Treatment Building	$22,436
Office Building	$8,721
Surface Reclamation	$6,078
Warehouse Removal and Reclamation	$3,595
Total	$132,041
Water Treatment Ponds and Irrigation Reservoir	
Water Treatment Ponds	$64,497
Irrigation Reservoir	$103,856
Total	$168,354
Other Structures and Facilities	
Trunklines	$146,988
Access Road	$1,289
Irrigation Site	$4,204
Miscellaneous	$20,000
Total	$172,480
Subtotal	* $1,790,867
Contingency - 15%	$268,630
Contractors, Profit, Overhead, Mobilization - 10%	$179,087
Project Design & Document Preparation - 2%	$35,817
Insurance, Accounting, Monitoring - 2.5%	$44,772
Subtotal	$528,306
TOTAL - YEAR FIVE	* **$2,319,173**

* Totals contain rounding adjustments

18. U.S. NUCLEAR REGULATORY COMMISSION

18.1 RADIATION AND SAFETY PROGRAM

18.1.1 CORPORATE STRUCTURE

The EFNI corporate organizational structure as it relates to the planned uranium mining activities at the Reno Creek ISL Project is presented in Figure 18.1. A discussion of corporate ownership is presented in Section 1.3 of this document. The positions identified on the organizational chart have various responsibilities relating to operations and radiation safety. These responsibilities are discussed in the following Sections. The minimum requirements of personnel responsible for operations and safety at the Reno Creek ISL Project are presented at the end of Section 18.7.

EFNI will maintain an office on the Reno Creek Project. This office will be supported by the Denver corporate office.

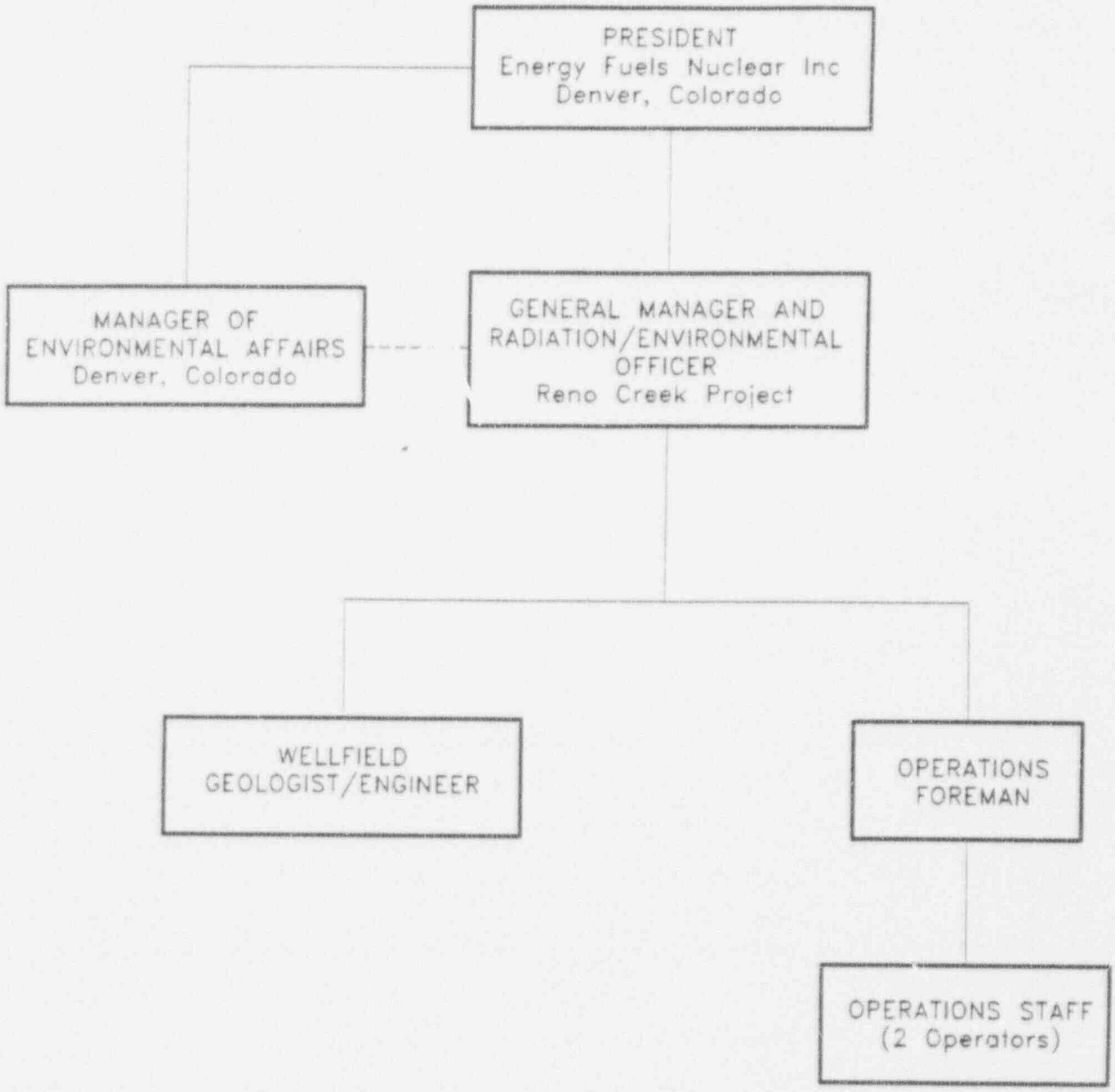
18.1.1.1 PRESIDENT, ENERGY FUELS NUCLEAR, INC.

The President of EFNI has overall responsibility for all mining operations conducted by the company in the United States. The corporate offices for EFNI are located in Denver, Colorado. The President has the ultimate responsibility for ensuring that mining operations are conducted in a safe manner and in full compliance with the law.

18.1.1.2 GENERAL MANAGER AND RADIATION SAFETY AND ENVIRONMENTAL OFFICER

The Reno Creek ISL Project is small relative to other existing and proposed in situ projects in the Powder River Basin. For this reason, the functions of the General Manager and Radiation Safety and Environmental Officer (GMRSEO) will be combined.

The General Manager and Radiation Safety and Environmental Officer (GMRSEO) is responsible for the day to day operations that will take place at the Reno Creek ISL Project. The GMRSEO will be responsible for developing, implementing and monitoring all operating procedures. The General Manager must ensure that all operating procedures conform to the requirements of the radiation safety



energy fuels nuclear inc.

Project	RENO CREEK ISL PROJECT
County	Campbell
State	Wyoming
Location	T 43 N, R 73 W
Revisions (Date / By)	

RENO CREEK IN-S[illegible]
MINING ORGANIZATIONAL CHAR[illegible]

18-2

Scale	N/A
Date	Oct. 1993
File	rc-org
Author	
Drafted By	D. L. Siedd

Figure: 18.1

and environmental protection programs. The GMRSEO is also responsible for ensuring that all operations and activities conducted at the mine are performed in a safe manner. This individual has the authority to suspend or terminate any activities that may be dangerous to personnel or damaging to the environment. The GMRSEO reports directly to the President of EFNI in Denver, Colorado. The GMRSEO will communicate with the Manager of Environmental, Health and Safety in Denver on a regular basis on matters pertaining to health, safety and the environment. The Manager of Environmental, Health and Safety will support the GMRSEO in reporting and quality control functions.

The GMRSEO is responsible for the development, implementation, and day to day supervision of the radiation, safety and environmental programs at the Reno Creek ISL Project. The GMRSEO is responsible for ansuring that all mining operations comply with license conditions and with the law. This individual has direct responsibility for radiation and general safety training. Through personal inspections and monitoring, the GMRSEO will ensure compliance with the radiation safety program. The GMRSEO also has the responsibility of keeping the President and the Manager of Environmental Affairs (Corporate) advised as to the status of the radiation safety program.

The GMRSEO will also be assisted by the wellfield Geologist/Engineer in the collection and reporting of all environmental data. Environmental sample data includes, but is not limited to, wellfield compliance sampling, regional groundwater sampling and surface water sampling.

18.1.1.3 WELLFIELD GEOLOGIST/ENGINEER

The Wellfield Geologist/Engineer will have ongoing responsibilities, including the calculation of wellfield reserves, interpretation of geologic data as it relates to uranium recovery and environmental monitoring, well completions and wellfield engineering. The Wellfield Geologist/Engineer will report directly to the GMSREO.

18.1.1.4 OPERATIONS FOREMAN AND STAFF

The Operations Foreman and staff are responsible for the maintenance and operation of wellfield and plant equipment. All operations personnel will be trained in radiation and industrial aspects of their jobs. The Operations Foreman reports directly to the GMRSEO.

18.1.1.5 MANAGER OF ENVIRONMENTAL AFFAIRS, HEALTH AND SAFETY

The Manager of Environmental Affairs, Health and Safety (MEAHS) located in the EFNI Denver office will be responsible for quality control and quality assurance of the radiation protection and environmental monitoring programs. The MEAHS will perform formal audits of radiation and environmental monitoring programs according to the Inspection and Audit Program described in 18.1.3. Additionally, the MEAHS will maintain regular and frequent communications with the GMRSEO to keep the Reno Creek staff current with regulatory changes and to offer licensing support and to ensure quality control on the site.

18.1.2 OPERATIONS MANUAL AND SPECIAL WORK PERMITS

Prior to the start of mining operations at the Reno Creek ISL Project, EFNI will develop and finalize an Operations Manual which will contain operating procedures for all mining activities at the site. The procedures will include appropriate safety requirements relating both to radiological and non-radiological matters. The operating procedures will also cover non-process activities such as environmental sampling, laboratory assays, quality assurance programs, etc. All operating procedures will be approved by the GMRSEO and the MEAHS. The Operations Manual will be reviewed annually. Any changes to the manual will be approved by the GMRSEO and the MEAHS. A copy of the Operations Manual will be located in the operations office at the Reno Creek Project site and at the Denver Office.

A Radiation Work Permit (RWP) will be issued for any non-routine maintenance or mining activity not covered in the Operations Manual where the potential for radiation exposure exists. The RWP will detail the required radiation safety and monitoring requirements, the equipment and any special clothing needed to safely complete the task. The RWP will be issued and signed by the GMRSEO.

18.1.3 INSPECTION AND AUDIT PROGRAM

The internal inspection and audit program at the Reno Creek ISL Project will consist of the following:

- Monthly

The GMRSEO or his trained assistant will conduct a monthly inspection of the processing plant building to determine the general radiation and non-radiation safety condition of the plant and the on going operations. The monthly inspection will be documented in writing. Any problem areas or items of non-compliance will be brought to the attention of the GMRSEO and the MEAHS. The GMRSEO will prepare a written monthly report to the President and the MEAHS describing the radiation safety status of the Reno Creek ISL Project. The Monthly Report will include a discussion of all radiation monitoring and exposure data for the month. Any actual or potential safety problems will be presented in the report and a comparison of the radiological data to the ALARA (As Low As Reasonably Achievable) program will be made in order to define any unsatisfactory trends. If deemed necessary, the GMRSEO will make recommendations in the Monthly Report to improve the general or radiation safety programs.

- Bi-Annually

EFNI will complete a Bi-Annual ALARA Audit which will include an inspection of the facilities and radiation records, and the preparation of a written report. The written report will be forwarded to the NRC. The audit team will consist of the GMRSEO and the MEAHS. Copies of the Bi-Annual ALARA Audit report will be forwarded to the President of EFNI.

The Bi-Annual ALARA Audit team will review the following:

1. Bioassay results;
2. Employee exposure records;
3. Training records;
4. Visitor and inspection logs;
5. Radiological monitoring data;
6. Safety meeting reports;
7. Over exposure reports;
8. Approved changes in operating procedures; and
9. Quality assurance program.

The Bi-Annual ALARA Audit report will discuss any trends in personnel exposures and, if appropriate, suggest changes that will further reduce the potential radiation exposure to employees. Where possible, recommendations regarding the overall improvement int he ALARA program will be presented in the report.

18.1.4 GENERAL MANAGER AND RADIATION SAFETY AND ENVIRONMENTAL OFFICER QUALIFICATIONS

The GMRSEO will at a minimum have the technical qualifications specified in U.S. N.R.C. Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be as Low as is Reasonably Achievable."

18.1.5 RADIATION AND SAFETY TRAINING PROGRAM

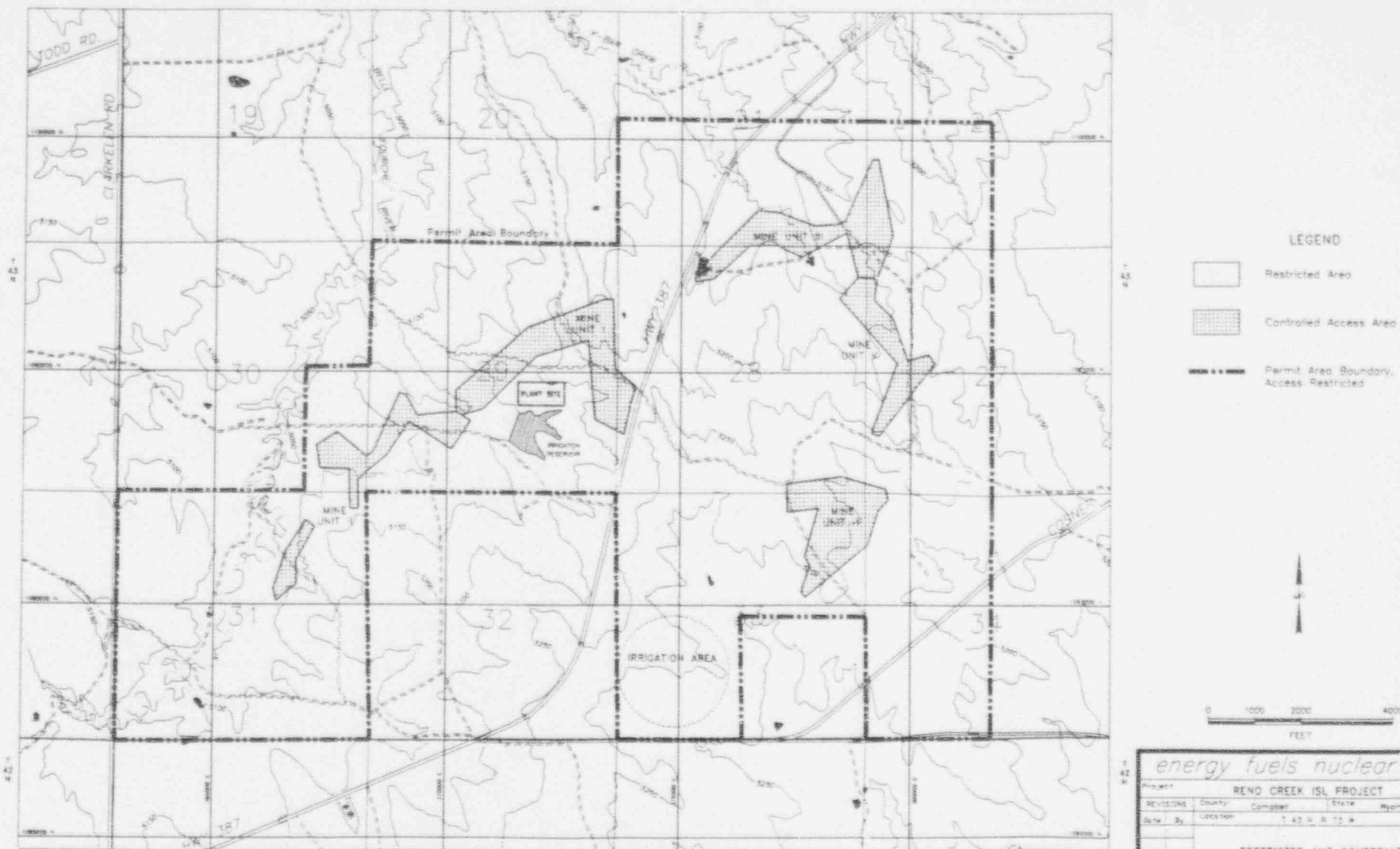
All site employees will receive radiation and general safety training that complies with NRC and MSHA regulations. Specifically, training will be performed according to the EFNI Radiation Safety Manual which incorporates the elements of radiation training specified in U.S. N.R.C. Regulatory Guide 8.31.

18.1.6 SITE SECURITY

EFNI intends manned operation of the Reno Creek In Situ Project seven days a week during daylight hours. An automated control system which automatically shuts down all active portions of the wellfield and process circuits in the event of a pressure buildup or loss will ensure minimization of spills during hours of unmanned operation. The automated system will notify the GMRSEO and/or the designated operations supervisor of the system shut down by pager. Upon notification of shut down, a Reno Creek supervisor will investigate the reason for the shut down and take appropriate action.

Process areas include the process plant and radium settling ponds. These areas constitute the only "Restricted Areas" as defined in 10 CFR 20. These areas will be posted with signs identifying the area as a "Restricted Area" and will be enclosed within a 5-strand barbed wire fence to exclude livestock and unauthorized personnel. Restricted and Control Areas are designated on Figure 18.2. Wellfields will be considered controlled access areas and will be fenced to exclude livestock.

Additionally, access points to the WDEQ-LQD permit area will be controlled through use of locking gates. The entire permit area is designated as a "control area" as defined in 10 CFR 20. The entrance



energy fuels nuclear inc.

Project	RENO CREEK ISL PROJECT		
REVISIONS	County: Campbell	State: Wyoming	
Date / By	Location: T 43 N R 73 W		
	RESTRICTED AND CONTROLLED ACCESS AREAS		
	Scale: 1"=2000'	Date: Oct. 1993	
	Author:	Draftsman:	

Figure [illegible]

to the processing area will have a sign which reads "Any Area or Building Within This Facility May Contain Radioactive Materials."

18.1.7 PERSONNEL RADIATION MONITORING PROGRAM

18.1.7.1 SOURCES AND CONTROL OF EFFLUENT

The proposed satellite in situ mining operation at the Reno Creek site consists of only the ion exchange, lixivant make-up and wellfield circuits since the product shipped from the site is uranium loaded resin. No precipitation, drying or packaging of yellowcake is planned for the Reno Creek operation. Accordingly, the only potential radioactive airborne effluent for the operation is radon gas. Radon gas dissolved in the groundwater is released from the solution when exposed to the atmosphere.

Wellfield solutions are under pressure and are not exposed to the atmosphere except at three points in the process.

1. Radium settling ponds;
2. Resin Transfer Tank (Solution Only); and
3. Wellfield Injection Wells.

Figure 18.3 illustrates the location of these contribution points as used in the MILDOS-AREA Model discussed in Section 18.8. By far the largest contributor to radon gas in the environment is the primary radium solids settling pond. Of the total release of radon over the life of the project, 88% is estimated to originate from this location. The resin transfer tank will have a volume of 7,000 gallons resulting in barren wellfield solution exposed to the atmosphere. This tank will be vented to the atmosphere through the roof of the process building. A small contribution of radon to the environment is from Armstrong vents at injector well sites. A detailed presentation of radon release assumptions and modeled impacts is presented in Section 18.8.

18.1.7.2 GAMMA SURVEYS

On a quarterly frequency, EFNI will perform gamma exposure rate surveys inside the satellite facility at the resin transfer station and in the vicinity of the ion exchange columns. Additionally, walk-through scanning gamma surveys will be performed frequently and documented whenever a spill or occurrence which has the potential for increasing external exposures has taken place. Prior to the start of mining operations, a gamma survey will be conducted at a number of locations within the plant building to establish background radiation levels. The action level for gamma exposure rate surveys will be 1.0 mR/hr at which point the RSEO will conduct an investigation to locate and correct the problem. Once the action level has been exceeded, the frequency of gamma measurements will be increased to monthly until the values are less than 0.5 mR/hr. Records of gamma surveys and any gamma survey related investigations will be maintained at the site. Any areas in the plant with gamma radiation levels high enough to be designated a "Radiation Area" as defined in 10 CFR 20 will be posted and access restricted. Gamma surveys within a "Radiation Area" will be conducted quarterly.

Additionally a gamma survey outside of trailers containing organic resin onsite will be conducted monthly and recorded, as required by NRC license conditions for License SUA-1558.

18.1.7.3 PERSONNEL THERMOLUMINESCENT DOSIMETRY

Environmental TLD's will be monitored on a quarterly basis. Environmental TLD's will be placed at the seven locations established for gamma baseline purposes. An eighth location will be established at the southeast corner of Section 20, T43N, R73W.

Personal external gamma radiation exposure monitoring will be performed by the use of thermoluminescent dosimeter (TLD) badges. The badges will be read on a quarterly basis for all EFNI employees assigned to work at the Reno Creek satellite facility. Records of personnel TLD readings will be maintained at the site. If two consecutive quarterly TLD badges indicate gamma radiation exposures in excess of 10% of the occupational total effective dose equivalent (500 Mrem) specified in 10 CFR 20, measures will be taken to reduce the exposure.

18.1.7.4 BIOASSAY PROGRAM

The bioassay program at the satellite Reno Creek ISL Project will consist of only urinalysis since the uranium is shipped in a wetted form and is not dried on site. A urine sample will be collected from each site employee on a monthly basis and analyzed for natural uranium. Each new employee will be sampled for a urine specimen prior to reporting to work to establish his/her uranium background concentration. EFNI will use the NRC urinalysis action levels of 15 ug U/liter and 35 ug U/liter specified in U.S. N.R.C. Guideline 8.22, Revision 1.

18.1.7.5 AIRBORNE URANIUM PARTICULATE MONITORING

Airborne uranium particulate levels at the Reno Creek satellite facility should be very low since no precipitation, drying or packaging of yellowcake will take place on site. Additionally, the uranium will be transferred and shipped in a wetted state. One location near the resin transfer station will be sampled monthly for airborne uranium particulates. The action level for airborne uranium particulates will be the Derived Air Concentration (DAC) for uranium found in Appendix B, Table 1, Footnote 3. This will be determined through gross alpha counting of high volume pump filters.

18.1.7.6 RADON DAUGHTER SURVEYS

Radon daughter surveys at the Reno Creek satellite facility will be performed on a monthly basis at one location in the building near the resin transfer station. If radon levels exceed one working level month (WLM) per quarter for two consecutive quarters, investigation of the cause and appropriate corrective action will be taken.

18.1.7.7 PERSONNEL EXPOSURE DETERMINATIONS

The amount of exposure of Reno Creek ISL Project personnel to airborne radioactive materials will be calculated from both the concentrations of airborne radionuclides and the worker occupancy factors. The worker occupancy factors will be determined from an initial time study that will be based on occupancy times in worker occupied locations. The time study will be performed on an annual basis after the initial study.

Exposures will be maintained according to ALARA principles. In any event, exposure to radiation levels will be held below applicable ALI's as specified in 10 CFR 20. Calculated values for uranium particulates and radon daughters exposure for each employee will be placed in the individual's personnel file. The exposure data will be reviewed systematically to ensure that no employee exceeds ALI's.

18.1.7.8 ALPHA SURVEYS

All Reno Creek site employees will self monitor for alpha contamination before leaving the restricted area, monitoring for alpha contamination regardless of whether they worked in a restricted area or not. If the action level of 1000 DMP/100 cm^2 is exceeded, the individual will remove the contamination and monitor again to ensure that the alpha reading is below the action level. Good housekeeping procedures coupled with the nature of the operation and the availability of protective clothing should greatly reduce the incidence of either personnel or equipment alpha contamination. Alpha monitoring equipment will be located at a convenient place within the process building. The alpha meter will be checked for consistency with a check source once each day.

The personnel support facilities (change rooms, lunch room, offices, etc.) shown in Figure 15.1 are not in the restricted area. However, these spaces will be alpha surveyed on a monthly basis. The personnel trailer located west of the plant building will be alpha surveyed at three locations once a month.

18.1.7.9 RADIATION INSTRUMENTATION

Radiation survey instruments will be available to perform the radiation monitoring specified in the above sections. The RSEO will ensure that the instruments used to perform the surveys are well maintained and calibrated according to the manufacturers specifications or every six months, whichever is sooner. The specifications for the various radiation monitoring equipment are presented in Table 18.1.

Table 18.1		
INSTRUMENTATION FOR RADIOLOGICAL SURVEYS		
Instrument and Detector	Measurement Type	MDA Range
Eberline ESP-1 Portable Smart with AC-3 Alpha Scintillometer Probe #2299/ #706605	Alpha Direct/ scan/removable	30-160 dpm/100 cm^2
ESP-1/AC-3 - 7 or 8 #2286/#706606	Alpha direct/ scan/removable	50-133 dpm/100cm^2 (32)
ESP-1/AC-3 - 7 or 8 #2286/#3	Alpha direct/ scan/removable	45-200 dpm/100cm^2
ESP-1/HP-260 #2299	Beta direct/ scan/removable	147-736 dpm/100cm^2
Eberline RD-14/MS II Alpha well Counter/Scaler #174/82135	Alpha	18 dpm
Eberline E-120/HP-270 #6772/HP270	Beta/gamma scan	0.2 mr/hr
Mt. Sopris SC-132 Scintillation Counter	Gamma Scan/direct	2 microR/hr
Bosch & Lomb Spec 20 Spectrophotometer	Chemical Uranium	0.2 mg/gm U-nat (31)

Table 18.1 - INSTRUMENTATION FOR RADIOLOGICAL SURVEYS

18.1.7.10 PROTECTIVE EQUIPMENT AND CLOTHING

The GMRSEO will be responsible for ensuring that all employees working at the Reno Creek site wear the prescribed safety clothing including safety boots and glasses. Additional safety equipment such as protective clothing and gloves will be available as needed. Half face respirators, full face respirators and SCBA units will be maintained on site for process tank entry. Respirator equipment will be on site if needed for specific tasks. Respiratory protection will be used whenever deemed necessary by the GMRSEO. First aid equipment and fire extinguishers will be placed at key locations within the plant building.

18.1.8 AIRBORNE EFFLUENT MONITORING

The continuous monitoring for airborne effluents outside of the process building will include passive radon monitoring with trac-etch cups and environmental TLD's to determine the radon daughter concentrations and the external gamma radiation levels, respectively. The monitoring devices will be located at the same seven sites used for baseline determination of radon and gamma radiation levels. An additional radon monitor is proposed at the permit perimeter. The baseline data is presented in Section 14 and the locations of the monitoring sites are shown in Figure 16.1. The trac-etch cups and environmental TLD's will be exchanged quarterly.

18.1.9 ENVIRONMENTAL MONITORING PROGRAM

The program for environmental monitoring, including the radiological aspects, is presented in Section 16 of this document.

18.2 ENVIRONMENTAL EFFECTS OF ACCIDENTS

The Reno Creek ISL Project is planned to be a satellite uranium solution mining operation which means that the normal processing circuits such as elution, precipitation, and drying will not exist on site. Instead, the uranium in the wellfield production stream is loaded on to ion exchange resin and the resin is shipped off site to a NRC licensed facility for further concentration and processing. Since the uranium is not concentrated on site the potential for a serious environmental accident is minimized.

18.2.1 SURFACE ACCIDENTS

18.2.1.1 FAILURE OF PROCESS AND CHEMICAL STORAGE TANKS

All process and chemical storage vessels will be constructed of either steel, coated steel, fiberglass, or plastic. Figure 15.9 illustrates the location of process vessels. The largest vessel within the process building is the resin exchange vessel with a capacity of 7,000 gallons. The volume of this largest tank can easily be contained within the concrete foundation of the building. The entire building will drain to a sump. The sump will be equipped with a pump that will transfer spilled liquid to the radium treatment ponds.

The environmental consequences of a tank failure are considered minor since the leaked fluids will be diverted back into the process system or to the radium treatment.

Carbon dioxide and oxygen will be stored on site under pressure in liquid form. The storage tanks for these chemicals will be specifically designed for the purpose and will be provided by the vendors. A leak from these type vessels would result in the venting of a harmless gas to the atmosphere. Diesel and gasoline storage tanks located on site will be placed above ground level inside earthen berms to contain any spilled fuels.

18.2.1.2 PIPE FAILURES

The liquid escaping from a failed pipe inside of the processing building will be collected in the sump and either returned to the process circuit or discharged to the radium treatment ponds. The failure of a well field pipeline will result in either pregnant or barren leach solutions spilling on the ground. A large and sudden rupture will be detected by a drop in pressure in the system and an interruption in the flow of liquids both of which will result in an automatic shutdown of the system. Corrective actions will take place as soon as the problem is detected. A small leak in the wellfield pipelines will be detected visually during the daily inspection of the system. Any ground contaminated by spilled liquid will be disposed of in accordance with WDEQ/LQD and NRC requirements.

18.2.1.3 RADIUM TREATMENT POND LEAKAGE

As discussed in Section 16.9 of this document, each of the two treatment ponds to be used at the Reno Creek ISL Project will have a leak detection monitoring system. In the event a leak is confirmed in a pond, the necessary actions will be taken to correct the problem as discussed in Section 16.8. As part of the final decommissioning of the facility, any soil underneath the evaporation ponds contaminated by leakage will be disposed of in accordance with DEQ/LQD and NRC requirements.

18.2.1.4 TORNADOS

The likelihood of a tornado striking the Reno Creek site during the life of the project is extremely remote. If a tornado did strike the Reno Creek site while in operation, there will only be a remote possibility of contamination of soils in the immediate area of the building. Since no concentration of the uranium product takes place on site, the environmental consequences should not be severe. If a tornado struck the Reno Creek area and damaged the recovery circuit, the automated pressure activated switches would shutdown the entire process preventing the continued pumping of pregnant solution on the ground.

18.2.2 SUBSURFACE ACCIDENTS

18.2.2.1 WELL CASING FAILURE

Should a well fail due to cracks in the well casing or surrounding cement in the annulus, it is possible that the mining solutions could escape into the aquifer above the mining zone. If the failure is in an injection well, only the barren solutions would be involved, but should a producing well fail, the pregnant lixivant could possibly enter the upper saturated zone. The main protection against either occurrence is correct well installation, proper well completion and a thorough integrity testing program.

In spite of the above mentioned efforts, should cracks appear and contaminating solutions invade the upper saturated zone, wellfield solutions will be detected in upper zone monitor wells. These monitor wells will be sampled on a regular bi-monthly basis for the hydrostatic water level and chemical parameters which are found in the leaching solutions. (See Section 16.1.)

18.2.2.2 HYDRAULIC FRACTURING

Hydraulic fracturing of the formation at the Reno Creek site is very unlikely. The accepted technical standard is 0.7 psi per foot of depth to conservatively calculate the fracture pressure of a given formation at a specific depth. The ore body at the Reno Creek site averages about 300 feet in depth which yields an estimated fracture pressure of 210 psi. The maximum operating pressure will be about 100 psi which is less than 50% of the fracture pressure. At no time is it anticipated that pressures of 75% of the fracture pressure (210 PSI) will be encountered.

18.2.2.3 EXCURSION CONTROL - MONITOR WELLS

Upon final determination of the perimeter of a mining unit wellfield, monitor wells will be installed. These wells are designed to detect any migration of mining solutions beyond a specified distance from the wellfield in the horizontal plane and to detect any vertical migration to the underlying and overlying aquifer in a mining unit.

A ring of horizontal monitor wells around a mining unit, spaced a maximum of 400 feet out from the outermost injection or production well and from 400 to 1,000 feet apart will be utilized at the Reno Creek project (see Section 16.1). These monitors will be completed through the mineralized sand zone.

Monitor wells in the overlying aquifer will be located near the long axis of the wellfield at a frequency of one upper aquifer well for every three acres of wellfield. In the overlying B Sand aquifer, the entire sand will be exposed during completion to obtain the maximum detection possible of any vertically migrating solutions. Figure 15.6 shows a schematic of the monitor well configuration.

18.2.3 TRANSPORTATION ACCIDENTS

The transportation of supplies, product and wastes to and from the Reno Creek site falls into three categories that can be summarized as follows:

1. Shipments of chemicals, fuels, etc. to the Reno Creek site that are used in the day to day operations;

2. Shipments of uranium loaded resin from the Reno Creek site to an NRC licensed source material processing facility and the shipment of eluted (barren) resin from the off site processing facility back to the Reno Creek site; and

3. Shipment of low specific activity (LSA) radioactive wastes from the Reno Creek site.

The actions that the EFNI staff will take in the event of a transportation accident will be detailed in an Emergency Response Plan. This written plan will be finalized prior to development and construction activities at the Reno Creek site. All site employees and contract employees will be thoroughly briefed on the contents of the Emergency Response Plan and copies of the plan will be placed at strategic locations in the site office.

Shipments of both resin loaded with uranium and LSA wastes will comply with U.S. Department of Transportation regulations pertaining to shipment of radioactive materials (49 CFR 173.4) and will be "exclusive use" shipments.

18.2.3.1 CHEMICALS AND FUELS SHIPMENT ACCIDENTS

The anticipated chemicals and fuels that will routinely be shipped in bulk to the Reno Creek site are carbon dioxide, potassium hydroxide, hydrochloric acid, liquid oxygen, cement, propane, diesel and gasoline. These chemicals and fuels will be supplied by vendors in transport vehicles owned, leased or otherwise acquired by the vendors. The commercial shippers will have their own accident plans and the EFNI staff will provide backup assistance, if required, in the event of a serious accident. The EFNI Emergency Response Plan will provide information on dealing with accidents involving chemicals and fuels, and training will be provided to employees for the safe handling of spilled materials.

18.2.3.2 RESIN SHIPMENT ACCIDENTS

It is estimated that on the average about five tanker trailer loads per week of uranium loaded resin will be transported off site to an NRC licensed processing facility most likely located in the Powder River Basin area of northeast Wyoming. A like number of trailer loads of eluted resin will be hauled from the processing facility back to the Reno Creek site. The resin will be transported in tanker trailers that meet or exceed DOT and NRC requirements. The tanker trailers will be maintained in good mechanical condition and only DOT qualified drivers with tractors in good mechanical condition will be engaged by EFNI to pull the resin trailers to and from the off site processing facility.

From and environmental viewpoint, the worst case transportation accident involving the shipment of resin would involve a major rupture of the vessels spilling the entire contents of uranium loaded resin. The wet resin with the chemically bonded uranium would be confined to the site of the accident and would not be subject to airborne transport. The environmental effects of such an accident would not be significant as cleanup crews, following the Emergency Response Plan, could quickly contain and remove the spilled resin. The impact on the environment would be the potential contamination of vegetation and soil in the immediate vicinity of the accident. Any contaminated soils and vegetation would be disposed of in accordance with NRC requirements and any disturbed land would be reclaimed.

In order to minimize the potential impact of a transportation resin spill EFNI will require the drivers to use a check-in procedure and each resin hauling trailer will have an emergency equipment package. The Reno Creek staff and contract truck drivers will receive specialized training in responding to a transportation accident involving resin.

18.3 ECONOMIC AND SOCIAL EFFECTS OF THE PROJECTS

18.3.1 BENEFITS

18.3.1.1 UNITED STATES NUCLEAR ENERGY SUPPLY

The addition of about 3.2 million pounds of uranium in the form of U_3O_8 from a domestic source to the world supply to generate low cost, environmentally clean electricity is one of the benefits of the proposed Reno Creek ISL Project.

18.3.1.2 EMPLOYMENT AND INCOME

Approximately five to seven people are expected to be employed by the Reno Creek ISL Project. Because mining is a basic industry, this job creation will produce a multiplier effect on employment in the region. The annual payroll, including fringe benefits, for the project is approximately $300,000. Since the employees are expected to live in the region, the entire income benefit will accrue to the local economics of Gillette and Wright, Wyoming. A commonly used economic multiplier of three will triple the economic benefits of the local EFNI payroll.

18.3.1.3 TAXES

The mining and selling of some 3.2 million pounds of uranium as U_3O_8 during the life of the project will produce direct and indirect tax benefits to local, state, and federal government bodies.

18.3.1.4 ROADS

EFNI, during the life of the Reno Creek ISL Project will assist with the maintenance of the existing dirt and gravel road that leads from the paved state highway to the oil field located beyond and north of the Reno Creek site. EFNI's assistance with the road maintenance will lower the cost of maintenance to the other road users which includes the land owner (rancher) and the oil and gas lease.

18.3.2 COSTS

18.3.2.1 PUBLIC FACILITIES AND SERVICES

The adverse impact on public facilities and services, such as congestion of streets and highways, overloading of utilities such as water supply and sewage treatment systems, and the overtaxing of public facilities such as schools, hospitals, and police and fire protection is expected to be insignificant for the following reasons:

1. Relatively small size of the work force;

2. Small to no increase in population due to the availability of a suitable work force in northeast Wyoming; and

3. Current under utilization of existing facilities.

18.3.2.2 HOUSING

There will be no negative impact on the housing situation in the region due to the anticipated use of local labor and the relatively small size of the work force.

18.3.2.3 IMPAIRMENT OF HISTORICAL, SCENIC AND RECREATION VALUES

No official or unofficial historical, recreational or scenic places if interest are found in the vicinity of the Reno Creek site. The Wyoming State Archeologist and Wyoming DEQ will be notified immediately if any cultural resources are encountered during the construction or operation of the Reno Creek ISL Project. All land within the WDEQ-LQD permit area is private. Refer to Section 5, Section 6 and Section 7 of this document.

18.4 ALTERNATIVES TO THE PROPOSED PLAN

18.4.1 ALTERNATE METHODS OF MINING

Alternate methods of mining for the Reno Creek ISL Project are by underground and open pit methods. From an economic standpoint, the relatively small size of the ore body precludes the much larger capital investment necessary for either an underground or open pit mine.

An underground mine would entail the lowering of the water table to dry out the working levels. The water removed, which is somewhat high in radium, would have to be disposed of on the surface. Workers would be exposed to the normal hazards of underground mining plus the radiation exposure from radon gas. The personnel injury rate is traditionally much higher with underground mines than with in situ mines. Another problem involved with underground mining is the disposal of the solid tailings that would result from the mining and milling operation. Land subsidence is another problem that can be associated with underground mining.

Conventional open pit mining methods have many of the above stated disadvantages plus up to three times the area of the ore body (wellfields) would be excavated or otherwise disturbed and require expensive land reclamation practices. Another problem associated with open pit mining is the stability of the cut slopes and the associated hazards.

18.4.2 ALTERNATE CHEMICAL PROCESSES FOR LEACHING

The in situ mining method proposed for the Reno Creek ISL Project will utilize. This lixivant and oxidant combination proved successful during the RME Pilot Test, Pattern 2, in terms of both mining and aquifer restoration, and the same lixivant chemistry has worked well at other in situ operations in Wyoming.

Alternative leach chemistries include acid lixivants and carbonate lixivants with cations using sodium or other cations other than sodium. Acid lixivants have produced problems at other R & D sites mainly in terms of aquifer restoration and is not being proposed for the Reno Creek ISL Project. While carbonate leaching with a sodium cation is presently believed to be the best methodology to employ at the Reno Creek ISL Project at this time, future technology advances may produce better alternatives from either a mining or restoration standpoint.

18.4.3 ALTERNATIVE SITES

The locations of the process building and radium settling ponds are shown in Figure 15.1. Additionally, the RME pilot process building already existing on site will be utilized as a warehouse, and these facilities were built for the R & D operation and will be used for the same purposes during the commercial operation. There is no realistic alternative for the location of these facilities since they are already built. Additional buildings such as the office/change rooms and the personnel unit will be moved on site after the necessary permits and licenses have been received by EFNI. The proposed locations of these facilities are based on the locations of the existing major facilities and therefore no realistic alternative as to locations exists.

18.4.4 ALTERNATIVE ENERGY SOURCES

The question of alternative energy sources is a matter of national policy which is controlled mainly by the actions of the executive and legislative branches of the federal government.

18.5 BENEFIT - COST ANALYSIS

A discussion of the benefits and costs associated with the proposed in situ uranium mining project is contained in Section 18.3 of this document.

18.6 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

The various state and federal permits and licenses needed for the Reno Creek ISL Project are listed in Table 18.2. Prior to the injection of chemically fortified water into the ore body aquifer, EFNI will have obtained all the required permits and licenses.

18.7 MINIMUM REQUIREMENTS FOR SUPERVISORY PERSONNEL AT THE RENO CREEK ISL PROJECT

Personnel responsible for the operation and protection of health and safety at the Reno Creek ISL Project have not yet been selected. Figure 18.1 shows the organization chart for the Reno Creek ISL Project. Key supervisory personnel will have the following minimum qualifications which are consistent with provisions of 10 CFR 20 and NRC Regulatory Guide 8.31.

General Manager of Operations

The General Manager will have a degree in engineering or physical science from an accredited college or university and at least 10 years experience in the recovery and processing of minerals. At least five years of work experience will be in the area of uranium recovery in a supervisory position.

Radiation Safety and Environmental Officer (RSEO) and Manager of Environmental Affairs, Health and Safety

The Radiation Safety and Environmental Officer will have a degree from an accredited university in engineering, physical or biological sciences and at least two years of experience relevant to uranium processing health protection in health physics, radiation protection, industrial hygiene or similar work. The RSEO will have specialized training amounting to at least four weeks of specialized training in health physics directly applicable to health physics and refresher training every two years. The RSEO

Table 18.2 Permits and Licenses for Reno Creek ISL Project		
Permit or License	**Agency**	**Status**
WDEQ Permit to Mine and Aquifer Exemption	WDEQ	Submitted
NRC Source License	NRC	Submitted
Appropriation of Groundwater State Engineer	WSEO	Submitted
Permit to Construct Ponds (Radium Settling and Irrigation)	WQD	Submitted
Permit to Appropriate Surface Water	WSEO	Submitted
Septic Tank / Leach Field	WQD	In Preparation
Air Quality Permit to Construct	AQD	Variance Requested
Land Application Permit for Surface Irrigation	WQD	In Preparation
Campbell County Development Permit	Campbell County	In Preparation

NOTES:
- NRC- U.S. Nuclear Regulatory Commission
- LQD- Water Quality Division of the DEQ
- WQD- Water Quality Division of the DEQ
- AQD - Air Quality Division of the DEQ
- DEQ- Department of Environmental Quality
- SEO- State Engineer's Office
- EPA- Environmental Protection Agency

will have a thorough knowledge of the proper application and use of all equipment in the processing plant, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of the uranium mining process and equipment used to recover uranium. The RSEO will also have experience in the monitoring and reporting of environmental impacts other than radiological.

18.8 ATMOSPHERIC DISPERSION MODELLING ASSUMPTIONS AND RESULTS

The computer atmospheric dispersion model used for determining the concentrations of radionuclides and dose rates at various potential exposure points is the MILDOS-AREA (June, 1989). This program uses input data estimating radionuclide concentrations expected from the various operational phases of uranium recovery to generate the modeled exposure rates. MILDOS-AREA has been used to model and predict compliance with 10 CFR 20 standards for radiological dose to individuals. The full computer run is included as Attachment 18.1.

Data input and modeling using the MILDOS-AREA program was conducted by EnecoTech of Denver, Colorado under contract to EFNI. Assumptions used to develop the source term input values were developed by EFNI based upon methods presented in USNRC Regulatory Guidelines 3.46 (June, 1982) and 3.59 (March, 1987). All source term values were developed by EFNI using assumptions based on the proposed process and equipment configuration presented in Section 15 of this document. Meteorological data used in the model is from Casper, Wyoming and is based upon information gathered by the National Weather Service during 1985 to 1989. A wind rose showing the frequency of winds by wind speed and stability class for this period is presented as Figure 18.3. Other assumptions used within the model are presented below.

TABLE 18.3 MILDOS RECEPTOR LOCATIONS INDIVIDUAL RECEPTOR LOCATION DATA					
I	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)
1	R1	-1.22	-0.55	0.00	1.34
2	R2	-1.22	-0.05	0.00	1.22
3	R3	-0.41	0.53	0.00	0.67
4	R4	0.26	0.98	0.00	1.02
5	R5	0.48	0.98	0.00	1.09
6	R6	0.55	0.31	0.00	0.63
7	R7	0.48	-0.22	0.00	0.53
8	R8	-0.58	-0.22	0.00	0.62
9	R9	-0.70	-0.29	0.00	0.75
10	R10	0.91	0.77	0.00	1.19
11	R11	1.15	0.77	0.00	1.38
12	R12	1.49	0.96	0.00	1.77
13	R13	1.68	0.96	0.00	1.93
14	R14	1.68	1.22	0.00	2.08
15	R15	1.49	1.46	0.00	2.09
16	R16	1.25	1.46	0.00	1.92
17	R17	0.98	1.03	0.00	1.43
18	RANCH BLDGS	5.20	1.50	0.00	5.41
19	SUNBURST RANCH	4.00	6.60	0.00	7.72
20	DALE L. WRIGHT	7.00	6.70	0.00	9.69
21	WRIGHT	13.40	10.50	0.00	17.02
22	ROBERT ROUSH	-10.40	2.30	0.00	10.65
23	TURNERCREST RANCH	-1.20	-10.40	0.00	10.47
24	MATHEW FAMILY	4.00	16.50	0.00	16.98
25	JUSTIN JOE RENO	4.21	-2.10	0.00	4.70
26	COSNER RANCH	10.50	1.50	0.00	10.61
27	OPAL MARGUISS RANCH	-0.80	12.50	0.00	12.53
28	FLOYD RENO JR FAMILY	12.50	-14.50	0.00	19.14

Table 18.3 Mildos Receptor Locations

18.8.1 PROCESS DESCRIPTION AS IT RELATES TO MILDOS-AREA ASSUMPTIONS

The Reno Creek project is proposed as a satellite plant. The project will consist of production wellfields, a uranium recovery plant using ion exchange technology, and wellfield solution treatment and land application facilities. No precipitation or drying of uranium oxide will take place on site. Precipitation and drying of uranium oxide will take place at another existing facility licensed for possession and processing of this material. Therefore, all uranium oxide on the project area is wet and in a relatively diluted form. Release of uranium to the environment will be in quantities less than found in the natural environment except due to accidental release. Therefore, the major radionuclides of concern associated with the Reno Creek operation are radon and its decay daughters. Radionuclides occurring above radon 222 in the uranium 238 decay chain have not been considered in the MILDOS-AREA modeling of the project.

The uranium recovery process is a closed loop process described in Section 15.8.1 of the Mine Plan. Solutions remain under pressure and are not exposed to the atmosphere except for the portion of the wellfield solutions discharged to the radium treatment reservoir for land application and the resin transfer tank in the process building. These solutions consist of a 2% production bleed stream (40 gpm) and solutions generated from restoration activities including groundwater sweep (200 gpm) and reverse osmosis brine (100 gpm). If all restoration solutions were to be exposed to the atmosphere and radon released, the total source term would be approximately 649 Ci/yr using the methodology and methods outlined in USNRC Regulatory Guide 3.59. However, 457 Ci/yr of this total possible source term is returned to the wellfield without escaping to the atmosphere. Thus a total of 192 Curies/year will be released to the atmosphere. This concentration of radon is apportioned to four sources described in Section 18.8.3.

18.8.2 SOURCE TERM ASSUMPTIONS

USNRC Regulatory Guide 3.46 describes information requested for the purpose of determining the radiological impacts of uranium recovery operations. The requested information is summarized in Appendix A of the Regulatory Guide 3.46. Much of the information requested pertains to conventional milling operations. The Reno Creek project is an in situ uranium recovery facility with no precipitation or drying of uranium oxide. Therefore, much of the information requested in Appendix A is not applicable. For simplicity and completeness, EFNI has followed the same format and numbering system for presentation of the requested data as presented in Appendix A of Regulatory Guide 3.46, referencing other portions of the document and including further detail where needed. USNRC Appendix A assumptions are included as Section 18.8.5.

For purposes of this model, a worst case year has been selected for determining radon emissions. In the case of the Reno Creek project this assumes the concurrent production of radon due to leaching and restoration. Also, a quantity of radon has been assumed for start up of wellfields for leaching and restoration. In reality, all of these activities are not expected to occur concurrently, and the model has used very conservative assumptions.

The total source term is assigned to various operations as described in USNRC Regulatory Guide 3.56. The total source term is summarized below.

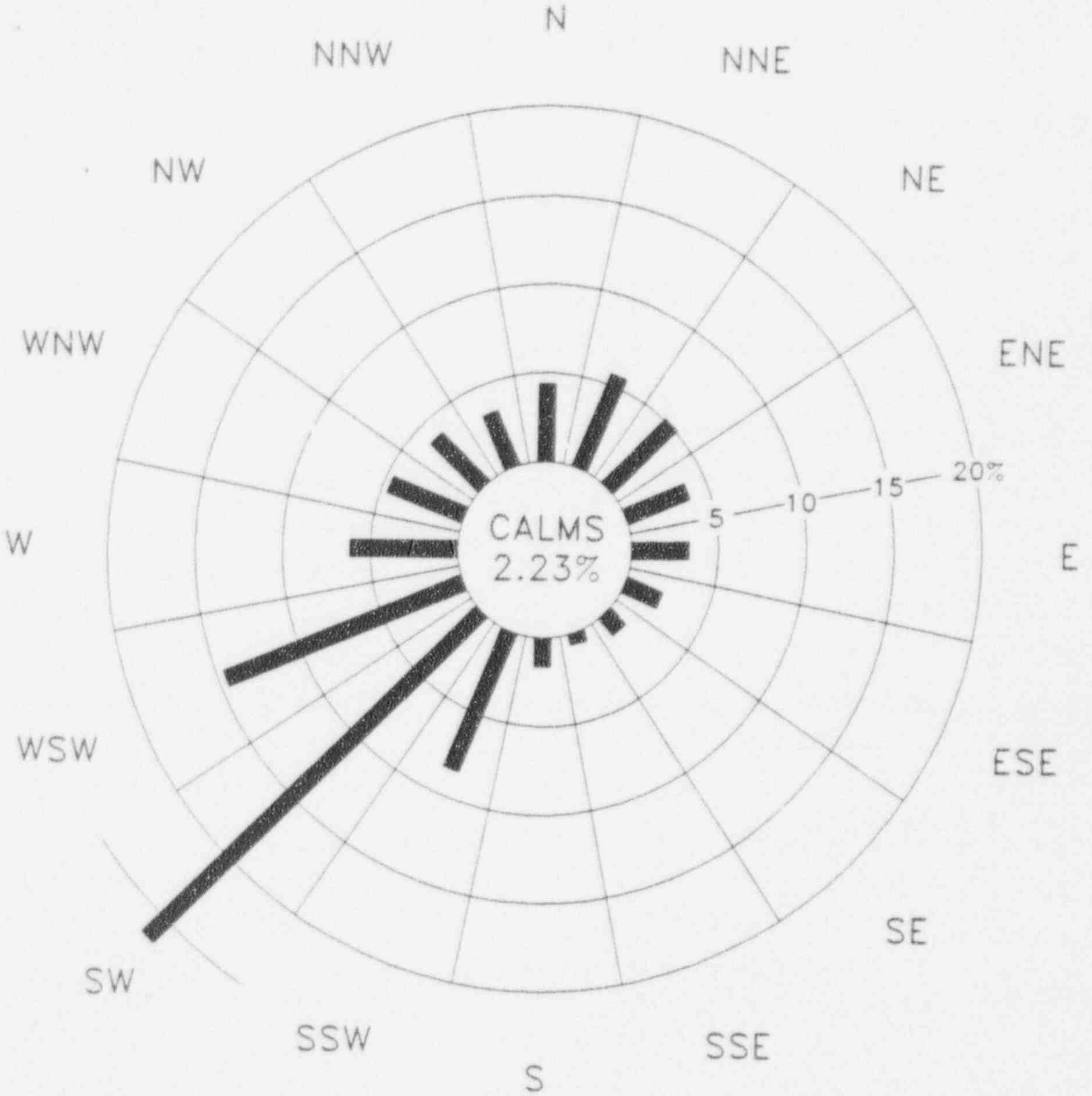
Solution produced by start up of production operations - 18 Ci/yr
Solution produced during production - 533 Ci/yr
Solution produced during restoration - 80 Ci/yr
Solution produced during start-up - 18 Ci/yr

The total source term is 649 Ci/yr. However, because the uranium recovery system is closed loop except for the solutions discharged to the radium treatment ponds and the resin transfer tank in the process building, 457 Ci/yr of radon is returned to the wellfield and is not released to the atmosphere. A further breakdown of sources is provided in the following section.

18.8.3 MILDOS-AREA SOURCE DESCRIPTIONS AND LOCATIONS

Four radon emission sources have been assumed for use in the MILDOS model. The locations and coordinates of these source locations are identified on Figure 18.5 with coordinates listed in the source category. The emission sources are described below:

Vent stack from the resin transfer tank outside the process building - The only tank involved in the uranium recovery process which will result in solutions being exposed to the atmosphere is the resin transfer tank. This tank will have a capacity of 7,000



energy fuels nuclear inc.

Project	RENO CREEK ISL PROJECT		
REVISIONS	County Campbell	State Wyoming	
Date / By	Location T 43 N. R 73 W		
	1985-89 NWS DATA-CASPER, WYOMING FREQUENCY OF WINDS BY WIND SPEED AND STABILITY CLASS		
	Scale N/A	Date October, 1993	windrose
	Author	Drafted By D. L. Sieda	

Figure: 18.4

gallons. Solution retained in this tank for resin transfer will be exposed to the atmosphere. Assuming 292 shipments/year of uranium laden resin are made, less than 1% of the radon contained in production fluids is attributable this source. This amounts to 6 Ci/yr from this source.

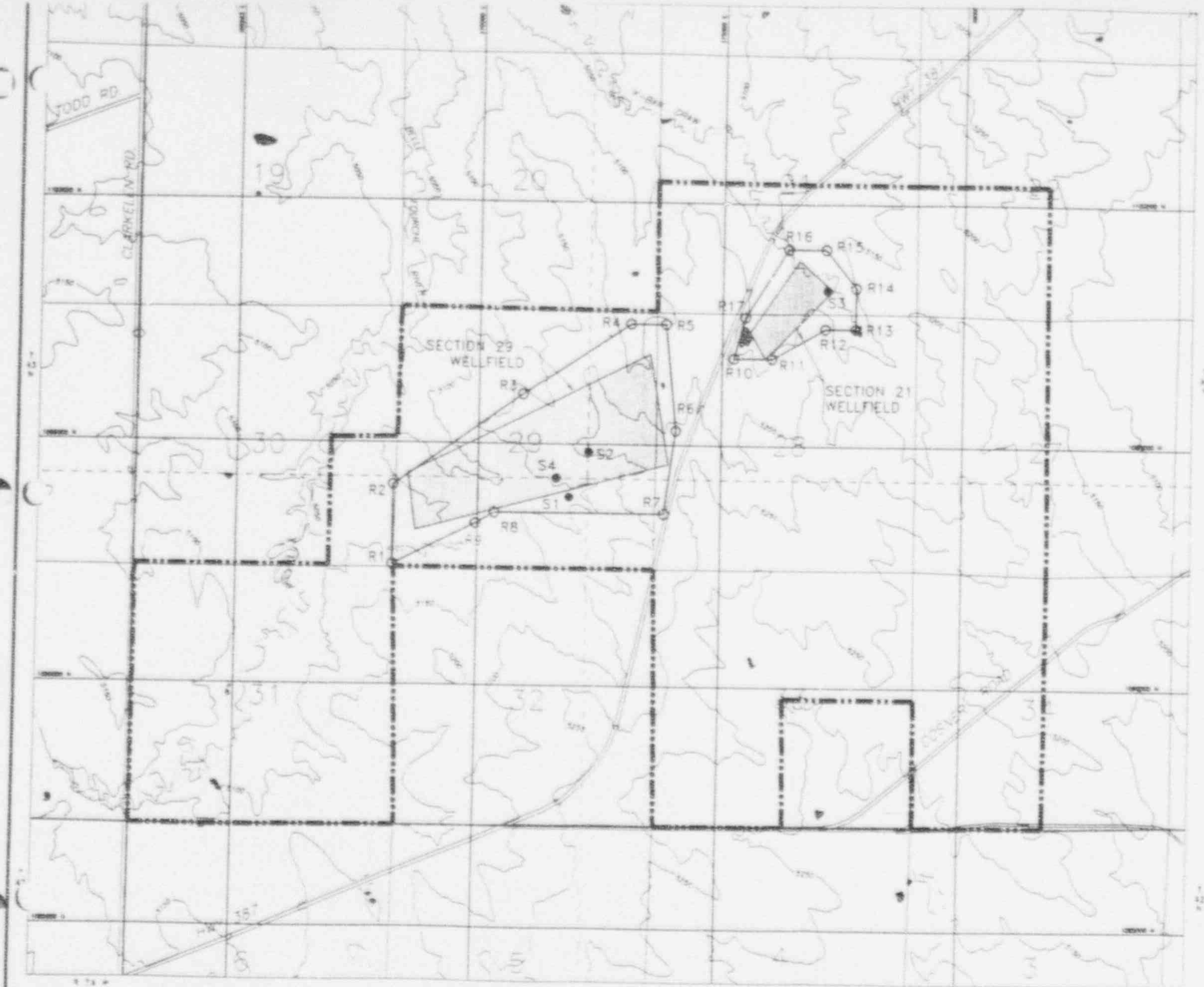
Center of wellfield Mining Unit 1 located principally in Section 29, T43N R93W - Injector wells are vented to the atmosphere at the wellhead with Armstrong vents. Theoretically, no radon should escape the wellhead since a positive pressure is needed to open the valve. However, a small quantity of gas escapes to the atmosphere through the Armstrong vents due to pressure build up in the well. The gas will contain radon. This source has been estimated as 10% of the total production solutions circulated through the wellfield containing a total concentration of 116 Ci/yr. This concentration has been apportioned on the basis of area within the wellfield between the two wellfields identified as source locations. Section 29 wellfields account for 45.3 Ci/yr.

Center of wellfield mining units 2 located principally in Section 21, T43 R93W - Section 21 wellfields account for 8.7 Ci/yr.

Recovery plant outfall point to radium treatment ponds - The largest source of radon emission to the atmosphere is at the outfall from the production plant to the radium treatment ponds. These ponds receive a 2% production bleed stream, solution produced during groundwater sweep and reverse osmosis brine. This source accounts for 132 Ci/yr.

18.8.4 RECEPTOR DESCRIPTIONS AND LOCATIONS

EFNI proposes to establish areas with controlled access to humans and livestock. Control areas will consist of continuous fencing and posting around wellfields. Close proximity receptor points corresponding to the approximate location of wellfield fences are shown on Figure 18.3. Close proximity receptors are identified as R-1 through R-17. Residences representing potential or actual human exposures within a 15 kilometer radius of the project site are also listed in Table 18.3. The



LEGEND

● SOURCE LOCATION

○ RECEPTOR LOCATION

Coordinate Grid

COORDINATES FOR SOURCES (Kilometers)

SOURCE	Area of Source	[illegible]	[illegible]	[illegible]
[illegible] [illegible]	0	[illegible]	[illegible]	[illegible]
[illegible] Center of Section 29 Wellfield	0.73	0	0.158	0
[illegible] Center of Section 21 Wellfield	0.138	1.5	1.2	0
[illegible] Ra Treatment Pond Outfall	0	-0.1	0	0

SCALE FEET

energy fuels nuclear inc.

RENO CREEK PROJECT

T 43 N, R 73 W

MILDOS SOURCE AND CLOSE PROXIMITY RECEPTOR LOCATIONS worst case annual effective dose commitment is predicted to be at the Justin Joe Reno ranch (Receptor 25) located in Section 2, T72N R42W. This resident is both the nearest residence and the nearest downwind resident to the project. The predicted maximum annual dose rate at this site will be 0.0186 mSv/yr above background. This exposure is well within the limits set in 10 CFR 20 for limits to members of the public. The closest town (Wright, Wyoming) is located approximately 17 kilometers northeast of the project area.

18.8.5 USNRC APPENDIX A INFORMATION

Appendix A of USNRC Regulatory Guideline 3.46 has been reproduced in this section with the origin of assumptions used for calculation of the source term.

18.8.6 CALCULATION OF RADON DOSE EQUIVALENT AT PERMIT BOUNDARY DUE TO RADON DAUGHTERS

Appendix B, Table 2 of 10 CFR 20 regulations specifies radiation protection limits for members of the general public. The table specifies two concentration limits for radon 222, one with radon daughters and one without. In order to demonstrate compliance with both limits, calculations have been made to calculate concentrations of radon 222 with daughters at the control area boundary and at the permit area boundary.

Table 18.4 shows the receptor with the greatest radon 222 concentration and the working level (WL) calculated for that receptor. This data shows that the receptor with the highest radon 222 levels are distributed around the source locations with no predominant direction. Of the receptors shown in Table 18.4 receptors 2, 6, 8 and 11 are at the edge of the proposes wellfield and well within the permit boundary. Receptors 4 and 5 are at the edge of the proposed wellfield and are also located very close to the permit boundary. The radon-222 concentrations at receptors 4 and 5 is 0.006 pCi/l and 0.014 pCi/l respectively, and the WL measurement is 4.504E-6 and 6.961E-6. Table 18.4 shows the equilibrium factor (EF) calculated for these receptors. The average equilibrium factor in this area is approximately 6%. The preamble to 10 CFR 20 found in FR Vol. 56, No 98, Tuesday, May 21, 1991 states that the applicant can adjust the Appendix B Table 2 value for radon 222 (with daughters) by taking into account the actual degree of equilibrium present in the environment. Using the calculated equilibrium factor of 6% and Radon Daughter Effective Dose Equivalent Table, Table 18.2. This table was generated by Mr. Dennis Sollenberg of the NRC staff and distributed at an NRC Workshop) the applicant proposes a radon 222 limit of approximately 3.8 pCi/l above background. This limit in conjunction with the dose estimated by MILDOS at the permit boundary will assure that the 100 mrem/year exposure to the general public will not be exceeded.

In summary the applicant has shown compliance with the annual does limit in 10 CFR 20.1301 by demonstrating that the total effective dose equivalent (TEDE) to the most effected individual does not exceed the annual dose limit. The applicant has also proposed an adjusted effluent concentration limit for radon 222 based on the degree of equilibrium calculated by MILDOS.

RADON DAUGHTER CONCENTRATIONS WITH EQUILIBRIUM FACTOR

Receptor	Rn 222 (pCi/l)	Working Level	Equilibrium Factor
#2	0.019	6.72E-6	3.5%
#4	0.006	4.50E-6	7.5%
#5	0.014	6.96E-6	5.0%
#6	0.019	1.27E-5	6.7%
#8	0.019	1.25E-5	6.6%
#11	0.025	9.24E-6	3.7%

The Equilibrium Factor (EF) was calculated using the protocol found in NCRP Report No. 97, Measurement of Radon and Radon Daughter in Air.

$$\text{Equilibrium Factor} = \frac{WL \times 100}{Rn222 \text{ in pCi/l}} \times 100$$

Table 18.4 Radon Daughter Concentrations with Equilibrium Factors

APPENDIX A

INFORMATION NEEDED BY NRC STAFF TO PERFORM RADIOLOGICAL IMPACT EVALUATIONS FOR COMMERCIAL-SCALE IN SITU URANIUM SOLUTION MINING FACILITIES

1. **Detailed site plot plan (overlaid on topographic map, with scale and true north arrow) clearly identifying all locations of:**

   a. **Site property boundaries** - Refer to Figure 19.2, Restricted and Control Areas.

   b. **Restricted area boundaries, if different from site property boundaries** - Refer to Figure 19.2, Restricted and Control Areas.

   c. **All radiological effluent release points (or areas) such as:**

      (1) **Production wells** - Refer to Plate 15.1, Mine Plan, for locations well fields.

      (2) **Yellowcake drying and packaging area emission stacks or vents (if applicable)** - Refer to Plate 15.1, for plant layout.

      (3) **Evaporation, settling, or any other solid/liquid disposal pond areas** - Refer to Figures 15.7 thru 15.12, for illustration.

      (4) **Any other release points of emission to the atmosphere, e.g., surge tanks, process building vents** - None

   d. **Lands owned, leased, otherwise controlled (including mill site claims) by the applicant** - Refer to Appendix C for description of lands within permit area.

   e. **Lands usable and available for grazing** - All lands outside restricted area shown on Figure 19.2.

   f. **Private residences or other structures used by the general public** - Refer to Plate 19.1, MILDOS Remote Receptors and Figure 19.5, MILDOS Source and Close Proximity Receptors.

   g. **Vegetable or other crops, identified by type and growing season** - None within at least a 3 mile radius.

   h. **Milk animals (cows or goats)** - None within permit area.

2. **Locations of sources and receptors** - Refer to Page 3, MILDOS AREA Model Output, Attachment 19.1 for coordinates. Refer to Figure 19.5 and Plate 19.1 for illustration.

3. **Time sequenced bar, graph describing stages of the facilities operational and post operational life** - Refer to Figure 19.6, Projected Mining and Restoration Schedule.

4. **The following parameter values should be provided (if there are changes in Part 3 above, multiple corresponding values for each stage should be reflected here):**

Parameter	Value
Average ore quality, U_3O_8, in ore body	0.075%
Ore activity, U-238, U-238, Th-230, Ra-226, and Pb-210	212 pCi/g
Operating days per year (plant factor)	365 days
Dimensions of the ore body or bodies	
• Acres per year to be mined	20 acres
• Average thickness of body (bodies)	5.18 meters
Average production flow rate	2000 gpm
Formation porosity	28 %
Process recovery	98 %
Leaching efficiency	70 %
Rock density	1.9 g/cm^3
Restoration flow rate	200 gpm
Production cell parameters	
Residence time	6.1 days
Type of cell pattern (5,7 spot, or other)	5 spot
Radius	21.3 m

Average cell flow rate	20 gpm
Annual Rn-222 emission from production	533 Ci/yr[1]
Annual Rn-222 emission from restoration	98 Ci/yr[1]

Yellowcake drying and packaging data (if applicable). Not Applicable

Stack heights and airflows, Resin Transfer Tank Height 7.4M
Exit Velocity 0.4m^3/s

Anticipated release rates for dryer stack, the packaging area ventilation exhaust, and any yellowcake storage area ventilation exhausts. Not Applicable

Drying and packaging operations are carried out.
Not Applicable

Description of all ventilation air filtration equipment with design, expected, and minimum efficiencies (if applicable)
Not Applicable

Filtration equipment testing procedures and frequencies
Not Applicable

Solid/liquid disposal impoundments, e.g., evaporation ponds
(Attach sheet)

Complete physical, chemical, hydrological, and radiological description of disposal impoundment system.

Total area of each impoundment area and surface areas expected to be under water, saturated, moist, and dry. Assumed 100% of radium treatment ponds under water.

Anticipated Rn-222 release rates for surface areas under water, saturated, moist, and dry, Ci/yr per m^2. Assumed release of 100% of radon contained in discharge to radium treatment ponds discharged to atmosphere at outfall from recovery plant to Retreatment ponds. Refer to Section 19.8.2 for discussion.

(1) Refer to Section 19.8.2 for assumptions and derivation of source term of total source term, 457 Ci/yr returned to formation.

5. (a,b,c) - Refer to Page 2, MILDOS-AREA Model Output, Attachment 19.1, for wind speed, frequency and stability summary. Wind rose provided on Figure 19.4. All data based on Casper, Wyoming meteorological data, 1985 thru 1989.

5. (d) - Regional Population Data

Refer to Table 19.1, Population Distribution, and Table 19.2, Residences within a 15 kilometer Perimeter. Refer to Plate 19.1 for illustration of population demographics within 80 kilometers of recovery plant and Figure 19.5 for close proximity receptors.

6. Miscellaneous

Acreage required to graze 1 animal unit (450 kg) for one month (AUM) — 1.5 ha

Length of growing season — 5 mo/yr

Fraction of locally produced vegetables consumed locally — Est. 100 %

Fraction of locally produced meat consumed locally — Est. 5 %

Fraction of locally produced milk consumed locally — Est. 100 %

Fraction of year during which cattle gaze locally — Est. 90 %

Fraction of cattle feed obtained by grazing — Est. 90 %

Fraction of stored cattle feed grown locally — Est. 50 %

equilibrium factor of 6% and Radon Daughter Effective Dose Equivalent Table, Table 18.2. This table was generated by Mr. Dennis Sollenberg of the NRC staff and distributed at an NRC Workshop) the applicant proposes a radon 222 limit of approximately 3.8 pCi/l above background. This limit in conjunction with the dose estimated by MILDOS at the permit boundary will assure that the 100 mrem/year exposure to the general public will not be exceeded.

In summary the applicant has shown compliance with the annual does limit in 10 CFR 20.1301 by demonstrating that the total effective dose equivalent (TEDE) to the most effected individual does not exceed the annual dose limit. The applicant has also proposed an adjusted effluent concentration limit for radon 222 based on the degree of equilibrium calculated by MILDOS.

RADON DAUGHTER CONCENTRATIONS WITH EQUILIBRIUM FACTOR			
Receptor	Rn 222 (pCi/l)	Working Level	Equilibrium Factor
#2	0.019	6.72E-6	3.5%
#4	0.006	4.50E-6	7.5%
#5	0.014	6.96E-6	5.0%
#6	0.019	1.27E-5	6.7%
#8	0.019	1.25E-5	6.6%
#11	0.025	9.24E-6	3.7%

The Equilibrium Factor (EF) was calculated using the protocol found in NCRP Report No. 97, Measurement of Radon and Radon Daughter in Air.

$$\text{Equilibrium Factor} = \frac{\text{WL} \times 100}{\text{Rn222 in pCi/l}} \times 100$$

Table 18.4 Radon Daughter Concentrations with Equilibrium Factors