Reclamation Plan
White Mesa Mill
Blanding, Utah

Source Material License No. SUA-1358

Docket No. 40-8681

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B Hydrogeologic Evaluation of White Mesa Uranium Mill, (July 1994). Titan Environmental Corporation.

C Points of Compliance, White Mesa Uranium Mill, September 1994. Titan Environmental Corporation.

D Tailings Cover Design, White Mesa Mill, October 1996. Titan Environmental Corporation.

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INTRODUCTION

This document prepared by Energy Fuels Nuclear, Inc. (EFN), presents EFN's plans and estimated costs for the reclamation of Cells 1-I, 2, 3, and 4, and for decommissioning of the White Mesa Mill.

The uranium processing sections of the mill will be decommissioned as follows:

The uranium and vanadium processing areas of the mill, including all equipment, structures and support facilities will be decommissioned and disposed of in tailings or buried on site as appropriate. All equipment, including tankage and piping; agitation; process control instrumentation and switchgears; and contaminated structures; will be cut up, removed, and buried in tailings prior to final cover placement. Concrete structures and foundations will be demolished and removed or covered with soil as appropriate. These decommissioned areas would include, but not be limited to, the following:

- Coarse ore bin and associated equipment, conveyors and structures.
- Grind circuit including semi-autogenous grind (SAG) mill, screens, pumps and cyclones.
- Three pre-leach tanks to the east of the mill building, including all associated tankage, agitation equipment, pumps, and piping.
- Seven leach tanks inside the main mill building, including all associated agitation equipment, pumps and piping.
- Counter-current decantation (CCD) circuit including all thickeners and equipment, pumps and piping.
- Uranium precipitation circuit, including all thickeners, pumps and piping.
- Two yellowcake dryers and all mechanical and electrical support equipment, including uranium packaging equipment.
- Clarifiers to the west of the mill building including the preleach thickener and claricone.
- Boiler and all ancillary equipment and buildings.
- Entire vanadium precipitation, drying, and fusion circuit.

- All external tankage not included in the above list including: reagent tanks for the storage of acid, ammonia, kerosene, water, or dry chemicals; and the vanadium oxidation circuit.
- Uranium and vanadium solvent extraction (SX) circuit including all SX and reagent tankage, mixers and settlers, pumps, and piping.
- SX building.
- Mill building.
- Office building.
- Shop and warehouse building.
- Sample plant building.

The sequence of demolition would proceed so as to allow the maximum use of support areas of the facility, such as the office and shop areas. It is anticipated that all major structures and large equipment will be demolished with the use of hydraulic shears. These will speed the process, provide proper sizing of the materials to be placed in tailings, and reduce exposure to radiation and other safety hazards during the demolition. Any uncontaminated or decontaminated equipment to be considered for salvage will be released in accordance with the NRC document, Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials, dated September, 1984, and in compliance with the conditions of Source Material License SUA-1358. As with the equipment for disposal, any contaminated soils from the mill area will be disposed of in the tailings facilities in accordance with Section 4.0 of Attachment A, Plans and Specifications.

The estimated reclamation costs for surety are summarized as follows:

White Mesa Reclamation
Cost Summary

Direct Costs		M$
Mill Decommissioning		1,485
Cell 1 Reclamation		738
Cell 2 Reclamation		1,736
Cell 3 Reclamation		2,216
Cell 4A Reclamation		115
Misc. Items (Project General)		2,045
	Subtotal Direct:	8,335
Profit Allowance	10%	833
Contingency	15%	1,250
Licensing and Bonding	2%	167
Long Term Care Fund		585
	Total Surety Requirement:	11,170

REPORT ORGANIZATION

General site characteristics pertinent to the reclamation plan are contained in Section 1.0. Descriptions of the facility construction, operations and monitoring are given in Section 2.0. The current environmental monitoring program is described in Section 2.3. Seismic risk was assessed in Section 2.6.3.

The Reclamation Plan including descriptions of facilities to be reclaimed and design criteria, is presented in Section 3.0. Section 3.0 Attachments A, B, and C are the Plans and Specifications, Quality Plan for Construction Activities, and Cost Estimates, respectively.

Supporting documents, which have been reproduced as appendices for ease of review, include:

- Semi-Annual Effluent Report, White Mesa Mill, SUA-1358, Docket No. 40-8681, (July through December 1995) and Semi-Annual Effluent Report, White Mesa Mill, SUA-1358, Docket No. 40-8681, (January through June 1996) Energy Fuels Nuclear, Inc.

- Hydrogeologic Evaluation of White Mesa Uranium Mill, July 1994. Titan Environmental Corporation (Titan).

- Points of Compliance, White Mesa Uranium Mill, September 1994. Titan.

- Tailings Cover Design, White Mesa Mill, October 1996. Titan.

- Neshaps Radon Flux Measurement Program, White Mesa Mill, 1995, October 1995. Tellco Environmental.

1.0 SITE CHARACTERISTICS

The White Mesa Mill is located in southeastern Utah (see Figure 1-1), approximately six miles south of Blanding, Utah (see Figure 1-2).

The Environmental Report ("ER") (Dames and Moore 1978b) has been reproduced, with minor revisions, to describe site characteristics. The Final Environmental Statement ("Final ES") (U.S. NRC 1979) has also been used, where noted below, for descriptions of the preoperational environment. Section 2.0, Site Characteristics, contains certain pertinent sections reproduced from the Final ES with minor changes in syntax. Where these sections were reproduced, the ER or Final ES section numbers are referenced in parentheses after the section title.

Section 1.6.1, Regional Geology, and Section 1.6.2, Blanding Site Geology, were reproduced from the ER with minor changes in syntax. Section 1.6.3, Seismic Risk Assessment, summarizes the results of static and pseudostatic analyses performed in September of 1996. These analyses were based on the most recent data available as well as previously collected data, and were used to establish the stability of the side slopes of the tailings soil cover. Complete details of the tailings cover design are provided in Appendix D, Tailings Cover Design, White Mesa Mill (Titan Environmental Corporation, 1996).

The Semi-Annual Effluent Report for July through December, 1996 (EFN, 1996) is reproduced in Appendix A. Many of the graphs in the Semi-Annual Effluent Report show data from late 1979 or early 1980 to the present. The word "current" is used to describe these data and/or updates. The Hydrogeologic Evaluation of White Mesa Uranium Mill (Titan, 1994) is reproduced in Appendix B. Points of Compliance, White Mesa Mill (Titan, 1994) is reproduced in Appendix C. Tailings

Cover Design, White Mesa Mill (Titan, 1996) is reproduced in Appendix D. Appendix E is the most recently completed radon monitoring report.

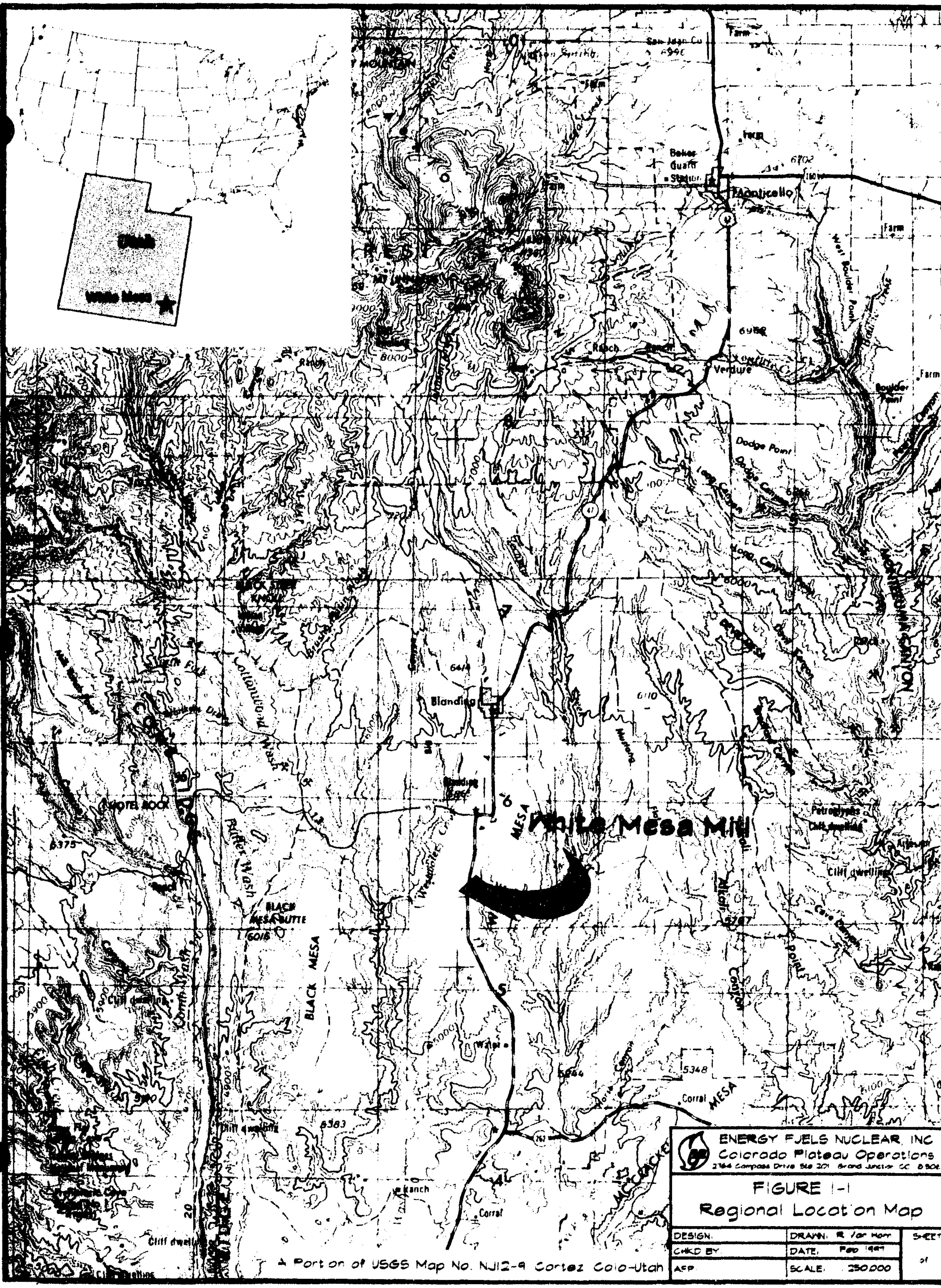

FIGURE 1-1
Regional Location Map

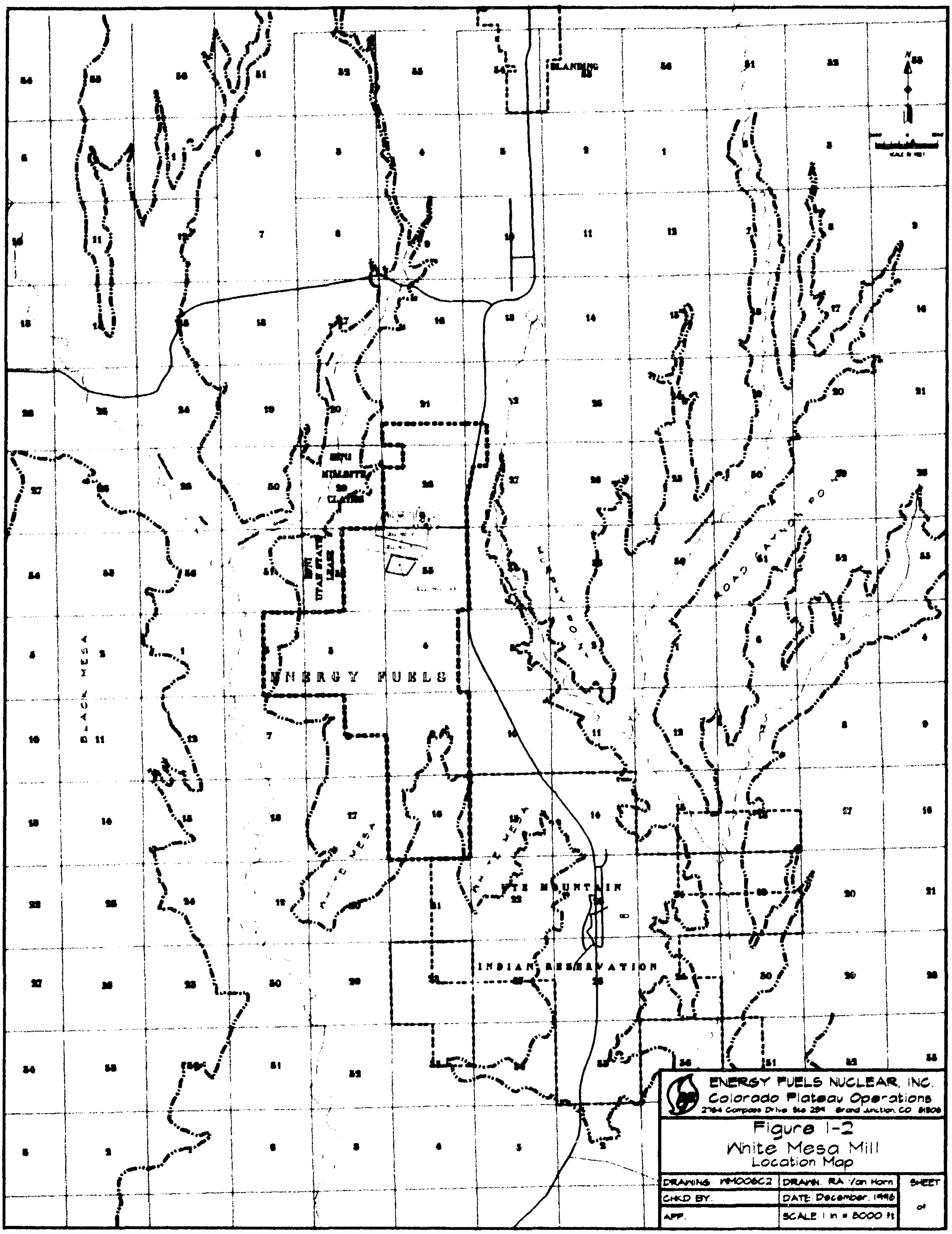

Figure 1-2
White Mesa Mill
Location Map

1.1 CLIMATE

Text on climate and associated tables are adapted, with minor revisions, from the Final ES. New table numbers are added to the text below to correspond to sections in this Reclamation Plan, but the original table numbers from the Final ES are cited on the modified tables, for ease of reference.

1.1.1 General Influences (Final ES Section 2.1.1)

Although varying somewhat with elevation and terrain in the vicinity of the site, the climate can generally be described as semiarid. Skies are usually clear with abundant sunshine, precipitation is light, humidity is low, and evaporation is high. Daily ranges in temperature are relatively large, and winds are normally light to moderate. Influences that would result in synoptic meteorological conditions are relatively weak; as a result, topography and local micrometerological effects play an important role in determining climate in the region.

Seasons are well defined in the region. Winters are cold but usually not severe, and summers are warm. The normal mean annual temperature reported for Blanding, Utah, is about 50° F (10° C), as shown in Table 1.1-1 (Table 2.1 in the Final ES). January is usually the coldest month in the region, with a normal mean monthly temperature of about 27° F (-3° C). Temperatures of 0° F (-18° C) or below may occur in about two of every three years, but temperatures below -15° F (-26° C) are rare. July is generally the warmest month, having a normal mean monthly temperature of about 73° F (23° C). Temperatures above 90° F (32° C) are not uncommon in the summer and are reported to occur about 34 days a year; however, temperatures above 100° F (38° C) occur rarely.

1.1.2 Precipitation (Final ES Section 2.1.2)

Precipitation in the vicinity of the White Mesa Uranium Project is light (Table 1.1-2) (Final ES Table 2.2). Normal annual precipitation is about 12 inches (30 cm). Most precipitation in the area is rainfall, with about 25 percent of the annual total in the form of snowfall.

There are two separate rainfall seasons in the region. The first occurs in late summer and early autumn when moisture-laden air masses occasionally move in from the Gulf of Mexico, resulting in showers and thunderstorms. The second rainfall period occurs during the winter when Pacific storms frequent the region.

1.1.3 Winds (Final ES Section 2.1.3)

Wind speeds are generally light to moderate at the site during all seasons, with occasional strong winds during late winter and spring frontal activity and during thunderstorms in the summer. Southerly wind directions are reported to prevail throughout the year.

1.1.4 Storms (Final ES Section 2.1.4)

Thunderstorms are frequent during the summer and early fall when moist air moves into the area from the Gulf of Mexico. Related precipitation is usually light, but a heavy local storm can produce over an inch of rain in one day. The maximum 24-hour precipitation reported to have fallen during a 30-year period at Blanding was 1.98 inches (5.02 cm). Hailstorms are uncommon in this area. Although winter storms may occasionally deposit comparable amounts of moisture, maximum short-term precipitation is usually associated with summer thunderstorms.

Tornadoes have been observed in the general region, but they occur infrequently. Strong winds can occur in the area along with thunderstorm activity in the spring and summer. The White Mesa site is susceptible to occasional dust storms, which vary greatly in intensity, duration, and time of occurrence. The basic conditions for blowing dust in the region are created by wide areas of exposed dry topsoil and strong, turbulent winds. Dust storms usually occur following frontal passages during the warmer months and are occasionally associated with thunderstorm activities.

TABLE 1.1-1

Temperature means and extremes at Blanding, Utah[a]

Month	Means						Extremes					
	Daily maximum		Daily minimum		Monthly		Record highest		Year	Record lowest		Year
	°C	°F	°C	°F	°C	°F	°C	°F		°C	°F	
January	3.9	39.1	-9.1	15.6	-2.6	27.4	16	60	1956	-27	-17	1937
February	6.5	43.7	-6.4	20.4	0.1	32.1	19	67	1932	-31	-23	1933
March	11.1	51.9	-3.3	26.1	3.9	39.0	22	72	1934	17	2	1948
April	17.0	62.6	0.9	33.7	8.9	48.1	28	82	1943	12	11	1936
May	22.2	71.9	5.2	41.3	13.7	56.6	33	92	1951	-5	23	1933
June	28.2	82.8	9.6	49.2	18.9	66.0	38	100	1954	-2	28	1947
July	31.7	89.1	13.8	56.9	27.8	73.0	39	103	1931	2	36	1934
August	30.3	86.5	13.1	55.5	21.7	71.0	37	98	1954	6	42	1950
September	26.2	79.3	8.7	47.7	17.6	63.6	35	95	1948	-2	29	1934
October	19.0	66.2	2.7	36.9	10.9	51.6	32	90	1937	-10	14	1935
November	10.4	50.8	-4.4	24.1	3.1	37.5	21	69	1934	-22	-7	1931
December	5.3	41.6	-7.4	18.6	1.1	30.1	16	61	1949	-24	-11	1935
Annual	17.7	63.8	1.9	35.5	9.8	49.7	39	103	July 1931	-31	-23	February 1933

[a]Period of record: 1931-1960 (30 years).

Source: Adapted from U. S. NRC (1979) Final Environmental Statement, Page 2-2, Table 2.1.
Original Source: Plateau Resources, Limited, *Application for Source Material License,* Table 2.2-1, p. 2-6, Apr. 3, 1978.

TABLE 1.1-2

Precipitation means and extremes at Blanding, Utah[a]

Month	Total						
	Mean monthly		Maximum monthly		Greatest daily		Year
	cm	in.	cm	in.	cm	in.	
January	3.04	1.20	10.31	4.06	2.64	1.04	1952
February	2.95	1.16	4.39	1.73	2.62	1.03	1937
March	2.38	0.94	5.00	1.97	2.54	1.00	1937
April	2.18	0.86	5.41	2.13	2.69	1.06	1957
May	1.63	0.64	5.11	2.01	2.39	0.94	1947
June	1.39	0.55	5.51	2.17	3.56	1.40	1938
July	2.13	0.84	7.79	3.07	3.35	1.32	1930
August	3.02	1.19	12.59	4.96	5.03	1.98	1951
September	3.02	1.19	9.60	3.78	3.07	1.21	1933
October	3.51	1.38	16.79	6.61	3.94	1.55	1940
November	1.88	0.74	5.21	2.05	2.41	0.95	1946
December	3.20	1.26	9.29	3.66	3.56	1.40	1931

[a]Period of record: 1931-1960 (30 years).

Source: Adapted from U. S. NRC (1979) Final Environmental Statement, Page 2-2, Table 2.2.
Original Source: Plateau Resources, Limited, *Application for Source Material License*. Table 2.2-2, p. 2-8, Apr. 3, 1978.

1.2 TOPOGRAPHY

The following text is reproduced from Section 2.3 of the Final ES.

The site is located on a "peninsula" platform tilted slightly to the south-southeast and surrounded on almost all sides by deep canyons, washes, or river valleys. Only a narrow neck of land connects this platform with high country to the north, forming the foothills of the Abajo Mountains. Even along this neck, relatively deep stream courses intercept overland flow from the higher country. Consequently, this platform (White Mesa) is well protected from runoff flooding, except for that caused by incidental rainfall directly on the mesa itself. The land on the mesa immediately surrounding the White Mesa site is relatively flat.

1.3 ARCHEOLOGICAL RESOURCES

The following discussion of archeological sites is adapted from Section 2.5.2.3 of the Final ES.

1.3.1 Archeological Sites

Archeological surveys of portions of the entire project site were conducted between the fall of 1977 and the spring of 1979. The total area surveyed contained parts of Section 21, 22, 27, 28, 32, and 33 of T37S, R22E, and encompassed 2,000 acres (809 ha), of which 200 acres (81 ha) are administered by the U. S. Bureau of Land Management and 320 acres (130 ha) are owned by the State of Utah. The remaining acreage is privately owned. During the surveys, 121 sites were recorded and all were determined to have an affiliation with the San Juan Anasazi who occupied this area of Utah from 0 A.D. to 1300 A.D. All but 22 of the sites were within the project boundaries.

Table 1.3-1, adapted from Final ES Table 2.18, summarizes the recorded sites according to their probable temporal positions. The dates of occupation are the best estimates available, based on professional experience and expertise in the interpretation of archeological evidence. Available evidence suggests that settlement on White Mesa reached a peak in perhaps 800 A.D. Occupation remained at approximately that level until some time near the end of Pueblo II or in the Pueblo II/Pueblo III transition period. After this period, the population density declined sharply, and it may be assumed that the White Mesa was, for the most part, abandoned by about 1250 A.D.

Archeological test excavations were conducted by the Antiquities Section, Division of State History, in the spring of 1978, on 20 sites located in the area later to be occupied by tailings cells 2, 3 and 4. Of these sites, 12 were deemed by the State Archeologist to have significant National Register potential and four possible significance. The primary determinant of significance in this study was the presence of structures, though storage features and pottery artifacts were also common.

In the fall of 1978, a surface survey was conducted on much of the previously unsurveyed portions of the proposed mill site. Approximately 45 archeological sites were located during this survey, some of which are believed to be of equal or greater significance than the more significant sites form the earlier study. Determination of the actual significance of all untested sites would require additional field investigation.

TABLE 1.3-1

Distribution of Recorded Sites According to Temporal Position

Temporal position	Approximate dates (A.D.)*a*	Number of sites
Basket Maker III	575-750	2
Basket Maker III/Pueblo I	575-850	27
Pueblo I	750-850	12
Pueblo I/Pueblo II	850-950	13
Pueblo II	950-1100	14
Pueblo II/Pueblo III	1100-1150	12
Pueblo III	1150-1250	8
Pueblo II+	*b*	5
Multicomponent	*c*	3
Unidentified	*d*	14

a Includes transitional periods.

b Although collections at these locations were lacking in diagnostic material, available evidence indicates that the site would have been used or occupied no earlier than 900 A.D. and possibly later.

c Ceramic collections from each of these sites indicate an occupation extending from Pueblo I through Pueblo II and into Pueblo III.

d These sites did not produce evidence strong enough to justify any identification.

Source: Adapted from Dames & Moore (1978b) (ER), Table 2.3-2, U. S. NRC (1979) Final Environmental Statement, Page 2-20, Table 2.18, and from supplementary reports on project archeology.

Pursuant to 10 CFR Part 63.3, the NRC submitted on March 28, 1979, a request to the Keeper of the National Register for a determination of eligibility for the area which had been surveyed and tested. The area contained 112 archeological sites and six historical sites. The determination by the Keeper of the National Register on April 6, 1979, was that the White Mesa Archeological District is eligible for inclusion in the National Register.

1.3.2 Current Status of Excavation

Archeological investigations for the entire mill site and for Cells 1-I through Cell 4 were completed with the issuance of four separate reports covering 30 sites, excluding re-investigations. (Lindsay 1978, Nielson 1979, Casjens et al 1980, and Agenbroad et al 1981).

The sites reported as excavated are as follows:

6380	6394	6437
6381	6395	6684
6384	6396	6685
6385	6397	6686
6386	6403	6697
6387	6404	6698
6388	6420	6699
6391	6429	6754
6392	6435	6757
6393	6436	7754

Sites for which excavation has not been required are:

6379	6441	7658	7690
6382	6443	7659	7691
6405	6444	7660	7693

6379	6441	7658	7690
6382	6443	7659	7691
6405	6444	7660	7693

The sites remaining to be excavated are (continued):

6408	6445	7661	7696
6421	6739	7665	7700
6427	6740	7668	7752
6430	7653	7675	7876
6431	7655	7684	8014
6432	7656	7687	
6439	7657	7689	

1.4 SURFACE WATER

The following description of undisturbed surface water conditions is adapted from Section 2.6.1 of the Final ES. Since construction, the mill has been designed to prevent runon or runoff of storm water. No perennial surface water drainages exist on the site. The description of surface water quality in subsection 1.4.2 reflects baseline sampling performed in July 1977 - March 1978. Continuous monitoring of surface water is not possible due to lack of streamflow.

1.4.1 Surface Water Description (Final ES Section 2.6.1.1)

The mill site is located on White Mesa, a gently sloping (1% SSW) plateau that is physically defined by the adjacent drainages which have cut deeply into regional sandstone formations. There is a small drainage area of approximately 62 acres (25 ha) above the site that could yield surface runoff to the site. Runoff from the project area is conducted by the general surface topography to either

snowmelt and local rainstorms (particularly thunderstorms). Surface runoff from approximately 384 acres (155 ha) of the project site drains westward and is collected by Westwater Creek, and runoff from another 384 acres (155 ha) drains east into Corral Creek. The remaining 713 acres (289 ha) of the southern and southwestern portions of the site drain indirectly into Cottonwood Wash (Dames & Moore, 1978b, p. 2-143). The site and vicinity drainages carry water only on an intermittent basis. The major drainages in the project vicinity are depicted in Figure 1.4-1 and their drainages tabulated in Table 1.4-1. Total runoff from the site (total yield per watershed area) is estimated to be less than 0.5 inch (1.3cm) annually (Dames & Moore, 1978b, p. 2-143).

There are no perennial surface waters on or in the vicinity of the project site. This is due to the gentle slope of the mesa on which the site is located, the low average annual rainfall of 11.8 inches (29.7 cm) per year at Blanding (Dames & Moore, 1978b, p. 2-168), local soil characteristics and the porous nature of local stream channels. Prior to construction, three small ephemeral catch basins were present on the site to the northwest and northeast of the scale house.

Corral Creek is an intermittent tributary to Recapture Creek. The drainage area of that portion of Corral Creek above and including drainage from the eastern portion of the site is about 5 square miles (13 km^2). Westwater Creek is also an intermittent tributary of Cottonwood Wash. The Westwater Creek drainage basin covers nearly 27 square miles (70 km^2) at its confluence with Cottonwood Wash 1.5 miles (2.5 km) west of the project site. Both Recapture Creek and Cottonwood Wash are similarly intermittently active, although they carry water more often and for longer periods of time due to their larger watershed areas. They both drain to the south and are tributaries of the San Juan River. The confluences of Recapture Creek and Cottonwood Wash with the San Juan River are approximately 18 miles (29 km) south of the project site. The San Juan River, a major tributary for the upper Colorado River, has a drainage of 23,000 square miles

(60,000 km^2) measured at the USGS gauge to the west of Bluff, Utah (Dames & Moore, 1978b, p. 2-130).

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FIGURE 4-1
Drainage Map of the Vicinity of the White Mesa Mill

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CHKD BY	DATE Feb 1987	of
APP	SCALE As Shown	

● 1 USGS GAUGE NO. 09376900
● 2 USGS GAUGE NO. 09378630
● 3 USGS GAUGE NO. 09378700

TABLE 1.4-1

Drainage Areas of Project Vicinity and Region

Basin description	Drainage area	
	km²	sq. miles
Corra' ' at confluence with Recapture Creek	15.0	5.8
Westwater Creek at confluence with Cottonwood Wash	68.8	26.6
Cottonwood Wash at USGS gage west of project site	<531	<205
Cottonwood Wash at confluence with San Juan River	<860	<332
Recapture Creek at USGS gage	9.8	3.8
Recapture Creek at confluence with San Juan River	<518	<200
San Juan River at USGS gage downstream at Bluff, Utah	<60,000	<23,000

Source: Adapted from Dames & Moore (1978b), Table 2.6-3

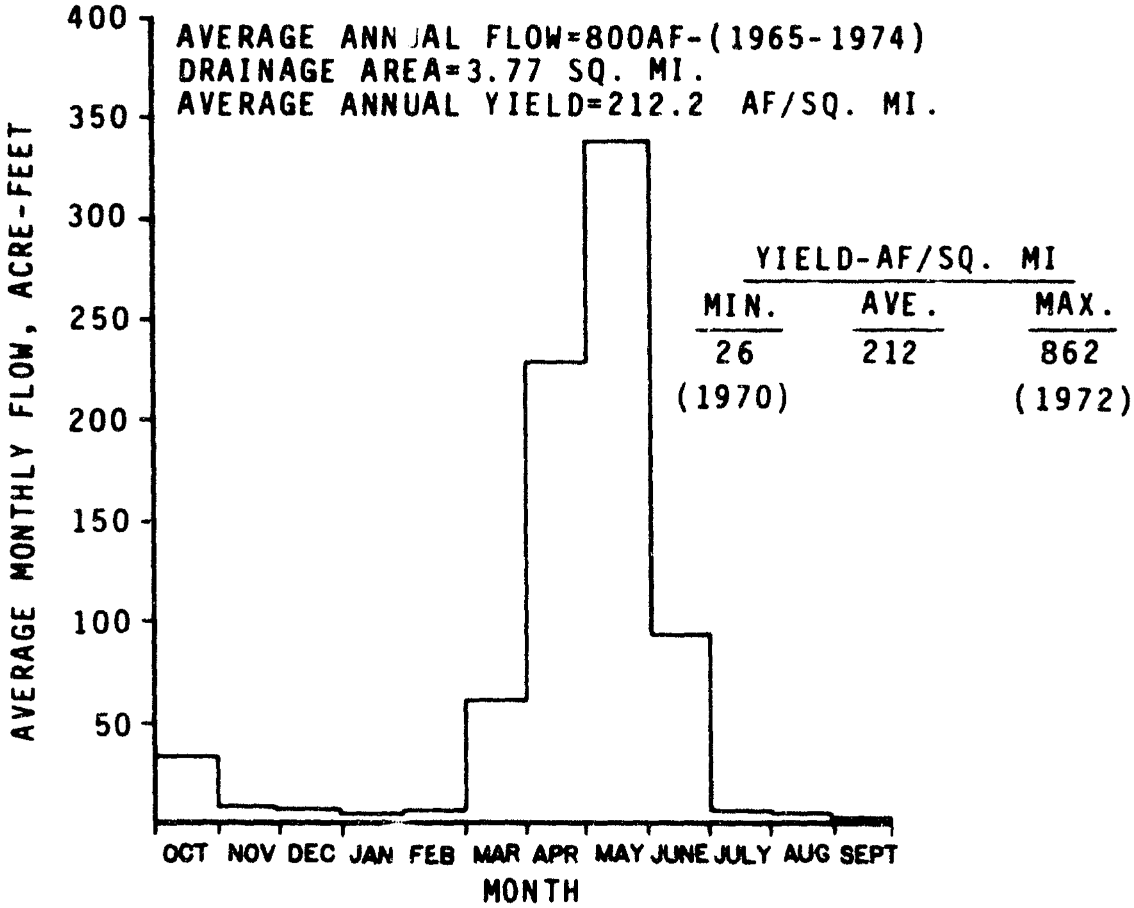
Storm runoff in these streams is characterized by a rapid rise in the flow rates, followed by rapid recession primarily due to the small storage capacity of the surface soils in the area. For example, on August 1, 1968, a flow of 20,500 cfs (581 m^3/sec) was recorded in Cottonwood Wash near Blanding. The average flow for that day, however, was only 4,340 cfs (123 m^3/sec). By August 4, the flow had returned to 16 cfs (0.5 m^3/sec) (Dames & Moore, 1978b, p. 2-135). Monthly streamflow summaries are presented in Figure 1.4-2 for Cottonwood Wash and Recapture Creek. Flow data are not available for the two smaller water courses closest to the project site, Corral Creek and Westwater Creek, because these streams carry water infrequently and only in response to local heavy rainfall and snowmelt, which occurs primarily in the months of April, August, and October. Flow typically ceases in Corral and Westwater Creeks within 6 to 48 hours after precipitation or snowmelt ends.

1.4.2 Surface Water Quality (Final ES Section 2.6.1.2)

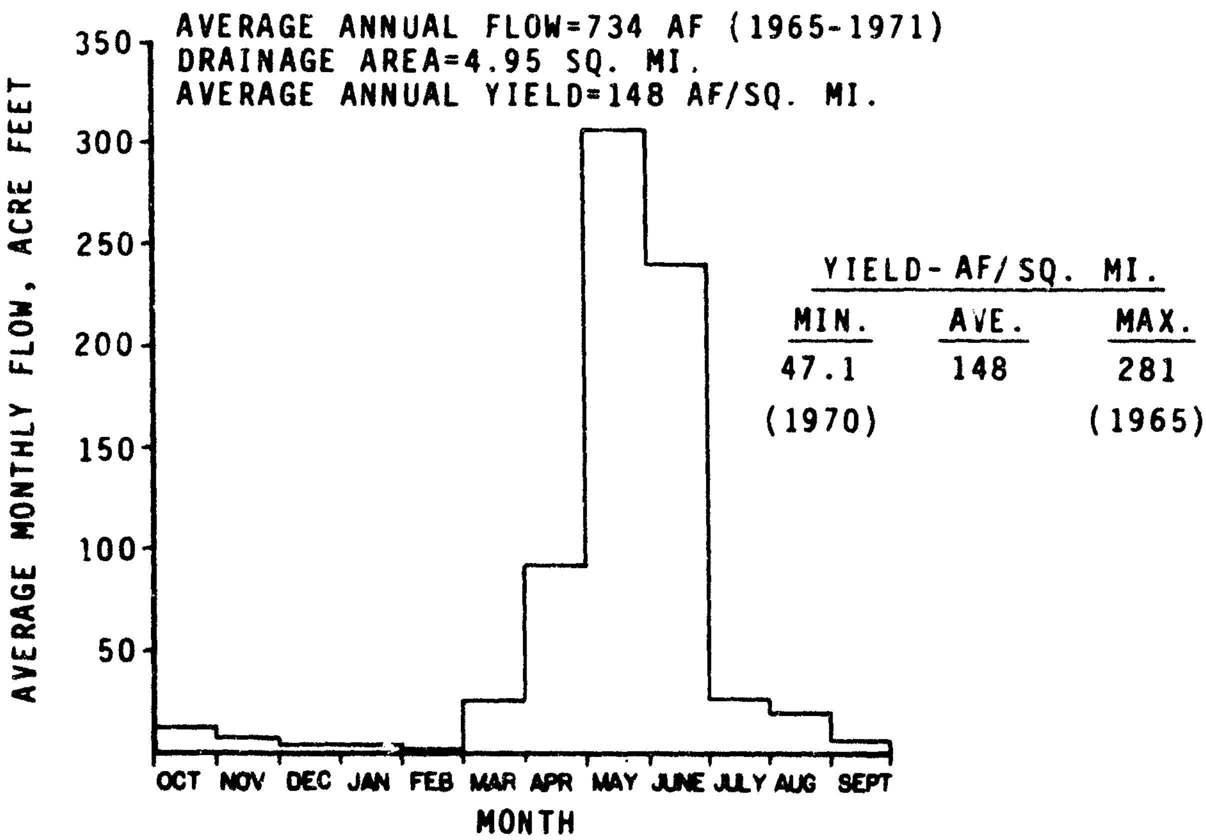
Sampling of surface water quality in the project vicinity began in July 1977 and continued through March 1978. Baseline data describe and evaluate existing conditions at the project site and vicinity. Sampling of the temporary on-site surface waters (two catch basins) has been attempted but without success because of the lack of naturally occurring water in these basins. The basin to the northeast of the mill site has been filled with well water to serve as a nonpotable water source during construction of office and laboratory buildings in conjunction with the mill (approximately six months). This water has not been sampled but presumably reflects the poor quality associated with local groundwater. Sampling of ephemeral surface waters in the vicinity was possible only during major precipitation events, as these streams are normally dry at other times.

The locations of the surface water sample sites are presented in Figure 1.4-3. The water quality values obtained for these sample sites are given in Dames & Moore (1978b) Table 2.6-7, and U.S. NRC (1979) Table 2.22. Water quality samples were collected during the spring at several intermittently active streams that drain the project area. These streams include Westwater Creek (S1R, S9) Corral Creek below the small irrigation pond (S3R), the junction of Corral Creek and Recapture Creek (S4R), and Cottonwood Creek (S8R). Samples were also taken from a surface pond southeast of the mill (S5R). No samples were taken at S2R on Corral Creek or at the small wash (S6R) located south of the site.

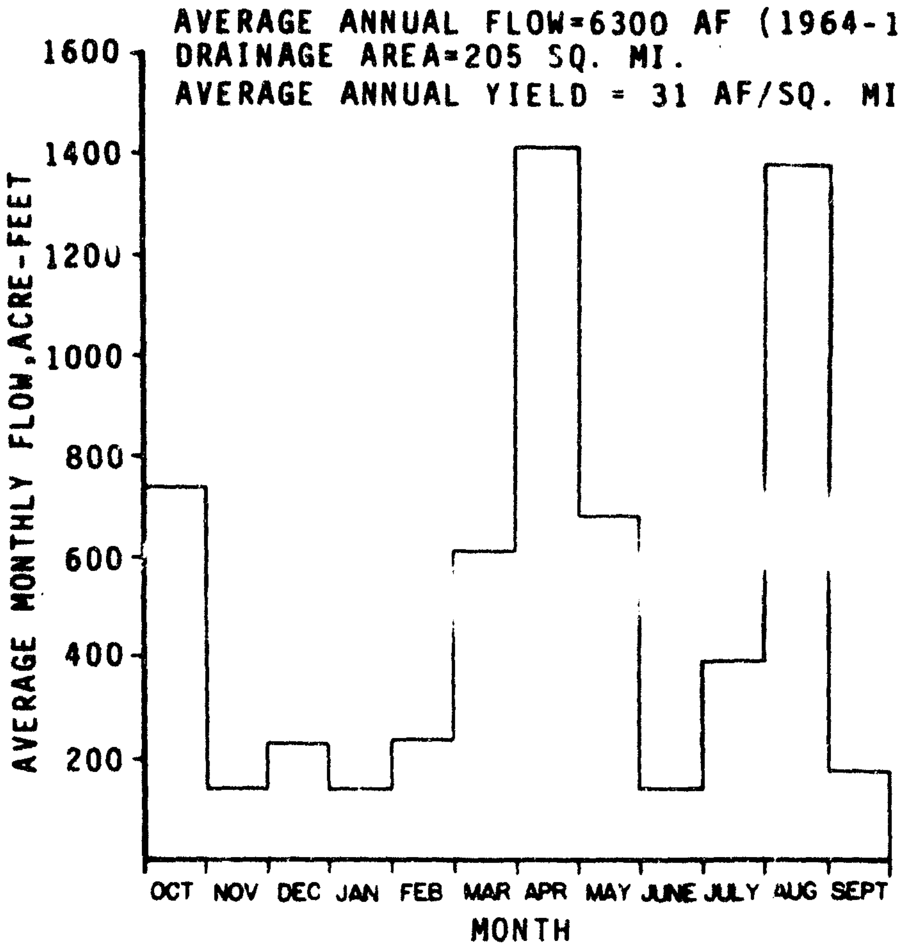
Surface water quality in the vicinity of the mill is generally poor. Waters in Westwater Creek (S1R and S9) were characterized by high total dissolved solids (TDS; mean of 674 mg/liter) and sulfate levels (mean 117 mg of SO_4 per liter). The waters were typically hard (total hardness measured as $CaCO_3$; mean 223 mg/liter) and had an average pH of 8.25. Estimated water velocities for Westwater Creek averaged 0.3 fps (0.08 m/sec) at the time of sampling.



RECAPTURE CREEK NEAR BLANDING
USGS GAUGE 09378630



SPRING CREEK ABOVE DIVERSIONS,
NEAR MONTICELLO
USGS GAUGE 09376900



COTTONWOOD WASH NEAR BLANDING
USGS GAUGE 09378700

YIELD-AF/SQ. MI.		
MIN.	AVE.	MAX.
6.7	31	100
(1969)		(1973)

NOTES

1. FOR THE LOCATION OF WATERCOURCES SUMMARIZED, SEE PLATE
2. SOURCE OF DATA. WATER RESOURCES DATA RECORDS. COMPILED AND PUBLISHED BY USGS

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FIGURE 1.4-2
Stream Flow Summary
in the Blanding, Utah Vicinity

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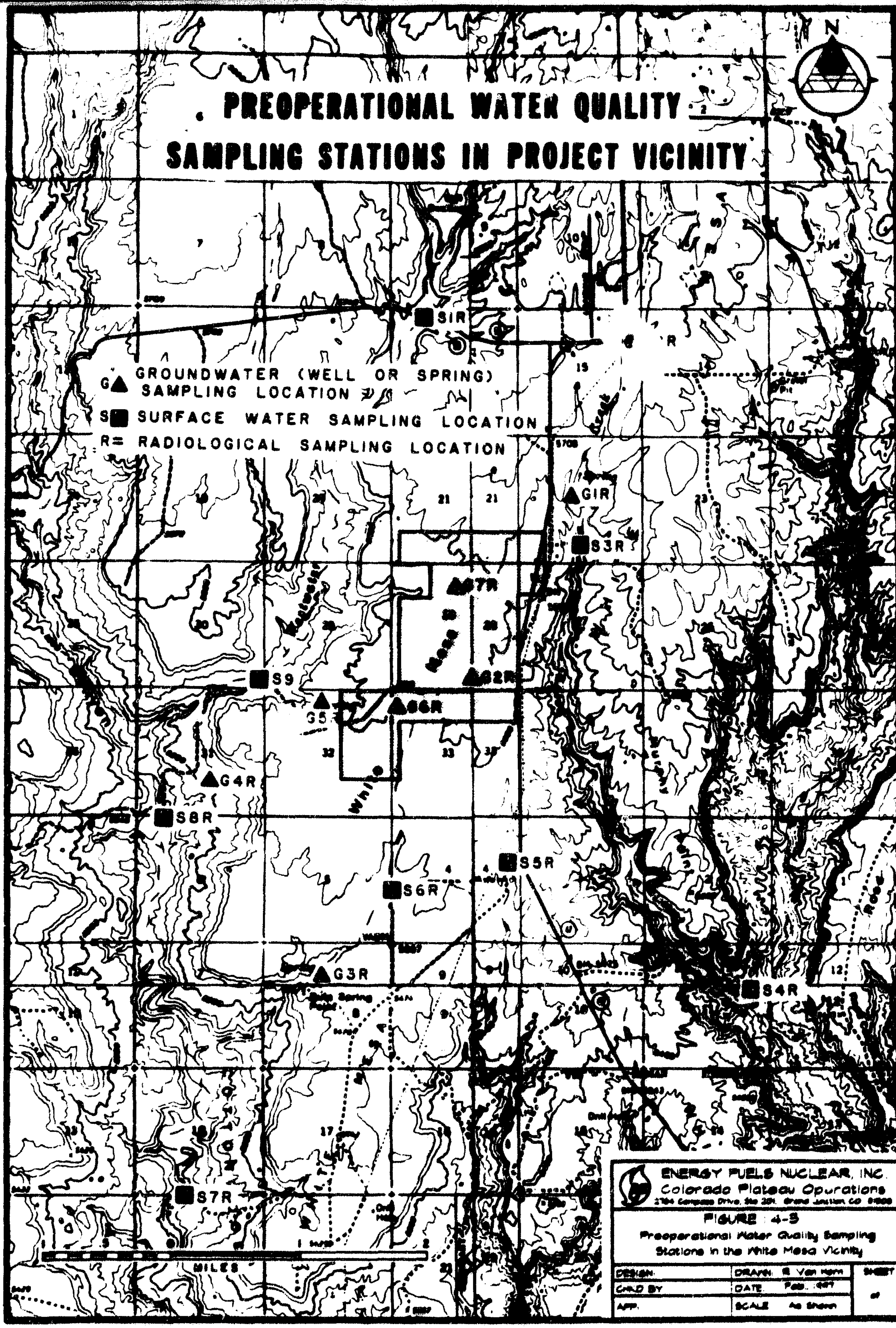
PREOPERATIONAL WATER QUALITY
SAMPLING STATIONS IN PROJECT VICINITY
N
G▲ GROUNDWATER (WELL OR SPRING) SAMPLING LOCATION
S■ SURFACE WATER SAMPLING LOCATION
R= RADIOLOGICAL SAMPLING LOCATION
S1R
G1R
S3R
G7R
G2R
S9
G5
G6R
G4R
S8R
S5R
S6R
G3R
S4R
S7R
MILES
ENERGY FUELS NUCLEAR, INC.
Colorado Plateau Operations
FIGURE 4-3
Preoperational Water Quality Sampling Stations in the White Mesa Vicinity
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DRAWN
CHKD BY
DATE
APP.
SCALE As Shown
SHEET

Samples from Cottonwood Creek (S8R) were similar in quality to Westwater Creek water samples, although the TDS and sulfate levels were lower (TDS averaged 264 mg/liter; SO_4 averaged 40 mg/liter) during heavy spring flow conditions [80 fps (24 m/sec) water velocity].

The concentrations of TDS increased downstream in Corral Creek, averaging 3,180 mg/liter at S3R and 6,660 mg/liter (one sample) at S4R. Total hardness averaged in excess of 2,000 mg/liter, and pH values were slightly alkaline. Estimated water velocities in Corral Creek were typically less than 0.1 fps (0.03 [illegible]) during sampling.

The spring sample collected a the surface pond south of the project site (S5R) indicated a TDS concentration of less than 300 mg/liter. The water was slightly alkaline with moderate dissolved sulfate levels averaging 42 mg/liter.

During heavy runoff, the concentration of total suspended solids in these streams increased sharply to values in excess of 1,500 mg/liter (U.S. NRC 1979, Table 2.22). High concentrations of certain trace elements were measured in some sampling areas. Levels of mercury (total) were reported as high as 0.002 mg/liter (S3R, 7/25/77; S8R, 7/25/77). Total iron measured in the pond (S5R, 11/10/77) was 9.4 mg/liter. These values appear to reflect groundwater quality in the vicinity and are probably due to evaporative concentration and not due to human perturbation of the environment.

1.5 GROUNDWATER

The following descriptions of groundwater occurrence and characteristics in and around the White Mesa Mill is a summary and compilation of information contained in documents previously submitted to and reviewed by the U.S. NRC. These include the Final ES, the Hydrogeologic

Evaluation of White Mesa Uranium Mill ("Hydrogeologic Evaluation") (Titan, 1994a), Points of Compliance, White Mesa Uranium Mill ("POC") (Titan, 1994b), the Semi-Annual Effluent Report for July through December 1995 and the Semi-Annual Effluent Report for January through June 1996 ("Semi-annual Effluent Reports") (Energy Fuels Nuclear, Inc.).

The Hydrogeologic Evaluation referenced numerous technical studies: Regional geologic and geohydrologic data were obtained primarily from U.S. Geologic Survey (U.S.G.S.) and State of Utah publications; Site-specific information was obtained from the 1978 Environmental Report (Dames & Moore); a 1992 groundwater study report submitted to the NRC by Umetco; a 1991 groundwater hydrology report on White Mesa prepared by Hydro-Engineering; and reports by D'Appolonia (1981, 1982, and 1984). See the Hydrogeologic Evaluation, transmitted herewith in its entirety as Appendix B, for complete data tables, lists of references, and technical details described in this section.

This section is primarily an adaptation of the Hydrogeologic Evaluation. For ease of reference, a copy of the Hydrogeologic Evaluation is included as Appendix B. The POC is included as Appendix C. The Hydrogeologic Evaluation focused on description and definition of the site hydrostratigraphy, and occurrence of groundwater as it relates to the natural and manmade safeguards which protect groundwater resources from potential leakage of tailings cells at the site. The POC summarized and statistically analyzed the available groundwater database, and proposed a revised groundwater monitoring and data review program.

The findings of the Hydrogeologic Evaluation indicated that the tailings located in the existing disposal cells are not impacting groundwater at the site. In addition, it does not appear that future impacts to groundwater would be expected as a result of continuing operations.

These conclusions are based on chemical and hydrogeologic data which show that:

1. The chemistry of perched groundwater encountered below the site does not show concentrations or increasing trends in concentrations of constituents that would indicate seepage from the existing disposal cells;

2. The useable aquifer at the site is separated from the facility by about 1,200 feet of unsaturated, low-permeability rock;

3. The useable aquifer is under artesian pressure and, therefore, has an upward pressure gradient which would preclude downward migration of constituents into the aquifer; and

4. The facility has operated for a period of 16 years and has caused no discernible impacts to groundwater during this period.

Continued monitoring of groundwater at the site are performed to verify that past, current, and future operations will not impact groundwater. The existing monitoring program and results are presented in the Semi-annual Effluent reports (Appendix A).

1.5.1 Site Description

As shown on Figure 1.1-2, White Mesa Uranium Mill is located in southeastern Utah, approximately six miles south of the town of Blanding. It is situated on White Mesa, a flat area bounded on the east by Corral Canyon, to the west by Westwater Creek, and to the south by Cottonwood Canyon. The site consists of the uranium processing mill, and four engineered lined tailings disposal cells.

1.5.2 Geologic Setting

The White Mesa Uranium Mill site is located near the western edge of the Blanding Basin within the Canyon Lands section of the Colorado Plateau physiographic province (Figure 1.5-1, Hydrogeologic Evaluation Figure 1.1). The Canyon Lands have undergone broad, fairly horizontal uplift and subsequent erosion which have produced the region's characteristic topography represented by high plateaus, mesas, buttes and deep canyons incised into relatively flat lying sedimentary rocks of pre-Tertiary age. Elevations range from approximately 3,000 feet in the bottoms of the deep canyons along the southwestern margins of the region to more than 11,000 feet in the Henry, Abajo and La Sal mountains located to the northwest and northeast of the facility. With the exception of the deep canyons and isolated mountain peaks, an average elevation slightly in excess of 5,000 feet persists over most of the Canyon Lands. The average elevation at the White Mesa Uranium Mill is 5,600 feet mean sea level (MSL).

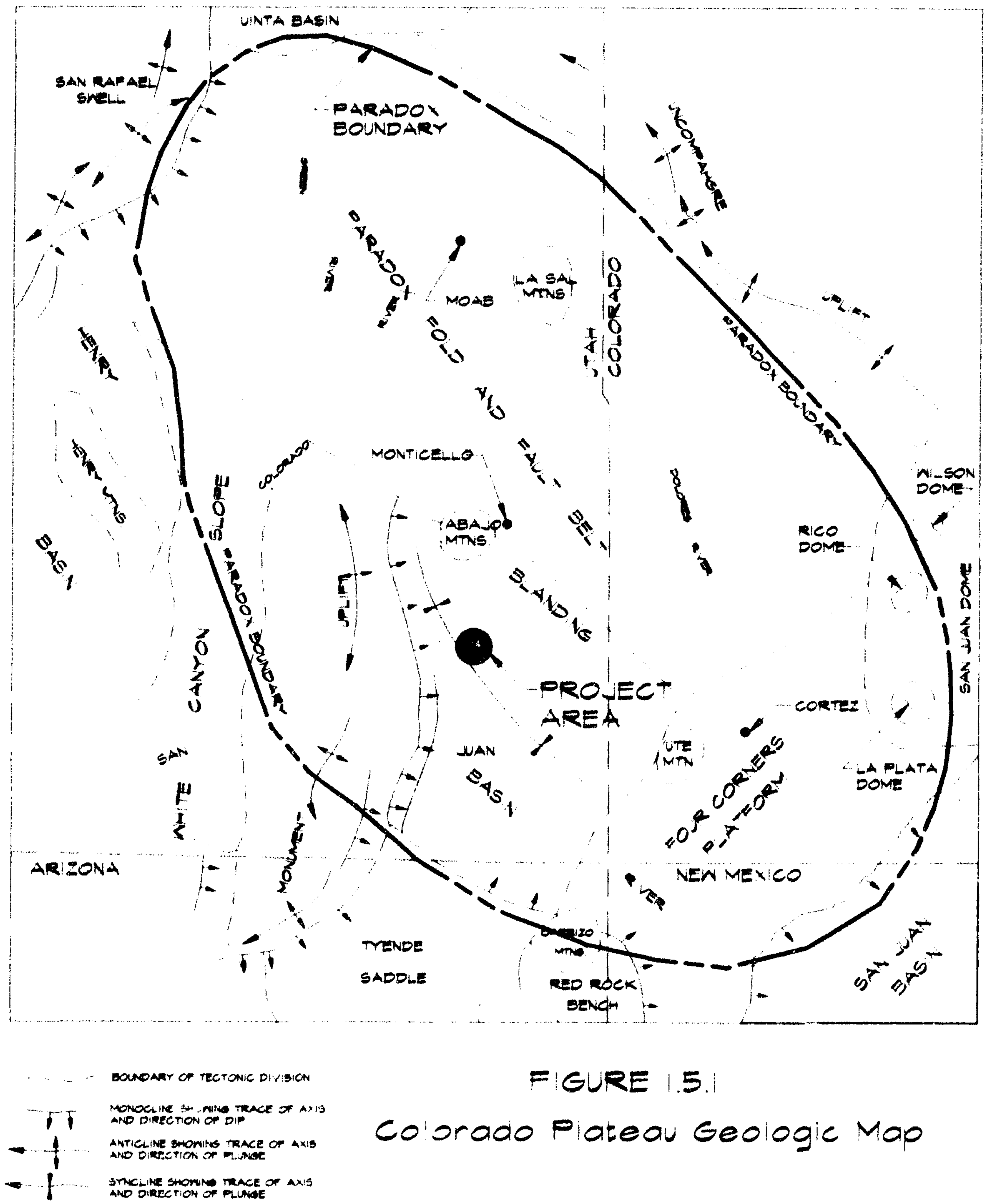

FIGURE 1.5.1

Colorado Plateau Geologic Map

1.5.2.1 Stratigraphy

Rocks of Upper Jurassic and Cretaceous age are exposed in the canyon walls in the vicinity of the White Mesa Uranium Mill site. These rock units (Figure 1.5-2, Hydrogeologic Evaluation Figure 1.2) include, in descending order, the following. Eolian sand of Quaternary Age and varying thickness overlies the Dakota sandstone and Mancos shale on the mesa. A thin deposit of talus derived from rock falls of Dakota sandstone and Burro Canyon formation mantles the lower valley flanks. Underlying these units are the Cretaceous Age erosional remnants of Mancos shale, Dakota Sandstone, and Burro Canyon formation. Erosional remnants of Mancos shale are only found north of the Mill site. The Brushy Basin, Westwater Canyon, Recapture and Salt Wash Members of the per Jurassic Age Morrison formation are encountered below the Burro Canyon formation. The Summerville formation, Entrada Sandstone and Navajo Sandstone are the deepest units of concern encountered at the site.

1.5.2.2 Local Geologic Structure

In general, the rock formations of the region are flat-lying with dips of 1 to 3 degrees. The rock formations are incised by streams that have formed canyons between intervening areas of broad mesas and buttes. An intricate system of deep canyons along and across hog-backs and cuestas has resulted from faulting, upwarping and dislocation of rocks around the intrusive rock masses, such as the Abajo Mountains. Thus the region is divided up into numerous hydrological areas controlled by structural features.

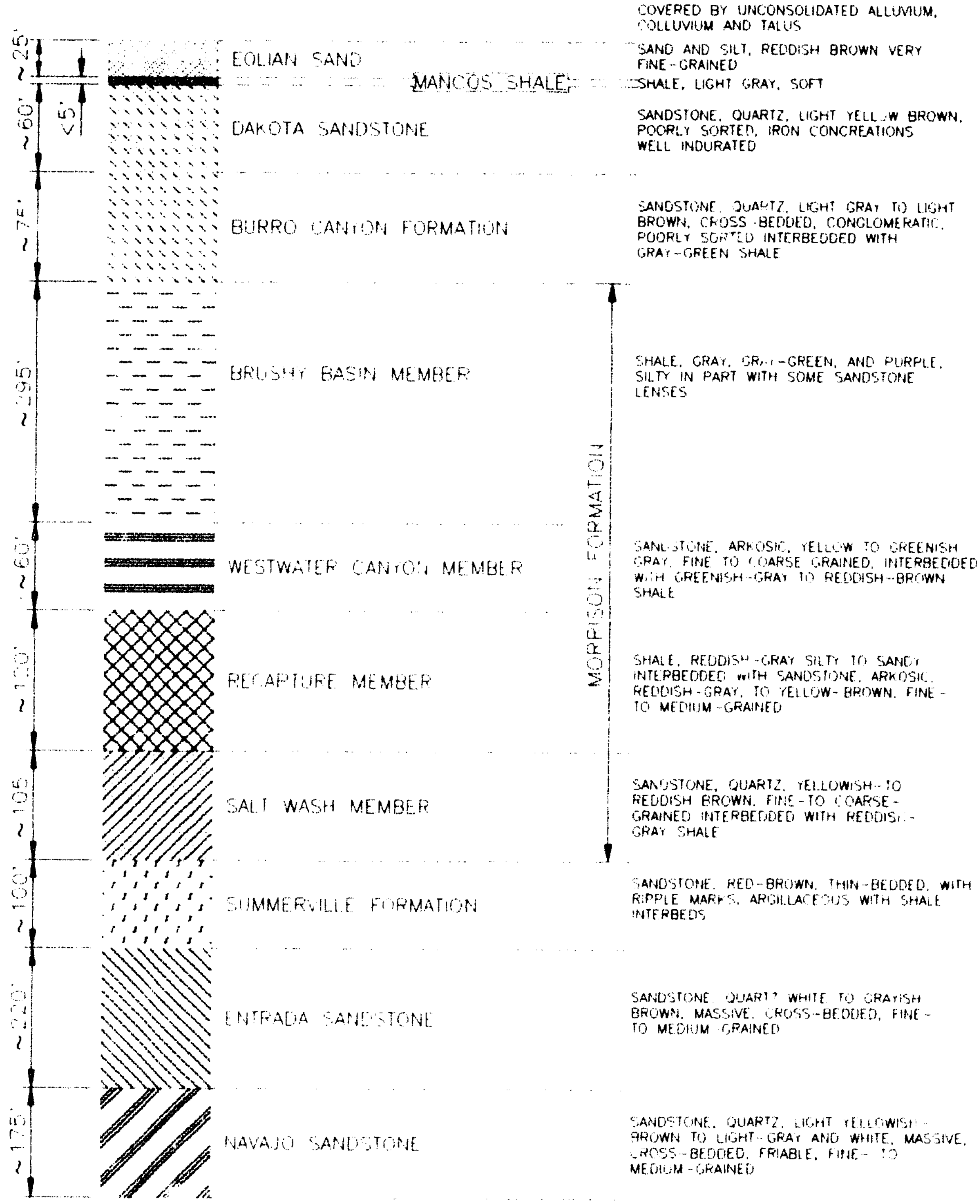

FIGURE 1.5-2

Generalized Stratigraphy of White Mesa

The strata underlying White Mesa have a regional dip of 1/2 to 1 degrees to the south; however, local dips of 5 degrees have been measured. Haynes, et al (1972) includes a map showing the structure at the base of the Dakota formation. Approximately 25 miles to the north, the Abajo Mountains, formed by igneous intrusions, have caused local faulting, upwarping, and displacement of the sedimentary section. However, no faults have been mapped in the immediate vicinity of White Mesa.

1.5.3 Hydrogeologic Setting

On a regional basis, the formations that are recognized as aquifers are: Cretaceous-age Dakota Sandstone and the upper part of the Morrison formation of late Jurassic age; the Entrada Sandstone, and the Navajo Sandstone of Jurassic age; the Wingate Sandstone and the Shinarump Member of the Chinle formation of Triassic age; and the DeChelle Member of the Cutler formation of Permian age.

Recharge to aquifers in the region occurs by infiltration of precipitation into the aquifers along the flanks of the Abajo, Henry and La Sal Mountains and along the flanks of folds, such as Comb Ridge Monocline and the San Rafael Swell, where the permeable formations are exposed at the surface (Figure 1.5-1, Hydrogeologic Evaluation Figure 1.1).

Seventy-six groundwater appropriation applications, within a five-mile radius of the Mill site, are on file with the Utah State Engineer's office. A summary of the applications is presented in Table 1.5-1 and shown on Figure 1.5-3. The majority of the applications is by private individuals and for wells drawing small, intermittent quantities of water, less than eight gpm, from the Burro Canyon formation. For the most part, these wells are located upgradient (north) of the White Mesa Uranium Mill site. Stockwatering and irrigation are listed as primary uses of the majority

of the wells. It is important to note that no wells completed in the perched groundwater of the Burro Canyon formation exist directly downgradient of the site within the five-mile radius. Two water wells which available data indicate are completed in the Entrada/Navajo sandstone (Clow, 1997), exist approximately 4.5 miles southeast of the site on the Ute Mountain Ute Reservation. These wells supply domestic water for the Ute Mountain Ute White Mesa Community, situated on the mesa along Highway 191 (see Figure 1 5-3). Data supplied by the Tribal Environmental Programs Office indicate that both wells are completed in the Entrada/Navajo sandstone, which is approximately 1,200 feet below the ground surface. Insufficient data are available to define the groundwater flow direction in the Entrada/Navajo sandstone in the vicinity of the mill.

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Table 1.5-1
Wells Located Within A 5-Mile Radius of
The White Mesa Uranium Mill

Map No.	Water Right	SEC	TWP	RNG	CFS	USE	Depth (ft.)
1	Nielson, Norman and Richard C.	11	37S	22E	0.015	IDS	150-200
2	Guymon, Willard M.	10	37S	22E	0.015	S	82
3	Nielson, J. Rex	10	37S	22E	0.015	IDS	160
4	Nielson, J. Rex	10	37S	22E	0.013	S	165
5	Lyman, Fred S.	10	37S	22E	0.022	IDS	120
6	Plateau Resources	15	37S	22E	0.015	O	740
7	Plateau Resources	15	37S	22E	0.015	O	135
8	Nielson, Norman and Richard C.	14	37S	22E	0.015	IS	150-200
9	Lyman, George F.	15	37S	22E	0.015	S	135
10	Holt, N.E., McLaws, W.	15	37S	22E	0.007	S	195
11	Perkins, Dorothy	21	37S	22E	0.015	S	150
12	Energy Fuels Nuclear, Inc.	21	37S	22E	0.6	O	1600
13	Energy Fuels Nuclear, Inc.	22	37S	22E	1.11	O	1820
14	Utah Launch Complex	27	37S	22E	0.015	D	650
15	Energy Fuels Nuclear, Inc.	28	37S	22E	1.11	O	1885
16	Energy Fuels Nuclear, Inc.	28	37S	22E	1.11	O	1850
17	Energy Fuels Nuclear, Inc.	28	37S	22E	0.015	DSO	1800
18	Energy Fuels Nuclear, Inc.	28	37S	22E	0.6	O	1600
19	Jones, Alma U.	33	37S	22E	0.015	S	200
20	Energy Fuels Nuclear, Inc.	33	37S	22E	0.6	O	1600
21	BLM	8	37S	22E	0.01	S	170
22	Halliday, Fred L.	11	37S	22E	0.015	IS	180
23	Perking, Paul	2	37S	22E	0.015	ID	180
24	Redd, James D.	2	37S	22E	0.1	ID	200
25	Brown, Aroe G.	1	37S	22E	0.015	IS	210
26	Brown, George	1	37S	22E	0.015	IDS	140

Table 1.5-1
Wells Located Within A 5-Mile Radius of
The White Mesa Uranium Mill
(continued)

Map No.	Water Right	SEC	TWP	RNG	CFS	USE	Depth (ft.)
27	Brown, Llo M	1	37S	22E	0.004	IDS	141
28	Rentz, Alyce M.	1	37S	22E	0.015	ID	180
29	Rogers, Clarence	2	37S	22E	0.015	S	142
30	Perkins, Dorothy	2	37S	22E	0.015	S	100-200
31	Brandt J.R. & C.J.	1	37S	22E	0.015	IDS	160
32	Montella, Frank A.	3	37S	22E	0.015	IDO	190
33	Snyder, Bertha	1	37S	22E	0.1	IDS	196
34	Martineau, Stanley D.	1	37S	22E	0.015	ID	160
35	Kirk, Ronald D. & Catherine A.	1	37S	22E	0.015	IDS	160
36	Palmer, Ned J. and Marilyn	1	37S	22E	0.015	IDS	0
37	Grover, Jess M.	1	37S	22E	0.015	S	160
38	Monson, Larry	1	37S	22E	0.015	IDS	140
39	Neilson, Norman and Richard	1	37S	22E	0.015	IS	132
40	Watkins, Henry Clyde	1	37S	22E	0.015	IS	150
41	Shumway, Glen & Eve	15	37S	22E	0.015	IS	60
42	Energy Fuels Nuclear, Inc. (not drilled)	21	37S	22E	0.600	O	1600
43	Energy Fuels Nuclear, Inc. (#1)	28	37S	22E	1.100	O	1860
44	Watkins, Ivan R	1	37S	22E	0.200	S	185
45	Waukesha of Utah	3	37S	22E	0.015	D	226
46	Simpson, William	3	37S	22E	0.030	ID	180
47	Guyman, Willard M.	2	37S	22E	0.030	S	164
48	Harrieson, Lynda	2	37S	22E	0.012	IDS	---
49	Hurst, Reed	2	37S	22E	0.015	D	100-300
50	Kaer, Alvin	2	37S	22E	0.015	IDS	100-300
51	Heiner, Gerald B.	2	37S	22E	0.015	ID	75
52	Laws, James A.	2	37S	22E	0.015	IDS	100-300

Table 1.5-1
Wells Located Within A 5-Mile Radius of
The White Mesa Uranium Mill
(continued)

Map No.	Water Right	SEC	TWP	RNG	CFS	USE	Depth (ft.)
53	Laws, J. Parley	2	37S	22E	0.015	IDS	
54	Anderson, Dennis & Edith	2	37S	22E	0.015	IDS	160
55	Guymon, Eugene	2	37S	22E	0.100	IDS	130
56	Guymon, Eugene	2	37S	22E	0.015	S	130
57	Guymon, Dennis & Doris	2	37S	22E	0.030	IDS	210
58	Guymon, Eugene	2	37S	22E	0.115	IDS	100-200
59	Guymon, Eugene	2	37S	22E	0.115	IDS	100-200
60	Perkins, Dorothy	2	37S	22E	0.015	IDS	140
61	Watkins, Ivan R.	1	37S	22E	0.015	IDS	145
62	Roper, Lloyd	34	36S	22E	0.015	ID	180
63	Smith, Lee & Marylynn	34	36S	22E	0.060	IDS	170
64	McDonald, Kenneth P.	34	36S	22E	0.015	IDS	734
65	Brake, John	34	36S	22E	0.015	ID	250
66	Brake, John	34	36S	22E	0.015	IS	150
67	Redd, Parley V. & Reva V.	34	36S	22E	0.015	IS	200
68	C & C Construction	34	26S	22E	0.015	IS	190
69	Guymon, Dean W.	3	37S	22E	0.015	IDS	180
70	Phillips, Elizabeth Ann Hurst	34	36S	22E	0.015	I	165
71	Howe, Leonard R.	3	37S	22E	0.015	O	160
72	Shumway, Mark Eugene	3	37S	22E	0.015	ID	
73	Shumway, Mark Eugene	3	37S	22E	0.015	IDS	150
74	Lyman, Henry M.	3	37S	22E	0.100	IDS	200
75	Uta Mountain Ute	23	38S	22E	0.535	D	-
76	Ute Mountain Ute	23	38S	22E	0.1606	D	1515

Notes:

D - Domestic
I - Irrigation
S - Stockwatering
O - Industrial
SEC - Section
TWP - Township
RNG - Range
CFS - Cubic Feet Per Second

The well yield from wells completed in the Burro Canyon formation within the White Mesa site is generally lower than that obtained from wells in this formation upgradient of the site. For the most part, the documented pumping rates from on-site wells completed in the Burro Canyon formation are less than 0.5 gpm. Even at this low rate, the on-site wells completed in the Burro Canyon formation are typically pumped dry within a couple of hours.

This low productivity suggests that the White Mesa Uranium Mill is located over a peripheral fringe of perched water; with saturated thickness in the perched zone discontinuous and generally decreasing beneath the site, and with conductivity of the formation being very low. These observations have been verified by studies performed for the U.S. Department of Energy's disposal site at Slick Rock, which noted that the Dakota Sandstone, Burro Canyon formation, and upper claystone of the Brushy Basin Member are not considered aquifers due to the low permeability, discontinuous nature, and limited thickness of these units (U.S. DOE, 1993).

1.5.3.1 Hydrostratigraphy

The site stratigraphy is described above in Section 1.5.2.1. The detailed site stratigraphic column with descriptions of each geologic unit is provided on Figure 1.5-2. The following discussion, adapted from the Hydrogeologic Evaluation, focuses on those geologic units at or in the vicinity of the site which have or may have groundwater present.

The presence of groundwater within and in proximity to the site has been documented in three strata: the Dakota Sandstone, the Burro Canyon formation, and the Entrada/Navajo Sandstone. The Burro Canyon formation hosts perched groundwater over the Brushy Basin Member of the Morrison formation at the site.

The Entrada/Navajo Sandstones form one of the most permeable aquifers in the region. This aquifer is separated from the Burro Canyon formation by the Morrison formation and Summerville formation. Water in this aquifer is under artesian pressure and is used by the site's operator for industrial needs and consumption. The artesian conditions present in this aquifer are discussed in Section 1.5.6.4.

Geologic cross sections which illustrate the stratigraphic position of the Entrada/Navajo Sandstone aquifer and intervening strata are shown on Figures 1.5.3-1, 1.5.3-2, and 1.5.3-3 (from Hydrogeologic Evaluation Figures 2.1, 2.2, and 2.3, respectively). The summary of the borehole information supporting the site's stratigraphy, description of the drilling information and boring logs are presented in Appendix A of the Hydrogeologic Evaluation. With the exception of six deep water supply wells installed at various locations around the site and completed in Entrada/Navajo Sandstone, all of the boring data are from wells drilled through the Dakota/Burro Canyon Sandstones and terminated in the Brushy Basin Member. The drilling and logging data indicate that the physical characteristics of the bedrock vary considerably, both vertically and laterally. The following sections discuss the relevance of those strata and their physical characteristics to the site's hydrogeology.

Dakota Sandstone

The Dakota Sandstone is a low- to moderately-permeable formation that produces acceptable quality water at low production rates. Water from this formation is typically used for stock water and/or irrigation.

The Dakota Sandstone is the uppermost stratum in which the tailings disposal cells are sited. At the ground surface, the Dakota Sandstone is overlain by a veneer of reddish-brown clayey or sandy silts

with a thickness of up to 10 feet and extends to depths of 43 to 66 feet below the surface (D'Appolonia, 1982). The Dakota Sandstone at this site is typically composed of moderately hard to hard sandstones with random discontinuous shale (claystone) and siltstone layers. The sandstones are moderately cemented (upper part of formation) to well cemented with kaolinitic clays. The claystones and siltstones are typically 2 to 3 feet thick, although boring WMMW-19 encountered a siltstone layer having a thickness of 8 feet at 33 to 41 feet below the ground surface.

Porosity of the Dakota Sandstone is predominately intergranular. Laboratory tests performed (see Table 1.5.3.1-1, from Hydrogeologic Evaluation Table 2.1) show the total porosity of the sandstone varies from 13.4 to 26.0 percent with an average value of 19.9 percent. The formation is very dry to dry with volumetric water contents varying from 0.6 to 7.1 percent with an average value of 3.0 percent. Saturation values for the Dakota Sandstone vary from 3.7 to 27.2 percent. The hydraulic conductivity values as determined from packer tests range from 9.12E-04 centimeters per second (cm/sec) to 2.71E-06 cm/sec with a geometric mean of 3.89E-05 cm/sec (Dames & Moore, 1978; Umetco, 1992). A summary of hydraulic properties of the Dakota Sandstone is presented in Table 1.5.3.1-2 (Hydrogeologic Evaluation Table 2.2).

Table 1.5.3.1-1
Properties of the Dakota/Burro Canyon Formation
White Mesa Uranium Mill

Formation	Well No. and Sample Interval		Moisture Content (Percent)	Mosture Content Volumetric	Dry Unit Weight (lbs/cu ft)	Porosity (Percent)	Particle Sp. Gr.	Saturation (Percent)	Retained Moisture (Percent)	Liquid Limit (Percent)	Plastic Limit (Percent)	Plasticity Index (Percent)	Rock Type
Dakota	WMMW-16	26.4' - 38.4'	1.5	3.3	135.2	17.9	2.64	18.2	5.1				Sandstone
	WMMW-16	37.8' - 38.4'	0.4	0.8	127.4	22.4	2.63	3.7	6.3				Sandstone
	WMMW-17	27.0' - 27.5'	0.3	0.6	138.8	13.4	2.57	4.8	5.1				Sandstone
	WMMW-17	49.0' - 49.5'	3.6	7.1	121.9	26.0	2.64	27.2	9.6				Sandstone
Burro Canyon	WMMW-16	45.0' - 45.5'	5.6	12.6	140.9	16.4	2.70	77.2		29.6	15.4	14.2	Sandy Mudstone
	WMMW-16	47.5' - 48.0'	2.6	5.9	142.8	12.0	2.60	48.9	4.4				Sandstone
	WMMW-16	53.5' - 54.1'	0.7	1.4	129.0	19.9	2.58	7.1	6.4				Sandstone
	WMMW-16	60.5' - 61.0'	0.1	0.2	117.9	27.3	2.61	0.8	9.9				Sandstone
	WMMW-16	65.5' - 66.0'	2.6	5.5	131.5	19.3	2.62	28.2	7.1				Sandstone
	WMMW-16	73.0' - 73.5'	0.1	0.3	130.3	20.6	2.63	1.3	5.5				Sandstone
	WMMW-16	82.0' - 82.4'	0.1	0.1	134.3	18.5	2.64	0.6	4.8				Sandstone
	WMMW-16	90.0' - 90.7'	0.1	0.3	161.5	2.0	2.64	12.8	0.9				Sandstone
	WMMW-16	91.1' - 91.4'	5.2	9.8	118.1	29.1	2.67	33.8		33.7	16.2	17.5	Claystone
	WMMW-17	104.0' - 104.5'	0.2	0.4	161.4	1.7	2.67	26.6	0.8				Sandstone
Average:			**1.65**	**3.4**	**135**	**17.6**	**2.63**	**21**	**5.5**				

Adapted from: Table 2.1, Hydrogeologic Evaluation.

Table 1.5.3.1-2
Summary of Hydraulic Properties
White Mesa Mill

Boring/Well Location	Test Type	Interval (ft. - ft.)	Document Referenced	Hydraulic Conductivity (ft./yr.)	Hydraulic Conductivity (cm./sec.)
Soils					
6	Laboratory Test	9	D&M	1.2E+01	1.2E-05
7	Laboratory Test	4.5	D&M	1.0E+01	1.0E-05
10	Laboratory Test	4	D&M	1.2E+01	1.2E-05
12	Laboratory Test	9	D&M	1.4E+02	1.4E-04
16	Laboratory Test	4.5	D&M	2.2E+01	2.1E-05
17	Laboratory Test	4.5	D&M	9.3E+01	9.0E-05
19	Laboratory Test	4	D&M	7.0E+01	6.8E-05
22	Laboratory Test	4	D&M	3.9E+00	3.8E-06
			Geometric Mean	2.45E+01	2.37E-05
Dakota Sandstone					
No. 3	Injection Test	28-33	D&M (1)	5.68E+02	5.49E-04
No. 3	Injection Test	33-42.5	D&M	2.80E+00	2.71E-06
No. 12	Injection Test	16-22.5	D&M	5.10E+00	4.93E-06
No. 12	Injection Test	22.5-37.5	D&M	7.92E+01	7.66E-05
No. 19	Injection Test	26-37.5	D&M	7.00E+00	6.77E-06
No. 19	Injection Test	37.5-52.5	D&M	9.44E+02	9.12E-04
			Geometric Mean	4.03E+01	3.89E-05
Burro Canyon Formation					
No. 3	Injection Test	42.5-52.5	D&M	5.80E+00	5.61E-06
No. 3	Injection Test	52.5-63	D&M	1.62E+01	1.57E-05
No. 3	Injection Test	63-72.5	D&M	5.30E+00	5.13E-06
No. 3	Injection Test	72.5-92.5	D&M	3.20E+00	3.09E-06

Table 1.5.3.1-2
Summary of Hydraulic Properties
White Mesa Mill
(continued)

Boring/Well Location		Test Type	Interval (ft. - ft.)		Document Referenced		Hydraulic Conductivity (ft./yr.)	Hydraulic Conductivity (cm./sec.)
No. 3		Injection Test	92.5-107.5		D&M		4.90E+00	4.74E-06
No. 3		Injection Test	122.5-142		D&M		6.00E+01	5.80E-07
No. 9		Injection Test	27.5-42.5		D&M		2.70E+00	2.61E-06
No. 9		Injection Test	42.5-59		D&M		2.00E+00	1.93E-06
No. 9		Injection Test	59-82.5		D&M		7.00E+01	6.77E-07
No. 9		Injection Test	82.5-107.5		D&M		1.10E+00	1.06E-06
No. 9		Injection Test	107.5-132		D&M		3.00E+01	2.90E-07
No. 12		Injection Test	37.5-57.5		D&M		9.01E+01	8.70E-07
No. 12		Injection Test	57.5-82.5		D&M		1.40E+00	1.35E-06
No. 12		Injection Test	82.5-102.5		D&M		1.07E+01	1.03E-05
No. 28		Injection Test	76-87.5		D&M		4.30E+00	4.16E-06
No. 28		Injection Test	87.5-107.5		D&M		3.00E+01	2.90E-07
No. 28		Injection Test	107.5-132.5		D&M		2.00E+01	1.93E-07
WMMW1	(7)	Recovery	92-112		Peel	(2)	3.00E+00	2.90E-06
WMMW3	(7)	Recovery	67-87		Peel		2.97E+00	2.87E-06
WMMW5	(7)	Recovery	95.5-133.5		H-E		1.31E+01	1.27E-05
WMMW5	(7)	Recovery	95.5-133.5		Peel		2.10E+01	2.03E-05
WMMW11	(7)	Recovery	90.7-130.4		H-E	(3)	1.23E+03	1.19E-03
WMMW11	(7)	Single well drawdown	90.7-130.4		Peel		1.63E+03	1.58E-03
WMMW12	(7)	Recovery	84-124		H-E		6.84E+01	6.61E-05
WMMW12	(7)	Recovery	84-124		Peel		6.84E+01	6.61E-05
WMMW14		Single well drawdown	90-120	(5)	H-E		1.21E+03	1.16E-03
WMMW14		Single well drawdown	90-120	(6)	H-E		4.02E+02	3.88E-04
WMMW15		Single well drawdown	99-129		H-E		3.65E+01	3.53E-05
WMMW15	(7)	Recovery	99-129		Peel		2.58E+01	2.49E-05
WMMW16		Injection Test	28.5-31.5		Peel		9.42E+02	9.10E-04
WMMW16		Injection Test	45.5-51.5		Peel		5.28E+01	5.10E-05

Table 1.5.3.1-2
Summary of Hydraulic Properties
White Mesa Mill
(continued)

Boring/Well Location	Test Type	Interval (ft. - ft.)	Document Referenced		Hydraulic Conductivity (ft./yr.)	Hydraulic Conductivity (cm./sec.)
WMMW16	Injection Test	65.5-71.5	Peel		8.07E+01	7.80E-05
WMMW16	Injection Test	85.5-91.5	Peel		3.00E+01	2.90E-05
WMMW17	Injection Test	45-50	Peel		3.10E+00	3.00E-06
WMMW17	Injection Test	90-95	Peel		3.62E+00	3.50E-06
WMMW17	Injection Test	100-105	Peel		5.69E+00	5.50E.06
WMMW18	Injection Test	27-32	Peel		1.14E+02	1.10E-04
WMMW18	Injection Test	85-90	Peel		2.69E+01	2.60E-05
WMMW18	Injection Test	120-125	Peel		4.66E+00	4.50E-06
WMMW19	Injection Test	55-60	Peel		8.69E+00	8.40E-06
WMMW19	Injection Test	95-100	Peel		1.45E+00	1.40E-06
			Geometric Mean		1.05E+01	1.01E-05
Entrada Navajo Sandstones						
WW-1	Recovery		D'Appolonia	(4)	3.80E+02	3.67E-04
WW-1	Multi-well drawdown		D'Appolonia		4.66E+02	4.50E-04
WW-1,2,3	Multi-well drawdown		D'Appolonia		4.24E+02	4.10E-04
			Geometric Mean		4.22E+02	4.08E-04

Notes:

(1) D&M = Dames & Moore, Environmental Report, White Mesa Uranium Project, January, 1978.
(2) Peel = Peel Environmental Services, UMETCO Minerals Corp., Ground Water Study, White Mesa Facility, June 1994.
(3) H-E= Hydro-Engineering, Ground-Water Hydrology at the White Mesa Tailings Facility, July, 1991.
(4) D'Appolonia, Assessment of the Water Supply System, White Mesa Project, Feb. 1981.
(5) Early test data.
(6) Late test data.
(7) Test data reanalyzed by TEC.

Adapted from: Table 2.2. Hydrogeologic Evaluation.

Burro Canyon Sandstone

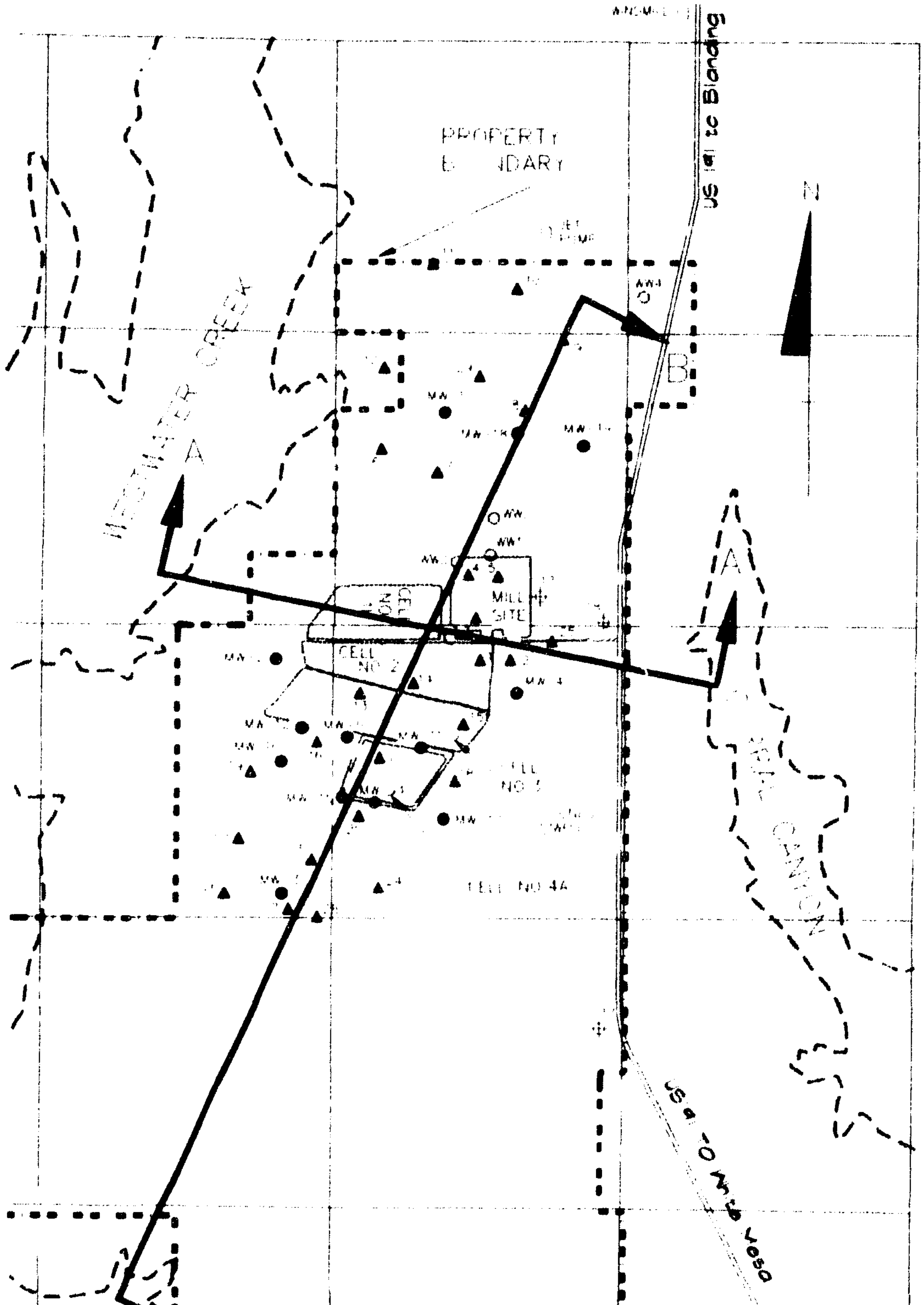
Directly below the Dakota Sandstone, the borings encountered sandstones and random discontinuous shale layers of the Burro Canyon formation to depths of 91 to 141 feet below the site. The importance of this stratum to the site's hydrogeology is that it hosts perched water beneath the site. Beneath the Burro Canyon formation, the Brushy Basin Member is composed of variegated bentonitic mudstone and siltstone; its permeability is lower than the overlying Burro Canyon formation and prevents downward percolation of groundwater (Haynes, et al, 1972). Observed plasticity of claystones (Umetco, 1992) forming the Brushy Basin Member indicates low potential for open fractures which could increase permeability. Section 1.5.3.2 contains a summary of a drilling program carried out in response to agency requests to obtain additional hydrogeologic data.

Previous investigators have seldom made a distinction between the Dakota and Burro Canyon Sandstones. However, examination of borehole cuttings, cores and geophysical logging methods has allowed separation of the two formations. Although similar to the Dakota, the Burro Canyon formation varies from a very fine- to coarse-grained sandstone. The sand grains are generally poorly sorted. The coarse-grained layers also tend to be conglomeratic. The grains are cemented with both silica and kaolin, but silica-cemented sandstones are dominant. The formation becomes argillaceous near the contact with the Brushy Basin Member.

The saturated thickness in the Burro Canyon formation varies across the project area from 55 feet in the northern section to less than 5 feet in the southern area. Some wells are dry, which suggests that the zone of saturation is not continuous. Saturation ceases or is marginal along the western and southern section of the project. The extent toward the east is not defined, but its maximum extent is certainly not beyond the walls of Westwater Creek and Corral Canyons where the Burro Canyon

formation crops out. Perched groundwater elevations and saturated thickness of this formation are shown on Figures 1.5.3.1-4 and 1.5.3.1-5, respectively (from Hydrogeologic Evaluation Figures 2.4 and 2.5).

Hydraulic properties of this stratum have been determined from 12 single, well-pumping/recovery tests and from 30 packer tests. A summary of the hydraulic properties is given in Table 1.5.3.1-2 (Hydrogeologic Evaluation Table 2.2). These tests indicate the hydraulic conductivity geometric mean to be 1.0E-05 cm/sec. The physical properties of the Burro Canyon Sandstone are summarized in Table 1.5.3.1-1. Based on the core samples tested, the sandstones of the Burro Canyon formation vary in total porosity from 1.7 to 27.6 percent, the average being 16.0 percent. Volumetric water content in these sandstones ranges from 0.1 to 7.1 percent, averaging 2.2 percent, with the fine-grained materials having the higher moisture content. Porosities in the claystone layers vary from 16.4 to 29.1 percent with saturation values ranging from 33.8 to 77.2 percent.



▲ DAMES AND MOORE 1978 BORINGS

○ WW4 WATER SUPPLY WELLS D'APPOLONIA (1981)

● MW EXISTING MONITORING WELLS

EXISTING WATER SUPPLY WELLS

STOCK WELLS

FIGURE 1.5.3.1-1

White Mesa Mill
Site Plan Map showing
Monitor Wells and Borings

SCALE

2000 0 2000 4000 feet

Brushy Basin Member

The Brushy Basin Member of the Morrison formation is the first aquitard isolating perched water in the Burro Canyon formation from the productive Entrada/Navajo Sandstones. The Brushy Basin Member, in contrast to the overlying Dakota Sandstone, is composed of bentonitic mudstone and claystone. Limited site-specific hydraulic property data are available for the Brushy Basin Member.

The thickness of the Brushy Basin Member in this region reportedly varies from 200-450 feet (Dames & Moore, 1978). This stratum was penetrated by six water supply wells [see Figure 1.5.3.1-1 (Hydrogeologic Evaluation Figure 2.1)]and Appendix A of the Hydrogeologic Evaluation) and its thickness was estimated at 275 feet. Borings which terminate in the Brushy Basin Member encounter moderately plastic dark green to dark reddish-brown mudstones. Plastic bentonitic mudstone is not prone to develop fracturing. Hence, competency of this strata, as an aquitard, is very likely.

Entrada/Navajo Aquifer

Within and in proximity to the site, the Entrada/Navajo Sandstones are both prolific aquifers. Since site water wells are screened in both aquifers, they are, from a hydrogeologic standpoint, treated as a single aquifer. The Entrada/Navajo Sandstone is the first useable aquifer of significance documented within the project area. This aquifer is present at depths between 1,200 and 1,800 feet below the surface and is capable of delivering from 150 to 225 gpm of water per well (D'Appolonia, 1981).

Water is present under artesian pressure and is documented to rise by about 800 to 900 feet above the top of Entrada/Navajo Sandstone contact with the overlying Summerville formation. The static water level is about 400 to 500 feet below the surface (Figures 1.5.3.1-2 and 1.5.3.1-3). Section 1.5.6.4. provides a more detailed discussion regarding the artesian conditions of this formation.

The thickness of the strata separating this aquifer from water present in the Burro Canyon formation is about 1,200 feet. This confining layer is competent enough to maintain pressure of 900 feet of water or 390 pounds per square inch (psi) within the Entrada/Navajo Aquifer.

The positioning of this aquifer and its hydraulic head versus other strata is shown on Figures 1.5.3.1-2 and 1.5.3.1-3. In-situ hydraulic pressure of groundwater in the Entrada/Navajo Aquifer is strong evidence of the confining (i.e. "aquitard") properties of the overlying sedimentary section. Due to the presence of significant artesian pressure in this aquifer, any future hydraulic communication between perched water in the Burro Canyon formation and the Entrada/Navajo Aquifer is unlikely.

1.5.3.2 Data Collected in 1994

This subsection contains a summary of a 1994 drilling program carried out in response to a request by the U. S. Nuclear Regulatory Commission (NRC) and the U. S. Environmental Protection Agency (EPA) to further investigate the competence of the Brushy Basin member of the Morrison formation and to provide additional hydrogeologic data. Three vertical and four angle core holes were drilled.

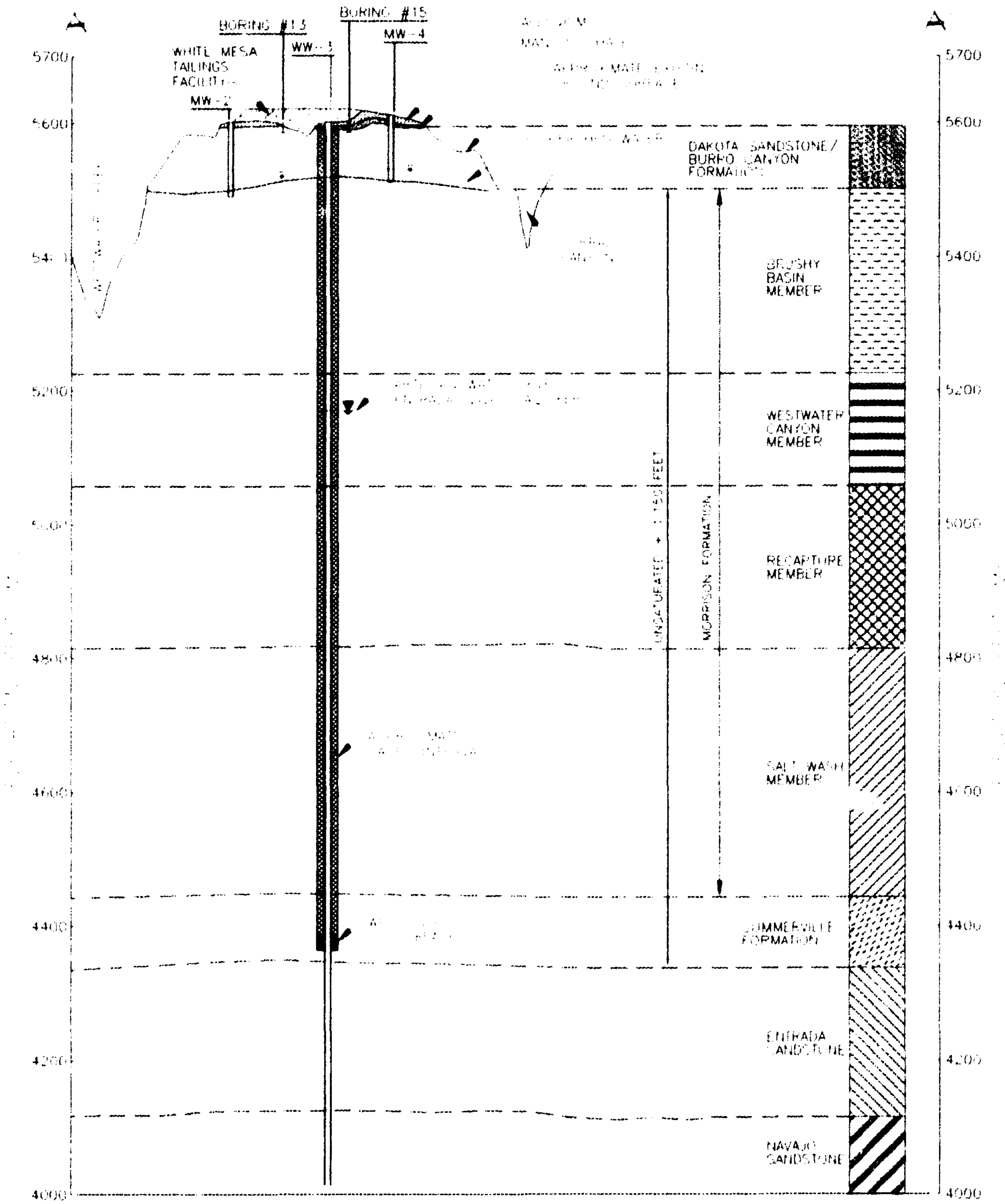


FIGURE 1.5.3.1-2

White Mesa Mill
Section A-A'

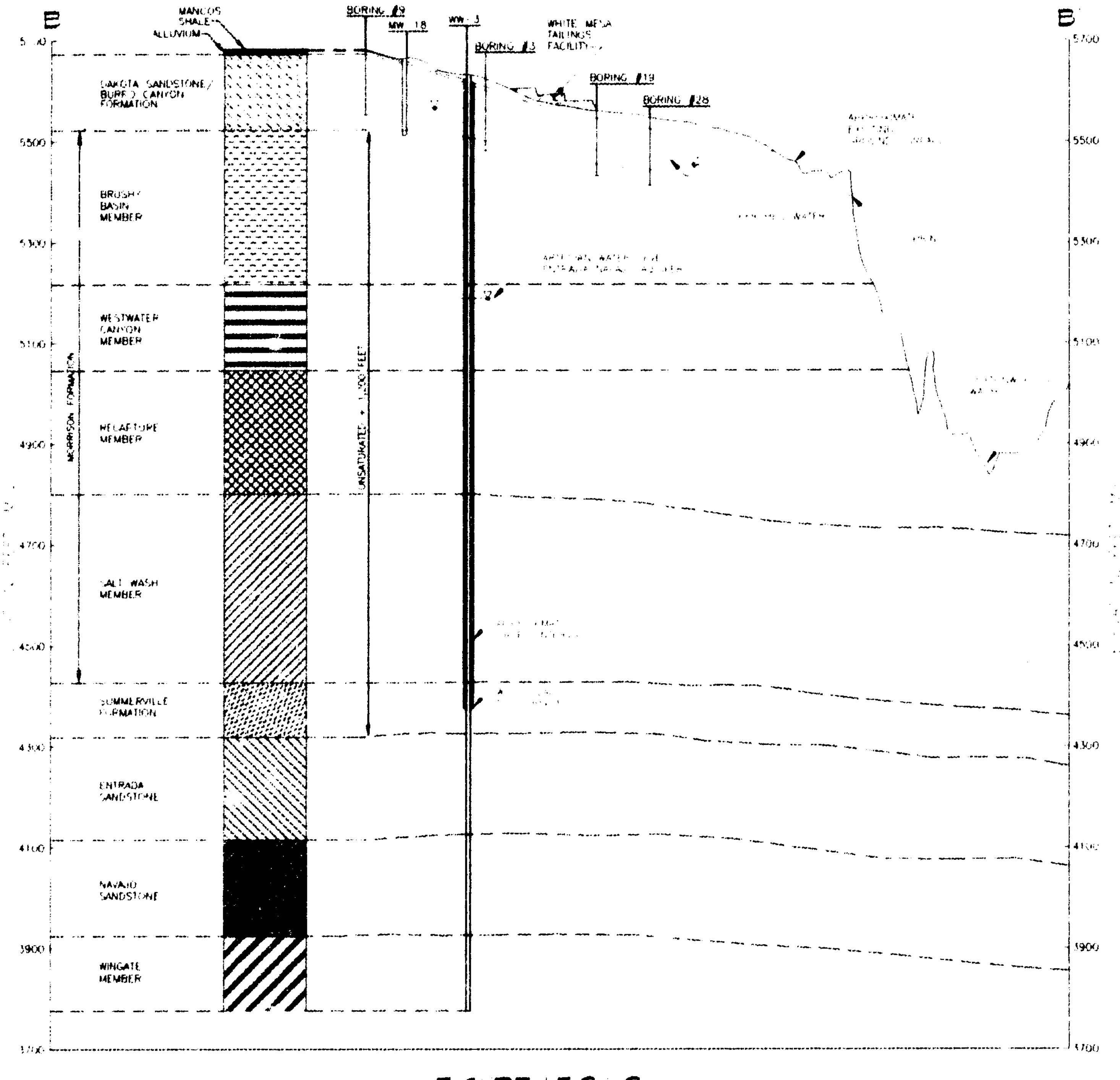


FIGURE 1.5.3.1-3
White Mesa Mill
Section B-B'

The three vertical holes (WMMW-20, WMMW-21, and WMMW-22) were drilled downgradient of the existing monitoring wells. Constant head packer tests were conducted over intervals within the Brushy Basin member to gain information about the horizontal hydraulic conductivity of this unit. Selected cores samples of the Brushy Basin member were analyzed for vertical hydraulic conductivities. The three vertical holes were drilled to sufficient depth to penetrate 20± feet of Brushy Basin Member. Four core holes were drilled along the edge of tailings ponds No. 3 and No. 4. The cores were examined to determine if open fractures were present. Few fractures were observed, and where noted, they were closed and infilled with gypsum. Packer tests were conducted during the drilling of the holes to gain further information about the hydraulic conductivity of the rocks.

Upon completion of drilling, all the geotechnical holes were logged using wireline geophysical methods. A video camera survey was performed in three of the four core holes. The holes were then plugged and abandoned.

Selected cores of the Brushy Basin from all the holes were sent for laboratory measurement of the vertical permeability. The results of these tests are presented in Table 1.5.3.2-1. The hydraulic conductivities calculated from these tests vary from 7.10E-06 cm/sec to 8.90E-04 cm/sec in the Dakota formation, from 9.88E-07 cm/sec to 7.70E-04 cm/sec in the Burro Canyon formation and from 2.30E-07 cm/sec to 1.91E-06 cm/sec in the Brushy Basin member. Three packer tests run within the Brushy Basin member yielded "No Take." Due to the low hydraulic conductivities, measurements could not be made with the equipment available. The hydraulic conductivities of these zones can be expected to be lower than the zones in which actual measurements were made. It can, therefore, be assumed that the hydraulic conductivities of these zones are less than 2.30E-07

cm/sec. Packer tests tend to reflect horizontal hydraulic conductivities which can be expected to be greater than vertical hydraulic conductivities of the same zone.

Slug tests were conducted in wells WMMW-20 and WMMW-22. The test results are shown in Table 1.5.3.2-1. A hydraulic conductivity of 3.14E-06 cm/sec was calculated for WMMW-20 and 9.88E-07 cm/sec (essentially 1.0E-06 cm/sec) for WMMW-22.

Cores from the Brushy Basin were sent to Western Engineers of Grand Junction, Colorado for horizontal and vertical permeability determination. The results of these tests are shown on Table 1.5.3.2-2. The vertical hydraulic conductivities of the cores vary from 5.95E-04 to 7.28E-11 cm/sec. The geometric mean of the vertical permeabilities is 1.23E-08 cm/sec.

For the few analyses conducted for horizontal permeabilities, the results ranged from 1.09E-07 to 6.14E-10 cm/sec and the geometric mean of these values was calculated to be 6.72E-09 cm/sec.

Packer tests were conducted over zones within the Dakota, Burro Canyon and Brushy Basin units. The cores and video surveys of the drill holes showed that the few closed hairline fractures present in the Burro Canyon and Dakota Formations do not substantially affect the hydraulic conductivity of the formations.

TABLE 1.5.3.2-1
Summary of Borehole Tests, 1994 Drilling Program
White Mesa Project, San Juan County, Utah

Well No	Interval	Type of Test	Formation	Hydraulic Conductivity gpd/ft^2	Hydraulic Conductivity cm/sec
WMMW-20	110.5-114.5	Constant Head	Brushy Basin	0.005	2.30E-07
	87.0-90.0	Slug	Burro Canyon	0.015	5.29E-06
WMMW-21	109.5-117.0	Constant Head	Brushy Basin	0.17	8.15E-06
WMMW-22	130.0-140.0	Constant Head	Brushy Basin	-No Take-	
	76-120	Slug	Burro Canyon	0.06	3.14E-06
GH-94-1	34.0-40.0	Constant Head	Dakota	0.16	7.10E-06
	40 -50.0	Constant Head	Dakota	1.18	5.60E-05
	70.0-80.0	Constant Head	Burro Canyon	0.01	9.88E-07
	92.0-100	Constant Head	Burro Canyon	13.1	6.20E-04
	103.0-110.0	Constant Head	Burro Canyon	15.84	7.70E-04
	130.0-140.0	Constant Head	Brushy Basin	3.6	1.70E-04
	163.0-165.0	Constant Head	Brushy Basin	-No Take-	
GH-94-2A	34.0-40.0	Constant Head	Dakota	0.66	3.10E-05
	32.5-40.0	Constant Head	Dakota	18.72	8.90E-04
	50.0-56.0	Constant Head	Dakota	2.30	1.10E-04
	60.0-70.0	Constant Head	Burro Canyon	1.04	4.90E-05
	70.0-80.0	Constant Head	Burro Canyon	4.18	2.00E-04
	80.0-90.0	Constant Head	Burro Canyon	3.02	1.50E-04
	138.0-144.0	Constant Head	Brushy Basin	-No Take-	
GH-94-3	155.0-161.0	Constant Head	Brushy Basin	0.07	3.26E-06
	138.0-144.0	Constant Head	Brushy Basin	0.06	2.70E-06

TABLE 1.5.3.2-2
Results of Laboratory Tests

Well No.	Interval Tested (ft)	Formation Tested	Vertical Permeabilities cm/sec
WMMW-20	92.0-92.5	Brushy Basin	7.96E-11
	95.4-96.0	Brushy Basin	2.96E-09
	104.0-104.4	Brushy Basin	2.43E-09
	105.0-105.5	Brushy Basin	7.28E-11
	109.5-110.0	Brushy Basin	1.02E-09
WMMW-21	94.8-95.3	Brushy Basin	5.78E-06
	106.5-107.0	Brushy Basin	6.38E-10
	114.5-115.0	Brushy Basin	1.46E-07
WMMW-22	122.2-122.7	Brushy Basin	1.08E-06
	126.3-127.2	Brushy Basin	6.94E-10
	133.3-133.7	Brushy Basin	2.11E-09
	137.3-137.8	Brushy Basin	5.95E-04
GH-1	163.0-163.5	Brushy Basin	1.68E-08
	165.0-165.5	Brushy Basin	6.76E-07
GH-2A	161.0-161.5	Brushy Basin	6.73E-09
GH-3	157.0-157.5	Brushy Basin	9.42E-10
GH-4	158.0-158.5	Brushy Basin	2.17E-09

Well No.	Interval Tested (ft)	Formation Tested	Horizonal Permeabilities cm/sec
WMMW-20	95.4-96.0	Brushy Basin	1.09E-07
	105.0-105.5	Brushy Basin	6.14E-10
WMMW-21	94.8-95.3	Brushy Basin	8.31E-10
WMMW-22	137.3-137.8	Brushy Basin	3.67E-08

1.5.4 Climatological Setting

The climate of southeastern Utah is classified as dry to arid continental. The region is generally typified by warm summer and cold winter temperatures, with precipitation averaging less than 11.8 inches annually and evapotranspiration in the range of 61.5 inches annually (Dames and Moore, 1978).

Precipitation in southeastern Utah is characterized by wide variations in seasonal and annual rainfall and by long periods of no rainfall. Short duration summer storms furnish rain in small areas of a few square miles and this is frequently the total rainfall for an entire month within a given area. The average annual precipitation in the region ranges from less than 8 inches at Bluff to more than 16 inches on the eastern flank of the Abajo Mountains, as recorded at Monticello. The mountain peaks in the Henry, La Sal and Abajo Mountains may receive more than 30 inches of precipitation, but these areas are very small in comparison to the vast area of much lower precipitation in the region

1.5.5 Perched Groundwater Characteristics

The perched water in the Burro Canyon formation originates in the areas north of the site as shown by the direction of groundwater flow from north to south (see Figure 1.5.5-1). The thickness of saturation is greatest in the northern and central sections of the site and reduces toward the south. The configuration of the perched water table and map of saturated thicknesses are provided on Figures 1.5.5-1 and 1.5.5-2, respectively. The topography of the Brushy Basin Member which defines the bottom of the perched water is shown on Figure 1.5.5-3 (Hydrogeologic Evaluation Figure 2.6).

The groundwater from the Burro Canyon formation discharges into the adjacent canyons (Westwater Creek and Corral Canyon) as evidenced by springs and productive vegetation patterns. Some part of the groundwater flow may enter the Brushy Basin Member via relief fractures which occur in close proximity to the canyons. The location of the canyons which bound the White Mesa on the west, east and south are shown on Figure 1.5.3-1.

The geometric mean of the hydraulic conductivity of the saturated part of Burro Canyon formation is 1.0E-05 cm/sec. The water yield per well is very low, as documented by nine pumping tests, and is typically below 0.5 gpm. In contrast to the very low pumping rates observed in eight wells, Well WMMW-11 produced a higher yield on the order of 2 gpm. This higher yield may be attributable to the presence of localized high-permeability material, such as a lense of coarser material acting as a drainage gallery. Localized fracturing could also cause a similar effect, but few fractures have been documented during drilling of this or other wells (Umetco, 1992; Dames & Moore, 1978).

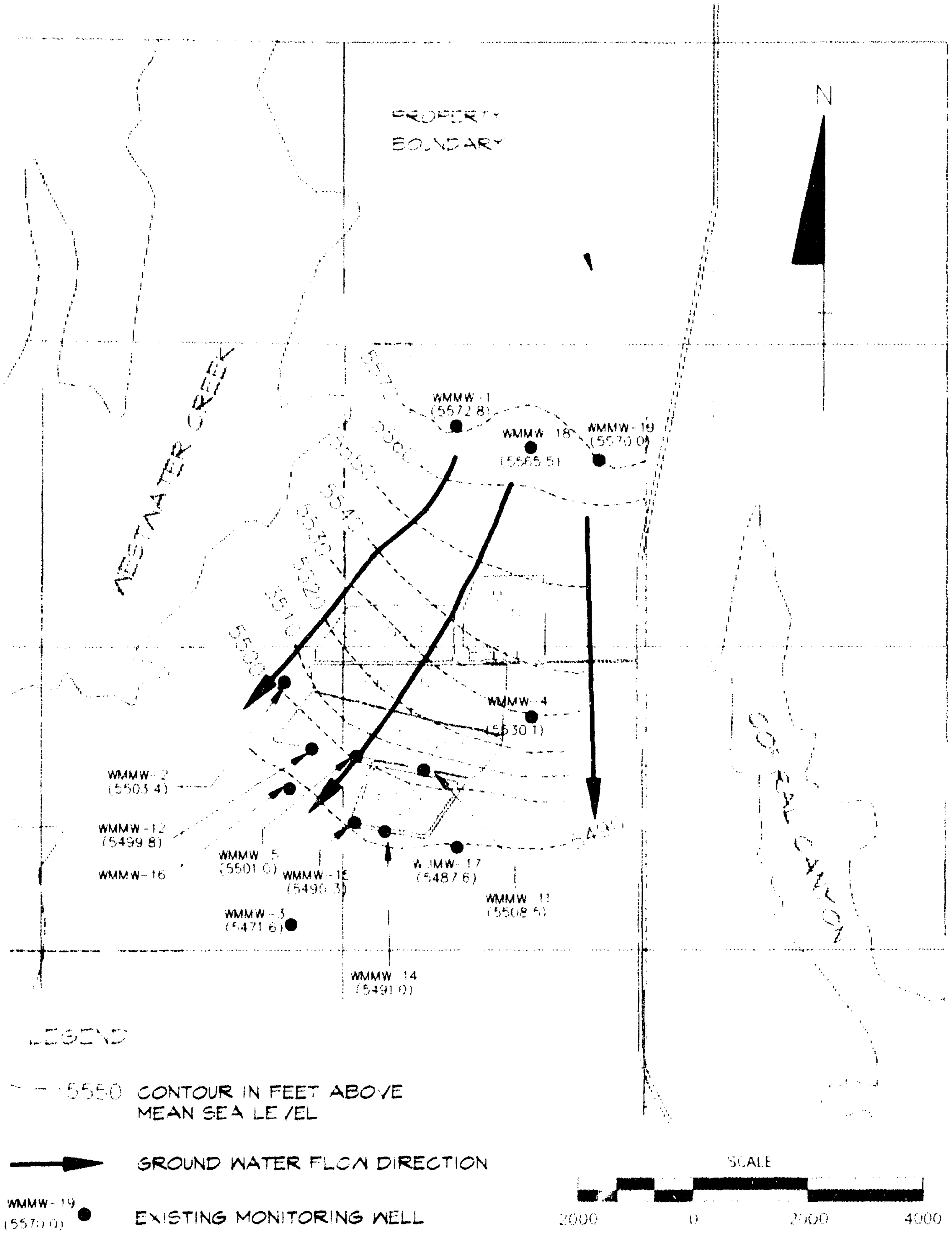


FIGURE 1.5.5-1 : Perched Ground Water Levels

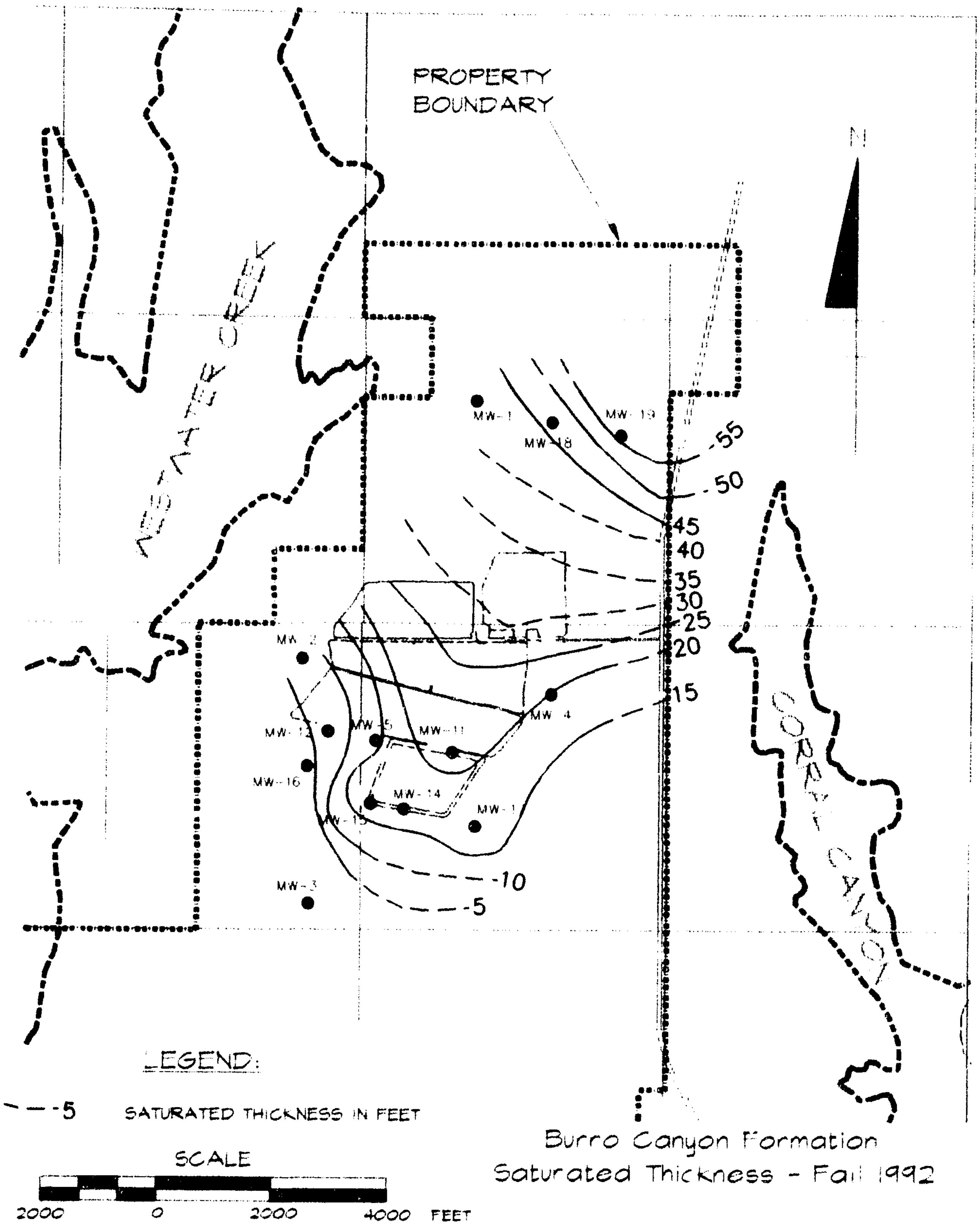


FIGURE 1.5.5-2: Saturated Thickness of Perched Water

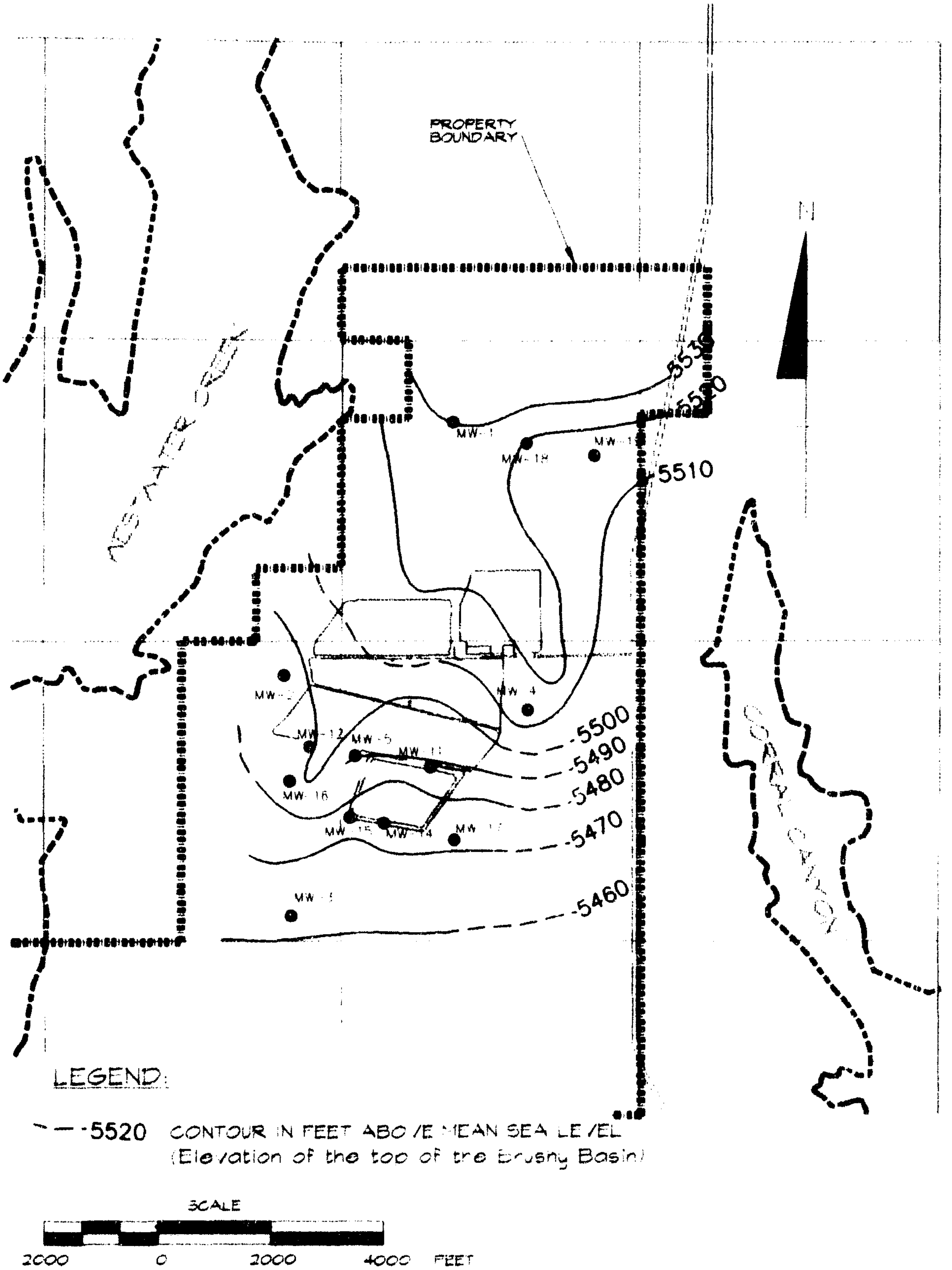


FIGURE 1.5.5-3: Topography of the Brushy Basin Formation

Table 1.5.5-1
Monitoring Well and Ground Water Elevation Data
White Mesa Uranium Mill

Well Name	Date Installed	Total Depth	Perforations	Water Level			Measuring Point	
				Date	Depth (ft.)	Elevation (ft.-MSL)	Above LDS (ft.)	Elevation (ft.-MSL)
WMMW-1	Sep-79	117'	92'-112'	11/19/92	75.45	5572.77	2.0	5648.22
WMMW-2	Sep-79	128.8'	85'-125'	11/19/92	110.06	5503.43	1.8	5613.49
WMMW-3	Sep-79	98'	67'-87'	11/19/92	83.74	5471.58	2.0	5555.32
WMMW-4	Sep-79	123.6'	92'-12'	11/19/92	92.42	5530.15	1.6	5622.57
WMMW-5	May-80	136'	95.5'-133.5'	11/19/92	108.32		0.6	5609.33
WMMW-6	May-80		This well was destroyed during construction of Cell 3.					
WMMW-7	May-80		This well was destroyed during construction of Cell 3.					
WMMW-8	May-80		This well was destroyed during construction of Cell 3.					
WMMW-11	Oct-82	135'	90.7'-130.4'	11/19/92	102.53	5508.55	2.4	5611.08
WMMW-12	Oct-82	130.3'	84'-124'	11/19/92	109.68	5499.77	0.9	5609.45
WMMW-13	Oct-82	118.5'	This well was destroyed during construction of Cell 4A.					
WMMW-14	Sep-89	129.1'	90'-120'	11/19/92	105.34	5491.05	0.0	5596.39
WMMW-15	Sep-89	138'	99'-129'	11/19/92	108.28	5490.34	0.8	5598.62
WMMW-16	Dec-92	91.5'	78.5'-88.5'	7/12/92	Dry		1.5	
WMMW-17	Dec-92	110'	90'-100'	11/30/92	87.56		1.5	
WMMW-18	Dec-92	148.5'	103.5'-133.5'	11/30/92	92.11		1.5	
WMMW-19	Dec-92	149'	101'-131'	10/12/92	85.00		1.5	
#9-1	May-80	33.5'	10'-30'	3/4/91	Dry		1.8	5622.83
#9-2	May-80	62.7'	39.7"-59.7"	3/4/91	Dry		2	5622.58
#10-2	May-80	33.5'	11.3'-31.3'	3/4/91	Dry		2	5633.58
#10-2	May-80	62.2'	39.2'-59.2'	3/4/91	Dry		2.1	5633.39

Notes:
1. Well locations provided on Figure 1.5.3-1.
2. LDS = leak detection system.
3. ft.-MSL = feet - mean sea level.

.dapted from: Table 2.3, Hydrogeologic Evaluation

1.5.5.1 Perched Water Quality

Groundwater monitoring of the Burro Canyon formation saturated zone has been conducted at the White Mesa facility since 1979. Table 1.5.5-1 (Hydrogeologic Evaluation Table 2.3) provides a list of wells that have been constructed for monitoring purposes at the facility. Figure 1.5.3.1-1 indicates the locations of thes ells. The water quality data obtained from these wells are provided both in tabular and graphica rm in Appendix B of the Hydrogeologic Evaluation, with more recent data in the Semi-annual Effluent Report for July through December 1995 and the Semi-annual Effluent Report for January through June 1995 (Energy Fuels Nuclear, Inc).

Examination of the spatial distribution and temporal trends (or lack thereof) in concentrations of analyzed constituents provides three significant conclusions:

1. The quality of perched water throughout the site shows no discernible pattern in variation,

2. The water is generally of poor quality [moderately high values of chloride, sulfate, and totally dissolved solids (TDS)], and

3. Analytical results show that operations at the White Mesa Uranium Mill have not impacted the quality of the perched water of the Burro Canyon formation.

To arrive a these conclusions, comparisons of the water chemistries from the various wells were analyzed in the Hydrogeologic Evaluation by graphical techniques. The purpose of the comparisons was to determine if trends in chloride, which would be associated with water from the tailings ponds,

were increasing in the perched water of the Burro Canyon formation. The trilinear plot and the Stiff diagram were used to conduct a preliminary evaluation of differences or similarities in water quality data between wells. The following is a summary of the conclusions drawn in the Hydrogeologic Evaluation.

Temporal and Spatial Variations

The trilinear plots and Stiff diagrams presented in the Hydrogeologic Evaluation (Figures 2.7-2.10) show that the water from all wells is of the sulfate (anion) type. The cation definition of the water type is variable. Of the 13 wells analyzed for water chemistry, four fall in the calcium-sulfate type category, four fall in the (sodium plus potassium)-sulfate type, two samples classify as the magnesium-sulfate type. Five samples have no dominant cation type. However, these five samples tend to classify more closely to the (sodium plus potassium)-sulfate and calcium-sulfate types.

The spatial variability of water quality data within the Burro Canyon formation is illustrated on Hydrogeologic Evaluation Figures 2.7 through 2.13, and the data Tabled in Appendix B of the Hydrogeologic Evaluation. Upgradient Monitoring Wells WMMW-1, WMMW-18, and WMMW-19 varied in sulfate concentrations from 676 to 1736 milligrams per liter (mg/l). Likewise, chloride concentrations in these wells varied from 12 to 92 mg/l. Across the site, sulfate and chloride concentrations vary with no discernible pattern to the variations. Details regarding chemistry of the Burro Canyon formation water can be found in Appendix B of the Hydrogeologic Evaluation.

Variability of water within the Burro Canyon formation is the result of slow moving to nearly stagnant groundwater flow beneath the site. These conditions are likely leading to dissolution of minerals from the Brushy Basin Member and the formation of sulfate-dominated waters.

Statistical Analysis

Because of the variable groundwater chemistry in the Burro Canyon formation baseline data, comparison of individual well groundwater chemistries to a single background groundwater well is not an appropriate method of monitoring potential disposal cell leakage or groundwater impacts. Water quality baseline and comparisons to that baseline established on a well-by-well basis has been proposed in the POC, as this method will best provide a meaningful representation of changes in groundwater chemistry.

Based on a review of water quality data gathered from 1979 through 1992, which are presented in the Hydrogeologic Evaluation, and considering the apparent variability of chemical composition of perched water and the absence of any impact from operations, EFN proposes to apply, an intra-well approach for assessing water quality trends. This approach, described in Appendix C, the Points of Compliance (POC) report (Titan, 1994), involves determination of background concentrations for a number of selected wells.

1.6 GEOLOGY

The following text is copied, with minor revisions, from the Environmental Report (Dames and Moore, 1978b) (ER). The text has been duplicated herein for ease of reference and to provide background information concerning the site geology. ER Subsections used in the following text are shown in parentheses immediately following the subsection titles.

The site is near the western margin of the Blanding Basin in southeastern Utah and within the Monticello uranium-mining district. Thousands of feet of multi-colored marine and non-marine

sedimentary rocks have been uplifted and warped, and subsequent erosion has carved a spectacular landscape for which the region is famous. Another unique feature of the region is the wide-spread presence of unusually large accumulations of uranium-bearing minerals.

1.6.1 Regional Geology

The following descriptions of regional physiography; rock units; and structure and tectonics are reproduced from the ER for ease of reference and as a review of regional geology.

1.6.1.1 Physiography (ER Section 2.4.1.1)

The project site is within the Canyon Lands section of the Colorado Plateau physiographic province. To the north, this section is distinctly bounded by the Book Cliffs and Grand Mesa of the Uinta Basin; western margins are defined by the tectonically controlled High Plateaus section, and the southern boundary is arbitrarily defined along the San Juan River. The eastern boundary is less distinct where the elevated surface of the Canyon Lands section merges with the Southern Rocky Mountain province.

Canyon Lands has undergone epeirogenic uplift and subsequent major erosion has produced the region's characteristic angular topography reflected by high plateaus, mesas, buttes, structural benches, and deep canyons incised into flat-laying sedimentary rocks of pre-Tertiary age. Elevations range from approximately 3,000 feet (914 meters) in the bottom of the deeper canyons along the southwestern margins of the section to more than 11,000 feet (3,353 meters) in the topographically anomalous laccolithic Henry, Abajo and La Sal Mountains to the northeast. Except for the deeper

canyons and isolated mountain peaks, an average elevation in excess of 500 feet (1,524 meters) persists over most of the Canyon Lands section.

On a more localized regional basis, the project site is located near the w stern edge of the Blanding Basin, sometimes referred to as the Great Sage Plain (Eardly, 1958), lying east of the north-south trending Monument Uplift, south of the Abajo Mountains and adjacent to the northwesterly-trending Paradox Fold and Fault Belt (Figure 1.6-1). Topographically, the Abajo Mountains are the most prominent feature in the region, rising more than 4,000 feet (1,219 meters) above the broad, gently rolling surface of the Great Sage Plain.

The Great Sage Plain is a structural slope, capped by the resistant Burro Canyon formation and the Dakota Sandstone, almost horizontal in an east-west direction but descends to the south with a regional slope of about 2,000 feet (610 meters) over a distance of nearly 50 miles (80 kilometers). Though not as deeply or intricately dissected as other parts of the Canyon Lands, the plain is cut by numerous narrow and vertical-walled south-trending valleys 100 to more than 500 feet (30 to 152+ meters) deep. Water from the intermittent streams that drain the plain flow southward to the San Juan River, eventually joining the Colorado River and exiting the Canyon Lands section through the Grand Canyon.

1.6.1.2 Rock Units (ER Section 2.4.1.1)

The sedimentary rocks exposed in southeastern Utah have an aggregate thickness of about 6,000 to 7,000 feet (1,829 to 2,134 meters) and range in age from Pennsylvanian to Late Cretaceous. Older unexposed rocks are known mainly from oil well drilling in the Blanding Basin and Monument Uplift. These wells have encountered correlative Cambrian to Permian rock units of markedly

differing thicknesses but averaging over 5,000 feet (1,524 meters) in total thickness (Witkind, 1964). Most of the wells drilled in the region have bottomed in the Pennsylvanian Paradox Member of the Hermosa formation. A generalized stratigraphic section of rock units ranging in age from Cambrian through Jurassic and Triassic (?), as determined from oil-well logs, is shown in Table 1.6-1. Descriptions of the younger rocks, Jurassic through Cretaceous, are based on field mapping by various investigators and are shown in Table 1.6-2.

Paleozoic rocks of Cambrian, Devonian and Mississippian ages are not exposed in the southeastern Utah region. Most of the geologic knowledge regarding these rocks was learned from the deeper oil wells drilled in the region, and from exposures in the Grand Canyon to the southwest and in the Uinta and Wasatch Mountains to the north. A few patches of Devonian rocks are exposed in the San Juan Mountains in southwestern Colorado. These Paleozoic rocks are the result of periodic transgressions and regressions of epicontinental seas and their lithologies reflect a variety of depositional environments.

In general, the coarse-grained feldspathic rocks overlying the Precambrian basement rocks grade upward into shales, limestones and dolomites that dominate the upper part of the Cambrian. Devonian and Mississippian dolomites, limestones and interbedded shales unconformably overlay the Cambrian strata. The complete absence of Ordovician and Silurian rocks in the Grand Canyon, Uinta Mountains, southwest Utah region and adjacent portions of Colorado, New Mexico and Arizona indicate that the region was probably epeirogenically positive during these times.

The oldest stratigraphic unit that crops out in the region is the Hermos formation of Middle and Late Pennsylvanian age. Only the uppermost strata of this formation are exposed, the best exposure being in the canyon of the San Juan River at the "Goosenecks" where the river traverses the crest of the

Monument uplift. Other exposures are in the breached centers of the Lisbon Valley, Moab and Castle Valley anticlines. The Paradox Member of the Hermosa formation is sandwiched between a relatively thin lower unnamed member consisting of dark-gray shale siltstone, dolomite, anhydrite, and limestone, and an upper unnamed member of similar lithology but having a much greater thickness. Composition of the Paradox Member is dominantly a thick sequence of interbedded slat (halite), anhydrite, gypsum, and black shale. Surface exposures of the Paradox in the Moab and Castle Valley anticlines are limited to contorted residues of gypsum and black shale.

Conformably overlying the Hermosa is the Pennsylvanian and Permian (?) Rico formation, composed of interbedded reddish-brown arkosic sandstone and gray marine limestone. The Rico represents a transition zone between the predominantly marine Hermosa and the overlying continental Cutler formation of Permian age.

Two members of the Cutler probably underlying the region south of Blanding are, in ascending order, the Cedar Mesa Sandstone and the Organ Rock Tongue. The Cedar Mesa is a white to pale reddish-brown, massive, cross-bedded, fine-to medium-grained eolian sandstone. An irregular fluvial sequence of reddish-brown fine-grained sandstones, shaly siltstones and sandy shales comprise the Organ Rock Tongue.

The Moenkopi formation, of Middle (?) and Lower Triassic age, unconformably overlies the Cutler strata. It is composed of thin, evenly-bedded, reddish to chocolate-brown, ripple-marked, cross-laminated siltstone and sandy shales with irregular beds of massive medium-grained sandstone.

A thick sequence of complex continental sediments known as the Chinle formation unconformably overlies the Moenkopi. For the purpose of making lithology correlations in oil wells this formation

is divided into three units: The basal Shinarump Member, the Moss Back Member and an upper undivided thick sequence of variegated reddish-brown, reddish- to greenish-gray, yellowish-brown to light-brown bentonitic claystones, mudstones, sandy siltstone, fine-grained sandstone, and limestones. The basal Shinarump is dominantly a yellowish-grey, fine- to coarse-grained sandstone, conglomeratic sandstone and conglomerate characteristically filling ancient stream channel scours eroded into the Moenkopi surface. Numerous uranium deposits have been located in this member in the White Canyon mining district to the west of Comb Ridge. The Moss Back is typically composed of yellowish- to greenish-grey, fine- to medium-grained sandstone, conglomeratic sandstone and conglomerate. It commonly comprises the basal unit of the Chinle where the Shinarump was not deposited, and in a like manner, fills ancient stream channels scoured into the underlying unit.

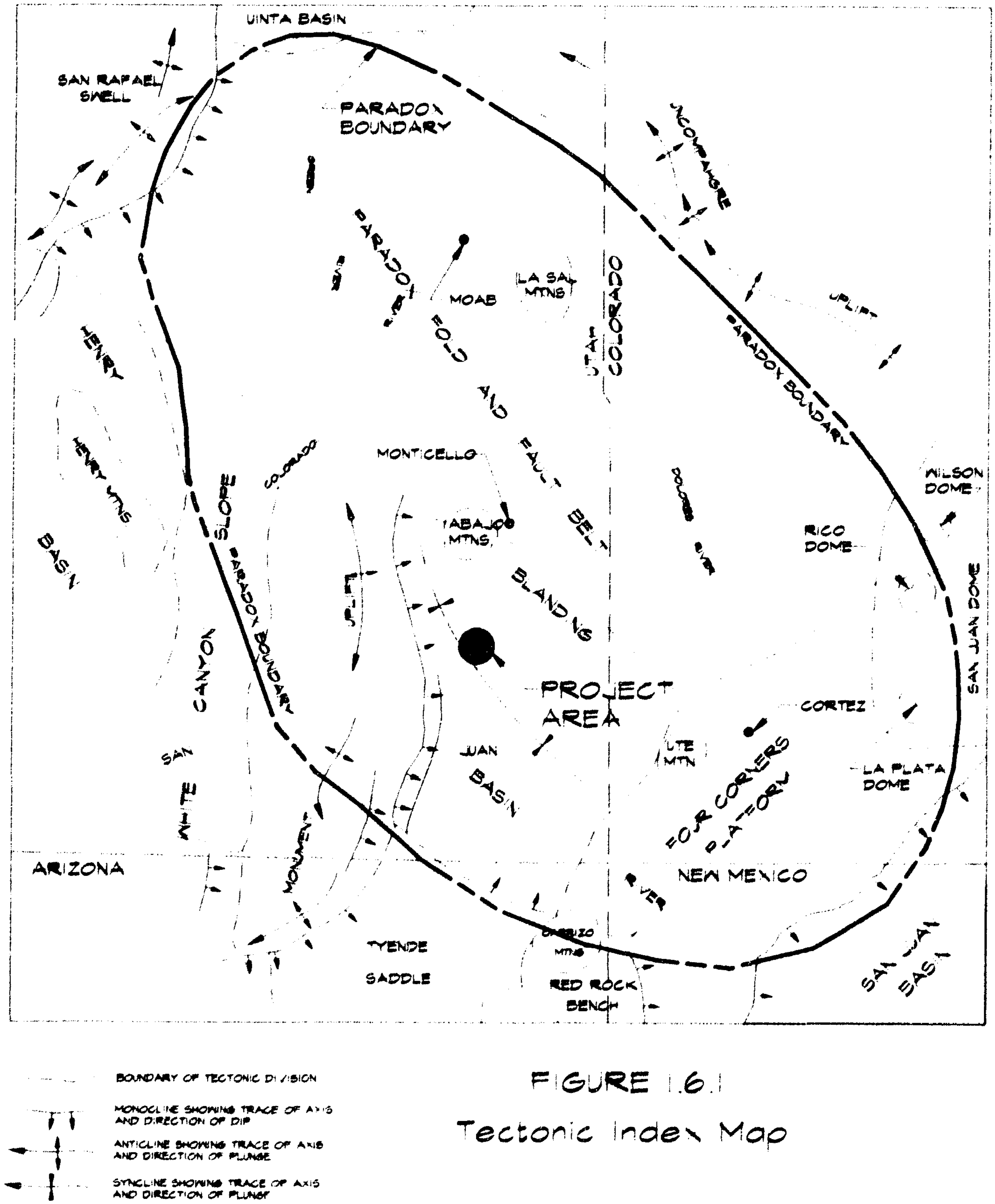


FIGURE 1.6.1

Tectonic Index Map

TABLE 16-1

GENERALIZED STRATIGRAPHIC SECTION OF SUBSURFACE ROCKS BASED ON OIL-WELL LOGS

(After Stokes, 1954, Witkind, 1964, Huff and Lesure, 1965, Johnson and Thordarson, 1966)

Era	Age	Stratigraphic Unit	Thickness* (ft.)	Description
MESOZOIC		Glen Canyon Group:		
	Jurassic and Triassic (?)	Navajo Sandstone	300 - 400	Buff to light gray, massive, cross-bedded, friable sandstone
	Triassic (?)	Kayenta Formation	100 - 150	Reddish-brown sandstone and mudstone and occasional conglomerate lenses
	Triassic	Wingate Sandstone	250 - 350	-brown, massive, cross-bedded, ined sandstone
		Chinle Formation:		
		Undivided	600 - 700	Variegated claystone with some thin beds of siltstone and limestone
		Moss Back Member	0 - 100	Light colored, conglomeratic sandstone and conglomerate
		Shinarump Member	0 - 20	Yellowish-gray, fine to coarse-grained sandstone: conglomeratic sandstone and conglomerate
		— Unconformity —		
	Middle (?) and Lower Triassic	Moenkopi Formation	50 - 100	Reddish-brown mudstone and fine-grained sandstone
		— Unconformity —		
PALEOZOIC	Permian	Cutler Formation:		
		Organ Rock Member	0 - 600	Reddish-brown, sandy mudstone
		Cedar Mesa Sandstone Member	1100 - 1400	Reddish-brown, massive, fine to medium-grained sandstone
	Pennsylvanian and Permian (?)	Rico Formation	450	Red and gray calcareous, sandy shale: gray limestone and sandstone
	Pennsylvanian	Hermosa Formation:		
		Upper Member	1000 - 1200	Gray, massive limestone: some shale and sandstone
		Paradox Member	1200	Halite, anhydrite, gypsum, shale, and siltstone
		Lower Member	200	Limestone, siltstone, and shale
		— Unconformity —		
	Mississippian	Leadville Limestone	500	White to tan sucrose to crystalline limestone
	Devonian	Ouray Limestone	100	Light gray and tan, thin-bedded limestone and dolomite
		Zilbert Formation	200	Gray and brown dolomite and limestone with thin beds green shale and sandstone
		— Unconformity —		
	Cambrian	Ophir Formation and Tintic Quartzite	600	Gray and brown limestone and dolomite, feldspathic sandstone and arkose

* To convert feet to meters, multiply by 0.3043. Average thickness given if range is not shown.

TABLE 6-2

GENERALIZED STRATIGRAPHIC SECTION OF EXPOSED ROCKS IN THE PROJECT VICINITY

(After Haynes et al. 1962, Witkind 1964, Huff and Lesure 1965)

ERA	SYSTEM	SERIES (Age)	STRATIGRAPHIC UNIT		THICKNESS* (ft)	LITHOLOGY
CENOZOIC	QUATERNARY	Holocene to Pleistocene		Alluvium	2 - 25+	Silt, sand and gravel in arroyos and stream valleys.
				Colluvium and Talus	0 - 15+	Slope wash, talus and rock rubble ranging from cobbles and boulders to massive blocks fallen from cliffs and outcrops of resistant rock
				Loess	0 - 22+	Reddish-brown to light-brown, unconsolidated, well-sorted silt to medium-grained sand; partially cemented with caliche in some area, reworked partly by water
				Unconformity		
MESOZOIC	CRETACEOUS	Upper Cretaceous		Mancos Shale	0 - 11(?)	Gray to dark-gray, fissile, thin-bedded marine shale with fossiliferous sandy limestone in lower strata.
				Dakota Sandstone	30 - 75	Light yellowish-brown to light gray-brown, thick bedded to cross-bedded sandstone, conglomeratic sandstone; interbedded thin lenticular gray carbonaceous claystone and impure coal; local course basal conglomerate.
				Unconformity		
		Lower Cretaceous		Burro Canyon Formation	50 - 150	Light-gray and light-brown, massive and cross-bedded conglomeratic sandstone and interbedded green and gray-green mudstone; locally contains thin discontinuous beds of silicified sandstone and limestone near top.
				Unconformity (?)		
	Jurassic	Upper Jurassic	Morrison Formation	Brushy Basin Member	200 - 450	Variegated gray, pale-green, reddish-brown, and purple bentonitic mudstone and siltstone containing thin discontinuous sandstone and conglomerate lenses.
			Morrison Formation	Westwater Canyon Member	0 - 250	Interbedded yellowish- and greenish-gray to pinkish-gray, fine- to course-grained arkosic sandstone and greenish-gray to reddish-brown sandy shale and mudstone.
			Morrison Formation	Recapture Member	0 - 200	Interbedded reddish-gray to light brown fine-to medium-grained sandstone and reddish-gray silty and sandy claystone.
			Morrison Formation	Salt Wash Member	0 - 350	Interbedded yellowish-brown to pale reddish-brown fine-grained to conglomeritic sandstones and greenish- and reddish-gray mudstone.
				Unconformity		
			San Rafael Group	Bluff Sandstone	0 - 150+	White to grayish-brown, massive, cross-bedded, fine- to medium-grained eolian sandstone.
			San Rafael Group	Summerville Formation	25 - 125	Thin-bedded, ripple-marked reddish-brown muddy sandstone and sandy shale.
			San Rafael Group	Entrada Sandstone	150 - 180	Reddish-brown to grayish-white, massive, cross-bedded, fine- to medium-grained sandstone.
		Middle Jurassic	San Rafael Group	Carmel Formation	20 - 100+	Irregularly bedded reddish-brown muddy sandstone and sandy mudstone with local thin beds of brown to gray limestone and reddish- to greenish-gray shale.
				Unconformity		

*To convert feet to meters, multiply feet by 0.3048.

In the Blanding Basin the Glen Canyon Group consists of three formations which are, in ascending order, the Wingate Sandstone, the Kayenta and the vajo Sandstone. All are conformable and their contacts are gradational. Commonly cropping out in sheer cliffs, the Late Triassic Wingate Sandstone is typically composed of buff to reddish-brown, massive, cross-bedded, well-sorted, fine-grained quartzose sandstone of eolian origin. Late Triassic (?) Kayenta is fluvial in origin and consists of reddish-brown, irregularly to cross-bedded sandstone, shaly sandstone and, locally, thin beds of limestone and conglomerate. Light yellowish-brown to light-gray and white, massive, cross-bedded, friable, fine- to medium-grained quartzose sandstone typifies the predominantly eolian Jurassic and Triassic (?) Navajo Sandstone.

Four formations of the Middle to Late Jurassic San Rafael Group unconformably overly the Navajo Sandstone. These strata are composed of alternating marine and non-marine sandstones, shales and mudstones. In ascending order, the formations are the Carmel formation, Entrada Sandstone, Summerville formation, and Bluff Sandstone. The Carmel usually crops out as a bench between the Navajo and Entrada Sandstones. Typically reddish-brown muddy sandstone and sandy mudstone, the Carmel locally contains thin beds of brown to gray limestone and reddish- to greenish-gray shale. Predominantly eolian in origin, the Entrada is a massive cross-bedded fine- to medium-grained sandstone ranging in color from reddish-brown to grayish-white that crops out in cliffs or hummocky slopes. The Summerville is composed of regular thin-bedded, ripple-marked, reddish-brown muddy sandstone and sandy shale of marine origin and forms steep to gentle slopes above the Entrada. Cliff-forming Bluff Sandstone is present only in the southern part of the Monticello district thinning northward and pinching out near Blanding. It is a white to grayish-brown, massive, cross-bedded eolian sandstone.

In the southeastern Utah region the Late Jurassic Morrison formation has been divided in ascending order into the Salt Wash, Recapture, Westwater Canyon, and Brushy Basin Members. In general, these strata are dominantly fluvial in origin but do contain lacustrine sediments. Both the Salt Wash and Recapture consist of alternating mudstone and sandstone; the Westwater Canyon is chiefly sandstone with some sandy mudstone and claystone lenses, and the heterogenous Brushy Basin consists of variegated bentonitic mudstone and siltstone containing scattered thin limestone, sandstone, and conglomerate lenses. As strata of the Morrison formation are the oldest rocks exposed in the project area vicinity and are one of the two principal uranium-bearing formations in southeast Utah, the Morrison, as well as younger rocks, are described in more detail in Section 1.6.2.2.

The Early Cretaceous Burro Canyon formation rests unconformably (?) on the underlying Brushy Basin Member of the Morrison formation. Most of the Burro Canyon consists of light-colored, massive, cross-bedded fluvial conglomerate, conglomerate sandstone and sandstone. Most of the conglomerates are near the base. Thin, even-bedded, light-green mudstones are included in the formation and light-grey thin-bedded limestones are sometimes locally interbedded with the mudstones near the top of the formation.

Overlying the Burro Canyon is the Dakota Sandstone of Upper Cretaceous age. Typical Dakota is dominantly yellowish-brown to light-gray, thick-bedded, quartzitic sandstone and conglomeratic sandstone with subordinate thin lenticular beds of mudstone, gray carbonaceous shale and, locally, thin seams of impure coal. The contact with the underlying Burro Canyon is unconformable whereas the contact with the overlying Mancos Shale is gradational from the light-colored sandstones to dark-grey to black shaly siltstone and shale.

Upper Cretaceous Mancos Shale is exposed in the region surrounding the project vicinity but not within it. Where exposed and weathered, the shale is light-gray or yellowish-gray, but is dark, to olive-gray where fresh. Bedding is thin and well developed; much of it is laminated.

Quaternary alluvium within the project vicinity is of three types: alluvial silt, sand and gravels deposited in the stream channels; colluvium deposits of slope wash, talus, rock rubble and large displaced blocks on slopes below cliff faces and outcrops of resistant rock; and alluvial and windblown deposits of silt and sand, partially reworked by water, on benches and broad upland surfaces.

1.6.1.3 Structure and Tectonics (ER Section 2.4.1.3)

According to Shoemaker (1954 and 1956), structural features within the Canyon Lands of southeastern Utah may be classified into three main categories on the basis of origin or mechanism of the stress that created the structure. These three categories are: (1) structures related to large-scale regional uplifting or downwarping (epeirogenic deformation) directly related to movements in the basement complex (Monument Uplift and the Blanding Basin); (2) structures resulting from the plastic deformation of thick sequences of evaporite deposits, salt plugs and salt anticlines, where the structural expression at the surface is not reflected in the basement complex (Paradox Fold and Fault Belt); and (3) structures that are formed in direct response to stresses induced by magmatic intrusion including local laccolithic domes, dikes and stocks (Abajo Mountains).

Each of the basins and uplifts within the project area region is an asymmetric fold usually separated by a steeply dipping sinuous monocline. Dips of the sedimentary beds in the basins and uplifts rarely exceed a few degrees except along the monocline (Shoemaker, 1956) where, in some

instances, the beds are nearly vertical. Along the Comb Ridge monocline, the boundary between the Monument Uplift and the Blanding Basin, approximately eight miles (12.9 kilometers) west of the project area, dips in the Upper Triassic Wingate sandstone and in the Chinle formation are more than 40 degrees to the east.

Structures in the crystalline basement complex in the central Colorado Plateau are relatively unknown but where monoclines can be followed in Precambrian rocks they pass into steeply dipping faults. It is probable that the large monoclines in the Canyon Lands section are related to flexure of the layered sedimentary rocks under tangential compression over nearly vertical normal or high-angle reverse faults in the more rigid Precambrian basement rocks (Kelley, 1955; Shoemaker, 1956; Johnson and Thordarson, 1966).

The Monument Uplift is a north-trending, elongated, upwarped structure approximately 90 miles (145 kilometers) long and nearly 35 miles (56 kilometers) wide. Structural relief is about 3,000 feet (914 meters) (Kelley, 1955). Its broad crest is slightly convex to the east where the Comb Ridge monocline defines the eastern boundary. The uniform and gently descending western flank of the uplift crosses the White Canyon slope and merges into the Henry Basin (Figure 1.6-1).

East of the Monument Uplift, the relatively equidimensional Blanding Basin merges almost imperceptibly with the Paradox Fold and Fault Belt to the north, the Four Corners Platform to the southeast and the Defiance Uplift to the south. The basin is a shallow feature with approximately 700 feet (213 meters) of structural relief as estimated on top of the Upper Triassic Chinle formation by Kelley (1955), and is roughly 40 to 50 miles (64 to 80 kilometers) across. Gentle folds within the basin trend westerly to northwesterly in contrast to the distinct northerly orientation of the Monument Uplift.

Situated to the north of the Monument Uplift and Blanding Basin is the most unique structural feature of the Canyon Lands section, the Paradox Fold and Fault Belt. This tectonic unit is dominated by northwest trending anticlinal folds and associated normal faults covering an area about 150 miles (241 kilometers) long and 65 miles (104 kilometers) wide. These anticlinal structures are associated with salt flowage from the Pennsylvanian Paradox Member of the Hermosa formation and some show piercement of the overlying younger sedimentary beds by plug-like salt intrusions (Johnson and Thordarson, 1966). Prominent valleys have been eroded along the crests of the anticlines where salt piercements have occurred or collapses of the central parts have resulted in intricate systems of step-faults and grabens along the anticlinal crests and flanks.

The Abajo Mountains are located approximately 20 miles (32 kilometers) north of the project area on the more-or-less arbitrary border of the Blanding Basin and the Paradox Fold and Fault Belt (Figure 1.6-1). These mountains are laccolithic domes that have been intruded into and through the sedimentary rocks by several stocks (Witkind, 1964). At least 31 laccoliths have been identified. The youngest sedimentary rocks that have been intruded are those of Mancos Shale of Late Cretaceous age. Based on this and other vague and inconclusive evidence, Witkind (1964), has assigned the age of these intrusions to the Late Cretaceous or early Eocene.

Nearly all known faults in the region of the project area are high-angle normal faults with displacements on the order of 300 feet (91 meters) or less (Johnson and Thordarson, 1966). The largest known faults within a 40-mile (64 kilometer) radius around Blanding are associated with the Shay graben on the north side of the Abajo Mountains and the Verdure graben on the south side. Respectively, these faults trend northeasterly and easterly and can be traced for approximate distances ranging from 21 to 34 miles (34 to 55 kilometers) according to Witkind (1964). Maximum displacements reported by Witkind on any of the faults is 320 feet (98 meters). Because of the

extensions of Shay and Verdure fault systems beyond the Abajo Mountains and other geologic evidence, the age of these faults is Late Cretaceous or post-Cretaceous and antedate the laccolithic intrusions (Witkind, 1964).

A prominent group of faults is associated with the salt anticlines in the Paradox Fold and Fault Belt. These faults trend northwesterly parallel to the anticlines and are related to the salt emplacement. Quite likely, these faults are relief features due to salt intrusion or salt removal by solution (Thompson, 1967). Two faults in this region, the Lisbon Valley fault associated with the Lisbon Valley salt anticline and the Moab fault at the southeast end of the Moab anticline have maximum vertical displacements of at least 5,000 feet (1,524 meters) and 2,000 feet (609 meters), respectively, and are probably associated with breaks in the Precambrian basement crystalline complex. It is possible that zones of weakness in the basement rocks represented by faults of this magnitude may be responsible for the beginning of salt flowage in the salt anticlines, and subsequent solution and removal of the salt by groundwater caused collapse within the salt anticlines resulting in the formation of grabens and local complex block faults (Johnson and Thordarson, 1966).

The longest faults in the Colorado Plateau are located some 155 to 210 miles (249 to 338 kilometers) west of the project area along the western margin of the High Plateau section. These faults have a north to northeast echelon trend, are nearly vertical and downthrown on the west in most places. Major faults included in this group are the Hurrican,Toroweap-Sevier, Paunsaugunt, and Paradise faults. The longest fault, the Toroweap-Sevier, can be traced for about 240 miles (386 kilometers) and may have as much as 3,000 feet (914 meters) of displacement (Kelley, 1955).

From the later part of the Precambrian until the middle Paleozoic the Colorado Plateau was a relatively stable tectonic unit undergoing gentle epeirogenic uplifting and downwarping during

which seas transgressed and regressed, depositing and then partially removing layers of sedimentary materials. This period of stability was interrupted by northeast-southwest tangential compression that began sometime during late Mississippian or early Pennsylvanian and continued intermittently into the Triassic. Buckling along the northeast margins of the shelf produced northwest-trending uplifts, the most prominent of which are the Uncompahgre and San Juan Uplifts, sometimes referred to as the Ancestral Rocky Mountains. Clearly, these positive features are the earliest marked tectonic controls that may have guided many of the later Laramide structures (Kelley, 1955).

Subsidence of the area southwest of the Uncompahgre Uplift throughout most of the Pennsylvanian led to the filling of the newly formed basin with an extremely thick sequence of evaporites and associated interbeds which comprise the Paradox Member of the Hermosa formation (Kelley, 1956). Following Paradox deposition, continental and marine sediments buried the evaporite sequence as epeirogenic movements shifted shallow seas across the region during the Jurassic, Triassic and much of the Cretaceous. The area underlain by the Paradox Member in eastern Utah and western Colorado is commonly referred to as the Paradox Basin (Figure 1.6-1). Renewed compression during the Permian initiated the salt anticlines and piercements, and salt flowage continued through the Triassic.

The Laramide orogeny, lasting from Late Cretaceous through Eocene time, consisted of deep-seated compressional and local vertical stresses. The orogeny is responsible for a north-south to northwest trend in the tectonic fabric of the region and created most of the principal basins and uplifts in the eastern-half of the Colorado Plateau (Grose, 1972; Kelley, 1955).

Post-Laramide epeirogenic deformation has occurred throughout the Tertiary; Eocene strata are flexed sharply in the Grand Hogback monocline, fine-grained Pliocene deposits are tilted on the

flanks of the Defiance Uplift, and Pleistocene deposits in Fisher Valley contain three angular unconformaties (Shoemaker, 1956).

1.6.2 Blanding Site Geology

The following descriptions of physiography and topography; rock units; structure; relationship of earthquakes to tectonic structure; and potential earthquake hazards to the project area are reproduced from the ER for ease of reference and as a review of the mill site geology. (See Figure 1.6-2)

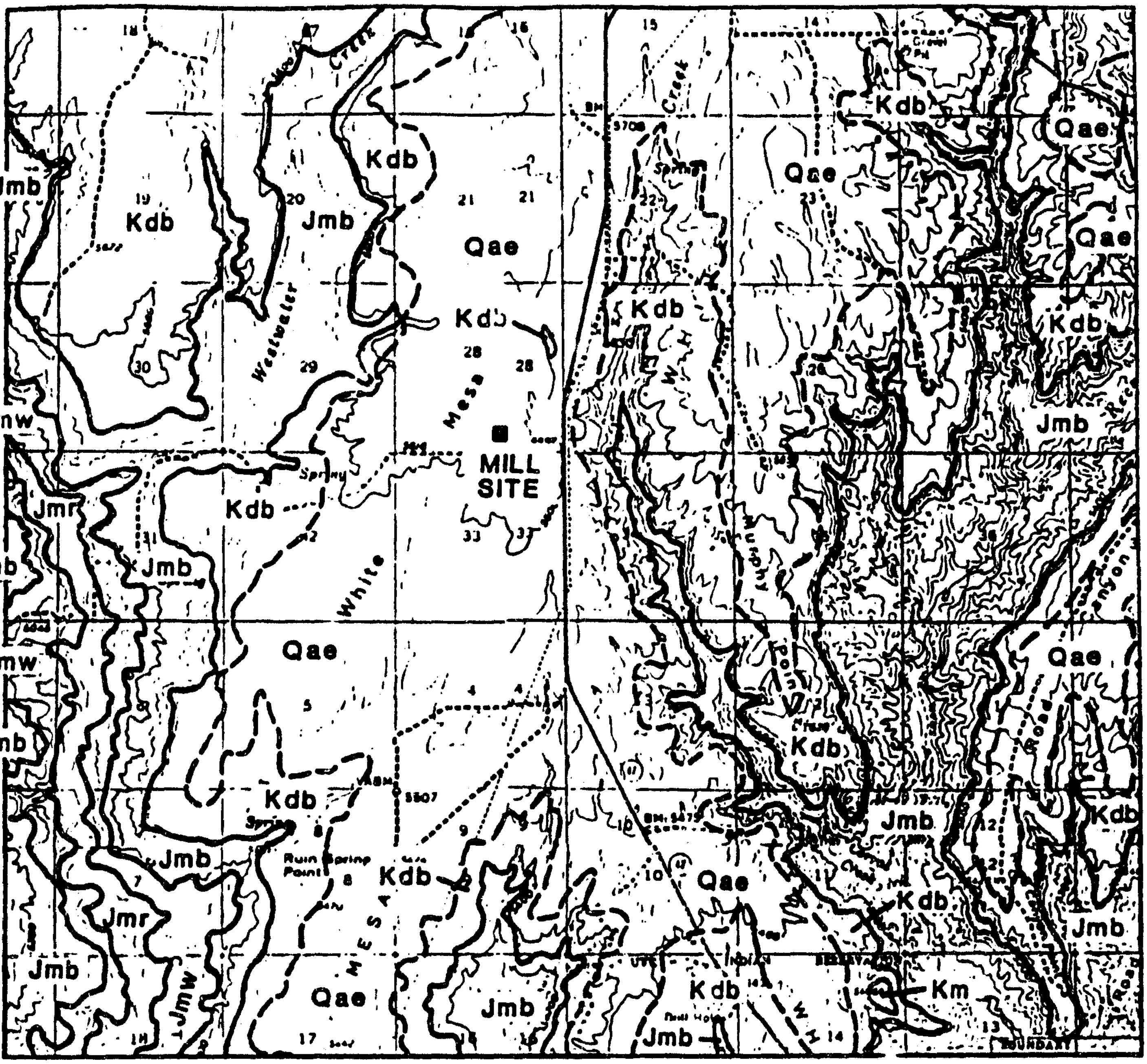
1.6.2.1 Physiography and Topography (ER Section 2.4.2.1)

The project site is located near the center of White Mesa, one of the many finger-like north-south trending mesas that make up the Great Sage Plain. The nearly flat upland surface of White Mesa is underlain by resistant sandstone caprock which forms steep prominent cliffs separating the upland from deeply entrenched intermittent stream courses on the east, south and west.

Surface elevations across the project site range from about 5,550 to 5,650 feet (1,692 to 1,722 meters) and the gently rolling surface slopes to the south at a rate of approximately 60 feet per mile (18 meters per 1.6 kilometer).

Maximum relief between the mesa's surface and Cottonwood Canyon on the west is about 750 feet (229 meters) where Westwater Creek joins Cottonwood Wash. These two streams and their tributaries drain the west and south sides of White Mesa. Drainage on the east is provided by Recapture Creek and its tributaries. Both Cottonwood Wash and Recapture Creeks are normally

intermittent streams and flow south to the San Juan River. However, Cottonwood Wash has been known to flow perennially in the project vicinity during wet years.



REFERENCES: GEOLOGY, IN PART, AFTER HAYNES ET AL. , 1962. BASE MAP PREPARED FROM PORTIONS OF THE BLANDING, BRUSHY BASIN WASH, BLUFF, AND MONTEZUMA CREEK U.S.G.S. 15-MINUTE TOPOGRAPHIC QUADRANGLES.

EXPLANATION

Qae	LOESS
Km	MANCOS SHALE
Kdb	DAKOTA AND BURRO CANYON FORMATIONS (UNDIFFERENTIATED)
Jmb	MORRISON FORMATION: BRUSHY BASIN MEMBER
Jmw	WESTWATER CANYON MEMBER
Jmr	RECAPTURE MEMBER
—- - -	CONTACT, DASHED WHERE APPROXIMATE

N.

3000 0 3000 6000

SCALE IN FEET

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FIGURE 1.6-2

White Mesa Millsite
Geology of Surrounding Area

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APP	SCALE: As Shown	

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1.6.2.2 Rock Units (ER Section 2.4.2.2)

Only rocks of Jurassic and Cretaceous ages are exposed in the vicinity of the project site. These include, in ascending order, the Upper Jurassic Salt Wash, Recapture, Westwater Canyon, and Brushy Basin Members of the Morrison formation; the Lower Cretaceous Burro Canyon formation; and the Upper Cretaceous Dakota Sandstone. The Upper Cretaceous Mancos Shale is exposed as isolated remnants along the rim of Recapture Creek valley several miles southeast of the project site and on the eastern flanks of the Abajo Mountains some 20 miles (32 kilometers) north but is not exposed at the project site. However, patches of Mancos Shale may be present within the project site boundaries as isolated buried remnants that are obscured by a mantle of alluvial windblown silt and sand.

The Morrison formation is of particular economic importance in southeast Utah since several hundred uranium deposits have been discovered in the basal Salt Wash Member (Stokes, 1967).

In most of eastern Utah, the Salt Wash Member underlies the Brushy Basin. However, just south of Blanding in the project vicinity the Recapture Member replaces an upper portion of the Salt Wash and the Westwater Canyon Member replaces a lower part of the Brushy Basin. A southern limit of Salt Wash deposition and a northern limit of Westwater Canyon deposition has been recognized by Haynes et al. (1972) in Westwater Canyon approximately three to six miles (4.8 to 9.7 kilometers), respectively, northwest of the project site. However, good exposures of Salt Wash are found throughout the Montezuma Canyon area 13 miles (21 kilometers) to the east.

The Salt Wash Member is composed dominantly of fluvial fine-grained to conglomeratic sandstones, and interbedded mudstones. Sandstone intervals are usually yellowish-brown to pale reddish-brown

while the mudstones are greenish- and reddish-gray. Carbonaceous materials ("trash") vary from sparse to abundant. Cliff-forming massive sandstone and conglomeratic sandstone in discontinuous beds make up to 50 percent or more of the member. According to Craig et al. (1955), the Salt Wash was deposited by a system of braided streams flowing generally east and northeast. Most of the uranium-vanadium deposits are located in the basal sandstones and conglomeratic sandstones that fill stream-cut scour channels in the underlying Bluff Sandstone, or where the Bluff Sandstone has been removed by pre-Morrison erosion, in similar channels cut in the Summerville formation. Mapped thicknesses of this member range from zero to approximately 350 feet (0-107 meters) in southeast Utah. Because the Salt Wash pinches out in a southerly direction in Recapture Creek three miles (4.8 kilometers) northwest of the project site and does not reappear until exposed in Montezuma Canyon, it is not known for certain that the Salt Wash actually underlies the site.

The Recapture Member is typically composed of interbedded reddish-gray, white, and light-brown fine- to medium-grained sandstone and reddish-gray, silty and sandy claystone. Bedding is gently to sharply lenticular. Just north of the project site, the Recapture intertongues with and grades into the Salt Wash and the contact between the two cannot be easily recognized. A few spotty occurrences of uriniferous mineralization are found in sandstone lenses in the southern part of the Monticello district and larger deposits are known in a conglomeratic sandstone facies some 75 to 100 miles (121 to 161 kilometers) southeast of the Monticello district. Since significant ore deposits have not been found in extensive outcrops in more favorable areas, the Recapture is believed not to contain potential resources in the project site (Johnson and Thordarson, 1966).

Just north of the project site, the Westwater Canyon Member intertongues with and grades into the lower part of the overlying Brushy Basin Member. Exposures of the Westwater Canyon in Cottonwood Wash are typically composed of interbedded yellowish- and greenish-gray to pinkish-

gray, lenticular, fine- to coarse-grained arkosic sandstone and minor amounts of greenish-gray to reddish-brown sandy shale and mudstone. Like the Salt Wash, the Westwater Canyon Member is fluvial in origin, having been deposited by streams flowing north and northwest, coalescing with streams from the southwest depositing the upper part of the Salt Wash and the lower part of the Brushy Basin (Huff and Lesure, 1965). Several small and scattered uranium deposits in the Westwater Canyon are located in the extreme southern end of the Monticello district. Both the Recapture Member and the Westwater Canyon contain only traces of carbonaceous materials, are believed to be less favorable host rocks for uranium deposition (Johnson and Thordarson, 1966) and have very little potential for producing uranium reserves.

The lower part of the Brushy Basin is replaced by the Westwater Canyon Member in the Blanding area but the upper part of the Brushy Basin overlies this member. Composition of the Brushy Basin is dominantly variegated bentonitic mudstone and siltstone. Bedding is thin and regular and usually distinguished by color variations of gray, pale-green, reddish-brown, pale purple, and maroon. Scattered lenticular thin beds of distinctive green and red chert-pebble conglomeratic sandstone are found near the base of the member, some of which contain uranium-vanadium mineralization in the southernmost part of the Monticello district (Haynes et al., 1972). Thin discontinuous beds of limestone and beds of grayish-red to greenish-black siltstone of local extent suggest that much of the Brushy Basin is probably lacustrine in origin.

For the most part, the Great Sage Plain owes its existence to the erosion of resistant sandstones and conglomerates of the Lower Cretaceous Burro Canyon formation. This formation unconformably(?) overlies the Brushy Basin and the contact is concealed over most of the project area by talus blocks and slope wash. Massive, light-gray to light yellowish-brown sandstone, conglomeratic sandstone and conglomerate comprise more than two-thirds of the formation's thickness. The conglomerate

and sandstone are interbedded and usually grade from one to the other. However, most of the conglomerate is near the base. These rocks are massive cross-bedded units formed by a series of interbedded lenses, each lens representing a scour filled with stream-deposited sediments. In places the formation contains greenish-gray lenticular beds of mudstone and claystone. Most of the Burro Canyon is exposed in the vertical cliffs separating the relatively flat surface of White Mesa from the canyons to the west and east. In some places the resistant basal sandstone beds of the overlying Dakota Sandstone are exposed at the top of the cliffs, but entire cliffs of Burro Canyon are most common. Where the sandstones of the Dakota rest on sandstones and conglomerates of the Burro Canyon, the contact between the two is very difficult to identify and most investigators map the two formations as a single unit (Figure 1.6-2). At best, the contact can be defined as the top of a silicified zone in the upper part of the Burro Canyon that appears to be remnants of an ancient soil that formed during a long period of weathering prior to Dakota deposition (Huff and Lesure, 1965).

The Upper Cretaceous Dakota Sandstone disconformably overlies the Burro Canyon formation. Locally, the disconformity is marked by shallow depressions in the top of the Burro Canyon filled with Dakota sediments containing angular to sub-rounded rock fragments probably derived from Burro Canyon strata (Witkind, 1964) but the contact is concealed at the project site. The Dakota is composed predominantly of pale yellowish-brown to light gray, massive, intricately cross-bedded, fine- to coarse-grained quartzose sandstone locally well-cemented with silica and calcite; elsewhere it is weakly cemented and friable. Scattered throughout the sandstone are lenses of conglomerate, dark-gray carbonaceous mudstones and shale and, in some instances, impure coal. In general, the lower part of the Dakota is more conglomeratic and contains more cross-bedded sandstone than the upper part which in normally more thinly bedded and marine-like in appearance. The basal sandstones and conglomerates are fluvial in origin, whereas the carbonaceous mudstones and shales were probably deposited in back water areas behind beach ridges in front of the advancing Late

Cretaceous sea (Huff and Lesure, 1965). The upper sandstones probably represent littoral marine deposits since they grade upward into the dark-gray siltstones and marine shales of the Mancos Shale.

The Mancos shale is not exposed in the project vicinity. The nearest exposures are small isolated remnants resting conformably on Dakota Sandstone along the western rim above Recapture Creek 4.3 to 5.5 miles (6.9 to 8.9 kilometers) southeast of the project site. Additional exposures are found on the eastern and southern flanks of the Abajo Mountains approximately 16 to 20 miles (26 to 32 kilometers) to the north. It is possible that thin patches of Mancos may be buried at the project site but are obscured by the mantle of alluvial windblown silt and sand covering the upland surface. The Upper Cretaceous Mancos shale is of marine origin and consists of dark- to olive-gray shale with minor amounts of gray, fine-grained, thin-bedded to blocky limestone and siltstone in the lower part of the formation. Bedding in the Mancos is thin and well developed, and much of the shale is laminated. Where fresh, the shale is brittle and fissile and weathers to chips that are light- to yellowish-gray. Topographic features formed by the Mancos are usually subdued and commonly displayed by low rounded hills and gentle slopes.

A layer of Quaternary to Recent reddish-brown eolian silt and fine sand is spread over the surface of the project site. Most of the loess consists of subangular to rounded frosted quartz grains that are coated with iron oxide. Basically, the loess is massive and homogeneous, ranges in thickness from a dust coating on the rocks that form the rim cliffs to more than 20 feet (6 meters), and is partially cemented with calcium carbonate (caliche) in light-colored mottled and veined accumulations which probably represent ancient immature soil horizons.

1.6.2.3 Structure (E.R. Section 2.4.2.3)

The geologic structure at the project site is comparatively simple. Strata of the underlying Mesozoic sedimentary rocks are nearly horizontal; only slight undulations along the caprock rims of the upland are perceptible and faulting is absent. In much of the area surrounding the project site the dips are less than one degree. The prevailing regional dip is about one degree to the south. The low dips and simple structure are in sharp contrast to the pronounced structural features of the Comb Ridge Monocline to the west and the Abajo Mountains to the north.

The project area is within a relatively tectonically stable portion of the Colorado Plateau noted for its scarcity of historical seismic events. The epicenters of historical earthquakes from 1853 through 1986 within a 200-mile (320 km) radius of the site are shown in Figure 1.6-3. More than 1,146 events have occurred in the area, of which at least 45 were damaging; that is, having an intensity of VI or greater on the Modified Mercalli Scale. A description of the Modified Mercalli Scale is given in Table 1.6-3. All intensities mentioned herein refer to this table. Table 1.6-3 also shows a generalized relationship between Mercalli intensities and other parameters to which this review will refer. Since these relationships are frequently site specific, the table values should be used only for approximation and understanding. Conversely, the border between the Colorado Plateau and the Basin and Range Province and Middle Rocky Mountain Province some 155 to 240 miles (249 to 386 km) west and northwest, respectively, from the site is one of the most active seismic belts in the western United States.

Only 63 non-duplicative epicenters have been recorded within a 120 mile (200 km) radius of the project area (Figure 1.6-4). Of these, 50 had an intensity IV or less (or unrecorded) and two were recorded as intensity VI. The nearest event occurred in the Glen Canyon National Recreation Area

approximately 38 miles (63 km) west-northwest of the project area. The next closest event occurred approximately 53 miles (88 km) to the northeast. Just east of Durango, Colorado, approximately 99 miles (159 km) due east of the project area, an event having local intensity of V was recorded on August 29, 1941 (Hadsell, 1968). It is very doubtful that these events would have been felt in the vicinity of Blanding.

Three of the most damaging earthquakes associated with the seismic belt along the Colorado Plateau's western border have occurred in the Elsinore-Richfield are about 168 miles (270 km) northwest of the project site. All were of intensity VIII. On November 13, 1901, a strong shock caused extensive damage from Richfield to Parowan. Many brick structures were damaged; rockslides were reported near Beaver. Earthquakes with the ejection of sand and water were reported, and some creeks increased their flow. Aftershocks continued for several weeks (von Hake, 1977). Following several weeks of small foreshocks, a strong earthquake caused major damage in the Monroe-Elsinore-Richfield area on September 29, 1921. Scores of chimneys were thrown down, plaster fell from ceilings, and a section of a new two-story brick wall collapsed at Elsinore's schoolhouse. Two days later, on October 1, 1921, another strong tremor caused additional damage to the area's structures. Large rockfalls occurred along both sides of the Sevier Valley and hot springs were discolored by iron oxides (von Hake, 1977). It is probable that these shocks may have been perceptible at the project site but they certainly would not have caused any damage.

Seven events of intensity VII have been reported within 320 kilometers (km) around Blanding, Utah, which is the area shown in Figure 1.6-3. Of these, only two are considered to have any significance with respect to the project site. On August 18, 1912, an intensity VII shock damaged houses in northern Arizona and was felt in Gallup, New Mexico, and southern Utah. Rock slides occurred near the epicenter in the San Francisco Mountains and a 50-mile (80 km) earth crack was reported north

of the San Francisco Range (U. S. Geological Survey, 1970). Nearly every building in Dulce, New Mexico, was damaged to some degree when shook by a strong earthquake on January 22, 1966. Rockfalls and landslides occurred 10 to 15 miles (16 to 24 km) west of Dulce along Highway 17 where cracks in the pavement were reported (Hermann et al., 1980). Both of these events may have been felt at the project site but, again, would certainly not have caused any damage. Figure 1.6-4 shows the occurrence of seismic events within 200 km of Blanding.

TABLE 1.6-3

Modified Mercalli Scale, 1956 Version[a]

M§	Intensity	Effects	v † cm/s	g ‡
	I	Not felt. Marginal and long-period effects of large earthquakes (for details see text)		
3	II	Felt by persons at rest on upper floors, or favorably placed		
	III	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.		0.0035-0.007
4	IV	Hanging objects swing. Vibration like passing of heavy trucks or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.		0.007-0.015
	V	Felt outdoors: direction estimated. Sleepers wakened. Liquids disturbed. Some spilled. Small unstable objects displaced or upset. Doors swing close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate	1-3	0.015-0.035
5	VI	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc. off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle - CFR)	3-7	0.035-0.07
6	VII	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments - CFR). Some cracks in masonry C. Waves on ponds, water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.	7-20	0.07-0.15
	VIII	Steering of motor cars affected. Damage to masonry C, partial collapse. Some damage to masonry B, none is masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down, loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes	20-80	0.15-0.35
7	IX	General panic. Masonry D destroyed, masonry C heavily damaged. Sometimes with complete collapse, masonry B seriously damaged. (General damage to foundations - CFR). Frame structures, if not bolted, shifted off foundations. Frames rocked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand craters	80-200	0.35-0.7
8	X	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly	200-500	0.7-1.2
	XI	Rails bent greatly. Underground pipelines completely out of service.		>1.2
	XII	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.	From Fig. 11.14	

Note: Masonry A, B, C, D. To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering (which has no connection with the conventional Class A, B, C construction)

- Masonry A — Good workmanship, mortar, and design reinforced, especially laterally, and bound together by using steel, concrete, etc., designed to resist lateral forces.
- Masonry B — Good workmanship and mortar; reinforced, but not designed to resist lateral forces.
- Masonry C — Ordinary workmanship and mortar, no extreme weaknesses such as non-ded-ia corners, but masonry is neither reinforced nor designed against horizontal forces.
- Masonry D — Week materials such as adobe, poor mortar, low standards of workmanship, week horizontally.

[a]From Richter (1958). [1]Adapted with permission of W. H. Freeman and Company by Hunt (1984).
†Average peak ground velocity, cm/s
‡Average peak acceleration (away from source).
§Magnitude correlation

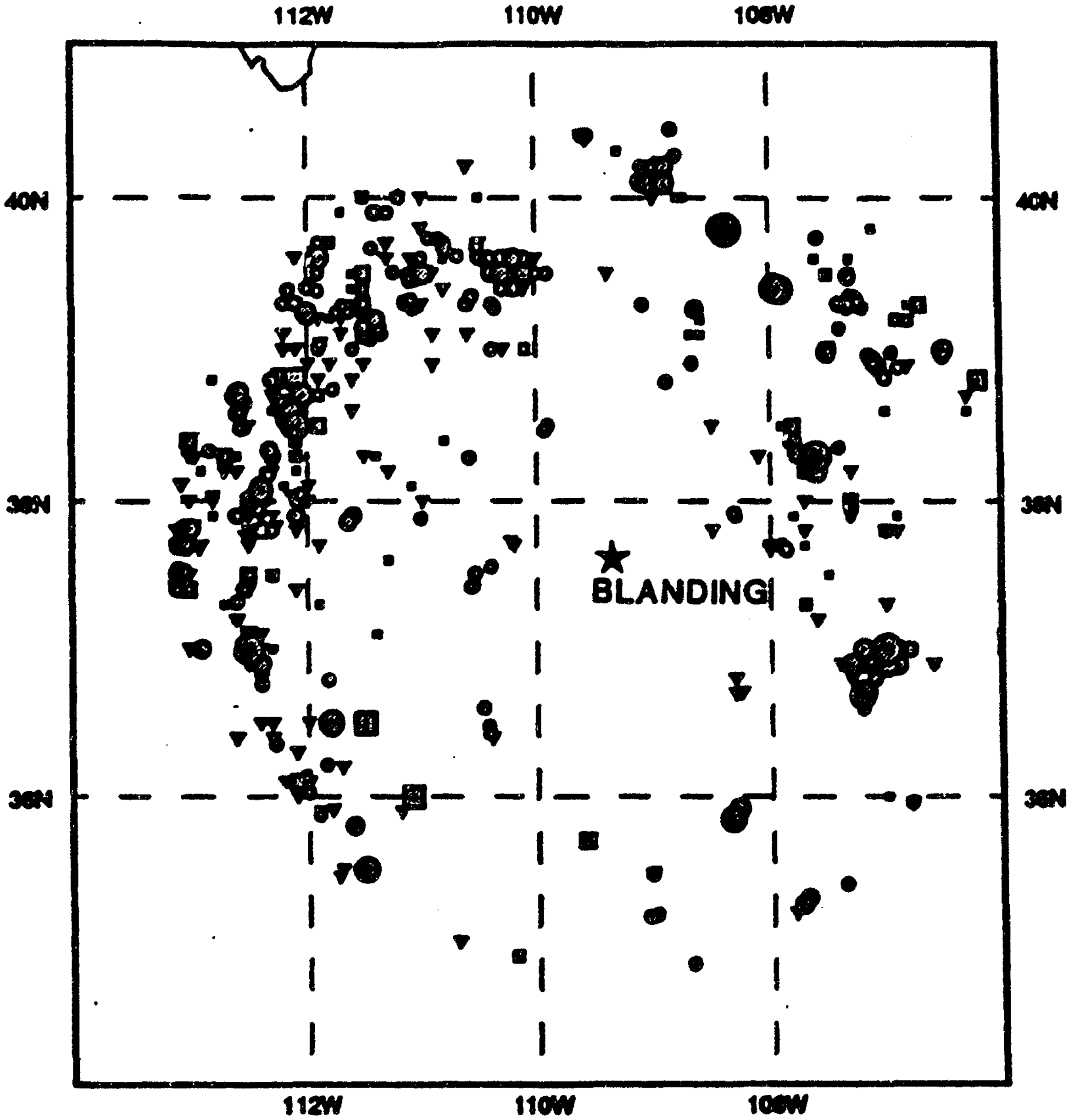
1.6.2.4 Relationship of Earthquakes to Tetonic Structures

The majority of recorded earthquakes in Utah have occurred along an active belt of seismicity that extends from the Gulf of California, through western Arizona, central Utah, and northward into western British Columbia. The seismic belt is possibly a branch of the active rift system associated with the landward extension of the East Pacific Rise (Cook and Smith, 1967). This belt is the Intermountain Seismic Belt shown in Figure 1.6-5 (Smith, 1978).

It is significant to note that the seismic belt forms the boundary zone between the Basin and Range - Great Basin Provinces and the Colorado Plateau - Middle Rocky Mountain Provinces. This block-faulted zone is about 47 to 62 miles (75 to 100 km) wide and forms a tectonic transition zone between the relatively simple structures of the Colorado Plateau and the complex fault-controlled structures of the Basin and Range Province (Cook and Smith, 1967).

Another zone of seismic activity is in the vicinity of Dulce, New Mexico, near the Colorado border. This zone, which coincides with an extensive series of tertiary intrusives, may also be related to the northern end of the Rio Grande Rift. This rift is a series of fault-controlled structural depressions extending southward from southern Colorado through central New Mexico and into Mexico. The rift is shown on Figure 1.6-5 trending north-south to the east of the project area.

Most of the events south of the Utah border of intensity V and greater are located within 50 miles (80 km) of post-Oligocene extrusives. This relationship is not surprising because it has been observed in many other parts of the world (Hadsell, 1968).



1146 EARTHQUAKES PLOTTED

MAGNITUDES	NO INTENSITY OR MAGNITUDE ▼	INTENSITIES
<4.0 ●		I-IV •
5.0 ●		V •
6.0 ●		VII ■
7.0 ●		IX ■

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FIGURE 1.6-3
Seismicity within 320 KM
of the White Mesa Mill

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APP	SCALE: As Shown	

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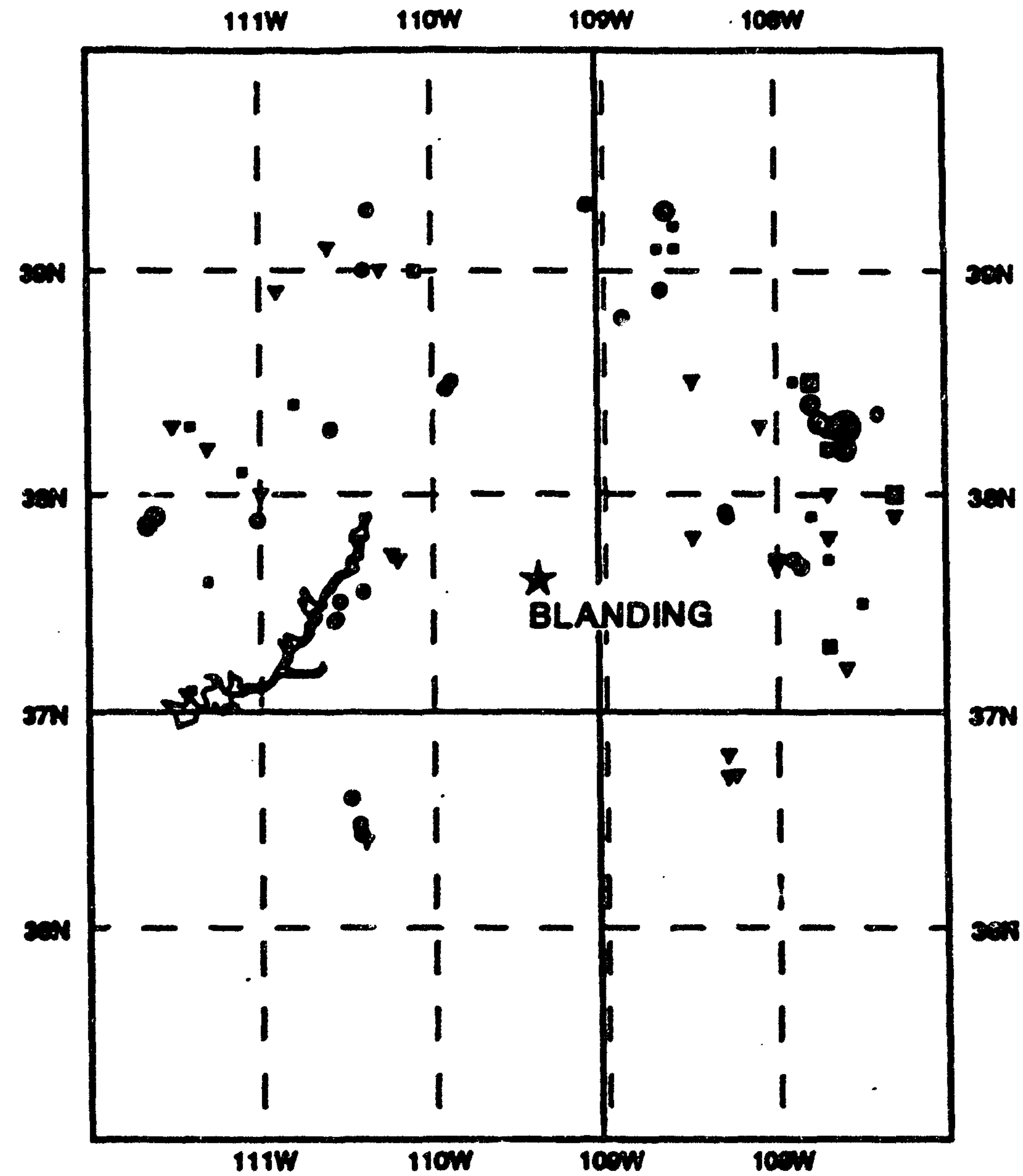

103 EARTHQUAKES PLOTTED

MAGNITUDES
<4.0
5.0
6.0
7.0

NO INTENSITY OR MAGNITUDE ▼

INTENSITIES
I-IV
V
VII
IX

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FIGURE 1.6-4
Seismicity within 200 KM
of the White Mesa Mill

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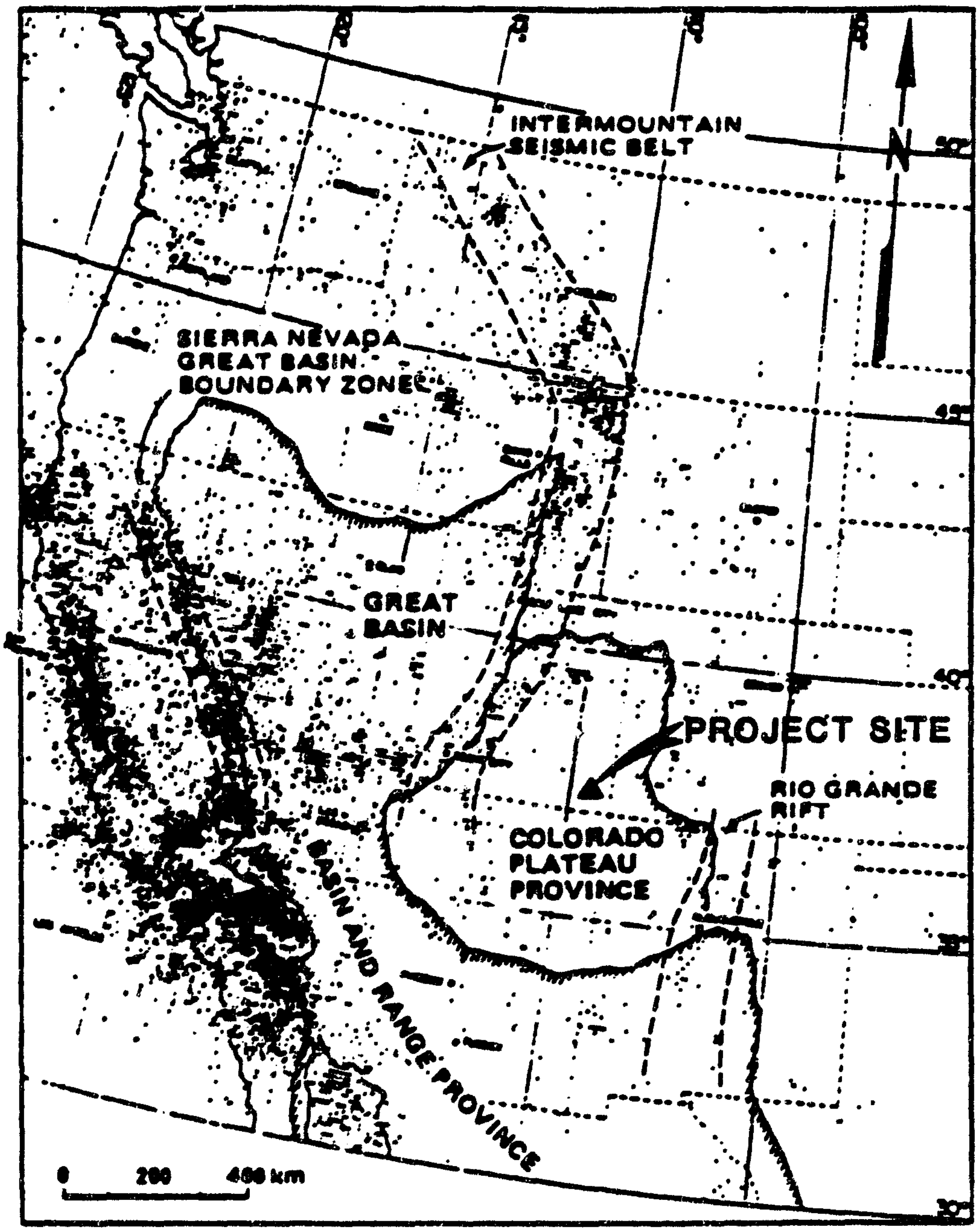

Modified from Smith, 1978

SHOWS RELATIONSHIP OF THE COLORADO PLATEAU PROVINCE TO MARCANAL BELTS

After Umetco #88

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FIGURE 1.6-5 Seismicity of the Western United States, 1950 to 1976		
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In Colorado, the Rio Grande Rift zone is one of three siesmotectonic provinces that may contribute energy to the study area. Prominent physiographic expression of the rift includes the San Luis Valley in southern Colorado. The valley is a half-graben structure with major faulting on the eastern flank. Extensional tectonics is dominant in the area and very large earthquakes with recurrence intervals of several thousand years have been projected (Kirkham and Rodgers, 1981). Mountainous areas to the west of the Rio Grande rift province include the San Juan Mountains. These mountains are a complex domicil uplift with extensive Oligocene and Miocene volcanic cover. Many faults are associated with the collapse of the calderas and apparently have not moved since. Faults of Neogene age exist in the eastern San Juan Mountains that may be related to the extension of the Rio Grande rift. Numerous small earthquakes have been felt or recorded in the western mountainous province despite an absence of major Neogene tectonic faults (Kirkham and Rodgers, 1981).

The third seismotectonic province in Colorado, that of the Colorado Plateau, extends into the surrounding states to the west and south. In Colorado, the major tectonic element that has been recurrently active in the Quaternary is the Uncompahgre uplift. Both flanks are faulted and earthquakes have been felt in the area. The faults associated with the Salt Anticlines are collapsed features produced by evaporite solution and flowage (Cater, 1970). Their non-tectonic origin and the plastic deformation of the salt reduces their potential for generating even moderate-sized earthquakes (Kirkham and Rodgers, 1981).

Case and Joesting (1972) have called attention to the fact that regional seismicity of the Colorado Plateau includes a component added by basement faulting. They inferred a basement fault trending northeast along the axis of the Colorado River through Canyonlands. This basement faulting may be part of the much larger structure that Hite (1975) examined and Warner (1978) named the Colorado lineament (Figure 1.6-6). This 1,300-mile (2,100 km) long lineament that extends from

northern Arizona to Minnesota is suggested to be a Precambrian wrench-fault system formed some 2.0 to 1.7 billion years before present. While it has been suggested that the Colorado lineament is a source zone for larger earthquakes (m = 4 to 6) in the west-central United States, the observed spatial relationship between epicenters and the trace of the lineament does not prove a casual relation (Brill and Nuttli, 1983). In terms of contemporary seismicity, the lineament does not act as a uniform earthquake generator. Only specific portions of the proposed structure can presently be considered seismic source zones and each segment exhibits seismicity of distinctive activity and character (Wong, 1981). This is a reflection of the different orientations and magnitudes of the stress fields along the lineament. The interior of the Colorado Plateau forms a tectonic stress province, as defined by Zoback and Zoback (1980), that is characterized by generally east-west tectonic compression. Only where extensional stresses from the Basin and Range province of the Rio Grande rift extend into the Colorado Plateau would the Colorado lineament in the local area be suspected of having the capability of generating a large magnitude earthquake (Wong, 1984). At the present time, the well defined surface expression of regional extension is far to the west and far to the east of the project area.

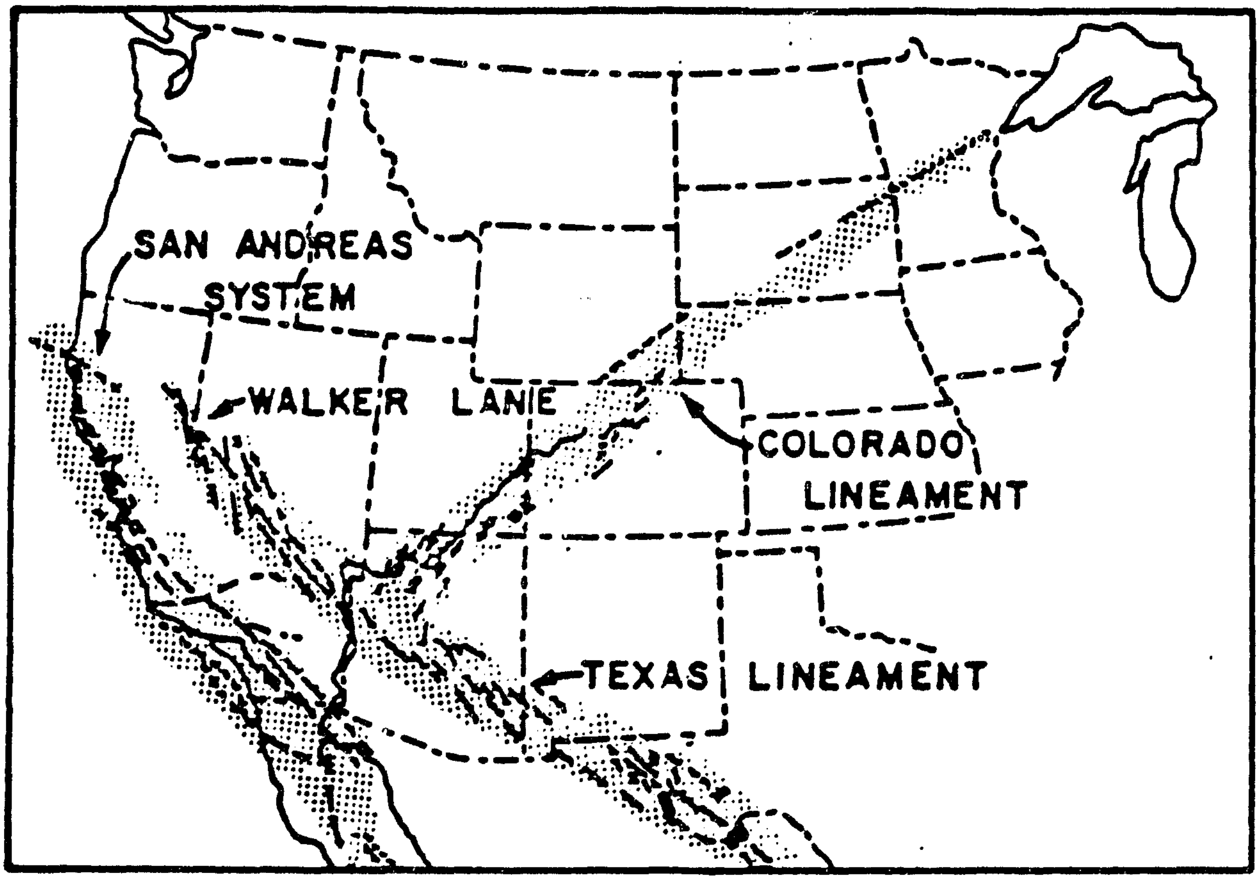
Recent work by Wong (1984) has helped define the seismicity of the whole Colorado Plateau. He called attention to the low level (less than M_L = 3.6) but high number (30) of earthquakes in the Capitol Reef Area from 1978 to 1980 that were associated with the Waterpocket fold and the Cainville monocline, two other major tectonic features of the Colorado Plateau. Only five earthquakes in the sequence were of M_L greater than 3, and fault plane solutions suggest the swarm was produced by normal faulting along northwest-trending Precambrian basement structures (Wong, 1984). The significance of the Capitol Reef seismicity is its relatively isolated occurrence within the Colorado Plateau and its location at a geometric barrier in the regional stress field (Aki, 1979). Stress concentration that produces earthquakes at bends or junctures of basement faults as indicated

by this swarm may be expected to occur at other locations in the Colorado Plateau Province. No inference that earthquakes such as those at Capitol Reef are precursors for larger subsequent events is implied.

1.6.2.5 Potential Earthquake Hazards to Project

The project site is located in a region known for its scarcity of recorded seismic events. Although the seismic history for this region is barely 135 years old, the epicentral pattern, or fabric, is basically set and appreciable changes are not expected to occur. Most of the larger seismic events in the Colorado Plateau have occurred along its margins rather than in the interior central region. Based on the region's seismic history, the probability of a major damaging earthquake occurring at or near the project site is very remote. Studies by Algermissen and Perkins (1976) indicate that southeastern Utah, including the site, is in an area where there is a 90 percent probability that a horizontal acceleration of four percent gravity (0.04g) would not be exceeded within 50 years.

Minor earthquakes, not associated with any seismic-tectonic trends, can presumably occur randomly at almost any location. Even if such an event with an intensity as high as VI should occur at or near the project site, horizontal ground accelerations would not exceed 0.10g but would probably range between 0.05 and 0.09g (Coulter et al., 1973; Trifunac and Brady, 1975). These magnitudes of ground motion would not pose significant hazards to the existing and proposed facilities at the Project Site.



SOURCE: WARNER, 1978

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FIGURE 1.6-6

Colorado Lineament

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1.6.3 Seismic Risk Assessment

In addition to general estimates of earthquake hazards, such as those offered by Dames and Moore (1978b), and summarized above, a more detailed analysis of the relationship between the project area and regional seismicity was performed. As can be seen in Figure 1.6-3, a map based on the seismologic data base from the National Geophysical Data Center of the National Oceanic and Atmospheric Administration (NOAA 1988), many events occur within the Intermountain Seismic Belt and within the Rio Grande rift. Since the Colorado Plateau Province (and particularly the Blanding basin portion, in which the project site lies) is a distinctly different tectonic province, the historical sample chosen for magnitude/frequency estimates was limited to a radius of about 120 miles (200 km) from the project. This sample included a region which is more representative of the seismicity of the Colorado Plateau.

Static and pseudostatic analyses were performed to establish the stability of the side slopes of the tailings soil cover. These analyses, together with analyses of radon flux attenuation, infiltration, freeze/thaw effects, and erosion protection, are summarized below, and are detailed in Appendix D, the Tailings Cover Design report (Titan, 1996).

The side slopes are designed at an angle of 5H:1V. Because the side slope along the southern section of Cell 4A is the longest and the ground elevation drops rapidly at its base, this slope was determined to be critical and is thus the focus of the stability analyses.

The computer software package GSLOPE, developed by MITRE Software Corporation, was used to determine the potential for slope failure. GSLOPE applies Bishop's Method of slices to identify the critical failure surface and calculate a factor of safety (FOS). The slope geometry and properties

of the construction materials and bedrock are input into the model. These data and drawings are included in the Stability Analysis of Side Slopes Calculation brief included as Appendix G of the Tailings Cover Design report. For this analysis, competent bedrock is designated at 10 feet below the lowest point of the foundation [i.e., at a 5,540-foot elevation above mean sea level (msl)]. This is a conservative estimate, based on the borehole logs supplied by Chen and Associates (1979), which indicate bedrock near the surface.

1.6.3.1 Static Analysis

For the static analysis, a Factor of Safety ("FOS") of 1.5 or more was used to indicate an acceptable level of stability. The calculated FOS is 2.91, which indicates that the slope should be stable under static conditions. Results of the computer model simulations are included in Appendix G of the Tailings Cover Design report.

1.6.3.2 Pseudostatic Analysis (Seismicity)

The slope stability analysis described above was repeated under pseudostatic conditions in order to estimate a FOS for the slope when a horizontal ground acceleration of 0.10g is applied. The slope geometry and material properties used in this analysis are identical to those used in the stability analysis. A FOS of 1.0 or more was used to indicate an acceptable level of stability under pseudostatic conditions. The calculated FOS is 1.903, which indicates that the slope should be stable under dynamic conditions. Details of the analysis and the simulation results are included in Appendix G of the Tailings Cover Design report.

In June of 1994, Lawrence Livermore National Laboratory ("LLNL") (1994) published a report on seismic activity in southern Utah, in which a horizontal ground acceleration of 0.12g was proposed for the White Mesa site. The evaluations made by LLNL were conservative to account for tectonically active regions that exist, for example, near Moab, Utah. Although, the LLNL report states that "...[Blanding] is located in a region known for its scarcity of recorded seismic events," the stability of the cap design slopes using the LLNL factor was evaluated. The results of a sensitivity analysis reveal that when considering a horizontal ground acceleration of 0.12g, the calculated FOS is 1.778 which is still above the required value of 1.0, indicating adequate safety under pseudostatic conditions. This analysis is also included in Appendix G of the Tailings Cover Design report.

1.7 BIOTA (ER Section 2.9)

1.7.1 Terrestrial (ER Section 2.9.1)

1.7.1.1 Flora (ER Section 2.9.1.1)

The natural vegetation presently occurring within a 25-mile (40-km) radius of the site is very similar to that of the potential, being characterized by pinyon-juniper woodland intergrading with big sagebrush (Artemisia tridentata) communities. The pinyon-juniper community is dominated by Utah juniper (Juniperus osteosperma) with occurrences of pinyon pine (Pinus edulis) as a codominant or subdominant tree species. The understory of this community, which is usually quite open, is composed of grasses, forbs, and shrubs that are also found in the big sagebrush communities. Common associates include galleta grass (Hilaria jamesii), green ephedra (Ephedra viridis), and broom snakewood (Gutierrezia sarothrae). The big sagebrush communities occur in deep, well-drained soils on flat terrain, whereas the pinyon-juniper woodland is usually found on shallow rocky

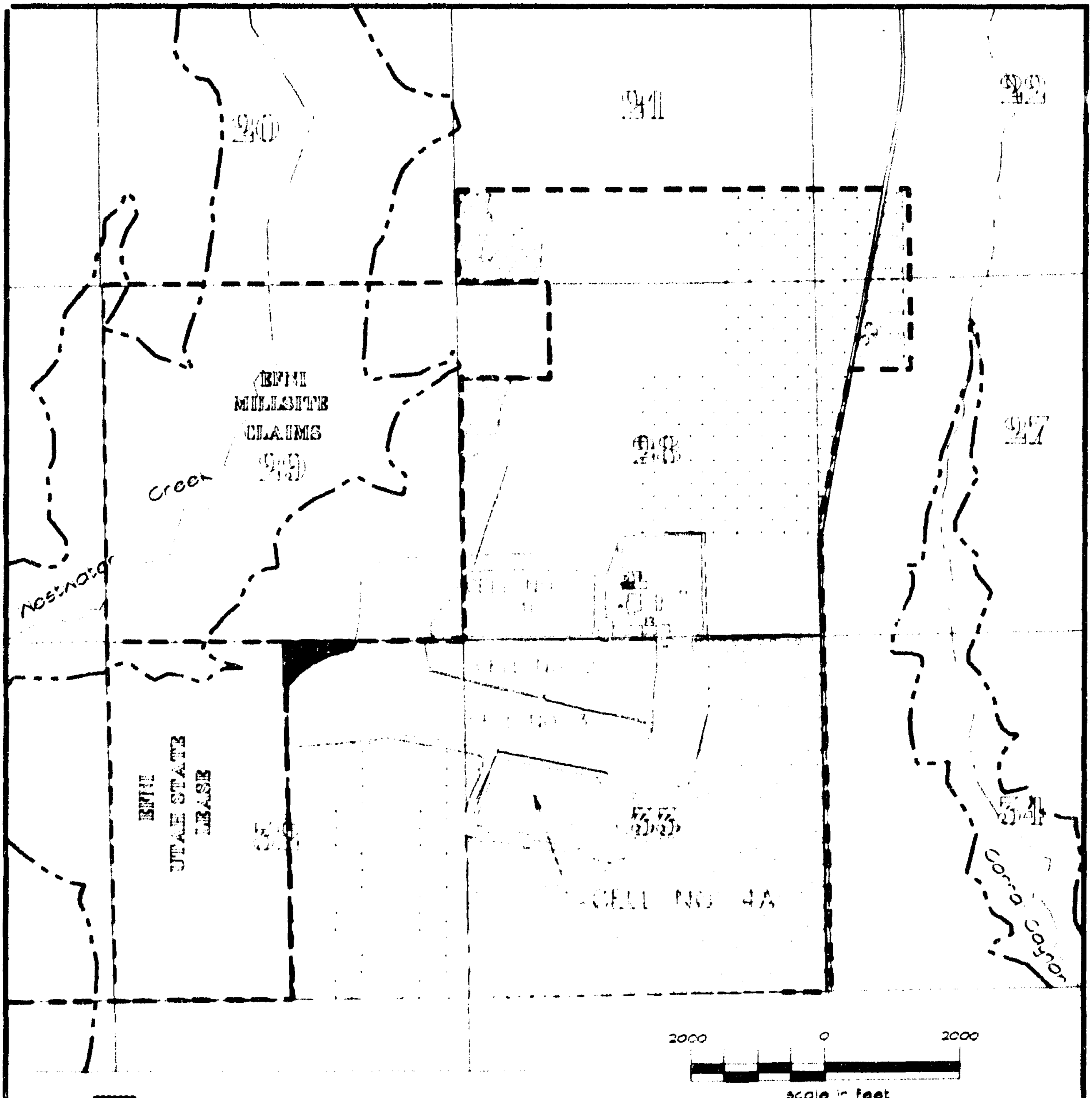
soil of exposed canyon ridges and slopes.

Seven community types are present on the project site (Table 1.7-1 and Figure 1.7-1). Except for the small portions of pinyon-juniper woodland and the big sagebrush community types, the majority of the plant communities within the site boundary have been disturbed by past grazing and/or treatments designed to improve the site for rangeland. These past treatments include chaining, plowing, and reseeding with crested wheatgrass (Agropyron desertorum). Controlled big sagebrush communities are those lands containing big sagebrush that have been chained to stimulate grass production. In addition, these areas have been seeded with crested wheatgrass. Both grassland communities I and II are the result of chaining and/or plowing and seeding with crested wheatgrass. The reseeded grassland II community is in an earlier stage of recovery from disturbance than the reseeded grassland I community. The relative frequency, relative cover, relative density, and importance values of species sampled in each community are presented in Dames and Moore (1978b), Table 2.8-2. The percentage of vegetative cover in 1977 was lowest on the reseeded grassland II community (10.7%) and highest on the big sagebrush community (33%) (Table 1.7-2).

Based upon dry weight composition, most communities on the site were in poor range condition in 1977 (Dames & Moore (1978), Tables 2.8-3 and 2.8-4). Pinyon-juniper, big sagebrush, and controlled big sagebrush communities were in fair condition. However, precipitation for 1977 at the project site was classed as drought conditions (Dames & Moore (1978b), Section 2.8.2.1). Until July, no production was evident on the site.

No designated or proposed endangered plant species occur on or near the project site (Dames & Moore (1978b), Section 2.8.2.1). Of the 65 proposed endangered species in Utah, six have documented distributions on San Juan County. A careful review of the habitat requirements and

known distributions of these species indicates that, because of the disturbed environment, these species would probably not occur on the project site.



- Pinyon-Juniper
- Reseeded Grassland I
- Reseeded Grassland II
- Big Sagebrush
- Controlled Big Sagebrush
- Disturbed

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FIGURE 1.7-1
Vegetation Community Types on the White Mesa Site

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TABLE 1.7-1

Community Types and Expanse Within the Project site Boundary

Community Type	Expanse	
	Ha	Acres
Pinyon iuniper Woodland	5	13
Big Sagebrush	113	278
Reseeded Grassland I	177	438
Reseeded Grassland II	121	299
Tamarisk-salix	3	7
Controlled Big Sagebrush	230	569
Disturbed	17	41

TABLE 1.7-2

Ground Cover For Each Community Within the Project Site Boundary

Community Type	Percentage of Each Type of Cover		
	Vegetative Cover	Litter	Bare Ground
Pinyon-juniper Woodland[a]	25.9	15.6	55.6
Big Sagebrush	33.3	16.9	49.9
Reseeded Grassland I	15.2	24.2	61.0
Reseeded Grassland II	10.7	9.5	79.7
Tamarisk-salix	12.0	20.1	67.9
Controlled Big Sagebrush	17.3	15.3	67.4
Disturbed	13.2	7.0	80.0

[a]Rock covered 4.4% of the ground.

1.7.1.2 Fauna (ER Section 2.9.1.2)

Wildlife data have been collected through four seasons at several locations on the site. The presence of a species was based on direct observations, trappings and signs such as the occurrence of scat, tracks, or burrows. A total of 174 vertebrate species potentially occur within the vicinity of the mill (Dames & Moore (1978b), Appendix D), 78 of which were confirmed (Dames & Moore (1978b), Section 2.8.2.2).

Although seven species of amphibians are thought to occur in the area, the scarcity of surface water limits the use of the site by amphibians. The tiger salamander (Ambystoma tigrinum) was the only species observed. It appeared in the pinyon-juniper woodland west of the project site (Dames & Moore (1978b), Section 2.8.2.2).

Eleven species of lizards and five snakes potentially occur in the area. Three species of lizards were observed: the sagebrush lizard (Sceloparas graciosus), western whiptail (Cnemidophorus tigris), and the short-horned lizard (Phrynosoma douglassi) (Dames & Moore (1978b), Section 2.8.2.2). The sagebrush and western whiptail lizard were found in sagebrush habitat, and the short-horned lizard was observed in the grassland. No snakes were observed during the field work.

Fifty-six species of birds were observed in the vicinity of the project site (Table 1.7-3). The abundance of each species was estimated by using modified Emlen transects and roadside bird counts in various habitats and seasons. Only four species were observed during the February sampling. The most abundant species was the horned lark (Eremophila aepestis) followed by the common raven (Corvus corax), which were both concentrated in the grassland. Avian counts increased drastically in May. Based on extrapolation of the Emlen transect data, the avian density

on grassland of the project site during spring was about 123 per 100 acres (?05 per square kilometer). Of these individuals, 94 percent were horned larks and western meadowlarks (Sturnella neglecta). This density and species composition are typical of rangeland habitats. In late June the species diversity declined somewhat i grassland but peaked in all other habitats. By October the overall diversity decreased but again remained the highest in grassland.

Raptors are prominent in the western United States. Five species were observed in the vicinity of the site (Table 1.7-3). Although no nests of these species were located, all (except the golden eagle, Aquila chrysaetos) have suitable nesting habitat in the vicinity of the site. The nest of a prairie falcon (Falco mexicanus) was found about 3/4 mile (1.2 km) east of the site. Although no sightings were made of this species, members tend to return to the same nests for several years if undisturbed (Dames & Moore (1978b), Section 2.8.2.2).

Of several mammals that occupy the site, mule deer (Odocoileus hemionus) is the largest species. The deer inhabit the project vicinity and adjacent canyons during winter to feed on the sagebrush and have been observed migrating through the site to Murphy Point (Dames & Moore (1978b), Section 2.8.2.2). Winter deer use of the project vicinity, as measured by browse utilization, is among the heaviest in southeastern Utah [25 days of use per acre (61 days of use per hectare) in the piny n-juniper-sagebrush habitats in the vicinity of the project site]. In addition, this area is heavily used as a migration route by deer traveling to Murphy Point to winter. Daily movement during winter periods by deer inhabiting the area has also been observed between Westwater Creek and Murphy Point. The present size of the local deer herd is not known.

Other mammals present at the site include the coyote (Canis latrans), red fox (Vulpes vulpes), gray fox (Urocyon cineroargenteus), striped skunk (Mephitis mephitis), badger (taxidea taxus), longtail

weasel (Mustela frenata), and bobcat (Lynx rufus). Nine species of rodents were trapped or observed on the site, the deer mouse (Peromyscus maniculatus) having the greatest distribution and abundance. Although desert cottontails (Sylvilagus auduboni) were uncommon in 1977, black-tailed jackrabbits (Lepus californicus) were seen during all seasons.

Three currently recognized endangered species of animals could occur in the project vicinity. However, the probability of these animals occurring near the site is extremely low. The project site is within the range of the bald eagle (Haliaeetus leucocephalus) and the American peregrine falcon (Falco peregrinus anatum), but the lack of aquatic habitat indicates a low probability of these species occurring on the site. Although the black-footed ferret (Musetela nigripes) once ranged in the vicinity of the site, it has not been sighted in Utah since 1952, and the Utah Division of Wildlife feels it is highly unlikely that this animal is present (Dames & Moore (1978b), Section 2.8.2.2).

1.7.2 Aquatic Biota (ER Section 2.9.2)

Aquatic habitat at the project site ranges temporally from extremely limited to nonexistent due to the aridity, topography and soil characteristics of the region and consequent dearth of perennial surface water. Two small catch basins (Dames & Moore (1978b), Section 2.6.1.1), approximately 20 m in diameter, are located on the project site, but these only fill naturally during periods of heavy rainfall (spring and fall) and have not held rainwater during the year-long baseline water quality monitoring program. One additional small basin was completed in 1994 to serve as a diversionary feature for migrating waterfowl. Although more properly considered features of the terrestrial environment, they essentially represent the total aquatic habitat on the project site. When containing water, these catch basins probably harbor algae, insects, other invertebrate forms, and amphibians.

TABLE 1.7-3
Birds Observed in the Vicinity of the White Mesa Project

Species	Relative Abundance and Status[a]	Species	Relative Abundance and Status[a]
Mallard	CP	Pinyon Jay	CP
Pintail	CP	Bushtit	CP
Turkey Vulture	US	Bewick's Wren	CP
Red-tailed Hawk	CP	Mockingbird	US
Golden Eagle	CP	Mountain Bluebird	CS
Marsh Hawk	CP	Black-tailed Gnatcatcher	H
Merlin	UW	Ruby-crowned Kinglet	CP
American Kestrel	CP	Loggerhead Shrike	CS
Sage Grouse	UP	Starling	CP
Scaled Quail	Not Listed	Yellow-rumped Warbler	CS
American Coot	CS	Western Meadowlark	CP
Killdeer	CP	Red-winged Blackbird	CP
Spotted Sandpiper	CS	Brewer's Blackbird	CP
Mourning Dove	CS	Brown-headed Cowbird	CS
Common Nighthawk	CS	Blue Grosbeak	CS
White-throated Swift	CS	House Finch	CP
Yellow-bellied Sapsucker	CP	American Goldfinch	CP
Western Kingbird	CS	Green-tailed Towhee	CS
Ash-throated Flycatcher	CS	Rufous-sided Towhee	CP
Say's Phoebe	CS	Lark Sparrow	CS
Horned Lark	CP	Black-throated Sparrow	CS
Violet-green Swallow	CS	Sage Sparrow	UC
Barn Swallow	CS	Dark-eyed Junco	CW
Cliff Swallow	CS	Chipping Sparrow	CS
Scrub Jay	CP	Brewer's Sparrow	CS
Black-billed Magpie	CP	White-crowned Sparrow	CS
Common Raven	CP	Song Sparrow	CP
Common Crow	CW	Vesper Sparrow	CS

[a]W. H. Behle and M. L. Perry, *Utah Birds*, Utah Museum of Natural History, University of Utah, Salt Lake City, 1975.

Relative Abundance	Status
C = Common	P = Permanent
U = Uncommon	S = Summer Resident
H = Hypothetical	W = Winter Visitant

Source: Dames & Moore (1978b), Table 2.8-5

They may also provide a water source for small mammals and birds. Similar ephemeral catch and seepage basins are typical and numerous to the northeast of the project site and south of Blanding.

Aquatic habitat in the project vicinity is similarly limited. The three adjacent streams (Corral Creek, Westwater Creek, and an unnamed arm of Cottonwood Wash) are only intermittently active, carrying water primarily in the spring during increased rainfall and snowmelt runoff, in the autumn, and briefly during localized but intense electrical storms. Intermittent water flow most typically occurs in April, August, and October in those streams. Again, due to the temporary nature of these steams, their contribution to the aquatic habitat of the region is probably limited to providing a water source for wildlife and a temporary habitat for insect and amphibian species.

No populations of fish are present on the project site, nor are any known to exist, in its immediate vicinity. The closest perennial aquatic habitat to the mill appears to be a small irrigation basin (approximately 50 m in diameter) about 3.8 miles (6 km) upgrade to the northeast. This habitat was not sampled for biota and it has been reported that the pond is intermittent and probably does not harbor any fish species.

The closest perennial aquatic habitat known to support fish populations is the San Juan River 18 miles (29 km) south of the project site. Five species of fish Federally designated (or proposed) as endangered or threatened occur in Utah (Table 1.7-4). One of the five species, the woundfin (Plegopterus argentissiumus), does not occur in southeastern Utah where the mill site is located. The Colorado squawfish (Ptychocheilus lucius) and humpback chub (Gila cypha), however, are reported as inhabiting large river systems in southeastern Utah. The bonytail chub (Gila elegans), classified as threatened by the State and proposed as endangered by Federal authorities, is also limited in its distribution to main channels or large rivers. The humpback sucker (razorback sucker; Xyrauchen

texanus), protected by the State and proposed as threatened by the Federal authorities, is found in southeastern Utah inhabiting backwater pools and quiet areas of mainstream rivers. The closest habitat suitable for the Colorado squawfish, humpback chub, bonytail chub, and humpback sucker is the San Juan River 18 miles (29 km) south of the site.

TABLE 1.7-4

Threatened and Endangered Aquatic Species Occurring in Utah

Species	Habitat	Listing	Occurrence in Southeastern Utah
Woundfin *Plegopterus Argentissimus*	Silty streams; muddy, swift-current areas; Virgin River critical habitat[a]	Federal - endangered[b] State - threatened	No
Humpback Chub *Gila Cypha*	Large river systems, eddies, and backwater	Federal - endangered[b] State - threatened	Yes
Colorado River Squawfish *Ptychocheilus Lucius*	Main channels of large river systems in Colorado drainage	Federal - endangered[b] State - threatened	Yes
Bonytail Chub *Gila Elegans*	Main channels of large river systems in Colorado drainage	Federal - proposed endangered[c] State - threatened	Yes
Humpback Sucker (razorback sucker) *Xyrauchen Texanus*	Backwater pools and quiet-water areas of main rivers	Federal - proposed threatened[c] State - threatened	Yes

a "Endangered and Threatened Wildlife and Plants," *Fed. Regist.* 42(211): 57329 (1977).

b "Endangered and Threatened Wildlife and Plants," *Fed. Regist.* 42(135): 36419-39431 (1977).

c "Endangered and Threatened Wildlife and Plants," *Fed. Regist.* 43(79): 17375-17377 (1978).

1.8 NATURAL RADIATION

The following sections describe background levels of natural radiation and refer the reader to recent reports containing current radiation monitoring data.

1.8.1 Background (ER Section 2.10)

Radiation exposure in the natural environment is due to cosmic and terrestrial radiation and to the inhalation of radon and its daughters. Measurements of the background environmental radioactivity were made at the mill site using thermoluinescent dosimeters (TLDs). The results indicate an average total body dose of 142 millirems per year, of which 68 millirems is attributable to cosmic radiation and 74 millirems to terrestrial sources. The cosmogenic radiation dose is estimated to be about 1 millirem per year. Terrestrial radiation originates from the radionuclides potassium-40, rubidium-87, and daughter isotopes from the decay of uranium-238, thorium-232, and, to a lesser extent, uranium-235. The dose from ingested radionuclides is estimated at 18 millirems per year to the total body. The dose to the total body from all sources of environmental radioactivity is estimated to be about 161 millirems per year.

The concentration of radon in the area is estimated to be in the range of 500 to 1,000 pCi/m^3, based on the concentration of radium-226 in the local soil. Exposure to this concentration on a continuous basis would result in a dose of up to 625 millirems per year to the bronchial epithelium. As ventilation decreases, the dose increases; for example, in unventilated enclosures, the comparable dose might reach 1,200 millirems per year.

The medical total body dose for Utah is about 75 millirems per year per person. The total dose in the area of the mill from natural background and medical exposure is estimated to be 236 millirems per year.

1.8.2 Current Monitoring Data

The most recent data for radon, gamma, vegetation, air and stock sampling, groundwater, surface water, meteorological monitoring, and soil sampling discussed in the following sections are found in the Semi-Annual Effluent Reports for July through December 1995 (Semi-Annual Effluent Report, 1995) (Energy Fuels Nuclear, Inc. 1996) and the Semi-Annual Effluent Report for January through June 1995 (Semi-Annual Effluent Report, 1995) (Energy Fuels Nuclear, Inc., 1995), which are reproduced in Appendix A.

1.8.2.1 Environmental Radon

Until 10 CFR 20 standards were reduced to 0.1 pCi/l, environmental radon concentrations were determined by using Track Etch detectors. There was one detector at each of five environmental monitoring stations with a duplicate at BHV-2, the nearest residence. See Appendix A, the Semi-Annual Effluent reports, for maps showing these locations. After 1995, with concurrence of the NRC, environmental radon concentrations are no longer measured at these locations due to the lack of sensitivity of available monitoring methods to meet the new 10 CFR 20 standard of 0.1 pCi/l.

1.8.2.2 Environmental Gamma

Gamma radiation levels are determined by Thermal Luminescent Dosimeters (TLDs). The TLDs are placed at the five environmental stations located around the perimeter boundary of the mill site discussed above. The badges are exchanged quarterly. The data are presented in Appendix A.

1.8.2.3 Vegetat Samples

Vegetation samples are collected at three locations around the mill periphery. The sampling locations are northeast, northwest, and southwest of the mill facility. Vegetation samples are collected during early spring, late spring, and fall. Vegetation results are included in Appendix A. No trends are apparent, as the Ra-226 and Pb-210 concentrations at each sampling location have remained consistent.

1.8.2.4 Environmental Air Monitoring and Stack Sampling

Air monitoring at the White Mesa Mill is conducted at five high volume (40 standard cubic feet per minute) stations located around the periphery of the mill. These locations are shown in Appendix A. BHV-1 is located at the northern mill boundary at the meteorological station site. BHV-2 is further north at the nearest residence. BHV-3 is the background station located approximately three to five miles due east of the mill. BHV-4 is south of Cell 3 and BHV-5 is just south of the ore storage pad. Appendix A, the Semi-Annual Effluent reports, contain air monitoring data.

The results of the first quarter 1996 stack samples are presented in Appendix A. These samples were collected during the period between January 27, 1996 and February 3, 1996. Samples were collected

from the North Yellowcake Dryer, the South Yellowcake Dryer, and the Yellowcake Baghouse. The Demister Stack and Grizzly Stack were not sampled because they were not in operation during that time. The material being processed during that time for recovery of the source material content was a uranium calcium fluoride solid in powder form, which requires no grinding. No second quarter 1996 gas samples were collected on any process stack, because material processing and drying operations ceased on March 23, 1996. Graphical representation of uranium release rate is presented in Appendix A. The south yellowcake dryer and yellowcake baghouse have only been sampled twice. No graphs had been generated for those data.

Pursuant to NRC License Amendment No. 41 for the White Mesa Mill Source Material License No. SUA-1358, air particulate radionuclide monitoring at BHV-3 was discontinued at the end of the third quarter 1995. Sufficient data were accumulated over a 12-year period to adequately establish background radionuclide concentrations. As a result of Amendment No. 41, the air particulate radionuclide concentrations at each monitoring site are calculated by subtracting the appropriate quarterly background average. Appendix A tables show the radionuclide concentrations at each location with background concentrations subtracted, and the results of the dose calculations, including the 50-year dose commitment to the nearest residence. Appendix A shows the yearly dose to the nearest resident, which is very low. No apparent trends are evident.

1.8.2.5 Groundwater

Appendix A tables list the groundwater monitoring data and the Quality Control (QC) results. No trends are apparent.

1.8.2.6 Surface Water

The results of surface water monitoring are presented in Appendix A. Cottonwood Creek is sampled Semi-annually and Westwater Creek is sampled on an annual basis. No water flowed in Westwater Creek during 1996. No trends are apparent.

1.8.2.7 Meteorological Monitoring

The Semi-Annual Air Quality and Meteorology Monitoring Report provided by Enecotech is included in Appendix A.

2.0 EXISTING FACILITY

The following sections describe the construction history of the White Mesa Mill; the mill and mill tailings management facilities; mill operations including the mill circuit and tailings management; and both operational and environmental monitoring.

2.1 Facility Construction History

The White Mesa uranium/vanadium mill was developed in the late 1970's by Energy Fuels Nuclear, Inc. (EFN) as an outlet for the many small mines that are located in the Colorado Plateau and for the possibility of milling Arizona Strip ores. At the time of its construction, it was anticipated that high uranium prices would stimulate ore production. However, prices started to decline about the same time as mill operations commenced.

As uranium prices fell, producers in the region were affected and mine output declined. After about two and one-half years, the White Mesa Mill ceased ore processing operations altogether, began solution recycle, and entered a total shutdown phase. In 1984, a majority ownership interest was acquired by Union Carbide Corporation's (UCC) Metals Division which later became Umetco Minerals Corporation (Umetco), a wholly-owned subsidiary of UCC. This partnership continued until May 26, 1994 when EFN reassumed complete ownership.

2.1.1 Mill and Tailings Management Facility

The Source Materials License Application for the White Mesa Mill was submitted to the U. S. Nuclear Regulatory Commission (NRC) on February 8, 1978. Between this date and the date the

first ore was fed to the mill grizzly on May 6, 1980, several actions were taken including: increasing mill design capacity, permit issuance from the Environmental Protection Agency and the State of Utah, archeological clearance for the mill and tailings areas, and an NRC pre-operational inspection on May 5, 1980.

Construction on the tailings area began on August 1, 1978 with the movement of earth from the area of Cell 2. Cell 2 was completed on May 4, 1980, Cell 1-I on June 29, 1981, and Cell 3 on September 2, 1982. In January of 1990 an additional cell, designated 4A, was completed and placed into use solely for solution storage and evaporation.

2.2 Facility Operations

In the following subsections, an overview of mill operators and operating periods are followed by descriptions of the operations of the mill circuit and tailings management facilities.

2.2.1 Operating Periods

The White Mesa Mill was operated by EFN from the initial start-up date of May 6, 1980 until the cessation of operations in 1983. Umetco, as per agreement between the parties, became the operator of record on January 1, 1984. The White Mesa Mill was shut down during all of 1984. The mill operated at least part of each year from 1985 through 1990. Mill operations were again ceased during the years of 1991 through 1994. EFN reacquired sole ownership on May 26, 1994 and the mill operated again during 1995 and 1996. Typical employment figures for the mill are 118 during uranium-only operations and 138 during uranium/vanadium operations.

2.2.2 Mill Circuit

While originally designed for a capacity of 1,500 dry tons per day (dtpd.), the mill was boosted to the present rated design of 1980 dtpd. prior to commissioning.

The mill uses an atmospheric hot acid leach followed by counter current decantation (CCD). This in turn is followed by a clarification stage which precedes the solvent extraction (SX) circuit. Kerosene containing iso-decanol and tertiary amines extract the uranium and vanadium from the aqueous solution in the SX circuit. Salt and soda ash are then used to strip the uranium and vanadium from the organic phase.

After extraction of the uranium values from the aqueous solution in SX, uranium is precipitated with anhydrous ammonia, dissolved, and re-precipitated to improve product quality. The resulting precipitate is then washed and dewatered using centrifuges to produce a final product called "yellowcake." The yellowcake is dried in a hearth dryer and packaged in drums weighing approximately 800 to 1,000 lbs. for shipping to converters.

After the uranium values are stripped from the pregnant solution in SX, the vanadium values are transferred to tertiary amines contained in kerosene and concentrated into an intermediate product called vanadium product liquor (VPL). An intermediate product, ammonium metavanadate (AMV), is precipitated from the VPL using ammonium sulfate in batch precipitators. The AMV is then filtered on a belt filter and, if necessary, dried. Normally, the AMV cake is fed to fusion furnaces when it is converted to the mill's primary vanadium product, V_2O_5 tech flake, commonly called "black flake."

The mill processed 1,511,544 tons of ore and other materials from May 6, 1980 to February 4, 1983. During the second operational period from October 1, 1985 through December 7, 1987, 1,023,393 tons were processed. During the third operational period from July 1988 through November 1990, 1,015,032 tons were processed. During the fourth operational period from August 1995 through January 1996, 203,317 tons were processed. The fifth and most recent operational period from May 1996 through September 1996, processed 3,868 tons of calcium fluoride material. Inception to date material processed through September 1996 totals 3,757,154 tons. This total is for all processing periods combined.

2.2.3 Tailings Management Facilities

Tailings produced by the mill typically contain 30 percent moisture by weight, have an in-place dry density of 74.2 pounds per cubic foot, have a size distribution with a predominant -325 mesh size fraction, and have a high acid and flocculent content.

The tailings facilities at White Mesa currently consist of four cells as follows:

- Cell 1, constructed with a 30-millimeter (ml) PVC earthen-covered liner, is used for the evaporation of process solution.
- Cell 2, constructed with a 30-millimeter (ml) PVC earthen-covered liner, is used for the storage of barren tailings sands.
- Cell 3, constructed with a 30-millimeter (ml) PVC earthen-covered liner, is used for the storage of barren tailings sands and solutions.
- Cell 4A, constructed with a 40-millimeter (ml) HDPE liner, is currently used only for the storage of solutions.

Total estimated design capacity of Cells 2, 3, and 4A is approximately six million (mm) cubic yards.

2.2.3.1 Tailings Management

Constructed in shallow valleys or swale areas, the lined tailings facilities provide storage below the existing grade and reduce potential exposure. Because the cells are separate and distinct, individual tailings cells may be reclaimed as they are filled to capacity. This phased reclamation approach minimizes the amount of tailings exposed at any given time and reduces potential exposure to a minimum.

The perimeter discharge method involves setting up discharge points around the east, north, and west boundaries of the cell. This results in low cost disposal at first, followed by higher disposal costs toward the end of the cell's life. The disadvantage to this method is that reclamation activities cannot take place until near the end of the cell's life. This disadvantage was recognized and led to the development of the final grade method.

Slurry disposal has taken place in both Cells 2 and 3. Tails placement accomplished in Cell 2 was by means of the above described perimeter discharge method, while in Cell 3 the final grade method, described below, has been employed.

The final grade method used in Cell 3 calls for the slurry to be discharged until the tailings surface comes up to final grade. The discharge points are set up in the east end of the cell and the final grade surface is advanced to the slimes pool area. When the slimes pool is reached, the discharge points are then moved to the west end of the cell and worked back to the middle. An advantage to using the final grade method is that maximum beach stability is achieved by (1) allowing water to drain from the sands to the maximum extent, and (2) allowing coarse sand deposition to help provide

stable beaches. Another advantage is that radon release and dust prevention measures (through the placement of the initial layer of the final cover) are applied as expeditiously as possible.

2.2.3.2 Liquid Management

As a zero-discharge facility, the White Mesa Mill must evaporate all of the liquids utilized during processing. This evaporation takes place in three areas:

- Cell 1, which is used for solutions only;
- Cell 3, in which tailings and solutions exist; and
- Cell 4A, which is currently for the evaporation of tailings solutions only.

The original engineering design indicated a net water gain into the cells would occur during mill operations. As anticipated, this has been proven to be the case. In addition to natural evaporation, spray systems have been used at various times to enhance evaporative rates and for dust control. To minimize the net water gain, solutions are recycled from the active tailings cells to the maximum extent possible. Solutions from Cells 3 and 4 are brought back to the CCD circuit where metallurgical benefit can be realized. Recycle to other parts of the mill circuit are not feasible due to the acid content of the solution.

2.3 Monitoring Programs

Operational monitoring is defined as those monitoring activities that take place only during operations. This is contrasted with environmental monitoring, which is performed whether or not the mill is in operation.

2.3.1 Operational Monitoring

In the mill facilities area, the operational monitoring programs consist of effluent gas stack sampling; daily inspection of process tanks, lines and equipment; and daily inspection of tailing impoundments and leak detection systems. Quarterly effluent gas stack samples are collected on all mill process stacks when those process systems are operating. These include the yellowcake dryers No. 1 and No. 2, the vanadium dryer stack, their respective scrubber stacks, the demister stack, and the grizzly stack.

A visual inspection is made daily by supervisory personnel of all process tanks and discharge lines in the mill and of the tailings management area. In the event of a failure in one of the normal process streams, corrective actions are taken to ensure that there are no discharges to the environment.

Leak detection systems ("LDS") under each tailings cell are monitored for the presence of solution weekly. If sufficient solution is present in the LDS of Cells 2, 3, or 4 to be pumped, the solution is sampled and analyzed for nickel, chlorides, sulfates, potassium, selenium, and pH.

2.3.2 Environmental Monitoring

Environmental monitoring consists of the following: groundwater and surface water samples; air particulate samples, gamma radiation measurements, soil, and vegetation samples. Refer to the Semi-annual Effluent Reports contained in Appendix A for sampling location, frequency and analytical results.

Groundwater

Wells MW-6, MW-7, and MW-8 were plugged because they were under Cell 3, as was MW-13, under Cell 4A. Wells MW-9 and MW-10 are dry and have been excluded from the monitoring program. The ten monitoring wells in or near the uppermost aquifer are MW-1, MW-2, MW-3, MW-4, MW-5, MW-11, MW-12, MW-14, MW-15 and MW-17. These wells vary in depth from 94 to 189 feet. Flow rates in these wells vary from 15 gallons per month to 10 gallons per hour. The culinary well (one of the supply wells) is completed in the Navajo aquifer, at a depth of approximately 1,800 feet below the ground surface.

The groundwater monitoring program consists of parameters measured quarterly and semi-annually. Quarterly parameters include: pH, specific conductance, temperature, depth to water, chlorides, sulfates, total dissolved solids (TDS), nickel, potassium, and U-natural. The parameters measured on a semi-annual basis, in addition to the quarterly parameters, are: arsenic, selenium, sodium, radium-226, thorium-230, and lead-210. Semi annual parameters which all measured are: all physical chemical criteria of quarterly sampling as well as additional analyte parameters as, Se Na and Radionuclides Ra-226, Th-230, and Pb216.

Surface Water

Surface water samples are taken from the two nearby streams, Westwater Creek and Cottonwood Creek. Cottonwood Creek usually contains running water, but has also been dry on occasion. Westwater Creek rarely contains running water, and when it does, it is from precipitation runoff. Water samples are collected quarterly from Cottonwood Creek and analyzed for TDS and total suspended solids (TSS). Additional semi-annual water samples are collected at a minimum of four

(4) months apart. These samples are analyzed for TDS, TSS, dissolved and suspended U-nat, Ra-226, and Th-230.

Currently the program includes sampling water from Westwater Creek once a year, if the creek is flowing. However, if water is not running, an alternate soil sample is collected from the creek bed. Water samples from Westwater Creek are analyzed for TDS, TSS, Dissolved and Suspended U-nat, Ra-226, and Th-230. If a soil sample is collected, it is analyzed for U-nat and Ra-226 (per License Condition 24C).

Radiation

Natural radiation monitoring includes air particulate sampling, gamma radiation measurements, and vegetation and soil sampling. Air particulate monitoring is conducted continuously at four monitoring stations located around the periphery of the mill. Gamma radiation measurements, vegetation sampling, and soil sampling are conducted at five locations. See Section 1.8 for details concerning the monitoring program.

Gamma radiation levels are determined at the five environmental monitoring stations and are reported quarterly, with duplicate samples collected at the nearest residence.

Approximately five pounds of "new growth" vegetation samples are collected from areas "northeast of the mill, northwest of the mill, and southwest of the mill" during early spring, late spring, and late fall. Sample collection areas vary depending on the growth year (i.e. in low or no moisture years it may take an area several acres in size to collect five pounds of vegetation, while in "wet" years a much smaller area is needed). Vegetation is analyzed for radium-226 and lead-210.

Soils are sampled at each of the five environmental monitoring stations annually in August. The soils are analyzed for U-natural and radium-226.

3.0 RECLAMATION PLAN

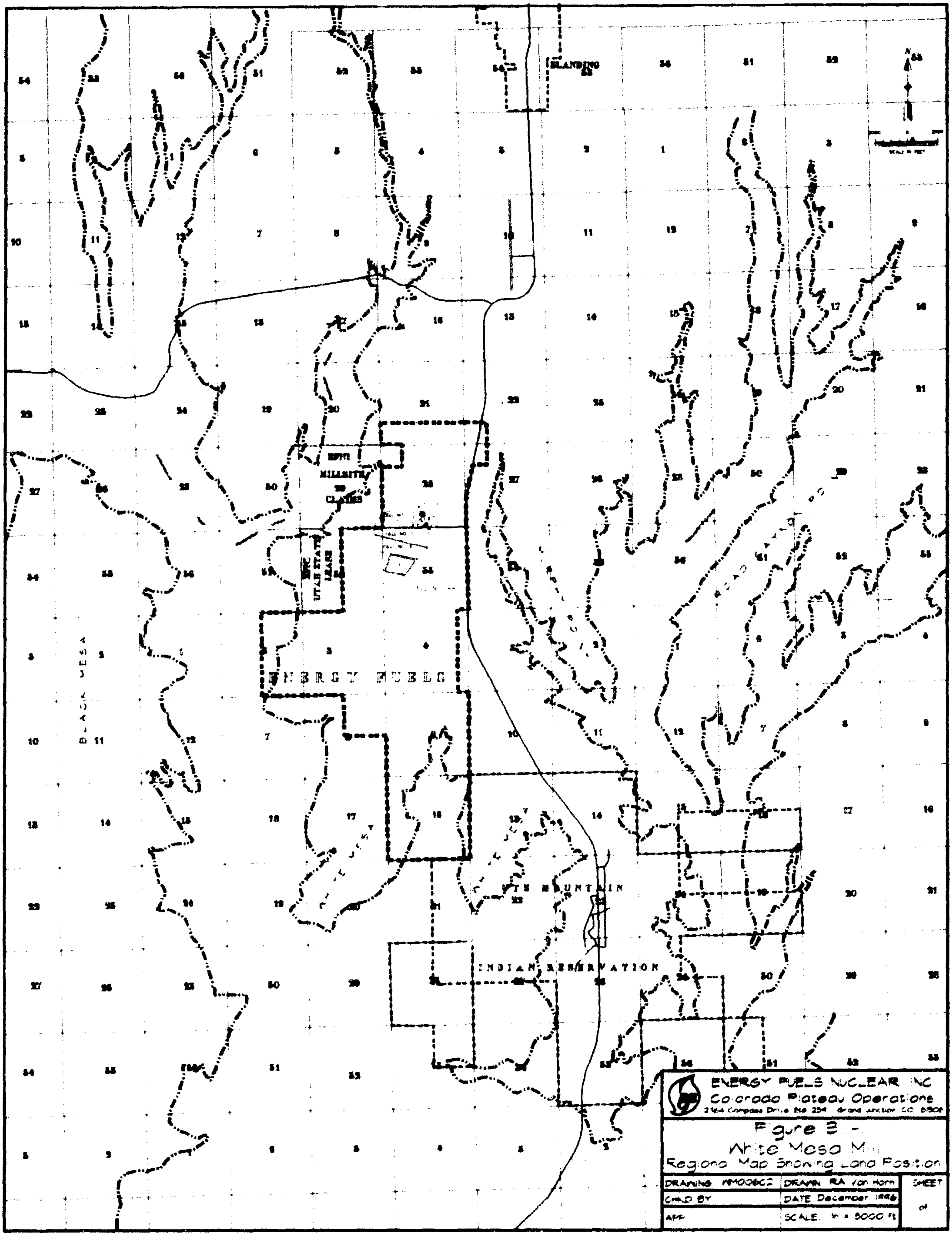
This section provides an overview of the mill location and property; details the facilities to be reclaimed; and describes the design criteria applied in this reclamation plan. Reclamation Plans and Specifications are presented in Attachment A. Attachment B presents the quality plan for construction activities. Attachment C presents cost estimates for reclamation.

3.1 Location and Property Description

The White Mesa Mill is located six miles south of Blanding, Utah on US Highway 191 on a parcel of land encompassing all or part of Sections 21, 22, 27, 28, 29, 32, and 33 of T37S, R22E, and Sections 4, 5, 6, 8, 9, and 16 of T38S, R22E, Salt Lake Base and Meridian described as follows (Figure 3.1-1):

> The south half of Section 21; the southeast quarter of the southeast quarter of Section 22; the northwest quarter of the northwest quarter and lots 1 and 4 of Section 27 all that part of the southwest quarter of the northwest quarter and the northwest quarter southwest quarter of Section 27 lying west of Utah State Highway 163; the northeast quarter of the northwest quarter, the south half of the northwest quarter, the northeast quarter and the south half of Section 28; the southeast quarter of the southeast quarter of Section 29; the east half of Section 32 and all of Section 33, Township 37 South, Range 22 East, Salt Lake Base and Meridian. Lots 1 through 4, inclusive, the south half of the north half, the southwest quarter, the west half of the southeast quarter, the west half of the east half of the southeast quarter and the west half of the east half of the east half of the southeast quarter of Section 4; Lots 1 through 4, inclusive, the south half of the north half and the south half of Section 5 (all); Lots 1 and 2, the

south half of the northeast quarter and the south half of Section 6 (E1/2); the northeast quarter of Section 8; all of Section 9 and all of Section 16, Township 38 South, Range 22 East, Salt Lake Base and Meridian. Containing approximately 4,871 acres.


BLANDING
EFN MILLSITE 20 CLAIMS
EFN UTAH STATE LEASE
ENERGY FUELS
BLACK MESA
UTE MOUNTAIN
INDIAN RESERVATION
ENERGY FUELS NUCLEAR INC
Colorado Plateau Operations
Figure 3.-
White Mesa Mill
Regional Map Showing Land Position
DRAWING WM006C2
DRAWN RA Van Horn
CHKD BY
DATE December 1996
APP
SCALE 1in = 5000 ft
SHEET
of

3.2 Facilities to be Reclaimed

See Figure 3.2-1 for a general layout of the mill yard and related facilities and the restricted area boundary.

3.2.1 Summary of Facilities to be Reclaimed

The facilities to be reclaimed include the following:

- Cell 1 (evaporative), Cells 2 and 3 (tailings) and Cell 4A (solutions only).
- Mill buildings and equipment.
- On-site contaminated areas.
- Off-site contaminated areas (i.e., potential areas affected by windblown tailings).

The reclamation of the above facilities will include the following:

- Placement of materials and debris from mill decommissioning in tailings Cells 2 and 3.
- Placement of contaminated soils, crystals, and synthetic liner material from Cell 1 in tailings Cells 2 and 3.
- Placement of contaminated soils, crystals and synthetic liner material from Cell 4A in tailings Cells 2 and 3.
- Placement of an engineered multi-layer cover on Cells 2 and 3.
- Construction of runoff control and diversion channels as necessary.
- Reconditioning of mill and ancillary areas.
- Reclamation of borrow sources.

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3.2.2 Tailings and Evaporative Cells

The following subsections describe the cover design and reclamation procedures for Cells 1I, 2, 3, and 4A. Complete engineering details and text are presented in the Tailings Cover Design report, Appendix D.

3.2.2.1 Soil Cover Design

A six-foot thick soil cover for the uranium tailings in Cell 2 and Cell 3 was designed using on-site materials that will contain tailings and radon emissions in compliance with regulations of the United States Nuclear Regulatory Commission ("NRC") and by reference, the Environmental Protection Agency ("EPA"). The cover consists of a one-foot thick layer of clay, available from within the site boundaries (Section 16), below two feet of random fill, available from stockpiles on site. The clay is underlain by three feet (minimum) random fill soil, also available on site. In addition to the soil cover, a minimum three inch (on the cover top) to 12-inch (on the cover slopes) layer of riprap material will be placed over the compacted random fill to stabilize slopes and provide long-term erosion resistance.

Uranium tailings soil cover design requirements for regulatory compliance include:

- Attenuate radon flux to an acceptable level (20 picoCuries-per meter squared-per second [pCi/m^2/sec]) (NRC, 1989);
- Minimize infiltration into the reclaimed tailings cells;
- Maintain a design life of up to 1,000 years or to the extent reasonably achievable, and in any case for at least 200 years; and
- Provide long-term slope stability and geomorphic durability to withstand erosional forces of

wind, the probable maximum flood event, and a horizontal ground acceleration of 0.1g due to seismic events.

Several models/analyses were utilized in simulating the soil cover effectiveness: radon flux attenuation, hydrologic evaluation of infiltration, freeze/thaw effects, soil cover erosion protection, and static and pseudostatic slope stability analyses. These analyses and results are discussed in detail in Sections 3.3.1 through 3.3.5, and calculations are also shown in the Tailings Cover Design report, Appendix D. The soil cover (from top to the bottom) will consist of: (1) minimum of three inches of riprap material; (2) two feet of compacted random fill; (3) one foot of compacted clay; and (4) minimum three feet of compacted random fill soil.

The final grading plan is presented in Section 5, Figure 5.1-1. As indicated on the figures, the top slope of the soil cover will be constructed at 0.2 percent and the side slopes, as well as transitional areas between cells, will be graded to five horizontal to one vertical (5H:1V).

A minimum of three feet random fill is located beneath the compacted fill and clay layers (see cross-sections on Figures 5.1-2 and 5.1-3). The purpose of the fill is to raise the base of the cover to the desired subgrade elevation. In many areas, the required fill thickness will be much greater. However, the models and analyses presented in the Tailings Cover Design report (Appendix D) were performed conservatively, assuming only a three-foot layer. For modeling purposes, this lower, random fill layer was considered as part of the soil cover for performing the radon flux attenuation calculation, as it effectively contributes to the reduction of radon emissions (see Section 3.3.1). The fill was also evaluated in the slope stability analysis (see Section 3.3.6). However, it is not defined as part of the soil cover for other design calculations (infiltration, freeze/thaw, and cover erosion).

3.2.2.2 Cell 1-I

Cell 1-I, used solely for evaporation of process liquids, is the northernmost existing cell and is located immediately west of the mill. It is also the highest cell in elevation, as the natural topography slopes to the south. The drainage area above and including the cell is 216 acres. This includes drainage from the mill site.

Cell 1-I will be evaporated to dryness. The synthetic liner and raffinate crystals will then be removed and placed in the tailings cells. Any contaminated soils below the liner will be removed and also placed in the tailings cells. Based on current regulatory criteria, the current plan calls for excavation of the residual radioactive materials to be designed to ensure that the concentration of radium-226 in land averaged over any area of 100 square meters does not exceed the background level by more than:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface, and
- 15 pCi/g, averaged over a 15 cm thick layer of soil more than 15 cm below the surface.

Cell 1-I will then be breached and converted to a sedimentation basin. All runoff from the mill area and immediately north of the cell will be routed into the sedimentation basin and will discharge onto the natural ground via the channel located at the southwest corner of the basin. The channel is designed to accommodate the PMF flood.

The HEC-1 model was used to determine the PMF and route the flood through the sedimentation basin. The peak flow was determined to be 1,987 cubic feet per second (cfs). A 100-foot wide channel will discharge the flow to the natural drainage. During the local storm PMF event, the maximum discharge through the channel will be 746 cfs. The entire flood volume will pass through

the discharge channel in approximately four hours.

At peak flow, the velocity in the discharge channel will be 3.5 feet per second (fps). The maximum flow depth will be 2.2 feet. Twenty-four inches of riprap having a nominal (D_{50}) size of 12 inches will be placed on the bottom and up the sides of the channel. A free board depth of 0.5 feet will be maintained for the PMP event.

3.2.2.3 Cell 2

Cell 2 will be filled with tailings and covered with a multi-layered engineered cover to a minimum cover thickness of six feet. The final cover will drain to the south at a 0.2 percent gradient.

The cover will consist of a minimum of three feet of random fill, followed by a clay radon barrier of one foot in thickness, and two feet of upper random fill for protection of the radon barrier. A minimum of three inches of rock will be utilized as armor against erosion. Side slopes will be graded to a 5:1 slope and will have one foot of rock armor protection.

3.2.2.4 Cell 3

Cell 3 will be filled with tailings, debris and contaminated soils and covered with the same multi-layered engineered cover as Cell 2.

3.2.2.5 Cell 4A

Cell 4A will be evaporated to dryness and the crystals, synthetic liner and any contaminated soils placed in tailings. Non-contaminated materials in cell 4A dikes will be used to reduce the southern

slopes of Cell 3 from the current 3:1 to 5:1.

3.2.3 Mill Decommissioning

A general layout of the mill area is shown in Figure 3.2.3-1.

3.2.3.1 Mill Building and Equipment

The uranium and vanadium sections, including ore reclaim, grinding, pre-leach, leach, CCD, SX, and precipitation and drying circuits will be decommissioned as follows:

All equipment including instrumentation, process piping, electrical control and switchgear, and contaminated structures will be removed. Contaminated concrete foundations will be demolished and removed or covered with soil as required. Uncontaminated equipment, structures and waste materials from mill decommissioning may be disposed of by sale, transferred to other company-owned facilities, transferred to an appropriate off-site solid waste site, or disposed of in one of the tailings cells. Contaminated equipment, structures and waste materials from mill decommissioning, contaminated soils underlying the mill areas, and ancillary contaminated materials will be disposed of in tailings cells.

Debris and scrap will have a maximum dimension of 20 feet and a maximum volume of 30 cubic feet. Material exceeding these limits will be reduced to within the acceptable limits by breaking, cutting or other approved methods. Empty drums, tanks or other objects having a hollow volume greater than five cubic feet will be reduced in volume by at least 70 percent. If volume reduction is not feasible, openings shall be made in the object to allow soils or other approved material to enter the object.

Debris and scrap will be spread across the designated areas to avoid nesting and to reduce the volume of voids present in the placed mass. Stockpiled soils, and/or other approved material shall be placed over and into the scrap in sufficient amounts to fill the voids between the large pieces and the volume within the hollow pieces to form a coherent mass.

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3.2.3.2 Mill Site

Contaminated areas on the mill site will be primarily superficial and includes the ore storage area and surface contamination of some roads. All ore will have been previously removed from the ore stockpile area. All contaminated materials will be excavated and be disposed in one of the tailings cells. The depth of excavation will vary depending on the extent of contamination and will be governed by the criteria in Section 4.3.2.1.

Windblown material is defined as mill-derived contaminants dispersed by wind to surrounding areas. Windblown contaminated material detected by a gamma survey using the criteria in Section 4.3.2.1 will be excavated and disposed in one of the tailings cells.

Disturbed areas will be covered, graded and vegetated as required. The proposed grading plan for the mill site and ancillary areas is shown on Figure A-3.2-1 in Attachment A.

3.3 Design Criteria

The design criteria summaries in this section are adapted from Tailings Cover Design, White Mesa Mill (Titan, 1996). A copy of the Tailings Cover Design report is included as Appendix D. It contains all of the calculations used in design discussed in this section.

3.3.1 Regulatory Criteria

Information contained in 10 CFR Part 20, Appendix A, 10 CFR Part 40, and 40 CFR Part 192 was used as criteria in final designs under this reclamation plan. In addition, the following documents also provided guidance:

- Environmental Protection Agency (EPA), 1994, "The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3." EPA/600/R-94/168b, September.
- Nuclear Regulatory Commission (NRC), 1989, "Regulatory Guide 3.64 (Task WM-503-4) Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers," March.
- NRC, 1980, "Final Staff Technical Position Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites," August.
- NUREG/CR-4620, Nelson, J. D., Abt, S. R., et. al., 1986, "Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments," June.
- NUREG/CR-4651, 1987, "Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase 1," May.
- U. S. Department of Energy, 1988, "Effect of Freezing and Thawing on UMTRA Covers," Albuquerque, New Mexico, October.

3.3.2 Radon Flux Attenuation

The Environmental Protection Agency (EPA) rules in 40 Code of Federal Regulation (CFR) Part 192 require that a "uranium tailings cover be designed to produce reasonable assurance that the radon-222 release rate would not exceed 20 pCi/m^2/sec for a period of 1,000 years to the extent reasonably achievable and in any case for at least 200 years when averaged over the disposal area over at least a one year period" (NRC, 1989). NRC regulations presented in 10 CFR Part 40 also restrict radon flux to less than 20 pCi/m^2/sec. The following sections present the analyses and design for a soil cover which meets this requirement.

3.3.2.1 Predictive Analysis

The soil cover for the tailings cells at White Mesa Mill was evaluated for attenuation of radon gas

using the digital computer program, RADON, presented in the NRC's Regulatory Guide 3.64 (Task WM 503-4) entitled "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers." The RADON model calculates radon-222 flux attenuation by multi-layered earthen uranium mill tailings covers, and determines the minimum cover thickness required to meet NRC and EPA standards. The RADON model uses the following soil properties in the calculation process:

- Soil layer thickness [centimeters (cm)];
- Soil porosity (percent);
- Density [grams-per-cubic centimeter (gm/cm^3)];
- Weight percent moisture (percent);
- Radium activity (piC/g);
- Radon emanation coefficient (unitless); and
- Diffusion coefficient [square centimeters-per-second (cm^2/sec)].

Physical and radiological properties for tailings and random fill were analyzed by Chen and Associates (1987) and Rogers and Associates (1988). Clay physical data from Section 16 was analyzed by Advanced Terra Testing (1996) and Rogers and Associates (1996). See Appendix D for laboratory test data results.

The RADON model was performed for the following cover section (from top to bottom):

- two feet compacted random fill;
- one foot compacted clay; and
- a minimum of three feet random fill occupying the freeboard space between the tailings and clay layer.

The top one foot of the lower random fill clay layer and two foot upper random fill are compacted to 95 percent maximum dry density. The top riprap layer was not included as part of the soil cover for the radon attenuation calculation.

The results of the RADON modeling exercise show that the uranium tailings cover configuration will attenuate radon flux emanating from the tailings to a level of 17.6 pCi/m^2/sec. This number was conservatively calculated as it takes into account the freeze/thaw effect on the uppermost part (6.8 inches) of the cover (Section 3.3.4). The soil cover and tailing parameters used to run the RADON model, in addition to the RADON input and output data files, are presented in Appendix D as part of the Radon Calculation brief (See Appendix B in the Tailings Cover Design report, included herewith in its entirety as Appendix D). Based on the model results, the soil cover design of six-foot thickness will meet the requirements of 40 CFR Part 192 and 10 CFR Part 40.

3.3.2.2 Empirical Data

Radon gas flux measurements have been made at the White Mesa Mill tailings piles over Cells 2 and 3 (see Appendix D). Currently these cells are partially covered with three to four feet of random fill. Radon flux measurements, averaged over the covered areas, were as follows (EFN, 1996):

	1994	1995
Cell 2	7.7 pCi/m^2/sec	6.1 pCi/m^2/sec
Cell 3	7.5 pCi/m^2/sec	11.1 pCi/m^2/sec

Empirical data suggest that the random fill cover, alone, is currently providing an effective barrier to radon flux. Thus, the proposed tailings cover configuration, which is thicker, moisture adjusted, contains a clay layer, and is compacted, is expected to attenuate the radon flux to a level below that

predicted by the RADON model. The field radon flux measurements confirm the conservatism of the cover design. This conservatism is useful, however, to guarantee compliance with NRC regulations under long term climatic conditions over the required design life of 200 to 1,000 years.

3.3.3 Infiltration Analysis

The tailings ponds at White Mesa Mill are lined with synthetic geomembrane liners which under certain climatic conditions, could potentially lead to the long-term accumulation of water from infiltration of precipitation. Therefore, the soil cover was evaluated to estimate the potential magnitude of infiltration into the capped tailings ponds. The Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3.0 (EPA, 1994) was used for the analysis. HELP is a quasi two-dimensional hydrologic model of water movement across, into, through, and out of capped and lined impoundments. The model utilizes weather, soil, and engineering design data as input to the model, to account for the effects of surface storage, snowmelt, run-off, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, and unsaturated vertical drainage on the specific design, at the specified location.

The soil cover was evaluated based on a two-foot compacted random fill layer over a one-foot thick, compacted clay layer. The soil cover layers were modeled based on material placement at a minimum of 95 percent of the maximum dry density, and within two percent of the optimum moisture content per American Society for Testing and Materials (ASTM) requirements. The top riprap layer and the bottom random fill layer were not included as part of the soil cover for infiltration calculations. These two layers are not playing any role in controlling the infiltration through the cover material.

The random fill will consist of clayey sands and silts with random amounts of gravel and rock-size

materials. The average hydraulic conductivity of several samples of random fill was calculated, based on laboratory tests, to be 8.87 x 10^{-7} cm/sec. The hydraulic conductivity of the clay source from Section 16 was measured in the laboratory to be 3.7 x 10^{-8} cm/sec. Geotechnical soil properties and laboratory data are presented in Appendix D.

Key HELP model input parameters include:

- Blanding, Utah, monthly temperature and precipitation data, and HELP model default solar radiation, and evapotranspiration data from Grand Junction, Colorado. Grand Junction is located northeast of Blanding in similar climate and elevation;

- Soil cover configuration identifying the number of layers, layer types, layer thickness, and the total covered surface area;

- Individual layer material characteristics identifying saturated hydraulic conductivity, porosity, wilting point, field capacity, and percent moisture; and

- Soil Conservation Service runoff curve numbers, evaporative zone depth, maximum leaf area index, and anticipated vegetation quality.

Water balance results, as calculated by the HELP model, indicate that precipitation would either run-off the soil cover or be evaporated. Thus, model simulations predict zero infiltration of surface water through the soil cover, as designed. These model results are conservative and take into account the freeze/thaw effects on the uppermost part (6.8 inches) of the cover (See Section 1.3 of the Tailings Cover Design report, Appendix D). The HELP model input and output for the tailings soil cover are presented in the HELP Model calculation brief included in Appendix D.

3.3.4 Freeze/Thaw Evaluation

The tailings soil cover of one foot of compacted clay covered by two feet of random fill was evaluated for freeze/thaw impacts. Repeated freeze/thaw cycles have been shown to increase the bulk soil permeability by breaking down the compacted soil structure.

The soil cover was evaluated for freeze/thaw effects using the modified Berggren equation as presented in Aitken and Berg (1968) and recommended by the NRC (U.S. Department of Energy, 1988). This evaluation was based on the properties of the random fill and clay soil, and meteorological data from both Banding, Utah and Grand Junction, Colorado.

The results of the freeze/thaw evaluation indicate that the anticipated maximum depth of frost penetration on the soil cover would be less than 6.8 inches. Since the random fill layer is two feet thick, the frost depth would be confined to this layer and would not penetrate into the underlying clay layer. The performance of the soil cover to attenuate radon gas flux below the prescribed standards, and to prevent surface water infiltration, would not be compromised. The input data and results of the freeze/thaw evaluation are presented in the Effects of Freezing on Tailings Covers Calculation brief included as Appendix E in the Tailings Cover Design report, which is included herewith as Appendix D.

3.3.5 Soil Cover Erosion Protection

A riprap layer was designed for erosion protection of the tailings soil cover. According to NRC guidance, the design must be adequate to protect the soil/tailings against exposure and erosion for 200 to 1,000 years (NRC, 1990). Currently, there is no standard industry practice for stabilizing tailings for 1,000 years. However, by treating the embankment slopes as wide channels, the

hydraulic design principles and practices associated with channel design were used to design stable slopes that will not erode. Thus, a conservative design based on NRC guidelines was developed. Engineering details and calculations are summarized in the Erosion Protection Calculation brief provided in Appendix F in the Tailings Cover Design report, which is included herewith as Appendix D.

Riprap cover specifications for the top and side slopes were determined separately as the side slopes are much steeper than the slope of the top of the cover. The size and thickness of the riprap on the top of the cover was calculated using the Safety Factor Method (NUREG/CR-4651, 1987), while the Stephenson Method (NUREG/CR-4651, 1987) was used for the side slopes. These methodologies were chosen based on NRC recommendations (1990).

By the Safety Factor Method, riprap dimensions for the top slope were calculated in order to achieve a slope "safety factor" of 1.1. For the top of the soil cover, with a slope of 0.2 percent, the Safety Factor Method indicated a median diameter (D_{50}) riprap of 0.28 inches is required to stabilize the top slope. However, this dimension must be modified based on the long-term durability of the specific rock type to be used in construction. The suitability of rock to be used as a protective cover must be assessed by laboratory tests to determine the physical characteristics of the rocks. The sandstones from the confluence of Westwater and Cottonwood Canyons require an oversizing factor of 25 percent. Therefore, riprap created from this sandstone source should have a D_{50} size of a t least 0.34 inches and should have an overall layer thickness of at least three inches on the top of the cover.

Riprap dimensions for the side slopes were calculated using Stephenson Method equations. The side slopes of the cover are designed at 5H:1V. At this slope, Stephenson's Method indicated the unmodified riprap D_{50} of 3.24 inches is required. Again, assuming that the on-site sandstone will be used, the modified D_{50} size of the riprap should be at least 4.05 inches with an overall layer

thickness of at least 12 inches.

The potential of erosion damage due to overland flow, sheetflow, and channel scouring on the top and side slopes of the cover, including the riprap layer, has been evaluated. Overland flow calculations were performed using site meteorological data, cap design specifications, and guidelines set by the NRC (NUREG/CR-4620, 1986). These calculations are included in Appendix F of the Tailings Cover Design report. According to the guidelines, overland flow velocity estimates are to be compared to "permissible velocities," which have been suggested by the NRC, to determine the potential for erosion damage. When calculated, overland flow velocity estimates exceed permissible velocities, additional cover protection should be considered. The permissible velocity for the tailings cover (including the riprap layer) is 5.0 to 6.0 feet per-second (ft./sec.) (NUREG/CR-4620). The overland flow velocity calculated for the top of the cover is less than 2.0 ft./sec., and the calculated velocity on the side slopes is 4.9 ft./sec. Therefore, the erosion potential of the slopes, due to overland flow/channel scouring, is within acceptable limits and no additional erosion protection is required.

3.3.6 Slope Stability Analysis

Static and pseudostatic analyses were performed to establish the stability of the side slopes of the tailings soil cover. The side slopes are designed at an angle of 5H:1V. Because the side slope along the southern section of Cell 4A is the longest and the ground elevation drops rapidly at its base, this slope was determined to be critical and is thus the focus of the stability analyses.

The computer software package GSLOPE, developed by MITRE Software Corporation, has been used for these analyses to determine the potential for slope failure. GSLOPE applies Bishop's Method of slices to identify the critical failure surface and calculate a factor of safety (FOS). The

slope geometry and properties of the construction materials and bedrock are input into the model. These data and drawings are included in the Stability Analysis of Side Slopes Calculation brief included in Appendix G of the Tailings Cover Design report. For this analysis, competent bedrock is designated at 10 feet below the lowest point of the foundation [i.e., at a 5,540-foot elevation above mean sea level (msl)]. This is a conservative estimate, based on the borehole logs supplied by Chen and Associates (1979), which indicate bedrock near the surface.

3.3.6.1 Static Analysis

For the static analysis, a Factor of Safety ("FOS") of 1.5 or more was used to indicate an acceptable level of stability. The calculated FOS is 2.91, which indicates that the slope should be stable under static conditions. Results of the computer model simulations are included in Appendix G of the Tailings Cover Design report.

3.3.6.2 Pseudostatic Analysis (Seismicity)

The slope stability analysis described above was repeated under pseudostatic conditions in order to estimate a FOS for the slope when a horizontal ground acceleration of 0.10g is applied. The slope geometry and material properties used in this analysis are identical to those used in the stability analysis. A FOS of 1.0 or more was used to indicate an acceptable level of stability under pseudostatic conditions. The calculated FOS is 1.903, which indicates that the slope should be stable under dynamic conditions. Details of the analysis and the simulation results are included in Appendix G of the Tailings Cover Design report.

In June of 1994, Lawrence Livermore National Laboratory ("LLNL") published a report entitled Seismic Hazard Analysis of Title II Reclamation Plans, (Lawrence Livermore National Laboratory,

1994) which included a section on seismic activity in southern Utah. In the LLNL report, a horizontal ground acceleration of 0.12g was proposed for the White Mesa site. The evaluations made by LLNL were conservative to account for tectonically active regions that exist, for example, near Moab, Utah. Although, the LLNL report states that "...[Blanding] is located in a region known for its scarcity of recorded seismic events," the stability of the cap design slopes using the LLNL factor was evaluated. The results of a sensitivity analysis reveal that when considering a horizontal ground acceleration of 0.12g, the calculated FOS is 1.778 which is still above the required value of 1.0, indicating adequate safety under pseudostatic conditions. This analysis is also included in Appendix G of the Tailings Cover Design report.

3.3.7 Cover Material/Cover Material Volumes

Construction materials for reclamation will be obtained from on-site locations. Fill material will be available from the stockpiles that were generated from excavation of the cells for the tailings facility. If required, additional materials are available locally to the west of the site. A clay material source, identified in Section 16 at the southern end of the White Mesa Mill site, will be used to construct the one-foot compacted clay layer. Riprap material will be produced from on-site sandstone.

Detailed material quantities calculations are provided in Attachment C, Cost Estimates for Reclamation of White Mesa Mill Facilities, as part of the volume and costing exercise.

PLANS AND SPECIFICATIONS

FOR

RECLAMATION

OF

WHITE MESA FACILITIES

BLANDING, UTAH

PREPARED BY

ENERGY FUELS NUCLEAR, INC.

THREE PARK CENTRAL

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1.0 GENERAL

The specifications presented in this section cover the reclamation of the White Mesa Mill facilities.

2.0 CELL 1-I RECLAMATION

2.1 Scope

The reclamation of Cell 1-I consists of evaporating the cell to dryness, removing raffinate crystals, synthetic liner and any contaminated soils. A sedimentation basin will then be constructed and a drainage channel provided.

2.2 Removal of Contaminated Materials

2.2.1 Raffinate Crystals

Raffinate crystals will be removed from Cell 1-I and transported to the tailings cells. It is anticipated that the crystals will have a consistency similar to a granular material when brought to the cells, with large crystal masses being broken down for transport. Placement of the crystals will be performed as a granular fill, with care being taken to avoid nesting of large sized material. Voids around large material will be filled with finer material or the crystal mass broken down by the placing equipment. Actual placement procedures will be evaluated by the QC officer during construction as crystal materials are brought and placed in the cells.

2.2.2 Synthetic Liner

The PVC liner will be cut up, folded (when necessary), removed from Cell 1-I, and transported to the tailings cells. The liner material will be spread as flat as practical over the designated area. After placement, the liner will be covered as soon as possible with at least one foot of soil, crystals or other materials for protection against wind, as approved by the QC officer.

2.2.3 Contaminated Soils

The extent of contamination of the mill site will be determined by a scintillometer survey. If necessary, a correlation between scintillometer readings and U-nat/Radium-226 concentrations will be developed. Scintillometer readings can then be used to define cleanup areas and to monitor the cleanup. Soil sampling will be conducted to confirm that the cleanup results in a concentration of Radium-226 averaged over any area of 100 square meters that does not exceed the background level by more than:

- 5 pCi/g averaged over the first 15 cm of soils below the surface, and
- 15 pCi/g averaged over a 15 cm thick layer of soils more than 15 cm below the surface

Where surveys indicate the above criteria have not been achieved, the soil will be removed to meet the criteria. Soil removed from Cell 1-I will be excavated and transported to the tailings cells. Placement and compaction will be in accordance with Section 4.0 of these Plans and Specifications.

2.2.4 Sedimentation Basin

Cell 1-I will then be breached and constructed as a sedimentation basin. All runoff from the mill area and immediately north of the cell will be routed into the sedimentation basin and will discharge onto the natural ground via the channel located at the southwest corner of the basin. The channel is designed to accommodate the PMF flood.

A sedimentation basin will be constructed in Cell 1-I as shown in Figure A2.2.4-1. Grading will be performed to promote drainage and proper functioning of the basin. The drainage channel out of the sedimentation basin will be constructed to the lines and grades as shown.

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3.0 MILL DECOMMISSIONING

The following subsections detail decommissioning plans for the mill buildings and equipment; the mill site; and windblown contamination.

3.1 Mill

The uranium and vanadium processing areas of the mill, including all equipment, structures and support facilities, will be decommissioned and disposed of in tailings or buried on site as appropriate. All equipment, including tankage and piping, agitation equipment, process control instrumentation and switchgear, and contaminated structures will be cut up, removed and buried in tailings prior to final cover placement. Concrete structures and foundations will be demolished and removed or covered with soil as appropriate. These decommissioned areas would include, but not be limited to the following:

- Coarse ore bin and associated equipment, conveyors and structures.
- Grind circuit including semi-autogeneous grind (SAG) mill, screens, pumps and cyclones.
- The three preleach tanks to the east of the mill building, including all tankage, agitation equipment, pumps and piping.
- The seven leach tanks inside the main mill building, including all agitation equipment, pumps and piping.
- The counter-current decantation (CCD) circuit including all thickeners and equipment, pumps and piping.
- Uranium precipitation circuit, including all thickeners, pumps and piping.

- The two yellow cake dryers and all mechanical and electrical support equipment, including uranium packaging equipment.
- The clarifiers to the west of the mill building including the preleach thickener (PLT) and claricone.
- The boiler and all ancillary equipment and buildings.
- The entire vanadium precipitation, drying and fusion circuit.
- All external tankage not included in the previous list including reagent tanks for the storage of acid, ammonia, kerosene, water, dry chemicals, etc. and the vanadium oxidation circuit.
- The uranium and vanadium solvent extraction (SX) circuit including all SX and reagent tankage, mixers and settlers, pumps and piping.
- The SX building.
- The mill building.
- The office building.
- The shop and warehouse building.
- The sample plant building.

The sequence of demolition would proceed so as to allow the maximum use of support areas of the facility such as the office and shop areas. It is anticipated that all major structures and large equipment will be demolished with the use of hydraulic shears. These will speed the process, provide proper sizing of the materials to be placed in tailings, and reduce exposure to radiation and other safety hazards during the demolition. Any uncontaminated or decontaminated equipment to be considered for salvage will be released in accordance with the terms of License Condition 14. As with the equipment for disposal, any contaminated soils from the mill area will be disposed of in the tailings facilities in accordance with Section 4.0 of the Specifications.

3.2 Mill Site

Contaminated areas on the mill site will be primarily superficial and include the ore storage area and surface contamination of some roads. All ore will have been previously removed from the ore stockpile area. All contaminated materials will be excavated and be disposed in one of the tailings cells in accordance with Section 4.0 of these Plans and Specifications. The depth of excavation will vary depending on the extent of contamination and will be based on the criteria in Section 2.2.3 of these Plans and Specifications.

All ancillary contaminated materials including pipelines will be removed and will be disposed of by disposal in the tailing cells in accordance with Section 4.0 of these Plans and Specifications.

Disturbed areas will be covered, graded and vegetated as required. The proposed grading plan for the mill site and ancillary areas is shown on Figure 3.2-1.

3.3 Windblown Contamination

Windblown contamination is defined as mill derived contaminants dispersed by the wind to surrounding areas. The potential areas affected by windblown contamination will be surveyed using scintillometers taking into account historical operational data from the Semi-annual Effluent Reports (Appendix A) and other guidance such as prevailing wind direction and historical background data.

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3.3.1 Guidance

The necessity for remedial actions will be based upon an evaluation prepared by EFN, and approved by the NRC, of the potential health hazard presented by any windblown materials identified. The assessment will be based upon analysis of all pertinent radiometric and past land use information and will consider the feasibility, cost-effectiveness, and environmental impact of the proposed remedial activities and final land use. All methods utilized will be consistent with the guidance contained in NUREG-5849: "Manual for Conducting Radiological Surveys in Support of License Termination."

3.3.2 General Methodology

The facility currently monitors soils for the presence of Ra-226, such results being presented in the second semi-annual effluent report for each year. Guideline values for these two materials will be determined and will form the basis for the cleanup of the White Mesa Mill site and surrounding areas. For purposes of determining possible windblown contamination, areas used for processing of uranium ores as well as the tailings and evaporative facilities will be excluded from the initial scoping survey, due to their proximity to the uranium recovery operations. Those areas include:

- The mill building, including CCD, PLT area, uranium drying and packaging, clarifying, and preleach.
- The SX building, including reagent storage immediately to the east of the SX building.
- The ore pad and ore feed areas.
- Tailings Cells No. 2, 3, and 4A.
- Evaporative cell No. 1-I.

The remaining areas of the mill will be divided up into two areas for purposes of windblown determinations:

- The restricted area, less the above areas; and,
- A halo around the restricted area.

The restricted area, as shown on Figure A3.2-1 will be initially surveyed on a 30 x 30 meter grid as described below in Section 3.3.3. The halo around the restricted area will also be initially surveyed on a 50 x 50 meter grid using methodologies described below in Section 3.3.3. Any areas which are found to have elevated activity levels will be further evaluated as described in Sections 3.3.4 and 3.3.5.

3.3.3 Scoping Survey

The scoping survey will be conducted using a calibrated Mount Sopris Model SC-132 scintillometer (or equivalent) capable of detecting radiation at levels less than or equal to 25 percent of the guideline value. The meter will be swung from side to side at an elevation of six (6) inches above the ground level while walking a path within the grid shown in Figure A-3.3-1. These paths will be designed so that a minimum of 10 percent of the area within the grid sidelines will be scanned, using an average coverage area for the scintillometer of one (1) meter wide. Grids where hotspots are encountered or where readings of 75 percent of the guideline level are found will be reclassified as affected areas, and will be subject to further characterization as described below. Grids where no readings exceed 75 percent of the guideline value will be classified as unaffected, and therefore will not require remediation. It is assumed that by following methodologies that would be utilized during the final survey, that the classification of these areas would stand and would require no further survey confirmation.

A sufficient quantity of QA samples will be taken to provide a correlation between the meter readings and the actual Ra-226 concentrations in the soil.

3.3.4 Characterization and Remediation Control Surveys

After the entire subarea has been classified as affected or unaffected, the affected areas will be further scanned to identify areas of elevated activity requiring cleanup. Such areas will be flagged and sufficient soils removed to, at a minimum, meet activity criteria. Following such remediation, the area will be scanned again to ensure compliance with activity criteria. A calibrated Mount Sopris SC-132 scintillometer (or equivalent) capable of detecting activity levels of less than or equal to 25 percent of the guideline values will be used to scan all the areas of interest.

3.3.5 Final Survey

After remediation, the affected areas deemed to be in compliance with standards will then undergo a final survey, utilizing a 10 x 10 meter grid system with sample point locations as shown in Figure A-3.3-2. Again a calibrated Mount Sopris SC-132 scintillometer (or equivalent) capable of detecting activity levels of less than or equal to 25 percent of the guideline values will be used, and will be held at a one meter distance above the systematic sample locations. As with the scoping survey, a statistically significant quantity of QA samples will be taken at randomly selected points to provide a correlation between the meter readings and the actual Ra-226 concentrations in the soil.

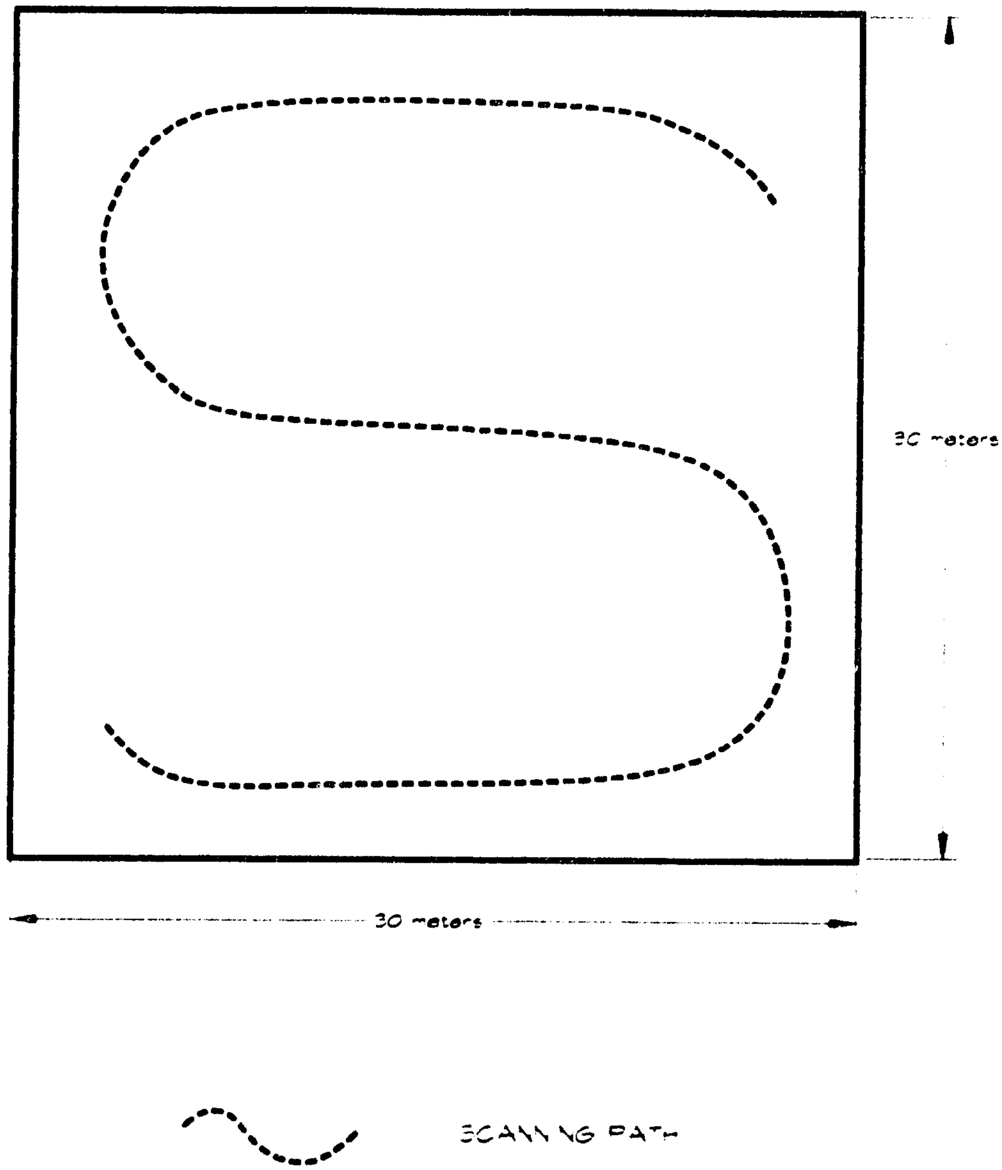

FIGURE A-3.3-1
TYPICAL SCANNING PATH
SCOPING SURVEY

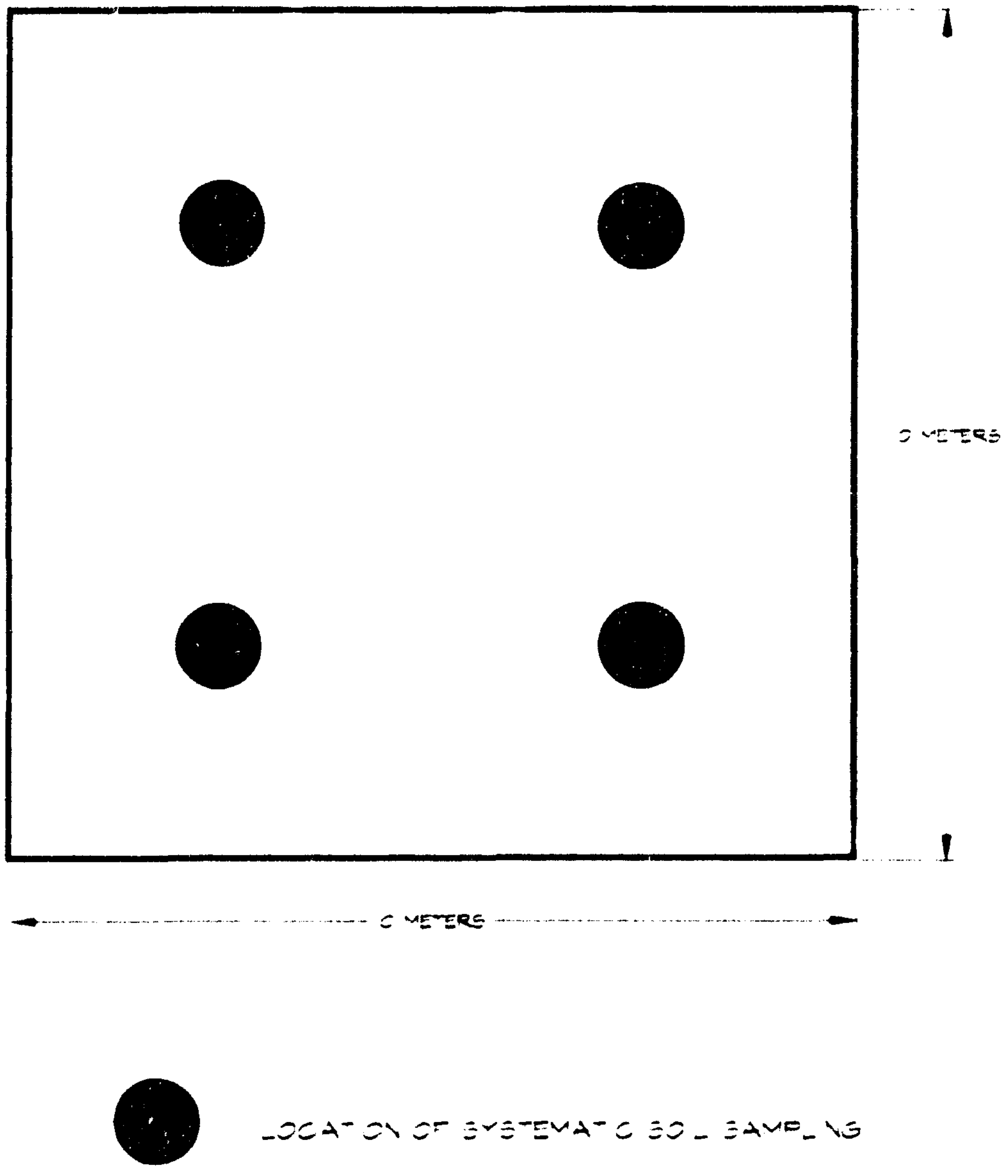

FIGURE A-3.3-2
STANDARD SAMPLING PATTERN FOR
SYSTEMATIC SURVEY OF SOIL

4.0 PLACEMENT METHODS

4.1 Scrap and Debris

The scrap and debris will have a maximum dimension of 20 feet and a maximum volume of 30 cubic feet. Scrap exceeding these limits will be reduced to within the acceptable limits by breaking, cutting or other approved methods. Empty drums, tanks or other objects having a hollow volume greater than five cubic feet will be reduced in volume by at least 70 percent. If volume reduction is not feasible, openings will be made in the object to allow soils, tailings and/or other approved materials to enter the object at the time of covering on the tailings cells. The scrap, after having been reduced in dimension and volume, if required, will be placed on the tailings cells as directed by the QC officer.

Any scrap placed will be spread across the top of the tailings cells to avoid nesting and to reduce the volume of voids present in the disposed mass. Stockpiled soils, contaminated soils, tailings and/or other approved materials will be placed over and into the scrap in sufficient amount to fill the voids between the large pieces and the volume within the hollow pieces to form a coherent mass. It is recognized that some voids will remain because of the scrap volume reduction specified, and because of practical limitations of these procedures. Reasonable effort will be made to fill the voids. The approval of the Site Manager or a designated representative will be required for the use of materials other than stockpiled soils, contaminated soils or tailings for the purpose of filling voids.

4.2 Contaminated Soils and Raffinate Crystals

The various materials will not be concentrated in thick deposits on top of the tailings, but will be spread over the working surface as much as possible to provide relatively uniform settlement and consolidation characteristics of the cleanup materials.

4.3 Compaction Requirements

The scrap, contaminated soils and other materials for the first lift will be placed over the existing tailings surface to a depth of up to four feet thick in a bridging lift to allow access for placing and compacting equipment. The first lift will be compacted by the tracking of heavy equipment, such as a Caterpillar D6 Dozer (or equivalent), at least four times prior to the placement of a subsequent lift. Subsequent layers will not exceed two feet and will be compacted to the same requirements.

During construction, the compaction requirements for the crystals will be reevaluated based on field conditions and modified by the Site Manager or a designated representative, with the agreement of the NRC Project Manager.

The contaminated soils and other cleanup materials after the bridging lift will be compacted to at least 80 percent of standard Proctor maximum density (ASTM D-698).

5.0 CELLS 2, 3, AND 4A

5.1 Earth Cover

A multi-layered earthen cover will be placed over tailings Cells 2, 3, and 4A. The general grading plan is shown on Drawing 5.1-1. Reclamation cover cross-sections are shown on Drawings 5.1-2 and 5.1-3.

5.2 Materials

5.2.1 Physical Properties

The physical properties of materials for use as cover soils will meet the following:

Random Fill (upper and lower layers)
These materials will be mixtures of clayey sands and silts with random amounts of gravel and size material. In the initial bridging lift, rock sizes of up to 24 inches in diameter will be allowed. On all other random fill lifts, rock sizes will be limited to 12 inches in diameter, with at least 30 percent of the material finer than 40 seive. For that portion passing the No. 40 sieve, these soils will classify as CL, SC, MC or SM materials under the Unified Soil Classification System.

Clay Layer Materials
Clays will have at least 40 percent passing the No. 200 sieve. The minimum liquid limit of these soils will be 25 and the plasticity index will be 15 or greater. These soils will classify as CL or CH materials under the Unified Soil Classification System.

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5.2.2 Borrow Sources

The sources for soils for the cover materials are as follows:

1. Random Fill - stockpiles from previous cell construction activities currently located to the east and west of the tailing facilities.

2. Clay - will be imported from borrow areas located in Section 16, T38S, R22E, SLM.

3. Rock Armor - will be produced by using oversize materials in the random fill piles, using crushing and screening as necessary to produce proper size fractions.

5.3 Cover Construction

5.3.1 General

Placement of cover materials will be based on a schedule determined by analysis of settlement data, piezometer data and equipment mobility considerations. Settlement plates and piezometers will be installed and monitored in accordance with Section 5.4 of these Plans and Specifications.

5.3.2 Placement and Compaction

5.3.2.1 Methods

The distribution and gradation of the materials throughout each fill layer will be such that the fill will, as far as practicable, be free of lenses, pockets, streaks or layers of material differing

substantially in texture, gradation or moisture content from the surrounding material. Successive loads of material will be placed on the fill so as to produce the best practical distribution of material.

If the compacted surface of any layer of fill is too dry or smooth to bond properly with the layer of material to be placed thereon, it will be moistened and/or reworked with a harrow, scarifier, or other suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next succeeding layer of earthfill is placed. If the compacted surface of any layer of earthfill in-place is too wet, due to precipitation, for proper compaction of the earthfill material to be placed thereon, it will be reworked with harrow, scarifier or other suitable equipment to reduce the moisture content to the required level shown in Table 5.3.2.1-1. It will then be recompacted to the earthfill requirements.

No material will be placed when either the materials, or the underlying material, is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density, without developing frost lenses in the fill.

5.3.2.2 Moisture and Density Control

As far as practicable, the materials will be brought to the proper moisture content before placement on tailings, or moisture will be added to the material by sprinkling on the earthfill. Each layer of the fill will be conditioned so that the moisture content is uniform throughout the layer prior to and during compaction. The moisture content of the compacted fill will be within the limits of standard optimum moisture content as shown in Table 5.3.2.1-1. Material that is too dry or too wet to permit bonding of layers during compaction will be rejected and will be reworked until the moisture content is within the specified limits. Reworking may include removal, re-harrowing, reconditioning, rerolling, or combinations of these procedures.

Density control of compacted soil will be such that the compacted material represented by samples having a dry density less than the values shown in Table 5.3.2.1-1 will be rejected. Such rejected material will be reworked as necessary and rerolled until a dry density equal to or greater than the percent of its standard Proctor maximum density shown in Table 5.3.2.1-1.

To determine that the moisture content and dry density requirements of the compacted fill are being met, field and laboratory tests will be made at specified intervals taken from the compacted fills as specified in Section 7.4, "Frequency of Quality Control Tests."

5.4 Monitoring Cover Settlement

5.4.1 Temporary Settlement Plates

5.4.1.1 General

Temporary settlement plates will be installed in the tailings Cells. At the time of cell closure, a monitoring program will be proposed to the NRC. Data collected will be analyzed and the reclamation techniques and schedule adjusted accordingly.

TABLE A-5.3.2.1-1

Placement and Compaction Criteria
Reclamation Cover Materials

Cover Layer	Maximum Lift Thickness	Per Cent Compaction	Allowable Placement Moisture Content from Optimum Moisture Content
Lower Random Fill	3 Feet Bridging Lift	80	± 2
	1 Foot	90	± 2
Clay Layer	1 Foot	95	0 to + 3
Upper Random Fill	2 Feet	95	± 2
Riprap			
Top of Tails	3 Inches		
Slope	1 Inch		

Note:

Percent Compaction is based on standard Proctor dry density (ASTM D-698).

Optimum moisture content of a soil will be determined by ASTM D-698 methods.

5.4.1.2 Installation

At the time of cell closure or during the placement of interim cover, the temporary settlement plates will consist of a corrosion resistant steel plate 1/2 inch thick and three foot square to which a three inch diameter corrosion resistant pipe has been welded.

The installation will consist of leveling an area on the existing surface of the tailings, and placing the base plate directly on the tailings. A minimum three feet of initial soil or tailings cover will be placed on the base plate for a minimum radial distance of five feet from the pipe.

5.4.1.3 Monitoring Settlement Plates

Monitoring of settlement plates will be in accordance with the program submitted to and approved by the NRC. Settlement observations will be made in accordance with Quality Control Procedure QC-16-WM, "Monitoring of Temporary Settlement Plates."

6.0 ROCK PROTECTION

6.1 General

The side slopes of the reclaimed cover will be protected by rock surfacing. Drawings 5.1-1, 5.1-2, and 5.1-3 show the location of rock protection with the size, thickness and gradation requirements for the various side slopes.

A riprap layer was designed for erosion protection of the tailings soil cover. According to NRC guidance, the design must be adequate to protect the soil/tailings against exposure and erosion for

200 to 1,000 years (NRC, 1990). Currently, there is no standard industry practice for stabilizing tailings for 1,000 years. However, by treating the embankment slopes as wide channels, the hydraulic design principles and practices associated with channel design were used to design stable slopes that will not erode. Thus, a conservative design based on NRC guidelines was developed. Engineering details and calculations are summarized in the Tailings Cover Design report (Appendix D).

Riprap cover specifications for the top and side slopes were determined separately as the side slopes are much steeper than the slope of the top of the cover. The size and thickness of the riprap on the top of the cover was calculated using the Safety Factor Method (NUREG/CR-4651, 1987), while the Stephenson Method (NUREG/CR-4651, 1987) was used for the side slopes. These methodologies were chosen based on NRC recommendations (1990).

By the Safety Factor Method, riprap dimensions for the top slope were calculated in order to achieve a slope "safety factor" of 1.1. For the top of the soil cover, with a slope of 0.2 percent, the Safety Factor Method indicated a median diameter (D_{50}) riprap of 0.28 inches is required to stabilize the top slope. However, this dimension must be modified based on the long-term durability of the specific rock type to be used in construction. The suitability of rock to be used as a protective cover must be assessed by laboratory tests to determine the physical characteristics of the rocks. The sandstones from the confluence of Westwater and Cottonwood Canyons require an oversizing factor of 25 percent. Therefore, riprap created from this sandstone source should have a D_{50} size of at least 0.34 inches and should have an overall layer thickness of at least three inches on the top of the cover.

Riprap dimensions for the side slopes were calculated using Stephenson Method equations. The side slopes of the cover are designed at 5H:1V. At this slope, Stephenson's Method indicated the unmodified riprap D_{50} of 3.24 inches is required. Again assuming that the on-site sandstone will be

used, the modified D_{50} size of the riprap should be at least 4.05 inches with an overall layer thickness of at least 12 inches.

The potential of erosion damage due to overland flow, sheetflow, and channel scouring on the top and side slopes of the cover, including the riprap layer, has been evaluated. Overland flow calculations were performed using site meteorological data, cap design specifications, and guidelines set by the NRC (NUREG/CR-4620, 1986). According to the guidelines, overland flow velocity estimates are to be compared to "permissible velocities," which have been suggested by the NRC, to determine the potential for erosion damage. If calculated overland flow velocity estimates exceed permissible velocities, additional cover protection should be considered. The permissible velocity for the tailings cover (including the riprap layer) is 5.0 to 6.0 feet per second (ft./sec.) (NUREG/CR-4620). The overland flow velocity calculated for the top of the cover is less than 2.0 ft./sec., and the calculated velocity on the side slopes is 4.9 ft./sec. Therefore, the erosion potential of the slopes, due to overland flow/channel scouring, is within acceptable limits and no additional erosion protection is required. See Appendix D for details.

6.2 Materials

Materials utilized for riprap applications will meet the following specifications:

Location	D_{50} Size	D_{100} Size	Layer Thickness
Top Surface	0.4"	0.6"	3"
Slope Surface	4"	8"	12"

During construction of the tailings facilities, significant quantities of oversize was produced through drilling and blasting, as the rocks of the Burro Canyon/Dakota were too hard to rip. As these materials will have to be segregated from the random fill for some applications, it is anticipated that all rock requirements will be met by crushing and screening the random fill oversize.

Riprap quality will be evaluated by methods presented in NUREG/CR-4620 "Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundment." Size adjustment will be made in the riprap for materials not meeting the quality criteria.

6.3 Placement

Riprap material will be hauled to the reclaimed surfaces and placed on the surfaces using scrapers, in a manner to minimize segregation of the material. Placement of the riprap will avoid accumulation of riprap sizes less than the minimum D_{50} size and nesting of the larger sized rock. The riprap layer will have at least two passes by a D-7 Dozer (or equivalent) in order to key the rock for stability.

7.0 QUALITY CONTROL/QUALITY ASSURANCE

7.1 Quality Plan

A Quality Plan has been developed for construction activities for the White Mesa Project. The Quality Plan includes the following:

1. QC/QA Definitions, Methodology and Activities.
2. Organizational Structure.

3. Surveys, Inspections, Sampling and Testing.
4. Changes and Corrective Actions.
5. Documentation Requirements.
6. Quality Control Procedures.

7.2 Implementation

The Quality Plan will be implemented upon initiation of reclamation work.

7.3 Quality Control Procedures

Quality control procedures have been developed for reclamation and are presented in Attachment B of this Reclamation Plan. Procedures will be used for all testing, sampling and inspection functions.

7.4 Frequency of Quality Control Tests

The frequency of the quality control tests for earthwork will be as follows:

1. The frequency of the field density and moisture tests will be not less than one test for each 5,000 cubic yards of placed fill material (clay or random fill).

2. There will be at least two field density and moisture tests for each lift of fill material placed.

3. Gradations and Atterberg limits of compacted fill materials will be performed at a frequency of not less than each 10,000 cubic yards of placed clay or each 20,000 cubic yards of compacted random fill.

4. Frequency of laboratory standard Proctor compaction tests will be such that maximum densities are determined for the range of materials being placed in the fill; however, frequency of compaction tests will not be less than one test for each 5,000 cubic yards of compacted fill material.

5. For riprap materials, each load of material will be checked against standard piles for gradation prior to transport to the tailings piles.

QUALITY PLAN

FOR

CONSTRUCTION ACTIVITIES

WHITE MESA PROJECT

BLANDING, UTAH

PREPARED BY

ENERGY FUELS NUCLEAR, INC.

THREE PARK CENTRAL

1515 ARAPAHOE STREET, SUITE 900

DENVER, COLORADO 80202

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1.0 GENERAL

1.1 SCOPE OF QUALITY PLAN

The following Quality Plan for Construction Activities ("Quality Plan") describes how the Construction Quality Control/Quality Assurance ("QC/QA") activities are implemented.

This Quality Plan includes the following:

(1) Organizational Structure;

(2) Surveys, Inspections, Sampling and Testing;

(3) Changes and Corrective Actions; and

(4) Documentation Requirements.

1.2 QUALITY PLAN OBJECTIVES

The objectives of the Quality Plan are as follows:

(1) Quality Control: To verify that the construction is in accordance with the Plans and Specifications.

(2) Quality Assurance: To provide cross-checks and auditing functions on Quality Control.

(3) Monitoring: To provide the required information and data to evaluate the effects of Construction Activities.

1.3 DEFINITIONS

Compliance Report: A report prepared by the QC Officer ("QCO") upon completion of a Construction Segment. A Compliance Report requires the approval of the Site Manager. Any subsequent Construction Segment that is dependent upon successful completion of a specific Construction Segment cannot be initiated until a Compliance Report is prepared and approved for the previous dependent Construction Segment. Compliance Reports are to be completed on Form No. F-23 which is attached in Part V.

Construction Task: A basic construction feature of a Construction Project involving a specific Construction Activity.

Construction Project: The total authorized/approved Project that requires several Construction Segments to complete.

Design Change: Changes made in a Construction Project that alters or changes the intent of the Plans and Specifications. Design changes require approval of the Design Engineer and the Site Manager or a designated representative. Design Changes are to be reported on Form No. F-26, which is attached in Part V.

Field Change: Changes made during construction to fit field conditions that do not alter the intent of the Plans and Specifications. Field Changes require approval of the Site Manager or a designated representative. Field Changes are to be reported on Form No. F-25, which is attached in Part V.

Final Construction Report: A report prepared by the Site Manager or a designated representative upon completion of a Construction Project. This report will be submitted to the NRC.

1.4 QUALITY CONTROL/QUALITY ASSURANCE

1.4.1 Methodology

1.4.1.1 Flow of Activities

Figure 1 shows the general relationships of Quality Control and Quality Assurance activities in the performance of the Construction Activities for a given work area. The Quality Control Activities implemented with standardized QC procedures, provide the necessary tests and observations for the construction, sampling and monitoring process. Quality Assurance audits and reviews will provide oversight of the QC Activities.

1.4.1.2 Compliance Reports

For each project, the Quality Plan requires a Compliance Report at the successful completion of a Construction Segment. The Construction Tasks making up a Construction Segment will be determined to be in compliance with the Plans and Specifications by the QCO. A Compliance Report will then be prepared by the QCO with a copy to the NRC Project Manager, and submitted to the Site Manager for approval, before the next dependent phase of construction can begin. The Site Manager will review Quality Control data, Quality Assurance documentation, and review any observations before approving the Compliance Report.

After the Construction Project has been completed, a Final Construction Report will be prepared by the Site Manager or a designated representative for submittal to the NRC.

1.4.2 Quality Control

1.4.2.1 General

Quality Control ("QC") will be conducted by the QCO or a designated representative. Hereinafter referred to as the QCO. The QCO will implement the QC Program.

1.4.2.2 Quality Control Activities

Quality Control requirements for a Construction Project are presented in the Specifications.

The Quality Control Activities will be implemented with standardized Quality Control Procedures. The Quality Control Procedures include field sampling, testing, observations and monitoring procedures, and laboratory testing procedures. The Quality Control Procedures are listed and are included in Part VI.

1.4.3 Quality Assurance

1.4.3.1 General

Quality Assurance ("QA") will be conducted by the QAO or a designated representative. The QAO will implement the QA Program.

1.4.3.2 Quality Assurance Activities

The QA functions will be implemented by the QAO by performing the following activities.

1.4.3.2.1 Pre-qualification of QC Technicians

Each QC Technician ("QCT") will be pre-qualified by a QAO, who is a knowledgeable specialist in the area of qualification. The QAO will determine the areas of expertise of the respective technician and maintain a QA file on the technician. Areas of competency will be identified and training needs noted for the respective technician.

1.4.3.2.2 Verification of Effectiveness of QC Program

The effectiveness of the QC Program will be verified by the QAO by performing the following audits:

(1) Test and Sampling Procedures. Test procedures will be audited on a quarterly basis by appropriate specialists. This will entail direct observation of test methods and sampling, and performing random duplicate tests.

(2) Equipment. Equipment will be inspected and checked regularly. Calibration certificates will be verified and maintained in the files.

(3) Calculations and Documentation. Calculations from tests and monitoring will be spot checked randomly from the files. Documentation will be checked for accuracy and completeness.

1.4.4 Documentation

Each QA activity and audit will be documented in writing. Audit reports will be prepared by the QAO and submitted to the Site Manager. These will be kept in the White Mesa project files, and made available for review by the NRC Project Manager.

1.5 MONITORING

Monitoring functions fall under the responsibilities of · QCO. Scheduled monitoring and observations shall be made at the intervals required in the Plans and Specifications by Quality Control Technicians ("QCTs") under the direction of the QCO. Monitoring records will be reviewed by the QCO and will be available for review by the NRC. The QAO will audit monitoring records on an unscheduled basis. Monitoring records originals will be maintained in the White Mesa Project Files.

2.0 ORGANIZATIONAL STRUCTURE

2.1 SCOPE

The following items are covered in this section:

(1) A description of the Quality Control Organization.

(2) The classification, qualifications, duties, responsibilities and authority of personnel.

(3) The individual who will be responsible for overall management at the site for Quality Control.

(4) The specific authority and responsibility of all other personnel regarding the Quality Plan.

(5) A program for information flow among workers, construction management and inspectors about various QC/QA, and health and safety requirements.

2.2 ORGANIZATION

A schematic diagram of the organization for implementation of the Quality Plan is shown on Figure B-2. The Site Manager, the QCO, and the QAO, play major roles.

2.3 DUTIES AND QUALIFICATIONS OF PERSONNEL

2.3.1 Personnel Designations

The Site Manager or a designated representative will be referred to as the "Site Manager."

The Quality Control Officer or a designated representative will be referred to as the "QC Officer ("QCO")."

The Quality Assurance Officer or a designated representative will be referred to as the "QA Officer ("QAO")."

2.3.2 Site Manager

2.3.2.1 Duties, Responsibilities and Authority

The Site Manager will oversee the Construction Project and will be responsible for the conduct, direction and supervision of the Work. As shown on the organizational chart, the Site Manager

will have ultimate responsibility for all construction and QC/QA Activities. The Site Manager will appoint all personnel, and interact as required with the QAO, the QCO and the NRC Project Manager.

2.3.3 Designated Representative for Site Manager

In the absence of the Site Manager, a designated representative will assume the duties of the Site Manager.

2.3.4 Quality Control Officer ("QCO")

2.3.4.1 Duties, Responsibilities and Authority

The QCO will be responsible for overall implementation and management of the Quality Control Program for the Construction Project. The QCO will supervise Field and Laboratory Quality Control Technicians, and will coordinate with the Document Control Manager, the Office Staff and the Health and Safety Officer. The QCO will have specific authority and responsibility with regard to all other personnel for the Quality Plan. The QCO will have the authority to reject work or material, to require removal or placement, to specify and require appropriate corrective actions if it is determined that the Quality Control/Quality Assurance, personnel, instructions, controls, tests, records are not conforming to the Plans and Specifications. The signature of the QCO is required on all Compliance Reports ("CR's") required in the Specifications.

The QCO will be familiar with the existing White Mesa Facilities, and QC/QA methodology. Responsibilities of the QCO will include the following:

(1) Provide overall surveillance of Quality Control requirements.

(2) Be familiar with all documents, requirements, equipment and procedures relating to project construction.

(3) Provide and document Quality Control Technician ("QCT") training.

(4) Evaluate and approve all reports.

(5) Assure schedules are met and adequately documented.

(6) Schedule data reduction activities.

(7) Arrange consultation with additional staff, the QAO, Site Manager, and/or NRC Project Manager to help find solutions to unsolved problems.

(8) Identify invalid, unacceptable, or unusable data.

(9) Take corrective action if Quality Control procedures indicate the construction is not meeting the requirements of the Specifications.

(10) Assure all documentation is complete, accurate, and up to date.

(11) Interact and cooperate with QA Technicians

2.3.5 Designated Representative for QCO

In the absence of the QCO, a designated representative will assume the duties of the QCO. In addition, the designated representative may be assigned some of the duties, responsibilities and authority of the QCO.

2.3.6 Quality Assurance Officer ("QAO")

2.3.6.1 Duties

The QAO, who may be an independent consultant, will implement the Quality Assurance functions which includes pre-qualification of QCTs, verification of test procedures and results by spot retests, equipment checks, and review of calculations and documentation and Compliance Reports (CR's). The QAO should be familiar with the construction process and be qualified in construction testing.

Responsibilities of the QAO will include the following:

(1) Be familiar with all documents, requirements, equipment and procedures relating to project construction.
(2) Certify that the QCO is qualified to conduct the various test and monitoring procedures and observations, and document same.
(3) Through spot checks, retests, equipment checks and review of calculations and documentation verify test procedures, monitoring and observations are being performed correctly and accurately in accordance with the Specifications.
(4) Consult with the QCO, and the Site Manager to help solve problems.
(5) Prepare QA reports for review by the Site Manager and NRC Project Manager.

2.3.7 Designated Representative of the Quality Assurance Officer

In the absence of the Quality Assurance Officer ("QAO"), the designated representative of the QAO will assume the duties of the QAO. In addition, certain specialists may be designated to assume some of the duties of the QAO.

2.3.8 NRC Project Manager

The NRC Project Manager will represent the NRC's interests in the Construction Project. The NRC Project Manager may choose to review selected procedures, personnel qualifications, equipment, calculations, and documentation.

2.3.9 Quality Control Technicians ("QCT")

2.3.9.1 Duties

The Quality Control Technicians ("QCTs) for implementation of the Quality Plan will be classified as follows:

(1) Construction Quality Control Technicians - Field.

(2) Construction Quality Control Technicians - Laboratory.

A QCT may be qualified for and perform the duties in more than one classification.

2.3.9.2 Qualifications

The QCO will supervise (or may appoint a supervisor) for each classification to provide scheduling, oversee equipment calibrations, enforce documentation requirements, and provide for preliminary document review. The number of QCTs in each classification will depend on the project needs as the work progresses.

The Construction QCTs will satisfactorily complete a training program and receive on-the-job training as required under the direction of the QCO.

A procedure verification program will be implemented by the QAO for all Construction QCTs.

2.4 PROGRAM FOR INFORMATION FLOW

2.4.1 Review of Documents

The Plans and Specifications for the Construction Project describe the work to be performed, the QC/QA, and the monitoring requirements. These documents will be reviewed and approved in depth by licensee personnel, including the QCO and Site Manager.

2.4.2 Information Flow

2.4.2.1 Internal Information Flow

As shown on the Organization Chart (Figure B-2), the Construction Superintendent gives instructions to the Construction Foremen, who supervise the construction workers. The Construction Superintendent may directly supervise all or some of the construction workers.

The QCO monitors the construction work and completes the forms and reports as given in the Quality Control Procedures. The QCO ensures that all key personnel receive the required information.

Section 4.0 below, "Changes and Corrective Actions," outlines the procedure for implementing changes and corrective actions.

2.4.2.2 Information Flow to NRC

All reports of sampling, tests, inspections and construction records will be maintained in the White Mesa Project files. These documents will be available to the NRC Project Manager at all times. The NRC Project Manager will have the right to inspect and reproduce any documents as needed.

A list of the required reports is shown on Table B-I. These reports will be kept in the White Mesa Project Files.

3.0 SURVEYS, INSPECTIONS, SAMPLING AND TESTING

3.1 SCOPE

The following items are covered in this Section:

(1) Methods and procedures for surveys, inspections, sampling and testing during various construction tasks.

(2) The necessary qualifications of individuals performing surveys, inspections, sampling and testing.

(3) The number and type of surveys, inspections and/or tests to be conducted.

TABLE B-1
REQUIRED REPORTS

REPORT TYPE	FREQUENCY	ORIGINATOR	APPROVAL
Construction Activities	Daily during Construction	QC Technician	QC Officer
Sampling, Field and Laboratory Testing	Report for each respective test	QC Technician	QC Officer
*Compliance Report	Upon completion of Construction Segment	QC Officer	Site Manager
*Final Construction Report	After completion of the Construction Project	QC Officer Site Manager	Site Manager

* Reports to be submitted to the NRC

3.2 QUALITY CONTROL PROCEDURES

Quality Control Procedures will be written to meet the following objectives:

(1) To describe the equipment, calibration and methods/procedures to be followed in performing surveys, sampling and testing.

(2) To describe the procedures to observe construction activities.

(3) To describe the procedures for monitoring.

All Quality Control Procedures for sampling, testing, and monitoring will be conducted by the QCO and/or QCTs. The results will be reviewed and approved by the QCO before being delivered to the Document Control Officer ("DCO") for reproduction, distribution, and filing.

All boundary surveys will be made and documented by a registered land surveyor. Construction surveys will be made and documented by appropriately trained QCTs.

3.3 FREQUENCY AND TYPE

The number and type of survey, observations, inspections and/or tests are specified in the Plans and Specifications.

4.0 CHANGES AND CORRECTIVE ACTIONS

4.1 SCOPE

The methodology for dealing with changes and corrective actions is detailed in this Section.

4.2 AUTHORITY OF PERSONNEL

The Site Manager and/or the QCO will have the authority to reject material or work, to require removal or replacement, to specify and require appropriate actions if it is determined that the Quality Control/Quality Assurance, personnel, instructions, controls, tests, records are not conforming to the Plans and Specifications.

4.3 METHODOLOGY

4.3.1 Field and Design Changes

Changes in locations or alignments of construction features that do not alter design concepts will be approved by the Site Manager or a designated representative. These changes will require a Field Change Order (Form F-25).

Changes in design concepts will be approved and documented by the Design Engineer, will be approved by the Site Manager. These changes will require a Design Change Order (Form F-26).

All changes will be recorded in the Final Construction Report including "as-built" drawings for the work.

4.3.2 Corrective Actions

The QCO will require corrective actions if tests and observations indicate the work is not conforming to the intent of the Plans and Specifications. Appropriate corrective actions will be determined by

reviewing pertinent Quality Control records. Contemplated corrective actions will be brought to the attention of the Site Manager and the Construction Superintendent.

5.0 DOCUMENTATION

5.1 SCOPE

Documentation requirements will include the following:

(1) The identification of the person who has authority to provide for the submittal and/or storage of all survey, test and inspection reports.

(2) Specification of reporting requirements, forms, formats, and distribution of reports.

(3) A description of record keeping to document construction methods and results, surveys, sampling, testing and inspection of construction. Samples of forms and records will be included.

(4) Documentation of corrective actions.

5.2 PERSONNEL

5.2.1 <u>Document Control Officer ("DCO")</u>

5.2.1.1 Duties

The Document Control Officer ("DCO") will be appointed by the Site Manager. Responsibilities will include:

(1) Maintaining permanent files for the Construction Project. All tests, surveys, monitoring and report originals will be maintained in the project files.

(2) Instituting and overseeing data reproduction and distribution. A distribution list will be prepared for each project number and will be reviewed and approved by the QCO.

5.3 FORMS

All test results, sampling, surveys, and monitoring will be documented on the forms for those particular procedures where applicable. Specific surveys require a notebook prepared for data recording. Each Construction Field QCT will complete a Construction Activities report for each day's work. Forms will be completed so that all important data are recorded. Data required on all forms and notebooks includes project number, date, technician's signature, and the signature of the supervisor or a designee, who has reviewed and approved the work. The DCO will return all incomplete forms to the appropriate supervisor to be properly filled out.

Forms F-23, F-25, and F-26 follow.

Form No. F-26

DESIGN CHANGE ORDER

Project No. ______________ Date ________________

Drawing No. ______________

Specification No. ____________

Design feature

____

____

____

Change in design

____

____

____

____

Reason

____

____

____

Initiated by: ________________________________

Approvals:

Site Manager ________________________________

NRC Project Manager ___________________________

Design Engineer ______________________________

Form No. F-25

FIELD CHANGE ORDER

Project No. ______________ Date ______________

Drawing No. ______________

Specification No. ______________

Design feature

____

____

____

____

Modifications

____

____

____

____

Reason

____

____

____

____

Initiated by: ______________________________

Approved by: ______________________________

Site Manager

Form No. F-23

COMPLIANCE REPORT

Project No. ______________ Date ________________

Construction Segment ______________________________________

____

Drawing No. ______________

Specification No. ____________

Description of Completed Construction Segment

____

____

____

____

____

____

____

____

____

____

____

____

By: QC Officer ________________________________

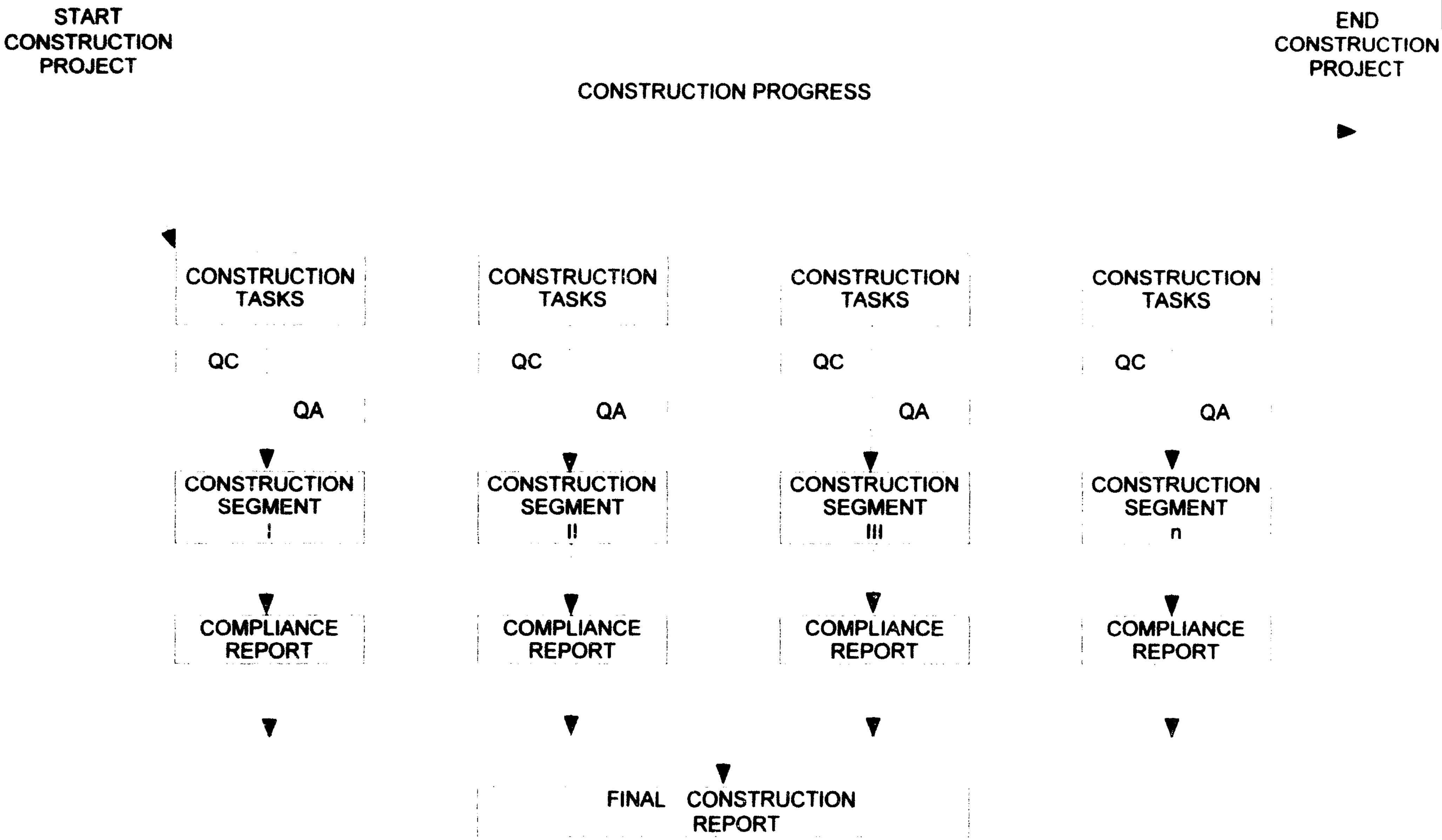
Approvals

Site Manager ________________________________

NRC Project Manager __________________________

FIGURE B-1

TYPICAL FLOW CHART FOR CONSTRUCTION PROJECT



COST ESTIMATES

FOR

RECLAMATION

OF

WHITE MESA FACILITIES

BLANDING, UTAH

PREPARED BY

ENERGY FUELS NUCLEAR, INC.

THREE PARK CENTRAL

1515 ARAPAHOE STREET, SUITE 900

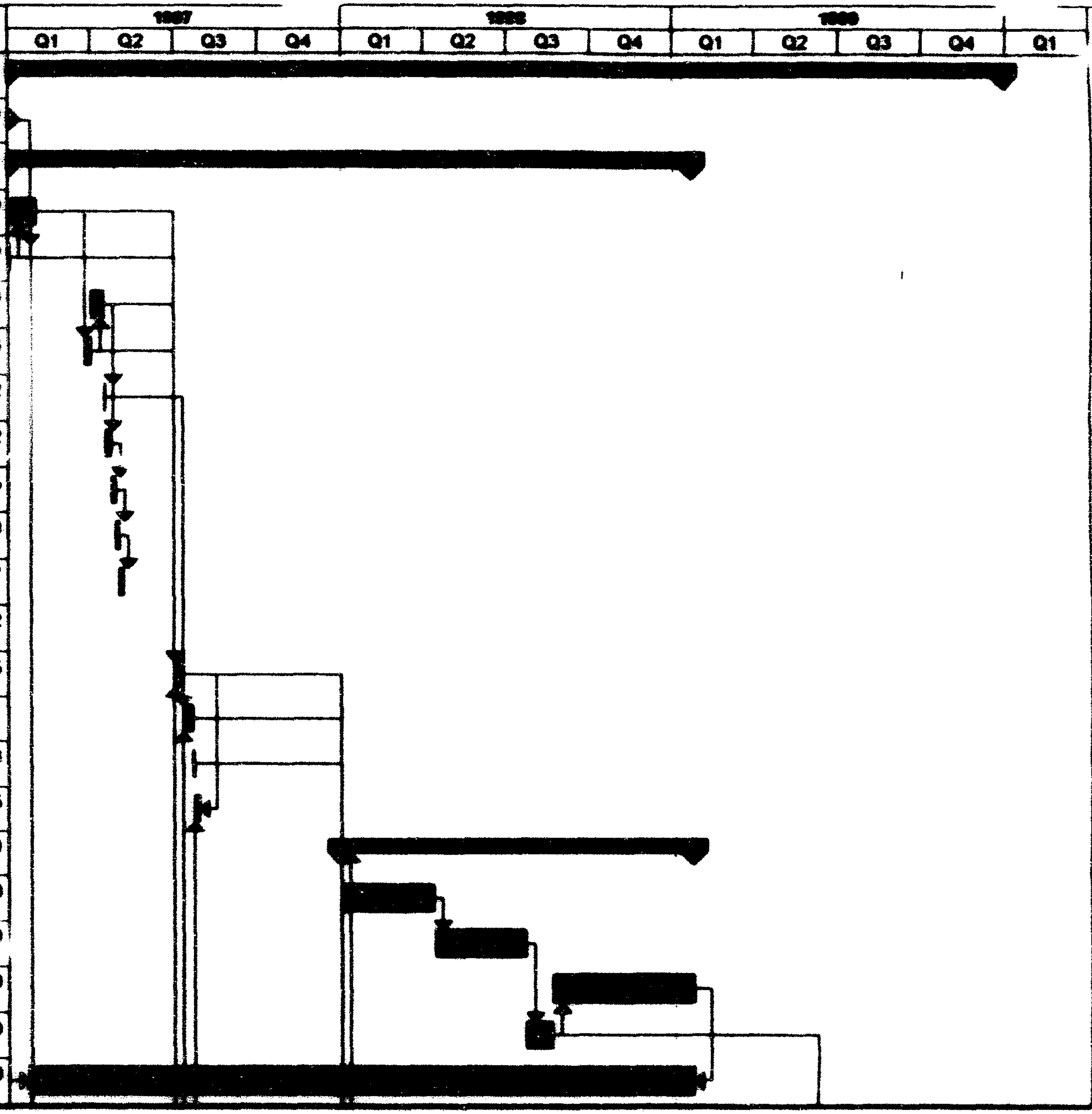
DENVER, COLORADO 80202

White Mesa Mill
Surety Requirements Summary
Revision of 12/1/96

Description	Factor	Amount
Mill Decommissioning		1,484,551
Cell 2		1,735,852
Cell 3		2,215,999
Cell 4A		114,756
Cell 1		738,371
Miscellaneous(w/o LTC)		2,045,035
Subtotal Direct Costs		8,334,564
Profit Allowance	10.00%	833,456
Contingency	15.00%	1,250,185
Licencing & Bonding	2.00%	166,691
Long Term Care Fund		585,300
Total Surety Requirement		11,170,196

Amounts are in 1996 Dollars

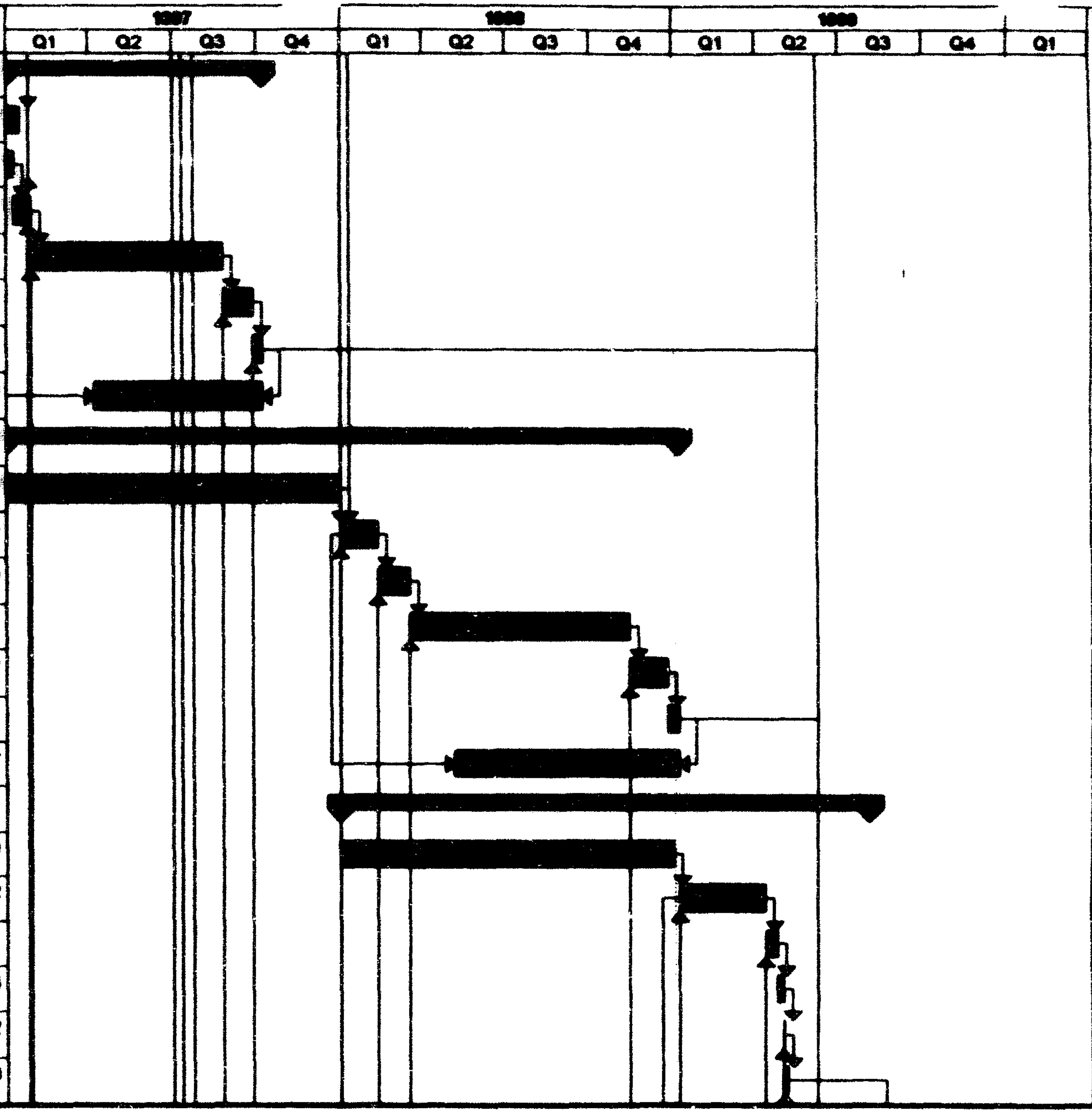
ID	Task Name	Total Cost
1	TOTAL RECLAMATION & DECON	$6,919,883
2	Project Start	$0
3	MILL DECOMMISSIONING	$1,484,511
4	Mill Building Demolition	$284,630
5	Ore Feed Demolition	$14,229
6	SX Building Demolition	$280,240
7	CCD Circuit Removal	$74,974
8	Sample Plant Removal	$28,882
9	Boiler Demolition	$45,382
10	Vanadium Oxidation Circuit Re	$15,865
11	Main Shop/Warehouse	$83,370
12	Office Building	$82,427
13	Misc Tankage & Spare Parts	$7,342
14	Mill Yard Decontamination	$72,985
15	Ore Storage Pad Decontaminat	$53,891
16	Equipment Storage Area	$19,488
17	Revegetate Mill Yard & Ore Pa	$30,225
18	Windblown Contamination	$368,880
19	Scoping survey	$28,000
20	Characterization Survey	$37,800
21	Final Status Survey	$58,400
22	Windblown Cleanup	$183,780
23	Quality Control	$128,880



Project:
Date: 12/1/96

Task		Summary	
Progress		Rolled Up Task	
Milestone	◆	Rolled Up Milestone	◇
Rolled Up Progress			

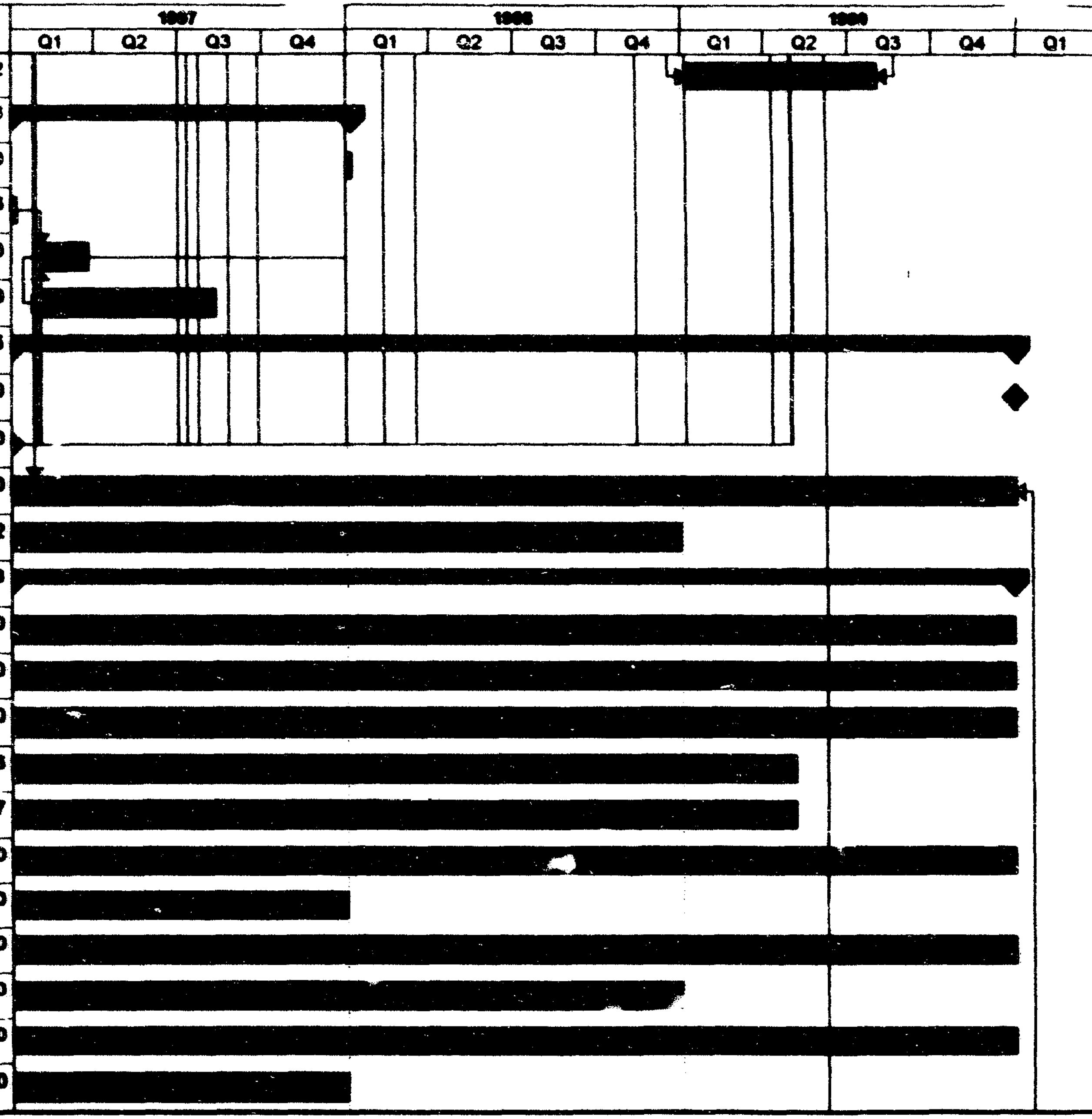
ID	Task Name	Total Cost
24	RECLAMATION OF CELL 2	$1,736,888
25	Obtain Permit for Section 16	$50,000
26	Place Remainder of Bridging Li	$91,854
27	Place Lower Random Fill (12")	$110,788
28	Clay Layer	$797,315
29	Upper Random Fill	$225,800
30	Rock Armour on top	$425,188
31	Quality Control	$85,100
32	RECLAMATION OF CELL 3	$2,216,880
33	Dewatering of Cell 3	$30,000
34	Lower Random Fill	$283,883
35	Lower Random Fill (12")	$214,880
36	Clay Layer	$857,151
37	Upper Random Fill	$259,732
38	Rock Armour	$503,881
39	Quality Control	$87,172
40	RECLAMATION OF CELL 1	$738,371
41	Dewatering	$30,600
42	Crystal Removal	$500,892
43	Contaminated Materials Remov	$71,771
44	Topsoil Application	$35,994
45	Construct Channels	$1,092
46	Rock Protection	$24,980



Project:
Date: 12/1/96

Task | Summary | Rolled Up Progress
Progress | Rolled Up Task
Milestone | Rolled Up Milestone

ID	Task Name	Total Cost
47	Quality Control	$73,532
48	CELL 4A WORK	$114,786
49	Dewatering	$5,000
50	Remove Fencing	$1,936
51	Remove Liner to Cell 3	$87,670
52	Quality Control	$20,150
53	MISCELLANEOUS ITEMS	$2,636,336
54	Long Term Care Fund Allowan	$585,300
55	Butler Machinery Mobilization	$131,000
56	Temporary Office Facilities	$97,500
57	Wheel Wash Facilities	$150,672
58	Managerial Support	$1,006,863
59	Manager/Engineer	$360,000
60	Radiation Safety Officer	$225,000
61	Secretary	$90,000
62	Clerk	$58,486
63	Environmental Technician	$93,577
64	Maintenance Foreman	$165,000
65	Chemist	$45,000
66	Security	$180,000
67	Safety Engineer	$80,000
68	Misc Materials and Suppli	$234,000
69	Health Physics Costs (Mill	$134,800



Project:
Date: 12/1/96

Task		Summary		Rolled Up Progress	
Progress		Rolled Up Task			
Milestone	◆	Rolled Up Milestone	◇		

ID	Task Name	Total Cost	1997 Q1	1997 Q2	1997 Q3	1997 Q4	1998 Q1	1998 Q2	1998 Q3	1998 Q4	1999 Q1	1999 Q2	1999 Q3	1999 Q4	Q1
70	ProjectCompletion	$0													

Project:
Date: 12/1/96

Task

Progress

Milestone

Summary

Rolled Up Task

Rolled Up Milestone

Rolled Up Progress

[redacted]

Mill Decommissioning

1) Removal of Contaminated Materials from Mill Yard.

Assume :

- 18" (1.5 feet) will have to be Removed
- Area (From CAD) = 1,643,453 ft²
  = 37.8 Acres

Therefore Volume Moved = [1,643,453 × 1.5] ÷ 27 = 91,302 yd³

$\frac{91,300 \text{ yd}^3}{355 \text{ yd}^3/\text{hr}}$ = **257 hours**   Say **91,300 yd³**

Haul Route # 2

2) Removal of Contaminated Materials from Ore Pad

Assume :

- 18" will have to be Removed
- Area (from CAD) = 976,780 ft²
  = 22.4 Acres.

Therefore Volume Moved = [976,780 × 1.5] ÷ 27 = 54,265 yd³

Say **54,300 yd³**

$\frac{54,300 \text{ yd}^3}{287 \text{ yd}^3/\text{hr}}$ = **189 hours**   **Haul Route # 3**

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MILL DECOMMISSIONING

3) DEMOLITION EQUIPMENT

- KAMATSU PC400 (OR CAT EQUIVALENT) WITH La Baunty Shears (hydraulic)
- CAT 245 BACKHOE W/ GRAPPLES.
- 769C ROCK TRUCKS
- 988 LOADER

4) DEMOLITION CREW.

- HEAVY EQUIPMENT OPERATORS - PC400, 245, 4-769C, 988
- DUST CONTROL - 2
- MECHANICS - CUTTING UP OF DEBRIS TO REMOVE VOIDS 4
-

5) TOOL & EXPENDABLE ALLOWANCE, COVERING THE FOLLOWING:

- SAFETY GEAR
- HAND TOOLS
- BOTTLED GASES & TORCHES.
- ALLOW 10^{00} / MAN HOUR FOR ALL BUT H.E. OPERATORS

[redacted]

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MILL DECOMMISSIONING

6) DEMOLITION TIME ESTIMATES. (SHEAR & GRAPPLE)

• MILL BUILDING	20 days
• COARSE ORE	2 days
• SX BUILDING	10 days
• CCD, PLT, CLARIFIER	5 days
• SAMPLE PLANT	1 day
• BOILER	5 days
• Vanadium Oxidation	2 days
• SHOP / WAREHOUSE	4 days
• OFFICE BUILDING	3 days
• MISC TANKAGE & "NORTH FORTY"	4 days

7) FOUNDATION DEMOLITION

- ASSUME THAT MEANS 020-750-0440 OVER ENTIRE AREA OF STRUCTURE WILL SUFFICE @ \$3.20/ft²
- AREAS ARE AS FOLLOWS. (FROM CAD)

	AREA, ft²	EST \$
MILL BUILDING	37,500	120,000
SX BUILDING	55,970	179,100
SHOP / WAREHOUSE	19,280	61,700
OFFICE	12,100	38,700
SAMPLE PLANT	4,200	13,400
DIESEL SHOP	2050	6,600
BOILER	2900	9,300

- LABOR \$2.69, EQUIP \$0.51

[redacted]

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MILL DECOMMISSIONING

B) REVEGITATION

ASSUME . . .

- MILL YARD AREA = 1,643,453 ft^2
- ORE PAD AREA = 976,780 ft^2
- PLACE 6"
- 637 ROUTE #4 APPROXIMATES HAUL

therefore $\left[\left[1,643,453 + 976,780 \right] ft^2 \times \frac{1}{2} ft \right] \div 27 \frac{ft^3}{yd^3} = 48,522 \ yd^3$

say **48,600 yd^3**

$\therefore \quad \frac{48,600 \ yd^3}{368 \ yd^3/hr} =$ **132 "637" hours**

MILL DECOMMISSIONING
WIND BLOWN CONTAMINATION

1) SCOPING SURVEY

- INITIAL SURVEY WILL BE CONDUCTED ON AN AREA TO BE DETERMINED BUT APPROXIMATED BY A PERIMETER APPROXIMATELY 1000' OUT SIDE OF THE RESTRICTED AREA BOUNDARIES.
- AREA BY CAD : 38,728 M sq ft
  - INCLUDES TAILS, MILLYARD & ORE PAD

Therefore AREA THAT REQUIRES WIND BLOWN SURVEY IS

		M ft^2
AREA OF WINDBLOWN SURVEY		38,728
less	Cell 4A	1,909
	Cell 3	3,234
	Cell 2	2,987
	Cell 1	2,576
	Mill Yard	1,643
	Ore Storage	977
		25,402

- ASSUME PLACEMENT OF STANDARD NRC/EPA 10 x 10 m grid (1076 ft^2)
- ASSUME SCOPING SURVEY COMPLETED BY SCANNING WITH µR METER HELD CLOSE TO GROUND WHILE TRAVERSING AT ± 0.5 m/sec AS PER GUIDANCE IN NUREG 5849
- SURVEY CREW OF 2 CAPABLE OF SETTING 500 GRID POINTS / DAY

$$25{,}402 \text{ M ft}^2 \div 1076 \text{ ft}^2 = 23{,}600 \text{ GRID POINTS}$$

$$23{,}600 \div 500/\text{day} = 47.2 \text{ days}$$

say **47 days**

- SCANNING CREW CONSISTS OF 2 & CAN COVER

$$1.5 \text{ m/sec} \times 0.5 \text{ efficiency} \times 60 \text{ sec/min} \times 60 \text{ min/hr} \times 5 \text{ hr} = 13{,}500 \text{ m/day}$$

- Assume 30 m path for each 10 x 10 m grid to cover 10% of SURFACE AREA (NUREG 5849)

Therefore TEAM SURVEYS (SCANS) 13,500 ÷ 30 = 450 GRIDS/DAY

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MILL DECOMMISSIONING
WIND BLOWN CONTAMINATION (CONT)

1) SCOPING SURVEY (CONTINUED)

SCANNING THEREFORE TAKES
23,600 ÷ 450 = 52+ DAYS

say **53 DAYS**

- MAP PREPARATION & DATA REDUCTION WILL TAKE SCANNING CREW ANOTHER 20 days
- WILL ALSO REQUIRE 100 CONFIRMATORY SOIL SAMPLES

2) CHARACTERIZATION SURVEY OF AFFECTED AREAS DEFINED IN #1
ASSUME:
- 20% OF AREAS WILL REQUIRE ADDITIONAL SAMPLING
- PROBING WILL BE USED, 4 PER 10x10 M GRID
- SOIL SAMPLES WILL BE REQUIRED ON 10% OF ABOVE
  - UNAT & Ra
  - $50/SAMPLE.

25,402 ÷ 1076 × .20 = 4721 SAMPLES (PROBE)
4721 × 0.10 = 472 SOIL SAMPLES.

- CREW CAN TAKE 100 PROBE SAMPLES/DAY
- CREW CAN OBTAIN 25 SOIL SAMPLES/DAY

Verify PROBING TAKES 4721 ÷ 100 = **47 DAYS**
SOIL SAMPLES TAKE 472 ÷ 25 = **19 DAYS**

- MAP PREPARATION & DATA REDUCTION TAKE ANOTHER 5 days

3) REMEDIATION CONTROL SURVEY
- PROVIDED BY QA/QC CONTRACTOR AS WITH OTHER TASKS

4) FINAL STATUS SURVEY

- IN ORDER TO GAIN FINAL RELEASE, WILL REQUIRE 4 GAMMA ESTIMATES PER EACH 100 m² GRID SQUARE IN THE AFFECTED AREA (20% of Area)
- 200 RANDOM SOIL SAMPLES WILL BE GATHERED FROM THE UNAFFECTED AREAS (80% of Area)
- WILL REQUIRE 100 CONFIRMATORY SAMPLES FOR THE AFFECTED AREA

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MILL DECOMMISSIONING
WIND BLOWN CONTAMINATION (CONT)

4) Continued

Therefore

$25{,}402 \div 1076\ ft^2/100m^2$	=	23,607	GRIDS TOTAL
$23{,}607 \times 0.20$	=	4,721	GRIDS AFFECTED
$4{,}721 \times 4$	=	18,886	GAMMA ESTIMATES.

- CREW CAN TAKE 100 PROBE SAMPLES / DAY
  $\therefore\ 18886 \div 100 = 188.8$ days say 190 days
- CREW CAN TAKE 25 SOIL SAMPLES / DAY
  $\therefore\ [200 + 100] \div 25 = 12$ days.

∘ ASSUME 20 additional DAYS FOR DATA REDUCTION & REPORT GENERATION

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MILL DECOMISSIONING
WIND BLOWN CONTAMINATION (CONT)

5) CLEAN-UP.

- ASSUME 20% OF AREA SURVEYED REQUIRES CORRECTIVE ACTION
- 6" OF SOIL WILL BE STRIPPED

Therefore $25.402 ft^2 \times 0.20 \times 0.5 ft = 2,540,000 ft^3$

or $94,080 yd^3$

say **94,100 yd^3**

- AS IT IS NOT KNOWN WHAT AREAS MAY BE CONTAMINATED, ASSUME THE USE OF 637 HAUL ROUTE #6 TO BE CONSERVATIVE.
- BECAUSE OF THE POTENTIAL FOR IRREGULAR & DISCONNECTED AREAS, EFFICIENCY WILL BE ONLY 50% OF REGULAR 637 EFFICIENCY.

Therefore $277 yd^3/hr \times 0.50 = 138.5 yd^3/hr$

say **138 yd^3/hr**

Therefore $94,100 yd^3 \div 138 yd^3/hr =$ 681 scraper hours

say **680 hours**

United States
Nuclear Regulatory Commission

Using CPI U (for urban consumers, across the U.S. - not the Denver-area CPI).

.19% is applied to long-term care fund for each additional month beyond August 1996

September, October, and November = 3 x .19 = .57%

November calculation would = $580,871 x 1.0057 = $584,182

Get on mailing list for Bureau of Labor Statistics - Call Richard Turtil at
301 415 6721
to get e-mail address for the Bureau.

assumed for minimum fee):
minimum GW monitoring (once every 3 years)
annual site inspection
very little maintenance

fee set with assumption that U.S. Govt. will be long-term custodian.

Example

Last available data is for August 1996 CPI-U = 157.3
December 1978 CPI-U = 67.7

$$\$250{,}000 \times \frac{August'96CPI-U}{December'78CPI-U}$$

= $580,871 Through August 1996.

Other data: July 1996 CPI-U = 157

The Consumer Price Index has increased .19% from July to August, 1996.

Today's dollars:

$$\$250{,}000 \times \frac{November '96\ CPI-U}{December '78\ CPI-U}$$

However, CPI-U data for September, October, November '96 not available at this time.

- **Procedure for Determining Minimum Long-Term Care Fund**
  - **Cost adjustment for most recent months for which CPI data does not exist is based on last available CPI-U figure, and applied to remaining months**

CELL 1 (EVAPORATIVE)

VOLUME & RESOURCE CALCULATIONS

1) SURFACE AREA (from CAD) = 2,575,703 ft²
= 59.1 Acres

2) CALCULATION OF CRYSTAL VOLUMES
- BASED ON AS-BUILTS & KNOWN ELEVATION OF CRYSTALS FROM AERIAL MAPPING, ASSUME AVERAGE THICKNESS = 3 ft
- SOIL OVER PVC LINER (AS BUILT) = 1½ feet
- LINER IS PICKED UP WITH ABOVE SOIL COVER

Therefore 2,575,703 ft³ × [3.0 + 1.5] ft = 11,590,663 ft³
= 429,293 yd³
say **429,300 yd³**

3) VOLUME OF CONTAMINATED MATERIALS UNDER LINER
- ASSUME AVERAGE OF 1 FOOT UNDER LINER OVER ENTIRE AREA OF CELL

= 2,575,703 ft³
= 95,396 yd³
say **95,500 yd³**

4) TIME REQUIRED TO REMOVE CRYSTALS TO CELL 3 DISPOSAL AREA
- ASSUME SPREAD OF 4 769C TRUCKS, 1 245 BACKHOE
- USE HAUL ROUTE No 1 FOR EFFICIENCY CALCS.

Therefore 429,300 yd³ ÷ 199 yd³/truck-hour = **2157 TRUCK HOURS**
= **539 FLEET HOURS**

CELL 1 (EVAPORATIVE)

5) TIME REQUIRED TO REMOVE CONTAMINATED MATERIALS UNDER LINER

- ASSUME 637 SCRAPERS (4 each) ARE USED
- USE HAUL ROUTE #1 FOR EFFICIENCY

Therefore $95{,}500 \text{ yd}^3 \div 310 \text{ yd}^3/\text{hour}$ = **308 SCRAPER HOURS**

= **77 "FLEET" HOURS**

JOB/PROJECT White Mesa Recl. Date 10/6/96 Calc by R A Van Horn Sheet 1 of

VOLUME CALCULATIONS
CELL 2

1) AREA OF CELL 2 (from CAD) = 2,986,660 ft^2
= **68.56 ACRES**

2) AREA OF CELL 2 STILL OPEN (ESTIMATE @ 20%) = 597,332 ft^2
= 13.72 ACRES

3) ASSUME THE FOLLOWING:
- BRIDGING LIFT IS PLACED USING RANDOM FILL PRIMARILY FROM THE PILES TO THE WEST OF TAILS
- PILES DESIGNATED AS "CLAY" WILL BE USED IN CONJUNCTION WITH GRADING TO BRING THE TOP OF FILL TO DESIGN ELEVATIONS USING MECHANICAL COMPACTION TO 95%
- CLAY WILL BE MINED, BLENDED, & HAULED FROM BORROW AREAS IN SECTION 16
- THE UPPER 2 FEET OF RANDOM FILL WILL BE PLACED UTILIZING THE REMAINING "CLAY" & FINES FROM "RANDOM FILL" PILES.
- ROCK FOR TOP & SIDE SLOPE ARMOUR WILL BE PRODUCED BY CRUSHING & SCREENING OPERATIONS ON RANDOM FILL OVERSIZE.

4) RANDOM FILL (BRIDGING LAYER) LEFT TO PLACE

FROM (2), $[597,332 \times 3] \div 27 = 66,370\ yd^3$

say **66,400 yd^3**

5) BRING LOWER RANDOM FILL UP TO ENGINEERING ELEVATIONS.

= FULL AREA OF CELL × 1 FOOT THICK ÷ 27 ft^3/yd

$= [2,986,660\ ft^2 \times 1\ foot] \div \frac{27\ ft^3}{yd^3} = 110,617\ yd^3$

say **110,700 yd^3**

[illegible]

E/PROJECT White Mesa Recl. Date 10/6/96 Calc by R Van Horn Sheet 3 of

CELL 2 (Cont)

6) PLACEMENT OF CLAY LAYER (1 foot thick)

= FULL AREA OF CELL × 1 ft ÷ 27 ft³/yd³

$= [2{,}986{,}660\ ft^2 \times 1\ foot] \div \frac{27\ ft^3}{1\ yd^3} = 110{,}617\ yd^3$

say **110,700 yd³**

7) UPPER RANDOM FILL VOLUME:

= FULL AREA OF CELL × 2 FEET ÷ 27 ft³/yd³

$= [2{,}986{,}660\ ft^2 \times 2\ ft] \div 27\ ft^3/yd^3 = 221{,}234\ yd^3$

say **221,300 yd³**

8) ARMOR PROTECTION - TOP OF CELL

= AREA CELL 2 × 0.5 ft ÷ 27 ft³/yd³

$= [2{,}986{,}660\ ft^2 \times 0.5\ ft] \div 27\ ft^3/yd^3 = 55{,}308\ yd^3$

say = **55,400 yd³**

9)

ENERGY FUELS NUCLEAR, INC.
Cost Estimate

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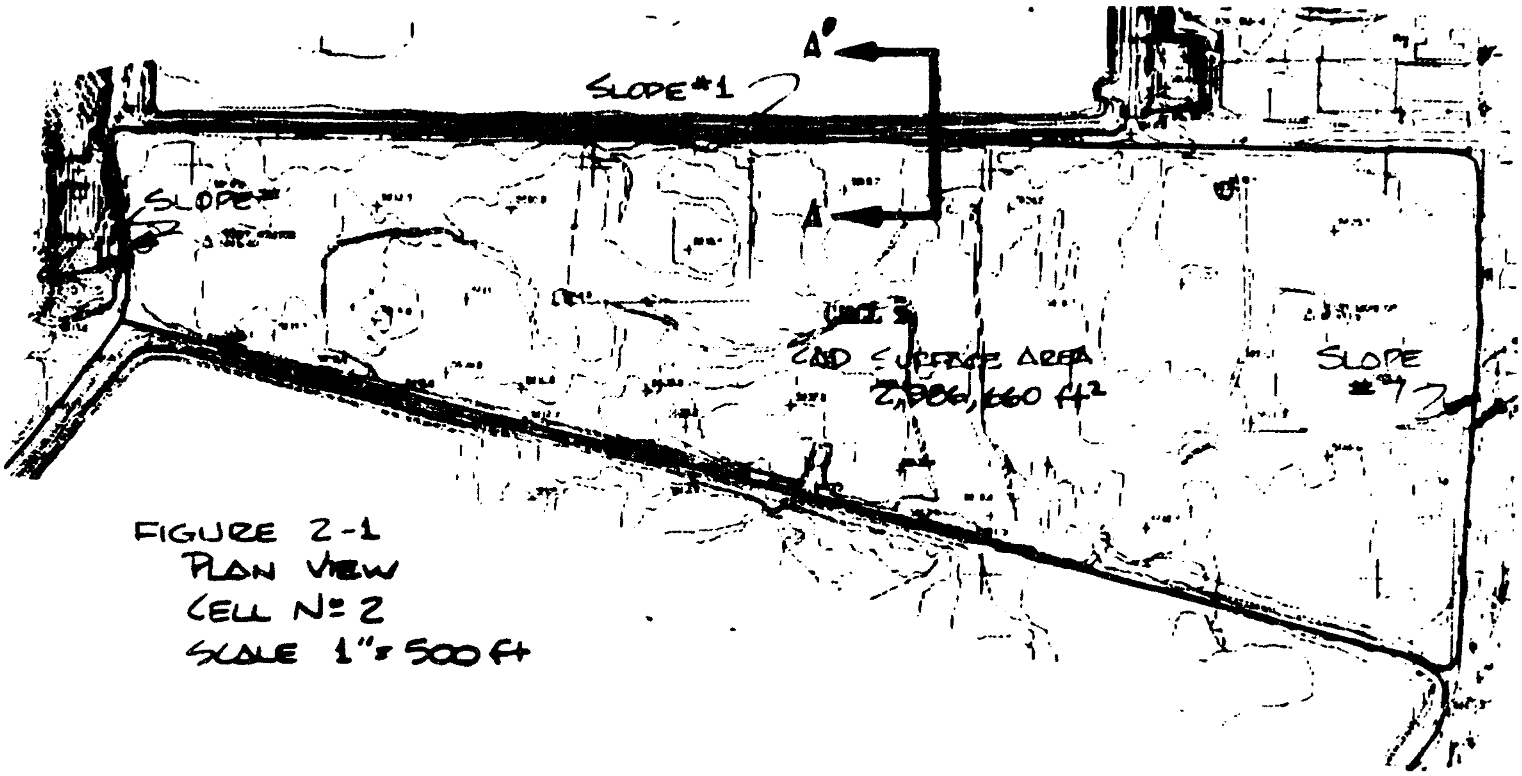

FIGURE 2-1
PLAN VIEW
CELL № 2
SCALE 1" = 500 ft

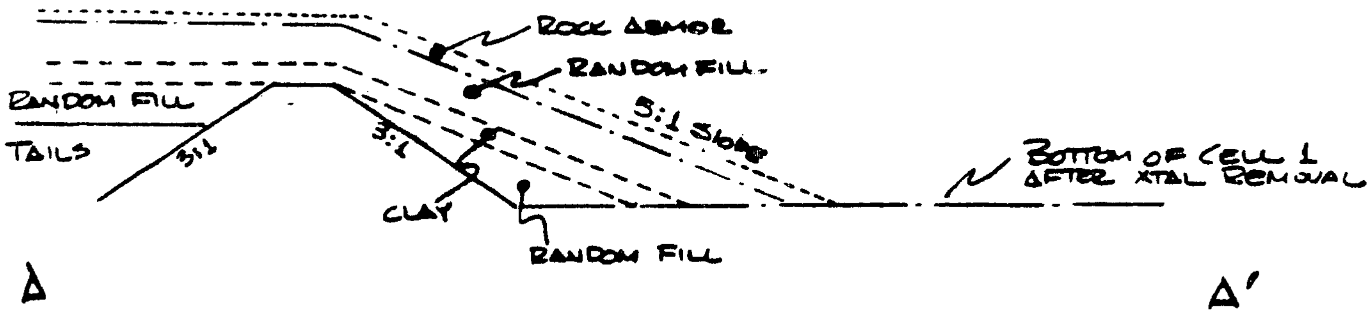

FIGURE 2-2
TYPICAL SECTION THRU DIKE

[illegible]

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VOLUME CALCULATIONS
CELL 2

9) CELL 2 NORTH DIKE (SLOPE #1), AREA COMMON WITH CELL 1

- AVERAGE HEIGHT 12 FEET
- LENGTH 2,600 FEET

a) RANDOM FILL WEDGE $= \left[\frac{12 \times 12 \times 5}{2} - \frac{12 \times 12 \times 3}{2}\right] \times 2600$

$= 374,400 \text{ ft}^3$

$= 13,867 \text{ yd}^3$

say **13,900 yd³**

b) CLAY LAYER $= \left[\frac{13 \times 13 \times 5}{2} - \frac{12 \times 12 \times 5}{2}\right] \times 2600$

$= 162,500 \text{ ft}^3$

$= 6,018 \text{ yd}^3$

say **6,100 yd³**

c) UPPER RANDOM FILL $= \left[\frac{15 \times 15 \times 5}{2} - \frac{13 \times 13 \times 5}{2}\right] \times 2600$

$= 364,000 \text{ ft}^3$

$= 13,481 \text{ yd}^3$

say **13,500 yd³**

d) ROCK ARMOUR $= \left[\frac{16 \times 16 \times 5}{2} - \frac{15 \times 15 \times 5}{2}\right] \times 2600$

$= 201,500 \text{ ft}^3$

$= 7,463 \text{ yd}^3$

say **7,500 yd³**

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VOLUME CALCULATIONS
CELL 2

10) CELL 2 NORTH DIKE (SLOPE #2), AREA COMMON WITH MILL YARD

- AVERAGE HEIGHT 1 foot
- LENGTH 900 feet

a) RANDOM FILL WEDGE $= \left[\frac{1 \times 1 \times 5}{2} - \frac{1 \times 1 \times 3}{2}\right] \times 900$

$= 900\ ft^3$

$= 33\ yd^3$

say **100 yd^3**

b) CLAY LAYER $= \left[\frac{2 \times 2 \times 5}{2} - \frac{1 \times 1 \times 5}{2}\right] \times 900$

$= 6{,}750\ ft^3$

$= 250\ yd^3$

say **300 yd^3**

c) Upper Random Fill $= \left[\frac{4 \times 4 \times 5}{2} - \frac{2 \times 2 \times 5}{2}\right] \times 900$

$= 27{,}000\ ft^3$

$=$ **1000 yd^3**

d) ROCK ARMOUR $= \left[\frac{5 \times 5 \times 5}{2} - \frac{4 \times 4 \times 5}{2}\right] \times 900$

$= 20{,}250\ ft^3$

$= 750\ yd^3$

say **800 yd^3**

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VOLUME CALCULATIONS
CELL 2

11) CELL 2 WEST DIKE (SLOPE = 3)

- AVERAGE HEIGHT 2 FEET
- LENGTH 500 FEET

a) RANDOM FILL WEDGE $= \left[\frac{2\times2\times5}{2} - \frac{2\times2\times3}{2}\right] \times 500$

$= 2000 \text{ ft}^3$

$= 74 \text{ yd}^3$

say $\boxed{100 \text{ yd}^3}$

b) CLAY LAYER $= \left[\frac{3\times3\times5}{2} - \frac{2\times2\times5}{2}\right] \times 500$

$= 6{,}250 \text{ ft}^3$

$= 231 \text{ yd}^3$

say $\boxed{300 \text{ yd}^3}$

c) UPPER RANDOM FILL $= \left[\frac{5\times5\times5}{2} - \frac{3\times3\times5}{2}\right] \times 500$

$= 20{,}000 \text{ ft}^3$

$= 741 \text{ yd}^3$

say $\boxed{800 \text{ yd}^3}$

d) ROCK ARMOUR $= \left[\frac{6\times6\times5}{2} - \frac{5\times5\times5}{2}\right] \times 500$

$= 13{,}750 \text{ ft}^3$

$= 509 \text{ yd}^3$

say $\boxed{600 \text{ yd}^3}$

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Volume Calculations
Cell 2

12) Cell 2 East Dike (Slope #4)

- Average Height 1 Foot
- Length 1,250 Feet

a) Random Fill Wedge $= \left[\frac{1\times1\times5}{2} - \frac{1\times1\times3}{2}\right] \times 1250$

$= 1250\ ft^3$

$= 46\ yd^3$

say $\boxed{100\ yd^3}$

b) Clay Layer $= \left[\frac{2\times2\times5}{2} - \frac{1\times1\times5}{2}\right] \times 1250$

$= 1875\ ft^3$

$= 69\ yd^3$

say $\boxed{100\ yd^3}$

c) Upper Random Fill $= \left[\frac{4\times4\times5}{2} - \frac{2\times2\times5}{2}\right] \times 1250$

$= 7{,}500\ ft^3$

$= 278\ yd^3$

say $\boxed{300\ yd^3}$

d) Rock Armour $= \left[\frac{5\times5\times5}{2} - \frac{4\times4\times5}{2}\right] \times 1250$

$= 28{,}125$

$= 1042\ yd^3$

say $\boxed{1{,}100\ yd^3}$

Volume Calculations
Cell 2

3) Cell 2 South Dike (Slope #5) [Common with Cell 3]

- Average Height = 3 Feet
- Length = 3500 Feet

(a) Random Fill Wedge $= \left[\frac{3 \times 3 \times 5}{2} - \frac{3 \times 3 \times 3}{2}\right] \times 3500$

$= 31{,}500 \text{ ft}^3$

$= 1167 \text{ yd}^3$

say $\boxed{1200 \text{ yd}^3}$

(b) Clay Layer $= \left[\frac{4 \times 4 \times 5}{2} - \frac{3 \times 3 \times 5}{2}\right] \times 3500$

$= 61{,}250 \text{ ft}^3$

$= 2268 \text{ yd}^3$

say $\boxed{2300 \text{ yd}^3}$

(c) Upper Random Fill $= \left[\frac{6 \times 6 \times 5}{2} - \frac{4 \times 4 \times 5}{2}\right] \times 3500$

$= 175{,}000 \text{ ft}^3$

$= 6481 \text{ yd}^3$

say $\boxed{6{,}500 \text{ yd}^3}$

(d) Rock Armour $= \left[\frac{7 \times 7 \times 5}{2} - \frac{6 \times 6 \times 5}{2}\right] \times 3500$

$= 113{,}750 \text{ ft}^3$

$= 4212 \text{ yd}^3$

say $\boxed{4{,}200 \text{ yd}^3}$

JE/PROJECT White Mesa Recl Date Calc by RVH Sheet of

CELL 2 RECLAMATION

CAT 631 RESOURCE REQUIREMENTS

	Volume	Route	Yds/Hr	%	Equip hrs
Cell 2 Bridging Lift					
Tailings Surface	66,400	5	296	100%	224.3
				TOTAL	224.3
Cell 2 Lower Random Fill					
Tailings surface	110,700	5	296	67%	250.6
Tailings Surface	110,700	4	368	33%	99.3
Slope 1	13,400	5	296	100%	47.0
Slope 2	100	4	368	100%	0.3
Slope 3	100	5	296	100%	0.3
Slope 4	100	4	368	100%	0.3
Slope 5	1,200	5	296	100%	4.1
				TOTAL	401.7
Cell 2 Upper Random Fill					
Tailings surface	221,300	5	296	67%	500.9
Tailings Surface	221,300	4	368	33%	198.4
Slope 1	13,500	5	296	100%	45.6
Slope 2	1,000	4	368	100%	2.7
Slope 3	800	5	296	100%	2.7
Slope 4	300	4	368	100%	0.8
Slope 5	6,500	5	296	100%	22.0
				TOTAL	773.2
Cell 2 Rock Armour					
Tailings Surface	53,400	5	296	100%	187.2
Slope 1	7,500	5	296	100%	25.3
Slope 2	800	5	296	100%	2.7
Slope 3	600	5	296	100%	2.0
Slope 4	1,100	5	296	100%	3.7
Slope 5	4,200	5	296	100%	14.2
				TOTAL	235.1

VOLUME CALCULATIONS
CELL 3

1) AREA OF CELL 3 FROM CAD = 3,234,252 ft²
= **74.25 ACRES**

2) AREA OF RANDOM FILL (BRIDGING LIFT) ALREADY PLACED =
= 851,820 ft²
= **19.55 ACRES**

3) ASSUME THE FOLLOWING:

- BRIDGING LIFT IS PLACED USING RANDOM FILL PILES FROM THE WEST OF TAILS UTILIZING ROUTE #6
- STOCKPILES DESIGNATED AS "CLAY" WILL BE USED IN CONJUNCTION WITH GRADING & MECHANICAL COMPACTION TO BRING THE TOP OF FILL TO ENGINEERED ELEVATIONS
- CLAYS FOR THE RADON BARRIER WILL BE MINED, BLENDED, PREPARED & HAULED FROM BORROW AREAS IN SECTION 16.
- THE 2 FOOT THICK RANDOM FILL LAYER ABOVE THE CLAY WILL BE PLACED UTILIZING THE REMAINING "CLAY" STOCKPILED IMMEDIATELY EAST & WEST OF TAILS & FINES FROM RANDOM FILL PILES.
- ROCK FOR TOP & SIDE SLOPE ARMOUR WILL BE PROVIDED BY CRUSHING & SCREENING OPERATIONS ON OVERSIZE MATERIALS IN THE RANDOM FILL PILES.

4) RANDOM FILL ([illegible]ING LAYER) LEFT TO PLACE:

FROM (1) & (2)...

$(3,234,252\ ft^2 - 851,820\ ft^2) \times 3\ ft \div 27\ \frac{ft^3}{yd^3}$

$= 2,382,432 \times 3 \div 27 = 264,715\ yd^3$

say **264,800 yd³**

VOLUME CALCULATIONS
CELL 3

5) BRING LOWER RANDOM FILL UP TO ENGINEERING ELEVATIONS

= Full Area of Cell × 1 foot thick ÷ 27 ft^3/yd^3

= 3,234,252 ft^2 × 1 foot ÷ 27 ft^3/yd^3

= 119,787 yd^3

say **119,800 yd^3**

6) PLACEMENT OF CLAY LAYER (1 foot thick)

= Full Area of Cell × 1 ft ÷ 27 ft^3/yd^3

= 3,234,252 ft^2 × 1 ft ÷ 27 ft^3/yd^3 = 119,787 yd^3

say **119,800 yd^3**

7) UPPER RANDOM FILL VOLUME:

= Full Area of Cell × 2 ft thick ÷ 27 ft^3/yd^3

= 3,234,252 ft^2 × 2 ft ÷ 27 ft^3/yd^3 = 239,574 yd^3

say **239,600 yd^3**

8) ARMOUR PROTECTION

= Full Area of Cell × 0.5 ft thick ÷ 27 ft^3/yd^3

= 3,234,252 ft^2 × 0.5 ft ÷ 27 ft^3/yd^3

= 59,894 yd^3

say **59,900 yd^3**

VOLUME CALCULATIONS
CELL 3

9) CELL 3 WEST DIKE (SLOPE #6), 2 foot high, 1100 feet long

RANDOM FILL (WEDGE) $= \left[(2 * 2 * 5/2) - (2 * 2 * 3/2)\right] * 1{,}100$

$= 4400 \text{ ft}^3$

$= 163 \text{ yd}^3$

say **200 yd³**

CLAY LAYER $= \left[\frac{3 \times 3 \times 5}{2} - \frac{2 \times 2 \times 5}{2}\right] \times 1{,}100$

$= 13{,}750 \text{ ft}^3$

$= 509 \text{ yd}^3$

say **600 yd³**

UPPER RANDOM FILL $= \left[\frac{5 \times 5 \times 5}{2} - \frac{3 \times 3 \times 5}{2}\right] \times 1{,}100$

$= 44{,}000 \text{ ft}^3$

$= 1630 \text{ yd}^3$

say **1,700 yd³**

RIP RAP LAYER $= \left[\frac{6 \times 6 \times 5}{2} - \frac{5 \times 5 \times 5}{2}\right] \times 1{,}100$

$= 30{,}250 \text{ ft}^3$

$= 1120 \text{ yd}^3$

say **1200 yd³**

VOLUME CALCULATIONS
CELL 3

10) CELL 3 SOUTH DIKE (SLOPE #7),
- 16 feet Average height
- 1,750 feet long

a) RANDOM FILL WEDGE $= \left[\frac{16 \times 16 \times 5}{2} - \frac{16 \times 16 \times 3}{2}\right] \times 1750$

$= 448{,}000\ ft^3$

$= 16{,}592\ yd^3$

say **16,600 yd³**

b) CLAY LAYER $= \left[\frac{17 \times 17 \times 5}{2} - \frac{16 \times 16 \times 5}{2}\right] \times 1{,}750$

$= 144{,}375\ ft^3$

$= 5347\ yd^3$

say **5400 yd³**

c) UPPER RANDOM FILL $= \left[\frac{19 \times 19 \times 5}{2} - \frac{17 \times 17 \times 5}{2}\right] \times 1750$

$= 315{,}000\ ft^3$

$= 11{,}667\ yd^3$

say **11,700 yd³**

d) RIP RAP ARMOUR $= \left[\frac{20 \times 20 \times 5}{2} - \frac{19 \times 19 \times 5}{2}\right] \times 1{,}750$

$= 170{,}625\ ft^3$

$= 6{,}319\ yd^3$

say **6400 yd³**

NE/PROJECT White Mesa Recl Date .... Calc by .... Sheet 5 of ....

Volume Calculations
Cell 3

11) Cell 3 South Dike (Slope #8), Area Common with Cell 4A

- 39 foot Average height
- 1700 feet long

a) Random Fill Wedge $= \left[\frac{39 \times 39 \times 5}{2} - \frac{39 \times 39 \times 3}{2}\right] \times 1{,}700$

$= 2{,}585{,}700 \text{ ft}^3$

$= 95{,}767 \text{ yd}^3$

say $\boxed{95{,}800 \text{ yd}^3}$

b) Clay Layer $= \left[\frac{40 \times 40 \times 5}{2} - \frac{39 \times 39 \times 5}{2}\right] \times 1{,}700$

$= 335{,}750 \text{ ft}^3$

$= 12{,}435 \text{ yd}^3$

say $\boxed{12{,}500 \text{ yd}^3}$

c) Upper Random Fill $= \left[\frac{42 \times 42 \times 5}{2} - \frac{40 \times 40 \times 5}{2}\right] \times 1{,}700$

$= 697{,}000 \text{ ft}^3$

$= 25{,}814 \text{ yd}^3$

say $\boxed{25{,}900 \text{ yd}^3}$

d) Rip-Rap Armour $= \left[\frac{43 \times 43 \times 5}{2} - \frac{42 \times 42 \times 5}{2}\right] \times 1700$

$= 361{,}250 \text{ ft}^3$

$= 13{,}379 \text{ yd}^3$

say $\boxed{13{,}400 \text{ yd}^3}$

Volume Calculations
Cell 3

12) Cell 3 East Dike (Slope #9)
- Average Height 6 Feet
- 800 Long

a) Random Fill Wedge $= \left[\frac{6 \times 6 \times 5}{2} - \frac{6 \times 6 \times 3}{2}\right] \times 800$
$= 28{,}800 \text{ ft}^3$
$= 1067 \text{ yd}^3$
say $\boxed{1100 \text{ yd}^3}$

b) Clay Layer $= \left[\frac{7 \times 7 \times 5}{2} - \frac{6 \times 6 \times 5}{2}\right] \times 800$
$= 26{,}000 \text{ ft}^3$
$= 963 \text{ yd}^3$
say $\boxed{1{,}000 \text{ yd}^3}$

c) Upper Random Fill $= \left[\frac{9 \times 9 \times 5}{2} - \frac{7 \times 7 \times 5}{2}\right] \times 800$
$= 64{,}000 \text{ ft}^3$
$= 2{,}370 \text{ yd}^3$
say $\boxed{2{,}400 \text{ yd}^3}$

d) RipRap Armour $= \left[\frac{10 \times 10 \times 5}{2} - \frac{9 \times 9 \times 5}{2}\right] \times 800$
$= 38{,}000$
$= 1407 \text{ yd}^3$
say $\boxed{1500 \text{ yd}^3}$

NE/PROJECT White Mesa Rec..... Date..... Calc by RM..... Sheet..... of.....

CELL 3 RECLAMATION

CAT 631 RESOURCE REQUIREMENTS

	Volume	Route	Yds/Hr	%	Equip hrs
Cell 3 Bridging Lift					
Tailings Surface	264,800	6	277	100%	956.0
				TOTAL	956.0
Cell 3 Lower Random Fill					
Tailings surface	119,800	6	296	100%	404.7
Slope 6	200	6	296	100%	0.7
Slope 7	16,600	6	368	100%	45.1
Slope 8	95,800	6	296	100%	323.6
Slope 9	1,100	6	368	100%	3.0
				TOTAL	777.2
Cell 3 Upper Random Fill					
Tailings surface	239,600	6	296	100%	809.5
Slope 6	1,700	6	296	100%	5.7
Slope 7	11,700	6	368	100%	31.8
Slope 8	25,900	6	296	100%	87.5
Slope 9	2,400	6	368	100%	6.5
				TOTAL	941.0
Cell 3 Rock Armour					
Tailings Surface	59,900	6	296	100%	202.4
Slope 6	1,200	6	296	100%	4.1
Slope 7	6,400	6	296	100%	21.6
Slope 8	13,400	6	296	100%	45.3
Slope 9	1,500	6	296	100%	5.1
				TOTAL	278.4

NE/PROJECT .... Date .... Calc by .... Sheet ...... of ......

CELL 4A WORK

1) ASSUMPTIONS
- ANY XTALS ARE PICKED UP WITH LINER
- AVERAGE OF 1 FOOT UNDER LINER WILL GO TO CELL 3
- ALL DIKE MATERIAL IS UNCONTAMINATED & CAN BE UTILIZED FOR CELL 3 COVER, THEREFORE, NO COST IS PLACED AGAINST ITS REMOVAL
- AREA OF CELL FOR VOLUME ESTIMATES IS 1,909 M ft^2
- CRYSTALS ESTIMATED TO BE 6" THICK OVER ENTIRE AREA

Transfer

QUANTITY OF CONTAMINATED MATERIAL =

$$\left[1,909,000 \times \left[\tfrac{6}{12} + \tfrac{12}{12}\right]\right] \div 27\ ft^3/yd^3 = 106,055$$

say **106,100 yd^3**

and

BASED ON HAUL ROUTE B PROFILE, EFFICIENCY = 175 yd^3/truck hour

$106100\ yd^3 \div 175\ yd^3$ = 606 TRUCK HOURS

= 303 FLEET HOURS (2 TRUCKS)

ID	Resource Name	Group	Max. Units	Peak	Std. Rate	Ovt. Rate	Cost	Work
1	637 scraper		4	8	$146/h	$66/h	$876,192	6613h
2	D8N Dozer w/ripper		2	2	$70/h	$34/h	$275,100	3930h
3	D7 Dozer		2	2	$60/h	$28/h	$118,127	1963h
4	825 Compactor		1	1	$69/h	$30/h	$204,911	2984h
5	651 Waterwagon		1	2	$76/h	$36/h	$283,684	3746h
6	14G Motorgrader		2	2	$50/h	$24/h	$196,821	3948h
7	980C Loader		1	1	$67/h	$32/h	$58,316	866h
8	5000 gal water truck		1	1	$41/h	$18/h	$46,933	1132h
9	Highway Trucks (12yd)		20	8	$32/h	$0/h	$482,875	15104h
10	Operators		50	34.5	$12/h	$0/h	$686,564	56740h
11	Permits and Licences		1	[illegible]	$0/h	$0/h	[illegible]	[illegible]
12	Seeding per Acre		100	0	$0/h	$0/h	$0	0h
13	Dewatering Costs		50	35	$0/h	$0/h	$65,000	######
14	Quality contol contract		2	2.6	$62/h	$0/h	$374,914	6047h
15	769 Haul Truck		4	10	$62/h	$28/h	$276,679	4477h
16	988 Loader		2	3	$90/h	$48/h	$139,316	1461h
17	Rock Production Cost		100	82.1	$0/h	$0/h	$780,057	######
18	Wheelwash costs		10	10	$0/h	$0/h	$50,000	80h
19	245 Excavator		1	2	$167/h	$80/h	$161,842	963h
20	DP Rock per 100 yd3		100	0	$0/h	$0/h	$0	0h
21	Long Term Care Fund		100	58.53	$0/h	$0/h	$586,300	1h
22	Mechanics		25	12	$19/h	$0/h	$44,121	2292h
23	Small tools		100	1.92	$0/h	$0/h	$4,800	28.88h
24	65 Ton Crane		2	1	$47/h	$0/h	$9,002	190h
25	30 Ton Crane		1	1	$41/h	$0/h	$3,914	96h
26	Mobilization per 10k dolla		20	0	$0/h	$0/h	$131,000	0h
27	Manager/Engineer		1	1	$120,000/y	$0/h	$360,000	6240h
28	Radiation Safety Officer		1	1	$75,000/y	$0/h	$225,000	6240h
29	Secretary		1	1	$30,000/y	$0/h	$90,000	6240h
30	Clerk		1	1	$25,000/y	$0/h	$58,486	4866h
31	Engineer		1	0	$75,000/y	$0/h	$0	0h
32	Environmental Technicia		1	1	$40,000/y	$0/h	$93,577	4866h
33	Maintneance Foreman		1	1	$55,000/y	$0/h	$165,000	6240h
34	Security Personnel		3	3	$20,000/y	$0/h	$180,000	18720h
35	Safety Engineer		1	1	$40,000/y	$0/h	$80,000	4160h
36	Chemist		1	1	$45,000/y	$0/h	$45,000	2080h
37	Misc Supplies		1	1	$1,500/w	$0/h	$234,000	6240h
38	Buffer Maintenance Cost		100	30	$10/h	$0/h	$483,220	48322h
39	Additional Clay per 10k y		100	0	$0/h	$0/h	$0	0h
40	Health Physics Program		100	1	$2,400/w	$0/h	$134,800	2080h
41	PC400 w/shear		1	2	$204/h	$0/h	$78,336	384h
42	Concrete Removal per 1		100	56.97	$0/h	$0/h	$470,304	######
43	Soil Samples per 100		100	5	$0/h	$0/h	$68,600	58.05h
44	Survey crew		2	2	$13/h	$0/h	$11,436	915h
45	Sample Crew		4	4	$13/h	$0/h	$74,238	5936h
46	Office trailers(Technical)		10	5	$125/w	$0/h	$97,500	31200h

ID	Task Name	Total Cost
1	**TOTAL RECLAMATION & DECOM**	$8,919,823
2	Project Start	$0
3	**MILL DECOMMISSIONING**	$1,484,511
4	Mill Building Demolition	$284,630

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	9	$16,456	$7,536	$0	$16,456	1360h	0h	623h	0h	1360h
15	769 Haul Truck	4	$30,562	$0	$0	$30,562	640h	0h	0h	0h	640h
16	988 Loader	1	$15,910	$0	$0	$15,910	160h	0h	0h	0h	160h
19	245 Excavator	1	$17,115	$0	$0	$17,115	160h	0h	0h	0h	160h
22	Mechanics	6	$18,400	$156,560	$0	$18,400	960h	0h	8133h	0h	960h
23	Small tools	9.6	$0	$40,880	$0	$0	0h	0h	0h	0h	0h
24	65 Ton Crane	1	$7,581	$25,623	$0	$7,581	160h	0h	540h	0h	160h
25	30 Ton Crane	1	$3,296	$2,700	$0	$3,296	80h	0h	66h	0h	80h
38	Butler Maintenance Cost	9	$13,600	$0	$0	$13,600	1360h	0h	0h	0h	1360h
41	PC400 w/shear	1	$32,640	$0	$0	$32,640	160h	0h	0h	0h	160h
42	Concrete Removal per 1000 ft2	37.5	$120,000	$0	$0	$120,000	1h	0h	0h	0h	1h

ID	Task Name	Total Cost
5	Ore Feed Demolition	$14,229

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$1,366	$535	$0	$1,366	112h	0h	60h	0h	112h
15	769 Haul Truck	4	$3,966	$0	$0	$3,966	64h	0h	0h	0h	64h
16	988 Loader	1	$1,591	$0	$0	$1,591	16h	0h	0h	0h	16h
19	245 Excavator	1	$1,712	$0	$0	$1,712	16h	0h	0h	0h	16h
22	Mechanics	4	$1,232	$61,254	$0	$1,232	64h	0h	3182h	0h	64h
23	Small tools	6.64	$0	$15,910	$0	$0	0h	0h	0h	0h	0h
25	30 Ton Crane	1	$0	$2,700	$0	$0	0h	0h	66h	0h	0h
38	Butler Maintenance Cost	9	$1,120	$0	$0	$1,120	112h	0h	0h	0h	112h
41	PC400 w/shear	1	$3,264	$0	$0	$3,264	16h	0h	0h	0h	16h

ID	Task Name	Total Cost
6	SX Building Demolition	$250,240

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$6,776	$2,505	$0	$6,776	560h	0h	207h	0h	560h
15	769 Haul Truck	4	$19,776	$0	$0	$19,776	320h	0h	0h	0h	320h
16	988 Loader	1	$7,955	$0	$0	$7,955	80h	0h	0h	0h	80h
19	245 Excavator	1	$8,558	$0	$0	$8,558	80h	0h	0h	0h	80h
22	Mechanics	4	$6,160	$122,526	$0	$6,160	320h	0h	6365h	0h	320h
23	Small tools	3.2	$0	$31,820	$0	$0	0h	0h	0h	0h	0h
24	65 Ton Crane	1	$0	$6,383	$0	$0	0h	0h	130h	0h	0h
25	30 Ton Crane	1	$0	$2,700	$0	$0	0h	0h	68h	0h	0h
38	Butler Maintenance Cost	7	$5,600	$0	$0	$5,600	560h	0h	0h	0h	560h
41	PC400 w/shear	1	$16,320	$0	$0	$16,320	80h	0h	0h	0h	80h
42	Concrete Removal per 1000 ft2	56.97	$179,104	$0	$0	$179,104	560h	0h	0h	0h	560h

ID	Task Name	Total Cost
7	CCD Circuit Removal	$74,074

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	9	$3,812	$2,505	$0	$3,812	315h	0h	207h	0h	315h
15	769 Haul Truck	4	$7,416	$0	$0	$7,416	120h	0h	0h	0h	120h
16	988 Loader	1	$2,983	$0	$0	$2,983	30h	0h	0h	0h	30h
19	245 Excavator	1	$3,209	$0	$0	$3,209	30h	0h	0h	0h	30h
22	Mechanics	6	$3,465	$102,102	$0	$3,465	180h	0h	5304h	0h	180h

ID	Task Name	Total Cost

"CCD Circuit Removal" continued

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
23	Small tools	1.8	$0	$26,520	$0	$0	0h	0h	0h	0h	0h
24	65 Ton Crane	1	$1,421	$3,191	$0	$1,421	38h	0h	85h	0h	38h
25	30 Ton Crane	1	$618	$5,520	$0	$618	15h	0h	138h	0h	15h
38	Boiler Maintenance Cost	9	$3,150	$0	$0	$3,150	315h	0h	0h	0h	315h
42	Concrete Removal per 1000 ft2	15	$48,000	$0	$0	$48,000	480h	0h	0h	0h	480h

8 Sample Plant Removal $20,862

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$678	$1,258	$0	$678	56h	0h	104h	0h	56h
15	769 Haul Truck	4	$1,978	$0	$0	$1,978	32h	0h	0h		32h
16	988 Loader	1	$796	$0	$0	$796	8h	0h	0h		8h
19	245 Excavator	1	$856	$0	$0	$856	8h	0h	0h	0h	8h
22	Mechanics	6	$824	$27,230	$0	$824	48h	0h	1415h	0h	48h
23	Small tools	0.48	$0	$7,800	$0	$0	0h	0h	0h	0h	0h
25	30 Ton Crane	1	$0	$4,160	$0	$0	0h	0h	104h	0h	0h
38	Boiler Maintenance Cost	7	$560	$0	$0	$560	56h	0h	0h	0h	56h
41	PC400 w/shear	1	$1,632	$0	$0	$1,632	8h	0h	0h	0h	8h
42	Concrete Removal per 1000 ft2	4.2	$13,440	$0	$0	$13,440	33.6h	0h	0h	0h	33.6h

9 Boiler Demolition $46,392

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$3,388	$2,940	$0	$3,388	280h	0h	243h	0h	280h
15	769 Haul Truck	4	$9,888	$0	$0	$9,888	160h	0h	0h	0h	160h
16	988 Loader	1	$3,978	$0	$0	$3,978	40h	0h	0h	0h	40h
19	245 Excavator	1	$4,279	$0	$0	$4,279	40h	0h	0h	0h	40h
22	Mechanics	6	$4,620	$41,264	$0	$4,620	240h	0h	3182h	0h	240h
23	Small tools	2.4	$0	$15,910	$0	$0	0h	0h	0h	0h	0h
24	65 Ton Crane	1	$0	$9,620	$0	$0	0h	0h	208h	0h	0h
25	30 Ton Crane	1	$0	$1,400	$0	$0	0h	0h	35h	0h	0h
38	Boiler Maintenance Cost	7	$2,800	$0	$0	$2,800	280h	0h	0h	0h	280h
41	PC400 w/shear	1	$8,160	$0	$0	$8,160	40h	0h	0h	0h	40h
42	Concrete Removal per 1000 ft2	2.9	$9,280	$0	$0	$9,280	116h	0h	0h	0h	116h

10 Vanadium Oxidation Circuit Removal $15,805

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$1,356	$3,182	$0	$1,356	112h	0h	263h	0h	112h
15	769 Haul Truck	4	$3,956	$0	$0	$3,956	64h	0h	0h	0h	64h
16	988 Loader	1	$1,501	$0	$0	$1,501	16h	0h	0h	0h	16h
19	245 Excavator	1	$1,712	$0	$0	$1,712	16h	0h	0h	0h	16h
22	Mechanics	6	$1,848	$34,034	$0	$1,848	88h	0h	1768h	0h	88h
23	Small tools	0.96	$880	$8,840	$0	$880	1h	0h	781.45h	0h	1h
24	65 Ton Crane	1	$0	$9,620	$0	$0	0h	0h	208h	0h	0h
25	30 Ton Crane	1	$0	$2,280	$0	$0	0h	0h	55h	0h	0h
38	Boiler Maintenance Cost	7	$1,120	$0	$0	$1,120	112h	0h	0h	0h	112h
41	PC400 w/shear	1	$3,264	$0	$0	$3,264	16h	0h	0h	0h	16h

11 Main Shop/Warehouse $93,370

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$2,710	$0	$0	$2,710	224h	0h	0h	0h	224h

ID	Task Name	Total Cost

"Main Shop/Warehouse" continued

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	769 Haul Truck	4	$7,910	$0	$0	$7,910	128h	0h	0h	0h	128h
16	988 Loader	1	$3,182	$0	$0	$3,182	32h	0h	0h	0h	32h
19	245 Excavator	1	$3,423	$0	$0	$3,423	32h	0h	0h	0h	32h
22	Mechanics	6	$3,686	$0	$0	$3,686	192h	0h	0h	0h	192h
23	Small tools	1.92	$1,920	$0	$0	$1,920	15.37h	0h	0h	0h	15.37h
38	Butler Maintenance Cost	7	$2,240	$0	$0	$2,240	224h	0h	0h	0h	224h
41	PC400 w/shear	1	$6,520	$0	$0	$6,520	32h	0h	0h	0h	32h
42	Concrete Removal per 1000 ft2	19.3	$61,760	$0	$0	$61,760	617.6h	0h	0h	0h	617.6h

12 Office Building $82,427

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$2,033	$0	$0	$2,033	168h	0h	0h	0h	168h
15	769 Haul Truck	4	$5,933	$0	$0	$5,933	96h	0h	0h	0h	96h
16	988 Loader	1	$2,387	$0	$0	$2,387	24h	0h	0h	0h	24h
19	245 Excavator	1	$2,567	$0	$0	$2,567	24h	0h	0h	0h	24h
22	Mechanics	6	$2,772	$0	$0	$2,772	144h	0h	0h	0h	144h
23	Small tools	1.44	$1,440	$0	$0	$1,440	11.52h	0h	0h	0h	11.52h
38	Butler Maintenance Cost	7	$1,680	$0	$0	$1,680	168h	0h	0h	0h	168h
41	PC400 w/shear	1	$4,896	$0	$0	$4,896	24h	0h	0h	0h	24h
42	Concrete Removal per 1000 ft2	12.1	$38,720	$0	$0	$38,720	290.4h	0h	0h	0h	290.4h

13 Misc Tankage & Spare Parts $7,342

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$678	$0	$0	$678	56h	0h	0h	0h	56h
15	769 Haul Truck	4	$1,978	$0	$0	$1,978	32h	0h	0h	0h	32h
16	988 Loader	1	$796	$0	$0	$796	8h	0h	0h	0h	8h
19	245 Excavator	1	$856	$0	$0	$856	8h	0h	0h	0h	8h
22	Mechanics	6	$924	$0	$0	$924	48h	0h	0h	0h	48h
23	Small tools	0.46	$480	$0	$0	$480	1h	0h	0h	0h	1h
41	PC400 w/shear	1	$1,632	$0	$0	$1,632	8h	0h	0h	0h	8h

14 Mill Yard Decontamination $72,505

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$37,406	$66,380	$0	$37,406	257h	0h	480h	0h	257h
2	D8N Dozer w/ripper	1	$4,540	$8,262	$0	$4,540	65h	0h	123h	0h	65h
3	D7 Dozer	1	$3,872	$7,840	$0	$3,872	65h	0h	123h	0h	65h
5	651 Waterwagon	1	$4,924	$8,981	$0	$4,924	65h	0h	123h	0h	65h
6	14G Motorgrader	1	$3,224	$5,872	$0	$3,224	65h	0h	123h	0h	65h
10	Operators	9	$6,256	$13,915	$0	$6,256	517h	0h	1150h	0h	517h
16	966 Loader	1	$6,464	$11,765	$0	$6,464	65h	0h	123h	0h	65h
38	Butler Maintenance Cost	10	$5,820	$11,050	$0	$5,820	582h	0h	1105h	0h	582h

15 Ore Storage Pad Decontamination $53,991

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$27,500	$29,986	$0	$27,500	189h	0h	215h	0h	189h
2	D8N Dozer w/ripper	1	$3,352	$3,627	$0	$3,352	40h	0h	54h	0h	40h
3	D7 Dozer	1	$2,850	$3,085	$0	$2,850	40h	0h	54h	0h	40h
5	651 Waterwagon	1	$3,636	$3,890	$0	$3,636	40h	0h	54h	0h	40h
6	14G Motorgrader	1	$2,381	$2,578	$0	$2,381	40h	0h	54h	0h	40h

ID	Task Name	Total Cost

"Ore Storage Pad Decon/ ination" continued

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	9	$5,191	$5,880	$0	$5,191	429h	0h	486h	0h	429h
	988 Loader	1	$4,773	$5,166	$0	$4,773	48h	0h	54h	0h	48h
38	Butler Maintenance Cost	10	$4,290	$4,850	$0	$4,290	429h	0h	486h	0h	429h

16 Equipment Storage Area $19,468

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$10,043	$9,626	$0	$10,043	68h	0h	68h	0h	68h
2	D8N Dozer w/ripper	1	$1,187	$1,142	$0	$1,187	17h	0h	17h	0h	17h
3	D7 Dozer	1	$1,013	$974	$0	$1,013	17h	0h	17h	0h	17h
5	651 Waterwagon	1	$1,288	$1,227	$0	$1,288	17h	0h	17h	0h	17h
6	14G Motorgrader	1	$843	$812	$0	$843	17h	0h	17h	0h	17h
10	Operators	9	$1,863	$1,863	$0	$1,863	154h	0h	154h	0h	154h
16	988 Loader	1	$1,690	$1,626	$0	$1,690	17h	0h	17h	0h	17h
38	Butler Maintenance Cost	10	$1,540	$1,540	$0	$1,540	154h	0h	154h	0h	154h

17 Revegetate Mill Yard & Ore Pad $30,225

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$19,213	$27,902	$0	$19,213	132h	0h	200h	0h	132h
2	D8N Dozer w/ripper	1	$2,305	$3,360	$0	$2,305	33h	0h	50h	0h	33h
3	D7 Dozer	1	$1,966	$2,866	$0	$1,966	33h	0h	50h	0h	33h
6	14G Motorgrader	1	$1,637	$2,387	$0	$1,637	33h	0h	50h	0h	33h
10	Operators	7	$2,795	$4,235	$0	$2,795	231h	0h	350h	0h	231h
38	Butler Maintenance Cost	10	$2,310	$3,500	$0	$2,310	231h	0h	350h	0h	231h

18 Windblown Contamination $309,980

19 Scoping survey $29,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
43	Soil Samples per 100	1	$5,000	$0	$0	$5,000	1h	0h	0h	0h	1h
44	Survey crew	2	$9,400	$0	$0	$9,400	752h	0h	0h	0h	752h
46	Sample Crew	2	$14,600	$0	$0	$14,600	1168h	0h	0h	0h	1168h

20 Characterization Survey $37,800

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
43	Soil Samples per 100	4.72	$23,600	$0	$0	$23,600	1h	0h	0h	0h	1h
46	Sample Crew	2	$14,200	$0	$0	$14,200	1136h	0h	0h	0h	1136h

21 Final Status Survey $59,400

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
43	Soil Samples per 100	3	$15,000	$0	$0	$15,000	6d	0h	6d	0h	6d
46	Sample Crew	4	$44,400	$0	$0	$44,400	3552h	0h	0h	0h	3552h

22 Windblown Cleanup $183,780

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$98,974	$0	$0	$98,974	680h	0h	0h	0h	680h
2	D8N Dozer w/ripper	1	$11,873	$0	$0	$11,873	170h	0h	0h	0h	170h
3	D7 Dozer	1	$10,127	$0	$0	$10,127	170h	0h	0h	0h	170h
6	14G Motorgrader	1	$8,432	$0	$0	$8,432	170h	0h	0h	0h	170h

ID	Task Name	Total Cost

"Windblown Cleanup" continued

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	7	$14,380	$0	$0	$14,380	1190h	0h	0h	0h	1190h
38	Butler Maintenance Cost	7	$11,900	$0	$0	$11,900	1190h	0h	0h	0h	1190h
43	Soil Samples per 160	5	$25,000	$0	$0	$25,000	8.06h	0h	0h	0h	8.06h
44	Survey crew	2	$2,836	$0	$0	$2,836	163h	0h	0h	0h	163h
46	Sample Crew	2	$1,830	$0	$0	$1,830	83h	0h	0h	0h	83h

23 Quality Control $128,960

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
14	Quality contol contractor	6.5	$128,960	$0	$0	$128,960	2080h	0h	0h	0h	2080h

24 **RECLAMATION OF CELL 2** $1,736,862

25 Obtain Permit for Section 16 $50,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
11	Permits and Licences	50	$50,000	$10,000	$0	$50,000	4000h	0h	0h	0h	4000h

26 Place Remainder of Bridging Lift $61,854

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$32,603	$43,109	$0	$32,603	224h	0h	306h	0h	224h
2	D8N Dozer w/ripper	1	$3,911	$5,230	$0	$3,911	56h	0h	78h	0h	56h
3	D7 Dozer	1	$3,336	$4,470	$0	$3,336	56h	0h	78h	0h	56h
4	825 Compactor	1	$3,846	$5,118	$0	$3,846	56h	0h	78h	0h	56h
5	651 Waterwagon	1	$4,242	$5,632	$0	$4,242	56h	0h	78h	0h	56h
6	14G Motorgrader	1	$2,778	$3,724	$0	$2,778	56h	0h	78h	0h	56h
10	Operators	9	$6,098	$8,458	$0	$6,098	504h	0h	698h	0h	504h
38	Butler Maintenance Cost	10	$5,040	$6,980	$0	$5,040	504h	0h	698h	0h	504h

27 Place Lower Random Fill (12") $110,788

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$58,511	$80,218	$0	$58,511	402h	0h	576h	0h	402h
2	D8N Dozer w/ripper	1	$6,984	$9,672	$0	$6,984	100h	0h	144h	0h	100h
3	D7 Dozer	1	$5,957	$8,253	$0	$5,957	100h	0h	144h	0h	100h
4	825 Compactor	1	$6,867	$9,449	$0	$6,867	100h	0h	144h	0h	100h
5	651 Waterwagon	1	$7,575	$10,397	$0	$7,575	100h	0h	144h	0h	100h
6	14G Motorgrader	1	$4,980	$6,875	$0	$4,980	100h	0h	144h	0h	100h
10	Operators	9	$10,914	$15,670	$0	$10,914	902h	0h	1296h	0h	902h
38	Butler Maintenance Cost	10	$9,020	$12,960	$0	$9,020	902h	0h	1296h	0h	902h

28 Clay Layer $797,315

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$0	$138,952	$0	$0	0h	0h	996h	0h	0h
2	D8N Dozer w/ripper	1	$61,450	$16,726	$0	$61,450	880h	0h	240h	0h	880h
3	D7 Dozer	1	$0	$14,270	$0	$0	0h	0h	240h	0h	0h
4	825 Compactor	1	$60,430	$16,339	$0	$60,430	880h	0h	240h	0h	880h
5	651 Waterwagon	1	$66,660	$17,978	$0	$66,660	880h	0h	240h	0h	880h
6	14G Motorgrader	1	$43,648	$11,887	$0	$43,648	880h	0h	240h	0h	880h
7	988C Loader	1	$58,250	$0	$0	$58,250	880h	0h	0h	0h	880h
8	5000 gal water truck	1	$18,242	$9,836	$0	$18,242	440h	0h	240h	0h	440h
9	Highway Trucks (12yd)	8	$225,000	$0	$0	$225,000	7040h	0h	0h	0h	7040h

ID	Task Name	Total Cost

"Clay Layer" continued

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
16	Operators	13.5	$143,748	$30,129	$0	$143,748	11880h	0h	2489h	0h	11880h
38	Butler Maintenance Cost	10	$118,800	$24,900	$0	$118,800	11880h	0h	2489h	0h	11880h
39	Additional Clay per 10k yds	0	$0	$262,500	$0	$0	0h	0h	0h	0h	0h

29 Upper Random Fill $225,809

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$112,510	$123,048	$0	$112,510	773h	0h	882h	0h	773h
2	D8N Dozer w/ripper	1	$13,479	$14,845	$0	$13,479	193h	0h	221h	0h	193h
3	D7 Dozer	1	$11,407	$12,886	$0	$11,407	193h	0h	221h	0h	193h
4	825 Compactor	1	$13,253	$14,592	$0	$13,253	193h	0h	221h	0h	193h
5	651 Waterwagon	1	$14,620	$15,956	$0	$14,620	193h	0h	221h	0h	193h
6	14G Motorgrader	1	$9,573	$10,551	$0	$9,573	193h	0h	221h	0h	193h
8	5000 gal water truck	1	$8,002	$8,730	$0	$8,002	193h	0h	221h	0h	193h
10	Operators	10	$23,365	$26,741	$0	$23,365	1931h	0h	2210h	0h	1931h
38	Butler Maintenance Cost	10	$19,310	$22,100	$0	$19,310	1931h	0h	2210h	0h	1931h

30 Rock Armour on top $425,186

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$34,204	$10,324	$0	$34,204	235h	0h	74h	0h	235h
2	D8N Dozer w/ripper	1	$4,121	$1,276	$0	$4,121	58h	0h	18h	0h	58h
3	D7 Dozer	1	$3,515	$1,089	$0	$3,515	58h	0h	18h	0h	58h
4	825 Compactor	1	$4,062	$1,247	$0	$4,062	58h	0h	18h	0h	58h
5	651 Waterwagon	1	$4,489	$1,372	$0	$4,489	58h	0h	18h	0h	58h
6	14G Motorgrader	1	$2,926	$907	$0	$2,926	58h	0h	18h	0h	58h
10	Operators	13	$6,413	$8,034	$0	$6,413	530h	0h	664h	0h	530h
17	Rock Production Cost	68.4	$360,186	$0	$0	$360,186	3613.35h	0h	0h	0h	3613.35h
38	Butler Maintenance Cost	10	$5,300	$6,640	$0	$5,300	530h	0h	664h	0h	530h

31 Quality Control $65,100

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
14	Quality contol contractor	1	$65,100	$65,100	$0	$65,100	1050h	0h	1050h	0h	1050h

32 RECLAMATION OF CELL 3 $2,216,900

33 Dewatering of Cell 3 $30,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	Dewatering Costs	30	$30,000	$20,000	$0	$30,000	62400h	0h	20000h	0h	62400h

34 Lower Random Fill $263,983

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$130,146	$175,225	$0	$130,146	956h	0h	1258h	0h	956h
2	D8N Dozer w/ripper	1	$16,682	$21,159	$0	$16,682	239h	0h	315h	0h	239h
3	D7 Dozer	1	$14,237	$18,053	$0	$14,237	239h	0h	315h	0h	239h
4	825 Compactor	1	$16,412	$20,670	$0	$16,412	239h	0h	315h	0h	239h
5	651 Waterwagon	1	$18,104	$22,743	$0	$18,104	239h	0h	315h	0h	239h
6	14G Motorgrader	1	$11,854	$15,038	$0	$11,854	239h	0h	315h	0h	239h
10	Operators	9	$26,027	$34,255	$0	$26,027	2151h	0h	2831h	0h	2151h
38	Butler Maintenance Cost	10	$21,510	$28,310	$0	$21,510	2151h	0h	2831h	0h	2151h

ID	Task Name	Total Cost
35	Lower Random Fill (12")	$214,880

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$113,082	$80,776	$0	$113,082	777h	0h	579h	0h	777h
2	D8N Dozer w/ripper	1	$13,619	$9,740	$0	$13,619	195h	0h	145h	0h	195h
3	D7 Dozer	1	$11,616	$8,310	$0	$11,616	195h	0h	145h	0h	195h
4	825 Compactor	1	$13,301	$9,515	$0	$13,301	195h	0h	145h	0h	195h
5	651 Waterwagon	1	$14,771	$10,460	$0	$14,771	195h	0h	145h	0h	195h
6	14G Motorgrader	1	$9,672	$6,922	$0	$9,672	195h	0h	145h	0h	195h
10	Operators	10	$21,190	$15,778	$0	$21,190	1752h	0h	1304h	0h	1752h
38	Butler Maintenance Cost	10	$17,520	$13,040	$0	$17,520	1752h	0h	1304h	0h	1752h

ID	Task Name	Total Cost
36	Clay Layer	$857,151

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$0	$147,323	$0	$0	0h	0h	1056h	0h	0h
2	D8N Dozer w/ripper	1	$71,376	$17,733	$0	$71,376	1022h	0h	264h	0h	1022h
3	D7 Dozer	1	$0	$15,130	$0	$0	0h	0h	264h	0h	0h
4	825 Compactor	1	$70,181	$17,324	$0	$70,181	1022h	0h	264h	0h	1022h
5	651 Waterwagon	1	$77,417	$19,061	$0	$77,417	1022h	0h	264h	0h	1022h
6	14G Motorgrader	1	$50,891	$12,683	$0	$50,891	1022h	0h	264h	0h	1022h
7	988C Loader	0	$0	$0	$0	$0	0h	0h	0h	0h	0h
8	5000 gal water truck	1	$21,186	$10,428	$0	$21,186	511h	0h	264h	0h	511h
9	Highway Trucks (12yd)	8	$261,387	$0	$0	$261,387	8176h	0h	0h	0h	8176h
10	Operators	13.5	$166,944	$31,944	$0	$166,944	13797h	0h	2640h	0h	13797h
38	Butler Maintenance Cost	10	$137,970	$26,400	$0	$137,970	13797h	0h	2640h	0h	13797h
39	Additional Clay per 10k yds	0	$0	$262,560	$0	$0	0h	0h	2983.2h	0h	0h

ID	Task Name	Total Cost
37	Upper Random Fill	$259,732

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$136,963	$124,164	$0	$136,963	941h	0h	890h	0h	941h
2	D8N Dozer w/ripper	1	$16,412	$14,879	$0	$16,412	235h	0h	223h	0h	235h
3	D7 Dozer	1	$13,990	$12,700	$0	$13,990	235h	0h	223h	0h	235h
4	825 Compactor	1	$16,137	$14,633	$0	$16,137	235h	0h	223h	0h	235h
5	651 Waterwagon	1	$17,801	$16,101	$0	$17,801	235h	0h	223h	0h	235h
6	14G Motorgrader	1	$11,656	$10,646	$0	$11,656	235h	0h	223h	0h	235h
10	Operators	9	$25,604	$24,285	$0	$25,604	2116h	0h	2007h	0h	2116h
38	Butler Maintenance Cost	10	$21,160	$20,070	$0	$21,160	2116h	0h	2007h	0h	2116h

ID	Task Name	Total Cost
38	Rock Armour	$503,081

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$40,463	$10,324	$0	$40,463	278h	0h	74h	0h	278h
2	D8N Dozer w/ripper	1	$4,869	$1,276	$0	$4,869	70h	0h	19h	0h	70h
3	D7 Dozer	1	$4,170	$1,089	$0	$4,170	70h	0h	19h	0h	70h
4	825 Compactor	1	$4,807	$1,247	$0	$4,807	70h	0h	19h	0h	70h
5	651 Waterwagon	1	$5,303	$1,372	$0	$5,303	70h	0h	19h	0h	70h
6	14G Motorgrader	1	$3,472	$4,774	$0	$3,472	70h	0h	100h	0h	70h
10	Operators	13	$7,590	$8,900	$0	$7,590	626h	0h	743h	0h	626h
17	Rock Production Cost	82.1	$426,090	$0	$0	$426,090	5747h	0h	0h	0h	5747h
38	Butler Maintenance Cost	10	$6,290	$7,430	$0	$6,290	626h	0h	743h	0h	626h

ID	Task Name	Total Cost
39	Quality Control	$87,172

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
14	Quality contol contractor	1	$87,172	$87,172	$0	$87,172	1408h	0h	1408h	0h	1408h

ID	Task Name	Total Cost
40	RECLAMATION OF CELL 1	$738,371
41	Dewatering	$30,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	Dewatering Costs	30	$30,000	$0	$0	$30,000	62400h	0h	0h	0h	62400h

ID	Task Name	Total Cost
42	Crystal Removal	$500,992

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
2	D8N Dozer w/ripper	1	$37,644	$48,698	$0	$37,644	539h	0h	725h	0h	539h
3	D7 Dozer	1	$32,168	$29,746	$0	$32,168	538h	0h	362h	0h	538h
5	651 Waterwagon	1	$40,829	$26,136	$0	$40,829	538h	0h	362h	0h	538h
6	14G Motorgrader	1	$26,734	$17,282	$0	$26,734	538h	0h	362h	0h	538h
10	Operators	10	$65,219	$74,524	$0	$65,219	5380h	0h	6150h	0h	5380h
15	789 Haul Truck	4	$133,303	$171,836	$0	$133,303	2157h	0h	2898h	0h	2157h
16	988 Loader	1	$53,598	$89,346	$0	$53,598	538h	0h	725h	0h	538h
19	245 Excavator	1	$57,657	$74,530	$0	$57,657	538h	0h	725h	0h	538h
38	Butler Maintenance Cost	10	$53,900	$28,980	$0	$53,900	5380h	0h	2898h	0h	5380h

ID	Task Name	Total Cost
43	Contaminated Materials Removal	$71,771

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$44,829	$0	$0	$44,829	308h	0h	0h	0h	308h
2	D8N Dozer w/ripper	1	$5,378	$24,316	$0	$5,378	77h	0h	362h	0h	77h
5	651 Waterwagon	1	$5,633	$13,068	$0	$5,633	77h	0h	181h	0h	77h
6	14G Motorgrader	1	$3,819	$8,641	$0	$3,819	77h	0h	181h	0h	77h
10	Operators	10	$6,522	$37,244	$0	$6,522	538h	0h	3078h	0h	538h
38	Butler Maintenance Cost	10	$5,390	$30,780	$0	$5,390	538h	0h	3078h	0h	538h

ID	Task Name	Total Cost
44	Topsoil Application	$35,994

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	637 scraper	4	$22,415	$0	$0	$22,415	154h	0h	0h	0h	154h
2	D8N Dozer w/ripper	1	$2,724	$24,316	$0	$2,724	38h	0h	362h	0h	38h
5	651 Waterwagon	1	$2,954	$13,068	$0	$2,954	38h	0h	181h	0h	38h
6	14G Motorgrader	1	$1,934	$8,641	$0	$1,934	38h	0h	181h	0h	38h
10	Operators	10	$3,267	$37,244	$0	$3,267	270h	0h	3078h	0h	270h
38	Butler Maintenance Cost	10	$2,700	$30,780	$0	$2,700	270h	0h	3078h	0h	270h

ID	Task Name	Total Cost
45	Construct Channels	$1,092

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
2	D8N Dozer w/ripper	1	$419	$403	$0	$419	6h	0h	6h	0h	6h
10	Operators	1	$73	$73	$0	$73	6h	0h	6h	0h	6h
38	Butler Maintenance Cost	10	$600	$600	$0	$600	60h	0h	60h	0h	60h

ID	Task Name	Total Cost
46	Rock Protection	$24,990

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
3	D7 Dozer	1	$894	$860	$0	$894	15h	0h	15h	0h	15h
5	651 Waterwagon	1	$1,136	$1,093	$0	$1,136	15h	0h	15h	0h	15h

ID	Task Name	Total Cost

"Rock Protection" continued

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	14G Motorgrader	1	$744	$716	$0	$744	15h	0h	15h	0h	15h
10	Operators	6	$1,428	$1,428	$0	$1,428	118h	0h	118h	0h	118h
15	769 Haul Truck	4	$3,584	$3,441	$0	$3,584	58h	0h	58h	0h	58h
16	988 Loader	1	$1,482	$1,435	$0	$1,482	15h	0h	15h	0h	15h
17	Rock Production Cost	2.8	$14,532	$35,756	$0	$14,532	32h	0h	32h	0h	32h
38	Butler Maintenance Cost	10	$1,180	$1,180	$0	$1,180	118h	0h	118h	0h	118h

47 Quality Control $73,532

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
14	Quality contol contractor	1	$73,532	$73,532	$0	$73,532	1186h	0h	1186h	0h	1186h

48 CELL 4A WORK $114,786

49 Dewatering $5,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	Dewatering Costs	5	$5,000	$5,000	$0	$5,000	200h	0h	200h	0h	200h

50 Remove Fencing $1,936

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	4	$1,936	$1,936	$0	$1,936	160h	0h	160h	0h	160h

51 Remove Liner to Cell 3 $87,670

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	3	$10,980	$13,262	$0	$10,980	908h	0h	1096h	0h	908h
15	769 Haul Truck	2	$37,451	$32,513	$0	$37,451	606h	0h	540h	0h	606h
16	988 Loader	1	$30,130	$13,164	$0	$30,130	303h	0h	137h	0h	303h
38	Butler Maintenance Cost	10	$9,080	$10,980	$0	$9,080	908h	0h	1098h	0h	908h

52 Quality Control $20,150

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
14	Quality contol contractor	6.3	$20,150	$20,150	$0	$20,150	325h	0h	325h	0h	325h

53 MISCELLANEOUS ITEMS $2,630,336

54 Long Term Care Fund Allowance $585,300

ID	Resource Name	Units	Cost	Baseline Cost	[illegible]ost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
21	Long Term Care Fund	58.53	$585,300	$551,200	$0	$585,300	1h	0h	0h	0h	1h

55 Butler Machinery Mobilization $131,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
26	Mobilization per 10k dollars	13.1	$131,000	$131,000	$0	$131,000	0h	0h	0h	0h	0h

56 Temporary Office Facilities $97,500

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
46	Office trailers(Technical)	5	$97,500	$0	$0	$97,500	31200h	0h	0h	0h	31200h

ID	Task Name	Total Cost
57	Wheel Wash Facilities	$150,672

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
10	Operators	2	$100,672	$0	$0	$100,672	8320h	0h	0h	0h	8320h
18	Wheelwash costs	10	$50,000	$0	$0	$50,000	80h	0h	0h	0h	80h

ID	Task Name	Total Cost
58	**Managerial Support**	**$1,866,863**
59	Manager/Engineer	$360,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
27	Manager/Engineer	1	$360,000	$280,731	$0	$360,000	6240h	0h	4866h	0h	6240h

ID	Task Name	Total Cost
60	Radiation Safety Officer	$225,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
28	Radiation Safety Officer	1	$225,000	$175,457	$0	$225,000	6240h	0h	4866h	0h	6240h

ID	Task Name	Total Cost
61	Secretary	$90,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
29	Secretary	1	$90,000	$70,183	$0	$90,000	6240h	0h	4866h	0h	6240h

ID	Task Name	Total Cost
62	Clerk	$58,486

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
30	Clerk	1	$58,486	$58,486	$0	$58,486	4866h	0h	4866h	0h	4866h

ID	Task Name	Total Cost
63	Environmental Technician	$93,577

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
32	Environmental Technician	1	$93,577	$93,577	$0	$93,577	4866h	0h	4866h	0h	4866h

ID	Task Name	Total Cost
64	Maintenance Foreman	$165,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
33	Maintenance Foreman	1	$165,000	$55,000	$0	$165,000	6240h	0h	2080h	0h	6240h

ID	Task Name	Total Cost
65	Chemist	$45,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
36	Chemist	1	$45,000	$45,000	$0	$45,000	2080h	0h	2080h	0h	2080h

ID	Task Name	Total Cost
66	Security	$180,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	Security Personnel	3	$180,000	$110,586	$0	$180,000	18720h	0h	11502h	0h	18720h

ID	Task Name	Total Cost
67	Safety Engineer	$80,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
35	Safety Engineer	1	$80,000	$40,000	$0	$80,000	4160h	0h	2080h	0h	4160h

ID	Task Name	Total Cost
68	Misc Materials and Supplies	$234,000

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
37	Misc Supplies	1	$234,000	$182,475	$0	$234,000	6240h	0h	4866h	0h	6240h

ID	Task Name	Total Cost
69	Health Physics Costs (Mill Decom)	$134,800

ID	Resource Name	Units	Cost	Baseline Cost	Act. Cost	Rem. Cost	Work	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	Health Physics Program Costs	1	$134,800	$112,000	$0	$134,800	2080h	0h	1760h	0h	2080h

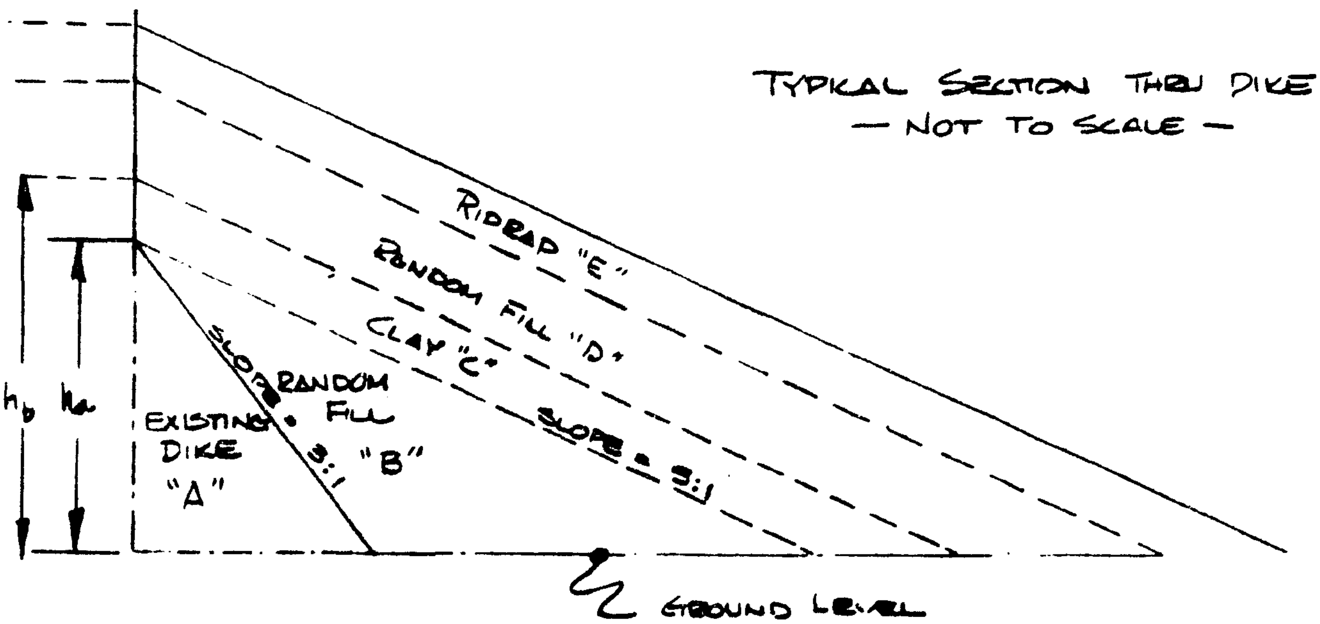
ID	Task Name	Total Cost
70	ProjectCompletion	$0
		$8,910,823

NE/PROJECT WHITE MESA RECL .... Date .... Calc by .... Sheet ..... of .....

CALCULATION OF SLOPE VOLUMES

Slope No.		Height feet	Length feet	EXISTING DIKE "A"		WEDGE "B"		CLAY "C"		RANDOM FILL "D"		RIPRAP "E"	
				AREA	VOL (YD)	AREA	VOL (YD)	AREA	VOL (YD)	AREA	VOL (YD)	AREA	VOL (YD)
1	Cell 2 North dike	12	2,600	216.0	20,800	144.0	13,867	62.5	6,019	140.0	13,481	77.5	7,463
2	Cell 2 North Dike	1	900	1.5	50	1.0	33	7.5	250	30.0	1,000	22.5	750
3	Cell 2 West Dike	2	500	6.0	111	4.0	74	12.5	231	40.0	741	27.5	509
4	Cell 2 East Dike	1	1,250	1.5	69	1.0	46	7.5	347	30.0	1,389	22.5	1,042
5	Cell 2 South Dike	3	3,500	0.0	0	9.0	1,167	17.5	2,269	50.0	6,481	32.5	4,213
6	Cell 3 West Dike	2	1,100	6.0	244	4.0	163	12.5	509	40.0	1,630	27.5	1,120
7	Cell 3 South Dike	16	1,750	384.0	24,889	256.0	16,593	82.5	5,347	180.0	11,667	97.5	6,319
8	Cell 3 South Dike	39	1,700	2,281.5	143,650	1,521.0	95,767	197.5	12,435	410.0	25,815	212.5	13,380
9	Cell 3 East Dike	6	800	54.0	1,600	36.0	1,067	32.5	963	80.0	2,370	47.5	1,407
10	Cell 4 West dike	23	1,200	793.5	35,267	529.0	23,511	117.5	5,222	250.0	11,111	132.5	5,889
11	Cell 4 South Dike	31	1,400	1,441.5	74,744	961.0	49,830	157.5	8,167	330.0	17,111	172.5	8,944
12	Cell 4 East Dike	14	1,300	294.0	14,156	196.0	9,437	72.5	3,491	160.0	7,704	87.5	4,213
	Total Material Requirements		18,000		315,581		211,554		45,250		100,500		55,250

NOTE:
Values shown in the "Area" column are the CROSS SECTIONAL AREA for the component in SQUARE FEET.
Values shown in the "Volume" column are the component's area x length converted to CUBIC YARDS.



AREA 'A' = $[h_a * 3h_a] / 2$

AREA 'B' $\{[h_b * 5h_b]/2\}$ − Area A

AREA "C" = $\{[h_c * 5h_c]/2\} - \{[h_b * 5h_b]/2\}$

IE/PROJECT .... Date .... Calc by .... Sheet ..... of ......

ROCK PRODUCTION COSTS

1) ASSUMPTIONS

- ALL ROCK NECESSARY FOR ARMOUR WILL BE SANDSTONE FROM LOCAL SOURCES
- OVERSIZE FROM RANDOM FILL STOCKPILES TO THE WEST OF TAILS WILL BE PROCESSED TO PROVIDE RIP-RAP
- FALL-BACK POSITION WOULD BE TO MINE (QUARRY) DAKOTA SS ON SITE.
- FOR PURPOSES OF THIS ESTIMATE, ALL ROCK COSTS WILL BE THE SAME
- ROCK WILL BE PRODUCED DURING HANDLING OF RANDOM FILL AND WILL BE STOCKPILED
- ONLY PIECE OF MOBILE EQUIPMENT WILL BE A FULL TIME FEL (980 OR EQUIV) FOR HANDLING & STOCKPILE
- WILL UTILIZE :
  - 35"x46" JAW CRUSHER W/ VIBRATING ~~[illegible]~~ FEEDER
  - 5'x16' OVERHEAD VIBRATING SCREEN
  - 3 OPERATORS.
- PRODUCTION WILL BE 50 yd^3/hr.

2) COSTS

CRUSHER/FEEDER	=	\$110.00/hr
SCREEN PLANT	=	\$48.00/hr
LOADER	=	\$65.00/hr.
OPERATORS	=	\$36.30/hr
		\$259.30/hr

Therefore \$259.30 ÷ 50 yd^3/hr = **\$5.19/yd^3**

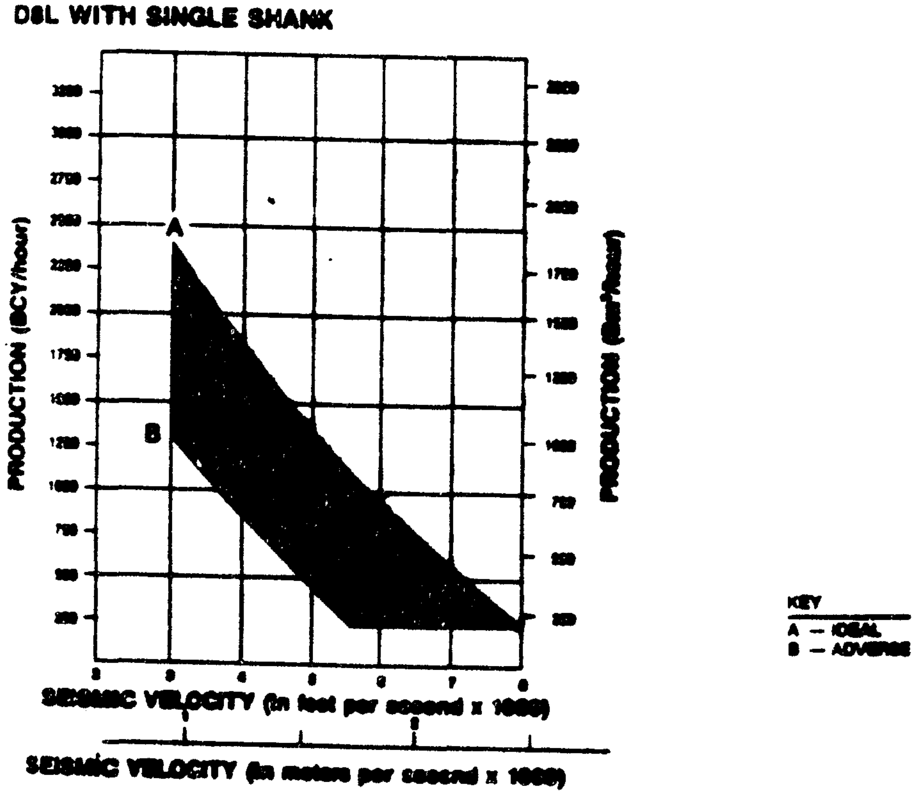
or **\$5,190 / 1000 yd^3**

E/PROJECT WHITE MESA BELL Date .... Calc by .... Sheet ..... of ....

CLAY PRODUCTION COSTS
– SECTION 16 SOURCE –

1). CLAY PRODUCTION

- CLAYS WILL BE RIPPED FROM SOURCE @ SECTION 16
- APPROX 400 VERTICAL FEET OF BRUSHY BASIN EXPOSURE
- FROM CAT HAND BOOK ...
  MAX SEISMIC VELOCITY OF CLAY ≥ 6000 ft/sec



- BASED ON THE ABOVE, D8 CAT SHOULD BE ABLE TO PRODUCE AT LEAST 250 BCY / HOUR WITH AN AVERAGE OF -

  500 BCY/HR

- WE WILL ASSUME THAT THE CAT IS UTILIZED EVERY DAY OF CLAY PRODUCTION FOR RIPPING AND OR DOZING / BLENDING / PREPARATION.

CLAY PRODUCTION COSTS
— SECTION 16 SOURCE —

1) CLAY PRODUCTION [CONTINUED]

DAILY COST =

D8 DOZER - $67.17/hr for 8 hours
= **$537.36/day**

LABOR = $12.00/hr for 8 hours
= **$96.00/day**

TOTAL = $634.00/day
say **$650/day**

ASSUME 8 haul units × 136 yd³/day each = 1088 yd³/day

$\frac{\$650}{1088}$ = **$0.60/yd³**

E/PROJECT White Mesa Rel Date .... Calc by .... Sheet ..... of .....

CLAY PRODUCTION COSTS
SECTION 16 SOURCE

2) HAULAGE FROM SECTION 16 TO TAILINGS CELLS.

- HAUL PROFILE FROM SEC 16

#	SEGMENT LENGTH	GRADE
1	2000'	4.0%
2	1,800'	11.0%
3	4,200'	1.8%
4	5,600'	0.5%
5	5,700'	1.4%
6	5,200'	0.8%
TOTAL	24,500'	

= 4.6 MILE TRIP, 9.2 MILE ROUND TRIP

- FROM MEANS (22-266-1250) HAULAGE FOR A 10 MILE ROUND TRIP WILL YIELD AN EFFICIENCY OF 136 YD/DAY/UNIT
- UNIT IS ASSUMED TO BE A 40 TON TRACTOR w/ 20 YD^3 TRAILER
- UTILIZE MEANS EQUIPMENT COST, BUT ADJUST LABOR

MEANS ESTIMATE BASED ON \$20.70 /hour
LOCAL DAVIS-BACON RATE (DOE) = \$12.10 /hour

Therefore LABOR NEEDS TO BE REDUCED BY

$$\frac{12.10}{20.70} = 0.58$$

Therefore HAULAGE COST = $\frac{\$1.22}{yd}$ x 0.58 = \$0.71/yd^3 for LABOR

3.83/yd^3 for EQUIP

\$4.54/yd^3 total

CLAY PRODUCTION COSTS
SECTION 16 SOURCE

3) LOADING @ SECTION 16
- ASSUME USE OF 980 LOADERS
- BASED ON BUTLER MACHINERY COSTS, RATE = $64.71 /hr.
- FROM MEANS (22-238-1650) EFFICIENCY = 185 yd^3/hr
- BASED ON 8 TRUCK HAULAGE SPREAD

Therefore:

AVERAGE DAILY PRODUCTION = $\frac{136 yd^3}{\text{UNIT DAY}} \times \frac{8 \text{ UNITS}}{1} = \boxed{\frac{1,088 yd^3}{day}}$

DIRECT LOADING COST:

LABOR → $12.10/hr * 8hr =		$96.80
EQUIP → 64.71/hr * 8hr =		517.68
	TOTAL	614.48

$\frac{\$614.88}{1 \text{ day}} \times \frac{1 \text{ day}}{1088 yd^3} = \boxed{\$0.56/yd^3}$

4) ROAD MTCE FROM SECTION 16 to TAILS AREA

ASSUME:
- 16G MAINTAINER 4 HOURS/DAY
- 5000 GAL H_2O TRUCK 4 HOURS/DAY

= [16G @ 70.06/hr × 4 hr] + [5000 gal Truck @ 39.50/hr × 4 hr]

= $280 + 158

= $438 /day

plus LABOR AT $97.00/day

= $535.00/day for 1088 yd^3

$\boxed{= \$0.49/yd^3}$

[illegible], INC

E/PROJECT White Mesa Rec Date .... Calc by RVA .... Sheet .... of ....

CLAY COSTS

5) PLACEMENT COSTS

ASSUME FOLLOWING EQUIPMENT SPREAD

825 C COMPACTOR	\$65.62/HOUR	8 HR/DAY
16G MAINTAINER	\$70.06/HR	8 HR/DAY
651 WATER WAGON	\$72.20/HR	8 HR/DAY
3 OPERATORS	\$12.10/HR	8 HR/DAY

DAILY COSTS ...

	EQUIPMENT	LABOR	TOTAL
COMPACTOR	\$525	\$97	\$622
MAINTAINER	\$560	\$97	\$657
651 H_2O WAGON	\$578	\$97	\$675

= \$1954/day

or over 1088 yd^3/day = **\$1.80/yd^3**

E/PROJECT........ Date........ Calc by........ Sheet.... of....

CLAY COSTS.

6) SUMMARY OF COSTS @ 1088 yd³/day rate

CLAY PRODUCTION	$/day	$/yd
RIPPING	$650	$0.60
LOADING	$615	$0.56
HAULAGE	$4,940	$4.54
ROAD MTCE	$535	$0.49
CLAY PLACEMENT		
GRADING	$657	$0.60
H_2O CONTENT	$675	$0.62
COMPACTION	$622.	$0.57
	$8694	$7.98/yd³

7). SUMMARY OF CLAY REQUIREMENTS

	YD³	DAYS	HOURS
CELL 2 TOP	110,700	102	816
CELL 2 SIDESLOPES	9,116	8	64
CELL 3 TOP	119,800	110	880
CELL 3 SLOPES	19,254	18	142
TOTALS	258,870	238	1902

PROJECT WHITE MESA BCL Date .... Calc by .... Sheet ...... of ......

CLAY PRODUCTION COSTS (CHECK CALCULATION)

- ASSUME USE OF MEANS HEAVY CONSTRUCTION COSTS ADJUSTED FOR PREVAILING LABOR RATES (DAVIS-BACON)

MEANS → 20.70 /hr
DB → 12.10 /hr
∴ **58% of MEANS**

DESCRIP.	MEANS No	L	Adjusted	EQUIPMENT	TOTAL
RIPPING	22-242-5040	0.28	0.16	1.08	1.24
LOADING	22-238-1650	0.19	0.11	0.61	0.72
HAULAGE	22-266-1250	1.22	0.71	3.83	4.54
			total		**6.50/yd³**

12/96

EQUIPMENT COSTS - NEW FUEL & EQUIP RENTAL

	RATE		MTCE	FUEL	FUEL @	TOTAL
	MONTHLY	HOURLY	EXPENDABLES	USAGE	$0.86	COST
637E Scraper	21,630	122.90	2.01	24.0	20.64	145.55
D8N Dozer	10,815	61.45	1.08	8.5	7.31	69.84
D7H Dozer	9,270	52.67	0.88	7.0	6.02	59.57
825C Compactor	9,785	55.60	1.03	14.0	12.04	68.67
980 F Loader	10,300	58.52	1.08	9.0	7.74	67.34
988 F Loader	15,450	87.78	1.34	12.0	10.32	99.44
769C Haul Truck	9,270	52.67	1.39	9.0	7.74	61.80
245B Excavator	16,480	93.64	1.29	14.0	12.04	106.96
651 Water Wagon	10,300	58.52	1.75	18.0	15.48	75.75
5000 gal Water Truck	5,665	32.19	0.67	10.0	8.60	41.46
14G Maintaniner	7,725	43.89	0.98	5.5	4.73	49.60
16G Maintainer	11,330	64.38	1.13	8.5	7.31	72.82

11/96

EQUIPMENT COSTS WITH 3% INCREASE

	RATE		MTCE	FUEL	FUEL @	TOTAL
	MONTHLY	HOURLY	EXPENDABLES	USAGE	$0.76	COST
637E Scraper	21,630	122.90	2.01	24.0	18.24	143.15
D8N Dozer	10,815	61.45	1.08	8.5	6.46	68.99
D7H Dozer	9,270	52.67	0.88	7.0	5.32	58.87
825C Compactor	9,785	55.60	1.03	14.0	10.64	67.27
980 F Loader	10,300	58.52	1.08	9.0	6.84	66.44
988 F Loader	15,450	87.78	1.34	12.0	9.12	98.24
769C Haul Truck	9,270	52.67	1.39	9.0	6.84	60.90
245B Excavator	16,480	93.64	1.29	14.0	10.64	105.56
651 Water Wagon	10,300	58.52	1.75	18.0	13.68	73.95
5000 gal Water Truck	5,665	32.19	0.67	10.0	7.60	40.46
14G Maintaniner	7,725	43.89	0.98	5.5	4.18	49.05
16G Maintainer	11,330	64.38	1.13	8.5	6.46	71.97

WEESE PETROLEUM
BOX 888
DOVE CREEK, COLORADO 81324
970-677-2424
NOVEMBER 25, 1996

ENERGY FUELS
ATTENTION: RICK VANHORTON

IE: BID PRICE OF DIESEL FUEL DELIVERED TO BLANDING, UTAH

#2 DIESEEL FUEL	\$.8143
FREIGHT	\$.0425
	\$.8559

#1 DIESEL FUEL	\$.9143
FREIGHT	\$.0425
	\$.9559

PRICE SUBJECT TO CHANGES WITH RACK PRICES

RECEIVED
NOV 26 1996
R.A. VAN HO

RECEIVED
26 1996
R.A. VAN HORN

DATE: 11-26-96

TO: Jim Fisher

FAX #: 1-970-677-2747

FROM: Johnny Dufur) Sierra Petroleum INC

COMMENTS: #2 Red DSL Delivered TO Blanding Mill site Price PR GAL .8418 Plus UTAH EXT .0050 Total Price .8468

Thanks Johnny

[illegible]
Cost Estimate

MINE/PROJECT White Mesa Reclamation Date 6/21/95 Calc by R Van Horn Sheet ____ of ____

EQUIPMENT OPERATING COSTS INCLUDING FUEL CONSUMPTION

Based on the Butler Machinery Quote of 5/8/95, EFNI is responsible for:

- Tires
- Ground Engaging Components (GEC)
- Fuel

Based on the length of the project, EFNI would qualify for a 15% discount off of the quoted Butler rates. This analysis assumes that the discount, when taken with no credit for the lower overtime rates, will more than offset the tire and GEC costs. Fuel consumption (shown in gal/hr) has been added at rates quoted in the area for off-road diesel fuels.

	RATE		MTCE	FUEL	FUEL @	TOTAL
	MONTHLY	HOURLY	EXPENDABLES	USAGE	$0.76	COST
631E Scraper	21,000	119.32	1.95	24.0	18.24	139.51
D8N Dozer	10,500	59.66	1.05	8.5	6.46	67.17
D7H Dozer	9,000	51.14	0.85	7.0	5.32	57.31
825C Compactor	9,500	53.98	1.00	14.0	10.64	65.62
980 F Loader	10,000	56.82	1.05	9.0	6.84	64.71
988 F Loader	15,000	85 23	1.30	12.0	9.12	95.65
769C Haul Truck	9,000	51.14	1.35	9.0	6.84	59.33
245B Excavator	16,000	90.91	1.25	14.0	10.64	102.80
651 Water Wagon	10,000	56.82	1.70	18.0	13.68	72.20
5000 gal Water Truck	5,500	31.25	0.65	10.0	7.60	39.50
14G Maintaniner	7,500	42.61	0.95	5.5	4.18	47.74
16G Maintainer	11,000	62.50	1.10	8.5	6.46	70.06

Fuel consumption is based on the Cat Performance Handbook using medium load factors

WEESE PETROLEUM
BOX 888
DOVE CREEK, COLORADO 81324
970-677-2424

ENERGY FUELS
BID PRICE TO BLANDING, UTAH

45000 GALLONS RED DIESEL

$.7521 PER GALLON PER TRANSPORT

PRICE IS SUBJECT TO CHANGE WITH INCREASE OR DECREASE OF RACK PRICE.
EFFECTIVE JUNE 22, 1995 TO JUNE 22, 1998.

THANK YOU.

SINCERELY,

Constance L. Weese

CONSTANCE L. WEESE

FAX TRANSMISSION

BUTLER MACHINERY COMPANY
1351 PAGE DRIVE, PO BOX 9559
FARGO ND 58106
800-873-8858
701-298-1727
FAX: 701-298-1717

RECEIVED
NOV 22 1996
R.A. VAN HORN

To: RICK VAN HORN
ENERGY FUELS

Date: November 22, 1996

Fax #:

Pages: 1, including this cover sheet.

From: JOEL NIKLE

COMMENTS:

RICK:

PER OUR TELEPHONE CONVERSATION YESTERDAY REFERENCE OUR PROPOSAL DATED MAY 8, 1995, BUTLER MACHINERY COMPANY AGREES TO A 3% INCREASE FOR ALL RATES QUOTED.

THESE NEW RATES WOULD BE VALID UNTIL THE END OF 1996.

IF YOU HAVE ANY QUESTIONS, PLEASE GIVE ME A CALL.

SINCERELY,

BUTLER MACHINERY COMPANY

JOEL NIKLE
RENTAL FLEET MANAGER

JN:jw

Butler CAT

Butler Machinery Co.
1351 Page Drive
PO Box 9559
Fargo, ND 58106
(701) 232-0033
FAX (701) 298-1717

FAX TRANSMISSION NOTE

DATE: May 8, 1995

TO: Mr. Rick Van Horn

FROM: Joel Nikle

NUMBER OF PAGES 5 (INCLUDING THIS PAGE)

IN CASE OF PROBLEM, CALL: Joel (701) 232-0033

( ) IF CHECKED, PLEASE CONFIRM RECEIPT OF DOCUMENT.

COMMENTS:

CAT

Butler Machinery Company • (701) 232-0033 • FAX (701) 280-1717 • 1351 Page Dr. • Box 9559 • Fargo, ND 58106

MAY 8, 1995

ENERGY FUELS NUCLEAR, INC.
ATTN: RICK VAN HORN
2764 COMPASS DRIVE, SUITE 101
GRAND JUNCTION, CO 81506

DEAR RICK:

THANK YOU FOR THE INVITATION TO QUOTE ENERGY FUELS NUCLEAR, INC. (EFNI) THE EQUIPMENT NEEDED FOR THEIR MINING PROJECT IN BLANDING, UTAH. BUTLER MACHINERY COMPANY (BUTLER) RESPECTFULLY SUBMITS OUR PROPOSAL FOR A MAINTAINED FLEET OF CATERPILLAR MACHINES.

LISTED ON ATTACHMENT A, YOU WILL FIND THE MODELS, QUANTITIES, MONTHLY RENTAL RATES, HOURS ALLOWED PER MONTH, EXCESS HOUR CHARGE, GUARANTEED NUMBER OF MONTHS RATES ARE BASED UPON, TOTAL FREIGHT CHARGES AND THE MAINTENANCE RATE PER HOUR FOR MATERIALS ONLY.

ALL RATES SHOWN ON ATTACHMENT A DO NOT INCLUDE ANY STATE, LOCAL, PROPERTY OR ANY OTHER TAXES THAT MAY BE APPLICABLE.

RATES ARE BASED UPON ELECTRIC HOUR METER READINGS WHICH ARE ATTACHED TO THE DASH OF EACH MACHINE. RATES ARE BASED ON 176 HOURS OF USE EACH MONTH. EXCESS HOUR CHARGES, IF ANY, WILL BE CALCULATED AND INVOICED AT THE END OF THE PROJECT. THERE WOULD BE NO CREDIT ISSUED FOR ANY HOURS UNDER THE ALLOWED DURING THE TERM OF THIS PROPOSAL. IF EFNI ELECTS TO DOUBLE SHIFT MACHINES, THEN BUTLER WOULD INVOICE THOSE HOURS AT THE END OF EACH MONTH. (TO FIGURE THE DOUBLE SHIFT RATES, TAKE THE EXCESS HOUR RATE SHOWN ON ATTACHMENT A TIMES THE NUMBER OF HOURS).

RATES ARE BASED UPON A MINIMUM GUARANTEE OF 3 MONTHS AND A PACKAGE DEAL. IF EFNI WERE TO GUARANTEE A LONGER RENTAL TERM FOR ALL MACHINES LISTED ON ATTACHMENT A, THEN BUTLER WOULD ALLOW THE FOLLOWING ADDITIONAL DISCOUNTS ON THE MONTHLY RENTAL RATES AND EXCESS HOUR CHARGES RETROACTIVE TO DAY ONE: 1. FOR A MINIMUM OF 6 MONTHS RENT, DEDUCT 5%. 2. FOR A MINIMUM OF 9 MONTHS RENT, DEDUCT 10%, OR 3. FOR A MINIMUM OF 12 MONTHS RENT, DEDUCT 15%.

MAINTENANCE:

THE MAINTENANCE RATES PER HOUR LISTED ON ATTACHMENT A INCLUDES THE MATERIAL PART ITEMS ONLY, SUCH AS AIR, OIL, AND FUEL FILTERS, LUBRICANT OILS, GREASE, ANTI-FREEZE, BATTERIES, FAN BELTS, LIGHTS AND MAKE-UP OILS. BUTLER WOULD INVOICE EFNI ACTUAL HOURS USED ON MACHINES AT THE END OF EACH MONTH.

OUR MONTHLY MAINTENANCE CHARGE WOULD BE $20,750.00, WHICH INCLUDES OUR LABOR, SPECIALIZED LUBE TRUCKS, SUPPORT VEHICLES AND EQUIPMENT, SPECIALIZED TOOLING, SCHEDULED OIL SAMPLING, PARTS TRAILERS AND INVENTORIES, MILEAGE AND TRAVEL EXPENSE. BUTLER WILL PROVIDE TWO (2) FULL-TIME MAINTENANCE TECHNICIANS ON SITE FIFTY (50) HOURS PER WEEK ON A SCHEDULE TO BE DETERMINED, MONDAY THROUGH FRIDAY. EFNI WOULD HAVE TO SCHEDULE THE MACHINES AVAILABLE FOR A TIME FRAME YET TO BE DETERMINED ADEQUATE FOR BUTLER MAINTENANCE PERSONNEL TO PERFORM THE REQUIRED MAINTENANCE. BUTLER WOULD INVOICE EFNI FOR THE MONTHLY MAINTENANCE CHARGE AT THE BEGINNING OF EACH MONTH.

REPAIRS:

BUTLER WOULD BE RESPONSIBLE FOR ALL REPAIRS INCLUDING PARTS AND LABOR ON OUR MACHINES OTHER THAN FAILURES CAUSED BY DAMAGES OR MIS-USE. REPAIRS INCLUDE ITEMS AS MINOR AS STARTERS, ALTERNATORS, WATER PUMPS, HYDRAULIC HOSES, ETC. TO THE MAJOR ITEMS SUCH AS ENGINES, TRANSMISSIONS, DIFFERENTIALS, BRAKES, HYDRAULIC PUMPS AND CYLINDERS, ETC. IF TIME PERMITS AND EFNI REQUESTS BUTLER'S TECHNICIAN TO PERFORM REPAIRS OR MAINTENANCE ON THEIR MACHINES, OUR HOURLY CHARGE WOULD BE $45.00 PER HOUR 'S MATERIALS.

FREIGHT:

FREIGHT CHARGES INCLUDE BOTH DELIVERY AND RETURN, ASSEMBLY, AND DISASSEMBLY OF EQUIPMENT.

EFNI'S RESPONSIBILITIES INCLUDE:

OPERATORS. PROVIDE THE OPERATORS AS NEEDED TO OPERATE MACHINES AS STATED IN CATERPILLAR'S OPERATING GUIDE. BUTLER WILL PROVIDE, AT NO EXPENSE TO EFNI, QUALIFIED TRAINING INSTRUCTORS FOR THE PURPOSES OF TRAINING OPERATORS. THIS TRAINING WOULD TAKE PLACE ON THE JOBSITE AT THE INITIAL START UP OF THE JOB AND WOULD INCLUDE CLASSROOM, WALK AROUND, AND IN IRON DEMONSTRATIONS.

FUEL. SUPPLY AND FILL ALL FUEL FOR EQUIPMENT INCLUDING BUTLER'S SERVICE VEHICLES.

DAMAGES. THIS INCLUDES GLASS BREAKAGE, BENT HANDRAILS, STEP LADDERS, FENDERS, ETC. BUTLER'S NORMAL POLICY FOR REPAIRING DAMAGES TO RENTAL MACHINES IS TO REPAIR THEM WHEN THE RENTAL PERIOD IS COMPLETED, HOWEVER, IF THE DAMAGED ITEM IS OF A SAFETY CONCERN, WE WOULD REPAIR THE DAMAGES AS SOON AS POSSIBLE AFTER THEY OCCURRED. AN ITEMIZED LIST OF THE PARTS AND LABOR REQUIRED WOULD BE PROVIDED TO EFNI PRIOR TO STARTING THE 'PAIR, AND INVOICED AT CURRENT LIST PRICES PLUS FREIGHT UPON COMPLETION.

UNDERCARRIAGE AND TIRES: EFNI WOULD BE RESPONSIBLE FOR ALL TIRE WEAR INCLUDING TIRE DAMAGES ON THE MACHINES WITH AN ASTERISK LISTED ON ATTACHMENT A. EQUIPMENT WOULD HAVE TO BE RETURNED WITH SAME BRAND AND MODEL TIRES AS WHEN DELIVERED, OR PRORATED ACCORDINGLY BY PERCENTAGE OF TIRE WEAR AND CONDITION AT TERMINATION OF RENTAL PERIOD.

UPON DELIVERY OF MACHINES, A REPRESENTATIVE OF BUTLER, A REPRESENTATIVE OF EFNI AND A REPRESENTATIVE FROM AN INDEPENDENT TIRE DEALER OR MANUFACTURER WOULD JOINTLY VERIFY IN WRITING THE CONDITION, PERCENTAGE OF WEAR, AND TIRE VALUE. UPON TERMINATION OF RENTA', WE WOULD AGAIN HAVE THE REPRESENTATIVES MENTIONED ABOVE DETERMINE THE CONDITION, PERCENTAGE OF WEAR, AND TIRE VALUES. ANY DIFFERENCES NOTED, WOULD THEN BE CHARGED OR CREDITED TO EFNI INCLUDING BOTH MATERIALS AND LABOR.

UNDERCARRIAGE WEAR ON ALL TRACK TYPE MACHINES WOULD BE BUTLER'S EXPENSE.

GROUND ENGAGING TOOLS:

EFNI WOULD BE RESPONSIBLE FOR ALL PARTS RELATING TO GROUND ENGAGING TOOLS (G.E.T.), I.E. CUTTING EDGES, RIPPER TIPS AND PROTECTORS, BUCKET TIPS AND .PTERS, EDGES BETWEEN ADAPTERS, WEAR PLATES ON BOTTOM OF BUCKETS AND . MOUNTING HARDWARE. BUTLER WOULD INSTALL THESE ITEMS ON AN AS NEEDED BASIS AT THE CURRENT CATERPILLAR LIST PRICE PLUS FREIGHT AT NO ADDITIONAL LABOR COSTS. ALL MACHINES WOULD BE DELIVERED WITH NEW G.E.T. ITEMS AND ARE TO BE RETURNED WITH NEW.

WE WISH TO THANK EFNI AND YOU FOR GIVING US THE OPPORTUNITY TO PRESENT OUR PROPOSAL AND FOR ALL THE CONSIDERATION WE RECEIVE.

SINCERELY YOURS,

BUTLER MACHINERY COMPANY

JOEL W. NIKLE
RENTAL FLEET MANAGER

JWN/del
cc: OSCAR SWENSON, RENTAL FLEET MARKETING MANAGER

ATTACHMENT A
ENERGY FUELS NUCLEAR, INC.
EQUIPMENT NEEDED FOR JOB IN BLANDING, UTAH
MAY 8, 1995

MODEL	QTY	MONTHLY RENTAL RATE	HOURS ALLOWED PER MONTH	EXCESS HOUR CHARGE	MINIMUM GUARANTEED NUMBER OF MONTHS RATE BASED UPON	TOTAL** FREIGHT CHARGES TO & FROM	MAINTENANCE RATE PER HOUR
*637E	4	$21,000 EA.	176 EA.	$66 EA.	3 EA.	$10,000 EA.	$1.95 EA.
D9N/RIPPER	1	13,000	176	42	3	8,000	1.30
D8N/RIPPER	1	10,500	176	34	3	7,000	1.05
D7H/RIPPER	1	9,000	176	28	3	6,000	.85
25C	1	9,500	176	30	3	7,000	1.00
80F	1	10,000	176	32	3	7,000	1.05
988F	1	15,000	176	48	3	8,000	1.30
769C	4	9,000 EA.	176 EA.	28 EA.	3 EA.	7,000 EA.	1.35 EA.
45B	1	16,000	176	50	3	12,000	1.25
0,000 GALLON ATER WAGON	1	10,000	176	30	3	8,000	1.70
,000 GALLON ATER WAGON	1	5,500	176	18	3	3,000	.65
G/RIPPER	1	7,500	176	24	3	5,000	.95
5G/RIPPER	1	11,000	176	34	3	6,000	1.10

* PLUS TIRE WEAR
**INCLUDES ASSEMBLY AND DISASSEMBLY

ENERGY FUELS NUCLEAR, INC.
Cost Estimate

NE/PROJECT Mill Decom Date 9/30/96 Calc by R Ven Horn Sheet of

HYDRAULIC SHEAR COSTS.

SOURCE -
POWER MOTIVE OF GRAND JUNCTION
GROVER THOMPSON 241-1550

They carry LaBounty Shears, the same unit that ENVIROTECH USED AT URAVAN.

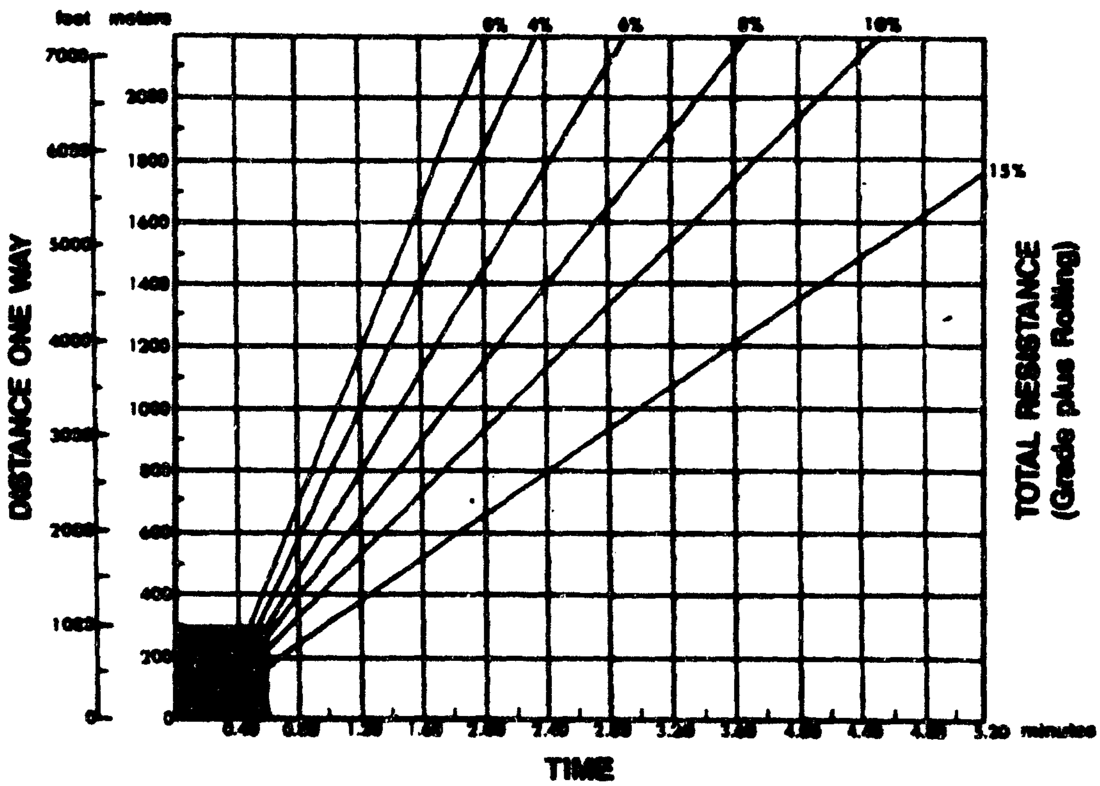
- PURCHASE PRICE FOR SHEAR — $121,500.00
- RENTAL OF UNIT ON KAMATSU PC400 (ie cat 235) would run $25,900.00/month (+ wear items)
- WEAR ITEMS COST $10,000/month.

E/PROJECT White Mesa Recl Date........ Calc by RVH Sheet...... of........

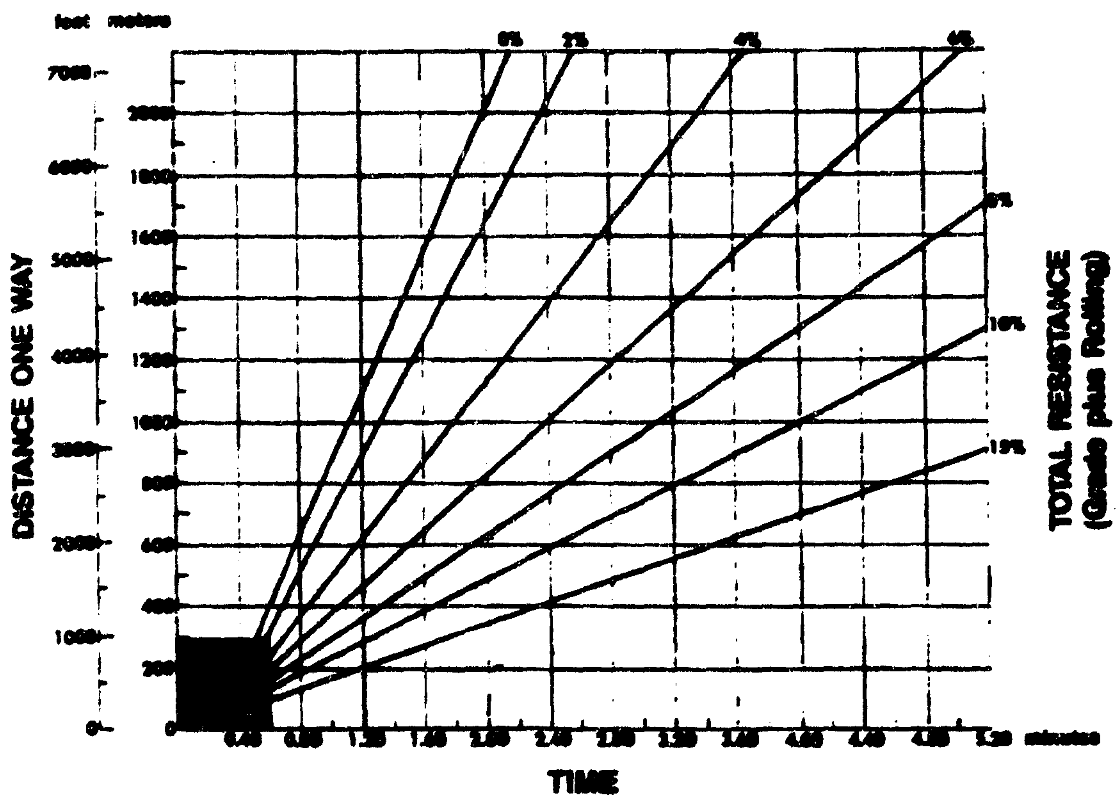
EQUIPMENT EFFICIENCIES

EMPTY

Off-Highway Trucks | 769C Travel Time
• 18.00-33 Tires



LOADED



TRAVEL TIMES FOR CAT 769C TRUCKS

BASED ON PROJECTED HAUL ROUTES

Haul Segment	Distance Feet	Distance Meters	Rolling Resistance	Grade %	Avg Speed MPH	Time Min
1a	200	67	7.5	0.0	7.6	0.30
1b	500	167	5.0	0.0	12.6	0.45
1c	200	67	3.0	2.5	9.1	0.25
1d	1400	467	3.0	0.0	18.7	0.85
1e	250	83	3.0	0.0	9.5	0.30
1f	250	83	3.0	0.0	11.4	0.25
1g	1400	467	3.0	0.0	22.7	0.70
1h	200	67	3.0	(2.5)	11.4	0.20
1i	400	133	5.0	0.0	13.0	0.35
1j	200	67	7.5	0.0	9.1	0.25
						3.90
2a	200	67	7.5	0.0	7.6	0.30
2b	2150	717	3.0	(0.5)	24.4	1.00
2c	250	83	5.0	0.0	9.5	0.30
2d	250	83	5.0	0.0	11.4	0.25
2e	2250	750	3.0	+0.5	26.9	0.95
2f	200	67	7.5	0.0	9.1	0.25
						3.05
3a	250	83	7.5	0.0	8.1	0.35
3b	3300	1100	3.0	-0.5	25.0	1.50
3c	250	83	5.0	0.0	9.5	0.30
3d	250	83	5.0	0.0	11.4	0.25
3e	3300	1100	3.0	+0.5	28.8	1.30
3f	250	83	7.5	0.0	9.5	0.30
						4.00

769C TRUCK EFFICIENCY

NOMINAL CAPACITY 25

HAUL ROUTE	TRAVEL TIME	FIXED TIME	EFFICIENCY	MINUTES PER TRIP	TRIPS/ HOUR	YARDS/ HOUR
1	3.90	2.50	85%	7.5	8.0	199
2	3.05	2.50	85%	6.5	9.2	230
3	4.00	2.50	85%	7.6	7.8	196

[illegible] FUELS NUCLEAR, INC.
[illegible] Estimate

[illegible]E/PROJECT White Mesa Rcl. Date .... Calc by .... Sheet ...... of ......

637 SCRAPER EFFICIENCY

NOMINAL CAPACITY 31

HAUL ROUTE	TRAVEL TIME	FIXED TIME	EFFICIENCY	MINUTES PER TRIP	TRIPS/ HOUR	YARDS/ HOUR
1	3.90	1.20	85%	6.0	10.0	310
2	3.25	1.20	85%	5.2	11.5	355
3	4.30	1.20	85%	6.5	9.3	287
4	3.10	1.20	85%	5.1	11.9	368
5	4.15	1.20	85%	6.3	9.5	296
6	4.50	1.20	85%	6.7	8.9	277
7	3.75	1.20	85%	5.8	10.3	319

ENERGY FUELS NUCLEAR, INC.
Cost Estimate

NE/PROJECT WHITE MESA RECL Date .... Calc by .... Sheet ...... of ......

EQUIPMENT EFFICIENCIES

TRAVEL TIMES FOR CAT 631 SCRAPERS
BASED ON PROJECTED HAUL ROUTES

Haul Segment	Distance Feet	Distance Meters	Rolling Resistance	Grade %	Avg Speed kph	Time Min
1a	200	67	7.5	0.0	9.1	0.25
1b	500	167	5.0	0.0	12.8	0.45
1c	200	67	5.0	2.5	9.1	0.25
1d	1400	467	3.0	0.0	18.7	0.85
1e	250	88	5.0	0.0	9.5	0.30
1f	250	88	3.0	0.0	11.4	0.25
1g	1400	467	3.0	0.0	21.2	0.75
1h	200	67	5.0	(2.5)	11.4	0.20
1i	400	133	5.0	0.0	13.0	0.35
1j	200	67	7.5	0.0	9.1	0.25
						[illegible]
2a	200	67	7.5	0.0	9.1	0.25
2b	2150	717	3.0	(0.5)	22.2	1.10
2c	250	88	5.0	0.0	9.5	0.30
2d	250	88	5.0	0.0	11.4	0.25
2e	2250	750	3.0	+0.5	23.2	1.10
2f	200	67	7.5	0.0	9.1	0.25
						[illegible]
3a	250	88	7.5	0.0	8.1	0.35
3b	3300	1100	3.0	-0.5	23.4	1.60
3c	250	88	5.0	0.0	9.5	0.30
3d	250	88	5.0	0.0	11.4	0.25
3e	3300	1100	3.0	+0.5	23.0	1.50
3f	250	88	7.5	0.0	9.5	0.30
						4.50
4a	350	117	7.5	-3.5	11.4	0.35
4b	1450	483	3.0	0.0	19.4	0.85
4c	250	88	5.0	0.0	9.5	0.30
4d	250	88	5.0	0.0	11.4	0.25
4e	1700	567	3.0	0.0	22.7	0.85
4f	500	167	7.5	+3.5	11.4	0.50
						3.10
5a	1400	467	7.5	-2.75	15.4	1.00
5b	1350	450	3.0	0.0	14.3	0.80
5c	250	88	5.0	0.0	9.5	0.30
5d	250	88	5.0	0.0	11.4	0.25
5e	2250	750	3.0	0.0	23.2	1.10
5f	700	233	7.5	+5.5	11.4	0.70
						4.1[illegible]
6a	600	200	7.5	0.0	11.4	0.60
6b	900	300	3.0	-3.3	20.5	0.50
6c	1450	483	3.0	0.0	19.4	0.85
6d	400	133	5.0	0.0	11.4	0.40
6e	400	133	5.0	0.0	11.4	0.40
6f	1450	483	3.0	0.0	22.0	0.75
6g	900	300	3.0	+3.3	17.0	0.60
6h	450	150	7.5	0.0	12.8	0.40
						4.50
7a	750	250	7.5	-1.5	12.2	0.70
7b	1600	533	3.0	0.0	20.2	0.90
7c	350	117	5.0	0.0	11.4	0.35
7d	350	117	5.0	0.0	11.4	0.35
7e	1600	533	3.0	0.0	22.7	0.80
7f	750	250	7.5	+1.5	13.1	0.65
						[illegible]

ENERGY FUELS NUCLEAR, INC.
Cost Estimate

E/PROJECT.................Date.................Calc by.................Sheet.......of...........

FUEL USAGE

1) BASED ON STATUS OF SCHEDULE ON 11/18/96, THE FOLLOWING FUEL REQUIREMENTS ARE IDENTIFIED:

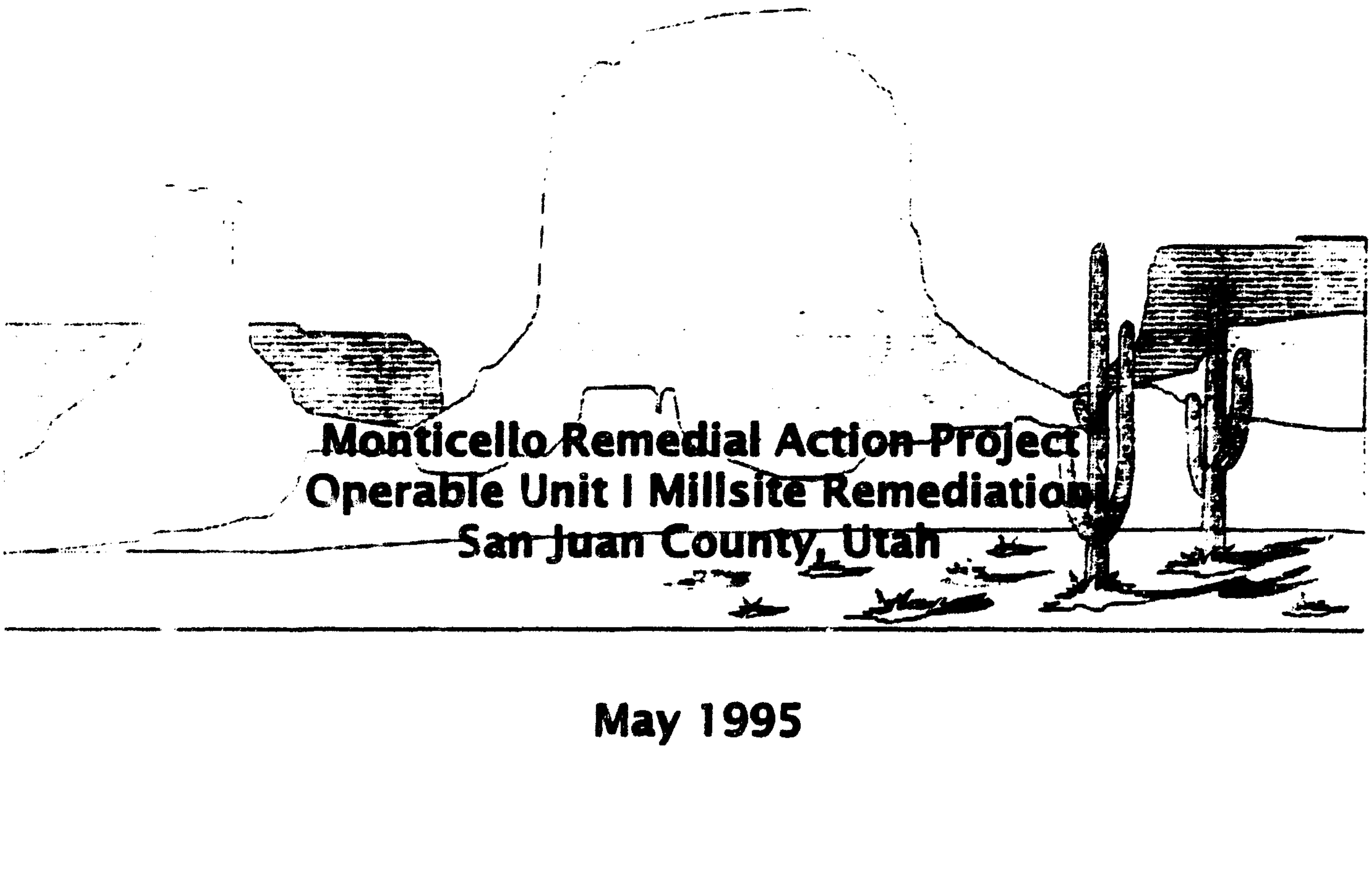
Unit	Hours	gal/hour	total gal
637 SCRAPERS	6013	24.0	72,312
D8 DOZER	3939	8.5	33,481
D7 DOZER	2257	7.0	15,799
825 COMPACTOR	2984	14.0	41,776
651 H_2O WAGON	4019	18.0	72,342
14G GRADER	4085	5.5	22,467
980 LOADER	866	9.0	7794
988 LOADER	1509	12.0	18,108
769 TRUCKS	5513	9.0	49,617
245 EXCAVATOR	953	14.0	13,342
KAMATSU	384	14.0	5,376
5000 gal H_2O Truck	1132	10.0	11,320
HIWAY TRUCKS	15,104	10.0	151,040
			514,775

Request for Proposal

1348

for

Rust Geotech
U.S. Department of Energy
Grand Junction Projects Office



Monticello Remedial Action Project
Operable Unit I Millsite Remediation
San Juan County, Utah

May 1995

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REQUEST FOR PROPOSAL RFP-1348

I. COVER LETTER FOR RFP-1348
- Sample Performance and Payment Bond Forms

II. EXHIBIT A, STATEMENT OF WORK AND DRAWINGS - IN FOUR PAGES

III. EXHIBIT B, GENERAL PROPOSAL INSTRUCTIONS - IN SIX PAGES

IV. EXHIBIT C, BUSINESS PROPOSAL INSTRUCTIONS - IN FOUR PAGES
- Schedule A DOL Wage Decision UT940009 (3 Pages)
- Schedule B Notice of Requirements for Affirmative Action (1 Page)
- Schedule C Unit price/lump sum proposal, Proposal Form Summary (9 Pages)
- Schedule D Minimum Requirements for Small Business and Small Disadvantaged Business Subcontracting Plan (1 Page)
- Schedule E Contract Pricing Proposal Cover Letter (Form 1411) (1 Page)
- Schedule F Proposal B[illegible] (3 Pages)
- Schedule G Representations and Certifications (GJ-PROC-113) (14 Pages)
- Schedule H Organizational Conflict of Interest (GJPO-PPM-1333) (2 Pages)
- Schedule I Terms and Conditions (GJPO-PROC-111) (99 Pages)

V. EXHIBIT D, TECHNICAL PROPOSAL INSTRUCTIONS - IN FIVE PAGES

VII. SITE SPECIFIC SPECIFICATIONS - IN THREE-HUNDRED PAGES
- Engineering Document E02926AB

VIII. SIGNATURE PAGE WITH SUBCONTRACT SCHEDULE - IN SEVEN PAGES

table:ou1

RUST Rust Geotech Inc.

A WMX Technologies Company
PO Box 14000 • 2597 B¾ Road
Grand Junction, Colorado 81502-5504

Phone 970 248 6000
Fax 970 248 6040

May 22, 1995

COVER LETTER

FOR

REQUEST FOR PROPOSAL RFP-1348

TO ALL OFFERORS

SUBJECT: Request for Proposal (RFP) #1348 for Construction of an RCRA-Type Repository in Monticello, Utah

Dear Offerors:

Rust Geotech Inc., Operating Contractor for the U.S. Department of Energy (DOE), Grand Junction, Colorado, cordially invites your firm to submit a proposal for the subject construction project.

This solicitation includes the following documents:

I. Cover Letter and Payment and Performance Bond Forms.

II. Exhibit A) Statement of Work and Drawings in support of the repository and associated construction, remediation, operation and maintenance.

III. Exhibit B) General Proposal Instructions: This document contains general administrative information pertaining to the proposal as a whole as well as evaluation criteria.

IV. Exhibit C) Business Proposal Instructions: This document covers business data such as pricing, terms, period of performance, and includes the following:

a. Schedule A — DOL Wage Decision UT940009, Dated September 9, 1994.

b. Schedule B — Notice of Requirements for Affirmative Action.

c. Schedule C — Unit price/lump sum proposal.

d. Schedule D — Minimum Requirements for Small Business and Small Disadvantaged Business Subcontracting Plan.

e.	Schedule E	Contract Pricing Proposal Cover Letter (Form 1411).
f.	Schedule F	Proposal Bond
g.	Schedule G	Proposal Representations and Certifications (GJ-PROC-113). These are to be executed by an official authorized to bind the offeror and are made a part of this proposal. Return one completed and signed copy with your proposal.
h.	Schedule H	Organizational Conflicts of Interest (GJPO-PPM-1333). This is to be executed by an official authorized to bind the offeror and is made a part of this proposal. Return one completed and signed copy with your proposal.
i.	Schedule I	Terms and Conditions (GJ-PROC-111), dated May, 1995. These Terms and Conditions will be included in any subcontract resulting from this solicitation.

VI. Exhibit D) Technical Proposal Instructions. This document contains a list of technical information and documentation required. Pricing is NOT to be included in this technical proposal.

VII. Site Specific Specifications: Engineering Document E02926AB.

VIII. Signature Page with Subcontract Schedule

Performance of the Work by the Subcontractor

The Subcontractor shall perform on the work site, and with its own organization, work equivalent to at least twelve (12) percent of the total amount of work to be performed under the subcontract. This percentage may be reduced by supplemental agreement to this subcontract if, during the performance of the work, the Subcontractor requests a reduction and the Contractor determines it would be in the best interest of the Government to do so.

Pre-Proposal Conference and Site Inspection

A pre-proposal conference and inspection of the work site(s) will be conducted on June 13, 1995, beginning at 9:00 A.M. at the Rust Geotech Office in Monticello, Utah. Answers to questions addressed to the Subcontract Administrator, received no later than June 8, 1995, will be addressed. All questions, including those arising during the site

inspection, shall be submitted in writing to the Subcontract Administrator; a written response will be sent to all prospective offerors.

Schedules

Refer to detailed sections within the Specifications to acquire scheduling data.
The construction schedule shall be as follows:

Start Date	Completion Date
November 1, 1995	June 30, 2000

Estimate

The Rust in-house estimate for the total solicitation package is between $25,000,000.00 and $50,000,000.00. The in-house estimate will not be revealed.

If any of the documentation that you submit for this proposal is considered proprietary to your firm, please so identify. Geotech will take every precaution to ensure the security of the information. See the General Proposal Instructions, Exhibit B, for additional information.

Your response is due no later than close of business, 4:30 P.M. MST, July 19, 1995. Should your firm desire not to offer a proposal, please send notification of your decision. Response should be transmitted as follows:

U.S. Mail:	Air or Surface Carriers:
Rust Geotech Inc.	Rust Geotech Inc.
ATTN: S. H. Johnson	ATTN: S. H. Johnson
Subcontracts	Subcontracts
P.O. Box 14000	2597 B 3/4 Road
Grand Junction, CO 81502-5536	Grand Junction, CO 81503

Labels identifying the RFP, and defined as Technical Proposal and Business Proposal, should be affixed to the outside of the respective proposal packages.

Should any additional information be required, please contact the undersigned at 970/248-6113.

Sincerely,

Stephen H. Johnson
Subcontract Administrator

shj/ib

rfpcov:ou1

SCHEDULE A

RFP - 1348

DOL WAGE DECISIONS

General Decision Number UT940009

Superseded General Decision No. UT930009

State: Utah

Construction Type:
HEAVY

County(ies):

BEAVER	IRON	SEVIER
CARBON	JUAB	UINTAH
DAGGETT	KANE	WASHINGTON
EMERY	PIUTE	WAYNE
GARFIELD	SAN JUAN	
GRAND	SAN PETE	

HEAVY CONSTRUCTION PROJECTS

Modification Number	Publication Date
0	02/11/1994
1	04/01/1994
2	09/09/1994

COUNTY(ies):

BEAVER	IRON	SEVIER
CARBON	JUAB	UINTAH
DAGGETT	KANE	WASHINGTON
EMERY	PIUTE	WAYNE
GARFIELD	SAN JUAN	
GRAND	SAN PETE	

* BOIL0182B 01/01/1994

	Rates	Fringes
BOILERMAKERS	18.48	7.89

CARP0722B 10/01/1993

	Rates	Fringes
MILLWRIGHTS	19.27	2.65

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* IRON0027G 07/01/1994

	Rates	Fringes
IRONWORKERS:		
Structural	17.75	4.46

SUUT2007A 03/01/1988

	Rates	Fringes
CARPENTERS	10.81	
CEMENT MASONS	11.52	
ELECTRICIANS	14.52	2.71
IRONWORKERS:		
Reinforcing	11.00	
LABORERS (including pipelayers)	7.65	1.60
PIPEFITTERS	12.60	
POWER EQUIPMENT OPERATORS:		
Backhoes	10.00	
Cranes	10.43	
Dozers	13.10	
Graders	12.67	
Loaders	11.26	
Scrapers	10.00	
Trackhoes	10.00	
Tractors	9.42	
TRUCK DRIVERS	9.42	

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after

award only as provided in the labor standards contract clauses (29 CFR 5.5(a)(1)(v)).

In the listing above, the "SU" designation means that rates listed under that identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

END OF GENERAL DECISION