If you have any questions concerning these results, please call.

Harold A. Connell
Assistant Lab Manager

R.L. Taylor, Ph.D., Manager 22 Jul 83
Instrumental Analysis Division

APPENDIX 3-F

SLOPE STABILITY ANALYSIS

Dames & Moore

250 East Broadway, Suite 200
Salt Lake City, Utah 84111
(801) 521-9255
TWX: 910-925-5692 Cable address DAMEMORE

February 20, 1981

Mr. Wendell Owen
Co-op Mining Company
Box 300
Huntington, Utah 84528

Dear Mr. Owen:

Summary Report
Slope Stability Analyses
Bear Creek Portal
Access Road
Near Huntington, Utah
For Co-op Mining Company

INTRODUCTION

This report summarizes the results of our stability analyses of the slopes along the Bear Creek Portal Access Road located northwest of Huntington, Utah.

PURPOSE AND SCOPE

The purpose and scope of this study were planned in discussions between Mr. Wendell Owen of Co-op Mining and Mr. Bill Gordon of Dames & Moore. In general, the purpose of this investigation was to analyze the static factor of safety of the side-cast cut and fill slopes along the Bear Creek Portal Access Road.

BACKGROUND

The Co-op Mining Company is in the process of reopening an abandoned coal mine at the Bear Creek Portal. Several abandoned facilities from a previous mining effort exist near the portal. We understand that the existing old portal will be used for ventilation of the new mine. The mine is located on a steep slope in the Wasatch Plateau and access to the portal is by a typical unsurfaced access road constructed by conventional side-cast methods.

Co-op Mining Company was issued a citation by the Department of Natural Resources Division of Oil, Gas, and Mining. The nature of the violation was with regard to the placement of side-cast cut and fill material on steep slopes (20 degrees or more). Regulations require that such fills achieve a minimum static factor of safety of 1.5.

An engineering geologist from Dames & Moore previously visited the site and performed a reconnaissance survey of the area and sideslopes in question. Laboratory tests have been performed on samples of the side-cast cut and fill material obtained at the site. These laboratory tests included sieve analyses and Atterberg Limits. The results of these laboratory tests, a discussion of our site reconnaissance survey, and a summary of our conclusions were presented in a report dated December 29, 1980*.

---

*"Report, Geotechnical Consultation, Bear Creek Portal, Near Huntington, Utah, For Co-op Mining Company."

SITE CONDITIONS

The general location of the Bear Creek Portal Access Road is shown on Plate 1, Plot Plan. Side-cast cut and fill areas as determined by others are also indicated on Plate 1. The slopes in the area of the Bear Creek Portal are generally steeper than 20 degrees and the access road has been constructed by conventional side-cast methods. The material being excavated and forming this side-cast cut and fill typically consists of fine and coarse gravel and cobble sized pieces of silty sandstone in a sandy and silty clay matrix. Calcium carbonate derived from the cement in the sandstone is also present.

The surface of the side-cast material is quite firm, which we believe to be related to the composition of clay and calcium carbonate in the soil. The clay acts as a binder and gives the soil cohesive strength and the calcium carbonate tends to cement the soil particles together. As discussed in our previous letter, the calcium carbonate cement in the soil probably provides a significant component of the factor of safety of the side-cast fill material. However, the determination of a numerical value for the influence of the calcium carbonate cementation would be very difficult to accurately determine.

SOIL PROPERTIES

Based on the results of laboratory tests performed on samples of the side-cast cut and fill material from the Bear Creek Portal site and our experience with similar soils, we have assumed the following soil properties:

Side-Cast Fill Material

Angle of Internal Friction	$\phi = 26^\circ$
Cohesion	C = 350 psf
Unit weight soil	δ = 98 pcf

Natural Soils

Angle of Internal Friction	$\phi = 26^\circ$
Cohesion	C = 700 psf
Unit weight soil	δ = 120 pcf

SLOPE STABILITY ANALYSIS

To aid in evaluating the stability of the side-cast cut and fill material of the Bear Creek Portal Access Road, a computer slope stability analysis was performed. The computer analysis utilized a simplified Bishop's Method in computing the long-term static factor of safety of the slopes. Due to the limited laboratory and field data, and the uncontrolled method in which side-cast cut and fill materials are placed, ultra conservative soil strength parameters were used in the computer analysis. A Geometric cross-section of a critical section utilized in the analysis is shown on Plate 2, Slope Cross Section. It was also assumed that a phreatic water surface would not develop in the slopes of the embankment.

The computer program analyzed the slope stability by searching a specified coordinate grid area for the center of the circle having the lowest factor of safety. The slope stability analyses was performed using a total of four separate coordinate grid areas. The number of trial failure arc centers analyzed in each of these four areas varied from 12 to 63. As indicated on Plate 2, this analysis indicated a minimum static factor of safety varying from 1.43 to 2.15.

Copies of the results of the computer analysis for each coordinate grid area are included with this report.

DISCUSSIONS AND RECOMMENDATIONS

GENERAL

Supporting data upon which our recommendations are based have been presented in the previous sections of this report and in the previous Dames & Moore report dated December 29, 1980.

SLOPE STABILITY

The computer slope stability analysis indicates a minimum static factor of safety varying from 1.43 to 2.15 for the trial arcs analyzed.

It should be noted that the factor of safety of the trial arc which cuts deep into the slope does not consider the presence of bedrock, increasing strength of the natural soils with depth, or the effect of the calcium carbonate cementation in the soil. If the above were incorporated into the analysis, the factor of safety would be significantly higher.

Stability of the slopes will be influenced by the degree of saturation of the existing soils. Therefore, surface drainage must be channeled to minimize runoff over the slopes. However, during wet periods of the year, small localized slides and sloughs should be anticipated along the slopes. However, these occurrences should be minor. The performance of these side-cast cut and fill slopes is anticipated to be similar to virtually identical side-cast cut and fill slopes along the nearby road leading to the Trail Canyon Portal. These slopes have been stable since their construction, varying from 10 to 25 years ago.

Based on our slope stability analysis and observations made during our reconnaissance visit to the site, it is our opinion that the side-cast fill material located along the Bear Creek Portal Access Road generally has a long-term static factor of safety of 1.5 or greater and will perform in a satisfactory manner.

o0o

We appreciate the opportunigy of performing this service for you. If you have any questions or require additional information, please contact us.

Very truly yours,

DAMES & MOORE

William J. Gordon
Associate
Professional Engineer No. 457
State of Utah

Douglas G. Beck
Staff Engineer

WJG/DGB/wb

Attachments"

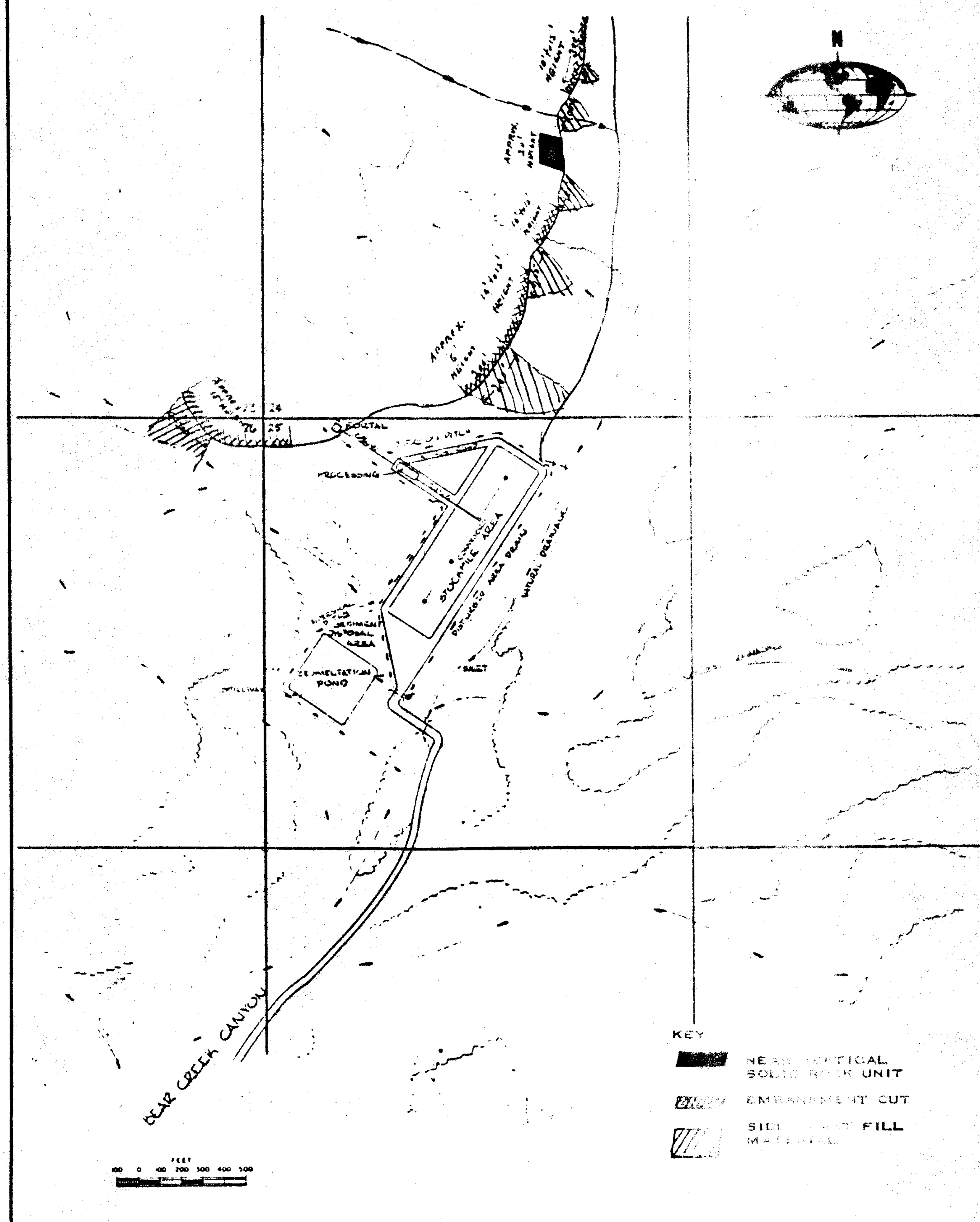
Plate 1 - Plot Plan
Plate 2 - Slope Cross-Section
Computer Anlaysis Results

cc: Department of Natural Resources
Division of Oil, Gas and Mining (2)

REVISIONS BY ______ DATE ______

FILE ______

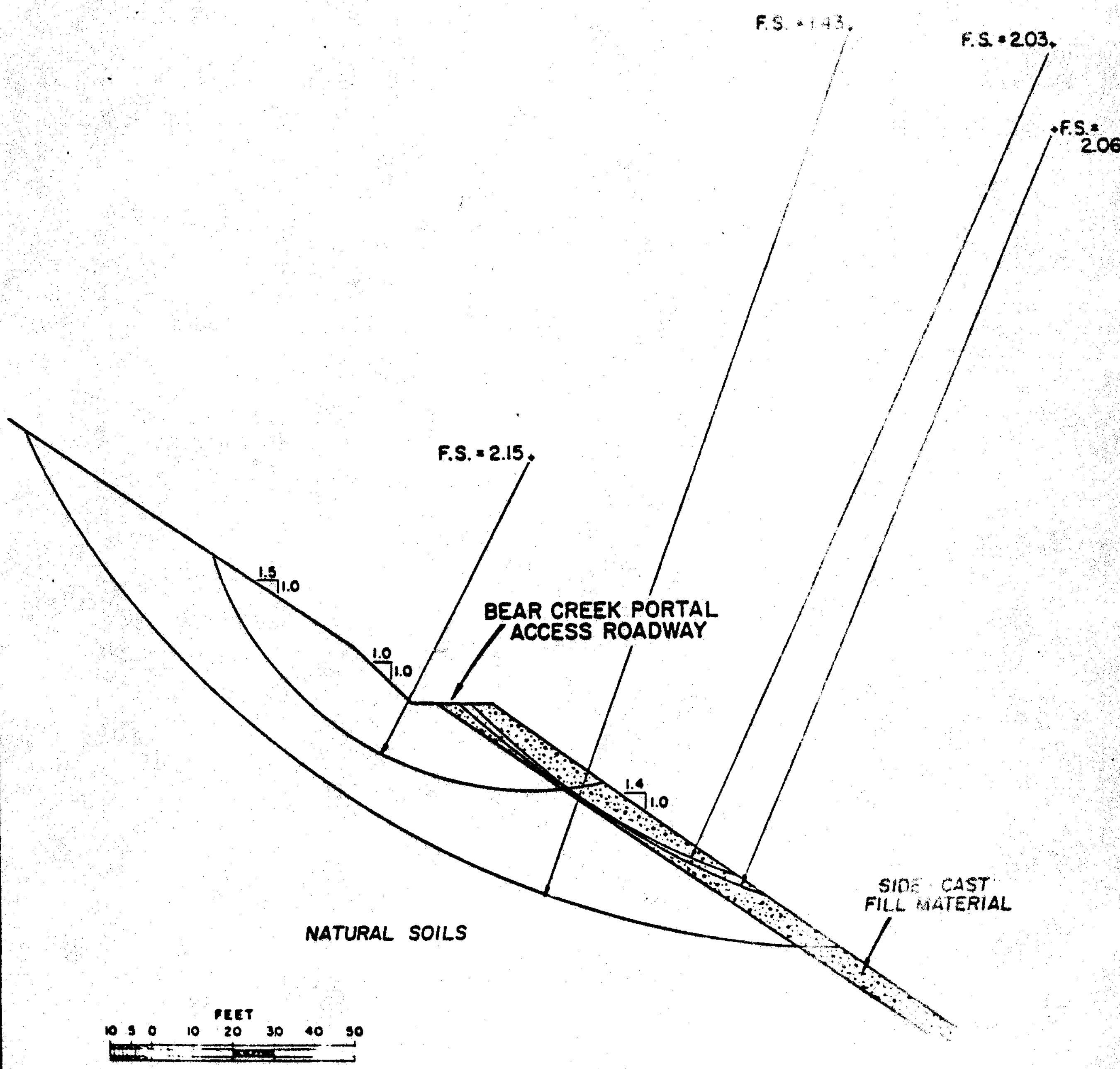
BY ______ DATE ______ CHECKED BY ______



PLOT PLAN

REFERENCE
ADAPTED FROM PRINT
SUPPLIED BY OTHERS.

DAMES & MOORE



SLOPE CROSS SECTION

DAMES AND (SLOPE8)

SLOPE STAB... SIMPLIFIED BISHOP'S METHOD

DATE OF LAST REVISION - DEC 11 78

DATE RUN - 02/19/81 TIME RUN - 19.00.45

0546101206 6093 GMB 022081 STABILITY ANALYSIS CUTSLOPE PARTIAL FILL

****

DATA INPUT MODE = 1
EARTHQUAKE COEFFICIENT = 0.000
PORE PRESSURE IS DEFINED BY WATER LINE DATA
TOTAL NUMBER OF SOIL LINES = 6 NUMBER OF WATER LINES = 0
OSLOPE GEOMETRY DATA

LINE NO	LEFT-X	LEFT-Y	RIGHT-X	RIGHT-Y	SOIL DATA- WT BELOW LINE-PCF	FRICT.ANGLE(DEG) (OR C/P-RATIO**) ABOVE	FRICT.ANGLE BELOW	COHESION-PSF ABOVE	COHESION BELOW	PORE RATIO ABOVE	PORE RATIO BELOW	NEW BELOW	NUU ABOVE	NUU BELOW
1	1018.00	1180.00	1086.00	1134.00	120.0	0.00	26.00	0.0	[illegible]	[illegible]	[illegible]	0	0	0
2	1086.00	1134.00	1100.00	1120.00	120.0	0.00	26.00	0.0	[illegible]	[illegible]	[illegible]	0	0	0
3	1100.00	1120.00	1106.00	1120.00	120.0	0.00	26.00	0.0	[illegible]	[illegible]	[illegible]	0	0	0
4	1106.00	1120.00	1120.00	1120.00	98.0	0.00	26.00	0.0	[illegible]	[illegible]	[illegible]	0	0	0
5	1120.00	1120.00	1232.00	1040.00	98.0	0.00	26.00	0.0	[illegible]	[illegible]	0.000	0	0	0
6	1106.00	1120.00	1220.00	1042.00	120.0	26.00	26.00	350.0	[illegible]	[illegible]	0.000	0	0	0

NOTE: IF(NEW.EQ.1) SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH NUU=1
IF(NUU.EQ.1) SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH NUU=1

UNIT WEIGHT OF WATER = 62.40 NUMBER OF COLUMN LOADS = 0

MODE OF PROGRAM OPERATION = 3

CENTER VARIATIONS	MIN-X	MAX-X	MIN-Y	MAX-Y	DX	DY
	1240.00	1260.00	1250.00	1280.00	10.00	10.00

RADIUS TANGENTS MAX= 1058.00 MIN= 1062.00 INCR= 1.00
1
RESULTS

\-------

\---

CNTR NO	RAD	CENTER COORDINATES	CIRCLE	FACTOR OF SAFETY	SUMWS	SUM1	SUM2	XP	XL	ARC	NN	TRIAL
NO	NO60.26	170.08	2									

TRM
RDY
EDIT,OLD,GMB
UNIEDIT 3.32 READY ? WIDTH=/132/$FIND:/TABUL/$P.1;*
1

TABULATION OF MINIMUM SAFETY FACTORS
(CRITICAL RADIUS IN PARENTHESES)

Y COORDINATES \ X COORDINATES	1240.0	1250.0	1260.0
1280.0	1.802 (222.)	2.111 (222.)	2.026 (219.)
1270.0	1.877 (212.)	2.034 (212.)	2.108 (210.)
1260.0	1.953 (202.)	2.114 (202.)	2.065 (202.)
1250.0	1.954 (191.)	2.084 (188.)	2.575 (192.)

READY ? END
RDY-FOR
BYE
CT = 00.23 SU-A = 1.9
KCH = 7
D034008 LOG OFF. 19.04.00.

$FIND:/TABUL/$P.1;*
TABULATION OF MINIMUM SAFETY FACTORS
(CRITICAL RADIUS IN PARENTHESES)

Y COORDINATES \ X COORDINATES	1210.0	1215.0	1220.0	1225.0	1230.0	1235.0	1240.0
1310.0	1.534 (240.)	1.504 (244.)	1.478 (248.)	[illegible] ([illegible])	1.495 (252.)	1.549 (252.)	1.617 (252.)
1305.0	1.512 (237.)	1.486 (241.)	1.431 (247.)	[illegible] (247.)	1.515 (247.)	1.569 (247.)	1.646 (247.)
1300.0	1.462 (236.)	1.440 (240.)	1.445 (242.)	1.485 (242.)	1.531 (242.)	1.594 (242.)	1.672 (242.)
1295.0	1.449 (233.)	1.427 (237.)	1.460 (237.)	1.501 (237.)	1.552 (237.)	1.619 (237.)	1.701 (237.)
1290.0	1.437 (230.)	1.441 (232.)	1.477 (232.)	1.518 (232.)	1.575 (232.)	1.643 (232.)	1.734 (232.)
1285.0	1.426✓ (227.)	1.456 (227.)	1.491 (227.)	1.538 (227.)	1.595 (227.)	1.670 (227.)	1.766 (227.)
1280.0	1.440 (222.)	1.471 (222.)	1.509 (222.)	1.559 (222.)	1.618 (222.)	1.699 (222.)	1.802 (222.)
1275.0	1.455 (217.)	1.485 (217.)	1.528 (217.)	1.577 (217.)	1.645 (217.)	1.727 (217.)	1.836 (217.)
1270.0	1.468 (212.)	1.503 (212.)	1.545 (212.)	1.600 (212.)	1.669 (212.)	1.759 (212.)	1.877 (212.)

1

TABULATION OF MINIMUM SAFETY FACTORS
(CRITICAL RADIUS IN PARENTHESES)

Y COORDINATES \ X COORDINATES	1140.0	1145.0	1150.0	1155.0	1160.0
1180.0	2.425 (82.)	2.675 (82.)	3.063 (82.)	3.269 (81.)	2.729 (80.)
1175.0	2.536 (77.)	2.819 (77.)	3.262 (77.)	2.883 (73.)	2.744 (75.)
1170.0	2.662 (72.)	2.982 (72.)	3.294 (70.)	2.867 (68.)	2.604 (71.)
1165.0	2.811 (67.)	3.167 (67.)	3.041 (67.)	2.703 (64.)	2.479 (67.)
1160.0	2.984 (62.)	3.235 (60.)	2.997 (62.)	2.565 (60.)	2.519 (62.)

TABULATION OF MINIMUM SAFETY FACTORS
(CRITICAL RADIUS IN PARENTHESES)

Y COORDINATES \ X COORDINATES	1120.0	1125.0	1130.0	1135.0	1140.0
1180.0	5.342 (82.)	2.219 (78.)	2.146✓ (82.)	2.260 (82.)	2.425 (82.)
1175.0	5.061 (77.)	2.173 (76.)	2.225 (77.)	2.352 (77.)	2.536 (77.)
1170.0	2.181 (71.)	2.220 (72.)	2.315 (7[illegible].)	2.456 (72.)	2.662 (72.)
1165.0	2.241 (67.)	2.314 (67.)	2.421 (67.)	2.577 (67.)	2.811 (67.)
1160.0	2.344	2.425	2.543	2.718	2.984

Dames & Moore
250 East Broadway, Suite 200
Salt Lake City, Utah 84111
(801) 521-9255
TWX: 910-925-5692 Cable address DAMEMORE

December 29, 1980

Mr. Wendell Owen
CO-OP Mining Company
Box 300
Huntington, Utah 84528

Dear Mr. Owen:

Report
Geotechnical Consultation
Bear Creek Portal
Near Huntington, Utah
For CO-OP Mining Company

INTRODUCTION

The purpose of this report is to discuss the stability of side-cast fill material placed during construction of the access road to the CO-OP Mining Company Bear Creek Portal. The scope of our consultation was formulated in discussions with Mr. Owen and consisted of a brief field reconnaissance, collection of a sample of the fill material, limited laboratory testing and preparation of this report.

The Bear Creek Portal is located in the SW 1/4, SW 1/4, S. 24, T. 16S., R. 7E., Emery County. Several abandoned facilities from a previous mining effort exist near the Portal. We understand that the CO-OP Mining Company is in the process of re-opening the old mine and that the existing old Portal will be used for ventilation of the new mine. The mine is located in a steep slope in the Wasatch Plateau; access to the Portal is by a typical unsurfaced access road constructed by conventional side-cast methods.

CO-OP Mining Company
December 29, 1980
Page-2-

We understand that a violation of the federal regulations (Section 717.14 in the Federal Register, Vol.42 No.239, P.62695, issued December 13, 1977) was issued by the State Division of Oil Gas and Mining to CO-OP Mining Company. Part (e) of this section states that surface operations on steep slopes (20 degrees or more) "shall be conducted so as not to place any material on the down slope below road cuts, mine workings or other benches, other than in conformance with part (a)(1)" of Section 717.14. Part (a)(1) states that fills shall achieve a minimum static safety factor of 1.5.

The slope where the Bear Creek Portal is located is steeper than 20 degrees and the only feasible way to construct the access road is by conventional side-cast methods. Therefore, the static factor of safety of the side-cast material is the key issue.

DISCUSSION

The material being excavated and forming the side-cast fill is gravel and cobble sized pieces of silty sandstone in a sandy and silty clay matrix. Calcium carbonate derived from the cement in the sandstone is also present. The results of a partial grain size analysis are tabulated below:

SIEVE NUMBER	PERCENT FINER BY WEIGHT
#4	72.2
#40	64.0
#200	37.2

CO-OP Mining Company
December 29, 1980

The results of an Atterberg Limit determination performed on the material finer than the number 200 sieve are tabulated below:

LIQUID LIMIT(%)	PLASTIC LIMIT (%)	PLASTICITY INDEX	UNIFIED SOIL CLASSIFICATION
30.5	15.6	14.9	CL

During our reconnaissance, we examined the access road leading to the Trail Canyon Portal in Section 22. This road is in virtually indentical conditions to the road leading to the Bear Creek Portal. Some of the side-cast fill near the Trail Canyon Portal is 25 years old; the youngest of it is about 10 years old. The side-cast fill material near the Trail Canyon Portal is nearly everywhere sloping at 35 degrees (approximately 1-1/2 horizontal to 1 vertical).

The side-cast material appears to be performing in a satisfactory manner. In many places, the side-cast material appears to be very similar to natural slopes between nearly vertical exposures of resistant sandstone. Very minor gullies and slumps are present locally. Vegetation is becoming established on some of the slopes.

The surface of the side-cast material is quite firm and difficult to walk on because boot heels don't penetrate. We believe that the reason the surface is so firm is related to the clay and the calcium carbonate in the soil. The clay gives the soil cohesive strength and the calcium carbonate tends to cement the soil particles together.

The calcium carbonate cement in the soil is probably a significant constituent in the safety factor of side cast fill material which has remained stable for 25 years in a situation identical to the access road leading to the Bear Creek Portal.

CONCLUSION

Based on observations made during our reconnaissance studies and the discussions presented above, it is our opinion that the side-cast material located adjacent to the access road leading to the Bear Creek Portal will behave in a manner similar to the side-cast material located adjacent to the access road leading to the Trail Canyon Portal. Since the material near the Trail Canyon Portal has been grossly stable for 10 to 25 years as determined by its performance, we believe that the material placed during construction of the Bear Creek Portal access road will also be grossly stable.

Consequently, we believe that the stability concern identified in the regulations can best be addressed by the empirical evidence of the performance of similar material in a similar situation rather than a calculated factor of safety.

We trust that this report satisfies your present needs. If you have any questions or require additional discussions or information, please contact us.

Very truly yours,

DAMES & MOORE

William J. Gordon
Associate
Professional Engineer No. 3457
State of Utah

Jeffrey R. Keaton
Engineering Geologist

WJG/jrk/kc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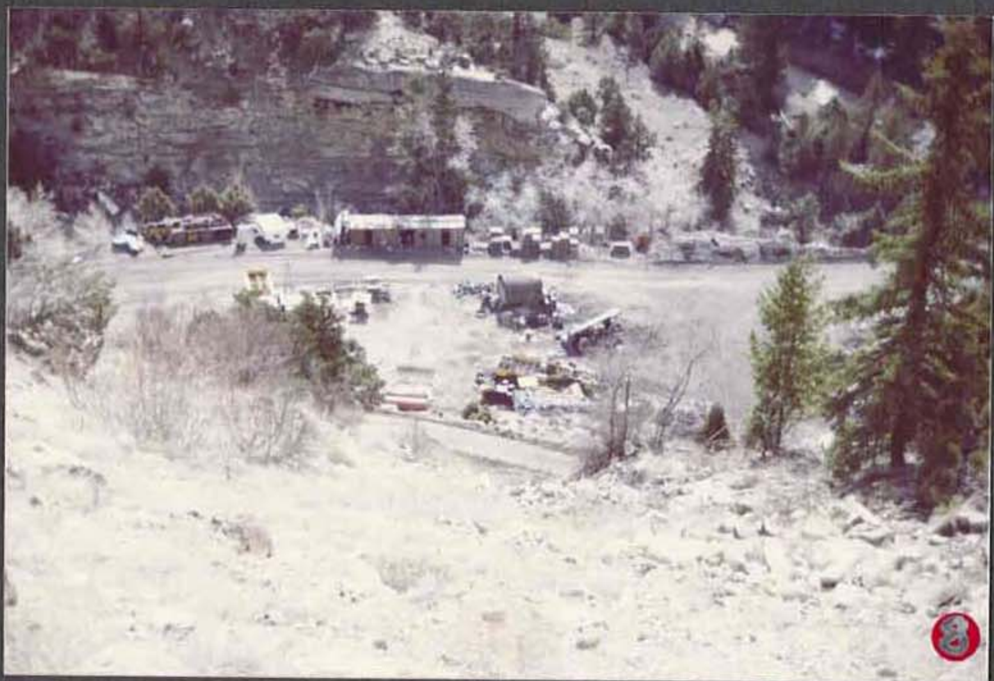
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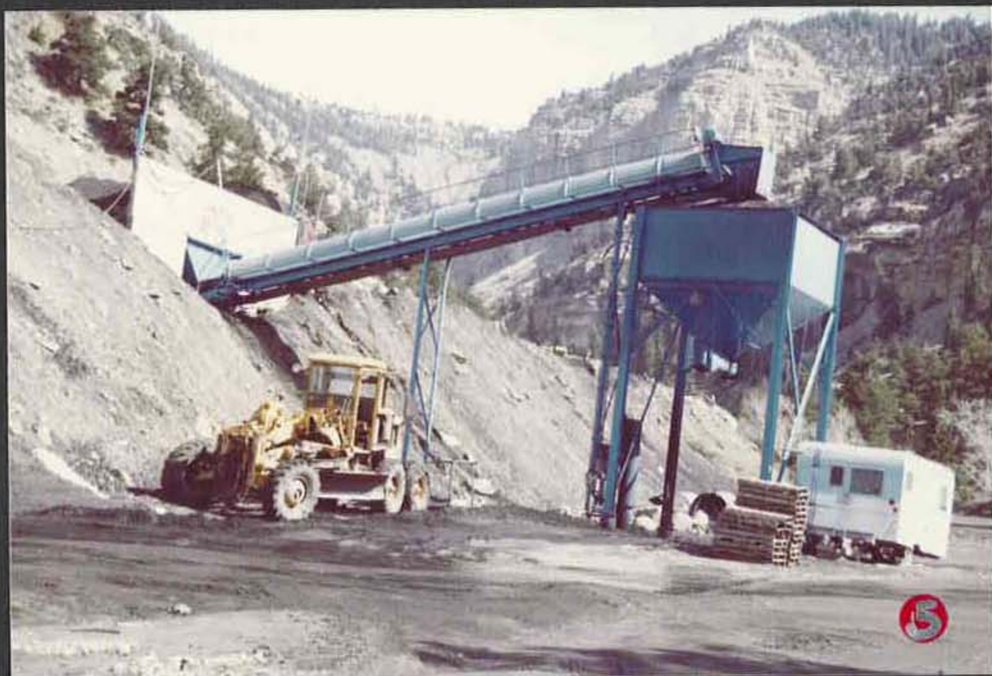

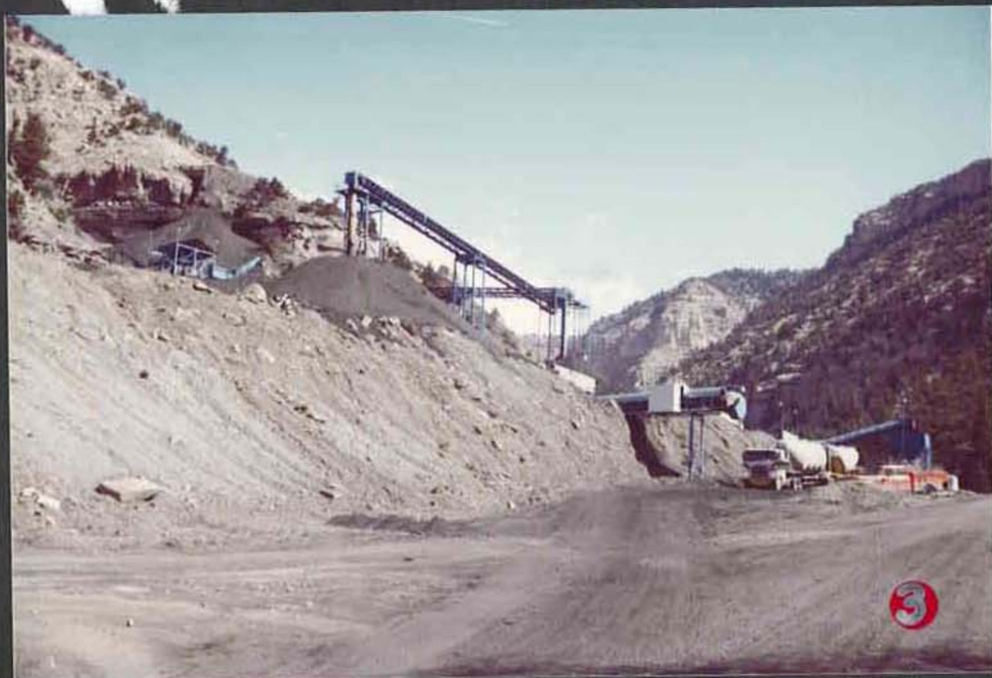
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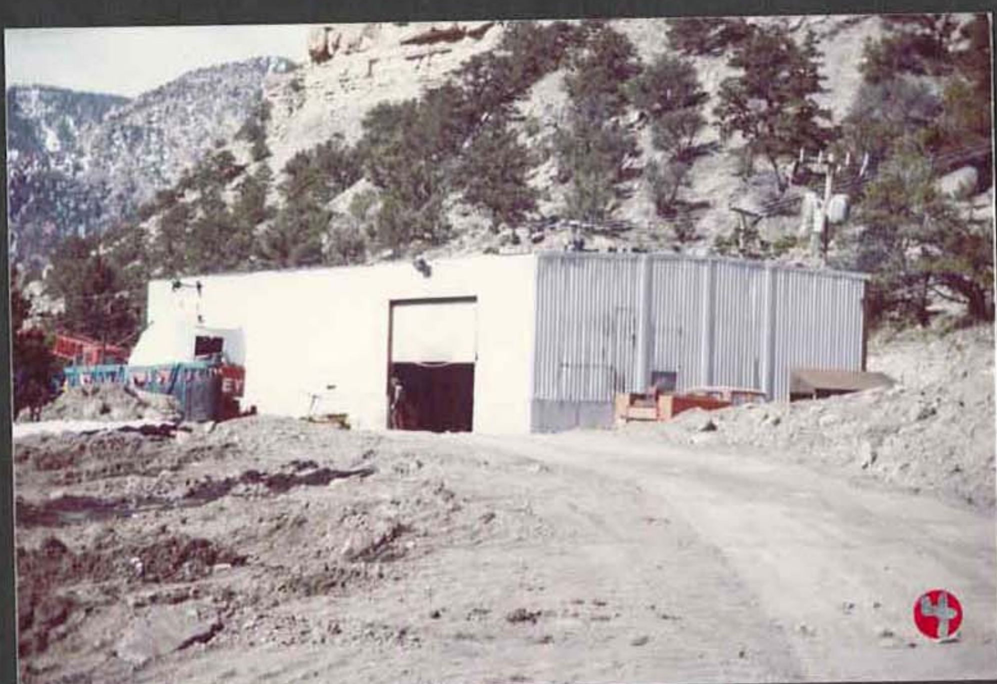
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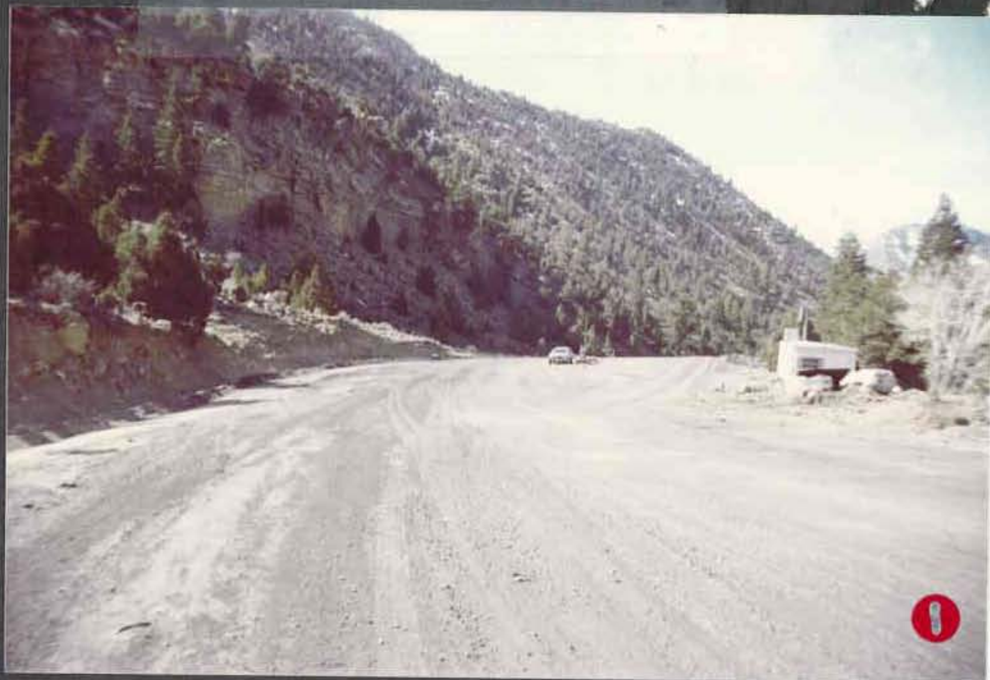
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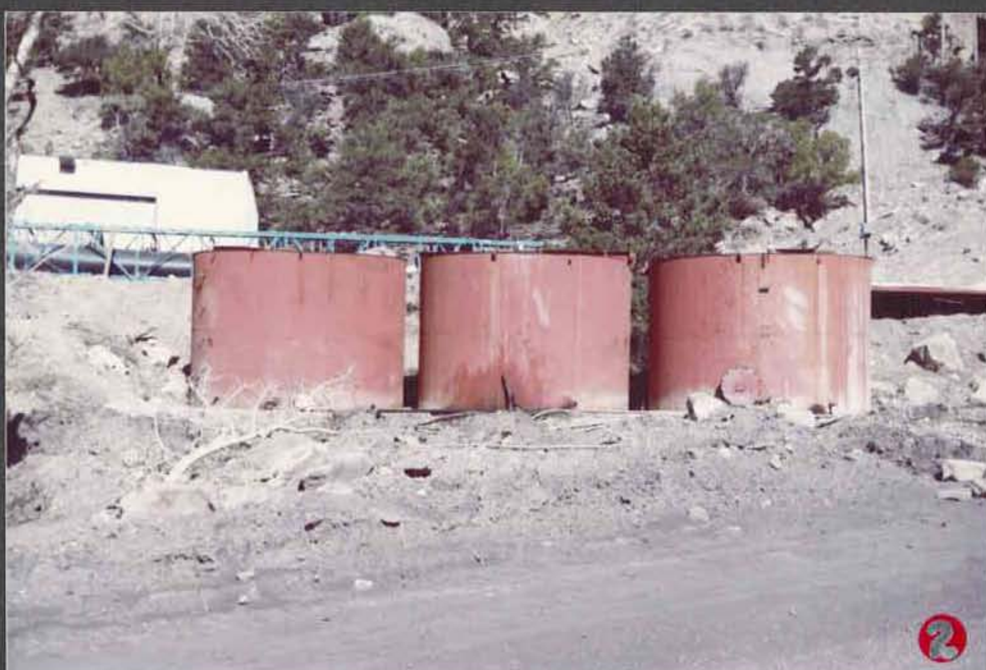
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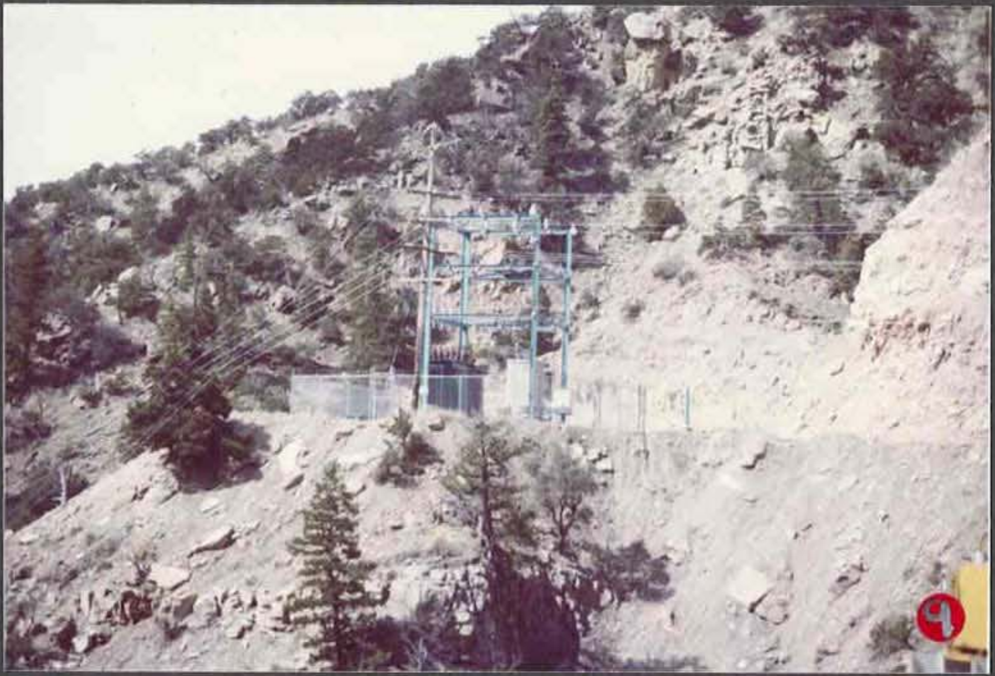
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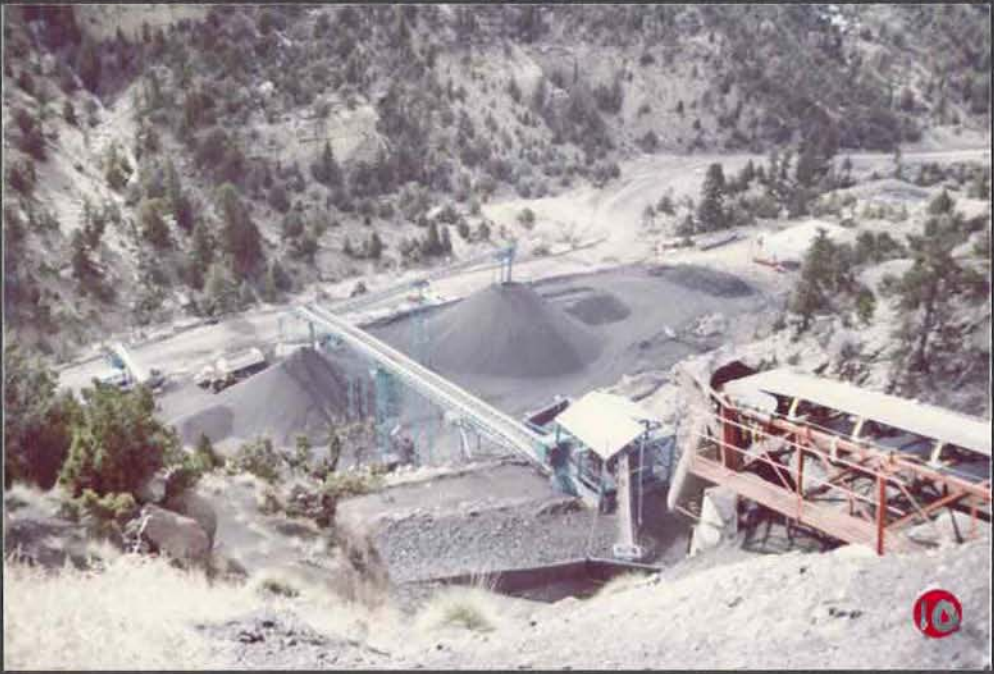
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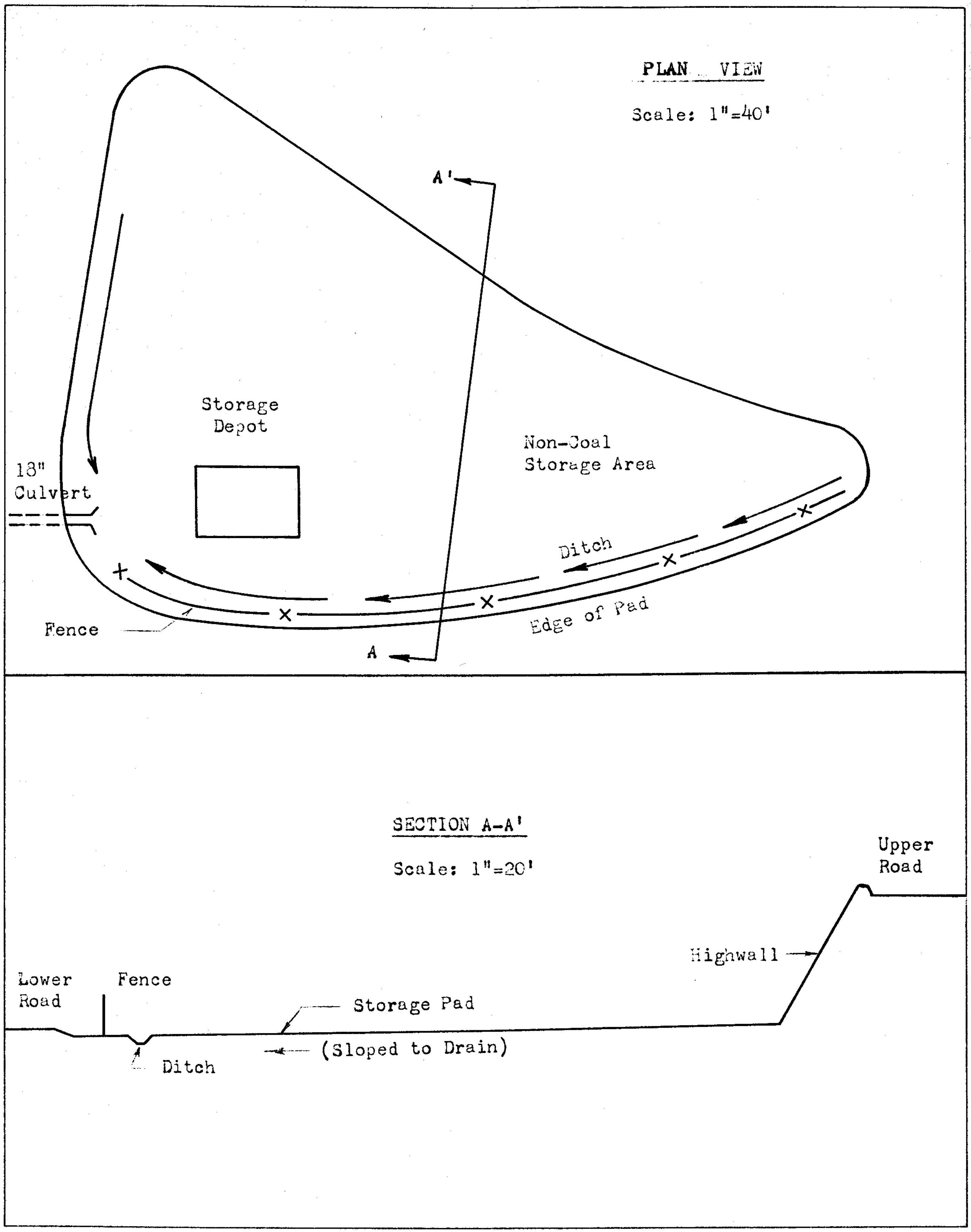
TABLE 3-6

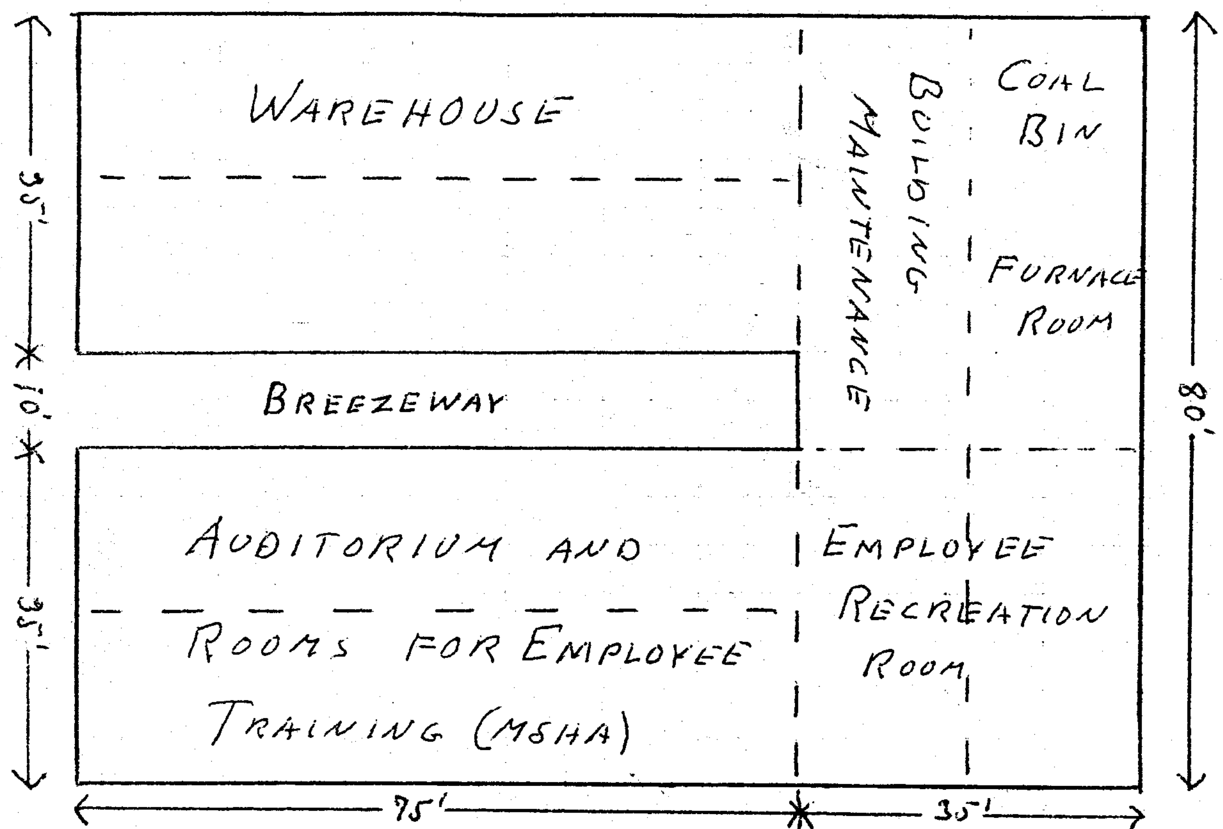
Parameters Included in Surface Water and Groundwater Monthly Monitoring Plan

1. Flow (gpm)
2. pH
3. Temperature (°C)
4. Total Dissolved Solids (mg/l)
5. Dissolved Calcium (mg/l)
6. Dissolved Iron (mg/l)
7. Dissolved Magnesium (mg/l)
8. Dissolved Potassium (mg/l)
9. Dissolved Sodium (mg/l)
10. Dissolved Bicarbonate (mg/l)
11. Dissolved Carbonate (mg/l)
12. Dissolved Chloride (mg/l)
13. Dissolved Nitrate (mg/l)
14. Dissolved Sulfate (mg/l)
15. Total Suspended Solids (mg/l)

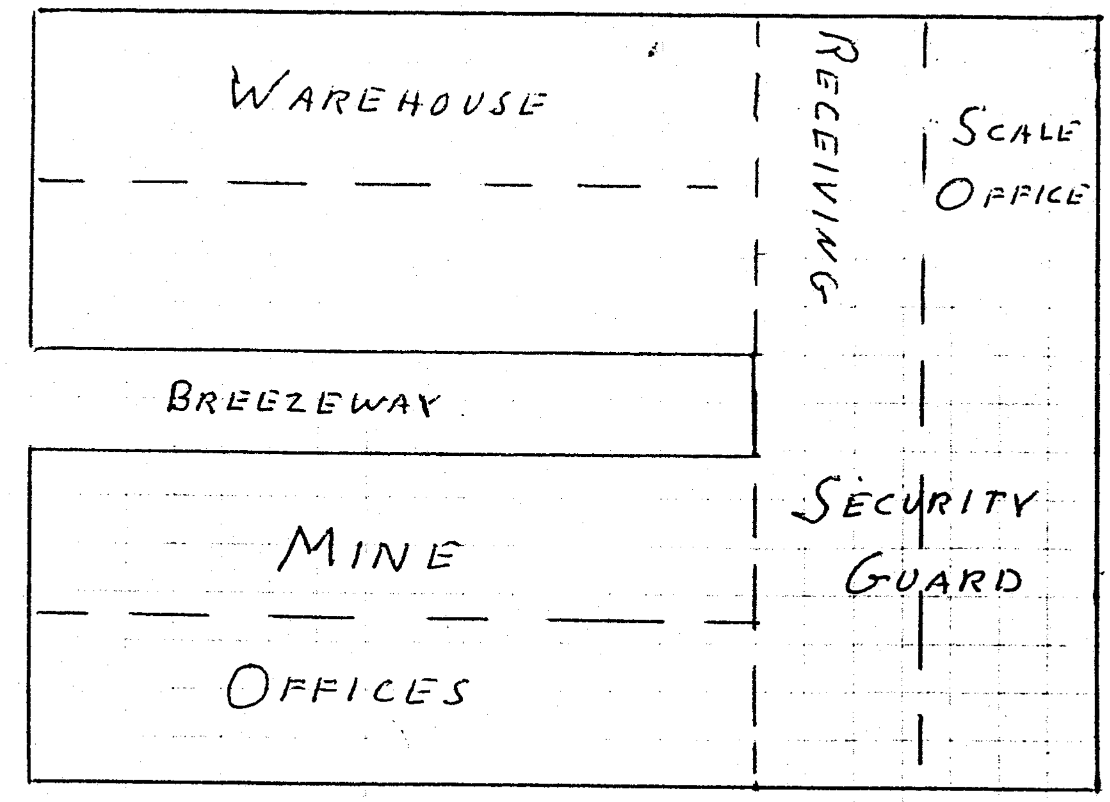
Note: See Figure 7-4 for reporting format.



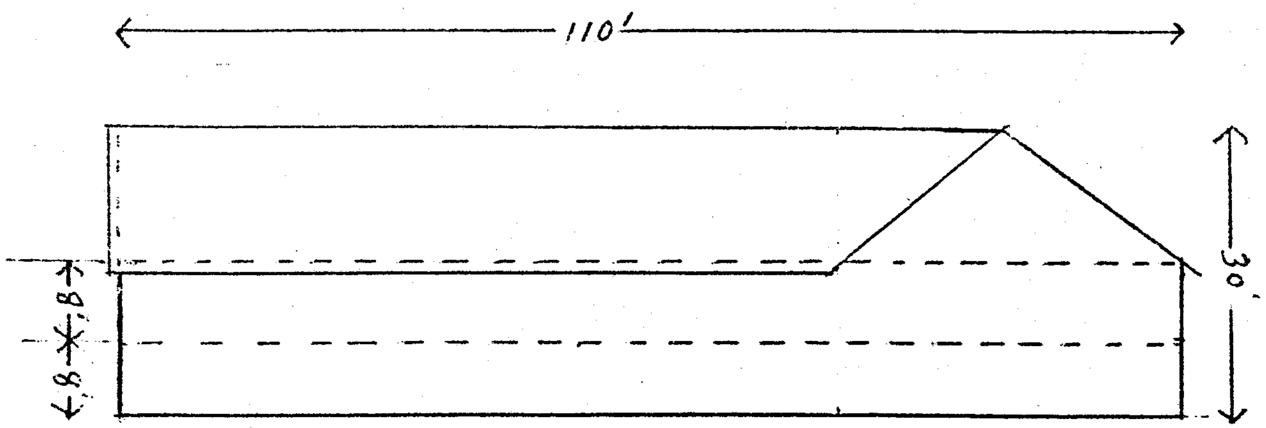
NON-COAL STORAGE AREA	BEAR CANYON	FIGURE NO. 3.8.1



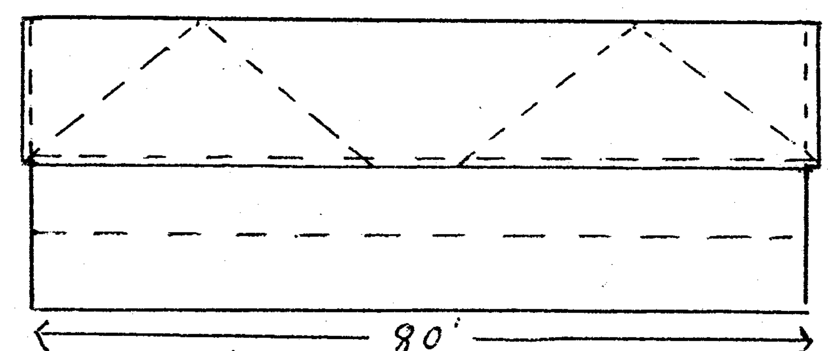
PLAN VIEW - LOWER LEVEL



PLAN VIEW - UPPER LEVEL



SIDE VIEW



FRONT VIEW

CHAPTER 4

LAND STATUS, LAND USE AND POSTMINING LAND USE

CHAPTER 4

Table of Contents

4.1 SCOPE

This chapter describes the status of the land within and adjacent to the permit boundaries of the Co-Op Coal Company's property located in the La Sal Mountain Range. Current land uses are described, along with plans for post mining land use. A brief discussion of socioeconomics is also included.

4.2 METHODOLOGY

This chapter is based mainly on the collection and review of existing published information. Existing legal documents and maps were used to support the section on land status. The discussion of current land use is based on scientific data and expert testimony from representatives of the SCS, BLM, UDWR, and the U. S. Forest Service, supplemented by information from a field survey of local, state, and federal land use policies and plans.

4.3 LAND STATUS

4.3.1 Surface Land Status/Mine Plan Area

The land within the Co-Op Mining Company's permit area fall under the jurisdiction of the State of

Utah, Emery County, and private surface owners. [See Plate 2-1].

County zoning ordinances classify the permit area as Industrial, to be used for "mining".

4.3.1.1 Ownership

Plate 2-1 shows the ownership of property within and contiguous to the permit boundaries. Land parcels within or adjacent to the permit boundaries are designated by capital letters. The fee owner of surface and mineral property rights, and holder of record of leasehold surface and mineral interests within the permit boundary is Cop Development Co.

4.3.1.2 Surface Managing Authorities

Plate 2-1 also shows the surface managing authorities for each parcel within the permit boundaries. These local, state, and federal managing authorities are Emery County, State of Utah, and the U.S. Forest Service.

The Emery County zoning ordinance zones the coal property for mining.

4.3.1.3 Utility Corridors and Other Rights-of-Way

Co-Op Mining Company has been granted a mine access right-of-way in Section 26 [see Plate 7-1]. Utility corridors, such as power lines, telephone lines and water pipes, are also shown in Plate 7-1.

4.3.1.4 Special Use Permits and Leases

Co-Op Mining Company leases land owned by Cop Development Company. Special Use permits and leases are not applicable.

Grazing, oil and gas, and other mineral leases for the permit area are owned by Cop Development.

4.3.2 Mineral Ownership/Mine Plan Area

Other than coal, no minerals of value have been mined within the lease and permit area. No other mineral resources are known to be present in commercial quantities.

4.3.2.1 Coal Ownership and Mines [Permit Area and Contiguous Areas]

Coal ownership and mines in the permit area and contiguous areas are shown in Plate 2-1. The names and addresses of the owners of coal in the area are listed in Section 4.3.1.1.

4.3.2.2 Coal Leases

The following coal leases are held by the Co-Op Mining Company adjacent to the permit area. For the locations of these coal leases, please refer to Plates 2-1, 2-1-A.

Trail Canyon Permit area

Bear Canyon Premit Area

4.3.2.3 Mineral Ownership and Mining Map

Plate 2-1 shows the mineral ownership of land parcels adjacent to the permit boundaries. Section 4.3.1.1 lists the fee owners of mineral property. Table 2-1 furthur lists the miner owners of each land parcel adjacent to the permit boundary.

4.3.2.4 Mineral Leases

Not Applicable

4.3.2.5 Oil and Gas Ownership and Wells

No oil and gas interests are represented.

4.3.2.6 Oil and Gas Leases

No oil and gas lease interests are represented.

4.4 LAND USE

The land in the project area and adjacent areas is used for mining, cattle grazing, recreation, and wildlife. Recreational uses consist primarily of hunting, camping, and picnicking. Past and present land uses of the project area and the region as a whole are discussed in the following sections.

4.4.1 Regional Land Use

The South East Utah coal region encompasses lands in federal, state, county, and private ownership. Land use management plans for public and National Forest lands generally allow for mine and mine-related activities. Coal mining has been an integral part of the region's economy. Mining and related construction activity dominate employment in Emery county. Active mining is going on in areas adjacent to the project area and one new mine has been proposed adjacent on the east of the permit area.

Historically, the livestock industry has been an integral part of the region's economy. Early settlers depended on range land for grazing sheep, cattle and horses. As time passed, grazing operations became smaller, more numerous, and directly associated with small farms. Timber also has been tied to an integral part of the economy of the region, but on a much smaller scale than the livestock industry. Early settlers needed fenceposts, corral poles, house logs, mine timber, railroad ties and lumber; numerous small sawmills supplied local needs. As time passed and needs diminished, most mills went out of business. Little timber has been harvested for commercial purposes in the past 20 years.

Recreational use of the general region of the permit area consists of hunting, camping and picnicking. Snowmobiling also occurs where the slopes are not too steep.

4.4.2 Land Use in the Mine Plan Area

4.4.2.1 Existing Use

The Co-Op Mining property and adjacent area is currently used for grazing, recreation and coal mining.

Plate 2-1 coupled with Tables 2-1 2-2 show the fee ownership and leasehold interests adjacent to the permit boundary and the fee ownership of contiguous areas. This information provides a guide to the land uses of the various parcels.

The surface under which Co-Op Mining Company has leases is managed by the Co-Op Mining Company's owners under multiple use and sustained yield concepts. Present management emphasizes livestock grazing and wildlife; and watershed development. Coal preparation and management facilities are located on fee land.

Grazing

Private land owned by Cop Development Company is not grazed presently.

Recreation

Recreational use of the area affected by mining operations consists primarily of hunting and camping. Heavy hunting of mule deer occurs on the area. Camping frequently occurs on land adjacent to the property.

Forestry

There is no merchantable timber although much of the area is covered by pinyon pine and juniper.

Mining

The type and extent of mining activities are discussed in detail in Chapters 3 and 12.

4.4.2.2 Historical Use

Historically, the area in question was the site of an active coal mine. However, during the last five years, land use within the permit boundary has not changed in any essential way.

4.4.2.3 Land Capability and Productivity Before Any Mining

Present land capability and productivity will be only slightly reduced compared to the after mining capability. Mining activities have proceeded on the current lease areas of the Co-Op Mining Company historically with only minor effects on productive capabilities in terms of soils, topography, vegetation or hydrology. The soils indigenous to the area affected by the operations are described in Chapter 8. Vegetation is discussed in Chapter 9.

Surface water in the permit area is limited to surface run-off that flows most heavily during the spring and early summer months and then normally dry up. The quality and quantity of this water and of the ground water will be identified in Chapter 7.

4.4.2.4 Land Productivity Before Mining in Terms of Average Yield of Food, Fiber, Forage or Wood Products

Land productivity in terms of plant products before any mining will not differ greatly from future productivity. Early settlers depended upon range land for grazing sheep, cattle and horses. Timbering was active, but on a much smaller scale than grazing. Early settlers needed fenceposts, corral poles, house logs and railroad ties.

The permit area affected by Surface operations and facilities of the underground Bear Canyon mine is capable of supporting limited grazing and recreational uses. Farming in the area is prohibited by the steep and rocky terrain.

Current and future land use will suit the physical features of the mine plan area, which is mostly steep and rocky. Such land is well suited for management as a multi-use area and coal mining fits appropriately into the overall land use scheme.

Land productivity data were obtained from the U.S. Soil Conservation Service.

4.4.2.5 Previous Mining

The Bear Canyon mine was started in 1896 and was worked until 1906. Then reopened in 1938 and worked intermittantly until 1957. At this point the mine was abandoned until Co-Op Mining re-entered in 1981.

4.4.2.5.1 Mining Method

Room and pillar mining with continuous mining methods will be used with pillar recovery as mining conditions permit. The room and pillar system is the only logical choice for recovering the coal in the old workings and for driving development openings into the virgin areas.

All proposed mining will be done with continuous mining methods; coal loaded directly into diesel or electric shuttle cars, then to a belt system. The coal is transported directly out of the mine to a stockpile and then trucked to potential markets principally along the Wasatch front.

All proposed mining will be underground, with a minimum of surface disturbances. The current mining method is described in Chapters 3 and 12 in detail.

4.4.2.5.2 Coal Seams and Other Minerals Mined

Coal

The Co-Op Mining Company is located outside of Huntington, Utah, with the mine portal at approximately 7,300 feet above sea level. The coal-bearing strata are in the Blackhawk Formation. Coal will be extracted from 3 seams, which, from uppermost to lowermost, are the Upper, Bear Canyon, and, Lower seams. When mining began in the late 1800's, entry was made into the Bear Canyon Seam and coal extracted from it first. Mining has never been expanded into the other seams.

Minerals

No other minerals are known to exist within the permit area.

4.4.2.5.3 Extent of Coal Removal

The quantity of coal presently removed from the old workings is unknown.

4.4.3 Land Use During Operations

Mining has been in progress in the permit area in past years and land use presently and during operation is described in Section 4.4.2.1 [Existing Use] and in Section 4.4.2.2 [Historical Use]. Therefore, the subsections below describe the differences between current land use as opposed to land use during mining or future land use.

4.4.3.1 Effect of Operation on Land Use [On-Site and Adjacent]

There has been no significant land-use disturbance in the lease area due to mining activities since 1957. Land use should remain the same: recreation, grazing, wildlife and mining.

The simultaneous production of oil, gas, and coal should present no major conflicts. Though other minable coal seams may be at greater depths, the oil and gas zones are at sufficient depths to result in no overlap between oil and gas zones and coal seams. Therefore, the production of oil, gas, and coal should be compatible.

4.4.3.2 Mitigation of Effects of Operation

The operation of the Bear Canyon, as with any mine, will have some environmental effects. These effects are summarized in Section 1-2 and presented in more detail in Sections 3.5, 5.5.2, 6.6, 7.2.5, 8.10, 9.5, 10.4, 11.4 and 12.4.2. Operations will be conducted in ways designed to mitigate these effects. These plans are summarized in Section 3.5.

4.5 POSTMINING LAND USE

4.5.1 Method of Achieving and Supporting Postmining Land Use

Chapter 3 present, in detail, the abandonment steps and revegetation/reclamation activities to be used to achieve the proposed postmining land uses.

Area Cleanup

Solid waste generated in the abandonment operation will be collected and removed.

Return of Other Drainages to Natural State

Natural drainage will be returned to patterns similar to the original patterns to the extent that this is physically possible. [See Appendix 7-G .]

Recontouring of the General Area

Grading and backfilling will be done to achieve a final contour suitable for the wildlife/grazing habitat specified as the postmining land use.

* Operational benches will not be removed. Their banks will be reduced whenever possible; their surface areas will have a 33h:1v slope for drainage.

* Side hill cuts will be reduced to the maximum extent physically possible. The cuts which are already physically stable will not be reduced.

Wind Protection Barriers

In addition to the wind protection provided by the abandonment slopes, rock wind barriers will be constructed by a small portion of the rock generated during the mining operation. During abandonment small piles of this rock will be formed on the upper decks to provide protection from wind for wildlife.

Scarifying Areas

Operational areas will be scarified to reduce compaction and to prevent topsoil slippage. Steep slope areas which must remain after abandonment will recieve special ripping to create ledges, crevices, pockets and screes. This will allow better soil retention and vegetation establishment.

Distribution of Topsoil

Topsoil from the stockpile will be spread over the distsurbed areas in such a manner as to prevent excessive compaction.

Fertilization and Neutralization

Fertilization or neutralization determined as necessary by soil testing will be done.

Seeding and Tree Planting

Vegetation will be established to prevent erosion, to optimize the edge effect and to provide cover. Perennial woody species will be emphasized, along with those of proven nutritional value and ability to support wildlife. The types and amounts of such vegetation are discussed in Section 9.7 and Appendix 9D.

Moisture Retention

If operational testing determines that moisture retention is necessary, the following systems may be used:

* Straw - - Terrace benches

* Mulch - - Wood mulch may be sprayed on terrace banks

* Soil Retention Blanket - - Wood fiber held by plastic net may be used on steeper banks

* Jute Mesh and Straw - - Burlap material holding straw may be used on the steepest banks

* Tacifier - - Mulch with tacifying agent may be used on steep banks

Maintenance

Fencing, irrigation and weed control will be used only as needed, according to operational testing results.

Regrading and Reseeding

Erosion that develops in completed areas will be minimized by repeated grading and seeding.

Success Monitoring and Extended Responsibility Period

Vegetation and water will be monitored furing the applicable period of liability to determine success of abandonment reclamation. A determination of revegetation success will then be made.

Removal of Site Drainage Ditches and Sedimentation Ponds

After the disturbed areas are stabilized and the runoff meets the suspended solids standard without detention time, the site drainage system will be removed. The site drainage system areas will be backfilled and revegetated.

4.5.1.2 Financial Feasibility and Attainment

Based on the reclamation costs discussed in Section 3.6.7, it appears at this time that the proposed postmining land use is financially feasible and attainable.

4.5.2 Differing Postmining Land Use Support

The mine site will be returned to wildlife/grazing [rangeland] habitat, which is similar to the premining land use.

4.5.3 Consistency with Underground Activities

The underground mining system is consistent with the land use plan since it minimizes subsidence effects. Pillars will be pulled uniformly from areas of room and pillar mining to promote even subsidence and thus reduce subsidence effects.

4.5.4 Final Surface Configuration

The proposed final surface contour plan would allow the side hill cuts and operational benches at the mine site to be brought back to original contour.

4.5.5 Compatibility with Surrounding Land Uses

Throughout the life of the project and especially during abandonment phases, the following assessments will be made:

- The visual resources will be assessed. The abandonment assessment will concentrate on how effectively final drainages and slope patterns fit into the area's general visual resources. This assessment will be made through the period of liability.

- The recreational resources will be assessed. This process will include a review of postmining hunting, camping, hiking and recreational land use. If it is found, during the liability period, that any of these activities have significantly decreased because of the mining operation, corrective actions may be taken.

* The mineral resources contained within the permit area will be assessed. The abandonment assessment will ensure that oil and gas development will be possible at the conclusion of mining. Measures taken to protect the unmined coal, such as portal sealing, will also be assessed. No other mineral resources are known to be present in commercial quantities.

4.5.6 Compatibility with Land Use Policies and Plans

Letters have been sent out to each surface owner for comments regarding postmining land use policies and plan [Appendix 4A]. This permit application will address all concerns voiced therein.

Ground Water

Management Objective. "Improve and maintain watershed conditions to reduce overland flows and to recharge the underground aquifer. Reduce soil losses from the unit where feasible. Protect perennial springs and ground water and maintain or improve water quality to meet the standards for existing or possible future uses of water."

Impacts

Approximately 6.4 acres of soil will be disturbed within the permit area, including the loadout area, offices, shops, bath house, substations, roads, portal area and the topsoil storage area.

Soil disturbance over most of these areas would be complete during the life of the mine, resulting in increased onsite runoff and soil erosion. Though onsite erosion will increase, it will not reach Bear Creek and significantly impact the water quality due to required sediment control measures. Therefore, the water quality of this creek will not be degraded.

Vegetation, Range Management and Soils

Vegetation Management Objective. "Improve desirable vegetative cover to protect watershed, decrease erosion and maintain soil stability."

Range Management Objective. "Improve desirable plant species composition and increase forage production on suitable livestock range. Maintain livestock numbers and capacities at a level which is compatible with watershed values, wildlife uses and other resource uses."

Soil Management Objective. "Maintain soil productivity and minimize soil loss through sound resource management."

Impacts

Vegetation has been removed from portions of the mine portals and access roads. This has increased onsite erosion during the life of the mine.

The reduction in desirable plant species will reduce forage production and livestock capacities.

Though the short-term effect from coal mining activities will degrade vegetation and reduce soil stability, the long-term effect will enhance the management objectives. Revegetative measures after mining activities will improve desirable vegetative cover, resulting in improved soil stability, decreased erosion and increased forage production over the entire disturbed area, including the portion currently disturbed.

Minerals

Management Objective. "Provide for mineral activities within the role of responsibility that is compatible with other resource uses and national and local needs."

Impacts

As noted in Section 4.4.2.5.2, coal is the only known mineral of value within the permit boundaries. The production of gas and oil, which have been found in adjacent areas, would be compatible with coal mining [See Section 4.4.3.1].

Archeology and Paleontology

Management Objectives. "Manage and protect important archeological, historical and paleontological resources to preserve scientific and interpretive values in accordance with applicable laws and regulations."

Impacts

There are no archeological sites within the proposed disturbed areas as discussed in Chapter 5.

Timber, Fire and Roads

Tiber Management Objective. "Harvest timber and forest products on a sustained yield basis where environmental effects to resource uses and activities are acceptable and where regeneration can be assured. Improve timber growth and yield on productive sites."

Fire Management Objective. "Provide fire management and other protective measures that will complement ecologic and economic values."

Transportation Management Objective. "Manage and coordinate transportation systems compatible with various uses and activities to provide for feasible, safe movement of goods and services."

Impacts

A few pinyon and juniper would be removed by the proposed surface operation facilities of the mine. These areas are limited to a portal area which would disturb very little surface area. No timber would be affected by surface disturbance.

Mining activities have provided improved access roads for fire protection and have removed some deadfall timber, thereby decreasing fire hazard.

Recreation and Scenic Resources

Recreation Management Objective. "Provide for a broad range of quality recreation opportunities in coordination with federal, state and local agencies. Manage off-road vehicle use to the extent needed to prevent environmental damage."

Scenic Resources Management Objective. "Plan resource activities to add variety and minimize adverse impacts on scenic resources."

Impacts

The surface operation facilities of the mine impose industrial modifications and intrusions and conflict with the scenic resources management objectives. Proposed surface operation facilities will furthur impair scenic resources during the life of the mine. However, reclamation of these areas will restore the scenic resources to their approximate existing condition.

Wildlife in the area will adapt to the operation of existing surface facilities due to the relative small area involved. Proposed construction may disrupt wildlife if human disturbance is not kept to a minimum. These topics are discussed in detail in Chapter 10.

Revegetative measures after the life of the mine will restore wildlife habitats to a condition improved over their existing condition.

Fish habitats will not be affected, as discusses in Chapter 10.

Short-term effects on wildlife habitats will be detrimental to a small degree. However, long-term impacts will be to improve the habitats and restore unreclaimed lands to usable wildlife habitats.

Wilderness Roadless Areas

Management Objective. "Determine the future status of inventoried roadless areas."

Impacts

There are no inventoried roadless areas within the Bear Canyon Mine permit area.

4.5.7 Safety, Environmental Protection and Pollution Control Compliances

Upon expiration of the responsibility period and at the time of bond release, compliance documentation will be presented by the applicant. This would apply to air quality, especially particulates; storm water runoff; ground water protection and revegetation.

4.6 SOCIOECONOMIC CONSIDERATIONS

A community infrastructure survey was conducted for another permit application in the area to determine the capabilities of local communities to provide permanent employees for the mine, to accept new residents [workers] and to provide new residents with the necessary infrastructure, i.e., community services such as water, sewage systems, housing, schools and medical care. The purpose of the investigation was to identify those communities that have shortages or deficiencies in necessary infrastructure and to suggest ways for rectifying the shortages before they adversely affect the mine operations or the communities. This section summarizes the report of that survey in the communities around the Bear Canyon Coal Mine in Emery County in Utah. The investigations included both field surveys and the collection and review of existing published information.

4.6.1 Service Area

The service area of the Bear Canyon Mine is limited by the distance to the source of supply. Conceptually, the service area can be viewed as two concentric circles. The inner circle is primary to the mine; the outer is secondary.

The primary area contains those communities that lie within a 45 minute commute of the mine and are therefore most likely to recieve new residents seeking employment at the mine. The secondary service area consists of those communities requiring over 45 minutes to commute to the mine. These communities are shown in Table 4-2 by service area category.

Although some permanent residents from the secondary service area communities will probably commute to the Bear Canyon Mine for employment, newcomers are not expected to settle so far from the mine. Experience with other mines in similar areas has shown that a 30 to 40 minute commute over 40 miles or less represents the maximum that miners can commute and still maintain a high degree of reliabaility. If the time/distance factor is greater, experience demonstrates that the miners will either move closer to the mine or seek work elsewhere.

4.6.2 Growth Capability

The ability of various communities to accept additional population is important in terms of water and sewage systems and the availability of land for expansion of schools, hospitals, housing and commercial facilities. Infrastructure aspects of the primary service area communities are summarized in Table 4-3.

4.6.3 Labor Force

Demographically, there is a shortage of miners in the 30 to 50 year age bracket. A dormant period in the mining industry from the early 1950's to the early 1970's resulted in few new miners coming into the field for those 20 years. Consequently, the present miners tend to be either in their 50's approaching retirement or in their 20's, embarking on their first job.

The older miners are well settled in the existing towns and for the most part are located reasonably close to their present employment. They are not likely to change jobs or communities. The younger miners, who are still learning mining skills, frequently change jobs to gain additional experience and/or to improve their earning power. It is anticipated that about 5 new employees would be needed if the mine expands to 400,000 tons/year. This would not affect the socioeconomics of the area.

TABLE 4-1

PROPOSED POSTMINING LAND USE

A. Land Use in Relation to Mine Features

Area	Present Ownership	Premining Use	Proposed Postmining Use	Alternate Use
Mine Site and Exploratory Excavations	Private	Wildlife/Grazing	Wildlife/Grazing	Picnic Area
Conveyor, Pipeline and Powerline Route	Private	Grazing	Grazing	Wildlife Habitat
Main Access	Private	Service Road	Service Road	Wildlife Habitat

B. Land Use in Relation to Physical Features

Area	Proposed Postmining Use	Ability to Support Proposed Postmining Use
Flatlands	Wildlife/Grazing Habitat	Adequate
Canyons	Wildlife/Grazing Habitat	Adequate
Moderate Elevation: North and East Slopes	Wildlife/Grazing Habitat	Adequate
High Elevations; Steep land North and East Slpoes	Wildlife Habitat	Adequate
South and West Slopes	Wildlife Habitat	Moderate - because of harsh Natural Conditions

TABLE 4-2

Communities in the Co-Op Mine Service Area

Primary Service Area

Carbon County	(min.) Commute Time
Price	45
Helper	50
Wellington	45
Hiawatha*	35

Emery County	(min.) Commute Time
Huntington	15
Cleveland	30
Castle Dale	30
Orangeville	30

Secondary Service Area

Carbon County	(min.) Commute Time
East Carbon City	90
Sunnyside	90

Emery County	(min.) Commute Time
Ferron	50
Emery	65

* Hiawatha would be virtually eliminated from labor force projection because it is mainly associated with the U.S. Fuel Company.

TABLE 4-3

Summary of Growth Capability

Community	Water	Sewer	Schools	Hospital	Housing	Commercial Facilities	Land for Expansion
Price	Adequate	Adequate	Adequate	Yes	Acute Shortage	Full Convenience	Yes
Helper	Adequate	Adequate	Adequate	None	Shortage	Partial	Yes
Wellington	Adequate	Adequate	Adequate	None	Shortage	Partial	Yes
Huntington	Adequate	Adequate	Adequate	None	Shortage	Partial	Yes
Cleveland	Adequate	Adequate	Adequate	None	Shortage	Partial	Yes
Castle Dale	Adequate	Adequate	Adequate	None	Shortage	Partial	Yes
Orangeville	Adequate	Adequate	Adequate	None	Shortage	Partial	Yes

TABLE 4-4

Mines Projected to Open on Federal Land Prior to 1985

Mine Name Operator Location	Millon Tons Per Year (1990)	*Employment
"B" Canyon U.S. Steel Near Sunnyside	1.0	280
Fish Creek and Dugout Canyon PG&E Near Wellington	3.2	896
Deadman's Mine AmCA Resource 10 mi east of Kennilworth	1.0	280
Skyline Mines Coastal State Near Scofield	4.0**	800**
Belina #2 & O'Connor Valley Camp Near Scofield	2.4	672
Mine #1 Mt. States Resources 20 miles south of Emery	.5	140
Skumpah Canyon Energy Resource Group 20 miles east of Emery	1.0	280
		3,348

*Employment based on 15 tons per man/shift, 480 production shifts per year.

**Applicant corrected values to current mine plan.

SOURCE: Adapted from Table I-1 on page I-3 of U.S. Department of the Interior (1978).

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Appendix 4A

Salt Lake City, Utah
November 15, 1982

TO WHOM IT MAY CONCERN:

Co-op Mining Co. asked us, as land owners, to describe our intended future use of the property currently being mined by Co-op Mining Co. in Emery County, Utah.

Co-op Mining Co. now occupies the premises pursuant to a written lease agreement, authorizing the removal and sale by Co-op, of coal from the property. Our best current information indicates that there exists sufficient coal reserves on the property to support a mining operation for in excess of fifty years, at the current rate of coal removal. Upon the expiration of the Co-op Mining Co. lease, and assuming sufficient coal reserves remain, we will re-lease the property, either to Co-op or to some other company interested in mining the coal.

Upon the cessation of coal mining activity, assuming we still own the property and no more beneficial use of the land becomes apparent, the land will most likely be used for grazing cattle or other livestock.

Very truly yours,

Ronald Tucker

COP Development Co.

CHAPTER 5

HISTORICAL AND CULTURAL RESOURCES

CHAPTER 5

Table of Contents

5.1 SCOPE

The project area is situated in the Blackhawk Mining area, approximately 15 miles west-southwest of Huntington, Utah USGS 7.5 Minute topographic quads of the project area include those and adjacent areas.

Surfaces within the large intensive survey area include privately owned, state, and Bureau of Land Managment (BLM) administered lands, and U.S. Forest Service.

5.1.1 Environment and Locality

The Co-Op Mining Company project area is located on the east flank of the Wasatch Mountain Range. The highland locations are situated above the 8,000-ft. elevation adjacent to the Manti-LaSal National Forest while the larger mine facility in Bear Canyon lies at the base of the Wasatch Plateau between the 6,800 and 8,000-ft. elevations.

The survey area contains a wide variation of associated vegetation communities because of variations in soil, slope, elevation, and subsurface moisture retention. The rolling ridges and arroyos of the 680 acre survey unit incorporate pinyon and juniper communities within the broken arroyo drainage system; these plants gradually reduce their dominance upon the high flats where sagebrush vegetation exists. Serviceberry, rabbitbrush, and scattered saltbush plants also exist along these drainages. The steeper areas ascending the plateau contain mountain shrub communities, which include live oak and mountain mahogany. North-facing slopes contain Douglas fir in the drainages above the upper juniper zone.

Precipitation rates relative to the different elevations within the mine permit area vary. The nearest weather monitoring station, 1 mile southeast, records an annual average of 13 inches, with 6 occurring between May and September. The annual freeze-free season is relatively short, but varies depending on elevation and exposure.

5. History of Land Use

Prior to the beginning of the Holocene Epoch (about 10,000 years ago), the pluvial conditions of the Pleistocene in the eastern Great Basin and in the Wasatch Range began to decrease. The gradual heating and drying trend of the Anathermal (about 10,000 to 7,500 years ago) was accelerated until about 4,000 years ago, although this occurrance varied in different localities throughout the West relative to local conditions. The ecosystems of the project area were influenced by these climatic changes from cool and wet through a period of increasing desiccation. About 4,000 years ago, the climate in the Intermountain West became cooler and wetter than at present with a subsequent remigration of floral and faunal species from the upper elevations back into the lower basins. These fluctuations in climate affected prehistoric human occupation patterns in the West, as shall be noted in a later section.

Land use techniques employed in the project area have ranged from hunting-gathering activities, which began during the Pleistocene, to primitive farming technology practiced along the river bottoms by the Fremont peoples as early as 1,500 years ago. With the introduction of the Euro-American settlers in the 19th century, modern farming technology, including horticulture and livestock production, became established in the Castle Valley area. From the historic period to the present, the general project area has been primarily utilized as livestock grazing land. Some horticulture related to the livestock industry has developed along the alluvial creek bottoms that extend to the east along the drainages. In addition, some coal mining has occurred during the 19th and 20th centuries at the Wattis mines to the North and at the site of the existing mine.

5.2 METHODOLOGY

A literature search, and a review of State Historical Society documents were utilized to compile a general history.

5.3 RESEARCH DESIGN

Not applicable - History Review

[The following 25 pages are extrapolated from a historical inventory conducted for another mine in the immediate area.]

The Prehistoric Period

The prehistoric period within the project region can be subdivided into four main temporal phases: Paleo Indian, Archaic, Fremont and Shoshonean.

Paleo Indian Phase

The Paleo Indian phase began approximately 12,000 years ago and terminated about 7,000 years ago; it is generally divided into three subphases, known as the Llano, Folsom and Plano cultures (Jennings 1974:81).

The Llano culture was characterized by the hunting of mammoth 10,000 to 12,000 years ago. Since the Llano culture has been defined primarily from the excavation of mammoth kill sites, very little is known about the overall subsistence activities of this culture.

Evidence of the Llano culture has been found over a widespread area in the Intermountain West and Southwest. The Clovis point, a large, lanceolate, fluted spear point is the only artifact which can be used confidently to infer the presence of the Llano hunters. Clovis points, in association with mammoth remains, have been found in New Mexico, Oklahoma, Colorado, Arizona and Wyoming.

Based on these sites, which are characterized by mammoth-Clovis point association, the core area of the Llano culture is limited to eastern Colorado, most of New Mexico, and eastern Arizona. However, the Clovis point by itself has a much larger distribution. Clovis points, or very similar fluted points, have been found throughout the entire United States.

Within Utah, no characteristic Llano sites have been found, although several isolated Clovis points and one fluted point site have been reported. An isolated Clovis point was reported from Sevier County, Utah (Tripp 1966). Gunnerson (1956) performed a test excavation on a small rockshelter in Emery County (permanent site number 42Em8) from which a local collector had obtained a Clovis point. The test excavation did not, however, recover any additional Clovis points. An unusual fluted point, which very closely resembled the Cumberland fluted points that are commonly found east of the Mississippi River, was found by an amateur collector in the San Rafael Swell and reported by Hauck (42Em677).

The Folsom culture (circa 11,000 to 9,000 years ago) immediately followed the Llano culture, but several differences in subsistence and artifacts allow a clear distinction to be drawn. Although primary evidence of the Folsom culture is also derived from kill sites, fauna hunted and projectile points used are different from the Llano culture. The Folsom point is a lanceolate, fluted and usually eared projectile point that is generally smaller and thinner than the Clovis point. In addition, the Folsom point is associated at kill sites of the extinct bison.

Folsom kill sites are found predominantly within the same region as the Llano core area but isolated Folsom points are not as widely distributed as Clovis points. Isolated Folsom points are almost entirely limited to the High Plains immediately east of the Rocky Mountains. Eleven Folsom points have been found in Utah but only one of these, found by an amateur collector somewhere in the San Rafael Swell, is known to be from the general area of the project (Tripp 1967).

The Plano subphase of the Paleo Indian phase extends from circa 9,000 to 7,000 years ago. The Plano culture, like the Llano and Folsom cultures before it, was partially economically dependent on large game, particularly bison. However, the Plano culture is characterized by a great diversity of projectile point types. Plano culture projectile points are typically lanceolate, precisely flaked, and nonfluted.

Evidence of Plano culture habitation is predominantly limited to the High Plains east of the Rocky Mountains. The presence of Plano culture hunters in Utah is not widely acknowledged.

The presence of Paleo Indian cultures within Utah was minimal even during the Llano subphase and tended to decrease with time. The slight Paleo Indian utilization of Utah might be tied to the relative scarcity of large game species in Utah compared to the Great Plains east of the Rocky Mountains. The widespread increase in aridity following the end of the Pleistocene was more acute west of the Rocky Mountains than on the eastern side. As a result, the large herbivorous animals utilized by the Paleo Indian cultures were present on the Great Plains in considerably greater numbers.

Archaic Phase

Because of the relatively arid conditions of Utah and the Great Basin, large mammal hunting was not a viable subsistence technique in that area. The Great Basin and adjacent Colorado Plateau of eastern Utah were occupied at an early date by Indian groups who were engaged in a subsistence pattern that was dependent on smaller game animals and gathering wild plant foods.

The utilization of caves and rockshelters by Archaic cultures in Utah has resulted in good temporal sequences for the entire Archaic phase. Radiocarbon dates from Danger Cave (Jennings 1957) verify human habitation of the Great Basin as early as 10,000 years ago, but the artifacts retrieved from the lowest levels of Danger Cave are not diagnostic of any recognized culture group.

In addition to Danger Cave, Hogup Cave (Aikens 1970) in the Great Basin, Sudden Shelter (Jennings et al. 1980a) in the southern Wasatch Mountains, and Cowboy Cave (Jennings et al. 1980) in southeastern Utah, have all supplied important data that is pertinent to development of a cultural sequence for the Archaic inhabitants of

Utah. The Archaic phase has been divided into three periods - Early, Middle, and Late - based on changes in projectile point types.

The Early Archaic period began approximately 8,500 years ago and continued until about 6,000 years ago. Subsistence during this period was based on generalized gathering and hunting techniques. A large variety of plant, animal and insect resources was utilized. Hunting was primarily limited to deer and mountain sheep, although antelope and bison were also sought. Rabbit and small rodent trapping provided an important source of protein.

The habitation of caves and rockshelters in conjunction with the aridity of the area has resulted in conditions suited to preservation of normally perishable materials. Due to excellent preservation, it is known that the spear thrower (atlatl) was the tool used for hunting. The atlatl was used with a two- or three-component shaft and stone dart point throughout the Archaic phase. The Early Archaic period was characterized by four types of dart points: Pinto, Humboldt, Elko and Northern Side-notch (Holmer 1978). During this time period, the Elko point type had a limited areal extent confined primarily to the northeastern Great Basin and the northern Colorado Plateau. Pinto and Humboldt points, generally found in close association in archeological contexts, had the same distribution as Elko points, but are also found in sites in southern and central Idaho. The Northern Side-notch point had a very wide distribution during the Early Archaic period encompassing the northern Great Basin, Columbia Plateau, Northern Colorado Plateau and Great Plains.

The Middle Archaic period began about 6,000 years ago and ended about 4,500 years ago. Subsistence techniques and utilization of caves were the same as during the Early Archaic, but dart point styles diversified; dart points such as the Rocker Side-notched, Sudden Side-notched, McKean Lanceolate and San Rafael Side-notched were characteristic (Holmer 1978). The Elko point continued to be used in the same areas as it had been used during the Early Archaic period. Although Rocker Side-notched and Sudden Side-notched points were limited in their distribution to central Utah, McKean Lanceolate and San Rafael Side-notched styles had wider distributions, including the Great Plains, at this time. Another point style, the Gypsum point, made its appearance during the Middle Archaic (Holmer 1978). This point style was very common in the southern Great Basin and northern Colorado Plateau and continued to be utilized through the end of the Late Archaic period.

The Late Archaic period began about 4,500 years ago and ended roughly 1,700 years ago. Subsistence techniques were essentially unchanged from the earlier Archaic periods and the utilization of Elko and Gypsum points styles was continued, although the latter style is generally limited in its occurrence to the southern half of Utah. At the end of the Late Archaic period, two new technological developments occurred which mark a significant change in prehistoric subsistence patterns: the introduction of corn and the bow and arrow.

Evidence of corn horticulture in the latter part of the Late Archaic period has been found at several locations: Cowboy Cave (Jennings et al. 1980), Cottonwood Cave in western Colorado (Hurst 1948), and Clyde's Cavern in central Utah (Winter 1973, Winter and Wylie 1974). At all three locations, corn caches found which were dated between 1,600 and 2,000 years ago. The very late portion of the Late Archaic period also witnessed the advent of the bow and arrow. At Cowboy Cave (Jennings et al. 1980), Rose Spring arrowheads were recovered from the uppermost level and were dated about 1,700 years ago.

The entire Archaic phase is characterized by a gathering and hunting subsistence mode and a sequence of dart point styles that have been defined through the analysis of excavated cave and rock shelter sites. Transient habitation of these caves during the annual migratory round is the most widely accepted interpretation of the Archaic subsistence pattern.

The atlatl was the universal Archaic hunting tool until the very last centuries of the Late Archaic period. However, the advent of the bow and arrow around 1,700 years ago does not seem to have eliminated the utilization of the atlatl during the late Archaic. Gypsum dart points continued to be manufactured even after the appearance of Rose Spring arrowheads at Cowboy Cave (Holmer in Jennings et al. 1980b).

Fremont Period

The Fremont culture of Utah has traditionally been divided into five regional variants: Parowan, Sevier, Great Salt Lake, Uintah and San Rafael. However, a recent re-evaluation has resulted in a three-fold division. The Sevier culture now includes the Sevier, Great Salt Lake and Parowan variants; the Uintah variant is replaced by an as yet unnamed northeastern Utah culture; and the San Rafael variant is designated as the Fremont culture. No cultural entity has been defined that can take into account the variation present between these three groups or areas. The differences are ascribed to separate origins (Madsen and Lindsay 1977).

All of these Utah cultures are characterized by utilization of permanent dwellings, ceramics and some degree of corn horticulture. According to Madsen, the Sevier culture (circa 1,300 to 650 years ago) can be distinguished from the Fremont culture because of the former's primary dependence on wild foods collected from marshland environments west of the Wasatch Plateau. Madsen notes that Sevier villages are normally located near marshland or riverine biomes and consist of deep semi-subterranean dwellings which are frequently clay lined. In addition, adobe surface storage structures are prevalent.

The Fremont culture is found east of the Wasatch Plateau and north of the Colorado River and dates from between 1,500 to 700 years ago. The Fremont culture relied heavily on corn horticulture and is characterized by a settlement pattern which is also distinctly different from the Sevier culture (Madsen and Lindsay 1977). Fremont culture villages are relatively small and are located adjacent to permanent streams such as Ivie Creek, Muddy Creek, Ferron Creek, Cottonwood Creek and Huntington Creek. Fremont culture architecture also differs from that of the Sevier; rock-lined semi-subterranean dwellings and coarse masonry surface storage structures predominate. In addition, Anasazi tradewares are considerably more prevalent in the Fremont culture sites than in the Sevier culture sites.

The unnamed plains-derived culture of northern and northeastern Utah existed from about 1,300 to 650 years ago (Madsen and Lindsay 1977). This culture was dependent upon hunting of bison and the collecting of wild plants. The dwellings are normally shallow basin structures without any clear evidence of the type of superstructure utilized. Unlike the coiled pottery of the Sevier, Fremont and Anasazi cultures, the unnamed culture produced pottery by the paddle and anvil techniques. It is important to note that there is a considerable spatial overlap of the unnamed culture and Fremont culture traits in the northern portion of the latter's distribution. There is currently insufficient data to determine whether the spatial trait overlap is due to alternate occupation, simultaneous occupation by the two cultures or a combination of these two possibilities.

Hunting activities among Sevier, Fremont and unnamed cultures are evident from the many varieties of small arrowheads that have been recovered from excavations. Small stemmed, corner-notched (Rose Spring) arrowpoints are present in the earlier phases of all three cultures, but after about 1,100 years ago, numerous regional variants developed. Side-notch arrowpoint styles (Bear River Side-notched and Uinta side-notched) were common in the northern part of Utah while Parowan Basal-notched and Bull Creek arrowpoint styles were common in southwestern and south-central portions of Utah, respectively. The Bull Creek points are of particular interest because they are found in high frequencies at both Kayenta Anasazi sites in southern Utah and Fremont sites along the east side of the Wasatch Mountains (Coombs Village, Bull Creek sites, Snake Rock Village, Old Woman, and Poplar Knob) and probably indicate the reciprocal exchange of males for matrimonial purposes (Holmer and Weder 1980).

Dart points, the Elko series and Gypsum in particular, are also found in association with Fremont sites. This association has been used by Schroedl (1976) to verify the indigenous development of the Fremont culture from Archaic antecedents. Dart points, during the Archaic, were used as both projectile points and knives (Weder in Jennings et al. n.d.) but their function in the Fremont context has not yet been evaluated.

In reference to Utah, Mesa Verde and Kayenta variants of the Anasazi culture are of particular importance. The San Juan Anasazi culture was centered around the Four Corners area where Colorado, New Mexico, Arizona and Utah meet. The Kayenta Anasazi inhabited the extreme southern periphery of Utah from the San Juan River west to central Utah. As has already been noted, Kayenta influence is particularly evident in a narrow band of sites running from Coombs Village northward past the Henry Mountains to the Snake Rock Village site adjacent to Interstate 70 on the east side of the Wasatch Plateau.

Shoshonean Phase

The Shoshonean populations, who were the sole inhabitants of Utah at the time of Euro-American contact, have been in the northeastern

Great Basin region since approximately 650 years ago. Their origin has been the subject of considerable controversy, however, and several hypotheses have been expressed.

One hypothesis maintains that the Shoshoneans came from the southwest of the Great Basin at about the time of the dispersal of the Sevier, Fremont and Anasazi agriculturalists (Madsen 1975b and Lamb 1958). Gunnerson's hypothesis (1962) states that Fremont, Sevier and Virgin cultures were Shoshonean peoples who had taken up horticultural and ceramic techniques diffused from the Anasazi, but later reverted to an Archaic subsistence style after a climatic change which made agricultural subsistence techniques unproductive.

Regardless of which hypothesis is correct, Shoshonean groups (Ute, Paiute, Shoshone, and Bannock) were inhabiting the Great Basin into eastern Utah (circa 1300, A.D.) roughly coincident with the disappearance of the Fremont and Sevier cultures.

The Shoshonean subsistence pattern was quite similar to the Archaic adaptation. Small familial bands were engaged in a gathering and hunting subsistence that utilized a wide variety of nondomesticated plant, mammal and insect species.

Very little archeological evidence is available for this time period. Two characteristic artifact types can generally be associated with the Shoshonean occupation of Utah. The bow and arrow was utilized for hunting and a type of arrowhead, the Desert side-notch point, has been correlated with Shoshonean occupation (Holmer and Weder 1980). Shoshoneans also utilized ceramics to a small degree. Shoshonean ceramics are easily distinguished from Sevier, Fremont and Anasazi wares by the former's relative crudeness. Shoshonean ceramics are typically thick-walled, have large temper particles, are poorly smoothed, exhibit little decoration, and have been fired in an uncontrolled or oxidizing atmosphere.

5.4 HISTORICAL INVENTORY

5.4.1 The Prehistoric Period

The prehistoric Shoshonean occupation of the Intermountain West continued up to and through the period of Euro-American contact. Indian groups inhabiting the area of eastern Utah within which the project locality is situated came to be called the Utes.

Precontact

Utes are a group belonging to the Shoshonean (Uto-Aztecan) linguistic family of which there are three branches: Ute-Chemehuevi, Shoshoni, and Mono-Paviotso. The Ute-Chemehuevi branch includes those groups which came to be known as the Utes, Southern Paiutes, and Chemehuevi. Although there is little archeological evidence, the Utes probably were characterized by a social organization and subsistence mode quite similar to all of the other aboriginal groups in the Great Basin and Colorado Plateau, i.e., Utes were pedestrian gatherers and hunters who utilized a relatively large area of western Colorado and eastern Utah (Steward 1974).

Utes were grouped into loosely organized bands consisting of extended families. Leadership was present only for subsistence task groups. They could be reliably distinguished from other contemporary aboriginal groups only in terms of linguistic differences.

Group territoriality was developed only in a statistical sense. A particular Ute band might consider a certain area as a home, but the seasonal round of each band was highly variable from year to year. The area with which any band was most familiar was not exclusively utilized by that band. Intermarriage among various Ute bands tended to maintain linguistic unity but blurred the definition of a territorial homeland for any particular band. Except for those Utes who were utilizing aquatic resources around Utah Lake, local populations were small and mobile (Steward 1974).

Early Contact

The presence of the Spanish colony at Santa Fe by 1598 resulted in the first contact between Utes and Euro-American groups. The relationship which developed between the Utes and the Spaniards was consistently friendly and resulted in the spread of the horse among the Ute bands. When the Utes obtained the horse, a change in their subsistence occurred. The equestrian Ute was able to travel more widely and more effectively and concentrate on bison hunting (O'Neill 1973).

Utilization of the horse was strongly mitigated by environmental factors, however. The maintenance of an extensive horse herd required substantial supplies of grass which generally limited the advantage of the horse to those areas where grass was plentiful such as western Colorado, the Uintah Basin, and along the western slopes of the Wasatch Mountains. The supply of grass also determined distribution of bison. The horse, therefore, was not equally valuable to all Ute bands. Bands in Colorado were able to support their horses whereas those bands in Utah, eastern Utah in particular, were unable to utilize the horse effectively and were more likely to eat it than to ride it.

Considerable trading activity with Utes was occurring during the 17th and 18th centuries. Of particular importance was the slave trade (O'Neill 1973). Utes were able to conduct slave raids on neighboring tribes (especially Navajo) because of their equestrian status. The slaves were then exchanged for horses and other Spanish goods. Whether slaves were exchanged with traders traveling into Ute territory or were driven by Utes to Spanish settlements is unknown because of the lack of documentation.

Until the 1770s, there was little official Spanish interest in the territory of the Utes. However, at that time, King Charles III of Spain decided that an exploration of areas north of Santa Fe would be beneficial to Spanish control. His developing interest was a reaction to the growing influence and explorations by the British and French in the west. Charles III felt that it was important to ensure control of trade by the Spaniards since he considered British and French traders a threat to Spanish rule (O'Neill 1973).

The first documented Spanish exploration of the area north of Santa Fe was the Dominguez-Escalante Expedition of 1776-1777. The purpose of this first officially sponsored exploration was to find a route between Santa Fe and the Spanish settlements in California. Although the expedition was unsuccessful in reaching its goal, it did extensively explore the territory occupied by Utes who, in all recorded instances, welcomed the Spaniards.

A trail was eventually established between Santa Fe and California which came to be known as the Spanish Trail. Origins of the Spanish Trail are obscure; however, this trail was probably utilized in prehistoric times as evidenced by its association with archeological sites.

Late Contact

Beginning in the early 1800s, the fur trade became active in Utah. The Arze-Garcia expedition traded for furs with Utes at Utah Lake in 1813 and soon thereafter trappers began to actively exploit the area. Etienne Provost was a member of the Choteau-DeMun exploration from 1815 to 1817 and, subsequently, founded his own trapping company which operated primarily within Ute territory. He was later killed by Utes near the site of the city which now bears his name (O'Neill 1973).

During this time, more detailed information on the Shoshonean people was recorded. In particular, specific Ute bands are mentioned with reference to their respective territories. Within the project area, the Weeminuche band conducted its yearly rounds (O'Neill 1973).

The Adams-Onis treaty of 1819, which gave New Mexico its independence, resulted in an influx of Americans to Santa Fe, mostly to engage in trapping. The newly arrived trappers caused a considerable increase in traffic along the Spanish Trail and an increase in competition for available fur resources. This competition was not welcome by Utes who were no longer consistently friendly with Euro-Americans.

Although there were a large number of independent trappers operating in Utah, their activities have not been well documented. Antoine Robidoux was an important trapper who, by 1824, was operating primarily in the Uintah Mountains. William Ashley and Peter Skene Ogden were trapping in the northern Ute territory during the summer of 1824 and, about the same time, Jedediah Smith was exploring eastern Ute territories to evaluate their trapping potential (O'Neill 1973).

The growing traffic along the Spanish Trail had an important effect on local Ute bands. Wakara, a Tumpanuwache leader, became quite powerful in the 1820s by conducting horse raids in southern California and returning to Utah by way of the Spanish Trail (Lyman and Denver 1970). He enhanced his power and wealth by exacting tribute from travelers along the trail and by trading stolen horses and Pahvant and Paiute slaves (O'Neill 1973). In addition, Wakara and his band actively engaged in fur trapping.

By the late 1830s, there was considerable competition for fur resources in Utah and western Colorado. Robidoux established a permanent fort and trading center in 1837 near White Rocks in the Uintah Basin to capitalize on beaver-laden streams of the Uintah Mountains.

Prosperity of the fur trade was not destined to last very long, however. Fierce competition over trapping areas led to widespread disruptive conflicts; most important, the demand for furs used to make beaver skin hats, fashionable in Europe and the eastern United States, declined rapidly about 1840 as fashions changed. Fort Robidoux was burned in 1844 by Utes, who apparently blamed the trappers for the declining value of their furs (O'Neill 1973; Lyman and Denver 1970).

The decline of the fur trade had a serious impact on the Ute bands of Utah. The entire economic base of the Utes began to disintegrate after 1840. Trading activities with Santa Fe began to dwindle with the decline of the horse and slave trade. Termination of Mexican control over the area in 1846 and the subsequent loss of contact for slave trade into Mexico (Lyman and Denver 1970) was very disruptive to the relationships existing between Utah and Santa Fe.

During the declining years of the fur trade, the largest invasion of Ute territory occurred. Beginning in 1847, Mormon pioneers began to move into Utah and rapidly swelled their numbers through immigration. At first, there was little conflict with the Utes because the major Mormon settlement, Salt Lake City, was on the periphery of Ute territory and the earliest Mormon expansion was to the north. In 1849, Fort Utah (later to become the town of Provo) was founded near Utah Lake on the traditional campsite of the Tumpanuwache band. Since the Tumpanuwache band, still under the leadership of Wakara, had been forced to revert to their earlier mode of subsistence due to the decline of the fur trade, their utilization of the resources around Utah Lake became of vital importance. Conflicting interests in the Utah Lake vicinity escalated into a series of raids and counterraids during the 1850s which became known as the Walker War. In the end, the Utes were forced to leave the valley and moved east across the Wasatch Mountains (O'Neill 1973).

The next few years were difficult for the Utes, who were being gradually forced to split up into small bands and resume a subsistence mode similar to the Precontact Period. Some bands, however, chose to raid Mormon settlements and farms to obtain cattle so that they could avoid starvation. These raids became more prevalent during the 1860s. Raids were conducted on Mormon settlers west of the Wasatch and Utes returned to the unsettled areas east of the Wasatch with the stolen cattle (O'Neill 1973). Although several bands were responsible for these raids, one man by the name of Black Hawk became the focus of the blame for all the raiding.

The areas east of the Wasatch Mountains remained under Ute domination for several years. A Mormon attempt to colonize at Moab was undertaken in 1855, but the Mormon settlers were harassed by Utes and forced to return to Salt Lake City. It was not until 1877, by which time the Utes had been removed to the Uintah Reservations, that Mormon colonists were able to safely settle east of the Wasatch Mountains (O'Neill 1973).

5.4.2 The Historic Period

The history of the east-central coal areas of Utah begins with the exploration and colonization efforts of the Spanish during the last quarter of the 18th Century. East-central Utah was first explored and mapped by the Dominguez-Escalante Expedition of 1776-1777 in its efforts to establish a line of communication between the Spanish settlements of New Mexico and Monterey, California (Miller 1968).

Although the Dominguez-Escalante Expedition failed to achieve this end, subsequent attempts from the New Mexico settlements and the travelings of Spanish and American fur trappers, traders, and frontiersmen resulted in a connecting route known as the Old Spanish Trail (Miller 1968:Map 20). Thousands of horses and numerous trading, trapping, and Indian slave trade expeditions passed through this route which lead from Santa Fe through the San Juan country, across the Colorado River at Moab, over the Green River at the present site of Green River, across the San Rafael Desert into Castle Valley, then wound south through Salina Canyon to southwestern Utah and southern California (Miller 1968).

By the 1830s, the trail was well established; portions of its route were being followed in 1853 by explorer, John C. Fremont and government surveyor, John W. Gunnison, who reported several sets of well-worn tracks near Green River where Interstate 70 presently runs. Other sections of the trail still remain near the Big Hole Wash in Emery County. The primary route of the Old Spanish Trail, plus divergent trails to Utah Lake, Fort Robidoux and Fort Kit Carson, brought the first extended contact into the project area (Miller 1968:Map 20).

Although forts and trading posts were scattered sparsely through southern and central Utah, the first attempts at organized settlement were undertaken by the Mormon Church. In 1855, the Elk Mountain Mission passed southward through Castle Valley to the area of Moab with the intent of establishing permanent settlement, but Indian hostility forced a quick retreat. The combination of hostile Indians, the desolate appearance of the region, the hardships involved in securing sufficient water for irrigation, and doubts about the quality of the soil caused further attempts at colonizing the eastern area of what was then Sanpete County to be dropped for over 20 years (McElprang et al. 1949:16).

At a priesthood meeting at Mt. Pleasant on September 22, 1877, encouragement was given to settle Castle Valley; soon after, 75 men from Sanpete Stake were called with Christian G. Larsen as leader. Very few responded, however, because of the aforementioned reasons. Orange Seely was subsequently given the responsibility of superintending the founding of settlements and another call for colonizers was issued by the Church in the fall of 1878. Some of the earliest settlers of the area who dwelt in dugouts in hills or washes until log houses could be erected were Elias and John Cox, Ben Jones, William Avery and Anthony Humbel. By the fall of 1878, the crops were sufficient and the situation stable enough for the families of these men to join them, a sure sign of an intent to remain (McElprang et al. 1949).

Work progressed on the agricultural settlements of Castle Valley and roads were built through the Wasatch Mountains to the more stable areas of western Sanpete County. Additionally, in the fall of 1878, the "Star-Mail Route" was opened between Salina and Ouray, Colorado; it followed the paths of the Old Spanish Trail and the "Gunnison" Trail of years before (McElprang et al. 1949:19-21). Within three years, the towns of Castle Dale, Wilsonville, Ferron, Greenriver (Blake), Huntington, Lawrence, Molen and Orangewill had been established; in February 1880, the Legislative Assembly was created in Emery County which embraced all of present-day Carbon, Emery, and Grand Counties (Lever 1898:593).

Although the project region was established for its agricultural and grazing possibilities, it was the area that inspired active settlement and the mining-dominated industrial base that central and eastern Utah retain today.

The first recorded discovery of coal in eastern Utah was by the Gunnison Expedition of 1853 (Powell 1976:13) when they located coal deposits approximately 3 miles east of present-day Emery. The isolated location of the Gunnison find coupled with the hope that deposits already discovered at Coalville and Wales would prove sufficient for the territory's needs caused Gunnison's discovery to be forgotten. The subsequent failure of the efforts at Wales to produce good coking coal and the Union Pacific Railroad's monopolization and price-fixing on deposits at Coalville caused a re-evaluation of the potential coal producing areas east of the Sanpete settlements (Powell 1976:13).

As a result, the first effort to exploit the newly found eastern coal deposits was undertaken in 1875 at Connellsville in the upper reaches of Huntington Canyon. The Fairview Coal Mining and Coke Company was organized by men from New York, Salt Lake City, and Fairview. Eleven coke ovens were constructed and the coke was hauled by wagon into Springville. The expense involved with the hauling and the questionable quality of the coke produced caused the failure and abandonment of Connellsville by 1878 after only 3 years of operation (Powell 1976:13).

The next development of coal resources was begun in the Pleasant Valley area, also in 1875. The Pleasant Valley Coal Company constructed a wagon road from Springville up Spanish Fork Canyon to Pleasant Valley coal lands in 1876; 1877 saw the opening of the No.1 Mine in Winter Quarters Canyon (Powell 1976:14). A narrow gauge rail line was completed from Springville through Spanish Fork Canyon in October 1879 by the Pleasant Valley Railroad Company since the haul to Springville by the wagon road occupied 4 days in good weather while in winter the road was impassable. This Pleasant Valley area proved to be extremely productive. The first three large-scale mines in eastern Utah were established in this area when the Mud Creek Mine was re-opened in 1882; this was followed by the 1884 opening of the Union Pacific Mine at Scofield just east of Winter Quarters Canyon (Powell 1976:15).

From the earliest times, the railroads sought to control the supply of coal in the territory, e.g., the Coalville resources and Union Pacific Railroad's control over that source. During the early 1880s, the Denver and Rio Grande Railroad was extending its lines from Colorado through Utah. Although originally graded through Castle Valley and Salina Canyon, the route was altered to pass through Price and Spanish Fork Canyon, thus taking in the rich coal areas of what was to become Carbon County (McElprang et al. 1949:22).

Further expressing its interest in eastern Utah coal, the Denver and Rio Grande Western (Denver and Rio Grande's Utah holdings) purchased the independently owned Pleasant Valley Railroad Company and Pleasant Valley Coal Company in 1882. Shortly thereafter, Union Pacific Railroad Company (UPRR) penetrated the Pleasant Valley area in order to protect its threatened monopoly on Utah coal (Powell 1976:16). UPRR formed the Utah Central Coal Company in 1882 and opened the Union Pacific Mine near Scofield in 1884. With the Denver and Rio Grande's Pleasant Valley Coal development (1882), the establishment of Utah Fuel Company in 1887, and the creation of Utah Central Coal of Union Pacific, the railroad companies almost totally dominated the ownership and production of the Utah mines until the early 1900s (Reynolds et al. 1948:195).

In 1888, a mine was opened at Castle Gate on the Price River near the mouth of Price Canyon. In about 1899, a new mine began operations at Sunnyside just 24 miles east of present-day Price at the base of Book Cliffs. The Sunnyside No. 2 Mine also began its production in 1899 with the coal obtained there utilized for coking purposes and at Castle Gate (Powell 1976:17-18).

In 1906, the first coal operations which would remain free from railroad control began production at Kenilworth, 3 miles east of Helper and was called the Independent Coal and Coke Company because of its unique ownership status. A mine was opened on the middle fork of Miller Creek in 1908 and the camp was named Hiawatha (Reynolds et al. 1948:213). This locality at the foot of Gentry Mountain, about 18 miles southeast of Price, was the scene of further coal mining development when Black Hawk Mine was opened in 1911. Just a few miles to the south in northern Emery County, a small wagon mine was purchased by the Castle Valley Fuel Company and the town Mohrland was begun. The last development in this area was undertaken in 1916 at Wattis, several miles north of Hiawatha on the flank of Castle Valley Mountain.

The decade from 1911 to 1920 saw an increase in activity in the coal regions of east-central Utah with many new mines being opened in hitherto undeveloped areas within the Utah coal producing regions.

The region around Panther Canyon on the Price River was prospected in 1911, and in 1914, the first coal was shipped out by the Utah Fuel Company which had leased the properties out for development. A small camp at the base of Castle Rock, about 5 miles northwest of Helper was also developed and opened. Located directly on the main line of the Denver and Rio Grande Western Railroad, the camp's name was changed many times, as was its ownership. Originally known as Bear Canyon, it soon was called Cameron for its developer, then Rolapp, and finally, Royal (Reynolds et al. 1948:244).

In 1912, 1,600 acres of coal land west of Helper was bought to provide coal for smelting operations in the Tintic District. The mine, at what eventually became known as Spring Canyon, began production in 1913 and was the first of many mines in the Spring Canyon District, one of the most prolific coal producing areas in eastern Utah. Soon after the establishment of Storrs (Spring Canyon), another mine was opened in Spring Canyon at Standardville, so called because it was considered to be the standard for the development of future mining camps. The year 1914 saw the opening of the Latuda Mine and camp by Liberty Fuel Company while mines were opened in 1916 at Peerless and Rains. The last mining development undertaken in the Spring Canyon District was Mutual Coal Company's Mutual and Little Standard operations, begun in 1921 and 1925, respectively.

The final major coal producing area to be opened in east-central Utah was the Gordon Creek District. This region had first been prospected in 1908, but was really brought to prominence in 1920 at the Spring Canyon Mine. Mines were developed in this area until 1925 by Consumers Mutual Coal Company, National Coal Company, and Sweet Coal Company. The operations of all three companies ceased by 1950 (Carr 1972:81).

After the development of the Gordon Creek area, further work on the coal regions was undertaken in areas that had been opened previously. In 1922, Columbia Steel Company opened a mine at Columbia near the location of Sunnyside to further exploit the excellent coking coal obtainable from that region. One very late development of these coal veins was initiated in Horse Canyon in 1942 by the United States Government to aid steel production at its Geneva plant (Reynolds et al. 1948:252). Both the mine and steel plant were taken over by U.S. Steel after World War II and continue in operation today.

Most of the mines in east-central Utah continued production through the heavy demand years of World War I and the years of prosperity that followed; however, a combination of overdevelopment, the increased use of other natural fuels, rising costs associated with expensive underground haulage, and the Depression caused several camps to be abandoned. Among the first mines to succumb were the long exploited Pleasant Valley mines. Winter Quarters, near Scofield, was closed down in 1928 while operations decreased at Scofield and Clearcreek during the early 1920s and 1930s, respectively. Despite these setbacks, 22 coal mines were operating in Carbon, Emery, and Grand counties as of 1929. The production of these mines provided 98% of the state's output (Sutton 1949:852).

Economic and production difficulties continued to plague Utah's coal industry during the 1930s, forcing the closure of the Mutual and Mohrland mines in 1938. World War II brought a temporary respite to the general downward trend with many mines achieving their highest production levels during the war years and immediately thereafter.

The 1950s signaled the end for a great number of the eastern Utah coal mining operations. The increasing use of natural gas for heating homes and for heavy industrial use, as well as the railroad's switch to diesel power were among the developments that severely hurt the coal industry. This situation has drastically changed with the advent of America's "energy shortage" and new technologies for coal use in the future have caused an upswing in coal production in east-central Utah. Mines which were closed or were operated with skeleton crews have begun to increase operations during the last decade and the possibility of a new sustained burst of coal mining activity definitely exists (Alexander 1963:244-247).

Previous Investigations in the Region

Archeological research in the Castle Valley locality began with the Claflin Emerson Expedition. In 1929, explorations and limited test excavations were conducted along the Fremont River and as far north as the Muddy River in Emery County. The work resulted in the original definition of the Fremont cultural entity (Morss 1931, Gunnerson 1969). The description of Fremont sites north of the Colorado River was an important contribution to the understanding of the prehistoric horticultural adaptation in the American Southwest.

With the exception of the description of the large petroglyph panel in Buckhorn Draw (Reagan 1935), there were no archeological investigations in the Castle Valley region for the next 15 years. Between 1952 and 1957, the University of Utah conducted a series of surveys to better define the nature of the Fremont occupation in Utah. Many Fremont sites were located along the east side of the Wasatch Plateau, several of which were subjected to limited test excavations, including site 42Em5, the Emery Site (42Em47), and Snake Rock Village (42Sv5). These three sites were each Fremont habitations (Gunnerson 1957). In addition to these Fremont sites, Gunnerson also tested a shallow rock shelter on Silverhorn Wash (42Em8) as a result of a local collector's report that a fluted projectile point resembling the Clovis style had been found eroding from the shelter deposits. Little additional information was obtained by the excavation, however (Gunnerson 1956).

In the 1970s, there was a significant upsurge in archeological activity in the Castle Valley region. In 1970, three sites endangered by vandalism were excavated by the University of Utah. These sites, Windy Ridge Village (42Em73), Crescent Ridge (42Em74), and Power Pole Knoll (42Em75), all proved to be Fremont habitation sites (Madsen 1975a) dating between about 980 and 1,260 years ago.

During the following year, the University of Utah conducted excavations at Clyde's Cavern (42Em177). Clyde's Cavern was a locus of summer plant gathering activities during the Late Archaic Period, but the majority of the cultural deposits were shown to be the result of summer maize cultivation and wild plant harvesting activities during the subsequent Fremont Period (Wylie 1972, Winter and Wylie 1974).

The next site to be excavated in the study area was Joe's Valley Alcove (42Em693). During the summer of 1974, the United States Forest Service excavated this site which had cultural strata, dated by both radiocarbon and typological means, from the Early Archaic, Late Archaic, and Fremont Periods (E. DeBloois, personal communication). That same summer, a University of Utah field school excavated the Innocents Ridge site, which proved to be yet another Fremont habitation locus (Schroedl and Hogan 1975).

During the early fall of 1975, the Antiquities Section, Division of State History (Utah) conducted an excavation of a small rockshelter as a part of the cultural resource mitigation program for Consolidation Coal Company of Denver, Colorado. This site, known as Pint Size Shelter (42Em625), had two main cultural strata, one dated to the Late Archaic and the other dated to the early Fremont Period. Both of these occupations were evidently the result of wild plant procurement activities (Lindsay and Lund 1976).

Other Fremont habitation sites, located further to the south, have been excavated. These sites include Snake Rock Village (Aikens 1967), Old Woman and Poplar Knob (Taylor 1957), and the Old Road Site and Ivie Ridge Site (Wilson and Smith 1976). These five sites were all Fremont period habitations although Kayenta and Mesa Verde Anasazi ceramics were recovered at low frequencies, indicating that there was contact with other cultural groups located further south.

In addition to these Fremont sites, a deeply stratified rock-shelter (Sudden Shelter, 42Sv6) was found to contain occupational strata spanning the entire Archaic period, circa 8,000 to 3,000 years ago (Jennings et al. 1980). When it was originally documented, the site report indicated that Fremont diagnostics were present; however, these artifacts were no longer present when the excavations were begun. The Sudden Shelter site is of particular importance to the local prehistory and to the prehistory of the eastern Great Basin and of the northern Colorado Plateau because of its numerous well-defined occupational strata which has allowed a fine-grain correlation between certain diagnostic projectile point types and the temporal phases of the Archaic period.

A test excavation of two heavily vandalized rockshelter sites (42Em959 and 42Em960) in Cottonwood Canyon conducted by AERC in 1979 seem to mirror the results of the excavations at the nearby Joe's Valley Alcove. Radiocarbon analyses have not yet been completed but projectile point correlations indicate that these two sites were occupied during the Early Archaic period, Late Archaic, and most heavily, during the Fremont Period (Weder and Hauck, n.d.).

Since 1970, the level of survey intensity has increased drastically. The various cultural resource inventories conducted during the 1970s have generally been the result of natural resource development programs and are too numerous to summarize in the present context. Summaries of the inventories performed before 1978 can be found in Sargent (1977) and Hauck (1977a). The combined inventory results as of 1977 indicate that the majority of culturally identifiable sites in the general area are Fremont although Archaic sites are also well represented. Protohistoric Numic sites are present but rare (Hauck 1979a:110).

5.5 EFFECTS OF MINING ON ARCHEOLOGICAL AND HISTORICAL RESOURCES

On two occasions the Division of State History was contacted in reference to that portion of ground in T16S, R7E, Sec. 22 and 23 that has been or may be disturbed. It was the conclusion, in both conversations, that:

[1] There are no known sites of any significance existing in the area in question,

and [2] That the majority of the land in question has been previously disturbed due to earlier mining activities,

and [3] That a survey of areas of future disturbance may be advantages but to survey ground which is disturbed serves no purpose.

However, in the event that Co-Op Mining is in a position to permit new facilities on disturbed ground, it has committed to a thorough Paleo - Archo Survey prior to any new disturbances. Also, should any evidence of Paleo - Archo finds be discovered in the course of present construction, the site will be roped off and construction halted until the Historical Division is contacted. However, a survey will be conducted the summer of 1984 for that area which may be adversely impacted by subsidence. This information will be submitted as Appendix 5-1.

5.5.1 National Register Criteria of Eligibility

Application of the National Register Criteria of Eligibility, as defined under 36 CFR 60.6, indicate that there are no sites within the permit area which would be considered candidates.

5.5.2 Discussion of Impact Potential on Cultural Resource Sites

No known sites exist, therefore, there would be no impacts anticipated at this time.

5.5.3 Mitigation of Potential Adverse Effects

A variety of archeological and historic techniques are available for use in avoiding and protecting sites, or for mitigating potential adverse affect to significant cultural resouces. Such actions, once proposed, are contingent upon comments from relevant Department of Interior agencies and Utah State Preservation offices.

Avoidance procedures are the most effective means of preserving cultural resources and will be implemented in the event that a site is uncovered.

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5.6 PALEONTOLOGIC

A literature search was made for paleontologic date within the general area. The purpose of the search was to:

[1] identify all known paleontologic sites within the designated area;

[2] identify stratigraphic horizons which are potential producers of paleontologic resources;

[3] evaluate the uniqueness of known or potential fossil sites compared to similar or duplicate faunas from the same stratigrapic horizon in other nearby areas.

Stratigraphy

Most of the ground surface within the general area is composed of the Masuk Member of the Cretaceous Mancos Shale. The Masuk is the uppermost shale member of the marine Mancos, overlying the Emery Sandstone Member and underlying the Star Point Sandstone. The lithology of the Masuk is silt, mudstone, and shale. It is about 1,000 ft. (305 m) thick in the permit area, and covers most of the area in question. Above the Masuk Member is the Star Point Sandstone, a transitional marine-nonmarine sandstone bed which is approximately 500 ft. (152 m) thick.

Paleontologic Resources

The marine Masuk Shale contains a widespread fauna consisting of abundant foraminifera (Maxfield, 1976). Ammonoids, bivalves, gastropods, fish and turtle teeth (Fisher, 1960), and probably also ostracodes (Lessard, 1973).

The Star Point Sandstone, a deltaic sequence, has produced only trace fossils from the general area. Burrowing remains of two generic types have been described from the Star Point Sandstone by Howard (1972) and Marley it al. (1979).

In every case these fossils have been reported over broad areas surrounding the study site; therefore, it is almost certain that the Masuk Shale and the Star Point Sandstone within the study area contain similar fossils.

Conclusions and Recommendations

Although no specific paleontologic sites within the designated study area are reported in published literature, there are many occurrences in the surrounding areas, strongly indicating the presence of these same fossils at the study site.

Previous paleontologic investigations demonstrate widespread occurrences of the faunas within Late Cretaceous marine and nonmarine strata in this area. Therefore, all fossils which likely occur within the study site are almost certainly duplicated in surrounding outcrops of Masuk Shale and Star Point Sandstone.

The paleontologic resources within the permit area are neither particularly abundant nor unique compared to their counterparts in similar stratigraphic horizon within the general area. Based upon present knowledge, development of this site would not pose a threat to the paleontologic resources of the area.

5.7 PUBLIC PARKS

There are no Public Parks within the permit area.

5.8 PALEO-ARCHAEOLOGICAL INVENTORY

Co-Op Mining Company has counselled with the Utah Division of State Historical Preservation Office and has agreed to an on-site survey. The survey will be conducted by an approved archaeologist from BYU (Brigham Young Univ.) as soon as weather permits, (June or July, 1984). The survey and results will be submitted at that time as Appendix 5-1. Co-Op is committed to take all necessary steps to protect any sites deamed necessary in the event any are located.

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