

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 during 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.

Maintenance

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

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Regrading and Reseeding

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Erosion that develops in completed areas will be minimized by repeated grading and seeding as described in Chapter 3, page 103.

Success Monitoring and Extended Responsibility Period

Vegetation and water will be monitored during 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.

5/10/85

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."

and ground water and maintain or improve water quality to meet the standards for existing or possible future uses of water."

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Impacts

Approximately 10 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 further 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 receive 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 reliability. 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 USEA. 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 Slopes	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

<u>Primary Service Area</u>		<u>Secondary Service Area</u>	
<u>Carbon County</u>	(min.) <u>Commute Time</u>	<u>Carbon County</u>	(min.) <u>Commute Time</u>
Price	45	East Carbon City	90
Helper	50	Sunnyside	90
Wellington	45		
Hiawatha*	35		
<u>Emery County</u>		<u>Emery County</u>	
Huntington	15	Ferron	50
Cleveland	30	Emery	65
Castle Dale	30		
Orangeville	30		

* 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

<u>Community</u>	<u>Water</u>	<u>Sewer</u>	<u>Schools</u>	<u>Hospital</u>	<u>Housing</u>	<u>Commercial Facilities</u>	<u>Land for Expansion</u>
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

<u>Mine Name</u> <u>Operator Location</u>	<u>Million Tons</u> <u>Per Year (1990)</u>	<u>*Employment</u>
"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	<u>280</u> 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

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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 Management (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 gradu-

ally 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 occurrence 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. Inter-marriage 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 sub-

sistence 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) pur-

chased 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 pre-

viously. 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 rock-shelter 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 rockshelter (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 data 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 stratigraphic 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 et 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 deemed necessary in the event any are located.

4/25/84

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CHAPTER 6

GEOLOGY

CHAPTER 6

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6.1 SCOPE

The geology section of this report describes the general geological conditions of the Co-Op Mining permit area and adjacent areas and identifies whether the conditions are acceptable for recovery of the coal by underground methods.

The following major topics are covered: methodology, regional geologic framework, stratigraphy and structure of the project vicinity, extent of coal reserves, coal quality and characteristics, characteristics of the adjacent units, and the geologic hazards and impacts of mining.

6.2 METHODOLOGY

The information used in preparing the geology section of this report includes available literature from surrounding mines, and up-to-date mapping and reserve estimates by the Co-Op Mining Company personnel. Physical and chemical analyses were performed in a certified laboratory.

6.3 REGIONAL GEOLOGIC FRAMEWORK

The mining site lies at the base of an erosional escarpment that forms the eastern face of the Wasatch Plateau, a subdivision of the Colorado Plateau physiographic province.

East of the Wasatch Plateau is Castle Valley, a relatively

flat area over 80 miles long and 10 miles wide trending northeast-southwest. East of Castle Valley lies the San Rafael Swell, a great upfold marked by rings of hogback hills and intervening valleys.

The Wasatch Plateau is a high, broad, flat area dissected by numerous streams. The high plateaus of Utah, which include the Wasatch Plateau, are thought to be a transition zone containing geologic structures common to both the Colorado Plateau Province and the Basin and Range Province to the west.

The Co-Op Mining Company site is located near the east central edge of what is known as the Wasatch Plateau coal field. The plateau edge is a steep cliff with a maximum relief of about 1,000 ft. Coal outcrops appear in the canyon walls and along the cliffs. Rock types at the site are late Cretaceous in age and are generally composed of gray sandstone of fine to medium grain, interbedded with subordinate gray and dark gray carbonaceous shale and coal seams. These represent continental and/or transitional sediments. Marine sediments occur below the sequence and are exposed to the east of the escarpment in Castle Valley.

Table 6-1 gives the generalized stratigraphic sequence and unit description for the Wasatch Plateau. The oldest rocks

are of early Upper Cretaceous age. The major commercial coal seams occur in the Blackhawk Formation and are of Campanian age.

Structurally, strata in the eastern Wasatch Plateau generally dip southerly (sometimes slightly southeast or southwest) at low angles of 1 to 3 degrees. Locally, near faults, the dip increases to about 20 degrees. Three major north-south trending fault zones have been defined in the Wasatch Plateau Coal Field (see Fig. 6-1). Each zone is the product of a high angle block fault with extensive minor fracturing within the graben. The Joes Valley Fault is the largest zone. As shown in Fig. 6-1, the zone lies several miles west of the Co-Op permit area. The Pleasant Valley Fault Zone is approximately 3 to 5 miles wide. In most areas the fault planes of the Pleasant Valley Zone are vertical with between a few feet to 100 feet displacement (Doelling, 1972), although greater displacement occurs locally. The North Gordon Fault Zone, which occurs near the eastern boundary of the Wasatch Plateau field, is the least extensive of the zones. The trends of the faults have a complex pattern. Displacement is generally less than 800 feet (See Plate 2-1 for a larger scale view of faults within the permit area.)

6.4 GEOLOGY OF THE PROJECT VICINITY

Plates 2-3, and 3-1 show the topography of the area. The permit area is generally rugged, with elevations varying from 7,000 to about 10,000 feet above sea level. Slopes within the permit area vary from more than 210% (65 degrees) east of Star Point to less than 4% (2 degrees) on Gentry Ridge.

6.4.1 Stratigraphy

All of the geologic formations exposed on or adjacent to the permit area are Cretaceous members of the Mesaverde group, with the exception of the North Horn Formation, which is Tertiary (See Table 6-1 & Figure 6-2). The mineable coal seams are located in the Upper Cretaceous Blackhawk Formation.

Star Point Sandstone

The Star Point Sandstone, the basal formation of the Mesaverde group (Doelling, 1972), is a light-colored, fairly well-sorted marine sandstone of medium to fine grain (Spieker, 1931).

North of the Wattis

Canyon area, the Star Point Sandstone divides into three tongues. In the project vicinity, the tongues are essentially fused into one massive cliff-forming unit. The Star Point becomes thicker to the southeast, ranging from 400 to 460 feet near the eastern edge of the lease area to 600 feet or more near the central part of Huntington Canyon (Spieker, 1931).

Blackhawk Formation

Overlying the Star Point Sandstone is the coal-bearing Blackhawk Formation, the middle division of the Mesa-verde group. The Blackhawk consists of alternating sandstone, shale, and coal beds, with thin beds of argillaceous freshwater limestone occurring occasionally. The sequence represents deposition alterations between littoral and lagoonal sediments. The formation is approximately 1,000 feet thick, with the valuable coal seams located within the lower 400 feet (Doelling, 1972).

The sandstone beds are fine to medium-grained (Spieker, 1931) and yellow-gray to tan in color (Doelling, 1972). The sands of the Blackhawk are generally cemented by calcium carbonate or silica, with the exception of a few localized areas in which the cement is almost entirely clay. Iron is also present in the cement of all but the pure white sandstone (Spieker,

1931). An exception to above mentioned sandstone is the Aberdeen Sandstone, a coarse-grained, white sand that is traceable from the northern part of the Wasatch Plateau coal field southward to the northwestern slopes of Gentry Mountain (Spieker, 1931). The generally discontinuous nature of the Blackhawk and apparent low specific water yield (Cordova, 1964) indicates that the water yielding capabilities of the Blackhawk are only of local importance.

Three general types of shale, all continental in origin, have been identified in the Blackhawk Formation (Spieker, 1931): ordinary clay shale, carbonaceous shale, and smoke-gray shale. The ordinary clay shale is gray or green, granular, and normally soft at the outcrop; the carbonaceous shale is brown to black, massive, and laminated; and the smoke-gray shale is tough and leathery, and in its unweathered state is hard and homogeneous (Spieker, 1931). Shale acts as an effective barrier to the vertical movement of water within the Blackhawk Formation. Therefore, a significant portion of the water that reaches the Blackhawk probably percolates downward until it reaches a shale layer, which causes horizontal movement to the surface or another "drain" (i.e. sandstone finger) within the formation.

Castlegate Sandstone

The Castlegate Sandstone, generally considered the basal member of the Price River Formation (Spieker, 1931) consists of massive, highly resistant medium to coarse-grained sandstone beds containing, in places, conglomerate with a matrix of grit (Doelling, 1972). It is thought to be of marine origin (Paul Wier Company, 1977). Although the Castlegate overlies the Blackhawk Formation, it appears barren of coal in the Plateau lease area.

Price River Formation

The lithologic characteristics of the Price River Formation and the underlying Castlegate Sandstone are similar; however, the Castlegate member is differentiated from the Price River by its cliff-forming characteristic (Spieker, 1931). Like the Castlegate, the Price River Formation consists of medium to coarse-grained sandstone beds with occasional lenses of shale. Although the unit has a high porosity, its apparent low permeability (Cordova, 1964) reduces its water yielding capabilities except through fractures.

North Horn Formation

The youngest geologic formation within the lease area is the North Horn Formation, which caps the Price River Formation on Gentry Mountain (Doelling, 1972). The North Horn, the lowest member of the Wasatch Group, consists of variegated shales, irregular beds of gray, brown, or cream colored sandstone of various textures, and thin beds of steel-gray and cream colored limestone (Spieker, 1931).

Surficial Deposits

A few small areas in the easternmost permit area are covered with Quaternary gravel. There are no alluvial deposits within the area to be affected by the mining. Likewise, the permit area is not prone to slides.

6.4.2 Structure

Structurally the strata in the Wasatch Plateau generally dip southerly (slightly southeast or southwest) at angles of 1 to 3 degrees. Three major north-south trending fault zones have been defined in the Wasatch

Plateau Coal Field. Each zone is the product of a high block fault with extensive minor fracturing within the graben. The Bear Canyon Mine is located in the Pleasant Valley Fault Zone. The vertical displacement between a few feet and 200 feet plus. A major fault separates the Bear Canyon Mine from the Trail Canyon Mine. (Note: Geotechnical section and the mine map for Bear Canyon are located in the appendix.) Displacement on this particular fault is estimated to be 220 feet. During the mining of the Bear Canyon Seam several minor faults were discovered in the Trail Canyon Mine. These faults may effect the mining of other seams.

6.5 GEOLOGY OF THE COAL BEDS AND ADJACENT UNITS

Stratigraphy

All of the geologic formation exposed on or adjacent to the permit area are Cretaceous members of the Mesaverde group, with the exception of the North Horn Formation, which is Tertiary. The minable coal seams are located in the Upper Cretaceous Blackhawk Formation.

6.5.1 Exploration and Drilling

6.5.1.1 Test Borings

Co-Op has not done any test borings. A request was made to Northwest Carbon for the information from Northwest Carbon concerning drilling North of the permit boundary which would be incorporated into the plan, but the request was not granted.

The applicant respectfully requests that the division supply the applicant with the Utah Geological and Mineral Survey reports referred to in the ACR. See Appendix G1.

6.5.2 GEOLOGY

General Stratigraphy

The exposed geologic column, in ascending order, consists of the Mancos Shale, the Star Point Sandstone, the coal-bearing Blackhawk Formation and the Castlegate Sandstone Member of the Price River Formation. All of these geologic units are Cretaceous in age. The Star Point Sandstone through the Price River Formation

composes the Mesaverde Group in this locality.

The Mancos Shale forms the initial steep slopes rising from the washes which in turn is overlain by the initial cliff-forming Star Point Sandstone (".... thick-bedded to massive beds separated by subordinate Mancos-like shale".)⁽¹⁾

The Blackhawk Formation is composed of alternating sandstones, shales, mudstones and coal representing marine, transitional and terrestrial varieties of sedimentation. Depositional environments of the Blackhawk Formation include littoral, lagoonal, estuarine and swamp type environments. The Blackhawk outcrops to form a step and slope topography slightly less resistant than the Star Point below and the Castlegate above. Multiple coal seams are found within the lower 350 feet of the Blackhawk.

The Castlegate Member of the Price River Formation makes up a massive, resistant cliff-former above the Blackhawk.

⁽¹⁾ 1972, Central Utah Coal Fields: Sevier-Sanpete, Wasatch Plateau, Book Cliffs and Emery, Monograph Series No. 3, U.G.M.S., H.H. Doelling.

Structure

The Bear Canyon fault, which is part of the north-south trending Pleasant Valley fault zone, is the only major structural feature in the study area which has any effect on the mineability and continuity of the coal. Displacement on this particular fault is estimated by the author to be 200'+ in the vicinity of Bear Creek Campground on the north side of State Highway 31. The west side of the fault is down relative to the east side. In the vicinity of the Bear Canyon Mine, Section 24, Township 16 South, Range 7 East, the fault is buried by alluvium, however, the fault trace expresses itself in the falls in the NW $\frac{1}{4}$, NW $\frac{1}{4}$ of Section 24, Township 16 South, Range 7 East and displacement at this point is apparently less than five feet. Strata immediately bordering the fault is disturbed and inconsistent in spatial attitude with equivalent strata in the study area east of the Bear Canyon fault. This will no doubt have a limiting effect on the extent to which coal can be mined in the immediate vicinity of the fault. The Bear Canyon fault marks the western boundary of the study area.

Strata east of the fault are nearly horizontal in attitude providing excellent mining conditions.

Coal outcrops slightly lower in elevation in the southern portion of the area than in the northern portion.

Small faults noted in the field along outcrop were interpreted to be largely of non-tectonic origin (e.g. landslide and slump) by the author. Other faults observed did not express displacement of sufficient magnitude to be prohibitive to mining.

Coal

Multiple coal seams are found in the lower 350 feet of the Blackhawk Formation as was previously mentioned. In ascending order the seams are as follows: Hiawatha, Blind Canyon, Bear Canyon and the upper beds,⁽¹⁾ (see Table 1 - following).

None of the coal lies at depths of more than 1,800 in the study area. Depth should not be a limiting factor in mining.

It was noted in the field that strata situated at elevations consistent with the upper beds structural horizon were badly burned and not of economic importance.

LOWER HUNTINGTON CANYON	FEET
Upper beds	0-6
Interval	200
Bear Canyon bed	0-10
Interval	40-60
Blind Canyon bed	0-10
Interval	40-60
Hiawatha	5-8
Star Point Sandstone	

Author's Note: Hiawatha to Blind Canyon interval can be as great as 110 feet.

TABLE 1 (AFTER DOELLING, 1972)