SOUTHERN UTAH FUEL COMPANY

SUFCO COAL MINE

COASTAL STATES ENERGY COMPANY

1980

VOLUME 6

VOLUME 6

TABLE OF CONTENTS

UPDATE REPORTS - 1980 (continued)

Avifauna

*Air Monitoring

(updated)

Particulate Emissions

* Aquatic Resources

*Drainage/Sediment Control

(with 1981 Submittal)

TECHNICAL CORRESPONDENCE

* Denotes change or addition (4/83)

RAPTOR AND GENERAL AVIFAUNA STUDIES

SUFCo Mine, Convulsion Canyon

July - August, 1980

to

Coastal States Energy Company

Nine Greenway Plaza

Houston, Texas 77046

by

Clayton M. White

Department of Zoology

Brigham Young University

Provo, Utah 84602

INTRODUCTION AND OBJECTIVES

Previous reports by WESTECH (1977, 1978) have rather thoroughly described the flora and physiogamy of the Convulsion Canyon area. It is complete and useful. That description which is complete and useful need not be repeated here. Our work during 1980 in the Convulsion Canyon area took place over an eight day period, July 18-20, 24-26, and August 8 and 9. We have also obtained observations from other Brigham Young University (BYU) personnel working with mammals in the same area.

Our prime objectives were to (1) determine the nature of the avifauna; (2) document nesting species of raptors; (3) determine presence of two threatened or endangered species, the Bald Eagle (*Haliaeetus leucocephalus*) and Peregrine Falcon (*Falco peregrinus*); (4) investigate the status of several species of high federal interest, namely, Golden Eagle (*Aquila chrysaetos*), Ferruginous Hawk (*Buteo regalis*), Flammulated Owl (*Otus flammeolus*), Lewis' Woodpecker (*Asyndesmus lewis*), Williamson's Sapsucker (*Sphyrapicus thyroideus*), Pileated Woodpecker (*Dryscopos pileatus*) and Western Bluebird (*Sialia mexicana*).

In addition to the above objectives, there has been raised the issue of a series of birds that are important nationally. The National Audubon Society recognizes a category they refer to as the "Blue List" (Arbib, 1979). These are species that are recently or currently giving indications of non-cyclical population declines or range contractions, either locally or wide spread and they merit surveillance as an early warning list. Seven of the species we found are on that list for category I, wide spread species. An additional three are in category II, species with restricted ranges. Lastly, two other species of those we observed are in

category III, marginal list, or those that require special attention to clarify their status since in previous years they were nominated for the "Blue List." Of the "Blue List" birds, the Lewis' Woodpecker and Western Bluebird are also mentioned as species of high federal interest (see above). The Utah Division of Wildlife Resources issued a mimeographed list in May 1980 of selected species in Utah whose status is questioned. At least one additional species, the Mountain Bluebird (*Sialia currucoides*), that occurs in the SUFCo area is on that list.

We were not able to do work in the SUFCo area prior to mid-July and thus we missed some birds that may have occurred there in May or June. However, the list of birds generated by the U.S. Forest Service (1976) has been useful. There is generally a lack of published material on birds from that area and only general reference to birds in the region is found in Woodbury *et al*. (1949), Behle and Perry (1975). The only specific treatment by habitat and species is that of Worthen (1968) in an area just to the west of the Convulsion Canyon--Salina Region.

AFFECTED ENVIRONMENT

While certain habitats will be affected by the mining operation none are considered limited enough to seriously impact any of the aforementioned species. Also, based on the species we found (Table 1) none are considered habitat specific enough to be negatively impacted by normal mining operations.

METHODS

This research was designed to quantitatively assess the nature of the avifauna species composition and their relative abundance in the mine base area. Each habitat type was surveyed and areas that proved to have a rich diversity of avifauna were thoroughly searched for the presence or absence of species. These surveys were conducted simply by visual observations. No trapping nor netting was done. Our specific observations were made between July 18-20, 24-26 and August 8 and 9, although other Brigham Young University personnel working on mammals in the area in June supplied us with three additional observations.

RESULTS AND DISCUSSION

During our work we encountered 53 species and an additional four were reported to us by other BYU personnel working in the same area bringing the total to 57 species. Of the species we observed, WESTECH also found 25 of them or 89% of their list. They found three species, the Scrub Jay (*Aphelocoma coerulescens*), Swainson's Thrush (*Catharus ustulata*) and Lark Sparrow (*Chondestes grammacus*) that we did not find.

Those species we found are typical of the habitat of the SUFCo Mine area and of that portion of the state (Behle and Perry, 1975). Only one species, the Lucy's Warbler (*Vermivora luciae*), was atypical of the area and is a northward extension of its usual habitat of the Lower Sonoran portion of the state.

General Avifauna

There was neither anything remarkable nor unexpected in the composition of the avifauna. We would anticipate many more species to be recorded if observations had been started in May and early June because many migrants pass through the area in addition to some species that breed early and then leave. A perusal of Table I suggests that the general avifauna is balanced in terms of the distribution of taxa. Observations in at least two other seasons will doubtless produce double the numbers of species we recorded since the U.S. Forest Service (1976) has listed 102 species for the region.

During the study period, each day was clear and warm and weather could not be blamed for our having missed some species we expected to find. Fourteen species were seen every survey day of which at least seven species could be considered common (Table I). None of the species

TABLE 1. Birds observed by Brigham Young University personnel in the SUFCo mine lease area.

Anseriformes		
Mallard	*Anas platyrhynchos*	nesting Mud Lake
Falconiformes		
Turkey Vulture	*Cathartes aura*	4[a]/1[b]
Cooper's Hawk (pair) nesting	*Accipiter cooperii*	3/(3)
Red-Tailed Hawk	*Buteo jamaicenais*	1/(1)
Swainson's Hawk	*B. swainsoni*	1/(1)
Golden Eagle (2 ad. & 1 juv.)	*Aquila chrysaetos*	7/(3)
American Kestrel	*Falco sparverius*	8/4
large falcon	*F. mexicanus* ?	1/1
Galliformes		
Blue Grouse	*Dendragapus obscurus*	3/(3)
Ruffed Grouse	*Bonasa umbellus*	1/(4)
Sage Grouse	*Centrocercus urophasianus*	2/1
Strigiformes		
Great-horned Owl	*Bubo virginianus*	(heard only) rest on new lease area
Columbiformes		
Mourning Dove	*Zenaidura macroura*	6/2
Caprimulgiformes		
Poor-will	*Phalaenoptilus nutallii*	2/(2)
Common Nighthawk	*Chordeiles minor*	2/1
Apodiformes		
White-throated Swift	*Aeronautes saxatalis*	8/ca. 8
Black-chinned Hummingbird	*Archilochus alexandri*	1/(1)
Broad-tailed Hummingbird	*Selasphorus platycercus*	8/many
Piciformes		
Common Flicker	*Colaptes auratus*	8/3
Yellow-bellied Sapsucker	*Sphyrapicus varius*	2/(4)
Hairy Woodpecker	*Dendrocopos villosus*	5/6-10
Passeriformes		
Western Flycatcher	*Empidonax difficilis*	2/3
Western Wood Pewee	*Contopus sordidulus*	1/(1)

TABLE 1. Continued.

Passerines continued		
Olive-sided Flycatcher	Nutallornis borealis	4/2
Horned Lark	Eremophila alpestris	1/(1)
Violet-green Swallow	Tachycineta thalassina	8/>10
Cliff Swallow	Petrochelidon pyrrhonota	8/>10
Steller's Jay	Cyanocitta stelleri	6/5
Black-billed Magpie	Pica pica	3/(15)
Clark's Nutcraker	Nucifraga columbiana	8/3
Mountain Chickadee	Parus gambeli	8/>10
White-breasted Nuthatch	Sitta carolinensis	6/3
Pygmy Nuthatch	S. pygmaea	8/>10
Brown Creeper	Certhia familiaris	1/(2)
House Wren	Troglodytes aedon	2/7
Rock Wren	Salpinctes obsoletus	4/(4)
Robin	Turdus migratorius	8/4
Western Bluebird	Sialia mexicana	2/3
Mountain Bluebird	S. currucoides	8/>10
Townsend's Solitaire	Myadestes townsendi	1/(1)
Solitary Vireo	Vireo solitarius	3/2
Warbling Vireo	V. gilvus	1/(1)
Virginia Warbler	Vermivora virginiae	1/(1)
Myrtle Warbler	Dendroica coronata	2/1
Townsend's Warbler	D. townsendi	1/(2)
Grace's Warbler	D. graciae	2/2
Lucy's Warbler ?	Vermivora luciae	1/(1)
Western Tanager	Piranga ludoviciana	7/1
Black-headed Grosbeak	Pheucticus melanocephalus	3/3
Cassin's Finch	Carpodacus cassinii	1/(1)
Pine Siskin	Spinus pinus	saw 1 heard 3
Green-tailed Towhee	Chlorura chlorura	5/2
Rufous-sided Towhee	Pipilo erythrophthalmus	1/(1)
Vesper Sparrow	Pooecetes gramineus	8/>10
Gray-headed Junco	Junco caniceps	8/9
Chipping Sparrow	Spizella passerina	8/6
Brewer's Sparrow	S. breweri	1/1

[a]First number indicates the number of days for which a species was observed.

[b]Second number represents the approximate number of encounters per day for a species. (A number in parenthesis represents the actual number of observations for a species during the study.)

recorded require a unique or limited habitat. However, such species as Pygmy Nuthatch and Western Bluebird are seemingly confined to Ponderosa Pine habitat in Utah (see also Behle and Perry, 1975).

Raptors

Only one nest, that of a Cooper's Hawk, was found (Fig. 1). We note that nests were also not found by WESTECH during their survey. The few numbers of raptors seen attests to the paucity of them. Golden Eagles were seen on nearly every survey day and may nest in the general area if not within the lease area proper. The presence of two adults accompanied by a juvenal suggest their nearby breeding. We could not, however, locate any nests. The Prairie Falcon has also been reported by U.S. Forest Service and Bureau of Land Management personnel for the planning unit that encompasses the SUFCo area.

The conspicuous lack of permanently running water has an effect on raptors. Many species, such as accipiters, appear to rely on streams and the associated riparian vegetation (Hennessy, 1978). The one Cooper's Hawk nest found was in an area seemingly less favorable than surrounding canyons. Quitchupah Canyon appeared to be prime habitat, but no nests were found. There are no obvious reasons why more raptors, especially the buteos, were not found. Habitat does not appear to be limiting and thus perhaps some essential food resource is not present.

Threatened and Endangered Species

None have been recorded on the mine lease area. Bald Eagles have a winter roosting area in the U.S. Forest Service planning unit, but any occurrence of them in the Convulsion or Quitchupah Canyon area needs documentation. For them to arrive at various localities south of the lease area we suspect that they must traverse the area in small numbers in late autumn and late winter during migration.

The nearest known historically occupied Peregrine Falcon eyrie is in excess of 25 miles for the mine lease area. The Gray Vireo (Vireo vicinior) has recently been proposed for listing as an endangered species, but its occurrence in the area is not documented. The area is slightly northeast of its currently known breeding range, although the habitat is suitable.

Species of High Federal Interest

In Utah, the Western Bluebird appears to be a near obligate of Ponderosa Pine as a nesting bird. It can be locally common and its habitat is widespread. It therefore does not represent any special problem in the lease area. Neither the Ferruginous Hawk nor the three woodpeckers (see above) were indentified in the area, although the Ferruginous Hawk may migrate at the elevation of the lease area. Any suggested impact upon species in this category would be conjectured unless specific data were at hand. Some species of high Federal interest (eg. Ferruginous Hawk) may not be as sensitive to human impact as previously thought (see White, Thurow and Sullivan, 1979).

Habitat of Unusually High Value

In terms of avifauna requirement, there does not appear to be any habitat that falls into this category. The possible exception may be the extensive cliff development along the North Fork of Quitchupah Canyon where the proposed ventilation ports are planned. However, such habitat is very wide spread in closely adjacent regions and there were not noteworthy records of birds in that area.

UNSUITABILITY CRITERIA

This section considers the unsuitabiltiy criteria according to 43 CFR 3461.2 as they specifically apply to the avifauna, specifically criteria numbers 9, 10, 11, 12, 13 and 14.

Criteria No. 9:

There are no Federally designed critical habitats for threatened and endangered plants and animal species.

Since the only threatened or endangered avian species that may occur there would do so briefly during migration and the area they would traverse not large enough to be significant the area of concern meets this criterion.

Criterion No. 10:

The State of Utah Division of Wildlife Resources does not maintain a threatened or endangered species lists for plants and animals.

Criterion No. 11:

There are three Golden Eagle nest sites within the KRCRA boundary. The U.S. Fish and Wildlife Service considers that any section of land on which the nests are located to be an appropriate buffer zone. Therefore the nest sites and buffer zone are unsuitable for future coal lease consideration.

Exception:

The Fish and Wildlife Service has determined that subsurface mining would not jeopardize the continued existence of these species. However, strict stipulations must be applied to any surface disturbance within the buffer zone.

Criterion No. 12:

There is one Bald Eagle roost and concentration area within the Planning Unit.

Exception:

The Fish and Wildlife Service has determined that subsurface mining would not jeopardize the continued existence of this species. However, strict stipulations must be applied to any surface disturbance within the area.

While we have speculated on the presence of this species on the mine lease area, other than on the Planning Unit as a whole, this species has not been seen and we corroborate the Fish and Wildlife Service findings.

Criterion No. 13:

There are no known active falcon nest sites within the KRCRA boundary. However, the prairie falcon has been observed in the area within the planning unit.

Criterion No. 14:

Five migratory bird species of high Federal interest are found within the KRCRA boundary. These species are: Western Bluebird, Flammulated Owl, Ferruginous Hawk, Golden Eagle and Bald Eagle. High priority habitat for the Golden and Bald Eagles have been previously discussed under Criteria 11 and 12. High priority habitat for the remaining species has been determined in consultation with the U.S. Fish and Wildlife Service.

Exception:

The BLM and USFS have determined after consultation with the Fish and Wildlife Service that subsurface coal mining will not adversely

affect the habitat during the periods when such habitat is used by the species.

In addition to the species listed in this Criterion, the Lewis' Woodpecker, Pileated Woodpecker and Williamson Sapsucker are also species of concern for the U.S. Fish and Wildlife Services. Our studies suggest that the same exception applies for these species because of a lack of high priority habitat.

MITIGATION

Since the mining operation in the region have been in operation approximately 40 years, little can or should be done to change the existing operation procedures. Any species that occurs in the immediate area of the mine portal or road system have made the behavioral adjustments necessary or they no longer occur there.

The ventilation portals may be of concern but based on our findings their placement will not be of sufficient impact to warrant any special mitigating action. The numbers of species of birds or individuals affected by the portals will be minimal.

Increased human activity normally brings with it increased leisure time. This time may be occupied by sporting activities. Our experience in many parts of the United States suggests that increased pressure may be put on certain species by wanton shooting. Roadside species particularly vulnerable to this are hawks, woodpeckers and upland game birds. This can be mitigated against by regulations prohibiting the discharge of firearms by employees although enforcement is difficult.

Increased road traffic will exact a heavier toll on some species such as upland game birds. This may reduce the number of any species locally, but at the same time provide increased food as carrion for other species, eg. ravens, magpies, hawks, etc. This is difficult to mitigate and any toll exacted will probably be within acceptable levels.

LITERATURE CITED

Arbib, R. 1979. The blue list for 1980. American Birds, 33:820-835.

Behle, W. H. and M. L. Perry. 1975. Utah Birds: Guide, Check-list and Occurrence Charts. Utah Museum of Natural History, Univ. of Utah, 143p.

Hennessy, S. P. 1978. Ecological relationships of accipiters in northern Utah -- with special emphasis on the effects of human disturbance. MS thesis, unpbl., Utah State Univ., 66p.

U.S. Forest Service. 1976. Final environmental statement for land use plan, Salina Planning Unit, Fishlake Nat. Forest.

WESTECH. 1979. Supplement to: Environmental assessment and impact evaluation of Southern Utah Fuel Company property in central Utah. Tech. Report to Coastal States Energy Co., March 1979.

White, C. M., T. Thurow, J. F. Sullivan. 1979. Effects of controlled disturbance on ferruginous hawks as may occur during geothermal energy development. Geothermal Resource Council, Trans. Vol 3:777-780.

Woodbury, A. M., C. Cottam and J. W. Sugden. 1949. Annotated checklist of the birds of Utah. Univ. Utah Biol. Ser. 11:1-40.

Worthen, G. L. 1968. The taxonomy and distribution of the birds of the southeastern Great Basin, Utah. MS thesis, unpbl., Univ. of Utah, 588p.

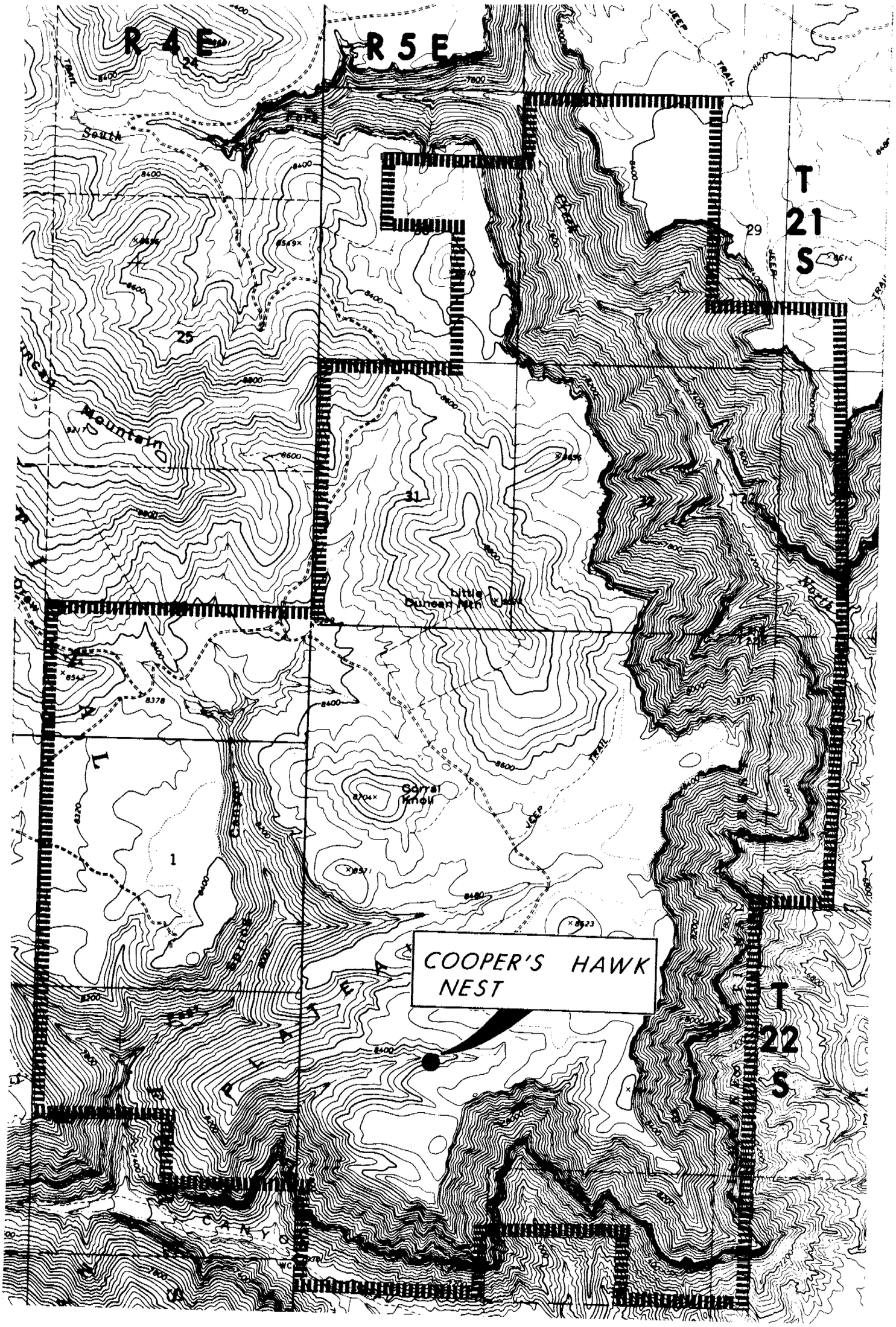


FIGURE 1

SUFCO MINE AREA SHOWING LOCATION OF THE COOPER'S HAWK NEST

CORPORATION

DCN 82-120-169-07

ANNUAL AIR MONITORING REPORT FOR COASTAL STATES ENERGY COMPANY SUFCo MINE AT SALINA, UTAH SEPTEMBER 1, 1980 - AUGUST 31, 1981

Presented to:

Mr. Kevin L. Yocum
Director of Land & Environmental Affairs
Coastal States Energy Company
9 Greenway Plaza
Houston, Texas 77046

Prepared by:

Radian Staff

RADIAN CORPORATION

TABLE OF CONTENTS

		Page
I.	GENERAL DESCRIPTION OF THE AIR MONITORING PROGRAM	1
	A. Purpose of the Air Monitoring Program	1
	B. Network Description	2
	C. Site Description	3
II.	OPERATIONAL SUMMARY	8
III.	DATA PRESENTATION AND SUMMARY	16
IV.	SYSTEM DESCRIPTION	26
	A. Meteorological Systems	26
	B. Air Quality Instrumentation	28

RADIAN CORPORATION

LIST OF TABLES

		Page
TABLE I.	DATA CAPTURE RATES (%) FOR SUFCO - SEPTEMBER 1, 1980 - AUGUST 31, 1981	9
TABLE II.	OVERALL DATA CAPTURE RATES (%) FOR SUFCO SEPTEMBER 1, 1980 - AUGUST 31, 1981	10
TABLE III.	NUMBER OF OBSERVATIONS (HRS) FOR SUFCO SITE 005 AND SITE 007 - SEPTEMBER 1, 1980 - AUGUST 31, 1981	11
TABLE IV.	THE FIVE MAXIMUM TOTAL SUSPENDED PARTICULATE AVERAGES	18
TABLE V.	MONTHLY AVERAGES	20
TABLE VI.	WIND ROSE	23

RADIAN CORPORATION

LIST OF FIGURES

		Page
Figure I	SUFCo Mine (Utah) Air Quality Monitoring Site Region	4
Figure II	SUFCo Site 005	6
Figure III	SUFCo Site 007	7
Figure IV	Monthly Maximum 24-Hour TSP Averages SUFCo Site 005, September 1, 1980 - August 31, 1981	12
Figure V	Monthly Maximum 24-Hour TSP Averages SUFCo Site 007, September 1, 1980 - August 31, 1981	13
Figure VI	Mean Monthly Concentrations of TSP SUFCo Site 005, September 1, 1980 - August 31, 1981	14
Figure VII	Mean Monthly Concentrations of TSP SUFCo Site 007, September 1, 1980 - August 31, 1981	15
Figure VIII	Wind Rose - Site 005 - Septemer 1980 - August 1981	24
Figure IX	Summary of Wind Data at Site 005, September 1, 1980 - August 31, 1981	25

I. GENERAL DESCRIPTION OF THE AIR MONITORING PROGRAM

A. Purpose of the Air Monitoring Program

Coastal States Energy Company owns and operates the SUFCo Coal Mine in Sevier County, Utah. A revised and upgraded mine plan was filed with the Utah Division of Oil, Gas, and Mining, 26 November 1980. This action was followed by submittal of an application for an Air Quality Approval Order from the Utah Division of Environmental Health. A comment on the mine plan related to the lack of air monitoring data in support of this plan, and a comment on the application reflected concern for mitigating measures for the generation of fugitive dust resulting from the existing mine operations.

In response to these comments, Coastal States elected to field a monitoring program in the immediate vicinity of the mine in order to gather Total Suspended Particulates (TSP) and meteorological data. The mine is located in very rugged terrain, making placement of a monitoring network extremely difficult and operation of the monitoring equipment very dangerous. Therefore, Coastal States determined that the goal of the monitoring program would be to gather the most representative data possible within the limitations of safety.

The monitor siting of interest would be near the mine portal and haul roads. Such placement of monitors precludes the usefulness of the monitoring data as representative of local air quality conditions, and therefore, is not comparable to National Ambient Air Quality Standards. However, the monitoring data would serve as a useful tool to determine the effectiveness of the particulate matter control measures implemented over the duration of the monitoring program.

As will be pointed out in subsequent sections of this report, the siting of the monitors resulted in high TSP values over the one-year monitoring duration. However, the results also indicate that mitigating measures, in the form of road paving and cleaning, reduced the overall fugitive particulate matter loading. Monthly average TSP values monitored near the haul road reduced two-fold immediately following pavement of the roadway. Monthly maximum TSP values dropped by a factor of three.

Although this control measure has greatly improved conditions in the vicinity of the mine, monitored values indicate that some further improvement in reducing the particulate matter loading is possible. Coastal States continues to investigate plant operations in search of other mitigating measures that can be implemented at reasonable cost to continue improvement of air quality in the vicinity of the mine location.

B. Network Description

Radian Corporation provided air monitoring services to Coastal States Energy Company at two sites near the SUFCo mine located in Sevier County, Utah. One site (site 005) was equipped with a portable meteorological station and one hi-vol sampler. The other site (site 007) was equipped with both a regular and a collocated hi-vol. The parameters monitored at the SUFCo sites included:

Total Suspended Particulates (TSP)
Wind Speed/Wind Direction (WS/WD)
Temperature (TMP)
Rainfall (RAI)

Meteorological values were continuously recorded on a strip chart which was sent bimonthly to Radian's home office for analysis. Particulate filters and flow charts were also forwarded to Austin for further analysis.

Because the objective for this monitoring program was to gather valid data which could legitimately determine positive air quality effects of particulate matter control techniques, Coastal States requested that quality be stressed in the program. Therefore, all instrumentation, operational procedures, and quality assurance activities incorporated into the monitoring program met or exceeded the specifications of EPA's "Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring," May 10, 1979.

C. Site Description

The monitoring sites are located in East Spring Canyon, a steep-sided canyon about 25 miles (40 kilometers) east-southeast of Salina, Utah (see Figure I). The sites' elevation is approximately 7600 feet (2287 meters).

The very rugged terrain was reflected in the meteorological data obtained. Wind speeds exhibited characteristics typical of a canyon environment protected from large scale, strong wind flows. Wind directions were influenced by upslope and downslope flows, which generally follow the north-south orientation of the canyon, and by turbulence and channeling effects created by smaller topographical features within the canyon. Precipitation amounts were not significantly influenced by the immediate site terrain.

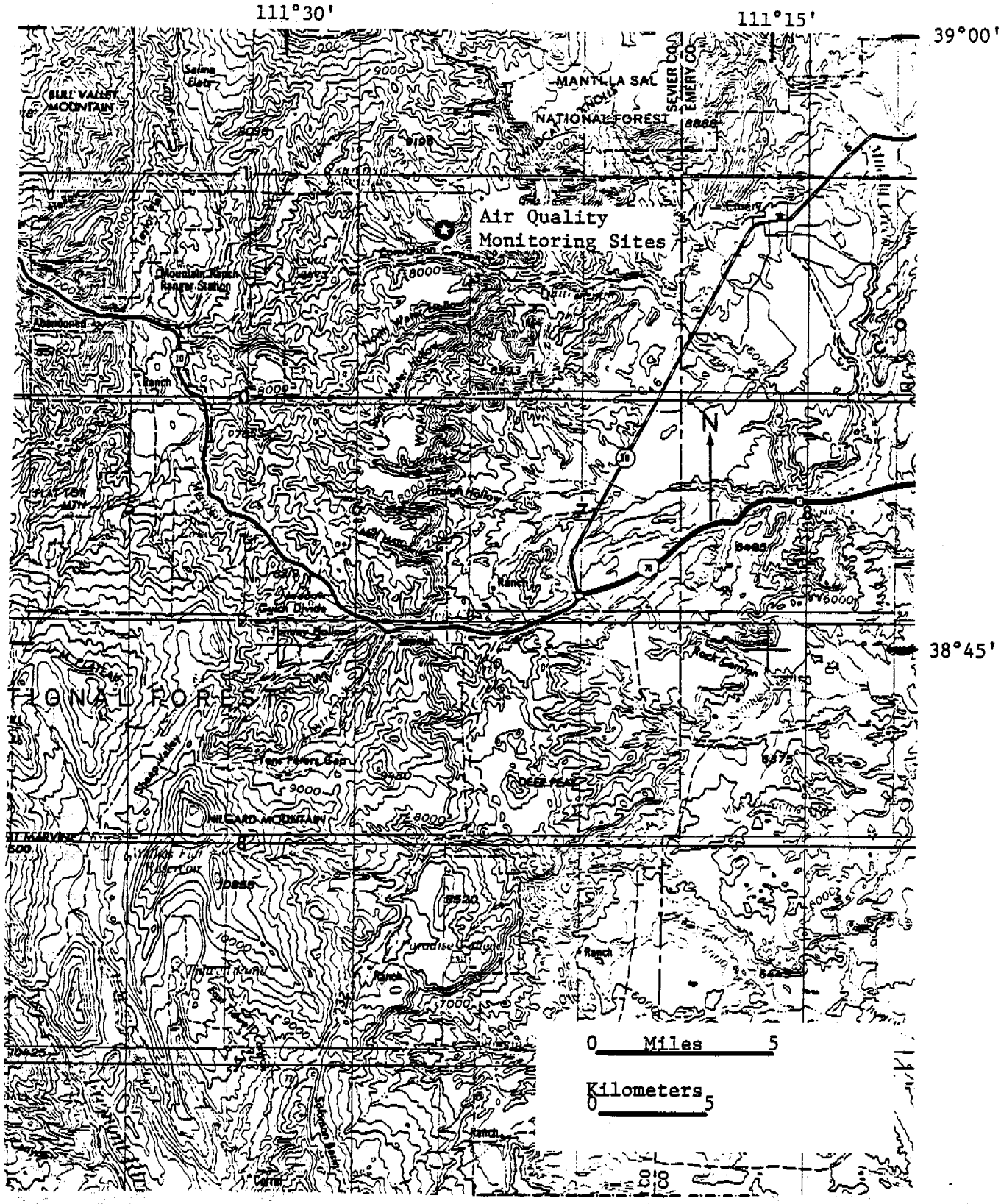


Figure I. SUFCo Mine (Utah) Air Quality Monitoring Site Region

The location of the two particulate sampling sites in East Spring Canyon are shown in Figures II and III. One site (005) is located at the SUFCo mine guardhouse within 10 feet (3 meters) of the mine/haulage road. This is the most distant point from the mine having electrical service. A mechanical weather station was placed nearby. This monitoring site would represent the particulate level of the mine downwind of the operations near the mine access/haulage road, where elevated particulate levels result from heavy truck traffic.

The second site (007) is located nearer the mine shaft entrance at the end of the canyon. The objective of locating a permanent site near the mine was attained by establishing site 007 at the end of the canyon near the warehouses and the mine's exhaust fans (Figure III). At site 007, Radian constructed a 4-foot tall wooden platform and placed two particulate samplers on it, one for routine particulate sampling, and the second to be run simultaneously for purposes of quality assurance. AC power was obtained from the nearby warehouse annex.

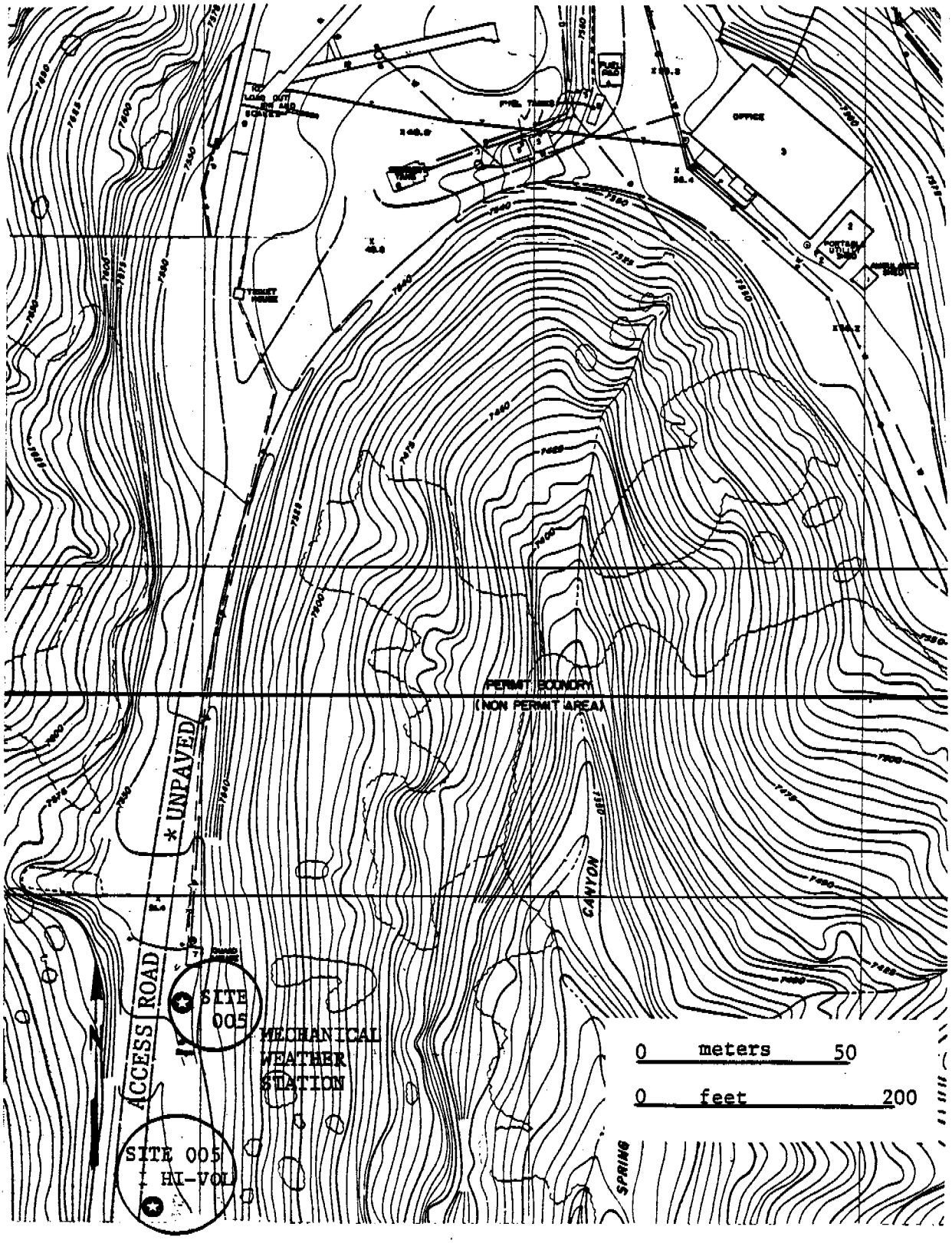


Figure II. SUFCo Site 005

*Access road paved 6/20/81

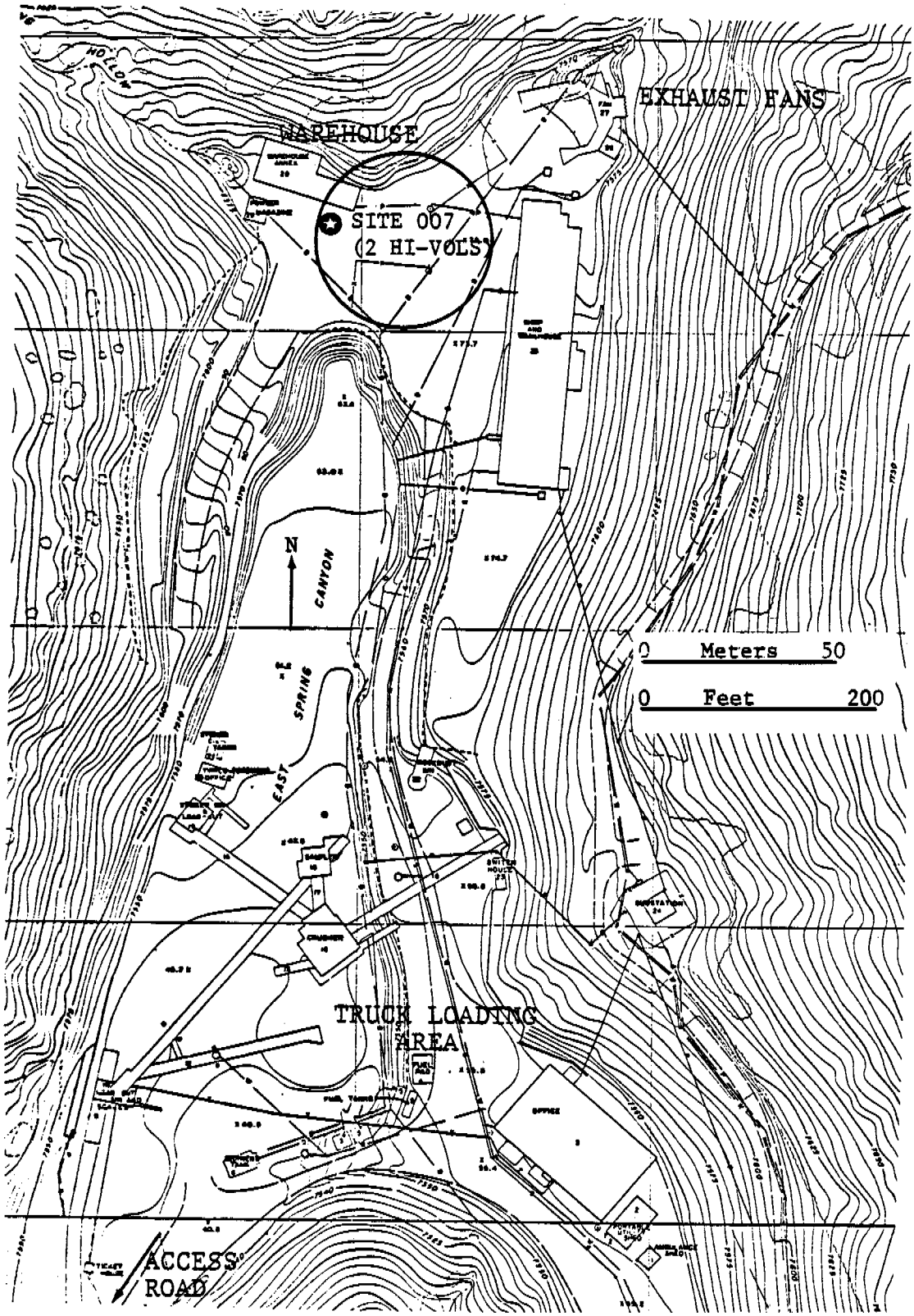


Figure III. SUFCo Site 007

II. OPERATIONAL SUMMARY

Radian Corporation conducted air monitoring operations at sites 005 and 007 from September 1, 1980 to August 31, 1981. Data capture improved steadily throughout the year-long monitoring period. The cumulative data capture rates for particulates were 92 percent at site 005 and 73 percent at site 007. The annual meteorological data capture rate at site 005 was 86 percent.

Monthly and annual data capture rates for the SUFCo sites are presented for each parameter in Table I. Data capture rates for each site, and the overall network, are presented in Table II. The total number of samples obtained per parameter are given in Table III.

A summary of the maxima for the operational period is given below.

	Highest Value ($\mu g/m^3$)	
Pollutant	Site 005	Site 007
24-hour TSP	1761.0 (6/18)*	1141.0 (9/3)
TSP (average to date)	221.7	147.6

*Date of occurrence is provided in parenthesis.

The monthly maximum TSP 24-hour averages and mean concentrations are found in Figures IV through VII. These histograms show the TSP levels measured at site 005 to be generally higher than those observed at site 007, possibly due to site 005's location near the mine haulage road. The road was paved June 20, 1981 and the histograms display a dramatic reduction in TSP levels recorded at site 005 in July and August.

TABLE I.
DATA CAPTURE RATES(%) FOR SUFCO
SEP 1, 1980 THRU AUG 31, 1981

SITE 005

PERIOD		WS	WD	TMP	RAI	TSP
SEP	1-30	50	50	50	50	100
OCT	1-31	88	88	88	88	100
NOV	1-30	100	100	11	0	100
DEC	1-31	94	94	82	49	100
JAN	1-31	98	98	98	98	0
FEB	1-28	99	99	99	99	100
MAR	1-31	90	90	90	90	100
APR	1-30	76	76	76	76	100
MAY	1-31	99	99	99	99	100
JUN	1-30	100	100	100	100	100
JUL	1-31	100	100	100	100	100
AUG	1-31	99	99	99	99	100
ACCUMULATED RATE		91.	91.	83.	79.	92.

SITE 007

PERIOD		TSP
SEP	1-30	70
OCT	1-31	65
NOV	1-30	70
DEC	1-31	61
JAN	1-31	90
FEB	1-28	89
MAR	1-31	61
APR	1-30	30
MAY	1-31	81
JUN	1-30	90
JUL	1-31	81
AUG	1-31	90
ACCUMULATED RATE		73.

TABLE II.
OVERALL DATA CAPTURE RATES(%) FOR SUFCO
SEP 1, 1980 THRU AUG 31, 1981

AIR QUALITY

PERIOD	5	7	OVERALL
SEP 1-30	100	70.0	85.0
OCT 1-31	100	65.0	82.5
NOV 1-30	100	70.0	85.0
DEC 1-31	100	61.0	80.5
JAN 1-31	0	90.0	45.0
FEB 1-28	100	89.0	94.5
MAR 1-31	100	61.0	80.5
APR 1-30	100	30.0	65.0
MAY 1-31	100	81.0	90.5
JUN 1-30	100	90.0	95.0
JUL 1-31	100	81.0	90.5
AUG 1-31	100	90.0	95.0
OVERALL AIR QUALITY	91.5	73.0	82.3

METEOROLOGY

PERIOD	5	7	OVERALL
SEP 1-30	50.0	-	50.0
OCT 1-31	88.0	-	88.0
NOV 1-30	52.7	-	52.7
DEC 1-31	79.7	-	79.7
JAN 1-31	98.0	-	98.0
FEB 1-28	99.0	-	99.0
MAR 1-31	90.0	-	90.0
APR 1-30	76.0	-	76.0
MAY 1-31	99.0	-	99.0
JUN 1-30	100.0	-	100.0
JUL 1-31	100.0	-	100.0
AUG 1-31	99.0	-	99.0
OVERALL METEOROLOGY	86.0	-	86.0

TABLE III.

NUMBER OF OBSERVATIONS (HRS) FOR SUFCO

SITE 005 AND SITE 007 - SEPTEMBER 1, 1980 THRU AUGUST 31, 1981

	Site 005						Site 007
Period		WS	WD	TMP	RAI	TSP	TSP
SEP	1-30	361	361	361	361	8	8
OCT	0-31	654	654	654	654	4	6
NOV	1-30	720	720	77	0	3	7
DEC	1-31	700	700	609	368	2	6
JAN	1-31	728	728	728	728	0	10
FEB	1-28	665	665	665	665	7	8
MAR	1-31	669	669	669	669	5	6
APR	1-30	549	549	549	549	9	3
MAY	1-31	738	738	738	738	6	8
JUN	1-30	718	718	718	718	9	9
JUL	1-31	742	742	742	744	8	8
AUG	1-31	735	735	735	735	7	9
TOTAL		7979	7979	7245	6929	68	88

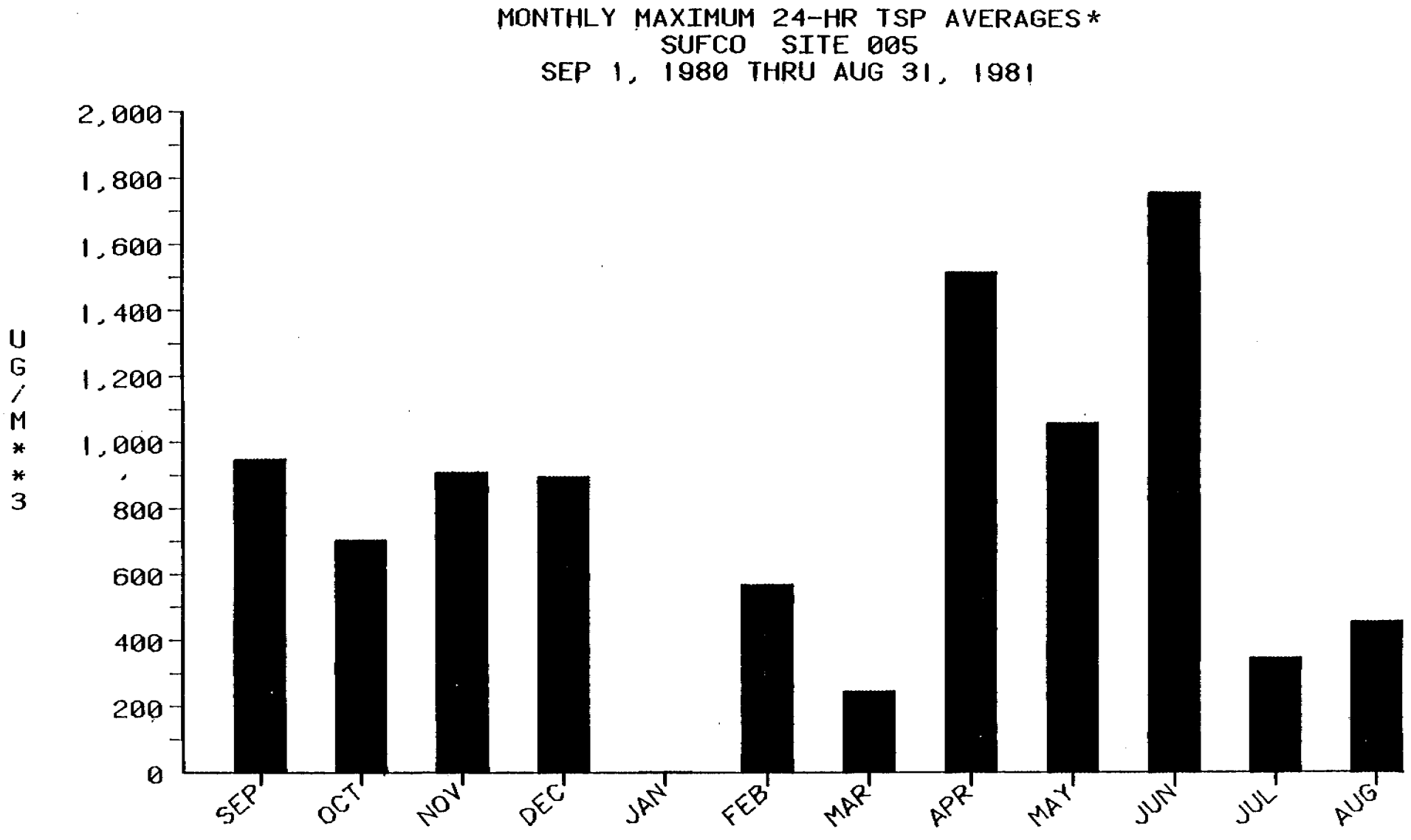


Figure IV.

*No TSP data were collected at site 005 during January.

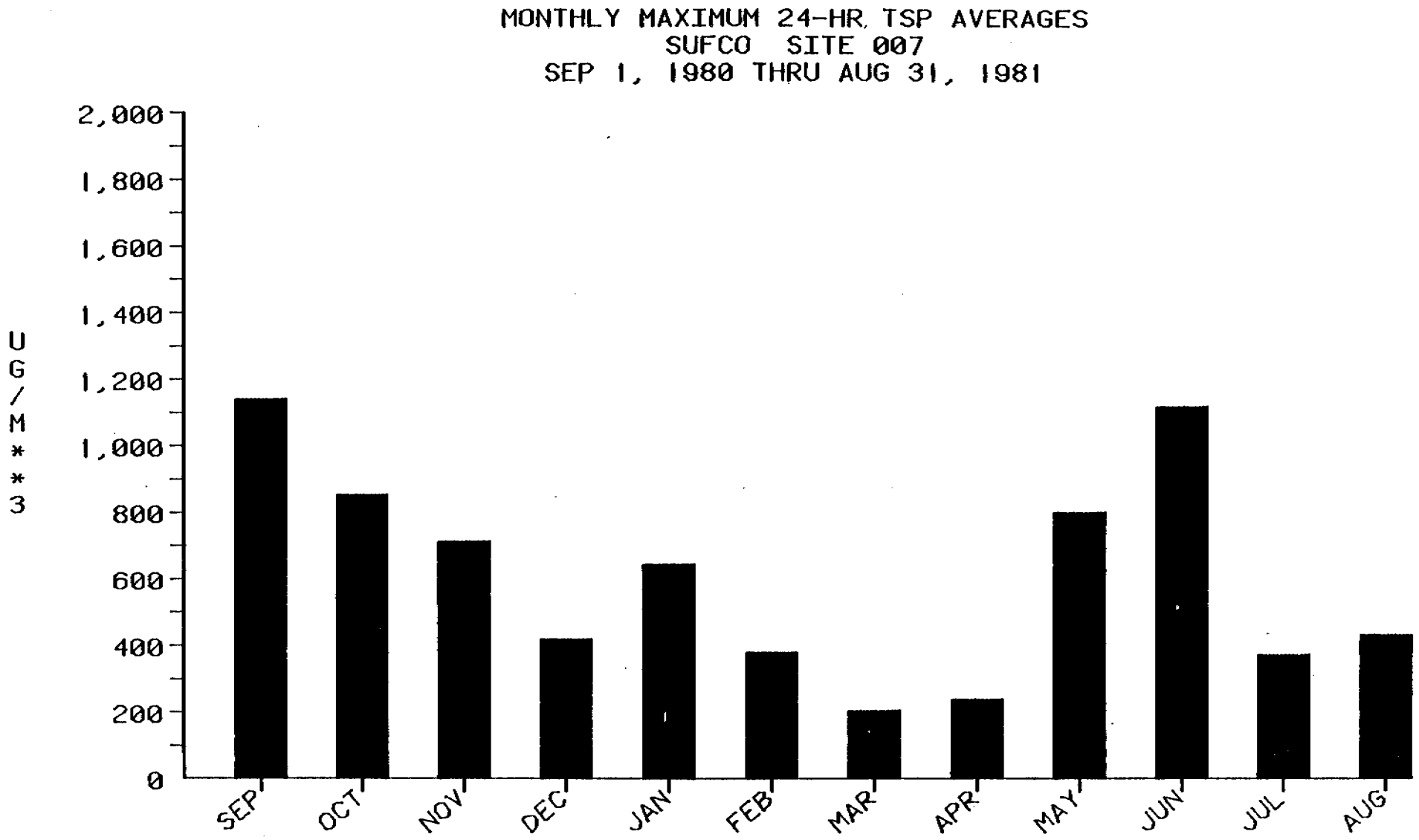

MONTHLY MAXIMUM 24-HR TSP AVERAGES
SUFCO SITE 007
SEP 1, 1980 THRU AUG 31, 1981
UG/M**3
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG

Figure V.

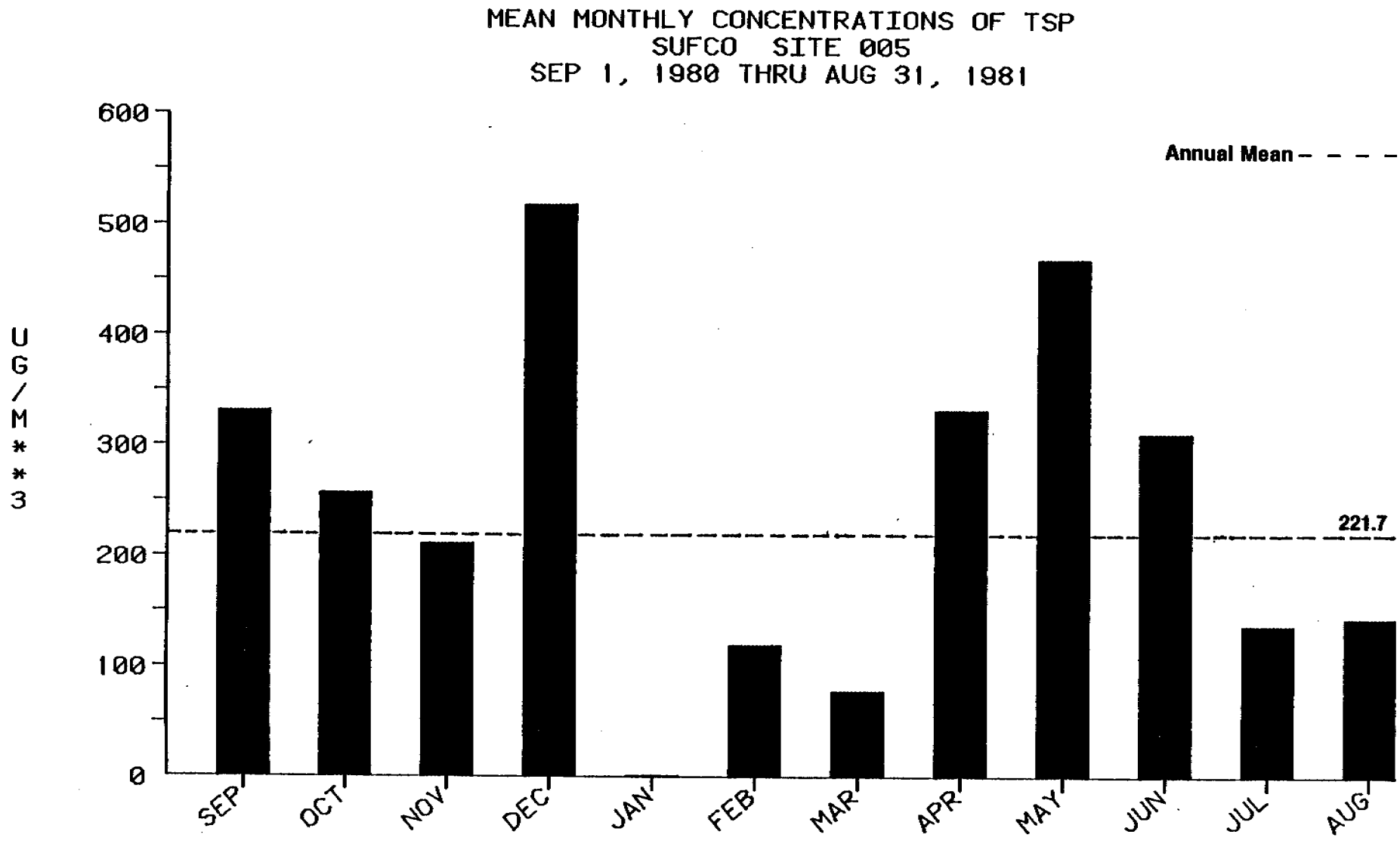

MEAN MONTHLY CONCENTRATIONS OF TSP
SUFCO SITE 005
SEP 1, 1980 THRU AUG 31, 1981
UG/M**3
600
500
400
300
200
100
0
Annual Mean
221.7
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG

Figure VI

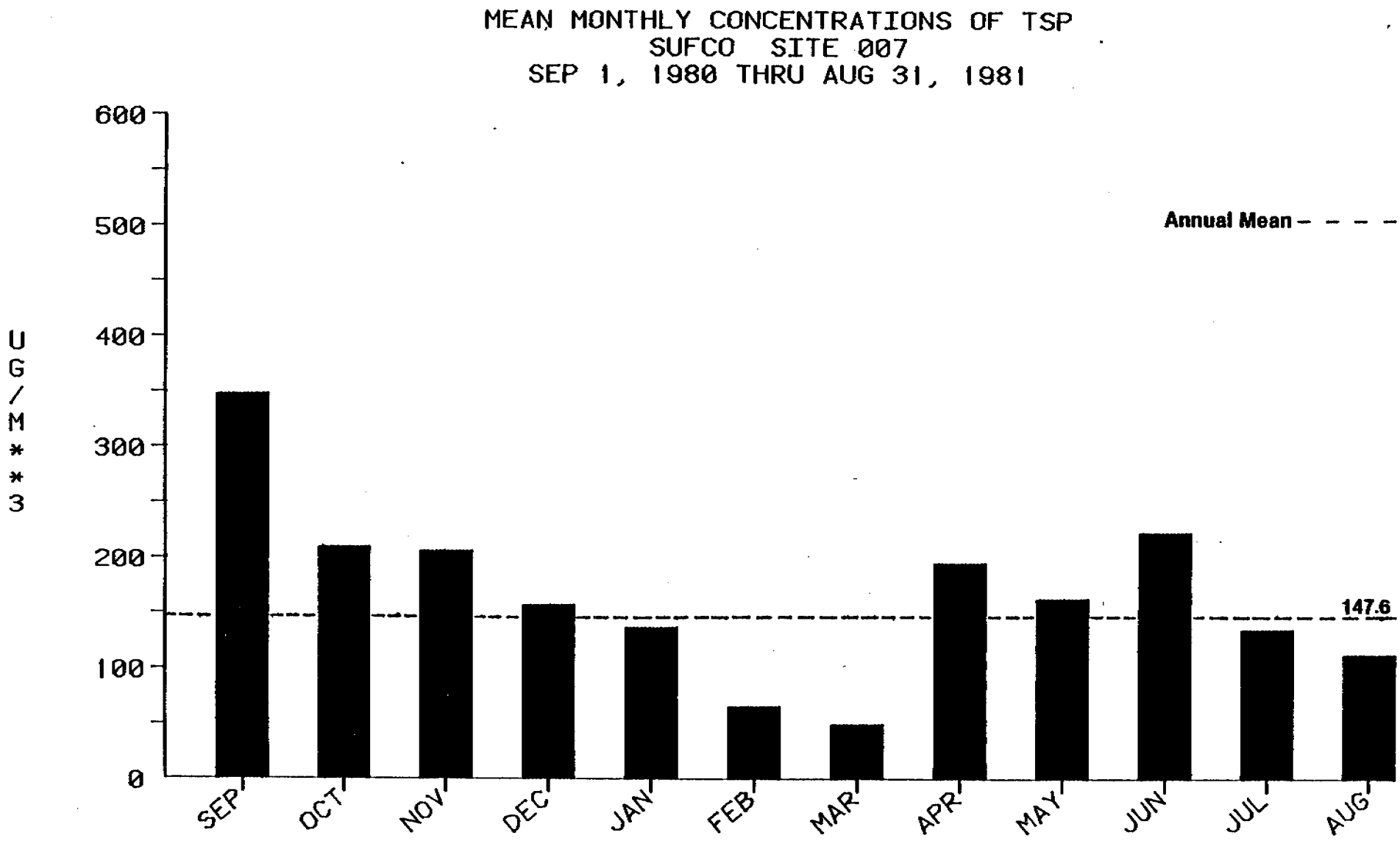

MEAN MONTHLY CONCENTRATIONS OF TSP
SUFCO SITE 007
SEP 1, 1980 THRU AUG 31, 1981
UG/M**3
600
500
400
300
200
100
0
Annual Mean
147.6
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG

Figure VII

III. DATA PRESENTATION AND SUMMARY

This section includes summaries for various recorded data at the monitoring sites. The data presentations indicate the variability of pollutant concentrations and meteorological parameters with time. In addition, the presentations indicate the dependence of pollutant concentrations on wind direction.

Table IV indicates the five largest total suspended particulates (TSP) averages during the monitoring period.

Table V displays the monthly and annual statistics for the monitoring stations.

Table VI shows the bivariate distribution of wind direction and wind speed. Graphical representations of the wind data collected at site 005 are given in Figures VIII and IX.

All parameters, except suspended particulates (24-hour samples), were recorded continuously on a strip chart. Hourly averages were reduced from the strip chart data and are included, along with the total suspended particulate data, in the master data base from which these tables were generated.

All TSP pollutant data is presented in micrograms per cubic meter ($\mu g/m^3$). The units of the meteorological parameters are given at the top of each table.

Times given in the data presentations correspond to the appropriate local times, i.e., Mountain Dalight Savings Time and Mountain Standard Time, depending on the time of the year.

Table IV: The Five Maximum Total Suspended Particulate Averages

Table IV presents the five largest TSP 24-hour averages, computed from midnight to midnight, for the September 1, 1980 to August 31, 1981 monitoring period.

TABLE IV. THE FIVE MAXIMUM INDEPENDENT SLIDING AVERAGES FOR SEP 1, 1980 - AUG 31, 1981
(WITH ASSOCIATED WIND SPEED AND WIND DIRECTION)
UNITS: WIND SPEED-MILES PER HOUR; WIND DIRECTION-DEGREES WITH RESPECT TO THE NORTH

TOTAL SUSPENDED PARTICULATE (UG/M**3) [WS:WD]
24-HOUR

SITE	005	007
1.	6/18(0:00- 0:00)1761.0[6:335]	1. 9/ 3(0:00- 0:00)1141.0
2.	4/10(0:00- 0:00)1517.0[6:190]	2. 6/12(0:00- 0:00)1119.0
3.	6/ 9(0:00- 0:00)1241.0[4:333]	3. 9/30(0:00- 0:00) 923.0
4.	5/19(0:00- 0:00)1061.0[5:222]	4.10/ 9(0:00- 0:00) 853.0
5.	6/12(0:00- 0:00)1036.0[7:279]	5. 5/13(0:00- 0:00) 801.0

Table V: Monthly Averages

Table V displays the monthly and annual statistics for the monitoring station. To ensure statistical significance, and to reduce the possibility of introducing a bias in the presentation, monthly averages are computed only when at least 50 percent of the hourly values subject to averaging are present. If less than the required number of hourly values is present for a particular parameter, that entry will be blank, thus indicating an insufficient number of hourly values present for that day. The averages in Table V are arithmetic averages with the following exceptions:

- Precipitation values are cumulative totals.
- Wind direction is computed using a vector averaging technique where each vector is assigned a unit magnitude.
- Particulate monthly averages are computed as the geometric mean.

TABLE V. MONTHLY AVERAGES FOR SEP 1 1980 THRU AUG 31 1981

SITE / DATE	WIND SPEED (MPH) 005	WIND DIRECTION (DEG) 005	TEMPERATURE OUTSIDE(DEG F) 005
SEP 01 -30	5.4	346.0	56.6
OCT 01 -31	5.1	329.4	43.8
NOV 01 -30	6.8	354.2	
DEC 01 -31	4.9	358.8	39.0
JAN 01 -31	4.6	322.8	24.4
FEB 01 -28	5.6	334.4	29.7
MAR 01 -31	4.9	331.7	33.8
APR 01 -30	5.9	322.1	49.3
MAY 01 -31	5.7	340.3	48.8
JUN 01 -30	5.9	337.4	64.9
JUL 01 -31	5.4	348.5	67.1
AUG 01 -31	4.8	332.5	64.3
SEP 01 -AUG 31	5.4	338.5	47.3

TABLE V. MONTHLY AVERAGES FOR SEP 1 1980 THRU AUG 31 1981

SITE / DATE	RAINFALL (HINCH) 005	TOTAL SUSPENDED PARTICULATE (UG/M**3) 005	007
SEP 01 -30	0.0	330.4	347.4
OCT 01 -31	43.0	256.4	209.2
NOV 01 -30		210.5	205.6
DEC 01 -31		517.0	157.1
JAN 01 -31	1.0		136.6
FEB 01 -28	7.0	119.2	65.6
MAR 01 -31	104.0	77.5	49.6
APR 01 -30	142.0	332.0	194.9
MAY 01 -31	57.0	468.9	162.9
JUN 01 -30	54.0	310.7	222.8
JUL 01 -31	72.0	137.0	135.0
AUG 01 -31	160.0	144.1	112.8
SEP 01 -AUG 31	640.0	221.7	147.6

Table VI: Wind Rose

Table VI shows a bivariate distribution of wind direction and wind speed. A graphical wind rose is shown in Figure VIII.

Figure IX presents a three-dimensional perspective view of the frequency of occurrence of wind direction and wind speed. Peaks on this display indicate the most frequent wind direction and wind speed combinations.

TABLE VI. WIND ROSE
(NUMBER OF HOURLY AVERAGES FOR THE INDICATED
WIND DIRECTION AND WIND SPEED LEVELS)

WIND SPEED

SUFCO

TRAILER NO. - 5 PERIOD(9/ 1/80 TO 8/31/81)

WIND DIRECTION

WIND SPEED MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM	TOTA
GT 24 :																		
18 - 24 :																		
12 - 18 :	12	10	7			1	3		2		1			1				3
7 - 12 :	368	176	128	22	34	40	62	66	52	8	22	4	27	14	77	113		121
3 - 7 :	956	387	248	51	80	113	293	399	291	68	83	65	187	254	844	816		513
LE 3 :	176	56	23	8	16	14	22	24	79	42	83	105	284	201	277	175	9	159
TOTAL :	1512	629	406	81	130	168	380	489	424	118	189	174	498	470	1198	1104	9	7979
MEAN	6.	6.	7.	6.	6.	6.	6.	6.	5.	4.	4.	4.	4.	4.	5.	5.	0.	5.

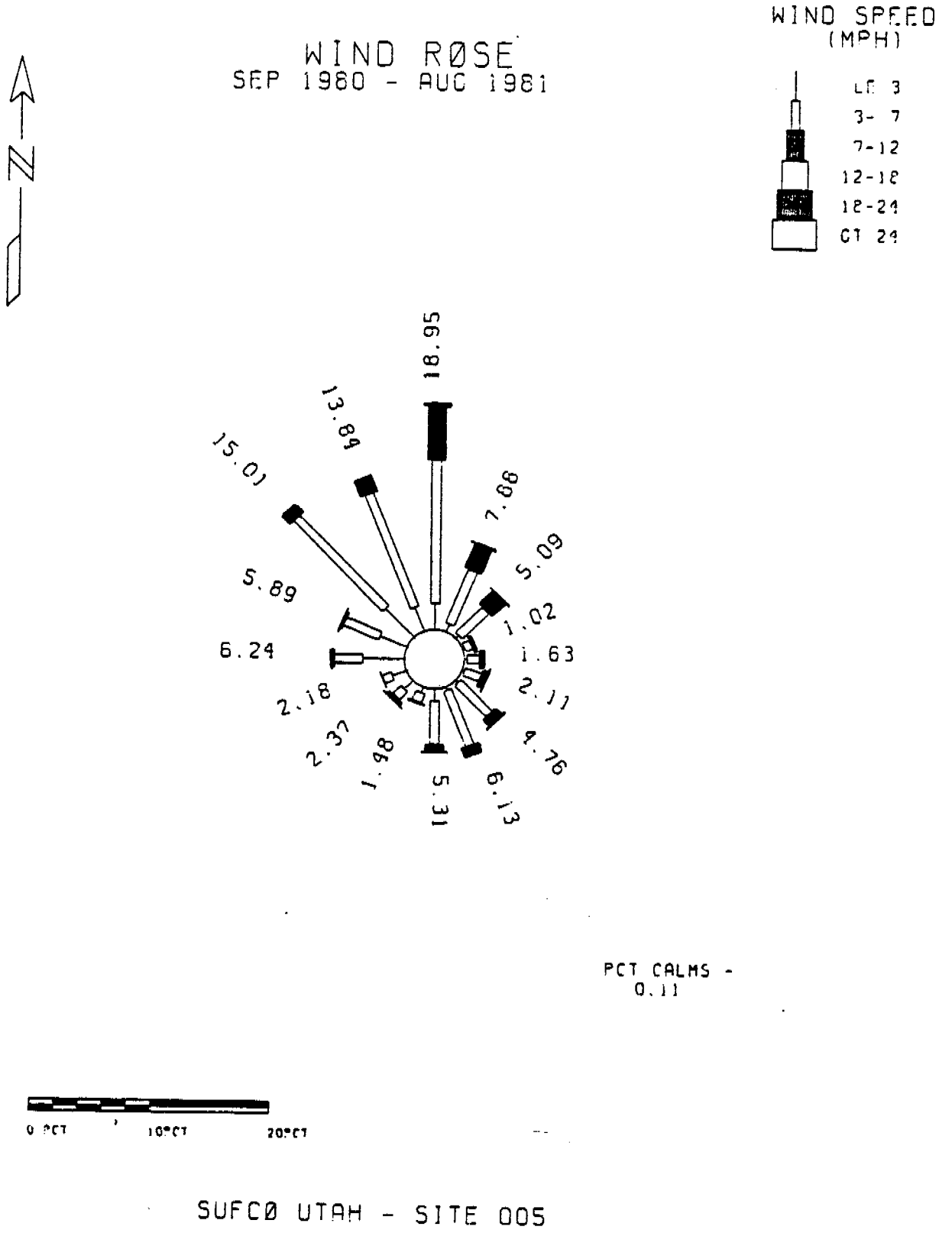

WIND RØSE
SEP 1980 - AUG 1981
N
WIND SPEED
(MPH)
LT 3
3- 7
7-12
12-18
18-24
GT 24
18.95
13.84
15.01
7.06
5.09
5.89
1.02
6.24
1.63
2.18
2.11
2.32
4.76
1.98
5.31
6.13
PCT CALMS -
0.11
0 PCT
10 PCT
20 PCT
SUFCØ UTAH - SITE 005

Figure VIII.

SUMMARY OF WIND DATA AT SITE 005, SEPTEMBER 1 1980 THRU AUGUST 31, 1981

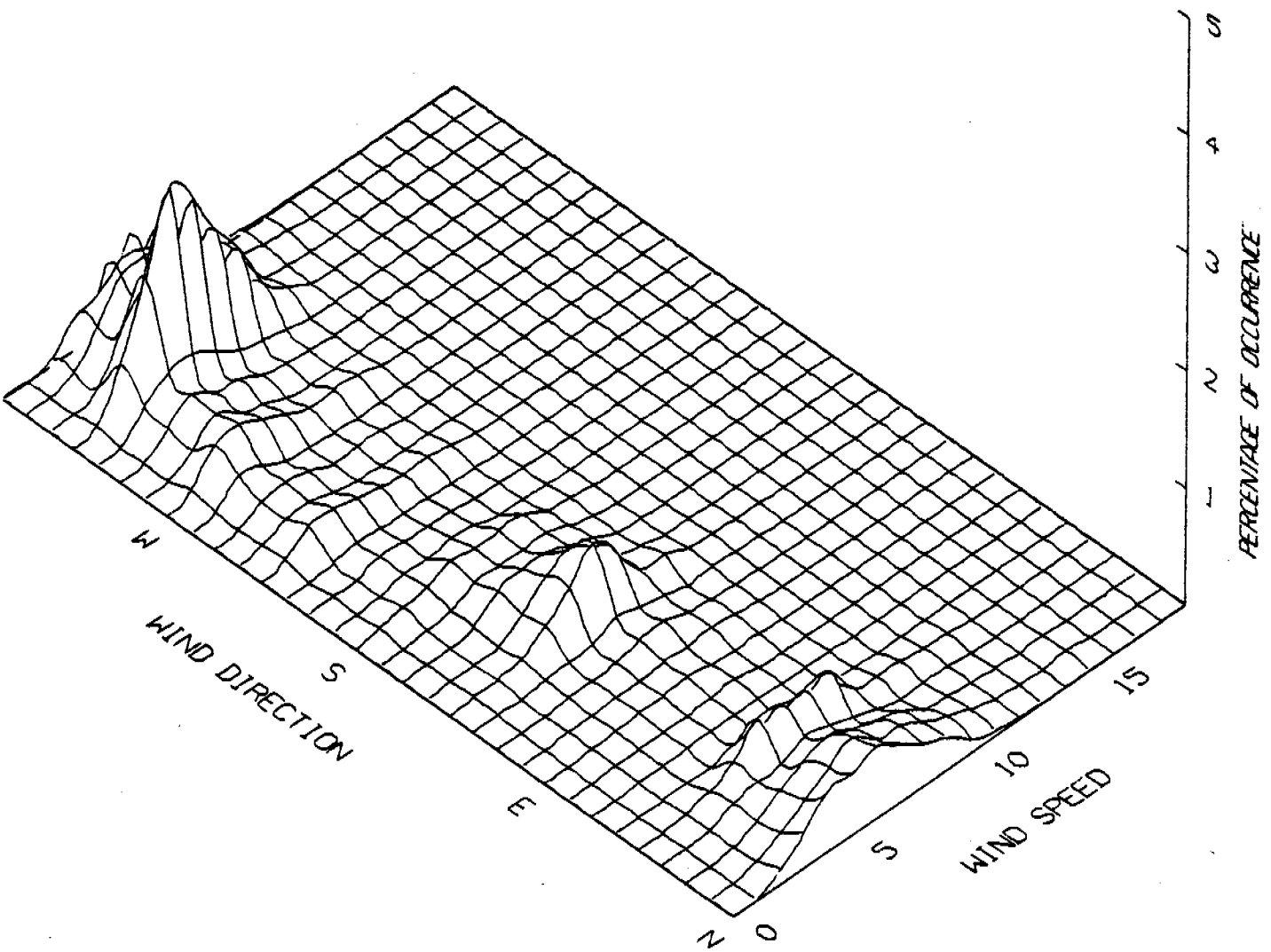


Figure IX

IV. SYSTEM DESCRIPTION

A. Meteorological Systems

The meteorological parameters which were measured at the monitoring site are wind speed, wind direction, temperature, and precipitation. These parameters were measured by a mechanical weather station mounted on a post at a height of about 12 feet (the rain gauge sat on the ground, and was connected by a cable to the weather station). Data were recorded on pressure sensitive strip chart paper. Specifications for the two mechanical weather station models which operated at the site (refer to Section II, Operational Summary) are given below.

Manufacturer:	Met One, Inc.
Model Number:	Met Set 4
Wind Speed Specifications:	. Operating Range: 0-100 mph . Accuracy: 0.5 mph or 1.5%
Wind Direction Specifications:	. Operating Range: 0-540° . Accuracy: 3°
Temperature Specifications:	. Operating Range: -30°C to +30°C (-22°F to +86°F) and -10°C to +50°C (+14°F to +122°F) . Accuracy: 0.5°C (0.9°F) under conditions of maximum solar radiation
Precipitation Specifications:	. Resolution: .01 inch . Accuracy: .01 inch or 1%

Manufacturer:	MRI, Inc.
Model Number:	1072
Wind Run Specifications:	. Accuracy: ±2%
Wind Direction Specifications:	. Operating Range: 0-360° . Accuracy: ±1% full scale
Temperature Specifications:	. Operating Range: -68°C to +15.5°C (-90°F to +60°F) and -35°C to +49°C (-30°F to +120°F) . Accuracy: ±1.67°C (±3°F)
Precipitation Specifications:	. Resolution: .01 inch . Accuracy: within ±1% at 2 inches/hour

B. Air Quality Instrumentation

Total Suspended Particulates

A General Metal Works Model GMWL 2000H hi-vol sampler was used to sample for total suspended particulates. The GMW sampler is designed to meet or exceed all Federal performance and dimensional specifications including those in CFR 40 Part 50 Appendix B, dated July 1, 1975. Gelman type A-E glass fiber filters or equivalent were used as a collection medium for particulate sampling. Each filter lot possessed a collection efficiency of 99 percent for particulates of 0.3 microns in diameter.

Each hi-vol sampler was equipped with a recorder for measuring flow rate as a function of time for a 24-hour sampling period. Hi-vol samplers were sequenced for automatic operation at each site, and operated from midnight to midnight every third day at site 007, and two to three times per month at site 005. A collocated sampler was also operated at site 007 every third day as part of the quality assurance program.

RADIAN
CORPORATION

DCN 80-121-173-02

ASSESSMENT OF PARTICULATE EMISSIONS AT THE SUFCo UNDERGROUND COAL MINE IN SOUTHERN UTAH

Prepared for:

Coastal States Energy Company
Nine Greenway Plaza
Houston, Texas 77046

Prepared by:

Radian Corporation
P.O. Box 9948
Austin, Texas 78766

21 October 1980

RADIAN CORPORATION

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	SEQUENCE OF MINING OPERATIONS	2
3.0	QUANTIFICATION OF EMISSIONS	5
4.0	CONTROLS	7
Appendix A	Uncontrolled Particulate Emissions Calculations	10

1.0 INTRODUCTION

The purpose of this report is to reply to comments made by the Office of Surface Mining with respect to a mining permit submitted by the Southern Utah Fuel Company for their SUFCo mine. One OSM comment requested a detailed quantification of particulate emissions including fugitive dust and a discussion of the control technology employed to mitigate their impacts.

The mine was visited by the Radian staff. All sources of particulate emissions have been identified. Uncontrolled particulate emissions have been quantified using EPA Region VIII emission factors. The control technology employed at the SUFCo mine has been described and controlled particulate emissions have been estimated using the control efficiencies proposed by EPA Region VIII.

The total controlled particulate emissions including fugitive dust from the existing SUFCo mining operations is 82 tons per year which will increase to 111 tons per year, if the proposed expansion is approved.

2.0 SEQUENCE OF MINING OPERATIONS

A plot plan showing the existing facilities of the SUFCo mine is given by Figure 2-1. Also shown is the run of the mine stock pile which is part of the proposed expansion of activities at the SUFCo mine.

Coal is conveyed from the mine portal to the crushing and screening facilities. Breaker crushers located in the mine proper reduce the size of the coal sufficiently so that only secondary crushing is required. In addition screening precedes crushing and only 40 percent of the annual production is crushed. After screening and crushing 100,000 tons of the annual throughput is conveyed to the Stoker Circuit where it is oiled and loaded into hand trucks for transport off site. The remainder of the annual production is conveyed through a sampling tower to a bin-hopper load and station. Overflow from the load and bin is conveyed to a temporary stock pile. The crushed coal is loaded onto the pile by means of a vertical stacking tube (lowering well). The average annual size of this pile is about 600 tons. Front end loaders are used to load the coal from the pile into haul trucks for transport off site. Efforts are made to remove the overflow coal as rapidly as possible so that the time of duration of any given pile is seldom more than one day.

The proposed run of the mine stock pile will have a capacity of 10,000 tons. Four thousand one hundred tons (41 percent) will be live storage and the remaining 5900 (59 percent) will be dead storage.

Loading onto the pile will be via a vertical stacking tube, the same as the present crushed coal stacking tube. The pile formed will be 61 feet high and have a radius of 81 feet

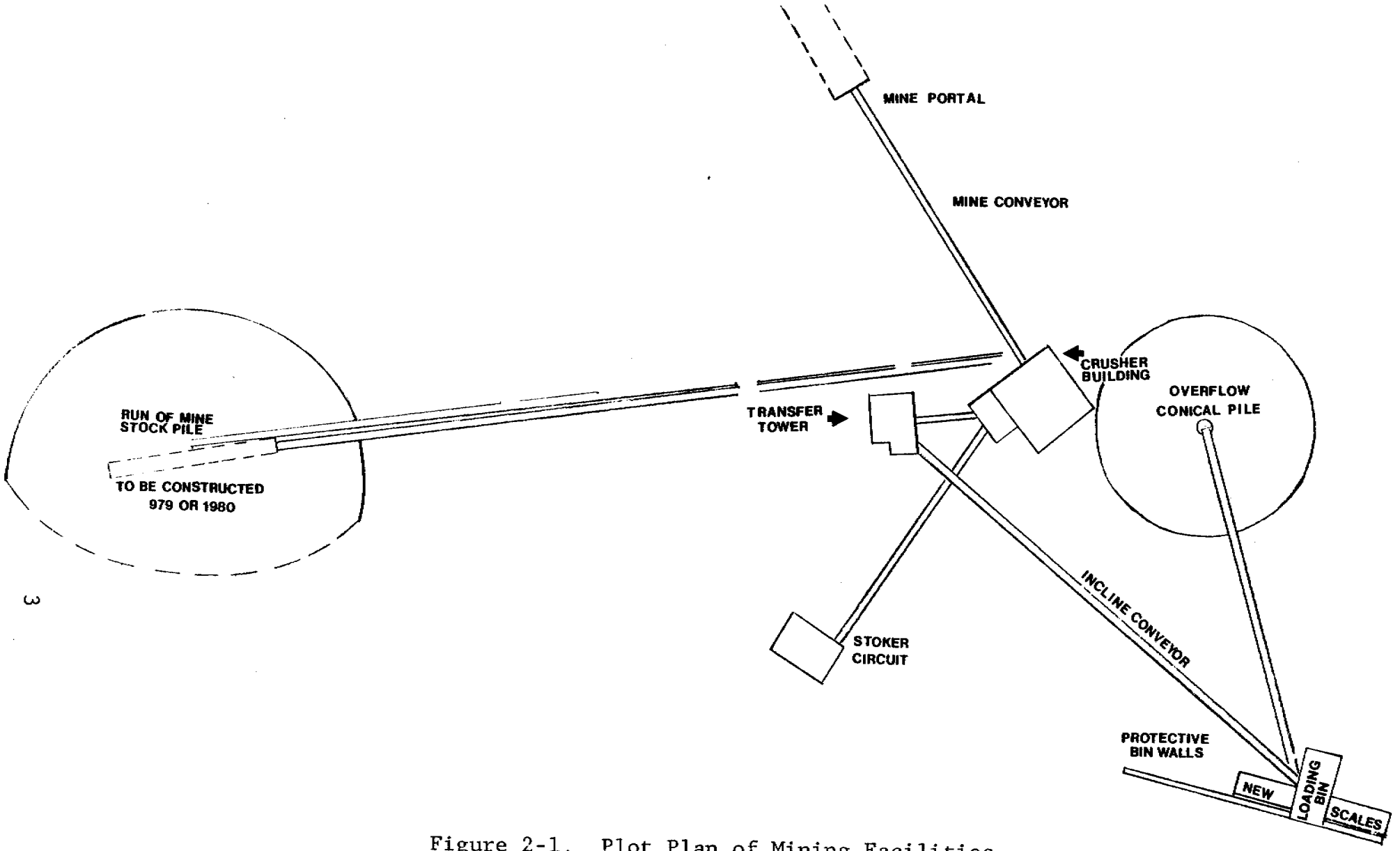


Figure 2-1. Plot Plan of Mining Facilities of the SUFCo Mine

(assuming a 37 degree angle of repose). Coal will be reclaimed by two underground drawpoints with flood gates and vibratory feeders dumping directly onto the reclaim conveyor.

3.0 QUANTIFICATION OF EMISSIONS

Particulate emissions were quantified using the emission factors given in the Region VIII Interim Policy Paper on the Air Quality Review of Surface Mining Operations, 1979. The emission factors used and the resultant uncontrolled particulate emissions are shown in Table 3-1. Particulate emissions were computed for both the current production rate of 1.65 million tons per year and the projected increased rate of 2.2 million tons per year. The detailed emission calculations re included as Appendix A.

The Interim Policy Paper treats the conveying and transferring of coal as a process emission. The operations of unloading coal at the crusher, and dropping coal from the conveyor into the stacking tubes associated with the two storage piles have all been catagorized as transferring. Their emissions are therefore included in Table 3-1 under conveying and transferring.

The 10,000 ton storage piles utilizes an underground reclaim system so that particulate emissions from this operation should be negligible. For this reason they have not been included in Table 3-1.

TABLE 3-1

EMISSION FACTORS AND UNCONTROLLED PARTICULATE EMISSIONS FOR THE SUFCo MINE FOR CURRENT AND PROJECTED ANNUAL PRODUCTION RATES

Operation	Emission Factor	Uncontrolled Particulate Emissions Current Production 1.65 Million tons/year	Uncontrolled Particulate Emissions Proposed Production 2.2 Million tons/year
Conveying and Transferring	0.200 lb/ton	165.0	220.0
Screening	0.100 lb/ton	82.5	110.0
Secondary Crushing	0.060 lb/ton	19.8	26.4
Load Out from Bin Hopper	0.016 lb/ton	10.7	15.1
Load Out of Stoker Coal	0.016 lb/ton	0.8	0.8
Load Out from 600 ton Temporary Storage Pile with Front End Loaders	0.120 lb/ton	10.0	10.0
Wind Erosion of 600 ton Storage Pile	0.401 lb/hr	1.4	1.4
Wind Erosion of 10,000 ton Storage Pile	3.791 lb/hr	--*	5.4**
Exposed Area Erosion	0.390 ton/acre-yr	2.0	2.0
Haul Road	5.300 lb/VMT	62.4	83.2
TOTAL		354.6	474.3

* currently does not exist

**result of construction of sedimentation pond--not related to increased production

RADIAN CORPORATION

4.0 CONTROLS

Controlled particulate emissions were computed by assigning control efficiencies and multiplying the uncontrolled emissions by 1.00-control efficiency. Whenever possible the control efficiencies given in the Interim Policy Paper were employed. The control efficiencies adopted and the resultant controlled particulate emissions are given in Table 4-1.

A control efficiency of 90 percent was assigned to transferring and conveying, screening and crushing. The conveyors in use at the SUFCo mine have the bottom of the belts exposed for convenience of maintenance and cleaning. The Interim Policy Paper lists a control efficiency of 90 percent for this type of conveyor.

The crushing and screening facility, and the transfer tower are completely enclosed but do not have bag houses.

The Interim Policy Paper does not list control efficiencies for enclosures without bag houses. However, Technical Guidance for Control of Industrial Process Fugitive Particulate Emissions, EPA-450/3-77-610, March 1977 gives a control efficienty range of 77 to 99 percent for enclosures only. Hence, a 90 percent control efficiency for the crusher building is reasonable.

All transfer points with the exception of the stacking tubes associated with the storage piles are also completely enclosed. However, the use of stacking tubes together with the fact that the coal mined at the SUFCo mine has a surface moisture content of 9 percent should ensure a control efficiency of 90 percent for the totality of the transferring operations as well.

TABLE 4-1

CONTROLLS AND CONTROLLED PARTICULATE EMISSIONS FOR THE SUFCo MINE AND CURRENT PROJECTED ANNUAL PRODUCTION RATES

Operation	Control Efficiency (%)	Controlled Particulate Emissions Current Production 1.65 million tons/year	Controlled Particulate Emissions Projected Production 2.2 million tons/year
Conveying and Transferring	90	16.5	22.0
Screening	90	8.3	11.0
Secondary Crushing	90	2.0	2.6
Load Out from Bin Hopper	None	10.7	15.1
Load Out of Stoker Coal	95	<0.1	<0.1
Load Out from 600 ton Temporary Storage Bin with Front End Loaders	None	10.0	10.0
Wind Erosion of 600 ton Storage Pile	None	1.4	1.4
Wind Erosion of 10,000 ton Storage Pile	None	--*	5.4**
Exposed Area Erosion	None	2.0	2.0
Haul Road	50	31.2	41.6
TOTAL		82.1	111.1

* Currently does not exist

**Result of construction of sedimentation pond -- not related to increased production

RADIAN CORPORATION

With the exception of the stoker coal load out, all emissions resulting from load and operations were treated as uncontrolled. Coal is loaded into haul trucks at the loading bin by dropping the product from a bin-hopper into the haul trucks. Drop points are well protected from the prevailing wind directions. Loading is carried out almost immediately after the product is removed from the mine and the water content of the product is responsible for substantially decreasing fugitive particulate dust emissions. Control efficiencies for these measures are not documented, hence no credit for emission reductions was taken. In actuality one could expect the measures described to produce a reduction in emissions of approximately 40 percent.

Particulate emissions resulting from loading and the 100,000 tons of oiled stoker coal should be non-existent. Therefore, a 95 percent control efficiency was assigned for oiling of coal. The State of Colorado Air Pollution Control Division accepts a 95 percent control efficiency for the oiling of coal.

Particulate emissions from front end loading of coal and wind erosion from storage piles and exposed areas were treated as uncontrolled.

The truck paths inside the mine which constitute the haul road will be watered to achieve a 50 percent reduction of the fugitive particulate emissions.

APPENDIX A
UNCONTROLLED PARTICULATE EMISSIONS CALCULATIONS

UNCONTROLLED PARTICULATE EMISSIONS CALCULATIONS

The uncontrolled particulate emissions for the current and projected annual production rates of 1.65 million tons per year and 2.2 million tons per year are designated as E(1.65) and E(2.2), respectively. Whenever the methodology of computation is the same for both cases the detailed computations are shown only for E(1.65).

Particulate emissions were computed using the following basic data:

Operating days per year	= 350
Dry days per year	= 290
Density of coal	= 50 lb/cubic foot

so that

1 ton of coal occupies 1.48 cubic yards.

1.0 CONVEYING AND TRANSFERRING

Unloading the coal at the crusher building and unloading coal onto the two stockpiles were assumed to be included in the transferring operation.

$$E(1.65) = 1.65 \times 10^6 \text{ ton/yr} \times 0.20 \text{ lb/ton} \times 1/2000 \text{ ton/lb}$$
$$= 165 \text{ ton/yr}$$
$$E(2.2) = 220 \text{ ton/yr}$$

2.0 SCREENING

Screening precedes crushing so that all of the annual output is screened.

$$E(1.65) = 1.65 \times 10^6 \text{ ton/yr} \times 0.10 \text{ lb/ton} \times 1/2000 \text{ ton/lb}$$
$$= 82.5 \text{ ton/yr}$$
$$E(2.2) = 110 \text{ ton/yr}$$

3.0 CRUSHING

Since screening precedes crushing not all of the annual production will be crushed. The amount of coal crushed is 40 percent of the annual output. Also the breaker crusher in the underground mine sizes the coal enough so that only secondary crushing is required.

$$E(1.65) = (1.65 \times 10^6 \text{ ton/yr} \times 0.40) \times 0.06 \text{ lb/ton} \times 1/2000 \text{ ton/lb}$$
$$= 19.8 \text{ ton/yr}$$
$$E(2.2) = 26.4 \text{ ton/yr}$$

4.0 LOAD OUT

The annual coal production is loaded at three separate stations. The stations and the amount of coal loaded at each are:

a. Stoker Coal Loadout - 100,000 ton/yr

b. 600 Ton Temporary Storage Pile - 600 ton/day x 350 day/year - 210,000 ton/year, and

c. Storage Bin - Annual Production - 310,000 ton/year

Current = 1.65×10^6 ton/year - 3.10×10^5 tons/year
= 1.34×10^6 ton/year

Projected = 2.2×10^6 ton/year - 3.10×10^5 ton/year
= 1.89×10^6 ton/year.

Exactly how the figure of 210,000 ton/year for the 600 ton temporary storage pile was derived will be discussed in Section 5.0.

The emissions for the three load out facilities are the following:

a. Stoker Coal Load Out

E(Stoker) = 10^5 ton/year x 0.016 lb/ton
x 1/2000 ton/lb
= 0.80 ton/year

b. 600 Ton Temporary Storage Pile

E(600t) = E(2.2) = 2.10×10^5 ton/year x 0.12 lb/ton
x 1/200 ton/lb x $\frac{290}{365}$
= 10.0 ton/year

The ratio 290/365 is the fraction of the year when no significant precipitation occurs.

c. Load Out from Coal Bin

E(1.65) = 1.34×10^6 ton/year x 0.016 lb/ton
x 1/2000 lb/ton
= 10.7 ton/year

E(2.2) = 15.1 ton/year

5.0 STORAGE PILES

5.1 Size of 600 Ton Temporary Storage Pile

Every effort is made to remove the temporary overflow as quickly as possible. On the average any given overflow is cleared within one day. Therefore, the total amount of coal that passes through the temporary storage pile in a year is:

600 tons/day x 350 day/year = 210,000 ton/year

The actual number is considerably smaller than 210,000 ton/year. However, 210,000 tons per year represents the maximum amount of coal that can be expected to pass through temporary storage. Hence, the particulate emissions based on this figure are conservative.

5.2 Shape of Storage Piles

The shape of the coal piles is a right cone with a 37° angle of repose. The geometric parameters that define such a cone are:

R = radius
H = height
$L = \sqrt{R^2 + H^2}$
Θ = angle of repose,

where

$$\tan \Theta = H/R = 0.7537$$

The surface area A and the Volume V of such a cone are:

$$A = \pi RL = 3.933\ R^2 \tag{5.1}$$

$$V = \frac{\pi}{3} HR^2 = 1.311\ R^3 \tag{5.2}$$

5.3 Wind Erosion Emission from the 600 Ton Temporary Storage Pile

The emission factor EF for wind erosion is:

$$E - 1.6\ \mu\ \text{lb/acre-hour},$$

where

μ is the mean annual wind speed in meters per second.

In order to evaluate the emission factor, it is necessary to know the mean annual wind speed and the area of the storage pile in areas. A representative value for μ is 4 meters per second.

The area of the coal pile was computed using equations (5.1) and (5.2). The volume of the 600 ton coal pile is:

$$V = 600\ \text{tons} \times 1.48\ \text{yd}^3/\text{ton} = 888.\text{yd}^3$$

Therefore according to (5.2)

$$R^3 = 888.\text{yd}^3/1.331,$$

so that

$$R = 8.78\ \text{yd}$$

The surface area of the storage pile is then:

$$A = 3.933 \times (8.78\ yd)^2 \times 1/4840\ acre/yd^2$$

$$= 0.0626\ acres.$$

The emission factor E for wind erosion then reduces to:

$$E = 1.6 \times 4.0 \times 0.0626\ lb/hr = 0.401\ lb/hr$$

The particulate emissions in tons for a year having 290 dry days are:

$$E\ (wind\ erosion) = 0.401\ lb/hr \times 24\ hr/day \times 290\ day/yr \times 1/200\ ton/lb$$
$$= 1.39\ ton/year.$$

5.4 Wind Erosion Emissions from the 10,000 Ton Run of the Mine Stock Pile

The radius R is given as 81 feet or 27 yards. The surface area is then:

$$A = 3.933 \times (27\ yd)^2 \times 1/4840\ acre/yd^2$$
$$= 0.5924\ acres.$$

Hence, the emission factor:

$$EF = 1.6 \times 4 \times 0.5924\ lb/hr = 3.791\ lb/hr$$

The annual particulate emissions from the 10,000 ton storage pile are:

$$E(10,000) = 3.791 \text{ lb/hr} \times 24 \text{ hr/day} \times 290 \text{ day/year} \times 1/200 \text{ ton/lb} \times 0.41 \text{ live storage} = 5.41 \text{ ton/year.}$$

6.0 EXPOSED AREA EMISSIONS

Wind erosion from exposed or active areas is determined by means of the soil loss equation formulated by Cowherd, et al., 1974.

The complete soil loss equation and the parameters used to determine wind erosion of exposed areas are:

E_s = AIKCL´V´ tons/acre-year

A = portion of total wind erosion losses that would be measured as suspended particulates, estimated to be 0.025

I = soil erodibility = 47 tons/acre-year[1]

K = surface roughness factor = 1.0[2]

---

[1]Based on soil maps for the study region.

[2]Assuming an unridged surface.

C = climatic factor = 0.4[3]

L′ = unsheltered field width factor = 0.83[3]

V′ = vegetative cover factor = 1.0[4]

With the values of the parameters as given, the soil loss equation yields E_s = 0.39 tons/acre-year.

The active area of the SUFCO mine consists of about five acres so that the particulate emissions from this activity are

E(exposed area) = 0.39 ton/acre-year x 5 acres

= 1.95 ton/year

It is not anticipated that the increased annual production rate will significantly increase the active area of the mine.

[3]Cowherd, et al., 1974.

[4]Assuming no vegetative cover on the exposed area.

7.0 HAUL ROAD EMISSIONS

The emission factor for haul roads is

$$EF = \frac{sS}{60} \frac{D}{365} \text{ lb/VMT},$$

where s = silt content of road surface

S = vehicle speed in mph

D = dry days per year

For the SUFCo mine

s = 80 percent

S = 5 mph

D = 290

and EF = 80 x 5/60 x 290/365 = 5.30 lb/VMT

Based on a 0.25 mile round trip and 269 trips/day the uncontrolled particulate emissions are

E(1.65) = 5.30 lb/VMT x 0.25 mile/trip x 269 trips/day x 350 days/year x 1/2000 ton/lb

= 62.4 ton/year

E(2.2) = 83.2 ton/year

REFERENCES

Cowherd, Chatten, Kenneth Axetell, Jr., Christine Guenther, George Jutze, 1974: Development of Emission Factors for Fugitive Dust Sources, Publications No. EPA-450/3-74-037, U.S. Environmental Protection Agency, Office of Air and Waste Management, Research Triangle Park, North Carolina.

AQUATIC RESOURCE INVENTORY
OF
SOUTHERN UTAH FUEL COMPANY
PERMIT AREA

Prepared for:
COASTAL STATES ENERGY COMPANY
411 West 7200 South
Suite 200
Midvale, Utah 84047

28 October 1980

Prepared by:
Robert N. Winget,
ENVIRONMENTAL CONSULTANTS
483 East 1834 South
Orem, Utah 84057
801-225-7598

TABLE OF CONTENTS

INTRODUCTION 1

INVENTORY BACKGROUND AND JUSTIFICATION 2

APPROACH TO RESOURCE INVENTORY 3

PREVIOUSLY COLLECTED AQUATIC RESOURCE DATA 6

RESULTS OF INVENTORY SURVEYS 7
- East Spring Canyon 7
- Springs in Mud Spring Hollow 8
- Quitchupah Creek 10
  - Station QC-045 11
  - Station QC-041 13
- South Fork Quitchupah Creek. 15
  - Station SFQC-006 15
- North Fork Quitchupah Creek. 16
  - Station NFQC-007 16
  - Station NFQC-042 18
  - Station NFQC-037 19

INDEX OF TABLES

Table 1. Aquatic resource inventory stations - station codes and description of locations. 21

Table 2. Aquatic resource monitoring schedule. 22

Table 3. Partial taxanomic list of aquatic macroinvertebrates collected from Stations ES-001 and MS-032 23

Table 4. Sediment composition of gravel bars at selected stations on surface waters of the permit area . . . 24

Table 5. Aquatic macroinvertebrate community description at Station QC-045. 25

Table 6. Aquatic macroinvertebrate community description at Station QC-041. 26

Table 7. Resource description at Station SFQC-006. 27

Table 8. Aquatic macroinvertebrate community description at Station SFQC-006. 28

Table 9. Resource description at Station NFQC-007. 29

Table 10. Aquatic macroinvertebrate community description at Station NFQC-042. 30

Table 11. Aquatic macroinvertebrate community description at Station QC-037. 31

AQUATIC RESOURCE INVENTORY OF SOUTHERN UTAH FUELS COMPANY CONVULSION CANYON COAL LEASE AREA

INTRODUCTION

Under Sections 784.21 and 780.16 of OSM Regulations, Federal Register 44(50):15053-15055, 15076-15077, 13 March 1979, is the requirement to prepare a "plan to minimize adverse effects of their mining operation on fish, wildlife and related environmental values, and achieve enhancement of such resources where practicable...Plans must also show compliance with all standards of Section 816.97." Section 816.97 requires the use of the "best technology currently available (BTCA) to minimize disturbances and adverse impacts of the operation on fish, wildlife and related environmnental values where practicable...and to restore the land affected to a condition capable of supporting the uses, or higher or better uses, than it was capable of supporting prior to mining...include all the elements of the environment upon which fish and wildlife resources depend, including...water, food sources, cover and the space they occupy. Collectively, these components of the environment comprise fish and wildlife habitat."

The SUFCO Mine portal located at 111° 25' W, 38° 54' 30" N, has been in operation for approximately 40 years. Much of the project surface disturbance of the aquatic resources has already occurred. As new lease areas are mined, subsidence could significantly alter existing flow patterns in the perennial North Fork Quitchupah and

Quitchupah Creeks and several small springs in the area such as Mud Springs and East Canyon Springs.

INVENTORY BACKGROUND AND JUSTIFICATION

The surface waters of the SUFCO permit area need to be inventoried as required under Sections 783.12, 13, 16, 19, 20 and 779.12, 13, 16, 19, 20 of the OSM Regs, plus comments of Utah Division of Wildlife Resources and Division of Oil, Gas and Mining, and the US Forest Service.

Some information was previously collected concerning water quality, stream and spring discharges and macroinvertebrate communities at several locations on surface waters of the lease area (itemized under APPROACH TO RESOURCE INVENTORY). These data are of value in preparing the inventory resource description, but as reported in the "Apparent Completeness Review" prepared for OSM by Willard Owens Associates Inc. (Jan. 1980), available information is not entirely adequate.

The surface waters in the lease area are not of game fish quality, either due to small size, intermittent flows or poor habitat and water quality. Because of the relatively low importance of these waters to the fisheries resources of Utah, there has been little survey work done of the biota of these waters. Biotic community data collected prior to 1980 are from Station QC-037 and a station approximately 4 km downstream. Methods of sampling were not consistent with those presently being used -

results (Appendix A) are not easily equated with present study data.

A preliminary on-site inventory of aquatic macroinvertebrates was completed on 16 and 17 July 1980 with 5 stream and 2 spring stations being sampled (stations listed in Table 1). Preliminary data analysis indicated one additional station on upper North Fork Quitchupah Creek (Station NFQC-007) would provide valuable control data to compare with data from high impact potential stations. This station along with the other 7 stations were surveyed on 30 September 1980. Survey will include aquatic macroinvertebrate samples and physical habitat measurements as outlined in Table 2. Survey data will be correlated with water quality and hydrology measurement results as they become available.

The inventory data will provide the basis for: (a) projected impact analyses; (b) evaluations of surface water potentials in relationship to present resource availability; (c) determination of types and extent of protective measures required; (d) probabilities for success of proposed mitigation measures; and (e) monitoring of effectiveness of fish habitat plan.

APPROACH TO RESOURCE INVENTORY

1. Available information on water quality and quantity and stream biota was reviewed and incorporated into the resource inventory where applicable. Included was: (a)

Environmental Assessment and Impact Evaluation of Underground Coal Mining at the SUFCO Property in Central Utah, by WESTECH; (b) Hydrology, Vegetation and Wildlife Monitoring at the Southern Utah Fuel Company Mine No. 1 near Salina, Utah - a Three Year Summary, by Hydrometrics; (c) 208 reports prepared for the Southeastern Association of Governments by Vaughn Hansen Associates (1976-77); (d) USBLM - EMRIA reports by BYU Aquatic Ecology Laboratory under subcontract with GeoScientific of California; and (e) Reports of the Aquatic Ecology Laboratory, Intermountain Region, National Forest Service. Utah Division of Wildlife Resources has no fisheries survey data available for waters in the permit area according to personal communication with Mr. John Livesay, Fisheries Biologist, Price Office.

2. Resource surveys of stream habitat and biota (aquatic macroinvertebrates) during summer and fall of 1980 were conducted at the 8 stations listed in Table 1 (these stations correspond with existing water quality and hydrology stations) according to the schedule given in Table 2 . Qualitative and/or quantitative macroinvertebrate samples were taken from 7 stations 16 and 17 July 1980. These stations plus 1 additional station were sampled on 30 September 1980, both biotic and physical habitat determinations were made. Analysis of the data collected during these surveys will provide the data base needed for determination of surface waters: (a) requiring protection (Section 816.97, OSM Regs); (b) that could benefit from

mitigating modifications (Section 784.16,21: 816.44, 45, 57, 97; OSM Regs); (c) that warrant on-going monitoring during the project (Section 783.12, 25, OSM Regs); and (d) that will need reclamation following the project (Section 784.13, 21; 816.57, 97; OSM Regs).

3. Surface waters requiring descriptions of habitat were selected following the preliminary inventory survey of July 1980. Stations QC-045, MS-032, ES-001, NFQC-042 and QC-041 had a photographic record made of their habitat. Representative waters (tpper North and South Forks of Quitchupah Creek) having significant existing value, and/or potential value to the aquatic communities of the lease area were selected for detailed quantitative habitat surveys (results are presented in Tables 7 and 9). These surveys are essential prerequisites to impact analysis, habitat improvement (mitigation) or maintenance planning.

4. A surface water resource monitoring program has been prepared (Table 2) based upon preliminary survey (July 1980) analysis. Important stations, as listed in Table 2, will be monitored for a period estimated at 3 years in order to obtain a solid data base line. Further monitoring will continue throughout all project phases at any stations that could be impacted by mining activities. Frequency and scope of monitoring as outlined (Table 2) will be modified as project impacts warrant (any changes subject to approval by regulatory agencies).

5. No threatened or endangered fishes or other aquatic species have been reported from the permit area or from any immediately adjoining areas. This information was contained in a Section 7 Official Consultation obtained from an endangered species biologist, Mr. Robert D. Williams, Utah Area Office, US Fish and Wildlife Service (personal communication per telephone conversation between Mr. Williams and Dr. Winget, July 1980).

6. An updated aquatic resource management plan will be developed, incorporating data from the 1979 plan, mine project plans, water quality and quantity data, biotic and habitat inventory results, and in-put from Utah Division of Oil, Gas and Mining; Utah Division of Wildlife Resources; Utah Division of Health; Office of Surface Mining; and Fishlake National Forest.

7. Where applicable, needed post project reclamation of surface aquatic resources will be defined, and reclamation plans prepared (approval being required from DOGM, UDWR, OSM and Fishlake National Forest.

8. Hydrology and water quality monitoring being conducted by another contractor, is essential to the preperation of an adequate Fish Habitat Plan. Data collected will be used as it becomes available.

PREVIOUSLY COLLECTED AQUATIC RESOURCE DATA

Aquatic community descriptive data were obtained from 2 sources as listed in Table A-1 (Appendix A). It was the

conclusion of previous investigators that the biota of Quitchupah Creek was of marginal quality with little potential for significant improvement under existing land and water uses. These conclusions were derived after analysis of limited data from only 2 stations on lower Quitchupah Creek.

Quitchupah Creek goes through some fairly undesirable clays, silts and sandstone formations before reaching the 2 previously sampled stations (Station QC-037 and another station 4 km downstream). Also, a short distance below Utah highway 10 crossing, Quitchupah Creek has been reported as being dry during summer and fall months of most years. When there has been water present it was of poor quality with high TDS, alkalinity and sulfate loads. Quitchupah Creek has been reported as being of little value to the water quality or biota of downstream waters including the Muddy and Dirty Devil Rivers.

RESULTS OF INVENTORY SURVEYS

To date 2 surveys have been completed - 16-17 July and 30 September 1980. Data summaries are presented in Tables 3, 4, 5, 6, 7, 8, 9, 10 and 11.

East Spring Canyon

In July and September 1980 East Spring Canyon was dry except for about 150 m of channel beginning at the upper springs. Combined flows from the springs were approximately

3 gpm as previously reported by WESTECH. The springs and stream channel are heavily impacted by domestic animal use - sparse riparian vegetation; fecal material abundant on stream banks and in water; water a brown color with foam present; extremely high numbers of mosquito larvae (Culiseta incidens) and simuliid black fly larvae and pupae in the water (July); and an obvious lack of mayflies and stoneflies expected in a perennial high elevation spring (Table 3).

East Spring Canyon springs are of marginal value for aquatic organisms at present, but the water is important to domestic livestock and wildlife in the area. The mosquitoes and black flies could pose a pest and/or health threat to animals of the area, including man. These springs could be impacted by the project through disruption of ground watter flow to the springs. Reduced flows would pose a hardship on animals of the area during summer/fall months - they would have to travel farther for water. By fencing the main springs and the perrenially watered channel and providing watering access for domestic animals at the lower reaches of the fenced area anly, the quality of this resource could be significantly enhanced.

Springs in Mud Spring Hollow

In July, Mud Springs were mainly a soggy meadow with little apparent surface flow. A small (<0.05 ha or 0.10 acre) man-made impoundment was partially full of water and

appears to be continuously wet. The pond is located at the lower end of the soggy meadow area to maximize the amount of water collected. The stream channel was dry a short distance (<100 m) below the impoundment. Apparently the seeps dry up during dry years as WESTECH reported them dry in September 1977.

The vegetation and soil type in the meadow indicated: **SYSTEM** Palustrine; **CLASS** Emergent Wetland; **SUBCLASS** Persistent; **WATER REGIME** Seasonally Flooded; **WATER CHEMISTRY** Fresh; **SOIL** Mineral; **DOMINANT PLANTS** Emergent Hydrophytes (rushes, grasses, sedges); **DOMINANT ANIMALS** Tiger salamander (Ambystoma tigrinum), midges, mayflies, oligochaete worms, water boatmen, copepods, ostracods, cladocerans, damselflies, dragonflies, diving beetles, flies and mosquitoes (Table 3). This wetland classification system used was taken from "Classification of Wetlands and Deepwater Habitats of the United States" by L. M. Cowardin, V. Carter, F. C. Golet and E. T. LaRoe, published as FWS/OBS-79/31, December 1979, Biological Services Program, Fish and Wildlife Service, U. S. Department of the Interior (Stock No. GPO 024-010-00524-6, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402).

The springs were heavily enriched organically due mainly to heavy domestic cattle use. Horse and deer flies and mosquitoes were abundant in the area. Numerous mosquito larvae were observed in depressions in ground (cattle

tracks) that were filled with water.

Mud Spring Hollow springs are an important habitat island for aquatic organisms of the permit area. Springs in Utah, especially in dry parts of the state, act for aquatic organisms much as islands in the ocean for land dwelling animals - providing resting, feeding, reproductive and pioneering habitat allowing species to extend their ranges or reinvade an area following decimation of previously inhabiting populations.

On 30 September 1980 the meadows were mostly dry, the water level in the pond had dropped so that the surface area of the pond was approximately only 60% of that in July. Cattle had grazed off most of the tall grass and had trampled the pond shore line. There was a heavy growth of filamentous algae in the water, probably Cladophora.

Quitchupah Creek

Quitchupah Creek has its beginning mainly in Convulsion Canyon with the majority of the perennial flows coming from the springs above and below the mouth of East Spring Canyon. Water pumped out of the SUFCO mine into East Spring Canyon approximately 200 m above the mouth of the canyon is an important part of Quitchupah Creek flows, especially during low-flow months. East Spring Canyon, Mud Spring Hollow and Convulsion Canyon, all tributaries to Quitchupah Creek, have intermittent flows limited to spring snow melt and storm runoff. These tributaries were all dry in July

and September 1980.

In a literature review, "Effects of Coal Mining Activities on Aquatic Ecosystems" by V. F. Ramakka and L. B. Dalton (Utah Division of Wildlife Resources, September 1979), it is reported that the water coming from the Convulsion Canyon Mine has an average TDS concentration of 276 mg/l compared with 421 mg/l in Quitchupah Creek waters sampled downstream of the mine. The mine water is generally of better water quality than the receiving waters making it of value to the receiving water biota (there are no fish reported occurring in the receiving waters).

Station QC-045 (Quitchupah Creek 300 m below the mouth of East Spring Canyon). Quitchupah Creek from the mouth of East Spring Canyon flows through an extensive layer of Mancos Shale more than 80 m (>600 ft) thick with some Quaternary alluvium along the canyon bottom. Mancos Shale formations cause rapid deterioration in water quality and stream habitat to any stream flowing through it.

The stream channel is mostly a deep, narrow, steep sided gulley with claystone banks (Masuk member of the Mancos Shale). The stream subtsrate as measured in September 1980, was mostly gravel (15%), rubble (10%) heavily embedded in a sand(40%)/clay(25%) matrix, with some silt (5%) and organic muck (5%). There are few pools of any size due to the unstable banks and heavy sediment loads following surface runoff occurrences (storms and snow

melt). Mean water width in September (Q<1cfs) was 3ft and mean depth was 0.3ft. Stream gradient was 3 percent. There are dense growths of shrubs along the stream including wild rose, willows, sage brush and rabbit brush. Stream substrates contained extensive fine refuse materials, some from the mine loading area upstream, but mostly from natural sourrces. The subsurface sediment was more brown than black and there was no noticeable hydrogen sulfide smell indicating that the sediments were oxidized. Percent by weight composition of sediments at this station is given in Table 4.

The aquatic macroinvertebrate community of Quitchupah Creek at this statiion reflects existing environmental stresses. On 17 July 1980 only 8 taxa were collected and over 90 percent of the organisms collected had the highest possible tolerance quotients (Table 5). High tolerance quotients indicate high tolerances of that species to changing environmental conditions. The stonefly, Isogenoides zionensis, was the only taxon collected with a low tolerance (TQ=24) to environmental stress, and it was found in very low numbers. Even the highly tolerant taxa were found in low numbers, further attesting to the existence of regularly occurring environmental stresses.

The predicted community tolerance quotient (CTQ_p) for this section of Quitchupah Creek was 85 compared to the actual (CTQ_a) of 93 in July (Table 4) resulting in a Biotic Condition Index (BCI) of 91. This indicates that the biotic

community condition was 91 percent of what it should have been given the existing aquatic resources of habitat and water quality. It appears that community degradation is due largely to natural factors such as sedimentation from clay and sand formations, poor water quality (bicarbonate alkalinity >400 mg/l, TDS between 400 and 600 mg/l, sulfates from 70 to 180 mg/l) and near intermittent flows at Station QC-045. Less than 10 percent of community degradation in 1980 was use-related. Without mine waters, the community would be in even poorer condition.

Station QC-041 (above confluence with North Fork Quitchupah Creek). The biotic community at this station was quite similar to that of Station QC-045 (Tables 5 and 6). Of the 8 taxa collected in July at QC-045, 6 were also collected in similar densities at QC-041. The CTQ_a was nearly identical at both stations - 93 at QC-045 and 92 at QC-041 in July and 90 at QC-041 in September - even though QC-041 samples contained nearly twice as many taxa.

The aquatic macroinvertebrate community at station QC-041 was in slightly better condition (BCI=95 in July and 98 in September) than QC-045 (BCI=91 in July), when judged by the condition of the available resource -- physical habitat and water quality.

Water quality was poorer at QC-041 (bicarbonate alkalinity 271 mg/l, chloride 30 to 42 mg/l, sodium 90 to 190 mg/l, sulfate 188 to 260 mg/l, TDS 470 to 712 mg/l -

data from Hydrometrics, 1980) than QC-045. Stream banks were 50-75 percent unstable in July and September 1980, riparian vegetation was mostly bare soil and sparse grasses, willow and sagebrush with a few scattered cottonwood trees. The riparian zone was only an average of 5 feet wide. Watered stream channel on 30 September 1980 (Q=1.5cfs) was 5 feet wide average and 0.4 feet deep. Channel gradient was 2 percent. Substrates were mostly gravel (30%) with some rubble (15%) and boulder (10%) deeply embedded in a sand (35%) and clay (15%) matrix. Table 4 contains a breakdown of sediment composition as percent by weight of several size categories. Substrates were lightly cemented rendering gravel beds unsuitable for many aquatic organisms and as spawning habitat for most fishes.

The BCI at QC-041 indicates that the aquatic macroinvertebrate community in Quitchupah Creek was 95 percent in July and 98 percent in September 1980 of what could be expected in a stream of that quality. This stream section is naturally poor habitat for aquatic communities. Improved resource management would result in little improvement. There is no practical potential to establish a fishery in Quitchupah Creek. The SUFCO mining operations should have no deleterious impacts on this stream section, rather, increased discharge of mine waters would be beneficial.

South Fork Quitchupah Creek

Station SFQC-006 (South Fork Quitchupah Creek above the confluence with North Fork Quitchupah Creek). South Fork Quitchupah Creek is mostly a low gradient mountain meadow stream with a rubble (15%) and gravel (15%) substrate laying on a sand (20%) and clay (40%) base. Reported water quality indicates poorer quality than one would expect in a mountain stream at an elevation over 2500 m (>8200 ft) - TDS 328-525 mg/l, sulfate 63-120 mg/l, bicarbonate alkalinity 290-402 mg/l (Hydrometrics, 1980). The stream is subject to stress from cattle grazing, clay-sand substrate, low flows (from 0.004 cfs on 20 September 1978 to 2.1 cfs on 3 July 1979 as reported by WESTECH and Hydrometrics), and poor water quality. Table 7 contains a summary description of the stream at Station SFQC-006 on 30 September 1980. Table 4 contains a sediment description as percent by weight of sediment size classes.

Considering the small size and existing environmental stresses, the aquatic community of 1980 was in excellent condition (Table 8). The presence of 5 species each of mayflies (Ephemeroptera) and 4 species of stoneflies (Plecoptera) plus 4 species of caddisflies (Trichoptera) indicated a fairly diverse, healthy community. The CTQ_a of 78 in July and 76 in September is good compared with 90 to 93 at Stations QC-045 and QC-041. Due to better water quality and location above the Mancos Shale, this stream section has higher potential (CTQ_p=65) than Stations QC-045

and QC-041 with CTQ_p of 85 and 88, respectively. The biotic community at SFQC-006 was 83 and 86 percent of expected (BCI) in July and September, repectively, indicating stream habitat protection and enhancement could result in noticeable improvement in the stream; and conversely, reduction in flows could significantly impact the stream quality.

Potential project impacts are mainly subsidence related and entail reduction of stream flows. This stream section has no fisheries value but is important as a watering source for wildlife and domestic animals plus a source of aquatic organisms for downstream North Fork Quitchupah Creek.

North Fork Quitchupah Creek

Station NFQC-007 (North Fork Quitchupah Creek above the confluence with South Fork Quitchupah Creek). This stream section was not sampled for aquatic organisms in July 1980 but was sampled on 30 September 1980. Due to higher stream flows (0.04 cfs on 14 September 1977 to 6.5 cfs on 4 June 1979), better water quality (TDS 256-430 mg/l, sulfate 17-50 mg/l, bicarbonate alkalinity 210-303 mg/l) and location of drainage farther from the center of subsidence area than Station SFQC-006, this station was added to the list of stations originally sampled. It will serve as an excellent control for comparison with SFQC-006 during active subsidence of its drainage area. Table 9

presents a summary description to the physical resource on 30 September 1980.

The macroinvertebrate community at Station NFQC-007 on 30 September 1980 was quite similar to that at Station SFQC-006 (Tables 8 and 10). Baetis mayflies were highly dominant at both stations indicating physically (habitat or water quantity) limited systems rather than water quality limited. The presence of a fairly diverse community including several species each of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) indicate good water quality and habitat, thus water quantity must be the main limiting factor.

Station NFQC-007 supports a quality aquatic community but the relative low numbers of most taxa (Table 10) indicate that a reduction in stream discharge could result in a reduction in community diversity (elimination of the more fragile species).

This stream section, under present conditions has little fisheries value due to small size and low summer-fall-winter flows. It is an important resource to the overallk aquatic community of the region providing a "stepping stone" of usable habitat for aquatic species in a near "desert". Each species has a limit to the distance it can travel between suitable aquatic resources. Thus, each stream. pond or spring in an area increases the total area any given species can successfully colonize. This is especially critical following periods of stress that may

eliminate species from marginal habitat - recolonization is dependant upon these species being able to "leap frog" from habitat "island"

to "island" until they reach the formerly inhabited habitat.

Station NFQC-042 (North Fork Quitchupah Creek 100 m above the confluence with Quitchupah Creek). This station was selected for monitoring because of its perennial flows and the location of its drainage in relation to the lease areas. As seen in Table 10, the biotic community on 17 July 1980 was in good condition (91% of expected, BCI=91), but had deteriorated by 30 September 1980 (BCI=83). Stream flows at this station are subject to extreme fluctuations (0.006 cfs on 18 September 1977 to 6.7 cfs on 5 June 1978), although a short distance upstream flows are better (on 18 September 1977, Westech, 1978, reported 2.8 gpm at QC-042 and 33 gpm less than 2 miles upstream). Apparently, the biotic community is able to withstand these flow fluctuations -- probably some go hyporheic (under the substrate surface) during low flows; others are probably in the adult (winged, terrestrial stage) or egg (inactive, resistant stage) stage during these severe periods; others seek pools or spring areas; and some are eliminated from localized areas but recolonize these areas following the stress period by drifting downstream from upstream protected stream reaches.

North Fork Quitchupah Creek is relatively unimportant as a fisheries habitat (low flows and cemented substrates) but it does support a relatively diverse aquatic community. This stream should be monitored during coal mining activities that may impact the stream. Reduced flows could cause significant changes in the biota of the stream.

Stream substrates on 30 September 1980 were rubble (25%) and gravel (20%) in a sand (30%) and clay (15%) matrix with limited boulder (5%) and silt (5%). Riparian vegetation was sparse (25% cover), mainly grasses, willow, sage and rabbit brush and cottonwood trees. Stream banks were mostly unstable (30% to 40% stability) with 25 percent or less vegetative cover (grass and low brush). Banks were near vertical and averaging near 20 feet high. Riparian zone was less than 10 feet wide on each side of the stream. Ungulate damage to stream banks was evident but not severe (25% of banks impacted). Stream gradient was 2.5 percent, water width was 5.4 feet but channel width was 29 feet.

Station NFQC-037. This section of Quitchupah Creek is biologically (Table 11) an extension of QC-041 and QC-042, with the poor water quality of QC-041 and the poor habitat from the surrounding claystone shale but with the obvious advantage from the combined flows of Quitchupah and north Fork Quitchupah Creeks. The BCI did not reflect the level of impact on the stream at this station in July 1980, possibly due to aquatic macroinvertebrates being carried

downstream by spring flows (Table 11).

This stream section does not support a fishery as far as is presently known. It definitely is not of adequate quality for a trout fishery. It is water (quality and quantity) and habitat limited. The stream substrate is mostly sand-clay (60%) with some gravel (30%) and rubble (10%). The channel is wide and shallow with sparse riparian vegetation consisting of grasses, willows, rabbit brush and a few scattered cottonwood trees.

Table 1. Aquatic resource inventory stations - station codes and description of locations.

MS-032:	Mud Springs, Sevier County, Utah, T21S, R4E, Sctn 35, 1/4 sctn c, 2520 m (8280 ft) elevation.
ES-001:	Springs at the head of East Spring Canyon below the mouth of Duncan Draw, Sevier County, Utah, T21/22S, R4E, Sctn 36, 1/4 sctn d, 2530 m (8300 ft) elevation.
STQC-006:	Upper South Fork Quitchupah Creek, Sevier County, Utah, T21S, R4E, Sctn 24, 1/4 sctn c, 2520 m (8280 ft) elevation.
NFQC-007:	Upper North Fork Quitchupah Creek above confluence with upper South Fork Quitchupah Creek, Sevier County, Utah, T21S, R4E, Sctn 13, 1/4 sctn a, 2510 m (8240 ft) elevation.
NFQC-042:	North Fork Quitchupah Creek immediately above confluence with Quitchupah Creek, Sevier County, Utah, T22S, R5E, Sctn 16, 1/4 sctn d, 1/4 1/4 sctn d, 1950 m (6400 ft) elevation.
QC-045:	Quitchupah Creek below mine portal and mine drainfield, Sevier County, Utah, T22S, R5E, Sctn 12, 1/4 sctn d, 2145 m (7041 ft) elevation.
QC-041:	Quitchupah Creek immediately above the confluence with North Fork Quitchupah Creek, Sevier County, Utah, T22S, R5E, Sctn 16, 1/4 sctn d, 1/4 1/4 sctn d, 1950 m (6400 ft) elevation.
QC-037:	Quitchupah Creek at the U-10 bridge, Sevier County, Utah, T22S, R5E, Sctn 24, 1/4 sctn b, 1840 m (6040 ft) elevation.

Table 2. Aqautic resource monitoring schedule, station codes used are explained in Table 1. Su=summer; Fa=fall; An=annual or yearly; Photo=photographic survey; Qual=qualitative samples; Quant=quantitative samples and or measurements.

Station	Macroinvertebrate Samples	Habitat Samples	Sediment Sampling
MS-032	Su, An, Qual	Su, An, Photo	--
ES-001	Su, An, Qual	Su, An, Photo	--
SFQC-006	Su, Fa, Quant	Su, An, Quant	Su, Fa, An
NFQC-007	Su, Fa, Quant	Su, An, Quant	Su, Fa, An
NFQC-042	Su, Fa, Quant	Su, An, Photo	Su, Fa, An
QC-045	Su, Quant	Su, An, Photo	Su, Fa, An
QC-041	Su, Fa, Quant	Su, An, Phot	Su, Fa, An
QC-037	Su, Quant	--	--

[1] QC-045 will not be sampled for macroinvertebrates after 1980 due to intermittent nature of flows and poor natural habitat. Station QC-041 samples will provide data on mine impact on stream biota.

Table 3. Partial taxanomic list of aquatic macroinvertebrates collected from Station ES-001 (springs at the head of East Spring Canyon) and Station MS-032 (springs in Mud Spring Hollow), Sevier County, Utah, 17 July 1980.

	Station	
	ES-001*	MS-032*
Oligochaeta	X	X
Cladocera	--	X
Copepoda	--	X
Ostracoda	--	X
Ephemeroptera		
Callibaetis	--	X
Odonata		
Aeshna	--	X
Lestes	--	X
Ischnura	--	X
Hemiptera		
Corixidae	--	X
Gerris	X	X
Trichoptera		
Lepidostoma	X	--
Coleoptera		
Dytiscidae	X	X
Hydrophilidae	--	X
Elmidae		X
Diptera		
Eriocera	X	--
Culiseta incidens	X	X
Dixa	--	X
Simuliidae	X	--
Chironomidae	X	X
Ceratopogonidae	--	X
Euparyphus	--	X
Tabanidae	--	X
Ephydridae	--	X
Limnophora	X	--
Number of taxa	9	20

X=present; --=absent from samples

*Springs were perennial but flow disappears within less than 1 km downstream most of the time each year (observed September 1977, June and September 1978 and July 1980). Flow from springs have shown little fluctuation in rate of discharge according to the hydrology report (preliminary Environmental Assessment of SUFCO Property in Central Utah).

Table 4. Sediment composition of gravel bars at selected stations on surface waters of the SUFCO permit area. Results are given as percent by weight. Samples were taken on 30 September 1980.

Station	QC-045	QC-041	SFQC-006	NFQC-007	NFQC-042
Sieve size (mm)	Percent by weight passed through seive				
25.4	90.5	83.2	90.2	61.6	69.2
4.75	61.1	38.8	60.1	36.4	38.1
2.00	51.0	25.8	49.0	29.2	27.5
0.85	42.5	20.7	42.3	24.7	21.1
0.50	32.3	18.0	32.3	20.0	15.6
0.074	0.7	0.4	0.6	0.7	0.7

Particle Diameter (mm)	Percent by weight of each size class				
Gravel >4.75	38.9	61.2	39.9	63.6	61.9
Coarse sand 2.0-4.75	10.1	13.0	11.1	7.2	10.6
Medium sand 0.5-1.99	18.7	7.8	16.7	9.2	11.9
Fine sand .074-.49	31.6	17.6	31.7	19.3	14.9
Silt/clay <0.074	0.7	0.4	0.6	0.7	0.7

Table 5. Aquatic macroinvertebrate community description as mean number per meter^2 at Station QC-045, Quitchupah Creek below mine portal, Sevier County, Utah.

	17 July 1980	TQ
Nematoda	57	108
Oligochaeta	889	108
Hydracarina	144	108
Copepoda	57	108
Ephemeroptera		
Baetis	115	72
Plecoptera		
Isogenoides zionensis	4	24
Diptera		
Chironomidae	29	108
Euparyphus	29	108

Mean No/m^2	1,323
Standard Deviation	302
Coefficient of Variation	22.8
Mean dry wt., gm/m^2	0.63
Number of taxa	8
H (Shannon Weaver)	1.69
CTQ_a (Winget & Mangum)	93
CTQ_p	85
BCI	91

Table 6. Aquatic macroinvertebrate community description as mean number per meter^2 at Station QC-041, Quitchupah Creek above confluence with North Fork Quitchupah Creek, Sevier County, Utah.

	17 July 1980	30 Sept 1980	TQ
Nematoda	65	11	108
Gastropoda	--	5	108
Oligochaeta	492	89	108
Hydracarina	51	22	108
Ostracoda	11	--	108
Ephemeroptera			
Baetis	2,545	1,068	72
Tricorythodes minutus	32	--	108
E. inermis	11	8	48
Odonata			
Ophiogomphus severus	--	8	108
Argia	11	--	108
Plecoptera			
Isoperla	11		48
Isogenoides zionensis	--	3	24
Trichoptera			
Hydropsyche	30	264	108
Coleoptera			
Elmidae	22	3	108
Diptera			
Eriocera	3	8	36
Chironomidae	108	8	108
Ceratopogonidae	19	--	108
Hemerodromia	8	--	108
Mean No/m^2	3,146	1,496	
Standard Deviation	1,223	586	
Coefficient of Variation	35.8	39.2	
Mean dry wt., gm/m^2	0.56	3.18	
Number of taxa	15	12	
H (Shannon Weaver)	1.42	1.39	
CTQ_a (Winget & Mangum)	92	90	
CTQ^p	88	88	
BCI	95	98	

Table 7. Resource description of South Fork Quitchupah Creek at Stn SFQC-006 on 30 September 1980.

Water Surface (Q=0.2cfs)		
mean water width: 2.7ft; range 1.5 to 3.8ft		
mean water depth: 0.18ft; range 0.1 to 0.23ft		
mean water velocity: 0.3ft/sec; range 0 to 0.4ft/sec		
Channel		
Total width: mean 24ft; range 11 to 40ft		
Substrates:	boulder (>12in diam)	0%
	rubble (3-12in diam)	15%
	gravel (.1-3in diam)	15%
	sand	20%
	silt	0%
	clay	40%
Gradient: mean 2.2%; range 1 to 3%		
Left Bank		
	cover	65%
	stability	80%
	class	low shrubs + grass
	gradient	45%
	ungulate damage	30%
	riparian zone	9.6ft (3-19ft)
Right Bank		
	cover	75%
	stability	75%
	class	brush + trees
	gradient	35%
	ungulate damage	25%
	riparian zone	10.8ft (4-18ft)

Table 8. Aquatic macroinvertebrate community description as mean number per meter^2 at Station SFQC-006, upper South Fork Quitchupah Creek, Sevier County, Utah.

	17 July 1980	30 Sept 1980	TQ
Nematoda	--	32	108
Gastropoda	29	--	108
Oligochaeta	642	301	108
Hydracarina	11	320	108
Copepoda	29	--	108
Ostracoda	143	13	108
Ephemeroptera			
Baetis	3,052	32,759	72
Cinygmula	68	159	21
E. coloradensis	11	--	18
E. grandis	--	22	24
E. inermis	--	8	48
Plecoptera			
Zapada	--	355	16
Prostoia besametsa	4,677	--	24
Capniidae	68	1,332	32
Isoperla	785	253	48
Trichoptera			
Hydropsyche	154	484	108
Hydroptila	11	--	108
Hesperophylax	4	--	108
Lepidostoma	11	--	18
Coleoptera			
Dytiscidae	57	--	108
Elmidae	--	81	108
Diptera			
Tipulidae	--	105	72
Dicranota	86	56	24
Holorusia grandis	--	5	72
Simuliidae	6,553	73	108
Chironomidae	172	920	108
Ceratopogonidae	29	--	108
Stratiomyidae	--	19	108
Hemerodromia	75	70	108
Limnophora	--	43	108
Mean No/m^2	23,410	37,410	
Standard Deviation	14,608	14,373	
Coefficient of Variation	62.4	38.4	
Mean dry wt., gm/m^2	12.00	2.01	
Number of taxa	22	22	
H (Shannon Weaver)	2.51	0.95	
CTQ_a (Winget & Mangum)	78	76	
CTQ_p	65	65	
BCI	83	86	

Table 9. Resource description of North Fork Quitchupah Creek at Stn NFQC-007 on 30 September 1980.

Water Surface (Q=0.5cfs)

mean water width: 3.9ft; range 2.4 to 4.6ft
mean water depth: 0.4ft; range 0.1 to 0.95ft
mean water velocity: 1.0ft/sec; range 0 to 1.2ft/sec

Channel

Total width: mean 21ft; range 12 to 31ft

Substrates:	bedrock	5%
	boulder (>12in diam)	10%
	rubble (3-12in diam)	35%
	gravel (.1-3in diam)	20%
	sand	15%
	silt	0%
	clay	15%

Gradient: mean 4.0%; range 2 to 7%

Left Bank		
	cover	50%
	stability	70%
	*class	low shrubs + grass
	gradient	55%
	ungulate damage	42%
	riparian zone	5.7ft (2-12ft)
Right Bank		
	cover	50%
	stability	58%
	*class	grass + low shrubs
	gradient	66%
	ungulate damage	42%
	riparian zone	6.0ft (4-9ft)

*Actual landform gradient above steep eroded banks was approximately 22%. Tall bank top was 25ft above water surface showing extensive past channel erosion.

Table 10. Aquatic macroinvertebrate community description as mean number per meter^2 at Station NFQC-042, North Fork Quitchupah Creek, immediately above confluence with Quitchupah Creek, Sevier County, Utah.

	17 July 1980	30 Sept 1980	TQ
Nematoda	--	16	108
Oligochaeta	43	11	108
Hydracarina	32	11	108
Ephemeroptera			
Baetis	344	662	72
E. inermis	32	32	48
Plecoptera	11		48
Capniida	--	16	32
Prostoia besametsa	11	--	24
Pteronarcella badia	22	3	24
Isogenoides zionensis	110	54	24
Isoperla	75	--	48
Trichoptera			
Hydropsyche	54	178	108
Lepidostoma	--	5	18
Coleoptera			
Dytiscidae	11	--	108
Diptera			
simuliidae	--	65	108
Chironomidae	32	--	108
Empididae	--	11	108
Mean No/m^2	777	1,063	
Standard Deviation	372	536	
Coefficient of Variation	47.9	51	
Mean dry wt., gm/m^2	0.63	3.03	
Number of taxa	12	12	
(Shannon Weaver)	2.72	1.92	
CTQ_a (Winget & Mangum)	66	72	
CTQ_p	60	60	
BCI	91	83	

Table 11. Aquatic macroinvertebrate community description as mean number per meter^2 at Station QC-037, Quitchupah Creek at Utah Highway 10, Sevier County, Utah.

	17 July 1980	TQ
Nematoda	43	108
Oligochaeta	422	108
Hydracarina	234	108
Ostracoda	19	108
Ephemeroptera		
Baetis	6219	72
Heptagenia	3	48
Cinygmula	11	21
Ehpemerella	22	48
Odonata		
Ophiogomphus severus	24	108
Argia	22	108
Plecoptera		
Prostoia besametsa	22	24
Isogenoides zionensis	132	24
Isoperla	97	48
Hemiptera		
Gerris	35	--
Coleoptera		
Dytiscidae	43	108
Elmidae	22	108
Diptera		
Eriocera	3	36
Simuliidae	11	108
Chironomidae	183	108
Ceratopogonidae	46	108

Mean No/m^2	7642
Standard Deviation	7887
Coefficient of Variation	103
Mean dry wt., gm/m^2	1.76
Number of taxa	21
H (Shannon Weaver)	1.31
CTQ_a (Winget & Mangum)	78
CTQ^p	80
BCI	103

RESULTS OF 1980-1982 AQUATIC RESOURCE MONITORING IN THE CONVULSION CANYON COAL LEASE AREA - SOUTHERN UTAH FUEL COMPANY

15 MARCH 1983

Prepared by:

Robert N. Winget
Environmental Consultants
483 East 1834 South
Orem, Utah 84057
(801) 225-7598

RESULTS OF 1980-1982 AQUATIC RESOURCE MONITORING IN THE CONVULSION CANYON COAL LEASE AREA - SOUTHERN UTAH FUEL COMPANY

15 March 1983

by: Robert N. Winget, Environmental Consultants
483 East 1834 South
Orem, Utah 84057 - (801) 225-7598

INTRODUCTION

This report is mainly an update of results from the on-going monitoring of the aquatic resources of Quitchupah and North Fork Quitchupah Creeks within the SUFCo lease area. The SUFCO Mine portal located at 111° 25' W, 38° 54' 30" N, has been in operation for approximately 40 years. Much of the project surface disturbance of the aquatic resources has already occurred. As new lease areas are mined, subsidence could significantly alter existing flow patterns in the perennial North Fork Quitchupah and Quitchupah Creeks and several small springs in the area. The surface waters in the lease area are not of game fish quality, either due to small size, intermittent flows or poor habitat and water quality. Because of the relatively low importance of these waters to the fisheries resources of Utah, there had been little survey work done of the biota of these waters prior to the present monitoring program.

A preliminary on-site inventory of aquatic macroinvertebrates was completed on 16 and 17 July 1980 with 5 stream and 2 spring stations being sampled (stations listed in Table 1). Preliminary data analysis indicated one additional station on upper North Fork Quitchupah Creek (Station NFQC-007) was needed to provide data for future evaluations of subsidence impacts on the north end of the lease area. Station NFQC-007 has been sampled on each subsequent sampling. Results from Station QC-037 indicated that this station was under so much impact from factors other than the SUFCo project that it was not pertinent to the program. This station has not been sampled since 1980.

Available information on water quality and quantity and stream biota was reviewed and incorporated into the resource inventory where applicable. Included was: (a) Environmental Assessment and Impact

Evaluation of Underground Coal Mining at the SUFCO Property in Central Utah, by WESTECH; (b) Hydrology, Vegetation and Wildlife Monitoring at the Southern Utah Fuel Company Mine No. 1 near Salina, Utah - a Three Year Summary, by Hydrometrics; (c) 208 reports prepared for the Southeastern Association of Governments by Vaughn Hansen Associates (1976-77); (d) USBLM - EMRIA reports by BYU Aquatic Ecology Laboratory under subcontract with GeoScientific of California; and (e) Reports of the Aquatic Ecology Laboratory, Intermountain Region, National Forest Service. Utah Division of Wildlife Resources has no fisheries survey data available for waters in the permit area according to personal communication with Mr. John Livesay, Fisheries Biologist, Price Office.

RESULTS OF INVENTORY SURVEYS

To date, five surveys have been completed - July 1980, September 1980, June 1981, June 1982 and October 1982. This report is an update of sampling results for 1980-1982. For a more detailed description of stream characteristics, water quality and permit area habitat refer to the report entitled "Aquatic Resources Inventory of Southern Utah Fuel Company Permit Area", (Winget, October 1980).

SEDIMENT SAMPLING

Table 2 presents a summary of sediment sampling results at five stations. All stations showed a buildup of fine sediments during 1981 and into the spring of 1982, the result of lack of runoff high enough to clean out accumulations of fine materials. Following the 1982 runoff and summer storms of the same year, levels of fine sediments in October 1982 was lower at all stations than during the previous June. Sediments passing through a 2.00mm sieve opening was lower in October 1982 at Stations SFQC-006 and QC-045 than during any previous sampling.

Levels of fine sediments in the streams indicate a system subject to chronic sedimentation - fine materials being added regularly from streamside erosion. That is a natural characteristic of this drainage, although extensive cattle grazing has aggravated the situation, increasing the amounts of fines added annually.

STREAM HABITAT

Tables 3 and 4 summarize habitat measurements taken at two stations, one each on the upper forks of Quitchupah Creek - Station NFQC-007 and Station SFQC-006. Photo surveys have been made during each of the three years of study and will continue in 1983. Actual stream channel measurements will not be made again unless noticeable changes show up in the photos.

AQUATIC MACROINVERTEBRATES

Quitchupah Creek

Station QC-045 (Quitchupah Creek 300 m below the mouth of East Spring Canyon). After 1980, macroinvertebrate samples were taken twice - June and October 1982 (Table 5). This station was not sampled in 1981 due to extremely low water flow conditions. It is under a naturally occurring stress due mainly to sedimentation, low water flows and poor water quality (Winget 1980). During the sampling period there was an improvement in the macroinvertebrate community. This is the apparent result of the construction of a sediment pond above this station.

Most of the community indicators from the June 1982 sample indicated a stressed condition - low water flows, sedimentation and poor water quality. During 1982 community structure improved. The number of taxa increased from 9 to 16, H (Shannon Weaver diversity index) went from 0.61 to 1.54, the CTQa (actual community tolerance quotient) dropped from 108 to 94 and the BCI (biotic condition index) improved from 79 to 90. Also, many of the taxa appearing in the October 1982 sample had TQs (tolerance quotients) less than 108, the maximum TQ an insect can obtain. Most taxa had a TQ of 72, one had a 95 and one a 36. This indicates a movement of more fragile insects into the area. By October 1982 the aquatic community was in noticeably better condition than during 1980 (pre-sediment pond period) - in 1982 there was a greater number of insects per square meter (1,323 in July 1980 and 4,000 in October 1982) and more taxa were found (8

in July 1980 and 16 in October 1982).

Station QC-041 (above confluence with North Fork Quitchupah Creek). The aquatic macroinvertebrate community at this station also showed an improvement in 1982, although not quite as much as at station QC-045. This station, located downstream of QC-045, was apparently benefited by the sediment pond on Quitchupah Creek immediately below the SUFCo Mine. The improvement from July 1980 to October 1982 was manifest mainly in the CTQa which dropped from 92 in July and 90 in September 1980 to 87 in June and October 1982 (Table 6). This resulted in an increase of the BCI from 95 and 98 during 1980 to 101 in 1982. The community improved although the number of taxa dropped from 15 and 12 in 1980 and 16 in 1981 to 10 and 11 in 1982. Of importance was the increased numbers of *Isogenoides zionensis* stoneflies during 1982 with a corresponding drop in *Baetis* mayfly numbers. The influence of the sediment pond on the aquatic insect community quality at station QC-041 becomes even more evident when compared to community condition at station NFQC-042. This station had its lowest numbers, biomass and diversity of the study period during October 1982 (Station NFQC-042 is addressed later in this section.

South Fork Quitchupah Creek

Station SFQC-006 (South Fork Quitchupah Creek above the confluence with North Fork Quitchupah Creek and Convulsion Canyon). Throughout the sampling period, the macroinvertebrate community quality in South Fork Quitchupah Creek remained diverse (Table 7). The macroinvertebrate community, as sampled in June 1982, yielded some of the poorest values since the study began in July 1980 - the number of macroinvertebrates per square meter was down to 1,805, dry weight in gms/m^2 was 0.97, the number of taxa was 13, the CTQa rose to 81 and the BCI was only 80. This was in response to the low stream flows during 1981, including the winter of 1981-82. The increased flows of 1982, including several late summer thunderstorms resulted in an improvement in community condition by October 1982. The community condition in October 1982 approached levels existing before 1981. The mean number of macroinvertebrates per square meter was up to 10,316, the number of taxa up to 22 and the CTQa was at its lowest

level (66) during the study. The resulting BCI in October 1982 was 98, indicating that the aquatic community was at 98% of its expected potential. The presence of taxa with TQ values <30 indicate relatively high water quality and the presence of areas of clean rocky substrates.

North Fork Quitchupah Creek

Station NFQC-042 (North Fork Quitchupah Creek 100 m above the confluence with Quitchupah Creek). North Fork Quitchupah Creek contains water year-round but is subject to extreme seasonal fluctuations in quantity (Winget 1980). These fluctuations also result in changes in the macroinvertebrate community condition. The October 1982 samples showed a severe stress situation (Table 8) - numbers of oligochaete worms, Hydracarina mites, *Baetis* and *Ephemerelly inermis* mayflies, and all species of Plecoptera (stoneflies) were the lowest during the study. Total community numbers, standing crop (gm/m^2) and number of taxa were at their lowest during October 1982. A late summer storm had washed out the stream flow measuring weir and scoured the stream substrates severely. This was most likely the cause of the community degradation. Samples in 1983 will help clarify the cause of the community structural change. Of interest was the improvement in the community at Station QC-041, only 250 ft away.

Station NFQC-034 (North Fork Quitchupah Creek in Convulsion Canyon midway between Stations NFQC-007 and NFQC-042). This station was sampled qualitatively in June 1982 to better understand the changes in the community between the top and bottom of Convulsion Canyon. The species collected (Table 9), with the exception of three taxa, were all found either at Station NFQC-007 or NFQC-042. The community had similarities to both stations 007 and 042 - 16 taxa in common with 007 and 14 taxa with 042. With the high similarities in communities at all three stations, sampling at 007 and 042 should suffice for the objectives of this monitoring.

Station NFQC-007 (North Fork Quitchupah Creek above the confluence with South Fork Quitchupah Creek). The trends of the macroinvertebrate community at station NFQC-007 were basically the same as those observed at station SFQC-006. Almost all indicator values decreased in June 1981 and were at their lowest point in June 1982 - mean number of macroinvertebrates per square meter was 942, mean dry weight in gms per square meter was 0.63, number of taxa was 13, CTQa was 74 and BCI was 87 (Table 10). This was due to reduced flows in 1981 with the carry-over effect of that stress into the spring of 1982. As with the macroinvertebrate comunity at SFQC-006, the community at NFQC-007 showed resilience in 1982 when the October sample yielded 5,504 macroinvertebrates per square meter, 21 species, a dry weight of 1.23 gms/m^2, a CTQa of 70 and a BCI of 93 - overall, the best condition measured during the study. Apparently the stress shown at Station NFQC-042 in October 1982 resulted below this station.

Station NFQC-007 does not have quite as diverse a community as Station SFQC-006 in relation to total number of taxa collected during the study but condition is nearly equal (number of taxa/date, number/m^2, CTQa and BCI).

Station NFQC-037. This station was sampled only twice, in July 1980 and June 1981 (Table 11). This station is so heavily impacted by factors not related to the SUFCo project that it has been dropped from the monitoring program.

SUMMARY OF CONDITION

Quitchupah and North Fork Quitchupah Creeks are marginal quality (both habitat and water quality) streams due to highly variable flows, chronic grazing impacts, and naturally alkaline waters. The communities of aquatic macroinvertebrates are composed mainly of taxa considered tolerant or moderately tolerant to environmental stresses. Receiving waters downstream are of poorer quality than Quitchupah Creek due mainly to decreased water quality resulting from total dissolved solids buildup from

agricultural return flows and additions from shale and clay formations below the canyon mouths, the worst being the extensive Mancos Shale. These streams are not, and probably never have been fishery streams. Even with improved grazing controls, water quantity and quality are not suitable for developing a fisheries in these streams.

Table 1 Aquatic resource inventory stations - station codes and description of locations.

MS-032: Mud Springs, Sevier County, Utah, T21S, R4E, Sctn 35, 1/4 sctn c, 2520 m (8280 ft) elevation.

ES-001: Springs at the head of East Spring Canyon below the mouth of Duncan Draw, Sevier County, Utah, T21/22S, R4E, Sctn 36, 1/4 sctn d, 2530 m (8300 ft) elevation.

SFQC-006: Upper South Fork Quitchupah Creek, Sevier County, Utah, T21S, R4E, Sctn 24, 1/4 sctn c, 2520 m (8280 ft) elevation.

NFQC-007: Upper North Fork Quitchupah Creek above confluence with upper South Fork Quitchupah Creek, Sevier County, Utah, T21S, R4E, Sctn 13, 1/4 sctn a, 2510 m (8240 ft) elevation.

NFQC-034: North Fork Quitchupah Creek in Convulsion Canyon, midway between Stations NFQC-042 and NFQC-007, Sevier County, Utah.

NFQC-042: North Fork Quitchupah Creek immediately above confluence with Quitchupah Creek, Sevier County, Utah, T22S, R5E, Sctn 16, 1/4 sctn d, 1/4 1/4 sctn d, 1950 m (6400 ft) elevation.

QC-045: Quitchupah Creek below mine portal and mine drainfield, Sevier County, Utah, T22S, R5E, Sctn 12, 1/4 sctn d, 2145 m (7041 ft) elevation.

QC-041: Quitchupah Creek immediately above the confluence with North Fork Quitchupah Creek, Sevier County, Utah, T22S, R5E, Sctn 16, 1/4 sctn d, 1/4 1/4 sctn d, 1950 m (6400 ft) elevation.

QC-037: Quitchupah Creek at the U-10 bridge, Sevier County, Utah, T22S, R5E, Sctn 24, 1/4 sctn b, 1840 m (6040 ft) elevation.

Table 2. Sediment composition at five stations in the SUFCo permit area as percent by weight of sediments passing through six USGS sieve sizes.

Sieve size (mm)	Sept 1980	June 1981	June 1982	Oct 1982
	Station SFQC-006			
12.70	81.8	67.2	88.3	84.1
4.75	60.1	55.6	63.8	57.5
2.00	49.0	46.2	51.3	42.5
0.85	42.3	39.5	44.4	35.6
0.50	32.3	34.7	36.6	29.1
0.074	0.6	0.3	1.6	2.1
	Station NFQC-007			
12.70	48.7	49.2	64.3	---
4.75	36.0	31.8	48.6	---
2.00	28.4	20.7	38.1	---
0.85	24.1	15.1	30.9	---
0.50	19.2	11.5	24.6	---
0.074	0.7	0.4	1.0	---
	Station QC-045			
12.70	79.2	81.6	75.3	72.2
4.75	61.1	70.8	63.5	43.6
2.00	51.0	61.6	58.3	31.6
0.85	42.5	48.1	54.6	26.8
0.50	32.3	21.2	47.9	20.9
0.074	0.7	0.4	2.5	2.3
	Station QC-041			
12.70	65.1	49.3	91.9	87.4
4.75	38.8	31.4	73.8	62.4
2.00	25.8	19.9	56.0	40.5
0.85	20.7	15.3	41.4	28.6
0.50	18.0	13.0	29.0	22.5
0.07	0.4	0.4	1.8	2.0
	Station NFQC-042			
12.70	59.5	47.0	77.0	67.6
4.75	37.9	27.6	54.7	45.3
2.00	27.3	17.5	41.7	31.8
0.85	21.2	12.4	35.1	24.8
0.50	15.3	8.8	29.2	19.9
0.074	0.4	0.3	1.1	2.0

Table 3. Resource description of South Fork Quitchupah Creek at Station SFQC-006.

	30 Sep 1980	02 Jun 1981	average
Water Surface			
Q (discharge):	0.2 cfs	0.5 cfs	0.35 cfs
Water width - mean:	2.7 ft	1.9 ft	2.3 ft
range:	1.5-3.8 ft	1.5-2.3 ft	1.5-3.8 ft
Water depth - mean:	0.18 ft	0.25 ft	0.21 ft
maximum:	0.23 ft	0.4 ft	0.4 ft
Water velocity - mean:	0.3 fps	1.0 fps	0.65 fps
maximum:	0.4 fps	1.2 fps	1.2 fps
Channel			
Channel width - mean:	24 ft	21 ft	22.5 ft
range:	11-40 ft	19-22 ft	11-40 ft
Substrates - percent bottom cover:			
boulder (>12in diam)	0%	0%	0%
rubble (3-12in diam)	15%	0%	7.5%
gravel (.1-3in diam)	15%	18%	16.5%
sand	20%	33%	26.5%
silt	0%	6%	3.0%
clay	40%	38%	39.0%
Gradient - mean:	2.2%	2.5%	2.4%
range:	1-3%	---	---
Left Bank			
cover:	65%	82%	73.5%
stability:	80%	80%	80.0%
class:	low shrubs + grass		
gradient:	45%	4%	24.5%
ungulate damage:	30%	35%	32.5%
riparian zone width -			
mean:	9.6 ft	8.8 ft	9.2 ft
range:	3-19 ft	3-17 ft	3-19 ft
Right Bank			
cover:	75%	85%	80.0%
stability:	75%	75%	75.0%
class:	brush + trees		
gradient:	35%	9%	12.0%
ungulate damage:	25%	30%	27.5%
riparian zone width -			
mean:	10.8 ft	11.1 ft	16.9 ft
range:	4-18 ft	4-21 ft	4-21 ft

Table 4. Resource description of North Fork Quitchupah Creek at Station NFQC-005.

	30 Sep 1980	02 Jun 1981	average
Water Surface			
Q (discharge):	0.5 cfs	2.2 cfs	1.35 cfs
Water width - mean:	3.9 ft	6.0 ft	4.9 ft
range:	2.4-4.6 ft	5.3-6.3 ft	2.4-6.3 ft
Water depth - mean:	0.4 ft	0.36 ft	0.38 ft
maximum:	0.95 ft	0.44 ft	0.95 ft
Water velocity - mean:	1.0 fps	1.0 fps	1.0 fps
maximum:	1.2 fps	1.4 fps	1.4 fps
Channel			
Channel width - mean:	21 ft	18 ft	19.5 ft
range:	12-31 ft	15-24 ft	12-31 ft
Substrates - percent bottom cover:			
bedrock	5%	0%	2.5%
boulder (>12in diam)	10%	16%	13.0%
rubble (3-12in diam)	35%	27%	31.0%
gravel (.1-3in diam)	20%	22%	21.0%
sand	15%	30%	22.5%
silt	0%	5%	2.5%
clay	15%	0%	7.5%
Gradient - mean:	4.0%	3.0%	3.5%
range:	2-7%	2-5%	2-7%
Left Bank			
cover:	50%	65%	57.0%
stability:	70%	60%	65.0%
class:	low shrubs + grass		
gradient:*	55%	47%	51.0%
ungulate damage:	42%	44%	43.0%
riparian zone width -			
mean:	5.7 ft	6.2 ft	6.0 ft
range:	2-12 ft	3-14 ft	2-14 ft
Right Bank			
cover:	50%	65%	57.5%
stability:	58%	63%	60.5%
class:	brush + trees		
gradient:*	66%	55%	60.5%
ungulate damage:	42%	41%	41.5%
riparian zone width -			
mean:	6.0 ft	5.8 ft	5.9 ft
range:	4-9 ft	4-10 ft	4-10 ft

*Actual landform gradient above steep eroded banks was approximately 22%. Tall bank top was 25ft above water surface showing extensive past channel erosion.

Table 5. Aquatic macroinvertebrate community description as mean number per meter^2 at Station QC-045, Quitchupah Creek below mine portal, Sevier County, Utah.

	17 Jul 1980	22 Jun 1982	19 Oct 1982	TQ
Nematoda	57	29	266	108
Gastropoda	--	14	--	108
Pelecypoda	--	29	30	108
Oligochaeta	889	2,955	2,967	108
Hydracarina	144	--	--	108
Copepoda	57	--	56	108
Ostracoda	--	29	8	108
Lepidoptera				
Pyralidae	--	--	11	72
Ephemeroptera				
Baetis	115	--	164	72
Odonata				
Argia	--	--	40	108
Hyponeura	--	14	--	108
Plecoptera				
Isogenoides zionensis	4	--	--	24
Trichoptera				
Hydroptila	--	43	--	108
Hesperophylax	--	--	22	108
Diptera				
Eriocera	--	--	24	72
Ormosia	--	--	11	72
Pericoma	--	--	11	36
Chironomidae	29	57	347	108
Ceratopogonidae	--	29	11	108
Euparyphus	29	--	22	108
Empididae	--	--	11	95
Mean No/m^2	1,323	3,199	4,000	
Standard Deviation	302	2,118	4,927	
Coefficient of Variation	22.8	66.2	123.2	
Mean dry wt., gm/m^2	0.63	0.88	0.65	
Number of taxa	8	9	16	
H (Shannon Weaver)	1.69	0.61	1.54	
CTQ_a (Winget & Mangum)	93	108	94	
CTQ_p	85	85	85	
BCI	91	79	90	

Table 6. Aquatic macroinvertebrate community description as mean number per meter^2 at Station QC-041, Quitchupah Creek above confluence with North Fork Quitchupah Creek, Sevier County, Utah.

	17 Jul 1980	30 Sep 1980	18 Sep 1981	22 Jun 1982	19 Oct 1982	TQ
Nematoda	65	11	89	13	--	108
Gastropoda	--	5	--	--	--	108
Oligochaeta	492	89	132	433	199	108
Hydracarina	51	22	538	11	27	108
Cladocera	--	--	3	--	--	108
Copepoda	--	--	--	11	--	108
Ostracoda	11	--	13	--	3	108
Ephemeroptera						
Baetis	2,545	1,068	8,974	2,354	1,894	72
Cinygmula	--	--	11	--	--	30
Tricorythodes minutus	32	--	--	--	--	108
E. inermis	11	8	--	--	3	48
Odonata						
Ophiogomphus severus	--	8	--	--	--	108
Argia	11	--	--	--	--	108
Plecoptera						
Isogenoides zionensis	--	3	11	35	38	24
Isoperla	11	--	43	--	--	48
Trichoptera						
Hydropsyche	30	264	143	--	344	108
Coleoptera						
Dytiscidae	--	--	--	19	--	72
Elmidae	22	3	11	--	5	108
Diptera						
Tipulidae	--	--	--	11	--	72
Eriocera	3	8	--	--	5	36
Chironomidae	108	8	237	78	3	108
Ceratopogonidae	19	--	32	--	5	108
Tabanidae	--	--	3	--	--	108
Hemerodromia	8	--	22	22	--	95
Mean No/m^2	3,146	1,496	10,260	2,986	2,526	
Standard Deviation	1,223	586	2,734	1,206	1,016	
Coefficient of Variation	35.8	39.2	26.7	40.4	40.2	
Mean dry wt., gm/m^2	0.56	3.18	1.62	0.29	0.70	
Number of taxa	15	12	16	10	11	
H (Shannon Weaver)	1.42	1.39	0.87	1.11	1.24	
CTQ_a (Winget & Mangum)	92	90	86	87	87	
CTQ_p	88	88	88	88	88	
BCI	95	98	102	101	101	

Table 7. Aquatic macroinvertebrate community description as mean number per meter^2 at Station SFQC-006, upper South Fork Quitchupah Creek, Sevier County, Utah.

	17 Jul 1980	30 Sep 1980	02 Jun 1981	22 Jun 1982	19 Oct 1982	TQ
Nematoda	--	32	43	13	78	108
Gastropoda	29	--	--	27	--	108
Oligochaeta	642	301	1,227	116	78	108
Hydracarina	11	320	387	56	213	108
Copepoda	29	--	--	--	--	108
Ostracoda	143	13	22	--	19	108
Lepidoptera						
Noctuidae	--	--	--	--	3	72
Ephemeroptera						
Baetis	3,052	32,759	947	129	8,920	72
Cinygmula	68	159	22	--	62	21
E. coloradensis	11	--	--	--	--	18
E. grandis	--	22	43	--	--	24
E. doddsi	--	--	3	8	--	2
E. inermis	--	8	--	--	8	48
Plecoptera	--	--	86	--	--	48
Nemouridae	--	--	2,130	--	--	36
Amphinemura	--	--	--	855	--	48
Zapada	--	355	968	--	--	16
Zapada cinctipes	--	--	--	--	11	16
Prostoia besametsa	4,677	--	--	--	--	24
Capniidae	68	1,332	--	--	194	32
Pteronarcella badia	--	--	--	--	3	24
Isogenoides zionensis	--	--	3	--	250	24
Isoperla	785	253	560	43	--	48
Trichoptera						
Hydropsyche	154	484	65	83	46	108
Arctopsyche grandis	--	--	--	--	11	18
Hydroptila	11	--	--	--	--	108
Hesperophylax	4	--	5	--	--	108
Lepidostoma	11	--	--	--	--	18
Coleoptera						
Dytiscidae	57	--	22	--	--	108
Elmidae	--	81	--	--	--	108
Diptera						
Tipulidae	--	105	--	--	--	72
Dicranota	86	56	--	--	11	24
Tipula sp. g	--	5	3	--	8	72
Eriocera	--	--	--	11	8	72
Ormosia	--	--	--	--	11	72
Pericoma	--	--	22	--	11	36
Simuliidae	6,553	73	65	35	8	108
Chironomidae	172	920	215	417	336	108
Ceratopogonidae	29	--	--	--	--	108
Stratiomyidae	--	19	43	--	--	108
Euparyphus	--	--	43	11	--	108
Hemerodromia	75	70	86	--	30	108
Limnophora	--	43	--	--	--	108
Mean No/m^2	23,410	37,410	7,007	1,805	10,316	
Standard Deviation	14,608	14,373	6,003	684	1,925	
Coefficient of Variation	62.4	38.4	85.7	37.9	18.7	
Mean dry wt., gm/m^2	12.00	2.01	2.21	0.97	1.02	
Number of taxa	22	22	24	13	22	
H (Shannon Weaver)	2.51	0.95	3.01	2.39	1.01	
CTQ_a (Winget & Mangum)	78	76	71	81	66	
CTQ_p	65	65	65	65	65	
BCI	83	86	92	80	98	

Table 8. Aquatic macroinvertebrate community description as mean number per meter^2 at Station NFQC-042, North Fork Quitchupah Creek, above confluence with Quitchupah Creek, Sevier County, Utah.

	17 Jul 1980	30 Sep 1980	18 Jun 1981	22 Jun 1982	19 Oct 1982	TQ
Nematoda	--	16	22	8	--	108
Oligochaeta	43	11	75	43	8	108
Hydracarina	32	11	75	40	--	108
Ostracoda	--	--	11	--	--	108
Ephemeroptera						
Baetis	344	662	5,078	161	191	72
Cinygmula	--	--	11	11	--	30
Tricorythodes minutus	--	--	32	--	--	108
E. inermis	32	32	22	13	5	48
Plecoptera	11	--	11	--	--	48
Amphinemura	--	--	--	3	--	6
Malenka	--	--	59	--	--	36
Prostoia besametsa	11	--	--	8	--	24
Zapada cinctipes	--	--	--	8	--	16
Capniidae	--	16	--	--	5	32
Pteronarcella badia	22	3	--	--	5	24
Isogenoides zionensis	110	54	97	54	16	24
Isoperla	75	--	43	22	--	48
Trichoptera						
Hydropsyche	54	178	--	--	97	108
Lepidostoma	--	5	--	--	--	18
Micrasema	--	--	--	5	--	24
Coleoptera						
Dytiscidae	11	--	81	--	--	108
Elmidae	--	--	16	--	3	104
Diptera						
Eriocera	--	--	--	--	3	72
Ormosia	--	--	5	--	--	72
Simuliidae	--	65	985	1,458	--	108
Chironomidae	32	--	285	414	8	108
Ceratopogonidae	--	--	70	8	--	108
Empididae	--	11	--	--	--	108
Hemerodromia	--	--	--	3	--	95
Mean No/m^2	777	1,063	6,978	2,260	342	
Standard Deviation	372	536	5,405	1,199	177	
Coefficient of Variation	47.9	51.0	77.5	53.1	51.8	
Mean dry wt., gm/m^2	0.63	3.03	0.45	0.86	0.30	
Number of taxa	12	12	18	16	10	
H (Shannon Weaver)	2.72	1.92	1.55	1.77	1.84	
CTQ_a (Winget & Mangum)	66	72	78	64	70	
CTQ_p	60	60	60	60	60	
BCI	91	83	77	94	86	

Table 3 Partial taxanomic list of aquatic macroinvertebrates collected from North Fork Quitchupah Creek midway down Convulsion Canyon between NFQC-007 and NFQC-042 on 23 June 1982 (in the immediate vicinity of Station NFQC-034, a water quality station used in the SUFCo applicaiton).

Phylum Mollusca
Gastropoda
Planorbidae
Phylum Annelida
Oligochaeta
Phylum Platyhelminthes
Turbellaria
Phylum Arthropoda
Hydracarina
Ephemeroptera
Baetis
Cinygmula
Epeorus
Plecoptera
Isogenoides zionensis
Isoperla fulva
Zapada cincitipes
Trichoptera
Rhyacophila bifila
Rhyacophila angelita
Hydropsyche
Hesperophylax
Coleoptera
Dytiscidae
Elmidae
Diptera
Eriocera
Simuliidae
Chironomidae
Euparyphus
Hemerodromia
Number of taxa 22

Table 10. Aquatic macroinvertebrate community description as mean number per meter^2 at Station NFQC-007, upper North Fork Quitchupah Creek, Sevier County, Utah.

	30 Sep 1980	02 Jun 1981	22 Jun 1982	19 Oct 1982	TQ
Nematoda	32	--	8	16	108
Pelecypoda	--	13	--	--	108
Oligochaeta	19	38	51	11	108
Hydracarina	172	19	--	110	108
Ostracoda	8	--	5	11	108
Ephemeroptera					
Baetis	10,607	885	320	4,336	72
Cinygmula	100	40	24	92	21
Epeorus	--	145	13	--	21
E. coloradensis	--	46	8	--	18
E. inermis	5	--	--	24	48
Plecoptera					
Zapada cinctipes	--	11	11	16	16
Capniidae	428	--	--	301	32
Pteronarcella badia	8	8	--	16	24
Isogenoides zionensis	--	--	--	38	24
Isoperla	94	8	--	--	48
Trichoptera					
Rhyacophila	13	22	--	3	18
Hydropsyche	2,047	73	19	191	108
Lepidostoma	--	13	--	--	18
Coleoptera					
Dytiscidae	5	--	--	--	72
Diptera					
Tipula sp. g	--	--	--	5	72
Eriocera	--	--	5	--	72
Ormosia	--	--	--	5	72
Tanyderidae	--	--	--	3	72
Pericoma	13	--	--	24	36
Simuliidae	27	5,555	229	--	108
Chironomidae	75	143	237	218	108
Ceratopogonidae	--	11	--	5	108
Euparyphus	13	13	--	3	108
Hemerodromia	102	38	11	75	95
Mean No/m^2	13,845	7,088	942	5,504	
Standard Deviation	6,840	7,818	577	2,654	
Coefficient of Variation	49.4	110.3	61.4	48.2	
Mean dry wt., gm/m^2	0.83	1.38	0.63	1.23	
Number of taxa	21	19	13	21	
H (Shannon Weaver)	1.28	1.28	2.44	1.42	
CTQ_a (Winget & Mangum)	71	70	75	70	
CTQ_p (Winget & Mangum)	65	65	65	65	
BCI	92	93	87	93	

Table 11. Aquatic macroinvertebrate community description as mean number per meter^2 at Station QC-037, Quitchupah Creek at Utah Highway 10, Sevier County, Utah.

	17 Jul 1980	18 Jun 1981	TQ
Nematoda	43	--	108
Oligochaeta	422	32	108
Hydracarina	234	32	108
Ostracoda	19	3	108
Ephemeroptera			
Baetis	6,219	172	72
Heptagenia	3	--	48
Cinygmula	11	--	21
Ehpemerella	22	11	48
Odonata			
Ophiogomphus severus	24	11	108
Argia	22	--	108
Plecoptera			
Prostoia besametsa	22	--	24
Isogenoides zionensis	132	--	24
Isoperla	97	--	48
Trichoptera			
Hydropsyche	--	11	108
Hemiptera			
Gerris	35	--	72
Coleoptera			
Dytiscidae	43	--	108
Elmidae	22	11	108
Diptera			
Eriocera	3	--	36
Simuliidae	11	11	108
Chironomidae	183	118	108
Ceratopogonidae	46	355	108
Hemerodromia	--	11	95
Mean No/m^2	7642	767	
Standard Deviation	7887	319	
Coefficient of Variation	103	42	
Mean dry wt., gm/m^2	1.76	0.11	
Number of taxa	21	11	
H (Shannon Weaver)	1.31	2.26	
CTQ_a (Winget & Mangum)	78	97	
CTQ_p	80	80	
BCI	103	82	

Table 12. Partial taxanomic list of aquatic macroinvertebrates collected from Station ES-001 (springs at the head of East Spring Canyon) and Station MS-032 (springs in Mud Spring Hollow), Sevier County, Utah, 17 July 1980 and 2 June 1981.

	Station			
	ES-001*		MS-032*	
	July 1980	June 1981	July 1980	June 1981
Oligochaeta	X	X	X	X
Cladocera	--	--	X	X
Copepoda	--	--	X	X
Ostracoda	--	X	X	X
Ephemeroptera				
Baetis	--	--	--	--
Callibaetis	--	--	X	--
Odonata				
Aeshna	--	--	X	--
Lestes	--	--	X	--
Ischnura	--	--	X	X
Hemiptera				
Corixidae	--	--	X	--
Gerris	X	--	X	--
Trichoptera				
Rhyacophila	--	X	--	--
Limnephilidae	--	X	--	--
Hesperophylax	--	X	--	--
Lepidostoma	X	--	--	--
Coleoptera				
Dytiscidae	X	X	X	X
Hydrophilidae	--	--	X	--
Elmidae	--	--	X	--
Diptera				
Eriocera	X	--	--	--
Culiseta incidens	X	--	X	--
Dixa	--	--	X	--
Simuliidae	X	X	--	X
Chironomidae	X	X	X	X
Ceratopogoniidae	--	X	X	X
Forocipomyia	--	--	--	X
Euparyphus	--	X	X	X
Tabanidae	--	--	X	--
Hemerodromia	--	--	--	X
Ephydridae	--	--	X	--
Limnophora	X	--	--	--

X=present; --=absent from samples

*Springs were perennial but flow disappears within less than 1 km downstream most of the time each year. Flow from springs have shown little fluctuation in rate of discharge according to the hydrology report (preliminary Environmental Assessment of SUFCO Property in Central Utah).

ALTERNATE # 1

DRAINAGE FACILITIES

AND

SEDIMENT CONTROL PLAN

SOUTHERN UTAH FUEL COMPANY

MINE NO. 1

June 11, 1980

Prepared For

SOUTHERN UTAH FUEL COMPANY

P.O. Box P

Salina, Utah 84654

REGISTERED PROFESSIONAL ENGINEER
No. 4522
M. Gregory Howard
State of Utah

Prepared By

VALLEY ENGINEERING, INC.

850 North Main

Richfield, Utah 84701

Project # 600007.02

Valley Engineering, Inc.

850 North Main Street
Richfield, Utah 84701
Phone (801) 896-5434

June 11, 1980

Kerry Frame
Chief Engineer
Southern Utah Fuel Company
P.O. Box P
Salina, Utah 84654

Dear Kerry:

Submitted herewith is the report, concept plans, calculations, and drawings for Alternate # 1 to the present Drainage Plan which was submitted to you by Merrick and Company, Engineers and Architects of Denver, Colorado.

The proposed Alternate deals with a relocation of the sedimentation pond to the area immediately below the fill on which existing mine facilities are constructed. This plan also includes a new concrete sedimentation basin which will remove in excess of 65% of all solids before runoff from the disturbed area enters the sediment pond. This allowed us to reduce the size of the sediment pond as outlined in the regulations and to decrease the amount of overall disturbance. We feel that this alternate is more efficient in removing and controling sedimentation and controling drainage, as well as being more economical and fitting in more readily with the overall reclamation plan for Mine # 1.

Much of the original hydrologic and hydraulic information has been taken from the report by Merrick and Company dated September 17, 1979, where applicable. Notations for drainage basins, such as ATOF and SOF are described in Merrick's Report. We have not attempted to reiterate calculations and information that are detailed in their report, and some familiarity with Merrick's Report is necessary to adequately understand the information given here.

Sincerely,

M. Gregory Cloward, P.E.

DESCRIPTION OF PROPOSED ALTERNATES

Alternate # 1, to the drainage and sedimentation plan prepared by Merrick and Associates, primarily involves relocation of the sedimentation pond, and enlargement and redesign of the existing concrete sedimentation basin on top of fill slope near the existing crushing operation.

The primary drainage plan as outlined by Merrick will be used with this alternate. The 72" CMP which collects water from East Spring Canyon and Mud Spring Hollow will be reduced to a 48" pipe on the steep fill slope below the mine facility area. This 48" pipe will run underneath the proposed dam and empty water from above the disturbed area into the existing drainage. The water from the existing sedimentation tank, which currently connects and empties into the 72" pipe, will be diverted to a newly constructed 24" pipe and run down into the new sediment pond. The sediment pond will be located immediately below the toe of the existing fill, as shown on Sheet 2 of the enclosed drawings. The sedimentation pond in conjunction with the concrete sediment basin located on top of the fill are adequately sized to handle all runoff and sediment volume for a 10-year 24-hour storm event.

The spillway has been designed to handle a 100-year 24-hour event. The primary outlet has been designed to drain the 10-year 24-hour storm in 24 hours, and has been equipped with a grease and oil skimmer. Concrete cutoff collars have been designed and placed on the 48" pipe that passes underneath the dam and on the 12" primary outlet pipe. An energy dissipater has been designed to be placed at the toe of the spillway for erosion and channel protection.

A riprap and gravel filter slope drain has been designed to protect the toe of the existing fill from erosion or movement as a result of having a saturated toe caused by water in the sediment pond. The slope drain allows for free movement of water from the existing fill material for good drainage without permitting a migration of soil material. The slope drain also acts as ballast to further insure slope stability.

The dam will be keyed into competent rock with abutments in the fine grain massive sand stone, known as the Star Point Formation.

Material for construction of the dam will conform to U.S. Bureau of Reclamation standards for design of small dams, and will be obtained locally from previously disturbed areas. Riprap for the project will be collected on the dam site location. Gravel and filter material will be imported from the Salina area.

As can be seen on Sheet # 1 of the drawings, the dam will be located in a drainage which has very little impact, should the structure fail, on any downstream facilities. The Quitchupah Creek drainage runs under Utah Highway 10, and continues eastward into the Colorado River Basin Drainage. There are no houses, buildings, or structures which can be affected should the dam fail. All significant hydraulic structures and earthwork structures have been designed with a minimum 1.5 to 1 safety factor.

The concrete sedimentation basin on top of the hill has been designed to remove a minimum of 65% of the total sediment volume which is created from the basin designated by Merrick as ATOF, which is primarily the disturbed area around the mine portal facilities and crusher area. The structure will remove more than 65% of the sediment material as low flows expected under normal runoff conditions, and storms smaller than the 10-year 24-hour event.

As mentioned in the attached cover letter, sedimentation volumes and runoff volumes were taken from the report by Merrick. The design of these facilities has been based on that work. One distinct advantage of locating a sediment pond at the location described in this alternate, is that it is compatible with the overall final reclamation plan. The downstream 2 to 1 slope will be continued upstream towards the portal facilities during final reclamation, and the spillway will also be continued up this 2 to 1 slope to become the permanent stream channel upon final reclamation. This means that facilities that are now constructed are compatible and will be compatible with final reclamation and will not need to be removed, but rather a small amount of additional grading and contouring to blend with the final grading plan is all that will be necessary. This enhances and creates a minimal amount of disturbance as opposed to locating the structure farther downstream.

Reclamation

An access road will be constructed down to the pond as shown on Sheet # 2, and will have a maximum 15% slope. This will allow for cleaning and maintenance of the pond.

Not indicated

The complete plan set showing details and design of all structures associated with this alternate has been included. These plans are in final form for approval with exception that some information necessary to the selected contractor and for his benefit such as structural detailing and contract documents will be prepared upon approval by the reviewing agencies of this concept plan. Hydrologic and hydraulic calculations are included in this report and follow here:

CALCULATIONS

POND SIZING

discrepancy between SOF Q here and P. 2 Merrick RUNOFF = .10

Total Runoff Area

ATOF = Area top of fill = 12.0 acres

SOF = Area slope of fill = 95,000 sq. ft. = 2.2 acres

Use 2.5 acres " from Merrick Report

Runoff volume .10 acre @ 1.9 cfs

Sediment volume = .25 ac. ft.
CBW = Contributing Basin west = .51 acre feet

Runoff Volume =	.49 ac. ft.	ATOF
	.25 ac. ft.	SOF ← error should be 0.10
	.51 ac. ft.	CBW
	1.25 Total Runoff Volume	

Sediment Volume
(Reduce volume from ATOF by 65% due to concrete settling basin. See page 10).

	.25	SOF
.35 x 1.2	= .42	ATOF (From Merrick)
	1.45 = .67	Total Sediment Volume

Pond Volume = 1.25 + .67 = 1.92 ac. ft.

It is proposed to:
Reduce sediment volume by 50% by cleaning when sediment volume reaches 60% of total volume.
Reduce sediment volume to .34 ac. ft.
Total 10 year pond volume = 1.25 + .34 = 1.59 ac. ft.

1.45

Elev.	Area (Sq. Ft.)	Volume (Ac. Ft.)
7418	9720	
		.22
7417	8577	
		.35
7415	6813	
		.61
7410	3807	
		.32
7405	1728	
		.12
7400	369	

Total Volume Available = 1.62 Ac. Ft.

Spillway Design

Design @ 100 years 24 peak = 62.4 cfs x 1.5 S.F. = 94 cfs

$Q = CLH^{3/2}$ C = 3.0 H = 2.0 feet L = 11.08 feet

Check Manning

$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$ n = .045

$Q = \frac{1.49}{.045} (22.16) (\frac{22.16}{15.08})^{2/3} (1/2)^{1/2}$

Q = 670 cfs OK

Pipe Sizing

Mud Spring Hollow = 147 cfs

East Spring Canyon = 247 cfs

Mine Flow = 5 cfs

Total 399 cfs Say 400 cfs

$S = \frac{120}{175}$ on steep slope

Try 48" on steep slope

$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$

n = .027 A = 12.57 S.F. R = 1 S = .69

$Q = \frac{1.49}{.027} 12.57 (1)^{2/3} (.69)^{1/2} = 576$ cfs OK

Try 42" on steep slope A = 9.62 R - .875

$Q = \frac{1.49}{.027} (9.62)(.875)^{2/3} (.69)^{1/2} = 403$ cfs OK

Try 48" for overall length = 495

$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$

$= \frac{1.49}{.027} (12.57)(1)^{2/3} (.35)^{1/2}$

= 410 cfs - Good - Use 48" pipe velocity = 32.63

Use heavy gauge for scour protection

Check Entrance loss from 72" to 48"

$h_e = k_e \frac{V2}{29}$ Assume $k_e = .5$

$h_e = .5 \frac{(\frac{410}{12.57})^2}{64.4} = 8.26$ feet

Try 10' of 72" at S = .54

L = 18.51' say 20'

$410 = \frac{1.49}{.027} (36) (1.5)^{2/3} (\frac{hL}{20})^{1/2}$

$h_L = .50'$

$h_{L_t} = .5 + 8.26 = 8.76$ feet

Use 20 of 72" down slope with gentle transition

Pond Outlet Q 10 = 20.6 $Q_{p\ 25}$ = 36.3 cfs

Q_{25} = .72 + .15 + .85 + .07 = 1.79 ac. ft./24 hrs. = .90 cfs

Use 1.5 SF Q = 1.35 cfs

Try 12" pipe L = π D = 3.14'

Q/ft. = .43 cfs/ft.

from table 20-17 Seelye

H = .24' 12" acceptable

Top of Slope Inlet (After Merrick)

Existing inlet HW = 18"
Q = 23.2 cfs, Not enough head available

Try new 24" Dia CMP

Orifice Control
HW req = 1.14 ft. = 14", Good
Inlet Control (at bend)
HW req = 2.8 ft. = 34", Good

Pipe Sizing Along Slope

Shallowest slope 0.05
Use unpaved CMP 2-2/3 x 1/2 Corrugations
n = .024
Q = 23.2 cfs

$$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$$

Size	A	R	Q		
18	1.77	0.375	15.5	No Good	
24	3.14	0.50	27.5	Good	V = 8.75 fps
21	2.41	0.44	19.3	No Good	
Q/Q Full = .84		V = 9.8 fps		D = 1.23 ft.	

S	Q Cap	V Cap	Q/Q Cap	V	d
0.215	52.3	16.6	0.44	9.4	0.92
0.135	41.4	13.2	0.56	13.5	1.06
0.120	39.1	12.4	0.59	12.9	1.10

Cutoff Collars

L = 289'
S = .24
Y = 4'
Z = 3'

L_{rt} L_5 = 1.25 L = 361.25

collar length - 72.25' $L = L_5$

Use 8 collars @ 4' x 1' above pipe

Riprap Sizing in East Spring Canyon (After Merrick)

V_b = 9.81 (based on velocity and depth in natural stream)

D_{50} req = 15" Class II riprap

Filter Sizing

Existing Soil

d_{85} = 0.47 mm

d_{50} = 0.135 mm

3_{15} = 0.017 mm

Filter Layer 1

$DF_{1\ 15}$	$5d_{85}$	$DF_{1\ 15}$	1.85 mm	$DF_{1\ 15}$	= 0.55 mm
$DF_{1\ 15}$	$5d_{15}$	$DF_{1\ 15}$	0.085 mm	$DF_{1\ 50}$	1.50 mm
$DF_{1\ 50}$	$25d_{50}$	$DF_{1\ 50}$	3.38 mm	$DF_{1\ 85}$	3.50 mm
$DF_{1\ 15}$	$40d_{15}$	$DF_{1\ 15}$	0.68 mm		

Filter Layer 2

$DF_{2\ 15}$	17.50 mm	$DF_{2\ 15}$	= 7.0 mm
$DF_{2\ 15}$	2.50 mm	$DF_{2\ 50}$	= 23.0 mm
$DF_{2\ 50}$	37.50 mm	$DF_{2\ 85}$	= 55.0 mm
$DF_{2\ 15}$	20.00 mm		

Riprap Limits

RR_{15}	275 mm
RR_{15}	35 mm
RR_{50}	575 mm
RR_{15}	280 mm

Energy Dissapater for 24" Pipe

Q = 23.2 cfs in 24" Dia CMP
S = 51% Down Face of Slope
S - 15% Final 30' into stilling basin

$Q\ Cap = \frac{1.49}{n} AR^{2/3} S^{1/2}$ n = 0.027 A = 3.14 SF R = 0.5 feet S = 0.15

Q Cap = 42.3 cfs V Cap = 13.5 fps
Q/Q Cap = .55 V = 13.9 fps y = 1.1 ft.

Froude number = V/ gd
where V = 2gh
g = acceleration of gravity
h = head loss required
d = A
V = 2g (4.1) = 16.2
gd = g(1.77) = 7.6

F = 2.15
W/d = 4.4
W = 7.8 ft = use W = 8 ft.

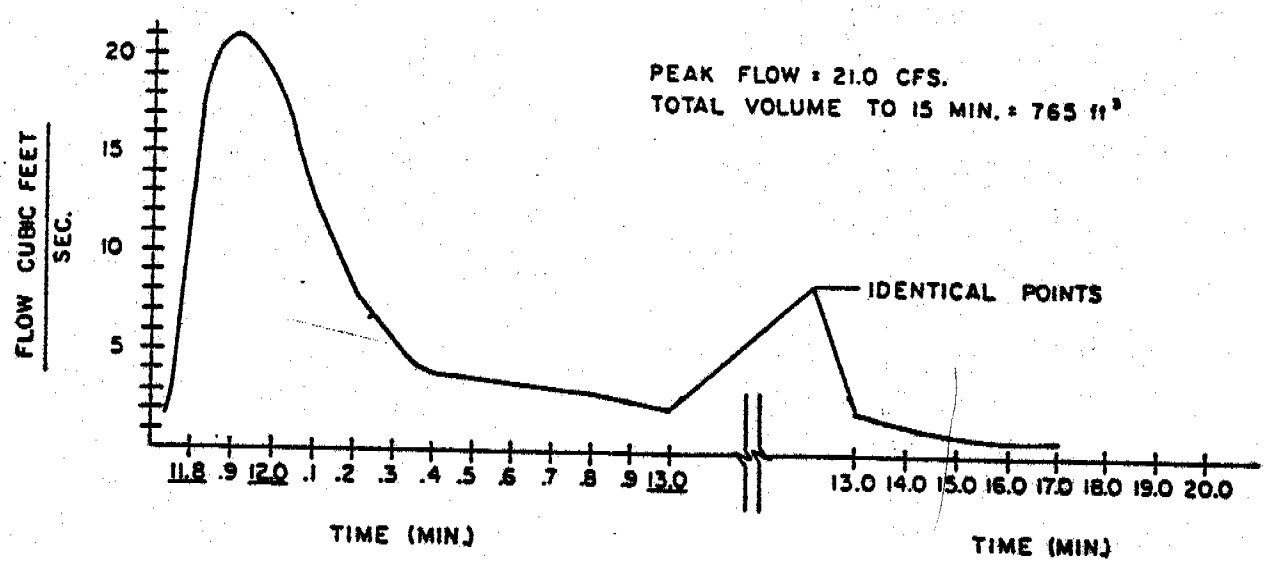
CONCRETE SEDIMENTATION BASIN

SOUTHERN UTAH FUEL COMPANY
SALINA UTAH

DESIGN STORM VOLUMES:

For a 10-year 24-hour storm the water reaching the sedimentation basin prior to 15 min. after the storm beginning, based on the Hydrograph computed by Merrick and Companies 765 ft^3.

If a basin of 1900 ft^3 of volume is used and assumed to be nearly empty when the storm began, the average over flow from the basin will be about 0.57 c.f.s. during a 10-year 24-hour storm.



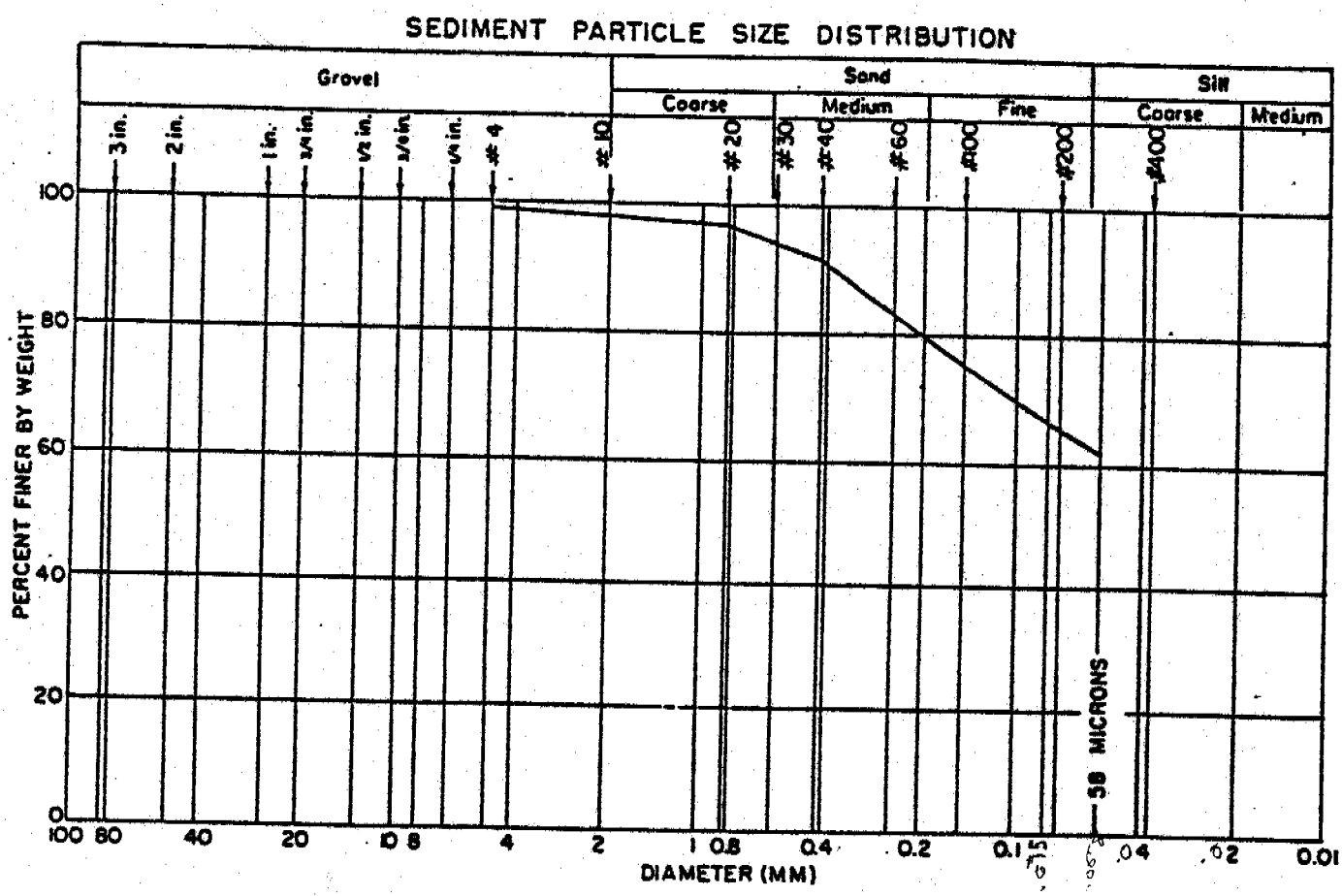
HYDROGRAPH AT SEDIMENTATION BASIN FOR 10 YEAR 24 HOUR STORM

At this flow rate of 0.57 cfs, which will be the average loading rate for the design storm, an effective detention time of 1053 seconds will exist when the tank is all but 1 foot full of settleable solids. This will remove all particules larger than .58 microns according to Stokes Law.

$$Vs = \frac{g}{18} \cdot \frac{(Ss - Sw)}{K} d^2$$

Where Vs = Settling velocity of solid.
g = 32.2 ft/sec^2
Ss = specific gravity of solid = 2.48 for coal
Sw = specific gravity of water 1.94
d = diameter of solids
K = dynamic visocity

The following table shows graphic results of a sieve analyses of typical sediment collected from the existing sedimentation basin.



As can be noted from the sieve analysis this amount to 39% removal of the material entering the tank.

Because some settling in the concrete basin will be Class 2 sedimentation, which occurs when small particles attach themselves to large particles by surface tension, the actual volume to be settled out will be considerably higher than that indicated by Stokes Law.

To determine the amount of actual removal a laboratory test was run. 75 ml of sample sediment was placed into a settlemeter then diluted and suspended in cold water. Following the prescribed time period of 1053 seconds, the water was decanted from the settlemeter and about 50 ml of soil mass was recovered. This indicates a 66% removal rate based on volume.

It should be pointed out that this is based on the detention times for the design storms and in actual use the removal rate from the concrete basin would be larger because of the longer detention times that will exist with smaller magnitude storms which occur most frequently.

Larger removal rates into the concrete sedimentation basin can be accomplished by the addition of alum to the water flowing into the sedimentation basin or placing it directly into the basin. Further laboratory testing showed that 95% of the sediment volume could be removed during the 1053 second detention time if alum is used to floculate the smaller solids. It is recommended that this procedure be used for smaller storms and to settle the solids from the liquid within the tank prior to decanting the tank following any storm.

In the laboratory test 1.5 grams per liter or about 180 # for the tank volume produced good settling rates. To determine the best dosage for field conditions other dosages should be tried.

The sedimentation tank is designed to handle a peak hydraulic flow of 21 cfs throughout the tank and draining the entire flow into the 24 inch diameter outlet pipe.

1981 SUBMITTAL

APPENDIX A

SUMMARY REPORT
SLOPE STABILITY ANALYSIS
SEDIMENTATION POND ACCESS ROAD
SOUTHERN UTAH FUEL COMPANY
CONVULSION CANYON MINE
LOCATED EAST OF SALINA, UTAH
FOR COASTAL STATES ENERGY COMPANY

RECEIVED
FEB 1 0 1981
DIVISION OF
OIL, GAS & MINING

DAMES & MOORE JOB NO. 6701-016-06
SALT LAKE CITY, UTAH
FEBRUARY 16, 1981

Dames & Moore

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

February 16, 1981

Coastal States Energy Company
411 West 7200 South
Suite 200
Midvale, Utah 84047

Attention: Mr. Allon Owen

Gentlemen:

Summary Report
Slope Stability Analysis
Sedimentation Pond Access Road
Southern Utah Fuel Company
Convulsion Canyon Mine
Located East of Salina, Utah
For Coastal States Energy Company

INTRODUCTION

This report summarizes the results of our stability analysis of the slopes along the sedimentation pond access road at Southern Utah Fuel Company, Convulsion Canyon Mine located east of Salina, Utah.

PURPOSE AND SCOPE

The purpose and scope of this study were planned in discussions between Mr. Allon Owen of Coastal States Energy Company and Mr. Bill Gordon of Dames & Moore. In general, the purpose of this investigation was to analyze the static factor of safety of the sideslopes along the sedimentation pond access road.

BACKGROUND

In order to obtain access to the site of a proposed sedimentation pond, it was necessary to construct an access road along the southeast-facing slope, near the mine mouth facilities at the Convulsion Canyon Mine. Now that the sedimentation pond has been completed, the road will only be used during periods of sediment removal. It is projected that this will occur once every two or three years.

In December, 1980, Coastal States Energy Company was issued a citation at Southern Utah Fuel Company Convulsion Canyon Mine (violation No. N 80-1-13-2, No's 1 & 2). The nature of the violation No. 1, as issued by the Department of Natural Resources Division of Oil, Gas, and Mining was stated as "failure to retain all earth, rock and other mineral non-waste materials on the solid portion of the existing or new benches of road cuts, mine workings or other benches."

SITE CONDITIONS

SURFACE

The sedimentation pond access road is located immediately south of the mine mouth facilities at the Convulsion Canyon Mine. The access road extends from the main entrance road, downward in a northeasterly direction to the sedimentation pond. The 22 foot wide dirt road cuts across a southeasterly-facing hillside. The hillside has a slope on the order of 33 to 38 degrees. In constructing the road, cuts and fills of 14 and 10 feet were constructed. Numerous large boulders and rock outcrops are present along the hillside. Ground surface vegetation consists of a very sparse cover of short weeds and scattered pinion pine trees.

SUBSURFACE

EXPLORATION

Subsurface soil and ground water conditions along the access road were explored by excavating two test pits to depths of 9.5 and 10.5 feet below existing ground surface. The test pits, excavated using a rubber tire-mounted backhoe, were located along the downslope side of the access road. Samples were also obtained from the cut area along the upslope portion of the road between the two test pits. Tabulated logs of the subsurface soil conditions encountered in the two test pits are presented below:

Test Pit 1

(located along downslope edge of access road, approximately 250 feet from the juncture of the access road and the main entrance road)

0.0' to 7.5'	Gray brown fine to coarse sandy clayey silt with some fine and coarse gravel and occasional cobbles and pieces of rubble (fill) - loose - ML/CL
7.5' to 9.5'	Gray silty clay, stiff to very stiff - CL/ML

Ground water was not encountered to the depth penetrated.

Test Pit 2

(located on the downslope of the access road, approximately 350 feet from the juncture of the access road and the main entrance road)

0.0' to 10.5'	Gray brown fine and coarse sandy clayey silt with some fine and coarse gravel and occasional cobbles and pieces of rubble (fill) loose -ML/C

Ground water was not encountered to the depth penetrated.

The fill material, extending to a depth of 9.5 feet in Test Pit 1, and to the depth penetrated in Test Pit 2, 10.5 feet, typically consists of gray brown, fine to coarse sandy clayey silt with varying amounts of fine and coarse gravel and occasional cobbles. Occasional pieces of miscellaneous rubble and debris were also encountered in the fill material at both test pit locations. Underlying the fill material in Test Pit 2, natural gray silty clay was encountered and extended to the depth penetrated, 9.5 feet below surrounding grade. The consistency of the natural silty clay was typically stiff to very stiff.

The depths designating the interface between soil types on the test pit logs generally represent the approximate boundaries. In-situ, the transition between materials may be gradual.

No ground water was encountered during excavation and sampling of the test pits.

LABORATORY TESTING

GENERAL

A laboratory testing program was conducted to provide data for engineering analyses. The program included sieve, collapse, compaction, and direct shear tests. The following paragraphs describe the tests and summarize the test results.

SIEVE ANALYSES

To aid in classifying the soils and help correlate other test data, sieve analyses were performed on selected disturbed samples

of the existing fill material. The results of the sieve analyses are tabulated below:

Sample No.	Percent Passing Sieve #4	#10	#40	#200
1	81.1	75.3	65.4	51.0
2	76.2	71.6	67.1	51.3

COLLAPSE TESTS

Collapse tests were performed on representative samples of the brown fine to coarse sandy clayey silt fill material encountered at the site, in order to assess moisture sensitivity characteristics of the end-dumped fill material. The data obtained from these tests were used in evaluating the overall stability of the side-slopes. Results of the collapse tests are tabulated below:

Test Pit Number	Depth (feet)	Soil Type	Natural Dry Density (pcf)	Natural Moisture Content (percent)	Axial Load When Saturated (psf)	Collapse (-) or Swell (+) (percent)
1	1.0	ML/CL	94.9	9.5	800	2.0 (-)
*	4.0	ML/CL	96.9	11.8	800	4.0 (-)

*Sample obtained in fill soils exposed along upslope road cut between Test Pits 1 and 2.

COMPACTION TESTS

A compaction (modified proctor) test was performed in accordance with the AASHTO*T-180 (ASTM**D-1557) specifications

*American Association of State Highway and Transportation Officials
**American Society for Testing and Materials

in order to determine the maximum dry density of the existing fill materials. Results of the test are presented below:

Soil Description	Soil Type	Maximum Dry Density (pcf)	Optimum Moisture Content (percent)
Gray brown fine to coarse sandy clayey silt*	ML/CL	127.5	8.7

*Bulk sample of existing fill material provided by Coastal States Energy Company

DIRECT SHEAR TESTS

Direct shear tests were performed on four remolded samples of the gray brown fine to coarse sandy clayey silt fill material at the site. These remolded samples were compacted to densities varying from 83.0 to 85.2 percent of the maximum dry density as determined by the compaction (modified proctor) test previously performed. The data obtained from these tests were used in evaluating the long-term stability of the embankment slopes. Results of the direct shear tests are tabulated below:

Sample Number	Dry Density (pcf)	Moisture Content (percent)	Compaction* (percent)	Normal Pressure (psf)	Peak Shear Strength (psf)
1	108.6	7.2	85.2	1000	1880
2	105.9	7.0	83.0	2000	2310
3	106.0	7.3	83.1	3000	3300
4	106.5	6.8	83.5	4000	3910

*AASHTO T-180 (ASTM D-1557) method of compaction.

A plot of the above data indicates an angle of internal friction ϕ of 36° and a cohesion of 1000 pounds per square foot.

SLOPE STABILITY ANALYSIS

To aid in evaluating the stability of both the upslope and downslope embankments of the sedimentation pond 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 uncontrolled method in which the fill materials were placed, soil strength parameters obtained from the direct shear tests were significantly decreased for use in the computer analysis. Due to the numerous large boulders and rock outcrops observed at the site, a shallow bedrock surface was assumed in the analysis. A geometric cross section utilized in the analysis is shown on Plate 1, Slope Cross Section. It was also assumed that a phreatic water surface would not develop in the slopes of the embankments.

Two different sets of soil parameters were utilized in performing the computer analysis. Three trial arcs were analyzed using the soil parameters listed below:

Angle of internal friction	$\phi = 28^{\circ}$
Cohesion	C = 500 psf
Unit weight soil	γ = 107 pcf

The results of this analysis indicated a factor of safety varying from 2.2 to 2.9 for the trial arcs analyzed.

A second series consisting of 10 trial arcs were analyzed utilizing the soil parameters listed below:

Angle of internal friction	$\phi = 26^{\circ}$
Cohesion	C = 350 psf
Unit weight soil	γ = 107 pcf

This second series included the three trial arcs analyzed in the first series plus seven additional trial arcs not previously analyzed. This analysis indicated a factor of safety varying from 1.7 to 3.3 for the trial arcs analyzed.

Copies of the results of the computer analysis for each trial arc 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.

SLOPE STABILITY

The computer slope stability analysis indicates an overall long-term static factor of safety varying from 1.7 to 3.3 for the trial arcs analyzed.

Although the slope stability analysis indicates a factor of safety in excess of 1.5, consideration should be given to the site conditions and the uncontrolled methods under which the fill material was placed. Stability of the slopes will be influenced by the degree of saturation of the existing soils. Therefore, surface drainage should be channeled to minimize runoff over the slopes. We have discussed these drainage considerations with representatives of Coastal States Energy Company and they will utilize ditches, berms and water bars to minimize erosion and excessive wet conditions on the cuts and side cast slopes.

During wet periods of the year, small localized slides and sloughs should be anticipated along the full slopes. However, the problems created by these occurrences should be minor. Immediately prior to removal of the accumulated material in the sedimentation pond, minor regrading and clearing of the roadway will probably be necessary to remove soil material deposited on the roadway as a result of minor sloughs and slides.

oOo

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

Very truly yours,

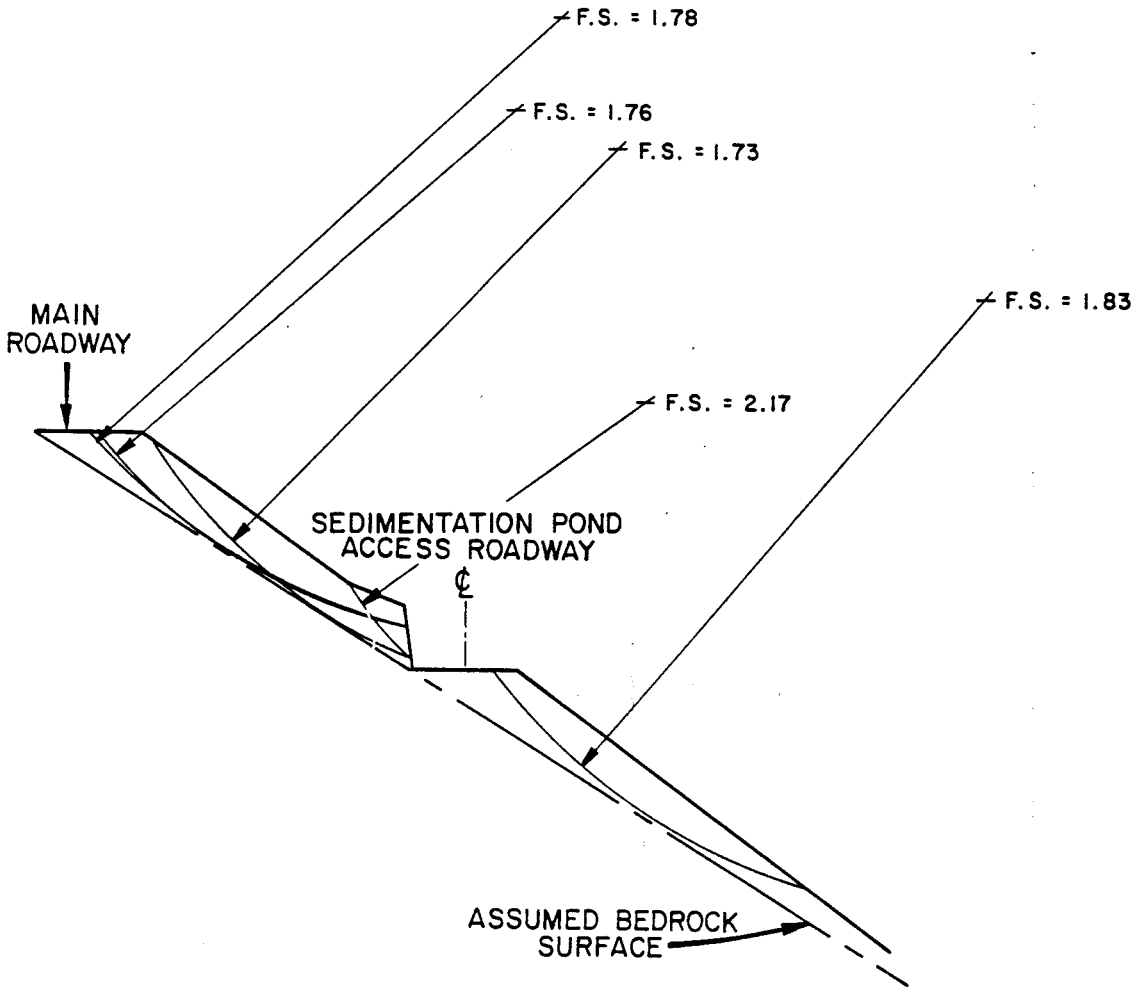
DAMES & MOORE

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

Douglas G. Beck
Staff Engineer

WJG/DGB/wb

Attachments:
Plate 1 - Slope Cross Section
Computer Analysis Results



SLOPE CROSS-SECTION

FEET
20 0 40 60

DAMES & MOORE

PLATE 1

FILE

BY

CHECKED BY

01/30/81. 17.25.31.
LIST OF GMB

1**********

DAMES AND MOORE PROGRAM EP1 (SLOPER)

SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

DATE OF LAST REVISION - DEC 11 78

DATE RUN - 01/30/81 TIME RUN - 17.24.36

0670101606 0107 GMB 013081 SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

****

DATA INPUT MODE = 1
EARTHQUAKE COEFFICIENT = 0.000
PORE PRESSURE IS DEFINED BY WATER LINE DATA
TOTAL NUMBER OF SOIL LINES = 5 NUMBER OF WATER LINES = 0
0SLOPE GEOMETRY DATA

LINE NO	COORDINATES LEFT-X	LEFT-Y	RIGHT-X	RIGHT-Y	SOIL DATA, WT BELOW LINE-PCF	FRICT.ANGLE(DEG) (OR C/P-RATIO**) ABOVE	BELOW	COHESION-PSF ABOVE	BELOW	PORE PRESSURE RATIO ABOVE	BELOW	NEW BELOW	NUU ABOVE	NUU BELOW
1	1000.00	1110.00	1022.00	1110.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
2	1022.00	1110.00	1066.00	1078.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
3	1066.00	1078.00	1078.00	1074.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
4	1078.00	1074.00	1080.00	1060.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
5	1080.00	1060.00	1090.00	1020.00	107.0	0.00	28.00	0.0	500.0	0.000	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 = 1
1

RESULTS

CNTR NO	RAD NO	CENTER COORDINATES X	Y	CIRCLE RADIUS	FACTOR OF SAFETY BISHOP	FELENIUS	SUMWS	SUM1	SUM2	XR	XL	ARC	NN	TRIAL
1	1	1118.00	1128.00	74.00	2.893	(2.344)	5963.	5962.	820.	1079.30	1059.42	26.87	1	2
2	1	1122.00	1172.00	116.00	2.235	(1.899)	23586.	23585.	3668.	1079.41	1025.73	69.96	1	2

RDY

Trial #2

```
NOT FOUND.
OLD,GMB
*RDY-FOR*
LIST

 02/03/81. 16.43.31.
 LIST OF  GMB

1*****************************************************************************

 DAMES AND MOORE PROGRAM EP1     (SLOPED)

 SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 DATE OF LAST REVISION - DEC 11 78

 DATE RUN -  02/03/81   TIME RUN -  16.43.14

 0670101606 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

 *****************************************************************************

 DATA INPUT MODE = 1
 EARTHQUAKE COEFFICIENT =  0.000
 PORE PRESSURE IS DEFINED BY WATER LINE DATA
 TOTAL NUMBER OF SOIL LINES =   5      NUMBER OF WATER LINES =  0
0SLOPE GEOMETRY DATA
```

LINE NO	COORDINATES LEFT-X	LEFT-Y	RIGHT-X	RIGHT-Y	SOIL DATA, WT BELOW LINE-PCF	FRICT.ANGLE(DEG) (OR C/P-RATIO**) ABOVE	BELOW	COHESION-PSF ABOVE	BELOW	PORE PRESSURE RATIO ABOVE	BELOW	NEW BELOW	NUU ABOVE	NUU BELOW
1	1000.00	1110.00	1022.00	1110.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
2	1022.00	1110.00	1066.00	1078.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
3	1066.00	1078.00	1078.00	1074.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
4	1078.00	1074.00	1080.00	1060.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
5	1080.00	1060.00	1090.00	1020.00	107.0	0.00	26.00	0.0	350.0	0.000	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 =   1
1                                          RESULTS
```

CNTR NO	RAD NO	CENTER COORDINATES X	Y	CIRCLE RADIUS	FACTOR OF SAFETY BISHOP	FELENIUS	SUMWS	SUM1	SUM2	XR	XL	ARC	NN	TRIAL
1	1	1080.00	1180.00	100.00	2.021	(1.849)	18835.	18835.	2217.	1060.65	1008.59	60.07	1	3
2	1	1100.00	1180.00	110.00	2.009	(1.784)	21822.	21813.	2877.	1078.26	1015.15	75.03	1	2
2	2	1100.00	1180.00	112.00	1.764	(1.582)	29611.	29611.	4320.	1078.56	1012.57	78.74	1	3
3	1	1100.00	1160.00	90.00	3.326	(2.841)	8238.	8237.	745.	1078.19	1028.62	60.41	1	2
3	2	1100.00	1160.00	92.00	2.303	(1.979)	15633.	15631.	2019.	1078.49	1023.48	68.66	1	2
3	3	1100.00	1160.00	94.00	1.844	(1.598)	23967.	23962.	3757.	1078.80	1020.40	73.55	1	2
4	1	1110.00	1200.00	134.00	1.775	(1.608)	29873.	29873.	4255.	1078.61	1010.72	80.12	1	3

```
*RDY*

BYE
```

```
01/30/81. 17.33.33.
LIST OF  GMB

1*****************************************************************************

 DAMES AND MOORE PROGRAM EP1    (SLOPEB)

 SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 DATE OF LAST REVISION - DEC 11 78

 DATE RUN -  01/30/81   TIME RUN -  17.33.14

 0670101606 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

 *****************************************************************************

 DATA INPUT MODE = 1
 EARTHQUAKE COEFFICIENT =  0.000
 PORE PRESSURE IS DEFINED BY WATER LINE DATA
 TOTAL NUMBER OF SOIL LINES =   3     NUMBER OF WATER LINES =   0
OSLOPE GEOMETRY DATA
 LINE   - - -  - COORDINATES -  -  - - -   SOIL DATA,  FRICT.ANGLE(DEG)                          PORE
  NO    LEFT-X    LEFT-Y   RIGHT-X   RIGHT-Y   WT BELOW   (OR C/P-RATIO**)    COHESION-PSF   PRESSURE RATIO      NEW   NUU   NUU
                                               LINE-PCF   ABOVE    BELOW    ABOVE    BELOW   ABOVE  BELOW      BELOW ABOVE BELOW
   1   1080.00   1060.00   1102.00   1060.00    107.0   0.00    28.00      0.0    500.0   0.000  0.000        0     0     0
   2   1102.00   1060.00   1180.00   1002.00    107.0   0.00    28.00      0.0    500.0   0.000  0.000        0     0     0
   3   1000.00   1100.00   1182.00    996.00    135.0  28.00     0.00    500.0  20000.0   0.000  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 =   1
1                                        RESULTS
                                         -------


 ==========================================================================================================================
 CNTR  RAD   CENTER COORDINATES   CIRCLE   FACTOR OF SAFETY    SUMWS    SUM1     SUM2      XR       XL       ARC    NN  TRIAL
  NO    NO      X          Y     RADIUS   BISHOP  FELENIUS
   1    1   1200.00    1140.00   130.00   2.374   (  2.049)   24739.   24736.    3387.  1161.33  1097.53   78.76   1    2
*RDY*
BYE
CT = 00.71    SU-A =       8.3
KCH =   25
D034Q16   LOG OFF.   17.35.13.
```

```
00290 107.[illegible]26./0./350.
00300 107./[illegible]26./0./350.
00310 135./26./0./350./20000.
REP
*RDY*

RJE
 EQPSD8Q / RJE        ROUTED TO APEX

*RDY*
RJS,EQPSD8Q
NOT FOUND.
OLD,GMB
*RDY-FOR*
LIST

 02/03/81. 16.19.05.
 LIST OF  GMB

1*****************************************************************************

 DAMES AND MOORE PROGRAM EP1     (SLOPE8)

 SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 DATE OF LAST REVISION - DEC 11 78

 DATE RUN -  02/03/81    TIME RUN -  16.18.46

 0670101606 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

 *****************************************************************************

 DATA INPUT MODE = 1
 EARTHQUAKE COEFFICIENT =  0.000
 PORE PRESSURE IS DEFINED BY WATER LINE DATA
 TOTAL NUMBER OF SOIL LINES =   3     NUMBER OF WATER LINES =   0
0SLOPE GEOMETRY DATA                                  SOIL DATA,  FRICT.ANGLE(DEG)                                  PORE
 LINE   - - -  - COORDINATES -  - - -  - -  -   WT BELOW   (OR C/P-RATIO**)   COHESION-PSF   PRESSURE RATIO      NEW   NUU   NUU
  NO    LEFT-X    LEFT-Y   RIGHT-X   RIGHT-Y   LINE-PCF   ABOVE    BELOW    ABOVE    BELOW   ABOVE  BELOW     BELOW ABOVE BELOW
   1   1080.00   1060.00   1102.00   1060.00    107.0    0.00    26.00      0.0     350.0   0.000  0.000       0     0     0
   2   1102.00   1060.00   1180.00   1002.00    107.0    0.00    26.00      0.0     350.0   0.000  0.000       0     0     0
   3   1000.00   1100.00   1182.00    996.00    135.0   26.00     0.00    350.0   20000.0   0.000  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 =   1
1                                        RESULTS
                                         -------

 ==========================================================================================================================
 CNTR  RAD   CENTER COORDINATES   CIRCLE   FACTOR OF SAFETY   BUMWS    SUM1     SUM2      XR       XL       ARC    NN  TRIAL
  NO   NO      X         Y       RADIUS   BISHOP  FELENIUS
   1    1   1209.00   1140.00    130.00   1.832   ( 1.599)   24739.   24733.    3916.  1161.33  1097.53   78.76   1    2
 *RDY*
```

```
*RDY*
RJS,EQP[illegible]M
    AF[illegible] INPUT QUEUE.
RJS.._,EQPSD6M
NOT FOUND.
OLD,GMB
*RDY-FOR*
LIST

 02/03/81. 16.13.20.
 LIST OF  GMB

1*****************************************************************************

 DAMES AND MOORE PROGRAM EP1    (SLOPEB)

 SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 DATE OF LAST REVISION - DEC 11 78

 DATE RUN -  02/03/81   TIME RUN -  16.12.38

 0670101606 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

 *****************************************************************************

 DATA INPUT MODE = 1
 EARTHQUAKE COEFFICIENT =  0.000
 PORE PRESSURE IS DEFINED BY WATER LINE DATA
 TOTAL NUMBER OF SOIL LINES =   5     NUMBER OF WATER LINES =   0
0SLOPE GEOMETRY DATA                                  SOIL DATA,  FRICT.ANGLE(DEG)                                  PORE
 LINE   - - - - COORDINATES - - - - - -               WT BELOW   (OR C/P-RATIO**)    COHESION-PSF   PRESSURE RATIO      NEW   NUU   NUU
  NO    LEFT-X    LEFT-Y   RIGHT-X   RIGHT-Y          LINE-PCF    ABOVE    BELOW    ABOVE    BELOW   ABOVE  BELOW      BELOW ABOVE BELOW
   1   1000.00   1110.00   1022.00   1110.00            107.0    0.00    26.00      0.0    350.0   0.000  0.000        0     0     0
   2   1022.00   1110.00   1066.00   1078.00            107.0    0.00    26.00      0.0    350.0   0.000  0.000        0     0     0
   3   1066.00   1078.00   1078.00   1074.00            107.0    0.00    26.00      0.0    350.0   0.000  0.000        0     0     0
   4   1078.00   1074.00   1080.00   1060.00            107.0    0.00    26.00      0.0    350.0   0.000  0.000        0     0     0
   5   1080.00   1060.00   1090.00   1020.00            107.0    0.00    26.00      0.0    350.0   0.000  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 =   1
1                                        RESULTS
                                         -------

 ==========================================================================================================================
 CNTR  RAD   CENTER COORDINATES   CIRCLE   FACTOR OF SAFETY    SUMWS    SUM1     SUM2      XR       XL       ARC    NN  TRIAL
  NO   NO      X          Y      RADIUS   BISHOP  FELENIUS
   1    1   1118.00    1128.00    74.00   2.169   (  1.708)   5963.    5963.     966.  1079.30  1059.42   26.87   1    2
   2    1   1122.00    1172.00   116.00   1.732   (  1.494)  23586.   23582.    4176.  1079.41  1025.73   69.96   1    2
 *RDY*
```

APPENDIX B

S O U T H E R N U T A H F U E L C O .

M I N E N O . 1

Estimate and
Technical Specifications
For

SEDIMENTATION POND

IMPROVEMENTS

August 1980

REGISTERED PROFESSIONAL ENGINEER
No. 4622
M. Gregory
Cloward
State of Utah

INDEX

	ITEM	PAGE
	Index	I-1
	Contract Estimate	E-1
Section 1	Special Provisions	1-1
Section 2	Pipeline Trench Excavation Backfill	2-1
Section 3	Corrugated Metal Pipe	3-1
Section 4	Earthwork for Concrete Structures	4-1
Section 5	Portland Cement Concrete (PCC)	5-1
Section 6	Steel Reinforcement for Concrete	6-1
Section 7	Riprap	7-1
Section 8	Placing and Finishing Structural Concrete	8-1
Section 9	Clearing and Grubbing	9-1
Section 10	Removal of Structures and Obstructions	10-1
Section 11	Excavation	11-1
Section 12	Borrow, Granular Borrow, and Granular Backfill Borrow	12-1
Section 13	Embankment and Backfill	13-1
Section 14	Watering	14-1
Section 15	Compaction and Backfill Compaction	15-1
Section 16	Underdrains and Underdrain Granular Backfill	16-1
Section 17	Surface Ditches	17-1
Section 18	Topsoil	18-1
Section 19	Seeding	19-1
Section 20	Mulching	20-1
Section 21	Final Cleanup	21-1
Section 22	Miscellaneous Materials and Small Structures	22-1

SECTION 1

Specifications for
SPECIAL PROVISIONS

ITEM	PAGE
Scope	1-1
Temporary Office	1-1
Temporary Utilities	1-1
Examination of the Site	1-1
Progress of Construction:	1-1
Compliance With Governmental Regulations	1-2
Interfering Structures and Utilities Responsibility	1-2
Surveying Monuments	1-2
State and Federal Inspections	1-3
Approval of Working Drawings	1-3
Manufacturer's Directions	1-4
Equipment and Materials Selection	1-4
Mine Water	1-5
Protection of Water Quality	1-5
Materials Acquisition	1-5
Riprap Availability	1-5
Seeding, Topsoil, and Fertilizer	1-6
Engineer and Owner for Purposes of Administrating These Technical Specifications	1-6

SECTION 1

Specifications For
SPECIAL PROVISIONS (Cont.)

ITEM	PAGE
Quality of Workmanship	1-6
Mobilization	1-6
Small Ditches	1-6
Geotechnical Analysis of Abutment and Embankment Foundations	1-6
Removal and Salvage of Existing Concrete Sedimentation Basin	1-7

SECTION 1

Specifications for

SPECIAL PROVISIONS

1) SCOPE: The Contractor shall furnish all labor, materials, and equipment necessary or required to complete the work in all respects as shown on the plans, as hereinafter specified, or both. If there is a conflict between requirements of this section and requirements of other sections of these specifications, then the requirements contained in the Special Provisions shall govern.

2) TEMPORARY OFFICE:

The Owner shall maintain a temporary office at the site for the use of the Contractor, Subcontractors, Agent, and the Engineer. A complete set of drawings and specifications shall be maintained in this office at all times.

3) TEMPORARY UTILITIES:

The Contractor shall arrange for, secure and pay for directly, any and all temporary utility supplies he may require for prosecution of his work. Existing utilities at the mine site may be used if there is no interference with the normal operations of the mine.

4) EXAMINATION OF THE SITE:

The bidder shall examine the site before submitting his proposal and inform himself regarding existing facilities and conditions affecting the proposed work. Failure to make such inspection shall in no way relieve the Contractor of any of the obligations or conditions of this specification or serve in any way as a basis for extra remuneration to the Contractor for conditions arising from unfamiliarity with the site or conditions affecting the work.

5) PROGRESS OF CONSTRUCTION:

It is the intention of the contract documents that the progress of the work shall proceed in a systematic and expeditious manner so that a minimum of inconvenience will result to the mine operations and other Contractors in the course of construction. With this in mind, the schedule submitted by Contractor shall include the Contractor's plan of operation with supporting data relative to starting and completion dates on the various phases of the work, methods, and items which are to be concurrently constructed. Such a schedule of progress will be used by the Owner and the Engineer as a basis for arranging inspections and for coordination of the work of others.

The progress schedule shall be submitted by each Contractor as required in the General Conditions within 5 days after the award of the Contract. The progress schedule shall be in reproducible form subject to the approval of the Engineer. The Contractor shall submit copies of the progress schedule with each request for payment showing the relation of the completed work to the progress schedule.

6) COMPLIANCE WITH GOVERNMENTAL REGULATIONS.

The Contractor's equipment and operations shall comply fully with all applicable standards, regulations, and requirements of existing Federal, Utah State and Local governmental agencies. This shall include, but not necessarily be limited to, the following:

A. Utah Occupational Safety and Health Act (1973), and Employer-Employee Safe Practices for Excavations and Trenching Operations (Jan. 1, 1974) as published by Industrial Commission of Utah, including any and all amendments or revisions effective prior to performance of the work, the Mine Safety and Health Act, and the Surface Mine and Reclamation Act.

7) INTERFERING STRUCTURES AND UTILITIES RESPONSIBILITY:

The Contractor shall exercise all possible caution to prevent damage to existing structures and utilities, whether above ground or underground. An attempt has been made to show these structures and utilities on plans. While the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed, and it is presented simply as a guide to possible difficulties.

8) SURVEYING MONUMENTS:

The Contractor shall preserve existing survey and federal land monuments wherever possible. When these monuments cannot be preserved, the Contractor shall notify the Engineer at least one (1) week in advance of the proposed construction in order that the Engineer will have ample opportunity to reference these monuments for later replacement. The Contractor shall be responsible for all monument replacement to an existing or better than existing condition.

9) STATE AND FEDERAL INSPECTIONS:

The site of construction is to be open at all reasonable times and places for inspection by accredited representatives of the State or Federal agencies who have regulatory or supervisory authority over any part of the work proposed or related thereto.

10) APPROVAL OF WORKING DRAWINGS:

The Contractor shall submit, in quadruplicate, to the Engineer for his approval such shop or working drawings and/or datalog cuts for fabricated items and manufactured items, including mechanical and electrical equipment, as may, in the opinion of the Engineer be required for the construction of the work or any part thereof.

Drawings shall be submitted sufficiently in advance to allow the Engineer not less than regular working days for examining the drawings.

These drawings shall be accurate, distinc and complete and shall contain all required information, including satisfactory identification of items, units assemblies in relation to the contract drawings and/or specifications.

When the shop drawings are approved by the Engineer, two sets of prints will be returned to the Contractor marked "Approved", "Approved, Except as Noted", or similar notation; if changes or corrections are necessary, one set will be returned to the Contractor with such changes or corrections indicated by a brief statement and the Contractor shall correct and resubmit the drawings, in triplicate, when requested by the Engineer.

The approval of such drawings and/or catalog cuts by the Engineer shall not relieve the Contractor from responsibility for correctness of dimensions, fabrication details and space requirements, or for deviations from the contract drawings or specifications, unless the Contractor has called attention to such deviations in writing by a letter accompanying the drawings, and the Engineer approves the change or deviations in writing at the time of submission; nor shall approval by the Engineer relieve the Contractor from the responsibility for errors in the shop drawings. When the Contractor does call such deviations to the attention of the Engineer, the Contractor shall state in his letter whether or not such deviations involve any deduction or extra cost adjustment.

11) MANUFACTURER'S DIRECTIONS:

All manufactured items, articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned as directed by the manufacturer's written instructions, unless herein specified to the contrary.

At the termination of the work, the Contractor shall submit three complete sets bound in the best grade, hard-backed binder of all operating and maintenance instructions, presenting full details for care and maintenance of all visible surfaces and all mechanical and electrical equipment installed. The sets shall include the following information:

Complete description of items including catalog numbers.
Complete parts list for each item.
Name and address of local supplier.
Name and address of manufacturer.
Complete operating instructions.
Complete maintenance instructions.

12) EQUIPMENT AND MATERIALS SELECTION:

Equipment and materials specified by name in these specifications or on the plans have been investigated and found suitable for the service and/or construction conditions anticipated. However, names are given primarily as a guide; bidding is not intended to be restrictive only to the extent of obtaining equipment and materials which will properly and effectively do the job. Manufacturers of competitive equipment are invited to submit requests to the Engineer for permission to bid their equipment. Such requests must be received by the Engineer at least days prior to the bid opening and must be complete with the information necessary to properly evaluate the ability of the alternate equipment to meet the requirements of the project.

Information should include specification data, materials of construction, dimensions, performance curves and data, location of nearest representative and service personnel, and all other pertinent information. If alternative equipment or materials are approved, the Contractor shall, at his expense, make any changes in the structures, buildings, piping or other necessary to accommodate the alternate items.

13) MINE WATER: At the present time the existing 72" pipe shown on the plans has a nearly continuous flow of water coming from the underground workings of Mine #1. It will be necessary for the contractor to re-route this water in order to construct the 48" pipe down the fill slope and under the dam. If necessary, the water can be shut off for periods of up to 8 to 10 hours by giving at least 24 hours notice to the Engineer.

14) PROTECTION OF WATER QUALITY:

It is necessary to protect the existing stream and channel from undue concentrations of silt and sediment which may find their way into the drainage during the construction period. Removal of the existing sedimentation basin and construction of the roads, embankments, and other structures, shall be carried out in such a manner so as to minimize the amount of silt and disturbance to the existing stream and water quality.

15) MATERIALS ACQUISITION:

Materials for this project shall be supplied as per the contract, with the exception that the Owner shall supply all of the corrugated pipe and bands necessary to construct the 48", 72", and 24" culverts. The Contractor shall acquire the 8" drain pipe. It is anticipated that all borrow for embankment, top soil, filter material, and granular borrow will need to be imported to the job site, and supplied by the Contractor. The Contractor shall make arrangements to haul the material to the job site in the most economical and expeditious manner possible. Careful consideration should be given to using existing coal haulers to move the material on the back haul to the mine site. The Engineer shall approve the method used by the Contractor to transport this material to the mine site prior to moving or accepting of the material. The Contractor shall specify the location of the borrow pit used for embankment, top soil, and granular borrow. The Contractor shall supply, at the direction of the Engineer, all soils and materials tests which may be required to adequately determine the suitability of the material as embankment material or other material as specified. These tests may include, but shall not be limited to proctors, direct shear analysis, and percolation tests. Costs of these tests shall be included in the cost for the material, or in the fixed fee portion of the contract.

16) RIPRAP AVAILABILITY:

It is anticipated that there will be sufficient raprap available on site. However, the Contractor shall make every effort to save all material which meets the riprap specification, and located underneath the proposed embankment and pond bottom. In addition, rock material which is removed for the keyway and for pipe structures, shall be segregated and saved for use as riprap.

17) SEEDING, TOPSOIL, AND FERTILIZER:

Placement of topsoil shall be made in those areas shown on the plans, or as directed by the Engineer. Topsoil shall be placed to a depth of 4 inches, and shall be of a suitable quality to promote active plant growth. All seeding shall be Method C and shall include a Method B mulch. An application rate shall be determined at a later date. Fertilizer shall be included if specified at that time.

18) ENGINEER AND OWNER FOR PURPOSES OF ADMINISTRATING THESE TECHNICAL SPECIFICATIONS

The term Owner shall refer to the Southern Utah Fuel Company, its General Manager and Agents. The term Engineer shall refer to Mr. Mike Davis of the Southern Utah Fuel Co., Mr. Kerry Frame of the Southern Utah Fuel Co., and/or Mr. Greg Cloward of Valley Engineering, Inc.

19) QUALITY OF WORKMANSHIP:

It shall be the responsibility of the Contractor to carry out the work in an expeditious and workmanlike manner. Should the Contractor fail to perform good workmanship such as failure to meet compaction through improper compaction amounts and techniques, or over excavation for pipe and structures, etc., the Contractor shall correct the situation at no extra cost to the Owner.

20) MOBILIZATION:

Mobilization shall consist of preparatory work and operations including but not limited to those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of all offices, buildings, and other facilities necessary for work on the project; for furnishing direction and maintenance of construction signs, and for all other work and operations which must be performed or cost incurred, not otherwise paid for, prior to beginning work on the various items on the project site. Costs for all items of work included in mobilization shall be incorporated and paid for as indicated in the contract.

21) SMALL DITCHES:

In addition to work shown on the plans, approximately 2500 linear feet of small ditches shall be constructed to divert water around the disturbed area at the mine site. The location of these ditches shall be given by the Engineer to the Contractor.

22) GEOTECHNICAL ANALYSIS OF ABUTMENT AND EMBANKMENT FOUNDATIONS:

After removal of all loose material, riprap, and other unsatisfactory material from beneath proposed embankments, and after excavation for the embankment and the abutments is completed, the Engineer shall undertake any or all Geotechnical Investigations of the foundation as he deems necessary prior to construction of any embankment on the construction site. The

Contractor shall notify the Engineer 24 hours prior to completion of the preliminary work and excavation so that the Engineer can undertake the necessary Geotechnical Investigations.

23) REMOVAL AND SALVAGE OF EXISTING CONCRETE SEDIMENTATION BASIN:

The existing concrete sedimentation basin shall be removed as indicated on the plans and in the specifications. Southern Utah Fuel Co. shall have the option to salvage any or all parts or equipment from the existing sedimentation basin prior to removal by the Contractor. All parts and materials not salvaged by Southern Utah Fuel Co. shall become the property of the Contractor, as indicated in the specifications, and shall be disposed of accordingly. The existing pipe from the concrete sedimentation basin, which runs to the existing 72" pipe, shall be plugged with at least two feet horizontally of concrete, and sealed tightly.

SECTION 2

Specifications for
PIPELINE TRENCH EXCAVATION AND BACKFILL

ITEM	PAGE
Scope	2-1
Clearing	2-1
Excavation	2-1
Blasting	2-3
Sheeting and Bracing	2-3
Excavating Through Easements	2-3
Pipe Bedding	2-4
Backfilling	2-5
Backfill Materials	2-7
Underground Obstruction	2-8
Drainage	2-8

SECTION 2

Specifications for

PIPELINE TRENCH EXCAVATION AND BACKFILL

1) SCOPE: Trench excavation and backfill shall include all labor, materials, tools, equipment, and services necessary to make the required excavation and backfills, and to perform the required grading of whatever character necessary for the proper construction and completion of sewers, service lines, culverts, conduits, and other appurtenant sewer structures, all in accordance with the plans and these specifications.

2) CLEARING:

Where necessary (as determined by the Engineer) the area involved in the construction shall be cleared of all trees, brush, rubbish, and other objectionable matter, and such materials shall become the property of the Contractor, and shall be removed from the site of the work before the date of completion, or otherwise disposed of as approved by the Engineer, or as specified in the Special Provisions.

3) EXCAVATION:

The Contractor, as part of his contract, shall perform all excavation of every description and of whatever substances encountered, to the depth specified on the plans and/or required to accomplish the work. During the excavation operations, the material which might be found suitable for use in backfilling, shall be piled in an orderly manner a sufficient distance from the banks of the trench, for convenience in operating equipment, to avoid embankment overloading, and to prevent slides and cave-ins. All excavated materials not required or not suitable for backfilling, shall be promptly removed from the site of the work and wasted in an area to be provided by the Contractor with the approval of the Engineer.

The ground shall be excavated in open trenches, except where tunneling is considered necessary or proper by the Engineer, or otherwise indicated on the plans.

Trenches are to be excavated to the lines and grades shown on the drawings regardless of the type of material encountered. the width of the excavation shall be sufficient to permit proper installation of the pipe. The bottom of the trench shall be accurately graded, to provided uniform bearing and support for each section of the pipe on undisturbed soil at every point

along its entire length, except for the portions of the pipe section where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes and impressions for joints shall be dug after the trench bottom has been graded. To insure support of the pipe for as nearly the full length of pipe as practicable, the bell holes shall be only of such length, depth, and width required to properly place the pipe, as specified herein.

Care shall be taken not to excavate below the required depths. Where soft, spongy, or otherwise unstable material is encountered, which will not provide a firm foundation for the pipe, the Engineer will direct the extent to which removal and replacement with suitable material shall be made. Where rock excavation is encountered, the rock shall be excavated to a minimum overdepth of four inches (4") below the outside wall of the pipe used. The overdepth rock excavation shall be backfilled with suitable granular material.

When it is necessary to excavate below the lines and grades shown on the plans to remove undesirable materials, the Contractor shall do so upon direction of the Engineer. Select backfill, approved by the Engineer, shall be used to backfill to the lines and grades shown on the plans.

Unauthorized overdepths shall be backfilled with coarse sand, fine gravel, or other suitable granular material as approved by the Engineer at no expense to the Owner.

When excavation is complete, the bottom of the trench shall have the shape and dimensions shown on the plans or as specified herein. Trenches below the top of the pipe shall be not less than twelve (12) inches nor more than twenty-four (24) inches wider than the maximum outside diameter of the pipe. For service lines, a maximum three feet (3') wide trench width below the top of the pipe shall be allowed.

All excavated materials shall be piled in such a manner as will cause a minimum of inconvenience.

The excavation of the trench shall not advance more than six hundred feet (600') ahead of the completed pipe work, except where, in the opinion of the Engineer, it is necessary or desirable for drainage or other purposes.

Bituminous pavement, concrete pavement, curbs, sidewalks, or driveways in connection with construction of the pipeline shall be removed in a neat line. Removal of these items shall be a part of the work for trench excavation.

4) BLASTING:

When blasting is required in trenches or other excavation, the Contractor shall use precautions against accident or damage on account of the explosions or the use and storage of the explosives. The Contractor shall be solely responsible for any damage resulting from the use of explosives and shall keep the Owner free of any claim for damages resulting from the Contractors' blasting operations. If, in the judgment of the Engineer, the situation or the Contractors' methods indicate that it is unsafe to do blasting, the Engineer may order the blasting stopped and the excavation completed in a safe manner. Blasting is not a bid item.

5) SHEETING AND BRACING:

The Contractor shall do all shoring, bracing, and tight sheeting required to prevent caving and to protect the workmen and adjacent property and structures.

When, in the judgment of the Engineer, the trenching operation, or the shoring or bracing provided is unsafe or inadequate, he may order widening of the trenches or shoring or bracing.

Failure on the part of the Engineer to order additional widening, shoring, or bracing shall not relieve the Contractor of his responsibility to keep the work and workmen safe and unharmed.

6) EXCAVATING THROUGH EASEMENTS:

The Contractor shall carefully remove all shrubs, fences, and other above-ground items; carefully cut and remove all lawn sod and remove the topsoil for a depth of at least 30 inches (or the depth of the actual topsoil if less than 30 inches) with the width of the lawn sod and topsoil removal being at least 2 feet wider (1 foot each side) than the excavated trench width. The topsoil material shall be piled separately from, and shall not be mixed with, the remainder of the excavated material.

Following completion of the backfilling and the compaction of the trench in accordance with "Class D Backfill", the Contractor shall replace the lawn sod, shrubs, fences, or other items that may have been removed from within the easement area and shall clean up and remove any rocks, dirt, or any debris that remain from the construction work. In lieu of removing and replacing the lawn sod, the Contractor may, with the agreement of the property owner, replant the lawn or pay the property owner to replant the lawn. Such agreements shall be documented in the final letter of release from the property owners.

All costs incurred by the Contractor during the salvaging and restoring of the topsoil and surface features, are to be included as part of excavation and backfill.

7) PIPE BEDDING:

Where the ground at the pipe grades is sufficiently firm and unyielding, the pipe may be laid directly without special bedding treatment; but whenever this is not the case, upon direction of the Engineer, a proper foundation shall be built by the Contractor in accordance with the plans and these specifications. This special bedding will be Class "B" (first class bedding). Class "B" is that method of bedding pipe completely buried in trenches in which the pipe is placed on fine granular materials in an earth or rock fill foundation, carefully shaped to fit the lower part of the pipe exterior, for a distance of one-fourth of the outside diameter below the pipe, up to a point equal to the center of the pipe. Granular materials are carefully placed by hand to completely fill all spaces under and adjacent to the pipe; and thoroughly tamped under and on each side of the pipe in layers not exceeding six inches (6") thickness; all under the direction of the Engineer or his inspector, who will be present during the installation. Details are as shown in the plans. Should the trench be excavated to a depth greater than that required by the plans and profiles, the Contractor shall refill such excess excavation with selected granular material to the proper lines and grades and properly compact it ready for placement of the pipe.

"Select Material" shall be understood to mean a granular material with a maximum size of three inches (3") and shall be well graded. Class "B" bedding material shall then be placed around the pipe in accordance with the drawings and these specifications

Imported material for Class "B" pipe bedding will be granular material, with no stones or rock in excess of one and one-half inches (1 1/2") in any dimension. The material shall be free of excessive fine material and shall be subject to the approval or rejection of the Engineer. When quick conditions exist, larger rock may be used to provide a base for the one and one-half (1 1/2") imported bedding material upon Engineer's approval.

Where depths of pipe are too great to allow vertical cuts for the entire depth of the trench, "Y" trenches, with the side slopes meeting OSHA safety requirements, shall be used. Class "B" bedding defined in WPCF Manual of Practice Number Nine and ASCE Engineering Practice Number Thirty-Seven will be used in those sections of the lines designated by the Engineer. Typical cross sections of Class "B" bedding are as shown in the plans.

8) BACKFILLING:

After pipes have been laid, the open trench shall be backfilled to the level of the original ground surface. Unless otherwise ordered or required by the Engineer, the trench backfilling shall not be left unfinished more than three hundred (300') feet behind the completed pipe work.

Trench backfill above the pipe zone shall be classified as Class "B" or Class "D", as defined herein. The class of backfill required is indicated on the plans. Rock or solid objects exceeding eight inches (8") in size, frozen earth, etc., shall not be used for backfill.

A. CLASS "B" BACKFILL:

This class of backfill shall be a combination of water densification, and mechanical compaction. It is intended for use in those areas where subsequent trench settlement must be held to a minimum.

Suitable backfill material shall be placed in the trench to a depth of four feet (4') below the ground surface in one lift for trenches less than twelve feet (12') in overall depth, and in two lifts for trenches greater than twelve feet (12'). After the backfilling of each lift, water shall be placed in the trench section in such quantities and in such a manner that all portion of the lift become completely saturated. The use of a hose and long pipe nozzle shall be employed to induce settlement and assure complete saturation of the backfill. The nozzle shall be inserted at such spacing as necessary to assure complete saturation and settlement of the backfill.

It shall be the Contractor's responsibility to determine and provide the quantity of water required in every case to effect complete water settlement of the backfilled material. Any subsequent settlement of the trench during the Contractor's guarantee period, shall be considered to be the result of improper Class "B" backfilling and shall be corrected at the Contractor's expense.

The remainder of the trench shall be backfilled in twelve (12") inch lifts of suitable and approved backfill material or pit-run gravel. Each lift shall be sprinkled and thoroughly compacted by means of tamping rollers, sheepsfoot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers. All such equipment shall be of a size and type approved by the Engineer. Impact-type pavement breakers (stompers) will not be permitted over clay, asbestos cement, cast iron, or non-reinforced concrete pipe.

Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under the contract. The Contractor shall make his own determination in the regard. Suitable backfill material, as discussed herein, shall be approved granular excavated material which is free from clods of earth, frozen materials, excessive amounts of clay and rocks larger than twelve inches (12") in diameter for the water settle lifts and six inches (6") in diameter for the top four foot (4') section.

The compaction requirement in the top four feet (4') shall be herein defined as 95 percent (95%) of the maximum laboratory density as determined by AASHO T-99 Test methods.

In those areas of Class "B" backfill, where there is not a specific surface repair pay item, the Contractor shall be responsible for complete replacement of all existing surface items, such as topsoil, grass, fences and etc. All surface items damaged, shall be replaced to an existing or better condition. The cost of repairing or replacing these surface features, shall be considered incidental to Class "B" backfill.

B. CLASS "D" BACKFILL

This class of backfill is intended for use in agricultural areas where trench settlement must be minimized and surface replacement must be included in the backfill pay item.

The compaction requirements for Class "D" backfill are the same as Class "B" above, except the backfill may be water densified to a depth of 2.0 feet below the existing ground surface.

The top two feet (2') of the trench shall be backfilled with native topsoil, salvaged during the excavation operation. The topsoil shall be placed in six inch (6") lifts and mechanically tamped or wheel rolled to a density of not less than ninety percent (90%) of the AASHO T-99 maximum laboratory density.

In the event soil is removed or contaminated by the Contractor during the construction operation, he must secure and haul in a topsoil acceptable to the owner of the property in question. The extra cost incurred by this topsoil importation, shall be incidental to Class "D" backfill.

C. WATER FOR BACKFILL:

Water will be provided from the mine running in the existing 72" pipe.

D. ALTERNATE BACKFILL METHODS:

Alternate compaction methods may be considered, provided the Contractor submits his proposed method in writing to the Engineer five days (5) prior to initiating any backfill operations.

9) BACKFILL MATERIALS:

A. AROUND PIPE:

The backfill material to be placed around and over the pipes, to a depth of at least one foot (1') shall be excavated or imported materials consisting of clay, loam, sand, gravel, soft shale, or other suitable material, free from debris and stones larger than one and one-half inches (1 1/2") in any dimension,(1" for asbestos cement pipe).

B. REMAINDER OF BACKFILL:

The remainder of the backfill shall be the same as that around the pipe, except that the inclusion of a limited amount of stones and rock will be permitted. Stones and rock shall in no case be larger than eight inches (8") in any dimension, and they shall be so placed, that each piece

is completely surrounded with compacted material. The size and number of rocks or stones used in the backfill shall be such as not to interfere with proper compaction, as determined by the Engineer.

10) UNDERGROUND OBSTRUCTION:

The Contractor shall preserve intact, any underground pipes or other utilities encountered during construction (except as hereinafter specified) provided they do not interfere with new pipelines or structures being installed. In case any such utilities or other structures are accidentally broken, they shall be immediately replaced in a condition at least equal to that in which they were found.

11) DRAINAGE:

The Contractor shall control the grading in the vicinity of the trenches and structures as much as possible, so that ground surface water is prevented from running into the excavated areas. When water does get into the excavations, the Contractor shall take immediate steps to remove the water and stabilize the foundations prior to continuing with the work.

SECTION 3

Specifications for
CORRUGATED METAL PIPE

ITEM	PAGE
Scope	3-1
Materials	3-1
Assembly and Joining	3-2
Repairing and Damaged Finish	3-2
End Finish	3-3
Excavation and Foundation	3-3
Metal End Sections	3-4
Certification	3-4

SECTION 3

Specifications For

CORRUGATED METAL PIPE

1) SCOPE:

This specification provides the requirements for corrugated metal pipe to be furnished under this contract.

Corrugated metal pipe shall be installed at the locations designated on the plans and shall be used as replacement culverts for any culverts damaged by the Contractor during trench excavation and pipe installation procedures.

It is intended that galvanized steel corrugated pipe be used within this project. In the event that the Contractor elects to use an alternate, the alternate CMP provided must be equivalent in all aspects including dimensional, hydraulic, corrosive resistance, and dead load capabilities,and such alternate must be approved by the Engineer, prior to installation.

2) MATERIALS:

A. Corrugated Steel Pipe. The pipe, connecting bands, and belts shall be zinc coated (galvanized). Pipe and band metal shall be 16 gage for 24" and smaller, and 12 gage for all large diameter, and the pipe, bands, and bolts shall conform to the requirements of AASHO Designation M-36, except that the flat metal prior to corrugation shall meet the following minimum strength requirements when tested in accordance with AASHO Designation T-68:

Tensil Strength, psi	45,000
Yield Strength, psi	38,000
Elongation, 2 inches	30%

The pipe may be riveted, welded or helical fabrication, but must be water tight. All joints and seams shall be water tight and shall be similar to ARMCO welded seam, loc seam soldered, loc seam asphalt coated, or approved equal.

B. Connecting Bands. Field joints shall be made with bands of the same base metal as the pipes. All bands shall be so constructed as to lap an equal portion of each of the pipe sections and the band ends shall be drawn together by galvanized angles and bolts, or by any other method approved by the Engineer.

C. Marking. Each pipe shall be marked clearly and legibly to show the class of pipe, the date of manufacture, and the name or trade mark of the manufacturer.

D. All 48" pipe, 72" pipe, and 24" pipe located on steep grades, shall be supplied with two tension bolts and suitable flanges at each joint. The tension bolts shall be similar to those shown on the plans and shall carry 60,000 lbs. tension, each bolt for 48" and 72" pipe, and 15,000 lbs. tension for 24" pipe.

3) ASSEMBLY AND JOINING:

Corrugated metal pipe and structural plate pipe shall be assembled and installed in accordance with the manufacturer's instructions. Plates for forming skewed or sloped ends shall be cut to give the angles and dimensions shown on the plans. All cuts shall be free of burrs and burned edges, and shall present a uniform finished edge. The cut edges shall be coated with a zinc-dust, zinc-oxide primer conforming to Federal Specification TT-P-641.

All pipe shall be unloaded and handled with reasonable care. C.M. Pipe or plates shall not be rolled or dragged over gravel or rock, and during placement in a trench or on bedding, care shall be taken to prevent striking rock or other hard objects. Special care shall be taken in handling and placing coated pipe to avoid damaging the coating.

The pipe sections shall be joined with coupling bands of like material. One-piece or two-piece bands may be used. Coupling bands for annular and helical formed pipe shall provide circumferential and longitudinal strength to preserve the culvert alignment, prevent separation of the pipe sections, and prevent infiltration of sidefill material.

4) REPAIRING DAMAGED FINISH:

In lieu of the requirements of AASHO Designation: M 36, damaged spelter coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating, after which the cleaned area shall be painted with 2 coats of zinc oxide, zinc dust paint conforming to the requirements of Federal Specification MIL -P-15145, the paint to be properly compounded in a suitable vehicle in the ration of one part zinc oxide to 4 parts zinc dust, by weight. The paint shall be furnished by the Contractor at his expense.

When the spelter coating has been burned by welding, all surfaces of the welded connections shall be thoroughly cleaned by wire brushing and all traces of the welding flux and loose or cracked spelter removed, after which the cleaned areas shall be painted as above specified.

Damaged areas caused by end finishing shall be thoroughly cleaned and painted as above specified.

5) END FINISH:

If headwalls or flared end sections are not to be provided and if called for on the plans or in the special provisions, the ends of all 16 and 14 gage installations shall be reinforced. The reinforcement shall consist of a galvanized steel rod not less than 7/16 inch in diameter rolled in the sheet, or by a galvanized metal band equivalent in cross-section to 3/8 inch minimum thickness by 1 1/2 inches wide, or at least the outer one foot of 16 gage pipe shall be of at least 12 gage material and the outer one foot of 14 gage pipe shall be of at least 10 gage material. If a band is used it shall be placed around the ends of the pipe and fastened with rivets at intervals of 10 inches or less.

6) EXCAVATION AND FOUNDATION:

Trenches shall be excavated to a width sufficient to allow for proper joining of the conduit and thorough compaction of the bedding and backfill material under and around the culvert.

The completed trench bottom shall be firm for its full length and width. Where required, in the case of cross drains, the trench shall have a longitudinal camber of the magnitude specified.

If rock strata is closer than six inches (6") from the pipe, the rock shall be removed and replaced with a layer of suitable granular material. Where the natural foundation soil is unstable or unsuitable, such material shall be replaced by a layer of suitable granular material as shown on the standard plan. The depth shall be determined by the Engineer following subsurface exploration and analysis.

Where culverts are to be placed in embankment fill, the excavation shall be made after the embankment has been completed to the specified height above the designed grade for those culverts specified on the plans or as ordered by the Engineer.

Excavation, foundation preparation, pipe installation, and backfill shall all be accomplished in strict conformance with Sections 2 and 3 of these specifications.

7) METAL END SECTIONS:

Where required, this work shall consist of furnishing and installing metal end sections for pipe and pipe-arch culverts of the designated sizes and dimensions, at the locations shown on the plans or designated, and in conformity with the details shown on the plans and these specifications.

The end sections shall be fabricated of metal plates of the gage or thickness as specified for the pipe. Metal end sections connecting to metal pipe shall be of the same type of metal.

Metal end sections shall be placed in accordance with the construction methods prescribed for the type of pipe with which they connect and with the requirements shown on the plans.

8) CERTIFICATION:

Certified test certificates shall be furnished to the Engineer prior to the delivery of any pipe to the construction site. This certification shall indicate that the pipe and joining material meet specified requirements, including those for material quality and acceptance testing. In addition, the Engineer may require that test samples be taken and that test certificates be furnished by a reputable, materials testing laboratory, at the Contractor's expense.

SECTION 4

Specification for
EARTHWORK FOR CONCRETE STRUCTURES

ITEM	PAGE
Scope	4-1
Excavation	4-1
Backfilling	4-2
Clean-up	4-3

SECTION 4

Specification For

EARTHWORK FOR CONCRETE STRUCTURES

1) SCOPE:

This section covers excavation, backfill and embankment for concrete structures. Concrete structures shall be constructed in conformity with the plans and special provisions.

2) EXCAVATION:

A. General. The Contractor shall perform all excavation of every description and of whatever substances encountered, to the lines and grades shown on the plans or otherwise specified. The Contractor shall inform and satisfy himself as to the character, quantity, and distributions of all materials to be excavated.

B. Limits Of Excavation. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal and inspection of forms, except where the Contractor is authorized to place concrete directly against excavated surfaces. Undercutting will not be permitted.

Excavation shall be carried only to the depths required for placing structures on undisturbed earth unless otherwise shown on the drawings. Where suitable bearing is not encountered at the design elevation, the Engineer may direct that additional depth, as required, be excavated. Over-excavation below slabs and footings shall be replaced with select material, thoroughly compacted to not less than ninety-five percent (95%) of maximum standard density, to the subgrade elevation. Additional depth of excavation below footings may be poured with concrete as a part of the footing. The cost of unauthorized over-excavation and replacement with compacted fill or extra concrete shall be borne by the Contractor. Where over-excavation is authorized by the Engineer, the additional cost incurred for excavation and backfill will be borne by the Owner.

C. Protection Of Excavations. All necesseary bailing, drainage sheetin and construction of water diversions, cribs, and coffer dams shall be included as part of the excavations. Excavations over four feet in depth unless well compacted, stable material, shall be shored, sheeted, and braced as may be necessary for the protection of the work and the safety of the personnel, or shall be sloped to the angl of repose of the material when saturated.

Adjacent areas shall be graded so that surface drainage is away from excavations and any water accumulating therein shall be promptly removed. Pumping from the interior of any foundation enclosure shall be done so that the possibility of any portion of the concrete material being carried away, is eliminated. No pumping will be allowed during the placing of concrete or twenty-four (24) hours thereafter unless it is done from a suitable sump separated from the concrete work by a water-tight wall.

Where concrete is to be placed on an excavated surface care shall be taken not to disturb the bottom of the excavation. Final removal of material to grade shall be made just before the concrete is poured. When excavation is at the required depth, any water, if present, shall be pumped out for cleaning and inspcetic of the foundation bed.

After each excavation is complete, the Contractor shall notify the Engineer and no footing shall be place until after the Engine has approved the depth of the excavation and the character of foundation material.

D. Disposal Of Excavated Materials. Excess excavated material not required for fill or backfill, and unsuitable excavated materials shall be wasted in approved areas. All spoil areas shall be leve to a uniform line and section and shall present a neat appearance before project acceptance.

Suitable material that cannot be placed readily in the permanent work shall be separately stockpiled. Stockpiles shall be kept in neat, well-drained, workable condition at all times. Stockpiles shall be located in areas shown on the plans, or if none is shown, at approved locations in the immediate vicinity of the wor so selected as not to interfere with the owrk being performed.

3) BACKFILLING:

After completion of foundations, walls, and other construction below ground level, and prior to backfilling, forms shall be removed and th excavation shall be cleaned of trash and debris. All material used for backfill shall be of a quality acceptable to the Engineer and sha be free of large and frozen lumps, wood and other extraneous material In general, this material shall be selected from the material excavat from the structure.

Backfill shall be placed in continuous horizontal layers not to excee eight inches (8"0 in depth, and compacted to ninety

maximum standard density at optimum moisture. Where backfill is placed on both sides of the wall or column, both sides shall be backfilled simultaneously so that differences in grade do not exceed eighteen inches (18") at any time. Jetting or ponding of the backfill will not be permitted. Water may be added only to bring the backfill to optimum moisture content. All backfill around structures shall be compacted as specified to the final grades shown. No backfilling shall be done until permission is given by the Engineer. Care shall be taken in compacting around footings and walls to prevent damage to the structure.

Where called for on the plans, gravel fills shall be crushed rock or gravel, three-fourths inch (3/4") maximum size. Gravel fills shall be compacted with vibratory compactors suitable for such material, to the satisfaction of the Engineer. Sand fills will not be permitted.

4) CLEAN-UP:

All excess material, sheeting, and debris shall all be removed from the site and disposed of by the Contractor. The area shall be graded and all rocks and boulders bladed into a furrow and picked up and disposed of by the Contractor. Where backfill is of a rocky nature and there is insufficient fine material to provide a smooth surface comparable to the orginal surface, the Contractor shall remove a portion of the backfill and haul in sufficient select fine material to restore the surface to it's original condition.

SECTION 5

Specifications for
PORTLAND CEMENT CONCRETE (PCC)

ITEM	PAGE
Scope	5-1
Portland Cement	5-1
Aggregates	5-1
Water	5-2
Storage of Materials	5-2
Admixtures	5-2
Proportioning	5-3
Classification	5-4
Design of Concrete Mixes	5-4
Mixing	5-5
Concrete Consistency	5-6
Testing	5-7
Grout	5-7

SECTION 5

Specifications For

PORTLAND CEMENT CONCRETE (PCC)

1) SCOPE:

All of the concrete used in structures and appurtenances shall consist of a mixture of an approved Portland cement, water, fine aggregate and coarse aggregate, and approved admixtures all mixed in accordance with these specifications and placed as shown on the plans.

2) PORTLAND CEMENT:

All cement to be used or furnished shall be Type II, Portland cement, conforming to ASTM C-150 unless otherwise specified. Whenever suitable facilities, as approved by the Engineer, are available for handling and weighing bulk cement, such facilities shall be used. Otherwise the cement shall be delivered in original unopened sacks that have been filled by the manufacturer. They shall be plainly marked with the manufacturer's name or brand and cement type. Each sack shall contain 94 pounds of cement.

All Portland cement used in concrete for any individual structure shall be of the same brand and type unless otherwise approved by the Engineer.

3) AGGREGATES:

A. Rock and Gravel - All rock and gravel shall be clean, hard, sound, durable, uniform in quality, and free of any determental quantity of soft, friable, thin, elongated or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance. The concrete aggregate's mix shall be composed of gravel or a well blended mixture of crushed rock and gravel, provided the quantity of crushed rock is less than 50% by weight of the total mixture.

B. Sand - Sand shall be the fine granular material naturally produced by the disintegration of rock and shall be sufficiently free of organic material, mica, loam, clay and other deleterious substances to be thoroughly suitable for the purpose for which it is intended.

C. General - Aggregates which are found to have a silica-released to alkali-reduced ratio greater than one, when tested in accordance with ASTM C-289, may be used only when approved by the Engineer and provided low-alkali cement is used. No additional allowance will be made for the use of low-alkali cement.

4) WATER:

Water used for concrete shall be clear and free from oil, vegetable matter and other deleterious substances. Water shall not contain an amount of impurities that will cause a change in the time of setting of Portland cement of more than 25 percent nor a reduction in the compressive strength of mortar at fourteen days of more than 5 percent compared to results obtained with distilled water.

In conventionally reinforced concrete work, water shall not contain more than 1,000 ppm of chlorides calculated as Cl, nor more than 1,000 ppm of sulfates calculated as Cl, nor more than 1,000 ppm of sulfates calculated as SO^4.

In non-reinforced concrete work, water shall not contain more than 2,000 ppm of chlorides calculated as Cl, nor more than 1,500 ppm of sulfates calculated as SO^4.

5) STORAGE OF MATERIALS:

A. Cement - Cement shall be stored so as to prevent deterioration or contamination. Cement which has become caked, partially set, or otherwise deteriorated, damaged or contaminated shall be rejected and not used even though it may have been previously approved by the Engineer.

B. Aggregates - Aggregates shall be stored and handled so as to preserve the gradation and cleanliness of the material. Segregation and contamination are cause for rejection and the deficient material shall be removed and replaced.

6) ADMIXTURES:

No admixture of any type shall be used unless authorized by the Engineer. When an admixture is permitted or specified it shall be measured accurately into each batch or load in liquid form by a mechanical dispensing device and method approved by the Engineer.

When an air-entraining agent is used it will be limited to the extent that the amount of entrained air by volume shall not exceed 6 percent, and the mix shall be redesigned to adjust the yield.

Admixtures to be used in grouting ducts in prestressed units shall not contain chloride ions in excess of 0.25 percent by weight of admixture and may be dispensed in a solid form when approved by the Engineer.

When calcium chloride is permitted or required to accelerate setting time and to reduce the time necessary for the concrete to reach its specified strength, it shall conform to ASTM D-98. The calcium chloride solution shall contain not more than 32 percent of anhydrous calcium chloride and the hydrogen ion concentration (pH) shall be not more than 8.0 nor less than 4.0. Calcium chloride solution shall be used at the rate of not more than four pints per sack of cement.

Patented accelerators, when permitted, shall be used strictly in accordance with the manufacturer's specifications.

Additional cement may be permitted in lieu of calcium chloride or patented accelerators to obtain high early strength in concrete. Unless otherwise approved by the Engineer, additional cement shall be measured into each batch or load at the rate of 1.5 sacks of cement per yard of concrete.

Subject to approval of the Engineer , Type III cement (High Early Strength) may be used in lieu of Type II cement in the same batch quantities specified for Type II cement.

When used by the contractor for his own convenience, the contractor shall bear the full cost of admixtures, additional cement or substitution of cement type. When ordered by the Engineer, payment for such admixtures and additional cement will be made by the Owner.

7) PROPORTIONING:

Aggregates and cement shall be proportioned by weight except that when the amount of concrete required for any one contract is 10 cubic yards or less, the materials may be measured by volume. Materials that are proportioned by volume shall be measured in containers of known capacity.

The amount of water to be added to the mixture shall be measured and discharged rapidly into the mixing drum through a valve with a positive cut-off. When water is measured by weight it shall be weighed on a separate scale.

8) CLASSIFICATION:

The following class of concrete shall be used for all concrete work related to this project:

Classes of Concrete

Minimum sacks per cubic yard	6 1/2 Sacks
Maximum water cement ratio (by weight)	48%
Percent entrained air	5% $\pm$ 1%
Maximum slump	4"
Maximum size coarse aggregate	3/4"
Minimum 7-day compressive strength	67% f'c
Minimum 28-day compressive strength (f'c)	4,000 lbs/sq. in.
Req. average strength ($\bar{X}r$)	f'c + 1.64 σ

σ = STD Dev

9) DESIGN OF CONCRETE MIXES:

A. Composition - The concrete shall be composed of Portland cement, sand, aggregate, water and approved admixtures.

B. Design of Mixtures - The Contractor shall have an independent testing laboratory, approved by the Engineer, prepare the mix designs for the classes of concrete specified. The Contractor shall furnish an adequate supply of the aggreagtes, cement and admixtures proposed for the work to the testing laboratory in sufficient time to enable the laboratory to design the mix and run the necessary strength tests. The proportions as developed shall be submitted to the Engineer along with at least four (4) sets of certified seven (7) day test results for review and approval. Concrete shall not be incorporated into the work until the proportions are approved by the Engineer.

The resultant concrete mixes shall be homogeneous, readily placeable and uniformly workable and shall be designed in accordance with A.C.I. 613 to attain the properties of strength, slump, entrained air content and gradation specified.

10) MIXING:

Machine mixing will be required in all cases other than those in which it would obviously prove to be impractical, in which event hand mixing will be permitted. Mixing shall be commenced as soon as possible after the cement is placed in contact with the aggregates, but in no event shall the intervening period exceed 30 minutes.

All concrete mixers shall be of such design and construction and so operated as to provide a thoroughly and properly mixed concrete in which the ingredients are uniformly distributed. Mixers shall be maintained in proper and serviceable working condition and any part or portion thereof that is out of order, or becomes worn to such extent as to detrmintally affect the quality of mixing, shall be promptly repaired or replaced.

Concrete shall be mixed for a period of not less than one (1) minute for a volume of one (1) cubic yard or less with an increase of fifteen (15) seconds mixing time for each one-half (1/2) cubic yard or fraction thereof, additional volume after all materials, including water, are in the mixer.

The entire contents of the mixer shall be removed from the drum before materials for the succeeding batch are placed therein. No mixer shall be operated above its rated capacity and no mixer of a rated capacity of less than twenty-seven (27) cubic feet shall be used.

Concrete shall be mixed only in such quantities as are required for immediate use and shall be placed while fresh, before initial set has occurred. Concrete in which initial set has begun shall be wasted. Retempering of concrete shall not be allowed.

Truck mixing shall meet the requirements of A.S.T.M. Designation C94-67 and shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to assure a uniform distribution of materials throughout the mass. Solid materials for the concrete shall be accurately measured in accordance with the approved mix proportions and charged into the drum at the proportioning plant. Except as subsequently provided, the truck mixer shall be equippped with a tank for carrying mixing water. Only the prescribed amount of water shall be placed in the tank unless the tank is equipped with a device by which the quantity of water added can be readily verified. The mixing water may be added directly to the batch, in which case a tank will not be required. Truck mixers may be required to be provided with means by which the mixing time can be readily verified by the Engineer. Mixing shall begin within thirty (30) minutes after the cement has been added either to water or aggregate.

Concrete transported in a truck mixer or agitator shall be discharged at the job and placed in its final position in the forms within one hour after the introduction of the mixing water to the cement and aggregate, or cement to the aggregate, except that in cool weather or under conditions that retard stiffening or setting of the concrete, the maximum allowable time may be increased by the Engineer.

Concrete shall be delivered at a rate such that time intervals between two consecutive batches or loads shall not exceed (30) thirty minutes, unless otherwise permitted by the Engineer.

Hand Mixing shall not be permitted except with the permission of the Engineer and then only in very small quantities or in the case of an emergency.

11) CONCRETE CONSISTENCY:

The amount of water added at the mixer shall be regulated to take into account the free water in the aggregates. Free water is defined as the total water minus the water absorbed by the aggregate in a saturated surface-dry condition.

The amount of water used in the mixture shall not exceed the minimum amount necessary to permit practical placement and consolidation of the concrete, and unless otherwise authorized by the Engineer, shall be that required to produce concrete with a slump within the range shown as nominal in the following table:

Type of Work	Nominal Slump (inches)	Maximum Slump (inches)
Concrete pavement	0-2	3
Non-reinforced concrete	0-3	4
Reinforced concrete structures		
Heavy sections	0-3	5
Thin sections and columns	0-4	6
Concrete placed under water	6-8	9

The concrete used in the work shall not have a slump greater than that shown as maximum above, nor a free water content greater than 312 pounds per cubic yard of concrete.

When adverse or difficult conditions affect the placement of concrete, the Engineer may authorize a greater slump to be used, provided both the water and cement are increased. Water shall be added at a ratio not to exceed 30 pounds per sack of added cement per cubic yard of concrete, and such additional water and cement shall be at the contractor's expense.

The consistency of concrete shall be determined in accordance with ASTM C-143.

12) TESTING:

Test specimens of the concrete will be taken by the Contractor under the direction of the Engineer to establish compliance with these specifications. These test specimens shall be made according to the latest requirements of ASTM Designation C-31. Cylinders shall be tested in accordance with latest requirements of ASTM Designation C-39. In general, not less than two test specimens shall be made each day concrete is poured. The number of specimens required for each day's pouring shall be as follows:

Less than 25 cubic yards	2 specimens
25 cubic yards to 100 cubic yards	4 specimens
100 cubic yards or more	6 specimens

For the purposes of representing the strength and quality of the concrete in the structures, the test specimens shall be cured in the same manner as the concrete in the structure for the first seventy-two (72) hours.

Test specimens shall be shipped to an approved testing laboratory for testing and the results of the tests shall be transmitted directly to the Engineer. Tests shall be made at specimen ages of seven (7) and twenty-eight (28) days, respectively.

All testing equipment including test specimen molds, slump cones, entrained-air measuring meters, and volume measuring devices shall be furnished by the Contractor. All costs in connection with mix designs, making quality tests, transporting test specimens, payment for laboratory testing shall be a Contractor's responsibility and these costs shall be included in the fixed fee portion of the Contract.

13) GROUT:

Grout used in setting machinery and equipment shall consist of a mixture of one sack of cement of one cubic foot of sand to one hundred (100) pounds of Master Builders "Embeco" carefully worked in under the machinery bases in such a manner as to preclude voids or pockets under the metal base. The edges shall be neatly finished to give a neat appearance. Concrete surfaces shall be roughened, cleaned, and soaked before the grout is placed.

SECTION 6

Specifications For

STEEL REINFORCEMENT FOR CONCRETE

ITEM	PAGE
Scope	6-1
Reinforcing Steel	6-1
Wire Reinforcement	6-1
Wire Mesh Reinforcement	6-1
Sampling and Testing	6-2
Shop Drawings	6-3
Bending Reinforcement Steel	6-4
Placing Reinforcement Steel	6-4
Splicing	6-4

SECTION 6

Specifications For

STEEL REINFORCEMENT FOR CONCRETE

1) SCOPE:

The following specifications set forth the requirements for bar, wire, and wire mesh reinforcement.

The reinforcement shall conform accurately to the dimensions and details indicated on the plans or otherwise prescribed. Before being placed in any concrete work, it shall be cleaned thoroughly of all rust, mill scale, mortar, oil, dirt, or coating of any character which would be likely to destroy, reduce, or impair its proper bonding with the concrete.

2) REINFORCING STEEL:

Unless otherwise specified reinforcing steel shall be either Grade 40 or Grade 60 billet steel conforming to ASTM A-615. Varying grades shall not be used interchangeably in structures.

Steel bending processes shall confrom to the requirements of ACI-318.

Bending or straightening shall be accomplished so that the steel will not be damaged. Kinked bars shall not be used.

3) WIRE REINFORCEMENT:

Wire reinforcement shall in all respects fulfull requirements prescribed in ASTM A-82.

4) WIRE MESH REINFORCEMENT:

Mesh reinforcement shall conform to ASTM A-185. The gage of the wire and the dimensions of the mesh will be specified in the Special Provisions or shown on the plans. The wire mesh reinforcement shall be so constructed as to retain its original shape and form during the necessary handling. The effective cross-sectional area of the wire shall be equal to that specified or indicated on the plans.

5) SAMPLING AND TESTING:

No reinforcing steel will be accepted under this specification until it has been approved by the Engineer. Samples shall be taken from bars selected by the Engineer and cut in his presence. The Contractor shall furnish a certified mill test report for each heat or size of steel when required by the Engineer.

A. Steel Bars - Two sample bars, each three feet long and cut from different bars, shall be taken from each bar size delivered to the job site on a cumulative tonnage basis in accordance with the following schedule:

Bar Sizes (Number)	Cumulative Weight of Steel per Bar Size Delivered to Job Site (Tons)
2	1/2
3	1
4	2
5	3
6	4
7	5
8	7
9	9
10	11
11	13
14	20
18	35

Note: At least two sample bars shall be taken from each bar si

Where purchased from a warehouse in small lots, reinforcing may at the direction of the Engineer, be accepted subject to the bending test. Bend test specimens for plain and deformed bars shall be taken from the finished bars, and shall be of the full thickness or diameter of bars as rolled, except that the specimens for deformed bars may be machined for a length of nine inches if deemed necessary by the manufacturer to obtain uniform cross-sections.

The test specimen shall bend cold around a pin without cracking on the outside of the bent portion, as follows:

BEND TEST REQUIREMENTS

Thickness of Diameter of Bars	Plain Bars	Deformed Bars
Under 3/4 inch	180 degrees d = 2t	180 degrees d = 3t
3/4 inch or over	90 degrees d = 2t	90 degrees d = 3t

d = the diameter of pin about which the specimen is bent.
t = the thickness or diameter of the specimen.

B. Wire Reinforcement - One sample consisting to two pieces, each three feet square, shall be taken from each two-ton lot or less of each size of wire delivered to the job site.

C. Wire Mesh Reinforcement - Two samples of a size suitable for testing shall be taken from each 3,000 square feet of fabric or fraction thereof.

6) SHOP DRAWINGS:

The Contractor shall furnish four (4) copies of shop details and placing drawings for all reinforcing steel to the Engineer for approval. After checking, the Engineer will return two marked-up sets of prints of the details and drawings for corrections. The Contractor shall furnish two corrected sets of prints to the Engineer. The Engineer's check of the details will be only for general conformity with the plans and checking of detailed dimensions will be the responsibility of the Contractor. The Engineer's check of the shop drawings will in no way relieve the Contractor from responsibility for furnishing all of the material as required by the plans and specifications. Reinforcing steel shall be detailed in accordance with the Manual of Standard Practice for Detailing Reinforced Concrete Structures published by the American Concrete Institute.

7) BENDING REINFORCEMENT STEEL:

Bending shall be accurately done without the use of heat. The form and dimension of bends shall be in accordance with the "Recomended Sizes" of the American Concrete Institute. Bars having cracks or splits at the ends shall be rejected. Bars of various size and shape shall be clearly and permanently marked so the markings will not be lost or destroyed in handling.

8) PLACING REINFORCEMENT STEEL:

Metal reinforcement, at the time concrete is placed, shall be free from rust, scale or other coating that will reduce the bond. All reinforcement shall be placed in the exact position shown on the plans, and shall be so securely held in position by wiring and other means that it will not be displaced during the depositing and compacting of concrete. Reinforcement shall be supported on metal bolsters and chainrs which shall be spaced as recommended by the American Concerete Institute in their Manual of Standard Practice for Detailing Reinforced Concrete Structures.

9) SPLICING:

Splices of bars shall be made only where shown on the plans or as approved by the Engineer. Where bars are spliced, they shall be lapped at least 30 diameters, unless otherwise shown on the plans.

Splicing shall be accomplished by placing the bars in contact with each other and wiring them together.

Welding of reinforcing steel will not be permitted unless specifically authorized by the Engineer.

Welded wire fabric shall be spliced not less than two meshes. It shall be lifted carefully into its specified position after the concrete is placed but still plastic.

SECTION 7

Specifications For

RIPRAP

ITEM	PAGE
Scope	7-1
Riprap	7-1
Placing Riprap	7-1
Filter Cloth	7-1

SECTION 7

Specifications For

RIPRAP

1) SCOPE: The "Riprap" bid item is provided to cover the Contractor's cost to furnish all labor, materials, tools, equipment, and services necessary to provide and place approved rock or stone where indicated on the plans or as directed by the Engineer.

2) RIPRAP: Riprap shall consist of durable, angular field or quarry stone that is sound, hard, free from seams, cracks or other structural defects. The stones shall be graded so that a reasonable dense mass is obtained. Size and thickness shall be in accordance with the following table.

Class	D_{50}	D_{max}	t
1	1.0'	1.5'	2.5'
2	6.0"	9.0"	8.0"
3	3.0"	4.5"	6.0"

D_{50} = Particle size of gradation, of which 50% of the mixture is smaller.

D_{max} = Maximum particle size

t = riprap blanket thickness

3) PLACING RIPRAP:

The entire mass of stone should be placed in conformance with the lines, grades and thicknesses specified. The riprap should be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing riprap in layers or by dumping into chutes and similar methods likely to cause segregation will not be permitted.

4) FILTER MATERIAL:

Filter material under riprap shall be the Under Drain material listed in these specifications and shall be placed under all riprap to the lines and grades shown on the plans.

SECTION 8

Specification For
PLACING AND FINISHING STRUCTURAL CONCRETE

ITEM	PAGE
Scope	8-1
Forms	8-1
Placing Structural Concrete	8-2
Concrete Finish	8-4
Curing	8-6
Cold Weather Concreting	8-7
Hot Weather Concreting	8-8
Removal of Falcework and Forms	8-9
Miscellaneous	8-9

SECTION 8

Specifications For

PLACING AND FINISHING STRUCTURAL CONCRETE

1) SCOPE:

Structural concrete is defined as all concret, formed or unformed, used in the construction, unless otherwise specifically designated on the plans or in these specifications.

2) FORMS:

A. Types and Erection. The Contractor shall provide suitable forms that conform to the shape, lines, and dimensions of the members as called for on the plans. The forms shall be free from surface defects as shall be sufficiently tight to prevent leakage of mortar. No form shall be used which is not clean and of proper shape and strength, and in every way suitable for the purposes for which it is to be used. Deformed, broken, or defective forms shall be removed from the work. Before placing concrete, the forms shall be cleaned and oiled or coated with other suitable substances, approved by the Engineer, to prevent adherence of the concrete to the form surfaces. Prior to placing concrete forms shall be properly braced or tied together and shall be adequately anchored to prevent deviations from the correct lines and grades.

The Contractor shall have the option of using wood, steel, or manufactured fiber forms approved by the Engineer. All wooden forms shall be built of clean, sound, No. 1 lumber, reasonably free from knots, dressed on all sides, and neatly fitted. Tongue and groove material shall be used and securely fastened by nails, screws, or bolts to ribs or supports. Wooden forms for walls shall be lined with plywood or other smooth-surface-producing lining materials where a finished surface is to be formed.

Forms shall be designed for the loads which will be placed upon them, and shall be solidly braced and anchored to prevent deformation while placing and vibrating concrete. If required, by the Engineer, the Contractor shall submit detailed plans and/or design details of proposed formwork for approval by the Engineer. Steel, plywood, or fiber board forms and braces manufactured off the site shall be used in strict conformance with the designs and specifications of their specific manufacturer.

No forms , falsework, or any part of the work shall be removed without the consent of the Engineer, and the Contractor shall furnish a sufficient number of forms so that the work can be pursued rapidly and without delay in resetting previously used forms. Forms shall be removed in such a manner and at such time as to insure the complete safety of the structure. In no case shall the supporting forms or shoring be removed until the members have acquired sufficient strength (as supported by concrete cylinder test results) to support safely their own weight and weights put upon them. The results of suitable control tests will be used as evidence that the concrete has attained the required strength.

B. Form Ties And Anchors. Forms shall be ridgidly tied together to prevent warping or moving. Only form clamps of a approved pattern utilizing rods that will terminate at least one inch (1") below the faces of the work when the forms are removed will be allowed. Form ties effective water stops shall be used.

Forms shall be firmly anchored against floating when concrete is deposited. Prior to placing any concrete in the forms, the interior of the forms shall be thoroughly cleaned of all loose sawdust, wood pieces, paper, metal scraps, and other debris to the satisfaction of the Engineer. On deep forms, doors or openings will be left in the base or bottom of the forms for this cleaning operation and for placing, vibrating, and inspection purposes.

3) PLACING STRUCTURAL CONCRETE:

The Contractor shall give the Engineer sufficient notice in advance of placing concrete to permit the Engineer to properly inspect the forms and reinforcement. No concrete shall be placed until the forms and reinforcement are approved by the Engineer.

A. General. The method and manner of placing shall be such as to avoid the possibility of segregation or separation of the aggregates or the displacement of the reinforcing steel. Concrete shall be placed in high wall and columns by means of "tremies" or other approved tools which will insure against segregation of the concrete.

The use of long chutes for conveying concrete from the mixing plant to the forms will not be permitted. Depositing of a large quantity of concrete at any point within the forms and running or working it along the forms will not be allowed and every effort will be made to initially place the concrete directly where it is required.

Prior to mixing and placing of the concrete the Contractor shall insure that all equipment such as concrete buggies, chutes, tremies, vibrators, pumps, cranes, ets., necessary for the proper mixing and placing of the concrete are in proper working order and are on the job site.

B. Placing. Concrete shall be placed in the forms immediately after mixing. The method and manner of placing each batch of concrete shall be such as to prevent segregation of the concrete or displacement of the reinforcement or the forms. Steel reinforcement shall not be covered with cement prior to its final embedment.

Concrete shall be deposited in horizontal continuous layers, the thickness of which generally shall not exceed eighteen to twenty inches (18" to 20"). Each layer of concrete shall be placed before the underlying layer has become set and shall be vibrated in a manner that will entirely break up and obliterate the tendency to produce a construction joint between the layers.

All concrete placed in walls or columns in excess of six feet (6') in height shall be spouted, tremied, or otherwise handled so that the actual free fall of the concrete will not exceed six (6) feet.

Sufficient tremies will be required so that the horizontal distance between tremies does not exceed five feet (5'). A sufficient number of tremies shall be furnished at any one time to accomplish the pour without moving any of the tremies.

C. Vibrating And Compacting. Concrete shall be thoroghly vibrated, rammed, tramped, and spaded as may be required to compact the entire mass into a dense, homogeneous structure conforming to the lines and grades shown on the plans.

Vibrators used shall be of an approved type with a vibration frequency of not less than thiry-six hundred (3600) impulses per minute. A sufficient number of vibrators shall be used to secure the compaction of each batch before the next batch is placed without delaying delivery. There will be at least one stand-by vibrator in reserve and ready for service at all times. A full-time operator for each vibrator will be available and without other duties during the placing operations.

Vibrators shall not be pushed rapidly but shall be allowed to work themselves into the concrete mass and must be withdrawn slowly to avoid holes.

The operation of depositing and compacting the concrete shall be so conducted as to form a compact, dense impervious, concrete of uniform texture which shall show smooth faces when forms are removed.

D. Joints. Construction joints shall be allowed at the locations and with the dimensions shown on the plans. If during the process of placing the concrete in the forms there is a breakdown of equipment or a failure of delivery of concrete the Contractor will be required to completely remove that concrete placed in the forms within the appropriate panel and will not be allowed to build an intermediate construction joint.

Any "cold joints" will be considered defective work and the Contractor will be required to completely remove the panel or wall section and replace the work in accordance with the plans and specifications, all at no increase in cost to the Owner.

Bulkheads shall be used in constructing all construction joints other than horizontal.

Shear keys shall be provided in joints as shown on the plans or as may be directed by the Engineer. shear keys when formed into the concrete may be made by the insertion of, and subsequent removal of, a water saturated timber or the specified water stop.

Joints not indicated on the plans but approved by thengineer shall be so made and located as to impair least the strength of the structure. Where a joint is to be made, the surface of the concrete shall be thoroghly cleaned and all laitance removed. In addition, vertical and horizontal joints shall be thoroghly wetted and slushed with a coat of neat cement grout, immediately before placement of new concrete.

4) CONCRETE FINISH:

All concrete surfaces shall be finished in accordance with this specification unless otherwise shown on the plans. Where there is no finish specified and the surface is to be covered with backfill material or otherwise concealed from view, the finish shall be assumed to be wood float finish, unless otherwise directed by the Engineer. The floor panels shall be given a light steel trowel finish to increase the water resistance of the surface of the concrete. No additional troweling or burnishing will be required.

All exposed concrete surfaces cast against plywood-faced forms shall be finished by one of the following:

A. Smooth rubbed finish - Smooth rubbed finish shall be produced on freshly hardened concrete. All necessary patching shall have been done immediately after forms have been removed, and rubbing shall be completed not later than the following day. Surfaces shall be wetted and rubbed with carborundum brick or other abrasive until a uniform color and texture are produced. No cement grout or slush shall be used other than the cement past drawn from the green concrete itself by the rubbing process.

B. Sand floated finish - The forms shall be removed the surface has fully hardened. The surface shall be wetted and rubbed with a wood float by a uniform circular motion, with fine sand being rubbed into the surface until the resulting finish is even and uniform in color and texture.

C. Grout cleaned finish - After the concrete, still freshly hardened, has been predampened, a slurry consisting of 1 part cement (including an appropriate quantity of white cement) and 1 1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Any surplus shall be cured in an approved manner.

Immediately after the forms on the wall panels have been removed, the Contractor shall remove all form bolts and tie wires to a depth of at least one inch (1") below the surface of the concrete. All holes and depressions caused by removal or setting back of form bolts or tie wires shall be cleaned and filled with a Portland Cement mortar composed of one (1) part by volume cement and two (2) parts sand. All rock pockets, honeycomb, and air pockets shall be chipped out, cleaned and filled with mortar, all in compliance with the instructions of the Engineer. If in the judgement of the Engineer, rock pockets are of such an extent or character as to affect the strength or water tightness of the structure or to endanger the life of the steel reinforcement, the Engineer will declare the concrete defective and order the complete removal and replacement of the portion of the structure so affected.

All mortar patches shall be carefully made using a very dry mortar tamped firmly in the void. The patches shall be kept wet for a period of three (3) days after which it will be inspected for shrinkage cracks. Excessive cracking will require complete removal and replacement of the patch.

The care and attention given to form work will have a direct

effect upon the amount of work to be performed on concrete surfaces after the forms have been removed. The Engineer shall judge the acceptibility of the finished concrete surfaces and if a surface needs additional work, the Contractor shall perform this work in accordance with the Engineer's instructions, all at no additional cost to the Owner.

5) CURING:

Fresh concrete shall be adequately protected from weather damage and mechanical injury throughout the entire curing period. Curing processes described herein are for the guidance of the Contractor only. Other curing processes may be used at the option of the Contractor provided proposed curing processes meet with the complete approval of the Engineer. Whatever the curing process chosen by the Contractor, it will be started as quickly as possible after pouring without causing injury to the concrete surface.

The curing period for this project may be considered to be a minimum of seven (7) days or longer as may be determined by the strength tests of the concrete and the observations of the Engineer. The first seventy-two (72) hours shall be considered critical and special precautions will be taken to protect the concrete from excessive drying or radical temperature changes during this period. Also during the remaining four (4) days of the curing period, care will be exercised to protect the concrete from direct rays of the sun, excessive temperature change, and evaporation. Alternate wetting and drying of the concrete will not be allowed during these first seven (7) days.

The following curing procedures are suggested for the guidance of the Contractor. The Contractor has the option of using the curing processes described below or of a different process of his own development. However, the curing processes used must meet with the complete approval of the Engineer.

A. Floor Slabs. Floor slabs shall be cured by wet burlap, cotton mats, or visqueen covers placed on the finished surface immediately after the finishing operation has been completed. Surface areas under the visqueen shall be kept wet at all times. The burlap or cotton mats shall be kept completely saturated by sprinkling. No alternate wetting and drying of the burlap or the conctrete surface will be allowed. Floors with drains shall be properly sloped toward the drain.

B. Walls And Roofs. The Contractor will be required to leave the

forms on the vertical walls for a period of not less than thirty-six (36) hours after the concrete is placed. Inside walls will be cured by use of a commercial chlorinated rubber curing compound applied immediately upon the removal of the forms or a satisfactory alternate method of curing will be with wet burlap or cotton mats which shall be kept saturated by sprinkling for the entire curing period of seven (7) days. Roof slabs shall be cured the same as floor slabs.

Upon the removal of the outside wallforms, the tie rod patches will be made, where exterior walls are to be waterproofed the entire surface shall be given a coating of a curing compound consisting of two coats of asphalt emulsion* painted on the entire surface. Asphalt emulsion* shall be of a type approved by the Engineer and will be applied in such a manner as to furnish a completely watertight surface. Only those alternate curing solutions proposed for the outside wall which will furnish a completely watertight membrance and a heat reflective surface will be considered as alternates. The preceding application is for the area of outside walls which will have backfill placed against the wall. Exposed areas shall be rubbed and stoned for a smooth finish and a rubber curing compound applied immediately.

6) COLD WEATHER CONCRETING:

During extreme weather season, placing of concrete will be permitted only under the following conditions:

A. Temperature Control. The temperature of the concrete placed in the forms shall not be less than 60° F., nor more than 100° F. To maintain this temperature range, the Contractor shall provide acceptable heating apparatus for heating the aggregates and the water.

B. Concrete may be placed when the air temperature in the shade, is 40° F., and rising. No concrete shall be placed, regardless of present temperature when the weather forecast promises freezing weather before final set of the concrete unless special means of heating and protection are used. Protection against freezing of the concrete is a Contractor's responsibility regardless of the weather forecast or climate conditions at the time of placing the concrete.

---

* Emulsified Asphalt shall be Laykold Emulsion available through Denver Industrial Sales, Inc. Alternates shall meet the American Bitumuls and Asphalt Specification No. LW-1.

C. Concrete placed in cold weather shall be protected from extreme temperatures as followes:

1) The concrete shall be kept at a temperature of at least 50° F., for the first seventy-two (72) hours.

2) After the first seventy-two (72) hours and until the concrete is seven (7) days old, the concrete shall be kept at a temperature of at least 40° F.

3) Concrete adjacent to heaters or salamanders shall be insulated from direct heat of the unit which may dry it out prior to being properly cured.

4) Temperatures shall be measured by maximum and minimun thermometers furnished by the Contractor and installed adjacent to the concrete as directed by the Engineer.

5) Non-porous insulated mats of a type approved by the Engineer may be used provided they maintain the temperature requirements cited herein.

D. Concrete slabs shall not be placed regardless of the temperature conditions if the supporting ground is frozen of contains frost.

E. The use of salt or other additives to prevent the concrete from freezing will not be allowed.

F. Concrete which has been frozen shall be completely removed and replaced as directed by and to the satisfaction of the Engineer, all at no added cost to the Owner.

7) HOT WEATHER CONCRETING:

During extremely hot weather seasons placing of concrete will be permitted only under the following conditions:

A. Temperature Control. The temperature of the concrete as placed in the forms shall not be more than 100° F. To maintain this temperature range it may be necessary to cool the mixing water by the additon of ice.

B. When the air tmeperature is 90° F. or above, concrete may be placed in the forms only with the following protective measures:

1) All forms, reinforcing steel and the supporting earth shall

be wetted down immediately prior to placing concrete in the forms.

2) All slab concrete shall be shaded form the direct rays of the sun until such time as the finishing operations have been completed and the curing compound is in place.

3) After the concrete is in the forms in vertical walls and columns the forms shall be intermittently sprinkled with water to reduce the temperature of the concrete and forms by evaporation.

4) A three inch (3"0 mat of earth convering roof slabs shall be kept saturated throughout the entire curing period and shall be kept wet during all hot weather periods in order to maintain the temperature of the roof slab within the specified limits.

8) REMOVAL OF FALSEWORK AND FORMS:

Falsework supporting any concrete work shall not be removed or wedges loosened without the consent of the Engineer. In general, side forms of other non-load-carrying forms may be removed after thirty-six (36) hours to allow finishing in accordance with these specifications. Load-carrying forms or falsework shall not be removed until after the concrete has set for seven (7) days. Forms under roof slabs shall not be removed until all construction activity on top of the newly placed concrete has been completed or until the concrete has set for twenty-eight (28) days excepting for placement of earth cover.

9) MISCELLANEOUS:

A. Chamfer. All forms shall be filleted at all sharp corners which will be exposed to public view, unless otherwise directed by the Engineer. Triangular moldings used for fillets shall have two equal sides.

B. Concrete Floor Slab Finishes.

1) Concrete slabs in floors shall be finished true to line and grade as shown on the plans.

2) Screed shall be set as required to produce the grade for the concrete in place.

3) After the concrete has been screeded off and has set up sufficiently to support a man's wieght, it shall be given an immediate steel trowel finish or a machine trowel finish.

4) No additonal hand troweling or burnishing will be required nor will a hardening or dustproofing treatment be required on floor slabs.

C. Concrete Roof Slab Finishes.

1) Concrete roof slabs shall be finished true to line and grade as shown on the plans.

2) Screeds shall be set as required to produce the required grade before the concrete is placed.

3) After the concrete has been screeded off and has set up sufficiently to support a man's weight, it shall be given an immediate wood float finish. This is a final finish for the roof slabs.

D. Straight Edge. An approved standard metal ten foot straight edge shall be available at the construction site at all times.

SECTION 9

Specifications for
CLEARING AND GRUBBING

ITEM	PAGE
Description	9-1
Construction Requirements	9-1

SECTION 9

Specifications for

CLEARING AND GRUBBING

1) Description: This work shall consist of clearing, grubbing, removing and disposing of all trees, vegetation and debris within the limits occupied by the construction and other areas designated on the plans and/or in the Special Provisions. This work shall also include the preservation from injury or defacement of all trees, vegetation and objects other than those designated for clearing.

2) Construction Requirements:

The Engineer will establish clearing lines between which the ground shall be cleared of all trees, stumps, brush, weeds, roots, and other objectionable material within the limits of the construction as shown on the plans or as directed. Timber of any value, which it may be necessary to cut, may be used or disposed of by the Contractor. All branches of trees close enough to the work to be considered an obstruction shall be carefully removed. All trees, stumps, roots, etc. shall be cut off, excavated, or removed to a depth of not less than 3 feet below the subgrade or embankment slopes, except under no condition shall said trees, stumps, roots, etc. be cut off and left more than one foot above the ground surface. The Contractor shall burn or otherwise dispose of all trees, stumps, brush, weeds, roots, sod, etc., in a satisfactory manner; and shall remove all rubbish and refuse. All excavations made by the removal of trees, stumps, etc., shall be filled with suitable material, which shall be compacted so as to make the surface at these points conform in contour and density to that of the surrounding ground.

If perishable material is burned, it shall be burned under the constant care of competent watchmen at such times and in such a manner that anything designated to remain on the construction site, the surrounding forest cover or other adjacent property will not be jeopardized. Burning shall be done in accordance with applicable laws and ordinances.

Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

SECTION 10

Specifications for
REMOVAL OF STRUCTURES AND OBSTRUCTIONS

ITEM	PAGE
Description	10-1
Construction Requirements	10-1

SECTION 10

Specifications for

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

1) Description: This work shall consist of the removal, wholly or in part, and satisfactory disposal of all structures and obstructions on the site including buildings, basements, foundations, bridges, culverts, fences, guard rail, pavements, and debris. It shall also include the salvaging of designated material and backfilling the resulting holes and pits.

All material removed, except that owned by and disposed of by utilities, unless otherwise provided, shall become the property of the Contractor and shall be disposed of in a satisfactory manner.

2) Construction Requirements:

The structures shown on the plans or listed in the special provisions shall be moved or demolished including all other incidental structures and obstructions, and all the material shall be removed and disposed of in a satisfactory manner.

No demolition or removal of any structure shall proceed until clearance is obtained from the Engineer.

The holes left by the removal of the structure shall be filled with granular material and compacted to at least the relative density of the surrounding ground, unless further excavation is needed to install new structures of facilities.

SECTION 11

Specifications for
EXCAVATION

ITEM	PAGE
Description	11-1
Construction Requirements	11-1
Selected Materials	11-2

SECTION 11

Specifications for

EXCAVATION

1) Description: This work shall consist of excavation and disposal of all material not being removed under some other item which is encountered within the construction limits and areas necessary for the construction of the dam and sediment pond in accordance with the specifications and plans or as directed by the Engineer. The work shall include ditches and channels and placing the material in the embankment in the locations and to the elevations and typical sections shown on the plan and placing the material at such locations established by the Engineer.

If directed, cuts shall be widened to obtain addtional material to replace "Borrow". Excavation shall not include small ditch excavation, surface ditches, and excavation for structures.

2) Construction Requirements:

The excavation for the dam, channels, pond, and access road shall be finished to the lines, grades, and typical sections shown on the plans, or as directed. No materials shall be wasted without permission of the Engineer. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed, unless otherwise directed.

The construction site shall be maintained in such condition that the work shall be well drained at all time, including periods of work suspension.

Rock cut slopes shall be scaled of all loose rocks and fragments, and left in a neat, safe, and workmanlike condition. Excess material created by trimming of slopes shall be used for widening embankments or disposed of as directed.

Excessive blasting will not be permitted. Any material outside the authorized cross section which may be shattered or loosened because of blasting shall be removed by the Contractor at his expense.

Unless otherwise specified, material classified as rock shall be excavated to a minimum depth of 6 inches below grade within the limits of the cut, and the excavation backfilled with material designated on the plans or approved by the Engineer and compacted. Care shall be taken that undrained pockets shall not be left in the surface of the rock. The backfilling and compacting of this depth in excess of 6 inches with material designated on the plans or approved by the Engineer will be at the expense of the Contractor.

When the Contractor's excavatigg operations encounter material of historical, archeological or palentological significance, the operation in that vicinity shall be temporarily discontinued. The Engineer will contact archeological authorities to determine the disposition thereof. When directed by the Engineer, the Contractor shall excavate the site in such a manner as to preserve the materials encountered and shall remove them for delivery to the custody of the proper State authorities.

3) Selected Material:

When ordered by the Engineer, suitable granular material or riprap encountered in excavation shall be used in constructing the top layer or layers of embankment for finishing the embankment or for backfill. When practicable, selected material shall be hauled directly from excavation to the final position on the site.

SECTION 12

Specifications for
BORROW, GRANULAR BORROW AND GRANULAR BACKFILL BORROW

ITEM	PAGE
Description	12-1
Material	12-1
Construction Methods	12-1

SECTION 12

Specifications for

BORROW, GRANULAR BORROW AND GRANULAR BACKFILL BORROW

1) Description: This work shall consist of furnishing material obtained outside the construction site or use in the construction of the embankment, backfill or for other portions of the work.

2) Material: The securement and use of borrow sources shall comply with the special provisions.

A. Borrow: Borrow shall consist of material conforming to Classifications A-1-a through A-$ AASHTO Designation M-145. Material shall be a practically imperyious, with a coefficient of permeability less than $K=10^{-4}$. The unit weight at optimum compaction shall be greater than 120 lb/ft^3 and the void ratio "e", less than .35. The California Bearing Ratio for the material (CBR) should be greater than 25. The material should be well graded for stability. No rock materials greater than 10" will be allowed in the borrow. No more than 5% of the borrdw material shall be retained on a 1" screen.

B. Granular Borrow: Granular borrow, when specified, shall consist of material conforming to Classification A-1-a, A-1-b, A-2-4, or A-3 of AASHTO Designation M-145. The material shall meet the design CBR or R value, a requirement for suitability of source and not for project control testing.

C. Granular Backfill Borrow: Granular backfill borrow shall conform to the requirements of A-1 Classification of granular materials of AASHTO Designation M-145 modified so as to limit the maximum size to 2 inches and be well graded.

3) Construction Methods:

The Contractor shall notify the Engineer sufficiently in advance of work, of the location of the borrow source so that samples may be taken and the material tested, if necessary, before being used. Clearing out of vegetation and stripping of unsatisfactory material from the pit or blending of materials when required, shall be performed by the Contractor. When there is a choice in quality of materials in the borrow source, the best material, when directed, shall be used. Borrow material shall be placed in the embankment and used for backfill as provided in specifications and on the plans.

Borrow material shall not be placed until after the excavation has been placed, unless approved by the Engineer. If the Contractor places more borrow than is required and thereby causes a waste of excavation, the amount of such waste will be deducted from the borrow volume or otherwise suitable recompensated to the owner.

SECTION 13

Specifications For
EMBANKMENT AND BACKFILL

ITEM	PAGE
Description	13-1
Construction Requirements	13-1
Backfill	13-3

SECTION 13

Specifications for

EMBANKMENT AND BACKFILL

1) Description: This item shall consist of constructing and compacting embankments and backfill in accordance with the typical section, plans and these specifications to the designed subgrade elevation, including preparation of the areas upon which they are to be placed; the construction of dikes within or outside the site; the placing and compacting of approved material within embankment areas where unsuitable material has been removed and in holes, pits and other depressions within the construction area.

2) Construction Requirements:

All foundations for embankments shall be reasonably free from organic material such as leaves, grass or roots. If the foundation is of such nature that it would impair the stability of the embankment, the unsuitable material shall be removed to the required width and depth and shall be disposed of as directed. No embankment material shall be placed until the foundation has been approved by the Engineer.

When the top layer of the ground underlying the proposed embankment is of loose material and the embankment height is less than 6 feet, the top 8 inches shall be moistened, processed and compacted to not less than 5 percent of maximum laboratory density.

Embankments and backfill shall be compacted to the density required in the Compaction Specification.

Where embankments are to be constructed across soft, springy or wet ground, an initial layer of material shall be placed to provide a minimum working platform for construction equipment. Consolidation of the initial layer may be accomplished by uniformly routing construction equipment over the entire layer. Density control shall only be applied to embankment placed above the initial layer.

The Contractor shall be responsible for the stability of all constructed embankments and shall replace any portions which have become displaced due to careless or negligent work on the part of the Contractor, or to damage resulting from natural causes, such as storms, and not attributed to the unavoidable movement of the natural ground upon which the embankment is made or to design deficiencies.

Whenever the site of an embankment is covered with snow of sufficient depth to impair the quality of the embankment, the

snow must be removed and deposited beyond the slope stakes. If the top layer of the embankment becomes frozen or if frozen material is delivered to the fill, operations shall be suspended until conditions are favorable for proper compaction.

Proper precautions shall be taken to insure that embankment construction does not move, damage, endanger, or cause undue strain or stress to any structure.

Except for rock fills and as otherwise provided, embankment materials shall be placed in layers not exceeding 12 inches (uncompacted depth) and shall be compacted before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density. Compacting equipment which causes shear failures in the embankment shall not be used.

Embankment material containing by volume approximately 25 percent or more of rock too large to be compacted in layers 12 inches thick shall not be used. The larger rock shall be well distributed and sufficient earth or other fine material shall be incorporated with the course rock as it is deposited in order to fill the interstices and to provide a dense, solid embankment. Each layer shall be compacted uniformly over the entire width.

The lifts of rock shall not be constructed above an elevation of 1 foot below the subgrade. The balance of the embankment shall be composed of suitable fine material placed in layers, smoothed and compacted.

When rock material is used in embankment construction, no fragments having a vertical dimension greater than 10" will be permitted. The rock shall be distributed and manipulated so that adequate space is provided for the proper placing and compacting of embankment material between the fragments in horizontal layers as specified elsewhere in the specifications.

At the time of compaction, the moisture of embankment material shall be such that the specified compaction will be obtained.

Embankment construction shall be maintained in such condition that it will be well drained at all times. During periods of work suspension, the Contractor shall open drainage culverts and ditches and take every precaution to prevent damage.

Where embankments are to be placed on a hillside, or against an existing embankment, the hillside or existing embankment shall be terraced to prevent slipping. The terraces shall be large enough for equipment to work and shall be as close together as the slopes of the original material will permit. The material thus excavated shall be used in the embankment.

3) Backfill: All backfilling and embankment construction adjacent to piers, abutments including spill through abutments, culverts, wing walls, retaining walls, pipe trenches under embankments, and other structures, and all other areas of backfill and embankments inaccessible to roller equipment, shall be properly moistened and compacted in successive 6 inch (loose measurement) courses or layers by means of mechanical tamping devices approved by the Engineer to the density required in Section 15. Limited tamping shall be made, as directed by the Engineer, immediately adjacent to bridge abutments, wing walls, and retaining walls. The rate of placing backfill materials shall at all times be coordinated with tamping operations so that the required compaction is obtained. Excessive water in backfill material or jetting will not be permitted. Filling shall not be placed against green concrete and wedging action against walls or abutments shall be prevented by stepping or serrating the sides of excavation. Where material from structural excavation is unsuitable for backfilling purposes, or if the amount of backfill quantities are in excess of the structural excavation quantities, the Contractor will be required to furnish and place suitable material obtained from other sources.

Filling and compaction adjacent to frame structures and pipe culverts shall proceed upward simultaneously at each side of the structure. The closing pour of concrete for frame structures shall have been completed at least seven days before backfilling.

Backfilling around pipe culverts and other conduits in a trench shall consist of granular or other fine, readily compactable material which shall not contain rock larger than 2 inches in size, frozen lumps, clay or other objectionable material and shall be noncorrosive.

When the top of the pipe is exposed above the top of the trench, embankment material shall be placed and compacted by mechanical tamping as above specified for a width on each side of the pipe equal to at least twice the horizontal inside diameter of the pipe or 3 feet, whichever is less. The embankment material within this distance and 1 foot over the top, shall be of the same material as specified above for trench backfill. The remainder of the adjacent side fill may be regular embankment material and if feasible, without damage to the culvert, can be compacted by power equipment.

The adjacent side fill shall be placed and compacted to a minimum width of two diameters of the pipe or 12 feet, whichever is less, prior to use by traffic or construction equipment.

SECTION 14

Specifications For
WATERING

ITEM	PAGE
Description	14-1
Materials	14-1
Construction Requirements	14-1
Equipment	14-1

SECTION 14

Specifications For

WATERING

1) Description: Watering shall consist of furnishing and applying water for the wetting or prewetting of embankment materials, base courses, gravel surface courses, sub-grade, dust control, haul road and detour maintenance as may be required in the specifications or as directed by the Engineer.

2) Materials: The Contractor shall make all necessary arrangements for obtaining water. Onsite water may be available.

3) Construction Requirements:

Water, when required, shall be applied at the locations, in the amounts and at any hour of the day or night and on any day of the week that the Engineer may determine as necessary. The water may be hauled in tank or applied by a pipeline system. Water added during finishing operations shall be uniformly applied.

4) Equipment: Mobile sprinkling equipment shall consist of water-tight tanks.

Equipment used for dust control and finishing operations of subgrade and surfaces shall be adequately powered and equipped with a pressure pump. Adjustable spray heads, front or rear, and spray bar shall provide uniform and controlled application of water without ponding or washing. Positive control of water from the driver's position is required.

An approved pressure pipeline hose nozzle or sprinkling system may be used for applying water in embankment construction or to moisten material before excavation.

The Contractor shall provide sufficient equipment to apply water as directed. Insufficient or inadequate watering equipment shall be cause for closing down those operations affected by such until the Contractor makes proper remedy of the deficiency.

SECTION 15

Specifications For
CONPACTION AND BACKFILL COMPACTION

ITEM	PAGE
Description	15-1
Density Requirements	15-1

SECTION 15

Specifications For

COMPACTION AND BACKFILL COMPACTION

1) Description: This item shall consist of compacting of the required density, embankments, dikes, backfill, and other designated material placed in the manner prescribed in Section 13 including compaction of areas through cuts and, when directed, the natural ground upon which fills are to be placed.

2) Density Requirements:

Acceptance of the subgrade and embankment with respect to density shall be based on the average density of all density determinations made in lot. A lot shall equal the number of tons or cubic yards of embankment placed and compacted each production day. A test lot shall be divided into sublots of approximately 1,000 tons or 500 cubic yards. One density test shall be taken within each sublot. The locations of test sites within a sublot shall be chosen on a random basis through the use of a suitable random number table. The in-place field density may be determined by use of sand core or nuclear densometer.

A test lot shall be accepted when the average of the density determinations is not less than 95 percent of maximum laboratory density and when no determination is lower than 92 percent of maximum laboratory density. The maximum laboratory density shall be determined in accordance with AASHTO Designation T-180, Method D for A-1 soils and AASHTO Designation T-99 Method D for all other soils.

A test area for backfill at pipes and structures shall not exceed 200 cubic yards of material or be more than one pipe or structure. Acceptance shall be based on average of two density determinations and the test area shall be accepted when the average density is 95 percent of maximum laboratory density and when no determination is below 92 percent.

Test lots or test areas that do not meet these density requirements shall be brought into compliance by additional rolling or tamping as directed by the Engineer.

SECTION 16

Specifications for
UNDERDRAINS AND UNDERDRAIN GRANULAR BACKFILL

ITEM	PAGE
Description	16-1
Materials	16-1
Underdrain Granular Backfill	16-1
Construction Methods	16-1
Alternate Materials	16-2

SECTION 16

Specifications for

UNDERDRAINS AND UNDERDRAIN GRANULAR BACKFILL

1) DESCRIPTION: This item shall consist of furnishing and placing pipe underdrains, at the location shwon on the plans or as directed by the Engineer, to the lines and grades specified, with a granular backfill around the pipe.

2) MATERIALS: The pipe shall consist of one of the following types, except when a specified type is designated on the plans or in the bid proposal.

A. Corrugated Metal Underdrain Pipe.

B. Perforated Clay Pipe.

C. Perforated Concrete Underdrain.

D. Perforated PVC.

3) UNDERDRAIN GRANULAR BACKFILL:

Underdrain granular backfill shall consist of hard, durable, and tough fragments of screened or broken stone, gravel, or slag conforming to one of the following gradations:

Sieve Size Sieve Size	Type A Percent	Type B Passing
1½ Inch	100	100
1½ Inch	80-100	50-80
½ Inch	55-75	30-65
No. 4	30-60	30-65
No. 40	10-25	10-30
No. 200	0-3	0-3

4) CONSTRUCTION METHODS:

Trenches for underdrains shall be excavated to a depth of at least 3 inches below the grade established for the bottom of the pipe, and to a width of 2 feet plus the outside diameter of the pipe. The lower portion of the trench shall be filled with granular backfill, thoroughly tamped in place, so that after compaction the top of the filling shall be at the elevation established for the bottom of the pipe. The pipe shall then be placed, and the trench filled with granular backfill to a point at least 12 inches above the top of the pipe but not less than 12 inches below the finished ground surface, or to such elevation as shown on the plans or as directed by the Engineer.

If pipe is placed under a roadway or other compacted embankment, backfill material shall be thoroughly tamped in layers not to exceed 6 inches in thickness by means of mechanical rammers or heavy iron tampers. Each layer shall be mointened if directed by the Engineer.

The pipe shall be laid reasonably close to the line and grade specified. Any pipe out of line shall be relaid at the Contractor's expense.

The separate sections of the metal pipe shall be rigidly connected with connecting bands and shall be laid with the perforations toward the bottom and performations on each side a uniform distance from bottom.

Clay or concrete pipe shall be laid with the bell or groove end up grade with the ends fully entered.

5) ALTERNATE MATERIALS:

Other material may be used, upon approval of the Engineer, if the material is reasonably well graded granular material, not exceeding 2 inches in diameter, non plastic and free from excessive amounts of fine grained materials. A gradation or gradations as required must be submitted to the Engineer for approval prior to use of the material.

SECTION 17

Specifications for
SURFACE DITCHES

ITEM	PAGE
Description	17-1
Construction	17-1

SECTION 17

Specifications for

SURFACE DITCHES

1) DESCRIPTION: This item consists of the construction of surface ditches in accordance with these specifications and where shown on the plans or as directed. Surface ditches shall include ditches beyond the roadway limits constructed to intercept and dispose of surface water. The ditch, unless otherwise specified, shall be "V" shaped, excavated at least 1 foot deep and 3 feet across the top.

2) CONSTRUCTION METHODS:

"Surface Ditches" may be formed by a grader or other approved means along the natural slope or contour of the ground. The excavated material shall be placed on the downhill side. The berm shall be neat in appearance and left in a workmanlike manner. When directed the ditch and berm shall be shaped to permit mowing.

SECTION 18

Specifications for
TOPSOIL

ITEM	PAGE
Description	18-1
Materials	18-1
Construction Methods	18-1
Stockpiling	18-1
Spreading	18-1

SECTION 18

Specifications for

TOPSOIL

1) Description: This item shall consist of furnishing, stripping, stockpiling, spreading topsoil or a combination thereof.

2) Materials: Topsoil shall be of a quality normal to the area or as designated on the plans. The topsoil shall be free of large rock, stiff clay, trash and other deleterious materials. If intermixed vegetation is designated, all plant material, except large tree and shrub parts, shall be excavated and spread with the topsoil, otherwise the topsoil shall be relatively free of vegetation.

3) Construction Methods:

Topsoil shall not be handled or worked when the soil is so wet that it will become puddled or the soil structure destroyed.

4) Stockpiling: This work shall consist of placing topsoil in a stockpile for storage. The location of the stockpiles shall be determined or approved by the Engineer.

5) Spreading: This work shall consist of spreading the topsoil over the designated slopes and areas to the specified depth.

Before the topsoil is spread, the surface on which it is to be placed shall be brought to the required section and cleared of all trash, debris, weeds and large rocks. If the ground has a hard smooth surface, it shall be loosened. After the topsoil is spread, all objectionable material shall be removed.

SECTION 19

Specifications for
SEEDING

ITEM	PAGE
Description	19-1
Materials	19-1
Seeding Time	19-1
Areas to be Seeded	19-1
Seed Bed Preparation	19-2
Methods of Seeding	19-2
Fertilizer	19-3

SECTION 19

Specifications for

SEEDING

1) Description: This item shall consist of furnishing seed, commercial fertilizer (when specified) and placing in areas designated in the plans or as directed by the Engineer.

2) Materials

A. Seed: Seed shall be of the species and variety specified in the seeding schedule on the plans, and shall meet all requirements of the "Utah Seed Law." Wet, moldy, or otherwise damaged seed shall not be accepted.

If a variety of seed specified is not available at the time of seeding, the "A" substitute as designated on the plans of that variety may be used. If the "A" substitute is not available, the "B" substitute may be used.

The Contractor shall obtain written approval from the Engineer before making a substitution. To obtain this approval, the Contractor shall submit signed statements from three recognized seed vendors, that the specified variety of seed is not available.

If there are not substitute varieties of seed given, the substitutes, if needed, will be determined by the Engineer.

B. Spreader Material: Seed spreader material shall be a commercial grade of rice hulls that have been prepared for this purpose. It shall be used when designated in the plans.

C. Commercial Fertilizer: Commercial fertilizer shall have a guaranteed chemical analysis as required in the fertilizer schedule on the plans. The amount listed in the schedule will be the amount of each chemical required in pounds per acre. The fertilizer shall meet any requirement as to form, type or condition listed in the plans.

3) Seeding Time: All seeding shall be done between September 1st and April 1st. If the seeding is not completed by April 1st, all remaining seeding and necessary related work shall be suspended until the following September 1st.

The Contractor shall do necessary finish grading and cleanup on as much of the project as possible as work progresses so as to permit all possible seeding during each seeding period.

4) Areas to be Seeded:

All areas to be seeded shall be as shown on the plans, or as determined by the Engineer. Areas that will not support plant growth shall not be seeded.

5) Seed Bed Preparation:

Unnatural mounds and ridges of earth shall be graded out along with other grading necessary to perform seeding operations.

Trash and debris shall be removed. Rocks and wood materials that will prevent seeding operations or may be a hazard shall be removed. In areas subject to mowing, any rocks or vegetation that will inhibit this operation shall be removed.

Ground surface that is compacted hard enough to prevent drill penetration shall be loosened at least 4 inches deep. In areas to be seeded by Method "B" any hard smooth surface shall be scarified to create a rough loose surface.

If the soil is in a loose powder dust condition, it shall be settled by artificial or natural watering before seeding.

6) Methods of Seeding:

Seeding shall be accomplished by the following Methods:

Method A - Drilling: Drilling in clay, silt and other type soils that have good cohesion qualities shall be done with a deep-furrow type drill which will leave a furrow at least 1½ inches deep. Drilling in sand and other soils that have poor cohesion qualities shall be done with a grain drill that can be controlled at a depth of approximately 1 inch below ground surface. Row spacing on all drills shall be no more than 9 inches. This method shall be used in areas where drill equipment can be operated. Small areas around obstructions, along ditches and other areas that the drill misses shall be seeded by Method B. Each area less than 1,000 square feet, shall be included with the measurement for Method A, if bid separately. If so directed, the drill seed box shall be divided so that different seed varieties can be seeded separately in various drill rows.

Method B - Broadcasting and Harrowing: Under this method, seed shall be applied by hydroseeder, cyclone seeder, by hand, or other approved method that will provide an even distribution of seed. After the seed has been placed, a contour-type harrow, spiked-type roller, or rake shall be used to work the ground to provide soil cover.

Method C: Seed shall be applied by hydroseeder, by cyclone seeder, by hand, or other approved method that will provide an even distribution of seed. The Contractor shall not be required to harrow or rake the seed into the soil.

The amount of seed to be used per acre shall be listed in a seeding schedule on the plans. The seed quantities listed are on the basis of live seed.

The total pounds of seed required per acre shall be determined by formula:

$$\text{Total seed} = \frac{\text{Pounds live seed required}}{\text{Percent purity x percent germination}}$$

7) Fertilizer: Commercial fertilizer shall be applied on all areas to be seeded at the rates per acre designated in the plans.

Fertilizer shall be spread at the time of seeding, at a later date or both as directed. When fertilizer is spread at the time of seeding, it shall be spread separate from the seed and just prior to seeding, except it may be spread with the seed when a hydroseeder is used.

The fertilizer may be spread by any method that will give an even distribution.

SECTION 20

Specifications for
MULCHING

ITEM	PAGE
Description	20-1
Materials	20-1
Areas to be Mulched	20-1

SECTION 20

Specifications for

MULCHING

1) Description: This item consists of furnishing and applying mulch material of the type and quantity as shown on the plans or as directed by the Engineer.

2) Materials: Type A Straw or Hay: The mulch material shall be clean cereal straw or grass hay, in that order or preference. Chopped or ground material is not acceptable. Straw and hay shall be air dry material having moisture content of 18 percent or less. The moisture content shall be determined by drying representative samples to constant weight of 220° F. and moisture above 18 percent shall not be included as part of the total tons of straw or hay required per acre. All straw shall be free of noxious weeds as certified by the local inspector of the State Department of Agriculture.

Type B Wood Fiber: This material shall consist of wood fiber that has been processed in such a way that it will contain no germination or growth inhibiting factors. It shall have been manufactured in such a manner that after application it will form a blotter-like ground cover. The fiber mulch material shall be air dry and shall contain no more than 15 percent moisture by weight. The suppliers shall certify that their product meets the foregoing requirements.

3) Areas to be Mulched:

All areas that have been seeded by Methods "B" and "C" and other areas shown on the plans shall be mulched unless otherwise specified or directed.

A. Time of Applying Mulch: Mulch shall be applied within seventy-two hours after seeding. If weather or other conditions might adversely affect the seeded area or the mulching operation the Engineer may require mulching before the seventy-two hour limit.

B. Mulching - Type A: Straw or hay mulch shall be applied at the rate of 1½ tons per acre. The straw of hay shall be pushed into the soil with a sheep's foot roller, a dull edged disk-type roller or other equipment that will anchor a portion of the material in the soil.

Mulch shall be applied by a blower-type mulching machine or by other approved methods. Mulch shall be applied beginning at the top of the slope and working generally downward. On cut slopes, the mulch shall extend a short distance over the top of the slope and tie in with existing vegetation if possible.

C. Mulching - Type B: Wood fiber mulch shall be applied at the rate of 3/4 ton air dry weight per acre.

The mulch shall be suspended in water to form a slurry-type material and shall be sprayed evenly over the area where it is applied.

SECTION 21

Specifications for
FINAL CLEANUP

ITEM	PAGE
Description	21-1
Construction Methods	21-1

SECTION 21

Specifications for

FINAL CLEANUP

1) DESCRIPTION: This work shall consist of shaping, finishing, and cleaning the entire area under construction.

2) CONSTRUCTION METHODS:

The construction site including shoulders, slopes, ditches, and borrow pits shall be smoothly trimmed, and shaped by machinery, or other satisfactory methods, to the lines, grades and cross-sections, as established, and shall be so maintained until accepted. The use of any equipment not equipped with pneumatic tires will be prohibited on bituminous surface. Small ridges or depressions in the side slopes of embankment not exceeding three inches paralleling the center line of the embankment, left in the regular operations of grader or other machinery overlaps will be accepted as a neat and workmanlike finish, except undercutting of lower portions of earth cut slopes shall not be permitted. All ditches and channels shall be cleared of all debris and obstructions. Any excess earth or other waste material adjacent to structures, poles, trees, or other objects shall be removed or otherwise disposed of as directed. All loose boulders or rocks that protrude more than 3 inches above the ground surface on fill slopes and cut slopes, shall be removed and hauled into depressions and covered, placed along embankment slopes where they extend into creek or river channels, or otherwise disposed of in a manner satisfactor to the Engineer except that on slopes steeper than 3:1 where the natural material is composed mainly of rock or large stones the cleanup of rocks will not be required. Where a fill slope is made from a solid rock excavation or large stones, if directed, suitable fine material shall be obtained from excavation or borrow and used as a cover on the slopes. Solid stones on embankment slopes may be left in place without cover when embankment slopes are on a grade of two to one or steeper. On cut slopes, except where 4:1 or flatter cut slopes are designated, solid ledge stones and partly buried soulders appearing to be one-third cubic yard or more in volume may be left in place. Overhanging rocks shall not be permitted.

Roots, trash, and other debris shall be disposed of as directed and the entire construction site placed in a neat and presentable condition.

SECTION 22

Specifications For
MISC. MATERIALS AND SMALL STRUCTURES

ITEM	PAGE
Ductile Iron Pipe	22-1
Telescoping Valve for Concrete Sedimentation Basin	22-1
Misc. Structures	22-1
Energy Dissapaters	22-1

SECTION 22

Specifications For

MISC. MATERIALS AND SMALL STRUCTURES

1) DUCTILE IRON PIPE:

A. General: This standard covers ductile iron pipe centrifically cast in metal molds, or sand lined molds for water or other liquids.

B. Ductile Iron Pressure Pipe: Ductile iron pipe, where designated, shall be centrifically cast, ductile iron Class 2, rated for 350 psi at 5 foot depth of cover. Ductile iron pipe shall conform to all requirements of AWWA Specifications C-151-65 for centrifugal spum ductile iron pipe, and shall have a half thickness cement liner conforming to ASA A21.4, AWWA C104 of latest revision. Required end connectors, glands, gaskets, bolts, and nuts shall be furnished. Pipe shall be coated with bituminous coal tar base, approximately 1 mil thick. The nominal laying length of the pipe shall be 18 feet. Mechanical joints shall conform to AWWA specifications C 111.64. The weight class or nominal thickness and casting shall be shown on each pipe, the manufacturer's mark, the year in which the pipe was produced, and the letters DUCTILE shall be stamped on the pipe.

2) TELESCOPING VALVE FOR CONCRETE SEDIMENTATION BASIN:

The telescoping valve shown in the concrete sedimentation basin shall be flanged of the size shown on the plans and as manufactured by Keene Corp., Water Pollution Division, Aurora, Illinois; Lakeside Equipment Corp., Bartland, Illinois; or an approved equal. Cast iron floor stand with base and hand wheel shall also be furnished. The valve shall have neoprene gaskets.

3) MISC. STRUCTURES:

The Contractor shall construct the drain inlet and oil skimmer shown on the plans, and the staff gage shown on the plans. The Contractor shall supply all labor and materials to construct these structures as shown on the plans. Specifications for materials and size are shown on the plans.

4) ENERGY DISSAPATERS:

The Contractor shall construct two energy dissapaters as shown on the plans. The energy dissapaters at the base of the 24" pipe shall be centered around an 8 foot boulder, which the Contractor shall select and save for this purpose. The Contractor shall provide necessary filter material and acquire the necessary riprap as shown on the plans and in these specifications. The energy dissapater at the base of the spillway shall be constructed as shown on the plans. Limits and location of the riprap for these structures may vary, and shall be placed as directed by the Engineer.

Coastal States Energy Company
Nine Greenway Plaza
Houston, Texas 77046
(713)877-6405

Subsidiary of
The Coastal
Corporation

November 14, 1980

To Whom It May Concern:

Please be advised that all engineering drawings prepared by Coastal States Energy Company contained in the SUFCo Mine Permit Application, made by Coastal States Energy Company, were prepared by/or under the direct supervision of the writer, Man Mohan Comar.

Mr. Comar is registered as a Professional Engineer in the State of Texas, certification number 47498.

Very truly yours,

Man M Comar

Man Mohan Comar

STATE OF TEXAS
MAN MOHAN COMAR
47498
REGISTERED
PROFESSIONAL ENGINEER

Coastal States Energy Company
Nine Greenway Plaza
Houston, Texas 77046
(713)877-6405

Subsidiary of
The Coastal
Corporation

November 14, 1980

To Whom It May Concern:

Please be advised that all geological drawings prepared by Coastal States Energy Company contained in the SUFCo Mine Permit Application, made by Coastal States Energy Company, were prepared by/or under the direct supervision of the writer, Richard Vance Hall.

Mr. Hall is a certified Professional Geologist, duly certified by the American Institute of Professional Geologists (No. 4530).

Very truly yours,

Richard Vance Hall

Richard Vance Hall

AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS
CERTIFICATE NUMBER
4530
AIPG
R. VANCE HALL

NEWSPAPER ADVERTISEMENT AND PROOF OF PUBLICATION

In compliance with federal regulations, the Applicant will publish an announcement of its intent to apply for a mining permit in a local newspaper of general circulation. The announcement will include a description of lands affected by the mining operation and will be published at least once a week for four consecutive weeks. Exhibit A represents the announcement as it will appear.

Proof of publication will be forwarded to the Division of Oil, Gas and Mining and the Office of Surface Mining within four weeks after the date of publication.

EXHIBIT A

LEGAL NOTICE

Coastal States Energy Company, Houston, Texas, hereby announces its intent to file an application for a revised and amended coal mining permit under the laws of the State of Utah and the U.S. Office of Surface Mining (OSM).

Approval of this application will allow an expansion of the Southern Utah Fuel Company mine operated on the leasehold interest and fee lands owned by Coastal States Energy Company. The lands on which mining is to occur (Sevier County) are parts of the Fishlake National Forest and Manti-LaSal National Forest, 30 miles east of Salina, Utah, in Convulsion Canyon. The entire property is within the USGS 7.5-minute "Accord Lakes" and "Emery West" Quadrangle maps. The approximately 6194.75 acre leasehold interests involve all or part of the following coal leases which have been assigned to Coastal States Energy Company.

Federal Lease	Issued To	Date of Issuance
Utah-0149084	Southern Utah Fuel Company	June 1, 1966
Utah-062453	Heiner Coal Company Southern Utal Fuel Company Equipment Rental Service	March 1, 1962
SL-062583	Lorenzo R. Hansen	September 11, 1941
Utah-28297	Coastal States Energy Company	January 1, 1979

The legal description of the above listed coal leases are:

Federal Coal Lease Serial Utah-0149084

T. 22 S., R. 4 E., SL Meridian, Utah

Sec. 12: NE 1/4 and N 1/2 SE 1/4
containing 240.00 acres;

Federal Coal Lease Serial Utah-062453

T. 21 S., R. 5 E., SL Meridian, Utah

Sec. 28: SW 1/4 SW 1/4;
Sec. 29: SE 1/4 SE 1/4;
Sec. 32: N 1/2;
Sec. 33: W 1/2 NW 1/4;
containing 480.00 acres;

Federal Coal Lease Serial SL-062583

T. 21 S., R. 4 E., SL Meridian, Utah

Sec. 36: S 1/2;

T. 21 S., R. 5 E., SL Meridian, Utah

Sec. 31: All;

T. 22 S., R. 4 E., SL Meridian, Utah

Sec. 1: Lots 1 to 4 incl., S 1/2 N 1/2, S 1/2;
Sec. 12: NW 1/4;

T. 22 S., R. 5 E., SL Meridian, Utah

Sec. 6: All;
Sec. 7: N 1/2 NE 1/4, E 1/2 NW 1/4;
containing 2,202.77 acres;

Federal Coal Lease Serial Utah-028297

T. 21 S., R. 5 E., SL Meridian, Utah

Sec. 32: Lots 1-4, N 1/2 S 1/2;
Sec. 33: Lot 1, NW 1/4 SW 1/4;

Federal Coal Lease Serial Utah-028297
(continued)

T. 22 S., R. 5 E., SL Meridian, Utah

Sec. 4: Lot 4, SW 1/4 NW 1/4, W 1/2 SW 1/4;
Sec. 5: All;
Sec. 7: S 1/2 NE 1/4, E 1/2 SW 1/4, SE 1/4;
Sec. 8: All;
Sec. 17: NE 1/4, N 1/2 NW 1/4;
Sec. 18: NE 1/4, E 1/2 NW 1/4;
containing 2,631.98 acres

Fee lands

The legal description of the coal lands owned in fee by the Applicant for which mining is proposed is:

T. 21 S., R. 5 E., SL Meridian, Utah

Sec. 29: SW 1/4, NW 1/4, W 1/2 NE 1/4, W 1/2 SE 1/4;
Sec. 30: S 1/2 NE 1/4, E 1/2 SE 1/4;
containing 640.00 acres

After filing, copies of the Permit Application will be available for inspection at the following locations: Utah Division of Oil, Gas and Mining, Salt Lake City, Utah; Office of Surface Mining, Denver, Colorado; U.S. Geological Survey, Salt Lake City, Utah; Coastal States Energy Company, Houston, Texas.

Written comments, objections or requests for informal conferences on the application may be addressed to the Utah Division of Oil, Gas and Mining, 1588 West North Temple, Salt Lake City, Utah 84116, with copies to Coastal States Energy Company, 9 Greenway Plaza, Houston, Texas 77046.

United States Department of the Interior
OFFICE OF SURFACE MINING
Reclamation and Enforcement
BROOKS TOWERS
1020 15TH STREET
DENVER, COLORADO 80202

OFFICE OF THE REGIONAL DIRECTOR

March 20, 1980

Mr. Vernal Mortenson
Coastal States Energy Co.
7 Greenway Plaza
Houston, TX 77046

Dear Mr. Mortenson:

This letter responds to your February 22 correspondence and the several discussions with you and John Garr.

Coastal States requested OSM approval of SUFCo mine operations entering Federal Lease U-28297 while the final review and action is being completed on the mine plan for the entire lease area. This request is to extend the second East Main into the new lease a distance only sufficient to allow the completion of panels 4, 5, and 6 as outlined on the attached diagram.

As we have discussed, these additional operations constitute a small part of the overall operation, are a minor modification to the existing 30 CFR 211 approval, and will not result in any significant change in rate of production. No new access roads, plant support areas or other surface facilities are necessary.

Based on these understandings, Coastal States may extend the SUFCo operations into the new lease area as identified above and conditioned upon the following:

a) Acceptance of the attached "Standard Stipulations";

b) Agreement that whatever "Special Stipulations" are made part of the action on the entire lease unit will retroactively apply to all operations undertaken pursuant to this approval; and

c) Acceptance of the requirement to install a subsidence monitoring "grid" which provides, at a minimum, two survey lines consisting of closely-spaced monuments reflecting all subsidence over those areas of panels 4, 5, and 6. The monuments should be spaced approximately 200 feet apart along two or more survey lines, one oriented perpendicular and central to the panels, the other(s) to include one at a 60 degree angle to the "perpendicular" line or at right angles to that "perpendicular" line. The

monuments should be established to negate the effects of processes other than subsidence and should be occupied immediately before the panels are mined, immediately after the panels are mined out, and at intervals agreed to by the regulatory authority after mining. All information will be reported to the regulatory authority within 90 days of collection.

SUFCo may proceed with operations identified above upon acceptance of these conditions. Acceptance can be indicated by co-signing and returning this letter or by separate correspondence.

Sincerely,

DONALD A. CRANE

Enclosures

Agreed and accepted on this the 25th day of March, 1979, by

Varnal J. Mortensen
Vice President
Utah Operations
Coastal States Energy Company

Standard Stipulations
Attached to Departmental Approval of Modification of
Coal Mining and Reclamation Plan
Hawk's Nest Mine, Gunnison County, Colorado for Proposed Mining
Federal Coal Lease No. C-27103

The approval to conduct mining at the site(s) described in the referenced mine plan is subject to the following standard and special conditions and stipulations. This approval shall be revocable at the discretion of the Director, Office of Surface Mining, if the operator fails to comply with any condition or stipulation. The term "Regulatory Authority" as used herein (including the Special Stipulations) means both the federal Office of Surface Mining and the Colorado Division Mined Land Reclamation unless otherwise specified.

1. The operator agrees to be bound by the provisions of Section 517 of the Surface Mining Control and Reclamation Act of 1977, 30 USC 1267 (P.L. 95-87, hereinafter referred to as "Act"), and agrees to allow the authorized representatives of the Secretary, without advance notice or a search warrant, upon presentation of appropriate credentials, and without delay, to:

A. Enter upon or through any surface coal mining and reclamation operations to:

1. Inspect any coal mining and reclamation operation, monitoring equipment, or procedure conducted pursuant to the permit;

2. Collect samples and other relevant information regarding air or water, fish and wildlife, soils, vegetation and other resources protected under the Act, this Chapter and the State program; and,

3. Obtain access to any copy of any records required to be maintained under the terms and conditions of the permit or the regulatory program.

B. Be accompanied by private persons for the purpose of conducting an inspection in accordance with Section 521(a) of the Act.

The term "authorized representative of the Secretary" as used in Section 517 and this paragraph shall be construed to include, but not be limited to, employees of the United States who are supervised by, or detailed or assigned to the Office of Surface Mining, any person under contract who is acting on behalf of the Secretary or any person employed by the State Regulatory Authority if it is authorized to regulate surface coal mining operations on federal lands; or any other person identified as an authorized representative by a letter signed by the Director, Office of Surface Mining.

2. The operator shall comply at all times with the provisos of the Surface Mining Control and Reclamation Act of 1977, the Mineral Leasing Act of 1920, as amended, and the rules and regulations promulgated pursuant to said Acts, and such other requirements as the Regulatory Authority shall promulgate by rule.

3. The operator shall conduct surface mining and reclamation operations only on those lands specifically designated on the map(s) submitted and approved for the term of the permit, and only in the manner or with the processes and techniques described in the approved mining and reclamation plan.

4. The operator shall (a) install, maintain, and use any monitoring equipment required by the Regulatory Authority as a condition of this approval or required subsequent to approval during the life of the mine; (b) establish and maintain appropriate records of such monitoring; (c) evaluate the results in accordance with such methods, at such location, intervals, and in such manner as the Regulatory Authority shall prescribe; (d) make reports of the results of monitoring as required by the Regulatory Authority and (e) provide such other information as the Regulatory Authority shall require.

5. The operator shall comply with the Surface Mining Control and Reclamation Act of 1977; the Federal Metal and Nonmetallic Mine Satety Act; the Federal Coal Mine Health and Safety Act of 1969; the Federal Water Pollution Control Act, as amended; the Clean Air Act, as amended; the Resource Conservation and Recycling Act, as amended; the Refuse Act of 1899; the Fish and Wildlife Coordination Act of 1934; the Mineral Leasing Act of 1920, as amended; and any regulation, performance standard, effluent limit, emission limit, water quality standard, or ambient air quality standard promulgated or approved there under, as well as all applicable state and local laws, ordinances, regulations, standards, and limitations.

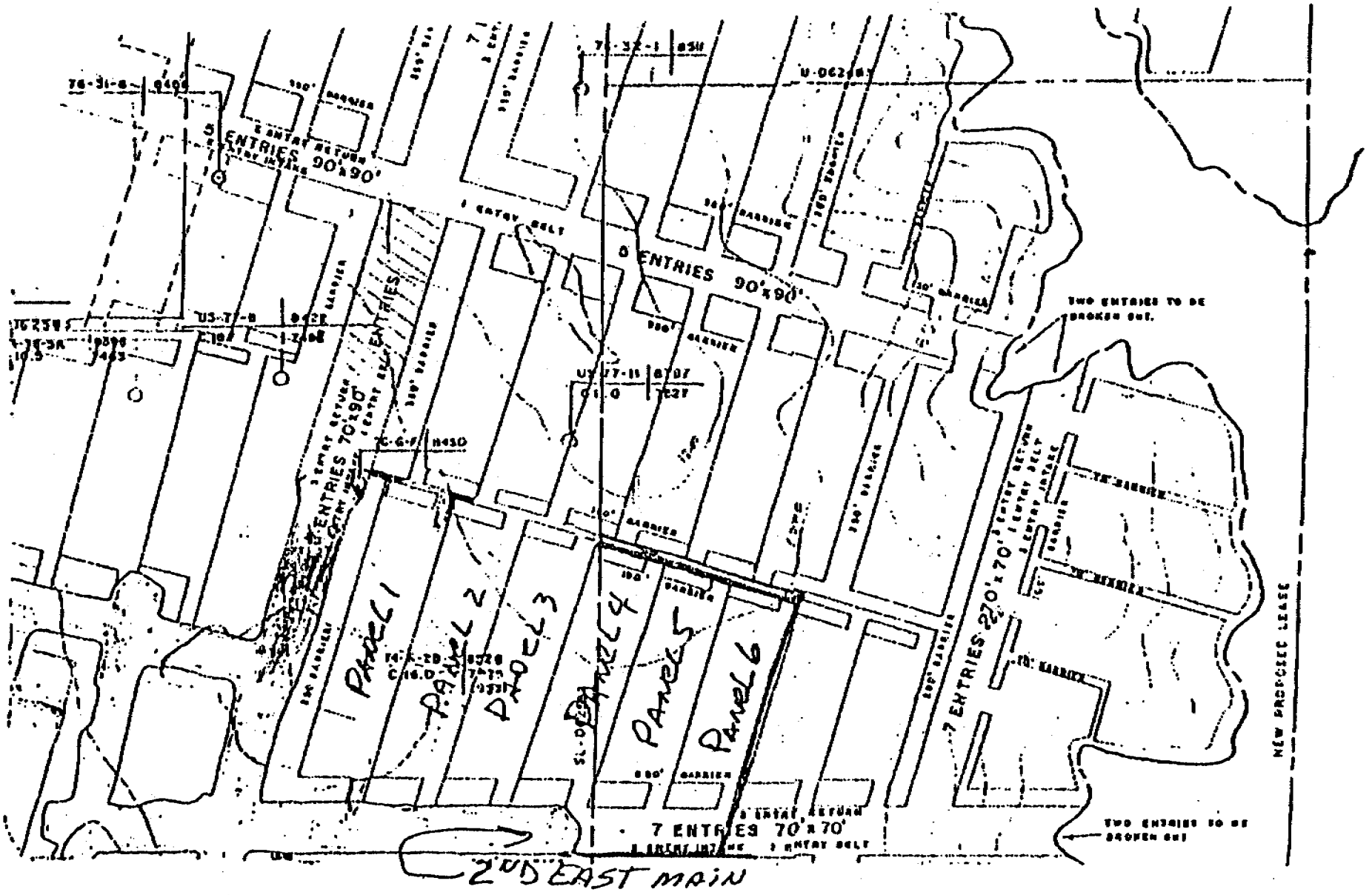
6. Compliance with any design criteria, or technology requirement, even where design criteria or the technology has been approved by the Regulatory Authority, shall not relieve the operator of the duty to comply with any applicable effluent limitations, emission limitation, applicable performance standard, water quality standard, ambient air quality standard, or any order issued by the Regulatory Authority under Section 521 of the Surface Mining Control and Reclamation Act.

7. The operator shall file a request with the Regulatory Authority seeking the release of all or part of a performance bond only during those seasonal periods when it is possible for the Regulatory Authority to inspect the area subject to the proposed release and make determination (a) regarding the completeness of reclamation; (b) the degree of difficulty to complete any remaining reclamation, including success of revegetation; (c) whether pollution of surface or subsurface water is occurring; and (d) the probability and estimated cost of abating such pollution or other applicable reclamation requirements.

8. Each of the mining, reclamation or monitoring procedures, techniques, methods or descriptions contained in the approved mining and reclamation plan or in any requirement, stipulation or condition established by the Regulatory Authority as part of any approval of a mining plan, or revision or modification thereof, or by order of the Regional Director following such approval shall be deemed a "permit condition required by this Act" for the purposes of enforcement under Section 521 of the Act and "a condition of a permit issued pursuant to a Federal Lands Program" for the purposes of Section 518 of the Act.

9. The approval of this permit shall terminate six months following the date on which a completed permit application is required to be filed pursuant to the Federal Lands Program unless the requirement to obtain a new permit is deferred beyond such date in accordance with said Federal Lands program. This approval shall not be construed as estopping the Federal Regulatory Authority from denying the permit application in accordance with the requirements of the Federal Lands Program then in effect.

10. Special Stipulations follow (page, stipulations).



extend 2nd EAST MAIN Sufficient

Vernal J. Mortensen
Vice President
Utah Operations

Coastal States Energy Company

411 West 7200 South
Midvale, Utah 84047
(801) 566-7111

RECEIVED
FEB 11 1981
DIVISION OF
OIL, GAS & MINING

Subsidiary of
The Coastal
Corporation

February 11, 1981

Mr. Cleon B. Feight, Director
State of Utah
Department of Natural Resources
Division of Oil, Gas and Mining
1588 West North Temple
Salt Lake City, Utah 84116

Dear Mr. Feight:

The GENERAL GUIDELINE FOR ORGANIZATIONAL FORMAT AND CONTENT FOR PERMIT APPLICATIONS as revised by The Division of Oil, Gas and Mining on November 3, 1980, was received by Coastal States Energy Company too late to be incorporated into our SUFCo Mining Permit Application Amendment. However, in accordance with our agreement, we are herewith submitting fourteen (14) copies of a cross-reference which correlates the locations of the various subjects in our amendment to the guideline table of contents.

This cross-reference should precede the Technical Correspondence Section located in Volume 5 of the November, 1980, permit application and be used in conjunction with the cross-reference submitted in Volume 1 of the same application.

Sincerely,

Vernal J. Mortensen by K. Welch

Vernal J. Mortensen
Vice President
Utah Operations

VJM/js

Enclosures

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING
1588 West North Temple
Salt Lake City, Utah 84116

PERMIT APPLICATIONS-
GENERAL GUIDELINE FOR ORGANIZATIONAL FORMAT AND CONTENT

* *

Pursuant to U.C.A. 40-10-10(2) and UMC 771.23(a)

Revised November 3, 1980

FORWARD

These guidelines are prepared to assist Utah Coal Operators in the preparation of permit applications for underground coal mining operations pursuant to the Utah Coal Mining and Reclamation Act and Rules and Regulations promulGated thereunder. The purpose of providing an organizational guideline is to standardize the permit application submittals into a form which will expedite efficient review. These guidelines are intended to encourage applicants to organize the permit application submittal. The organizations should assist the applicant to recognize portions to be prepared in the early stages of mine plan preparation and submit more complete plans initially. It is important to the Division that chapters and main headings be labeled in accordance with the following general format so that specific information of concern to the individual reviewer can be located quickly. The Division intends to compliment this organizational guideline with an additional guideline in the form of a checklist for apparent completeness review. Upon completion of the permit application please submit thirteen copies of the application to the Division with a $5.00 permit fee.

The Division is concerned with the applicants' problems or questions concerning the preparation of permit applications and welcomes suggestions which could improve these guidelines.

ORGANIZATIONAL GUIDELINE FOR PERMIT APPLICATIONS AND MINE PLANS

Table of Contents for Mine Permit Application

The table of contents for the overall mine plan should show the volume numbers, chapters and appendices. Each chapter should have a detailed table of contents. The chapter table of contents should list figures, tables, plates, or maps, appendices, and exhibits to facilitate cross referencing between chapters.

CHAPTER I

Introduction and Summary of Permit Application

1.1 Scope of Operation
1.2 Summary of Environmental Impacts
1.3 Introduction to Document Organization and Reviewers Checklist
1.4 Acknowledgements

Note: Parts 1.1 and 1.2 should form the basis of an Executive Summary useful in introducing a reviewer to the mine plan. This portion could form the basis of the Division's Executive Summary to introduce the mining and reclamation plan to the Board of Oil, Gas and Mining for approval action.

CHAPTER II

Legal, Financial, Compliance and Related Information

2.0 Table of Contents
2.1 Scope
2.2 Indentification of Interests (782.13)
2.3 Compliance Information (782.14)
2.4 Right of Entry and Operation Information (782.15)
2.5 Relationship to Areas Designated Unsuitable to Mining (782.16)
2.6 Permit Term (782.17 & 786.25)
2.7 Personal Injury and Property Damage Insurance (782.18)
2.8 Proposed Performance Bond (800, 805, 806)
2.9 Other Licenses and Permits (782.19)
2.10 Location of Public Office for Filing Application
2.11 Newspaper Advertisement (782.21, 786.11(a))

Note: Chapter II follows the format of the regulations UMC 782. Exhibits to be presented should be attached as appendices. It is recommended however, that the applicant list in the chapter the minimum information requested pursuant to the regulations. The applicant should be aware of areas where cross referencing can be used, such as Chapter II for reclamation costs as applicable to bonding. The applicant should attach maps following the chapter to show land ownership status, coal ownership status or reference Chapter IV Land-use and Land-status.

CHAPTER III

Operation and Reclamation Plan (784.0)

3.0 Table of Contents
3.1 Scope
3.2 Surface Facilities/Construction Plans
3.2.1 Site Selection and Preparation
3.2.2 Portals
3.2.3 Surface Buildings and Structures
3.2.4 Coal Handling, Processing, Preparation and Storage
3.2.5 Power System, Transmission Lines, Substations, Mine Feeders
3.2.6 Water Supply System
3.2.7 Sewage System
3.2.8 Water Diversion Structures
3.2.9 Sedimentation Control Structures and Water Treatment Facilities
3.2.10 Transportation, Roads, Parking Areas, Railroad Spurs
*3.2.11 Total Area for Surface Disturbance During Permit Term
*3.2.12 Additional Areas for Surface Disturbance for Life of Mine
*3.2.13 Detailed Construction Schedule
3.3 Operation Plan
3.3.1 Mining Plans
3.3.1.1 Orientation and Multiple Seam Considerations
3.3.1.2 Portals, Shafts and Slopes
3.3.1.3 Mining Methods, Room and Pillar, Longwall
3.3.1.4 Projected Mine Development, Mains, Submains, Panels, etc.
3.3.1.5 Retreat Mining
3.3.1.6 Roof Control, Ventilation, Water Systems, Dust Suppression, Dewatering, Electrical, Etc.
3.3.2 Barrier Pillars
3.3.2.1 Protection of Oil and Gas Wells
3.3.2.2 Protection of Surface Structures Streams
3.3.2.3 Property Boundaries
3.3.2.4 Outcrop Protection
3.3.2.5 Other
3.3.3 Conservation of Coal Resource
3.3.3.1 Projected Maximum Recovery
3.3.3.2 Justification for Non-recovery
3.3.3.3 Access to Future Reserves
3.3.4 Equipment Selection
3.3.4.1 Surface Equipment
3.3.4.2 Underground Equipment
3.3.5 Mine Safety, Fire Protection, and Security
3.3.5.1 Signs
3.3.5.2 Fences and Gates
3.3.5.3 Fire Protection
-Facilities
-Coal Stockpiles, Refuse Piles
-Coal Seam

3.3.5.4 Explosives
-Storage and Handling
-Use
3.3.6 Operations Schedule
3.3.6.1 Annual Production Per Year for Permit Term
3.3.6.2 Operating Schedule-Days-Shifts
3.3.6.3 Operation Employment
3.3.7 Mine Permit Area
3.3.7.1 Projected Mining by Year
3.3.7.2 Acreage and Delineation of Mine Permit Area
3.3.8 Mine Plan Area
3.3.8.1 Projected Mining by Future Permit Term for the Planned Life of Mine

3.4 Environmental Protection
3.4.1 Preservation of Land-Use
3.4.1.1 Projected Impacts of Mining on Current and Future Land-Use
3.4.1.2 Control Measures to Mitigate Impacts
3.4.2 Protection of Human Values
3.4.2.1 Projected Impacts of Mining on Human Values-Historical and Cultural
3.4.2.2 Control Measures to Mitigate Impacts
3.4.3 Protection of Hydrologic Balance
3.4.3.1 Projected Impacts of Mining on Hydrologic Balance
3.4.3.2 Control Measures to Mitigate Impacts
3.4.3.3 Monitoring Procedures to Measure Projected Impacts and Control
3.4.4 Preservation of Soil Resources
3.4.4.1 Projected Impacts of Mining on Soil Resources
3.4.4.2 Control Measures to Mitigate Impacts
3.4.5 Protection of Vegetative Resources
3.4.5.1 Projected Impacts of Mining on Vegetative Resources
3.4.5.2 Mitigating Measures to be Employed to Reduce Impacts on Vegetative Resources
3.4.5.3 Monitoring Procedures-Reference Areas, and Revegetation
3.4.6 Protection of Fish and Wildlife
3.4.6.1 Projected Impacts of Mining on Fish and Wildlife
3.4.6.2 Mitigating Measures to be Employed to Protect Fish and Wildlife
3.4.6.3 Monitoring Procedures
3.4.7 Protection of Air Quality
3.4.7.1 Projected Impacts of Mining Operation on Air Quality
3.4.7.2 Mitigating Measures to be Employed to Control Air Pollutants
3.4.7.3 Air Quality Monitoring Plans
3.4.8 Subsidence Control Plan
3.4.8.1 Projected Impacts of Subsidence
3.4.8.2 Control Measures to Mitigate Impacts
3.4.8.3 Monitoring Procedures to Measure Projected Impacts and Controls

3.4.9 Waste Disposal Plans
3.4.9.1 Projected Impacts of Disposal Areas and Methods on Environment
3.4.9.2 Control Measures to Mitigate Impacts
3.5 Reclamation Plan
3.5.1 Contemporaneous Reclamation
3.5.2 Soil Removal and Storage
3.5.3 Final Abandonment
3.5.3.1 Sealing of Mine Openings
3.5.3.2 Removal of Surface Structures
3.5.3.3 Disposition of Dams, Ponds, and Diversions
3.5.4 Backfilling and Grading Plans
3.5.4.1 Recontouring
3.5.4.2 Removal or Reduction of Highwalls
3.5.4.3 Terracing and Erosion Control
3.5.4.4 Soil Redistribution and Stabilization
3.5.5 Revegetation Plan
3.5.5.1 Soil Preparation
3.5.5.2 Seeding and Transplanting
3.5.5.3 Mulching
3.5.5.4 Management
3.5.5.5 Revegetation Monitoring
3.5.6 Schedule of Reclamation
3.5.6.1 Detailed Timetable for Completion of Each Major Step in Reclamation
3.5.6.2 Reclamation Monitoring
3.5.7 Cost Estimate for Reclamation
3.5.7.1 Cost Estimate of Each Step of Reclamation
3.5.7.2 Forecast of Performance Bond Liability During Permit Term and Forecast of Liability for Life of Mine
3.6 Bibliography

3.7 Chapter III - Photos (Maps)

Note: Chapter III is the primary portion of the permit application. The objective of Chapter III is to set out all of the plans that the applicant intends to undertake during the permit term and life of the operation. The organization of Chapter III is designed to address the requirements of UMC 784 and serve as the focal point of the application. The remaining chapters of the permit application address independent specific disciplines. Chapter III integrates the remaining subordinate chapters containing base data, analyses, and justifications into the proposed operation and reclamation plan.

Chapter III has been organized into four components for convenience. Surface Facilities/Construction Plans is the first since this is the initial activity and normally the major impact on the environment caused by an underground mining operation. The Operation Plan describes the mining activities during the permit term and life of the mine. Environmental Protection follows the operation plan since environmental protection must be accomplished during all aspects of the life of the mine from construction

through final reclamation. Environmental Protection addresses each aspect of the environment of concern and provides the applicants opportunity to address the impact of the mining operation, the mitigation of the impact, and monitoring plans to demonstrate the mitigation. Mitigation as used in the outline applies to compliance with the performance standards. Each of the aspects addressed under Environmental Protection is developed in the chapters following Chapter III.

The discussions under Environmental Protection should be kept to a minimum. Base data, analyses, justifications and discussions used in developing the information contained under Environmental Protection should be referenced to the subordinate Chapters, IV-XIV. A reviewer can review all aspects of environmental protection to see how it is integrated into the proposed plans by reading Chapter III and refeRring to the data, analyses, and detailed justifications contained in the subordinate chapters to see how the applicant developed the plans.

The final portion of Chapter III is the Reclamation Plan. The items in the regulations listed under reclamation plan UMC 784, which are concerned with final reclamation, are addressed in this part. An exception to this is the contemporaneous reclamation which will be accomplished after construction or along with operations as portions of disturbed areas prior to the final abandonment are reclaimed. Contemporaneous reclamation may include vegetation of disturbed areas such as cut banks and outslopes of fills for erosion and stability control. The Schedule of Reclamation and Cost for Reclamation serve to establish the performance bond liability and schedule and therefore are included in this part.

The Bibliography for references used in this chapter may be cross referenced to other chapters. It is recommended that all maps and cross-sections which are used as exhibits to Chapter III and are not small enough to incorporate as figures or tables in the chapter should be labeled "Plate III-___" and attached directly behind this chapter. Many plates which logically belong with other chapters may be referenced in Chapter III. A reference to a figure, table, or plate in any chapter can be accomplished simply by referring to "Plate IV-1" which identifies that it is a map attached to Chapter IV, Land Status, Land-Use, and Postmining Land-use.

Chapter IV

Land Status, Land-use and Postmining Land-use

4.0 Table of Contents
4.1 Scope
4.2 Methodology

4.3 Land Status
- 4.3.1 Surface Land Status/Mine Plan Area
- 4.3.1.1 Ownership
- 4.3.1.2 Surface Managing Authorities
- 4.3.1.3 Utility Corridors and Other Right-of-Ways
- 4.3.1.4 Special Use Permits and Leases
- 4.3.2 Mineral Ownership/Mine Plan Area
- 4.3.2.1 Coal Ownership and Mines
- 4.3.2.2 Coal Leases
- 4.3.2.3 Mineral Ownership and Mines
- 4.3.2.4 Mineral Leases
- 4.3.2.5 Oil and Gas Ownership and Wells
- 4.3.2.6 Oil and Gas Leases

4.4 Land Use
- 4.4.1 Regional Land-use
- 4.4.2 Land-use in Mine Plan Area
- 4.4.3 Land-use During Operations
- 4.4.3.1 Affect of Operation on Land-use
- 4.4.3.2 Mitigation of Effects of Operation

4.5 Postmining Land-use
4.6 Socioeconomic Considerations
4.7 Bibliography
4.8 Chapter IV - Plates (Maps)

Note: Chapter IV should include detailed information that could be cross-referenced from Chapter II concerning land status. This chapter is designed to discuss multiple land-use and how the mining operation can be integrated into the existing socioeconomic and physical uses of lands to be mined. Maps included in this section can show surface structures and improvements for the subsidence control plan shown in Chapter III and developed in Chapter XII.

Chapter V

Historical and Cultural Resources

5.0 Table of Contents
5.1 Scope
5.2 Methodology
5.3 Historical Resources
- 5.3.1 Historical Inventory
- 5.3.2 History of Mining
- 5.3.3 Effects of Mining on Historical Resources

5.4 Archeological Resources
- 5.4.1 Archeological Inventory
- 5.4.2 Effects of Mining on Archeological Resources

5.5 Paleontological
- 5.5.1 Paleontologic Inventory
- 5.5.2 Effects of Mining on Paleontologic Resources

5.6 Public Parks
5.6.1 Inventory of Public Facilities
5.6.2 Effects of Mining on Public Facilities
5.7 Bibliography
5.8 Chapter V - Plates (Maps)

Chapter VI

Geology

6.0 Table of Contents
6.1 Scope
6.2 Methodology
6.3 Regional Geologic Framework
6.4 Geology of Project Vicinity
6.4.1 Stratigraphy
6.4.2 Structure
6.5 Geology of Coal Bed and Adjacent Units
6.5.1 Exploration and Drilling
6.5.2 Stratigraphy
6.5.3 Structure
6.5.4 Detailed Columns of Interest and Cross-Sections
6.5.5 Coal Reserves
6.5.5.1 Reserve Calculations
6.5.5.2 Coal Quality and Characteristics, Sulfur Forms, Clay and Alkalinity
6.5.6 Adjacent Units (Overburden)
6.5.6.1 Rock Characteristics, Acid-toxic, Pyrite, Clay and Alkalinity
6.6 Geologic Effects of Mining
6.6.1 Mining Hazards
6.6.2 Surface Hazards
6.6.3 Impacts of Mining
6.7 Bibliography
6.8 Chapter VI - Plates (Maps)

Chapter VII

Hydrology

7.0 Table of Contents
7.1 Groundwater Hydrology
7.1.0 Scope
7.1.1 Methodology
7.1.2 Existing Groundwater Resources
7.1.2.1 Regional Groundwater Hydrology

7.1.2.2 Mine Plan Area Aquifers
-Aquifer Characteristics
-Aquifer Recharge, Movement, Storage (Piezometric Surfaces)
-Aquifer Water Quality
-Wells and Users
7.1.3 Groundwater Development and Mine Dewatering
7.1.3.1 Water Supply
-Quantity and Quality
-Water Rights
7.1.3.2 Mine Dewatering
-Quantity and Quality
-Water Rights
7.1.4 Effects of Mining Operation on Groundwater
7.1.4.1 Hydrologic Balance
7.1.4.2 Quantity
7.1.5 Mitigation and Control Plans
7.1.6 Groundwater Monitoring Plan
7.2 Surface Water Hydrology
7.2.0 Scope
7.2.1 Methodology
7.2.2 Existing Surface Water Resources
7.2.2.1 Regional Surface Water Hydrology
7.2.2.2 Mine Plan Area Watersheds and Streams, Springs and Seeps Characteristics, Streams Characteristics, Watershed Characteristics
7.2.3 Surface Water Development, Control and Diversions
7.2.3.1 Water Supply
-Quantity and Quality
-Water Rights
7.2.3.2 Sedimentation Control Structures and Diversions
-Watershed Characteristics
-Soil Loss and Sedimentation
-Runoff Characteristics
-Design Storms
-Peak Flows
-Diversion and Impoundment Structures
-Design Volume
-Sediment Volume
-Seepage
7.2.4 Effects of Mining on Surface Water
7.2.4.1 Hydrologic Balance
7.2.4.2 Quality
7.2.5 Mitigation and Control Plans
7.2.6 Surface Water Monitoring Plans
7.3 Alluvial Valley Floor Determination
7.4 Bibliography
7.5 Chapter VII - Plates (Maps)

Chapter VIII

Soil Resources

8.0 Table of Contents
8.1 Scope
8.2 Methodology
8.3 Soil Resource Information of Mine Plan Area (783.21)
    8.3.1 Soils Identification
    8.3.2 Soils Description
    8.3.3 Present and Potential Productivity of Existing Soils
8.4 Prime Farmland Investigation and Determination (783.27)
8.5 Soils, Physical and Chemical Properties of Soils and Results of Analyses, Tests and Trials (784.13 and 817.21)
8.6 Use of Selected Overburden Materials or Substitutes (783.21 and 817.22)
8.7 Plans for Removal, Storage and Protection of Soils (784.13, 817.22 and 817.23)
8.8 Plans for Redistribution of Soils (784.13 and 817.24)
8.9 Nutrients and Soil Amendments
8.10 Effects of Mining Operations on Soils, Nutrients and Soil Amendments to be Used (817.25)
8.11 Mitigation and Control Plans
8.12 Bibliography
8.13 Chapter VIII, Plates (Survey Map)

Chapter IX

Vegetation Resources

9.0 Table of Contents
9.1 Scope
9.2 Methodology
9.3 Existing Resources (See Vegetation Guidelines)
    9.3.1 General Site Description
    9.3.2 Vegetation Types: for Each Vegetation Type
    9.3.2.1 Cover Data
    9.3.2.2 Production Data
    9.3.2.3 Tree Data
    9.3.2.4 General Description per Vegetation Guideline
    9.3.2.5 Species List
    9.3.2.6 Total Acres in Plan Area
    9.3.2.7 Total Acres of Vegetation Types to be Disturbed
    9.3.2.8 Reference Area Supporting Data (or Alternative Methods)
9.4 Threatened and Endangered Species
9.5 Effects of Mining Operations on Vegetation
9.6 Mitigation and Management Plans

9.7 Revegetation Methods and Justifications
9.8 Revegetation Monitoring
9.9 Bibliography (UMC 771)
9.10 Chapter IX - Plates (Maps)

Chapter X

Fish and Wildllife Resources

10.0 Table of Contents
10.1 Scope
10.2 Methodology
10.3 Existing Fish and Wildlife Resources (See Wildlife Guidelines)
10.3.1 Wildlife Habitats in Mine Plan Area
10.3.2 Wildlife
10.3.2.1 Aquatic Wildlife and Habitat and Value Determination
10.3.2.2 Terrestrial Wildlife and Habitat and Value Determination
10.3.2.3 Mammals
10.3.2.4 Birds
10.3.2.5 Reptiles and Amphibians
10.3.3 Species of Special Signifigance
10.3.3.1 Threatened and Endangered Species
10.3.3.2 Raptors
10.4 Expected Impacts of Mining Operations on Fish and Wildlife
10.5 Mitigation and Management Plans
10.6 Stream Buffer Zone Determination by Division of Oil, Gas and Mining
10.7 Fish and Wildlife Monitoring
10.8 Bibliography (771 Information)
10.9 Chapter X - Plates (Maps)

Chapter XI

Climatology and Air Quality

11.0 Table of Contents
11.1 Scope
11.2 Methodology
11.3 Existing Environment
11.3.1 Precipitation
11.3.2 Temperature
11.3.3 Evaporation
11.3.4 Relative Humidity
11.3.5 Wind
11.4 Effects of Mining Operation on Air Quality
11.4.1 Estimate of Uncontrolled Emissions
11.4.2 Description of Control Measures
11.4.3 Estimate of Controlled Emissions
11.4.4 Estimated Cost of Emission Control

11.5 Climatological and Air Quality Monitoring
11.6 Bibliography
11.7 Chapter XI - Plates (Maps)

Chapter XII

Geotechnical

12.0 Table of Contents
12.1 Scope
12.3 Methodology
12.3 Underground Mine Design
12.3.1 Geotechnical Tests and Analysis
12.3.2 Coal Pillar Design
12.3.3 Roof Span Design
12.4 Surface Subsidence Effects of Mining
12.4.1 Subsidence Mechanisms
12.4.2 Projected Subsidence Effects
12.4.3 Subsidence Control and Mitigation Methods
12.4.4 Subsidence Monitoring Plan
-Method
-Monuments
-Schedule
12.5 Stability Analysis of Earthen Structures
12.5.1 Type of Structure
12.5.1.1 Hazard Considerations
-Impounding
-Non-impounding
-Location
12.5.2 Construction Material Characteristics
12.5.3 Foundation Material Characteristics
12.5.4 Hydrologic Characteristics
12.5.5 Design and Construction Plans
12.5.6 Stability Analysis
12.6 Bibliography
12.7 Chapter XII - Plates (Maps)

Chapter XIII

Designs

13.0 Table of Contents
13.1 Scope
13.2 Methodology
13.3 Detail Designs
-Compliance with Performance Standards
13.4 Bibliography
13.5 Chapter XIII - Plates (Maps)

Chapter XIV

Consultation and Coordination

14.0 Table of Contents
14.1 Scope
14.2 Federal Consultation and Coordination
14.3 State Consultation and Coordination
14.4 Local Consultation and Coordination
14.5 Consultation and Coordination with Entities of Interest
14.6 Other Consultation and Coordination

CROSS REFERENCE

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
CHAPTER I	
INTRODUCTION AND SUMMARY OF PERMIT APPLICATION	
1.1 Scope of Operation	Vol. 1, p. i
1.2 Summary of Environmental Impacts	Vol. 1, pp. ix-xi
1.3 Introduction to Document Organization & Reviewers Checklist	Vol. 1, pp. ii-viii; Cross Reference
1.4 Acknowledgements	Vol. 2, 79 Sub., pp. 4-6
CHAPTER II	
LEGAL, FINANCIAL, COMPLIANCE AND RELATED INFORMATION	
2.0 Table of Contents	Vol. 1, pp. iii-viii
2.1 Scope	Vol. 1, pp. ix-xi
2.2 Identification of Interests	Vol. 1, 77 Plan, p. 1 Vol. 2, 79 Sub., pp. 4-5, 7-9, 11 Vol. 3, 80 Sub., Map 80-1 Vol. 3, 80 Sub., Responses 782.13(a)(4), 782.13(b), 782.19(c),(d), 782.13(g)
2.3 Compliance Information	Vol. 2, 79 Sub., pp. 10-11 Vol. 3, 80 Sub., Response 782.14(c)(5)
2.4 Right of Entry & Operation Information	Vol. 3, 80 Sub., Responses 782.15(a),(b)(2), 782.15(b)(1), 782.15(b)(2)
2.5 Relationship to Areas Designated Unsuitable to Mining	Vol. 2, 79 Sub., p. 12 Vol. 3, 80 Sub., Response 782.16(a)
2.6 Permit Term Information	Vol. 1, 77 Plan, pp. 20-21 Vol. 2, 79 Sub., p. 7 Vol. 3, 80 Sub., Response 782.17(a)
2.7 Personal Injury/Property Damage Insurance	Vol. 2, 79 Sub., pp. 13-15

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
2.8 Proposed Performance Bond	Vol. 1, 77 Plan, p. 16 Vol. 3, 80 Sub., Response 784.13(b)(2)
2.9 Other Licenses & Permits	Vol. 2, 79 Sub., p.11 Vol. 3, 80 Sub., Response 782.19(c),(d)
2.10 Location of Public Office for Filing Application	Vol. 2, 79 Sub., p. 16
2.11 Newspaper Advertisement	Vol. 5, 80 Sub., Technical Correspondence
CHAPTER III	
OPERATION AND RECLAMATION PLAN	
3.0 Table of Contents	Vol. 1, pp. iii-viii
3.1 Scope	Vol. 1, pp. ix-xi
3.2 Surface Facilities/Construction Plans	
3.2.1 Site Selection/Preparation	Vol. 2, 79 Sub., Ex. 3, pp. 3-4
3.2.2 Portals	Vol. 1, 77 Plan, pp. 13-14 Vol. 3, 80 Sub., Responses 784.13(b)(8), 784.14(a)(4), 784.14(d)
3.2.3 Surface Buildings & Structures	Vol. 1, 77 Plan, pp. 13-14, 20 Vol. 1, 77 Plan, Map 1D Vol. 2, 79 Sub., Ex. 3, p. 8 Vol. 3, 80 Sub., Responses 783.24(d), 784.12(a)(2),(3), 784.12(a)(4) Vol. 3, 80 Sub., Maps 80-4, 4a, 4b, 4c, 80-11
3.2.4 Coal Handling, Processing, Preparation & Storage	Vol. 1, 77 Plan, pp. 13-14 Vol. 1, 77 Plan, Map 1D Vol. 2, 79 Sub., Ex. 3, p. 9 Vol. 2, 79 Sub., Ex. 9 Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
3.2.5 Power System, Transmission Lines, Substations, Mine Feeders	Vol. 1, 77 Plan, Map 1D Vol. 2, 79 Sub., Ex. 9 Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-3 Vol. 3, 80 Sub., Response 783.24(e) Vol. 3, 80 Sub., Maps 80-4, 4a, 4b, 4c
3.2.6 Water Supply System	Vol. 1, 77 Plan, pp. 16, 42-56 Vol. 2, 79 Sub., pp. 33-35 Vol. 2, 79 Sub., Ex. 5, p. 5 Vol. 3, 80 Sub., Response 783.16(a) Vol. 4, 80 Sub., Hydrometrics Report, pp. 27-37
3.2.7 Sewage System	Vol. 2, 79 Sub., Ex. 3, p. 8
3.2.8 Water Diversion Structures	Vol. 1, 77 Plan, p. 16 Vol. 2, 79 Sub., pp. 18, 30-32 Vol. 2, 79 Sub., Ex. 9, Map 9-8
3.2.9 Sedimentation Control Structures & Water Treatment Facilities	Vol. 1, 77 Plan, p. 21 Vol. 1, 77 Plan, Map 1D Vol. 2, 79 Sub., pp. 30-32 Vol. 2, 79 Sub., Ex. 1, Items 6, 8, 9, 11 Vol. 2, 79 Sub., Ex. 9 Vol. 2, 79 Sub., Ex. 9, Map 9-6 Vol. 3, 80 Sub., Fishlake Comment 1 Vol. 3, 80 Sub., Maps 80-4, 4a, 4b, 4c Vol. 5, 80 Sub., Valley Engineering Report
3.2.10 Transportation, Roads, Parking Areas, Railroad Spurs	Vol. 1, 77 Plan, p. 16 Vol. 1, 77 Plan, Map 1D Vol. 1, 77 Adden. #2, p. 3 Vol. 2, 79 Sub., pp. 22, 30-31 Vol. 2, 79 Sub., Ex. 1, Items 6, 8, 9, 11 Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3
3.2.11 Total Area for Surface Disturbance During Permit Term	Vol. 3, 80 Sub., Response 784.23(a)
3.2.12 Additional Areas for Surface Disturbance for Life of Mine	Vol. 3, 80 Sub., Response 784.23(a)
3.2.13 Detailed Construction Schedule	Vol. 1, 77 Plan, pp. 13-14, 20 Vol. 2, 79 Sub., Ex. 3, p. 8 Vol. 3, 80 Sub., Response 784.12(a)(2),(3)

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
3.3 Operation Plan	
3.3.1 Mining Plans	
3.3.1.1 Orientation & Multiple Seam Considerations	Vol. 1, 77 Plan, Map 1F Vol. 3, 80 Sub., Response 783.25(c)
3.3.1.2 Portals, Shafts, & Slopes	Vol. 1, 77 Plan, pp. 13-14 Vol. 2, 79 Sub., pp. 17-18 Vol. 2, 79 Sub., Ex. 9 Vol. 3, 80 Sub., Responses 784.13(b)(8), 784.14(a)(4), 784.14(d) Vol. 3, 80 Sub., Maps 80-4, 4a, 4b, 4c
3.3.1.3 Mining Methods	Vol. 1, 77 Plan, pp. 11-15 Vol. 2, 79 Sub., Ex. 3, pp. 4-8
3.3.1.4 Projected Mine Development, Mains, Submains, Panels	Vol. 1, 77 Plan, pp. 20-21 Vol. 1, 77 Plan, Maps 1A, 1E Vol. 2, 79 Sub., Ex. 3., p. 7, Vol. 3, 80 Sub., Responses 782.17(a), 783.25(e) Vol. 3, 80 Sub., Map 80-2
3.3.1.5 Retreat Mining	Vol. 2, 79 Sub., Ex. 3, p. 6
3.3.1.6 Roof Control, Ventilation, Water Systems, Dust Suppression, Dewatering, Electrical	Vol. 1, 77 Plan, Map 1D Vol. 2, 79 Sub., pp. 17-18, 47-51 Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3 Vol. 3, 80 Sub., Responses 783.24(e), 784.13(b)(8) Vol. 3, 80 Sub., Maps 80-4, 4a, 4b, 4c
3.3.2 Barrier Pillars	
3.3.2.2 Protection of Surface Structures, Streams	Vol. 2, 79 Sub., Ex. 9 Vol. 3, 80 Sub., Response 784.14(b)(1) Vol. 4, 80 Sub., Hydrometrics Report, p. 61
3.3.2.3 Protection of Property Boundaries	Vol. 1, 77 Plan, pp. 10-13

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
3.3.2.4 Outcrop Protection	Vol. 1, 77 Plan, pp. 10-13
3.3.2.5 Other	Vol. 1, 77 Plan, pp. 10-13 Vol. 2, 79 Sub., Ex. 3, pp. 4-7
3.3.3 Conservation of Coal Resources	
3.3.3.1 Projected Maximum Recovery	Vol. 1, 77 Plan, pp. 10, 21-22 Vol. 2, 79 Sub., Ex. 3, p. 7
3.3.3.2 Justification for Non-Recovery	Vol. 1, 77 Plan, pp. 10, 21-22 Vol. 2, 79 Sub., Ex. 3, p. 7
3.3.3.3 Access to Future Reserves	Vol. 3, 80 Sub., Map 80-2
3.3.4 Equipment Selection	
3.3.4.1 Surface Equipment	Vol. 2, 79 Sub., Ex. 3, p. 8
3.3.4.2 Underground Equipment	Vol. 1, 77 Plan, p. 15 Vol. 2, 79 Sub., Ex. 3, p. 8
3.3.5 Mine Safety, Fire Protection, & Security	
3.3.5.1 Signs	Vol. 2, 79 Sub., p. 19
3.3.5.2 Fences & Gates	Vol. 1, 77 Plan, p. 19 Vol. 2, 79 Sub., pp. 45, 54
3.3.5.3 Fire Protection	Vol. 1, 77 Plan, pp. 17, 20
3.3.5.4 Explosives	Vol. 1, 77 Plan, p. 20 Vol. 2, 79 Sub., Ex. 9 Vol. 2, 79 Sub., Ex. 9, Map 9-1
3.3.6 Operations Schedule	
3.3.6.1 Annual Production Per Year for Permit Term	Vol. 1, 77 Plan, p. 13 Vol. 2, 79 Sub., Ex. 3, p. 7
3.3.6.2 Operating Schedule-Days-Shifts	Vol. 2, 79 Sub., Ex. 3, pp. 27-29
3.3.6.3 Operation Employment	Vol. 2, 79 Sub., Ex. 3, pp. 27-29

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
3.3.7 Mine Permit Area	
3.3.7.1 Projected Mining by Year	Vol. 1, 77 Plan, p. 13 Vol. 1, 77 Plan, Map 1D Vol. 2, 79 Sub., Ex. 3, p. 7 Vol. 3, 80 Sub., Map 80-2
3.3.7.2 Acreage & Delineation of Mine Permit Area	Vol. 2, 79 Sub., Ex. 3, pp. 1-2 Vol. 4, 80 Sub., Hydrometrics Report, p. 55
3.3.8 Mine Plan Area	
3.3.8.1 Projected Mining by Future Permit Term for Planned Life of Mine	Vol. 3, 80 Sub., Map 80-2
3.4 Environmental Protection	
3.4.1 Preservation of Land Use	
3.4.1.1 Projected Impacts of Mining on Current & Future Land Use	Vol. 1, 77 Plan, pp. 8-10 Vol. 2, 79 Sub., Ex. 3, pp. 18-21
3.4.1.2 Control Measures to Mitigate Impacts	Vol. 2, 79 Sub., pp. 20-27 Vol. 2, 79 Sub., Ex. 3, pp. 18-21 Vol. 2, 79 Sub., Ex. 4, pp. 14-15
3.4.2 Protection of Human Values	
3.4.2.1 Projected Impacts of Mining on Human Values - Historical & Cultural	Vol. 2, 79 Sub., Ex. 3, pp. 21-22 Vol. 3, 80 Sub., Responses 783.12(b), 783.24(i), 784.17 Vol. 4, 80 Sub., Archaeology Report, pp. 43-45
3.4.2.2 Control Measures to Mitigate Impacts	Vol. 4, 80 Sub., Archaeology Report, pp. 45-46
3.4.3 Protection of Hydrologic Balance	
3.4.3.1 Projected Impacts of Mining on Hydrologic Balance	Vol. 1, 77 Plan, pp. 51-63 Vol. 1, 77 Adden. #2, p. 4 Vol. 2, 79 Sub., pp. 30-37 Vol. 2, 79 Sub., Ex. 5, pp. 4-20 Vol. 2, 79 Sub., Ex. 6 Vol. 2, 79 Sub., Ex. 8 Vol. 4, 80 Sub., Responses 783.17, 784.14(a)(1), 784.14(a)(3), 784.14(c)

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
	Vol. 4, 80 Sub., Hydrometrics Report, pp. 52-54, 59-60, 62
3.4.3.2 Control Measures to Mitigate Impacts	Vol. 1, 77 Plan, p. 21 Vol. 2, 79 Sub., p. 52 Vol. 2, 79 Sub., Ex. 1, Items 5, 6, 7, 10 Vol. 2, 79 Sub., Ex. 9 Vol. 3, 80 Sub., Response 784.14(b)(1) Vol. 4, 80 Sub., Hydrometrics Report, p. 61
3.4.3.3 Monitoring Procedures to Measure Projected Impacts & Controls	Vol. 2, 79 Sub., Ex. 5, pp. 4-20 Vol. 4, 80 Sub., Hydrometrics Report, pp. 63-66
3.4.4 Preservation of Soil Resources	
3.4.4.1 Projected Impacts of Mining on Soil Resources	Vol. 2, 79 Sub., p. 42 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 13-15
3.4.4.2 Control Measures to Mitigate Impact	Vol. 2, 79 Sub., Ex. 4, p. 51 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 14-15
3.4.5 Protection of Vegetative Resources	
3.4.5.1 Projected Impacts of Mining on Vegetative Resources	Vol. 1, 77 Plan, pp. 8-10
3.4.5.2 Mitigating Measures to be Employed to Reduce Impacts on Vegetative Resources	Vol. 1, 77 Plan, pp. 13-14, 17
3.4.5.3 Monitoring Procedures - Reference Areas & Revegetation	Vol. 2, 79 Sub., Ex. 6 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 35-37
3.4.6 Protection of Fish & Wildlife	
3.4.6.1 Projected Impacts of Mining on Fish & Wildlife	Vol. 4, 80 Sub., Wildlife Report, pp. 29-46
3.4.6.2 Mitigating Measures to be Employed to Protect Fish & Wildlife	Vol. 1, 77 Plan, pp. 16-17 Vol. 1, 77 Adden. #2, p. 1 Vol. 2, 79 Sub., pp. 44-46

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
	Vol. 2, 79 Sub., Ex. 1, Item 14 Vol. 2, 79 Sub., Ex. 5, pp. 29-49 Vol. 3, 80 Sub., Responses 784.21(b), 784.21(b)(1), 784.21(b)(2),(3) Vol. 4, 80 Sub., Hydrometrics Report, pp. 63-66 Vol. 4, 80 Sub., Wildlife Report, pp. 54-56 Vol. 5, 80 Sub., Avifauna Report, p. 13 Vol. 5, 80 Sub., Aquatic Resources Report, pp. 7-20
3.4.6.3 Monitoring Procedures	Vol. 3, 80 Sub., Response 784.21(b) Vol. 4, 80 Sub., Wildlife Report, pp. 54-56 Vol. 5, 80 Sub., Avifauna Report, p. 13 Vol. 5, 80 Sub., Aquatic Resources Report, pp. 7-20
3.4.7 Protection of Air Quality	
3.4.7.1 Projected Impacts of Mining on Air Quality	Vol. 2, 79 Sub., Ex. 3, pp. 16-17 Vol. 5, 80 Sub., Particulate Emissions Report
3.4.7.2 Mitigating Measures to be Employed to Control Air Pollutants	Vol. 1, 77 Plan, p. 21 Vol. 2, 79 Sub., pp. 47-51 Vol. 2, 79 Sub., Ex. 1, Item 15 Vol. 2, 79 Sub., Ex. 3, p. 10 Vol. 2, 79 Sub., Ex. 4, pp. 34-35 Vol. 3, 80 Sub., Response 784.26(b)
3.4.7.3 Air Quality Monitoring Plans	Vol. 1, 77 Plan, p. 21 Vol. 2, 79 Sub., pp. 47-51 Vol. 2, 79 Sub., Ex. 1, Item 15 Vol. 2, 79 Sub., Ex. 4, pp. 34-35 Vol. 5, 80 Sub., Response 784.26(a)
3.4.8 Subsidence Control Plan	
3.4.8.1 Projected Impacts of Subsidence	Vol. 1, 77 Plan, p. 11 Vol. 1, 77 Adden. #2, p. 1 Vol. 2, 79 Sub., Ex. 3, pp. 7, 24 Vol. 3, 80 Sub., Response 784.16(a)(1)(iv)

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
3.4.8.2 Control Measures to Mitigate Impacts	Vol. 1, 77 Plan, pp. 11-12 Vol. 1, Subsidence Report 1 (12-28-77) Vol. 1, Subsidence Report 2 (2-1-78) Vol. 2, 79 Sub., Ex. 3, pp. 4-7, 24 Vol. 3, 80 Sub., Response 784.20 Vol. 4, 80 Sub., Hydrometrics Report, pp. 63-66
3.4.8.3 Monitoring Procedures to Measure Projected Impacts & Controls	Vol. 2, 79 Sub., Ex. 5 Vol. 3, 80 Sub., Response 784.20 Vol. 4, 80 Sub., Hydrometrics Report, pp. 63-66
3.4.9 Waste Disposal Plans	Vol. 1, 77 Plan, p. 19 Vol. 1, 77 Plan, Map 1D Vol. 2, 79 Sub., pp. 28-29 Vol. 2, 79 Sub., Ex. 1, Item 5 Vol. 2, 79 Sub., Ex. 3, p. 9 Vol. 2, 79 Sub., Ex. 7, p. 2 Vol. 2, 79 Sub., Ex. 9 Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3, 9-6 Vol. 3, 80 Sub., Response 784.11(b)
3.4.9.1 Projected Impacts of Disposal Areas & Methods on Environment	Vol. 2, 79 Sub., Ex. 1, Item 5 Vol. 3, 80 Sub., Response 784.11(b)
3.4.9.2 Control Measures to Mitigate Impacts	Vol. 2, 79 Sub., pp. 28-29 Vol. 2, 79 Sub., Ex. 1, Item 5 Vol. 2, 79 Sub., Ex. 9 Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3, 9-6 Vol. 3, 80 Sub., Response 784.11(b) Vol. 5, 80 Sub., Valley Engineering Report
3.5 Reclamation Plan	
3.5.1 Contemporaneous Reclamation	Vol. 3, 80 Sub., Response 784.11(b)
3.5.2 Soil Removal and Storage	Vol. 1, 77 Plan, p. 19 Vol. 1, 77 Adden. #2, pp. 2-3 Vol. 2, 79 Sub., p. 53 Vol. 3, 80 Sub., Response 784.11(b)
3.5.3 Final Abandonment	
3.5.3.1 Sealing of Mine Openings	Vol. 1, 77 Plan, pp. 13-14 Vol. 3, 80 Sub., Responses 784.13(b)(8), 784.14(d)

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
3.5.3.2 Removal of Surface Structures	Vol. 1, 77 Plan, pp. 13-14, 20 Vol. 2, 79 Sub., Ex. 3, p. 8
3.5.3.3 Disposition of Dams, Ponds, & Diversions	Vol. 1, 77 Plan, p. 21 Vol. 2, 79 Sub., pp. 30-32 Vol. 2, 79 Sub., Ex. 1, Items 6, 8, 9, 11 Vol. 2, 79 Sub., Ex. 9
3.5.4 Backfilling & Grading Plans	Vol. 1, 77 Plan, pp. 13-14 Vol. 1, 77 Adden. #2, p. 2 Vol. 2, 79 Sub., p. 52 Vol. 2, 79 Sub., Ex. 11 (Map)
3.5.4.1 Recontouring	Vol. 1, 77 Plan, pp. 13-14 Vol. 1, 77 Adden. #1, Map - Cross Section D-D' Vol. 1, 77 Adden. #2, p. 2 Vol. 2, 79 Sub., p. 52 Vol. 2, 79 Sub., Ex. 11 (Map)
3.5.4.2 Removal & Reduction of Highwalls	Vol. 1, 77 Plan, pp. 13-14 Vol. 1, 77 Adden. #2, p. 2 Vol. 2, 79 Sub., p. 52 Vol. 2, 79 Sub., Ex. 11 (Map)
3.5.4.3 Terracing & Erosion Control	Vol. 1, 77 Plan, p. 13 Vol. 2, 79 Sub., p. 52 Vol. 1, 77 Adden. #2, p. 2
3.5.4.4 Soil Redistribution & Stabilization	Vol. 1, 77 Adden. #2, pp. 2-3 Vol. 2, 79 Sub., p. 53
3.5.5 Revegetation Plan	
3.5.5.1 Soil Preparation	Vol. 1, 77 Plan, pp. 13-14 Vol. 1, 77 Adden. #2, pp. 2-3 Vol. 2, 79 Sub., p. 53 Vol. 4, 80 Sub., Vegetation/Soils Report, p. 36
3.5.5.2 Seeding & Transplanting	Vol. 1, 77 Plan, p. 14 Vol. 1, 77 Adden. #2, pp. 2-3 Vol. 2, 79 Sub., pp. 53-54 Vol. 3, 80 Sub., Fishlake Comment 5 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 35-37

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
3.5.5.3 Mulching	Vol. 3, 80 Sub., Response 784.13(b)(5) Vol. 4, 80 Sub., Vegetation/Soils Report, p. 36
3.5.5.4 Management	Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 35-37
3.5.5.5 Revegetation Monitoring	Vol. 4, 80 Sub., Vegetation/Soils Report, p. 37
3.5.6 Schedule of Reclamation	
3.5.6.1 Detailed Timetable for Completion of Each Major Step in Reclamation	Vol. 1, 77 Plan, pp. 13-14 Vol. 1, 77 Adden. #2, pp. 2-3 Vol. 2, 79 Sub., pp. 52-54 Vol. 2, 79 Sub., Ex. 3, pp. 10-12
3.5.6.2 Reclamation Monitoring	Vol. 2, 79 Sub., Ex. 3, pp. 10-12
3.5.7 Cost Estimate for Reclamation	
3.5.7.1 Cost Estimate for Each Step of Reclamation	Vol. 1, 77 Plan, p. 16 Vol. 3, 80 Sub., Response 784.13(b)(2)
3.5.7.2 Forecast of Performance Bond Liability During Permit Term and Forecast of Liability for Life of Mine	Vol. 1, 77 Plan, p. 16 Vol. 2, 79 Sub., pp. 13-15 Vol. 3, 80 Sub., Response 784.13(b)(2)
3.6 Bibliography	
3.7 Photos - Maps	Vol. 1, 77 Plan, 1A, 1D, 1E, 1F Vol. 1, 77 Adden. #1, Cross Section D-D' Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3, 9-6, 9-8 Vol. 2, 79 Sub., Ex. 11 Vol. 3, 80 Sub., Maps 80-2, 80-4, 4a, 4b, 4c, 80-11

CHAPTER IV

LAND STATUS, LAND USE AND POSTMINING LAND USE

4.0 Table of Contents	Vol. 1, pp. iii-viii

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
4.1 Scope	Vol. 1, pp. ix-xi
4.2 Methodology	
4.3 Land Status	
4.3.1 Surface Land Status/Mine Plan Area	
4.3.1.1 Ownership	Vol. 1, pp. ix-xi Vol. 1, 77 Plan, p. 1 Vol. 2, 79 Sub., pp. 7-9 Vol. 3, 80 Sub., Responses 782.13(a)(2), 782.13(b) Vol. 3, 80 Sub., Map 80-1
4.3.1.2 Surface Managing Authorities	Vol. 1, 77 Plan, p. 1 Vol. 2, 79 Sub., p. 5
4.3.1.3 Utility Corridors & Other Right-of-Ways	Vol. 1, 77 Plan, Map 1A Vol. 3, 80 Sub., Response 784.23(b)(1) Vol. 3, 80 Sub., Maps 80-4, 4a, 4b, 4c
4.3.1.4 Special Use Permits & Leases	Vol. 3, 80 Sub., Fishlake Comment 3
4.3.2 Mineral Ownership/Mine Plan Area	
4.3.2.1 Coal Ownership & Mines	Vol. 1, pp. ix-xi Vol. 1, 77 Plan, p. 1 Vol. 1, 77 Agency Review Submittal, Map - Ownership Plat
4.3.2.2 Coal Leases	Vol. 2, 79 Sub., Ex. 3, pp. 1-3 Vol. 3, 80 Sub., Response 782.13(b)
4.3.2.3 Mineral Ownership & Mines	---
4.3.2.4 Mineral Leases	---
4.3.2.5 Oil & Gas Ownership/Wells	Vol. 1, 77 Plan, p. 76 Vol. 4, 80 Sub., Hydrometrics Report, p. 58
4.3.2.6 Oil & Gas Leases	---

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
4.4 Land Use	
4.4.1 Regional Land Use	Vol. 2, 79 Sub., Ex. 3, pp. 20-21
4.4.2 Land Use in Mine Plan Area	Vol. 1, 77 Plan, pp. 8-10 Vol. 2, 79 Sub., Ex. 1, Item 3 Vol. 2, 79 Sub., Ex. 3, pp. 18-21 Vol. 3, 80 Sub., Map 80-3
4.4.3 Land Use During Operation	
4.4.3.1 Affect of Operation on Land Use	Vol. 1, 77 Plan, pp. 9-10 Vol. 2, 79 Sub., Ex. 3, pp. 18-24
4.4.3.2 Mitigation of Effects of Operation	Vol. 2, 79 Sub., Ex. 3, pp. 18-24
4.5 Postmining Land Use	Vol. 1, 77 Plan, pp. 9-10 Vol. 2, 79 Sub., Ex. 3, pp. 18-21 Vol. 3, 80 Sub., Map 80-3
4.6 Socioeconomic Considerations	Vol. 2, 79 Sub., Ex. 3, pp. 21-23, 27-31
4.7 Bibliography	
4.8 Chapter IV - Plates (Maps)	Vol. 1, 77 Plan, Map 1A Vol. 1, 77 Agency Review Submittal, Ownership Plat Vol. 3, 80 Sub., Maps 80-1, 80-3, 80-4, 4a, 4b, 4c

CHAPTER V

HISTORICAL AND CULTURAL RESOURCES

5.0 Table of Contents	Vol. 1, pp. iii-viii
5.1 Scope	Vol. 1, pp. ix-xi
5.2 Methodology	
5.3 Historical Resources	
5.3.1 Historical Inventory	Vol. 3, 80 Sub., Response 783.12(b) Vol. 4, 80 Sub., Archaeology Report

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
5.3.2 History of Mining	Vol. 2, 79 Sub., Ex. 3, pp. 1-4 Vol. 4, 80 Sub., Archaeology Report, p. 21
5.3.3 Effects of Mining on Historical Resources	Vol. 3, 80 Sub., Response 784.17 Vol. 4, 80 Sub., Archaeology Report, pp. 40-56
5.4 Archaeological Resources	
5.4.1 Archaeological Inventory	Vol. 3, 80 Sub., Response 783.24(i) Vol. 4, 80 Sub., Archaeology Report
5.4.2 Effects of Mining on Archaeological Resources	Vol. 3, 80 Sub., Response 784.17 Vol. 4, 80 Sub., Archaeology Report, pp. 40-56
5.5 Paleontological	
5.5.1 Paleontologic Inventory	Vol. 4, 80 Sub., Archaeology Report, pp. 16-19, 30-33, 40-56
5.5.2 Effects of Mining on Paleontologic Resources	Vol. 3, 80 Sub., Response 784.17 Vol. 4, 80 Sub., Archaeology Report, pp. 40-56
5.6 Public Parks	
5.6.1 Inventory of Public Facilities	Vol. 3, 80 Sub., Response 784.17
5.6.2 Effects of Mining on Public Facilities	Vol. 3, 80 Sub., Response 784.17
5.7 Bibliography	
5.8 Chapter V - Plates (Maps)	

CHAPTER VI

GEOLOGY

6.0 Table of Contents	Vol. 1, pp. iii-viii
6.1 Scope	Vol. 1, pp. ix-xi

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
6.2 Methodology	
6.3 Regional Geologic Framework	Vol. 3, 80 Sub., Response 783.14(a)
6.4 Geology of Project Vicinity	
6.4.1 Stratigraphy	Vol. 1, 77 Plan, pp. 2-4 Vol. 1, 77 Plan, Map 1F Vol. 3, 80 Sub., Responses 783.14(a), 783.14(a)(1)(ii-iv), 783.14(a)(2)(iii) Vol. 3, 80 Sub., Map 80-6
6.4.2 Structure	Vol. 1, 77 Plan, pp. 3-4 Vol. 3, 80 Sub., Response 783.14(a)
6.5 Geology of Coal Bed & Adjacent Units	
6.5.1 Exploration & Drilling	Vol. 1, 77 Plan, p. 10 Vol. 2, 79 Sub., pp. 3-4
6.5.2 Stratigraphy	Vol. 1, 77 Plan, pp. 2-4 Vol. 1, 77 Plan, Map 1F Vol. 3, 80 Sub., Response 783.14(a) Vol. 3, 80 Sub., Map 80-6
6.5.3 Structure	Vol. 1, 77 Plan, pp. 3-4 Vol. 3, 80 Sub., Response 783.14(a)
6.5.4 Detailed Columns of Interest/ Cross Sections	Vol. 1, 77 Plan, Map 1F Vol. 3, 80 Sub., Response 783.14(a) Vol. 3, 80 Sub., Map 80-6
6.5.5 Coal Reserves	
6.5.5.1 Reserve Calculations	Vol. 1, 77 Plan, p. 10 Vol. 2, 79 Sub., Ex. 3, p. 2 Vol. 3, 80 Sub., Response 783.22(b)
6.5.5.2 Coal Quality & Characteristics, Sulfur Forms, Clay & Alkalinity	Vol. 1, 77 Plan, Map 1F
6.5.6 Adjacent Units (Overburden)	

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
6.5.6.1 Rock Characteristics, Acid-Toxic, Pyrite, Clay & Alkalinity	Vol. 1, 77 Plan, pp. 22-38 Vol. 1, 77 Plan, Map 1A Vol. 3, 80 Sub., Response 783.14(a)(2)(iii) Vol. 3, 80 Sub., Map 80-2
6.6 Geologic Effects of Mining	
6.6.1 Mining Hazards	Vol. 2, 79 Sub., Ex. 3, p. 24 Vol. 3, 80 Sub., Response 784.20 Vol. 3, 80 Sub., Maps 80-9, 8-10 Vol. 4, 80 Sub., Subsidence Report
6.6.2 Surface Hazards	Vol. 1, 77 Adden. #2, p. 1 Vol. 3, 80 Sub., Response 784.20 Vol. 3, 80 Sub., Maps 80-9, 80-10 Vol. 4, 80 Sub., Subsidence Report
6.6.3 Impacts of Mining	Vol. 1, 77 Adden. #2, p. 1 Vol. 2, 79 Sub., Ex. 3, p. 24 Vol. 3, 80 Sub., Response 784.20 Vol. 3, 80 Sub., Maps 80-9, 80-10 Vol. 4, 80 Sub., Subsidence Report
6.7 Bibliography	
6.8 Chapter VI - Plates (Maps)	Vol. 1, 77 Plan, Maps 1A, 1F Vol. 3, 80 Sub., Maps 80-2, 80-6, 80-9, 80-10
CHAPTER VII	
HYDROLOGY	
7.0 Table of Contents	Vol. 1, pp. iii-viii
7.1 Groundwater Hydrology	
7.1.0 Scope	Vol. 1, pp. ix-xi
7.1.1 Methodology	
7.1.2 Existing Groundwater Resources	
7.1.2.1 Regional Groundwater Hydrology	Vol. 1, 77 Plan, pp. 40-42 Vol. 4, 80 Sub., Hydrometrics Report, pp. 4-19

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
7.1.2.2 Mine Plan Area Aquifers	Vol. 1, 77 Plan, pp. 40-42, 57 Vol. 2, 79 Sub., pp. 36-37 Vol. 2, 79 Sub., Ex. 5, pp. 13-14 Vol. 3, 80 Sub., Responses 783.15(a)(1), 783.15(a)(2), 783.15(b) Vol. 4, 80 Sub., Hydrometrics Report, pp. 6-20; Plate H-II
7.1.3 Groundwater Development & Mine Dewatering	
7.1.3.1 Water Supply	Vol. 1, 77 Plan, pp. 40-42 Vol. 2, 79 Sub., p. 36 Vol. 2, 79 Sub., Ex. 5, pp. 13-14 Vol. 3, 80 Sub., Response 783.15(a)(4) Vol. 4, 80 Sub., Hydrometrics Report, pp. 21-37, 60
7.1.3.2 Mine Dewatering	Vol. 1, 77 Plan, p. 21
7.1.4 Effects of Mining Operation on Groundwater	
7.1.4.1 Hydrologic Balance	Vol. 4, 80 Sub., Hydrometrics Report, pp. 59, 61-62
7.1.4.2 Quantity	Vol. 4, 80 Sub., Hydrometrics Report, p. 60
7.1.5 Mitigation & Control Plans	Vol. 2, 79 Sub., Ex. 9 Vol. 3, 80 Sub., Response 784.14(b)(1) Vol. 4, 80 Sub., Hydrometrics Report, p. 61
7.1.6 Groundwater Monitoring Plan	Vol. 2, 79 Sub., Ex. 5, pp. 13-14 Vol. 4, 80 Sub., Hydrometrics Report, pp. 21, 59, 61
7.2 Surface Water Hydrology	
7.2.0 Scope	Vol. 1, pp. ix-xi
7.2.1 Methodology	
7.2.2 Existing Surface Water Resources	

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
7.2.2.1 Regional Surface Water Hydrology	Vol. 1, 77 Plan, pp. 16, 42-57 Vol. 3, 80 Sub., Response 783.16(a) Vol. 4, 80 Sub., Hydrometrics Report, pp. 27-51; Plate H-II
7.2.2.2 Mine Plan Area Watersheds & Streams, Springs, Seeps/ Characteristics	Vol. 1, 77 Plan, pp. 42-56 Vol. 4, 80 Sub., Hydrometrics Report, pp. 27-51
7.2.3 Surface Water Development, Control, & Diversions	
7.2.3.1 Water Supply	Vol. 1, 77 Plan, pp. 51-55 Vol. 2, 79 Sub., pp. 33-35 Vol. 2, 79 Sub., Ex. 1, Item 6 Vol. 2, 79 Sub., Ex. 5, pp. 15-19 Vol. 2, 79 Sub., Ex. 6 Vol. 2, 79 Sub., Ex. 8
7.2.3.2 Sedimentation Control Structures	Vol. 1, 77 Plan, pp. 43-52, 57-62 Vol. 2, 79 Sub., Ex. 5, pp. 5-14 Vol. 2, 79 Sub., Ex. 9 Vol. 2, 79 Sub., Ex. 9, Maps 9-1 through 9-9 Vol. 2, 79 Sub., Ex. 12 (Map) Vol. 3, 80 Sub., Response 783.16(b)(1) Vol. 4, 80 Sub., Hydrometrics Report, pp. 27-51
7.2.4 Effects of Mining on Surface Water	
7.2.4.1 Hydrologic Balance	Vol. 1, 77 Plan, p. 57 Vol. 4, 80 Sub., Hydrometrics Report, pp. 60, 62
7.2.4.2 Quality	Vol. 1, 77 Plan, pp. 51-55 Vol. 2, 79 Sub., pp. 33-35 Vol. 4, 80 Sub., Hydrometrics Report, p. 59
7.2.5 Mitigation & Control Plans	Vol. 2, 79 Sub., Ex. 9 Vol. 3, 80 Sub., Response 784.14(b)(1) Vol. 4, 80 Sub., Hydrometrics Report, p. 61

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
7.2.6 Surface Water Monitoring Plans	Vol. 1, 77 Plan, pp. 16, 21, 42-65, 75 Vol. 2, 79 Sub., pp. 33-35 Vol. 2, 79 Sub., Ex. 1, Item 7 Vol. 2, 79 Sub., Ex. 5, pp. 4-20 Vol. 2, 79 Sub., Ex. 6 Vol. 2, 79 Sub., Ex. 8
7.3 Alluvial Valley Floor Determination	Vol. 3, 80 Sub., Response 785.19 Vol. 4, 80 Sub., Hydrometrics Report, pp. 67-71; Plates H-I, H-II
7.4 Bibliography	
7.5 Chapter VII - Plates (Maps)	Vol. 2, 79 Sub., Ex. 9, Maps 9-1 through 9-9 Vol. 2, 79 Sub., Ex. 12 Vol. 4, 80 Sub., Hydrometrics Report, Plates H-I, H-II
CHAPTER VIII	
SOIL RESOURCES	
8.0 Table of Contents	Vol. 1, pp. iii-viii
8.1 Scope	Vol. 1, pp. ix-xi
8.2 Methodology	
8.3 Soils Resource Information of Mine Plan Area	
8.3.1 Soils Identification	Vol. 1, 77 Plan, p. 5 Vol. 2, 79 Sub., pp. 38-43
8.3.2 Soils Description	Vol. 1, 77 Plan, p. 5 Vol. 2, 79 Sub., pp. 38-43 Vol. 2, 79 Sub., Ex. 1, Item 12 Vol. 3, 80 Sub., Response 783.21(a)(3) Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 13-15; Maps B, D
8.3.3 Present & Potential Productivity of Existing Soils	Vol. 2, 79 Sub., pp. 38-43 Vol. 2, 79 Sub., Ex. 1, Item 12 Vol. 3, 80 Sub., Response 783.21(a)(4) Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 13-15

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
8.4 Prime Farmland Investigation & Determination	Vol. 3, 80 Sub., Response 783.27(a), (c),(d)
8.5 Soils, Physical & Chemical Properties of Soils & Results of Analyses, Tests & Trials	Vol. 2, 79 Sub., pp. 38-43 Vol. 2, 79 Sub., Ex. 7, p. 3 Vol. 3, 80 Sub., Response 783.21(a)(2) Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 13-15, 37, 79-101
8.6 Use of Selected Overburden Materials or Substitutes	Not Applicable
8.7 Plans for Removal, Storage & Protection of Soils	Vol. 1, 77 Adden. #2, pp. 2-3 Vol. 2, 79 Sub., p. 53 Vol. 2, 79 Sub., Ex. 1, Item 12
8.8 Plans for Redistribution of Soils	Vol. 1, 77 Plan, pp. 13-14 Vol. 1, 77 Adden. #2, pp. 2-3 Vol. 2, 79 Sub., p. 52 Vol. 2, 79 Sub., Ex. 11 (Map)
8.9 Nutrients & Soil Amendments	Vol. 2, 79 Sub., pp. 38-43 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 13-15
8.10 Effects of Mining Operations on Soils, Nutrients & Soil Amendments to be Used	Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 13-15, 18-34
8.11 Mitigation & Control Plans	Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 13-15, 35-37
8.12 Bibliography	
8.13 Chapter VIII, Plates (Survey Maps)	Vol. 2, 79 Sub., Ex. 11 Vol. 4, 80 Sub., Hydrometrics Report, Plates H-I, H-II Vol. 4, 80 Sub., Vegetation/Soils Report, Maps B, D

CHAPTER IX

VEGETATION RESOURCES

9.0 Table of Contents	Vol. 1, pp. iii-viii
9.1 Scope	Vol. 1, pp. ix-xi

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
9.2 Methodology	
9.3 Existing Resources	
9.3.1 General Site Description	Vol. 1, 77 Plan, pp. 5-6 Vol. 2, 79 Sub., pp. 23-26 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 2-4
9.3.2 Vegetation Types: for Each Vegetation Type	
9.3.2.1 Cover Data	Vol. 1, 77 Plan, p. 14 Vol. 2, 79 Sub., pp. 23-26, 53-54 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 2-4; Maps A, C
9.3.2.2 Production Data	Vol. 1, 77 Plan, p. 14 Vol. 2, 79 Sub., pp. 23-26, 53-54 Vol. 3, 80 Sub., Fishlake Comment 5
9.3.2.3 Tree Data	Vol. 2, 79 Sub., pp. 23-26, 53-54 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 2-4
9.3.2.4 General Description per Vegetation Guideline	Vol. 2, 79 Sub., pp. 23-26
9.3.2.5 Species List	Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 4, 103-107
9.3.2.6 Total Acres in Plan Area	Vol. 2, 79 Sub., pp. 22-26
9.3.2.7 Total Acres of Vegetation Types to be Disturbed	Vol. 2, 79 Sub., pp. 22-26
9.3.2.8 Reference Area Supporting Data (or Alternative Methods)	Vol 4, 80 Sub., Vegetation/Soils Report, pp. 4-11, 37
9.4 Threatened & Endangered Species	Vol. 1, 77 Plan, p. 6 Vol. 4, 80 Sub., Vegetation/Soils Report, p. 12
9.5 Effects of Mining Operations on Vegetation	Vol. 1, 77 Plan, p. 17 Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 9-11

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
9.6 Mitigation & Management Plans	Vol. 2, 79 Sub., Ex. 6 Vol. 2, 79 Sub., Ex. 11 (Map) Vol. 4, 80 Sub., Vegetation/Soils Report, p. 37
9.7 Revegetation Methods & Justification	Vol. 4, 80 Sub., Vegetation/Soils Report, pp. 35-37
9.8 Revegetation Monitoring	Vol. 4, 80 Sub., Vegetation/Soils Report, p. 37
9.9 Bibliography	
9.10 Chapter IX - Plates (Maps)	Vol. 2, 79 Sub., Ex. 11 Vol. 4, 80 Sub., Vegetation/Soils Report, Maps A, C
CHAPTER X	
FISH AND WILDLIFE RESOURCES	
10.0 Table of Contents	Vol. 1, pp. iii-viii
10.1 Scope	Vol. 1, pp. ix-xi
10.2 Methodology	
10.3 Existing Fish & Wildlife Resources	
10.3.1 Wildlife Habitats in Mine Plan Area	Vol. 2, 79 Sub., Ex. 5, pp. 29-49 Vol. 4, 80 Sub., Wildlife Report, Figures 2, 3
10.3.2 Wildlife	
10.3.2.1 Aquatic Wildlife & Habitat Value Determination	Vol. 5, Sub., Aquatic Resources Report
10.3.2.2 Terrestrial Wildlife & Habitat Value Determination	Vol. 4, 80 Sub., Wildlife Report
10.3.2.3 Mammals	Vol. 2, 79 Sub., Ex. 5, pp. 41-44 Vol. 4, 80 Sub., Wildlife Report, pp. 19-24, 29-37

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
10.3.2.4 Birds	Vol. 2, 79 Sub., Ex. 5, pp. 38-40 Vol. 3, 80 Sub., Response 784.21(b)(2),(3) Vol. 4, 80 Sub., Wildlife Report, p. 37 Vol. 5, 80 Sub., Avifauna Report
10.3.2.5 Reptiles & Amphibians	Vol. 4, 80 Sub., Wildlife Report, pp. 25-27
10.3.3 Species of Special Significance	
10.3.3.1 Threatened & Endangered Species	Vol. 1, 77 Plan, pp. 16-17 Vol. 1, 77 Adden. #2, p. 1 Vol. 2, 79 Sub., Ex. 1, Item 14 Vol. 3, 80 Sub., Response 784.21(b)(1) Vol. 4, 80 Sub., Wildlife Report, pp. 8, 44, 51 Vol. 5, 80 Sub., Avifauna Report, pp. 8-9, 10 Vol. 5, 80 Sub., Aquatic Resources Report, p. 6
10.3.3.2 Raptors	Vol. 2, 79 Sub., Ex. 5, pp. 38-40 Vol. 3, 80 Sub., Response 784.21(b)(2),(3) Vol. 4, 80 Sub., Wildlife Report, p. 37 Vol. 5, 80 Sub., Avifauna Report
10.4 Expected Impacts of Mining Operations on Fish & Wildlife	Vol. 1, 77 Plan, pp. 16-17 Vol. 1, 77 Adden. #2, p. 1 Vol. 2, 79 Sub., pp. 44-46 Vol. 2, 79 Sub., Ex. 1, Item 14 Vol. 2, 79 Sub., Ex. 5, pp. 29-49 Vol. 3, 80 Sub., Response 784.21(b)(1) Vol. 4, 80 Sub., Wildlife Report, pp. 42-47 Vol. 5, 80 Sub., Avifauna Report, pp. 3, 10-12 Vol. 5, 80 Sub., Aquatic Resources Report, pp. 7-20
10.5 Mitigation & Management Plans	Vol. 1, 77 Plan, pp. 16-17 Vol. 2, 79 Sub., pp. 44-46 Vol. 2, 79 Sub., Ex. 1, Item 14 Vol. 2, 79 Sub., Ex. 5, p. 48

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
	Vol. 4, 80 Sub., Wildlife Report, pp. 54-56 Vol. 5, 80 Sub., Avifauna Report, p. 13 Vol. 5, 80 Sub., Aquatic Resources Report, pp. 7-20
10.6 Stream Buffer Zone Determination	Vol. 1, 77 Plan, p. 39 Vol. 2, 79 Sub., pp. 30-32 Vol. 2, 79 Sub., Ex. 9 Vol. 5, 80 Sub., Valley Engineering Report, Sheet 1 (Map)
10.7 Fish & Wildlife Monitoring	Vol. 2, 79 Sub., Ex. 6 Vol. 3, 80 Sub., Response 784.21(b) Vol. 4, 80 Sub., Wildlife Report, pp. 54-56 Vol. 5, 80 Sub., Avifauna Report, p. 13 Vol. 5, 80 Sub., Aquatic Resources Report, pp. 7-20
10.8 Bibliography	
10.9 Chapter X - Plates (Maps)	Vol. 4, 80 Sub., Wildlife Report, Figures 2, 3 Vol. 5, 80 Sub., Valley Engineering Report, Sheet 1
CHAPTER XI	
CLIMATOLOGY AND AIR QUALITY	
11.0 Table of Contents	Vol. 1, pp. iii-viii
11.1 Scope	Vol. 1, pp. ix-xi
11.2 Methodology	
11.3 Existing Environment	
11.3.1 Precipitation	Vol. 1, 77 Plan, p. 7 Vol. 2, 79 Sub., Ex. 3, pp. 15-16 Vol. 5, 80 Sub., Air Quality Report

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
11.3.2 Temperature	Vol. 1, 77 Plan. p. 7 Vol. 2, 79 Sub., Ex. 3, pp. 15-16 Vol. 2, 79 Sub., Ex. 4, p. 34 Vol. 5, 80 Sub., Air Quality Report
11.3.3 Evaporation	---
11.3.4 Relative Humidity	---
11.3.5 Wind	Vol. 1, 77 Plan, p. 7 Vol. 2, 79 Sub., p. 50 Vol. 2, 79 Sub., Ex. 3, p. 15 Vol. 2, 79 Sub., Ex. 4, p. 34 Vol. 5, 80 Sub., Air Quality Report
11.4 Effects of Mining Operation on Air Quality	
11.4.1 Estimate of Uncontrolled Emissions	Vol. 5, 80 Sub., Particulate Emissions Report, pp. 10-19
11.4.2 Description of Control Measures	Vol. 1, 77 Plan, p. 21 Vol. 2, 79 Sub., pp. 50-51 Vol. 2, 79 Sub., Ex. 3, pp. 9-10 Vol. 5, 80 Sub., Particulate Emissions Report, pp. 9-10
11.4.3 Estimate of Controlled Emissions	Vol. 5, 80 Sub., Particulate Emissions Report
11.4.4 Estimated Cost of Emission Control	---
11.5 Climatological & Air Quality Monitoring	Vol. 1, 77 Plan, p. 21 Vol. 2, 79 Sub., pp. 47-51 Vol. 2, 79 Sub., Ex. 1, Item 15 Vol. 2, 79 Sub., Ex. 4, pp. 34-35 Vol. 3, 80 Sub., Response 784.26(a) Vol. 5, 80 Sub., Air Monitoring Report
11.6 Bibliography	
11.7 Chapter XI - Plates (Maps)	

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
CHAPTER XII	
GEOTECHNICAL	
12.0 Table of Contents	Vol. 1, pp. iii-viii
12.1 Scope	Vol. 1, pp. ix-xi
12.2 Methodology	
12.3 Underground Mine Design	
12.3.1 Geotechnical Tests & Analysis	Vol. 1, 77 Plan, pp. 32-39 Vol. 1, 77 Plan, Map 1F Vol. 2, 79 Sub., pp. 3-4 Vol. 3, 80 Sub., Response 783.25(a) Vol. 3, 80 Sub., Map 80-5
12.3.2 Coal Pillar Design	Vol. 1, 77 Plan, pp. 11-12 Vol. 2, 79 Sub., pp. 4-7
12.3.3 Roof Span Design	Vol. 2, 79 Sub., pp. 4-7
12.4 Surface Subsidence Effects of Mining	
12.4.1 Subsidence Mechanisms	Vol. 1, 77 Plan, pp. 11-12 Vol. 1, Subsidence Report 1 (12-28-77) Vol. 1, Subsidence Report 2 (2-1-78) Vol. 2, 79 Sub., pp. 4-7 Vol. 4, 80 Sub., Subsidence Report
12.4.2 Projected Subsidence Effects	Vol. 1, 77 Plan, pp. 11-12 Vol. 1, 77 Adden. #2, p. 1 Vol. 2, 79 Sub., Ex. 3, pp. 7, 24 Vol. 4, 80 Sub., Subsidence Report
12.4.3 Subsidence Control & Mitigation Methods	Vol. 1, 77 Plan, pp. 11-12 Vol. 2, 79 Sub., Ex. 3, pp. 7, 24 Vol. 3, 80 Sub., Response 784.20 Vol. 4, 80 Sub., Hydrometrics Report, pp. 63-66 Vol. 4, 80 Sub., Subsidence Report
12.4.4 Subsidence Monitoring Plan	Vol. 1, Subsidence Report 1 (12-28-77) Vol. 1, Subsidence Report 2 (2-1-78) Vol. 2, 79 Sub., Ex. 5

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
	Vol. 3, 80 Sub., Response 784.20 Vol. 4, 80 Sub., Hydrometrics Report, pp. 63-66 Vol. 4, 80 Sub., Subsidence Report
12.5 Stability Analysis of Earthen Structures	
12.5.1 Type of Structure	Vol. 1, 77 Plan, p. 15 Vol. 1, 77 Plan, Map 1D Vol. 1, 77 Adden. #2, p. 3 Vol. 2, 79 Sub., pp. 30-32 Vol. 2, 79 Sub., Ex. 1, Items 6, 8, 9, 11 Vol. 2, 79 Sub., Ex. 9 Vol. 5, 80 Sub., Valley Engineering Report
12.5.1.1 Hazard Considerations	Vol. 2, 79 Sub., Ex. 3, p. 9 Vol. 3, 80 Sub., Response 784.16(a)(1)(iv)
12.5.2 Construction Material Characteristics	Vol. 2, 79 Sub., Ex. 9 Vol. 5, 80 Sub., Valley Engineering Report
12.5.3 Foundation Material Characteristics	Vol. 2, 79 Sub., Ex. 9 Vol. 5, 80 Sub., Valley Engineering Report
12.5.4 Hydrologic Characteristics	Vol. 2, 79 Sub., pp. 30-32 Vol. 2, 79 Sub., Ex. 9 Vol. 5, 80 Sub., Valley Engineering Report
12.5.5 Design & Construction Plans	Vol. 2, 79 Sub., Ex. 9 Vol. 2, 79 Sub., Ex. 9, Maps 9-1 through 9-9 Vol. 3, 80 Sub., Response 784.16(v) Vol. 3, 80 Sub., Fishlake Comment 1 Vol. 5, 80 Sub., Valley Engineering Report, Sheets 1 through 6 (Maps) Vol. 5, 80 Sub., Technical Correspondence
12.5.6 Stability Analysis	Vol. 2, 79 Sub., Ex. 9 Vol. 5, 80 Sub., Valley Engineering Report

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
12.6 Bibliography	
12.7 Chapter XII - Plates (Maps)	Vol. 1, 77 Plan, Maps 1D, 1F Vol. 2, 79 Sub., Ex. 9, Maps 9-1 through 9-9 Vol. 3, 80 Sub., Map 80-5 Vol. 5, 80 Sub., Valley Engineering Report, Sheets 1 through 6
CHAPTER XIII	
DESIGNS	
13.0 Table of Contents	
13.1 Scope	
13.2 Methodology	
13.3 Detail Designs	Vol. 2, 79 Sub., Ex. 9, Maps 9-4, 9-5, 9-6, 9-7, 9-8 Vol. 5, 80 Sub., Valley Engineering Report, Sheets 3, 4, 5, 6
13.4 Bibliography	
13.5 Chapter XIII - Plates (Maps)	Vol. 2, 79 Sub., Ex. 9, Maps 9-4, 9-5, 9-6, 9-7, 9-8 Vol. 5, 80 Sub., Valley Engineering Report, Sheets 3, 4, 5, 6
CHAPTER XIV	
CONSULTATION AND COORDINATION	
14.0 Table of Contents	
14.1 Scope	Consultations of major importance between the Applicant and Federal, State and Local authorities and other interested parties are documented at various places throughout the Amended Mine Plan.

STATE OF UTAH FORMAT GUIDELINE	COASTAL STATES/SUFCO 1980 SUBMITTAL RESPONSE
14.2 Federal Consultation & Coordination	
14.3 State Consultation & Coordination	
14.4 Local Consultation & Coordination	
14.5 Consultation & Coordination with Entities of Interest	
14.6 Other Consultation & Coordination	

SOUTHERN UTAH FUEL COMPANY

SUFCO COAL MINE

COASTAL STATES ENERGY COMPANY

1980

VOLUME 5

NOV 26 1980

DIVISION OF
OIL, GAS & MINING

VOLUME 5

TABLE OF CONTENTS

UPDATE REPORTS - 1980 (Continued)

- Avifauna
- Air Monitoring
- Particulate Emissions
- Aquatic Resources
- Drainage/Sediment Control

TECHNICAL CORRESPONDENCE

United States Department of the Interior
OFFICE OF SURFACE MINING
Reclamation and Enforcement
BROOKS TOWERS
1020 15TH STREET
DENVER, COLORADO 80202

OFFICE OF THE REGIONAL DIRECTOR

FEB 17 1981

Mr. Vernal J. Mortensen
Coastal States Energy Company
411 West 7200 South
Midvale, UT 84047

Dear V/Bob:

This letter is in response to your January 19 correspondence and discussions with John Carr concerning a revision to Coastal States mining plan.

On March 25, 1980, OSM approved Coastal States request to enter Federal Lease U-28297; this approval was granted during the period that the mining and reclamation (M/R) plan for the entire lease area was being reviewed. This action permitted Coastal States to extend second East Main a sufficient distance to allow the completion of panels 4, 5, and 6.

As you have indicated, the revised mine layout plan proposes to (1) extend second East Main to the outcrop (all within Federal Lease U-28297), (2) extend third North Submain to the outcrop (with Federal Leases U-28297 and U-062453), and (3) extend fourth North Submain short of breaking out at the outcrop (all within Federal Lease U-28297). However, the coal production rate will not significantly change, nor will new access roads or other surface facilities be established. Therefore, these additional operations constitute a small part of the overall operation and are considered a minor modification to the existing 30 CFR 211 approval.

Based on these understandings, Coastal States may extend the proposed mining operations on Federal Leases U-28297 and U-062453 as identified above and conditioned upon the following:

a. Acceptance of the attached Standard Stipulations;

b. Agreement that any Special Stipulations developed as a result of the overall M/R plan review will be made part of the action on the entire mine plan and will retroactively apply to all operations undertaken pursuant to this approval;

c. The operator shall not construct the ventilation portals in a manner that would obstruct game trails and thus impede big game from using the migration corridor along the cliffs of Quitchupah Canyon; and

d. The operator shall not construct ventilation portals from April 1 through May 31, unless the operator can demonstrate to OSM and the State that raptor nests, cougar dens, or big game migration routes will not be impacted by construction activities. This demonstration must be submitted to OSM for approval prior to breaking out.

Coastal States Energy Company may proceed with operations identified above upon acceptance of these conditions. The U.S. Geological Survey, Fishlake National Forest, and Utah Division of Oil, Gas and Mining concur with OSM's approval of Coastal States' revision to the mining plan (see attached correspondence). Acceptance can be indicated by cosigning and returning this letter or by separate correspondence.

Sincerely,

DONALD A. CRANE

Attachment

Agreed and Accepted on this 19 day of February

By Vernon J. Mortensen

SCOTT M. MATHESON
Governor

GORDON E. HARMSTON
Executive Director,
NATURAL RESOURCES

CLEON B. FEIGHT
Director

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS, AND MINING
1588 West North Temple
Salt Lake City, Utah 84116
(801) 533-5771

OIL, GAS, AND MINING BOARD

CHARLES R. HENDERSON
Chairman

JOHN L. BELL
C. RAY JUVELIN
THADIS W. BOX
MAXILIAN A. FARBMAN
EDWARD T. BECK
E. STEELE McINTYRE

July 31, 1981

Mr. Kerry Frame
Southern Utah Fuel Company
P. O. Box P
Salina, Utah 84654

RE: U. S. Geological Survey
211 Regulations
Cross-Reference Index

Dear Mr. Frame:

The Division of Oil, Gas and Mining has recently received a request from the U. S. Geological Survey (USGS) for a cross-reference index of the 211 regulations and the Utah State Reclamation Program to be included in each permit application. Through such a cross-reference index, the coal mine permit reviews of the USGS may be expedited.

Since much of the 211 information may already be included in your mining and reclamation plan, and other subsequent modifications, it is suggested that you identify where and in which submissions the information may be found. A format for the cross-reference has been enclosed for your convenience.

If this material has been submitted to the USGS but not the Office of Surface Mining or Division of Oil, Gas and Mining, then this information should be duplicated for each.

Please contact Sally Kefer of my staff if you have any questions concerning this request.

Sincerely,

JAMES W. SMITH, JR.
COORDINATOR OF MINED
LAND DEVELOPMENT

JWS/SK/btm

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(1) Names, addresses, and telephone numbers of persons responsible for operations under the plan to whom notices and orders are to be delivered, and the names and addresses of surface owners of record, and owners of record of subsurface minerals, if other than the United States.

UMC	Section	Page
782.13	2.2	Vol. 1, 77 Plan, p. 1
(a)		Vol. 2, 79 Sub., pp. 4-5, 7-9
		Vol. 3, 80 Sub., Map 80-1
		Vol. 3, 80 Sub., Compliance Responses 782.13(a),(4), 782.13(b), 782.19(c),(d), 782.13(g)

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(2) A description of geologic conditions, with maps and tables where appropriate, within the area where mining is to be conducted and including any Logical Mining Unit. Such description shall include, as a minimum, potential geologic hazards; and a description of the structural features of the coal and overlying strata, including faults, cleats, joints and fractures and any other information which would affect the orientation of the mine or production methods.

UMC	Section	Page
783.14	3.3.1.1	Vol. 1, 77 Plan, pp. 2-4
	6.4.1	Vol. 1, 77 Plan, Map 1F
	6.4.2	Vol. 3, Sub., Compliance Responses 783.14(a), 784,14(a)(1)(ii-iv), 783.14(a)(2)(iii), 783.25(c)
	6.5.2	
	6.5.3	
	6.5.4	Vol. 3, 80 Sub., USGS Comment 6
		Vol. 3, 80 Sub., Maps 80-5, 80-6, 80-7, 80-8A, 80-8B
		Vol. 4, 80 Sub., Hydrology Report, pp. 6-9
		Vol. 7, 81 Suppl., Geology, pp. 3-5, Maps 81-2, 81-3, 81-4

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(6)(i) The nature and extent of the coal deposit in terms of Btu content, ash, water, sulphur, volatile matter and carbon content, and any other available information that may affect blending or combustion and including estimated recoverable reserves. The recoverable reserves shall be reported for all coal seams of mineable thickness, considering the type of mining and the value of the coal. (This information must conform with the requirements of General Mining Order No 1.)

UMC	Section	Page
783.25	3.3.1	Vol. 1, 77 Plan, p. 10
(c), (d)	3.3.1.1	Vol. 1, 77 Plan, Map 1F
	6.5.5.1	Vol. 2, 79 Sub., Ex. 3, p. 2
	6.5.5.2	Vol. 3, 80 Sub., Compliance Responses 783.22(b), 783.25(c)
		Vol. 3, 80 Sub., USGS Comment 6
		Vol. 7, 81 Suppl., Geology, p. 5; Maps 81-3, 81-4

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

2.11.10 (c)(6)(ii) The method of mining, including mining sequence and proposed production rate; the plan for any lease issued or readjusted after August 4, 1976, must provide for the mining of all the reserves of the logical mining unit of which the lease is a part in a period of not more than forty years; that period shall begin on the date of approval of the first mining plan for that logical mining unit.

UMC	Section	Page
784.11	3.3.1.3	Vol. 1, 77 Plan, pp. 11-15
(a)		Vol. 2, 79 Sub., Ex. 3, pp. 4-8
		Vol. 7, 81 Suppl., Mining Operation, pp. 1-3

211.10 (c)(6)(ii) - Continued

The plan must include planned sequence of mining by year for the first 5 years and by number in 5-year increments for remainder of mine life.

UMC	Section	Page
783.12	3.3.1.4	Vol. 1, 77 Plan, pp. 13, 20-21
(a)	3.3.7.1	Vol. 1, 77 Plan, Maps 1A, 1D, 1E
	3.3.7.2	Vol. 2, 79 Sub., Ex. 3, pp. 1-2, 7
	3.3.8.1	Vol. 3, 80 Sub., Compliance Responses 783.17(a), 783.25(e)
		Vol. 3, 80 Sub., USGS Comments 2, 3
		Vol. 4, 80 Sub., Hydrology Report, p.55
		Vol. 4, 81 Sub., Hydrology Report, Addition Plates H-I, H-II
		Vol. 7, 81 Suppl., Mining Operation, pp. 5-7; Exhibits 1 & 2

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(6)(iv) The engineering techniques proposed to be used in mining. The plan shall describe the method of mining and present justifications for the method selected. The selected mining system shall conform to sound mining practices and be based on current technology and economics.

UMC	Section	Page
784.11	3.3.1.3	Vol. 1, 77 Plan, pp. 11-15
(a)		Vol. 2, 79 Sub., Ex. 3, pp. 4-8
		Vol. 7, 81 Suppl., Mining Operation, pp. 1-3

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(6)(v) A list of all major equipment.

UMC	Section	Page
784.11	3.3.4.1	Vol. 1, 77 Plan, p. 15
(a)	3.3.4.2	Vol. 2, 79 Sub., Ex. 3, p. 8
		Vol. 7, 81 Suppl., Mining Operation, p. 4

211.10 (c)(6)(vii) The method of operation and measures by which the operator plans to comply with the obligations and requirements set forth in 211.4 and 211.40 of this Part and any special terms and conditions of the lease, permit, or license. (This can be by a narrative statement and must include only those items related to resource recovery.)

UMC	Section	Page
784.13	3.3.3.1	Vol. 1, 77 Plan, pp. 10, 21-22
(a)(2)	3.3.3.2	Vol. 2, 79 Sub., Ex. 3, p. 7
	3.3.3.3	Vol. 3, 80 Sub., Map 80-2
		Vol. 7, 81 Suppl., Mining Operation, pp. 5-7; Exhibits 1 & 2

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(6)(viii) The anticipated starting and termination dates of each phase of the mining operation and number of acres of land to be affected.

UMC	Section	Page
782.17	3.3.6.1	Vol. 1, 77 Plan, p. 13
(a)	3.3.7.1	Vol. 1, 77 Plan, Map 1D
784.13	3.3.7.2	Vol. 2, 79 Sub., Ex. 3, pp. 1-2, 7
(b)(1)		Vol. 3, 80 Sub., USGS Comment 3
		Vol. 3, 80 Sub., Map 80-2
		Vol. 4, 80 Sub., Hydrology Report, p. 55
		Vol. 4, 81 Suppl., Hydrology Report, Addition Plates H-I, H-II
		Vol. 7, 81 Suppl., Mining Operation, pp. 5-7; Exhibits 1 & 2

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(6)(x) The measures for ensuring the maximum practicable recovery of the mineral resource.

(Sufficient data should be submitted to substantiate the anticipated recovery factor of the resource for the coal reserve base. Data includes sufficient information in the form of narrative, cross-sections, coal thickness isopachs, overburden isopachs and quality and quantity data (Btu content, ash, moisture, sulfur, volatile matter, and fixed carbon and any other available information that may affect blending or combustion) of all known potentially mineable seams on the lands involved. The areal extent of mining of each seam to be mined should be delineated. This information must conform with the requirements of General Mining Order No. 1.)

UMC	Section	Page
784.13	3.3.1.1	Vol. 1, 77 Plan, pp. 2-4, 10, 21-38
(b)(6)	3.3.3.1	Vol. 1, 77 Plan, Maps 1A, 1F
	6.5.2	Vol. 2, 79 Sub., Ex. 3, pp. 2-7
	6.5.3	Vol. 3, 80 Sub., Compliance Responses
	6.5.4	783.14(a), (2)(iii), 783.22(b), 783.25(c)
	6.5.5.1	Vol. 3, 80 Sub., USGS Comment 6
	6.5.5.2	Vol. 3, 80 Sub., Maps 80-2, 80-5,
	6.5.6.1	80-6, 80-7, 80-8A, 80-8B
		Vol. 7, 81 Suppl., Goelogy, pp. 4-6,
		Maps 81-2, 81-3, 81-4

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(6)(xi) The method of abandonment of coal mine operations including protection of unmined coal and other mineral resources.

UMC	Section	Page
784.13	3.5.3.1	Vol. 1, 77 Plan, pp. 13-14, 20-21
(b)(8)	3.5.3.2	Vol. 2, 79 Sub., pp. 30-32
784.14	3.5.3.3	Vol. 2, 79 Sub., Ex. 1, Items 6, 8, 9, 11
(d)		Vol. 2, 79 Sub., Ex. 3, p. 8
		Vol. 3, 80 Sub., Compliance Responses 784.13(b)(8), 784.14(d)

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10(c)(6)(xii) Furnish complete logs of all exploration drill holes (both surface and underground) in Federal leases.

UMC	Section	Page
783.14	6.5.1	Vol. 1, 77 Plan, p. 10
(a)(1)		Vol. 2, 79 Sub., Ex. 3, pp. 3-4
(ii)		Vol. 7, 81 Suppl., Geology, p. 4

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(6)(xiv) Plans for protecting oil, gas, and water wells as well as oil, gas, and underground water resources, when encountered.

UMC	Section	Page
783.25	3.3.2.1	Vol. 1, 77 Plan, p. 76
(5)	7.1.5	Vol. 2, 79 Sub., Ex. 5, pp. 13-14
	7.1.6	Vol. 2, 79 Sub., Ex. 9
		Vol. 3, 80 Sub., Compliance Response 784.14(b)(1)
		Vol. 4, 80 Sub., Hydrology Report, pp. 21, 58-59, 61
		Vol. 4, 81 Suppl., Hydrology Report pp. 8-10

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(6)(xv) Any justification for not recovering any coal deposits that may be detrimentally affected in terms of future recovery by the coal development operations proposed.

(If no coal preparation plant is planned and if the operator plans not to mine coal beds or portions of coal beds because of high sulfur, high ash, or other chemical or physical properties, the operator shall submit a narrative and analyses of the rationale for not mining such beds or portions of seams.)

UMC	Section	Page
784.13	3.3.3.2	Vol. 1, 77 Plan, pp. 10, 21-22
(b)(6)		Vol. 2, 79 Sub., Ex. 3, p. 7

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

211.10 (c)(7) Suitable topographic maps or aerial photographs showing:

(i) Topographic and natural drainage features, roads and vehicular trails.

UMC	Section	Page
783.25	3.2.10	Vol. 1, 77 Plan, Map ID
(k)		Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3

211.10(c)(7) - Continued

(ii) The name of the watershed and location of the surface stream or tributary into which mine waters will be discharged, if applicable.

UMC	Section	Page
783.16	7.2.2.1	Vol. 4, 80 Sub., Hydrology Report, Plate H-II
(a)		
783.25		Vol. 4, 81 Suppl., Hydrology Report, Addition Plate H-I
(y)		
		Vol. 7, 81 Sub., Completeness Responses 783.13, 783.15, 784.14

211.10(c)(7) - Continued

(iii) Cross sections and plan views of the land to be affected, including the actual area to be mined, showing elevation and location of drill holes and depicting the following information: the nature and depth of the various strata of overburden; the nature and thickness and extent of any coal, or if rider seams above the specific coal proposed to be mined; the nature of the strata beneath the coal to be mined for a vertical distance of at least 20 meters beneath the base of the coal seam; the location of the next known deeper coal seam below the deepest seam to be mined and representative characteristics thereof; the location of any other mineral values encountered within the logical mining unit; hydrologic data and other information relevant to the mining plan; all mineral crop lines and the strike and dip of the coal to be mined within the area of land to be affected; location and extent of known surface and underground mine workings (active and abandoned), oil or gas wells, and water wells within 1/4 mile of the affected lands. (Hydrologic information is required only as relevant to resource recovery.)

UMC	Section	Page
783.25	3.2.11	Vol. 1, 77 Plan, Maps 1A, 1B, 1C, 1E, 1F
(a)	3.2.12	Vol. 3, 80 Sub., Maps 80-2, 80-5, 80-6
783.25	3.3.7.1	80-7, 80-8A, 80-8B
(j)	6.4.1	Vol. 5, 81 Suppl., Subsidence Report,
	6.4.2	Map 81-1
		Vol. 7, 81 Suppl., Mining Operation,
		Exhibits 1 & 2

211.10(c)(7) - Continued

Plan maps of the area to be mined on a suitable topographic base showing: lease boundaries and numbers, boundaries of nonfederal coal, LMU boundaries, and surface ownership boundaries.

UMC	Section	Page
	4.3.1.1	Vol. 1, 77 Agency Review Submittal,
	4.3.2.1	Map - Ownership Plat
		Vol. 3, 80 Sub., Map 80-1

211.10(c)(7) - Continued

(iv) Locations of surface structures and facilities, including loading facilities.

UMC	Section	Page
784.23	3.2.3	Vol. 1, 77 Plan, Map 1D
(b)(1)	3.2.4	Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3
		Vol. 3, 80 Sub., Maps 80-4, 4a, 4b, 4c, 80-11

211.10(c)(7) - Continued

(v) For an underground mine, in addition, the planned mine layout, including location and dimensions of shafts, slopes, drifts, crosscuts, rooms, haulageways, aircourses, entries, and barrier pillars; show typical panel recovery, sequence of development and retreat.

UMC	Section	Page
	3.3.1.2	Vol. 1, 77 Plan, Maps 1A, 1E
	3.3.1.4	Vol. 2, 79 Sub., Ex. 3, pp. 7.2a - 7.6
		Vol. 3, 80 Sub., Maps 80-2, 80-4, 4a, 4b, 4c, 80-11
		Vol. 7, 81 Suppl., Mining Operation, Exhibits 1 & 2

211.10(c)(7) - Continued

Submit the Roof Control and Ventilation System and Methane and Dust Control Plans approved by Mine Safety and Health Administration (MSHA) as a part of the mining and reclamation plan.

UMC	Section	Page
	3.3.1.6	Vol. 1, 77 Plan, Map 1D
		Vol. 2, 79 Sub., Ex. 9, Maps 9-1, 9-2, 9-3
		Vol. 3, 80 Sub., Maps 80-4, 4a, 4b, 4c

211.10(c)(7) - Continued

Include a structural contour map of bed(s) to be mined.

UMC	Section	Page
	6.4.2	Vol. 3, 80 Sub., Maps 80-5, 80-8A, 80-8B
	6.5.3	Vol. 7, 81 Suppl., Geology, Map 81-2

211.10(c)(7) - Continued

If several seams are involved, include interburden isopach map(s) on 10-foot intervals.

UMC	Section	Page
	6.5.3	Vol. 3, 80 Sub., Map 80-8A

211.10(c)(7) - Continued

Include an isopach map of overburden of surface mines on 20-foot intervals.

UMC	Section	Page
		Not Applicable

211.10(c)(7) - Continued

Include an isopach map of overlying strata over underground mines on 250-feet intervals.

UMC	Section	Page
	6.4.2	Vol. 3, 80 Sub., Map 80-8B
	6.5.3	

211.10(c)(7) - Continued

Furnish a copy of any subsidence control plan required by 30 UMC 784.20.

UMC	Section	Page
	12.4.3	Vol. 1, 77 Plan, pp. 11-12
	12.4.4	Vol. 1, Subsidence Report 1 (12-28-77)
		Vol. 1, Subsidence Report 2 (2-1-78)
		Vol. 2, 79 Sub., Ex. 3, pp. 7, 24
		Vol. 2, 79 Sub., Ex. 5
		Vol. 3, 80 Sub., Compliance Response 784.20
		Vol. 3, 80 Sub., Maps 80-9, 80-10
		Vol. 4, 80 Sub., Hydrology Report, pp. 63-66
		Vol. 5, 80 Sub., Subsidence Report
		Vol. 5, 81 Suppl., Subsidence Report, Map 81-1
		Vol. 7, 81 Sub., Completeness Response 784.20

211.10(c)(7) - Continued

(vi) If auger mining is proposed, the location and diameter of auger holes, the depth to be drilled, and the estimated percentage of recovery. In determining whether or not to recommend approval of proposed auger mining, the Regional Director and mining supervisor shall take into account the percentage of recovery, which shall in general exceed 30 percent, and probable adverse effects upon water quality.

UMC	Section	Page
(SMC)		Not Applicable
785.20		

211.10(c)(7) - Continued

If surface mining is proposed, include a general layout of the proposal including location and width of box cut(s), location of main haulroads, and location and width of coal fenders.

UMC	Section	Page
		Not Applicable

USGS CROSS REFERENCE INDEX

SUFCO MINE PLAN

) 211.10 (c)(8) Any requests for variances from the performance standards of 30 CFR Part 211.

UMC	Section	Page
		Not Applicable