ACT/045/017

MERCUR CANYON PROJECT

GETTY MINERAL RESOURCES COMPANY

NOTICE OF INTENTION

TO COMMENCE MINING OPERATIONS

AND

MINING AND RECLAMATION PLAN

SUBMITTED TO

STATE OF UTAH

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF OIL, GAS AND MINING

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DIVISION OF
OIL, GAS & MINING

THE MERCUR CANYON PROJECT

The Mercur Canyon Project as proposed within, would include an open pit gold mine and refining operation to be constructed in Mercur Canyon approximately fifteen (15) miles south-southeast of the town of Tooele, Tooele County, Utah on a combination of GETTY MINERAL RESOURCES COMPANY's (GMRC) privately owned land and public land on which the company has located mining claims.

Under the proposed mine plan, the open pit gold mine and milling operation would consist of three major activities: development, operation, and post-mining; commencing in mid-1981 and ceasing in 1988, dependent upon future economics.

This Application, as submitted to the State of Utah, Department of Natural Resources, Division of Oil, Gas and Mining (DOGM), includes both a "Notice of Intention to Commence Mining Operations", Form MR-1 (Section 1.0), and a "Mining and Reclamation Plan", Form MR-2 (Section 2.0), and meets all the requirements as delineated in Utah's Mined Land Reclamation Act of 1975, "General Rules and Regulations", and "Rules of Practice and Procedure" (As Amended).

DOGM PERMIT APPLICATION

TABLE OF CONTENTS

SECTION

EXECUTIVE SUMMARY

I. "NOTICE OF INTENTION..."

1.0 INTRODUCTION

1.1 LOCATION
1.2 OWNERSHIP
1.3 DISTURBANCE AREAS AND BORE HOLE DATA

II. "MINING AND RECLAMATION PLAN"

2.0 INTRODUCTION

2.1 LAND USE
2.1.1 HISTORICAL USAGE
2.1.2 PRESENT USAGE
2.1.3 LAND CAPABILITY
2.1.4 FUTURE USAGE

2.2 BASELINE SUMMARIES
2.2.1 CLIMATE
2.2.2 GEOLOGY
2.2.3 VEGETATION
2.2.4 SOILS
2.2.5 WILDLIFE
2.2.6 HYDROLOGY

2.3 MINING AND RECLAMATION PLAN
2.3.1 MINE PLAN
2.3.2 MINE DRAINAGE PLAN
2.3.3 RECLAMATION PLAN
2.3.4 WILDLIFE IMPACTS AND MITIGATION PLAN

LIST OF MAPS

1.0-1	Regional and Local Maps of the Mercur Canyon Project
1.1-1	Proposed Permit Area, Existing Topography
1.2-1	Surface and Mineral Ownership Map (Confidential)
1.3-1	Project with Natural and Modified Drainage System
1.3-2	Pit Area Drill Hole Locations (Confidential)
2.0-1	Mercur Canyon Project - Proposed Facilities Location
2.1-1(a-c)	Land Use Map
2.2-1	Location of Meteorological Stations
2.2-2	Geologic Cross-Section and Geologic Map
2.2-4(a-d)	Baseline Vegetation Map
2.2-5(a-d)	Baseline Soils Map
2.2-6	Wildlife Study Area
2.2-7	Baseline Hydrology Map
2.3-1	Detailed Mill Site
2.3-2	Mine Drainage Plan and Disturbance Boundaries

LIST OF FIGURES

2.2-1	Wind Rose for Tooele Army Depot - South
2.3-1	Project Schedule
2.3-2	Mill Flow Diagram
2.3-3	Cross Section of Tailings Dam
2.3-4	Cross Section of Haul Road with Culvert
2.3-5	Sediment Pond Design
2.3-6	Diversion Channel Design

LIST OF TABLES

1.2-1	List of Surface and Mineral Ownership
1.3-1	Land Requirements for Project
2.2-1	Temperature & Precipitation for Eureka
2.2-2	Precipitation for Mercur
2.2-3	Summary of Vegetative Cover
2.2-4	Soils Series Summary
2.3-1	Surface Acreage
2.3-2	Reagents to be Used
2.3-3	Settling Dam Characteristics
2.3-4	Ratings for Potential Impacts on Wildlife Components

SECTION I

NOTICE OF INTENTION TO COMMENCE MINING OPERATIONS

STATE OF UTAH

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF OIL, GAS AND MINING

1588 WEST NORTH TEMPLE

SALT LAKE CITY, UTAH 84116

NOTICE OF INTENTION TO COMMENCE MINING OPERATIONS

(Legal Compliance Information)

APPLICATION:	GETTY MINERAL RESOURCES COMPANY P. O. Box 15668 345 Bearcat Drive Salt Lake City, Utah 84115
RESIDENT AGENT:	Robert L. Hautala Vice President GETTY MINERAL RESOURCES COMPANY P. O. Box 15668 345 Bearcat Drive Salt Lake City, Utah 84115 Area Code: (801) 487-0861
LOCATION OF OPERATIONS:	Portions of Sections 5, 6, 7, and 8 of Township 6 South, Range 3 West SLM, Tooele County, Utah
NAME OF MINE:	Mercur Canyon Project
MINERAL TO BE MINED:	Gold Ore
MINING METHOD:	Open Pit
OTHER APPLICATION APPROVALS:	ACT-007-005 Skyline Coal Mining Project ACT-007-006 Plateau Mining Company
SURFACE OWNERS:	See Table 1.2-1
MINERAL OWNERS:	See Table 1.2-1

OWNERS NOTIFICATION: Owners have been notified in writing

RIGHT OF ENTRY: Ownership or Leasee of Mineral Rights through patented or unpatented claims

ACREAGE TO BE DISTURBED:

a) Operation Area	244
b) Road Area	19
c) Drainage System Area	9
Total	272

APPLICANT COMPANY OFFICERS:

H. E. Wendt	President	Los Angeles
Paul E. Carlton	Vice President	Los Angeles
Siegfried Muessig	Vice President	Los Angeles
Robert P. Blanc	Vice President	Salt Lake City
John M. Mintz	Vice President	Los Angeles
C. R. Moore	Vice President	Los Angeles
Paul A. Riddell	Vice President	Salt Lake City
R. L. Hautala	Vice President	Salt Lake City
J. Brooks McNeill	Secretary	Los Angeles
John C. Sample Jr.	Assistant Secretary	Los Angeles
K. A. Jensen	Assistant Secretary	Salt Lake City
Joseph E. Berg III	Assistant Secretary	Los Angeles
J. L. Falco	Assistant Secretary	Los Angeles
Donald E. Rovang	Treasurer	Los Angeles
M. G. Mannarelli	Assistant Treasurer	Los Angeles
J. E. Brown	Assistant Treasurer*	Los Angeles
T. F. Clarke	Assistant Treasurer*	Los Angeles
C. W. Giles	Assistant Treasurer*	Los Angeles
S. H. Moore	Assistant Treasurer*	Los Angeles
R. H. Benkow	Assistant Treasurer*	Los Angeles
M. J. Smith	Assistant Treasurer*	Los Angeles

* Authority Limited to Tax

Written correspondence to any of the Los Angeles officers should be addressed to:

GETTY MINERAL RESOURCES COMPANY
c/o GETTY OIL COMPANY
3810 Wilshire Boulevard
Los Angeles, California 90010

GETTY MINERAL RESOURCES COMPANY, and any subsidiary or affiliate or any person, partnership, association, trust, or corporation controlled by or under common control with GETTY MINERAL RESOURCES COMPANY, or any of the officers of GETTY MINERAL RESOURCES COMPANY have never had an approval of a Notice of Intention withdrawn nor has surety relating thereto ever been forfeited.

I, Robert P. Hautala, having been duly sworn, certify that all of the representations contained in this application are complete and correct to the best of my knowledge; that I am authorized to complete and file this application on behalf of GETTY MINERAL RESOURCES COMPANY and that this application has been executed as required by law.

GETTY MINERAL RESOURCES COMPANY

BY: RPHautala
(Vice President)

STATE OF UTAH
COUNTY OF SALT LAKE

Subscribed and sworn to before me this 9th day of March, 1981.

Notary Public: Lucanna M. Lashus

My Commission Expires: 11/6/84

There is confidential information contained in this Notice of Intention and Mining Reclamation Plan. Map 1.3-2, Map 1.2-1 and Section 2.2.2 should be maintained as confidential information RH.
(Vice President)

1.0 INTRODUCTION

The GETTY MINERAL RESOURCES COMPANY proposes to develop and operate an open pit gold mine, with an attendant milling and refining facility in Mercur, Utah. The overall project consists of two major components, the mine on Mercur Hill and the mill located one-half mile east of the mine. Map 1.0-1 shows the proposed permit location with respect to the surrounding areas of Tooele County and the State of Utah.

1.1 LOCATION

The proposed operation will be located in the Oquirrh Mountains approximately 35 miles southwest of Salt Lake City in Tooele County. The mine permit area includes portions of Sections 5, 6, 7, 8, T6S, R3W S.L.M.. Map 1.1-1 shows the boundaries of the permit area, the location of existing mines and tailings (all of which are inactive), water bodies, roads, and surface contours. There are no transmission lines, intact buildings, or surface facilities present within the proposed permit area. The ruins of old mining and milling facilities and the ghost town of Mercur are discussed in a cultural resources technical report (which has been submitted to the relevant federal and state agencies).

1.2 OWNERSHIP

The surface and mineral ownerships for the lands affected are shown on Map 1.2-1. The names and addresses of these surface and mineral owners are listed in Table 1.2-1. GETTY MINERAL RESOURCES COMPANY stresses that certain ownership areas within the proposed permit boundaries will not be disturbed, but have included these areas in the permit application for convenience because of the complexity of the ownership patterns. All proposed activity would be strictly limited to those locations where the applicant has surface and mineral rights.

TABLE 1.2-1
NAMES AND ADDRESSES OF AFFECTED AREA SURFACE AND MINERAL OWNERS

RECORD OWNER(S)
Walker Bank & Trust and Harold E. Raddatz Walker Bank & Trust, Trustee Salt Lake City, UT 84142
Raddatz Corporation 1112 Walker Bank Building Salt Lake City, UT 84111
Zion's First National Bank, Trustee (Cannon Trust) Attn: Real Estate Loan Department Box 1709 One South Main Street Salt Lake City, UT 84111
Johnell M. Yurka 4715 South Fairfield Drive Phoenix, AZ 85282
Zion's First National Bank One Main Street Salt Lake City, UT 84111
Richard L. McKinney RFD 1 Box 456 American Forks, UT 84003

Getty

Getty Mineral Resources Company | P. O. Box 15668, 345 Bearcat Drive, Salt Lake City, UT 84115 • (801) 487-0861

May 7, 1981

Mr. Thomas Tetting
Engineering Geologist
1588 West North Temple
Salt Lake City, Utah

Dear Mr. Tetting:

It has recently come to our attention that our listing of surface and mineral owners in our Mining and Reclamation Plan is incomplete. Specifically, the Getty/Steen property shown on the land map is not listed.

The Steen property is a 6.9% fee property interest owned and/or administered by:

Continental Bank and Trust Company
200 South Main Street
Salt Lake City, Utah 84125
Attention: Mr. William F. Dineen
Trust Officer

Mrs. Maxine Boyd
Melody Estates, Space 928
Route #1
Price, Utah 84501

Mrs. Wilma McCormick
c/o George McCormick
Route 1, Box 240
Aurora, Missouri 65800

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MAY 11 1981
DIVISION OF
OIL, GAS & MINING

Please include this information in our file.

Sincerely,

Brian W. Buck

BRIAN W. BUCK
Environmental Coordinator

BWB:lml

TABLE 1.2-1
NAMES AND ADDRESSES OF AFFECTED AREA SURFACE AND MINERAL OWNERS
(Continued)

RECORD OWNER(S)
Geyser Marion Gold Mining Company 503 West Fourth South Salt Lake City, UT 84101
Bothwell, Swaner Co. 610 East South Temple Salt Lake City, UT 84102
New Mercur Mining Co. 1604 Walker Bank Building Salt Lake City, UT 84111
Sacramento Gold Mining Co. 610 East South Temple Salt Lake City, UT
Bureau of Land Management 136 East South Temple University Club Building Salt Lake City, UT 84111

1.3 PROPOSED AREAS OF DISTURBANCE, DRAINAGE MODIFICATIONS, AND BOREHOLE AND CORE DATA

The proposed areas of disturbance would include the mine pit area, waste dump area, tailings and sediment ponds, topsoil storage piles, a low grade ore storage area and the plant facilities complex. Table 1.3-1 summarizes the land requirements for the Mercur Canyon Project, along with a summary of the acreage of previous disturbances. Acreages presented in Table 1.3-1 represent best estimates developed from preliminary engineering designs. For instance, exact locations of proposed haul roads can only be conceptualized until detailed designs are finalized. It is presently anticipated that much of the proposed project would take place on previously disturbed and mined areas (based on a calculated total of 272 acres, 127 acres or 47%, of previously disturbed land would be re-disturbed by the Mercur Canyon Project.) These areas, as well as natural drainages and planned berms and other constructed drainages, are shown on Map 1.3-1. Topsoil stripping would be done within the areas of the mine pit, the tailings pond impoundment, the overburden disposal site, and the proposed site facilities complex (as detailed in the Mining Plan). The tailings pond and sediment basin have been sized to function as no-discharge impoundments; it is not anticipated that there will be any off-site water discharges from this operation under design conditions.

TABLE 1.3-1

LAND REQUIREMENTS FOR MAJOR COMPONENTS OF MERCUR CANYON PROJECT

COMPONENTS	LAND REQUIREMENTS (ACRES)	PREVIOUS DISTURBANCES (ACRES)
Open Pit Mine	64	64
Overburden Disposal Area	49	41
Low Grade Ore Storage Area	11	--
Tailings Dam and Pond	57	--
Settling Pond	5	--
Mill Facilities Area	37	--
Soils Stockpile	18	--
Tailings Pipeline and Road	3	--
Haul Roads	10	--
County Road	9	22
Drainage System	9	--
TOTAL	272	127

Several hundred bore holes have been drilled within the permit area, the majority to a depth of 300 to 400 feet. Map 1.3-2 shows the locations of the bore holes in and adjacent to the pit area. No major aquifers were encountered during this exploratory drilling and indications are that the water logged by drillers was located in abandoned mine workings; field checks of several of these holes several weeks after drilling showing no standing water. No toxic material zones were identified during the drilling program. Drainage modifications for the area are presented in Section 2.3.2 - Mine Drainage Plan. A comprehensive reclamation plan which includes soil mapping units, topsoil stripping depths and related data is provided in Section 2.3.3 of this Application.

STATE OF UTAH

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF OIL, GAS AND MINING

1588 WEST NORTH TEMPLE

SALT LAKE CITY, UTAH 84116

MINING AND RECLAMATION PLAN

APPLICANT:	GETTY MINERAL RESOURCES COMPANY P. O. Box 15668 345 Bearcat Drive Salt Lake City, Utah
TYPE OF OPERATION:	Open Pit Gold Mine and Milling
LAND USE:	a) Prior - Mining b) Current - Grazing, Recreational c) Future - Grazing, Recreational
VEGETATION TYPES:	Pinyon-juniper Mixed-brush Bottomland-disturbed
VEGETATION PERCENT:	See Table 2.2-3
SOIL pH VALUE:	6.9 - 8.2 FRANK E. BASIL, INC.
ELEVATION RANGE:	6320 - 8140 Feet, ASL

No material has been classified as acid or alkali producing

Abandoned underground workings with trapped runoff waters will be encountered. There are no active discharges from these.

Section 2.3.1 presents a detailed sequence of procedures to be utilized during operations.

GRADING AND REGRADING

Specific details for grading are provided in Section 2.3.3 of this application.

TESTING

Continued monitoring of reclamation fill material will ascertain stability. Sections 2.2.4 and 2.3.3 fully describes soil testing, techniques, treatment, and surface preparation.

REVEGETATION

REVEGETATION PROGRAM: GETTY MINERAL RESOURCES COMPANY

REVEGETATION TECHNIQUES a) Broadcast and Drag
b) Conventional or Rangeland Drill

At present, neither mulch nor irrigation will be employed for revegetation. A revegetation plan and schedule are provided in Section 2.3.3 and the Appendices. Maintenance procedures for revegetation are anticipated.

Wildlife grazing will affect the revegetation areas and some protection may be needed.

I, Robert P. Hautala, having been duly sworn, certify that all of the representations contained in this application are complete and correct to the best of my knowledge; that I am authorized to complete and file this application on behalf of GETTY MINERAL RESOURCES COMPANY and that this application has been executed as required by law.

GETTY MINERAL RESOURCES COMPANY

BY: R P Hautala
(Vice President)

STATE OF UTAH
COUNTY OF SALT LAKE

Subscribed and sworn to before me this 9th day of March, 1981.

Notary Public: Luanna M Lasher

My Commission Expires: 11/6/84

There is confidential information contained in this Notice of Intention and Mining Reclamation Plan. Map 1.3-2, Map 1.2-1 and Section 2.2.2 should be maintained as confidential information RPH.
(Vice President)

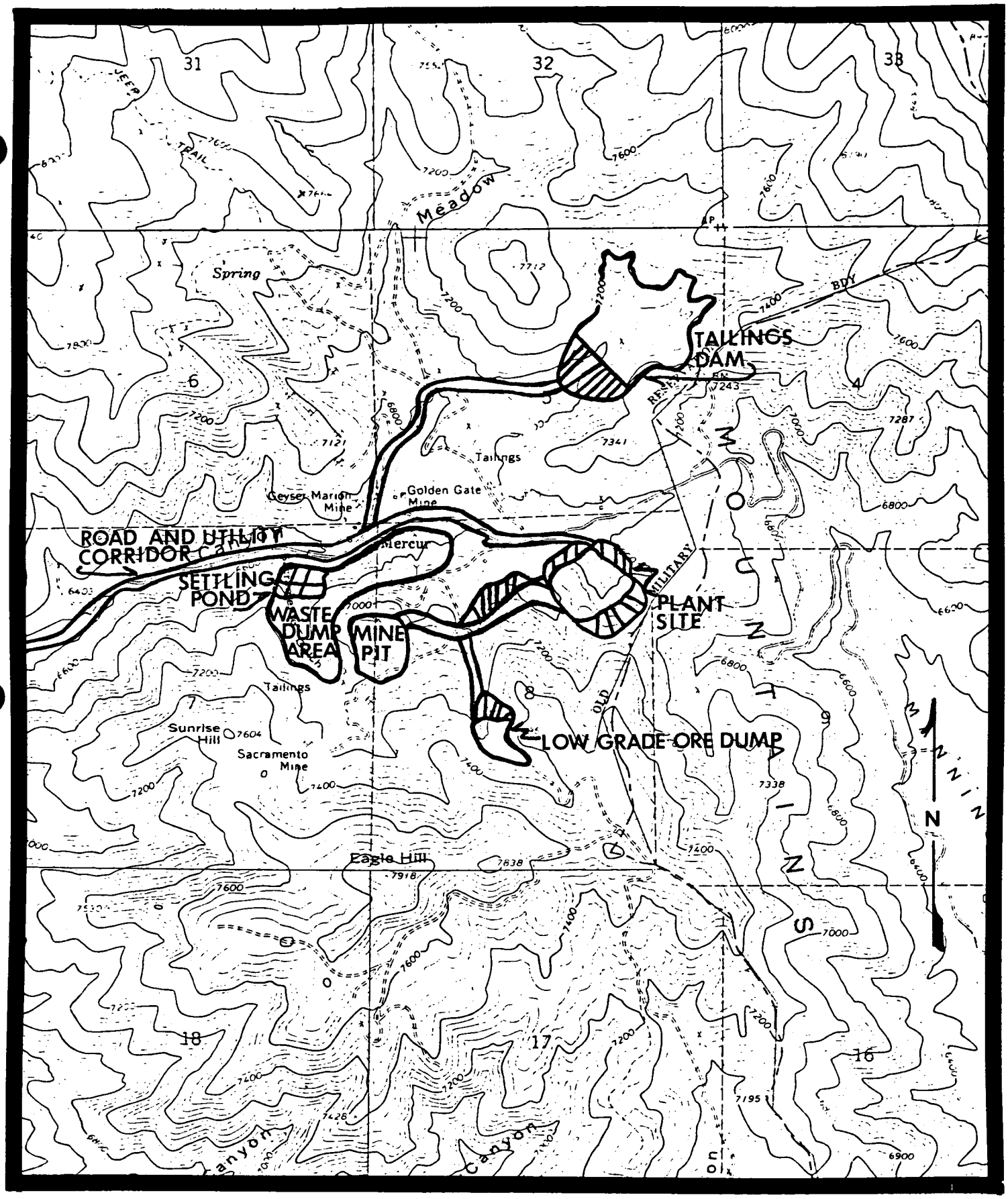
2.0 INTRODUCTION

The open pit mining operation, as envisioned, would remove overburden and process minable ore over the economic life of the mine. The run-of-mine (ROM) ore would be crushed, ground, and subjected to a cyanidation process to separate the gold from the ore. Mine waste rock and low grade ore would be stored in two separate areas near the mine pit, while tailings from the mill would be placed in a pond located north of the mill on the permit area. Water for the process would be pumped from a well and also reclaimed from the tailings pond. Also, because of anticipated dewatering activities from the old mine workings, a settling pond would be used to store this water for later utilization in the mine and milling processes. Preliminary power requirements for the mine and mill are estimated to be less than ten megawatts. Map 2.0-1 illustrates the proposed mine/mill complex for the Mercur Canyon Project.

Section 2 presents the existing baseline environment of the proposed permit area and those adjacent areas which may, in some way, be impacted by the Mercur Canyon Project. This approach, it is felt, can best satisfy the informational requirements of the regulatory agencies and be the foundation for the mining and reclamation plan for this project. By doing this, a clearer understanding of the methodology and techniques, as proposed by GETTY MINERAL RESOURCES COMPANY, will result.

Land use is the first topic presented in this section. Baseline environmental data, such as climatology, geology, vegetation, soils, and both surface and ground-water characteristics, are next presented.

The remaining sub-sections detail the mining sequences and techniques of the project as well as the proposed revegetation and reclamation plans for post-mine use. This includes a mitigation plan for wildlife impacts. This section then, fulfills those requirements outlined in Rules M-3 and M-10 of the Mined Land Reclamation Act of 1975, as amended.



MAP 2.0-1
MERCUR CANYON PROJECT
PROPOSED FACILITY LOCATIONS
SCALE : 1" = 2000'

2.1 LAND USE

2.1.1 HISTORICAL USAGE

The mine and mill permit area, located in the southern end of the Oquirrh Mountains (Camp Floyd Mining District), is rich in mining history. Initial prospecting and mining occurred as early as the 1850's, although profitable strikes of silver did not occur until the 1870's. Gold mining and milling came to prominence from 1895 to 1910 and again in the 1930's, when technological advances made it possible to economically extract gold from the mined ore. All mining activities ceased by the mid-1940's, with only infrequent exploration in the following years. Although few physical remains bear witness to the earlier mining activity except tailings, mine portals, and building foundations, the area at its zenith supported nearly 2,500 people. Thus, historically the primary land use for nearly one hundred years has been mining and milling.

2.1.2 PRESENT USAGE

The Tooele County Zoning Commission presently classifies the area as MU-40 (Multiple Use). However, usage has been limited to some grazing and recreation - primarily hunting - activities (Map 2.1-1).

The proposed project is within the Bureau of Land Management's Mercur Canyon Grazing Allotment with established dates for both cattle and sheep grazing. However, the complexity of ownership makes grazing management difficult and complicates any quantitative assessment of the timing, intensity, and season of grazing activities. During wildlife field studies in 1980, no cattle and few sheep were observed within the boundaries of the permit area.

The Utah Deer Herd 11 encompasses an area covering nearly 888 square miles of Salt Lake, Tooele and Utah counties including the proposed permit area. Because of it's closeness to large metropolitan areas, ease of access

to this and adjacent areas, and the mule deer population known to exist in the area, the southern Oquirrh Mountains are heavily utilized by hunters, off-road vehicles, as well as relic hunters. A detailed discussion of vegetation and wildlife within the area is presented in Sections 2.2.3 and 2.2.5. Impacts to wildlife are discussed in Section 2.3.4.

Numerous jeep trails are located within the project area, the most frequently traveled being the county road connecting Mercur and Ophir canyons. Although not within the proposed permit area, a now-closed motorcross course is still being used in Manning Canyon by bike enthusiasts.

The Mercur Canyon area has been prominently mentioned in numerous tourist and historical oriented publications, and therefore receives heavy visitation. This is due to its prominence in Utah's turn-of-the-century mining history. Because of this, what few remaining structures are in the area have been vandalized.

2.1.3 LAND CAPABILITY

The land within the permit area is relatively dry (less than 20 inches of rainfall per year), has a high relief, and has been disturbed through many decades of mining and milling activity. Therefore, the probable land uses are limited to those currently existing; that is mining, limited grazing, wildlife, and recreation.

2.1.4 PROSPECTIVE FUTURE USAGE

The Bureau of Land Management's Management Framework Plan for the area recognizes the potential for mining and has stated that "minerals should be considered the most important resource..." In addition, the value of the area for hunting and other recreational uses is lessened when the extent of previous disturbance is evaluated. As proposed, the open pit mine and mill complex will disturb approximately 272 acres; of this, approximately 127 acres

were previously disrupted. However, an estimated 262 acres (including the 127 acres) are presently considered "disturbed" within the permit area, consisting of open pit excavations, mine and mill tailings, and open shafts.

The proposed post-mining land use plan details the reclamation activites that GETTY MINERAL RESOURCES COMPANY would implement after cessation of mining. As described, these reclamation activities would provide improved wildlife habitat and forage conditions in the permit area. Basically, it is proposed that some of the previously disturbed areas (and disturbed during the present mining activities) would be reclaimed to varying degrees as would new mining disturbances due to GMRC's activities. Some portions of the GMRC operations, i.e., the open pit operations, will not be reclaimed to forage conditions but left in a condition to prevent them from becoming a public hazard.

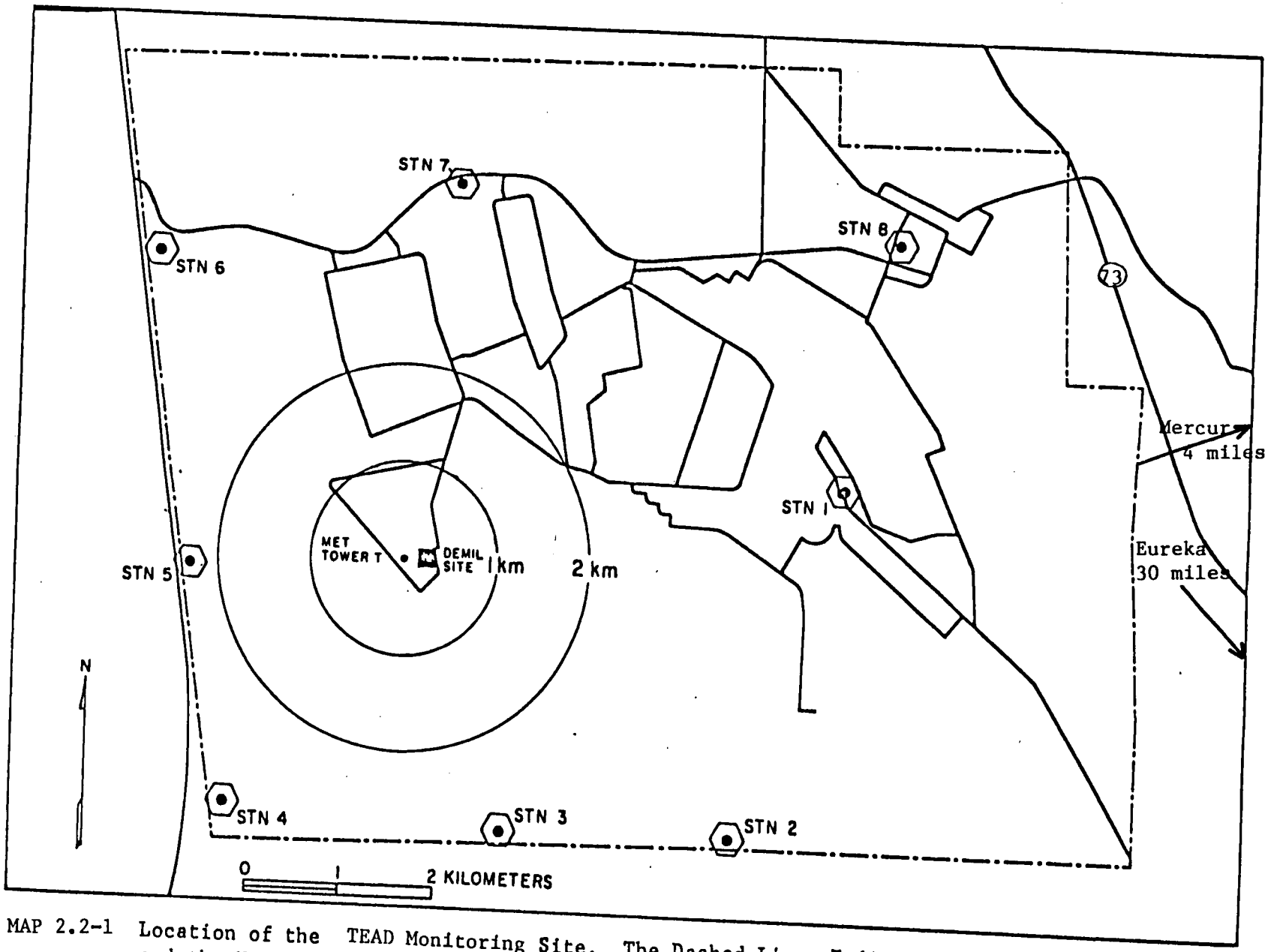
2.2 BASELINE SUMMARIES

2.2.1 CLIMATE

Under the Koeppen classification, the climate at the site would be termed semi-arid, cold ("BSk" climates) because evaporation exceeds precipitation. Prevailing winds as recorded at the Tooele Army Depot - South, approximately ten miles west of Mercur (Map 2.2-1), are from the NNW, SE and SSE. The NNW winds would carry moisture from the Great Salt Lake, while the southerly winds are usually quite dry. There is undoubtedly some convective precipitation, especially during the summer months. Figure 2.2-1 shows a wind rose for the Tooele Army Depot - South. This data may not be totally representative of the Mercur site because the monitoring location is approximately 1,000 feet lower than Mercur, in a NNW-SSE trending valley, whereas Mercur is to the east and near the top ridge which parallels this valley, as shown on Map 2.2-1.

The nearest station where comparable long-term temperature and rainfall data are available is Eureka, Utah (Map 2.2-1). Eureka is thirty miles south of Mercur and at approximately the same elevation (Eureka 6,460 ft. M.S.L., Mercur 6,600 - 7,000 ft. M.S.L.). Both locations are on the west side of ridge crests with the prevailing moisture-bearing winds moving from a generally northwesterly to southeasterly direction. The Mercur site is slightly higher and not as close to the ridge as Eureka, consequently precipitaton totals are expected to be greater at Mercur (Eureka data plus ten percent). Rain gauges were placed at the Mercur site at the end of September, 1980 and data from these stations will be compared with the estimated values to verify these values.

Temperature and precipitation data for Eureka, shown in Table 2.2-1 and estimated precipitation data for Mercur shown in Table 2.2-2, are based on unpublished data provided by the Utah Climatology Office (telephone conversation, July 25, 1980).



MAP 2.2-1 Location of the TEAD Monitoring Site. The Dashed Lines Indicate the TEAD-S Boundaries and the Hexagons Show the Location of the Peripheral Sampling Stations.

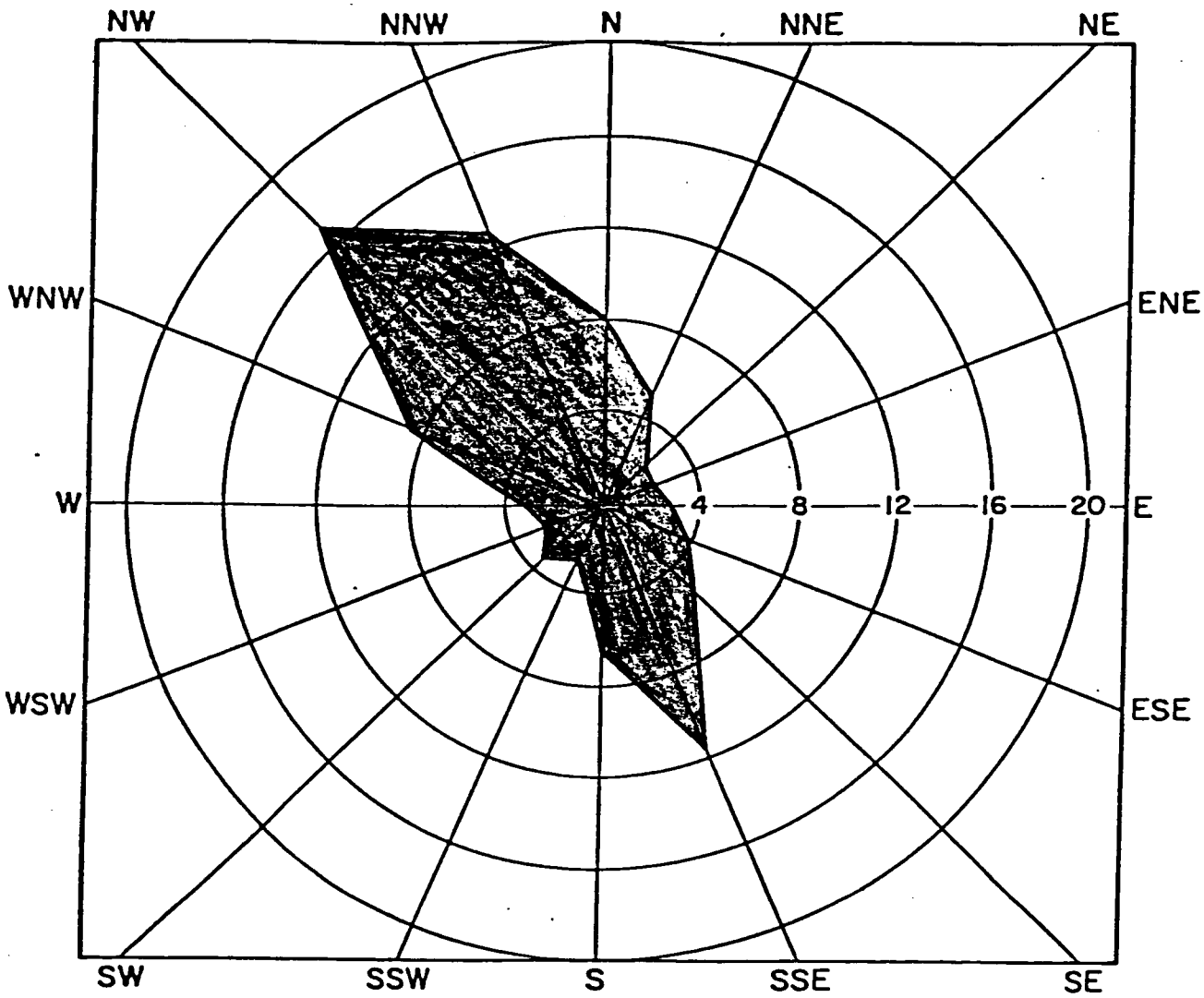


Figure 2.2-1: Wind Rose of the Tooele Army Depot-South Area
Directions show direction toward which the wind is blowing.

TABLE 2.2-1

ELEVATION	EUREKA	PERIOD OF RECORD
6460 Ft.	Weather Data	1962 - Present

Month	TEMPERATURE (°F) [1] Daily Max.	Daily Min.	Monthly Average	Total Precipitation (inches) Mean	Max. 24-hr.
January	55°F	-20°F	27.0°F	1.52	1.28
February	65	- 5	29.5	1.37	1.08
March	72	-10	36.1	1.48	1.01
April	76	15	42.4	1.49	0.97
May	86	19	52.9	1.33	2.14
June	95	30	60.9	1.12	1.70
July	98	40	70.0	1.11	2.51
August	95	32	67.9	1.38	1.43
September	91	21	58.4	0.83	1.10
October	80	9	47.6	1.37	1.34
November	70	3	36.6	1.25	1.70
December	57	-13	26.9	1.58	1.32
Annual	78.3	10.1	46.4	15.83	1.47

[1] The Mercur site is slightly higher and 30 miles north of Eureka, therefore, temperatures at the site may average somewhat lower than those listed for Eureka, but is considered representative.

TABLE 2.2-2
ESTIMATED PRECIPITATION FOR
MERCUR, UTAH BASED UPON 1962 - 1980
DATA FOR EUREKA, UTAH
(Unpublished data from Utah Climatology Office)

	EUREKA (moisture)	MERCUR (Eureka + 10%)
January	1.52"	1.67"
February	1.37"	1.51"
March	1.48"	1.63"
April	1.49"	1.64"
May	1.33"	1.46"
June	1.12"	1.23"
July	1.11"	1.22"
August	1.38"	1.52"
September	0.83"	0.91"
October	1.37"	1.51"
November	1.25"	1.37"
December	1.58"	1.74"
ANNUAL	15.83"	17.41"

Section 2.2.2
Geology is in the confidential file

2.2.3 VEGETATION

Site-specific field studies initiated in early June 1980 were conducted to determine the existing vegetative conditions for the Mercur area. These studies were performed by MARIAH ASSOCIATES and were patterned

after DOGM's preliminary guidelines for vegetative studies at surface coal mines. Vegetative data gathered during this program would not only be used to define baseline conditions, but also utilized in reclamation planning and as a guideline to determine reclamation and revegetation efforts success.

The Mercur area is located in the Oquirrh Mountains, a semi-isolated range that rises from the Great Basin Desert. More specifically, Mercur Canyon is in the southern end of this range, characterized by a semi-arid climate.

Four major vegetation types were identified on or adjacent to the proposed permit area: pinyon-juniper woodland, mixed brush, sagebrush, and bottomland - disturbed (Map 2.2.4[a]-[c]). The mixed brush vegetation type exhibited the greatest mean vegetative cover of the four types sampled on both affected (proposed disturbance) and control sites (Map 2.2-4[d]). Among the sampled "affected" sites, the sagebrush type displayed the greatest percentage of bare ground without any canopy cover while the bottomland - disturbed type displayed the greatest percentage of bare ground without any canopy cover among control sites.

The following more clearly delineates the four vegetation types identified on or near the permit area:

- Pinyon-juniper woodland - pinyon pine (primarily, *Pinus monophylla*) and Utah juniper (*Juniperus osteosperma*) generally dominate the drier, steeper south-facing slopes on the study area. Components of the mixed brush vegetation type appear interspersed in the pinyon-juniper woodland type to varying degrees depending on the aspect.

- Mixed brush - the general appearance of the mixed brush type is dense stands of gambel oak (Quercus gambelii), Utah serviceberry (Amelanchier utahensis), and mountain mahogany (Cercoaarpus montanus) with open parks of big sagebrush (Artemisia tridentata). This type is more highly developed on the more moist northfacing slopes and in the canyon ravines on the study area.

- Sagebrush - big sagebrush dominates alluvial fans on lower portions of the study area below the pinyon-juniper woodland type and the proposed permit area.

- Bottomland-Disturbed - rubber rabbitbrush (Chrysothamnus nauseosus), big sagebrush, and black greasewood (Sarcobatus vermiculatus) dominate bottomland areas on the study site. These alluvial bottomland areas have been subjected to varying degrees of disturbance, primarily increased sediment deposition that has resulted from previous mining activities in the Mercur area.

Comprehensive surveys were conducted within each vegetation type on all affected areas to obtain a complete listing of vegetative species for the study area and thereby, to identify any threatened, rare or endangered plant species protected by federal or state laws; any noxious weeds; and any selenium-indicating species. Surveys were conducted by a plant taxonomist during two days each month throughout the growing season (early June through late September). Four such surveys were completed.

To summarize the vegetation technical report, 228 different species were identified on the study area. Of these 228 species, four (4) are listed as noxious weeds, 34 as common weeds, and only one (1) listed as a primary selenium indicator. No plant species presently listed as endangered or threatened (Federal Register, December 15, 1980) were encountered on the study area. In addition, Utah plant species listed as endangered or threatened were not encountered on the proposed project area.

Of the eleven noxious weed species listed for Utah under the Utah Noxious Weed Act, four were encountered during vegetative species composition studies in the Mercur area. These species were: Convoluolos arvense (field bindweed) encountered in the pinyon-juniper woodland type and the bottom-land disturbed type; Cirsium arvense (Canada thistle) encountered in the sagebrush type, in the pinyon-juniver woodland, and along the roadside in the mixed brush type; Cardaria draba (hoarycress whitetop) encountered in a disturbed area at the old townsite of Mercur; and Cardaria chalepensis (whitetop) encountered in a riparian area near the study area. Since these four species were not identified on any of the study transects, it can be assumed that their distribution is not widespread on the study area and their numbers are probably low.

The only selenium - indicating plant species encountered was Stanleya pinnata (desert princess plume) which was located in several areas, though mostly on clay slopes in pinyon-juniper woodland type and on gravelly soils in the sagebrush type.

Other vegetation types near the proposed permit area but which would not be disturbed by the proposed mining activities include aspen and pinyon juniper-mixed brush.

Aspen (Populus tremuloides) occur as small stands, often in ravines at higher elevations on the northern end of the vegetation study area. Several grass (e.g., Poa, Stipa and Bromus sp.), forb (e.g., Achillea millefolia, Thalictrium sp.), and mountain shrub species (e.g., Symphoricarpos oreophilus, Amelanchier utahensis, Prunus virginianus, Quercus gambellii) comprise the understory in aspen stands. This type appeared to be heavily grazed.

On a few of the north-facing slopes supporting pinyon-juniper woodland within the vegetation study area, a more dense understory of mixed brush species occurs. This pinyon juniper-mixed brush subtype occurs on north facing slopes where additional moisture accumulates, thereby enhancing growing conditions. Common mixed brush species occurring in this subtype include

Artemisia tridentata, Quercus gambelii, Cercocarpus montanus, Cercocarpus ledifolius, Amelanchier utahensis, Symphoricarpos oreophilus, and Purshia tridentata.

The areas within the study boundaries mapped as "disturbed" type might be more properly considered a land-use type rather than a vegetation type. This type has been disturbed at various times in the past and some areas will be disturbed again by the proposed development. The area encompassing the old mining community of Mercur displays various degrees of disturbance. Extensive areas consisting of barren mounds of spoil and tailings material are prevalent in the vicinity of the old mine sites. Barren ridges are currently being used by dirt motorcycle enthusiasts and other recreationalists, while other disturbed sites are redisturbed by people searching for artifacts in the old mining town. Several dirt roads crisscross the area, primarily in areas where core drilling has been conducted. Mountain shrub species have invaded some of these disturbed areas, possibly from small islands of undisturbed mixed brush vegetation or from root stock materials that may have resprouted after disturbance. Some of these disturbed areas have been invaded by rubber rabbitbrush (Chrysothamnus nauseosus), similar to the bottomland-disturbed vegetation type, which probably indicates an early successional stage in more recently disturbed areas. Most disturbed areas are barren due to the especially sterile nature of some of the exposed spoil materials. Table 2.2-3 summarizes the percentage of vegetative cover for the study area.

2.2.4 SOILS

Detailed mapping, sampling, and description of soils were performed in the study area while a reconnaissance type survey was completed outside of this area. The purpose of this soils assessment is to provide an understanding of what topsoil materials would be impacted by the proposed project and provide a basis for designing methods for proper removal, handling, and replacement of topsoil materials.

TABLE 2.2-3 SUMMARY OF VEGETATIVE COVER DATA FOR ALL AFFECTED AND CONTROL SITES SAMPLED

Vegetative Type	Vegetative Cover (%)				Litter/Rock (%)				Vegetation, Litter/Rock (%)				Bareground (%)			
	Affected		Control		Affected		Control		Affected		Control		Affected		Control	
	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	X	S
Pinyon-Juniper Woodland	35.9	10.6	45.7	5.6	56.3	11.2	44.5	9.5	92.2	6.7	90.2	9.4	7.8	6.7	9.8	9.4
Mixed Brush	53.5	15.4	46.1	5.5	41.1	14.5	41.7	11.7	94.6	6.6	87.8	10.3	5.4	6.6	12.2	10.3
~~Sagebrush~~	30.8	10.3	34.1	6.0	25.0	13.5	19.3	9.5	55.7	14.4	53.4	11.5	44.3	14.4	46.6	11.5
Bottomland-Disturbed	49.3	14.3	38.8	9.5	31.6	11.4	37.2	11.5	80.9	16.8	76.0	12.3	19.1	16.8	24.0	12.3
Total (Entire Area)	42.375 x .7 = 29.66															

Sample Size:

- Pinyon-juniper woodland: 31 transects (affected), 15 transects (control)
- Mixed brush: 32 transects (affected), 10 transects (control)
- Sagebrush: 40 transects (affected), 15 transects (control)
- Bottomland-disturbed: 30 transects (affected), 20 transects (control)

Six principal soil series overlie the area of the proposed mine and mill complex. Map 2.2-5(a-d) shows soil mapping unit boundaries in relation to the proposed project area. The FRANK E. BASIL, INC. Soils Technical Report provides a detailed detailed discussion of the soils including laboratory results. Table 2.2-4 summarizes the soil characteristics of each principal unit.

TABLE 2.2-4
SOIL SERIES SUMMARY

TYPE	ACORD	ANT FLAT	BEZZANT	MANILA	ST. MARYS	TOEHEAD
% V.F.S & Sand*	27.0	41.0	13.0	37.0	40.0	40
% Silt*	39.0	29.0	47.0	34.0	39.0	41 - 37
% Clay*	34.0	30.0	40.0	29.0	21.0	19 - 23
pH (Range)	6.9-8.0	6.9-7.9	7.6-7.9	7.8-8.0	7.8-8.1	7.3 - 8.0
Na* (ppm)	0.49	1.37	0.30	0.55	0.64	0.70 - 3.70
Ca* (ppm)	1.85	2.84	1.78	1.62	1.51	2.15 - 13.20
Mg*(ppm)	0.48	1.23	0.43	0.23	0.93	0.38 - 4.45
SAR*@	0.46	0.96	0.29	0.57	0.58	0.63 - 1.25
Organic Matter	2.0	1.0	2.3	1.9	1.1	4.6 - 2.1

* Averaged and weight by depth

@ (SAR) Sodium Adsorption Ratio = $\frac{Na\ (ppm)}{\sqrt{\frac{Ca(ppm) + Mg(ppm)}{2}}}$

The following briefly describes each principal soils type:

The Acord Variant clay loams are found on terraces, ridgetops and high fan remnants in high mountain valleys as well as on steep mountain sides with slopes ranging from 8 to 35 percent. The soils are fairly deep with good drainage, have 20 percent gravels increasing to 60 percent at greater depths, and is moderate permeable. The pH ranges from 6.9 to 8.0, generally increasing with depth.

The Ant Flat Variant loams are found on remnants of high terraces and fans in the mountain valleys with slopes ranging from 3 to 50 percent. The

soil is moist with a very friable, subangular blocky, neutral (pH 7.0), surface layer to a very hard, angular alkaline (pH 7.7) subsoil.

The Bezzant Variant loamy clay is found on mountain slopes and ridgetops with slopes 15 to 75 percent. This type of soil is moderately deep, well drained and of moderately permeability. The majority of the soils are 40 to 60 percent limestones with a pH ranging from 7.6 to 7.9.

The Manila Variant loamy clays are on terraces, colluvial benches and remnant fans in high valleys on slopes 10 to 30 percent. The soil is moderately moist, with rock fragments varying from 5 to 15 percent and overlies bedrock.

St. Marys Variant soils have a loose, granular surface layer and consist of deep, somewhat excessively drained, rapidly permeable soils found on fan cones protruding into canyons at the mouth of ravines and on lower parts of steep mountainsides. Slopes are 20 to 50 percent. Formed in alluvium and colluvium from limestone and dolomite, the soil is mildly to strongly alkaline and exhibits a large percentage of limestone fragments (65 to 75 percent).

The Toehead Variant soils consists of deep, well-drained, moderately permeable soils found along intermittent stream courses in narrow canyons with slopes 2 to 20 percent. This type exhibits the greatest depth in the area with a weighted average of fragments usually less than 15 percent and a pH from 7.6 to 7.9.

There are other soil types in the area but these would not be affected by the proposed project. Two other classifications should be noted, however; the Mined Land and the Slickens mapping units. These units are the result of previous mining activity in the area and consists of areas dug up by mining activity, mine dumps, and mill tailings piles washed onto bottomlands of narrow canyons during flash floods. The material is of silty and loamy material and not suitable for either topsoiling or subsoiling.

2.2.5 WILDLIFE

Baseline wildlife conditions for the Mercur area are described from site-specific field studies conducted during June through October, 1980 by MARIAH ASSOCIATES, personal interviews of biologists familiar with the area, and results of literature search. Site-specific field studies are scheduled to continue through the 1980-81 winter and early spring period. Preliminary results of the winter studies do not indicate heavy winter usage of the area, although this may be due, in part, to the mild 1980-81 winter.

A portion of the study area (Map 2.2-6) is on mule deer winter range but most of the proposed project site is used as summer and transition range. Browse in the area was in fair condition; however, frequently used species exhibited heavily browsed conditions. A few elk occur in upper portions of the drainages during summer (elk use of the Mercur area during winter, if any, will be ascertained during winter 1980-81 field studies). Mammalian predators reported in the area include mountain lion, bobcat, coyote, red fox, badger and long-tailed weasel. Black-tailed jackrabbits and cottontails occur in the area and are especially abundant in the open sagebrush and bottomland types. Sign of porcupine activity was scattered throughout the mixed brush and pinyon-juniper types. The deer mouse was the most abundant and ubiquitous small mammal. Other small mammals include the rock squirrel; cliff, least, and Uinta chipmunks; southern red-backed and meadow voles; long-tailed pocket mouse; and Ord's kangaroo rat.

A total of 59 species of birds was recorded during avifaunal surveys on and near the site area. The most abundant species in pinyon-juniper habitat were the black-throated gray warbler, bushtit, and Virginia's warbler. Species in the mixed brush habitat that had at least two birds/km transect were the rufus-sided towhee, MacGilluray's warbler, green-tailed towhee, Brewer's sparrow, Virginia's warbler, broad-tailed hummingbird, mourning dove, and warbling vineo. The most common birds in the sagebrush type, which lies outside the permit area, were the mourning dove, sage thrasher, black-throated sparrow, and western meadowlark.

The most abundant upland game bird was the mourning dove, however, the area is also used by a small number of chukar and, during the spring, blue grouse. All sitings of raptors during the 1980 wildlife study and all known locations of active and inactive raptor nests in the study area were recorded and are shown on Map 2.2-6.

No active raptor nests were located within the permit area, although two Marsh hawk nests were found just north of the boundary, one in Meadow Canyon and one near the northwest corner of the permit area. An active ferruginous hawk nest was located near the junction of the Mercur Canyon road and Utah 73, slightly more than two miles west of the southwest corner of the permit boundary. One active golden eagle eyrie was observed during the 1980 wildlife survey. This nest was approximately one mile east of Ophir and three and one half miles from the nearest part of the permit boundary. Two other golden eagle eyries have been identified as having been active recently, but not during the 1980 season. One of these is in Ophir Canyon about one and one half miles west of Ophir and over three miles from the nearest portion of the proposed permit area. The other currently inactive golden eagle eyrie is on the north side of Manning Canyon about one and one half miles north of the townsite of Manning and two and one half miles east of the townsite of Mecur. A currently inactive prairie falcon eyrie is located near the inactive golden eagle eyrie west of Ophir, as shown on Map 2.2-6.

Other raptors which were observed, and probably nest, in the area are the red-tailed hawk, Cooper's hawk, American kestrel and great-horned owl. Prairie falcons were observed late in the summer but no active prairie falcon eyrie was located even though an eyrie used in the past was located. During the winter, bald eagles roost in Ophir Canyon, north of Mercur. This roost is shown on Map 2.2-6. Peregrine falcons have not been reported in the study area. A variety of passerine and other birds were observed on the study site and adjacent areas. The mixed brush type had the highest abundance of passerines of any type and also had a relatively high species diversity index. Waterfowl were not observed on the Mercur study area and are limited by the lack of suitable habitat.

Amphibians were not observed on the site and few areas of suitable amphibian habitat occur in the area. Several common reptiles were observed on the area, including the Western collard lizard, Great Basin sage brush lizard, short-horned lizard, Great Basin whiptail, gopher snake and Great Basin rattle snake.

The only threatened or endangered animal species known or likely to be present in the general area is the bald eagle. Species of High Federal Interest which occur in the area are golden eagle, ferruginous hawk, Cooper's hawk and prairie falcon. All sitings of these species are shown by Map 2.2-6.

Potentially important wildlife habitats identified in the study area are water sources and raptor nesting sites. Bald eagle winter roosts occur within two miles of the permit boundaries. Additional important wildlife habitat may be identified during the remaining field studies.

2.2.6 HYDROLOGY

Beginning in the summer of 1980, a comprehensive hydrologic study was initiated to determine baseline surface and ground-water conditions within and surrounding the proposed permit area. The general hydrological characteristics of the area are defined in the following paragraphs.

Except for the high mountain ridges along Lewiston Peak and Silveropolis Hill, the climatic conditions of the area can be described as semi-arid, cold. That is, it is a region where evaporation exceeds the available precipitation, where there is little or no surface water present with a general lack of a constant ground-water level, and only impermanent streams originate (as defined by Koeppen). Within the mine and mill complex area, surface water resources are characterized by their scarcity. With no perennial or intermittent streams present, the surface water regime is dominated by Mercur Creek, an ephemeral stream which flows only in direct response to local thunderstorm activity and spring snowmelt runoff. There is

little evidence that any stream flow activity occurs beyond the mouth of Mercur Canyon in Rush Valley. It appears that flows percolate into the alluvial strata once they enter the Rush Valley area. The presence of three small seasonal springs north of the proposed complex, and at higher elevations, is primarily the result of localized snowmelt recharge and discharge phenomena. In most cases, the recharge from these springs is within one-half mile of their discharge point. Only the spring located immediately north of the tailings impoundment area is within the potential disturbance boundary.

Ground-water resources of the project region are limited by the semi-arid climate and low rainfall conditions, and extensive drilling has shown that apparently no active ground-water aquifer systems are present within 1000 feet of the surface in the general area of the pit. Project process water will come from wells drilled in the alluvium of Rush Valley and are not related to any ground-water aquifers in the proposed permit area.

The drilling program has revealed the existence of some water trapped in the abandoned mine workings in the area. This is to be expected, since other mining activities within the Oquirrh range have encountered a quantity of trapped water in similarly situated mine workings. This water is snowmelt runoff trapped within these workings and should be insignificant in quantity. Although no analyses have been performed to determine the quality of this discharge water, similar mine discharge water is of relatively good water quality. A settling pond is planned to contain any open pit mine discharge water which would be pumped from the pit. As discussed in the Mine Drainage Plan, this pond will also receive runoff from the storage areas for the waste rock and ore as well as from the plant site. Water in the pond will be used in the mine and mill or lost by evaporation. A spillway is provided in the event that a storm in excess of twice the 24 hour - 10 year event occurs. Plans for this pond are being reviewed by the appropriate regulatory agencies relative to permit requirements.

Because no flows have occurred during the summer and fall field study programs, surface water quality characteristics have not been determined.

Seven drainage basins were outlined in the proposed project area, typified by deeply incised canyons with moderate to steep walls. Preliminary soils analyses show that soils in the area have moderate to rapid infiltration rates due to the sparse vegetation, the generally friable nature of the soil, and the lack of antecedent moisture conditions. These conditions appreciably reduce the amount of runoff resulting from light or moderate precipitation. As discussed in the Mine Drainage Plan, appropriately placed diversion berms will be employed on the site to divert upland flow around the areas of disturbance.

Map 2.2-7 illustrates the surface characteristics of the project area as well as the drainage basins.

2.3 MINING AND RECLAMATION PLAN

2.3.1 MINE PLAN

The schedule for the project (Figure 2.3-1) assumes commencement of detailed engineering in April 1981, mill site development in late 1981 and initial overburden removal by April 1982. Full production would commence in 1983 and continue through 1988, with cessation of mining activities and reclamation of abandonment areas requiring an additional two years completion. However, future economic conditions will govern the life of the project.

o Mine Complex

The proposed mine complex is shown on Map 2.3-1. This complex includes the following components: open mine pit, overburden disposal area, and low grade ore stockpile and the attendant haul roads. Table 2.3-1 gives the estimated surface disturbance acreage.

TABLE 2.3-1

ULTIMATE ACREAGE TO BE DISTURBED BY MERCUR CANYON PROJECT

COMPONENT	ACREAGE	
Open Pit Mine	64	
Overburden Disposal Area	49	60
Low Grade Ore Storage Area	11	
Soils Stockpile	18	18
Mill and Office Facilities	37	
Tailings Dam & Pond #2	57	
Settling Pond	5	
Road Corridor, Misc.	31	
	272	

The open pit mine's growth has been keyed to the mill's ability to meet a full production schedule over the life of the facility, set at approximately 1.1 million tons per year. The open pit would, at the end of five years, cover approximately 64 acres on Mercur Hill to the 7200 foot elevation level.

FIGURE 2.3-1

ESTIMATED ENGINEERING AND PRODUCTION SCHEDULES

```
                    1981  1982  1983  1984  1985  1986  1987  1988  1989  1990

Open Pit Mine
  Engineering       [-----------------------------------------]
  Procurement        [-------]
  Development           [---------]
  Full Production                  [---------------------------]
  Closure                                                      0

Mill Facility
  Engineering       [-------]
  Procurement         [-------]
  Site Development    [-----]
  Yard Utilities      [-----------]
  Crushing/Storage       [-------]
  Service Buildings   [------]
  Mill Complex           [-------]
  Tailings Area         [----]
  Full Production                 [---------------------------]
  Closure                                                      0

Reclamation
  Shutdown                                                     [-----]
  Revegetation                                                 [------------]
```

It is expected that the following criteria would be utilized as standard operating procedures in the open pit mine area:

- Overburden would be mined in 30 foot benches.
- Ore would be mined in 10 foot benches to permit a degree of selectivity.
- Because of bench height limitations, 6-inch diameter rotary drills will be used for overburden blast holes and 4-inch diameter rotary drills for ore blast holes.
- Because overburden is competent limestone, a powder factor of 0.8 lb/ton would be used to ensure good fragmentation, based on engineering calculations.
- Haul roads would be, at maximum, 8 percent gradients in and out of the pit, based on preliminary engineering design.

Only overburden will be moved from the open pit during the first year of mine development. This would be used to build the initial tailings dam (two year production level), and as production increased, would be used to raise the elevation of the dam in successive stages. Additional overburden may be used on the various haulroads and for the mill site foundation. It is anticipated that approximately 3 to 4 percent of the total overburden removed from the open pit would be used for these construction purposes. All other overburden would be placed in the waste disposal area, located in Sacramento Gulch, which is adjacent to the pit area (see Map 2.3-1). Placement of these materials would be initially in the southern most end of the gulch and proceed north, then finally east, to completely fill the gulch to approximately the 6940 foot elevation level. The waste disposal area would require approximately 49 acres.

During the course of mining gold bearing ores, continual on-site laboratory tests will determine the grade of ore being mined. By mining the ore in 10-foot benches, a certain amount of selectivity of run-of-mine ore will be possible, ensuring a high ratio of recoverable gold to ore mined. When low grade ore is mined, it will be hauled by rear-dump trucks to the

proposed low grade ore stockpile, located southeast of the open pit mine area. As favorable economics occur, it is anticipated that this lowgrade ore could be processed for gold recovery. Therefore, reclamation efforts will allow for this contingency (see Section 2.3.3).

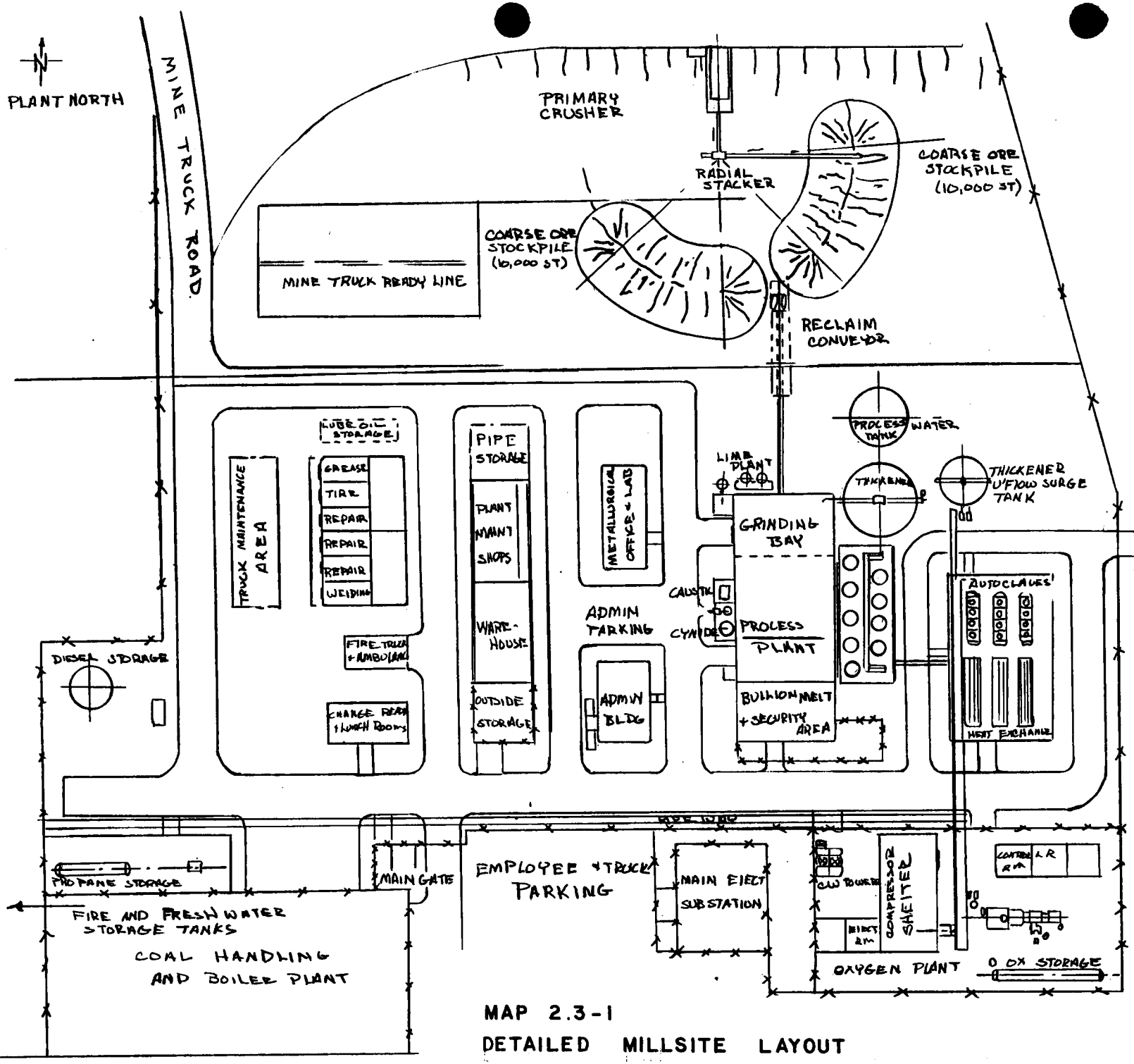
o Mill Complex -

The proposed mill complex is shown on Map 2.3-1. This complex includes the following components: course ore stockpile, crushing facility, processing plant, oxygen plant, electrical substation, administrative buildings, service facilities, boiler plant with coal storage, and tailings dam and impoundment. Table 2.3-1 gives the estimated surface disturbance acreage for this complex.

Located approximately one half mile east of the open pit mine, the mill facilities are designed for the production rate of 1.1 million tons per year. Based on an operating year of 350 days, the designed production rate would then be 3,000 tons per day.

The proposed mill complex would be situated on the top of a knoll at the 7,000 foot elevation level. Although specifically detailed in Section 2.3.3, in general the usable portion of the topsoil would be removed and stockpiled for later reclamation use prior to grading the site for the major mill structures. Excavated material will be used to create a base for the coarse ore storage area and while overburden will be used for the parking area.

When ore is encountered in the open pit and removed, it will be hauled by rear-dump trucks on a two shift, five days per week schedule to either the coarse ore stockpile or the crusher surgehopper. In order to minimize the use of a front-end loader, trucks will normally deliver ore to the crusher surgehopper. The 200,000 ton coarse ore stockpile will be engineered to minimize wind and water erosion.



MAP 2.3-1
DETAILED MILLSITE LAYOUT

Once the ore is crushed, it will be ready for processing in the mill. Figure 2.3-2 presents a simplified flow diagram of the milling process. Basically, the gold recovery involves the following processes and facilities:

- Grinding and Thickening - The flow of ore into the grinding circuit will be controlled by a variable speed apron feeder. This circuit will consist of an open-circuit semi-autogenous grinding mill, ball mill and cyclone classifiers. The resultant slurry feed will be sent to a storage tank.

- Pressure oxidation, Cyanidation, Carbon-in-Leach recovery (CIL), and Concentration - Through a system of autoclaves requiring steam and oxygen, the slurry will be heated, agitated, and pressurized to oxidize the ore prior to retention in the cyanidation tanks. When in the cyanidation tanks, the slurry will simultaneously be mixed with activated carbon which will absorb the soluable gold. The loaded carbon will be delivered to desorption vessels where the gold will be stripped off the carbon. This gold rich solution will then be circulated through electrowinning cells to plate out metallic gold. Once this is completed the resultant gold sponge will be ready for refining into the final product.

- Gold Refining - The gold refining operation will be a two-stage process. First the gold sponge will be placed in sealed retorts which will dry the material. The gold sponge will then be placed into a tilting furnace where gold will be separated from the slag. The gold will be fired once more and then poured into gold bullion molds. The furnace uses propane as a fuel source.

As part of the leaching process, pressure oxidation facilities are required to oxidize any refractory ore encountered during mining. In order to accomplish this, oxygen must be introduced into the autoclaves at high pressures. To provide these, two additional facilities would be constructed on the mill site, shown on Map 2.3-3.

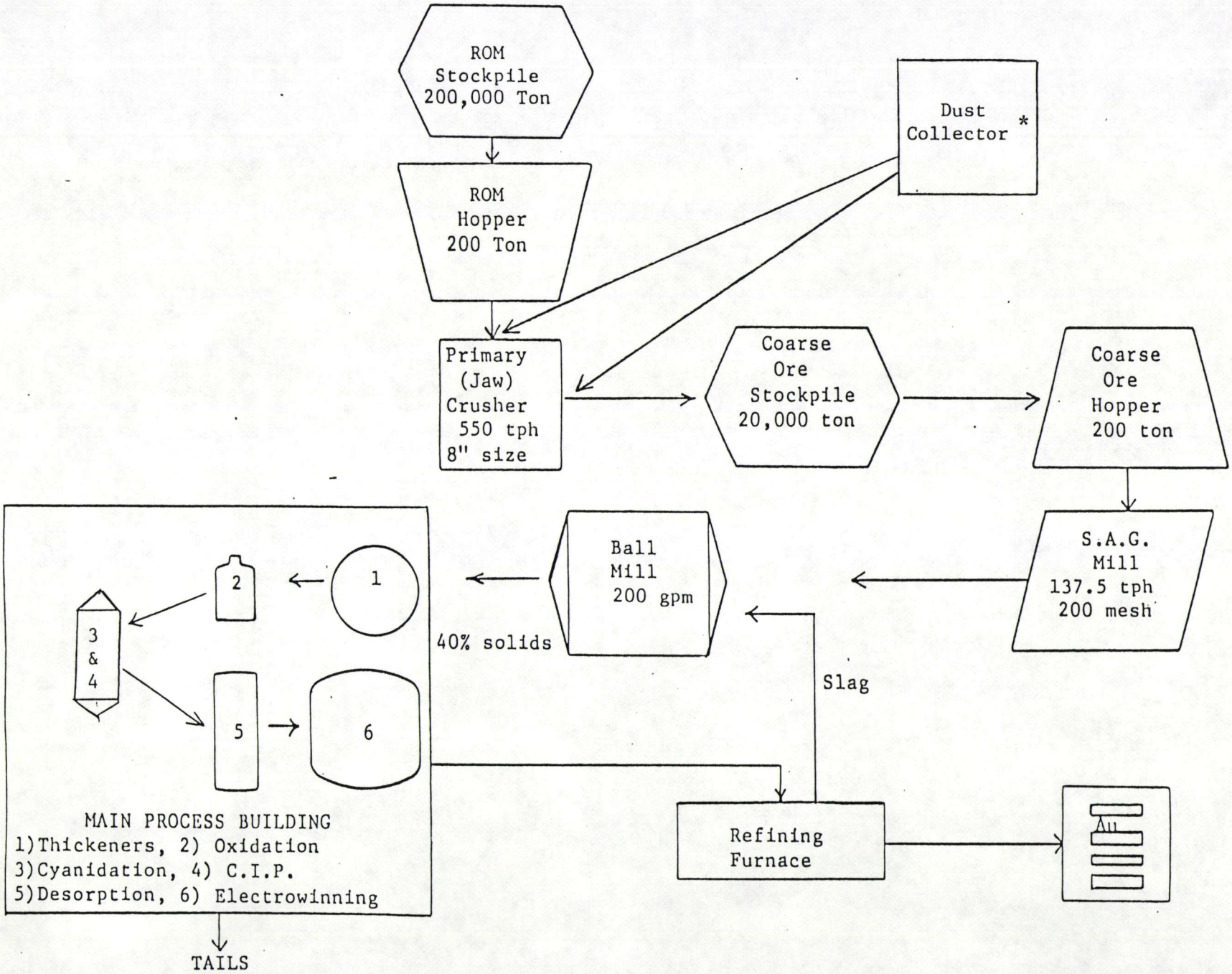


FIGURE 2.3-2
Simplified Flow Diagram of
MERCUR CANYON PROJECT

*Air Pollution Control Equipment

Process steam would be provided by two coal-fired fluidized-bed industrial boilers. The boilers would be provided with pollution control equipment as specified by sound engineering practices. Fly ash would be pumped as a slurry to the tailings pond.

Oxygen would be provided by an oxygen plant or oxygen tank to provide oxygen to the autoclaves.

Tailings from the mill will be collected in either of two disposal sumps. From these sumps, tailings will be pumped through a pipeline to the tailings pond and discharged across the upstream face of the dam. The tailings, primarily consisting of fine rock particles separated from the product material in the various processes, would also contain process water and reagents introduced to aid the gold extraction. Table 2.3-2 lists some of the reagents used and its purpose.

TABLE 2.3-2
REAGENTS USED IN MILL PROCESS

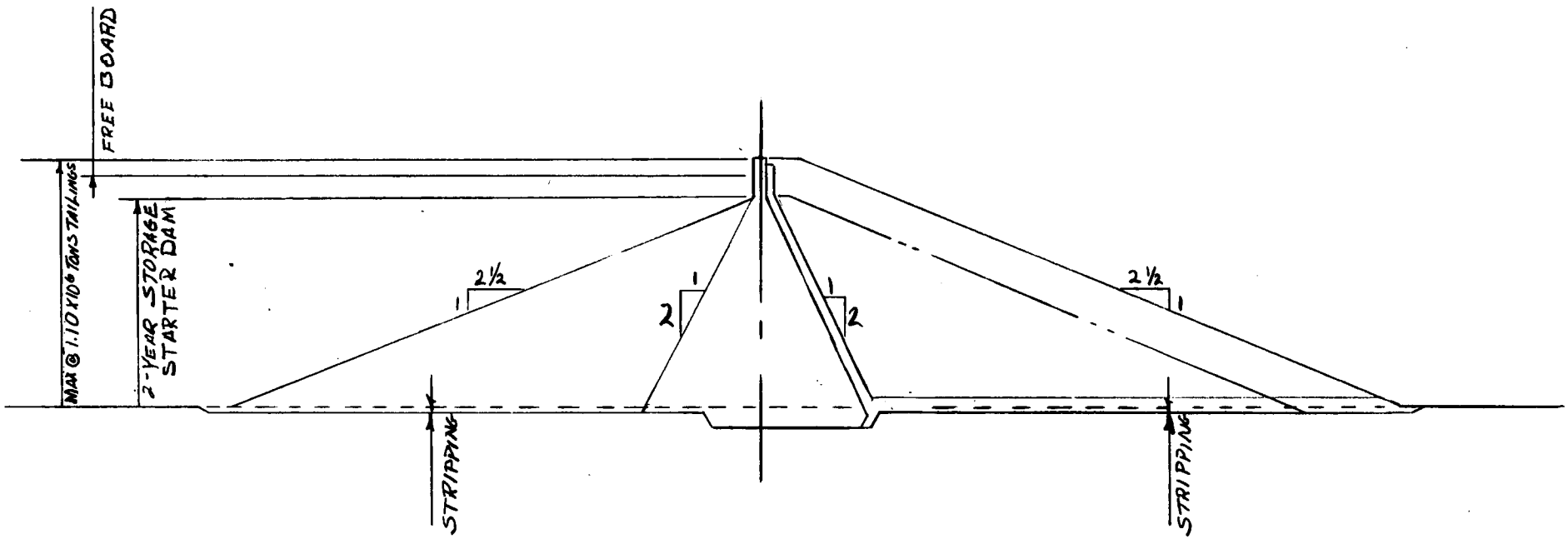
NAME	PURPOSE
Pebble Lime	Preparation of milk of lime for pH control on mill water and leaching process. Used in boiler plant for SO_2 scrubbing.
Sodium Cyanide	Separation/Desorption
Nitric Acid	Washing Desorption vessels
Phosphate	Cleaning Carbon-in-Leach
Activated Carbon	Gold Absorption
Flocculant	Thickeners
Sodium Hydroxide	Desorption

The proposed tailings dam and tailings pond would be located in Reservation Canyon, approximately one half mile north-northwest of the mill. Initially, a starter dam will be constructed sized to store two years of mill production. Thereafter, the dam would be raised in increments until the ultimate storage capacity is achieved. The total acreage of the tailings impoundment at the end of five years of production is estimated at 57 acres (Table 2.3-1).

Physically, the dam will be approximately 275 feet high at its maximum section with a crest length of approximately 1,200 feet. The design of the dam would include an internal filter/drain zone. The internal filter would prevent the hydraulic movement of dam material while the internal drain would allow for control of seepage through the dam. The embankment would be constructed of locally available materials (i.e., mine overburden) after the dam foundation and area has been cleared of topsoil. A typical cross-section view of the tailings dam is shown in Figure 2.3-3.

Diversion channels would be constructed to divert clean flood flows (up to the 10 year - 24 hour flood) around the pond while larger floods would breach these channels and enter the pond. The pond would be sized to contain both the required tailings volume as well as any flood runoff volume from both a 100 year - 24 hour event and a maximum probable flood event. The pond sizing storage criteria are estimated to be 3840 acre-feet. Complete details for the diversion channels are given in Section 2.3.2 - Mine Drainage Plan.

Recycling of the tailings pond water is planned. Water would be reclaimed with barge mounted pumps which would pump the water through a pipeline to the mill thickener overflow tank located near the main processing building.



TYPICAL CROSS SECTION - TAILINGS DAM

(CENTERLINE RAISING METHOD)

FIGURE 2.2-3

o AUXILIARY FACILITIES

The primary water supply will come from a well. The water would then be pumped to a tank located above the mill site.

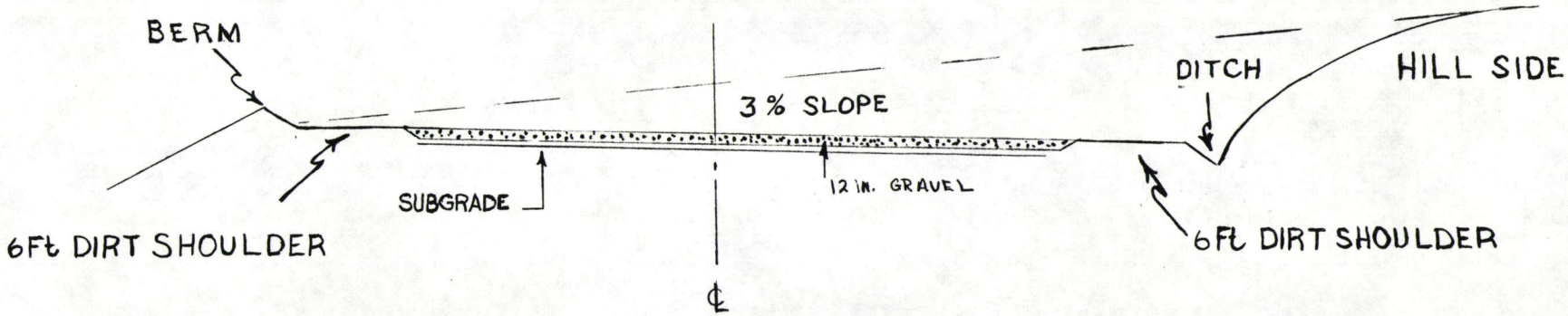
A secondary water supply would be the recycled tailings pond water and possibly, water from the abandoned mines which would be collected in a proposed five acre settling pond and then later recycled.

Utah Highway 73 will provide the primary access to the proposed mine/mill complex from the Tooele area. The existing two lane road connecting Utah 73 with Mercur will be utilized and improved, where necessary. The project site roads and parking areas will be paved with crushed rock placed on subgrade. Those project roads which would be subject to heavy haul and the mine haul road would have the roadbed increased to twelve inches of crushed rock and to a width of 45 feet. All roads would be constructed using good engineering practices; Figure 2.3-4 illustrates the typical haul road.

An on-site septic tank and leaching system would collect all sanitary wastes from the mill complex and attendant auxiliary buildings. The system will be approvable by the State of Utah and Tooele County. Solid waste, consisting primarily of construction materials, will be disposed of in a sanitary landfill.

Besides coal for the industrial steam boilers, a propane storage tank would be onsite to fire the tilting and crucible furnaces, for boiler start-up, and for the hot-water system. Fuel storage tanks would be constructed to service the mine trucks and service vehicles. In addition, an underground waste oil tank will be installed.

The following procedures would be incorporated into the proposed mine plan and become standard operating procedures for the complex. Not included



TYPICAL HAUL ROAD CROSS SECTION

FIGURE 2.3-4

herein are detailed revegetation procedures for the project (which are included in the reclamation plan, Section 2.3.3.):

- Those buildings included in the mine/mill complex would be in neutral colors that would blend with the existing landscape.
- All electrical equipment and construction would be in accordance with the following codes: National Electrical Safety Codes, Utah and Federal Office of Safety and Health Administration (OSHA) Standards, and Mining Safety and Health Administration (MSHA) Regulations.
- The septic system would be designed in accordance with the Uniform Plumbing Code and United States Public Health Service. The system would have approval from the State of Utah and Tooele County prior to construction.
- Lighting to all areas in the plant would be in accordance with Illuminating Engineering Society (IES) requirements.
- A system of diversions and a sediment pond would be constructed to collect run-off from buildings and plant facilities and to alleviate possible surface water contamination.
- Air pollution would be minimized with implementation of various fugitive dust control techniques and installation of dust collectors on point sources.
- Monitor wells would be installed near the tailings dam and samples analyzed on a regular basis to assess the potential movement of contaminated water.

With cessation of mining activities, GETTY MINERAL RESOURCES COMPANY would revegetate those areas of disturbance outlined in the detailed reclamation plan.

2.3.2 MINE DRAINAGE PLAN

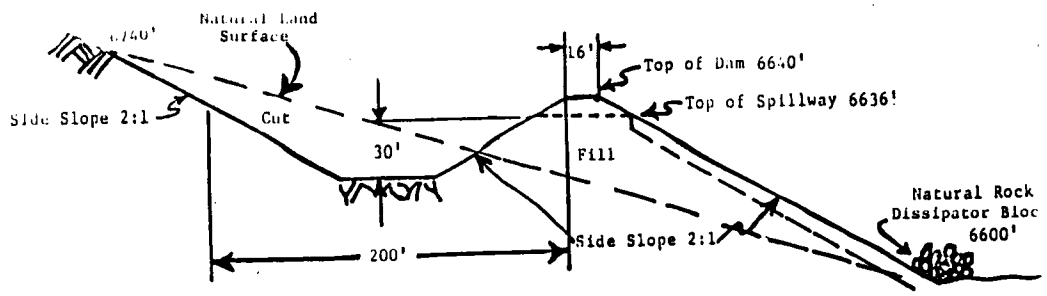
The mine drainage plan as developed is designed as a no-discharge system of berm diversions with a single settling pond located in the north east section of Section 7 T6S, R3W (Map 2.3-2). Two primary areas of disturbance exists where overland flow must be contained or diverted to reduce adverse affects from sedimentation. These areas include the open pit/mill area and the tailings pond area.

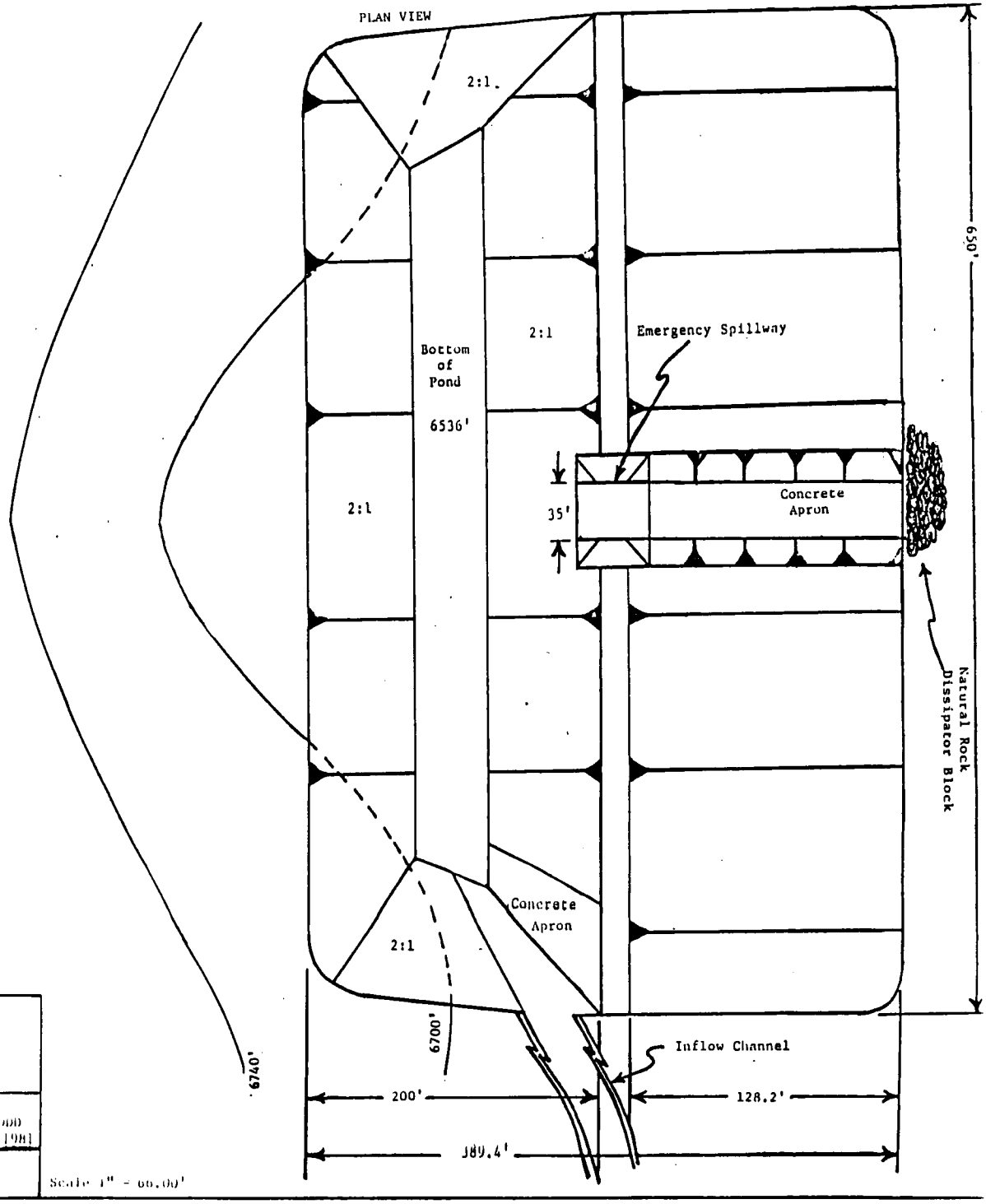
A berm/trench diversion structure has been designed to divert the majority of overland flow that would normally flow into the tailings pond (Map 2.3-2). This structure is designed with standard cut and fill procedures utilizing Standard Soil Conservation Service (SCS) methods from "The Handbook of Channel Design for Soil and Water Conservation", SCS-TP-61. Water diverted from the headwaters of the basin will be diverted around the tailings impoundment for eventual discharge into Mercur Creek.

The second area which requires substantial structural drainage modification is the mine and mill facilities complex. It is necessary to hydrologically isolate the area since most of the land within the perimeter is either already disturbed or will be disturbed by anticipated mining activity. Consequently, a berm/trench complex of the same basic design as used around the tailings pond is to extend along the entire northern portion of the mine and mill facilities area. This berm will effectively prevent overland flows from entering Mercur Creek. Instead, waters will be diverted to a proposed settling pond (Map 2.3-2) located on the western edge of the drainage basin. This settling and evaporation pond has been designed to accept the 10 year 24-hour flood from the entire drainage area without discharge. In the event that a large precipitation event should take place, an emergency spillway has been designed to accomodate the 100 year 24 hour storm. This design will prevent destruction of the pond complex if such an event occurs. In addition to handling flow from surface water runoff, the pond is also designed to accept water pumped from the pit. Figure 2.3-5 is a conceptual engineering drawing of the proposed pond. Table 2.3-3 summarizes dam impoundment dimensions and general characteristics.

The diversion channels have the capacity to carry the peak runoff from the contributory watershed for a 10 year 24 hour event. In addition, the constructed cross-section was planned to provide for appropriate freeboard and settlement allowances with channel grades selected to meet capacity requirements for the site and in accordance with principles used in SCS-TP-61.

CROSS SECTION





SEDIMENT POND DESIGN	
TRC ENVIRONMENTAL CONSULTANTS, INC. 8775 E. Orchard R. Suite 816 Englewood, Colo. (303) 779-4940	Drawn By: GEH Approved By: DDD Date: Feb. 9, 1981
	Figure 2.3-5

Scale 1" = 66.00'

TABLE 2.3-3 DAM CHARACTERISTICS

DRAINAGE AREA	Spill 10YR, 24HR w/ infiltration	Spill 10YR,24HR w/o infiltration	Spill 100YR,24HR w/ infiltration	Minimum Spilling Width w/ 1' Head Flow	Side Slopes of Pond	Pond Depth
614 Acres	0.0	0.0	78.12 cfs	35'	2:1	34'

POND WIDTH	POND LENGTH	SPILLWAY ELEV.*	TOP OF DAM ELEV.*	ELEV. OF DEAD STORAGE*	FREEBOARD	COMPACTION
200'	650'	30'	34'	10.75'	2	1'

*Feet Above Standard - 6606'

The structure is designed as a trapezoidal channel with side slope of 2:1 that is cut back into the existing grade until daylight is reached. This design (Figure 2.3-6) allows for a deep channel without the use of retaining walls. Specifications for this design are in Table 2.3-4.

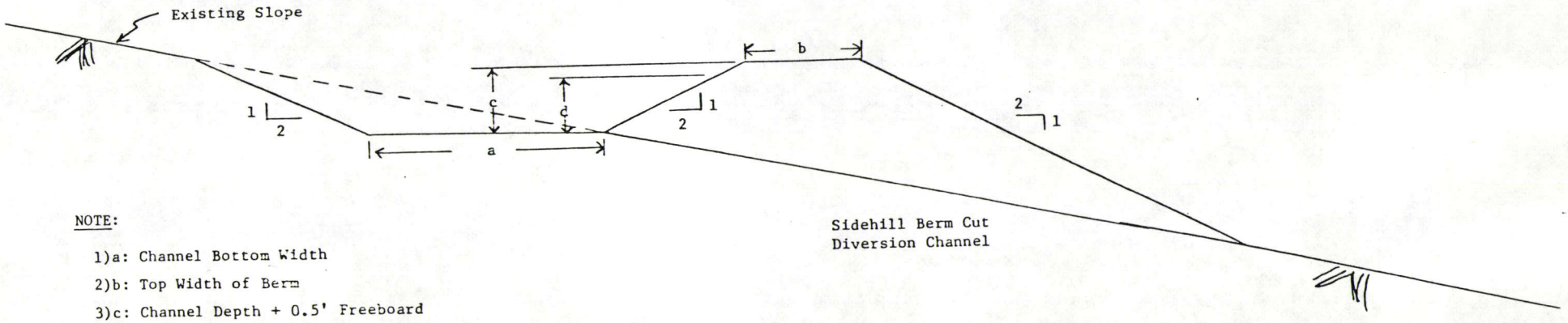
The channel design requires that the bottom and side slopes be covered with vegetation as soon after construction as possible.

TABLE 2.3-4

DIVERSION CHANNEL SPECIFICATIONS

614 AC.

	TAILINGS AREA	MINE/MILL
Channel Length	4250'	4250'
Channel Slope	1%	1%
Channel Retardant	D	C
Hydraulic Radius (R)	1.40	1.3
Channel Side Slopes	2:1	2:1
Channel Bottom Width	8.0'	6.0'
Channel Depth + 0.5 Freeboard	2.5'	2.5'
Velocities	5.6 fps	5.30 fps
Channel Capacity	134.4 cfs	103.4 cfs
10 yr - 24 hr Flood Event	127.0 cfs	102.0 cfs
Channel Area	24 ft^2	19.5 ft^2



NOTE:

1) a: Channel Bottom Width
2) b: Top Width of Berm
3) c: Channel Depth + 0.5' Freeboard
4) d: Depth of Flow
5) Diversion is built on 1% Grade
6) Cut and fill operation required for construction fo berm
7) Existing slope grade varies with location

CHANNEL SIZING	Tailings Area	Mine/Mill
a	8.0'	6.0'
b	4.0'	4.0'
c	2.5'	2.5'
d	2.0'	2.0'

TYPICAL SECTION
HYDRAULIC STRUCTURE

TRC ENVIRONMENTAL CONSULTANTS, INC.
8775 E. Orchard Rd.
Suite 816
Englewood, Colo. 80111
(303) 779-4940

DATE: 2/16/81
DRAWN BY: GEH
APPROVED BY: GEH

FIGURE 2.3-6

2.3.3 POST MINING LAND USE PLAN - Reclamation Plan

State Reg. Since it is sometimes difficult to determine where the mining process ends and reclamation begins, for the purposes of this report reclamation refers to surface configuration, grading, topsoil handling, seeding and planting, land management,
M-10(1) abandonment, and obligation bond release. All these phases of reclamation are directed toward post mining land use. Since
M-3(2)(a) the uses prior to renewed mining mainly include wildlife and
M-3(2)(b) domestic livestock (sheep); after mining the site will in part be able to be used by livestock and wildlife.

It should be noted that the disturbance boundary of Map 2.3-2,
M-5 the detailed Mine Drainage and Disturbance Map, is GMRC's best estimate of what could be disturbed. Since bonding will be based upon this entire area, at the time of commencing abandonment, any areas which have not been disturbed should be released from compliance bond obligation. Furthermore, areas such as existing county roads should not be under compliance bond since continuing use of these facilities after mining is their greatest value. Areas of previous mine disturbance not proposed for reuse by GMRC also should not be bonded since the previous mine areas were left in an unreclaimed condition. It would be unwarranted to require the reclamation of areas which were not only mined prior to 1975 but also disturbed by an entirely different operator from GMRC. Those previously disturbed areas proposed by GMRC for further use will be incorporated in GMRC's reclamation plans.

As with mining operations, reclamation will be conducted in a
M-10(2) manner which will promote the safety and welfare of the general public and mine employees.

State Reg. o TOPSOIL REMOVAL

M-10(14) The removal of topsoil will be accomplished with the use of scrapers, dozers, end-loaders, trucks, motor graders, or other appropriate equipment. Generally, a down slope recovery method will be employed. Where slopes are less than 35% (during favorable weather) soil will usually be removed by a scraper and dozer. The dozer will make ramps, landings, and help to consolidate soil materials. The scraper will salvage topsoil by driving downhill and using the blade and bowl of the scraper as a brake. Where slopes are greater than 35%, dozers will push soil downhill and consolidate soil materials to areas where scrapers can be used.

It is estimated that enough topsoil materials (thin by nature and on steep slopes) that are able to support vegetation can
M-10(14)(5)be gathered from the mine pit area, low grade ore dump, and mill area to allow replacement over the abandoned ore dump and mill areas. As seen subsequently in the text, the mine pit will not be graded, topsoiled, or planted since reduction of slopes to less than approximately 1:1 slopes would cause massive environmental disturbance above the pit wall. It is anticipated that enough topsoil materials which are able to support vegetation can be removed from the tailings pond area to allow an overall replacement of topsoil following use of the tailings facility. Topsoil which is removed from roadways, diversions, and impoundments fills (including the tailings fill) will be distributed along the cuts and fills of such structures and seeded. Topsoil which can support vegetation and which can be salvaged from the waste rock dump area are generally located only at the east end of the proposed dumping area. Therefore, the areas which do not have soil prior to dumping will not have topsoil returned following dumping. This is due to the fact that attempts to distribute soils over the entire area from the existing topsoil inventory

State Reg. would result in such thin overall replacement that seeding would penetrate through the entire replaced layer. While the salvageable topsoil materials will only be removed from the eastern portion of the waste rock dumping area, it is anticipated that the overburden which could actually arrive on the site (Long Trail Shale) would be of a nature conducive to plant growth without topsoil. Therefore, these overburden materials will be worked, amended as future testing indicates, and examined by means of vegetative test plots to determine the potential for plant production. When a high potential for vegetative success is observed on dump material, the topsoil materials salvaged from the site may be used at other locations of the project area as needed.

Soils suitable for reclamation will be removed from those areas which are expected to undergo new disturbance. Areas which are not actually included in the disturbance as it occurs on the ground will not have topsoil removed merely for the sake of fulfilling soil budgets in other locations (i.e., dump); rather, locations such as the mill site and tailings pond will have topsoil distributed as evenly as possible from the materials which were salvaged at those locations. Note, however, that topsoil from the pit area will be salvaged for use at the mill site. Should areas go wanting for topsoil, the seed mix (Seed Mix #2 as seen later in the text) which is adapted to thin soil areas will be employed. Topsoil horizons only will be removed from the tailings pond area and the subsoils will be left in place. The clay-rich subsoils in this area will be used to control seepage from the tailings pond.

o REGRADING

M-10(4) Generally, areas which will be regraded will be rounded and sloped so as to avoid safety hazards and erosion. The top

State Reg. portion of the mine pit wall will be reduced by blasting to a 1:1 slope at the time of overburden removal in order to provide a safe working area above the pit. Further reduction

M-10(5) of the pit slope is not warranted due to the amount of additional land disturbance which this process would cause. In fact, up to 400 additional feet of disturbance would be needed to tie into the existing slope by employing a 2:1 pit slope and up to 1875 feet would be required for a 3:1

M-3(2)(d) tie-in. These could add up to 33 acres and 253 acres of increased disturbance respectfully. Also, the incremental benefits from this practice are not at all equitable to the large additional mining costs. The surfaces of the mill area and waste rock dumping area will be regraded to a flattened condition with the outboard edges rounded. In no case will

M-10(3) these be left with slopes that exceed the angle of repose. The tailings facility will not receive regrading since the impoundment dam will have been seeded and stabilized during

M-10(13) construction and since the tailings will be in a naturally gently sloping condition. However, the required impoundment spillway will be lowered and a stabilized flow-through drainage established to prevent post mining impounding of water. The area where low grade ore was stored will be, after such low grade ore has been processed, sloped and rounded into

M-10(7) the existing topography. Roads which are to be left for continuing use will be left in a stabilized condition as per the agreements between GMRC and the future owners. The roads which are under bond obligation and which have no value to the post mining land uses will be scarified and abandoned in accordance with the approved abandonment procedures (as seen later in the reclamation plan)..

M-10(8) Diversion ditches around the tailings pond will not be regraded since they will have been previously planted and

State Reg. since either in a functional or breeched condition the waters
M-10(11) from such structures will be directed to the reclaimed tailings area. If NPDES sampling indicates that impounded
M-10(3) water is of a quality suitable for continued animal watering use, the sedimentation pond will not be scheduled for grading. Grading and shaping will be accomplished by using dozers, scrapers, trucks, end-loaders, motor graders, or other suitable equipment.

o TOPSOIL STORAGE AND REPLACEMENT

M-10(14) Topsoil which is salvaged and stockpiled will be located in such a manner that the stockpiled materials will be protected
M-10(6) from wind and water erosion and toxic materials. Such erosion control will primarily be accomplished by vegetation establishment. Topsoil stockpiles will be seeded the first fall seeding season after stockpile establishment. Unnecessary traffic on the topsoil stockpiles will be avoided as will rehandling of stockpiled topsoil materials.

M-3(2)(c) Before topsoil replacement the site to receive topsoil will be scarified on the contour to avoid slippage zones. During topsoil replacement, topsoil will be placed as evenly as possible and left in a cobbly or cloddy condition to help conserve soil moisture. Topsoil replacement will be accomplished by the use of end-loaders, trucks, scrapers, dozers, motor graders, or other appropriate equipment. When topsoil stockpiles are removed or are ready for abandonment, the remaining stockpile site will be reseeded.

Topsoil will be replaced on the area where the low grade ore dump will have been and on the abandoned mill site. The tailings facility will also be capped with a layer of topsoil. All other areas will have received topsoil on the cuts and fills during structure installation or will be reclaimed without topsoil.

State Reg. o REVEGETATION:

M-3(2)(a) When final grading is accomplished and scheduled topsoil is replaced, the site will be seeded and planted in accordance with the provision of Appendix A, Section 2, 3, and 4. Where slopes will allow, a seedbed will be prepared by discing, harrowing, plowing, or by the use of other suitable scarification methods.

Where slopes do not permit seedbed preparation, hand or aerial broadcast seeding of the specified perennial seed mix will be employed. On prepared seedbeds a cover crop will be planted. During the following season, the established cover crop will be planted. During the following season, the established cover crop will be where slopes allow disced in and seeded with the appropriate perennial mix.

M-10(12) With the exception of the cover crop, fall seeding will be practiced. Broadcast and covering with equipment such as an E-ZEE Flow-type or steep slope seeder and cultipacker has been shown to best promote species diversity. On the areas where tree and shrub planting is scheduled, such planting will be accomplished the season following seeding. Plants will be containerized rather than bare root stock and they will always be planted in the fall. Fall planting will be employed because the drought season is the most stresing for the proposed plant species; from fall to drought is 6 to 9 months as opposed to spring to drought which is 1 1/2 to 3 months. Fall planting allows greater chance for a plant to receive 100% of spring moisture than does spring planting.

Each of the following seed mixes and tree and shrub species lists have been assembled to meet the needs of specific areas within the project area. Non-noxious native plants that will give a quick, permanent, protective cover and enrich the soil

State Reg. have been given priority; the mixture includes both native and introduced species. The following is a summary of the seed mixes and the tree and shrub planting lists:

o SEED MIX #1

The seed mix for areas where topsoil is replaced has been designed to adapt to moderately deep soil conditions. There are species which are suited to moist or dry sites. Legumes are included to help promote soil fertility.

o SEED MIX #2

The seed mix for areas where topsoil will not be replaced has been designed for shallow soils and steep slopes. Species adapted to loose soils, droughty soils, and coarse textures have also been included. Legumes are included to help promote soil fertility.

o SEED MIX #3

The seed mix for tailings diversion, impoundment, and stream channel areas are adapted to periodic inundation, soil holding (and bank stabilizaion), prolonged droughtiness, and varied soil depths. Early greening species are included along with late season species so that erosion is controlled throughout the growing season. Deep rooted species have not been employed in order to avoid trace mineral pumping from covered tails areas.

o SEED MIX #4

The seed mix for topsoil stockpiles has been designed with species that are adapted for deep nitrogen replenishment, a variety of soil textures, and surface stabilization. Species which green early as well as plants that grow late into the season have been included.

State Reg. o SEED MIX #5

The seed mix for road right-of-ways has been designed to meet the greatest variation in soil depth (cuts vs. fills). Legumes have been included to promote soil fertility. Since domestic livestock is not abundant in the area, palatable species were included. Low growing species were maximized in order to promote visibility and to reduce fire hazzard.

o SEED MIX #6

The cover crop mix was designed for areas where the slope was gentle enough to allow discing-in of the crop. Wheat will be broadcasted in the fall and barley will be broadcasted in the spring.

o TREE AND SHRUB PLANTING LIST #1

The species of List #1 are adapted to moist or dry conditions and moderately deep soils.

o TREE AND SHRUB PLANTING LIST #2

The species of List #2 are adapted to dry conditions and usually moderate to shallow soils.

o TREE AND SHRUB PLANTING LIST #3

The species of List #3 are adapted to moist conditions and deep soils.

State Reg. Each of the proposed seed mixes and planting lists have been based upon the seed mixes and planting lists of other mined land areas. They have also been assembled with respect to the species (kinds and amounts) which occurred prior to mining.

M-10(12)(3) To further assure success of revegetation efforts, test plots are proposed in order to further examine species and plant rate adequacy. Specific fertilizer kinds, amounts, and durations will be obtained from these plots and then employed in general fertilizer applications for reclaimed areas.

Reseeding maintenance will be accomplished as necessary by employing interseedings of the original mixes. Interseeding will be performed either by drilling methods or by broadcasting without harrowing. Interseeding will be done in a manner so as to minimize the disturbance of existing vegetation.

To review the specific seeding and planting treatments of the project areas:

a) The mill site and abandoned area where low grade ore was temporarily stored will be seeded with Seed Mix #1 and planted with the species of Tree and Shrub List #1.

b) Untopsoiled areas adjacent to the mine pit and waste rock dumping area will be seeded with Seed Mix #2 and planted with the species of Tree and Shrub List #2.

c) Topsoil Stockpiles will be seeded with Seed Mix #4; areas where topsoil stockpiles have been removed will be seeded with Seed Mix #1 and planted with the species of Tree and Shrub List #1.

State Reg. d) Diversions and impoundments not underlain by tailings will be seeded with Seed Mix #3 and planted with the species of Tree and Shrub List #3. Diversions and impoundments which are underlain by tailings will be seeded with Seed Mix #3 and will not be planted.

e) Roads which are no longer needed and are reclaimed will be seeded with Seed Mix #2.

f) Road cuts and fills of rights-of-way intended for continuing use will be seeded with Seed Mix #5.

M-8(6)(3) When seeding and planting is accomplished, records and reports will be kept. All seed tags, shrub packing lists, fertilizer invoices, and the like will be kept on file as partial proof of reclamation. A seeding and planting map is expected to be maintained and on file after each planting and for seeding which is part of the permanent reclamation.

Irrigation is not anticipated at this time since water for mill operation needs a higher priority than water for supplemental use to plants which already should have adequate moisture to establish.

As stated previously, a nitrogen fertilizer will be applied to areas of permanent seeding at a rate determined by vegetative tests plots. A slow release fertilizer tablet will be planted along with each of the tablings. Legume seed (particularly alfalfa) will be innocculated.

RECLAMATION SCHEDULE

Phase of Operation	Reclamation Action Performed
1) Mineral Extraction is Complete	Surface Shaping is Accomplished
2) Surface Shaping is Complete	Scarifying and Topsoil Placement is Accomplished
3) Topsoil Placement is Complete	Seeding Commences
4) Seeding is Complete	Planting Commences
5) Planting is Complete	Reseed Maintenance
6) Maintenance is Complete - 3 yr	Bond Release

State Reg. o ABANDONMENT

Abandonment of operations will include the leaving of county roads in a maintained condition for continuing use. The other phases of abandonment will be accomplished as follows:

M-10(5) As mentioned previously, the mine pit area will not be reduced from the initial mining slopes in order to avoid
M-10(5) additional undue surface disturbance and excessive mining costs. Therefore, abandonment will be complete when the present recoverable ore has been extracted and when all equipment and debris have been removed from the surface.

M-10(9) When the ore at the low grade ore dumping area has been processed and equipment and debris removed, the site surface will be shaped, scarified, and topsoil will be replaced. The site will be seeded with Seed Mix #1 and later planted with the species from Tree and Shrub List #1.

M-10(9) When the mill area is no longer needed, all structures equipment, and debris will be removed from the site. The foundations of buildings will remain in place because the surface disruption caused by blasting and breaking up the foundations would be substantially greater than leaving them in place. Furthermore, it is GMRC's belief that these relatively small foundation areas will not appreciably affect the overall post mining land use. The rest of the site will be scarified, the edges of the pad area will be rounded and graded in order to avoid erosion, and topsoil will be replaced. The site will be seeded with Seed Mix #1 and later planted with the species of Tree and Shrub List #1.

M-10(9) The waste rock dumping area will be shaped and equipment and debris will be removed from the surface. Shaping will include the rounding of upper edges to produce a smooth transition from the flat top of the dune and the outer slopes. Scarificaton will be performed on all compacted areas to be reseeded. Areas which may receive topsoil replacement will be seeded with Seed Mix #1 and planted with the species of Tree and Shrub List #1. Areas which will not receive topsoil will be seeded with Seed Mix #2 and planted with the species of Tree and Shrub List #2.

M-10(8) The runoff diversion areas will have been seeded at the time of installation and will not be reclaimed.

State Reg. M-10(13) M-10(6) The tailings facility tails area will be capped with topsoil and seeded with Seed Mix #3. The impoundment dam will be left at the final operational configurations with the exception of the spillway entry which will be reduced in elevation to allow for through drainage. The spillway lip will be stabilized in order to avoid a moving channel nick point. Seeding of Seed Mix #3 will be employed on the excavated through drainage where future water flow is expected. The outboard surface of the dam will have been previously seeded with the appropriate seed mix and should not need to be reseeded.

M-10(7) Roads which are not to remain after reclamation will be removed by ripping. Any surface pipelines within the rights-of-way, equipment, and debris will be removed. Water bars or other necessary water control devices will be installed where needed as well as ditches in order to avoid restricting drainage crossings. The ripped roads will be seeded with Seed Mix #2 and later planted with the species of Tree and Shrub List #2.

M-10(11) M-10(3) The sedimentation impoundment when no longer needed as part of the mining process, will be left as part of the approved post mining grazing and wildlife land use. The embankment structure will have been seeded after construction with Seed Mix #3 and will be planted with the species of Tree and Shrub List #3. This will be the last area to be abandoned since this structure must control the sediments from areas disturbed in mining or reclamation activities. When it becomes a stockwater and wildlife impoundment, it will be allowed to silt in naturally (designed obsolescence) as is the custom with any such livestock and wildlife structure.

State Reg. As seen in the wildlife mitigation section of this permit, it should also be noted that small areas of rocks and boulders will be placed at strategic locations at reclaimed sites to enhance cover and to expedite the repopulation of such areas of wildlife.

In summary, the reclamation methods, as proposed in the post
M-10(1) mining land use plan, will stabilize the site and bring about the approved land uses. Wind and water erosion will be minimized. Further future mineral developments will not be precluded by GMRC's use of the land.

2.3.4 WILDLIFE IMPACTS AND MITIGATION PLAN

Site-specific baseline wildlife data (Mariah Associates, 1980) for the Mercur area, combined with the most recent mine engineering plan (Bechtel Corporation, 1980), form the basis for the assessment of impacts to wildlife resulting from GMRC's proposed surface gold mine and processing facilities. Assessments address impacts to all wildlife resulting from surface disturbance; development and operation of the mine, mill, and appurtenant facilities; and increased human presence in the general vicinity of the mine.

Certain additional site-specific baseline data will be gathered during the 1980-81 winter and early spring. At the time that this report was written, engineering plans (e.g., water sources, final design plans) had not been finalized. Consequently, impacts are addressed in as much detail as possible based on present information but additions in the baseline data or modification of engineering plans may affect certain impacts. Many of the impacts discussed in this report will occur regardless of the specific engineering plans (e.g., habitat removal, increased human activity).

Specific measures to be undertaken by GETTY MINERAL RESOURCES COMPANY to reduce or mitigate the impacts are defined in this report and a monitoring plan to document changes in wildlife use and measure the effectiveness of mitigation is also presented.

2.3.4.1 IMPACTS

Impacts on wildlife from mining activities may be classified as either short-term or long-term. Short-term impacts would be those that would result directly from and occur during mining operations but, assuming reclamation efforts are successful, would cease after reclamation. Long-term impacts are those that would persist even after successful reclamation efforts. Long-term impacts usually result indirectly from mining activities and are much more difficult to identify and evaluate (e.g., potential permanent reduction in the local mule deer population as a result of decreased quantity and quality of forage due to changes in soil nutrient cycling). Most of the impacts identified for the Mercur area resulting from the development's activities, can be considered of a short-term nature provided reclamation is successful.

Impacts may occur at a number of different levels of population organization ranging from the individual through herds or groups to the entire population. Since most of the anticipated impacts on the Mercur area are of a short-term nature or are restricted to the disturbed site and immediately adjacent areas, few lasting effects are anticipated at the regional population level for most species (e.g., the elimination of small mammals or mammalian predators during mining activities by the recovery to baseline population levels after sucessful reclamation). Accordingly, the individual or groups of individuals (e.g., herds) are the primary focus of the following impact assessment.

The general categories of potential impact to wildlife expected from the development at Mercur and severity ratings of each impact on the wildlife components in the study area are presented in Table 2.3-4. This table is the basis for the subsequent discussion of impact to wildlife in the Mercur area.

- MODIFICATION OF VEGETATION

The potential impact of removal of vegetation during the development and operation of the mine and mill is reduced because a portion of the area to be disturbed has already been drastically disturbed during previous mining

Table 2.3-4 Ratings for Potential Impacts on Wildlife Components.

	IMPACTED COMPONENTS										
	Elk	Mule Deer	Mammalian Predators	Small Mammals	Raptors	Upland Game Birds	Passerine and Other Birds	Herpetofauna	Threatened and Endangered Species	Important Wildlife Habitat	Wildlife Oriented Recreation
Modification of Vegetation	3	2	3	2	2	3	2	3	3	3	3
Topographic Changes	3	3	3	3	3	3	3	3	3	3	3
Water Supply Alterations	3	2	3	4	4	2	3	2	3	2	3
Noise and Ground Shock	3	3	3	3	3	3	2	3	2	3	4
Airborne Emissions	3	3	3	3	3	3	3	3	3	3	4
Direct Wildlife Mortality	3	2	3	1	3	3	2	2	4	3	3
Presence of Development and Associated Humans	3	2	2	3	2	3	3	3	2	2	2

[1]Impact ratings:

1 = Severe

2 = Moderate

3 = Slight

4 = Unanticipated

Impact severity ratings are base on:

- Knowledge of the mining operation and expected duration of the impact.
- Site-specific wildlife baseline data describing the abundance, distribution and reliance of wildlife components on mine site habitats.

operations and presently provides little good quality wildlife habitat. The development will, however, disturb vegetation in previously undisturbed habitats, primarily in mixed brush. Vegetation and habitat removed by the development destroys food and cover components and reduces the potential habitat available for use by wildlife during the operation phase. Vegetation replaced during reclamation will not immediately be equivalent in species or structure as the predevelopment habitat.

Mobile wildlife species such as elk and mule deer will move to adjacent areas, as they did in previous mining episodes. Relatively few elk occur on the sites to be disturbed and the major use of those sites by mule deer is for transition or summer range. Reduction in browse species and abundance would be a negative impact during fall, however, the increased use of herbaceous cover on reclaimed areas during spring may offset some of the negative impact. Use of the herbaceous covered reclaimed areas would be dependent on proper cover being provided by topography and shrubs within the reclaimed areas. Mammalian predators would likely move to undisturbed habitat nearby. The primary impact on predators would be loss of potential prey due to reduction in small mammals when vegetation is removed. Small mammals will likely re-invade the area after it has been revegetated during reclamation. The prey base for raptors would also be reduced, and although no known active raptor nests will be affected by the vegetation removal, the development will reduce potential nesting habitat for a few species which nest on the ground or in mixed brush types. Relatively few upland game birds occur in the areas to be disturbed so modification of vegetation and most other potential impacts are expected to be slight. Reduction in the mixed brush type, the most productive and one of the most diverse avifauna habitats, will have a moderate impact on passerine and other birds. It will require many years for the vegetation on the reclaimed areas to reestablish habitat with the diverse structure of the mixed brush type. The bald eagle is the only threatened or endangered wildlife species in the area. Bald Eagles reside in the area during winter and have established winter roosts in Ophir Canyon (the closest roost is approximately 3.5 miles from Mercur). Bald eagles usually forage in the sagebrush flats in the nearby valleys. Because

no roost area will be destroyed and the major foraging areas used by bald eagles are not on the site, modification of vegetation on the Mercur area will have slight impact on the bald eagle.

Effects of modification of vegetation on important wildlife habitat (e.g., critical habitat for important wildlife species and unique habitats that contribute to regional wildlife diversity) and wildlife oriented recreation are also expected to be short-term and minor. The primary concern for important wildlife habitat is for water sources, which are discussed below. Wildlife oriented recreation would primarily be affected by changes in access although it is also potentially indirectly affected by changes in abundance of game species.

o TOPOGRAPHIC CHANGES

Topographic changes will impact wildlife on a relatively localized level. During mining, wildlife will most likely not be near the major areas of topographic change and the grading during reclamation will reduce any potentially dangerous highwall areas. The filling of Sacramento Gulch with overburden and another gulch with tailings will reduce topographic variability in the local area and will slightly reduce cover associated with more variable topography. Overall, impacts on wildlife due to topographic changes are considered slight. Most impacts on wildlife due to topographic changes would likely be associated with the effect of topography on revegetation success and microhabitat conditions.

o WATER SUPPLY ALTERATIONS

Water sources are an important component of wildlife habitat in the Mercur area, particularly for most game species. However, none of the perennial water sources in the area will be disturbed by the proposed action. Waste handling and disposal procedures will be designed to prevent the degradation of water quality in surrounding areas so no significant impacts due to changes in water quality are anticipated.

o NOISE, GROUND SHOCK, AND AIRBORNE EMISSIONS

Noise, ground shock, and airborne emissions are expected to have slight impact on most wildlife species. Project related airborne dust, other particulates, or other emissions are expected to have a slight additional impact above existing baseline conditions because air quality regulations will be met. The baseline dust levels are already relatively high due to the nearby limestone quarry, traffic on existing gravel roads, and the large tailings pile exposed to wind erosion.

The most common responses of wildlife to noise and ground shock are avoidance or accommodation. As was most likely the response to previous mining episodes, most mobile species will avoid the area where noise or ground shock are not tolerable, however, noise tolerance levels of wildlife are not presently known. Abrupt and intermittent noises (e.g., blasting) are less likely to be accommodated than are more steady, continuous noises (e.g., milling or conveyor systems). Animals that rely on vocalization for communication (e.g., passerine birds) will be more adversely impacted and will likely move further from disturbed areas than other species that are less vocal. The highest intensity noise and most ground shock will probably be localized at the site and, therefore, will not cause significant impact.

o DIRECT WILDLIFE MORTALITY

Direct mortality will occur to wildlife such as small mammals, and young passerine birds that occur in the areas to be disturbed and that are not able to move rapidly enough to avoid equipment. This mortality is severe at the localized disturbance but most of these animals reproduce rapidly and will reinvade the area if the proper habitat is provided by reclamation.

The other major source of direct mortality will be vehicle-wildlife collisions. Although this impact will affect small mammals, predators, and avifauna, the primary concern will be for mule deer. High levels of collision caused mule deer death have been documented along State Highway 73

(Utah Division of Wildlife Resources, 1974, 1980) which will be the primary access route for the workers employed at the Mercur development. Most mule deer-vehicle collisions occur while the mule deer are on the winter range. Increased traffic volume and improvements in the road up Mercur Canyon will likely result in more frequent vehicle-mule deer collisions.

Electrocution of large raptors (e.g., golden eagle, bald eagle) is not anticipated. The transmission line will be constructed such that simultaneous contact between conductor and ground is unlikely due to inherent design requirements of large capacity lines or specific raptor protection practices (Miller et al., 1975) for the smaller lines. Avifauna mortality may occur due to collisions with structures and transmission lines, however, the overall impact of such mortality would be minor.

o PRESENCE OF DEVELOPMENT AND ASSOCIATED HUMANS

Increased human activity associated with mine development increases the potential impact on several wildlife species. Most wild animals, particularly those that are hunted, avoid contact with humans by moving away. The distance they move away from human activity depends on numerous factors including intensity and duration of human activity, cover, topography, weather, species of animal, and previous experience of animals. Most big game, such as elk and mule deer, appear to prefer to be at least one-fourth mile from human disturbance. This avoidance reaction increases the habitat rendered less suitable for wildlife. Increased human activity in the area of active raptor nests could result in nest abandonment and nestling mortality if such disturbance becomes severe.

Disturbance of the bald eagles at their winter roost sites would also be a significant undesirable impact. The closest bald eagle winter roost is approximately 3.5 miles from Mercur. It is separated from the development area by the ridge that divides the Ophir and Mercur drainage and is therefore somewhat sheltered from the activity.

Most of the proposed development will be south of Mercur but a tailings pond will be located northeast of the old townsite. The northern edge of this pond will be about two miles from the roost.

Raptors may use the transmission line poles as hunting perches. This use may be a positive impact if it aids the raptor population but a potential negative impact, the easy target offered by a raptor perched on a pole, is also present.

Human activity and unsuitable habitat conditions on disturbed sites are expected to keep most wildlife out of potantially dangerous areas such as the mine pit. The tailings pond will be fenced and water recover/recycling equipment will also discourage wildlife activity on the pond. Plans to mitigate and monitor this, as well as other undesirable impacts, are presented in the next section.

Activities associated with the project will have the greatest impact on wildlife during the initial phases of development. Animals will likely become somewhat habituated to the development after a routine has been established and will use nearby habitats that were avoided during the initial activity, contingent, of course, on not being harassed.

2.3.4.2 REDUCTION AND MITIGATION OF IMPACT, AND MONITORING PLAN

Many different types of adverse impacts to wildlife will occur due to the Mercur project. Mitigating measures are not possible for all impacts (e.g., reduction in passerine bird abundance and diversity when overstory vegetation is removed). Pragmatic reduction of impact and mitigation measures that are possible are described in this section. The wildlife monitoring plan for the Mercur area is also described in this section. Wildlife monitoring will be conducted throughout the life of the project and will be carried out by GETTY MINERAL RESOURCES COMPANY's environmental staff. The monitoring plan will document changes in wildlife use of the site and, thereby, allow adjustment of impact mitigation measures accordingly.

- MODIFICATION OF VEGETATION

The reclamation plan for the Mercur project commits the Company to reclamation of disturbed areas as soon as practicable. This reclamation plan describes measures to be employed in reestablishing vegetation, a major habitat component necessary for wildlife habitation. In addition, only the minimum area necessary for the operation will be disturbed.

Successful reclamation will produce a vegetative cover that will be repopulated first by small mammals and passerine birds. Although the diversity of small mammals and passerine bird species utilizing the area will be low, their numbers may be sufficient to restore a portion of the prey base lost to raptors and mammalian predators as a result of vegetation removal. Adequate seeds and green vegetation are generally available at revegetated areas two years old or older. Adequate cover at such sites is often quite limited, however. Small areas of rubble (rocks and boulders) will be placed at strategic locations at reclaimed sites to enhance cover opportunities and expedite the repopulation of such areas by wildlife.

Mule deer will likely graze in the reclaimed area, particularly if the herbaceous growth is more lush than surrounding native vegetation and sufficient topographic and vegetative cover is provided.

o TOPOGRAPHIC CHANGES

Considerable topographic changes will take place on several sites on the Mercur area.

Certain topographic types in the Mercur area that are important to wildlife cannot be reconstructed. Among these are deep gulches that will be filled with waste materials. Each such area offers additional cover opportunities for wildlife. It is not possible to totally mitigate the impact to wildlife resulting from the loss of such areas, however, steps will be taken to recreate topographic features important to wildlife that are lost when these areas are disturbed. These steps include:

- Large rocks and boulders will be placed at strategic locations on reclaimed areas to provide roosting and possible nesting sites for raptors. All such reclamation activities will be closely coordinated with Utah Division of Wildlife Resources.

- With the consent of Utah Division of Oil, Gas and Mining, high walls in the pit will be left exposed and as such could provide potential raptor nesting and roosting habitat.

- Placement of rock rubble to enhance cover opportunities at reclaimed sites.

Specific migratory corridors for mule deer have not been identified for the study area during baseline studies thus, the effects of creating large overburden piles and large open pits are not clearly understood.

Subsequent wildlife monitoring at the Mercur area should reveal whether specific migration routes are utilized. If such routes exist in the area, GMRC will take the following measures to ensure that big game migration is not interrupted:

- Migratory animals will be routed around active mining areas through the use of drift fences where practicable.
- Speed limits will be reduced and appropriate warning signs posted along areas of haul and access roads where migratory animals consistently cross.
- Fences (other than diversion fences), ancillary facilities, or other potential obstructions will not be placed in know migratory corridors if possible.

o WATER SUPPLY ALTERATIONS

It is not anticipated that the proposed tailings pond will remove an important wildlife water source, however, if this does occur an alternate source of water will be provided for wildlife. Options which could be considered include developing, one or more existing springs in the area at a higher elevation in the drainage, provision of water at another source (e.g., wells drilled to supply the mine and mill), and guzzlers.

Guzzlers have usually been constructed specifically to benefit big game and upland game species but they also benefit other wildlife species that require water. Guzzlers have been successfully used to provide water for wildlife in arid and semi-arid areas for over 30 years. The California Department of Fish and Game (Glading, 1947; McLean, 1962 both cited by Yoakum and Dasmann, 1971) has constructed over a thousand catchments on dry quail and partridge ranges. In Utah, guzzlers constructed for big game or upland game are used by most all other wildlife in the area that require water (Drobnick, UDWR, personal communication, August 1980). Use of guzzlers in Utah generally increases for a period after initial

placement as animals find the water and as additional animals can be supported on the nearby range (Drobnick, personal communication, August, 1980).

Guzzlers are simplistically designed and constructed such that little maintenance is required (Yoakum and Dasmann, 1971). The guzzler is a permanent, self-filling water catchment that consists of rain collecting apron, storage tank, and water trough. There are several variations of the basic design and various materials can be used for the components of guzzlers. The Utah Division of Wildlife Resources (UDWR) presently uses a design for a guzzler that can be constructed for a total cost of approximately $3,000 - $5,000 each (Coffeen and Drobnick, USWR, personal communications, July and August, 1980).

Because guzzlers capture and store rain water, they are not dependant on ground water sources and can be located at strategic locations for wildlife. Water dispersed at 2 mile intervals was considered ideal by Swank (1958) because 1 to 1 1/2 miles is about the distance deer will move to water in the driest months. Drobnick (personal communication, August, 1980) also suggested a maximum of 2 mile intervals as an initial water source dispersal pattern.

Wildlife requirements for water are influenced by temperature, evaporation, water content of forage, exercise, and physiological condition of the individual. Maximum use of guzzlers as a water source will probably be in summer and late fall when other sources of water (e.g., snow, natural water catchments such as small ponds are not available). If guzzlers are constructed, they would be monitored to detect whether adequate water was provided.

- NOISE, GROUND SHOCK AND AIRBORNE EMISSIONS

Impacts to wildlife from noise, ground shock and airborne emissions will occur at all areas where heavy equipment is operated and at open pit sites where blasting is required. In general, all wildlife in the immediate

vicinity of the surface mining operation, haul roads and recontouring activities will be harassed to a certain degree by these short-term impacts. Mule deer may avoid certain areas of otherwise acceptable forage as a result of noise, dust and ground shock constituting a relatively slight impact which is not mitigatable. Airborne emissions and noise will be limited as much as practicable during the operations.

o DIRECT WILDLIFE MORTALITY

Road kills of wildlife may occur along mine haul and access roads. Posted speed limits for access roads and for haul roads will be enforced. If excessive road kill of big game animals is noted by the environmental staff, GMRC will take appropriate steps to more strictly enforce posted speed limits by taking action against employees and contractors found in violation. Speed limits will be reduced if the above mentioned techniques prove ineffective to the appropriate UDWR official.

Mass transit may be another method to reduce vehicle-wildlife collisions. The feasibility of mass transit (e.g., buses) for the employees will be analyzed and may be implemented if appropriate.

No electrocution of raptors is expected (see Section 2.5), however, if a raptor electrocution problem is detected during the monitoring, appropriate modifications (Miller, 1975) will be made to eliminate the hazard.

o PRESENCE OF DEVELOPMENT AND ASSOCIATED HUMANS

Nesting raptorial birds are particularly susceptible to disturbance impacts in the immediate vicinity of their nesting sites. Unusual disturbance near an active nest site may cause nesting raptors to abandon their eggs or young. Active golden eagle nests were not located

within the project area in the 1980 reproductive season and the known active nests of other raptors in the area are not the sites to be disturbed during development. Several active nests of raptors, including golden eagles, are located in adjacent areas, however,

The GMRC environmental staff will monitor raptor nests active in 1980 during subsequent years to determine their status (active or inactive). They will also monitor potential nesting sites prior to disturbance to determine whether new nests have been established. All raptor nests will be protected from disturbance during the reproductive season as is feasible. Nests of birds protected under the Migratory Bird Treaty Act will not be removed without obtaining the appropriate permits from the U.S. Fish and Wildlife Service.

Human disturbance is the primary impact of concern for the bald eagle winter roost sites in the vicinity. Employees will be instructed to avoid harassment of bald eagles at the roosts, as well as all other wildilfe in the vicinity of the project area.

The GMRC environmental staff will be monitoring wildlife populations throughout the life of the project. They will be in the best position to detect poaching and deliberate wildlife harassment. To prevent inadvertent poaching by employees (many employees may be new to the area and are not aware of regulations), the GMRC environmental staff will post current UDWR regulations and instructions to avoid harassment of wildlife in places where they will be read by the maximum number of employees. Any employee or contractor involved in deliberate acts of wildlife harassment and/or poaching, will receive appropriate reprimands.

If monitoring of potentially dangerous areas indicates that wildlife are being attracted to these areas and subsequently harmed, appropriate techniques (e.g., additional fencing, dispersion devices such as noise or banners) will be employed to reduce the impact.

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APPENDIX A

SECTION 1 TOPSOIL SUMMARY

SECTION 2 SEED MIXES

SECTION 3 TREE AND SHRUB PLANTING LISTS

SECTION 4 NATURAL RETURN OF PLANT SPECIES

SECTION 1

TOPSOIL SUMMARY

During the summer of 1980 a soil survey was conducted on the Mercur Study Area for GETTY MINERAL RESOURCES COMPANY. The survey included intensive sampling and laboratory analyses conducted by TRC ENVIRONMENTAL CONSULTANTS through contract with FRANK E. BASIL INC. and F & L LABORATORIES, INC. both of Fort Collins, Colorado. The soil reconnaissance shows that a variety of soil units and complexes of units exist on the area to be disturbed. Of these many can be salvaged for use in resurfacing after final grading so that reclamation success can be assured.

It is important to note that much of the available topsoil and subsoil is adjacent to steep areas and rock outcrops. The salavaging of such soils could be inefficient and hazardous to men and equipment at best. However, recovery of materials employing down slope recovery methods are being proposed to salvage only topsoils suitable for reclamation in lieu of recovering poor materials at lesser slopes. Therefore, the following is a summary of the materials which occur on the site:

1D Acord Variant clay loam, 12 percent slopes

The Acord Variant soils of this unit are deep. They are on terraces, ridgetops and high fan remnants in high mountain valleys. Slopes are usually about 12 percent and range from 8 to 20 percent. Included in mapping are small areas of St. Marys Variant soils and Ant Flat Variant soils. Good to fair soil for topsoiling is available.

1E Acord Variant clay loam, 20 - 35 percent slopes

The Acord Variant soils of this unit are deep. They are on steep mountainsides, benches along valley walls, terraces, fan remnants, and in cores. Included in mapping are small areas of Ant Flat Variant soils in the heads of drainage basins, especially in aspen groves. Slopes are 20 to 35 percent. Topsoil is recoverable when down slope recovery methods are employed. Steep slopes would inhibit the recovery of additional materials.

2B Ant Flat Variant loam, 5 percent slopes

The Ant Flat Variant soils are deep. They are on gently sloping, high terraces within the mountains. Slopes are usually about 5 percent and range from 3 to 8 percent. Included in mapping are small areas of Acord Variant and Toehead Variant soils. Good to fair soil for topsoiling is available.

2C Ant Flat Variant loam, 12 percent slopes

The Ant Flat Variant soils are deep. They are on sloping terraces in the mountains and footslopes along mountain valley walls. Slopes are usually about 12 percent and range from 8 to 15 percent. Included in mapping are small areas of Toehead Variant, Acord Variant, and Manila Variant soils. Good to fair soil for topsoiling is available.

2D Ant Flat - Acord - St. Marys Complex, 20 percent slopes

This unit consists of aobut 50 percent Ant Flat Variant soils intermingled with about 25 percent Acord Variant soils and about 25 percent St. Marys Variant soils. These soils are all deep. They are on moderately steep sides of high terraces within the mountains. The component soils do not seem to occupy any particular feature of the landscape. Slopes are usually about 20 percent and range from 15 to 30 percent. Included in mapping are small areas of Manila Variant soils. By employing downslope topsoil recovery methods portions of this material can be salvaged as topsoil.

2E Ant Flat - Acord - Bezzant Complex, 30 - 50 percent slopes

This unit consists of about 40 percent Ant Flat Variant soils intermingled with about 35 percent Acord Variant soils, and about 25 percent Bezzant Variant soils. They are on steep scarps below high terraces in the mountains. Slopes are 30 to 50 percent. Included in mapping are small areas of St. Marys Variant soils, and Mined Land. Soil is not suitable for topsoiling because of the steep slopes.

3C Ant Flat - Mined Land Complex, 8 percent slopes

This unit consists of Ant Flat Variant soils 30 to 70 percent disturbed by mine pits, mine road construction, drilling pits, and old building sites. Slopes are usually about 8 percent and range from 4 to 12 percent. Included in mapping are small areas of St. Marys Variant soils. Good to fair soil for topsoiling is available.

3D Ant Flat - Mined Land Complex, 12 - 20 percent slopes

This unit consists of Ant Flat Variant soils 30 to 70 percent disturbed by mine pits, mine road construction, drilling pits, and old building sites. Slopes are 12 to 20 percent. Included in mapping are small areas of St. Marys Variant soils and Acord Variant soils. Good to fair soil for topsoiling is available.

6E Bezzant Variant very cobbly loam, 25 percent slopes

The Bezzant Variant soils of this unit are moderately deep. They are 20 to 25 inches deep on the narrow ridgetops and 30 to 40 inches deep on the sideslopes bordering the ridgetops. Slopes are usually about 25 percent and range from 20 to 30 percent. Included in mapping are small areas of rock outcrop on the ridgetops, St. Marys Variant and Acord Variant soils on the lower sideslopes. Soil is suitable for subsoiling only.

6F Bezzant Variant very cobbly loam, 35 percent slopes

The Bezzant Variant soils of this unit are moderately deep, ranging from 30 to 40 inches to limestone. They are on steep mountainsides. Slopes are usually about 35 percent and range from 30 to 40 percent. Included in mapping are small areas of rock outcrop and St. Marys Variant soils. In the vicinity of Mercur this unit includes small areas of mined land. The middle-zone of this soil may be suitable for subsoil only.

6G Bezzant Variant very cobbly loam, 40 - 60 percent slopes

The Bezzant Variant soils of this unit are moderately deep. They are on very steep mountainsides. Slopes range from 40 to 60 percent. Included in mapping are small areas of rock outcrop and St. Marys Variant Soils. Soil is not suitable for topsoiling or subsoiling because of the high quantity of rock fragments and the very steep slopes.

8D Bezzant - Rock Outcrop Complex, 6 to 20 percent slopes

This unit consists of about 65 percent Bezzant very cobbly loam intermixed with about 35 percent rock outcrop, on narrow ridgetops. Slopes range from 60 to 20 percent. The Bezzant Variant soils are 20 to 25 inches deep. Soil is not suitable for topsoiling because of the high quantity of rock fragments and the interspersion of limestone outcrops.

8E Bezzant - Rock Outcrop Complex, 20 to 30 percent slopes

This unit consists of about 50 percent Bezzant very cobbly loam intricately intermixed with about 50 percent rock outcrop, on sloping spurs. Slopes range from 20 to 30 percent. The Bezzant soils are 20 to 30 inches deep. Soil is not suitable for topsoiling because of the high quantity of rock fragments, steep slopes, and the frequent outcropping of limestone.

8F Bezzant - Rock Outcrop Complex, very steep

This unit consists of about 60 percent Bezzant very cobbly loam intricately intermixed with about 40 percent rock outcrop on very steep mountainsides. Slopes are 40 to 60 percent. Soil is not suitable for topsoiling because of the high quantity of rock fragments, very step slopes, and the frequent outcropping of limestone.

13 Mined Land

This unit consists of areas disturbed by mining activity, mine dumps, and mill tailings piles.

16F Rock Outcrop - Bezzant Complex, 40 - 75 percent slopes

This unit consists of about 60 percent rock outcrop and 40 percent Bezzant Variant soils. The rock outcrop are exposed bedrocks on ledges and cliffs and rubble land. The Bezzant Variant soils are sandwiched between the ledges. The landscape is a steep pattern. Slopes range from 40 to 75 percent. Included in mapping are a few small areas of mined land in the vicinity of Mercur. Soil is not suitable for topsoiling because of the steepness of slope and the dominance of rock outcrop in the unit.

18D St. Marys Variant very channery loam, 15 percent slopes

St. Marys Variant soils of this unit are deep. They are on alluvial fan cones at the mouths of ravines. Slopes are usually about 15 percent and range from 8 to 20 percent. Include in mapping are small areas of Slickens washed from mill tailing piles. Soil is not suitable for topsoiling because of the large quantities of rock fragments.

19F St. Marys - Acord - Ant Flat Complex, 40 - 60 percent slopes

This unit consists of about 60 percent St. Marys Variant soils, intermingled with about 30 percent Acord Variant soils and about 20 percent Ant Flat Variant soils. These soils formed in material mainly from limestone which filled a wide crack caused by faulting in the bedrock. The Ant Flat Variant series are in the drainage heads. Slopes range from 40 to 60 percent. Soil for topsoiling (or subsoiling) is not suitable because of the very steep slopes.

20 Slickens

This unit consists of silty and loamy material washed from piles of mill tailings. This material is on bottomlands of narrow canyons and in dissected fans in large valleys. Included in mapping are small areas of Toehead soils and piles of boulders dumped as refuse or deposited during flash floods. This material is not suitable for topsoiling (or subsoiling).

21B Toehead Variant loam, 5 percent slopes

Toehead Variant soils of this unit are deep. They are on narrow canyon bottomlands that are over 50 feet wide and on narrow elongated shallow basins within high terraces. Stream channels that cut through these soils are 1 to 8 feet deep. Slopes are usually about 5 percent and range from 4 to 8 percent. The very gravelly lenses when mixed with other horizons would only slightly affect the quality of soil for topsoiling.

21D Toehead Variant loam, 14 percent slopes

Toehead Variant soils of this unit are deep. They are on bottoms of heads of drainages within the mountains. Stream channels have cut into these soils. Slopes are usually about 14 percent and range from 8 to 20 percent. The very gravelly lenses when mixed with other horizons would only slightly affect the quality of soil for topsoiling.

SOIL SERIES SUMMARY

TYPE	ACORD	ANT FLAT	BEZZANT	MANILA	ST. MARYS	TOEHEAD
% V.F.S & Sand*	27.0	41.0	13.0	37.0	40.0	40
% Silt*	39.0	29.0	47.0	34.0	39.0	41 - 37
% Clay*	34.0	30.0	40.0	29.0	21.0	19 - 23
pH (Range)	6.9-8.0	6.9-7.9	7.6-7.9	7.8-8.0	7.8-8.1	7.3 - 8.0
Na*	0.49	1.37	0.30	0.55	0.64	0.70 - 3.70
Ca*	1.85	2.84	1.78	1.62	1.51	2.15 - 13.20
Mg*	0.48	1.23	0.43	0.23	0.93	0.38 - 4.45
SAR*@	0.46	0.96	0.29	0.57	0.58	0.63 - 1.25
Organic Matter	2.0	1.0	2.3	1.9	1.1	4.6 - 2.1

* Averaged and weight by depth

@ (SAR) Sodium Adsorption Ratio = $\frac{Na\ (ppm)}{\sqrt{\frac{Ca(ppm) + Mg(ppm)}{2}}}$

SECTION 2
SEED MIXES

SEED MIX #1 RECLAMATION SPECIES FOR AREAS WITH TOPSOIL

- Pure Live Seed

		DRILL LBS./ACRE
Agropyron dasystachyum	Thickspike Wheatgrass	4
Agropyron desertorum	Desert Wheatgrass	1
Agropyron riparium	Streambank Wheatgrass	2
Agropyron smithii	Western Wheatgrass	2
Agropyron spicatum var. inerme	Beardless Bluebunch Wheatgrass	2
Agropyron trachy caulum	Slender Wheatgrass	2
Agrostis alba	Redtop Bent	1/4
Bromus biebersteinii	Regar Brome	1
Bromu inermis	Smooth Brome	1/2
Elymus canadensis	Canada Wildrye	
Elymus cinereus	Basin Wildrye	
Elymus junceus	Russian Wildrye	1
Elymus triticoides	Creeping Wildrye	
Poa compressa	Canada Bluegrass	1/4
Stipa columbiana	Subalpine Needlegrass	
Stipa lettermanii	Letterman Needlegrass	1
Stipa viridula	Green Needlegrass	
Medicago sativa	Alfalfa Medic	1
Melilotus alba	White Sweetclover	
Meliotus officinalis	Yellow Sweetclover	1/2
		18 1/2

As calculated from Sharp Bros. Seed Company predicted p.l.s values, the above mix has a pure-liveness of 0.814;
18.5 lbs - 0.814 = 22.7 bulk lbs

- Bulk Seed: From Calculations Above 22.7

Atriplex canescens	Fourwing Saltbush	
Atriplex confertifolia	Shadscale Saltbush	
Astragalus cicer	Cicer Milkvetch	
Carex spp.	Sedge species	
Dactylis glomerata	Common Orchardgrass	
Eleocharis spp.	Spikerush species	
Festuca ovina var. duriuscula	Hard Sheep Fescue	
Juncus spp.	Rush species	
Koeleria cristata	Prairie Junegrass	1.3
Leucopoa (Hesperochloa) kingii	King Spikefescue	
Oryzopsis hymenoides	Indian Ricegrass	
Phleum pratense	Common Timothy	
Poa palustris	Fowl Bluegrass	
Poa pratensis	Kentucky Bluegrass	
Poa secunda	Sandberg Bluegrass	
Spartina gracilis	Alkali Cordgrass	
Sporobolus airoides	Alkali Sakaton	
Sporobolus cryptandrus	Sand Dropseed	
Commercial Forb Selection (seed mix list prior to tree & shrub lists)		
	Bulk Total	24 lbs

APR 1 1981

NOTES:

a) Broadcast rate is double the drill rate.

b) Bracketed species will be used as they become commercially available. It is important to recongnze that the maximum number of species will be used for each seeding.

c) P.l.s. is the pure live seed content or percentage found in bulk seed. P.l.s is calculated by multiplying the germination rate times the purity rate. Example: A seed tag lists alfalfa as being 99% pure and having a 91% germination rate would have a pure live seed rate of 90% as seen by:

$$.99 \times .91 = .9009$$

A 5 lb/acre drill rate would be adjusted to a 5.6 lb/acre as seen by:

$$\frac{5}{.9009} = 5.6 \text{ adjusted lbs}$$

Because purity and germination rates vary with each growing season and from one seed producer to the next, the seed rates listed unless otherwise stated are p.l.s. rates.

d) Any species which are unavailable during any given seeding season will be replaced with additional amounts of Agropyron dasystachyum, Agropyron smithii, and/or Stipa viridula or the unavailable species will be deleted from the mix until the nex seeding season.

e) These seed mixes are proposed as general guidelines for actual practice. They may be revised due to site specific revegetation test plots and economic availability. The bracketed species will be selected from and are not intended to reflect the actual species diversity to be planted.

Site Variation Adaptability of SEED MIX #1*

Dry Sites:	Agropyron, Elymus, Medicago, Melilotus
Moist Sites:	Agropyron smithii, Bromus inermis, Agrostis, Poa, Stipa
Warm Season:	Medicago, Melilotus
Cool Season:	All species listed
Silt Adapted:	Agropyron riparium, Agropyron smithii, Agrostis, Bromus, Elymus, Poa, Medicago, Melilotus, Stipa
Sand Adapted:	Agropyron dasystachyum, Agropyron trachycaulum, Elymus triticoides, Bromus, Medicago, Melilotus
Clay Adapted:	Agropyron, Bromus, Elymus, Stipa, Poa, Melilotus, Medicago
Rhizomatous Species	Agropyron dasystachyum, Agropyron riparium, Agropyron smithii, Agrostis alba, Elymus triticoides, Bromus inermis

COMMENTS: Species such as Agropyron desertorium, Elymus, Bromus inermis, Stipa, and Agropyron trachycaulum will provide early spring greening. Agropyron spicatum var. inerme, Poa, and Agropyron trachycaulum have been included for their adaptability to shallow soils.

*The bulk seed species listed previously would also contribute members to each of the adaptability categories; however, the cover and frequency of the bulk species are of low significance as compared to total cover and frequency. Therefore, these species are not categorized.

SEED MIX #2 RECLAMATION SPECIES FOR AREAS WITHOUT TOPSOIL

- Pure Live Seed

		DRILL LBS/ACRE*
Agropyron dasystachyum	Thickspike Wheatgrass	2
Agropyron desertorum	Desert Wheatgrass	1
Agropyron smithii	Western Wheatgrass	2
Agropyron spicatum var. inerme	Beardless Bluebunch Wheatgrass	3
Agropyron trachycaulum	Slender Wheatgrass	3
Bromus inermis	Smooth Brome	2
Elymus canadensis	Canada Wildrye	1/2
Elymus cinereus	Basin Wildrye	
Elymus junceus	Russian Wildrye	
Elymus triticoides	Creeping Wildrye	1
Poa compressa	Canada Bluegrass	1
Medicago sativa	Alfalfa Medic	2
Melilotus alba	White Sweetclover	1/2
Melilotus officinalis	Yellow Sweetclover	
Atriplex cansecens	Fourwing Saltbush	1/2
Atriplex confentifolia	Shadscale Saltbush	
	18 1/2	18 1/2

As calculated from Sharp Bros. Seed Company predicted p.l.s values, the above mix has a pure-livenes of 0.803;
18.5 lbs - 0.803 = 23.0 bulk lbs

- Bulk Seed: From Calculations Above 23.0

Astragalus cicer	Cicer Milkvetch	1.0
Dactylis glomerata	Common Orchardgrass	
Festuca ovina var. duriscula	Hard Sheep Fescue	
Koeleria cristata	Prairie Junegrass	
Poa palustris	Fowl Bluegrass	
Poa pratensis	Kentucky Bluegrass	
Poa secunda	Sandberg Bluegrass	
Oryzopsis hymenoides	Indian Ricegrass	
Phleum pratense	Common Timothy	
Spartina gracilis	Alkali Cordgrass	
Sporobalus airoides	Alkali Sakaton	
Sporobolus cryptandrus	Sand Dropseed	
Distichlis spicata var. stricta	Inland Saltgrass	
Agrostis alba	Redtop Bent	
Bromus biebersteinii	Regar Brome	
Puccinellia airoides	Nuttall Alkaligrass	
Commercial Forb Selection (Seed Mix List prior to Tree & Shrub Lists)		
	Bulk Seed Total	24 lbs

APR 1 1981

NOTES:

a) Broadcast rate is double the drill rate (Establishment of Diverse Native Plant Communities on Coal Surface-Mined Lands in Montana as Influenced by Seeding Method, Mixture, and Rate by Edward J. DePuit, Joe G. Coenenberg, and Chester L. Skilbred, Montana State University 1980).

b) Bracketed species will be used as they become commercially available.

c) P.l.s. is the pure live seed content or percentage found in bulk seed. P.l.s is calculated by multiplying the germination rate times the purity rate. Example: A seed tag lists alfalfa as being 99% pure and having a 91% germination rate would have a pure live seed rate of 90% as seen by:

$$.99 \times .91 = .9009$$

A 5 lb/acre drill rate would be adjusted to a 5.6 lb/acre as seen by:

$$\frac{5}{.9009} = 5.6 \text{ adjusted lbs}$$

Because purity and germination rates vary with each growing season and from one seed producer to the next, the seed rates listed unless otherwise stated are p.l.s. rates.

d) Any species which are unavailable during any given seeding season will be replaced with additional amounts of Agropyron dasystachyum, Medicago sativa, Agropyron smithii, Bromus inermis, and/or Atriplex canescens.

e) Seed Mix #2 will be used for temporary reclamation areas as well as areas which lack topsoil.

f) These seed mixes are proposed as general guidelines for actual practice. They may be revised due to site specific revegetation test plots and economic availability. The bracketed species will be selected from and are not intended to reflect the actual species diversity to be planted.

Site Variation Adaptability of SEED MIX #2*

Dry Sites:	Agropyron, Elymus, Medicago, Melilotus, Atriplex
Moist Sites:	Agropyron smithii, Bromus, Poa, Medicago, Melilotus
Warm Season:	Medicago, Melilotus, Atriplex
Cool Season:	All species listed with the possible exception of Atriplex
Silt Adapted:	Agropyron smithii, Agrostis, Bromus, Elymus, Poa, Medicago, Melilotus, Atriplex
Sand Adapted:	Agropyron dasystachyum, Agropyron trachycaulum, Elymus triticoides, Medicago, Melilotus, Atriplex
Clay Adapted:	Agropyron, Bromus, Elymus, Poa, Melilotus, Medicago, Atriplex
Rhizomatous Species	Agropyron dasystachyum, Agropyron smithii, Elymus triticoides, Bromus inermis

COMMENTS: Tolerence to salts, shallow soils, and drought are especially inherent in this seed mix.

*The bulk seed species listed previously would also contribute members to each of the adaptability categories; however, the cover and frequency of the bulk species are of low significance as compared to total cover and frequency. Therefore, these species are not categorized.

SEED MIX #3 DIVERSION, STREAM CHANNEL, OR IMPOUNDMENT PERMANENT RECLAMATION SPECIES FOR AREAS WITH OR WITHOUT TOPSOIL

- Pure Live Seed:

		DRILL LBS/ACRE
Agropyron dasystachyum	Thickspike Wheatgrass	2
Agropyron elongatum	Tall Wheatgrass	1
Agropyron riparium	Streambank Wheatgrass	2
Agropyron smithii	Western Wheatgrass	4
Agrostis alba	Redtop Bent	1/2
Bromus inermis	Smooth Brome	1
Bromus biebersteinii	Regar Brome	1
Dactylis glomerata	Common Orchardgrass	1
Elymus triticoides	Creeping Wildrye	1 1/2
Phleum pratense	Common Timothy	1
Poa compressa	Canada Bluegrass	1/4
Sporobolus airoides	Alkali Sakaton	1/4
Stipa viridula	Green Needlegrass	1
Astragalus cicer	Cicer Milkvetch	2
		18 1/2

As calculated from Sharp Bros. Seed Company predicted p.l.s values, the above mix has a pure-liveness of 0.790;

18.5 lbs ÷ 0.790 = 23.4 bulk lbs

- Bulk Seed: From Calculations Above 23.4

Trifolium hybridum	Alsike clover	
Festuca arundinacea	Tall Fescue	
Festuca ovina var. duriuscula	Hard Sheep Fescue	
Elymus canadensis	Canada Wildrye	
Oryzopsis hymenoides	Indian Ricegrass	
Eleocharis spp.	Spikerush species	
Juncus spp.	Rush species	
Koeleria cristata	Prairie Junegrass	
Poa palustris	Fowl Bluegrass	1.6
Poa pratensis	Kentudcky Bluegrass	
Poa secunda	Sandberg Bluegrass	
Spartina gracilis	Alkali Cordgrass	
Sporobolus cryptandrus	Sand Dropseed	
Puccinellia airoides	Nuttall Alkaligrass	
Distichlis spicata var. stricta	Inland Saltgrass	
Carex spp.	Sedge species	
Onobrychis viciaefolia	Common Sanfoin	
Typha latifolia	Common Cattail	
Commerical Forb selection (Seed mix prior to tree & shrub lists)		
	Bulk Seed Total	25 lbs

APR 1 1981

NOTES:

a) Broadcast rate is double the drill rate (Establishment of Diverse Native Plant Communities on Coal Surface-Mined Lands in Montana as Influenced by Seeding Method, Mixture, and Rate by Edward J. DePuit, Joe G. Coenenberg, and Chester L. Skilbred, Montana State University 1980).

b) Bracketed species will be used as they become commercially available.

c) P.l.s. is the pure live seed content or percentage found in bulk seed. P.l.s is calculated by multiplying the germination rate times the purity rate. Example: A seed tag lists alfalfa as being 99% pure and having a 91% germination rate would have a pure live seed rate of 90% as seen by:

$$.99 \times .91 = .9009$$

A 5 lb/acre drill rate would be adjusted to a 5.6 lb/acre as seen by:

$$\frac{5}{.9009} = 5.6 \text{ adjusted lbs}$$

Because purity and germination rates vary with each growing season and from one seed producer to the next, the seed rates listed unless otherwise stated are p.l.s. rates.

d) Any species which are unavailable during any given seeding season will be replaced with additional amounts of Agropyron dasystachyum, Agropyron elongatum, Agropyron smithii, Sporobolus airoides, and/or Phleum pratense or the unavailable species will be deleted from the mix until the next seeding season.

e) These seed mixes are proposed as general guidelines for actual practice. They may be revised due to site specific revegetation test plots and economic availability. The bracketed species will be selected from and are not intended to reflect the actual species diversity to be planted.

Site Variation Adaptability of SEED MIX #3*

Dry Sites:	Agropyron, Elymus, Sporobolus, Astragalus
Moist Sites:	All listed species
Warm Season:	Sporobolus, Astragalus, and any of the species receiving late spring to early summer runoff
Cool Season:	Agropyron, Bromus, Dactylis, Elymus, Phleum, Poa, Stipa, Astragalus
Silt Adapted:	Agropyron riparium, Agropyron smithii, Bromus, Elymus, Dactylis, Phleum, Poa, Sporobolus, Astragalus, Stipa
Sand Adapted:	Agropyron dasystachyum, Agropyron elongatum, Agropyron trachycaulum, Bromus, Dactylis, Elymus triticoides
Clay Adapted:	Agropyron, Bromus, Dactylis, Elymus, Phleum, Poa, Sporobolus, Stipa, Astragalus
Rhizomatous Species	Agropyron dasystachyum, Agropyron riparium, Agropyron smithii, Agrostis alba, Elymus triticoides, Bromus inermis

COMMENTS: Species which provide early greening and soil holding have been maximized. Species such as Agropyron smithii, Elymus triticoides, Phleum pratense, Sporobolus airoides, and Agropyron elongatum are especially adapted not only to drought but to periodic inundation.

*The bulk seed species listed previously would also contribute members to each of the adaptability categories; however, the cover and frequency of the bulk species are of low significance as compared to total cover and frequency. Therefore, these species are not categorized.

SEED MIX #4 RECLAMATION SPECIES FOR TOPSOIL STOCKPILES

- Pure Live Seed:

		DRILL LBS/ACRE
Agropyron dasystachyum	Thickspike Wheatgrass	4
Agropyron smithii	Western Wheatgrass	4
Agropyron spicatum var. inerme	Beardless Bluebunch Wheatgrass	2
Agropyron trachycaulum	Slender Wheatgrass	2
Bromus inermis	Smooth Brome	1
Elymus cinereus	Basin Wildrye	1/2
Dactylis glomerata	Common Orchardgrass	1/2
Phleum pratense	Common Timothy	1/2
Sporobolus airoides	Alkali Sakaton	}
Sporobolus cryptandrus	Sand Dropseed	} 1/2
Oryzopsis hymenoides	Indian Ricegrass	1/2
Medicago sativa	Alfalfa Medic	1
Astragalus cicer	Cicer Milkvetch	2
		18 1/2

As calculated from Sharp Bros. Seed Company predicted p.l.s values, the above mix has a pure-liveness of 0.822;

$$18.5 \text{ lbs} \div 0.822 = 22.5 \text{ bulk lbs}$$

NOTES:

a) Broadcast rate is double the drill rate (Establishment of Diverse Native Plant Communities on Coal Surface-Mined Lands in Montana as Influenced by Seeding Method, Mixture, and Rate by Edward J. DePuit, Joe G. Coenenberg, and Chester L. Skilbred, Montana State University 1980).

b) Bracketed species will be used as they become commercially available.

c) P.l.s. is the pure live seed content or percentage found in bulk seed. P.l.s is calculated by multiplying the germination rate times the purity rate. Example: A seed tag lists alfalfa as being 99% pure and having a 91% germination rate would have a pure live seed rate of 90% as seen by:

$$.99 \times .91 = .9009$$

A 5 lb/acre drill rate would be adjusted to a 5.6 lb/acre as seen by:

$$\frac{5}{.9009} = 5.6 \text{ adjusted lbs}$$

Because purity and germination rates vary with each growing season and from one seed producer to the next, the seed rates listed unless otherwise stated are p.l.s. rates.

d) Any species which are unavailable during any given seeding season will be replaced with additional amounts of Agropyron dasystachyum, Agropyron smithii, and/or Astragalus cicer or the unavailable species will be deleted from the mix until the next seeding season.

e) These seed mixes are proposed as general guidelines for actual practice. They may be revised due to site specific revegetation test plots and economic availability. The bracketed species will be selected from and are not intended to reflect the actual species diversity to be planted.

APR 1 1981

Site Variation Adaptability of SEED MIX #4*

Dry Sites:	Agropyron, Elymus, Sporobolus, Oryzopsis, Medicago, Astragalus
Moist Sites:	Bromus, Agropyron smithii, Dactylis, Phleum, Medicago
Warm Season:	Sporobolus, Medicago, Astragalus
Cool Season:	All species listed except for Sporobolus
Silt Adapted:	Agropyron smithii, Bromus, Elymus, Dactylis, Oryzopsis, Phleum, Sporobolus, Medicago, Astragalus,
Sand Adapted:	Agropyron dasystachyum, Agropyron trachycaulum, Bromus, Dactylis, Sporobolus cryptandrus, Oryzopsis, Medicago
Clay Adapted:	Agropyron, Bromus, Dactylis, Elymus, Phleum, Sporobolus, Medicago, Astragalus
Rhizomatous Species	Agropyron dasystachyum, Agropyron smithii, Bromus inermis

COMMENTS: Quick green will be achieved by species such as Agropyron trachycaulum, Bromus inermis, and Elymus cinereus. Species such as Agropyron spicatum var. inerme and Agropyron trachycaulum are adapted to shallow soils. Late spring and early summer growth and, more importantly, deep nitrogen replenishment will be provided by Medicago and Astragalus. Sporobolus will also provide late season growth in addition to salt tolerance.

*The bulk seed species listed previously would also contribute members to each of the adaptability categories; however, the cover and frequency of the bulk species are of low significance as compared to total cover and frequence. Therefore, these species are not categorized.

SEED MIX #5 RECLAMATION SPECIES FOR RIGHTS-OF-WAY

- Pure Live Seed:

		DRILL LBS/ACRE
Agropyron dasystachyum	Thickspike Wheatgrass	2
Agropyron desertorum	Desert Wheatgrass	1/2
Agropyron elongatum	Tall Wheatgrass	1/2
Agropyron riparium	Streambank Wheatgrass	1
Agropyron spicatum var. inerme	Beardless Bluebunch Wheatgrass	1
Agropyron smithii	Western Wheatgrass	4
Agropyron trachycaulum	Slender Wheatgrass	1
Agrostis alba	Redtop Bent	1/4
Bromus biebersteinii	Regar Brome	1/2
Bromus inermis	Smooth Brome	1/2
Dactylis glomerata	Common Orchardgrass	1/4
Elymus canadensis	Canada Wildrye	1/2
Elymus cinereus	Basin Wildrye	
Elymus triticoides	Creeping Wildrye	
Oryzopsis hymenoides	Indian Ricegrass	1/2
Phleum pratense	Common Timothy	1/4
Poa compressa	Canada Bluegrass	1/4
Festuca arundinacea	Tall Fescue	1/2
Festuca ovina var. duriuscula	Hard Sheep Fescue	1/2
Sporobolus airoides	Alkali Sakaton	1/4
Sporobolus cryptandrus	Sand Dropseed	1/4
Medicago sativa	Alfalfa Medic	1/2
Melilotus alba	White Sweetclover	1/2
Melilotus officinalis	Yellow Sweetclover	
Astragalus cicer	Cicer Milkvetch	1
Atriplex canescens	Fourwing Saltbush	1/2
Stipa Columbiana	Subalpine Needlegrass	1 1/2
Stipa lettermanii	Letterman Needlegrass	
Stipa viridula	Green Needlegrass	
		18 1/2

As calculated from Sharp Bros. Seed Company predicted p.l.s values, the above mix has a pure-liveness of 0.765;

18.5 lbs ÷ 0.765 = 24.2 bulk lbs

APR 1 1981

NOTES:

a) Broadcast rate is double the drill rate (Establishment of Diverse Native Plant Communities on Coal Surface-Mined Lands in Montana as Influenced by Seeding Method, Mixture, and Rate by Edward J. DePuit, Joe G. Coenenberg, and Chester L. Skilbred, Montana State University 1980).

b) Bracketed species will be used as they become commercially available.

c) P.l.s. is the pure live seed content or percentage found in bulk seed. P.l.s is calculated by multiplying the germination rate times the purity rate. Example: A seed tag lists alfalfa as being 99% pure and having a 91% germination rate would have a pure live seed rate of 90% as seen by:

$$.99 \times .91 = .9009$$

A 5 lb/acre drill rate would be adjusted to a 5.6 lb/acre as seen by:

$$\frac{5}{.9009} = 5.6 \text{ adjusted lbs}$$

Because purity and germination rates vary with each growing season and from one seed producer to the next, the seed rates listed unless otherwise stated are p.l.s. rates.

d) Any species which are unavailable during any given seeding season will be replaced with additional amounts of Agropyron dasystachyum, Agropyron smithii, and/or Oryzopsis hymenoides, or the unavailable species will be deleted from the mix until the next seeding season.

e) These seed mixes are proposed as general quidelines for actual practice. They may be revised due to site specific revegetation test plots and economic availability. The bracketed species will be selected from and are not intended to reflect the actual species diversity to be planted.

Site Variation Adaptability of SEED MIX #5*

Dry Sites:	Agropyron, Elymus, Sporobolus, Oryzopsis, Medicago, Astragalus, Melilotus, Atriplex, Stipa
Moist Sites:	Agropyron elongatum, Agrostis, Bromus, Agropyron smithii, Dactylis, Phleum, Poa, Festuca, Medicago, Melilotus
Warm Season:	Sporobolus, Medicago, Melilotus, Astragalus, Atriplex
Cool Season:	All species listed except for Sporobolus and the possible exception of Atriplex
Silt Adapted:	Agropyron riparium, Agropyron smithii, Agrostis, Bromus, Elymus, Dactylis, Oryzopsis, Phleum, Poa, Festuca, Sporobolus, Medicago, Astragalus, Melilotus, Atriplex, Stipa
Sand Adapted:	Agropyron elongatum, Agropyron dasystachyum, Agropyron trachycaulum, Bromus, Dactylis, Elymus triticoides, Sporobolus cryptandrus, Oryzopsis, Medicago, Melilotus, Atriplex
Clay Adapted:	Agropyron, Bromus, Dactylis, Elymus, Festuca, Phleum, Poa, Sporobolus, Medicago, Astragalus, Melilotus, Atriplex, Stipa
Rhizomatous Species	Agropyron dasystachyum, Agropyron riparium, Agropyron smithii, Bromus inermis, Elymus triticoides, Agrostis alba

COMMENTS: Due to the high amount of site variation (i.e., cuts and fills) expected along rights-of-way, the number of species included in the mix was maximized. Palatable plant species were not avoided since domestic livestock does not greatly habitate the area. One possible deletion from the mix is melilotus (due to high growth form and potential fire hazard); if such deletion is desired, Agropyron smithii and Medicago sativa in a 50-50 ratio would ba a suitable replacement.

*The bulk seed species listed previously would also contribute members to each of the adaptability categories; however, the cover and frequency of the bulk species are of low significance as compared to total cover and frequency. Therefore, these species are not categorized.

SEED MIX #6 COVER CROP

			BULK BROADCAST RATE LB/ACRE
Spring	*Hordeum vulgare*	Sixrow Barley	50-60
Fall	*Triticum aestivum*	Bread Wheat	50-60

NOTE: For use only on areas where the slope is gently enought to allow farm equipment to disc in a cover crop.

COMMERCIAL FORB SELECTION

Seed Mixes #1, #2, and #3 include commercial forbs as part of the bulk seed mix.

Achillea millefolium	Common Yarrow
Achillea lanulosa	Western Yarrow
Artemisa ludoviciana	Louisiana Sagewort
Balsamorhiza sagittata	Arrowleaf Balsamroot
Linum lewisii	Lewis Flax
Penstemon palmeri	Palmer Penstem
Penstemon venustus	Blue Mountains Penstem
Sphaeralcea munroana	Munro Globemallow
Thermopsis montana	Mountain Termopsis
Wyethia amplexicaulis	Mulesear Wyethia
Achillea borealis	Northern Yarrow
Aquilegia cerulea	Colorado Columbine
Arctostaphylos uva-ursi	Bearberry Manzanita
Arnica cordifolia	Heartleaf Arnica
Atriplex corrugata	Mat Saltbush
Centaurea cyanus	Cornflower Bachelor-button
Clarkia pulchella	Deerhorn Clarkia
Dodecathon spp.	Shootingstar species
Epilobium angustifolium	Fireweed Willowherb
Gaillardia aristata	Common Gaillardia
Gilia aggregata	Skyrocket Gilia
Helianthella uniflora	Oneflower Helianthella
Helianthus annuus	Common Sunflower
Iris missouriensis	Rockymountain Iris
Lonicera involucrata	Bearberry Honeysuckle
Lonicera utahensis	Utah Honeysuckle
Lupinus nootkatensis	Alaska Lupine
Mentzelia laevicaulis	Blazingstar Mentzelia
Oenothera hookeri	Hooker Eveningprimrose
Pedicularis groenlandica	Elephanthead Lousewort
Penstemon deustus	Scabland Penstem
Penstemon gracilis	Slender Penstem
Penstemon procerus	Littleflower Penstem
Penstemon triphyllus	Threeleaf Penstem
Penstemon strictus	Rockymountain Penstem
Philadelphus lewisii	Lewis Mockorange
Polygonum bistortoides	American Bistort
Prunus tomentosa	Nanking Cherry
Rosa gymnocarpa	Baldhip Rose
Rubus perviflorus	Western Thimbleberry
Smilacena racemosa	Wildspikenard False-solomonseal
Smilacena stellata	Starry Falsesolmonseal
Solidago occidentalis	Western Goldenrod
Vaccinium spp.	Whortleberry species
Wyethia helianthoides	Whitehead Wyethia

COMMERCIAL FORB SELECTION (Continued)

Alyssum saxalite	Basketofgold Alyssum
Anagallis arvensis	Sarlet Pimpernel
Aster chilensis	Pacific Aster
Aster tanacetifolius	Tansyleaf Aster
Baileya multiradiata	Desert Marigold
Chrysanthemum leucanthemum	Oxeyedaisy Chrysanthemum
Coreopsis lanceolata	Thickleaf Coreopsis
Delphinium ajacis	Rocket Larkspur
Dimorphotheca sinuata	Blueeyed Capemarigold
Penstemon cyananthus	Wasatch Penstem
Clematis ligusticifolia	Western Vriginsbower
Echinacea purpurea	Purple Echinacea
Erigonum umbellatum	Sulfur Wildbuckwheat
Eschscholtzia californica	California Goldpoppy
Gaillardia pulchella	Rosering Gaillardia
Geranium viscosissimum	Sticky Geranium
Gilia leptantha (chamissonis)	Blue Gilia
Gilia tricolor	Birdseye Gilia
Hedysarum boreale	Northern Sweetvetch
Lathyrus latifolius	Perrennial Peavine
Layia platyglossa	Yellowdaisy Tidytips
Liatris spicata	Spike Gayfeather
Ligusticum porteri	Porters lovage
Linanthus grandiflorus	Mountain Flaxflower
Linum grandiflorum rubrum	Scarlet Flowering Flax
Lomatium nuttalli	Nuttall Lomatium
Lupinus alpestris	Mountain Lupine
Lupinus sericeus	Silty Lumpine
Mentzelia lindleyi	Lindley Mentzelia
Nemophilia maculata	Spotted Nemophilia
Nemophilia menzeisii	Babyblueyes Nemophilia
Oenothera lamarckiana	Lamrck Eveningprimrose
Oenothera missouriensis	Ozark Sundrops
Oenothera pallida	Pale Eveningprimerose
Osmorhiza occidentalis	Anise Sweetroot
Papver nudicaule	Iceland Poppy
Papver rhoeas	Corn Poppy
Phacelia campanularia	Harebell Phacelia
Ratibida columaris	Upright Prairieconeflower
Rudbeckia hirta	Blackeyed Coneflower
Sanguisorba minor	Small Burnet
Saponaria officinalis	Bouncingbet Soapwort
Sphareralcea grossulariaefolia	Gooseberry Globemallow
Viguiera multiflora	Showy Goldeneye
Petalostemum candidum	White Prairieclover
Petalostemum purpureum	Purple Prairieclover
Amorpha canescens	Leadplant Amorpha

Arnica cordifolia	Heartleaf Arnica
Artemisia ludoviciana	Louisiana Sagewort
Aruncus sylvesterus	Sylvan Goastbeard
Balsamorrhiza hookeri	Hooker Balsamroot
Calochortus nuttalli	Sego Mariposalily
Carex geyeri	Elk Sedge
Cercis canadensis	Eastern Redbud
Clintonia uniflora	Queencup Cornlily
Lonicera ciliosa	Westerntrumpet Honeysuckle
Helianthus maximiliana	Maximilian Sunflower
Mimulus nanus	Dwarf Monkeyflower
Penstemon alpinus	Alpine Penstem
Phlox longifolia	Longleaf Phlox
Rubus leucodermis	Whitebark Raspberry
Senecio intergerrimum	Threadleaf Groundsel

SECTION 3
TREE AND SHRUB PLANTING LISTS

TREE AND SHRUB PLANTING LIST #1

Species which are commercially available have been listed. Approximately 150 to 300 plants per acre will be fall planted on any areas where Seed Mix #1 is employed. The species will be planted in various sized clumps (5 to 15 individuals per clump) to assure 1) greater protection from wildlife during early establishment, and 2) cover for wildlife when fully established. Containerized stock is recommended over bare root stock. The numbers listed for any single species represent the maximum per acre planted of that kind. At least five varieties per acre will be planted.

		PLANT/ACRE
Amelanchier alnifolia	Saskatoon Serviceberry	50
Artemisia frigida	Fringed Sagewort	50
Artemisia ludoviciana	Louisiana Sagewort	100
Artemisia abrotanum	Oldman Wormwood	50
Artemisia tridentata var. wyomingensis	Wyoming Big Sagebrush	25
Atriplex canescens	Fourwing Sgebrush	100
Atriplex gardneri	Gardner Saltbush	100
Ceanothus velutinus	Snowbrush Ceanothus	25
Cercocarpus ledifolius	Curlleaf Mountainmahogany	100
Chrysothamnus nauseosus	Rubber RAbbitbrush	150
Cowania mexicana	Mexican Cliffrose	25
Elaeagnus angustifolia	Russianolive	25
Elhedra viridis	Green Mormontea	25
Ephedra torreyana	Torrey Mormontea	25
Ephedra trifurca	Longleaf Mormontea	25
Eriogonum umbellatum	Sulfur Wildbuckwheat	25
Frageria vesca	Wild Stawberry	25
Juniperus monosperma	Oneseed Juniper	25
Juniperus scopulorum	Rockymountain Juniper	25
Juniperus osteosperma	Utah Juniper	25
Juniperus osteosperma	Utah Juniper	25
Linum lewisii	Lewis Flax	50
Lonicera alba	White Honeysuckle	25
Lonicera japonica	Halls Honeysuckle	25
Acer glabrum	Rockymountain Maple	75
Acer grandidentatum	Bigtooth Maple	100
Acer negundo	Boxelder Maple	25
Atriplex confertifolia	Shadscale Saltbush	100
Ceratoides lanata	Common Winterfat	100
Berberis repens	Oregon Grape	25
Physocarpus malvaceus	Mallow Ninebark	25
Pinus edulis	Pinon Pine	25
Populus tremuloides	Quaking Aspen	50

TREE & SHRUB PLANTING LIST #1 (Continued)

		PLANT/ACRE
Potentilla fruiticosa	Shrubby Cinquefoil	25
Prunus besseyi	Bessey Cherry	50
Prunus virginiana	Common Chokecherry	50
Purshia tridentata	Antelope Bitterbrush	25
Quercus gambeli	Gambel Oak	50
Quercus turbinella	Shrub Liveoak	50
Rhus glabra	Smooth Sumac	100
Rhus trilobata	Skunkbush Sumac	100
Ribes aureum	Golden Currant	75
Ribes cereum	Wax Currant	75
Ribes hudsonianum	Hudsonbay Currant	25
Ribes inerme	Whiteskem Currant	25
Ribes lacustre	Prickley Currant	25
Rosa rugosa	Rugosa Rose	100
Rosa woodsii	Woods Rose	150
Salix exigua	Coyote Willow	25
Salix amygdaloides	Peachleaf Willow	25
Sorbus scopulina	Greenes Mountainash	25
Symphoricarpos occidentalis	Western Snowberry	50
Symphoricarpos oreophilus	Mountain Snowberry	100
Lycium halimifolium	Matrimonyvine Wolfberry	15
Caragana arborescens	Siberian Peashrub	15
Shepherdia argentea	Silver Buffaloberry	25
Shepherdia canadensis	Russet Buffaloberry	25
Amelanchier utahensis	Utah Serviceberry	100
Alnus tenuifolia	Thinleaf Alder	15
Artemisia cana	Silver Sagebrush	10
Artemisia nova	Black Sagebrush	25
Atriplex rosea	Tumbling Ovach	25
Cercocarpus intricatus	Littleleaf Mountainmahogany	50
Chrysothamnus viscidiflorus	Douglas Rabbitbrush	50
Grayia spinosa	Spiny Hopsage	50
Holodiscus dumosus	Bush Rockspirea	25
Peraphyllum ramosissum	Common Squawapple	25
Ribes setosum (missouriensi)	Missouri Gooseberry	50
Salix alba	White Willow	25
Sambucus canadensis	American Elder	25
Tetradymia canescens	Gray Horsebrush	50
Tetradymia galbrata	Littleleaf Horsebrush	50
Tetradymia spimosa	Cottonthorn Horsebrush	50
Populus alba	White Poplar	25
Populus angustifolia	Narrowleaf Poplar	50
Populus nigra	Black Poplar	25

TREE AND SHRUB PLANTING LIST #2

Species which are commercially available have been listed. Approximately 300 to 600 plants/acre will be fall panted on the areas where Seed Mix #2 is seeded and which are not potential future development areas. These species will be planted in various sized clumps (5 to 30 individuals per clump to assure 1) greater protection from wildlife during early establishment and 2) cover for wildlife when fully established. Containerized stock is recommended over bare root stock. The numbers listed for any single species represent the maximum per acre planted of that kind. At last five varieties per acre will be planted.

		PLANT/ACRE
Amelanchier alnifolia	Saskatoon Serviceberry	25
Artemisia frigida	Fringed Sagewort	50
Artemisia ludoviciana	Louisiana Sagewort	100
Artemisia abrotanum	Oldman Wormwood	50
Artemisia tridentata var. wyomingensis	Wyoming Big Sagebrush	50
Atriplex canescens	Fourwing Sagebrush	150
Atriplex gardneri	Gardner Saltbrush	150
Ceanothus velutinus	Snowbrush Ceanothus	25
Chrysothamnus nauseosus	Rubber Rabbitbrush	100
Cowania mexicana	Mexican Cliffrose	50
Elaeagnus angustifolia	Russianolive	50
Ephedra viridis	Green Mormontea	50
Ephedra torreyana	Torrey Mormontea	50
Ephedra trifurca	Longleaf Mormontea	50
Eriogonum umbellatum	Sulfur Wildbuckwheat	50
Juniperus monosperma	Oneseed Juniper	25
Juniperus scopulorum	Rockymountain Juniper	25
Juniperus osteosperma	Utah Juniper	25
Linum lewisii	Lewis Flax	100
Acer galbrum	Rockymountain Maple	25
Acer gradidentum	Bigtooth Maple	100
Acer negundo	Boxelder Maple	75
Atriplex confertifolia	Shadscale Saltbush	150
Ceratoides lanata	Common Winterfat	150
Quercus gambeli	Gambel Oak	75
Quercus turbinella	Shrub Liveoak	75
Rosa Rugosa	Rugosa Rose	100
Rosa woodsii	Woods Rose	150
Symphoricarpos occidentalis	Western Snowberry	50
Symphoricarpos oreophilus	Mountain Snowberry	100
Lycium halimifolium	Matrimonyvine Wolfberry	30
Caragana arborescens	Siberian Peashrub	50
Shepherdia argentea	Silver Buffaloberry	25
Shepherdia canadensis	Russet Buffaloberry	25

TREE & SHRUD PLANTING LIST #2 (Continued)

		PLANT/ACRE
Amelanchier utahensis	Utah Serviceberry	100
Artemisia nova	Black Sagebrush	50
Atriplex rosea	Tumbling Orach	50
Cercocarpus intricatus	Littleleaf Mountainmahogany	50
Chrysothamnus visicidflorus	Douglas Rabbitbrush	100
Grayia spinosa	Spiney Hopsage	100
Holodiscus dermosus	Bush Rockspirea	100
Tetradymia canescens	Gray Horsebrush	100
Tetradymia glabrata	Littleleaf Horsebrush	100
Tetradymia spinosa	Cottonthorn Horsebrush	100

TREE AND SHRUB PLANTING LIST #3

Species which are commercially available have been listed. Approximately 300 to 600 plants/acre will be planted on the areas where Seed Mix #3 is seeded and which are not underlain by tailings. These speces will be planted in various sized clumps (5 to 30 individuals per clump) to assure 1) greater protection from wildlife during early establishment and 2) cover for wildlife when fully established. containerized stock is recommended over bare root stock. The numbers listed for any single speices represent the maximum per acre planted of that kind. At least five varieties per acre will be planted.

		PLANT/ACRE
Amelanchier alnifolia	Saskatoon Serviceberry	50
Artemisia ludoviciana	Louisiana Sagewort	100
Cernothus velutinus	Snowbrush Ceanothus	25
Cercocarpus leadifolius	Curlleaf Mountainmahogany	100
Frageria vesca	Wild Strawberry	100
Lonicera alba	White Honeysuckle	50
Lonicera japonica	Halls Honeysuckle	50
Acer glabrum	Rockymountain Maple	25
Acer gratididentatum	Bigtooth Maple	25
Acer negundo	Boxelder Maple	
Berberis repens	Oregon Graps	25
Physocarpus malvaceus	Mallow Ninebark	25
Prunus besseyi	Bessey Cherry	50
Prunus virginiana	Common Chokecherry	75
Purshia tridentata	Antelope Bitterbrush	50
Rhus glabra	Smooth Sumac	50
Rhus trilobata	Skunkbush Sumac	50
Ribes aureum	Golden Currant	150
Ribes cereum	Wax Currant	150
Ribes hudsonianum	Hudsonbay Currant	50
Ribes inerme	WHiteskem Currant	50
Ribes lacustre	Prickley Curant	150
Rosa rugosa	Rugosa Rose	50
Rosa woodsii	Woods Rose	50
Salix exigua	Coyote Willow	100
Salix amygadaloides	Peachleaf Willow	100
Sorbus scopuliana	Greenes Mountainash	25
Symphoricarpos occidentalis	Western SNowberry	25
Symphoricarpos oreophilus	Mountain Snowberry	25
Lycium halimifolium	Matrimonyvine Wolfberry	45
Shepherdia argentea	Silver Buffaloberry	50
Shepherdia canadensis	Russet Buffaloberry	50
Typha latifolia	Common Cattail	50
Betula occidentalis	Water Birch	25
Amerlancier utahensis	Utah Serviceberry	100
Alnus tenuifolia	Thinleaf Alder	25

TREE & SHRUB PLANTING LIST #3 (Continued)

		PLANT/ACRE
Artemisia cana	Silver Sagebrush	75
Artemisia filifolia	Sand Sagebrush	75
Cercocarpus intricatus	Littleleaf Mountainmahogany	75
Peraphyllum ramosissum	Common Squawapple	25
Ribes setosum (missouriensis)	Missouri Gooseberry	100
Salix alba	White Willow	50
Sambucus canadensis	American Elder	25
Populus alba	White Poplar	50
Populus angustifolia	Narrowleaf Poplar	100
Populus nigra	Black Poplar	50

SECTION 4
NATURAL RETURN OF PLANT SPECIES

Besides the plant species which are specifically planted and seeded, it is anticipated that a number of speices will naturally return. These plants will establish through 10 soil handling processes, 2) aerial pioneering, 3) animal transport, 4) hydraulic means, and 5) their own physiologic structures (e.g., stolons, rhizomes, etc.). Some of these species include:

Agropyron dasystachyum	Thickspike Wheatgrass
Agropyron smithii	Western Wheatgrass
Agropyron spicatum	Bluebunch Wheatgrass
Agropyron trachycaulum	Slender Wheatgrass
Agrostis alba	Redtop Bent
Bromus inermis	Smooth Brome
Bromus marginatus	Mountain Brome
Elymus candensis	Canada Wildrye
Elymus cinereus	Basin Wildrye
Koeleria cristata	Prairie Junegrass
Oryzopsis hymenoides	Indian Ricegrass
Poa canbyi	Canby Bluegrass
Poa cusickii	Cusick Bluegrass
Poa fendleriana	Fendler Bluegrass
Poa asecida	Dandberg Bluegrass
Poa palustris	Fowl Bluegrass
Stipa lettermannii	Lettermann Needlegrass
Stipa columbiana	Subapline Needlegrass
Carex spp.	Sedge species
Juncus balticus	Baltic Rush
Juncus spp.	Rush speices
Eleocharis parishii	Parish Spikerush
Achillea millefolium	Common Yarrow
Arenaria spp.	Sandwort speices
Arnica longifolia	Longleaf Arnica
Artemisia ludoviciana	Louisiana Sagewort
Balsamorphiza sagittata	Arrowleaf Balsamroot
Calochortis nuttallii	Sego Mariposilily
Ceratoides lanata	Common Winterfat
Clematis orientalis	Oreintal Celmatis
Cryptantha spp.	Crypthantha species
Distichlis spicata var. stricta	Inland Saltgrass
Deschampsia caespitosa	Bluejoint Reedgrass
Phleum alpinum	Alpine Timothy
Festuca idahoensis	Idaho Fescue
Puccinellia airoides	Nuttall Alkaligrass
Oryzopsis exigua	Little Ricegrass
Erigeron spp.	Fleabane species
Erogonum spp.	Wildbuckwheat speices
Erysimum asperum	Plains Wallflower
Haplopappus spp.	Goldlenweed species

NATURAL RETURN PLANT SPECIES LIST (Continued)

Helianthella spp.	Helianthella species
Helinathus spp.	Sunflower speices
Hymenoxys spp.	Actinea speices
Lomatium dissectum	Fernleaf Lomatium
Cowania mexicana	Mexican Cliffrose
Gravia spinosa	Spiny Hopsage
Mentzelia albicaulis	Whitestem Mentzelia
Mentzelia laevicaulis	Blazingstar Mentzelia
Mentzelia fusiformis	Spindleroot Bluebells
Mimulus guttatus	Common Monkeyflower
Oenothera caespitosa	Tufted Eveningprimrose
Orthocarpus tolmiei	Tolmie Owlclover
Penstemon spp.	Penstem species
Petalostemum spp.	Prairieclover speices
Phlox spp.	Phlox speices
Ranunculus spp.	Buttercup speices
Senecio crassulus	Thickleaf Groundsel
Sphaeralcea grossulariaefolia	Gooseberry Blobemallow
Taraxacum officinale	Common Dandelion
Atriplex gardneri	Gardner Saltbush
Atriplex canescens	Fourwing Saltbush
Atriplex confertifolia	Shadscale Saltbush
Cercocarpus intricatus	Littleleaf Mountainmahogany
Cercocarpus ledifolius	Curlleaf Mountainmahogany
Cercocarpus montanus	True Mountainmahogany
Chrysothamnus nauseosus	Rubber Rabbitbrush
Chrysothamnus viscidiflorus	Douglas Rabbitbrush
Ephedra viridis	Green Mormontea
Holodiscus dumosus	Bush Rockspirea
Lycium halimifolium	Matrimonyvine Wolfberry
Peraphyllum ramosissum	Common Squawapple
Prunus virginiana	Common Chokecherry
Purshia tridentata	Antelope Bitterbrush
Quercus gambeli	Gambel Oak
Rhus trilobate	Skunkbush Sumac
Ribes aureum	Golden Currant
Ribes cereum	Wax Currant
Ribes inerme	Whitestem Currant
Ribes setosum	Currant species
Rosa woodsii	Woods Rose
Salix alba	White Willow
Salix exigua	Coyote Willow
Sambucus canadensis	American Elder
Sarcobatus vermiculatus	Black Greasewood
Symphoricarpos oreophilus	Mountain Snowberry
Tetradymia canescens	Gray Horsebrush
Tetradymia spinosa	Cottonthorn Horsebrush
Acer glabrum	Rockymountain Maple

NATURAL RETURN PLANT SPECIES LIST (Continued)

Acer grandidentatum	Bigtooth Maple
Acer negundo	Boxelder Maple
Juniperus osteosperma	Utah Juniper
Pinus edulis	Pinon Pine
Pinus monophylla	Singleleaf Pine
Populus alba	White Poplar
Populus angustifolia	Narrowleaf Poplar
Populus nigra	Black Poplar
Populus tremuloides	Quacking Aspen
Tamarix pentandra	Saltcedar Tamarix