Volume II

INACTIVE AND ABANDONED NONCOAL MINES

State Reports

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

Disclaimer

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WGA MINE WASTE TASK FORCE STATES

ALASKA

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February 13, 1991

Mr. Richard Juntunen
Consultant to WIEB
Box 174 MCR
Clancy, MT 59634

Re: WIEB Inactive/Abandoned Mines Data Summary Report

Dear Mr. Juntunen:

Enclosed you will find the WIEB Inactive/Abandoned Mines Data Summary Report for Alaska. This report attempts to address the issues that were outlined in your request for Inactive/Abandoned Mine data.

The State of Alaska is just beginning to address the abandoned mine issue through discussions with other agencies and hopes to develope a program that will lead to inventory and mitigation of hazards and environmental impacts.

If Division of Mining can be of further assistance, please feel free to contact me at (907) 762-2109.

Sincerely,

Mitch Henning

Mitch Henning
Minerals Geologist

WIEB INACTIVE/ABANDONED MINE DATA SUMMARY
NARRATIVE SUMMARY

1.0 INTRODUCTION

The mining industry in Alaska began with the discovery of gold in numerous locations throughout the state. The first mining activity was carried out as early as 1849 by a Russian mining engineer named Peter Doroshin, working for the Russian American Company prospecting for gold on the Kenai Peninsula.(Mark Anthony, 1976).

Placer Gold has been known on the Seward Peninsula since 1865 when Western Union Telegraph Co. began construction of a telegraph line to connect the United States with Eastern Asia(USGS Bult. 533). In 1870 Gold was found at Sundum Bay, in Southeastern Alaska. This led to further discoveries at Juneau in 1880. These discoveries were the beginnings of the AJ Alaska Juneau and Treadwell Mines.

Gold was discovered on the Klondike River in 1896. This discovery led to a stampede that spilled over into Alaska. From 1899-1900 a major stampede to Nome occurred with more than 20,000 people landing in Nome. These discoveries along with the major development of large copper deposits at Kennecott, and in Prince William Sound helped fuel numerous stampedes to Alaska.

In early 1933 the United States was in the throes of a major economic depression. In order to stimulate the economy President Roosevelt increased the price of gold from $20.67 per troy ounce to $35.00 per troy ounce. This increase touched off expansion of the gold mining industry in Alaska. This expansion continued unabated until World War II when Congress passed the War Manpower Act which prohibited gold mining. This adversely affected gold mining and many Alaskan mines did not resume production. Gold production continued its steep decline after World War II until 1967 when the $35.00 an ounce price for gold could no longer be sustained by the United States, and the U.S. moved off the gold standard allowing the price of gold to rise. Alaska has seen a resurgence of mine development in the 1980s and 1990s.

Noncoal mining has produced a variety of other mineral commodities including metallic, industrial and construction materials. Production of metallic minerals includes antimony, copper, chromium,lead, mercury, platinum, silver, tin, tungsten, zinc, and uranium. Industrial commodities include barite, building stone, limestone, peat and sand and gravel.

2.0 MINING AND MILLING METHODS

Three basic mining methods have been employed in Alaska to extract noncoal minerals. They include underground, surface, and placer with variations of all three. Underground mining methods have been used in Alaska to develop precious metal and base metal mines. The most famous being Kennecott Copper and The Alaska Juneau Gold Mine. This method involves the development of shafts or adits along with subsidiary tunnel systems to access the ore body. Waste rock was usually hauled out of the mine and dumped near the portal creating waste rock dumps. These dumps occupied the sides of slopes, tops of hills or valley bottoms.

Historically, open pit surface mining methods have been little used in Alaska. Ore deposits have been dominantly high grade low tonnage and not amenable to bulk mining methods. There are exceptions to this with the Alaska Juneau and Treadwell Gold Mines and the Beatson Copper Mine utilizing open pit techniques to initiate mine development before moving underground. The open pit process utilizes drilling and blasting to break up the ore and then excavation of the ore to form the pit.

Placer mining methods have been the most utilized in developing Alaska's mineral resources. These methods include the use of basic sluice boxes, hydraulic giants, small wash plants/riffle systems using mercury amalgam, floating bucketline dredges, and underground drift mining in frozen ground. Placer mining methods extract elemental metals or other commodities from gravels using water and gravity.

Processing of metallic ores in Alaska involved a variety of methods. Historical milling methods involved the use of stamp mills to crush and break the ore. Many ore deposits were high grade and low tonnage allowing for efficient use of stamp mills. As milling technology advanced, use of ball and rod mills, jaw crushers and other grinding methods became prevalent and are utilized today. When the desired grinding size was reached, the ore was further concentrated through gravity separation, mercury amalgamation, cyanidation, and flotation.

Tailings that resulted from the processing of ores were disposed in various ways. Tailings were deposited with process waters to a disposal area away from or adjacent to the mine. Historic disposal of tails may have involved discharge into an adjacent water body or directly onto the ground. Final benefiction usually involved loading the concentrate for shipment and shipping to a stateside smelter.

3.0 HEALTH AND SAFETY IMPACTS

Noncoal open pit and underground mines have created some hazards to human safety in Alaska. Most mine development presently identified in Alaska took place from 1885 thru the 1940s. This development for the most part occurred in very remote uninhabited regions of the state. The potential threats associated with inactive mine sites to the public health and safety is not well documented in Alaska.

Mine hazards that have been identified in Alaska and considered a threat to the public consists of: Abandoned explosives, rotten support timbers in adits, steep narrow and eroded access trails, partially caved and unstable adits, shafts concealed by vegetation and soil, rotten ladders in stopes, winzes, and raises, slippery and/or rotten board crossings over a winze, heavy loose rock buildup on roof support timbers, fractured rock overhead with no support timbers, poor mine ventilation, weathered and unstable equipment and structures. Identification of mine drainage hazards in Alaska has not been conducted in any concise manner to allow for identification of associated problems, due largely to remoteness of sites and climatic conditions.

Mine sites that could be considered a public hazard occur in areas that are experiencing higher use levels for recreational activities by the general public. The Treadwell Mine in Juneau-Douglas is an example. An interpretive trail has even been developed to attract the public. Few inactive mine sites in Alaska occur within residential or populated areas.

4.0 ENVIRONMENTAL IMPACTS

4.1 WATER RESOURCES

Surface and ground water at inactive/abandoned mines may be impacted by leaching and sedimentation. In Alaska the affects of acid mine drainage from underground and surface workings at inactive/abandoned metal mines is not well understood or documented. Acid drainage is usually associated with oxidation of sulfide bearing ores, causing the formation of sulfuric acid which in turn solubilizes high concentrations of metals. Early metal production in Alaska was predominantly gold from free milling gold-quartz and gold-quartz-carbonate vein systems low in sulfides.

Discharge of sediment from both point and nonpoint sources may lead to surface water quality degradation through increased sedimentation and turbidity. This may occur on abandoned placer mines if unreclaimed settling ponds blow out during spring thaw or a major high water event. Most abandoned mine sites within Alaska are located in isolated remote areas; consequently the impacts to domestic water supplies is limited. The majority of documented impacts from discharging mine waters relates to fisheries and biological communities associated with streams.

4.2 AIR QUALITY

Air quality in the vicinity of unvegetated tailings and waste rock dumps may be impacted from fugitive dust emissions. Wind blown tailings and fugitive dust may affect offsite flora and fauna as well as contribute particulate of respirable size for human inhalation. As is the case with water resource impacts, propagation of dust from isolated abandoned mine properties does not pose a significant health hazard. The affects of fugitive dust is seasonally dependent and does not represent a continual source for impact to air quality.

5.0 STATE LAWS AND REGULATIONS

Inactive and abandoned mines (IAMs) are defined as "left or abandoned in either an unreclaimed or inadequately reclaimed condition and was part of a mining operation activity occuring before October 15, 1991." These sites included disturbances created prior to October 15, 1991 when the State of Alaska's Mine Reclamation Act, section 1 takes effect October 1, 1991. This Act and Regulations requires operators to develop a reclamation plan and secure reclamation bonding before the state will issue a mining permit. Small mining operations that reclaim as they proceed and maintain an cumulative unreclaimed mined area of less than five acres at one site or produce less than 50,000 cubic yards will receive an exemption through the filing of a LETTER OF INTENT.

Title IV of the Surface Mining Control and Reclamation Act (SMCRA-1977) provides for the collection of a federal tax on coal production. One half of the tax collected is available to participating states to reclaim IAMs in their state. Expenditure of Title IV monies on noncoal mines is limited to remediation of human safety hazards. Once a state certifies that remediation of all abandoned coal properties has been completed, the Title IV monies can be expended on environmental problems associated with noncoal sites.

Hazardous mine openings (HMOs) were the first noncoal sites eligible for Title IV funds in Alaska.

6.0 RECLAMATION EFFORTS

Noncoal reclamation in Alaska has been performed by several State agencies, U.S. Department of Interior, and private companies.The amount of expenditure for reclamation is unknown due to lack of available data. It is estimated that over $5 to $10 million will be required to remediate the State's remaining IAM noncoal sites.

The Alaska AML Program has not expended any funds on noncoal projects. There is a proposed project for the Treadwell mine to seal up several portals and mine openings.

WIEB INACTIVE/ABANDONED MINE DATA SUMMARY
REFERENCE GUIDE

Numerous agencies in Alaska have become involved in efforts to identify hazards and environmental impacts related to Inactive/Abandoned Mine sites. These efforts have not been coordinated consistently between agencies and has led to the development of data bases with various levels of information. There has not been a systematic inventory and identification of Inactive/Abandoned sites or hazards associated with them for Alaska. Listed below are agencies that are involved in developing inactive/abandoned mine site data bases in Alaska.

1. Alaska Department of Natural Resources, Division of Mining
   Alaska Surface Coal Mining Section

   Alaska's AML program is managed under the surface coal mining section within the Division of Mining. A systematic inventory of inactive/abandoned mines sites has not been conducted within Alaska at this time. Numerous agencies have inventoried specific areas and identified problems but have not compiled the data into one inventory list covering the state. The Division of Mining has conducted some field investigations identifying several major mine opening hazards and has applied for a grant to mitigate them. The data presented from this reference source is reported with a 90% confidence level.

   The Division of Mining has also identified several inactive mine sites in Prince William Sound for possible mitigation related to the State of Alaska's Oil Spill Restoration project.
   Contact: Sam Dunaway, Acting Director

2. United States Department of Interior, National Park Service, Alaska Regional Office.

   The National Park Service has initiated a program to identify inactive/abandoned mine sites within National Park Units in Alaska. This effort has identified 459 sites that have levels of disturbance the National Park Service would consider significant. All of the sites are associated with metals mining. The National Park Service is constructing a computerized data base identifying the location, type and level of disturbance, type of hazard, and level of impact related to site development. The National Park Service has provided a list of sites to the Division of Mining, but detailed data on hazards or environmental impacts is still in the compilation phase and not readily available. The data

provided should have a 90% or higher confidence level.
Contact: Lynn Griffiths, Chief, Mining and Minerals

3. United States Department of Interior, Bureau of Mines, Alaska Field Office.

The U.S. Bureau of Mines has initiated a Mine Hazard Identification Program with the U.S. Forest Service for the Chugach National Forest in southcentral Alaska. The program includes: literature research, field examination and development of remediation measures for the hazards identified. Some 200 mine sites have been identified as potential hazardous sites. Nine site have been inventoried to date. Some of the hazards identified are: abandoned explosives, rotten support timbers in adits, steep narrow and eroded access trails, partially caved and unstable adits, concealed shafts by vegetation and soil, rotten ladders in stopes, winzes, and raises, slippery and/or rotten board crossings over a winze, heavy loose rock buildup on ceiling support timbers, poor mine ventilation, weathered and unstable equipment and structures. The data field checked has a 90% or higher confidence level.
Contact: Chris Roe, Bureau of Mines Geologic Engineer and Hazards Specialist.

4. United States Department of Agriculture, U.S. Forest Service, Alaska Region, Chugach National Forest.

The potential threats associated with inactive mine sites to the public health and safety and to the resources of the Chugach National Forest is not known in detail. The U.S. Forest in cooperation with the U.S. Bureau of Mines has initiated "The Mine Hazard Identification Program" to identify, inventory, and eliminate serious hazards to the health and safety of Forest visitors and employees. Types of hazards that have been identified are: Abandoned explosives, rotten support timbers in adits, steep narrow and eroded access trails, partially caved and unstable timbers in adits, concealed shafts by vegetation and soil, rotten ladders in stopes, winzes, and raises, slippery and/or rotten board crossings over a winze, heavy loose rock buildup on ceiling support timbers, fractured rock overhead with no support timbers, poor mine ventilation, weathered and unstable equipment and structures.

Many of the identified sites are popular hiking and recreation areas for the general public. In all cases, roads and trails accessing these mining areas were easily identified and located. A survey of the recreation users was taken at each site. This survey consisted of counting numbers of hikers and recreation users sighted as well as asking questions concerning the popularity of the area. The data field checked

has a 90% or higher confidence level.
Contact: Carol Huber, Chugach National Forest Geologist

5. Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation

The Alaska Division of Parks and Outdoor Recreation maintains the Alaska Heritage Resource Survey. This survey is a source for information on sites that may have historic archaeologic significance to Alaska or the nation. Included in the survey are numerous mine sites. Data available from the survey on these sites varies from the site location, to who provided the information, description of the physical condition of the site materials and structures. Each site is assigned a number and plotted on a USGS topographic map. The Alaska Heritage Survey is a computerized data base. The Division of Parks and Outdoor Recreation does not have an on going field inventory program to identify mine sites. Data is collected through published literature and public input.

The data base is computerized and sites are cataloged by number. Data consists of basic site location, who provided the information, description of sites physical attributes and condition of the site. Data has a 70% confidence level.
Contact: Greg Dixon, Archeologist Division of Parks.

6. Alaska Department of Environmental Conservation

The Alaska Department of Environmental Conservation maintains a list of oil and hazardous substance sites for Alaska. Twelve inactive/abandoned mine sites have been identified by DEC and added to this list. Hazardous materials identified at these sites would include type and quantity of chemical reagents and processed ores left at sites. Sites include old mills, an ore terminal load out facility, and tailings disposal areas. The data available on each site is very general and needs to be upgraded. Data has a 50% confidence level.
Contact: Kevin Kleweno, Department of Environmental Conservation.

7. United States Environmental Protection Agency

The United States Environmental Protection Agency maintains a list identifying superfund sites in Alaska. There are twelve inactive/abandoned mines sites identified and listed. The level of data available on these sites is sketchy at best and needs to be updated. These sites are also included on the Alaska Department of Environmental Conservation list of oil and hazardous waste sites.

NON-COAL INVENTORY - INACTIVE/ABANDONED MINES
REFERENCE GUIDE FOR DATA SUMMARY

REFERENCE GUIDE

MINERAL TYPE (acres)	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)	(cost) 13
Metallic Ores	Mines	1,2,3,4	Federal	1,2	Polluted Water	(miles) 6,7	13
	Millsites	1,2,3,4/6	Private	1,2	Mine Dumps	(acres) 2,3	13
	Smelters	2,3,6	State	1,2	Disturbed Land	(acres) 3,2	13
	Other	3,1	Other		Highwalls	(miles)	
					Mine Openings	(number) 1,2,3,4,5	13
					Subsidence Prone	(acres) 1	
					Hazardous Structures	(number) 2,3,4	
					Other	(units)	
Construction Ores	Mines	1,3	Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres) 1,3	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	

WIEB INACTIVE/ABANDONED MINE INVENTORY SUMMARY
STATE OF ALASKA
FOOTNOTES

1. Inactive and abandoned mines (IAMs) are defined as "left or abandoned in either and unreclaimed or inadequately reclaimed condition and was part of a mining operation activity occuring before October 15, 1991.

2. Included with this report package is a Reference Listing consisting of the Data Summary Table and a discussion of agencies and programs involved with inactive/abandoned mines in Alaska. The Reference Listing also summarizes the data base and qualifies the level of data available. The Data Summary Table lists acreages for the different mining types based on data from the U.S. Bureau of Mines. Other categories have been left blank due to the low level of confidence or lack of data.

3. Data on inactive/abandoned mine sites in Alaska is incomplete. Numerous agencies are developing data bases that identify IAM sites, but have not inventoried sites for human hazards or environmental impact in any substantial detail. The different agencies have defined these sites

4. The acres listed for each mineral type include the disturbed or impacted land resulting from mining/milling/smelting activities within the IAM noncoal site. This acreage total includes health and safety hazards, unvegetated areas, and environmental degradation on and off site.

5. The "other" mining type reported for metallic ores consists of unvegetated placer tailings which are included in estimates for metallic ores. The acreage total listed is reported with 40% confidence level.

6. Polluted Water: The data reported from this source were derived from the Alaska Department of Environmental Conservation statewide water quality assessment report required by Section 305(b) of the Clean Water Act. This data is presented in a tabular listing of waterbodies determined to be impaired or suspected of being affected. The assessment found a total of 77 waterbodies documented to be impaired, and 129 to be suspected. Five were identified as being mine related. No mileage for polluted water is listed on the data summary due to lack of direct inventory. Alaska's water resources, in keeping with its overall dimensions, are vast and remote. In its 586,000 square miles there are an estimated 3,000,000 lakes,

365,000 miles of rivers, 170,000,000 to 225,000,000 acres of wetlands, and 36,000 miles of coastal shoreline. The majority of Alaska's waters, well over 99 percent are unaffected by man's activities, and are in a natural state. Assessing these waters is hampered by the limited availability of data to comprehensively and scientifically characterize water quality in Alaska.

7. Mine Dumps: An area adjacent to the mine site where waste rock has been deposited from mine excavation. This includes waste rock dumps, tailings impoundments, or overburden stock piles.

8. Disturbed land: Land or water mined or affected by mining of minerals and materials other than coal. Any land which has not revegetated to a similar condition or has a utility to adjacent land.

9. Hazardous Highwalls: Open face of exposed overburden and mineral in an open cut or strip mining operation. Reclamation of these sites may involve backfilling, contouring and grading, a pit wall may be exempt if the steepness of the wall makes it impractical or impossible to accomplish.

10. Hazardous Mine Openings: Mine openings that would not allow exit or cause an individual to become trapped or unable to escape unaided. Horizontal openings where roof collapse or timber supports may fail. Reclamation of these sites may involve permanent closure.

11. Subsidence Prone: An area over mine workings or any area subject to ground surface collapse.

12. Hazardous Structures: Hazardous structures have been defined as noncoal related buildings, foundations, headframes, etc. which could pose a hazard to people being in, on, or around them. Mitigation of these hazards involves demolition or removal but can also be accomplished through restoration.

13. The following explanation summarizes cost estimates for various catagories listed on the data summary sheet. The estimates were made using data for proposed reclamation projects and from AML coal projects that have been completed.

    POLLUTED WATER- Presently the data base consists of a tabular listing of streams that have been impacted and those that are suspected of being impacted. No estimate of impacted steam miles has been developed at this time because of insufficient data cost estimates cannot be determined.

    MINE DUMPS- Reclamation of noncoal impacts defined in the mine dump category are diverse and site specific. In Alaska inactive/abandoned mine dumps are generally remote and associated with mining activities that took place 40 to 80 years ago. These sites are generally considered to be stabilized and disturbing them could lead to destabilization and new impacts. Many are revegetated with native plant species. In reviewing AML coal spoil sites, per acre costs ranged from $4000 to $7000 an acre. There are no per acre costs for reclamation of mine dumps due to lack of documentation of past reclamation efforts and inventory data. Due to the remoteness of most Alaskan sites, per acre costs are expected to be high.

DISTURBED LAND- Reclamation of disturbed land involves revegetation efforts. This may include leveling and recontouring of the disturbed area along with seeding or the use of native species. Review of AML coal projects were used to determine a per acre cost. The per acre cost ranges between $1000 to $4500 an acre, although costs for remote sites may be much higher.

MINE OPENINGS- Actual construction costs for closing of hazardous mine openings can only be speculated upon due to the lack of inventory data, and small amount of mitigation that has been preformed. The one example that was used evaluated closing three shafts and barricading one glory hole. Estimated costs for this project was $74,000. This work has not been funded yet. Due to a low level of mitigation work preformed on inactive/abandoned mine sites, it is difficult to generate accurate cost figures or derive an average cost figure for mitigation.

NON-COAL INVENTORY
INACTIVE/ABANDONED MINES[1]

State of AlASKA

Agency Contact Sam DunaWay

Telephone (907)-762-2171

DATA SUMMARY*							
MINERAL TYPE (acres)	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)	(cost)
Metallic Ores	Mines	1000	Federal	UnKnown	Polluted Water 6	(miles)	UnKnown
	Millsites	850	Private	"	Mine Dumps 7	(acres) 1,100	"
	Smelters	20	State	"	Disturbed Land 8	(acres) 17,770	"
	Other	15,900	Other	"	Highwalls" 9	(miles)	
					Mine Openings 10	(number) 500	"
					Subsidence Prone 11	(acres) 100	"
					Hazardous Structures 12	(number) 300	"
					Other	(units)	
Construction Ores	Mines	9,910	Federal	"	Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land 10	(acres) 9910	"
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	

ARIZONA

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STATE OF ARIZONA

INACTIVE/ABANDONED MINES

SUMMARY REPORT

- Narrative Summary
- Data Summary Table
- Footnote Section
- Resources
- Policy Options

Compiled by:

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Assistant State Mine Inspector
Registered Geologist
Registered Environmental Assessor

DOUGLAS K. MARTIN
ARIZONA STATE MINE INSPECTOR
APRIL 15, 1991

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ACKNOWLEDGEMENT

The Western Governor's Association has long been concerned with the problems associated with inactive/abandoned mines: problems regarding public safety, health, and the environment. To obtain a better perspective on the nature and extent of hazards associated with old mines, the association, through a contractor, solicited this report from Arizona.

Arizona produces more non-ferrous metallic wealth than any other state, territory, or province in America. Mining has dominated the economic development of the state; and, understandably, it has left Arizona with a vast inventory of inactive/abandoned mine (IAM) workings.

The contractor, Western Interstate Energy Board, requested that the Arizona State Mine Inspector prepare this report. The Mine Inspector is required by law to locate, identify, and eliminate hazards associated with inactive/abandoned mines and has the most extensive database regarding IAM's. Accordingly, the Inspector respectfully submits the following report.

- HISTORY -

In 1540 Coronado discovered the streets of the fabled Seven Cities of Cibola were not paved with gold. Thus ending the first major search for mineral wealth in Arizona. Of course, Coronado probably had more thievery in mind than mineral exploration.

During the next 300 years little actual mining was done. Hostile Indians, recalcitrant Spanish politicos and Mexican indifference inhibited prospecting. Still, tales of fabulously rich deposits and the real discoveries at Planchas, Ajo and Jerome stimulated a great influx of miner-pioneers.

The presence of calvary troops during the Civil War brought stability to the territory and prospectors flooded in from the California gold fields. The era saw the great placer gold discoveries of Gila, La Paz, Quartzite, Richhill and others. Lode discoveries followed and by 1870 the gold camps of Oatman, Wickenburg and Yuma were producing millions of ounces of gold annually.

By 1872 the emphasis had shifted from gold to silver. The deposits at Tombstone, Cerbat, Bradshaw, Silver King and Globe were discovered. In 1874, 13,000 mines were producing or being developed in Arizona. The transcontinental rail system was completed in 1881. Access to markets enabled the exploitation of Arizona's great copper deposits. Mines at Ajo, Clifton-Morenci, Jerome, Bisbee, Ray, Superior, Globe-Miami, Bagdad, Silver Bell and San Manuel began the longest sustained copper production in America.

From the turn of the century until the collapse of the commodities market in 1930, copper and silver dominated as products won from Arizona mines. The '30's brought renewed activity to the gold camps. Both large and small scale operations proliferated until the second world war directed attention back to copper and other strategic metals.

Large scale, open pit, copper mining began at Morenci in 1942. Base metals were heavily demanded by the war effort, followed by interest in tungsten, manganese, asbestos, vanadium and other critical metals and minerals. The development of the atomic bomb intensified uranium exploration. Since 1950, with the implementation of new technologies, copper production in Arizona has increased. Recently, new technology has benefited copper production by cost effective in-situ and mine dump leaching, solvent extraction and electro-winning processes. Additionally, new technology has prompted exploration and development of low-grade gold ores and various industrial minerals. Construction in the industrial and private sector has caused sustained growth of aggregate mining.

Today, Arizona produces nearly two thirds of all the copper mined in the United States, and is also a major producer of gold, silver, lead, zinc, molybdenum, uranium, vanadium and the industrial minerals: cement, clay, perlite, pumice, sand and gravel aggregate, silica, stone, salt, fluorspar, gemstones, gypsum, lime, zeolites and certain rare elements. Known deposits of asbestos, barite, diatomite, feldspar, mica and tungsten await the proper economic climate.

Arizona produces more non-ferrous metallic wealth than any other state or territory in the union. Mines in Arizona contributed over 8.5 billion dollars to the state's economy last year. Mining has dominated the economic development of this state, with it came merchants, cattlemen and lumbermen. These individuals, in turn, brought ranching, industry and a broad and diverse population base. Understandably, mining has also left Arizona with a vast inventory of inactive/abandoned mine workings.

- MINING AND MILLING METHODS -

In the early days, mining in Arizona was a one or two man operation. Ore was found by classical prospecting and extracted through shafts, adits and tunnels. Placer ores and most industrial and construction aggregates were mined by surface excavation. Some metallic ores, mostly copper, were also mined by surface or open pit methods. Waste rock generated by either method was simply pushed, hauled or dumped in the nearest convenient location.

Ore beneficiation was accomplished by a variety of processes. Placer gold was commonly recovered simply by gravity concentration, often aided by mercury amalgamation. Hard rock ores were crushed and ground to the desired size and separated by gravity, amalgamation, flotation, cyanidation or acid leaching. Waste from the milling process, called tailings, were usually pumped or drained into an impoundment downhill from the milling facility where process water could be reclaimed.

Often waste rock and low-grade ores of copper, gold and other metals were stacked and leached or leached in place with weak acid solution or cyanide solution. The metal-bearing solution was collected in a pond and values recovered by electrowinning or chemical precipitation.

Final treatment of metallic ore concentrates was by smelting or electrowinning followed by refining. Smelter waste, called slag, was dumped in any convenient location close by. Smelters of all sizes have operated in Arizona. Today, three very large copper smelters operate continuously.

- HEALTH, SAFETY AND ENVIRONMENTAL IMPACTS -

Accounts differ, depending on whose doing the counting, but old mine workings number between 3000 and 100,000. The U.S. Bureau of Mines has documents proving that around 3000 mines produced a product in Arizona. The State Mine Inspector estimates that between 60,000 and 100,000 mine workings and related structures exist. The discrepancy is accounted for by the following example: The Amole Mining District occupies less than a square mile in southwest Tucson. The U.S. Bureau of Mines list one past producer in the district. The Arizona State Mine Inspector physically inventoried the district and found sixty five open holes as well as a large mine dump, a tailings pile and smelter slag. The State Mine Inspector finds sixty eight old mine workings and related structures where the U.S. Bureau of Mines lists one.

The State Mine Inspector's estimate is derived from a pilot program conducted in 1987 and 1988. During this period two of Arizona's 246 mining districts were inventoried for potential hazards to public safety and health. The Arizona State Legislature wisely established a law to address the safety and health hazards associated with abandoned and inactive mine workings by enacting Arizona Revised Statute #27-318. The law directs the State Mine Inspector to locate all the old mine workings in Arizona which constitute a danger and to notify the owner of the violation. It requires the owner to secure the hazard in a timely fashion. The law also enables the State Mine Inspector to eliminate the hazard, if funds are available.

The Legislature funded the program for two years, 1987 and 1988. The Arizona State Mine Inspector selected a representative area and inventoried 2000 mine sites. Three hundred were found to have hazards. Thirty-one of those exhibited potential threats to the environment and they were appropriately forwarded to the Arizona Department of Environmental Quality for restoration. The remaining two hundred seventy were processed through title and the claim holders notified. Owners voluntarily eliminated nearly all hazards (99% compliance to date).

Based on the pilot program inventory, the Arizona State Mine Inspector estimates between 60,000 and 100,000 old mine workings exist in the State. Using 80,000 as a highly subjective yet reasonable number, statistics show 15% or 12,000 mine sites will pose a threat to public safety. Of these, 10% or 1200, will exhibit a threat to the environment.

Public safety hazards include unprotected mine openings, unstable ground, unsafe timber, bad air, hidden pools of water, attack from wild animals and reptiles, hazardous mine buildings and structures, abandoned explosives and chemicals. Accidents and deaths continue to accrue in Arizona, especially where urban sprawl and recreational activities encroach on old mining districts. Abandoned mine incidents are reported to the State Mine Inspector nearly every week. Injuries occur monthly and deaths occur annually. The Central Arizona Mountain Rescue Association reports mine related rescues and recoveries have nearly doubled since 1985.

Adverse environmental impacts associated with old mines are largely unknown. Certain mines clearly constitute a threat to surface and ground water quality and possibly air quality. Flora and fauna have been impacted by acid mine drainage, elevated metals in streams and increased sedimentation. Fugitive dust from blowing mine tailings is certainly a nuisance in a few places, but no known health hazards have, thus far, been documented. Arizona's four inactive, large scale smelters are not known to have caused irreversible, deleterious environmental effects over widespread areas.

- LAWS AND REGULATIONS -

Arizona law defines an **ABANDONED MINE** as an excavation where mining operations have been permanently terminated or for which no operator, owner or other claimant can be located. Similarly, an **INACTIVE MINE,** is defined as an operation not conducting mining for more than six months or where operations have been temporarily suspended. **MINING** means those activities conducted to develop or extract minerals from a mine including on site transportation, concentrating, milling, leaching, smelting or other processing of ores or other minerals. (See Arizona Revised Statutes 27-301 and 27-303.)

Arizona Revised Statute 27-318 reads as follows:

> Abandoned and inactive mines to be secured; inspector authority; violation; classification
>
> A. Every mine operator or former mine operator or claimant who owns a mine or mining claim or possesses a mine or mining claim under lease, contract, permit or otherwise, who knowingly permits the existence on the premises of an abandoned or inactive mining shaft, portal, pit or other excavation which is dangerous to persons legally on the premises, who fails to cover, fence, fill or otherwise secure it and post warning signs, within sixty days of notification by the inspector and who fails to keep it so protected is guilty of a class 2 misdemeanor. If it is impossible or impracticable to comply with this subsection within the required sixty days, the operator may submit a written plan of action to the inspector which specifically outlines the measures that will be taken and the number of additional days necessary to comply with this section. In no case may the time extension granted by the inspector exceed an additional one hundred eighty days.

B. The inspector may enter on such land to inspect for dangerous conditions which may present a health and safety hazard to the public. If hazards exist, the inspector may erect warning signs across or near the entrance of any mine shaft, portal, pit or other mine opening prohibiting the entry of unauthorized persons or erect other protective devices as necessary.

C. If the mine operator cannot be located through reasonable efforts, the owner of record is the responsible party for the purposes of this section. If neither the mine operator or owner of record can be located through reasonable efforts,the inspector shall erect warning signs across or near the entrance of any mine shaft, portal, pit or other mine opening prohibiting entry of unauthorized persons or erect other protective devices as necessary.

D. A person who knowingly and without authority removes, destroys or tampers with any warning sign, covering, fencing or other protection placed on, around or over any shaft, portal or other excavation is guilty of a class 6 felony.

Additionally, rules have been promulgated by the Arizoan State Mine Inspector which establish minimum closure requirements. Inter-related laws, rules and definitions contained in the Mining Code (A.R.S. 27-121 through 27-469 and R11-1-001 through R11-1-2299) enable the State Mine Inspector to provide a safe working environment for miners, mining communities and the general public in and around mining operations. The Mining Code has evolved over 79 years into a document acceptable to industry and government.

Arizona laws relating to environmental quality are administered by the Department of Environmental Quality. Those presently affecting mining are water quality and air quality. (A.R.S. 49-201 through 49-391 and A.R.S. 49-401 through 49-506) Soon, solid waste management (A.R.S. 49-201 through 49-837) will affect mining.

Water quality laws and rules require that water introduced into surface or groundwater be of the same quality as water that is already there, within certain limitations. They require compliance with the Federal Clean Water Act (33 United States Code 1317). Operating mines acquire an Aquifer Protection Permit which ensures a negligible discharge of poor quality water. Old mining operations, obviously, cannot comply without remedial action.

Air quality laws and rules define contaminants and air pollution. They require an operating permit for anything that could impair ambient air quality, with certain exceptions. Abandoned and inactive mines are not exempt from these laws.Old mining operations, especially tailings impoundments, locally pollute the air continually with dust during windy conditions. Solid waste management could become an expensive consideration in mine site reclamation and hazard elimination.

In short, present laws and rules enforced by the Arizona State Mine Inspector and the Arizona Department of Environmental Quality adequately address health, safety and environmental hazards associated with old mines. New and operating mines are strictly regulated to minimize safety, health and environmental hazards. Old abandoned mines can be brought into compliance with adequate funding.

- RECLAMATION EFFORTS -

Industry is clearly the leader of reclamation efforts in Arizona. Major mining companies spend millions annually on securing hazardous openings, stabilizing and revegetating tailings, controlling drainage, treating acid mine water, erosion control, dust control and remediating other environmental problems. Small mining companies, individual prospectors and land owners are voluntarily eliminating hundreds of hazardous mine openings annually.

The Arizona State Mine Inspector allocates approximatly $20,000 per year to investigate complaints involving dangerous conditions associated with past mining activity. The U.S. Bureau of Land Management, the U.S. Forest Service, the U.S. Park Service and the Arizona State Land Department have very limited abandoned/inactive mine inventory programs for their areas of jurisdiction.

Arizona's Department of Environmental Quality, similar to the State Mine Inspector, investigates environmental complaints and requires remedial action, where necessary. Adequate financing for a systematic inventory has been a major obstacle. Several funding mechanisms have been put into motion through our combined efforts. The State Mine Inspector has applied for Water Quality Assurance Revolving Fund money to determine the nature and extent of water pollution directly attributable to two old mines. The Department of Environmental Quality administers the special mini-superfund for pollution clean-up. Excellent cooperation and genuine interest has been shown by the department in mine hazard evaluation.

The Arizona State Mine Inspector's volunteer abandoned mine program has reached semi-finalist status for a $100,000 grant from the Ford Foundation. The award is for "Innovations in State and Local Government". Our program utilizes volunteer groups to continue the inventory of old mine hazards.

Arizona's Department of Environmental Quality, with support from the State Mine Inspector, the Bureau of Land Management and the U.S. Forest Service, has applied to the U.S. Environmental Protection Agency for Non Point Source water pollution fund. This allocation will establish adverse water quality impacts associated with past mining activities encompassing two central Arizona watersheds.

Each year the Arizona State Mine Inspector requests a General Fund Appropriation from the Legislature to carry on the inventory of old mines, and each year the request has been denied. This year the State Mine Inspector introduced legislation designed to fund the program through a modest user fee attached to mining claim transactions. The Bill failed under the guise of (no new taxes).

Undaunted, the Inspector continues to prospect for the resources needed to accomplish the statutory requirement to locate, identify and eliminate health and safety hazards associated with abandoned/inactive mines in Arizona.

STATE OF ARIZONA
OFFICE OF STATE MINE INSPECTOR
WILLIAM VANDERWALL, ASSISTANT STATE MINE INSPECTOR
(602) 542-5971

INACTIVE/ABANDONED MINES [1] DATA SUMMARY						COMPILED SPRING 1991	
MINERAL TYPE	MINING TYPE	(Acres)	OWNERSHIP	(Acres)	FEATURES	(units)	(cost) [6]
Metallic Ores	Mines [2]	67,690	Federal [5]	69,450	Polluted Water [4]	200.2 miles	$200.2 mm
	Millsites [7]	4,102	Private [5]	17,362	Mine Dump [3]	33,845 acres	84.613 mm
	Smelters [8]	4	State [5]	4,569	Distributed Land [3]	57,536 acres	172.608 mm
	Other	0	Other	0	Highwalls [3]	0	0
					Mine Openings [2]	67,690	27.076 mm
					Subsidence Prone [3]	0	0
					Hazardous Structures [9]	0	0
					Other [6]	0	145.349 mm
Construction Ores [3]	Mines	7,850	Federal	29,830	Polluted Water	0	0
	Millsites	0	Private	7,456	Mine Dump	3,925 acres	0
	Smelters	0	State	1,963	Distributed Land	35,325 acres	0
	Other	0	Other	0	Highwalls	0	0
					Mine Openings	7,850	0
					Subsidence Prone	0	0
					Hazardous Structures	0	0
					Other	0	0
Industrial Ores	Mines	4,455	Federal	4,571	Polluted Water	0	0
	Millsites	270	Private	1,143	Mine Dump	2,228 acres	$5.57 mm
	Smelters	0	State	301	Distributed Land	3,787 acres	11.361 mm
	Other	0	Other	0	Highwalls	0	0
					Mine Openings	4,455	1.782 mm
					Subsidence Prone	0	0
					Hazardous Structures	0	0
					Other	0	5.614 mm
Phosphate Rock	Mines		Federal		Polluted Water		
	Millsites		Private		Mine Dump		
None	Smelters		State		Distributed Land		
	Other		Other		Highwalls		
					Mine Openings		
					Subsidence Prone		
					Hazardous Structures		
					Other		
Uranium	Mines		Federal		Polluted Water		
Overburden	Millsites		Private		Mine Dump		
None	Smelters		State		Distributed Land		
	Other		Other		Highwalls		
					Mine Openings		
					Subsidence Prone		
					Hazardous Structures		
					Other		

STATE OF ARIZONA
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INACTIVE/ABANDONED MINES DATA SUMMARY Page 2					COMPILED SPRING 1991		
MINERAL TYPE	MINING TYPE (Acres)		OWNERSHIP (ACRES)		FEATURES	(units)	(cost)
Oil Shale	Mines		Federal		Polluted Water		
	Millsites		Private		Mine Dump		
None	Smelters		State		Distributed Land		
	Other		Other		Highwalls		
					Mine Openings		
					Subsidence Prone		
					Hazardous Structures		
					Other		
Other	Mines	5	Federal	5.00	Polluted Water	0	0
(Gemstones)	Millsites	0	Private	1.30	Mine Dump	2.5 acres	$6,250
	Smelters	0	State	0.33	Distributed Land	4.25 acres	12,750
	Other	0	Other	0	Highwalls	0	0
					Mine Openings	5	2,000
					Subsidence Prone	0	0
					Hazardous Structures	0	0
					Other	0	6,300
Total	Mines	80,000	Federal	103,806	Polluted Water	200.2 acres	$200,200,000
	Millsites	4,372	Private	25,962	Mine Dump	40,000 acres	90,189,250
	Smelters	4	State	6,833	Distributed Land	96,652 acres	183,981,750
	Other	0	Other	0	Highwalls	0	0
					Mine Openings	80,000	28,860,000
					Subsidence Prone	0	0
					Hazardous Structures	0	0
					Other	0	150,969,300
					GRAND TOTAL		$654,200,300

- FOOTNOTES EXPLAINING DATA SUMMARY TABLE -

1. An Inactive or Abandoned Mine (IAM) is defined in the narrative summary. Briefly, they include mines and mining related activities which have been terminated or suspended for a period exceeding six months. Sites reported in this summary are not covered by any mining permits, reclamation bonds, reclamation agreements or hazard elimination activities. Sites reported in this summary do not include those which occur on Indian lands.

2. Interestingly, the most reliable data was provided by the Arizona Department of Transportation (ADOT). Perhaps as high as 95% accurate and believable. Operators and owners of construction aggregate deposits list their products with ADOT, hoping to sell them. (ADOT contractors have ready access to this information.) The Arizona Department of Transportation lists 8100 sites and these include clay pits, borrow pits, cinder pits, gypsum pits, diatomote and bentonite pits, rip-rap quarries, decorative stone quarries and the "run of the mill" sand and gravel mines. The Arizona State Mine Inspector's records show an average of 250 of these 8100 sites having operated in any of the past five years. Thus, it is concluded, 7850 IAMs in the category of construction ores exist in Arizona.

   By strict interpretation of the law, mine sites are exempted from county planning and zoning requirements if they occupy five acres or more. Therefore, this figure of five acres was used to calculate the acres of disturbed land. Reclamation efforts are tenuous at best, considering these are inactive mines and even the most remote would start right up if a highway or canal project suddenly surfaced. Also, the Arizona State Mine Inspector requires certain closure practices be observed when an operation shuts down. Accordingly, no reclamation costs are associated with construction ores in the data summary.

   The traditional sources of information concerning other mines were explored, for example, the U.S. Bureau of Mines. The published records of the U.S. Geological Survey and the Arizona Department of Mines and Mineral Resources were also explored. In all cases, information regarding IAMs was found to be very sketchy and of little help in addressing the IAM data summary report.

   For reasonable data, with a 50% confidence level, untraditional sources were employed. The Arizona State Mine Inspector's pilot inventory program has evaluated over 2000 mine sites for potential hazards to public safety and health. Information from that data base regarding number and character of IAMs is used exclusively throughout the data summary sheet.

Reclamation costs are largely judgmental and loosely based on documented costs provided by the states of Colorado, New Mexico and Montana. These states have well documented Abandoned Mines Reclamation Programs. Mine dump and disturbed land acreages were estimated using mathematical factors which relate the total number of IAMs with the number of disturbed acres, the size of mine dumps and the number of related structural hazards. These factors were provided by the states of Montana and Colorado.

3. Disturbed lands include exploration drilling sites, living facility remnants, junk yards, poorly constructed access roads and other land not in conformity with surrounding land. Mine dumps include waste rock dumps, smelter slag piles and mill tailing. Abandoned structures include all fabricated structures, mostly headframes and unsound old buildings not protected as historic sites. Hazardous mine openings are adequately described in the narrative summary. Highwalls and subsidence prone areas were considered negligible and not included in the data summary.

4. Polluted waters were determined by examining the latest Section 305 report from the Arizona Department of Environmental Quality to the U.S. Environmental Protection Agency. The report states 1846.9 miles of watercourses have been adversely impacted by natural resource extraction. It further states 200.2 miles are threatened. For the purpose of the data summary sheet, Montana's estimate of $1,000,000 per mile for highly impacted streams was used for a cost to reclaim 200.2 miles in Arizona. No additional cost was attributed to the remaining miles of low or moderately impacted streams since elimination of the source of pollutants, i.e. disturbed lands, mine dumps and mine openings, would naturally correct the problem in a relatively short time.

5. Ownership was categorized by records generated by the Arizona State Mine Inspector's pilot inventory program. Of the total number found to have safety and health hazards (300), ownership records indicated 76% ultimately belonged to the federal government, 19% to private parties and 5% to the State of Arizona or local governments. These percentages are used for calculating ownership for the data summary.

6. Reclamation cost estimates were arrived at as follows:

* Polluted Water: $1,000,000 per mile of highly impacted waterway based on the State of Montana's estimate.

* Mine Dumps: the State of Colorado's estimate of $2500 per acre for basic, recontouring, amending the soil and reseeding was used in the data summary.

* Disturbed Land: The State of Montana's estimate of $3000 per acre was used since it takes into account clearing refuse from the land as well as basic recontouring, soil augmentation and reseeding.

*Mine Openings and Hazardous Structures: Can be eliminated by fencing, filling in or demolishing for an average cost of $400 each, according to copies of receipts submitted to the Arizona State Mine Inspector as proof of compliance with ARS 27-318.

* Other Costs: include administration, construction oversight and contingency. This cost is estimated at 30% of all other costs.

7. Factors which relate number of mine openings to millsites, disturbed lands and mine dumps were supplied by the states of Colorado and Montana. These factors are as follows:
1 millsite per 16.5 mine openings
1/10 acre of disturbed land at each opening
1/2 acre of mine dump at each opening
3/4 acre of disturbed land around each site

8. Smelters, only the four large inactive smelters in Arizona are listed. Many smaller smelters have existed but are included under mine dumps.

9. Hazardous structures are included under mine openings.

- RESOURCES -

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William Cotee, Mineral Resource Specialist, U.S. Forest Service, Prescott National Forest

Dale Dunning, National Priorities List Section Manager, U.S. Environmental Protection Agency

Denise Gallegos, Abandoned Mines Program Manager, State of New Mexico

Michael Garcia, Material Resource Specialist, Arizona Department of Transportation

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Lawrence Nelson, Area Manager, Mine Safety and Health Administration, U.S. Department of Labor

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David Ridinger, President, Arizona Mining Association

Carol Russell, Program Manager, Non Point Source Water Pollution, Arizona Department of Environmental Quality

The Government Documents Staff at the Arizona State University Library

Stephanie Wilson, Acting Program Manager, Solid Waste, Arizona Department of Environmental Quality

- POLICY OPTIONS -

The Arizona Mining Code requires minimum closure standards be achieved at mines which cease operations. The Code is particularly effective in eliminating dangers to public safety and health involving mine openings, highwalls, unsafe structures, ponds and unsecured process chemicals. Arizona State Water Quality and Air Quality laws ensure environmental protection at operating and recently closed mines and related facilities.

Efforts by the Arizona State Mine Inspector and the Arizona Department of Environmental Quality to apply these requirements to Inactive/Abandoned Mines (IAM) have been stymied by lack of funds. Competition for Federal and State pollution clean up funds is stiff with nearly all going into urban industrial projects. Arizona receives no funds from the Surface Mining Control Act (except on Indian lands) and the Arizona State Legislature has provided only token funding for Arizona's Abandoned/Inactive Mine hazards elimination effort (ARS 27-318).

The Arizona State Mine Inspector is in strong agreement with the spirit and intent of the Surface Mining Control Act, in as much as it puts the onus of hazard elimination on those currently benefiting from the activity. In this case, coal consumers. Extending the authority of the Act to include non-coal mining seems to be a logical eventuality. The bills presently introduced in Congress (Rahall H.R. 918 and Bumpers S. 433) hopefully are not the eventuality since they are anti-productive in the sense of generating IAM reclamation funds. Obviously, eliminating or minimizing the incentive to explore and develop Federal lands for any use (as the Bumpers and Rahall bills do to mining) is shortsighted. Perhaps a better strategy is to tax the end product or better still, tax imported newly mined metals to provide IAM reclamation funds.

IAM clean up is further stymied by current liability laws. Many old mines present attractive targets for re-mining. Such endeavors, however, are often uneconomic due simply to reclamation requirements the new operator may have to undertake for past producers' environmentally unsound practices. One case, in Arizona, particularly demonstrates this paradox. The Hillside Mine in Yavapai County contains substantial quantities of recoverable gold, silver and copper in the huge tailings impoundment at the site. The mine also presents and interesting exploration target for precious and rare minerals as well as a potential source of water for an active mine closeby. The mine presently pollutes the surface water of Boulder Creek, threatens the waters in Burro Creek and may possibly threaten the local aquifer. The creeks drain a Federal Wilderness area. Consequently, industry participation in the clean up of the Hillside Mine is out of the question unless a public-private partnership arrangement can be worked out to indemnify new operators from the claims against those who were there before them.

Federal Wilderness lands are a more complex paradox. For this report, suffice to say those lands are of no use and as such, deserve no attention. Inactive/Abandoned Mines on wilderness lands will pose hazards to no one because no one will be there.

Cooperative efforts involving the U.S. Park Service, the U.S. Bureau of Land Management, the U.S. Forest Service, the U.S. Bureau of Reclamation, the Arizona State Land Department, the Arizona Department of Environmental Quality, and the Arizona State Mine Inspector have cast out an overlapping net of regulations which require absolutely strict compliance with Arizona's Safety, Health and Environmental laws. Even the smallest fish cannot escape compliance. Any additional laws, rules and regulations are viewed as wilderness lands.

Still, the public outcry for a stable and secure environment, free of all safety and health hazards, continues to be heard by the Arizona State Mine Inspector. An appropriate funding source for an inventory of the true nature and extent of Inactive/Abandoned Mine hazards will have to be established, as will a clean up source.

CALIFORNIA

STATE OF CALIFORNIA

PETE WILSON, Governor

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MAR 1 8 1991

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Dear Mr. Juntunen:

INACTIVE AND ABANDONED MINE LANDS PROJECT - TASK IIIb, INACTIVE AND ABANDONED MINE INVENTORY

This is the final report for Task IIIb, the Inactive and Abandoned Mine Lands Inventory Project. In this report we present an abbreviated history of mining in California, a description of mining reclamation under the 1975 Surface Mining and Reclamation Act (SMARA), a description of the database used for the inventory, and an inventory of inactive and abandoned mines in California.

CALIFORNIA MINING HISTORY

California has produced and continues to produce a variety of mineral commodities; consequently, describing the State's complete mining history would not be practical. Therefore, we have limited our description to the history of California's production of gold, mercury, copper, industrial minerals, and construction materials. The mining of these commodities were, and in the case of construction materials, continue to be the dominant mining activities. Additionally, many of the environmental and health threats attributed to mining in California resulted from the mining of the foregoing commodities. The following description of California's mining history has been paraphrased from the more complete histories published in the California Division of Mines and Geology Bulletin 191 "Mineral Resources of California" and Bulletin 193 "Gold Districts of California".

Gold Mining

Although gold was mined to a limited extent in the late 18th and early 19th century by the early Spanish and Mexican settlers, gold mining in earnest did not begin until after John Marshall's discovery of gold at Sutters Mill in 1848. Gold production peaked at 81 million dollars in 1852 but declined with the exhaustion of the rich surface placers. Hydraulic mines became the largest producers until curtailed by court order in 1884. Thereafter, lode mines and dredges were the principal sources with gold production nearly reaching historic gold rush levels during the depression (1931 to 1941). During World War II, gold production fell as gold mines closed pursuant to War Production Board Limitation Order L-208. After this order was rescinded in 1945, several large lode mines reopened and gold production rose. However, rising costs caused a general decline in mining until by 1968 all sustained mining operations had been shut down. Gold mining between 1968 and the late 1970s was limited to small-scale, seasonal operations. Since 1979, gold mining in California has experienced a resurgence because of the development of heap leach technology by the United States Bureau of Mines.

Old abandoned/inactive underground gold mines present a substantial but, unfortunately, undefined safety hazard. There has not been a systematic, statewide effort to seal old adits, shafts, portals, inclines, air vents, and caved stopes. Consequently, as old gold mining areas are subjected to development or increased recreational use, these relics of bygone days may become very real safety hazards. Abandoned/inactive gold mines also threaten water quality with unacceptable metals loading, changes in pH (usually from acid mine drainage), and contamination by ore processing compounds and cyanide.

Mercury Mining

California, although not a significant producer now, was the source of most of the mercury produced in the United States. The history of mercury mining in California is prehistoric; its primary ore, cinnibar, was used by indians for ceremonial paints. The two largest deposits, New Almaden and New Idria, were discovered just prior to and after Marshall's gold discovery. The New Almaden deposit began producing mercury in 1846 with New Idria following in 1853. Both these mines produced mercury until 1972. The mercury from these mines played an important part in gold refining process used in California's gold mines.

The extensive underground workings of abandoned/inactive mercury mines present a substantial safety hazard. Additionally, these mines also present a potential health threat from elevated mercury levels in soils, old mine dumps, and retorted mine waste. These mines also threaten water quality with metals loading and adverse changes in pH from acid mine drainage.

Copper

Copper mining of massive sulfides became important in California between 1862 and 1881 along the 250 mile-long Foothills Copper Belt and persisted intermittently until about 1960. Massive sulfides of the East and West Shasta districts were also exploited for copper starting in 1894. Since World War II, however, these mines have not been significant producers.

Copper mines in these districts and their associated dumps and waste piles present serious threats to water quality primarily from acid mine drainage and metals loading. Attempts to remediate the environmental damage caused by both the Iron Mountain Mine and the Penn Mine have been largely unsuccessful. The extensive underground workings of these mines also present a substantial safety hazard.

Industrial Minerals

Two large borate deposits, the Searles Lake and the Kramer deposit, have made California a world leader in borate production. Early borate production was typified by small borate producing operations that were widespread in California and included operations in Death Valley, Saline Valley, Los Angeles County and the margins of Searles Lake.

Many of these historic operations left unreclaimed dumps which may present a threat to water quality through the introduction of boron into surface and/or groundwater.

Construction Materials

California's rapid economic and population growth has been paralleled by the growth of the sand and gravel industry. The annual value of sand and gravel produced in California outstrips the value of all other mineral commodities and California has lead the nation in sand and gravel production since 1942. Developmental trends of this industry will probably continue to follow California's economic and population growth patterns.

The State Water Resources Control Board (State Board) and Regional Water Quality Control Boards (Regional Boards) regulate sand and gravel mines to protect surface waters from degradation from siltation and increased turbidity.

MINE RECLAMATION

In California mine reclamation is administered locally by cities and counties under SMARA (there are about 110 local entities). Under SMARA mine operators must submit a reclamation plan to the appropriate local entity for approval prior to beginning operation. The California Division of Mines and Geology (CDMG), historically, has provided technical assistance to the local entities when these plans are being reviewed prior to approval. Recently, CDMG was given authority to enforce provisions of approved reclamation plans in cases where the local entity was judged not to be enforcing the conditions of the plan.

The Regional Boards also play a role in mine reclamation because Waste Discharge Requirements (WDRs) for mines under Chapter 15, Division 3, Title 23 of the California Code of Regulations must incorporate relevant portions of a mine reclamation plan approved under SMARA. As a result, there is usually some effort made among the Regional Boards and other agencies to ensure that WDRs and reclamation plans for individual mines are consistent.

INACTIVE AND ABANDONED MINE INVENTORY DATA BASE

As the Inactive and Abandoned Mine Inventory Project proceeded, it became apparent that the principal data source would be the California Water Resources Control Board Basin Planning Study -- Principal Areas of Mine Pollution (completed in 1972). The listing includes all mines known to have exceeded $100,000 in value and those lesser mines which may have a high potential to pollute water resources. The listing was produced from over fifty CDMG publications; United States Geological Survey professional papers; and correspondence files from CDMG, Regional Boards, and United States Forest Service. Information provided included individual mine name, location, commodities produced, mine type, ownership, operation status, and observed or suspected adverse water quality effects. After checking the database references and after cross checking the database with other local mine inventories, we only needed to add 35 underground mines from the Central Valley Regional Board's abandoned mine inventory. Based on our compilation, there are at least 2484 inactive and abandoned mines in California.

The accuracy of data within the database is variable. For example, the location of underground mines is highly accurate because underground mining activities were well documented and underground mining had largely been discontinued at the time the study was completed. On the other had, data on aggregate mining is less accurate because aggregate mining has expanded rapidly since 1972. As a result, many aggregate operations have been opened, worked out, and closed since our primary database was completed in 1972.

TERMS

As previously stated, the principal database only included information about the type, location, adverse water quality effects, and product(s) produced by each individual mine. Consequently, we could provide information for only a limited number of categories used on the sample inactive and abandoned mines data sheets you provided.

For the purposes of our response:

1. The term "other" with respect to mine ownership means that the ownership of the mine is unknown. The ownership of most abandoned, underground metal mines in California apparently is unknown.

2. The term "polluted water" encompasses recorded actions taken against mines by the Regional Boards or other agencies; measurements and/or observations of discharges from mines by staff of various agencies; and observations of conditions at mines that, in the judgement of the observer, could adversely affect water quality.

3. The term "underground openings" included all mines listed as underground mines (counted as one mine opening). Assigning one opening to each underground listing, however, probably results in a low estimate because many underground mines have more than one opening. Additionally, there has been no systematic, statewide effort to close mine openings, some mine openings have been left to cave in naturally, some have been closed privately through the efforts of developers, and others some have been closed within State Parks by the State Department of Parks and Recreation.

MAR 1 8 1991

INACTIVE AND ABANDONED MINE INVENTORY FORMAT

Our statewide inventory indicates that there are at least 2484 inactive and abandoned mines in California. Mining activities within the state, however, were concentrated in different areas. Consequently, in order to illustrate where the greatest concentrations of inactive and abandoned mines are, we reported the numbers of inactive and abandoned mines within each of the nine Regional Board jurisdictional areas. A map illustrating the area administered by each Regional Board is included with each Regional Board data summary sheet.

This completes our inactive and abandoned mine inventory. If your have any questions, please telephone Rick Humphreys at (916) 739-4254.

Sincerely,

James Cornelius

for Harry M. Schueller, Chief
Division of Clean Water Programs

Enclosure

NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

State Wide Summary

DATA SUMMARY[2,3]							
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	1928	Federal	5	Highwalls[8]		(cost)[16]
	Millsites	36	Private	282	Mine Openings[9]	1642	
	Smelters		State	5	Disturbed Land[10]		
	Other[5]		Other[6]	1636	Polluted Water[11]	513	
					Mine Dumps[12]	142	
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	351	Federal		Highwalls		
	Millsites		Private	182	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	169	Polluted Water	45	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	195	Federal	4	Highwalls		
	Millsites		Private	62	Mine Openings	43	
	Smelters		State	1	Disturbed Land		
	Other		Other	128	Polluted Water	20	
					Mine Dumps	29	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines	10	Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State	1	Disturbed Land		
	Other		Other	9	Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	2484	Federal	9	Highwalls		
	Millsites	36	Private	582	Mine Openings	1685	
	Smelters		State	7	Disturbed Land		
	Other		Other	1942	Polluted Water	(miles) 578	
					Mine Dumps	171	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

Region One, North Coast

DATA SUMMARY[2,3]

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	158	Federal		Highwalls[8]		(cost)[16]
	Millsites	4	Private	126	Mine Openings[9]	109	
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]	32	Polluted Water[11]	42	
					Mine Dumps[12]	4	
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	47	Federal		Highwalls		
	Millsites		Private	42	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	5	Polluted Water	9	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	1	Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	1	Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	206	Federal		Highwalls		
	Millsites	4	Private	168	Mine Openings	109	
	Smelters		State		Disturbed Land		
	Other		Other	38	Polluted Water	51	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

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Oakland, CA 94607
(415) 464-1255

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(805) 549-3147

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(619) 346-7491

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(714) 782-4130

SAN DIEGO REGION (9)

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San Diego, CA 92124
(619) 265-5114

NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

Region Two, San Francisco Bay

DATA SUMMARY[2,3]							
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	37	Federal		Highwalls[8]		(cost)[16]
	Millsites		Private	15	Mine Openings[9]	31	
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]	22	Polluted Water[11]	25	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	65	Federal		Highwalls		
	Millsites		Private	45	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	20	Polluted Water	1	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	14	Federal		Highwalls		
	Millsites		Private	7	Mine Openings		
	Smelters		State	1	Disturbed Land		
	Other		Other	6	Polluted Water		
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	116	Federal		Highwalls		
	Millsites		Private	67	Mine Openings	31	
	Smelters		State	1	Disturbed Land		
	Other		Other	48	Polluted Water	26	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

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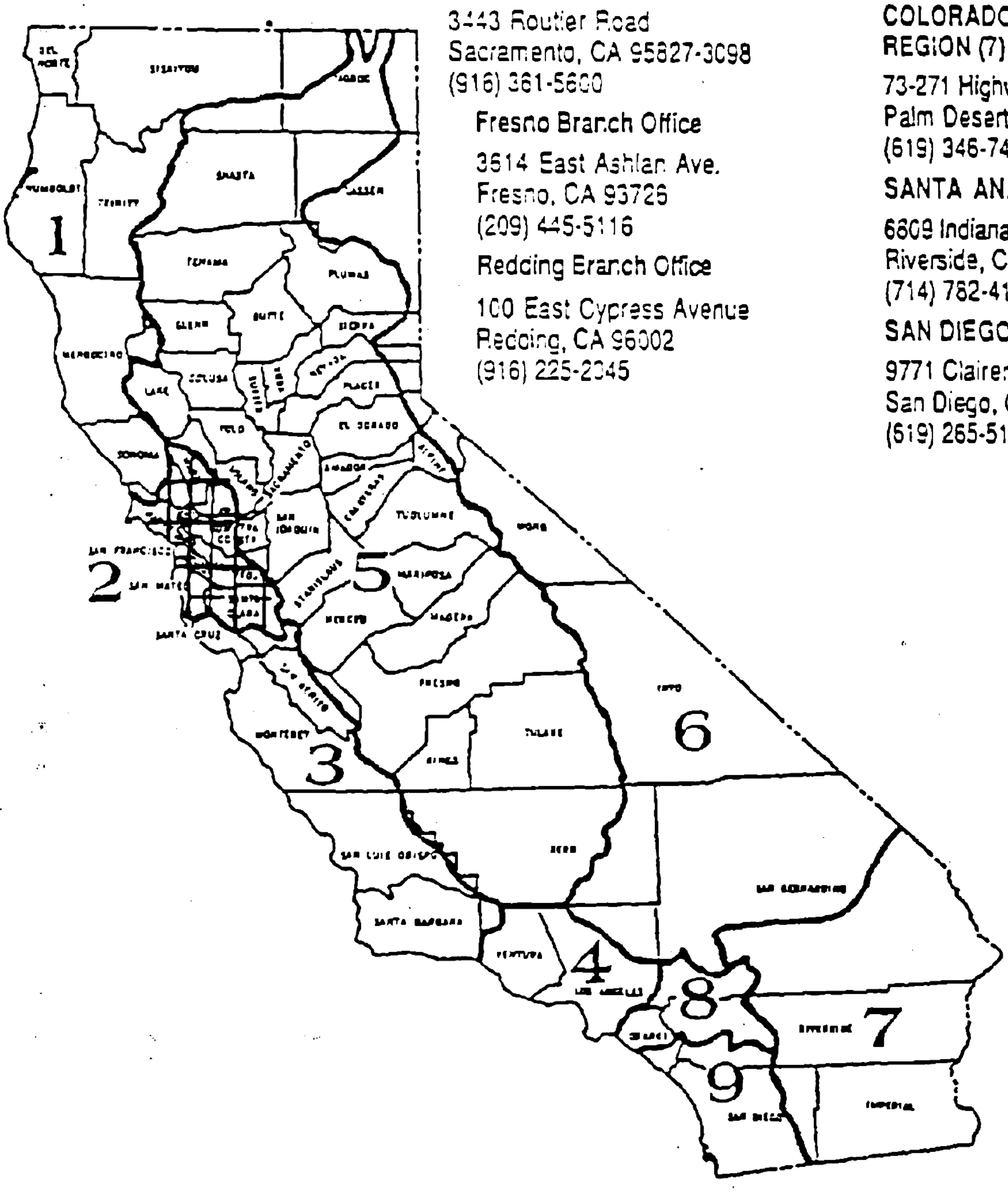

NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

Region Three, Central Coast

DATA SUMMARY[2,3]							
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	35	Federal		Highwalls[8]		(cost)[16]
	Millsites		Private	4	Mine Openings[9]	35	
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]	31	Polluted Water[11]	31	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	32	Federal		Highwalls		
	Millsites		Private	1	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	31	Polluted Water	1	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	5	Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	5	Polluted Water		
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2							
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	72	Federal		Highwalls		
	Millsites		Private	5	Mine Openings	35	
	Smelters		State		Disturbed Land		
	Other		Other	67	Polluted Water	31	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

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NON-COAL INVENTORY of INACTIVE/ABANDONED MINES

State of California

Règion Four, Los Angeles

DATA SUMMARY[2,3]							
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	16	Federal		Highwalls[8]		(cost)[16]
	Millsites		Private	10	Mine Openings[9]	15	
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]	6	Polluted Water[11]	9	
					Mine Dumps[12]	10	
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	26	Federal		Highwalls		
	Millsites		Private	26	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	4	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	10	Federal		Highwalls		
	Millsites		Private	6	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	4	Polluted Water	4	
					Mine Dumps	3	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water		
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	52	Federal		Highwalls		
	Millsites		Private	42	Mine Openings	15	
	Smelters		State		Disturbed Land		
	Other		Other	10	Polluted Water	17	
					Mine Dumps	13	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

STATE WATER RESOURCES CONTROL BOARD
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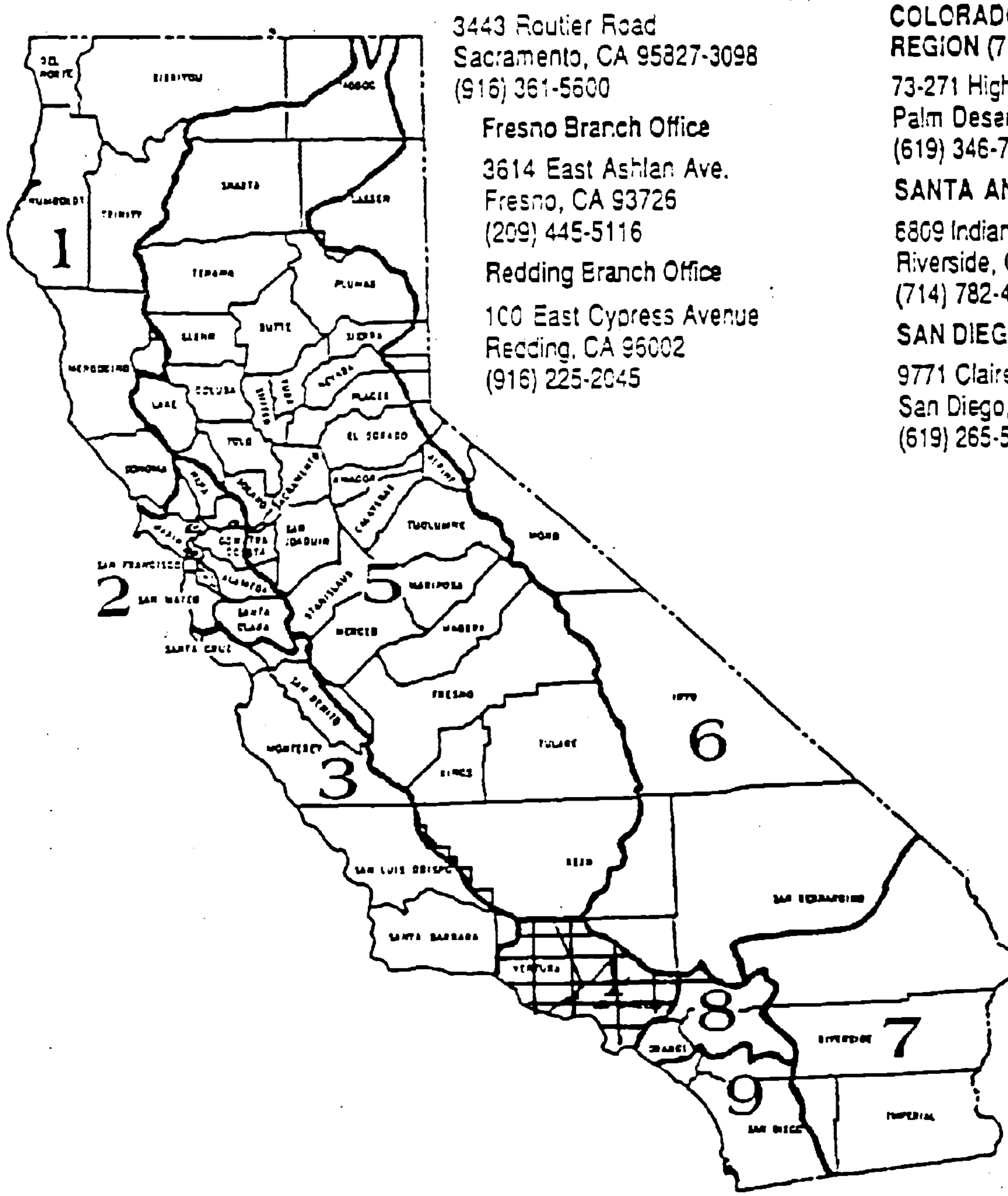

NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

Region Five, Central Valley

DATA SUMMARY[2,3]

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	1289	Federal		Highwalls[8]		(cost)[16]
	Millsites	2	Private	37	Mine Openings[9]	1278	
	Smelters		State	2	Disturbed Land[10]		
	Other[5]		Other[6]	1250	Polluted Water[11]	187	
					Mine Dumps[12]	40	
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	128	Federal		Highwalls		
	Millsites		Private	45	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	83	Polluted Water	17	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	70	Federal		Highwalls		
	Millsites		Private	8	Mine Openings	2	
	Smelters		State		Disturbed Land		
	Other		Other	62	Polluted Water	7	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines	6	Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	6	Polluted Water		
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	1493	Federal		Highwalls		
	Millsites		Private	90	Mine Openings	1080	
	Smelters		State	2	Disturbed Land		
	Other		Other	1401	Polluted Water	194	
					Mine Dumps	40	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

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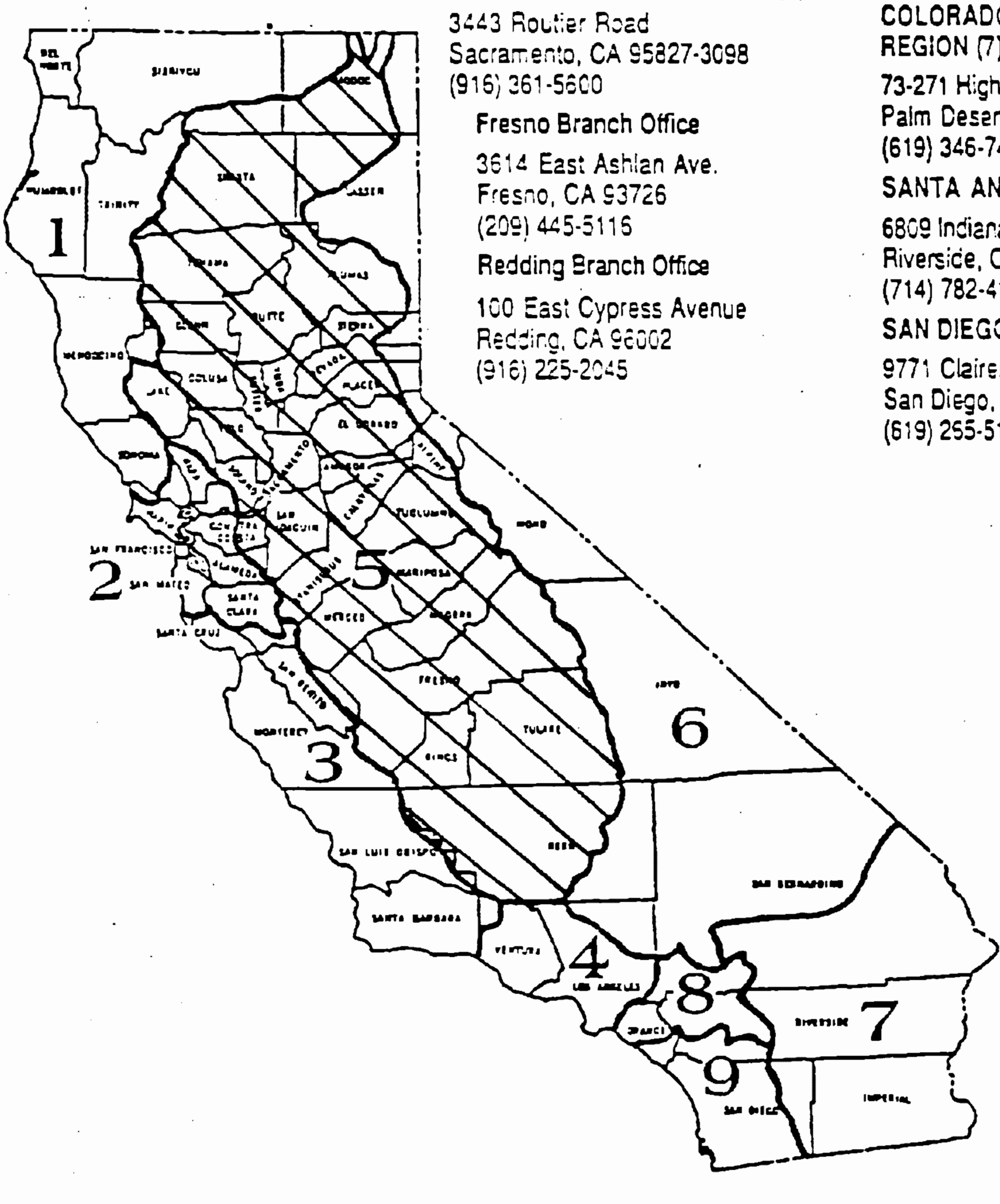

NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

Region Six, Lahontan

DATA SUMMARY[2,3]

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	271	Federal	4	Highwalls[8]		(cost)[16]
	Millsites		Private	8	Mine Openings[9]	259	
	Smelters		State	2	Disturbed Land[10]		
	Other[5]		Other[6]	257	Polluted Water[11]	160	
					Mine Dumps[12]	6	
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	35	Federal		Highwalls		
	Millsites		Private	12	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	23	Polluted Water		
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	58	Federal	4	Highwalls		
	Millsites		Private	6	Mine Openings	25	
	Smelters		State		Disturbed Land		
	Other		Other	48	Polluted Water	7	
					Mine Dumps	1	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines	2	Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	2	Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	366	Federal	8	Highwalls		
	Millsites		Private	26	Mine Openings	284	
	Smelters		State	2	Disturbed Land		
	Other		Other	330	Polluted Water	167	
					Mine Dumps	7	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

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NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

Region Seven, Palm Desert

DATA SUMMARY[2,3]							
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	105	Federal	1	Highwalls[8]		(cost)[16]
	Millsites	27	Private	68	Mine Openings[9]	99	
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]	36	Polluted Water[11]	51	
					Mine Dumps[12]	74	
				—	Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	10	Federal		Highwalls		
	Millsites		Private	5	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	5	Polluted Water	3	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	14	Federal		Highwalls		
	Millsites		Private	14	Mine Openings	2	
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps	10	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water		
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines	1	Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State	1	Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	130	Federal	1	Highwalls		
	Millsites	27	Private	87	Mine Openings	101	
	Smelters		State	1	Disturbed Land		
	Other		Other	41	Polluted Water	54	
					Mine Dumps	74	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

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NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

Region Eight, Santa Ana

DATA SUMMARY[2,3]

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	9	Federal		Highwalls[8]		(cost)[16]
	Millsites	1	Private	7	Mine Openings[9]	8	
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]	2	Polluted Water[11]	2	
					Mine Dumps[12]	2	
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	7	Federal		Highwalls		
	Millsites		Private	5	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other	2	Polluted Water	10	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines	13	Federal		Highwalls		
	Millsites		Private	12	Mine Openings	5	
	Smelters		State		Disturbed Land		
	Other		Other	1	Polluted Water	2	
					Mine Dumps	6	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	29	Federal		Highwalls		
	Millsites	1	Private	24	Mine Openings	13	
	Smelters		State		Disturbed Land		
	Other		Other	5	Polluted Water	14	
					Mine Dumps	8	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

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NON-COAL INVENTORY of INACTIVE/ABANDONED MINES[1]

State of California

Region Nine, San Diego

DATA SUMMARY[2,3]							
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Metallic Ores	Mines	8	Federal		Highwalls[8]		(cost)[16]
	Millsites	2	Private	7	Mine Openings[9]	8	
	Smelters		State	1	Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	6	
					Mine Dumps[12]	6	
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	1	Federal		Highwalls		
	Millsites		Private	1	Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water		
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores (+ Gems)	Mines	10	Federal		Highwalls		
	Millsites		Private	9	Mine Openings	9	
	Smelters		State		Disturbed Land		
	Other		Other	1	Polluted Water		
					Mine Dumps	9	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
SUBTOTAL	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(acres)	(cost)
Phosphate Rock	Mines		Federal		Highwalls[8]		(cost)[16]
	Millsites		Private		Mine Openings[9]		
	Smelters		State		Disturbed Land[10]		
	Other[5]		Other[6]		Polluted Water[11]	(miles)	
					Mine Dumps[12]		
					Subsidence Prone[13]		
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Highwalls		
	Millsites		Private		Mine Openings		
	Smelters		State		Disturbed Land		
	Other		Other		Polluted Water	(miles)	
					Mine Dumps		
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other		
TOTAL	Mines	19	Federal		Highwalls		
	Millsites	2	Private	16	Mine Openings	14	
	Smelters		State		Disturbed Land		
	Other		Other	1	Polluted Water	6	
					Mine Dumps	15	
					Subsidence Prone		
					Hazardous Structures	(number)	
					Other	(units)	

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COLORADO

Inactive/Abandoned Mine Lands Project

State of Colorado

Western Governors Association

Introduction

The purpose of this report is to assemble existing information regarding inactive/abandoned mine lands (IAMS) in Colorado. These IAM sites are specifically non-coal mine sites which ceased production prior to 1977 and where the current owner/operator has no continuing reclamation responsibility. Definitions of terms used in the study are presented in the Appendix.

The State of Colorado has an existing inventory of both coal and non-coal IAM sites. The inventory is detailed in "Their Silent Profile -- Inactive Coal and Metal Mines of Colorado". The study was completed in 1980 and formed the basis for implementation of the Colorado AML program under the Surface Mining Control and Reclamation Act (SMCRA). Since 1986 the Colorado Inactive Mine Reclamation Program (CIMRP) has safeguarded about 1,865 hazardous non-coal mine openings in various parts of the State.

The existing IAM inventory was reconnaissance in nature, and is regarded as conservative. More detailed field work related to active construction and reclamation projects of IAM sites confirms the conservative stance of the original inventory. As detailed field work proceeds in preparation of construction, additional openings are often discovered and incorporated into reclamation. As a result of field experience of reclamation specialists, it is estimated that 20,229 IAM sites remain in Colorado.

Narrative Summary

This narrative summary is, in part, abstracted from "Their Silent Profile", the 1982 plan outlining the coal and non-coal inactive mine problem in Colorado. A copy of "Their Silent Profile" is attached since it is a significant resource detailing relevant historical and mine-related information. Also attached is a copy of the data recording form used in the 1980 inventory. Many of the openings mentioned within the text have since been reclaimed as part of the Colorado AML program.

Metal Mine Opening Hazards

Overview

Approximately 7,300 metal mines were evaluated during the inventory; these mines accounted for 5,747 acres of disturbed land in Colorado. One of the most serious problems associated with mineral mines is open or inadequately sealed shafts. Since old mining districts are of particular interest to people visiting the state and access to many mining areas is relatively easy, these shafts pose a definite hazard. Four hundred ninety-seven shafts were rated as extremely hazardous, and 1,363 rated as dangerous during the statewide survey.

Stopes, like open shafts, are hazardous because they are often deep and unstable around the edges. They are somewhat more dangerous because there often are no structures or dumps to announce their presence. Stope complexes often radiate great distances away from the mine entry. They are created as mining proceeds underground and the ore body is removed from above and dropped into ore carts in the tunnel. Sometimes, stopes extend upward so near the ground surface that they collapse into the underground workings. Eighty-nine stopes were rated as extremely hazardous and 178 rated as dangerous.

Adits pose a less immediate threat to visitors than shafts, although some adits with winzes (vertical shafts) just inside, are common in certain metal mining districts. Thirty-five of these adits, where winzes pose more of a threat to the explorer, were considered extremely hazardous and 1,355 other adits were rated dangerous. Adits (horizontal mine openings) are much more inviting to the casual explorer than vertical shafts since shafts cannot be entered in most cases without special equipment.

Metal Mine Drainage

Overview

The degradation of water quality so often associated with metal mining operations would not become manifest if the metal-sulfide minerals were allowed to remain in the reducing environments under which they were formed. Problems arise only when these minerals become oxidized as when they are transported to the earth's surface. The oxidation of pyrite (FeS_2), commonly associated with metal ore and coal deposits, is the primary mechanism by which acid is released to mine drainage waters.

Metal sulfides are, of course, present in abandoned metal-mine adits but they are also present in mine dumps and mill tailings areas. Tailings and mine dumps areas can contribute acidity and metals to water flowing through them. Storm events and spring snow-melt will cause large amounts of runoff through tailings and mine dumps, oxidizing the exposed pyrite that it contacts. Often, tailings were placed behind cribbing or made into dams which held mining process water. This water is commonly very acidic and metalliferous and can make its way to receiving streams by way of seeps or dam failures.

The concerns with the various pollutants associated with past mining activities mainly stem from their potential for rendering waters of the state unfit for their customary and beneficial uses. The primary concern is the detrimental effect of acidity and heavy metals on life itself. These effects may make a stream or aquifer unfit for use as a domestic water supply, an aquatic life habitat, or an agricultural water source.

During the inventory, over 170 adits were found to be discharging acid mine drainage. These were considered environmental problems. These data include the results of water quality analyses. Detailed studies of four acid mine drainage problem areas were done apart from the inventory project. The four study areas were Clear Creek (Argo Tunnel Segment), North Fork of Clear Creek (Central City, Blackhawk), California Gulch (Yak Tunnel) and the upper Howards Fork of the San Miguel River. The studies were done to identify the major sources of mine related stream contamination in the selected watersheds and to develop control strategy alternatives. The complete studies are available through the Mined Land Reclamation Division.

Mine Dumps and Tailings

Overview

Surface rock dumps, mine waste piles, and tailings piles associated with underground mines are vulnerable to erosion and thus can contribute significantly to sediment loading and siltation problems. The waste dumps, tailings, and overburden piles from both surface and underground mining are particularly vulnerable to erosion when they are located in or adjacent to waterways and because their fine-grained texture limits their ability to support vegetation. Sediment problems from mining in Colorado have resulted from unstable tailings ponds and waste piles, causing failure (landslides) and consequent deposition of sediments in valleys and stream channels. Repeated failures of some tailings ponds and waste piles along waterways have occurred in each of the major mining districts in Colorado., The most dramatic failures in recent memory were the Jim Dandy Mill tailings along Fourmile Creek near Boulder, the Sunnyside Mine tailings on the Animas River along Silverton, the Rico Argentine tailings along the Dolores River at Rico, the catastrophic tailings wash out into Henson Creek above Lake City and a dramatic blowout at the Argo Tunnel near Idaho Springs in the early 1980's.

Hydrology of Fills

Most failures of fills occur when foundational drainage is channelled over the fill. Failure of the Argo Tunnel fill resulted from saturation when the effluent of the tunnel overflowed the banks of the channel. Massive erosion and circular failure of the slopes followed. The overflow was great enough to wash away massive amounts of material as the slopes failed, setting up conditions for subsequent failures.

Hazard Potential of Fills

Hazard potential is defined as the damage which would be done to man made structures if the fill failed catastrophically. Environmental hazard is considered in a separate section. Few of the fills evaluated constituted a hazard potential. Notable exceptions were fills located in the gold fields. The Couer D'Alene in Central City posed a possible threat to buildinga and parking facilities. The Mary McKinney of Crippla Creek poses a definite threat to a state highway. Either could result in loss of life if the fill failed catastrophically during heavy traffic. Many hillside dumps are located near talus slopes which indicate a steady weathering of bedrock, yet few signs of major failures such as landslides, slope failures, or massive settling are found at target sites. Few of the old fills have evidence of original engineer design. Most were merely dumped at the nearest convenient location. Notable exceptions are the log cribbing and Cornish stone walls built to retain the fills in some old mining districts. The performance of such structures has been adequate. The life expectancy for timber cribbing is lower than the rock walls. The timbers at the Mary McKinley and at the Argo Tunnel show signs of rot and cannot be expected to last any significant period. The original life expectancy of most fills was as long as the mine operated. The fills were not designed, but built and expanded as necessary. Minor failures were repaired by adding fill until the failure stabilized itself. Once the mine closed, fill stability was no longer of interest.

Environmental Impacts of Fills

The greatest impacts of dumps and tailings piles in Colorado are on the environment and not for the public health and safety. Of the 5,054 fills encountered during the inventory, 95 were rated environmental problems. The hydrology of the fill has impact on water quality primarily through sediment contributions through erosion. Percolation of water through fills often adversely affects the nearby surface water quality by the introduction of chemicals leached from the fill.

The most common environmental impacts are related to lack of vegetation on fills. Along with lack of vegetation are surface erosion contributing to sediments in waterways and fugitive dust from exposed soil. The impacts could be minimized through surface seedbed preparation and revegetation programs.

Current Reclamation and Legislative Arena

Title IV of SMCRA provides for the collection of a reclamation fee on coal production. One half of the fee is available to states for reclamation of IAM sites. The State of Colorado has worked on safeguarding the most hazardous non-coal IAM sites since 1986. Colorado has safeguarded an average of about 450 IAM sites per year. The monies available to Colorado for IAM safeguarding efforts may halve in 1992 and the funding source is scheduled to end in 1995.

The most significant safeguarding efforts are located in and around highly touristed areas. A recently approved referenda enabled three historic mining towns, Central City, Black Hawk and Cripple Creek, to initiate low stakes gambling. Tremendous increases in tourism are expected, and with it increased exposure of the incautious to hazardous IAM sites. Education efforts sponsored by CIMRP are underway to teach Colorado K-12 students about IAM hazards. However, these education efforts are unlikely to benefit Colorado visitors and tourists. The only solution is the installation of physical barriers through safeguarding efforts.

The CIMRP is currently the only agency directly involved in safeguarding efforts. The Colorado Department of Health and the Federal EPA reclamation focus is more towards the contribution of selected IAM sites to environmental degradation and its mitigation.

Direct and Indirect Effects of IAM Sites in Colorado

Unrestricted and unregulated mining in Colorado since the mid-1800's until the mid-1970's left a legacy of hazards and pollution sources. Mine openings not only present a physical hazard, but allow oxygenation of mineral suites which in turn produce acids contaminating water sources. While these are the direct effects of past mining there also exist significant, and not easily quantifiable, indirect effects.

The indirect effects of past mining include complete disturbance of pre-mining ecotonal relationships. For example, broad regions surrounding mining camps were stripped of trees to provide timbers for mines and fuel for boilers and home heating. Mine waste dumps and resulting contaminated runoff may prevent regeneration of succeeding plant growth. Acidic runoff reduces the availability of drinking water by raising treatment costs.

The most critical direct effect of IAM sites is the presentation of physical danger. The unwary too often suffer mortally for close inspection of IAM sites. The following table presents known injuries and fatalities at Colorado IAM sites since the mid-1950's.

Deaths and Injuries at IAM sites in Colorado

Compiled from Colorado Division of Mines and Colorado Mined Land Reclamation Division files as well as search and rescue volunteer organizations

Fatalities

September 15, 1955	Two men entered an old mine by digging through to the tunnel from above. The mine atmosphere contained bad air (no oxygen). Both men were found dead approximately 6,200 feet from the portal 3 days later.
August 1, 1958	A 17 year old boy, who was exploring a mine, fell 120 feet to his death when the ladder gave way.
February 12, 1961	A 17 year old youth was shot by another target practicing youth who discharged his gun into the adit where the youth, father and friend were collecting ore samples.
May 24, 1965	Two boys entered a mine. One fell 320 feet to his death.
September 15, 1968	A Fort Carson Soldier, who was exploring a mine, was overcome by gases and fell 90 feet to his death. The mine was the Dolly Varden in Cripple Creek. It was sealed by the CIMRP in 1987.
April 5, 1970	On an outing with friends, an individual fell to his death in a snow covered shaft at the Glory Hole in Gilpin County.
October 1, 1977	A 45 year old Lakewood man was killed when he fell into the Glory Hole Mine near Central City in Gilpin County.
April 27, 1986	A 24 year old Colorado Springs man was killed after falling down a 900 foot mine shaft at the Mary McKinney Mine near Cripple Creek.
December 7, 1986	An 11 year old boy died when he fell into a mine shaft while skiing out of bounds on Aspen Mountain.
June 19, 1987	Two 21 year old men were test driving a new 4-wheel drive vehicle in Gilpin County. One of the men was in the vehicle when it went into the Empress Mine shaft, fell, and became lodged 35 feet down the shaft. The vehicle had to be removed in order to continue rescue efforts. The man's body was eventually found 350 feet below the surface.

March 24, 1989	A 2 year old boy slipped into an open mine shaft and fell 200 feet to his death. The shaft was located just behind his family home in Central City.
August 1989	A man vacationing in Colorado was exploring at the Skyline Clay Mine stope complex in the hogback just west of Canon City in Fremont county. While climbing inside the mine, an 800 pound rock pulled away from the wall and pressed against his chest. He died of suffocation.
August 13, 1989	Three people aged 15, 16 and 17, entered the previously safeguarded Bookcliffs Mine in Mesa County and were in 300 feet from the entrance when they encountered a lethal concentration of CO_2 and died. The 1/2" x 2" lockbox hasp on the 1/4 inch thick steel door had been vandalized a few weeks to a few months earlier.

<u>Injuries</u>

October 7, 1957	An airman who was trapped while exploring a mine, was rescued in good condition after being trapped 8 1/2 hours.
May 14, 1961	A man walked into an inactive mine and stepped into a winze. He suffered a broken neck, broken right ankle, and internal injuries becoming a quadriplegic.
November 10, 1962	Two airmen were exploring a mine when one fell 170 feet suffering serious injury.
August 6, 1967	A 19 year old boy was walking around at night and fell 40 feet into a shaft. He held on to a rock to avoid falling an additional 600 feet. One of the rescuers suffered from shock.
September 28, 1971	A 27 year old man went down a mine shaft to rescue a dog. He was injured by falling rock 30 feet below the surface.
May 19, 1974	A 17 year old Aurora youth was seriously injured when a motorcycle accident hurtled him 200 feet down the shaft of the Glory Hole Mine.
1975?	A BLM employee was injured in a room collapse (subsidence) in a uranium mine.
August 7, 1975	A man fell 70 feet down a mine shaft and suffered pulled muscles, a broken wrist, a broken shoulder blade and a gash on the head.
August 26, 1983	A 16 year old Denver boy was injured when he fell 84 feet down a mine shaft near Central City.

October 27, 1985	A 28 year old man drove his motorcycle into a 40 foot deep mine shaft just west of Central City in Gilpin County and suffered severe leg injuries.
June 19, 1986	A 17 year old Durango youth was seriously injured when he fell while exploring the Weaver Mine, 18 miles north of his home. He was rescued after a frantic effort by 100 volunteers.
August 24, 1986	Three drunk men broke into the Alps Hill Mine in Gilpin County, climbed down the shaft on a wooden ladder which broke. One man fell a short distance, had a lung punctured and was able to climb out. Another man, who had an estimated blood alcohol level of .3 fell 40 feet, suffered severe bruises, a collapsed lung and was rescued 9 hours later.
1988	A Texas Gulf geologist broke a leg in the Chicago Adit in Cripple Creek.
March 1988?	A man fell 120 feet down a winze in the Poorman Mine in Boulder County. Exact injuries are unknown.
May 1989	A 7 year old boy and his father were looking down the Cashier Mine Shaft in Gilpin County when the boy slipped and fell in to a timber and snow bridge located approximately 35 feet from the surface. The father went for help and the child was rescued suffering minor bruises.

1955 - 1990 Summary

County	Injuries	Fatalities
Gilpin	9	6
Clear Creek	3	2
Boulder	2	
La Plata	1	
Teller	1	2
Lake		1
Pitkin		1
Fremont		1
Huerfano	1	
Gunnison	2	
Mesa	1	3
San Miguel	1	
Total	21	16

Data Summary

The Data Summary section uses data from the Colorado 1980 inventory modified by the experience of CIMRP personnel. The original unmodified data set is presented as Table 1. Although reconnaissance in nature, confidence in these data is high, approaching 100 percent. However, field checking over the past decade has shown the inventory to be conservative, or too low.

Review of newly available archives in the Colorado Division of Mines indicates that 17 additional Colorado counties had IAM activity than shown by the 1980 inventory. Detailed field work by CIMRP personnel has also indicated a significantly higher number of IAM sites in areas investigated. IAM site estimates presented in Table 2 reflect a subjective change from the 1980 inventory which is shown in the column labelled "Field Personnel Estimate". Sites safeguarded by CIMRP are subtracted from the total yielding the numbers presented in the column labelled "Hazardous Openings Remaining".

The accuracy of the original inventory is high within its scope. However, the current estimate may be in error by as much as plus or minus 10 percent. Similarly, the 1987 water quality study which showed IAM impact on 1,300 stream miles is accurate and verifiable, however, not all stream miles were evaluated.

Analysis of the 1980 inventory indicates a ratio of mine openings to waste dumps and acres disturbed as 60:35:40, respectively. Applying this ratio to IAM sites yields an estimated IAM waste dump area of 11,800 acres and disturbed area of 13,486 acres. These estimates are subject to the same errors as the IAM estimate.

Data presented in Table 2 is repeated in Table 3 which is the requested format. Colorado did not break out commodity information above four categories in the 1980 inventory for presentation in Table 3. However, Table 4 is a summary of mine openings by commodity type. The data in Table 4 was derived from by apportioning mine openings by commodity using staff experience and knowledge of geologic conditions. It is probable that a great deal of error is inherent in this type of analysis, perhaps as much as plus or minus 30 percent. The vast majority of sites however relate to metallic ores with over 17,000 openings. The next highest IAM incidence is related to uranium mines with over 1,800.

Mills and Smelters

Data sources for the numbers of mills and smelters are disaggregated and fraught with potential errors. Independent reports by the U. S. Geological Survey, Colorado Division of Mines and U. S. Bureau of Mines are the best sources. Such reports are at best snapshots of the population of mills and smelters at one moment. Many mills existed for a short time and went out of business and/or were torn down. Similarly, reliable reports early in the history of a district may indicate a number of mills or smelters working, however, at a later time a name change may show a 'new' facility when in fact only the ownership changed. In many geological and mining reports, emphasis was on geology or mining methods and scant mention made of processing plants operating at the time of the report.

TABLE 1 -- STATE OF COLORADO IAMS Assessment Of Non-Coal Mine Features

Data abstracted from "Inactive Mines of Colorado" 1982

County	Shafts	Adits/ Portals	Pits/ Stopes	Waste Dumps	Acres Disturbed
ADAMS					
ALAMOSA					
ARAPAHOE					
ARCHULETA					
BACA					
BENT					
BOULDER	490	575	387	571	557
CHAFFEE	37	63	10	66	147
CHEYENNE					
CLEAR CREEK	279	550	74	631	250
CONEJOS	3	1		2	3
COSTILLA					
CROWLEY					
CUSTER	332	49	209	505	184
DELTA					
DENVER					
DOLORES	20	54	1	41	54
DOUGLAS	2	4	24	5	36
EAGLE	8	76		45	47
EL PASO		3	6	3	3
ELBERT					
FREMONT	5	14	26	9	74
GARFIELD		11		3	13
GILPIN	703	137	18	546	250
GRAND					
GUNNISON	52	74	3	72	161
HINSDALE	3	23	4	63	95
HUERFANO					
JACKSON	20	5	3	12	36
JEFFERSON	10	39	45	24	150
KIOWA					
KIT CARSON					
LA PLATA	3	29		27	42
LAKE	266	141	5	267	333
LARIMER	43	47	105	54	
LAS ANIMAS					
LINCOLN					
LOGAN					
MESA	2	25	5	31	64
MINERAL	10	44	1	61	64
MOFFAT		5	6	4	202
MONTEZUMA					
MONTROSE	25	38	2	230	140
MORGAN					
OTERO					
OURAY	43	95	5	57	200
PARK	46	41	100	65	200
PHILLIPS					
PITKIN	324	280		57	12
PROWERS					
PUEBLO					
RIO BLANCO					
RIO GRANDE	3	5	11	8	10
ROUTT	3	25	10	7	35
SAGUACHE	102	117	206	149	615
SAN JUAN	38	352	15	319	400
SAN MIGUEL	11	228	4	156	170
SEDGEWICK					
SUMMIT	99	292	11	290	275
TELLER	518	79	52	502	682
WASHINGTON					
WELD					
YUMA					
TOTAL	3,538	3,764	1,354	5,076	5,664

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TABLE 2 -- STATE OF COLORADO AML Assessment of Abandoned Mine Features
Data abstracted from Inactive Mines of Colorado, 1982 and Field Personnel Records

County	Shafts	Adits/ Portals	Pits/ Stopes	1982 Inventory Openings	Field Personnel Estimate	Reclaimed By CMRP	Hazardous Openings Remaining
ADAMS				0	5		5
ALAMOSA				0	1		1
ARAPAHOE				0	5		5
ARCHULETA				0	5		5
BACA				0	2		2
BENT				0	2		2
BOULDER	490	505	387	1,382	3,600	513	3,087
CHAFFEE	37	63	10	110	150	43	107
CHEYENNE				0	5		5
CLEAR CREEK	279	550	74	903	3,000	215	2,785
CONEJOS	3	1		4	35	25	10
COSTILLA				0	10		10
CROWLEY				0	2		2
CUSTER	332	49	209	590	1,800	246	1,554
DELTA				0	3		3
DENVER				0	0		0
DOLORES	20	84	1	105	210	3	207
DOUGLAS	2	4	24	30	40	3	37
EAGLE	8	76		84	100		100
EL PASO		3	5	8	15	1	14
ELBERT				0	0		0
FREMONT	6	14	26	46	50	12	38
GARFIELD		11		11	15		15
GILPIN	703	137	18	858	5,000	276	4,724
GRAND				0	0		0
GUNNISON	52	74	3	129	200	7	193
HINSDALE	3	23	4	30	50		50
HUERFANO				0	0		0
JACKSON	20	5	3	28	35	6	29
JEFFERSON	10	39	45	94	100	19	81
KIOWA				0	0		0
KIT CARSON				0	0		0
LA PLATA	3	29		32	50		50
LAKE	266	161	5	432	550	54	496
LARIMER	43	47	105	195	250	1	249
LAS ANIMAS				0	2		2
LINCOLN				0	0		0
LOGAN				0	0		0
MESA	3	25	5	33	150	5	145
MINERAL	10	44	1	55	200		200
MOFFAT		5	5	10	15	4	11
MONTEZUMA				0	10	3	7
MONTROSE	25	287	8	320	1,280	40	1,240
MORGAN				0	0		0
OTERO				0	0		0
OURAY	43	95	5	143	350	50	300
PARK	46	41	100	187	250	69	181
PHILLIPS				0	0		0
PITKIN	324	280		604	750	5	745
PROWERS				0	0		0
PUEBLO				0	10		10
RIO BLANCO				0	10		10
RIO GRANDE	3	8	11	22	30	1	29
ROUTT	9	25	10	44	44	5	39
SAGUACHE	102	117	206	425	800	36	764
SAN JUAN	39	352	15	406	500	26	474
SAN MIGUEL	11	228	4	243	700	8	692
SEDGWICK				0	0		0
SUMMIT	99	292	11	402	600	31	569
TELLER	518	79	52	649	1,100	158	942
WASHINGTON				0	0		0
WELD				0	0		0
YUMA				0	0		0
TOTAL	3,538	3,764	1,354	8,656	22,094	1,865	20,229

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TABLE 4 -- STATE OF COLORADO IAM Site Commodity Breakdown by County

Data abstracted from Inactive Mines of Colorado, 1982 and Field Personnel Records

County	Metal	Construction Materials	Industrial Materials	Uranium	Oil Shale	Other	Total
ADAMS			5				[illegible]
ALAMOSA	1						[illegible]
ARAPAHOE		3	3				[illegible]
ARCHULETA	5						[illegible]
BACA		1	1				[illegible]
BENT		1	1				[illegible]
BOULDER	2,778	154	154				[illegible]
CHAFFEE	96	5	5				[illegible]
CHEYENNE		3	3				[illegible]
CLEAR CREEK	2,729		56				[illegible]
CONEJOS	8	3					[illegible]
COSTILLA	8	3					[illegible]
CROWLEY		1	1				[illegible]
CUSTER	1,523		31				[illegible]
DELTA	3						3
DENVER							
DOLORES	203	2	2				207
DOUGLAS	30	4	4				[illegible]
EAGLE	75	20	5				[illegible]
EL PASO	8	3	3				[illegible]
ELBERT							
FREMONT	29	2	8				[illegible]
GARFIELD	11	1	2	2			[illegible]
GILPIN	4,677	24	24				4,724
GRAND	3						3
GUNNISON	154	19	19				[illegible]
HINSDALE	40	5	5				50
HUERFANO							
JACKSON	23	3	3				[illegible]
JEFFERSON	65	8	8				[illegible]
KIOWA							
KIT CARSON							
LA PLATA	40	5	5				50
LAKE	486	5	5				[illegible]
LARIMER	199	25	25				[illegible]
LAS ANIMAS	2			[illegible]			[illegible]
LINCOLN							
LOGAN							
MESA		15	15	116			[illegible]
MINERAL	190	4	6				[illegible]
MOFFAT	6				6		[illegible]
MONTEZUMA	4			4			[illegible]
MONTROSE	12	50		1,178			1,240
MORGAN							
OTERO							
OURAY	270	15	15				300
PARK	163	9	9				181
PHILLIPS							
PITKIN	671	37	37				745
PROWERS							
PUEBLO	9			1			[illegible]
RIO BLANCO	9				[illegible]		[illegible]
RIO GRANDE	23	3	3				[illegible]
ROUTT	31	4	4				[illegible]
SAGUACHE	726	8	31				[illegible]
SAN JUAN	427	24	24				[illegible]
SAN MIGUEL	69	35	35	554			[illegible]
SEDGEWICK							
SUMMIT	512	28	28				569
TELLER	848	47	47				[illegible]
WASHINGTON							
WELD							
YUMA							
TOTAL	17,164	575	629	1,854	7		20,229

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TABLE 4

TABLE 3 -- NON-COAL INVENTORY -- IAMS
STATE OF COLORADO

COLORADO MINED LAND RECLAMATION DIVISION
Inactive Mine Program
Program Supervisor: Dave Bucknam
Telephone: (303) 866-3567

DATA SUMMARY

Mineral Type	Mining Type	(Acres)	Ownership	(Acres)	Features	(Units)	(Cost)
Metallic Ores	Mines		Federal		Polluted Water (Mi)		
	Millsites		Private		Mine Dumps (Ac)		
	Smelters		State		Disturbed Land (Ac)		
	Other		Other		Highwalls (Mi)		
					Mine Openings		
					Subsidence Prone (Ac)		
					Hazardous Structures		
					Other		
Construction Ores	Mines		Federal		Polluted Water (Mi)		
	Millsites		Private		Mine Dumps (Ac)		
	Smelters		State		Disturbed Land (Ac)		
	Other		Other		Highwalls (Mi)		
					Mine Openings		
					Subsidence Prone (Ac)		
					Hazardous Structures		
					Other		
Industrial Ores	Mines		Federal		Polluted Water (Mi)		
	Millsites		Private		Mine Dumps (Ac)		
	Smelters		State		Disturbed Land (Ac)		
	Other		Other		Highwalls (Mi)		
					Mine Openings		
					Subsidence Prone (Ac)		
					Hazardous Structures		
					Other		

DATA SUMMARY – PAGE 2

Mineral Type	Mining Type		Ownership		Features	Units	Cost
Phosphate Rock	Mines		Federal		Polluted Water (Mi)		
	Millsites		Private		Mine Dumps (Ac)		
	Smelters		State		Disturbed Land (Ac)		
	Other		Other		Highwalls (Mi)		
					Mine Openings		
					Subsidence Prone (Ac)		
					Hazardous Structures		
					Other		
Uranium Overburden	Mines		Federal		Polluted Water (Mi)		
	Millsites		Private		Mine Dumps (Ac)		
	Smelters		State		Disturbed Land (Ac)		
	Other		Other		Highwalls (Mi)		
					Mine Openings		
					Subsidence Prone (Ac)		
					Hazardous Structures		
					Other		
Oil Shale	Mines		Federal		Polluted Water (Mi)		
	Millsites		Private		Mine Dumps (Ac)		
	Smelters		State		Disturbed Land (Ac)		
	Other		Other		Highwalls (Mi)		
					Mine Openings		
					Subsidence Prone (Ac)		
					Hazardous Structures		
					Other		
					Other		
Other	Mines		Federal		Polluted Water (Mi)		
	Millsites		Private		Mine Dumps (Ac)		
	Smelters		State		Disturbed Land (Ac)		
	Other		Other		Highwalls (Mi)		
					Mine Openings		
					Subsidence Prone (Ac)		
					Hazardous Structures		
					Other		
TOTAL	Mines	0	Federal	0	Polluted Water (Mi)	1,298	72,947,600
	Millsites	615	Private	0	Mine Dumps (Ac)	11,800	29,500,625
	Smelters	32	State	0	Disturbed Land (Ac)	13,486	33,715,000
	Other	0	Other	0	Highwalls (Mi)	0	0
					Mine Openings	20,229	108,225,150
					Subsidence Prone (Ac)	0	0
					Hazardous Structures	1,125	140,000
					Other		0
							244,528,375

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The numbers of physical plants depend greatly on the time of construction and the available transportation network. In the early development of mining districts in remote areas, construction of mills and smelters on or near the mining site made economic sense. As the transportation network filled in and improved with time, it typically would be possible to ship ore to a centralized location out of the district, with fewer processing plants in the district.

In Boulder County, for example, there were 94 mills and 5 smelters in the various mining districts since discovery in the mid-1800's. A U. S. Geological Survey Professional Paper about Gilpin County reports 60 operating mills in that county in 1860 alone. Most records regarding mine processing facilities are anecdotal in nature and disseminated throughout technical reports in an unstructured manner.

One method of estimating mill and smelter sites is based on the relationship of openings to known processing sites. Boulder County is well documented in terms of absolute numbers of mills and smelter sites. Extrapolating from the 2,778 metal mine openings in Boulder County, per Table 4, to the documented 94 mills and 5 smelters, according to Cobb in "Prospecting Our Past", 1988, in that county to the statewide figure of 17,164 metal mine openings yields values of 580 mills and 31 smelters statewide. Clearly, such a simple extrapolation is subject to great error. As a counter check of the number of mill sites in Colorado the Bureau of Land Management reports that there are 1,178 patented mill sites in the State of Colorado.

Although not all mill sites were run, and some may have been mined through in later years this is balanced against processing plants which may have been in other locations. In addition, processing facilities of non-metal IAM mineral goods were not addressed in this simple analysis. Given all countering data and the better statewide perspective of BLM records the number of 1,178 mills is used in this report. For lack of better data on smelters the number of smelters is set at five percent of the number of mills, or 59 smelters statewide.

Hazardous Structures

According to the 1980 inventory there were 482 structures associated with IAM sites. Using a simple proportion with the estimated IAM mine sites presented in this paper there are 1,125 mine-related structures in Colorado. It is the position of the CIMRP that structures associated with IAM sites are not the essential safety hazard at an IAM site. In most cases it is found that stabilization of a mine opening in turn stabilizes nearby structures. This is true of headframes and out-buildings situated within the erosion cone of a shaft.

CIMRP funds are rarely expended to safeguard structures. Removal of historic structures is regarded as a last resort and is generally considered only when the safety of the construction crew may be jeopardized or where the condition of the structure is such that its long-term survival is low. Given this philosophical approach it is estimated that removal may be an option for one in twenty structures. The experienced cost of demolition or stabilization of such a structure is about $2,500, therefore the remediation cost would be about $140,000.

Highwalls

There currently exist no reliable information on the length of highwalls associated with IAM mine sites. Therefore, no data are presented. There are quarries and unreclaimed surface mined IAM sites which do contain highwall hazards.

Re.erence Guide

Colorado Department of Natural Resources

Mined Land Reclamation Division

The Colorado Mined Land Reclamation Division (CMLRD) consists of three programs; Coal Regulatory, Minerals Regulatory and the Inactive Mine Reclamation Program (CIMRP).

The Minerals Group of CMLRD maintains a database of over 4,000 mines active since promulgation of reclamation laws in 1973. However, most of these mines are responsible to Colorado reclamation laws and would not be eligible for inclusion in an IAM site assessment. Only 47 mines ceased operation prior to 1977 and the reclamation needs, if any, of these sites was not examined for purposes of this report.

The CIMRP completed an inventory of coal and non-coal IAM sites in 1980. The inventory documented about 8,600 non-coal mine hazards and related environmental impacts of IAM sites. Metal mines constitute the bulk of the hazards in the inventory. The non-coal commodity breakout was restricted to metal, uranium and industrial. Sand and gravel operations were not included in the inventory

A computer database was developed to catalog the mine sites and a corresponding set of USGS topographic maps key into mine site ID numbers. Information to initiate the survey was derived from the U. S. Geological Survey, U. S. Bureau of Mines, Colorado Division of Mines, Colorado Geological Survey, and the Colorado School of Mines. Geological and mining publications were evaluated prior to the field work. The data obtained includes, but is not restricted to, size, location and number of hazardous openings, area of tails and waste dumps, presence of structures and proximity to roads and receiving streams. A copy of a sample field form is presented in the Appendix. Water problems relating to IAM sites were noted and included pH, conductance and flow estimates.

In 1987 a more detailed assessment of water quality problems relating to IAM sites was made and includes a wider range of chemical analyses. A copy of the data record form used in this study is attached. Preceding this field effort the existing water quality databases of the National Uranium Resource Evaluation (NURE), the U. S. Geological Survey STORET and CIMRP databases were evaluated. Several hundred additional water quality samples were taken and entered into dBase, a computer database. Estimates of water quality problems made in this report reflect results of the 1987 study.

Continuing reclamation and construction projects in the Colorado mining districts led field researchers to re-evaluate the inventory numbers as more detailed work led to discoveries of greater numbers of hazardous openings. Site specific aerial photos, interviews with 'old-timers' and more detailed field work form the basis for updating inventory information.

- Camille Meyer
- Peter Rushworth
- Paul Krabacher
- Jim Herron
- Bob Kirkham
- Barb Chiappone (Minerals)
- Dan Hernandez (Minerals)

Colorado Division of Mines

The Colorado Division of Mines (DOM) has, in one form or another, been in existence since the late 1800's. Therefore, many IAM sites were inspected by the State while these mines were operating. DOM records are disaggregated, however, due to incorporation of DOM functions with other legislative or regulatory bodies at various times, and incorporation of file information with those of the various regulatory bodies. A report from the 1960's indicated approximately 35,000 mining claims have been patented in the State.

- Joe Nugent

Colorado Geological Survey

The Colorado Geological Survey (CGS) continues to update mineral resource information for the State. A copy of the U. S. Geological Survey's Mineral Resource Data System is available at CGS. Previous geologic research efforts have catalogued both the scope and location of mineral occurrences as well as updates of pertinent bibliographic material.

- Bruce Stover
- Randall Streufert

State Land Board

The Colorado State Land Board controls and monitors State lands for the benefit of the State. Although the State Land Board does not have a separate inventory of IAM sites it is possible to research past extraction activities through royalty payments to the State. This information is not computerized. However, there is impetus to place State Land information on a Geographic Information System (GIS) in the future.

- Mark Davis

Colorado Department of Health

The Colorado Department of Health consists of several divisions. Pertinent to IAM site assessments are the Water Quality Control Division and the Hazardous Materials & Waste Management Division. There are nine Uranium Mill Tailings projects ongoing in the State. Additional information regarding uranium mining problems may be available in EPA study 520/1-83 007 published in 1983 which summarized locations of uranium mines by county and state.

- Jeff Deckler and Candy Thompson (Hazardous Materials Division)
- Dave Holm and Greg Parsons (Water Quality Control Division)
- Ken Weaver, (Radiation Control)

U. S. Environmental Protection Agency

The Environmental Protection Agency (EPA) has the responsibility to investigate areas of imminent and significant endangerment to human health and the environment as a result of actual or potential exposure to hazardous substances, contaminants and pollutants. There are five Superfund sites at Colorado IAM sites. These sites, California Gulch, Smuggler, Clear Creek/Central City, Eagle and Idarado, were included in the inventory count, but not in the associated costing.

- Bruce Gander
- Rob Walline
- Orville Kiehn

National Park Service

National Park Service is conducting an inventory of their properties and are requesting funds to reclaim and safeguard these IAM sites. The number of such sites in Colorado is less than 75, and it is possible that some of these sites are double counted. However, this potential error is reflected in the error range associated with the total number of IAM sites in Colorado.

- Robert Higgins

Bureau of Land Management

The Bureau of Land Management (BLM) maintains records of claimant information regarding mining properties. Their records include information on thousands of patented and unpatented mining claims in Colorado. About 35,000 patented lode mining claims exist in Colorado. There were 21,458 patents issued for lode mining claims, with many patents describing more than one claim. Patents issued for placers total 1,877. Placer mining claims include both gulch placers that follow the course of streams and lands patented by legal subdivisions of the rectangular survey system. This latter category includes land patents of oil shale placer mining claims. These oil shale claims are usually association placers of 160 acres. Many of these mining claims are commonly included in one patent. There are a total of 1,178 millsites that have been patented. Currently, BLM records show 85,555 unpatented mining claims, about 55,000 of which are being kept active through annual assessment work. Approximately 47,000 of these are lode claims, 6,500 are placers, 60 are tunnel sites, and 1,260 are millsites.

- Lonnie Kent

CIMRP Experienced Costs -- IAMS Reclamation and Safeguarding

The cost estimates are derived from historically experienced costs of IAM site reclamation by CIMRP since 1986. Since work on non-coal mine closures began, construction funds totalling about $6.74 million were expended on IAM sites out of a total construction grant allocation of $10.26 million. Therefore, about 66 percent of CIMRP SMCRA funding for AML reclamation since 1986 has gone to non-coal IAM sites. Personnel direct and indirect cost for 1991 are projected at $820,000. Total construction and administrative costs since 1986 for IAM sites are approximately $9.98 million. Spread over total of 1,865 mine closures the cost per closure is about $5,350. Allocating each years' personnel cost to reclamation costs per year would result in a lower number, however, current construction, administrative and overhead charges are more indicative of the current costs.

The current construction grant seeks to close 262 openings for an estimated cost of $573,800 or a direct construction cost of about $2,200 per opening. The allocated administrative and overhead cost to IAM sites is $323,000. Spreading this cost over 262 openings yields a figure of $1,220. Therefore the current cost of reclaiming an IAM opening is about $3,420, on average.

The discrepancy between the long-term average cost of $5,350 and the current cost of $3,420 is a result of improved and simpler closure techniques netting lower costs. In addition both CIMRP and a suite of successful low bidders have risen higher on the learning curve. CIMRP purchases many commodities in bulk to reduce costs such as seed and concrete panels. Computer programs expedite the flow of field data to bid documents and contractors regularly improve their methods of operation.

Lower costs emanate from increased efficiency and a larger experience base. These benefits accrue to any 'going concern' in industry or government. Should CIMRP work be disrupted and organizational momentum lost then the experience must be relearned and higher costs will result. Therefore, the cost per closure used for an IAM site is $5,350 per opening. This figure is used despite certain cost savings from efficiency to counterbalance the probable effect of inflation.

The total cost is approximately $108 million to reclaim the 20,229 IAM sites in Colorado.

The following table shows costs currently experienced by CIMRP:

Item	Cost $	Units
ADIT, BACKFILL	1250	EA
ADIT, BLAST - FRONT RANGE	3200	EA
ADIT, BLAST - WEST SLOPE	1500	EA
ADIT, BULKHEAD, GOOD ACCESS	2200	EA
ADIT, BULKHEAD, POOR ACCESS	4000	EA
ADIT, CULVERT WITH GRATE, GOOD ACCESS	2300	EA
ADIT, CULVERT WITH GRATE, POOR ACCESS	2300	EA
ADIT, GRATED DOOR	1200	EA
BRASS CAP INSTALLATION	120	EA
BRASS SURVEY MARKERS	7	EA
BULKHEAD SEAL	2200	EA
CAST-IN-PLACE CAP	17	SF
CULVERT, ASPHALT COATED, 18 IN., NO SEEP	29	LF
CULVERT--48 INCH DIAMETER	30	LF
FENCING, 5 STRAND BARBED WIRE, GOOD ACCESS	3.75	LF
FENCING, 5 STRAND BARBED WIRE, POOR ACCESS	4.50	LF
FENCING, CHAIN LINK, 6 FOOT, GOOD ACCESS	12	LF
FENCING, CHAIN LINK, 6 FOOT, POOR ACCESS	28.41	LF
GROUTED ROCK RIPRAP	43	CY
HOLLOW CORE SHAFT CLOSURE, NO STRUCTURE, GOOD ACCESS	4500	EA
HOLLOW CORE SHAFT CLOSURE, NO STRUCTURE, POOR ACCESS	6500	EA
HOLLOW CORE SHAFT CLOSURE, WITH STRUCTURE, GOOD ACCESS	7800	EA
HOLLOW CORE SHAFT CLOSURE, WITH STRUCTURE, POOR ACCESS	11500	SF
MONOLITHIC PLUG	150	CY
PANEL, A-1 (5 X 10) GRATE, GOOD ACCESS	803	EA
PANEL, A-1 (5 X 10) GRATE, POOR ACCESS	882	EA
PANEL, A-1 (5 X 10), GOOD ACCESS	623	EA
PANEL, A-1 (5 X 10), POOR ACCESS	702	EA
PANEL, A-1 HALF (5 X 5), GOOD ACCESS	510	EA
PANEL, A-1 HALF (5 X 5), POOR ACCESS	589	EA
PANEL, B-1 (6 X 12) GRATE, GOOD ACCESS	906	EA
PANEL, B-1 (6 X 12) GRATE, POOR ACCESS	985	EA
PANEL, B-1 (6 X 12), POOR ACCESS	803	EA
PANEL, B-1 (6 x 12), GOOD ACCESS	724	EA
PANEL, B-1 HALF (6 X 6), GOOD ACCESS	576	EA
POLYURETHANE	235	CY
RIPRAP	18	CY
SEEDING	1000	AC
SHAFT, BACKFILL (OVER 1,000 CUBIC YARDS)	5	CY
SHAFT, BACKFILL, GOOD ACCESS	18	CY
SHAFT, BACKFILL, POOR ACCESS	26.32	CY
SHAFT, GRATE	33	SF

Costs of Water Pollution Reclamation

High impact pollution areas are assumed to contain multiple sources; a 'moderate' impact pollution area contains two to three sources; and a "low" impact area contains one source of pollution. On this basis and based upon an average of $25,000 for cleanup of one source per mile of stream the following estimates are derived:

Pollution Type	Estimate Cost Per Mile	Cost with Overhead Per Mile
Low Impact	$25,000	$29,500
Moderate Impact	$26,000 - $75,000	$30,680 - $ 88,500
High Impact	$76,000 - $100,000+	$89,680 - $118,000

Cost estimates for reclamation of IAM sites impacting the stream system requires greater study than possible in this report. However, a crude estimate will be possible by assuming a normal distribution, and using mid-point cost estimates of IAM reclamation derived from CIMRP experience. The costs per mile have been allocated an administrative and overhead allowance of 18 percent. This percentage of overhead assumes some economies result from concurrently running an IAM mine closure program.

Stream Impact (million)	Affected Stream Miles	Mid-Point Cost	Total
Low	543	$ 29,500	$16.01
Moderate	485	$ 59,590	$28.90
High	270	$103,840	$28.03
Total			$72.94

The total cost is approximately $73 million to reclaim the 1,298 stream miles in the 1987 report or about $56,200 per mile.

Definitions

Disturbed Lands - Lands adversely affected by past, unregulated mining. The disturbance may include poorly or non-vegetated areas, oversteep, unstable slopes of piled material, excessive wind or water erosion, unreclaimed borrow areas and staging areas.

Hazardous Structures - buildings, foundations, ore processing facilities and headframes related to non-coal mining.

Highwalls - Vertical cuts greater than 10 feet in height created due to mining or quarrying operations.

Inactive/Abandoned Mines (IAM) - Mine site operated before and ceased prior to 1973. A property where there is no continuing reclamation responsibility by the owner or claimant/lessee. Sites reported in the tables may be on permitted mining properties, but the current mine operators are not under obligation to reclaim pre-law disturbances.

Mine Dumps - Waste rock from mining, reject material from processing, pre-law heap leaches, slag and tails. It would be preferable to segregate slag and tailing materials to reflect the different genetic origin. However, for this preliminary data survey no attempt to split out this data was made.

Mine Openings - Openings allowing access into IAM workings. Reference in text is made to shafts, stopes and adits. Please see respective definition, in this section below.

Adits - Openings allowing pedestrian or vehicular access at the horizontal or inclined. Winzes, which develop vertical connection with another mine level, often exist within adits, or portals.

Shaft - Vertical mine opening greater than six feet in depth. Great variation in excavated dimension. Depth and erodibility of the shaft opening varies with district geologic conditions. Typical mine shaft is greater than 300 feet in depth.

Stope - Vertical to nearly vertical mine opening typically 1 1/2 feet to 5 feet in width. The stope is a linear feature following vein trends and may extend to great depths.

Polluted Water - Any water impacted by past mining which contains constituents (primarily heavy metals) in excess of aquatic life or drinking water standards.

Subsidence Prone Areas - Areas overlying near-surface mine workings.

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FLORIDA

Task III B

INACTIVE AND ABANDONED MINED LANDS STUDY For Florida

Submitted to the Western Governor's Association

TABLE OF CONTENTS

PART I - GENERAL IAM LANDS INFORMATION

PART II - NONMANDATORY (IAM) PHOSPHATE LANDS RECLAMATION PROGRAM IN FLORIDA

INACTIVE AND ABANDONED MINE (IAM) LANDS STUDY FOR FLORIDA

Part I - General IAM Lands Information

(PART I - GENERAL IAM LANDS INFORMATION)

1.0 INTRODUCTION

The State of Florida has no law which compels a land owner or former mine operator to reclaim lands disturbed by mining prior to the implementation mandatory reclamation laws. For phosphate, fuller's earth and other clays, and heavy minerals, mandatory reclamation laws took effect in 1975. For all other resources, mandatory reclamation laws become effective in 1986.

Florida has no metal mines and all extraction is done by surface mining. Phosphate mining, which disturbs approximately 5,000 acres of land annually is the preeminent mining activity and was initiated in the late nineteenth century. Limestone and dolomite mining account for the disturbance of approximately 300 acres annually as does sand and gravel mining. It is estimated that heavy minerals mining disturbs 400 acres annually while clay mining accounts for 100 acres. The following are estimates of acreage mined prior to the implementation of mandatory reclamation laws.

Phosphate	-	149,000	acres
Limestone	-	30,000	"
Sand and Gravel	-	10,000	"
Clays	-	3,000	"
Heavy Minerals	-	9,000	"

2.0 ELIGIBILITY

This report considers eligible for analysis, those inactive/abandoned mined (IAM) lands for which there is no state or federal requirement that the landowner or former mine operator reclaim the land, and which the State considers may warrant state or federal intervention to remove serious environmental, health and safety impacts. The absence of underground mining and acid mine waters in Florida significantly reduce the adverse impacts of IAM lands. As a result only phosphate IAM lands were considered eligible even though inventories of nonmandatory acreage of other resources were compiled.

3.0 MINING AND BENEFICIATION

3.1 PHOSPHATE

Phosphate mining involves the removal of a layer of overburden; spoiling the removed overburden in a previously mined out area; extraction of the ore; slurrying of the ore; and finally pumping the slurried ore to the beneficiation plant. Occasionally the ore is loaded into dump trucks and hauled to the beneficiation plant. Typically overburden removal and ore extraction are accomplished by large walking draglines (in the 45 to 65 cubic yard range). Ore slurrying is done by high pressure hydraulic monitors. One mining company uses dredging for overburden removal and ore extraction.

Phosphate mining by dragline results in a series of spoil piles and water-filled pits because the water table is relatively close to the surface.

The beneficiation of phosphate ore involves washing, classification by screens, cyclones, gravity, and flotation. The waste products from beneficiation are sand tailings and phosphatic clays. Sand tailings are usually pumped back into mine cuts. Phosphatic clays are pumped into settling ponds, which are later de-watered and reclaimed. Settling ponds, to a great extent, are constructed in areas which have already been mined. Industry-wide, beneficiation results in the generation of approximately equal tonnages of phosphate product, sand tailings and phosphate clays.

3.2 LIMESTONE

Limestone mining involves overburden removal, drilling, blasting, ore excavation, and haulage. Typical equipment includes scrapers or draglines for overburden removal, draglines or front-end loaders for ore extraction and large dump trucks for haulage. In areas where the water table is close to the surface, mining results in a water-filled pit. This circumstance is prevalent in the southern portion of the state. Where dry mining occurs, the results are pits strewn, to varying degrees, with boulders and islands of unmined low grade rock. In both wet and dry mining, the pit walls are usually close to being vertical.

Beneficiation in limestone mining involves crushing, screening, some settling by gravity and cycloning. The tailings from beneficiation, a mixture of sand silt and clay, are returned to the water-filled mined out pits in the case of wet mines. For dry mines, the tailings are stored in dammed above-grade storage ponds.

3.3 SAND MINING

Sand mining is accomplished by dredging where the water table is sufficiently close to the surface. Mining results in a water-filled pit. Where dry mining occurs, front end loaders are the primary excavation tool. Beneficiation in sand mines involves screening and cycloning. The slopes in sand mine pits are usually left at the angle of repose of the material. Where a steeper slope is left, sloughing occurs until a stable surface is attained.

3.4 HEAVY MINERALS

The heavy minerals mined in Florida include rutile, zircon, leucoxene, ilmenite and monazite. Dredging is used to excavate the ore and beneficiation is done by screens, Humphrey's spirals, cyclones, vibrating tables, and electrostatic and magnetic separators. Approximately 3% of the mined ore ends up as product. The remaining 97% is returned to the mined out area where approximate original contours are restored.

3.5 CLAYS

Fuller's earth, kaolin and common clays mined in Florida. Stripping is done primarily by draglines and scrapers and extraction is accomplished by draglines or front end loaders. Beneficiation consists of screening, settling by gravity, cycloning and very little waste (usually sand-sized) is produced.

4.0 HEALTH AND SAFETY IMPACTS

The most significant safety problems created by mining in Florida relate to the steep slopes left by the mining of all resources and the unconsolidated waste clays left by phosphate. For all the resources, the IAM lands' slopes have generally attained a high level of stability and have not had a history of causing any alarming frequency of serious injury or death. Phosphatic waste clays, generally stored in above grade ponds, remain dangerously unconsolidated for decades, and present a hazard.

5.0 ENVIRONMENTAL IMPACTS

5.1 WATER RESOURCES

IAM lands have negligible adverse impacts on surface and ground water quality in Florida. As a matter of fact, untreated water in abandoned mined lands pits serve as excellent fishing areas and provide outstanding habitat for various types of water fowl.

As far water quantity is concerned, IAM lands have served to disrupt stream channels and watersheds. In most instances, this disruption results in a higher level of attenuation than in the premining condition. However no serious adverse effects have resulted.

5.2 AIR QUALITY

None of the abandoned mined lands in Florida present a problem with respect to fugitive dust emissions. 'Even where relatively sterile tailings occur, enough vegetation occurs to prevent significant levels of dust emissions.

5.3 REVEGETATION

The relatively unconsolidated surfaces left by mining and beneficiation, coupled with over 50 inches of rainfall annually ensures that abandoned mined lands and generally well-vegetated.

5.4 OTHER IMPACTS

Chemical processing of phosphate rock results in the generation of phosphogypsum stacks. The migration of radioactive contaminants from the stacks into the ground water is a concern which is currently being evaluated by the State and the EPA. In addition, radioactive emissions from mined out phosphate lands has been raised as an issue. To date no significant concerns have been identified.

6.0 STATE LAWS AND REGULATIONS

IAM lands, in the State of Florida, are referred to as nonmandatory lands. For all resources, except phosphate, the State of Florida has no program for the reclamation of abandoned mined lands. The nonmandatory phosphate program is discussed extensively in Part II of this report.

Thousands of acres of nonmandatory lands have been reclaimed voluntarily by mine operators and landowners for a wide variety of uses ranging from housing developments to fish farms and wildlife habitats.

7.0 WIEB IAM LANDS DATA SUMMARY - SOURCES OF INFORMATION

7.1 FLORIDA DEPARTMENT OF NATURAL RESOURCES, BUREAU OF MINE RECLAMATION (BMR)

The BMR is responsible for administering the regulation of reclamation in all mines within the state. The bureau has conducted a comprehensive study on abandoned mined phosphate lands (see Part II of this report). For limestone, the BMR requires the identification of nonmandatory acreage only in those mines in which mandatory reclamation requirement exists. For other resources, the BMR has no means of tracking nonmandatory lands.

For phosphate mine reclamation, the information presented in this report has a 90% confidence level. The nonmandatory limestone acreage available through mandatory reclamation plans is reported with a 90% confidence level-this acreage however, only represents about 35% of all nonmandatory limestone lands.

The contacts at the BMR are:

Joe Bakker, Bureau Chief
Steve Windham, Environmental Administrator

7.2 FLORIDA DEPARTMENT OF NATURAL RESOURCES, BUREAU OF GEOLOGY (BOG)

The BOG surveys strata in mined out pits to develop geological maps. The BOG also keeps a record of mines which have been visited. The BOG is a source for the data on limestone, clays, and heavy minerals and the information is reported with a 60% confidence level.

The contacts at the BOG are:

Walt Schmidt, Bureau Chief
Tom Scott, Geological Administrator

7.3 VARIOUS COUNTIES

Several counties keep records of mining acreage. This information was obtained and incorporated into the study by the BMR. The county information, where available was reported with a 90% confidence level.

7.4 OVERALL ANALYSIS

The BMR compiled the information from the various sources and estimates the following overall confidence levels

Phosphate nonmandatory lands	-	90%
Limestone	-	70%
Sand and gravel	-	60%
Clays	-	70%
Heavy Minerals	-	80%

8.0 NON-COAL INVENTORY

Table I shows the completed data summary. The following definitions relate to the data summary.

"Mine Dumps" - for phosphate, mine dumps refer to clay settling ponds.
"Other" - under "Features" for phosphate, other refers to mined out areas which are not clay settling ponds.

9.0 COSTS

Reclamation cost per acre for clay settling ponds currently costs the State approximately $2800 and for mined out areas without clays $4200. These costs are based on actual funding for reclamation projects.

NON-COAL INVENTORY
INACTIVE/ABANDONED MINES[1]

State of Florida

Agency Contact Joe Bakker

Telephone (904)488-8217

DATA SUMMARY[2,3]							
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)	(cost)
Metallic Ores	Mines		Federal		Polluted Water[8]	(miles)	(cost)[16]
	Millsites		Private		Mine Dumps[9]	(acres)	
	Smelters		State		Disturbed Land[10]	(acres)	
None	Other[5]		Other[6]		Highwalls[11]	(miles)	
					Mine Openings[12]	(number)	
					Subsidence Prone[13]	(acres)	
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines		Federal		Polluted Water	(miles)	
Limestone, sand, gravel,	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
(not considered eligible)	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
None	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	

Table 1 cont'd

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)	(cost)
Phosphate Rock	Mines	62,080	Federal	0	Polluted Water	(miles)	(cost)
	Millsites	0	Private	60,744	Mine Dumps	(acres) 49,020	$137,000,000
	Smelters	0	State	1336	Disturbed Land	(acres)	
	Other	0	Other	0	Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units) 13,060	$55,000,000
Uranium Overburden (None)	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale (None)	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7] Clays, Peat (not considered eligible)	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
TOTAL	Mines	62,080	Federal	0	Polluted Water	(miles)	
	Millsites	0	Private	60,744	Mine Dumps	(acres) 49,020	
	Smelters	0	State	1,336	Disturbed Land	(acres)	
	Other	0	Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units) 13,000	

INACTIVE AND ABANDONED MINED (IAM) LANDS STUDY FOR FLORIDA

Part II - Nonmandatory Phosphate Land Reclamation Program

PART II - NONMANDATORY PHOSPHATE LAND RECLAMATION PROGRAM IN FLORIDA

1.0 INTRODUCTION

This report summarizes mining and reclamation in Florida, with respect to lands mined or disturbed by the extraction of phosphate rock from its inception to the year 1977, to provide a historic perspective. The principal focus of the report covers the time frame from 1977 to 1983 and chronicles the development of an "Old Lands" or "abandoned inactive lands" reclamation program for lands mined or disturbed by phosphate mining prior to the passage of the Mandatory Reclamation Act of 1975. This voluntary program (termed nonmandatory) was implemented in 1983, providing economic incentives to the landowner in the form of reimbursements for costs of approved reclamation work on eligible lands.

In developing this program there were no other similar programs to offer guidance to the staff. This report is offered for that reason, as it may assist or serve as a point of beginning or a catalyst to the thought process to persons charged with developing abandoned lands reclamation programs. Considerable emphasis is placed on concepts and methodology to achieve a product. The implementation of the product or the operational aspects of the program from 1983 to 1991 will be the subject of a later report. The report is taken from files of the Florida Bureau of Mine Reclamation, supplemented by personal recollections by staff involved with the program development from 1977 to 1983.

The staff was counseled from the beginning by concerned and respected people of the pitfalls of a massive, state "give-away program." They painted a picture of potential pressures for preferential treatment and fund misuse that would appear to be almost insurmountable. These concerns were reinforced as it quickly became obvious there was no concensus as to the essential elements in reclamation. The concept of "return to beneficial use" was too abstract, too qualitative, and too subjective. Reclamation had to be defined and quantified not for the purpose of reclaiming the land but for determining which land should be reclaimed.

Staff spent long hours with its consultants and others trying to understand and define the essences of reclamation. Once the task was recognized and conceded to be impossible, only then was it possible to move forward. In the end, four elements emerged as principles; Economics Utility, Environmental and Aesthetic Quality, and Time.

Considering this climate the staff decided on a course of action which included the following:

1. Utilize commissions and committees with qualified representatives for guidance, and as a sounding board for

staff's concepts if a member of the staff could serve as chairman and if the staff and its consultants could serve as the support to the commissions or committees.

2. Identify the parameters of reclamation.

3. Define, analyze, and quantify every specific element within each reclamation parameter utilized.

4. Site-inspect all of the land to be included or excluded from this program, quantifying and inter-relating all data collected.

5. Relate all work to cost in a fixed and variable cost model so that an activity could be modeled and the economic impact on the parcel and program could be demonstrated.

6. Adopt all of our methodologies, data, analyses and conclusions into admnistrative rule, and relate them in such a fashion that to change one aspect requires that change to run throughout the program. There are specific legal procedures for adoption and amending administrative rules including public hearings and final approval by the Executive Board of the Department of Natural Resources (Governor and Cabinet). This provides a very strong control necessary to the integrity of the program.

7. Develop cost reimbursement controls that would involve an independent but related analysis by engineering, accounting and audit personnel, utilizing a fixed and variable cost model to establish the upper levels of funding. These controls would also be adopted into administrative rule.

The approaches taken in the development of this program became much "simpler" when it was accepted that the parameters of reclamation as we perceived them to be could not be quantified. In essence, our efforts would be "graded on the curve," therefore, we simply had to do a better job than anyone else had done or could do in total, yielding a stable product and yet one which could be changed in the future if the facts warranted a change.

Pre 1975
Phosphate Mined Lands

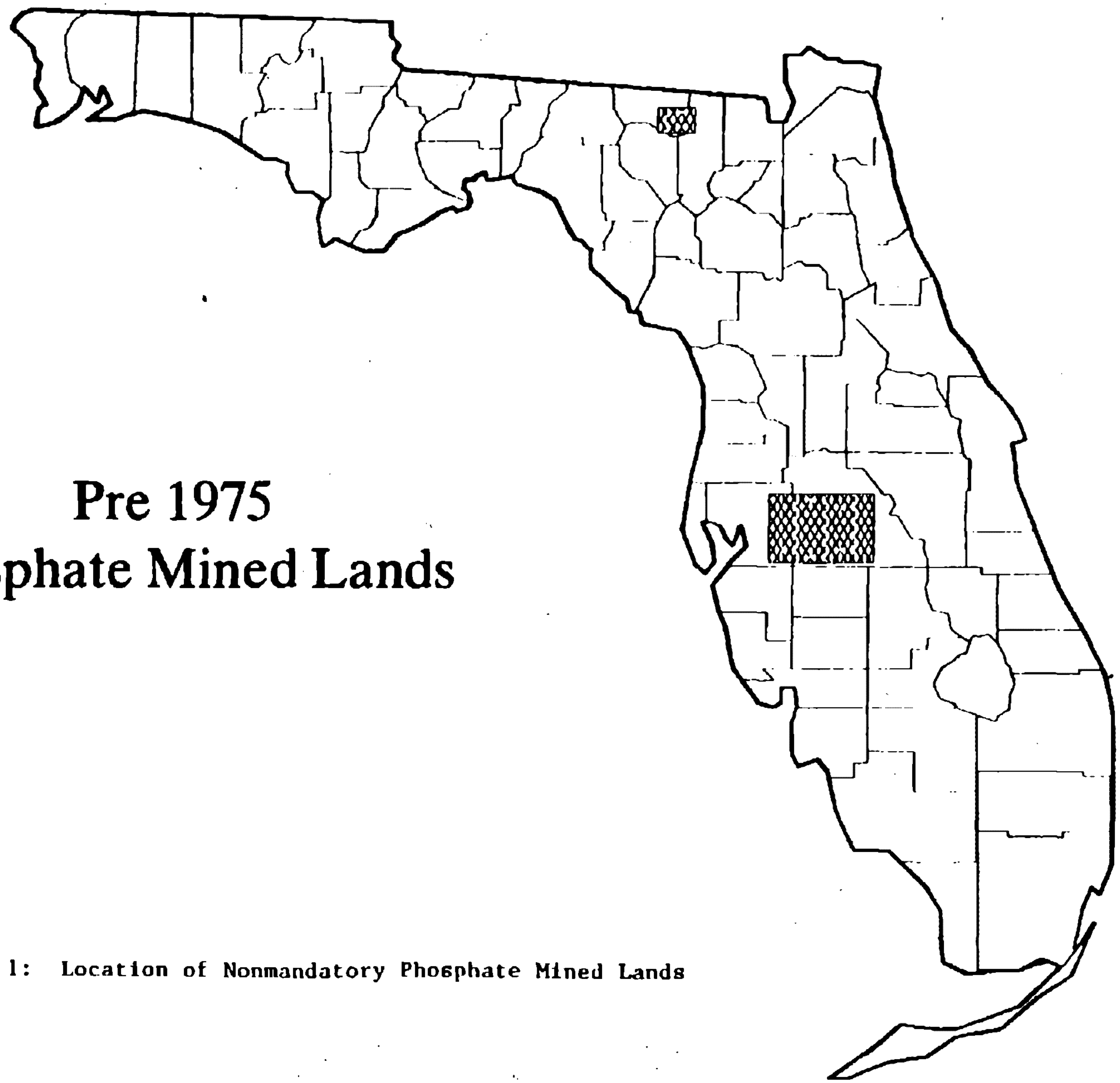


Figure 1: Location of Nonmandatory Phosphate Mined Lands

2.0 PHOSPHATE AND PHOSPHATE MINING IN FLORIDA

Phosphate occurs in Miocene age sediments and rocks wherever they occur in Peninsula Florida. Only in the northwest part of the peninsula is the Miocene absent exposing surface outcrops of older limestones. In this area phosphate commonly occurs as a replacement of the upper few feet of the limestone; in addition, phosphate occurs in potholes in the limestone as a residuum from the dissolution of the limestone. This residuum is commonly a fine grained calcareous phosphate mixture. These two types of occurrences of phosphate associated with the exposed limestones have been termed "hard rock" phosphate and "soft rock phosphate" respectively.

Although phosphate occurs throughout the miocene, economic deposits of phosphate are generally limited to structural highs where the phosphate has been reworked and concentrated. This reworking results in a very coarse fraction of the total phosphate particles which is termed "pebble", thus these commercial deposits of phosphate have been termed "land pebble" when extracted from uplands and "river pebble" when extracted from rivers.

River pebble extractions were initiated from the bottom, edges and sand bars in the Peace River in 1881 and continued only to the early 1900's. Hard rock and soft rock phosphate mining began about the same time and has continued sporadically until recently; however, the principal activities were early in the 1900's and the impacts have been minimal because of the scattered nature of the mining and the very shallow occurrence of the ore. Land pebble was discovered in Polk County around 1888 as an extension of the river pebble operation and mining began in earnest around 1908.

The subject of this abandoned lands reclamation issue is restricted to the areas affected by the extraction of land pebble phosphate. Only three counties qualify in having this type of extraction prior to 1975; Hamilton County in north Florida (since 1965)and Polk and Hillsborough counties in central Florida (since 1908) (Figure 1).

As mentioned, the land pebble operations were initiated in 1908. Unconsolidated overburden, principally quartz sands with minor clay content, was removed by hydraulic guns or by steam shovels and spoiled on adjacent lands. The matrix or ore zone was removed and only the pebble fraction recovered, with the remaining phosphatic sands and clays returned to the pits or spoiled on unmined land. Between 1908 and 1920 approximately 5,700 acres of land were disturbed by phosphate operations utilizing these mining and processing techniques.

The pace of land disturbance accelerated significantly after 1920 with the introduction of two technological advances. The first was electrically driven draglines that greatly increased digging capacity (up to 65 cu. yd. buckets) and allowed mining of deeper deposits. The use of draglines created a distinct land form in and of itself. The mined out area is characterized by rows of spoil piles alternating with elongated mine pits which are frequently filled with water. The spoil piles are the result of the over burden side cast by the dragline along a regular mine cut and are shaped by an angle of repose of approximately 45 degrees. The crest-to-crest distance between spoil piles is generally uniform since it is dictated by the boom lengths of the mining dragline. The linear spoil piles are commonly referred to as "windows" and the alternating long narrow water filled pits as "finger lakes".

The second innovation revolutionized the industry and increased both the quantity and quality of phosphate mined in Florida. A selective flotation process, first introduced in 1928, recovered the sand sized fraction of the phosphate ore that was previously discarded as waste (debris piles). This sand sized phosphate fraction equalled or exceeded the pebble fraction in quantity and was also a higher quality phosphate (P205 content) than was the pebble fraction. This processing isolated two waste products which had to be disposed of in some fashion.

When the phosphate pebble fraction is recovered by mechanical screens all finer fractions pass through. Once discarded, this fraction was now processed through hydro cyclones and settling tanks to separate a clay sized fraction and a sand fraction. The sand sized fraction termed "feed" went through the flotation process in which the phosphate was recovered and a quartz sized fraction "tailings" was discarded. The clay sized fraction termed "waste clay or slimes" and the quartz sand-sized fraction termed "tailings" leave the processing plant (beneficiation plant) as a slurry with water and are pumped to disposal areas. The sand tailings were usually pumped a short distance from the plant, discharged into a pile and allowed to drain by gravity leaving isolated mounds of quartz sand. The clay fraction was not as easily disposed of as the slurry leaving the plant is only about 3% solids and the total fraction required months to settle and years to consolidate.

While there was some early random disposal in abandoned mine cuts, soon the quantities being generated required dams to be constructed, usually around mined out areas to take advantage of below grade storage. The dams were constructed of overburden and sand tailings; some as high as 50 feet above natural grade and encompassing areas up to 640 acres. Waste clays were pumped into these areas at rates that would allow time for settling and then clear water decanted (at a point fartherest from the inflow) and returned by ditches to the plant for reuse. This procedure was followed until the system reached capacity. Waste clay settling ponds normally were not taken out of production even when filled but rather joined together with several others as flow thru systems or retained singularly as water storage systems. This long term use obviously delayed reclamation. Most of the consolidation of the clays is dependent on the self weight of the clays which is minimal as long as they are immersed in a water column. Once the water levels are reduced to below the clay surface, consolidation begins, reducing the surface elevation of the elevated storage areas and increasing the percent solids. Effective consolidation terminates at percent solids of 40 to 45% primarily because the permeability of the clays is so low that additional dewatering is accomplished only over many years, perhaps even geologic time to approach its in place unmined percent solids level of 65%.

High dams and inadequate design led to several catastrophic dam failures which resulted in major environmental damage to several streams and river systems. In 1972, dam construction began to be regulated, requiring better design and construction and also inspections and maintenance. This signaled the end to the extremely high dams, as costs to meet the new design requirements rendered the high dams uneconomical. Hydrologic and environmental concerns about these elevated systems have further reduced the height of the dams, however, low dams and at grade systems have attendant problems related to consolidation. In any case, these clay settling areas commonly cover 60 to 80% of land mined for the extraction of phosphate and represent the most significant land form involved in reclamation.

Figure 2 shows the incremental distribution of disturbed acres. Large draglines and the flotation process were introduced earlier but were not fully implemented by the industry until about 1940; after which the industry really began to assume a dominant role in the world marketplace for phosphate. The pace at which these disturbed land forms were created increased so that half the acreage disturbed since mining began in Florida in 1881 was disrupted between 1960 and 1975. The concentration of disturbance in such a relatively short time span increased the visibility of mining operations and generated public concern over future disturbances and the role of reclamation in mining.

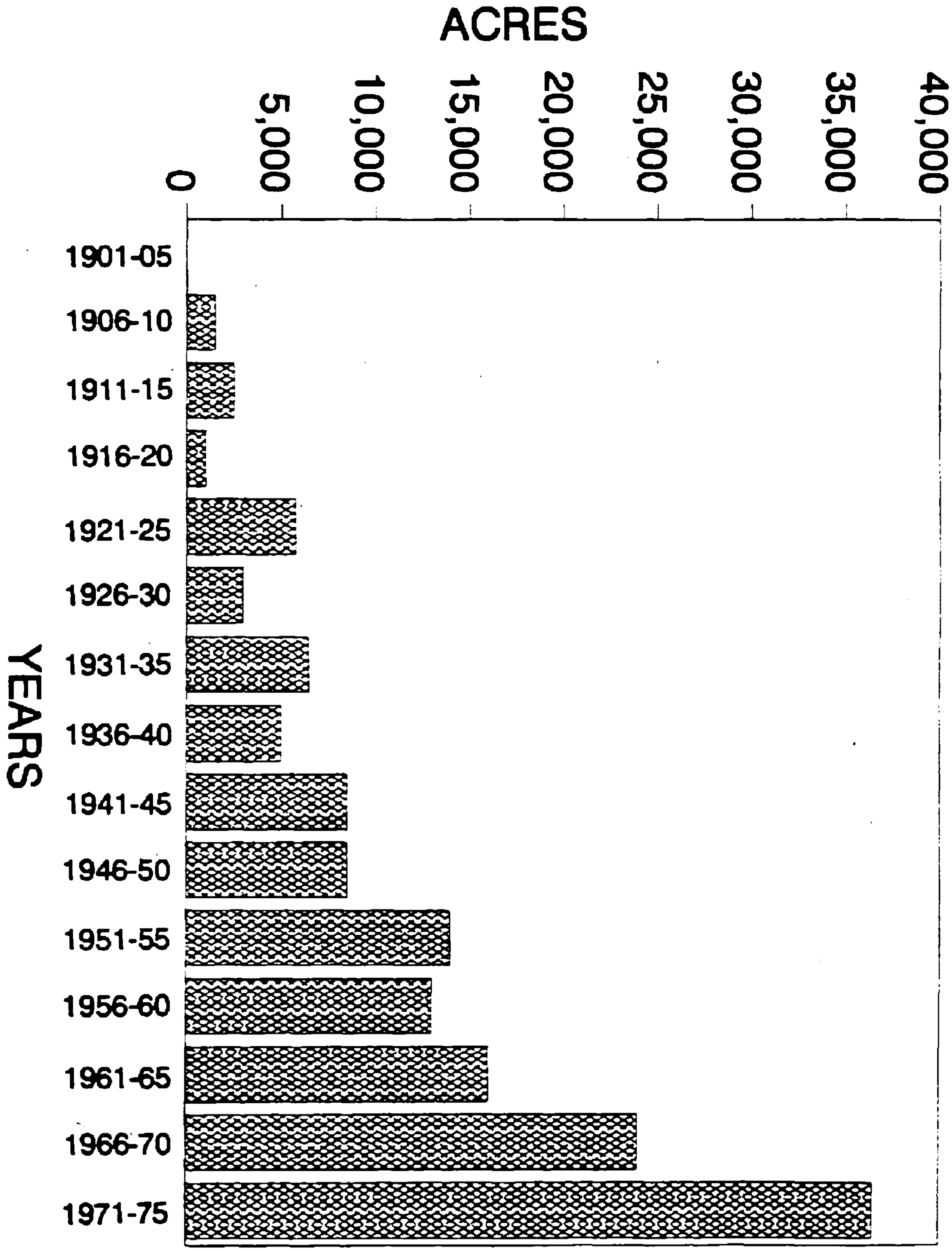


Figure 2: Incremental Distribution of Disturbed Acres

3.0 HISTORY OF RECLAMATION

In the early years of land pebble phosphate mining, the sparsity of people, the scattered occurrence of mines and the "unlimited" abundance of land engendered an environment of unconcern relative to reclamation. While there were scattered examples of individuals acquiring mined-out lands at virtually no cost and utilizing portions thereof, or of isolated industry projects, there was no concerted effort toward reclamation until the late 1940's.

In 1947, the mining of phosphate was in such close proximity to the City of Lakeland in Polk County, the Lakeland Chamber of Commerce attempted to have legislation passed by the Florida Legislature requiring reclamation. Although no immediate reclamation legislation resulted from this effort, agreements were reached between the Chamber and the phosphate industry to initiate reclamation. In the 1950's, as an outgrowth of these negotiations, several members of the phosphate industry made serious efforts to reclaim mined-out land.

These first large scale reclamation efforts demonstrated that while reclamation was possible, the feasibility was not enhanced because of the expense involved. There had been considerable speculation that Florida land values were such that reclamation was not only sensible but would be economically advantageous to the companies because the profit margin from the land sale would more than pay for reclamation. This did not prove so. In 1960, the eight companies mining phosphate rock in Polk and Hillsborough counties established a Land Use and Reclamation Committee through the Florida Phosphate Council to coordinate and promote reclamation.

This decade witnessed significant changes in the industry's approach to reclamation. For the first time, real emphasis was given to the development of mining plans, which included a plan for reclamation. These efforts resulted in the type of reclamation known today as land and lakes and demonstrated the economic feasibility of reclamation with proper planning.

The efforts of the individual companies through the Land Use and Reclamation Committee were primarily use oriented both in the private and public sectors. Mined-out lands were leased to the Florida Game and Fresh Water Fish Commission to manage for public fishing and hunting and substantial acreage was leased to the Audubon Society for bird sanctuaries. Park and school sites and road rights-of-way were donated or leased to counties and cities and landfill garbage disposal areas were provided to both Polk and Hillsborough counties. Pastures were made available to schools in both counties for use by vocational agricultural students for cattle projects.

The following tabulation demonstrates the types of reclamation activities carried out by the phosphate industry during the 1960's:

Example	Company	Description of Project
1	IMC	Southwest Bartow-100 acres-A tract adjoining IMC's Bartow offices. Mined 1965-66. Residential sites.
2	IMC	U.S. 17 strip-135 acres south of Bartow. Right-of-way for anticipated 4 lane road. Good for commercial.
3	IMC	West Mulberry-31 acres-2,000 ft. frontage on Fla. 60. Sold to out-of-state industrial firm.
4	IMC	Noralyn recovery plant site-20 acres-office, lab, on reclaimed land.
5	IMC	Mulberry area-1,000 acres-north, south, and southeast of Mulberry; all acreage fronting on a highway. One part recreational, another agricultural, rest of reclaimed area for residential or commercial uses.
6	Armour	West Bartow Elementary School-Dedicated in May, 166. Deeded to City in 1960.
7	Armour	Clark Property-170 acres. A real estate subdivision.
8	Cyanamid	Saddle Creek Park-740 acres; land has been donated to people of Polk County for recreational area. Swimming, fishing, picnicking, and other activities. East of Lakeland.
9	Cyanamid	Orange Park, north of Lakeland-2,224 acres reclaimed-mining and simultaneous reclamation. Reclamation completed within a month after mining.
10	Cyanamid	315 acres-east of Lakeland-donated to Florida Audubon Society as a wildlife sanctuary. Largest reserve owned by society in state.
11	Mobil	Peace River Park-donated to City of Bartow (east of city limits) as recreational area.

12	Cyanamid	Pleasant Grove Fish Management area, east of Tampa-1,160 acres. Under supervision of Florida Game & Fresh Water Fish Commission.
14	IMC	Bartow Civic Center-10 acres-1966, land was donated to City for civic center.
15	Cyanamid	Sydney-1,1613 acres reclaimed-15 miles east of Tampa. Sold portion of reclaimed land for 18-hole golf course.
16	W.R. Grace	Sylvester Shores-residential subdivision built on reclaimed land in southeast Lakeland. Mined in 1955. Reclaimed in 1960.
17	W.R. Grace	North of Mulberry area-367 acres fronting on SR 37 and Carter Road. Potential commercial and residential property. 2,600 feet reclaimed on SR 37.
18	W.R. Grace	East of Mulberry area-155 acres with 4,400 feet on SR 60. Potential commercial property.

In the late 1960's there was a gradual slowing of reclamation activities. There were several factors involved in this slowdown; (1) a general economic downturn of the industry, (2) a saturation of the need for public facilities, and (3) no immediate market for other types of reclamation.

In 1971, the legislature of the state of Florida, seeking additional revenue, proposed an excise tax on the severance of solid minerals. Industry lobbyists negotiated a compromise wherein they would support the tax if 50% would go to a trust fund (The Land Reclamation Trust Fund) to be returned to the industry for engaging in voluntary reclamation. The monies would be held in individual taxpayer accounts, the amount dependent on the tax paid by the taxpayer. The monies would be deposited annually with each annual contribution held in trust a maximum of five years. Any monies remaining from an annual contribution after five years would revert to the general revenue fund of the state. Participation by the taxpayer was voluntary; however, should they participate, any reclamation work accomplished would be certified by the Department of Natural Resources to the Department of Revenue and the taxpayer would submit invoices to the Department of Revenue for reimbursement. This Bill passed and is codified as Chapter 211, Part II, Florida Statutes, and represents the beginning of the state's reclamation efforts. The excise tax on the severance of solid minerals applied to only a portion of the states mining industry, but did include phosphate. Those commodities on which Florida sales tax was paid at the point of sale were exempt from paying the new tax, and thus were exempt from the provisions of the law. This marriage of a tax and reclamation in a single law has caused significant problems, some of which remain today.

This voluntary reclamation program lasted only until 1975, however, during the time period, 3,865 acres of land were reclaimed to a status of having potential use as agricultural, residential or industrial land.

In 1975, the Florida Legislature revisited and amended Chapter 211, Pt.2 F.S.. The principal new provisions were as follows:

1. Imposed mandatory reclamation on lands subject to the tax after July 1, 1975.

2. Allowed submittal of "old lands" by the phosphate industry for reimbursement purposes. "Old lands" were lands mined prior to 1975 and not subject to mandatory reclamation. Industry maintained there would be insufficient mandatory lands available for reclamation for several years and monies in taxpayer accounts would be lost.

The rules adopted in 1975 (Chapter 16C-16, Florida Administrative Code) emphasized restructuring and stabilizing new land forms in a timely manner to eliminate the visual scars of mining, to eliminate safety hazards and to control water quality exiting the area. Specifically, these actions were to reduce precipitous slopes both on land and in water areas to a more aesthetically pleasing rolling topography with less hazards to animals and peoples from falls and drownings; to remove old machinery, wires, pipes and other physical evidence of mining from the ground surface; to alleviate any toxic or sediment-laden water from exiting the mined area and entering other lakes or streams and to stabilize the newly contoured land by establishing a ground cover of vegetation. This approach to reclamation involves a conceptual change to previous voluntary efforts; that is, to de-emphasize immediate use or reuse and emphasize quality as a basis of reclamation. Further in this report it can be seen there exists a basic distinction between the concepts of use and the concepts of quality in land reclamation.

In general, the 1975 amendments appear to have been effective in promoting more reclamation as 6,869 acres were reclaimed in the next two years. This acreage figure is deceiving, however, in that much of the reclamation completed during this time period represented lands on which reclamation had been initiated earlier and virtually all the land represented "old land", not land subject to mandatory reclamation.

By 1977, The Florida legislature again amended Chapter 211, Pt.2, [specifically 211.32(3)(d)], Florida Statutes, and added paragraphs (m) and (n) to said subsection to wit:

1. There is hereby created a Phosphate Land Reclamation Study Commission composed of seven members to be appointed by the Governor. The Governor shall designate one member of the commission to serve as chairman and the commission shall meet at the call of the chairman. Members of the commission shall receive no compensation but shall receive travel and per diem as provided by s. 112.061.

2. The Department of Natural Resources shall provide the commission with the staff necessary to carry out the duties of the commission. Advice and expertise in economic matters shall be provided by the Division of Budget of the Department of Administration upon request of the commission.

3. The Phosphate Land Reclamation Study Commission shall make a study of the reclamation of land in this state disturbed by the severance of pebble phosphate rock. The commission in making its study shall consider but not be limited to:

a. An inventory of lands in the state disturbed by the severance of pebble phosphate rock prior to July 1, 1975, which lands have not been reclaimed. Such inventory shall consider the ownership of the land and the ownership of mineral rights in such lands.

b. An estimate of the present and future costs of reclaiming lands which have been disturbed by the severance of phosphate rock.

4. On or before March 1, 1978, the Phosphate Land Reclamation Commission shall report the results of its study to the Governor, the President of the Senate, and the Speaker of the House of Representatives. At that time, it may also recommend:

(a) legislation designed to promote and insure the restoration and reclamation of land disturbed by the severance of solid minerals which in the absence of incentives provided by law might not be restored or reclaimed, and (b) whether paragraph (n) of subsection (3) of Section 211.32, Florida Statutes, as adopted herein, be amended, modified, or repealed.
(n) Notwithstanding any other provision in this part, refunds from the taxes levied under this part based upon the severance of solid minerals on or after July 1, 1978, shall be paid from the Land Reclamation Trust Fund only for the cost of restoration and reclamation of lands:

1. Disturbed by the severance of solid minerals prior to July 1, 1975; or

2. Included within a site of severance on or before the effective date of this act with a restoration and reclamation program theretofore filed with the program theretofore filed with the Department of Natural Resources."*

*Note: Underlined is quotation of Florida Law

4.0 PHOSPHATE LAND RECLAMATION STUDY COMMISSION

In July of 1977, Governor Reuben O'D. Askew named the following persons to serve on the Phosphate Land Reclamation Study Commission:

Honorable Pat Frank, Representative, Florida Legislature,
Honorable Kenneth H. MacKay, Jr. Senator, Florida Legislature
Mr. Sterling Hall, County Commissioner
Mr. Terry McDavid*, Industry Representative
Charles W. Hendry, Jr., Staff, DNR, Chairman
Mr. Nathaniel Reed, Environmental Representative
Mr. T. E. Holcolm, Industry Representative

*Resigned in November, 1977, and was replaced by Mr. Maywood Chesson. Mr. Chesson resigned in February, 1978.

The staff of the DNR presented to the Commission a study recommendation to review mining and reclamation in Florida, to inventory and categorize the lands disturbed by the severance of pebble phosphate including the ownership and to estimate the costs of reclaiming the disturbed lands. This study was to be completed in four months.

The Commission met several times, took field trips to survey the various aspects of mining and reclamation, received comments from the public and interested agencies and groups.

The staff presented the Commission its report and worked with the Commission to develop recommendations for presentations to the Governor and Legislature.

LAND RECLAMATION STUDY COMMISSION REPORT SYNOPSIS

Present land conditions were separated into five categories. These categories are mined-out and left as is, disturbed, settling areas, reclaimed lands other than settling areas, and reclaimed settling areas. The "mined-out, left as is" category represents lands where the mineral was actually severed and then the land left in its mined-out state. "Disturbed lands" are lands that have been altered for use by the mining process. This includes lands used for haul roads, pipelines, debris piles, overburden dumps, and other uses needed in the mining and processing of the phosphate matrix. Specifically excluded from this category are plant sites and mined-out lands. All lands (both mined and unmined lands) covered by waste clays are included in the "settling areas" category. The "reclaimed lands other than settling areas" category includes all lands (both mined and disturbed) that have been reclaimed according to industry accepted reclamation techniques and in some cases to Department of Natural Resources criteria. Specifically excluded from this category are "reclaimed settling areas". These lands were put into a separate category and include "reclaimed settling areas" on both mined and unmined lands.

Reference materials utilized in the mined-out and disturbed land inventory included:

1. Set of unpublished industry airphotos, scale 1"=400', prepared in 1975 delineating reclaimed lands.

2. Set of Mark Hurd airphotos, scale 1"=24,000", flown in 1972 on file with the Department of Natural Resources - Bureau of Geology.

3. U.S. Geological Survey topographic maps, scale 1"=24,000' various dates on file with the Department of Natural Resources - Bureau of Geology.

4. Soil Conservation Service soil maps 1916 and 1917 on file with the Department of Natural Resources - Bureau of Geology.

5. U.S. Geological Survey - Trace Elements Memorandum Report, 672 maps, 1953 on file with the Department of Natural Resources - Bureau of Geology.

6. Individual phosphate companies' pit take-up records, files, and maps on file with individual companies.

7. Department of Natural Resources - Bureau of Geology Reclamation Programs - 1971-1977 on file with the Department of Natural Resources - Bureau of Geology.

8. Review by individual phosphate company personnel and consulting companies.

The mining and reclamation data were compiled using U.S. Geological Survey 7 1/2 minute topographic maps as a base. The acreage of individual inventory categories was acquired by planimetering the completed map compilation. Statistical results of this inventory are as follows:

I. Mined-Out Lands	
1. Before 7-1-71	95,879
2. 7-1-71 to 7-1-75	19,886
3. 7-1-75 to 7-1-77	10,939
4. 7-1-77 to present	874
5. Total Mined-Out Lands	127,578
6. Mined-Out Lands left as-is	54,076
7. Mined-Out Lands under slimes (unreclaimed)	45,373
8. Mined-Out Lands that have been reclaimed	24,173

9. Mined-Out Lands under slimes that have been reclaimed	2,956
II. Disturbed Lands	
1. Disturbed Lands left as-is	18,038
2. Disturbed Lands under slimes (unreclaimed)	13,331
3. Disturbed Lands that have been reclaimed	5,941
4. Disturbed Lands under slimes that have been reclaimed	1,375
	38,685
III. Total Lands Disturbed by Mining	165,753
IV. Reclaimed Lands	
1. Reclaimed Lands other than slimes (I.8+II.3)	30,114
2. Reclaimed Lands under slimes (I.9+II.4)	5,331
3. Total Reclaimed Lands	35,445
4. Total Unreclaimed Lands (III-Iv.3)	130,308
V. Total Lands Under Slimes	58,704
VI. Land Ownership	
1. Lands in Company Ownership	125,601
2. Lands in Other Ownership	38,552
3. Reclaimed Lands in Company Ownership	21,800
4. Reclaimed Lands in Other Ownership	13,645
5. Unreclaimed Lands in Company Ownership	103,801
6. Unreclaimed Lands in Other Ownership	24,907

It was anticipated at the inception of the Commission study that sufficient information would be available from the state agency handling reclamation reimbursements and from industry records to develop a reclamation cost overview. This unfortunately was not the case as the industry had not as yet established cost centers for reclamation work. In essence, they were using men and equipment, primarily on down time, from other cost centers. Also, the billing to the state was not necessarily related to single projects but might be, for example, bulldozer time working on several projects combined. The disbursement of funds was also not related to single projects but rather on a "first come, first pay" basis. The result was that it was necessary to develop rudimentary cost data.

A geological-engineering consulting firm specializing in phosphate mining located in Lakeland, Florida was selected to assist the staff in this effort. The firm selected, the Zellars-Williams Company was to remain as principal consultant to the staff of the Department of Natural Resources throughout the development of the Old Lands Program.

Cost analysis was carried out by land form or reclamation type and reported as an average per acre cost, however, the cost curves showed a wide range of potential costs depending on the source and distance of transport of fill materials and related grading.

These two studies, the inventory and the cost analysis, were to provide the basis for establishing the limits of a new trust fund to be recommended for the reclamation of old lands. The difficulties encountered with the cost analysis and the recognition that mining had occurred over such a long time span that some of these lands may have become stabilized landforms, with vegetative cover and productive fish and/or wildlife systems, such that the effects of extensive land recontouring on such ecosystems and the cost of recontouring such might be that the public interest is better served by allowing these lands to remain as is. Standards for this value judgement were not available but a site specific evaluation could provide the basis for reasonable judgment. Until such questions could be concluded, the total acreage of lands mined or disturbed by the severance of phosphate rock prior to July 1, 1975, for which reclamation is desired could not be ascertained.

The Commission made several recommendations in their final report pertinent to the subject matter of this report. These included:

1. The creation of a Nonmandatory Land Reclamation Trust Fund for funding of reclamation and restoration programs approved by the Department of Natural Resources for lands mined or disturbed by the severance of phosphate rock prior to July 1, 1975.

2. Create a Land Use Advisory Committee which shall be composed of the following:
   (a) One member representing the staff of the Department of Natural Resources, as Chairman, to be appointed by the Executive Director of the Department of Natural Resources;
   (b) One member representing the Division of State Planning, Department of Administration, to be appointed by the Secretary of the Department of Administration;
   (c) One rotating member representing the Regional Planning Council in which the lands are located, to be appointed by the Director of the Regional Planning Council;
   (d) One rotating member or designee representing the appropriate Board of County Commissioners in which county the old lands are located, to be appointed by the Chairman of each Board of County Commissioners in which the lands are located;
   (e) One member representing the Game and Fresh Water Fish Commission, to be appointed by the Director of the Game and Fresh Water Fish Commission; and
   (f) Two members of the public to be appointed by the Governor.

The duties of the Land Use Advisory Committee were to be as follows:

(a) To evaluate the potential land use needs of the area affected by the mining or disturbance of land in the severance of phosphate rock prior to July 1, 1975 which lands are not covered by mandatory reclamation.

(b) To formulate a general old lands reclamation plan for the area affected by the mining or disturbance of land in the severance of phosphate rock prior to July 1, 1975, which plan shall not be inconsistent with local government plans prepared pursuant to the Local Government Comprehensive Planning Act.

(c) To define the desired types of landforms, the desired surface water regimes and the desired types of vegetation, to enhance the natural recovery of the land into mature sites with high potential for the land use desired.

(d) To evaluate old unreclaimed lands with naturally developed environmental systems to determine if the quality and the quantity of such systems enhance the overall environment quality of the area, such that artificial reclamation need not be recommended.

(e) To provide a prioritization of lands to be reclaimed and potential land uses to best serve the public interest.

(f) To furnish its report to the Department of Natural Resources on or before July 1, 1980.

(3) Direct the Department of Natural Resources to conduct an on site evaluation of lands mined or disturbed by the severance of phosphate rock prior to July 1, 1975 which lands are not covered by mandatory reclamation for the purpose of:

(a) Determining those lands where current reclamation standards (section 211.32 (3) (a), F.S.) are to be applied and on which to provide an assessment of the residual land condition and the feasibility of various reclamation alternatives including approximate fill and revegetative costs.

(b) Determining those lands where current reclamation standards, if applied, would be destructive of naturally developed environmental systems which in their current state enhance the overall environmental quality of the area; recommending exceptions to the current reclamation standards for such lands whereby such lands would not qualify for reclamation funding.

(c) Develop a master old lands reclamation plan for lands mined or disturbed by the severance of phosphate rock prior to July 1, 1975 which lands are not subject to mandatory reclamation based on the recommendations of the Land Use Advisory Committee and on the on-site evaluations conducted by the Department of Natural Resources.

> The master old lands reclamation plan shall be developed as soon as practicable, presented at a public hearing before the Executive Board of the Department of Natural Resources and on adoption shall be the guideline for programs submitted for funding from the Nonmandatory Land Reclamation Trust Fund.

In addition to these recommendations, the Committee responded to other sections of the report dealing with problems associated with the phosphate industry by recommending the creation of a research institute, to be entitled the Florida Institute of Phosphate Research, its research menu, administration and funding.

5.0 THE NONMANDATORY RECLAMATION LAW
CHAPTER 378, FLORIDA STATUTES

The recommendations of the Commission were enacted into law during the legislative session of 1978 effective July 1, 1978. The phraseology of one portion of the law is of particular interest as is identifies the criteria or elements of reclamation very well. The on-site evaluation was to determine:

1. "The quality of surface waters leaving the land does not meet applicable water quality standards, if any; or health and safety hazards exist on the land; or, the soil has not stabilized and revegetated; or, the remaining natural resources associated with the land are not being conserved;

2. "The environmental or economic utility or aesthetic value of the land would not naturally return within a reasonable time, and reclamation would substantially promote the environmental or economic utility or the aesthetic value of the land; and

3. "The reclamation of the land is in the public interest because the reclamation, when combined with other reclamation under the master plan, would provide a substantial regional benefit."

In addition to water quality, health and safety and soil, the act speaks to environmental, economic, aesthetic qualities and time. Thus we have our subject parameters on which to develop a precise analysis of mined land to qualify for reclamation.

The implementation of Chapter 378, Florida Statutes began in a two pronged approach. First, the staff and the Zellars-Williams Company reviewed and mutually agreed on a biological consultant, Conservation Consultants, Inc., a Florida firm specializing in Botany, Biology and Ecology. This task was to develop a methodology for making a numerical or quantitative analysis of the reclamation parameters. Secondly, the Land Use Advisory Committee begun meeting to study their tasking of land use. These two efforts were to be completed within one year.

6.0 LAND USE ADVISORY COMMITTEE

The Land Use Advisory Committee spent some months grappling with their task, finally concluding that specific land use assignments to specific tracts of land was not practical. A variety of circumstances led to this conclusion. Important among these were:

1. Lands reclaimed and donated or just donated to the public sector and to wildlife management agencies by the public sector and to wildlife management agencies by the phosphate in the preceding years had filled much, if not all, of this need.

2. Most Florida local governments derive their operating funds from property taxes. Property taxes are assessed in accordance with use or potential use with each "higher use" having a higher assessment. Landowners, both company and private were most concerned about being shown on a map as to be reclaimed for some potential "higher use" which might not be forthcoming and its impact on their property taxes.

3. The Comprehensive Land Use Plans already adopted by the counties involved were vague or highly generalized in the rural areas where most of the disturbed land existed. This situation existed because the local and regional planning entities had no firm direction or plans for these areas. This left the Committee in a most difficult position of how to maintain consistency with these plans as adopted and yet be specific about future land uses.

4. The Central Florida mining area essentially had no commercial forest nor row crop products. Principal agricultural products were restricted to citrus and cattle. Committee members were uncomfortable with the lack of technical knowledge concerning the potential utilization of some of the landforms for citrus and the expense of converting others. Additionally, there was concern that the conversion to pasture might represent an interim land use in company ownership that could not be continued after sale because of the economics.

The Land Use Advisory Committee redirected its efforts to assist the staff in evaluating the methodology being developed by the DNR consultants. In this effort the committee provided the staff an invaluable contribution, provided discussions and constructive criticism and also served as a focal point for inviting the review of and input from environmental groups such as the Audubon Society, the Sierra Club and the Florida Defenders of the Environment.

The final recommendations of the Land Use Advisory Committee are included herein; however, they were developed in two time periods. The Land Use Advisory Committee adjourned at the end of the year's activity and reconvened one year later after the site evaluation of the old lands was completed. The committee reviewed the results of the site analysis and then completed its final report.

7.0 LAND USE ADVISORY COMMITTEE REPORT

The duties of the Land Use Advisory Committee shall be:

To evaluate the lands mined or disturbed by the severance of phosphate rock prior to July 1, 1975, which lands are unreclaimed and not subject to mandatory reclamation under Part II of Chapter 211, for the purpose of identifying and designating, as a part of the general reclamation plan to be developed pursuant to paragraph (b), the following items:

The potential land use needs of the area:

The committee recognizes the land use needs as identified i each county's adopted comprehensive land use plan and as such any specific land uses recommended by the committee must be consistent with the comprehensive land use plan in existence now or as modified in the future.

The types of landforms, surface water regimes, and vegetation deemed desirable to enhance the natural recovery of land into mature sites with high potential for the land use desired.

The committee recognized the high probability of proposed land uses in reclamation plans especially on lands in mining company ownership to be designed toward accommodating short-term interim management goals in contrast to long term land use utilization. As such the committee stresses that landforms, surface water regimes and vegetation created through reclamation be guided by two general concepts (1) naturalness, and (2) diversity, as opposed to specific designs enhancing a single conceptual land use. Naturalness and diversity of landforms, waterbodies and vegetation can be accomplished in such a manner to enhance the natural recovery of the site to maturity while accommodating any proposed interim land use.

The kinds and descriptions of lands with viable naturally developed environmental systems such that artificial reclamation need not be undertaken;

The committee considered this topic at length conceptually and it was essentially on this point that the committee requested that its responsibilities be deferred until such time as the Department of Natural Resources conducted an on-site evaluation of all lands mined or disturbed by the severance of phosphate rock prior to July 1, 1975. The proposed methodology of conducting the site evaluations was presented to and approved by the committee prior to the field investigations. This methodology was utilized by the Department and its consultants in evaluating 149,000 acres of mined or disturbed land. Of this acreage 35,000 acres were removed from further consideration on the basis of the following considerations.

1. Parcels released as reclaimed by the DNR.

2. Parcels scheduled for remining.

3. Parcels whose owners did not grant permission to conduct on-site evaluation.

4. Parcels judged to have been reclaimed to economically beneficial use.

The remaining 115,000 acres were site evaluated and 86,500 acres recommended for partial or complete reclamation. This acreage represents those mined or disturbed acres whose environmental systems are judged to not have the potential to recover naturally to the level of quality of other selected natural systems. The committee approved the recommendations of the DNR site evaluations as presented to the committee; however, the committee recommends that the utilization of the site evaluations be within a flexible management system. The characterization and quantification of criteria to qualify for reclamation is a first effort of its kind and as new data is acquired through current and future research a mechanism must be available to recognize and incorporate new knowledge which could impact the recommendations as adopted.

<u>A prioritization of lands and descriptions of lands to be reclaimed and potential land uses to best serve the public interest.</u>

1. To encourage acquisition of unreclaimed land by fee-simple title, or long-term lease by public entities to reclaim for public use open or green spaces, recreation areas, and wildlife habitats.

2. Development of high quality wetlands especially on those lands which are by topographic occurrence most conducive to this type of reclamation. This includes

    a. Clay settling areas which occur or will occur at or below grade. The projected "will occur" condition is achievable through currently accepted practices of ditching, draining, and cover removal utilized in clay settling area reclamation.
    b. Mined-out areas where the grading of spoil piles to meet minimum standards of 4:1 slopes results in a topographic wetland unit at or below grade.

This recommendation is especially important in that it achieves a highly desirable landform at the lowest earth moving cost which satisfies minimum slope standards. Additionally, where feasible surface drainage from adjacent reclaimed lands should be designed and integrated with the restored "wetlands" in such a manner as to provide an adequate "catchment" basin to enhance the functional capability of the "wetland" landforms.

c. A general priority is recognized and recommended wherein the numerical Ecologic values as determined by the DNR site evaluations be utilized in determining reclamation priority, that is, the lands with the lowest ecologic value should receive the highest priority for reclamation.

3. The reestablishment or enhancement of regional drainage systems. This recommendation applies not only to those areas recommended in the DNR site evaluations but is a general recommendation applicable to any historic regional drainage system where restructuring or improvement is feasible. The primary goals of reestablishment and enhancement of regional drainage systems are improving the aesthetic quality of the system and improving the quality of wildlife habitats. Normal historic hydrologic functions of drainage and/or flood control cannot be reestablished de facto, as the surface topography, surficial sediments and groundwater regime has been too highly altered.

General Recommendations

The Land Use Advisory Committee recommends that the Department of Natural Resources pursue the clarification of the status of lands mined or disturbed prior to 1975 which are currently being utilized as waste clay retention areas and/or water recirculation systems and those which are proposed for future clay settling retention areas and/or water recirculation systems. The amount of acreage involved in this mandatory-nonmandatory classification is approximately 46,500 acres with an attendant minimum reclamation cost of approximately $101,800,000. The Committee recognized the present ambiguity attendant to the classification of such lands as either mandatory or nonmandatory; however, it lacks the legal expertise to comment constructively as to the adjudication of the problem.

This situation originates from the interrelationship of taxation and reclamation. Areas where the mineral was severed prior to the enactment of mandatory reclamation in 1975 do not qualify for inclusion in mandatory reclamation; however, these areas are being used or proposed for use to store wastes from current mining operations where the mined and disturbed areas are subject to mandatory reclamation. In a sense they represent a third distinct category; however, since no such category exists, they were included in the old lands program to provide assurance of reclamation.

The Committee recommends the Department of Natural Resources investigate the feasibility of considering reclamation to consist of distinct stages wherein refunds may be made at the completion of stages as opposed to refunds only at the completion of the total project. At the current interest rates on loans, it would appear to be in the best interest of the state and the landowner to minimize the pay-back period on loans made to landowners for necessary working capital to carry out reclamation.

The Committee recommends the Department of Natural Resources maintain a close review of the degree of private ownership participation in the Nonmandatory Reclamation Program to determine if additional economic incentives are necessary to encourage participation. One of the principal concerns expressed by private ownership relates to the potential increase in property tax assessment on reclaimed lands. If such a concern adversely affects substantial participation, it would appear that the long range interest of the area would be better served by instituting some type of temporal moratorium on increasing assessments for reclaimed lands. Such a moratorium could be time limited by resale, economic use or other appropriate measures.

The Committee recommends the Department of Natural Resources acquire and maintain in State ownership those portions or segments or regional drainage systems restored or enhanced through the Nonmandatory Reclamation Program. Such permanent acquisition may be feasible under the present statutes or statutory revision may be necessary.

8.0 SITE STUDY PREPARATION

The methodology developed by the Zellars-Williams Company and Conservation Consultants was concluded and adopted by the DNR as appropriate. The Methodology report will not be presented, as such, but the detailed description of the site evaluation that follows will demonstrate the methodology developed. In addition to the environmental analysis, considerable effort was expended in developing a cost analysis appropriate to each site and to the total program cost. The importance of this cost study cannot be understated as it provided the basis for the continuity of the trust fund to serve this reclamation. The cost analysis as constructed also served in the administration of the program which will be addressed later in the report.

The Zellars-Williams Company with Conservation Consultants as a sub-contractor entered into contract with the DNR to conduct the site analysis. It is important to note that the DNR staff played an integral part of the study ranging from assisting in data collection to participating in all major or important decisions in the study. It was the intent of the DNR staff to not have a turn-key contract, but to have a contract wherein the staff would participate and be completely familiar with not only the results, but the thought process, problems and successes in achieving the result.

Identification of Pre-July 1, 1975 Disturbed Lands

The Phosphate Land Reclamation Study Commission Report on Phosphate Mining and Reclamation is the basis for identification of pre-July 1, 1975 disturbed lands. As part of this study, the Commission prepared an inventory of lands disturbed by the severance of pebble phosphate rock prior to July 1, 1975. Records of both existing and extinct mining companies were utilized in the preparation of this inventory. The inventory included both actual sites of severance for phosphate rock and sites disturbed by the disposal of wastes from pre-July 1, 1975 phosphate mining and beneficiation operations. Both the Central and North Florida land pebble districts were in the inventory.

All lands identified in the Commission's inventory were considered for inclusion in the on-site evaluation program. During the evaluations, a few discrepancies were between the Commission's inventory and the company mining records were noted. These discrepancies were resolved by including only those lands shown in company mining records to have been mined or disturbed prior to July 1, 1975.

Parcelization of Pre-July 1, 1975 Disturbed Lands

To facilitate the evaluation of the pre-July 1, 1975 disturbed phosphate lands, the lands included in the inventory were divided into 748 parcels. Disturbed phosphate lands which differ in landform, post-disturbance age, and vegetative characteristics have markedly different ecological values. Therefore, in the parcelization of the disturbed lands, parcel boundaries were drawn to include within a give parcel those lands which are similar in landform, post-disturbance age and vegetative characteristics.

Phosphate mining companies own the majority of the pre-July 1, 1975 disturbed land. Active mining companies were asked to assist in the parcelization of their lands by submitting suggested parcel boundaries and by supplying basic data on date of disturbance, type of mining, nature of waste disposal, present land use, drainage characteristics, and presence of residual minerals. The active mining companies cooperated in supplying this information.

Suggested parcelizations submitted by active mining companies were reviewed to insure that parcel boundaries were drawn around disturbed lands of similar characteristics and that all disturbed land in a company's ownership were parcelized. Aerial photographs of the Central Florida mining district taken in January, 1979 were used as a base for the review. The single North Florida producer supplied aerial photographs, and preliminary field surveys verified that parcelization was done according to similar land characteristics. In some cases, parcel boundaries submitted by phosphate companies were altered to group more uniform land characteristics within parcel boundaries. In other cases, additional parcels were created to include pre-July 1, 1975 disturbed land that had been overlooked by the mining company.

A substantial portion of the pre-July 1, 1975 disturbed land in the Central Florida district is no longer in active phosphate company ownership. Most of this land is currently owned by private individuals or companies. Some of the land in this category is accessible through public rights-of-way; however, there is no public access for the majority of privately owned lands. It was, therefore, necessary to obtain permission from the nonphosphate private and government owners for inclusion of those lands in the on-site evaluation program.

To identify the owner of land in nonphosphate ownership, a comprehensive search of the tax assessor's records in Polk and Hillsborough counties was made. Letters of notification were then sent to all nonphosphate owners without public access. The letters of notification contained a brief explanation of the program with a request for permission to conduct an on-site evaluation of the disturbed lands.

Parcelization of nonphosphate ownerships was done according to the same basic criteria used for the phosphate company ownerships, i.e., similar lands were included within parcel boundaries in so far as possible. Aerial photographs and preliminary field inspections were used to identify like lands. In some cases, the landowners assisted in parcelization of their lands. In general, nonphosphate ownerships tend to be smaller that phosphate company ownership and frequently a relatively uniform disturbed land type encompassed several ownerships. To hold the number of evaluations required within manageable levels, nonphosphate-ownership parcel boundaries were frequently drawn to include several ownerships when the disturbed land within the parcel was relatively uniform in characteristics. This also assisted in getting access to the land for on-site evaluation, as at least one owner would usually grant permission for entry.

Due to the heterogeneity of some disturbed sites, it was not always possible to achieve uniformity of land characteristics within parcel boundaries. For example, in some cases clay settling areas included relatively small sand tailings areas within the boundaries of the dike. The time and resources available for this evaluation did not permit these small minority systems to be treated as separate parcels. Instead, as will be explained in the ecological evaluation methodology, the methodology was adapted to consider minority systems in the overall parcel evaluation.

Final verification of parcel boundaries was left to the field team which did the on-site ecological evaluation. If, in the opinion of the field team, a parcel contained two or more land types which differed significantly in existing or potential ecological rating, the parcel was subdivided along boundaries delineated by the field team.

Exclusion of Parcels from Evaluation

During the parcelization of the disturbed lands, it became obvious that, for some parcels, a comprehensive ecological, economic, aesthetic, regional drainage contribution, and health and safety evaluation did not serve the intent of the law. The following categories of disturbed land were excluded from the comprehensive evaluation process:

* Parcels released as reclaimed by the DNR. Some pre-July 1, 1975 disturbed lands have been reclaimed under approved DNR programs. With the exception of a few parcels which were evaluated to provide an indication of the ecological ratings for reclaimed land, parcels released as reclaimed by the DNR were not evaluated.

* Parcels scheduled for remining. Some pre-July 1, 1975 disturbed lands have sufficient remaining phosphate resources

to justify remining. The remining of such parcels will make them subject to mandatory reclamation requirements. Therefore, parcels scheduled for remining in current mining plans were not evaluated. Parcels with identified mineral resources that were not definitely scheduled for remining were evaluated since there is no assurance these areas will be remined and, therefore, subject to mandatory reclamation requirements.

* Parcels scheduled for future disturbance that would make an evaluation of their existing condition meaningless. Some mined-out areas are scheduled to be converted to clay settling areas or gypsum disposal areas, thereby, completely altering the existing condition of the parcel. Such parcels were excluded from the comprehensive evaluation process.

* Parcels whose owners did not grant permission to conduct an on-site evaluation. This category is restricted to private owners, some of which, for a variety of reasons, did not grant permission to evaluate their lands. All such parcels were excluded from the evaluation.

* Parcels judged to have been reclaimed to an economically beneficial use in an on-site inspection by a DNR representative. Some of the disturbed land, particularly that in private ownership near urban areas, has been reclaimed for residential, industrial or agricultural use. Parcels with such obvious economic use were excluded from further evaluation.

Basic Parcel Data Compilation

A basic data sheet was completed for each of the parcels included in the evaluation. The following information was included:

* Name of the owner or owners
* General description of the parcel
* Size of the parcel
* Date mined
* Type of mining
* Nature of waste disposal, if any
* Present land use
* Adjoining land use
* Nature of surface soil
* Drainage characteristics
* Proximity of residual minerals

The phosphate companies supplied most of this information for lands in their ownership. Nonphosphate private owners assisted in supplying basic parcel data in many cases, although time limitations did not allow interviews with every private landowner. In cases where basic data could not be obtained from the landowner, aerial photographs, mining records, interviews with individuals knowledgeable in past mining activities, and preliminary inspections provided the necessary information. Information listed on the basic data sheets were verified during the on-site inspections.

Numerical Rating System

The 1-10 numerical rating system proposed in the methodology report was essentially followed in assigning ecological and contribution to regional drainage system ratings in these evaluations. This report included a detailed study of 12 representative disturbed sites in order to correlate ecological and contribution to regional drainage system ratings with interpretations of the ratings. The numerical rating interpretations are summarized as follows:

Rating	Interpretation
1	Site characteristic so objectionable as to require modification.
2-3	Site characteristic sufficiently objectionable to require modification if it is economically acceptable to do so.
4-6	Site characteristic neither objectionable nor desirable.
7-8	Site characteristic sufficiently desirable to warrant preservation unless modification is necessary for non-environmental reasons.
9	Site characteristic sufficiently desirable to warrant preservation.
10	Site characteristic so desirable to require preservation.

10.0 SITE STUDY - ECOLOGICAL EVALUATION

Preliminary Studies

The development of methodologies for the ecological evaluation posed formidable problems which were resolved only after several months of preliminary studies. The landscapes of abandoned phosphate mines do not exist elsewhere in Florida or in other regions with similar geology and biota. The very scanty scientific and technological literature on the biota of mined lands in Florida gave no precedents from which ecological survey methods could be adapted. As a result, the methodologies employed had to be formulated *de novo*. The project demanded a uniform methodology of evaluation, so that overall ecological values of all parcels could be compared. This requirement was complicated by the diversity of habitats on abandoned mine sites and by the differences in ages of these sites since abandonment. The methodologies were further limited to these sites since abandonment. The methodologies were further limited to those which yielded significant information during brief site inspections. Careful selection of methods was of utmost importance, because once the project began, logistical limitations prevented the re-examinations of parcels.

Considerable effort was devoted to the development of methodologies during the summer and fall of 1978. This effort consisted largely of four tasks: familiarization in the field with the variety of landscapes and habitats at abandoned mines; an intensive investigation of twelve parcels in order to test the effectiveness of various field methods; a search of the literature for any pertinent ecological information; and interviews with sixteen persons with specific knowledge of abandoned phosphate mines. The twelve parcels for intensive study were selected from the many sites examined during the process of familiarization with landscapes and habitats. These parcels consisted of four clay settling ponds which had been abandoned from 5 to 25 years, four sites that had been mined with draglines and abandoned from 5 to 45 years previously, two sand tailings disposal sites which were abandoned 10 to 20 years previously, and two areas that had been mined hydraulically 60 to 70 years previously. These sites contained a broad representation of the terrestrial and wetland biota typical of abandoned mines. In addition, mine-pit lakes were studied at three of these sites.

The following activities constituted the survey at these parcels. Bathymetric recordings were made in the lakes; water samples were analyzed for 13 criteria of water quality (Ph, color, DO, BOD, fecal coliform, hardness, Ca, conductance, NH3, NO3, TKN, P, chlorophyll 'a'); soil samples from terrestrial sites were analyzed for Ph, particle size distribution, organic matter content, and available nutrients (Ca, Mg, P, K); species lists for all vascular plants and vertebrate animals were prepared; in wooded terrestrial habitats quadrats (500 m2) were established for density counts of trees and shrubs and for basal area determinations of trees; biomass of the leaf litter was determined from ten, 0.1 m2 quadrats nested within each 500 m2 quadrat; percent cover was estimated visually for woody plants collectively and herbaceous plants collectively within each 500 m2 quadrat; and the presence of all exotic plan species was noted.

The methods selected for the project were based primarily on the results and experiences obtained during the study of these twelve parcels. Several methods used in the study of the twelve parcels were rejected because they consumed too much time or they yielded little useful information. Other methods accepted, some with modification.

The literature search yielded only a few published scientific papers, government documents, and unpublished technical reports that were in any way pertinent to the project. Collectively, they provided a qualitative overview of terrestrial and wetland habitats and also some specific information on mine-pit lakes.

Overview

Upon completion of the preliminary studies, two related tasks awaited completion before the ecological evaluations could begin. The first was to decide upon the exact methodologies that would be used in the field. The second was to develop an ecological model, so that the field data could be translated into an ecological index value for each parcel. The parcels could be ranked, then, by their ecological index values. The model depended on field methodologies which had proven to be effective in the preliminary studies.

The initial impediment to be overcome in developing the ecological model was the heterogeneity of the habitats. How could the aquatic habitat of a mine-pit lake be compared in ecological value to that of a well-drained spoil windrow? The model had to be developed so that such comparisons could be made. This problem was complicated by the need for applying entirely different methodologies of field data collection to aquatic and terrestrial habitats.

The first step in the resolution of this problem was to divide the array of habitats into three broad categories; aquatic, terrestrial, and wetland. Once the three systems were defined, the kinds of data and the techniques for their collection were selected individually for each system. A routine for each system was developed for calculating ecological values. Collectively, these routines constituted the ecological model. Several subroutines and modifications were included in the model to cover special situations.

Systems Definitions

The three habitat categories were defined as follows:

* Aquatic Systems were those that were permanently inundated, at least during years of near-normal rainfall. Nearly all aquatic habitats consisted of mine-pit lakes and most of these were quite deep and steep-sided.

* Terrestrial Systems were those that occupied upland habitats, all forested habitats, and clay settling ponds that had dewatered to the point that the surface soils were aerated most of the time. These dewatered settling ponds generally were dominated by willows, often in combination with shrubs and small trees like was-myrtle and saltbush (*Baccharis* spp.).

* Wetland Systems included two kinds of sites. The first consisted of the shorelines and lowlands around mine-pit lakes

where the hydroperiod was sufficiently prolonged to exclude forested vegetation. The second consisted of all clay settling ponds with the exception of those that contained permanently deep waters and those that had dewatered to the point that the surface soils were aerated much of the time. Settling ponds that contained permanently deep waters were those that were constructed below-grade; i.e., old mine cuts into which slimes had been introduced.

Younger clay settling areas were often shallow ponds, sometimes with patches of emergent cattails scattered about. These ponds were often part of the recirculation system for an active beneficiation plant, even though they no longer served as active settling areas. As such, their water levels were manipulated according to the needs of the beneficiation plants. At times they contained virtually no water, and at other times they contained water several feet deep. These settling areas were treated as wetlands because of their shallow, widely fluctuating, and usually temporary waters.

The model was constructed according to certain ecological propositions that were applicable to the mined lands of the region. The ecological processes and principles which comprised these propositions were determined from the preliminary studies, from a familiarity with the natural history of Florida, and from general tenents of ecology. These propositions are summarized below for each of the three systems.

Ecological Propositions Used as the Basis of the Ecological Rating System

Aquatic Systems

Littoral zones are important for the production of aquatic plans and invertebrate animals, which serve as the basis for food chains. Lakes that are so shallow as to be comprised primarily of littoral zones, though, may become overgrown with undesirable levels of vegetation.

Both emergent and submersed plants are important for cover for birds and small fish and for surfaces of attachment for algae, larval insects, and other invertebrates. Prolific growth of aquatic plants makes forage fishes unavailable to game fish, causes oxygen depletion at night, and makes the lake unsuitable for ducks.

Clear water allows the penetration of sunlight. The greater the penetration, the greater the size and productivity of the littoral zone. Excessive nitrogen leads to undesirable algal blooms which reduce light penetration and cause oxygen depletion at night. Too little nitrogen, though, reduces primary productivity below optimal levels.

Exotic species, especially water hyacinth and hydrilla, may overtake lakes, rendering them useless for recreation and lowering their biological diversity. Duckweed (Lemnaceae) in abundance reduces the abundance and reproduction of fish (Crittenden, 1965).

Terrestrial Systems

The mature, potential vegetation on abandoned mine sites will be a forest dominated by deciduous and semi-evergreen species. Fire will be a rare occurrence and of little consequence because of topographic irregularities and the sparsity of grasses and other highly flammable fuels. Mined sites already containing well developed forests are valued higher than those sites that are less copiously wooded.

The primary source of seeds and other propagules for this forest will be from the natural mesic and hydric forests of floodplains bordering streams. Abandoned mine sites remote from floodplains are sparsely vegetated with wind- and bird-dispersed plants, while sites nearer floodplains are more copiously vegetated by a greater variety of plants. Plants of pinelands and scrub are little represented on abandoned mine sites.

The proximity of a forested mine site to an extensive, natural floodplain will allow the free migration of animals between these habitats and thus will enhance the faunal richness of forests on abandoned mines.

The mature, potential vegetation on any mine site will not closely resemble the mature vegetation in natural habitats of the surrounding region. Topographic differences and immature soils of uncharacteristic parent materials will contribute to the vegetational dissimilarities. Furthermore, the older abandoned mine sites seem to maintain their distinctive vegetational character and show little evidence of succession towards the regional climaxes. The Eglerian concept of initial floristic composition seems to represent the predominant process in vegetational development, rather than the more traditionally accepted process of succession, based on the reaction theory.

Exotic and weedy species are common on mined sites and often include nuisance species. These are defined as those which colonize open sites aggressively and persist indefinitely, because they are much better established and can compete effectively with the seedlings of indigenous and non-weedy species.

The greater the number of plant species on a site, the more stable the ecosystem and the better the habitat for animals. The greater the number of dominant species, the better for the same reasons.

Leaf litter which forms a continuous mat on the forest floor is considered beneficial. It provides a habitat for many animals, stabilizes eroding soils, and it reduces the diurnal fluctuations in soil moisture and temperature. It is also the source of finer organic matter which, when incorporated into the mineral soil, causes the development of a mature soil profile.

Wetland Systems

Wetland vegetation consists of herbaceous growth (e.g., cattails) or of thickets of brush or small trees rather than of forests of tall trees. Wetland vegetation is maintained by fluctuating water tables and/or by frequent fires and/or by cattle grazing. Fluctuating water tables make the habitat too dry at times for the colonization of submersed aquatic species and too wet at other times for the colonization of most trees. Fires and grazing also retard the invasion of trees and shrubs. It is questionable if prolonged hydroperiods from seasonally high water tables are sufficient to prevent the invasion of forest species without the added influence of fire or grazing.

High numbers of plant species and high numbers of dominant plant species both favor ecological stability and habitat quality for animals.

Exotic nuisance species degrade habitat quality.

Well-vegetated sites with occasional openings are optimal for most animals that inhabit wetlands.

10.0 SITE STUDY - ECOLOGICAL EVALUATION SYSTEMS CALCULATIONS

Routine for Determining the Ecological value of an Aquatic System

The ecological values of aquatic systems are determined on the basis of points assigned to each of the categories below. The ecological value for this routine equals the sum of the points for each category.

These categories reflect the difficulties of making accurate population estimates of most aquatic plants and animals by direct observation. Physical parameters serve as indirect indicators of biological productivity, along with the percent cover of the more easily observed plants.

Extent of Littoral Zone	Points
No littoral zone	0
1-10% of the lake	1
11-20% or 31-100%	2
21-30%	3
Cover of Submersed or Floating-leaved Plants	
< 1%	0
1-10%	1
11-20% or 31-100%	2
21-30%	3
Water Clarity (Visibility of Secchi disk in inches)	
0-12	0
13-24	1
25+	2
Water Quality (ppm of total Kjeldahl nitrogen)	
over 6 ppm	0
26-50%	-1
51-100%	-2

In 38 parcels containing aquatic systems, water clarity and/or water quality measurements were not made. Inaccessibility and personal risk prevented some water clarity readings. Some lakes could not be reached by vehicle, and a canoe would have to have been carried over rough terrain over long distances to reach the shore. Other lakes were completely surrounded by long steep slopes with loose, slippery soil containing large cobbles. Transporting a canoe over such slopes constituted an unwarranted accident hazard. Nitrogen values were not obtained in recently abandoned clay settling ponds which were being used in the recirculation systems of active mines. Nitrogen values from these waters would have indicated industrial, more than habitat, conditions. In order to compensate for the missing parameters, the following formula was used as a subroutine.

$$\text{Total Points} = \frac{V}{V-P} \times T$$

Where, V = Maximum points possible for the system
P = Maximum points possible for the missing parameter
T = The sum of the points obtained for all other parameters at that site

For example, if the water clarity value was missing in a lake for which all other values equaled 2, then

$$\frac{10}{10-2} \times 2 = 2.5$$

The ecological value of that lake would be 2.5.

Routine for Determining the Ecological Value of Terrestrial System

The ecological value for a terrestrial system is determined on the basis of the points assigned to each of the categories listed below. To determine this value, add the points awarded in each category and divide that sum by three.

Basal Area of Trees (m2/ha)	Points
0	0
1-4	1
5-7	2
8-10	3
11-15	4
16-23	5
24-31	6
32+	7

Numbers of Trees with a Relative Density of .5% Excluding Exotic Species	
0-1	0
2-3	1
4-5	2
6+	3

Litter Cover

0-0.50	0
0.51-0.75	1
0.76-1.00	2

Number of Tree Species on the Site

0-5	0
6-10	1
11-16	2
17+	3

Number of Non-Arboreal Species on the Site

0-14	0
15-29	1
30-44	2
45-59	3
60-74	4
75+	5

Present Exotic Species on the Site

0-5	0
6-10	-1
11-15	-2
16+	-3

Percent of Escape Cover for Animals

0-5	0
6-15	1
16-30	2
31-50 or 81-100	3
51-80	4

Water Resource for Animals

No water near the site	0
Water available nearby	1
Water present on the site	2

Details on Forested Parcels - The first three parameters listed (basal area of trees, number of trees with a relative density of >5% excluding exotics, litter cover) were determined in a 500 m2 quadrat. A quadrat was established only in parcels containing forested cover; that is, with many trees of at lest four inches in diameter. If forested cover was absent, then no points were awarded for the first three parameters. The quadrat was placed where the forest was well developed, as long as the development was representative of the forested portion of the parcel. For example, if the forest was rather uniform except for a small grove of exceptionally large trees, that grove was not included in the quadrat. Likewise, brushy openings and edges were excluded from the quadrat.

Some terrestrial parcels contained both forested areas and open areas dominated by grasses, herbs, or brush. In order that values for basal area and density of trees would not inflate the true ecological value of a partially wooded parcel, the following subroutine was utilized for partially forested sites:
If the forested areas collectively comprised no more than 9% of a parcel, no quadrat data were taken. If the forested area exceeded 9%, then the values of basal area (m2/ha) and litter (% cover) were transformed according to the following schedule before being entered in the point total for the parcel:

Percent of Forested Area	Multiply by
10-30	.3
31-50	.5
51-70	.7
71-100	1.0

Details on Food Resources - The estimate of food resources for animals was based on the abundance of plan species known from the literature as being important in the diets of bobwhite quail, eastern cottontail rabbit, and white-tailed deer. These species were selected because of their presence on the parcels, their importance as game animals, the wealth of literature pertaining to their diets, and because many other animals of mined lands are likely to utilize the same food items in their diets.

The initial step in determining the density of important food plants consisted of estimating the abundance of these plants within each of six plant groups: Trees, Shrubs, Woody Vines, Ferns, Graminoids (grasses, sedges, rushes), and Forbs (other herbs). Four degrees of abundance were recognized - Absent, Low Density, Moderate Density, and High Density. Estimates were made relative to coverage by terrestrial systems and seasonally dry wetlands. After determining density by plant group, point values were assigned in the following manner: Absent - 0 points, Low Density - 1 point, Moderate Density - 2 points, High Density - 3 points. The final and overall density determination was based on the cumulative point value. If the total point value was else than ten, the plot was rated as having a low density of food plants; if the cumulative point value was ten or greater, the plot was rated as having a high density of food plants. An example of this rating routine is as follows:

	Trees	Woody Shrubs	Vines	Ferns	Graminoids	Forbs
Density Est.	High	Low	Mod		Low	
Point Value	3	1	2	2	1	

The cumulative point value was 10, and the density, therefore, rated as "high".

There are two advantages of this type of rating system. First, it is much easier to make consistent field estimates of plant densities when estimates are made by plant group rather than attempting to make one gross estimate. Second, it minimizes the chance of distorted estimates in parcels that contain a dense growth of a food plant that is beneficial to only one of the three target species (bobwhite, cottontail, deer).

In parcels where the density of food plants in a plant group was difficult to ascertain, a judgement was made on the quality of food plants present. For example, if the plant group in question was composed largely of food plants beneficial to all three target species or was composed of plants which produced a great quantity of food, then this plant group was rated upwards. Conversely, if the plant group was composed largely of species which were of importance to only one target species or of plants which provided limited food supplies, then the density of this plant group was rated downwards.

Many parcels contained improved pastures. Often these pastures were seeded to species beneficial to the target animals, especially bobwhite and cottontail. Just as often, however, these pastures were subjected to very heavy grazing by cattle; thus, creating the paradox of having a beneficial food plant present, but one which provided very little foodstuffs; e.g., few seeds for bobwhite. Density estimates were downgraded one point in such instances.

Food resources were estimated not only on density but also diversity. A plot was rated as having a high density of food plants if it provided a year round food supply for all three target species, and if it included food plants from at least three of the six plant groups. In parcels where the year-round availability of food sources was doubtful, a high diversity rating was given only if a minimum of 20 food plant species were present.

Details on Escape Cover Resources

For cover resources, the percent cover of available habitat was estimated for use as nesting, bedding, roosting, shelter, or escape by any of the three target species. This estimate was provided whenever terrestrial systems occupied five percent or more of the parcel. The basic cover requirements for each of the target species was determined from the literature, and then a composite of all requirements was prepared.

The bobwhite requires a mix of ungrazed grassland, brushland (cutover woodlands, shrub thickets, or lands reverting to woodlands), and open woodlands for cover. Ideally, these cover types should occur as small units interspersed among or in proximity (within about 50 yards) to feeding territories. The character of the ground vegetation is critical; it must not be too sparse to prevent concealment nor too dense to prevent or impede movement. The bobwhite will seldom utilized dense and extensive stands of timber or inundated woodlands. For nesting, the bobwhite prefers a cover of tall grasses whereas for roosting, shelter, and escape it prefers a wooded cover.

The cover requirements of the eastern cottontail are similar to those of the bobwhite. It, too, prefers a mix of open woodlands, brushland, and ungrazed grassland, and these need to be interspersed as small patches among feeding territories for optimal conditions. Nesting habitat is much less restricted than that for bobwhites. Nests may be located in any of the cover types noted above. For escape, shelter, and resting the cottontail prefers wooded retreats. Like the bobwhite, the cottontail generally avoids dense and extensive stands of timber and also flooded woodlands.

The white-tailed deer prefers woodlands for cover, particularly young dense forested stands in which hardwoods or a mix of hardwoods and conifers occur. For bedding and resting, deer will seek the more open stands which offer a relatively unobstructed view. For escape and shelter, deer will often retreat to thickets of evergreen shrubs and trees. The white-tailed deer will also utilize flooded woodlands for escape cover.

Based on the cover requirements of the three target species, the following were accepted as suitable cover habitats on mined lands:

* All grasslands or fields that supported a mix of grasses and other herbaceous plants in which densities were not too sparse to prevent concealment or too dense to prevent movement by bobwhite or eastern cottontail and in which at least one patch of woody cover existed somewhere within about a 50 yard radius.

* All shrubby thickets that bordered fields or occurred among forested openings.

* All forested habitats except in those willow swamps in which the saturated clay substrates were unable to support the weight of a white-tailed deer.

Routine for Determining the Ecological Value of a Wetland System

The ecological values of wetland systems are determined on the basis of points assigned to each of the categories below. The ecological value for this routine equals the sum of the points for each category divided by two.

Percent Cover	Points
1-10	1
11-30	2
31-50	3
51-70 or 81-100	4
71-80	5

Number of Species with Frequencies . 0.2	
1-2	1
3-4	2
5-6	3
7-8	4
9+	5

Number of Native Species	
1	1
2	2
3-4	3
5-6	4
7-9	5
10-14	6
15-21	7
22-30	8
31-41	9
42+	10

Ecological Evaluation of Heterogenous Parcels

A heterogeneous parcel was defined as one in which two or three systems were present. Any system represented on 5% or more of the parcel was called a majority system. Any system represented on less than 5% of the parcel was a minority system. Minority systems were not evaluated except for the determination of a minority system value which was determined as follows:

> The native plant species were listed which were present in one or two minority systems, except for those species that also occurred in one or both majority systems. A value of 1 was assigned for each group of 15 species or fraction thereof. The minority system value was the sum of these values.
>
> For example, assume that a parcel consisted of all three systems: 96% terrestrial, 2% aquatic, and 2% wetland. The terrestrial system was the only majority system and the aquatic and wetland systems were both minority systems. Assume that 33 species occurred in terrestrial sites. The minority system value for the parcel would be calculated as follows:
>
> > 33-17 = 16, or
> > 2 points : one point for the first 15 species and one for the 16th.
>
> If one majority system was present, its ecological value was calculated and added to the minority system value. The sum was the ecological value for the parcel.
>
> If two or three majority systems were present, their ecological values were calculated independently. Each of these values was multiplied by the percentage (nearest 1%) of the parcel that was the respective systems occupied. The ecological value of the parcel was their sum plus the minority system value, if any.

Modification of Values for Rare and Endangered Species

Sites that contained significant populations of endangered, threatened, or other listed species by governmental agencies were to receive an automatic rating of nine. A "significant" population is defined as one that contains many individuals that would not survive on a reclaimed site or that would not migrate and survive elsewhere following reclamation. If a population of listed species was judged not to be "significant", then the ecological value of the site may have been increased to reflect the importance of the listed species population. The evaluator was required to explain in writing on the Environmental Rating Sheet any adjustments of ecological values for a site, based on listed species.

Although alligators, woodstorks, and several other listed animal species were sighted on some parcels, no populations of these species were considered as being "significant".

Determination of Potential Ecological Values

After determining the present ecological value of a parcel, the evaluator had to estimate the potential value; i.e., the probable ecological value 25 years hence, assuming no substantial disturbance of the parcel from land use or other human activities. Guidelines used for the determination of the potential values for each system are presented below.

Terrestrial Systems

Physical conditions that have considerable influence are soil moisture and soil type. Excessively drained soils at the peaks of spoil windrows and in sand tailings disposal areas are sparsely vegetated, regardless of the number of years of abandonment. The lack of clay in sand tailings disposal areas not only promotes rapid internal drainage but also insures minimal levels of mineral nutrients. The soils of debris piles are only slightly clayey and are nearly as well drained and infertile as those of sand tailings. Soils developing on overburden have a higher clay content, more mineral nutrients, and better moisture holding capacities.

These observations suggested that little or no change in ecological value can be expected within 25 years on sand tailings, debris soils, and similar sites with excessive drainage and/or low clay content. On parcels with better soils, the preliminary studies generally showed an increase in ecological value with age, at least on spoil windrows.

Further, the highest values were associated with sites adjacent to natural floodplains forest, which serves as a seed source. General observations made during the course of the preliminary studies indicated that the vegetation became sparse and floristically depauperate with distance from the nearest floodplain forest. At greater distances the predominant plants are those with wind- and bird-dispersed seeds. Dikes around settling ponds appeared to be effective deterrents to dispersal for most floodplain species.

As a guide for determining the potential ecological value for spoil windrows, the following procedure was used, unless there were site-specific circumstances which merited consideration. An increase of one point was assigned to a site that lies one-half mile from a floodplain. An increase of two points were assigned to sites contiguous with floodplains.

Aquatic Systems

The preliminary studies showed that ecological conditions did not differ significantly between recently formed lakes and older lakes.

As a result, potential ecological values should not differ from present values.

Clay Settling Ponds

The preliminary studies indicated that settling ponds have moderately high ecological values about five years after being taken out of service. As dewatering progressed, the ecological values dropped sharply.

After ten years, the vegetation was dominated by willow or other woody growth, requiring the site to be reclassified as a terrestrial system. Very few settling ponds existed that had been left undisturbed for more than ten years. As a result, it is not known whether or not the very low ecological values will improve in time. The oldest site studied had been out of service for about 25 years. The willow forest was senescent, and the openings created by fallen trees were occupied by tangles of vines. Trees of only a few other species occurred with the willows and these in low densities. Seedlings and saplings of other trees were spotty in distribution and virtually absent in various localities within the parcel. The possibility of such a site ever supporting a well developed forest is doubtful. The high dikes surrounding most settling ponds would be expected to retard the dispersal of many species, even from adjacent floodplain forests.

The potential ecological values of clay settling ponds were not rated higher than their present values unless extraordinary circumstances were noted on the evaluations for specific parcels. A minor exception was made for settling ponds that were taken out of service very recently and, therefore, had very low ecological values, usually below 3.0. The potential values of settling ponds that will change from wetlands to terrestrial systems ordinarily were given ecological values that were lower than their present values.

Ecological Evaluation

The field data were summarized later on an Ecological Evaluation Form. This one page summary contained a brief narrative describing each system and all data necessary for calculating present and potential ecological values. The Ecological Evaluation Form is included as Figure 3.

Assignment of Ecological Ratings by the Grouping Technique

During the course of the evaluation process, it became obvious that parcels of like disturbed land type, age, and vegetative

ECOLOGICAL EVALUATION

Parcel ____________
Date ____________
By ____________

Points | Potential

TERRESTRIAL SYSTEM, ___ % of Parcel ______%

Description/Dominants: ________________________________
____
____

Percent forested area ____%
Total number of species _____
Basal area _____ m2/ha
____ No. of native tree species with rel. density >5% _____ ____
____ Litter cover ____% ____
____ No. of trees in system _____ ____
____ No. of non-arboreal species in system _____ ____
____ No. of exotic species in system _____, _____% ____
____ Escape cover for animals ____% ____
____ Food resources: density _____ diversity _____ ____
____ Water resources: _____on site; _____<1/2 mi; _____ >1/2 mi. ____
____ Total Points ____

AQUATIC SYSTEM, ___ % of Parcel ______%

Description/Dominants: ________________________________
____
____

Extent of littoral zone ____%
____ Cover of aquatics (submersed of floating-leaved) ____% ____
____ Water clarity ____ inches ____
____ Water quality _____ ppm TKN ____
____ Nuisance species ____% cover ____
____ Total Points ____

WETLAND SYSTEM, ___ % of Parcel ______%

Description/Dominants: ________________________________
____
____

Vegetational cover ____%
____ Species with frequency >0.2 _____ ____
____ Total number of species _____ ____
____ Number of exotic species ____, ____% ____
____ Total Points ____

____ Minority System Value _____ no. native species not in majority systems

ECOLOGICAL VALUE
Calculation:

POTENTIAL VALUE
Justification:

Figure 3: Ecological Evaluation Form

characteristics were receiving very similar ecological ratings. When a group of similar parcels occurred within the boundaries of a mine site, it was determined that the collection of detailed ecological data on a few representative parcels would provide an accurate indication of the ecological rating of the group as a whole. In order to facilitate the evaluation of the large number of parcels dealt with in this study, similar parcels within a mine site were assigned to specific groups such as young, predominately open water clay settling areas; mature, predominately terrestrial clay settling areas; etc. The ecological evaluation team collected detailed data on one or more parcels representative of the group, calculated an ecological rating for these representative parcels, and then assigned this representative rating to the group as a whole.

All parcels within a group were inspected by the ecological evaluation team to verify the grouping assignment. If the field team had any doubt about the accuracy of the grouping assignment for any particular parcel, detailed data were collected for that parcel and an ecological rating was assigned based on the detailed data. Of the 498 parcels assigned an ecological rating, 111 were rated by the grouping technique. The remaining 387 parcels were rated on the basis of detailed ecological data collected on the particular sites.

10.1 SITE STUDY - REGIONAL DRAINAGE

Contribution to Regional Drainage System Evaluation

The contribution to regional drainage system evaluation considered the following two factors:

*Effect on regional water quality

*Effect on storm water drainage

Numerical ratings of from 1-10 were assigned to these factors in an on-site evaluation of each parcel.

Effect on Regional Water Quality

Ratings were designed to consider the full range of possible effects that pre-July 1, 1975 disturbed lands might have on regional water quality. Numerical ratings were assigned according to the following site characteristics identified in the on-site evaluation:

Numerical Rating	Effect on Regional Water Quality
1	Major source of turbid runoff, toxic wastes, or excess nutrients. This rating was reserved

for sites in which there was evidence of extreme gully-type erosion or acid runoff into a regional drainage course.

2-3	Minor source of turbid runoff or excess nutrients. These ratings were assigned to sites in which there was some evidence of erosion or nutrient runoff into a regional drainage course but no evidence of fish kills or other severe degradational effects on the receiving waterbody.
4-6	No effect. These ratings were assigned to sites in which there was either no drainage outlet to a regional drainage course or there was no apparent effect of drainage from the site on the water quality of the receiving body. Terrestrial sites were assumed to have no effect if there was no evidence of erosion into a drainage course. Aquatic sites with an outlet to a drainage course were sampled to determine if the drainage water would meet Department of Environmental Regulation's pH, turbidity, and fecal coliform standards for discharges into Class III waters. Aquatic sites which were part of active waste disposal or water recirculation systems were assumed to have no effect, since discharges from these areas are monitored by the Department of Environmental Regulation for acceptability.
7-9	Minor filtering effect on sediment or excess nutrients. These ratings were reserved for parcels which met two conditions. First, there had to be some evidence of turbid runoff or drainage water of substandard quality entering the parcel from off-site. Next, there had to be evidence that the water draining from the parcel was of acceptable quality. For terrestrial sites, such evidence was inferred by the absence of erosion gullies. For aquatic sites with an outlet to a drainage course, the water quality had to meet Department of Environmental Regulation's pH turbidity, and fecal coliform standards for discharges into Class III waters.
10	Major filtering effect on toxic wastes, sediment, or excess nutrients. This rating was reserved for sites which include a

catchment area in the absence of which fish kills or other severe degradational effects would result in the receiving water body.

Effect on Storm Water Drainage

Through creation of lakes and settling areas, some pre-July 1, 1975 disturbed lands may be serving as retention areas for storm water surges, thereby reducing downstream flooding problems. On the other hand, mining may have altered natural retention areas such as floodplains; therefore, some disturbed sites may be contributing to downstream flooding problems. The numerical rating system listed below was designed to consider the full range of possible effects.

Numerical Rating	Effect on Storm Water Drainage
1	Major contribution to downstream flooding.
2-3	Minor contribution to downstream flooding.
4-6	No significant effect on storm water damage.
7-9	Minor contribution to storm water attenuation.
10	Major contribution to storm water attenuation.

The effect on storm water drainage evaluation is one case in which it was not realistic to consider the full range of ratings based on field observation. A detailed hydrological study is required to determine if a site makes a major contribution to downstream flooding or storm water attenuation. Such studies were beyond the scope of the evaluation. In lieu of such studies, inferences as to a site's effect on storm water drainage were made based on field observation of the site's topography, a review of U.S.G.S. Quadrangle maps of the disturbed area before and after mining, and a general knowledge of the drainage history of the area. If a parcel had no significant retention area for storm water, if no natural floodplains were disturbed in the mining of the site, and if there was no history of downstream flooding problems either before or after mining, then the parcel was assumed to have no significant effect on storm water drainage. Parcels in this category were assigned a rating of 5. If a parcel had a significant retention area for water storage, e.g., clay settling areas and lakes with a freeboard of 10 feet or greater, then it was assumed that the site had a potential for storm water attenuation. Such parcels were assigned a rating of from 7-9, depending on the freeboard available.

The assignment of ratings to indicate either a major or minor contribution to downstream flooding or a major contribution to storm water attenuation was judged to be beyond the capabilities of this evaluation. If a natural floodplain had been altered in the mining of a site and there was a history of downstream flooding in the area, then the field evaluation was directed to indicate that a hydrology study was necessary to determine the effect of the site on storm water drainage characteristics.

11.0 SITE STUDY - AESTHETIC EVALUATION

Aesthetic Evaluation

The aesthetic evaluation of the individual parcels was researched and prepared by Ms. Edwina Horn as a Master's Thesis in the Department of Landscape Architecture at the University of Florida. Ms. Horn's advisor was Dr. Earl Starnes, a member of the Land Use Advisory Committee (LUAC). Data for the aesthetic evaluation were collected by Department of Natural Resources' staff on a parcel-by-parcel basis.

These data were categorized by Ms. Horn according to landscape character types (LCT). The LCT categories are based on the types of landforms that were noted in the initial twelve-site survey conducted by Conservation Consultants, Inc. and Zellars-Williams, Inc.

Positive, negative or neutral ratings were given to parcels for each of several factors. One important factor involved in the aesthetic evaluation was the effect of age on each LCT at various stages of abandonment. Other factors, such as the presence of surface water, site diversity, etc., were rated according to their effect on aesthetics. The weighting of these effects resulted in the ultimate assignment of a priority rating.

Parcels were assigned aesthetic reclamation priority ratings of exempt, low, or high based on the projected aesthetic value of the parcel without artificial reclamation. Projections were estimated for 20 to 25 years in the future. Exempt ratings were assigned to parcels which are projected to have acceptable aesthetic value without artificial reclamation. High aesthetic reclamation priority ratings were assigned to parcels which have poor projected aesthetic values if left unreclaimed, but not sufficient value to warrant an exempt rating.

Some parcels were excluded from the aesthetic reclamation priority analysis. Any lands considered artificially reclaimed were assigned an excluded rating.

12.0 SITE STUDY - HEALTH AND SAFETY EVALUATION

The on-site inspections included an analysis of site characteristics that might affect human health and safety. The following four factors were considered in this evaluation:

* Bank slope
* Alien material
* Water quality
* Soil bearing capacity

The 1-10 numerical rating system was not considered suitable for the health and safety evaluation. A area may be so hazardous so as to warrant modification, but no area can be so safe that it should not be modified on this basis alone. In lieu of the 1-10 numerical rating system, each of the health and safety factors was classified into one of the following categories:

Category 1. Sufficiently hazardous to require modification regardless of environmental rating and modification cost.

Category 2. Potentially hazardous - should modify if environmentally and economically acceptable.

Category 3. Not hazardous.

Current Department of Natural Resources' reclamation standards (1975) address each factor considered in the health and safety evaluation. If a parcel met current Department of Natural Resources' standards for the factor considered, the parcel received a Category 3 rating for this factor. If a parcel failed to meet current Department of Natural Resources' standards, the parcel received a Category 1 or 2 rating for this factor, depending on the severity of the health and safety hazard identified.

The bank slope, alien material, and soil bearing capacity factors were visually evaluated during the on-site inspection. In order to assign water quality category ratings, water samples were taken from recirculation systems. The water quality categorization was based on coliform standards for discharges into Class III waters. These standards provide a good indication of water quality acceptable for body contact recreational use. Specific criteria followed in assigning Category 1,2, or 3 ratings are listed below for each of the factors considered.

Bank Slope Category	Site Characteristics
1	Accessible overhanging bank present on a site near a residential area.
2	Some on-site slopes steeper than 4:1.
3	All on-site slopes 4:1 or less.

Alien Material Category	
1	Presence of abandoned structures with unstable flooring, stairways, walls, etc. or open wells with diameters of six inches or larger.
2	Presence of miscellaneous mine junk, pipe, equipment, wire, etc. on the surface.
3	No alien material on the site.

Water Quality Category	
1	Water fails to meet Category 2 standards.
2	Water fails to meet all Category 3 standards but meets the following standard: * Free from deleterious and toxic substances in quantities that would render the water unsuitable for agricultural irrigation, stock watering, or industrial use. Water is suitable for recreational use such as swimming, water skiing, etc. as evidenced by its meeting the following minimum standards: * pH between 6.0 and 8.5 * Fecal coliform < 200/100 ml. * Turbidity < Jackson units * Free from deleterious materials and toxic substances that produce color, odor, or other conditions in such a degree to create a nuisance or health hazard.

Soil Bearing Capacity Category	
1	Presence of clay settling area dikes abandoned prior to institution of the Department of Environmental Regulation's abandonment procedure and which would now be considered unsafe.
2	Presence of soils incapable of supporting a human's weight.
3	Absence of soils incapable of supporting a human's weight.

13.0 RECLAMATION COST EVALUATION

The reclamation cost evaluation was intended to provide a versatile and consistent means of quantifying the funding level necessary for reclaiming those pre-July 1, 1975 disturbed lands determined to be in need of rehabilitation. Parcels were evaluated individually to insure application of the technology best suited to reclamation of each type of disturbance within the parcel. The reclamation cost estimates were based on conventional reclamation technology employed by the phosphate industry. The cost estimates for each parcel represent the amount necessary to achieve <u>minimum</u> compliance with reclamation standards as defined in Chapter 16C-16 of the Florida Administrative code.

The reclamation cost evaluation was organized into three tasks - engineering, field data collection, and computer manipulation of data to define the work effort necessary to comply with reclamation standards. The engineering evaluation specified the functions (earthmoving, revegetation, etc.) required to reclaim each type of disturbance (dams, clay settling areas, sand tailings piles, etc.) within a parcel.

The engineering phase of the evaluation also assigned fixed unit costs to the various reclamation functions. Unit costs assigned to the reclamation functions are listed below:

Unit Costs Assigned to Reclamation Functions

Reclamation Function	Unit Cost
Surveying	$ 25/acre
Supervision	$100/acre
Outside services	$ 20/acre
Hydraulically Transported Sand Tailings Fill	$0.05/yd3/mile*
Dewatering	$0.0001/gal*
Spillway Abandonment	$5000/spillway
Diversion Drainage	$0-10,000/parcel
Perimeter Ditching	$2.92/linear foot
Interior Ditching	$0.92/LF x 200 LF =$184/acre
Vegetation Cover Chopping	
Light vegetation	$0/acre
Medium vegetation	$100/acre
Heavy vegetation	$300/acre
Revegetation	$300/acre

*Volume is computed by variable cost model

In order to compute the total cost incurred in the reclamation function, it is necessary to multiply the unit cost by the variable involved. In most cases, the variable is defined on the field inspection form. For example, the revegetation cost for a parcel may be calculated by multiplying the unit revegetation cost of $300 per acre by the number of acres which require revegetation. The cost of perimeter ditching may be calculated by multiplying the unit cost for perimeter ditching of $2.92 per linear foot by the perimeter of the clay settling area listed on the field inspection form. When pumping is required to dewater an area, the dewatering cost may be calculated by multiplying the unit dewatering cost of $0.0001 per gallon by the volume of water that must be pumped out.

In order to compute the total earthmoving cost, the unit earthmoving cost, i.e., cost-per-cubic-yard of material, must be multiplied by the volume of material to be moved. Unit earthmoving cost varies depending on such factors as the distance the earth is to be moved, the equipment employed, the stability of the material over which the earth is moved, and the total volume of earth to be moved. The volume of earth to be moved is one variable that cannot be read or computed directly from the field inspection form. A variable cost model was, therefore, developed to compute the volume of earth that must be moved to achieve minimum compliance with reclamation standards. The variable cost model deals with earthmoving requirements for seven disturbed landforms.

The nature and extent of disturbances present in each parcel were identified during the field data collection task. Field data for the reclamation cost evaluation was gathered by staff employed by the Department of Natural Resources and temporarily assigned to Zellars-Williams Inc. A field inspection team composed of two Department of Natural Resources' geologists visited each parcel included in the cost evaluation. Field inspections were organized and conducted under the supervision of the Zellars-Williams, Inc. engineering staff.

A one-page field inspection form was prepared for use by the field inspection team. A sample field inspection form is shown in Figure 4. The form was designed to list information pertinent to the cost formulae and computations. The form lists 39 data entries divided among four specific types of disturbed land that must be dealt with in reclamation.

Each field inspection form was reviewed by the Zellars-Williams, Inc. engineering staff to verify field observations.

The refined field data were coded and entered in a computer program containing the unit cost data and the decision routine. The computer program manipulated the field data and the unit cost data to calculate the cost of reclaiming each specific type of disturbed land within a parcel. These costs were then summed by the computer to calculate the total estimated reclamation cost for each parcel. The final reclamation cost estimate for each parcel is, therefore,

PRELIMINARY FILED INSPECTION/DATA SHEET

Date ___________ Investigator _____________ Parcel # __________________

Company __________ Mine _______ Sec. ___ Twp. ___ Rng. ___ County _____

Total Area, Acres ____

I. Dams

A. Acres, Dam ____

B. Vegetation Cover, % 1. Lite _____ 2. Med. _____ 3. Dense _____ ______________

C. Linear Feet of Dike @ Centerline ______________________________

D. Number of Spillways ____

E. Water Flow: 1. In _______ 2. Out _______ 3. Both _______ ______________

F. Width at Crest, Feet ____

G. Average Height of Dike, Feet __________________________________

H. Freeboard, Feet ____

1. Present ____

2. Adjusted by Maturity Index: 1. Unstable____ 2. Avg. ____ 3. Mature ____ ______________

I. Outside Slope ____

J. Inside Slope ____

K. Comments ____

II. Clay (Within or Outside Dams)

A. Clay Acres ____

B. Spoil Acres ____

C. Height of Spoil (Reference) ___________________________________

D. Spoil Vegetation, % of Spoil Acres ____________________________

E. Spoil Vegetation: 0. Lite _____ 1. Med. _____ 2. Dense _____ ______________

F. Clay Cover Vegetation, % of Clay Acres _________________________

G. Perimeter Ditch, Y/N? ____

H. Interior Ditching, Y/N? _______________________________________

I. Maturity Index ____

J. Clay Reference Index ____

K. Comments ____

III. Piles (Identify Material)

A. Piles Acres ____

B. Height (Reference) ____

C. Vegetation Cover, %: Lite _____ Med. _____ Dense _____ ______________

D. Slope Less Than 4:1 (Y/N?) ____________________________________

E. Depression to Modify (Y/N?) ___________________________________

F. Depression Depth, Feet _____ Length Feet _____ Width Feet _____ ______________

G. Depression Slope, Avg. ____

H. Comments ____

IV. Interior Windrows (To Move, Shape, Cap, Pond Fill Tails/Cap w/Dike)

A. Acres ____

B. Ovb. Thick. _____ Mtx. Thick. _____ Total Cut _____ ______________

C. Vegetation Cover, %: Lite _____ Med. _____ Dense _____ ______________

D. Tails Available (Y/N?) ____

E. Pumping Distance, Feet ____

F. Big Dragline (Y/N?) ____

G. Dewatering Req. (Y/N?) ____

H. Water Surface Elev, MSL _______________________________________

I. Comments ____

Figure 4: Preliminary Field Inspection Form

the sum of the reclamation cost estimates for the specific disturbed land types encountered in each parcel.

The reclamation cost estimate derived in this manner represents the lowest cost which achieves minimum compliance with the law without regard to ecological, aesthetic, or specialized land use considerations. For some parcels, cost estimates were prepared for more than one reclamation method to determine which method resulted in the lowest reclamation cost. The computer was programmed to retain input information and computed data for ready recall in the event a variance in the reclamation method employed was desired. Changes of this type can be accomplished by making appropriate revisions to the entries on the data sheet before re-running the program in the computer.

In some cases, not all the acreage within a parcel required reclamation to achieve minimum compliance with the law. For example, in many hydraulically mined areas, only the lake edges needed to be graded to meet slope requirements. Consequently, there are often significant differences among parcels between cost per total parcel acre and cost per worked acre. The cost estimates computed for this study are for the total parcel acreage.

The cost estimates are representative of reclamation applied to the general physical character of the parcels evaluated. The cost estimates may not address specific, unique aspects of the parcels or the reclamation methods which may ultimately be proposed for the parcels. The most important aspect of the reclamation cost estimating procedure is its uniform treatment of each parcel which minimizes subjective interpretation that might be applied by different evaluators using different estimation procedures.

14.0 PARCEL ELIGIBILITY CONCLUSIONS

Chapter 378.021 of the Florida Statutes directs the Department of Natural Resources to identify with specificity those pre-July 1, 1975 disturbed lands which are, or will be in a reasonable period of time, acceptable without artificial reclamation. Listed as criteria to be considered in this determination are health and safety, water quality, environmental, economic, and aesthetic characteristics of the disturbed land. Based on these general criteria and an analysis of the data base for each parcel, conclusions were reached as to which parcels were acceptable without further reclamation. Parcels judged to be acceptable were indicated as ineligible, whereas parcels determined to be in need of artificial reclamation were indicated as eligible.

Specific criteria used in arriving at the eligibility decision are discussed in the following sections. The criteria are listed in the order in which they were considered in the decision process. The eligibility decision can be made at any step in the decision process. Therefore, the order in which the criteria were considered is of critical importance to the decision process.

Health and Safety

The elimination of severe health and safety hazards was considered of paramount importance. Therefore, any parcel receiving a Category 1 health and safety rating for any of the four factors considered (bank slope, alien material, water quality, and soil bearing capacity) was automatically judged eligible for reclamation. By definition, Category 1 ratings indicate a site characteristic that is so hazardous as to require modification regardless of other considerations. Only three parcels qualified for reclamation eligibility on this basis.

Category 2 ratings, which indicate potentially hazardous site characteristics as defined by current Department of Natural Resources standards, were not judged sufficiently hazardous to mandate reclamation. Other criteria were used in determining reclamation eligibility for parcels receiving Category 2 and 3 ratings.

Remining Potential

The remining potential of parcels was judged to be definite, probable, improbable, or none based on basic data submitted by the landowner and on-site inspections of the parcel. Definite remining potential was assigned to parcels included in current mine plans. Probable remining potential was assigned to parcels which had significant quantities of debris or unmined matrix on-site. Though not definitely scheduled for remining, such parcels have a high potential for remining at some future date, but remining of disturbed sites will make them subject to mandatory reclamation requirements. Therefore, all parcels with definite or probable remining potential were judged ineligible for reclamation consideration.

Improbable remining potential was assigned to parcels which had intermediate-grade sand tailings or relatively small quantities of debris or unmined matrix on site. Though remining of such sites is possible, it is unlikely under present and projected economic considerations and recovery technology. Ratings of no remining potential were assigned to completely mined-out parcels, clay settling areas, and low-grade sand tailings fill areas. For parcels receiving improbable or no remining potential ratings, other criteria were used in determining reclamation eligibility.

Effect on Regional Water Quality

Sites determined to have a negative impact on regional water quality as indicated by a rating of ≤ 3 for this factor were judged eligible for reclamation consideration.

Economic Utility

Economic utility ratings of high, low, or none were assigned to all evaluated parcels based on the present land uses identified on the basic data sheets. High economic utility ratings were assigned to parcels used as improved pasture, cropland, industrial, residential, or commercial forest sites. Essentially all these uses have resulted from unrecorded reclamation activities of phosphate companies or private individuals. Some of these areas would not meet current Department of Natural Resources' reclamation standards, but all have obvious economic utility. In some cases, economic utility ratings were assigned based on potential rather than present use. For example, sites leveled and planted in improved forage species were classified as having high economic utility for improved pasture even though they were not used for this purpose at the time of evaluation. Gypsum disposal areas were classified as having high economic utility based on their value to the fertilizer processing industry. Sites which received high economic utility ratings were judged ineligible for reclamation consideration regardless of their ecological and aesthetic ratings.

Low economic utility ratings were assigned to parcels used as unimproved pasture. Some mined-out areas, hydraulically mined areas, and clay settling areas have been fenced for cattle. If such sites have not been cleared of volunteer brush growth and planted in improved forage species, the quality of the grazing land is relatively low. Such sites were, therefore, rated as having low economic utility.

Ratings of no economic utility were assigned to parcels where the present land use was identified as idle vegetated, idle barren, recreation, waste disposal, and water recirculation. Waste disposal and water recirculation uses have economic value to active mining operations. However, all mines have a finite life; therefore, these economic uses are only temporary. The purpose of this evaluation was to identify permanent economic utility. Therefore, the economic uses related to active mining were not considered in the assignment of economic utility ratings.

Factors other than economic utility were considered in determining reclamation eligibility for parcels with economic utility ratings of low or none.

Potential Ecological Ratings

In determining reclamation eligibility based on potential ecological ratings, the interpretations of the 1-10 numerical rating system were essentially adhered to. Parcels with a potential rating of $\geq$8.5 (sufficiently desirable to warrant preservation) were judged ineligible for reclamation consideration regardless of their aesthetic reclamation priority rating. Parcels with potential ecological ratings of $\leq$6.5 were judged eligible for reclamation consideration regardless of their aesthetic reclamation priority ratings. It is important to remember that potential ecological value is considered after economic utility in the decision process. Therefore, parcels with high economic utility would already have been eliminated. Only those parcels with economic utility ratings of low or none could be rated eligible due to potential ecological ratings of $\leq$6.5. For parcels with a potential ecological rating of 6.5 - 8.4, the aesthetic reclamation priority rating was considered in determining reclamation eligibility.

Aesthetic Reclamation Priority

No parcel was judged ineligible for reclamation consideration based on an exempt aesthetic reclamation priority rating. However, for parcels with potential ecological ratings between 6.5 and 8.4 (sufficiently desirable to warrant preservation unless modification is necessary for non-environmental reasons), the aesthetic reclamation priority rating was used as the basis for the eligibility decision.

A high aesthetic reclamation priority rating indicates that modification of the site is highly desirable for aesthetic reasons. Therefore, parcels in the potential ecological rating group 6.5 - 8.4, which received a high aesthetic reclamation priority rating, were judged eligible for reclamation consideration. On the other hand, a low, excluded, or exempt aesthetic reclamation priority rating indicates modification of the site is not highly desirable for aesthetic reasons. Therefore, parcels in the potential ecological rating group 6.5 - 8.4, which received low, excluded, or exempt aesthetic reclamation priority ratings were judged ineligible for reclamation consideration.

Reclamation Eligibility Decision Process

Figure 5 summarizes the decision process used in determining reclamation eligibility. This figure illustrates the vital importance of the order in which the criteria are considered. For example, the decision process ends at Step 1 for parcels which receive a Category 1 health and safety rating. The process ends at Step 2 for parcels with definite or probable remining potential. Potential ecological rating is considered after economic utility and is a decision factor only for those parcels with economic eligibility ratings of low or none. Aesthetic reclamation priority is considered last and is only a decision factor for those parcels with a potential ecological rating between 6.5 adn 8.4.

Parcel Eligibility for Non-Evaluated Parcels

All parcels not included in the evaluation for the reasons listed on pages 21-22 were judged ineligible for reclamation consideration, except for those parcels scheduled for conversion to clay settling areas. According to the results of the on-site evaluations, abandoned clay settling areas, almost without exception, have no remining potential, no economic utility, low potential ecological ratings, and high aesthetic reclamation priority ratings. Therefore, based on the decision process followed for the evaluated parcels, areas that are to become clay settling areas will qualify for eligibility.

Justification of the Potential Ecological Rating Eligibility Cut-off at 6.5

The ecological ratings for the parcels do not cluster into discrete units, rather, they form a continuum from low to high. As a result, the decision to use an ecological value of 6.5 as the limit for determining parcel eligibility may appear arbitrary. This limit, though, is not arbitrary for two, very different reasons.

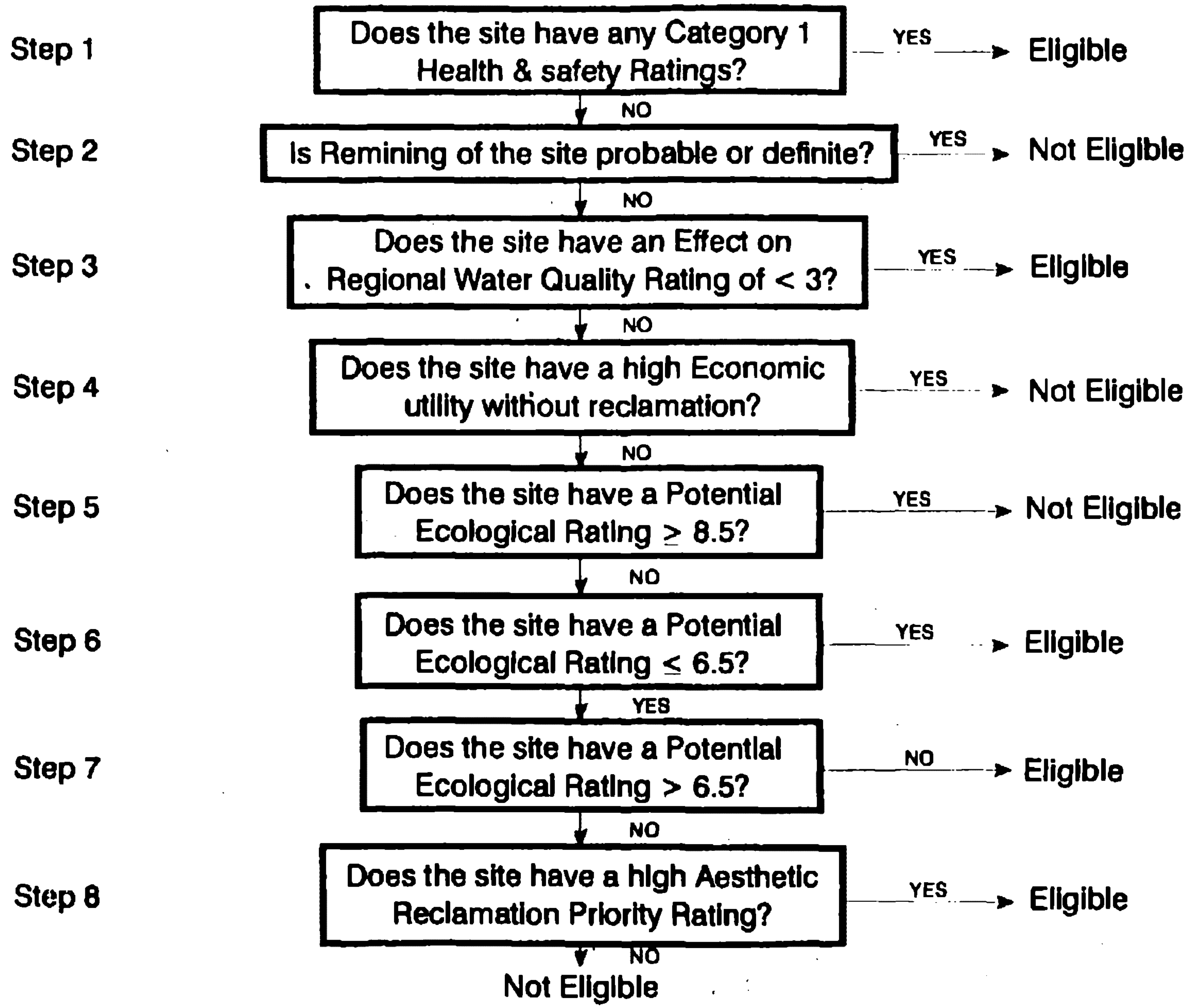


Figure 5: Reclamation Eligibility Decision Process

First, the ecological model, as described earlier was designed specifically so that parcels with high ecological worth would receive a rating of at least 7.0. Since evaluations of 6.5 to 6.9 would be rounded off to 7.0, the eligibility limit was lowered to 6.5. The 12 preliminary studies proved to be adequate for determining the relative ecological worth of mined parcels. These studies comprised the basis for constructing the routines for the model.

Second, ecological values were generally 6.5 higher for stands of natural vegetation on unmined habitats. It would be unreasonable to designate mined parcels as being eligible, if their ecological values equaled those of mature, natural vegetation. Only a few studies are available which describe natural vegetation of Florida in sufficient detail to allow the application of the model. A search was made in the published ecological literature for such studies. Other than for tidal marshes and the Everglades, few stands of natural vegetation have been described quantitatively. Almost all such studies lack comprehensive species lists, which are required in applying the model. The other published studies were deficient in other respects.

Other possible sources of quantitative descriptions were unpublished documents, contract reports, and files. Several ecological descriptions were available from these sources. In all, descriptions were adequate for applying the model to two natural wetlands and six forests. The wetlands were fresh water grassy marshes in shallow depressions within pine-palmetto flatwoods, in Manatee County and both marshes received an ecological rating of 9.5.

Two of the forested sites were hardwood hammocks from Wakulla County. One site received a rating of 7.3 and the other of 6.0 to 6.3, depending on how the animal habitat data were interpreted in the evaluation. This latter stand was dominated by live oaks which colonized an old field about 125 years ago. This stand does not represent entirely natural vegetation, and its ecological value is slightly below the 6.5 eligibility limit.

Four additional stands of hardwood forest were described from central Florida. Ecological values for these stands were 8.3, 8.0 - 8.3 (again, depending on the interpretation of animal habitat data), 7.7, and 5.3. The latter community fell below the 6.5 eligibility limit. The habitat of this community was a hydric river swamp dominated by a tree that typically has low basal areas. The habitat was too wet for a large number of plant species to be present. As a result, the ecological value was low. This type of habitat is rare on mined parcels, and therefore, the low ecological value does not detract from the general finding that natural vegetation has ecological values generally in excess of 6.5.

Users of the model who might apply it to pinelands should be advised that the routines for terrestrial systems were designed for assigning high ratings to forests dominated by hardwoods. The potential natural vegetation of mined lands was considered to be hardwood forest, rather than pineland. Native Florida pinelands, when severely disturbed, generally undergo succession towards a hardwood forest, rather than recovering as a pineland.

15.0 PROGRAM IMPLEMENTATION

Following the completion of the evaluation of abandoned phosphate-mined lands, the administrative rules were developed and adopted in 1982 (Chapter 16C-17, Florida Administrative Code (F.A.C.). The consultant reports, including the methodology, analysis and results including individual parcel evaluation, were incoporated into the rule. Many interests had availed themselves of the opportunity to achieve certain reclamation standards and criteria in these new rules that they had not been able to achieve in the mandatory reclamation rules (Chapter 16C-16, F.A.C.). Differences with Rule 16C-16, F.A.C., had been anticipated (the basis for the first cost model); however, the new rule had major cost elements of earthmoving that necessitated a major revision to the existing cost model. The principal cost element involved the abolishment of finger lakes and the creation of rounded, smooth bottom, shallow lakes.

A new cost modification contract was entered into with the Zellars Williams Company and work initiated expediously. This cost model was envisioned to serve several needs; (1) it would redefine the total cost of the program, and (2) it would be utilized as a basis of cost control and defining minimum work standards and criteria, as defined by Rule 16C-17, F.A.C. Since the cost model was constructed on generalized data, it was anticipated that as active program applications were submitted, more exact data (elevations, cross-section, etc.) would be substituted into the cost model to develop precise costs. In preparing the new cost model it soon became apparent that the new costs were going to be extremely high, running ten times the per acre cost of the first model for the particular landform in question (mined-out water- filled pits with internal spoil windrows). A variety of alternatives were investigated and one routine was selected that cut windrows below water, created islands and moved some spoils to the lake perimeter. Routines were run to optimize the size land area in which to create a single lake. These efforts reduced the cost to approximately four times the acre costs of the first model.

Unfortunately, before the revised model could be completed political pressures to initiate the program became so intense that the decision was made to approve ten programs that had already been submitted, utilizing the cost analysis or estimates from the first model. The approval process required not only the approval of the work effort but also the estimated cost.

When the second cost model was completed staff attempted to have the estimated cost of those first ten approved programs amended to reflect the new cost estimates and also released the impacts on the total trust fund, altering the total amount from $176,000,000 to $213,000,000. The State could now see and appreciate what the translation of concepts into reality could cost and there was considerable concern over the potential future escalation of costs with no definite upper limit. The new cost model was rejected (not incorporated into rule) and a moratorium adopted until the statute could be revisited in the next legislative session.

In 1983, the Florida legislature made major revisions to Chapter 378, Florida Statutes (F.S.). These changes can be summarized as follows:

1. The program responsibility initially split between two agencies was transferred totally to the Department of Natural Resources to focus accountability.

2. A per acre funding cap was established according to landform type. This cap was $4000/acre for mined-out areas and $2500/acre for clay settling areas. Provisions were made to annually adjust these totals in response to inflation.

3. Funding would be in the form of reimbursements, not to exceed the cap, but only for actual expenditures.

4. Actual expenditures would be evaluated in accordance with a doctrine of reasonableness to be established by the agency and the authority granted to the agency to reduce reimbursement requests to meet the test of reasonableness.

5. Provided for the DNR to adopt rules and regulations for reimbursement procedures.

6. Established a Land Reclamation Committee consisting of four members named by the Governor to assist the DNR in establishing a prioritization of reclamation applications when the number of applications exceeded the available funding level for that year.

7. Provided a total funding cap for each year to spread out and stabilize the work effort. The annual funding cap would be 10% of the unencumbered balance of the Nonmandatory Land Reclamation Trust Fund.

Following the enactment of these legislative changes and the adoption of amendments to Chapter 16C-17, F.A.C., the program stabilized and has run successfully to the present time. This phase of the program, an operational one, has undergone considerable evolution and will be the subject of a second report to be prepared later this year.

16.0 PROGRAM OPERATION

16.1 ORGANIZATION

The nonmandatory phosphate section of the Bureau of Mine Reclamation (BMR) is responsible for administering the reclamation program for phosphate IAM lands. The organization chart for the nonmandatory phosphate section is shown in Figure 6. Application review, inspections, and bid documents review are handled by engineering section while reimbursements are handled by the certification and reimbursement section. Apart from two field engineers who live and work in the central phosphate district area, the staff is located in Tallahassee, some 250 miles from the central phosphate district.

16.2 MASTER RECLAMATION PLAN

The nonmandatory reclamation program is administered pursuant to the Master Reclamation Plan. The Master Reclamation Plan, adopted by rule, identified eligible lands, set standards and criteria for applications, reclamation, acquisition of nonmandatory lands by the state, donations of nonmandatory lands to the state,and reimbursement.

16.3 PROGRAM FUNDING

The nonmandatory phosphate program is funded by the Nonmandatory Land Reclamation Trust Fund. This fund is financed by the a portion of the tax levied on phosphate mining operators and interest accruing from the fund itself. The withdrawals from the fund to initiate the program were not made until the fund had accumulated over $60 million. Figures 7 and 8 show the history of the fund. All applications which have met the requirements of the Master Reclamation Plan are prioritized pursuant to priorities established in the Master Reclamation plan. The funding available for reclamation in a given year is 10% of the uncommitted balance in the Nonmandatory Reclamation Trust Fund and has varied between $6 million and $8 million. Applications which fall outside the funding limit in a given year may be resubmitted in the following year.

16.4 APPLICATIONS AND APPLICATION REVIEW

A list of the parcels which are eligible for funding is available to the public through the BMR. Private landowners' interest in applying for funding is quite often generated by consultants. These consultants, who are generally very conversant with the program, are invariably retained to prepare the applications and oversee the program up to its completion. Phosphate mining companies submit applications at their convenience.

An application for reclamation funding through the nonmandatory reclamation program consists of the following:

a) Legal proof of ownership of the property, including notification of adjacent land owners.
b) Written description of existing condition of the program area.

c) Written and detailed description of the work effort involved in engineering, surveying, de-watering, drainage, clearing, earthmoving, revegetation, and the establishment of the vegetation. Quantities are generated for each activity.
d) Estimates of the unit and total costs of each of the activities mentioned in item (c).
e) Aerial photos of the existing condition of the program area.
f) Premining and proposed reclamation contour maps and cross sections.
g) Proposed revegetation maps

The state requires all reclamation application plans and drawings to be signed and sealed by a registered engineer.

The BMR reviews the applications to ensure that all the requirements of the Master Reclamation Plan are being met and also to ensure the accuracy of engineering, cost and other calculations.

16.5 RECLAMATION CONSTRUCTION

Once a nonmandatory reclamation application has been approved, a contract setting forth the conditions for reclamation and reimbursement is signed. Construction must begin within six months of the execution of the contract.

It is responsibility of the landowner to hire the various contractors to perform the reclamation. If a contract exceeds $25,000, competitive bidding is required. However, the BMR reviews and approves all bid documents and proposals prior the contracting of the service. The bureau engineers inspect the construction sites at least once per month.

Reclamation construction is divided into three stages, earthmoving, revegetation, and establishment of the vegetation.

16.6 REIMBURSEMENT

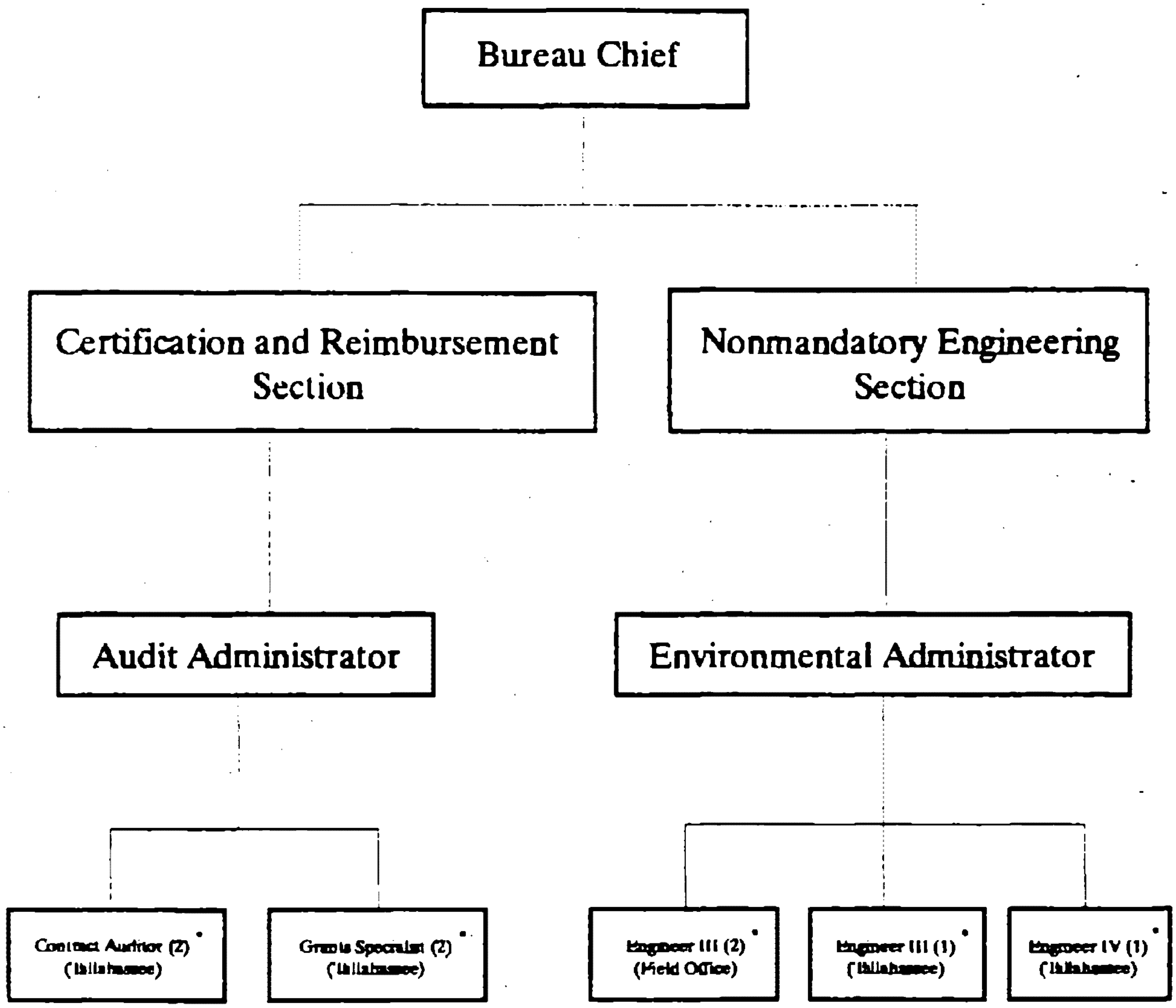
Prior to reimbursement, work completed must be certified by a registered engineer as well as by the BMR's engineer. In addition, proof of payment is required.

Reimbursement can be requested quarterly or at the completion of any of the reclamation stages.

16.7 GENERAL

Figures 8 thru 12 show various statistics of the history and current status of the nonmandatory phosphate program operations.

NONMANDATORY PHOSPHATE ORGANIZATION



* Indicates Number of Positions

FIGURE 6

NONMANDATORY TRUST FUND

ANALYSIS OF FUND INCOME

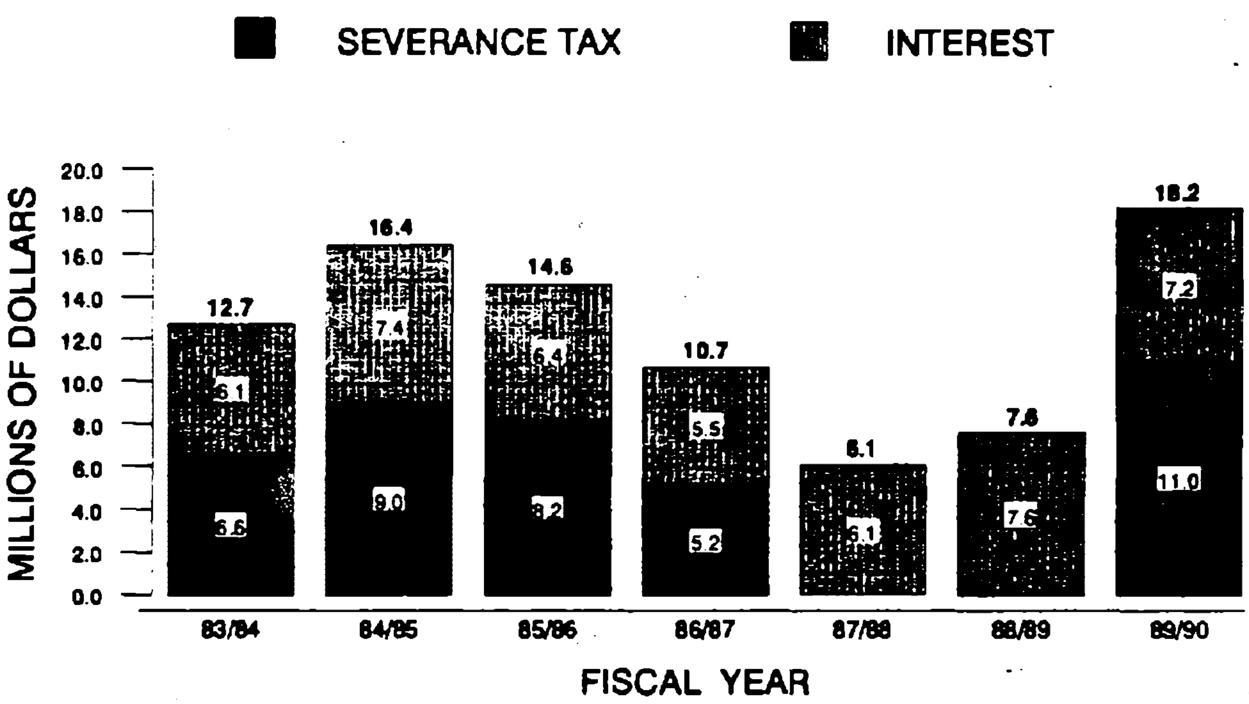


FIGURE 7

NONMANDATORY TRUST FUND
ANALYSIS OF FUND BALANCE

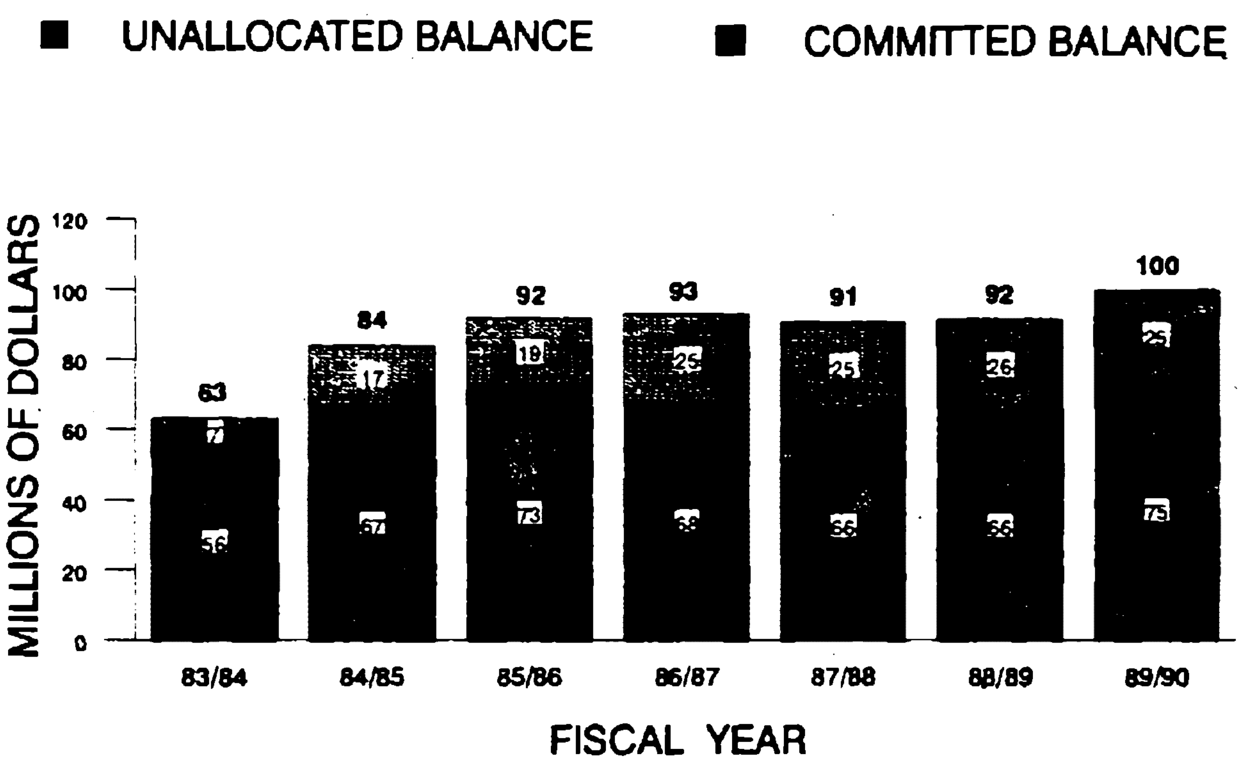


FIGURE 8

STATUS OF ELIGIBLE LANDS

NONMANDATORY PHOSPHATE ACRES

TOTAL ACRES - 86,624

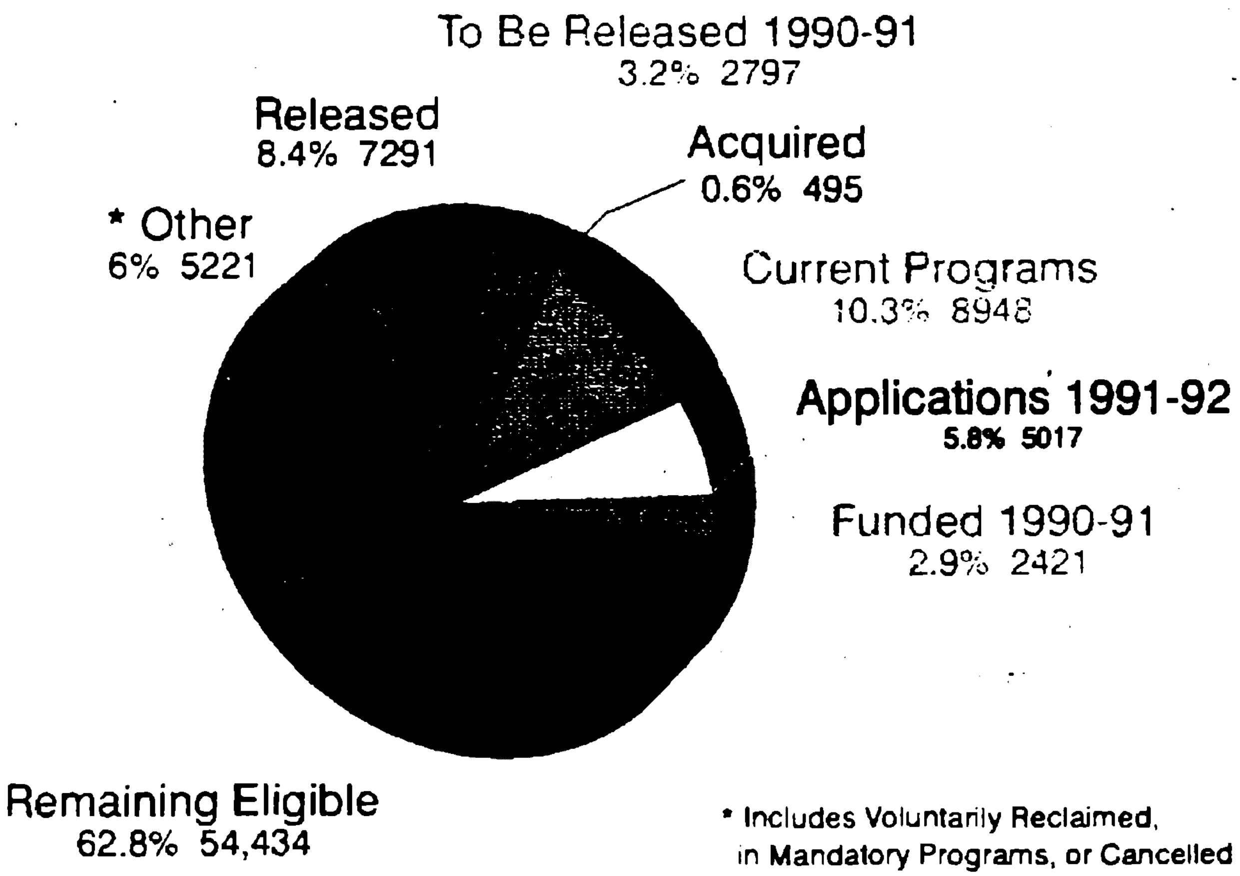


FIGURE 9

STATUS OF FUNDED ACRES

AS OF JUNE 30, 1990

TOTAL FUNDED ACRES - 22,603

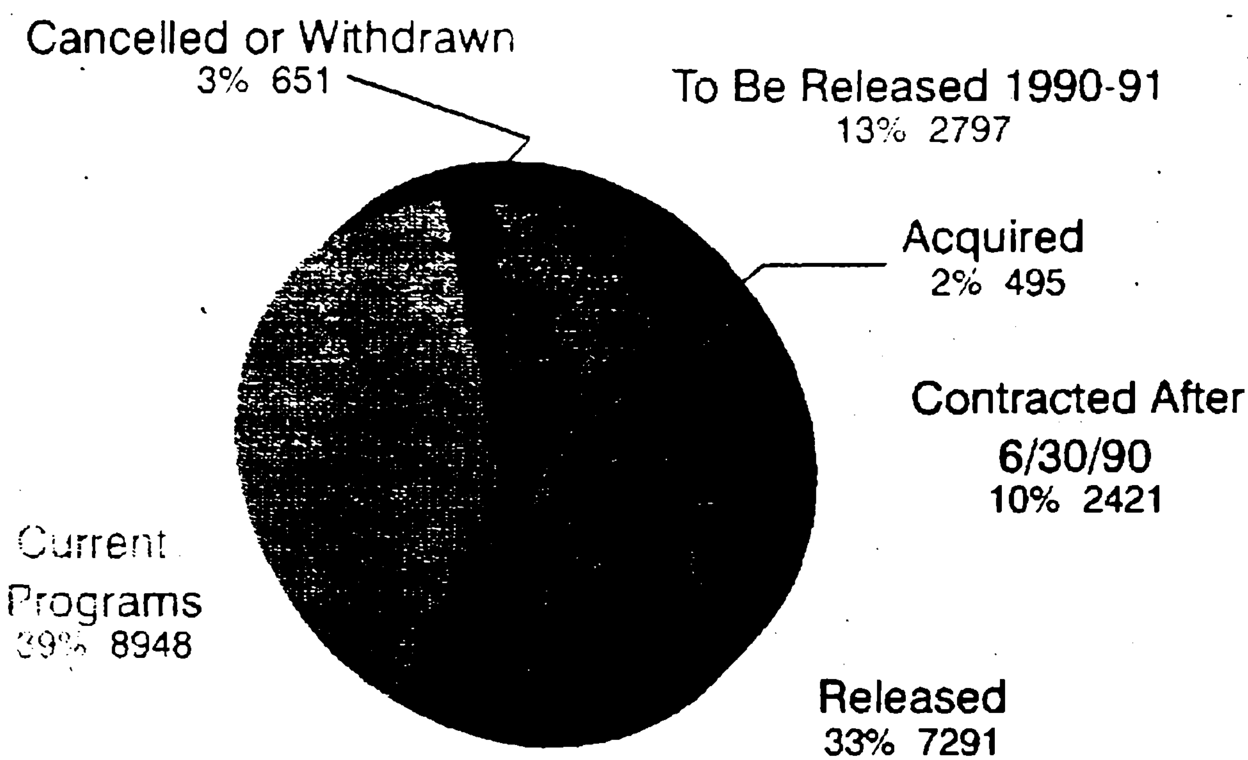


FIGURE 10

NONMANDATORY RECLAMATION

ACRES FUNDED, RELEASED, OR ACQUIRED

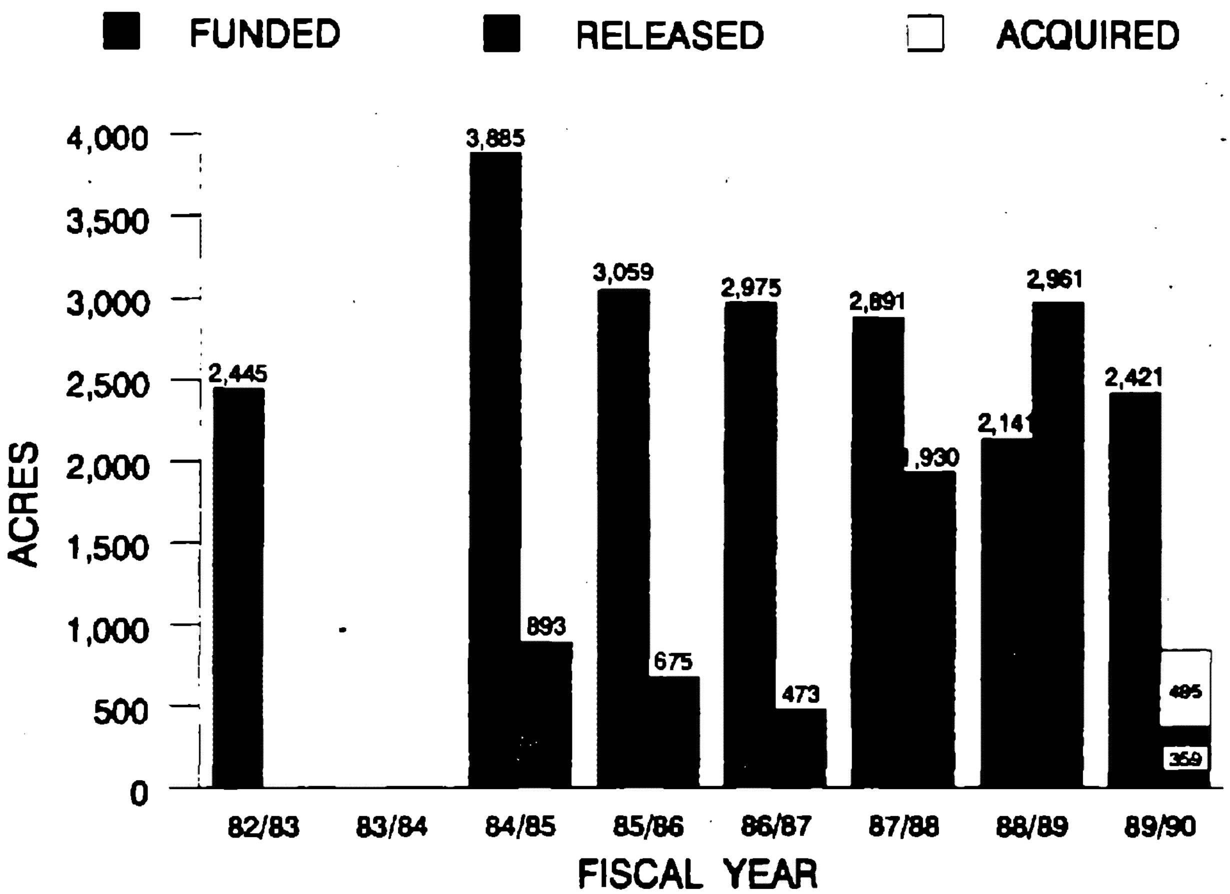


FIGURE 11

NONMANDATORY PHOSPHATE RECLAMATION PROGRAM

Analysis of Funds Applied for vs. Funding Approved

FISCAL YEAR	(A) $ REQUESTED IN APPLICATIONS	(B) $ FUNDING APPROVED	PERCENT OF FUNDING APPROVED (B/A)
84/85	$13,791,383.00	$8,389,022.00	60.83%
85/86	$8,052,791.00	$6,028,573.00	74.86%
86/87	$10,080,716.00	$5,809,314.00	57.63%
87/88	$10,530,519.00	$6,689,932.00	63.53%
88/89	$16,088,767.00	$7,132,698.00	44.33%
89/90	$16,647,458.00	$6,646,752.00	39.93%
90/91	$13,876,939.00	$6,552,398.00	47.22%
91/92	$13,800,988.00	$7,561,722.00	54.79%
TOTAL	$102,869,561.00	$54,810,411.00	53.28% (Average)

FIGURE 12

IDAHO

IDAHO'S MINED LANDS INVENTORY AND ANALYSIS

Prepared by: Bruce A. Schuld

April 15, 1991

Idaho Department of Health and Welfare
Division of Environmental Quality
Water Quality Bureau

FOREWORD

Compilation of data for this report revealed many problems in existing data bases for mined lands in Idaho. Segregation of active, inactive, and abandoned mines is impossible at this time because of the various ways in which information is compiled and stored.

The lack of accurate up-to-date information on operational status of mines has lead to a redefinition of scope for this report. Data for inactive and abandoned mined lands has been compiled and pooled so little or no reference is made to "active or inactive and abandoned mined lands". Most mineral lands exhibit current or historical scars of exploitation, therefore, the term "mined lands" shall include active, inactive, and abandoned mined lands.

TABLE CONTENTS

ABSTRACT

PRIMARY MINERALS MINED: Production of metallic materials include gold, silver, copper, thorium, tungsten, antimony, cobalt and columbium. Gemstones, including garnets, beryl, and diamonds. Construction stone, including sand and gravel, travertine, quartzite and clay. Industrial materials, which include pumice, silica, diatomite and asbestos.

STATE RECLAMATION LAWS: The Idaho Dredge and Placer Mining Protection Act, adopted in 1954, includes provisions for reclamation. The Surface Mining Act requires reclamation for surface mines put into production after May 31, 1972, there is no stipulation for any mines closed prior to that date. The Environmental Protection and Health Act of 1972 provides broader category of authorities to protect the environment, health and safety through regulation of pollutant discharge to water and air. Safety of Dams Act regulates mine tailings impoundments. The Stream Channel Protection Act provides authority for the regulation of stream channel alterations. Idaho does not have statutory authorities for the regulation of underground mining operations.

INACTIVE AND ABANDONED MINE (IAM) RECLAMATION TO DATE: Idaho does not have an inactive and abandoned mine lands program. Reclamation work done has been performed on select inactive or abandoned sites by Federal agencies (EPA, USFS, BPA) and mining companies which have reaffected an abandoned mining area. Newly distributed surface areas are subject to the Surface mining Rules.

IAM INVENTORY ACREAGE: Based on data from the U.S. Bureau of Mines there are over 8,700 mineral location exploitations and developments in the state. These mineral locations are responsible for disturbance of over 24,000 acres.

IAM INVENTORY COST ESTIMATE: This report includes cost estimates to do a field inventory of IAM sites for the state of Idaho. The total projected cost is $1.5 million. The report indicates that reclamation costs per site and feature would be similar to Montana's experience.

INVENTORY CONFIDENCE LEVEL: Information from the USBM, USGS and BLM data systems is considered to have an accuracy of 75%. Information from the Idaho Nonpoint Source assessment (IDHW, 1988) is about 40% accurate, while information about surface water quality derived from the EPA is judged to be 90% accurate.

INTRODUCTION

Idaho mining has evolved from primitive collection of salt and obsidian to a highly technical industry (McNary, nd). Idahoans have mined placer deposits, developed and produced underground lodes, and quarried construction stone and industrial minerals. With advances in technology, Idaho has become host to surface mining of low grade precious and industrial mineral deposits. Idaho mining was developed and exists on various scales from one man operations to complex corporate structures.

Surface and underground mines can be found in or near every community in Idaho, and may pose health and safety risks to those communities. Features which pose the greatest threats to those communities include polluted water, mine dumps, disturbed lands, highwalls, mine openings, and hazardous structures. Mines in Idaho have impacted thousands of acres of residential, commercial, recreational, and agricultural lands adjacent to and overlapping mineral lands. Metal contaminants maybe transported in the environment through the air, ground, and surface water systems.

Idaho has several statutes authorizing regulation of the mining industry. Idaho's Dredge and Placer Mining Protection Act was adopted in 1954, which now includes provisions for reclamation. The Surface Mining Act requires reclamation for mines put into production after May 31, 1972, but does not stipulate reclamation for any mines closed prior to that date. These acts require operators to develop a reclamation plan, and secure bonding before a permit may be issued. Idaho's legislature ratified the Environmental Protection and Health Act in 1972 to ensure public health and safety, and maintain the state's environmental quality.

Idaho has areas listed on EPA's National Priorities List for mine waste sites. Under the auspices of CERCLA, EPA and Idaho are reclaiming a portion of the Silver Valley in Northern Idaho. Reclamation includes mine and mill tailings excavation and disposal, replacement of contaminated soils, facility demolition and disposal, revegetation, and stream rehabilitation. The U.S. Forest Service is also reclaiming some mined lands.

The research leading to this report has identified major discrepancies in data regarding Idaho's mined lands. The most important information lacking in the data is the current status of the lands or mineral developments and possible hazards they pose. Lack of information regarding mined lands has lead to very liberal projections of the threat posed by mined lands and the funding necessary to remediate hazards. The remedial cost figures presented in this analysis are large and therefore, argue for investigating Idaho's mined lands through a field survey. The field survey, outlined in the following text, would cost less than one half of one percent (0.5 %) of the funds projected necessary to remediate hazards posed by mined lands. The survey would require at most five staff, and take approximately five years to complete. The results of the survey would most certainly reduce the figures projected in this report, and lead to a hierarchy for sites of concern.

HISTORY OF MINING IN IDAHO

Idaho has an abundance of industrial, agricultural, construction, semi-precious and precious minerals. Development of the state's deposits has been subject to great enthusiasm and controversy dating back to prehistoric time. The earliest use of industrial minerals in Idaho may have taken place in the central part of the state as early as 15,000 years ago (McNary, nd). Crude mineral development exploited obsidian and jasperoid quarries in the Snake River Plain, Owyhee Mountains, and Columbia River Plateau. There is evidence of developments of salt springs on the Idaho-Wyoming border and high grade pottery clay pits throughout the state. These developments were highly regarded by native Americans and settlers. Many are still producing minerals for commercial and private uses.

Gold in the Boise Basin is reputed to have been known to exist by a trapper for the Hudson Bay Company as early as 1844 (Wells, 1983). Documentation dates the earliest discoveries in 1860 when E.D. Pierce, a California Miner and trader with the Nez Perce Indians, managed to prove that gold could be found in Nez Perce country (Wells, 1983) and thus started the first of Idaho's gold rushes. Veteran placer miners from California and fortune hunters from around the world flocked to the Salmon River country near Florence. Other minor discoveries were being made throughout the northern Rocky Mountain region, but increasing hostility by native Americans put a hold on development.

Gold was discovered on August 2, 1862 in the Boise Basin (Wells, 1983). Subsequent gold rushes in South Boise, the Owyhees, Atlanta and at Rocky Bar resulted in excavation and sorting of millions of yards of fluvial deposits. Development of extensive waterways and hydraulic monitors destroyed the thin soils of slopes adjacent to the placer ground. Before the end of the first boom in 1869, the Boise Basin produced more gold than that previously produced by any mining district in the world.

The ensuing gold rushes prompted the development of industrial mineral deposits throughout the northwestern United States. Construction of improved roads for transportation of heavy equipment resulted in the development of sand and gravel quarries along streams and rivers. High grade building stone was first quarried by inmates at the territorial prison near Boise. The stone was used to construct such historical buildings as the Assay Office, the Territorial Prison, and many mansions built by prominent miners from the Boise Valley.

The discovery of massive deposits of silver ore in the Owyhee Mountains, in southern Idaho, and Silver Valley, in northern Idaho, in the mid-1860's led to a preference of silver mining over gold mining by the mid-1870's. Reports of 18" thick solid silver veins and rapidly rising silver prices diverted new investment capital away from new gold prospects to silver prospects. For almost 100 years following this swing Idaho's precious metals mining was dominated by silver.

The Silver Valley and Coeur d'Alene Mining District grew rapidly in the 1870's. Rapid growth was originally due to the presence of silver. Interest in silver was quickly overshadowed by the district's vast lead deposits, which hosted silver. In 1887, lead output from Idaho was reported to have been 20,000 short tons with the Coeur d'Alene district contributing about 35% (Lowe, nd). By 1890 Idaho would compete with Colorado as the nations major producer of lead. At the turn of the century northern Idaho was the country's principal lead producing region. In 1907, however, Missouri's lead district surpassed Idaho's production and maintained the position as principal lead producer for the remainder of the century.

During the panic of 1893 silver prices plunged dramatically (Wells, 1983). For the next fifteen years gold producers found financiers much more cooperative. During this temporary slide in the silver market, gold production at most of today's producing mine first got started. In this fifteen year period mines were opened in areas such as Stibnite, Thunder Mountain, Pearl, and Gibbonsville. These areas would, however, enjoy a brief period of notoriety, and then suffer through a very long period of low production or dormancy.

In the next ninety years other metallic, gem, construction, and industrial mineral deposits were located and developed (McNary, nd). During this period, Idaho would contribute many strategic minerals, including copper, thorium, tungsten, antimony, cobalt, and columbium, to the nation's reserves. Gemstones, including garnets, beryl, and diamonds, were discovered and mined. Construction stone, including sand and gravel, travertine, quartzite, and clay, became targeted by miners to support growth in the state. Industrial minerals, which include pumice, silica, diatomite, and asbestos, were mined and marketed worldwide.

During the early 1970's, federal and state legislation was passed which would forever change the course of mining. Federal legislation included the National Environmental Protection Act with spin offs such as the Clean Water, Clean Air, and Safe Drinking Water Act. This legislation represented, to the mining industry, undue government intervention and attacks on the Mining Act of 1872 and miners' rights. Idaho ratified the Dredge and Placer Mining Act, Surface Mining Act, and Environmental Protection and Health Act.

In the late 1970's, gold and silver prices rapidly rose and reached all time highs by the early 1980's. Speculative investment, exploration, and precious metals mining soared to unprecedented levels, even when compared to the booms in the 1800's. New technology in large tonnage surface mining and ore processing by cyanidation reduced mining costs to as low as $15.00 per ton. Exploration programs were designed for every historic mining district in Idaho. Many of the programs have met with tremendous success and have resulted in several large tonnage gold and silver mines which are now in final production or reclamation stages.

MINING, MILLING, AND SMELTING

Idaho mining has evolved from primitive collection of salt and obsidian to a highly technical industry (McNary, nd). Idahoans have mined placer deposits, developed and produced underground lodes, and quarried construction stone and industrial minerals. With advances in technology, Idaho has become host to surface mining of low grade precious and industrial minerals deposits. Idaho mining was developed and exists on various scales from one man operations to complex corporate structures.

Milling of ore and stone has also taken many forms. Originally, placer grounds were exploited using the hydraulics of spring runoff (Wells, 1983). For several years gold production was limited to placer mining which was further limited by seasonal availability of water. Construction of waterways and small load mines were developed during the long winter months. In 1883 stamp mills (Wells, 1983) were first introduced to Idaho mining districts. With that introduction, Idaho mining evolved from unorganized groups of miners working a few claims to a planned and managed industry. Eventually, accidental discoveries led to the use of mercury and pine oil to liberate precious and base metals from ores. The chemical industry thrived on the use of Idaho minerals and the development of a market for chemical reagents used to process Idaho ores. Although cyanidation has replaced many mineral processing techniques, gravity, flotation, and electrolytic milling techniques may still be found in the state.

Many areas still harbor evidence of the kilns, mercury retorts, and smelters used to refine mill concentrates. Several valleys are still recovering from air pollution which devastated plants and animals alike. Thousands of tons of smelter tailings have accumulated in vast dumps which dot the hillsides of many abandoned mining districts and pollute the local streams.

THREATS TO HUMAN HEALTH AND SAFETY

Surface and underground mines can be found in or near every community in Idaho, and pose health and safety risks to those communities. Features which pose the greatest threats to those communities include unprotected mine openings, highwalls, deteriorating mine and mill buildings, storage tanks abandoned in underground mines, abandoned explosives and chemicals, hazardous waste or materials, and subsidence structures.

Most often, however, the health and safety risks are invisible, and only become apparent through statistical analysis of community health. Idaho has several communities which have shown unusually high concentrations of heavy metals in blood and tissue samples, and which exhibit higher rates of cancer development and infant mortality. The Coeur d'Alene Basin is the area which is best known for these mining related health impacts. Mine and smelter tailings, and air borne smelter effluent from the Bunker Hill Mine and Smelter can be found throughout the basin.

Idaho is by and large a rural community with over sixty percent (60%) of the state in federal ownership. Over ninety per cent (90%) of Idaho, including agricultural lands, sees multiple use. These lands contain over 8,700 mineral locations covering approximately 200,000 acres. Although mineral locations are usually in remote areas, the rural community often focuses on these areas for recreation. This recreation increases the threat of inactive and abandoned mined land features to the community.

ENVIRONMENTAL IMPACTS

Mines in Idaho have impacted thousands of acres of residential, commercial, recreational, and agricultural lands adjacent to and overlapping mineral lands. Metal contaminants may be transported in the environment through the air, ground, and surface water systems. Sources for pollution include acid mine drainage, air borne particulates and surface run-off from mine, mill, and smelter waste piles.

Surface and ground water at inactive and abandoned mines are affected by chemical and physical degradation of minerals in dumps and in-situ rock. Elevated metals concentration in streams have impacted aquatic communities, riparian habitat, livestock, and wildlife which drink the polluted waters. Documented water pollution, such as acid drainage from surface and underground mines, occurs in several locations including the Coeur d'Alene Basin, Panther Creek, and Jordan Creek. Mine drainage can be as acidic as a car battery, and will normally adversely impact any biological community with which it interacts.

REGULATORY AUTHORITIES

Idaho has several statutes authorizing regulation of mining. These statutes are administered by Idaho's departments of Health and Welfare, Lands, and Water Resources. These agencies coordinate with federal agencies and mine operators.

Idaho's Environmental Protection and Health Act of 1972 (EPHA) provides a broader category of authorities to protect the environment, human health, and safety through regulation of pollutant discharges to water and air. The EPHA authorizes the promulgation of Water Quality Standards, Rules and Regulations for Ore Processing by Cyanidation and Air Quality Regulations.

Idaho's mine reclamation laws include the Dredge and PLacer Mining Act and Surface Mining Act, which are administered by the Department of Lands. Idaho's Dredge and Placer Mining Protection Act was adopted in 1954, which now includes provisions for reclamation. The Surface Mining Act requires reclamation for mines put into production after May 31, 1972, but does not stipulate reclamation for any mines closed prior to that date. These reclamation acts require operators to develop a reclamation plan, and secure bonding before a permit may be issued. There are no reclamation exemptions for exploration, but operators do not need to submit a plan if they impact less than five acres.

The Department of Water Resources regulates mining in accordance with the Safety of Dams Act and the Stream Channel Protection Act. The Safety of Dams Act authorizes regulation of water and mine tailings impoundment structures. The Stream Channel Protection Act provides for regulation of stream channel alterations.

RECLAMATION HISTORY

Idaho has a few areas listed on EPA's National Priorities List for mine waste sites. Under the auspices of CERCLA, EPA and Idaho are reclaiming a portion of the Silver Valley in northern Idaho. Reclamation includes mine and mill tailings excavation and disposal, soil removal and replacement, facility demolition and disposal, revegetation, and stream rehabilitation.

Idaho does not have an inactive and abandoned mined lands program. There are cases, however, where abandoned mined lands have been reclaimed during recent mining company operations which has reaffected these areas. In these instances, the newly disturbed lands are subject to regulation under the Surface Mining Rules. In one case, the company chose to stabilize old tailings with newly mined spent ore, benefitting both the environment and the operation.

The U.S. Forest Service has also performed some reclamation work. At the Blackbird Mine, in the Salmon National Forest, the U.S. Forest Service has revegetated and stabilized mine tailings and affected areas for run-off control.

The Bonneville Power Administration funded a fisheries rehabilitation project in the Bear Valley, near Lowman, Idaho. The natural salmon fishery was destroyed by placer mining which began at the turn of the century and was recently abandoned. Salmon spawn in the valley, and it is targeted by sportsmen who pursue trout and big game.

DATA SOURCES FOR IDAHO'S MINED LANDS INVENTORY

According to the U.S. Bureau of Mines, there are over 8,700 mineral locations, explorations, and developments in the state. A mined lands data base was compiled for the state of Idaho based on the U.S. Bureau of Mines Mineral Industry Location System (MILS). The Division of Environment Quality, however, has incorporated information from the Mineral Resource Data System (MRDS), EPA's Storage and Retrieval Data System (STORET), and a mined lands questionnaire. The questionnaire was sent to forty-nine (49) U.S. Forest Service District Rangers, eight (8) U.S. Bureau of Land Management District or Resource Area offices, and fourteen (14) State of Idaho resource agency field offices. The Idaho and U.S. geological surveys were also contacted regarding their data bases. Mined lands were identified which were, in the opinion of field personnel, thought to threaten safety and the environment. In completing this project, a foundation for a comprehensive data base on mines and mineral lands in Idaho has been laid.

Current data is deficient of some information which the Western Interstate Energy Board (WIEB) wants each state to compile. Status and ownership of most locations is questionable. Possible error in accuracy of location is often in excess of miles. Verification of the data will largely depend on completing the mined lands survey proposed in phase 2 of Idaho's program. Additional data from the U.S. Geological Survey, and research in the U.S. Bureau of Land

Management data system were used to supplement the MILS data. Because of the various data bases and information being merged for Idaho's inventory.

A summary of data sources for Idaho's mined lands inventory is provided in Table 1. The numbers contained in the information fields of Table 1 correspond to the following information sources:

1. U.S. Bureau of Mines

   The Mineral Industry Location Information System (MILS) is part of the computerized Minerals Availability System (MAS), a comprehensive data base of known mineral deposits. MILS is a location subsystem of MAS. Information on U.S. mineral locations and processing plants include names, locations, mineral commodities, types of operations, current operational status, holdings, bibliography, and cross references for each location. A "mineral industry location" is defined as metallic or non-metallic occurrences, prospects, mines, geothermal wells, and mineral processing plants. The data are estimated to be about 75% reliable.

2. U.S. Geological Survey

   The Mineral Resource Data System (MRDS) is a large and comprehensive system which contains 450 data items for each mine listed. MRDS is a computerized, storage, retrieval and display system developed by the Branch of Resource Analysis within the U.S.G.S. The MRDS data files contain geologic and related mineral resource and occurrence information for the U.S. and many countries. Types of data available from this source include: deposit name; location; commodity information; exploration and development; deposit description; mine workings; geology and mineralogy; cumulative production; reserves and resources; and references. MRDS has been used extensively by government agencies and private industry. As such, the data are presumed to be about 75% accurate.

TABLE 1. Idaho Mined Lands Inventory Data Source Summary

MINERAL TYPE	MINING TYPE	SOURCE	OWNER	SOURCE	FEATURE	SOURCE	COST SOURCE
Metallic Ore	Mines	1,2,3,4	Fedr.	1,2,3,4	Polluted Water	2,4	
	Mill	1,2,3,4	State	1,2,3,4	Mine Dumps	2,4	5
	Smelt.	1,2,3,4	Priv.	1,2,3,4	Disturbed Land	2,4	5
	Other	1,2,3,4	Other	1,2,3,4	Highwalls	2,4	5
					Mine Openings	2,4	5
					Subsidence Prone	2,4	5
					Haz. Constructions	2,4	
					Haz. Geology	2,4	5
					Other	2,4	
Construction Ore	Mines	1,2,3,4	Fedr.	1,2,3,4	Polluted Water	2,4	
	Mill	1,2,3,4	State	1,2,3,4	Mine Dumps	2,4	5
	Smelt.	1,2,3,4	Priv.	1,2,3,4	Disturbed Land	2,4	5
	Other	1,2,3,4	Other	1,2,3,4	Highwalls	2,4	5
					Mine Openings	2,4	5
					Subsidence Prone	2,4	5
					Haz. Constructions	2,4	
					Haz. Geology	2,4	5
					Other	2,4	
Industrial Ore	Mines	1,2,3,4	Fedr.	1,2,3,4	Polluted Water	2,4	
	Mill	1,2,3,4	State	1,2,3,4	Mine Dumps	2,4	5
	Smelt.	1,2,3,4	Priv.	1,2,3,4	Disturbed Land	2,4	5
	Other	1,2,3,4	Other	1,2,3,4	Highwalls	2,4	5
					Mine Openings	2,4	5
					Subsidence Prone	2,4	5
					Haz. Constructions	2,4	
					Haz. Geology	2,4	5
					Other	2,4	
Phosphate Rock	Mines	1,2,3,4	Fedr.	1,2,3,4	Polluted Water	2,4	
	Mill	1,2,3,4	State	1,2,3,4	Mine Dumps	2,4	5
	Smelt.	1,2,3,4	Priv.	1,2,3,4	Disturbed Land	2,4	5
	Other	1,2,3,4	Other	1,2,3,4	Highwalls	2,4	5
					Mine Openings	2,4	5
					Subsidence Prone	2,4	5
					Haz. Constructions	2,4	
					Haz. Geology	2,4	5
					Other	2,4	
Uranium Overburden	Mines	1,2,3,4	Fedr.	1,2,3,4	Polluted Water	2,4	
	Mill	1,2,3,4	State	1,2,3,4	Mine Dumps	2,4	5
	Smelt.	1,2,3,4	Priv.	1,2,3,4	Disturbed Land	2,4	5
	Other	1,2,3,4	Other	1,2,3,4	Highwalls	2,4	5
					Mine Openings	2,4	5
					Subsidence Prone	2,4	5
					Haz. Constructions	2,4	
					Haz. Geology	2,4	5
					Other	2,4	
Coal/Petroleum	Mines	1,2,3,4	Fedr.	1,2,4,5	Polluted Water	2,4	
	Mill	1,2,3,4	State	1,2,4,5	Mine Dumps	2,4	5
	Smelt.	1,2,3,4	Priv.	1,2,4,5	Disturbed Land	2,4	5
	Other	1,2,3,4	Other	1,2,4,5	Highwalls	2,4	5
					Mine Openings	2,4	5
					Subsidence Prone	2,4	5
					Haz. Constructions	2,4	
					Haz. Geology	2,4	5
					Other	2,4	
Other	Mines	1,2,3,4	Fedr.	1,2,4,5	Polluted Water	2,4	
	Mill	1,2,3,4	State	1,2,4,5	Mine Dumps	2,4	5
	Smelt.	1,2,3,4	Priv.	1,2,4,5	Disturbed Land	2,4	5
	Other	1,2,3,4	Other	1,2,4,5	Highwalls	2,4	5
					Mine Openings	2,4	5
					Subsidence Prone	2,4	5
					Haz. Constructions	2,4	
					Haz. Geology	2,4	5
					Other	2,4	

3. U.S. Bureau of Land Management

The U.S. Bureau of Land Management land status files contain location and operational status of mineral locations. Although not comprehensive, the information will be used to qualify mineral locations and names on the MILS data base. The information should be very reliable and rates about 75% accuracy.

4. Idaho Department of Health and Welfare, Division of Environmental Quality, Water Quality Bureau

Section 305(b) of the federal Clean water Act requires each state to submit a biennial report to the U.S. Environmental Protection Agency (EPA) describing the quality of the state's waters. This reference consists of Idaho's 1990 305(b) report. This data should be about 40% accurate.

Information about Idaho's surface water quality is derived from ambient water quality records in EPA's computerized water quality data base STORET. The data contained in STORET has been interpreted and is contained in the Research Triangle Institute's report "State of Idaho Identification of 304(I) Waterbodies: Candidate Lists" (1988). Accuracy of STORET data from this source is presumed to be about 90%.

The Water Quality Bureau has sent 500 copies of WIEB's Inactive and Abandoned Mined Lands Inventory Sheet to federal and state field staff in the form of a questionnaire. Preliminary response to the questionnaire has been good, but information is not anticipated to be very quantitative. The accuracy of information obtained is presumed to be 60%.

5. Montana Department of State Lands

Montana's rough draft of it's Inactive and Abandoned Mined Lands Summary Report will be used to estimate costs for reclamation activities of certain mine features. Idaho will, however, make additional cost analyses for reclamation of these and other features.

A number of agencies have been involved in mined lands data collection resulting in duplication of some information. Duplication of documentation assisted in cross checking of the data. Cross checking data was important to developing a quality data base which will only be surpassed with a field survey. Initial assessment of existing data leads to the conclusion that very little information is documented regarding the numbers and character of features at mined lands.

Questions on the mined lands questionnaire were similar in form to those provided by WIEB. Information was cross checked with the MILS data base and information provided by other state and federal field personnel. This information included:

1) Name of Mine;

2) Location in Township, Range and Section;

3) Type of Mining

4) Type of Ore:

5) Land Ownership; and

6) Features.

The survey has inadvertently accomplished one other very significant task. Questionnaires which are filled out have indicated mined lands with outstanding or memorable characteristics. Hence they are likely sites of particular concern.

FISCAL IMPACT ANALYSIS FOR IDAHO'S MINED LANDS PROGRAM

Development of a mined lands program should progress in three phases. The initial phase, data base construction contains available data on mined lands in Idaho. Funding for this phase, $7,000, was provided by EPA through the Western Governors' Association. The second phase should be a field survey of mined lands to verify existing data and enable development of a mined lands reclamation program based on a hierarchy of problem sites. Phase three would be remediation of problems on mined lands.

Field surveys will be critical to an accurate mined lands inventory. It is apparent that existing data is deficient, and that assessments of mined lands are probably inaccurate. Efficiency and consistency of data taken in the field will be very important, and therefore, a very select and small group of technical staff should be used in the field survey. Technology, used in minerals exploration should be used in the field survey.

Cost estimates for Phase two are based on a projected schedule of five years and current operating costs. Staff, and operating costs for the field survey will be approximately $1,405,500 (see Table 2). The field survey is anticipated to require two (2) full time employees. This combined staff should have skills in data processing, engineering, surveying, geology, biology, and water quality assessment. Operations will include some transportation by helicopter and high resolution aerial photography. Phase two would require one time capital expenditures. Two personal computers, two four wheel drive vehicles, and field and office equipment would be needed. Total initial capital expenditures would be approximately,

$50,500.00. Total cost for the five year program will be approximately $1,456,000 in 1991 dollars.

Phase three of Idaho's Mined Lands Program would involve remediation of problems on mined lands which are hazardous to safety or the environment. Idaho cannot estimate costs of remedial action from experience but has based cost projections on those presented in Montana's Inactive and Abandoned Mined Lands Report. Montana's Abandoned Mined Lands Report does not, apparently, include administrative costs incurred during the development and processing of environmental assessments or impact statements. Montana's figures, therefore, have been multiplied by 1.3 to add an additional 30% administrative cost of completing federally mandated environmental assessments. Total cost of remediation based on existing information, is $315,566, 900, and is itemized in Table 3.

Remedial action for polluted waters related to mining activities may involve remediation of many problems at mine sites. A dollar amount for remediation has been based on Montana's experience in reclamation, and may be applied to the sources of pollution rather than the stream. Highly impacted streams may require remedial action costing $1,300,000 per mile. Moderately impacted streams may cost $650,000 per mile, and slightly impacted streams may cost little or nothing. Interpolated data from STORET indicates that Idaho has approximately 132 miles of streams impacted by mining. Intensity of impacts on various stream segments is unknown. Costs for moderately impacted streams were used for cost estimates. Therefore, approximately $85,800,000 will be needed to remediate Idaho's waters impacted by mining activities. According to the 1988 Water Quality Status report and Nonpoint Source Assessment, as many as 1,350 stream miles may be impaired.

Mine dumps will most likely be one prevalent sources of pollution. Some dumps may require excavation and disposal in stable areas, while other may require minimal stabilization and revegetation. Cost estimates for reclaiming mine dumps are based on Montana's figures, plus an additional 30% for administration of environmental assessments and permitting. Cost is estimated at $39,000 per acre of mine dump. To account for dumps which are missed in the inventory, one acre of dump has been attached to each known mine opening and five acres of dump to each open pit known. Cost figures for mine openings may be somewhat high. The mined lands inventory indicates that there may be approximately 3,048 acres of mine and mill dumps abandoned in the state. If data and cost figures are correct, approximately $118,872,000 will be necessary to secure these features.

Reclamation of disturbed lands is projected to entail minor contouring and revegetation. Cost estimates for reclaiming disturbed lands are based on Montana's figures, plus an additional 30% for administration of environmental assessments and permitting. Costs are estimated at $3,900 per acre of disturbed land. The mined lands inventory will include abandoned roads, trails, town sites, and livery or shop yards. For any mineral location which indicate past production, development, or exploration, it has been assumed that at least five acres have been developed for access, temporary housing, and equipment storage. Where placer activities are

TABLE 2. **Estimated Costs for Idaho's Field Survey of Mined Lands (Phase 2)**

ITEM	COST ESTIMATE
Personnel Costs	
Two Full Time Employees	$ 120,000.00 annually
Three Part Time (6 Month) Employees	$ 40,000.00 annually
Operating Costs	
Travel Expenses (Travel and Per diem for Field Personnel)	$ 30,000.00 annually
Office Space and Utilities	$ 7,500.00 annually
Fuel and Maintenance	$ 7,000.00 annually
Helicopter Services	$ 40,000.00 annually
Laboratory Analysis	$ 50,000.00 annually
Aerial Photography	$ 6,600.00 annually
TOTAL ESTIMATED ANNUAL COSTS	$ 281,100.00 annually
Capital Expenditures	
Two Four-Wheel-Drive Trucks (one time cost)	$ 36,000.00
Two Personal Computers (one time cost)	$ 10,000.00
Office Furniture (one time cost)	$ 4,500.00
TOTAL CAPITAL EXPENDITURES	$ 50,500.00

TABLE 3.

Idaho Mined Lands
Inventory Summary

MINERAL TYPE	MINING TYPE	OWNERSHIP	FEATURE	UNITS	COST OF REMEDIATION
Metallic Ore	Mines 1,463	Private 682	Polluted Water	* mi.	$ ---
	Mill UNK	State 92	Mine Dumps	2,215 ac.	1,560,000
	Smelters UNK	Forest 3,423	Disturbed Land	15,741 ac.	2,698,800
	Exploration 2,054	BLM 970	Highwalls	8 mi.	195,000
	Unknown 1,666	Indian 16	Mine Openings	2,150 ea.	77,000
	Producer 113	Other 0	Subsidence Prone	UNK	---
	Other 12		Haz. Constructions	1,231 ea.	---
			Haz. Geology	UNK	101,400
			Other	NA	---

Construction Ore	Mines 1,167	Private 603	Polluted Water	* mi.	$ ---
	Mill UNK	State 56	Mine Dumps	478 ac.	507,000
	Smelters UNK	Forest 362	Disturbed Land	5,915 ac.	647,400
	Exploration 87	BLM 518	Highwalls	4 mi.	0
	Unknown 3 72	Indian 85	Mine Openings	472 ea.	896,000
	Producer 444	Other 2	Subsidence Prone	UNK	---
	Other UNK		Haz. Constructions	459 ea.	1,790,100
			Haz. Geology	UNK	---
			Other	NA	---
Industrial Ore	Mines 112	Private 96	Polluted Water	* mi.	$ ---
	Mill 1	State 5	Mine Dumps	70 ac.	2,730,000
	Smelters UNK	Forest 135	Disturbed Land	832 ac.	3,244,800
	Exploration 98	BLM 165	Highwalls	18 mi.	1,170,000
	Unknown 206	Indian 15	Mine Openings	72 ea.	280,800
	Producer 16	Other 1	Subsidence Prone	UNK	---
	Other UNK		Haz. Constructions	72 ea.	280,800
			Haz. Geology	UNK	---
			Other	NA	---
Phosphate Rock	Mines 46	Private 23	Polluted Water	* mi.	$ ---
	Mill UNK	State 12	Mine Dumps	40 ac.	1,560,000
	Smelt. UNK	Forest 107	Disturbed Land	692 ac.	2,698,800
	Exploration 36	BLM 23	Highwalls	3 mi.	195,000
	Unknown 92	Indian 9	Mine Openings	41 ea.	77,900
	Producer 15	Other 0	Subsidence Prone	UNK	---
	Other 0		Haz. Constructions	26 ea.	101,400
			Haz. Geology	UNK	---
			Other	NA	---

TABLE 3. (cont.) Idaho Mined Lands Inventory Summary

MINERAL TYPE	MINING TYPE		OWNERSHIP		FEATURES	UNITS	COST OF REMEDIATION
Uranium Overburden	Mines	10	Private	32	Polluted Water	* mi.	
	Mill	UNK	State	12	Mine Dumps	13 ac.	$ ---
	Smelt.	UNK	Forest	51	Disturbed Land	166 ac.	507,000
	Exploration	74	BLM	38	Highwalls	0 mi.	647,400
	Unknown	46	Indian	2	Mine Openings	12 ea.	0
	Producer	0	Other	0	Subsidence Prone	UNK	22,800
	Other	0			Haz. Constructions	10 ea.	---
					Haz. Geology	UNK	39,000
					Other	NA	---

Coal/Petroleum	Mines	24	Private	12	Polluted Water	* mi.	
	Mill	UNK	State	4	Mine Dumps	24 ac.	$ ---
	Smelters	UNK	Forest	49	Disturbed Land	115 ac.	936,000
	Exploration	24	BLM	18	Highwalls	0 mi.	448,500
	Unknown	40	Indian	4	Mine Openings	23 ea.	0
	Producer	2	Other	1	Subsidence Prone	UNK	43,700
	Other	0			Haz. Constructions	10 ea.	---
					Haz. Geology	UNK	39,000
					Other	NA	---

Other	Mines	157	Private	209	Polluted Water	* mi.	
	Mill	UNK	State	64	Mine Dumps	208 ac.	$ ---
	Smelters	UNK	Forest	427	Disturbed Land	1,187 ac.	8,112,000
	Exploration	870	BLM	583	Highwalls	1 mi.	4,629,300
	Unknown	255	Indian	2	Mine Openings	200 ea.	65,000
	Producer	26	Other	0	Subsidence Prone	UNK	380,000
	Other	0			Haz. Constructions	128 ea.	---
					Haz. Geology	UNK	499,200
					Other	NA	---

Total	Mines	2979	Private	1,657	Polluted Water	132 mi.	
	Millsites	UNK	State	240	Mine Dumps	3,048 ac.	$ 85,800,000
	Smelters	UNK	Forest	4,554	Disturbed Land	24,495 ac.	118,872,000
	Exploration	3243	BLM	2,315	Highwalls	34 mi.	95,530,500
	Unknown	2677	Indian	133	Mine Openings	2,970 ea.	2,210,000
	Producer	616	Other	4	Subsidence Prone	UNK	5,643,000
	Other	12			Haz. Constructions	1,926 ea.	---
					Haz. Geology	UNK	7,511,400
					Other	NA	---

						TOTAL COST OF REMEDIATION	$315,566,900

* Effected stream lengths are not reported for individual mining types as the data has not been directly linked to individual mine sources but rather to watersheds within mining districts. Only the total length, therefore, of streams effected by mining activities have been reported. Lack of information regarding the source of polluted waters is another argument for the need for a field survey of mined lands.

indicated as past producers, twenty acres of disturbed land has been accounted. Using these assumptions, there are approximately 24,495 acres of disturbed lands in Idaho. These lands are estimated to require $95,530,500 to reclaim.

Highwalls can be dealt with in several methods which shall depend on site specific conditions. Some highwalls may require drilling and blasting to create stable benches, whereas some highwalls may be reduced by backfilling and minor excavation of the brow. Montana's cost of $65,000 per mile of highwall may be somewhat low depending on the highwall. For example, a high wall which is less than one hundred feet in height may be easily backfilled and graded, but a highwall which is three hundred feet in height will require much more work. Idaho would for the time, accept Montana's cost estimate, but will analyze this activity further to confirm a cost estimate. Accounting of existing highwalls has proven futile due to the lack of documentation and, therefore, figures for reclamation of these features is most likely very low. The mined lands inventory does indicate that at least 34 miles of highwalls have been developed in the state. These features will require an estimated $2,210,000 to reclaim.

Closure of mine openings will also be dependent on site specific characteristics, and will vary tremendously in costs. Backfilling and blasting may remediate most of the problems posed by mine openings and would average about $900 per opening. Shafts and open stopes tend to be the more difficult problems to remedy and may require site specific engineering of caps, plugs, or seals. Caps, plugs, or seals may cost approximately $2,000 per site, which raises the costs to $2,900 for these types of mine openings. For cost projections, an average of the least and most expensive closure costs, $1,900, has been used. The mined lands inventory indicates that at least 2970 mine openings exist statewide. If abandoned, these features will cost approximately $5,643,000 to reclaim.

Hazardous constructions will require demolition and removal. Cost projections were based on Montana's reported costs plus an additional administration cost for environmental assessment and permits. The cost of reclamation, $3,900, has been applied in these cost projections. Assuming that one cabin, mill building, powder magazine, or headframe, is present for every three mine openings or pits, 1,926 hazardous structures may still exist. Removal of these structures would cost approximately $7,511,400.

Remedial action for hazardous geologic structures and subsidence prone areas, will require cost estimates for drilling, blasting, backfilling, and grouting. Montana does not relate any costs associated with these types of features. As little or no data exists for these features it is assumed they represent little or no immediate threat to health and safety.

SUMMARY

Existing data on mined lands in Idaho is overwhelmingly deficient. Federal and state field staff have identified mineral locations which pose, in their opinion, substantial threats to personal safety and/or the environment. Until this time, no means to verify these threats has been developed. Existing data from federal and state agencies have been compiled, but should be substantiated with field surveys.

The Idaho Department of Health and Welfare would substantiate existing data if federal funding is made available. This would be accomplished by a small group of probably five individuals, who have backgrounds in engineering, hydrogeology, biology, chemistry, and data processing. The group would make site assessments, substantiate the existing data base, and formulate a technical plan of operations for statewide inactive and abandoned mined lands reclamation. Expertise and technology is available to significantly reduce any threats that may be posed by inactive and abandoned mined lands.

The legal problems of remediation are numerous. One of the problems which will be encountered during this phase is the discrimination between inactive and abandoned mineral locations. Although many sites are not active, very few outside of wilderness areas are not claimed under the 1872 Mining Act. Terms of remediation may require negotiation with mineral land claimants. The third phase may also require additional authorities and environmental assessment prior to implementation.

Research leading to this report has identified major discrepancies in data regarding Idaho's mined lands. The most important information lacking is current status of lands or mineral developments, and possible hazards they pose. Lack of information regarding mined lands has lead to very liberal projections of hazards posed by mined lands and the funding necessary to remediate those hazards. Figures presented in this analysis are overwhelming and are arguments for conducting a field survey of Idaho's mined lands. The field survey, outlined in the following text, would be less than one half of one percent (0.5%) of the necessary projected funds to remediate hazards posed by mined lands. The survey would require at most, five staff and take approximately five years to complete. The results of the survey would most certainly reduce remedial cost figures projected in this report, and lead to a hierarchy for sites of concern.

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GLOSSARY OF TERMS FOR MINED LANDS CHARACTERIZATION

"Inactive Mine" means any surface or underground construction developed for excavation and beneficiation of mineral ores that is being retained as private land under the United States Mining Act of 1872, and is designated by the legal claimant(s) as temporarily closed, except as required for annual assessment under said act. Mineral ores include metallic ores, construction stone, industrial minerals, phosphate rock, uranium overburden, oil shale, coal, placer deposits, and semi-precious stones.

"Abandoned Mine" means any surface and underground construction which was developed for removal and beneficiation of mineral ores but is not being retained as private land under the United States Mining Act of 1872, and is not designated by any legal claimant(s) as temporarily closed.

"Metallic Rock" refers to any mineral deposit from which metal(s) can be extracted through metallurgical process. Metallic rock excludes those rocks whose excavation and processing does not specifically include metallic beneficiation. Idaho's phosphate deposits, for instance, contain sulfides which are not extracted during phosphatic liberation, and therefore are not considered metallic.

"Construction Stone" is rock, mineral or other naturally occurring substance which requires excavation and minimal processing prior to use in buildings, roadways, and reservoirs etc.. Minimal processing is qualified to include rudimentary sizing and crushing. Construction stone includes road aggregates, such as sand, gravel, or coarsely crushed limestone, liner clays, and building stone including travertine, marble, sandstone and granite.

"Industrial Minerals" are rocks, minerals, or other naturally occurring substances of economic value, exclusive of metal ores, construction stone, mineral fuels, and gemstones. Industrial minerals differ from construction stone in both processing and use. Industrial minerals are usually milled to enhance physical and chemical characteristics. Industrial minerals will normally be used in many different applications such as abrasive, dry wall materials, fertilizers, petrochemical additives, filters, and refractories.

"Phosphate Rock" is any rock that contains one or more phosphatic minerals of sufficient purity and quantity to permit it's commercial use as a source of phosphatic compounds or elemental phosphorous.

"Uranium Overburden" will include all soil, unconsolidated waste rock, ore and waste dumps, mill tailings, and other materials contaminated during excavation, processing, and refining radioactive ore.

"Oil Shale" a kerogen bearing, finely laminated brown or black sedimentary rock that will yield liquid or gaseous hydrocarbons on distillation.

"Surface Mining" means any surface construction or excavation to develop and appropriate raw minerals, coal, oil shale or other similar commodities from naturally occurring lithified deposits. General classifications of surface mines include, open pits, quarries, strip mines, and sand and gravel pits. Surface mining does not include dredge or placer mining, and milling or refining facilities.

"Underground Mining' means those subsurface construction and excavation methods used in the development and appropriation of raw minerals, coal, oil shale or other similar commodities. Underground mining includes tunneling, drifting, raising, stoping, shaft sinking, in-situ leaching, and related underground activities.

"Placer or Dredge Mining" means the surface mining techniques which use hydraulics to separate precious metals or gemstones from fluvial, colluvial, or otherwise unconsolidated non-lithified sedimentary deposits.

"Geothermal" characterizes ground waters naturally heated, by geological conditions. Geothermal waters may be conducted through naturally occurring vents or drilled wells, or may be untapped ground water reservoirs.

"Federal Ownership" will be further qualified as Forest Service or Bureau of Land Management lands and shall designate those lands under the jurisdiction of those agencies. This classification shall exclude any lands held in private ownership as patented lands in accordance with the U.S. Mining Act of 1872, and indian lands

"State Lands" shall designated as any and all lands owned by the State of Idaho.

"Indian Lands" shall designate any and all lands owned by autonomous indian nations or are administered by the U.S. Bureau of Indian Affairs.

"Private Lands" shall designate any land held in ownership by an individual, group of individuals, or corporation, which was obtained by said individuals through land grant, purchase, or location under the U.S. Mining Act of 1872. Private lands shall exclude those lands held in private ownership as unpatented lands under said mining act, whose ownership may return to the federal agency under whose jurisdiction they fall.

"Features" which will be qualified at IAM sites are those which threaten safety or the environment. Features include polluted water, mine dumps, disturbed lands, hazardous highwalls, hazardous constructions, hazardous mine openings, subsidence prone areas, hazardous geologic structures, and other features such as solid waste landfills, abandoned roads, and underground storage tanks. The features will be qualified as miles of stream segments effected, effected acres, number of constructions or openings,and types and risks of geologic structures.

"Polluted Water" or "water pollution" is such alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or such discharge of any contaminant into the waters of the state as will or is likely to create a nuisance or render such waters harmful or detrimental or injurious to public health, safety or welfare, or may threaten domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses, or represent a threat to livestock, wild animals, birds, fish, or other aquatic life (39-103).

"Mine Dump" means any surface or underground construction used for the temporary or permanent storage of unconsolidated mine ore or wastes accumulated during excavation, which have not been treated in the course of mineral beneficiation. An attempt will be made to qualify dumps with tonnage figures and quantify acres effected.

"Disturbed Land" or "affected land" means the land area included in overburden disposal areas, mined areas, mineral stockpiles, roads, tailings ponds, and other areas disturbed at the surface mining operation site. For the purposes of this inventory it will be used to include those areas subjected to subsidence due to underground mining or air borne contamination from mineral processing facilities, tailings or other surface disturbance due to underground mining, and riparian habitat effected by acid mine drainage or sedimentation.

"Hazardous Highwall" means a slope or cut bank in overburden and/or bedrock constructed during excavation for open pits, roads, or other facility construction such as portals, which either exceeds or will exceed slope stability limits after some natural weathering, and will eventually fail or subside in a rapid event. Hazardous highwalls with be characterized in linear feet.

"Hazardous Mine Openings" mean shafts, raise collars, portals or adits, exploration trenches, bore holes, surficial exposures of stopes, and subsidence structures with escarpments.

"Subsidence Prone" is a description of any surface or underground construction or void which has structural features such as walls and backs (ceilings, roofs), which tend to fail or cave under normal or unnatural loading conditions such as gravity and excess pore pressure. For the purpose of this inventory, subsidable structures shall include: tunnels, shafts, raises, stopes, and miscellaneous underground facilities such as shops and hoist rooms.

"Hazardous Structures" means structures resulting from either geologic or man made events or activities. Hazardous structures may either cause a failure or fail. For the purpose of this inventory, hazardous structures will be redefined as either "Hazardous Geologic Structures" and "Hazardous Constructions".

"Hazardous Geologic Structures" means faults, joint systems, or bedding planes. These structures may cause structural or slope failures, or convey pollution. Where possible geologic structures will be qualified through risk assessment in a similar manner as they are qualified during dam studies.

"Hazardous Constructions" include buildings, headframes or hoisting facilities, mine tailings impoundments, and water impoundments, which are in such a state of disrepair as to pose safety or health risks.

"Other Features" include but may not be limited to solid waste landfills, buried septic systems, abandoned roads, ditches, stream alterations or diversions, and underground storage tanks.

MINNESOTA

WESTERN GOVERNORS ASSOCIATION

ABANDONED MINED LANDS PROJECT

DATA SUMMARY REPORT

FOR THE STATE OF MINNESOTA

Final Draft

April 4, 1991

MINNESOTA'S ABANDONED MINED LANDS

NARRATIVE SUMMARY

1.0 INTRODUCTION

Minnesota's metallic mining industry consists entirely of iron ore mining at the present time. The iron ore mining industry in Minnesota is over 100 years old. Although mining historically took place on three separate iron ranges (Cuyuna, Vermilion, and Mesabi), today it occurs only on the Mesabi Range. The first shipments of ore were from the Soudan Mine in the Vermilion Range in 1884. Development of the Mesabi Range began in the early 1890s, while production in the Cuyuna Range did not begin until 1911.

Vermilion Range

There were eleven mines on the Vermilion Range and total production was nearly 104 million tons. The last mine on this range was closed in 1964. The Vermilion's largest mine, the Soudan, was sold by U.S. Steel Corporation to the State for $1.00 with the understanding it would become a State Park. Today, this underground mine is the Tower-Soudan State Park and receives thousands of visitors each year.

Cuyuna Range

Approximately 106 million tons of ore were produced by the Cuyuna Range from over 50 underground and open pit mines. The last shipment from this range was in 1984 from stockpiled material. All open pit operations on the Cuyuna are now flooded and many are used for recreational purposes. Ore still remains on the Cuyuna Range, including the nation's largest reserve of manganese.

Mesabi Range

The ores of the Biwabik Iron Formation of the Mesabi Range are associated with a sedimentary type of rock, called taconite, containing 25 to 30 percent iron. Natural oxidation and leaching processes resulted in enrichment of this low-grade taconite to form oxidized iron minerals (e.g., hematite and limonite) and increased iron content to greater than 50 percent. Since early mining days, 364 mines have produced more than 3 billion tons of ore from the Mesabi Range. Although the Mesabi Range's enriched hematite ore deposits are nearly exhausted, large reserves of taconite remain and will take over 200 years to exhaust with current economic mining methods. New mining and processing techniques could extend this taconite resource well beyond 200 years.

At the present time, the only abandoned mines in Minnesota are natural iron ore mines.

2.0 MINING AND MILLING METHODS

The natural enrichment process identified above took place over geologic time on the three ranges. The resulting "natural ore" or hematite was high enough in iron content that processing techniques were limited to gravity separation of the ore from waste materials. Such techniques involved the use of relatively unsophisticated equipment, such as cyclones, jigs, or spirals, in conjunction with crushing and washing. No flotation chemicals were needed for these processes, as compared to the milling of taconite ores that require grinding, chemical floatation, magnetic separation, and pelletizing to produce a marketable product.

The shift in Minnesota's mining industry from natural iron ore to an emphasis on taconite production began in the late 1940s and early 1950s. The shift in emphasis to taconite production is shown in the following table.

Year	Total Production (000s of Tons)	Percent of Total	
		Iron Ore	Taconite
1950	62,235	99.9 %	0.1 %
1955	67,893	98.0	2.0
1960	57,425	76.7	23.3
1965	52,466	63.8	36.2
1970	56,520	37.5	62.5
1975	51,067	20.1	79.9
1980	45,280	4.9	95.1
1981	51,033	3.3	96.7
1982	24,234	3.3	96.7
1983	26,024	3.3	96.7
1984 (est)	36,200	2.2	97.8

Minnesota's share of total U.S. production has been consistently greater than 60 percent, generally falling in the 60 to 70 percent range. While Minnesota's share of total U.S. production has remained steady, Minnesota's mining industry produced over 25 percent of the total world production of iron ore and taconite at one time. By 1960, this had dropped to just over 11 percent, and was just under six percent in 1975. Since 1975, Minnesota production had been holding at about six percent of the total world production through 1981. Beginning in 1982, Minnesota's share fell to just over three percent.

3.0 HEALTH AND SAFETY IMPACTS

Abandoned open pits remaining from mining activities may pose safety hazards. Once mining is discontinued, the pits are often left to fill with water. The State has an active county mine inspector program which requires abandoned pits, as well as active pits, to be fenced for safety purposes. However, people do get past the fencing; falls and drownings have resulted in some deaths. Bank erosion and severe slumping along pit banks caused by heavy rains also create hazards. Safety problems may also result if steep-sloped stockpiles are unscreened and accessible.

4.0 ENVIRONMENTAL IMPACTS

Although natural iron ore mining has the potential to cause some environmental problems, no known significant adverse impacts have resulted from abandoned mines in the State of Minnesota. Natural iron ore is an oxide ore rather than a sulfide ore, and therefore acid mine drainage is not associated with oxide iron ore in Minnesota. Furthermore, the use of reagents in the milling of this natural oxide ore was not necessary. Therefore, fewer impacts have resulted in Minnesota than in many other areas of the country.

In 1975, the State commissioned a study, "Minnesota Mineland Reclamation: A Program for the Reclamation of Metallic Mined Lands," to examine the potential environmental problems that might result from nearly a century of mining activity in Minnesota. Included in this report is a section on the various environmental and social impacts resulting from past mining activities.

The 1975 study examined problems caused by overburden and lean ore stockpiles, and open pits. Several problems associated with overburden stockpiles include the removal or burial of high quality topsoil. The resulting lack of quality surficial material, in a few instances, has resulted in little or no vegetative cover. This in turn, can lead to high erosion rates, and subsequently, alteration of natural drainage patterns and increased sediment loading of streams and lakes. Areas of slumping have occurred after heavy rains, as well. Natural lean ore stockpiles have contributed to erosion problems and can cause portions of streams and lakes to turn a deep red color. While this "red water phenomenon" is not a pollution problem, it is unsightly.

In summary, while abandoned minelands can be environmentally troublesome, impacts have been limited and are decreasing due to slope stabilization and natural invasion of vegetation; the work of the Iron Range Resources and Rehabilitation Board (IRRRB), which is described below; and the County Mine Inspectors program.

5.0 LAWS AND REGULATIONS

A previous report, The Minnesota Mine Waste Program State Regulatory Analysis, also done under this contract, describes in detail the laws and regulations governing mining in the State of Minnesota. This section identifies the agencies that oversee mining activities in the State, and outlines their responsibilities.

The Minnesota Department of Natural Resources (DNR) and the Minnesota Pollution Control Agency (MPCA) signed a Memorandum of Agreement in 1987 to establish procedures for cooperative involvement for regulating mining industries in the State.

The Minerals Division of the DNR has the statutory and regulatory authority to oversee mineland reclamation on lands in the State. Land disturbed after August 1980 must be reclaimed by the mineland owner in accordance with the Mineland Reclamation Rules and as stipulated in the permit to mine issued by the DNR. The Division's responsibilities include:

- serving as the permitting and enforcement authority for the State's Mineland Reclamation Rules;[1]
- making land available for exploration and mining through mineral and peat leasing;
- implementing the exploratory boring law;
- conducting environmental studies to ensure that environmental impacts of mining can be controlled;
- identifying State and county mineral ownership;
- providing environmental review for proposed leases and mining operations; and
- encouraging mineral development through support of cooperative industrial research, value-added processing, and market development.

Minelands abandoned prior to August 1980, are the responsibility of the Iron Range Resources and Rehabilitation Board (IRRRB). The IRRRB uses funds from the Taconite Area Environmental Protection Fund, established by the State legislature, to eliminate dangerous areas, establish vegetation, repair and prevent erosion and dust problems, and create other uses for these abandoned minelands.

The Minnesota Pollution Control Agency has responsibility for regulating certain other aspects of mining operations. Four divisions within the Agency oversee mining operations. The divisions are Air Quality; Water Quality; Hazardous Waste; and Ground-Water and Solid Waste. The MPCA is mandated to enforce State laws and regulations addressing:

- air pollution;
- water pollution;
- solid and hazardous waste disposal; and
- noise control.

MPCA takes the lead agency responsibility for:

- identifying and regulating air quality impacts;
- regulating solid and hazardous waste disposal and management;
- establishing and enforcing effluent limitations, water quality standards, and compliance monitoring (including the NPDES permit system);
- regulating ground-water quality, surface water quality, and point and nonpoint source pollution; and
- State and Federal Superfund cleanup activities.

At the present time, the only metallic mining conducted in the State of Minnesota is iron ore. These iron ore and taconite mines are operated by private industry. State mineral ownership includes 18 percent of the Mesabi Iron Range; about half of the 6 million acres of peatland; and a large portion of the copper-nickel, titanium, and manganese resources. The Minerals Division also manages more than 10 million acres of State-owned trust fund and tax-forfeited mineral rights; 3 million acres of State and county peatlands; and construction materials

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[1] These rules address all mining activities subsequent to their enactment in August 1980.

on the 3 million acres of additional State surface lands. Besides these known resources, the geology of Minnesota indicates that significant potential exists for the mining of gold, platinum, other precious metals, copper, zinc, other base metals[2], industrial minerals and construction commodities.

6.0 ABANDONED MINELAND RECLAMATION

In 1977, the Minnesota legislature passed an act establishing the Taconite Area Environmental Protection Fund (TAEP) and creating the Mineland Reclamation Division of the Iron Range Resources and Rehabilitation Board (IRRRB). The TAEP fund derives revenues from the taconite production tax which is paid by the mining companies in lieu of local property taxes. The fund is used to carry out reclamation, restoration, and enhancement of the parts of northeastern Minnesota region which have been mined.

The Mineland Reclamation Division of the IRRRB receives TAEP funds to be used for the reclamation of minelands abandoned in Minnesota prior to August 1980. These funds are used to:

- eliminate dangerous areas;
- establish vegetation;
- repair and prevent erosion and dust problems; and
- create another use for these lands, i.e., recreation, wildlife habitat, and/or reforestation.

Abandoned mine areas can often be turned into excellent recreational areas. Several IRRRB Mineland Reclamation Division projects include:

- bike trails;
- campgrounds;
- swimming beaches;
- boat and canoe access; and
- winter tubing slides.

Additionally, pit wall reshaping, elimination of unsafe areas, stockpile reclamation, revegetation, and economic and community development projects are implemented by the IRRRB.

Lands disturbed after August 1980 are covered by the State's Mineland Reclamation Act. Reclamation of these lands is the responsibility of the mineland owner and is addressed in the Minnesota Department of Natural Resources' mineland reclamation permitting program.

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[2] It should be noted that non-ferrous metallic mining cannot take place at new sites in Minnesota until the DNR promulgates regulations specific to that mining sector.

TABLE 1
MINNESOTA'S ABANDONED MINE SITES
REFERENCE GUIDE FOR DATA SUMMARY

(See Reference Guide, page 9)

			REFERENCE GUIDE					
MINERAL TYPE	MINING TYPE	acres	OWNERSHIP	acres	FEATURES		UNITS	COST
METALLIC ORES	Mines (II)		Federal (I)		Polluted Water		miles (II)	
	Millsites (II)		Private (I)		Reservoirs		acres (II)	
	Smelters (II)		State (I)		Mine Dumps		acres (II)	
	Other (II)		Mixed (I)		Disturbed Land		acres (II)	
			Not Classified (I)		Pitwalls		miles (II)	
					Mine Openings		acres (II)	
					Caved Areas		acres (II)	
					Mine Shafts		acres (II)	
					Tailings Basins		acres (II)	
CONSTRUCTION ORES [sand and gravel, etc.]	Mines		Federal		Polluted Water		miles	
	Millsites		Private		Mine Dumps		acres	
	Smelters		State		Disturbed Land		acres	
	Other		Other		Highwalls		miles	
					Mine Openings		number	
					Subsidence Prone		acres	
					Hazardous Structures		number	
					Other		units	
INDUSTRIAL ORES	Mines		Federal		Polluted Water		miles	
	Millsites		Private		Mine Dumps		acres	
	Smelters		State		Disturbed Land		acres	
	Other		Other		Highwalls		miles	
					Mine Openings		number	
					Subsidence Prone		acres	
					Hazardous Structures		number	
					Other		units	

TABLE 1 (continued)
MINNESOTA'S ABANDONED MINE SITES
REFERENCE GUIDE FOR DATA SUMMARY

PHOSPHATE ROCK	Mines		Federal		Polluted Water		miles	
	Millsites		Private		Mine Dumps		acres	
	Smelters		State		Disturbed Land		acres	
	Other		Other		Highwalls		miles	
					Mine Openings		number	
					Subsidence Prone		acres	
					Hazardous Structures		number	
					Other		units	
URANIUM OVERBURDEN	Mines		Federal		Polluted Water		miles	
	Millsites		Private		Mine Dumps		acres	
	Smelters		State		Disturbed Land		acres	
	Other		Other		Highwalls		miles	
					Mine Openings		number	
					Subsidence Prone		acres	
					Hazardous Structures		number	
					Other		units	
OIL SHALE	Mines		Federal		Polluted Water		miles	
	Millsites		Private		Mine Dumps		acres	
	Smelters		State		Disturbed Land		acres	
	Other		Other		Highwalls		miles	
					Mine Openings		number	
					Subsidence Prone		acres	
					Hazardous Structures		number	
					Other		units	

TABLE 1 (continued)
MINNESOTA'S ABANDONED MINE SITES
REFERENCE GUIDE FOR DATA SUMMARY

OTHER	Mines		Federal		Polluted Water		miles	
	Millsites		Private		Mine Dumps		acres	
	Smelters		State		Disturbed Land		acres	
	Other		Other		Highwalls		miles	
					Mine Openings		number	
					Subsidence Prone		acres	
					Hazardous Structures		number	
					Other		units	
TOTAL	Mines		Federal		Polluted Water		miles	
	Millsites		Private		Reservoirs		acres	
	Smelters		State		Mine Dumps		acres	
	Other		Mixed		Disturbed Land		acres	
			Not Classified		Pitwalls		miles	
					Mine Openings		acres	
					Caved Areas		acres	
					Mine Shafts		acres	
					Tailings Basins		acres	

REFERENCE GUIDE

Iron ore and taconite mining are the only metallic mining activities currently reg . .d under State authority in Minnesota. In addition, a large number of sand and gravel minc .re regulated at the county level. This summary does not present data for sand, silica, peat, or gravel mines because these mines are not closely tracked on State or U.S. Geological Survey data bases, are too numerous to compile separately, and are not addressed under Strawman II. Consequently, summary data are reported for only the metallic ore mineral type.

(I) A portion of this summary was compiled from the several existing lists which are referenced below. These data were used to determine figures for the categories in the Reference Guide Table (Table 1) marked (I).

- The Minerals Availability System (MAS) Domestic Deposit Listing for Minnesota from the Department of the Interior Bureau of Mines data base.
- Four documents from the National Park Service listing information about abandoned minelands on national park lands. These documents include minelands on NPL and CERCLIS lists.
- The Minnesota Mining Directory (MMD) from 1988 which was developed by the University of Minnesota Mineral Resources Center.
- The State of Minnesota 1988 Water Quality 305(b) report.
- The U.S. Geological Survey's Mineral Resource Data System (MRDS).

These data were compiled and identified by selecting those mines with a "past producer," "inactive," or "exhausted" status as determined by MAS, presented in the Minnesota Mining Directory (MMD), or defined by MRDS. MAS and MMD define inactive mines as permanently inactive closed mines, while MRDS defines inactive mines as "intermittently active" mines, or those mines that are inactive at least part of the time. Due to this discrepancy, double counting may have occurred, although an effort was made to avoid double counting of mine sites.

(II) Additional data from the Iron Range Information System were provided by the Minnesota Department of Natural Resources. This data base was used to supply data for the entries marked with (II) on the Reference Guide Table (Table 1). These figures, compiled in 1984, apply to the Mesabi Range only, and they include all mine facilities (abandoned and active). Therefore, the acres of truly abandoned minelands on the Mesabi Range are overestimated by these data.

There are 649 documented abandoned mine sites in Minnesota. Of these, almost two-thirds are owned by private industry. Ten percent of ownership is comprised of Federal, State, and mixed State and private industry. The remaining mine site ownerships have not been classified.

Acreage values were available for only mine sites located in the Mesabi Range in Minnesota. Furthermore, little or no data are available documenting environmental impacts, such as polluted water or soil contamination. In sum, few data exist to characterize the environmental impacts, "features," or size of the mine sites as requested for the WGA summary.

The Data Summary Table, Table 2 below, presents the findings for the State of Minnesota's Abandoned Mined Lands Project. Table 2 footnotes are denoted by a number within parentheses, e.g., (1).

TABLE 2
MINNESOTA'S ABANDONED MINE SITES (1)
DATA SUMMARY

(See numbered footnotes, page 14)

			DATA SUMMARY (2)					
MINERAL TYPE	MINING TYPE	acres	OWNERSHIP	acres	FEATURES		UNITS	COST
METALLIC ORES (3)	Mines 364	NA	Federal 1	NA	Polluted Water (4)	NA	miles	NA
	Millsites 7	NA	Private 424	NA	Reservoirs	848	acres	NA
	Smelters 0	NA	State 29	NA	Mine Dumps (5)	32,689	acres	NA
	Other 0	NA	Mixed 47	NA	Disturbed Land (6)	87,584	acres	NA
			Not Classified 148	NA	Pitwalls (7)	516	miles	NA
					Mine Openings (8)	24,703	acres	NA
					Caved Areas (9)	145	acres	NA
					Mine Shafts (10)	113	acres	NA
					Tailings Basins (11)	25,035	acres	NA
CONSTRUCTION ORES [sand and gravel, etc.]	Mines	na	Federal	na	Polluted Water	na	miles	na
	Millsites	na	Private	na	Mine Dumps	na	acres	na
	Smelters	na	State	na	Disturbed Land	na	acres	na
	Other	na	Other	na	Highwalls	na	miles	na
					Mine Openings	na	number	na
					Subsidence Prone	na	acres	na
					Hazardous Structures (12)	na	number	na
					Other	na	units	na
INDUSTRIAL ORES	Mines	na	Federal	na	Polluted Water	na	miles	na
	Millsites	na	Private	na	Mine Dumps	na	acres	na
	Smelters	na	State	na	Disturbed Land	na	acres	na
	Other	na	Other	na	Highwalls	na	miles	na
					Mine Openings	na	number	na
					Subsidence Prone	na	acres	na
					Hazardous Structures	na	number	na
					Other	na	units	na

TABLE 2 (continued)
MINNESOTA'S ABANDONED MINE SITES (1)
DATA SUMMARY

PHOSPHATE ROCK	Mines	0	Federal	0	Polluted Water	0	miles	0
	Millsites	0	Private	0	Mine Dumps	0	acres	0
	Smelters	0	State	0	Disturbed Land	0	acres	0
	Other	0	Other	0	Highwalls	0	miles	0
					Mine Openings	0	number	0
					Subsidence Prone	0	acres	0
					Hazardous Structures	0	number	0
					Other	0	units	0
URANIUM OVERBURDEN	Mines	0	Federal	0	Polluted Water	0	miles	0
	Millsites	0	Private	0	Mine Dumps	0	acres	0
	Smelters	0	State	0	Disturbed Land	0	acres	0
	Other	0	Other	0	Highwalls	0	miles	0
					Mine Openings	0	number	0
					Subsidence Prone	0	acres	0
					Hazardous Structures	0	number	0
					Other	0	units	0
OIL SHALE	Mines	0	Federal	0	Polluted Water	0	miles	0
	Millsites	0	Private	0	Mine Dumps	0	acres	0
	Smelters	0	State	0	Disturbed Land	0	acres	0
	Other	0	Other	0	Highwalls	0	miles	0
					Mine Openings	0	number	0
					Subsidence Prone	0	acres	0
					Hazardous Structures	0	number	0
					Other	0	units	0

TABLE 2 (continued)
MINNESOTA'S ABANDONED MINE SITES (1)
DATA SUMMARY

OTHER	Mines	0	Federal	0	Polluted Water	0	miles	0
	Millsites	0	Private	0	Mine Dumps	0	acres	0
	Smelters	0	State	0	Disturbed Land	0	acres	0
	Other	0	Other	0	Highwalls	0	miles	0
					Mine Openings	0	number	0
					Subsidence Prone	0	acres	0
					Hazardous Structures	0	number	0
					Other	0	units	0
TOTAL	Mines 364	NA	Federal 1	NA	Polluted Water	NA	miles	NA
	Millsites 7	NA	Private 424	NA	Reservoirs	848	acres	NA
	Smelters 0	NA	State 29	NA	Mine Dumps	32,689	acres	NA
	Other 0	NA	Mixed 47	NA	Disturbed Land	87,584	acres	NA
			Not Classified 148	NA	Pitwalls	516	miles	NA
					Mine Openings	24,703	acres	NA
					Caved Areas	145	acres	NA
					Mine Shafts	113	acres	NA
					Tailings Basins	25,035	acres	NA

Key: NA = Not available
na = Not applicable under scope of contract

FOOTNOTES

1. Abandoned Mined Lands means all mine properties that are not disturbed by mining activities after August 1980.

2. Included with this report is a Reference Guide which consists of the Reference Guide to the Data Summary Table (Table 1) and accompanying text which identifies the sources of data. Reference numbers appear throughout the table and correspond to the data sources cited in the text. The quality of the data and the basis of its reliability are reported in the Reference Guide.

3. Mining Disturbed Lands on Minnesota's Mesabi Iron Range. These 1984 data were developed for the Mesabi Iron Range only and do not include the Vermilion and Cuyuna ranges. They include all mine facilities (abandoned and active) at the time. Therefore, these figures overestimate the acres of truly abandoned mine lands on the Mesabi for each category shown.

4. Polluted Water means waters of the State into which any pollutant or contaminant has been discharged so as to create a nuisance or render such waters unclean, noxious, or impure and be potentially or actually detrimental to public health, safety, or welfare; to domestic, agricultural, commercial, industrial, recreational, or other legitimate use; or to livestock, wildlife, birds, fish, or other aquatic life.

5. Storage Piles (Mine Dumps) means a landform used for the disposal of material generated during mining operations such as surface overburden, rock, lean ore, and leached ore. It does not include tailings basins, or fossil fuel, finished product, or surge piles.

6. Mining Area (Disturbed Land) means any area of land from which material is hereafter removed in connection with the production or extraction of metallic minerals, including the lands upon which material from such mining is hereafter deposited, the lands upon which beneficiating plants, heap and dump leaching facilities, and auxiliary facilities are hereafter located, lands upon which the water reservoirs used in the mining process are hereafter located, and auxiliary lands that are hereafter used or intended to be used in a particular mining operation.

7. Pitwalls (Highwalls) means the exposed face of overburden and/or mineral formation resulting from an open pit cut.

8. Mine Shafts means any vertical or horizontal opening used to access underground ore.

9. Caved Areas (Subsidence Prone Areas) means any areas over underground mine workings where the ground surface has collapsed.

10. Mine Openings means any vertical or horizontal opening used to access underground ore.

11. Tailings means waste by-products of mineral beneficiating processes other than heap and dump leaching consisting of rock particles which have usually undergone crushing and grinding, from which profitable mineralization has been separated using technologies that exist at the mining operation.

12. Hazardous Structures means related buildings, foundations, headframes, etc. which could pose a hazard to people being in, on, or around them.

MISSOURI

NON-COAL INVENTORY OF INACTIVE/ABANDONED MINES[1]
STATE OF MISSOURI

DATA SUMMARY

Department of Natural Resources
Division of Environmental Quality
Southeast Regional Office
Jim Burris (314-785-0832)

NOTE: The reclamation costs listed in this table are strictly estimates based on federal Office of Surface Mining coal mine reclamation guidelines. Refer to footnote 16 for a detailed explanation.

DATA SUMMARY[2,3]

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)		(cost)[16]
Metallic Ores	Mines	11,008	Federal	---	Polluted Water[8]	(miles)	109	$3,270,000
	Millsites	---	Private	11,008	Mine Dumps[9]	(acres)	1,706	$8,530,000
	Smelters	---	State	---	Disturbed Land[10]	(acres)	11,008	$22,016,000
11,008 ac. (2,946 sites)	Other[5]	2,319	Other[6]	---	Highwalls[11] (number)	~~(acres)~~	131	$589,500
		reported			Mine Openings[12]	(number)	323	$1,615,000
		sites			Subsidence Prone[13]	(acres)	7,665	$766,500,000
					Hazardous Structures[14]	(number)	---	---
					Other[15]	(units)	---	---
Construction Ores	Mines	12,858	Federal	---	Polluted Water	(miles)	---	---
	Millsites	---	Private	12,858	Mine Dumps	(acres)	---	---
	Smelters	---	State	---	Disturbed Land	(acres)	12,858	$25,716,000
12,858 ac. (2,396 sites)	Other	1,609	Other	---	Highwalls (number)	~~(acres)~~	1,956	$8,802,000
		reported			Mine Openings	(number)	---	---
		sites			Subsidence Prone	(acres)	4,385	$438,500,000
					Hazardous Structures	(number)	---	---
					Other	(units)	---	---
Industrial Ores	Mines	23,604	Federal	---	Polluted Water	(miles)	---	---
	Millsites	---	Private	23,604	Mine Dumps	(acres)	---	---
	Smelters	---	State	---	Disturbed Land	(acres)	23,604	$47,208,000
23,604 ac. (2,120 sites)	Other	710	Other	---	Highwalls	(miles)	---	---
		reported			Mine Openings	(number)	1,899	$15,192,000
		sites			Subsidence Prone	(acres)	130	$13,000,000
					Hazardous Structures	(number)	---	---
					Other	(units)	---	---

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[6]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)	(cost) 16
Phosphate Rock	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
None	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Uranium Overburden	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
None	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
None	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines	705	Federal	---	Polluted Water	(miles) ---	---
	Millsites	---	Private	705	Mine Dumps	(acres) ---	---
	Smelters	---	State	---	Disturbed Land	(acres) 705	$1,410,000
705 ac. (193 sites)	Other	285	Other	---	Highwalls	(miles) ---	---
		reported			Mine Openings	(number) 46	$368,000
		sites			Subsidence Prone	(acres) ---	---
					Hazardous Structures	(number) ---	---
					Other	(units) ---	---
TOTAL	Mines	48,175	Federal	---	Polluted Water	(miles) 109	$3,270,000
	Millsites	---	Private	48,175	Mine Dumps	(acres) 1,706	$8,530,000
	Smelters	---	State	---	Disturbed Land	(acres) 48,175	$96,350,000
48,175 ac. (7,655 sites)	Other	4,923	Other	---	Highwalls (number)	(XXX) 2,087	$9,391,500
		reported			Mine Openings	(number) 2,268	$17,175,000
		sites			Subsidence Prone	(acres) 12,180	$1,218,000,000
					Hazardous Structures	(number) ---	---
					Other	(units) ---	---

NON-COAL INVENTORY OF INACTIVE/ABANDONED MINES
STATE OF MISSOURI

FOOTNOTES TO DATA SUMMARY

1) Missouri has included all non-coal mine sites which were abandoned prior to 1971 and have no existing reclamation responsibility by any individual, company, or governmental agency. Missouri has excluded all active non-coal mines and those abandoned after 1971, for which the Missouri Department of Natural Resources, Division of Environmental Quality, Land Reclamation Program has regulatory responsibility.

2) Missouri's data sources include: (a) the USBM-MILS database, which contains approximately 15,000 mine sites (refer to Appendix 2); (b) the USGS-MRDS database, which contains approximately 200 mine sites; (c) the Missouri Department of Natural Resources, Division of Geology and Land Survey's mineral resource files and maps; and (d) personal communications with Missouri Department of Natural Resources, Division of Geology and Land Survey geologists Ardel Rueff and Mike McFarland.

3) Data quality is high (about 95% accurate) for nearly all of Missouri's mine sites in regard to mine location, commodity mined, and acreage affected by mining. Descriptions and/or knowledge of individual mining features are very reliable (about 90% accurate) where fieldwork or air-photo analysis has yielded quantifiable data.

4) Acreage totals listed for each 'Mineral Type' category include entire mine site areas as measured from USGS, ASCS, and USFS aerial photos.

5) Missouri has listed "reported sites" under the 'Other Mining Type' heading. A reported site is a mine which was referenced (location and commodity) by a publication, map, geologist's field notebook, or other published/unpublished literature. Reported sites were entered into the MILS database; however, they were not verified on air-photos nor observed in the field.

A more detailed survey will be necessary to research existing information sources for the purpose of tabulating mill/smelter sites. However, it is generally known that many mill sites exist in the Tri-State Zinc-Lead District (southwest Missouri).

6) As with mills and smelters, a more detailed survey will be necessary to accurately determine the amount of federal and state land ownership which exists in Missouri's abandoned mine areas. However, governmental acreage ownership is perceived to be minimal.

7) For Missouri, the 'Mineral Type' groupings include the following commodities, ordered by relative abundance:

Metallic - lead, zinc, iron, copper, manganese, silver, cobalt, nickel and tungsten.

Construction - limestone, sand and gravel, sandstone, granite, rhyolite, and chert.
Industrial - barite, clay, silica, tripoli, and tar sand.
Other - borrow and unknown.

'Borrow' describes any unconsolidated soils, sands, clays, glacial tills, or rock residuums which are removed by surface excavation or strip and utilized primarily as fill material. 'Unknown' describes any referenced mine site for which the commodity was either unrecorded or simply not known.

8) For the 'Polluted Water' heading, the reference used was the USGS Water Resources Investigation Report 87-4286 (Assessment of Water Quality in Non-Coal Mining Areas of Missouri: B. J. Smith, 1988). This report delineates the various Missouri streams whose quality is known to be affected by non-coal mining. These effects were measured against water-quality standards established by the State of Missouri as shown below.

Missouri Water Quality Standards

(All values in micrograms per liter, unless otherwise noted; mg/L = milligrams per liter; -- = no standard determined; values for trace elements are dissolved)

	Drinking-Water Supply	Protection of Aquatic Life	Livestock, Wildlife Watering
Arsenic	50	20	--
Barium	1,000	--	--
Cadmium	10	12	--
Cobalt	--	--	1,000
Copper	1,000	20	500
Iron	300	1,000	--
Lead	50	50	--
Nickel	--	100	200
Selenium	10	10	--
Zinc	5,000	100	2,000
Sulfate, mg/L	250	--	--

(Missouri Department of Natural Resources, 1984)

9) Elongate, conical, and dome-shaped accumulations of development rock (boulders) and waste rock (chats and fines), resulting from metal mining, are included under the 'Mine Dump' heading.

10) Acreage totals listed under the 'Disturbed Land' heading represent all mine-related features and lands affected by mining, as measured from USGS, ASCS, and USFS aerial photos.

11) Missouri has changed the units under the 'Highwall' heading from "miles" to "number" because a more detailed survey will be necessary to further quantify this group. Features include high-angle to vertical quarry faces (limestone and sandstone) and steep-sided collapse holes (subsidence features above underground lead and zinc mines).

12) The 'Mine Opening' heading includes any unprotected mine entry, many of which are flooded with water. Features include vertical shafts (metallics), near-vertical pits (metallics, clay, and borrow), horizontal adits (metallics, limestone, and sandstone), and inclined openings (metallics).

13) The past history of Missouri's abandoned underground mining areas has shown that ground subsidence and/or collapse occurs above only a small percentage of the total underground mine void acreage. However, Missouri has included the estimated areal extent of all documented underground mine workings under the 'Subsidence Prone' heading. The majority of the acreage listed for metallic ores occurs in the large metal mining regions of the Tri-State District (southwest Missouri) and the Old Lead Belt (southeast Missouri). Acreage listed for construction ores includes underground limestone and sandstone mines, while underground silica mines comprise the total for industrial ores. These totals are exclusive of any surface acreage amounts (such as 'Disturbed Land') that appear in the data summary. Additional undocumented acreage exists at underground clay mine sites in several Missouri localities (St. Louis, Kansas City, Mexico, Fulton, and others). Further research will be necessary to determine estimates of the extent of these mines.

14) For the 'Hazardous Structure' heading, a more detailed survey involving fieldwork will be necessary to research fully the number, type, and condition of the structures remaining in Missouri's abandoned mine areas. Previous mine inventory fieldwork has established that many of these features do exist, as well as remnant concrete foundations indicating prior existence of buildings.

15) At this time, Missouri has no miscellaneous abandoned mine features to be entered under the 'Other Features' heading.

16) For the 'Costs' heading, the reference used was the U. S. Department of Interior, Office of Surface Mining's 1989-1990 revision of <u>Guidelines for Estimating Abandoned Coal Mine Lands Reclamation Costs</u>, included as Appendix 1. The amounts figured are strictly estimates because the guidelines were established from coal mine reclamation experience. They undoubtedly will be inaccurate and not represenative of potential non-coal mine reclamation costs in Missouri. In addition, the actual percentage of each feature group (miles, acres, or number) which is truly in need of reclamation is much less than the listed inventory total. This would also drastically reduce any reclamation cost estimate assigned to each group of features. The following examples may clarify these statements. The cost estimates listed for reclaiming polluted streams may be largely avoided if the mine-related features which are the source of the pollution (e.g., mine dumps and mine openings) are eliminated or reclaimed. The materials

contained in a large percentage of Missouri's mine dumps have been removed and used for various purposes, thus reducing the reclamation costs associated with this feature group. Much of the acreage listed as disturbed land has already been adequately reclaimed by nature. Backfilling of excavations and pits has never been required by state reclamation laws. And, the past history of Missouri's abandoned underground mining areas has shown that ground subsidence and/or collapse occurs above only a small percentage of the total underground mine void acreage. Thus, it is emphasized that the reclamation cost estimates listed in the data summary table are inherently misleading because of the apparent prioritizing of feature groups and guideline inaccuracies when applied to non-coal mine problems. However, applications of the Office of Surface Mining's coal mine reclamation costs to non-coal mine problems were attempted. The following explanations outline these applications for each feature group.

'Polluted Water' - Refer to Appendix 1, section 5b: an average cost of $30,000/mile was applied to cleaning streams whose quality has been affected by mining.

'Mine Dump' - Refer to Appendix 1, section 1d: a cost of $5,000/acre was used for significant earthmoving work necessary to reclaim mine waste pile sites.

'Disturbed Land' - Refer to Appendix 1, section 1c: a cost of $2,000/acre was used for moderate earthmoving work necessary to reclaim lands not severely affected by mining.

'Highwall' - Refer to Appendix 1, section 3: because highwall lengths and heights are not presently known, a minimum cross-section of 30 feet high and 100 feet long was applied to OSM's "required fill volume equation", giving:

$$\text{Volume (cubic yards)} = (.05)(\text{height})^2(\text{length})$$
$$= (.05)(30\text{ ft})^2(100\text{ ft})$$
$$= 4{,}500\text{ cubic yards}$$

At a $1/cubic yard rate, a minimum cost of $4,500/highwall was used.

'Mine Opening' - Refer to Appendix 1, section 5d for clay and borrow pits: because these types of mine openings have large surface expressions and retain large amounts of water, they require drain and fill work. A minimum cost of $8,000/pit was used.

Refer to Appendix 1, section 7b for metallic mine openings: reclamation experience has shown that these types of mine openings, small in surface expression, have been successfully reclaimed by closure. A cost of $5,000/entry was used.

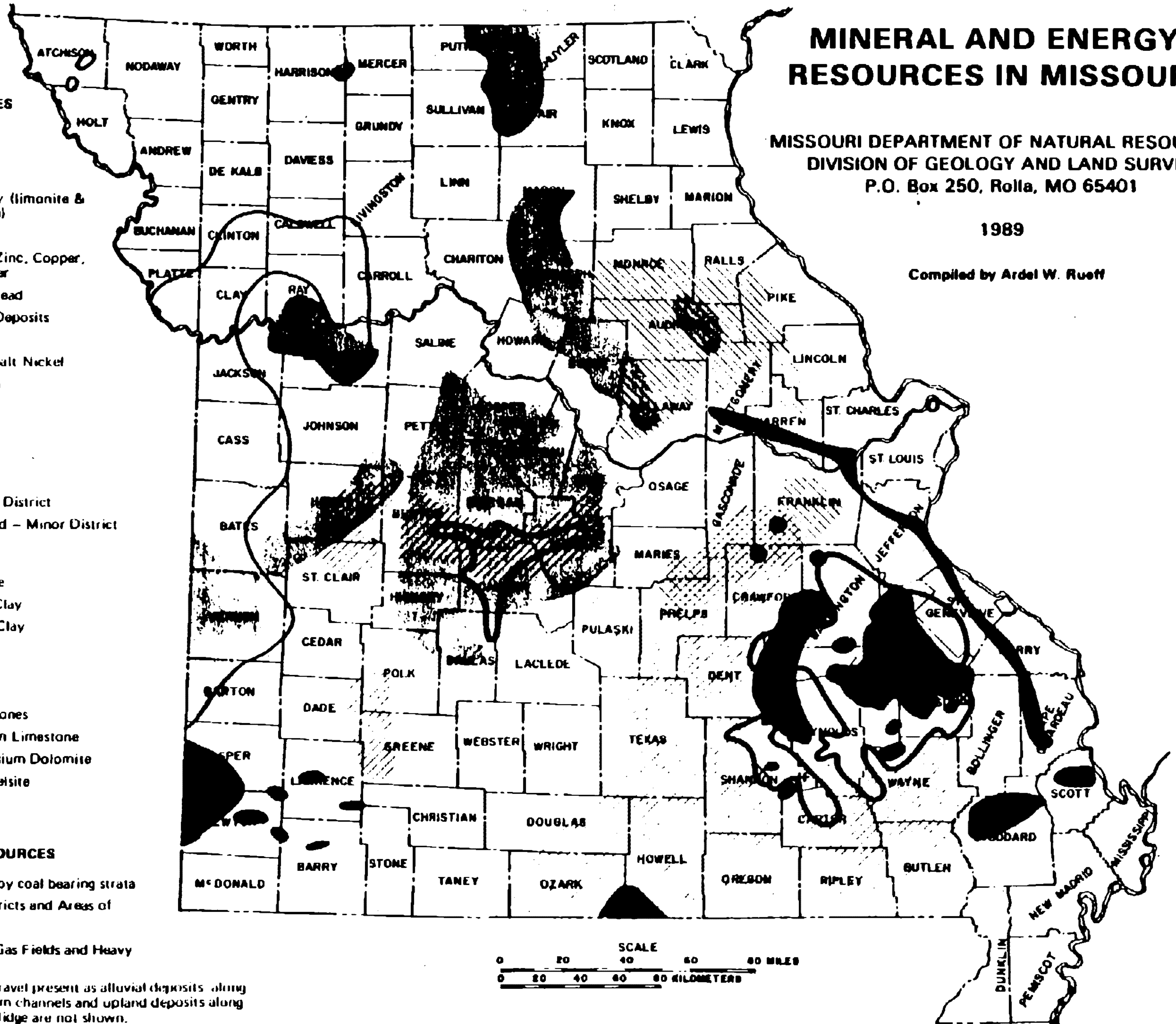
'Subsidence Prone' - Refer to Appendix 1, sections 9a and 9b: using an "area allocation factor" of 2 (which indicates a median land use type - "developed") and the standardized $50,000/acre cost, a total subsidence reclamation cost of $100,000/acre was applied.

MINERAL AND ENERGY RESOURCES IN MISSOURI

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
P.O. Box 250, Rolla, MO 65401

1989

Compiled by Ardel W. Rueff



LEGEND

MINERAL RESOURCES

METALS

Iron
- Magnetite
- Sedimentary (limonite & hematite)

Lead & Zinc
- Lead with Zinc, Copper, and Silver
- Zinc with Lead

Miscellaneous Deposits
- Copper
- Copper Cobalt Nickel
- Copper-Iron
- Manganese
- Tungsten

NONMETALS

Barite – Major District

Barite with Lead – Minor District

Clay
- Clay & Shale
- Absorbent Clay
- Refractory Clay

Silica Sand

Sand & Gravel*

Stone
- Thin Limestones
- High-Calcium Limestone
- High Magnesium Dolomite
- Granite & Felsite
- Tripoli

ENERGY RESOURCES

Area underlain by coal bearing strata

Major Coal Districts and Areas of Mining

Areas of Oil & Gas Fields and Heavy Oil Deposits

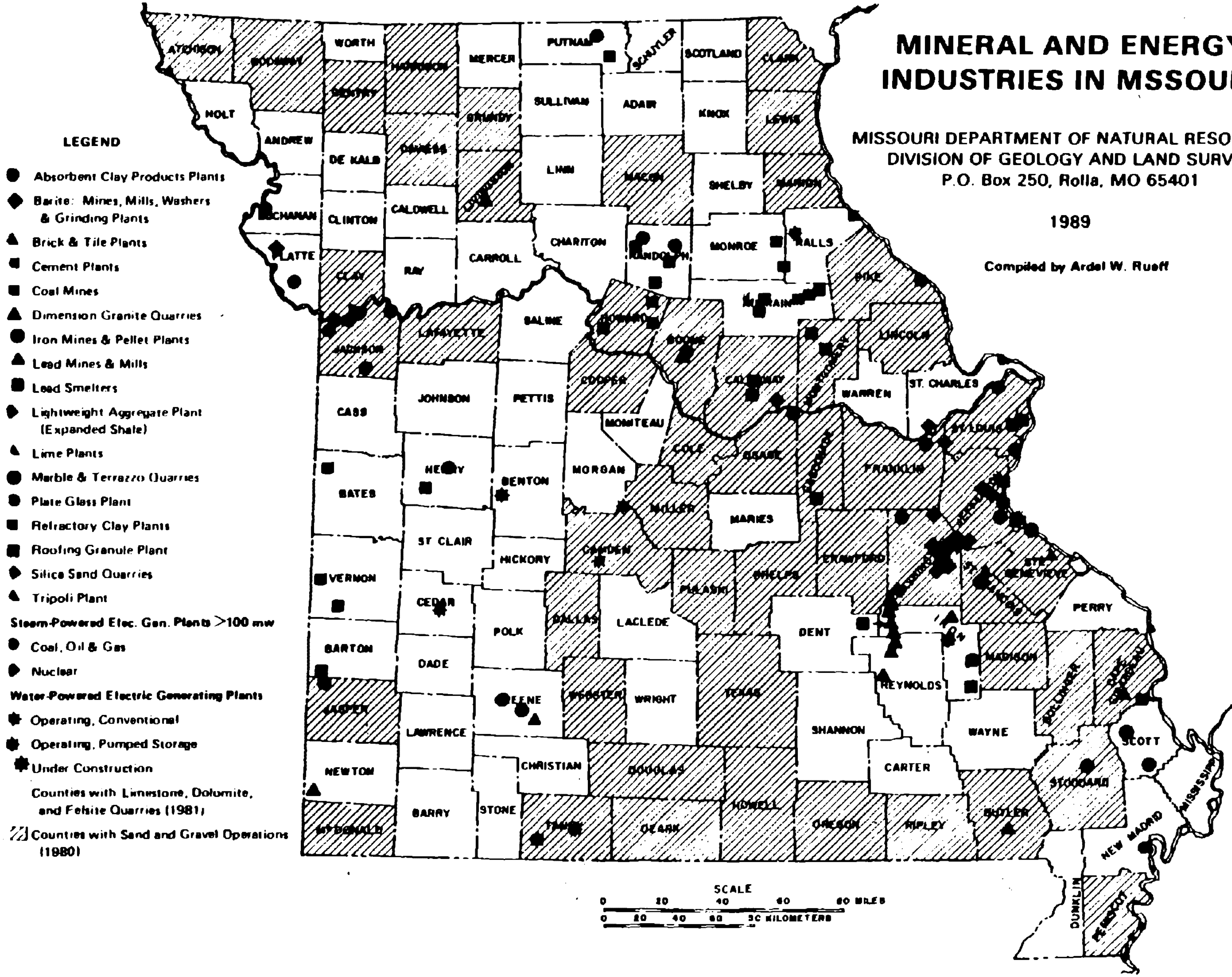
*Sand and gravel present as alluvial deposits along major stream channels and upland deposits along Crowleys Ridge are not shown.

MINERAL AND ENERGY INDUSTRIES IN MSSOURI

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
P.O. Box 250, Rolla, MO 65401

1989

Compiled by Ardel W. Rueff



WESTERN INTERSTATE ENERGY BOARD
WESTERN GOVERNORS ASSOCIATION

NON-COAL INVENTORY OF INACTIVE/ABANDONED MINES

STATE OF MISSOURI

Final Report
April 15, 1991

NON-COAL INVENTORY OF INACTIVE/ABANDONED MINES
STATE OF MISSOURI

NARRATIVE SUMMARY

HISTORY OF NON-COAL MINING

The earliest mining in Missouri was conducted by Indians in search of chert for arrowheads, clay for pottery, and iron oxides for paints. In the mid-1600's, French-Canadians, the first Europeans to explore Missouri, actively prospected for minerals. As early as 1700, lead diggings existed along what is now the Meramec River in Washington County. By 1720, other French adventurers had initiated shallow lead mining at Mine La Motte, in what is now northern Madison County. During the next 100 years, many other lead deposits were found and exploited throughout southeast Missouri. The mining camp of Potosi, in Washington County, was particularly active during this period. By 1830, additional lead deposits were discovered in the central part of the state, south of the Missouri River.

In 1848, mining began in southwest Missouri with the discovery of valuable deposits of lead near Joplin, in Jasper County. The associated zinc ores were originally discarded for lack of an efficient technology for recovery of the zinc. By 1870, the extension of railway lines into southwest Missouri and the development of new milling and smelting techniques led to the first production of zinc in the region. Other mining camps that capitalized on this profitable zinc industry included Oronogo and Webb City in Jasper County, Granby in Newton County, and Aurora in Lawrence County. By 1875, Missouri had become the nation's top zinc producer.

During the 1870's, a new milestone in hard-rock mining was reached in Missouri's southeast mining area. The revolutionary diamond exploratory drill, along with explosive blasting, allowed miners to pursue rich surface ore trends that continued further underground. Expanding with this lead mining industry, small mining camps gradually grew into towns: Bonne Terre and Flat River in St. Francois County and Fredericktown in Madison County. By 1907, Missouri had attained the highest lead production in the nation. Eventually, both Missouri's southwest and southeast metal mining regions (later known as the Tri-State District and the Old Lead Belt, respectively) grew to become world-class districts, each producing metals worth over one billion dollars.

By the end of World War II, the economically profitable ore deposits in both the Tri-State and Old Lead Belt had been depleted. From 1947-1962, new exploratory drilling programs, initiated west of the Old Lead Belt, had revealed several large commercial deposits of lead, zinc, copper, and silver underlying parts of Washington, Crawford, Iron, and Reynolds Counties. These great discoveries led to the development of the largest lead mining district in the world, the Viburnum Trend (also known as the New Lead Belt). This mining region remains active to the present day.

Deposits of iron ore were observed in Missouri as early as 1673 at localities which are now in Perry and Ste. Genevieve Counties. In 1815, the state's first iron ore mining of record was executed at Shepherd Mountain, in Iron County. By 1825, other iron ventures had taken place in Crawford and Washington Counties. During the next 25 years, major iron operations were begun at Iron Mountain (St. Francois County), Pilot Knob (Iron County), and Meramec Spring (Phelps County). From 1850 to the late 1960's, some 400 relatively small iron ore deposits were mined throughout southern Missouri. The Pea Ridge deposit (Washington County) was discovered by aeromagnetic surveys in 1951 and mined intermittently from 1964 to the present. This operation is the only active iron mine in the state today, but ranks as the largest underground iron mine in the nation. Several other underground iron ore deposits in southern Missouri have been revealed by magnetic surveys and verified by exploratory drilling, but remain undeveloped.

The earliest copper mining in Missouri occurred in Washington County in 1830. From 1837 to the late 1920's, sporadic mining of copper took place at various sites in Shannon, Crawford, Franklin, St. Francois, and Ste. Genevieve Counties. Although some of these localities were valued for their lead deposits, the associated copper mineralization was also profitably exploited during this time period. The Fredericktown and Mine La Motte areas were the most notable of these. Some copper was also recovered from the zinc ores of the Tri-State District. The only mines in the state operated solely for copper were the Eminence mines (Shannon County) and the Cornwall mines (Ste. Genevieve County). From 1944-1961, renewed lead mining in the Fredericktown region resulted in additional copper output. Since 1961, all copper production in Missouri has been as a byproduct of the lead ores mined in the Viburnum Trend. One underground copper deposit, discovered in 1959 and located in Dent County, has potential commercial value but remains undeveloped.

Other metallic commodities mined in Missouri include cobalt, nickel, manganese, silver, and tungsten. From 1844-1961, cobalt and nickel were recovered from the important lead ores of the Fredericktown area. Manganese mining was conducted intermittently from 1872-1958 in Iron, Madison, Reynolds, Wayne, and Shannon Counties. Beginning in 1877, silver was produced sporadically in the Silver mines area of Madison County. However, nearly all of Missouri's silver output has been as a byproduct of the lead ores in the Old Lead Belt and the Viburnum Trend. Tungsten was produced in the Silver mines area during the years 1916-1950.

The quarrying of stone in Missouri began with the earliest settlements in the state. Many of the first houses had stone foundations and chimneys; some were constructed entirely of stone. Missouri's diverse stone sources include limestone, dolomite, sandstone, granite, rhyolite, and chert. Limestone and dolomite have been quarried in nearly every Missouri county for a wide variety of uses, including concrete aggregate, cement manufacture, agricultural lime, and building/dimension stone. In general, thick sequences of limestone and dolomite have been quarried throughout the central and southern parts of the state, whereas thinner units have been worked in northern and western Missouri. With the exception of minor declines, the limestone industry of Missouri has grown steadily since 1920 to its present production level of over 50 million tons annually.

Sandstone has been quarried in Missouri since the late 1800's. This durable stone was used extensively for bridge abutments prior to 1900. After that time, its primary applications have been as building/dimension stone and as a source of industrial or silica sand. The first quarrying of granite occurred prior to 1870 in the St. Francois Mountains area of southeast Missouri. The durability, beauty, and high polishing quality of this rock made it suitable for usage as headstones and monuments as well as building/dimension stone. Today, red granite from Missouri remains one of the most desirable stone products in the nation. Rhyolite quarrying commenced around 1900 in Wayne County with the rock being used primarily as building stone. From 1965 to the present, a rhyolite deposit in Iron County has been worked for the exclusive use as roofing granules in the manufacture of shingles. During the period 1913-1939, chert gravels from the Meramec and Osage Rivers were crushed and utilized as roofing "chips". For the past several decades, mine wastes in the Tri-State District, composed mostly of chert, have been worked and marketed for many purposes, including roadstone, pipe coatings, and blasting/grinding/polishing sands. One recent operation in Newton County was quarrying chert bedrock solely for use as railroad ballast.

Sand and gravel have been produced in most counties of Missouri, with the first reported output occurring in 1905. Prior to that time, early settlers worked river and creek deposits by hand methods. Later, power shovels and dredges were used to exploit the large floodplain and in-channel deposits of the Mississippi and Missouri Rivers and their tributaries. Upland terrace deposits of the Bootheel area in southeast Missouri and glacial drift accumulations in the northern part of the state have also been operated commercially. Major uses of sand and gravel include roadstone, concrete aggregate, and abrasives. Recent sand and gravel production in Missouri is approximately 10 million tons annually.

Despite its occurrence with the oldest lead deposits of southeast Missouri, barite was originally discarded as valueless during the early days of lead mining. However, in 1850, the newly developed paint and rubber industries required a steady supply of barite. By the early 1900's, extensive barite mining was being conducted in the Washington County area. Over the next 70 years, this district ranked among the nation's leaders in barite production. Barite has also been recovered from the central part of the state, primarily Cole, Miller, Morgan, and Moniteau Counties. In 1925, the demand for barite soared when its use as a weighing agent in rotary well drilling fluids was developed. From 1925-1970, Missouri's barite production gradually increased to about 300 thousand tons annually. Since 1970, the industry has slowly declined and, presently, only a few companies in Washington County remain operative.

Indians were the first to mine and form clay into pottery. Early European settlers mixed clay with water to seal gaps in log cabins and also fashioned clay bowls and pipes. Early in the 18th century, the first French communities along the Mississippi River manufactured common brick for building purposes. The first recorded clay production was by a pottery company in 1827 in Callaway County. By 1845, the first firebrick plant in the state was built in the city of St. Louis. From 1865-1900, the flint clays of southern Missouri (principally, Phelps, Crawford, Franklin, Maries, Osage, and Gasconade Counties) and the plastic clays of northern Missouri (Audrain, Callaway, Monroe, and Montgomery Counties) were discovered and mined. Also during this period, high-quality refractory clay was recovered from operations in the city of St. Louis and St. Louis County. After 1900, Missouri's clay industry gradually expanded to the present production level of approximately 1.5 million tons annually.

Silica sand is primarily used in the production of plate glass and many types of abrasives. The St. Peter Sandstone, a formation composed of unusually pure silica sand, was observed as early as 1840 in east-central Missouri. During the 1870's, exploitation of this sandstone gave rise to silica mining and glass manufacturing in the Crystal City area of Jefferson County. This region has continued its output of high-quality glass products to the present time. The majority of Missouri's silica production has been from Jefferson, St. Louis, and St. Charles Counties. Until recently, silica sands suitable for abrasive purposes were produced in the Tri-State District by grinding mine wastes composed principally of chert, a cryptocrystalline form of silica.

Tripoli, an ideal abrasive used in polishing and buffing compounds, was first mined in Newton County in 1871. Missouri was the nation's leading producer of tripoli until 1914. Limited resources probably preclude any large scale resumption of tripoli mining in Missouri. All present production is from adjacent areas in Oklahoma.

Tar sand, a sandstone impregnated with bituminous matter, occurs throughout western Missouri. During the mid-1960's, "asphaltic" sandstone was quarried in Barton and Vernon Counties and used for road paving. This material is not entirely suitable for paving purposes because of its shrinkage and lack of binding properties. Probably the greatest potential of the state's tar sand deposits is for energy production.

PAST MINING PRACTICES

Both surface and underground mining methods have been conducted in Missouri to recover a wide variety of mineral commodities. All construction and industrial minerals plus lead, zinc, iron, copper, and manganese have been mined by surface operations. Developments included shallow pits and trenches, small hillside cuts, large open pits, deep quarry excavations, and dredging/stripping operations. All metallic minerals plus limestone, sandstone, clay, and silica have been mined by underground methods. Vertical shafts, inclined entries, horizontal adits, and underground networks of drifts, tunnels, chambers, and railways were developed to access and exploit the ore deposits. Miscellaneous features related to all types of mining operations include access and haulage roads, mineral stockpile areas, overburden disposal areas, and buildings/structures used for storage of equipment and materials.

Beneficiation of the various ores involved the use of washer facilities, mechanical and chemical separators, crushers and grinders, concentrating mills, roasting furnaces, and smelters. Waste materials resulting from mining and milling were accumulated in large piles and ponds directly on the land surface adjacent to the mine areas. Large development rock was heaped in irregularly shaped boulder piles while smaller size wastes (chats, tailings, and fines) were deposited in more symmetrically shaped piles or conveyed into gravity settling ponds. Waste waters used during ore processing were either released directly to adjacent streams or recycled through settling ponds and other basins.

DESCRIPTIONS OF MINE-RELATED PROBLEMS

(Refer to history section and mineral resource map for generalized geographic localities which may contain some of the following mine-related problems.)

Typical safety hazards resulting from abandoned mining include open shafts having vertical drop-offs, subsided areas possessing unstable slopes, adit entries leading into mine drifts, and open pits and quarry excavations containing pools of water. In many cases, open shafts are concealed by surrounding trees and vegetation. Subsidence pits have long been popular sites for trash dumping. Adit openings tempt the exploring nature of persons who discover them. Waterfilled excavations are visited regularly by fishermen, swimmers, and scuba divers. Some damages to buildings, roads, and crop/pasture lands above collapsing underground mine workings have been documented. Occasional catastrophic collapses have opened up holes in public parking areas and on private urban property. Accidents to people and livestock frequenting or wandering into abandoned mining sites have also occurred. Drownings in waterfilled pits have been reported and at least one death and one injury have been attributed to the collapse of an undercut mine waste pile.

Typical environmental impacts caused by abandoned mining include surface/subsurface water quality problems, surface stream turbidity and sedimentation, decreased numbers and unbalanced diversity of aquatic organisms in affected streams, high levels of trace elements in fish and other aquatic life, erosion of tailings piles and ponds into streams, elevated concentrations of metals in stream bottom sediments, decreased fish habitats due to sedimented pools, acid mine drainage, airborne mine waste particles, barren land areas, and unsightly abandoned structures and trash accumulations at mine sites.

Shallow aquifers may be readily contaminated by direct or lateral proximity to flooded underground metallic mine workings. Deeper aquifers may also be degraded due to hydrologic connections to the shallow aquifers via geologic structures (faults, fractures, and joint systems), abandoned wells with incompetent casings, and uncased exploratory drillholes. Normal rainwater runoff and seepage from mine waste piles and settling ponds causes trace element levels above background values in streams and their bottom sediments. Intense rainfalls have caused erosion of tailings piles and failure of tailings pond dams, allowing mine waste sediments to enter nearby streams and be transported tens of miles from their source. In some instances, extensive fish kills have resulted from these sudden releases of sediment. Fish species which feed on stream bottom materials accumulate high levels of heavy metal contaminants in their organs and tissues, often rendering them unsuitable for human consumption. Artesian flow of acidic mine waters from open shafts, adits, and unplugged exploratory drillholes adversely affects the quality of soils and streams. In some of the abandoned metallic mining areas of southwest Missouri, local concentrations of lead, zinc, iron and cadmium in surface and ground water exceed the acceptable limits for public drinking water. Elevated levels of numerous metals have been detected in algae, rooted plants, crayfish, mussels, snakes, bullfrogs, herons, and muskrats throughout the Old Lead Belt mining region of southeast Missouri.

Windblown particulates derived from barren or poorly vegetated abandoned mine lands contain undesirable elements (e.g., lead, sulfur, and silica) and pose air quality problems to plants, animals, and humans. Other consequences of these barren lands include increased erosion of soil, lack of cover for animal species, and a continuing unproductive status. Abandoned mining structures and equipment further degrade the appearance of mine sites. The unlawful disposal of industrial and residential wastes in mine areas is a continuing problem.

Some reclamation of surface lands mined for non-coal commodities after 1971 is required by state legislation. Disturbed areas are usually graded to a traversable, rolling topography. In some cases, pasture or crop lands are established. Exposed mineral seams which may cause acidic or toxic conditions are covered and vegetated. Erosion problem areas are controlled by establishing appropriate vegetative cover. Removal of abandoned equipment and structures is effected. Noncompliance of operators at permitted sites can result in bond forfeitures and/or injunctions. In addition, operators of nonpermitted sites are referred to county prosecutors for legal action. A small percentage of mine operators perform reclamation that exceeds regulatory standards. At some sites, pits and excavations have been backfilled and crop lands established. At other sites, water reservoirs with accessible side slopes have been created.

RECLAMATION AND ENVIRONMENTAL LEGISLATION

Approximately 250 years of mining activity predate reclamation legislation in Missouri. Some mined areas were abandoned with little regard for future safety hazards or environmental impacts. Prior to Missouri's mining reclamation laws of the 1970's, other state laws applicable to potential environmental impacts resulting from abandoned mining were enacted. In 1957, a Water Pollution Board was authorized to provide standards of water quality and to regulate all discharges of water to the environment. The Air Conservation Act of 1965 stipulated air pollutant standard levels and empowered the regulation of all public air emissions. During the 1970's, Missouri established land reclamation laws to regulate the surface mining of coal, limestone, sand and gravel, barite, clay, and tar sand (Land Reclamation Act of 1971 and Strip Mine Laws of 1971, 1976, and 1979). Under this legislation, mine operators must acquire mining permits and post performance bonds to ensure the costs of reclaiming all acreage affected by mining. Inspection of sites and enforcement of regulations are also authorized. Recent legislation entitles the regulation of all non-metallic surface mining and metallic mining waste areas (Strip Mine Law of 1990 and Metallic Minerals Waste Management Act of 1990). These laws increased all permit, bond, and reclamation requirements. Presently, no underground mines are regulated except for surface features (e.g., tailings ponds) which may be developed. At this time, no state laws have established funds for the assessment and reclamation of non-coal mine lands abandoned prior to 1971.

Early federal legislation relevant to abandoned mining and resultant environmental problems includes the Clean Air Act of 1970 and Clean Water Act of 1972. The formation of the U.S. Environmental Protection Agency (EPA) occurred in 1972. The Surface Mining Control and Reclamation Act of 1977 (SMCRA) applied primarily to coal mine lands. This law established a trust fund, generated from fees paid by active coal mine operators, to be utilized for reclaiming abandoned coal mine areas. The Abandoned Mine Reclamation Fund is administered by the Secretary of Interior through the Office of Surface Mining. All coal reclamation projects have priority to draw on this fund. However, the Governor of any state is authorized to request money from this federal fund to be used for the reclamation of non-coal mine areas which endanger public health and safety. Other federal legislation which may effect non-coal mine reclamation in Missouri includes the Resource Conservation and Recovery Act of 1976 (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Under the authority of these laws, the EPA recently designated a portion of Missouri's Tri-State District in Jasper County to be added to the National Priorities List, commonly referred to as Superfund Sites. Previous reclamation work in this abandoned zinc-lead mining region has been conducted by the EPA in adjacent areas of Kansas and Oklahoma during the 1980's.

NON-COAL RECLAMATION

As previously stated, Missouri has no available funds for reclaiming non-coal mine lands abandoned prior to 1971. Some private landowners have employed successful methods of safeguarding dangerous sites. Mine entries have been sealed, filled, blockaded, fenced, or sign-posted as hazardous. Abandoned buildings have been razed. Some barite tailings ponds and clay mine pits have been converted into attractive fishing lakes. The gradual removal and use of mine waste materials, with subsequent leveling and reuse of the land, has effected some surface reclamation. However, other than backfilling shafts, nothing has been done to stabilize areas above underground mines. Any major improvements in surface/subsurface water quality are far beyond the scope of individual efforts. The specific impacts of mine-related problems have been researched, catalogued, and evaluated. Federal demonstration projects have indicated viable mitigations and solutions. But lack of governmental funding precludes a comprehensive program of hazard control and environmental reclamation.

NON-COAL INVENTORY OF INACTIVE/ABANDONED MINES
STATE OF MISSOURI

APPENDIX 1

Guidelines for Estimating Abandoned Coal Mine Lands Reclamation Costs

*(Subject to change as Reclamation Project cost experience increases. States, Tribes, SCS, and the OSM Support Centers now have many years experience with reclamation. They are therefore encouraged to use costs based on there experience. If these cost are 25 percent higher or lower than these cost guidelines they must be documented.)

*New cost guidelines were developed as part of OSM's 1989-1990 review of AMLIS for dangerous highwalls, subsidence, and underground mine fires. These new cost guidelines are now incorporated in AML-1.

1. Revegetation of spoils, bench, pits (when filling is not required), gob material, and haul roads.

   a. Spot plantings and a few scattered silt control structures, no grading: $ 500/acre

   b. Conditioning and ground cover, no grading.

      On less than 10 acres: $1,500/acre
      Over 10 acres: $1,000/acre

   c. Smoothing with rubber-tired equipment (some grading), conditioning, ground cover.

      On less than 10 acres: $2,000/acre
      Over 10 acres: $1,500/acre

   d. Significant grading, conditioning, ground cover.

      On less than 10 acres: $5,000/acre
      Over 10 acres: $3,500/acre

   e. For toxic soil, double cost/acre for the affected acreage.

   f. For burning acres (surface burning), double the cost/acre for the affected acreage.

   g. For extremely large piles of mine wastes (generally over 40 feet high or with an average depth of 15 feet or more or containing more than 25,000 cubic yards of material/acre) where removal of material is likely to be required in addition to grading, it may be appropriate to calculate cost according to the volume of material involved rather than by the acreage disturbed.

Cost: $4/cubic yard

2. Slurry Areas

a. Under 10 acres:	$15,000/acre
b. Over 10 acres:	$10,000/acre

*3. Highwalls

Background:

In the original AML Inventory Update Manual reclamation cost estimates were based on a highwall height-length-product (HLP) formula, whereby, the vertical height of the highwall was multiplied by its length to determine the approximate surface area of the highwall face. The surface area product was then multiplied by a cost rate factor to arrive at the reclamation cost estimate.

Since earthmoving is the predominant highwall reclamation task, and earthmoving costs are based on the volume of material to move, it was concluded that reclamation cost estimates should be based on a presumed fill volume, rather than the highwall face area. Consequently, OSM has developed a new reclamation cost formula, which is based on the cost of backfilling and grading highwalls.

In the present reclamation cost formula it is assumed that a triangular fill section with a constant, uniform slope will be constructed against the highwall face, which is assumed to be vertical. The cross-sectional area is then multiplied by the appropriate highwall length to estimate the required fill volume. A cost rate factor (dollars per cubic yard) is then multiplied by the calculated fill volume to arrive at the backfilling and grading cost. Finally, the backfilling and grading cost is increased by a percentage to cover other direct and indirect reclamation costs.

It was assumed that all highwalls will be reclaimed by backfilling and grading a triangular fill section against the highwall face. The triangular fill section geometry consists of a height, base distance, and a uniform slope.

The fill height will vary depending upon the availability of spoils. If enough fill material exists near the highwall to completely cover the highwall face, the effective fill height will equal the actual highwall height. If no spoils are available to cover the highwall face, it would be necessary to cut or blast the highwall face to eliminate the highwall. Material at the top of the highwall would be moved to the base of the highwall for fill material. In the most extreme situation half of the highwall height would be removed, in which case the effective fill height would be one-half of the original highwall height. All other spoil conditions would result in an effective fill height between one-half and the total original highwall height.

Next, the geometry of the fill slope is considered. Because the AML Inventory is intended to give only a relative perspective of reclamation costs among the States, not absolute cost estimates, and because most highwalls are reclaimed to uniform slopes, a uniform slope assumption was used for the reclamation cost formula. No consideration was given to the end conditions of the highwall, where transitional grading will be necessary to blend the fill section with the surrounding terrain. Reclaimed slope grades will vary depending upon such considerations as land use, hydrology, and the prevailing terrain. Nevertheless, for cost estimation purposes a single slope grade is usable for all reclaimed slopes. A uniform slope of 2.7:1 (horizontal:vertical) was selected. This slope falls well within the range that is used in practice, and the grade simplifies the reclamation cost calculation.

Once the height and slope grade of the triangular fill section is determined, the base distance is set and the required fill volume can be calculated by multiplying the cross-sectional fill area by the highwall length. Once the volume is known, a cost rate can be applied.

A volumetric cost rate (dollars per cubic yard) can be used to estimate the cost of rough backfilling and grading a highwall. For estimation purposes a national cost rate is used. Although a complete record of cost rates for the Nation has not been established, a rate of $.80 per cubic yard was selected.

After rough backfilling and grading is completed, fine grading, topsoiling, and revegetation may be necessary. In addition, other reclamation costs, such as equipment mobilization and sedimentation control, could be incurred. To cover all direct reclamation costs, other than rough backfilling and grading of the highwall, a dollar amount that is equal to 10 percent of the rough backfilling and grading cost was added to the estimate.

Three significant indirect costs that add to the cost of reclamation are the contractor's profit, overhead, and contingencies. OSM assumed that a 15 percent increase over the cost of rough backfilling and grading would be adequate to cover most indirect costs.

Therefore, the reclamation cost formula is the required fill volume multiplied by the yardage cost, which is increased by 25 percent to cover all other costs.

The resulting yardage cost is $1 per cubic yard ($.80 x 1.25). The $1 per cubic yard figure has three important beneficial features. First, the cost rate permits easy conversions from fill volume to reclamation cost. Second, the even dollar value implies the gross nature of the estimate, i.e., the value does not suggest misleading accuracy. Third, the cost rate is within a cost range that would be considered reasonable for most reclamation projects.

It is not suggested that other costs be disallowed for a State's inventory. However, any reclamation costs other than those costs that are calculated by the new reclamation cost formula must be documented before the costs can be accepted into the AML Inventory.

Required Fill Volume Equation

Required Fill Volume (V) = 1/2 triangular base(b) x highwall height(h) x highwall length (L).

Assuming a 2.7:1 reclaimed slope grade and a vertical highwall, the fill volume equation would change to the following:

$V = 1/2\ bhL$
$= 1/2\ (2.7h \times h \times L)$, where the triangular base (b) = 2.7h
$= 2.7/2\ h^2 L$

Because all highwall dimensions are reported in feet it is necessary to divide the calculated volume by 27 to arrive at the required fill volume in cubic-yards. Then, the equation for the required volume of fill is:

$$V = 2.7/54\ h^2L\ (yd^3) = .05\ h^2L\ (yd^3).$$

4. Slides

These are generally in the $100,000 to $500,000 range when located in areas where major improvements exist. For slides that require only correction of drainage patterns or some grading, estimate costs on the amount of acreage to be disturbed and the type of work needed in order to stabilize the slide.

5. Water problems (costs vary considerably with volume, plus water quality and treatment method chose).

a. Water treatment

Treatment of small flows of less than 15 gpm (often limestone drains, air seals, aeration wiers): $1-10,000

Treatment of flows from about 15-100 gpm:	$10K- $100K
Treatment of flows from about 100-500 gpm:	$100K-$500K
Treatment of flows over 500 gpm:	Over $500K

b. Stream cleaning: $10K-50K/mile

c. Treating/draining ponds: $1,600/acre foot; $5,000/million gallons

d. Backfilling pits and draining and backfilling ponds or pits: $8K/Ac/10' depth

6. Dismantling large steel or reinforced concrete structures: $50,000

Note: Discretion must be used when estimating costs for other structures. Base estimates on the size, condition, accessibility, and type of construction material (wood, sheet metal, etc.) of the structure to be dismantled.

7. Portals and Shafts

a. Sealing portals or shafts by blasting: $2,000/opening

b. Sealing portals or shafts by methods other than blasting (economies of scale assume openings are in same general area).

1- 2 openings:	$5,000 each
3- 5 openings:	$4,000 each
6-10 openings:	$3,000 each

more than 10 openings $2,000 each

*8. Large Underground Mine Fires:

Analysis of existing mine fire PADs in the Inventory shows that handling of earth materials in cubic yards is common to all UMF control techniques. A proposed common cost factor based on the cubic yardage is used. The cost factor multiplied by the volume of the UMF represents the inventory value. The State/Tribe, OSM Support Center and SCS shall provide a narrative of objective evidence to document volume estimates.

Reclamation Cost Guidelines

Reclamation costs shall be based on the cubic yardage of overburden overlying the mine fire. The cubic yardage shall be determined by the following: A) the length and width of the estimated burn zone as surface area; B) the average depth of overburden to the bottom of the coal seam; and C) the volume of the burn area. The development of a reclamation cost based on volumetric determination does not imply the State will use excavation as the method of abatement.

Estimates of areal extent and depth for UMF cost determination shall be based on geotechnical data and/or observable surface features. Surface features include ground cracks and ground openings (that may or may not be venting visual steam, combustion products, and heat emissions), dead and dying vegetation, lack of forest/organic litter, burned trees, and elevated ground temperatures.

Cost Determination

The estimator shall:

A. Determine the following mine fire parameters:

1. Surface area of the estimated burn zone.

2. Average depth of overburden to the bottom of the coal seam.

3. Volume of the burn area in cubic yards.

   Use surface area and average overburden depth to determine total cubic yards.

4. Geotechnical drilling data if available may be used to determine volume estimates.

5. A narrative and objective evidence for establishing burn zone and surface area must be provided.

B. Determine reclamation cost: Multiply burn area volume by $2.50.

*9. Large Subsidence Prone Areas Impacting Property:

A. Establishing Areal Extent

A standardized procedure for defining the areal extent of a subsidence- prone area has been developed. The process employs the type of land use and depth of mining to arrive at an areal allocation factor to be multiplied by the number of subsidence events. The areal allocation factors are given in the following table:

Guidelines for Setting Areal Extent of Impact Area

Type of Land Use	Mining Depth (Feet)	Area (Acres/Event)
A. Highly Developed (Urban)	>100	5
	50-100	4
	<50	3
B. Developed (Suburban, Industrial)	≥50	2
	<50	1
C. Rural (Limited use, Individual Setting)	≥50	1
	<50	1/2

B. Subsidence Reclamation Cost

Based on an analysis of construction costs on completed subsidence control projects throughout the Nation, a standardized cost/acre has been established. PAD estimated costs are to be developed by multiplying the areal allocation factor determined in Section B times the cost of $50,000. The estimated costs do not include administrative or design development costs.

10. Large Flows of Polluted Mine Drainage

Some of the variables affecting the actual cost of treatment are:

* Seasonal flow rate variability
* Variability of the pH and iron content (or other pollutants) of the drainage
* The number of drainage sources
* The impact on any receiving streams
* The interrelationships between drainage in the Problem Area and that from other Problem Areas.

Water treatment methods are very site-specific with such options as air seals, aeration weirs, holding ponds, limestone drains, recharge control, and treatment plants being among the possibilities to be considered. For purposes of formulating Update cost estimates, it is assumed that treatment plants would be required for the larger flows although it is recognized that this means of addressing a particular problem might not prove to be the most appropriate after required engineering studies have been done.

It is also recognized that use of a water treatment facility does not provide true reclamation but only abatement of the problem for as long as plant maintenance is continued. This is an example of a problem not being addressed in full during the course of the AML program. In order to provide the required cost estimates, some very broad assumptions should be made:

* The flow rate is the average rate over a year's time
* A treatment facility will be needed
* A lime with sludge removal method will be used
* Treatment costs for moderate acidity will apply in all cases

The Appalachian Regional Commission's 1960 publication, Acid Mine Drainage in Appalachia, is used as a resource. A table on page 60 of the book gives estimated costs for water treatment associated with water treatment plants of three sizes. The costs include plant amortization and are assumed to have doubled since 1969 because of inflation. The following rough guidelines are based on the figures in the table and should be used to estimate current treatment costs.

Guidelines for Estimating Abandoned Coal Mine Lands Reclamation Costs

Total flow of polluted mine drainage	Cost of treatment/1000 gals./day in dollars
500-600 gpm	.74
600-700 gpm	.70
700-1200 gpm	.66
1200-2400 gpm	.64
2400-3600 gpm	.62
3600-5500 gpm	.60
5500-9000 gpm	.58
9000-15,000 gpm	.56
15,000 or more gpm	.54

Two cost estimates are calculated for treatment of large flows. One is the cost/year for water treatment (including plant amortization) and the other, the estimated Inventory restoration cost. This latter figure is 10 times the yearly figure and is intended to be a rough estimate of the cost of abatement for the duration of the AML program.

The following calculations may be performed in each case using the gpm figures:

gpm x 60 mins./hr. = 24 hrs./day = gpd

$\frac{\text{gpd}}{\text{1000 gals.}}$ x dollar cost/1000 gals./day (from above table) =cost/day

cost/day x 365 days/year = cost/year = anticipated cost of abatement/year

cost/year x 10 = estimated Inventory restoration cost

Water problems involving wells and septic systems will require more individual consideration. Providing new, cased wells is one option available to address polluted domestic water supplies. Another might be installing new water lines. Although these options do not sound like reclamation they fall in the same category as building guardrails along highwalls.

NON-COAL INVENTORY OF INACTIVE/ABANDONED MINES
STATE OF MISSOURI

APPENDIX 2

Missouri Mines Inventory

The Department of Natural Resources, Division of Geology and Land Survey (DGLS) maintains voluminous mineralogic and geologic records in its archives. These records include published volumes and reports of investigations, geologic and mining maps, research manuscripts, unpublished theses, staff geologists' field maps and notebooks, and mineral resource correspondence files. During the late 1970's and early 1980's, these sources were researched and compiled into an inventory of active and abandoned mines and lands affected by mining under a U. S. Bureau of Mines (USBM) contract. Mine sites were outlined on a set of 7.5-minute topographic maps, researched information was recorded on inventory forms, and all data was submitted to the USBM for entry into their Mineral Industry Location System (MILS) database. Recorded information includes mine names, owner/operator names, commodities mined, locational data (county, section-township-range, and UTM or latitude/longitude coordinates), mine-related features and acreage as determined by air-photo analysis, and references. A total of about 15,000 active and abandoned mine sites were inventoried. The following table summarizes the approximate amount of acreage and number of sites for each major commodity.

Commodity	Acreage	Sites
Coal	86,850	1,800
Stone	25,300	3,400
Barite	17,250	500
Lead/Zinc	10,500	3,800
Clay	8,350	2,300
Sand/Gravel	5,250	800
Iron	1,450	1,500
Miscellaneous	450	900
TOTALS	155,400	15,000

During the late 1980's, the majority of the MILS database was transferred into Dbase III Plus files to facilitate access to the inventory data. Samples of the DGLS inventory maps and forms, the final USBM-MILS database entries, and the DGLS Dbase III Plus files are included in this appendix.

DGLS Inventory Form

INVENTORY OF MINES & AFFECTED AREAS

A. Location

County: Ozark Commodity: Zinc

1°x2°(AMS) Harrison Quad: Caulfield

Sec - Twp - Range N2-SE Sec. 12 - 22N - 11W

Coordinate Location: center of pit

UTM Zone 15	Elevation	River Basin
4049900N	1000'	44D
578625E	MILS Seq. #	

B. Commodity & Mine

Mineral: sphalerite, smithsonite Product(s):

Mine Name: Alice Mine Status: Abd.
(Active, Idle, Abandoned)

Opened: 1890

Operator: Empire Zinc Co. Closed: 1945

Owner: G.E. Doane & L.E. Ives

Mine Type: pit Mine Entry: Mine Map

Remarks: Sphalerite occurs as breccia cement in cherty dolomite - smithsonite occurs in dolomite cavities and fractures.

C. Feature(s) & Dimension(s)

Total Acreage Affected: 11 ac.

Overall Dimension:

Acreage &/or Dimension of Identifiable Feature(s):

Pit: 4 ac. Plant:

Processing Area 3 ac. Bldgs:

Stockpiles Other(s)

Waste Piles 4 ac.

Tailings Ponds

DGLS Inventory Form

D. Condition: Photo X Field___ Other___

Subjective Statement: Mine visible — pit has water in it — waste piles are partially vegetated.

Total Acreage Reclaimed: ___ Barren: ___

Vegetation (% & type): ___ Water: ___

Grading (degree or %): ___

Remarks: ___

E. Source

Field check (by & date): ___

Reference(s) (maps, reports, etc): 1) USBM RI-4056
2) MGS Manuscript 25023
3) MGS Geologic Map HA-37
4) MGS Field Notebook 459

F. Air Photo Analysis: By whom & date KS 5/22/79

List Photos used (source, ID#, date, scale): 1:20,000 unless otherwise indicated

ASCS BLX-695 1/10/39

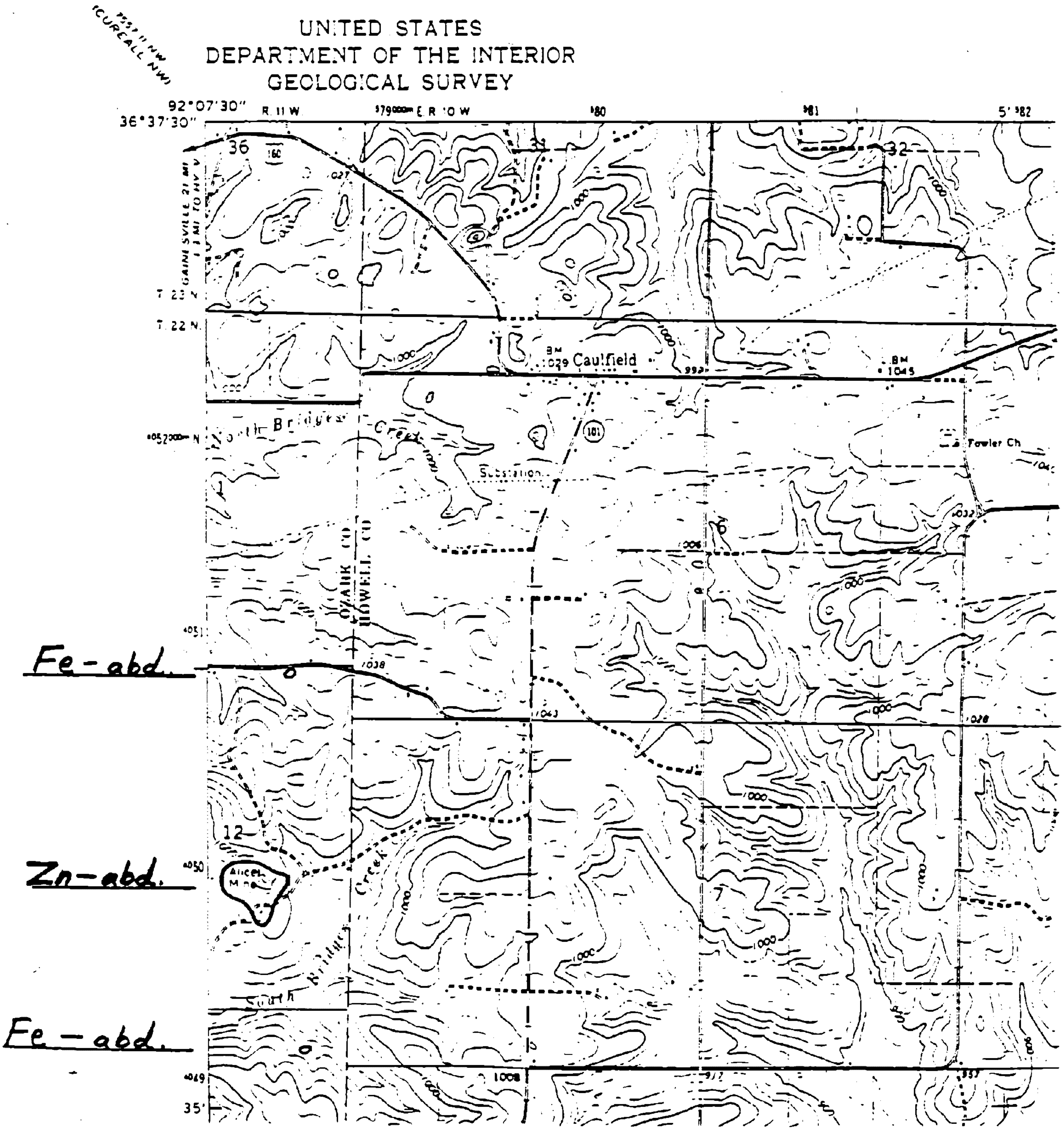
USGS GS-VBCB 1-43 2/27/65

ASCS BLX-2MM-33 8/27/71

G. Geology: Field Analysis, Units Mined, Formations, etc.

Ord. - Can. - Jeff. City Fm.

DGLS Inventory Map



MILS Database Entry

```
273 NAME- ALICE MINE                                 SEQUENCE NUMBER- 0291530011
    STATE- MISSOURI                  COUNTY- OZARK                     ELEV:PREC- 000305
    LATITUDE-    N 36 35 35        PRECISION-
    LONGITUDE- W 092 07 16  REFERENCE POINT- MAIN ENT
    UTM:  ZONE 15N  NORTHING 4049887  EASTING 578617
    PUBLIC LAND SURVEY  TOWNSHIP- 022 N   RANGE- 011 W
       DESCRIPTION       SECTION- 12  SECTION SUBDIVISION- N2SE
    RIVER BASIN- 44D   NORTH FORK RIVER           DOMAIN- PRIVATE
    STATUS- PAST PRODUCER  OPERATION TYPE- SURFACE
    MSHA ID NO. 00 00000  YEAR FIELD CHECKED- 999 MAP REPOSITORY-  FOC
    MAP NAME- CAULFIELD          TYPE-
    1:250,000 MAP NAME- HARRISON            MINERAL PROPERTY FILE-   .
    PRIMARY NAME- ALICE MINE
    COMMOD/MOD-   LEAD                                          ZINC
    MGS GEOL MAP HA-37 STINCHCOMB 1960
    MGS NB 802 PG 48 MATHER 1944
    MGS NB 703 PG 62 MCQUEEN
    MGS NB 459 PG 59-66 BODMAN 1910
    MGS NB 511 PG 59 1915
    MGS NB 567 PG 3 HUGHES 1918
    MGS NB 796 PG 26,68 MATHER 1944
    MGS MSC 25023 KIDWELL 1945
    ASCS PHOTO BLX-6-95 1-10-39 1:20000 - 11 AC


273 NAME- UNKNOWN - IRON                             SEQUENCE NUMBER- 0291530051
    STATE- MISSOURI                  COUNTY- OZARK                     ELEV:PREC- 000290
    LATITUDE-    N 36 35 09        PRECISION-
    LONGITUDE- W 092 07 13  REFERENCE POINT- ORE BODY
    UTM:  ZONE 15N  NORTHING 4049087  EASTING 578699
    PUBLIC LAND SURVEY  TOWNSHIP- 022 N   RANGE- 011 W
       DESCRIPTION       SECTION- 13  SECTION SUBDIVISION- NENE
    RIVER BASIN- 44D   NORTH FORK RIVER           DOMAIN- PRIVATE
    STATUS- PAST PRODUCER  OPERATION TYPE- SURFACE
    MSHA ID NO. 00 00000  YEAR FIELD CHECKED- 9991MAP REPOSITORY-  FOC
    MAP NAME- CAULFIELD          TYPE-
    1:250,000 MAP NAME- HARRISON            MINERAL PROPERTY FILE-   .
    PRIMARY NAME- UNKNOWN - IRON
    COMMOD/MOD-   IRON
    MGS 1967 MINED LAND INVENTORY


273 NAME- UNKNOWN - IRON                             SEQUENCE NUMBER- 0291530052
    STATE- MISSOURI                  COUNTY- OZARK                     ELEV:PREC- 000311
    LATITUDE-    N 36 36 07        PRECISION-
    LONGITUDE- W 092 07 15  REFERENCE POINT- MAIN ENT
    UTM:  ZONE 15N  NORTHING 4050873  EASTING 578633
    PUBLIC LAND SURVEY  TOWNSHIP- 022 N   RANGE- 011 W
       DESCRIPTION       SECTION- 12  SECTION SUBDIVISION- NWNENE
    RIVER BASIN- 44D   NORTH FORK RIVER           DOMAIN- PRIVATE
    STATUS- PAST PRODUCER  OPERATION TYPE- SURFACE
    MSHA ID NO. 00 00000  YEAR FIELD CHECKED- 9991MAP REPOSITORY-  FOC
    MAP NAME- CAULFIELD          TYPE-
    1:250,000 MAP NAME- HARRISON            MINERAL PROPERTY FILE-   .
    PRIMARY NAME- UNKNOWN - IRON
    COMMOD/MOD-   IRON
    ASCS PHOTO BLX-6-95 1-10-39 1:20000 - 1 AC
    USGS PHOTO GS-VBCB 1-43 2-27-65 1:29800
    ASCS PHOTO BLX-2MM-33 8-27-71 1:20000
```

DGLS Dbase III Plus File

SEQUENCE	PROP_NAM	COMMODITY	COUNTY	MAP_SCALE		LATITUDE	LONGITUDE	SEC_SUB	SECTION	TOWNSHIP	RANGE
0291530011	ALICE MINE	ZINC	OZARK	CAULFIELD	7.5 MIN	N363535	W0920718	N2SE	17	022 N	011 W
0291530012	ARNETT LAND	IRON	OZARK	BAKERSFIELD	7.5 MIN	N363006	W0921836	SESWSE	11	021 N	011 W
0291530013	B B + B MINE	IRON	OZARK	CUREALL NW	7.5 MIN	N363827	W0920840	SESENW	26	023 N	011 W
0291530014	BRADLEY LAND	IRON	OZARK	THORNFIELD	7.5 MIN	N364237	W0924831	NENW	5	023 N	016 W
0291530015	BUTTRAM LAND NUMBER TWO	IRON	OZARK	BAKERSFIELD	7.5 MIN	N363044	W0921115	NW	9	021 N	011 W
0291530016	COLLINS LAND	IRON	OZARK	CUREALL NW	7.5 MIN	N364341	W0921252	C	30	024 N	011 W
0291530017	D + D LIME QUARRY	STONE	OZARK	GAINESVILLE NW	7.5 MIN	N364012	W0922904	SENWSE	15	023 N	014 W
0291530018	EVERETT MAHAN PROSPECT	IRON	OZARK	UDALL	7.5 MIN	N363646	W0921700	SWSENE	4	022 N	012 W
0291530019	GARRETT BANK	IRON	OZARK	BAKERSFIELD	7.5 MIN	N363435	W0921447	SESE	14	022 N	012 W
0291530020	GLASIER LAND	IRON	OZARK	BAKERSFIELD	7.5 MIN	N363115	W0920752	N2NESW	1	021 N	011 W
0291530021	GOLMAN TURNER PIT	ZINC	OZARK	BAKERSFIELD	7.5 MIN	N363205	W0921137	N2SE	32	022 N	011 W
0291530022	HOLT SHAFTS	LEAD	OZARK	PROTEM	7.5 MIN	N363040	W0924544	S2	7	021 N	016 W
0291530022	HOLT SHAFTS	ZINC	OZARK	PROTEM	7.5 MIN	N363040	W0924544	S2	7	021 N	016 W
0291530023	J C BOND PROSPECT	IRON	OZARK	CUREALL NW	7.5 MIN	N364131	W0920935	SWSWSE	3	023 N	011 W
0291530024	JOHN/SKILES MINE	IRON	OZARK	SYCAMORE	7.5 MIN	N364338	W0921803	N2SE	29	024 N	012 W
0291530025	L M STRONG PIT	IRON	OZARK	UDALL	7.5 MIN	N363701	W0921920	NWNE	6	022 N	012 W
0291530026	NEWTON MINING CO LAND	IRON	OZARK	AVA	15 MIN	N364800	W0923800	NENW	17	024 N	015 W
0291530028	PRATT LAND	IRON	OZARK	DORA	7.5 MIN	N364527	W0921144	C	17	024 N	011 W
0291530029	PRICE LAND	IRON	OZARK	BAKERSFIELD	7.5 MIN	N363601	W0921118	SWNWNW	9	022 N	011 W
0291530030	RALPH JACOBS PROSPECT	IRON	OZARK	BAKERSFIELD	7.5 MIN	N363717	W0920838	C	35	023 N	011 W
0291530031	SHARP MINE	ZINC	OZARK	CUREALL NW	7.5 MIN	N363745	W0921316	NW	31	023 N	011 W
0291530032	SOUTH MISSOURI LAND CO NUMBER ONE	IRON	OZARK	CUREALL NW	7.5 MIN	N364340	W0921242	C	29	024 N	011 W
0291530033	SOUTH MISSOURI LAND CO NUMBER TWO	IRON	OZARK	CUREALL NW	7.5 MIN	N364245	W0920536	C	34	024 N	011 W
0291530034	STEEL BANK	IRON	OZARK	BAKERSFIELD	7.5 MIN	N363117	W0920957	NENESW	3	021 N	011 W
0291530035	SUMMERS MINE	IRON	OZARK	BAKERSFIELD	7.5 MIN	N363113	W0920735	SENWSE	1	021 N	011 W
0291530036	T A HARRIS PROSPECT	IRON	OZARK	CUREALL NW	7.5 MIN	N364155	W0920901	SWSWNW	2	023 N	011 W
0291530037	UNKNOWN		OZARK	BAKERSFIELD	7.5 MIN	N363541	W0921134	NWNESE	8	022 N	011 W
0291530038	UNKNOWN		OZARK	AVA	15 MIN	N364650	W0923705	NWNW	9	024 N	015 W
0291530039	UNKNOWN		OZARK	BAKERSFIELD	7.5 MIN	N363357	W0920739	C	24	022 N	011 W
0291530040	UNKNOWN		OZARK	BAKERSFIELD	7.5 MIN	N363247	W0921115	SESWSW	28	022 N	011 W
0291530041	UNKNOWN		OZARK	BAKERSFIELD	7.5 MIN	N363636	W0921124	SENESE	5	022 N	011 W
0291530042	UNKNOWN		OZARK	BAKERSFIELD	7.5 MIN	N363637	W0921131	N2NESE	5	022 N	011 W
0291530043	UNKNOWN		OZARK	BAKERSFIELD	7.5 MIN	N363632	W0921125	NENESE	5	022 N	011 W
0291530044	UNKNOWN		OZARK	BAKERSFIELD	7.5 MIN	N363633	W0921052	NENESW	4	022 N	011 W
0291530045	UNKNOWN		OZARK	BAKERSFIELD	7.5 MIN	N363628	W0921111	SENWSW	4	022 N	011 W
0291530046	UNKNOWN - CLAY	CLAY	OZARK	GAINESVILLE NW	7.5 MIN	N363754	W0922545	NE	31	023 N	013 W
0291530047	UNKNOWN - IRON	IRON	OZARK	CUREALL NW	7.5 MIN	N364329	W0921159	SWNESW	29	024 N	011 W

NON-COAL INVENTORY OF INACTIVE/ABANDONED MINES
STATE OF MISSOURI

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MONTANA

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January 14, 1991

Ms. Sandra Olsen, Chief
Hard Rock Bureau
Department of State Lands
Capitol Station
Helena, MT 59620

RE: WIEB Inactive/Abandoned Mine Data Summary Report

Dear Sandi:

Attached herewith is the final draft of the above referenced report. The components of this submittal include:

- Data Summary Table
- Narrative Summary
- Footnotes Section
- Reference Guide

The final draft is presented for your review at this time. Should you identify deficiencies or report edits, return a copy to us for revision. It is our understanding that WIEB has requested the draft report by February 1, 1991.

Should you have any questions or comments, please feel free to call. We have enjoyed working on this project and look forward to preparing the final report by April 1, 1991.

Sincerely,

Daphne Digrindakis

Daphne Digrindakis
Project Manager

cc: Ed Gensler, AMRB
Richard Juntunen, WIEB Consultant

WIEB INACTIVE/ABANDONED MINE DATA SUMMARY
STATE OF MONTANA NARRATIVE SUMMARY

1.0 INTRODUCTION

The mining industry in Montana began with discoveries of gold in placer gravels in the vicinity of Bannack in 1862. Additional placer gold discoveries were made in the ensuing years of 1863 and 1864 in Virginia City and Last Chance Gulch (Helena) respectively. These discoveries fueled the mining boom for the Treasure State.

Noncoal mining in Montana has produced a variety of mineral commodities including metallic, industrial, and construction ores, phosphate, and uranium. Production of metallic minerals include antimony, gold, silver, platinum, palladium, lead, copper, chromite, zinc, iron, molybdenum, titanium, and tungsten. Industrial ores include barite, bentonite, chlorite, fluorspar, graphite, gypsum, limestone, peat, sapphires, semiprecious stones, silica, talc, and vermiculite. Construction ores include sand, gravel, and quarry stone. Limited production occurred for uranium and thorium ores in Montana.

2.0 MINING AND MILLING METHODS

Three basic mining methods have been employed in Montana to extract noncoal minerals. They include underground, surface, and placer mining. Underground mining, utilized primarily for metallic ores, phosphate and uranium, involves the development of shafts, adits and tunnels to access ore bodies. Waste rock generated from the mine was hauled and dumped at the most convenient location adjacent to the mine. These dumps occupy side-hills, valley bottoms, and heads of drainages. Open pit surface mining has been utilized in the production of some metallic deposits and most construction and industrial ores. This method of mineral extraction consists of drilling and blasting the rock, excavating an open pit or cut, and hauling of waste rock to a waste rock dump and ore to processing facilities. Placer operations involve the use of floating dredges, hydraulic giants, and small wash plants/riffle boxes to recover "free" gold from the gravels. Mercury amalgamation was frequently used to enhance fine gold recovery in placer operations. Placer mining methods utilized for extracting depositional gold, semi-precious stones and sapphires often resulted in restructuring stream beds and in the case of amalgamation, releasing mercury to stream gravels.

Processing of metallic ores in Montana involved a variety of methods. Early milling methods incorporated stamp mills to break and crush the ore. Technological advances in crushing and grinding equipment resulted in the development of rod and ball mills, jaw crushers, and cyclone crushers. When the desired grain size was achieved, the ore material was further concentrated through gravity separation, mercury amalgamation, cyanidation, or flotation.

Tailings and waste materials which resulted from mineral processing were disposed of in a variety of methods. Tailings were discharged with mill process waters away from the mill facility. Typically, these tailings were deposited in stream channels or other low points downhill from the mill site. If make-up water for the mill was in short supply, the tailings were deposited in a constructed impoundment so that water could be recovered from the tailings waste stream and returned to the mill.

Final beneficiation of metallic ore concentrate was done through smelting processes. Smelting in Montana ranged from open roasting of concentrate on wood or coal fuel fires to controlled roasting in smelting facilities. Waste generated from the smelting of ores was deposited adjacent to the smelter site as "slag" piles. Open smelting resulted in uncontrolled disposal of slag at the site where the roasting occurred. Electrolytic methods were used at some locations in Montana to further refine aluminum and copper ores.

3.0 HEALTH AND SAFETY IMPACTS

Noncoal mining methods have created some of the most severe health and safety hazards in Montana. Physical hazards including unprotected mine openings, highwalls, flooded excavations, hazardous structures and subsidence features which threaten public safety across the State. Health hazards caused by ingestion, inhalation, or absorption of toxic metallic mine waste have impacted several Montana communities.

Inactive/abandoned mining areas in Montana experience multiple use as residential and recreation areas. The public is exposed to hazardous mine openings and subsidence features with uncontrolled access. Abandoned mine structures often appear structurally intact but rotting wood and deteriorated foundations have have weakened many of the structures. Cave-ins, collapse of unstable slopes, and drowning at flooded excavations have claimed seven lives in the past ten years in Montana sand and gravel pits. Other physical hazards at inactive mine sites include abandoned explosives and ore processing chemicals.

Mine waste is the cause of significant human health hazards in Montana. Leachate from mill tailings and smelter slag have contaminated ground water requiring development of new domestic water supplies in several communities. Exposure to heavy metals in waste rock tailings and contaminated soils have impacted the health of residents living within and adjacent to mining areas.

4.0 ENVIRONMENTAL IMPACTS

Abandoned mines in Montana have impacted thousands of acres of residential, commercial, recreational, and agricultural land which are adjacent to mining areas. Metal contaminants are transported in the environment through air, ground water, and surface water pathways. Sources of this environmental pollution include acid mine drainage from underground workings, air borne particulate from smelter emissions, and metal laden process wastes.

Surface and groundwater at inactive/abandoned mines are impacted by leaching and increased sedimentation resulting from waste rock and tailings material discharging into receiving waters. Rain and snowmelt percolating through and eroding waste materials transport dissolved metals to receiving groundwater and surface waters. Elevated metals concentrations in receiving streams have impacted fisheries populations and aquatic ecosystems in numerous Montana drainages. Thousands of acres of agricultural land have been affected from the use of metal laden water for irrigation.

Acid mine drainage from underground workings at inactive metal mines is another major impact to surface water courses. Oxidation of sulfide bearing ores, causes the formation of sulfuric acid which in turn solubilize high concentrations of metals. Acid mine drainage has been demonstrated to impact cold water aquatic life and fisheries in receiving streams.

Air resources in the vicinity of unvegetated tailings and waste rock dumps have been impacted from fugitive dust emissions. Wind blown tailings and fugitive dust can affect offsite flora and fauna as well as contribute foreign particulate of respirable size for human inhalation. The affects of fugitive dust is seasonally dependent and does not represent a continual source for impact to air quality.

Smelter emissions have been transported over one hundred miles from their source and have caused wide spread soil contamination throughout entire valleys. The greatest impact to soil resources are within a 2 to 3 mile radius of the smelter source. Respiration and ingestion of contaminants has resulted in impacts to human health as well as removing numerous acres of land from productive use.

5.0 LAWS AND REGULATIONS

The unrestricted mineral development Montana faced prior to the 1960's led to significant health, safety and environmental hazards at and adjacent to inactive and abandoned mine sites across the State. It is estimated that over $1 billion will be required to remediate these problems. In the past twenty years, various laws and regulations have been enacted to ensure impacts from resource extraction are minimized and the quality of State air and water are maintained. (Montana Water Quality Act; 75-5-103, Montana Clean Air Act; 75-2-103.)

Inactive and abandoned mines (IAMs) are defined as those sites where there is no continuing reclamation responsibility by an owner or operator. These sites primarily include disturbances created prior to 1971 when the Metal Mine Reclamation Act, Open Cut Mining Act, and Strip and Underground Mine Reclamation Act (MCA 82-4-300, 82-4-400, and 82-4-200 respectively) were implemented. These reclamation acts require operators to develop a reclamation plan and secure reclamation bonding before the State will issue a mining permit. Prior to 1971, operators had no obligation to restrict or reclaim mine disturbances. Small miners are issued exemptions from reclamation responsibility by the State if a hard rock mining operation is less than five acres and produces less than 36,500 tons of ore annually. These exempt disturbances also contribute to the IAM problem in the State when left unreclaimed.

Many of the State's IAM problems consist of physical hazards which threaten public safety. Hazardous mine openings, are being addressed by the State Abandoned Mine Land (AML) Program. State nuisance laws (Department of Fish, Wildlife & Parks; Public Law 45-8-113 "Creating a Hazard") and current mining regulations (Montana Safety and Health Standards for Metal and Nonmetallic Mining and Related Industries; MT57.20-20 & 21) have been utilized to obtain cooperation from noncoal landowners for reclamation. These projects have been funded by Title IV of the Surface Mining Control and Reclamation Act of 1977 (SMCRA) which provides for the reclamation of previously mined areas abandoned and left without adequate reclamation. The AML Program also addresses IAM sites exhibiting environmental and human health hazards.

In addition, clean-up of IAM environmental hazards are being funded and/or directed by other state and federal laws. The U.S. Environmental Protection Agency (EPA) has listed on the National Priority List (NPL) several abandoned mine sites in Montana where there has been a release of a hazardous substance. Under the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) the EPA is investigating and directing clean-up efforts at these sites.

A State administered cost recovery program for IAM problems also exists in Montana legislation. The Comprehensive Environmental Cleanup and Responsibility Act of 1989 (CECRA), was developed in order to investigate and clean up hazardous waste sites which are not on the NPL but still pose an imminent and substantial threat to human health, welfare, safety or to the environment. CECRA was created through the passage of the Environmental Quality Protection Fund Act in 1985.

The Reclamation and Development Grants Program (RDGP) is a state-funded grants program to fund projects that "indemnify Montana citizens from the effects of mineral development on public resources" (MCA 90-2-1102). The funding source for this program is the interest income from the Resource Indemnity Trust (RIT) Fund, (established by MCA 15-38-201, which receives proceeds from taxes levied on mineral production. Beginning in 1990, 46% of the interest income from the RIT fund must be allocated to the RDGP (approximately $6.4 million/biennium).

6.0 RECLAMATION EFFORTS

Noncoal reclamation in Montana has been performed by several State agencies, the EPA and private companies. Over $30 million has been spent to date to remediate noncoal IAM problems.

The Montana AML Program has spent over $9 million on noncoal reclamation since 1979. Construction has included remediation of hazardous mine openings through backfilling, engineered bulkheads and semi-permanent closures such as fencing, gates, grates and culverts. Where human health hazards could be documented, the AML Noncoal Program performed reclamation to remediate environmental problems including the removal and revegetation of mine waste dumps, installation of water systems, drainage control and asbestos removal. Upon completion of coal reclamation projects in 1990, AML funds are to be expended on other noncoal environmental problems. The treatment of acid mine drainage and erosion control of tailings are the immediate focus of the Montana program.

The Environmental Protection Agency (EPA) is currently investigating five NPL mine waste sites in Montana. Immediate removal actions have been performed in areas of severely contaminated mine waste at a cost of $20 million. Remedial investigations and feasibility studies have been conducted on three operable units in the State at a cost $60 million (to date). Demonstration projects have also been performed at these Superfund sites to determine the feasibility of innovative technologies such as deep plowing and lime injection to remediate the impacts of past mining.

The Montana Department of Natural Resources and Conservation administers the Reclamation and Development Grants Program which has funded eighteen noncoal reclamation projects at IAM sites. State monies are available from the Resource Indemnity Trust (RIT) Fund to repair, reclaim and mitigate environmental damage to public resources from mineral extraction. To date, over $3 million has been allocated for projects including streambank restoration, erosion control and construction of artificial wetlands.

The Montana Environmental Quality Protection Fund, created by CECRA, also funds reclamation of non-NPL, IAM sites. Emergency funds are available to respond to releases of hazardous or deleterious substances. To date, $20,000 has been spent, in conjunction with an RIT grant, to construct a surface water diversion system around a tailings impoundment at an historic millsite. This is a cost recovery program which seeks reimbursement from principle responsible parties (PRPs) for reclamation costs. CECRA is administered by the Montana Department of Health and Environmental Sciences.

Several major mining companies have reclaimed historic disturbances within their privately owned properties or those areas permitted for development or exploration. Although these reclamation projects were not required, the efforts have demonstrated the companies "good faith" in addressing problems associated with inactive properties.

NON-COAL INVENTORY
INACTIVE/ABANDONED MINES[1]

State of MONTANA

DEPARTMENT OF STATE LANDS
ABANDONED MINE RECLAMATION BUREAU
Attn: Ed Gensler
(406) 444-2074

DATA SUMMARY[2]

MINERAL TYPE(acres)[3]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)		(cost)[16]
Metallic Ores	Mines	2,878	Federal	-	Polluted Water[6]	(miles)	1,091	$488,850,000
	Millsites	373	Private	6,887	Mine Dumps[7]	(acres)	7,726	$231,780,000
	Smelters	100	State	-	Disturbed Land[8]	(acres)	1,726	$5,178,000
	Other[4]	6,000	Other[5]	3,734	Highwalls[9]	(miles)	100	$5,000,000
					Mine Openings[10]	(number)	4,535	$11,337,500
					Subsidence Prone[11]	(acres)	870	0
					Hazardous Structures[12]	(number)	1,383	$4,149,000
					Other	(units)	-	-
Construction Ores	Mines	12,388	Federal	-	Polluted Water	(miles)	0	0
	Millsites	0	Private	4,543	Mine Dumps	(acres)	3,097	$92,910,000
	Smelters	0	State	-	Disturbed Land	(acres)	8,291	$27,873,000
	Other	-	Other[5]	7,445	Highwalls	(miles)	350	$17,500,000
					Mine Openings	(number)	25	$82,500
					Subsidence Prone	(acres)	0	0
					Hazardous Structures	(number)	300	$900,000
					Other	(units)	-	-
Industrial Ores	Mines	1,110	Federal	-	Polluted Water	(miles)	0	0
	Millsites	0	Private	906	Mine Dumps	(acres)	300	$9,000,000
	Smelters	1	State	-	Disturbed Land	(acres)	810	$2,430,000
	Other	-	Other[5]	204	Highwalls	(miles)	12	$800,000
					Mine Openings	(number)	14	$35,000
					Subsidence Prone	(acres)	0	0
					Hazardous Structures	(number)	5	$15,000
					Other	(units)	-	-

DATA SUMMARY - Page 2

MINERAL TYPE (acres)[3]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)		(cost)[16]
Phosphate Rock	Mines	35	Federal	-	Polluted Water[6]	(miles)	0	0
	Millsites	0	Private	18	Mine Dumps[7]	(acres)	0	0
	Smelters	0	State	-	Disturbed Land[8]	(acres)	10	$30,000
	Other	-	Other[5]	17	Highwalls[9]	(miles)	0	0
					Mine Openings[10]	(number)	15	$37,500
					Subsidence Prone[11]	(acres)	35	0
					Hazardous Structures[12]	(number)	3	$9,000
					Other	(units)	-	-
Uranium Overburden	Mines	200	Federal	-	Polluted Water	(miles)	0	0
	Millsites	0	Private	510	Mine Dumps	(acres)	34	$1,020,000
	Smelters	0	State	-	Disturbed Land[13]	(acres)	650	$1,950,000
	Other[13]	650	Other[5]	340	Highwalls	(miles)	1	$500,000
					Mine Openings	(number)	33	$82,500
					Subsidence Prone	(acres)	100	0
					Hazardous Structures	(number)	1	$3,000
					Other	(units)	-	-
Oil Shale	Mines	0	Federal	0	Polluted Water	(miles)	0	0
	Millsites	0	Private	0	Mine Dumps	(acres)	0	0
	Smelters	0	State	0	Disturbed Land	(acres)	0	0
	Other	-	Other	-	Highwalls	(miles)	0	0
					Mine Openings	(number)	0	0
					Subsidence Prone	(acres)	0	0
					Hazardous Structures	(number)	0	0
					Other	(units)	-	-
Other (acres)[14] (NPL Sites)	Mines	3,040	Federal	?	Polluted Water	(miles)	27	*
	Millsites	610	Private	?	Mine Dumps	(acres)	2,881	*
	Smelters	958	State	?	Disturbed Land	(acres)	8,375	*
	Other[15]	147,150	Other	-	Highwalls	(miles)	3	$150,000
					Mine Openings	(acres)	46	$713,000
					Subsidence Prone	(acres)	1,040	0
					Hazardous Structures	(number)	55	$165,000
					Other[15]	(units)	140,700	*
TOTAL	Mines	19,751	Federal	-	Polluted Water	(miles)	1,118	$488,850,000+
	Millsites	1,183	Private	13,244+	Mine Dumps	(acres)	14,038	$334,710,000+
	Smelters	1,057	State	-	Disturbed Land	(acres)	20,862	$37,481,000+
	Other	153,800	Other	11,740+	Highwalls	(miles)	488	$23,750,000
					Mine Openings	(number)	4,968	$12,288,000
					Subsidence Prone	(acres)	1,845	0
					Hazardous Structures	(number)	1,747	$5,241,000
					Other	(units)	140,700	*

WIEB INACTIVE/ABANDONED MINE INVENTORY SUMMARY
STATE OF MONTANA
FOOTNOTES

1. Inactive/abandoned mines (IAMs) have been defined as properties where there is no continuing reclamation responsibility by the owner or claimant/lessee to remediate the impact of past noncoal mining. Sites reported in this data summary are not covered by any mining permits, reclamation bonds, state or federal licenses or any reclamation contracts. The "other" mineral type category (footnote #14) describes a variation from this standard definition.

2. Included with this report package is a Reference Guide which consists of the Data Summary Table and accompanying text. Reference numbers appear throughout the table corresponding to data sources cited in the text. The quality of the data and basis of its reliability is reported in either the Reference Guide or these Footnotes.

3. The acres listed for each mineral type include the disturbed or impacted land resulting from mining/milling/smelting activities within the IAM noncoal site. This acreage total includes health and safety hazards, unvegetated areas, and environmental degradation on and off site.

4. The "other" mining type reported for metallic ores consists of unvegetated placer tailings which were not included in estimates from the AML Noncoal Inventory. The acreage total listed is reported with a 10% confidence level.

5. The ownership data reported in the "other" category represents all public lands including federal, state and tribal. The data source for ownership acreage, the AML Noncoal Inventory Database, reports ownership according to the following three categories: private, public, and public/unpatented.

6. The data reported from this source were derived from the Montana Water Quality Bureau's, 1990 Section 305 (b) report to the U.S. EPA. For the purpose of this summary, the definition of polluted water are stream miles that do not meet the fishable goal of the federal Clean Water Act. Less than full support of the beneficial use of a Montana stream is the result of various pollutants (causes) and activities (sources). Impact from mineral extraction accounts for less than 10% of Montana's non-point source pollution. The principle causes of toxic contamination to surface water in Montana are heavy metals which impact cold water aquatic life and have been measured in approximately 5% of the State's total stream miles.

7. Mine dumps have been defined to include waste rock dumps, slag piles, tailings impoundments, hazardous waste, or overburden stock piles. Reclamation of these sites could involve any of the following: grade out and/or relocate mine waste, construct drainage systems, install erosion netting, dispose of hazardous waste, apply soil amendments, and revegetate disturbances.

8. Disturbed land means any land which has not revegetated to a similar condition or has a utility similar to surrounding land. Included in this definition are disturbances such as open pits, portal areas, haul roads, exploration boreholes and waste water treatment ponds. Reclamation of these sites would involve revegetation efforts which could be performed without earthwork.

9. Highwalls are defined as the face of exposed overburden and mineral in an open cut or strip mining operation. Reclamation of these sites would involve excavation and embankment, regrading, or blast and terrace procedures.

10. Hazardous vertical mine openings have been defined as those that a person could not escape from unaided if he/she were to accidently fall in. Any horizonal mine opening is defined as hazardous due to the threat of collapse and/or bad air. Reclamation of these sites would consist of permanent closure which include backfilling, blasting and engineered structures (concrete shaft caps).

11. Subsidence prone features have been defined as areas over shallow mine workings or any area which may be subject to ground surface collapse in the future. Reclamation is generally not considered for these features until collapse has occurred. At that time reclamation is consistent with treatment of hazardous mine openings.

12. Hazardous structures have been defined as noncoal related buildings, foundations, headframes, etc. which could pose a hazard to people being in, on, or around them. Remediation of these hazards involves demolition or removal but can also be accomplished through restoration.

13. The "other" mining type category reported under uranium overburden consists of areas of exploratory drill holes which remain unreclaimed.

14. The "other" mineral type category has been utilized to report impacts associated with the five EPA National Priority List (NPL) sites dealing with noncoal mine sites in Montana; the Anaconda Company Smelter, East Helena Smelter, Milltown Reservoir Sediments, Mouat Industries, and Silver Bow Creek. The impacts from metallic mining/processing at these sites are of such magnitude that although there is an existing reclamation responsibility by the principle responsible parties (PRPs), as defined under CERCLA, it is unknown whether the total cost of remediation can be obtained from these sources.

15. The "other" feature category under the "other" mineral type category reports acreage totals of impacted land exhibiting environmental degradation from noncoal mining without displaying surface disturbance. Included are acres of contaminated stream bank sediments and soils contaminated by smelter emissions.

16. The following explanation is the rationale and basis for the cost estimates presented in this report.

POLLUTED WATER - Stream miles containing elevated metals concentrations resulting from noncoal mineral extraction have been categorized by the state Water Quality Bureau according to high, moderate and low impacts. A dollar amount for remediation has been assigned to each category as follows and may be applied to reclamation of the pollution source rather than to the stream itself. The basis for these cost estimates are professional judgement.

- High Impact (236.4 miles) @ $1,000,000/mile
- Moderate Impact (524.9 miles) @ $500,000/mile
- Low Impact (330.2 miles) @ $0.00/mile

MINE DUMPS - Reclamation of noncoal impacts defined in the mine dump category are diverse and site specific. Actual costs of noncoal reclamation funded through the Montana AML Program and Resource Development Grant Program were analyzed and evaluated. A $30,000/acre cost figure was developed, 30% of which was estimated for administrative costs including design and construction oversight. Funds earmarked for mine dump reclamation may be used in conjunction with those estimated for polluted water in remediation of source areas.

DISTURBED LAND - Reclamation of disturbed land was limited by definition to include revegetation efforts. Based on actual reclamation costs at Montana AML noncoal sites, $3,000/acre has been utilized for this estimate, 30% of which are estimated as administrative costs.

HIGHWALLS - The State Open Cut Bureau provided actual costs for reduction of sand and gravel highwalls. These values were compared to highwall reclamation performed at Montana AML coal sites, and averaged. The resulting cost figure, $50,000/mile includes 30% for administrative costs.

MINE OPENINGS - Actual construction costs for permanent closure of hazardous mine openings (HMOs) performed by the Montana AML Program were analyzed to develop a cost/HMO figure. Backfills and blasts, utilized 90% of the time, average $700/site. The AML Program has installed concrete caps for vertical shaft closures which are engineered for permanence. It is estimated that these bulkheads, which cost $1550/site, will be utilized 10% of the time. The reclamation cost per mine opening is estimated at $2,500, 30% of which is included for administration.

SUBSIDENCE PRONE - No reclamation cost was estimated for these features as their remediation would be covered under one of the other categories after surface collapse has occurred.

HAZARDOUS STRUCTURES - Actual costs of structure demolition performed at Montana AML coal and noncoal projects were evaluated to form the basis of this estimate. The average figure to remediate a hazardous structure is $3,000.

* - No reclamation costs were presented for these features. The U.S. EPA is currently involved in remedial investigations/feasibility studies on these sites, whereby reclamation cost estimates are unknown.

NON-COAL INVENTORY - INACTIVE/ABANDONED MINES
REFERENCE GUIDE FOR DATA SUMMARY
State of MONTANA

DEPARTMENT OF STATE LANDS
ABANDONED MINE RECLAMATION BUREAU
Attn: Ed Gensler
Telephone (406) 444-2074

REFERENCE GUIDE

MINERAL TYPE (acres)	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)		(cost)
Metallic Ores	Mines	2	Federal	-	Polluted Water	(miles)	1	
	Millsites	2	Private	2,3	Mine Dumps	(acres)	2	
	Smelters	2	State	-	Disturbed Land	(acres)	3	
	Other	3	Other	2,3	Highwalls	(miles)	2	
					Mine Openings	(number)	2	
					Subsidence Prone	(acres)	2	
					Hazardous Structures	(number)	2	
					Other	(units)	-	
Construction Ores	Mines	2,3	Federal	-	Polluted Water	(miles)	3	
	Millsites	3	Private	2,3	Mine Dumps	(acres)	2,3	
	Smelters	3	State	-	Disturbed Land	(acres)	3	
	Other	-	Other	2,3	Highwalls	(miles)	3	
					Mine Openings	(number)	2	
					Subsidence Prone	(acres)	3	
					Hazardous Structures	(number)	2,3	
					Other	(units)	-	
Industrial Ores	Mines	2,6	Federal	-	Polluted Water	(miles)	6	
	Millsites	6	Private	2,6	Mine Dumps	(acres)	2,6	
	Smelters	6	State	-	Disturbed Land	(acres)	6	
	Other	-	Other	2,6	Highwalls	(miles)	6	
					Mine Openings	(number)	2	
					Subsidence Prone	(acres)	2	
					Hazardous Structures	(number)	2	
					Other	(units)	-	

REFERENCE GUIDE - Page 2

MINERAL TYPE (acres)	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)		(cost)
Phosphate Rock	Mines	5	Federal	-	Polluted Water	(miles)	5	
	Millsites	5	Private	5	Mine Dumps	(acres)	5	
	Smelters	5	State	-	Disturbed Land	(acres)	5	
	Other	-	Other	5	Highwalls	(miles)	5	
					Mine Openings	(number)	2	
					Subsidence Prone	(acres)	5	
					Hazardous Structures	(number)	2	
					Other	(units)	-	
Uranium Overburden	Mines	3	Federal	-	Polluted Water	(miles)	9	
	Millsites	9	Private	9	Mine Dumps	(acres)	2	
	Smelters	9	State	-	Disturbed Land	(acres)	2,9	
	Other	9	Other	9	Highwalls	(miles)	9	
					Mine Openings	(number)	2	
					Subsidence Prone	(acres)	9	
					Hazardous Structures	(number)	2	
					Other	(units)	-	
Oil Shale	Mines	2	Federal	2	Polluted Water	(miles)	2	
	Millsites	2	Private	2	Mine Dumps	(acres)	2	
	Smelters	2	State	2	Disturbed Land	(acres)	2	
	Other	-	Other	-	Highwalls	(miles)	2	
					Mine Openings	(number)	2	
					Subsidence Prone	(acres)	2	
					Hazardous Structures	(number)	2	
					Other	(units)	-	
Other (acres)[7]	Mines	10	Federal	-	Polluted Water	(miles)	4	
	Millsites	10	Private	-	Mine Dumps	(acres)	10	
	Smelters	4	State	-	Disturbed Land	(acres)	4,10	
	Other	4	Other	-	Highwalls	(miles)	2	
					Mine Openings	(acres)	2	
					Subsidence Prone	(acres)	2,10	
					Hazardous Structures	(number)	2	
					Other	(units)	4	
TOTAL	Mines		Federal		Polluted Water	(miles)		
	Millsites		Private		Mine Dumps	(acres)		
	Smelters		State		Disturbed Land	(acres)		
	Other		Other		Highwalls	(miles)		
					Mine Openings	(number)		
					Subsidence Prone	(acres)		
					Hazardous Structures	(number)		
					Other	(units)		

WIEB INACTIVE/ABANDONED MINE DATA SUMMARY
STATE OF MONTANA REFERENCE GUIDE

1. **Montana Department of Health and Environmental Sciences, Water Quality Bureau**

   Section 305(b) of the federal Clean Water Act requires each state to submit a biennial report to the U.S. Environmental Protection Agency (EPA) describing the quality of its waters. This reference consists of Montana's 1990 305(b) report. Information about the quality of Montana's surface waters was derived from three sources: ambient water quality records in EPA's computerized water quality database (STORET); published reports of water quality investigations; and fish biologists, hydrologists, and other water resource management specialists statewide. The EPA Waterbody Tracking System (WBS) was then used by the Department to allow for an accurate estimate of stream miles.

2. **Montana Department of State Lands, Abandoned Mine Reclamation Program**

   Montana's Abandoned Mine Reclamation (AMR) Bureau completed a systematic inventory of abandoned/inactive noncoal mines in 1989. The Noncoal Inventory verified and documented safety hazards and environmental impacts at 3000+ sites in 206 Montana mining districts. Metallic mines were the majority of those investigated but inventories were performed at bentonite, uranium, phosphate and other industrial and construction mineral mines. A computer database was developed to catalog locational and field data from the sites. All mining districts were reviewed using the following information sources: U.S. Geological Survey (USGS) Quadrangle map locations, aerial reconnaissance flights, USGS Mineral Resource Data System (MRDS) records, USGS and Montana Bureau of Mines and Geology literature, and public agency input. Information collected during the inventory included hazardous mine openings, hazardous structures, volume estimates of waste dumps and tailings impoundments, an assessment of unstable slopes, and estimates of unvegetated acreages. Field measurements including pH, conductance, and flow were made to identify potential water quality problems. The information presented from this reference source is reported with a 75% confidence level.

   Actual construction costs for noncoal reclamation projects were obtained from this source to develop cost estimates for this data summary. Costs of comparable coal reclamation projects were also utilized where applicable. AMR staff and their consultants have used professional judgement for data cited in this report.

   - Ed Gensler
   - John Koerth
   - Mary Beth Linder
   - Susan McAnally
   - Chen-Northern, Inc.; D. Digrindakis, T. Grotbo

3. **Department of State Lands, Open Cut Bureau (OCB)**

Mining permits are issued by this agency for industrial and construction mineral commodities mined using open cut methods. The Open Cut Mining Act of 1971 requires proposed mining ventures to post reclamation bonds to cover the cost of restoring the land after mining has ceased. Pre-law site inspections conducted by OCB staff (who have 35 years of cumulative experience) are the source of the estimates presented in this data summary. The following persons have used professional judgement and report this data with a 20% confidence level.

- Jerry Burke
- Ed Surbrugg
- Steve Welch

4. **U.S. Environmental Protection Agency**

EPA has the responsibility to deal with circumstances on sites listed on the National Priority List (NPL) where there is an imminent and substantial endangerment to human health and the environment as a result of actual or potential exposure to hazardous substances, contaminants and pollutants. The following persons have used professional judgement for data cited in this report.

- Mike Bishop, Environmental Scientist
- Scott Brown, East Helena Site Project Manager
- Charlie Coleman, Anaconda Smelter Site Project Manager
- Julie DalSoglio, Milltown Site Project Manager
- Russ Forba, Silver Bow Creek Site Project Manager
- Sarah Weinstock, Mouat Site Project Manager

5. **U.S. Department of the Interior, Bureau of Land Management (BLM); Division of Solid Minerals, Mining Regulation and Development Section**

The BLM has the responsibility of managing phosphate leasing in the State of Montana. Under the federal Mineral Leasing Act, reclamation bonding is required as part of lease agreements. Few phosphate properties have been active since the early 1960's though lease terms are maintained through payment of an annual fee. It has been found that reclamation bonds have been insufficient on relinguished leases to cover the required reclamation costs. Field inspections and a review of abandoned phosphate leases have provided the basis for the data which is reported with a 50% confidence level by the following specialist.

- Steve VanMatre

6. **Montana Department of State Lands, Abandoned Mine Reclamation Bureau; Bentonite Mine Inventory, 1989.**

A systematic inventory of abandoned bentonite mines was completed by the AMR Bureau to document safety hazards and environmental impacts at bentonite mines across the State. All bentonite areas were verified during aerial reconnaissance. The information presented from this reference source is reported with a 75% confidence level. The following AMR consultants have used professional judgement for data cited in this summary.

- L.C. Hanson Company; C. Neiffer, K. Redmond, B. Shaw
- HKM Inc.; D. Nebel, G. Underhill, R. Waples
- Robert Peccia & Associates; B. Morton

7. **Montana Department of Natural Resources and Conservation, Water Development Bureau; Reclamation and Development Grants Program**

Cost estimates on noncoal projects funded through Reclamation and Development Grants were obtained from this source. Approximately $6.4 million is available per biennium from the State to repair, reclaim and mitigate environmental damage to public resources from mineral extraction. The source of funding for this program is 46% of the interest generated from the State's Resource Indemnity Trust (RIT) Fund. The level of project funding is from $125,000 to $200,00 with a $300,000 maximum. The following persons have contributed data to this summary.

- Greg Mills
- Les Pederson

8. **Montana Department of Health and Environmental Sciences, Solid and Hazardous Waste Bureau; Environmental Quality Protection Fund Program**

Cost estimates on noncoal reclamation projects funded through the Environmental Quality Protection Fund were obtained from this source. Approximately $100,000 is available per year for emergency projects which respond to a release of hazardous or deleterious substances. The source of funding for this program is RIT interest and income and penalties from environmental enforcement. This is a cost recovery program created by the Comprehensive Environmental Cost Recovery Act (CECRA). The following person has contributed data to this summary.

- Carol Fox

9. **Montana Department of State Lands, Coal and Uranium Bureau**

Mining permits are issued by this agency for exploration and mining of coal and uranium. The Montana Strip and Underground Mine Reclamation Act of 1973 requires proposed mining ventures to post reclamation bonds to cover the cost of restoring the land after mining has ceased. Research of existing uranium exploration records and familiarity with the extent of pre-law disturbance are the source of the estimates presented in this data summary. The following person has used professional judgement to report this data with a 20% confidence level.

- Bob Bowman

10. **Natural Resource Information System; Montana State Library**

Acreage estimates are based on 1987 aerial photography interpreted by the EPA Environmental Photographic Interpretation Center in Warrenton, Virginia. The interpretation was sent to the Montana State Library and referenced by computer according to the following catagories: waste rock dumps, mines, tailings, and millsites. The computer specialist generating numbers for this data summary is:

- Jerry Daumiller

NEVADA

NEVADA - NARRATIVE SUMMARY

INTRODUCTION

Mining has had a long and interesting history in the state of Nevada. According to local legend the earliest mining was done by the Spaniards in the 1700's, but it is likely that Native Americans were engaged in some mining activity even before that. Intense interest in mining in Nevada began with the discovery of precious metals in the Comstock Lode in the 1850's. News of the Comstock caused prospecting to increase in many parts of the state. This prospecting led to discoveries, that in turn, attracted population, a reason for settlement, railroads and other industries to Nevada. Many of Nevada's towns owe their existence to these early mining pioneers.

The main mineral commodities produced in Nevada have been the precious metals, gold and silver. Upswings and downswings in the prices of these metals have caused corresponding ups and downs in precious metal production. Nevada is fortunate, however, to have a wide variety of geologic environments, and a number of important mineral commodities. Quite often, when precious metal production is down, production of other commodities such as tungsten, copper or barite will be up. Nevada is currently the leading domestic producer of gold, silver, magnesite, mercury, and barite. Other important minerals are gypsum, diatomite, copper, molybdenum, lithium and others. Construction ores include sand, gravel, and limestone. Mining is Nevada's second largest industry after tourism (casinos), and is a cornerstone of Nevada's economy. Mining employs about 13,500 people in Nevada.

MINING AND RECOVERY METHODS

The early miners were following veins of high grade ore that outcropped at the surface. Practically all of the early mining was done by a variety of underground methods. Square set stoping, for example, was invented in response to the geometry and ground conditions of Comstock mines. More often than not, no specific mining method was used. The miners simply followed the veins.

Some placer mining has taken place in Nevada, but due to the relative scarcity of surface water, that method has not had a major impact overall.

Open pit (surface) mining became more common in the years following World War II. Currently, the vast majority of Nevada's mines are open pit. A large number of these open pits are on-going operations.

One final type of mining is solution mining. This method involves extracting certain minerals, mainly lithium, from brines.

A wide variety of recovery methods have been used to extract precious metals. Early operations used stamp mills to break the ore followed by mercury amalgamation, flotation, cyanidation, and gravity separation. Current milling operations use more technologically advanced equipment such as jaw crushers and ball mills which are capable of processing large volumes of material. Mercury amalgamation is not currently used. Cyanidation is the most common method of precious metal recovery. Heap leaching with weak cyanide solutions has been increasingly used in the past 15 years. Advances in heap leaching technology have been and continue to be made.

HEALTH AND SAFETY IMPACTS

Mining in Nevada was not regulated to any great extent until the mid 1970's with the passage of FLPMA. With Nevada's long history of mining it is not surprising that many underground mine openings exist, some of which pose severe health and safety problems to the unwary. Potential hazards at these sites include falling, bad-air, old explosives, rotten timbers, and ladders, and others. It is estimated that some 300,000 abandoned mine workings exist in Nevada, of which some 50,000 pose a significant hazard.

Nevada is the fastest growing state in the union which leads to an increase of the public visiting former mining areas. Housing developments continue to expand and in some cases are located near mine shafts and other potential hazards. An increase in dirt bikes and ATV's has made formerly remote areas more accessible.

There have been documented deaths in Nevada associated with accidental or unauthorized entry into abandoned mines. Accurate statistics are difficult to obtain but it is estimated that about 15 fatalities have occurred over the past 20 years. There have also been injuries, near misses, and pet fatalities.

Open pit mining has resulted in the creation of highwalls. These highwalls are generally not too hazardous unless they are located near towns, buildings, or roads. In many cases, natural topographic features such as cliffs are as or more hazardous than highwalls.

STATE LAWS AND REGULATIONS

Recognizing the potential hazard created by abandoned mine openings and an expanding population, the Nevada Legislature in 1987 created a program to deal with abandoned mines. This program is administered by the Department of Minerals. The goals of the program are to discover and rank abandoned mine hazards, determine the person responsible for the hazard (if such person exists), notify the person responsible, report the existence of these hazards to the appropriate board of county commissioners, and, perhaps most importantly, conduct a public awareness and education program urging people to stay away from these types of hazards.

Regulations (NAC 513) provide for a ranking system of hazards, methods of securing hazards, and time frames for securing hazards. A copy of these regulations is attached to this report.

In 1989, the Nevada Legislature expanded the program by giving the Department of Minerals authority to physically secure orphaned abandoned mines. Orphaned means that no mining claimant or property owner exists. As of April 12, 1991, 4,215 potentially hazardous mine openings have been inventoried. Of those, about 1200 have been or will soon be secured. These numbers change almost daily with additional mine openings being discovered and secured.

In 1990 state law giving the Division of Environmental Protection authority to permit, regulate, and bond reclamation activities of current and future mining operations became effective.

Numerous state agencies are responsible for permitting and regulating mining and milling operations. A summary of the required permits and responsible agency, Nevada Bureau of Mines and Geology Special Publication L-6, is attached to this report.

NOTES TO TABLE (NEVADA)

1. Nevada's definition of inactive/abandoned mines used in the table relates to "dangerous condition." NAC 513.230 defines "dangerous condition" as a condition resulting from mining practices which took place at a mine that is no longer operating or its associated works that could reasonably be expected to cause substantial physical harm to persons or animals. Our definition does not include mines that are currently operating.

2. Sources of data include, but are not limited to, the following:

   a. USGS 7 1/2 minute topographic maps. We have topographic map coverage for the entire state. Locations of mine openings are symbolized on the maps. Our field experience has shown that only about one fourth of the mine openings are shown on the maps, but the maps are valuable for showing areas to field check.

   b. Toll free "hot line." We have established a toll free phone number 1 (800)541-MINE for use within Nevada for people to report the presence of abandoned mine openings they know of. Use of the hot line has resulted in the discovery and later securing of several very hazardous mine openings.

c. Input and cooperation from federal agencies. Agencies such as Bureau of Land Management, U.S. Forest Service, and National Park Service have been made aware of our program. Field personnel from these agencies have generally been quick to report hazardous mine openings they find during the course of their regular duties.

d. Various books and publications on old mining camps and ghost towns offer information on areas to field check.

e. Grass roots field investigations by division staff. All data on our hazard inventory sheets is collected by division staff in the field.

3. Quality of data as far as hazard type, degree of hazard, location and description of hazard is generally 100 percent accurate because it is logged in the field. The estimate of 50,000 potentially hazardous mine openings is probably 80% accurate. Data involving ownership or status of mining claims is approximately 95 percent accurate. In certain instances, a hazard may exist where claims overlap, where there is split ownership of land, or where claim boundaries prevent making an absolutely accurate call without a survey. Claim status itself is dynamic as new claims are staked, and old claims are dropped, leased, sold, etc. We refer to the owner or mining claimant as the

"apparent owner." In the event we are wrong we are usually notified by the apparent owner.

Data involving mineral type is an estimate. We do not distinguish hazards on the basis of mineral type. Practically all of the under ground mines in Nevada were dug in pursuit of metallic ores. There are some notable exceptions to this (mainly gypsum). We are not aware of any phosphate, uranium or oil shale mines in Nevada.

4. Data involving acreage is an estimate. For purposes of this report, it is assumed that, on average, each identified hazard occupies 30 feet by 30 feet, or 0.02 acres. This figure does not include the entire mine site, but just the areas immediately surrounding a hazardous mine openings. Many mine sites have more than one opening. Each opening is counted as a separate hazard. The 4215 logged mine openings would involve about 80 acres. The estimated 50,00 mine openings would involve about 1000 acres.

5. Not applicable.

6. Nevada does have Tribal Lands. At this time no field investigations have been done on Tribal Lands.

7. Not applicable.

8. Our definition of hazardous highwall relates back to our definition of dangerous conditions. We rank hazards on the basis of their location and their degree. The degree of hazard for a highwall is a 1 on scale of 1 to 5, 1 being the lowest. (NAC 513.340 (1) (d)).

9. Our definition of hazardous mine openings relates back to our definition of dangerous condition. The degree of hazard for mine openings varies from 1 to 5 based on the geometry, size, and visibility of the opening. The rating of degree of danger is contained in NAC 513.340.

10. The definition of abandoned mine lands does not have a specific definition of disturbed land and associated environmental problems. during the course of field investigations we do note whether or not there is any apparent chemical toxicity.

11. The division of abandoned mine lands does not have a specific definition of polluted water. During the course of field investigations we do note whether or not any water is present. In most cases, no water is present. When water is present, it is not necessarily polluted.

12. Mine dumps are generally not considered to be a hazard. In many cases natural revegetation is occurring, especially at

older dumps. Acreage covered by mine dumps is not included in this report.

13. Subsidence prone areas are very rare in Nevada. They are generally handled by local authorities on a case by case basis.

14. Hazardous structures are generally old mill buildings, but also, include old headframes and aerial tramways. Several hazardous structures are known to exist, but at this time, no attempt to inventory them has been made. Many of these structures have historical significance.

15. Other features - Not applicable.

16. Costs for securing hazardous mine openings vary with the method of securing and the size, scope, and location of the site. Past experience has shown the average cost of securing a mine opening to be about $600. Some can be secured for as little as $100 while others are considerably higher. Nevada law (NAC 513.290) says the person responsible for securing a hazardous mine opening is the owner of the patented claim or the claimant of the unpatented claim on which the hazard is located. Approximately 85% of the mine openings investigated thus far have a responsible person who is required to secure hazards at their own expense.

NON-COAL INVENTORY
INACTIVE/ABANDONED MINES[1]

State of NEVADA

Agency Contact DOUG DRIESNER

Telephone (702) 687-5050

DATA SUMMARY[2,3] NOTE: DATA CURRENT TO APRIL 12, 1991

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)	(cost)
Metallic Ores	Mines	80	Federal	70	Polluted Water[8]	(miles)	(cost)[16]
	Millsites		Private	10	Mine Dumps[9]	(acres) 80	
	Smelters		State		Disturbed Land[10]	(acres)	
	Other[5]		Other[6]		Highwalls[11]	(miles) 6	
					Mine Openings[12]	(number) 4215	
					Subsidence Prone[13]	(acres)	
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Construction Ores	Mines	40	Federal		Polluted Water	(miles)	
	Millsites		Private	40	Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres) 40	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number) 12	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Industrial Ores NONE INVENTORIED AS OF APRIL 12, 1991	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)	(cost)
Phosphate Rock	Mines		Federal		Polluted Water[8]	(miles)	(cost)[16]
	Millsites		Private		Mine Dumps[9]	(acres)	
NONE	Smelters		State		Disturbed Land[10]	(acres)	
	Other[5]		Other[6]		Highwalls[11]	(miles)	
					Mine Openings[12]	(number)	
					Subsidence Prone[13]	(acres)	
					Hazardous Structures[14]	(number)	
					Other[15]	(units)	
Uranium Overburden	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
NONE	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
NONE	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
TOTAL	Mines	120	Federal	70	Polluted Water	(miles)	
	Millsites		Private	50	Mine Dumps	(acres) 80	
	Smelters		State		Disturbed Land	(acres) 40	
	Other		Other		Highwalls	(miles) 6	
					Mine Openings	(number) 4215	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	

$1.00

NEVADA BUREAU OF MINES AND GEOLOGY
Special Publication L-6
(revised to November 1989)

STATE AND FEDERAL PERMITS REQUIRED IN NEVADA BEFORE MINING OR MILLING CAN BEGIN

compiled by
Doug Driesner
Nevada Department of Minerals

This is a list of State and Federal permits and actions required during development, planning, construction, and before operation of Nevada mines and mills. We hope it will help both individuals and companies through the complex, often confusing regulatory maze—please understand that inclusion in this list does not indicate approval of these regulations.

Remember that in addition to State and Federal permits, County and City permits may be required. We have attempted to include a general description of County and City permits necessary. As these may vary, it is suggested you contact the local County Planning Commission for specific requirements.

This list will be revised periodically, however, the user should be aware that there may be additional, new, or revised regulations issued after this list was compiled. We welcome any additions, and/or corrections, as well as any suggestions on how to improve this list. For more information about permitting, contact: Nevada Department of Minerals, 400 W. King Street, Suite 106, Carson City, NV 89710, (702) 687-5050.

STATE REQUIREMENTS

OPENING AND CLOSING MINES

Agency to contact .... State Inspector of Mines, 1380 S. Curry St., Carson City, NV 89710, (702) 687-5243
When required .... Before opening and upon closing mine operations
Required action .... Operators shall notify the inspector of mines; the notice must include the name and location of the mine(s); the name and address of the operator, the name of the person in charge of the operation, a statement of whether the operation will be continuous or intermittent, and upon closing, a statement of whether the closing is temporary or permanent.
Governing statute .... NRS Chapter 512.160

PERMIT TO APPROPRIATE THE PUBLIC WATERS

Granting agency .... Nevada Division of Water Resources, 201 S. Fall St., Carson City, NV 89710, (702) 687-4380
When required .... Prior to construction
Maximum time to obtain ... 180 days
Minimum time to obtain .... 90 days
Cost of permit .... $200 application fee plus $150 plus $1 per acre foot applied for
Public Notice required ..... Yes
Information required ...... Location of point of diversion and place of use; use to which water will be applied; annual consumption of water.
Governing statute .... NRS Chapter 533 and 534

STATE REQUIREMENTS (continued)

PERMIT TO CONSTRUCT TAILINGS DAM

Granting agency .... Nevada Division of Water Resources, 201 S. Fall St., Carson City, NV 89710, (702) 687-4380
When required .... Prior to construction
Maximum time to obtain ... 120 days
Minimum time to obtain .... 45 days
Cost of permit .... $500 plus annual storage fee of $100 plus $1 per acre foot of storage capacity
Public Notice required ..... No
Information required ...... Plans and specifications must be filed with application for any tailings dam which will be higher than 10 feet or impound more than 10 acre feet; supportive engineering study.
Governing statute .... NRS Chapter 535

NEVADA WATER POLLUTION CONTROL PERMIT

Granting agency .... Nevada Division of Environmental Protection, 201 S. Fall St., Carson City, NV 89710, (702) 687-4670
When required .... Prior to operation
Maximum time to obtain ... 180 days
Minimum time to obtain .... 60 days
Cost of permit .... Facility dependent (see NAC 445.144)
Public Notice required ..... Yes
Information required ...... Site plan; water or treatment works to which discharge will be released.
Governing statute .... NRS Chapter 445; NAC 445.070-.241

NEVADA GROUNDWATER OR ZERO DISCHARGE PERMIT

Granting agency .... Nevada Division of Environmental Protection, 201 S. Fall St., Room 221, Carson City, NV 89710, (702) 687-4670
When required .... Prior to operation
Maximum time to obtain ... 165 days
Minimum time to obtain .... 60 days
Cost of permit .... Facility dependent. (See NAC 445.144)
Public notice required ...... Yes
Information required ...... Site plan; water or treatment works to which discharge will be released; information specified in mining regulations (for mining facilities). For mining activities on private or state lands, the permit application would identify potential non-point source (NPS) pollution generating activities and appropriate Best Management Practices (BMP) from the State BMP manual. For operations on federal lands, generally the "plan of operation" submitted to the appropriate federal agency satisfies State BMP implementation requirements.
Governing statute .... NRS Chapter 445; NAC 445.199-.234 (NPS-BMP)

ENDANGERING WILDLIFE

Agency to contact .... Nevada Department of Wildlife, 1100 Valley Rd., Reno, NV 89512, (702) 789-0500
When required .... Prior to construction and operation
Required action .... Ascertain whether or not the mining operation would endanger fish and game habitat, etc.
Governing statute .... NRS 445, 501.181, NAC 504.520

DREDGING PERMIT

Agency to contact .... Nevada Department of Wildlife, 1100 Valley Rd., Reno, NV 89512, (702) 789-0500
When required .... Prior to operation
Time to obtain .... 10 days
Cost of permit $5.00
Required action .... Contact Nevada Department of Wildlife
Governing statute .... NRS Chapter 503.425

STATE REQUIREMENTS (continued)

AIR QUALITY PERMIT TO CONSTRUCT

Granting agency .... Nevada Division of Environmental Protection, 201 S. Fall St., Carson City, NV 89710, (702) 687-5065
When required .... 75 days prior to construction
Time to obtain .... 75 days
Cost of permit .... Determined upon review of application
Public Notice required ..... Yes if emissions are greater than or equal to 100 tons per year, if less than 100 tons per year notice may not be required.
Information required ...... Location of source; specifications and design of source; type and quantity of air emissions; basis of data; materials used in process; air contaminant control equipment; type of combustion unit; hourly fuel consumption operating schedule; process products; flow diagram; baseline data.
Governing statute .... NAC 445.430-.846

AIR QUALITY PERMIT TO OPERATE

Granting agency .... Nevada Division of Environmental Protection, 201 S. Fall St., Carson City, NV 89710, (702) 687-5065
When required .... Prior to permanent operation
Time to obtain .... 180 days to demonstrate compliance
Cost of permit .... Determined by final operational capacity of facility
Public Notice required ..... No
Required action .... Inspection by Nevada Division of Environmental Protection
Governing statute .... NRS Chapter 445.401-.601

PERMITS FOR SANITATION FACILITIES

Granting agency .... Nevada Division of Health/Consumer Health Protection Services, 505 E. King St., Carson City, NV 89710, (702) 687-4750
When required .... Prior to construction
Maximum time to obtain ... 30 days
Minimum time to obtain .... 5 days
Cost of permits .... Drinking water supply, $150 fee for plan review plus $90 per year to operate; Sewage system, $200 fee for plan review.
Public Notice required ..... No
Information required ...... Contact Nevada Division of Health for details concerning: Labor camp (NRS 444), Public bathing place (NRS 444), Mobile Home park (NRS 439.200), Camp kitchen & dining room (NRS 446), Drinking water supply (NRS 445), Recreational vehicle park (NRS 439.200), Sewage system (NRS 444), Sub-division (NRS 278).

AUTHORIZATION FOR DISPOSAL OF SOLID WASTES

Granting agency .... Nevada Division of Environmental Protection, 201 S. Fall St., Carson City, NV 89710, (702) 687-4670
When required .... Prior to disposal of construction wastes and/or disposal of workers' solid wastes
Maximum time to obtain ... 3 months
Minimum time to obtain .... 2 weeks
Cost of Authorization ...... None
Public Notice required ..... No
Information required ...... Site location, design and operational plan as specified in Nevada regulations governing solid waste management.
Governing statute .... NRS Chapter 444.400-.630

HISTORIC PRESERVATION

Agency to contact .... Nevada Division of Historic Preservation & Archaeology, 201 S. Fall St., Carson City, NV 89710, (702) 687-5138
When required .... Prior to actual mining
Required action .... Submit a legal description with map of the area to be disturbed so NDHPA can determine if it is within any particular state historic preservation area.
Governing statute .... Sec. 106 National Historical Preservation Act of 1966 as amended.

HAZARDOUS WASTE

Agency to contact .... Nevada Division of Environmental Protection, 201 S. Fall St., Carson City, NV 89710, (702) 687-5872

Required action .... This agency does not have any regulations in effect regarding the generation, transportation, treatment, storage, or disposal of waste from the extraction, benefication and processing of ores and minerals. It would be advisable, however, to contact this office for a possible change or update of state or federal regulations.

LICENSE FOR RADIOACTIVE MATERIAL

Agency to contact .... Nevada Division of Health, Radiological Health Section, 505 E. King St., Carson City, NV 89710, (702) 687-5394

When required .... Prior to use of radioactive material in Nevada

Required action .... Apply for license with Nevada Division of Health

Time required .... 2-3 weeks

Cost of license .... $100 per year

Governing statute .... NRS Chapter 459

CONTRACTORS LICENSE

Agency to contact .... Contractors Board, 70 Linden St., Reno, NV 89502, (702) 789-0141

When required .... Prior to construction

Required action .... Applicant must apply for a contractors license and pass the Contractors Management Test and technical examination if applicable.

Time required .... 60-90 days

Cost of license $246

Governing statute .... NRS Chapter 624

MINE REGISTRY FORMS

Agency to contact .... Nevada Department of Minerals, 400 W. King St., Suite 106, Carson City, NV 89710, (702) 687-5050

When required .... Within 30 days after a mine operation begins

Required action .... Operators shall submit a completed form for registration.

Governing statute .... NRS 513.063 and 513.073

ANNUAL STATUS AND PRODUCTION REPORT

Agency to contact .... Nevada Department of Minerals, 400 W. King St., Suite 106, Carson City, NV 89710, (702) 687-5050

When required .... On or before April 15 of each year

Required action .... Operators shall submit a report relating to the annual status and production of the mine for the preceding calendar year.

Governing statute .... NRS 513.063 and 513.073

FEES FOR ABATEMENT OF HAZARDOUS CONDITIONS

Agency to contact .... Nevada Department of Minerals, 400 W. King St., Suite 106, Carson City, NV 89710, (702) 687-5050

When required .... Within 30 days after approval of a plan of operation or amended plan of operation, or within 30 days after filing a notice of intent.

Required action .... Operators shall provide the department with a copy of the plan of operation, amended plan of operation, or notice of intent.

Fees .... For a plan of operation or amended plan of operation, $20 for each acre or partial acre to be distributed. For a notice of intent, $20 regardless of acreage to be disturbed.

Governing statue .... NRS Title 46

FIRE AND LIFE SAFETY

Agency to contact .... State Fire Marshal Division, Capitol Complex, Stewart Facility, Building 107, Carson City, NV 89710. (702) 687-6917

When required .... Prior to construction and operation

Required action .... Architectural plans for the construction remodel, addition or alteration of any building in a county with a population of less than 25,000 shall be reviewed for the non-structural features of fire and life safety.

Fee schedule .... Fee is based upon the proposed cost of construction.

Governing statute .... NAC 477.740 and NAC 477.750

STATE REQUIREMENTS (continued)

HAZARDOUS MATERIALS PERMIT

Agency to contact ....State Fire Marshal Division, Hazardous Materials Section, Capitol Complex, Stewart Facility, Building 107, Carson City, NV 89710, (702) 687-6917

When required ....Prior to construction

Required action ....Section 80.103(a) Uniform Fire Code, 1988 Edition; no person, firm or corporation shall store, dispense, use or handle hazardous material in excess of quantities specified in Section 4.108 unless and until a valid permit has been issued pursuant to this article.

Cost of permit $100.00

Governing statute ....NAC 477.325.

FEDERAL REQUIREMENTS

USE OF BLM-ADMINISTERED LAND

Agency ....Bureau of Land Management (BLM), State Office:

Reno—850 Harvard Way, P.O. Box 12000, Reno, NV 89520, (702) 784-5142

District Offices:

Winnemucca—705 E. 4th St., Winnemucca, NV 89445, (702) 623-3676

Carson City—1535 Hot Springs Road, Suite 300, Carson City, NV 89701, (702) 882-1631

Elko—2002 Idaho St., P.O. Box 831, Elko, NV 89801, (702) 738-4071

Ely—Star Route 5, Box 1, Ely, NV 89301, (702) 289-4865

Las Vegas—4765 W. Vegas Dr., P.O. Box 26569, Las Vegas, NV 89126, (702) 388-6403

Battle Mountain—Box 1420, Battle Mountain, NV 89820, (702) 635-5181

Susanville—P.O. Box 460, Cedarville, CA 96104, (916) 279-6101

When required ....Affects lands open to mining and administered by BLM (except lands under wilderness review). The surface management regulations (43 CFR 3809) incorporate three levels of operation: 1) Casual use by part-time miner or weekend prospector who does negligible disturbance. No notice or plan required. Need not contact BLM. No use of mechanized earth-moving equipment or explosives; 2) Notice—surface disturbance of 5 acres or less. A written notice must be submitted to BLM 15 days prior to starting operations. Notice must describe the operation, location, and access, and must contain a statement that the lands will be reclaimed to the standards spelled out in the regulations. Operator must notify BLM when reclamation is completed so an inspection can be made. No approval or bonding necessary; 3) Plan of operation—disturbance of more than 5 acres or if operations are proposed in Wild & Scenic River areas, areas of critical environmental control, National Wilderness Preservation System, or off-road vehicle closed areas. A plan of operation must describe the entire operation, equipment to be used, location of access, support facilities, drill sites measures to prevent undue degradation and reclamation plans. BLM acknowledges receipt of plan; 30 days to act; 60-day extension if necessary; reclamation required for all operations. Bonding may be required.

USE OF BLM-ADMINISTERED LAND UNDER WILDERNESS REVIEW

Granting agency ....Bureau of Land Management, District Offices

When required ....A plan of operations submitted under the 43 CFR 3802 regulations shall include appropriate environmental protection and reclamation measures. An approved plan of operations within lands under wilderness review is required prior to commencing 1) mining operations which involve construction of means of access, or improving or maintaining such access facilities in a way that alters the alignment, size, and character of such facilities; 2) operations which destroy trees 2 or more inches in diameter; 3) mining operations using tracked or mechanized earth-moving equipment; 4) mining operations using motorized vehicles over an area that has been designated as "closed" to off-road vehicles, unless the use of a motorized vehicle can be covered by a temporary use permit; 5) construction or placing of any mobile, portable, or fixed structure on public land for more than 30 days; 6) mining operations requiring the use of explosives; 7) any operation which may cause changes in a wate course. A plan of operation is not required when: 1) searching for and occasionally removing mineral samples or specimens; 2) operating motorized vehicles over open use areas and trails; 3) maintaining or making minor improvements to existing access routes or other facilities; 4) making geological, radiometric, geochemical, geophysical, or other tests using instruments, devices or drilling equipment which are transported without using mechanized earth-moving equipment or vehicles. Bonding may be required for approved plans of operations.

TEMPORARY USE OF BLM-ADMINISTERED LAND

Granting agency .... Bureau of Land Management, District Offices
When required .... Prior to use
Maximum time to obtain ... 90 days
Minimum time to obtain .... 15 days
Cost of permit .... Varied. Consult BLM district offices
Public Notice required ..... No
Information required ...... Location of use area; proposed use; cost of use development; archaeological and historical clearances.

RIGHT OF WAY FOR ELECTRIC TRANSMISSION ON BLM-ADMINISTERED LAND

Granting agency .... Bureau of Land Management, District Offices
When required .... Prior to construction
Maximum time to obtain ... Approximately 6 months
Minimum time to obtain .... Approximately 20 days
Cost of permit .... $50.00 per mile up to 5; $500.00 for 5 to 20 miles. Rental.
Public Notice required ..... Yes
Information required ...... Corridor route; archaeological and historical clearances; methods of construction; notice of completion (within 90 days).

ROAD ACCESS (R/W) ON BLM-ADMINISTERED LAND

Granting agency .... Bureau of Land Management, District Offices
When required .... Prior to construction
Maximum time to obtain ... Approximately 6 months
Minimum time to obtain .... Approximately 30 days
Cost of permit .... $50.00 per mile up to 5 miles; $500.00 for 5 to 20 miles. Rental.
Public Notice required ..... Yes
Information required ...... Corridor route; archaeological and historical clearances; methods of construction; notice of completion (within 90 days).

ALL USES OF USDA FOREST SERVICE ADMINISTERED LAND

Agency to contact .... U.S. Forest Service, District Offices
Required action .... Contact USFS for details

PURCHASE, TRANSPORT, OR STORAGE OF EXPLOSIVES

Agency to contact .... Bureau of Alcohol, Tobacco and Firearms (BATF), 801 I St., Sacramento, CA 95814, (916) 551-1323
When required .... Permit required before purchasing explosives from out of State source and/or transporting explosives across a State line.

License required before manufacturing, selling or importing explosives. License is required for persons mixing two component explosives.

Storage requirements apply to ALL persons storing explosives even if no license or permit is held.

Required action .... Obtain license or permit. Information and necessary forms can be obtained from the BATF Sacramento office. Any loss, theft or misuse of explosives should be reported to the BATF Law Enforcement office, 350 S. Center St., Reno, NV, (702) 784-5251.

FLORA AND FAUNA

Agency to contact .... Forest Service, District Offices or Bureau of Land Management (BLM), 850 Harvard Way, P.O. Box 12000, Reno, NV 89520, (702) 784-5455

FEDERAL REQUIREMENTS (continued)

When required .... Before beginning operations
Required action .... Find out if any plants or animals in the area of operations are on the threatened and endangered species list.

DREDGING PERMIT

Agency to contact .... Forest Service, District Offices
Required action .... Requires a plan of operation or notice of intent for work on Forest Service lands.

NOTIFICATION OF COMMENCEMENT OF OPERATION

Granting agency .... Mine Safety & Health Administration, 3680 Grant Dr., Reno, NV 89509, (702) 784-5892
When required .... Prior to start-up
Information required ...... Location; estimated commencement date; safety training plan; legal identity.

PATENTING MINING CLAIMS

Granting agency .... Bureau of Land Management, 850 Harvard Way, P.O. Box 12000, Reno, NV 89520, (702) 784-5142
When required .... When desired by claim holder
Maximum time to obtain ... 18 months
Minimum time to obtain .... 10 months
Patenting cost .... $25.00 filing fee and proof that not less than $500.00 has been expended for development of each claim. Purchase price: Lode Claim—$5.00 per acre; Placer Claim—$2.50 per acre; Mill Site—$5.00 per acre.
Public Notice required ..... Yes, posted on claim and local newspaper
Information required ...... Mineral survey plat, field notes, proof of posting on claim, evidence of title, proof of citizenship, publishers agreement.

HISTORIC PRESERVATION

Agency to contact .... Forest Service, District Offices
Required action .... Special Use Permit required for cultural clearance to conduct surveys on Forest Service lands.

CITY/COUNTY REQUIREMENTS

General Plan: Many counties are governed by a general plan and have adopted special land use ordinances with regard to this general plan. Mining in some areas may be allowable by right, where in others, such as urbanized areas and agricultural and housing districts, it may be prohibited.

Building Permit: Prior to construction of any structure, many counties require the issuance of a building permit. Cost of the permit may vary depending on extent and type of construction. There must be prior approval for construction from the Nevada State Health Division.

Special Use Permit: Various counties require special use permits in relation to mining activities. A full description of all phases of the proposed operation is required. Cost of the permit may vary among counties. Public notice is generally required.

Zoning Change: A description of the proposed mining operation is required for a zoning change for industrial use. Often in open use zones, a special use permit may be required. Public notice is generally required.

Business License: Various city/county governments require any firm, person, association or corporation to have a license before engaging in any business activities.

513.094 Executive director to establish program to discover dangerous conditions of nonoperating mines; funding; employment of qualified assistant; regulations.

1. An additional fee of $0.50 per claim is imposed upon all filings to which NRS 517.185 applies. Each county recorder shall collect and pay over the additional fee, and the additional fee must be deposited, in the same manner as provided in that section.

2. The executive director shall, within the limits of the money provided by this fee, establish a program to discover dangerous conditions that result from mining practices which took place at a mine that is no longer operating, identify if feasible the owner or other person responsible for the condition, and rank the conditions found in descending order of danger. He shall annually during the month of January, or oftener if the danger discovered warrants, inform each board of county commissioners concerning the dangerous conditions found in the respective counties, including their degree of danger relative to one another and to such conditions found in the state as a whole. He shall further work to educate the public to recognize and avoid those hazards resulting from mining practices which took place at a mine that is no longer operating.

3. To carry out this program and these duties, the executive director shall employ a qualified assistant, who must be in the unclassified service of the state and whose position is in addition to the unclassified positions otherwise authorized in the department by statute.

4. The commission shall provide by regulation:

(a) Standards for determining which conditions created by the abandonment of a former mine or its associated works constitute a danger to persons or animals and for determining the relative degree of danger. A condition whose existence violates a federal or state statute or regulation intended to protect public health or safety is a danger by virtue of that violation.

(b) Standards for abating the kinds of dangers usually found, including but not limited to standards for excluding persons and animals from dangerous open excavations.

(Added to NRS by 1987, 1867)

CHAPTER 513
COMMISSION ON MINERAL RESOURCES

DANGEROUS CONDITIONS CREATED BY ABANDONMENT OF MINES

DANGEROUS CONDITIONS CREATED BY ABANDONMENT OF MINES

513.200 Definitions. As used in NAC 513.210 to 513.390, inclusive, unless the context otherwise requires, the words and terms defined in NAC 513.210 to 513.290, inclusive, have the meanings ascribed to them in those sections.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.210 "Animal" defined. "Animal" means any member of the bovine, equine, porcine or caprine species as well as dogs, cats or other animals under the restraint or control of a person.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.220 "Commission" defined. "Commission" means the commission on mineral resources.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.230 "Dangerous condition" defined. "Dangerous condition" means a condition resulting from mining practices which took place at a mine that is no longer operating or its associated works that could reasonably be expected to cause substantial physical harm to persons or animals.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.240 "Department" defined. "Department" means the department of minerals.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.250 "Executive director" defined. "Executive director" means the executive director of the department.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.260 "Fence" defined. "Fence" has the meaning ascribed to it in subsection 5 of NRS 207.200.

(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.270 "Owner" defined. "Owner" means the owner of real property who is shown to be the owner on records located in the courthouse of the county in which the real property is located.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.280 "Person" defined. "Person" means a natural person.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.290 "Responsible person" defined. "Responsible person" means the owner of a patented claim or the claimant of an unpatented claim.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.300 Scope. The provisions of NAC 513.200 to 513.390, inclusive, apply to all owners or other responsible persons for dangerous conditions on private or public land.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.310 Waiver of provisions. Upon the approval of the executive director, the department may grant a waiver from any provision of NAC 513.200 to 513.390, inclusive, if the waiver does not defeat the purpose of NRS 513.094.
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.320 Assignment of points to dangerous condition. The executive director or his representative shall assign a dangerous condition one to five points for the location of the condition and an additional one to five points for the degree of danger associated with the condition. The condition must then be ranked according to the total number of points for location and degree of danger
(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.330 Rating of location. The location of a dangerous condition must be rated in the following manner:

1. One point must be assigned to a dangerous condition located at least 5 miles from an occupied structure or a public road maintained by some governmental entity.
2. Two points must be assigned to a dangerous condition located between 1 and 5 miles from an occupied structure or a public road maintained by some governmental entity.
3. Three points must be assigned to a dangerous condition located 1/2 to 1 mile, inclusive, from a town.
4. Four points must be assigned to a dangerous condition located not more than 1/2 mile from a town or not more than 1 mile from an occupied structure or a public road maintained by some governmental entity.

5. Five points must be assigned to a dangerous condition located within a town or within 100 feet of an occupied structure or a public road maintained by some governmental entity.

(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.340 Rating of degree of danger. The degree of danger for a dangerous condition must be rated in the following manner:

1. One point must be assigned to a dangerous condition consisting of:

(a) A vertical or near vertical hole 8 to 20 feet, inclusive, in depth and highly visible upon approach;

(b) An inclined hole less than 50 feet deep from which a person could climb out;

(c) A horizontal hole with no associated stopes, winzes, or raises; or

(d) A high wall of an open pit.

2. Two points must be assigned to a dangerous condition consisting of:

(a) A vertical or near vertical hole 8 to 20 feet, inclusive, in depth which is not visible upon approach;

(b) Any vertical or near vertical hole 20 to 50 feet, inclusive, in depth; or

(c) Any inclined hole greater than 50 feet deep from which a person could climb out with no associated stopes, winzes or raises.

3. Three points must be assigned to a dangerous condition consisting of:

(a) Any vertical or near vertical hole 50 to 100 feet, inclusive, in depth; or

(b) Any horizontal or inclined hole with associated stopes, winzes or raises with less than a 20-foot vertical opening.

4. Four points must be assigned to a dangerous condition consisting of:

(a) Any vertical or near vertical hole which is at least 100 feet deep and visible upon approach; or

(b) Any horizontal or inclined hole with associated stopes, winzes or raises with a vertical opening greater than 20 feet.

5. Five points must be assigned to a dangerous condition consisting of any vertical or near vertical hole which is at least 100 feet deep and not visible upon approach.

The executive director or his representative may assign a higher degree of danger to a dangerous condition if other factors such as loose ground or the presence of water increase the danger, but the degree of danger for a single dangerous condition may not be scored higher than five points.

(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.350 Dangerous condition causing fatality or injury. Any dangerous condition that has been the cause of a documented fatality or injury must be ranked as a high hazard, regardless of its numerical score.

(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.360 Rating of dangerous condition. Dangerous conditions must be rated as follows:

1. A dangerous condition with a total number of 2 or 3 points is a minimal hazard;

2. A dangerous condition with a total number of 4 or 5 points is a low hazard;

3. A dangerous condition with a total number of 6 or 7 points is a moderate hazard; and

4. A dangerous condition with a total number of at least 8 points is a high hazard.

(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.370 Posting warning sign. A dangerous condition regardless of its ranking must be posted with a warning sign, [redacted]. The sign must be posted within 30 days after the responsible person is notified by the county sheriff of the existence of the condition.

(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.380 Period after notification to secure dangerous condition. Upon notification of the existence of a dangerous condition, the responsible person shall:

1. Secure within 180 days a dangerous condition rated as a low hazard;

2. Secure within 120 days a dangerous condition rated as a moderate hazard; and

3. Secure within 60 days a dangerous condition rated as a high hazard,

in the manner prescribed in NAC 513.390.

(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

513.390 Methods for securing dangerous condition. A dangerous condition must be secured by one or more of the following:

1. A barricade made of wood, metal or plastic, set in place in a solid manner with an orange warning sign attached.

2. A fence constructed to prevent a person or animal from accidentally exposing himself to the dangerous condition.

3. Permanently anchored seals constructed of material not subject to rapid decomposition and, if used to secure a vertical opening, strong enough to support the weight of any person or animal.

4. Backfilling so that no void spaces remain.

(Added to NAC by Comm'n on Mineral Resources, eff. 12-21-88)

CHAPTER 519A

RECLAMATION OF LAND SUBJECT TO MINING OPERATIONS OR EXPLORATION PROJECTS

GENERAL PROVISIONS

EXPLORATION PROJECTS

MINING OPERATIONS

PLAN FOR RECLAMATION

VIOLATIONS AND PENALTIES

PROGRAM FOR THE POOLING OF RECLAMATION PERFORMANCE BONDS

GENERAL PROVISIONS

519A.010 Legislative finding; state policy. [Effective October 1, 1990.]
1. The legislature hereby finds that:
(a) The extraction of minerals by mining is a basic and essential activity making an important contribution to the economy of the State of Nevada;
(b) Proper reclamation of mined land, areas of exploration and former areas of mining or exploration is necessary to prevent undesirable land and surface water conditions detrimental to the ecology and to the general health, welfare, safety and property rights of the residents of this state; and
(c) The success of reclamation efforts in this state is dependent upon cooperation among state and federal agencies.
2. The legislature hereby directs that all agencies and political subdivisions of the State of Nevada which are involved in or whose work is related to the administration or enforcement of the provisions of this chapter shall cooperate fully with all other state and federal agencies in any related matter.
(Added to NRS by 1989, 1281, effective October 1, 1990)

519A.020 Definitions. [Effective October 1, 1990.] As used in this chapter, unless the context otherwise requires, the words and terms defined in NRS 519A.030 to 519A.130, inclusive, have the meanings ascribed to them in those sections.
(Added to NRS by 1989, 1281, effective October 1, 1990)

519A.030 "Administrator" defined. [Effective October 1, 1990.] "Administrator" means the administrator of the division.
(Added to NRS by 1989, 1281, effective October 1, 1990)

519A.040 "Affected" defined. [Effective October 1, 1990.] "Affected" means that the surface of the land is or will be disturbed by mining, or that the land will be used:
1. As an evaporation or settling pond, leach dump, placer area or tailings pond or dump; or
2. In conjunction with any structure, facility, equipment, machine, tool, material or property incident to mining.
(Added to NRS by 1989, 1281, effective October 1, 1990)

519A.050 "Commission" defined. [Effective October 1, 1990.] "Commission" means the state environmental commission.
(Added to NRS by 1989, 1281, effective October 1, 1990)

519A.060 "Division" defined. [Effective October 1, 1990.] "Division" means the division of environmental protection of the state department of conservation and natural resources.

(Added to NRS by 1989, 1281, effective October 1, 1990)

519A.070 "Exploration project" defined. [Effective October 1, 1990.] "Exploration project" means all activities conducted in this state by a person on or beneath the surface of land for the purpose of, or in connection with, determining the presence, location, extent, depth or grade of any mineral, which affects the surface. The term does not include a small exploration project.

(Added to NRS by 1989, 1281, effective October 1, 1990)

519A.080 "Mining operation" defined. [Effective October 1, 1990.] "Mining operation" means all activities conducted in this state by a person on or beneath the surface of land for the purpose of, or in connection with, the development or extraction of any mineral. The term does not include an aggregate or sand pit or a small mining operation.

(Added to NRS by 1989, 1282, effective October 1, 1990)

519A.090 "Operator" defined. [Effective October 1, 1990.] "Operator" means any person who owns, controls or manages an exploration project or a mining operation.

(Added to NRS by 1989, 1282, effective October 1, 1990)

519A.100 "Reclamation" defined. [Effective October 1, 1990.] "Reclamation" means actions performed during or after an exploration project or mining operation to shape, stabilize, revegetate or otherwise treat the land in order to return it to a safe, stable condition consistent with the establishment of a productive post-mining use of the land and the abandonment of a facility in a manner which ensures the public safety, as well as the encouragement of techniques which minimize the adverse visual effects.

(Added to NRS by 1989, 1282, effective October 1, 1990)

519A.110 "Small exploration project" defined. [Effective October 1, 1990.] "Small exploration project" means an exploration project which is limited to a surface disturbance of not more than 5 acres in any calendar year. To determine the area of the surface disturbed, all land disturbed and left unreclaimed by an operator within a 1-mile radius of the center of the project must be considered.

(Added to NRS by 1989, 1282, effective October 1, 1990)

519A.120 "Small mining operation" defined. [Effective October 1, 1990.] "Small mining operation" means a person who does not remove from the earth in any calendar year material in excess of 36,500 tons and who disturbs less than 5 acres of land in any calendar year. To determine the area of the surface disturbed, all land disturbed and left unreclaimed by an operator within a 1-mile radius of the center of the project must be considered.

(Added to NRS by 1989, 1282, effective October 1, 1990)

519A.130 "Surety" defined. [Effective October 1, 1990.] "Surety" means, but is not limited to, a trust fund, surety bonds that guarantee performance or payment into a trust fund, letters of credit, insurance, corporate or other guarantees of performance, or any combination of these or other forms of security approved by the director of the state department of conservation and natural resources and used to ensure that reclamation will be completed.

(Added to NRS by 1989, 1282, effective October 1, 1990)

519A.140 Duties of division. [Effective October 1, 1990.] The division shall:

1. Administer and enforce the provisions of NRS 519A.010 to 519A.280, inclusive, and the regulations adopted by the commission pursuant to NRS 519A.160.
2. Employ persons who are experienced and qualified in the area of reclamation.
3. Enter into a memorandum of understanding with both the United States Bureau of Land Management and the United States Forest Service concerning the adoption by those agencies of plans of reclamation that:

(a) Apply to mining operations or exploration projects that are conducted on a site which includes both public land administered by a federal agency and privately owned land; and

(b) Substantially provide for the reclamation and security required by this chapter.

4. Develop and offer to operators on a regular basis educational workshops that include and emphasize reclamation training and techniques suitable for small exploration projects and mining operations.
5. Offer advice and technical assistance to operators.
6. Approve, reject or impose conditions upon the approval of any plan for reclamation for an exploration project or mining operation.
7. Provide the department of minerals with a copy of any conditions imposed upon an approved plan and the security required, on the same day that information is sent to the operator.

(Added to NRS by 1989, 1282, effective October 1, 1990)

519A.150 Powers of division. [Effective October 1, 1990.] The division may:

1. Conduct or authorize investigations, research, experiments and demonstrations relating to reclamation.

2. Collect and disseminate nonconfidential information relating to mining reclamation.

3. Enter into agreements relating to reclamation with other state and federal governmental agencies pursuant to which services relating to reclamation are provided by the division or a governmental agency in exchange for other consideration.

4. Receive federal, state or any other money and expend it to carry out the purposes of NRS 519A.010 to 519A.280, inclusive, or any regulation adopted by the commission pursuant to NRS 519A.160.

5. Hold hearings and issue orders relating to the administration or enforcement of the provisions of NRS 519A.010 to 519A.280, inclusive, or any regulation adopted by the commission pursuant to NRS 519A.160.

6. Summon witnesses, administer oaths and require the production of pertinent records, books and other documents for examination at any hearing or investigation conducted by it relating to the administration or enforcement of the provisions of NRS 519A.010 to 519A.280, inclusive, or any regulation adopted by the commission pursuant to NRS 519A.160.

7. Request the attorney general to bring suit in the name of the State of Nevada against any person whom it finds has violated any provision of NRS 519A.010 to 519A.280, inclusive, or any regulation adopted by the commission pursuant to NRS 519A.160, to restrain the person from continuing the violation.

8. Modify any plan for reclamation previously approved by it if:

(a) Any provision of the plan is in conflict with the provisions of a specific statute;

(b) Any provision of the plan becomes impossible or impracticable to implement; or

(c) Any significant problem that was not previously considered by the division is discovered to exist which results or may result from reclamation.

9. Suspend or revoke a permit upon a noticed hearing and a finding by the division that the holder of the permit has violated any provision of NRS 519A.010 to 519A.280, inclusive, a plan of reclamation, any condition placed on a plan of reclamation or any regulation adopted by the commission pursuant to NRS 519A.160.

10. Take any other action reasonable and necessary to enable it to administer or enforce the provisions of NRS 519A.010 to 519A.280, inclusive.

(Added to NRS by 1989, 1283, effective October 1, 1990)

519A.160 Regulations of commission. The commission shall adopt regulations:

1. Establishing reasonable fees, based on the actual cost of administration and enforcement, to be charged by the division for an application for and the issuance of a permit, the rates of which must be set to differentiate between mining operations located on federal land and those operations on state or private land;

2. Consistent with regulations adopted by the United States Bureau of Land Management that are contained in Title 43 of the Code of Federal Regulations and that do not conflict with any provision of this chapter or any other regulation adopted by the commission pursuant to this section;

3. Setting forth the information required in relation to the mining operation and maps of the area for inclusion in the checklist developed pursuant to NRS 519A.220;

4. Providing for the holding of reclamation performance bonds or other surety by the state and conditions governing the release and forfeiture of those bonds or other surety;

5. Providing for a schedule within which reclamation must be completed;

6. Establishing a schedule of civil penalties for the violation of NRS 519A.010 to 519A.280, inclusive;

7. Providing for informational filings related to reclamation by small mining operations; and

8. Necessary to enable the division to carry out the provisions of NRS 519A.010 to 519A.280, inclusive, and the regulations adopted by the commission pursuant to this section.

(Added to NRS by 1989, 1283)

—ANNOTATIONS—

Reviser's Note.

Ch. 599, Stats. 1989, the source of this section, contains the following provisions not included in NRS:

"1. The state environmental commission shall adopt the regulations required by section 17 of this act on or before October 1, 1990.

2. The department of minerals shall adopt the regulations required by section 30 of this act on or before October 1, 1990."

519A.170 Fee for application and permit; disposition. [Effective October 1, 1990.] Fees collected by the division for an application for and the issuance of a permit must be deposited with the state treasurer for credit to the appropriate account of the division and must be used in the administration of NRS 519A.010 to 519A.280, inclusive.

(Added to NRS by 1989, 1284, effective October 1, 1990)

EXPLORATION PROJECTS

519A.180 Permit required. [Effective October 1, 1990.] A person shall not engage in an exploration project without a valid permit for that purpose issued by the division.

(Added to NRS by 1989, 1284, effective October 1, 1990)

519A.190 Application for permit; fee; conditions; bond. [Effective October 1, 1990.] A person who desires to engage in an exploration project must:

1. File with the division, upon a form approved by it, an application for a permit. The application must include:

(a) The name and address of the applicant and, if a corporation or other business entity, the name and address of its principal officers and its resident agent for service of process;

(b) An exploration map or sketch in sufficient detail to enable the division to locate the area to be explored and to determine whether significant environmental problems are likely to result;

(c) The kinds of prospecting and excavation techniques that will be used in the exploration project; and

(d) Any other information required by the regulations adopted by the commission pursuant to NRS 519A.160.

2. Pay to the division the application fee established in the regulations adopted by the commission pursuant to NRS 519A.160.

3. Agree in writing to assume responsibility for the reclamation of any surface area damaged as a result of the exploration project.

4. Not be in default of any other obligation relating to reclamation pursuant to this chapter.

5. File with the division a bond or other surety in a form approved by the administrator and in an amount required by the regulations adopted by the commission pursuant to NRS 519A.160.

(Added to NRS by 1989, 1284, effective October 1, 1990)

MINING OPERATIONS

519A.200 Permit required. [Effective October 1, 1990.] A person shall not engage in a mining operation without a valid permit for that purpose issued by the division.

(Added to NRS by 1989, 1284, effective October 1, 1990)

519A.210 Application for permit; fee; conditions; bond. [Effective October 1, 1990.] A person who desires to engage in a mining operation must:

1. File with the division, upon a form approved by it, an application for a permit for each location at which he will conduct operations. The application must include:

(a) The name and address of the applicant and, if a corporation or other business entity, the name and address of its principal officers and its resident agent for service of process;

(b) A completed checklist developed by the division pursuant to NRS 519A.220; and

(c) Any other information required by the regulations adopted by the commission pursuant to NRS 519A.160.

2. Pay to the division the application fee established in the regulations adopted by the commission pursuant to NRS 519A.160.

3. Agree in writing to assume responsibility for the reclamation of any land damaged as a result of the mining operation.

4. Not be in default of any other obligation relating to reclamation pursuant to this chapter.

5. File with the division a bond or other surety in a form and amount required by regulations adopted by the commission pursuant to NRS 519A.160.

6. File with the department of minerals a copy of the plan for reclamation which is filed with the application pursuant to subsection 1, on the same day the application is filed with the division.

(Added to NRS by 1989, 1284, effective October 1, 1990)

519A.220 Applicant to complete checklist for permit; contents. [Effective October 1, 1990.] The division shall develop a checklist to be completed by applicants for a permit to engage in a mining operation. The information requested by the checklist must include:

1. Information relating to the plan for reclamation, including:

(a) The proposed subsequent use of the land after the mining operation is completed;

(b) The proposed schedule of reclamation that will be followed;

(c) The proposed topography of the land after the mining operation is completed;

(d) The treatment of slopes created or affected by the mining operation;

(e) The proposed use of impoundments;

(f) The kinds of access roads to be built and the manner of reclamation of road sites;

(g) The methods of drainage that will be used during the mining operation and reclamation;

(h) The revegetation of the land;

(i) The monitoring and maintenance of the reclaimed land that will be performed by the operator;

(j) The reclamation that will be necessary as a result of instream mining;

(k) The effect that reclamation will have on future mining in that area; and

(l) The effect of the reclamation on public safety.

2. Information relating to the mining operation and maps of the area which is required by the regulations adopted by the commission pursuant to NRS 519A.160.

3. Other information as requested by the administrator which he determines is pertinent to the reclamation activities of the mining operation.

(Added to NRS by 1989, 1285, effective October 1, 1990)

PLAN FOR RECLAMATION

—ANNOTATIONS—

Reviser's Note.

Ch. 599, Stats. 1989, the source of NRS 519A.230 to 519A.260, inclusive, contains the following provision not included in NRS:

"A person engaged in an exploration project or a mining operation on October 1, 1990, shall file a plan for reclamation, approved by the division:

1. On or before October 1, 1993; or
2. Before abandonment of the mining operation,

whichever occurs first."

519A.230 Provisions of plan for reclamation; exceptions. [Effective October 1, 1990.]

1. A plan for reclamation must provide:

(a) That reclamation activities, particularly those relating to the control of erosion, must be conducted simultaneously with the mining operation to the extent practicable, and otherwise must be initiated promptly upon the completion or abandonment of the mining operation in any area that will not be subject to further disturbance. Reclamation activities must be completed within the time set by the regulations adopted by the commission pursuant to NRS 519A.160.

(b) For vegetative cover if appropriate to the future use of the land.

(c) For the reclamation of all land disturbed by the exploration project or mining operation to a stability comparable to that of adjacent areas.

2. The operator may request the division to grant an exception for open pits and rock faces which may not be feasible to reclaim. If an exception is granted, the division shall require the operator to take sufficient measures to ensure public safety.

3. Except in the case of an emergency, an operator shall not depart from an approved plan for reclamation without prior written approval from the division.

4. Reclamation activities must be economically and technologically practicable in achieving a safe and stable condition suitable for the use of the land.

(Added to NRS by 1989, 1285, effective October 1, 1990)

519A.240 Compliance with federal plan sufficient under certain circumstances. [Effective October 1, 1990.] If a mining operation or exploration project is conducted on land administered by a federal agency, an approved federal plan of reclamation and a surety that are consistent with the requirements of this chapter supersede the requirements for a permit and bond or other surety otherwise required by this chapter. If the mining operation or exploration project is conducted on a site which includes both public land and privately owned land, compliance with the federal plan suffices if that plan substantially provides for the reclamation and bond or other surety required by this chapter.

(Added to NRS by 1989, 1286, effective October 1, 1990)

519A.250 Operator to provide department of minerals copy of filing of plan of operation, amended plan or notice of intent required by federal agency; fee; refunds; program for abatement of hazardous conditions; department to file report with governor and legislature.

1. An operator who is required by federal law to file a plan of operation, an amended plan of operation or a notice of intent with the United States Bureau of Land Management or the United States Forest Service for operations relating to mining or exploration on public land administered by a federal agency, shall, not later than 30 days after approval of the plan or amended plan, or within 30 days after filing a notice, provide the department of minerals with a copy of the filing and pay the following fee to the department of minerals:

(a) For a plan of operation or an amended plan of operation filed with the United States Bureau of Land Management or the United States Forest Service, the operator shall pay a fee of $20 for each acre or part of an acre of land to be disturbed by mining included in the plan or incremental acres to be disturbed under an amended plan.

(b) For a notice of intent filed with the United States Bureau of Land Management or the United States Forest Service, the operator shall pay a fee of $20.

2. The department of minerals shall adopt by regulation a method of refunding a portion of the fees required by this section if a plan of operation is amended to reduce the number of acres or part of an acre to be disturbed under the amended plan. The refund must be based on the reduced number of acres or part of an acre to be disturbed.

3. All money received by the department of minerals pursuant to subsection 1 must be accounted for separately and used by the department of minerals to create and administer a program for the abatement of hazardous conditions existing at abandoned mine sites which have been identified and ranked pursuant to the degree of hazard established by regulations adopted by the department of minerals. All interest and income earned on the money in the account, after deducting applicable charges, must be deposited in the fund for the department of minerals.

4. On or before February 1 of each odd-numbered year, the department of minerals shall file a report with the governor and the legislature describing its activities, total revenues and expenditures pursuant to this section.

(Added to NRS by 1989, 1286; A 1989, 2063)

519A.260 Operator to submit report to administrator; contents; fee; distribution of money received by state treasurer. [Effective October 1, 1990.]

1. Each operator shall, on or before April 15 of each year after a permit has been issued to him, submit to the administrator a report for the preceding calendar year relating to the status and production of all mining operations and exploration projects in which he engaged and identifying each acre of

land affected and land reclaimed by that mining operation, and shall pay to the division a fee of:

(a) One dollar and fifty cents for each acre of pubic land administered by a federal agency; and

(b) Five dollars and fifty cents for each acre of privately owned land, which was disturbed by mining operations engaged in by the operator and not reclaimed during the preceding calendar year.

2. All money received by the state treasurer pursuant to paragraph (a) of subsection 1 together with three-elevenths of all money received by the state treasurer pursuant to paragraph (b) of subsection 1, up to a maximum of $100,000 annually, must be distributed directly to the bureau of mines and geology of the State of Nevada to be used to carry out the provisions of NRS 514.060. Any money in excess of the maximum and the balance collected pursuant to paragraph (b) of subsection 1 must be credited to the appropriate account for the division and used to administer the provisions of this chapter.

(Added to NRS by 1989, 1287, effective October 1, 1990)

VIOLATIONS AND PENALTIES

519A.270 Notice of noncompliance; method of service; contents; hearing. [Effective October 1, 1990.] If the division has reason to believe that any provision of NRS 519A.010 to 519A.280, inclusive, a plan for reclamation, any condition placed on a plan for reclamation or any regulation adopted by the commission pursuant to NRS 519A.160, has been violated, the division shall serve a notice of noncompliance upon the holder of the permit. The notice must:

1. Be served personally or by registered mail addressed to the holder of the permit at his address as shown on the records of the division;
2. Specify each violation; and
3. Set a date and time for a hearing and inform the person that his permit may be suspended or revoked and his bond or other surety forfeited upon completion of the hearing or if he fails to attend the hearing.

(Added to NRS by 1989, 1287, effective October 1, 1990)

519A.280 Penalties. [Effective October 1, 1990.]

1. A person who violates any provision of NRS 519A.010 to 519A.280, inclusive, or any regulation adopted by the commission pursuant to NRS 519A.160, is guilty of a misdemeanor and, in addition to any criminal penalty, is subject to a civil penalty imposed by the division at a hearing for which notice has been given, in an amount determined pursuant to the schedule adopted by the commission pursuant to NRS 519A.160.
2. Any money received by the division pursuant to subsection 1 must be deposited in the state general fund.

(Added to NRS by 1989, 1287, effective October 1, 1990)

PROGRAM FOR THE POOLING OF RECLAMATION PERFORMANCE BONDS

519A.290 Department to develop and administer program; requirements for program; attorney general may bring action to recover costs incurred by program.

1. The department of minerals shall develop and administer a program providing for the pooling of reclamation performance bonds to assist operators to meet the bonding and surety requirements of this chapter. The program must:

(a) Be designed to reduce the financial burden of obtaining a reclamation performance bond for small mining operations;

(b) Require each operator who participates in the program to pay an amount into the pool each year which annually is actuarially determined to enable the program to be self-sustaining;

(c) Use the money in the pool to cover the bonded liability of the operators who participate in the program;

(d) Provide a limit on the total bonded liability of any person that may be covered under the program; and

(e) Provide conditions for the release of bonds and bond forfeiture.

2. The department shall adopt regulations relating to the development and administration of the program.

3. In the event that an operator's reclamation performance bond is forfeited, the attorney general may bring an action in the name of the State of Nevada in any court of competent jurisdiction against the operator to recover the costs incurred by the program in the reclamation of the land.

(Added to NRS by 1989, 1287)

NEW MEXICO

State of New Mexico
ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT
Santa Fe, New Mexico 87505

BRUCE KING
GOVERNOR

ANITA LOCKWOOD
CABINET SECRETARY

April 19, 1991

Mr. Jim Souby, Executive Director
Western Governor's Association
600 17th Street
Suite 1705, South Tower
Denver, Colorado 80202-5401

RE: Agreement for Mine Waste Regulatory Program.

Dear Mr. Souby:

Attached is our final report of Task III-6, Inactive and Abandoned Mine Lands Study. The data contained within the report is our best estimate using professional judgement. In many cases, there are no sources of reference available, but by relying upon our staff's experiences, coupled with literature reviews, etc., we feel we have provided you with a reasonable summary of the situation in New Mexico.

If you have any questions, please feel free to contact Rick Koehler at (505) 827-5949. Thank you.

Sincerely,

Richard W. Koehler for

Barry Bailey, Operations Manager
Mining and Minerals Division

xc: Carol Leach, Acting Director MMD
Denise Gallegos, AML Program Manager

VILLAGRA BUILDING - 408 Galisteo
Forestry Resources Conservation Division
P O Box 1948 827-5830
87504-1948
Park and Recreation Division
P O Box 1147 827-7465
87504-1147

2040 South Pacheco
Office of the Secretary
827-5950
Administrative Services
827-5925
Energy Conservation & Management
827-5900
Mining and Minerals
827-5970

LAND OFFICE BUILDING - 310 Old Santa Fe Trail
Oil Conservation Division
P O Box 2088 827-5800
87504-2088

WIEB INACTIVE/ABANDONED MINE DATA SUMMARY
STATE OF NEW MEXICO NARRATIVE SUMMARY

I. INTRODUCTION

Mining in New Mexico has been conducted for perhaps thousands of years, depending upon what is considered "mining". Native Americans used minerals for a variety of purposes (tools, jewelry, and cosmetics), but many have considered this use incidental, rather than a deliberate attempt to extract resources from the earth. There are indications that Native Americans did "mine" both turquoise and lead (for pottery glazes), but the mine sites were later exploited by the Spanish. Further activity in the last two centuries has largely obscured earlier workings.

Mining continues as a major industry in New Mexico, although the cyclical nature of supply and demand has somewhat reduced its' contribution to the State's economic well-being. Copper, potash, gold & silver, molybdenum, and uranium are important commodities, and each has endured boom and bust episodes.

II. MINING & MILLING METHODS

Both surface and underground mining techniques have been used in New Mexico. Open pit operations have been used to extract most types of commodities: copper, molybdenum, gold, uranium, and gypsum mining have left their impression upon the State. A compilation of minerals derived from underground mining would be too lengthy, but a partial list includes arsenic, beryllium, copper, rare earths, fluorspar, gold, halite, iron, lead, manganese, nickel, potash, radium, silver, tungsten, uranium, vanadium, and zinc.

A combination of surface and underground techniques has also been used when necessary. Placer deposits have been worked for various precious and semi-precious stones, and gold. Numerous sand, gravel, and aggregate operations are conducted within the state also.

The technology used in processing the ores has advanced from crude crushing/melting through stamp mills/amalgamation/smelting to jaw and cyclone crushers/floatation/leaching. Some older uranium mines have been switched from underground room and pillar mining to <u>in situ</u> leaching.

III. HEALTH AND SAFETY IMPACTS

Health and safety hazards caused by noncoal mining through the years include the following:

- Dangerous openings at shafts, adits, or trenches
- Highwalls at stripping operations
- Steep cliff faces at open pit benches
- Inundated excavations

- Hazardous materials used in mining such as explosives
- Hazardous materials illegally dumped by others
- Poisonous gases or lack of oxygen within workings
- Dilapidated buildings and structures in danger of collapse
- Cave-ins or falling slabs in underground workings
- Subsidence caused by collapse of mined-out voids

Although some mines are located in remote areas, many mines have a high degree of public access. Population growth in old mining districts, and recreational use (hunting, fishing, hiking, rock collecting, and off-road vehicle riding) of lands adjacent to abandoned or inactive mines, increase the public's exposure to mining-related hazards.

IV. ENVIRONMENTAL IMPACTS

The environmental impacts of mining in New Mexico encompass practically every kind of degradation. Air pollution may be traced to fugitive dust at surface mines, particulate emissions from processing facilities, and chemical contaminants. Uranium mill tailings may become wind-borne, spreading radioactive particles over wide areas.

Water pollution occurs as degradation of surface waters and groundwater. Water quality in streams and lakes is affected by runoff from mines, and the affects range from increased sediment load from unvegetated disturbed areas, to high heavy metals concentrations derived from waste piles.

Groundwater pollution can occur when precipitation infiltrates the soil and percolates down into permeable layers of soil and rock. The water chemistry can be radically changed from the natural system, as the infiltrating water may pick up undesirable chemical characteristics. Waste or spoil piles may affect groundwater in this way, and flooded mine workings also add pollutants.

V. LAWS AND REGULATIONS

There is no legislation in New Mexico comparable to the Surface Mining Control and Reclamation Act of 1977 (SMCRA) which regulates surface coal mining and remediates abandoned coal mines. Mining today is regulated by clean air and clean water legislation (both State and Federal), but even these measures are relatively recent developments. With the exception of a few mines reclaimed using Title IV of SMCRA, there has been no mechanism available to address the hazards posed by the thousands of abandoned/ inactive mines in New Mexico.

The New Mexico Mine Registration, Reporting and Safeguarding Regulations (Rule EMNRD MMD 89-1) do require the safeguarding of mine surface openings when operations are suspended and no one is present at the site to prevent access by unauthorized persons. This Rule primarily targets current and future operators; its' retroactive applicability towards abandoned mines has not been tested and is uncertain.

NON-COAL INVENTORY
INACTIVE/ABANDONED MINES[1]

State of NEW MEXICO

Agency Contact: RICK KOEHLER

Telephone (505) 827-5949

DATA SUMMARY[2,3]

MINERAL TYPE (name)	MINING TYPE (number)		OWNERSHIP (acres)		FEATURES	(units)	(cost)
Metallic Ores	Mines	3524	Federal	13350	Polluted Water	(miles) 43.5	48500000
	Millsites	102	Private	5247	Mine Dumps	(acres) 2635	39525000
	Smelters	7	State	460	Disturbed Land	(acres) 4708	47401200
	Other	0	Other	969	Highwalls	(miles) 9.8	4900000
					Mine Openings	(number) 12123	25458300
					Subsidence Prone	(acres) 1344	6800800
					Hazardous Structures	(number) 576	1008000
					Other	(units) 0	0
Construction Ores	Mines	2628	Federal	6100	Polluted Water	(miles) 2	2000000
	Millsites	6	Private	9200	Mine Dumps	(acres) 2700	26730000
	Smelters	0	State	3300	Disturbed Land	(acres) 15370	46110000
	Other	0	Other	4100	Highwalls	(miles) 14	7000000
					Mine Openings	(number) 0	0
					Subsidence Prone	(acres) 0	0
					Hazardous Structures	(number) 9	15750
					Other	(units) 0	0
Industrial Ores	Mines	652	Federal	12200	Polluted Water	(miles) NA	NA
	Millsites	17	Private	2150	Mine Dumps	(acres) 600	5400000
	Smelters	0	State	900	Disturbed Land	(acres) 3260	16300000
	Other	0	Other	2050	Highwalls	(miles) 6.5	3250000
					Mine Openings	(number) 998	2095800
					Subsidence Prone	(acres) 80	368000
					Hazardous Structures	(number) 37	129500
					Other	(units) 0	0

DATA SUMMARY[4,3] - Page 2

MINERAL TYPE (acres)[1]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES			(cost)
Phosphate Rock	Mines	2	Federal	20	Polluted Waters[2]	(miles)	0	(cost)[6] 0
	Millsites	0	Private	0	Mine Dumps[2]	(acres)	0	0
	Smelters	0	State	0	Disturbed Land[2]	(acres)	2	7000
	Other	0	Other	0	Highwalls	(miles)	0	0
					Mine Openings[2]	(number)	[illegible]	10500
					Subsidence Areas[2]	(acres)	0	
					Hazardous Structures[2]	(number)	0	
					Other[2]	(units)	0	
Uranium Overburden	Mines	416	Federal	7500	Polluted Water	(miles)	18.5	18500000
	Millsites	7	Private	17000	Mine Dumps	(acres)	400	8000000
	Smelters	0	State	4100	Disturbed Land	(acres)	1900	17100000
	Other	0	Other	7000	Highwalls	(miles)	2.8	1400000
					Mine Openings	(number)	540	1350000
					Subsidence Areas	(acres)	20	2500000
					Hazardous Structures	(number)	36	63000
					Other	(units)	0	0
Oil Shale	Mines	0	Federal	0	Polluted Water	(miles)	0	0
	Millsites	0	Private	0	Mine Dumps	(acres)	0	0
	Smelters	0	State	0	Disturbed Land	(acres)	0	0
	Other	0	Other	0	Highwalls	(miles)	0	0
					Mine Openings	(number)	0	0
					Subsidence Areas	(acres)	0	0
					Hazardous Structures	(number)	0	0
					Other	(units)	0	0
Other (acres)[7]	Mines	0	Federal	0	Polluted Water	(miles)	0	0
	Millsites	0	Private	0	Mine Dumps	(acres)	0	0
	Smelters	0	State	0	Disturbed Land	(acres)	0	0
	Other	0	Other	0	Highwalls	(miles)	0	0
					Mine Openings	(number)	0	0
					Subsidence Areas	(acres)	0	0
					Hazardous Structures	(number)	0	0
					Other	(units)	0	0
TOTAL	Mines	7222	Federal	39670	Polluted Water	(miles)	69	69000000
	Millsites	132	Private	33597	Mine Dumps	(acres)	6335	79655000
	Smelters	7	State	8760	Disturbed Land	(acres)	25320	126918200
	Other	0	Other	14119	Highwalls	(miles)	33.1	16550000
					Mine Openings	(number)	13666	28914600
					Subsidence Areas	(acres)	1444	9668000
					Hazardous Structures	(number)	658	1216250
					Other	(units)	0	0

NOTES ON DATA SUMMARY REPORT

Mining Type

Mining Type figures are taken largely from available MILS data for all categories, and have been derived using professional judgement. Confidence level for these figures is approximately 75%.

Ownership

Ownership acreage is estimated from MILS data, geologic reports, topographic maps, BLM land status maps, and other sources. The confidence level is 55% for these figures.

Features

The figures for the various features tabulated are NM AML's best estimate using available data and professional judgement. The figures vary rather widely between different Mineral Type categories, with Metallic Ores having the highest level of confidence, and Construction Ores the lowest. The averaged confidence levels for the values listed under each specific feature are as follows:

a). Polluted Water..50%
b). Mine Dumps..55%
c). Disturbed Land..60%
d). Highwalls...50%
e). Mine Openings...80%
f). Subsidence Prone......................................65%
g). Hazardous Structures..................................55%

Cost Estimates

Cost estimates are extrapolated from New Mexico AML projects involving similar types of reclamation operations, supplemented by information from the BLM, construction industry groups, and assorted state and federal agencies. Confidence levels on a per feature basis are as follows:

a). Polluted Water, very general......................50%
b). Mine Dumps, varies by mineral type.................65%
c). Disturbed land......................................70%
d). Highwalls, based on a few projects.................45%
e). Mine Openings, several projects....................85%
f). Subsidence Prone, some experience..................65%
g). Hazardous Structures, based on a few projects......55%

DEFINITIONS USED IN DATA SUMMARY REPORT

Inactive or Abandoned Mines

The U.S. Bureau of Mines' Mineral Industry Location System (MILS) database was the primary source of information for this draft Data Summary Report. This database contains specifiers for current status such as producer, past producer, developed deposit, explored prospect, raw prospect, and unknown.

Sites designated as producers were considered as "active" mines, while every other current status designation was counted as falling into the categories of "inactive" or "abandoned" mines. All the listings were cross-referenced with a New Mexico Mining & Minerals Division database on active mines within the state. This information was developed to aid in tracking mine registrations, a responsibility of the Mineral Industries Services Bureau of MMD. The two print-outs provided by Michael Sawyer of USBM used "past producer" as the key field in sorting, but our experience has been that with the exception of past producers re-entering the market, sites not designated as producers in the MILS data are either inactive or abandoned.

Mines in standby mode or temporary shutdown were considered active, although in some cases such terminology seems to be wishful thinking on the operator's part. Permitted mines under reclamation were also considered active.

Acreage Estimates

Acreage figures are given in the Ownership column, while the Mineral Type column gives site counts. The acreage figures are estimates of the total property controlled by the owner. For instance, consider the "Junebug" patented fluorspar claim (20 acres) containing 2 shafts and an adit, a small amount of spoil around the shaft collars, and two USBM trenches each 25' wide by 900' long. One site would be added to the Industrial Ores category, 20 acres under "private" ownership, 3 mine openings, and 0.5 acres of disturbed land.

"Other" Ownership

Any lands designated as Indian Reservation, Municipal, County, or Unknown were placed in this category.

Polluted Water

Data for "Polluted Waters" was derived from the State of New Mexico's Nonpoint Source Pollution Water Quality Assessment of February 3, 1989. The effects of disturbed lands on surface hydrology, (ie. sediment load in streams) is largely unaccounted for in this assessment, particularly relating to sand & gravel operations and the like.

Another question arises concerning groundwater contamination by various mining activities. It is difficult to see how one could characterize groundwater aquifer degradation and pollution using "miles of polluted water".

Mine Dumps

Piles of material derived from processing, sorting, or beneficiation of some type were considered "mine dumps", while small spoil piles around a collar were not. Large waste dumps derived from extensive workings such as deep shafts were factored in as mine dumps.

Disturbed Land

Disturbed land totals do not include mine dump acreage, but do include shafts, adits, trenches, roads, and any other modification of the original ground surface.

Highwalls

Vertical or near-vertical slopes derived from strip mining, open pits, and excavated hillsides are considered highwalls.

Mine Openings

The features considered as mine openings are as follows:

a) Shafts over 4' to 10' deep with vertical sides, or any feature greater than 10' deep with at least one sheer wall;

b) Adits longer than 10' or those shorter ones with bad ground;

c) Trenches with sheer walls over 6' tall;

d) Deep pits, subsidence openings, and stopes or glory holes that have intercepted the surface.

The basic concept is the same one NM AML follows when performing reconnaissance on potential projects. If a feature is dangerous enough to possibly cause injury from a fall, it is slated for remediation. Shallow prospect pits or trenches are defined as surface disturbance acreage only.

Subsidence Prone Areas

If a site has underground workings close to the surface, it is considered to be subsidence prone. Acreage values are calculated from the extent of workings. The cutoff is a field judgement based on height and extent of void space, and depth to the shallowest workings. Stoped out drifts in incompetent rock within 50' of the surface are prime candidates.

Hazardous Structures

Hazardous Structures are loadouts, headframes, conveyors, and any mine-associated buildings in a state of disrepair.

OREGON

Oregon

DEPARTMENT
OF GEOLOGY
AND MINERAL
INDUSTRIES

Mined Land Reclamation

February 14, 1991

Richard Juntunen
WIEB

FAX: 406 443-3005

Dear Dick,

Thank you for the opportunity to comment on AM Lands in Oregon.

Oregon has no existing Abandoned Mine Land Reclamation Program. One abandoned coal mine was reclaimed by OSM on the coast near Coos Bay in the mid-1980s.

No ground truthed AML inventory exists for previously mined lands. Oregon has experienced some coal mining, but Oregon is not a primacy state under SMCRA.

Non-coal abandoned mines exist over a considerable portion of the state, although numbers of sites would be considerably lower than numbers in states such as Montana, Colorado, or Idaho, which had substantially more historic lode mining.

Abandoned site areas are identifiable on a rather imprecise scale by using geologic maps which identify significant mineral deposits.

Some coal sites exist along the southern coast. Metal sites exist in six areas along the Cascades with the largest number of sites likely being in the southwest corner in Josephine County.

Baker County has had significant historic mining and as a result, a concentration of abandoned sites.

The remainder of sites are scattered throughout the state, particularly in the following mountain ranges:

Blue
Ochoco
Strawberry
Wallowa

GWL:dm:juntunen

1534 Queen Avenue SE
Albany, OR 97321
(503) 967-2039

While the numbers of sites have not been quantified, the types of impacts associated with these sites are predictable. Open shafts and pits, acid mine drainage, placer tailings, and highwalls are among the unreclaimed impacts associated with this historic mining.

In addition, a significant number of abandoned aggregate sites exist across the state. Typically, these sites do not pose a threat to public health or safety or pose an imminent threat to the environment. Impacts such as erosion and weed encroachment are more typical of the aggregate sites, although highwalls do exist at some sites.

Finally, two abandoned uranium mines exist in Lake County. The sites have water filled pits discharging acid water, low-grade radioactive dumps, and adits. The USFS has initiated a review of these sites to determine what can be done to reclaim the sites which are considered the most serious sites in the state.

Oregon recognizes abandoned mine sites as a problem. However, unlike those states that have received assistance for inventories, etc., under the federal Coal Program, little has been done to date regarding this issue. We look forward to working with the WGA and its contractors in attempting to resolve this issue.

Sincerely,

Gary W. Lynch
Supervisor
Mined Land Reclamation

GWL:dm:juntunen

Narrative Summary Review

Introduction

It is estimated that Oregon has 3,500 abandoned mine sites. Oregon has no existing abandoned mined land program and is not a coal-producing state. The abandoned sites include metallics, construction and industrial ores, uranium, and some gem sites. No ground truthed inventory exists for Oregon. The estimation is explained later in this document.

Mining and Milling Techniques

Mining techniques have included open pit and underground methods. Milling techniques were those typically associated with historic lode mining, including gravity separation, vat leaching, etc.

Health and Safety Impacts

Health and safety impacts are considered to be:

1. Highwalls
2. Open holes
3. Landslides

Environmental Impacts

Environmental impacts are considered to be:

1. Acid mine drainage
2. Weed infestation
3. Erosion
4. Dust
5. Improper disposal of waste

Laws and Regulations

None exist for abandoned mined lands.

Reclamation Efforts

* One abandoned coal site was reclaimed by OSM.

* Two uranium sites are currently being reviewed by USFS and state agencies.

Non-Coal Inventory
Inactive/Abandoned Mines[1]
Data Summary[2,3]

State of Oregon

Agency Contact: Gary Lynch
Telephone: (503) 967-2039

Mineral Type[4]

Metallic Ores

Ownership	Features	Units	Cost
Federal	Polluted Water[6]	2-20 miles	$2-20 million
Private	Mine Dumps	180 acres	$5.6 million
State	Disturbed Land[7]	3,000 acres	$9 million
Other[5]	Mine Openings[9]	3,750	$9.3 million
	Hazardous Structures[10]	75	$225,000

Construction Ores

Ownership	Features	Units	Cost
Federal	Disturbed Land	6,200 acres	$18.6 million
Private	Highwalls[8]	93 miles	$9.3 million
State	Hazardous Structures	620	$2.4 million
Other			

Uranium
Overburden 10 Mines, 50 Millsites, 200 Waste Dumps

Federal
Private

The summary data is based on the following:

The state GIS indicates 1/10 of 1 percent of the land area has been disturbed by mining, or 61,000 acres. It is then estimated that 31,000 of those acres have been disturbed as a result of construction ores and 30,000 for metallic ores. Impact as used here simply means there has been an occurrence, prospect or mine identified. We then assumed 20 percent of the construction ore sites and 10 percent of the metallic ore sites were abandoned and in need of reclamation. The lower figure for the metallic ore sites reflect the abundance of low-impact prospecting.

Reference Guide Review

Information Sources Footnoted on Data Summary Reference Guide

State GIS, state employees, USBM, federal employees.

Major Sources Listed

State GIS
Allen Throop - Oregon Department of Geology, Reclamationist
USBM - Mines Minerals Availability System
Felix Mira - USFS, Fremont National Forest
Gary Lynch - Oregon Department of Geology, Supervisor

Footnotes to Data Summary Table

1. State definition of inactive/abandoned mines.
   No official definition. For this analysis, non-permitted activities

2. Data sources footnoted.
   State employee, GIS data base, Bureau of Mines, and questionnaires.

3. Quality of data described and basis for the estimate.
   We are relatively confident in the number of sites; however, eligibility estimate of 20 percent is based on professional experience, but not ground truthed.

4. Acres defined for each mineral type.

   Construction Ores

   a. Based on GIS, state employee, USBM, and questionnaires, approximately 31,000 acres have an occurrence, prospect, or mine.

   b. Of the 31,000 acres, 20 percent (6,2000 acres) of that acreage was assumed to have existed pre-law, considered abandoned, and, therefore, eligible or in need of reclamation.

   c. Categories of disturbance were:

      Highwalls - 30 percent of acreage
      Disturbed land - 60 percent of acreage
      Structures - 10 percent of acreage

   Metallic Ores

   a. Using the same analysis in (a.) above, it was estimated 30,000 acres have an occurrence, prospect, or mine.

   b. Of the 30,000 acres, 10 percent (3,000 acres) were assumed to have existed pre-reclamation law and were considered abandoned and eligible for reclamation.

   c. The number of mine openings was established by assuming 25 percent of the eligible acreage had underground lode mining and openings would occur at a rate of five per acre.

5. Describe any other ownership.
   Tribal land and local government jurisdictions exist and are expected to have such sites, but this has not been verified.

6. Provide definition of polluted water.
   Defined in state ground water and surface water standards.

7. <u>Provide definition of disturbed land.</u>
For these purposes, see No. 4.

8. <u>Provide definition of hazardous highwalls.</u>
That which would have potential to cause a threat to public health or safety and existed as a result of ore extraction.

9. <u>Provide definition of hazardous mine openings.</u>
An opening resulting form prospecting, exploration, or mining that would pose a threat to public health or safety.

10. <u>Provide definition of hazardous structures.</u>
Mine facility structure that would pose a threat to public health or safety.

Projected Reclamation Costs

Construction Ores

20 percent eligibility

Percent Occurrence	Category	Unit Cost	Total Million
30	Highwall	$100,000/mile	9.3
60	Disturbed land	$3,000/acre	18.6
10	Structures	$4,000/structure	2.4

Metallic Ores

Mine opening = 30,000 x 10 percent eligibility x 25 percent associated with lode mining. Rate of occurrence estimated at five openings per acre = 3,750.

$2,500 per opening actual western state closure costs

Disturbed land = 3,000 acres x $3,000 per acre = 9 million

Open holes	3,750 @ $2,500 per hole
Polluted waters	2-20 miles @ $1M per mile
Mine dumps	180 @ $30,000 per dump
Disturbed land	@ $3,000 per acre
Hazardous structures	75 @ $4,000 per occurrence

SOUTH CAROLINA

INACTIVE/ABANDONED

MINE DATA SUMMARY

FOR

SOUTH CAROLINA

SOUTH CAROLINA LAND RESOURCES COMMISSION

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

APRIL 1991

WIEB INACTIVE/ABANDONED MINE DATA SUMMARY FOR SOUTH CAROLINA NARRATIVE SUMMARY

INTRODUCTION

South Carolina's mining industry dates back to the pre-Revolutionary War period. Colonial settlers discovered iron ore and other necessary minerals in the northern Piedmont and began developing numerous small iron foundries that supplied South Carolina with metallic iron. In 1802, gold was discovered in South Carolina. With this discovery, several significant gold mines were opened along with numerous prospects throughout the Piedmont section of South Carolina. Gold mining in South Carolina has been an intermittent business since these initial discoveries.

South Carolina has produced a variety of non-coal mineral commodities throughout its' history. Production of metallic minerals include gold, silver, nickel, cobalt, copper, tin, lead, manganese, iron and titanium. Industrial minerals include kaolinite, silica, barite, mica, feldspar, corundum, talc, phosphate, vermiculite, peat, asbestos, monazite and fullers' earth. Construction mineral commodities include sand, gravel, clays, granite and limestone.

MINING METHODS

Gold mining methods from 1829 through 1942 generally saw a range of technology used to mine and mill the gold ore. Mining gold ore was accomplished through open pit, placer mining and underground mining. Milling of the ore was accomplished by crushing the ore with arrastre, Chilean mill or stamp mill. Gold recovery from the ore was accomplished by gravity and/or amalgamation with mercury or chlorination in the 1800's. The cyanidation process replaced chlorination in the early 1900's because of greater efficiency.

Gold mining reappeared in South Carolina in 1986 after a 34 year absence. This absence of active commercial gold mining resulted from the World War II shutdown of all non-essential mining operations. The present active gold mines have received environmental permits and are subject to state reclamation laws.

Phosphate deposits and inactive phosphate mines are confined to the lower Coastal Plain of South Carolina. Specifically, these mines are located in the region between Charleston and Beaufort. The phosphate mining industry developed in 1869 and continued until 1939. The phosphate industry in South Carolina peaked in 1889 and gradually declined as more extensive and more easily accessible phosphate deposits in Florida and Tennessee were developed.

Phosphate deposits were mined by two primary methods: dredging river deposits of rock and surface mining of land deposits.

Initially, land deposits were mined by hand. Gradually steam shovels replaced hand digging and allowed companies to dig deeper for thinner, less pure deposits. River deposits were mined by floating dredges in the coastal rivers around Charleston and Beaufort.

Industrial and construction mineral commodities in South Carolina have been mined by open pit surface mines. The majority of these abandoned mines were for construction minerals, with sand and gravel mines accounting for the majority of the disturbed acreage. Minerals used for construction purposes require only a minimum amount of processing and waste dumps have been generally benign to the environment.

HEALTH AND SAFETY

Abandoned mines in South Carolina can present hazards to the general public. Abandoned mines are generally located in rural areas of the state, but a significant number of sites are located near higher population centers. Highwalls and hazardous mine openings associated with rock quarries and gold mines are generally located in rural areas and present danger to only a relative small number of people. Sand, gravel and clay mines may be located closer to populated areas and may represent a threat to a larger number of people. While such dangers are hard to quantify, it is known that several children have died from suffocation while digging tunnels in clay banks and by drowning in abandoned mine site ponds.

Mined phosphate areas in Charleston County may present health hazards due to the minor amounts of uranium bearing minerals associated with the phosphate deposits. Approximately one-fifth of the previously mined areas have been restored to commercial and residential property.

ENVIRONMENTAL IMPACTS

Water Resources

Impacts to water resources from abandoned mined sites throughout South Carolina have been varied. On many of the sites, volunteer vegetation has been established. This vegetation has lessened sedimentation impacts to nearby water resources on a majority of the sites. There are a few abandoned mine waste dumps that are located on active mine sites. The waste dumps, however, are not part to the active mining operations and are exempt from present reclamation laws. These sites can be a source of sediment and dissolved metals to neighboring streams.

Drainage from abandoned metallic mine sites have the potential to produce acid mine drainage into nearby rivers and streams. This is believed to be minimal, however, because most of the mines only exposed oxidized ore which has a lower potential for acid water generation. Additionally, established vegetation on waste dumps and mine openings reduces the potential of acid water generation.

Phosphate mining in South Carolina involved the dredging of several coastal rivers around Charleston and Beaufort. It appears, approximately 6300 acres of river beds extending over 70 to 80 river miles were dredged to recover phosphate rock. There appears to have been no residual environmental damage to these rivers. However, to our knowledge, an assessment of long term effects has not been done.

Abandoned construction mineral mines represent the greatest amount of unreclaimed land. Natural vegetation has established itself and/or drainage from the sites are closed to the natural drainage systems outside the disturbed areas on many of these abandoned mines sites. These conditions tend to minimize adverse impacts on nearby surface water resources.

Air Quality

Abandoned phosphate mines can be a source of radon due to radioactive decay of uranium. Emissions of radon gas from these sites could present adverse effects on human health in improperly ventilated buildings.

In general, other abandoned mine sites have little impact on air quality. As mentioned previously, the high rainfall and extensive vegetation stabilizes the soil and lessens problems with fugitive dust. There are instances, however, where fugitive dust from exposed soils has degraded air quality in close proximity to the abandoned mine site.

STATE LAWS AND REGULATIONS

The S.C. Mining Act defines mining as "(a) the breaking of the surface soil to facilitate or accomplish the extraction or removal of ores or mineral solids for sale or processing or consumption in the regular operation of a business; (b) removal of overburden lying above natural deposits of ore or mineral solids and removal of the mineral deposits exposed, or by removal of ores or mineral solids from deposits lying exposed in their natural state". Land disturbed by mining operations before July 1, 1974 and which has not been disturbed by mining related activities since July 1, 1974 is not regulated by the S.C. Mining Act and is classified as an abandoned mine. Mitigation of hazards and pollution from abandoned mine sites cannot be mandated under the S.C. Mining Act. There are, however, incentives for mining companies to reclaim abandoned mine sites to abate adverse environmental problems as stated in the S.C. Mining Act and in accordance with policies of the S.C. Land Resources Commission.

South Carolina law defines environmental pollution and has regulations which mandate that water and air quality standards be maintained with development of industry and natural resources. The S.C. Pollution Control Act and implementing regulations is administered by the S.C. Department of Health and Environmental Control which coordinates with the S.C. Land Resources Commission in regulating the mining industry.

RECLAMATION EFFORTS

South Carolina does not have an active program to reclaim abandoned mine sites. As mentioned, there is an incentive within the present mine reclamation law to encourage mining companies to reclaim these sites.

Due to climate in the Southeastern United States, vegetation, in most instances, readily establishes itself on barren soil. Many of these old abandoned mine sites (age greater than 50 years) do have varying amounts of volunteer vegetation. The topography of these sites, however, can be rough and in some cases, may require extensive grading to be utilized for purposes other than wildlife habitat. In the case of some abandoned phosphate mine and sand and gravel sites, the hydrology and vegetation is such that significant portions of these sites have been declared jurisdictional wetlands.

DATA SUMMARY TABLE
NON-COAL INVENTORY
INACTIVE/ABANDONED MINES[1]

State of South Carolin

Agency Contact: Craig Kennedy

Telephone (803) 734-9100

DATA SUMMARY[2,3]								
MINERAL TYPE (acres)[4]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)		(cost)
Metallic Ores	Mines	403	Federal		Polluted Water[8]	(miles)	5	(cost)[7]
	Millsites	20	Private	423	Mine Dumps[9]	(acres)	20	10,000
	Smelters	0	State		Disturbed Land[10]	(acres)	403	202,000
	Other[5]	0	Other[5]		Highwalls[11]	(miles)	1	5,000
					Mine Openings[12]	(number)	110	75,000
					Subsidence Prone[13]	(acres)	40	16,000
					Hazardous Structures[14]	(number)	0	-
					Other[15]	(units)	0	-
Construction Ores	Mines	13,246	Federal		Polluted Water	(miles)	10	-
	Millsites	0	Private	13,246	Mine Dumps	(acres)	500	250,000
	Smelters	0	State		Disturbed Land	(acres)	13,246	6,623,000
	Other	0	Other		Highwalls	(miles)	200	808,000
					Mine Openings	(number)	0	-
					Subsidence Prone	(acres)	0	-
					Hazardous Structures	(number)	0	-
					Other	(units)	0	-
Industrial Ores	Mines	917	Federal		Polluted Water	(miles)	10	-
	Millsites	0	Private	917	Mine Dumps	(acres)	0	-
	Smelters	0	State		Disturbed Land	(acres)	917	459,000
	Other	0	Other		Highwalls	(miles)	10	42,000
					Mine Openings	(number)	0	-
					Subsidence Prone	(acres)	0	-
					Hazardous Structures	(number)	0	-
					Other	(units)	0	-

DATA SUMMARY[2,3] - Page 2

MINERAL TYPE (acres)[1]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)		(cost)
Phosphate Rock	Mines	4611	Federal		Polluted Water	(miles)		(cost) -
	Millsites	0	Private	4611	Mine Dumps	(acres)		-
	Smelters	0	State		Disturbed Land	(acres)	4611	2,306,000
	Other	0	Other		Highwalls	(miles)	0	-
					Mine Openings	(number)	0	-
					Subsidence Prone	(acres)	0	-
					Hazardous Structures	(number)	0	-
					Other	(units)	0	-
Uranium Overburden	Mines	0	Federal		Polluted Water	(miles)		
	Millsites	0	Private		Mine Dumps	(acres)		
	Smelters	0	State		Disturbed Land	(acres)		
	Other	0	Other		Highwalls	(miles)		
					Mine Openings	(number)		
					Subsidence Prone	(acres)		
					Hazardous Structures	(number)		
					Other	(units)		
Oil Shale	Mines	0	Federal		Polluted Water	(miles)		
	Millsites	0	Private		Mine Dumps	(acres)		
	Smelters	0	State		Disturbed Land	(acres)		
	Other	0	Other		Highwalls	(miles)		
					Mine Openings	(number)		
					Subsidence Prone	(acres)		
					Hazardous Structures	(number)		
					Other	(units)		
Other (acres)[7]	Mines	0	Federal		Polluted Water	(miles)		
	Millsites	0	Private		Mine Dumps	(acres)		
	Smelters	0	State		Disturbed Land	(acres)		
	Other	0	Other		Highwalls	(miles)		
					Mine Openings	(number)		
					Subsidence Prone	(acres)		
					Hazardous Structures	(number)		
					Other	(units)		
TOTAL	Mines	19,177	Federal		Polluted Water	(miles)	25	-
	Millsites	20	Private	19,177	Mine Dumps	(acres)	520	260,000
	Smelters		State		Disturbed Land	(acres)	19,177	9,590,000
	Other		Other		Highwalls	(miles)	211	855,000
					Mine Openings	(number)	110	75,000
					Subsidence Prone	(acres)	40	16,000
					Hazardous Structures	(number)	0	
					Other	(units)	0	

FOOTNOTES TO DATA SUMMARY TABLE

1) Inactive/abandoned Mine

Land that was mined or a portion of a presently active mine that was mine prior to July 1, 1974 (effective date of the South Carolina Mining Act) and subsequently has not undergone additional mining or reclamation since July 1, 1974.

2) Data sources footnoted

Data sources are given in the Reference Guide Table and Reference Guide Summary.

3) Estimate on data quality

Data quality estimates are given in Reference Guide Summary.

4) Mineral types

The acreage estimates attempted to include the presently disturbed area from past mining activity.

5) Mining type "other"

Not applicable

6) Ownership

Ownership in the vast majority of the cases is private. Some abandoned mines are probably located on land owned by the federal or state government. These cases, however, are somewhat limited for South Carolina and time necessary to provide more accurate ownership data was prohibitive.

7) Mineral type "other"

Not applicable

8) Polluted water

For this survey, polluted water means water that has been adversely affected by contaminates (sediment, dissolved solids, etc.) from abandoned mine site. Polluted waters from abandoned mine lands are judged to be minimal in South Carolina.

9) Mine dumps

Mine dumps would includ waste rock, ore dumps, tailings, overburden or spoil piles.

10) Disturbed Land

Land that has been subject to the practices of mining and/or beneficiation and left in an unusable or non-productive state and/or is a source of pollution to the environment. Some abandoned mine lands are considered jurisdictional wetlands.

11) Hazardous Highwalls

Hazardous highwalls are considered to be unprotected vertical highwalls with a relief of 10 feet or greater.

12) Hazardous Mine Opening

An opening to an underground mine. The opening may be to a shaft, slope or adit that is not protected from unauthorized or accidental entry from the public.

13) Subsidence Prone Areas

Area around underground mines with a shallow cover where a chance of subsidence is great.

14) Hazardous Structures

Not applicable

15) "Other" Features

Not applicable

16) Cost factors

The reclamation cost estimates are based upon restoring the abandoned mine lands consistent with the present statutes, regulations and minimum standards for reclamation. Cost estimates in the DATA SUMMARY TABLE are rounded to the nearest thousand.

Polluted waters -- A cost estimate was not performed to determine cleanup cost for polluted water from abandoned mine land sites. The quantity of polluted waters resulting from abandoned mine lands are estimated to be relatively low. For this estimate, it was decided that any polluted waters would significantly clear after the source of the pollution was abated through reclamation of the abandoned mine site(s).

Mine Dumps -- The cost estimated assumed minimal grading to achieve 3:1 slope and revegetation. Estimated cost per acre is $500. This estimate is low compared to present reclamation cost. It should be noted, however, that in the humid climate of the Southeastern United States, revegetation has been naturally established and in many areas may be suitable as wildlife habitat. All of the abandoned metallic mine dumps are over 50 years old. Mine dumps that are presently vegetated, stable and not a source of pollution would possibly be left in their current state rather than re-disturbing for reclamation to present minimum standards.

Disturbed Land -- The cost of reclamation estimated to be $500 per acre. The low cost would reflect the large acreage that could be reclaimed as fresh water lakes and ponds; thus, lowering the unit cost per acre for reclamation. The reclamation of abandoned phosphate mines would include backfilling and grading. These practices would place "fill" into areas currently considered jurisdictional wetlands; thereby, possibly restricting reclamation of some areas.

Highwalls -- It was estimated that approximately 25% of the existing highwalls would be hardrock and could only be fenced. Fencing cost were estimated to be $1.00 per foot. The remaining 75% of the highwalls are assumed to be in unconsolidated materials (sand, clays etc.) and could be reclaimed by grading to 3:1 slope and revegetated. Average height of unconsolidated highwall was assumed to be 30 feet and when graded would equal approximately 7.25 acres per mile. Estimated cost per acre is $500.

Mine Openings -- Cost estimate assumes that shafts located near populated areas would be backfilled with unconsolidated material and loose rock to lessen the potential of accidental falls. The other mine openings, approximately 80%, are located in relative less populated areas and may necessitate only fencing. Fencing cost are estimate to be $1.00 per foot. The adits would be filled with a concrete plug to prevent persons from entering.

Subsidence Prone -- Fencing to restrict access around a subsidence prone area would be appropriate. Fencing cost approximately $1.00 per foot.

REFERENCE GUIDE TABLE

NON-COAL INVENTORY
INACTIVE/ABANDONED MINES[1]

State of South Carolina

Agency Contact Craig Kennedy

Telephone (803) 734-9100

Reference Guide								
MINERAL TYPE (acres)[2]	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)		(cost)
Metallic Ores	Mines	2	Federal		Polluted Water[8]	(miles)	2	(cost)[4]
	Millsites	2	Private		Mine Dumps[9]	(acres)	2	
	Smelters	2	State		Disturbed Land[10]	(acres)	2	
	Other[3]	2	Other[4]		Highwalls[11]	(miles)	2	
					Mine Openings[12]	(number)	2	
					Subsidence Prone[13]	(acres)	2	
					Hazardous Structures[14]	(number)	2	
					Other[15]	(units)	2	
Construction Ores	Mines	1	Federal		Polluted Water	(miles)	1	
	Millsites	1	Private		Mine Dumps	(acres)	1	
	Smelters	1	State		Disturbed Land	(acres)	1	
	Other	1	Other		Highwalls	(miles)	1	
					Mine Openings	(number)	1	
					Subsidence Prone	(acres)	1	
					Hazardous Structures	(number)	1	
					Other	(units)	1	
Industrial Ores	Mines	1	Federal		Polluted Water	(miles)	1	
	Millsites	1	Private		Mine Dumps	(acres)	1	
	Smelters	1	State		Disturbed Land	(acres)	1	
	Other	1	Other		Highwalls	(miles)	1	
					Mine Openings	(number)	1	
					Subsidence Prone	(acres)	1	
					Hazardous Structures	(number)	1	
					Other	(units)	1	

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MINERAL TYPE (acres)	MINING TYPE (acres)		OWNERSHIP (acres)		FEATURES	(units)	(cost)
Phosphate Rock	Mines	3	Federal		Polluted Water	(miles)	(cost)
	Millsites	3	Private		Mine Dumps	(acres)	
	Smelters	3	State		Disturbed Land	(acres)	
	Other	3	Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Uranium Overburden	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Oil Shale	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
Other (acres)[7]	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	
TOTAL	Mines		Federal		Polluted Water	(miles)	
	Millsites		Private		Mine Dumps	(acres)	
	Smelters		State		Disturbed Land	(acres)	
	Other		Other		Highwalls	(miles)	
					Mine Openings	(number)	
					Subsidence Prone	(acres)	
					Hazardous Structures	(number)	
					Other	(units)	

WIEB INACTIVE/ABANDONED MINE DATA SUMMARY REFERENCE GUIDE FOR SOUTH CAROLINA

1. South Carolina Land Resources Commission Abandoned Mine Inventory 1978

   An abandoned mine land inventory for South Carolina was completed by the SC Land Resources Commission in 1978. The survey for the inventory located lands that were mined and abandoned prior to the effective date of the South Carolina mine reclamation law (SC Mining Act) in 1974. The inventory identified the abandoned mine location, mineral mined, reclamation efforts and pollution resulting from abandoned mine. Estimate of any resulting pollution was not quantified. The emphasis of this inventory was on construction mineral commodities. Data accuracy from this inventory is estimated at 75 percent.

   Contacts: Patrick Walker, SC Land Resources Commission
   Craig Kennedy, SC Land Resources Commission

2. South Carolina Geologic Survey

   U. S. Geologic Survey bulletins and publications that are archived with the S.C. Geologic Survey describe mine operations and locations of mines active prior to the enactment of the S.C. Mining Act. This information was reviewed for abandoned metallic, phosphate and industrial ore mines. Additionally, the USGS Mineral Resource Data System (MRDS) listed abandoned gold mines in South Carolina. This list of abandoned gold mines in MRDS, however, included numerous mineral prospect pits that were not production oriented. Abandoned pits that were deemed to have been non production are not included in this list of abandoned gold mines. The separation between gold mines and gold prospect pits was based on literature review and site visits by S.C. Geologic and S.C. Land Resources Commission personnel. Accuracy of the information is estimated at 75 percent.

   Contacts: Arthur Maybin, SC Geologic Survey
   Craig Kennedy, SC Land Resources Commission

3. South Carolina Land Resources Commission Abandoned Phosphate Mine Inventory.

The South Carolina Land Resources Commission conducted an inventory of abandoned phosphate mines in Charleston, Colleton, Beaufort and Berkeley counties. The inventory was obtained by review of USGS Topographic maps, recent National High Altitude Aerial Photography and review of USGS Geologic Bulletins. Information from this survey provided location of abandoned phosphate mines, state of disturbance and current land use. There has not been an effort to quantify off site impacts to the environment. Accuracy of information is estimated at 75 percent.

Contact: Craig Kennedy, SC Land Resources Commission

SOUTH DAKOTA

MEMORANDUM

To: State of South Dakota Office of Mining and Minerals, Department of Water and Natural Resources

From: Browne, Bortz & Coddington, Inc.

Subject: Inactive and Abandoned Mines Inventory for the State of South Dakota

Date: March 21, 1991

This memorandum was prepared in response to a request by the State of South Dakota under a letter of agreement between the State and Browne, Bortz & Coddington, Inc. (BBC). This agreement calls for a collection of existing data on inactive and abandoned mines lands (IAM) in the State of South Dakota and a discussion of efforts undertaken by the state to address and correct problems posed by IAM lands.

State of South Dakota Narrative Summary

Introduction. Mining in South Dakota began with the discovery of gold in the Black Hills in 1874. This discovery was followed by a gold rush in 1875 which continued through 1876. Gold seekers initially placer mined along French Creek near Custer, but the placers were low in grade. Prospecting moved north to the Deadwood area and east to the Rockerville area. Soon thereafter lode mining began in the northern Black Hills culminating in the development of the Homestake Mine in Lead. Development of the northern Hills was rapid, with the principal metal being gold.

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(303) 321-2547

A variety of metallic, industrial and construction ores and uranium have been historically produced in South Dakota. Much of the production of metallic minerals occurred in the Black Hills and included beryllium, columbite, copper, gold, iron, lead, manganese, silver, tantalum, tin, tungsten, uranium, vanadium and zinc. Industrial ore production occurred throughout the state and included bentonite, clay, feldspar, lithium, shale, silicone, sodium and sulfur. Construction ores include calcium, gypsum, mica, sand and gravel and crushed stone. Uranium was mined primarily in Fall River County, although uranium also occurred in lignite beds in Harding County.

Mining and Milling Methods. Three mining methods, underground, placer and surface, have been used in South Dakota to extract non-coal minerals. Underground mining was used primarily for metallic ores and involved the construction of tunnels, shafts and adits to reach ore bodies. Placer mining was undertaken primarily for gold in stream beds. Surface, or open pit, mining was used in the production of certain metallic minerals, primarily gold, and construction and industrial ores.

Milling of metallic ores was originally accomplished through chlorination. The cyanide process, superior for treating large tonnages of low grade ore, was introduced in about 1900, and its use continues today.

Health, Safety and Environmental Impacts. IAM hazards stem from air and water-borne toxic compounds and from unsafe mine openings, land subsidence and hazardous structures. Personal safety hazards arise from unsafe mine openings, unstable slopes and unsafe structures. Health and environmental impacts arise from air and water transportation of various contaminants, fugitive emissions and acid mine drainage.

South Dakota Laws and Regulations. Prior to 1982, mineral development in South Dakota was essentially unregulated. The state's mining laws were substantially revised in 1982 and in 1988. The South Dakota Mined Land Reclamation Act, known as SDCL 45-6B, provides for 87 separate statutes related to the various aspects of mining. Current law requires the development of a comprehensive reclamation plan as part of the permitting process. Several regulations regarding treatment of mine tailings, disposal of hazardous and non-hazardous waste, rehabilitating the disturbed landscape for specified beneficial uses and monitoring have been promulgated. In addition, mine operators must post a surety bond to be redeemed upon successful reclamation of the site.

Reclamation Efforts in South Dakota. The state of South Dakota does not have an integrated, cohesive program for reclaiming inactive and abandoned mine lands. To date, reclamation of IAM lands in the state has been piecemeal with reclamation accomplished through limited state funding, current reclamation laws, reclamation in lieu of penalty for permit violations, reclamation on federal lands and reclamation for acreage expansion.

Previous to the substantial rewriting of mined land reclamation laws in 1983, South Dakota reclamation law established a fund earmarked for the reclamation of inactive and abandoned mine sites. According to Office of Minerals and Mining, a total of $31,000 was deposited into the fund. Using $11,000 from this fund, the Darrell Neville uranium mine in Fall River County was partially reclaimed by infilling a small pit and installation of sediment controls. The remaining $20,000 will be used to reclaim abandoned sand and gravel sites as wildlife habitat. Potential sites have yet to be selected.

Under current law, reclamation is required for new mines sited on or existing mines which expand onto IAM lands. For example, Wharf Resources is utilizing an old tailings site as an overburden dump, and Brohm Mining will reclaim an old tailings site and install sediment controls to prevent erosion of tailings into Strawberry Creek. A proposed joint venture between Homestake Mining and Goldstake Explorations involves the mining of 10 to 14 million tons of old tailings along Whitewood Creek.

Another mechanism for IAM reclamation is for permit violators to undertake reclamation in lieu of fine payment. Wharf Resources, for example, reclaimed an old tailings site in Nevada Gulch rather than pay a penalty for permit violation.

Various agencies within the federal government have either reclaimed or plan to reclaim selected IAMs in the state. The U.S. Bureau of Reclamation performed reclamation work at the 1.3 acre Spokane Mine in Custer County. This site was a potential source of acid mine drainage. The U.S. Forest Service reclaimed a uranium site in Fall River County and is currently reclaiming certain pegmatite IAMs in Custer County in cooperation with the South Dakota National Guard. In 1991, the U.S. Forest Service plans to reclaim a 200 acre abandoned uranium mine in Harding County. The site contains one million cubic yards of highly erosive soils.

A provision of the current moratorium on issuing permits for new large scale gold mines in the Black Hills allows for expansion if the operator agrees to reclaim an equal amount of previously mined land, including land outside the operator's permit boundary. No operator to date has applied for a permit expansion under this provision of the moratorium, which is scheduled to expire on January 1, 1992.

State of South Dakota Reference Guide

Overview. Considering that data on non-coal IAMs in South Dakota is sparse and that the state has not initiated a program for regulating or reclaiming IAM lands, this memorandum serves an important function in presenting data sources which may be of use should such a program be developed. Various secondary data sources identify the location and nature of IAM sites in South Dakota. Other sources provide useful information on potential health, safety and environmental impacts which may be associated with IAMs. Thus, the magnitude of the IAM circumstance can be gauged.

The United States Bureau of Mines (BOM) maintains a database of IAMs, known as the Mineral Industry Location System (MILS). For South Dakota, data are available for non-coal IAMs throughout the state. The BOM has also evaluated potential hazards stemming from openings to underground mines located in the western part of the state. Other data sources, specifically the United States Geological Survey, the U.S. Forest Service, and the South Dakota School of Mines and Technology (SDSMT), have focused on non-coal IAMs located in the western part of the state, principally within the Black Hills region. The South Dakota Department of Water and Natural Resources, Office of Minerals and Mining houses information regarding current mining activity, reopening of old mines and reclamation activity at new mines and certain non-coal IAMs.

Aside from South Dakota non-coal IAM sites on the U.S. Environmental Protection Agency's (EPA) National Priority List (NPL) and CERCLIS database, relatively little is known about the areal extent and magnitude of the environmental threat posed by IAMs in the state. A report on the physical and environmental effects of uranium mining produced somewhat inconclusive results. Researchers at SDSMT reported on the mineral content of drainage water from a limited number of IAMs. The South Dakota Department of Water and Natural Resources, through the Office of Water Quality, monitors the quality of surface water and groundwater in the state. The Division of Water Resource Management is responsible for reporting the quality of the state's waters to the U.S. EPA, as required by Section 305(b) of the federal Clean Water Act. Water quality degradation due to IAMs, however, is not specifically addressed in these reports. The Office of Point Source Control monitors surface waters in areas of current mining activity, which includes surface waters potentially affected by IAMs.

The above data sources list mineral activity sites in the state and describe in general terms the nature of potential health and environmental impacts associated with IAMs. However, data on mine dumps, highwalls, mine openings and hazardous structures and a full characterization of health and environmental impacts stemming from IAMs are not available. Furthermore, the accuracy of many of the existing data sources cannot be reliably confirmed.

Mineral Industry Location System (MILS). The MILS database is a subsystem of the Mineral Availability System (MAS) database maintained by the BOM. A mineral industry location is considered to be a mine, prospect, millsite or smelter. MILS provides nonproprietary information such as the primary name of the property, location, type of operation, current operational status and the type of minerals produced.

The MILS database was initiated in the mid-1970s and continued through 1982. According to BOM personnel, mineral industry location data for the State of South Dakota were entered into the database in 1980. Thus, the database should fairly accurately represent IAMs in the state, since the bulk of mining activity ceased (with the exception of certain sand and gravel, pegmatite and bentonite operations) after the mid-1950s.

A perceived problem with the MILS data is its lack of accuracy with respect to the location of specific mineral industry activities. For example, some locations in the database can be off by as much as one mile. This imprecision can hamper fieldwork and environmental and physical impact assessments. Nonetheless, the MILS database is considered important, since it is the only existing database which indicates the extent of IAMs on a state-wide basis.

USGS 7-1/2 Quadrangle Maps, Black Hills National Forest. The U.S. Geological Survey produced a series of maps in 1988 depicting the location of mines, prospects and patented claims within the Black Hills National Forest in South Dakota and Wyoming. Nearly all of the locations indicated are inactive and abandoned sites.

Sites were plotted only if the accuracy of location could be confirmed. If the location of a mine or prospect could not be verified to within closer than a quarter-mile radius of its actual location, it was not plotted. The location of certain mines, given by range, township and section, is known within a 200-foot radius. These mines are plotted on the maps, and the type of opening (adit, shaft, etc.) is also indicated. The location of other mines or prospects which could only be verified within a quarter-mile radius are plotted on the maps, but the type of opening is not indicated.

A drawback of this USGS database, relative to MILS, is that it covers only a portion of the state. However, the six-county area of the Black Hills (Butte, Custer, Fall River, Lawrence, Meade and Pennington Counties) accounts for more than 60 percent of the non-coal IAMs identified in the BOM database. Also, the nature of mining activity in the Black Hills would indicate that potential hazards to human health and the environment could be more pronounced in this region than elsewhere in the state.

Black Hills Mineral Atlas, USBOM. The U.S. Bureau of Mines published this information circular, consisting of two volumes, in 1953 in order to "summarize all pertinent data available on the mines and mineral deposits in the Black Hills that have been explored, developed, mined or located." The utility of this document lies in its compilation of 626 underground mineral properties located in a six-county area (Butte, Custer, Fall River, Lawrence, Meade and Pennington Counties) within the Black Hills.

For ease of exposition, the region was divided into four parts. A map for each part shows the location of mineral properties. Water courses in each of the four parts are also described. Descriptive material for each property includes location (to the nearest quarter section), ownership history, commodity listings and production data. For some properties, a description of the workings is also included.

South Dakota Department of Water and Natural Resources, Office of Minerals and Mining. The Office of Minerals and Mining has considerable information concerning pegmatite (feldspar, mica, tantalum, etc.), gold and construction aggregate mining. The office is currently in the process of establishing a database for mine disturbed land which may include some IAMs.

Environmental Impacts of Uranium Mining in the Edgemont Mining District, USFS. This document was prepared in 1982 for the U.S. Forest Service by researchers at the South Dakota School of Mines and Technology. This report indicates that there are more than 140 inactive and abandoned uranium mines or prospects in the sparsely populated Edgemont mining district of Fall River County.

A reconnaissance environmental evaluation was conducted for 24 major open-pit and underground mines located on U.S. Forest Service property. For these mines, a total of 490 acres were disturbed, and 400,000 cubic yards of spoils were generated.

The report states that physical hazards stem from cliff walls, unmarked pits, caving underground adits, unplugged test holes and ventilation shafts. Present and future health hazards, however, were difficult to assess due to uncertainty regarding low-level radioactivity hazards and sparse data about public exposure. The report's authors conclude that the hazards associated with inactive and abandoned uranium mines and prospects are likely to be small:

- The region is quite remote;
- Mined areas have low levels of radionuclides and trace metal concentrations;
- The dispersion of toxics is minimal.

Hazardous Surface Openings, Black Hills National Forest, USBOM. This document was prepared in 1979 for the U.S. Bureau of Mines by the NUS Corporation. The purposes of the study were four-fold:

- Examine a representative sample of openings to IAMs in Custer, Lawrence and Pennington Counties;
- Identify openings within the sample that are a public hazard;
- Design low cost methods for eliminating the hazard;

- Evaluate existing laws pertaining to hazard reduction, jurisdiction and enforcement.

The report concluded that openings to IAMs in the Black Hills are generally hazardous, that litigation related to accidents is costly and complex and that a comprehensive approach to mine closure should be initiated.

This report is useful for the purposes of compiling existing data on IAMs and evaluating efforts which might be undertaken to remedy attendant problems. Ownership and claim history information was updated to the extent possible for the properties identified in the *Black Hills Mineral Atlas*. This is crucial in determining parties which may be responsible for some form of remedial action.

The researchers developed several criteria for evaluating the hazard potential of underground IAMs. Parameters were established for determining which openings may present a hazard to human health, and a scale was established for subjectively evaluating the hazard of particular openings. For example, it was determined that 32 IAM sites should be visited. Three sites were determined to exhibit little hazard, as they had already been sealed. Of the remaining 29 sites, nearly 70 percent exhibited a weighted hazard value of 16 or more (based on a scale of 8 to 24). Closure methods were developed for particular types of openings in consideration of geologic, engineering, hydrologic, economic and hazard factors.

The Geochemistry of Mine and Spring Waters, Western South Dakota, SDWRI. This 1974 report was prepared for the South Dakota Water Resources Institute by researchers at the South Dakota School of Mines and Technology. This report is valuable as it reports the chemical content of drainage water from specific IAMs and evaluates water quality impacts due to IAMs in areas where mining activity has ceased.

Mostly located in Pennington County, fourteen IAMs which discharged water into surface streams were monitored over the course of a year. The water courses included:

- Silver Spring Creek
- Squaw Creek
- False Bottom Creek
- Deadwood Creek
- Spruce Gulch
- Strawberry Creek
- Bear Butte Creek
- West Gimlet Creek
- Rapid Creek

Impacts on water quality due to mine drainage are dependent on the mineral properties of the rock, the volume of discharge, and the length of time water is in contact with the rock. Several conclusions regarding potential water quality impacts were determined:

- Drainage from IAM lands in the Northern Black Hills is small, probably less than 500 gallons per minute on an annual basis;

- Drainage water temperature, 42 to 48 degrees Fahrenheit, approximates that of the surrounding area;

- Mineral content varies inversely with volume of drainage;

- pH is low where small volumes of water move over oxidized rocks, and pH is higher where larger volumes of water move over rocks with low mineralization;

- Seepage from dumps and tailings are prone to be low in pH and high in iron;

- High volume discharges are generally potable.

South Dakota Department of Water and Natural Resources, Division of Water Resource Management. The Division of Water Resource Management is responsible for submitting the 305(b) report to the Environmental Protection Agency. According to division personnel, the report provides a brief overview of water quality in the state. Water quality data are derived from the division's 93 ambient water quality stations and from USGS and Army Corps of Engineers surveys. Overall, water quality in the Black Hills is said to be good, although there are limited reaches where pH concentrations are low.

The division does not explicitly monitor water quality for potential degradation caused by drainage from IAM sites. Analysis of water quality impacts due to mining activity is concentrated in water courses where mining activity is currently taking place. Thus, division work is concentrated in the Whitewood, Strawberry, Annie and Rapid Creek water courses. Low pH concentrations have been found in isolated reaches of these streams.

Summary

Data are available which indicate the presence of more than 1,000 inactive and abandoned non-coal mine sites in South Dakota. More than 60 percent of these are located in a six-county area within the Black Hills region. Other data suggest that IAMs in the Black Hills region may pose substantial risk for bodily injury or death. Limited data are available for evaluating the areal extent and physical hazards of IAM sites in the state.

With regard to environmental hazards, data are available for the six IAM sites listed on the NPL and the CERCLIS database. A lack of information exists for effectively evaluating the potential environmental hazards posed by IAMs on a state-wide basis.

Recommendations for Addressing Potential Problems posed by IAMs

The state of South Dakota could take several steps to begin addressing the potential health, safety and environmental problems posed by IAMs. Specifically, the steps presented below would allow quantification, to the extent possible, of the areal extent and risks of IAMs in the state. What is not presented here is a plan for reclaiming IAMs or potential funding sources for accomplishing the reclamation work.

The first step would consist of a establishing a computerized database of IAMs in the state. Using a geographic information system (GIS) program, a map of IAM sites could also be produced. The principal data sources for establishing this database would include the *U.S. Geological Survey 7-1/2 Quadrangle Maps*, the *Black Hills Mineral Atlas (U.S. Bureau of Mines)* and the *Mineral Industry Location System (U.S. Bureau of Mines)*. These data provide information on location (Range, Township and Section) and on the types of commodities produced by the mine. In concert with the Division of Water Resource Management, principal water courses located in proximity to each IAM site could be included in the database. This would assist in estimating the number of stream miles potentially impacted by IAMs.

The second step would involve developing screening procedures or criteria to identify potentially hazardous or environmentally threatening sites. This step would reduce the number of field investigations required to accurately assess the IAM problem. It is suggested that *Hazardous Surface Openings, Black Hills National Forest,* prepared by NUS Corporation, be reviewed for acceptability and completeness as a guide in developing these procedures.

The last step would involve field investigations of sites identified as a result of the previous step. Field investigations should also be conducted for a sample of sites which were screened out in order to assess the reliability of the screening instrument. To reduce the cost of field investigations, is may be possible to employ geology, engineering and soils and water science graduate students from the state's universities and colleges. Based on the results of the field investigations, a scale or criteria could be developed for determining closure requirements and methods.

STATE OF SOUTH DAKOTA
IAM LAND
DATA SUMMARY

Mineral Commodities Produced in South Dakota

Metallic Ores

Beryllium
Columbite
Copper
Gold
Iron
Lead
Manganese
Silver
Tantalum
Tin
Tungsten
Uranium
Vanadium
Zinc

Construction Ores

Calcium
Gypsum
Mica
Sand and Gravel
Stone

Industrial Ores

Bentonite
Clay
Feldspar
Lithium
Shale
Silicone
Sodium
Sulfur

MINERALS PRODUCED ON IAM LANDS, STATE OF SOUTH DAKOTA

Mineral Type	Number of Disturbances
Metallic Ores	403
Construction Ores	503
Industrial Ores	136
Phosphate Rock	0
Uranium Overburden	NA
Other	0
Total	1,042

Source: U.S. Bureau of Mines, Mineral Industry Location System (MILS).

NA: The number of sites containing uranium overburn is not reported.

MINERAL COMMODITIES PRODUCED ON IAM LANDS, SOUTH DAKOTA

Principal Commodity Type	Number of Disturbances
Metallic Ores	
Beryllium	13
Columbite	16
Copper	5
Gold	179
Iron	10
Lead	23
Manganese	1
Silver	9
Tantalum	3
Tin	12
Tungsten	15
Uranium	116
Zinc	1
Subtotal	403
Construction Ores	
Calcium	3
Gypsum	6
Mica	57
Sand and gravel	409
Stone	28
Subtotal	503
Industrial Ores	
Clay	2
Feldspar	121
Lithium	9
Silicone	2
Sodium	1
Sulfur	1
Subtotal	136
Total	1,042

Source: U.S. Bureau of Mines, Mineral Industry Location System (MILS).

Note: Feldspar, gold and mica figures may include old sites that are either being partially or totally reworked under new mining and reclamation laws and thus may no longer be considered IAMs.

ESTIMATED DISTURBED ACREAGE, IAM LANDS, SOUTH DAKOTA

Principal Commodity Type	Estimated Acreage
Metallic Ores	2,800
Construction Ores	4,400
Industrial Ores	1,175
Total	8,375

Source: South Dakota Department of Water and Natural Resources, Office of Minerals and Mining.

Note: The confidence of the reported data varies up to 25 percent.

State of South Dakota References

IAM definition. Inactive and abandoned mine lands are defined as sites where there is not continuing reclamation responsibility by an owner and/or operator. For purposes of this report, IAMs include mines, prospects, millsites and smelters.

Number of IAM sites in South Dakota. These data are based on the U.S. Bureau of Mines, Mineral Industry Location System (MILS) database and relate to occurrences, prospects, mines and processing facilities located in the state. This database was selected since it is the only existing database which indicates the extent of IAMs on a state-wide basis.

Amount of disturbed land at IAM sites. The South Dakota Department of Water and Natural Resources, Office of Minerals and Mining provided the following estimates:

Commodity Type	Acreage Disturbed	Reliability
Sand & Gravel	4,000	25%
Uranium	800	25
Gold/Silver	2,000	25
Crushed Rock	75	25
Bentonite	750	10
Clay	50	10
Pegmatites (Feldspar, Mica, etc.)	500	25
All Other	200	10
Total	8,375	NA

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___1988j, Map of mines, prospects and patented mining claims, and classification of mineral deposits in the Rockerville 7 1/2-minute quadrangle, Black Hills, South Dakota: U.S. Geological Survey Open-File Report 87-0261-H, scale 1:24,000.

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___1988n, Map showing locations of mines, prospects, and patented mining claims, and classification of mineral deposits in the Cicero Peak 7 1/2-minute quadrangle, and part of the Pringle 7 1/2-minute quadrangle, Black Hills, South Dakota: U.S. Geological Survey Miscellaneous Field Studies Map MF-1978-P, scale 1:24,000.

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___1988p, Map showing locations of mines, prospects, and patented mining claims, and classification of mineral deposits in the Deadwood South 7 1/2-minute quadrangle, and part of the Deadman Mountain 7 1/2-minute quadrangle, Black Hills, South Dakota: U.S. Geological Survey Miscellaneous Field Studies Map MF-1978-F, scale 1:24,000.

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___1988v, Map showing locations of mines, prospects, and patented mining claims, and classification of mineral deposits in the Rochford 7 1/2-minute quadrangle, Black Hills, South Dakota: U.S. Geological Survey Miscellaneous Field Studies Map MF-1978-H, scale 1:24,000.

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UTAH

WIEB/WGA
Non-coal Inactive/Abandoned Mine Lands Inventory Project

State of Utah
Division of Oil, Gas & Mining
Abandoned Mine Reclamation Program

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NON-COAL INVENTORY
INACTIVE/ABANDONED MINES

State of Utah
Division of Oil, Gas & Mining
Abandoned Mine Reclamation Program

NARRATIVE SUMMARY

The Noncoal Mining Problem in Utah

Historical Overview

Mining has always figured prominently in Utah history. Mining began in the state shortly after the first permanent settlement by Euro-American pioneers in 1847. For many years the mining was limited to "utilitarian" minerals such as coal and iron that were mined and marketed in the local pioneer economy. Gold and silver discoveries in the 1860's initiated the first of a series of metal mining booms that swept through the state over the next two decades and made the state a mineral exporter. Gold, silver, and lead were the principal products until about 1905, when copper assumed a lead role as a result of the discovery of techniques to recover copper from low grade ore. The metal mining continued into the twentieth century as new ore deposits were discovered or new technologies or economic conditions made played out deposits economic again. Most of the early mining was underground. The newer generation mines used more surface mining techniques. The Depression put an end to many of the older era mining operations. Following the second World War Utah mining expanded into nonmetallics (potash, phosphate, salt, etc.) and in the 1950's Utah experienced a uranium boom. In the last few decades production in the mining industry has become dominated by larger, capital-intensive open pit operations, although many small underground operations still exist.

Types of Abandoned Mine Problems

Nearly a century and a half of mining has left Utah with a legacy of problems. The types of problems at inactive and abandoned mines are functions of the type of mineral and the time period when the mining occurred (which determines the mining technology used and the age of the features). Most of the older metal, uranium, and phosphate mines in the state are underground mines (newer, active mines are often surface operations). Sand, gravel, and stone are quarried from surface pits. Most obvious of the problems are the physical hazards that can cause bodily injuries or deaths from falls, collapse, and so on. Underground mining methods leave behind shafts, adits, tunnels, and winzes. These hazards are quite common in Utah. The number of mine openings has been estimated in the tens of thousands. Other physical hazards at underground mines are subsidence prone areas, unbreathable atmospheres in underground workings, and rotted timbers and ladders. Surface excavations can leave highwalls, unstable spoil banks, and water impoundments. Other physical hazards common to both types of mining are stored explosives or acutely toxic materials and derelict structures and machinery.

Environmental problems accompany both surface and underground mines. Old underground mines typically dumped wasterock immediately downslope of the portals, leaving sterile fans of barren rock scarring hillsides. In some places the demand for wood for mine timbers, fuel, and buildings deforested large areas, causing soil erosion. Surface mines stripped vegetation, upset soil profiles, and left behind compacted soils, road cuts, and spoil banks. In Utah's arid climate and thin soils, recovery of damaged plant communities can take years. Some mine dumps are still barren a century after the mining occurred.

Less apparent than the physical hazards are environmental and health risks from chronic long term exposure to low levels of chemicals released by mining. The fracturing of rock above- and belowground to mine and process ore exposes significantly more mineral surface area for chemical reactions with air and water.

This greatly accelerates the release of toxic materials (e.g. acids, heavy metals) into surface and ground water. Chemicals used by heap leaching and other processing technologies can also be present in tailings piles and leach into groundwater. Water thus contaminated can harm vegetation, fish, and wildlife. In populated areas it becomes a public health threat. Common avenues of such toxins into the body are through drinking water, breathing airborne dust, and through contact with contaminated soil. The extent of such problems in Utah is not well known, but several known or suspected sites are being studied or treated (Vitro tailings and Midvale smelter in Salt Lake City, and Bingham Creek in west Salt Lake County).

All but two of 17 reported incidents involving deaths or injuries at abandoned mines in Utah since 1982 have occurred at noncoal mines (see Appendix A). These include all three of the fatalities (all from falls down shafts). Some victims have escaped death only through extraordinary luck. People have fallen 30 to 50 feet down shafts with only minor injuries. A ten-year-old boy survived being lost in a mine for five days without food or water. One county deputy sheriff told of chasing away teenagers who were inhaling intoxicants while sitting on the collar of a 1,500-foot shaft.

Some peculiar characteristics of Utah demographics put the population at additional risk. About 70% of the state's people live in the Wasatch Front metropolitan area (Ogden, Salt Lake City, Provo). This is adjacent to several former mining districts now developed as recreation areas. Wasatch National Forest, in which this occurs, is the most heavily used forest for recreation in the National Forest System. Due to this circumstance, the state's highest population center is directly exposed to one of the state's highest concentration of abandoned mines. Paradoxically, the remoteness of some mining areas is no guarantee of low risk. Backcountry recreation is very popular in Utah. For example, the state deer hunt puts tens of thousands of people into the remote parts of Utah each year.

Determining Hazards to Health and Safety

The Utah Abandoned Mine Reclamation Program (hereafter, AMR Program; also the antecedent of all first person pronouns) uses a "prudent person" test for determining whether mine features are hazardous. That is, would a prudent person of normal awareness and exercising normal, everyday caution and judgment be put at risk of injury by the feature? All mine openings are considered to be hazardous. Other features are evaluated on a case-by-case basis. The AMR Program has not yet developed standard criteria for the less tangible risks from chronic exposure to low level toxins or exposure to radiation. We have used established EPA guidelines for non-occupational exposure to radiation for assessing risks at uranium mines.

State Reclamation Laws

Coal Mining and Reclamation Act, 40-10-1 et seq., UCA

This is the state analog to the federal Surface Mining Control and Reclamation Act of 1977 (SMCRA, P.L. 95-87). Like its federal counterpart, it provides for regulation of active coal mining operations and for reclamation of abandoned mine sites, with priority given to abandoned coal mines. Noncoal mine reclamation is limited to protecting public health and safety until the coal reclamation is completed. The act is administered by the Division of Oil, Gas and Mining.

Utah Mined Land Reclamation Act, 40-8-1 et seq., UCA 1990

This act requires that mining operations active on or after July 1, 1977 reclaim their disturbance. The act is administered by the Minerals Program of the Division of Oil, Gas and Mining. The act requires operators to submit a mining and reclamation plan for approval and to provide sufficient surety to cover the costs of reclamation. Operations disturbing less than five acres must register with the Minerals Program and reclaim their disturbance, but are exempt from the reclamation plan and bonding requirements. Sand, gravel, and rock aggregate operations are excluded from regulation.

Determining Active/Inactive/Abandoned Status

Utah uses the "no continuing reclamation responsibility" language of the 1977 Surface Mining Control and Reclamation Act to determine eligibility of abandoned mine sites for reclamation funding. For noncoal sites, an active mine is one where the operator has filed a Notice of Intention with the Minerals Program. The Minerals Program uses the term "inactive" for permitted or registered mines that have suspended operations. These sites have a reclamation responsibility under the Mined Land Reclamation Act that is evidenced by the reclamation plan and bond. Some leasable minerals on public land may have a reclamation responsibility in the terms of the mineral lease. Claimholders who maintain assessment work on unpatented claims for locatable minerals have no reclamation responsibility under state law until they decide to start actively mining. The Utah AMR Program has on some occasions allowed holders of unpatented claims to voluntarily assume responsibility in writing. The terms inactive and abandoned are used interchangeably in this report to refer to sites where there is no statutory reclamation responsibility. For the mining impact estimates (see the Data Summary Table), the activity status was determined by the CRIB data, and is dependent on the judgment of the CRIB investigator.

Utah Noncoal Reclamation Experience

The Utah AMR Program has carried out eight noncoal reclamation projects totalling $1.15 million. A total of 364 mine openings have been sealed to date. Reclamation work has been performed in metal mining areas of the Wasatch Mountains near Salt Lake City, the Promontory Mountains, and the Tintic Mountains around the town of Eureka. Two uranium mine sites in Capitol Reef and Canyonlands National Park have been reclaimed. Also, a number of shafts and adits have been sealed in cooperative volunteer efforts by the National Guard and county road departments. The Program has posted warning signs in some hazardous mining areas. Finally, the Utah AMR Program has put together an educational curriculum for elementary schoolchildren to raise awareness of the safety hazards of abandoned mines.

All of the noncoal reclamation has been limited to portal closures by conventional means-- backfill, masonry bulkheads, structural grates, cable nets. No environmental rehabilitation, such as reclamation of mine dumps, has been done. Costs for typical noncoal closures range from $500 to $5,000 depending on site conditions and closure type. The average cost per mine opening for 153 portal closures in the Wasatch Project was $1,322.

Utah has only begun to inventory noncoal mine sites in the field. Most of the noncoal inventory effort has gone into the priority project areas above. Areas in Utah that have been inventoried by the AMR Program but not yet reclaimed include phosphate mines in the Crawford Mountains in Rich County, metal mines in the East and West Tintic and Deep Creek Mountains in Juab and Tooele Counties, metal and uranium mines in the Marysvale area, Silver Reef in Washington County, and the Thompson uranium mining district in Grand County. The U.S. Forest Service has inventoried mines in the La Sal and Tushar Mountains. The Utah Division of Environmental Health is in the process of inventorying ore processing facilities. These surveyed areas represent only a small fraction of the noncoal mines present in the state.

Utah has considered the physical safety hazards at noncoal mines, specifically the mine openings, to be the most significant problems in the short run. The very large number of openings and their proven record of deaths and injuries make them the most immediate problem to deal with. Soil and water contamination by heavy metals and other toxic materials in dumps and processing facilities will become more significant concerns.

Reference Guide

Agency Sources of Information

a. Utah Division of Oil, Gas and Mining
Abandoned Mine Reclamation Program
(801) 538-5340
Contact: Mary Ann Wright, Ingrid Fagre, Chris Rohrer

b. Utah Division of Oil, Gas and Mining
Minerals Program
(801) 538-5340
Contact: Wayne Hedberg
The Minerals Program provided information on particular noncoal mine sites, regulatory background, and reclamation cost data.

c. Utah Geological and Mineral Survey
(801) 581-6831
Contact: Bryce Tripp
UGMS provided the CRIB data base for analysis.

d. Utah Division of Environmental Health
Bureau of Water Pollution Control
(801) 538-6146
Contact: Dave Wham
BWPC provided water quality data and was the liaison with BERR for mill and smelter data.

e. Utah Division of Environmental Health
Bureau of Environmental Response and Remediation
(801) 538-6121
Contact: Brad Johnson
BERR provided information on the CERCLIS mill and smelter sites.

f. U.S. Bureau of Mines
(303) 236-0423
Contact: Michael Sawyer
USBM provided the MAS data base for analysis.

CRIB Data Base

The Computerized Resources Information Base (CRIB) data base was the primary source of information used to estimate the mining impacts presented in the Data Summary Table. CRIB contains a variety of information on mineral occurrence and development. The information includes all minerals mined in the state. Most records have been field verified. CRIB contains 9,240 separate records for mineral locations in Utah. In the absence of a comprehensive field inventory of abandoned mine sites, CRIB was used as the closest equivalent. The CRIB data base does have its limitations, however. Many of the records have blank, incomplete, or inconsistently completed fields. Since the CRIB data base was not designed for this application, much of the data cannot be used for determining mining impacts. Consequently, to make estimates of mining impacts it was necessary to make many assumptions that affect the reliability of the results.

Mining Impacts Methodology

CRIB information was used only to estimate the impacts of mines, since the data base does not contain smelters or millsites. The "Features" data (number of mine openings, acres of disturbed land, etc.) were estimated by three main approaches depending on the completeness of the CRIB data and the availability of field data:

a. We sampled a fraction of the CRIB records, estimated the disturbance for each record from the information given, and summed the estimates. This was extrapolated proportionally to give the total disturbance for all records. This method was used for Construction Ores and Industrial Ores. All of the Oil Shale records were sampled, so extrapolation was not needed.

b. We figured an "average" or "typical" disturbance per CRIB record by comparing CRIB records for an area to actual field inventory data for the same area. The "average" disturbance per record was multiplied by the total number of records to give a statewide total. This method was used for Metallic Ores and Uranium Overburden.

c. A combination of (b) and actual field survey data. This method was used for Phosphate Rock.

The overall approach was one based on whole population attributes rather than on individuals. In other words, we made broad statistical inferences from the CRIB data, rather than adding up information for each individual record. For example, "Ownership" was calculated by multiplying the total estimated "Disturbed Area" by the land ownership proportions of the CRIB records. We did not add up the area of each site in each ownership category. This approach produces estimates with lower confidence levels, but it is a faster way to evaluate a large number of records. Given the limitations of the CRIB data for this purpose and the many assumptions necessary to estimate disturbance at individual sites, an individual record approach would also yield relatively low confidence levels. Most of the mining estimates should be given about a 20% confidence level. The Phosphate Rock estimates, based on fairly complete inventory, can be given about 80% confidence.

Water quality problems cannot be estimated confidently from the CRIB data, either by inferring directly from the contents or by projecting from the number of records. The estimates of polluted water are based on information provided by the Bureau of Water Pollution Control (BWPC). The estimates include only those stream segments for which there is reasonable evidence (in the professional judgment of the BWPC) to suggest that they are either currently impacted or that further study is likely to show a definite link between abandoned mines in the drainage and downstream water quality problems. The BWPC has identified approximately 83 miles of streams in Utah impacted by inactive/abandoned metal mines. However, they stress that this number only includes those stream segments known to BWPC and should not be represented as an estimate of total stream miles in the state affected by inactive/abandoned mines. No estimates are available for other mineral types. The BWPC has indicated a 90% confidence level that these stream miles are affected by inactive/abandoned mines. The confidence level that this figure is representative of the total impacted stream miles in the state is much lower, on the order of 5 to 10%

Details of the procedures used to derive the estimates are given in Appendix B.

Millsite/Smelter Impacts

A literature review conducted for the Utah Geological and Mineral Survey (James, L.P. In Press. Nonferrous metals milling plants in Utah. UGMS Open File Report) has indicated that there have been about 100 nonferrous mill plants in Utah (active and abandoned). About 85 of these are described as smaller mills and can be assumed to be inactive. The larger sites are mostly either still active or were custom processors located away from the mines, and thus not under consideration here. Estimates of impacts are based on the estimated figure of 85 millsites and have about 10% confidence.

The CERCLA Section of the Bureau of Environmental Response and Remediation has identified 20 to 25 inactive or abandoned milling and smelting sites. These are sites that have been ranked on the State CERCLIS according to the federal priority ranking system. A few of these sites include the Bauer Tailings near Stockton, the Highland Boy Smelter in Murray, and the Lark Tailings near Lark. All of these sites are stand-alone operations not associated with an individual mine and not located on a mine site. Thus they are outside the scope of this report.

NON-COAL INVENTORY
INACTIVE/ABANDONED MINES

State of Utah

Division of Oil, Gas & Mining
Abandoned Mine Reclamation Program
Contact: Mary Ann Wright
(801) 538-5340

DATA SUMMARY

Metallic Ores

Mining Type			Ownership			Features			Cost
Mines	6,837	acres	Federal	3,146	acres	Polluted Water[1]	83	miles	$41,500,000
Millsites	0	acres	Private	3,417	acres	Mine Dumps[2]	1,367	acres	$6,835,000
Smelters	0	acres	State	274	acres	Disturbed Land[3]	6,837	acres	$10,255,500
Other	0	acres	Other	0	acres	Highwalls[4]	0	miles	$0
						Mine Openings[5]	13,674	openings	$34,185,000
						Subsidence Prone[6]	1,367	acres	$6,835,000
						Haz. Structures[7]	114	structures	$228,000
						Other	0		$0

Construction Ores

Mining Type			Ownership			Features			Cost
Mines	11,329	acres	Federal	4,546	acres	Polluted Water	0	miles	$0
Millsites	0	acres	Private	5,995	acres	Mine Dumps	874	acres	$4,370,000
Smelters	0	acres	State	740	acres	Disturbed Land	11,329	acres	$16,993,500
Other	0	acres	Other[8]	48	acres	Highwalls	85.7	miles	$10,712,500
						Mine Openings	260	openings	$650,000
						Subsidence Prone	30	acres	$150,000
						Haz. Structures	94	structures	$188,000
						Other[9]	40	trash dumps	$40,000

Industrial Ores

Mining Type			Ownership			Features			Cost
Mines	707	acres	Federal	487	acres	Polluted Water	0	miles	$0
Millsites	0	acres	Private	161	acres	Mine Dumps	128	acres	$640,000
Smelters	0	acres	State	59	acres	Disturbed Land	707	acres	$1,060,500
Other	0	acres	Other	0	acres	Highwalls	4.7	miles	$587,500
						Mine Openings	430	openings	$1,075,000
						Subsidence Prone	37	acres	$185,000
						Haz. Structures	16	structures	$32,000
						Other	0		$0

DATA SUMMARY - Page 2

Phosphate Rock

Mining Type			Ownership			Features			Cost
Mines	350	acres	Federal	2	acres	Polluted Water	0	miles	$0
Millsites	0	acres	Private	347	acres	Mine Dumps	66	acres	$330,000
Smelters	0	acres	State	1	acre	Disturbed Land	350	acres	$525,000
Other	0	acres	Other[10]	0	acres	Highwalls	4	miles	$500,000
						Mine Openings	112	openings	$336,000
						Subsidence Prone[13]	11	acres	$24,407,000
						Haz. Structures	1	structures	$2,000
						Other			$0

Uranium Overburden

Mining Type			Ownership			Features			Cost
Mines	1,541	acres	Federal	1,396	acres	Polluted Water	0	miles	$0
Millsites	0	acres	Private	32	acres	Mine Dumps	364	acres	$1,820,000
Smelters	0	acres	State	113	acres	Disturbed Land	1,541	acres	$2,311,500
Other	0	acres	Other	0	acres	Highwalls	3.5	miles	$437,500
						Mine Openings	2964	openings	$7,410,000
						Subsidence Prone	5	acres	$25,000
						Haz. Structures	68	structures	$136,000
						Other	0		$0

Oil Shale

Mining Type			Ownership			Features			Cost
Mines	5	acres	Federal	5	acres	Polluted Water	0	miles	$0
Millsites	0	acres	Private	0	acres	Mine Dumps	0.5	acres	$2,500
Smelters	0	acres	State	0	acres	Disturbed Land	5	acres	$7,500
Other	0	acres	Other	0	acres	Highwalls	0	miles	$0
						Mine Openings	5	openings	$12,500
						Subsidence Prone	1	acre	$5,000
						Haz. Structures	0	structures	$0
						Other	0		$0

TOTAL for All Mineral Types

Mining Type			Ownership			Features			Cost
Mines[11]	20,769	acres	Federal	9,582	acres	Polluted Water	83	miles	$41,500,000
Millsites[12]	0	acres	Private	9,952	acres	Mine Dumps	2,800	acres	$13,997,500
Smelters	0	acres	State	1,187	acres	Disturbed Land	20,769	acres	$31,153,500
Other	0	acres	Other	48	acres	Highwalls	98	miles	$12,237,500
						Mine Openings	17,445	openings	$43,668,500
						Subsidence Prone	1451	acres	$31,607,500
						Haz. Structures	293	structures	$586,000
						Other	40	trash dumps	$40,000
							Total		$174,790,000

FOOTNOTES TO DATA SUMMARY TABLE

1. Polluted Water has been defined here as reaches of streams not meeting their beneficial use classifications for which there is reasonable evidence to suggest that they are either currently impacted by mining or likely to be found so with further study.

2. Mine dumps take in any mined material discarded on the ground surface, and may include overburden, uneconomic ore, tailings, etc.

3. Disturbed land takes in the mine itself and all related disturbance, including access roads, nearby shallow prospects and exploratory work, offsite erosion triggered by the mine, etc.

4. For this report highwalls greater than 15 feet high were assumed to be hazardous. Where no pit dimensions were available, estimates of highwall lengths were assumed from pit areas (see Appendix B for the method).

5. All mine openings were considered hazardous.

6. Subsidence prone areas have shallow underground mine workings subject to collapse or cave-in that results in surface depressions (sinkholes). For this report we have assumed 0.1 acre of subsidence prone ground for each mine portal.

7. Nearly all abandoned mine sites have some sort of structures, storage sheds, remnant equipment, or other debris of low hazard and inconsequential clean-up costs. For this estimate we considered as hazardous only substantial structures whose height or mass create a danger. Examples would be headframes, ore bins, tipples, offices, shop buildings, aerial tram towers, etc. We estimated these structures to occur at 5% of the sites.

8. County ownership.

9. Several open pits have been used as trash dumps for refuse not related to mining (household garbage, debris, etc.).

10. One phosphate occurrence estimated at less than one acre (0.2 acres) is on tribal land.

11. Primary sources for mine estimates are Utah AMR Program records and the CRIB data base.

12. Primary source for millsite estimates is James, L.P. Nonferrous metal milling plants in Utah. UGMS Open File Report. In Press.

13. Source for Crawford Mountains phosphate mines is "Report of Investigation for Crawford Mountains AML Study, Rich County, Utah" (1991)

APPENDIX A

Incidents at Abandoned Mines in Utah

This information was collected and compiled by the Utah Abandoned Mine Reclamation Program (UAMRP).

May 8, 1982 (Saturday)
Unknown mine, Five Mile Pass, Utah County (noncoal)

> Kerry West, 24, of Lehi fell 25 feet into a shaft on his motorcycle. He sustained a broken leg and other fractures and required rescue.

July 27, 1982 (Tuesday)
Unknown mine, Mineral Basin, American Fork Canyon, Utah County (noncoal)

> Sherm Evans of American Fork was leading his horse along a trail. The horse fell 40 feet into a shaft that had been obscured by vegetation and was killed.
> The shaft was capped in 1983 as part of the UAMRP's Alta-Brighton Project.

September 9, 1982 (Thursday)
C.C. Rich mine, Coal Mine Basin, Uintah County (coal)

> Scott Preston, 29, of Vernal drove his motorcycle onto an abandoned coal refuse pile and stepped off the bike. He broke through a crusted layer into burning coal underneath, suffering severe burns on his feet. He nearly lost the function of his right foot.
> The fire was put out at the request of the state by a federal emergency program project.

June 19, 1985 (Wednesday)
Unknown mine, near Toquerville, Washington County (noncoal)

> Wayne Monnett, 25, of LaVerkin died when he encountered black damp while descending a shallow shaft during a Sunday School class outing.
> The shaft was backfilled under the direction of the UAMRP by Washington County in a cooperative effort.

September 1, 1985 (Sunday)
Unknown mine, Promontory Mountains, Box Elder County (noncoal)

> Kris Marchant, 11, of Ogden died when he fell down a 475-foot shaft while riding a 3-wheeler ATV with his family.
> The shaft was backfilled in early 1986 as part of the UAMRP's Promontory Project, which closed 107 mine openings on Promontory Point.

October 26, 1985 (Saturday)
Maxfield mine, Big Cottonwood Canyon, Salt Lake County (noncoal)

> Brothers Dennis and Scott Workman, 26 and 25, of East Milcreek became lost while exploring the mine. They were rescued after 2-1/2 days underground. Black damp was known to occur in the area. The mine was posted with "Danger" signs and put under UAMRP investigation for reclamation. The mine was sealed after a second incident in 1988 (see July 12, 1988 incident below).

December 22, 1985 (Sunday)
Unknown mine, near Elberta, Utah County (noncoal)

Duane McManniss, 23, of Santaquin died when he fell 200 feet down a shaft while exploring the mine with two friends.

The shaft was immediately flagged and fenced and then backfilled in January, 1986 as part of the UAMRP's Bullion Beck Project.

January 20, 1986 (Monday)
Jim Fisk prospect, Ophir Canyon, Tooele County (noncoal)

Stephen Sanford, 65, a Boy Scout leader from Ogden was exploring the mine with five scouts. He fell 60 feet down a winze and over a 12-foot dropoff, suffering a broken wrist and sprains.

The mine was posted with "Danger" signs in January, 1986 and put under UAMRP investigation for reclamation.

February 19, 1986 (Wednesday)
Lucky Bill mine, Bonanza Flat, Summit County (noncoal)

The county sheriff reported that snowmobilers were using a cornice formed by a shaft opening as a jump. The mine had sloughed open recently. In the 1960's a shaft 100 yards away claimed the life of a 16-year-old.

The area was immediately flagged with warning tape by the UAMRP. The shaft was backfilled in September, 1986 as part of the UAMRP's Alta Project.

August 19, 1987 (Wednesday)
Price River Coal Pile, two miles north of Helper, Carbon County (coal)

UAMRP staff member Louis Amodt, 36, of Salt Lake City was managing a reclamation project to extinguish a fire in an abandoned coal refuse pile. He suffered second degree burns on his arms and legs when he broke through a crust covering burning coal.

The coal refuse fire was extinguished as part of UAMRP reclamation construction underway at the time and completed in 1991.

November 28, 1987 (Saturday)
Unknown mine, Mouth of Rock Canyon, Utah County (noncoal)

Mark Larson, 17, of Lindon suffered severe rope burns, minor cuts, and bruises when he fell approximately 30 feet down a shaft while trying to climb out.

The shaft was backfilled in the summer of 1988 as part of the UAMRP's Wasatch Project.

May 21, 1988 (Saturday)
Unknown mine, Five Mile Pass, Utah County (noncoal)

John Carlson, 25, of West Valley City was lowering himself into the mine when the rope broke. He fell approximately 50 feet and sustained minor injuries. He required rescue by the county search-and-rescue team.

The shaft was backfilled on June 1, 1988 under the direction of the UAMRP in a cooperative effort with the Bureau of Land Management and the claimholder.

July 9, 1988 (Saturday)
Monarch mine, North Willow, Tooele County (noncoal)

Phillip Butterfield, 15, entered the mine portal without a flashlight or safety gear and slipped down a shaft. His father, William Butterfield, 44, went after him and could not climb out.

The mine was flagged with "Danger Do Not Enter" warning tape. See October 22, 1988 report below.

July 12, 1988 (Tuesday)
Maxfield mine, Big Cottonwood Canyon, Salt Lake County (noncoal)

Lt. Mike Wilkinson, Salt Lake County Sheriff's office, reported incidents of two separate groups of people inside mine unable to climb out. Four people were inside the mine 1/3 mile. The mine contains vertical dropoffs and 18% grades. The last incident occurred on July 11, 1988.
The mine was sealed in the summer of 1988 as part of the UAMRP's Wasatch Project.

October 22, 1988 (Thursday)
Monarch mine, North Willow, Tooele County (noncoal)

Jim Cook, U.S. Forest Service Wasatch District, reported that two deer hunters had reported encountering a hazardous situation at the mine to him.
The mine was sealed in April, 1989 as part of the UAMRP's Wasatch Project.

September 23, 1989 (Saturday)
Hidden Treasure mine, Dry Canyon, near Stockton, Tooele County (noncoal)

Joshua Dennis, 10, of Kearns was exploring the mine with his scout troop. He became separated from the group and was lost for five days underground. After an intensive search effort he was rescued uninjured, but required hospitalization.
The mine was sealed under the direction of the UAMRP by the landowner, Sharon Steel.

May 28, 1990 (Monday)
Mutual Metals Tunnel, Big Cottonwood Canyon, Salt Lake County (noncoal)

The UAMRP received several reports of parties of explorers entering the mine over the previous weekend. All groups reported encountering bad air and nearly passing out.
The mine was closed in June, 1990 as part of the UAMRP's Wasatch Project.

April 1, 1991 (Monday)
Unknown mine, Muddy Creek area near Goblin Valley, Emery County (noncoal)

Jim Grail of Salt Lake City reported finding an open box of dynamite just inside the mine portal while visiting the area on the previous weekend.
The situation was reported to the Emery County sheriff for proper disposal of the dynamite.

Many more hazardous mines have been reported to the UAMRP, but without incident. The program receives calls from the public about once a week.

APPENDIX B

Detailed Estimation Methodology

Estimating Mining Impacts

The Computerized Resources Information Base (CRIB) data base was the primary source of information used to estimate the mining impacts presented in the Data Summary Table. CRIB contains a variety of information on mineral occurrence and development. The information includes all minerals mined in the state. Most records have been field verified. In the absence of a comprehensive field inventory of abandoned mine sites, CRIB was used as the closest equivalent.

The CRIB data base does have its limitations, however, for this purpose. Many of the records have blank, incomplete, or inconsistently completed fields. Much of the data cannot be used for determining mining impacts. Consequently the mining impact estimates entailed making many assumptions that affect the reliability of the results. Also, the data were collected for different purposes from what they are used for here. What is significant to a geologist is not necessarily what is significant to the reclamationist. For example, a 20-foot-deep prospect pit in the midst of other workings may not merit recording by a geologist, but would still be a safety hazard needing to be reclaimed. For this reason, where CRIB provides information on surface disturbance and mine workings, it often understates what is actually there.

CRIB information was used only to estimate the impacts of mines, since the data base does not contain smelters or millsites. The overall approach was one based on whole population attributes rather than on individuals. In other words, we made broad statistical inferences from the CRIB data, rather than adding up information for each individual record. For example, "Ownership" was calculated by multiplying the total estimated "Disturbed Area" by the land ownership proportions of the CRIB records. We did not add up the area of each site in each ownership category. This approach produces estimates with lower confidence levels, but it is a faster way to evaluate a large number of records. Given the limitations of many of the CRIB records and the many assumptions necessary to estimate disturbance at individual sites, an individual record approach would also yield relatively low confidence levels.

The CRIB data base in Utah is maintained by the Utah Geological and Mineral Survey (UGMS). CRIB contains 9,240 separate records for mineral locations in Utah. UGMS copied 25 fields from the source data base to the AMR Program for analysis. The fields contained information on site name, location, landowner, activity status, production, and descriptions of workings. To save computer storage space the "Description of Workings" text field was truncated at 100 characters. This was long enough for most records, but some with long descriptions were cut off. All other fields were long enough to avoid significant truncation.

The first step after acquiring the data base was to separate the records by commodity into the six main "Mineral Type" groupings. All subsequent analyses were performed within a "Mineral Type."

CRIB Commodity Code

The CRIB data base contains a commodity field for each record. This field contains one or more 1-4 character codes representing commodity types. The records were divided into the IAM inventory's six "Mineral Type" groups as listed below. In most cases all of the commodities listed for a record were in the same "Mineral Type" group (e.g. AG, AU, and CU occur together and are all metals). A small fraction of the records had commodities in two "Mineral Type" groups (e.g. SHL and GEM may occur together but are classed as construction ores and industrial ores, respectively). Where a record has more than one commodity listed, the first represents the primary commodity and only the first code was used to assign the record to a "Mineral Type."

CRIB contains 1,387 records for commodities that are not under consideration for this report (coal, petroleum, etc.). Screening these out leaves 7,843 records for further analysis. These break down into mineral types as follows:

Metallic Ores:

2,686 records; 21 commodities
Four commodities (lead, silver, copper, gold) account for 1,938 records, or 72%.

Construction Ores:
2,468 records; 20 commodities
Sand and gravel pits account for 1,987 records, or 81%.

Industrial Ores:
488 records; 27 commodities

Phosphate Rock:
68 records; 1 commodity

Uranium Overburden:
2,000 records; 2 commodities
All but one record were for uranium mines.

Oil Shale:
5 records; 1 commodity

Other:
148 records; 3 commodities
This group contains minerals extracted from the waters and salt flats of the Great Salt Lake. All but five records, or 97%, are for brines.

CRIB Activity Status Code

CRIB uses eight codes to indicate the development and activity status of a record. These are listed below. Codes 2, 4, 6, and 8 were considered inactive for the purposes of this report.

CRIB Code	Description
1	Occurrence: no development or activity; inactive
2	Prospect, inactive
3	Prospect, active
4	Little developed producer, inactive
5	Little developed producer, active
6	Developed producer, inactive
7	Developed producer, active
8	Intermittent producer
[ ]	No status indicated

CRIB Land Ownership Status Code

CRIB uses eighteen codes to indicate the land ownership status of a record. These are listed below.

CRIB Code	Description
00	Undetermined
01	Private
20	County
30	State (undifferentiated)
31	State Forest
32	State Park
33	State Offshore
40	Federal (undifferentiated)
41	National Forest
42	National Recreation Area
43	National Wilderness Area
44	National Primitive Area
45	National Park

46	National Monument
47	Indian Reservation
48	Federal Offshore
49	Bureau of Land Management Administered
50	Military Reservation
[ ]	No status indicated

Disturbance Estimates for METALLIC ORES

The following commodities were included in the METALLIC ORES Mineral Type:

CRIB Code	Description
AG	Silver
AL	Aluminum (general)
AL3	Alunite
AU	Gold
BE	Beryllium
CU	Copper
FE	Iron
GA	Gallium
HG	Mercury
MG	Magnesium
MN	Manganese
MO	Molybdenum
NB	Niobium (Columbium)
PB	Lead
PT	Platinum
RE	Rhenium
SB	Antimony
TI	Titanium
V	Vanadium
W	Tungsten
ZN	Zinc

Metallic Ores Activity Status Table

CRIB Code	Description	Number of Records	Per Cent
1	Occurrence; no development	311	11.58%
2	Prospect, inactive	903	33.62%
3	Prospect, active	59	2.20%
4	Little developed producer, inactive	380	14.15%
5	Little developed producer, active	4	0.15%
6	Developed producer, inactive	717	26.69%
7	Developed producer, active	30	1.12%
8	Intermittent producer	279	10.39%
blank	No status indicated	3	0.11%
other	Data entry error	0	0.00%
Total number of records		2,686	
Total records with development (codes 2-8)		2,372	
Total inactive status records (codes 2,4,6,8)		2,279	96.08%
Total of active status records (codes 3,5,7)		93	3.92%

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Metallic Ores Land Ownership Status Table

CRIB Code	Description	Number of Records	Per Cent
01	Private	909	33.84%
20	County	0	0.00%
30-33	State	73	2.72%
40-50	Federal	837	31.16%
00	Undetermined	1	0.04%
blank	No status indicated	865	32.20%
other	Data entry error	1	0.04%

Total number of records		2,686	
Records with owner indicated		1,819	
Percentage Private			49.97%
Percentage State			4.01%
Percentage Federal			46.01%

The information on site development in CRIB is not provided in all cases and thus not useful for determining amounts of mined land disturbance. The narrative site descriptions, where they existed at all, tended to understate the actual number of openings by as much as eight times. The Utah AMR Program has only begun to field survey metal ore mines. However, we do have surveys of several areas that are complete. To estimate the number of mine openings, we compared known, surveyed areas with the CRIB data for the same areas. The areas were chosen arbitrarily based on the availability, accuracy, and accessibility of the inventory data. All areas covered 2-5 square miles and contained multiple mine sites. The CRIB/field data comparison is presented in the table below:

Reference Area	Number of CRIB Records	Number of Openings	Openings Per Record
Silver Reef	9	240	26.7
Promontory Point	12	101	8.4
West Tintic Mtns	16	60	3.8
Davenport/Twin Lks	15	118	7.9
Mouth of Little Cottonwood Canyon	11	39	3.5
Brighton East	16	18	1.1
Mill D Fork	18	41	2.3
	--	---	----
Total	97	617	6.4

From this we chose to use an estimate of 6 mine openings per CRIB record as a representative average. CRIB has 2,686 records for Metallic Ores commodities. Of these, 311 are records of undeveloped mineral occurrences, 93 are active, and 3 are unidentified, leaving 2,279 records of inactive developed sites (see the Activity Status table). At the estimated 6 mine openings per record, this gives a statewide total of 13,674 inactive mine openings.

We assumed the area of mine dumps and other disturbance to be more a function of the number of openings than of the number of mine sites (i.e. CRIB records). For mine dumps we assumed an average of 0.1 acre per opening. Most dumps in the state encountered so far are smaller than this. Larger dumps exist, but they are usually associated with multiple openings where the individual contribution of an opening is small. For disturbed area we assumed 0.5 acres per opening. This is in line with the disturbance observed at the Silver Reef and West Tintic sites inventoried by the UAMRP. These assumptions yield 1,367 acres of mine dumps and 6,837 acres of disturbed land.

Disturbance Estimates for CONSTRUCTION ORES

The following commodities were included in the CONSTRUCTION ORES Mineral Type:

CRIB Code	Description
CER	Cement Rock (natural)
CLY	Clay (general)

CLY1 Bentonite
CLY3 Kaolin or Kaolinitic Clay (includes high alumina clay)
CLY5 Fire Clay (refractory)
CLY7 Common Brick Clay
GRT Granite, Granitic Gneiss
GYP Gypsum, Anhydrite
LST Limestone (general)
LST2 High Calcium Limestone ($CaCO_3$ > 95%)
MBL Marble
MON Monazite
QTZ Quartz
SDG Sand and Gravel
SHL Shale
SST Sandstone
SLA Slate
STN Stone
STN1 Crushed/Broken Stone (includes road metal, riprap, scoria, slag, clinker, baked clay, red dog)
STN2 Dimension or Building Stone

Construction Ores Activity Status Table

CRIB Code	Description	Number of Records	Per Cent
1	Occurrence; no development	296	11.99%
2	Prospect, inactive	167	6.77%
3	Prospect, active	11	0.45%
4	Little developed producer, inactive	720	29.17%
5	Little developed producer, active	8	0.32%
6	Developed producer, inactive	919	37.24%
7	Developed producer, active	258	10.45%
8	Intermittent producer	81	3.28%
blank	No status indicated	7	0.28%
other	Data entry error	1	0.04%
Total number of records		2,468	
Total records with development (codes 2-8)		2,164	
Total inactive status records (codes 2,4,6,8)		1,887	87.20%
Total active status records (codes 3,5,7)		277	12.80%

Construction Ores Land Ownership Status Table

CRIB Code	Description	Number of Records	Per Cent
01	Private	1,249	50.61%
20	County	10	0.41%
30-33	State	154	6.24%
40-50	Federal	947	38.37%
00	Undetermined	3	0.12%
blank	No status indicated	104	4.21%
other	Data entry error	1	0.04%
Total number of records		2,468	
Records with owner indicated		2,360	
Percentage Private			52.92%
Percentage State			6.53%
Percentage Federal			40.13%

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CRIB lists 2,468 records for the construction ore commodities, mostly for sand and gravel pits. Of the 2,468 total records, 1,887 are records for inactive sites (Status Code = 2, 4, 6, or 8). The CRIB data do not give suitable information to determine Polluted Water or Hazardous Structures occurrences. Many records did provide the area of the workings or pit dimensions, however, and these provided the basis for the disturbance estimates. Of the records where the area of workings was provided, about 95 records (or 5%) could be interpreted as having areas over ten acres, and only seven had areas over 100 acres. Two of these were described as larger than 200 acres. One record was for a 1,945-acre sand and gravel pit and the other was for a gypsum mine described as covering 4 square miles (2,560 acres). Because these two record were so atypical, we decided to deal with them separately, leaving 1,885 records to be sampled. As might be expected for these commodities, nearly all the records are for surface excavations of horizontal deposits. The "Area of Workings" information thus has high reliability since it is easily measured directly or estimated accurately by a field investigator. To derive the disturbance estimates, 94 records were sampled randomly and information on the extent of mining noted. From this information we estimated the disturbance making the following assumptions:

- Sand and gravel pits had no mine dumps (i.e. all material excavated was removed for use). Other commodities had overburden or waste rock that was discarded in mine dumps. The size of mine dumps was proportional to the size of the workings.
- Minimum area of disturbance for a record if any development was indicated was 0.1 acre.
- Highwalls were assumed if the depth of the deposit was greater than 15 feet or if the production was listed as medium or large. Highwall length was calculated by figuring the dimensions of the site as a square and taking two sides as highwalls (e.g. 3 acres = 130,680 sqft, or 361' x 361' if square; highwall length = 2 x 361 = 722 ft).
- For records with the area of workings less than 1.0 acre, we assumed an equal area of related disturbance. For workings of 1-10 acres, we assumed 1-2 acres of related disturbance. For workings over 10 acres, we assumed 2-5 acres related disturbance, proportional to the workings area.

After estimating disturbances, the estimates for the 94 records were summed, giving the following totals:

Mine Dumps	11.7 acres
Disturbed Land	341.2 acres
Highwalls	22,518 ft
Mine Openings	13
Subsidence Prone	1.5 acres
Other	2 trash dumps

Multiplying these totals by 20 (1,885 total records/94 records in sample) gives the following statewide estimates (for sites less than 200 acres):

Mine Dumps	234 acres
Disturbed Land	6,824 acres
Highwalls	450,360 ft
Mine Openings	260
Subsidence Prone	30 acres
Other	40 trash dumps

We estimated disturbances for the two records described by CRIB as larger than 200 acres using the same assumptions listed above, giving the following estimates:

Mine Dumps	640 acres
Disturbed Land	4,505 acres
Highwalls	2,000 ft
Mine Openings	0
Subsidence Prone	0 acres

Adding the two sets of estimates above together (small plus large sites) gives the following statewide estimates:

Mine Dumps	874 acres
Disturbed Land	11,329 acres
Highwalls	452,360 ft = 85.7 miles
Mine Openings	260
Subsidence Prone	30 acres

Haz. Structures	94*
Other	40 trash dumps

(* The estimated number of hazardous structures above is based on an arbitrary assumption of one site in 20 having a structure.)

The accuracy of these estimates depends on the completeness and accuracy of the original CRIB data and on the subsequent assumptions used to derive the estimates. The estimates were based on a sample of only about 5% of the total. The Disturbed Land estimate is the most reliable, since it is based on fairly reasonable assumptions and the strongest CRIB data. The average of 3.6 acres per site is reasonable. The other estimates are less reliable, since they are based on much more tenuous assumptions. Overall, there is probably about a 20% confidence level in the estimates.

Disturbance Estimates for INDUSTRIAL ORES

The following commodities were included in the INDUSTRIAL ORES Mineral Type:

CRIB Code	Description
AS	Arsenic
ASB	Asbestos
BA	Barium, Barite
BI	Bismuth
BIT	Ozokerite
C	Carbon
CA	Calcium
CAR	Carbonates
DIT	Diatomite
DOL	Dolomite
DOL1	Ultra Pure Dolomite
F	Fluorine, Fluorite
GAR	Garnet
GEM	Gemstones
GRF	Graphite
K	Potassium
KYN	Kyanite, Sillimanite, Andalusite, Dumortierite
LWA	Lightweight Aggregate
MIC	Mica (general)
PER	Perlite
PUM	Pumice
S	Sulfur
SAM	Sand, Molding
SAO	Tar Sands
SIL	Silica
TLC	Talc, Soapstone
VOL	Volcanic Materials (ash, cinders)

Industrial Ores Activity Status Table

CRIB Code	Description	Number of Records	Per Cent
1	Occurrence; no development	127	26.02%
2	Prospect, inactive	103	21.11%
3	Prospect, active	19	3.89%
4	Little developed producer, inactive	104	21.31%
5	Little developed producer, active	1	0.20%
6	Developed producer, inactive	79	16.19%
7	Developed producer, active	16	3.28%
8	Intermittent producer	39	7.99%
blank	No status indicated	0	0.00%
other	Data entry error	0	0.00%

Total number of records	488	
Total records with development (codes 2-8)	361	
Total inactive status records (codes 2,4,6,8)	325	90.03%
Total active status records (codes 3,5,7)	36	9.97%

Industrial Ores Land Ownership Status Table

CRIB Code	Description	Number of Records	Per Cent
01	Private	93	18.67%
20	County	0	0.00%
30-33	State	34	6.28%
40-50	Federal	281	59.70%
00	Undetermined	0	0.00%
blank	No status indicated	80	15.34%
other	Data entry error	0	0.00%
Total number of records		488	
Records with owner indicated		408	
Percentage Private			22.79%
Percentage State			8.33%
Percentage Federal			68.87%

CRIB lists 488 records for the industrial ore commodities. Of these, 325 are records for inactive sites (Status Code = 2, 4, 6, or 8). The CRIB data do not give suitable information to determine Polluted Water or Hazardous Structures occurrences. Many records did provide the area of the workings or pit dimensions, however, and these provided the basis for the disturbance estimates. Of the records where the area of workings was provided, only 17 had areas greater than one acre. Of these, only 3 were over ten acres (72, 100, 160 acres). Because these records were so atypical, we decided to deal with them separately, leaving 322 records to be sampled. To derive the disturbance estimates, 64 records were sampled randomly and information on the extent of mining noted. From this information we estimated the disturbance making the following assumptions:

- For commodities mined by underground methods where no information on workings was provided and no production was indicated (Production code = N), we assumed a minimum disturbance of 1 mine opening, 0.1 acre mine dump, and 0.2 acre disturbed area.
- For commodities mined by underground methods where no information on workings was provided and production was indicated (Production code = Y, S, M, or L), we assumed a minimum disturbance of 2 mine openings, 0.2 acre mine dump, and 0.5 acre disturbed area.
- Each mine opening had 0.1 acre mine dump and 0.1 acre subsidence prone area.
- For commodities mined by surface methods where no information on workings was provided and no production was indicated (Production code = N), we assumed a minimum disturbance of 0.1 acre disturbed area.
- For commodities mined by surface methods where no information on workings was provided and production was indicated (Production code = Y, S, M, or L), we assumed a minimum disturbance of 0.2 acre mine dump and 1.0 acre disturbed area.
- Surface mined commodities had overburden or waste rock that was discarded in mine dumps. The size of mine dumps was approximately one fourth the size of the workings.
- Highwalls were assumed if the depth of the deposit was greater than 15 feet or if the production was listed as medium or large. Highwall length was calculated by figuring the the dimensions of the site as a square and taking two sides as highwalls (e.g. 3 acres = 130,680 sqft. or 361' x 361' if square; highwall = 2 x 361 = 722 ft).
- For records with the area of workings less than 1.0 acre, we assumed an equal area of related disturbance.

After estimating disturbances, the estimates for the 64 records were summed, giving the following totals:

Mine Dumps	13.9 acres
Disturbed Land	75.0 acres
Highwalls	4,052 ft
Mine Openings	86
Subsidence Prone	7.4 acres

Multiplying these totals by 5 (322 total records/64 records in sample) gives the following statewide estimates (for sites less than ten acres):

Mine Dumps	69.5 acres
Disturbed Land	375.0 acres
Highwalls	20,260 ft
Mine Openings	430
Subsidence Prone	37.0 acres

We estimated disturbances for the three records described by CRIB as larger than ten acres using the same assumptions listed above, giving the following estimates:

Mine Dumps	58.0 acres
Disturbed Land	332 acres
Highwalls	4,550 ft
Mine Openings	0
Subsidence Prone	0 acres

Adding the two sets of estimates above together (small plus large sites) gives the following statewide estimates:

Mine Dumps	128 acres
Disturbed Land	707 acres
Highwalls	24,810 ft = 4.7 miles
Mine Openings	430
Subsidence Prone	37 acres
Haz. Structures	16*

(* The estimated number of hazardous structures above is based on an arbitrary assumption of one site in 20 having a structure.)

The accuracy of these estimates depends on the completeness and accuracy of the original CRIB data and on the subsequent assumptions used to derive the estimates. The estimates were based on a sample of only about 20% of the total. Overall, there is probably about a 20% confidence level in the estimates.

Disturbance Estimates for PHOSPHATE ROCK

The following commodity was included in the PHOSPHATE ROCK Mineral Type:

CRIB Code	Description
P	Phosphorus-Phosphates

Phosphate Rock Activity Status Table

CRIB Code	Description	Number of Records	Per Cent
1	Occurrence, no development	21	30.88%
2	Prospect, inactive	28	41.18%
3	Prospect, active	2	2.94%
4	Little developed producer, inactive	9	13.24%
5	Little developed producer, active	0	0.00%
6	Developed producer, inactive	7	10.29%
7	Developed producer, active	1	1.47%

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8	Intermittent producer	0	0.00%
blank	No status indicated	0	0.00%
other	Data entry error	0	0.00%

Total number of records		68	
Total records with development (codes 2-8)		47	
Total inactive status records (codes 2,4,6,8)		44	93.62%
Total active status records (codes 3,5,7)		3	6.38%

Phosphate Rock Land Ownership Status Table

CRIB Code	Description	Number of Records	Per Cent
01	Private	22	32.35%
20	County	0	0.00%
30-33	State	3	4.41%
40-50	Federal	28	41.18%
00	Undetermined	0	0.00%
blank	No status indicated	15	22.06%
other	Data entry error	0	0.00%

Total number of records		68	
Records with owner indicated		53	
Percentage Private			41.51%
Percentage State			5.66%
Percentage Federal			52.83%

CRIB lists 68 records for phosphate deposits. Of these, 21 records are for undeveloped mineral occurrences, leaving 47 records for developed mine sites. The most significant area of inactive phosphate mining activity in Utah is in the Crawford Mountains in Rich County. Eleven CRIB records are for sites in this area. All of the remaining records are listed as prospects (Activity Status code = 2). They are scattered about the state and represent, for the most part, older prospects and small underground mines. The Crawford Mountains mining activity is more recent and much larger in scope. It includes both large surface and extensive underground operations.

Estimates of mine hazards and disturbance for sites in the Crawford Mountains are based on a 1991 engineering feasibility study of the area performed for the Utah AMR Program by Morgan Mining and Environmental Consultants of Lexington, Kentucky (contact: John Morgan, 606-223-1591). This study gives the following estimates:

Polluted Water	Not determined
Mine Dumps	64.3 acres
Disturbed Land	346 acres
Highwalls	3.8 miles
Mine Openings	86
Subsidence Prone	8.2 miles
Haz. Structures	0
Other	na

Estimates of mine hazards and disturbance for the 36 remaining CRIB records are based on the descriptions of workings in the records with descriptions. There are no descriptions for subsidence prone so we assumed 0.1 acre subsidence prone per opening. All of the CRIB data suggest very small sites with little disturbance. The CRIB information gives the following estimates:

Polluted Water	Not determined
Mine Dumps	1.3 acres
Disturbed Land	3.8 acres
Highwalls	0.1 miles
Mine Openings	26
Subsidence Prone	2.6 acres
Haz. Structures	0

Other	na

Adding the estimates from the Crawford Mountains study to these estimates gives these statewide totals for the Data Summary Table:

Polluted Water	Not determined
Mine Dumps	66 acres
Disturbed Land	350 acres
Highwalls	4 miles
Mine Openings	112
Subsidence Prone	11 acres
Haz. Structures	1
Other	0

The Crawford Mountain study, which is up-to-date, comprehensive, and accurate, makes up the core of the estimates, so they can be given about a 80% confidence level.

Disturbance Estimates for URANIUM OVERBURDEN

The following commodities were included in the URANIUM OVERBURDEN Mineral Type:

CRIB Code	Description
RA	Radium
U	Uranium

Uranium Overburden Activity Status Table

CRIB Code	Description	Number of Records	Per Cent
1	Occurrence, no development	441	22.05%
2	Prospect, inactive	260	13.00%
3	Prospect, active	22	1.10%
4	Little developed producer, inactive	249	12.45%
5	Little developed producer, active	0	0.00%
6	Developed producer, inactive	385	19.25%
7	Developed producer, active	55	2.75%
8	Intermittent producer	588	29.40%
blank	No status indicated	0	0.00%
other	Data entry error	0	0.00%

Total number of records		2,000	
Total records with development (codes 2-8)		1,559	
Total inactive status records (codes 2,4,6,8)		1,482	95.06%
Total active status records (codes 3,5,7)		77	4.94%

Uranium Overburden Land Ownership Status Table

CRIB Code	Description	Number of Records	Per Cent
01	Private	20	1.00%
20	County	0	0.00%
30-33	State	71	3.55%
40-50	Federal	874	43.70%
00	Undetermined	0	0.00%
blank	No status indicated	1034	51.70%
other	Data entry error	1	0.05%

Total number of records		2,000	

Records with owner indicated	965	
Percentage Private		2.07%
Percentage State		7.36%
Percentage Federal		90.57%

The "Uranium Overburden" heading is misleading because most of Utah's abandoned uranium mines are underground mines. The problems associated with them are similar to those at the state's metal mines (shafts, adits, localized mine dumps) with the addition of radiologic concerns.

The information on site development in CRIB is not provided in all cases and thus is not useful for determining mined land disturbance. The narrative site descriptions, where they existed at all, tended to understate the actual number of openings by about half. The Utah AMR Program has only field surveyed a fraction of the state's abandoned uranium mining. To estimate the number of mine openings, we compared a known, surveyed area (six sections in the Thompson Mining District in Grand County) with the CRIB data for the same area. The area was chosen based on the availability, accuracy, and accessibility of the inventory data. The CRIB/Field data comparison is presented in the table below:

Reference Area	Number of CRIB Records	Number of Openings	Openings Per Record
22 S 22 E 31	13	8	0.62
23 S 21 E 1	8	9	1.13
23 S 22 E 6	30	67	2.23
23 S 22 E 7	4	11	2.75
23 S 21 E 11	4	6	1.50
23 S 21 E 12	6	22	3.67
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TOTAL	65	123	1.89

From this we chose to use an estimate of 2 mine openings per CRIB record as a representative average. CRIB has 2,000 records for Uranium Ore commodities. Of these, 441 are records of undeveloped mineral occurrences and 77 are active. This leaves 1,482 records of inactive developed sites (see the Activity Status table). At the estimated 2 mine openings per record, this gives a statewide total of 2,964 inactive mine openings. We used the same method for determining the other disturbances. The representative averages derived are: mine dumps, 0.13 acres per record; disturbed land, 0.55 acres per record; highwalls, 12.54 feet per record; subsidence prone, 150.15 feet per record; and hazardous structures, 0.05 per record.

This method yields the following totals:

Mine Dumps	364 acres
Disturbed Land	1,541 acres
Highwalls	3.52 miles
Mine Openings	2,964
Subsidence Prone	5 acres
Haz. Structures	68

Disturbance Estimates for OIL SHALE

The following commodity was included in the OIL SHALE Mineral Type:

CRIB Code	Description
SHO	Oil Shale

Oil Shale Activity Status Table

CRIB Code	Description	Number of Records	Per Cent
1	Occurrence; no development	0	0.00%
2	Prospect, inactive	5	100.00%
3	Prospect, active	0	0.00%

4	Little developed producer, inactive	0	0.00%
5	Little developed producer, active	0	0.00%
6	Developed producer, inactive	0	0.00%
7	Developed producer, active	0	0.00%
8	Intermittent producer	0	0.00%
blank	No status indicated	0	0.00%
other	Data entry error	0	0.00%

Total number of records		5	
Total records with development (codes 2-8)		5	
Total inactive status records (codes 2,4,6,8)		5	100.00%
Total active status records (codes 3,5,7)		0	0.00%

Oil Shale Land Ownership Status Table

CRIB Code	Description	Number of Records	Per Cent
01	Private	0	0.00%
20	County	0	0.00%
30-33	State	0	0.00%
40-50	Federal	5	100.00%
00	Undetermined	0	0.00%
blank	No status indicated	0	0.00%
other	Data entry error	0	0.00%

Total number of records		5	
Records with owner indicated		5	
Percentage Private			0.00%
Percentage State			0.00%
Percentage Federal			100 00%

CRIB lists only five records for oil shale. All five are described as inactive prospects with no production. Only two of the records have workings described, and these are less than an acre. Using 0.1 acre mine dump, 1.0 acre disturbed land, 1 mine opening, and 0.2 acre subsidence prone area as a representative, typical site gives the following estimate for the Data Summary Table:

Polluted Water	Not determined
Mine Dumps	0.5 acres
Disturbed Land	5 acres
Highwalls	0 miles
Mine Openings	5
Subsidence Prone	1 acre
Haz. Structures	0
Other	0

Disturbance Estimates for OTHER MINING

The following commodities were included in the "OTHER" Mineral Type:

CRIB Code	Description
BRI	Brines/Salines
HAL	Halite
NA	Sodium

Other Mining Activity Status Table

CRIB Code	Description	Number of Records	Per Cent
1	Occurrence; no development	79	53.38%
2	Prospect, inactive	7	4.73%
3	Prospect, active	26	17.57%
4	Little developed producer, inactive	8	5.41%
5	Little developed producer, active	0	0.00%
6	Developed producer, inactive	2	1.35%
7	Developed producer, active	25	16.89%
8	Intermittent producer	1	0.68%
blank	No status indicated	0	0.00%
other	Data entry error	0	0.00%

Total number of records		148	
Total records with development (codes 2-8)			69
Total inactive status records (codes 2,4,6,8)		18	26.09%
Total active status records (codes 3,5,7)		51	73.91%

Other Mining Land Ownership Status Table

CRIB Code	Description	Number of Records	Per Cent
01	Private	20	13.51%
20	County	0	0.00%
30-33	State	63	42.57%
40-50	Federal	64	43.24%
00	Undetermined	0	0.00%
blank	No status indicated	1	0.68%
other	Data entry error	0	0.00%

Total number of records		148	
Records with owner indicated		147	
Percentage Private			13.61%
Percentage State			42.86%
Percentage Federal			43.54%

The commodities included in this category are minerals extracted by evaporation from the waters of the Great Salt Lake. This method of mineral production has environmental effects that are difficult to evaluate in the terms of this study. Large areas of land are affected, but without the disturbance features of extraction by excavation. These minerals are noted here, but are not included in the disturbance estimates on the Data Summary Table.

Land Ownership Estimates

Land ownership acreage for mines was calculated using the "Disturbed Land" acreage estimate for each mineral type. The acreage was distributed among the ownership categories proportionally to the ownership distribution of the CRIB records. The ownership proportions were calculated using records for both inactive and active sites. See the land ownership tables under each Mineral Type heading above.

This approach assumes a uniform distribution of site sizes among the ownership categories. This may not be true. For example, active sites may (and probably do) tend to be larger than inactive sites, or privately owned sites may tend to be larger than sites on public land. Differences such as these would have the effect of increasing the error in the estimates. Since the number of active records in all of the mineral types is relatively small, the contribution to error from including them in the proportion calculations should also be quite small.

Another, probably more significant, source of error in the estimates is the CRIB data itself. We do not know how accurate it is. For example, we do not know if the CRIB reporters distinguished patented claims within larger blocks of federal land as private.

INACTIVE/ABANDONED MINE INVENTORY - UTAH
APPENDIX B

For the sake of comparison, the distribution of land ownership in Utah is 67.1% federal, 21.5% private, and 7.2% state. If sites (or CRIB records) were randomly distributed, they would be expected to have the same distribution. All of the mineral types deviated from this breakdown. However, UAMRP experience over nine years has shown that at least 75-80% of mine sites exist on private (fee) lands.

All millsites were assumed to be on private land.

Polluted Water Estimates

No agency has yet performed a comprehensive statewide study of effects of abandoned mines on water quality. A few studies have looked at water quality in particular mining areas. Water quality impacts from abandoned metal mines in Big and Little Cottonwood Canyons were specifically investigated in a 1987 joint Division of Oil, Gas & Mining/Salt Lake County report entitled *Water Quality in the Cottonwood Canyon's Watershed: Impacts From Abandoned Metal Mines – a Preliminary Report*. The Uinta National Forest assessed water quality impacts of mine drainages in the Sheeprock Mountains and North Fork of the American Fork River in 1988. Both reports documented mine discharges with low pH and/or elevated metals at several mines, but found downstream impacts harder to determine. Reaches of streams with unknown but potential water quality problems include Big and Little Cottonwood creeks, Bingham Creek, American Fork, and Silver Creek.

Many of Utah's mines occur in remote, arid regions. These areas have is little water to be affected and few people to be at risk. A notable exception is the Wasatch Front metropolitan area where heavily mined areas are used as municipal culinary watershed, and water pollution from mining could create a public health threat. When streams in the arid, remote districts do flow, it is normally in direct response to high intensity rainfall events. While it is likely that such events may flush sediments and metals into ephemeral and intermittent channels, it is unlikely that ambient water quality monitoring programs would pick up such high intensity, short duration flows.

Water quality problems cannot be estimated confidently from the CRIB data, either by inferring directly from the contents or by projecting from the number of records. The estimates of polluted water are based on information provided by the Bureau of Water Pollution Control (BWPC). The estimates include only those stream segments for which there is reasonable evidence (in the professional judgment of the BWPC) to suggest that they are either currently impacted or that further study is likely to be show a definite link between abandoned mines in the drainage and downstream water quality problems. The BWPC has identified approximately 83 miles of streams in Utah impacted by inactive/abandoned metal mines. However, they stress that this number only includes those stream segments known to BWPC and should not be represented as an estimate of total stream miles in the state affected by inactive/abandoned mines. No estimates are available for other mineral types. The BWPC has indicated a 90% confidence level that these stream miles are affected by inactive/abandoned mines. The confidence level that this figure is representative of the total impacted stream miles in the state is much lower, on the order of 5 to 10%

Millsite Disturbance Estimates

A literature review conducted for the Utah Geological and Mineral Survey (James, L.P. In Press. Nonferrous metals milling plants in Utah. UGMS Open File Report) has indicated that there have been about 100 nonferrous mill plants in Utah (active and abandoned). About 85 of these are described as smaller mills and can be assumed to be inactive. The larger sites are mostly either still active or were custom processors located away from the mines, and thus not under consideration here. Based on estimated production levels in the report and (arbitrarily) using 100 and 500 tons per day as cutoffs, the 85 sites can be broken down into groups of small (30), medium (25), large (5), and unknown (25) production. To estimate disturbance, we assumed the following: unknown production-- 1 structure, 1 acre tailings, 1 acre other disturbed land; small production-- 1 structure, 5 acres tailings, 2 acres other disturbance; medium production-- 2 structures, 10 acres tailings, 2 acres other disturbance; large production-- 3 structures, 15 acres tailings, 5 acres other disturbance. This gives the following statewide totals for metallic ores millsites:

Mine Dumps	500 acres
Disturbed Land	660 acres
Haz. Structures	120

These estimates should be given low confidence levels, about 10-20% We have assumed no mills for construction ores (no ore reduction), phosphate rock (no ore reduction), or oil shale (no development). We do not have adequate information on millsites for industrial ores or uranium to estimate disturbance. We have assumed all millsites to be on private land.

Smelter Impacts

Some on-site smelters may exist as problem areas in Utah, but not enough is known to quantify impacts. The literature review on millsites conducted for the Utah Geological and Mineral Survey (James, L.P. In Press. Nonferrous metals milling plants in Utah. UGMS Open File Report) notes that many remote mines tried on-site smelters to save on shipping costs, but were unable to realize the economies of scale necessary to smelt profitably. Most mines shipped milled ore to offsite smelters. The CERCLA Section of the Bureau of Environmental Response and Remediation has identified 20 to 25 inactive or abandoned milling and smelting sites. These are sites that have been ranked on the State CERCLIS list according to the federal priority ranking system. A few of these sites include the Bauer Tailings near Stockton, the Highland Boy Smelter in Murray, and the Lark Tailings near Lark. All of these sites are stand-alone operations not associated with an individual mine and not located on a mine site. Thus they are outside the scope of this report.

Reclamation Cost Analysis

Unit costs for reclamation were derived from actual costs for coal reclamation projects and bond estimates for noncoal active mines. Since the majority of the noncoal reclamation work is similar to coal reclamation, coal reclamation costs are generally applicable to noncoal. For nearly all of the commodities we were able to draw costs from recent reclamation work completed by our program or contractors. Also, reliable information on present day cost was gleaned from the bond estimates which are required in the applications for noncoal mining in Utah. Accumulated data from our reclamation projects show coal mine portal closures ranging from $2,500 to $6,000. Our experience with noncoal closures shows that they tend to be lower in cost. On the average, these costs range from $500 to $5,000, and generally under $2,000. General disturbed land reclamation (earthwork, revegetation) varies greatly with site conditions, but typically runs between $1,500 and $5,000 per acre. Revegetation alone is typically $900-1,500 per acre. We are assuming the following as average unit costs for reclamation work. These include both construction and project administration costs.

Features	Cost per unit
Polluted Water	500,000 $/mile
Mine Dumps	5,000 $/acre
Disturbed Land	1,500 $/acre
Highwalls	125,000 $/mile
Mine Openings	2,500 $/opening (most mineral types)
	3,000 $/opening (phosphate figures are based on the Crawford Mountains report)
Subsidence Prone	5,000 $/acre (phosphate figures are based on the Crawford Mountains report)
Haz. Structures	$2,000 each
Other	$1,000 each for trash dumps

Excluded Commodities

Commodities listed on the CRIB data base for Utah but excluded from analysis for this report are listed below:

CRIB Code	Description
CO2	Carbon Dioxide
COA	Coal (general)
COA2	Coal
COA3	Coal
COA4	Coal
GAS	Natural Gas
GEO	Geothermal
OIL	Petroleum
UNF	Unidentified
UNK	Unknown
[ ]	No commodity indicated
PRUI	Garbled record: data entry error

APPENDIX C

SAMPLE SITE INVENTORY FORM

SITE IDENTIFICATION

I.D. #__________________

Investigator____________

Date: _________________

Deposit Name: ________________________________ Mineral: ____________________

Planning District: ____________________________ County: ____________________

Cadastral: T. _____, R. _____, Sec: ____

Quadrangle: ____

Scale: ________________ Surface Ownership________________________________

Elevation: ____________________ Aspect: ____________________

Location Comments: ____

____

____

____

Photos

Roll	Frame	Description

Safety Score ________

Environmental Score _______

Socioeconomic Score _______

I.D. #________________

SITE MAP: (Include drainages, mine site hazards, structures)
(NOTE: Correct location on topo sheet)

dirt road	adit
trail	closed adit
gully	shaft
	subsidence

I.D. #______________

SAFETY INDEX SCORESHEET

Mine Site Hazards		Number			Comment Reference
Surface burning	( )*	______	x 10 pts =	______	______
Vertical openings (shafts)	( )	______	x 10 pts =	______	______
Dangerous gases	( )	______	x 10 pts =	______	______
Toxic chemicals & explosives	( )	______	x 10 pts =	______	______
Drinking water source threatened	( )	______	x 8 pts =	______	______
Horizontal openings (adits)	( )	______	x 8 pts =	______	______
Highwalls	( )	______	x 7 pts =	______	______
Dangerous slide area/unstable or steep slope Angle? _____	( )	______	x 5 pts =	______	______
Underground burning	( )	______	x 3 pts =	______	______
Subsidence	( )	______	x 2 pts =	______	______
Solid waste (trash & debris)	( )	______	x 2 pts =	______	______
Pits in mine area	( )	______	x 2 pts =	______	______
Equipment and structures: rate on a scale of 0 -10			( )	______	______

- 0 No structures, no equipment.
- 1-2-3 Foundations exist, walls may be standing but no (or very stable) roofs. Small equipment intact or equipment debris piles.
- 4-5-6 Wooden floor or deterioriating slab floor, walls stable, structures roofed or partially so, no floor damage(no drop off). Large equipment lying around or a substantieal pile of equipment and parts.
- 7-8-9 Deteriorating structure with roof and floor where stability is questionable. Large equipment standing that is stable, but that provides injury potential to someone climbing.
- 10 Clearly hazardous structures or equipment, unstable roof, floor and/or walls; large scale structures greater than 20 feet in height that one could climb on.

Safety Hazard Score ______

Exposure to public

Resident population within 2 miles (logical miles) 1 pt/household; maximum of 10 pts.	( )	______	______
Public facilities (businesses, school, churches, etc.) within 2 miles; 1 pt/facility; maximum of 10 pts	( )	______	______
Population with 40 miles (road miles)	( )	______	______

1. 0 - 1000
2. 1001 - 5000
3. 5001 - 10,000
4. 10,001 - 25,000
5. greater than 25,000

*( ) indicate data from literature, to be field checked

I.D. #______________

SAFETY INDEX SCORESHEET

			Comment Reference
Proximity to population centers of greater than 100 people	( )*	______	______

10. 0 - 5 miles (direct)
7. 5 - 10 miles (road)
4. 10 - 15 miles (road)
1. greater than 15 miles

Proximity to recreation areas (direct)	( )	______	______

0. none in area
1. recreation area within 2.5 miles
4. within 1 mile of low use recreation area
7. within 1 mile of medium use recreation area
10. within 1 mile of high use recreation area

Site usage and history	( )	______	______

0. none
5. evidence of site visitation (litter, graffiti, vandalism, etc.)
8. public welfare problem reported (property damage, safety incident without injury, etc.)
12. personal injury reported
15. fatality or life-threatening incident reported

Access (highest grade road within 1/2 mile)	( )	______	______

1. trail
2. ORV road
4. maintained dirt or gravel road
6. paved road
8. highway (2 or more marked lanes)

Exposure Score ______________

Safety Hazard Score ______________

SAFE[illegible] INDEX - Total = ______________

I.D. #___________

ENVIRONMENTAL INDEX SCORESHEET

Land Surface Impacts

		Number			Comment Reference
Highwall					
Avg height x length LT 2500 ft^2		_____	x 6 pts =	_____	_____
Avg height x length GT 2500 ft^2		_____	x 10 pts =	_____	_____
Openings		_____	x 2 pts =	_____	_____
Pits	_____	acres	x 10 pts/acre =	_____	_____
Blocked drainage	_____	acres	x 6 pts/acre =	_____	_____
Subsidence	_____	acres	x 10 pts/acre =	_____	_____
Erosion					
rills	_____	acres	x 8 pts/acre =	_____	_____
gullies	_____	acres	x 20 pts/acre =	_____	_____
Spoil pile/waste dump	_____	acres	x 4 pts/acre =	_____	_____
Coal storage area, tipple	_____	acres	x 4 pts/acre =	_____	_____
Disturbed soil profile and surface contour	_____	acres	x 6 pts/acre =	_____	_____
Burning-surface/underground	_____	acres	x 8 pts/acre =	_____	_____
Strip pits	_____	acres	x 8 pts/acre =	_____	_____
Total site area	_____	acres	x 1 pt /acre =	_____	_____
	Land Impacts Score = Total =			_____	_____

Onsite Water

Type of Water	Quality:					
None	0	0	0	0	_____	_____
Artificial impoundment						
LT 1 acre and LT 10 feet deep	0	2	4	6	_____	_____
LT 1 acre or LT 10 feet deep	0	4	6	8	_____	_____
Natural impoundment						
LT 1 acre and LT 10 feet deep	0	4	6	8	_____	_____
GT 1 acre or GT 10 feet deep	0	6	8	10	_____	_____
Stream	0	5	3	9	_____	_____
Water flowing from mine	0	3	3	9	_____	_____

*Chemical Contamination: acid, alkaline, saline, toxic

Onsite Water Score =_________

Q = _________

Iron = _________ml/l (GT .75)

pH = _________(GT 8.3 or LT 7.0)

Hardness = _________gr/gal

I.D. #________

ENVIRONMENTAL INDEX SCORESHEET

Vegetation

Surrounding (Baseline) Vegetation Type
--what site would be if mining had not occurred

Vegetation Type	Area	Comment Reference
0. Barren	acre= 70 yd x 70 yd	____
0. Salt Flat	1/2 acre= 50 yd x 50 yd	____
6. Salt Desert Grass or Shrub	1/4 acre= 35 yd x 35 yd	____
8. Hot Desert Shrub	1/8 acre= 25 yd x 25 yd	____
10. Cold Desert Shrub (Sagebrush)		
10. Pinyon-Juniper		
12. Mountain Brush-Pinderosa Pine		
13. Montane Forest (Aspen-Fir-Pine)		
13. Subalpine Forest (Spruce-Fir)		
12. Alpine Herbland		
6. Pastureland		
4. Cropland		
2. Urban		

Condition of Site Vegetation

	Acres			
Same as surrounding area				
Equally or more dense	____	x 0.0 =	____	____
Less dense	____	x 0.2 =	____	____
Different from surrounding area				
Advanced seral	____	x 0.3 =	____	____
Colonizers, weeds, abundant (GT 50%)	____	x 0.5 =	____	____
sparse (5-50%)	____	x 0.8 =	____	____
barren (LT 5%)	____	x 1.0 =	____	____
Site Condition Multiplier =	Total =	____		

Vegetation Score = ________ x ________ = ________

Surrounding Vegetation Score   Site Condition Multiplier

Endangered Species (Plant and Animal) (Additive) ____

0. no threatened or endangered species in vicinity
3. threatened species in vicinity
7. endangered species in vicinity
10. threatened or endangered species directly threatened by site conditions

( ) Endangered Species Score = ________

I.D. #____________

ENVIRONMENTAL INDEX SCORESHEET

Comment Reference

Wildlife Habitat (______) ______

0. within DWR crucial critical use area
0. within DWR high priority use area
0. within DWR substantial vaue use area
0. DWR limited value use area

Pollution

Water ______ ______

0. no impact
3. LT 1 mile downstream affected
5. 1 - 10 miles downstream affected
7. GT 10 miles downstream affected
7. offsite impoundment affected

Air quality ______ ______

0. no impact
3. occasional fumes, dust or odors
7. frequent fumes, dust or odors

Esthetics - site visible from ______ ______

1. trail
2. ORV road
3. maintained dirt or gravel road
4. paved road
5. highway (2 or more marked lanes)

Visual compatibility with surroundings ______ ______

0. high
1.
2.
3. low

Land Surface Impacts ______
On site water ______
Vegetation ______
Endangered Species ______
Wildlife ______
Pollution ______

ENVIRONMENTAL INDEX SCORE = ______

I.D. #______________

SOCIOECONOMIC INDEX SCORESHEET

		Comment Reference
Surrounding land use. (Highest #, if several apply)	________	________
Potential land use of mine site. 0. mining 3. designated public area, low use 4. private, low access; restricted 5. range land-grazing 8. agricultural 8. high use public area 11. residential 12. industrial-commercial	________	________
Proximity to active mine 1. less than 5 miles 4. 5 - 10 miles 7. greater than 10 miles	( )________	________
Mine site land ownership. 2. private 5. public	(________)	________
Proximity to archeological or historic sites 0. none in vicinity 5. actual or potential National Register site in vicinity 8. National Register site directly threatened by site conditions	(________)	________
Mine is located in U.S. Department of Labor Surplus Area? 3. yes 0. no	(________)	________
Unemployment rate of county (annual average). 0. less than 4.0% 2. 4.0 - 5.9% 4. 6.0 - 8.0% 8. greater than 8.0%	(________)	________
Percent of county population below poverty level (1980). 2. less than 10.0% 5. 10.0% or greater	(________)	________

SOCIOECONOMIC INDEX = Total Score = ____________

I.D. # ______________

SUBJECTIVE EVALUATION/NOTES

Historical and archaeological evidence:

Wildlife observations:
on site:

vicinity:

Entire site reclamation priority: High ______________________________ Low
Why?

I.D. # ______________

HAZARD DESCRIPTION

Feature:

Size/Materials ____

____

Slope ____

Aspect ____

Stability/condition ____

Access deterrents ____

Reclamation attempts ____

General Description ____

____

____

Degree of hazards ____

Reclamation potential & technique

Feature:

Size/Materials ____

____

Slope ____

Aspect ____

Stability/condition ____

Access deterrents ____

Reclamation attempts ____

General description ____

____

____

Degree of hazards ____

Reclamation potential & technique

INTERVIEWS:

Name: Phone:

Address:

Affiliation:

Comments:

I.D. # ____________

COMMENTS

REFERENCE | COMMENT

APPENDIX D

WASATCH PROJECT - INVENTORY SITE FORM

MINE SITE:______________________
CLAIM NAME:_____________________
SURFACE OWNER:__________________
____
____

FEATURE DESIGNATION (I.D.)#:____________
Township 1 2 3 4 South, Range 1 2 3 East
DRAINAGE :______________
ELEVATION :__________ft
Sec. ______ ASPECT :__________
SLOPE :__________ %

TYPE OF MINE OPENING
F ADIT
F Horizontal F Drainage
F Inclined F No Drainage
F SHAFT
F SUBSIDENCE
F OTHER ______________________
____

ACCESS TO SITE/OPENING
S O S O
F F 2-WD F F 4-WD
F F 2-WD access possible with substantial regrading
F F Rubber-tired backhoe
F F Crawler equipment
F F Helicopter F F Foot

CONDITION OF ENTRANCE
F Completely collapsed, no access
F Partially collapsed or backfilled at portal, mine visible but not accessible
F Partially collapsed or backfilled at portal, mine workings accessible
F Portal open for access with little or no backfill or collapse
F Obstruction at adit makes evaluation of of condition impossible
F Existing wall, fence, or grate
F intact, acceptable
F intact, unacceptable
F damaged, mine accessible
F Other ______________________
____
____

APPROXIMATE SIZE OF MINE OPENING

Height:_____ft Width:_____ft
Length:_____ft Depth:_____ft

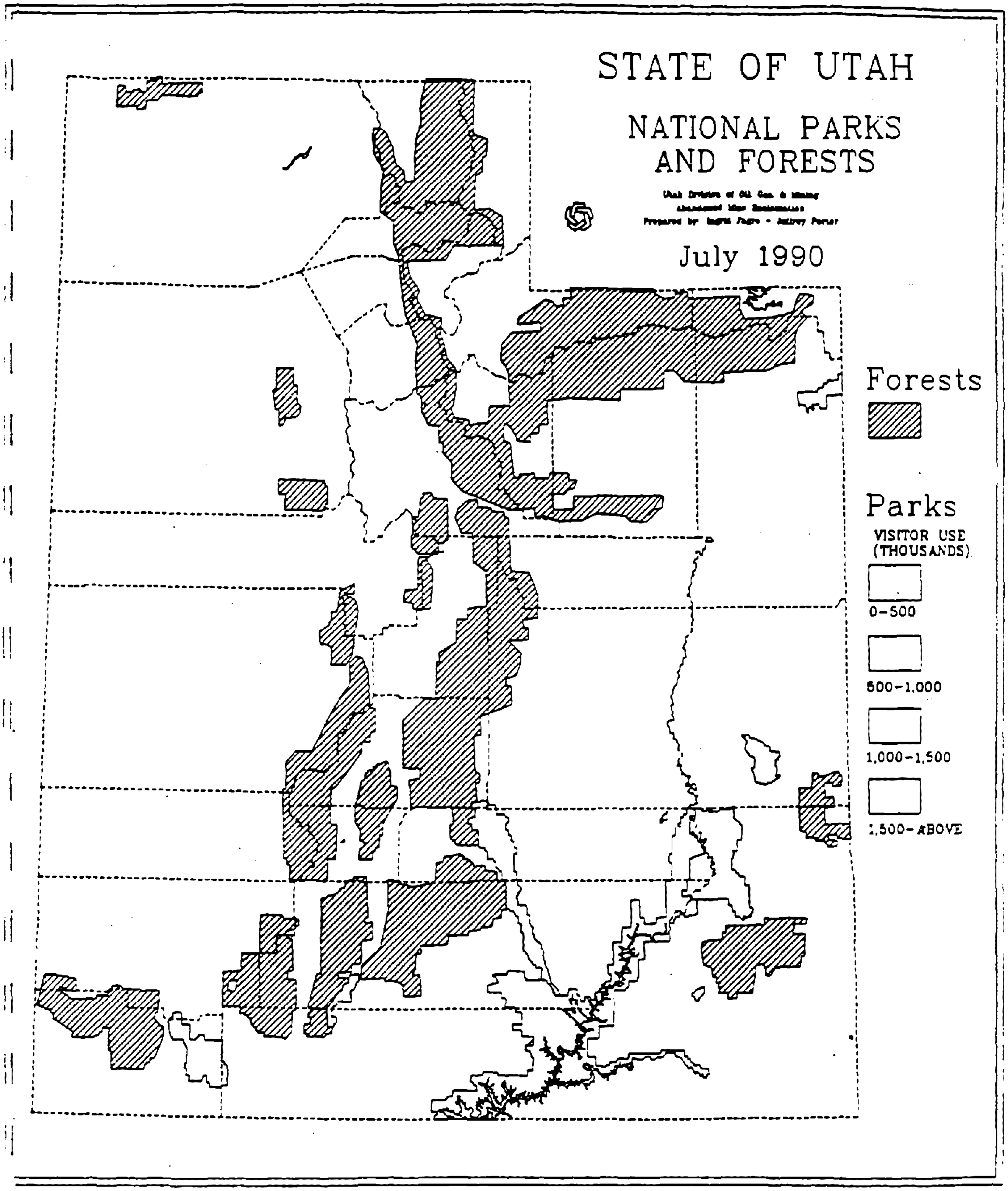
RECOMMENDED CLOSURE ACTION
F Bulkhead, No Drain
F Bulkhead, With Drain
F Bulkhead & Backfill, No Drain
F Bulkhead & Backfill, With Drain
F Backfill
F Probe for Mine Opening
F Grate Closure Method
F No Closure Required
F Local Site Clean-up & Regrading
F Structure Demolition
F Other ______________________
____
____

BACKFILL METHOD
F Hand
F Equipment
F Hand & Equipment
F No Backfill
F Other________________

BULKHEAD
Size: _____ft high x _____ft wide
Depth from brow to bulkhead: _____ft
F Material available onsite
F Material not available onsite

BACKFILL MATERIAL
Depth of placement, inby from brow: _____ft
Estimated volume of backfill needed: _____cyds
Source: F Mine Dump
Dimensions: (length) _____ft x (width) _____ft x (height) _____ft
Estimated volume ________________cyds
Location F Downslope F Adjacent
F Upslope F Distant _____ft
Particle size: ______________________
F Other ______________________________
F None on site
Description of unusual conditions____
____

AM42/2 11/16/88



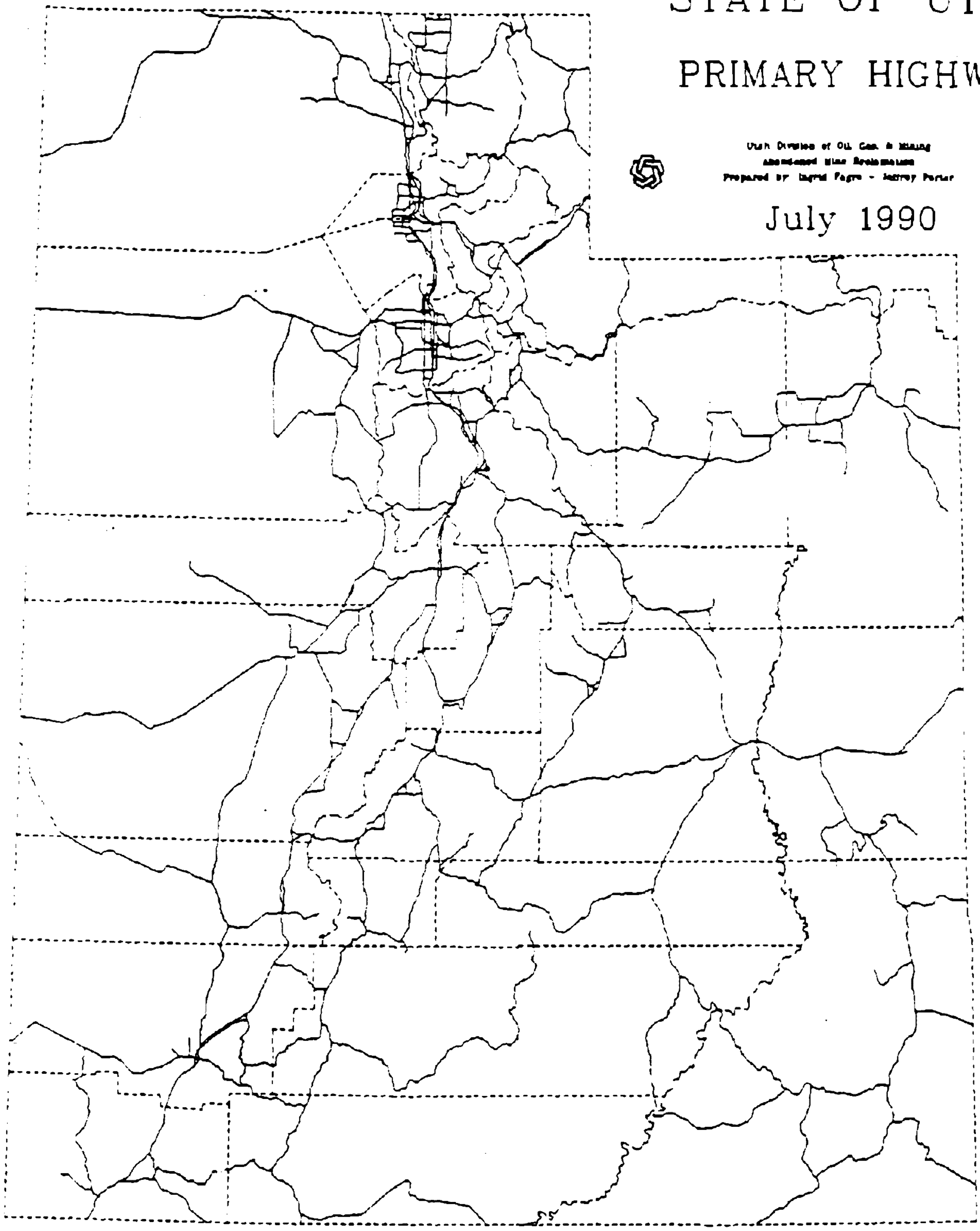
STATE OF UTAH
NATIONAL PARKS
AND FORESTS
July 1990
Forests
Parks
VISITOR USE
(THOUSANDS)
0-500
500-1,000
1,000-1,500
1,500-ABOVE

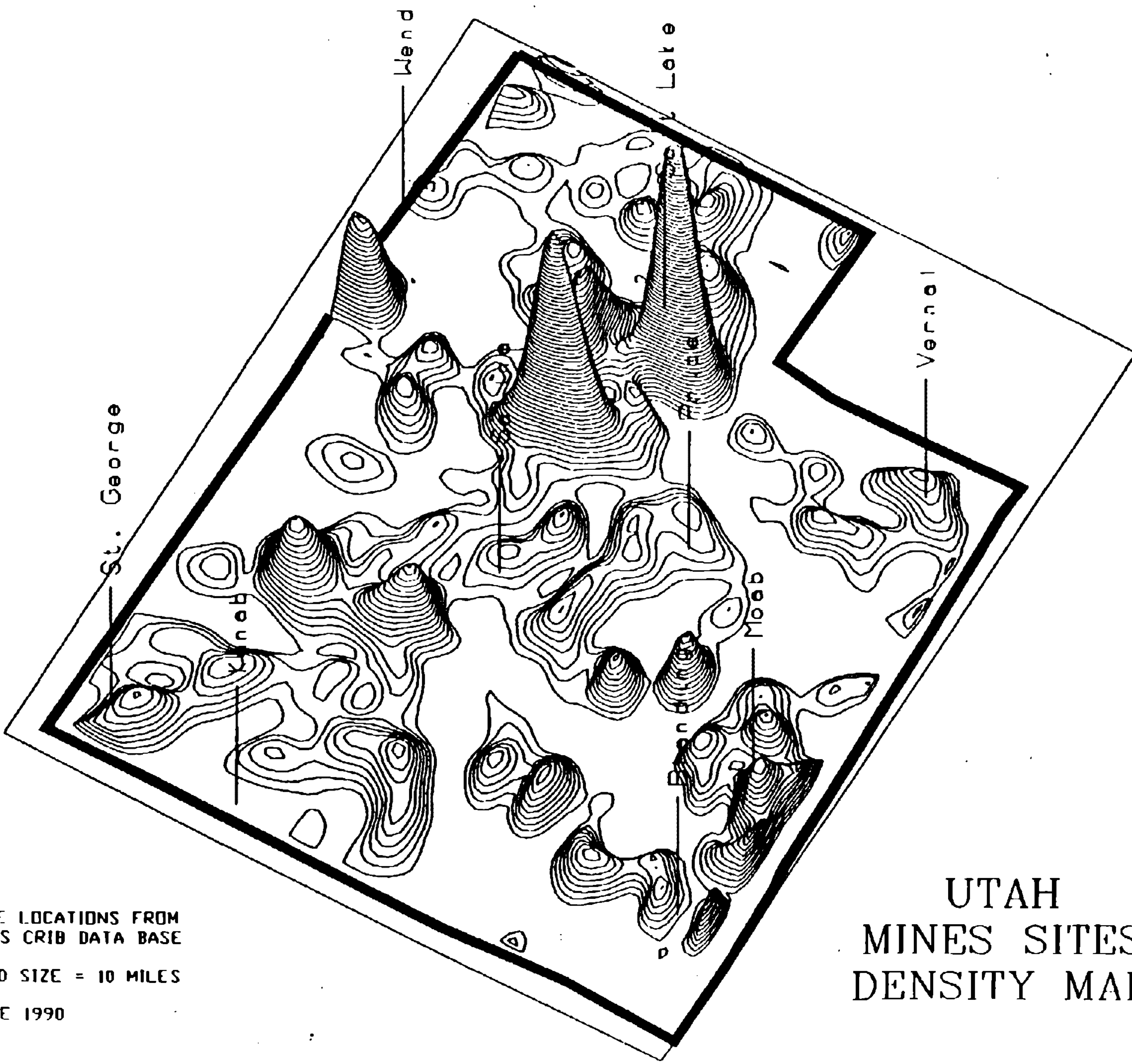
STATE OF UTAH

PRIMARY HIGHWAYS

Utah Division of Oil, Gas & Mining

July 1990





MINE LOCATIONS FROM
UGMS CRIB DATA BASE

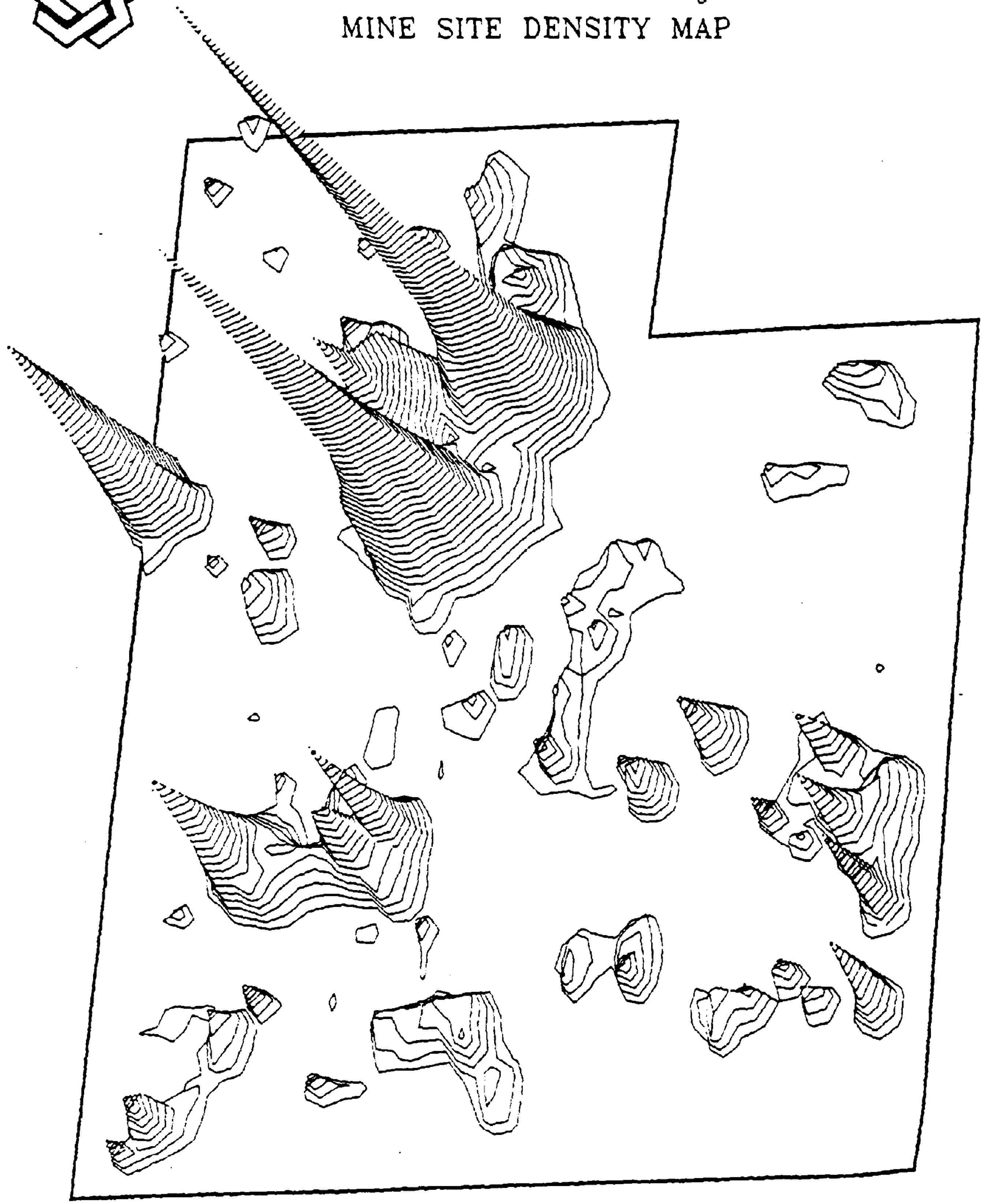
GRID SIZE = 10 MILES

JUNE 1990

UTAH
MINES SITES
DENSITY MAP

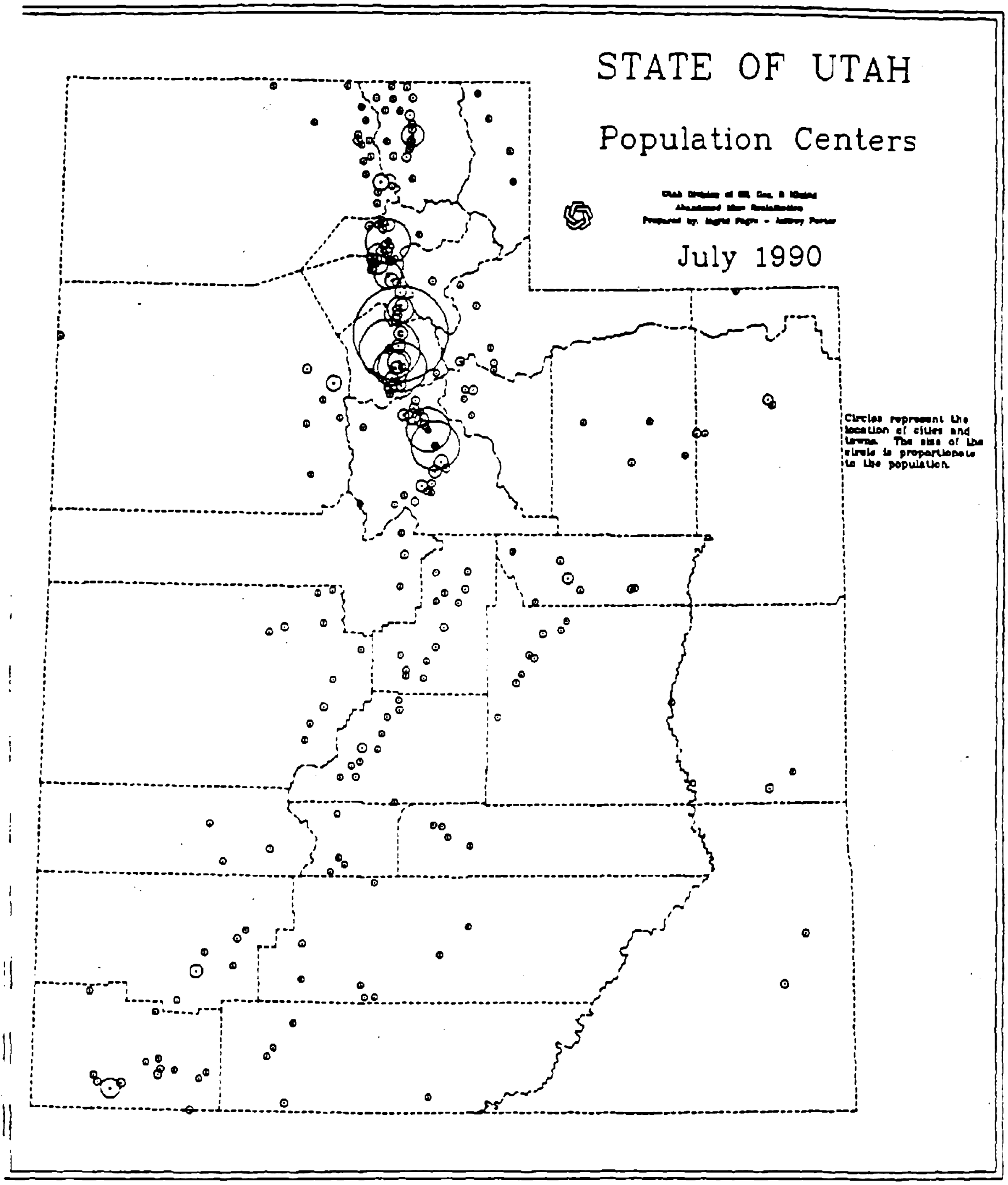
STATE OF UTAH
Division of Oil, Gas and Mining
Abandoned Mine Reclamation Program

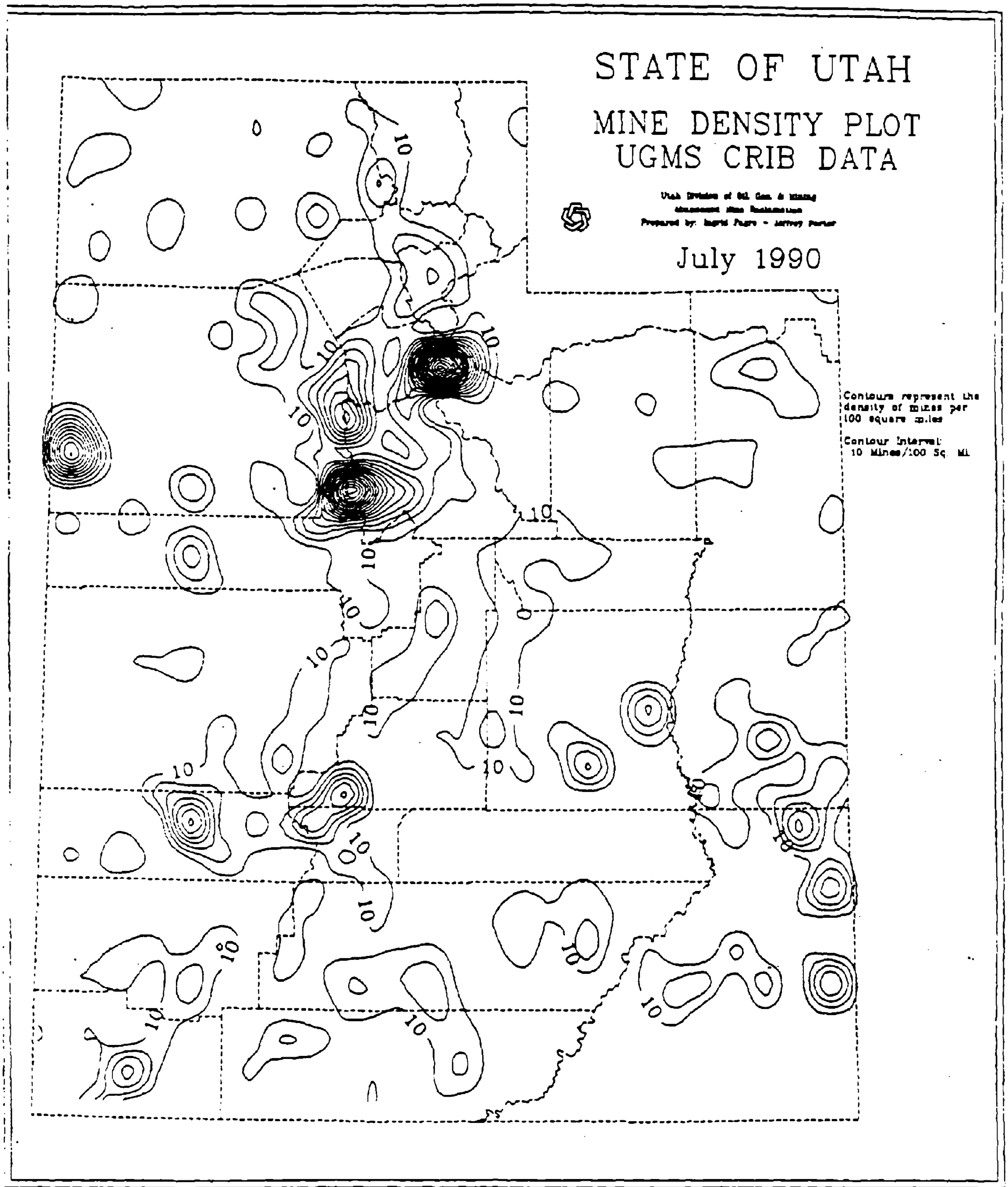
MINE SITE DENSITY MAP



Mine site data from UGMS
CRIB database

Contours represent the number of mines
in a 10 × 10 mile grid

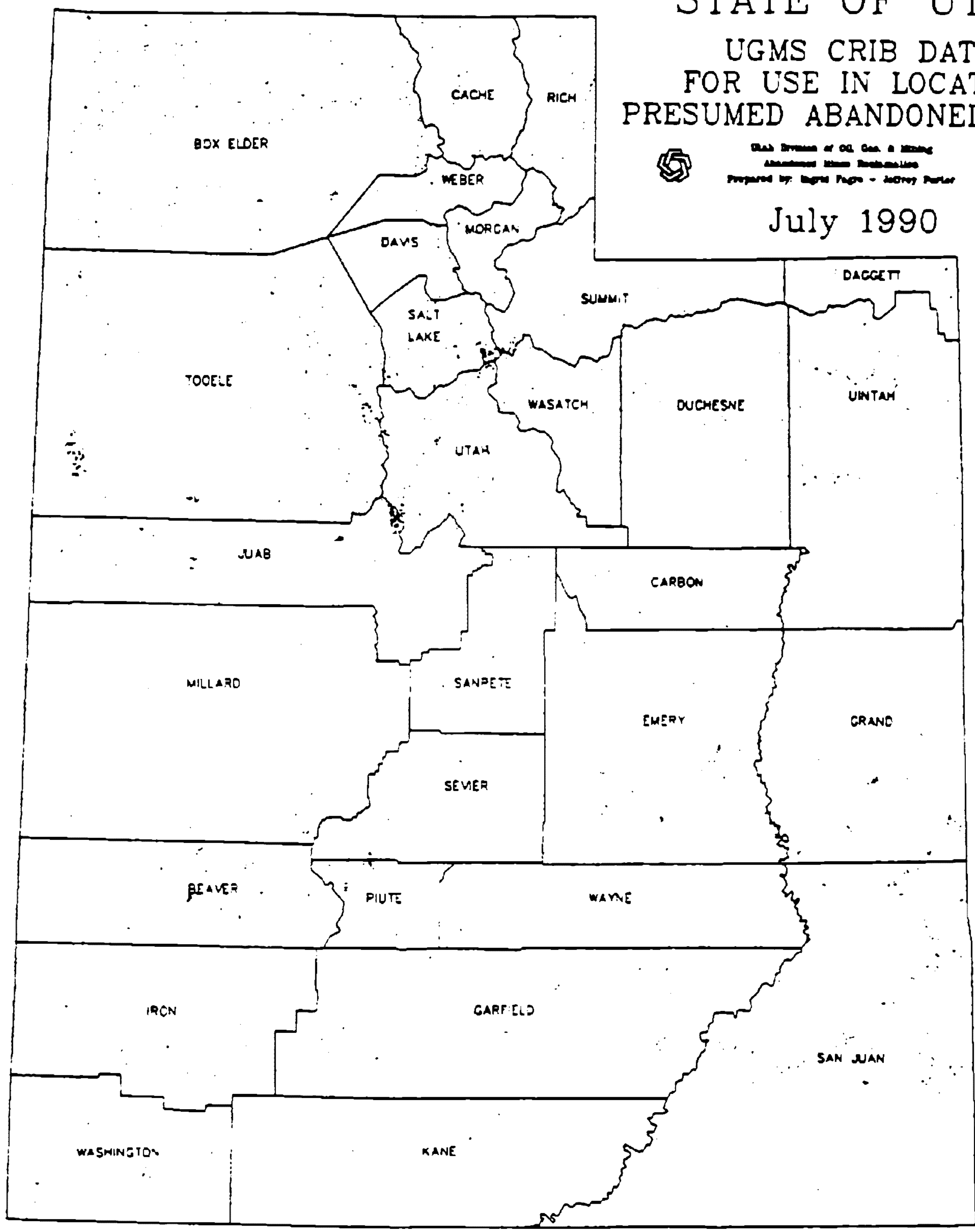

STATE OF UTAH
Population Centers
July 1990
Circles represent the location of cities and towns. The size of the circle is proportionate to the population.

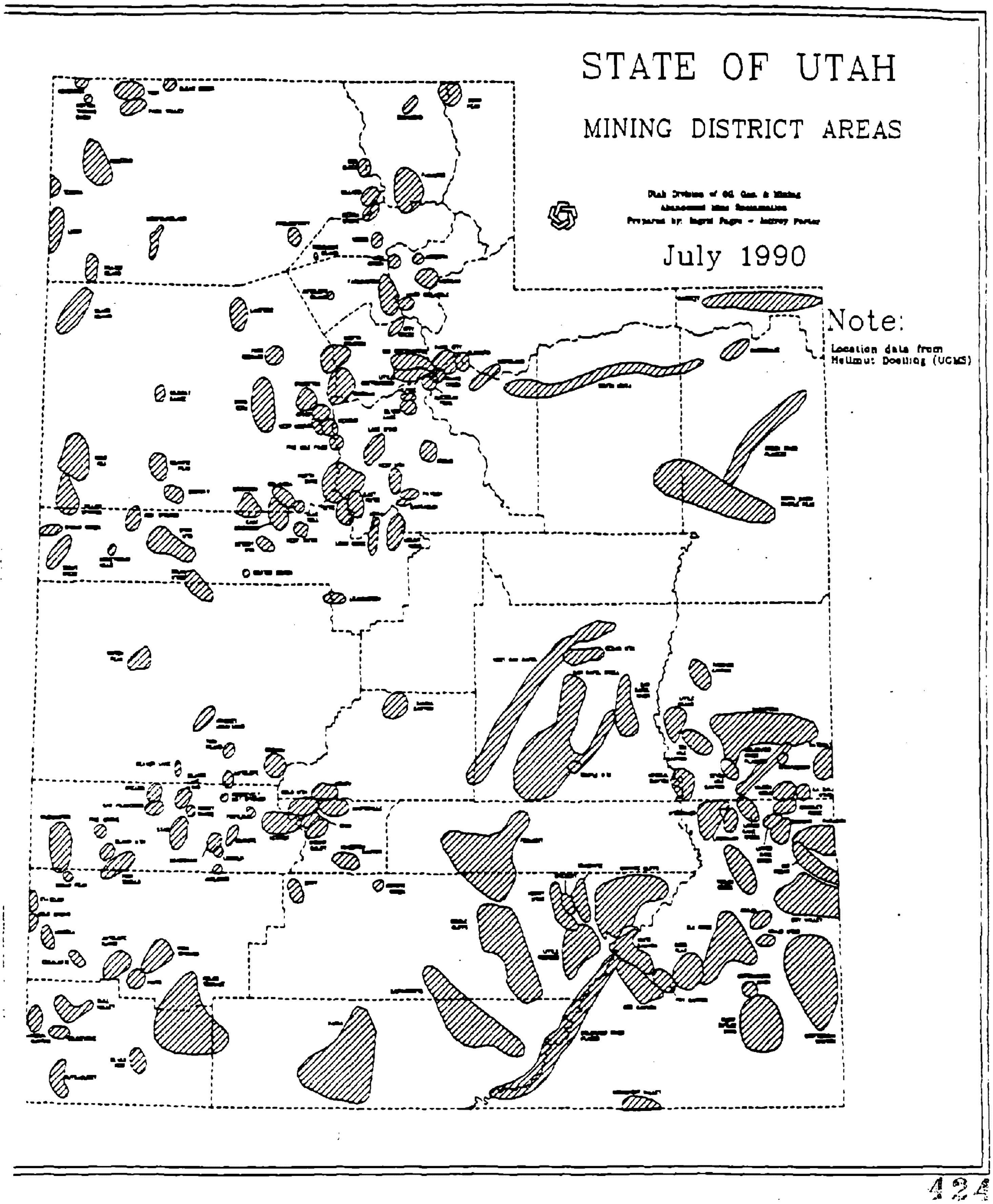

STATE OF UTAH
MINE DENSITY PLOT
UGMS CRIB DATA
July 1990
Contours represent the density of mines per 100 square miles
Contour Interval: 10 Mines/100 Sq. Mi.
10

STATE OF UTAH

UGMS CRIB DATA FOR USE IN LOCATING PRESUMED ABANDONED MINES

July 1990




STATE OF UTAH
MINING DISTRICT AREAS
July 1990
Note:
Location data from Hellmut Doelling (UGMS)

WASHINGTON

423

NO REPORT RECEIVED

WISCONSIN

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny, Secretary
Box 7921
Madison, Wisconsin 53707
TELEFAX NO. 608-267-3579
TDD NO. 608-267-6897

April 2, 1991

File Ref: 2720

Mr. Richard Juntenen
Helena Airphoto
Box 174 M.C.R.
Clancy, MT 59634

Dear Mr. Juntenen:

The following discussion is intended to provide you with an overview of the Inactive/Abandoned Mine issue in Wisconsin for use in the inventory being compiled for the Western Governor's Association Mining Waste Task Force. I apologize for the lateness of this information, but I hope that you will still find it of some use.

Up until the shutdown of the last mine in 1979, the southwest part of Wisconsin was part of the oldest continuously producing zinc-lead district in the United States. Mining had been continuous in the Upper Mississippi River Valley since 1685 and was the primary impetus for settling of the area by European immigrants. The mining activities which took place here generally consisted of several hundred small underground mines scattered throughout a three county area with a few centralized milling operations and very limited mineral processing activities. Considering the long history of the region, the extent of mining-related problems is remarkably limited. The main problem that exists is one of unreclaimed or poorly reclaimed mine openings which are a threat to safety and serve as possible conduits for groundwater contamination. It is estimated that there were 700 vertical shafts, 65 incline adits and over 27,000 drillholes constructed in the area. The location of many of these openings is documented in various U.S. Geological Survey and Bureau of Mines reports but much field reconnaissance would be necessary to verify the existing condition of the opening and formulate the best means of dealing with the situation. There are some unreclaimed tailings piles and waste rock piles but they do not present any significant environmental problems due primarily to the high carbonate content of the parent rock involved. These waste piles probably cover an area of less than 200 acres. The most significant environmental problem in the area comes from the limited mineral processing, consisting notably of roasting, which also occurred in the region. Approximately 20-30, generally small, piles of roaster waste material exist in the area and are frequently situated such that they are a source of surface water contamination. This waste material is very acidic, has elevated concentrations of metals and is very erosive and sedimentation into nearby streams has resulted in some severe localized surface water degradation.

In addition to the activity in the southwest part of the state, northern and, to a much lesser extent, south-central Wisconsin also experienced a substantial level of iron mining activity. The main area of mining was in Iron County in the northern part of the state. Mining was continuous from about 1870 to 1965 and consisted of very deep (up to 3500 feet) underground mining and direct shipment of the ore. As with the preceding discussion, the most significant problem which exists in the area is related to the mine openings. In addition to the unreclaimed mine openings, some areas have also experienced caving or subsidence problems which present a significant threat to public safety. Cost estimates prepared in the late 1970's for filling or partially filling the hazardous mine openings ranged up to $3 million. To date none of the major openings have been filled but most of the areas of caving have been fenced thereby limiting access but other easily accessed caves and other openings still exist. In addition to this problem there are also unreclaimed piles of waste rock present in the old iron mining districts which present problems more from aesthetic and land use perspectives.

I hope that this information is of some use to you and again, I am sorry for its extreme tardiness. Please contact me if you have any questions concerning this material or if I may be of any additional assistance.

Sincerely,

Laurence J. Lynch

Lawrence J. Lynch, Hydrogeologist
Mine Reclamation Unit
Bureau of Solid & Hazardous Waste Management

LJL:pc

WYOMING

THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

RECEIVED
APR 24 1991

Department of Environmental Quality

Herschler Building ● 122 West 25th Street ● Cheyenne, Wyoming 82002

Administration	Air Quality Division	Land Quality Division	Solid Waste Management Program	Water Quality Division
(307) 777-7937	(307) 777-7391	(307) 777-7756 FAX (307) 634-0799	(307) 777-7752	(307) 777-7781 FAX (307) 777-5973

April 19, 1991

Mr. James Souby
Executive Director
Western Governors' Association
600 17th Street, Suite 1705, South Tower
Denver, CO 80202-5442

RE: Task III-b, EPA Mine Waste - WGA/State of Wyoming Contract - Report on Abandoned Non-Coal Mine Sites

Dear Mr. Souby:

Enclosed is our final report on Abandoned Mine Sites in Wyoming. Please note that we have not prepared data sheets for the remaining sites. We now expect that all non-coal priority sites will be reclaimed by the AML program by 1995 and that detailed inventory data would be unnecessary. If you have any questions regarding the report, please contact me.

Sincerely,

Roger Shaffer
Administrator
Land Quality Division

Dennis Hemmer
Director
Dept. of Environmental Quality

RS:MM:mm:sp

Enclosure

xc: Gary Beach
Dennis Hemmer
Jim Uzzell
Mark Moxley

Report on Abandoned Non-Coal Mine Sites in Wyoming

Prepared by: Mark Moxley, DEQ-LQD District II Supervisor

Date: April 12, 1991

RE: EPA Mine Waste - WGA/State of Wyoming Contract - Task IIIb

Background

Since 1985 the U.S.EPA has been developing a regulatory program for non-coal mine wastes under the Resource Conservation and Recovery Act (RCRA). The current proposal is contained in a May, 1990 document known as "Strawman II". The program, as currently envisioned, addresses only active mining and processing operations. It is widely recognized however, that the problems associated with abandoned mining and processing sites are very extensive. The EPA is working with the States through the Western Governors Association (WGA) to quantify the problems posed by abandoned mine sites and to explore options for dealing with these problems.

Historical Overview

Wyoming, like most other Western states, saw significant mineral interest in the late 1800's and early 1900's. Several gold and copper "booms" occurred along with hundreds of other smaller base and precious metals discoveries. The most famous booms were the Atlantic City-South Pass gold district and the Encampment copper district. These booms were significant in the growth of the State's economy but the operations were generally small and short-lived. Notable exceptions were the large iron ore mines at Hartville, which operated from 1898-1980, and Atlantic City, which operated from 1962-1983.

Other than the gold, copper and iron ore development described above, there has been no truly large-scale production of base or precious metals in Wyoming. As a result, Wyoming has been spared many of the serious environmental consequences seen in other Western states. The environmental problems associated with Wyoming's abandoned hardrock operations generally involve only open adits and shafts. There are only a very few small tailings piles and only one serious case of acid mine drainage in the state.

Wyoming does produce the majority of the Nation's supply of two important industrial minerals, trona (sodium carbonate) and bentonite. Large scale production of these minerals began in the 1950's. Trona deposits are mined underground at depths over 800 feet and are confined to the Green River Basin west of the town of Green River. There are five active trona operations and no abandoned sites.

Bentonite is mined in small surface pits from outcrops flanking the mountain ranges in the northern and central portions of the State. Abandoned pits are quite extensive, with problems including highwalls, bogholes and offsite sedimentation.

The other non-coal mineral of major economic and environmental significance in Wyoming is uranium. Large scale exploration, development and production of uranium began in about 1950 and has continued to the present, though production has declined drastically since 1980. Most of Wyoming's uranium has been produced by open-pit mining, but there have been many underground operations. Problems associated with abandoned uranium sites include highwalls, offsite deposition of toxic sediments, open adits and acid impoundments. Another widespread problem is open and improperly plugged exploration drill holes. These represent a safety hazard as well as a serious threat to groundwater aquifers.

Aside from the major mineral producers described above, Wyoming has historically produced a host of other minerals in smaller quantities. Some of the more significant include phosphate, gypsum, limestone, sulfur, feldspar, and aggregate materials. Though there are some abandoned sites with highwalls and open adits, these are not extensive.

Mine Regulatory Program

Mined land reclamation was legislated in Wyoming in 1969. The "Open Cut Land Reclamation Act" also required permitting and bonding to insure reclamation of all surface mining operations. A more comprehensive regulatory program was established in 1973 with the passage of the "Wyoming Environmental Quality Act". That act created the Department of Environmental Quality and within it the Land Quality Division to regulate the environmental impacts of mining. The timing of this legislation was fortuitous in that it predated the tremendous expansion of the mining industry that occurred in the mid to late 1970's. Since reclamation is required by law for all lands affected by mining after 1969, we generally define "abandoned mined lands" as lands affected prior to 1969.

Abandoned Mined Lands Program

Following passage of Public Law 95-87, the Surface Mining Control and Reclamation Act of 1977 (SMCRA), Wyoming proceeded to develop an abandoned mined lands program which became fully operational in 1983. The initial thrust of the AML program was directed towards reclamation of abandoned coal mining sites. By 1985 however, most of the coal sites had been addressed and the program emphasis shifted towards non-coal sites.

It should be noted that the definition of "abandoned mined lands" used to determine eligibility under the AML program differs somewhat from the regulatory definition given above. Generally AML funds may be used to reclaim any site affected prior to the passage of SMCRA (August 3, 1977) for which there is no party responsible for reclamation. Thus AML has done additional reclamation work on sites that were affected after 1969 where the operator had satisfied the reclamation obligation, but for some reason the reclamation had later failed or additional work was necessary.

AML Inventory and Priorities

Early in the development of the AML program, from 1980-1983, a substantial effort was directed towards compiling a comprehensive inventory of abandoned mine sites across the State. Several contractors were employed to review records and maps, to conduct aerial surveys and to do on-site reconnaissance. Several government agencies were involved and consulted during this process, including the BLM, USFS, Park Service, Wyoming Geological Survey and the Wyoming Game and Fish Department. Efforts were also made to involve municipalities, citizen groups and private landowners in identifying and prioritizing sites. This process of updating the site inventory has continued through the present.

The non-coal priorities of the AML program are directed by the language contained in SMCRA. From section 409.(a): remediation efforts are to be directed towards sites that "could endanger life and property, constitute a hazard to the public health and safety, or degrade the environment." Sites that do not pose an imminent threat are not a high priority. This includes sites that are remote or inaccessible as well as those which may be classified generally as aesthetic problems.

AML Reclamation of Non-Coal Sites

Wyoming AML expenditures for reclamation of non-coal sites through September, 1990 total approximately $107 million. This represents approximately 70% completion of all non-coal sites on a cost basis. The reclamation work to date has included:
- backfill/closure of open adits and shafts statewide
- backfill, grading and revegetation of bentonite pits
- backfill, grading and revegetation of uranium pits, including reconstruction of Little Medicine Bow River
- plugging open uranium exploration holes in Shirley Basin and Gas Hills districts
- grading/revegetation of portions of Atlantic City Iron Mine

Remaining Non-Coal Sites

With the reauthorization of the SMCRA-AML program through 1995, it is now anticipated that Wyoming will complete the remediation of all priority mine sites. The remaining sites have been placed on a project schedule for completion by 1995, with planning, design and construction work underway. It is estimated that reclamation of remaining non-coal abandoned mine sites in Wyoming will be completed at a cost of approximately $45 million. The remaining projects generally involve the same types of work as listed above, with the addition of the Carissa gold tailings, some small phosphate sites and the Hartville/Sunrise iron mine. (With all sites now scheduled for reclamation by 1995, we have not attempted to fill out the detailed site inventory tables which were provided.)

The problems associated with open and improperly abandoned exploration drill holes are harder to quantify and remediate. It has been estimated that there are as many as one million such holes in Wyoming. The cost for remediation work is roughly estimated at $20 million. Wyoming has done substantial work on drill hole reclamation in the past, including the AML drill hole project which has been on-going since 1989. This project will continue through 1995, primarily directed at the major uranium districts, however it is estimated that only about 30% of the estimated one million holes will be addressed.

Summary/Policy Considerations

Wyoming's AML program has now remediated most of the abandoned mine sites in the state through the use our state share of SMCRA coal tax monies. AML efforts will continue to be directed towards non-coal mine sites and it is expected that all priority sites will be reclaimed by 1995. In this regard Wyoming is perhaps unique among the western states.

Wyoming recognizes the extensive set of problems posed by abandoned mine sites in the West. These problems led Wyoming to adopt a mine reclamation law in 1969. Other states have been slower to act and some have suffered the environmental consequences of recent mineral development. Our state mining industry as a whole has acted responsibly in addressing environmental concerns. Wyoming's coal industry provides almost 20% of AML funding nationwide.

Wyoming cannot support a Federal program that would impose additional tax burdens on Wyoming, via our mining industry, to correct mining related problems in other states. As a matter of fairness, it is our view that remediation costs should be borne directly by the citizens of each individual affected state or by the entire country as a whole.

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