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**Northern
Region**

Minerals, People and Dollars

Social, Economic and Technological Aspects of Mineral Resource Development

Minerals, People, and Dollars:

Social, Economic, and Technological

Aspects of Mineral Resource

Development

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Table of Contents

Table of Contents

Table of Contents

Figures

TABLES

Tables | Page

PREFACE

During the mid-1970's a series of sharp increases in the price of oil, gold, silver, platinum, and various rare metals spurred mineral industry efforts to locate new domestic sources. A significant portion of the nation's undeveloped mineral deposits are found on public lands and there is increased interest in claiming or leasing mineral rights on National Forest System lands.

U.S. mining laws permit citizens and domestic corporations to explore and develop the mineral resources of most public lands. The Forest Service has expanded its minerals program to process the growing number of lease and permit applications, to review proposed operating plans, and to manage land surface impacts.

The National Environmental Policy Act of 1969 (NEPA) and the National Forest Management Act of 1976 (NFMA) direct Federal agencies to consider social, economic, physical, and biological effects of programs which affect the human environment. Social and environmental analyses are also receiving greater agency emphasis because of intensified public interest in both environmental quality and public land use.

In response to these needs, and to overcome large gaps in existing information, the USDA Forest Service, Northern Region, developed a series of information and guideline documents for Forest and Regional use, including:

- Northern Region Oil and Gas Guide, 1979
- Socioeconomic Assessment Bibliographies for Minerals Activities, 1979, 1980
- Survey of the Social and Economic Effects of Oil and Gas Development: Little Missouri National Grasslands, 1980
- Oil and Gas Activity in the Northern Region, 1980, 1983
- The Outlook for Mineral Resources in the Northern Region, 1981
- Social and Economic Assessment of Oil and Gas Activities, 1979, 1981

The present document is part of this series. This publication is intended as a primer on mineral activities and their social implications for resource agencies. It introduces the reader to the world of minerals (Chapter 1) through a discussion of their origins, variety, and uses. It then describes the mining industry and its activities in the Northern Region, both on and off National Forest System lands. Brief scenarios of each type and stage of operations are presented, first to demonstrate the planning and technology requirements (Chapter 2) and then to display potential social benefits and costs (Chapter 4).

Chapter 3 identifies variables that influence the type and magnitude of social and economic effects generated by mineral activities. Chapter 5 summarizes public and agency concerns and provides suggestions for mitigating adverse effects. Appendices A and C supply information on laws and policies governing mineral activities on National Forest lands.

Because there is very little professional literature on communities impacted by the metals and industrial minerals industries, it has been necessary to make many inferences from studies of energy development. To gain additional information and to assess the relevance of energy impact studies, the author visited three mining areas of Montana and Idaho and conducted interviews with over 60 residents. Chapters 3 to 5 are based in part on these findings.

The reader who seeks additional information on impact assessment methods, effects estimation techniques, or the results of specific community studies should consult the bibliography in Appendix B. The first two sections cite social impact analysis handbooks and surveys of field research results.

The principal author for this publication is Dr. Lambert N. Wenner, Sociologist, currently in Programs and Legislation, in the Chief's Office. Dr. Wenner collected field data and prepared the original text of this publication in 1982 while he was assigned to the Minerals and Geology Staff Unit in the Northern Region. The 1982 draft document was reviewed by the Chief's Office and other Regions in 1983; and a final version of the document was produced in July 1984. Michael Burnside (Geologist) and Norman Yogerst (Soil Scientist), of the Northern Region's Minerals and Geology Staff Unit were contributing editors for the final document. All three have been involved in development of numerous minerals impact related documents, including those mentioned above, and served on numerous interdisciplinary teams for environmental analyses and special studies for Northern Region mineral projects and programs.

A word of appreciation is due to several other persons who helped prepare this document. The first draft was read and critiqued by Billy Hicks, Geologist; Arnold Holden, Sociologist; Dave Kapaldo, Economist; Dick Marshall, Economist; and Jim Nichols, Geologist.

Information on Northern Region mineral activities was supplied by Brian White, Mining Engineer; Sherm Sollid, Geologist; Joe Spehar, Resource Officer; and Bill Ferrell, Resource Officer. Gary Morrison, Geologist, provided data on mineral potential in the Northern Region. Bob Newman, Mining Engineer; John Nichols, Mining Geologist; and Mike Burnside, Geologist, helped clarify technical and policy issues. Buster LaMoure, Minerals Staff Director, reviewed the drafts and encouraged the project. Most illustrations were drawn by Dee Williams, Graphic Artist. Toni Lay provided logistical support and Suzette Dailey typed both the draft and final manuscripts.

The selection of information for inclusion, the analysis of this information, and any personal impressions of minerals activities or their effects are intended to be informational and descriptive. Any opinions expressed or implied are those of the author. The document does not represent official Forest Service position or policy.

Chapter 1: MINERAL RESOURCES

Americans, rural and urban, have become extremely dependent on minerals in hundreds of forms, yet know rather little about them. Usually minerals products are recognized as such (as distinct from wood, animal, or vegetable products), but even this distinction can be difficult. Plastics or fabrics, for example, may be composed of mineral, plant, or animal substances.

Minerals Defined

The concept "mineral" is used in several different ways. In technical usage, minerals are naturally occurring inorganic substances of relatively fixed composition. Some authorities limit the use of the term to crystalline solids, while others include substances such as mercury, water, and even gases. In common usage, "mineral resource" is applied to any homogeneous components of the earth's crust including various rocks, industrial minerals, metals, geothermal resources, and fossil fuels such as oil, gas, and coal.

In this document, "mineral" includes any material that might be used from the earth's crust for home or industrial use. Modifiers are used to denote those of organic origin; i.e., mineral or fossil fuels. This broad conception encompasses over 2,500 different substances including the 100 known elements and many of the combinations in which they occur.

All elements and many mineral compounds are extracted and utilized by humans. About a hundred are significant components of international trade. These are used to manufacture literally thousands of different consumer products.

Looking about from an office desk one sees numerous examples of minerals commodities. Most obvious are the metal products: the typewriters, calculators, file cabinets, aluminum window frames, heat ventilators, bookcases, and the desk itself. But other minerals abound. Above and below are fiberglass ceiling tiles and nylon carpets. The building itself is of brick, stone, concrete, glass, and gypsum board. It is outfitted with copper wiring and plumbing and ceramic and metallic fixtures. A wide array of minerals materials is also used in homes, factories, schools, modern transportation, utilities, agriculture, and national defense.

Nature and Origin

Scientists theorize that the basic elements of matter are created in the nuclear furnaces of evolving stars. The intense heat and enormous pressure permit the formation of different elements with distinctive physical characteristics. When planets are formed from fragments of a star, the number, quantity, and quality of these elements are relatively fixed, except for radioactive substances which continue to change at a very slow rate.

The basic chemical elements seldom exist in a pure or free state. Usually they are locked in molecular compounds with other elements. These compounds are mixed or concentrated with other compounds in various rock forming processes in the earth's mantle or crust. A typical "rock" consists of one or more mineral compounds combined by natural processes. This may obscure the identity of specific minerals and increase the difficulty of locating and extracting them.

Planetary forces including continental drift, gravity, heat, wind, water, volcanic activity, earthquakes, the actions of living organisms, and chemical activity continually alter the earth's crust. Subterranean materials are transported to the surface; rock structures and compounds are decomposed; loose materials and liquids move to new locations, and new surface features result.

There is an extremely great variation in the relative abundance of the minerals that make up the earth's crust. Eight of the known elements combine readily to form compounds with others and together account for about 98 percent of the crust's volume. Oxygen is the most plentiful (47 percent), followed by silicon (28 percent), aluminum, iron, and calcium (Table 1-1).

Table 1-1: Relative Abundance of Selected Elements: Percentage of Earth's Crust

Oxygen	46.6	Titanium	.4	Chromium	.01	Molybdenum	.0001
Silicon	27.7	Hydrogen	.1	Nickel	.007	Tungsten	.0001
Aluminum	8.3	Phosphorus	.12	Zinc	.007	Iodine	.00005
Iron	5.0	Manganese	.09	Copper	.005	Antimony	.00002
Calcium	3.6	Sulfur	.03	Cobalt	.002	Mercury	.000008
Sodium	2.8	Carbon	.02	Nitrogen	.002	Silver	.000007
Potassium	2.6	Vanadium	.01	Lead	.001	Platinum	.000001
Magnesium	2.1	Chlorine	.01	Tin	.0002	Gold	.0000004

Source: Adapted from Brian Mason, Principles of Geochemistry, 3rd edition. New York: John Wiley, 1966, pp. 45-46. Rand McNally's Atlas of Earth Resources, 1979, provides slightly different estimates for most of these and demonstrates how oceanic and continental crusts differ in their average composition.

Mineral Categories

More than 100 Minerals (Table 1-2) have become almost indispensible in modern life.[1/] Extracting, producing, and marketing minerals has become a multibillion dollar business in over 30 nations of the world, and annual mineral sales exceed 100 million dollars in 60 more.[2/] Some minerals are merely extracted, processed to remove impurities, and crushed or milled to a uniform size. They are then ready for use in construction and landscaping, or as a fuel, fertilizer, abrasives, etc. Sand and gravel, building stone, coal, phosphate, and pumice are examples. But most minerals are separated into more basic components and used for fuels, or transformed through chemical and metallurgical processes into products for personal and industrial use.

1/ Very readable background sources on minerals include: Cargo, David N. and Bob F. Mallory. Man and His Geologic Environment. Reading, Mass.: Addison-Wesley Publ. Co., 1974; McDevitt, James F. and Gerald Manners, Minerals and Men, 2nd Ed. Baltimore: Johns Hopkins Press, 1974.

2/ Gallot, Francois G., "World Mineral Production and Consumption in 1978," in Resources Policy 7, 1 (March 1981): 22-23.

Table 1-2: Categories of Mineral Resources

METALS

Metals Used in Iron Alloys

Iron Ore
Chrome
Cobalt
Columbium
Manganese
Molybdenum
Nickel
Tungsten
Vanadium

Base Metals

Antimony
Bismuth
Cadmium
Copper
Lead
Tin
Zinc

Light Metals

Aluminum
Magnesium
Titanium

Precious Metals

Gold
Platinum Group
Silver

Rare Metals

Beryllium
Radium
Uranium

Other Metals

Mercury

FOSSIL FUELS AND GASES

Coal
Natural Gas
Peat
Petroleum
Shale Oil
Synthetic Gas
Argon
Carbon Dioxide
Helium
Hydrogen
Neon
Nitrogen
Oxygen

NONMETALLIC INDUSTRIAL MINERALS

Building Material

Cement
Gypsum
Limestone
Perlite
Sand & Gravel
Stone, Crushed
Stone, Dimension

Insulation

Asbestos
Mica
Vermiculite

Abrasives

Corundum
Flint
Garnet
Industrial Diamonds
Pumice

Ceramic Materials

Calcite, Optical
Clays
Feldspar
Fluorspar
Glass Sand
Quartz

Chemicals (Diverse Uses)

Arsenic
Boron
Bromine
Carbon
Cesium
Chlorine
Fluorine
Graphite
Lithium
Salt
Silicon
Sodium
Sulfur

Fertilizers

Guano
Lime
Phosphate
Potash

Pigments and Fillers

Barite
Bentonite
Clays
Kaolin
Talc

Gem Stones

Beryl
Diamond
Emerald
Opal
Sapphire

Decorative Stones

Granite
Marble
Obsidian
Petrified Wood
Slate
Travertine

Water

Surface water
Aquifers
Geothermal Sources
Hydropower Sources

Other

Amber
Fossil Plants, Animals
Topsoil

Sources: USDI Bureau of Mines. Mineral Commodity Summaries, 1979.
McDevitt, James F. and Gerald Manners. Minerals and Men, 2nd Edition. Baltimore: John Hopkins Press, 1974.

Metallic minerals. Among the nonfuel minerals, metals are especially valuable because of their many industrial applications and in some cases, their rarity. Most metals are dutile (easily shaped), fusible (readily melted together), and efficient conductors of heat and electricity. Each has some unique qualities suited to particular product needs. A metal may be selected because it is tough, springy, resistant to corrosion or heat, flammable, lustrous, malleable, or alloys well with other elements to form compounds with unique properties.

Iron is presently the most vital and widely used mineral because of its great strength, relative abundance, widespread distribution, and the capacity to alloy with many other elements, greatly extending its utility. The U.S. uses several times more iron (by weight) than all other metals combined. About 90 percent of iron is sold as carbon steel, which contains enough carbon to permit tempering and thereby increase the metal's hardness. Cast iron with additional carbon and silicon added is hard and brittle but quite fusible. Pure iron is relatively soft and malleable.

Many comparatively scarce metals have increased in importance in recent years because when small amounts are added to steel the resulting alloy has greatly enhanced properties of strength, hardness, heat resistence, and/or corrosion resistance. Stainless steels containing chrome, nickel, tungsten or vanadium are familiar examples. Manganese is used both as a catalyst in smelting iron ores and as an alloy of iron. The portion (by weight) of the rarer metal(s) needed for each steel alloy varies from a small fraction of one percent (boron) to as much as 27 percent (chrome), but is usually about 1 or 2 percent.

The base metals (Table 1-2) usually occur as compounds of sulfur, oxygen, and/or carbon and, occasionally form minable deposits. They have been collected and used since ancient times. Base metals are very malleable and durable. They often occur together in ores and blend easily with each other to form metal compounds with desirable properties. Common examples are brass (copper with zinc), bronze (copper with tin), and pewter (often tin with lead).

The precious metals are sometimes found in a pure state and have been used for jewelry and coins since ancient times. They are highly valued because they are rare, usually chemically inert (corrosion resistant), and very malleable. Because of their great worth, rather little of the world supply is used up each generation and new discoveries tend to add to the total supply.

Aluminum, the most abundant metal in the earth's crust, is now cheaply produced with an electrolytic process and is second only to iron in demand. Its light weight, resistance to corrosion, good conductivity, and the strength of its alloys assure its widespread use in aircraft, construction, appliance, automobile, machine, kitchen utensil, and electrical applications.[3/] Both precious and light metals (Table 1-2) have only recently been produced in large quantity due to the difficulty of separating them from native ores.

3/ A detailed discussion of metals and industrial minerals is found in USDI Bureau of Mines publications, including:
Mineral Commodity Summaries, published annually.
Minerals Yearbook, published annually.
Minerals Facts and Problems, 1975, 1980.

Nonmetallic industrial minerals. This is a catch-all category for a wide variety of nonmetallic, nonfuel minerals used in manufacturing chemicals or as basic materials in the construction, automobile, petroleum, textile, and other industries. Industrial minerals vary in value from diamonds to gravel and include such diverse materials as sulfur, borax, clays, phosphate, salt, and marble.

Most industrial minerals are both abundant and available in many parts of the world. Some require only limited processing to be useable and are cheap enough to permit many applications. Table 1-2 above identifies some of the more common varieties.

Fuels. Mineral fuels include fossil fuels (crude oil, natural gas and coal), synthetic fuels (methane, butane, or other fuels derived from fossil fuels), uranium (a radioactive metal), and oil from shale and tar sands (which are saturated with fossil fuels). Energy is also derived from water sources (geothermal, hydropower, tidal, etc.).

Petroleum is the most widely used mineral fuel, supplying 45 percent of U.S. and roughly 45 percent of world demand for commercial energy. Coal is second, meeting 21 percent of U.S. and about 29 percent of world demand in 1980. The U.S. has abundant coal supplies (Figure 1-1) and domestic consumption has generally increased since the sharp escalation of oil prices in the mid-1970's. Natural gas is third, supplying about 27 and 18 percent respectively.[4/]

Other commercial energy sources play relatively minor roles, accounting for 7.5 percent of U.S. and about 9 percent of world supplies. The leading forms are hydroelectric and nuclear power, still well ahead of wind, solar, geothermal, synthetic fuels, and other energy sources not mentioned above.

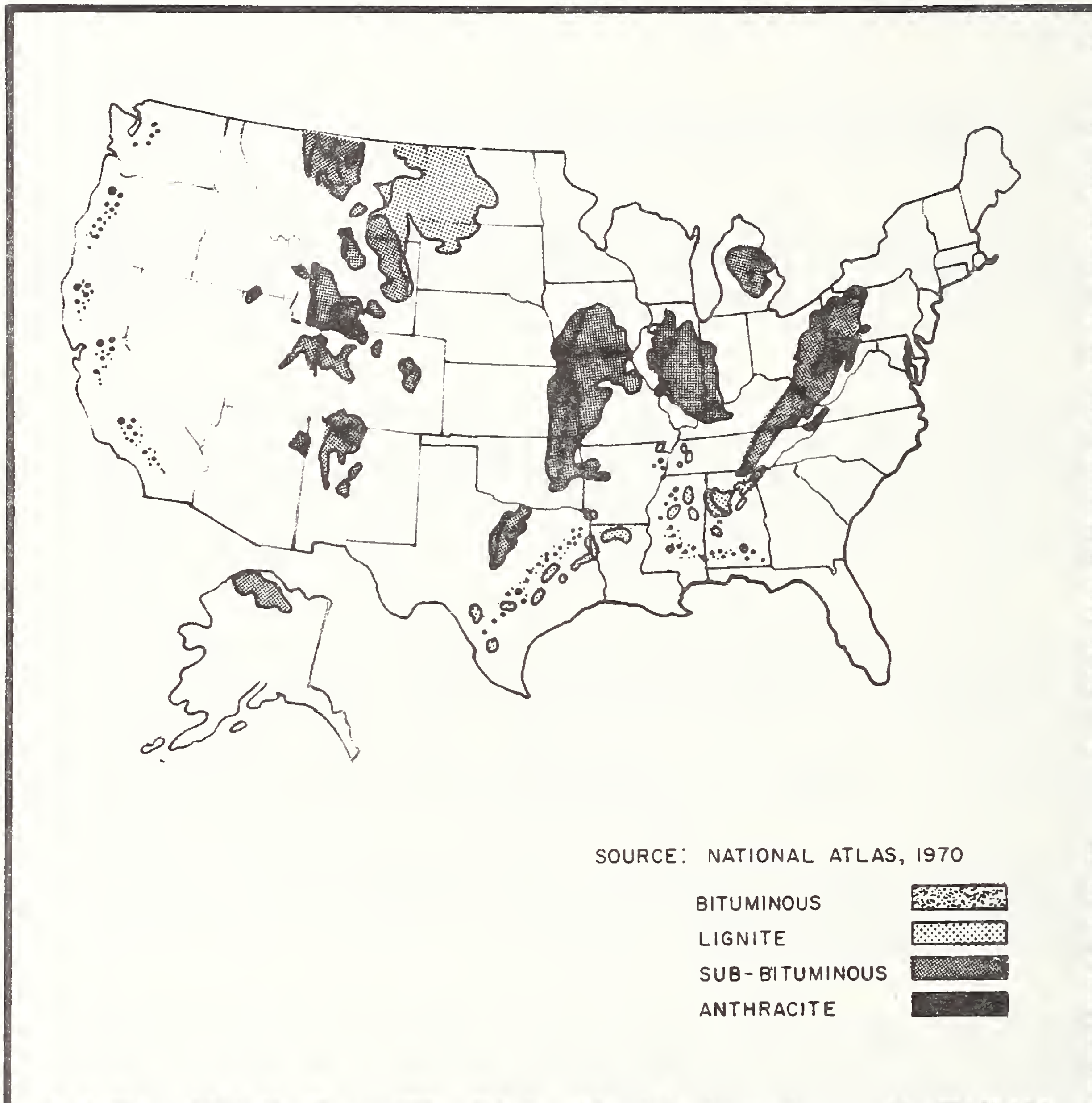
In addition to mineral fuels, biomass materials such as wood, animal dung, crop residues, and garbage are also widely used and are under increased scrutiny as supplementary fuels. Much biomass consumption is noncommercial and unrecorded but is estimated to supply about 6 percent of the world's energy demand.[5/] It contributes a smaller percentage in most industrial countries, yet it remains significant in some rural areas of the U.S. including Idaho and Montana. The demand for "alternative" fuels is expected to increase if oil and gas price increases continue to exceed other fuels.

A variety of conventional as well as resource-specific mining techniques is utilized in extracting mineral fuels. Large quantities of these fuels are necessary for mining, transporting, and processing other mineral commodities. Energy availability is often a major consideration in selecting sites for mills, smelters and refineries.

4/ Compiled from U.S. Department of Energy, Monthly Energy Review, April 1981; Energy Administration Data in U.S. Statistical Abstract, 1979; and Exxon Corporation, World Energy Outlook, December 1979.

5/ CEQ/USDOS Global 2000 Report, 1980.

Figure 1-1: Coal Reserve Areas in the United States



Mineral Resource Potential

Several of the mineral commodities useful to humans are widely distributed on the earth's surface and also occur in concentrations that permit their use without extensive processing. Examples include building stone, sand, gravel, clays, chalk, sulfur, salt, and coal. Most other minerals are also widely distributed, but only occasionally exist in the concentrations necessary to make mining economically feasible. In a few instances the world's reserves are confined to four or five countries, as is now true of gem diamonds, boron, chromium, platinum, and trona.

With four exceptions (aluminum, iron, magnesium, and titanium), each metallic element is less than 0.1 percent of the earth's crust. Metals are seldom found in a pure state and even then usually exist as isolated particles in host rocks or gravels. Almost all metal is extracted from ores, that is, from rocks with minerals concentrations great enough to justify mining. Just how rich an ore must be depends on such factors as the value of the metal; the quality, size, shape, and accessibility of the ore body; labor, energy, and transportation costs; and the current state of mining technology. In the U.S. in 1900, copper concentrations of 6 percent or more were required to mine, but today the average mine processes ores with metal concentrations of 0.7 percent or less.

Metallic ores, minerals fuels, and many industrial minerals tend to be scattered in mineralized zones that vary in their geologic composition and surface features. Mineral deposits are frequently found where:

- the earth's crust is unstable, and minerals associated with igneous bodies have been intruded, exposed, or shifted to accessible locations.
- fast-flowing streams have slowed their pace and deposited flakes and nuggets of certain rare metals (gold, platinum, tin) or quantities of gemstones.
- water or glacial action has left layers of useful sediments (clays, sand, gravel).
- ancient swamps or seas have left extensive deposits of organic material which have been transformed into other substances (oil, gas, coal, amber, limestone, petrified wood) by heat, pressure, and chemical action.

Classifying Deposits

Over the years a mining vocabulary has been evolving [6/] which permits an increasingly precise description of the quantity, quality, and degree of certainty of U.S. and world mineral resources. In 1976, the U.S. Geological Survey and Bureau of Mines adopted a system for classifying known and prospective mineral wealth on the basis of (1) the extent of available geologic information about an area's potential and (2) the economic feasibility of development at a given time. Revised in 1981, this system defines 16 different resource categories (Figure 1-2).

6/ See USDI Geological Survey Circular 831, 1980, or USDI Bureau of Mines, Mineral Commodity Summaries, 1981, for details on definitions adopted in 1976.

Figure 1-2: Major Categories for Classifying Mineral Resources

RESOURCES OF (commodity name)

(A part of reserves or any resource category may be restricted from extraction by laws or regulations (see text))

AREA: (mine, district, field, State, etc.) UNITS: (tons, barrels, ounces, etc.)

Cumulative Production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES
	Demonstrated		Inferred	Probability Range
	Measured	Indicated		high — low
ECONOMIC	Reserves		Inferred Reserves	Recoverable Reserves
MARGINALLY ECONOMIC	Marginal Reserves			
SUB-ECONOMIC	Demonstrated Subeconomic Resources			
Other Occurrences	Includes nonconventional and low-grade materials			

Key concepts in this system of classification are resources, reserves, and economic. A resource is a naturally occurring concentration of solids, liquids, or gases that is economically feasible to extract, now or in the foreseeable future. A reserve is that portion of the resource which can be extracted economically at the time it is assessed. Economic means that it can be extracted at a profit. The other terms in Figure 1-2 are logical subcategories reflecting the degree of certainty that a given resource exists or that its extraction would be profitable.7/

This classification system is potentially useful in agency planning and scenario construction, but data are usually incomplete and, when available, must be regularly updated. Marginal reserves and subeconomic resources may become economic at some future date when mining technology is improved or minerals prices increase more rapidly than mining costs. Additional exploration data may require the reclassification of certain inferred reserves or undiscovered resources. Alternatively, a portion of a nation's resources (including reserves) may be exempted from mining by laws, regulations, or land-use priorities.

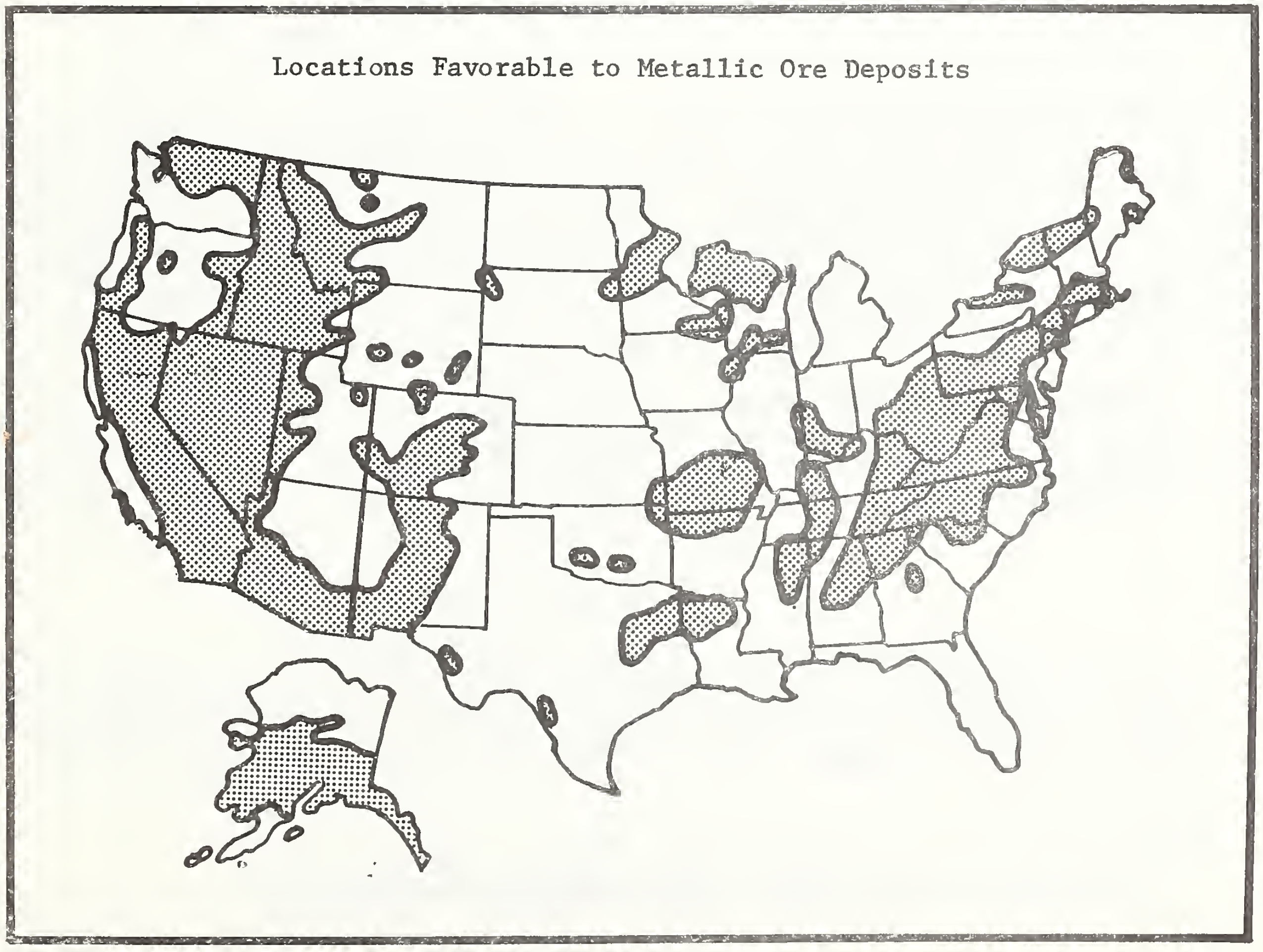
7/ After definitions standardized by the U.S. Geological Survey and Bureau of Mines.

U.S. Mineral Potential

The United States is large and geographically varied enough to possess commercial quantities of most important minerals. Every state has active mines and significant quantities of anywhere from 8 to 40 different mineral commodities. Minerals-rich areas are widely scattered, reflecting the diversity of the natural forces that produced them. Thus the list of states leading in the production of at least one commodity (1979) includes California (asbestos), Michigan (gypsum), Missouri (lead), Idaho (silver), Arizona (copper), Montana (vermiculite), Florida (phosphate), Texas (petroleum), Minnesota (iron ore), and 21 other states.

Figure 1-3 identifies the metallic minerals areas of the U.S. Figure 1-1 displays coal fields. Additional maps would be needed to identify deposits of petroleum, natural gas, and various industrial minerals. Appendix A provides detailed maps of the mineral resources of Idaho, Montana, and the Dakotas. These Northern Region states are leading producers of copper, lead, silver, zinc, antimony, garnet, phosphate, bentonite, talc, vermiculite, oil, coal, and natural gas.

Figure 1-3: Mineralized Areas of the United States



The U.S. Bureau of Mines makes periodic estimates of the mineral resources and reserves of the U.S. and world, and forecasts future demand patterns. From these we observe that individual minerals vary widely in their abundance. Six examples are provided in Table 1-3.

Table 1-3: U.S. and World Demand, Reserves, Resources, 1978-2000

Commodity	Unit	Cumulative Demand, 1978-2000 U.S.	World	Reserves U.S.	World	Resources U.S.	World	Ratio to U.S. Demand of U.S. Resv.	Resr.
Bauxite	million s.t.	225	783	10	5,200	50	8,850	.04	0.2
Copper	million m.t.	55	274	92	494	382	2,316	1.7	7.0
Iron Ore	million s.t.	3,400	19,900	4,000	103,000	19,600	217,000	1.7	8.2
Phosphate	million m.t.	1,100	4,800	1,800	34,500	9,250	129,500	1.6	8.4
Platinum Group	million tr. oz.	49	173	1	1,180	300	3,220	.02	6.1
Tungsten	million lb.	741	2,910	275	5,700	995	14,900	0.4	1.3

Source: USDI Bureau of Mines, Mineral Facts and Problems, 1980.

Note that the expected U.S. demand for bauxite (aluminum ore) greatly exceeds domestic reserves, but world reserves are over 6 times the predicted world demand for the 1978-2000 period. The U.S. will be dependent on imports or substitutes, unless new domestic reserves are discovered. The situation is less critical for copper, iron ore, and phosphate. In the case of platinum and tungsten, the situation looked critical in 1976. Since then some platinum resources of the Custer and Gallatin National Forests in Montana have been reevaluated as reserves and two large mines are in the planning stages.

It is reasonable to expect some upward revision of estimated resources and reserves due to continuing exploration for new deposits. In addition, the development of new mining or ore benefication techniques that permit utilization of lower-grade ores will justify the conversion of some resources to reserves.

Demand for Minerals

The total demand for minerals and mineral fuels has steadily increased for decades. In the U.S., total consumption of mineral materials increased about 3.8 percent annually from 1950 to 1970. [8/] Then it slowed significantly to about 2 percent, perhaps reacting to increased energy costs, the mid-1970

8/ Based on median rate of increase reported for 87 metals, nonmetal minerals, and gases by the Bureau of Mines in Minerals Trends and Forecasts, 1979.

Figure 1-4: World Production and United States Production and Consumption of Crude Petroleum 1930-1980

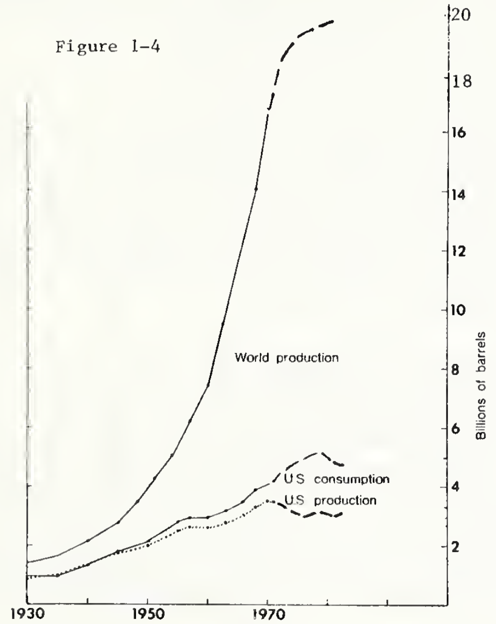


Figure 2.7. World production and United States production and consumption of crude petroleum, 1930–71. Data from U.S. Bureau of Mines, *Minerals Yearbook* and *Commodity Data Summaries*. Extended to 1980 by the author. Additional Sources: U.S. Department of Energy, Monthly Energy Review; Exxon Corporation, World Energy Outlook, 1979.

Figure 1-5: World Production and United States Production and Consumption of Eighteen Minerals

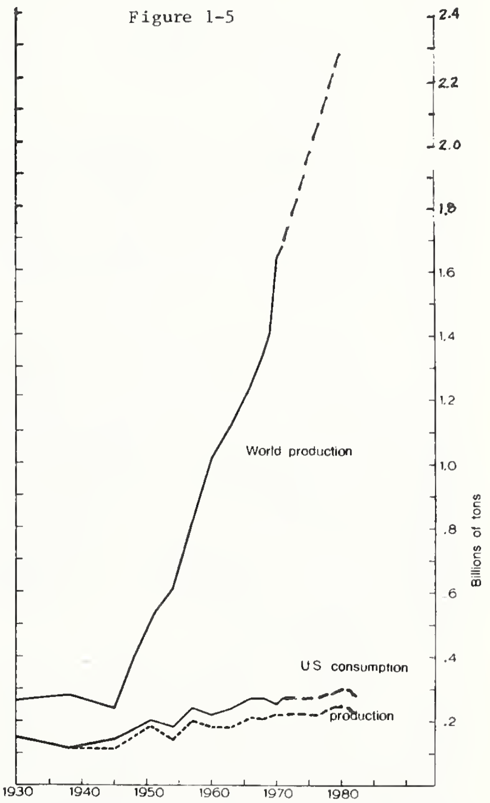


Figure 2.4. World production and United States production and consumption, 1930–71, of eighteen minerals (iron ore, bauxite, copper, lead, zinc, tungsten, chromium, nickel, molybdenum, manganese, tin, vanadium, fluorspar, phosphate, cement, gypsum, potash, and sulfur), in metric tons. Data compiled at the University of Wisconsin by Kenneth D. Markart and E. N. Cameron, from U.S. Bureau of Mines, *Minerals Yearbook* and *Commodity Data Summaries*. Extended to 1979 by author.

Figure 1-6: Increase in World Consumption of Copper During the Last Century and a Half

Increase in world consumption of copper during the last century and a half. Source: United States Bureau of Mines.

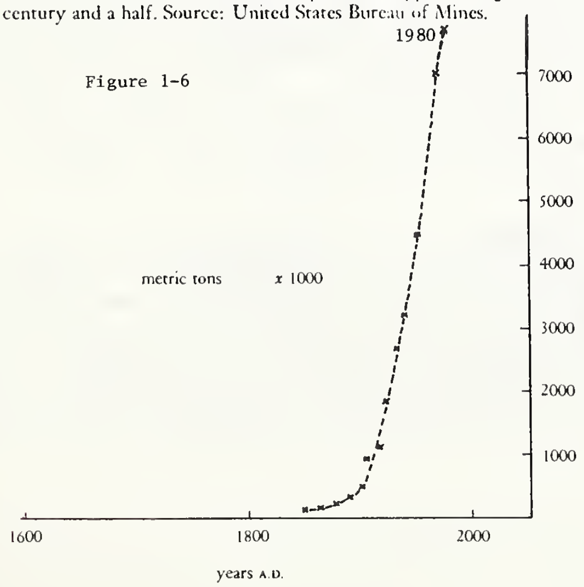
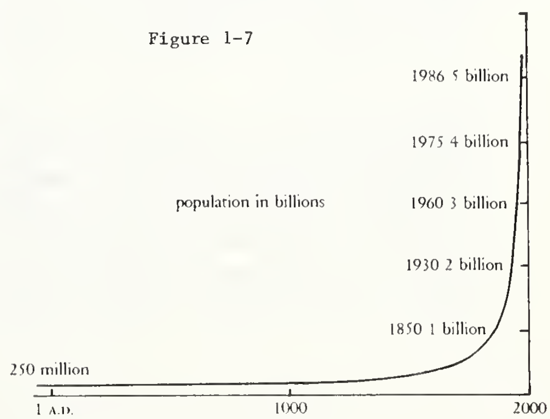


Figure 1-7: World Population Growth

The world's population growth. Source: United Nations.



recession, and high interest rates. The annual increase in petroleum products consumption averaged about 4.3 percent between 1954 and 1973. Following the 1973 oil embargo and the subsequent OPEC price increases, the U.S. consumption curve declined, rose again, and then steadily declined from 1978 to 1981 when it dipped below the 1973 level (Figure 1-4). In contrast, coal demand (which had gradually decreased in deference to petroleum during the 1940-1970 period) has been in growing demand as a source of heat and electrical power.

Since 1950 the world demand for minerals and mineral fuels increased between 50 and 75 percent each decade, more rapidly than in the U.S. (Figures 1-5 and 1-6). One important factor has been world population growth, which has averaged about 2 percent annually during this period (Figure 1-7). Growth at this rate could double the world's population in about 40 years. Several "developing" nations now double their populations in as few as 20 to 25 years, while most established industrial nations require 75-150 years to double in size.

Rapid modernization is a second reason for sharp increases in world minerals consumption. Extensive reconstruction occurred in Europe, the U.S.S.R., and Japan following the widespread devastation of World War II. At the same time many Asian, Mideastern, African, and Latin American nations launched programs of industrialization. Additional mineral deposits were developed, new industries were established, and extensive urbanization with its associated construction activities followed. The examples of Brazil, Venezuela, Korea, Taiwan, Israel, Saudi Arabia, Mexico, Nigeria, and Egypt illustrate the worldwide involvement in this transition.

In the industrial democracies of the West, a rising living standard has been a major factor contributing to increased minerals consumption. Population growth has been relatively slow (0.5 to 1.2 annually in most countries), and capital investment in new plants and equipment has gradually stabilized. Yet for three decades, per capita consumption has continued to increase as families and individuals redefine their needs at ever-higher levels. Consumer expectations have risen, in part because of an expanding and increasing effective advertising industry.

Compared to a generation ago, the contemporary citizen demands and receives more automobiles, home conveniences, floor space, toys, clothing, fast foods, commercial recreation, health care, schooling, and other consumer goods and services that require minerals in their manufacture, packaging, or performance. These goods are viewed as desirable, useful, and in many cases, necessary. Many people regard them as evidence of career success and high status. Table 1-4 provides several examples of U.S. consumption increases in recent years.

The expectation of ever-increasing consumption of factory goods and professional services is spreading worldwide. Increasingly it is shared by the growing middle classes and the industrial working classes of the world's developing nations. Universal achievement of this goal would require the commitment of several times more mineral wealth each generation than is now consumed, unless there are compensating trends such as reduced population growth rates, greater energy efficiency, longer product life, or recycling of discarded materials.

Table 1-4: U.S. Per Capita Consumption Increases

CATEGORY	EXAMPLES	CURRENT LEVEL	EARLIER LEVEL
Housing Units	Median number of rooms per unit	5.1 in 1980	4.9 in 1960
	Percent with air conditioning	57.3 in 1980	12.4 in 1960
	Percent with clothes dryers	61.5 in 1979	19.6 in 1960
	Percent lacking some or all plumbing	2.7 in 1980	13.2 in 1960
Energy	Millions of BTU's consumed per capita	322. in 1981	223. in 1950
Motor Vehicles	No. registered vehicles, per person	.69 in 1980	.41 in 1960
	Percent of population using urban transit on average day	3.3 in 1976*	5.2 in 1960
Social Services	Health Expenditures: percent of GNP	9.8 in 1981	4.4 in 1950
	Police, fire, sanitation: percent of GNP	1.3 in 1977	0.8 in 1950
Education	Median years of school completed	12.5 in 1981	10.6 in 1960
	School expenditures: percent of GNP	6.5 in 1981	3.3 in 1950
	Percent of pupils transported by bus	57.0 in 1980	16.3 in 1940

* With increased gasoline prices, this percentage has been increasing since 1976.

SOURCE: Statistical Abstract of the U.S., 1979 and 1982-1983.

Rising consumption implies increased family "buying power" and expanded supplies of raw materials. Both trends were very evident in the U.S. between 1950 and 1977, when average family income increased from $8,647 to $17,517 (in constant dollars), a rise of over 200 percent.[9/] Some factors that have contributed to increased buying power are:

- a dramatic increase in the number of wives employed outside of the home (from 25 percent in 1950 to 50 percent in 1980).
- increased industrial efficiency, permitting negotiated and legislated wage increases.
- extended credit arrangements, enabling consumers to commit future income.
- the discovery and development of rich overseas deposits of oil and essential metals, offered at very competitive prices.
- market competition offered by Japan and Common Market nations, tending to hold prices of manufactured goods down.
- increases in social programs that supplement and stablize family incomes.

The expansion of family buying power began to level off in 1974 with the sharp escalation of energy prices. The persistent increases in interest rates during 1978-1981 effectively decreased the buying power of many families, especially those who purchased homes during this period.

Domestic Requirements

Today the U.S. is the leading consumer in most categories of mineral commodities, including energy, metals, industrial minerals, and factory goods. Because these demand categories are closely correlated, energy demand serves as a rough indicator for all of them. The U.S., with 5.1 percent of the world's people, uses about 28 percent of the available commercial energy. This computation excludes the nonmarket energy sources mentioned earlier. To illustrate the magnitude of this level of demand, if all of the people on earth used energy at the U.S. per capita rate, five times as much commercial energy would be consumed each year[10/] (Figure 1-8).

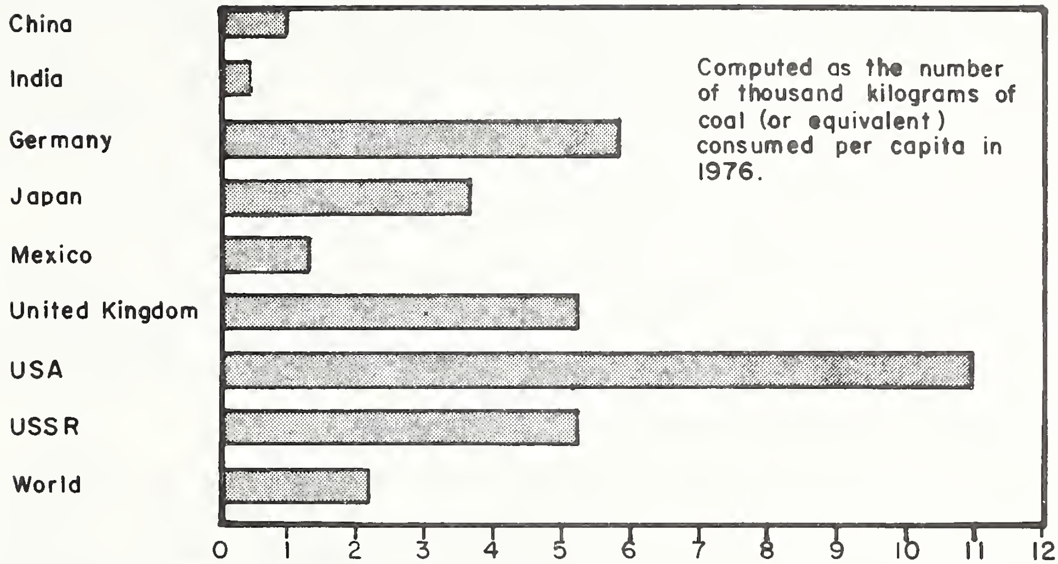
Most U.S. energy is used to meet domestic needs. About 20 percent is consumed in residential heating, 26 goes for transportation, 14 to commercial heating and cooling, industry consumes 37, and agriculture uses 3 or 4 percent.[11/] The mining and minerals processing industries are major industrial energy consumers.

9/ Bureau of the Census. Current Population Reports, series p-60.

10/ Some of the bases for the U.S. energy consumption level are explored in The Outlook for Mineral Resources in the Northern Region 1980-1990, R-1 81-05.

11/ Resources for the Future, Energy in America's Future: The Choices Before Us. Baltimore: Johns Hopkins University Press, 1979.

Figure 1-8: Per Capita Commercial Energy Consumption in Selected Nations (Excludes Non-Market Sources)



Source:
U.S. Statistical Abstract, 1979-Table 1564

Although some energy is used to produce goods for export, roughly equivalent quantities of raw materials and manufactured products are imported. In 1978, the value of U.S. imports exceeded exports by 24 percent.[12] When fuels are omitted from this computation, exports exceed imports by 3 percent. In the automotive, appliance, electronic, and optical industries, imports were almost double exports. In agriculture, the U.S. imported about 60 percent of the volume it exported.

About the same U.S.-to-world demand relationship applies to most other mineral commodities, as Table 1-5 indicates.

Table 1-5: U.S. Mineral Demand as a Percentage of 1979 World Mine Production

Aluminum	30%	Copper	24%	Lead	21%
Antimony	30	Tungsten	21	Phosphate	29
Asbestos	11	Gypsum	30	Salt	27
Chromium	17	Iron ore	14		

Source: Computed from U.S. Bureau of Mines, <u>Mineral Facts and Problems,</u> 1980.

12/ U.S. Statistical Abstract, 1979. Preliminary data.

Supply-Demand Trends

The United States is a major producer of most mineral commodities on the international market and a world leader in its output of boron, cement, silver, sodium compounds, iron, lead, coal, copper, magnesium, molybdenum, vanadium, phosphate, talc, sulfur, and salt.[13/] For most commodities, domestic production has steadily increased since 1950, responding to the needs of an expanding population with a rising living standard. In 1980, about 30 percent of the 91 minerals annually monitored by the U.S. Bureau of Mines were amply produced in the U.S., usually with a surplus for export. About 55 percent were partially imported and 15 percent were almost totally imported. Of the 91 minerals, the median amount imported was about 30 percent of total demand.

The U.S. is more self-sufficient in minerals production than any other free-market industrial nation. It is nevertheless of concern to some citizens [14/] that the Soviet Union may be more self-sufficient, having pursued a policy of minerals independence for many years, even when it was not economic to produce some of the materials needed.

The percentage of a given commodity imported, less the amount exported, plus any adjustments due to reallocation of supplies on hand is the "net import reliance." The U.S. import reliance has increased somewhat since the 1950's. For 50 minerals on which data exist, the percentage imported has increased for 18, remained about the same for 22, and decreased for 10 during this period. Most increases, including antimony, bauxite, cobalt, gypsum, iron ore, manganese, mercury, salt, sulfur, vanadium, and zinc have been between 5 and 20 percent of total consumption. In contrast, domestic production has increased 5 to 20 percent for asbestos, copper, gold, lead, and nickel, and more for silver and uranium.[15/]

There is a very dramatic exception to this pattern of either stable or gradually changing imports. Until the 1950's, the U.S. was the major producer and an important exporter of oil. This gradually changed when high-volume fields were developed in Venezuela, the Middle East, and elsewhere. By 1977 the U.S. was importing 47 percent of its oil at $13.34 per barrel compared to $3.18 per barrel in 1970.[16/] This declined to 40 percent in 1980, but the average import price had passed the $30 mark. With the decontrol of oil prices in 1981, the price of domestic oil rapidly rose to more comparable levels and encouraged further exploration and development in the U.S.

13/ Mineral Commodity Summaries, 1981.

14/ American Institute of Petroleum Geologists, Metals, Minerals, and Mining. Golden, Colorado: AIPG Foundation, 1981. For a different point of view (that the two countries are about equally self-sufficient) see Energy and Minerals Resources newsletter, July 16, 1982.

15/ See USDI Bureau of Mines publications for details: Minerals Yearbook, issued periodically, or Minerals Commodity Summaries, issued annually

Crude oil is a very critical raw material for the U.S., essential for the manufacture of gasoline, heating oil, jet and diesel fuels, kerosene, plastics, hundreds of chemical products, and electrical power generation. An eightfold price increase between 1971 and 1980 did not reduce the per capita demand; i.e., population increased 10 percent, but demand went up 18 percent. However, the rate of increase in demand (which in the 1960-1970 decade was 48 percent compared to a population gain of 13 percent) did slow considerably. Since 1980, per-capita demand has also decreased as continuing high prices and rising unemployment encouraged conservation measures.

There are many reasons why a free-market country such as the U.S. may import some of its minerals. Most obvious is that they may not occur in significant amounts in the U.S. and they are sometimes cheaper overseas because of inequities in the currency exchange rate, efficiency of overseas production facilities, trade agreements, or other factors. In addition, some U.S. mining corporations have extended their operations abroad where (1) some mineral deposits are very rich, (2) pollution controls may be less rigid, (3) labor is less expensive, and (4) there are expanding consumer markets in the developing nations. The U.S. may import minerals or factory goods from American-owned overseas operations.

Today more than ever the U.S. has close economic ties with the rest of the world, both as a supplier of factory and farm products and as a customer for both raw materials and finished goods. The gradual reduction of tariffs and the entry into world trade of many additional nations have encouraged this trend.

Since 1950, international (non-communist) transportation and communications networks have been greatly extended and international trade has increased 30 times in current dollar value to almost two trillion dollars in 1980.[17] Americans travel abroad 10 times as often as in 1950 and overseas visitors are 30 times more common in the U.S. (excluding trips to or from Mexico and Canada).

In 1979, the U.S. imported over 200 billion dollars worth of commodities and exported goods valued at 180 billion.[18] That year petroleum imports cost the U.S. 60 billion dollars and 24 billion was spent for a wide variety of raw and processed mineral materials. In 1980, OPEC price increases and inflation had raised this total for minerals imports to over 105 billion, compared to minerals exports of about 35 billion, creating a 70 billion dollar deficit in this trade category, mostly due to crude oil purchases.

16/ USDOE Monthly Energy Review and USDI Bureau of Mines, Minerals Facts and Problems, 1975 Ed.

17/ Department of Commerce, Federal Communications Commission, and International Monetary Fund data, as reported in U.S. News and World Report, August 31, 1981, p. 57

18/ USDC Office of Planning and Research

Looking Ahead

Perceptions of future resource availability vary considerably, depending in part on the assumptions on which they are based. Optimistic industrialists, mining engineers, geologists, and economists point out that the earth's crust is composed of minerals and sea water is saturated with them. In this view, the assurance of future supplies is contingent on having proper incentives, opportunities, and technologies. If the latter are available, the mining industry will produce the necessary minerals.

Less optimistic scientists and environmentalists express concern about the future energy and minerals situation (Appendix B, items 37 and 42). In the modern era, the combination of quickened population growth (world population has doubled since 1940) and rising living standards has greatly increased the demand for minerals and other natural resources. At the same time the available private land area has been reduced due to business and residential expansion, establishment of public and private preserves and special-use areas, highway construction, etc. Many areas are experiencing unacceptable levels of pollution from existing industries, residences, and traffic.

Per capita consumption of newly mined mineral products is now approximately doubling each decade.[19/] There are indications that the U.S. trend toward increased consumption is leveling off. Some observers predict per capita consumption will eventually turn downward as rising energy prices, continuing population growth, and Third World industrial development make additional demands on the finite natural resources of the world. Escalating oil prices are regarded as only the first of a round of price increases spurred by diminished resource supplies or price fixing agreements among major suppliers.

Scientists in many fields seriously question the idea of perennial economic growth for the world for two basic reasons: (1) the assumed inadequacy of various critical resources in economic concentrations, and (2) the limited capacity of the environment to withstand the impacts associated with their extraction and processing.[20/] Each nation must determine the appropriate balance between (1) defining and meeting realistic resource needs and (2) maintaining the quality of environment that is essential to the survival and well-being of humans and other living things. Increasingly, these environmental concerns are defined to include the welfare of all citizens, future generations, and other nations adversely affected by trade policies, waste, or industrial pollution.

As the world's richest and most accessible ore deposits are depleted and additional low-grade sources are developed, the cost of production is likely to increase faster than the inflation of national currencies. The mounting cost of domestic petroleum production is a good current example. The resulting rise in the price of mineral commodities will provide a strong economic incentive to alter previous production and consumption patterns.

19/ Sources which discuss the implications of this: USDS/CEQ. Global 2000 Report to the President. New York: Pergamon, 1980. Skinner, Brian J., "A Second Iron Age Ahead?" in American Scientist, May-June, 1976.

20/ Schumacher, E.F. Small is Beautiful: Economics as if People Mattered. York: Harper and Row, 1973.

Producers will experiment with newer minerals technologies and seek additional sources, e.g., other metal-bearing compounds that were previously uneconomic to process. The scrap metal industry will expand, and more metals and other valuable minerals will be recycled. The present effort to design products that require less raw materials and consume less energy (e.g., autos, electronic equipment) will be intensified.

For agency planners this means increasing resource conflicts in the wake of fast-rising demands for business and residential space, recreation facilities, natural areas, agricultural land, roads and pipelines, energy corridors, and areas for mines, surface facilities, and mine waste disposal.

Despite these concerns, considerable investment in mining operations is occurring, both in the U.S. and overseas. Engineering and Mining Journal identified 358 projects being planned or constructed in 1980, at a projected cost of over 108 billion dollars.[21] About 63 percent of this investment is for metals, with the remainder divided among oil shale and tar sands (27 percent), phosphate (5.5), potash (3.7), and soda ash (1 percent). A large portion of the investment in mines metals processing operations is outside of the U.S., as Table 1-6 indicates. The same holds true for the other listed minerals except oil shale and sand projects, most of which are located in Canada (53 percent) and the U.S. (39 percent).

Table 1-6: Projected Capital Investment for Metals Projects in the 1980's (Aluminum, copper, lead, zinc, iron ore, nickel, gold, and uranium)

	No. of Projects	Millions of Dollars	Percent
North and Central America	79	9,684	15
So. America & Caribbean	47	22,774	35
Europe	25	2,335	4
Africa	24	7,754	12
Japan and Asia	25	8,395	13
Australia and Oceania	46	14,652	22
	246	$65,594	

Source: Engineering and Mining Journal, January 1981.

The potentials of sea water (which covers 70 percent of the earth's surface and contains numerous dissolved minerals), undersea mining (principally continental shelves), and ocean-floor nodule mining are being explored.[22] Currently, salt, bromine, and magnesium, all relatively abundant seawater components, can be extracted, but dozens of other valuable mineral substances are also present. Although some minerals (e.g., gold, chromium, and tungsten) are too dilute to be extracted economically with existing technology, new processes could change this.

21/ "Mining Investment 1981," in Engineering and Mining Journal, January 1981.

22/ For a more detailed discussion, see: Cargo, David and Bob Mallory, Man and His Geologic Environment. Menlo Park, California: Addison-Wesley, 1974.

The world's continental shelves overlay mineral deposits that are now being tapped in shallow locations. As new mining techniques are perfected, mineral resources will be extracted at greater depths. At the same time, techniques are being devised for gathering manganese nodules from the sea floor. These nodules contain assorted metallic elements including manganese, iron, nickel, copper, barium, aluminum, and cobalt.

As minerals prices rise, consumers will more often select either cheaper mineral substitutes or products made from plastics (many of which are composed of minerals), wood, wood wastes, crop residues, or other substances. However, for many existing uses, minerals are presently preferable or irreplaceable. In these instances, some consumers will either be unable to afford them or will have to settle for a smaller quantity.

The rising cost of locating and extracting crude oil has stimulated oil shale development research in recent years in Colorado and other Rocky Mountain states. The Colony Project in Colorado (now suspended) was designed to produce 50,000 barrels of shale oil daily for 30 years.[23/] This was about 0.3 percent of U.S. consumption in 1980. In 1980, Exxon unveiled a scenario for a $500 billion oil shale industry based in Colorado.[24/] A subsequent decline in oil prices, probably caused by the general decrease in world oil demand because of the major world-wide economic recession, has caused suspension of most oil shale projects. Renewed world economic growth could cause a surge in oil prices, which could again make oil shale development economically attractive.

Coal is another potential source of both synthetic gas (methane) and gasoline. Huge coal fields (Figure 1-1) are known to exist on the Great Plains and intermountain basins of the West. Portions of these fields are now being developed in several states, including Montana, North Dakota, Wyoming, Colorado, Utah, and Arizona. Plant construction and the extraction and conversion of oil shale and coal require substantial work forces. Large quantities of energy are needed to construct and operate mines, plants, and transportation facilities.

A rapid increase in U.S. coal consumption is projected for the remainder of this century, with the West supplying 49 percent of the total in the year 2,000, compared to 29 percent in 1980.[25/] Industry and utilities will consume most of the increased production.

23/ "Colony Project and Battlement Mesa Development," in The Mining Record, October 28, 1981, p. 4. Construction was suspended in May 1982 and may not be resumed. The shutdown was attributed to the 1981-1982 decline in oil prices (Mining Record, May 5, 1982).

24/ Engineering and Mining Journal, July 1980, p. 47.

25/ For estimates, see: The Mining Record, April 29, 1981, p. 2; June 17, 1981, p. 19.

The Department of Energy has identified 10 southeastern Montana counties as possible sites for 36 giant synthetic fuel conversion plants.[26] If this entire plan were implemented, within a decade it would increase the population of these counties by over 350,000 people. Other prospects that could materialize within a decade are the discovery and development of extensive oil and gas reserves in the Montana Overthrust or the construction of several major mines in Western Montana or Northern Idaho. Several projects are already in the planning and development stages and some are located on National Forest System lands.

Minerals Management in the Northern Region

There is growing evidence that some of this nation's best remaining minerals potential is on public lands. Many land areas remain in public domain because their rough terrain and high elevation were unsuited to agriculture. These and other public lands managed as National Forests, Parks, Monuments, and Wildlife Refuges do contain large, relatively undeveloped mineralized zones.

The Region's Resources

In the Forest Service Northern Region, commercial quantities of copper, lead, zinc, silver, gold, platinum, chrome, nickel, molybdenum, manganese and other metals are known to exist. There are also important deposits of phosphate, limestone, coal, decorative stone, gems and other industrial minerals and fuels useful in industry and agriculture (Appendix A, Figures A-2 through A-5).

Some idea of the ultimate minerals potential of the Northern Region can be gained from a study conducted by the Region's Minerals economists. In the Lolo Forest alone, there are 234 mineral deposits. There are at least five occurrences each of gold, silver, lead, copper, zinc, antimony, arsenic, barite, and fluorspar. Tungsten, kaolin, pumice, iron, uranium, germanium, nickel, cobalt, and molybdenum are also known to exist. To this list could be added sand and gravel, dimension stone, decorative stone, and gemstones (Table 1-7).

In 1979, only about 4 percent of the value of minerals production in Montana, Idaho, and the Dakotas occurred on National Forest System lands. In 1982, an estimated 15-20 percent of production is on National Forest claims and leases. This great increase is mainly due to the oil and gas activity in the National Grasslands of western North Dakota and the new ASARCO - Troy Mine in northwestern Montana.

Acquiring Mineral Interests

Most National Forest System lands, (excluding most wildernesses, which closed in 1984) are open to mineral claims or mineral leasing. The miner's rights are defined by a series of laws and vary according to the type of mineral sought and the legal status of the land (whether public domain or subsequently acquired Federal lands).

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[26] The Missoulian, August 1, 1979, p. 1.

Table 1-7: The Minerals Situation in the U.S. and Northern Region

Mineral (or ore)[a]		Extent of Imports[b]	Regional Situation[c] States	Forests	Mineral (or ore)		Extent of Imports	Regional Situation States	Forests
Aluminum metal		0	P		Magnesium		0		
Antimony	C	XX	EP	EP	Manganese	C	XXX	EP	E
Arsenic		NA	EP	EP	Mercury	C	X		
Asbestos	C	XXX	EP		Mica (scrap)		0	E	
Barium		X	EP	EP	Mica (sheet)	C	XXX	EP	E
Bauxite	C	XXX			Molybdenum		0	EP	EP
Bentonite	C	0	EP		Nickel	C	XX	EP	E
Bismuth	C	XXX	EP		Nitrogen (ammonia)		0		
Building Stone		0	EP	EP	Oil shale, sands		0	E	
Boron	C	0			Peat		X	E	
Cadmium	C	XX	EP		Perlite		0	EP	
Cement (limestone)		0	EP		Petroleum	C	X	EP	EP
Cesium	C	XXX			Phosphate	C	0	EP	EP
Chromium	C	XXX	EP	EP	Platinum Group	C	XXX	EP	EP
Clays		0	EP		Potash	C	XX	EP	
Coal		0	EP	EP	Quartz Crystal		X		
Cobalt	C	XXX	EP		Rubidium ore	C	XXX		
Columbium	C	XXX	EP	E	Rutile	C	XX		
Copper	C	0	EP	EP	Salt		0	EP	
Corundum		XXX	E	E	Sand & Gravel		0	EP	EP
Decorative Stone		NA	EP	EP	Selenium	C	X		
Diamonds	C	XXX			Silicon		X	EP	EP
Feldspar		0	EP		Silver	C	X	EP	EP
Fluorspar	C	XXX	EP	EP	Sodium compounds		0		
Garnet		0	EP	EP	Strontium	C	XXX		
Germanium	C	X			Sulfur	C	0	EP	
Gold	C	0	EP	EP	Talc		0	EP	EP
Graphite, natural		XXX	EP		Tantalum	C	XXX	E	E
Gypsum		X	EP		Tellurium	C	X		
Helium		0			Thorium	C	XXX	EP	EP
Ilmenite	C	X	E	E	Tin	C	XXX	EP	
Indium	C	NA			Titanium metal	C	0	E	E
Iodine		XX			Tungsten	C	XX	EP	EP
Iron ore	C	X	EP	E	Uranium	C	0	EP	E
Kyanite		0	EP	EP	Vanadium	C	X	EP	
Lead	C	X	EP	EP	Vermiculite		0	EP	EP
Lime		0	EP		Zinc	C	XX	EP	EP
Lithium	C	0			Zircon	C	XX	E	E

a/ C = Defined as "of compelling domestic significance" by the U.S. Geological Survey and the U.S. Bureau of Mines in a 1978 memo.

b/ Import dependency, as of 1981, is as follows:
XXX = 80 percent or more of domestic consumption is imported
XX = 50 percent to 79 percent is imported
X = 20 percent to 49 percent is imported
0 = Less than 20 percent is imported
NA = Insufficient data to estimate imports
See Appendix A for additional data on the volume and sources of imports.

c/ Northern Region minerals activities summarized.

E = The mineral is known to exist or being actively sought in one or more Northern Region states (or Forests).
P = Production is scheduled or occurring in one or more Northern Region states (or Forests).

Federally-owned minerals on Forest lands are placed in three general categories denoting the procedure for acquiring authorization to extract minerals from them. These are locatable, leasable, and salable, each described below. Appendix C provides further details.

Locatable. Regulated by the General Mining Law of 1872 (17 Stat. 91, as amended; 30 U.S.C. 22-47). This category includes intrinsically valuable minerals such as gold, silver, and platinum, and other metallic minerals; e.g., copper, lead, zinc, cinnabar (mercury ore), iron, tungsten, molybdenum, etc. Some industrial minerals such as high quality gypsum or feldspar, or metallurgical or chemical grade silica and limestone are also included.

The Organic Administration Act of 1897 (30 Stat. 34, as amended; 16 U.S.C. 477-478) which authorized the National Forest System reaffirms the citizen's right to prospect for and extract minerals from public domain lands (generally Federal lands acquired before June 4, 1897).

U.S. citizens and domestic firms are permitted to explore for minerals on most National Forest System lands (Appendix C), provided they observe Forest Service rules and regulations. If a valuable deposit is discovered, the finder has the right to locate a claim and to mine and market the mineral.[27]

The Federal Land Policy and Management Act (FLPMA) and the laws of individual states regulate monumenting (staking) and recording of claims. The claimant is also entitled to reasonable access to his claim and permitted to use as much of the claim surface and its resources (timber, stone) as reasonably necessary to extract the mineral or ore.

Under the 1976 Federal Land Policy and Management Act, claims must be registered at the appropriate Bureau of Land Management Office. The claimant must also present evidence to that office of at least $100 of labor or assessment work contributing to the development of the discovery by December 30 of each year, if the claim is to remain valid.

There are modest fees for locating claims; i.e., a $10 filing fee plus minor costs relating to the required paper work. There are no rentals or royalties to pay for locatable minerals removed from public domain lands.[28] The historic purpose behind this "gift" to the miner is to promote the discovery and development of the nation's mineral wealth.

27/ For a comprehensive discussion of mining law, see: Pruitt, Robert G., Jr. Digest of Mining Claim Laws. Boulder, CO, Rocky Mountain Mineral Law Foundation, 1977.

28/ A discussion of the "free minerals" issue and attempts to modify this legislation is found in: U.S. Council on Environmental Quality, Hard Rock Mining on Public Land, 1977, pp. 10-21.

There are two basic types of claims: <u>lodes</u> and <u>placers</u>. Lode claims are for veins or lodes in place, and have maximum dimensions of 600 X 1500 feet, with the 1500' dimension laid out along the trace of the vein or lode on the surface. Placer claims are for secondary deposits such as alluvial gold deposits. The size of placer claims varies according to the number of locators. One locator may claim 20 acres, two may claim 40, and so on up to 8 locators who may claim a maximum of 160 acres per claim.

There are two other types of claims: millsites and tunnel sites. Millsites are additional nonmineralized land used for a mill or some other nonextractive purpose related to mining. Such uses may be an office, shop, waste dump, etc. Millsites are a maximum of five acres in size. A tunnel site is not a mining claim in the true sense of the word; it is an exclusive right to prospect, and subsequently a possessory right to lay claim to any "blind" lode, vein, or ledge within a 3,000 foot square area containing a valuable mineral deposit that has been discovered by driving the tunnel.

The Multiple Use Mining Law of 1955 (69 Stat. 367, 30 U.S.C. 601, 603, 611-615) provides that (unpatented) mining claims shall be used only for prospecting, mining, minerals processing operations, and clearly related activities. The Federal Government has the right to remove plant materials or to manage other surface resources as long as the claimant's mining activities are not unreasonably obstructed.

If a discovery of a valuable mineral deposit is made and certain other conditions are met (i.e., $500 worth of work on the claim and application requirements), a patent (legal title to the claim) may be granted. Federal court decisions have established that mineral deposits must be economically valuable to be patented. That is, a "prudent man"[29] would find it worth his time and investment to extract the mineral.

Patent application is made to the State Director of the Bureau of Land Management. The claim is surveyed (requiring the services of a professional surveyor) and the economic worth of its mineral deposit is evaluated. If a patent is granted, a fee is assessed and the claim is thereafter regarded as private property.

More recent legislation has provided for leasing certain categories of minerals with the government retaining title to the land and collecting annual rentals and royalties on minerals extracted. Leasing is also the procedure for gaining access to <u>all</u> minerals on Federal lands (about 8 percent of the total) that have been acquired since 1897 through purchase, gift, or other transactions.

<u>Leasable</u>. Authorized by the Minerals Leasing Act of 1920 (41 Stat. 437, as amended; 30 U.S.C. 181-287); the Minerals Leasing Act for Acquired Lands of 1947 (61 Stat. 913; 30 U.S.C. 351, 352, 354, 359); the Geothermal Steam Act of 1970,

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[29] I.e., ". . . where mineral is found and the evidence shows that a person of ordinary prudence would be justified in the further expenditure of his labor and means, with a reasonable prospect of success in developing a valuable mine." (Castle vs. Wamble, December 5, 1894).

and other legislation. This group of minerals, including oil, natural gas, coal, oil shale, sodium, phosphate, geothermal resources, etc., has gradually been removed from the jurisdiction of earlier mining laws. As their titles suggest, the 1920 and 1947 mineral leasing acts apply respectively to original Federal public domain lands and to lands acquired through purchase, gift, condemnation, etc. Principles that apply to this group are:

- title to the land remains with the U.S.,
- a specified return (royalties) must be paid on minerals extracted,
- the decision to lease is discretionary, and
- full environmental protection is required.

Saleable. Governed by the Materials Act of 1947 (61 Stat. 681, as amended; 30 U.S.C. 601-602). This category includes commonly-occurring minerals of low unit value such as gravel, sand, stone, clay, cinders, etc. The Forest Service sells these materials on a price/unit basis (i.e., per ton or yard) at their appraised fair market value. Competitive sale procedures are required for large sales or where competitive interest exists.

Surface Resources and Uses

Persons who stake claims, lease mineral rights, or purchase saleable minerals on Federal lands must respect the surface resources and uses on these lands. Under law the miner is permitted access to the mineral resource and claim holders may use a reasonable amount of timber for their mine. Agency stipulations are attached to lease contracts and project operating plans to protect the environment and prevent unnecessary interference with other land uses. When Federal minerals exist on private lands, miners must compensate surface owners for damages incurred.

The Five-Year Program

The Minerals and Geology Staff Unit of the USDA Forest Service, Northern Region, formulates policies, plans, standards, criteria, and procedures necessary for the efficient administration of the Region's Minerals and Geology programs. Its goal is to assist the 13 member Forests in the orderly development of minerals resources while also protecting other surface resources and amenity values.

To this end, a five-year plan has been developed, anticipating an increasing volume of minerals activities on National Forest System lands along with greater legal and technical complexity in their administration. The plan reflects Washington Office direction, but also provides enough flexibility for effective on-the-ground administration at the Forest level.

The interdisciplinary Minerals and Geology Staff Unit will insure that the Region's program is smoothly and consistently administered. It will provide training, expertise, and other support services to facilitate the implementation of individual Forest programs. These include planning, permitting, monitoring, and coordinating activities, and compliance with the National Environmental Policy Act, the National Forest Management Act, the Forest Service Manual, and other applicable laws and regulations (Appendix A, Tables A-1 and A-2).

Chapter 2: THE MINERAL INDUSTRY AND ITS OPERATIONS

The U.S. mineral industry, its dynamic early leaders, and the social and economic effects of its widely scattered operations are topics of enduring historic interest. This industry's activities continue to stimulate public and agency interest as the Nation pursues a goal of increased domestic production of minerals and fossil fuels, while also reaffirming its commitment to protect and enhance environmental quality.

Perspectives of Mining and Minerals

There is considerable diversity in the statements and opinions of different individuals and groups regarding the costs and benefits of major, site-specific mineral projects. Because the range of possible effects is so extensive, most observers tend to overlook important aspects. Biased reporting and unsupported generalizations are also encountered when most of the readily available information about a proposed project is provided by special interest groups (Chapter 3) that favor or oppose it.

Social scientists, planners, and decisionmakers who wish to understand or predict the social and environmental effects of agency minerals programs can also gain valuable insights by examining the mining industry's role in the overall economic system and the nature of its field operations. This chapter briefly introduces these complex subjects.

Mining and Westward Expansion

Humans have utilized minerals in their natural state for thousands of years. Prehistoric man used stones as weapons or for pounding, and later learned to chip arrowheads and crude tools from flint. Ancient civilizations fashioned jewelry, utensils, and weapons from native gold, silver, copper, and gems, and constructed buildings of stone and clay. Some native American tribes used copper and other minerals for jewelry and as marks of status.

The history of U.S. mining and ore processing began with the English colonists along the Atlantic Coast who extracted iron ore and building materials from shallow surface mines and quarries.[1/] Iron was smelted in batches of a few hundred pounds in a charcoal furnace resembling a large blacksmith's forge. Hammersmith, Massachusetts was the location of the first U.S. ironworks, with a furnace, rolling mill, and foundry. It was also the first of many mine-related company towns to be established in this country.[2/]

Coal, clays, and building stone were also produced in the Atlantic Coast states during the colonial period. Because of the abundance of water power, wood and

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1/ For brief but colorful histories of U.S. mining, see either: USDI Bureau of Mines, Mineral Industry in Early America, by Hillary St. Clair, 1977; or Time-Life Books, The Miners, by Robert Wallace, 1976.

2/ See Allen, James B., The Company Town in the American West. Norman: University of Oklahoma Press, 1966.

charcoal, coal was not widely utilized until the perfection and industrial use of the steam engine in the early 1800's.

By 1810, lead was being mined and smelted in Missouri and Illinois. A rock-lined cavity dug into a hillside served as a smelter, with other holes and connecting troughs scooped out to provide molds. As the demand for lead increased, improved smelting technology was imported from Europe. Copper was soon discovered south of Lake Superior and Michigan became the nation's leading mining state until surpassed by Montana in 1887. Since then various western states have held the lead in minerals production.

The Gold Rush of 1849 brought 50,000 gold seekers to California. This resulted in the development of hundreds of placer claims in a 150 mile strip along the West slope of the Sierra Nevada Mountains. California's population doubled within 3 years and the numerous "finds" stimulated additional prospecting activity through the entire West. This period witnessed the emergence of a new personality type, the grizzled, restless prospector, and the creation of a new lifestyle, the mining community (Chapter 4).

1979 marked the 120th anniversary of the discovery of the Comstock Lode, a rich vein of silver and other metals in Western Nevada. The great size, depth, and immense value of this single cluster of deposits encouraged the improvement of existing mining practices and the development of new ones.

The square-set method of reinforcing mine walls and ceilings with heavy interlocking timbers was perfected at Comstock. Ores were successfully brought to the surface from unprecedented depths (over 3,000 feet), despite problems with flooding and extreme heat. On-site mills of impressive size efficiently separated metals from ores.

By 1870, the Comstock facilities had become a showplace of modern mining technology and were imitated in other mining areas of the West. In addition, the California and Nevada mining laws served as models for the Federal Mining Law of 1872.

Minerals activity in and near the Northern Region followed closely on the heels of developments in California, Nevada, and Colorado. It quickly expanded in scale, extending from the Coeur d'Alene District of Idaho to the Black Hills of South Dakota. The initial wave of placer gold mining in the 1850's and 1860's led to the founding of dozens of towns and cities, including Helena, Libby, Virginia City, Deadwood, Orofino, Elk City, Idaho City, Murray, and Bannack, Montana's first capital.

Numerous boomtowns were settled in northern and southwestern Idaho during the 1860 decade, but many were abandoned when the "diggings" were depleted. Frequently, Chinese miners worked the area for a few additional years. Florence, east of Riggins, once hosted thousands of miners, yet is now a ghost town.

The great silver mine at Granite, Montana, and its mill near Philipsburg were patterned after the Comstock Lode. The project was directed by the same engineer, Philip Deidesheimer, whose name was selected for the town. Granite is a classic example of a "boom and bust" mining town, growing to a population of 3,000 by 1889, declining with the silver panic of 1893, and "dying" when the mine was closed in 1913.[3] Philipsburg, the county seat, remains.

Virginia City, Montana's territorial capital from 1865-1875, experienced a much slower population decline to about 150 people in 1970 and is now growing. Like its namesake in Nevada, it has become a tourist attraction. Founded near the fabulous Alder Gulch gold diggings, the town was laid out in 1863 and reportedly had several thousand residents within two years.

Helena experienced a similar mining boom but continued to grow when it was selected as the state capitol. Nearby Marysville, site of the 40 million dollar Drumlummon Mine, once rivalled Helena and was served by two major railroads.

Thus, within a single generation, about 1850-1880, much of the West was prospected and hundreds of mining camps and cities were founded. Virginia City, Nevada, was an early leader, boasting a population of 18,000 in 1880 and supporting about 100 saloons, 4 churches, and the best hotel between San Francisco and Kansas City. By 1900, Butte had surpassed this. Fortunes were quickly made and lavishly spent. An influx of migrants from many countries of Europe and from China provided the mine labor.

Some ore deposits developed more than a century ago are still being mined. The Comstock Lode produced metals valued at 400 million dollars before the richer ores were depleted. The mines closed, but some sections are now reopening due to the improved metals market. In 1980, the Butte Mine (Berkeley Pit), the Homestake Mine, and the Silver Valley Mines of Idaho produced minerals valued at 50 to 100 million dollars annually at each location (Chapter 4).

The Mineral Industry Today

The mineral industry locates, extracts, and/or processes metals, industrial minerals, and mineral fuels. In 1980, it consisted of 30,000 firms with close to a million employees, plus smaller owner-operated units. Thousands of additional businesses provide supplies and services for mining operations, while still others transport minerals products or convert them into a variety of forms useful in manufacturing or construction.

Central to the mineral industry are several dozen major corporations with international operations and sufficient annual sales to rank among the nation's top 500 industrial corporations.[4] Of the 52 leading industrial corporations in 1980, 20 were oil firms. The largest oil company had assets of 50 billion dollars and annual sales of 80 billion, exceeding all other businesses of any type. Many oil firms are now diversifying their investments to include other energy fields, metals, manufacturing, various businesses, and overseas operations.

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[3] Wolle, Muriel. Montana Pay Dirt. Chicago: Swallow Press, 1963, pp. 246-254. (This is well-researched guide to Montana's dozens of mining communities).

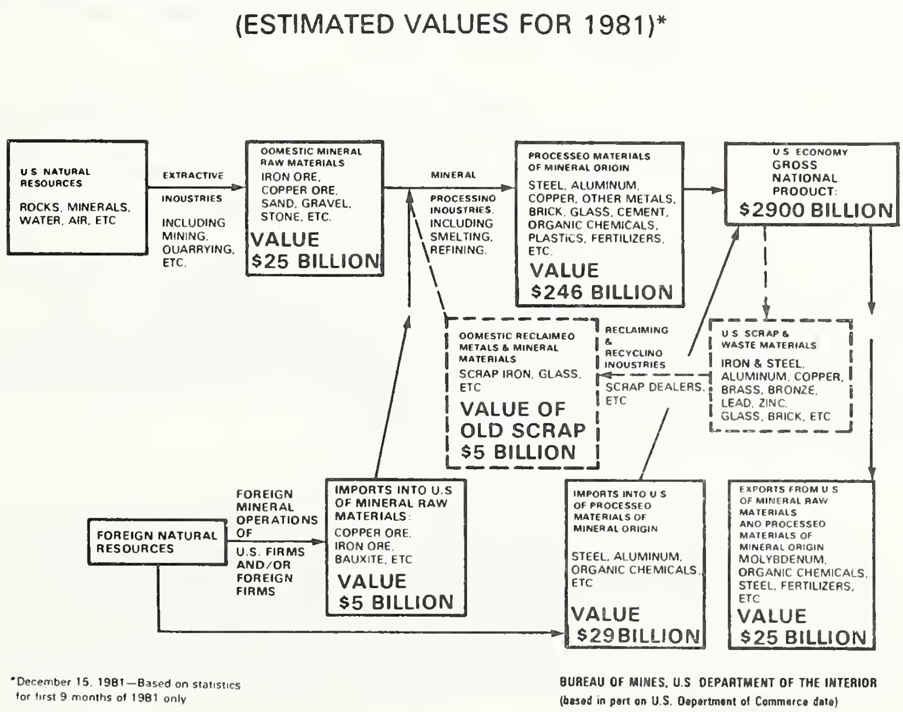
[4] Fortune, May 5, 1980.

The leading coal, metal, and industrial minerals firms tend to be smaller than the major oil companies and have a narrower margin of profit. Those engaged in metals processing (e.g., producing steel, aluminum, or copper stock) have the highest sales, several exceeding two billion dollars in 1980. But their investment in a single large mine or processing facility may be a hundred million to two billion dollars and require hundreds to thousands of employees.

The remainder of the size spectrum includes thousands of small-scale mines, local mine and oilfield service firms, earth moving and drilling contractors, exploration companies, and a variety of professional consultants. Many companies have only 1 to 50 employees and confine their operations to a small geographical area. Some of them market products such as sand and gravel, ore concentrates, or exploration information. Others provide specific supplies or services on a contract basis. But the trend is toward consolidation to increase cost-efficiency. Some exploration, consulting, or other service firms employ hundreds of employees and have nationwide or worldwide operations.

The manufacturing process, in which mineral raw materials are transformed into a variety of consumer products, usually multiplies the value of these minerals many times over (Figure 2-1). This added value is very significant in the pharmaceutical industries, where a few cents worth of basic ingredients may be transformed into a drug or medicine retailing for several dollars. It is much less significant in gasoline production, where crude oil costs $.80 per gallon and gasoline retails for $1.30.

Figure 2-1: The Role of Nonfuel Minerals in the U.S. Economy



A growing share of the world's mineral raw materials and factory goods are now produced abroad. Since 1950, many countries such as Japan, Korea, Germany, Italy, and Taiwan have increased their productive capacity faster than the U.S. There is now a very competitive international market for autos, appliances, textiles, chemicals, and other minerals products. A larger share of ore processing is also done abroad because of lower labor costs, more efficient plants, richer ores, or fewer pollution controls. From about 1970 to 1978, the volume of iron, copper, zinc, and lead smelted in the U.S. has been decreasing despite the generally increasing demand for these minerals. Throughout this period mining employment has remained stable nationally but declined in some States, most sharply in Montana and since then in Idaho. The closure of smelters in Anaconda and Great Falls and the subsequent ARCO agreement to have copper ore concentrated and smelted in Japan accentuated Montana's economic slump. The Bunker Hill mine and smelter closure gravely affected northern Idaho (Chapter 4).

Minerals and Living Standards

The high material living standards shared by the majority of people in industrial societies is closely linked to minerals consumption. The basic raw materials required by most manufacturing industries--and the energy needed to transform them into consumer goods--are supplied by the mining industry. The two major exceptions, the food and forest products industries, use minerals, including fossil fuels, fertilizers, rock aggregate, and chemicals in protecting, harvesting, processing, and transporting their commodities.

A reliable and expanding supply of mineral raw materials is also important in other life-support sectors: homes, schools, hospitals, transportation, communication, national defense, recreation, and public and private utilities. This growing minerals dependence has stimulated much discussion among those who regard the trend as excessive and unwise, and those who see it as an integral and desirable part of modern living.

It was noted in Chapter 1 that some scholars predict resource shortages and environmental degradation ahead, unless there are effective programs to conserve minerals, protect other resources, recycle minerals, and control population growth.

A second point of view is that technology and access are the crucial issues, not the existence of the resources. If the mining industry is granted access to mineral-rich areas, technology exists or can be developed to:

- extract deeper or less concentrated ores at affordable prices,
- provide the energy and water necessary to mine, process, transport, and transform mineral raw materials, and
- protect other surface resources and uses.

A third area of growing concern is the adverse social and economic impacts that often accompany major mining development activities. Typically, some local people support such ventures, anticipating increased growth in business activity, public revenues, and consumer services. Others oppose mine or plant development because of expected adverse effects, e.g., an influx of strangers, housing shortages, impacts on community services, and the disruption of community life (Chapter 4).

Responding to any of these concerns poses a challenge to the mining industry, whose rapidly-expanding operations have permitted each generation since the Industrial Revolution[5/] to use larger quantities of a greater variety of mineral materials. All imply a need for careful planning, sophisticated technology, and social responsibility.

Industry Trends

According to the National Research council, the U.S. mining industry spends most of its investment income exploring for new deposits and acquiring mineral rights.[6/] There is much less emphasis on improving the technology for extracting and concentrating low-grade ores. Industry-sponsored research and development that has been done tends to focus on immediate problems and their short-term solutions.

Much of the innovation that has occurred is the result of outside influences. For example, equipment manufacturers research the miner's needs, develop new products, and demonstrate their utility and cost-efficiency.[7/] Social and environmental legislation and agency policies induce changes in the way mining companies relate to the public, their employees, and the natural surroundings where their operations are located.

Today the mining industry faces a combination of growing foreign competition, increased social and environmental constraints, and a diminished probability of finding large, readily accessible high-grade deposits. These conditions encourage the industry to:

- design mines and plants that meet environmental standards,
- increase the efficiency of existing operations, or close them down,
- mine on public lands,
- seek Federal assistance for new domestic ventures,
- advocate the relaxation of some of the environmental policies and standards, and
- invest some profits in other industries.

Whatever the incentives, there have been many significant changes in industry policies and practices in recent decades and several are summarized here.

There is a pronounced trend toward greater mechanization and automation in mining operations. This reduces costs because much greater volumes of ore can be handled and fewer employees are required. There are fewer jobs per unit of production and many tedious or dangerous jobs have been eliminated.

5/ The "Industrial Revolution" refers to the transition from manual to power-driven machinery and the advent of large-scale factory-based manufacturing. It was first evident in England about two centuries ago and diffused to the U.S., Germany, France, and other Western countries within a generation or two. It continues today in the world's "developing" nations.

6/ National Research Council. Technology Innovation and Forces for Change in the Mining Industry, p. 15.

7/ Ibid, p. 20-21.

The properly designed modern mine is an improved workplace. Recent innovations (not equally evident in all mines) include:

- effective ventilation, lighting, and drainage,
- appropriate safety measures,
- more efficient, less hazardous equipment,
- safer and more dependable blasting techniques,
- massive drills for boring shafts and tunnels, and
- new mining techniques that permit a larger portion of the workforce to remain on the surface.

Mining productivity has not uniformly increased with the improvement of working conditions.[8/] For example, the amount of coal removed per man-shift in underground mining declined from 15.9 tons in 1968-1969 to 8.5 tons in 1976. This was attributed in part to a loss of workforce dedication and also to the requirements of the Mine and Health Safety Act of 1969. In contrast, surface mine production was 25.5 tons per man-shift in 1976 and recovered 90 percent of the seam, versus 55 percent underground.[9/] This degree of efficiency encourages strip mining, despite the increased costs associated with environmental protection.

The further development of open-pit mining technology using huge diesel or electric shovels and enormous trucks, bulldozers, and carryalls has resulted in a shift away from more hazardous and expensive underground mining techniques. A growing portion of the ore extracted in the U.S. comes from surface mines.[9/] The Berkeley Pit copper mine in Butte, begun in the 1950's and recently abandoned, was an open-pit operation that engulfed dozens of earlier shaft mines. Where the overlay of soil and rock (overburden) is too thick to be removed economically, or it is environmental prohibitive to do so, underground techniques may be used.

The perfection of the electrolytic reduction process made refined aluminum available at a much lower price. It became a suitable substitute for copper, lead, zinc, and steel when weight was a consideration, and the volume of its production increased rapidly.

The invention of many different plastic materials with widely varied characteristics provided suitable substitutes for metals in many situations where low cost, resistance to corrosion, or insulation are desired qualities. The U.S. demand for plastics has increased 2,000 percent since 1950, to 20 million tons (estimated, 1981). Some plastics are of minerals origin.

The development of disposable packaging, especially metal, glass, and minerals-based plastic containers has resulted in increased consumption and waste of

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8/ Ibid, p. 23.

9/ Engineering and Mining Journal, Operating Handbook, Vol. 2, New York: McGraw-Hill, 1978, p. 2.

minerals products. "Planned obsolescence" has similar results. This refers to the design of products that quickly wear out or become obsolete following the introduction of newer models of similar quality.

Some increase in minerals recycling has occurred, stimulated by rising costs of metals and energy, and the desire to reduce waste. However, of 18 scrap metals monitoried by the Bureau of Mines, in only 3 cases did recycled metals exceed 20 percent of total consumption in 1977 (Figure 2-2).

The Scope of Minerals Activities

The total sequence of operations necessary to locate, permit, extract, and process commodities for market is inherent in "mineral activities." With some minerals (e.g., sand, salt, limestone), this is a relatively simple procedure. The material is abundant, easy to recognize and requires minor processing to be useful. For other commodities (e.g., plutonium, duralumin, beryllium) the process is much more complex and requires more elaborate facilities. This is the case with metals, which are usually found in buried ore bodies and are difficult to locate and extract. In addition, the desired metal may exist in low concentration and extensive processing is necessary to recover it.

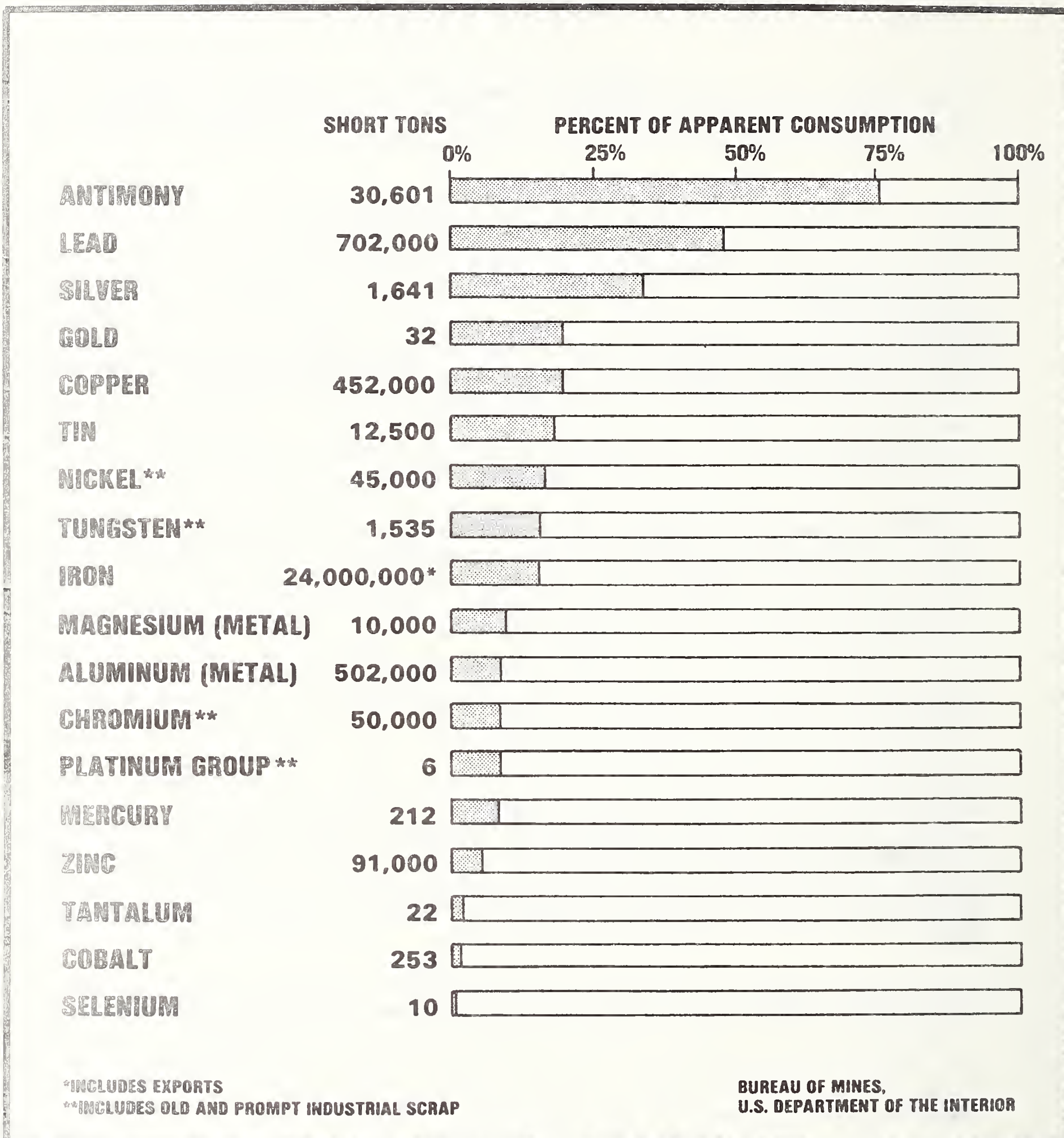
For these reasons the number, type, and sequence of mining activities vary not only with the type of mineral, but with the nature of the deposit in which it is found. Gold, for example, may be found as nuggets, dust, or flakes in stream beds; embedded as visible or invisible particles in quartz or other rock; or as a very minor component of mineral compounds. Oil varys considerably in its chemical composition from one geographic area to another and also in the way in which it is deposited; e.g., whether free-flowing, in deep or shallow pools, embedded in sand or shale, etc. Each situation offers quite different challenges to the petroleum engineer.

Large-scale mining operations are unlikely to occur unless there is a fortuitous combination of accessible ore, appropriate technology, available manpower, receptive markets, and enough political support to permit the activity. But commercially valuable mineral deposits are at specific, widely-scattered locations, including the earth's torrid and frigid zones, on mountain tops, and beneath the seas. As technology improves, mining's frontiers are extended outward.

Mining must compete with other established surface uses. Because of their weight and increasingly low concentrations, ores must be processed near the mine or in port cities to and from which they are easily transported. Unlike gas, oil, and coal, many minerals are heavy and abrasive, and difficult to convey long distances by pipeline. The production of many mineral commodities requires the disposal of large quantities of wastes and may result in air, water or soil pollution if the process is not carefully managed. Of all major economic activities, mining may indeed experience the greatest number of restraints.[10/]

10/ Warren, Kenneth, Mineral Resources. New York, John Wiley, 1973, pp. 29-30.

Figure 2-2: Old Scrap Reclaimed in the United States, 1977



Mine development is usually a 5 to 15 year process from exploration and discovery to initiating production. It is a high-risk venture. A major investment decision must be based on careful estimates of commodity needs, consumer preferences, labor and energy costs, and the market situation for a generation or more into the future.

Minerals technology has evolved to the point where minerals can be extracted from depths of a mile or more in all climatic zones, and from continental shelves--if the reserves are rich enough to justify the social, economic, and environmental costs. Moreover, modern mining and processing technology is capable of avoiding many of the adverse effects of earlier operations, some of which are now being closed because of pollution or other health violations. Newer operations tend to be large in scale, capital intensive, and carefully planned in advance from site construction to reclamation.

Because of the great variation in minerals activities, a comprehensive discussion would fill a thick volume. In this report they are briefly described from two perspectives. First, selected methods of mining are reviewed, including those most used on Forest lands in the Northern Region. The discussion then focuses on copper in order to summarize the entire sequence of minerals activities involved in the exploration, development, and production of one important metal.

Copper has been produced in Idaho and Montana for more than a century and its total market value exceeds any other metal extracted in the Region. It often coexists in compounds with lead, zinc, silver, antimony, gold, or other minerals and a comparable sequence (differing in details) is required for extracting and processing each of these minerals.

Survey of Mining Methods

Mining is the process of extracting specific minerals or ores and usually includes any on-site efforts to remove some of the unwanted materials or wastes in which the desired mineral is embedded. For example, a fairly good ore today might be 1.2 percent copper, .03 percent lead and .005 percent silver. These are separated out and the remaining 98.765 percent is considered waste material (tailings).

Surface Mining methods are used when an ore body is large and close to the surface. Unwanted materials (overburden) are first removed and the exposed ore body is broken up and hauled out. Excluding coal, sand and gravel, and stone, this method yielded 86 percent of U.S. and 57 percent of world crude ores in 1975.[11/] When ores (or coal) are deeper, but rich enough to justify their removal by sinking shafts and transporting workers beneath the surface, underground mining techniques are used. Some modern mines employ both strategies.

11/ Engineering and Mining Journal, Operating Handbook, Volume 2. New York: McGraw-Hill, 1978, p. 2.

Other methods blur this distinction by removing and sometimes processing minerals underground, using heat, chemicals, or equipment controlled from surface locations. This is called "in situ" mining or processing.

The more common mining methods are briefly introduced below. More detail is provided in sources listed in the bibliography.

Surface Mining

This includes open pit, strip, placer, and quarry mining. In each case the miner removes unwanted materials (overburden) and extracts ore or other materials thus exposed, moving downward as the excavation progresses. These four types differ in other respects.

Figure 2-3: Open Pit Mining

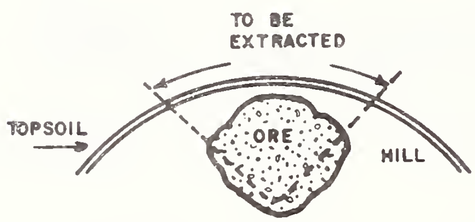
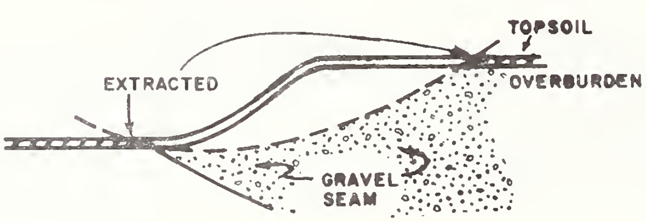
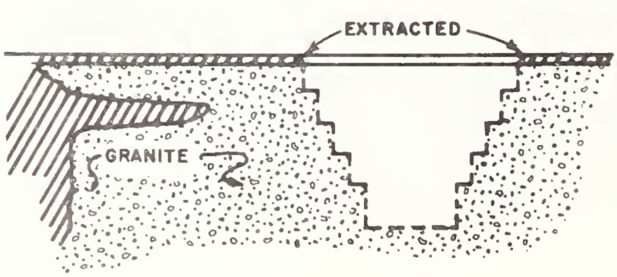


Figure 2-4: Two Types of Quarries

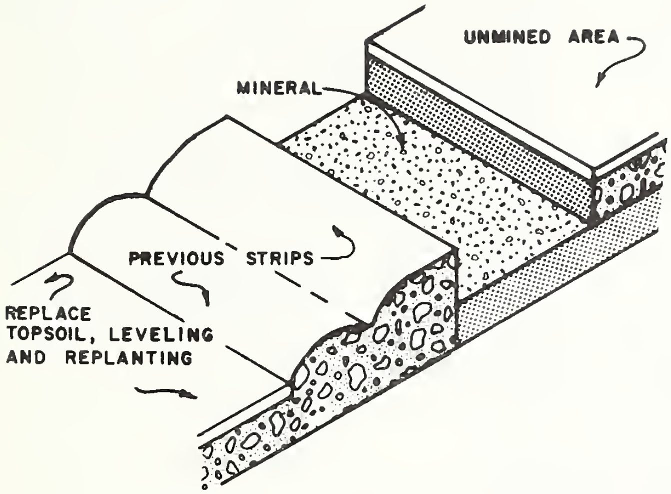




Open pit mining (Figure 2-3). Minerals, especially metallic ores, are extracted from a compact ore body or seam near the surface. Vegetation is removed, topsoil is stockpiled, and unwanted material is transported to a dump site. The exposed orebody is fragmented (a section at a time) with explosives and loaded on trucks or trains. The ore is hauled out of the pit via a special roadway to a nearby plant site for crushing and concentrating. The mine is abandoned when the ore body is depleted or the removal of additional overburden becomes too expensive due to its increased thickness at the edge of the pit. Following abandonment, topsoil can be replaced and native grasses or shrubs are replanted.

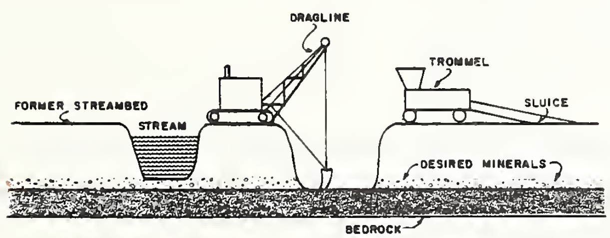
Quarrying (Figure 2-4). Building stone (such as slate or limestone) or gravel is extracted from a surface deposit. Vegetation and topsoil are first removed and any remaining overburden is cleared away. Exposed material is removed and utilized without chemical alteration or expensive processing. Gravel may be screened to assure uniform size. Stone is drilled, broken away with explosives, and crushed or cut into blocks of specified sizes.

Figure 2-5: Strip Mining



Strip mining (Figure 2-5). This method is commonly used when minerals such as coal, tar sands, uranium, gravel, and phosphate are deposited in layers (seams) near and parallel to the surface. Long strips are surveyed, topsoil is stockpiled, and overburden is removed. Large power shovels load the exposed mineral on trucks or trains for shipment to a nearby plant where it is crushed, pulverized, or further processed to remove impurities. When one strip has been removed, overburden from the second strip is placed in the void and reclamation can begin.

Figure 2-6: Placer Mining

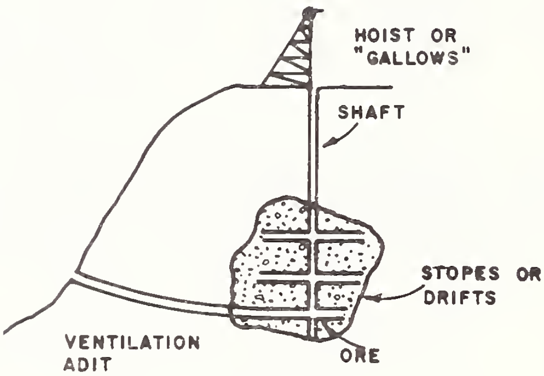


Placer mining (Figure 2-6). Over the centuries native metals and gemstones such as gold, platinum, tin, sapphires, garnet, and emeralds have been washed away from exposed lodes and deposited in present or former streambeds at points where the water flow was obstructed. The dust, flakes, nuggets, or stones are mixed with sand, gravel, or other sediments and may be concentrated near underlying rock because of their weight. They are removed by gold panning, sluicing, dredging, or hydraulic (water under pressure) techniques. The water flushes the lighter materials away from the heavier particles that settle to the bottom during the extraction process.

Underground Mining

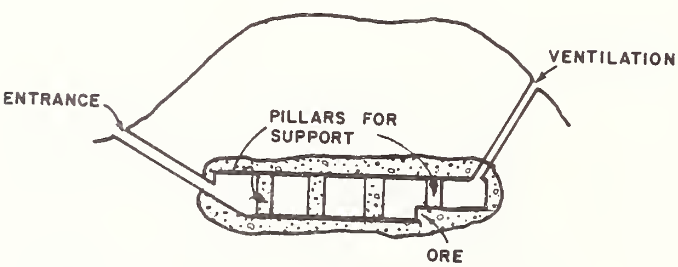
This includes conventional adit or shaft mining and may be defined to include newer techniques where desired minerals are extracted without bringing ores to the surface, especially if shafts are used and some employees work underground.

Figure 2-7a: Conventional Underground Mining Method



In conventional underground mining (Figure 2-7a), ore bodies or other deposits (salt, coal) are approached through vertical shafts and/or horizontal or sloping adits. A variety of techniques including drilling and blasting are used to remove ores which are brought to the surface for processing. Care must be taken to provide ventilation, reduce temperatures in deep mines, prevent cave-ins, and avoid flooding. Underground techniques are now used where deeply buried ores are rich enough to justify the expense and surface mining is not feasible.

Figure 2-7b: Room and Pillar Method



There is a wide variation in underground mining techniques, depending on the size, shape, depth, and grade of the ore body, the strength of the surrounding rock, and other factors.[12/] When the ore and adjacent rock are hard, the room and pillar method may be employed (Figure 2-7b) permitting the use of large, efficient equipment in the spacious caverns thus created.

Other methods

1. Wells. A hole is bored to a pool of liquid or gaseous mineral, e.g., water, oil, natural gas, or helium. Initially the substance may be under sufficient pressure to flow to the surface. Pumping will eventually be necessary to lift oil or other liquids when the pressure drops and additional quantities of fluid flow into the void created. Water, air, or chemicals may eventually be injected through other holes to increase subsurface pressure or otherwise enhance the well's production.

12/ See USDA Forest Service, Surface Environment and Mining, Anatomy of a Mine for details.

2. Solution mining. A liquid (often water or steam) is injected down a borehole in order to melt or dissolve a mineral (such as salt or sulfur) which is then pumped to the surface. Utilizing a pipe within a pipe, the Frasch process pumps super-heated steam down the outer pipe. This melts sulfur caps or salt domes and forces the liquid up the inner pipe to be collected and solidified.

3. In situ processing. Water or chemicals are used to dissolve minerals from ores below the ground surface. Ores must first be reduced to small particles by blasting or other means and the leached minerals-in-solution are collected from beneath the shattered materials. This technique is being improved for use in mining copper, oil shale, and other minerals previously brought to the surface for processing.

4. Heap leaching. Copper or other metals are recovered from piles of low-grade ore or waste dumps by periodically treating them with water, acid, and/or other liquids. The metal is absorbed by the solution, collected in tanks, and then precipitated from the solution by chemical means.

5. Seawater processing. Vast quantities of sea water are processed to recover the dissolved minerals, especially salt, magnesium, and bromine. It is not now economic to remove most other substances from seawater.

6. Ocean floor mining. Dredges process loose materials on the continental shelves up to 200 feet below sea level. Technology is now being developed to collect the metallic nodules scattered on the ocean floor. These are rich sources of several metals and industrial minerals.

Today most mineral elements and compounds (combined by nature with other materials) are first excavated from the mine and then separated out. Some of the residue (waste or tailings) may be returned to the mine, but much of it is dumped on the surface. As a result, large areas near the mine are covered with wastes and water may leach out chemicals which affect groundwater, streams, or soils.

Future mining technology appears to be moving toward in situ mining techniques, by which desired minerals are extracted without also removing most unwanted rocks or sediments. Already this is done in some instances with sulfur, potash, salt, copper, and uranium, and is being studied for oil shale. In at least some cases, surface and aquifer pollution is less serious than with other mining methods. It also reduces site acreage requirements and some of the occupational hazards of underground mining. It shows promise in lowering ore transportation and disposal costs, as well as the expense of complex processing plants with extensive antipollution equipment.

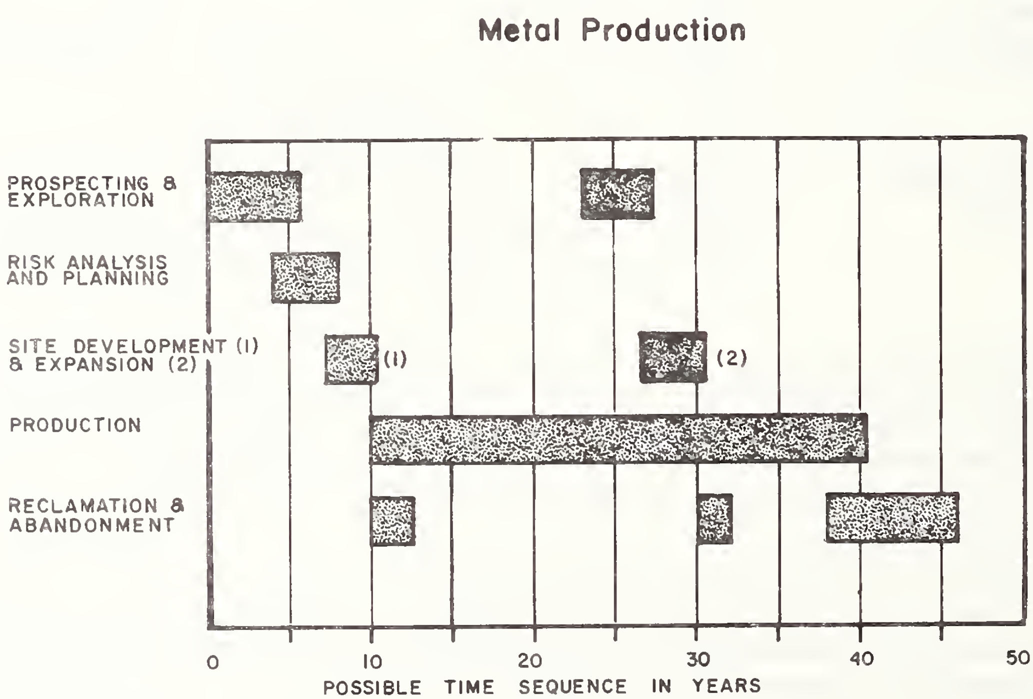
In situ mining may make it easier for U.S. mining companies to compete with foreign producers who have richer ores, cheaper labor, or fewer environmental constraints. It could permit mining of small, scattered, and relatively deep deposits that would not be feasible with conventional methods. However, it is likely that the bulk of mineral deposits will be mined by conventional methods for the foreseeable future.

The Sequence of Mining Operations

A mid-sized mining operation such as the ASARCO-Troy project in northwestern Montana involves a 30 to 60 year sequence of activities beginning with surface exploration and eventually culminating with mine site reclamation. Site monitoring may extend beyond this if there is a potential for pollution or subsidence.

Because metals and their ores differ in their properties, and each geographic situation poses unique challenges, there is no single, standardized format for hard rock mining activities. However, five general, overlapping stages common to most hardrock mining operations can be identified (Figure 2-8).

Figure 2-8: Stages of Mining Operations



Prospecting and Exploration

Normally prospecting is the essential first stage in the sequence of mineral activities. It is the search for evidence of mineral deposits, a time-honored activity that continues to occur in all parts of the U.S. and world.

There are numerous proven and experimental methods for determining the existence of ore bodies. The most commonly-used techniques (in order of apparent success) are geological inference, noting geophysical anomalies, conventional prospecting, geochemical evidence, or some combination of these.[13] Various newer techniques are presently gaining credibility, including remote sensing, geobotanical studies, and the analysis of natural sounds.

In brief these techniques involve:

Geological inference. The presence or absence of a desired mineral is logically deduced by evaluating the available geological data. Clues may exist in an area's geological history and present surface features. The location and characteristics of known deposits of a desired mineral provide the basis for inferring additional sources. Geological inference was the initial method used in identifying 35 of 50 U.S. mine projects analyzed by Albers.[14]

Analyzing geophysical anomalies. Local deviations from the general geophysical character of an area are noted and analyzed. Examples include irregularities in the magnetic field or differences in specific gravity of rock masses, heat flow, seismic characteristics, radioactivity, etc. A growing array of sophisticated instruments aids in locating and interpreting the significance of these features; i.e., Geiger counters, gravimeters, seismic equipment, and magnetometers.

Conventional prospecting. This begins with a systematic visual inspection of surface geology, seeking mineral outcroppings or displaced minerals that offer clues to the location of ores or lodes. It may involve digging shallow holes, breaking rocks to observe unweathered materials, or trenching with backhoes or bulldozers in order to examine subsurface features. This latter technique has the potential to be very surface disturbing but is sometimes used when explorers lack the knowledge, resources, or incentives to employ more sophisticated methods.

Geochemical prospecting. Scattered mineral samples are chemically analyzed to discover anomalies. Then follow-up samples are taken to verify and extend the knowledge of unique chemical properties in an area. Stream bed and soil samples may provide information about ore bodies at higher elevations. Biological activity or the action of water often bring traces of buried ores to the surface. Core samples from small drill holes may be collected and evaluated. The chemical content of water, geothermal vapors, and vegetation may also be analyzed.

13/ Engineering and Mining Journal, Operating Handbook, Volume 2, New York: McGraw-Hill, 1978, pp. 18-20.

14/ Engineering and Mining Journal, Operating Handbook, previously cited, p. 19

Geobotany. The distribution, growth characteristics, and chemical content of different species of vegetation is observed. Certain mosses, grasses, flowers, shrubs, and trees tend to favor or avoid particular minerals, including metals. In Montana, buckwheat is an indicator for silver. More generally in the West, goldenweed, locoweed, or poison vetch suggest the presence of selenium, uranium, or vanadium. In British Columbia certain trees are believed to be indicators for zinc (silver birch), manganese (hemlock), and molybdenum (balsam).[15]

Remote sensing. Observations can be made from aircraft or satellites using cameras, radar, color scanning devices, or radio equipment. Photographic images are thus obtained, revealing details of topography, areas of unusual vegetation, traces of fault systems, the presence of domes overlying petroleum, anomalous soil or radiation and water conditions. Some devices effectively penetrate cloud cover or darkness. All provide a permanent record which can be analyzed later. Clues to the location of oil and gas, copper, mercury, and diamonds have been located in this manner.[16]

When there is evidence of an ore body with development potential, the mineral rights are claimed or leased (or less commonly, the property is purchased) and more intensive exploration follows. By drilling a series of holes in a grid pattern, it is possible to determine the depth, thickness, and lateral boundaries of the ore body. The analysis of drill core samples reveals the chemical composition of each portion of the ore body.

Most prospecting and exploration efforts do not lead to a discovery. Ore bodies are either nonexistent, unrecognized, or lack the size and degree of concentration necessary for a commercial mining operation. Thus, the full sequence of minerals activities will occur only in high potential areas that are also available and accessible. This point can be illustrated by summarizing the experience of one major mining company over a 30 year period (Table 2-1).

Table 2-1: Ratio of Subsequent Activities to Prospecting Efforts

Locations prospected	1,000
Data warranted detailed drilling	78
Feasible to develop commercially	13
Returned costs and some profits	7
Extremely profitable	1

Source: adapted from Rand McNally. Our Magnificent Earth: Atlas of Earth Resources, 1979.

Risk Analysis and Planning

When sufficient exploration has occurred to verify the existence of an ore body of commercial value, further analyses will be undertaken to examine the costs and benefits of extracting it. This feasibility analysis will take as long as 4

15/ Engineering and Mining Journal, Operating Handbook, previously cited, p. 47.

16/ Ibid, pp. 25-28.

to 6 years to complete, on the assumption that it is better to spend one or two million dollars deciding not to develop than to spend one or two hundred million on a marginal or unprofitable operation.

An analysis of 50 U.S. metal mines that began production between 1940 and 1976 reveals that 6.4 years was the median length of time between the ore body discovery (or most recent rediscovery) and mine production,[17/] but 14 projects took 10 years or more. This interval was occupied by site construction as well as feasibility studies and may be extended for some of the reasons discussed below.

Large amounts of capital are required "up front" for opening new mines and constructing transportation and/or processing facilities. The return on this investment is often relatively low. At this writing (1983), high interest rates, high energy costs, and low or unusually unstable prices for commodities such as silver, gold, copper, and zinc are factors that must be carefully weighed prior to committing large sums of capital for new hardrock mining operations.

Because some materials are produced and exported by several different countries, international market trends must be examined. If U.S. costs for labor, pollution control, and/or severence taxes are higher than for overseas competitors, this may be in part offset by avoiding marginal sites, using cost-efficient technology, removing two or more metals from a given ore, or selecting locations with cheap power or established transportation facilities to mine first.

During this century there has been a general decline in the quality of ores being mined in the U.S. Most of the known high-grade iron, aluminum, and copper ores are depleted, lesser grade ores are being utilized, and more ores and concentrates are imported. To cite an extreme example of this transition, the original Anaconda Mine at Butte had ores assayed as high as 55 percent copper. Mines operating in 1900 commonly produced 6 percent ores. [18/] Today most copper ore samples are in the 0.5 to 1.0 percent range, which helps explain the trend toward open pit mining.

On a smaller scale, both amateur and professional miners are now converging on the long-abandoned placer deposits of Idaho, Montana, and other western states. Equipped with modern campers, trommels, motorized dry washers, or small suction dredges, they hope to extract gold that was missed by earlier miners. Their incentives include the tenfold increase in the price of gold (since 1971), the invention of efficient, low-cost equipment, and the current depressed job

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[17/] Engineering and Mining Journal. Operating Handbook, Volume 2, page 19.

[18/] Further examples abound. Venezuelan iron ore was noted and ignored in the 1920's. It is now mined and available in Birmingham, Alabama at a price below local ores because it is a high-grade surface deposit and easily transported by sea. Very little manganese is mined in the U.S. because foreign ores are cheaper, but during World War I the Philipsburg, Montana, deposits were extensively mined. It may be economic in the foreseeable to mine oil shale; millions of dollars have been invested in experimental projects to develop efficient methods of removing the oil and disposing of enormous quantities of waste rock.

market. There are also recreational miners who enjoy a change in activity, and prospectors or speculators who hope to locate a saleable deposit. Professional miners sometimes regret the activities of amateurs because it reduces the availability of desirable deposits.

In mining all deposits, it is extremely important to have detailed information about the size, shape, and composition of the ore body so that the most cost efficienct mining techniques can be selected. The cost of removing unwanted materials (overburden) must be kept low. For near-surface deposits of large size, the open-pit method provides the opportunity to use huge power shovels which can scoop up 12-25 cubic yards of ore (25 to 100 tons) and load it on trucks with a 170-350 ton capacity. When the ore body is deeper and buried beneath a thick, stable layer of rock, inclined adits and the room and pillar method may be used. In some locations this design provides wide ramps and gymnasium-sized rooms for the deployment of large trucks and machines.

Narrow seams of ore, on the other hand, must be much richer to justify the greater cost of the labor-intensive methods necessary to remove the ore and transport it up a shaft to the surface. Further cost considerations are the presence of numerous underground springs, very toxic chemicals, or loose or fractured rock that will require extensive reinforcement. Steep terrain, harsh climate, and the absence of all-weather roads require additional financial outlays.

Since 1960, the cost of building and operating mines and materials processing plants has increased about 310 percent, according to the Producers Price Index of the Bureau of Labor. During this period metals prices, with the notable exception of aluminum and copper, have increased this much or more (Table 2-2). Price increases are most pronounced for rare metals, iron alloys, and certain imported materials.

Table 2-2: Metals Price Trends

Material	Actual Price 1960	Actual Price 1970	Actual Price 1983	1983 Price in constant 1960 dollars	1960-83 real price change(%)	1983 U.S. net import reliance as a percent of apparent consumption
Aluminum metal ($ per lb.)	.26	.29	.78	.25	-4	18
Chromite ($ per s.ton)	62.00	72.00	135.00	43.00	-31	77
Cobalt ($ per lb.)	1.54	2.20	12.5	3.98	158	96
Copper ($ per lb.)	.32	.58	.77	.25	-22	17
Gold ($ per oz.)	35.00	36.41	425.00	135.41	287	21
Iron Ore ($ per s.ton)	14.50	16.40	28.04	8.93	-38	37
Iron & Steel ($ per lb.)	.062	.077	.258	.082	32	13
Molybdenum ($ per lb.)	1.47	1.92	4.00	1.27	-14	net exporter
Nickel ($ per lb.)	.74	1.28	3.20	1.02	38	77
Platinum ($ per oz.)	83.00	133.00	475.00	151.00	82	84 (pl. gr.)
Silver ($ per oz.)	.91	1.77	11.50	3.66	303	61
Tin ($ per lb.)	1.01	1.74	6.56	2.09	107	72

Source: USDI Bureau of Mines, Mineral Facts and Problems, 1980, and Mineral Commodity Summaries, 1984.

Thus mining remains a profitable venture when ore bodies are large, accessible, and sufficiently concentrated to offset costs that rise faster than normal inflation; e.g., fuels, pollution control, and reclamation. But the 1980-1982 slump in the auto and construction industries sharply reduced the demand for metals, depressed prices, and led to the closure of several marginal mine and plant facilities including the Anaconda complex in Montana and Bunker Hill in Idaho.

Many new mines, plants, and plant expansion projects are being planned, considered, or constructed during the 1980's, at projected costs ranging from 10 million to 3 billion dollars for a single facility.[19] Most of these are at overseas locations (Chapter 1).

The end goal of planning and risk analysis is to design a project that will amortize (return) the investment and interest payments within a reasonable length of time, possibly 15-20 years. If this is not feasible the project may be abandoned or suspended until market conditions or other limiting circumstances change for the better. Alternatively, a firm may share the risk of such a venture with interested companies and gain advantages such as increased capital, expertise, or access to production or marketing opportunities.

In compliance with the National Environmental Policy Act of 1969 (NEPA), an environmental analysis must be conducted prior to significiant surface disturbances resulting from Federal programs. States usually require a similar analysis for major state and private actions. Normally this would be accomplished during the planning and risk analysis phase and should provide additional information about local human and environmental needs that should be taken into account prior to site construction.

Site Development

When mining appears to be economically feasible, the necessary resources (sites, labor, capital, technology, and administrative skills) are available, and the required permits and clearances have been obtained, site development follows. Because no two mining situations are identical the facilities for each project must be tailored to the opportunities and limitations of each project area. In hardrock mining unique designs are necessary to accommodate local differences in topography, the nature of the ore body, the types of minerals desired, and wide variations in preexisting facilities and services.

In an open pit mine, development includes removing and piling the topsoil, then uncovering the ore body--an operation that may require years to complete. In an underground mine, shafts or adits (dead-end tunnels) must be drilled to provide access to the ore body and the mine waste may be used as fill to level construction sites. The site development process preceding production usually requires 2 to 5 years, depending on the rate and complexity of construction.

The copper, lead, and zinc mines of the Northern Region illustrate a number of features common to most mine and plant sites for metallic ores. These include (figure 2-9):

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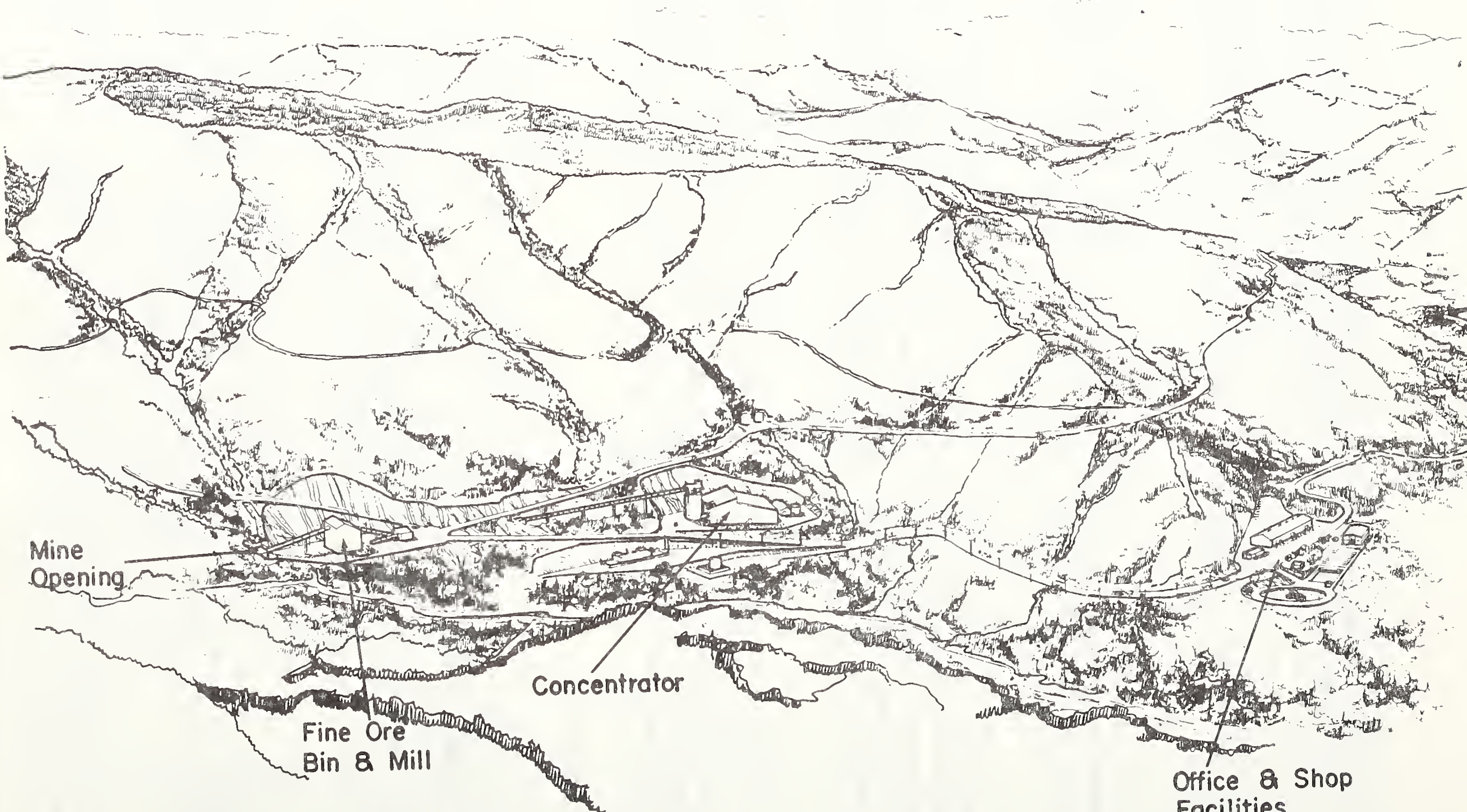
[19] Engineering and Mining Journal, January 1981.

Figure 2-9: ASARCO - Troy Project Artist Conception of Plant Site



SOURCE: ASARCO - Troy Project EIS

- one or more underground and/or open pit mines,
- an on-site crusher (or "mill") for reducing extracted ores to pebble size,
- a nearby concentrator for pulverizing ores and removing most of the metal particles,
- a settling pond for removing excess water from waste materials (tailings) prior to depositing them in surface dumps or returning them to the mine,
- a tailings pond for permanent storage of at least a portion of the tailings,
- level areas near the mine for parking and surface facilities.
- several surface structures, often including offices, maintenance shop and facilities for washing, changing, eating, and storage. In remote areas there may also be some housing or boarding facilities for miners.
- transportation links, as appropriate; e.g., conveyer belts from crusher to concentrator, roads to connect mines and surface installations with nearby communities, and slurry pipelines to transport wastes to the tailings enclosure.
- a power corridor and electrical substation,
- a water source (lake, creek, or deep wells) with storage and water pipelines,
- a railroad loading dock for loading concentrates and railroad access to a smelter where metals are extracted from the powdery concentrates.

Production

Minerals production, as defined in this analysis, begins with extracting ores from the earth and includes crushing, concentrating, smelting, and refining. Details of the procedure vary considerably from one metallic ore to another, so the example of Butte copper ore will be used to illustrate one process. Copper is the leading metal produced in Montana and a roughly comparable process is used for other base metal ores. Prior to the 1980 closure of the Anaconda Smelter and the Great Falls refinery, all of the stages of production took place in Montana. Since then, ores have been mined, crushed, and concentrated in Butte and are shipped to Japan for smelting and refining.

Minerals-rich Butte Hill (copper, silver, gold, lead, zinc, molybdenum) has been mined for more than a century. Although the Berkeley pit is now abandoned, the East Continental pit continues to operate. Until 1955, some 200 different underground mines had resulted in a maze of 40 miles of shafts with an estimated 2,400 miles of underground workings leading out from them. By this time most of the rich ores had been depleted and one company had acquired all of the mines. It was then determined that open-pit mining would permit large-scale extraction of remaining low-grade ores. The Berkeley Pit was begun after first clearing over 600 acres of man-made structures and millions of tons of overburden to expose the large ore body on the east edge of Butte. This waste material was deposited in leveled mounds adjacent to the pit and mining of the ore began.

To fragment the ore, it was necessary to drill a series of holes about 40 feet into the face of the rock.[20/] Samples were then taken to classify different segments as (1) ore (averaging 0.5 percent or more copper), (2) leaching material (about 0.2 percent), or (3) waste. Holes were then loaded with a mixture of ammonium nitrate and fuel oil and detonated, fracturing some 250,000 tons of

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20/ This discussion of copper production is derived primarily from Montana Copper, a 1979 publication of the Anaconda Corporation.

rock. Electric power shovels with 15 to 27 yard buckets loaded the 170-ton trucks which transported the material to the crusher, leach heap, or waste dump. Ore was crushed to less than four inches in diameter and sent via conveyor belt to the concentrator where it was further reduced to a fine powder. At this stage most of the metallic compounds had broken away from other minerals and could be removed via a flotation process. Pulverized ore was combined with water and reagents (catalysts) and blown with air to create a foam. As the resulting mixture was stirred, metal-bearing particles adhered to the foam, rose to the surface, and floated away from the remaining wastes that exited to the tailings pond (Figure 2-5). The result was a "concentrate" that averaged 26 percent copper.

This process, called flotation, is a relatively recent invention. It requires expensive equipment, is efficient, and has become the most widely-used method of removing base metals from ores. With the development of additional reagents, other materials can be separated in this manner. Magnetic, gravity, and other separation techniques may also be used depending on the properties of the ore and cost considerations.

Leach materials were placed in heaps at the rim of the pit and sulfuric acid was added. The copper was gradually dissolved, seeped out of the heaps, and was later recovered by chemical precipitation. This technique can also be used to extract additional copper from older mine waste dumps. These rocks are already fragmented and sometimes contain copper concentrations of 0.3 or higher. By varying the solvent, leaching can also be used to extract lead, uranium, sulfur, and other soluble minerals from a variety of rocks or other materials.[21/]

The ore concentrate was transported by rail to the smelter where it was "roasted" at high temperatures to remove some of the sulfur and then melted in an electric furnace. Molten copper was then transferred to a copper converter in which lighter impurities (slag) rise to the top and are skimmed off. Other waste materials were removed through the use of additives or compressed air. The copper, now over 99 percent pure, was poured into molds to form ingots (anodes). Sulfuric acid was also produced as a by-product.

The copper was transported by rail to a refinery where further impurities were removed by electrolysis. The resulting 99.9 percent pure copper was cast or shaped into useful bulk copper products such as wire, bars, billets (small balls or cubes), or rods. Figure 2-10 illustrates this entire process.

The total production process requires large quantities of energy. In the case of copper, pulverizing the crushed ore is the most energy-consumptive step. With aluminum, the earlier stages are relatively simple (bauxite ore is a loose material, rich in metal), but refining (electrolysis) requires the most energy (Table 2-3).

21/ Additional information is found in Engineering and Mining Journal, Operating Handbook of Mineral Processing, Volume 1, New York: McGraw-Hill, 1977.

Figure 2-10: Mining, Concentrating and Refining Copper

Montana Production

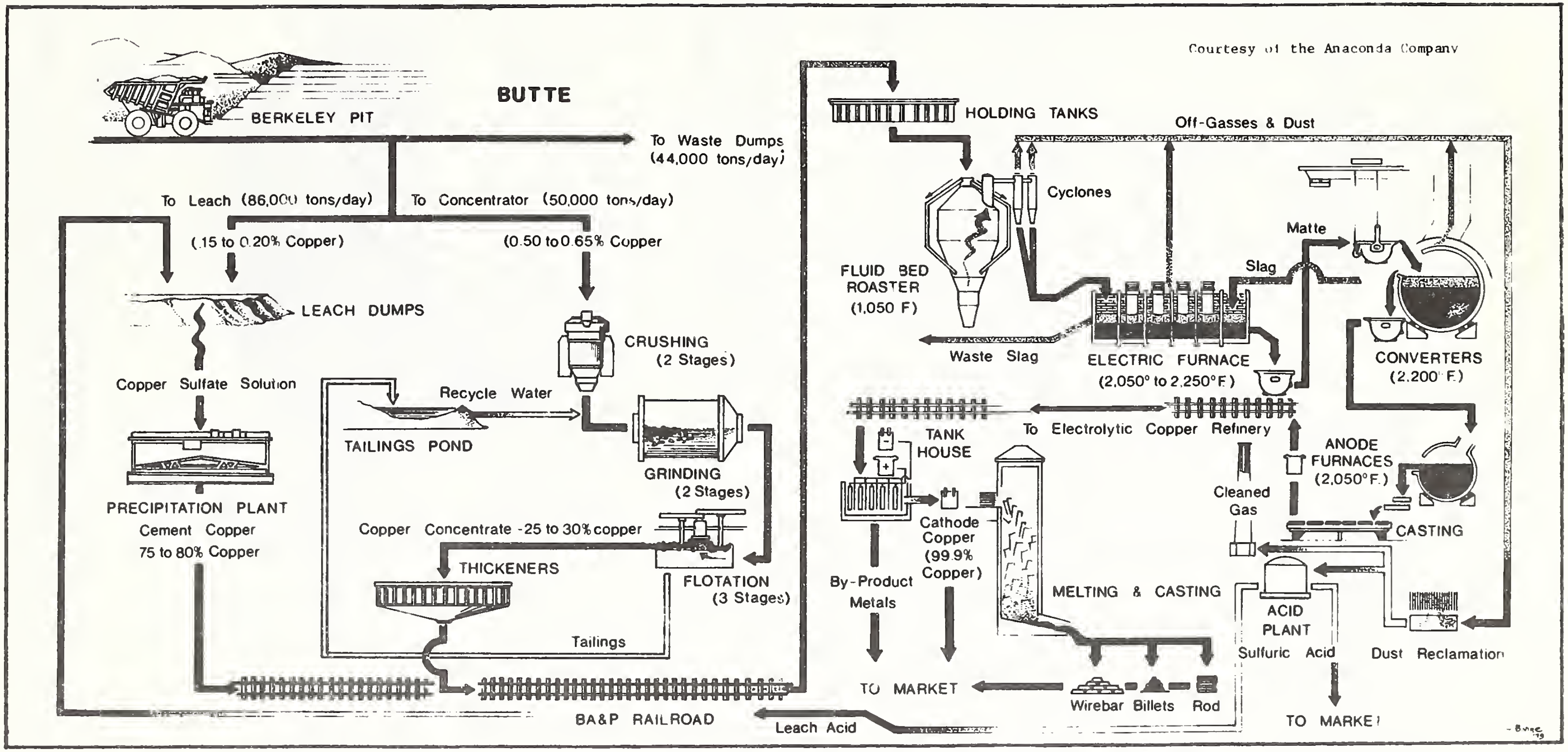


Table 2-3: Percentage Distribution of Energy Costs by Stage of Production: Copper and Aluminum

Stage	Copper	Stage	Aluminum
Open pit mining	14%	Bauxite mining	8.5
Concentration (flotation)	57%	Concentration (to produce alumina)	24.0
Smelting	17%	Electrolysis	64.5
Refining (electrolysis)	12%	Smelting	3.0
	100		100

Source: United Nations. Economics of Minerals Engineering. London: Mineral Journal Books, 1976.

Recycling metals requires far less energy than producing new metal from ore, an estimated 5 percent as much in the case of aluminum. Since irons and steels are over 90 percent of the tonnage of all metals produced, recycling is especially important for this industry. Less than 20 percent of U.S. steel is reused (Figure 2-2), but the example of Great Britain (where about half is recycled) demonstrates the potential for conserving both metal and energy. A major obstacle to recycling iron has been the cost of collecting and transporting this relatively low-valued but heavy metal to smelters for processing.

Abandonment and Reclamation

The life of a mine is highly variable, as the historical experience of Montana and Idaho attest. Very large ore bodies can sustain continuous operations for a century or more, whereas small veins and many placer "diggings" may be mined out in a few months.

Large mines and their attendant ore processing facilities tend to have large work forces and to be major employers in nearby communities. Their surface activities may require hundreds or thousands of acres. Small mines, still the most common pattern despite the trend toward larger operations, require far fewer workers and a much smaller area for surface operations. (However, their ratio of surface disturbance to the volume minerals production is frequently much higher.)

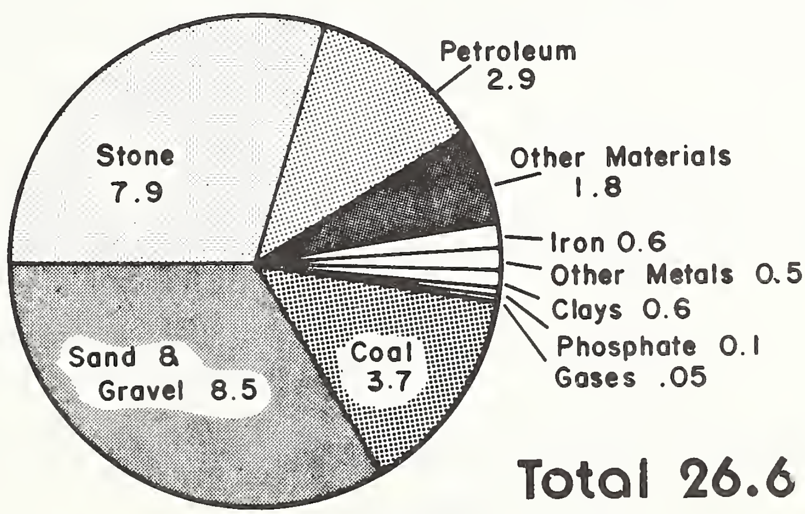
There is a need for ongoing reclamation throughout the life of a mining operation, beginning with the mitigation of surface disturbances resulting from exploration or site construction. Later there will be effluents to contain, facilities to erect or dismantle, erosion to manage, and changes in mining technology. Any of these could produce social as well as environmental effects. Perhaps the greatest potential for problems exists when a long established minerals operation ceases and abandons its facilities.

The closure of a large mine or processing facility has both social and environmental consequences that need to be addressed. The loss of a major employer is a traumatic experience in a sparsely-populated area (Chapter 4). The presence of an abandoned and deteriorating mine site and surface facilities is visually unappealing. In the absence of a permanent maintenance force there is a potential for problems such as surface subsidence, acids seeping out of mine wastes, vandalism, collapsing structures and soil erosion. Unless there is satisfactory surface reclamation, a significant land area will have been removed from production in a time of growing need for agricultural, timber, range, and residential acreage.

Growing public concern about environmental quality during the past decade resulted in a series of Federal and State laws designed to reduce long-term impacts from mining and other surface disturbing activities. The Environmental Protection Agency (EPA), the Office of Surface Mining, Reclamation, and Enforcement (OSM), the Forest Service (under NEPA and NFMA), the Geological Survey (GS), and various state agencies now monitor the environmental practices of mining operations and enforce the reclamation requirements specified in these laws.

The SEAM publication, "Creating Land for Tomorrow," provides illustrations of the surface effects of mining operations and a variety of reclamation techniques used to return these areas to productive use.

Figure 2-11: Annual World Production of Minerals, Including Fuels (billions of tons)



Source:
Derived from data in GLOBAL 2000 REPORT, 1980

The challenge ahead. Some idea of the challenges facing future generations can be gained from a review of present reclamation needs. In 1980, the world mining industry produced nearly 27 billion tons of refined minerals materials. Total world minerals consumption is doubling each generation (25 years) at current rates because the world population has approximately doubled since 1940 and material living standards are rising in many countries.[22] Figure 2-11 shows the volume of these commodities.

To produce this expanding volume of commodities, two to three times this quantity of earth materials was removed and disposed of as overburden or tailings. This ratio of waste to commodity is less than 1:1 for easily accessed, naturally concentrated substances (such as stone, clays, and sand or gravel). It is 6:1 for iron, 575:1 for copper, and still higher for some precious and rare metals, averaging 9600:1 for uranium in 1976.

Excluding coal, oil and gas, the materials removed in U.S. mining alone amount to 4.4 billion tons annually.[23] About 62 percent of this is ore or other usable material and 38 percent is discarded waste. As noted previously, a large portion of most ores is also waste, removed during concentration and smelting.

It is estimated that roughly 1.4 million acres, an area twice the size of Rhode Island (but half the size of an average Montana County), is disturbed each year by mining operations worldwide, excluding oil and gas.[24] Direct effects to the land surface include removal of overburden, separating and depositing unwanted materials (tailings), constructing plants and transportation corridors, erosion, releasing pollutants that affect groundwater and soils, and displacing human and wildlife populations.

Possible environmental effects experienced by residents near the mine site include road, railroad, and pipeline construction, air and water pollution, a decline in scenic values, and a further reduction of wildlife habitat. Growing numbers of authorities are expressing concern about the general climatic and health implications of carbon dioxide,[25] hydrocarbons, particulate pollution, acid rain, and the effects of various gases, asbestos, uranium, coal dust, mercury, and other substances on miners and local residents.

These trends underscore the importance of well-designed and conducted reclamation programs which either restore mined land to its original use or prepare it for another productive use such as recreation, housing, transportation, grazing, industry, or agriculture.

22/ Global 2000 Report previously cited, pp. 203

23/ USDI Bureau of Mines, Minerals Yearbook, 1976.

24/ Global 2000 Report, cited above.

25/ See Fyfe, 1981, cited in bibliography.

Chapter 3: SOCIAL EFFECTS ANALYSIS

Mining operations are of many types (chapter 2) and occur in a wide variety of social, economic, and environmental contexts. Each situation is unique and must be analyzed individually if an accurate assessment of effects is desired. Ongoing projects provide clues to possible differences in the effects of planned projects.

Although major projects are implemented for the benefits they produce, there are always related costs. The allocation of both costs and benefits is usually inequitable. Some people will realize a profit, others will perceive a net loss, and still others may be relatively unaffected.

Nevertheless, there are important differences from one project to another in:
- the percentage of residents who perceive gains, losses, or no significant changes,
- which categories of people gain and which lose,
- the nature of the benefits earned and the costs paid, and
- the intensity of the enthusiasm or frustration associated with the project.

Toward Socially Responsive Programs

The challenge implicit in this situation is to learn what factors (variables) account for these differences. It should then be feasible to work toward socially and environmentally responsive minerals programs. Such a program could include efforts to:
- identify and then avoid or mitigate adverse effects stemming from agency actions,
- cooperate with other Federal, state, and local agencies and private organizations to resolve common problems, and
- insure that those who benefit from the project also pay a share of its external costs.

One measure of a successful project or program is that it earns the continuing support of the clear majority of the people affected by it. This is most likely to happen when these people believe the project is necessary and that both the developers and the responsible resource agencies are maximizing local benefits and mitigating adverse effects.

Some Forest minerals programs directly and indirectly affect thousands of people. Intelligent estimates of the probable human consequences of these programs are essential if social benefits are to be compared with costs. Such information also suggests strategies for dealing with unwanted effects when a program is implemented. Social assessment and analysis techniques can be used to acquire this data.

What is Social Analysis?

Social impact analysis (SIA) is a procedure that includes evaluating social information and making intelligent estimates of the probable social effects of different agency alternatives, whether policy changes or new programs. Along with physical, biological, and economic effects assessment, SIA is required by the National Environmental Policy Act of 1969 (NEPA) and other resource management legislation. Hence, it is usually done as an integral part of a more comprehensive, interdisciplinary environmental analysis and assessment process (40 CFR 1500-1508; FSM 1950).

Social impact analysis for a proposed mineral project/program with important social consequences can be summarized in three steps.

1. Prepare a "baseline" portrait of the area that would be affected. Usually, there will be a local area of multiple impacts, plus one or more larger zones of more subtle effects. The baseline description reviews the total social situation, especially if the activity could or will be large in scale.

a. Include all aspects of social life that could be measurably affected by the proposed activity. The following elements are becoming standard:

(1) Socioeconomic: Economic base, employment, income, and the capacity of facilities and services. Include demographic data (population size, characteristics, and distribution).

(2) Sociocultural: Social organization, traditions, lifestyles, values, and issue orientations. Include political data (political structure, provisions for planning and decisionmaking), and psycho-social data (sense of security and well-being; gratifying aspects of life in affected locations).

b. Note any significant trends occurring prior to the implementation of the proposed activity.

2. Predict the most probable effects of the proposed activity on social life, as defined above. When alternatives are addressed, compare the expected effects of each.

a. Identify changes that either would not occur or would emerge more slowly in the absence of the proposed minerals program. These are the social "impacts." They may be either positive or negative, an evaluation that often varies with the observer.

b. If the activity occurs in stages, assess each phase.

c. Consider the relationships between social and physical, biological, and economic factors; social analysis is an integral part of environmental analysis.

d. Take other concurrent stages or development activities into account, since impacts are cumulative and each additional project produces more intense effects.

3. Identify potentially adverse effects (explain why each is adverse and for whom), and discuss mitigating measures that could reduce or eliminate these effects. See FSH 1909.17 for additional details of the analysis process.

Research Needs

Social impact analysis--like weather prediction and synthetic fuels technology--is a young and expanding field. The field is broad in scope and has a growing body of research from which to draw inferences about the social and economic effects of industrial development.

The precision of these estimates depends on the quality of the data available for both the project and the potentially affected populations. When effects are projected, the social scientist must know the type, scale, and expected timetable of the proposed project (plus any other concurrent development) and be familiar with the technology and sequence of operations. The social scientist's skills, experience, and opportunities for field research are critical when project-specific data are sparse. Ample time for library research, field work, data analysis, and writing is a prerequisite to quality research.[1/]

Functions of Social Impact Analysis

Although some social and economic effects resulting from a large-scale project will be felt regionally and nationally, their range and intensity of effects is greatest at the local level. It is these local effects that are of most concern to the Forest and Ranger District personnel administering the project.

A review of ongoing minerals activities in several Western locations suggests that many adverse social effects could either have been avoided or mitigated through appropriate planning or corrective action. In some cases unwanted effects were anticipated in advance but underestimated or ignored. In other instances they were not initially expected, became serious, and were difficult to remedy.

Historically, it has not been unusual for a developing firm, a Federal resource agency, or a state government to sidestep responsibility for adverse social and economic effects stemming from their programs. These effects (called "externalities") are often regarded as exterior to the organization's purposes, jurisdiction, and/or budget. Even when responsible officials are willing to take preventive or remedial measures, they may question their ability or authority to take the necessary action. When appropriate action is not taken, counties, municipalities, or other agencies must respond but may not act until the situation reaches the critical stage and is difficult to resolve. Local governments often lack the knowledge, foresight, and resources to cope with rapid changes.

Social impact analysis is a methodology for dealing with external effects. It has the potential to assist decisionmakers in several ways.

- It fulfills National Environmental Policy Act requirements.
- Social and economic problem areas in existing programs can be identified, analyzed, and in many cases, mitigated.
- Knowledge obtained from evaluating existing programs can be used to make future projects more responsive to social needs. In selecting a preferred program alternative, social data including projections can be weighed along with environmental data.
- Continuing evaluation of each new program helps determine when corrective action is needed.
- Social effects information is useful to other organizations including local governments responding to the same concerns.

1/ Social science and social assessment are discussed at greater length in a companion document, Social and Economic Assessment of Oil and Gas Activities, USDA Forest Service, Northern Region, 1981, Chapters 1 and 2.

Sources of Guidance

Social impact analysis (SIA) is a relatively new field handicapped by a lack of consistent direction. Until 1979, the process was not well specified in agency manuals and there were few handbooks and published data sources to aid novice researchers in assessing and analyzing the effects of minerals projects. Existing sources of data or procedures for SIA were incomplete, often limited in scope to economic considerations, and difficult to apply to mineral operations.

During 1979-83 this void was partially filled by several new publications. Forest Service Manual direction was provided (FSM 1970-1973), followed by Forest Service Handbook guidance (FSH 1909.17). Important new references were available from commercial sources. These sources, some of which are listed in the first two sections of Appendix B, contain (1) summaries of data from previous studies, and (2) detailed instructions for investigating and analyzing the effects of minerals projects.

Comparing Program Benefits and Costs

The commonly acknowledged benefits of minerals development take many forms (chapters 1, 2). These include: the basic materials needed for thousands of products, reliable energy supplies, stock dividends, tax revenues, employee payrolls, and enhanced national security. All of these benefits are consistent with important, widely-shared American values such as wealth, abundance, independence, convenience, and novelty. The production of these benefits is in accord with other central values, including private property, free enterprise, the opportunity to earn a profit from investments, and technological progress.

The frequently identified costs of minerals development are equally varied: direct surface disturbances, impacts on vegetation and wildlife, pollution of air, water and soil, social and economic displacement for some other businesses or industries, uprooting workers and their families, and hardships for communities experiencing rapid development or decline. These effects are weighed against other values such as natural beauty, clean air and water, traditional ways of life, local control of the community's social and economic life, the need for conservation, and the loss of nonrenewable resources.

Community Polarization

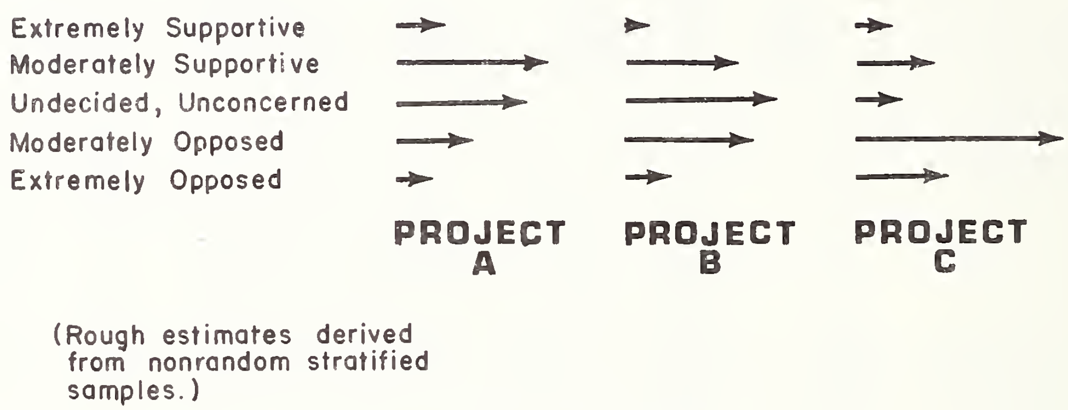
It is difficult to make objective assessments of the benefits and costs of mineral projects because individuals and groups vary considerably in the values they uphold. When a project is proposed, "prodevelopment" and "antidevelopment" factions tend to emerge in potentially affected communities. One set of people stresses the benefits to be derived and minimizes the adverse impacts; another emphasizes the adverse impacts and downgrades the benefits. Others are undecided, uninformed, or unconcerned. These orientations often reflect people's home or peer influences, occupation, personal stake in the project, or philosophy of life. The outlook of most individuals is not rigid. Many people are willing to modify their outlook in the face of convincing evidence. Table 3-1 shows the range of perspectives discussed above.

Table 3-1: Spectrum of Community Viewpoints on a Major Mineral Project

FAVOR IT: WHY?		UNCERTAIN OR UNCONCERNED		OPPOSE IT: WHY?
Zealously promotes development	Generally supports development with environmental safeguards	Neutral, uncommitted or ambivalent	Generally opposes development but not unconditionally	Energetically opposes development
Expects to gain personally--money, power, or status	Believes development need not lead to environmental ruin; we can now avoid this	Perplexed: uncertain of what position to take--costs and benefits seem equally balanced	Believes: we need this kind of development but not in our locality (because of its special qualities)	Expects to lose personally--money, power, or status
Represents an organization that expects to profit from development	Thinks the local community would benefit economically, e.g., increased spending, reduced unemployment	His organization favors it but he thinks costs probably outweigh benefits for the community at large	Thinks: selected projects would be acceptable if carefully screened, planned, and scheduled to avoid most adverse effects	Represents an organization that expects to profit or attain its goals if development is halted
Strong personal commitment to such values as: free enterprise progress materialism hedonism	Thinks he would personally benefit, or perceives development as essential to the U.S. economy	Informed on the issue but indifferent about what happens	Thinks he would lose money or other values would be threatened: hunting, fishing, cheap land, local lifestyles, existing economic activities	Strong personal commitment to such values as: conservation ecological balance preservation frugality
Believes technology can solve any problems it creates	Finds this the politically most expedient position to support	Uninformed; no opinion; has not thought about it	Opposes development because of peer pressure from friends, co-workers, or ethnic group	Believes the very survival of humanity is now threatened by pollution, resource depletion, or other types of environmental changes
	Concerned about specific issues: National and Regional energy shortages, our dependence on foreign oil, international balance of payments, defense readiness, etc.	Includes: -would like to be informed, might then have an opinion -do not care about it -could not do anything about it anyway	Concerned about specific issues: adequacy of natural resources for future generations, effects on wildlife, air pollution, water pollution, noise, crime, inflation, etc.	

Public responses to development proposals are not always as fragmented and polarized as this brief analysis may suggest. Available evidence indicates that in most project situations the majority of people take a rather moderate view. Depending on the proposal, the modal viewpoint concerning its suitability tends to be near the center, as figure 3-1 suggests.

Figure 3-1: Public Responses to Three Mineral Pprojects



After more than a decade of interaction between those who place mineral development first and others who give priority to environment, conservation, or other options, a broad consensus may be emerging in Northern Region Communities. The majority of people seem inclined to support generalized statements such as these:

1. We need a viable economy that provides
   a. steady jobs for workers
   b. an adequate supply of energy and factory goods
2. We should also
   a. Require environmental safeguards.
   b. Avoid boomtown conditions.
   c. Be willing to leave some resources for future generations.

Among the general public, most differences in opinion are a matter of degree, rather than representing opposite poles. People disagree on how much environment protection we need (rather than on whether we need it or not), on how much mining needs to be done, and on where it is most appropriate to permit operations. The Forest Service must answer questions like these and does so by examining the pro's and con's of each viable alternative.

The Multiple-Use Principle

Under the multiple-use principle, orderly minerals development is regarded as compatible with other public lands resources and uses, at least in many situations. It is assumed that most potentially severe effects can be foreseen and avoided or mitigated. Some areas must be exempted due to steep terrain, endangered species, existing facilities, well-established uses, or unique natural attributes.

A second assumption is that projects can be carefully designed with agency standards (stipulations) clearly specified in lease contracts and operating plans. Then responsible officials will monitor the project to insure compliance and identify unforeseen problems. Many older minerals projects in the U.S. were developed under less stringent criteria. Some facilities are now being updated to comply with recently enacted standards.

Identifying Key Variables

The decision to initiate, expand, or discontinue a large-scale mineral project is normally the result of a careful evaluation of many conditions (variables) that determine its feasibility (chapter 1). These same factors govern most of the social and environmental effects of the project, many of which are already evident during the planning and construction phases of new mine and plant facilities.

These variables include the following and are discussed in greater detail below:

1. The regulatory framework (Federal and State laws, executive policies, and county ordinances).
2. The effectiveness of resource agency programs (planning, permitting, monitoring).
3. Current and projected market situation for both project needs and commodity outputs.
4. Current perceptions of national need.
5. The financial resources, equipment, expertise, and social and environmental policies of the developing firms.
6. The physical, biological, and cultural resources of the affected area.
7. The zone (area) of influence observed, local, regional, national, or international.
8. The stage, rate, and scale of operations and the number of participating firms.
9. The social, economic, and demographic characteristics of the affected local area.
10. The social and demographic characteristics of the in-migrant workers and their families.

1. Political Framework for Development

United States minerals policy is extremely complex. It was initially formulated by Congress in a series of laws dating back to 1807. Successive laws often amend rather than replace earlier legislation. These laws have been interpreted by generations of Federal judges whose decisions also apply.

This framework of laws and legal decisions is implemented by the President and the heads of the various resource agencies in the executive branch of Government. Each new President and department or agency head has some latitude to extend, curtail, or redirect existing policies by pressing for new legislation, adapting agency procedures, and adjusting priorities.

State laws and executive policies and, in some instances county and municipal codes and ordinances, add to the network of regulations which govern Federal resource managers and the minerals industry.

The Federal commitment is clearly twofold, to encourage minerals exploration and production and to protect other surface and subsurface resources from undue harm. A complete discussion of this Federal role is beyond the scope of this brief document, but examples are illustrative.

a. Congressional mandates

(1) Authorizing mineral activities. Congress has repeatedly emphasized the National need for minerals and has provided some incentives for persons and organizations to develop them. Federal laws permit minerals exploration and development on all public lands that have not been designated and withdrawn for exclusive use as parks, military installations, administrative sites, etc. This right of entry applies to most National Forest lands. Table A-1 in Appendix A identifies and briefly summarizes major legislation with this emphasis.

(2) Protecting other resources. A second category of generally more recent legislation is aimed at protecting other resources. It requires that mining and other development activities be compatible with coexisting resources and uses and also responsive to the needs of affected human populations. These laws are summarized in table A-2 in Appendix A.

(3) Other regulatory legislation. Many other laws govern the day-to-day administration of public lands and resources, including minerals. This body of legislation provides Federal agencies with additional guidelines for planning and implementing their programs. Particular sections of these acts supplement the mining and environmental legislation described above and clarify agency roles and responsibilities in minerals programs. The Federal Land Policy and Management Act of 1976 (90 Stat. 2743; principally in 43 USC 1700) is a recent example. It provides procedures for withdrawing lands from mineral entry, requires withdrawal review, authorizes surface protection regulations, and requires the recording of mineral claims.

b. Executive policies

The content of new, minerals-related legislation and the emphasis accorded existing laws and policies may vary from one Presidental Administration to another, reflecting changing perceptions of National need, the composition of each new Congress, and the major thrusts of each President's program. A frequent criticism from representatives of the minerals industry is that the system of Federal and State laws and policies is unduly restrictive and discourages domestic production and self-sufficiency. The majority of the public endorses environmental protection measures. The present administration is reviewing current policies to determine if some of them are unnecessary, excessively costly, or needlessly time consuming.

2. Agency Minerals Management Practices

Although resource agencies function within the legislative framework described above, there are time and place differences in program emphasis and effectiveness. At all administrative levels the quality of an agency's minerals program depends on such factors as the number of personnel assigned to the minerals workload, the quality of their training and experience, and the adequacy of their operating budget. Personnel factors such as leadership, commitment, and morale are also important.

State and Federal resource agencies play an important role in identifying potentially adverse effects from minerals projects that are proposed for public or adjacent private lands. This necessitates extensive communication with both the prospective developers and the interested public. The responsible agencies must decide which projects are appropriate and then monitor their development to insure that other resources and uses of public lands are adequately protected.

The systematic, interdisciplinary environmental analysis required under NEPA and NFMA is an important part of this process. By this means, potential problems are identified early in the process and can be resolved or mitigated.

3. Economic Incentives and Constraints

The primary goal of most minerals operations is to make a suitable profit for the individuals or corporations supplying the capital. Thus current price trends for different minerals commodities are closely followed and a disproportionate share of capital is invested in the exploration, development, and production of the most promising commodities.

Between 1975 and 1980, silver, gold, cobalt, molybdenum, platinum, tin and diamonds were appreciating in value much more rapidly than normal inflation. This has increased prospecting activity for those thought to exist in commercial quantities in the Northern Region, especially silver, gold, and platinum. Some abandoned mines are being reopened and some tailings dumps are being reprocessed.

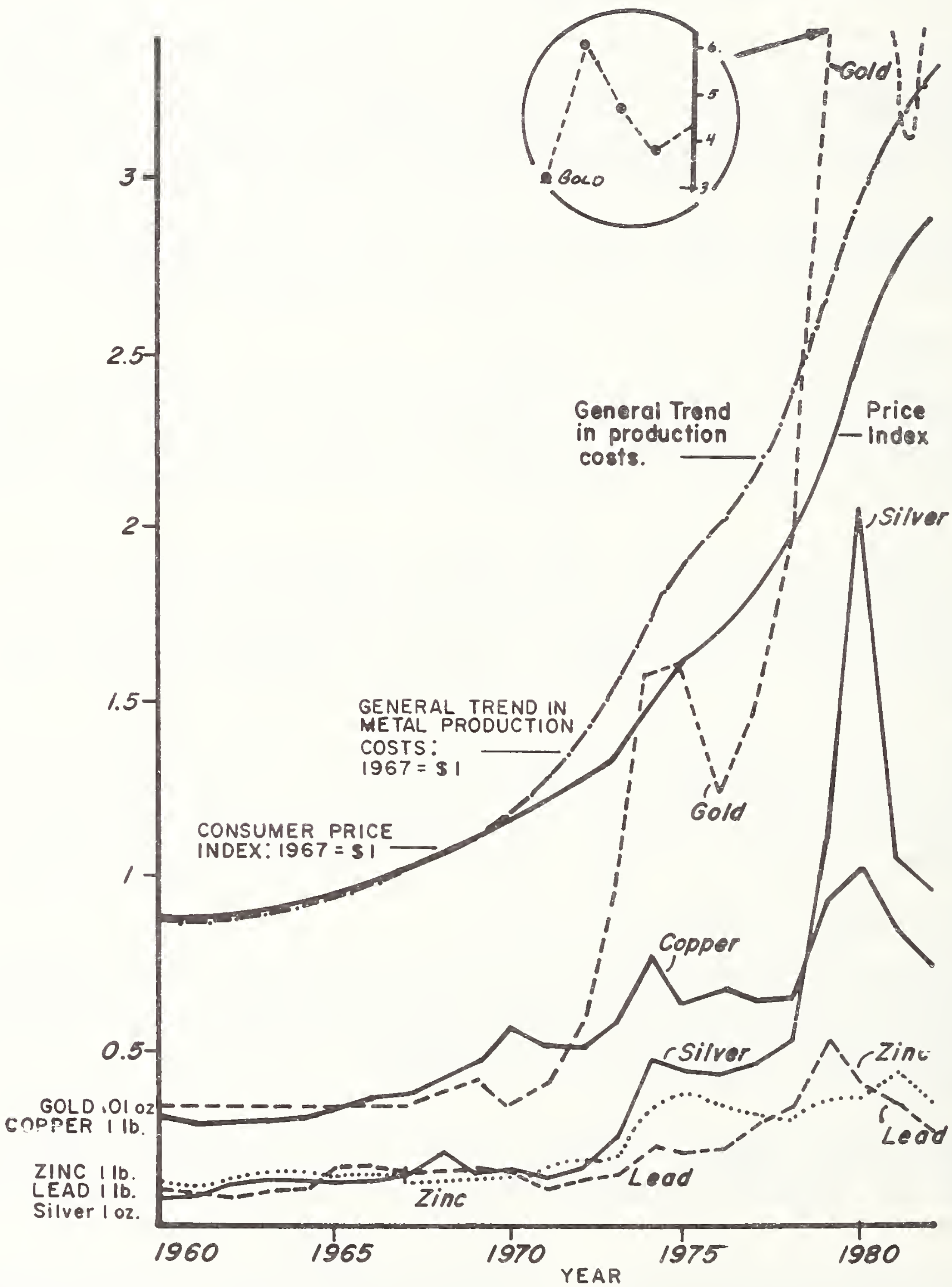
In contrast, a persistently depressed market can lead to workforce reductions, suspension of mine or plant operations, or permanent closure of less-efficient operations. Since about 1980 the price of copper, zinc, and lead have been depressed (Figure 3-2), resulting in the closure of Anaconda and Bunker Hill facilities in Montana and Idaho. Managers of marginal operations may be reluctant to invest additional money in them; e.g., in order to improve working conditions or reduce environmental impacts.

Rising costs of lease rentals and production royalties will encourage developers to explore on Federal lands where these costs are frequently lower. Even there, lease purchase by speculators can drive the price upward. The cost and productivity of labor, energy prices, and the adequacy of existing state and county roads are additional factors.

Taxes on income, property, and production are another important variable and change with the times and from one state or county to another. High severence taxes, for example, discourage the development of marginally profitable operations.

An extremely valuable deposit will enable the developer to pay premium wages, take elaborate measures to meet environmental standards, and offset unusually high costs due to depth, remoteness, etc.

Figure 3-2: Comparing Trends in Metal Prices with Cost and Price Indexes



4. Perceptions of National Needs

In time of war or other serious crises, the government may authorize, subsidize, and/or require mineral activities that would not otherwise occur. This may be done to reduce import dependence, stockpile critical materials, or encourage the production of substitute commodities.

There may be "crash programs" in which the usual permitting and monitoring procedures are simplified. Such programs could increase the adverse effects resulting from mineral activities. Development may occur in locations where it was hitherto prohibited or considered uneconomic.

5. Industry's Role

The social, economic, and environmental effects of minerals activities vary considerably with the manner in which individual firms conduct their operations. Some illustrations follow.

a. Level of financing. Level of financing is a key factor influencing the way mineral operations are planned and administered. Tight-budget operations encourage taking shortcuts such as poorly engineered roads, illegal dumping of wastes, or hiring underqualified workers. Well-financed projects can be more visually appealing, safer, and pose fewer environmental risks.

b. Company technology and expertise. Some firms perform their jobs competently with minimal social and environmental impacts because their employees know their work, activities are well coordinated, and the technology used is appropriate to the situation. Some routinely camouflage or landscape their facilities and protect surface resources. Others have lower standards, resulting in more adverse impacts.

c. Concern for employees. When a company hires and trains local workers, sponsors programs which demonstrate a concern for their welfare, and provides performance incentives, population influx impacts are reduced and community support for the project is increased.

d. Adequacy of communication. When detailed information, about proposed projects is made available to affected communities and agencies, they are able to formulate plans for dealing with anticipated social and environmental effects. In the absence of such data, rumors and speculation flourish and time and money may be spent for unrealistic preparations.

6. Affected Environment

The location of mineral deposits is increasingly critical. There is often strong public resistence to locating mines or plants in or near areas highly valued for other uses such as homes, schools, parks, municipal watersheds, organized recreation, wildlife habitat, historic sites, orchards, truck farms, or designated wildernesses. It is thought that the mining activity will increase local traffic, noise, and pollution, or that sites valued for their scenic or historic attributes may be unduly disturbed.

7. Zones (Areas) of Influence

Social, economic, and environmental effects tend to be the most intense, varied, and frequent in or near areas of field operations. Depending on the scale of these activities, one or more communities or counties may be affected. This is the local zone of influence, the area in which most of the mine and plant employees live, work, shop, and utilize public services.

Outside of the local zone the effects are more specialized and less frequently experienced. A major mine or plant may significantly affect a larger region; e.g., one or more states. A series of projects may have important national implications. The zone of influence concept is described in more detail and illustrated in items 3 and 4 in the bibliography (Appendix B).

8. Scope of Operations

Scope is the most critical factor in explaining the great variation in minerals impacts evident in different locations. This includes the type, scale, rate of change, and duration of the activity.

a. Type. Exploration, site development, mineral extraction, and processing have different workforce requirements; e.g., number of workers, number of local-hire, skills needed, and duration of employment. Generally site construction activities, smelters, and refineries require the largest workforces. Exploration and reclamation crews are much smaller.

b. Scale. In a minerals-rich area such as the Silver Valley of Northern Idaho, several companies may conduct operations simultaneously and require thousands of employees. There may be avoidable duplication of roading, drilling, mineral processing, and waste disposal operations. In contrast, a single small mine may employ only 1 to 25 people and ship its ores or concentrates to distant cities elsewhere for processing.

c. Rate of change. Ordinarily, the more rapid the pace of development, the more disruptive its social effects. Adverse social and economic effects become most intense and least manageable when several companies initiate major projects in the same rural location and make no effort to coordinate their operations.

Unless the local zone has a dire and immediate need for increased economic activity; e.g., Anaconda (city) or Kellogg in 1981, gradual development is much preferred. It offers manageable growth and prolonged economic activity for the area. Ideally, multiple projects should be coordinated so that intensive labor phases such as plant construction follow each other rather than occur together.

d. Duration. It is difficult for local communities or developers to provide the necessary support services for short-term projects. The time and money required to plan, acquire permits and funding, construct, and staff or occupy schools, malls, homes, or other facilities may not be sufficient, given the short duration of the mineral activity. When an activity is expected to continue for a generation or more these kinds of facilities can be constructed and necessary loans can be repaid from increased tax revenues.

9. Social and Economic Characteristics of the Local Zone

A given level of development can generate quite different effects, depending on the social and economic characteristics of the local zone. There is a growing number of studies [2/] of the effects of industrial development on small towns and rural communities. These case studies permit some generalizations about the impact of a given level of development on a community. They provide a basis for projecting changes that may occur when new projects are implemented in similar socioeconomic settings, especially when rapid growth continues for an extended period. Some of the factors associated with these changes are reviewed below.

a. Community size. The social and economic impacts of a certain level of development is directly related to community size. A fixed number of incoming workers, say 50, would overload a rural community of 300, but be readily absorbed in most small cities of 5,000 residents. Alternately, several small towns of 300-500 might have adequate housing and services for 50 new workers.

Other circumstances contribute to the plight of the small community. With fewer available local workers than in the larger town, more "imported" labor is required to do a given amount of work. Experience reveals that villages with less than 2,000 people often lack adequate services, even for their own residents.[3/] They may not have a dentist, high school, sewer system, adequate water supply, hospital, or improved streets. They usually have non-professional, part-time civic administrators and may have no procedures for planning and zoning. Small towns are often unincorporated or their charter provides them with only limited powers for dealing with new situations. Few local contractors are available to provide support services for drilling or construction, and these workers must also be brought in.

2/ See the bibliography, Appendix B, for listings of social effects studies.

3/ For a summary and analysis of the effects of coal and uranium development on several Rocky Mountain communities, see the extensive four-volume study: Energy from the West: A Progress Report of a Technology Assessment of Western Energy Resource Development, U.S. Environmental Protection Agency, 1977. Mountain West Research and Wyoming Research Association have prepared (1981-1982) a bibliography, field study, and assessment procedure for the Denver Office of the Bureau of Land Management. All deal with the social effects of coal development (Appendix B, items 5 and 8).

In contrast, most cities over 10,000 do have the personnel, facilities, and expertise to handle moderate growth routinely. There is usually a well-developed road system in the vicinity that can be used for exploration and hauling. Both skilled and unskilled local-hire employees, some with oil or mining experience, are available, thereby reducing the need for in-migrants. A much larger increase in minerals activities would be needed to produce the level of impacts experienced in a small town.

b. Degree of Isolation. Project construction in unpopulated areas is not uncommon due to the occurrence of rich mineral deposits in some very mountainous, extremely dry, or frigid locations. In many cases, the developer must construct community facilities, including homes, schools, stores, and service facilities, and pay bonuses to induce workers to the project.

The resulting "company town" may have special problems such as ineffective government, absence of pride of ownership, mental health problems relating to isolation and boredom, high rates of worker turnover, etc. These problems can be alleviated through creative programs, responsive management, and some measure of community self-government.

The social and cultural life of established "one-industry" mining towns may differ in important ways from communities that are dominated by agriculture, state and county facilities, food processing, or tourism (Chapter 4).

c. Public sector capability. Cities, countries, and states differ in their ability to cope with growth. Some have planning departments, supplementary aid programs (technical or financial), and sufficient facilities and staff to accommodate reasonable growth. But other jurisdictions may lack these services or are already committed to capacity. Some have excess capacity in such areas as schools, playgrounds, parks, social services, police and fire protection, or public utilities, while others have too little.

d. Established land-use patterns. Each geographic sector in the Northern Region tends to be dominated by two or three patterns of land use. Timber production and recreation, and cattle and wheat ranching are two common patterns. In some localities, mining, fruit growing, sheep raising, diversified farming, manufacturing, residential development, wilderness, or other land uses may surpass timber, cattle, or wheat in economic value.

Mining and minerals processing activities are more compatible with some of these activities than with others. New mineral projects are most acceptable in areas where some form of mining is already widespread, where responsible industry operators have already won public support, and/or where existing activities are not disrupted by the addition of such operations. In the Northern Region public resistance to mining tends to be strong when lands are valued for outdoor recreation, agriculture, or wilderness characteristics.

e. Opportunity for advance planning. In the coal and metal mining industries, the critical details of development (location, mine size, work force requirements, etc.) are often known months or years before the site is occupied. This permits desired planning, construction, and expansion of community facilities and services (if funding can be obtained) before the peak population influx occurs.

In contrast, specific estimates of future petroleum development are difficult to project and obtain due to industry secrecy, the multiplicity of specialized firms involved, the scattered nature of many petroleum deposits, and the speed with which these activities can be put in motion. Communities that realistically identify their future needs and mobilize their resources to meet them will experience fewer difficulties than those that are unable to do this.

f. Business sector capacity. Many local businesses in small Rocky Mountain and Great Plains communities are marginal or failing. Increased mechanization in agriculture and the consolidation of ranches have reduced the need for farm workers. There is also mounting competition from regional shopping centers and local chain stores. Thus small businesses are often receptive to new industries which bring "outside" money into their communities. They welcome new payrolls and locally offered contracts for construction or other services (even though major equipment or supplies are usually obtained from large industrial cities in the East and South). When a boom is too rapid, local businesses may have difficulty expanding their operations due to the decreased availability of construction contractors and job seekers.

g. Secondary employment generated. Economic activities, such as mining, agriculture, construction, railroads, or Federal employment, bring infusions of nonlocal capital into the economy. These are called "basic" or "primary" industries because community growth and economic prosperity tend to fluctuate with the size and health of these industries.

The increased local and regional spending results in expanded business activity. Local businesses increase their inventories and sometimes enlarge their premises. New businesses are founded, especially if the prospects for continuing growth look good. Additional employees are also required for these "nonbasic" or "secondary" industries and for expanding the public service sector to accommodate both basic and nonbasic in-migrants.

The mathematical expression of the extent of new employment generated by basic industry is called an employment multiplier, which varies from less than one to three or higher, depending on how it is computed and whatever other factors may operate to exaggerate or counteract the effects of increases in certain basic industries. Table 3-2 demonstrates one way to compute a rough employment multiplier using 1980 employment data for the State of Montana.

Table 3-2: Employment in Selected Montana Industries

Industry	1960	1965	1970	1975	1978	1979	1980**	CHANGE 1960 1970	CHANGE 1970 1980
BASIC				Thousands of Employees					
Agriculture	39.0	35.2	36.1	34.8	33.0	32.2	32.0	-2.9	-4.1
Mining	7.4	7.5	6.6	6.4	7.0	7.6	7.2	-0.8	.6
Metal	4.5	4.6	4.0	3.1	2.0	2.0	1.5	-0.5	-2.5
Coal	n/a	n/a	n/a	0.7	1.2	1.2	1.3	n/a	1.0
Oil & Gas	2.2	1.8	1.8	1.8	2.9	3.3	3.3	-0.4	1.5
Other Mining	0.7	1.1	0.8	0.8	.9	1.1	1.1	0.1	.3
Manufacturing	20.4	22.2	23.9	22.1	26.3	26.9	23.6	3.5	- .3
Wood Products	7.3	8.6	8.2	8.1	10.7	10.9	8.5	0.9	.3
Primary Metals	3.8	3.6	4.7	3.3	3.2	3.3	2.4	0.9	-2.3
Food Products	4.3	4.3	4.3	3.5	4.0	4.1	4.0	0.0	- .3
Other Mfg.	5.0	5.7	6.7	7.2	8.4	8.6	8.7	1.7	2.0
Railroad	9.0	7.5	6.6	6.1	6.8	7.4	7.1	-2.4	.5
Federal Govt., excluding military	9.9	12.1	11.9	14.2	13.6	13.3	13.0	2.0	1.1
Total Basic	85.7	84.5	85.1	83.6	86.7	87.4	82.9	-0.6	-2.2
NONBASIC				Thousands of Employees					
Transportation, Communications, & Utilities, excluding Railroad	10.0	10.0	10.8	12.9	14.9	15.8	16.3	0.8	5.5
Construction	11.0	12.0	11.0	12.1	16.7	15.3	15.6	0.0	4.6
Trade	40.5	42.9	48.3	59.1	72.2	74.5	74.9	7.8	26.6
Services*	30.0	33.3	41.8	54.5	64.8	67.4	68.7	11.8	26.9
State & Local Government	28.6	33.8	40.7	50.7	58.1	56.8	58.0	12.1	17.3
Nonfarm Proprietors & Other	30.2	30.0	23.7	29.1	32.6	33.8	34.3	-6.5	10.6
Total Nonbasic	150.3	162.0	176.3	218.4	259.3	263.6	267.8	26.0	91.5
TOTAL	236.0	246.5	261.4	302.0	346.0	351.0	350.7	25.4	89.3

Computation of 1980 employment multiplier:

$$\frac{\text{Nonbasic}}{\text{Basic}} = \frac{267.8}{82.9} = 3.23; \text{ and } 1 \times 3.23 = 3.23 \text{ jobs}$$

This suggests that, since there are three times as many nonbasic as basic jobs already, a new basic job would generate at least three more secondary jobs. If contract construction is considered basic (a common practice), the employment multiplier would be only 2.56.

SOURCE: Montana Department of Labor and Industry, Employment Security Division
* NOTE: Includes Employment in Finance, Insurance, and Real Estate
**NOTE: Estimate by Western Analysis, Inc.

The above approach is misleading when applied to local communities. For example, if 100 new basic employees moved to a rural community of 3,000, the local businesses and governments might expand less than suggested above. Existing secondary employees may simply handle more customers or patrons. Some of the new payroll would be sent to workers' families in other cities. Some would be collected as State and Federal taxes. Regional shopping centers in other cities would have increased sales. Economic benefits would thus be distributed far beyond the local zone. Individual county employment multipliers for Montana have been estimated at 1.5 to 2.5. This is an average of about one new local secondary job for each new basic job.[4/]

Some communities experiencing development will eventually have sufficient consumer buying power to justify new businesses or services. Because mining employees and associated construction workers are relatively well paid, both local business volume and tax revenues will gradually increase. The private sector is likely to respond first, adding motels, restaurants, a car or mobile home dealership, or possibly a realty. Later, tax revenues should increase enough to permit increased street construction, some new utilities, additional schools or hospitals, and expanded social services, any of which would create additional local employment and income.

h. Local labor supply. Although some company career employees are always brought in when a new mine or plant is developed, the industry and its contractors hire some workers locally. The number employed depends on the policies of individual firms, the abundance of local workers with relevant skills, the urgency of housing shortages for in-migrants, etc. Local workers are advantageous to employers, being available temporarily and without moving costs, but usually require additional training.

As a rule, the proportion of local-hire workers is greatest when many workers with diverse skills are locally available (or few special skills are needed), the employer's operations are rapidly expanding, and/or there is a conscious effort to maximize local hire. Such workers can be hired whenever needed, already have housing, and need not be subsidized for living away from home.

Most new, locally available jobs are not filled by the registered unemployed, but by people who change jobs or are not regularly on the labor market (e.g., ranchers, students, homemakers and outsiders who hear of the new opportunities). Both the mining and construction industries pay well, encouraging many residents to switch jobs (Appendix B, sources 13 and 28). Local wages rise as established businesses strive to retain their valued employees.

i. Established lifestyles. Mining operations may be locally regarded as threatening to established lifestyles. Examples include senior citizens who have selected a quiet, scenic, unhurried environment for retirement; cattle ranchers who wish to preserve their pastoral environment and family ranching tradition; tribal leaders who fear the continuing erosion of their ethnic heritage; and big-game hunters and backcountry outfitters who believe mining will have adverse effects on their own opportunities.

j. Orientation toward change. In some communities, the prevailing sentiment toward proposed economic development tends to be positive and optimistic. Population growth and economic diversity are acceptable to the majority. A pro-growth outlook conditions the residents to accept new economic activities and to capitalize on the opportunities they present.

In other communities, the majority or an influential segment feels threatened by change. There may be an organized effort to prevent the implementation of specific development proposals. Community leaders play an important role in determining which way public sentiments will veer. Prior community experiences with particular types of development activity may also be significant.

k. Current economic conditions. A town or city with chronically high rates of unemployment or one where a major industry has just shut down can be expected to seek new industries. A prosperous community with a stable economic base such as a combination of government facilities, light industry, and tourism could be much less receptive or even antagonistic to proposals for mines or plants in the vicinity.

10. Characteristics of Newcomers

The social and cultural characteristics of newcomers drawn to an area by a mineral project vary with the circumstances. Very isolated sites attract a disproportionate number of single and unaccompanied males. Conversely, if the area is populated and it is company policy to maximize local hire, the majority of newcomers will be skilled workers, professionals, managers, and their families. Construction contractors normally employ more transient and nonlocal workers than the mine or plant that follows. The personal characteristics of these workers (e.g., speech, dress, habits, and values) and the degree to which these patterns differ from local norms are both important. For example, one might expect that incoming miners could assimilate more readily in a community that is already accustomed to mining or heavy manufacturing than in one supported by farming, cattle ranching, or a major public institution. Chapter 4 discusses the lifestyle of the traditional mining town.

Other Considerations

The lengthy list of variables above suggests that the analysis of economic and social changes and resulting community adaptation can be a complex procedure. The social scientist must further consider that:

1. Prior studies of the effects of certain types of exploration and development activities (e.g., hardrock minerals, oil and gas, industrial minerals, or synthetic fuels) are not readily available. Although some inferences can be made from studies focusing on other types of projects, a competent analysis may require extended field work to identify unique effects and mitigation needs.

2. Most of the mineralized portion of the Rocky Mountain and Great Plains areas is unusually rural. In contrast, much of the remainder of the U.S. is more densely populated, land values are high, and land use is more intensive.

As recently as 1900, the U.S. was predominately rural. In 1980, 70 percent of Americans live in 281 urban complexes (SMSA's) with 100,000 or more people. Most of the remaining inhabitants reside in smaller towns and cities. Only three percent live on active farms or ranches. The emerging pattern has been the urban resident who looks to rural areas for food, raw materials, investment opportunities, and outdoor recreation. The recent counter-migration of urbanites to rural settings for work, recreation, or retirement has not changed this trend a great deal because most migrants want to retain their urban lifestyles and consumption patterns.

Thus, while rural people may be potentially most impacted by mineral development projects there are many outsiders with a vested interest in the success of a project proposal. When a project is approved despite widespread local opposition, special emphasis should be given to identifying and avoiding the potential adverse effects that generated the opposition (Chapter 5).

3. Rural settings in the U.S. are increasingly influenced by urban areas (through television, schooling, agency programs, mass marketing, in-migration, and visits to urban centers) and are changing, whether or not local industrialization occurs. A new mine or plant may increase the rate of these changes but it is difficult to determine how much cultural change can be attributed to a specific project.

4. Various special interest groups have a stake in National Forest System programs. These include organizations committed to resource conservation, environmental protection, wildlife, or resource development. When there are proposals for major changes or additions to agency programs, the most concerned special interest groups actively promote their interests through advertising, lobbying, legal action, or other available means. When a proposed change is important and controversial, new special interest groups may form to work for or against the action.

In social analysis the views of each special interest group must be weighed along with the needs and concerns of other publics who are not organized to further their individual or group interests. Because of the considerable influence they exert and the public support they sometimes muster, special interest groups may affect both resource decisions and public reactions to these decisions.

Chapter 4: SOCIAL EFFECTS OF MINERAL OPERATIONS

The whole spectrum of social and environmental effects stemming from mining and related activities has social implications. Humans (1) define the need for minerals, (2) plan and develop mineral projects, (3) perceive both positive and negative consequences from such projects, and (4) determine what corrective measures should be taken. Mineral operations may affect a person's livelihood, living space, quality of community life, or environmental sensibilities.

It is difficult to visualize the total pattern of effects that could result from a major mineral project and to remain objective when evaluating these effects. Project data may be incomplete or subject to change. The most readily available information may be provided by special interest groups that favor or oppose the project.

Chapter 3 surveys the large number of interacting factors that account for the unique pattern of social and environmental effects at each mineral project site. When these conditions are known for a given community situation, rough estimates of effects can be projected, and subsequently improved when more data become available.

In a period of growing public interest in National Forest programs, it is increasingly important that the minerals industry and responsible resource agencies study the implications of each proposed activity and select a project alternative that best (1) avoids adverse social and environmental impacts, (2) maximizes local economic opportunities, and (3) permits orderly project implementation.

The social assessment and analysis process can provide reasonably accurate insights into local sentiments, needs, and opportunities, an important first step in planning and developing a project that will earn broad community support. This process can also supply feedback on the merits and shortcomings of ongoing activities. People who initially favor or oppose a project sometimes change their minds about its desirability. The quality of the project influences this change.

An Overview of Effects

There has been a marked increase in mining activity in the western states since the mid-1970's. The main thrust has been toward fossil fuels--oil, gas, coal, and oil shale--but new metals and industrial minerals projects are also under construction, while other operations have been suspended or abandoned. Many known but undeveloped deposits with commercial potential exist in the National Forests of the Region (Chapter 1) and Nation. Most of these minerals are available for leasing, sale, or claims under the mining laws.

The 1981-82 recession has slowed considerably the momentum of mineral activities across the Nation, but a return to normalcy in the construction and auto industries would stimulate increased interest. Despite the recession there has been a net increase in the value of mineral production on National Forest System lands in the Northern Region during this period, and exploration for new deposits continues, if at a reduced level.

One or more major mineral projects can profoundly affect a rural area, especially when the population is sparse, and mining and minerals processing are locally regarded as inconsistent with established land-use patterns. The type and intensity of the effects varies considerably with the stage and scale of minerals operations.

When mineral exploration is proposed and initiated, potentially affected individuals and groups form impressions about the changes that eventual development would bring. These early impressions are shaped by news items in the local or regional press, data from special interest groups that favor or oppose the project, and rumors and speculation passed on by friends and neighbors (some of whom may have experienced similar projects). These expectations for development are periodically reformulated as more information becomes available at public meetings, in agency documents, and from personal observations of the events occurring locally. The point of emphasis is that local public impressions of project costs and benefits are derived largely from local evidence and may be revised as the situation changes.

In general, the economic benefits of a major mineral project on Federal lands include lease rentals and royalties for certain minerals covered by the 1920 Minerals Leasing Act (chiefly oil, gas, coal, oil shale, sodium, and some other industrial chemicals). There are also corporate profits, stockholder dividends, and increased tax revenues for all levels of government. At the local level, there are additional job opportunities and increased business activity.

The potential social costs of mineral development are more difficult to identify and measure, partly because they are less systematically researched and reported. They include the erosion of established lifestyles, local inflation for persons on fixed incomes, overburdened community facilities, increased personal stress, a greater incidence of antisocial behavior, reduced scenic and recreational options, and increased noise and pollution.

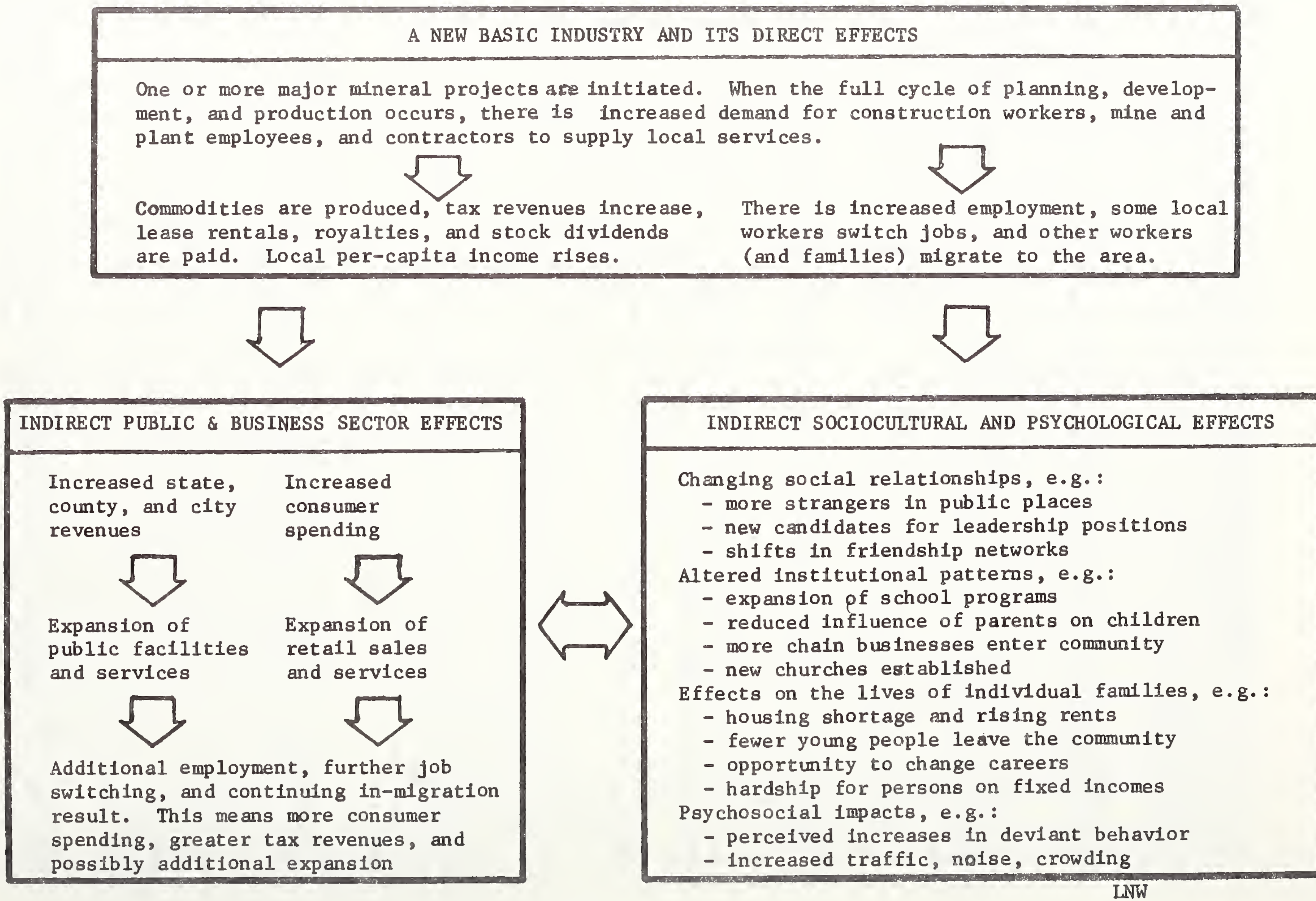
Figure 4-1 shows how a new basic industry creates jobs and increases local spending. These in turn generate additional public costs and revenues. When there is a significant population influx, local facilities and services must be expanded and, local institutions and lifestyles are affected. Well-planned and administered projects take these "external" effects into account.

Most prospecting efforts are short-lived, except when the presence of commercially valuable deposits is strongly suspected. In contrast, site development for a large project may require hundreds of employees for two or three years and the erection of temporary facilities to house them.

Production is usually the most stable and enduring phase and most production workers become permanent local residents. The last stage, abandonment, is potentially the most serious in relatively rural locations, especially when it occurs on short notice. Other local employment options for jobless workers are few and usually pay less.

These minerals operations are discussed in more detail in the following pages. Three case studies are included to provide illustrations of the effects of new development, changing production technology, and plant closure. Additional data sources are identified in Appendix B.

Figure 4-1: Characteristic Social Effects of Industrial Development in Rural Areas



Exploration

Preliminary prospecting activity is usually scattered, intermittent, and low-key. Few people are needed and little or no surface disturbance is required if modern methods are properly used. The geologists and other specialists typically reside in motels and make field trips to evaluate and map the sites of greatest interest.

In regions of great mineral potential, including western Montana and northern Idaho, mineral prospecting is commonplace and increases in frequency when the metals market looks favorable. Because few prospectors are likely to be present in any community at the same time, the social and economic effects of these operations are limited to minor increases in business activity, mainly in the travel-tourism sector.

When there is evidence of a large deposit with commercial potential, exploration intensifies. Several years of additional investigation may be necessary to gather enough data to justify a multimillion dollar investment decision. The social and economic effects of this exploration are governed by such factors as the type and size of the ore body, its accessibility (location, depth, existing roads), and the urgency attached to developing it. From one to several drills will be needed to determine the composition of the ore body and to locate all of its extremities. Roads, trails or helicopter landing sites are required to provide access and hundreds of holes will be drilled over a square mile or more of land, depending on the breadth and depth of the ore body (Chapter 2).

Drills require a crew of two or more operators, plus support personnel. Three shifts may be employed to permit 24-hour operations. Activities are usually confined to the warmer months but may be year-round in some "crash" exploration efforts. Anywhere from 10 to 150 persons might be involved in the summer exploration of an ore body.

One or a combination of methods may be used to house, transport, and supply exploration employees. They may live nearby in mobile units or in apartments in a neighboring town and drive to work. Shifts of workers may be ferried in from more distant places by helicopter. An onsite tent camp may be established, permitting workers to remain there for long periods, supported by weekly helicopter deliveries of food and supplies.

Exploration generates more social and economic effects than prospecting because it involves more employees who may also spend months in a given location. But the scope of these effects is limited by the fact that many nonlocal workers bring their mobile home units with them, are in the area only part of the year, and are often unaccompanied by families. Up to half of the workers may be local hire and require no additional facilities and services.

The major effects of exploration will be increased business volume for motels, restaurants, and gas stations, plus some temporary employment for local residents. At this stage most local residents and special interest groups become aware of potential mineral development and production in their vicinity. The intensity of their reaction varies from one project to another depending on such factors as local economic conditions, existing land uses, local lifestyles and outdoor preferences, the ecological sensitivity of the exploration site, and the way in which the proposed activity is designed and presented to the public.

In general, no significant expansion of local facilities and services is necessary for prospecting and exploration activities. The existing infrastructure usually can accommodate them. Exceptions occur either when a large project is initiated in a very remote area, when several companies decide to explore a given location during the same season, or when exploration is in addition to other new projects or recreation use that already taxes an area's capacity to house and supply transient people.

In the majority of cases (Chapter 2) systematic drilling will reveal that the ore body is not large or concentrated enough to be commercially feasible, and operations will cease. When the deposit is submarginal (almost economic to extract), operations may be suspended but resumed when higher prices, technological innovations, or new support facilities make a mining operation feasible.

Site Construction

In mining and mineral processing, site construction is often the most labor-intensive phase of operations. It may also overlap with production (Figure 2-8), thereby increasing population impacts. Hundreds, or occasionally thousands, of construction workers can seriously overburden rural counties and towns, particularly when the firms involved fail to provide any of the housing and services their new employees require.

When expansion of community facilities is necessary and feasible, the process is often unavoidably gradual and incremental, and thus too slow to benefit the construction workforce. Furthermore, it is unwise for local governments or businesses to extend their permanent facilities and services beyond the capacity needed to serve a long-term mine or plant labor force. For this reason some responsible mining firms provide for the needs of their construction workers when housing is in short supply. Temporary camps are established near the site for mobile or modular housing and group facilities for dining and recreation.

The unique characteristics of most nonlocal construction workers both simplify and complicate the task of accommodating them. Typically they differ from established residents in several respects:

1. The majority are from outside of the area. Most nonlocals live too far away to commute daily. They seek housing within commuting distance, which for most workers this is less than 50 miles one way.[1]

2. About 25 percent of all nonlocal construction workers are unmarried or separated and another 25 percent are married but not accompanied by their families.[2] As a result worker housing needs differ somewhat from the permanent force that will arrive later, largely married and with families.

1/ Leholm, Arlen, F. Larry Leistritz and James Wieland. Profile of Electric Power Plant Work Force. Fargo: North Dakota State University Experiment Station, 1976.

2/ Mountain West Research, Billings, Montana. Construction Worker Survey, 1977.

3. Family size averages about 3.5 persons per married nonlocal worker with family present. This computes to about 2.2 persons for each nonlocal worker hired. But locally this influx will vary considerably from one site to another depending on:

- the availability of appropriately skilled local workers and the developer's need for them. On 26 projects analyzed by Mountain West Research, local workers were 11 to 87 percent of all workers, with 30 to 60 percent the most usual range.[2/]

- the percentage of nonlocal workers accompanied by their families. This varies with the distance to the project, the availability of housing and community services, the age of the children, the degree of family integration, and the expected duration of employment.

4. At sites in very rural locations, construction workers tend to be 95-100 percent male, and disproportionately young and single. In the absence of established recreational programs, effective law enforcement, and the normal constraints imposed by friends, relatives, and neighbors, the incidence of anti-social behavior may be well above regional norms, especially in such areas as public intoxication, fighting, burglary, traffic violations, vandalism, and litter.

5. Construction workers are relatively well paid (Table 4-1) and may earn higher wages, overtime pay, and other compensation at hardship locations. They may be able to pay above average rents and prices for goods and services available in local communities, thereby inflating prices. Construction work frequently attracts local employees from other fields; e.g., farm labor, retail sales, local building or repair firms, or public services.

Table 4-1: Average Work Week and Income in Montana, June 1982

Industry	Hourly Earnings	Hours Worked	Weekly Earnings
Manufacturing	$9.83	41	405
Mining	12.85	37	472
Metal Mining	13.38	43	575
Construction	12.86	28	367
Transportation, Utilities	9.53	41	392
Wholesale & Retail	6.27	33	207
Finance, Ins., Real Estate	5.80	33	192
Services	6.13	32	196
Average Private Sector	7.68	34	263

Source: State of Montana, Employment and Labor Force, 2nd Quarter, July 1982.

6. When a project is completed, some workers will want to remain in the area. When permanent mine or plant jobs are not available, the worker will seek other employment, unemployment insurance, or county assistance.

The construction phase of project development is usually more impactive socially and economically than exploration or production. The workforce is sometimes larger than the subsequent operating force and portions of the two groups may coexist for several months. The construction force may increase rapidly at a time when the community is ill-equipped to meet its housing and service needs. The negative consequences of rapid development are most evident under such conditions. Increased rates of conventional crime, spouse and child abuse, divorce, suicide, job turnover, alcohol abuse, and mental health referrals suggest high levels of personal stress, especially for newcomers who lack the personal and institutional supports of established residents.

The combination of such factors as inadequate housing, limited recreational options, difficulty establishing credit, local hostility toward construction workers, and the bleakness of many rapid-growth communities is sufficient to demoralize residents and motivate some newcomers to move elsewhere. Sources 5, 7, 8, 10, 11, 13, 16 and 25 in Appendix B provide case study data.

Presently several major mineral projects are under construction in the Northern Region and others are underway in neighboring states. Table 4-2 provides descriptive data on 23 projects.

It is possible and desirable to increase the social responsiveness of a mineral project through careful design and implementation. First identify potential problems and opportunities by reviewing the experiences of similar projects and by considering unique elements of the present situation. Then encourage continuing consultation among the developer and major contractors, the concerned State and Federal resource agencies, local governments, and affected landowners to help insure that the environment is adequately protected and that local communities are in a position to receive discernible benefits and to manage the social effects generated by the project.

It is usually more expensive to design and construct a model facility than a makeshift operation, but there are potential long-term benefits for all concerned. A well-designed plant is attractive, provides a relatively safe and comfortable work place, and controls pollution. A program emphasizing local hire especially in the production phase should reduce local unemployment, avoid impacts on schools and housing, and provide a stable, responsible workforce. There should be widespread public support for the project and a reduced likelihood of costly lawsuits because of poor management practices, environmental degradation, and neglect. Evidence from a case study of the Troy, Montana experience supports this contention.

Case Study: Troy, Montana

The ASARCO-Troy project is a copper-silver mine located on National Forest lands in rural Lincoln County in mountainous northwest Montana. The mine and ore concentrator are located 20 miles south of Troy (population - 1,088), and about 30 miles southwest of Libby (2,748), the county seat.

Description. A mine and plant site were constructed during 1979-1981, following a decade of intermittent exploration. The prefabricated concrete and steel structures house a crusher, concentrator, connecting conveyor belts, offices and shower rooms, a workshop, storage tanks for water and fuel, a power substation, a sewage plant, a thickening pool, and fire control installations (Figure 2-9).

Table 4-2: A Sample of Recent Mineral Projects in the Western States

Company	Location	Type Facility	Eventual Production Capacity	Million $ Investment	Scheduled Start	Present Stage
Martin Marietta	Goldendale, WN	Aluminum smelter	65M st/yr Al	$125	1982	A
ASARCO	Troy, MT	Copper mine and concentrator	8.5M t/d ore	85	1981	P
Kennicott	Hurley, NM	Open pit copper mine	37M st/d ore	270	1983	A
Cominco	Trail, BC	Electrolytic	272M mt/yr Zn	210	1983	A
California Nickel	Gasket Mt., CA	Chromium mine and refinery	20M st/yr Cr	250	*	B
Noranda	Blackfoot, ID	Underground cobalt	1.4M st/yr ore	50	1984	A
Cyprus	Challis, ID	Open pit moly mine & plant	25M st/d ore	360	1983	A
Placer Service Corp	Marysville, CA	Placer gold mine	50M oz./yr	11.4	1982	A
Anaconda	Absarokee, MT	Mine, plant	*	85	1985	C
Calahan	Couer d'Alene, ID	Underground silver mine	*	26	1985	B
Hecla	Mullan, ID	Underground silver mine	1M st/d ore	26	1986	AB
Gulf	Mt. Taylor, NM	Underground uranium mine & concentrator	4.2M st/d ore	500	1984	A
Chevron	Clear Creek, CO	Mine & plant	100M bbl shale oil	5,000	1986	B
J.R. Simplot	Afton, WY	Open pit phosphate mine	500M st/yr	*	1984	A
Tenneco	Green River, WY	Soda ash mine, plant	1MM st/yr soda ash	50	1982	B
Johns Manville	Big Timber, MT	Platinum mine, plant	2M* st/d ore	50*	*	B
Sunshine	Silver Peak, ID	Mine	1M oz./yr	*	1982	A
Absaroka Mine	Big Horn Co., MT	Coal mine	10MM t/yr	*	1982	A
U.S. Steel & others	No. Tier States	Transmission pipeline for oil	700M bbl/d	1,150 (1978)	1983	BD
Am. Natural Resources	Beulah, ND	Coal gasification plant	Synthetic gas	2,000	1984	A
MT Power Co. and NW Associates	Colstrip, MT	Mine and power plant	Up to 1.4M megawatts of electricity	500 (1974)	1976	PA
Alumax	Anaconda or Great Falls, MT	Aluminum smelter	260,000 st/y	800	1984	C

P = some production is occurring
A = now under construction
B = development details worked out, but not under construction
C = initial proposal stage
D = suspended or deferred
M = thousand
MM = million
* = no official data
st/yr = short tons per year

Source: Engineering and Mining Journal

The mile-long subsurface ore body has been accessed by a large entrance ramp that can accommodate oversized trucks and drilling machines. There are also three ventilation adits and a powerful exhaust system. Some of the 200,000 tons of material removed to open the mine were used in plant site construction.

The plant parking lot is approached via seven miles of paved road from state highway 56. An existing power line has been upgraded and six miles of new line have been constructed to bring 115,000 volt current to the facility.

During the construction period the workforce peaked at 250 and declined to about 150 in the summer of 1981, at which time a portion of the operating force began limited production. By March 1982 the plant workforce of 330 was complete and full-scale production was underway.

The mine operates continuously, requiring three shifts daily and a skeleton force on weekends. Using the room and pillar method (Chapter 2), the ore is broken loose, and passes through the mine crusher. It is carried via conveyor belt to the concentrator, where it is reduced to a fine powder that is 33 percent copper and contains about 70 ounces of silver per ton. This concentrate is transported by truck to Troy where it is transferred to freight cars for shipment to a company smelter in Tacoma.

Concentrator wastes are thickened by removing excess water and piped six miles downhill to a 265 acre tailings enclosure. Wastes may also be stored in vacated portions of the mine at a later date.

The projected life of the ore body is 19 years, unless additional deposits are discovered in the vicinity. When the site is abandoned, the company is committed to reclamation by (1) replacing topsoil on the site, waste dumps, and tailings pond, (2) reseeding with a mixture of native vegetation, and (3) controlling drainage and thus preventing toxic runoff and erosion.[3/] Discovery of a new deposit may extend the life of the project.

Social effects. Local impressions of the social and economic effects of the project were obtained from several Forest personnel and a nonrandom sample of 40 residents of Lincoln and Sanders Counties. These included elected and appointed officials, businessmen, educators, representatives of special interest groups, law enforcement personnel, and plant employees.

Almost all respondents were supportive of the project, including some who offered criticisms. Several people said they were intially apprehensive about the project's social or environmental effects but their concerns were alleviated by the company's positive approach to planning and development. Those who remained critical of the project either focused on specific situations or expressed concern about the accumulative effects of additional mineral development activities. The general impressions gained from the interviews and site visit are summarized here, recognizing that this is only a partial sketch of the project's social effects.

[3/] The project EIS, prepared by the Kootenai National Forest and the Montana Department of State Lands, 1978, provides further details.

1. The project is well-designed and landscaped. The plant, entrance road and tailings enclosure occupy about one square mile of land. There are few eyesores such as visible waste dumps, abandoned materials, or eroded land surface. Located on a dead-end road and surrounded by trees, the mine and plant are inobtrusive. The tailings enclosure on the valley floor is much more conspicuous. The large U-shaped earth dam which impounds the continually accumulating tailings is difficult to camouflage. The pond will be reclaimed as it is filled by covering it with a layer of topsoil and planting a mixture of trees and grasses.

2. Increased opportunities for local employment. Since the completion of the Libby Dam about 1971, Lincoln County has been plagued by high rates of unemployment, generally 12-14 percent. The current slump in the wood products and construction industries has aggravated this situation.

The project's current workforce of 330 includes mine (31%), concentrator (26%), maintenance (27%), office (15%), and security (1%) personnel. The lowest wage paid at the mine is $10.15 (grade 1 worker, day shift, 1981). Overall earnings plus benefits exceed most other local opportunities and compare favorably with mining operations in other states.

As a result of the company's local hire policy, 96 percent of the newly hired employees were recruited from Troy, Libby, and other locations within commuting distance. Only 17 supervisory personnel were transferred to the plant from other locations to train local workers and to initiate mine and plant operations. 4/ This has increased the economic stability of many local families and reduced the number of defaults on home and auto loans.

Local hiring encouraged considerable job switching, as unemployed loggers and millworkers, seasonal Forest Service employees, local government workers, and underemployed office and sales personnel sought to improve their income. One Troy resident said "everyone moved up a notch." Official local unemployment in Lincoln County has been among the highest in the state since the completion of the Libby Dam and related construction a decade ago. Project employment has helped the situation, but has not reduced the unemployment rate (up to 35% in March 1982) in the face of increased layoffs in the lumber industry and Federal workforces.

The emphasis on local hire discouraged extensive in-migration but most project employees are spending more money than before. Since the completion of construction, existing businesses and public services are able to meet the increased demand without much additional staffing because the economy was very depressed and most were operating at below peak capacity. As a result, there has not been a substantial amount of secondary employment generated by the project.

3. Local earnings and revenues have increased. In 1981, ASARCO-Troy provided an $8 million local payroll, made substantial local purchases, and paid $5 million in Federal, state, and local taxes. 4/

4/ ASARCO Personnel Office data.

4. The project strengthens and diversifies the economy. Although there are a vermiculite mine and increasing tourism, wood products manufacturing is the dominant basic industry in Lincoln and Sanders Counties. The economy is sensitive to the effects of seasonal layoffs and annual fluctuations in the demand for lumber. The mine, an all-season industry with a different product, adds to the stability of the economy and increases local business activity. More people now have an assured annual income and are able to commit themselves to installment purchases such as homes, cars, and appliances.

5. The people of Troy have benefitted from the project. The suspension or reduction of most logging operations, the primary source of Troy's basic income, has had serious social and economic effects. Several small businessmen serving the Troy market area say they have managed to stay in business because of increased sales to project employees. A few businesses have been started or have occupied new premises and there are new business license applications.

The value of the plant complex and its production have more than doubled the assessed valuation of the unified Troy School District. New project employees account for only four percent of the enrollment and include children of returning residents as well as newcomers to the area. Company employees play an active role in the Troy government and in voluntary group work.

Of the project's facilities, only the loading dock is within the Troy city limits and it is on railroad property. Some respondents think the city has incurred some additional expenses due to increased traffic and more frequent use of city services, but has not had equivalent revenue increases. Currently the city's limited sewer capacity restricts building within the city and precludes the property tax revenues this would generate.

6. The project did not significantly impact county and city facilities and services. This is because Lincoln County's population was decreasing during the past decade (1.7%), the school-age population had declined at an even greater rate, and most project workers were hired from the existing population. Some school enrollments including Libby's continue to decline, but at a reduced rate, diminishing the need to curtail programs or staffing. Most city and county agencies report only minor changes in the demand for services. One exception is the manageable increase (perhaps 50-100 families) in social services case loads in Lincoln and Sanders Counties due to in-migrant workers who failed to obtain mine employment.

The company built its own mine entrance road and does not strain the existing county roads and facilities, yet it will contribute tax dollars based on the value of its holdings and the value of the metal produced. Company employees also pay county-city property taxes, which are increasing because some employees are purchasing new or larger homes.

City and county law enforcement officers say that virtually no increases in the type or frequency of law violations can be atributed to the project. They mentioned only the need to clarify local police authority on the ASARCO premises.

7. The company makes local purchases. Local firms have successfully contracted to supply the project with commodities and services, including sand

and gravel, light trucks, vehicle parts, office machines, furniture, drilling services, repair work, chartered helicopters, and fuel. At least some sales have resulted from local businesses taking the initiative in securing contracts.

8. The company demonstrates concern for its employees and seeks a positive public image. In 1981 the company sponsored a mine and plant open house with a luncheon for employees and their guests. There is a company-supported comprehensive insurance plan for employees and their families. The company provides bus service at low rates from Libby and Troy to the plant, supplies speakers to school and community groups, and permits mine field trips. ASARCO trained almost all of the local-hire mine workers and many of the concentrator employees. There are opportunities for promotion; i.e., 12 workers hired in 1981 are now foremen or shift bosses. Most mine and plant workers are fairly young males who have some prior experience with trucks and machinery. They are said to learn the required additional skills quickly. 4/

Employees and their families have reported that supervisors are both congenial and concerned about employee welfare. Management representatives describe the local workforce as unusually dedicated and responsible.

9. No major environmental problems have been identified thus far. Most respondents who commented on the subject had noted no serious environmental impacts and one made a reference to "Canada geese swimming in the tailings pond" as evidence of the safety of the project.

Not all respondents were this optimistic. A few expressed concern about eventual seepage of toxic substances from the mine or tailings pond which could degrade the high water quality of the area. Some interviewees said the company was reluctant to take all necessary measures to protect water quality, but ultimately did.

10. Local lifestyles have been relatively unaffected. Both established residents and newcomers to Lincoln County tend to be very attached to the area because of its natural amenities. This part of Montana is unusually rugged and scenic, with numerous pristine streams and lakes, lush vegetation, cool summers, and mild winters. There are unusually abundant opportunities for outdoor recreation. It was alleged that unemployment is persistently high in the county because some residents are not willing to leave, even when there is no available employment.

Most respondents, including some environmental group representatives, view the project as reasonably compatible with local lifestyles. Most employees were already residents, crime has not significantly increased, and most social changes that have occurred are regarded as minor but positive.

At least two small and one 90-unit housing area are being developed or expanded, due in part to the mine project. The absence of planning and zoning regulations could contribute to future problems in rural portions of Lincoln and Sanders Counties if additional growth occurred. Too many simultaneous construction and mining activities could create undesirable lifestyle impacts for residents and recreationists. Excessive roading and uncoordinated real estate development are two possible outcomes.

Production

In hardrock mining, production is ordinarily the most stable and enduring phase of operations. It includes extracting, crushing, and transporting ores to concentrators, removing their mineral compounds, and then smelting and refining the concentrates to produce metals.

Mining, including nonfuel minerals, coal, and petroleum, was a 2.2 billion dollar industry in the four states of the Northern Region in 1979 (Table 4-3). The mining industry employed 20,000 people in extracting activities, with a payroll of $500 million (Table 4-4). Thousands of additional workers were engaged in smelting, refining, and transporting mineral raw materials.

Table 4-3: Value of Mineral Production (in $1000) in Northern Region States, All Lands, 1980

State	Nonfuel Minerals	Crude Oil	Natural Gas	Coal	Total	% of Total Non-fuel	% of Total O&G
Idaho	522,095	-	-	-	522,095	100	0
Montana	280,084	613,495	76,400	296,000	1,265,979	22	55
N. Dakota	22,376	847,127	66,234	120,000(est.)	1,055,737	2	87
S. Dakota	227,701	22,605	2,093	NA	252,399	90	10
Totals	1,052,256	1,483,227	144,727	416,000	3,096,210	34	53

NA = Not available; presumed to be relatively minor in 1918.

Sources: Montana Oil Journal
Statistical Abstract of the U.S., 1980
Bureau of Mines, Mineral Industry Surveys, 1980
Montana State Board of Oil and Gas Conservation, 1981
North Dakota State University Extension Service

Table 4-4: Mining Employment in Northern Region States, 1979

State	No. of Employees	% of state total	Mining Payroll ($1,000)	% of state total
Idaho	4,295	1.0	91,922	1.7
Montana	7,733	2.1	200,060	4.6
N. Dakota	5,581	1.7	132,836	3.6
S. Dakota	2,859	0.8	72,500	1.7
Totals	20,468	1.4	497,318	2.9

Source: USDC Bureau of Economic Analysis

Since 1979, the volume of production of both fuels and nonfuels has changed significantly. The closure of the two largest mine and metal processing complexes in the Region has sharply curtailed the production of copper, zinc, lead, and antimony. In contrast, oil and gas production continues to increase in North and South Dakota and the removal of price controls roughly doubled the value of domestic crude oil between 1979 and 1981. The portion of total production occurring on National Forest System lands has at least tripled since 1979 (Chapter 1).

Local Economic Effects

Major new mine or plant facilities usually are planned, financed, and managed by nonlocal interests. Typically, a large corporation wishes to expand or diversify its operations in an effort to increase its return to investors. When the project is announced, it will receive some local support because of anticipated increases in area employment, business activity, and tax revenues.

Extracting and processing a large ore body creates 200 to 500 or more mine and concentrator jobs over a 20 to 50 year period. The construction of a smelter or refinery provides employment for additional hundreds of workers. The long-term trend toward open pit mining, and the mechanization of many extracting and hauling operations have reduced workforce and/or time requirements for removing a given quantity of ore.

The addition of a substantial new payroll to the economic base of one or more rural western communities normally results in population growth because only a portion of the workforce will be hired locally. This depends on company policy and the size, skills, and availability of local job candidates (Chapter 3). Typically, some unemployed local workers are hired, employed locals switch jobs to increase their earnings, and some worker in-migration occurs. A cadre of managerial, professional, and skilled employees is tranferred to the project to provide leadership and other newcomers arrive spontaneously in search of employment.

Most of the new payroll is spent for consumer goods and services or collected in taxes. There is increased business activity, both locally and in regional shopping centers. Previously successful businesses usually expand their operations and some marginal enterprises may now prosper. But at least a few other businesses are likely to be displaced by local outlets of national or regional chain stores and restaurants. A second round of employment is thus generated and additional newcomers arrive to fill some of these positions. Other jobs are filled by previously unemployed persons including homemakers, students, and unskilled workers who may have had difficulty obtaining mine or plant employment.

Affected counties and communities, especially in sparsely populated areas may find it necessary to add school classrooms, extend public utilities, enlarge police and fire departments, construct roads and streets, and add new services. This is ultimately feasible because of increasing property tax revenues, but hardships occur due to a two or three year lag between the need for such expansion and the eventual receipt of additional taxes, grants, or growth-related funding increases from state and Federal agencies.

The gap between expanding needs and delayed funding may be shortened by encouraging the developer to pay property taxes in advance, and by floating loans or securing special impact aid grants from public or private sources. Several months are required to obtain funding by these means and the planning and construction of new facilities usually takes another year or two, depending on their type, scale, and complexity.

Both the property value of a new mine or plant installation and its production are taxable. Sales, income, and excise tax collections will increase because of greater employee earnings and consumer expenditures. Table 4-5 estimates and compares state and local tax receipts from a coal mine of a given size in four different states.

Table 4-5: Comparison of State and Local Taxes for a 5 Million Ton/Year Model Mine (Coal)

				Colorado*	
State Taxes	**Montana**	**No. Dakota**	**Wyoming**	**$10/Ton Coal****	**$15/Ton Coal*****
Property Taxes	$ 71,663	$ 4	$ 185,086	$ 0	$ 0
Income Tax	288,552	196,406	0	195,786	195,786
Sales Tax	0	157,931	129,011	129,010	129,010
Severance Tax	7,376,214	3,450,000	2,757,970	3,150,000	3,150,000
School Equalization	0	0	0	0	0
Other	23,664	28,714	23,306	34,012	34,012
TOTAL	$8,198,128	$3,833,055	$3,095,373	$3,508,808	$3,508,808
Cost per ton	$1.64/ton	$0.77/ton	$0.62/ton	$0.70/ton	$0.70/ton
Local Taxes					
School District	$ 250,738	$ 9,809	$1,212,623	(see total)	(see total)
County	199,064	3,521	688,513	(see total)	(see total)
TOTAL	449,802	·13,330	$1,901,136	$ 842,826	$1,042,662
Cost per ton	$0.09/ton	$0.002/ton	$0.38/ton	$0.17/ton	$0.21/ton
Total State & Local Taxes	$8,647,930	$3,846,385	$4,996,509	$4,351,634	$4,551,470
Cost per ton	$1.73/ton	$0.77/ton	$1.00/ton	$0.87/ton	$0.91/ton

*Colorado property taxes based on 1978 Colorado Property Tax Division guidelines for coal mining property.
**Producing land valued assuming coal value of $10 per ton.
***Producing land valued assuming coal value of $15 per ton.

Source: Dr. Thomas F. Stinson, U.S. Department of Agriculture.

The earnings from coal are greatly enhanced by the severance tax collected in each state shown on the table. There is no tax of comparable magnitude on metal mining, and none is likely in the near future because of poor market conditions for many domestically produced metals.

The potential economic gains from metals and industrial minerals projects are nevertheless great. They include tax revenues for all levels of government and a wide variety of benefits for the private sector. Table 4-6 illustrates the range of possibilities.

Table 4-6: Potential Revenues and Income from Nonfuel Minerals (metals, industrial minerals, and coal development*)

Government Revenues

Federal Level

Corporate income tax of 40 to 46 percent of taxable income.
Individual income taxes of 17 to 21 percent or more from additional basic and secondary wages, salaries, and dividends that are paid.
Federal excise tax increases (on sales of gasoline, alcohol, and other taxed items).

Federal agency collections:
- Bureau of Land Management fees for prospecting, filing claims and lease applications, issuing licenses, and patenting claims.
- Forest Service special-use fees for off-site roads, pipelines, or other facilities.
- Lease rentals and royalties for coal and other leasable minerals (Chapter 1).
- Lease rentals and royalties for all minerals extracted from acquired lands.
- Fees and market prices for salable (common variety) minerals.
- Coal mine reclamation fees paid to the Department of Interior (PL 95-87, Sec. 402(a)).

State Revenues (ID, MT, ND, SD)

Corporate and individual income taxes (South Dakota excepted).
Sales taxes (Montana excepted).
Excise taxes on gasoline, tobacco, liquor and utilities.
Motor vehicle and other licenses and fees.
Estate and gift taxes.
Redistribution of agency collections from filing fees and special-use permits.
Property taxes.
Gross receipts taxes (Montana excepted).
Lotteries and betting in Idaho and South Dakota.
Federal transfer payments to states (social programs, impact aid, etc.).
Severance taxes on metals and coal.
Liquor store and public utilities sales.
Leasing rentals from state lands.

Local Revenues

County real estate receipts increase with property values.
County personal property tax receipts increase.
Increase in licenses and permits issued, fees collected.
Forest Service distributes 25 percent of surface-use fees collected to counties with National Forest lands.

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* Revenues from petroleum operations are discussed in source 4, Appendix B.

Local Revenues (cont.)

Redistribution of National Forest minerals revenues payments by states.
Montana: Payments for education are made to counties (whether or not oil is produced) using the equalization formula.
North Dakota: 25 percent of revenue (from acquired lands) is paid directly to the counties where production occurs.
Redistribution of a portion of the state coal and petroleum severance (production) taxes.
Grants (state, federal and private) can be obtained to assist communities in expanding facilities and services to accommodate additional people.
Receipts from state property, net proceeds taxes, and other sums routinely distributed to local governments by the state and Federal governments.
Municipal utility receipts (water, sewer, buses, etc.)
Street and sewer assessments.

Private Economic Benefits

National Level

Increased business activity; e.g., the manufacture and sale of machinery and equipment for mining and processing minerals, vehicles, pipe, building materials, and plant and mine supplies.
Additional demand for long-distance rail, truck, water, and/or pipeline transport, household moving, consultants, and other services.
Expanded employment in the above industries.
Greater availability of domestic sources of minerals and possible reductions in imports.
Dividends to investors.

Regional Level

Increased business activity, including seismic exploration, contract drilling, site development, and the construction of roads, pipelines, and power facilities. For regional market centers, increases in wholesale and retail sales, and an expanded demand for business and personal services.
Convenient sources of raw materials for regional processing plants.
Increased employment with drilling firms, road and site contractors, and mine service companies. More jobs in a variety of secondary fields; e.g., in medical services, education, retail sales and services, business and residential construction, transportation and communication, environmental protection, and other fields.

Local Level

Increased business activity for local stores, banks, service firms, utilities, bars and restaurants, motels, etc.
Expanded employment opportunities in both the mining industry and various support occupations, including teaching, medical services, social programs, and law enforcement.
Improved market for real estate, new houses, mobile homes, and rental housing.

Social Considerations

A major mine or processing plant may operate continuously for two or three generations. Its presence in a relatively rural area is imposing and influences the social organization, outlook, and lifestyles of nearby communities. The magnitude of the impacts varies with the size of the facility, hiring policies, the characteristics of the affected communities and other variables described in Chapter 3.

Population changes. Many researchers believe population change is the single most important factor affecting community well-being, contributing to prosperity in some instances and to economic instability, social disorganization, and adverse social conditions in others. In one-industry mining towns population shifts usually relate to changing labor force requirements in the mines or processing plants.

Excessively rapid growth puts severe burdens on local governments, schools, and utilities, and increases stress among affected residents. Steady but gradual growth contributes to local business prosperity and additional jobs in secondary industries. The loss of population may result in a depressed economy, business closures, and further population loss.

It is the rate of population change rather than the number of incoming residents that is crucial. Normally a city of 10,000 can absorb or lose a given number of people much more readily than a smaller community of 1,000. That is, if 90 workers and their families move in, the burden on the city's housing capacity, utilities, businesses, and public services is increased by 2 percent rather than by 20 percent.

The culture of a larger city is also more complex. Social class, ethnic, and occupational variations in lifestyle are experienced daily and the presence of strangers is routine. Formal law enforcement supplements the informal social controls that usually suffice in rural areas. The arrival of industrial workers is a less dramatic event in a city than in a small town, and many more newcomers are required to "outnumber" the older residents and thus significantly affect the course of social change.

In the Northern Region, the average annual growth rate in most locations is under 2 percent, requiring 40 years or more for the population to double. However, an increase of 15 percent annually would double the population in just 5 years, greatly reducing the time available for adapting facilities, expanding revenues, building homes, extending services, and adjusting traditions and attitudes. Generally, the more rapid the growth, the more problems there are to vex both newcomers and oldtimers, and the greater the schism between them.

The ability to cope successfully with the social and economic effects of mineral development is assuming greater importance in the wake of a National emphasis on achieving greater minerals self-sufficiency. The effort to develop domestic sources has been most evident in mineral fuels. In a 1979 report published by the Denver Office of the Department of Energy, 325 towns in six Rocky Mountain and Northern Plains States were identified as present and potential impact areas. [5/] Of these, 135 are in Montana and North Dakota. Over half of these towns had less than 1,000 inhabitants in 1970, and only 19 exceeded 10,000. They ranged in size from Birney (13) to Billings (76,600), both in Montana. Most are unfamiliar with the problems of growth and have developed no formal procedures for dealing with them.

When development-related population influx occurs, the affected towns and cities grow at different rates. This situation sometimes perplexes local planners, who wish to estimate where newcomers will live. Such information is essential if there are to be public and private efforts to prepare for the influx. Advance preparations can markedly reduce the disappointment and stress that result when in-migrants are unable to find adequate housing and community services.

Several considerations influence residence selection, and individuals and families differ in the importance they assign to each. Housing options are often extremely limited, and many persons and families do not find what they want or need. Eight criteria utilized when options exist are:

1. The time required to travel daily from home to work. Very few permanent residents are willing to drive more than 40 minutes each way.

2. The availability of the type of housing desired; i.e, one-family home of acceptable style and neighborhood, apartment, mobile home park, or single room.

3. Access to comprehensive consumer facilities such as a supermarket, shops, schools, restaurants, and medical services.

4. Cost and availability of credit (high mortgage interest rates encourage renting; newcomers may have difficulty arranging loans).

5. Access to valued amenities, such as fishing, streams, lakes, scenery, privacy, National Forest lands, golf course, and friends or relatives.

6. The presence of adequate public utilities and services; e.g., water, electricity, sewer, power, improved roads.

7. Worker income in relation to the cost of housing (professionals are more likely to buy homes; unskilled will more often rent).

8. The local tax structure (high city taxes can encourage rural residence).

[5/] U.S. Department of Energy. Regional Profile: Energy Impacted Communities. Springfield, VA: National Technical Information Service, 1979. The names of these communities are listed on pp. 418-421 of the document, and infrastructure data are included elsewhere.

The adjustment of incoming employees to the community and their eventual acceptance depends in part on the personal qualities of the workers. In predicting this, clues are evident in their age, marital status, whether or not they are trained career employees, their level of formal education, work history, etc. On the average, those with the most at stake (rank, income, job security, family) usually make the greater effort to meet community expectations.

In the mining centers of the Region, employment security has been periodically reduced by several factors including the fluctuating metals market, labor-management conflicts, and changes in mining and processing technology. In some mines, employee strikes for higher wages or improved working conditions have shut down operations for several weeks or months with significant losses in production and income.

The long-term trends toward open pit mining and the mechanization of many extraction and hauling operations have substantially reduced workforce requirements. As a result, miners are relatively fewer but better compensated than workers in other industries (Table 4-7). The closing of the several remaining underground mines at Butte and the opening of an open-pit operation reduced the number of mine employees from 13,000 in 1942 (union estimate) to 1,300 in 1981 (company estimate). At this writing further reductions are expected following the decision to close the central portion of the open pit mine. During this period, the extraction of ore tonnage increased and the production of copper decreased due to the much lower concentration of metal in the remaining ore.

In one-industry towns, mine and plant cutbacks imply equally severe reductions in business volume, public services, and secondary employment. The case studies later in this chapter (Butte and Kellogg) illustrate these secondary effects.

Quality of life implications. Residents of the large rural expanses of the Northern Region states demonstrate a strong attachment to the land, a fondness for outdoor recreation, and a loyalty to the locality in which they live. Whether the prevailing physical environment is forest, grasslands, or rough and rocky terrain, its uniqueness is recognized and highly regarded by those who call it home. Most newcomers as well as established residents are learning to respect the natural environment and are reluctant to alter it without carefully considering the implications of such actions.

Rural westerners differ from city residents. Traditions such as neighborliness, trust, and mutual aid are widely shared and upheld as ideals. The wide range of modern facilities and services that have become standard in urban centers are not considered as essential in the small town.6/ Physical amenities such as clean air and water, primitive forest, panoramic vistas, privacy, good hunting and fishing, and varied outdoor recreation are highly valued. These assume added importance when it is recognized that most Americans have increasingly limited access to such opportunities.

6/ See source 14, Appendix B.

Table 4-7 How Mining Compares with other U.S. Industries

	Days lost annually per 100 employees: Strikes 1981	Accidents or Illness 1980	Deaths per 100,000 1981	Weekly earnings 1975	1977	1979	June 1982	Percent unemployed 1975	1977	1979	1981	Percent Women Employees 1981
Agriculture	0	82.7	54	471*	343*	595*	NA	10.3	11.1	9.1	12.2	19.7
Manufacturing	0	86.7	7	191	229	269	334	10.9	6.7	5.5	8.3	31.7
Mining	0.1	163.6	55	249	301	365	462	4.0	3.8	4.9	6.0	15.2
Construction	0	117.0	40	266	296	342	428	18.1	12.7	10.2	15.6	8.2
Trans. Public Utilities	0	104.5	31	233	279	326	398	5.6	4.7	3.7	5.2	26.5
Wholesale	0	58.2	5	183	209	248	309	8.7	8.0	6.5	8.1	25.7
Retail	0	44.5		109	122	139	165					52.0
Finance, Ins., Real Estate	0	12.2	7	148	165	192	242	4.9	3.9	3.0	3.5	58.5
Services	0	35.8		135	153	175	223	7.1	6.6	5.4	6.6	60.9
Gov't.	0	NA	10	NA	NA	NA	NA	4.0	4.2	3.7	4.7	36.0
	------------ Excluding Government--------------------							-------Including Government--------				
Total	0	65.2	12	164	189	220	267	8.5	7.0	5.8	7.6	42.8

Source: Statistical Abstract of the U.S., 1980, and 1982-1983.

NA: Not available
* For operators only

Although local residents may perceive a need for certain "improvements" in local facilities, or some expansion of an often narrow economic base, there is limited support for large-scale development activities that are perceived as inconsistent with existing land-use patterns or disruptive of community life.

This suggests that a proposed mineral project would be most welcome where residents are accustomed to mining and economically dependent on this industry. However, when mining communities are already experiencing growth pains from existing projects, there will be increasing opposition to additional operations. Mining activities may also be acceptable to the majority of residents in areas where intensive logging, local quarrying, or other surface disturbing activities are already well established.

In contrast, there is often strong resistence to mineral operations in areas valued for their natural beauty, their recreation and tourism potential, their prime agricultural land, or other attributes that could be adversely affected by mineral extraction, processing, or transporting operations. There is often strong opposition to mining in wildernesses because of potential impacts on wildlife, air and water quality, scenery, established recreation uses, and other wilderness values.

For each rural location there is probably some level of mineral operations that will significantly degrade the quality of life of residents. The Forest social scientist could expect considerable variation from one area to another in the volume of mineral activity tolerated. An important variable would be the success of industry, agency, and local government efforts to anticipate and avoid adverse social and environment impacts from exploration, construction, and production operations.

When the arrival of the plant operating force overlaps with construction activities, the adverse effects associated with excessively rapid population growth may increase (see the following section on the boomtown syndrome). When the size of the workforce stabilizes, these conditions gradually return to near-normal levels. Community facilities expand to accommodate these newcomers and their families and they become integrated into the community.

Both formal and informal patterns of social organization are potentially affected by a new mineral project. The company becomes a new political and economic force in the community. Some of its employees eventually occupy positions of leadership and responsibility in local government and voluntary organizations. At the informal level, some newcomers develop friendships with residents, while others feel rejected or ignored and socialize chiefly with other company employees. Some older residents in leadership positions will ultimately be displaced by newcomers with differing conceptions of community needs. Some long-standing friendships may be severed because of job changes, the sale of mineral rights, or changing business fortunes -- all relating to the new basic industry in the community.

For Native Americans, the presence of mineral resources on reservation lands is a potential source of controversy and change. Historically such resources have been left alone or developed by outsiders with little return to the Indian tribe. Tribal leadership today is increasingly aware the great mineral wealth of western reservations and steps are being taken to insure wise use of these resources.

The emerging view held by many Indian leaders is that tribes should receive maximum benefits from royalty income and employment. This could, for example, enable tribes to expand their community business sector and benefit from the spending as well as the earning of income from mineral holdings. There is also a desire to avoid the adverse effects associated with a large population influx and the disruption of Indian community life.

Federal policy is changing to provide Indian governments with more authority in negotiating mineral development agreements and regulating activities.7/ At the same time, resource-rich tribes are cooperating to exchange information and support one another in negotiating development contracts.

Case Study: Butte, Montana

The Anaconda Company was established at Butte in 1880, at a time when gold and silver were the minerals of local interest. The company's founder, a veteran miner named Marcus Daly, foresaw a promising future for copper in the infant electrical and communications industries. Just 20 years later this company was mining, smelting and marketing about half of the world's copper. Butte Hill became famous as "the richest hill on earth." Production steadily increased until 1916, when over 290 million pounds of copper were produced. Since then production has declined at an uneven rate.

About 200 underground mines were dug on Butte Hill, resulting in a maze of shafts and tunnels to depths exceeding 5,000 feet. Over the years, the Anaconda Company acquired ownership of all these mines. Because most of the high grade ore had been extracted, underground mining was no longer profitable. In 1955, the west section of the hill including a portion under the city was converted to an open pit mine, the Berkeley Pit. Several Butte neighborhoods, including Meaderville, various residential areas, and the renowned Columbia Gardens, were displaced as millions of tons of overburden were removed to reach the remaining body of ore. The ore was concentrated in a new plant at the edge of the pit and transported 25 miles by rail to the company smelter in Anaconda, where copper anodes were produced. Anodes were shipped by rail to Great Falls to be refined to 99.9 percent purity and converted to standard commercial shapes; e.g., rods, sheets, and bars.

In 1981, the company closed the Anaconda smelter and the Great Falls refinery, citing depressed copper market prices as the major factor. In 1982, the major portion of the Berkeley Pit was also closed for the same reason.

Butte and Anaconda have been called "one-industry" cities because the Anaconda Company was by far the largest employer in each. The earnings of miners and metal workers are well above average (Table 4-7), so their effect on local business activity is great. When copper production decreased during the 1920's and 1930's, mine and plant employment also declined and the area's population decreased.

7/ Item 32, Appendix B, provides data on Indian reservations and tribal organization. Articles on reservation resources development are available in Saturday Review (November 25, 1978) and Engineering and Mining Journal (January 1980).

Following the conversion to the less labor-intensive open pit mine in 1955, the work force and population again declined rapidly until 1970, and then began increasing because of new energy-related industries. With the closure of Anaconda's Montana operations in 1981-1982, a third decline is occurring in both Butte and Anaconda, resulting in a reduction of jobs, population, business activity, public revenues, and community services. In 1980, the Anaconda Company employed 1,800 people in the Butte mining operations, 1,100 in the Anaconda smelter, and 500 in the Great Falls refinery. These figures have dropped, respectively, to 60 at Butte, 9 in Anaconda, and 1 in Great Falls as of July 1983. Anaconda Company cited the following as four major factors in the layoff: 1) the recession and its effects on world copper prices, 2) unyielding and restrictive labor unions, 3) government attitudes and environmental requirements, and 4) foreign competition. 8/

Although only about 5 percent of Butte's workers are now Anaconda employees, the closure of the mine is a blow to the community's pride and reason-for-being. 9/ Many families have been residents for two or three generations and wish to remain.

Both Butte and Anaconda have launched a systematic search for new industries to increase their economic base, but as of 1983, the Nationwide economic slump is frustrating their efforts. Comparatively smaller operations such as Placer Amex Inc.'s new Golden Sunlight open pit gold mine east of Butte, and Montoro Gold's proposed open pit gold mine between Butte and Anaconda will help with the employment situation, but the area will continue to be dependent on mining.

The Anaconda Company currently has an 18 million dollar per year payroll in Butte and Anaconda in the form of various retirement and benefit plans. This has helped mitigate the economic blow to the community and slowed somewhat the population loss. Loss of the company tax base has been a serious impact to schools and city government although the Anaconda Company has paid an estimated 27 million dollars into a fund to be used for "local development" needs.

Abandonment

The closure of a large mine or processing complex can be a traumatic experience, especially for small mining communities in a sparsely populated areas. It is a shock not only to mine and plant employees, but to industry investors and to local and regional businesses that provided goods and services for the facility.

The loss of several hundred or a thousand highly-paid jobs and the resulting out-migration will affect real estate values, the volume of local business activity, school enrollments, organizational membership, and the economic security and outlook of most of the resident population. It may increase the tax burden or reduce the level of services for those who remain in the community. The timely substitution of other basic industries may be the only satisfactory long-term solution to the problem.

8/ Gardner, Frank, Anaconda Minerals, in speech given at the Northwest Mining Convention, December 1, 1983.

9/ Missoulian, May 19, 1982, p. 9.

Despite the trend toward large mines (which employ a growing portion of the shrinking mine labor force), the great majority of mines are still relatively small operations with a limited workforce and a much shorter life span than large copper or iron mines. The mining operations usually are limited to (1) separating alluvial materials, as in placer deposits, (2) extracting and grinding ores, and occasionally concentrating mineral content, or (3) extracting, separating, and sorting nonmetallic minerals that require little processing before use; e.g., sand, gravel, salt, coal, building stone, or clay.

If a small mine closes, the local effects tend to be moderate because the local economy can survive the loss in revenues and perhaps absorb some of the displaced workers in other jobs. Alternatively, another small-scale operation may be started at another site. Newer technology or an improved market situation can make small operations feasible even when a large installation would be risky because of the long period required to amortize the investment.

Federal and state laws and agency policies now require site reclamation, usually after construction, during production, and following the abandonment of the facility. In Anaconda, Montana, there is an on-going effort to landscape and revegetate the surface of hundreds of acres of accumulated concentrator wastes.

Coal mine reclamation is now required and monitored under the Surface Mining Control and Reclamation Act of 1977. It is an expensive process, costing an average of $4,700 per acre in Montana in 1980, and is now a continuing process in the strip mining cycle (Chapter 2).

Reclamation can be an ongoing process in hardrock mining as well, involving site landscaping and the revegetation of waste dumps and tailings enclosures. But the abandonment of a large complex poses a major reclamation problem. Underground mines or an open pit are subject to flooding and possible leakage. The extensive site facilities should be removed or converted to other uses to avoid later hazards. Item 15 in Appendix B discusses reclamation requirements and techniques.

The following case study of the Bunker Hill mine complex in Idaho dramatically illustrates the scope and severity of the effects of the sudden closure of a mine, smelter, and refinery employing over 2,000 workers.

Case Study: Kellogg, Idaho

The Bunker Hill operation is the largest of three important mining complexes that dominate the economy of the "Silver Valley" in northern Idaho's Shoshone County. Bunker Hill is one of the nation's leading producers of silver, zinc, and lead. Company holdings include the century-old Bunker Hill Mine, a large smelter and refinery in Kellogg, and three other area mines.

Bunker Hill has been mining and concentrating ores for nearly 100 years, employing three generations of miners and metal workers. The main mine at Kellogg is now over a mile deep and consists of 130 miles of adits, drifts, and crosscuts. Current annual production was about 225,000 tons of lead and zinc (21 percent of national output) and 9 million ounces of silver (25 percent of U.S. output). By-products included other metals, phosphoric acid, phosphate fertilizer, and tree seedlings nurtured in abandoned mine tunnels.

<u>Social and economic significance.</u> The majority of residents in Kellogg (pop. 3417) and Smelterville (pop. 776) plus substanital portions of other neighboring communities depend directly or indirectly on the company payroll for their livelihood. Table 4-8 vividly demonstrates this degree of dependence in 1979, a fairly normal production year.

Table 4-8: A comparison of Idaho State and Shoshone County Income Sources, 1979

	Idaho			Shoshone County		
ACTIVITY	Income: $1,000	% of income	persons employed	Income: $1,000	% of income	persons employed
Farm proprietors	included below	6.5	26,725	4.	0.0	43.
Other proprietors		8.8	37,161	4,662	3.1	5.3
Farm, total	540,554	10.1	19,100	111	0.1	5
Agric., forest, fish.	38,478	0.7	4,302	420	0.3	28
Mining	91,922	1.7	4,295	58,911	39.7	2,476
Construction	437,316	8.1	19,158	2,959	2.0	109
Nondurable mfg.	378,838	7.0	26,028	954	0.6	64
Durable mfg.	592,535	11.0	32,240	37,939	25.6	1,648
Trans. & public util.	415,721	7.7	20,260	6,736	4.5	212
Wholesale trade	340,021	6.3	23,119	2,694	1.8	132
Retail trade	573,868	10.7	60,352	9,335	6.3	865
Finance, ins., real est.	261,660	4.9	15,647	3,412	2.3	263
Services	819,307	15.2	62,614	10,323	7.0	965
Federal empl.	308,939	5.7	24,522	4,138	2.8	389
State & local empl.	587,392	10.8	58,424	10,489	7.1	1,098
Total	5,377,551	99.9	433,952	148,421	100.1	8,808

Source: USDC Bureau of Economic Analysis

Bunker Hill is Shoshone County's single largest employer and taxpayer. It directly employed 2,040 people in 1981 and stimulated secondary employment opportunities for an estimated 3,500 people in Idaho and eastern Washington. The 55 million dollar payroll accounted for almost a third of the total wages and salaries paid in the county in 1981. Workers averaged $14.52 per hour in income and fringe benefits, up from $7.04 in 1977.10/ State and local tax revenues from company operations exceeded 10 million dollars. In addition, the company made local purchases of commodities and services valued at $15 million and donated both money and services to various community programs.

The smelter and refinery emitted large quanities of allegedly toxic gas which obscured distant viewing on windless days. Tall smokestakes were constructed to disperse the fumes, but were only partially effective. Gas concentrations were most dense on the inhabited valley floor and in exposed soils. It was feared that prolonged exposure was harmful to humans and animals, so the company installed pollution control devices and instituted a program of lawn planting to reduce the danger of harmful effects. Some observers believe the risk is still present in the vicinity of the smelter.

"Black Tuesday". During 1979 and 1980, the price of silver surged upward, rising from $5.40 to $20.63 per troy ounce. Copper, which is often extracted simultaneously from the same ore, rose from $.66 to $1.02 per pound. Lead and zinc also made substantial gains and Bunker Hill had a 1980 profit of $31.5 million. The strengthened metals market generated a lot of enthusiasm in the mining communities of the Northern Region. The prevailing mood in Kellogg and Wallace, Idaho, is captured in this featured news item:

> Silver is king and mining it has become a brand new game. Jobs are plentiful, and if miners can be found to fill them, an already high employment rate will increase.
>
> . . . Everyone is optimistic. Even if there is a recession this year, we don't think we are going to get hurt. 11/

Just 18 months later, on a day dubbed "Black Tuesday," (August 25, 1981) the imminent closure of the Bunker Hill mine, plant, and smelter was announced. The company expected a loss of $8,000,000 in 1981. These news clippings reflect the changed situation.

> People have been saying that Bunker Hill would never shut down. Well, never has arrived. . . . I'll sell you my house; it was worth $70,000 yesterday and it's worth $40,000 today. 12/

10/ Most information on Bunker Hill was gleaned from a series of articles in The Kellogg Evening News, August 25 to October 12, 1981; The Mining Journal, September 1981; and seven interviews with Silver Valley residents, October 1981.

11/ Missoulian, February 17, 1980.

12/ Kellogg Evening News, August 26, 1981.

The Bunker Hill Company began curtailing its operations in October 1981, and made periodic workforce reductions in the months that followed, with senior workers being retained the longest. The closure closely followed the shutdown of the Anaconda copper smelter and refinery in Montana. Both mining companies attributed their decision to a combination of factors beyond their control, including:

- Depressed markets and/or declining prices for metals they produced.

- Increased labor costs, making it difficult to compete with foreign operations.

- Greater capital outlays for the purchase of pollution control equipment necessary to meet new Federal and State environmental standards.

Other conditions no doubt contributed to the decision to close one or more of these operations, but may be too speculative to include in this analysis.

On the day following the closure announcement, the Idaho Governor and other state officials visited the Silver Valley to meet with mine representatives. At the same time, a joint State and local task force was formed to find a way to keep the mine complex open or to mitigate the effects of its closure. The Governor said a closure would be a severe economic disaster for the State of Idaho. [13/]

The task force immediately began a search for a new buyer. This was urgent because the company planned a rapid shutdown, explaining that it costs almost as much to keep the facility open as to operate it. Once the plant is partially shutdown and supplies of concentrate have been curtailed, reopening becomes both expensive and impractical.

A group of Idaho financiers soon responded with an offer to purchase the Kellogg complex for 65 million dollars if the money could be raised and employees would agree to a reduction in earnings. The local steelworkers union representing 1,400 of the workers accepted the purchase plan and agreed to a 25 percent wage cut, but this move was rejected by the national steelworkers organization, causing the financiers to withdraw from the venture.

The Bunker Hill operation, including the Bunker Hill and Crescent mines, smelter, and an estimated 50,000 acres of company land holdings, changed ownership in the early months of 1982. The new operation, Bunker Limited Partnership, opened the Crescent Mine in the fall of 1983 in anticipation of silver production. The company goal is to produce 1.2 million ounces of silver per year.[14/] In the meantime, the new owners intend to continue maintenance on the Bunker Hill mine and smelter facilities in the hopes that lead and other metal prices will increase sufficiently to allow reopening of these facilities.

13/ Kellogg Evening News, August 28, 1981.

14/ Western Mining Journal, December 1983.

Effects of closure. The closure of the Bunker Hill operation has national implications because the U.S. is not self-sufficient in any of the several metals Bunker Hill produced. In 1981, this country imported a portion of its antimony (51%), cadmium (63%), gold (7%), lead (10%), silver (50%), and zinc (67%). Increased domestic production would boost the U.S. economy, increase public revenues, and make the nation less susceptible to shortages during periods of international strife.

However, the most severe and immediate effects of the late 1981 closure were experienced at the local and, to a lesser extent, the State levels. Closure of the entire Kellogg complex, which potentially employs 2,040 persons, pushed the local unemployment rate to 36 percent, and sharply diminished local consumer spending resulting from a loss of a high proportion of the companies 55 million dollar payroll. It was anticipated that complete closure of the operation would result in loss of 2,500 or more Idaho jobs in other occupations due to the reductions in public revenues and business activity, resulting in a total loss of 80 million dollars in wage and salary income. 15/ The Spokane area will also experience some loss of business and earned income.

Kellogg Evening News articles following the closure reported that local businesses planned to continue operations, noting that the effects of Anaconda's smelter shutdown were not as severe as expected and, in fact, the Bunker Hill shutdown may only be temporary. An estimated 90 percent of those unemployed stayed in the valley, hoping to get their old or better jobs back, if and when the operation resumed. With extensions, unemployment benefits were paid out as long as 70 weeks. Those benefits kept the local economy afloat, paying out at times $1 million dollars a month to former workers. 16/ By late 1983, however, the seriousness of the closure was becoming apparent. A Kellogg Evening News article dated February 22, 1984, provides the following information.

- Unemployment benefits are exhausted for a large number of the county's unemployed. Only 400 of an estimated 1,800 unemployed currently qualify for unemployment benefits.

- Requests for county welfare have gone up 6 fold in the past year, and most of the county's indigent fund 17/ is expected to be exhausted less than half way through the year.

- Shoshone County food stamp recipients have increased 23 percent between August 1983 and January 1984.

15/ Estimated by Idaho State Division of Financial Management, September 1981.

16/ Kellogg Evening News, February 1984.

17/ Idaho State Law says, "The boards of county commissioners shall ... care for and maintain the medically or otherwise indigent." An indigent is defined as any person who is destitute of property and unable to provide for the necessities of life.

- Shoshone County food bank fed 200 families in January 1984 compared to 140 in December and 85 in October 1983.

- Over 2,000 households (a third of all households in the county) are listed as low-income and the number is growing.

- Approximately 1,000 families have applied for Federal energy assistance this year and an estimated 1,000 more are eligible.

- A record number of Shoshone County residents are eligible for state health and welfare programs, or have turned to Veterans medical benefits or VA hospitals, who accept them on a priority basis.

County and city tax revenues have declined sharply. Bunker Hill paid $1,588,000 in property taxes to local governments and Kellogg's share, $253,000, was close to 30 percent of the city's revenue. Some out-migration of residents will Further reduce this tax base and others will be unable to pay them. It is estimated that home property values have decreased by one third in the two years following the Bunker Hill closure.[18/]

There has been a 50 percent reduction in elementary school enrollment attributed to the younger families relocating. High school enrollment has fallen approximately 10 percent since the closure. Families with older children are not moving and most have no plans to do so. A larger percentage of students that remain may have emotional problems relating to increased stress at home.

High unemployment rates have led to a rise in crime in the county. Felonies increased from 57 to 93, and misdemeanors increased from 32 to 98 between 1982 and 1983. Juvenile crimes have approximately doubled during the same period.[19/]

Other effects are more difficult to quantify. Family life, church membership, political life, and voluntary group participation are apt to be affected. Friends and relatives may be separated by out-migration or local job changes. For some individuals the increased stress will become evident in rising levels of drug abuse, divorce and separation, child abuse, or suicide. The extent of these behaviors may be quite limited if persons affected by the closure receive financial help and strong emotional support from friends, relatives, the union, and public agencies. In long-established mining communities (unlike boomtowns), these supports can be very substantial.

As of March 1984, the outcome of the Bunker Hill operation remains unclear. Silver production is anticipated with substantial investment in the Crescent Mine by the new owners. Operations could commence in the Bunker Hill Mine given favorable increases in Bunker Hills basic metals (lead, zinc and silver). The decision to reopen the smelter is more complex and must also consider the availability of outside sources of concentrate to make smelter operations profitable. It must consider environmental requirements, including pending lawsuits over lead emissions, and liabilities for pensions and medical benefits under the

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18/ Kellogg Evening News, March 9, 1984.

19/ The Spokesman Review, March 11, 1984.

previous management. According to the company, the chances of the smelter reopening in the near future are not good (somewhat less than 50 percent). If it does not open this year, the company will likely abandon the smelting operations altogether rather than continue assuming high maintenance and overhead costs of an idle facility.

Unlike the Anaconda Company Operation's, where the announced closure was final, the 1981 Bunker Hill shutdown was viewed by management as a temporary measure, giving hopes that the operations will eventually return to some level of production. The social problems that were generated by the 1981 shutdown continue to burden the social and economic structure of the Silver Valley; it is unlikely the problems will diminish in the near future in the absence of a firm decision from the Bunker Hill Management as to its intentions.

On the positive side, there are a number of other activities and programs planned in Shoshone County that may, in part, compensate for the economic and social hardships caused by the Bunker Hill closure.

- Several other local mining concerns are expanding their operations to the extent of 100 million dollars in new projects.[20/]

- Construction is proposed for 1.2 miles of freeway (I-94) in 1986.

- Construction is proposed or underway for 500 kv and 230 kv energy transmission systems.

These operations may, in time, offset some of the losses and inequities resulting from shutdown of the Bunker Hill and other local operations.

Because humans have the capacity to adjust to a wide variety of situations, the local situation should eventually stabilize through some combination of population outflow, the creation of new industries, and individual redefinition of living standards. Most displaced families will, in time, become integrated into new social settings. In a sense, the social costs of the closure will have been paid, but not in an equitable way.

Mining Community Lifestyles

Mining differs from other occupations in several important respects. It is male-dominated, although the fraction of female employees is slowly increasing. Many mine operations are hazardous,[21/] tedious, and dirty, but the pay is relatively good. Good health, physical strength, and an aptitude for working with machinery are important job qualifications.

20/ Western Mining Journal, December 1983.

21/ This has been the prevailing pattern, but the present trend, motivated in part by Federal and State legislation, is toward less hazardous surface operations and improved lighting, ventilation, and safety precautions in underground facilities.

Major mine and plant facilities usually are owned and operated by large corporations with national or multinational interests. Thus the economic well-being of the local community is subject to decisions made by "outsiders" whose first loyalty ordinarily is to the corporation and its stockholders.

Mining is frequently the major economic activity in Rocky Mountain communities where large mineral deposits are being extracted and processed. These communities are often quite distant from other cities. When 50 to 100 years are required to deplete the deposit, mining becomes an intergenerational occupation. Sons follow the example of their fathers and remain in the same town, occasionally in the same residence. In many cases, a miner, most of his friends, many of his neighbors, and some of his relatives are employed by a single company. All of these factors encourage the development and perpetuation of distinctive community lifestyles.

Mining community lifestyles may be observed in three quite different settings, the one-industry (but otherwise conventional) community, the "boomtown," and the occasional "company town," which was constructed for mine or plant employees, and may still be owned and managed by the mining company. The mining subculture described below exists in all three settings, but is most clearly defined in the stable one-industry mining town and the established company town.

The Mining Subculture

The established mining community may have begun as a boomtown ten or a hundred years ago, but in most cases its population has stabilized or is now declining. Local residents have a wide circle of relatives, friends, and acquaintances, and identify with their town and area. Distinctive community values and norms have emerged.

Recent interviews provide some impressions of tne social life of Rocky Mountain mining communities. Professional people who have lived and worked in a variety of settings observe that social relationships and institutional patterns in established mining and smelting towns often differ from agricultural or commercial centers of similar size.

The physical appearance of the traditional mining community is the most obvious distinction. There are many small, older homes, often narrowly spaced because of the scarcity of level ground. The growing season is short (mines are often at high elevations) and there may be relatively few well-groomed lawns, gardens, and parks. Even some residents who are fond of their community and demonstrate strong loyalty in other contexts fail to support "grass roots" efforts to beautify or modernize the community, according to some observers.

On the edge of the mining town is often the scattered evidence of past and present mining activities: the active and abandoned sites, canals or aqueducts, buildings, equipment, waste dumps, and tailings ponds.

Family interaction often centers outside of the home, with relatives, at the church, and in restaurants, bars, and clubs. Family ties are nevertheless strong and extended family activities such as weddings, parties, or funerals are important and well-attended. Outside activities such as hunting, fishing, and snowmobiling are also popular and a lot of money is spent on four wheel drive vehicles, rifles, snowmobiles, and other equipment.

Mining is dangerous and often strenuous work and forges a close comradeship among miners, which carries over into social activities outside the mine. Strength and proficiency in manual skills are prized and drinking and storytelling are favorite ways to pass time. Some local mine and plant managers are civic-minded and participate in community activities. Social barriers between managers and employees are low in some towns and these groups may interact frequently in nonwork settings such as stores, restaurants, or the local Elk's Club.

Strikes are a fact of life in mining towns and affect most of the population. They sometimes last several months and greatly reduce the otherwise high incomes of mine workers. Often the community is supportive of the strikers. When the strike fund is depleted, county services and credit from merchants are needed to bridge the gap in income. Most miners have rather limited savings. It was reported in one city that if other residents sense that a strike is ill-timed or that the miners' demands are unreasonable (their income usually exceeds most other job holders), community support may be withdrawn. In any case, the county is obligated to provide basic medical, food stamp, dental, heating, and other support services to strikers.

Many businessmen, like miners, are intergenerational. They inherited their businesses, owe no debts, and can weather strikes and recessions better than new enterprises can. Established businessmen are often community leaders and tend to be reasonably satisfied with the existing order, sometimes to the dismay of newcomers who see a need for change and "improvements."

School officials indicate that most of their pupils come from reasonably stable homes and neighborhoods, and present no special problems for their teachers. They show an average range of scores on nationally standardized achievement tests. There are, however, migratory families whose children do not have the advantage of such stability and often have academic or emotional problems.

Some current trends noted by social services personnel in mining towns were:

- increased emphasis on obtaining modern homes and buying rather than renting them. Rising interest rates have slowed this trend;

- a more balanced sex ratio in the town and a deemphasis of all-male social activities; and

- a decline in the number of "rootless" people who stay a few weeks or months and move on.

There is some evidence that mining communities are losing their distinctive qualities and entering the mainstream of American life. Modern transportation, communication (especially television), extended public schooling, and increased family mobility combine to reduce the social and cultural isolation of rural mining towns.

Table 4-9 provides statistical evidence that mining communities do indeed differ in important respects from the U.S. norm.

Table 4-9: Comparing 11 Counties* Dominated by Mining Activity with the Average U.S. County

Item of Comparison	11-County Average	U.S. Average	Percent of U.S. Average
County population, No. of persons	21,400	65,170	33
1960-1970 growth trend (%)	11	13	85
Persons per square mile	30	56	54
Workers employed in mining (%)	40	0.8	5,000
Primary employees in mining (%)	84	2.7	3,111
Secondary employees per primary job	1.17	2.28	51
Education	.20	.26	75
Construction	.12	.20	60
Personal Services	.17	.28	59
Retail Sales	.24	.43	57
Business and Repair Services	.05	.10	49
Transportation, Communication, Utilities	.10	.22	47
Hospitals and Health	.08	.18	47
Public Administration	.07	.18	38
Wholesale Trade	.04	.13	35
Professonal Services	.10	.30	34
Secondary employees per 1,000 population			
Education	27	30	90
Retail Sales	45	60	75
Hospitals and Health	12	21	57
Public Administration	10	21	48
Physicians and Dentists	1.3	3	43
Protective Service Workers	2	5	40
Retail sales per capita, in dollars	1,750	2,200	80
Earnings in 1970, expressed in 1969 dollars			
Male employees	7,800	7,600	103
Female employees	2,900	3,600	81
Per capita	2,500	3,100	81

Item of Comparison	11-County Average	U.S. Average	Percent of U.S. Average
Percent of females 16 & over employed, 1970	27	36	75
Percent of females in primary employment	6	23	26
Median age of the population	26	28	93
Marital status (%)			
Males, over 14, single,divorced,separated	33	36	92
Females, over 14, single, separated, etc.	33	41	80
Persons per employee	3.2	2.7	120
Family size	3.7	3.6	103
Household size	3.3	3.1	106
Living in mobile home (%)			
Urban	7	2	350
Rural	13	7	186
Females per 100 males over 15	101	110	92
Married women per 100 male employees	98	93	105
Teachers per 100 pupils	4.9	5.3	92
5-17 year-olds enrolled in school	91	90	101
Incorporated towns (No. in county)			
Under 2,500	1.9	5.4	35
2,500-10,000	1.1	1.1	100
Over 10,000	0.1	0.6	20

Source: USDOE, Assistant Secretary for Resource Applications. Socioeconomic Impact Assessment: Methodology Applied to Synthetic Fuels, prepared by Murphy/William Consultants, 1978.

*Counties are sites of major coal, natural gas, oil, or metals production facilities, and include Campbell, WY; Mineral, CO; Grant, NM; Lake, CO; Lea, NM; Greenlea, AZ; San Juan, CO; Andrews, TX; Letcher, KY; Logan, WV; and McDowell, WV.

The Boomtown Syndrome

When one or a combination of development activities stimulates a population influx that persistently exceeds local efforts to supply the required facilities and services, a "boomtown" exists. Only a fraction of communities experiencing development become boomtowns, which usually result from a combination of factors; i.e., (1) a sparsely populated area, (2) large-scale, extended development involving a sizeable incoming workforce, and (3) little or no advance planning to accommodate the population influx (see Appendix A, especially items 7, 8, 10, 13, and 25).

Business travelers and tourists can easily recognize a boomtown. It is necessary to book lodgings weeks in advance and the room thus obtained is often noisy, poorly maintained, and expensive. Restaurants and bars are thriving and a number of new businesses in makeshift premises can be seen. There is an unusually large number of mobile homes, some in newly-established, crowded, unpaved parks and others scattered randomly on vacant lots or in the yards of older homes. Many homes lack lawns and shrubbery. Traffic jams occur during rush hours due to the limited number of arterial streets and railroad crossings. Dust and litter tend to exceed normal levels.

There is a growing body of research on social life in energy boomtowns, but rather limited published data on conventional mining communities. It is important to emphasize the distinction between the two. Boomtowns are characterized by unusually rapid population growth, hasty expansion of housing and support services, and relatively weak social and cultural ties. In the true boomtown, the majority of people are recent in-migrants from diverse locations. Their common goal is economic gain, whether this means a job that pays well, a chance to start a business, or a way to get rich quickly--sometimes by devious means.

In the boomtown the population turnover is great because of housing shortages, insufficient community support services, and the absence of strong emotional ties, community pride, and traditions of mutual aid among friends, relatives, and neighbors. Also, the influx of workers may in time exceed the available jobs, thereby increasing the county social services caseload.

Boomtown conditions are stressful for both newcomers and established residents. For newcomers, inadequate housing, limited personal services, the absence of close friends and relatives, the shabbiness of a rapid-growth town, and the often limited recreational opportunities are conducive to discouragement, depression, and increased alcohol and drug use. The lack of both career opportunities for women and day care centers for children means that some women who would otherwise take jobs or do volunteer work are housebound. The large percentage of young male residents results in a lopsided emphasis on male-centered interests and activities, with women often feeling left out or slighted.

Personal stress is an important factor in child and spouse abuse, physical and mental illnesses, and job turnover. With above-average frequency, incoming children experience adjustment problems relating to an unstable family situation, changing schools (especially when it happens during the school year), and limited options for chores and leisure.

Older residents are frequently dismayed by the presence of numerous strangers whose lifestyles, appearance, public behavior, or values diverge from the local norm. The incidence of theft, burglary, and vandalism often increases due to the greater population of young males.[22/] Some older residents suspect even higher rates are occurring and reluctantly take additional security measures such as locking their homes, staying off the streets at night, and refusing to rent rooms or admit strangers who call at their homes.

Local residents are upset by rising rents and the need to pay higher prices for goods and services. They are inconvenienced by delays in utility hook-ups and street repairs, shortages of classrooms and hospital beds, interruptions in water and sewer service, and the other symptoms of rapid growth. The majority have not had income increases commensurate with local price inflation and resent the tax increases levied to expand community services.

Severe boomtown conditions potentially affect both established traditions and cultural institutions. Figure 4-10, based on studies of rapid growth areas, summarizes the nature of these changes.

Community reactions to the boomtown syndrome differ. Those with capable leadership and sufficient resources to cope with growth strive to gain control of the situation. This involves looking ahead to capitalize on local opportunities, anticipating critical situations before they occur, developing strategies for solving problems, and utilizing limited community resources to maximum advantage.

Some communities lack effective leadership, financial resources, or sufficient autonomy to meet the challenges of extended rapid growth, and severe disruptions occur. In the extreme case, residents become demoralized, view the situation as chaotic, and feel powerless to cope with it. Some move away. In time the situation may be stabilized through a series of remedial actions, but the price in human hardship and discomfort is needlessly great. Many existing mining towns such as Butte, Kellogg, and Philipsburg began as boomtowns, but have since stabilized and then declined in population.

The Special Case of the Company Town.

The company town was once a common solution to the problem of housing industrial workers in the remote areas of the West. Hardrock mining, petroleum, lumber, railroad, and coal companies have constructed such towns, often complete with schools, churches, and company operated stores.[23/] In other instances, homes or boarding houses were provided by mining, oil, and agricultural firms and public agencies when their employees had access to existing community facilities. Potlatch (lumber) and Stibnite (metals) in Idaho, and Bonner (lumber) and Colstrip (coal) in Montana provide local examples of company towns.

22/ Nationally, over one-third of all arrests are of persons in the 18 to 24 age bracket (1979). This is a much higher rate than any other bracket except 15 to 17 year olds. See the FBI Uniform Crime Reports for details.

23/ See Allen, James B. The Company Town in the American West. Norman, University of Oklahoma Press, 1966.

Table 4-10: Some Observed Consequences of Rapid, Extended Change for Social Institutions in Boomtown Settings

Individuals and Family Groups	Quality of Neighborhood and Community Life	Schools, Churches, Voluntary Associations	Community, County Government	Social Aspects of the Economic Sector
Shortage of adequate housing; inflation of prices and rentals	With continuing in-migration, greater racial, cultural, and lifestyle diversity	New churches established; greater variety of denominations and sects	Political activity more intense, competitive; wider participation	Decline in production due to absenteeism; employee turnover due to worker out-migration
Local inflation surpasses national average, creates hardship for persons with fixed incomes	Increased support for newer, less conventional social and cultural activities in the community	New challenges to conventional morality and established customs of existing groups	Public services overburdened: police, fire, libraries, hospital, jails, juvenile home, social services, parks, swimming pools	TV cable, telephone, power companies unable to meet hookup demands
Greater incidence of anxiety, mental illness, alcoholism and other drug abuse, and suicide	Improved social and employment opportunities for women and minorities	Organized groups oriented toward conservation and environment or resource development become more prominent	Increased traffic, street damage; inadequate parking; abandoned cars	National chains open branch operations; some small businesses are displaced
Increase in the frequency of divorce, separation, remarriage, and illegitimate births	Decline in the effectiveness of informal community controls and an increase in formal/legal relationships	Crowded schools; demand for more classrooms, buildings, personnel (25-30 percent of all newcomers are school children); more competitive athletic teams and other groups; also more difficult to join	Public utilities insufficient: water, sewer, and power generation facilities	Shortage of responsible professionals and technicians: doctors, lawyers, dentists, TV repairmen, carpenters, mechanics, electricians, plumbers
Improved job opportunities, especially in rural areas	Multiple-family occupancy of some single-family dwellings; other makeshift living arrangements	Social clubs and lodges gain membership; new leadership patterns may emerge	Uncoordinated real estate development	Loss of trained employees to higher-paying jobs
Greater percentage of mothers employed outside of home	Increases in most categories of adult crime and juvenile delinquency; more people lock their homes and cars	Some shifts in relative prestige and influence of different organizations	Revenues for expanding facilities either very inadequate or 2- to 3-year lag behind needs	Rising unemployment: boom gets national publicity and excessive in-migration of jobless
More frequent abuse of spouses and children	Greater competition for and utilization of recreational facilities	Conservation groups increase their activity and prodevelopment factions often respond with public relations programs	Time and money required to plan and channel future development	Retail outlets unable to handle business volume with former courtesy and efficiency; loss of valued employees to energy jobs. Real estate, construction, mobile home, vehicle dealerships, other growth-related businesses thrive
Some young people drop out of school to take well-paid jobs	Realinement of friendships as new issues generate cleavages and new contacts permit alternatives	New voluntary organizations form to deal with selected effects of development	Possible increases in litter, animal control problems	Income redistribution due to higher rents, wages, profits, and land values; some people gain, and others lose
Increase in the percentage of single male adults, at least during initial phases of activity	Increased noise, pollution of air and water; more litter on streets, sidewalks, and highways		Long-range prospect of gains in per-capita revenues	

Most of the 200 known company towns in the U.S. were established around the turn of the century when the West was sparsely populated. Many have since shifted to resident ownership and some have been abandoned. Sometimes the mineral or other resource has been depleted; in other cases the motive for company sponsorship no longer exists. With improved systems of transportation, today's employees often have other options with a greater range of facilities. Yet a few company-administered towns remain in the U.S., chiefly in remote locations, and more exist in rural Canada and abroad.

The feasibility of company towns is currently being reexamined in the anticipation of major new minerals projects, especially coal-fired power and synthetic fuels plants that will bring thousands of additional employees into very rural areas. Colstrip has been recently expanded by Western Energy Corporation and Exxon began construction of a company town called Battlement Mesa to house workers at its now abandoned colony oil shale project in Southern Colorado. The plan called for 7,000 dwelling units plus sites for the usual community facilities. Provision was made for self-government and for individual ownership of some homes and businesses.

Company towns greatly reduce the population impacts of major new projects and provide an incentive for workers to move to remote areas. Necessary facilities can be constructed in advance of the need for them. The well-designed and managed community can provide quality homes, reasonably-priced goods and services, and opportunities for democratic participation in community government. This contributes to workforce stability and can improve the morale of the residents.

Chapter 5: MITIGATING ADVERSE EFFECTS

As broadly defined by Congress and executive direction, the Forest Service is responsible for the management of National Forests and uses. But this agency also has an obligation to identify and consider the social, economic, and environmental effects of its policies, and to involve the public in its planning and decisionmaking processes.

Local communities situated near proposed mineral projects on public lands have limited control over potentially adverse impacts. Sparsely populated counties and towns frequently lack both the financial resources and professional expertise to plan for and manage the complex pattern of social and economic effects generated by a major new facility or a combination of smaller projects.

Local governments and individuals may register their concerns with appropriate agency personnel, but do not have a direct vote in many resource allocation decisions. Hence, it is important that the mineral industry and responsible resource agencies accurately project and monitor the social and environmental effects of such programs so that:

1. The agency budgets and staffing permit effective minerals program administration.
2. The project is designed to avoid adverse impacts whenever possible.
3. Corrective measures can be taken when unwanted situations occur.

Two important functions of social impact analysis are to:

1. Identify potential or existing adverse social and economic impacts.
2. Suggest measures to avoid or mitigate these conditions.

No two project situations are identical and preliminary scoping (FSH 1909.15, Chapter 10), issue identification, alternative formulation and evaluation, program implementation, and subsequent monitoring are best conducted on a case-by-case basis. This chapter presents some guidelines for identifying problems and suggesting solutions.

Authority

Under the National Environmental Policy Act of 1969 (NEPA), each Federal agency, in cooperation with State and local governments and other concerned organizations, is enjoined to foster and promote the general welfare and to "fulfill the social, economic, and other requirements of present and future generations of Americans" (NEPA, Sec. 101(a)). Agencies must use an interdisciplinary approach to insure the integrated use of the natural and social sciences and environmental design arts in planning and decisionmaking which may have an impact on man's environment (Sec. 102 (2)(A)). Planning and decisionmaking must assure "safe, healthful, productive, and esthetically and culturally pleasing surroundings" for all Americans (Sec. 101(b)(2)).

In consultation with the Council on Environmental Quality (CEQ), methods and procedures are developed "which will insure that presently unquantified environmental amenities and values" may be considered in decisionmaking along with economic and technical considerations (Sec. 102(2)(B)).

The National Forest Management Act of 1976 (NFMA) provides that Forest Service planning at all levels will be coordinated with equivalent and related planning efforts of other Federal agencies, State and local governments, Indian tribes (36 CFR 219.8(a)), and intermingled landowners (219.8(g)). The public is to be "encouraged to participate throughout the planning process" (219.7(a)). "Monitoring and evaluation will be conducted that includes consideration of the effects of National Forest management on land, resources, and communities adjacent to or near the National Forest being planned . . . ." (219.8(i)). All public issues and management concerns are to be investigated and evaluated in order of their apparent importance (219.5(b)). In the Regional and Forest planning process, the interdisciplinary team will "estimate and display the physical, biological, economic, and social effects of implementing each alternative . . . ." (219.5(g)).

The Federal Land Policy and Management Act of 1976 (FLPMA) contains similar direction (Sec. 202(b), (c), (f); Sec. 210; and Sec. 309(e).

Identifying Issues and Concerns

Increases in the level of minerals activities or major changes in Forest resource programs tend to heighten public and agency interest in the issues, concerns, and opportunities associated with minerals development and production. In Forest Service usage, "issues" are questions, conflicts, or dilemmas identified by Forest publics. "Concerns" are analogous to issues, but originate within the agency. Because some issues may also be concerns, a rigid distinction between the terms is inappropriate here.

Issues and concerns deal primarily with social, economic, or environmental situations and are often interdisciplinary in scope. Some issues are commonplace, emerging with most major project proposals. Others may be unique to particular situations. The variables, described in chapter 3, taken together, have considerable bearing on the number, type, and intensity of the issues or concerns that are generated by Forest minerals projects or programs.

The following list demonstrates the range of issues that have been identified in various environmental analyses relating to mineral activities in the Northern Region. Each is followed with a brief discussion drawn from public comments and press items.

Issues Often Raised

1. National need for minerals. Some people are disturbed by the level of U.S. imports of raw materials (Table 1-7) and would like to see increased domestic production. Comparisons are made with the Soviet Union, which is said to be almost self-sufficient in minerals. It is alleged that the U.S. does not yet have an effective National policy to encourage nonfuel minerals development and that many competitors have the advantages of cheaper labor and fewer environmental restrictions.

Another view is that U.S. industries freely participate in an expanding and increasingly unregulated international market. U.S. firms compete with other countries in product sales and are able to purchase raw materials at the lowest possible cost. American consumers thus benefit from lower prices for factory goods. The U.S. is still one of the world's most self-sufficient countries in minerals production, and imports mainly raw materials that are not available or would be more expensive to produce in the U.S.

A third perspective derived from state and national surveys (Appendix B) suggests that a majority of Americans perceive a need to balance the nation's demand for raw materials with other land use requirements and a growing concern for the environment. Minerals development is essential but some individual proposals may be too costly.

2. Economic growth and expanded employment. The 1980-1982 slump in the construction and forest products industries has underscored the need for local industries that provide year-round employment. Rural areas are no longer as economically self-sufficient as they once were. Small, diversified farms, the local truck garden, flour mill, laundry, creamery, sawmill, foundry, power plant, and comparable productive activities have been largely displaced. Over 80 percent of the country's commercial goods and services are now produced by regional and national corporations which also employ the majority of workers.

Most families and communities are now very dependent on large-scale business and industry for jobs, houses, food, clothing, factory goods, entertainment, consumer credit, and medical and personal services. For many Americans, a stable, steadily growing economy is our first priority.

3. Unequal distribution of monetary costs and benefits. Some observers perceive gross inequalities in the distribution of benefits and costs of minerals development. Absentee stockholders, corporate managers, and some local landowners and businessmen are made wealthier. Additional local employment usually is created, and local revenues may eventually increase. But these gains are offset by "externalities," costs that people outside of the industry must pay. Additional public utilities, streets, police and fire services, school classrooms, and hospital beds are required. Local inflation increases prices and rents for all. People with fixed incomes often suffer hardships. Noise dust, chemical pollution, inadequate community services, and other unwanted lifestyle impacts may be experienced at some locations.

4. Reducing demand through effective conservation. A large segment of the public believes that Americans consume far more minerals than necessary. We then equate this high demand with need and seek to sustain it. This is a complex perspective, well documented, and one that has considerable public and scientific support.

Almost all other highly industrial countries consume energy and raw materials at about 40 to 60 percent of the U.S. per capita rate. Yet in their standards of health, nutrition, average literacy, life expectancy, cultural opportunities, and in their absence of crime, urban blight, and poverty, these nations equal or exceed the United States. Conservation including recycling appears to offer the largest quantity of "additional" supplies at lowest cost and without adverse environmental consequences. It enables us to reduce imports and assures future generations of a more adequate resource base.

Criticisms of this view are that continuing economic expansion contributes to full employment and a rising living standard, that recycling is sometimes unprofitable, and that minerals are plentiful if access to new sources is permitted and market conditions encourage additional development.

5. Resource agency capability. Mineral activities are expanding on public lands in the West. Some Northern Region residents are wondering if the Forest Service and other responsible public agencies have the quality of resource inventory, the staffing, and sufficient funds to administer leases and other mineral activities. This includes establishing and enforcing reasonable standards for site development and monitoring the effects of ongoing activities.

6. Minerals development as a priority activity. A segment of the public regards mineral development as essential, desirable, and inevitable. Supporters of this viewpoint believe that other resources and uses should give way when conflicts exist because "minerals are where you find them." The mineral resource is usually higher in measurable economic value than other resources in their proximity. Environmental and community impact legislation are perceived as excessive, costly, and antiproductive.

7. The sanctity of existing wildernesses. Wilderness supporters believe that the best remaining primitive and wilderness areas of the West should be preserved. They point out that much of the grandeur of this region has already been diminished by development. The remaining wildernesses and other natural areas should be protected from further threats to wildlife, vegetation, scenic values, and water quality. Mining is perceived as incompatible with other wilderness values. Large, protected areas are important for plant and animal species preservation, scientific study of ecosystems, dispersed recreation, and other purposes.

8. The desire to avoid "boom" and "bust" cycles. Many citizens favor economic growth at a manageable level, but disdain a "boom and bust" sequence. Some wonder why public lands are not opened for mineral activities on a staged basis rather than all at once. This would encourage gradual development over years of time and substantially reduce social, economic, and environmental impacts.

9. Stress associated with uncertainty. One of the most serious public concerns is whether or not a proposed project will actually occur and, if so, when. Operators or resource agencies may withhold information that would help affected communities plan ahead. Local governments are reluctant to commit funds for public facilities expansion if additional revenues may not be forthcoming.

10. The impacts of additional roads. A frequently voiced public concern is that road construction in previously unroaded areas will result in greatly increased use. There will be gradual deterioration of wildlife habitat, water quality, and traditional opportunities for dispersed recreation.

11. Effects on women. Recent studies and articles have discussed the effects of development activities, including mineral fuels, on female residents. Different perspectives are emerging. Some writers perceive difficulties for women in rapid-growth, male-dominant energy boomtowns, but there may also be

expanded economic opportunities for women, especially in secondary occupations such as business management, public agencies, teaching, nursing, sales, and office work. (Appendix B, items 8, 25).

12. Implications for minorities. Rapid change may reduce the stability of ethnic communities and hinder their efforts to preserve their heritage. Past resource development on Indian reservations has seldom produced lasting benefits in the form of increased employment or improved social conditions. Development near reservations tends to increase the intensity of outside influences and pressures for changes in tribal life.

13. Environmental quality. State and Federal laws, Forest Service policy, and the public interest require careful attention to the environmental effects of minerals and other resource programs. Forest Service concerns include:

a. Soil, air, and water. Control erosion, manage solid waste disposal, and meet established air and water quality standards. Insure that the quantities of water required by mining or processing operations do not preclude other uses.

b. Wildlife and fish. Protect threatened and endangered species, big game, fisheries, birds, and fur-bearing animals.

c. Outdoor recreation, scenic, cultural, and wilderness values. So far as possible withdraw critical locations, and elsewhere structure minerals activities to be compatible with these values.

d. Timber and range. Coordinate timber harvest, livestock grazing, and minerals activities to prevent surface-use conflicts and property damage.

Mitigation Opportunities

Agency Activities

Leases, permits, and operating plans can include provisions to protect physical and biological resources, such as water quality, soils on steep terrain, or endangered species.

Comparable procedures have not been developed for controlling social and economic effects in communities affected by Forest Service programs even though NEPA requires that such effects be identified and considered (40 CFR 1502.14, 1502.16, 1508.8, and 1508.20). Forest managers have opportunities to avoid or reduce adverse effects on these people or to increase their benefits. Social and economic impact mitigation for major activities should include:

1. Keeping the public informed of impending developments and providing interested persons with an opportunity to express their concerns and suggestions regarding Forest programs. This is the Inform and Involve responsibility required by NEPA and NFMA.

2. Assessing the social and economic characteristics of the area potentially affected by Forest minerals programs. Project the potential effects of proposed activities, considering also accumulative effects resulting from ongoing or impending operations on adjacent lands.

If development occurs, the resulting data could guide Forest decisionmakers, county land-use planners, commercial and residential development, and the expansion of schools, hospitals, and utilities. Periodic reassessments following significant changes would keep the scenario current and take into account any unforeseen trends.

3. Cooperating with other resource agencies, the mineral industry, State and local governments, and the owners of mineral rights in identifying and helping mitigate the adverse effects of minerals programs. A joint steering committee supported by its component organizations can provide leadership and direction for this effort. The States of Utah and Colorado have programs to facilitate such cooperation (Appendix B, 33).

4. Planning and coordination of petroleum and other development programs to avoid severe impact situations. This might involve:

a. Scheduling development activities to avoid the simultaneous occurrence of labor-intensive phases.

b. Allocating sufficient budget and manpower to administer the minerals program. Assigned personnel require a knowledge of the social, legal, technological, and environmental aspects of this activity.

c. Coordinating specific activities to avoid major use conflicts, e.g., hunting and seismic exploration.

d. Consulting with other resource agencies involved to assure an orderly, uniform administrative process.

e. Encouraging local hiring when appropriate skills are available in communities within commuting distance. This sharply reduces impacts on housing, public services, and area lifestyles.

Industry Options

A responsible operator can reduce adverse effects of minerals activities and earn the support and appreciation of the public and cooperating public agencies. Achieving this goal takes time and entails a commitment of the operator and his contractors, an awareness of local community and agency concerns, flexibility for local supervisors who wish to adapt programs to the needs of individual communities or areas, and responsibly conducted field operations. The company's commitment may include voluntary compliance with legal and moral requirements to protect other resources and personal property, open communication with people who are affected by company programs, technical or economic assistance to heavily impacted communities, neat appearing equipment and facilities, an emphasis on local hiring of qualified workers, and a willingness to train apt local people for semi-skilled positions.

Some firms (Chapter 4) strive to meet these obligations in the belief that it is both good public relations and reasonably cost-efficient in the long run (for example, local workers are already housed, there are classrooms for their children, and some employers find that local-hire workers are more productive than nonlocals). There is less duplication of effort, fewer lawsuits result, agencies cooperate more enthusiastically, and there is little community animosity toward the company and its local employees. At the other extreme are the "corner-cutting" operators with careless or poorly-trained employees and irresponsible field practices. Local residents who have suffered property damage or dishonest deals from such firms may form a negative attitude about the entire industry.

Community Approaches

Communities vary in their mode of organization, in their degree of integration, and in the quality of their social relationships. Each social milieu tempers the effects of growth and change, and any specific development project could be expected to affect each community somewhat differently. Some factors which enable communities to cope with development and reduce its adverse effects are:

1. An established procedure for managing development; e.g., zoning policies, systematic planning, provision for coordinated expansion of housing, streets, utilities, and services.

2. Local government efforts to monitor the situation, enforce existing policies and ordinances, and respond promptly to emerging needs. This implies a knowledge of community needs, feasible options, and available State, Federal, and private assistance. Generally, smaller towns and counties that lack a staff of experienced specialists will have the most difficulty dealing with economic growth and associated social change.

3. Pride in community which motivates residents to strive to maintain quality of life standards in the face of rapid growth. This would include "grassroots" efforts to keep neighborhoods livable, to curb delinquency, etc.

4. The presence of voluntary organizations (clubs, lodges, church, or civic groups) that aid and complement local government by providing leadership and resources for identifying and mitigating problems.

5. A community social system that is open enough to accept responsible newcomers. The alternative is to alienate them, encouraging a retreat to their occupational subculture. The community thus loses some opportunities to influence newcomer behavior and to profit from their active participation in community life. This accentuates the newcomer-oldtimer cleavage and may lead to increases in the frequency of illegal or discourteous behavior directed toward the opposite faction during field operations and in other contexts.

Section 12 of source 5 in Appendix B provides many additional approaches to both project monitoring and effects mitigation in energy development.

Conclusion

This document introduces minerals, minerals technology, the role of minerals in modern life, and various social and economic aspects of minerals development. It demonstrates that agency minerals programs may have important effects on social life as well as the natural environment.

A central theme of this analysis is that mineral development has a potential for both social costs and benefits, especially in the vicinity of mines and processing facilities. The most dramatic effects occur in rural areas where residents are unaccustomed to industrial activities and ill-prepared to accommodate a large influx of newcomers.

Individual minerals projects vary, sometimes widely, in the type and intensity of effects they produce, and in the kind of public response they receive. A truly successful operation requires socially responsive planning, effective agency supervision, and open communication among individuals and groups with a stake in the project. In this way, many of the adverse impacts associated with traditional approaches to mining and processing can be avoided or reduced in severity.

Table A-1: Federal Laws Permitting and Encouraging Mineral Entry on Public Lands [1/]

Act of July 26, 1866 (14 Stat. 251)	Declared all public lands open to exploration and development. Established a procedure for miners to obtain legal title to claims. Act of July 9, 1870, (16 Stat. 217) added placer locations.
General Mining Law of 1872 (17 Stat. 91)	Declares all U.S. mineral deposits to be open to exploration and purchase. Claims can be kept active by $100 worth of work each year. Supersedes part of above laws..
Mineral Leasing Act of 1920 (41 Stat. 437)	Establishes competitive and noncompetitive leasing programs for coal, oil, oil shale, gas, and sodium. Amended by 1927 Act (44 Stat. 1507), which authorizes adding chlorides, sulphates, carbonates, borates, silicates, or nitrates of potash.
Act of June 30, 1939 (53 Stat. 811)	The President is authorized to stockpile strategic and critical minerals; USDI is permitted to investigate and develop new sources of these materials.
Materials Act of 1947 (61 Stat. 681)	Authorizes disposing of sand, gravel, stone, and clay through a contract of sale. Competitive bidding is required for quantities valued above $1,000.
Act of July 23, 1955 (69 Stat. 367)	Defines common varieties of sand, gravel, cinders, pumice, pumicite, and clay as salable minerals governed by the Materials Act of 1947. Authorizes multiple surface uses on mining claims.
Act of August 21, 1958	USDI is authorized to develop a program to encourage private exploration for mineral reserves.
Geothermal Steam Act of 1970 (84 Stat. 1566)	Authorizes leasing of geothermal resources and by-products through competitive and noncompetitive leasing. The Act of September 3, 1974 (88 Stat. 1079) encourages its development.
U.S. Mining and Mineral Policy Act of 1970 (84 Stat. 1876)	Reaffirms Federal support of the domestic mining industry, minerals development, reclamation, and recycling of scrap metal.
Energy Security Act of June 1980 (96 Stat. 294)	Section 262 directs the Secretary of Agriculture to process applications for NF leases and permits to explore, drill, and develop resources, notwithstanding the current status of land management plans under section 6 of NFMA.
National Materials and Minerals Policy, Research, and Development Act of October 1980	Implements the 1970 Mining and Mineral Policy Act above. Directs the President to identify critical minerals needs; assess U.S. mineral resources; coordinate research, evaluation, and development efforts with private industry; and encourage stable, sound minerals enterprises.

[1/] For a detailed discussion of mining law see: Maley, Terry. Handbook of Mineral Law, 2nd Ed. Boise, Idaho: MMRC Publications, 1979.

Table A-2: Federal Laws to Protect Natural and Human Resources

The Clean Air Act of 1963, as amended (42 USC 7401)	Directs the Environmental Protection Agency to fix air quality standards and authorizes individual states to enforce them.
Wilderness Act of 1964 (78 Stat. 890)	Establishes a National Wilderness Preservation System to consist of Congressionally designated "wilderness areas," to insure that future generations will have access to places where "the earth and community of life are untrammeled by man, where man is himself a visitor and does not remain." The Act also permits mineral activity and development on claims in wilderness with valid existing rights.
National Historic Preservation Act of 1966 (80 Stat. 115)	Created the Council on Historic Preservation to review Federal activities affecting cultural and historic properties. It also authorized the development of a National Register of Historic Places, a listing of districts, sites, structures, and objects of significance, to identify cultural resources that should be protected and preserved.
Wild and Scenic Rivers Act of 1968 (82 Stat. 906)	Provides for preserving selected free-flowing rivers with "outstanding remarkable scenic, recreation, geologic, fish and wildlife, historic, cultural, or other similar values."
National Environmental Policy Act of 1969 (NEPA) (83 Stat. 852)	Establishes a National policy "to promote efforts which will prevent or eliminate damage to the environment and biosphere, and stimulate the health and welfare of man." The Act aims to achieve a balance between population and multiple resource use without environmental degradation, risks to health, or loss of "important historic, cultural, or natural aspects of our heritage." Creates a Council of Environmental Quality (CEQ) to implement NEPA.
National Environmental Quality Improvement Act of 1970 (84 Stat. 114)	Emphasizes the importance of environmental quality and places responsiblity for its protection; establishes the Office of Environmental Quality under CEQ.
Federal Water Pollution Control Act, as amended, 1972 (86 Stat. 816)	Requires the Environmental Protection Agency to set and enforce water quality standards. Provision is made for state-administered programs.
Endangered Species Act of 1973 (87 Stat. 205)	Each Federal agency must insure that any activity it authorizes, funds, or implements does not jeopardize the continued existence of endangered and threatened species, or result in the destruction or modification of their habitat. Amended in 1978 to provide a procedure for exempting specific projects.
Solid Waste Disposal Act of 1976 (90 Stat. 2795)	Establishes controls on waste dumping practices and the transportation of hazardous wastes, and standards for dump sites. Makes provision for approved state programs in lieu of the Federal guidelines.
Surface Mining Control and Reclamation Act of 1977 (91 Stat. 445)	Established the Office of Surface Mining, Reclamation, and Enforcement (OSM); requires reclamation of all surface-mined lands.

Table A-3: Montana Severance Taxes

Coal Severance Tax

Heating Quality (BTU/pound)	Surface Mining	Underground Mining
Under 7,000	$0.12 or 20% of value	$0.05 or 3% of value
7,000-8,000	$0.22 or 30% of value	$0.08 or 4% of value
8,000-9,000	$0.34 or 30% of value	$0.10 or 4% of value
Over 9,000	$0.40 or 30% of value	$0.12 or 4% of value

Oil and Gas Severence Tax

Oil
5% of gross value:

Gas
2.65% of gross value

Resource Indemnity Trust Tax (All Minerals)
$25 plus 0.5% of gross value of product if in excess of $5,000

Metalliferous Mines License Tax (Metallic Minerals)

Gross Value:

First $100,000	0.15 of 1% of gross value
$100,000 to $200,000	0.575 of 1% of gross value
$250,000 to $400,000	0.86 of 1% of gross value
$400,000 to $500,000	1.15%
Over $500,000	1.438%

Micaceous Minerals License Tax

Vermiculite, perlite, kernite, maconite, or other micaceous minerals	$0.05/ton

Cement License Tax

Cement	$0.22/ton
Cement, plaster, gypsum, or gypsum products	$0.05/ton

Table A-5: South Dakota Severance Taxes

Energy Minerals
Coal, oil, natural gas, uranium, and thorium

4.5% of gross value of sales price

Other Minerals
Gold, silver, other precious metals, limestone, soda, trona, bentonite, iron ore,

4% of net profits

Source:
Adapted from: Colorado Research Institute, Golden, Colorado. Report: Mineral Severance Taxes in the Western States, A Comparison, by Sandra L. Blackstone, 1979

Table A-4: Comparison of Severance Taxes on Surface-Mined Coal

	8,000 BTU/lb. $6.50/ton*	8,500 BTU/lb. $8.00/ton*	10,500 BTU/lb. $16.50/ton*	11,500 BTU/lb. $19.50/ton*
Colorado ($0.63/ton)				
dollars/ton	0.63	0.63	0.63	0.63
dollars/million BTU	0.04	0.04	0.03	0.03
percent of value	9.7%(4)**	7.9%(4)**	3.8%(5)**	3.2%(5)**
Montana (30% of value)				
dollars/ton	1.95	2.40	4.95	5.85
dollars/million BTU	0.12	0.14	0.24	0.25
percent of value	30%(1)	30%(1)	30%(1)	30%(1)
New Mexico (43.5¢/ton plus 0.75% of value)				
dollars/ton	0.48	0.50	0.56	0.58
dollars/million BTU	0.03	0.03	0.03	0.03
percent of value	7.4%(5)	6.2%(5)	3.4%(6)	3.0%(6)
North Dakota (83¢/ton)				
dollars/ton	0.83	0.83	0.83	0.83
dollars/million BTU	0.05	0.05	0.04	0.04
percent of value	12.8%(2)	10.4%(3)	5.0%(3)	4.3%(4)
South Dakota (4.5% of value)				
dollars/ton	0.29	0.36	0.74	0.88
dollars/million BTU	0.02	0.02	0.04	0.04
percent of value	4.5%(6)	4.5%(6)	4.5%(4)	4.5%(3)
Utah (none)	—	—	—	—
Wyoming (10.5% of value)				
dollars/ton	0.68	0.84	1.73	2.05
dollars/million BTU	0.04	0.05	0.08	0.09
percent of value	10.5%(3)	10.5%(2)	10.5%(2)	10.5%(2)

*F.O.B. Mine
**Number in parentheses represents rank among the six states for each class of coal.

Figure A-1: Total Use of New Nonfuel Mineral Supplies in 1977

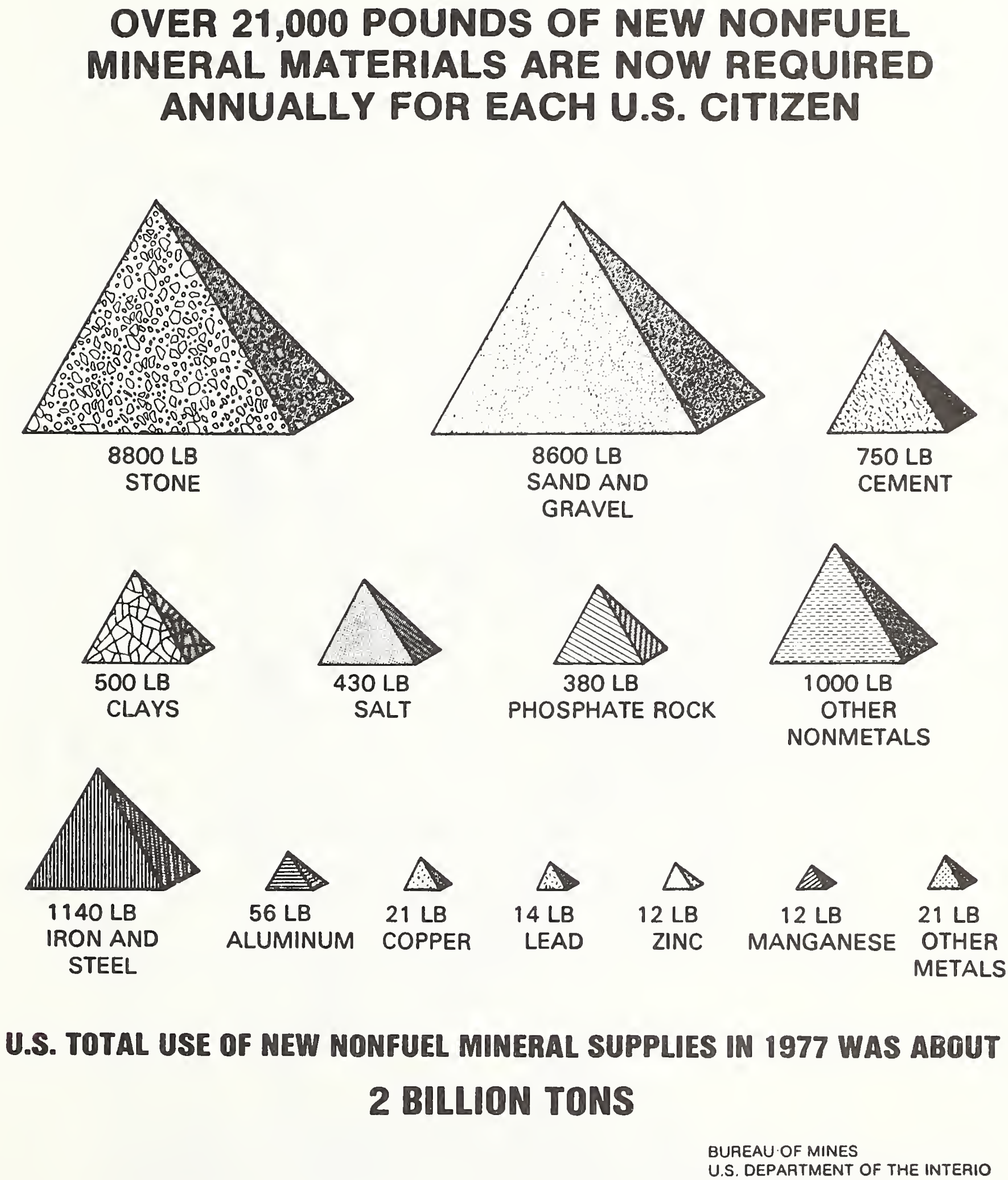

Figure A-2: Mineral Resource Map

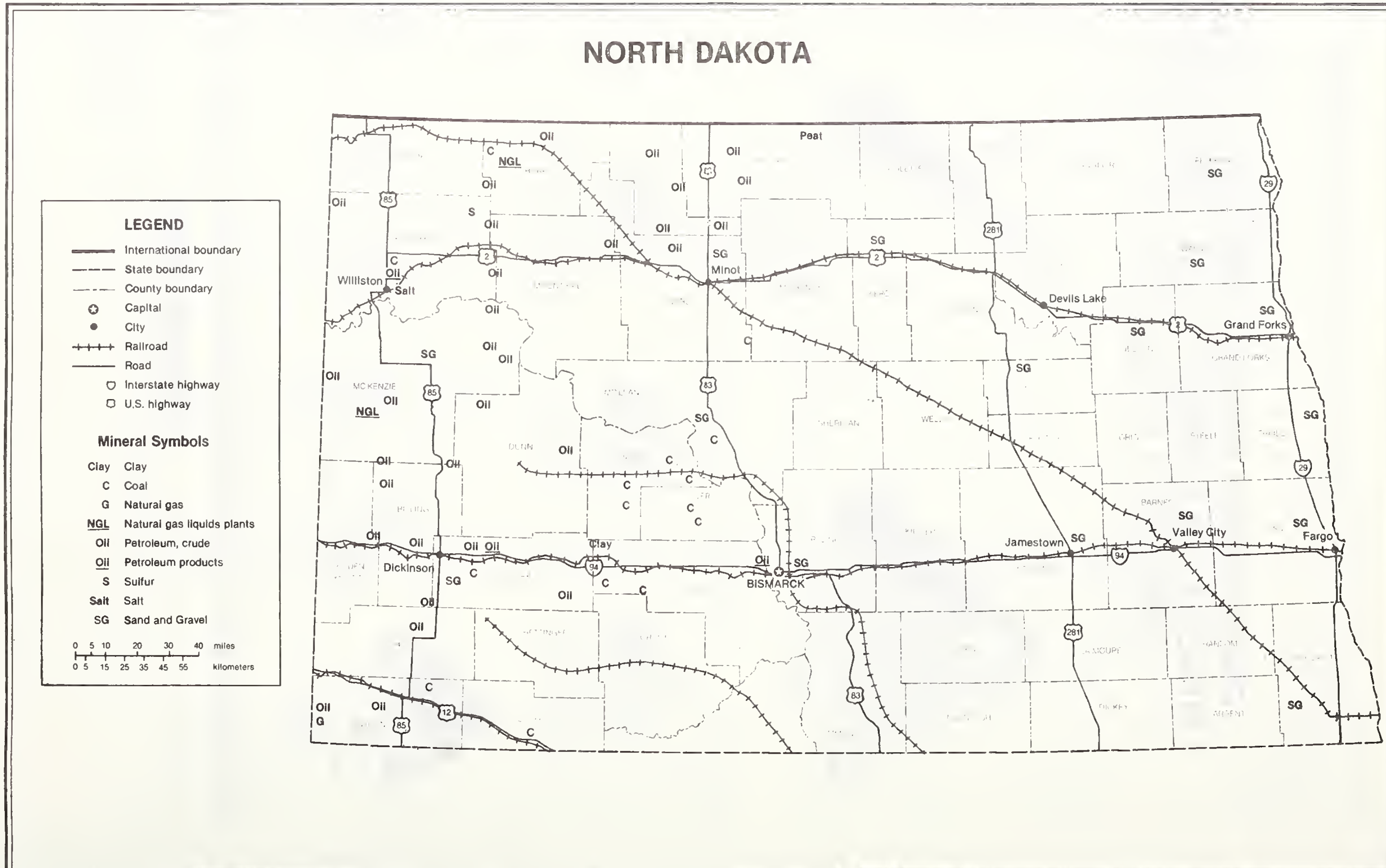

Figure A-3: Mineral Resource Map

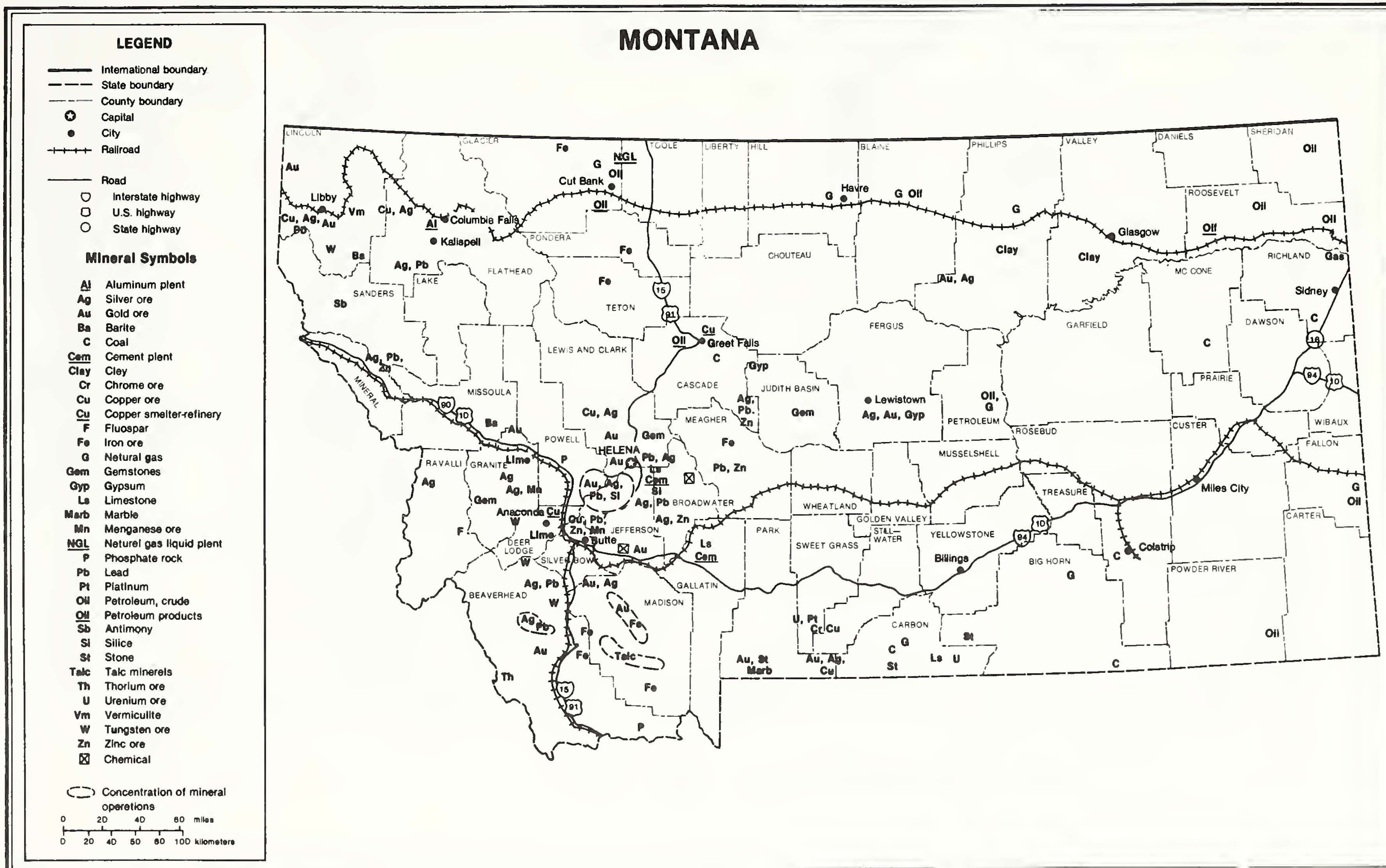

Figure A-4: Mineral Resource Map

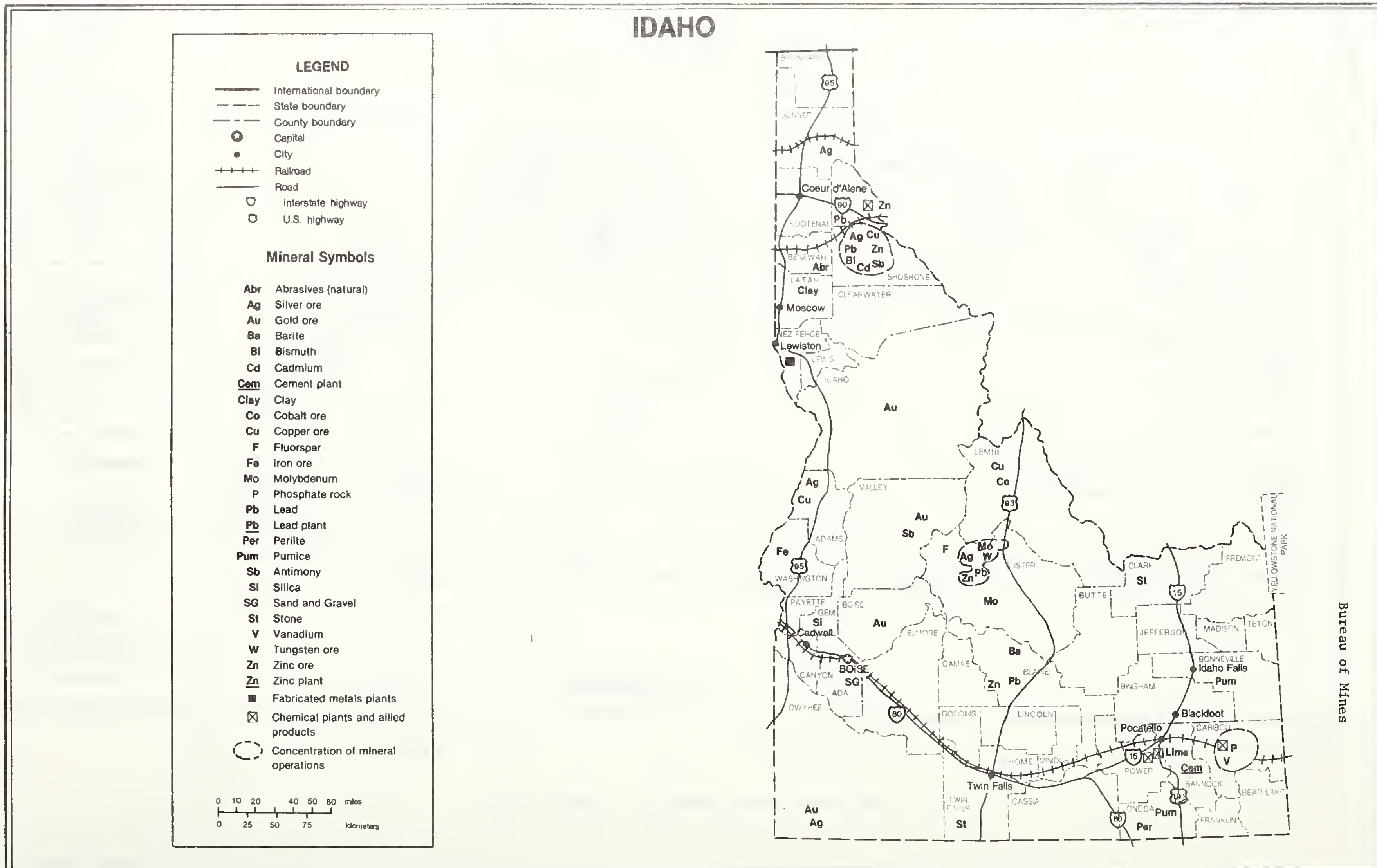

Figure A-5: Mineral Resource Map

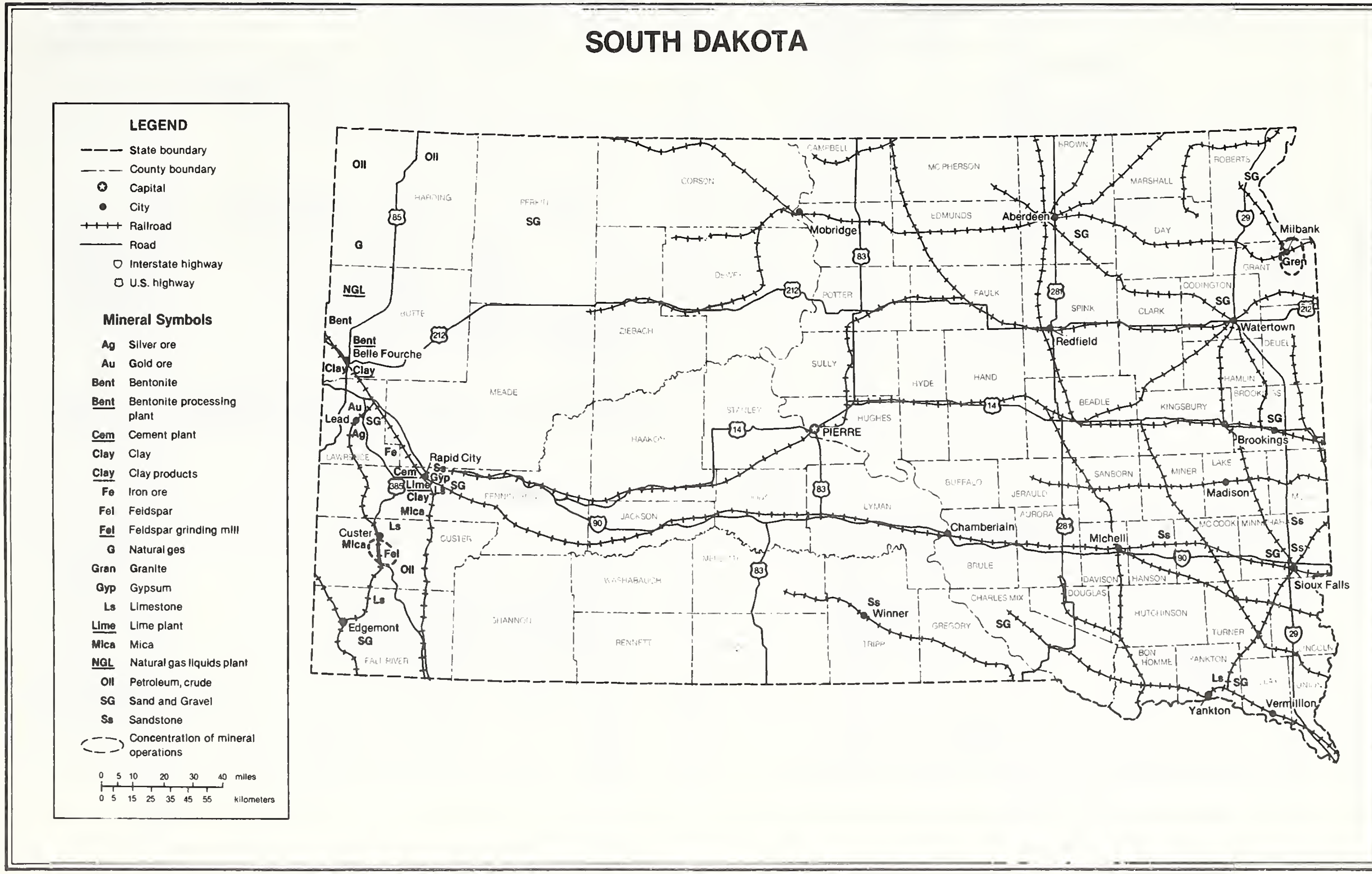

Table A-6: Comparison of Severance Taxes on Coal

State Severance Tax Rates	
Colorado	2.25% of gross income over $11 million, up to 50% credit for property taxes
New Mexico	$1.99 per pound U_3O_8 valued @ $40/lb, plus 0.75% of gross value
Utah	1% of gross value over $50,000
Wyoming	5.5% of gross value

Table A-7: Severance Taxes for Hypothetical Uranium Mine/Mill

	Amount	Dollars/lb.	Percent of Gross Income
Colorado	$ 112,500	$0.15	0.4%
New Mexico	1,717,500	1.99	5.7%
Utah	209,500	0.28	0.7%
Wyoming	515,625	0.69	1.7%

*Producing 750,000 lb. of U_3O_8 per year at $40/lb.

Table A-8: Comparison of Severence Taxes on Molybdenum

Severance Tax Rates	
Colorado	$0.15/ton ore
Montana	1.938% of gross value*
New Mexico	0.1875% of gross value*
Utah	1% of gross value* over $50,000

*See text for differences in definitions of gross value.

Table A-9: Severance Taxes for Hypothetical Molybdenum Mine

	Tax as percent of market value*	Rank
Colorado	0.73%	2
Montana	1.938%	1
New Mexico	0.1875%	4
Utah	0.5%	3

*Comparison based on market value of $5.50/pound for molybdenum, processing deductions assumed to be 50% of market value.

Table A-10: Comparison of Severance Taxes on Oil and Gas

Colorado*	5% of gross value less 87.5% of property taxes paid
Montana	Oil: 5% of gross value; Gas: 2.65%
New Mexico	Oil: $0.515***/barrel plus 2.55% of value Gas: $0.057/million cubic feet**
North Dakota	11½ % of gross value***
South Dakota	4.5% of gross value
Utah	2% of gross value
Wyoming	4% of gross value

*Maximum rates
**Resource Indemnity Trust Tax

***In lieu of state and local property taxes

<u>Note to the reader:</u> Tables A-3 to A-10 summarize tax data for 1979, except that A-10 has been updated to 1981 for Montana and North Dakota. Consult appropriate state agencies for current rates.

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Appendix C:

MINING IN NATIONAL FORESTS*
Protection of Surface Resources

Mineral Resources of the National Forest System

The 188-million-acre National Forest System is an important part of the Nation's natural resource base. As directed by the Organic Administration Act of 1897 and the Multiple Use-Sustained Yield Act of 1960, the National Forests are managed by the United States Department of Agriculture's Forest Service for continuous production of their renewable resources--timber, clean water, wildlife habitat, forage for livestock and outdoor recreation.

Although not renewable, minerals are also important resources of the National Forests. In fact, they are vital to the Nation's welfare. By accident of geography and geology, the National Forests contain much of the country's remaining stores of minerals--prime examples being the National Forests of the Rocky Mountains, the Basin and Range Province, the Cascade-Sierra Nevada Ranges, the Alaska Coast Range, and the States of Missouri, Minnesota, and Wisconsin. Less known but apparently good mineral potential exists in the southern and eastern National Forests.

Geologically, the National Forest System lands contain some of the most favorable host rocks for mineral deposits. Approximately 6.5 million acres are known to be underlain by coal. Approximately 45 million acres or one-quarter of the National Forest System lands have potential for oil and gas, while 300,000 acres have oil shale potential.** Another 300,000 acres have known phosphate potential. A large proportion of the most promising areas for geothermal development occur in the National Forests of the Pacific Coast and Great Basin States.

Within the past few years, the energy shortage in this country has reminded us that the Nation's mineral resources are limited. As with oil supplies, there will undoubtedly be a considerable tightening of world supplies of many minerals. Such a trend is leading to considerable expansion of domestic mineral prospecting, exploration and development. Much of this increased activity is on the National Forests, where about 85 percent of the land is open to mineral exploration and development.

Forest Service Role in Minerals Management

In the Mining and Minerals Policy Act of 1970, Congress declared that it is the continuing policy of the Federal Government, in the national interest, to foster and encourage private enterprise in (among other goals) the development of domestic mineral resources and the reclamation of mined land. This Federal policy obviously applies to National Forest System lands. The National Materials and Minerals Policy Act of 1980 reinforces these provisions (see Appendix A, table A-1).

*Reprinted from USDA Forest Service Current Information Report 14.
**Recent exploration results suggest these estimates may be conservative.

The Forest Service recognizes the importance of National Forest System mineral resources to the well-being of the Nation and encourages bona fide mineral exploration and development. But it also recognizes its responsibilities to protect the surface resources of the lands under its care. Thus, the Forest Service is faced with a double task: to make minerals from National Forest lands available to the national economy and, at the same time, to minimize the adverse impacts of mining activities on other resources.

Land management planning, as mandated by the National Forest Management Act of 1976, is a principal tool for assuring that mineral resources are given proper consideration. Before plans are developed, specialists evaluate, among other resource activities, existing and potential mineral development. Planners and decisionmakers then formulate plans to minimize potential conflicts and maximize the various uses and values of the lands. Since minerals are usually hidden, relatively rare, and governed by certain preferential laws, the land management planning procedures provide for flexibility and availability of minerals activities where possible.

Minerals management on National Forest System lands requires interagency coordination and cooperation. Although the Forest Service is responsible for the management of the surface resources, the Bureau of Land Management (BLM) and the Geological Survey (USGS)--both in the Department of the Interior--are primarily responsible for management of Government-owned minerals. Since it is impossible to divorce mineral operations from surface management, the agencies have developed cooperative procedures to accommodate their respective responsibilities.

Authority for Mineral Activities

Mining and related activities on National Forest System lands are governed by specific laws that identify procedures and conditions under which prospecting, exploration, and development of minerals can be carried out.

THE GENERAL MINING LAW OF 1872. The Mining Law of 1872, as amended, governs the prospecting for and appropriation of metallic and most nonmetallic minerals on the 140 million acres of National Forest* set up by proclamation from the public domain. Under the 1872 law, and its principal amendment of July 23, 1955, qualified prospectors may search for mineral deposits on these "public domain" lands. A prospector, upon discovering a valuable mineral deposit, may locate a mining claim. Recording that claim in the local courthouse and with the appropriate BLM State Office affords protection from subsequent locators. A mining claimant is entitled to reasonable access to the claim for further prospecting, mining or necessary related activities, subject to other laws and applicable regulations.

*Reference is to Federally-owned minerals of public domain National Forests.

After meeting rather rigorous specific requirements of the law, including a confirmation of the discovery of a valuable mineral deposit, a claimant may obtain legal title (patent) to the surface and mineral rights on the claim. A patent application must be filed with the appropriate State Office of the BLM. On National Forest lands, the Forest Service will conduct a mineral examination to determine if a valuable deposit has been found and, accordingly, recommend whether or not a patent should be granted. The Department of the Interior will consider the Forest Service's mineral report, plus information provided by the claimant, and determine whether a patent should be issued. If a patent is granted, legal title is conveyed, and thereafter the Forest Service has no authority over the lands conveyed.

MINERAL LEASING. Some minerals in National Forest System lands are disposable only by leases issued by the BLM. Operations under such leases are administered by the Geological Survey. These agencies cooperate with the Forest Service to assure that surface resources and other management concerns are coordinated with mineral activities.

The Mineral Leasing Act of February 25, 1920, as amended and supplemented, is commonly known as the "1920 Leasing Act." It applies to both the public domain and to National Forest lands reserved from the public domain. Mineral deposits subject to this act include coal, oil, gas, oil shale, other bitumens, potassium, sodium, phosphate, and--in Louisiana and New Mexico--sulphur. Applications for prospecting permits and leases under this act that involve National Forest System lands are referred by the BLM to the Forest Service for its recommendations and prescription of reasonable measures to be taken to protect the surface resources and reclaim disturbed lands. The Forest Service analyzes the possible environmental impacts that might be caused by mineral development. If significant environmental impacts are indicated, the Forest Service and the BLM may cooperate in preparing an environmental statement as required by the National Environmental Policy Act.

The Federal Coal Leasing Amendments Act of 1975 made a number of changes in leasing procedures for Federal coal. The act gives the Forest Service full consent authority for coal leasing in National Forest System lands.

The Mineral Leasing Act for Acquired Lands of August 7, 1947, makes "leasable" minerals on acquired National Forest System lands subject to provisions of the 1920 Leasing Act. Most of these acquired lands are in the East. Mineral leases for acquired lands may only be issued with the consent of the Secretary of Agriculture and subject to such terms and conditions as he may require to insure the adequate utilization of the lands for the purposes for which they were acquired. The Secretary of Agriculture has delegated his authority to the Chief of the Forest Service.

The President's Reorganization Plan of 1946 authorizes the Secretary of the Interior to lease the so-called "hardrock" minerals in acquired National Forest System lands. The Act of June 30, 1950, provides authority to issue leases in certain public lands in Minnesota. The minerals are the metallic and nonmetallic minerals that, in public domain lands, are locatable under the 1872 Mining Law. "Hardrock" mineral leasing is subject to the consent of the Secretary of Agriculture, through the Forest Service.

The Geothermal Steam Act of 1970 provides for leasing lands by the Department of the Interior for geothermal development, subject to the consent of the Forest Service on National Forest System lands.

COMMON VARIETIES OF MINERAL MATERIALS. The Forest Service has the authority to dispose of common varieties of mineral materials from lands under its jurisdiction and to specify the terms and conditions of operations. Common varieties include sand, stone, gravel, pumice, and other such materials without a unique property. A Forest Service permit is required prior to any exploration activity for these minerals. If a suitable deposit is located, the Forest Service weighs the relative values of the surface and mineral resources and determines if the site should be operated. The Forest Service sets the terms and conditions of operation, appraises the value of the resource, and enters into sale contracts. Most disposals are by free use permits to Federal, State, and local units of government for use in constructing and maintaining roads.

Regulations for Operating Under the 1872 Mining Law

From the time the National Forest System was established until the mid-1960's there was little public controversy about mining activities in the National Forests. As a heightened public awareness of environmental matters developed, concern began to be expressed that mineral operations were damaging the National Forests. In particular, the unrestricted operations permitted under the 1872 Mining Law caused widespread concern because of adverse impacts on other resources and on the environment.

Although the majority of miners and prospectors took steps to insure that surface resources were damaged as little as possible, there were numerous instances where careless and thoughtless prospecting and mining activities resulted in unnecessary road building; erosion and muddy streams because of inadequate surface drainage controls; careless disposal of garbage; abandoned equipment; scattered and poorly located piles of waste rock and mill tailings; and dangerous shafts and portals left uncovered, unfenced, and unmarked on National Forest System lands.

While public concern increased because of the adverse effects of unregulated mining and prospecting in the National Forests, looming prospects of mineral shortages promised increased prospecting and mining activities. Congress, in 1969, passed the National Environmental Policy Act "to promote efforts which will prevent or eliminate damage to the environment" and further ordered that "to the fullest extent possible the...public laws of the United States shall be interpreted and administered in accordance with the policies set forth in the Act."

In line with this direction from Congress and the long identified need for surface resource protection, the Department of Agriculture began to reexamine existing laws. It determined that the Organic Administration Act of 1897 provided sufficient authority to bring about some positive regulation of mineral activities taking place on National Forest System lands under the 1872 Mining Law. The Organic Act provides that persons entering the National Forests for purposes of prospecting, locating, and developing mineral resources under the 1872 Mining Law must comply with the rules and regulations covering the National Forests.

Accordingly, in December 1973, the Secretary of Agriculture published in the Federal Register proposed regulations to protect the surface resources of the National Forests during mining and prospecting operations and rehabilitation of land afterwards. The proposed regulations were open to public comment and were revised in accordance with the many responsible comments received. The final regulations were published in the Federal Register August 28, and became effective September 1, 1974.

HIGHLIGHTS OF REGULATIONS. The regulations apply to the 140 million acres of National Forest System lands subject to location and entry under the Mining Law of 1872; that is, to the prospecting for and mining of metallic and nonmetallic minerals subject to those laws. They have no effect on the development of fossil fuels and other minerals subject to and already regulated under the mineral leasing laws or the laws governing the disposal of the "common variety" minerals.

The regulations provide the Forest Service and the mining community with the means of meeting their mutual environmental responsibilities to protect the surface resources of National Forest System lands. Among the main points covered by the regulations are the following:

* Anyone proposing prospecting or mining operations under the 1872 mining laws in the National Forest System that might cause disturbance of surface resources must give the local Forest Service office a "notice of intention to operate." If the authorized forest officer determines that such operations will cause a significant disturbance to the environment, the operator must submit a proposed plan of operations. Of course, if an operator knows the proposed operation will cause significant surface disturbance, a proposed plan should be submitted immediately. District Rangers can be helpful in preparing such plans, if necessary. The plan must describe such things as the type of operation proposed and how it will be conducted; proposed roads or access routes and means of transporation; and the time period during which the proposed activities will take place.

* All operations under the Mining Law of 1872 must be conducted, insofar as feasible, to minimize adverse environmental impacts on the National Forests, and take into consideration requirements for meeting Federal, State, and local air and water quality standards and solid waste disposal; harmony with scenic values; protection of fish and wildlife habitats; and minimization of road construction damage.

* The plan of operations must also show what steps the operator will take for feasible rehabilitation of the area when the prospecting or mining is completed.

* Upon filing the plan of operations, the operator may be required to furnish a bond commensurate with the expected cost of rehabilitating the area.

* The plan of operations must be approved by the authorized forest officer before any operations are conducted.

In analyzing each plan for approval, the forest officer will consider the economics of the operation along with other factors in determining the reasonableness of the requirements for surface resource protection. The Forest Service will assess the environmental impacts of the proposed operation and prepare any environmental impact statements that might be required under the National Environmental Policy Act.

Any operator who disagrees with the decision of the authorized forest officer in connection with administration of the regulations may appeal that decision, up to the Regional Forester level. The decision of the Regional Forester is the final administrative decision. Aggrieved parties are thus provided quick access to the courts to seek redress.

APPLICATION TO WILDERNESS. The regulations apply also to mineral-related activities in wilderness and primitive areas. The Act that created the National Wilderness Preservation System in 1964 specified that prospecting for minerals and location of mining claims would be permitted in wilderness areas through December 31, 1983. Although prospecting and mining are authorized, they must be conducted in a manner as compatible as possible with preservation of the wilderness character.

Thus, the standards under which the regulations are applied in wilderness are somewhat stricter than on other lands. Special limitations and restrictions have been placed on the use of mechanized equipment because of its potential for causing surface disturbance and other impacts on the wilderness environment.

The Administration, in 1979, concluded the Roadless Area Review and Evaluation (RARE II) process by allocating 62 million acres of roadless and undeveloped National Forest System lands to one of three categories: 15.4 million acres were recommended to Congress for wilderness designation; 36 million acres were allocated to multiple uses other than wilderness; and 10.6 million acres were held for further planning. Those areas recommended for wilderness and further planning are managed, to the extent that the Forest Service has such authority, so as to protect the wilderness character until final decisions or designations are made. The regulations are applied to these areas in the same way as described for wilderness.

QUESTIONS AND ANSWERS

Q: Do these regulations apply to National Forest wilderness?

A: Yes. In order to protect wilderness values, the standards under which the regulations will be applied in designated wilderness are somewhat stricter than on other lands. Operators may enter a wilderness and prospect for minerals under the Wilderness Act of 1964, but such activities must be carried out in a manner compatible with the preservation of the wilderness environment and in conformance with the applicable regulations. For example, special limitations and restrictions have been placed on the use of mechanized equipment.

Q: What is the purpose of the regulations under 36 CFR 252* issued by the Forest Service, concerning mining and prospecting operations in National Forests?

A: The regulations are intended to protect the nonmineral values of National Forest System lands against unnecessary or unreasonable damages from prospecting, exploration, development, mining, and processing operations carried out under the authority of the Mining Law of 1872, as amended. They are intended to provide that protection without unreasonably inhibiting or restricting the activities of prospectors and miners.

Q: What is the authority for the Forest Service to issue these regulations?

A: The Organic Administration Act of June 4, 1897, authorizes the Secretary of Agriculture to regulate occupancy and use of the National Forests for the protection and management of their surface resources. All National Forest users, including prospectors and miners, are required to observe these regulations.

Q: When were these regulations issued?

A: On August 28, 1974.

Q: Why did the Forest Service issue regulations at that time, when mineral operations had been carried out in National Forests for 70 years without them?

A: The Forest Service was given added direction through the National Environmental Policy Act of 1969 to promote efforts to prevent or eliminate damage to the environment. During the 1960's and early 1970's there was increased prospecting and mining activity on the National Forests because of present or anticipated world mineral shortages. All indications were that such mineral activities on National Forests would increase intensively in the future, resulting in increased possibilities for surface resource damage.

Q: Do the regulations affect the mining laws and mining regulations of the Department of the Interior or its management of the mineral resources?

A: No. Those laws and regulations relate to the search for minerals, their discovery, extraction, and processing. The Forest Service regulations apply to the protection of nonmineral resources affected by mineral-related activities. The Department of the Interior manages federally owned locatable and leasable minerals on National Forest lands. The Forest Service is charged with the management and protection of the surface resources only.

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* Now 36 CFR 228

Q: Do these regulations apply to all minerals on all lands administered by the Forest Service?

A: No. They apply only to "locatable minerals" on National Forest System lands open to operation under the General Mining Law of 1872, as amended, and to operations conducted under those laws. They cover those lands reserved from the public domain for National Forest purposes and not otherwise withdrawn from their operation. They also apply to a very small portion of lands acquired by the Federal Government for National Forest purposes. Nearly all National Forest lands that are open to the mining laws, and thus subject to these regulations, are west of the Mississippi River, including Alaska.

Q: Are there any laws or regulations that cover other mineral activities on the remaining National Forest lands?

A: Yes. The Mineral Leasing Act of 1920, as amended and supplemented, provides for the disposal of the fossil fuels, such as coal, oil, gas, oil shale, and related bitumens, as well as sodium, potassium, and sulfur (the latter only in certain States) from public domain National Forests. The Mineral Leasing Act for Acquired Lands of 1947 provides for the disposal of federally owned leasable minerals on acquired National Forest System lands.

Q: Just exactly what is meant by an operating plan?

A: Operating plans, as required by these regulations, are documents by which mineral operators identify themselves, describe the work they intend to do, where and when they intend to do it, the nature of any proposed disturbance of surface resources, and the steps they will take to protect those resources. An approved operating plan is basically an agreement between the Forest Service and the operator. The operator agrees to observe necessary and reasonable precautions, spelled out in this plan, to reduce damage to surface resources during operations activities and to rehabilitate disturbed areas as and when feasible. In turn, the Forest Service agrees that protection of surface resources will be adequate if operations are carried out in accordance with the approved plan.

Q: When is an operating plan necessary?

A: A plan of operations is required from anyone whose proposed operations, under the 1872 Mining Law, would cause "significant disturbance of the surface resources." An operator who is unsure if the proposed operations might disturb surface resources should file a "notice of intention to operate" with the Forest Service. It should describe briefly what the operator intends to do, where and when it is to be done, and routes and methods of access to the site. The Forest Service will analyze the proposal and within 30 days notify the operator as to whether or not an operating plan will be necessary.

Q: <u>What is meant by a "significant" disturbance of surface resources?</u>

A: In general, operations using mechanized earthmoving equipment cause significant disturbance. Pick and shovel operations normally do not. Neither will explosives used underground, unless caving to the surface will result. Use of explosives on the surface generally will be considered to cause significant disturbance. Almost without exception, road and trail construction and tree-clearing operations will cause significant surface disturbance. Disturbance by a particular type of operation on flat ground covered by sagebrush, for example, might not be considered significant. But, that same sort of operation in a high alpine meadow or near a stream could cause highly significant surface resource disturbance. The determination of what is significant, thus, depends on a case-by-case evaluation of proposed operations and the kinds of lands and other surface resources involved.

Q: <u>What is the purpose of the bond requirement in the regulations?</u>

A: The requirement for a bond is to assure compliance with the reclamation provision of the regulations and operating plans. The amount of the bond will be determined by the estimated cost of the work needed to reasonably reclaim surface resources disturbed by operations. If the operators fail to do the work, the bond or deposit will be used by the Forest Service to do the work or have it done.

Q: <u>What action will the Forest Service take if miners and prospectors conduct operations on National Forest lands without an approved operating plan?</u>

A: If the operators cause significant surface resource disturbance, a Forest Service officer will contact the operators, seeking cooperation to work up an operating plan. In cases where operators refuse to cooperate, the Forest Service will, as a last resort, take whatever legal action may be required to end unnecessary or unreasonable damage to surface resources, to reclaim disturbed areas, and seek payment for damages when appropriate. The Forest Service will first, however, make every effort to secure the cooperation of the operators.

Q: <u>Do most proposed operations require preparation of environmental impact statements?</u>

A: No. In most cases environmental impact statements are not necessary. When they are, they generally are for new roads that may be needed across National Forest lands for access to mines, mills, and similar operations. Preparation of environmental impact statements is the responsibility of the Forest Service and other involved agencies.