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Report To The Congress OF THE UNITED STATES

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Interior Programs For Assessing Mineral Resources On Federal Lands Need Improvements And Acceleration

* p14 - GAD

p14 - GAD questions
re. reliability

p17 - 20 yrs.

The U.S. Geological Survey has begun a systematic assessment of the mineral potential of key areas in the United States; it will be of considerable value in determining the best use of public lands and will help the mining industry and other users of mineral data. But, to maximize its value, the assessment needs to be done faster and with management improvements.

p20 - Appraisal
Not in 03/77

p21 - Had
info from
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EWD-76-83

JULY 27, 1976



E-114812


To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the merits of U.S. Geological Survey programs to provide a systematic assessment of the mineral potential of key areas in the United States.

Our review showed that the value of these programs could be enhanced considerably by completing them faster.

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Agriculture; and the Secretary of the Interior.


Comptroller General
of the United States

D I G E S T

Minerals demand is increasing because the economy is growing and the standard of living is rising. If this demand is to be met, additional supplies must be acquired at a faster pace. A mineral resource assessment relating to national minerals policy is a high-priority matter.

INFORMATION FOR LAND USE PLANNING IS NEEDED

The Bureau of Land Management and the Forest Service--the two largest Federal land managing agencies--expect to spend about \$200 million preparing their land use plans through fiscal year 1986. But unless the Survey programs are accelerated, many of the plans will not be able to incorporate Survey information on possible mineral resources on Federal lands. Additional costs could be incurred from revising these plans after Survey information becomes available. (See p. 7.)

Reversing Survey land use decisions could also prove difficult, should the Survey programs later identify mineral resource potential in areas that had previously been designated as best suited for nonmineral uses. (See p. 9.)

*and other
applications*

OTHER PROGRAM BENEFITS

The Survey programs could help the Congress decide which Federal lands should be established as wilderness areas. (See p. 10.)

Should a leasing system for mining nonfuel minerals on Federal lands be enacted (as has been introduced into the 95th Congress), Survey information could be important in carrying out a leasing program. (See p. 10.)

Survey programs could also benefit the domestic mining industry with mineral exploration programs. (See p. 10.)

but Interior doesn't really want to help.

See Sheet. Upon removal, the report cover date should be noted hereon.

CONCLUSIONS

7/2/77

The Survey programs need to be accelerated, and Interior indicated that a 20-year time frame could be realized with additional funding. GAO estimates that annual funding requirements would be about \$17 million--about \$7 million more than the Survey 1979 budget request for these programs. (See p. 6.)

Along with accelerating Survey programs, however, GAO believes that certain improvements are needed in Survey management:

- Survey does not have a structured, formal plan for completing its mineral resource assessment. Such a plan would have demonstrated to the Congress and the executive branch the slow progress being made with the programs' present funding level. It would also be a useful management tool to Interior. (See p. 12.)
- Survey had not consulted Federal and State land managing agencies or the mining industry to determine their information needs. Federal and State land managing agency officials believe that the Survey programs could be improved if they helped establish the priorities. (See p. 13.)
- Survey could benefit from establishing a committee consisting of leading experts that have a direct interest in the mineral industry, from such groups as the academic sector, the mining industry, agencies such as the Forest Service and Bureau of Land Management, and others. Survey should use the committee input in developing a funding proposal and guidelines for (1) the format and content of Survey information, (2) the methods, techniques, and criteria needed to assure that credible resource estimates are used, and (3) the various scientific skills required to carry out the program. The committee should also recommend priorities. (See p. 16.)
- Bureau of Land Management, Forest Service, and Survey personnel should aid one another

to the greatest possible extent with coordinating land use planning schedules and mineral assessment schedules. (See p. 16.)

--Survey did not always have adequate scientific expertise to work on the programs, but taking action to correct this. (See pp. 13 and 14.)

RECOMMENDATIONS

GAO recommends that the Secretary of the Interior establish an advisory committee or other suitable mechanism to help Survey prepare a long-range plan for completing the mineral resource assessment.

The Secretary of the Interior should submit to the appropriate congressional committees for use in the fiscal year 1980 budget authorization process, a detailed plan and funding proposal for completing the assessment in the minimum feasible time. *12/37/70*

GAO also recommends that the Secretaries of Agriculture and the Interior direct the Forest Service and Bureau of Land Management to:

- Coordinate their land management planning schedules to the extent feasible to meet timely objectives to use Survey mineral data.
- Provide in their budget justification or completed land management planning those actions taken or progress achieved in their use of Survey mineral data.

AGENCY COMMENTS

Interior said that it was hoping for a step-by-step increase in Survey funding, but that the programs could not be completed in less than 20 years. This was attributed to difficulties in hiring qualified scientists in several disciplines.

Interior also pointed out that Survey programs are being given priority--fiscal year 1979 requests for the two programs are nearly \$10 million (up over \$1 million from 1978) and represent about a third of the total Survey budget for geological and mineral resource surveys.

Interior said that it was developing a formal plan that will identify data users' needs and the skill requirements for carrying out the programs. It expressed concern about establishing an external advisory committee and had reservations about including industry on such a committee, but did point out that there had been coordination with various users and in several actions it is now taking to improve this coordination, particularly with the Forest Service and Bureau of Land Management.

Interior was trying to hire additional scientists to work on the programs, but felt the work to date has not really suffered, but only been delayed.

The Forest Service agreed that Survey data would be a real asset, but stated that congressional mandates dictated that the Forest Service proceed with its land use planning with or without Survey data.

The Forest Service also disagreed with the GAO contention that major costs would be incurred in revising Forest Service plans to accommodate the new Survey data because Forest Service plans are always revised every 15 years.

The Forest Service pointed out that the Mining Law of 1872, as amended (which opens the public lands to private acquisition for mineral development), limited their discretion in making land management decisions and recommended that the proposed advisory committee include a citizen environmentalist.

§ NOMINATE DESTY JARVIS.

GAO EVALUATION

Interior actions to improve its planning and coordination process seem commendable and should increase the value of its assessment programs considerably if strong efforts are made to complete the programs in the 20-year time frame. GAO believes that the congressionally dictated mandates referred to by the Forest Service show the need for accelerating the assessments.

Even though Interior feels that the shortage of scientific expertise only delayed the completion of Survey assessments, rather than reduced assessment reliability, the GAO basis for questioning the reliability of Survey data was a Geological Survey program evaluation, the results of which were concurred with by other Survey officials. In any event, Interior is adding more scientists to the program.

While the Service disputes our contention that land use revisions could cause additional expenditures, GAO was told that this depends on the extent of changes. The additional cost can be substantial if major changes are made and public hearings are required to make such a change. One Bureau of Land Management official said that it could require as much as 50 to 70 percent of spending of the original agency planning effort.

GAO agrees with the Forest Service suggestion that an environmentalist be included in the proposed committee or other coordinating mechanism. GAO also agrees with Interior that care must be taken to avoid any problems with industry or other committee members.

go they are making decisions cheaper. quicker.

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ABBREVIATIONS

- BLM Bureau of Land Management
- GAO General Accounting Office

CHAPTER 1

INTRODUCTION

Additional supplies of natural resources from either domestic or foreign sources are needed if the United States is to maintain its standard of living. For example, the national economy demands over 4 billion tons of new mineral supplies each year--about 40,000 pounds a person. This amount (23 percent of world demand) is growing but domestic mineral production is not keeping pace.

Mineral demand is also rising in other countries as their economies grow and living standards rise. Competition between countries for available minerals is increasing. As a result, mineral deposits are being depleted and ore grades are declining while mining and mineral extraction costs are increasing.

To narrow the growing gap between domestic supply and demand, the United States has been importing more raw materials and processed materials of mineral origin. This is not a new practice, but imports have become more important as more U.S. foreign exchange is spent for materials previously produced in the Nation.

The major national concern in recent years has been the shortage of energy-related minerals--oil, gas, coal, oil shale, and uranium. But the others--nonfuel minerals--are also vital to the economy. According to the Department of the Interior, the United States imported 50 to 100 percent of its requirements for 23 of 32 major mineral commodities in 1976. Interior predicts that the United States could depend on imports for one-half of all basic raw materials by 1985.

This situation is important because it affects the balance of payments and the economy, and increases reliance on imports for critical minerals. Obviously, considerable mineral policy analysis is needed.

INFORMATION IS NEEDED FOR MINERALS POLICY ANALYSIS

Reserves are defined as mineral deposits that are found capable of being mined under present technological, economical, and legal constraints. Thus, reserve information will be important in the near future.

A resource evaluation, ^{1/} however, is essential in developing a long-term view of U.S. domestic supplies. Sources include (1) reserves, (2) known deposits that are not economically, technologically, or legally recoverable at present, and (3) deposits that could be discovered by scientific and geologic study.

Interior is the main Government information source on domestic mineral reserves and resources. Its data collection and analysis work is authorized by the Act of March 1879, as amended (43 U.S.C. 31) which created the Geological Survey (Survey), and the Act of May 16, 1910, as amended (U.S.C. 1), which created the Bureau of Mines.

The Bureau of Mines is the main Government information source on mineral reserves. Most of this information is collected directly from the mining industry and used for Bureau of Mines programs.

Survey is the main Government information source on domestic mineral resources. While Survey has studied national resources for many years, much of its information is incomplete and, therefore, of limited value for providing a sound long-term view of domestic supply capabilities.

We made separate reviews of Bureau and Survey central information systems--the minerals availability system in Bureau and the computerized resource information bank in Survey. The systems are the subject of two forthcoming GAO reports. Both systems are potentially important but have major deficiencies.

ASSESSING THE NATIONAL MINERAL RESOURCES

In July 1974 Survey began a program of laboratory and field studies to systematically assess Alaska mineral resources. A similar program to assess the lower 48 States (excluding the outer Continental Shelf) began in October 1977.

The programs are to provide resource availability information for Government national minerals and land use policy. The programs are also to assist the domestic mining industry search for new ore deposits.

^{1/}Resources are defined as defined deposits that may eventually become available.

The programs involve scientific investigations and mapping study areas that range from 5,700 to 6,600 square miles. QUADRANGLE

Areas are selected for study by the amount of federally owned land they contain, the probable importance of their mineral resources, and the urgency of the need for information on their resources. When completed, the programs will have assessed two-thirds of the Federal land in the lower 48 States, a great deal of the Federal land in Alaska, and a considerable amount of non-Federal land throughout both areas.

Information from various geochemical and geophysical investigative techniques is combined with a geologic map for each area. Samples for geochemical analysis are taken from rocks, soil, and streambed sediments in each quadrangle, and analyzed for 30 mineral commodities. Survey then produces a series of maps that are combined into a quantitative, resource assessment map. This map outlines the areas that have high potential for mineral deposits. The number, size, and grade of deposits that might be found within these areas are also estimated.

The present investigations in each area require about 2 years of laboratory and field work, and another year to analyze the information.

PURPOSE OF OUR REVIEW -10

This review evaluates the need to improve the amount, quality, and timeliness of national nonfuel, mineral resource information. We are concerned that inadequate or incomplete information may hinder such important functions as (1) determining the best use of federally owned lands, (2) forecasting future mineral supply and import trends, and (3) formulating strategies to deal effectively with possible shortages of certain key minerals. Our review describes the need for (1) accelerating the assessment program and (2) improving its quality and scope.

SCOPE OF REVIEW

We made our review primarily at U.S. Geological Survey Headquarters and offices of the Western Region in Menlo Park, California. Our information was obtained largely by (1) reviewing program plans, reports, correspondence, and other documents, (2) discussing the program with headquarters and

I have set for AK. OK

*and 5700 square miles
that I finish in 2015 at present funding
a response*

if TRUE THEN AK = 100 QUADS x 3 yrs each = 300 yrs.?!

*only 5 year
at a time...*

regional officials from Agriculture and Interior, and
soliciting comments from Federal and State Governments,
mining industry, and others about their need for, use of
and suggested improvements for information about the
mineral potential of Federal lands.

CHAPTER 2

FASTER ASSESSMENT IS NEEDED

The mineral resource assessment programs are moving much too slowly. A systematic assessment of the Nation's mineral resources is widely regarded as a key step toward developing a national minerals policy and improved Federal land use planning; given the present funding and staffing levels, it will take 50 years or more to complete. Accelerating the program will make the information more useful and beneficial to the Government.

MAJOR STUDIES STRESS THAT BETTER RESOURCE INFORMATION IS NEEDED

Some recent studies have stressed that improved information on the overall national ability to supply minerals is a necessary preliminary step to mineral policy decisions.

The Public Land Law Review Commission warned in 1970 that increasing reliance on foreign supply sources may be hazardous, and recommended making mineral resource investigations on public lands (1) before an emergency arises and (2) as a basis for improved land use planning. The Commission also recommended that more Federal funds be allocated for developing reliable geologic information to identify mineral areas.

The National Commission on Materials Policy also emphasized in 1973 the need to evaluate national mineral resources. It concluded that all policy work in this area is handicapped by inadequate and inaccurate information.

The Office of Technology Assessment March 1976 report, "Mineral Accessibility on Federal Lands," concluded that development of a mineral policy is severely handicapped by inadequate data. It also emphasized that an assessment of the mineral resources on Federal lands is needed to consider the potential benefits and costs of using Federal land for mineral development.

The National Commission on Supplies and Shortages pointed out in December 1976 that the Nation must be able to protect itself against the effects of actual or threatened foreign supply disruptions. The Commission report concluded that the amount of long-range, comprehensive policy planning must be increased and that the Government needs improved food and materials information for this planning.

THE ASSESSMENT COULD CONTRIBUTE TO POLICY ANALYSIS

A mineral resource assessment could provide the information needed to help evaluate policy options and forecast the national domestic supply capabilities. Such decisions could be greatly enhanced with good national mineral resources estimates.

For example, if an estimate indicates that a large amount of a resource is recoverable at modest price increases, national policy might emphasize expanding domestic production. However, if a resource estimate indicates that only a small amount is available for a great price increase, the policy might emphasize developing foreign supplies and a domestic stockpile as insurance against supply interruptions.

SLOW PROGRESS IN MAKING AN ASSESSMENT

Interior recognizes that a minerals policy requires accurate and reliable resource availability information, (see p. 2) but given present funding levels the Survey programs will not be completed until the year 2032. Survey believes that two-thirds of Alaska and one-third of the lower 48 States (two-thirds of all Federal lands in the lower 48) should be systematically assessed to provide sound overall information on national mineral resources. This would involve investigations in about 225 areas that cover about 893 million acres, covering substantial amounts of Federal lands.

Given present funding levels, Survey can complete studies covering only about 17 million acres each year. Survey officials agree that the program could be accelerated--they believe that the work could be completed in about 20 years. We estimate that this would require increasing the annual budget from Survey's requested 1979 level of \$9.7 million to approximately \$17 million; the additional money would be used primarily for hiring scientists.

TIMELY RESOURCE INFORMATION IS NEEDED FOR LAND USE PLANNING

but $893 \div 17 = 52$ years.

Land use plans are required for managing most Federal lands. Decisions by Federal land managing agencies such as the Bureau of Land Management (BLM) and the Forest Service generally greatly affect the future national material production.

Survey maps showing where mineral resources are likely to be located would help BLM and the Forest Service make informed land use decisions. We found that the agencies need this information as soon as possible.

The importance of Federal lands
for mineral development

Federal lands are an essential part of the national mineral base. Over 760 million acres (about one-third of the national land mass) are owned by the Federal Government, largely in Alaska and the 11 Western States.

The natural forces that created the rugged topography and varied geology in the Western States and Alaska have also concentrated a great natural storehouse of mineral wealth. Minerals from Federal lands have contributed markedly to national industrial and economic development. For example, Interior estimates that more than 90 percent of the national copper production and 80 percent of the silver production come from western Federal lands. Twenty of the 25 largest U.S. metal mines are in the West.

Thus, the 11 Western States and Alaska could be the country's major hope for increasing domestic mineral production because of their immense land areas, varied geology, and vast undeveloped areas.

A substantial reason for
speeding up the program

Environmental concerns, wilderness and wildlife preservation, the desire for recreation facilities, expanding urbanization, and increasing shortages of energy and other resources have increased the competition for using U.S. public lands. Land use planning involves a detailed study of the potential costs and benefits of optional uses of particular lands.

BLM and Forest Service schedules for completing land use plans are enough reason for speeding up Survey assessment programs. More timely information is needed because these agencies anticipate spending an estimated \$190 to \$260 million for work on land use plans, through fiscal year 1986.

The Office of Technology Assessment report (see p. 5) pointed out that the lack of information prevents land-managing agencies from adequately considering the possible benefits of mining Federal lands. As a result, mineral resource development is handicapped in its competition with other possible uses of Federal land.

BLM and Forest Service officials agreed that this is a problem and said that Survey mineral resource maps are needed to prepare sound land use plans. This information is needed to decide whether to develop area minerals or develop the more readily apparent nonmineral resources such as recreation, timber, livestock grazing, and wilderness and watershed protection areas.

One BLM official pointed out that he had to use obsolete geologic maps prepared in the 1880s and 1890s because, in many instances, this was the only information available. As a result, many land use decisions are made in ignorance of mineral values.

The Federal Land Policy and Management Act of 1976 provides that resources on public lands that are managed by BLM must be systematically inventoried, and their future use must be projected by land use planning. The Act declares it U.S. policy that the land must be managed in recognition of the national need for domestic sources of minerals, food, timber, and fiber.

BLM and Forest Service cannot delay
scheduled completion of land use plans

The need to acquire adequate and timely mineral resource information and to respond to the needs of other agencies is illustrated by BLM and Forest Service schedules to revise their land use plans. Officials from both agencies stated that they cannot wait until Survey completes its program. The officials stated that, depending on the amount of changes that might be made, additional funds may be needed to revise their plans when Survey mineral resource information becomes available.

BLM

BLM manages 80 percent of all Federal land; it has spent considerable time and money preparing land use plans, and major revisions are scheduled for the next 8 to 10 years. BLM has estimated that \$70 million to \$88 million will be needed to update existing plans or to prepare new plans. Much future BLM land use planning might have to be redone

because the Survey assessment cannot be completed for at least 20 years. However, BLM officials stated that they have other priorities and commitments arising under the legislation that require updated land use plans in a shorter time, and BLM cannot delay its plans to accommodate the Survey schedule.

Forest Service

We asked the Forest Service what might happen to its land use plans if they were completed before Survey information became available. While Forest Service land-management officials agree that mineral resource information is necessary in making sound land-management decisions and the national importance of mineral resources is recognized, competing resource uses require that land-management planning continue with the most current minerals inventory data. Forest Service officials also stated that they lack information on other resource data as well. They said that, if necessary, the Forest Service would revise its plans as the information from the Survey program becomes available. They noted that Survey information would be more useful if it could be produced faster.

Section 6 of the National Forest Management Act of 1976 directed the Forest Service to complete land use plans, if possible, by September 30, 1985. According to Forest Service estimates, this would cost the Government \$120 million to \$180 million. The Forest Service schedule calls for completing this work by 1983, which means that many Forest Service land use decisions will be based on inadequate knowledge of mineral resources.

The importance and cost of sound land use plans show the pressing need for Survey, BLM, and the Forest Service to coordinate the areas for study.

BLM officials stated that more coordination between Survey, BLM, and other users of mineral resource information is needed. However, Survey officials said that Survey, BLM, and the Forest Service have not discussed how the Survey program could best meet the needs of the agencies. Consequently, Survey may not be studying lands for which BLM and the Forest Service have a high priority for information.

BLM and the Forest Service could have difficulty reversing land use decisions, even if Survey programs were later to identify high mineral resource areas that were previously designated for nonmineral uses, because lawsuits from environmental groups and others could result.

MINERAL RESOURCE INFORMATION CAN HELP THE CONGRESS DESIGNATE WILDERNESS LANDS

Survey programs could help the Congress and executive branch in their consideration of adding Federal lands to the National Wilderness Preservation System. With Survey information, the Congress could better consider the potential area mineral values and consider whether land boundaries could be adjusted to exclude mineral areas.

According to the Forest Service, since 1975 33 National Forest units have been designated as wilderness areas and 4 other areas have been enlarged without adequate mineral resource studies--this involved about 2 million acres of Federal land. Since such studies were not available, the Congress could not evaluate area mineral-resource potential. We believe that it is essential that Survey programs be completed faster to improve the information that the Congress uses to make similar decisions in the future.

MINING LAW AND LAND USE PLANNING

Several bills that urge adoption of a mineral leasing program have been introduced into the 95th Congress. Survey maps would be useful in implementing a leasing program.

ASSISTANCE TO THE DOMESTIC MINING INDUSTRY

Survey could also help the domestic mining industry--industry could use the information for their mineral exploration programs, which could reduce the national dependence on foreign supplies.

We asked the American Mining Congress (the national organization of the mining industry) to solicit member views on the usefulness of Survey information to the industry. The responses generally endorsed the mineral resource assessments.

One official said that

"* * * the type of data provided * * * is an important first step towards the discovery of mineral deposits. Such data will speed up the exploration and discovery process and will help delay the impending mineral crisis. The Survey has done an outstanding job in its data collection and presentation."

Regarding the need for Survey programs, another industry official wrote

"* * * the resulting maps and data provide, in many cases, the only information upon which long-range exploration programs can be based. These maps and data provide a base that permits selection of areas with more potential, upgrading this selection many times. It would be practically impossible for us to do the type of wide ranging work done by the Survey."

Scale is the primary difference between Survey and industry investigations. Survey examines very broad areas that average over 6,000 square miles; industry studies target areas of 1 to 50 square miles. However, Survey information could be used by industry to identify favorable target areas.

Industry exploration requires very detailed geological mapping, and geochemical and geophysical investigations. Twenty years or more may be required to outline a profitable mineral deposit. Test hole drilling is generally required, and trenching might be needed for bulk samples and for sinking small exploratory mine shafts. Mine development and plant construction activities may require several years and millions of dollars.

OPPORTUNITIES TO IMPROVE THE QUALITY AND USEFULNESS
OF SURVEY RESOURCE ESTIMATES

While we believe that additional funds to accelerate the mineral resource assessment should be provided, we also believe that improvements should be made in program management.

Survey does not have a formal long-range program plan and has not consulted the major information users--the Federal land-managing agencies and the mining industry--to determine their needs. An advisory group of leading experts in the academic, private, and government sectors should be established to help Survey develop a comprehensive plan for early completion of the assessment. This group could also help Survey determine the priorities of information users and help assure that the resource estimates are of consistent quality.

LACK OF A FORMAL PROGRAM PLAN

Survey has no formal plan beyond identifying the 225 areas that it believes should be studied. We believe that formal long-range plans would have revealed that the 50-year time frame is inadequate to the needs of the land-managing agencies and other users.

Survey officials stated that its budget request to the Congress for fiscal year 1978 represented program plans. However, we found that the budget request shows only the amount requested, the work for fiscal year 1978, and comments on the reasons for compiling an assessment. There was no indication of a realistic time frame for completing a mineral resource assessment.

Survey has an important responsibility in providing early warning of problems and opportunities to the executive branch and the Congress. The Survey budget request accurately describes the importance of its mineral resource assessment, but fails to communicate that this work cannot be completed in a timely fashion under the proposed funding level.

Survey officials argue that formal long-range plans cannot be established due to uncertainties in future funding levels and program priorities. One official said that Survey can only estimate that about 50 years will be required to complete the programs.

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We believe that long-range planning can be an important aid to high-level management and the Congress in dealing with natural resource problems, and that the current assessment progress rate will be inadequate to meet this need.

INFORMATION USER NEEDS NOT DETERMINED

The National Commission on Supplies and Shortages emphasized that the primary users of information produced from Survey-type programs should help develop (1) program objectives and (2) information format and content. Survey has consulted neither Government land-managing agencies nor the mining industry to determine their priority needs. Survey unilaterally selected the initial study areas; no attempt was made to determine the suitability of the information to users' needs.

Federal and State land-managing officials believe that the programs could be improved if their agencies could provide input in establishing priorities of the study areas. One BLM official, for example, pointed out that BLM should participate in this selection because it is responsible for managing over 20 percent of the national land (over 60 percent of Federal land) and thus is clearly a major user of Survey products.

The need for Survey to determine user priorities is further demonstrated by the importance of the Survey programs to BLM and Forest Service land use planning activities discussed previously. (See ch. 2.) Also, as stated earlier, the mining industry could have worthwhile suggestions on the priority of study areas.

The scope of our review did not enable us to obtain detailed and comprehensive user opinions on how Survey should improve the content of mineral resource assessment data; the users contacted generally approved of the data Survey is providing.

Some officials suggested improvements. For example:

- Some Government and mining industry users noted that there is a need to routinely provide additional information on the location and geologic environment where geochemical samples are taken. Users would also like the information package to include a list of the values obtained from analyzing the sample materials.

- Users also believe that the information package should routinely contain information on deposits that are close to the surface, such as sand, gravel, quartz, and mica. They also suggested including available information on geologic hazards and water resources. Knowledge of water resources is important for evaluating the possibility of future mining operations.

Commenting on our draft report, Interior officials stated that geochemical data would soon be available--but on demand only, because of its volume. Interior would provide data on surface deposits when staffing permitted.

QUALITY OF RESOURCE ESTIMATES REDUCED

A Survey program analysis found that some aspects of the resource estimates were not given full attention, and we received similar comments from other Survey officials. Primarily, adequate scientific expertise was not always available. This contributed to reducing the quality of resource estimates of the first 10 areas completed in Alaska--36.5 million acres of Federal land.

For example, our analysis of Survey records and discussions with cognizant officials indicated that:

- Experienced economic geologists were not involved in the studies in most areas. This could have produced an inadequate understanding of the geologic framework of the mineral deposits.
- Scientists with mineral exploration expertise were not involved in the geochemical studies. Also, the purpose of the geochemical studies was in most cases not clearly understood by those involved, and the study results were not thoroughly interpreted. Therefore, the geochemical sampling and the data analysis were of reduced value for making reliable estimates of available resources.
- Specialists in evaluating hydrocarbon potential and low-grade chemical resources were not used; thus, not enough attention was given to studying the availability of these resources.
- Too few geophysicists and geostatisticians were assigned to the program to give adequate time to the work required.

--In some cases, scientists were reassigned to other Survey programs before their work was completed in the areas; as a result, the quality of the work probably suffered.

A Survey official stated that staffing problems would increase when the program expands to the lower 48 States because there were too few scientists with special skills to absorb the additional workload. Also, Survey could not hire the specialists needed because all but \$500,000 of the \$3.9 million budgeted for the lower 48 States work is money redirected from other Survey programs. The new money would be used largely to contract for helicopters to carry out the required aeromagnetic studies and other airborne activities.

The Survey official believes, however, that adequate scientific expertise could be obtained by increasing the funding level.

We believe that the lack of formal, structured plans for the program contributed to Survey staffing problems.

AN ADVISORY COMMITTEE IS NEEDED

The National Commission on Supplies and Shortages also pointed out that using such institutional safeguards as advisory committees to review methods and procedures keeps an agency better in touch with information users.

An advisory committee would provide a means for the users of mineral resource information to help develop the program plan and the information format and content. The committee could also improve the reliability of Survey resource estimates, and could be used to review the scientific skills assigned to the program and the methods and techniques used in making an assessment.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Completing a nonfuel mineral-resource assessment should be a high-priority matter. As discussed in chapter 2, such an assessment is a key step toward developing a national minerals policy.

Forest Service and BLM land use planning efforts further emphasize the need to complete an assessment as soon as possible. Interior officials claim that less than a 20-year time frame is not achievable because of the difficulties of hiring adequate scientific expertise.

However, the benefits of accelerating the programs will be diminished unless Survey, the Forest Service, and BLM coordinate their work schedules to the extent possible so that mineral resource information will become available for land use planning.

Management improvements should be made before the programs are accelerated. We identified (1) problems affecting the reliability of Alaskan resource estimates, (2) the lack of a long-range program plan, and (3) a need for determining whether the information is fully responsive to the needs of Federal and State land-managing agencies, industry, and other users. The need for the Forest Service, BLM, and Survey to collaborate in establishing priorities for study areas and in scheduling their respective activities further demonstrates the merits of establishing an advisory committee.

In our draft report, we proposed establishing an advisory committee composed of potential users of Survey data to aid in identifying the information required and the areas in most urgent need of mineral appraisal. The committee should consist of leading experts and interested parties, including representatives from the academic sector, the mining industry, and agencies (such as the Forest Service and BLM) that have direct interest in this information. Survey should use the committee input in developing a funding proposal and guidelines for (1) data format and content, (2) the methods, techniques, and criteria to assure that creditable resource estimates are used, and (3) the mix of scientific personnel required. The committee should also recommend priorities for the study areas. After such a plan and funding proposal have been prepared, the Congress would be in a better position to evaluate the need for additional

concern about establishing an external advisory committee and had reservations about including industry on such a committee, but did point out that there has been coordination with various users and cited several actions it is now taking to improve this coordination, particularly with the Forest Service and BLM.

Interior also said it was trying to hire additional scientists to work on the programs, but felt that work to date has not really suffered but has only been delayed.

The Forest Service agreed that Survey data would be a real asset, but congressional mandates dictated that the Service proceed with its land use planning, with or without Survey data.

The Service disagreed with our contention that major costs will be incurred when revising its plans to accommodate new Survey data because its plans are always revised every 15 years.

The Service also pointed out that the Mining Law of 1872 as amended (which opened the public lands to private acquisition for mineral development), limited their discretion in making land-management decisions. Service officials also recommended that the proposed advisory committee include a citizen environmentalist.

OUR EVALUATION

Interior actions to improve its planning and coordination process seem commendable and should enhance the value of their assessment programs considerably if strong efforts are made to complete the programs in the 20-year time frame. We believe that the congressionally dictated mandates referred to by the Forest Service show the need for accelerating the assessments.

Even though Interior feels that the shortages of scientific expertise only delayed completion of the assessments (rather than reduced their reliability), our basis for our evaluation was a Survey program evaluation, the results of which were concurred in by other Survey officials. In any event, Interior is taking action to add more scientists to the program.

While the Service disputes our contention that land use revisions could cause important additional expenditures, we were told that this depends on the extent of the changes.

The additional cost can be substantial if major changes are made and public hearings are required. Our BLM official stated that it could require spending as much as 50 to 70 percent of that agency's effort.

We agree with the Forest Service suggestion that an environmentalist be included in the proposed committee. We also agree with Interior that care must be taken to avoid any problems with industry or other committee members.

Departments of the Interior and Agriculture comments are reprinted as appendixes I and II of this report.



United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

APR 7 1978

Interview

Mr. Monte Canfield, Jr.
Director, Energy and Minerals
Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Canfield:

We appreciate this opportunity to comment on the GAO draft report, "A Timely Inventory of the Mineral Resources on Federal Lands is Needed to Improve National Minerals Policy and Land Use Planning."

First, we would like to suggest the use of the word "appraisal" rather than "inventory" in this context. Inventory connotes a level of definitiveness that cannot be achieved in programs of this nature, which can only indicate potential until actual mining is done. Also, an inventory connotes a static situation, whereas the goal of such a program must be dynamic. *data look good*

This draft report focuses on the Geological Survey's mineral resources appraisal program, both in Alaska and the conterminous States, and lists four criticisms of the management of these programs:

- (1) That the Survey does not have a structured formal plan to complete a timely mineral resource inventory;
- (2) That the Survey has not consulted Federal and State land management agencies nor the mining industry to determine their priority needs;
- (3) That the Survey did not insure adequate scientific expertise was available to work on the programs; and
- (4) That the Survey needs an advisory committee consisting of leading experts from the academic sector, the mining industry, and Government agencies such as the Forest Service and BLM to assist the Survey in preparing a long-range plan for completing a mineral resource inventory.

Before responding to these criticisms, there are a few important points that need to be made about the scope of the draft report.

The draft report should place the Survey's mineral resource appraisal programs in the context of other mineral appraisal activities that have been ongoing within the Department of the Interior by the Geological Survey and the Bureau of Mines. It considers only about one-third of the resources committed in the Department to mineral appraisal.

In Fiscal Year 1978, for example, a total of \$25.8 million was appropriated to Geological Survey for geologic and mineral resource surveys. Of this amount, \$8.5 million went to the Alaskan and conterminous States minerals surveys. Another \$2.6 million was appropriated for mineral surveys in Forest Service wilderness. Resource processes received \$5.8 million. This could be called the "intellectual framework" of the mineral survey program, for it studies the deposition of minerals. A total of \$4.3 million was appropriated to appraisal and exploration techniques -- a research program dealing largely with exploration techniques and mapping techniques relating to different mineral deposits. The budget provided \$2.1 million for mineral information systems and resource analysis and another \$2.2 million for a study of critical minerals and exotic nonfuel minerals that will be used in energy production. These programs are all vital to a mineral appraisal program.

In addition, the Bureau of Mines does about \$3.5 million worth of work a year on mineral appraisal activities from its own budget, plus about \$1.7 million in pass-through funds in FY 1978 on BLM wilderness and other mineral studies.

For FY 1979, the Survey has requested a \$27.6 million dollar budget for geologic and mineral resource surveys. The Alaskan and conterminous States surveys would receive \$9.7 million of this appropriation, the Forest Service wilderness survey \$2.7 million, and the other programs listed above correspondingly greater amounts. In addition, there is a request for \$3 million of pass-through funds from the Bureau of Land Management for Survey mineral appraisal of the BLM wilderness study lands.

While these are well-established programs, we recognize that improvements in the methodology, priorities and levels of effort may be needed.

In addition to these efforts, most of the "hard" information that goes into the total national mineral inventory comes from the private sector, which does considerable research and makes a major share of the mineral discoveries.

A timely appraisal of mineral resources on Federal lands cannot, by itself, improve national minerals policy. It can only provide data to be used in making policy decisions. The Department of the Interior has lead responsibility for a presidentially mandated Nonfuel Minerals Policy Review, which will focus on the policy information and analysis required to support Federal decision-makers in developing, implementing and monitoring minerals policy. Among the specific areas to be studied are: The adequacy of Government minerals data collection and data analysis capabilities to support policy analysis; the adequacy of Government capabilities for evaluating the mineral potential of Federal land prior to land use decisions; and Government policies affecting domestic minerals supply.

Following are the comments on the specific criticisms contained in the draft report:

1. The Survey does not have a structured formal plan for completing a mineral resource inventory. The Secretary of the Interior should submit by July 1, 1978, to the Congress a detailed plan and funding proposal for completing the resource inventory in the minimum feasible time.

GS began developing a structured formal plan for completing the mineral resource inventory both for the Alaska Mineral Resources Appraisal Program (AMRAP) and the Conterminous U.S. Mineral Appraisal Program (CUSMAP). It is being prepared by an internal advisory committee consulting with individuals and groups inside and outside the Survey. Program plans will consider needs of various users, need for the diverse specialists required to conduct the program, and the need for expanding research in processes of ore deposition and exploration techniques to improve resource appraisals. The preliminary plan should be completed by this summer.

From a management standpoint, it would be difficult to attain the goal suggested by GAO of completing 225 quadrangles in 15 years because of the difficulty of acquiring adequate scientific expertise, either through new hires or contracts, in several disciplines

quickly enough to accommodate an immediate large increase in the program. The programs are currently funded for \$7 million and 112 positions, with an increase to \$8 million and 116 positions now being considered by the Congress for FY 79. Under optimal conditions, including increases in appropriations and positions in years beyond FY 1979, the entire appraisal program could not be completed in less than 20 years.

2. The Survey has not consulted Federal and State land management agencies nor the mining industry to determine their priority needs.

This statement is not entirely true because GS is consulting with these people, but admittedly it needs to do more. The AMRAP program has been coordinated with the State Geologist of Alaska, and the CUSMAP program is being described to the continental U. S. State Geologists. At these sessions the program is explained and comments and recommendations are solicited. More coordination with BLM and more long-range coordination with the Forest Service is needed. GS plans to recommend establishment of a subcommittee of the GS/BLM Coordinating Committee to determine the BLM needs and to recommend the best plan for meeting these needs. GS has been working with the Forest Service closely on identifying and scheduling areas for wilderness studies. However, these have been mostly short-term plans and the need is to develop longer-term plans. GS had one meeting in January with mining company representatives in the Pacific Northwest to discuss the CUSMAP program and asked for comments and plans to hold another such meeting in Missouri in May. GS also plans to discuss within the next three or four months the CUSMAP program with the Commission on Energy and Mineral Resources of the National Academy of Sciences, and has outlined the program to a senior member of the Commission.

3. The Survey did not insure that adequate scientific expertise was available to work on the program.

The problem of adequate scientific expertise is a matter of available positions. When the AMRAP program was started in 1974, provision was made for adequate scientific expertise. In 1976, however, several of the more experienced people had to be diverted to complete the 1:1,000,000 mineral potential study that was needed to meet congressional deadlines for the d-2 lands decisions. That study was completed on schedule in January 1976. This delayed work on some AMRAP projects but did not reduce the reliability of the AMRAP reports.

- 4. The Survey needs an advisory committee consisting of leading experts from the academic sector, the mining industry, and Government agencies such as the Forest Service and BLM to oversee the program. The committee should develop a funding proposal, establish priorities for quadrangles to be studied under the programs, and recommend guidelines for (1) the format and content of information produced, (2) the methods techniques and criteria to insure that credible resource estimates are used, and (3) the mix of scientific personnel required to carry out the programs.

What + whose interest do they have in mind?

We have major reservations about establishing an advisory committee to oversee a scientific program of this nature. Advisory boards are a poor means of communication among Federal and State agencies. Including industry people on an advisory committee could raise the problem of conflict of interest. In lieu of establishing an advisory committee, GS is organizing a workshop for the fall of 1978 on mineral resource appraisal surveys to further develop long-range program plans and to determine types of products that would be most useful to industry, State and Federal agencies and other consumers. The workshop will involve people from many user groups, representing the public and private sectors.

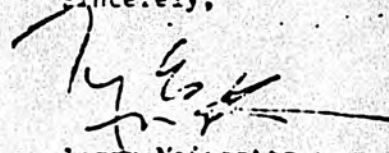
Concerning the suitability of the content and design of the information package to satisfy users' needs, GS knows of many user needs through experience with other mineral resource programs over a long period of time. For example, the non-geologist wants interpretative maps and reports showing specific areas of mineral potential, but the mining industry wants geological maps, geophysical maps of all kinds, geochemical maps, surficial geologic maps, isotope information, and other basic geoscience data. One of the purposes for the planned workshop is to evaluate these products and how we can improve them.

GS unilaterally selected the initial quadrangles to be studied in the CISMAT program, but they were not selected arbitrarily. Areas selected contained tracts of Federal lands, had known mineral potential, and included different environments of mineral deposition. Because of the limitations on the number of areas that could be studied initially, GS wanted to develop research techniques and study ore-forming processes in as many different climates and environments of ore deposition as possible.

In addition to these comments, we have attached a list of specific comments keyed to specific pages and statements in the draft report.

We would be happy to provide you with any additional information you may need to evaluate the draft report findings. We would also welcome the opportunity to meet with your staff to expand upon the comments we have made here.

Sincerely,



Larry Meierotto
Deputy Assistant Secretary -
Policy, Budget, and Administration

Attachment

SPECIFIC COMMENTS

Comments on GAO Draft Report, "A Timely Inventory of the Mineral Resources on Federal Lands is Needed to Improve National Minerals Policy and Land Use Planning," to supplement memo to AS/EM

- p. 1, p. 6. In July 1974 we began a program to systematically assess Alaska's mineral resources, not the Nation's; the conterminous U.S. program did not start until October 1977.
- p. 14, p. 16. An immediate increase from \$3 million for AMRAP and \$4 million for CUSMAP to \$24-1/2 million for the combined programs would be disastrous. We are hoping for a phased increase in the programs over the next 2 or 3 years.
- p. iv-vi. See memorandum and below for more specific comments on Chapter 3.
- p. 31, 1st paragraph. Relating a program's priority and the quality of its products is not valid. AMRAP products have not "suffered" because of the priority given to the program which, incidentally, has been very high.
- p. 34, 2nd paragraph. BLM (and FS, and others) priorities should be considered in selecting quadrangles, but they should not be the sole consideration. The program has objectives other than simply to satisfy the needs of BLM (or FS or other user).
- p. 35. Concerning geochemical data, these data will be available through a computer file as soon as the mechanism for releasing the data is available. To publish everything in hard copy would end up papering the world. Thus, we believe it would be more practical to provide this information on demand from a computer file.
- p. 35, last sentence, and top p. 36. Including information on surficial deposits is a problem and with limited manpower we cannot routinely collect surficial data on all quadrangles being studied. We are attempting to build this into the program where manpower is available to gather the information. Emphasis is being placed on those areas where information on surficial deposits is critical to assessing mineral potential.
- p. 36 & 37. We recognize that in some cases in the AMRAP program, more specialists would have been desirable, and this situation is being corrected now to the best of our limited manpower. In 1978 we are assigning the most experienced exploration geochemists and geophysicists in the Survey to work on the mineral appraisal programs, and we have hired additional geostatisticians, but clearly we need more manpower in these areas.
- p. 38. Concerning self-imposed deadlines, we recognize that some of the deadlines that were set in the AMRAP program were too short and are reconsidering them. In the CUSMAP program we do not have a standard

deadline which is applied to each area; however, we are establishing deadlines based on the evaluation by all the people concerned with a particular project. Though we recognize that deadlines can be dangerous, by the same token, we do believe that we have to establish certain deadlines for completion of the study.

- p. 38, 2nd paragraph. The statement was made, "an official further agreed that better resource estimates could be produced if the program's priority allowed it to command the services of additional scientists with special skills such as economic geologists, geostatisticians, and geophysicists." We agree with the need for additional scientists with the three skills mentioned and would add two more. The programs have a critical need for additional scientists to expand our study of processes of ore deposition and of exploration techniques of various kinds to improve our ability to evaluate mineral potential. An expansion of such studies would permit us to make better evaluations of future study areas. Finally, additional exploration geochemists are needed to adequately evaluate the geochemistry of areas in an expanded program.
- p. 41, last sentence. We believe that the establishment of priorities can be more effectively handled by coordinating and planning committees including the agencies involved rather than by an external advisory committee. This system has worked very well in establishing priorities for study of Forest Service wilderness areas.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
P.O. Box 2417
Washington, D.C. 20013

1420

APR 26 1978

Mr. Henry Eschwege, Director
Community and Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548



Dear Mr. Eschwege:

In response to your letter of February 28, here are our comments on the draft of your proposed report to the Congress, A Timely Inventory of the Mineral Resources on Federal Lands is Needed To Improve National Minerals Policy and Land Use Planning.

We do not agree that the Forest Service Land Management Planning schedule should be dictated by the availability of Geological Survey information on mineral data. Availability of the Survey data would be a great asset to the planning effort, but other conflicts and management problems may preclude waiting for up-to-date surveys. Congress has directed that the National Forest System be planned under regulations promulgated through the National Forest Management Act by 1985. It may not be feasible to complete mineral surveys in this short a time frame. As the plans are revised, new information on minerals and other resources can be brought into the process. Allocations which would affect mineral activities, such as wilderness classification, are being surveyed for minerals before classification.

Information concerning estimated cost for Forest Service planning on page 23 is not correct. The estimated cost for Forest plans is \$300,000 to \$500,000 each. The National Forest Management Act directs that these plans be revised at least every 15 years. We do not agree with GAO's conclusion concerning opportunities foregone due to lack of Geological Survey information or the substantial costs for revisions since this is the purpose of mandated 15 year revisions.

The information presented on pages 26-27 is not entirely accurate and up to date. The following language is presented for consideration in order to strengthen the text:

First paragraph. "Survey's program to provide information about the Nation's mineral resource potential is a necessary contribution to assist the Administration in formulating recommendations to the Congress and to assist Congress when it considers and decides

Mr. Henry Eschwege

2

which Federal lands should or should not be added to the National Wilderness Preservation System (NWPS). With a mineral resource assessment, Congress could fully consider mineral values to be foregone or determine necessary boundary adjustments to exclude mineralized areas."

Second paragraph. "Survey and the Bureau of Mines have an active coordinated program with other Federal Agencies to conduct mineral studies for areas designated by Congress or the Agencies for wilderness reviews. The minerals report is carefully considered in the decisionmaking process to determine resource tradeoffs and formulating recommendations for the Administration. Extreme time constraints placed by Congress for completion of wilderness studies has often placed a burden on the Survey and others to complete mandated studies and provide professional recommendations. With a limited financial base and availability of qualified personnel, priorities are necessarily adjusted often to the detriment of other studies or programs to meet the demands of Congress."

Third paragraph. "Congress has taken the initiative to designate wildernesses without complete resource data, including minerals. Since 1975, 33 National Forest units have been designated as wilderness and additions made to four designated wildernesses without benefit of adequate mineral resource studies being made. This involved about 2 million acres of Federal land. Congress has also deferred making a final decision for some areas with known mineral or energy potential."

Fourth paragraph. "Obviously, if a completed systematic mineral resource inventory of Federal lands was available, it would assist the Administration in making recommendations to Congress, and assist Congress in evaluating mineral resource values vs. wilderness resource values. Without a completed minerals inventory, and without sufficient funds, manpower, and time to prepare studies for selected areas, Congress will continue to lack sufficient minerals data when it considers potential wildernesses. GAO believes that Survey's program, if completed in a timely manner, would assist the Congress in their deliberations for establishing future wildernesses."

Suggested wording for Recommendation 3, pages v and vi:

"The Secretaries of Agriculture and the Interior should direct the Forest Service and BLM respectively to:

Mr. Henry Eschwege

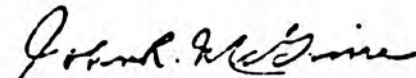
- Coordinate their land management planning schedules to the extent feasible to meet timely objectives to take advantage of minerals data available from the Geological Survey.
- Provide in their budget justification or completed land management planning those actions taken or progress achieved in their use of the mineral data provided by the Geological Survey.

There is a serious deficiency in the report. The report must recognize that because of the restrictions of the 1872 Mining Laws, the Forest Service lacks full discretion to make land management decisions. This is particularly true with respect to retention of Federal lands in public ownership, multiple use, sustained yield, and other well-established land management concepts.

We also recommend that the proposed advisory committee include a citizen environmentalist.

We are enclosing comments made by our Minerals and Geology Staff. Thank you for the opportunity to review and comment on the draft report.

Sincerely,



JOHN R. MCGUIRE
Chief

Enclosure

The following comments are offered to GAO Draft Report, dated February 26, 1978, Entitled "A Timely Inventory of the Mineral Resources on Federal Lands Is Needed To Improve National Minerals Policy and Land Use Planning"

Page v (1.) The concern is not with the formation of the committee but what Forest Service participation should be. There are two critical considerations that must be evaluated; (a) Land Management Planning Staff needs to be involved in setting priority areas; and (b) Minerals and Geology Staff involvement to assure that data supplied is in a format and of proper content to be evaluated by our resource planning teams.

Page v (3.) The concern is not with the recommendation but with follow up. The budget process is such that we need to keep very close track of this recommendation so that PD&B can be alerted at the earliest opportunity to assure that Forest Service involvement is entered into the budget process in a timely fashion.

Page 22, last sentence. "While Forest Service land management officials agreed that the information from a mineral resource inventory was useful in making sound land use decisions, they do not consider minerals important enough in relation to other land values to delay the Forest Service's scheduled land use planning efforts."

The choice of words is poor and does not reflect Forest Service policy. The following is offered as an alternative:

"While Forest Service land management officials agreed that mineral resource information is necessary in making sound land management decisions, and the importance of the mineral resource in the national society is recognized, other resource values demand that land management planning efforts continue with the most current minerals inventory data available."

The National Forest Management Act of 1976 is mentioned and the provisions of section 6(f)(4) and (5) are alluded to but the provisions for amendment and revision is not fully brought out. New inventories and/or demands could initiate an action to amend or revise an existing plan. Therefore, a mineral resource inventory can be incorporated into an existing plan or if it would significantly change existing management an amended or revised plan would be developed.

Page 24, lines 7, 8, and 9. "Lawsuits challenging mineral development from environmental groups and other interested parties could result . . ." While no specific wording change is recommended, it is suggested that it would be better to discuss that land allocations for nonmineral uses would not be reversed unless a need is identified for national security and/or economic reasons and that while environmental groups and other interested parties may be concerned, it can be reasonably expected that they would support such changes in the national interest.

PRINCIPAL OFFICIALS RESPONSIBLE FOR ADMINISTERING
ACTIVITIES DISCUSSED IN THIS REPORT

Tenure of office
From To

DEPARTMENT OF THE INTERIOR

SECRETARY OF THE INTERIOR:

Cecil D. Andrus	Jan. 1977	Present
Thomas S. Kleppe	Oct. 1975	Jan. 1977
Kent Frizzel (acting)	July 1975	Oct. 1975
Stanley K. Hathaway	June 1975	July 1975
Kent Frizzel (acting)	May 1975	June 1975
Rogers C. B. Morton	Jan. 1971	May 1975

ASSISTANT SECRETARY OF THE
INTERIOR--ENERGY AND MINERALS:

Joan M. Davenport	Apr. 1977	Present
William D. Bettenberg (acting)	Jan. 1977	Apr. 1977
William G. Fischer (acting)	Jan. 1976	Jan. 1977
Jack W. Carlson	Aug. 1974	Jan. 1976
King Mallory (acting)	May 1974	July 1974
Stephen A. Wakefield	Mar. 1973	Apr. 1974

DIRECTOR, GEOLOGICAL SURVEY:

William A. Radlinski	Jan. 1978	Present
Vincent E. McKelvey	Dec. 1971	Jan. 1978

(00856)